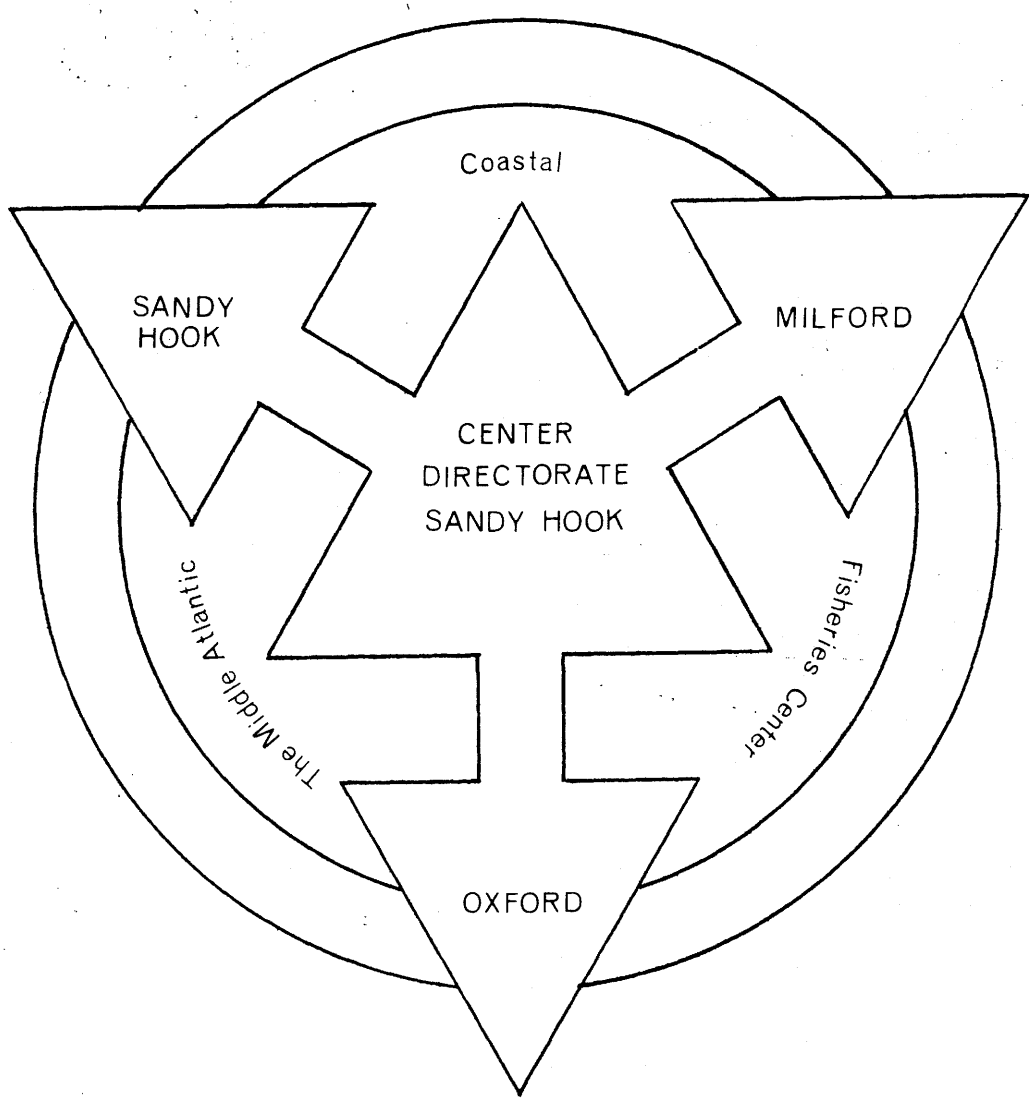
AN ENVIRONMENTAL SURVEY OF EFFECTS OF DREDGING AND SPOIL DISPOSAL, NEW LONDON, CONNECTICUT: 2ND QUARTERLY REPORT

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region

MIDDLE ATLANTIC COASTAL FISHERIES CENTER



Informal Report No. 49
7 February 1974

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
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SANDY HOOK LABORATORY
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ABSTRACT

This report addresses field activities conducted and results obtained since the submission of the initial quarterly reports (1 November 1974 for the Middle Atlantic Coastal Fisheries Center (MACFC); 1 October 1974 for subcontractors, the University of Connecticut (UCONN) and New York Ocean Science Laboratory (NYOSL).

UCONN completed three additional cruises in the Thames River to investigate suspended material transport. Progress has been made toward selecting a circulation model for determining dredging-induced variations, and toward characterizing average loads of suspended sediments during autumn. An intense southerly storm was found to have relatively minor effect on suspended sediment concentrations. Dredge-related increases in suspended loads were confined to within 150 m of the operation. Distributions of geofungi in river water and sediments are under study; the use of these organisms to trace movements of sediments suspended by dredging appears feasible. Mercury concentrations in river water were found to

fluctuate greatly due to inputs from sources unrelated to dredging. Concentrations in shellfish were approximately 1000 times greater than in the water column. Mercury content was higher in November for hard clams and Pitar, but lower for oysters. The UCONN report contains photographic documentation of the nature of spoils at the dump site and evidence of past dumping. SCUBA surveys conducted in late November and early December found no outstanding changes in bottom conditions.

The NYOSL reports establish predisposal values for the physical and chemical oceanography of the dump site, and describe changes found in September and December as well as effects of single dumping events at those times. Current investigations using meters and drogues indicated flows throughout the water column to be substantially greater on an ebbing than a flooding tide. Calculated net tidal flows were due east in surface waters, and approximately north near the bottom.

Dissolved oxygen, pH and total organic carbon may have exhibited dump-related changes in September, though not in December. Concentrations of suspended solids increased progressively through December. No significant differences were found in chemical oxygen demand, nitrogen or phosphorus content of sediments between July and October, or in seston heavy metals between July, September and December. Increases in sediment heavy metals from July to October were significant ($p < .10$). The report also presents predisposal concentrations of heavy metals in benthic animals.

Turbidity changes at the disposal buoy following a dump were minor; differences were greater but quite variable in the drogue-tracked plume of a dump. Effects of an individual dump included lowering of dissolved oxygen and pH, elevation of suspended solids and reduction in the proportion of volatile components of suspended solids. All of these parameters had reverted to background levels within two hours after the dump. The Chemical Oceanography subtask concludes that "no major unexpected changes have occurred in the water column, the organisms or the sediments which can be solely attributed to the dumping activities".

MACFC's benthic macrofauna studies have shown little change in community characteristics between July and October (outside of the dumping point itself, where October samples consisted of spoil material practically devoid of life). The only other significant ($p < .05$) difference found was a decline in number of organisms in October at a station ½ mile WNW of the disposal buoy. Much of this decline was due to reduced abundance of a single species of amphipod crustacean. Sediment analyses performed for selected stations revealed, as expected, a large increase in the proportion of fine materials at the disposal site in October. No other stations had notable increases in percent silt-clay of sediments. Sediment traps collected less material per unit time in October than in July, but with higher percentages of total and organic carbon.

The report includes a tentative schedule of field activities for all investigations through 1975.

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Submitted by

Ecosystems Investigations
Middle Atlantic Coastal Fisheries Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
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to

U. S. Navy, Northern Division, Naval Facilities Engineering Command

U. S. Army, Corps of Engineers

Interagency Scientific Advisory Subcommittee on
Ocean Dredging and Spoiling

7 February 1974

FOREWORD

This document comprises the second quarterly report on studies designed to monitor the effects of dredging and spoil disposal in the Thames River estuary and to establish detailed baselines for the dredging and spoiling sites. The report deals primarily with activities of the principal contractor, the Middle Atlantic Coastal Fisheries Center (MACFC), National Marine Fisheries Service (NMFS). Reports from subcontractors, the University of Connecticut (UCONN) and the New York Ocean Science Laboratory (NYOSL), were received by 5 February 1975 by MACFC. Reports of the subcontractors are included as appendices to this report, which summarize activities and available results of UCONN and NYOSL.

Overall goals, schedules and methodologies for the monitoring survey are contained in MACFC Informal Report No. 25-A, "A Proposal for an Environmental Survey of Dredging and Spoil Disposal in the Thames River and New London Dumping Ground" (21 May 1974), and will not be repeated in the quarterly reports. Changes or additions will be described in the pertinent quarterly report but not in subsequent reports.

A tentative schedule for all field activities has been developed at the request of the Regional Director, NMFS and the U. S. Army Corps of Engineers. The schedule is included as Appendix E to this report. All parties to the operations are reminded that the stipula-

tion to immediately report any observed violations of the dumping criteria or other impacts judged significant is in effect and an extremely important component of the monitoring and research program.

All studies, especially direct bottom observations via SCUBA, require the placement and maintenance of buoys at selected stations if they are to be maximally effective. We therefore request that buoys be maintained at Stations A3, C3, E3 and F9 in the interest of the accuracy and precision of the monitoring survey.

Reproduction or use of data from these reports must first be cleared through MACFC (and through subcontractors if applicable).

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APPENDICES:

A. Suspended Material Transport in the Thames River

B. Effects of Dredging in the Thames River on Shellfish Resources and Phytoplankton; Lobster Monitoring and Related Dump Site SCUBA Studies.

C. Physical Oceanography of Dump Site Area

D. Chemical Oceanography of Dump Site Area

E. Schedule of Field Activities for 1975

I. UNIVERSITY OF CONNECTICUT SUBTASKS

A. Suspended Material Transport in the Thames River (Appendix A).

Three cruises were conducted between 1 October and 31 December 1974. Data were collected on current characteristics over complete tidal cycles. This information will allow selection of a model (probably two-dimensional) for subsequent determination of dredging-induced variations. Suspended material concentrations were also measured over a tidal cycle, and are being combined with previous data to estimate average suspended loads during autumn. One set of measurements taken immediately after an intense storm with predominantly southerly winds indicated that these winds had a relatively minor effect on suspended sediment concentrations. Impacts of northerly storms were expected to be greater; this investigation will attempt to monitor responses to such a storm during the next quarter. A survey in the vicinity of the dredging operation revealed suspended material concentrations up to twenty times greater than ambient, but the influence of the dredging was evident only within a 150 m radius of the operation. Seston near the dredge differed from that collected elsewhere in having proportionally fewer fine materials. Analysis of percent organic materials in suspension is presently underway.

A survey of the geofungi of suspended and bottom sediments of the Thames River and two stations to the east of the river mouth, was begun in February 1974. This project hopes to use these organisms having a terrestrial origin to trace movements of sediments put in suspension by

dredging. Sixteen cruises were made between February and December 1974 to measure surface and bottom salinity, pH and suspended material concentrations, surface temperature, as well as to determine types and densities of fungi in surface and bottom waters and sediments. Results are presented in Appendix A, pp. 7-12. It appears that several of the tolerant genera of geofungi found in deep river muds may be suitable markers of dredging spoils and their movement.

B. Effects of Dredging in the Thames River on Shellfish Resources and Phytoplankton (Appendix B).

Mercury concentrations of surface and bottom waters were measured on 4 November 74 for comparison with samples taken on 2 and 18 July 74. Concentrations found on 2 July and 4 November (50 nanograms/liter) were considered typical of coastal waters in the Sound. On 18 July levels were much higher, reaching 410 ng/l in bottom waters near the river mouth. The variation was thought due to periodic introduction of mercury from unknown sources.

Mercury levels in the bivalves *Mercenaria mercenaria* (hard clam) *Crassostrea virginica* (oyster) and *Pitar morrhuana* were also compared between July and November. Concentrations in *Mercenaria* and *Pitar* were somewhat higher in November, with values increasing upriver for *Mercenaria*. *Crassostrea*, however, had lower mercury levels in November. All three species had concentrations approximately 1000 times those found in the water column.

C. Lobster Monitoring and Related Dump Site SCUBA Studies (Appendix B)

Cruises made on 25 November and 2 December were unsuccessful in obtaining lobsters for sonic tracking experiments due to the reduced activity of the animals during rapidly decreasing temperatures. For this reason, continuation of the tracking studies will be deferred until late spring 1975. Appendix B includes annotated photographs of bottom conditions and features at the dump buoy before and after the onset of spoil disposal, and at other selected areas in the vicinity of disposal. These photographs document the *in situ* nature of the spoils, and evidence of past dumping, as well as present conditions at areas where no new spoils are yet in evidence and sediments are apparently consolidated by an amphipod-dominated fauna. No outstanding changes in bottom conditions were noted during this quarter.

II. NEW YORK OCEAN SCIENCE LABORATORY (NYOSL) SUBTASKS

A. Physical Oceanography of Dump Site Area (Appendix C).

Appendix C gives further information on three cruises conducted during the first quarter and discussed initially in the previous report. Temperature, salinity, density and current characteristics measured on pre-disposal cruises (July and August 1974) are presented. Another experiment, similar to that conducted in September and described in the first report, was carried out on 11 December to determine currents and measure effects on turbidity of a single dumping event.

Figures 2 and 3 of Appendix C show paths of displacement for surface and bottom drogues over a tidal cycle, and corresponding current meter data. The derived data on average current velocities, directions, distances and durations over half-tidal cycles in the dump area, and on net flows and directions, are of special interest. Ebb distances were four times greater than flood distances in surface waters, and twice as great at the bottom. The net tidal flow was found to be due east at the surface and slightly east of north at depth. Highest average speeds recorded over half-tidal cycles were 54.0 cm/sec (surface) and 34.2 cm/sec (bottom), both in a generally easterly direction on ebbing tides.

Turbidity as measured by light transmittance and attenuation did not show any large changes at the dump site over a 7½ hour period following a dump. (Appendix C, Table 4). Changes were greater but quite irregular in the drogue-tracked plume of a dump. (Table 5).

B. Chemical Oceanography of Dump Site Area (Appendix D).

The 11 December 74 cruise generated additional data on effects of dumping on various water column parameters, for comparison to a similar survey made in September and to predump measurements taken in July. Dissolved oxygen (Appendix D, Figures 2 a-c) showed a slight decline in percent saturation between July and September. In September, though not in July or December, percent saturation was reduced east of the dump site relative to west of the site. Dissolved oxygen in bottom waters of a spoil plume (as tracked by drogues) was lowered by about 30% immediately following a dump, with a smaller reduction in surface concentrations. Values returned to ambient within 40 minutes after the dump (Figure 4). Measurements were also made on changes in pH and Eh in the same spoil plume. pH was reduced after the dump, and required thirty minutes to return to predump values in surface waters (Figure 6), which were flowing east on an ebbing tide. This may partially explain the difference in pH values between waters east and west of the dump point on the 11 September date of this experiment (Figure 5b). Eh was apparently unchanged by dumping activities (Figure 8).

Total organic carbon of water samples showed an increase in the vicinity (within one mile) of the dumping buoy in September, though not in December or in the predumping measurements. Values outside the one-mile radius in September were similar to concentrations everywhere in July. All December values were significantly lower than the July and September figures (Table 1 and Figures 9a-c). Suspended solids showed progressive, significant

($p < .2$, Student's test) increases from July-September-December. Highest values were found in bottom water, especially those within a one-mile radius of dumping (Figures 10a-c). Monitoring of a spoil plume indicated that surface concentrations of suspended solids quickly returned to background. Bottom values remained elevated for up to two hours, but the tides were such that the plume was still within 500 yards of the release point at that time (Figures 11a-b). The percentage of suspended solids consisiting of volatile materials decreased from July to December, and also decreased following a dump (Figures 12a-c and 13). These changes largely reflect the increased amounts of inorganic materials in suspension during dumping.

The heavy metals content of seston (Appendix D, Table 2) showed no significant ($p < .2$) differences between July, September and December (Table 2). Table 3 of Appendix D presents predumping concentrations of heavy metals in benthic organisms, while Table 5 shows metals in sediments for July and October. Locations for stations listed in Table 5 are indicated in Figure 4 of the MACFC section of this report. Increases in sediment heavy metals were most noticeable for mercury and copper, and were generally found at stations close to the dumping buoy. Note that large <u>decreases</u> were found for some metals and some stations. This finding is as yet unexplained.

Table 4 lists chemical oxygen demand, nitrogen and phosphorus content of sediments for July and October. No significant ($p. < .2$) differences in any of these parameters were found between the two sampling dates.

The chemical oceanography subtask concludes that "no major unexpected changes have occurred in the water column, the organisms or the sediments which can be solely attributed to the dumping activities".

C. Demersal Fish Distribution and Abundance

All information concerning the first two quarterly cruises was included in the first report. The next cruise is scheduled for 18-20 February 1975.

III. MIDDLE ATLANTIC COASTAL FISHERIES CENTER SUBTASKS

A. Benthic Macrofauna Studies

1. Field Activities: The third quarterly cruise to collect macrofauna and sediment samples from the dumping area and Thames River began on 20 January 1975. Shipboard inspection of grab samples collected to date indicated that some spoil material has probably spread to station C5, ¼ mile WNW of the dumping buoy. There was no visible evidence of spoils at other stations except for the original disposal point and Station C7, which is in the vicinity of the new release area. Bottom dissolved oxygen values showed no apparent anomalies.

2. Laboratory Activities: Sorting, identification and enumeration of macrofauna have been completed for 35 grabs from 14 of the stations occupied on the baseline cruise, (26 June - 12 July 1974), and 26 grabs from Cruise II (24 September - 4 October 1974; 12 stations). Numbers of species (S) and individuals (N), Shannon-Weaver species diversities (H') and equitabilities (J') have been tabulated for all samples. Confidence limits (95%) have been calculated for those stations with three or more processed samples. Results are presented as between-cruise changes in N, S, H' and J'. This is done as a function of distance from the dumping buoy for the A and C transects (Figures 1-2); data are also given for several other pertinent stations (Figure 3).

As expected, the point of dumping (Station C6) experienced large

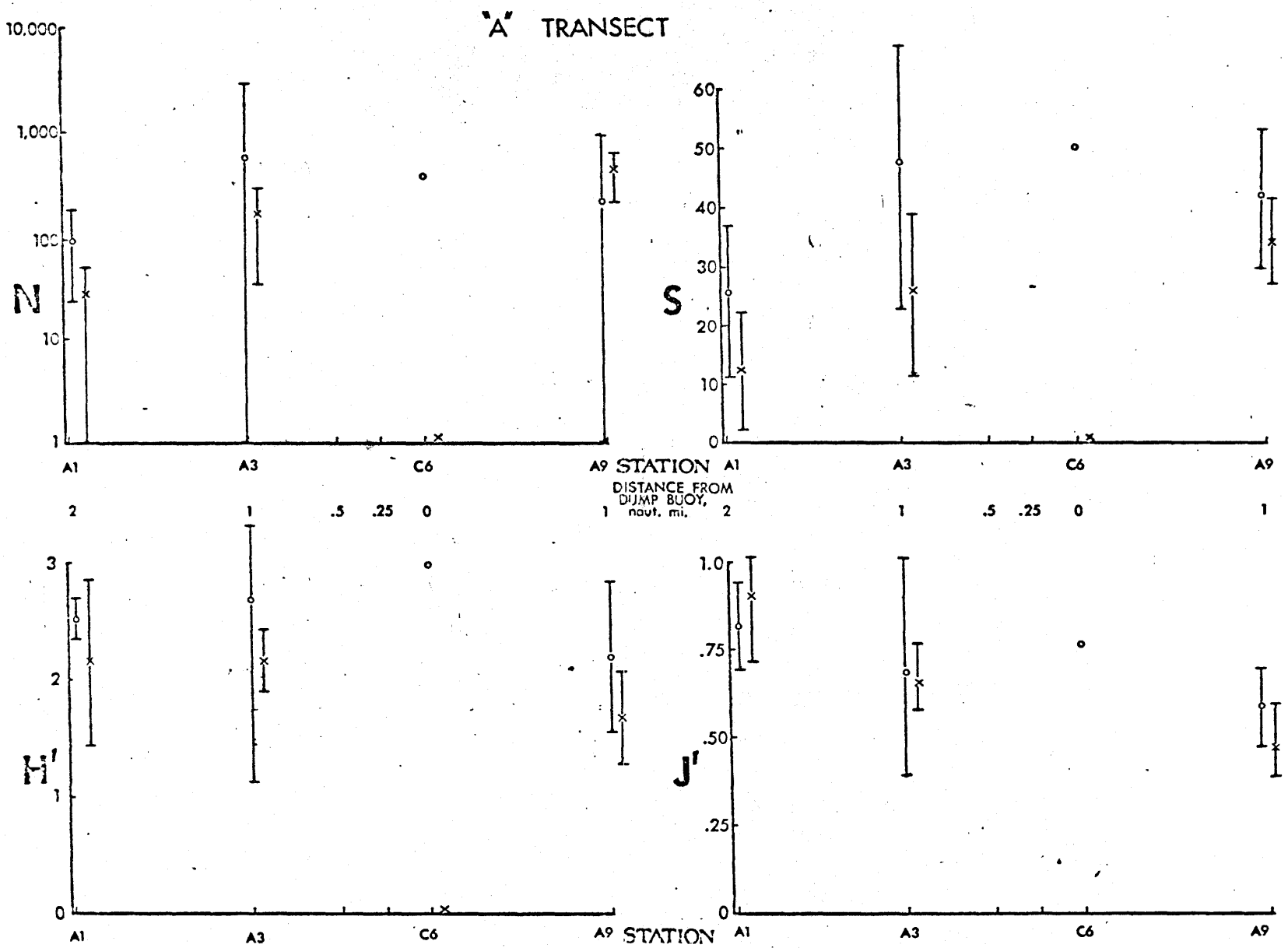


Figure 1. Values for numbers of individuals (N) and species (S), diversity (H') and equitability (J') of macrofauna at selected stations. Means and 95% confidence limits indicated where replicate grabs analysed.
June-Jul 1973 - o Sept-Oct 1973 - x

