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DISPERSION OF SEWAGE SLUDGE DISCHARGED INTO NEW YORK BIGHT

Physical Oceanographic Data - December 1974

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DISPERSION OF SEWAGE SLUDGE DISCHARGED INTO NEW YORK BIGHT

Physical Oceanographic Data December 1974

by

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FOREWORD

Effective regulatory and enforcement actions by the Environmental Protection Agency would be virtually impossible without sound scientific data on pollutants and their impact on environmental stability and human health. Responsibility for building this data base has been assigned to EPA's Office of Research and Development and its 15 major field installations, one of which is the Corvallis Environmental Research Laboratory (CERL).

The primary mission of the Corvallis Laboratory is research on the effects of environmental pollutants on terrestrial, freshwater, and marine ecosystems; the behavior, effects and control of pollutants in lake systems; and the development of predictive models on the movement of pollutants in the biosphere.

This report describes work performed in New York Bight as one aspect of an EPA study relating to the discharge of wastes from the New York-New Jersey metropolitan area. It is one of a series of four data reports relating specifically to digested sewage sludge discharged from vessels operated by the City of New York.

A. F. Bartsch
Director, CERL

ABSTRACT

This volume contains physical oceanographic data collected at the sewage sludge disposal site near the Appex of New York Bight December 18 through 21, 1974. An optical tracer method was used to measure the water column distribution of waste material with time after discharge. Profiles with depth were taken for 2 to 4 hours after waste discharge. Ambient temperature-salinity-density profiles and current measurements were also taken.

This report covers a period from June 1974 to May 1975 and work was completed as of May 1976.

CONTENTS

ACKNOWLEDGMENTS

We would like to thank Mr. E. O. Wagner and Capt. E. D. Hansen of the New York City Department of Water Resources for arranging sludge vessel sampling and vessel operations in the field.

Personnel from the Surveillance and Analysis Group under Mr. Richard Dewling in U.S. Environmental Protection Agency's Edison, New Jersey, Laboratory were helpful in many aspects of this work.

Dr. Jack Pearce of the Sandy Hook Marine Laboratory supplied us with storage, dock space and other amenities without which a difficult operation would have been more so.

SECTION 1

INTRODUCTION

This is the second volume of a projected series of data reports on a study of municipal wastes discharged from sludge carrying vessels in the New York Bight area (Figure 1). Preliminary analysis of the data has been given by Callaway et al. (1976). Sludge, defined as a residue from primary and/or secondary waste treatment operations, and other waste materials have been dumped in the Bight area for many years. The effect of these materials has been experienced in the Bight area for many years; and the impact on the endemic fauna and flora has been the subject of extensive study (e.g. Pearce, 1972) and considerable controversy.

It is estimated that 4.3 million wet tons of sewage sludge were transported to sea and discharged during 1975 (Hansler, 1976). The existing dumping ground is alleged to be overloaded and too close to the longshore residential and recreational areas of New York and Long Island. For this reason, new dumping grounds further offshore have been identified and considered for use (EPA, 1976).

After discharge from a sludge vessel, the wastes are transported and diffused throughout the water column. Particles settle at varying rates depending on their settling velocities, flocculation rates and initial momentum. The accumulation of sludge particles on the bottom depends on the above factors plus the current distribution and turbulent mixing within the water column. Resuspension of particles can occur if the current near the bottom is strong enough. The complexity of this process is obvious. To predict the fate of materials, a mathematical model is needed which will simulate as much detail of the physics as possible.

In this volume, physical oceanographic measurements made in situ during the December 1974 cruise are presented. In addition, descriptions of instruments, procedures, and processing are given for both the June 1974 cruise and the December 1974 cruise. The following sections explain measurement techniques, instrument performance, and data treatment. The data for the December 1974 cruise are presented in the Appendix. The data for the June 1974 cruise appears in Appendix B of Ditsworth et al. (1975), although the instruments used to make the measurements and the field and processing methods used are included in this volume.

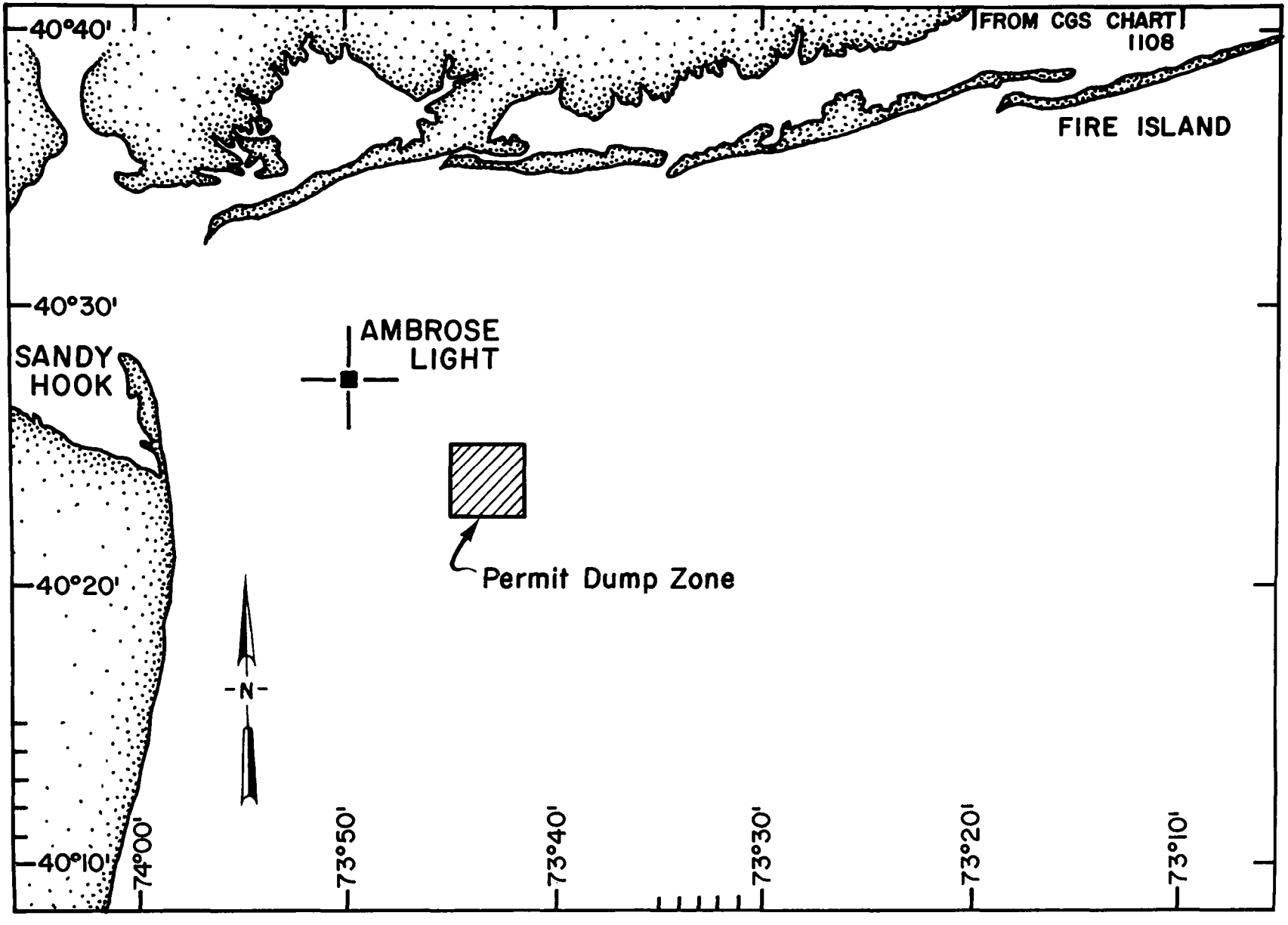

Figure 1. Sewage sludge disposal area in New York Bight.

SECTION 2

CRUISE OUTLINE

JUNE 1974 CRUISE

The objective of this cruise was to develop observational techniques and to observe the normal underway discharge method. The Atlantic Twin, a twin hull vessel of 28 meters overall length, was chartered for use from June 27 to July 2. Cruise participants were: R. J. Callaway, field party chief, G. R. Ditsworth, A. Teeter, and A. Yartzoff, of the Environmental Protection Agency's Corvallis (Oregon) Environmental Research Laboratory.

On June 27, the sludge vessel Newtown Creek was intercepted; radio contact was established and starting and finishing dump times fixed. The vessel carries about 3,000 m^3 of sludge and discharges vertically through 16 0.43 m diameter ports. The Atlantic Twin was then positioned in the sludge wake (which was visible) and sampling began. A parachute drogue, set to about 3 meters, was thrown overboard to assist in tracking the waste field. Suspended sediment samples were collected and temperature-salinity and current profiles taken.

On June 30, a transect was made between New York Harbor through the existing dumping ground and to buoy NB off Fire Island. This same transect was made during earlier cruises (reported in Ditsworth, et. al. (1975)). Suspended sediment samples, temperature-salinity and light transmittance profiles were made.

On July 1, the sludge tankship Owls Head was intercepted in the dumping ground and discharged while underway. The vessel carries about 1700 m^3 of sewage sludge and discharges vertically through 12 port openings, each 0.36 m in diameter. Drogues were deployed into the visible wake and sampling begun. Suspended sediment samples were taken. Transmittance profiles were made with a Bendix Model C-2 extinction transmissometer with a one meter path length. Temperature-salinity profiles and current profiles were made to characterize these ambient conditions and to provide data for computing vertical diffusion coefficients. Sampling continued for about two hours after the discharge.

The natural turbidity in the surface layer and the increased turbidity caused by the sludge discharge were too high to measure accurately with the transmissometer used on this cruise. However, data are useful in excluding regions of the water column from the immediate influence of the sludge dump. The data collected from this cruise are presented in Appendix B of Ditsworth et al. (1975). Sampling locations are shown in Figure 1 and Tables 1, 2 and 3 of that report. Navigation was performed with a model 101 Decca radar set and Loran A. Fixes are repeatable to about 450 meters. The absolute position is

not too important as a Lagrangian experiment was indicated and we attempted to stay in the sewage field. Possible data interpretation errors relate to our inability to determine what part of the narrow sewage field we were in, i.e., a fictitious concentration decay with time might result from sampling the borders of the field.

DECEMBER 1974 CRUISE

The second survey to sample sludge wastes was conducted from December 18 through 21. The Atlantic Twin was again chartered. Participants were: R. J. Callaway, field party chief, G. R. Ditsworth, A. Teeter, and D. Browne. Arrangements were made with the New York City Environmental Protection Agency to have their sludge vessels enter the dumping ground as usual but to unload the wastes at a stop rather than while underway. Samples were also obtained from the vessel prior to departure.

Before the arrival of the NYC vessel in the dumping ground, background samples were obtained in the vertical for temperature, salinity, suspended sediments and light transmission. On December 18, the vessel Newtown Creek was in radio contact with us and established the start and stop times of discharge, which took 6 minutes. The discharge was not at a complete halt because of tides and winds to 25 knots; the intitial patch size was about 45-70 meters in diameter.

After the Newtown Creek moved out, the Atlantic Twin backed in and remained stern to for the duration of the sampling. The discharge patch was easily discerned by color and by the slick. Once in the patch, the salinity-temperature-transmittance-depth profiling instrument (STD) was lowered; this set the suspended sediment sampling interval which was used almost exclusively: 0, 5, 10, 15, 20 meters. The STD visual records for the first few rounds were erratic but the trend could be detected. The trouble was due to slip ring problems in the electric winch. The transducer was then raised and lowered by hand and the problem was circumvented.

A summary of station times, locations, and the type of sampling done appears in Tables 1, 2, and 3. Station numbers indicate the month, day, year and sampling sequence of that day, respectively.

During the first day of sampling, the wind action was strong enough to completely mix the water column: temperature and salinity showed very little gradient. Light transmission also showed little gradient. After dumping, the most significant change was, of course, in transmittance. Rather good records were made of this event in conjunction with other profile features. A collapse phase was not obvious--the waste cloud did not contract vertically. On the second day of sampling the winds lessened and a double mixed layer developed for the remainder of the cruise, measuring currents at 2.5 meters depth. A similar sampling scheme was followed again on the second and the third day of the December cruise observing the discharge of the Newtown Creek.

TABLE 1. SAMPLING NEW YORK BIGHT: WAKE OF DISPOSAL VESSEL NEWTOWN CREEK, DECEMBER 18, 1974

Station	Time* Begin	Time* End	Latitude	Longitude	Parameter**
121874-1	0750	0850	40°24.9'N	73°44.8'W	X
121874-2	0946	1100	40°24.9'N	73°44.8'W	X,X,X,X, TSM
121874-3	1110	1202	40°25.8'N	73°44.3'W	X,X, TSM
121874-4	1230	1301	40°24.6'N	73°43.8'W	X,X, TSM
121874-5	1328	1355	40°24.4'N	73°41.7'W	X, TSM
121874-6	1412	1420	40°24.2'N	73°44.8'W	X

* Eastern Standard Time
** Parameter

X Profile with CSTD instrument; the number of profiles made at each station are indicated by the number of X's.

TSM Water samples collected for total suspended matter.

TABLE 2. SAMPLING NEW YORK BIGHT: WAKE OF DISPOSAL VESSEL NEWTOWN CREEK, DECEMBER 19, 1974

Station	Time* Begin	Time* End	Latitude	Longitude	Parameter**
121974-1	0842	0955	40°24.7'N	73°44.7'W	X,X, TSM
121974-2	1235	1256	40°24.7"N	73°44.7'W	X,X,X, TSM
121974-3	1323	1409	40°24.7'N	73°44.1"W	X,X,X, TSM
121974-4	1430	1502	40°25.3'N	73°42.7'W	X,X, TSM
121974-5	1529	1540	40°25.0'N	73°41.7'W	X, TSM
121974-6	1600	1602	40°25.7'N	73°45.3'W	X

* Eastern Standard Time
** Parameter

X Profile with CSTD instrument; the number of profiles made at each station are indicated by the number of X's.

TSM Water samples collected for total suspended matter.

TABLE 3. SAMPLING NEW YORK BIGHT: WAKE OF DISPOSAL VESSEL NEWTOWN CREEK, DECEMBER 20, 1974

Station	Time* Begin	Time* End	Latitude	Longitude	Parameter**
122074-1	1007	1010	40°24.7'N	73°44.7'W	X, TSM
122074-2	1020	1043	40°24.7'N	73°44.7'W	X,X, TSM
122074-3	1117	1153	40°24.1'N	73°44.9'W	X,X,X
122074-4	1232	1232	40°23.8'N	73°45.0'W[a]	X

* Eastern Standard Time

** Parameter

X Profile with CSTD instrument; the number of profiles made at each station are indicated by the number of X's.

TSM Water samples collected for total suspended matter.

[a] Position not located by navigation. Latitude and longitude estimated from drift between stations 122074-2 and 122074-3.

SECTION 3

INSTRUMENTATION AND CALIBRATION

BECKMAN MODEL RS5-3 PORTABLE SALINOMETER

This instrument was used to measure salinity, conductivity, and temperature at various depths in the water column. Similar units have been tested by the National Oceanographic Instumentation Center, National Oceanic and Atmospheric Administration (NOAA), USDC, Washington, D.C. (NOAA, 1970). Performance test data typical of these units are as follows:

Temperature

Range	0° to 40°C
Accuracy	-1.20° to +0.25°C
Nonlinearity	+0.50°C

Conductivity

Range	0 to 60 mmhos/cm
Accuracy	-0.16 to 0.05 mmhos/cm
Nonlinearity	+0.05 mmhos/cm

Salinity

Range	0 to 40 ppt
Accuracy	-0.31 to +0.38 ppt

Instrument calibration consisted of conductivity checks against a resistance loop, and salinity samples taken during the cruise. The test loop consists of a precision (0.05%) resistor and a short length of wire. Conductivity readings taken with this loop through the conductivity head are reduced in Figure 2. The indication is that there was a long-term stability problem with conductivity resulting in a drift of the daily mean of 0.5 mmhos/cm during the four-day December cruise. Twenty-nine salinity samples were taken and analyzed on a Plessey 6220 inductive lab salinometer. The mean error between these "true" values and those obtained in the field with the RS5 was 0.361 ppt, and the standard deviation of the error was 0.240 ppt.

BENDIX ALPHA METER MODEL C-2, S-4

This instrument measures turbidity in water by comparing the intensity of a beam of light projected to the intensity of that received after passing through a one meter length of water. The loss of intensity is due to absorption and scattering by suspended material, although a small amount of scat-

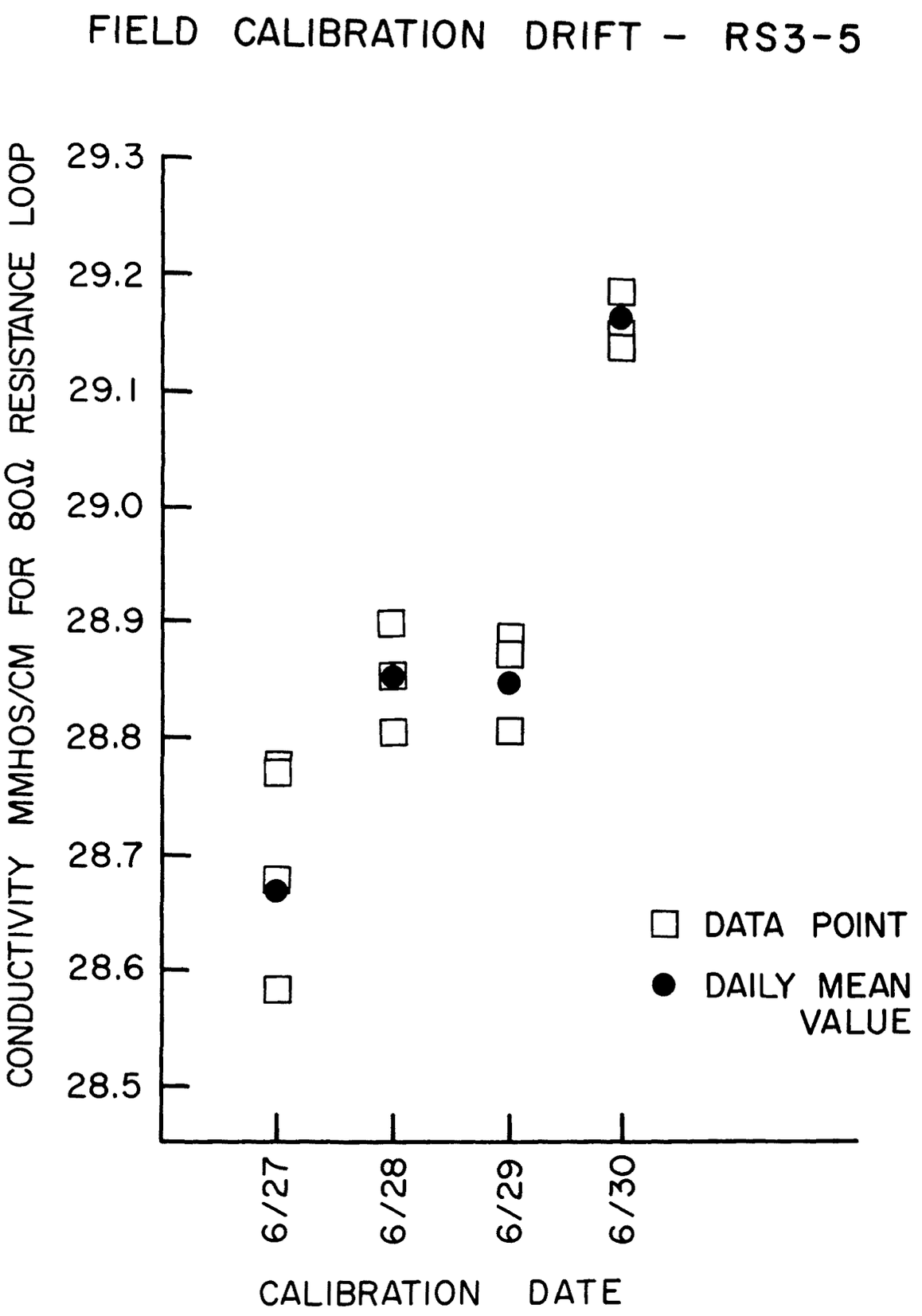

Figure 2. Field calibration data for the Beckman RS3-5.

tered light does find its way to the detector (McCluney, 1975). Any change in the intensity of the light source is compensated for automatically. This measurement is intended as a qualitative indicator of the distribution of suspended materials. The transmittance as read from the instrument is converted to an extinction coefficient, alpha. Alpha (A) is defined as equal to (1/d) lnT, where d is path length in meters and T is transmittance. This extinction coefficient can then be compared to concentration of suspended material, although it is also a function of the response spectrum of the instrument and certain properties of the particulates. This instrument, fitted with Wratten 45 filters, has a peak spectral sensitivity of 480 nanometers and a half band width of 30-40 nanometers. The manufacturer states the accuracy of this instrument as 3 percent. Calibration in the field consists of adjusting the lamp current and balancing the detectors to a pre-calibrated value in air. The useful range of the instrument is thought to be 3 to 90 percent transmittance, since the possible inaccuracies in transmittance make A values very qualitative outside these limits. Therefore, the useful range of the extinction coefficient, alpha, is from about 0.1 m^{-1} to 3.5 m^{-1}.

INTEROCEANS CSTD-TR IN SITU MONITOR

This instrument consists of a multi-parameter probe which is lowered through the water column and a digital readout, analog recorder and digital magnetic tape recorder on deck. Installed on the probe are a platimum wire temperature sensor, inductive conductivity sensor, strain gauge pressure transducer, a thermistor network used to convert conductivity to salinity, and a 10 cm extinction transmissometer. Analog signals are generated within the probe corresponding to conductivity, salinity, temperature, depth, and percentage of light transmission. These signals are recieved by (a) digital display readout, (b) digital magnetic tape recorder and (c) 4 channel analog recorder. Digitizing takes place in the former two units.

