REPORT ON DATA FROM THE NEARSHORE SEDIMENT TRANSPORT STUDY EXPERIMENT AT TORREY PINES BEACH, CALIFORNIA, NOVEMBER -- DECEMBER 1978

Edited by C. G. Gable

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PREFACE

The NEARSHORE SEDIMENT TRANSPORT STUDY (NSTS) is a national project, sponsored by the Office of Sea Grant, Washington, D. C., with the objective of developing improved engineering prediction techniques for sediment transport by waves and currents in the nearshore region.

The NSTS Review Group, recognizing the importance of the NSTS field data to other investigators, has directed that these data be made publically available in a timely manner and that a comprehensive experiment report be prepared to describe each major field experiment. This report, edited by Mr. C. G. Gable of the Institute of Marine Resources, covers the first in a series of reports for each of the several planned experiments. This document has been prepared to provide those investigators who were not involved with the conduct of this experiment with the following information:

1) The purpose and objectives of this experiment and its relationship to the overall NSTS program.

2) Details of the physical setting for the experiment necessary to evaluate the significance of the various measurements.

3) A precise identification of the kind of measurements obtained, including duration, time, quality of data, location of instrument, calibration history, relationship to adjacent instruments, etc.

4) Sufficient information to allow the investigator to extract meaningful data from the magnetic data tapes and data tables.

5) Where and how to receive the data tapes that supplement this report as discussed in Section V.

ACKNOWLEDGMENTS

The NSTS project was sponsored by the Office of Sea Grant (OSG) under the management of Dr. N. A. Ostenso (Director of the National Sea Grant Program), Mr. A. G. Alexiou (Associate Director for Programs) and Dr. D. B. Duane (Associate Program Director for Grants Management; Program Director, NSTS). OSG is advised by the NSTS Review Group which includes: Dr. W. R. James (U. S. Geological Survey), Prof. J. C. Ludwick, Jr. (Old Dominion University), Prof. B. J. Le Mehaute (University of Miami--RSMAS), Dr. A. (NMI) Malahoff (National Ocean Survey, NOAA), Dr. A. H. Sallenger (U. S. Geological Survey), Dr. J. H. Saylor (Great Lakes Environmental Laboratory, NOAA), Mr. T. (NMI) Saville, Jr. (Coastal Engineering Research Center) and Dr. R. J. Seymour, Ex Officio (State of California and Institute of Marine Resources). The conduct of the program undertaken by the NSTS Steering Committee and directed by Dr. R. J. Seymour includes: Prof. R. G. Dean (University of Delaware), Prof. D. L. Inman (Scripps Institution of Oceanography) and Prof. E. B. Thornton (Naval Postgraduate School).

The following people contributed valuable information in the preparation of this document: Dr. J. A. Bailard, Mr. M. P. Clark, Mr. P. M. Cunningham, Dr. R. E. Flick, Mr. M. H. Freilich, Prof. R. T. Guza, Mr. D. M. Hanes, Prof. D. L. Inman, Mr. R. L. Lowe, Mr. M. D. Parker, Mr. S. S. Pawka, Mr. B. W. Waldorf and Mr. J. A. Zampol of the Shore Processes Lab, Scripps Institution of Oceanography and Dr. R. J. Seymour of the Nearshore Research Group, Institute of Marine Resources; Prof. E. B. Thornton, Naval Postgraduate School; Prof. R. W. Sternberg and Mr. J. P. Downing, University of Washington; and Prof. R. A. Dalrymple, University of Delaware.

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A. HISTORY AND OBJECTIVES OF NEARSHORE SEDIMENT TRANSPORT STUDY

1. Statement of Problem

Sandy beaches form the primary barrier against erosion by ocean waves along much of the nation's coastline. The sediment forming the beach and the nearshore ocean bottom is in almost continuous motion under the combined forces of wind, waves, and currents. The motions are complex and irregular and, at this point, poorly understood. However, accumulative effects of these motions are easily recognized. They result in damaging erosion of the beach and wave attack on the areas behind it, in accumulations or accretions of sediment where there was none before, in formation of bars offshore and at river mouths, and in the clogging of harbors and lagoons.

Man's activity in the nearshore zone has made him acutely aware of the large volumes of sand that move along the shelves and beaches under the influence of waves and currents, and that he is generally unable to predict this motion. The construction of jetties, breakwaters, and other coastal structures that block the movement of sand has resulted in changes of shoreline location and the sometimes associated serious problems involving both erosion and deposition of large quantities of sand. In general, interception of the littoral drift causes accretion of the beach updrift from the obstacle and unwanted erosion downdrift where the sand supply has been cut off. Examples of this effect are numerous and the cost of remedial action is increasing each year. Intelligent use of the coastline requires an ability to work with, rather than against, natural processes. To achieve this ability, we must greatly expand our understanding of the nearshore environment.

Simplistic theoretical models for the on-offshore and for the longshore transport of sand have been formulated and partially tested. These models show some rough agreement with field observations suggesting that they may serve as a framework around which to build a more thorough understanding. It is now clear that substantial improvement of existing transport models is going to require significant advancement through careful field research in several related aspects of nearshore processes.

The natural sediment supplies to the sandy beach coastlines of the United States are suffering ever increasing impairment by coastal urbanization, flood control measures, and delta stabilization. This is especially true on some Atlantic beaches where sediment has been largely supplied by coastal erosion and urban pressures demand stabilization of source headlands. Florida coastlines are even now suffering severe starvation by loss of the biogenous sediment source, a major component of most of that state's beaches. The coastal investment throughout the country has long ago passed the point where coastlines can be abandoned with little economic loss to the increased erosion which must follow the deprivation of natural sediment sources. There are no feasible methods for reversing the trends which have denied these sources.

The only viable solution appears to be the careful conservation of the remaining sources and the creation of new sources, largely from offshore sediment deposits. In order that the costs of such remedies remain affordable, coastal engineers must have the ability to predict the sediment demands for a particular coastline with a degree of accuracy far greater than is available today. Present rudimentary methods for predicting the performance and periodic maintenance requirements of such nourishment projects would be enhanced by accomplishment of the objectives established in this plan.

With increasing awareness of the importance of coastal zone management, forward-looking coastal states are evaluating land use criteria in which setbacks, abandonment or construction limits are to be effected in areas of intermittent or continuing coastline recession. The political and economic penalties for misjudgment here are tremendous. Effective decisions require hard quantitative answers on sediment demands. No such answers are available today.

2. Creation of the Program

In an attempt to satisfy these needs, an ad hoc group was formed at the Fifteenth Coastal Engineering Conference in Honolulu (July 1976) to plan a large scale and coordinated series of investigations leading to improved predictive models of sediment transport. Less than a year later, in April 1977, the Nearshore Sediment Transport Study was initiated under the sponsorship of the Office of Sea Grant. The program began as a focused cooperative effort among four Sea Grant universities and several government agencies. With the advent of new legislation authorizing national Sea Grant projects to meet national needs, the NSTS program was designated as the first such national program in 1978.

3. NSTS Objectives and Schedule

The overall objective is to perfect relations for the prediction of sediment transport by waves and currents in the nearshore environment. Initially, this program will deal with the problems of sediment transport along straight coastlines. Detailed studies of the mechanics of water-sediment interaction will be coordinated into a working model, and tested by two or more "large scale" field experiments along the coast of the United States.

Results of the study will provide coastal engineers with a model that will allow useful prediction of the magnitude and direction of sediment transport under waves and currents on relatively straight sections of coastlines. This model will utilize measurement schemes that provide the necessary data in a practical and economical fashion. Concurrently with the later stages of this study, the U. S. Army Corps of Engineers will be undertaking a number of regional programs of gathering coastal wave data. One of the purposes of these programs will be to provide nearshore data for sediment management. Results of the NSTS will provide direction to this program in terms of the types of measurements necessary to predict sediment transport. At the same time, the Army Corps of Engineers programs will be beginning to develop the data base necessary to apply the findings of this study. To develop a model which will have sufficiently universal applicability, it is necessary to understand the physics of sediment motions under a range of conditions. Therefore, the intermediate objectives of this program are to characterize those physical processes and parameters that have significant effects on sediment motion. Only those investigations that continue to demonstrate this significance will be pursued under the study.

The general schedule for the program is shown in Figure 1-1.

To accomplish the NSTS objectives, it was understood from the earliest planning sessions that the program must contain certain attributes which would set it apart from many prior efforts. Among the most important of these attributes are:

a) NSTS is a broad-based program with many investigators from a large number of institutions. It is an attempt to bring together many experienced researchers to plan and execute a series of major experiments which would greatly exceed the capabilities of a single investigator.

b) NSTS is a field-oriented program. Laboratory and numerical modeling are not foreseen as significant elements of the project.

c) The NSTS field experiments will measure, simultaneously, the details of both the velocity field within the surf zone and the sediment response to these velocities. This is in recognition of the fact that there are significant spatial variations in sediment transport within the nearshore regime and that the ability to understand and predict these variations is a prerequisite to developing a universally applicable engineering model.

d) The NSTS measurement program will encompass a large number of parameters that are potentially significant to a predictive model.

e) The NSTS predictive model is intended to be two-dimensional. That is, it will predict on-offshore movement as well as longshore movement of sediment.

4. Organization of the Program

Management of this technically complex program and the effective coordination of the large and diverse group of investigators required the creation of a management concept substantially different from existing Sea Grant programs. The program employs a two-tier management structure which is shown schematically in Figure 1-2. The Director of the National Sea Grant College Program has appointed an advisory group referred to as the NSTS Review Group. This group, all experienced in nearshore processes, reviews proposals and makes funding recommendations to the Director, formulates overall program direction, and reviews the progress of the investigators. A second tier group, known as the NSTS Steering Committee, is formed of the senior investigators. The chairman of this group functions as the Program Manager and is an ex officio member of the Review Group. The Steering Committee formulates the details of the project program, plans and executes cooperative field programs, and conducts workshops to promulgate the findings of the study to the coastal engineering community.

The NSTS program will have a duration of six years and is anticipated to cost more than $5 million. During this period, four major functional elements will be completed. These are:

a) The development of necessary instruments and measurement and analysis techniques;

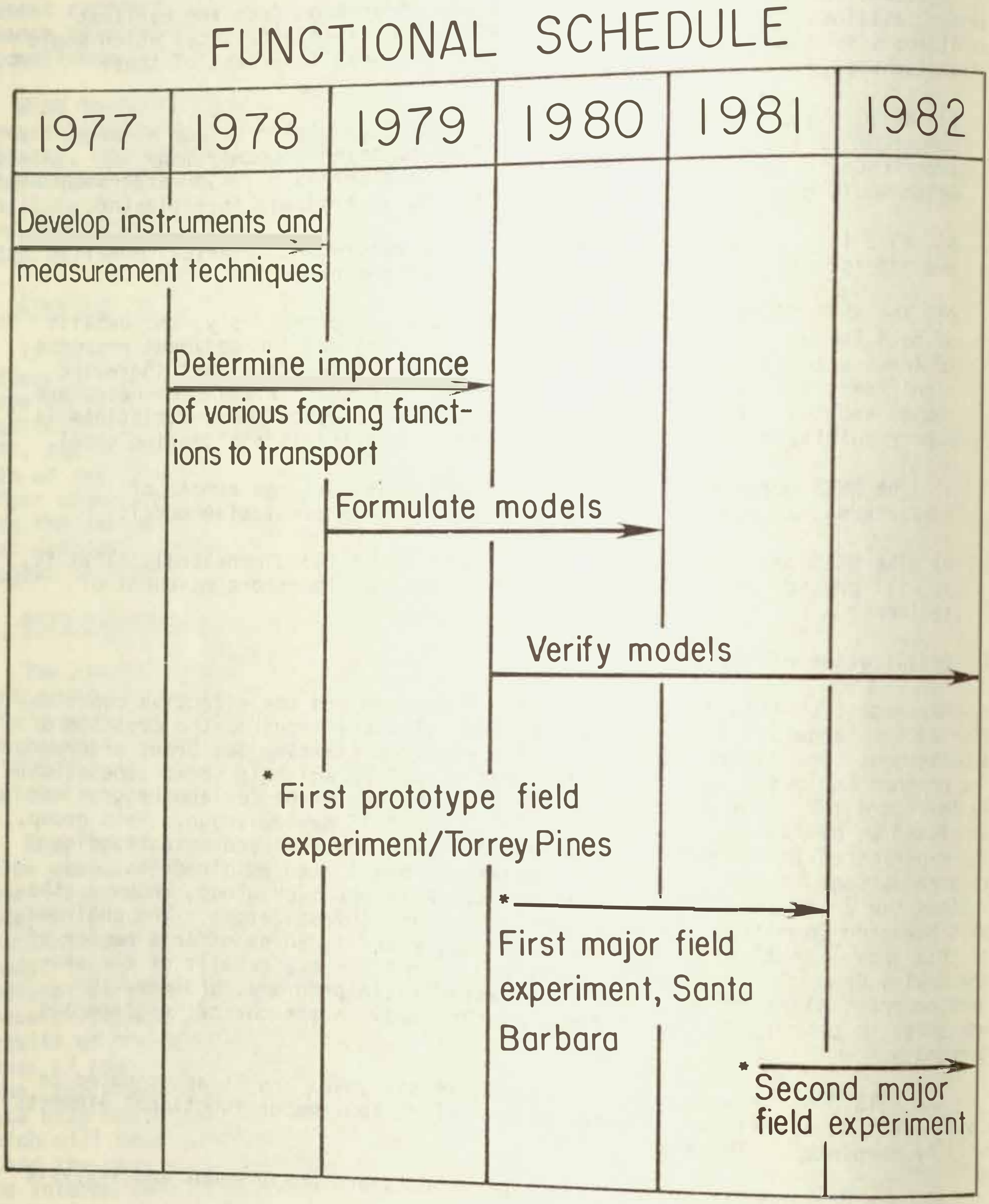

FIGURE 1-1 PROGRAM SCHEDULE

NSTS PROGRAM MANAGEMENT

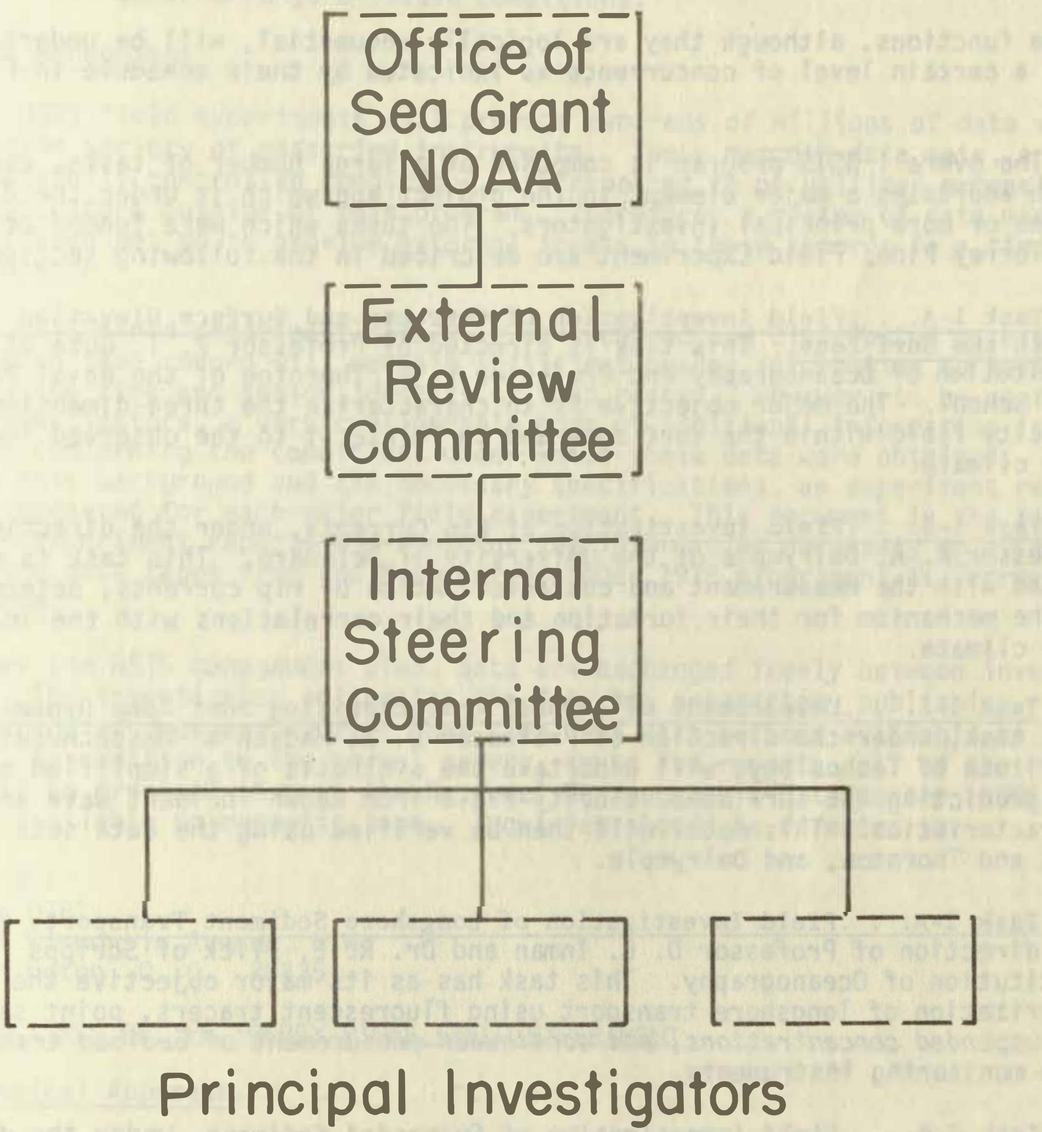

FIGURE 1-2 PROGRAM MANAGEMENT

b) The determination by field investigation of the parameters which are significant to nearshore sediment transport and the collection of sufficient data to allow characterization of these significant parameters;

c) The formulation of models to characterize the forcing and response functions and overall engineering models for predicting transport;

d) The verification of these models using field data obtained in this program.

These functions, although they are logically sequential, will be undertaken with a certain level of concurrence as indicated by their schedule in Figure 1-1.

The overall NSTS program is composed of a large number of tasks, each one of which addresses a major element in the project and which is under the direction of one or more principal investigators. The tasks which were funded prior to the Torrey Pines Field Experiment are described in the following sections.

Task 1-A. . .Field Investigation of Currents and Surface Elevation Within the Surf Zone. This task is directed by Professor R. T. Guza of Scripps Institution of Oceanography and Professor E. B. Thornton of the Naval Postgraduate School. The major objective is to characterize the three-dimensional velocity field within the surf zone and to relate it to the observed incident wave climate.

Task 1-B. . .Field Investigation of Rip Currents, under the direction of Professor R. A. Dalrymple of the University of Delaware. This task is concerned with the measurement and characterization of rip currents, determination of the mechanism for their formation and their correlations with the incident wave climate.

Task 1-E. . .Development of a Model Characterizing Surf Zone Dynamics. This task, under the direction of Professor O. S. Madsen of Massachusetts Institute of Technology, will undertake the synthesis of a simplified model for predicting the surf zone velocity field from known incident wave and wind characteristics. This model will then be verified using the data sets from Guza and Thornton, and Dalrymple.

Task 2-A. . .Field Investigation of Longshore Sediment Transport, under the direction of Professor D. L. Inman and Dr. R. E. Flick of Scripps Institution of Oceanography. This task has as its major objective the characterization of longshore transport using fluorescent tracers, point samplers of suspended concentrations, and continuous measurement of bedload transport with monitoring instruments.

Task 2-B. . .Field Investigation of Suspended Sediment, under the direction of Professor R. W. Sternberg of the University of Washington. This is a complementary project to the Inman and Flick task and is concerned with the development and deployment of monitoring instruments to obtain continuous measurements of suspended sediment concentrations.

Task 3-A. . .Field Investigation of On-Offshore Transport, under the direction of Dr. R. J. Seymour of the Institute of Marine Resources. This task is concerned with the characterization of on-offshore transport by means of precision profiling.

Task 4-A. . .Evaluation of Candidate Experimental Sites, under the direction of Professor R. G. Dean of the University of Delaware. This task is concerned with identifying and ranking potential sites along the United States coastlines for large-scale field experiments with the objective of testing the working model under a range of field conditions.

5. Data Management

The NSTS field experiments will produce hundreds of millions of data values from a wide variety of measuring instruments. These mammoth data sets, acquired under carefully controlled conditions, are expected to be utilized extensively by investigators outside of this program. Therefore, a system of data management has been set up to provide external access to these records in a timely and useful manner.

All NSTS field experiment data will be archived and distributed on magnetic tape. Each tape record will contain sufficient header information to positively identify the time and sensor identity of that record. However, to be useful to other investigators, a very considerable body of additional information is required concerning the conditions under which these data were obtained. To provide this background and the necessary specifications, an experiment report will be prepared for each major field experiment. This document is the first of these experiment reports and contains the information necessary to effectively use the data tapes from the November-December 1978 experiment at Torrey Pines, California.

Under the NSTS management plan, data are exchanged freely between investigators. The investigator collecting the data has proprietary publishing rights for a period of one year. After that time, all data becomes available to the public. In addition to the normal papers, texts and reports, all of the raw data will be archived through the National Oceanographic Data Center (NODC) and will be available on magnetic tape. Inquiries should be directed to:

N O D C
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2001 Wisconsin Avenue, N.W.
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B. OBJECTIVES OF THE TORREY PINES FIELD EXPERIMENT

1. Technical Approach

The major emphasis in the Torrey Pines Field Experiment was on the characterization of the nearshore velocity field in relationship to the incident wave field. This was to be accomplished through the deployment of large numbers of two-axis current meters across the surf zone. The wave field outside the surf zone was to be defined by a linear directional array of pressure sensors.

Additional single pressure sensors and wave staffs were deployed across the surf zone. The tide range at Torrey Pines is sufficiently large (2.3 meters) and the bottom slope sufficiently small so that large horizontal excursions of the surf zone occur. This allows for a smaller number of instruments to span the entire surf zone, but precludes simultaneous measurements in all regimes.

The second major objective was to obtain measurements of longshore transport rates by means of tracer studies and of on-offshore transport by means of profile analysis.

A final objective was to evaluate promising techniques for continuous point measurements of suspended sediment and bedload transport concurrently with the measurement of the local velocity field.

2. Significance of This Experiment to the NSTS Program

The verification of useful sediment transport relationships requires a number of carefully recorded data sets obtained under a wide variety of beach slopes, sand sizes, and wave and current regimes. Torrey Pines Beach provides a setting in which waves are quite large and of long period, nearshore contours are rather straight and parallel, and sediment size is moderate and uniform. The data set obtained forms an important part of that needed to provide a means of verifying transport models developed later in the program.

In addition, as the first major field experiment under NSTS, it provided a testing ground for coordinated planning as well as measurement and analysis techniques which will be used in future field experiments.

Perhaps of greatest significance, it provided an early and comprehensive look at the character of the nearshore velocity field which is the driving force for all nearshore transport. These data will provide the direction for the creation of new transport relationships based upon a more thorough understanding of the physics of the surf zone.

II. Experiment Setting

A. SITE SELECTION

The Torrey Pines Beach area was selected for the first NSTS field experiment based on the following favorable criteria:

1) Straight coastline;

2) Uncomplicated gently sloping offshore bathymetry (which avoids complicated wave refraction effects);

3) Exposure to several wave generating regions;

4) Beach texture of predominantly fine quartz sand;

5) Readily accessible by land and by boat from the instrumentation laboratory and launching facilities at Scripps (which simplified the overall logistics of the experiment in terms of instrument repair and manpower).

B. GEOGRAPHIC LOCATION OF TORREY PINES EXPERIMENT

Torrey Pines Beach is located in San Diego County approximately 3.2 Km north of Scripps Institution of Oceanography. A location map is provided in Figure 2-1. The study area consists of gently sloping offshore bathymetry and a straight fine-grained sand beach which starts at the base of a 91-meter high sea cliff. The central network of instrumentation was located approximately 200 meters north of the mouth of Indian Canyon which is an intermittent stream channel. The beach is exposed to several wave generating regions in the North and South Pacific, although the offshore Channel Islands do shelter the study site from waves propagating from certain sectors as shown in Figure 2-6 of Section 2 of this report.

C. GEOLOGIC AND COASTAL PROCESSES

Torrey Pines Beach is at the southern end of a littoral cell that extends northward 82 Km to Dana Point. Sand is supplied to this cell by streams entering the ocean along this stretch of coastline and from minor cliff erosion [State of California, 1969]. Waves cause a net longshore transport of sand to the south through the littoral cell to Scripps Submarine Canyon which is located 2.8 Km south of the study site. Chamberlain [1960] and State of California [1969] have estimated the net littoral transport in the vicinity of Torrey Pines Beach at about 2 x 10^5 m^3/yr. Once in Scripps Canyon, the sand is periodically transported by strong currents from the nearshore zone through the Canyon into deep water [Nordstrom and Inman, 1975]. The beach is approximately 61 meters wide and consists of fine to very fine well sorted quartz sand with minor amounts of feldspars and heavy minerals. Light minerals such as quartz and feldspars and shell fragments comprise 90% of a sample, while heavy minerals such as hornblende and biotite total about 10% [Inman, 1953].

Torrey Pines Beach is backed by steep sea cliffs which rise to heights of 107 meters. Whitaker [1960] reported that the Torrey Pines Cliffs are called

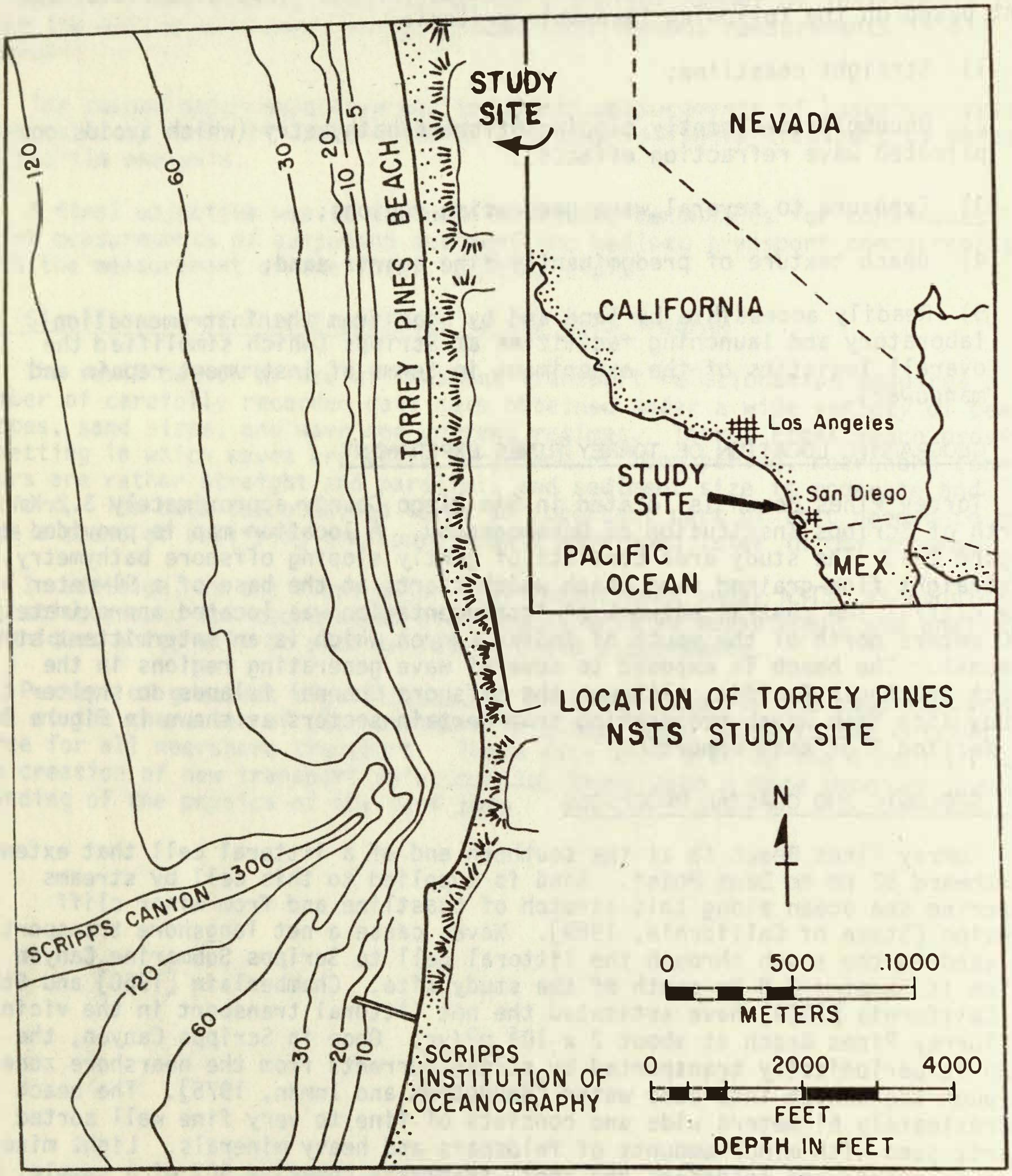


Figure 2-1 EXPERIMENT LOCATION MAP

the Torrey and Delmar Formations and are part of a thick sequence of marine sediments that were deposited during Tertiary and Quaternary periods. The geologic history of the region has been dominated by a series of marine inundations since pre-Tertiary times. The Delmar Formation is composed predominately of greenish siltstones and some sandstones, shales, and limestones located in the lower half of the cliff. The Torrey Sandstone outcrops in the upper steep portion of the cliff and is composed of clean, moderately well rounded grains of quartz and feldspars. The Torrey Formation is white to buff except for some areas where it appears a light rust color because of staining from the red Lindavista Formation terrace material above it. The Lindavista Formation consists of boulders, gravels, and sands cemented together by iron oxide [Whitaker, 1964]. The Torrey Pines Cliffs are interrupted occasionally by canyons and intermittent streams. The prominent Indian Canyon cuts through the cliffs to the beach at the study site.

Figure 2-2 presents a block diagram of a portion of Western San Diego County. Cross sections of the geologic structure of the Torrey Pines area are provided in Figures 2-3 through 2-5.

D. HISTORICAL WAVE CLIMATE AT TORREY PINES BEACH

From February 1973 to May 1974, wave records were taken four times daily using a line array of four pressure sensors which roughly paralleled the coastline at a depth of ten meters [Pawka, et al., 1976]. This data was used for the estimation of frequency and directional spectra for waves with periods 4 to 20 seconds. This period range includes nearly all the wind generated wave energy incident to the coast at Torrey Pines Beach.

It was reported by Pawka [1976] that the location and intensity of wave generating storms are important in determining the nature of the swell which approaches the area. The blocking effect of the continental land mass and offshore islands causes Torrey Pines Beach to be shadowed from waves from certain sectors. A rough approximation of the shadowing effects, not taking into consideration diffraction or refraction effects, is shown in Figure 2-6. Refraction over the shoals in the island region significantly affects this simple shadowing representation by smoothing the edges of the shadows.

The results of the wave climate study were grouped in terms of the four seasons. Pawka [1976] reports that the frequency spectra of summer waves (June, July, August) have a characteristic bimodal form. The lower frequency peak is relatively narrow (0.04 Hz width) and the peak period is between 12 to 17 seconds and is well directed from the south. Point La Jolla refracts most of the southern swell energy to angles of 225° to 245° true just offshore of the study site. The low frequency peak energy is usually between 20 to 200 cm^2 with a mean energy of 100 cm^2. The broader high frequency peak (0.1 Hz width) has a peak period between 6 to 10 seconds and is generally less well directed from the north. The offshore islands limit the fetch for certain directional sectors and thus cause a multi-modal directional spectrum for locally generated waves. The energy of the high frequency peaks varied from 30 to 500 cm^2 with a mean of 170 cm^2.

The wave climate of the fall months (September, October, November) is very similar to that of the summer with the addition of a long period (12 to

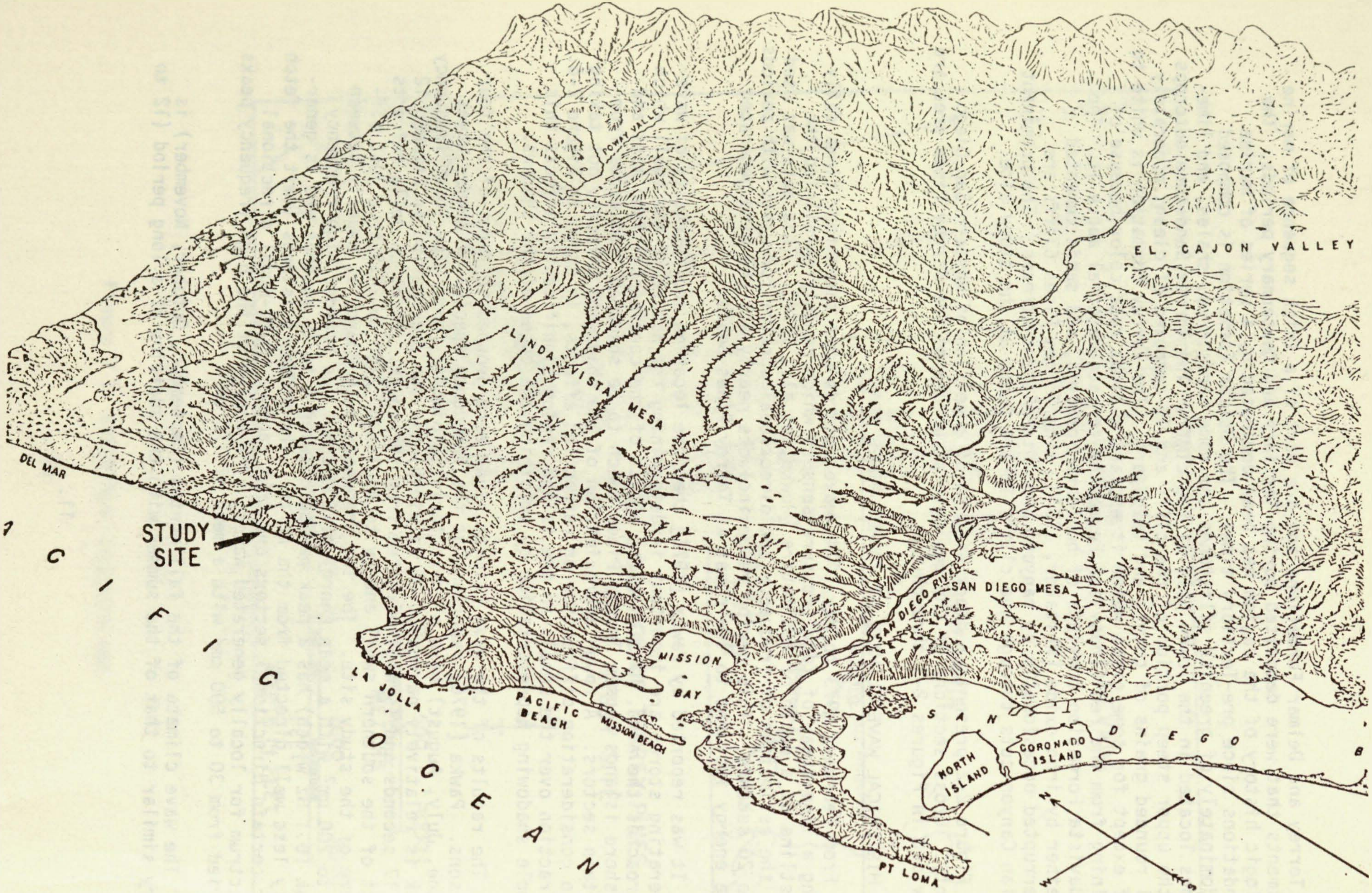


FIGURE 2-2 PHYSIOGRAPHIC BLOCK DIAGRAM OF A PORTION OF WESTERN SAN DIEGO COUNTY (AFTER HERTLEIN AND GRANT, 1944)

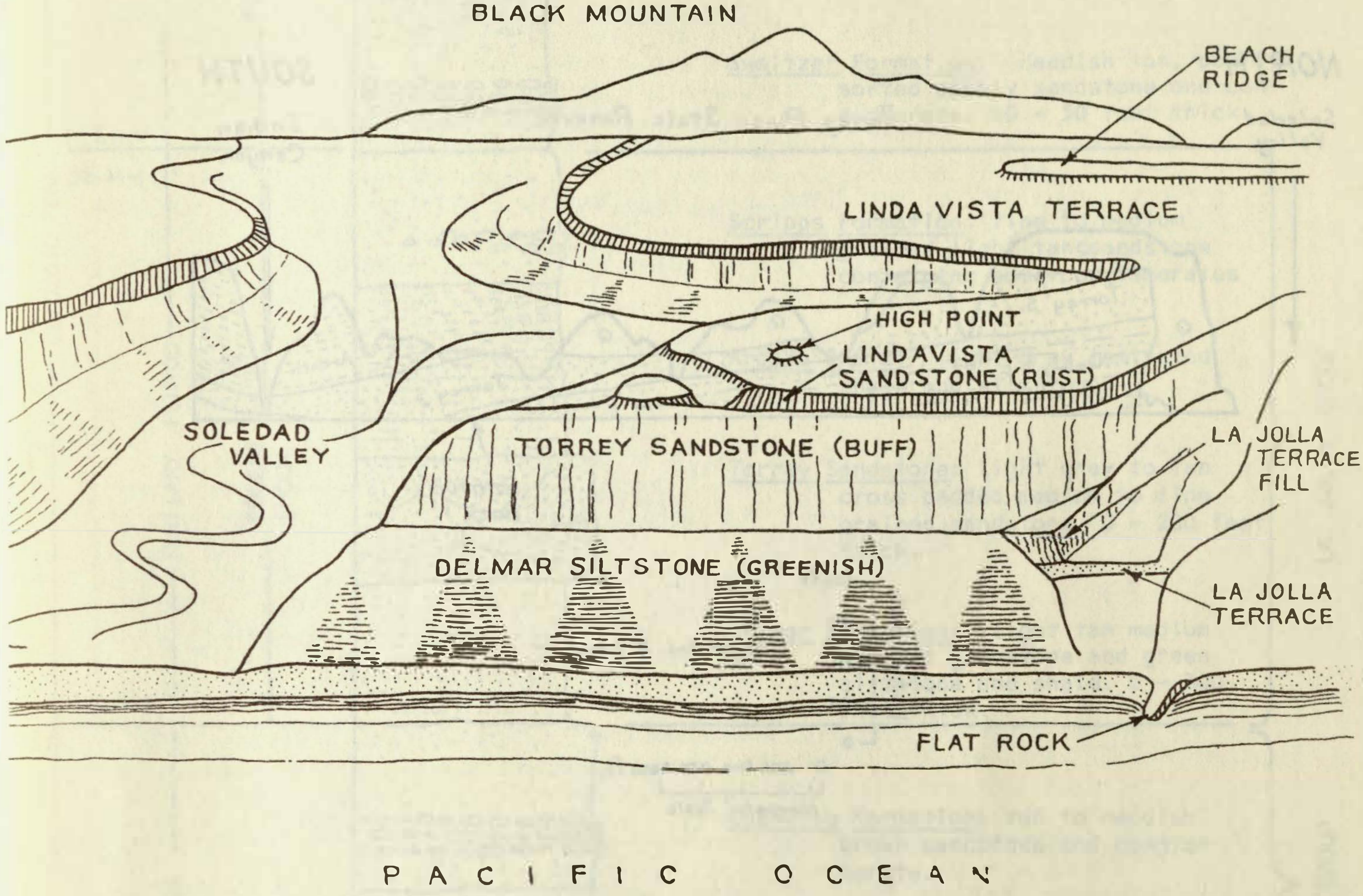


Figure 2-3 Geologic Structure [Inman and Flick]

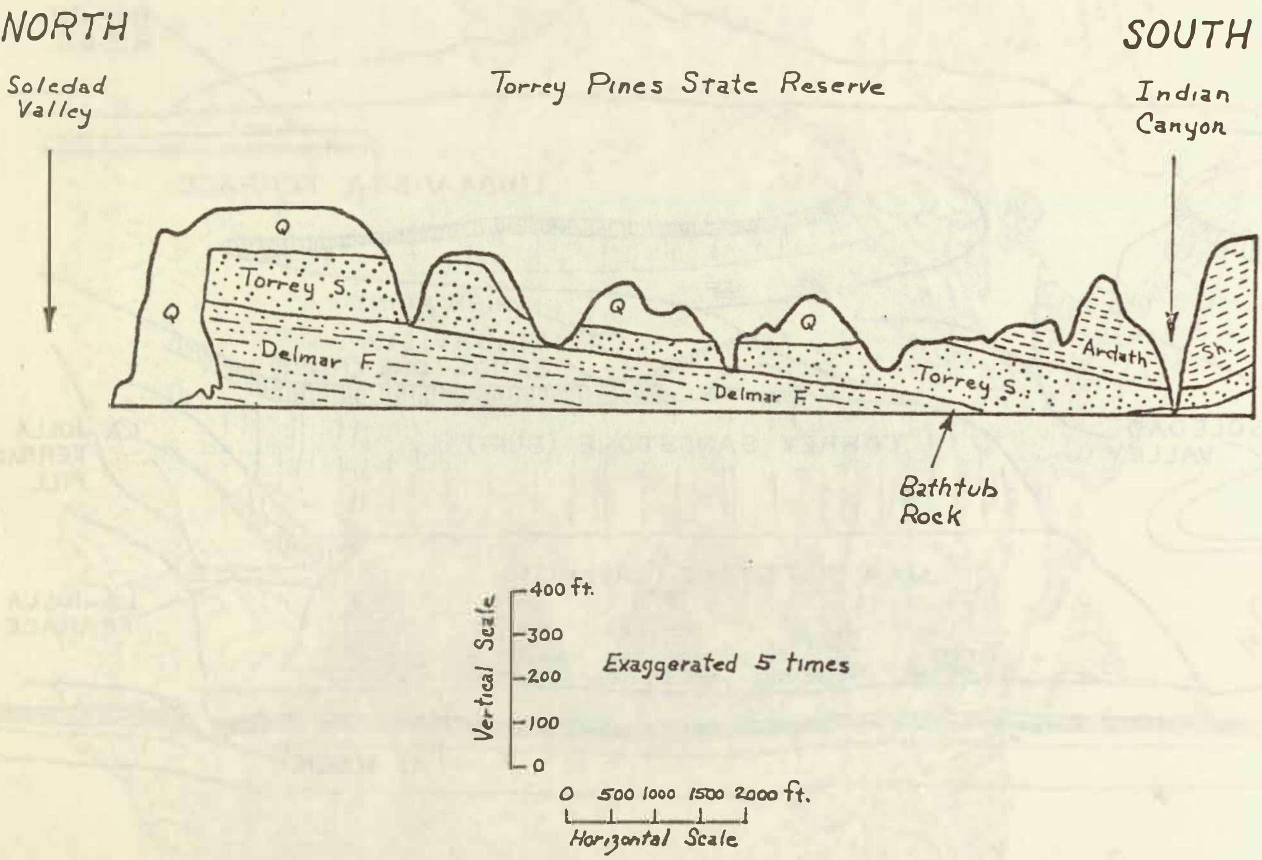


Figure 2-4.

Geologic section exposed in the sea cliffs at Torrey Pines State Reserve [Inman and Flick]

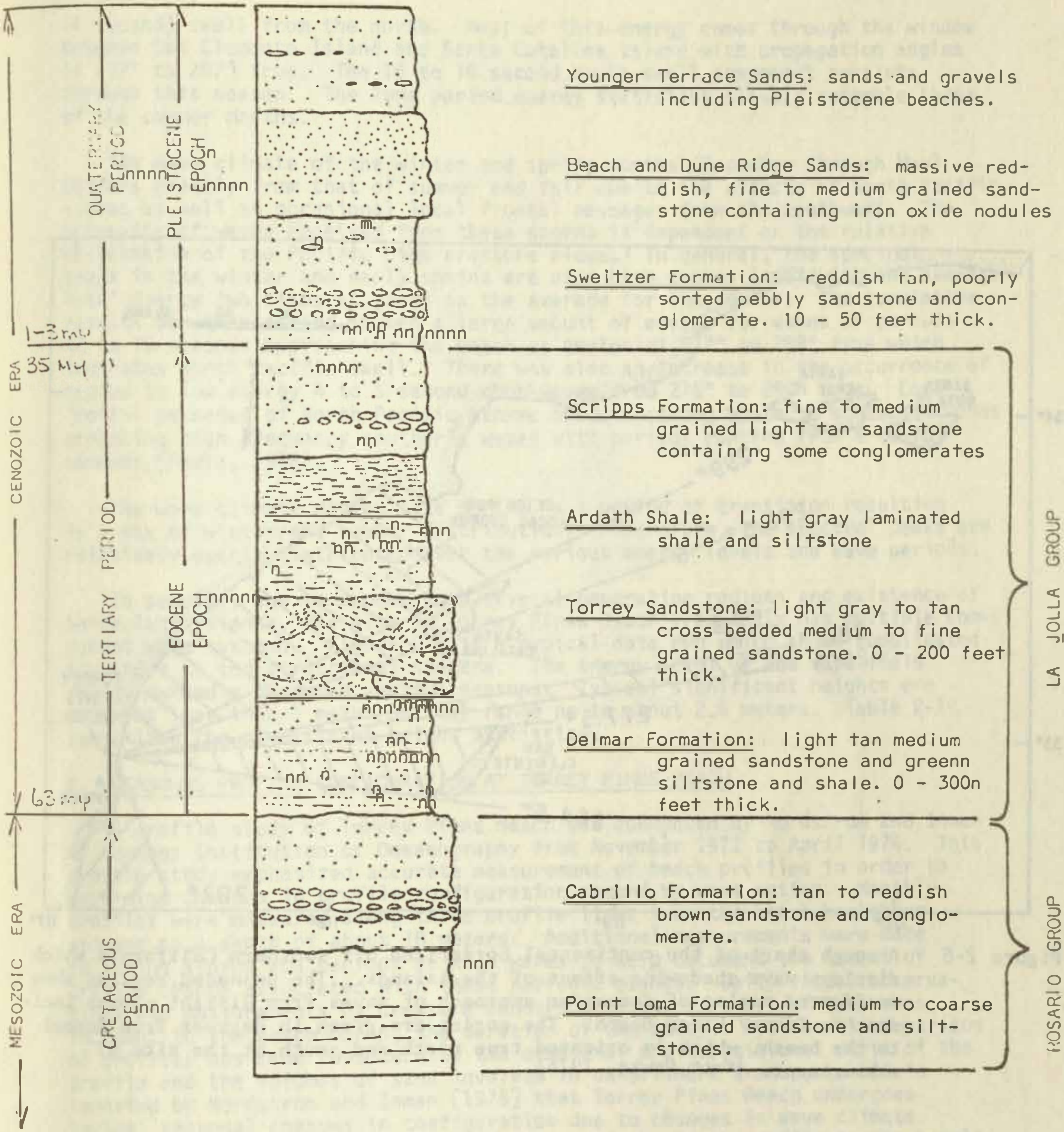


Figure 2-5

Simplified Columnar Section for the Torrey Pines - La Jolla Sea Cliffs [Inman and Flick]

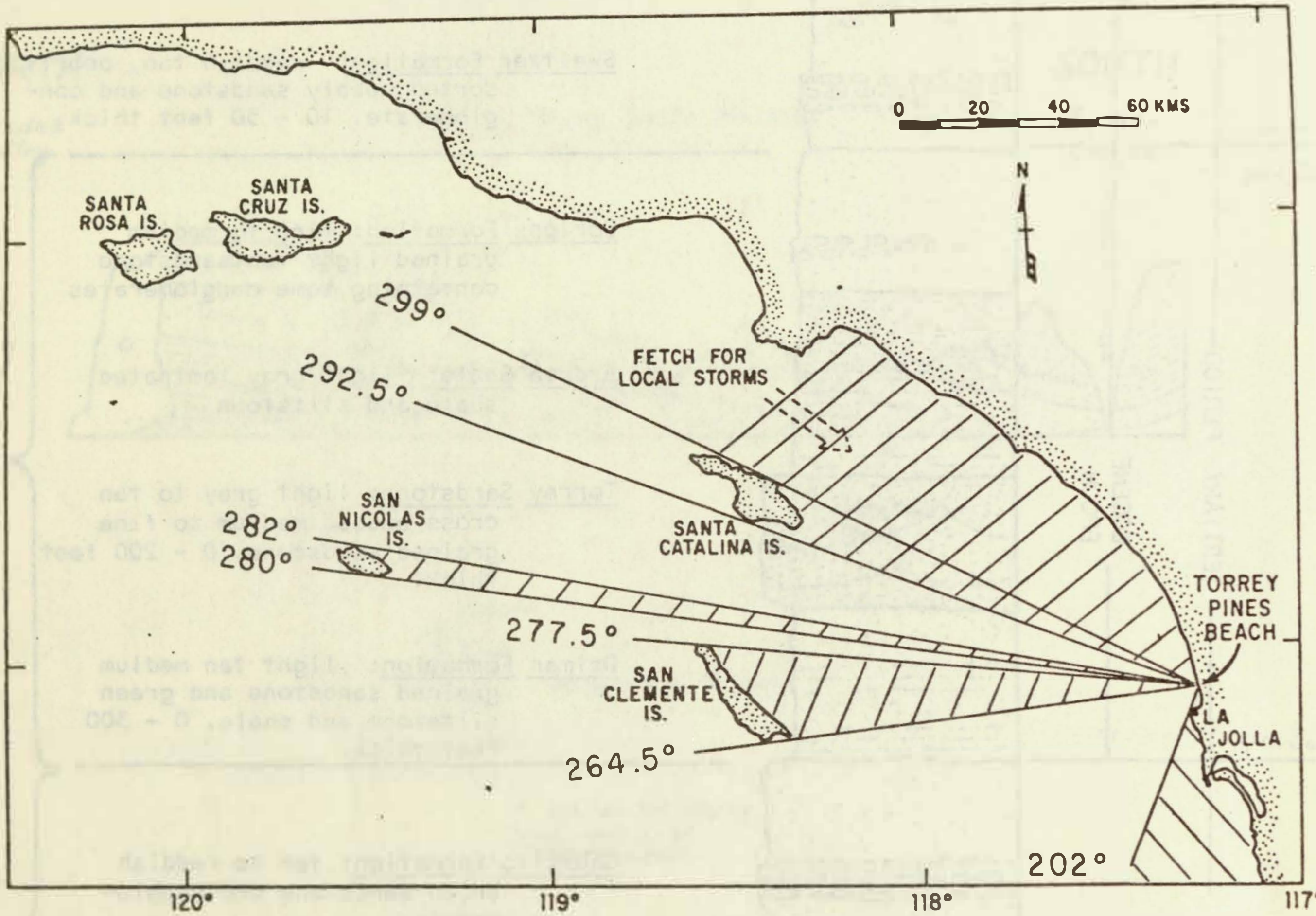


Figure 2-6 A rough chart of the continental borderland off southern California which displays wave shadowing effect of the islands. The unshaded regions show unaffected angles of deepwater approach of waves from distant storms incident to Torrey Pines Beach. The angles are given in degrees from normal to the beach, which is oriented true north and south at the site of measurement. [from Pawka, 1976]

14 second) swell from the north. Most of this energy comes through the window between San Clemente Island and Santa Catalina Island with propagation angles of 277° to 287° true. The 16 to 18 second south swell component persists through this season. The long period energy statistics closely resemble those of the summer months.

The wave climate of the winter and spring months (December through May) differs greatly from that of summer and fall due to the effects of North Pacific storms as well as occasional local frontal passages from the southwest. The intensity of waves received from these storms is dependent on the relative orientation of the Pacific high pressure ridge. In general, the spectral peaks in the winter and early spring are of a high energy level with the average total energy two times as great as the average for the summer. The cumulative results for this period showed a large amount of energy for waves of periods 12 to 15 seconds approaching the beach at angles of 277° to 288° true which indicates North Pacific swell. There was also an increase in the occurrence of medium to low energy 4 to 5 second chop waves from 275° to 290° true. Local frontal passages of North Pacific storms produce strong south to southwest winds producing high frequency southerly waves with periods ranging from 5 to 10 seconds [Pawka, 1976].

The wave climate during late spring is a period of transition resulting in a mix of winter and summer distributions. Therefore, the spectral peaks are relatively evenly distributed over the various energy levels and wave periods.

In summary, due to exposure to several generation regions and existence of borderland islands, the site at Torrey Pines Beach frequently has multiple component wave systems. Figure 2-7 is a typical data run which shows complicated structure to the directional spectra. The energy level of the wave field varies markedly over the various seasons. Typical significant heights are somewhat less than 1 meter but may range up to about 2.5 meters. Table 2-1 summarizes the significant height statistics.

E. SEASONAL PROFILE CONFIGURATION AT TORREY PINES BEACH

A profile study of Torrey Pines Beach was conducted by Nordstrom and Inman of Scripps Institution of Oceanography from November 1972 to April 1974. This profile study emphasized accurate measurement of beach profiles in order to determine changes in profile configuration caused by wave action. Monthly profiles were measured along three profile lines from the beach backshore seaward to a depth of about 18 meters. Additional measurements were made following storms and periods of high waves to help document the extent of profile change associated with these periodic events. Daily visual observations and measurements by pressure sensors provided a record of the waves incident to the beach during the duration of the study. A seasonal comparison of profiles was made to determine the erosional and depositional parts of the profile and the volumes of sand involved in on-offshore transport. It is reported by Nordstrom and Inman [1975] that Torrey Pines Beach undergoes typical seasonal changes in configuration due to changes in wave climate. During summer wave conditions the formation of the beach profile is the result of a progressive onshore migration of sand from depths less than 10 meters which accretes on the beach face. A berm crest is also developed by the progressive accretion of sand starting as a bar at depths of -1 meter.

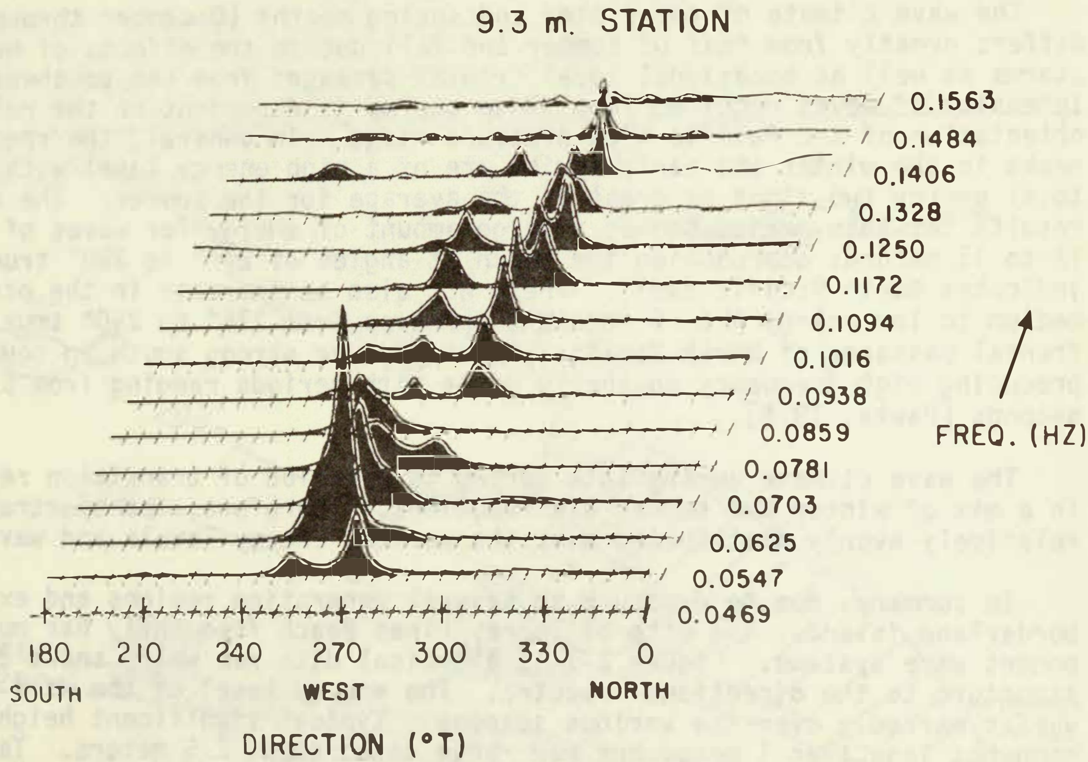


FIGURE 2-7 TYPICAL DIRECTIONAL SPECTRUM

for a day in June 1977
obtained from a five-element
linear array at a depth of 9.3m
at Torrey Pines Beach, Calif.

TABLE 2-1

PROBABILITY OF OCCURRENCE OF
H 1/3 (SIGNIFICANT HEIGHT) AT TORREY PINES BEACH
FOR THE PERIOD FEBRUARY 1973 TO MAY 1974

H 1/3 (M)	P(H 1/3≥H)			
	(400 RUNS) WINTER (DEC-JAN-FEB)	(424 RUNS) SPRING (MAR-APR-MAY)	(450 RUNS) SUMMER (JUN-JUL-AUG)	(375 RUNS) FALL (SEPT-OCT-NOV)
.05			100.0	100.0
.1			93.6	81.5
.2		100.0	54.6	51.7
.3		99.1	30.0	37.3
.4	100.0	95.3	13.1	27.4
.5	97.0	88.9	6.3	17.8
.6	87.8	76.2	4.8	16.0
.7	76.0	56.6	3.0	11.4
.8	63.0	40.6	2.1	8.0
.9	50.5	33.2	1.2	5.0
1.0	38.5	24.8	.8	3.6
1.1	27.0	18.6	.5	2.7
1.2	15.5	15.3	.4	1.5
1.3	11.5	13.0	.2	1.5
1.4	9.0	9.9	.2	.3
1.5	6.3	7.5	.2	0.0
1.6	3.8	5.2	.2	
1.7	2.3	4.0	.2	
1.8	1.3	3.3	.2	
1.9	1.0	1.2	.2	
2.0	.8	.5	0.0	
2.1	.8	0.0		
2.2	.3			
2.3	.3			
2.4	0.0			

The summer profile is fully developed when the foreshore is relatively steep, the berm crest furthest seaward, and the backshore relatively wide (30 to 60 meters).

The occurrence of winter storm waves and high tides overtop the summer berm and erode the foreshore and backshore, reducing the width of exposed beach. The eroded sand is transported offshore and deposited in depths of -3 to -9 meters. The winter beach profile is typified by a gently sloping foreshore that occasionally extends as far back as the toe of the sea cliff. There were no recorded sand level changes at depths greater than -13.7 meters. Figures 2-8a and 2-8b show the summer and winter profile configurations for the Torrey Pines Beach -- North Range area for 1972-73 and 1973-74. These profiles were measured approximately 442 meters north of the NSTS Torrey Pines Experiment site. The seasonal profile data indicate a general trend of a decrease in magnitude of sand level changes with increase in water depth.

F. CLIMATE AND WEATHER

The climate in the San Diego area is mild and semi-arid. The dominating factor in the weather for San Diego is the semi-permanent high pressure ridge of the Northeast Pacific Ocean. This pressure center migrates northward in summer, deflecting storm tracks from the Gulf of Alaska well to the north. Occasionally, however, moist air associated with chubascos drifts northward during the summer from the Gulf of Mexico or the Gulf of California.

In winter, the Pacific high decreases in intensity and retreats southward permitting storm centers from the Gulf of Alaska to swing into and across Southern California. These are the storms that bring widespread, moderate precipitation and stormy conditions. When changes in the circulation pattern permit storm centers to approach the California coast from a southwesterly direction, large amounts of moisture are carried by the northeastward streaming air. San Diego seldom receives the main frontal activity or vortex flow of these winter storms, but normally short pulses of trailing instabilities associated with the passage of a cyclonic front.