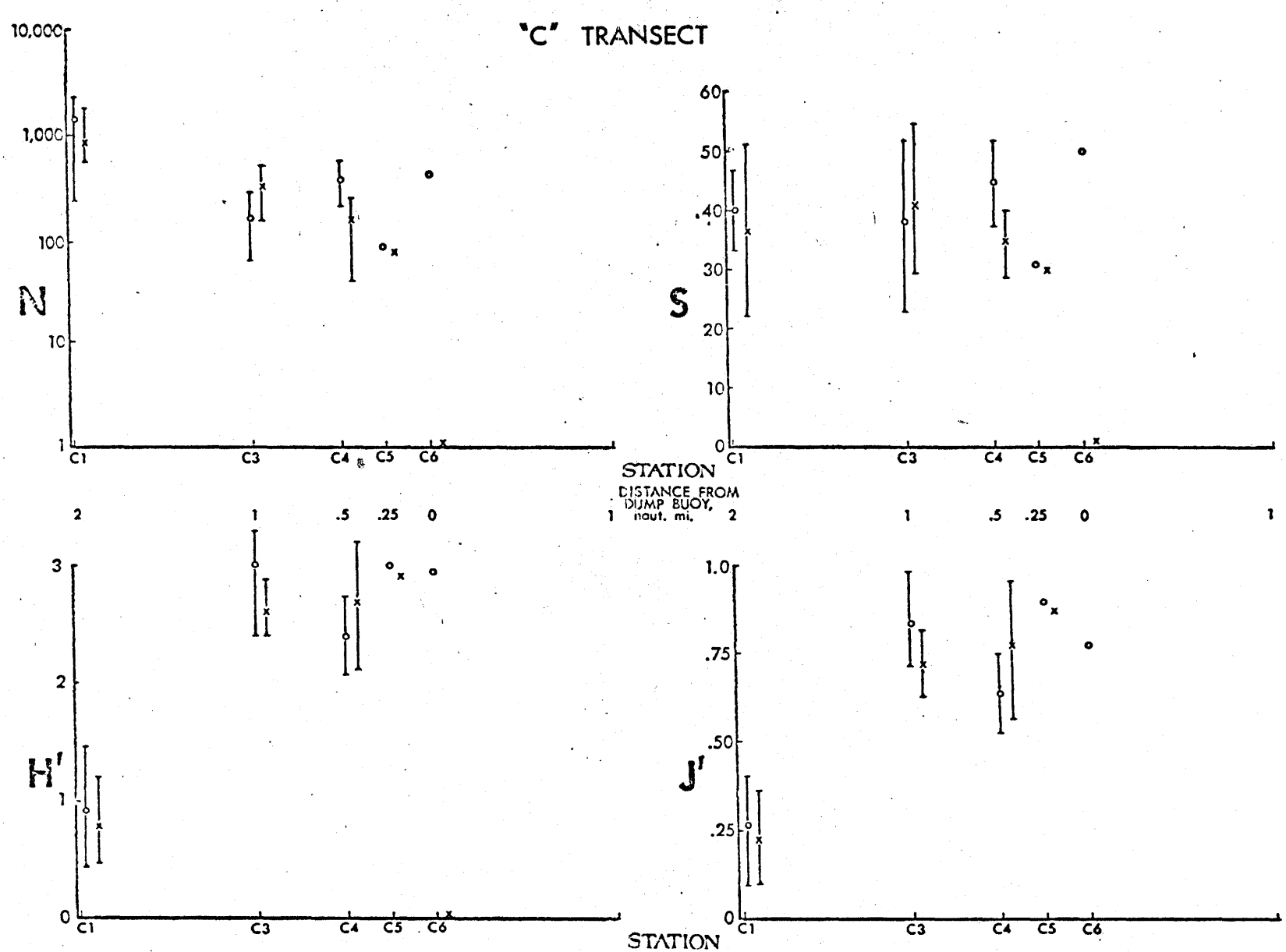


Figure 2. Values for numbers of individuals (N) and species (S), diversity (H') and equitability (J') of macrofauna at selected stations. Means and 95% confidence limits indicated where replicate grabs analysed.
June-Jul 1973 - o Sept-Oct 1973 - x

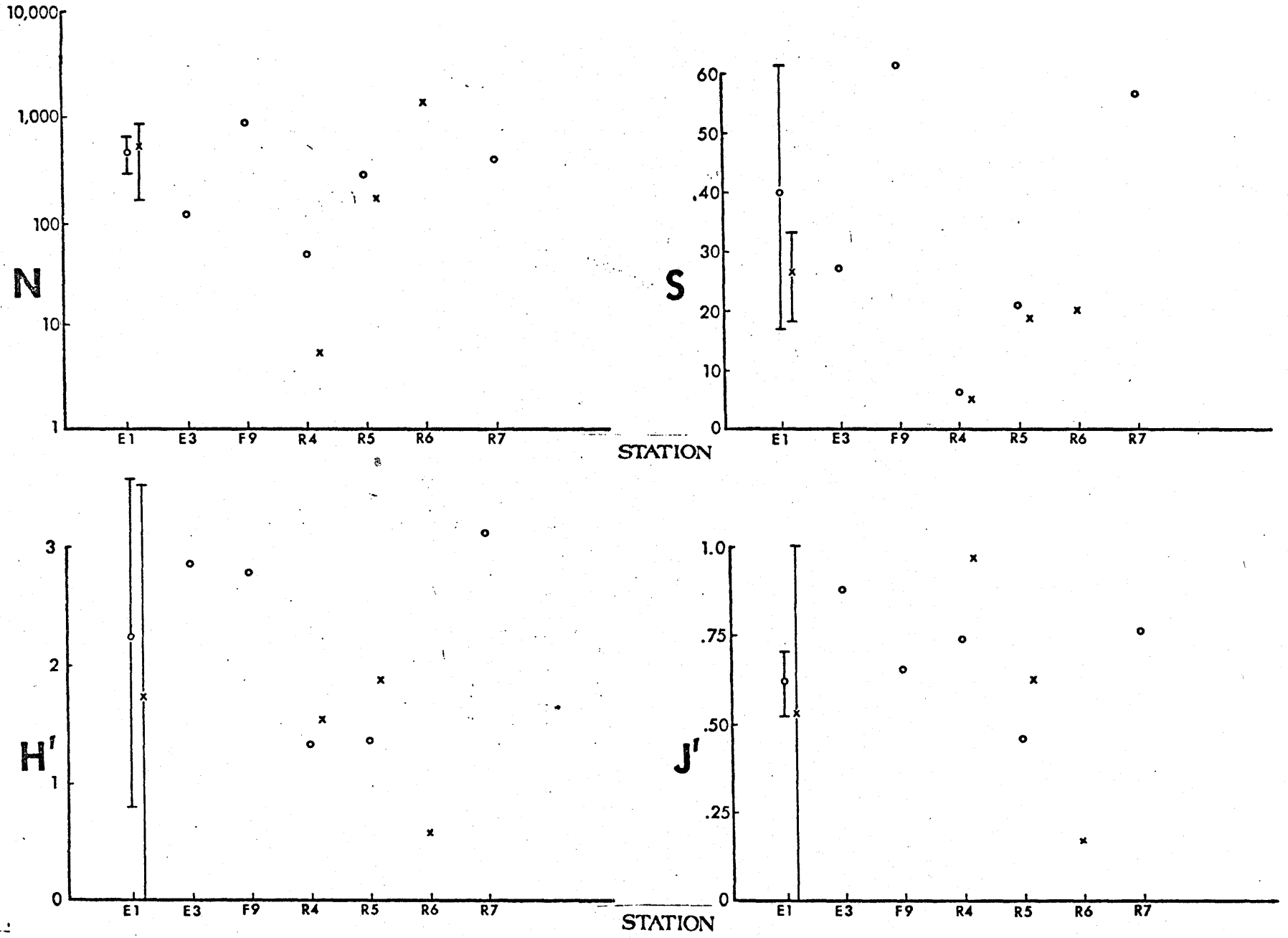


Figure 3. Values for numbers of individuals (N) and species (S), diversity (H') and equitability (J') of macrofauna at selected stations. Means and 95% confidence limits indicated where replicate grabs analysed.
June-Jul 1973 - o Sept-Oct 1973 - x

decreases in all of the above parameters; the single (apparently typical) grab analyzed for Cruise II contained soft spoils with a clay-like consistency and only one live organism. The only other significant change found to date at the $p < .05$ level was the reduction in number of individuals at C4 in October. This decrease could possibly be related to the spoil disposal, since C4 is ½ mile from the dump site, in the approximate direction of residual bottom drift. Much of the decrease was attributable to lower densities of Ampelisca vadorum, an amphipod crustacean. Ampelisca vadorum, whose distribution was somewhat patchy, appeared to experience a similar population reduction at Station C1, though not at C3, A3, A9 and A10, where it had also been abundant in July. Single grabs analyzed from C5, ¼ mile from the dump buoy, did not indicate any commensurate decline in N (Figure 2). In general, variability among replicate samples was such that in the future all five grabs per station must be processed, thus limiting the number of stations examined. Analysis of Cruise III samples will begin immediately upon return from the field operation in early February 1975.

B. Sediment Analyses

Short cores from 27 stations for each of Cruises I and II have been analyzed by Dr. Tony Cok, Department of Geology, Adelphi University, Long Island, New York, using a rapid sediment analyzer to determine percentages by weight of silt/clay, sand and gravel; mean and median grain diameters; as well as sorting index, skewness and kurtosis. Sediments taken in the

immediate spoiling area after dumping commenced contained a much higher proportion of fine materials than did the sediments typical of most of the disposal area. We are thus attempting to use increase in percent silt-clay as an indication of spoil movements away from the dump site. Figure 4 gives changes in silt-clay contents of surficial sediments between July and October. No large increase in fine materials is seen at any station except the dump site, C6. Decreases in percent silt-clay were found to outnumber increases at the stations analyzed.

C. Sedimentation Rate Studies

Results of further analyses of sediments collected in July and October 1974 in diver-deployed traps are given in Table 1. As discussed in the first quarterly report, total sedimentation appeared to diminish in October, perhaps due to lowered plankton productivity (this was corroborated by NYOSL's seston measurements). There may be a trend toward increasingly organic materials in October. More samples must be taken to see if this increase is persistent and statistically significant. Sediment traps have not been deployed since the October cruise. The third field survey is scheduled for 24-28 February 1975.

D. Biological Dive Studies

No further dives have been made since those discussed in the prior report. The next set of dives is scheduled for 24-28 February 1975.

Figure 4. Changes in % silt-clay of surficial sediments, July-October 1974

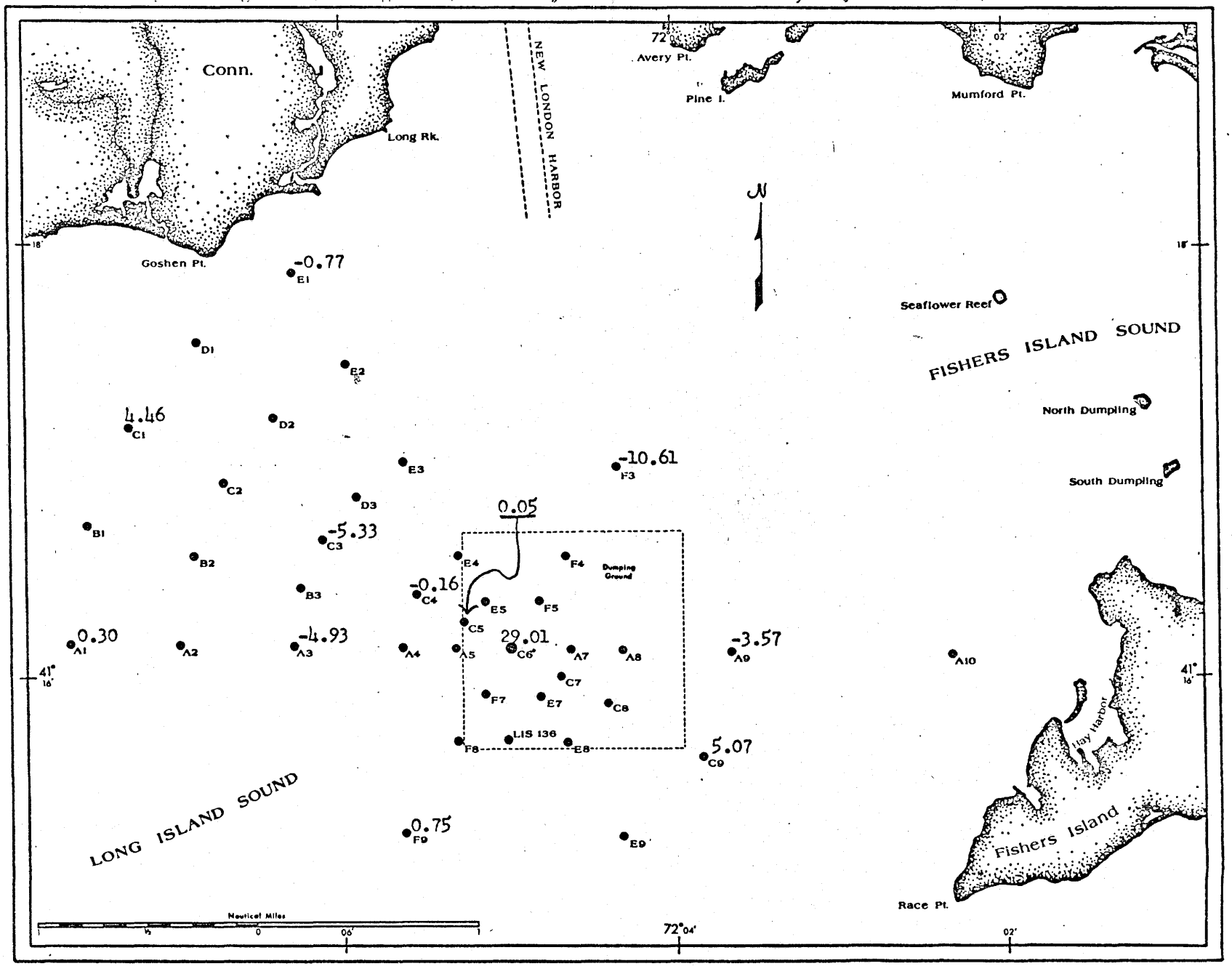


TABLE 1. SEDIMENTATION RATES AND ORGANIC CONTENT

July & October 1974

Station	TOTAL SEDIMENT (gm/trap/da)		DEPTH in SAMPLE	TOTAL CARBON, %		ORGANIC CARBON, %	
	July	Oct.		July	Oct.	July	Oct.
A2	4.11	1.34	TOP	1.62	3.64	1.01 2/	1.58
	(5.1) 1/		BOTTOM	0.79	3.78		3.47
A3	5.49	2.12	TOP	2.43	3.57	2.23 2/	3.21
			BOTTOM	0.36	3.13	1.97 3/	2.42
A4		0.95	TOP		3.55		2.61
			BOTTOM		3.40		3.33
E3		2.20	TOP		2.49		2.19
		(5.07)	BOTTOM		2.96		1.16

1/ Based on weight recovered and volume observed in trap prior to spillage

2/ Material taken from mid-depth in sampler

3/ Material from excess of total carbon analysis

E. Caged Organism Experiments

Analysis is under way on heavy metals contents and incidence of gill fouling and pathology in hard clams, *Mercenaria mercenaria*. These clams were returned to the laboratory for "baseline" analyses while other clams from the same batch were placed in cages at dumping and control buoys on 24 October 1974. Clams will be collected from the cages on the February cruise for comparative analysis.

IV. ACKNOWLEDGMENTS

This work is supported by the U. S. Navy through contract #74-00001 with MACFC. MACFC has subsequently subcontracted portions of the study to UCONN and NYOSL. Principal investigators for the various subprojects are:

UCONN - Dr. W. F. Bohlen (Suspended Material Transport, Thames River) Dr. S. Y. Feng (Dredging Effects on Shellfish Resources and Phytoplankton, Thames River); Dr. W. Lund (Dump Site Lobster Studies); Dr. L. Stewart (Related Dump Site SCUBA Studies); Mr. J. Cooke (Geofungi).

NYOSL - Dr. J. E. Alexander (Chemical) Oceanography of Dump Site); Dr. R. Valenti (Fish Distribution and Abundance); Dr. R. Hollman (Physical Oceanography of Dump Site).

MACFC - Mr. A. Draxler (Sediment Trap Experiments); Dr. J. Graikoski (Microbiology); Mr. R. McGrath (Benthic Macrofauna); Mr. R. Reid (SCUBA Surveys, Cage Experiments, Contract Representative).

We wish to thank Ms. Ann Frame for her role in identification of benthic macrofauna specimens, and also the many other personnel who aided in collecting, sorting, identifying and diving.

December 31, 1974

APPENDIX A

To: Dr. Robert Reid, Monitoring Project Leader

From: Dr. W. Frank Bohlen, Principal Investigator W. Frank Bohlen.

Subject: The Investigation of Suspended Material Transport in the Thames Estuary: Progress Report for the Quarter ending December 31, 1974.

During the quarter ending on December 31, 1974 the following project elements have been completed:

1. The velocity field within the study area was detailed over a tidal cycle. High resolution survey techniques were employed to determine current magnitude, direction and spatial variability. These data are being used to select the optimum modeling scheme for the determination of mass transport and hydraulic variations induced by dredging. Preliminary reviews indicate sufficient lateral homogeneity to permit use of two-dimensional modeling. At present two models are under consideration.

2. The temporal variability in suspended material concentration has been detailed over a tidal cycle. Hourly samples were obtained during the tidal cycle survey (Table 1) at a network of ten stations. These data are being combined with previous survey data to permit estimation of the average suspended load levels under streamflow, tidal and meteorological conditions characteristic of the fall season. The influence of aperiodic storm events on these average concentration levels will be examined during the next six months. The initial survey of this sequence was conducted in

November immediately following a five day period of intense winds. Initial reviews of these data indicate relatively minor perturbations. These data however are not considered to be representative of the total system response to storms. Previous studies have shown that the magnitude of storm-induced perturbations varies as a function of wind direction and storm duration. Maximum variations were induced by systems rich in northerly wind components. The event observed in November was dominated by southerly winds and is therefore not an accurate indicator of a 'worst-case' storm. Surveys during the next quarter will attempt to detail the system's response to such an event.

3. An initial evaluation of the impact of the dredging operation on the local suspended material field has been completed. Analyses of the concentration levels within the study area indicate that the direct influence of the dredge and barge is confined to an area having a radius of approximately 150 m. The impact area is seldom symmetrical and tends to elongate in response to the velocity field. Within this zone concentrations can exceed ambient levels by a factor of ten to twenty. The ultimate fate of these materials remains to be determined.

The composition of the suspended materials within the study area and the impact zone is presently being analyzed. Initial reviews indicate that particle size distributions in the vicinity of the dredge are skewed with respect to those outside of the impact

zone. Coulter Counter measurements suggest that a selective removal of fine particles has occurred. Possible causes for such removal and the accuracy of the measurements are presently being investigated.

In addition to particle sizing, composition analyses also permit detailing the relative percentage of organic materials in suspension. Laboratory measurements of the organic carbon content contained in each sample were initiated on a routine basis during the past month. Instrumentation difficulties precluded earlier initiation of this procedure. Analysis of the samples obtained during the past three months will be included in the next quarterly report.

4. The microbiological data were assembled and reviewed in order to assess the utility of geofungi as indicators of transport. The data report is included (Appendix A). Although this investigation is not yet complete, a review of these data suggests that the constraints on the microbiological community imposed by the environmental conditions characteristic of the lower Thames River will represent the primary determinant of the utility of geofungi as transport indicators. A low diversity assemblage of organisms able to survive the stress induced by the move from the anerobic riverine environment to the well-oxygenated, higher salinity conditions of the dumpsite may provide an excellent indication of transport. Conversely, limited tolerance will preclude accurate evaluations of transport. The factors governing the utility of geofungi as transport indicators will continue to be investigated during the next quarter.

Table 1

Survey Summary

October 1, 1974 - December 31, 1974

Date	No. of Stations	Parameters Sampled
November 27, 1974	5	Water Temperature, Salinity, Suspended Solids
November 29, 1974	26	Water Temperature, Salinity, Suspended Solids, Transmission Orthophosphates, Turbidity in Vicinity of Dredge-Barge
December 12, 1974	10	Current Speed and Direction over Tidal Cycle, Concurrent Water Temperature, Salinity, Suspended Solids, Transmission

Appendix A

Microbiological Studies

John C. Cooke

INTRODUCTION

Filamentous geofungi have not been used extensively as indicators of material transport in estuaries although their presence in marine habitats is well documented (Johnson, 1967). Geofungi enter estuaries with domestic and industrial wastes (Wang, 1965; Churchland and McClaren, 1973) and with sediments introduced through natural erosive processes. Most geofungi are introduced as spores and usually do not grow in the dilute nutrients of the river and estuarine waters. However, the spores are capable of surviving the initial changes in chemical and physical factors during transport into the marine waters.