The manufacturer's specifications of the model 513 are as follows:

Parameter	Range	Precision	Time Constant
Conductivity	0-65 mmhos/cm	±0.02 mmhos/cm	20 msec
Salinity	0-45 ppt	±0.02 ppt	1.4 sec
Temperature	-5° to +45°C	±0.02°C	60 msec
Depth	0-100 m	±0.3 m	60 msec
Turbidity	0-100%	±2%	50 msec

Calibration testing was performed at the Southwest Regional Calibration Center, NOAA, between August and October, 1974. Temperature, salinity, conductivity, and depth (pressure) reading from the instrument were checked against precision equipment and traceable standards. Depth testing consisted of two cycles each at four temperatures (0°, 5°, 10°, 20°C) and seven depths, (20, 25, 30, 35, 50, 100 m), a total of 56 points. The error range was found to be -0.15 to 0.8 m, repeatability was better than 0.3 m, and linearity of the depth error with depth was 0.5 m. Results from these test points were subjected to regression analysis. A good correlation was found between depth error, depth, and temperature. The regression correlation coefficient was 0.87. The standard deviation of the residuals from the regression curve was

0.14 m. The range of the residuals was -0.24 to +0.26 m. Temperature, conductivity, and salinity testing consisted of three cycles each at five temperatures (0°, 5°, 10°, 15°, 20°C), and at four salinities (20, 26, 30, 34 ppt). Regression analysis also was performed on these data. The constants from the regression equation were used as a correction function during data processing.

Table 4 briefly summarizes the calibration data, variables used in the regression, and the residuals from that regression.

TABLE 4. CALIBRATION DATA AND ERROR ANALYSIS INFORMATION ON INTEROCEANS CSTD

NOIC SRCC DATA	Conductivity (C) mmhos/cm	Salinity (S) ppt	Temperature (T) °C	Depth (D) m
Error Range				
Max	0.107	0.137	0.049	0.8
Min	-0.085	-1.193	-0.027	-0.15
Mean Error	0.035	0.031	0.017	0.39
Standard Dev. of error	0.035	0.087	0.017	0.27
Error Analysis				
Independent variables used in regression	C, C^3, T	S, S^3		D, D^2, D^3, T^2, T^3
Standard Deviation of Residuals	0.018	0.025	0.017	0.14

The long-term stablility of the instrument was checked over a 6 week period before taking it into the field. An American Instruments Bath, Hewlett Packard Quartz Thermometer, and Plessey 6220 lab salinometer were used. Nine cycles were completed between 1° and 17°C, and 29.5 to 32.5 ppt with no apparent calibration shift.

A small number of seperate measurements and samples were collected in the field for comparison with the STD data. Six samples were collected for salinities and reversing thermometer temperatures during the December cruise. Of these, two samples were taken in the thermocline layer. The temperature gradient in this area would cause a depth error in either the STD or reversing thermometers to be translated into possibly a large temperature error. These sampling point did yield abnormally high differences with the STD. The following table describes the differences between the mean of the two reversing thermometers in the same frame and the temperature from the averaged and standardized STD data.

TABLE 5. DIFFERENCES BETWEEN TEMPERATURES MEASURED BY REVERSING THERMOMETERS AND STD PROFILES

	All six samples	Excluding two worst cases	Comparison of pairs of reversing therm.
Mean Difference	0.01	-0.01	0.02
σ	0.05	0.02	0.02
Range	0.10 to -0.03	0.01 to -0.03	0.005 to 0.05

The following table describes the difference between STD salinity and samples run on a Plessey 6220 inductive lab salinometer for all six samples and excluding the same two samples as above.

TABLE 6. DIFFERENCES BETWEEN SALINITIES DETERMINED IN SAMPLES AND STD PROFILES

	All six samples	Excluding worst two cases
Mean Difference	0.054	0.032
σ	0.034	0.007
Range	0.100 to 0.026	0.039 to 0.026

The transmissometer installed on the probe is an extinction type much like the Bendix Alpha meter except that the path length is only 10 cm, and the spectral irradiance covers the entire visible range. The useful range of extinction coefficient, alpha, is from about 1 m^{-1} to 35 m^{-1}. Repeatability was checked and found to be within ±2% transmission withing this range. Field checks on the transmissometer consist of an in-air calibration with the lenses dry.

CURRENT METERS

A Hydro Products Model 460A/465A was used to profile current speed and direction. The speed sensor is a Savonious rotor which magnetically activates a switch. A directional vane is magnetically coupled to a potentiometer. Readings are taken from dial displays on the deck readout. A rotor spindown test was performed to check bearing conditions. Although this test indicated that the bearing condition was marginal, the rotor is expected to perform up to specifications in the speed range in which it was used. Typical accuracy specifications for this type of rotor are ± 0.05 knots at velocities from 0.05 to 1.0 knots, and ± 0.1 knots at velocities greater than 1.0 knots. An accuracy of ± 5° is claimed for the directional sensor.

A Bendix model Q-15 current meter was used to measure current speed and direction from a moored buoy. The bi-directional ducted impeller can differentiate between forward and reverse flow within the duct. These short term flows are integrated and the output of the instrument tends to represent the speed of the net flow. The magnetic heading of the vane is sensed potentiometrically. Proportional DC voltages are recorded on a Rustrak strip chart recorder. The manufacturer claims accuracies of ± 3% in speed and ± 12° in direction.

SECTION 4

FIELD PROCEDURES

During the June 1974 cruise, station sampling consisted of (1) water samples for suspended material, (2) vertical profile of currents, (3) salinity-temperature profile, (4) transmittance profile, and (5) salinity samples. Water samples were collected with a single Niskin bottle. A cast at five depths required about 12-15 minutes. Subsamples for salinity were drawn from some of the bottles. Meter wheel depths and wire angles were recorded. The Hydro Products current meter was lowered in 1.5 m steps from the deck of the unmoored research vessel. Readings were taken immediately after the desired depth was reached. Time required was less than 10 minutes for a profile. Salinity-temperature profiles with the Beckman RS3-5 required about 20 minutes. Depth steps of 2 or 4 meters were made by cable markings. Wire angles were noted several times during each profile. Transmittance profiles with the Bendix Alpha-meter were made using 1.5 meter depth steps. Cable was metered out and wire angles recorded. All sample depths, sample number reading times, wire angles, etc., were entered into a common rough log.

During the second cruise made to study physical conditions in the close proximity to a sewage sludge discharge, water samples and in situ measurements were taken in the waste plume after discharge and continued for about 3 hours. These stations were sampled for total suspended material (TSM) and size distribution analysis. Profiles of salinity, temperature and light transmittance with depth were made with the Interocean CSTD-Tr. Background stations also were occupied at which hydro-casts for salinity samples and reversing thermometer temperatures, as well as the above, were taken. During a STD profile, the instrument was lowered and raised at above 0.5 m/sec. Normally this was done by winch, but during the December cruise a slip ring problem required that it be done by hand. A continuous analog record of salinity, temperature and transmittance versus depth was made. The digital magnetic tape recorder scanned all parameters once per second. Conductivity, salinity, temperature and depth are scanned in 0.4 seconds, once per second. Total scanning time is 0.7 seconds, 0.1 second for each channel of input. At each eighth scan the mission time, in hours and minutes, and station identification number were also recorded.

During the December cruise, water samples were collected for correlation of transmittance and suspended solids concentration. Samples generally were taken within 10 minutes of the corresponding STD measurement. This delay could be a cause for the breakdown of a correlation of those parameters, since some "patchiness" of the waste plume was observed visually from the boat. The procedures used for the laboratory correlation of these two parameters is given by Browne and Callaway (1975).

The weather on December 18, 1974 was rather uncertain, so the current meter deployment was postponed one day. A sketch of the deployment arrangement and hardware is given in Figure 3. A spar type buoy was used for suspending the instrument as it was felt that its characteristic lag in response to heave forces would minimize the perturbations of the current sensor which might be caused by short crested waves. The bi-directional ducted impeller and long vane also helped to smooth out most buoy surges and wave orbital acceleration. The time constant for the impeller electronics is about 50 seconds. Rustrak strip chart strike rate was once every 2 seconds. Chart speed was 10 cm per hour.

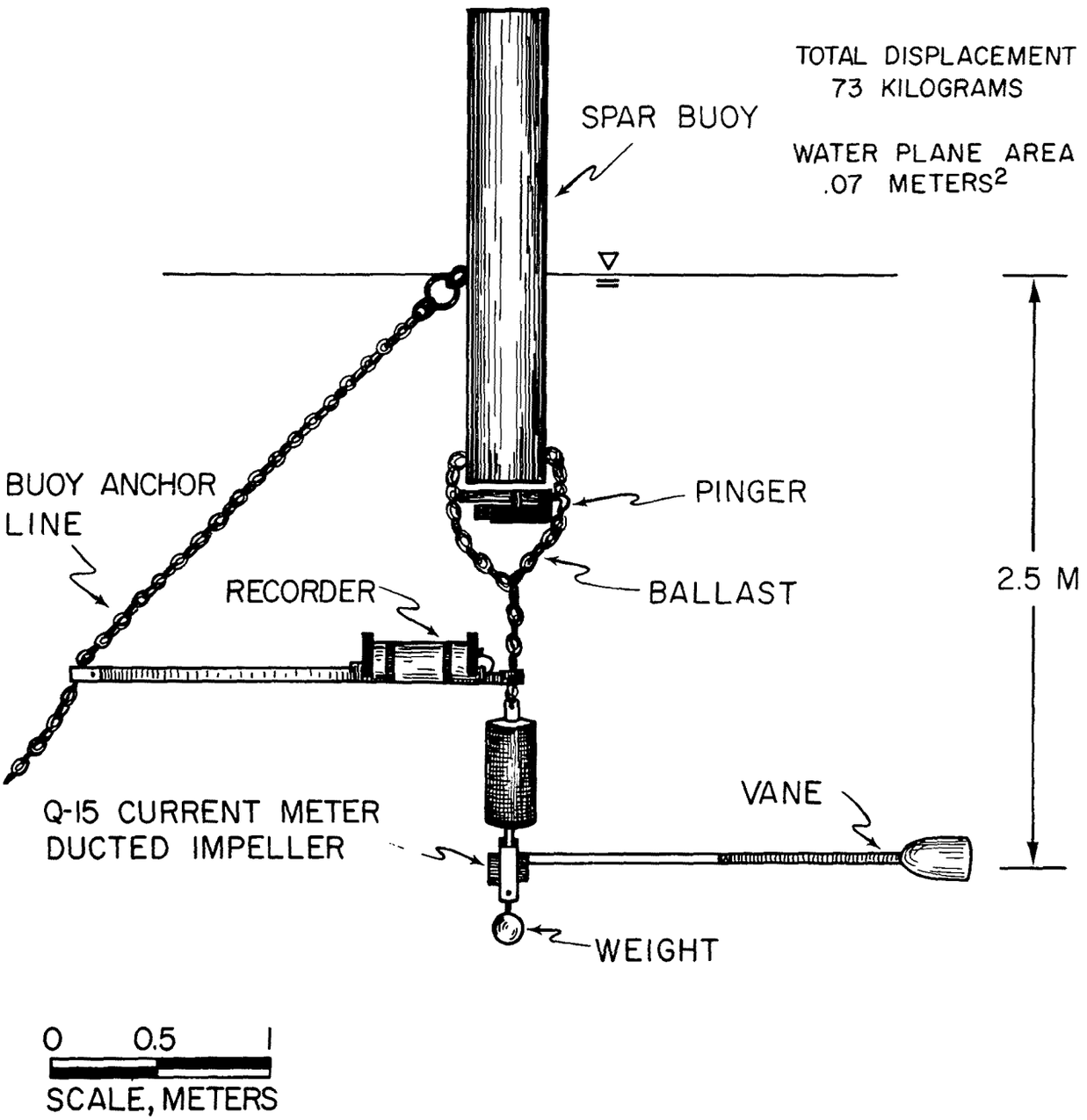

Figure 3. Current meter mooring arrangement.

SECTION 5

DATA PROCESSING

Data processing was required to decode, apply corrections to, and present data collected with the STD and Q-15 current meter. The STD data, because of the method available for recording and the large number of points, were processed almost entriely by machine. The Q-15 data required manual digitizing, then processing by available programs.

STD data were processed in two steps. First, a program translated the magnetic tape cassette into eight columns of data, breaking the file whenever the recorded identification code changed. Calibration correction functions were applied during translation. Also, any large stepwise changes in values were annotated by the program for manual inspection. About 0.25% or fewer points of a normal data file were found to be erroneous; that is, over 4 standard deviations from surrounding points. These errors possibly were caused by tape reader error or faults in the tape itself. These points were deleted from the data file. The second program used in processing was *CSTD. This program was developed by Donald Denbo and is on public file at Oregon State University. The program computes salinity, density, density gradient, and extinction coeffiecient. Salinity was computed using functions from Perkin and Walker (1971) and sigma-t density from Knudson's equation as reported by Swoors (1971). Density gradient was computed as

$$\frac{\sigma_{t(a)}\ \sigma_{t(o)}}{(1000 + \sigma_{t(o)})\Delta Z}$$

where $\sigma_{t(o)}$ is the sigma-t density at a reference depth and $\sigma_{t(a)}$ is the sigma-t density at a depth which is ΔZ below the reference depth. The increment depth change, ΔZ, was one meter. The extinction coefficient alpha as $-(1/d)\ln T$, where T equals transmittance and d is the path length in meters, was computed. The program averages by depth intervals and interpolated (extrapolate to 0) to specific depths. Output is in the form of plots and listing.

A program which accepts output from *CSTD profiles and computes a vertical diffusion coefficient defined by

$$K_Z = \frac{1}{\partial s/\partial z}\int_o^z \frac{\partial s}{\partial t}\, dz$$ was used.

Temperature and density can be used in this equation, as well as salinity. The differences between values (which are actually means) compared over vari-

ous time and depth intervals were checked for statistical significance to select the time interval between profiles and the depth interval within each profile for computation.

The record from the Q-15 was scrutinized and digitized manually. Readings were picked off the record at 10 minute intervals. Direction was corrected for local magnetic variation. Programs which are available on public file at Oregon State University's computer system were used to analyze the data. Those current speeds outside the 0 to 1 knot range of the instrument were given the value >1.

Some in situ meaurements required that their depths be corrected for wire angle. Depths were computed using wire lengths corrected in steps for wire angle. A constant vessel drift was assumed. Depths at various wire lengths were found by:

$$D_1 = L_1 \text{ Cos } \Theta_1$$

$$D_2 = D_1 + (L_2 - L_1) \text{ Cos } \Theta_2$$

where D_1 is the depth at wire length L_1 and wire angle Θ_1. D_2 is a second depth at wire length L_2 and having a wire angle of Θ_2. This correction method assumes that cable drag is significant relative to cable weight, probe drag and probe weight.

Data from the Beckman RS3-5 salinometer were corrected for depth and then processed by *CSTD program as described in this report.

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APPENDIX

DATA FROM DECEMBER 1974 CRUISE

The processed data from the STD and current meter appear sequentially in this appendix. Data sheets are arranged so that the time series currents and tidal information for each day appear first followed by water column profiles in order. Note that there are no current meter data for the first day. Currents are described by time series readings at 10 minute intervals. Out of range readings are described as >1. Predicted times and heights of time at Sandy Hook are from National Ocean Survey's tide tables (NOAA, NOS, 1973).

The profiles were generated by reordering the data point by increasing depth, averaging by one meter intervals, and interpolating to one meter intervals. The zero meter value is extrapolated, since the smallest depth at which measurements are made was about one-half meter. This causes some peculiar negative values to appear as percent transmission reading because of the very high near-surface gradient this variable can exhibit in the presence of dumping activities. In these cases, the extinction coefficient does not compare to the transmittance at zero meters, but was extrapolated from greater depths. Since the extinction coefficient is a linear function of the concentration of the sludge material, it is of greater value here.

The affect of the averaging technique used is to merge the down and up casts of the STD into one profile, cancelling the lag effects caused by the response time of the sensors and the scanning time of the recorder. The weight of either the down or up casts in this merger depends on the relative lowering/raising rate, since the sampling interval is constant. The resulting curve lies closer to the slower half of the profile, which is reasonable since the slower cast would have a smaller lag effect. The down and up casts were done at approximately the same speed, however.

Figure A-1 shows an example profile and the response lag which the platinum wire temperature sensor exhibits in a thermocline. The results from the down and up casts of the instrument lie below and above, respectively, the averaged profile. The averaged profile was averaged in one meter intervals. The three curves merge above and below the thermocline.

A summary of station times, locations, and the type of sampling done appears in Tables 1, 2, and 3.

The transmittance readings presented have been rounded off to the nearest percent. The extinction coefficients were computed from the higher resolution readings which the instrument gives. This causes some extinction coefficients to be slightly different even though the percent transmission appears to be the same. The dimensions of alpha in the listing is m^{-1} not m-1.

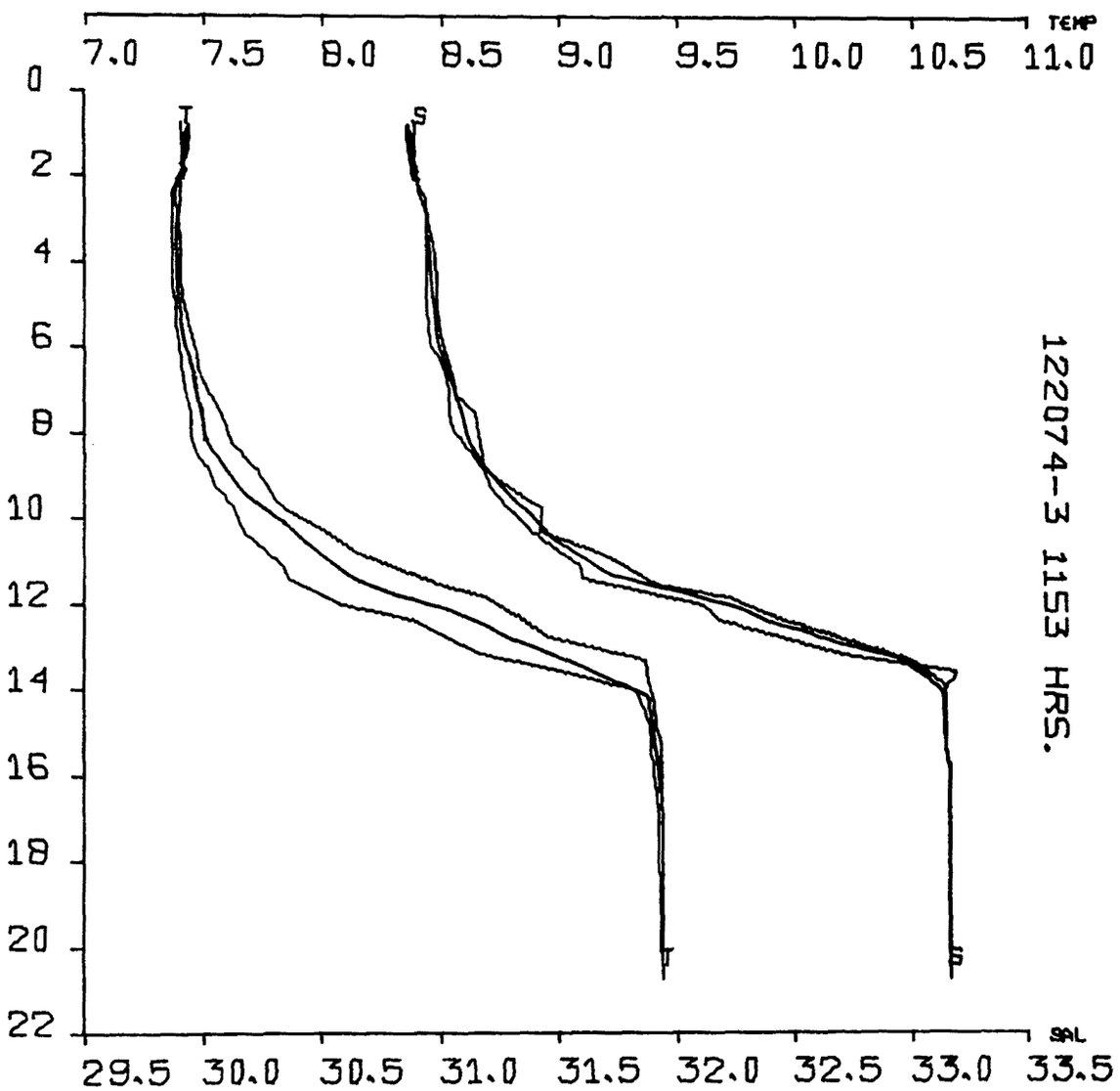


Figure A-1. Averaged salinity and temperature profiles enveloped by down and up casts showing the thermal-lag effects on the temperature sensor.