The average annual range in wind speeds for San Diego is 4 to 30 knots with a predominant direction from the northwest. High wind speeds are associated with postfrontal activity. The mean annual temperature range in San Diego is 12.7° to 20.4° C with the annual mean temperature of 16.5° C. The mean annual precipitation is 24.6 cm. [Elford, 1970 and NOAA National Climatic Center, 1977]

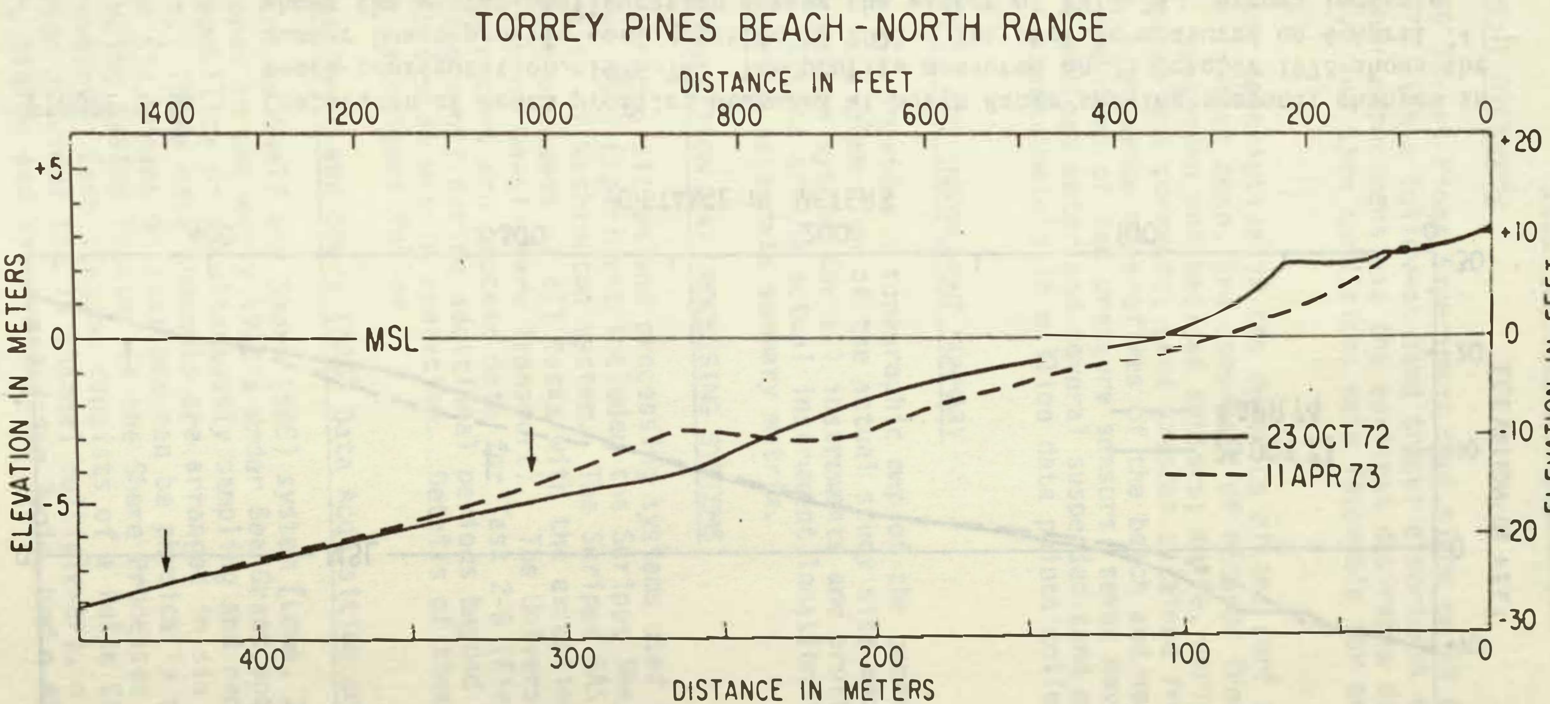


FIGURE 2-8a. Comparison of beach profiles measured at North Range showing seasonal changes in beach configuration 1972-73. The profile measured on 23 October 1972 shows the summer beach profile configuration in 1972. The profile measured on 11 April 1973 shows the winter configuration during the winter of 1972-73. Arrows indicate the positions of reference rod stations. [Nordstrom and Inman, 1975]

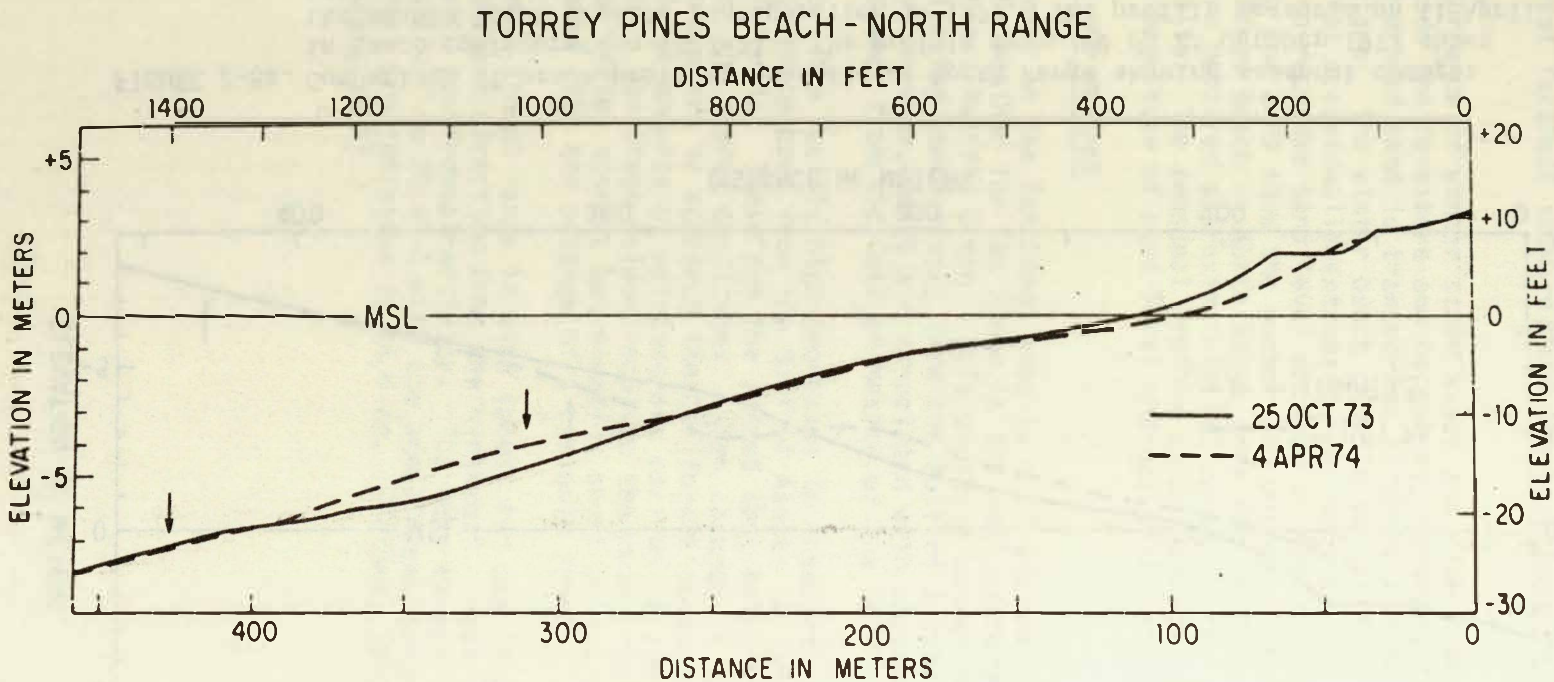


FIGURE 2-8b. Comparison of beach profiles measured at North Range showing seasonal changes in beach configuration, 1973-74. The profile measured on 25 October 1973 shows the summer beach profile configuration in 1973. The profile measured on 4 April 74 shows the winter configuration during the winter of 1973-74. Arrows indicate the positions of reference rod stations. [Nordstrom and Inman, 1975]

III. Experiment Description

A. EXPERIMENT OVERVIEW

The NSTS Torrey Pines Experiment took place on 19 days from 4 through 24 November 1978 with a follow-on sand tracer experiment on 6 December 1978. The 6 December experiment was the earliest desirable day after 24 November when the wave and tide conditions were favorable for another sand tracer experiment.

The data, descriptive of the dynamics of the surf zone and the movement of sediment in that zone, are comprised of records from current meters and wave gages; suspended and bedload sensors; movie, aerial, and still photographs of waves and currents; sand samples obtained from three tracer experiments; and, a sequence of profiles of the beach and nearshore. The instrument array was comprised of ten pressure sensors, seven wavestaffs, 22 current meters, one bedload meter and several suspended sand meters, which aggregated a record of approximately 16 million data points collected over a span of three weeks.

B. EXPERIMENT AND INSTRUMENT SUMMARY

Figure 3-1 provides a topographic map of the general experiment area. Figure 3-2 is a plan view of the actual study site and the Cartesian coordinate grid location system for all instruments and profile ranges. Table 3-1 provides a listing of the actual instrument location in Cartesian coordinates. Table 3-2 serves as a data summary matrix.

C. DATA ACQUISITION AND PROCESSING SYSTEMS

The data acquisition and processing systems used for the November 1978 Torrey Pines NSTS Experiment included the Scripps Shelf and Shore system and the University of Washington system. The Scripps SAS system supported the data acquisition needs of all tasks with the exception of Task 3-A(Field Investigation of On-offshore Transport). The University of Washington system was used to record and process data for Task 2-B (Field Investigation of Suspended Sediment) during additional periods beyond those in which the Scripps SAS system was in operation. Details of these systems and data processing techniques follow.

1. Scripps Shelf and Shore (SAS) Data Acquisition and Processing System

The Scripps Shelf and Shore (SAS) system [Lowe, Inman and Brush, 1973] was developed in the early 1970's under Sea Grant sponsorship. This system has the capability of simultaneously sampling and recording data from up to 90 sensors. These data channels are arranged in six groups of 15 channels each. The six groups or stations can be physically separated and are linked to a recording system located in the Shore Processes Lab (SPL) at Scripps via radio-telemetry. Each station consists of a Pulse Code Modulation (PCM) encoder (which provides the 15 channel multiplexer), a 12 bit analog to digital converter, timing and synchronization logic, and a RF transmitter.

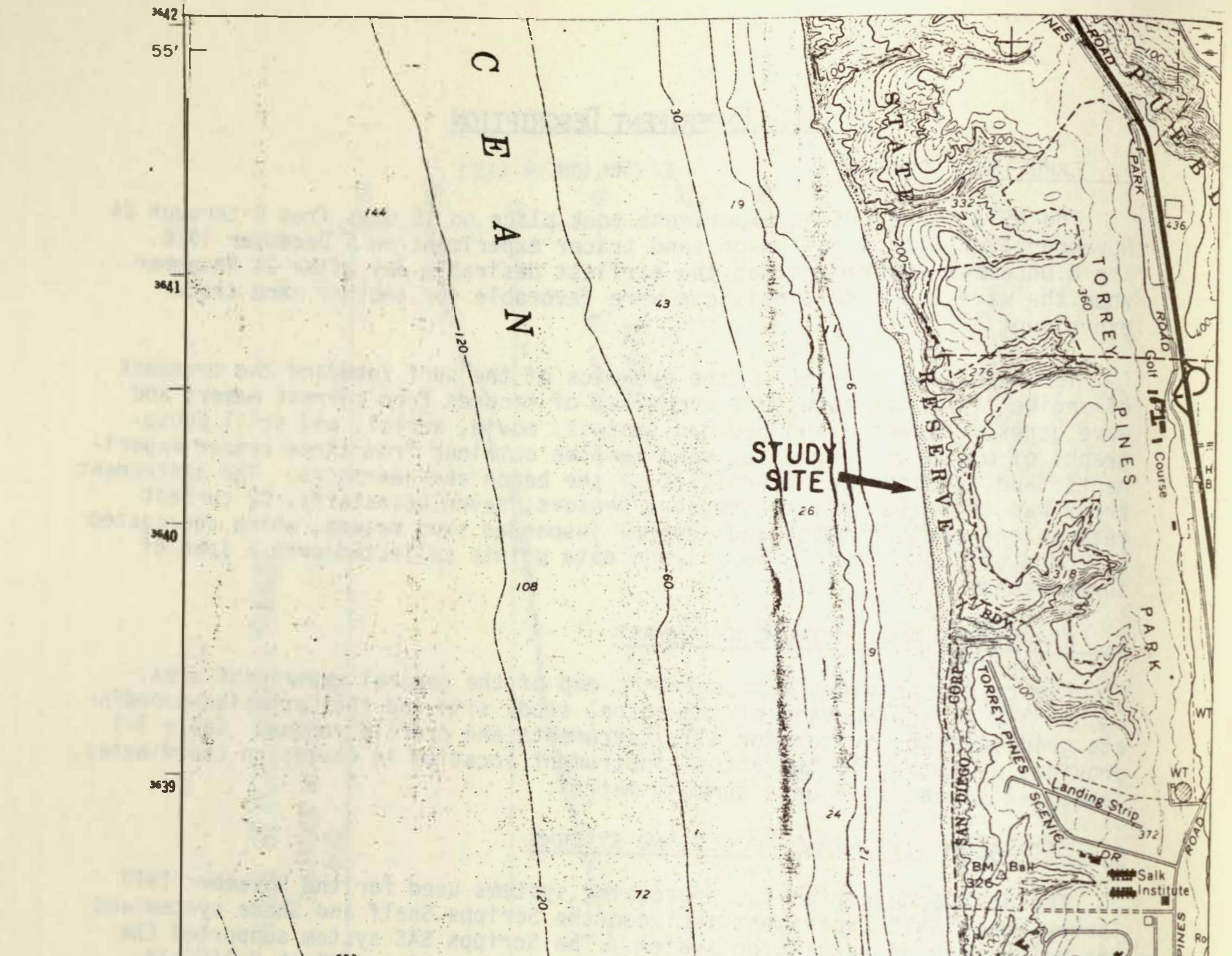


Figure 3-1 TOPOGRAPHIC MAP

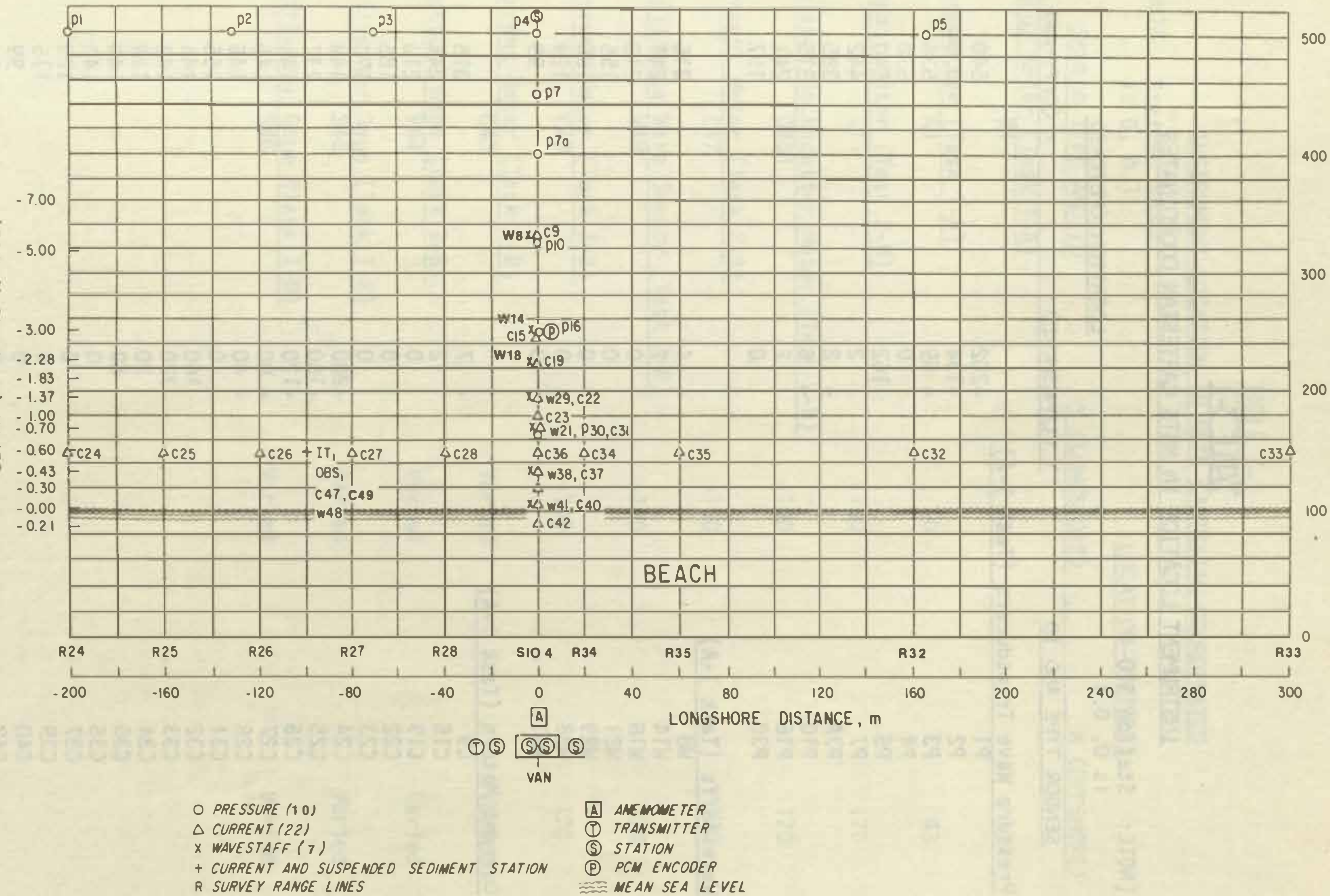


Figure 3-2 Experiment and Instrument Plan View

TABLE 3-1

INSTRUMENT LOCATION IN NSTS CARTESIAN COORDINATES

[NOTE: Station SIO-4 is 0, 0.]

SENSOR TYPE AND ID	LOCATION (METERS) Y (LONGSHORE)	X (OFFSHORE)
Pressure Wave Transducers (Task 1-A)		
P1	-202	540
P2	-134	539
P3	- 69	538
P4	0	538
P5	162	540
P7	2	442
P7A	- 2	385
P10	- 6	315
P16	2	241
P30	0	157
Wavestaffs (Task 1-A)		
W8	- 4	315
W14	2	241
W18	0	210
W21	0	155
W29	0	185
W38	0	129
W41	0	99
Current Meters (Task 1-A)		
C9	- 7	315
C15	2	241
C19	0	210
C22	0	185
C23	0	170
C24	-200	148
C25	-160	137
C26	-120	141
C27	- 80	145
C28	- 40	146
C31	0	155
C32	160	144
C33	320	143
C34	20	139
C35	60	149
C36	0	143
C37	0	129
C39	0	115
C40	0	99
C42	0	85

TABLE 3-1

INSTRUMENT LOCATION IN NSTS CARTESIAN COORDINATES

[NOTE: Station SIO-4 is 0, 0.]

SENSOR TYPE AND ID	LOCATION (METERS) Y (LONGSHORE)	X (OFFSHORE)
Runup Meter (Task 1-A) R1	0	17
Anemometer (Task 1-A) A1	0	43
Impact Meter (Task 2-B) IT1	-100	170
Optical Backscatter Meter (Task 2-B) OBS1	-100	170
Current Meter (Task 2-B) C47	-100	170
Resistence Wave Sensor (Task 2-B) W48	-100	170
Current Meter (Task 2-B) C49	-100	170
Current Meter (Task 1-B) C43	Varied	Varied
Pressure Gage (Task 1-B) P44	Varied	Varied
Stillwater Gage (Task 1-B) S45	Varied	Varied
Stillwater Gage (Task 1-B) S46	Varied	Varied

TABLE 3-2 DATA SUMMARY INDEX

	27	29	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	6
	Oct. 1978														Nov. 1978										Dec. 1978
TASK 1-A SURF ZONE DYNAMICS																									
Pressure Wave Sensors				X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Wave Staff Sensors				X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
E.M. Current Meters				X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Runup Meter						X	X			X		X		X	X		X	X	X		X	X			
TASK 1-B RIP CURRENTS																									
Portable Current Meter & Pressure Sensor							X	X		X							X			X					
Still Water Level Gage																		X	X	X	X	X		X	
Time Lapse Photography					X	X	X											X			X	X		X	
TASK 2-A SEDIMENT TRANSPORT																									
Dye Injection								X												X	X	X		X	X
Sand Tracer Injection								X																X	X
Optical Suspended Sediment Corer								X							X					X		X		X	
Suspended Sediment Corer								X																X	X
Acoustic Bed Load Detector								X							X					X					
Aerial Photography								X																X	X
TASK 2-B SUSPENDED SEDIMENT																									
E.M. Current Meter					X		X	X		X	X						X	X	X	X	X	X		X	
Resistance Wave Sensor					X		X														X	X		X	
Impact Meter and Mech. Sampler																	X	X	X	X	X	X		X	
Optical Backscatter Meter					X		X			X	X						X	X	X	X	X	X		X	
TASK 3-A ON-OFFSHORE PROFILES																									
Beach Profiles	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X		X	X	X	X		X	
Offshore Profiles									X									X							
TASK SUPPORT DATA																									
Tides	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Onsite Anemometer			X	X	X	X	X	X		X	X	X	X	X			X	X	X	X	X	X	X		
Beach Observations			X	X	X		X	X		X	X		X		X	X	X	X		X	X				
Land Still Photography			X																					X	
Surface Weather Charts																								X	X
and Statistics	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

In order to fulfill the requirements of the Torrey Pines Experiment, six telemetry stations were utilized. One station was located on a spar buoy at the 10 meter depth. This station acquired the five pressure sensor array data as well as two pressure sensors on the on-offshore range line (SIO-4). This station was completely self-contained with its own batteries and timer which allowed data collection for any eight-hour period per day. Another PCM encoder station provided data acquisition for sensors between the 3 to 7 m depths and was located in three meters of water, just outside the breakers. One long cable provided the power necessary for these sensors as well as the return signal to the transmitter on shore. The remaining four stations were all located in a temporary instrument van on the beach which provided 60 channels of data for instruments located in the surf zone. These instruments were all individually cabled back to the van. All of these station encoders were recorded.

The receiving system at the SPL consisted of a special six channel receiver tuned to each of the transmitting stations (i.e., 216.5, 217.0, 217.5, 218.0, 218.5, 219.0 MHz). The serial (multiplexed) output of each of the receivers was recorded on a seven-track instrumentation type tape recorder (Honeywell 7600) at 64 samples per second. The seventh track was used to record time in a IORIG-B format. This time recording technique tags the six other tracks of data with continuous time information to a milli-second resolution. The capacity of one reel of tape was approximately eight hours of continuous recording from the six stations.

In order to recover the data from the transmitted serial PCM, special synchronization equipment was used. A PCM bit synchronizer, using a special type of phase lock loop, produces a coherent bit rate clock and also detects and converts the serial data back to binary "1's" and "Ø's." The recovered data and clock are used by the frame synchronizer which is programmed to recognize a unique frame sync word inserted by the PCM encoder. Once this synchronization is established all data channels can be identified by their bits of location relative to the sync word. The resulting 12 bit data words and four bits of location information are presented in parallel to the computer which processes the data and prepares multiplexed data tapes [Lowe, et al., 1973]. The sample rate is reduced from 64 samples per second to 8 samples per second by block averaging eight consecutive data points of each data channel.

Only one set of synchronization equipment was available, therefore data from only one transmitting station was processed at a time. Simultaneous samples from all six stations are made possible by the time code that is recorded along with the data on the analog tapes. Precise control of the start time in the playback mode insures simultaneous sampling of the data. Playing the analog tape through the system while holding the start time constant enables all stations to be sampled at the same time. The demultiplexed nature of these tapes allows all sensors to be on the same tape with 128 seconds of data for each sensor per file. The software and hardware of the total system allows a speed up factor of 16:1 in the playback mode thus reducing the time of data processing. These demultiplexed tapes are further processed by an editing routine to remove data spikes (i.e., deglitching) and low pass filtering to substantially reduce energy between 0.5 and 1 Hz. The data are then decimated and output to tape at two samples per second (512 data points). These demultiplexed tapes will be referred to hereafter as data tapes. A functional block diagram of the Scripps SAS data acquisition transmit station and receiver data processing system is provided in Figures 3-3a and 3-3b. Figure 3-4 is a flow chart summarizing the data processing procedure.

2. University of Washington Data Acquisition and Processing System

The University of Washington data acquisition system consists of an IMSAI 8080 microprocessor, a 12 bit A/D converter and a digital system dual floppy disk recorder which is capable of recording 10 channels of analog data at a sampling rate of 10 per channel per second. The signal from the suspended sediment meters, current meters and resistence wave sensor was cabled to a mobile camper on shore where it was recorded by the system briefly described above.

The processed data tape consists of 389 files with seven records per file (i.e., each record corresponds to each data channel). Each record consists of 512 points (1024 bytes) or 2 samples per second as binary integer values from the various sensors. The data contain actual raw values and have not been edited or filtered. The data values have a time interval of 0.1 second per scan.

Section V of this report will provide the necessary information required to correctly read and interpret both the Scripps SAS and University of Washington data tapes.

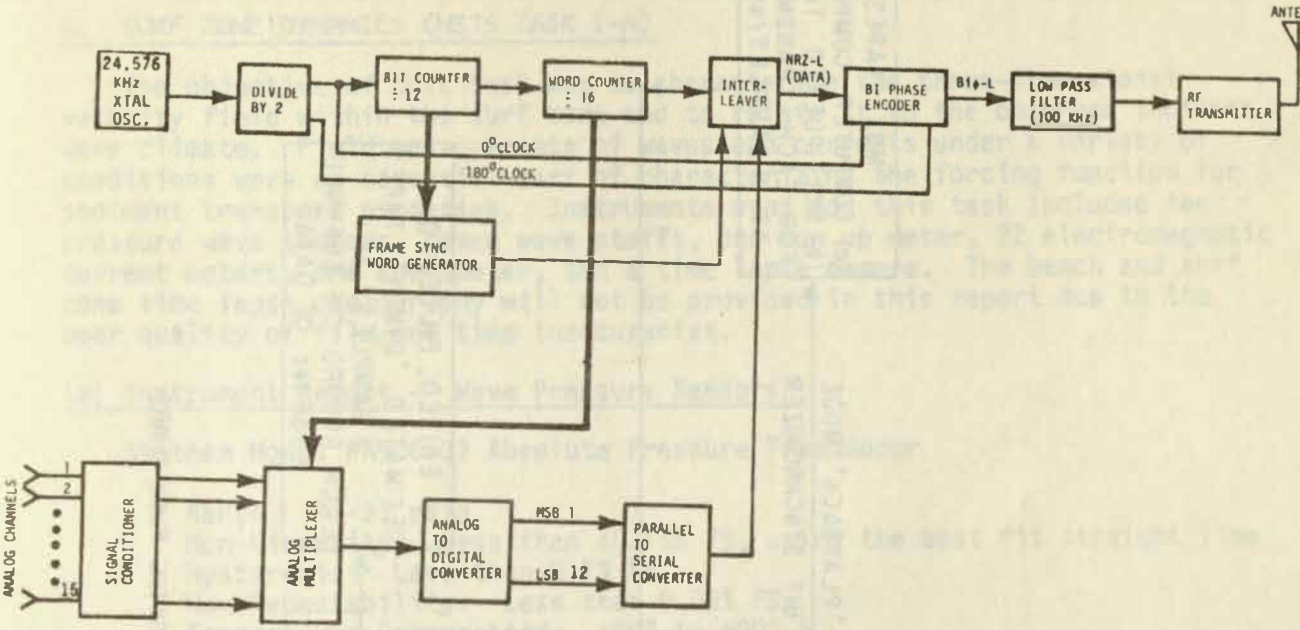


FIGURE 3-3a
BLOCK DIAGRAM OF SAS
TRANSMIT STATION

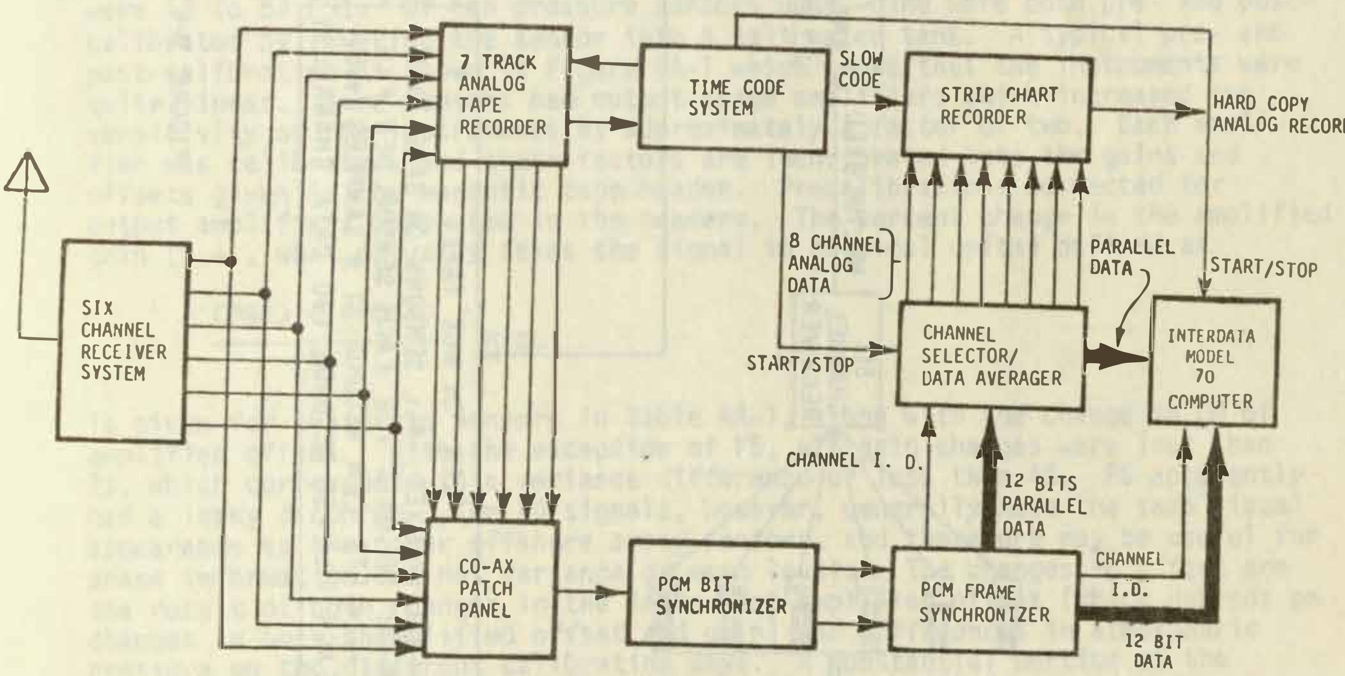


FIGURE 3-3b
BLOCK DIAGRAM OF SAS
RECEIVING AND DATA PROCESSING SYSTEM

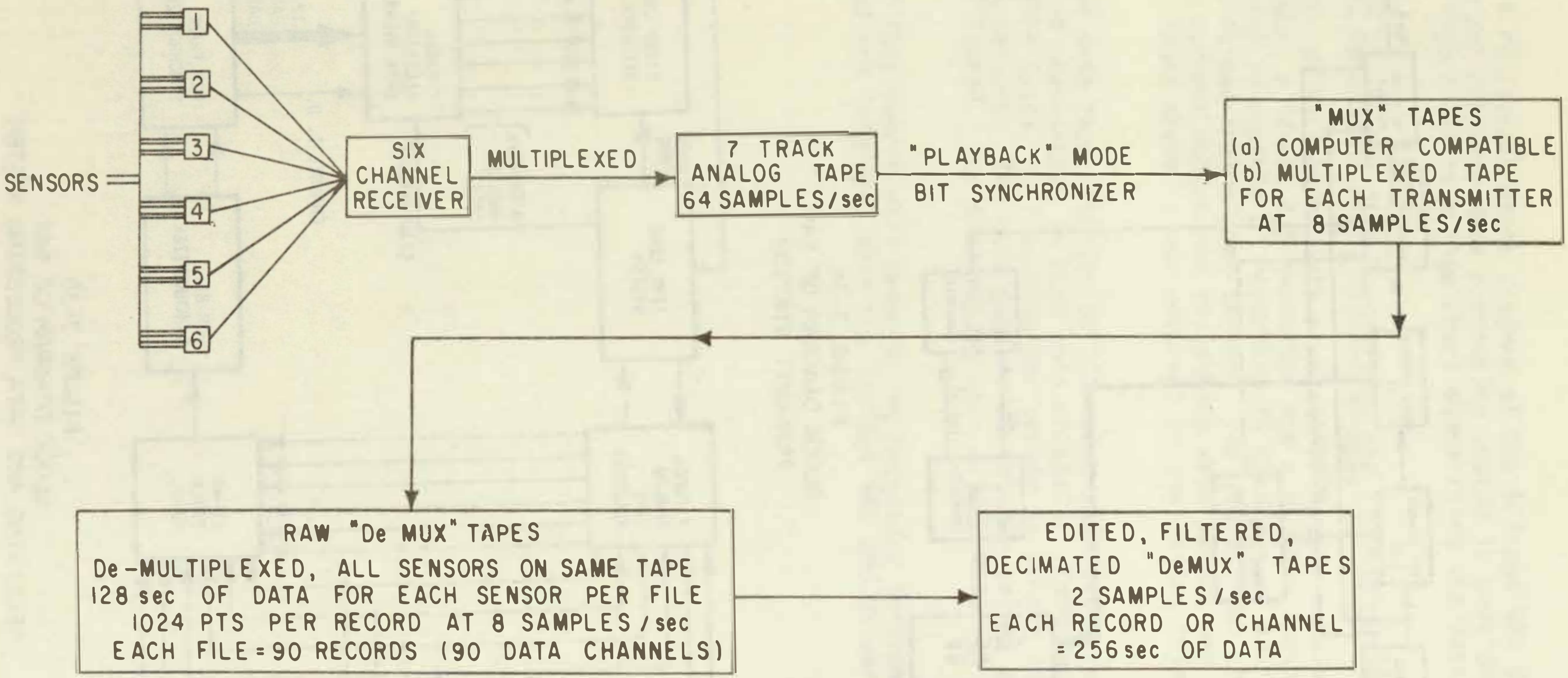


FIGURE 3-4 DATA PROCESSING FLOW CHART

IV. Task Description

A. SURF ZONE DYNAMICS (NSTS TASK 1-A)

The objective of this task was to characterize the three-dimensional velocity field within the surf zone and to relate it to the observed incident wave climate. Field measurements of waves and currents under a variety of conditions were an essential part of characterizing the forcing function for sediment transport processes. Instruments used for this task included ten pressure wave sensors, seven wave staffs, one run up meter, 22 electromagnetic current meters, one anemometer, and a time lapse camera. The beach and surf zone time lapse photography will not be provided in this report due to the poor quality of film and time inaccuracies.

1a) Instrument Report -- Wave Pressure Sensors

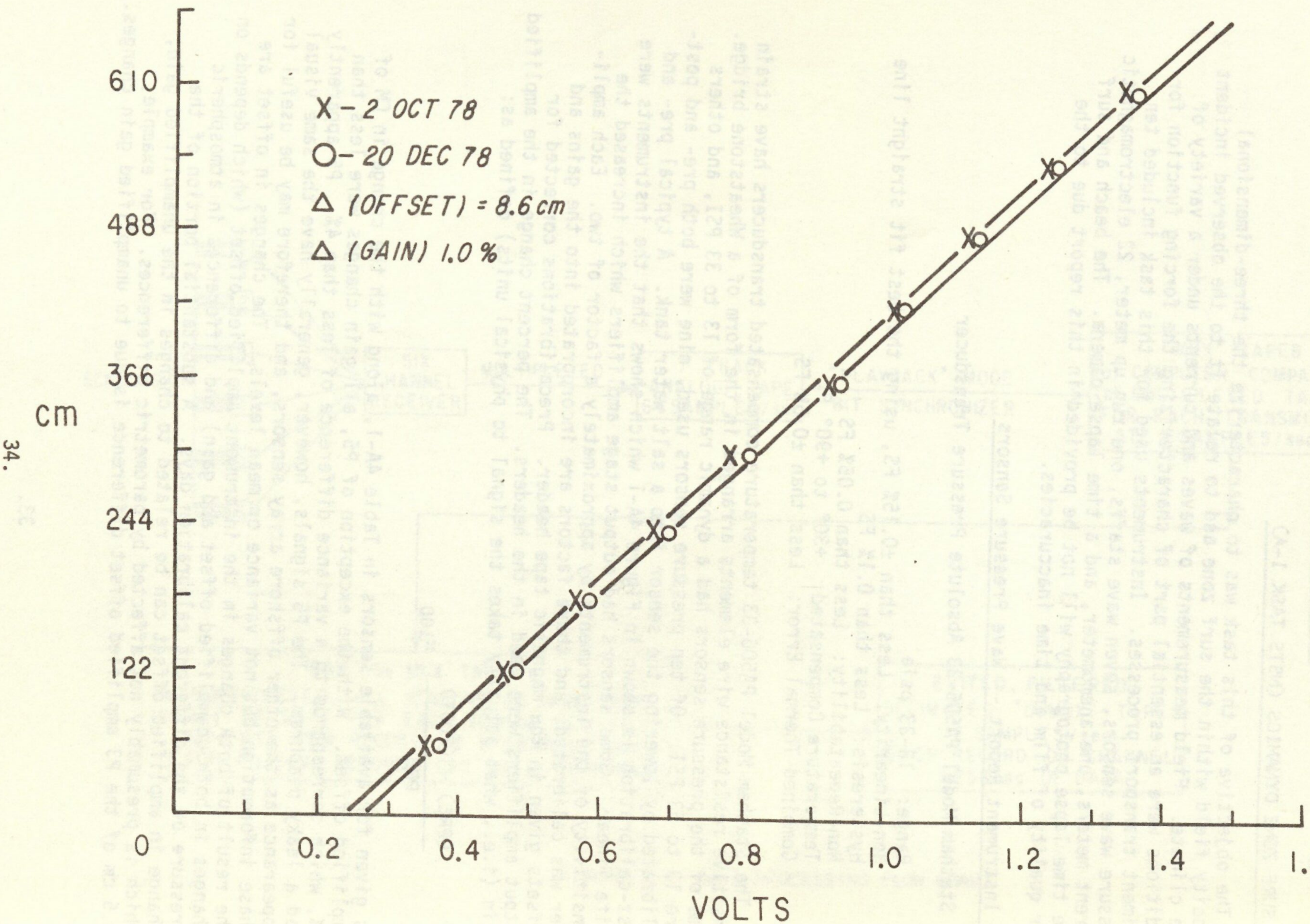
Statham Model PA506-33 Absolute Pressure Transducer

Range: 13-33 psia
Non-Linearity: Less than ±0.15% FS, using the best fit straight line
Hysteresis: Less than 0.1% FS
Non-Repeatability: Less than 0.05% FS
Temperature Compensated: +30° to +90° F.
Combined Thermal Error: Less than ±0.5% FS

The Statham Model PA506-33 temperature compensated transducers have strain sensitive resistance wire elements arranged in the form of a Wheatstone bridge. Some of the pressure sensors had a dynamic range of 13 to 33 PSI, and others were 13 to 53 PSI. Of ten pressure sensors used, nine were both pre- and post-calibrated by lowering the sensor into a salt water tank. A typical pre- and post-calibration is shown in Figure 4A-1 which shows that the instruments were quite linear. Some sensors had output stage amplifiers which increased the sensitivity of the instruments by approximately a factor of two. Each amplifier was calibrated, and these factors are incorporated into the gains and offsets given in the magnetic tape header. Precalibrations corrected for output amplifiers were used in the headers. The percent change in the amplified gain (i.e., what actually takes the signal to physical units) defined as:

$$\frac{(PRE) - (POST)}{PRE} \times 100$$

is given for available sensors in Table 4A-1, along with the change in CM of amplified offset. With the exception of P5, all gain changes were less than 2%, which corresponds to a variance difference of less than 4%. P5 apparently had a leaky diaphram. The P5 signals, however, generally have the same visual appearance as the other offshore array sensors, and therefore may be useful for phase information but not variance or mean levels. The changes in offset are the result of both changes in the instrument amplified offset (which depends on changes in both unamplified offset and gain) and differences in atmospheric pressure on the different calibration days. A substantial portion of the change in amplified offset can be related to changes in the unamplified gain, which is presumably not affected by barometric differences. For example, 9.5 cm of the P3 amplified offset difference is due to unamplified gain changes.



PRE AND POST CALIBRATION
FOR PRESSURE SENSOR NO. 1

FIGURE 4A-1

TABLE 4A-1 PRESSURE SENSOR GAINS AND OFFSETS

SENSOR	Δ GAIN (%)	Δ OFFSET (cm)
P1	.11	13.8
P2	.4	3.9
P3	1.35	24.5
P4	1.2	19.7
P5	64.	38.
P7	-1.69	10.2
P7A	+1.41	17.3
P10	-1.2	6.0
P16	-.84	8.3
P30	Post-cal Only	

$$\Delta \text{ OFFSET} = \text{OFFSET (PRE)} - \text{OFFSET (POST)}$$

$$\Delta \text{ GAIN} = \frac{\text{GAIN (PRE)} - \text{GAIN (POST)}}{\text{GAIN (PRE)}} \times 100$$

In summary, gains for the pressure sensors given in the headers are probably accurate within 2 or 3%. Offsets do not account for barometric pressure differences, and also include electronic drift of roughly 10 cm.

Figure 4A-2 shows a photograph of the type of pressure sensor used.

1b) Offshore and On-offshore Pressure Arrays

The offshore measurements of the wave field were made using a line array of five Statham Model PA506-33 pressure sensors mounted on the ocean bottom at a mean depth of approximately 9.7 meters. The study site was chosen for its relatively plane depth contours. Figure 4A-3 is a refraction plot which slows the regularity of the wave rays in the vicinity of the array. The array's axis points 4.5° west of true north (355.5° true) which is roughly parallel to the depth contours. The mean depth of the array was chosen as a trade-off between high frequency sensitivity (increased depth causes loss of signal for short waves) and wave nonlinearity. The high frequency cut-off for frequency spectral analysis is about 3.8 seconds.

The spacings of the array were in an approximate 2-2-2-5 configuration with a unit lag of 33 meters. The length of the array was designed for resolution of long period waves coming around the north and south ends of San Clemente Island. This requires directional resolution sufficient to define peaks separated by 5° to 10° in ten meters of water.

Difficulties with side lobes in the directional spectra limit the computational value of the spectra for waves with periods less than nine seconds. A planned shorter lag (33 meters) that did not function would have carried this cut-off down to wave periods of about 6.5 seconds. The long period limit of high quality directional spectra (due to resolution) is about 20 seconds. Although of limited quantitative value, the directional spectra for periods 6 to 9 seconds do accuartely locate the primary directional modes.

The routine directional spectrum analysis was performed using the maximum likelihood estimator (MLE). This estimator performs well with the narrow directional spectra which are frequently present at Torrey Pines Beach.

Pressure sensors P4, P7, P7A, P10, and P16 were located in an on-offshore line orthogonal to the axis of the offshore array. This on-offshore array was deployed for the study of the shoaling transformation in the wave energy spectrum. The sensor locations were chosen for a conservative coverage of the zone from near linear waves to the breaker line.

The on-offshore array axis points 4.5° south of west (265.5° true) which was the best estimate to a line orthogonal to the depth contours. The long-shore location (inshore of P4) was chosen for linearity of depth contours. Also, it was desired to be well north of Indian Canyon, which has considerable run-off during rains.

2. Instrument Report -- Wave Staffs

Scripps Institution of Oceanography Dual Resistance Wire Analog Wavestaff

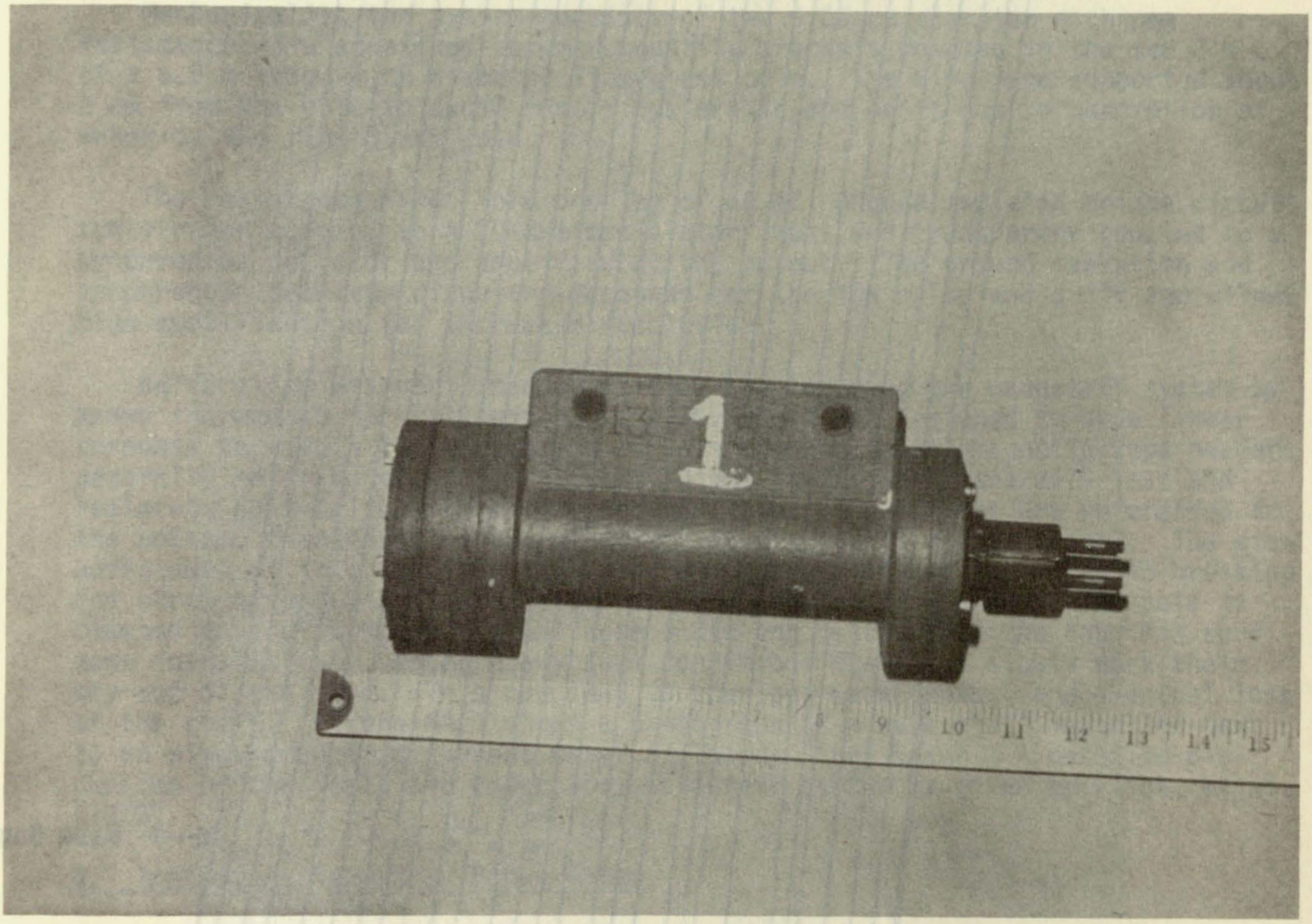


Figure 4A-2. Pressure Sensor

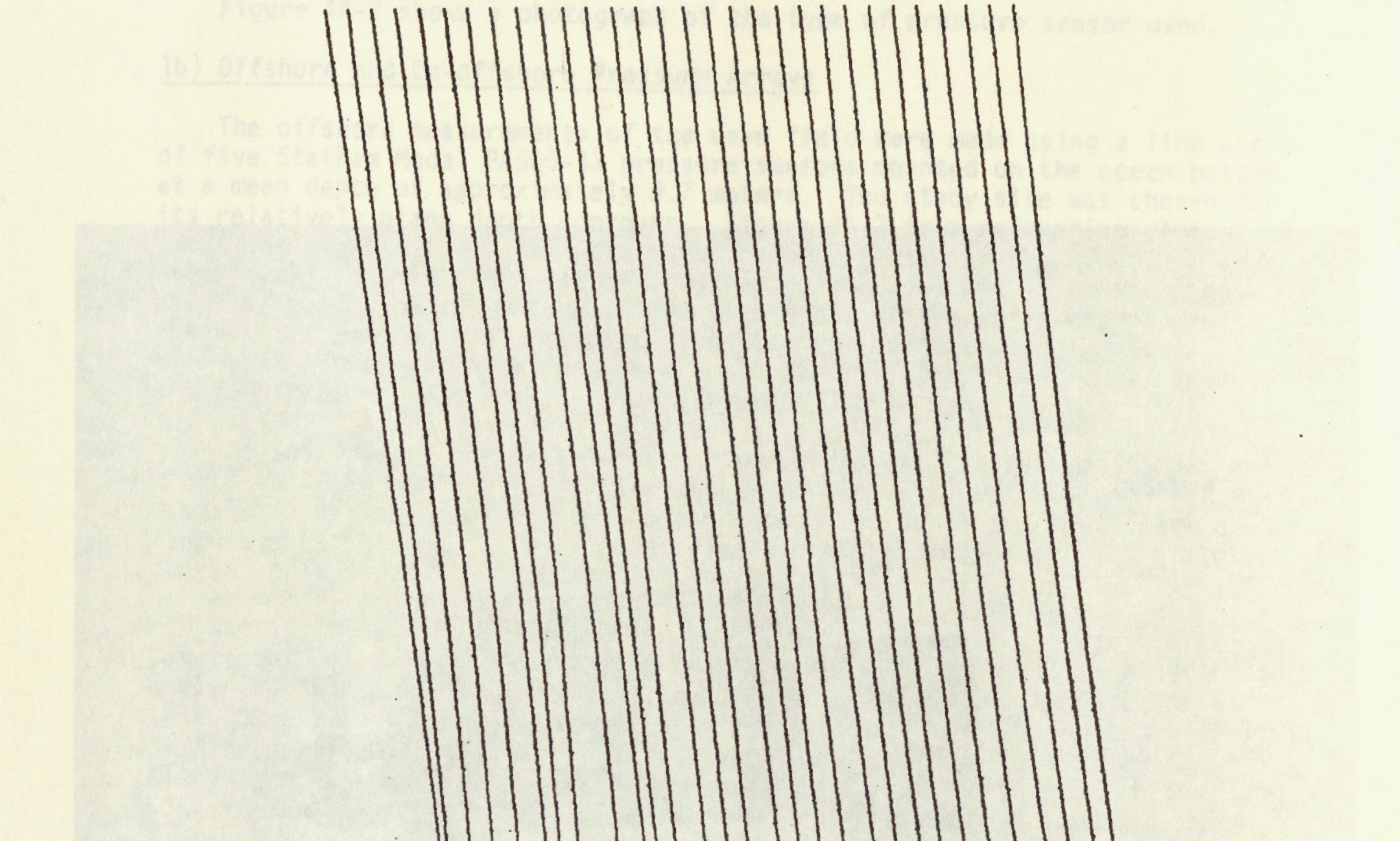


Figure 4A-3 Wave Refraction Plot at Torrey Pines Beach

Dynamic Range: 3 meters
Resolution and Maximum Drift: 0.3 cm
Output Signal: DC voltage proportional to the length of resistance wire above the water
Staff: 6.5 m length fiberglass structural tubing with 4 cm O.D.
Sensing Element: 2, 0.06 cm diameter nichrome wires

Dual resistance wire wavestaffs with low noise and drift, and high resolution developed at the SIO Shore Processes Lab were used for surf zone measurements of wave height. The wavestaffs have a usable dynamic range of 3 m, with resolution on the order of 0.3 cm.

Mechanically, the system consists of two 0.06 cm diameter nichrome resistance wire stretched between mounting brackets mounted in the top 3 m of a 6.5 m long, 4 cm diameter fiberglass pole. The wires are supported about 2 cm from the pole to avoid runoff hysteresis and drift due to absorption of water by the fiberglass pole.

The resistance wires form one leg of an AC, ground isolated bridge circuit transformer coupled to a 20 KHz oscillator input and transformer coupled to a synchronous detector and amplified at the output. The ground isolation and synchronous detector circuitry accounts for the low noise and drift and allows high amplification for increased resolution.

Calibration was performed by raising and lowering the wavestaff system by known increments in still water. The wavestaff was designed to have linear response to within 1%. Gains and offsets entered in the magnetic tape headers generally refer to pre-calibrations. Since staffs were generally lost and replaced, post-calibrations were not possible. The offsets are referenced to the bottom, therefore the use of these offsets yields a total depth. The disadvantages of this configuration is the vulnerability of the wires to breaking and stretching during installation and when fouled by seaweed. The pole is clamped to a disk-shaped, steel base plate and jetted into the sand for surf zone installation. Under heavy surf conditions the poles slowly work their way out of the sand. This can lead to spurious mean depths, and eventual loss of the staff. Figure 4A-4 shows a photograph of a wave staff installed next to an electromagnetic current meter at Torrey Pines Beach. A detailed discussion of the field and laboratory wavestaff system is given by Flick, et al. [1979].

3. Instrument Report -- Runup Meter

(Note: Instrument specifications same as wavestaff except as noted below.)

The investigation of long-period oscillations nearshore was studied using a runup meter developed at Scripps Institution of Oceanography [Flick, Lowe, Freilich, Boylls, 1979]. The runup meter is a variation of Scripps wavestaff system and contains two parallel 0.016 cm diameter wires 100 meters long supported about 2 cm off the beach face. As the swash runs up the beach, more wire is submerged and the output voltage changed resulting in an accurate representation of the up-rush. The downrush signal is under investigation. The calibration procedure was the same as that used for the wavestaffs. The gains and offsets entered in the magnetic tape headers represent pre- and post-calibrations. Figure 4A-5 provides a photograph of the runup meter at Torrey Pines Beach.

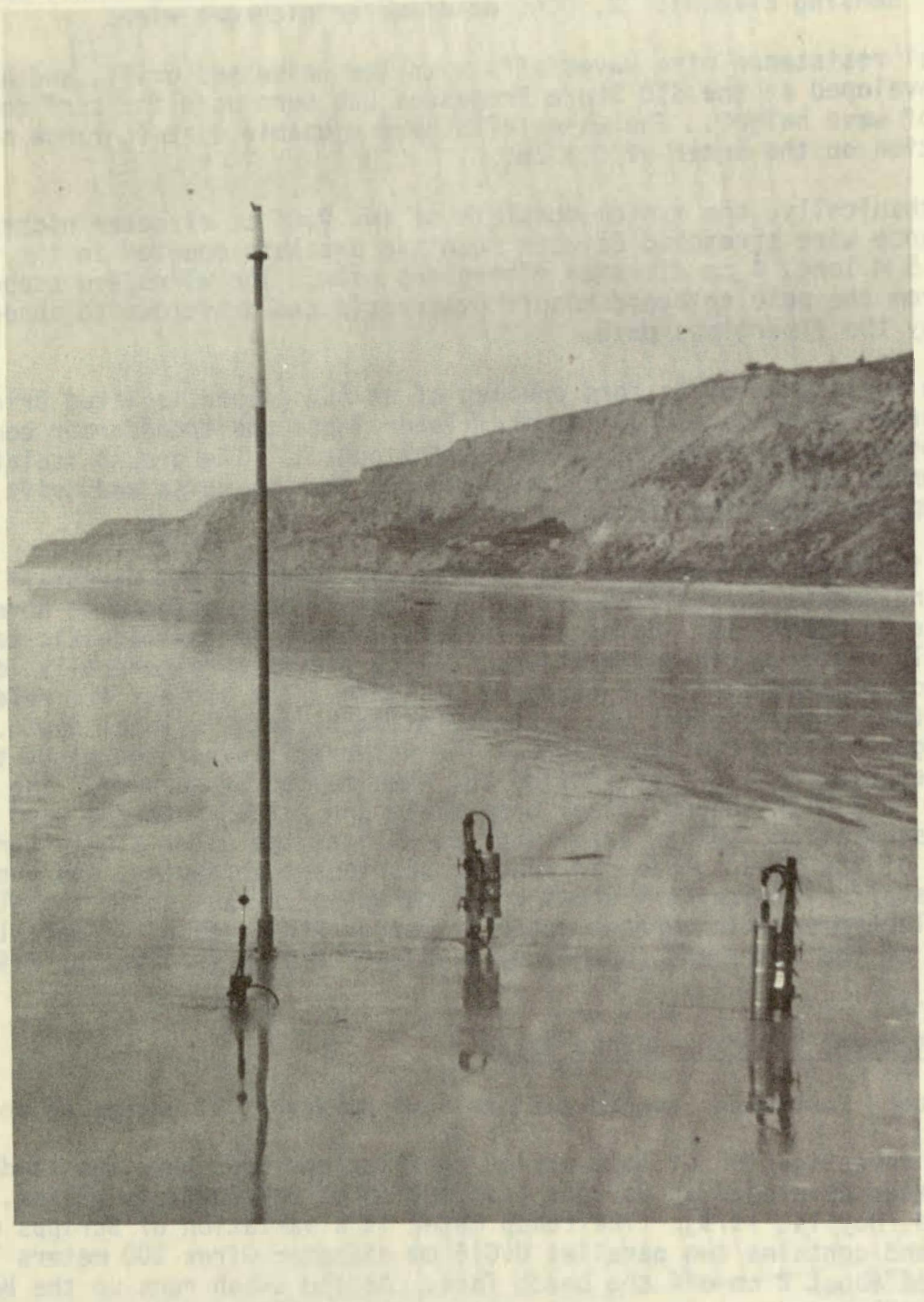


Figure 4A-4 Wave Staff and Electromagnetic Current Meter at Torrey Pines Beach

Figure 4A-5 . RUNUP METER
INSTALLED AT TORREY PINES BEACH.

4. Instrument Report -- Electromagnetic Water Current Meters

Marsh-McBirney, Inc.

Model 512 OEM
2-axis, 4 cm diameter spherical probe
Nominal Output Gain: 1v for a flow of 1 m/s
Output Filter: 3 pole, 4Hz
Output Impedance: 100 Ω
Accuracy: 5-10%

The Marsh McBirney electromagnetic current meter sensors operate on the principle of Faraday induction, whereby a voltage is induced in a conductor moving relative to a magnetic field. In this case, seawater is the conductor, the magnetic field (AC) is set up by an electromagnet inside the probe and the electrodes measure the induced voltage to generate the output signal. Figure 4A-6 provides a photograph of the current meter probe and electronics package. Figure 4A-4 shows the field installation of a current meter at Torrey Pines Beach.

Overall, these sensors performed well with only four failings during the extent of the experiment. Most sensors were repaired within an hour. The sensors stood up to great physical punishment and only one suffered mechanical failure (a bent probe stick). One recurring problem was that connectors worked loose, with resultant noisy signals. Fasteners to eliminate this problem have been developed. All sensors had offsets equal to:

$$\pm 0.2 \frac{cm}{sec}$$

Gains were measured by the following two methods:

a) towing at a steady speed (DC gain) and b) attaching the probe to an oscillating arm executing motions with known stroke and frequency (AC gain).

Gain which is the calibration or scale factor and offset which is the baseline or zero correction is defined as:

$$\text{signal } \left(\frac{cm}{sec}\right) = \text{OFFSET} + (\text{GAIN} * V)$$

where V is the output voltage of the sensor. DC gains and offsets were measured on most instruments both before and after the experiment by towing at:

$$100 \frac{cm}{sec}$$

Gains and dates measured are provided in Table 4A-2. DC gains almost always varied by less than 5%.

AC gains were less satisfactory. As shown in Figure 4A-7, the instruments do not have constant gain for varying frequencies. This is not due to the filter characteristics of the electronics, which are flat for frequencies less

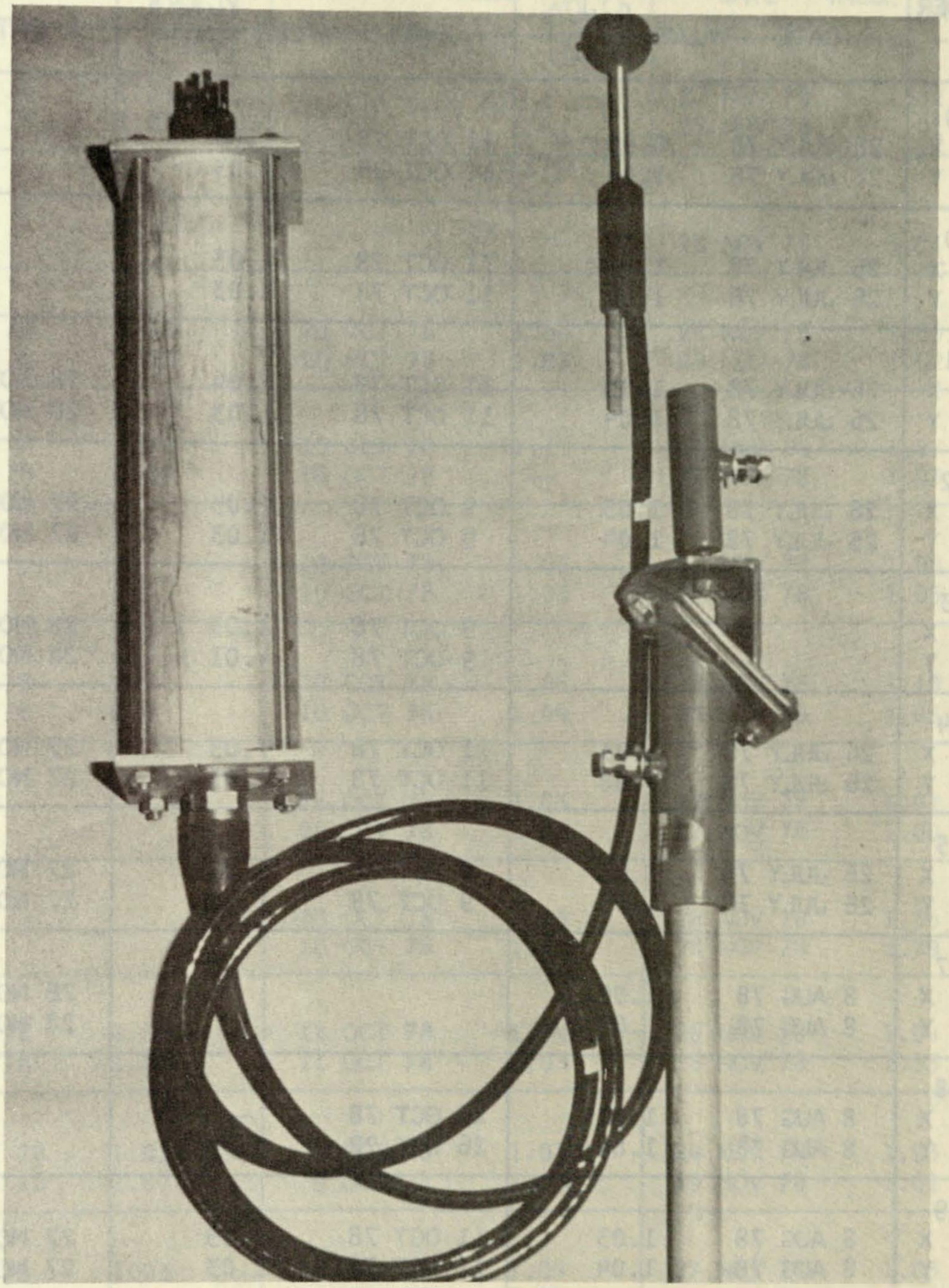


Figure 4A-6. Marsh McBirney Electromagnetic Current Meter Probe and Electronics Package.