In February of 1974 a survey of geofungi associated with suspended and bottom sediments was begun in the main channel of the Thames River estuary and adjacent waters of Long Island Sound. The study was begun prior to the beginning of dredging operations in the river. This study is part of an investigation to determine the suspended material transport characteristics and the effects of channel dredging on the material transport in the lower Thames River estuary. The main objectives of this part of the study are: (1) to determine the quantity of suspended sediments in surface and bottom water samples at selected stations and to correlate the findings with the number and genera of geofungi present, (2) to correlate temperature, pH and salinity with the number and genera of geofungi present at each station and (3) to determine the geofungi present in sedentary bottom muds to determine the viability of fungi deposited with associated sediments. A preliminary study of geofungi in the Connecticut River estuary was made in the

summer of 1973 (Cooke, 1974). The results of this study suggest that isolation and identification of geofungi associated with suspended sediments will help to determine the source of the sediments and the routes and rates of sediment transport.

This report presents the data from the first 8 months of this investigation. The physical and chemical characteristics of the water sampled and the number of fungi per sample are included.

METHODS

I. Sampling Sites

Samping stations were established initially in New London Harbor, in channel, at Buoy #2 (A) and Buoy #6 (B) and to the east of the harbor at Vixen Ledge (E). Additional stations were established at a later date in the Thames River at Buoy #2 (D) north of Gold Star Memorial Bridge; in the area of dredging (C), not a permanent location; and in Mumford Cove (F) to the west of Channel Marker #5, an area not directly affected by river discharge. The location of each of the stations is shown in Fig. 1.

Sampling was begun on February 19, 1974 for stations A, B, and E; on March 7, 1974 for station F; and April 18, 1974 for station D. Sampling at station C was begun September 17, 1974. Dates and times samples were collected are given in the following tables. Sixteen cruises were made between February and December 1974.

II. Sampling Procedures

Surface water samples were collected aseptically 1 meter below the surface of the water in 500 ml sterile polyethylene bottles using a sampling device designed to open and close the lid of the sampling jars below the surface of the water. Two liters of surface water were collected at each station. Bottom water samples were collected aseptically 2 meters from the bottom using sterile Niskin bags (Niskin, 1962). One to two liters of bottom water were collected at each station. Sediment samples were collected with a Phleger Corer lined with presterilized plastic liners (surface sterilized with

10% Chlorox solution). Surface water, bottom water and core samples were placed in a cooler and brought back to the laboratory for analysis.

Temperature of surface water at each station was made with a standard oceanographic bucket thermometer.

III. Analytical Procedures

The pH of surface and bottom water samples was determined with a pH meter (Coleman; Metrion IV) in the laboratory within 2 hours of sampling time. Salinity of water samples was determined from measurements made for chlorinity using a tritration method. Determinations of the by-weight concentration of total suspended material in water samples was made with standard vacuum filtration techniques. Preweighed membrane filters (Millipore 47mm - 0.45μ Type HA) were mounted in glass Millipore filtration assemblies. One liter of sampled water was filtered. The filters were dried at 50°C overnight and reweighed.

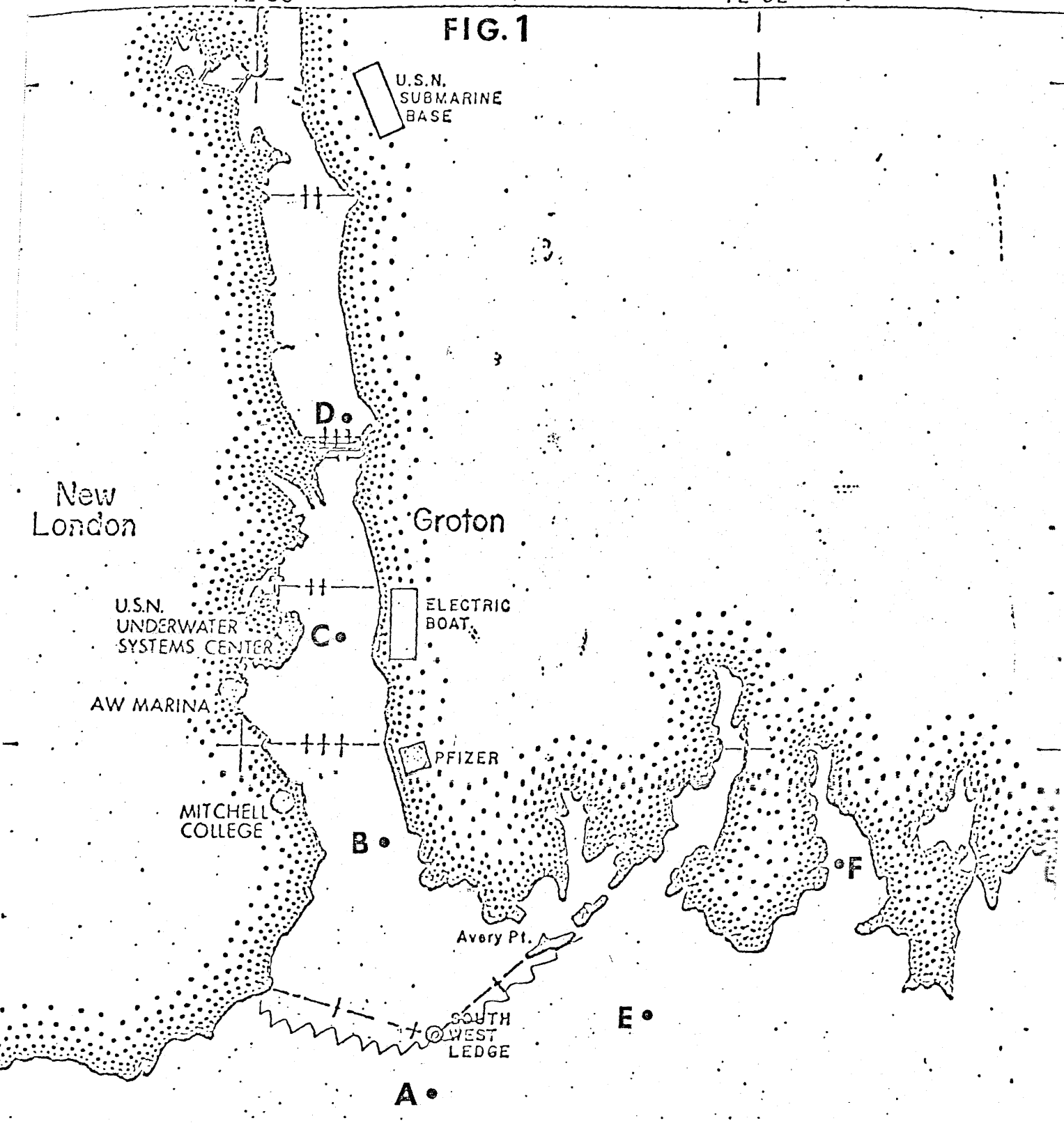
One milliliter alequots of sampled water were placed on the surface of sterile media in 9 cm. plastic petri plates. Two different media were used: special salt water agar and low nutrient Sabourard's dextrose agar. Penicillin-G and streptomycin sulfate were added to each to retard bacterial growth. Three replicate plates of each medium were made for each water sample.

Core samples were treated as follows. Small portions of mud (0.25g wet weight) from the center-top and from 1 inch below the top of each core were suspended by shaking in 200 ml of sterilized aged sea water. One milliliter alequots were placed on the surface of each

medium (2 replicate plates for each suspended sample). Also, direct application of mud was made from the top of the core and from 1 inch below the top on two replicate plates of each medium (15 spots of core material/ plate). Aseptic techniques were followed while working with the cores to prevent air contamination.

The plates were maintained at room temperature or at 22°C for 4-6 weeks. They were then examined for the total number of different species per plate. Identification of each species or genus was made at this time if possible or slides and pure cultures were made for identification at a later time.

FIG. 1


U.S.N.
SUBMARINE
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AW MARINA
PFIZER
MITCHELL
COLLEGE
B
F
Avery Pt.
SOUTH
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LEDGE
E
A

STATION A: BUOY #2 - New London Harbor (South of New London Light)

DATE	HIGH TIDE	TIME SAMPLED	°C. TEMP.	pH	°/oo SALINITY	mg/l SEDIMENT	Surface - TOTAL #/SAMPLE	Bottom - TOTAL #/SAMPLE	Core - TOTAL #/SAMPLE
2-19-74	7:00AM	10:00A.M.	3.2	7.5	29.06	1.10	38/13plates		
3-07-74	9:07AM	9:30 A.M.	4.9	7.5	29.98	1.90	19/9 plates		
3-26-74	11:57AM	9:20 A.M.	4.1	7.5	24.59	2.29	64/8 plates		
4-18-74	7:07AM	9:55A.M.	10.0	7.8	24.07	1.05	64/8 plates		
5-09-74	12:23PM	9:10A.M.	9.2	7.8	29.53	2.20	13/8 plates		
5-17-74	6:22AM	12:30P.M.	14.6	7.8	25.45	5.22	27/6 plates		
6-06-74	11:17AM	10:45A.M.	13.4	7.8	29.08	0.79	6/6 plates		
6-27-74	4:28PM	10:40A.M.	15.1	7.8	30.89	4.70	8/6 plates		
7-17-74	7:55AM	11:20A.M.	18.7	7.9	30.86	1.07	16/6 plates		
7-03-74	9:31AM	11:40A.M.	-	-	-	-			6/8 plates (35 foot depth)
8-06-74	12:16PM	9:30A.M.	20.0	7.9	27.31	2.19	7/6 plates		28/16 plates
8-28-74	7:02AM	10:40A.M.	21.4	7.1	30.35	39.74	5/6 plates		29/16 plates
9-17-74	10:44AM	3:00P.M.	20.0	8.0S 8.2B	29.89S 30.81B	8.84S 10.18B	10/6 plates	5/6 plates	
10-11-74	4:02AM	10:40A.M.	16.2	8.1S 8.2B	28.58S 30.63B	6.34S 3.80B	15/6 plates		
11-1-74	9:42AM	1:45P.M.	14.1	8.2S 8.2B	30.81S 30.81B	lost			
12-13-74	8:42AM	10:25A.M.	5.4	8.0S 8.1B	21.18S 30.35B	4.98S 3.76B			

STATION B: Buoy #6 - New London Harbor (Near Pfizer's)

DATE	HIGH TIDE	TIME SAMPLED	°C. TEMP.	pH	‰ SALINITY	mg/l SEDIMENT	Surface - TOTAL #/SAMPLE	Bottom - TOTAL #/SAMPLE	Core - TOTAL #/SAMPLE
2-19-74	7:00AM	10:30A.M.	2.7	7.5	22.72	1.00	39/14plates		
3-07-74	9:07AM	9:00A.M.	6.6	7.5	20.00	3.50	18/8 plates		
3-26-74	11:57AM	8:50A.M.	5.2	7.5	13.70	4.27	59/8 plates		
4-18-74	7:07AM	9:00A.M.	9.1	7.8	14.55	2.49	63/8 plates		
5-09-74	12:23PM	9:25A.M.	12.0	7.6	20.45	1.98	49/8 plates		
5-17-74	6:22AM	11:45A.M.	17.7	7.1	12.28	2.50	27/6 plates		
6-06-74	11:17AM	11:00A.M.	15.5	7.8	19.54	2.15	15/6 plates		
6-27-74	4:28PM	10:50A.M.	15.7	7.5	26.81	9.16	7/6 plates		
7-03-74	9:31AM	11:00A.M.	-	-	-	-	-		7/8 plates (32 ft. depth)
7-17-74	7:55AM	11:35A.M.	19.8	7.8	29.08	0.88	24/6 plates		
8-06-74	12:16PM	9:45A.M.	21.0	7.8	25.61	4.94	7/6 plates		31/16 plates
8-28-74	7:02AM	10:15A.M.	21.4	7.3	27.60	9.3	11/6 plates		28/16 plates
9-17-74	10;44AM	2:35P.M.	20.5	8.1S 8.1B	28.52S 30.81B	11.71S 11.84B	9/6 plates	4/6 plates	
10-11-74	4:02AM	11:00A.M.	16.4	8.0S 8.1B	26.22S 30.35B	11.68S 7.20B			
11-1-74	9:42AM	1:30P.M.	15.0	7.9S 8.2B	25.30S 30.81B	lost			
12-13-74	8:42AM	10:45A.M.	5.0	7.7S 7.9B	11.08S 29.43B	0.92S 12.55B			

STATION C: (In area of dredging) - New London Harbor (between Buoy #6 and Buoy #12)

DATE	HIGH TIDE	TIME SAMPLED	°C. TEMP.	pH	°/oo SALINITY	mg/l SEDIMENT	Surface - TOTAL #/SAMPLE	Bottom - TOTAL #/SAMPLE	LOCATION
9-17-74		2:15P.M.	21.0	8.1S 8.0B	29.97S 30.87B	10.31S 15.28B	5/6 plates	6/6 plates	Between Buoys #8 #12 W. side of channel.
11-01-74	9:42A.M.	1:10P.M.	14.2	8.1S 8.1B	27.59S 30.81B	lost			same as above. Next to Sound Lab.
12-13-74	8:42A.M.	11:40A.M.	6.6	7.8S 8.1B	19.33S 30.35B	18.29S 11.06B			¼mi. S. of Buoy #8 below dredge, off Pfizers.

STATION D: Buoy #2 - Thames River (North of Gold Star Memorial Bridge)

DATE	High TIDE	Time SAMPLED	°C. TEMP.	pH	°/oo SALINITY	mg/l SEDIMENT	Surface - TOTAL #/SAMPLE	Bottom - TOTAL #/SAMPLE	Core - TOTAL #/SAMPLE
4-18-74	7:07AM	9:25A.M.	12.1	7.6	5.93	4.61	83/8 plates		
5-09-74	12:23PM	10:00A.M.	13.8	7.5	11.37	2.25	42/8 plates		
5-17-74	6:22AM	12:08P.M.	17.7	7.3	7.74	6.22	54/6 plates		
6-06-74	11:17AM	11:30A.M.	20.2	7.7	15.01	3.17	17/6 plates		
6-27-74	4:28PM	11:30A.M.	17.0	7.5	20.91	9.60	27/6 plates		
7-03-74	9:31AM	10:30A.M.	-	-	-	-	-		1/8 plates (34 ft. depth)
7-17-74	7:55AM	12:15P.M.	22.5	7.9	25.45	7.82	26/6 plates		
8-06-74	12:16PM	10:50A.M.	26.0	8.3	18.79	11.36	4/6 plates		21/16 plates
*9-17-74	10:44AM	1:45P.M.	21.0	8.2S 8.0B	23.92S 29.90B	12.12S 12.95B	7/6 plates	4/6 plates	
10-11-74	4:02AM	11:35A.M.	16.2	7.9S 8.0B	21.17S 29.90B	37.36S 8.90B			
11-1-74	9:42AM	12:50P.M.	15.7	7.9S 8.0B	18.41S 29.43B	lost			
12-13-74	8:42AM	11:10A.M.	5.4	7.7S 8.0B	12.89S 29.90B	3.75S 6.61B			Samples for this date were taken S. of Buoy #12 in N.L. Harbor. (above Dunbar Dredge).
*8-28-74	7:02AM	10:15A.M.	21.4	7.3	27.60	9.30	1/6 plates		26/16 plates

STATION E: Vixen Ledge (Red Buoy marker)

DATE	HIGH TIDE	TIME SAMPLED	°C. TEMP.	pH	°/oo SALINITY	mg/l SEDIMENT	Surface - TOTAL #/SAMPLE
2-19-74	7:00AM	11:00A.M.	3.5	7.5	29.06	0.53	19/13 plates
3-07-74	9:07AM	9:45A.M.	4.8	7.5	29.06	2.80	17/8 plates
3-26-74	11:57AM	9:40A.M.	4.2	7.5	27.32	2.14	58/8 plates
4-18-74	7:07AM	10:00A.M.	7.5	7.9	25.90	0.67	58/8 plates
5-17-74	6:22AM	12:40P.M.	13.5	7.8	24.99	3.34	35/6 plates
6-06-74	11:17AM	10:20A.M.	13.3	7.7	29.08	1.06	5/6 plates
6-27-74	4:28PM	10:20A.M.	15.2	7.9	30.89	5.22	6/6 plates
7-17-74	7:55AM	10:45A.M.	18.3	8.1	30.44	0.18	10/6 plates
8-06-74	12:16PM	11:30A.M.	20.8	8.3	27.31	7.15	9/6 plates
8-28-74	7:02AM	11:00A.M.	21.7	7.6	30.36	1.53	7/6 plates
10-11-74	4:02AM	10:15A.M.	16.5	8.2	29.44	6.93	
11-01-74	9:42AM	2:00P.M.	14.6	7.9	27.59	lost	
12-13-74	8:42AM	9:55A.M.	7.4	8.1	28.52	4.26	

STATION F: Mumford Cove (West of Channel Marker #5)

DATE	HIGH TIDE	TIME SAMPLED	°C. TEMP.	pH	°/oo SALINITY	mg/l SEDIMENT	Surface - TOTAL #/SAMPLE
3-07-74	9:07AM	10:00A.M.	5.6	7.5	28.17	1.89	15/8 plates
3-26-74	11:57AM	10:00A.M.	4.3	7.5	27.32	2.41	42/8 plates
5-17-74	6:22AM	1:10P.M.	19.5	8.2	27.26	9.80	11/6 plates
6-06-74	11:17AM	9:40A.M.	16.5	8.0	29.98	0.77	5/6 plates
6-27-74	4:28PM	9:54A.M.	16.1	7.6	30.44	9.78	30/6 plates
7-17-74	7:55AM	10:15A.M.	20.8	8.0	29.98	0.40	30/6 plates
8-06-74	12:16PM	12:10P.M.	22.8	7.9	25.61	2.80	9/6 plates
8-28-74	7:02AM	11:30A.M.	23.7	7.7	29.44	8.24	5/6 plates
10-11-74	4:02AM	9:50A.M.	14.2	8.4	30.35	7.57	
11-1-74	9:42AM	2:10P.M.	15.3	8.4	30.35	lost	
12-13-74	8:42AM	9:35 A.M.	6.2	8.1	28.98	1.85	

RESULTS

Additional plates were used during initial sampling at each station. While this increased the total number of fungal colonies it added relatively few additional genera of geofungi. Dates with small numbers of genera observed are due in part to overgrowth of bacteria although a higher concentration of antibiotics was used.

Material plated from the cores collected on July 3 was taken at approximately 3 inches from the surface of the core. Five genera of fungi were observed but most plates showed no growth of either bacteria or fungi. This suggested that the anaerobic conditions of the bottom muds have an effect on the viability of the microbes and that the anaerobic organisms present in such muds do not grow on the media and under the conditions used. Subsequently, core samples taken during August, made use of material from the top of the cores or 1 inch below the surface for plating. Surface core material resulted in more fungal colonies and genera than the material from below the surface. Most of the genera observed from the cores are geofungi considered common and represent species that tolerate the chemical and physical conditions in the bottom sediments.

FUTURE PLANS

During the next month, the plates from October through December will be examined microscopically. During January through March, 3 cruises will be made to collect top and bottom water samples at stations A, B, C, and D.

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APPENDIX B

Quarterly Report

An Investigation on the Effects of Dredging in the Thames River on Shellfish Resources and Phytoplankton
(Contract No. 03-5-043-301)

October 1 to December 31, 1974

Submitted to

Sandy Hook Laboratory, Middle Atlantic Coastal Fisheries Center,
National Marine Fisheries Service
N.O.A.A.
U. S. Department of Commerce

by

S. Y. Feng
Marine Research Laboratory
University of Connecticut
Noank, Connecticut 06340

January 22, 1974

I. Field Accomplishments:

A. River Studies - Three cruises were made in November, 1974. Twenty four water samples from the six designated transects were collected for heavy metal analyses on November 4. In addition chlorophyll a, b and c were determined on 64 water samples. As usual temperature, salinity and dissolved oxygen measurements were taken at three depths (surface, mid-depth and bottom) at each station. On November 19 and 20 the following bivalve molluscs were taken from the mouth of the Thames River to ca. 9 miles upstream: *Mercenaria mercenaria*, 11 samples; *Crassostrea virginica*, 4 samples and *Pitar morrhuana*, 10 samples.

B. New London Dump Site Studies - Cruises to the dump site were made on November 25 and December 2, 1974. The purpose of these trips was to obtain lobsters from their burrows for use in the sonic tracking experiments. These attempts were unsuccessful primarily due to the lowered activity of lobsters associated with molting and rapidly decreasing water temperatures during this time of the year. The sonic tracking experiments will be deferred until late spring 1975 when water temperatures are more favourable for conducting such investigations. No outstanding events were detected on bottom conditions since dumping activities were minimal during this quarter.

Results of underwater photographic survey briefly described in our first quarterly report are now available in 3½ X 4½ prints. Underwater survey sites from which photographs were taken at New London disposal area, are shown in Fig. 1. Underwater photographs with descriptions of natural and dredge spoil bottom conditions as well as lobster habitats are presented for selected locations (Photo No. 1-16). 16 mm color footage at each location has also been edited and is available for viewing.