TIDES: DECEMBER 18, 1974

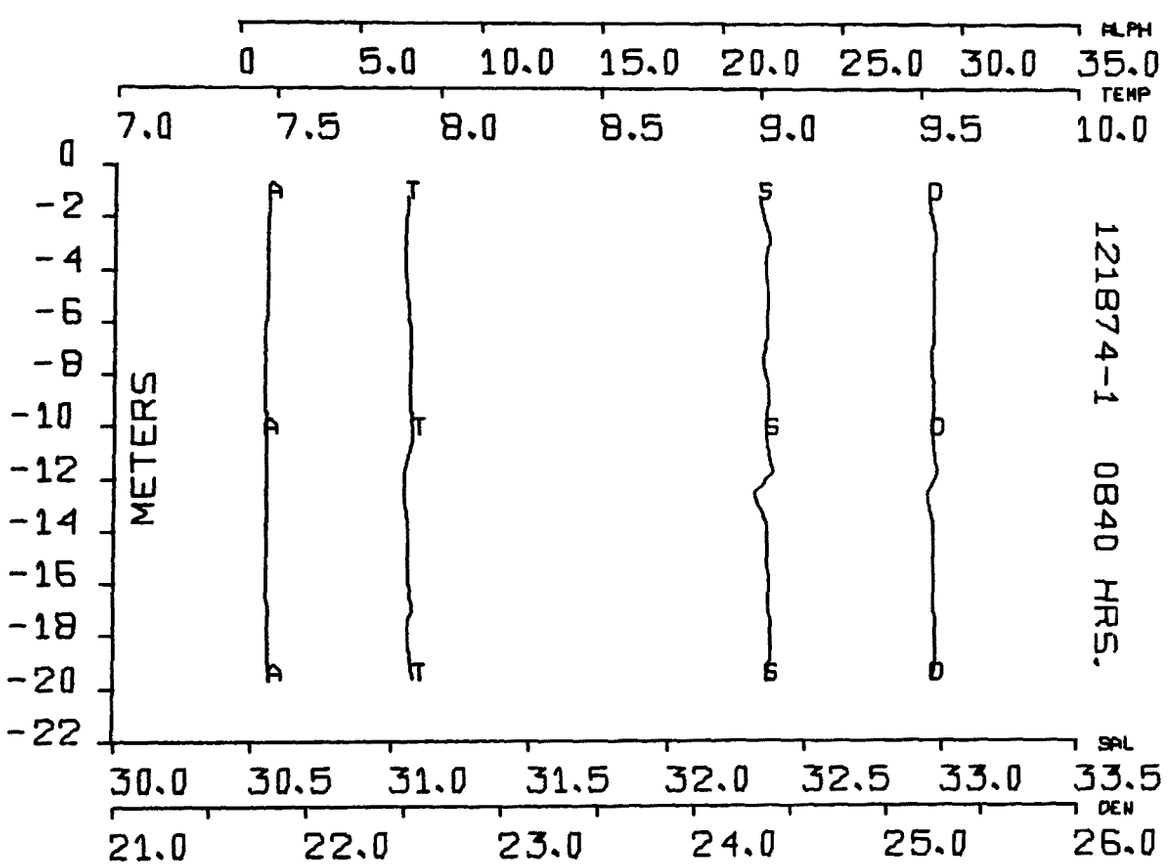
Predicted tides at Sandy Hook, N.J.	
Time (Zone)	Height Ft. (MLW)
0421	0.3
1032	4.3
1653	-0.1

****

STATION 121874-1 0840 HRS.
AT DUMPSITE BEFORE SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	32.28	7.89	25.18	88	1.24
1.0	32.31	7.89	25.20	89	1.22
2.0	32.35	7.89	25.23	89	1.20
3.0	32.36	7.89	25.24	89	1.19
4.0	32.35	7.90	25.23	89	1.20
5.0	32.36	7.90	25.24	89	1.19
6.0	32.35	7.91	25.23	89	1.13
7.0	32.34	7.91	25.23	89	1.15
8.0	32.35	7.91	25.23	89	1.16
9.0	32.36	7.91	25.24	89	1.16
10.0	32.35	7.91	25.23	89	1.17
11.0	32.37	7.90	25.25	89	1.18
12.0	32.35	7.89	25.23	89	1.18
13.0	32.33	7.90	25.22	89	1.18
14.0	32.36	7.90	25.24	89	1.19
15.0	32.35	7.90	25.24	89	1.16
16.0	32.36	7.91	25.24	89	1.19
17.0	32.36	7.92	25.24	88	1.28
18.0	32.37	7.90	25.25	88	1.29
19.0	32.36	7.91	25.24	87	1.35



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* STATION 121874-2 1003 HRS.

* AT DUMPSITE 17 MINUTES AFTER SLUDGE DISCHARGE

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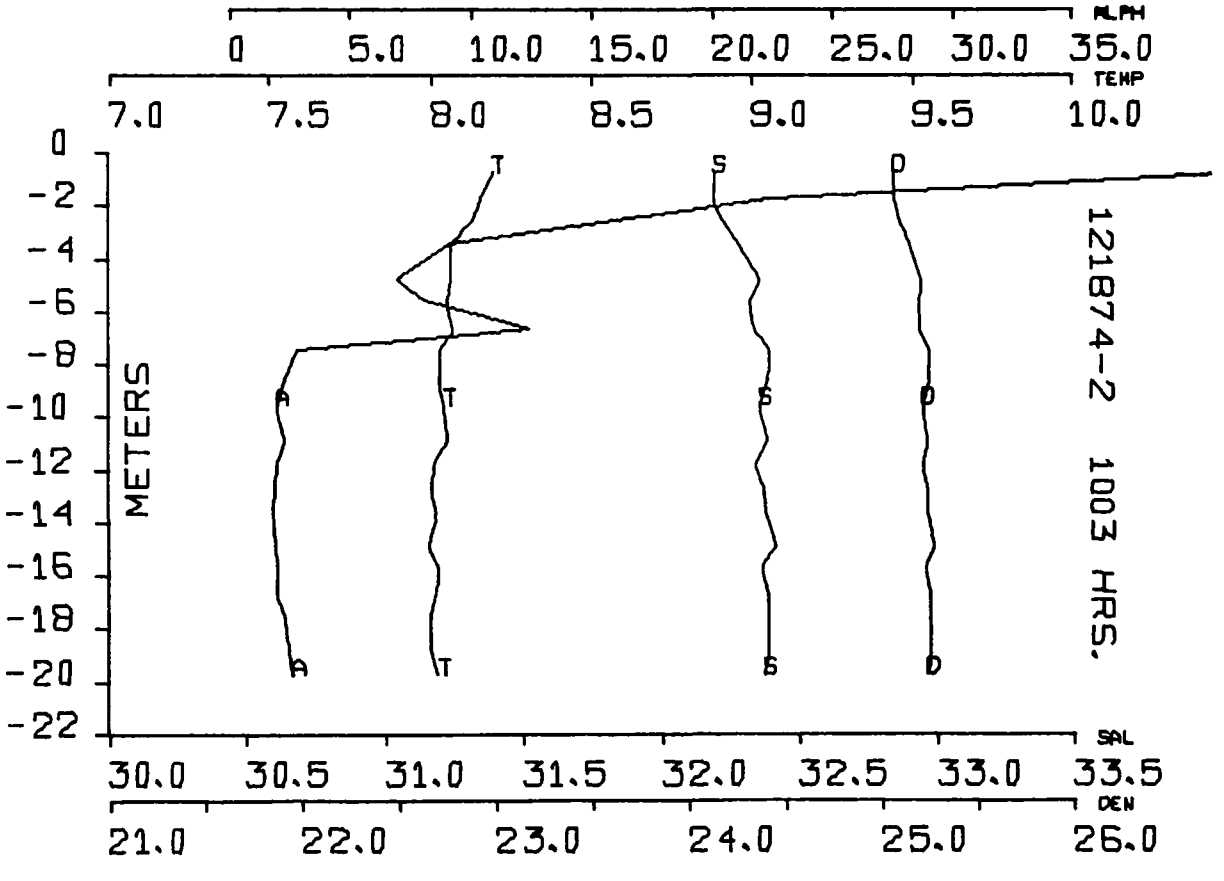
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	32.19	8.22	25.06	-6	57.34
1.0	32.19	8.18	25.07	4	37.49
2.0	32.20	8.14	25.08	14	20.46
3.0	32.25	8.09	25.13	30	12.73
4.0	32.31	8.06	25.18	45	8.12
5.0	32.34	8.05	25.21	49	7.22
6.0	32.33	8.05	25.19	39	9.64
7.0	32.36	8.05	25.22	46	8.84
8.0	32.39	8.02	25.24	78	2.46
9.0	32.37	8.03	25.23	82	2.04
10.0	32.36	8.04	25.22	82	2.01
11.0	32.38	8.04	25.23	80	2.18
12.0	32.35	8.00	25.22	83	1.86
13.0	32.38	8.00	25.24	84	1.78
14.0	32.39	8.00	25.25	84	1.79
15.0	32.40	7.99	25.26	83	1.89
16.0	32.37	8.01	25.23	83	1.92
17.0	32.39	8.00	25.25	82	2.04
18.0	32.39	7.99	25.25	79	2.33
19.0	32.38	8.00	25.24	78	2.48



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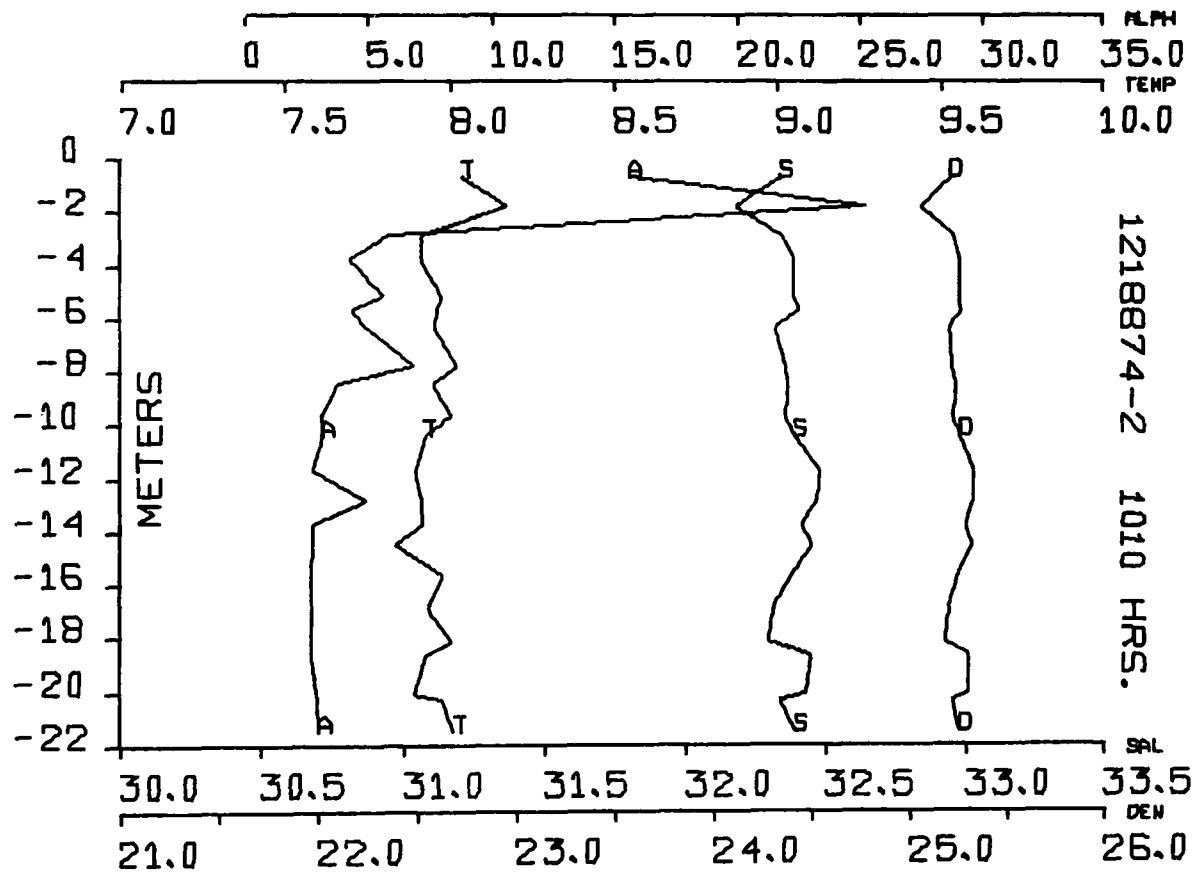
STATION 121874-2 1010 HRS.
AT DUMPSITE 24 MINUTES AFTER SLUDGE DISCHARGE

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	32.43	7.96	25.29	29	9.99
1.0	32.29	8.08	25.16	17	18.70
2.0	32.22	8.11	25.10	19	20.86
3.0	32.35	7.90	25.23	58	5.45
4.0	32.39	7.92	25.26	64	4.47
5.0	32.39	7.96	25.25	58	5.52
6.0	32.36	7.95	25.23	63	4.60
7.0	32.34	7.98	25.21	56	5.81
8.0	32.36	8.00	25.23	56	5.86
9.0	32.36	7.97	25.23	71	3.40
10.0	32.37	7.96	25.24	73	3.10
11.0	32.43	7.90	25.29	75	2.90
12.0	32.47	7.89	25.33	72	3.37
13.0	32.46	7.91	25.31	64	4.54
14.0	32.43	7.88	25.29	77	2.66
15.0	32.41	7.90	25.28	77	2.63
16.0	32.35	7.96	25.22	77	2.60
17.0	32.30	7.93	25.19	77	2.66
18.0	32.29	7.99	25.17	77	2.59
19.0	32.44	7.91	25.30	76	2.73
20.0	32.42	7.88	25.29	75	2.91
21.0	32.36	7.99	25.23	74	2.96



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* STATION 121874-2 1030 HRS.

* AT DUMPSITE 44 MINUTES AFTER SLUDGE DISCHARGE

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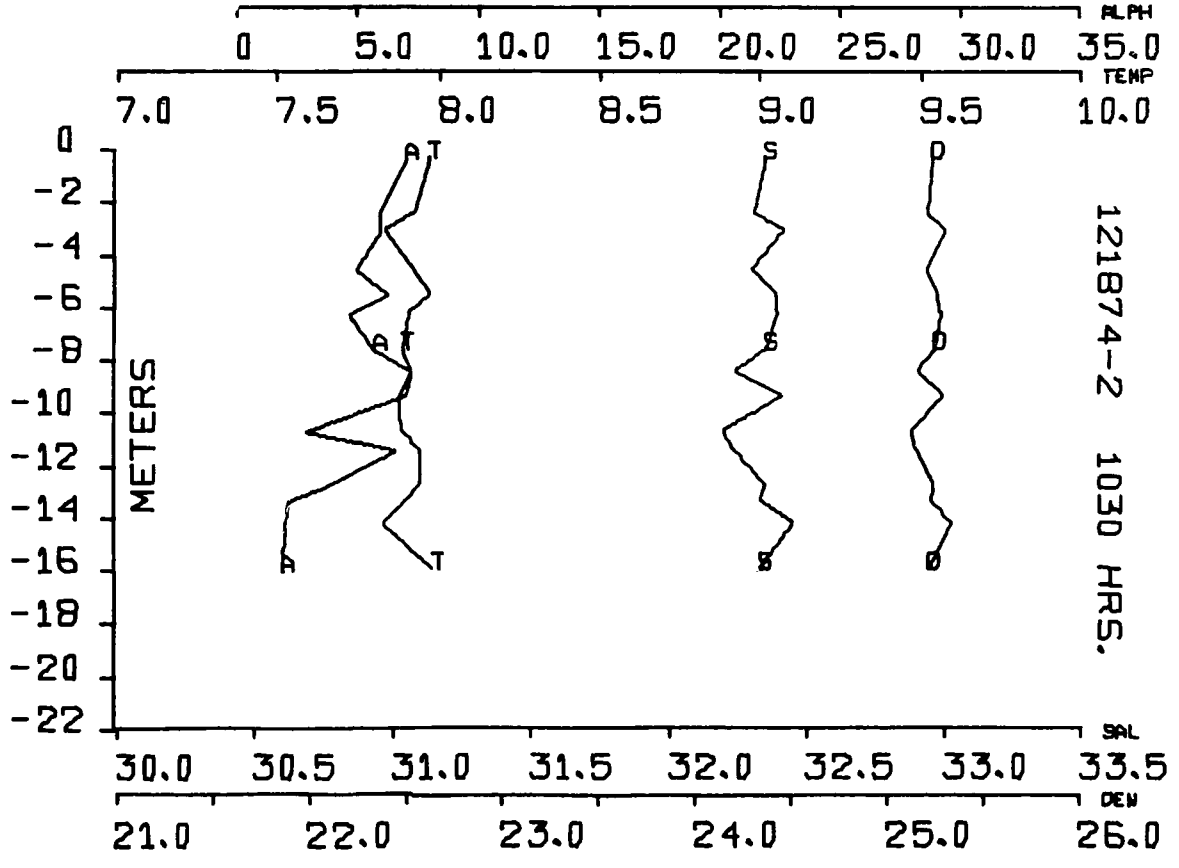
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	32.35	7.97	25.22	49	7.21
1.0	32.33	7.95	25.21	51	6.67
2.0	32.31	7.93	25.20	54	6.13
3.0	32.40	7.84	25.28	55	5.97
4.0	32.34	7.88	25.23	59	5.35
5.0	32.34	7.94	25.22	57	5.56
6.0	32.39	7.92	25.26	59	5.24
7.0	32.36	7.89	25.24	59	5.24
8.0	32.30	7.89	25.19	53	6.42
9.0	32.34	7.89	25.22	50	7.03
10.0	32.31	7.87	25.20	62	4.97
11.0	32.21	7.90	25.12	66	4.37
12.0	32.28	7.94	25.17	59	5.41
13.0	32.34	7.92	25.22	74	3.07
14.0	32.42	7.84	25.29	82	1.99
15.0	32.39	7.90	25.26	83	1.92



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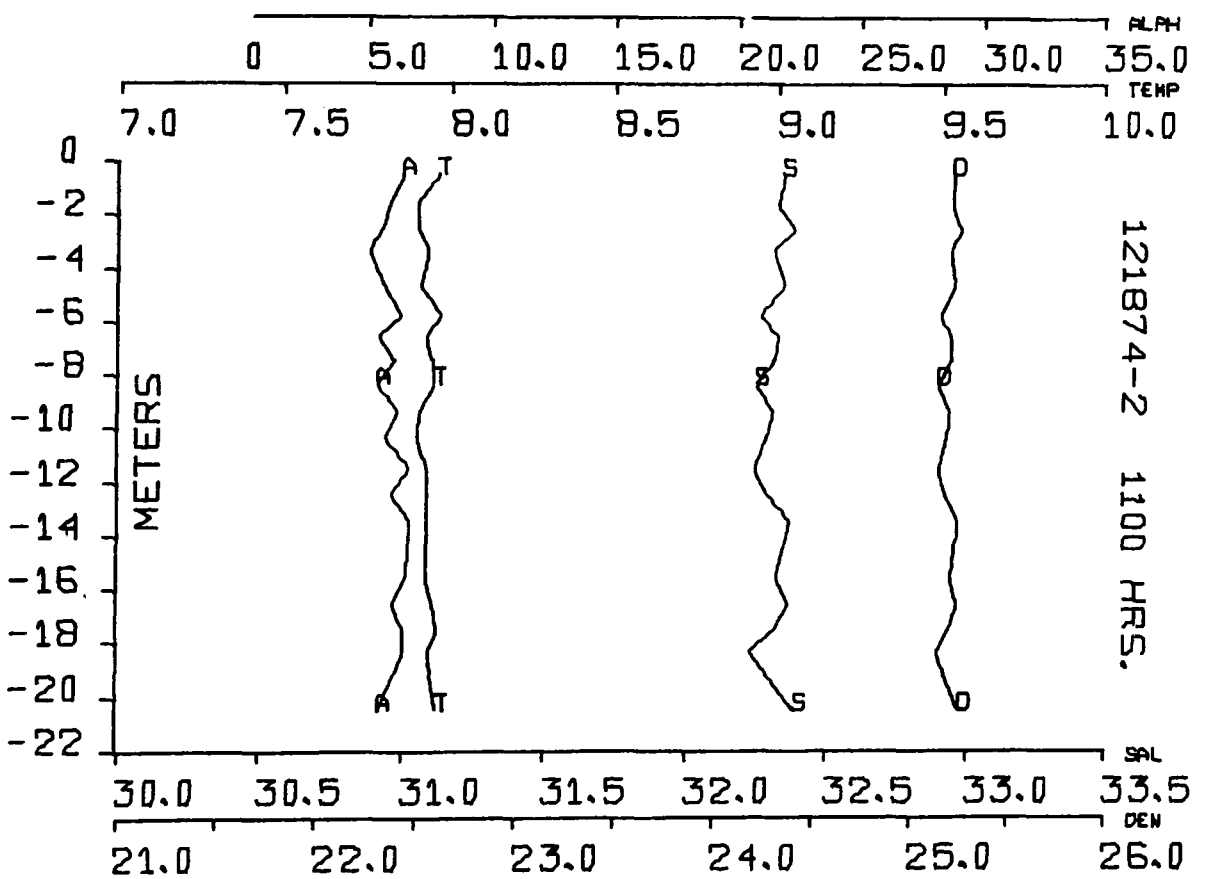
STATION 121874-2 1100 HRS.