TABLE 4A-2 CALIBRATION (D.C. GAINS) OF CURRENT METERS

D.C. GAINS

CM NUMBER	CALIBRATIONS (towed at 1 M/S)		CALIBRATIONS (towed at 1 M/S)		CALIBRATIONS (towed at 1 M/S)	
	DATE	VALUE (M/S / VOLT)	DATE	VALUE (M/S / VOLT)	DATE	VALUE (M/S / VOLT)
S109						
X	26 JULY 78	0.99	11 OCT 78	1.03		
Y	26 JULY 78	1.04	11 OCT 78	1.03		
S110						
X	26 JULY 78	1.03	11 OCT 78	1.03		
Y	26 JULY 78	1.00	11 OCT 78	1.03		
S111						
X	26 JULY 78	1.00	11 OCT 78	1.04	28 NOV 78	1.01
Y	26 JULY 78	1.04	11 OCT 78	1.03	28 NOV 78	1.01
S112						
X	26 JULY 78	1.05	9 OCT 78	1.03	27 NOV 78	1.04
Y	26 JULY 78	1.04	9 OCT 78	1.03	27 NOV 78	1.04
S113						
X			9 OCT 78	1.03	28 NOV 78	1.05
Y			9 OCT 78	1.01	28 NOV 78	1.03
S114						
X	26 JULY 78	1.03	11 OCT 78	1.05	27 NOV 78	1.06
Y	26 JULY 78	0.98	11 OCT 78	1.05	27 NOV 78	1.02
S115						
X	26 JULY 78	1.03	9 OCT 78	1.03	27 NOV 78	1.03
Y	26 JULY 78	1.03	9 OCT 78	1.03	27 NOV 78	1.03
S117						
X	8 AUG 78	1.00			28 NOV 78	1.05
Y	8 AUG 78	1.00			28 NOV 78	1.02
S118						
X	8 AUG 78	1.01	26 OCT 78	--		
Y	8 AUG 78	1.00	26 OCT 78	0.99		
S119						
X	8 AUG 78	1.03	11 OCT 78	1.05	27 NOV 78	1.04
Y	8 AUG 78	1.04	11 OCT 78	1.03	27 NOV 78	1.03
S122						
X	8 AUG 78	1.08	9 OCT 78	1.03	28 NOV 78	1.03
Y	8 AUG 78	1.07	9 OCT 78	1.02	28 NOV 78	1.03

D.C. GAINS

CM NUMBER	CALIBRATIONS (towed at 1 M/S) DATE	VALUE (M/S / VOLT)	CALIBRATIONS (towed at 1 M/S) DATE	VALUE (M/S / VOLT)	CALIBRATIONS (towed at 1 M/S) DATE	VALUE (M/S / VOLT)
S123						
X	8 AUG 78	1.11			27 NOV 78	1.02
Y	8 AUG 78	1.08			27 NOV 78	1.01
S124						
X						
Y					28 NOV 78	1.01
S125						
X	8 AUG 78	1.05	26 OCT 78	1.04	28 NOV 78	1.05
Y	8 AUG 78	1.00	26 OCT 78	1.03	28 NOV 78	1.02
S127						
X	8 AUG 78	1.10	26 OCT 78	1.11	27 NOV 78	1.07
Y	8 AUG 78	1.03	26 OCT 78	--	27 NOV 78	1.03
S128						
X			10 OCT 78	1.05	27 NOV 78	1.04
Y			10 OCT 78	1.03	27 NOV 78	1.05
S129						
X	8 AUG 78	1.0	10 OCT 78	1.06	28 NOV 78	1.10
Y	8 AUG 78	1.0	10 OCT 78	1.04	28 NOV 78	1.05
S130						
X			26 OCT 78	1.03	27 NOV 78	1.01
Y			26 OCT 78	1.03	27 NOV 78	1.00
S131						
X			10 OCT 78	1.05	28 NOV 78	1.36
Y			10 OCT 78	1.05	28 NOV 78	1.29
S132						
X	10 OCT 78	1.05	11 OCT 78	1.04	28 NOV 78	1.04
Y	10 OCT 78	1.03	11 OCT 78	1.03	28 NOV 78	1.03
S133						
X	26 JULY 78	1.03	9 OCT 78	1.03	24 NOV 78	1.03
Y	26 JULY 78	1.07	9 OCT 78	1.03	24 NOV 78	1.02
S134						
X	8 AUG 78	1.03	26 OCT 78	1.04	27 NOV 78	1.03
Y	8 AUG 78	1.0	26 OCT 78	1.04	27 NOV 78	1.03
S151						
X			11 OCT 78	0.62	27 NOV 78	0.63
Y			11 OCT 78	0.63	27 NOV 78	0.62
S152						
X			11 OCT 78	0.62	27 NOV 78	0.62
Y			11 OCT 78	0.61	27 NOV 78	0.62

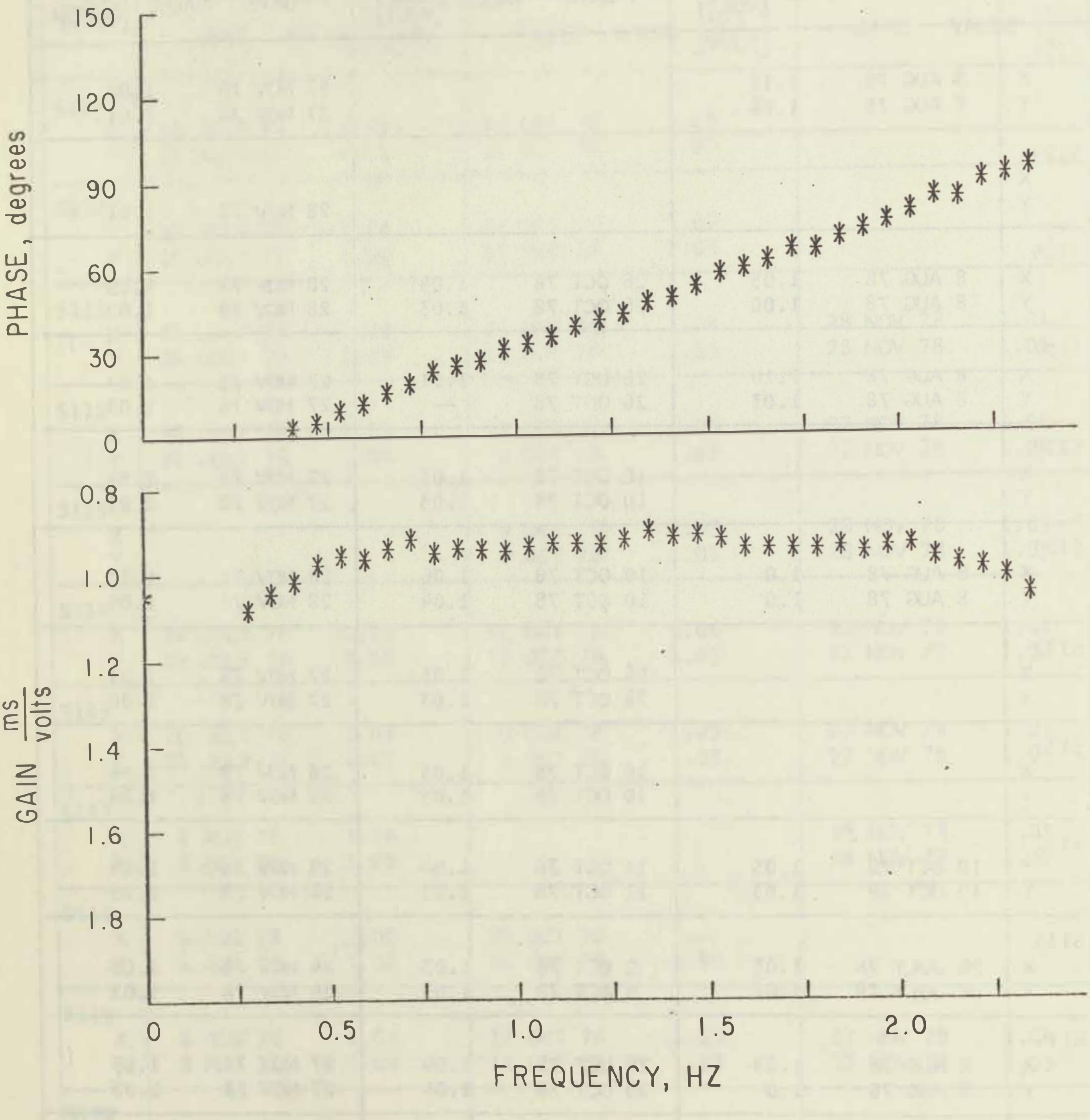


FIGURE 4A-7

A. C. GAINS VS. FREQUENCY
FOR CURRENT METER SENSOR S112

than 1 Hz. Comparison of AC calibrations with a single sinusoidal motion, and pseudo-random motions containing many frequencies show that the gain at a particular frequency depends on the characteristics of the total motion. This suggests that a single gain number, of a single gain vs. frequency curve, does not exist, which is not surprising because the meters measure the flow field very close to the probe head. Sensibly, the boundary layer region, and the detailed structure of AC boundary layers, is going to depend on the entire spectrum of fluid velocities. Typically, gains at a particular frequency vary by 5 to 10% depending on what other frequency motions are present. Gains entered in the headers are averages of DC calibrations. It is possible that the AC results are caused by inaccuracies in the calibration device. Nevertheless, we have assigned an uncertainty of 5 to 10% in instrument gain. Calibration runs in still water show approximately white noise for frequencies 0 to 4 Hz (some roll-off at high frequency due to electrical filtering) with an r.m.s. amplitude of ≈1 cm/sec which is low noise level. The orientation of the current meter was checked daily on the foreshore areas and every 2 to 3 days offshore. The accuracy of the orientation was ±5°.

The elevation, location, and condition of the current meter electrodes relative to mean sea level for each day of the experiment is provided in Appendix B.

Summary:

1) The instruments offsets remained constant through the experiment.

2) Hydrodynamic effects apparently make the instrument gain frequency dependent in a complicated way, which depends on the total spectrum of velocities.

3) Gains used in magnetic tape headers are DC gains. An approximate 5 to 10% error is associated with this number.

4) Noise levels of the instruments are low ($Q_{r.m.s.}$ ≈1 cm/sec).

5. Instrument Report -- Anemometer

Meteorology Research Inc. (MRI) Model 1022 Anemometer

(Note: Wind speed and direction performance specifications are provided in Figure 4A-8.)

A Meteorology Research, Inc. (MRI) model 1022 anemometer was installed at a height of seven meters above mean sea level on the shore near bench mark SIO-4. The effects of the nearby cliffs on the onshore winds were minimal. Wind speed and direction was telemetered and recorded on the Scripps SAS system. The gain for the wind speed (A_1S) is 514 cm/sec or 1 volt = 514 cm/sec and for wind direction (A_1D) is 108° (magnetic) or 1 volt per 108° from magnetic north. Instrument performance specifications for the speed and direction sensors are provided in Figure 4A-8. Overall, the winds were very light and variable throughout the experiment duration except for November 10, 11, and 21 when the winds gusted up to approximately 30 knots.

WIND SENSOR

Model 1022

WIND SPEED

Performance Specifications

Starting Threshold	0.5 mph
Response Distance	5 ft (63% Recovery)
Flow Coefficient	6.0 ft/rev
Accuracy	±0.15 mph or 1% of wind speed
Range	0.5 - 120 mph maximum
Output:	
Voltage	Pulses, approx. 4 V peak-to-peak
Frequency	0 to approx. 2500 Hz
Impedance	Less than 10 K ohms

WIND DIRECTION

Performance Specifications

Starting Threshold	0.70 mph
Delay Distance	3.7 ft (50% Recovery)
Damping Ratio	0.4 at 10° angle of attack
Accuracy	±2.5°
Range	540°
Output:	
Pot A	
Full scale	20 K ohms ±3%
Linearity	±0.5% of full scale
Resolution	0.1%
Maximum power	2.0 watts

Figure 4A-8 Performance Specifications
for MRI Model 1022 Anemometer

B. FIELD MEASUREMENTS OF RIP CURRENTS (NSTS TASK 1-B)

The objectives of this task were to use state of the art field technology to measure the characteristics of the nearshore circulation system in situ and to develop a predictive model to

1) Identify conditions when rip currents will develop,

2) Provide information on the characteristics of these currents, and

3) Determine their effects on the transport of sand along the beach.

The methodology used at the Torrey Pines Experiment to meet these objectives included the measurements of rip current spacing along the beach and the offshore extent of the rip heads through the use of time lapse and still photography, dye measurements, and visual observations. The nearshore circulation and the mean velocities and directions associated with migrating rip currents was measured by the current meter array associated with Task 1-A. To measure both the horizontal and vertical structure of stationary rip currents, a portable tripod supporting a current meter and pressure sensor was deployed directly into the rip current itself. A Marsh-McBirney electromagnetic current meter was supported on a tripod which was anchored to the bottom through the use of three earth anchors, as shown in Figure 4B-1. The tripod mount and swing arm for the current meter leveling bracket is adjustable in the vertical for the vertical distribution of the currents as well as in the horizontal plane for orientation and leveling purposes. A pressure sensor was also attached to this tripod to provide water level information. Data from these two instruments were transmitted to shore via an FM telemetry link and recorded on the beach on cassette tape and also re-transmitted on Scripps SAS telemetry link. A filtered wave staff used as a still water level gage was placed in the longshore direction near W-41 to examine the mean water level variations due to steady longshore variation in setup and low frequency waves.

The portable tripod-mounted current meter (C-43) and pressure sensor (P-44) were operated on the following days:

NOVEMBER	TURN-ON	X (OFFSHORE)	Y (LONGSHORE)	BALL ELEV ABOVE BED
3	1000	141.0 m	-28.9 m	52 cm
7	1200	123.4	-16	52
8	1030	123.4	-16	55
10	0630	123.4	-16	55
17	0830	129	- 7	86
20	1315	132	-190	65

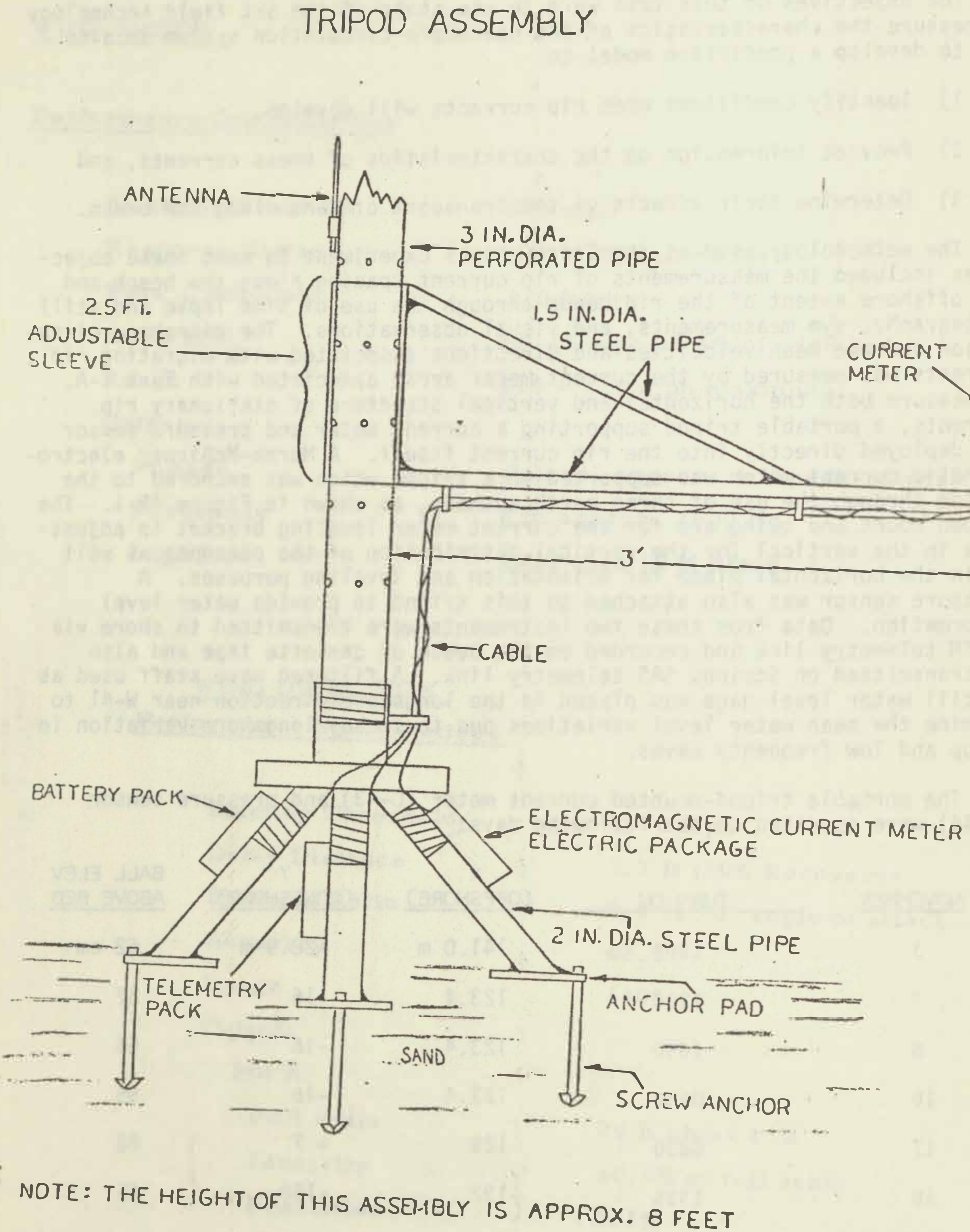


FIGURE 4B-1 Portable Current Meter Tripod Assembly

A still 35 mm camera was located in a weather box mounted on the cliff about ~100 m south of the main range line. Time lapse photos were taken on the following dates and times:

NOVEMBER	TIME	INTERVALS (PRINTS)
3	8:18 - 10:02	8 min
5	8:59 - 11:04	8 min
6	10:38 - 13:50	8 min
7	12:01 - 12:03	2 min
18	9:26 - 12:06	8 min
21	9:46 - 15:04	6 min
22	9:18 - 09:42	8 min
24	8:45 - 14:42	6 min

Because these photos and field notes are of very limited value to other investigators, they are not provided with this report.

The still water level gage (S-45) was located near W-41 at

X (offshore) = 99

Y (longshore) = -7

and was operational from November 18 through 24. (Note: SIO-4 = 0,0)

Data obtained from the current meter and pressure sensor on the portable sled and the still water level gage are provided in the edited data tapes.

C. SEDIMENT TRANSPORT STUDIES (NSTS TASK 2-A)

The objective of this task was to make field measurements of sand transport by waves and currents and to define the relative importance of bedload and suspended sand movement in the overall longshore transport of sand. The following studies were performed at the NSTS Torrey Pines Experiment to help meet these objectives:

1) Fluorescent sand tracer measurements of total longshore transport in the surf zone;

2) In situ suspended sand concentration measurements in the surf zone using a suspended sediment corer;

3) Field testing of an acoustic bed load meter to test the feasibility of making continuous measurements of bed load transport in the field.

This section will discuss:

1) The methodology used in conducting the tracer experiments;

2) Laboratory procedures;

3) Instruments and equipment used both in the field and laboratory.

Specific comments, summaries, and actual raw data for each tracer experiment are provided in Appendix A. Textural data of the sediment samples are not available.

1. Sand Tracer Measurements

The dates and times of fluorescent sand tracer injection were carefully selected to meet certain criteria. These criteria were:

1) Minimal change in the tide elevation during a 3- to 4-hour period in the middle of the day;

2) Occurrence of dominant waves of sufficient height and breaker angle to generate a strong, unidirectional longshore current;

3) Absence of either stationary or migrating rip currents in the study area; and,

4) Submergence and operation of current meters and wave sensors in the study area.

Target dates were picked in advance from the tide calendar and all necessary personnel notified. During the morning of the given day, Rhodamine-B dye was injected at several positions in the surf zone and observed from the cliff above the site. The dye dispersal patterns indicated the approximate mean longshore current speed as well as the occurrence of complicating rip currents. If all conditions were satisfied, the injection location and sampling grid were determined appropriate to the current speed and direction and the range flags were installed on the beach. If conditions remained favorable a sand tracer injection was initiated as shown in Figure 4C-1. After a predetermined time, temporal core sampling and spacial grab sampling were started. Successful experiments were carried out on 8 and 24 November and 6 December 1978 with the most meaningful data gathered on 6 December [Inman and Flick, 1979].

The tracer experiments used native beach sand collected from the beach face and beach berm at Torrey Pines. The sand was delivered to the Great American Color Company in Los Angeles, California for dyeing. Standard florescein dye of a green hue was attached to the sand grains using a binding medium of air-curing plastic and organic solvent. The dye is permanent and settling tube studies have shown that the hydraulic properties of the dyed grains are unaffected as long as a wetting agent is used prior to release. Settling tube sand grain analysis of the natural undyed sand and the dyed sand is provided in Tables 4C-1 and 4C-2. The dyed sand was bagged in plastic bags of carefully weighed ten-pound quantities. These bags were carried to each injection point and the tracer introduced by carefully tearing the bag on the ocean bottom avoiding suspending tracer grains as much as possible. Rhodamine-B dye injections and drift bottle measurements were continued throughout the tracer experiments to help monitor the circulation in the study area, particularly to determine the presence of both migrating and stationary rip currents.

The tracer grain distribution after injection was sampled by two independent methods simultaneously. One method used the traditional grab sampler which sought to survey the study area grid as rapidly as possible to get a synoptic aerial view of the tracer distribution. This method is referred to as "spacial sampling." The second method used a specially designed coring device to repeatedly core the bottom on a fixed on-offshore range downstream from the injection line and at constant intervals of time. This method is called "temporal sampling."

Table 4C-3 outlines the dates and times of dye injection and tracer experiments. Table 4C-4 provides an outline of current, wave, and suspended sediment data collected in support of the tracer experiments during the three sand tracer days.

2. NSTS Sand Tracer Sample Analysis Techniques

Grab Samples

The grab samples were collected using a hand-held scissors type grab sampler with the sample volume of 7.5 x 12.5 and 3 cm deep. The samples were transferred to plastic bags and labeled with date and grid location. Upon return to the laboratory, each sample was transferred to a large evaporating dish and rinsed three times with deionized water, decanting the water carefully after each rinse. Samples were then evaporated to dryness at 120° C overnight in a drying oven.

Samples were split into sub-samples weighing approximately 10 gm each using a Jones sample splitter. Each sample was split to the desired size by resplitting either the right or left-hand halves. Sub-samples were

Figure 4C-1. Tracer Injection of 8 November 1978

TABLE 4C-1 GRAIN SIZE ANALYSIS OF UNDYED TRACER SAND

1978 NSTS UNDYED TRACER SAND

TOTAL SAMPLE WEIGHT = 70.34701

MICRONS	PHI	PERCENT	CUM PERCENT
2828.427	-1.5001	0.057	0.057
1414.213	-0.5001	0.1181	0.1751
1000.0001	0.0001	0.2321	0.4071
707.1071	0.5001	2.2721	2.6781
500.0001	1.0001	8.7511	11.429
420.4481	1.2501	5.7021	17.131
353.5531	1.5001	10.593	27.724
297.3021	1.7501	14.419	42.1431
250.0001	2.0001	17.107	59.2491
210.2241	2.2501	21.023	80.2721
176.7771	2.5001	9.280	89.5521
148.6511	2.7501	6.566	96.1181
125.0001	3.0001	2.913	99.0311
105.1121	3.2501	0.515	99.545
88.388	3.500	0.256	99.8011
74.325	3.7501	0.095	99.8961
62.500	4.0001	0.043	99.9391
44.1941	4.5001	0.061	100.0001

	MEDIAN	MEAN	DISPERSION	SKEWNESS	SKEWNESS2	KURTOSIS
GRAPHIC MOMENTS	1.865(1 274.56)1	1.7751 (292.11)	0.575	-0.1551	-0.3391	0.804
SAMPLE MOMENTS		1.7891 (289.36)1	0.619	-0.6971		5.530

PHI05= 0.6327
PHI16= 1.2004
PHI50= 1.8648
PHI84= 2.35041
PHI95= 2.70741

TABLE 4C-2 GRAIN SIZE ANALYSIS OF DYED TRACER SAND

1978 [illegible] TRACER [illegible]

TOTAL SA[illegible] = [illegible]

MIC[illegible]	PHI	PERCENT	CUM PERCENT
1000.[illegible]	0.[illegible]	0.005	0.005
707.1[illegible]	[illegible]	0.016	0.021
500.[illegible]	1.[illegible]	0.993	1.01[illegible]
420.[illegible]	1.2[illegible]	[illegible]	[illegible]
353.5[illegible]	1.5[illegible]	9.022	13.[illegible]
297.[illegible]	1.7[illegible]	19.312	33.177
250.[illegible]	2.[illegible]	23.363	56.541
210.224.	2.250	27.446	83.987
176.777	2.[illegible]	6.777.	90.764
148.651.	2.7[illegible]	6.000	96.765
125.000	3.0[illegible]	2.462	99.226
105.112.	3.[illegible]	0.458.	99.684
88.388	3.[illegible]	0.173	99.857
74.325	3.75[illegible]	0.082	99.940
62.500	4.000.	0.034	99.973
44..194.	4.500	0.027	100.000

	MEDIAN	MEAN		DISPERSION	SKEWNESS	SKEWNESS2	KURTOSIS
GRAPHIC MOMENTS	1.930(. 262.43).	1.892	(269.46)	0.359	-0.106	0.118.	0.964
SAMPLE MOMENTS		1.927	(262.97)	0.416	0.375		7.197

PHI05= 1..2602.
PHI16= 1.5033.
PHI50= 1.9300.
PHI84= 2.2595.
PHI95= 2.6765.

TABLE 4C-3 DATES AND TIMES OF DYE INJECTION AND TRACER EXPERIMENTS

8 Nov 78

0846 - 0910	Dye Injection
1314 - 1330	Sand Tracer under unidirectional current
1318 - 1350	Dye Injection

20 Nov 78

0749 - 0820	Dye Injection
1132 - 1206	Dye Injection

21 Nov 78

0831 - 0900	Dye Injection
1035 - 1000	Dye Injection

22 Nov 78

0832 - 0846	Dye Injection

24 Nov 78

0950 - 1006	Dye Injection
1215 - 1530	Sand Tracer under unidirectional current
1328 - 1345	Dye Injection

6 Dec 78

0932 - 0944	Dye Injection (strong S. current)
1250 - 1505	Sand Tracer under unidirectional current
1256 - 1304	Dye Injection (strong S. current)
1322 - 1335	Dye Injection (strong S. current)

TABLE 4C-4

SAND TRACER STUDY

DATE AND INJECTION TIME (PST)	CURRENT DATA			TIDE		WAVE DATA			SEDIMENT DATA				
							WAVE SENSORS			TRACER STUDY		SENSORS	
	Dye Patterns	Drift Bottles	Current Meters		Aerial Photos And Visual Observations	Freq. Spectra	Directional Spectra	S_{xy} Estimates	Suspended Concentration	Temporal Method	Spatial Method	Suspended Sensor	Bed Load Sensor
8 NOVEMBER Dyed Sand Released At 1316	0846 1318-1350	None	Vector Plots 1311-1402 Analog Plots 1105-1620	SIO Pier Tide Gauge	B&W 1350-1410 Color Slides 1320-1359	1313 1347	1313 1347	1313 1347	1330 1346	1330-1530	1429-1446	1315-1608	1030-1700
24 NOVEMBER Dyed Sand Released at 1215	0950-1006 1328-1338	1215-1530	Vector Plots 1216-1510 Analog Plots 1215-1535 17-Minute Averages 1000-1510	Tide Gauge At SIO Pier	B&W 1204-1346 Color Slides 1209-1325 Intermittent Visual Observations	Plots 1212-1446	Plots 1355	1034-1449	[illegible]	1230-1530	1335-1402	1000-1545	----
6 DECEMBER Dyed Sand Tracer Injection At 1250	0932-0944 1256-1304 1322-1344	1250-1500	Means 1135-1425 Analog Plots 0942-1143 1202-1504	Tide Gauge At SIO Pier	B&W 1250-1444 Color Slides 1300-1451 Intermittent Visual Observations	Plots 1135-1442	Plots 1430	1135-1442	1320	1305-1457	1331-1401 1422-1439	----	----

weighed using porcelain weighing dishes and a Mettler H80 analytical balance to ±0.00 gm. Samples were analyzed for a number of fluorescently dyed grains by spreading the sub-sample onto a smooth black counting grid. Using a paint brush, the sub-sample was carefully manipulated to cover the counting board to a single grain layer thickness. The fluorescent sand grains were counted using a long wave ultra-violet light (B-100A Blak-Ray) in a completely darkened room. The number of grains were tallied using a hand counter. Values for each sample were reported in number of fluorescently dyed grains per kilogram of sample.

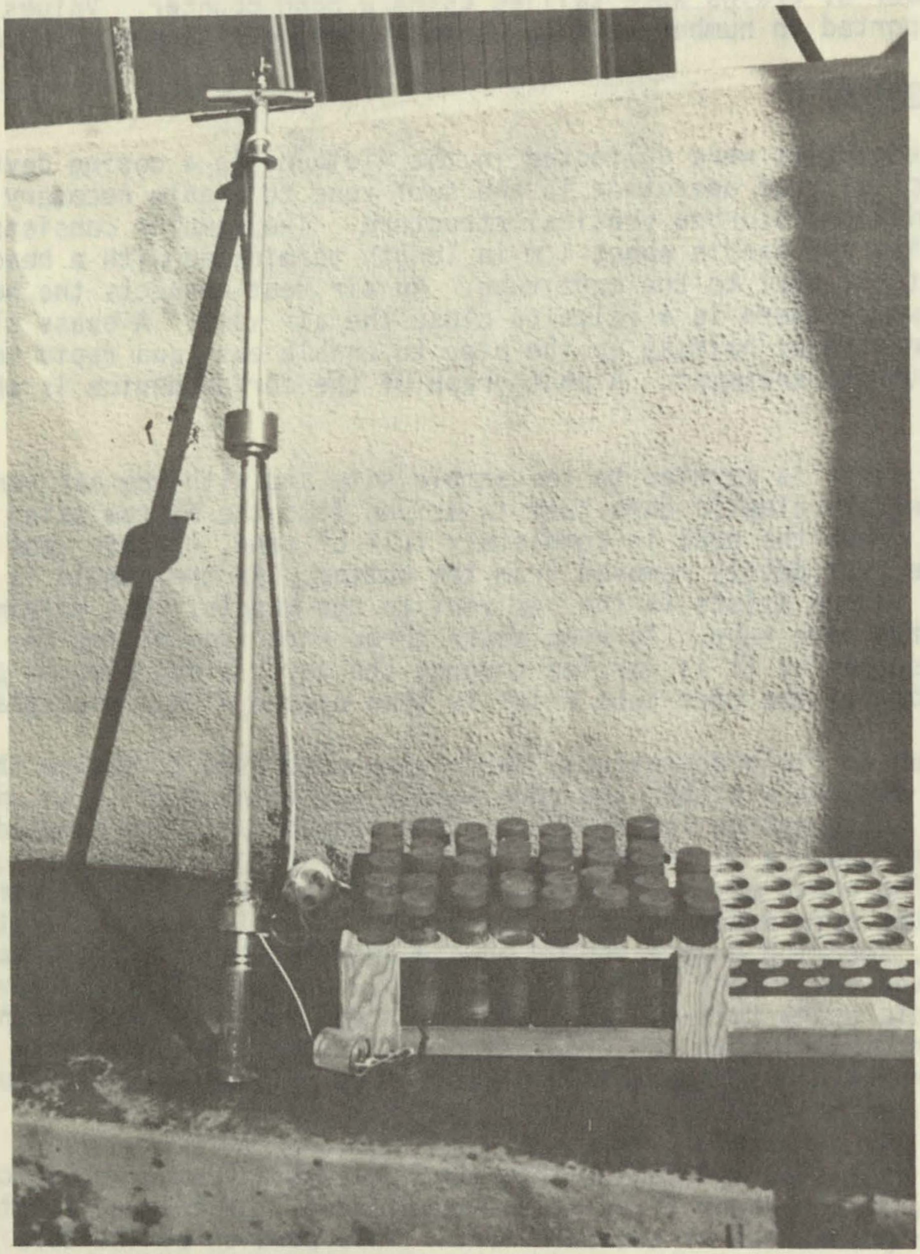
Core Samples

Core samples were collected in the field using a coring device designed for simplicity of operation in the surf zone to enable recovery of sediment cores with undisturbed vertical structure. The sampler consists of a stainless steel pipe and handle about 1 m in length terminated with a head machined to be an air tight seal to the core tube. An air vent connects the head to the handle where there is a valve to close the air vent. A brass slide hammer is positioned about halfway up the pipe to enable easy and rapid insertion of the core into the sediment. A photograph of the coring device is shown in Figure 4C-2.

The corer is carried to the sample site and with the air vent in the open position, the plastic core tube is driven into the bottom using the slide hammer. When the core is completely full of sand, the air vent is closed and the core tube gently removed from the bottom. As the sample is withdrawn, a partial vacuum exists in the air vent to the handle, thus holding the sand inside the core tube. To keep water turbulence from mixing the lower portion of the sample as it is carried through the surf, a PVC plug is placed into the bottom of the core tube which is then capped with a plexiglas retainer.

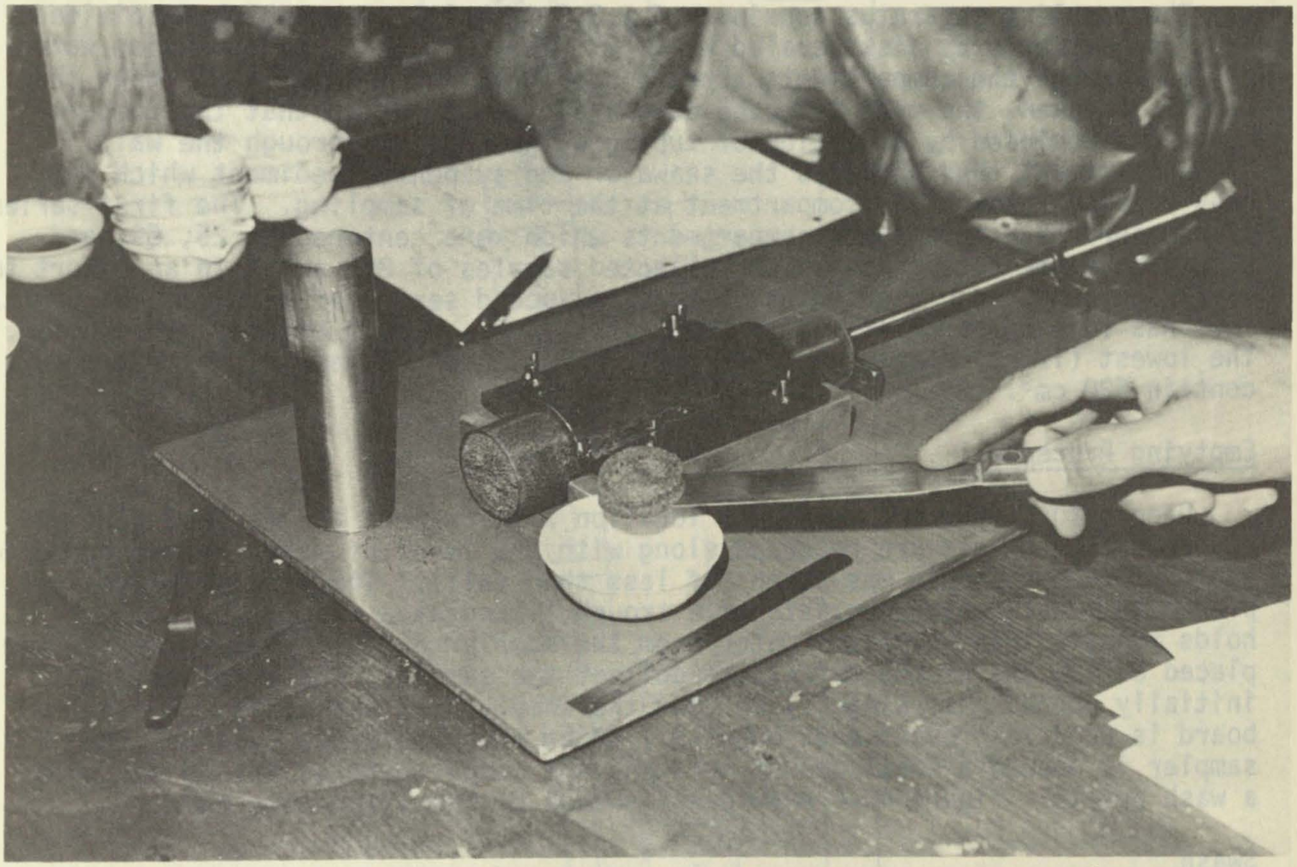
Prior to field operations, tests were conducted to ensure that the sedimentary structure within the core sample was maintained in an undisturbed manner. Alternating layers of dyed and undyed sand were sampled and carefully inspected under a fluorescent light for disruption of the horizontal stratification. The outer edges of the sample were found to have some vertical smearing due to the core dragging particles along the wall as it penetrated the sand. However, smearing only extended inward from the core wall one to two grain layers and the effect could be removed by cutting away the outer edges of the sample using thin-walled stainless steel tubing one-half centimeter in diameter smaller than the original plastic core tube. Butyrate tubing was used for the cores; the inside diameter was 4.13 cm with 0.16 cm wall thickness and the length was 15 cm.

For analysis, sediment within the core was extruded in 0.5 cm increments. By means of a plunger fixed to a threaded rod, the desired length of sample could be pushed out of the core tube. This portion of the core was sliced off and the outer portion of the core where contamination may have occurred due to drag on the walls was removed using the thin walled tubing. The remaining sample was then placed in a porcelain weighing dish. A photograph showing this operational sequence is shown in Figure 4C-3. By continuing this process, each half centimeter within any one core could be inspected for dyed tracer yielding concentration as a function of depth in the core. Each sample from within a core was rinsed three times with deionized water by decanting



8 Nov.'78 78.160-18

Figure 4C-2. Corer



16 Jan. 79 79.2-9

Figure 4C-3. Core Sample Methodology

the excess water after each rinse. The samples were then evaporated to dryness in an evaporating oven at 120° C overnight. Samples were analyzed for total number of dyed grains per gram of sample using the same technique as with the grab samples. The counting technique was carefully tested between individual counters to eliminate "operator bias." This was done by having four or five different individuals count the same samples independently. Comparisons showed less than 2% discrepancy between counts, so that high confidence can be placed in the counting technique.

3. Discrete Suspended Sediment ("Water Core") Samples

Sampler

The sampling apparatus consists of a 3.5 inch I.D. tube which is divided into compartments by disks sealed with "O" rings. In the open position water passes through the compartments through openings in the tube wall. When the sample is taken, the tube is moved downward by a spring so that the compartments are enclosed by a section of tubing without holes through the wall. The compartment thus encloses the seawater and suspended sediment which had been passing through the compartment at the time of sampling. The first series of samplers have three such compartments which were centered at 25, 59, and 93 cm above the bottom and which collected samples of 800 cm^3. In an effort to obtain information closer to the bottom, a second series of samplers was built. This has four compartments centered at 17, 37, 60, and 83 cm above the bottom. The lowest (17 cm) compartment contains 320 cm^3 and the remaining compartments contain 620 cm^3.

Emptying Procedure

Upon return from the surf, the location with respect to the surf zone and any reference points are recorded along with the level of water in the compartments after the sample was taken (if less than full). The full samplers are placed in a rack which consists of a trough tilted at a slight angle which holds funnels into which the water from the sampler drains. Numbered jars are placed on the end of the funnels to collect the sample. The samplers are initially opened only slightly so that the sample does not spill. A stop board is used to prevent over-opening. After the sample has drained, the sampler is opened a small amount more and the compartment is washed out with a wash bottle. Figure 4C-4 provides a sketch of the water core rack.

Swash

The swash sampler consists of a plastic bag which is held open by two horizontal bars at its mouth. The sampler's mouth is directed into the flow and the bars at the mouth are closed to seal the sample in the bag. The sample and bag are stored in a numbered jar(s).

Laboratory Procedure

The samples were processed as follows:

1) The sample bottles were shaken to resuspend the sediment and the contents were emptied into a large evaporating dish. The bottle and cap

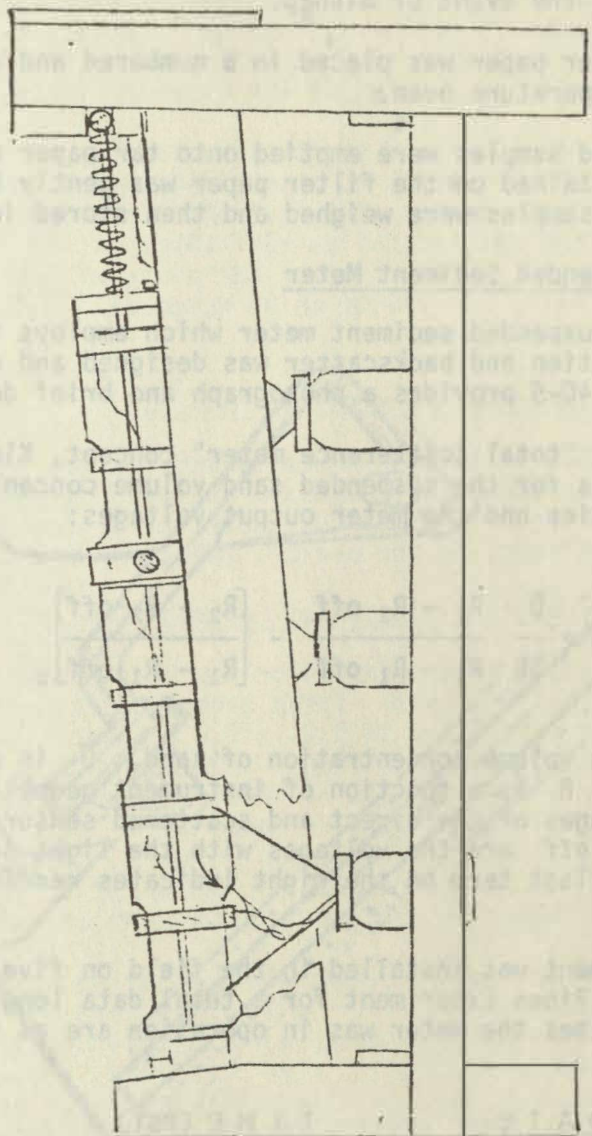


Figure 4C-4. Water Core Rack

were rinsed into the dish with deionized water to collect any remaining particles. The surface was sprayed with distilled water to break surface tension and thus allow the sediment to settle. Water was decanted into another dish and examined to be sure no material was lost during decanting. The remaining seawater and sediment was washed into a 150 ml fluted funnel lined with 18.5 cm diameter #2 Whatman filter paper. A Schleicher and Schnell #123 two-inch filter support was used and a beaker was placed below the funnel so that the sample would be protected from loss in the event of mishap.

2) The filter paper was placed in a numbered and dated vial and dried in a low temperature oven.

3) The dried samples were emptied onto tar paper and any sediment which was still retained on the filter paper was gently brushed unto the tar paper. The samples were weighed and then stored in labeled vials.

4. Optical Suspended Sediment Meter

An optical suspended sediment meter which employs the combined principle of light attenuation and backscatter was designed and developed by Klein [1972] at SIO. Figure 4C-5 provides a photograph and brief description of the meter.

Based on the "total scatterance meter" concept, Klein [1972] gave the following formula for the suspended sand volume concentration in terms of the sediment properties and the meter output voltages:

$$N = \frac{\overline{D}}{3B} \frac{R_2 - R_2\,\mathrm{off}}{R_1 - R_1\,\mathrm{off}} - \left[\frac{R_2 - R_2\,\mathrm{off}}{R_1 - R_1\,\mathrm{off}}\right]_0$$

where N is the volume concentration of sand, $\overline{D}$ is a measure of the average grain diameter, B is a function of instrument geometry, R_1 and R_2 are the output voltages of the direct and scattered sensors, respectively, and R_1 off and R_2 off are the voltages with the light source off. Finally, the sub-zero in the last term on the right indicates readings at zero sand concentration.

This instrument was installed in the field on five separate days during the NSTS Torrey Pines Experiment for a total data length of about 17 hours. The dates and times the meter was in operation are as follows:

DATE	TIME (PST)
NOV 08	1315 - 1608
NOV 15	1150 - 1345
NOV 20	1030 - 1430
NOV 22	1057 - 1400
NOV 24	1000 - 1545

The meter was located at X(offshore) = 170.7 meters and Y(longshore) = 10 meters.

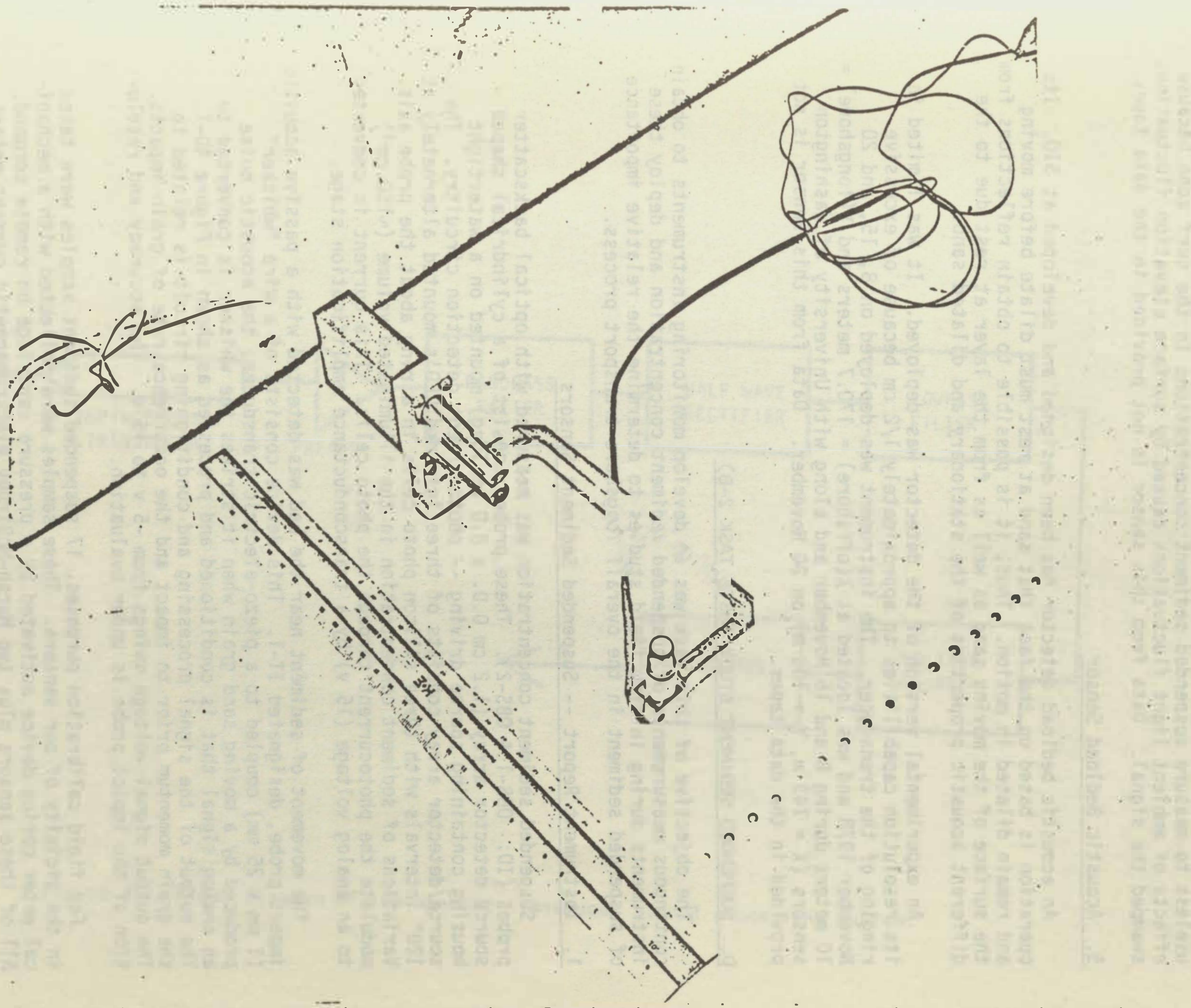


Figure 4C-5. Integrated scatterance meter in use at Scripps Institution of Oceanography. Light source with cosine distribution (in the foreground) is detected directly by upper sensor (acting as transmisometer), while lower sensor only sees light that has been scattered. The scattering coefficient is proportional to the volume concentration of the suspended sediment. Meter was designed by Steve Klein.

It was reported by Flick and Parker [1978] that the device was essentially useless to measure suspended sediment concentrations in the surf zone because effects of ambient light fluctuations caused by surface elevation fluctuations swamped the signal. Data from this sensor is not provided in the data tapes.

5. Acoustic Bedload Sensor

An acoustic bedload detector has been designed and developed at SIO. Its operation is based on the fact that sand at rest must dilate before moving and remain dilated in motion. Thus, it is possible to obtain reflections from the surface of the moving sand as well as from the layer at rest due to the different acoustic properties of the stationary and dilated sand.

An experimental version of the detector was deployed. It was limited in its resolution capabilities to approximately 1/2 cm because of excessive ringing of the transducer. The instrument was deployed on 8, 15, and 20 November 1978 and was located at X(offshore) = 170.7 meters and Y(longshore) = 10 meters during 8 and 15 November and along with University of Washington sensors (X = 143 m, Y = 100 m) on 20 November. Data from this sensor is not provided in the data tapes.

D. SUSPENDED SEDIMENT STUDY (NSTS TASK 2-B)

The objective of this task was to develop monitoring instruments to obtain continuous measurements of suspended sediment concentration and deploy these instruments during in situ field studies to determine the relative importance of suspended sediment in the overall longshore transport process.

1. Instrument Report -- Suspended Sediment Sensors

Suspended sediment concentration was measured with optical backscatter probes (ID: OBS-1 & OBS-2). These probes consist of a cylindrical shaped source detector array (1.2 cm O.D. x 8.0 cm long) mounted on a watertight housing containing source driving -- photocurrent detection circuitry. The source/detector array consists of three infrared LED's mounted alternately at 120° intervals with three silicon photo cells in a ring about the probe axis. Variations of sediment concentration in the illuminated volume ($\sim$150 cm^3) modulate the photocurrent through the photo cells. This current is converted to an analog voltage (15 v) by a transconductance amplification stage.

The movement of sediment near the bed was detected with a passive acoustic impact probe, designated IT-1. This device consists of a wire "whisker" (1 mm x 25 mm) coupled to a piezo-electric transducer; the acoustic noise produced by a moving sand grain when it strikes the whisker is converted to an analog signal that is conditioned and processed as shown in Figure 4D-1. The output of the signal processing and conditioning circuit is related to the grain momentum prior to impact and the occurrence rate of grain impacts. The output signal voltage swings from -5 v to +5 v. The accuracy and resolution of the impact probe is under evaluation.

For field calibration purposes, 17 suspended sediment samples were taken in the vicinity of our sensors. These samples were collected with a mechanical water coring device activated by a pressure cartridge on remote command. All of these sensors plus two Marsh-McBirney electromagnetic current meters

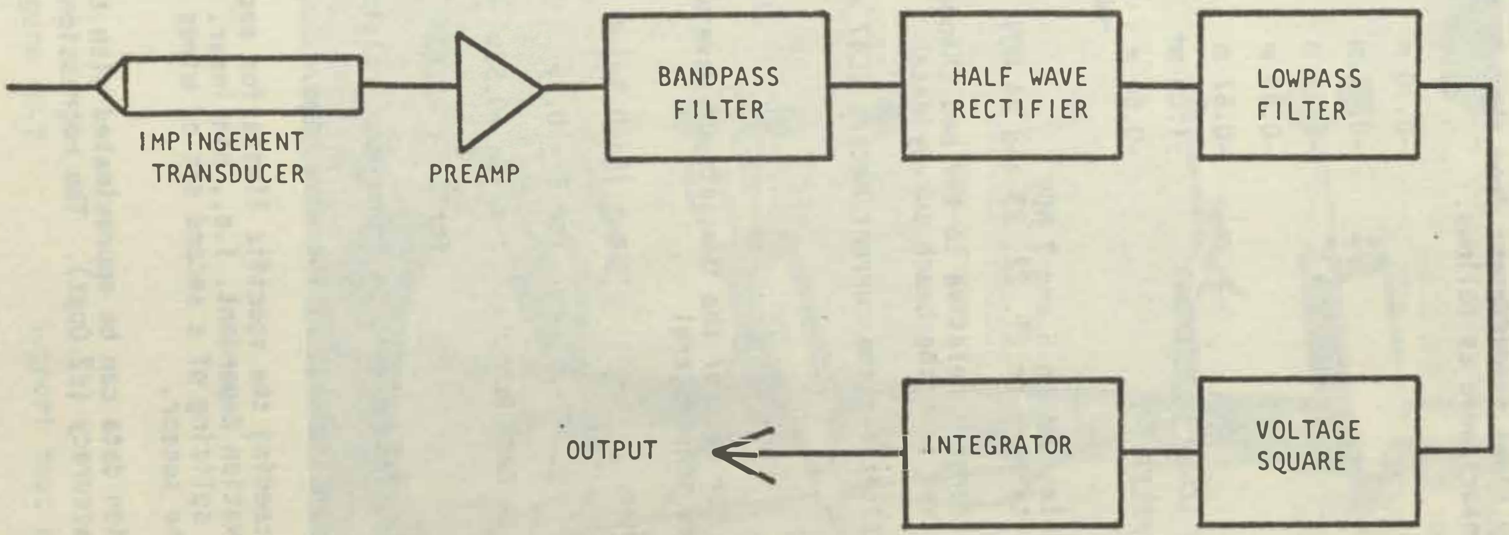


Figure 4D-1 Block diagram of impingement transducer signal processing system.

(I.D.: C-47, C-49) were mounted on a guyed mast that was located at -100 m longshore (Y) and +170 m offshore (X) from bench mark SIO-4. A SIO-SPL resistance wave sensor (I.D.: W-48) was used to measure the true surface elevation and was located on the guy wires. A photograph of the mast and the attached sensors is provided in Figure 4D-2. The relative position of the probes used at Torrey Pines is different from that in the photograph. The elevations of the sensors were as follows:

C47	-0.30 m	
C49	-0.74 m	
OBS-1	-0.74 m	
OBS-2	-0.45 m	
IT-1	-0.87 m	
W48 (ELEV. OF LOWER WIRE ENDS)	-1.03 m*	-0.76 m+
MECHANICAL SAMPLER	-0.64 m (-2.10 ft)	

*for data runs on 5 and 7 NOV
+for data runs on 21, 22, 23 and 24 NOV

The elevations of the sensors relative to the bed changed day to day. These elevations can be derived from the beach survey data.

The still water offset for the current meters (C47 and C49) was Ø and the gain

$0.62\ mv^{-1}$.

The gains and offsets for each of the two sets of wave wires used with the SIO-SPL resistance wave sensors are:

NOV 5 AND 7 DATA RUNS $z = |E_o - 0.9v|\ 0.493 m \cdot v^{-1} - 0.43m$

for $E \leq 0.9v$

NOV 21, 22, 23, & 24 DATA RUNS: $z = |E_o + 0.52v|\ 0.459 m \cdot v^{-1} - 0.07m$

for $E_o \leq -0.53$

where: z = free surface elevation in meters (relative to MSL)

E_o = DC output voltage of the wave gage.

For output voltages exceeding the specific limits for each of the equations above, the gain is elevation dependent, i.e., nonlinear. The gains differ by about 7% due to the splicing of a second set of wires that changed the series resistance of the sensor.

The OBS-1 calibration data can be approximated with two linear relationships with reasonable accuracy (±2.0ppt). The regressions are as follows:

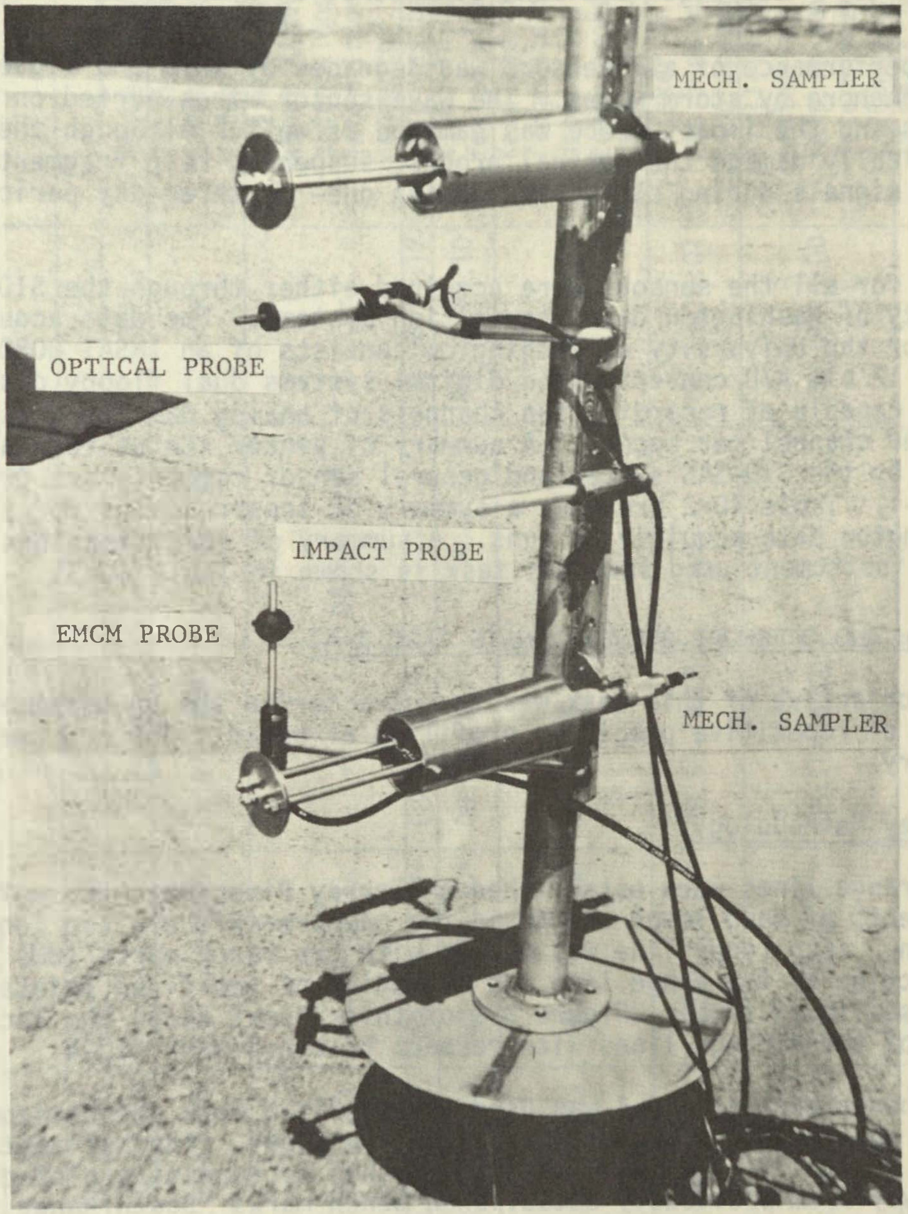


Figure 4D-2 Support Mast and Sensors

for: +2.42v $\leq$ Eo $\leq$ +4.94v $C_s = (4.94-E_o)\ 16.4\text{ppt}\cdot v^{-1} + 8.7\text{ppt}$

for: -013v $\leq$ Eo <2.42v $C_s = (2.42-E_o)\ 20.6\text{ppt}\cdot v^{-1} + 50.0\text{ppt}$

where C_s = suspended sediment concentration by weight.

The performance of all sensors was degraded by kelp and algae fragments carried onshore by storm waves. The wave-sensor wires parted on a number of occasions and the impact probe was damaged as well. Although the kelp did not physically damage the optical probes, suspended kelp fragments produced spurious signals during storms and during one- to three-day periods following storms.

Data for all the sensors were acquired either through the SIO-SAS or University of Washington data acquisition systems. The data acquisition system for the University of Washington consists of an IMSAI 8080 microprocessor, a 12 bit A/D converter and digital systems dual floppy disk recorder which is capable of recording ten channels of analog data at a sampling rate of ten per channel per second. A summary of sensor status for data transmissions by the SIO-SAS system and general sensor comments are provided in Table 4D-1. Table 4D-2 provides a summary of sensor status for the University of Washington data acquisition runs. A summary of specifications and calibrations for each instrument used for this task is shown in Table 4D-3.

E. BEACH AND OFFSHORE SURVEYS (NSTS TASK 3-A)

The objective of this task was to characterize the on-offshore transport by means of repetitive precision profiling of beach slope and nearshore bathymetry.

1. Survey Methodology

Ten range lines were established on Torrey Pines Beach to make repeated measurements of sand level change in the onshore-offshore and longshore direction. Each range line was marked with two bench marks (BM) that define the direction of the range line and elevation of two fixed points relative to mean sea level (MSL). Figure 3-2 of this report shows the location and spacing of these range lines with respect to bench mark SIO-4.

The bench mark at SIO-4 was used to establish both the horizontal and vertical control for all other profile range lines. The horizontal and vertical control for BM SIO-4 was established by running a closed loop level line survey from previously established bench marks "South Range," "Indian Canyon," and "North Range" [Nordstrom and Inman, 1975]. As a result, all the Torrey Pines NSTS bench marks are tied into the closest government bench mark USCGS "Ball" which is located in the NW 1/4 of Section 12, Township 15 South Range 4 West from the San Bernardino meridian and base line. The horizontal and vertical control for USCGS "Ball" and SIO-4 are as follows:

USCGS "BALL"

Latitude: 32°53'14" N
Longitude: 117°15'01" W

TABLE 4D-1

SUMMARY OF SENSOR STATUS FOR DATA TRANSMISSIONS
BY SCRIPPS-SAS SYSTEM
DURING NOVEMBER 1978 NSTS TORREY PINES BEACH EXPERIMENT

DATE	HOURS OF OPERATION						COMMENTS
	W48	C47 (U&V)	C49 (U&W)	OBS-1	OBS-2	IT-1	
7 NOV	09:56-15:25	09:56-15:25	09:56-15:25	09:56-15:25			
8 NOV	----	12:30-17:00	----	----	----	----	Tracer Experiment
10 NOV	----	06:47-11:45	06:47-11:45	06:47-11:45	----	----	07:35-08:05 Sensor Outputs grounded to record D.C. offsets.
11 NOV	----	06:45-12:11	06:45-12:11	----	06:45-12:11	----	C49 W has D.C. Offset of about 450mV. Possible ground loop? OBS-2 had intermittent short in connector.
17 NOV	----	08:06-14:17	08:06-14:17*	08:06-14:17	----	08:06-14:17	Kelp was bad on this day.
18 NOV	----	08:00-14:10	08:00-14:10*	08:00-14:10	----	08:00-14:10	11:00-14:00 Instruments fouled with kelp.
19 NOV	----	08:30-14:03	08:30-14:03*	08:30-14:03	----	08:30-14:30	Kelp and other algae fragments in scour depression at base of tower probably degraded OBS-1 & IT-1 data.
20 NOV	----	08:55-14:01	08:55-14:01*	08:55-14:01	----	08:55-14:01	Whisker of impact probe was bent ≈30° but operation appears unaffected.
21 NOV	08:18-16:00	08:18-16:00	08:18-16:00*	08:18-16:00	----	08:18-16:00	11:11-11:26 Off line, generator out of fuel. 14:00 Kelp on wave wires. 13:30 Intermittent D.C. offsets (~200mV) on all channels.
22 NOV	08:20-14:34	08:20-14:34	08:20-14:34*	08:20-14:34	----	08:20-14:34	12:00-14:34 Wave wires were quite slack but signal looked reasonable.
24 NOV	09:00-15:00	09:00-15:00	09:00-15:00*	09:00-15:00	----	09:00-15:00	

*049 Probe was operated in a damaged condition during these periods (probe axis bent slightly ~65° relative to mounting sting).

U&V = horizontal

U&W = vertical

TABLE 4D-2

SUMMARY OF SENSOR STATUS DURING UNIVERSITY OF WASHINGTON DATA ACQUISITION RUNS -- 1978 NSTS TORREY PINES BEACH EXPERIMENT

DATE	HOURS OF OPERATION						COMMENTS
	W48	C47 (U&V)	C49 (U&W)	OBS-1	IT-1	DISK NOS.	
5 NOV	23:29-23:49	23:29-23:49	23:29-23:49	23:29-23:49	---	20	
7 NOV	00:31-01:31 09:56-11:14	00:31-01:31 09:56-11:14	00:31-01:31 09:56-11:14	00:31-01:31 09:56-11:14	---	22,23 24,25,26	
10 NOV	---	08:05-10:38	08:05-10:38	08:05-10:38	---	27-32	
19 NOV	---	23:15-23:58	22:15-23:58	22:15-23:58	22:15-23:58	33-35	Wave-Sensor Wires Parted
20 NOV	---	23:25-23:56	23:25-23:56	23:25-23:56	23:25-23:56	36	See Comments in Table 4D-1
21 NOV	11:32-16:50 23:36-02:14	11:32-16:50 23:36-02:14	11:32-16:50 23:36-02:14	11:32-16:50 23:36-02:14	11:32-16:50 23:36-02:14	37-45 46-55	See Comments in Table 4D-1
22 NOV	09:12-14:10	09:12-14:10	09:12-14:10	09:12-14:10	09:12-14:10	56-67	See Comments in Table 4D-1
23 NOV	10:30-13:10	10:30-13:10	10:30-13:10	10:30-13:10	10:30-13:10	68-74	See Comments in Table 4D-1

TABLE 4D-3

SPECIFICATIONS OF INSTRUMENTATION USED BY THE UNIVERSITY OF WASHINGTON
TORREY PINES BEACH EXPERIMENT

INSTRUMENT NBR.	SENSOR TYPE - MODEL NO./ (SERIAL NO.)	DYNAMIC RANGE	ACCURACY/ RESOLUTION	GAIN/OFFSET RELATIONSHIP
C47	Electromagnetic Current Meter #512 OEM/(S-139)	±3.44 ms^{-1}	±5 -10% of† value	C47-X: Gain=0.66 $m \cdot s^{-1} \cdot V^{-1}$;offset = 0.0V C47-Y: Gain=0.69 $m \cdot s^{-1} \cdot V^{-1}$;offset = 0.0V Output Filter: 3 pole, 4 Hz
C49	Electromagnetic Current Meter #512 OEM/(S-140)	±3.44 ms^{-1}	±5 -10% of† value	C49-X: Gain=0.69 $m \cdot s^{-1} \cdot V^{-1}$;offset = 0.0V C49-Z: Gain=0.71 $m \cdot s^{-1} \cdot V^{-1}$;offset = 0.0V Output Filter: 3 pole, 4 Hz
W48	Surface Piercing Resistance Wave Gage	2.5 m	±3% of † value	Gain=0.46 $m \cdot s^{-1} \cdot V^{-1}$ Zero Drift: 0.3 cm per week †
OBS-1	Optical Backscatter Suspended Sediment Sensor	8.7-50 ppt*	±0.5 ppt*	$C_s = (4.94V - E_0)\ 16.4\ ppt \cdot V^{-1} + 8.7\ ppt;$ $2.42V \leq E_0 \leq 4.94V$ $C_s = (2.42V - E_0)\ 20.6\ ppt \cdot V^{-1} + 50.0\ ppt;$ $-0.13V \leq E_0 < 2.42V$
OBS-2	Optical Backscatter Suspended Sediment Sensor	1.0-60 ppt*	±1.0 ppt*	$C_s = 35\ ppt - (E_0 + 1.45V)\ 30.3\ ppt \cdot V^{-1};$ $-3.62V \leq E_0 \leq 1.45V$ $C_s = \quad - (E_0 - 0.23V)\ 20.8\ ppt \cdot V^{-1};$ $-0.23V \leq E_0 < -1.45V$
IT-1	Grain Impact Suspended Sediment Sensor	0.7-100 ppt*	±50% of value	$C_s = 17.5\ [X];\ X \leq 0.40$ $C_s = 332\ (X - 0.40) + 7\ ppt;\ 0.40 < X \leq 0.71$ $X = [(4.31V - E_0)/(U_x^2 + U_y^2)]^{-}$[illegible]

E_0 = Analog voltage output

† Based on tests conducted by Shore Processes Lab (SIO)

* Sediment concentration is by weight

California Lambert Coordinates, Zone 6:

N 263,653
E 1,692,936

Elevation: 326.30 feet MSL

"SIO-4"

Latitude: 32°53'55" N
Longitude: 117°15'10" W

California Lambert Coordinates, Zone 6:

N 268,150
E 1,692,000

Elevation: 10.02 feet above MSL

All NSTS survey range lines were oriented normal to the offshore contours resulting in a bearing of 4.5° south of true west or 265.5° true. Beach profile data of the backshore and upper foreshore were measured using a level, surveyor's rod, and tape. The method described here is identical to that explained by Nordstrom and Inman [1975]. Elevations were measured to 0.3 cm and distances to 3 cm. Alignment along the range line was achieved by using flags to mark the two bench marks on the range. Rod stations were measured at six-meter intervals seaward of the bench mark except where pronounced changes in slope occur. Measurements were made out into the water by the tapeman paying out the tape in six-meter increments from a fixed point at the water's edge. The land or wading profile survey was terminated when the water became too deep for the rodman to wade or the breaking waves made it impossible to plumb the rod.