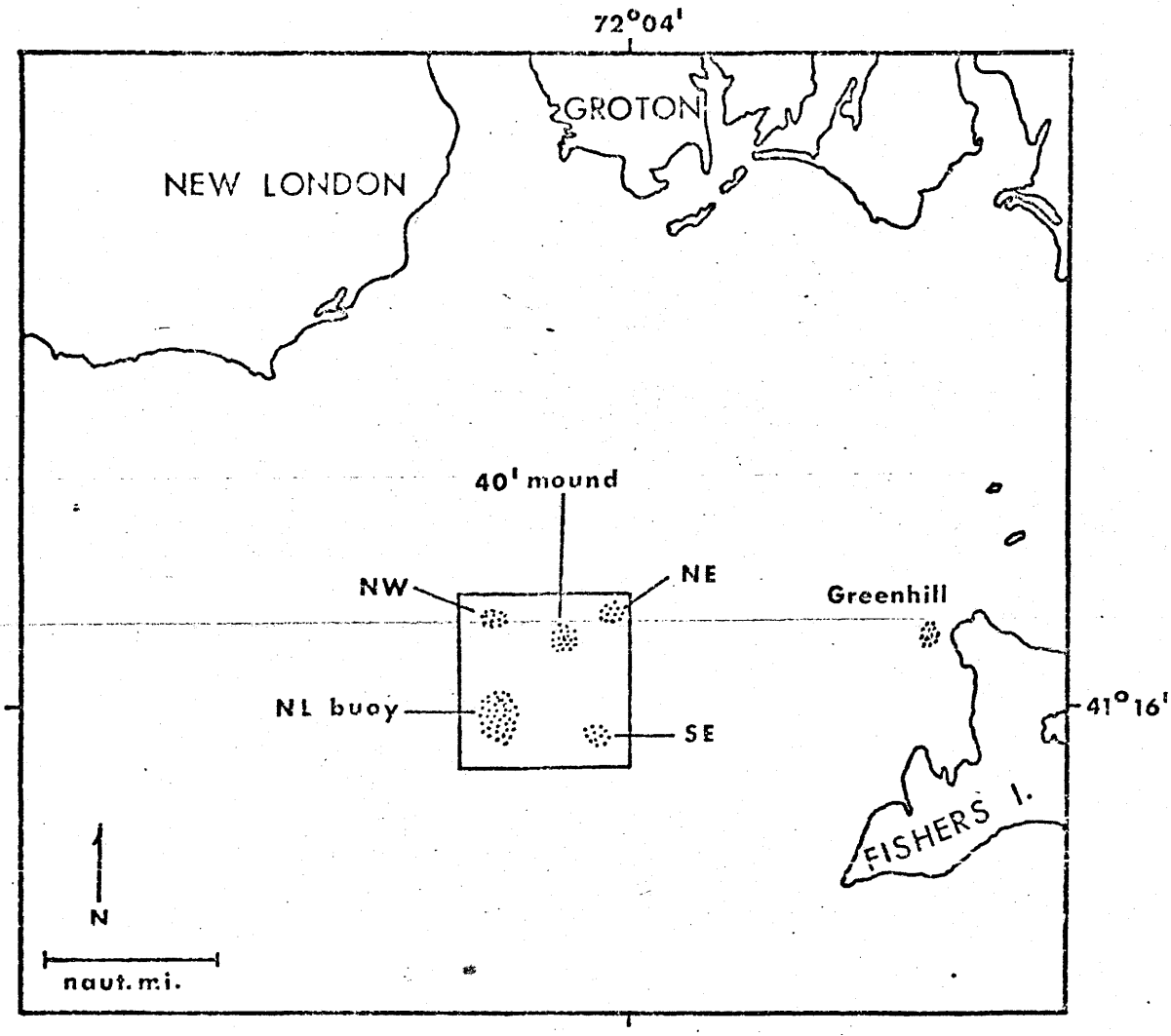

Figure 1. Locations of dive survey sites on the New London disposal area, May-October 1974.

Underwater Photographs at Selected Stations at the New London Dump Site

A. General Bottom Types

Photo No. 1. 5/21/74; N.E. Corner; Depth 52'; Horizontal field view of the photo (HFVP), 10". Natural erosion zone around masses of amphipod tubes with an exposed tube of Diopatra cuprea (upper center). General sediment condition compact and apparently consolidated by the infauna.

Photo No. 2. 5/21/74; N.E. Corner; Depth 52'; HFVP 8". Sponge Desmacidon sp. attached to shell fragments in dense concentration of amphipod tubes. Settling of suspended matter resulted in a fine silt veneer over relatively compact bottom sediment at the water-substrate interface.

Photo No. 3. 5/21/74; N.E. Corner; Depth 52'; HFVP 18". The demersal fish, Pseudopleuronectes americanus was abundant at all sites and frequently associated with amphipod community.

Photo No. 4. 6/26/74; N.L. Buoy; Depth 80'; HFVP 15". Natural sediment turnover mainly attributed to the activities of Busycon canaliculatum, Pagurus bernhardus, other crustaceans and burrowing finfish. Note the disturbed amphipod tubes and dislodged shell fragments.

Photo No. 5. 6/26/74; N.L. Buoy; Depth 80'; HFVP 18". Evidence of previous dumping of dredge spoils of estuarine origin as witnessed by the presence of oyster and bay scallop shells. Encrustation of Halichondria growth and squid egg clusters were often encountered.

Photo No. 6. 9/9/74; S.E. Corner; Depth 85'; HFVP 5'. Bloodstar, Henricia sanquinolenta was a major component of the epibenthic fauna at all stations. The heavy shell fragments and sand-mud substrate were similar to the substrate observed at N.L. site.

Photo No. 7. 5/21/74; Greenhill; Depth 40'; HFVP 8". Boulder substrate at Greenhill, N.Y. ca. 1.5 nautical miles to the east of the dump site showing dense fouling by Diadumine leucolena, Campanularia sp. and assorted algal tufts, mostly red Phycodrys sp.

Photo No. 8. 5/21/74; N.E. Corner; Depth 52'; HFVP 8". Boulder substrate at this site showing similar species compositions found at Greenhill.

B. Lobster Habitat

Photo No. 9. 6/26/74; N.L. Buoy; Depth 80'; HFVP 36". Typical lobster burrow in substrate rock also showing excavated materials, range of cobble-boulder sizes and associated epibenthic organisms.

Photo No. 10. 6/26/74; N.L. Buoy; Depth 75'; HFVP 30". Lobster burrow excavated in cohesive mud-silt substrate rich in amphipod tubes.

Photo No. 11. 5/21/74; N.E. Corner; Depth 50'; HFVP 20". Lobster burrow constructed with waterlogged wood from previous dumping operations. Wooden and steel beams, brass pipes and iron bulkheads were often sighted and provided attachment surfaces or shelter for benthic organisms.

C. Dredge Spoil Characteristics

Photo No. 12. 9/16/74; N.L. Buoy (N); Depth 70'; HFVP 15". Wood debris and clay clumps. Newly deposited spoil materials were estimated to be ca. 3 m. deep at this date.

Photo No. 13. 9/16/74; N.L. Buoy (N); Depth 70'; HFVP 8". Intact cohesive clay clump containing Crepidula fornicata shells.

Photo No. 14. 9/16/74; N.L. Buoy (N); Depth 70'; HFVP 24". Stable dredge spoil apparently showing minimal sorting and sediment transport by currents of 1-2 kt. flowing over the mound.

Photo No. 15. 9/16/74; N.L. Buoy (N); Depth 70'; HFVP 6". Finfish, crustaceans and fouling organisms were seen to colonize niches created by the newly deposited dredge spoils. Photo shows a Mercenaria shell embedded in clay with a newly settled anemone, D. leucolena (arrow).

Photo No. 16. 10/14/74; N.L. Buoy (S); Depth 75'; HFVP 20". Evidence of erosion of fine sediment about the clay clump.

Photo No.

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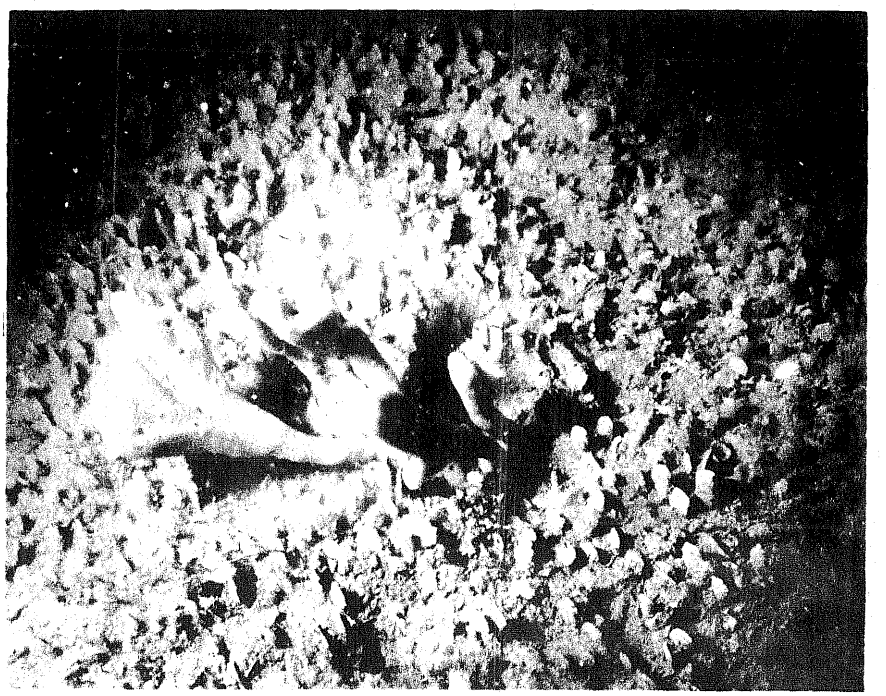

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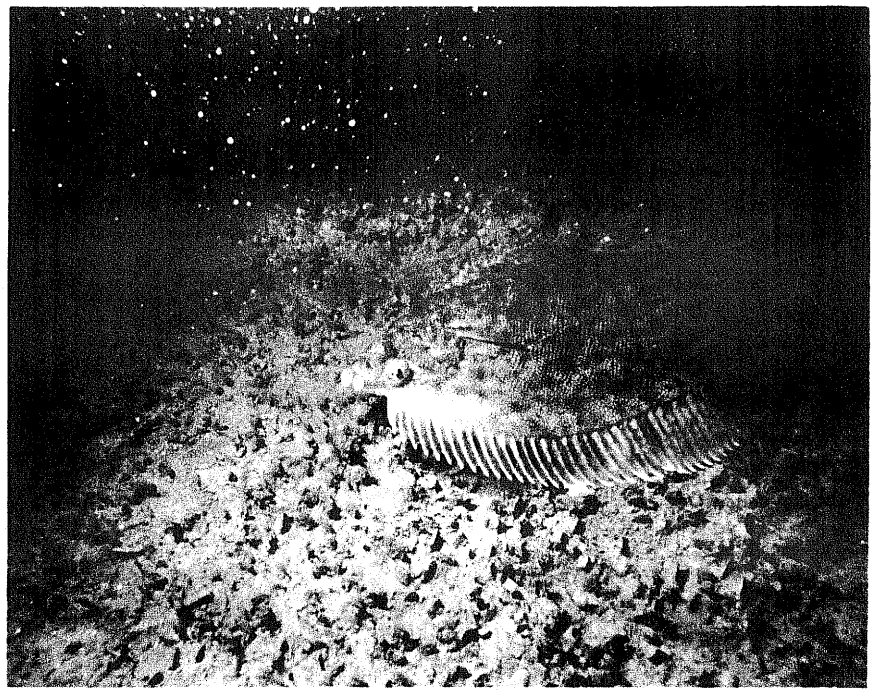

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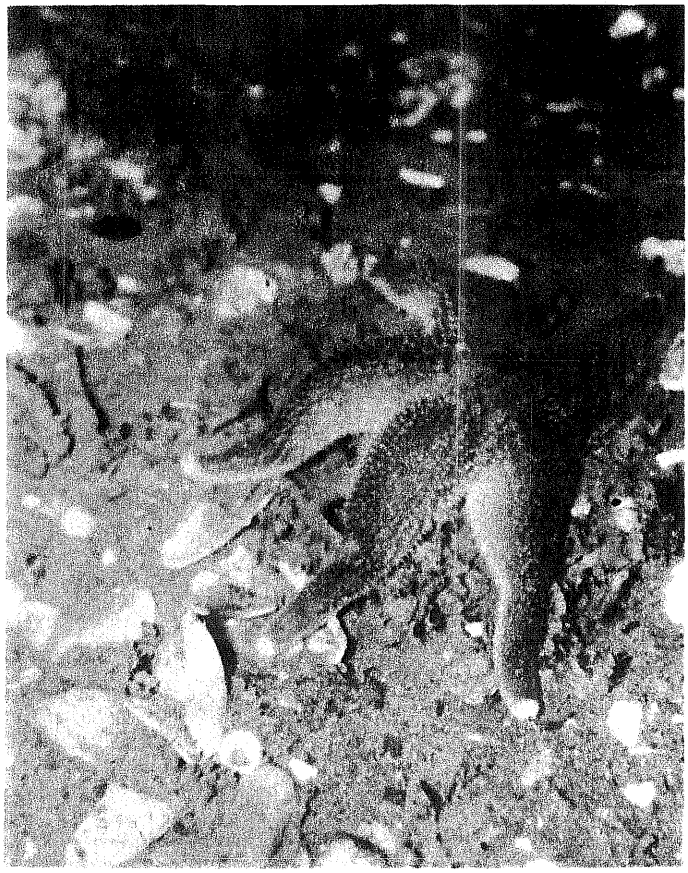

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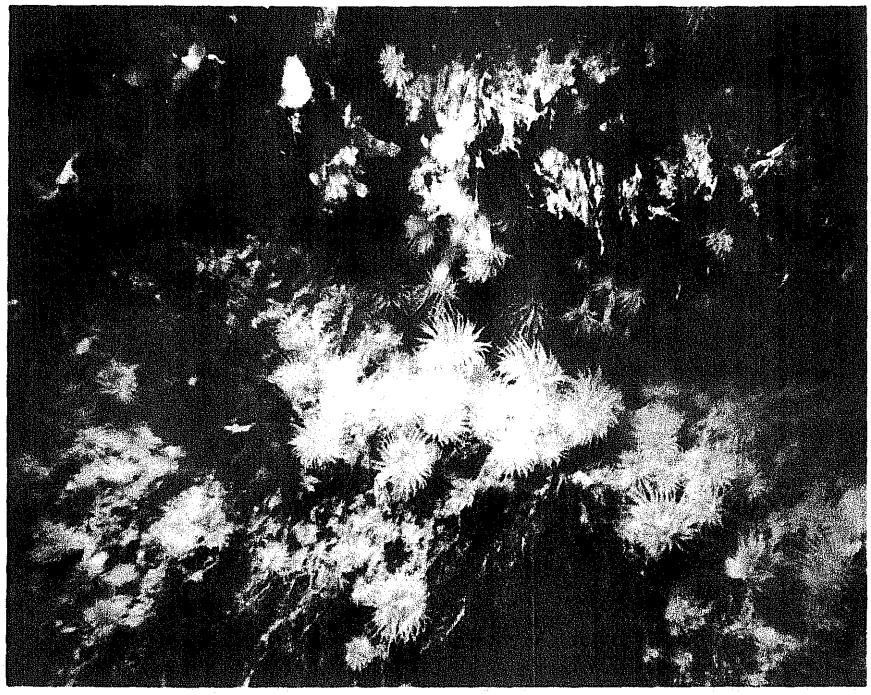

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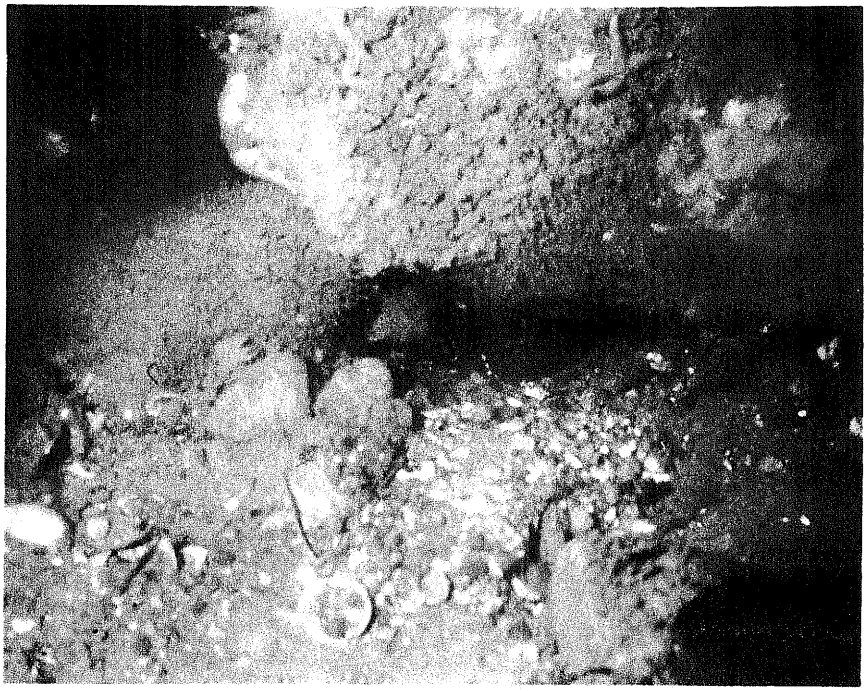

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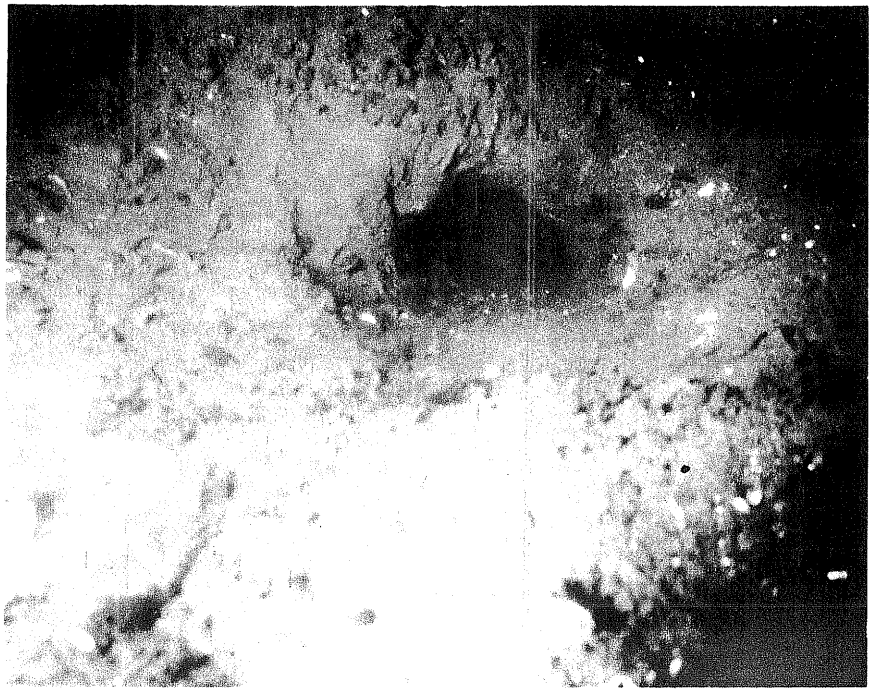

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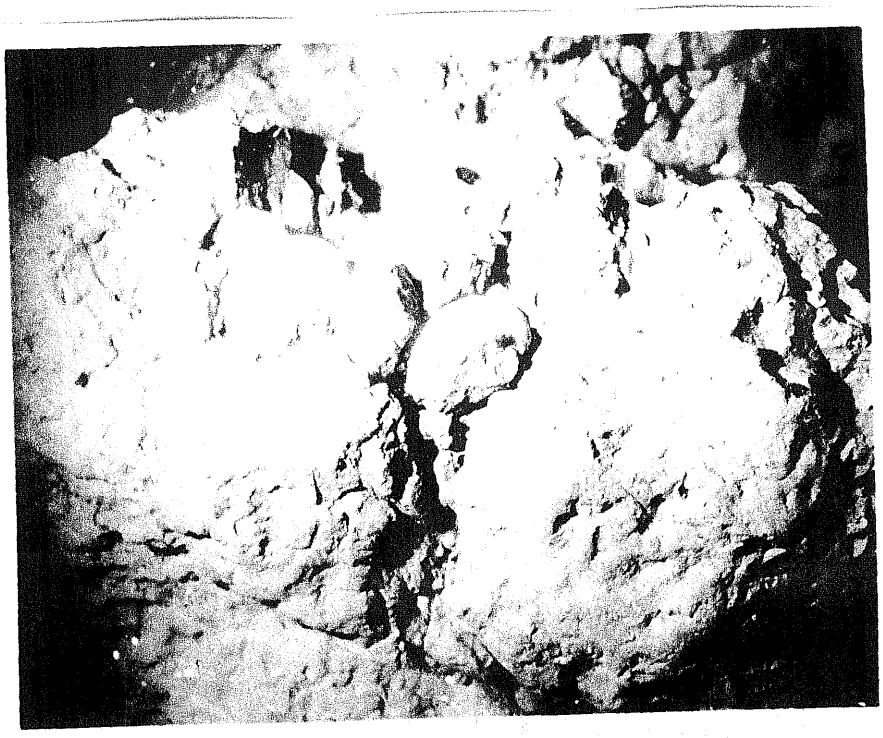

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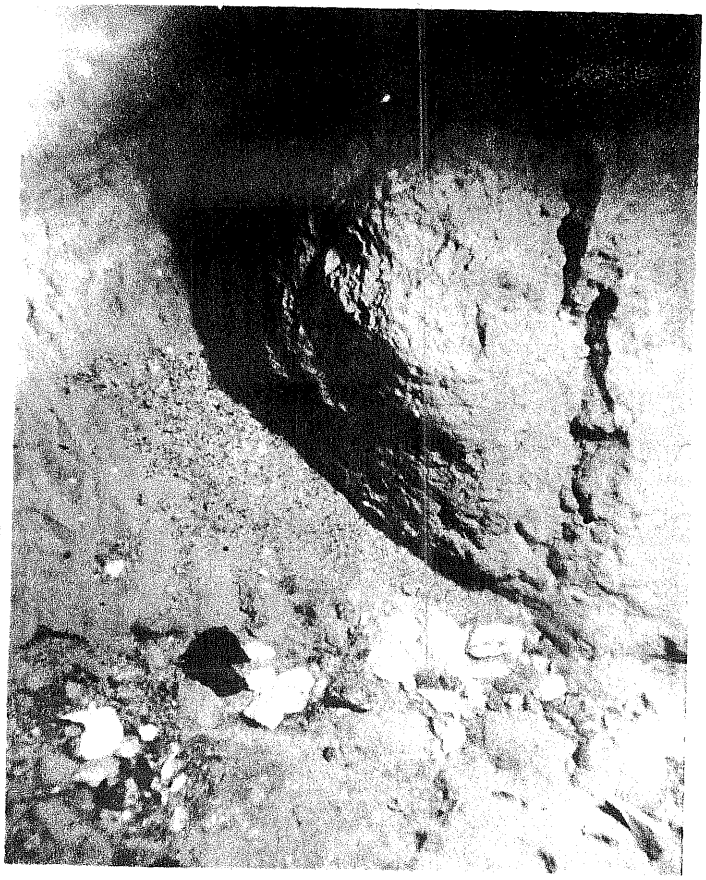


II. Laboratory Analyses:

A. Gross Pathological Survey - 8 to 10 individuals of the three species of shellfish from each station were dissected. The following anatomical regions were inspected for gross pathological conditions: inner and outer aspects of gills and palps, inner and outer aspects of mantle and pericardial cavity. Examinations of the specimens revealed no discernible abnormalities when contrasted with the control organisms obtained from Fishers Island Sound.