AT DUMPSITE 74 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	32.35	7.98	25.22	52	6.57
1.0	32.33	7.93	25.21	54	6.08
2.0	32.35	7.90	25.24	57	5.65
3.0	32.34	7.92	25.22	60	5.15
4.0	32.33	7.92	25.22	58	5.37
5.0	32.32	7.93	25.20	55	5.91
6.0	32.28	7.95	25.17	55	5.98
7.0	32.32	7.93	25.20	56	5.77
8.0	32.26	7.95	25.16	57	5.57
9.0	32.29	7.91	25.18	55	5.93
10.0	32.29	7.90	25.18	56	5.75
11.0	32.26	7.92	25.16	54	6.27
12.0	32.27	7.92	25.16	54	6.21
13.0	32.34	7.92	25.22	53	6.37
14.0	32.35	7.92	25.23	52	6.60
15.0	32.33	7.93	25.21	52	6.52
16.0	32.34	7.94	25.22	54	6.22
17.0	32.34	7.95	25.21	54	6.25
18.0	32.26	7.94	25.15	52	6.45
19.0	32.28	7.94	25.17	54	6.10
20.0	32.35	7.95	25.23	57	5.62



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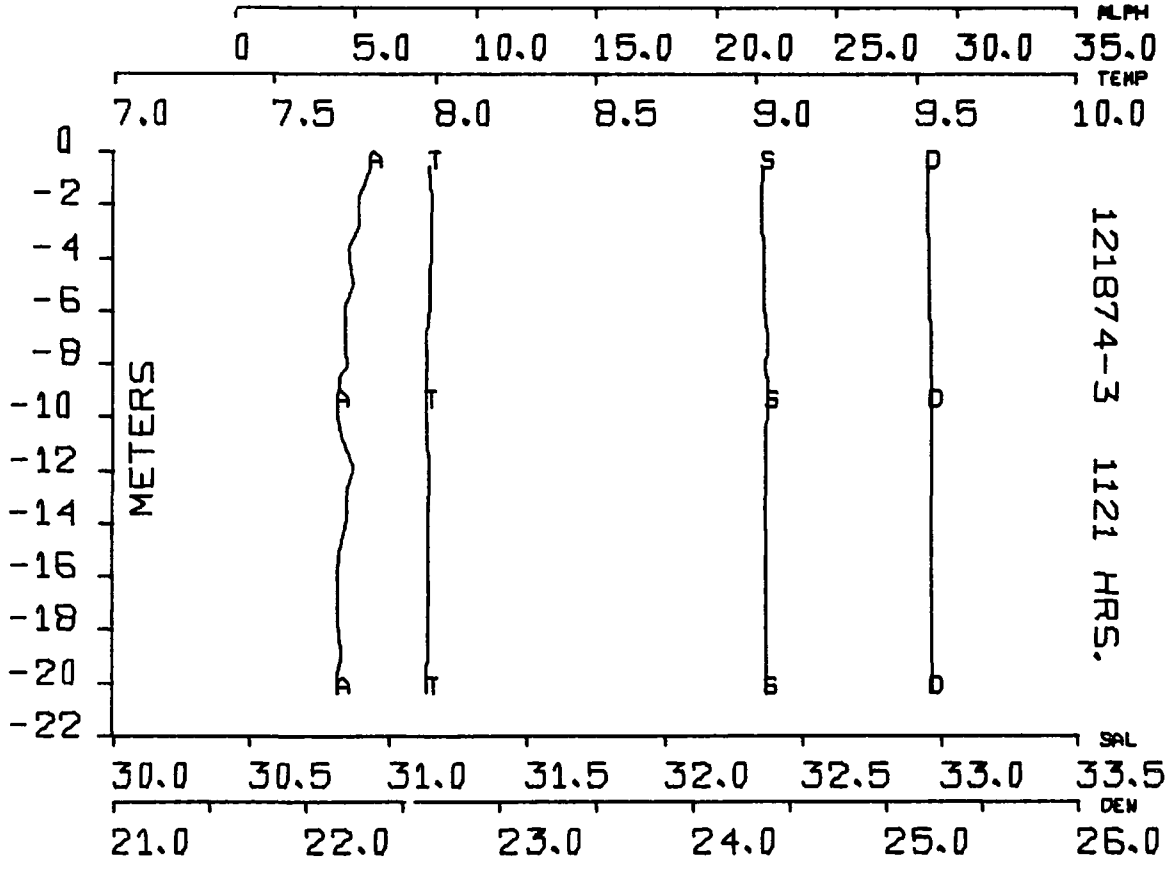
STATION 121874-3 1121 HRS.
AT DUMPSITE 95 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	32.35	7.97	25.22	56	5.84
1.0	32.35	7.98	25.22	58	5.43
2.0	32.35	7.99	25.22	60	5.12
3.0	32.35	7.99	25.22	61	5.00
4.0	32.36	7.98	25.23	62	4.75
5.0	32.36	7.98	25.23	61	4.87
6.0	32.36	7.97	25.23	63	4.55
7.0	32.37	7.97	25.24	63	4.55
8.0	32.36	7.97	25.23	62	4.72
9.0	32.36	7.97	25.23	65	4.26
10.0	32.36	7.97	25.23	65	4.30
11.0	32.36	7.97	25.23	63	4.56
12.0	32.36	7.98	25.23	62	4.83
13.0	32.36	7.97	25.23	63	4.63
14.0	32.36	7.97	25.23	63	4.55
15.0	32.36	7.97	25.23	65	4.31
16.0	32.36	7.97	25.23	66	4.20
17.0	32.36	7.97	25.23	65	4.30
18.0	32.36	7.97	25.23	65	4.34
19.0	32.37	7.97	25.23	64	4.41
20.0	32.36	7.97	25.23	65	4.23



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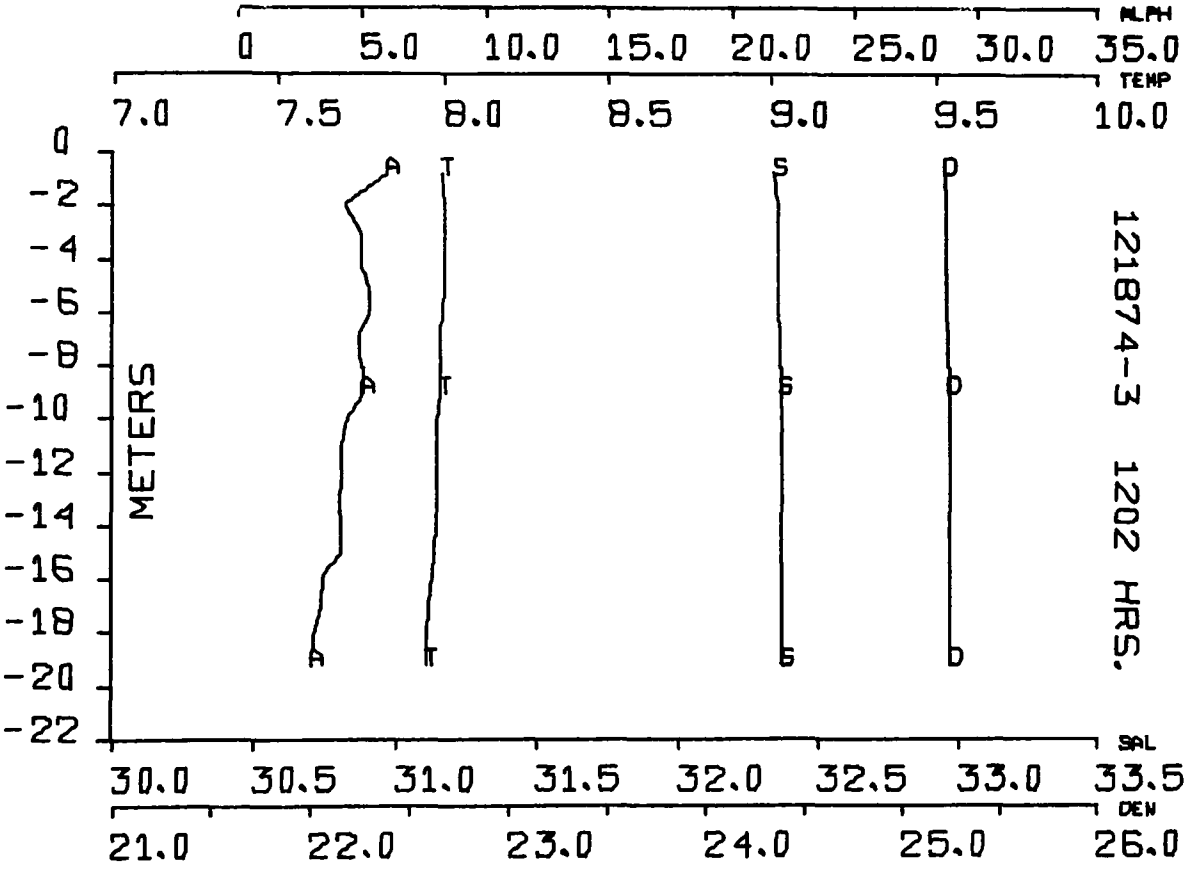
STATION 121874-3 1202 HRS.
AT DUMSITE 136 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	32.33	7.98	25.20	48	7.20
1.0	32.34	7.99	25.21	57	5.64
2.0	32.35	8.00	25.22	65	4.33
3.0	32.35	8.00	25.22	61	5.01
4.0	32.35	8.00	25.22	61	4.95
5.0	32.35	8.00	25.22	59	5.28
6.0	32.35	7.99	25.22	59	5.32
7.0	32.36	7.99	25.23	61	4.89
8.0	32.36	7.99	25.23	61	4.99
9.0	32.36	7.99	25.23	61	4.99
10.0	32.36	7.97	25.23	65	4.34
11.0	32.36	7.97	25.23	66	4.14
12.0	32.36	7.97	25.23	66	4.19
13.0	32.36	7.97	25.23	66	4.09
14.0	32.36	7.97	25.23	66	4.16
15.0	32.36	7.97	25.23	66	4.10
16.0	32.37	7.96	25.24	71	3.40
17.0	32.37	7.95	25.24	72	3.30
18.0	32.37	7.94	25.24	74	3.05
19.0	32.37	7.94	25.24	74	2.96



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* STATION 121874-4 1231 HRS.

* AT DUMSITE 165 MINUTES AFTER SLUDGE DISCHARGE

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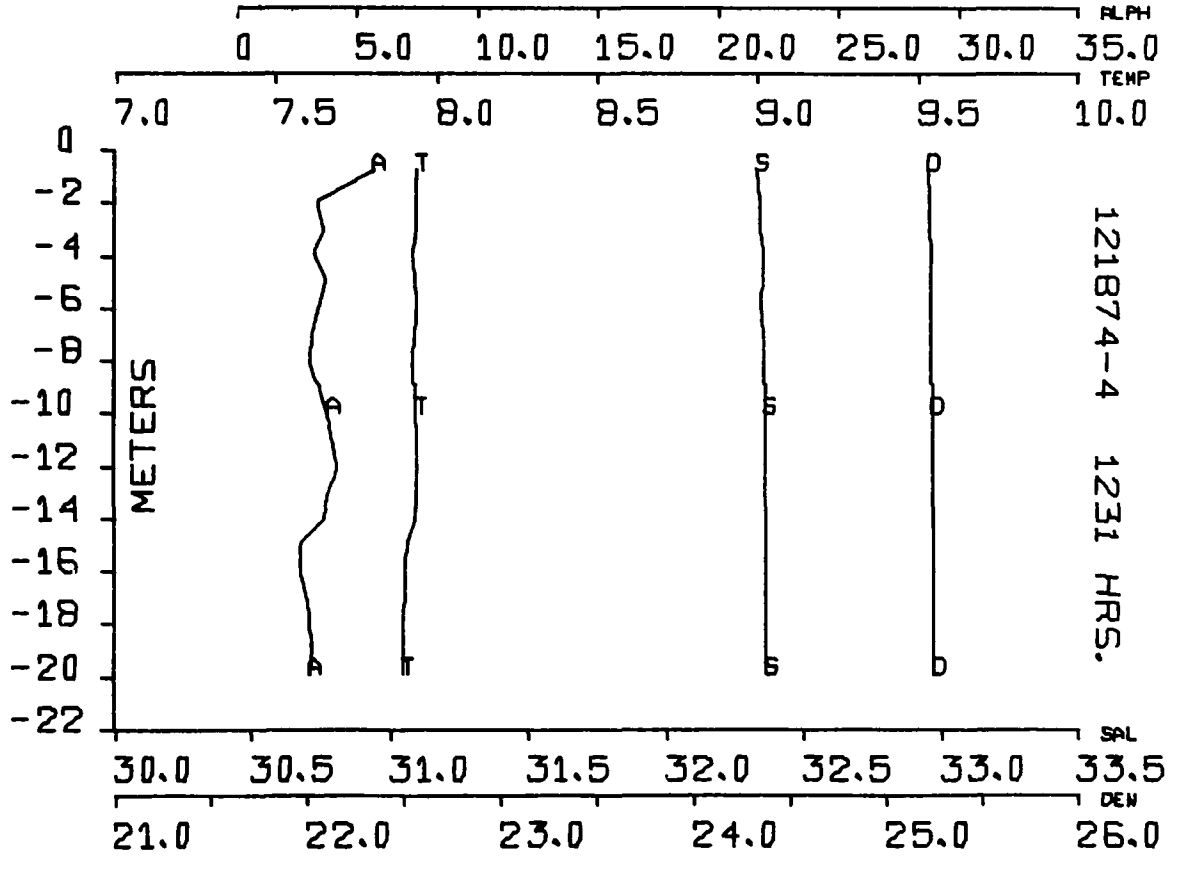
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	32.31	7.93	25.20	47	7.18
1.0	32.33	7.93	25.21	60	5.19
2.0	32.34	7.93	25.22	71	3.37
3.0	32.34	7.93	25.22	70	3.58
4.0	32.35	7.92	25.23	72	3.26
5.0	32.34	7.93	25.22	69	3.66
6.0	32.34	7.93	25.22	72	3.34
7.0	32.35	7.92	25.23	74	3.07
8.0	32.35	7.92	25.23	74	3.06
9.0	32.35	7.93	25.23	71	3.42
10.0	32.35	7.93	25.23	68	3.79
11.0	32.35	7.94	25.23	67	3.99
12.0	32.35	7.94	25.23	66	4.14
13.0	32.35	7.93	25.23	69	3.78
14.0	32.36	7.92	25.23	70	3.60
15.0	32.36	7.90	25.24	77	2.61
16.0	32.36	7.90	25.24	76	2.69
17.0	32.36	7.89	25.24	74	2.95
18.0	32.36	7.89	25.24	73	3.09
19.0	32.36	7.89	25.24	73	3.14



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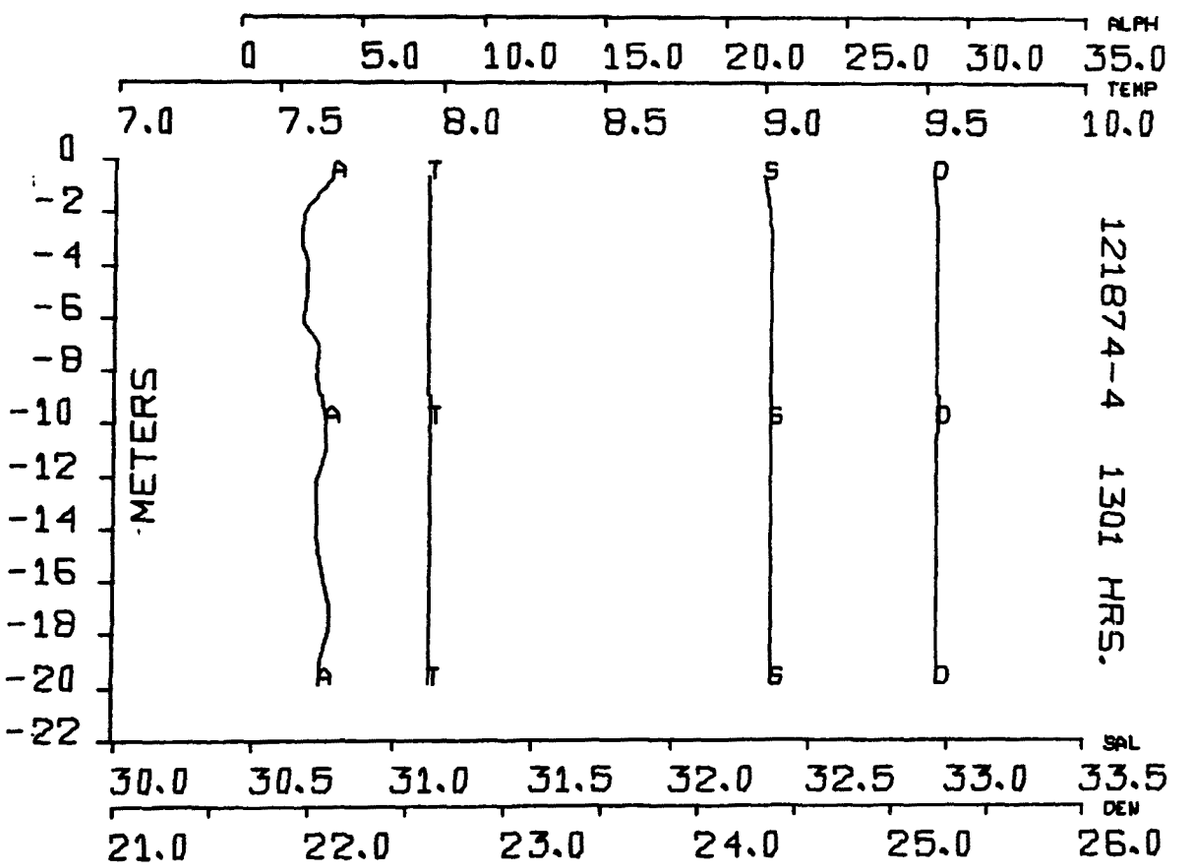
STATION 121874-4 1301 HRS.
AT DUMSITE 195 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	32.32	7.95	25.20	64	4.44
1.0	32.34	7.95	25.21	71	3.49
2.0	32.35	7.96	25.23	77	2.59
3.0	32.36	7.96	25.23	78	2.52
4.0	32.35	7.96	25.23	75	2.84
5.0	32.35	7.96	25.23	76	2.75
6.0	32.36	7.95	25.23	77	2.59
7.0	32.35	7.96	25.23	72	3.33
8.0	32.35	7.96	25.23	73	3.19
9.0	32.35	7.96	25.23	71	3.40
10.0	32.35	7.96	25.23	70	3.62
11.0	32.35	7.96	25.22	70	3.58
12.0	32.35	7.96	25.22	72	3.22
13.0	32.36	7.96	25.23	73	3.18
14.0	32.35	7.96	25.23	72	3.22
15.0	32.35	7.96	25.23	71	3.39
16.0	32.36	7.96	25.23	70	3.56
17.0	32.35	7.96	25.22	68	3.80
18.0	32.36	7.96	25.23	69	3.67
19.0	32.35	7.96	25.23	72	3.34



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* STATION 121874-5 1328 HRS.

* AT DUMPSITE 222 MINUTES AFTER SLUDGE DISCHARGE

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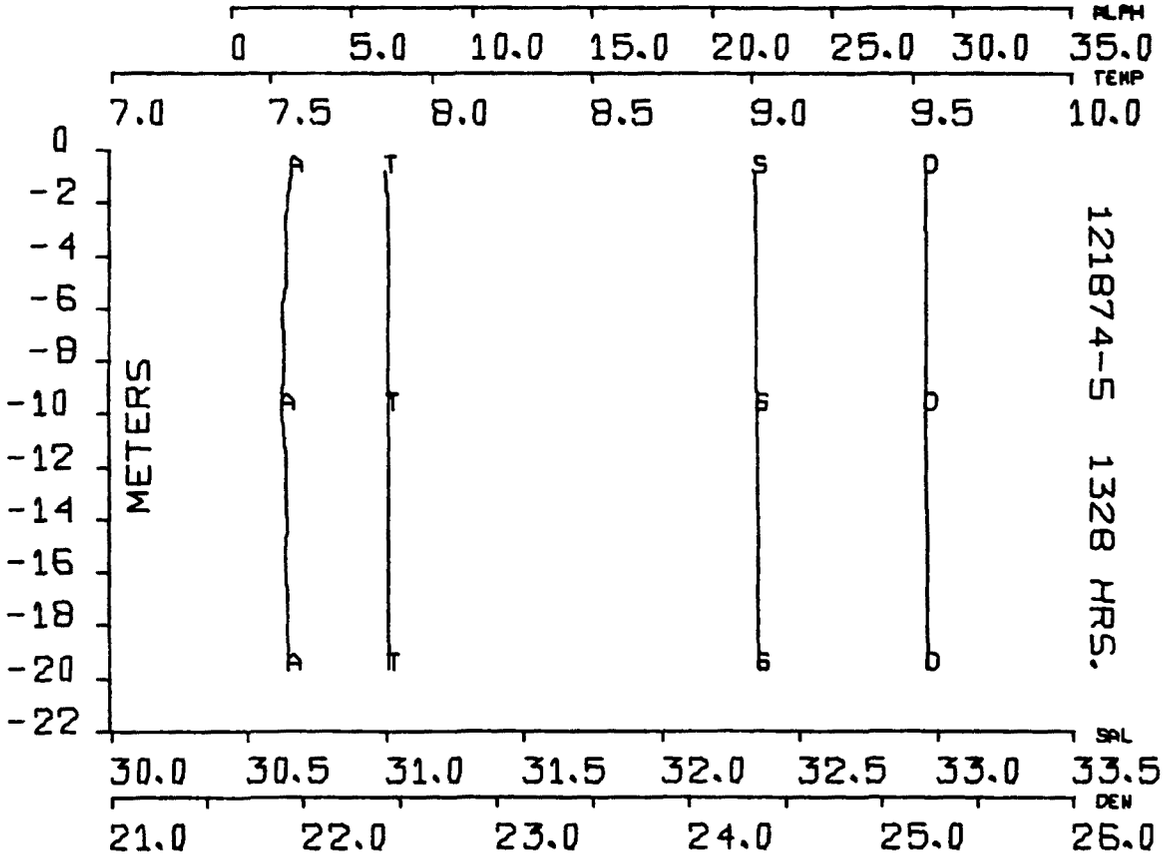
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	32.34	7.85	25.23	77	2.57
1.0	32.34	7.85	25.23	79	2.41
2.0	32.34	7.86	25.23	80	2.27
3.0	32.34	7.87	25.23	80	2.22
4.0	32.34	7.86	25.23	80	2.20
5.0	32.34	7.86	25.23	81	2.16
6.0	32.34	7.86	25.23	82	2.04
7.0	32.34	7.86	25.23	81	2.16
8.0	32.34	7.86	25.23	80	2.17
9.0	32.35	7.86	25.23	81	2.08
10.0	32.35	7.86	25.23	81	2.12
11.0	32.35	7.86	25.23	80	2.24
12.0	32.34	7.86	25.23	80	2.26
13.0	32.34	7.86	25.23	80	2.18
14.0	32.35	7.86	25.24	79	2.33
15.0	32.35	7.86	25.24	80	2.23
16.0	32.34	7.86	25.23	79	2.30
17.0	32.34	7.86	25.23	79	2.37
18.0	32.34	7.86	25.23	79	2.34
19.0	32.34	7.86	25.23	79	2.37



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* STATION 121874-6 1414 HRS.