Surveys of the offshore profile were obtained through the use of a 16-foot boat equipped with a Raytheon Model DE719 survey depth fathometer and a Motorola Miniranger III line of sight microwave range positioning system.

The portable fathometer allows for calibration of seawater temperature and salinity as well as draft. Other corrections needed to eliminate wave and tide errors were also performed to correct the raw fathometer readings to the actual bottom profile (corrected to MSL), as described in the following sections.

The Miniranger III system outputs distances from two portable shore referenced stations located at known geographic positions to trilaterate the exact position of the boat to within one meter at distances less than two kilometers. The computer program used to perform these calculations is contained in Appendix G.

The offshore profiles were measured at high tide on November 9 and 18, 1978. The beach profiles were measured on the following day at low tide to provide continuous elevation data through the surf zone, foreshore, and backshore. The offshore and beach surveys are combined into a single profile by referencing all data points to the MSL datum.

Wading and offshore profile dates and a list of all ranges surveyed for each date are provided in Tables 4E-1 and 4E-2. Figure 4E-1 provides a sketch of the survey procedure that was used for the beach and offshore surveys.

2. Positioning System (MRS III) Calibration Methodology

The Miniranger system was calibrated using a known range of 304.8 meters (Scripps Pier). During the calibration for the 9 November survey, difficulty was experienced in maintaining consistent calibration settings and drifting on the order of four to six meters (±2%) was observed. When the data from this survey were analyzed, using the mean value of the calibration factor, it was apparent that drifting had occurred during the survey. As part of the fathometer calibration check, marks were made on the fathometer record when certain spar buoys and wave poles were directly abeam. The position of these fixed references had been carefully determined in prior surveys. In addition, on two occasions, the fathometer passed directly over pressure sensors of known position and these appeared as spikes on the fathometer record. By cross-comparisons of time marks, it was possible to determine the actual position for several positions indicated by the Miniranger. Further, there was overlap, or near overlap, with several of the wading surveys so that a number of fits could be obtained in this manner. Using all available data, "best fit" calibrations were obtained for each Miniranger survey line. These calibrations ranged from 1.00 to 1.04, a total variation of 4%, which was consistent with the observed drift during the pier calibration.

The 18 November survey required no ad hoc adjustment of the calibration factors.

3. Fathometer Calibration and Bar Check Methodology

The fathometer was calibrated against two references. The first was a standard lead line which was employed several times during each survey. The second was by means of bottom-mounted pressure sensors. The average value of sea surface elevation was obtained from fifteen minute records centered at the time of the survey boat passing the sensor. The height of the sensor above the bottom was obtained by diver measurements.

There was excellent agreement between calibrations obtained by both methods for both surveys as well as lead line checks made on the same instrument during surveys on 14 and 15 August 1978. The calibration factor during all surveys was 1.075 and there was no offset.

4. Wave Smoothing and Digitizing Methodology

The strip chart records from the fathometer were filtered manually to remove the effects of waves. This was accomplished by sketching a smoothed line through the visually determined mean. All records were smoothed by the same operator to insure that any bias would be consistently applied.

Time marks at approximately one minute intervals were applied to the strip chart using the Miniranger time base. Interpolations were made between these marks to ten-second intervals and the uncalibrated depth was read at these points and transferred to IBM cards along with the corresponding ranges from the Miniranger paper tape record.

TABLE 4E-1

WADING PROFILES

DATE	RANGES COMPLETE
OCTOBER 27	All
29	SIO-4
NOVEMBER 3	All
4	SIO-4
5	SIO-4; R-24, 25, 27, 28, 35, 32, 33
6	SIO-4
7	All
8	SIO-4; R-24, 25,26, 27, 28
10	SIO-4; R-24, 26, 28, 35, 32, 33
12	SIO-4
13	All
14	SIO-4
15	SIO-4; R-24, 25, 27, 28, 35, 32, 33
16	SIO-4
17	SIO-4; R-24, 26, 27, 28, 34, 32, 33
19	All
20	SIO-4
21	SIO-4; R-34, 35, 32, 33
22	SIO-4
24	All

TABLE 4E-2

OFFSHORE PROFILES

NOVEMBER 9, 1978

RANGES:

SIO 4 (UPPER BEACH SURVEY OCT 29)

R 24

R 26

R 27

R 28

R 32

R 33

R 34

R 35

NOVEMBER 18, 1978

RANGES:

SIO 4

R 24

R 25

R 26

R 27

R 28

R 32

R 33

R 34

R 35

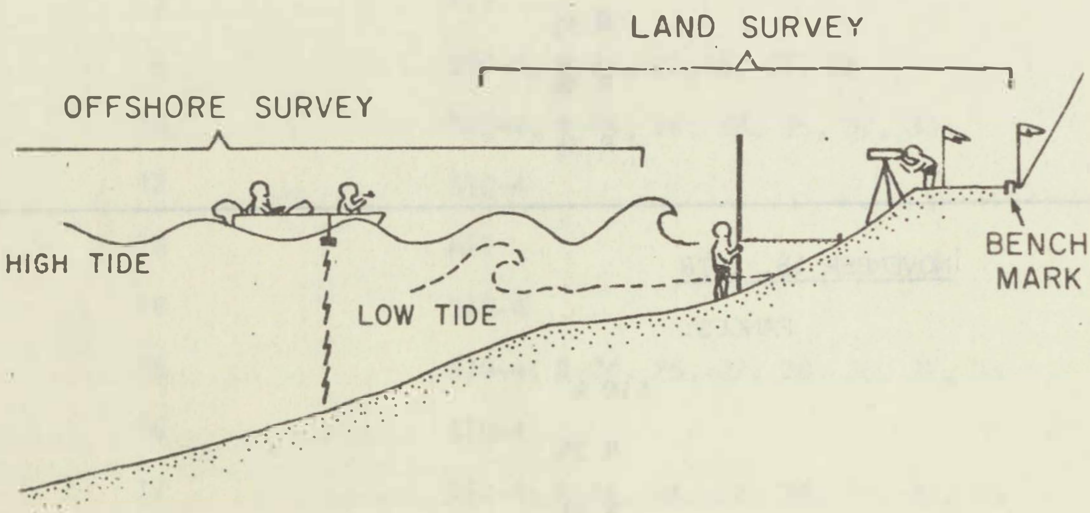


Figure 4E-1. Survey Procedure

5. Tide Corrections and Methodology

A computer program, contained in Appendix G, was written to calculate the tide height above or below MSL for any time. The tide model uses the eight most important tidal functions with the coefficients determined from long-term observations at Scripps Pier. The raw fathometer depths were calibrated in the computer and then the calculated tide was removed to give depth below MSL. Because of the ease of calculation, the tidal correction was calculated for each survey point so that no time lags were involved.

The tide predicting program was verified by comparing it to the measured tides taken from bottom-mounted pressure sensors at the experiment site. The maximum error was 6 cm in predicting the tidal amplitude.

6. Contour Plots

The fathometer surveys for 9 and 18 November and the beach face surveys for adjacent days have been contoured in meters above MSL. These contour plots are shown in Figures 4E-2 and 4E-3.

Horizontal range control on the fathometer surveys was restricted by large waves and poor visibility, particularly during the 18 November survey. Therefore, it was necessary to extrapolate depths to the actual range lines to facilitate data reduction on instruments mounted on these ranges. This was accomplished from the contour plots by redigitizing depths. The data tapes contain depths along the range lines obtained in this manner.

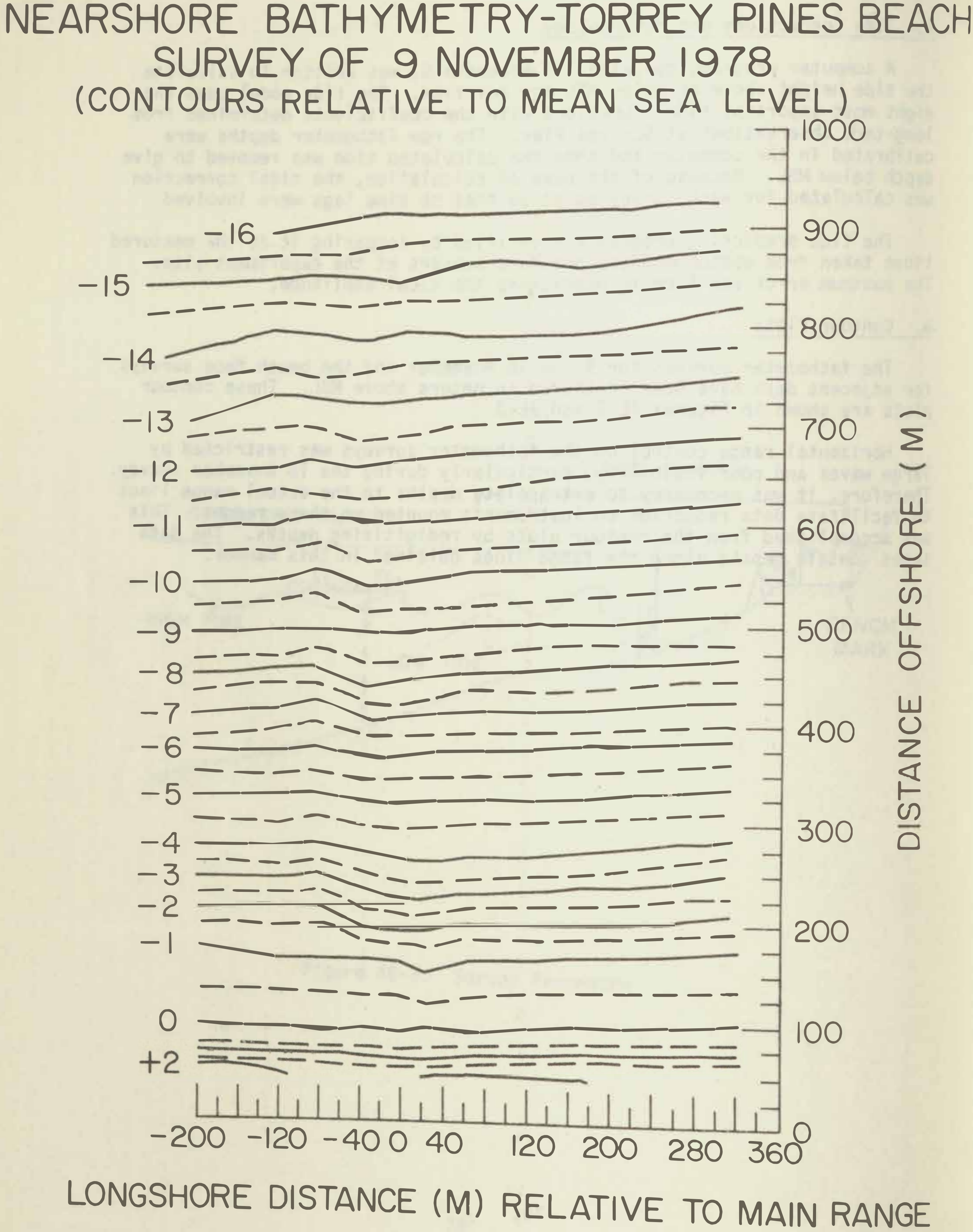

NEARSHORE BATHYMETRY-TORREY PINES BEACH
SURVEY OF 9 NOVEMBER 1978
(CONTOURS RELATIVE TO MEAN SEA LEVEL)
-16
-15
-14
-13
-12
-11
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
+2
1000
900
800
700
600
500
400
300
200
100
0
DISTANCE OFFSHORE (M)
-200
-120
-40
0
40
120
200
280
360
LONGSHORE DISTANCE (M) RELATIVE TO MAIN RANGE

FIGURE 4E-2

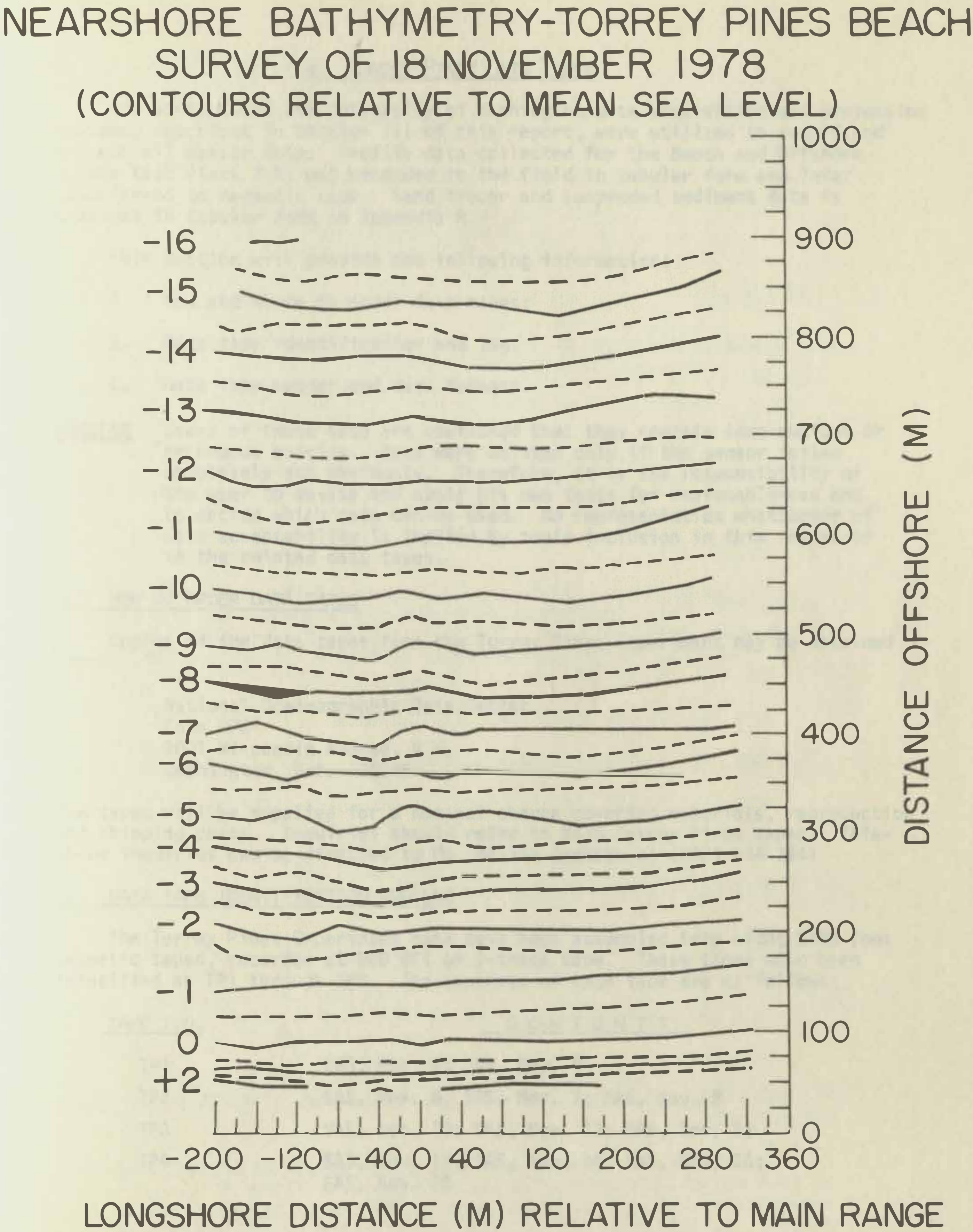

NEARSHORE BATHYMETRY-TORREY PINES BEACH
SURVEY OF 18 NOVEMBER 1978
(CONTOURS RELATIVE TO MEAN SEA LEVEL)
-16
-15
-14
-13
-12
-11
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
+2
1000
900
800
700
600
500
400
300
200
100
0
DISTANCE OFFSHORE (M)
-200
-120
-40
0
40
120
200
280
360
LONGSHORE DISTANCE (M) RELATIVE TO MAIN RANGE

FIGURE 4E-3

V. TORREY PINES DATA TAPES

The Scripps SAS and University of Washington data acquisition and processing systems, described in Section III of this report, were utilized to record and process all sensor data. Profile data collected for the Beach and Offshore Survey task (Task 3-A) was recorded in the field in tabular form and later transferred to magnetic tape. Sand tracer and suspended sediment data is provided in tabular form in Appendix A.

This section will provide the following information:

A. How and where to order data tapes;

B. Data tape identification and log;

C. Data tape header and data formats.

WARNING Users of these data are cautioned that they contain some dubious or erroneous entries. Data were deleted only if the sensor failed completely and obviously. Therefore, it is the responsibility of the user to devise and apply his own tests for reasonableness and to decide which data can be used. No representation whatsoever of data acceptability is implied by their inclusion in this report or in the related data tapes.

A. HOW TO ORDER DATA TAPES

Copies of the data tapes from the Torrey Pines Experiment may be obtained from:

National Oceanographic Data Center
Code D781
2001 Wisconsin Avenue, N.W.
Washington, D.C. 20235

The tapes will be supplied for a nominal charge covering materials, reproduction and shipping costs. Inquiries should refer to NSTS Torrey Pines tapes. Telephone inquiries can be directed to Ms. Maxine Jackson at (202) 634-7441.

B. DATA TAPE IDENTIFICATION AND LOG

The Torrey Pines Experiment data have been assembled into eight 2400 foot magnetic tapes, recorded at 800 BPI on 9-track tape. These tapes have been identified as TP1 through TP8. The contents of each tape are as follows:

TAPE I.D.	CONTENTS
TP1	SAS, Nov. 4; SAS, Nov. 5
TP2	SAS, Nov. 6; SAS, Nov. 7; SAS, Nov. 8
TP3	SAS, Nov. 10; SAS, Nov. 11; SAS, Nov. 12
TP4	SAS, Nov. 13; SAS, Nov. 14; SAS, Nov. 15; SAS, Nov. 16

TAPE I.D.	CONTENTS
TP5	SAS, Nov. 17; SAS, Nov. 18
TP6	SAS, Nov. 19; SAS, Nov. 20
TP7	SAS, Nov. 21; SAS, Nov. 22
TP8	SAS, Nov. 24; SAS, Dec. 6; all University of Washington data recorded separately from the SAS system; and all Beach and Offshore Survey data

C. TAPE FORMATS

1. Scripps SAS Tapes

Each day's data forms a logical tape on the master tape. A logical tape is defined as a number of files with the last file denoted by an extra end of file mark (EOF).

The twenty Scripps SAS logical (daily) tapes each contain two types of files. The first file is a header file and the remaining each contain up to 90 data records.

a) Header File

The header file consists of three records. The first contains 108 unformatted binary integers. The second and third each contain 540 unformatted binary integers. The only significant data contained in the first (108 word) record are the number of active transmitters and the date and time of the run.

Word (41) is the starting day of the month.

Word (42) is the starting month number.

Word (43) is the starting hour (24 hour basis) PST and,

Word (45) is the starting minute. Similarly,

Word (53) is the ending day.

Word (54) is the ending month.

Word (55) is the ending hour, PST.

Word (57) is the ending minute, and,

Word (61) is the number of active transmitters.

The end times are accurate to within a few minutes. The starting times are accurate.

The second and third (540 word) records should be spliced together to form a 1080 word array. In this array are contained 90 groups of 12 consecutive words. Each of these sets of 12 words describes one data channel.

A 12 word sequence is arranged as follows:

Word (1) = ID, the first integer in a pair that forms the sensor type and numerical designation.

Word (2) = NO, second word in channel designation.

The two integers, "ID" and "NO" when written into a "2A2" format should produce an alphanumeric code identifying the sensor. Most computers will make this conversion directly. However, some experimentation may be required [for example, on a Prime Computer, it was necessary to perform the following conversions: ID = AND (ID, :077577)
NO = AND (ID, :077577)
in which the additional bits resulted in the proper alphanumeric conversion]. To test your machine, "17204" should convert to "C4" and "1288" should convert to "2X."

Word (3) = TK, original transmitter number.

Word (4) = CH, original channel number.

"TK" and "CH" are not necessary to use on these tapes. However, if TK is set to zero, it means that no data are available in this logical tape for this sensor.

Word (5) = LX, offshore location relative to coordinate system in meters (+ is offshore direction).

Word (6) = LY, longshore location relative to coordinate system in meters (+ is north).

Word (7) = COND, a dummy variable without significance.

Word (8) = RECNO, the number of the corresponding record within each data file.

Word (9) = integer part of the sensor gain value.

Word (10) = fractional part of gain value X 1000 [i.e., to recover the gain divide Word (10) by 1000 and add to Word (9)].

Word (11) = integer part of offset

Word (12) = decimal part of offset X 1000 [i.e., combine Word (11) and Word (12) to get the sensor offset in the same manner as for the gain].

A sample of the proper conversion of the header records to a useful format is shown in Table 5-1.

TABLE 5-1

SAMPLE MAGNETIC TAPE HEADER

NSTS EDIT MASTER
SHORE PROCESSES BUILDING
START 171178 810 PST
END 171178 1330 PST
6 TRANSMITTERS

IDNO	TK	CH	LX	LY	COND	RECNO	GAIN	OFFSET
A1S	2	1	43	0	0	2	514.40	0.00
A1D	2	2	43	0	0	8	108.00	0.00
C40X	2	3	99	0	3	14	104.00	0.00
C40Y	2	4	99	0	0	20	104.00	0.00
C39X	2	5	115	0	0	26	104.00	0.00
C39Y	2	6	115	0	0	32	102.00	0.00
C37X	2	7	129	0	0	38	105.00	0.00
C37Y	2	8	129	0	0	44	102.00	0.00
C36X	2	9	143	0	0	50	103.00	0.00
C36Y	2	10	143	0	0	56	103.00	0.00
C35X	2	11	149	60	3	62	63.00	0.00
C35Y	2	12	149	60	3	68	63.00	0.00
C34X	2	13	139	20	0	74	104.00	0.00
C34Y	2	14	139	20	0	80	103.00	0.00
W41	2	15	99	0	3	86	-55.80	157.00
C33X	3	1	143	320	0	3	104.00	0.00
C33Y	3	2	143	320	0	9	103.00	0.00
C32X	3	3	144	160	0	15	108.00	0.00
C32Y	3	4	144	160	0	21	105.00	0.00
C31X	3	5	155	0	0	27	103.00	0.00
C31Y	3	6	155	0	3	33	101.00	0.00
C28X	3	7	146	-40	0	39	109.00	0.00
C28Y	3	8	146	-40	0	45	103.00	0.00
C27X	3	9	145	-80	0	51	105.00	0.00
C27Y	3	10	145	-80	0	57	104.00	0.00
C26X	3	11	141	-120	3	63	103.00	0.00
C26Y	3	12	141	-120	0	69	102.00	0.00
C25X	3	13	137	-160	0	75	101.00	0.00
C25Y	3	14	137	-160	0	81	100.00	0.00
W38	3	15	129	0	0	87	-46.80	153.00
C24X	6	1	148	-200	0	6	121.00	0.00
C24Y	6	2	148	-200	0	12	117.00	0.00
C23X	6	3	170	0	0	18	103.00	0.00
C23Y	6	4	170	0	0	24	104.00	0.00
C22X	6	5	185	0	0	30	100.00	0.00
C22Y	6	6	185	0	0	36	101.00	0.00
R1	6	7	17	0	2	42	4169.10	-735.20
P30	6	8	157	0	0	48	-137.10	559.00
W21	6	9	155	0	0	54	-55.50	224.00
W29	6	10	185	0	0	60	-45.00	228.00
C43X	6	11	129	-7	3	66	62.00	0.00
C43Y	6	12	129	-7	3	72	62.00	0.00
P44	6	13	129	-7	0	78	250.00	-1015.00
C42X	6	14	0	0	1	84	1.00	0.00
C42Y	6	15	85	0	1	90	1.00	0.00

IDNO	TK	CH	LX	LY	COND	RECNO	GAIN	OFFSET
P1	1	1	540	-202	0	1	-143.10	1082.20
P2	1	2	539	-134	0	7	-140.20	574.20
P3	1	3	538	-69	0	13	-141.70	1086.10
P4	1	4	538	0	3	19	-142.70	1083.20
P5	1	5	540	162	3	25	-142.10	600.00
P7	1	6	442	2	0	31	-137.70	582.00
P7A	1	7	385	-2	0	37	-146.50	1101.00
NC	1	8	0	0	0	43	0.00	0.00
NC	1	9	0	0	0	49	0.00	0.00
NC	1	10	0	0	0	55	0.00	0.00
NC	1	11	0	0	0	61	0.00	0.00
NC	1	12	0	0	0	67	0.00	0.00
NC	1	13	0	0	0	73	0.00	0.00
NC	1	14	0	0	0	79	0.00	0.00
NC	1	15	0	0	0	85	0.00	0.00
C47X	4	1	143	-100	3	4	62.00	0.00
C47Y	4	2	143	-100	3	10	62.00	0.00
IT1	4	3	143	-100	3	16	1.00	0.00
OBS1	4	4	143	-100	3	22	1.00	0.00
C49X	4	5	143	-100	3	28	62.00	0.00
C49Z	4	6	143	-100	3	34	62.00	0.00
NC	4	7	0	0	0	40	0.00	0.00
HF	4	8	0	0	0	46	0.00	0.00
NC	4	9	0	0	0	52	0.00	0.00
NC	4	10	0	0	0	58	0.00	0.00
NC	4	11	0	0	0	64	0.00	0.00
NC	4	12	0	0	0	70	0.00	0.00
NC	4	13	0	0	0	76	0.00	0.00
NC	4	14	0	0	0	82	0.00	0.00
NC	4	15	0	0	0	88	0.00	0.00
P10	5	1	315	-6	3	5	276.10	-117.90
P16	5	2	241	2	3	11	554.10	-131.90
NC	5	3	0	0	0	17	0.00	0.00
NC	5	4	0	0	0	23	0.00	0.00
NC	5	5	0	0	0	29	0.00	0.00
NC	5	6	0	0	0	35	0.00	0.00
NC	5	7	0	0	0	41	0.00	0.00
NC	5	8	0	0	0	47	0.00	0.00
C19Y	5	9	210	0	3	53	101.00	0.00
C19X	5	10	210	0	3	59	103.00	0.00
C15Y	5	11	241	2	3	65	103.00	0.00
C15X	5	12	241	2	3	71	101.00	0.00
C9Y	5	13	315	-7	3	77	101.00	0.00
C9X	5	14	315	-7	3	83	100.00	0.00
NC	5	15	0	0	0	89	0.00	0.00

The "IDNO" designation is coded as follows:

P = pressure sensor

W = surface piercing wave staff

C = electromagnetic current meter

R = runup meter

A1S = wind speed

A1D = wind direction

IT1 = impact probe (suspended sediment) (Task 2-B)

OBS1 = optical backscatter sensor (suspended sediment) (Task 2-B)

SS = optical suspended sediment meter (Task 2-A)

NC = not active

(NOTE: EXCEPT WHERE NOTED IN TEXT.)

With respect to the current meter identification, the X notation is the on-offshore direction and Y notation the longshore direction. The current meter data indicates a (+) for offshore and (-) for onshore flow and (+) north and (-) south flow.

The gain and the offset provide information to convert from the computer units contained in the data records to physical (C.g.S.) units.

value in physical units = offset + (gain X volts)

where $$\text{volts} = \frac{\text{value in computer units}}{409.6}$$

For current meters and anemometers, the physical unit is cm/sec. For wave staffs, pressure sensors and runup meters, the physical unit is cm.

Using the sample header for 17 NOV shown in Table 5-1, Sensor P2 (the number two pressure sensor) was located at: X = 539 m. and Y = 134 m. It is record number 7, its gain is: -140.20 and its offset is: 574.20. Therefore, all of the data in record number 7 of each data file must be calibrated in the following way:

$$\underbrace{\text{PRESSURE (j)}}_{\text{value in cm of } j^{th} \text{ point}} = \underbrace{574.2}_{\text{offset cm}} + \underbrace{-140.2}_{\text{gain cm/volt}} \times \underbrace{C(j)}_{\text{value of } j^{th} \text{ point in computer units}} \times \underbrace{\frac{1}{409.6}}_{\text{conversion factor CU's/VOLTS}}$$

The same methodology would be used with current meters except that the physical units would be cm/sec.

b) Data Files

The number of records in each data file is given by:

number of records = number of active transmitters X 15

Note that the last file in a logical tape may contain less than this number of records.

The number of files in each logical tape can be approximated from the start and finish times recognizing that each file represents 256 seconds of data. The number of data files is a variable and is not contained in the header so that search programs must be able to recognize the double EOF at the end of the logical tape.

Each data file (with the possible exception of the last) contains one 256 second long, 512 word record for each active sensor. The record number for a specific sensor within each data file remains constant for a complete logical tape and is given by RECNO as discussed under the header above.

The first file on the logical tape contains the first 256 seconds of data from all active sensors. The second file contains the second 256 seconds, etc.

To construct a time history for a particular sensor, on a given day, the following sequence should be used:

1. Read the three records in the header file.
2. Verify that this is the proper logical tape for the desired day.
3. Construct ID and NO, the two code integers for defining the sensor.
4. Search the header file to find RECNO, the record number associated with IDNO.
5. Extract the gain and offset values.
6. Check the location coordinates. These can change between logical tapes.
7. Advance to the next file, the first data file.
8. Skip RECNO-1 records.
9. Read the 512 unformatted binary integer words in the data record.

10. Advance to the next data file.

11. Repeat 8, 9 and 10 until double EOF is reached signifying the end of the logical tape.

Each 512 word record, if added sequentially to an array, will provide a time history of that sensor for the day.

2. University of Washington Data Tapes

The twenty-first logical tape, the first logical tape following the Scripps SAS tapes, contains the data recorded from the University of Washington instruments at times when the SAS system was not being operated. This logical tape consists of 389 files. Each file contains 7 records with 512 unformatted binary integers in each record.

The seven records are simultaneous time series from each of seven instrument channels, as follows:

RECORD	CHANNEL DESCRIPTION	
1	W48	Wave Staff
2	C47X	Current Meter (on-off)
3	C47Y	Current Meter (longshore)
4	C49X	Current Meter (on-off)
5	C49Z	Current Meter (vertical)
6	IT-1	Impact Type Sediment Sensor
7	OBS-1	Optical Backscatter Type Sediment Sensor

The data are sampled at 10 Hz so that each 512 word record represents 51.2 seconds. Data for several days are contained within the 389 files as follows:

FILE NUMBERS	MONTH AND DAY	START TIME	APPROX. END TIME
1-30	NOV 05	23:29:38	23:55:33
31-60	NOV 07	00:57:39	01:23:34
61-150	NOV 19	22:26:06	23:59:46
151-210	NOV 20	23:00:05	23:56:19
211-389	NOV 23	10:30:25	13:18:44

The calibrations for the various channels, as described in a previous section, are given in Table 4D-3.

3. Beach and Offshore Survey Tapes

The records of the wading surveys and the offshore fathometer surveys are contained in the twenty-second logical tape which contains three files. The first file, with 150 records, contains all of the beach face wading survey data. Each record represents a single survey line. The second and third files, containing 443 and 230 records, respectively, contain the results of the two fathometer surveys on 9 and 18 November 1978.

a) Beach Face Surveys

Each record within the first (150 record) file consists of 67 unformatted binary integers. The arrangement of data within the record is as follows:

Word (1) = range number (the range designations used in the text contained letter prefixes, but the numberical part of the designation is unique).

Word (2) = month and day written in I4 format (MMDD).

Word (3) = time in I4 format (HHMM).

Word (4) = offshore distance of first survey point from coordinate system measured in centimeters.

Word (5) = elevation of the first survey point above MSL in centimeters.

Word (6) through Word (67) = the even numbered words are distances followed by the next odd numbered word which is the matching elevation.

The record is filled with zeros after the last survey point.

b) Fathometer Surveys

The second file in this logical tape (443 records) contains the results of the 9 November survey. Each record represents an individual depth observation and each record contains five unformatted binary integers. The arrangement of the data within each record is as follows:

Word (1) = date in I4 format (MMDD) (should be 1109 in second file).

Word (2) = time in I4 format (HHMM).

Word (3) = offshore distance in meters relative to coordinate system.

Word (4) = longshore position in meters relative to coordinate system.

Word (5) = depth below MSL in centimeters (notice that wading surveys are elevations and these are depths).

The third (230 record) file contains an identical arrangement for the survey of 18 November.

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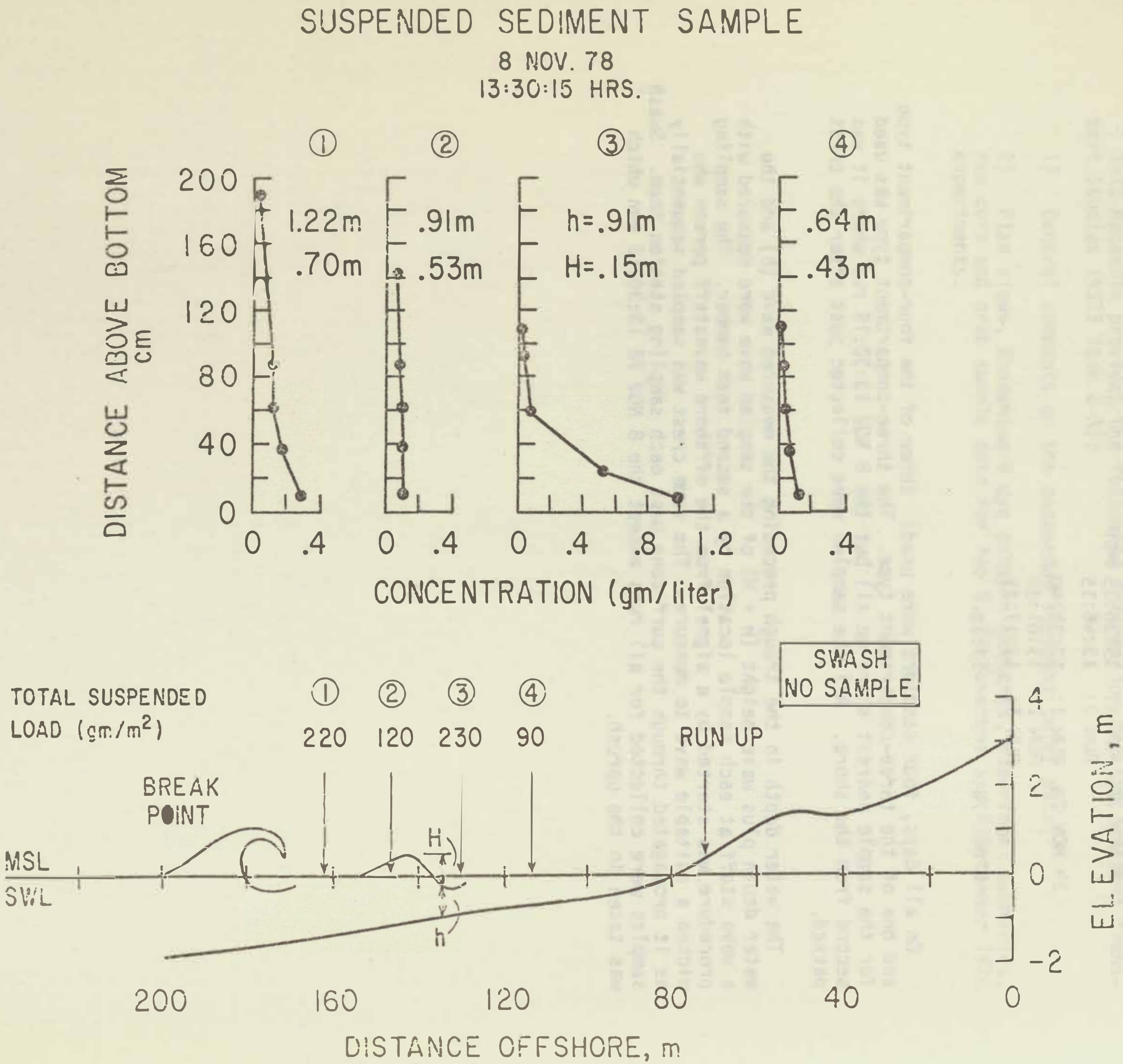
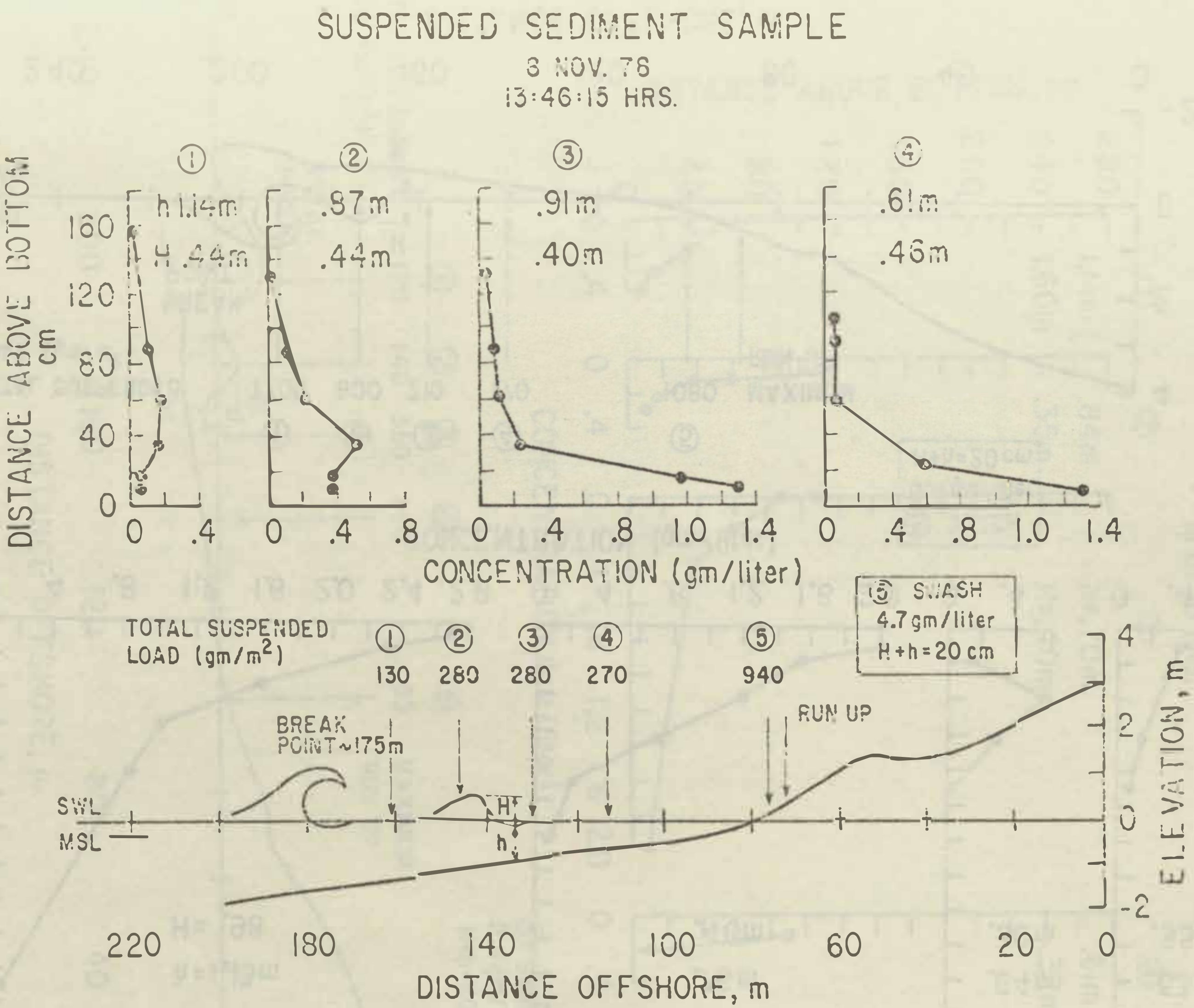
APPENDIX A

SEDIMENT TRANSPORT STUDIES

(NSTS TASK 2-A)



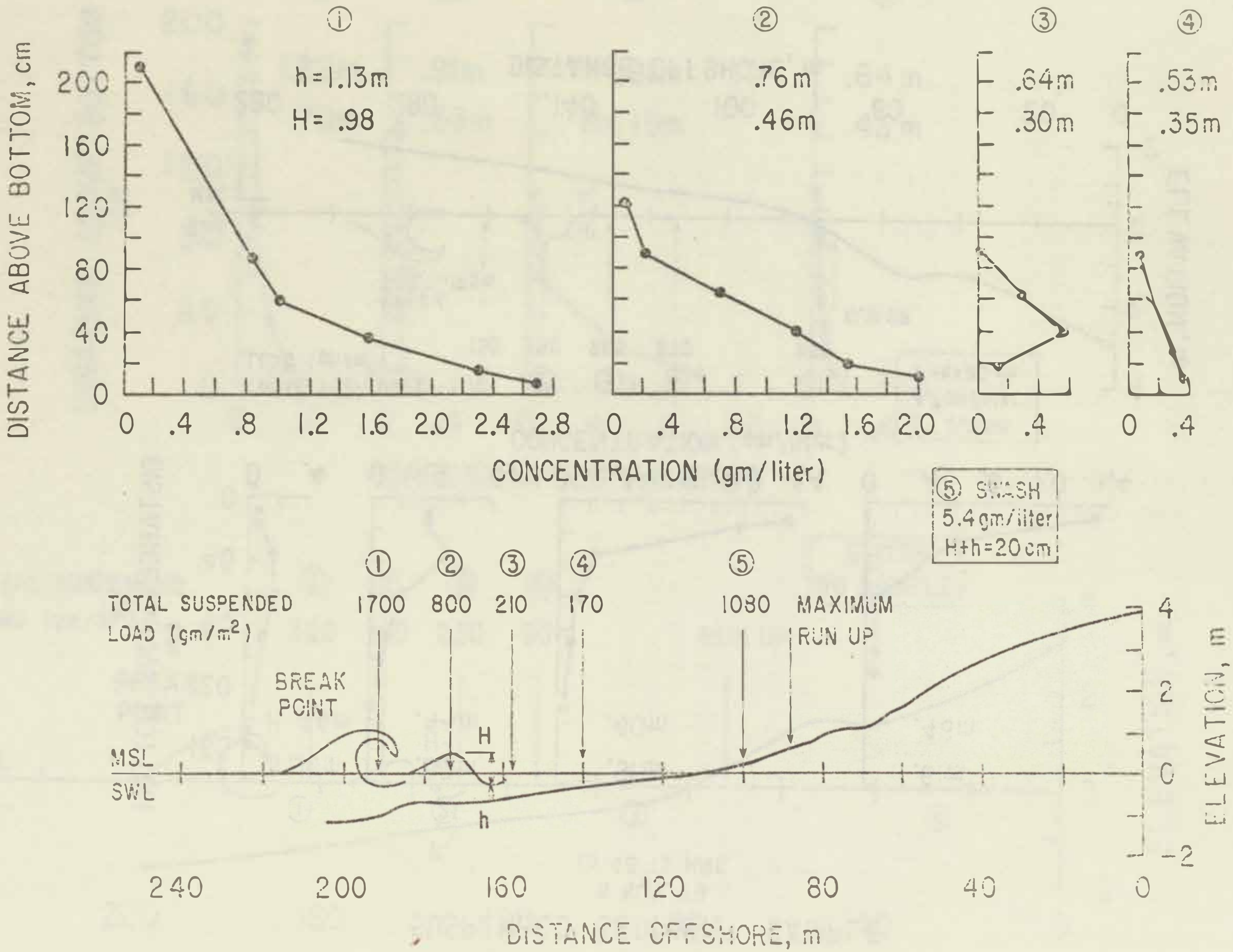
SUSPENDED SEDIMENT SAMPLE
8 NOV. 78
13:30:15 HRS.
①
②
③
④
DISTANCE ABOVE BOTTOM cm
200
160
120
80
40
0
1.22m
.70m
.91m
.53m
h=.91m
H=.15m
.64m
.43m
0
.4
0
.4
0
.4
.8
1.2
0
.4
CONCENTRATION (gm/liter)
SWASH NO SAMPLE
TOTAL SUSPENDED LOAD (gm/m2)
220
120
230
90
RUN UP
BREAK POINT
H
h
MSL
SWL
ELEVATION, m
4
2
0
-2
200
160
120
80
40
0
DISTANCE OFFSHORE, m


SUSPENDED SEDIMENT SAMPLE
3 NOV. 76
13:46:15 HRS.
①
②
③
④
h 1.14m
H .44m
.87m
.44m
.91m
.40m
.61m
.46m
DISTANCE ABOVE BOTTOM cm
160
120
80
40
0
0
.4
.8
1.0
1.4
CONCENTRATION (gm/liter)
⑤ SWASH
4.7 gm/liter
H+h=20 cm
TOTAL SUSPENDED LOAD (gm/m²)
① 130
② 280
③ 280
④ 270
⑤ 940
BREAK POINT~175m
RUN UP
SWL
MSL
H
h
ELEVATION, m
4
2
0
-2
220
180
140
100
60
20
0
DISTANCE OFFSHORE, m

SUSPENDED SEDIMENT SAMPLE

24 NOV. 78

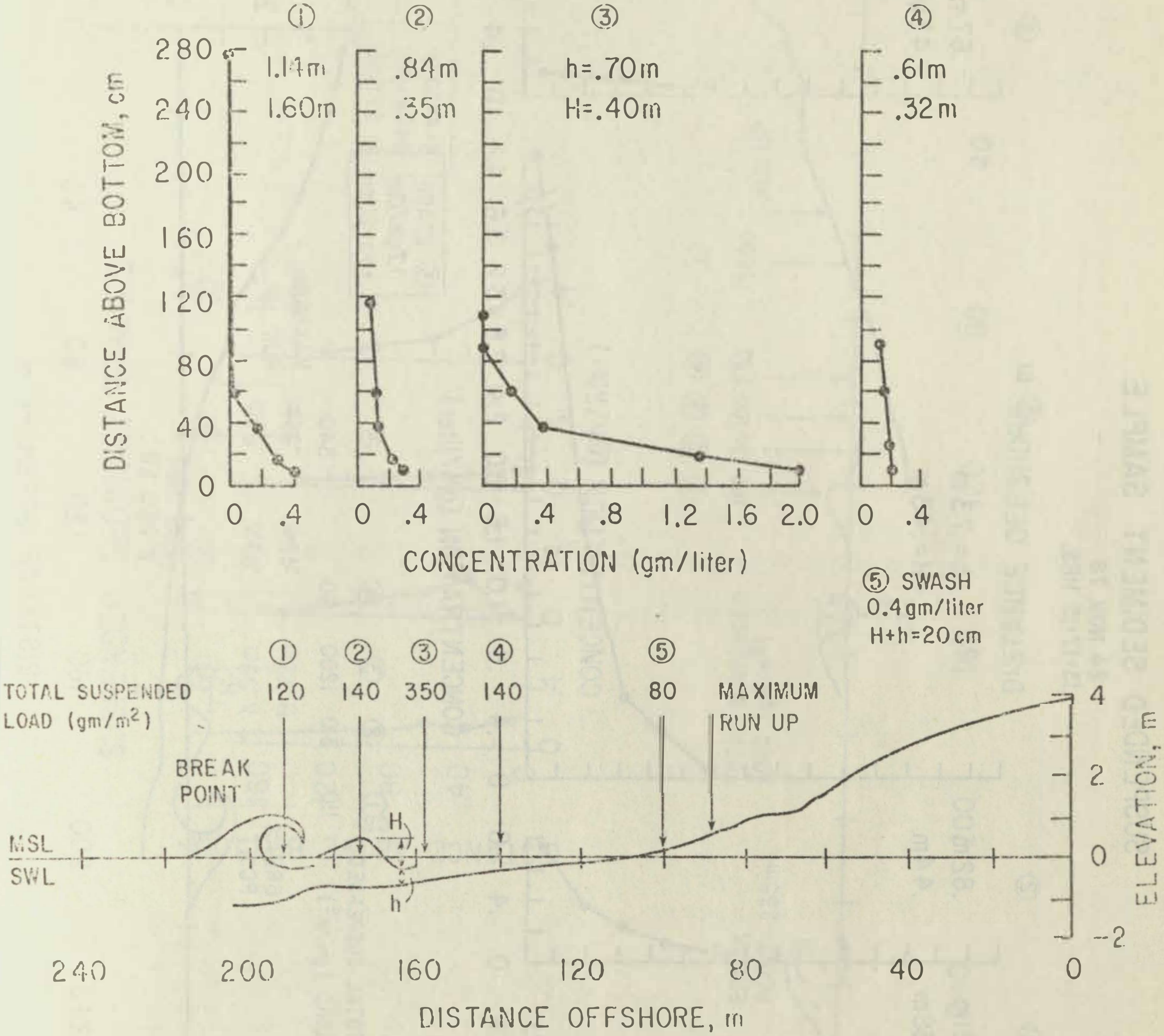
12:34:40 HRS.



SUSPENDED SEDIMENT SAMPLE

24 NOV. 78

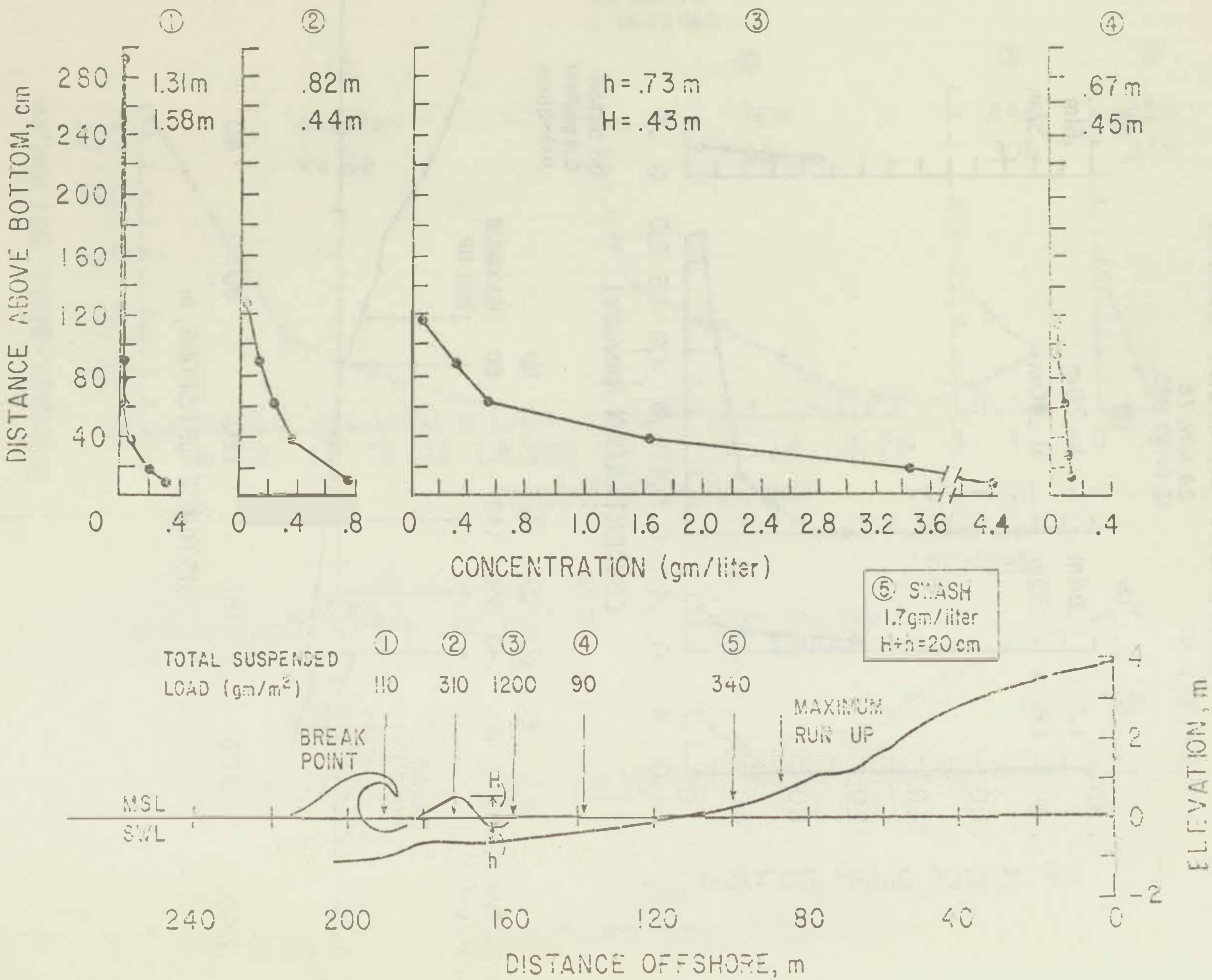
13:01:30 HRS.

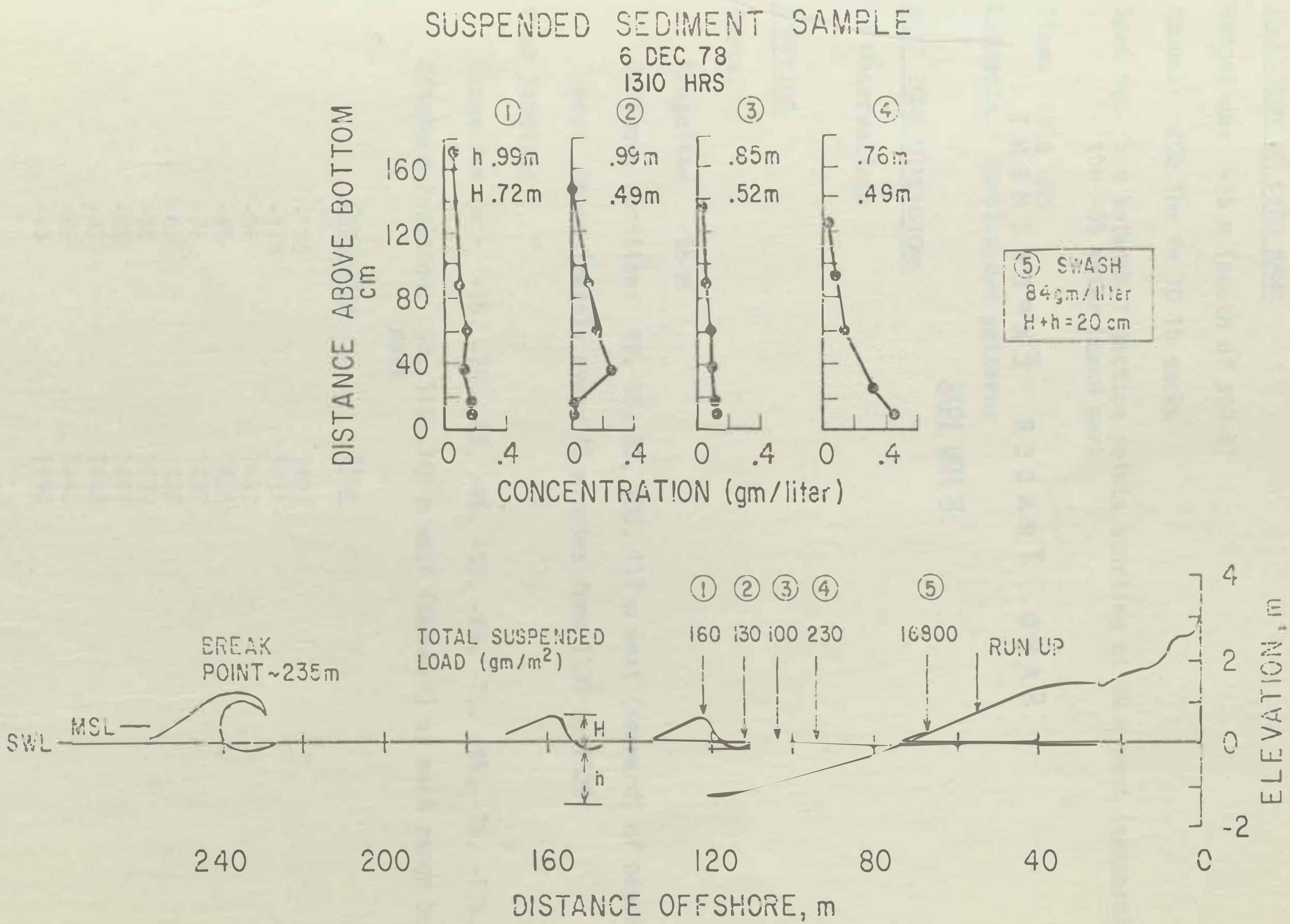


SUSPENDED SEDIMENT SAMPLE

24 NOV. 78

13:17:15 HRS.





SUSPENDED SEDIMENT SAMPLE
6 DEC 78
1310 HRS
①
②
③
④
h .99m
H .72m
.99m
.49m
.85m
.52m
.76m
.49m
DISTANCE ABOVE BOTTOM cm
160
120
80
40
0
0
.4
CONCENTRATION (gm/liter)
⑤ SWASH
84gm/liter
H+h=20 cm
①
②
③
④
⑤
160
130
100
230
16900
BREAK POINT~235m
TOTAL SUSPENDED LOAD (gm/m²)
RUN UP
MSL
SWL
H
h
240
200
160
120
80
40
0
DISTANCE OFFSHORE, m
4
2
0
-2
ELEVATION, m

Sand Tracer Experiment

8 NOV 1978

SUMMARY OF 8 NOVEMBER 1978 SAND TRACER EXPERIMENT

INJECTION OF DYED SAND

Rangeline: -35 m (south of SIO-4)

Amount: 200 lbs in 10 lb sacks

Spacing: 5 m between injection points starting at 80 m west (seaward) of the -35 meter bench mark

Time: 1316 HRS

Comments: Complex dye patterns

SURF ZONE DIMENSIONS

No Observations

SAMPLING

Cores:

Rangeline: -55 m

Offshore Position: 49, 66, 83, 100, 117 m west (seaward) of bench mark

Times: Approximately every 15 minutes from 1330 to 1530

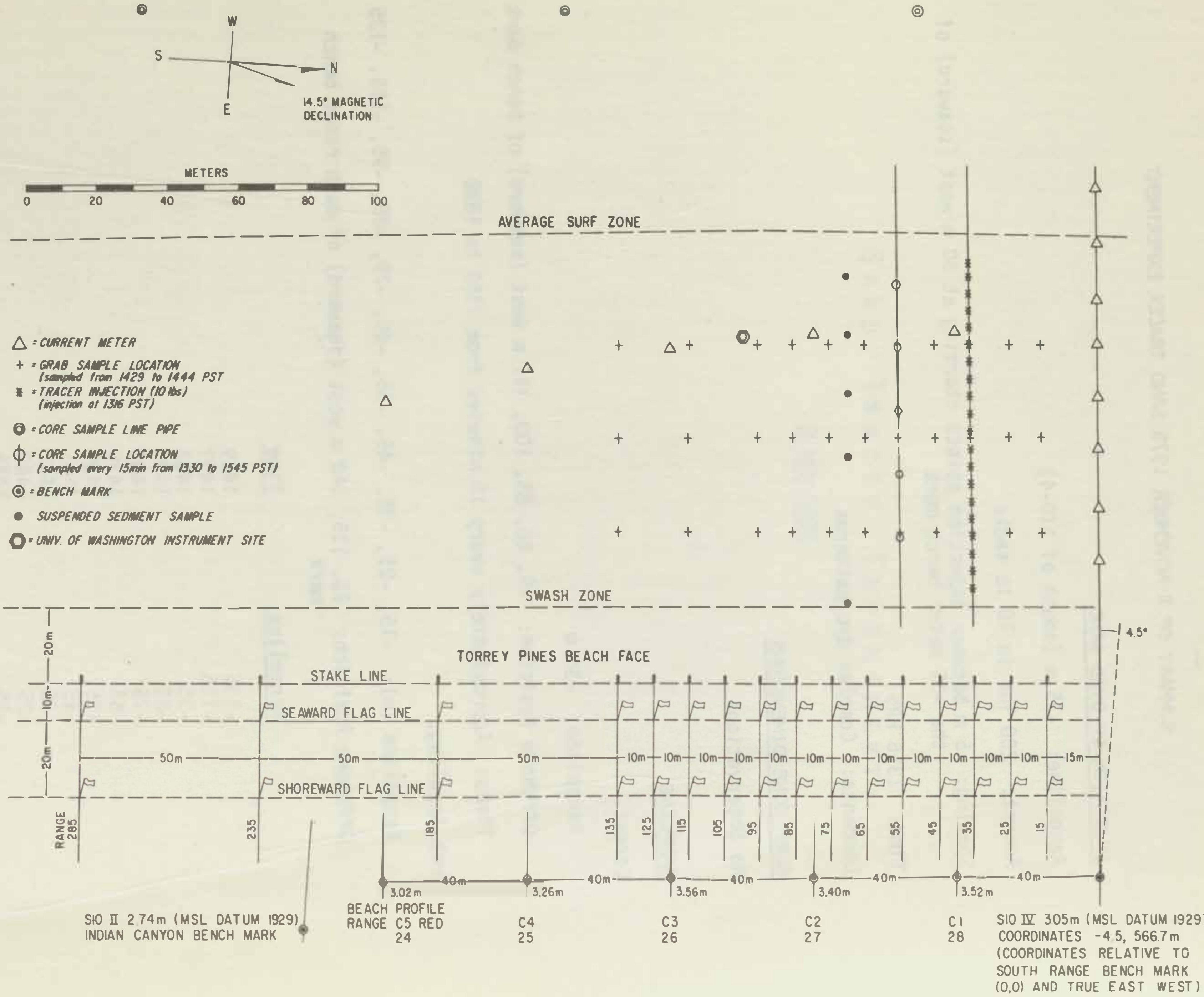
Grab Sampling:

Rangeline (m): -15, -25, -35, -45, -55, -65, -75, -85, -95, -115, -135

Offshore Position: 93, 115, 140 m west (seaward) of each range bench mark

Rangeline	Time
-135	1429
-115	1431
-95	1433
-85	1435
-75	1437
-65	1438
-55	1439
-45	1441
-35	1442
-25	1443
-15	1445

EXPERIMENT GRID
8 NOV 78



Plan View of 8 November 1978 Tracer Experiment

DYE PATTERN

8 NOV 78

(TOO COMPLEX TO PLOT)

8 NOV 1978

GRAB SAMPLES (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1316 INJECTION LOCATION: Y = 35 METERS SOUTH SAMPLING TIME: 1429-1446

LONGSHORE LOCATION (Y, METERS)

OFFSHORE LOCATION (X, METERS)	15_S	25_S	35_S	45_S	55_S	65_S	75_S	85_S	95_S	115_S	135_S
93 -	330	720	168,900	2340	0	170	260	57	0	339	201
115 -	2970	1060	8,700	3370	1920	0	1000	830	317	0	0
140 -	560	3170	0	480	400	120	--	266	2273	145	0

08 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1316 PST

SAMPLING TIME: 1330 PST

INJECTION LOCATION: Y = 35 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
49 -	0	86	0									
66 -	0											
83 -	0											
100 -	0											
117 -	91	0										

08 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1316 PST

SAMPLING TIME: 1345 PST

INJECTION LOCATION: Y = 35 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
49 -	341	0	0	0	59	0						
66 -	0											
83 -	0											
100 -	0											
117 -	274	93	237	203	0							

08 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1316 PST

SAMPLING TIME: 1400 PST

INJECTION LOCATION: Y = 35 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
49 -	343	350	254	0	60	0						
66 -	478	0										
83 -	0											
100 -	0											
117 -	461	0										

08 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1316 PST

SAMPLING TIME: 1415 PST

INJECTION LOCATION: Y = 35 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
49 -	6229	636	111	0								
66 -	123	107	119	0								
83 -	4611	1592	0									
100 -	86	0	92	160	0							
117 -	398	0										

08 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1316 PST

SAMPLING TIME: 1430 PST

INJECTION LOCATION: Y = 35 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
49 -	2439	764	0									
66 -	569	123	0									
83 -	2712	1074	0									
100 -	903	0										
117 -	114	0	115	127	0							

08 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1316 PST

SAMPLING TIME: 1445 PST

INJECTION LOCATION: Y = 35 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
49 -	9372	8520	4554	1581	63	0						
66 -	2247	0										
83 -	980	95	0									
100 -	0	511	214	102	0							
117 -	0											

08 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1316 PST

SAMPLING TIME: 1500 PST

INJECTION LOCATION: Y = 35 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
49 -	1361	1218	0									
66 -	270	0										
83 -	114	307	0									
100 -	97	672	750	115	0							
117 -	936	1962	110	111	0							

08 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1316 PST

SAMPLING TIME: 1530 PST

INJECTION LOCATION: Y = 35 METERS SOUTH

SAMPLE LOCATION: Y = 35 METERS SOUTH

DEPTH IN BED (CM)

	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
49 -	7470	1747	95	216	57	125	240	0				
66 -												
83 -	36,268	3232	0									
100 -												
117 -	10,437	5032	0	109	401	463	0					

SAND TRACER EXPERIMENT

24 NOV 1978

SUMMARY OF 24 NOVEMBER 1978 SAND TRACER EXPERIMENT

INJECTION OF DYED SAND

Rangeline: -170 m (south of SIO-4)

Amount: 160 lbs in 10 lb sacks

Spacing: 7 m between injection points starting at 96 m west (seaward) of the -170 meter bench mark

Time: 1215 HR

COMMENTS

There were persistent rip currents over the duration of the experiment located at -300 m (south) and +250 m (north). During the morning there was a weak rip at -100. This rip was present at injection time and started to weaken and drift northward at approximately 1300. At 1335 the rip was at -30 m and at 1345 it had weakened to where it was unobservable.