B. Heavy Metal Concentrations in the Thames River

The analyses of Zn, Cu, Cd, Ni and Cr in the three species of shellfish and water samples are still incomplete due to instrument failures. However, we expect to resume our analyses very soon; Instrumentation Laboratory has informed us that they will come to install the new atomic absorption spectrophotometer on January 29, 1975.

The mercury concentrations in the river water and in three species of shellfish were determined. The mercury concentrations of shellfish samples collected in July (pre-dredging) and November (post-dredging), 1974, are shown in Table I. The data are derived from averages of 252 *Mercenaria mercenaria* grouped into 30 samples, 192 *Pita morrhuana* grouped into 16 samples, and 70 *Crassostrea virginica* grouped into 8 samples. The sampling stations were distributed from the mouth of the river (station A) to about 7 miles upriver (station H). The oysters were taken from stations located about 8 to 9 miles upriver. The concentrations of mercury in *M. mercenaria* tended to be greater in the samples taken from farther up the river. The mercury concentrations of both *M. mercenaria* and *P. morrhuana* were somewhat greater in the November samples than in the July samples. On the other hand the concentrations of mercury in *C. virginica* were consistantly lower in the November samples.

The mercury concentrations of the water samples were determined using a new technique involving the concentration of the mercury in a cold trap before its measurement by gas phase atomic absorption spectrophotometry (Fitzgerald, et al., 1974. Analytical Chem., 43, 1882-1885). With this technique accurate determinations can be made on samples containing as little as 2 ng/L. The coefficient of variation or relative standard deviation of 14 standard solutions of 1 ng measured over a one month period was 8.2%.

Sixty water samples taken during July and November, 1974 at six transects ranging from the mouth at transect I to about 10 miles upstream at transect VI were analyzed for mercury (Table II, Figs. 2-4). The mercury concentrations of the July 2 samples ranged from 6 to 30 ng/L, which is typical of the concentrations in coastal Long Island Sound waters found by this laboratory. However, 16 days later on July 18 the trend had changed dramatically. During the low water period on that date the concentrations near the mouth were much greater and reached 410 ng/L in the bottom water at transect II. The flooding tide swept this highly mercury contaminated water mass up the river and a concentration of 132 ng/L was found in the bottom water at transect V. At this point the river still maintains a two-layer system and the high concentration of mercury in the more saline water moving up the river with the tide was restricted to the bottom layer. The concentrations in the river on November 4 were similar to those found on July 2. As with the July 2 samples, there was no clear pattern in the variations of the mercury concentrations among different transects or between the surface and bottom samples.

The data suggest that the concentrations of mercury in the water were about 1000 times less than in the shellfish. The concentrations of mercury in the water fluctuated greatly, apparently due to the periodic introduction of mercury from unknown sources in the area. On the other hand

the mercury concentrations in the shellfish did not vary greatly between the July and November samples, although small increases of *M. mercenaria* and *P. morrhuana* and small decreases for *C. virginica* were noted in the November samples.

Table I. Mercury Concentrations in the Three Species of Shellfish (expressed in ng/gm wet weight or ppb).

Species	Station	July 1974	November 1974
Mercenaria mercenaria	B	22	-
	C	26	39
	D	29	30
	E	26	41
	F	40	58
	G	41	48
	H	47	102
Pitar morrhuana	A	22	24
	C	12	21
	D	18	26
	E	-	34
	F	16	7
Crassostrea virginica	0-1	38	19
	0-2	50	34
	0-3	44	14
	0-4	46	38

Relative standard deviation = 6.8% for 50 ng Hg

Relative standard deviation = 3.9% for 100 ng Hg

Relative standard deviation = 2.4% for 200 ng Hg

Table II. Mercury Concentrations in Thames River Water (expressed in ng/L or ppt*)

Transect	Tide	7/2/74	7/18/74	11/4/74
I	LW-Surface		23	12
	-Bottom		80	48
	HW-S	12	15	17
	-B	12	62	9
II	LW-S		254	32
	-B		410	20
	HW-S	12	12	14
	-B	15	11	12
III	LW-S		15	26
	-B		7	20
	HW-S	10	6	8
	-B	30	7	7
IV	LW-S		13	11
	-B		33	9
	HW-S	14	46	16
	-B	15	41	16
V	LW-S		16	11
	-B		12	9
	HW-S	6	4	12
	-B	16	132	13
VI	LW-S		31	11
	-B		17	18
	HW-S	28	11	15
	-B	10	18	15

Relative standard deviation = 8.3% for 1 ng Hg

* parts per trillion.

Fig. 2. Mercury concentrations in Thames River water samples (7/2/74).

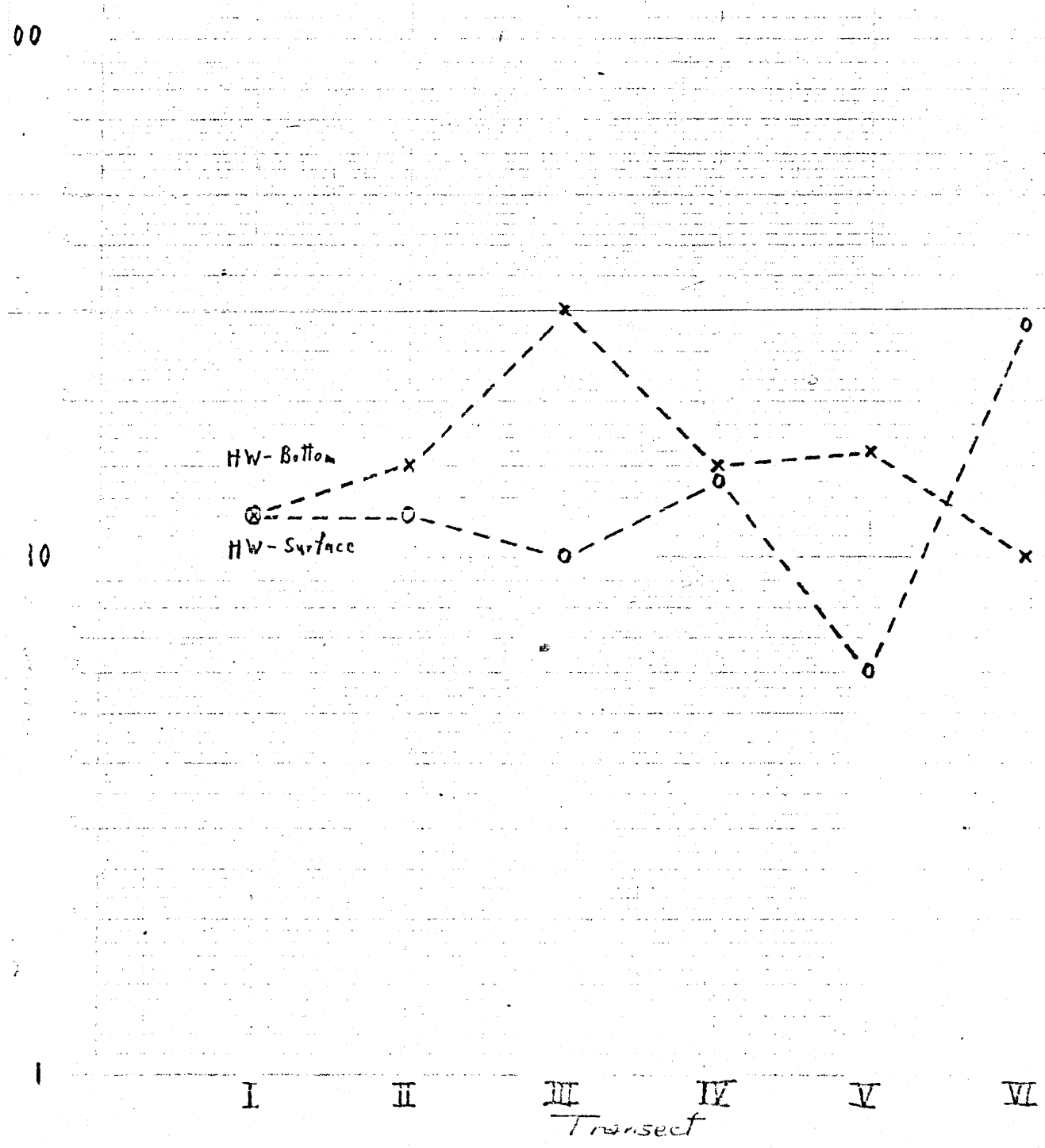


Fig. 3. Mercury concentration in Thames River water samples (7/18/74).

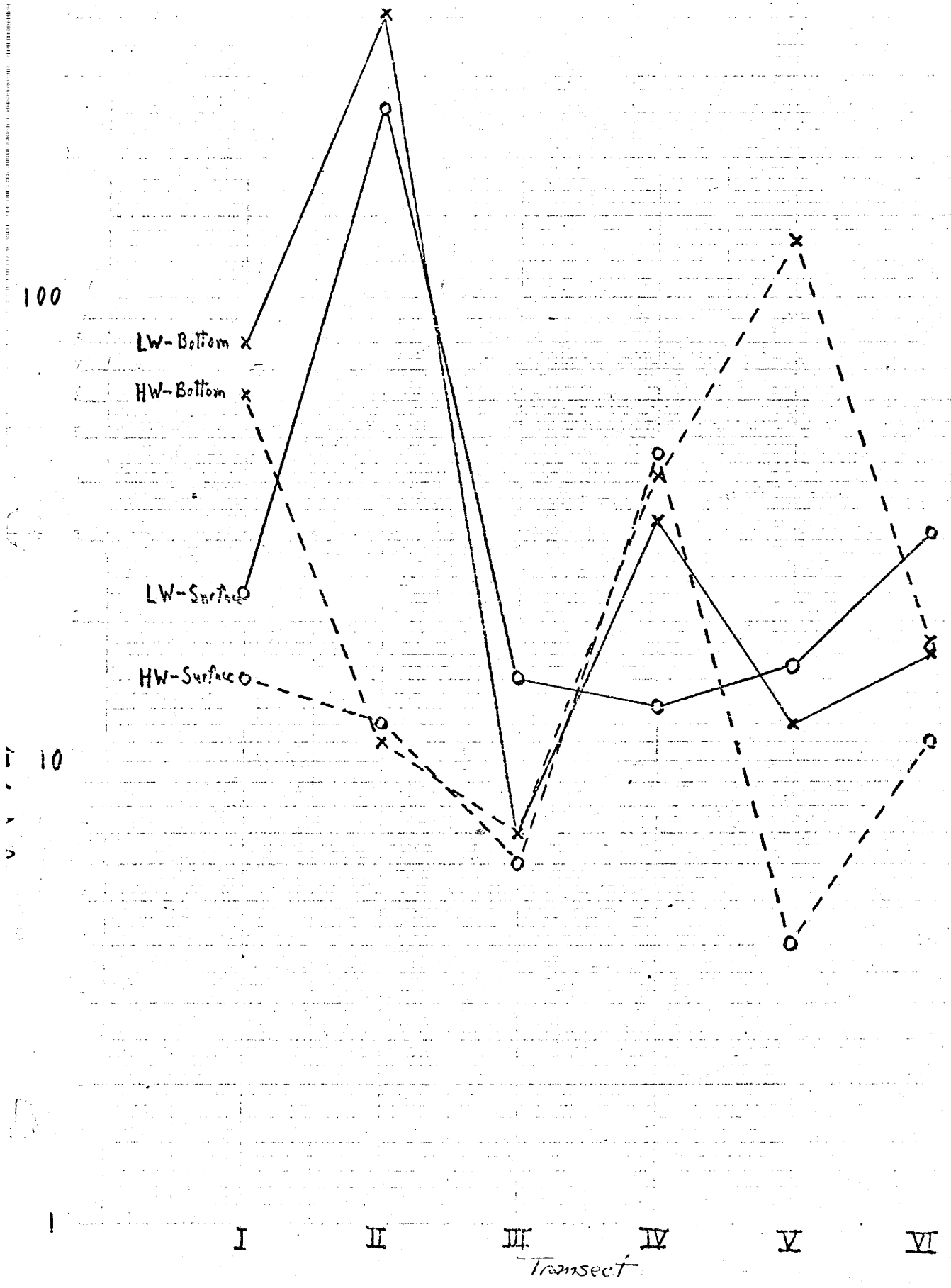
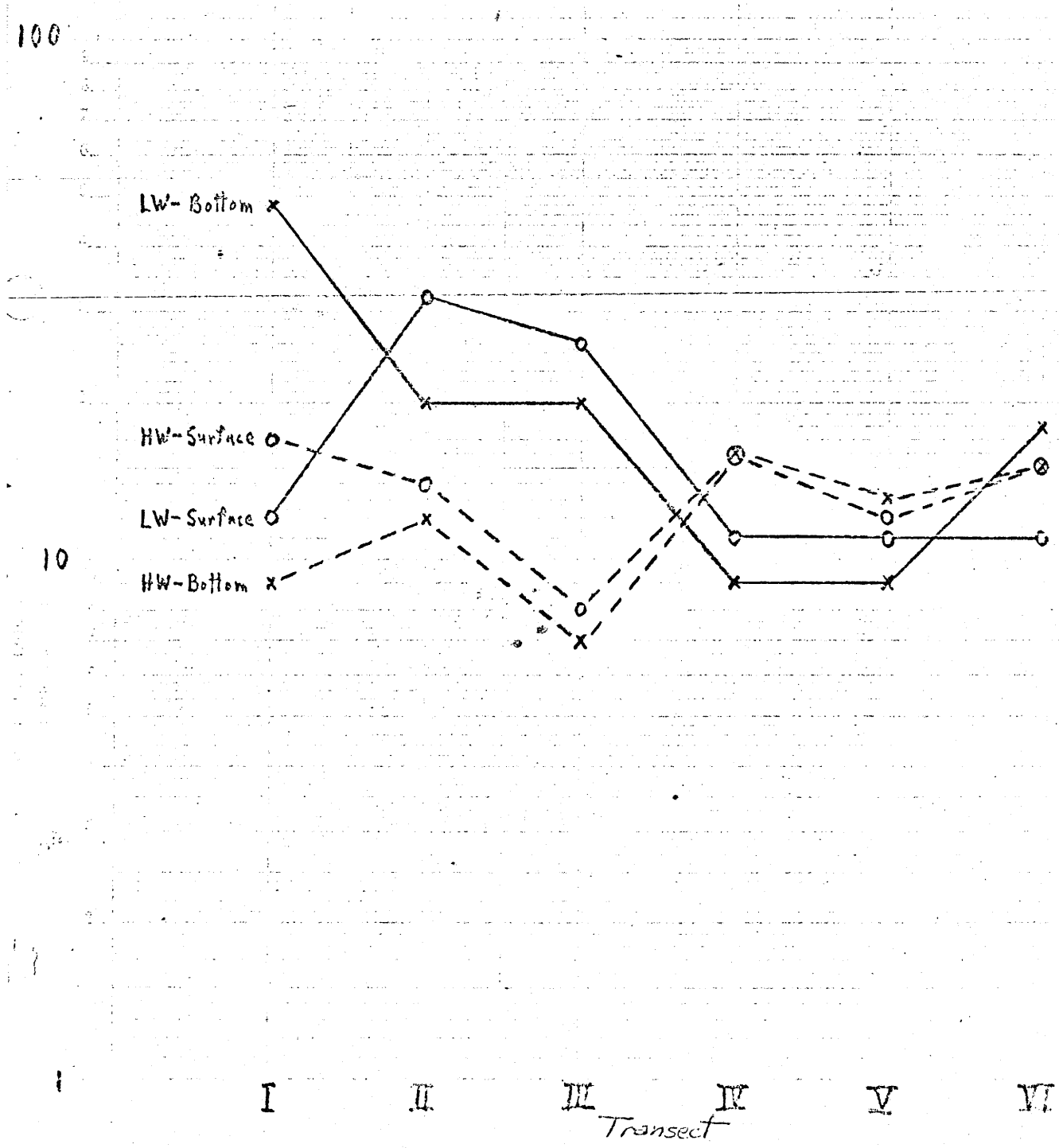


Fig. 4. Mercury concentration in Thames River water samples (11/4/74).



APPENDIX C

QUARTERLY REPORT

Physical Oceanography of the New
London Dump Site Area
October through December, 1974

Submitted to

Sandy Hook Laboratory, Middle Atlantic Coastal
Fisheries Center, National Marine Fisheries Service
NOAA/U.S. Dept. Commerce
under Contract No. 03-5-043-305

by

Rudolph Hollman, Ph.D.
New York Ocean Science Laboratory
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A. Cruise Descriptions

1) 31 July 1974.

Each station within the New London Dump Site Area (Figure 1) was sampled 5 times over a time interval of approximately 10 hours. The general aim was to determine background levels and tidal cycle variations. Fog had caused a delay in the start of this quasi-synoptic sampling program. The average results for temperature, salinity, and σ_t are tabulated in Table 1.

2) 5 August 1974.

A 3 current meter sub-surface array was installed at the Center Station, C, (Figure 1). Surface (2m) and bottom (16m) drogues of 12 square feet of cross-sectional area, were launched by the Center Station and tracked over a tidal cycle. The displacement diagram for the surface drogue and corresponding current meter data are shown in Figure 2, and in Figure 3 for the bottom drogue and current meter.

3) 11 September 1974.

Fog was a major problem during this cruise with visibility generally below 200 yards for most of the day. The monitoring of the first barge dump at 1346 hours was accomplished by vessels anchored at and around the Center Station, C, (Figure 1). When the fog lifted sufficiently, stations

along the East/West transect through the Center Station were sampled prior to the second barge dump at 1710 hours. These results are tabulated in Table 2 for temperature, salinity, and σ_t. At this later dump, drogues, both surface (2m) and bottom (16m) were launched in the wake of the discharging barge. Transmissivity measurements were carried out during both dump periods with the tabulated results found in Tables 4 and 5. A three (3) current meter sub-surface array was also installed and operating throughout the sampling period.

4) 11 December 1974.

A three (3) current meter sub-surface array was installed and then 10 stations were systematically and synoptically sampled while waiting for a barge dump to occur. The results for temperature, salinity, and σ_t are tabulated in Table 3 (stations are shown in Figure 1). Two drogues, surface (2m) and bottom (16m) were launched in the wake of the barge at approximately 1345 hours. Transmissometer results are tabulated in Table 6.