* OUT OF DUMP AREA

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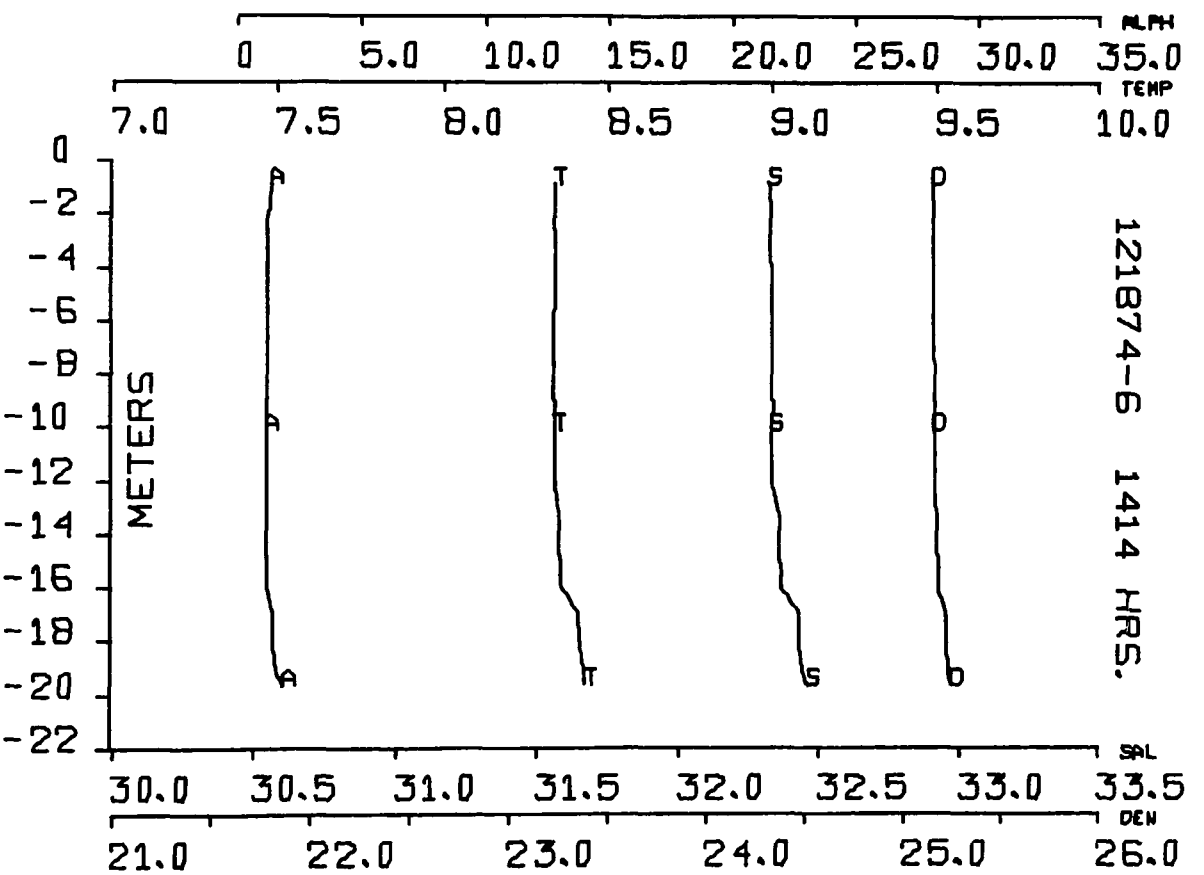
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	32.31	8.33	25.14	87	1.45
1.0	32.32	8.33	25.14	88	1.32
2.0	32.33	8.33	25.15	89	1.19
3.0	32.32	8.34	25.14	88	1.23
4.0	32.33	8.33	25.15	89	1.16
5.0	32.33	8.33	25.15	89	1.15
6.0	32.32	8.33	25.15	89	1.17
7.0	32.33	8.33	25.15	89	1.15
8.0	32.33	8.33	25.15	89	1.13
9.0	32.33	8.33	25.15	89	1.13
10.0	32.33	8.33	25.15	89	1.13
11.0	32.33	8.33	25.16	89	1.13
12.0	32.33	8.34	25.15	89	1.13
13.0	32.35	8.35	25.17	89	1.17
14.0	32.35	8.35	25.17	89	1.18
15.0	32.36	8.35	25.18	89	1.22
16.0	32.37	8.36	25.18	88	1.29
17.0	32.43	8.41	25.22	86	1.51
18.0	32.43	8.42	25.22	86	1.49
19.0	32.44	8.43	25.23	85	1.63



TIDES: DECEMBER 19, 1974

Predicted Tides at Sandy Hook, N.J.

Time (Zone)	Height Ft. (MLW)
1114	4.1
1735	0.1

CURRENTS: DECEMBER 19, 1974

Time-series current measurements at the dump site, 2.5 m depth

Time (Zone)	Speed (Knots)	Direction (°True)
1120	.12	90
1130	.02	102
1140	.30	114
1150	.20	102
1200	.35	108
1210	.27	108
1220	.55	102
1230	.80	96
1240	.65	96
1250	.95	78
1300	1.0	72
1310	1.0	84
1320	>1.0	90
1330	>1.0	90
1340	>1.0	93
1350	>1.0	96
1400	>1.0	90

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* STATION 121974-1 0845 HRS.

* AT DUMPSITE BEFORE SLUDGE DISCHARGE

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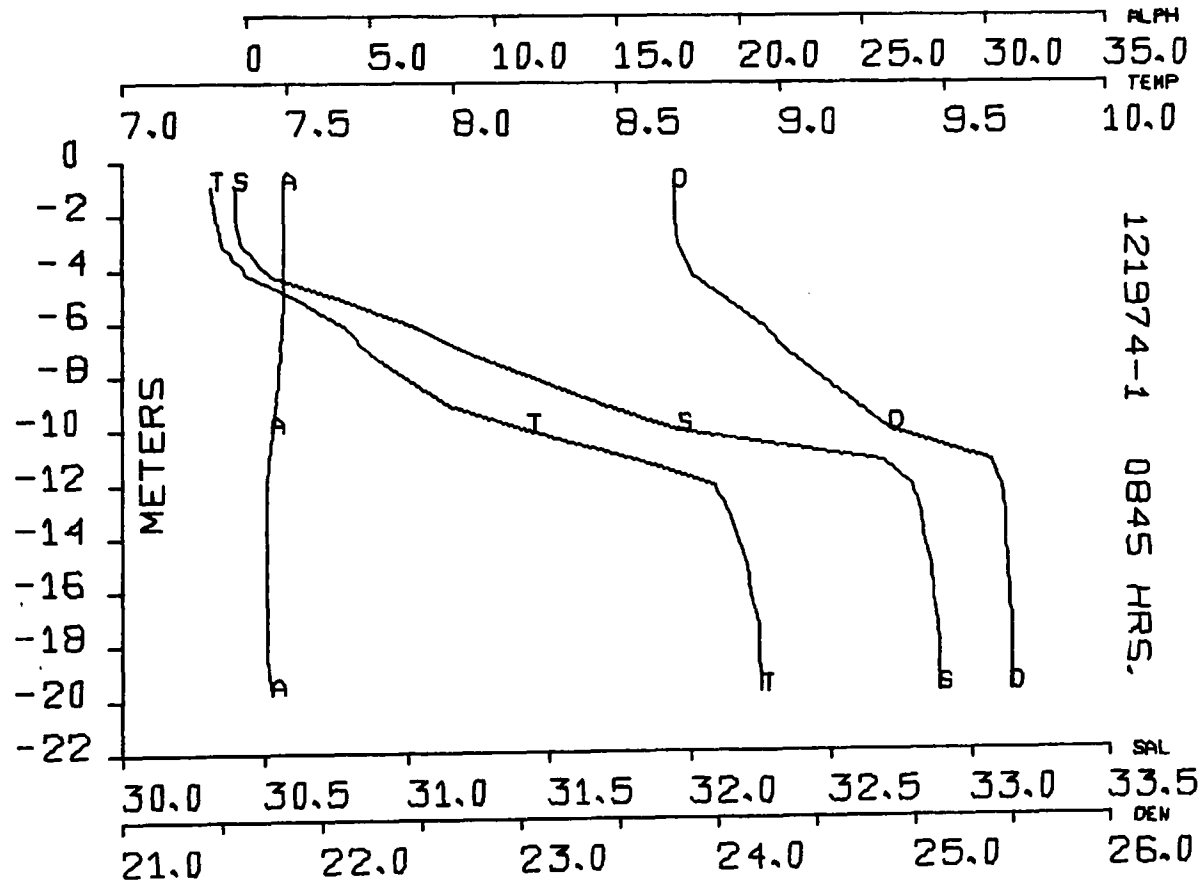
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.39	7.25	23.79	87	1.38
1.0	30.39	7.26	23.78	87	1.37
2.0	30.39	7.28	23.78	87	1.37
3.0	30.42	7.30	23.80	87	1.38
4.0	30.51	7.37	23.86	87	1.38
5.0	30.73	7.51	24.02	87	1.36
6.0	30.99	7.65	24.20	88	1.30
7.0	31.19	7.74	24.35	88	1.24
8.0	31.42	7.84	24.51	89	1.17
9.0	31.67	7.97	24.69	90	1.05
10.0	31.95	8.21	24.87	91	.95
11.0	32.55	8.51	25.30	92	.80
12.0	32.78	8.76	25.44	93	.71
13.0	32.82	8.83	25.46	93	.68
14.0	32.84	8.86	25.47	93	.69
15.0	32.86	8.89	25.48	93	.69
16.0	32.87	8.90	25.49	93	.72
17.0	32.88	8.92	25.50	93	.76
18.0	32.89	8.92	25.50	93	.77
19.0	32.89	8.93	25.50	92	.85



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* STATION 121974-1 0945 HRS.

* AT DUMPSITE BEFORE SLUDGE DISCHARGE

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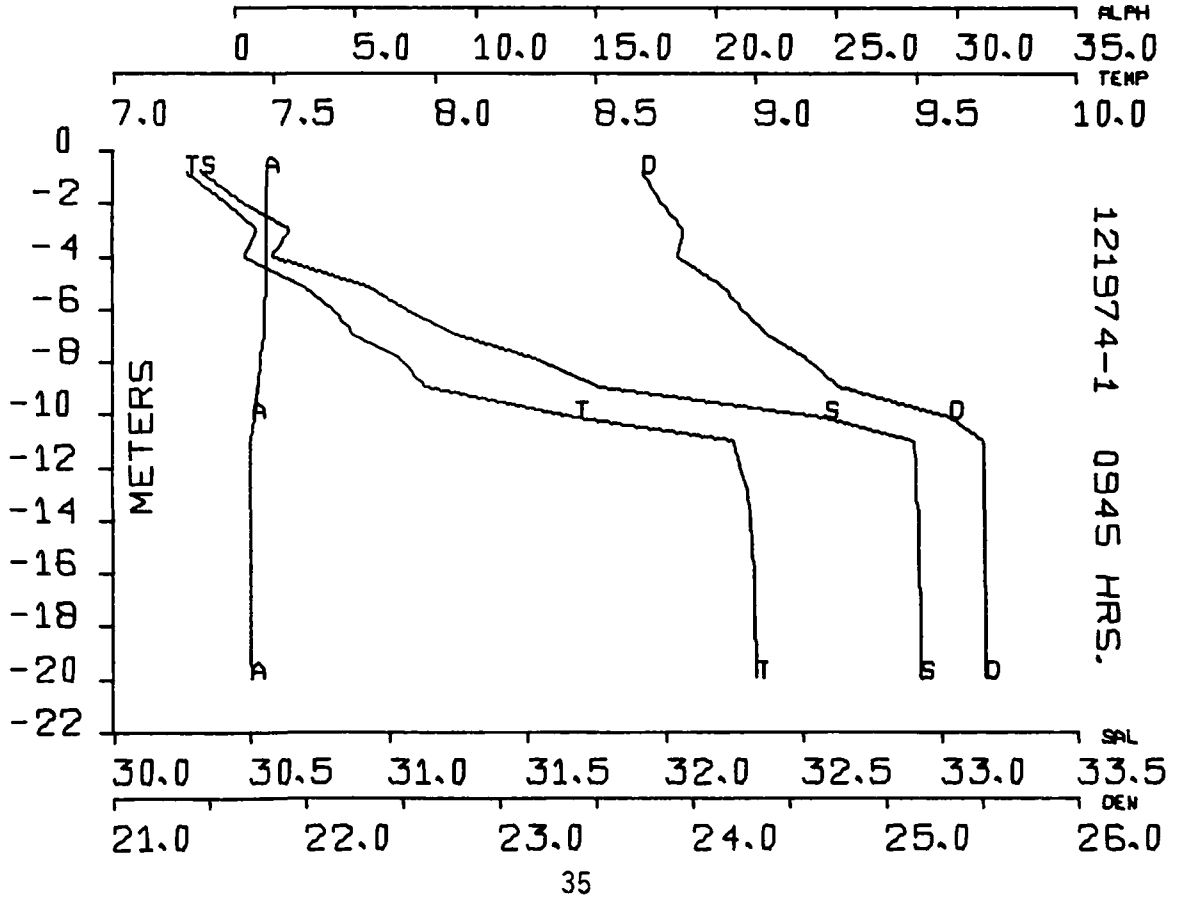
****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.22	7.15	23.67	88	1.29
1.0	30.35	7.25	23.76	88	1.28
2.0	30.48	7.36	23.84	88	1.28
3.0	30.63	7.44	23.95	88	1.25
4.0	30.57	7.41	23.91	88	1.28
5.0	30.89	7.58	24.13	88	1.25
6.0	31.06	7.68	24.26	89	1.20
7.0	31.26	7.76	24.40	89	1.13
8.0	31.56	7.90	24.61	90	1.02
9.0	31.78	7.98	24.78	91	.96
10.0	32.51	8.40	25.28	92	.79
11.0	32.90	8.92	25.51	94	.62
12.0	32.91	8.95	25.51	94	.60
13.0	32.91	8.97	25.51	94	.62
14.0	32.92	8.98	25.51	94	.61
15.0	32.91	8.99	25.51	94	.61
16.0	32.92	8.99	25.51	94	.62
17.0	32.92	8.99	25.52	94	.64
18.0	32.92	8.99	25.52	94	.65
19.0	32.92	9.00	25.51	93	.68



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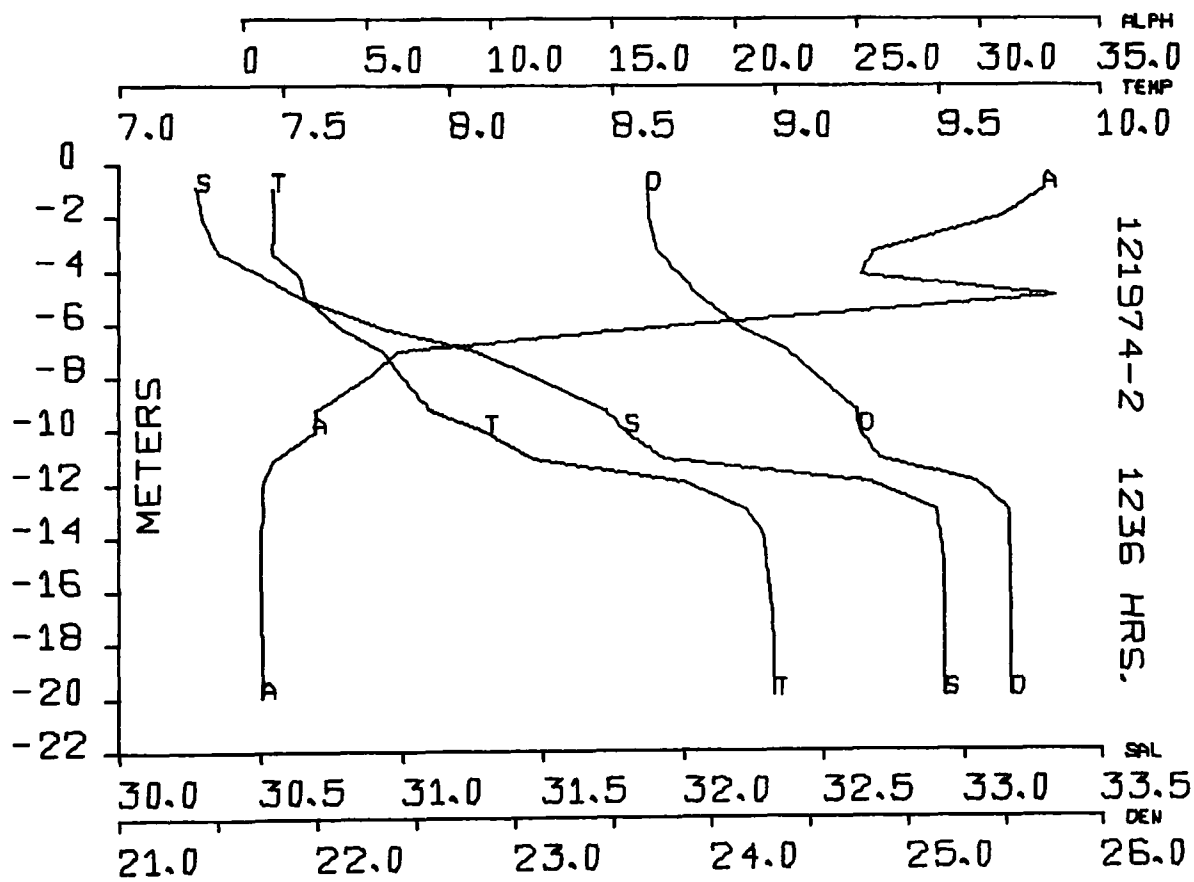
STATION 121974-2 1236 HRS.
AT DUMPSITE 16 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.26	7.45	23.65	3	34.09
1.0	30.28	7.46	23.67	4	32.47
2.0	30.30	7.47	23.68	5	30.80
3.0	30.34	7.46	23.72	7	26.80
4.0	30.47	7.52	23.81	8	25.10
5.0	30.65	7.57	23.95	4	32.60
6.0	30.90	7.66	24.13	17	18.57
7.0	31.24	7.79	24.38	52	6.74
8.0	31.47	7.86	24.55	62	4.88
9.0	31.68	7.93	24.70	73	3.21
10.0	31.79	8.11	24.76	76	2.74
11.0	31.93	8.25	24.85	88	1.28
12.0	32.67	8.72	25.36	93	.72
13.0	32.91	8.91	25.52	93	.68
14.0	32.92	8.96	25.52	94	.63
15.0	32.93	8.97	25.52	94	.60
16.0	32.93	8.98	25.52	94	.64
17.0	32.93	8.99	25.52	93	.68
18.0	32.94	8.99	25.53	93	.73
19.0	32.93	8.99	25.52	93	.76



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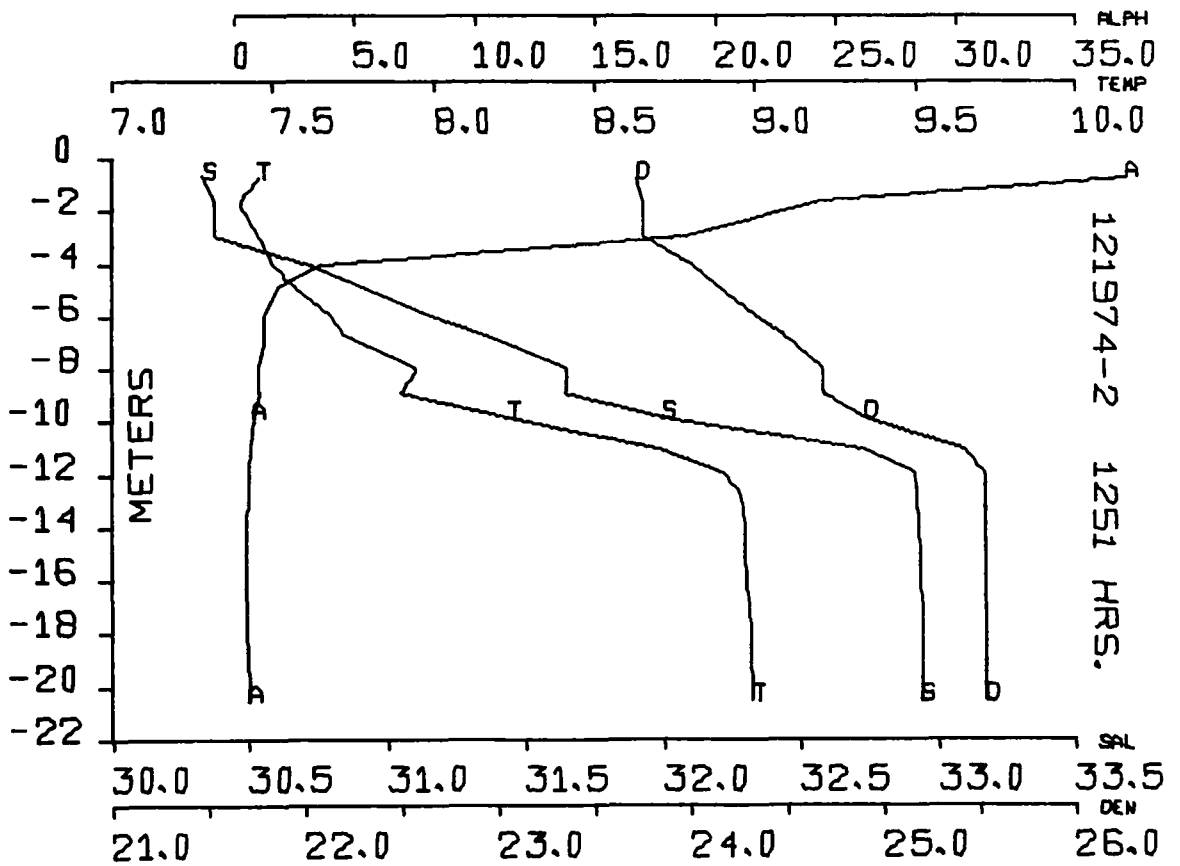
STATION 121974-2 1251 HRS.
AT DUMPSITE 31 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.29	7.51	23.67	-3	48.71
1.0	30.34	7.43	23.72	4	33.42
2.0	30.37	7.41	23.75	11	22.57
3.0	30.40	7.46	23.77	20	17.49
4.0	30.71	7.50	24.00	68	4.06
5.0	30.93	7.58	24.17	85	1.66
6.0	31.17	7.68	24.34	89	1.18
7.0	31.43	7.78	24.53	89	1.15
8.0	31.65	7.94	24.68	91	.94
9.0	31.68	7.93	24.70	91	.99
10.0	32.12	8.31	24.99	93	.75
11.0	32.72	8.69	25.40	94	.59
12.0	32.91	8.91	25.52	95	.51
13.0	32.92	8.96	25.52	95	.49
14.0	32.93	8.97	25.52	95	.48
15.0	32.93	8.97	25.53	95	.49
16.0	32.93	8.98	25.53	95	.51
17.0	32.94	8.98	25.53	95	.53
18.0	32.93	8.99	25.53	95	.56
19.0	32.93	8.99	25.53	94	.63
20.0	32.93	8.99	25.53	94	.66