SURF ZONE DIMENSIONS (approximate)

The width and location of the surf zone varied during the experiment. At 1135 the maximum surf zone covered 95 m to 205 m west of the bench mark. By 1508 it was from 66 to 178 m. The typical maximum surf zone width was 110 meters located between 78 m and 188 m west of the bench mark.

SAMPLING

Cores:

Rangeline: -150 m

Offshore Position: 96, 114, 132, 150, 168 m west (seaward) of bench mark

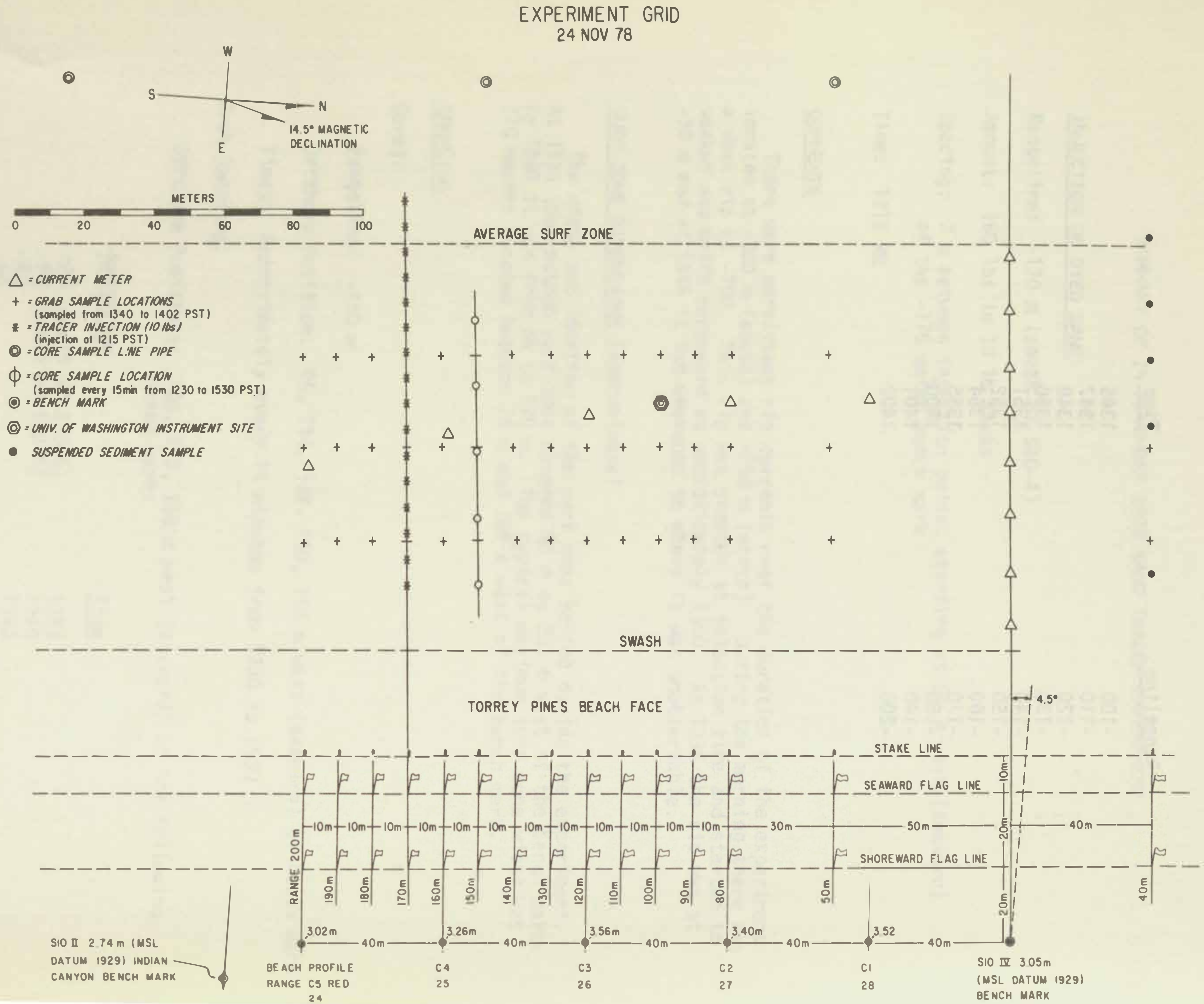
Times: Approximately every 15 minutes from 1230 to 1530

Grab Sampling:

Offshore Positions: 108, 133, 158 m west (seaward) of the following bench marks

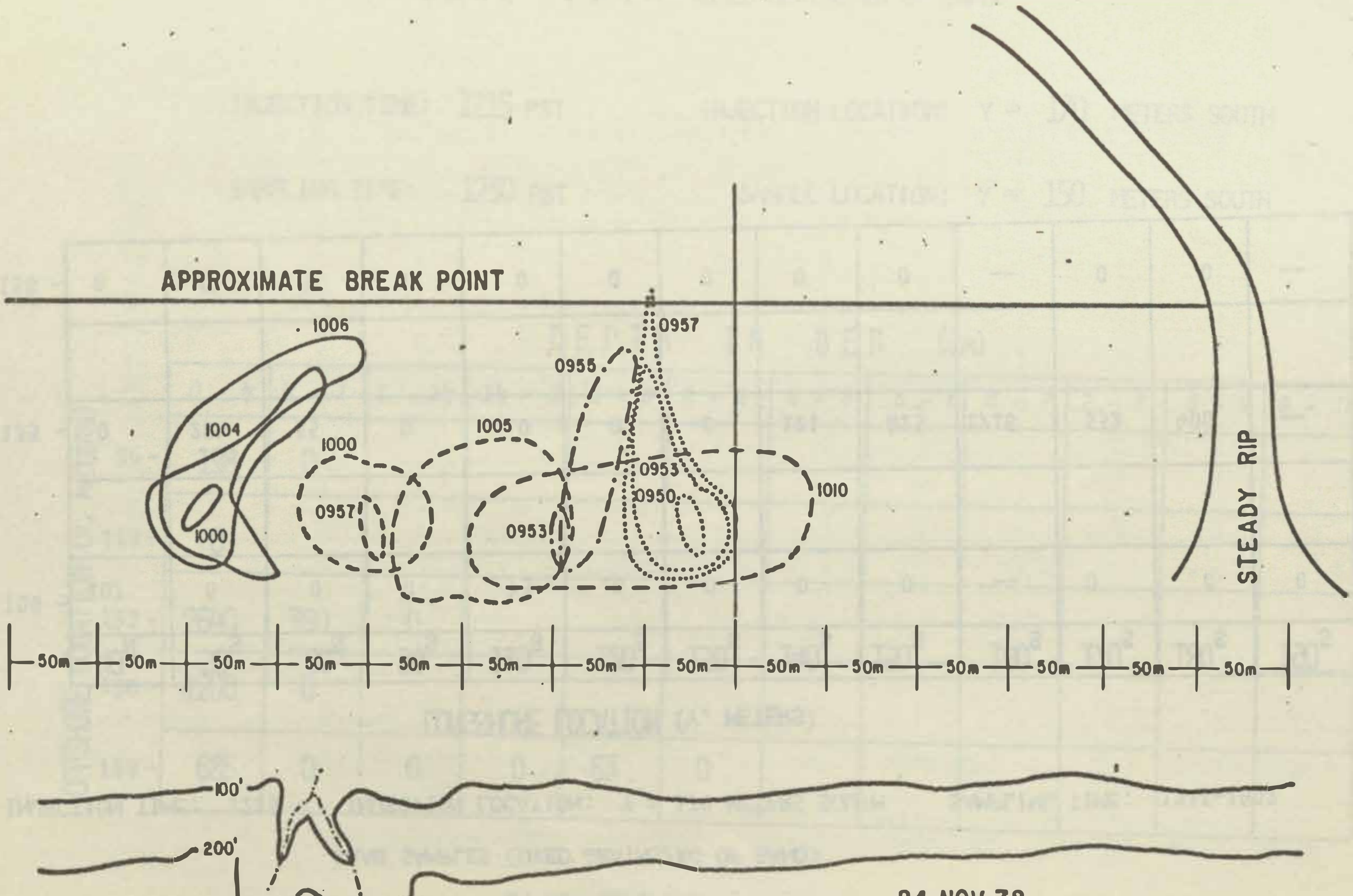
Rangeline	Time
+40 (north of SIO-4)	1335
-50 (south of SIO-4)	1340
-80	1343
-90	1344

Rangeline	Time
-100	1346
-110	1347
-120	1348
-130	1350
-140	1351
-150	1352
-160	1354
-170	1355
-180	1400
-190	1401
-200	1402



Plan View of 24 November 1978 Tracer Experiment

DYE DISPERSION IN THE SURF ZONE
24 NOV 78



Dye motion in the surf zone prior to 24 November 1978 sand tracer injection.

24 NOV 1978

GRAB SAMPLES (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 INJECTION LOCATION: Y = 170 METERS SOUTH SAMPLING TIME: 1335-1402

LONGSHORE LOCATION (Y, METERS)

OFFSHORE LOCATION (X, METERS)	40_N	50_S	80_S	90_S	110_S	120_S	130_S	140_S	150_S	160_S	170_S	180_S	190_S	200_S
108 -	107	0	0	0	73	0	0	0	0	--	0	0	0	0
133 -	0	284	35	0	0	0	0	121	823	1716	532	400	--	0
158 -	0	0	0	0	0	0	0	0	0	--	0	0	--	0

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST — INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1230 PST — SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96	198	0										
114	0											
132	2640	380	0									
150	1200	0										
168	685	0	0	0	63	0						

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1245 PST SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96	0											
114	0											
132	0											
150												
168	1399	0										

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST

INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1230 PST

SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96 -	198	0										
114 -	0											
132 -	2640	380	0									
150 -	1200	0										
168 -	685	0	0	0	63	0						

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST

INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1245 PST

SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96	0											
114	0											
132	0											
150												
168	1399	0										

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST

INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1330 PST

SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96	0											
114	345	131	0									
132	890	0										
150	2445	100	224	108	173	61	0	61	0	0	62	0
168	3077	4544	104	108	0	0	0	0	0	58	0	0

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST

INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1345 PST

SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96	0											
114	3050	0										
132	2538	554	0									
150	310	111										
168	0											

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST

INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1400 PST

SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96	0											
114												
132	790	120	0	0	0	0	60	0				
150	0	0	117	112	0							
168	0											

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST

INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1415 PST

SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96	0	240	0	0	0	0	0					
114	1570	370	0									
132	3760	100	0									
150	0	110	0									
168	0	120	0	0	0	60	0					

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1430 PST SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96	0											
114	5730	130	0									
132	17880	3190	2220	340	1210	0	60	0				
150	1390	130	0									
168	0											

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST

INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1445 PST

SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96	0											
114	12740	4870	0									
132	530	330	0	0	110	0	130	0				
150	0											
168	0											

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1500 PST SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96	510	640	240	300	0							
114	3730	240	0									
132	13110	1060	120	0								
150	8540	2340	0									
168	6160	120	250	130	260	0	60	0	60	60	0	0

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST   INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1515 PST   SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96	100	0										
114	380											
132	9600	2020	0									
150	290	380	110	120	0	110	0	0	110			
168	1500	380	110	0								

24 NOV 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1215 PST

INJECTION LOCATION: Y = 170 METERS SOUTH

SAMPLING TIME: 1530 PST

SAMPLE LOCATION: Y = 150 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
96	280	0										
114	1000	120	0	0	180	0						
132	84140	83750	25370	6130	210	120	0					
150	1840	110	0	130	120	0						
168	2130	810	230	130	120	0						

Sand Tracer Experiment

6 DEC 1978

SUMMARY OF 6 DEC 1978 SAND TRACER EXPERIMENT

INJECTION OF DYED SAND

Rangeline: -20 m (south of SIO-4)

Amount: 200 lb in 10 lb sacks

Spacing: 7 m between injection points starting at 67 m west (seaward) of SIO-4 bench mark

Time: 1250 HR

COMMENTS

Due to adverse surf conditions approximately 5 of the people injecting sand were grouped together approximately 15 m inside the deepest injection point. Injection was within 5 m of rangeline.

SURF ZONE DIMENSIONS (approximate)

Maximum Width: 200 m [55 to 255 m west (seaward) of bench mark]

Deepest Breakpoint: 255 m west (seaward) of bench mark

SAMPLING

Cores:

Rangeline: -50 m

Offshore Position: 70, 90, 110, 130 m west (seaward) of bench mark

Times: Approximately ever 10 to 15 minutes from 1305 to 1505. Surf conditions prevented core samplers from sampling entire surf zone width.

Note: Cores marked 5 DEC should be marked 6 DEC 78.

Grab Sampling:

Offshore Positions: 108, 133, 158 m west (seaward) of bench mark. The grab sample grid was occupied twice as noted on the following page.

GRAB SAMPLING

TRAVERSE 1 RANGE (M)	TRAVERSE 1 TIME	TRAVERSE 2 RANGE (M)	TRAVERSE 2 TIME
-0	1331	-30	1422
-10	1333	-40	1424
-20 (injection line)	1335	-50	1426
-30	1338	-60	1428
-40	1343	-90*	1432
-50	1345	-100*	1433
-60	1347	-120*	1434
-80	1349	-150*	1436
-100	1352	-200*	1437
-110	1353	-250	1439
-120	1355		
-150	1357		
-200	1359		
-250	1401		

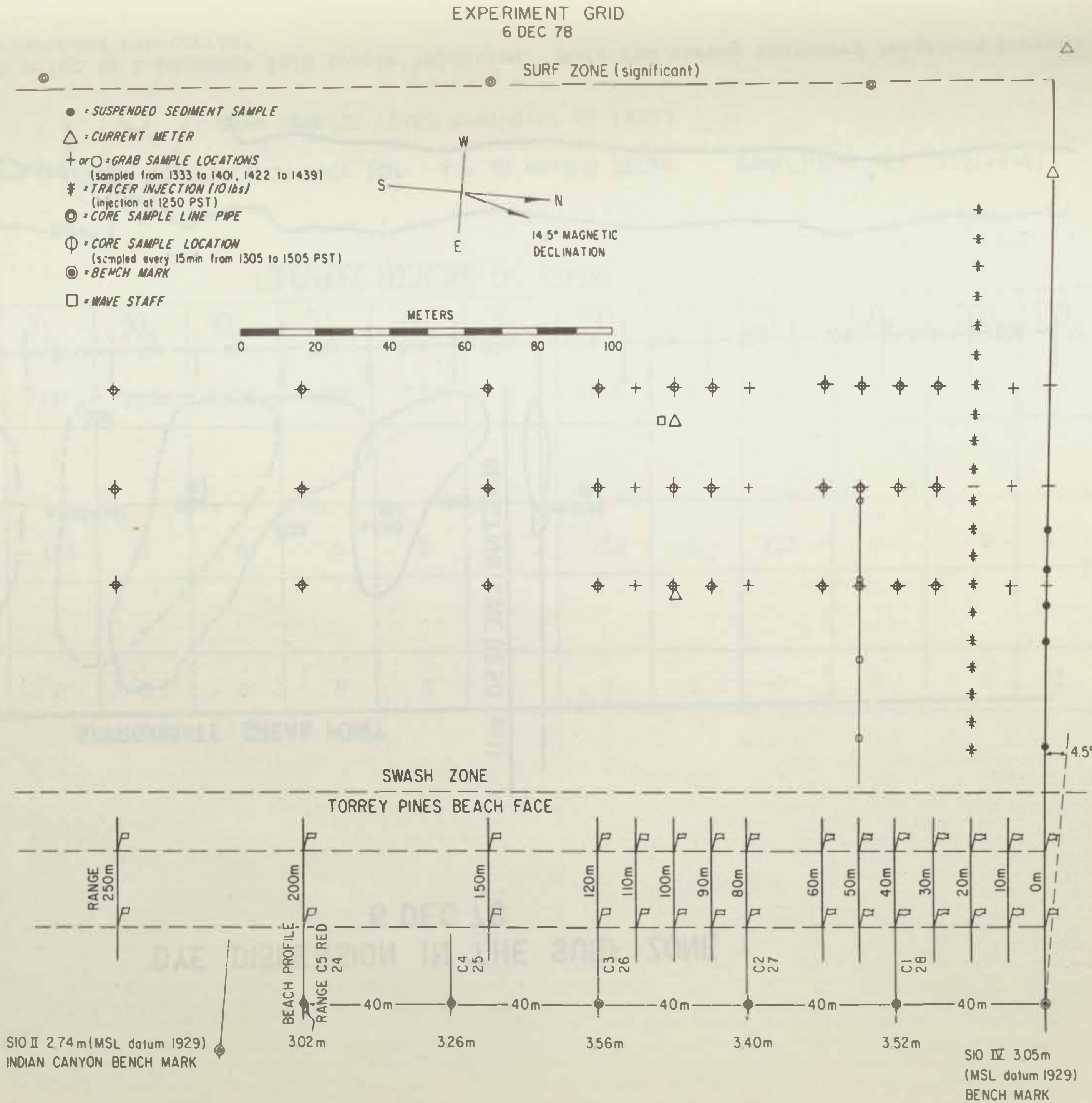
*samples suspect due to confusion of labels

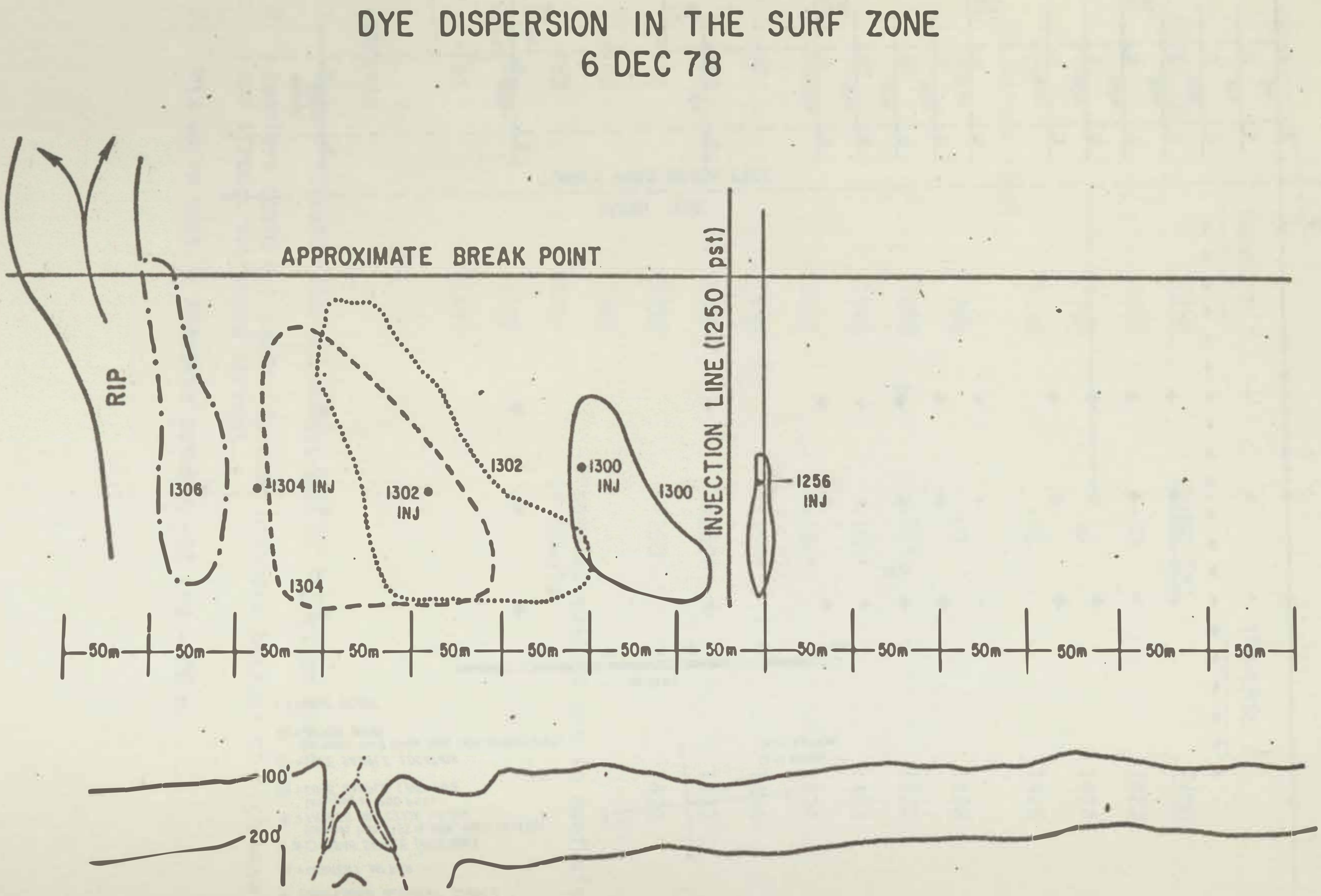
Comments:

1. Second traverse started downstream of injection point.

2. Samplers could not sample further offshore because of high wave conditions and strong, southward current.

3. Mix up in tags in traverse between -90 and -200 m.


EXPERIMENT GRID
6 DEC 78
SURF ZONE (significant)
• = SUSPENDED SEDIMENT SAMPLE
△ = CURRENT METER
+ or ○ = GRAB SAMPLE LOCATIONS
(sampled from 1333 to 1401, 1422 to 1439)
* = TRACER INJECTION (10 lbs)
(injection at 1250 PST)
= CORE SAMPLE LINE PIPE
= CORE SAMPLE LOCATION
(sampled every 15min from 1305 to 1505 PST)
= BENCH MARK
□ = WAVE STAFF
W
S
N
E
14.5° MAGNETIC DECLINATION
METERS
0 20 40 60 80 100
4.5°
SWASH ZONE
TORREY PINES BEACH FACE
RANGE 250m
200m
150m
120m
110m
100m
90m
80m
60m
50m
40m
30m
20m
10m
0m
BEACH PROFILE
RANGE C5 RED 24
C4 25
C3 26
C2 27
C1 28
40m
SIO II 2.74m (MSL datum 1929)
INDIAN CANYON BENCH MARK
3.02m
3.26m
3.56m
3.40m
3.52m
SIO IV 3.05m
(MSL datum 1929)
BENCH MARK



Dye motion prior to 6 December 1978 tracer injection. Note the strong southward longshore current and the pronounced rip-current.

6 DEC 1978

GRAB SAMPLES (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 INJECTION LOCATION: Y = 20 METERS SOUTH SAMPLING TIME: 1331-1401

LONGSHORE LOCATION (Y, METERS)

OFFSHORE LOCATION (X, METERS)	0	10_S	20_S	30_S	40_S	50_S	60_S	80_S	100_S	110_S	120_S	150_S	200_S	250_S
108 -	0	0	7950	2980	6581	4206	2326	0	1866	0	0	0	0	161
133 -	0	0	118	0	0	0	0	0	768	0	920	0	0	0
158 -	0	0	0	0	0	0	0	0	0	0	0	0	0	92

6 DEC 1978

GRAB SAMPLES (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250   INJECTION LOCATION: Y = 20 METERS SOUTH   SAMPLING TIME: 1422-1439

LONGSHORE LOCATION (Y, METERS)

OFFSHORE LOCATION (X, METERS)	0	10_S	20_S	30_S	40_S	50_S	60_S	80_S	100_S	110_S	120_S	150_S	200_S	250_S
108				4180	5426	2040	2479		1851		1496	625	538	433
133				669	1846	361	1968		1767		1165	531	190	367
158				2231	12,370	1957	6708		3276		2075	1039	1865	1328

06 DEC 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 PST

SAMPLING TIME: 1305 PST

INJECTION LOCATION: Y = 20 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
70 -	4677	5248	6287	6496	4260	0						
90 -	2777	1120	875	113	709	1600	305	167	0			
110 -	1611	0										
130 -												

06 DEC 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 PST   INJECTION LOCATION: Y = 20 METERS SOUTH

SAMPLING TIME: 1315 PST   SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
70 -	2095	4504	4423	6941	6628	8285	6959	1600	0			
90 -	420	707	106	315	165	58	0	56	0	53	0	0
110 -	6373	3516	0									
130 -	3833	2394	1433	432	60	0	62	0				

06 DEC 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 PST

SAMPLING TIME: 1330 PST

INJECTION LOCATION: Y = 20 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (X, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
70	3191	2437	4137	286	59	0						
90	2559	615	718	231								
110	124	0	96	0	78	0						
130	5567	10592	3326	811	0							

06 DEC 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 PST

SAMPLING TIME: 1345 PST

INJECTION LOCATION: Y = 20 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
70	3353	617	0									
90	1366	3900	3852	6751	384	0						
110	114	117	0									
130	264	0										

06 DEC 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 PST

SAMPLING TIME: 1354 PST

INJECTION LOCATION: Y = 20 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
70	2750	959	0									
90	2700	4320	1660	430	60	60	470	110	0			
110	0											
130	0											

06 DEC 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 PST

SAMPLING TIME: 1405 PST

INJECTION LOCATION: Y = 20 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
70 -	1428	827	2406	797	0							
90 -	4210	1360	3410	3252	1743	478	60	0				
110 -	829	94	0									
130 -	0											

06 DEC 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 PST

SAMPLING TIME: 1412 PST

INJECTION LOCATION: Y = 20 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (X, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
70	2186	739	0									
90	389	0	0	0	0	0	0	0	58	52	0	0
110	0	232	102	0								
130	510	0										

06 DEC 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 PST

SAMPLING TIME: 1420 PST

INJECTION LOCATION: Y = 20 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
70	2799	1864	1354	1512	374	0						
90	760	0										
110	226	114	0									
130	191	0										

06 DEC 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 PST

SAMPLING TIME: 1430 PST

INJECTION LOCATION: Y = 20 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
70	1093	1588	1864	2587	2082	2792	122	0				
90	4688	3643	282	171	0							
110	625	0										
130	0	458	498	0								

06 DEC 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 PST

SAMPLING TIME: 1441 PST

INJECTION LOCATION: Y = 20 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
70 -	336	677	567	1434	1586	654	0					
90 -	1897	0										
110 -	0	0	0	0	0	334	515	0				
130 -	0											

06 DEC 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 PST

SAMPLING TIME: 1450 PST

INJECTION LOCATION: Y = 20 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (x, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
70	1306	816	837	1646	954	0						
90	86	0										
110	967	1193	491	746	226	116	0					
130	966	0										

06 DEC 78

CORE DATA (DYED GRAINS/KG OF SAND)

INJECTION TIME: 1250 PST

SAMPLING TIME: 1457 PST

INJECTION LOCATION: Y = 20 METERS SOUTH

SAMPLE LOCATION: Y = 50 METERS SOUTH

DEPTH IN BED (CM)

OFFSHORE LOCATION (X, METERS)	0 - ½	½ - 1	1 - 1½	1½ - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10
70	1915	363	0									
90	1950	1420	986	0								
110	113	0	0	196	0							
130	3216	495	0									

APPENDIX B

CURRENT METER ELEVATIONS,
LOCATION AND CONDITION

DATE

3 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-41	127.7	-200	
C42	56	85.0	0	
C43	-20	141.0	-29	X AXIS ORIENTATION: 24

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

4 November 1978

ELEVATION OF CURRENT METER ELECTRODES RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	10°
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	10°
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	20°
C24	-41	127.7	-200	
C42	56	85.0	0	
C43	---	---	--	
C15				45°
C19				45°

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

5 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	5°
C24	-41	127.7	-200	
C42	56	85.0	0	
C43	-26	141.0	-29	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

6 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	BENT
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	BENT
C24	-41	127.7	-200	
C42	56	85.0	0	
C43	----	----	----	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

7 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
				ALL O.K.
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-11	127.7	-200	
C42	----	----	----	
C43	-3	123.4	-16	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

8 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-41	148.3	-200	
C42	----	----	----	
C43	6	123.4	-16	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

10 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-41	148.3	-200	
C42	----	----	----	
C43	2	123.4	-16.0	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

11 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	15° E
C35	-40	149.1	60	30° N
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	5° NE
C31	-31	155.4	0	
C28	-44	146.3	-40	20° N, 5° OUT OF VERTICAL
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	5° OFF IN HORIZONTAL
C23	-60	170.2	0	
C22	-98	184.7	0	COULDN'T SEE
C24	-41	148.3	-200	25° NE
C42	----	----	----	
C43	----	----	----	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

D A T E

12 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	10° S
C35	-40	149.1	60	10° NE
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	45° NE
C28	-44	146.3	-40	5° N FISHING LINE WRAPPED AROUND SENSOR
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-41	148.3	-200	
C42	----	----	----	
C43	----	----	----	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

13 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	15° E
C32	-61	144.5	160	5° E
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-41	148.3	-200	
C42	----	----	----	
C43	----	----	----	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

D A T E

14 November 1979

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	5° W (OFFSHORE)
C24	-41	148.3	-200	
C42	----	----	----	
C43	----	----	----	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

15 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-41	148.3	-200	
C42	----	----	----	
C43	----	----	----	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

16 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	10° SHOREWARD
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	5° SHOREWARD
C24	-41	148.3	-200	6° SHOREWARD
C42	-56	129.1	-0.3	
C43	20	129	-7	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

17 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	SHEARED OF @ ~ 1300 HRS
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-41	148.3	-200	
C42	-56	129	-3	
C43	20	129.1	-7	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

18 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	5° SHOREWARD
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-41	148.3	-200	
C42	-56	129.1	-3	
C43	----	----	----	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

19 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	8° SHOREWARD
C24	-41	148.3	-200	
C42	31	85.0	0	
C43	-----	-----	-----	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

20 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	19	99.4	0	
C39	0	115.2	0	
C37	-18	129.1	0	
C36	-43	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-31	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-41	148.3	-200	5° SHOREWARD
C42	10	85.0	0	
C43	-4	132	-190	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

21 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	-20	99.4	0	FIXED DURING RUN
C39	-18	115.2	0	
C37	-44	129.1	0	
C36	-64	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-71	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	STARTED BAD, BUT GOOD AT END
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-14	148.3	-200	
C42	10	85.0	0	
C43	----	----	----	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

22 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	-20	99.4	0	
C39	-18	115.2	0	
C36	-64	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-71	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-14	148.3	-200	
C42	10	85.0	0	
C43	----	----	----	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

DATE

24 November 1978

ELEVATION OF CURRENT METER ELECTRODES
RELATIVE TO MEAN SEA LEVEL

INSTRUMENT	ELEVATION (MSL) (CM)	XLOC (OFFSHORE) (METERS)	YLOC (LONGSHORE) (METERS)	CONDITION*
C40	-20	99.4	0	
C39	-18	115.2	0	
C37	-44	129.1	0	
C36	-64	143.2	0	
C35	-40	149.1	60	
C34	-43	139.1	20	
C33	-46	142.8	320	
C32	-61	144.5	160	
C31	-71	155.4	0	
C28	-44	146.3	-40	
C27	-40	145.0	-80	
C26	-43	141.4	-120	
C25	-40	137.3	-160	
C23	-60	170.2	0	
C22	-98	184.7	0	
C24	-14	148.3	-200	
C42	10	85.0	0	
C43	----	----	----	

*NOTATION GIVES DEGREES BENT FROM VERTICAL TOWARDS DIRECTION GIVEN.

APPENDIX C

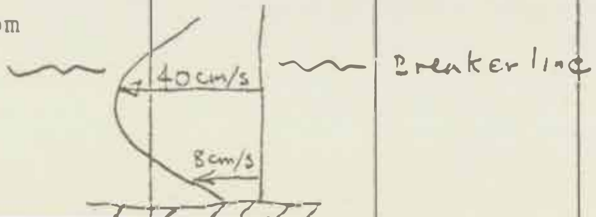
VISUAL BEACH OBSERVATIONS

BEACH OBSERVATIONS

DATE 3 Nov Cine Start Time 0909:00 Stop Time 2 min sequence; 2 min blank sequence preceeds

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
0730		100cm				ws4 by largest waves	C42		
0810	C42	plugged	in		Light onshore wind, very clear, sunny day		C42		
0830									
0840	ws 4 overtopped								
0920								4m mean = 16m	26m
0950				lsc so at 48cm/sec					
1005	dye injected @ 20mN SIO4			lsc so @ 20cm/sec					
1019				dye flowed so. as a line extending offshore just so. of U. of W.					
1023				dye flowed so. at 16cm/sec					
1027				dye release 65m no. of SIO4 at 60m offshore	weak wind from west				
1035	between ws 3&4 to ws 2&3			dye spread offshore from 60m to 145m					
1039				main blob of dye 35m north of SIO4					

* w.s. - wave staff
l.s.c. - longshore current
SAS - shelf station spar



2/2

BEACH OBSERVATIONS

DATE 3 Nov Cine Start Time ____ Stop Time ______________

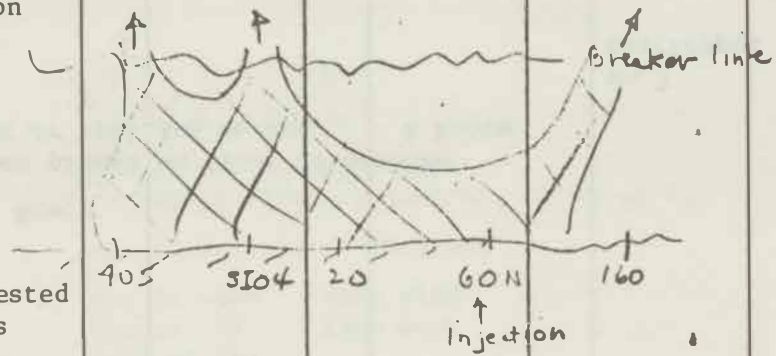
Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
1044			Breaker line		No visible rips				
1058	145m		Beach waves plunge on front of onshore bar or spilling on bar		6 knots				
1100						ws 3 overtopped			
1109								9m	25m
1110							C42		
1125	weak cusps 20cm high just in front of tower: 25m, 19m, 24m, 23m								
1213		85 cm	wave periods : 13.5 s 10 1 5 — peak 8 — mean		onshore breeze 4 knots	DLI pressure sensor out of water		15m	35m
1235							C42 C40		
1315	no apparent surf beat						C39	30	54

* w.s. - wave staff
l.s.c. - longshore current
SAS - shelf station spar

BEACH OBSERVATIONS

DATE 4/11 Cine Start Time 744,0 Stop Time 1335

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
0744							C40, C42		
0814	between ws 2&4 @ 3		Mild surf			No overtop	C33 not working		
1034	@ ws 2		spilling		light breeze from SE				
1050	intermediate station off; fix on C33								
				Dye injected at 60 mN; Dye spread in both directions.					
1137 --	15 min after dye injection								



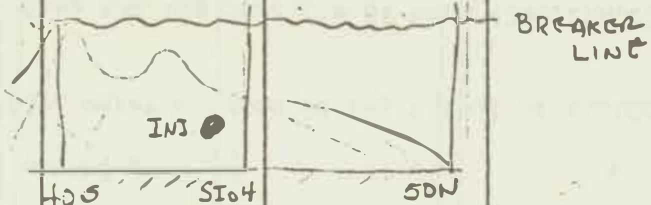
Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
			long crested breakers						
1250	Average cusp space of 26m, 0.3m high							15m	33m
								surf	beat
1335	Shut off anemometer				slight onshore breeze; very sunny warm day				

* w.s. - wave staff
l.s.c. - longshore current
SAS - shelf station spar

0855.35 start cina film pack #2- bad start two min. blank to indicate new start

BEACH OBSERVATIONS

DATE 5 Nov Cine Start Time 0841:0 Stop Time ______

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
0807	Turn on transmitters, Anemometer turned on at 0830								
0915	Ridge and runnels at C24 and C25								
0935	Clock on offshore encoder doesnt work so left on all the time				sunny day, slight haze, breezw from SW at 4 kts.		C42		
		100 cm	longcrested						
1025								10 m	31 m surf beat at 30 and 60 s.
1027				no well defined rips					
	Dye injection at 5 m south of SI04 at C40								
1036					wind picking up from so. at 8 kts.		Only 4 wave staffs up		
									
1115	Dye pattern hasnt moved		spilling						
1120					6 knots from SW	#3 and #4			
1158							C42	9 m	29m
1236						#3 and #4 Big wave over topped W14 offshore			

* w.s. - wave staff
l.s.c - long shore current
SAS - shelf station spar

BEACH OBSERVATIONS

DATE 5 Nov   Cine Start Time ____   Stop Time 1533

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
1240		up to 180 cm		c. to no. at W18					
1305	Generator surging when running out of gas								
1315			-	Blue water outside ws #4; turbulent inside			C42	3m	42 m
1328								Surf beat 105 sec.	
	Retreived 2 deep staffs.			Cusp spacing near top of berm (24m,22m,27m) height= 30cm					
1445			plunging at ws.#4 at front of bar				C42,C40,C39	19m	49m
1505							C42,C40,C39, C37		
1512				Spar tilting north					
1533		surf increasing			light breeze from Sw	another deep staff broke			

* w.s. - wave staff
l.c.s. - longshore current
SAS - shelf station spar

1402:0 cina restarted , reel #3

BEACH OBSERVATIONS

DATE 7 Nov Cine Start Time 1234:0 Stop Time __________

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
1156	Turn of transmitter								
1157				Dye injection at SIO4					
1300		33 cm small waves	α_b - 3^o - nice wave angle		light breeze from NW bright sunny day				
1337	Time code reestablished								
1515								run up meter turned off	
1616	Shut down	40 cm			wind 5 kts. from NW				

* w.s. - wave staff
l.s.c. - longshore current
SAS - shelf station spar

BEACH OBSERVATIONS

DATE 11/8 Cine Start Time ___

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
1022	Transmitters on								
1037							C40, C39, C37 N-S range okay		
1105		Two wave trains NW, W-short-crested					Downing; no waves today		
1325				Inshore to South, SAS to south					

BEACH OBSERVATIONS

DATE 11/10 Cine Start Time ____

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
0735		up to 150 cm		Strong north current, SAS to north	South wind Sea - S.W. Swell - west				
1039				offshore flow at D.L.I.					
1041				offshore flow at U.W. tower					

BEACH OBSERVATIONS

DATE 11/11 Cine Start Time 6:48:40 sec Stop Time 9:21

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
7:10	break @ w.s. 3 & 4	150 cm	T=8.6-120 sec	North	Stormy; wind from so., waves from S.W. many rips				
8:45	X_b ~10m west of #3 w.s.	100 ~ 130 cm		Northerly	S.E. wind			16m west of anemometer (59m)	

* w.s. - wave staff
l.s.c. - longshore current
SAS - shelf station spar

BEACH OBSERVATIONS

DATE 13 Nov   Cine Start Time 0803:0 Stop Time ____________

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
0650	Turn on transmitters, intermediate station out Lots of kelp, all wave staffs broken, only four marker poles left								
0858	Offshore station turned off						C33 not working yet		
0845				Rip current between C32 and C33 and north of C33			C32 turned on		
1009					1-2 knot wind from so. ,overcast Rained last night				
1010	Station back on the air		Waves not long crested surf going down		light 1-3 knot wind from so.				

* w.s. - wave staff
l.s.c. - longshore current
SAS - shelf station spar

0746:0 - ran film continuously for about 10 min to finish reel, reloded and restarted

BEACH OBSERVATIONS

DATE 15 Nov Cine Start Time 0811:0 Stop Time ______________

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
0645	Turn on transmitters								
0655	Flowmeters and wave guages all turned on								
0710	Everything turned on								
	Big waves break on ws #4		plunging nice swell		offshore wind 5-6 knots	ws#4 (W29)			
0735							Kelp on W38 cleaned off		
0910							Plug in C47 and C49		
0915				l.s. north		W29 knocked down			
0924	Run up turned on		long crested swell		dead calm			52 m	37 m
0958							C47 & C49 turned off		
1025							C47 & C49 turned on		
1027		H_b appears to decrease at high tide							
1050	W21	Long crested waves from W		l.s.c. variable	Wind from WNW 5-6 kts			35 m small run up	26 m

* w.s. - wave staff
l.s.c. - longshore current
SAS - shelf station spar

BEACH OBSERVATIONS

DATE 16 Nov   Cine Start Time 0852   Stop Time ____________

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
0852	Large amounts of sea grass on bottom between W38 & W29						C42 moved in-line with W38 &c37,DLI		
0910					wind 1 kn from NW, clear sky	no overtopping			
1020					very clear and sunny				
1038	W38			offshore current at SAS = 0			C42 connected		

* w.s. - wave staff
l.s.c. - longshore current
SAS - shelf station spar

BEACH OBSERVATIONS

DATE 11/17 Cine Start Time 9:09:00 Stop Time ______

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
8:38	Breaker at wave staff 4 & off shore		sets 2.5 min interval	SAS slightly to north				Start 8:18	
8:40	@ 2								
10:06			T = 6.6 s	SAS to so.				10:02 slack wires	
11:00				lsc to so. SAS vertical				11:00 -off	
12:45				SAS to no. lsc to so.				Surf zone from old C42 to braking between w.s. 2 & 3	
12:50				rip at C24-C25			C39		
1:10							C37		

* w.s. - wave staff
l.s.c. - longshore current
SAS - shelf station spar

BEACH OBSERVATIONS

DATE 18 Nov   Cine Start Time 0906:0   Stop Time _____

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
1057	W29			Rip @ C25 Dye injection Strong current to south inshore of C40		Offshore array suspect			

* w.s. - wave staff
l.s.c. - longshore current
SAS - shelf station spar

BEACH OBSERVATIONS

DATE 11/20 Cine Start Time 0857

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
0915	changed filter characteristics of S45								
1002	Staff 3	70-150cm groupy	Plunging	Strong north longshore current	West wind			70m to SWL	
1020							C42 out C40 in		
1106	Breakers @ wave staff#3	100-150cm		longshore current in-shore to south	light westerly		C42 intermittant		
1117				longshore current reverses with sets				correlates with groups	
1325							C40 out		
1330	Break @ w.s. 3&4	80-100 cm		north	west wind				
1408							C39		
1433							C37		

BEACH OBSERVATIONS

DATE 11/21 Cine Start Time 9:30:00 Stop Time ______

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
8:55	w.s. 3 to outside ws 4	1-1.5m (groups)		lsc north, SAS to north	SE wind (strong)			Rip 25m	no. of S104
9:18							C42		
9:50	3 & 4 to 4	70 - 150 cm	plunge - spill		strong so. wind		C42 in & out		
average cusps spacing 20.5m (20, 19, 22 m)									

* w.s. - wave staff
l.s.c. - longshore current

BEACH OBSERVATIONS

f-stop changed at 1411

DATE 24 Nov   Cine Start Time 0940:05   Stop Time ______

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
1056	outside ws#4	70 cm		SAS 30° to So.	wind N-NW		C42 under sand C40,C39		
1110			plunge @C20	southerly lcs					
1130				rip @ C28 inshore river plume to no.	NW wind 5 kts				
				SAS 25° south					
1155	C32 and C33 low batteries, 2 second interrupt to fix batteries at 1153								
1207				sediment plume flows no. @C35		W41 out of water	C42,C40,C39		
1220				lsc so.@SI04					
1230	W29		plunging			W41 out	C42,C40,C39		
1322	ws.#3	60 cm		SAS to so.					
1329	so. swell:T=1.5 s from no. longcrested from WSW			Sediment plume out SI04					
1333				rip @ C27					
1350	w.s. #3			lsc no.					
1400				SAS to so.			C39		

* w.s. - wave staff
l.s.c. - longshore current
SAS - shelf station spar

BEACH OBSERVATIONS

DATE 24 Nov Cine Start Time ____ Stop Time _____

Time	X_B	H_b	Breaker Type	Currents	Weather	Wave Staff Overtop	E.M. out of H_2O	Run Up MAX	Run Up MIN
1418				large rip 300 m no. of SI04					
1535	3rd & 5 m	50 cm groupy		SAS to so.	wind from so		C42		

* w.s. - wave staff
l.s.c. - longshore current
SAS - shelf station spar

APPENDIX D

TIDE DATA

TIDES

The tidal cycle in the San Diego area is semi-diurnal with two high and two low waters in a tidal day. Since the tides follow the moon more closely than the sun, the lunar or tidal day is about 50 minutes longer than the solar day. This causes the tide to occur later each day. The mean tidal range is 3.6 feet and the mean tide level is 2.7 feet (MLLW). During the month of November 1978 the tides ranged from -.7 feet to +6.8 feet (MLLW). The mean lower low water (MLLW) datum is -2.7 feet (-75.5 cm) relative to MSL at the study site so that all elevations can be cross-referenced to MLLW.

Table D-1 provides the predicted tide tables for October, November and December 1978 for the San Diego area. The tidal difference and correction to be made on the predicted tidal curve for the Torrey Pines area is provided in Table D-2.

SAN DIEGO, CALIFORNIA, 1978

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

OCTOBER

DAY	TIME h.m.	HT. ft.	DAY	TIME h.m.	HT. ft.
1 SU	0219	0.4	16 M	0238	0.5
	0830	5.8		0851	6.7
	1439	0.5		1521	-0.5
	2043	5.6		2130	5.3
2 M	0245	0.6	17 TU	0310	0.9
	0856	6.0		0924	6.6
	1511	0.3		1603	-0.4
	2118	5.4		2212	4.9
3 TU	0313	0.8	18 W	0342	1.4
	0922	6.1		0956	6.4
	1550	0.2		1642	-0.2
	2157	5.1		2258	4.5
4 W	0341	1.1	19 TH	0413	1.9
	0953	6.2		1027	6.0
	1632	0.2		1727	0.1
	2241	4.7		2352	4.0
5 TH	0411	1.5	20 F	0445	2.3
	1030	6.1		1102	5.6
	1720	0.3		1819	0.5
	2334	4.2			
6 F	0449	2.0	21 SA	0056	3.7
	1110	5.9		0523	2.8
	1820	0.4		1142	5.1
				1919	0.8
7 SA	0045	3.8	22 SU	0234	3.6
	0534	2.4		0623	3.2
	1203	5.6		1238	4.7
	1935	0.5		2035	1.0
8 SU	0222	3.7	23 M	0418	3.7
	0650	2.8		0830	3.3
	1319	5.4		1404	4.3
	2058	0.5		2153	1.1
9 M	0403	4.0	24 TU	0514	4.1
	0844	2.9		1021	3.1
	1452	5.2		1541	4.3
	2218	0.3		2250	1.0
10 TU	0509	4.4	25 W	0546	4.4
	1024	2.5		1124	2.6
	1621	5.4		1653	4.4
	2317	0.0		2335	0.8
11 W	0556	5.0	26 TH	0614	4.8
	1134	1.8		1206	2.0
	1730	5.7		1749	4.6
12 TH	0006	-0.2	27 F	0009	0.8
	0634	5.6		0636	5.2
	1230	1.1		1243	1.4
	1829	5.9		1834	4.8
13 F	0051	-0.2	28 SA	0040	0.7
	0710	6.0		0702	5.6
	1315	0.4		1317	0.8
	1918	6.0		1915	4.9
14 SA	0128	-0.1	29 SU	0109	0.7
	0745	6.4		0726	6.0
	1400	-0.1		1351	0.3
	2005	5.9		1952	5.0
15 SU	0206	0.1	30 M	0137	0.8
	0817	6.7		0753	6.3
	1441	-0.4		1424	-0.1
	2049	5.7		2032	5.0
			31 TU	0209	1.0
				0823	6.5
				1501	-0.5
				2111	4.9

NOVEMBER

DAY	TIME h.m.	HT. ft.	DAY	TIME h.m.	HT. ft.
1 W	0240	1.2	16 TH	0312	1.8
	0853	6.7		0925	6.5
	1541	-0.7		1627	-0.5
	2155	4.7		2249	4.2
2 TH	0313	1.4	17 F	0341	2.1
	0927	6.7		0953	6.1
	1623	-0.7		1705	-0.3
	2243	4.5		2338	3.9
3 F	0351	1.8	18 SA	0414	2.5
	1006	6.6		1025	5.8
	1712	-0.6		1747	0.1
	2339	4.2			
4 SA	0433	2.1	19 SU	0027	3.8
	1051	6.3		0451	2.8
	1811	-0.4		1102	5.3
				1833	0.4
5 SU	0050	4.0	20 M	0138	3.7
	0533	2.5		0542	3.1
	1148	5.8		1142	4.8
	1917	-0.1		1927	0.7
6 M	0215	4.1	21 TU	0255	3.8
	0656	2.8		0712	3.2
	1300	5.3		1245	4.3
	2028	0.1		2030	0.9
7 TU	0335	4.4	22 W	0401	4.1
	0846	2.7		0915	3.1
	1433	5.0		1415	3.9
	2141	0.2		2129	1.1
8 W	0435	4.9	23 TH	0446	4.4
	1023	2.2		1044	2.6
	1602	4.8		1551	3.8
	2242	0.2		2223	1.1
9 TH	0527	5.4	24 F	0521	4.8
	1132	1.4		1137	2.0
	1719	4.9		1705	3.9
	2334	0.3		2308	1.2
10 F	0605	5.9	25 SA	0550	5.3
	1224	0.7		1219	1.3
	1821	5.0		1804	4.1
				2350	1.2
11 SA	0020	0.4	26 SU	0618	5.7
	0643	6.3		1257	0.6
	1313	0.0		1854	4.3
	1915	5.0			
12 SU	0059	0.6	27 M	0026	1.2
	0719	6.7		0649	6.2
	1355	-0.4		1333	-0.1
	2000	5.0		1939	4.4
13 M	0134	0.8	28 TU	0102	1.2
	0751	6.8		0721	6.6
	1434	-0.7		1412	-0.6
	2045	4.9		2022	4.5
14 TU	0209	1.1	29 W	0136	1.3
	0822	6.8		0755	7.0
	1513	-0.8		1452	-1.1
	2126	4.7		2108	4.6
15 W	0240	1.5	30 TH	0216	1.4
	0853	6.7		0831	7.2
	1548	-0.7		1532	-1.3
	2209	4.4		2154	4.6

DECEMBER

DAY	TIME h.m.	HT. ft.	DAY	TIME h.m.	HT. ft.
1 F	0257	1.5	16 SA	0325	2.1
	0913	7.2		0934	6.2
	1617	-1.4		1643	-0.5
	2240	4.5		2312	4.0
2 SA	0340	1.8	17 SU	0357	2.3
	0956	7.0		1004	5.9
	1704	-1.3		1717	-0.3
	2336	4.4		2354	4.0
3 SU	0433	2.0	18 M	0436	2.5
	1043	6.6		1038	5.5
	1755	-1.0		1752	0.1
4 M	0037	4.4	19 TU	0039	3.9
	0531	2.3		0518	2.7
	1139	6.0		1113	5.0
	1853	-0.6		1831	0.4
5 TU	0141	4.5	20 W	0128	4.0
	0653	2.4		0619	2.9
	1245	5.3		1155	4.5
	1953	-0.1		1913	0.8
6 W	0253	4.8	21 TH	0224	4.1
	0831	2.3		0749	2.9
	1407	4.7		1256	3.9
	2057	0.3		2001	1.1
7 TH	0355	5.1	22 F	0320	4.4
	1007	1.8		0938	2.6
	1541	4.3		1427	3.5
	2159	0.6		2100	1.4
8 F	0448	5.6	23 SA	0412	4.7
	1124	1.1		1058	2.0
	1706	4.2		1615	3.3
	2258	0.9		2159	1.5
9 SA	0537	6.0	24 SU	0455	5.2
	1219	0.4		1153	1.2
	1817	4.2		1737	3.5
	2350	1.1		2255	1.6
10 SU	0617	6.4	25 M	0537	5.7
	1308	-0.1		1238	0.4
	1913	4.3		1838	3.7
				2343	1.6
11 M	0033	1.3	26 TU	0614	6.3
	0654	6.6		1318	-0.3
	1350	-0.6		1929	4.0
	2002	4.3			
12 TU	0111	1.4	27 W	0033	1.6
	0731	6.7		0654	6.8
	1429	-0.8		1400	-1.0
	2044	4.3		2015	4.3
13 W	0147	1.6	28 TH	0118	1.5
	0803	6.7		0736	7.2
	1504	-0.9		1439	-1.5
	2123	4.3		2101	4.5
14 TH	0220	1.8	29 F	0203	1.4
	0831	6.6		0818	7.4
	1536	-0.9		1521	-1.7
	2158	4.2		2143	4.7
15 F	0254	1.9	30 SA	0248	1.4
	0903	6.5		0902	7.4
	1611	-0.7		1604	-1.8
	2237	4.1		2227	4.8
			31 SU	0337	1.4
				0949	7.2
				1649	-1.6
				2315	4.9

TIME MERIDIAN 120° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.

TABLE D-1

TIDAL DIFFERENCES AND OTHER CONSTANTS

No.	PLACE	POSITION		DIFFERENCES				RANGES		Mean Tide Level
		Lat. N.	Long. W.	Time: High water	Time: Low water	Height: High water	Height: Low water	Mean	Spring	
		° ′	° ′	h. m.	h. m.	feet	feet	feet	feet	feet
	CALIFORNIA									
425	Point Loma	32 40	117 14	-0 12	-0 06	*0.92	*0.92	3.7	5.3	2.8
427	San Diego, Quarantine Station	32 42	117 14	-0 07	-0 02	*0.96	*0.96	3.9	5.6-	2.9
429	SAN DIEGO (Broadway)	32 43	117 10	Daily predictions				4.1	5.7	3.0
431	National City, San Diego Bay	32 40	117 07	+0 01	+0 06	+0.2	0.0	4.3	5.9	3.0
433	Quivira Basin, Mission Bay	32 46	117 14	+0 02	0 00	*0.95	*0.95	3.8	5.4	2.8
435	Crown Point, Mission Bay	32 47	117 14	-0 06	+0 12	*0.96	*0.96	3.9	5.5-	2.8
437	La Jolla (Scripps Institution Wharf)	32 52	117 15	-0 03	-0 04	*0.90	*0.90	3.6	5.2-	2.7
439	San Clemente	33 25	117 37	-0 18	-0 15	*0.92	*0.92	3.7	5.3	2.7

*Ratio.-

†For places on the Caribbean Sea and Gulf of Mexico, see Tide Tables, East Coast of North and South America.

‡The bore in the Colorado River above Phillips Point is reported to have a height of several feet at times of large tides.

[1]Tide is chiefly diurnal.

TABLE D-2

APPENDIX E

WEATHER OBSERVATIONS

Weather observations were taken at Lindbergh Field (San Diego International Airport) by the National Weather Service. Temperature, wind, and visibility measurements are provided at 3-hour intervals, precipitation measurements at hourly intervals, and daily and monthly weather statistics are provided for the months of November and December 1978.

The approximate distance between Lindbergh Field and Torrey Pines Beach is 12 miles.