B. Comments

Current meter results from the 3 cruises are tabulated in Table 7. Shown are the mean or averaged velocities over each half-tidal cycle of record (flood/ebb) by u (east/west), σ (north/south) components as well as the resultant speed, R, and direction θ, relative to geographic north. The term D(R) is merely the integrated speed (R) over each half tidal cycle, viz:

$$D(R) = \int_{1/2\ \text{tidal cycle}} R(t)dt$$

and t is the duration of each listed flood or ebb. Table 8 shows the average

speeds and directions from the data tabulated in Table 7 and Table 9 shows the average half-tidal cycle distances and durations. Note that the ebb distances are greater by almost a factor of 4 except at the bottom meter where it is greater by a factor of almost 2. The net flow is shown in Table 10. Here, the net surface flow is east at approximately 15 cm/sec and at the bottom, almost north (toward the harbor) at almost 6 cm/sec as one would expect.

The temperature and salinities are consistent with past results for Eastern Long Island Sound. The highest tidal variations occur in the surface waters, almost 1°C in temperature, and 0.5 ppt in salinity. Temperatures are greater in September than in July, again in agreement with past experience in both Long Island Sound and Block Island Sound. In December, the temperature field shows a slight inversion with slightly warmer bottom waters than surface. This too, is expected at this time of the year. Note however, that the water column still maintains a relative stability due to the vertical salinity gradient.

The beam transmittance over a 10 cm path length was measured with a Hydro Products Transmissometer. The attenuation coefficient, the sum of the absorption coefficient and the total scattering coefficient was calculated from

$$\beta = \frac{-1}{\ell} \ln(T/100)$$

where T is the beam transmittance in percent and ℓ is the path length (10 cm). Further analysis and experiments in optical properties of the dump site and dumped material are planned.

A basic problem exists in making a sounding of the transmissivity within a water column, that is disturbing to the bottom with the instrument itself. High turbidity readings can be observed close to the bottom that results from contact between the transmissometer and the bottom. As in Table 5, at 1710 hours, the time of the barge dump, the bottom reading probably reflects the impact of materials on the bottom (23m); the remaining bottom readings (between 20 and 23m) were deleted because of this uncertainty in cause and effect.

Further analysis in conjunction with "turbidity" and particle size analysis are planned or in progress. Future plans also call for inclusion of irradiance measurements. More detailed studies of the ebb tidal flow are also planned.

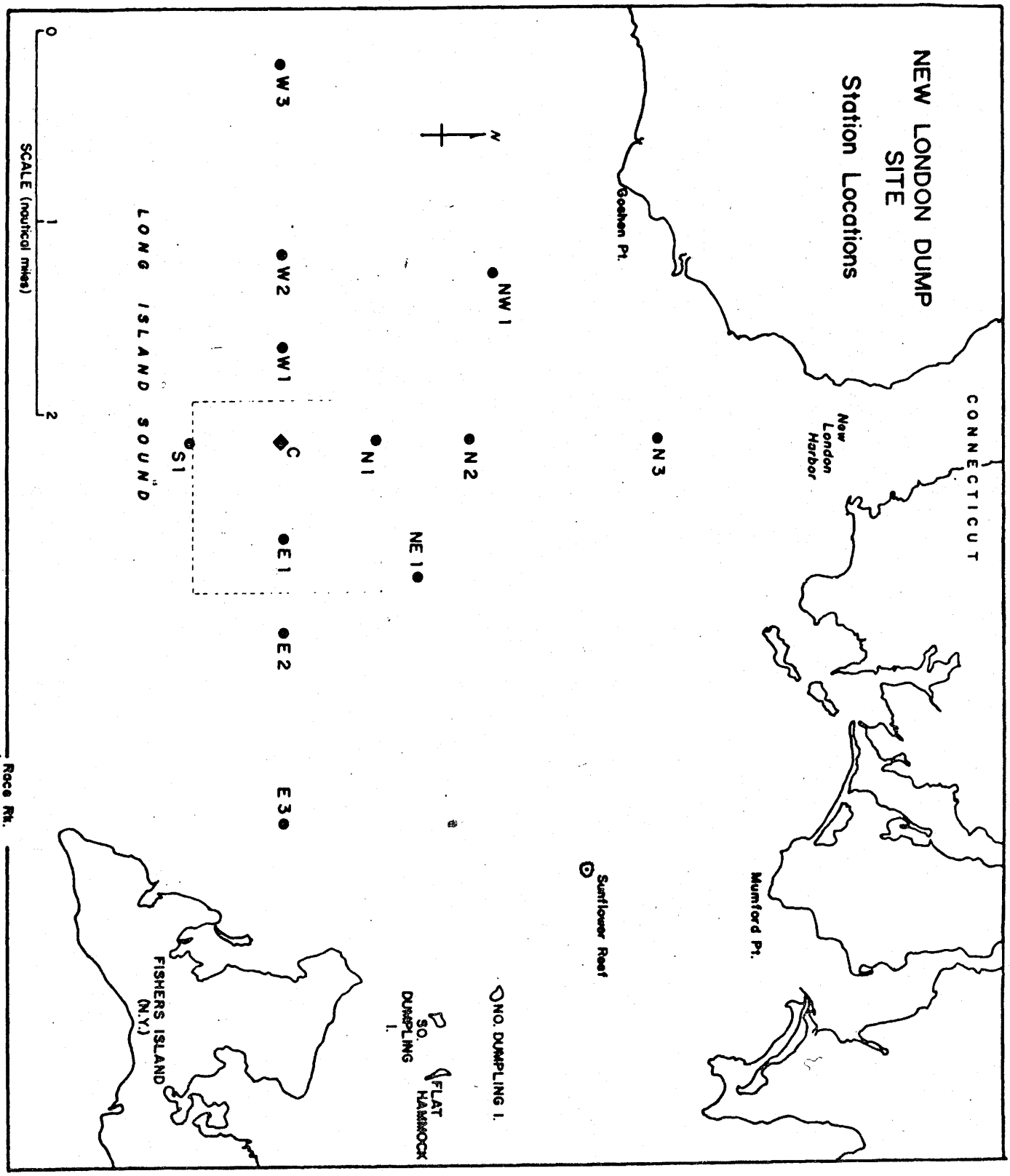

Figure 1: Map of Station Locations in New London Dump Site Area.

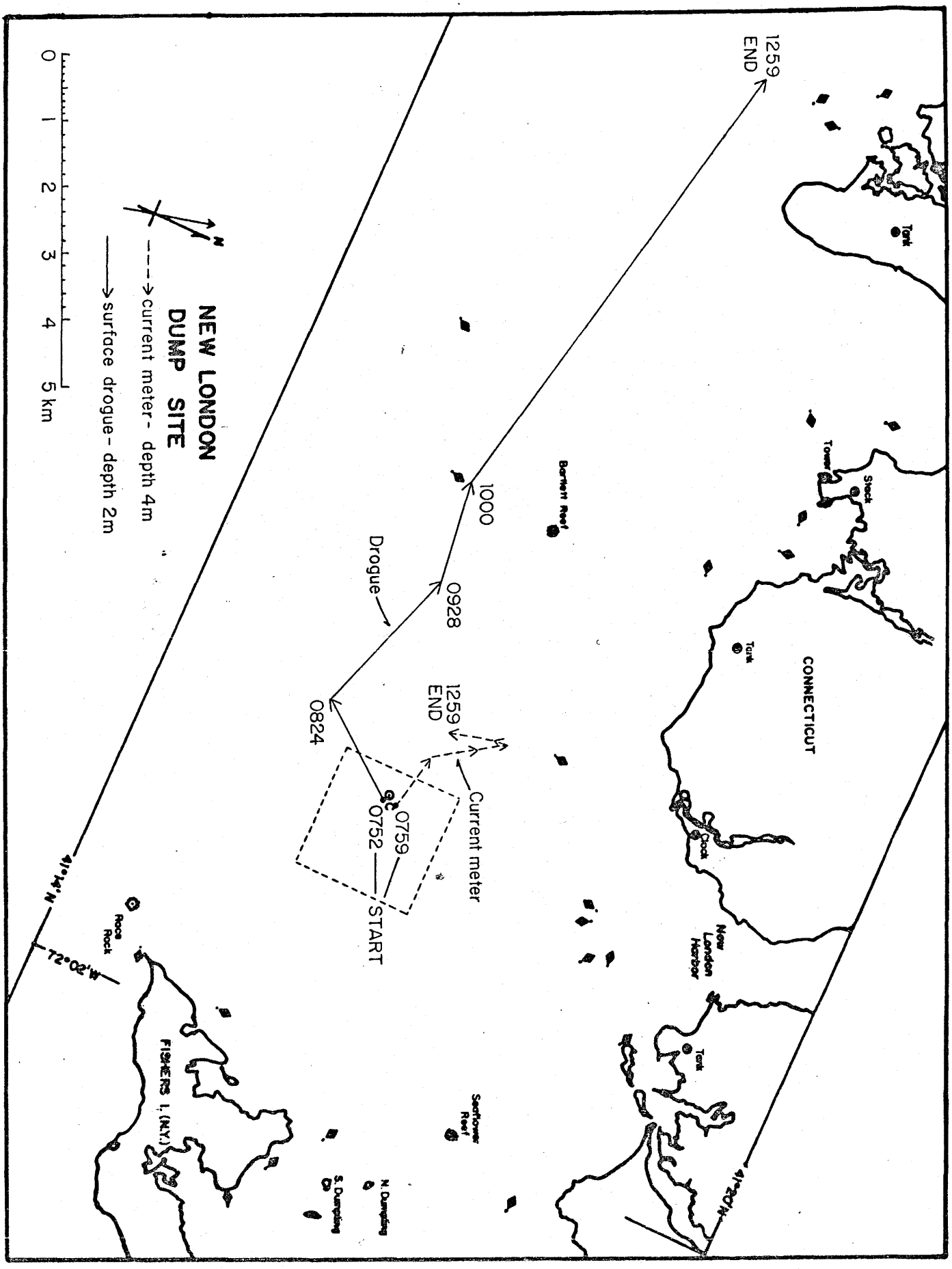

FIGURE 2: Displacement diagram for surface drogue and corresponding current meter data, 5 August 1974.

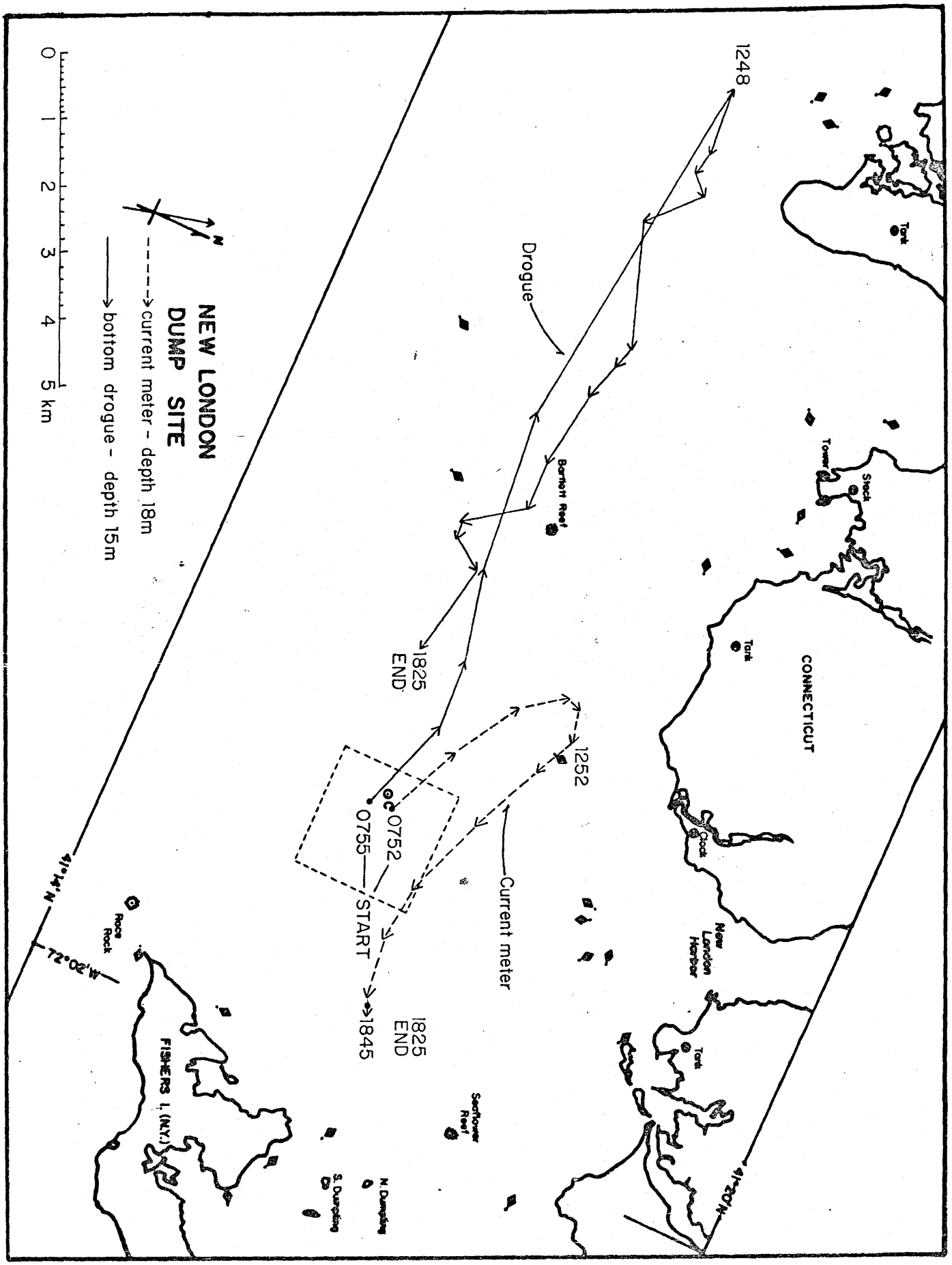

FIGURE 3: Displacement diagram for bottom drogue and corresponding current meter data, 5 August 1974.

Table 1: Average temperature, salinity, and σ_t for stations in the New London Dump Site, for 31 July 1974

Station	Depth (m)	$\overline{T}$°C ± s.d.	S°/oo ± s.d.	σ_t
W3	0	18.6 ± 0.7	30.06 ± 0.37	21.38
	20	17.8 ± 0.4	30.49 ± 0.15	21.90
W2	0	18.4 ± 0.5	30.26 ± 0.06	21.58
	15	17.7 ± 0.4	30.52 ± 0.19	21.94
W1	0	19.5 ± 0.1	30.18 ± 0.09	21.25
	15	18.6 ± 0.2	30.41 ± 0.02	21.64
C	0	19.5 ± 0.4	30.15 ± 0.16	21.22
	20	18.5 ± 0.1	30.53 ± 0.07	21.76
E1	0	19.5 ± 0.3	30.14 ± 0.12	21.22
	15	18.6 ± 0.1	30.45 ± 0.07	21.67
E2	0	18.7 ± 0.9	30.07 ± 0.22	21.36
	15	16.9 ± 0.3	30.44 ± 0.09	22.07
E3	0	18.7 ± 0.6	30.14 ± 0.25	21.41
	10	17.2 ± 0.3	30.41 ± 0.03	21.98
N3	0	19.4 ± 1.2	30.10 ± 0.32	21.21
	10	17.1 ± 0.2	30.41 ± 0.06	22.00
N2	0	18.5 ± 0.4	30.24 ± 0.13	21.54
	10	17.8 ± 0.04	30.48 ± 0.05	21.89
N1	0	19.5 ± 0.4	30.24 ± 0.08	21.29
	10	18.5 ± 0.1	30.46 ± 0.10	21.71
S1	0	19.7 ± 0.7	29.78 ± 0.43	20.89
	15	18.6 ± 0.1	30.43 ± 0.14	21.66
NW1	0	18.9 ± 0.7	30.33 ± 0.07	21.51
	5	18.3 ± 0.7	30.41 ± 0.07	21.72
NE1	0	18.2 ± 0.8	30.22 ± 0.16	21.60
	10	16.7 ± 0.2	30.50 ± 0.07	22.16

(Note: Each station was sampled 5 times)

Table 2: Average temperature, salinity, and σ_t for stations in the New London Dump Site, for 11 Sept., 1974

Station	Depth (m)	$\overline{T}$°C	S°/oo	σ_t
W3	0	20.4	30.46	21.23
	20	19.8	30.81	21.65
W2	0	20.0	30.24	21.16
	15	20.0	30.60	21.44
W1	0	20.2	30.05	20.97
	15	20.0	30.53	21.38
C	0	20.5	30.32	21.10
	15	20.3	30.67	21.41
E1	0	20.8	29.56	20.44
	15	20.3	30.61	21.37
E2	0	18.7	29.78	21.14
	15	18.2	30.60	21.89
E3	0	18.7	30.51	21.70
	10	18.4	30.56	21.81

Table 3: Average temperature, salinity, and σ_t for stations in the New London Dump Site, for 11 Dec., 1974

Station	Depth (m)	$\overline{T}$°C	S°/$_{oo}$	σ_t
W3	0	7.8	31.01	24.20
	20	8.0	31.63	24.65
W2	0	7.8	31.34	24.46
	15	8.0	31.80	24.79
W1	0	7.6	31.39	24.52
	15	7.9	31.81	24.81
C	0	8.4	30.80	23.95
	15	-	31.46	-
E1	0	7.7	30.05	23.46
	15	7.7	31.09	24.27
E2	0	7.4	28.87	22.58
	15	7.8	30.92	24.13
E3	0	6.4	21.95	17.27
	10	6.9	30.64	24.03
N3	0	7.8	21.59	16.84
	10	7.5	30.77	24.05
N2	0	7.9	30.59	23.85
	10	7.6	31.19	24.37
S1	0	8.0	29.99	23.37
	15	8.2	31.44	24.48

Table 4: Beam Transmittance, T, and Attenuation Coefficient β, as a function of depth and time for Center Station, New London Dump Site, 11 September, 1974

	0920 hrs.		1120 hrs.*		1210 hrs.		1400 hrs.		1545 hrs.		1645 hrs.	
Depth (m)	T%	$\beta(m^{-1})$	T%	$\beta(m^{-1})$	T%	$\beta(m^{-1})$	T%	$\beta(m-1)$	T%	$\beta(m^{-1})$	T%	$\beta(m^{-1})$
0	88	1.28	88	1.28	88	1.28	91	0.94	88	1.28	92	0.83
5	88	1.28	87	1.39	87	1.39	89	1.16	87	1.39	93	0.73
10	88	1.28	87	1.39	86	1.51	88	1.28	87	1.39	94	0.62
15	88	1.28	87	1.39	86	1.51	85	1.62	85	1.62	94	0.62
20	88	1.28	87	1.39	86	1.51	82	1.98	82	1.98	93	0.73

*Time of barge dumping

Table 5: Beam Transmittance (T) and Attenuation Coefficient, β, as a function of depth and distance from Center Station following a drogue planted in the wake of the barge at 1710 hrs. on 11 September, 1974.

	-0- (1710 hrs.*)		46m (1725 hrs.)		229m (1745 hrs.)		183m (1815 hrs.)		230m (1830 hrs.)		155m (1852 hrs.)	
Depth (m)	T%	$\beta(m^{-1})$	T%	$\beta(m^{-1})$	T%	$\beta(m^{-1})$	T%	$\beta(m^{-1})$	T%	$\beta(m^{-1})$	T%	$\beta(m^{-1})$
0	94	0.62	98	0.20	97	0.30	91	0.94	80	2.23	85	1.62
5	95	0.51	88	1.28	89	1.16	83	1.86	78	2.48	81	2.11
10	96	0.41	57	5.62	88	1.28	90	1.05	82	1.98	80	2.23
15	89	1.16	43	8.44	81	2.11	92	0.83	77	2.61	67	4.00
20	41	8.92	45	7.98	69	3.71	92	0.83	73	3.15	45	7.98
Bottom	02	39.12	-	-	-	-	-	-	-	-	-	-

*Time of barge dumping

Table 6: Beam Transmittance, T, and Attenuation Coefficient β, as a function of distance from point of barge dump following a drogue planted in the wake of the barge at 1344 hours on 11 December, 1974.

	-0-* (1346 hrs)		≈115m (1358 hrs)	
Depth (m)	T%	$\beta(m^{-1})$	T%	$\beta(m^{-1})$
0	85	1.62	94	0.62
5	82	1.98	93	0.72
10	78	2.48	89	1.16
Bottom*	75	2.88	84	1.74

*Approximate time and position of barge dump.