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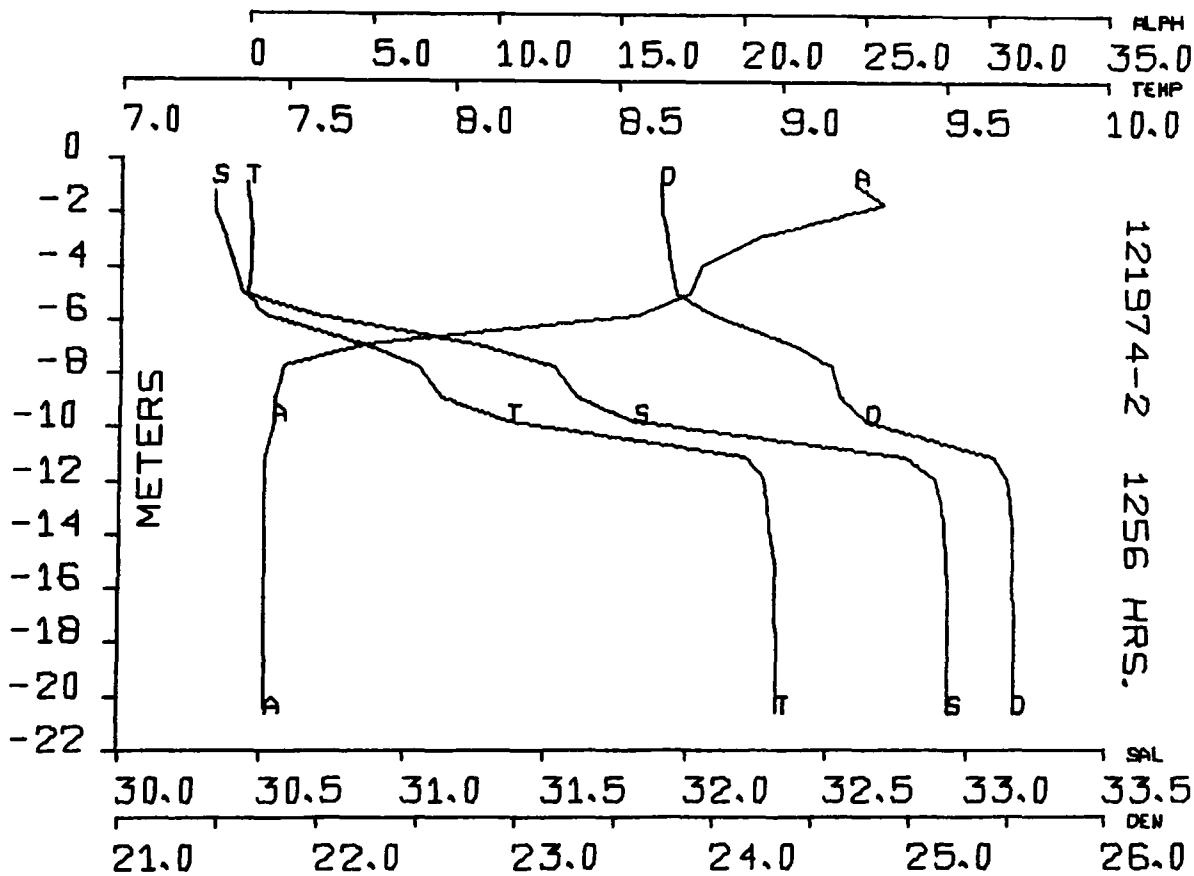
STATION 121974-2 1256 HRS.
AT DUMPSITE 36 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.32	7.36	23.72	10	23.17
1.0	30.32	7.37	23.71	8	24.78
2.0	30.33	7.39	23.72	9	24.29
3.0	30.37	7.39	23.75	13	20.31
4.0	30.40	7.38	23.77	16	18.28
5.0	30.42	7.37	23.80	17	17.77
6.0	30.80	7.49	24.07	29	13.47
7.0	31.30	7.76	24.43	66	4.20
8.0	31.55	7.92	24.60	88	1.30
9.0	31.64	7.99	24.66	90	1.07
10.0	31.98	8.29	24.88	90	1.02
11.0	32.71	8.85	25.38	93	.71
12.0	32.89	8.95	25.49	93	.71
13.0	32.91	8.96	25.51	93	.73
14.0	32.92	8.97	25.52	93	.75
15.0	32.93	8.98	25.52	93	.73
16.0	32.93	8.99	25.52	93	.75
17.0	32.93	8.99	25.52	93	.74
18.0	32.93	8.99	25.52	93	.76
19.0	32.93	8.99	25.52	92	.83
20.0	32.93	8.99	25.52	92	.81



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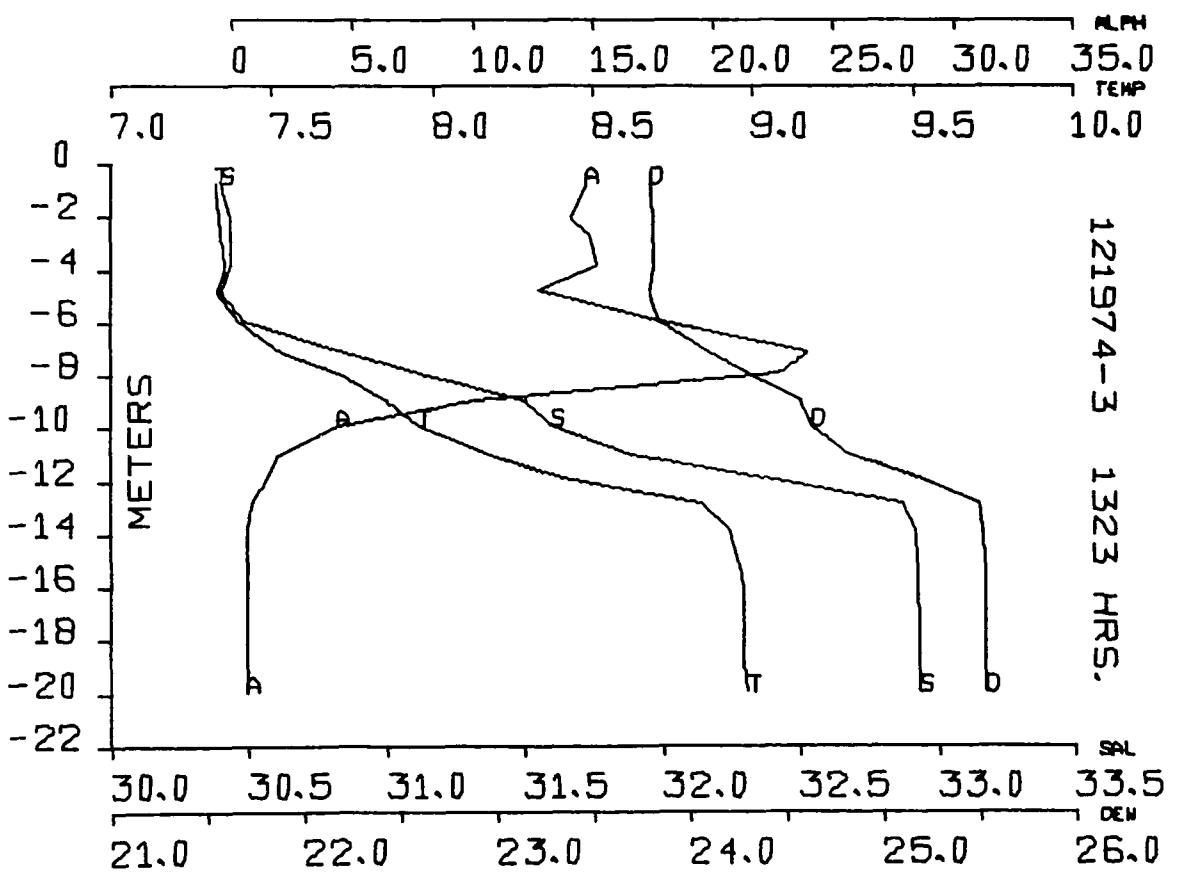
STATION 121974-3 1323 HRS.
AT DUMPSITE 63 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.38	7.31	23.77	22	15.11
1.0	30.41	7.32	23.79	23	14.54
2.0	30.43	7.34	23.81	25	14.02
3.0	30.43	7.34	23.80	22	14.92
4.0	30.42	7.35	23.80	23	14.71
5.0	30.41	7.34	23.79	26	13.60
6.0	30.51	7.41	23.86	16	18.23
7.0	30.81	7.52	24.08	10	23.27
8.0	31.15	7.72	24.32	12	21.74
9.0	31.50	7.85	24.57	38	9.78
10.0	31.62	7.97	24.65	67	4.07
11.0	31.88	8.17	24.83	83	1.83
12.0	32.42	8.44	25.21	88	1.27
13.0	32.88	8.85	25.50	94	.65
14.0	32.92	8.93	25.52	95	.53
15.0	32.93	8.95	25.52	95	.54
16.0	32.92	8.97	25.52	95	.52
17.0	32.93	8.97	25.53	95	.54
18.0	32.93	8.97	25.53	95	.56
19.0	32.93	8.97	25.53	94	.60



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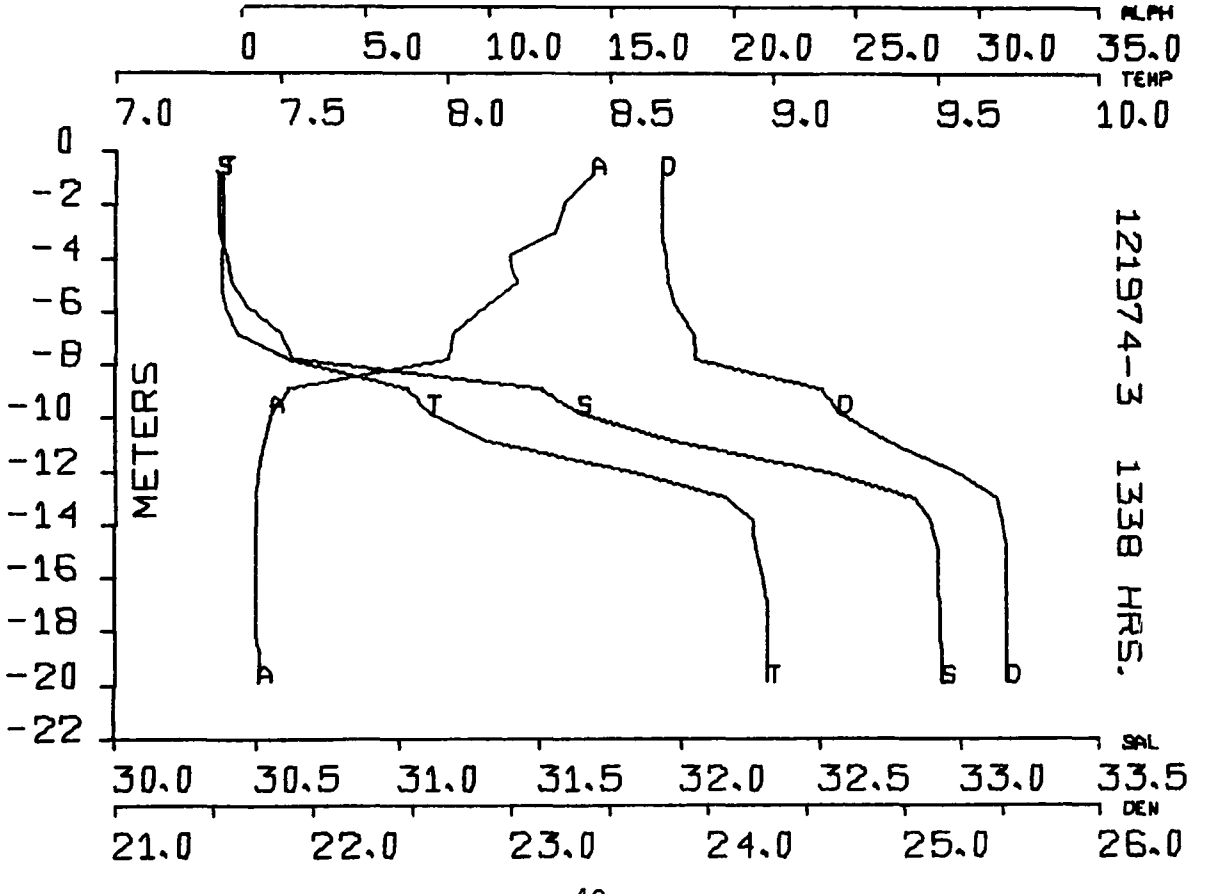
STATION 121974-3 1338 HRS.
AT DUMPSITE 78 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.36	7.31	23.75	22	15.05
1.0	30.36	7.32	23.75	25	13.99
2.0	30.36	7.33	23.75	27	12.99
3.0	30.36	7.33	23.75	29	12.52
4.0	30.39	7.31	23.78	34	10.78
5.0	30.41	7.31	23.79	33	10.97
6.0	30.49	7.34	23.85	39	9.53
7.0	30.59	7.39	23.92	43	8.42
8.0	30.81	7.59	24.07	52	6.93
9.0	31.52	7.89	24.58	83	1.84
10.0	31.71	7.99	24.72	90	1.10
11.0	32.05	8.19	24.96	92	.78
12.0	32.51	8.56	25.26	94	.62
13.0	32.83	8.86	25.47	95	.54
14.0	32.90	8.93	25.50	95	.50
15.0	32.92	8.95	25.52	95	.53
16.0	32.92	8.97	25.51	95	.54
17.0	32.92	8.98	25.52	94	.58
18.0	32.92	8.98	25.52	94	.61
19.0	32.93	8.98	25.52	93	.73



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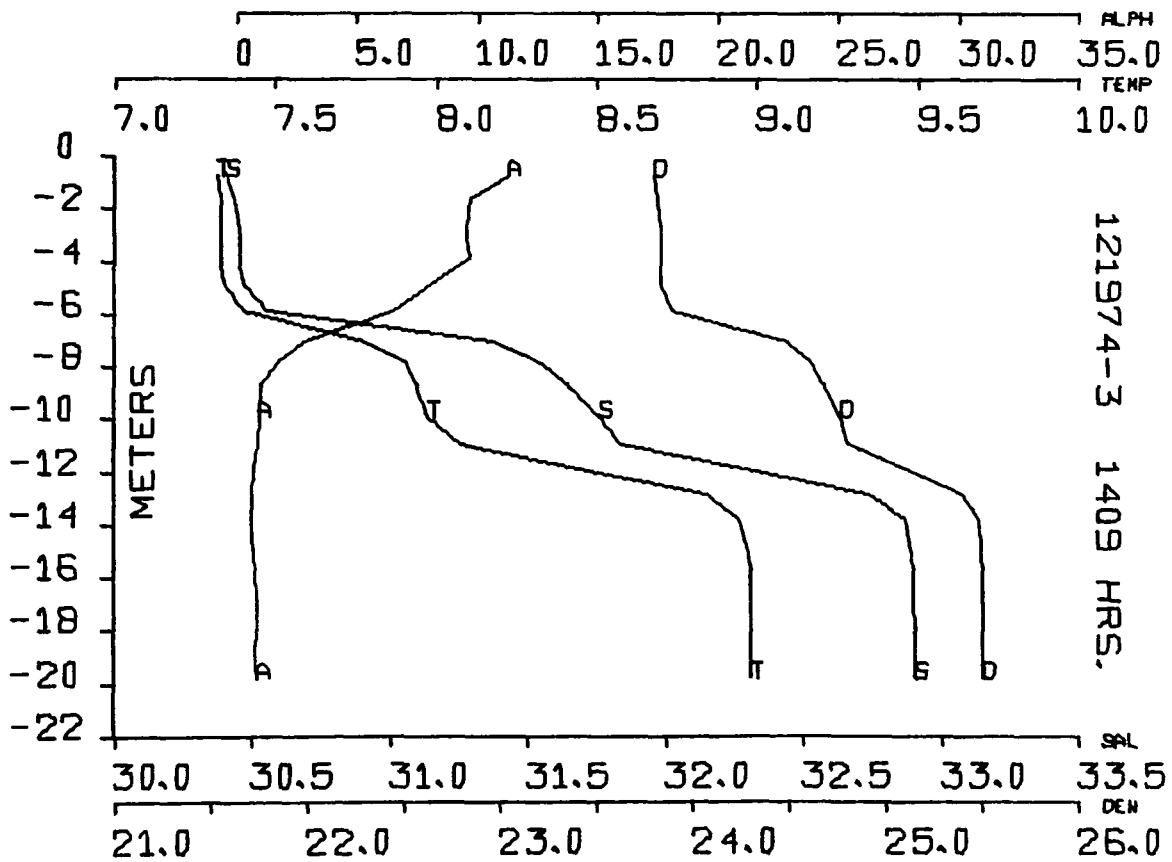
STATION 121974-3 1409 HRS.
AT DUMPSITE 109 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.38	7.31	23.77	28	12.45
1.0	30.41	7.32	23.79	34	10.70
2.0	30.44	7.33	23.82	38	9.58
3.0	30.45	7.32	23.83	38	9.55
4.0	30.45	7.33	23.82	39	9.43
5.0	30.48	7.35	23.84	46	7.83
6.0	30.65	7.45	23.96	55	6.01
7.0	31.37	7.77	24.48	76	2.80
8.0	31.57	7.91	24.62	86	1.53
9.0	31.67	7.95	24.69	91	.95
10.0	31.77	7.98	24.76	91	.91
11.0	31.88	8.11	24.83	92	.81
12.0	32.33	8.48	25.13	94	.67
13.0	32.75	8.85	25.41	94	.57
14.0	32.87	8.95	25.48	94	.59
15.0	32.89	8.97	25.49	93	.73
16.0	32.90	8.98	25.50	92	.83
17.0	32.90	8.98	25.50	91	.90
18.0	32.90	8.98	25.50	92	.82
19.0	32.90	8.98	25.50	93	.77



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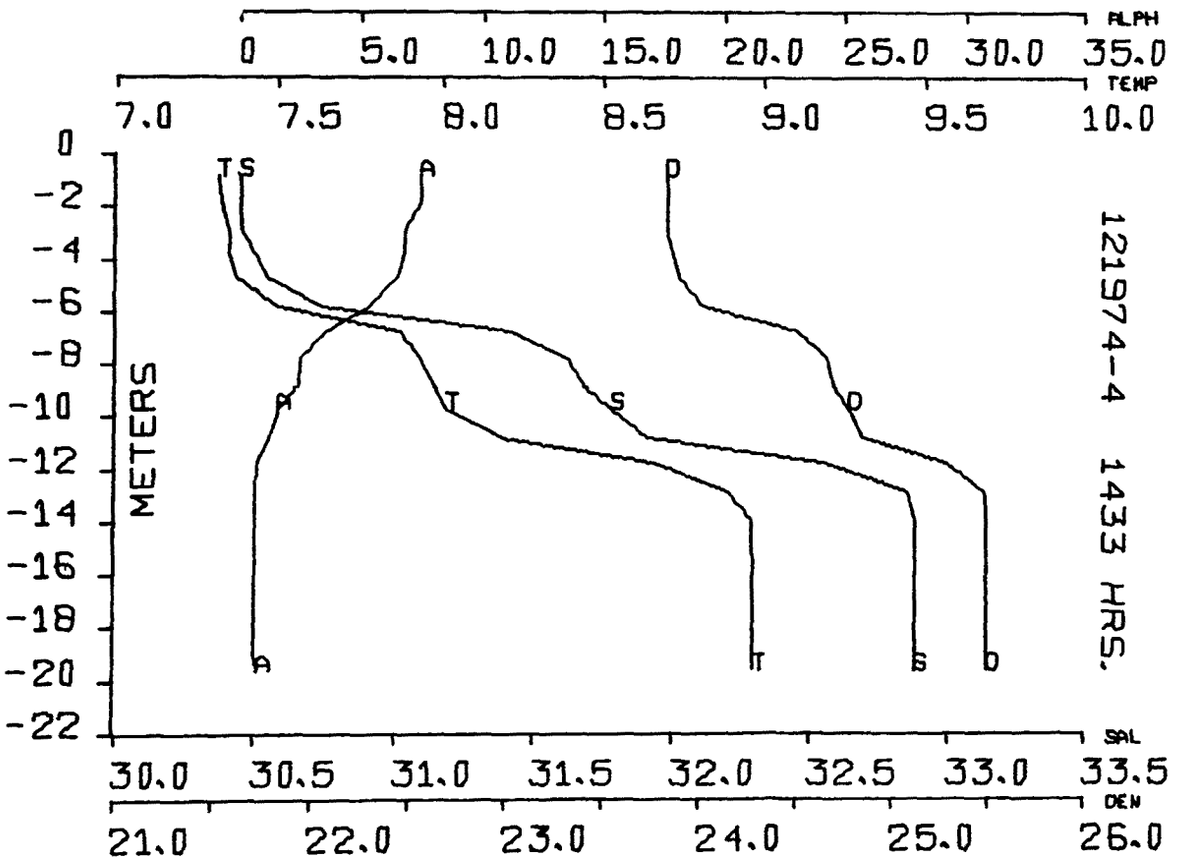
STATION 121974-4 1433 HRS.
AT DUMPSITE 133 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.43	7.30	23.81	48	7.41
1.0	30.44	7.32	23.82	48	7.38
2.0	30.45	7.33	23.82	49	7.18
3.0	30.46	7.35	23.83	51	6.64
4.0	30.51	7.36	23.87	52	6.59
5.0	30.59	7.40	23.93	54	6.10
6.0	30.87	7.57	24.12	61	4.92
7.0	31.47	7.89	24.54	73	3.20
8.0	31.64	7.94	24.67	79	2.41
9.0	31.70	7.98	24.71	80	2.23
10.0	31.82	8.06	24.79	87	1.44
11.0	32.06	8.30	24.95	90	1.04
12.0	32.63	8.71	25.33	94	.65
13.0	32.86	8.90	25.48	94	.61
14.0	32.88	8.96	25.49	94	.66
15.0	32.88	8.96	25.48	93	.69
16.0	32.88	8.97	25.48	93	.70
17.0	32.88	8.96	25.49	94	.65
18.0	32.88	8.96	25.48	93	.70
19.0	32.88	8.96	25.49	93	.70



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* STATION 121974-4 1501 HRS.