NOVEMBER 1978
SAN DIEGO, CALIFORNIA
NATIONAL WEATHER SERVICE OFC
LINDBERGH FIELD

Local Climatological Data

MONTHLY SUMMARY

NOVEMBER 1978 SAN DIEGO, CALIFORNIA

LATITUDE 32° 44' N LONGITUDE 117° 10' W ELEVATION (GROUND) 13 FT. STANDARD TIME USED: PACIFIC WBAN #23188

DATE	TEMPERATURE °F: MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	AVERAGE DEW POINT	DEGREE DAYS BASE 65°: HEATING (SEASON BEGINS WITH JULY)	COOLING (SEASON BEGINS WITH JAN.)	WEATHER TYPES ON DATES OF OCCURRENCE (1 FOG, 2 HEAVY FOG, 3 THUNDERSTORM, 4 ICE PELLETS, 5 HAIL, 6 GLAZE, 7 DUSTSTORM, 8 SMOKE, HAZE, 9 BLOWING SNOW)	SNOW, ICE PELLETS OR ICE ON GROUND AT 04AM IN.	PRECIPITATION: WATER EQUIVALENT IN	SNOW, ICE PELLETS IN.	AVG. STATION PRESSURE IN. ELEV. 28 FEET M.S.L.	WIND: RESULTANT DIR.	RESULTANT SPEED M.P.H.	AVERAGE SPEED M.P.H.	FASTEST MILE: SPEED M.P.H.	DIRECTION	SUNSHINE: MINUTES	PERCENT OF POSSIBLE	SKY COVER TENTHS: SUNRISE TO SUNSET	MIDNIGHT TO MIDNIGHT	DATE
1	2	3	4	5	6	7A	7B	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	69	58	64	1	53	1	0		0	0	0	30.11	32	4.3	6.3	17	NW	433	86	2	3	1
2	70	57	64	1	53	1	0		0	0	0	30.11	30	2.6	7.1	15	NW	584	90	1	1	2
3	74	55	65	2	51	0	0	8	0	0	0	30.08	31	5.5	6.0	17	NW	648	100	0	0	3
4	79*	57	68*	5	57	0	3	1 8	0	0	0	29.91	29	2.7	4.9	10	NW	623	98	0	2	4
5	70	63	67	4	60	0	2	1 8	0	0	0	29.87	17	6.2	7.6	9	S	209	32	10	9	5
6	74	60	67	5	61	0	2	1 8	0	0	0	30.01	32	4.7	5.6	11	NW	486	76	3	2	6
7	76	57	67	5	59	0	2	1 8	0	0	0	30.02	33	6.4	7.5	18	NW	600	94	1	2	7
8	74	57	66	4	60	0	1	2 8	0	0	0	29.91	30	2.5	7.3	10	NW	604	94	0	5	8
9	69	62	66	4	59	0	1	1 8	0	0	0	29.81	17	9.0	10.4	17	SW	149	23	10	9	9
10	69	58	64	2	57	1	0	1	0	.10	0	29.71	20	11.6	14.2	20	SW	15	2	10	10	10
11	61	54	58	-3	50	7	0		0	.50	0	29.77	23	12.5	14.1	28	SW	2	0	10	10	11
12	63	53	58	-3	45	7	0		0	.01	0	30.04	28	3.2	6.2	17	SW	444	70	5	5	12
13	62	54	58	-3	48	7	0	1	0	.35	0	30.02	18	6.2	7.6	17	SW	1	0	10	9	13
14	64	53	59	-2	49	6	0	1	0	.15	0	29.97	03	3.4	6.6	7	W	329	52	6	4	14
15	66	49	58	-3	47	7	0		0	0	0	30.09	33	4.4	6.8	16	NW	629	100	0	0	15
16	68	49	59	-2	47	6	0		0	0	0	30.15	31	3.5	4.9	14	NW	628	100	0	0	16
17	67	50	59	-1	51	6	0	8	0	0	0	30.06	30	3.4	5.5	13	NW	516	82	1	1	17
18	73	51	62	2	48	3	0	2	0	0	0	30.07	32	3.7	6.3	14	NW	625	100	0	0	18
19	67	54	61	1	52	4	0	1 8	0	0	0	30.04	33	4.4	5.6	14	NW	401	64	4	6	19
20	65	58	62	2	51	3	0	8	0	0	0	29.99	31	2.7	6.8	11	NW	398	64	8	9	20
21	66	58	62	2	53	3	0	1	0	.45	0	29.93	16	9.1	10.6	25	SW	209	34	9	9	21
22	66	57	62	2	54	3	0		0	0	0	29.99	14	4.1	6.6	9	SW	131	21	10	9	22
23	70	56	63	3	50	2	0		0	T	0	29.94	34	2.9	5.2	12	NW	476	77	4	6	23
24	62	57	60	1	53	5	0	1	0	.49	0	29.83	02	1.0	7.6	9	NE	130	21	9	7	24
25	65	58	62	3	50	3	0		0	0	0	29.99	23	3.9	6.5	8	SW	379	62	5	5	25
26	65	56	61	2	51	4	0		0	.05	0	29.97	36	.7	6.6	11	NW	435	71	4	4	26
27	68	50	59	0	48	6	0		0	0	0	30.04	33	3.3	5.2	12	NW	558	91	3	4	27
28	66	49*	58*	-1	42	7	0		0	0	0	30.15	32	5.5	6.6	17	NW	611	100	6	3	28
29	69	49	59	0	47	6	0		0	0	0	30.11	28	2.1	4.9	8	NW	507	83	4	2	29
30	70	51	61	2	51	4	0	1 8	0	0	0	30.07	32	3.2	5.5	12	NW	611	100	1	1	30

SUM	SUM				TOTAL	TOTAL		TOTAL	TOTAL	FOR THE MONTH:						TOTAL	%	SUM	SUM
2049	1649				102	11	NUMBER OF DAYS	2.09	0	29.99	27	1.8	7.1	26	SW	12369	FOR	136	137
AVG.	AVG.	AVG.	DEP.	AVG.	DEP.	DEP.	PRECIPITATION	DEP.						DATE: 11		POSSIBLE	MONTH	AVG.	AVG.
68.3	55.0	61.7	0.9	52	-38	-3	≥ .01 INCH 8	0.84								18887	66	4.5	4.6

NUMBER OF DAYS				SEASON TO DATE: TOTAL	TOTAL		
MAXIMUM TEMP. ≥ 90°	MAXIMUM TEMP. ≤ 32°	MINIMUM TEMP. ≤ 32°	MINIMUM TEMP. ≤ 0°	102	1276	SNOW, ICE PELLETS ≥ 1.0 INCH	0
				DEP.	DEP.	THUNDERSTORMS	0
0	0	0	0	-103	554	HEAVY FOG	2

CLEAR 13 PARTLY CLOUDY 8 CLOUDY 9

GREATEST IN 24 HOURS AND DATES: PRECIPITATION	DATES	SNOW, ICE PELLETS	GREATEST DEPTH ON GROUND OF SNOW, ICE PELLETS OR ICE AND DATE
.52	10-11	0	0

* EXTREME FOR THE MONTH - LAST OCCURRENCE IF MORE THAN ONE.
T TRACE AMOUNT
+ ALSO ON AN EARLIER DATE, OR DATES.
HEAVY FOG: - VISIBILITY 1/4 MILE OR LESS.
FIGURES FOR WIND DIRECTIONS ARE TENS OF DEGREES CLOCKWISE FROM TRUE NORTH. 00 = CALM.
DATA IN COLS. 6 AND 12-15 ARE BASED ON 7 OR MORE OBSERVATIONS PER DAY AT 3-HOUR INTERVALS.
FASTEST MILE WIND SPEEDS ARE FASTEST OBSERVED ONE-MINUTE VALUES WHEN DIRECTIONS ARE IN TENS OF DEGREES. THE / WITH THE DIRECTION INDICATES PEAK GUST SPEED.
ANY ERRORS DETECTED WILL BE CORRECTED AND CHANGES IN SUMMARY DATA WILL BE ANNOTATED IN THE ANNUAL SUMMARY

SUMMARY BY HOURS

HOUR LOCAL TIME	AVERAGES: SKY COVER TENTHS	STATION PRESSURE IN.	TEMPERATURE: AIR °F	WET BULB °F	DEW PT. °F	RELATIVE HUMIDITY %	WIND SPEED M.P.H.	RESULTANT WIND: DIRECTION	SPEED M.P.H.
01	5	30.00	59	55	52	79	6.3	14	1.1
04	5	29.99	57	53	50	79	5.2	05	.6
07	5	30.01	56	52	49	77	5.4	06	1.5
10	4	30.03	63	56	51	65	6.7	22	2.7
13	4	29.97	67	59	52	59	11.2	27	7.5
16	4	29.96	66	59	54	66	10.7	28	7.4
19	4	29.98	62	58	54	75	6.0	27	.7
22	5	30.00	60	56	53	78	5.7	09	.6

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

DATE	A.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	P.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	DATE
1																									1
2																									2
3																									3
4																									4
5																									5
6																									6
7																									7
8																									8
9																									9
10												T	T	.02	.02	.01	T	.02	T	T			.01	.02	10
11	.13	.04	T	T					.01	.03	T	T	.06	T	T	T		.01	.03	.14	.02	.02	.01	T	11
12			T	.01																					12
13																		T	.02	.07	.09	.17			13
14				T	.04	.06		.05	T		T	T													14
15																									15
16																									16
17																									17
18																									18
19																									19
20																									20
21						.01										T	.12	.27	T	T	.05				21
22																									22
23																						T	T	T	23
24	.02	.03	T	T	.01	.11	.15	.02	T	.08	.08	T													24
25																									25
26	T	T		T	.04	T	.01																		26
27																									27
28																									28
29																									29
30																									30

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noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION / ENVIRONMENTAL DATA AND INFORMATION SERVICE

David B. Mitchell
DIRECTOR, NATIONAL CLIMATIC CENTER

USCOMM--NOAA--ASHEVILLE 12/26/78 525

OBSERVATIONS AT 3-HOUR INTERVALS

Day	Hour	Sky cover (tenths)	Ceiling (hunds. of ft.)	Visibility whole miles	Visibility 16ths mile	Weather	Air °F	Wet bulb °F	Dew pt. °F	Rel. hum. %	Wind dir	Wind speed knots
01	01	9	25	10			62	57	53	73	09	4
01	04	4	UNL	10			60	56	53	78	07	4
01	07	4	UNL	12			59	55	51	75	12	4
01	10	5	UNL	12			67	59	54	63	28	7
01	13	1	UNL	25			69	60	53	57	29	14
01	16	0	UNL	25			68	60	54	61	30	13
01	19	0	UNL	15			64	58	53	68	36	6
01	22	4	UNL	10			62	57	53	73	02	6
02	01	3	UNL	12			60	56	53	78	05	4
02	04	0	UNL	12			58	54	51	78	04	3
02	07	0	UNL	15			58	54	50	75	04	3
02	10	0	UNL	12			66	59	53	63	24	7
02	13	2	UNL	15			70	61	55	59	28	12
02	16	0	UNL	15			69	58	50	51	29	10
02	19	0	UNL	10			65	59	55	70	36	4
02	22	0	UNL	10			61	57	54	78	12	6
03	01	0	UNL	12			58	55	51	75	33	3
03	04	0	UNL	12			56	52	49	78	34	3
03	07	0	UNL	12			56	51	47	72	02	3
03	10	0	UNL	6		H	70	58	48	46	28	5
03	13	0	UNL	6			74	62	53	48	30	12
03	16	0	UNL	10			72	62	55	55	31	11
03	19	0	UNL	15			68	58	51	55	31	5
03	22	0	UNL	15			64	58	53	68	00	0
04	01	0	UNL	10			61	56	52	72	28	4
04	04	0	UNL	10			59	54	50	72	33	3
04	07	0	UNL	6			59	54	49	70	09	3
04	10	0	UNL	7			73	62	55	53	25	3
04	13	0	UNL	10			77	66	59	54	30	9
04	16	0	UNL	12			72	67	65	79	31	7
04	19	0	UNL	7			67	65	64	90	00	0
04	22	10	4	5		F	66	65	64	93	17	5
05	01	10	6	6		FH	65	63	62	90	15	6
05	04	10	6	5		H	65	62	60	84	15	7
05	07	10	10	5		H	63	60	58	84	11	6
05	10	7	UNL	6		H	67	63	60	78	18	6
05	13	10	250	6			70	64	60	71	21	9
05	16	10	250	10			66	63	60	78	21	7
05	19	9	250	10			67	63	61	81	18	4
05	22	7	250	10			66	63	61	84	11	4
06	01	4	UNL	7			64	62	60	87	04	4
06	04	1	UNL	7			61	60	60	97	01	3
06	07	10	1	0	8	F	61	60	60	97	30	4
06	10	0	UNL	5		H	66	63	61	84	28	5
06	13	0	UNL	7			72	65	61	68	32	9
06	16	0	UNL	7			71	65	62	73	29	7
06	19	0	UNL	7			68	65	64	87	33	4
06	22	0	UNL	6		FH	65	62	60	84	32	3
07	01	0	UNL	7			64	60	58	81	05	4
07	04	0	UNL	7			59	57	55	87	36	4
07	07	2	UNL	10			60	54	49	67	36	6
07	10	0	UNL	6		H	73	64	58	59	32	6
07	13	1	UNL	6		H	76	67	61	60	29	6
07	16	2	UNL	3		H	72	67	64	76	32	10
07	19	0	UNL	2	8	FH	67	64	63	87	33	7
07	22	2	UNL	2	8	F	64	62	61	90	36	4
08	01	10	1	0	2	F	63	62	62	97	02	5
08	04	10	0	0	8	F	58	58	58	100	36	4
08	07	0	UNL	7			58	56	54	87	32	3
08	10	0	UNL	6		H	71	63	58	64	31	10
08	13	0	UNL	7			72	65	61	68	33	10
08	16	0	UNL	7			71	66	63	76	22	6
08	19	10	6	4		H	66	63	62	87	18	6
08	22	10	6	2	8	FH	63	61	60	90	16	5
09	01	10	7	6		H	63	61	59	87	18	7
09	04	10	9	4		H	63	60	58	84	20	6
09	07	10	10	4		H	62	59	57	84	06	7
09	10	6	12	5		H	65	60	57	75	18	7
09	13	10	17	6		H	66	63	60	76	18	12
09	16	10	17	10			67	63	61	81	17	6
09	19	7	18	7			67	63	60	78	16	12
09	22	9	20	7			67	62	59	76	15	11
10	01	10	17	6			67	63	60	78	15	16
10	04	10	17	7			67	62	59	78	18	6
10	07	10	140	6			66	62	60	81	18	14
10	10	10	25	10			66	64	63	81	20	14
10	13	10	9	10		RW	66	62	60	81	22	14
10	16	10	13	10		R	61	59	58	90	28	11
10	19	10	21	6		R	62	56	51	67	23	9
10	22	10	28	10			63	54	47	56	18	12
11	01	10	25	2		RW	59	57	55	87	23	17
11	04	10	28	6			58	55	52	78	23	6
11	07	10	25	14			60	53	47	62	28	10
11	10	10	28	18			69	66	61	78	18	6
11	13	10	21	15			58	56	53	81	22	11
11	16	10	28	15			60	54	48	65	23	15
11	19	10	28	12			59	54	49	70	22	16
11	22	10	25	10		RW	54	50	46	75	28	12
12	01	10	23	12			57	50	44	62	26	11
12	04	4	UNL	12			55	49	44	67	28	6
12	07	3	UNL	12			53	48	45	74	11	3
12	10	7	25	20			60	53	46	60	09	3
12	13	5	UNL	20			62	54	48	58	30	9
12	16	2	UNL	20			62	54	47	58	28	8
12	19	7	UNL	12			58	51	44	60	00	0
12	22	8	25	10			57	51	46	67	08	4
13	01	5	UNL	12			55	50	46	72	13	4
13	04	8	25	12			54	49	45	72	13	6
13	07	10	25	12			55	50	45	69	13	5
13	10	10	25	12			58	52	46	62	18	5
13	13	10	28	12			62	54	48	58	22	7
13	16	10	28	12			62	54	48	60	20	7
13	19	10	19	7		RW	58	55	53	84	22	8
13	22	10	18	12			60	58	57	90	19	11
14	01	8	20	10			57	55	54	90	12	6
14	04	8	36	7		RW	57	55	53	87	03	7
14	07	8	28	12			56	54	52	87	05	7
14	10	10	25	20			58	53	48	72	04	6
14	13	2	UNL	20			63	54	48	54	34	3
14	16	0	UNL	20			63	53	43	48	27	6
14	19	0	UNL	20			56	52	46	65	36	3
14	22	0	UNL	20			56	51	46	69	04	4
15	01	0	UNL	12			52	49	46	80	01	3
15	04	0	UNL	12			50	48	46	86	34	3
15	07	0	UNL	15			51	47	44	77	11	3
15	10	0	UNL	10			61	53	46	58	31	5
15	13	0	UNL	20			65	53	42	43	30	12
15	16	0	UNL	20			64	56	50	61	31	12
15	19	0	UNL	20			60	56	52	75	09	5
15	22	0	UNL	10			57	54	51	80	35	4
16	01	0	UNL	12			54	50	46	75	29	3
16	04	0	UNL	12			51	47	44	77	00	0
16	07	0	UNL	12			49	45	41	74	36	3
16	10	0	UNL	15			60	51	43	54	19	3
16	13	0	UNL	15			67	56	47	49	31	10
16	16	0	UNL	15			65	59	54	68	30	10
16	19	0	UNL	12			61	56	52	72	03	5
16	22	0	UNL	10			56	54	52	87	00	0
17	01	0	UNL	7			54	51	49	83	25	3
17	04	3	UNL	7			51	48	46	83	15	3
17	07	0	UNL	7			51	48	45	80	02	3
17	10	0	UNL	7			60	55	50	70	31	3
17	13	2	UNL	10			67	58	52	59	29	10
17	16	0	UNL	10			64	59	55	73	30	6
17	19	0	UNL	7			61	58	55	81	04	4
17	22	0	UNL	7			59	56	54	84	29	4
18	01	0	UNL	7			58	53	50	80	11	5
18	04	0	UNL	7			53	49	46	77	34	5
18	07	0	UNL	10			51	47	44	77	26	4
18	10	0	UNL	12			62	54	48	60	23	3
18	13	0	UNL	15			73	55	38	28	31	12
18	16	0	UNL	12			70	58	48	46	31	9
18	19	0	UNL	7			63	59	56	78	02	6
18	22	0	UNL	6		F	60	57	56	90	00	0
19	01	0	UNL	6		FH	56	52	49	78	01	3
19	04	5	UNL	7			54	49	45	72	05	3
19	07	6	9	7			54	48	42	64	05	3
19	10	2	UNL	7			63	57	53	70	31	3
19	13	0	UNL	6		H	67	61	56	68	30	10
19	16	10	UNL	10			63	59	57	81	31	9
19	19	10	250	7			62	58	56	81	34	4
19	22	10	12	7			60	57	55	84	01	4
20	01	10	14	7			60	56	53	78	01	4
20	04	10	16	10			59	55	52	78	09	3
20	07	10	17	6		H	58	54	51	78	06	7
20	10	10	17	6		H	62	56	51	67	18	6
20	13	6	UNL	15			65	57	51	61	28	9
20	16	9	UNL	15			63	58	50	63	30	10
20	19	10	17	15			60	55	50	70	30	5
20	22	10	23	15			61	55	50	67	30	3
21	01	8	28	15			61	54	49	65	17	4
21	04	10	28	15			60	55	50	70	11	6
21	07	10	28	15			58	54	50	75	11	7
21	10	8	UNL	15			63	56	50	63	17	10
21	13	8	UNL	15			66	59	53	63	18	17
21	16	10	17	12		RW	64	59	56	75	18	18
21	19	10	16	7		RW	60	58	56	87	18	9
21	22	10	12	10			60	58	57	90	06	3
22	01	10	100	10			59	57	56	90	09	5
22	04	8	UNL	10			58	56	55	90	11	4
22	07	10	200	10			57	55	54	90	09	3
22	10	10	200	10			62	57	54	75	12	7
22	13	10	180	25			64	58	54	70	18	9
22	16	10	200	25			65	57	51	61	20	8
22	19	9	120	15			63	59	56	78	19	4
22	22	10	80	15			61	58	55	81	04	5
23	01	5	UNL	15			56	53	50	80	11	4
23	04	4	UNL	10			57	53	49	75	08	3
23	07	10	100	15			56	52	48	78	04	3
23	10	1	UNL	25			61	53	46	58	00	0
23	13	3	UNL	25			66	57	49	47	30	8
23	16	4	UNL	25			66	58	53	63	31	6
23	19	4	UNL	15			64	58	54	70	01	4
23	22	10	33	15		RW	63	57	52	68	32	4
24	01	10	23	10		RW	61	56	53	75	29	3
24	04	10	33	10		RW	58	56	54	87	35	7
24	07	10	33	10		RW	57	55	54	90	32	6
24	10	10	23	7		R	57	55	54	90	31	6
24	13	6	60	10			[illegible]	55	54	78	06	5
24	16	6	80	20			61	55	51	70	16	7
24	19	7	17	15			61	56	53	75	16	5
24	22	2	UNL	12			58	54	51	78	12	10
25	01	4	UNL	12			58	55	52	81	10	5
25	04	3	UNL	12			58	55	52	78	22	6
25	07	7	19	12			59	55	51	75	26	3
25	10	4	UNL	20			63	54	47	56	22	6
25	13	2	UNL	20			64	56	49	58	24	7
25	16	6	20	15			62	55	49	63	26	7
25	19	5	UNL	15			60	54	49	67	25	3
25	22	6	30	15			58	53	49	72	10	4
26	01	10	21	12		RW	58	54	50	75	12	6
26	04	10	17	12		RW	57	53	50	78	05	3
26	07	6	19	10			56	53	50	80	12	3
26	10	4	UNL	10			58	55	51	75	18	5
26	13	4	UNL	10			64	58	53	68	27	10
26	16	0	UNL	10			63	57	53	70	30	6
26	19	0	UNL	12			60	55	50	70	02	4
26	22	0	UNL	12			58	54	50	75	02	7
27	01	0	UNL	12			54	51	49	83	32	4
27	04	0	UNL	12			53	49	46	77	31	3
27	07	0	UNL	12			51	48	45	80	01	3
27	10	0	UNL	7			60	52	44	56	08	4
27	13	1	UNL	7			65	56	49	56	27	6
27	16	10	UNL	7			65	57	51	61	32	10
27	19	6	UNL	8			61	58	53	75	07	3
27	22	5	UNL	10			57	53	49	75	36	3
28	01	4	UNL	10			53	48	44	72	36	4
28	04	2	UNL	10			51	46	41	69	03	3
28	07	0	UNL	15			48	44	39	71	32	4
28	10	6	UNL	12			60	50	41	50	28	5
28	13	10	UNL	20			66	53	38	33	30	11
28	16	9	UNL	25			66	55	45	47	31	11
28	19	2	UNL	25			61	52	44	54	03	4
28	22	0	UNL	15			57	50	44	62	34	4
29	01	0	UNL	10			53	48	45	74	28	3
29	04	2	UNL	10			52	46	39	61	10	3
29	07	10	UNL	12			50	45	39	66	02	3
29	10	5	UNL	12			60	52	44	56	22	5
29	13	0	UNL	15			67	57	49	53	23	7
29	16	2	UNL	15			65	58	52	63	28	7
29	19	0	UNL	10			61	58	55	81	01	3
29	22	0	UNL	7			58	55	52	81	34	3
30	01	0	UNL	10			54	51	49	83	34	4
30	04	3	UNL	7			52	50	48	86	35	4
30	07	1	UNL	7			52	49	47	83	01	3
30	10	0	UNL	7			62	54	48	60	17	4
30	13	0	UNL	7			69	58	52	55	32	8
30	16	0	UNL	8		H	66	61	57	73	30	9
30	19	0	UNL	5		H	62	57	54	75	33	3
30	22	0	UNL	5		H	58	55	52	81	16	3

NOTES

CEILING

UNL INDICATES UNLIMITED

WEATHER

- * TORNADO
- T THUNDERSTORM
- Q SQUALL
- R RAIN
- RW RAIN SHOWERS
- ZR FREEZING RAIN
- L DRIZZLE
- ZL FREEZING DRIZZLE
- S SNOW
- SP SNOW PELLETS
- IC ICE CRYSTALS
- SW SNOW SHOWERS
- SG SNOW GRAINS
- IP ICE PELLETS
- A HAIL
- F FOG
- IF ICE FOG
- GF GROUND FOG
- BD BLOWING DUST
- BN BLOWING SAND
- BS BLOWING SNOW
- BY BLOWING SPRAY
- K SMOKE
- H HAZE
- D DUST

WIND

DIRECTIONS ARE THOSE FROM WHICH THE WIND BLOWS. INDICATED IN TENS OF DEGREES FROM TRUE NORTH; I.E., 09 FOR EAST, 18 FOR SOUTH, 27 FOR WEST. ENTRY OF 00 IN THE DIRECTION COLUMN INDICATES CALM.

SPEED IS EXPRESSED IN KNOTS; MULTIPLY BY 1.15 TO CONVERT TO MILES PER HOUR.

STATION: SAN DIEGO CALIFORNIA

YEAR & MONTH: 78 11

DECEMBER 1978
SAN DIEGO, CALIFORNIA
NATIONAL WEATHER SERVICE OFC
LINDBERGH FIELD

Local Climatological Data

MONTHLY SUMMARY

DECEMBER 1978 SAN DIEGO, CALIFORNIA

LATITUDE 32° 44' N LONGITUDE 117° 10' W ELEVATION (GROUND) 13 FT. STANDARD TIME USED: PACIFIC WBAN #23188

Date	Temperature °F Maximum	Minimum	Average	Departure from normal	Average dew point	Degree days base 65° Heating (season begins with Jul. 1)	Cooling (season begins with Jan. 1)	Weather types on dates of occurrence (1 Fog, 2 Heavy fog, 3 Thunderstorm, 4 Ice pellets, 5 Hail, 6 Glaze, 7 Duststorm, 8 Smoke, haze, 9 Blowing snow)	Snow, ice pellets or ice on ground at 04AM in.	Precipitation Water equivalent in.	Snow, ice pellets in.	Avg. station pressure in. Elev. 28 feet m.s.l.	Wind Resultant dir.	Resultant speed m.p.h.	Average speed m.p.h.	Fastest mile Speed m.p.h.	Direction	Sunshine Minutes	Percent of possible	Sky cover tenths Sunrise to sunset	Midnight to midnight	Date
1	2	3	4	5	6	7A	7B	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	64	54	59	1	54	6	0	1 8	0	.05	0	29.86	22	4.0	10.4	19	NW	35	6	10	9	1
2	67	521	60	2	47	5	0		0	0	0	29.90	30	3.6	7.5	13	W	600	99	21	21	21
3	67	47	57	-1	39	8	0		0	0	0	30.12	31	2.4	5.2	12	NW	607	100	0	0	3
4	67	47	57	-1	40	8	0		0	0	0	30.15	31	4.1	5.0	11	NW	592	98	0	0	4
5	62	50	56	-2	45	9	0	1	0	.03	0	29.82	22	3.8	9.4	21	N	117	19	10	6	51
6	58	42	49	-9	19	16	0		0	T	0	29.83	34	6.3	9.9	17	NW	470	78	2	2	6
7	55	38	47	-11	19	18	0		0	0	0	30.12	35	4.3	7.3	16	NW1	605	100	0	0	7
8	561	34*	45*	-13	12	20	0		0	0	0	30.42	34	1.9	5.5	11	W	569	97	2	1	8
9	581	38	48	-9	25	17	0		0	0	0	30.35	32	4.8	6.0	17	NW	582	93	3	2	9
10	73	42	58	1	34	7	0		0	0	0	30.11	32	3.8	4.2	12	NW	569	98	0	0	10
11	75*	50	63*	6	37	2	0		0	0	0	30.11	31	2.7	5.0	12	NW	602	100	0	0	11
12	70	48	59	2	43	6	0		0	0	0	30.10	31	1.9	3.0	8	SW	524	87	10	8	12
13	74	45	60	3	36	5	0		0	0	0	30.15	31	3.7	5.2	12	NW	582	97	0	0	13
14	72	46	59	2	35	6	0		0	0	0	30.14	33	3.7	4.0	10	NW1	601	100	91	71	14
15	66	47	57	0	43	8	0	8	0	0	0	30.02	17	1.1	3.2	5	S	379	63	10	9	15
16	63	47	55	-2	46	10	0	8	0	.14	0	30.00	26	1.9	3.6	9	NW	439	73	101	10	16
17	621	54	58	1	57	7	0	1	0	1.32	0	29.88	17	3.7	8.5	17	NW	0	0	101	10	17
18	61	55	58	2	53	7	0		0	.38	0	29.86	22	6.6	9.8	28	SW	164	31	10	9	18
19	58	48	53	-3	44	12	0		0	.27	0	30.02	28	7.6	10.9	28	NW	430	72	8	6	19
20	63	43	53	-3	40	12	0		0	0	0	30.26	34	2.1	4.3	12	N	600	100	0	0	20
21	621	42	52	-4	37	13	0		0	0	0	30.18	31	3.7	4.6	12	NW	540	90	10	6	21
22	64	43	54	-2	43	11	0		0	0	0	30.05	31	3.5	4.8	11	NW	569	95	141	3	22
23	64	44	54	-2	48	11	0	8	0	0	0	30.03	24	.8	3.0	8	NW	600	100	1	1	23
24	651	46	56	0	51	9	0	2 8	0	0	0	30.02	32	2.9	4.3	10	NE	592	99	21	3	24
25	61	47	54	-2	50	11	0	2 8	0	0	0	29.94	32	2.2	3.0	11	NW	546	91	3	5	25
26	61	45	53	-3	50	12	0	2 8	0	0	0	29.97	33	2.7	4.9	8	NW	432	72	8	8	26
27	63	44	54	-2	49	11	0	2 8	0	0	0	29.95	36	1.2	4.8	10	NW	486	81	6	8	27
28	62	56	59	3	50	6	0	8	0	0	0	29.87	18	3.9	4.8	7	SE	372	62	9	10	28
29	63	55	59	3	51	6	0		0	0	0	29.84	33	1.7	5.2	8	NW	298	50	10	10	29
30	64	47	56	1	50	9	0	1 8	0	0	0	29.86	30	3.5	6.2	17	NW	557	93	0	3	30
31	64	47	56	1	48	9	0	1 8	0	0	0	30.07	30	1.4	5.2	9	NE	577	96	0	0	31
	SUM	SUM				TOTAL	TOTAL			TOTAL	TOTAL	FOR THE MONTH:						TOTAL	%	SUM	SUM	
	1982	1443				297	0	NUMBER OF DAYS		2.19	0	30.03	30	2.1	5.8	28	NW	14676	FOR	147	130	
	AVG.	AVG.	AVG.	DEP.	AVG.	DEP.	DEP.	PRECIPITATION		DEP.						DATE: 19+		POSSIBLE	MONTH	AVG.	AVG.	
	63.9	46.5	55.2	-1.5	42	40	0	≥ .01 INCH	6	0.46								18672	79	4.7	4.5	
						SEASON TO DATE		SNOW, ICE PELLETS														
	NUMBER OF DAYS					TOTAL	TOTAL	≥ 1.0 INCH	0	GREATEST IN 24 HOURS AND DATES						GREATEST DEPTH ON GROUND OF SNOW, ICE PELLETS OR ICE AND DATE						
	MAXIMUM TEMP.		MINIMUM TEMP.			399	1276	THUNDERSTORMS	0	PRECIPITATION		SNOW, ICE PELLETS										
	≥ 90°	≤ 32°	≤ 32°	≤ 0°		DEP.	DEP.	HEAVY FOG	4	1.46	16-17	0				0						
	0	0	0	0		-63	554	CLEAR 16, PARTLY CLOUDY 3, CLOUDY 12														

* EXTREME FOR THE MONTH - LAST OCCURRENCE IF MORE THAN ONE.
T TRACE AMOUNT
+ ALSO ON AN EARLIER DATE, OR DATES.
HEAVY FOG: - VISIBILITY 1/4 MILE OR LESS.
FIGURES FOR WIND DIRECTIONS ARE TENS OF DEGREES CLOCKWISE FROM TRUE NORTH. 00 = CALM.
DATA IN COLS. 6 AND 12-15 ARE BASED ON 7 OR MORE OBSERVATIONS PER DAY AT 3-HOUR INTERVALS.
FASTEST MILE WIND SPEEDS ARE FASTEST OBSERVED ONE-MINUTE VALUES WHEN DIRECTIONS ARE IN TENS OF DEGREES. THE / WITH THE DIRECTION INDICATES PEAK GUST SPEED.
ANY ERRORS DETECTED WILL BE CORRECTED AND CHANGES IN SUMMARY DATA WILL BE ANNOTATED IN THE ANNUAL SUMMARY

SUMMARY BY HOURS

Hour local time	Averages: Sky cover tenths	Station pressure in.	Temperature Air °F	Wet bulb °F	Dew pt. °F	Relative humidity %	Wind speed m.p.h.	Resultant wind Direction	Speed m.p.h.
01	4	30.03	51	47	41	72	4.2	35	1.6
04	4	30.02	48	45	39	72	3.3	31	.8
07	5	30.05	48	44	39	72	3.7	01	1.1
10	5	30.07	57	49	40	57	6.1	20	1.4
13	4	30.01	62	52	41	51	9.5	28	6.6
16	5	30.00	61	53	45	59	9.4	29	7.5
19	5	30.02	57	52	46	89	5.7	34	1.6
22	4	30.04	54	49	43	70	4.1	01	1.4

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

Date	A.M. 1	2	3	4	5	6	7	8	9	10	11	12	P.M. 1	2	3	4	5	6	7	8	9	10	11	12	Date
1																		.01	.04						1
2																									2
3																									3
4																									4
5																.03	T								5
6																					T	T			6
7																									7
8																									8
9																									9
10																									10
11																									11
12																									12
13																									13
14																									14
15																									15
16																				T	.01	.02	.05	.06	16
17	.29	.12	.03	.05	.02	.05	.08	.08	.06	.02	.02	.12	.08	.11	.07	.02	T		.01	.11					17
18											.02	.01	.16			.14	T			.02	.03	T	T		18
19	.04		.01	.03	.08	T	.11	T	T										T	T					19
20																									20
21																									21
22																									22
23																									23
24																									24
25																									25
26																									26
27																									27
28																									28
29																									29
30																									30
31																									31

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I CERTIFY THAT THIS IS AN OFFICIAL PUBLICATION OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND IS COMPILED FROM RECORDS ON FILE AT THE NATIONAL CLIMATIC CENTER, ASHEVILLE, NORTH CAROLINA 28801.

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION / ENVIRONMENTAL DATA AND INFORMATION SERVICE

Daniel B. Mitchell
DIRECTOR, NATIONAL CLIMATIC CENTER

OBSERVATIONS AT 3-HOUR INTERVALS

Day	Hour	Sky cover (tenths)	Ceiling (hund. of ft.)	Visibility whole miles	Visibility fraction	Weather	Air °F	Wet bulb °F	Dew pt. °F	Rel. hum. %	Wind dir	Wind speed knots
01	01	1	UNL	3		FH	58	54	52	87	14	3
01	04	10	8	4		FH	56	54	53	90	14	4
01	07	10	12	3		FH	58	56	54	87	12	8
01	10	10	13	8			60	57	55	84	17	6
01	13	10	16	15			63	58	57	81	18	13
01	16	10	21	15			63	58	56	78	23	10
01	19	10	13	10			60	58	56	87	29	18
01	22	10	25	10			58	54	48	70	30	10
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02	04	1	UNL	10			57	54	51	80	13	6
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02	13	2	UNL	15			65	54	45	49	26	8
02	16	2	UNL	20			64	52	40	42	29	10
02	19	0	UNL	15			59	51	44	58	03	4
02	22	0	UNL	10			56	49	43	62	05	7
03	01	0	UNL	10			53	47	41	64	28	3
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04	01	0	UNL	15			51	44	37	59	00	0
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04	07	3	UNL	25			47	41	34	61	00	0
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05	19	7	20	7			58	56	54	84	25	9
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17	10	10	38	7		R	59	58	57	93	13	14
17	13	10	4	7		RW	61	60	60	97	16	9
17	16	10	25	5		RWF	61	60	60	97	20	5
17	19	10	12	10			62	60	59	90	18	8
17	22	10	7	7			60	59	58	93	32	10
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18	04	10	120	15			57	55	53	87	25	3
18	07	10	220	10			56	55	54	93	12	8
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27	16	10	UNL	7			60	55	51	72	30	7
27	19	10	250	7			57	53	50	78	00	0
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28	01	10	25	6		H	57	53	49	75	13	4
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30	19	2	UNL	3		F	58	56	54	87	29	4
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31	13	0	UNL	7			63	54	47	56	22	5
31	16	0	UNL	7			62	56	51	67	30	6
31	19	0	UNL	8		H	57	54	51	80	09	3
31	22	0	UNL	5		H	55	52	50	83	08	6

STATION

SAN DIEGO CALIFORNIA

YEAR & MONTH

78 12

NOTES

CEILING

UNL INDICATES UNLIMITED

WEATHER

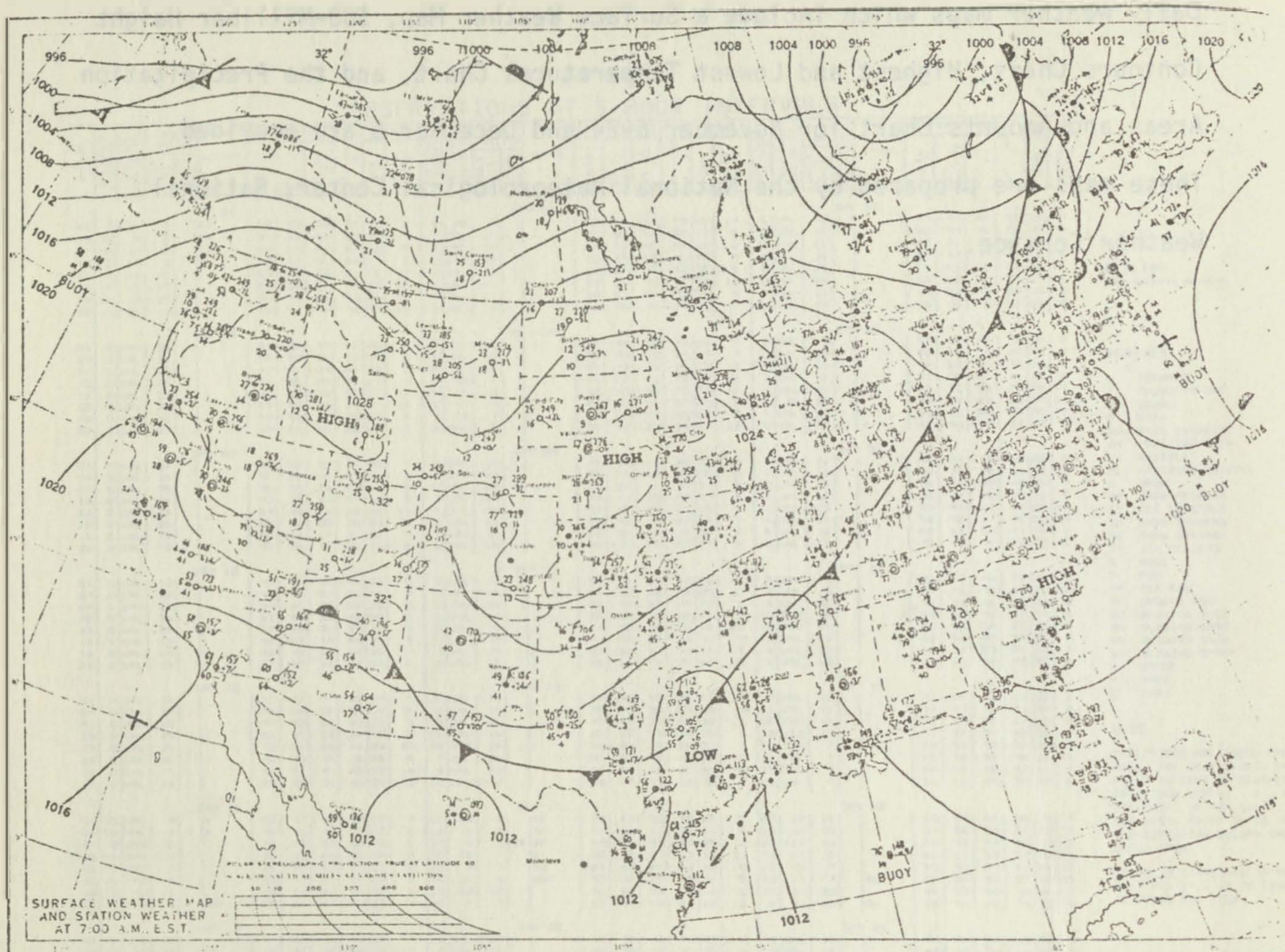
- * TORNADO
- T THUNDERSTORM
- Q SQUALL
- R RAIN
- RW RAIN SHOWERS
- ZR FREEZING RAIN
- L DRIZZLE
- ZL FREEZING DRIZZLE
- S SNOW
- SP SNOW PELLETS
- IC ICE CRYSTALS
- SW SNOW SHOWERS
- SG SNOW GRAINS
- IP ICE PELLETS
- A HAIL
- F FOG
- IF ICE FOG
- GF GROUND FOG
- BD BLOWING DUST
- BN BLOWING SAND
- BS BLOWING SNOW
- BY BLOWING SPRAY
- K SMOKE
- H HAZE
- D DUST

WIND

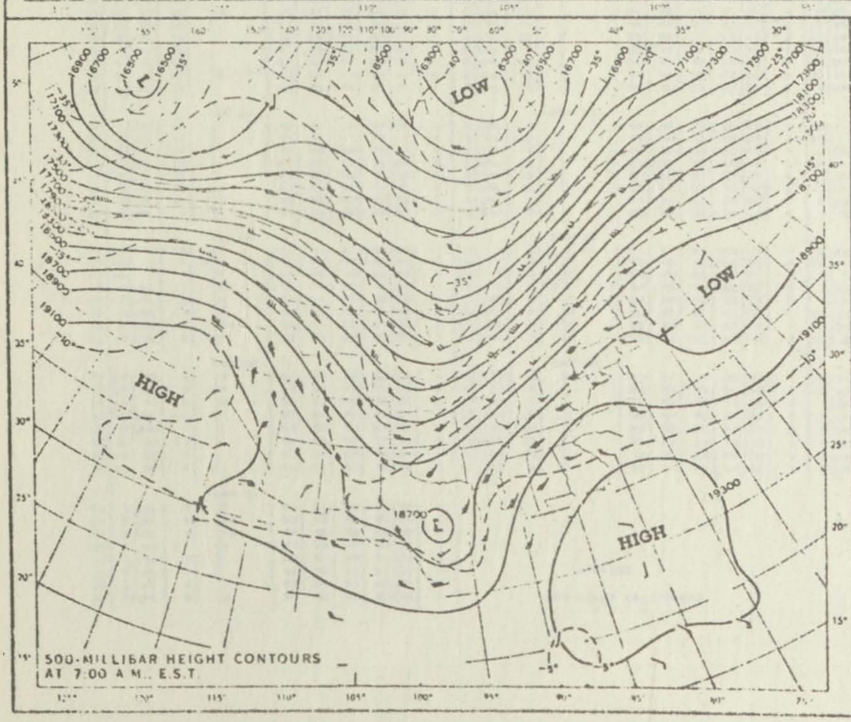
DIRECTIONS ARE THOSE FROM WHICH THE WIND BLOWS. INDICATED IN TENS OF DEGREES FROM TRUE NORTH: I.E., 09 FOR EAST, 18 FOR SOUTH, 27 FOR WEST. ENTRY OF 00 IN THE DIRECTION COLUMN INDICATES CALM.

SPEED IS EXPRESSED IN KNOTS. MULTIPLY BY 1.15 TO CONVERT TO MILES PER HOUR.

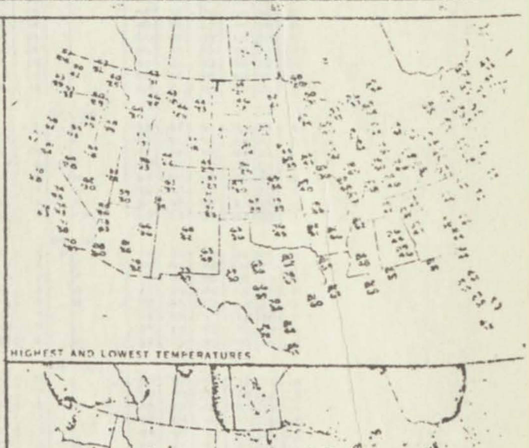
Daily weather maps which include a Surface Weather Map, 500-Millibar Height Contours Chart, Highest and Lowest Temperatures Chart, and the Precipitation Areas and Amounts Chart for November 6-24 and December 6 are provided. These maps are prepared by the National Meteorological Center, National Weather Service.



SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M., E.S.T.

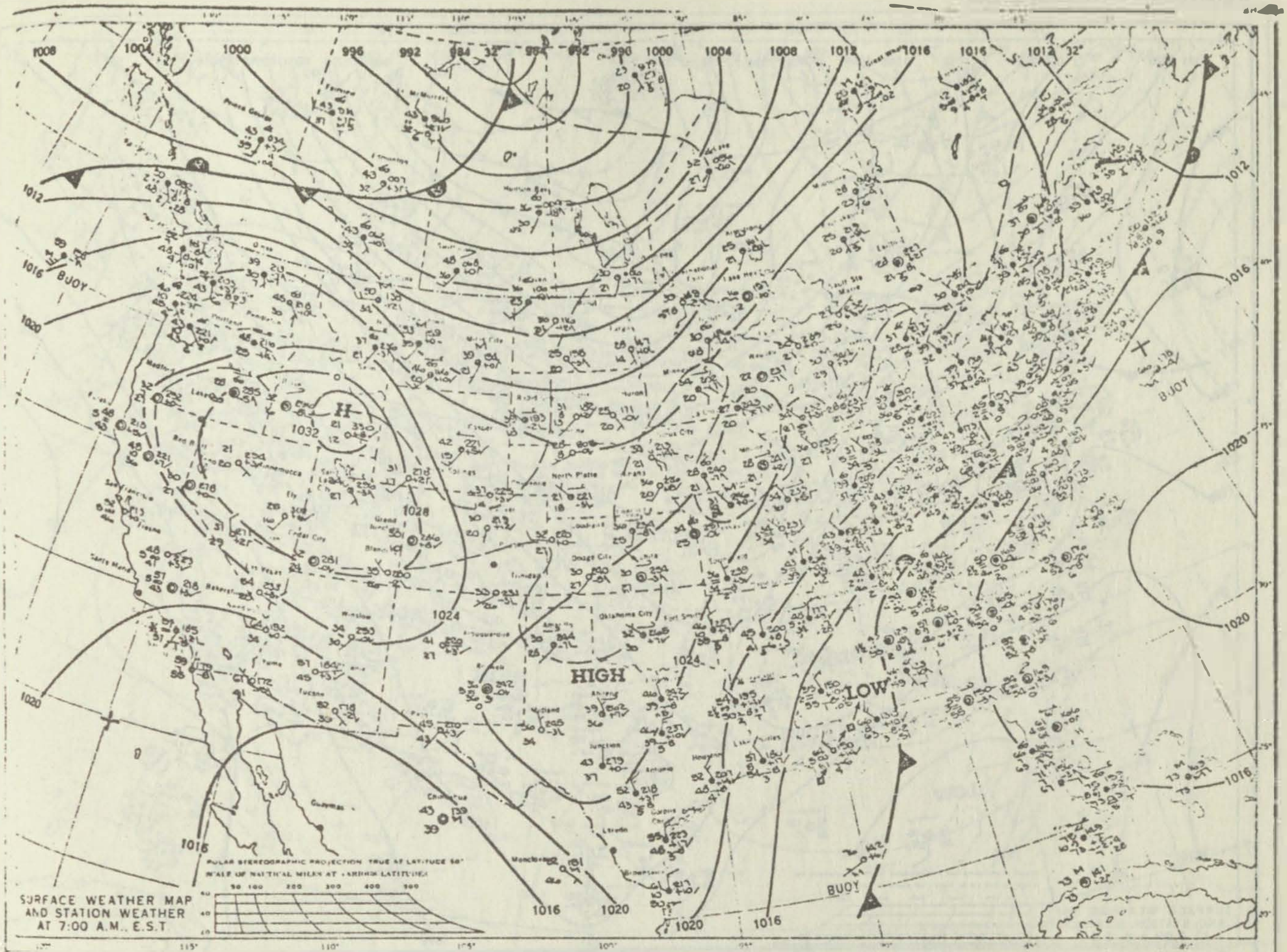


500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M., E.S.T.



HIGHEST AND LOWEST TEMPERATURES

PRECIPITATION AREAS AND AMOUNTS



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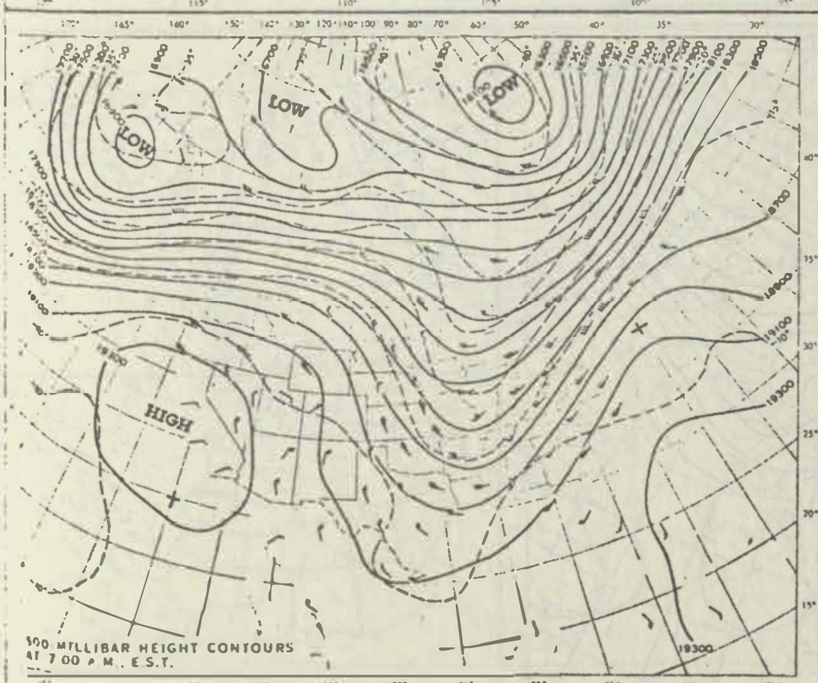

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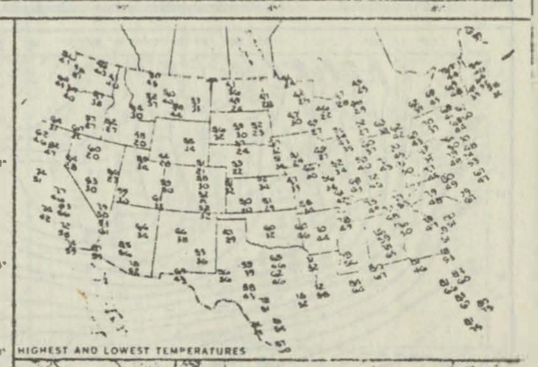
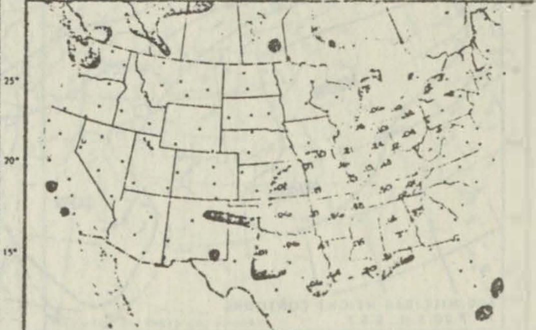
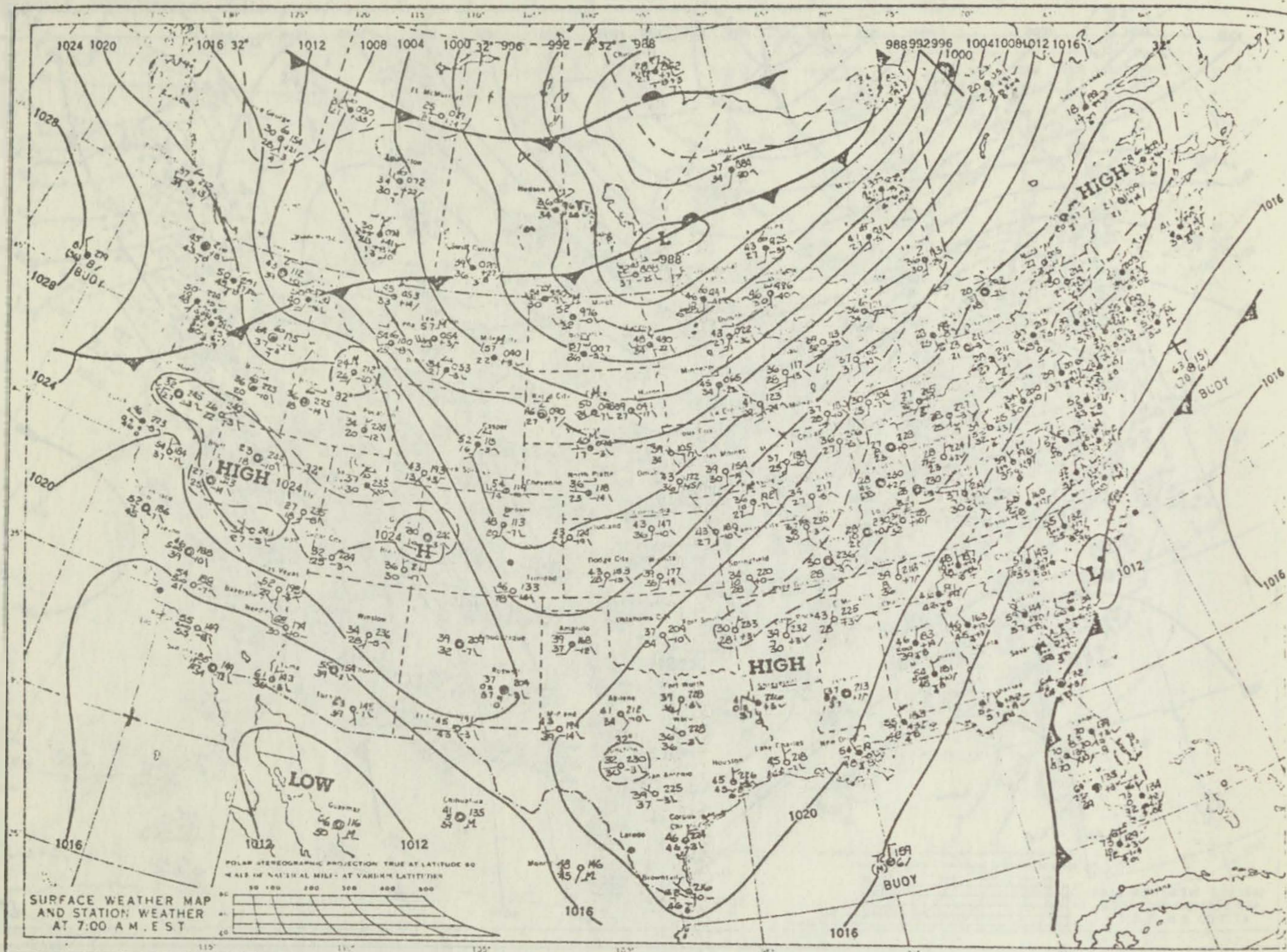
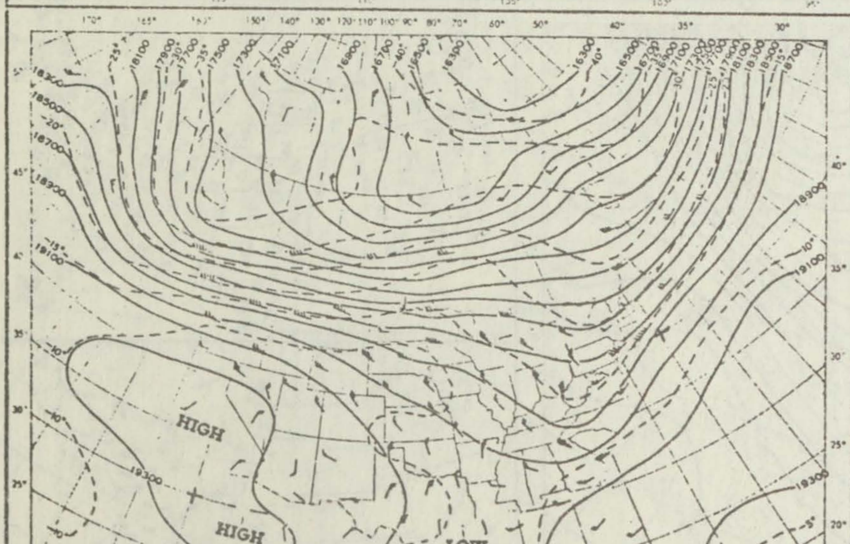

HIGHEST AND LOWEST TEMPERATURES

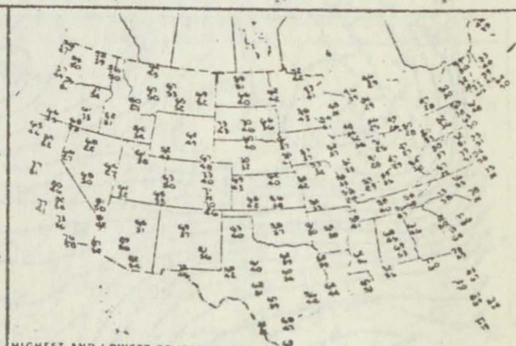

PRECIPITATION AREAS AND AMOUNTS



SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M. E.S.T.

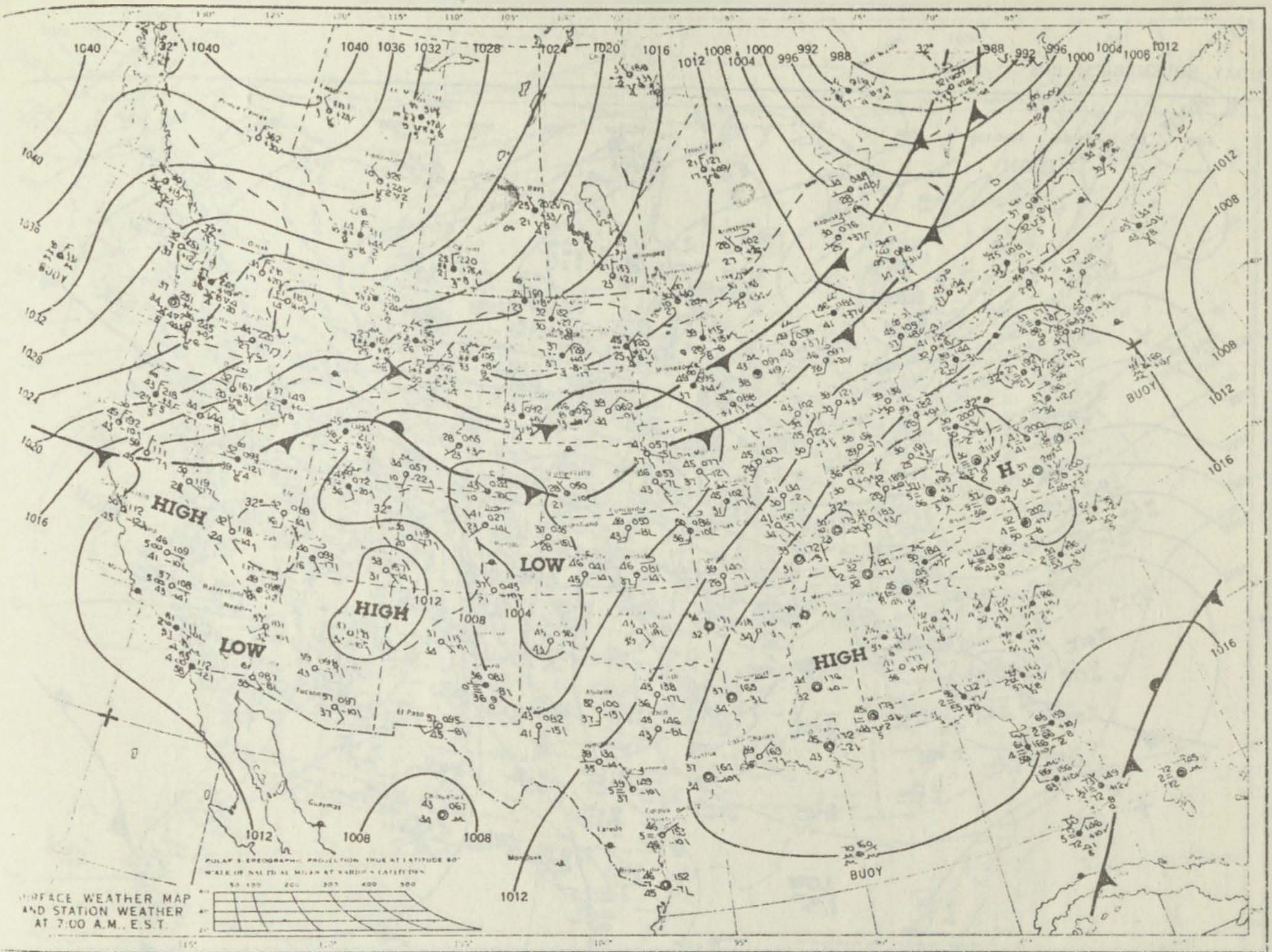


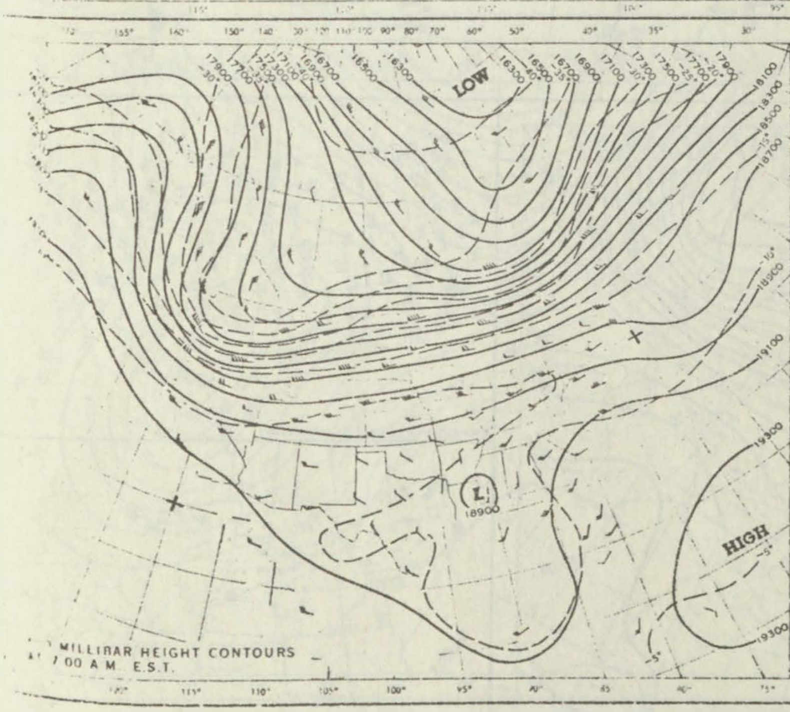
500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M., E.S.T.

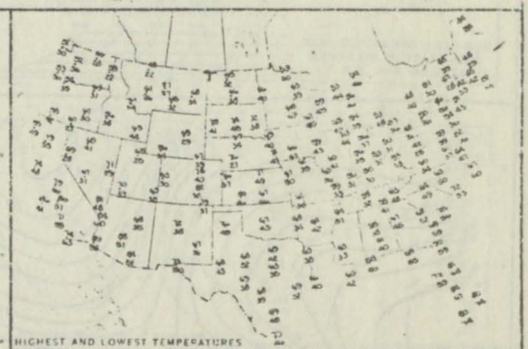


HIGHEST AND LOWEST TEMPERATURES

PRECIPITATION AREAS AND AMOUNTS

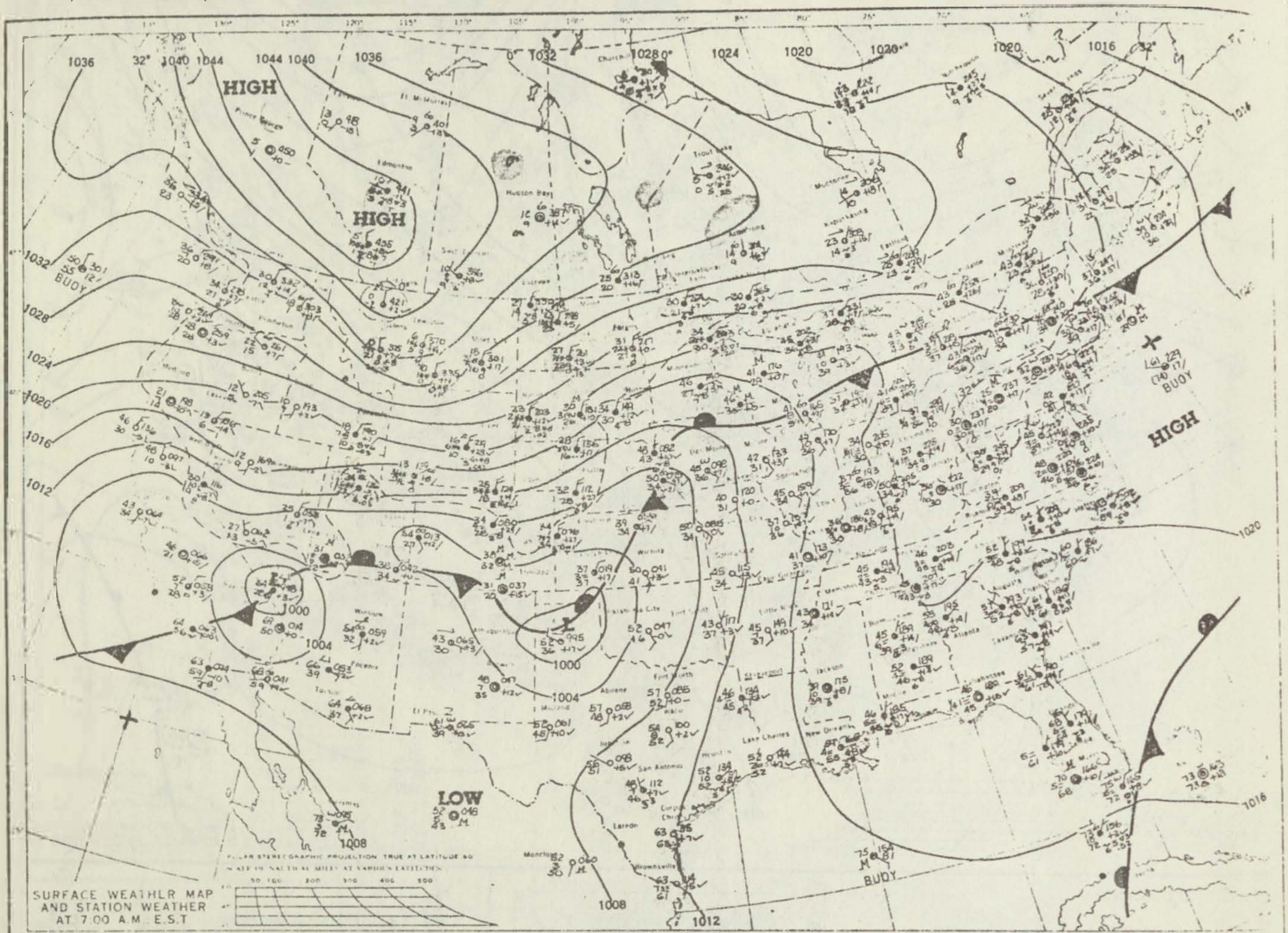

HIGH
LOW
HIGH
LOW
HIGH
H
BUOY
URFACE WEATHER MAP
AND STATION WEATHER
AT 7:00 A.M., E.S.T.


LOW
HIGH
MILLIBAR HEIGHT CONTOURS
7:00 A.M. E.S.T.