Table 7: The resultant current velocities at Center Buoy Stations. (half-tidal cycle)

				Flood						Ebb					
	Date	Cycle	Z (5)	U (1)	V (1)	R (1)	θ (2)	D(R) (3)	t (4)	U (1)	V (1)	R (1)	θ (2)	D(R) (3)	t (4)
Surface	5 VIII 74	1	4	-20.3	9.9	22.6	296	3.9	4.2	38.7	-10.4	40.1	105	11.6	7.0
	11 IX 74	1*	2	-10.7	10.3	14.8	314	2.0	3.3	37.6	-9.5	38.7	104	6.6	4.9
		2*	-	-	-	-	-	-	-	9.6	-7.7	12.3	129	1.7	2.3
	11 XII 74	1	2	-	-	-	-	-	-	52.6	-12.6	54.0	103	13.7	6.6
Mid-depth	5 VIII 74	1	10	-25.0	14.9	29.1	301	4.2	3.8	43.1	-1.2	43.1	92	10.9	6.8
	11 IX 74	1*	8	-17.8	9.7	20.2	299	3.8	4.8	42.6	-1.5	42.7	92	6.4	4.3
		2*	-	-	-	-	-	-	-	10.0	-4.3	10.9	113	1.06	2.3
	11 XII 74	1	8	-	-	-	-	-	-	48.0	-10.0	49.0	102	12.6	6.7
Bottom	5 VIII 74	1	18	-24.7	14.8	28.7	301	3.6	3.5	20.6	-2.9	20.8	98	6.6	8.2
	11 IX 74	1*	16	-19.5	10.0	21.9	297	4.0	4.8	33.9	4.8	34.2	82	5.1	4.1
		2*	-	-	-	-	-	-	-	11.4	2.0	12.1	81	1.0	2.2
	11 XII 74	1	16	-	-	-	-	-	-	34.0	-0.7	34.0	91	8.4	6.7

(1) cm/sec
(2) degrees (circular) relative to geographic North
(3) kilometers
(4) hours
(5) depth from the surface (meters)
* not a complete cycle

Table 8: Average velocities for flood and ebb tidal cycles calculated from the half tidal cycle data.

	Flood		Ebb	
Depth	R (cm/sec)	θ (°T)	R (cm/sec)	θ (°T)
Surface	18.7	305	47.1	104
Mid-depth	24.7	300	46.1	98
Bottom	25.3	299	27.4	95

Table 9: Average effective distances and durations calculated from half tidal cycle data.

	Flood		Ebb	
Depth	$\overline{D}$(km)	$\overline{t}$(hrs)	$\overline{D}$(km)	$\overline{t}$(hrs)
Surface	2.95	3.75	12.65	6.80
Mid-depth	3.00	4.30	11.75	6.75
Bottom	3.80	4.15	7.50	7.45

Table 10: The net average tidal cycle flow for each depth from average velocities.

Depth	R(cm/sec)	θ(°T)
Surface	15.2	91
Mid-depth	12.5	76
Bottom	5.6	28

APPENDIX D

QUARTERLY REPORT

Chemical Oceanography

of the

New London Dump Site Area

October through December, 1974

Submitted to

Sandy Hook Laboratory

Middle Atlantic Coastal Fisheries Center

National Marine Fisheries Service

NOAA/U.S. Dept. of Commerce

Contract No. 03-5-043-303

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Introduction

The release of barged materials into the open waters of the marine environment poses potentially large problems to the planktonic, nektonic and benthic organisms. These problems relate not only to the smothering effect and oxygen demanding characteristics of these materials, but also to the potential uptake of toxic materials by these organisms. So that the potential impact of these materials upon the organisms (both within and downstream of the dump zone) can be ascertained it is necessary to monitor the levels of the toxicants in the sediments and the biota.

In these investigations, monitoring is being conducted, on a quarterly basis, of the levels of heavy metals in both sediments and biota and investigations are being made of the length of time required for the area to return to "normal" following a dump as well as a determination of the transport characteristics of the released materials.

This report represents the results of the work accomplished through December, 1974.

Methods

A. Collection and Pretreatment of Samples.

1. Water. Samples of water for the measurement of dissolved oxygen, pH, Eh, total organic carbon, suspended and volatile solids were collected from the surface, mid-depth and one meter above the bottom with 5 liter Niskin bottles at each of the stations indicated in Figure 1. All pH and Eh de-

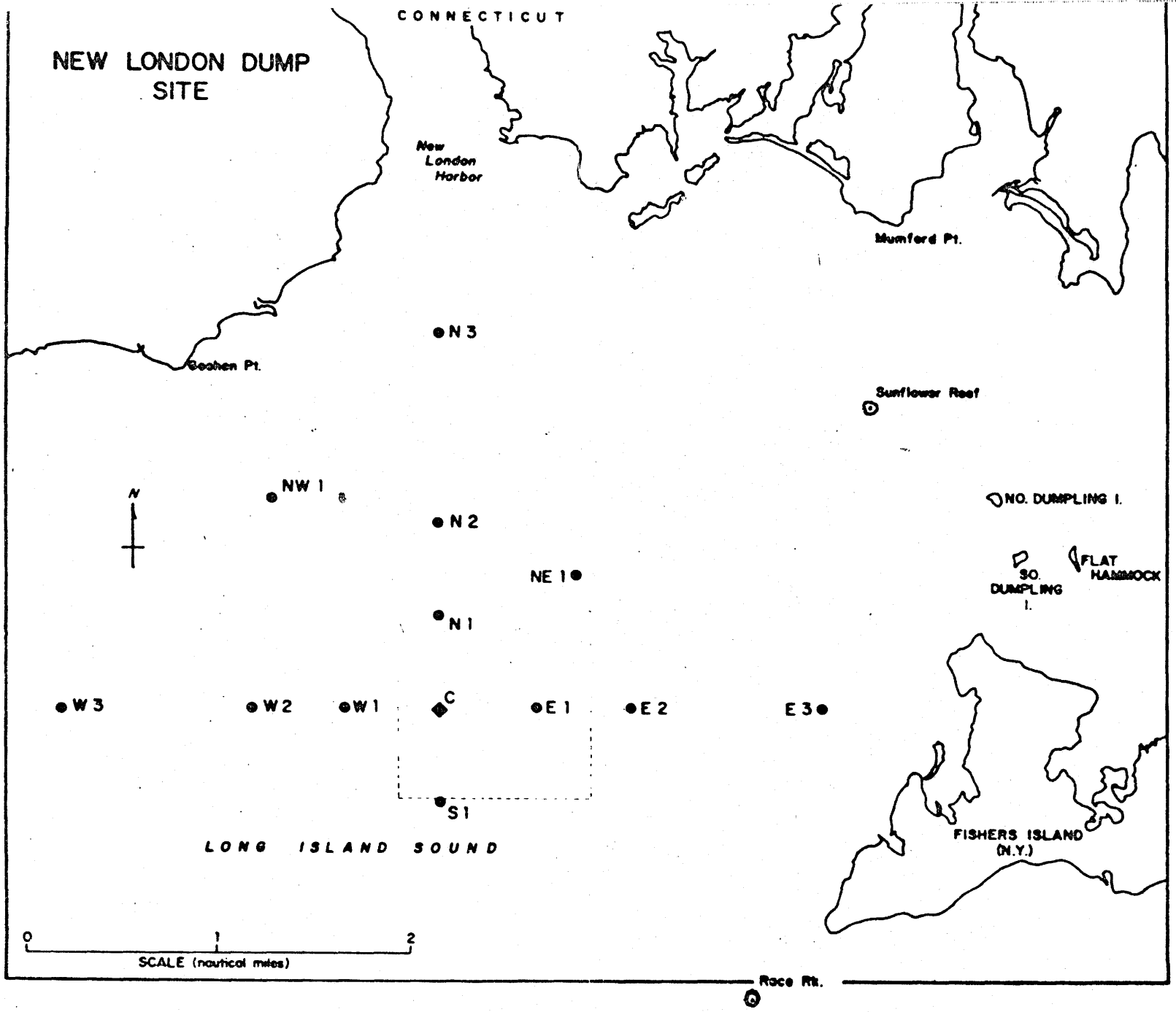


Figure 1: Station locations in the New London Dump Site area

terminations were made immediately on unfiltered samples. Appropriate reagents were added to the dissolved oxygen and total organic carbon samples immediately to fix them for subsequent laboratory analysis. Two to three liters of water were filtered for the suspended and volatile solids determination.

2. Seston. Seston samples were collected with 3/4 meter opening, 363μ mesh, metered opening-closing nets towed at the surface, mid-depth and near the bottom. Samples were stored frozen until analysis when they were composited as necessary and freeze dried.

3. Benthic Organisms and Sediments. These samples, provided by Sandy Hook Laboratory, were composited and freeze dried. Individual sediment samples were composited, dried at 70°C, gently ground and sieved through 2 mm non-metallic screen.

B. Analytical Methods

1. Water. Dissolved oxygen, pH, Eh, total organic carbon and suspended and volatile solids were determined by the methods described in APHA, 1971. Total organic carbon was determined with a Beckman Total Carbon Analyzer.

2. Seston and Organisms. Freeze dried samples were wet ashed with fuming nitric acid (Windom, 1972) and the metals determined by flame atomic absorption spectrophotometry. Mercury was determined by flameless atomic absorption spectrophotometry after an acid-permanganate digestion of a separate freeze dried sample.

3. Sediments

A. Metals. The sieved sample was extracted with dilute acid (4M HNO_3-0.7M HCl) (Anderson, 1974) for 2 hours on a steam bath, filtered and the metals determined on the filtrate by flame atomic absorption spectrophotometry. Mercury was determined on a separate sieved sample by flameless atomic absorption sepctrophotometry after aqua-regia digestion.

B. Nitrogen and phosphorus. Individual grab samples from each station were composited and the Kjeldahl nitrogen content determined by a specific ion electrode method similar to those described in U.S.E.P.A., 1974. Total phosphorus was determined by the ascorbic acid-molybdate blue method described in U.S.E.P.A., 1974 and Strickland and Parsons, 1968.

C. Chemical Oxygen Demand. The chemical oxygen demand of the composited sediments was determined according to the methods described in U.S.E.P.A., 1974.

Results

A. Water

1. Dissolved Oxygen. Dissolved oxygen distribution throughout the study area in percent saturation are shown in Figures 2a, b, and c. In all instances the concentrations ranged between 77 and 87 percent of saturation in July, 1974. In September (Figure 2b) oxygen concentrations to the west of the dump barge ranged between 70 and 74 percent while at and to the east the concentrations ranged between 59 and 69 percent of saturation. By December the oxygen content of the waters ranged between 74 and 79 percent and no significant differences were found between the various stations.

Figure 2a: The distribution of dissolved oxygen (percent saturation), 31 July, 1974

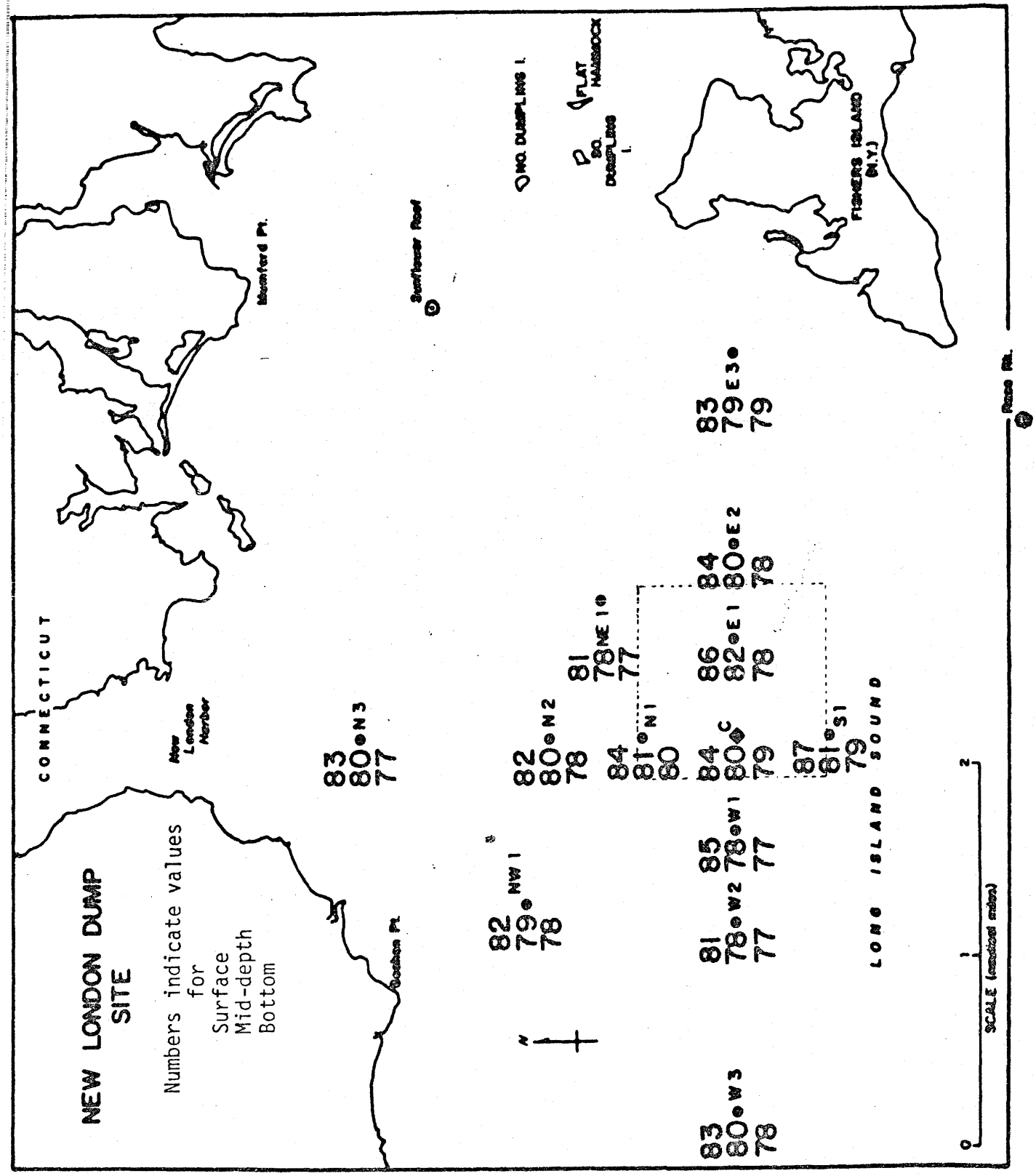


Figure 2b: The distribution of dissolved oxygen (percent saturation, 11 September, 1974

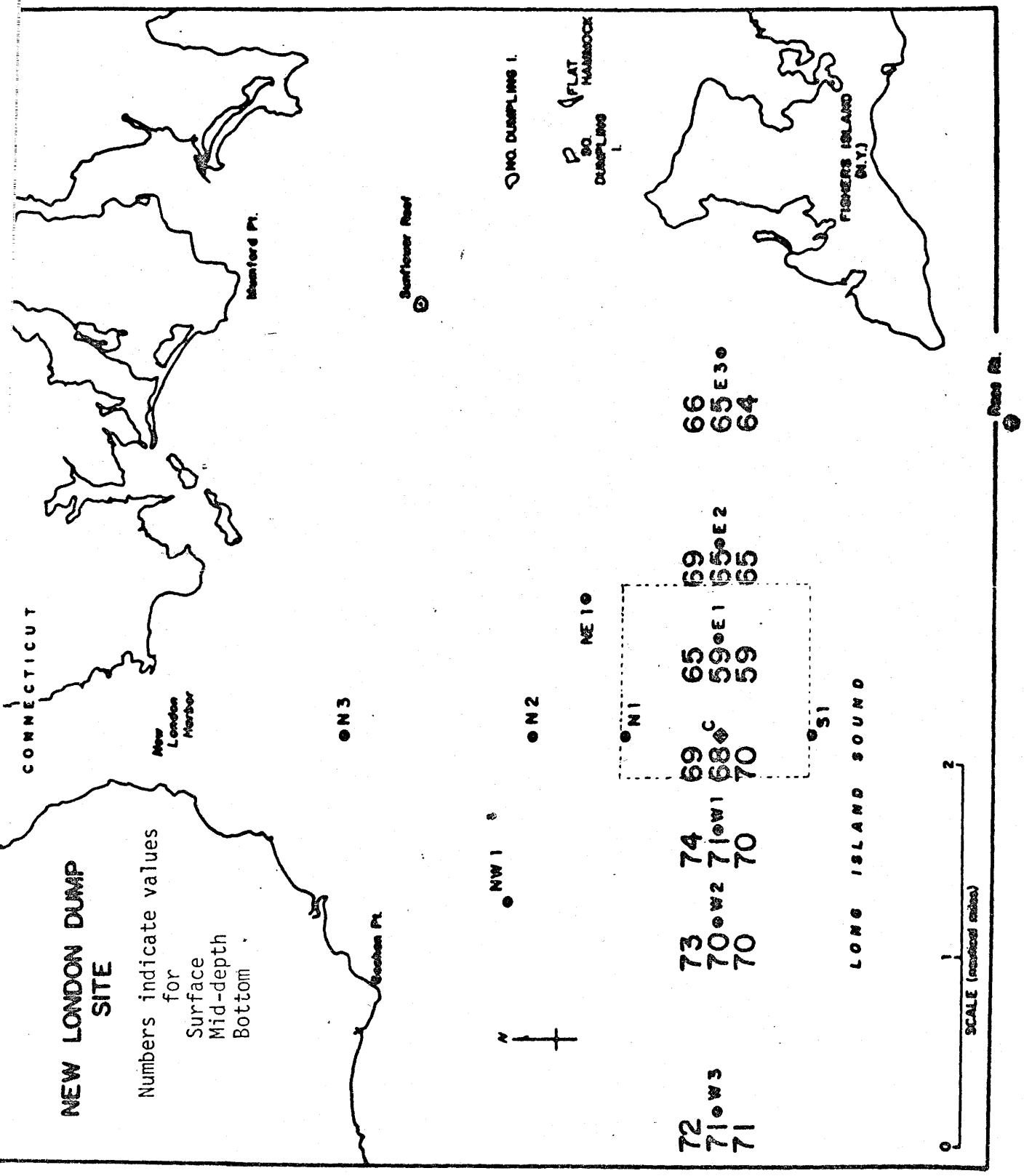
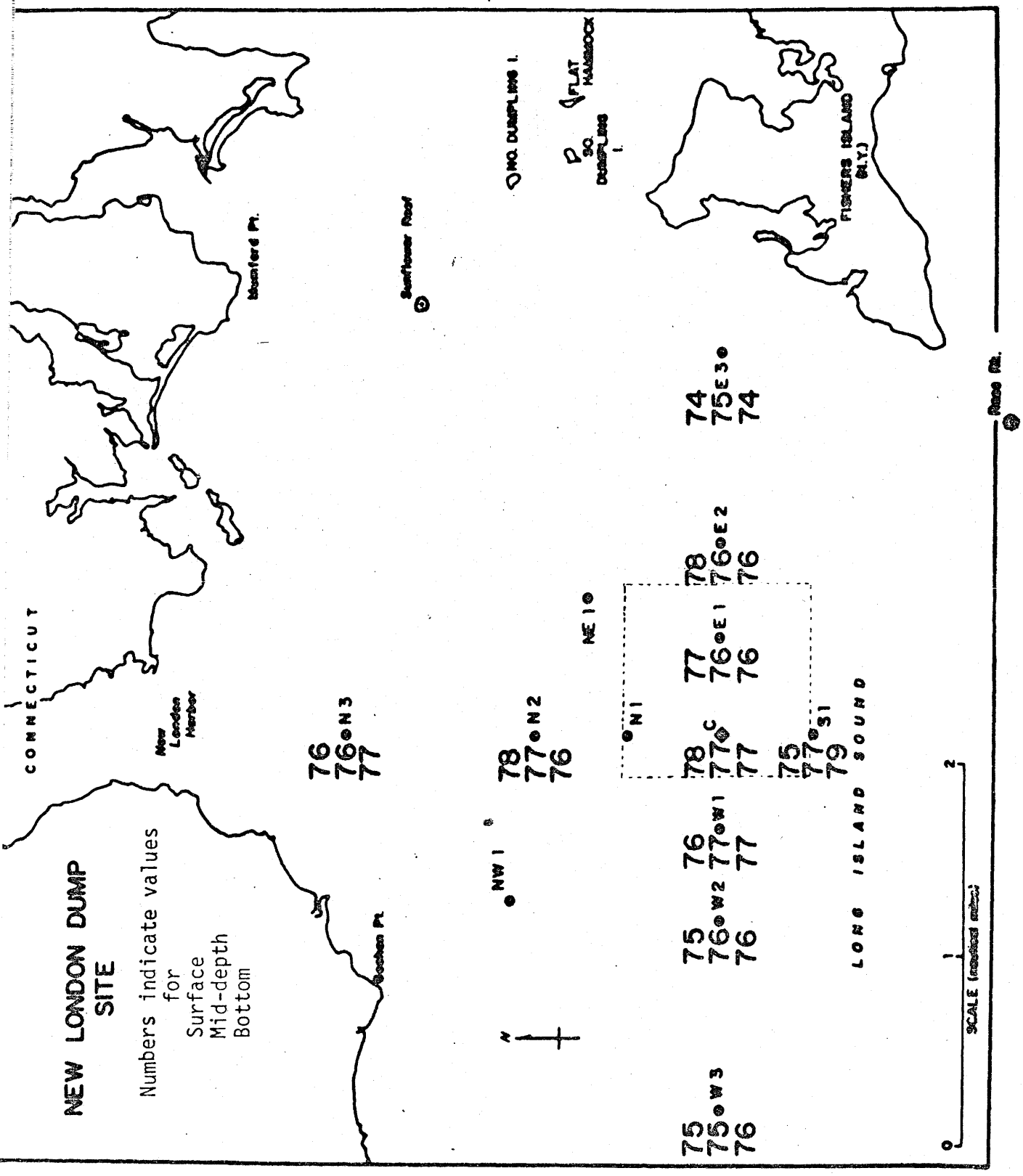


Figure 2c: The distribution of dissolved oxygen (percent saturation), 11 December, 1974



In September a series of observations were made to determine the distribution of oxygen in the plume immediately following the release of the barged materials. This was accomplished by collecting water samples from the area adjacent to a surface and a bottom drogue which had been released at the moment of dumping (Figure 3). The initial samples of water were collected at the point of release within one minute. The results of these observations are shown in Figure 4. As indicated on the figure, oxygen concentrations which initially decreased to 39 percent of saturation immediately after release had returned to 67 percent within 40 minutes in the surface and bottom waters. Similar experiments are planned for February.