* AT DUMPSITE 161 MINUTES AFTER SLUDGE DISCHARGE

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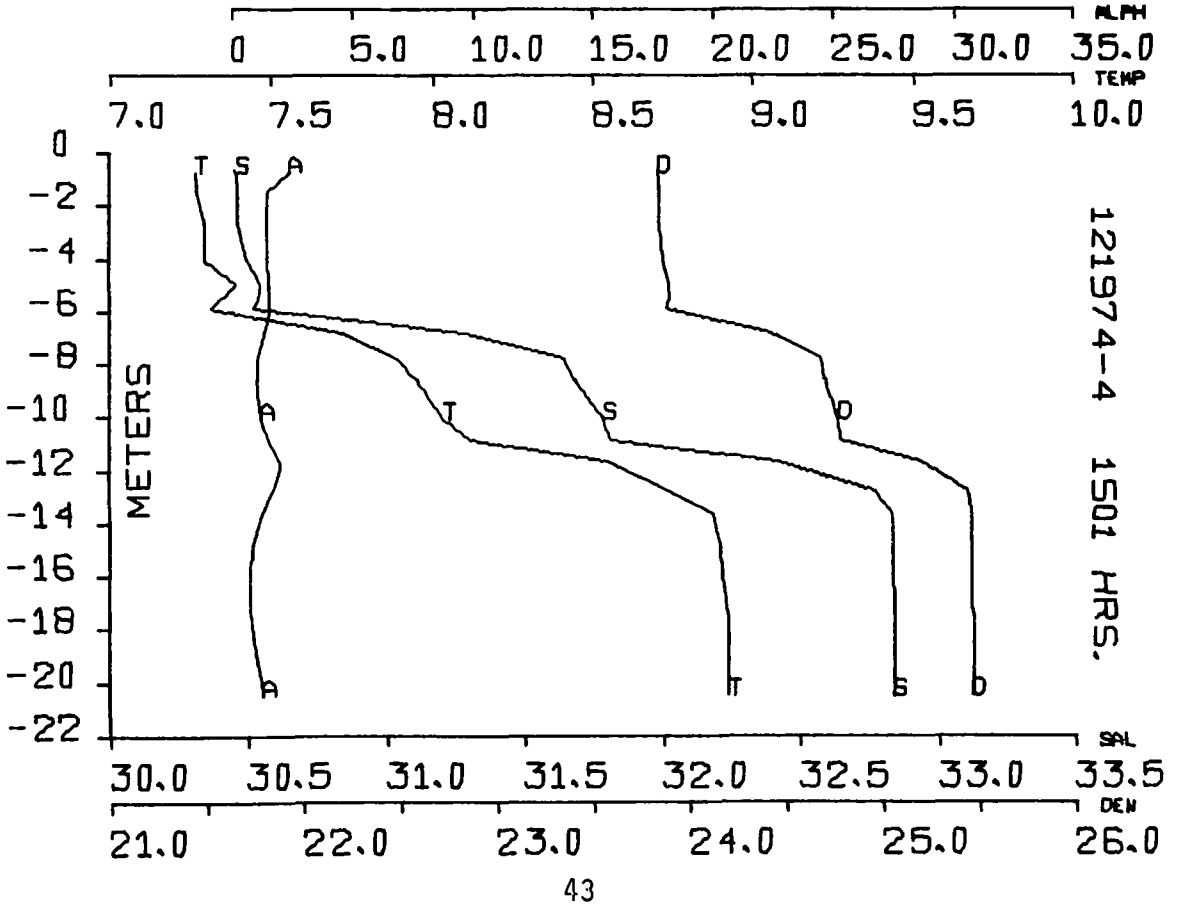
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.45	7.26	23.83	72	3.21
1.0	30.46	7.27	23.84	82	2.02
2.0	30.46	7.28	23.84	87	1.43
3.0	30.47	7.29	23.84	87	1.45
4.0	30.50	7.29	23.86	86	1.50
5.0	30.54	7.38	23.89	85	1.57
6.0	30.62	7.36	23.95	86	1.50
7.0	31.36	7.75	24.47	88	1.22
8.0	31.65	7.90	24.69	90	1.00
9.0	31.71	7.97	24.72	90	1.04
10.0	31.79	8.03	24.77	89	1.21
11.0	31.94	8.20	24.87	85	1.64
12.0	32.53	8.60	25.27	83	1.92
13.0	32.79	8.77	25.45	86	1.49
14.0	32.83	8.88	25.46	90	1.04
15.0	32.83	8.90	25.46	93	.72
16.0	32.83	8.90	25.46	94	.66
17.0	32.84	8.91	25.46	93	.69
18.0	32.84	8.92	25.47	92	.85
19.0	32.84	8.92	25.46	90	1.04
20.0	32.84	8.92	25.46	88	1.27



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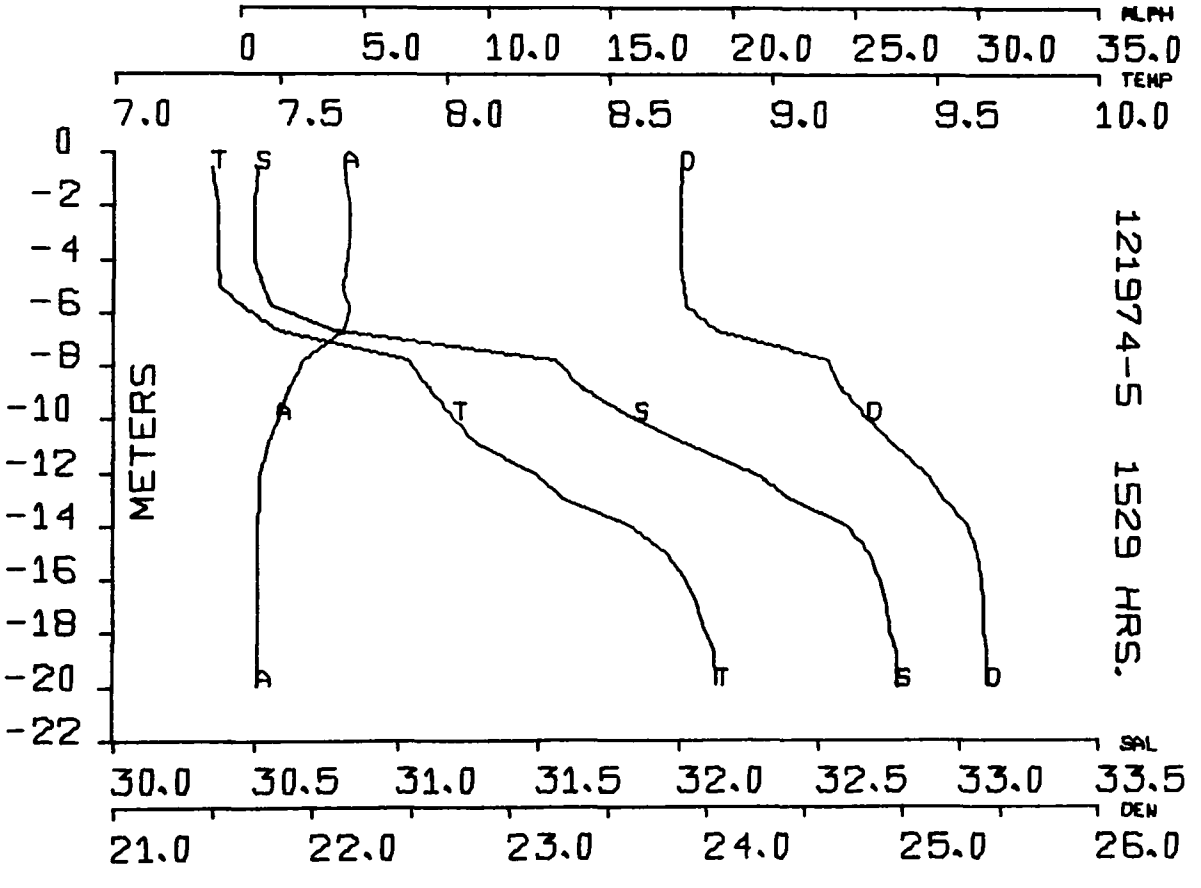
STATION 121974-5 1529 HRS.
AT DUMPSITE 189 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.51	7.28	23.87	66	4.15
1.0	30.49	7.30	23.86	65	4.29
2.0	30.48	7.31	23.85	64	4.42
3.0	30.49	7.31	23.85	64	4.47
4.0	30.49	7.31	23.86	65	4.24
5.0	30.52	7.32	23.88	66	4.09
6.0	30.61	7.42	23.94	65	4.36
7.0	31.02	7.62	24.23	70	3.60
8.0	31.58	7.90	24.63	79	2.38
9.0	31.68	7.96	24.70	83	1.87
10.0	31.85	8.03	24.82	86	1.45
11.0	32.05	8.12	24.96	90	1.05
12.0	32.27	8.27	25.12	92	.81
13.0	32.41	8.37	25.21	93	.73
14.0	32.60	8.56	25.33	94	.67
15.0	32.68	8.68	25.38	94	.65
16.0	32.72	8.74	25.40	94	.65
17.0	32.75	8.78	25.41	94	.66
18.0	32.76	8.80	25.42	93	.70
19.0	32.78	8.83	25.43	93	.74



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* STATION 121974-6 1602 HRS.

* OUT OF DUMP AREA

*

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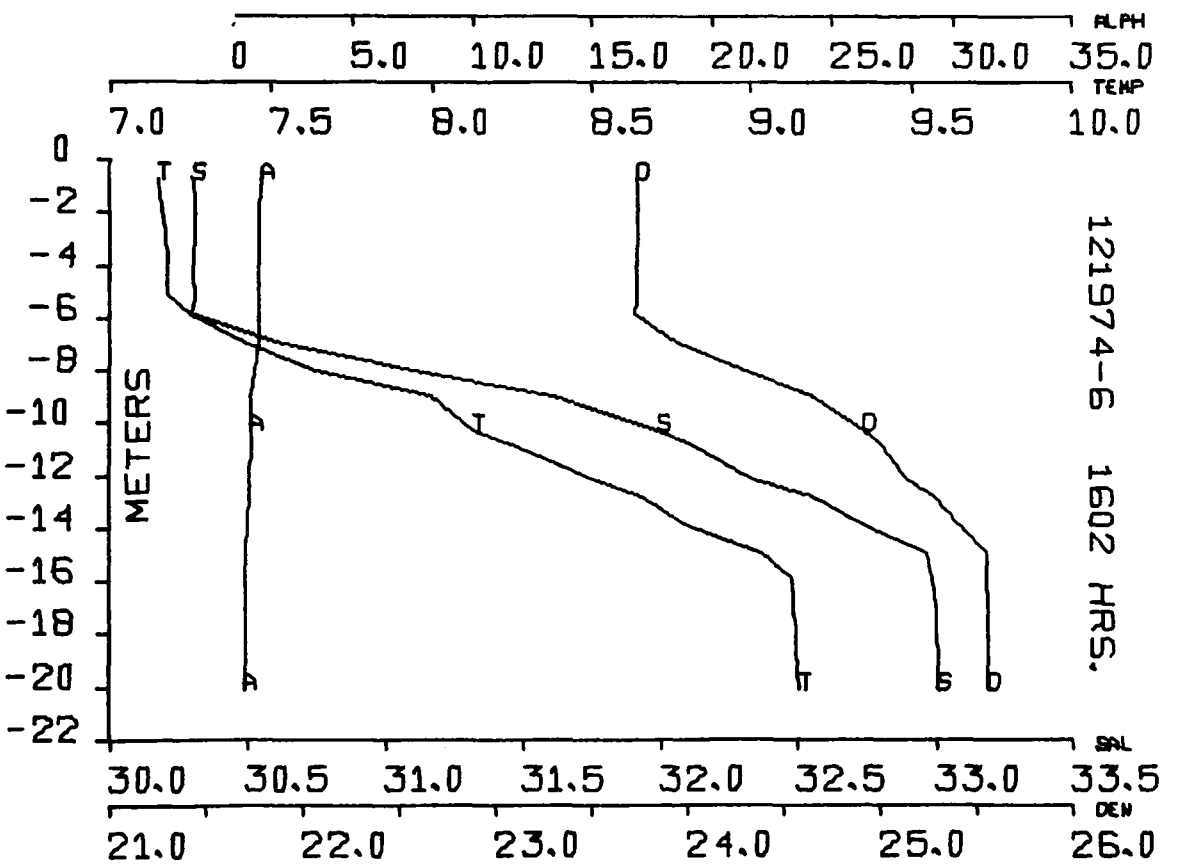
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.30	7.14	23.73	87	1.37
1.0	30.30	7.15	23.73	88	1.22
2.0	30.31	7.16	23.73	89	1.11
3.0	30.30	7.17	23.72	90	1.10
4.0	30.29	7.18	23.72	90	1.08
5.0	30.31	7.18	23.73	90	1.08
6.0	30.35	7.28	23.75	90	1.08
7.0	30.64	7.43	23.96	90	1.03
8.0	31.09	7.63	24.29	91	.95
9.0	31.62	8.00	24.64	92	.80
10.0	31.91	8.10	24.86	93	.75
11.0	32.15	8.29	25.02	93	.72
12.0	32.33	8.49	25.13	93	.68
13.0	32.60	8.69	25.31	94	.63
14.0	32.78	8.84	25.43	95	.56
15.0	32.97	9.04	25.55	95	.52
16.0	32.99	9.13	25.55	95	.50
17.0	33.00	9.13	25.55	95	.51
18.0	33.00	9.13	25.55	95	.50
19.0	33.01	9.14	25.56	95	.50
20.0	33.01	9.15	25.56	95	.50



TIDES: DECEMBER 20, 1974

Predicted tides at Sandy Hook, N.J.

Time (Zone)	Height Ft. (MLW)
0548	0.6
1114	4.1
1818	0.2

CURRENTS: DECEMBER 20, 1974

Time-series current measurements, at the dump site, 2.5 m depth

Time (Zone)	Speed (Knots)	Direction (°True)
1000	>1.0	192
1010	>1.0	192
1020	>1.0	186
1030	.95	204
1040	.98	198
1050	1.0	195
1100	>1.0	192
1110	>1.0	204
1120	>1.0	210
1130	>1.0	216
1140	>1.0	216
1150	>1.0	210
1200	>1.0	210
1210	>1.0	204
1220	>1.0	210
1230	>1.0	210
1240	>1.0	210
1250	>1.0	210
1300	>1.0	210

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STATION 122074-1 1007 HRS.
AT DUMPSITE BEFORE SLUDGE DISCHARGE

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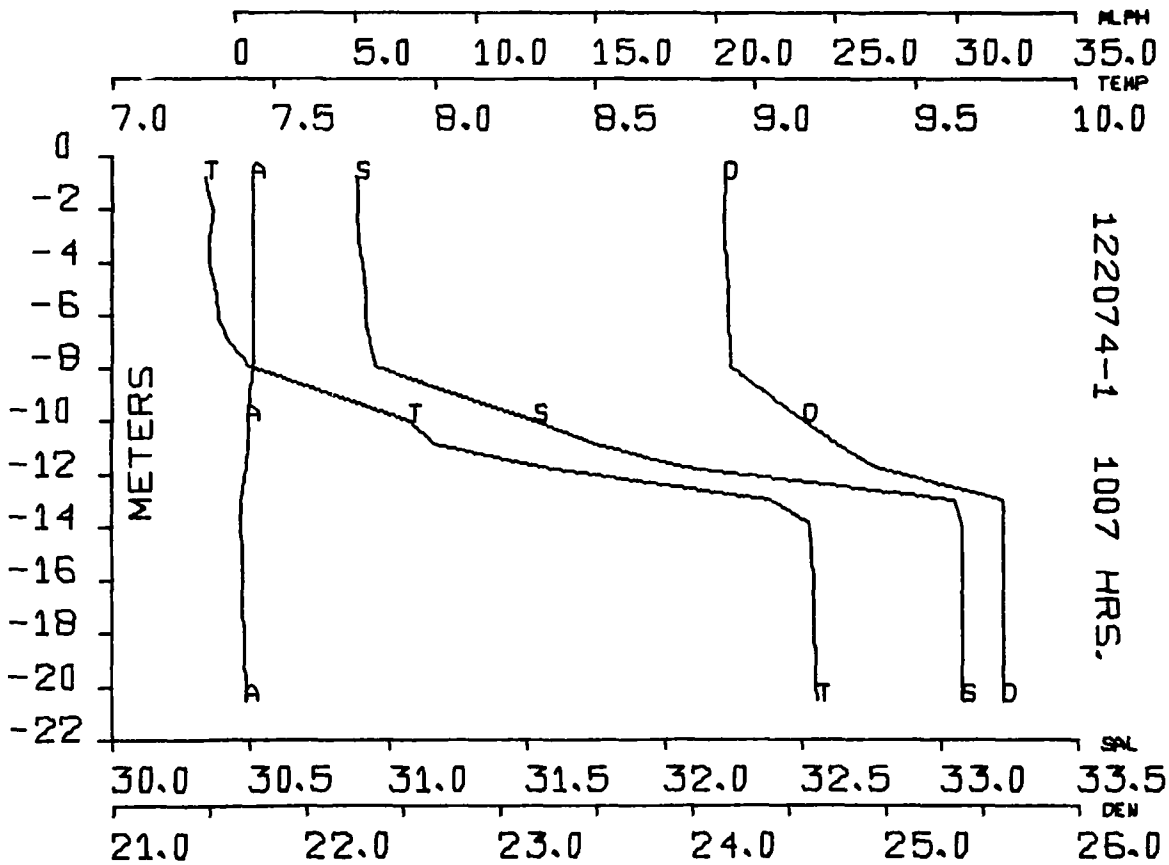
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.88	7.27	24.17	93	.76
1.0	30.88	7.29	24.17	93	.77
2.0	30.88	7.31	24.16	92	.79
3.0	30.89	7.30	24.17	92	.79
4.0	30.90	7.30	24.18	92	.79
5.0	30.91	7.32	24.19	92	.78
6.0	30.91	7.33	24.18	92	.78
7.0	30.93	7.36	24.20	93	.74
8.0	30.98	7.45	24.22	93	.72
9.0	31.24	7.68	24.39	94	.62
10.0	31.53	7.92	24.59	95	.55
11.0	31.80	8.04	24.78	95	.50
12.0	32.26	8.47	25.08	96	.40
13.0	33.05	9.05	25.61	98	.23
14.0	33.08	9.17	25.61	97	.31
15.0	33.08	9.17	25.61	97	.34
16.0	33.08	9.18	25.61	96	.37
17.0	33.08	9.18	25.61	96	.39
18.0	33.08	9.18	25.61	96	.45
19.0	33.08	9.19	25.61	96	.46
20.0	33.08	9.19	25.61	95	.49



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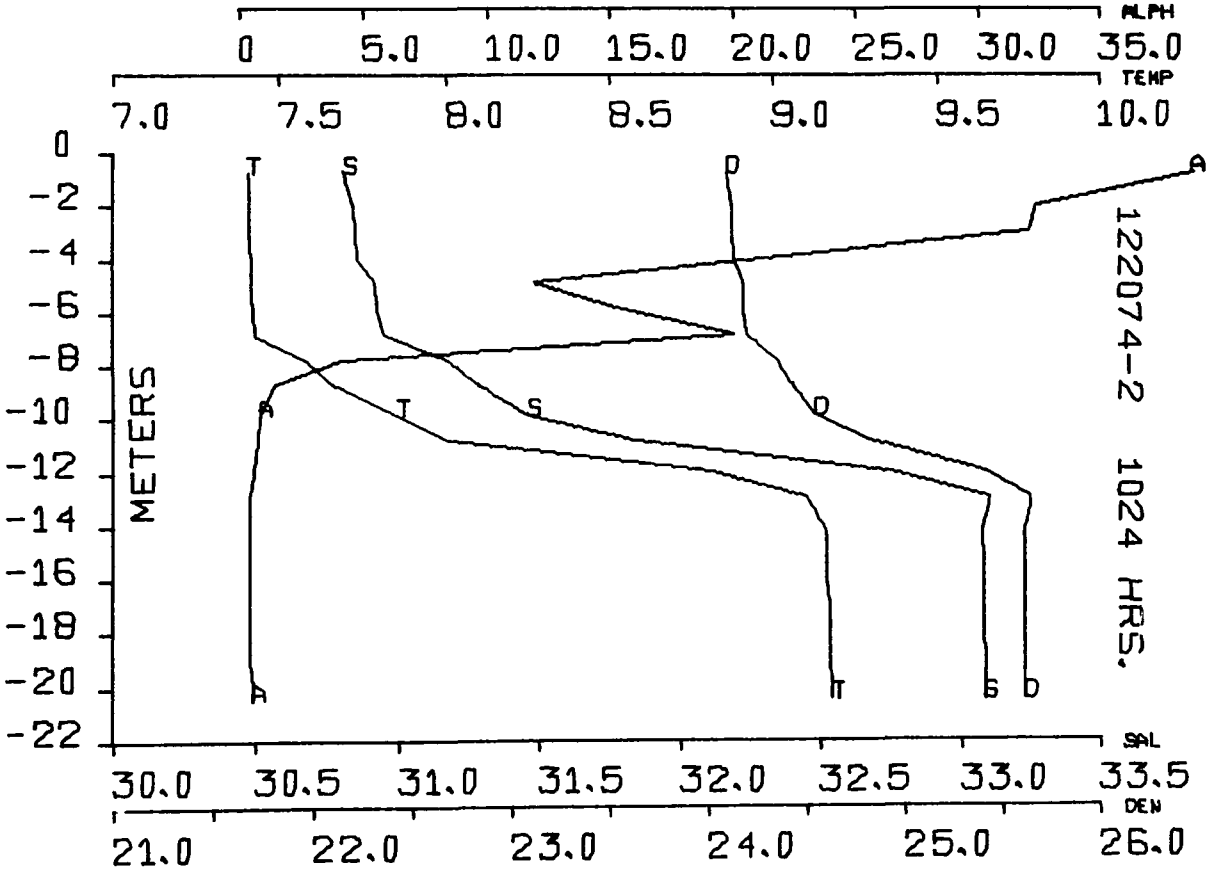
STATION 122074-2 1024 HRS.