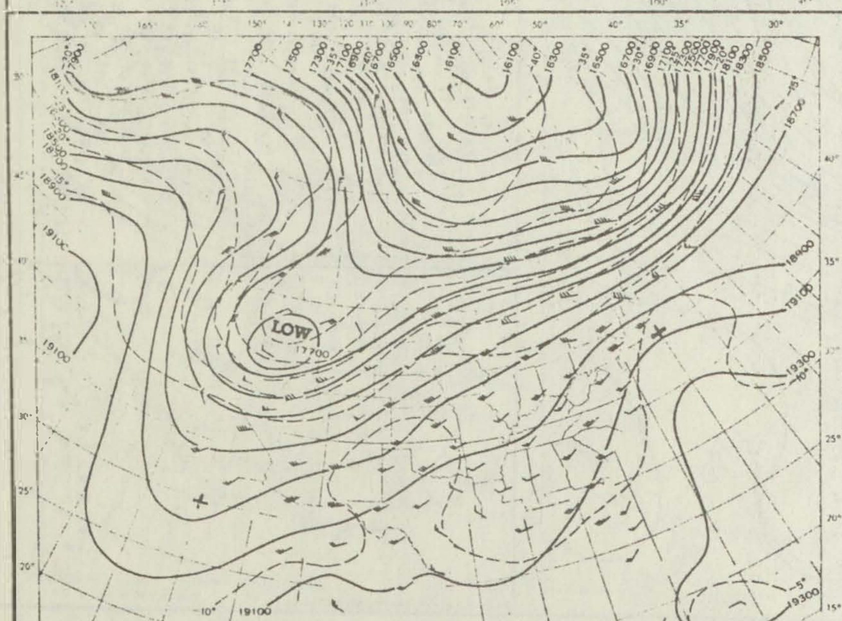

HIGHEST AND LOWEST TEMPERATURES


PRECIPITATION AREAS AND AMOUNTS

FRIDAY, NOVEMBER 10, 1978



SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M., E.S.T.



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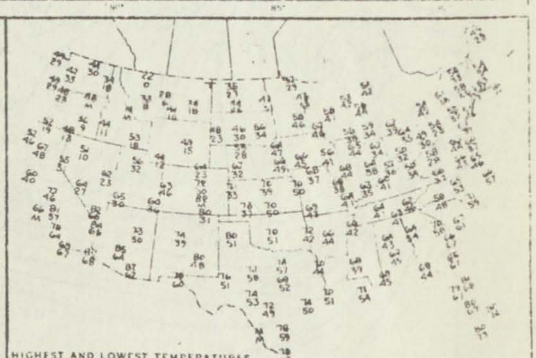
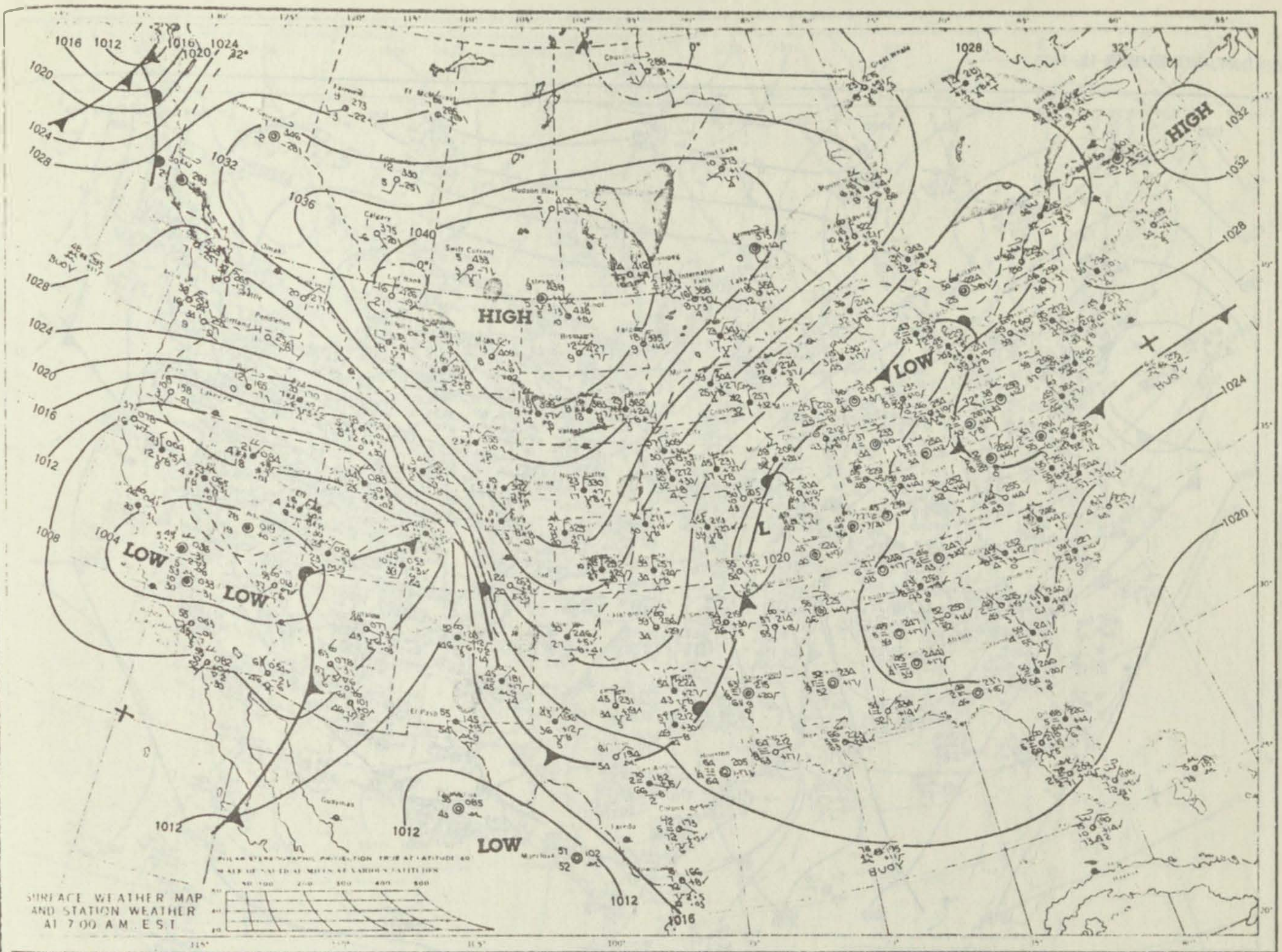
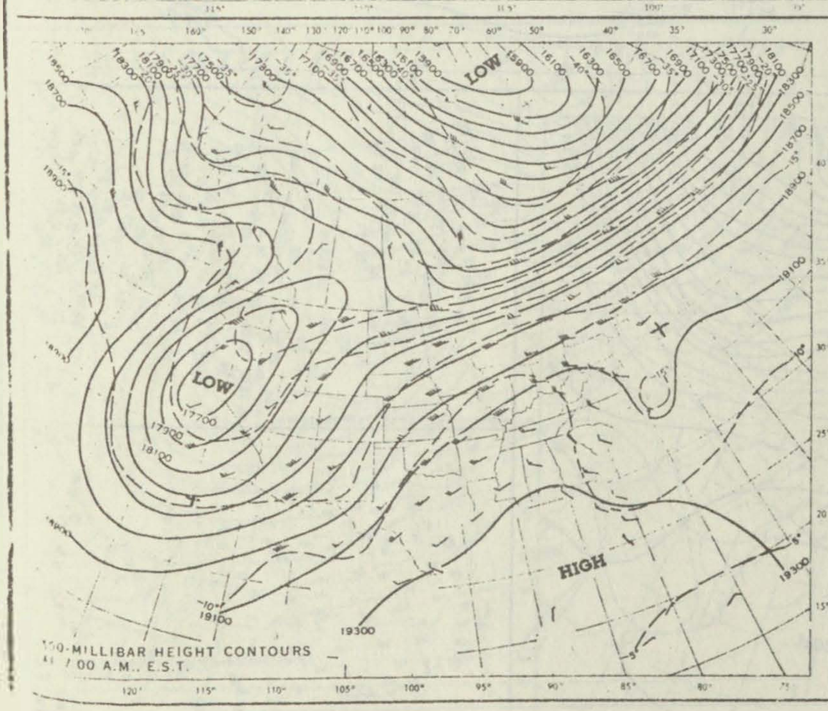

HIGHEST AND LOWEST TEMPERATURES


PRECIPITATION AREAS AND AMOUNTS



SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M. E.S.T.



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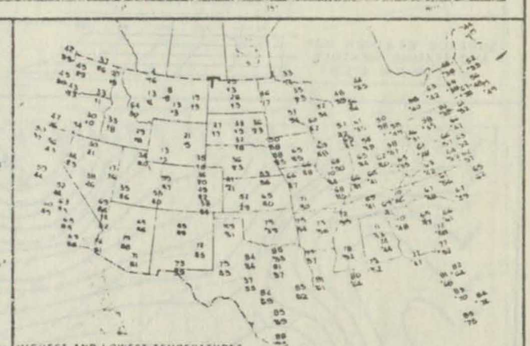
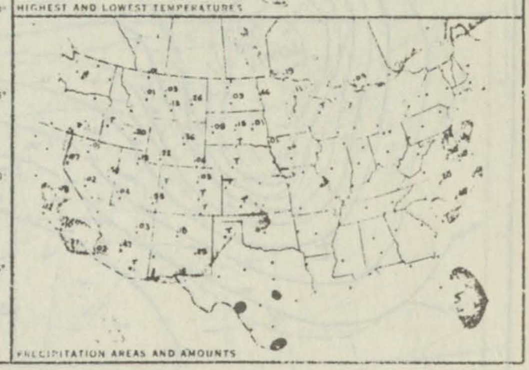
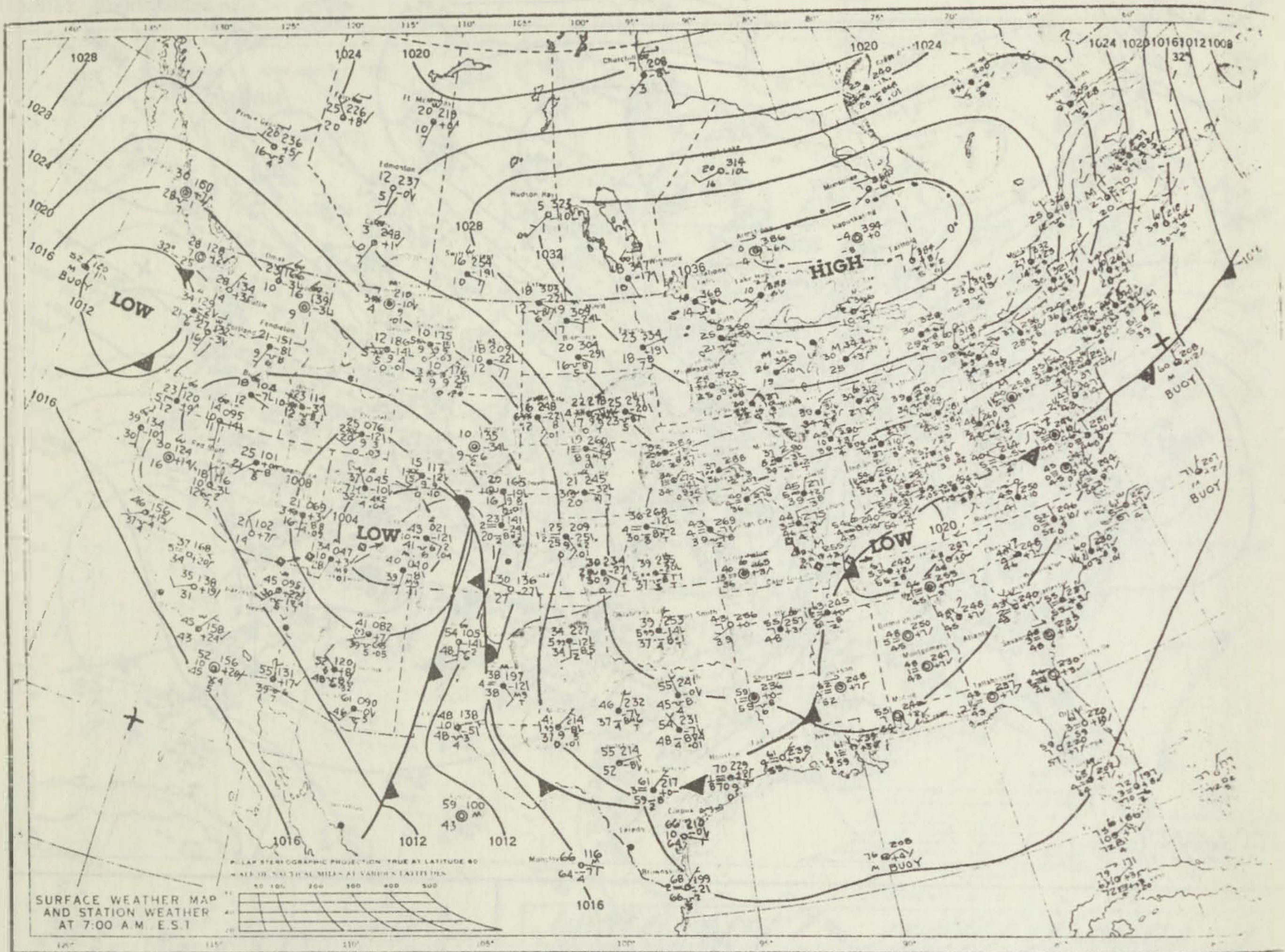


HIGHEST AND LOWEST TEMPERATURES

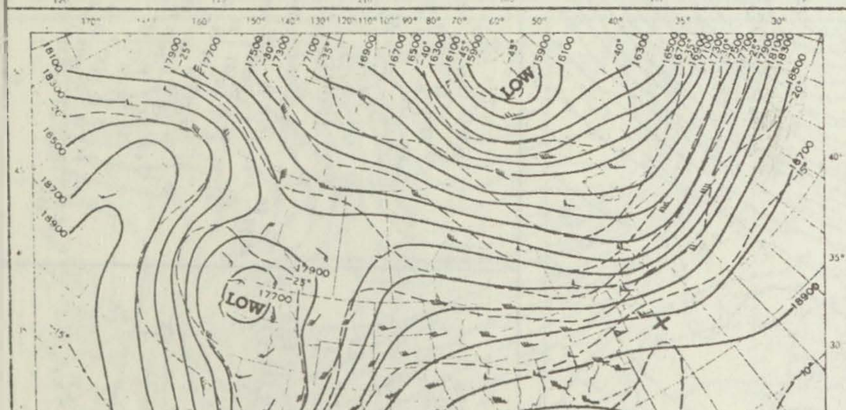


PRECIPITATION AREAS AND AMOUNTS

SUNDAY, NOVEMBER 12, 1978



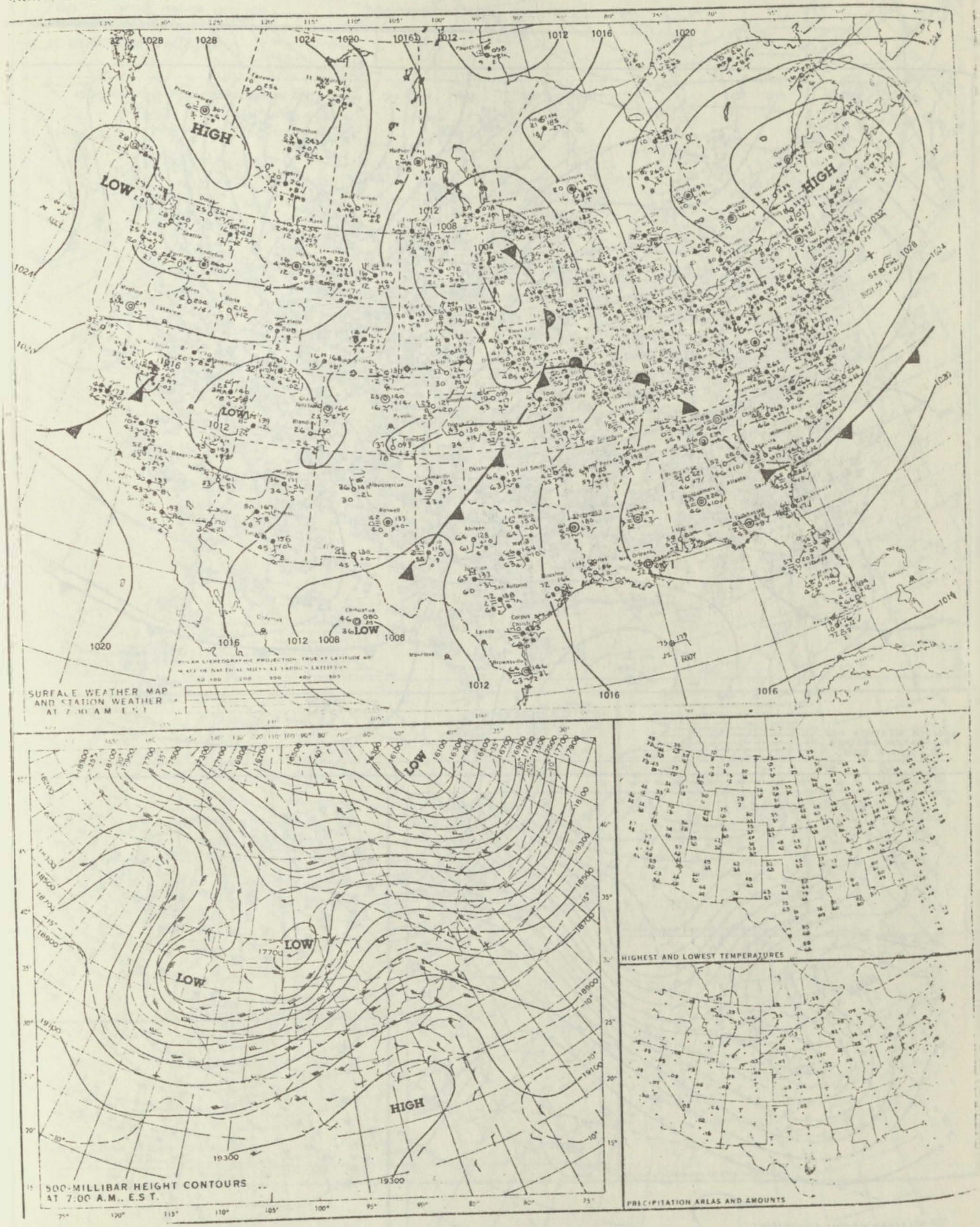
SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M. E.S.T.

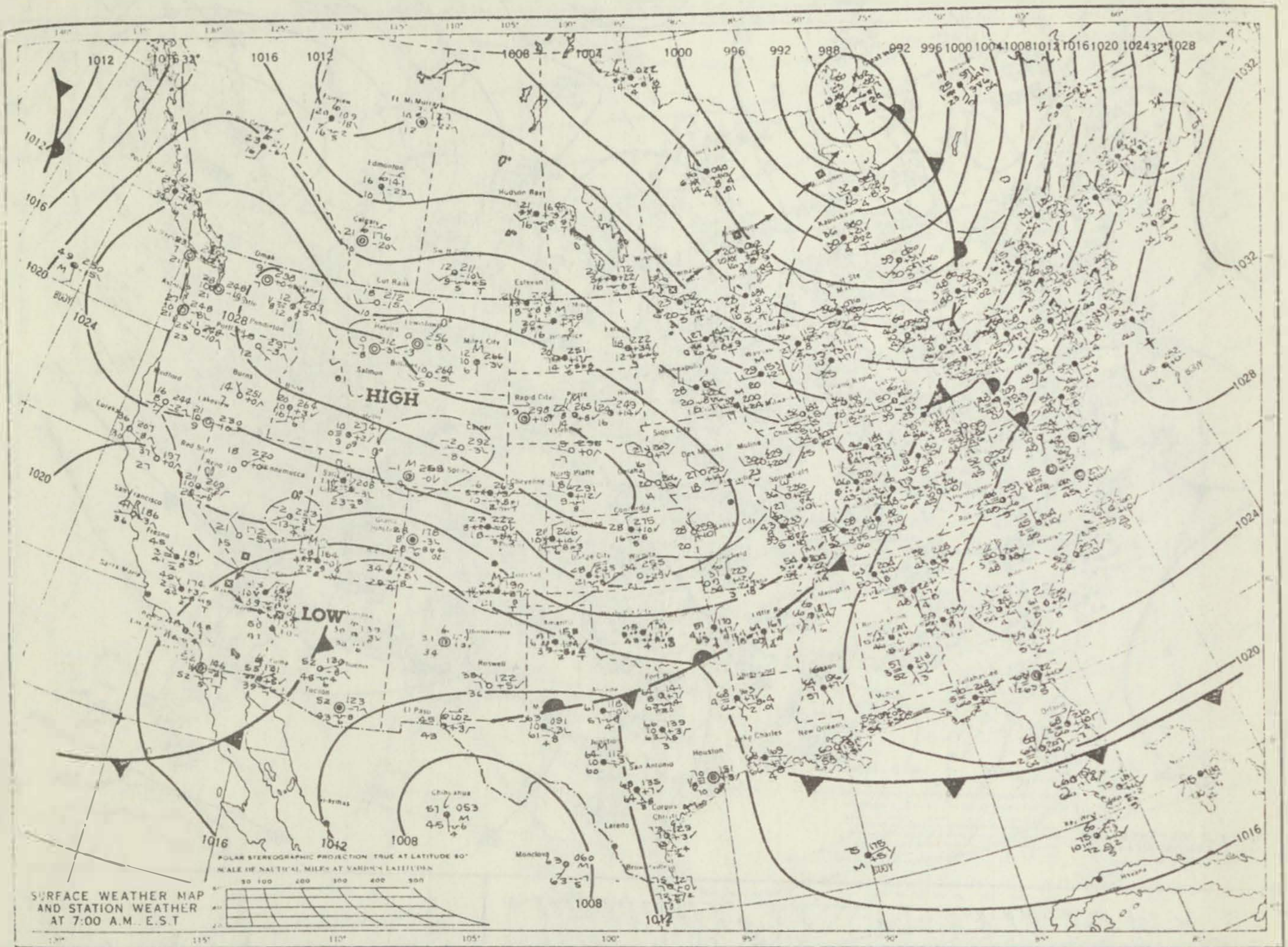


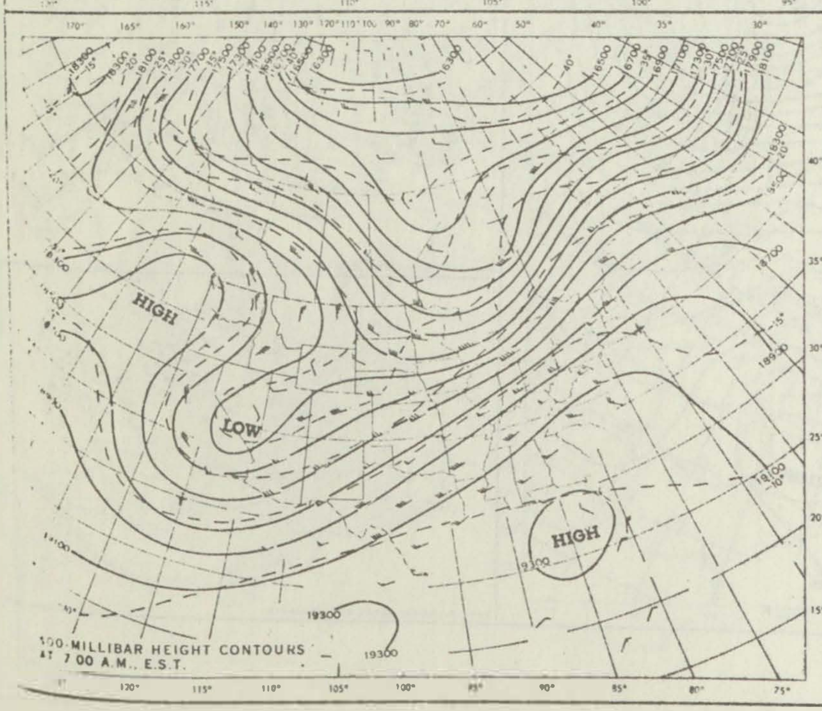
500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M. E.S.T.

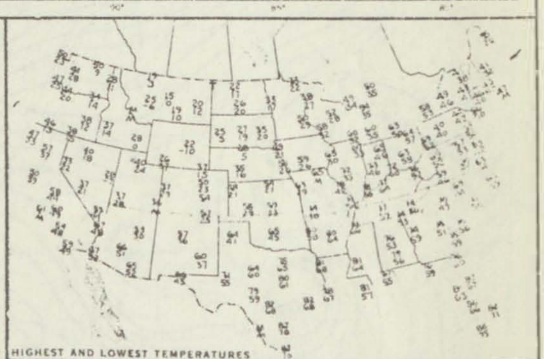

HIGHEST AND LOWEST TEMPERATURES

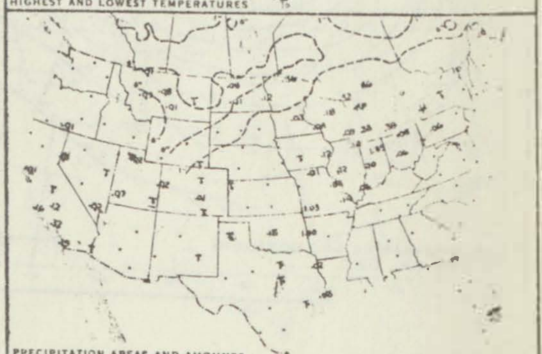

PRECIPITATION AREAS AND AMOUNTS

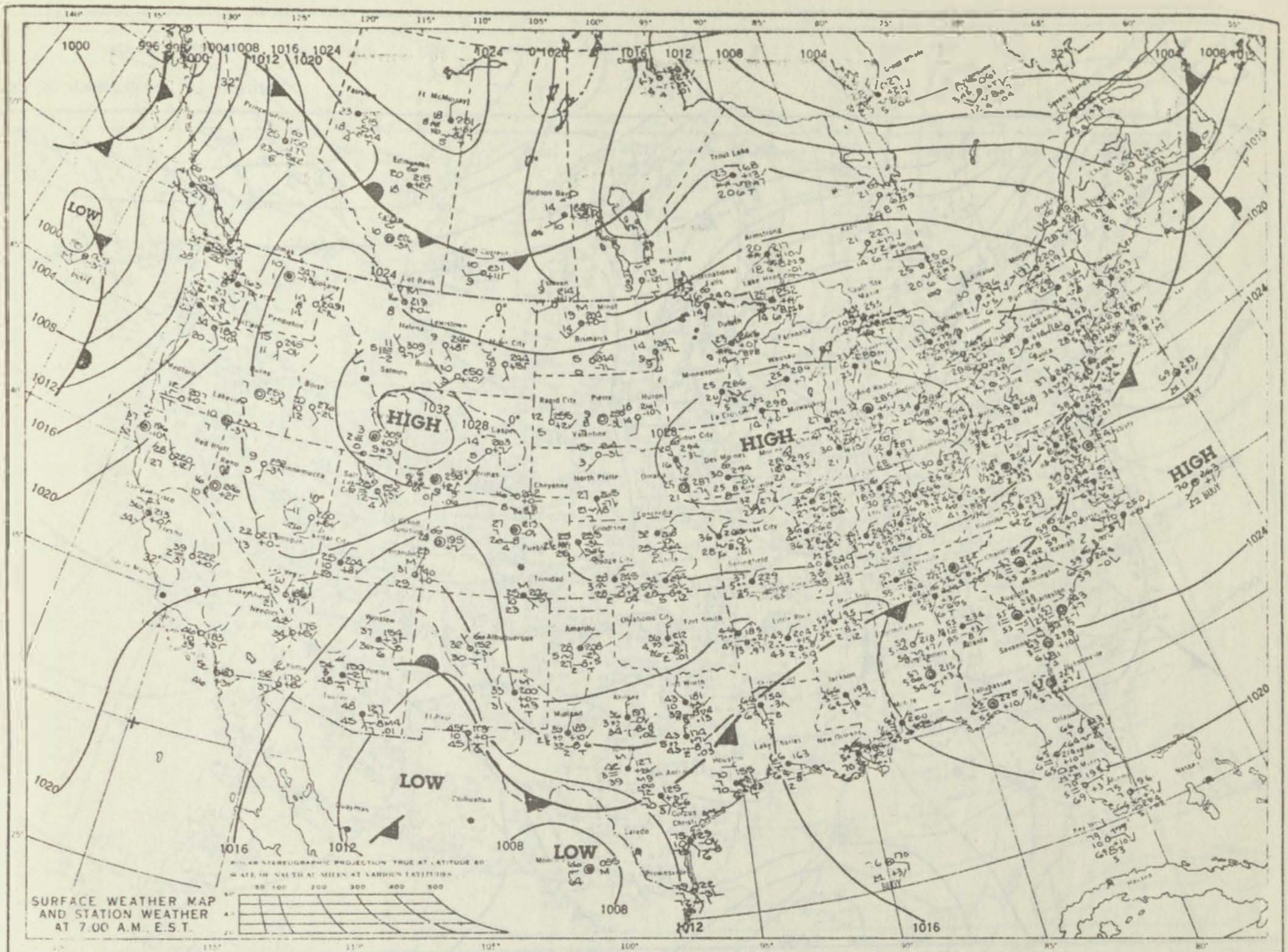

SURFACE WEATHER MAP
AND STATION WEATHER
AT 7:00 A.M. E.S.T.
HIGH
LOW
500-MILLIBAR HEIGHT CONTOURS
AT 7:00 A.M., E.S.T.
HIGHEST AND LOWEST TEMPERATURES
PRECIPITATION AREAS AND AMOUNTS


HIGH
LOW
POLAR STEREOGRAPHIC PROJECTION TRUE AT LATITUDE 60°
SCALE OF NAUTICAL MILES AT VARIOUS LATITUDES
SURFACE WEATHER MAP
AND STATION WEATHER
AT 7:00 A.M. E.S.T

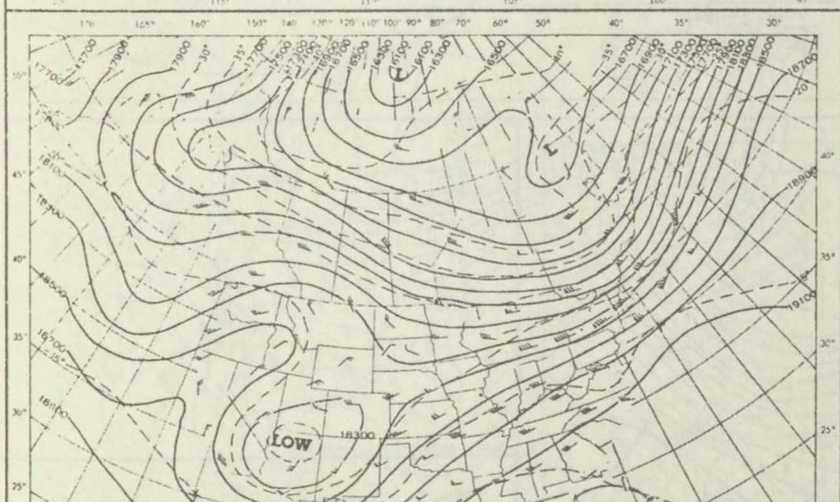

HIGH
LOW
HIGH
500-MILLIBAR HEIGHT CONTOURS
AT 7:00 A.M. E.S.T.


HIGHEST AND LOWEST TEMPERATURES

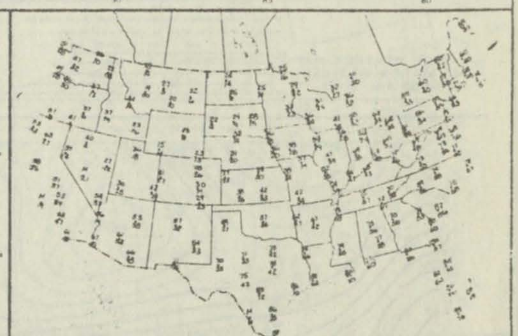

PRECIPITATION AREAS AND AMOUNTS



SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M., E.S.T.

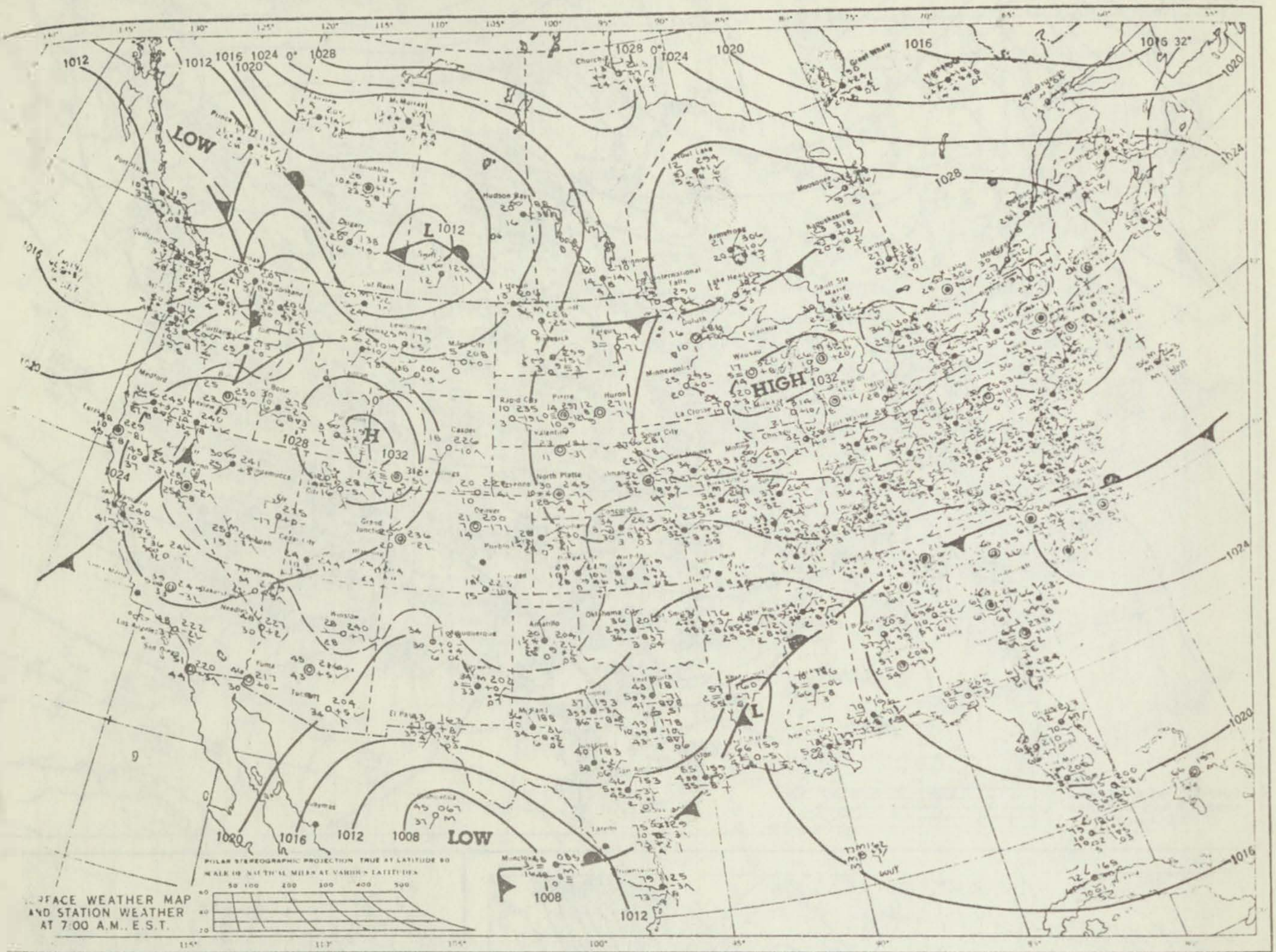


500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M., E.S.T.

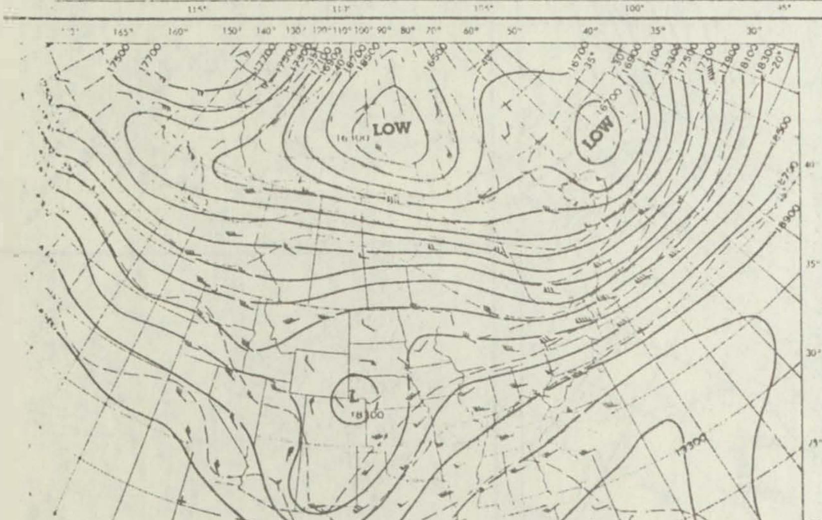


HIGHEST AND LOWEST TEMPERATURES

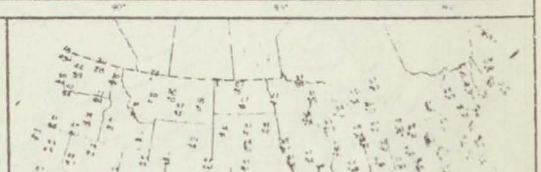
PRECIPITATION AREAS AND AMOUNTS



SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M., E.S.T.

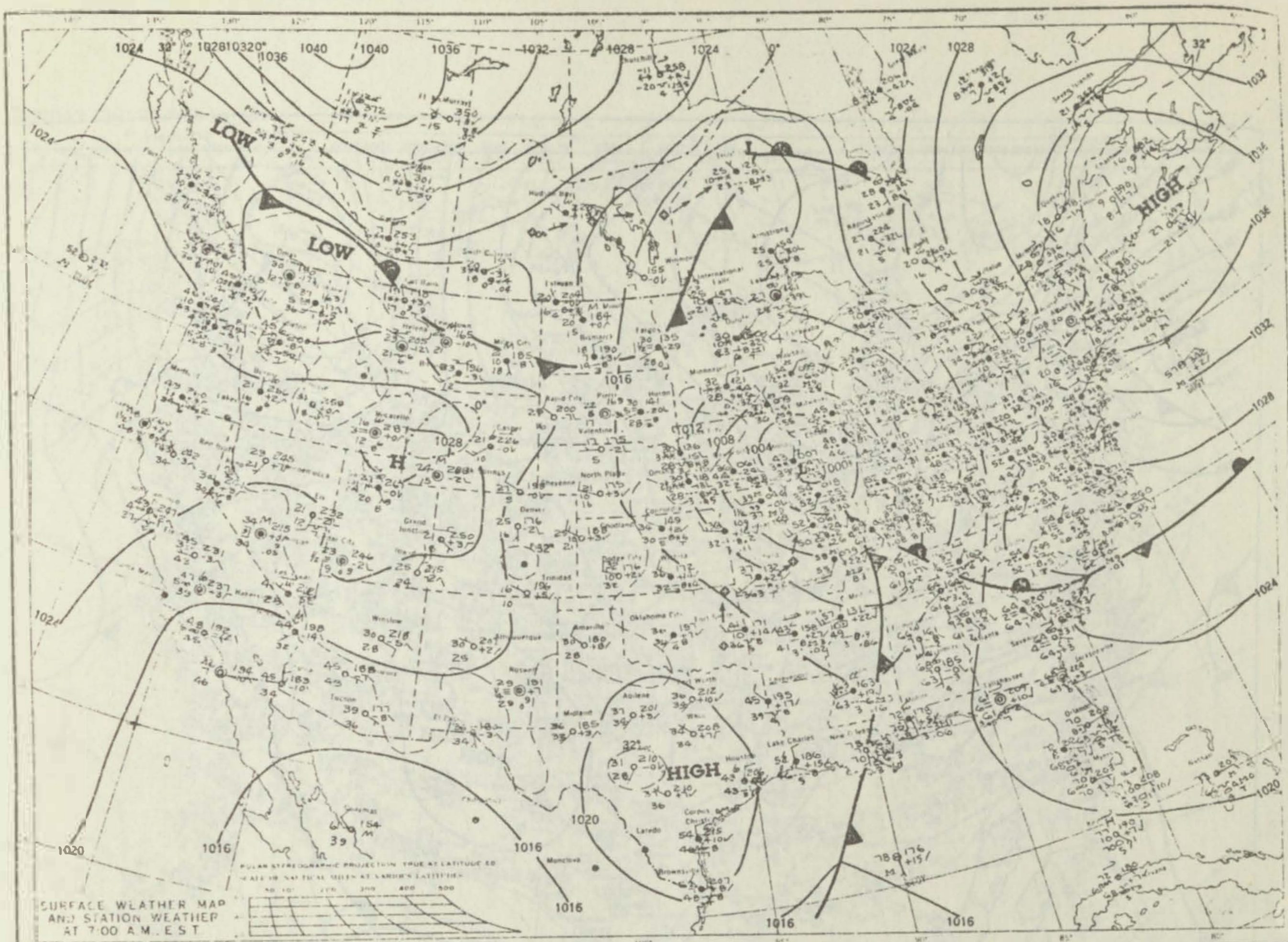


MILLIBAR HEIGHT CONTOURS 7:00 A.M., E.S.T.

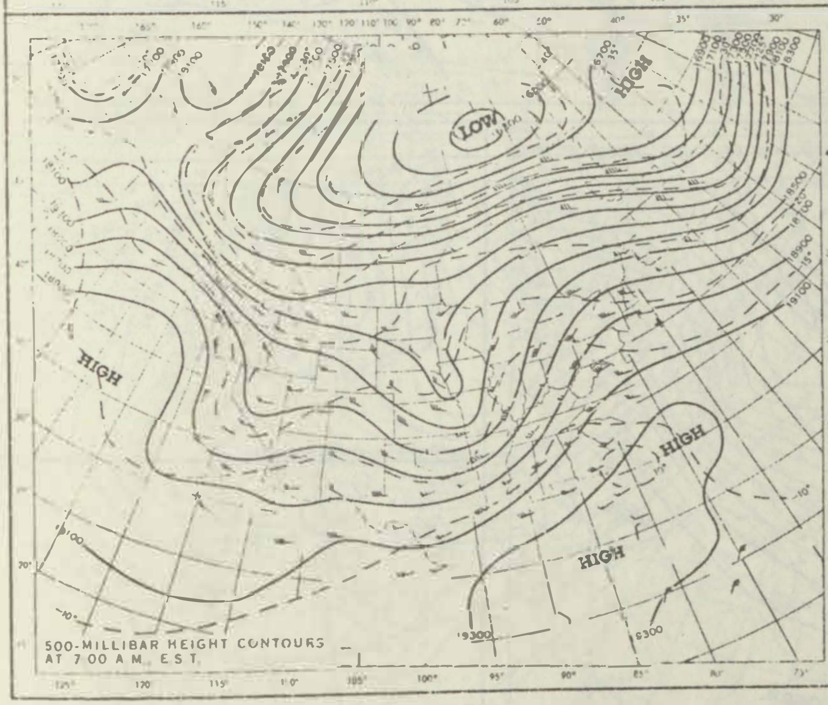


HIGHEST AND LOWEST TEMPERATURES

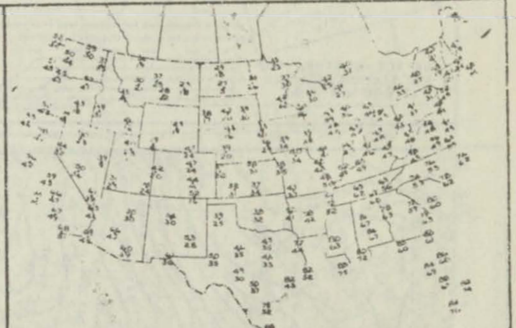
PRECIPITATION AREAS AND AMOUNTS



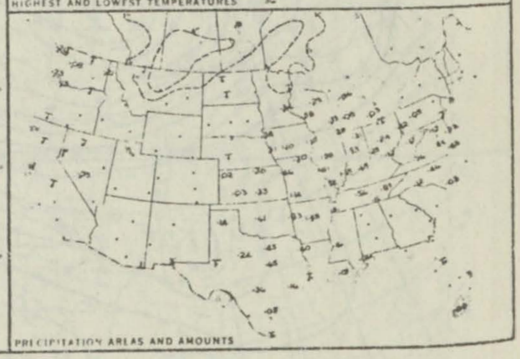
SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M. E.S.T.



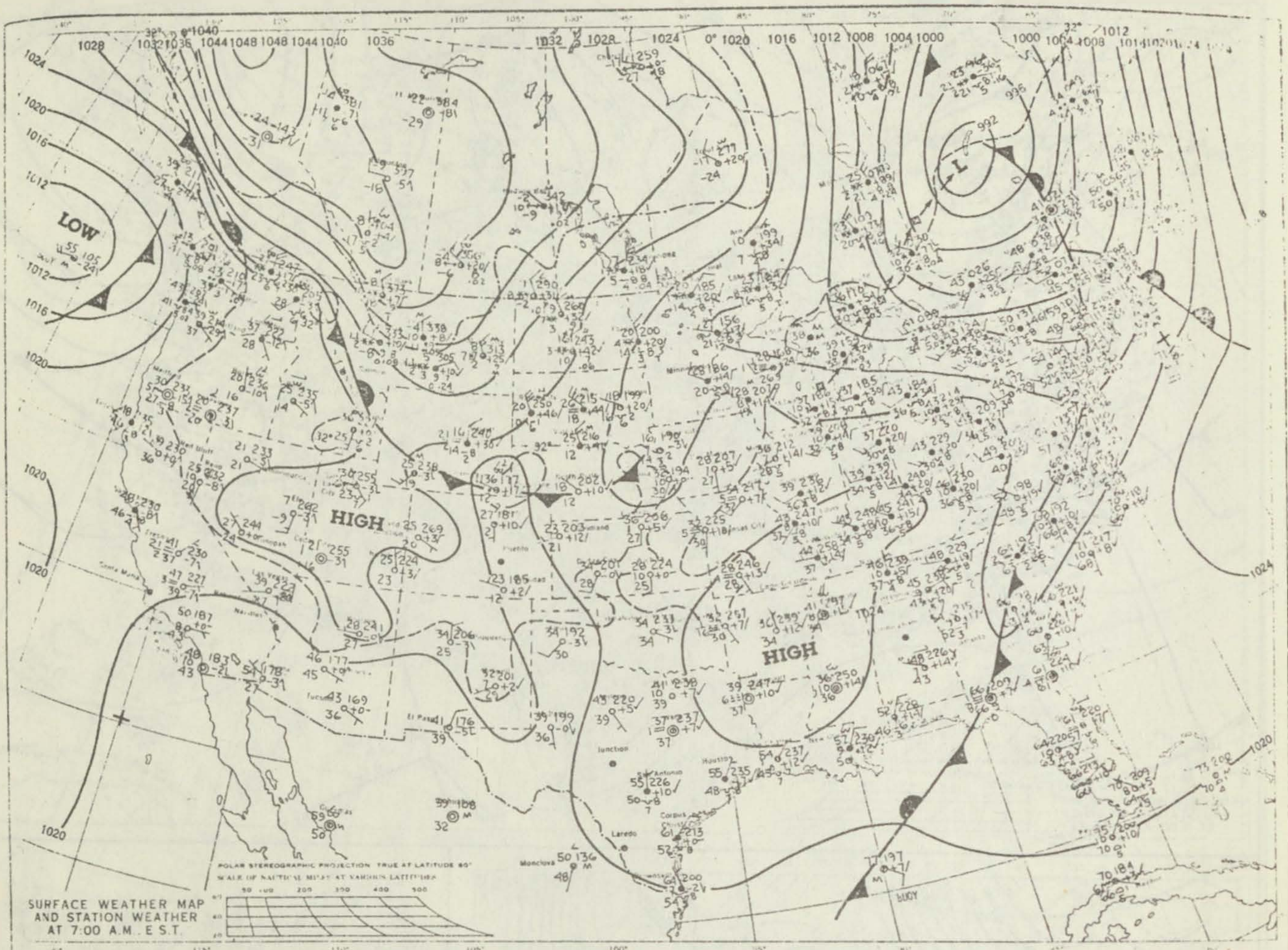
500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M. E.S.T.



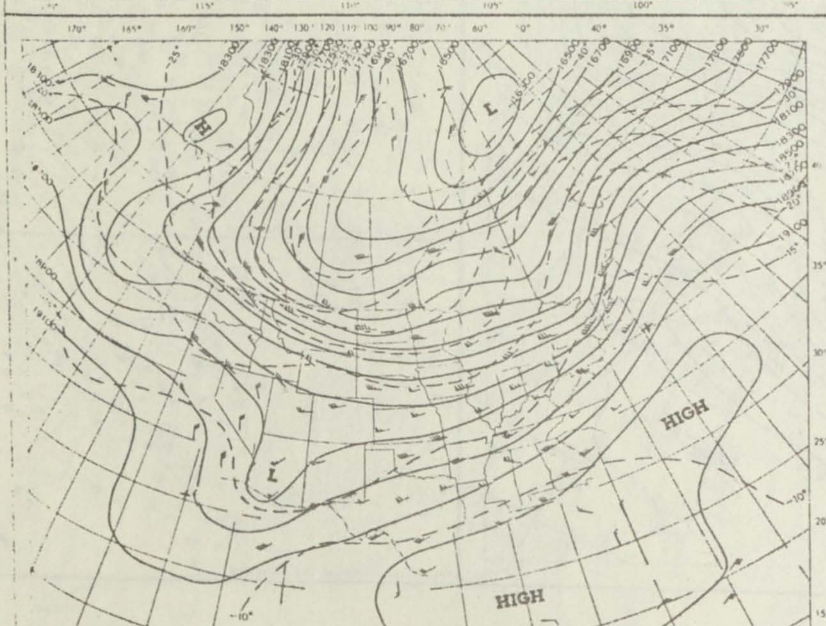
HIGHEST AND LOWEST TEMPERATURES



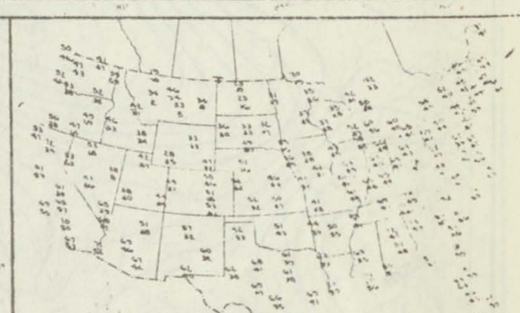
PRECIPITATION AREAS AND AMOUNTS



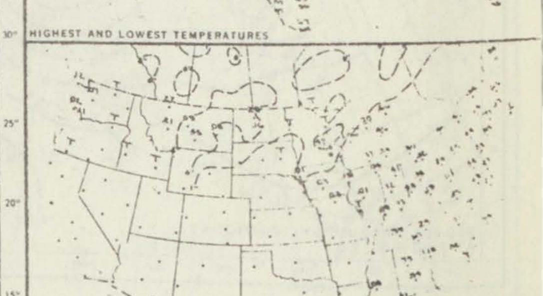
SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M. E.S.T.



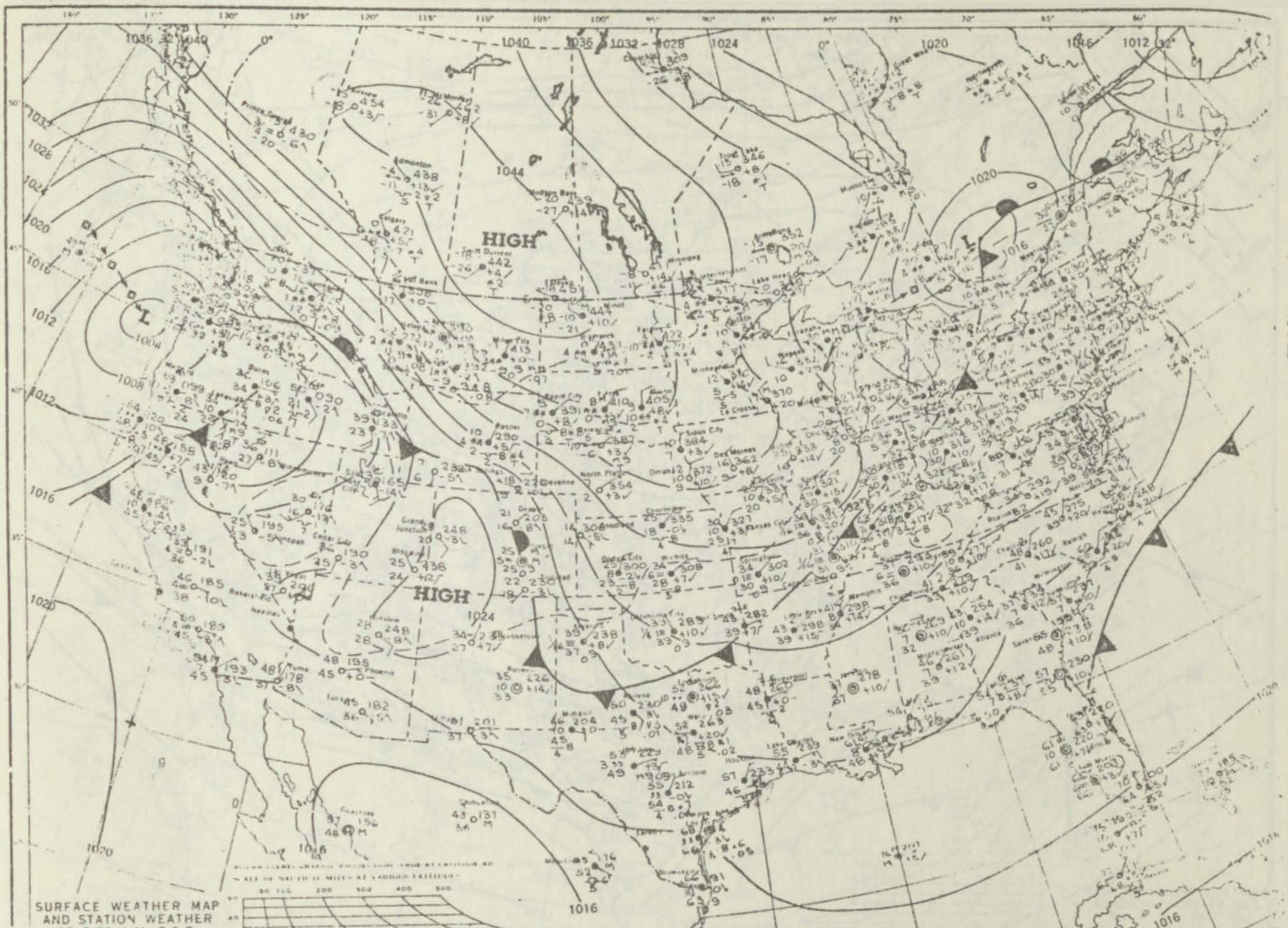
500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M. E.S.T.



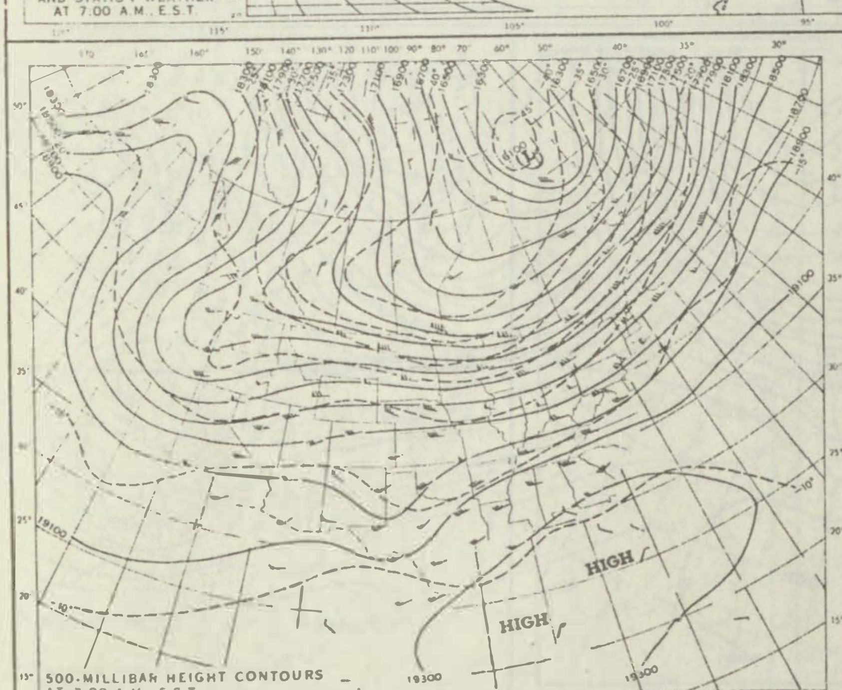
HIGHEST AND LOWEST TEMPERATURES



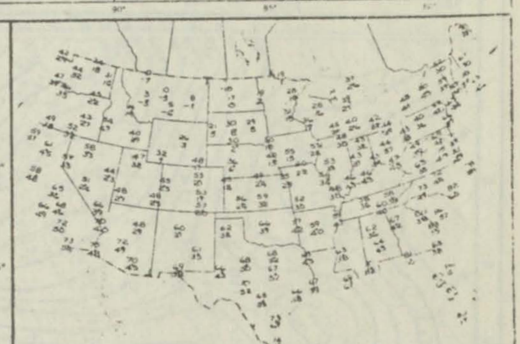
PRECIPITATION AREAS AND AMOUNTS



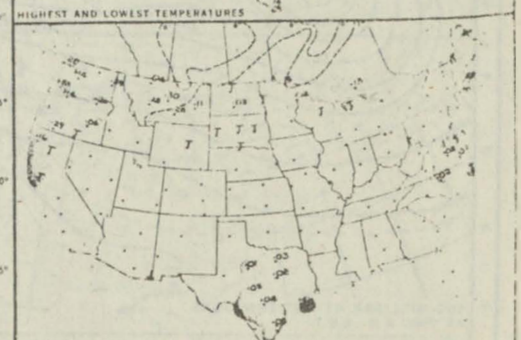
SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M., E.S.T.



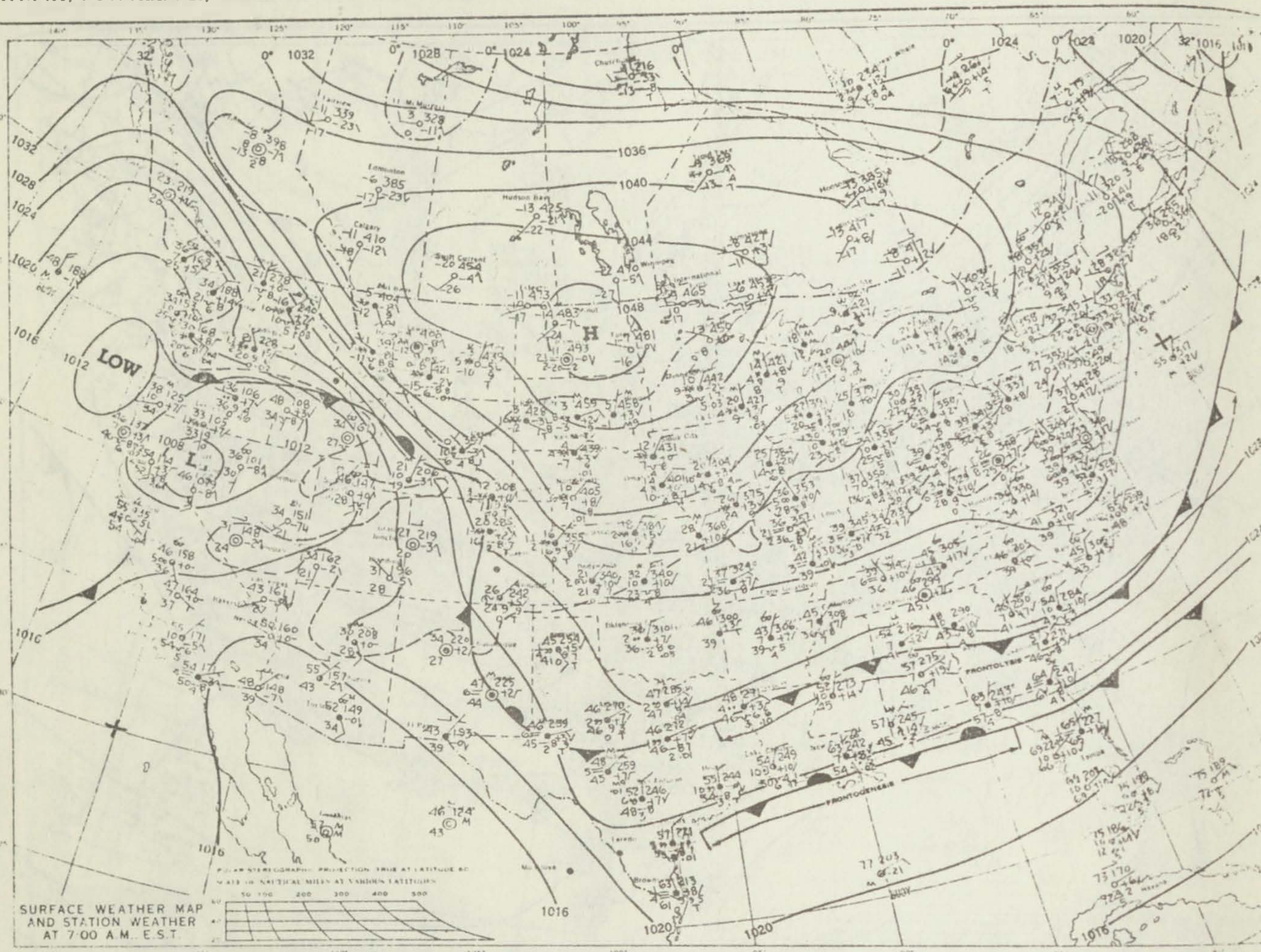
500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M., E.S.T.

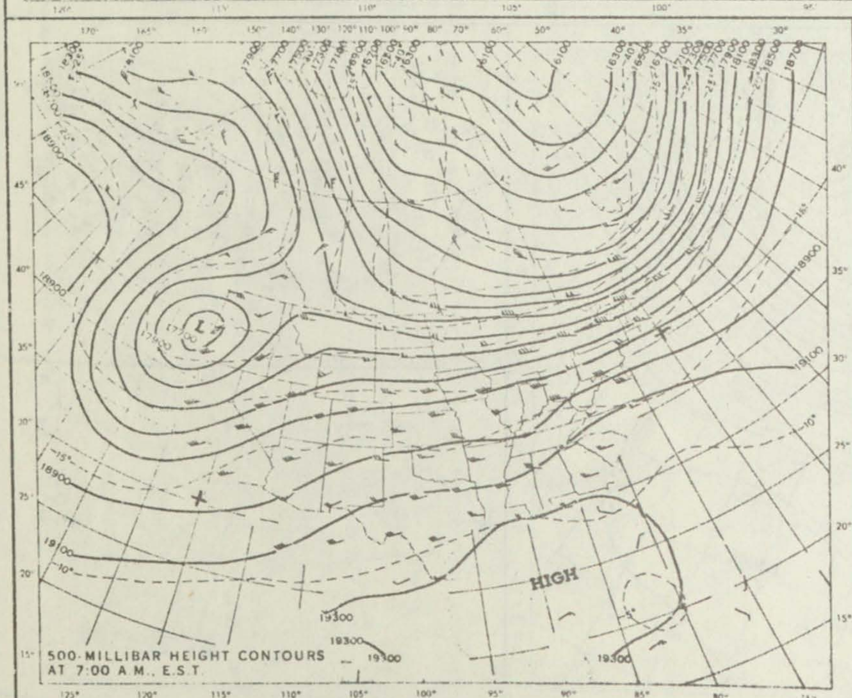


HIGHEST AND LOWEST TEMPERATURES

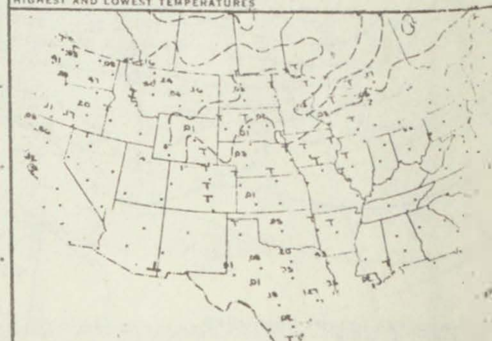


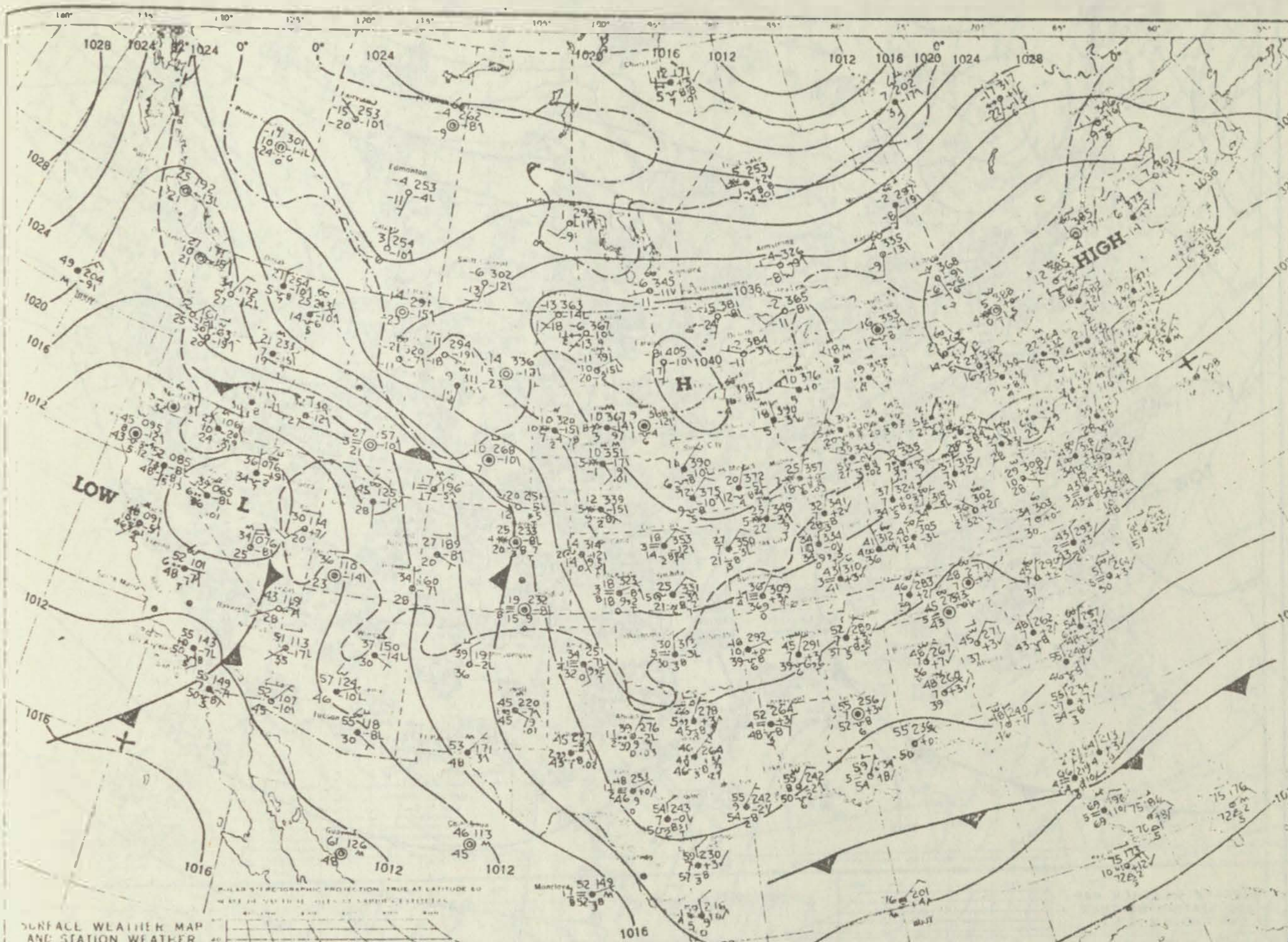
PRECIPITATION AREAS AND AMOUNTS


LOW
H
FRONTOGENESIS
FRONTOLYSIS
SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M., E.S.T.

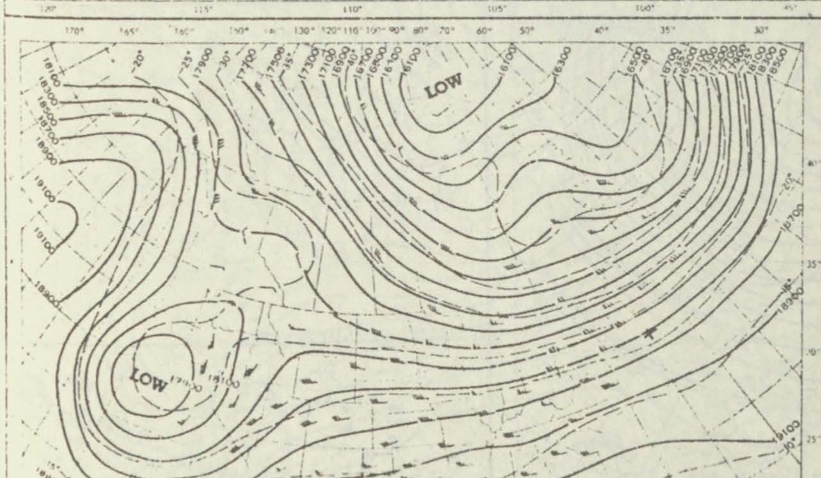

HIGH
500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M., E.S.T.


HIGHEST AND LOWEST TEMPERATURES

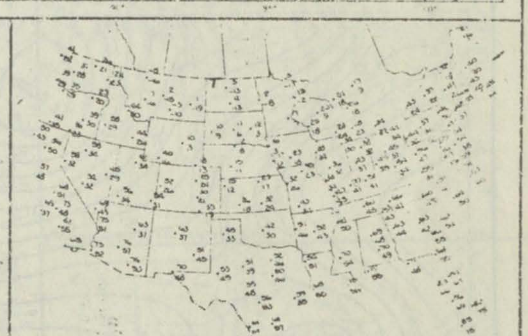

PRECIPITATION AREAS AND AMOUNTS



SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M., E.S.T.

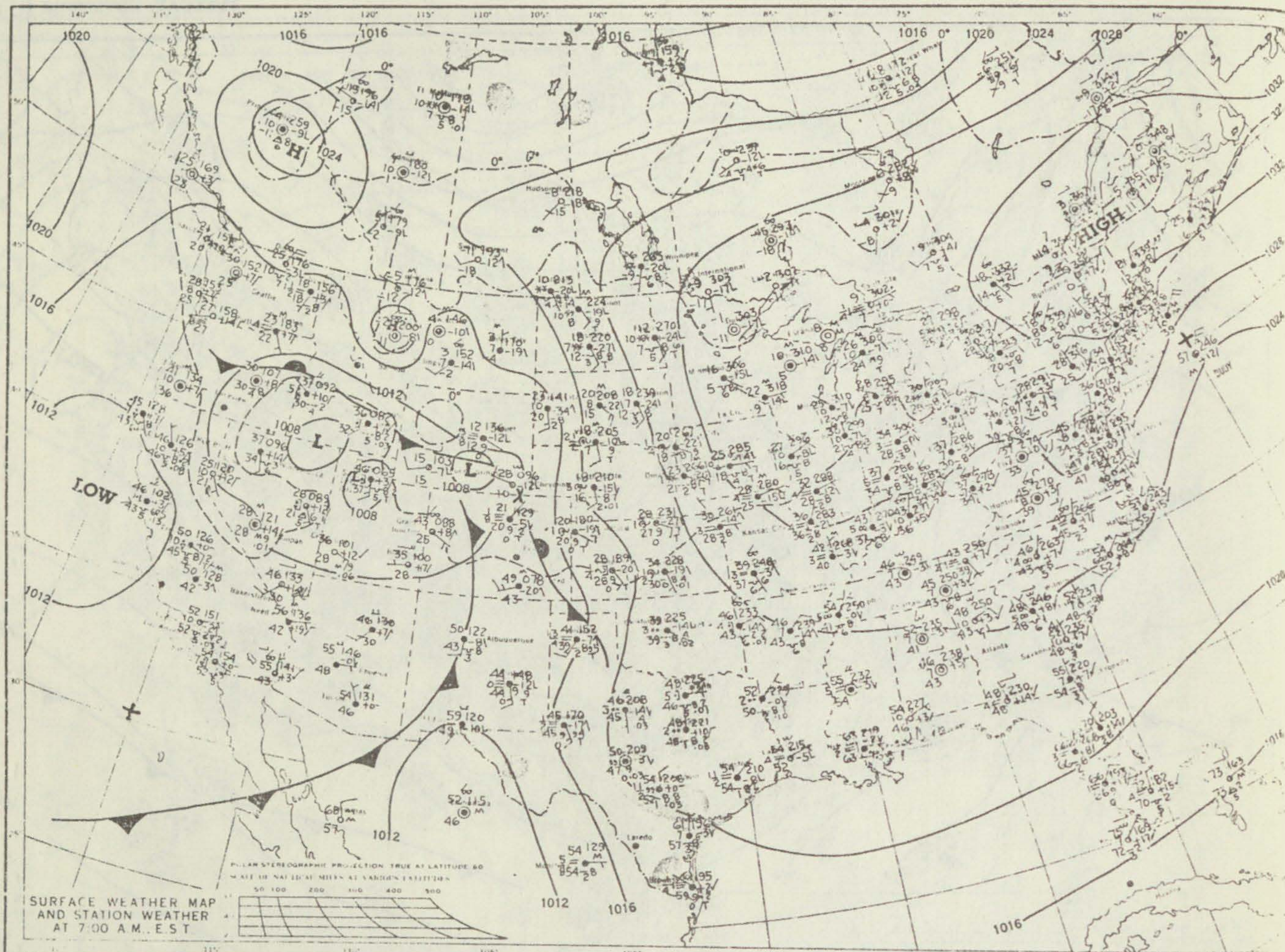


500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M., E.S.T.

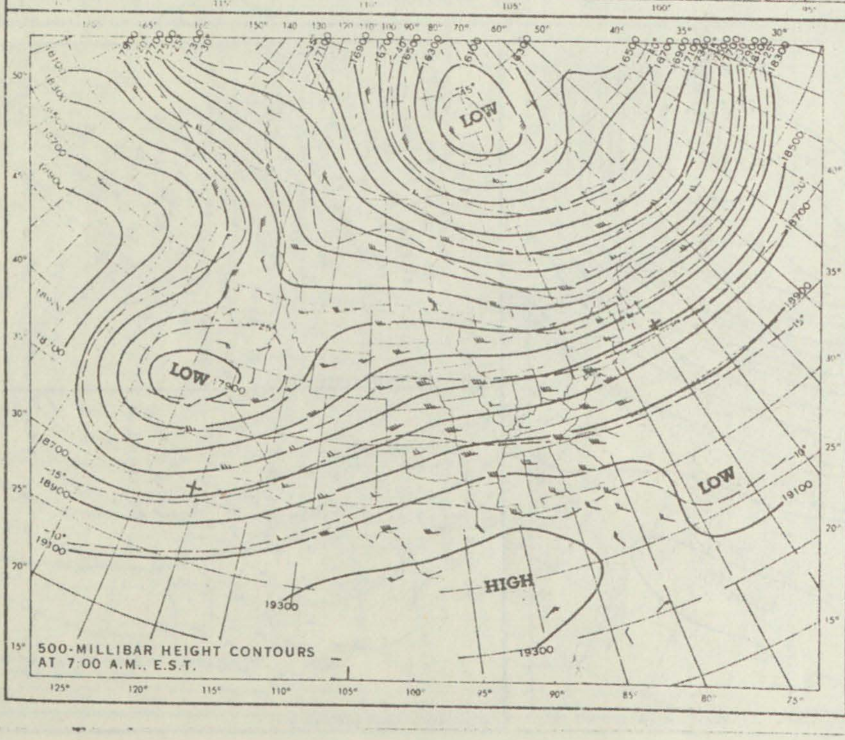


HIGHEST AND LOWEST TEMPERATURES

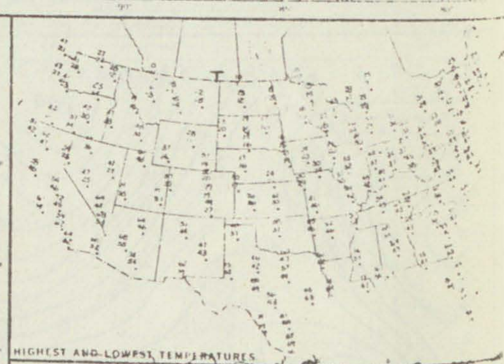
PRECIPITATION AREAS AND AMOUNTS



SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M., E.S.T.

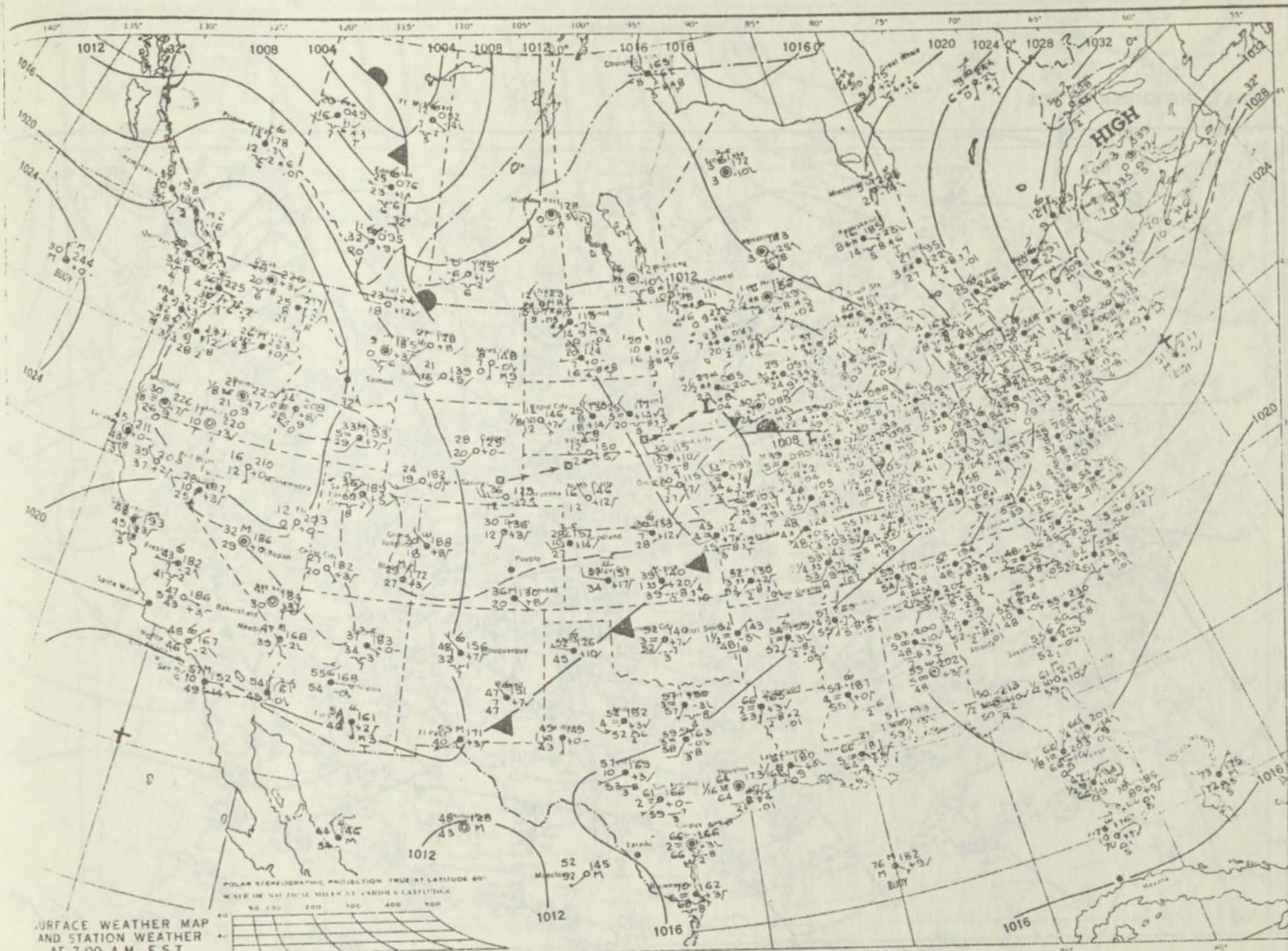


500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M., E.S.T.

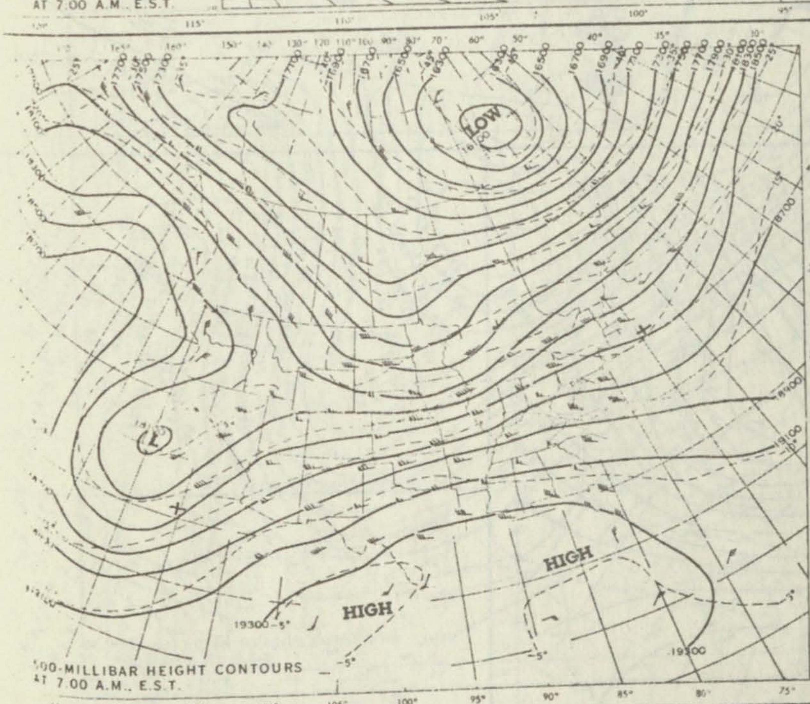


HIGHEST AND LOWEST TEMPERATURES

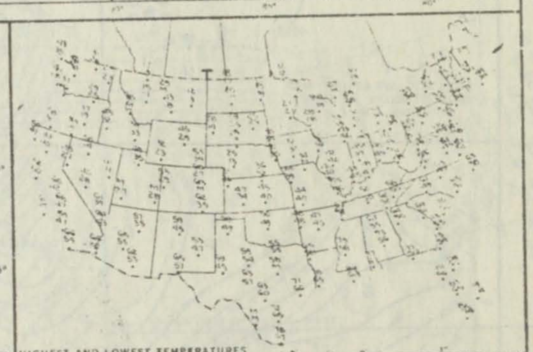
PRECIPITATION AREAS AND AMOUNTS

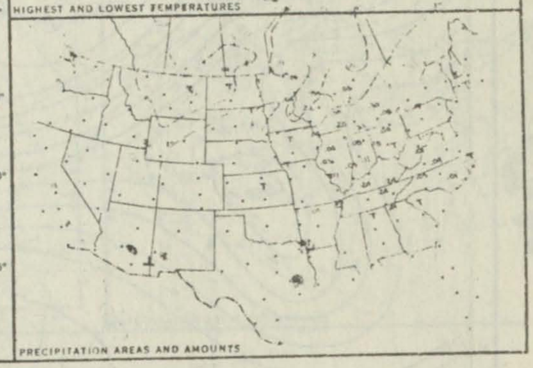


SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M., E.S.T.

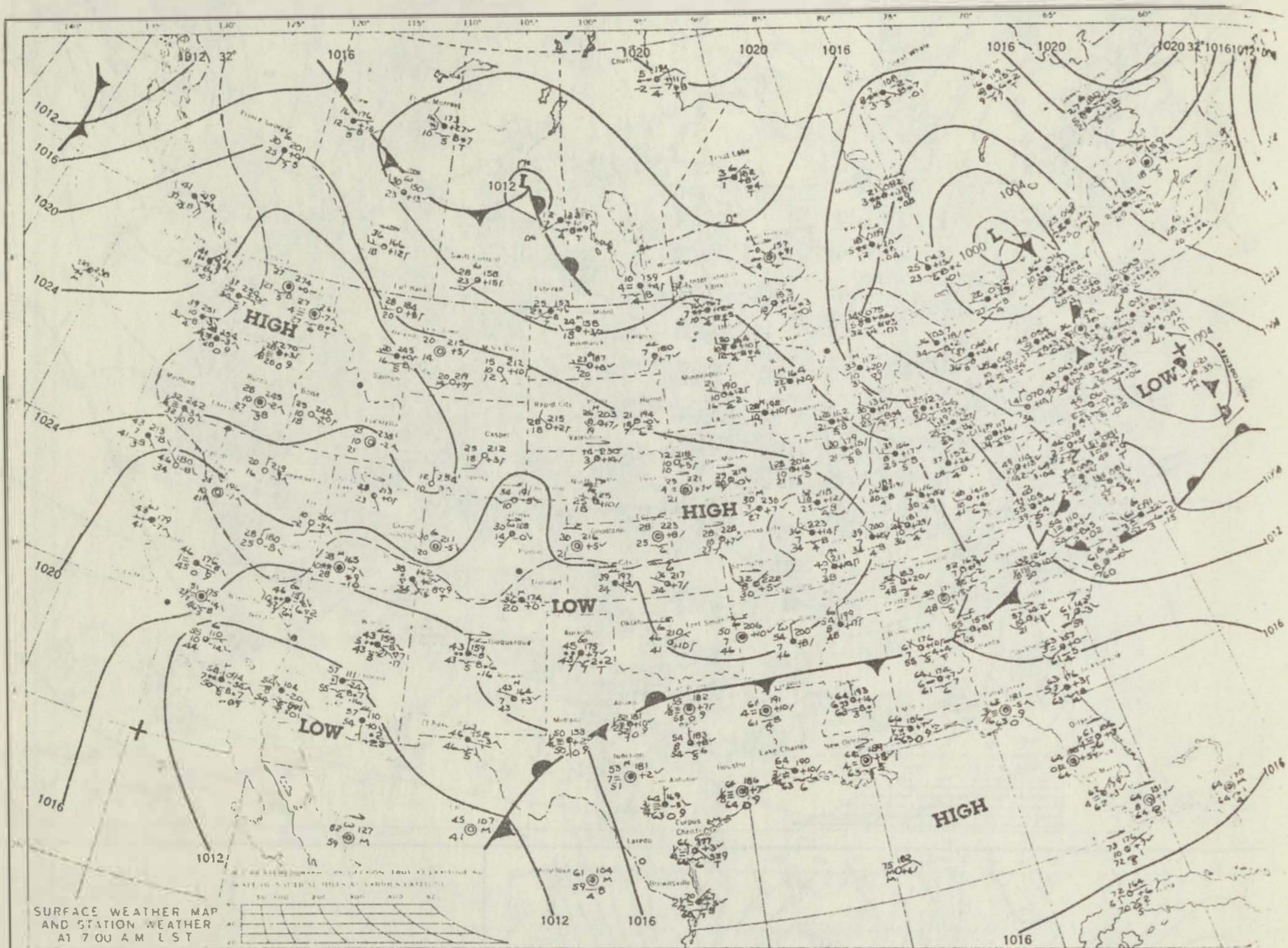


500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M., E.S.T.

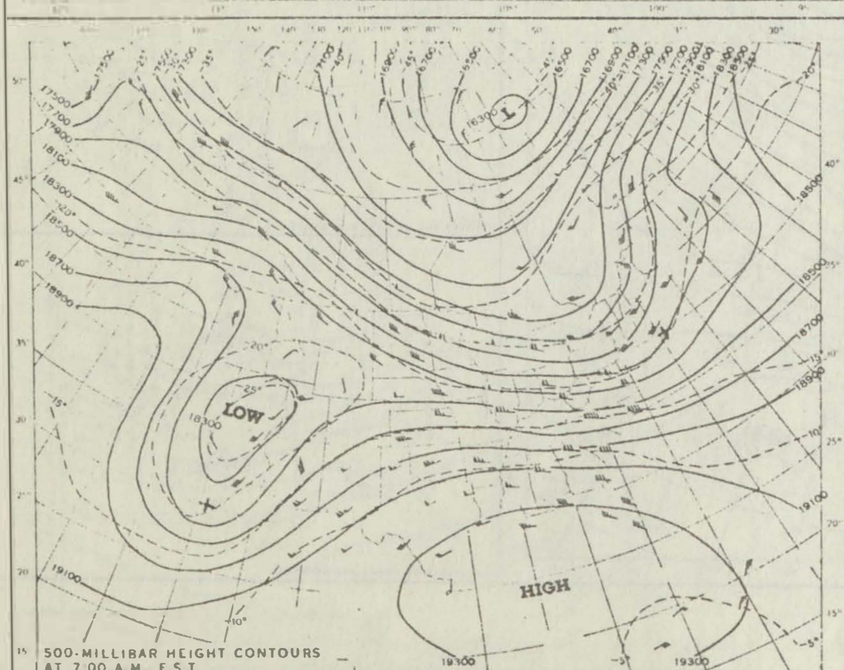

HIGHEST AND LOWEST TEMPERATURES


PRECIPITATION AREAS AND AMOUNTS

FRIDAY, NOVEMBER 24, 1978

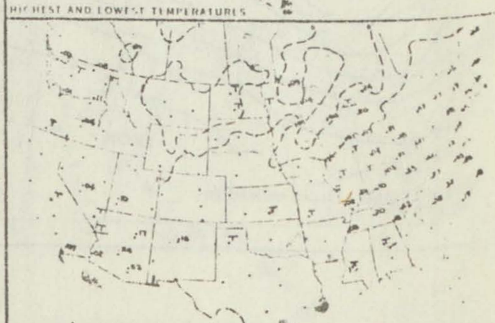


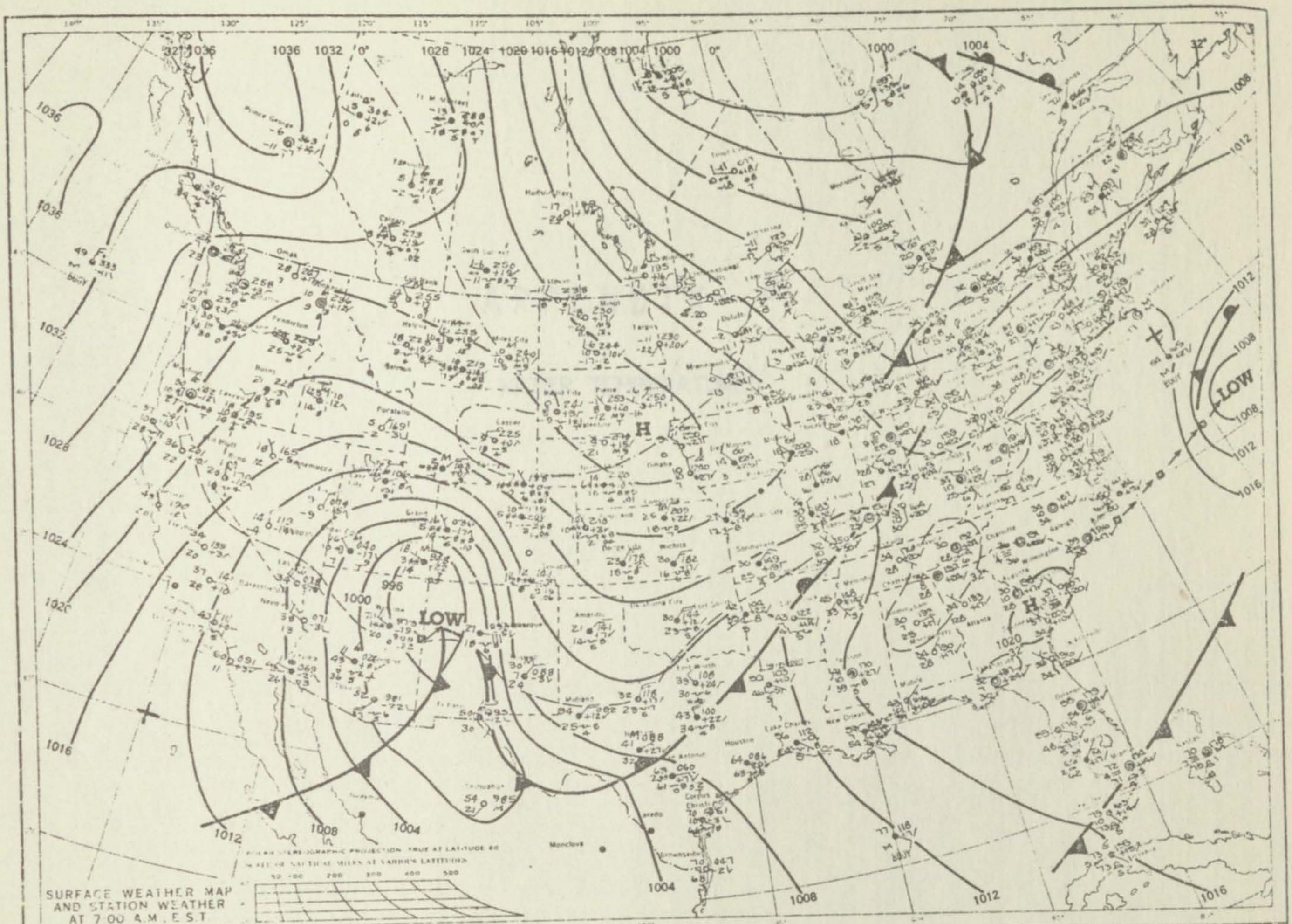
SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M. E.S.T.



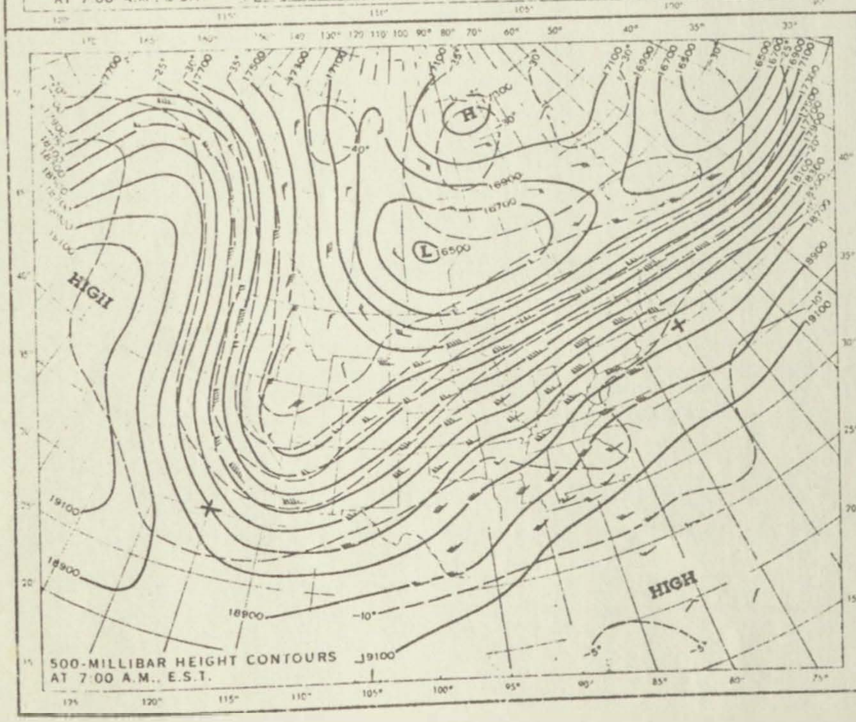
500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M. E.S.T.


HIGHEST AND LOWEST TEMPERATURES

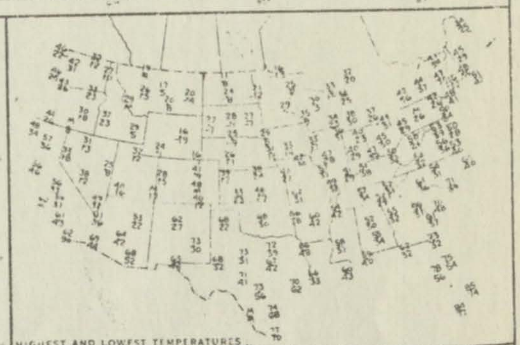

PRECIPITATION AREAS AND AMOUNTS



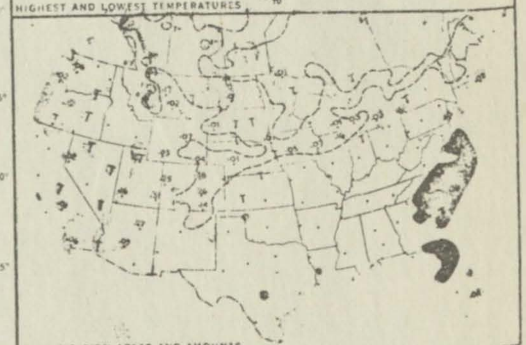
SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M. E.S.T.



500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M., E.S.T.



HIGHEST AND LOWEST TEMPERATURES



PRECIPITATION AREAS AND AMOUNTS

APPENDIX F

WATER TEMPERATURES

SCRIPPS PIER SURFACE TEMPERATURE YEAR 1978

DAYS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL MEAN	ANNUAL MAX	ANNUAL MIN
1	16.3	15.5	15.1	17.0	15.8	18.2	16.5	20.0	22.0	21.5	18.2	15.3			
2	16.3	15.5	15.2	16.4	15.1	17.7	17.6	19.3	21.6	21.9	18.4	15.0			
3	15.8	15.5	15.11	16.9	15.5	18.1	17.4	21.0	21.2	21.6	17.9	15.0			
4	15.8	15.5	15.7	17.4	14.7	19.0	17.2	21.2	21.5	21.1	18.2	15.2			
5	16.2	15.41	15.6	16.6	15.7	18.5	17.7	22.0	21.2	20.9	18.4	14.9			
6	16.2	15.51	15.4	17.3	16.1	18.9	19.0	20.0	20.0	19.5	18.1	13.9			
7	16.2	15.5	15.9	16.4	16.4	19.2	19.3	20.8	20.0	19.6	17.9	13.51			
8	16.3	15.5	15.8	16.1	17.7	18.7	19.5	21.7	19.4	20.0	17.5	12.2			
9	16.0	15.7	15.81	15.9	19.5	18.3	19.4	21.0	19.4	18.9	18.0	12.8			
10	16.0	15.3	15.6	16.5	17.6	18.0	19.7	22.1	20.0	19.4	17.8	13.4			
11	15.6	15.3	15.2	16.9	17.2	18.7	19.4	22.5	20.5	19.0	17.2	13.6			
12	15.8		15.2	17.2	17.4	19.6	19.7[1]	21.7	20.1	18.8	17.2	13.4			
13	15.8	15.4	15.7	17.0	17.5	20.1	20.0	20.6	20.0	18.5	16.5	13.4			
14	16.1	15.2	16.1	16.9	19.1	19.1	19.6	21.0	20.3	20.6	17.0	13.3			
15	16.0	15.2	17.0	16.9	19.2	19.8	21.0	19.4	20.1	17.0	17.0	13.41			
16	15.7	15.3	16.6	16.2	19.4	19.8	19.4	18.8	20.3	16.7	16.8	12.8			
17	16.1	15.3	16.6	16.5	16.1	19.7	17.4	18.0	20.3	17.2	16.6	14.6			
18	16.1	14.7	16.7	17.2	18.2	19.0	18.7	18.6	19.7	17.9	16.7	13.5			
19	16.2	14.9	16.61	16.9	17.8	19.31	19.9	19.5	19.7	16.8	16.6	13.4			
20	16.2	15.2	16.9	15.91	19.2	20.51	19.1	20.8	20.0	18.0	16.4	13.2			
21	15.8	15.4	16.8	15.61	19.1	19.91	18.0	21.0	20.1	16.9	16.7	13.2			
22	16.0	15.51	16.8	15.01	19.1	19.01	18.1	21.2	19.2	17.8	15.7	13.0			
23	15.4	15.51	16.61	16.4	16.8	17.51	19.81	21.3	19.4	17.1	16.3	12.8			
24	15.4	15.71	16.31	16.4	16.1	16.11	21.01	19.2	21.6	17.1	15.0	14.5			
25	15.5	15.5	16.41	17.0	17.0	12.71	20.61	20.8	19.01	18.5	15.7	14.2			
26	15.5	15.4	16.81	16.1	17.2	15.31	19.01	19.8	18.9	18.5	16.1	13.5			
27	15.7	15.5	16.9	16.4	18.3	17.21	18.0	21.0	21.01	18.0	15.8	14.3			
28	15.5	15.3	17.61	15.6	19.5	17.51	17.5	20.5	21.01	18.5	15.5	14.2			
29	15.7		17.41	16.3	18.8	16.71	19.01	20.8	21.81	17.2	15.6	14.4			
30	15.7		17.3	15.6	18.0	15.8	17.7	21.2	22.1	17.8	15.5	13.5			
31	15.5		16.9		17.21		18.5	21.6		18.5					
1-10 MEANS	16.11	15.54	15.52	16.65	16.41	18.46	18.331	20.91	20.63	20.411	18.041	14.12			
SAMPLE SIZE	10	10	10	10	10	10	10	10	10	10	10	10			
11-20 MEANS	15.96	15.17	16.26	16.76	18.31	19.56	19.42	20.09	20.10	18.05	16.80	13.46			
SAMPLE SIZE	10	9	10	10	101	10	10	10	10	10	10	10			
21-31 MEANS	15.61	15.49	16.89	16.04	17.921	16.77	18.84	20.76	20.41	17.81	15.79	13.76			
SAMPLE SIZE	11	8	11	101	11	10	11	11	10	11	10	10			
MONTHLY MEANS	15.88	15.40	16.25	16.48	17.56	18.26	18.86	20.59	20.38	18.71	16.88	13.78	17.42		
SAMPLE SIZE	31	27	31	30	31	30	31	31	30	31	30	30			
MAXIMUM VALUE	16.3	15.7	17.6	17.4	19.5	20.5	21.0	22.5	22.1	21.9	18.4	15.3		22.5	
MINIMUM VALUE	15.4	14.71	15.1	15.01	14.7	12.7	16.5	18.0	18.9	16.7	15.0	12.21			12.2
RANGE	.91	1.01	2.5	2.41	4.8	7.8	4.5	4.51	3.2	5.2	3.4	3.1			
STANDARD DEV.	.291	.23	.74	.58	1.401	1.66	1.15	1.09	.91	1.51	1.00	.80			

SCRIPPS PIER BOTTOM TEMPERATURE (≈ 5 METERS) YEAR 1978

DAYS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL MEAN	ANNUAL MAX	ANNUAL MIN
1	16.3	15.7	15.1	17.1	15.8	18.5	16.1	19.0	21.6	22.1	18.5	15.3			
2	16.3	15.6	15.3	17.4	15.2	18.4	17.3	14.0	21.6	21.7	18.4	15.1			
3	15.9	15.7	15.1	17.7	15.5	17.6	18.4	19.2	20.6	21.5	18.3	14.3			
4	15.9	15.5	15.5	17.4	14.7	19.0	17.4	20.3	21.5	20.9	16.7	15.1			
5	16.0	15.4	15.8	17.1	15.7	16.4	17.6	20.0	21.5	16.3	17.7	14.9			
6	16.1	15.4	15.8	17.2	16.4	18.8	18.7	16.0	20.0	15.6	17.9	13.3			
7	16.2	15.5	15.9	17.1	16.5	19.1	17.6	17.2	19.8	18.1	17.9	13.3			
8	16.3	15.5	15.7	16.1	17.5	18.7	19.4	21.0	19.4	18.2	18.1	12.8			
9	16.0	15.5	15.7	16.4	18.7	18.6	19.4	20.8	19.5	16.9	18.0	12.8			
10	15.9	15.5	15.8	17.7	17.9	18.3	19.2	20.8	19.4	19.1	17.9	13.4			
11	16.1	15.5	15.7	17.0	16.7	18.7	19.8	22.0	20.4	18.9	17.5	13.3			
12	16.0		15.2	17.2	16.7	19.8	22.0	22.0	20.1	18.8	17.7	13.5			
13	16.0	15.4	15.7	17.0	17.9	15.4	20.0	21.7	20.3	17.8	17.5	13.4			
14	16.1	15.4	16.1	17.2	19.5	18.3	17.4	21.0	20.3	17.2	17.2	13.3			
15	16.0	15.2	16.5	17.1	19.4	20.0	20.3	18.2	20.5	15.0	17.2	13.9			
16	15.4	15.4	16.3	16.9	19.9	20.1	18.8	17.8	20.4	15.6	16.5	13.9			
17	16.2	15.4	16.2	17.1	18.1	19.4	17.5	13.7	20.4	17.2	17.2	14.6			
18	16.0	15.2	16.5	17.7	16.6.	19.0	18.6	18.8	20.0	17.2	16.9	13.4			
19	16.1	15.3	16.6	16.8	17.5.	19.1	19.6	19.6	18.7	14.5	17.0	13.4			
20.	16.2	15.4	16.8	15.8	18.9.	20.2	19.0	20.5	19.5	16.9	16.9	12.9			
21	16.2	15.4	16.9	16.0	13.4	17.2	12.8	20.5	18.8	16.6	16.7	13.1			
22	16.1	15.5	16.7	14.1	12.7	16.5	13.0	20.8	17.9	17.2	16.4	13.0			
23	15.6	15.5	16.5	13.3	17.0	16.0	16.8	20.5	18.8	16.9	16.3	12.4			
24	15.2	15.9	16.4	15.0	16.3	15.2	18.0	16.8	16.7	17.2	15.5	14.1			
25	15.4	15.5	16.3	15.4	17.4	12.4	15.0	18.5	16.7	18.9	16.1	14.1			
26	15.4	15.4	16.8	16.2	18.0	15.0	14.7	21.4	18.4	18.5	16.1	13.8			
27	15.5	15.4	17.0	16.4	18.7	17.3	14.0		20.1	17.9	15.6	14.3			
28	15.6	15.4	17.7	15.3	19.1	16.2	17.5	20.5	20.1	18.6	16.0	14.2			
29	15.7		17.6	16.9	18.8	16.6	18.2	21.2	20.1	18.4	15.6	14.2			
30	15.7.		16.9	15.6.	17.6	16.0.	17.2	21.4	22.1.	17.8	15.5	13.4			
31	15.5		17.2		17.2		17.8	21.4		18.5					
1-10 MEANS.	16.09	15.50	15.52.	17.12.	16.39	18.34.	18.11	18.83	20.49	19.01	17.94	14.03			
SAMPLE SIZE.	10.	10.	10.	10.	10.	10.	10.	10	10.	10	10.	10.			
11-20 MEANS	16.01	15.36	16.16	16.98	18.12	19.00	19.30	19.53	20.06	16.91	17.16	13.56			
SAMPLE SIZE	10	9	10	10	10	10	10	10	10	10	10	10			
21-31 MEANS	15.63	15.54.	16.90.	15.42.	16.93.	15.84	15.91	20.30	18.97	17.83.	15.98.	13.66			
SAMPLE SIZE.	11.	8.	11.	10.	11.	10.	11.	10.	10.	11	10.	10.			
MONTHLY MEANS	15.90	15.30	16.23	16.51	17.14	17.73	17.71	19.55	19.84	17.94	17.03	13.75	17.07		
SAMPLE SIZE	31	27	31	30	31	30	31	30	30	31	30	30			
MAXIMUM VALUE	16.3	15.9	17.7	17.7	19.9	20.2	22.0	22.0	22.1	22.1	18.5	15.3		22.1	
MINIMUM VALUE	15.2	15.2	15.1	13.3	12.7	12.4	12.8	13.7	16.7	14.5	15.5	12.4			12.4
RANGE.	1.1	.7	2.6	4.4	7.2	7.8	9.2	8.3	5.4	7.6	3.0	2.9			
STANDARD DEV.	.31	.18	.69	1.06	1.72	1.83	2.10	2.20	1.30	1.82	.92	.75			

APPENDIX G

COMPUTER PROGRAMS

CONTOUR PLOT PROGRAM

C PROFIL - PLOTS COMBINED WADING AND FATHOMETER

```
C PROFIL  - PLOTS COMBINED WADING AND FATHOMETER
C SURVEYS.
      DIMENSION DX(100),DH(100),BX(100),BH(100)
      DIMENSION TITLE(60)
      XSCALE = 0.01
      YSCALE =0.0025
      CALL CONTRL(1,'DEPTHP',8)
      READ(8,99)
      READ(8,99)
      READ(8,99)
      READ(8,99)
   99 FORMAT(40A2)
      WRITE(1,1000)
 1000 FORMAT('RANGE NUMBER, I2'/)
       READ(1,*)NRANGE
      IF(NRANGE)5,701,5
    5 WRITE(1,1001)
 1001 FORMAT('NO. OF FIRST POINT IN RANGE '/)
      READ (1,*)LLOW
      WRITE(1,1002)
 1002 FORMAT('NO. OF LAST POINT IN RANGE'/)
      READ(1,*)LHIGH
      WRITE(1,1003)
 1003 FORMAT('PLOT TITLE'/)
      READ(1,1004) TITLE
 1004 FORMAT(15A4)
      WRITE(1,1005)
 1005 FORMAT('NUMBER OF CHARACTERS'/)
      READ(1,*) NUMC
      JJ=1
      DO 100 J=1,LHIGH
      READ(8,2000)NO,NDAY,NHR,MIN,NSEC,X,Y,IDEEP
 2000 FORMAT(T2,I3,T8,I2,1X,I2,1X,I2,1X,I2,T26,
     1F6.1,T41,F6.1,T56,I4)
      IF(NO-LLOW)100,40,40
   40 DX(JJ)=X
      DH(JJ)=-FLOAT(IDEEP)
      JJ=JJ+1
  100 CONTINUE
      CALL CONTRL(4,'DEPTHP',8)
      CALL CONTRL(1,'DAYPRO',7)
      NSTOP = JJ-1
      NFLAG = 0
      JJ=1
      DO 200 J=1,4000,5
      READ(7,3000, END = 201)I1,I2,I3,I4,I5
 3000 FORMAT(5(I6,1X))
      IF(I2-40)200,54,54
   54 IF(I1)55,201,55
   55 IF(I5-NRANGE)56,60,56
   56 IF(NFLAG)201,200,201
   60 BX(JJ)=I2
      BH(JJ)=I4
      JJ=JJ+1
      NFLAG =1
  200 CONTINUE
  201 CONTINUE
      YOFF = 7.0
```

C PROFIL - PLOTS COMBINED WADING AND FATHOMETER

```
      XOFF = 1.0
      NDO =JJ-1
      JJ=1
      CALL PLOTS(0,0,99)
      X=BX(1)*XSCALE+XOFF
      Y=BH(1)*YSCALE+ YOFF
      CALL PLOT(X,Y,3)
      DO 300 J=2,NDO
      X=BX(J)*XSCALE+XOFF
      Y=BH(J)*YSCALE+ YOFF
  300 CALL PLOT(X,Y,2)
      CALL PLOT(X,Y,3)
      X=DX(1)*XSCALE+XOFF
      Y=DH(1)*YSCALE*10.0 + YOFF
      CALL PLOT(X,Y,3)
      DO 400 J=2,NSTOP
      X=DX(J)*XSCALE+XOFF
      Y=DH(J)*YSCALE*10.0+ YOFF
  400 CALL PLOT(X,Y,2)
      CALL PLOT(X,Y,3)
      CALL CONTRL(4,'DAYPRO',7)
      CALL AXIS(11.0,3.0,24H ELEVATION ABOVE MSL (M),-24,5.0,
     190.0,-16.0,4.0,0)
      CALL AXIS(1.0,3.0,22H OFFSHORE DISTANCE (M),-22,10.0,
     10.0,0.0,100.0,0)
      CALL SYMBOL(4.0,8.0,0.2,27HTORREY PINES PROFILE SURVEY,
     10.0,27)
      CALL SYMBOL(4.0,7.5,0.2,TITLE(1),0.0,NUMC)
      CALL PLOT(0,0,40)
  700 CONTINUE
  701 CONTINUE
      CALL EXIT
      END
```

C CONPLT A PROGRAM TO PLOT DEPTH READINGS TO FACILITATE CONTOURING

```
C CONPLT    A PROGRAM TO PLOT DEPTH READINGS TO FACILITATE CONTOURING
      DIMENSION BX(1000),BY(1000),NE(1000),NDEEP(4),LDEEP(2),NRANGE(10)
      DATA NRANGE/24,25,26,27,28,04,34,35,32,33/
C SET PLOTTING SCALES
      XSCALE = 0.015
      YSCALE = 0.015
C ENTER NUMBER OF FATHOMETER POINTS TO PLOT, NDO.
      PRINT 555
  555 FORMAT('ENTER NO. OF FATHOMETER POINTS TO PLOT'/)
      READ(1,*)NDO
C OPEN FILES FOR READING
      CALL CONTRL(1,'DEPTHP',8)
      JJ=1
      NSTART = 0
      DO 150 K=1,10
      IFLAG =0
      CALL CONTRL(1,'DAYPRO',7)
C READ BEACH PROFILE DATA
      DO 100 J=1,500
    2 READ(7,1000,END = 147)NPT,NDIST,NY,NELEV,IRANGE
 1000 FORMAT(5(I6,1X))
C CHECK TO SEE THAT THIS IS RIGHT RANGE
      IF(IRANGE-NRANGE(K))98,3,98
    3 IFLAG = 1
      GO TO 5
C CHECK TO SEE IF RANGE IS ALREADY COMPLETE
   98 IF(IFLAG-1)100,149,100
C ELIMINATE VALUES FROM UPPER BEACH
    5 IF(NDIST -45) 2,7,7
C SET OFFSHORE COORDINATE
    7 BX(JJ)=NDIST
C SET LONGSHORE COORDINATE
      BY(JJ)=-FLOAT(NY-320)
C SET ELEVATION ABOVE M.S.L. IN DECIMETERS
      NE(JJ)=IFIX(FLOAT(NELEV)/10. + 0.5)
      NSTART = NSTART +1
      JJ=JJ+1
  100 CONTINUE
      GO TO 149
  147 PRINT 444 NRANGE(K)
  444 FORMAT('END OF FILE.NO DATA FOR RANGE',I3)
  149 CALL CONTRL(4,'DAYPRO',7)
      PRINT 333 NRANGE(K),NSTART
  333 FORMAT('RANGE   ',I2,3X,'NSTART    ',I4)
  150 CONTINUE
      CALL CONTRL(4,'DAYPRO',7)
C DETERMINE NUMBER OF BEACH PROFILE DATA POINTS
  101 NSTART = NSTART + 1
C DO DUMMY READ OF HEADER ON FATHOMETER SURVEY DATA
      READ(8,99)
      READ(8,99)
      READ(8,99)
      READ(8,99)
   99 FORMAT(40A2)
      NUM = NDO + NSTART - 1
C READ FATHOMETER SURVEY DATA
      DO 200 J=NSTART,NUM
      READ(8,2000,END = 201)NO,X,Y,IDEEP
```

```
 2000 FORMAT(T2,I3,T26,F6.1,T41,F6.1,T56,I4)
C CHECK FOR END OF DATA
C      PRINT 666 X,Y,IDEEP
       IF(NO)6,201,6
     6 BX(J)=X
C 666 FORMAT(2F12.1,I8)
       BY(J)=-(Y-320.)
       NE(J)=-IDEEP
  200 CONTINUE
C PRESERVE NUMBER OF POINTS TO PLOT
  201 NDONE =J-1
       XSAV =100000.
       YSAV =100000.
C SET VALUES FOR MINIMUM SPACING BETWEEN POINTS TO PLOT
       XMIN = 0.1
       YMIN = 0.1
       CALL PLOTS(0,0,99)
C MAKE AXES
       CALL AXES(0.2,8.6,-200.,360.,0.015,20.,40.,4HF5.0,-90.0,
     1 'LONGSHORE DISTANCE FROM SIO4 (M)',32)
       CALL AXES(0.2,0.2,0.,1000.,0.015,25.,100.,4HF5.0,0.0,
     1 'OFFSHORE DISTANCE FROM SIO4 ORIGIN (M)',38)
C WRITE ARRAYS TO FILE 'NUMPLT'
       CALL CONTRL(2,'NUMPLT',9)
       DO 350 J=1,NDONE
       WRITE(9,777)BX(J),BY(J),NE(J)
  777 FORMAT(2(F7.1,3X),I4)
  350 CONTINUE
       CALL CONTRL(4,'NUMPLT',9)
C LOOP TO PLOT POINTS
       DO 300 J=1,NDONE
       X=BX(J)*XSCALE+ 0.2
       Y=BY(J)*YSCALE+ 0.8
       IDEEP = NE(J)
C      PRINT 999 X,Y,IDEEP
C 999 FORMAT(2F12.1,I8)
C FIND SEPARATION FROM LAST PLOTTED POINT AND TEST FOR MINIMA
       DIFX=ABS(X-XSAV)
       DELX=DIFX-XMIN
C       IF(DELX)300,53,53
   53 DIFY =ABS(Y-YSAV)
       DELY=DIFY-YMIN
C      IF(DELY)300,54,54
   54 XSAV=X
       YSAV=Y
       IDUM = IABS(IDEEP)
       NDEEP(4) = 0
       I3 = IDUM/100
       I2 = IDUM/10 - I3*10
       I1 = IDUM - I2*10 - I3*100
       NDEEP(1) = I3
       NDEEP(2) = I2
       NDEEP(3) = I1
C      PRINT 999 NDEEP
  999 FORMAT(3I1)
       ENCODE(4,888,LDEEP)NDEEP
  888 FORMAT(4I1)
C WRITE DEPTH AT EACH LOCATION
```

```
      CALL SYMBOL(X,Y,0.06,LDEEP(1),270.0,3)
C     CALL NUMBER(X,Y,0.08,IDEEP,0.0,3H2A2)
  300 CONTINUE
      CALL PLOT(0,0,40)
      CALL CONTRL(4,'DEPTHP',8)
      CALL CONTRL(4,'DAYPRO',7)
      CALL EXIT
      END
```

TIDE PREDICTOR PROGRAM

```
C     ****** LA JOLLA TIDE PREDICTOR*****
C
C
C THE TIDE PREDICTOR COVERS THE PERIOD FROM JANUARY 1975 TO DECEMBER 1985.
C IT CALCULATES AN EIGHT COMPONENT TIDE AT S.I.O. PIER.
C
C THIS PROGRAM GENERATES THE NECESSARY COEFFICIENTS UPDATED TO THE
C DESIRED MONTH AND YEAR.
C ENTER WITH THE YEAR(NYEAR) USING ONLY THE LAST TWO DIGITS AND ALSO
C THE NUMBER OF THE MONTH (MONTH).
C
C
C
C THE NECESSARY OUTPUT DATA ARE CONTAINED IN THE FOUR ARRAYS,H,V,A AND G.
C EACH IS DIMENSIONED (8) AND ARE STORED SEQUENTIALLY IN FILE 'TIDEC'.
C
C IN THE          MAINLINE  CALL SUBROUTINE TIDEP TO RETURN THE TIDAL
C ELEVATION IN CENTIMETERS RELATIVE TO MEAN SEA LEVEL FOR EACH TIME.
C
C THE EIGHT COMPONENTS EMPLOYED ARE ....
C   K1,O1,P1,Q1,M2,S2,N2, AND K2
C VALUES FOR THE CORRESPONDING COEFFICIENTS ARE STORED IN ARRAYS IN
C THAT ORDER.
C
C THE PREDICTOR FOLLOWS THE METHOD OF THE COAST AND GEODETIC SURVEY
C SPECIAL PUBLICATION NO. 98, 'MANUAL OF HARMONIC ANALYSIS AND PREDICTION
C OF TIDES'. (1958 ED.)
C
C TIDES ARE CALCULATED ON THE BASIS OF PACIFIC STANDARD TIME.
C
C TO CORRECT TO HEIGHT ABOVE MLLW, ADD 82 CM.
C
      DIMENSION     V1(11),V2(11),V3(11),V4(11),V5(11),V7(11), HCM(8),
     1V8(11),U1(12),U2(12),U3(12), U4(12),U5(12),F(8),  U7(12),U8(12),
     2F1(11),F2(11),F4(11),F5(11),F7(11),F8(11),G(8),A(8),H(8),V(8)
      DATA HCM/32.92,21.03,10.67,3.66,48.77,19.81,11.89,5.49/
      DATA G/207.0,192.0,204.0,184.0,142.0,137.0,121.0,133.0/
      DATA A/15.041,13.943,14.959,13.399,28.984,30.0,28.440,30.082/
      DATA V1/18.2,16.2,14.1,10.5,6.8,3.7,2.5,1.5,1.5,2.4,4.9/
      DATA V2/263.5,6.5,85.7,191.3,296.9,41.6,119.4,221.1,321.4,60.8,
     1 134.2/
      DATA V3/350.0,350.2,349.5,349.7,349.9,350.2,349.4,349.7,349.9,
     1 350.2,349.4/
      DATA V4/271.5,285.8,263.2,280.1,297.0,312.9,289.0,301.9,313.5,
     1 324.2,295.8/
      DATA V5/285.8,26.0,101.8,201.8,301.9,42.0,117.9,218.4,319.1,60.0,
     1 136.8/
      DATA V7/293.8,305.3,279.3,290.6,301.9,313.3,287.4,299.2,311.2,
     1 323.4,298.4/
      DATA V8/215.8,211.5,207.6,200.9,194.2,188.2,185.6,183.1,182.6,
     1 184.2,189.3/
      DATA U1/0.0,30.56,58.15,88.71,118.28,148.83,178.4,208.96,239.51,
     1 269.08,299.64,329.21/
      DATA U2/0.0,293.62,303.34,236.96,195.94,129.56,88.55,22.16,315.78,
     1 274.77,208.39,167.37/
      DATA U3/0.0,329.44,301.85,271.29,241.72,211.17,181.6,151.04,120 49
     1 ,90.92,60.36,30.79/
```

```
      DATA U4/0.0,248.6,252.5,141.11,68.14,316.75,243.78,132.39,20.99,
     1 308.03,196.63,123.67/
      DATA U5/0.0,324.17,1.49,325.66,314.22,278.39,266.95,231.12,195.3,
     1 183.85,148.02,136.58/
      DATA U7/0.0,279.16,310.66,229.82,186.42,105.58,62.18,341.34,
     1 260.5,217.11,136.27,92.87/
      DATA U8/0.0,61.11,116.31,177.42,236.56,297.66,356.80,57.91,
     1 119.02,178.16,239.27,298.41/
      DATA F1/0.951,0.916,0.891,0.882,0.89,0.913,0.948,0.987,1.026,1.06,
     1 1.086/
      DATA F2/0.92,.863,.822,.806,.819,.858,.915,.979,1.041,1.096,1.14/
      DATA F4/0.92,.863,.822,.806,.819,.858,.915,.979,1.041,1.096,1.14/
      DATA F5/1.02,1.029,1.035,1.038,1.036,1.03,1.021,1.009,.997,.984,
     1 0.974/
      DATA F7/1.02,1.029,1.035,1.038,1.036,1.03,1.021,1.009,.997,.984,
     1 0.974/
      DATA F8/.871,.804,.763,.748,.760,.799,.864,.949,1.045,1.142,1.226/
C READ IN MONTH AND YEAR
      WRITE(1,888)
  888 FORMAT('INPUT YEAR AND MONTH, I2/I2')
      READ(1,999)NYEAR,MONTH
  999 FORMAT(I2,1X,I2)
      NUMBY = NYEAR-74
C CALCULATE VALUES OF EQUILIBRIUM ARGUMENT FOR EACH COMPONENT AT
C THE BEGINNING OF THE MONTH.
      V(1) = V1(NUMBY) + U1(MONTH)
      V(2) = V2(NUMBY) + U2(MONTH)
      V(3) = V3(NUMBY) + U3(MONTH)
      V(4) = V4(NUMBY) + U4(MONTH)
      V(5) = V5(NUMBY) + U5(MONTH)
      V(6) = 0.0
      V(7) = V7(NUMBY) + U7(MONTH)
      V(8) = V8(NUMBY) + U8(MONTH)
C CALCULATE NODE FACTOR, F , FOR MONTH AND YEAR.
      IF(MONTH-6) 220,230,280
  220 IF(NUMBY-1)240,230,240
  230 NYR = NUMBY
      GO TO 400
  240 NYR = NUMBY-1
      GO TO 400
  280 IF(NUMBY-11) 300,230,300
  300 NYR = NUMBY+1
  400 CONTINUE
      DIFF = ABS(MONTH-6)
      FACTR = DIFF/12.0
      F(1) = F1(NUMBY)*(1.0-FACTR) + F1(NYR)*FACTR
      F(2) = F2(NUMBY)*(1.0-FACTR) + F2(NYR)*FACTR
      F(3) = 1.0
      F(4) = F4(NUMBY)*(1.0-FACTR) + F4(NYR)*FACTR
      F(5) = F5(NUMBY)*(1.0-FACTR) + F5(NYR)*FACTR
      F(6) = 1.0
      F(7) = F7(NUMBY)*(1.0-FACTR) + F7(NYR)*FACTR
      F(8) = F8(NUMBY)*(1.0-FACTR) + F8(NYR)*FACTR
C CORRECT AMPLITUDE COEFFICIENTS
      DO 100 J=1,8
  100 H(J) = HCM(J)*F(J)
      CALL  CONTRL(2,'TIDEC',7)
      WRITE(7) H
```

```
      WRITE(7)V
      WRITE(7)A
      WRITE(7)G
      CALL  CONTRL(4,'TIDEC',7)
      WRITE(1,666) (V(L), L=1,8)
  666 FORMAT(8(F8.1,1X))
      CALL EXIT
      END
```

```
      SUBROUTINE TIDEP(NDAY,NTIME,G,A,H,V,TIDE)


      SUBROUTINE TIDEP(NDAY,NTIME,G,A,H,V,TIDE)
      DIMENSION G(1),A(1),H(1),V(1)
C ENTER DAY OF MONTH (NDAY) AND TIME (NTIME) USING PACIFIC STANDARD
C TIME AND THE 24 HOUR CONVENTION WITH TWO DIGIT HOUR FOLLOWED BY TWO
C DIGITS FOR THE MINUTES.
C
C CALCULATE GREENWICH TIME IN HOURS
      NHR = NTIME/100
      NMIN = NTIME-NHR*100
      GTIME = 7.0 + FLOAT(NHR) + FLOAT(NMIN)/60.0 + FLOAT((NDAY-1)*24)
C SUM EIGHT COMPONENTS OF THE TIDE
      TIDE = 0.0
      DO 100 J=1,8
C CALCULATE ANGULAR ARGUMENT
      ARG = A(J)*GTIME+V(J)-G(J)
      ARG = ARG*0.01745329
      TIDE = TIDE + H(J)*COS(ARG)
  100 CONTINUE
      RETURN
      END
```