AT DUMPSITE 9 MINUTES AFTER SLUDGE DISCHARGE

****

DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.78	7.40	24.07	1	42.83
1.0	30.81	7.40	24.10	2	37.51
2.0	30.84	7.41	24.12	4	32.30
3.0	30.85	7.40	24.12	5	31.26
4.0	30.86	7.41	24.13	13	20.64
5.0	30.92	7.41	24.18	29	12.46
6.0	30.93	7.42	24.18	20	16.29
7.0	31.00	7.46	24.24	24	16.77
8.0	31.20	7.60	24.37	72	3.40
9.0	31.32	7.71	24.45	88	1.23
10.0	31.53	7.88	24.59	93	.73
11.0	32.01	8.16	24.93	94	.65
12.0	32.76	8.82	25.42	95	.48
13.0	33.10	9.10	25.64	97	.33
14.0	33.07	9.15	25.61	97	.33
15.0	33.08	9.16	25.61	96	.36
16.0	33.08	9.16	25.61	97	.35
17.0	33.08	9.17	25.61	96	.40
18.0	33.08	9.17	25.61	96	.44
19.0	33.08	9.17	25.61	95	.46
20.0	33.08	9.18	25.61	94	.57



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* STATION 122074-2 1043 HRS.

* AT DUMPSITE 28 MINUTES AFTER SLUDGE DISCHARGE

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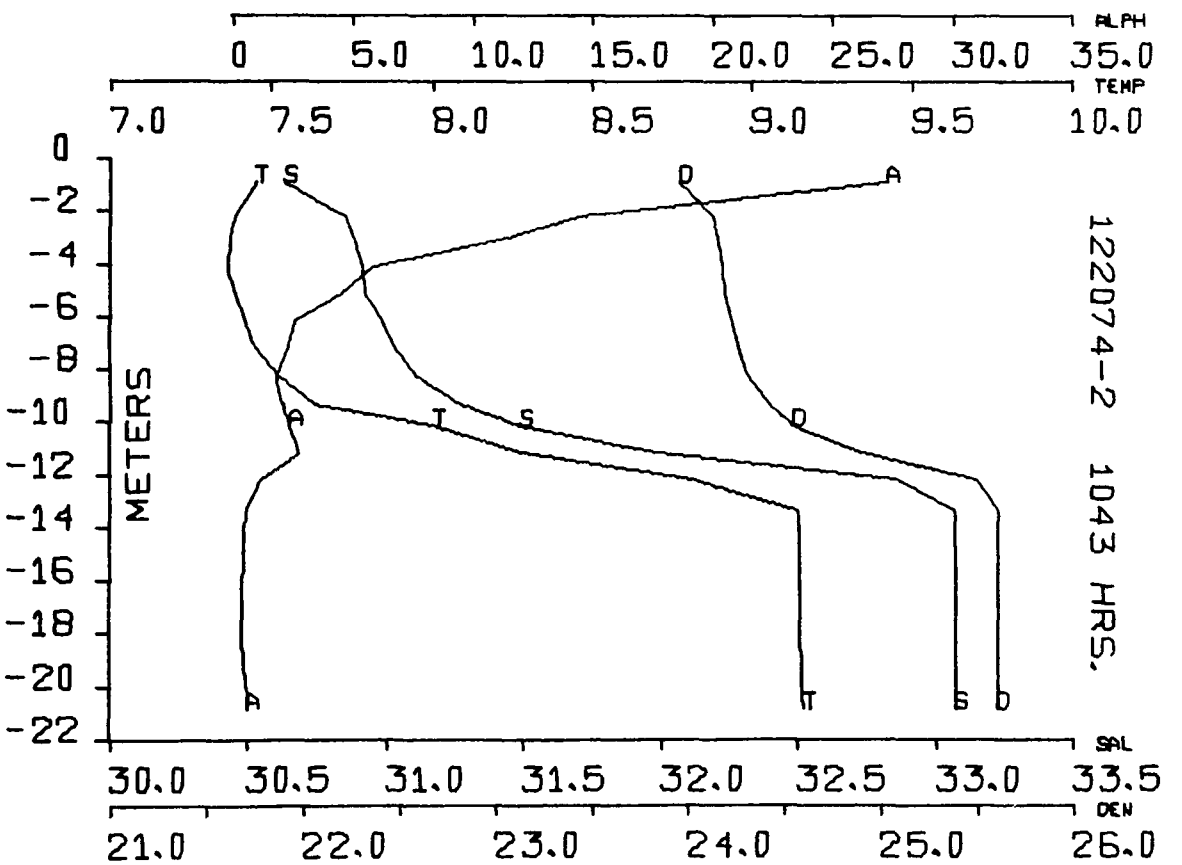
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.48	7.50	23.82	-5	36.04
1.0	30.65	7.44	23.96	8	26.02
2.0	30.82	7.39	24.11	22	16.00
3.0	30.89	7.36	24.16	32	11.36
4.0	30.91	7.36	24.18	54	6.29
5.0	30.92	7.39	24.19	63	4.59
6.0	30.98	7.41	24.23	76	2.81
7.0	31.02	7.45	24.26	79	2.31
8.0	31.09	7.51	24.30	83	1.90
9.0	31.22	7.61	24.39	82	2.02
10.0	31.45	7.94	24.52	79	2.41
11.0	31.90	8.23	24.83	76	2.80
12.0	32.71	8.72	25.39	86	1.49
13.0	33.00	9.04	25.57	93	.74
14.0	33.07	9.15	25.60	96	.46
15.0	33.07	9.15	25.61	96	.43
16.0	33.07	9.15	25.60	96	.39
17.0	33.07	9.15	25.60	96	.40
18.0	33.07	9.15	25.61	96	.43
19.0	33.07	9.15	25.61	95	.49
20.0	33.07	9.15	25.61	94	.64



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STATION 122074-3 1148 HRS.
AT DUMPSITE 93 MINUTES AFTER SLUDGE DISCHARGE

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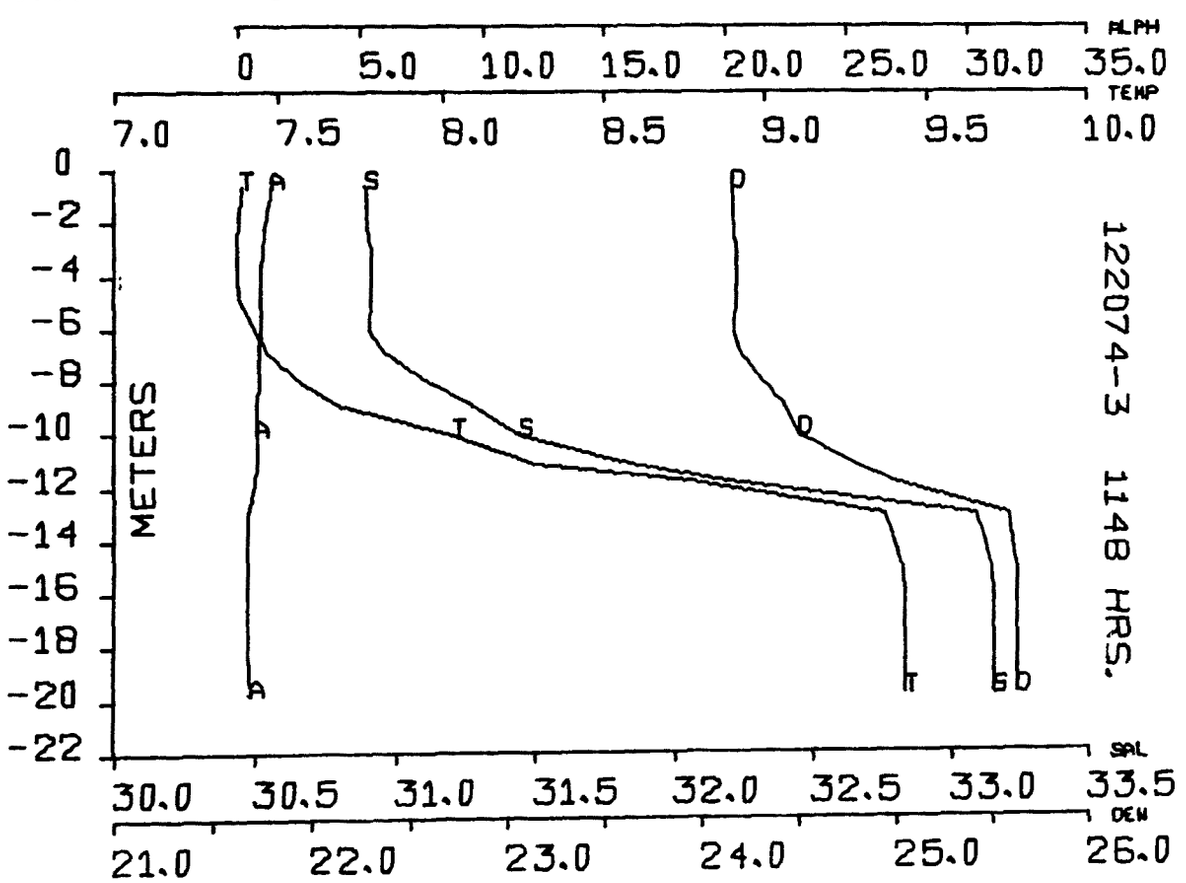
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.89	7.39	24.16	87	1.43
1.0	30.89	7.38	24.16	89	1.20
2.0	30.90	7.37	24.17	90	1.00
3.0	30.91	7.37	24.18	92	.88
4.0	30.91	7.37	24.18	92	.85
5.0	30.90	7.39	24.17	92	.83
6.0	30.90	7.42	24.16	92	.81
7.0	30.97	7.48	24.21	93	.78
8.0	31.11	7.57	24.31	93	.74
9.0	31.28	7.71	24.42	93	.71
10.0	31.44	8.02	24.50	93	.68
11.0	31.80	8.26	24.75	93	.68
12.0	32.35	8.87	25.09	95	.54
13.0	33.04	9.34	25.56	97	.33
14.0	33.13	9.40	25.61	97	.30
15.0	33.15	9.42	25.62	97	.31
16.0	33.16	9.43	25.63	96	.38
17.0	33.16	9.43	25.63	96	.38
18.0	33.16	9.43	25.63	96	.40
19.0	33.16	9.43	25.63	96	.43



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* STATION 122074-3 1153 HRS.

* AT DUMPSITE 98 MINUTES AFTER SLUDGE DISCHARGE

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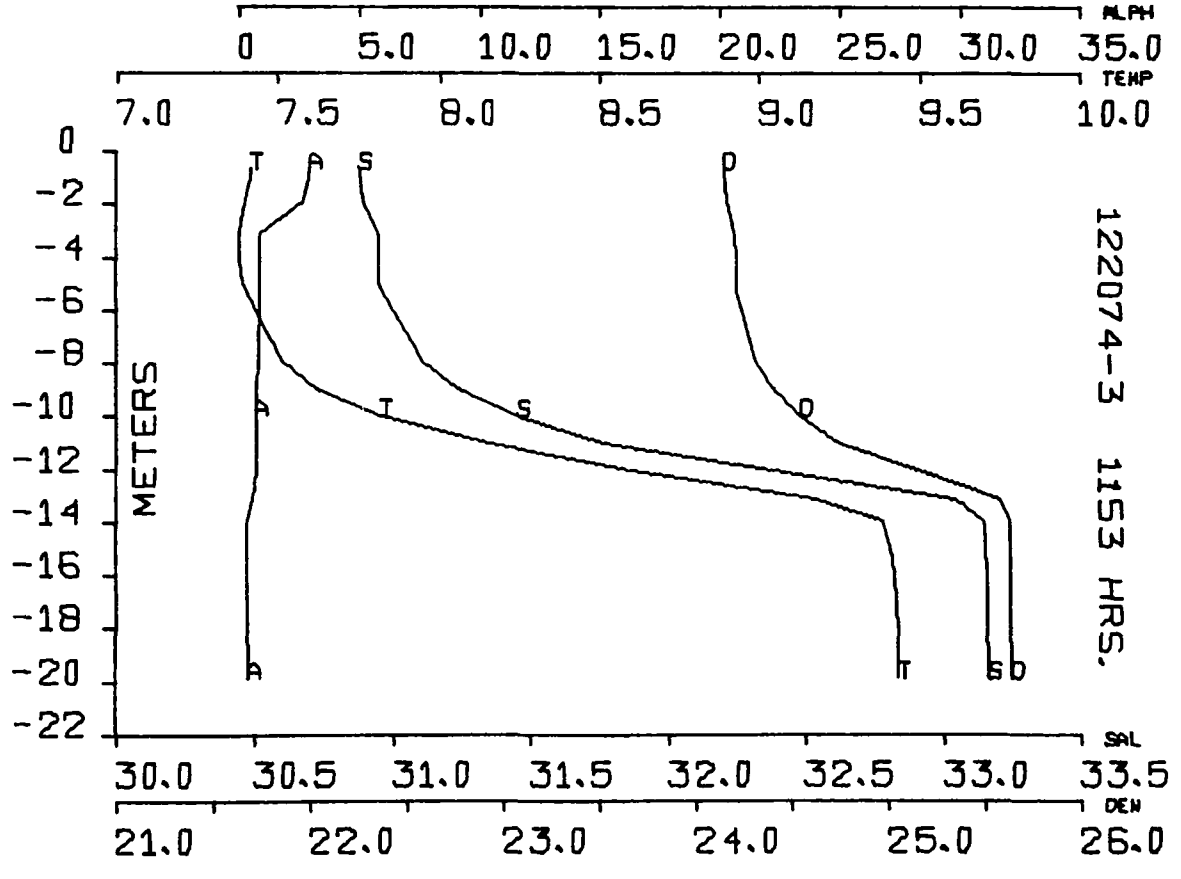
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.87	7.43	24.13	74	3.03
1.0	30.88	7.41	24.15	75	2.82
2.0	30.89	7.39	24.16	78	2.48
3.0	30.94	7.37	24.20	91	.93
4.0	30.95	7.38	24.21	92	.85
5.0	30.95	7.39	24.20	92	.81
6.0	31.00	7.43	24.24	92	.80
7.0	31.05	7.47	24.28	93	.77
8.0	31.12	7.52	24.32	93	.75
9.0	31.24	7.63	24.40	93	.70
10.0	31.45	7.82	24.54	94	.65
11.0	31.76	8.15	24.73	94	.65
12.0	32.36	8.58	25.14	94	.66
13.0	32.98	9.12	25.54	95	.55
14.0	33.14	9.38	25.63	97	.30
15.0	33.15	9.41	25.63	97	.26
16.0	33.16	9.42	25.63	97	.27
17.0	33.16	9.43	25.63	97	.30
18.0	33.16	9.43	25.63	97	.33
19.0	33.17	9.43	25.64	96	.44



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STATION 122074-4 1232 HRS.
AT DUMPSITE 137 MINUTES AFTER SLUDGE DISCHARGE

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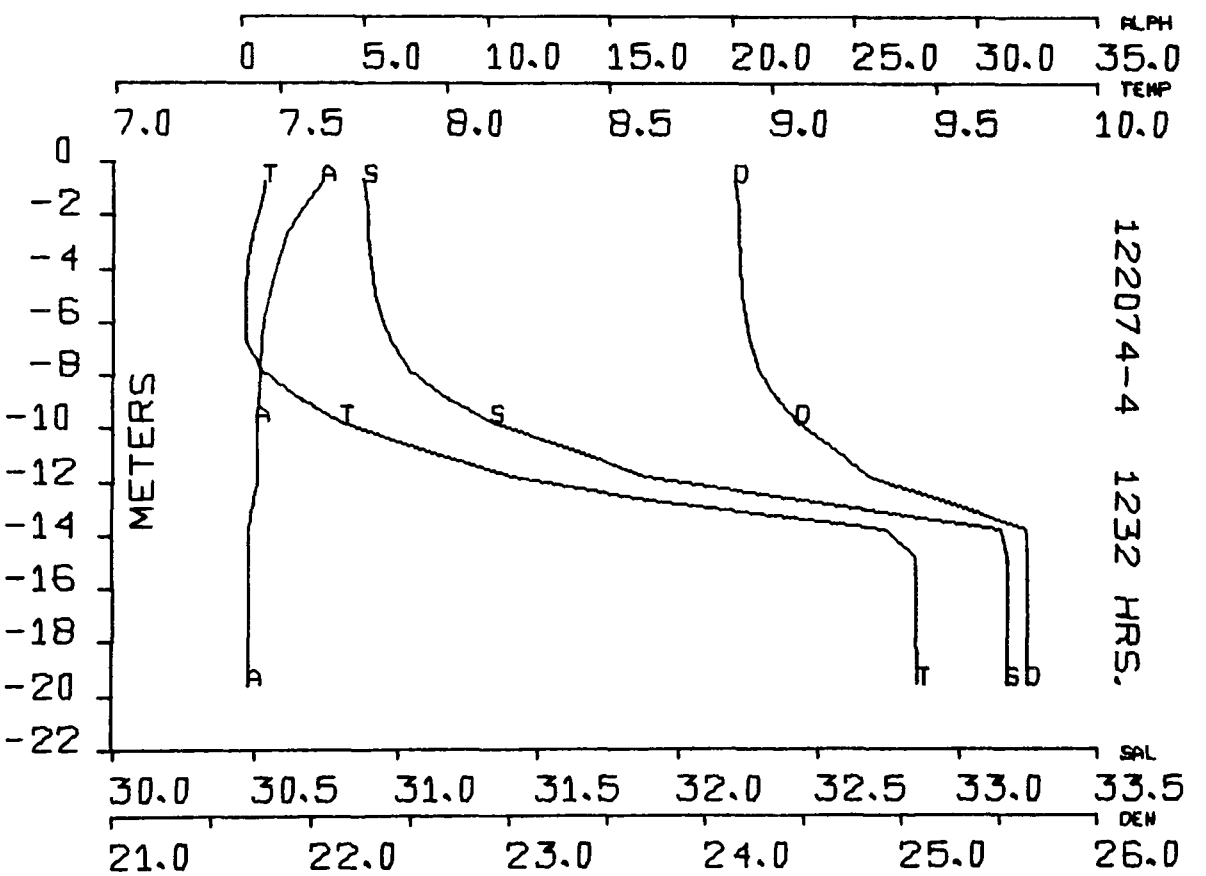
DEPTH (M)	SALINITY (PPT)	TEMPERATURE (C)	SIGMA-T	TRANSMIT. (%)	ALPHA (M-1)
0	30.86	7.46	24.13	68	3.83
1.0	30.88	7.44	24.14	74	3.08
2.0	30.89	7.42	24.16	79	2.34
3.0	30.90	7.40	24.16	84	1.72
4.0	30.91	7.39	24.17	87	1.40
5.0	30.92	7.39	24.19	90	1.10
6.0	30.95	7.39	24.21	92	.88
7.0	30.99	7.41	24.24	92	.83
8.0	31.06	7.47	24.28	93	.77
9.0	31.20	7.58	24.37	93	.75
10.0	31.40	7.74	24.51	93	.71
11.0	31.68	7.99	24.69	93	.69
12.0	32.02	8.30	24.92	93	.70
13.0	32.64	8.82	25.32	95	.49
14.0	33.16	9.37	25.64	97	.33
15.0	33.18	9.44	25.64	97	.35
16.0	33.18	9.44	25.64	97	.35
17.0	33.18	9.44	25.64	96	.38
18.0	33.17	9.45	25.64	96	.39
19.0	33.17	9.45	25.64	96	.43



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16. ABSTRACT

This volume contains physical oceanographic data collected at the sewage sludge disposal site near the apex of the New York Bight December 18 through 21, 1974. An optical tracer method was used to measure the water column distribution of waste material with time after discharge. Profiles with depth were taken for two to four hours after waste discharge. Ambient temperature-salinity-density profiles and current measurements were also taken.

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