2. pH. The pH of the waters in July, September and December, 1974, is shown in Figures 5a, b, and c. In July the pH ranged between 7.93 and 8.05 with the surface waters being slightly more alkaline. The waters to the east of the dump buoy were, on the average, less alkaline than the waters to the west by 0.08 pH units. By December, the pH of the waters in the immediate vicinity of the dump buoy ranged between 8.00 and 8.17. Unfortunately, the pH probes broke early in these latter observations and we were unable to complete these measurements for the rest of the area.

At least part of the observed pH differences from July to December reflect seasonal changes although the waters east of the buoy in September warranted further investigation to determine the possible impact of dumping. Accordingly surface and bottom drogues were released after a dump had occurred on 11 September, 1974. The pH of the waters immediately following a release was

Figure 3: The direction and distance traveled by the surface and bottom drogues, 11 September, 1974

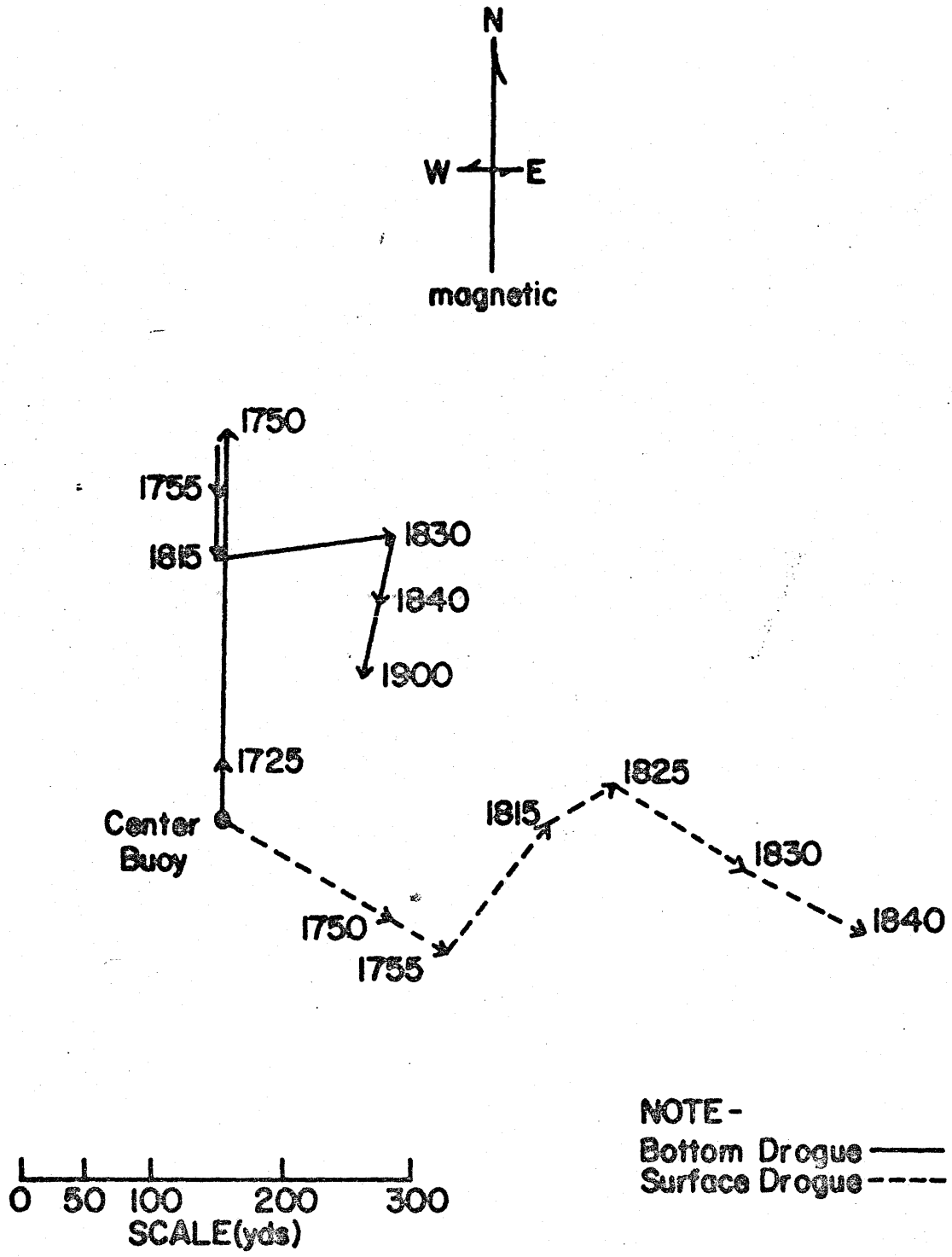
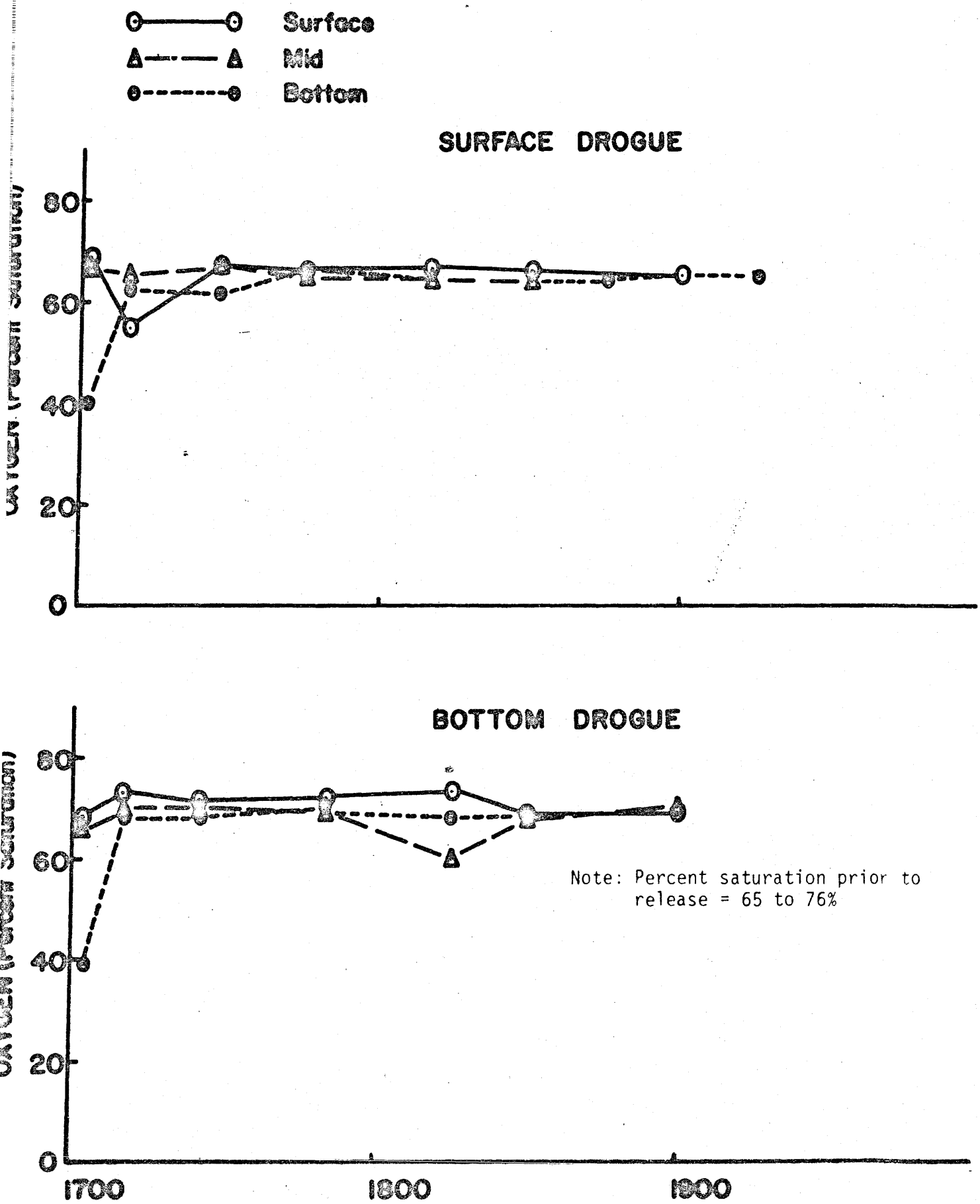


Figure 4: Dissolved oxygen content (percent saturation) versus time, 11 September, 1974



Note: Percent saturation prior to release = 65 to 76%

Figure 5a: The distribution of pH, 31 July, 1974

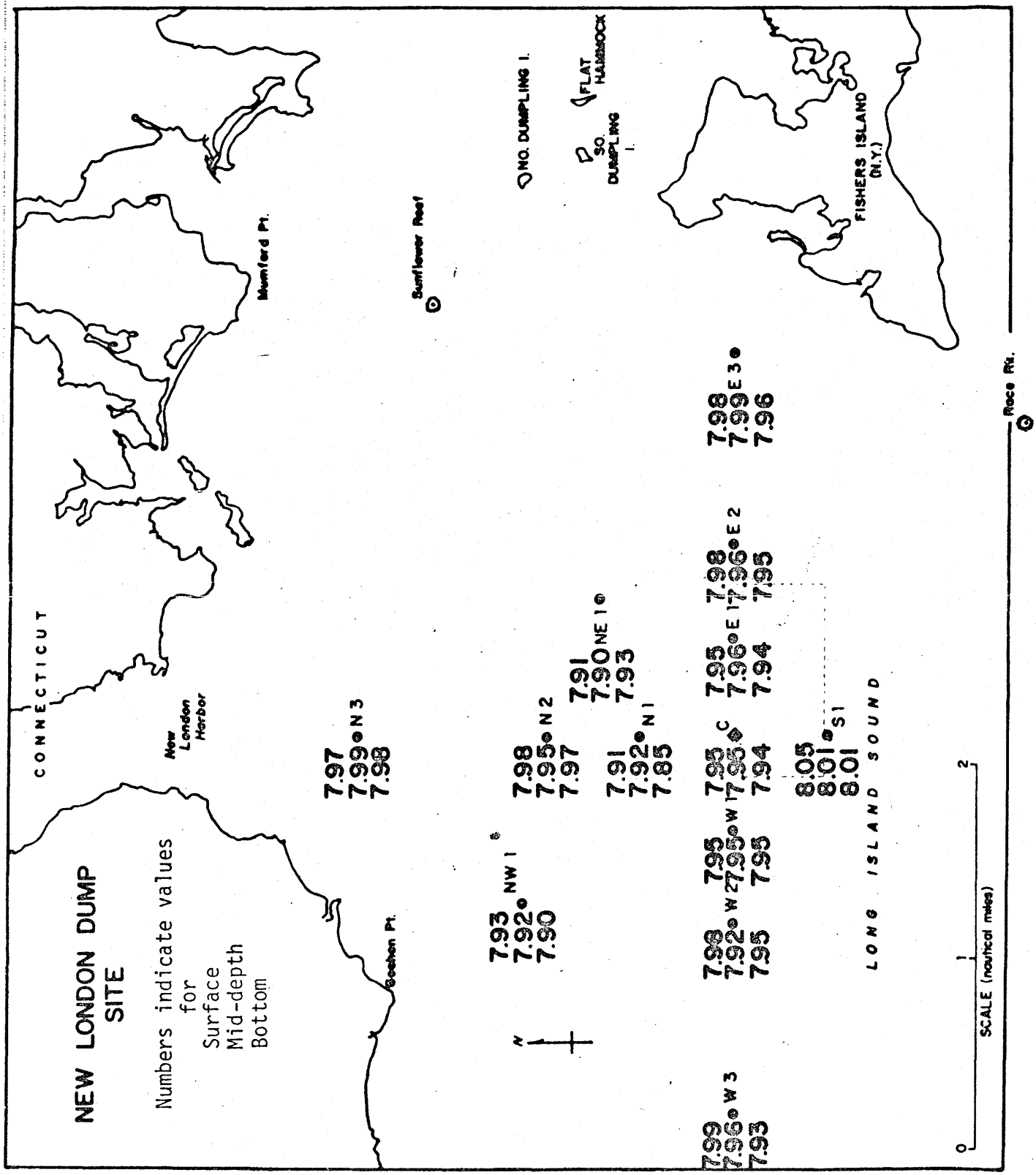


Figure 5b: The distribution of pH, 11 September, 1974

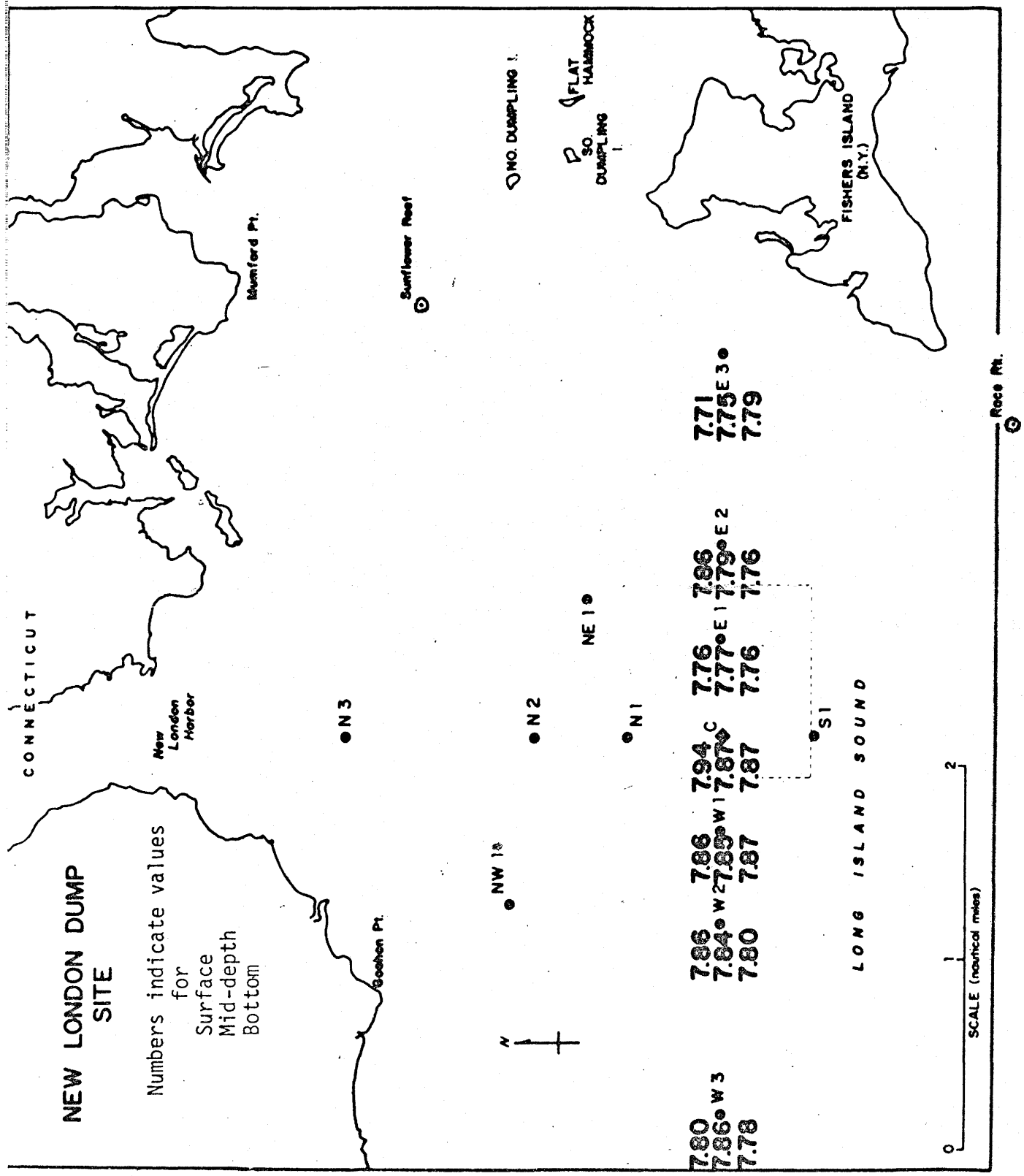
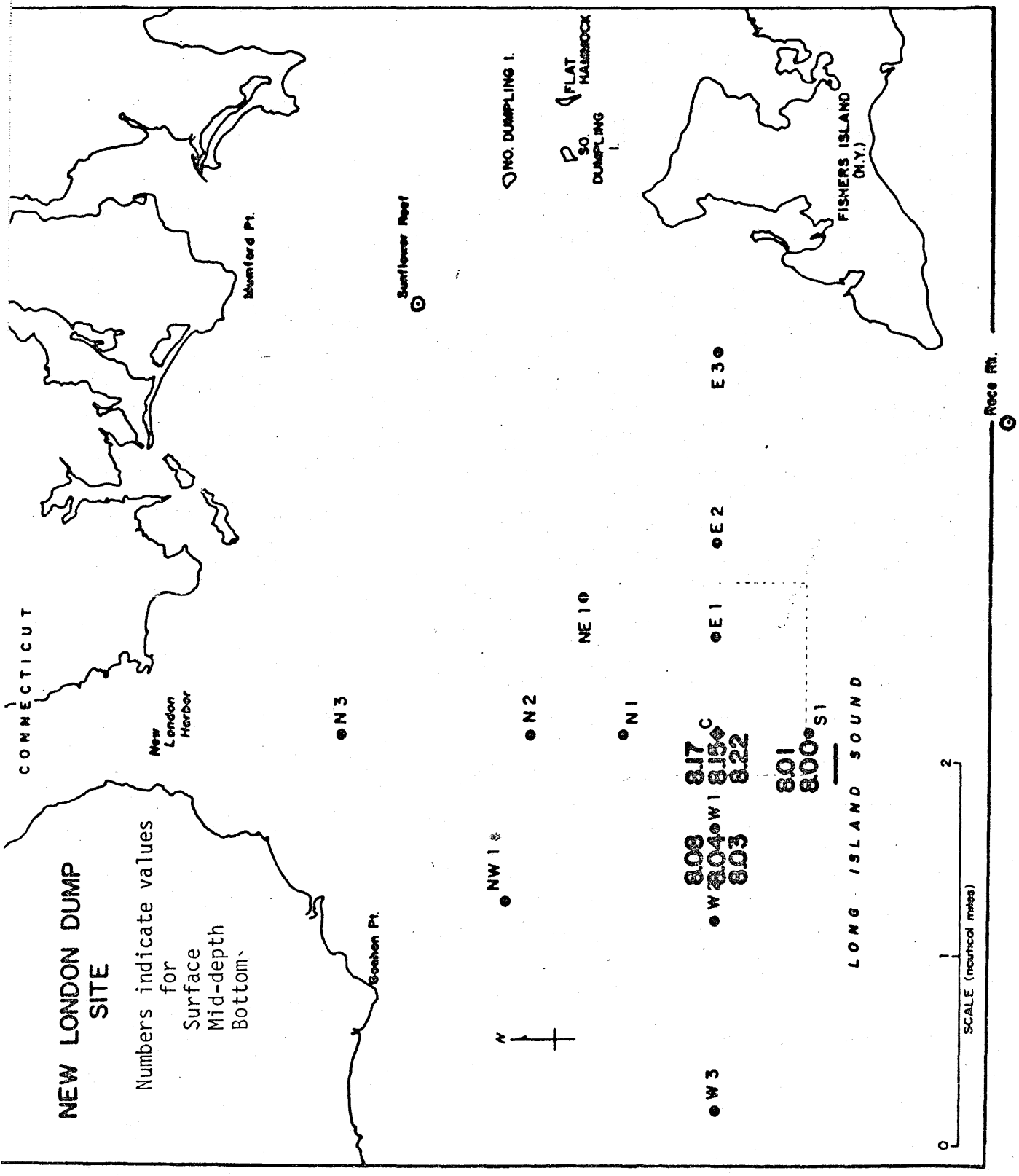


Figure 5c: The distribution of pH, 11 December, 1974



7.64 and 7.62 for the surface and bottom waters respectively. Within 8 minutes the waters to the north of the dump buoy (bottom drogue, Figure 6) had increased on the average by 0.1 pH units. Approximately 30 minutes was required for the waters flowing to the east (surface drogue, Figure 6) to increase in pH by a similar amount.

3. Eh. The distribution of Eh in July, September and December, 1973 is shown in Figure 7a, b, and c. Within any one sampling period no significant differences were found between stations (we estimate our repeatability to ±15mV); also no significance should be attached to the observed monthly changes at this time. As shown in Figure 8 no significant changes occurred in the water column following the release of barged materials (September, 1974).

4. Total Organic Carbon. The distribution of total organic carbon in July, September and December, 1974 is shown in Figure 9a, b, and c. The average concentrations were significantly different for each sampling period; 27.5, 56.8 and 12.6 mg/ℓ respectively. These changes reflect the seasonal as well as man-induced changes.

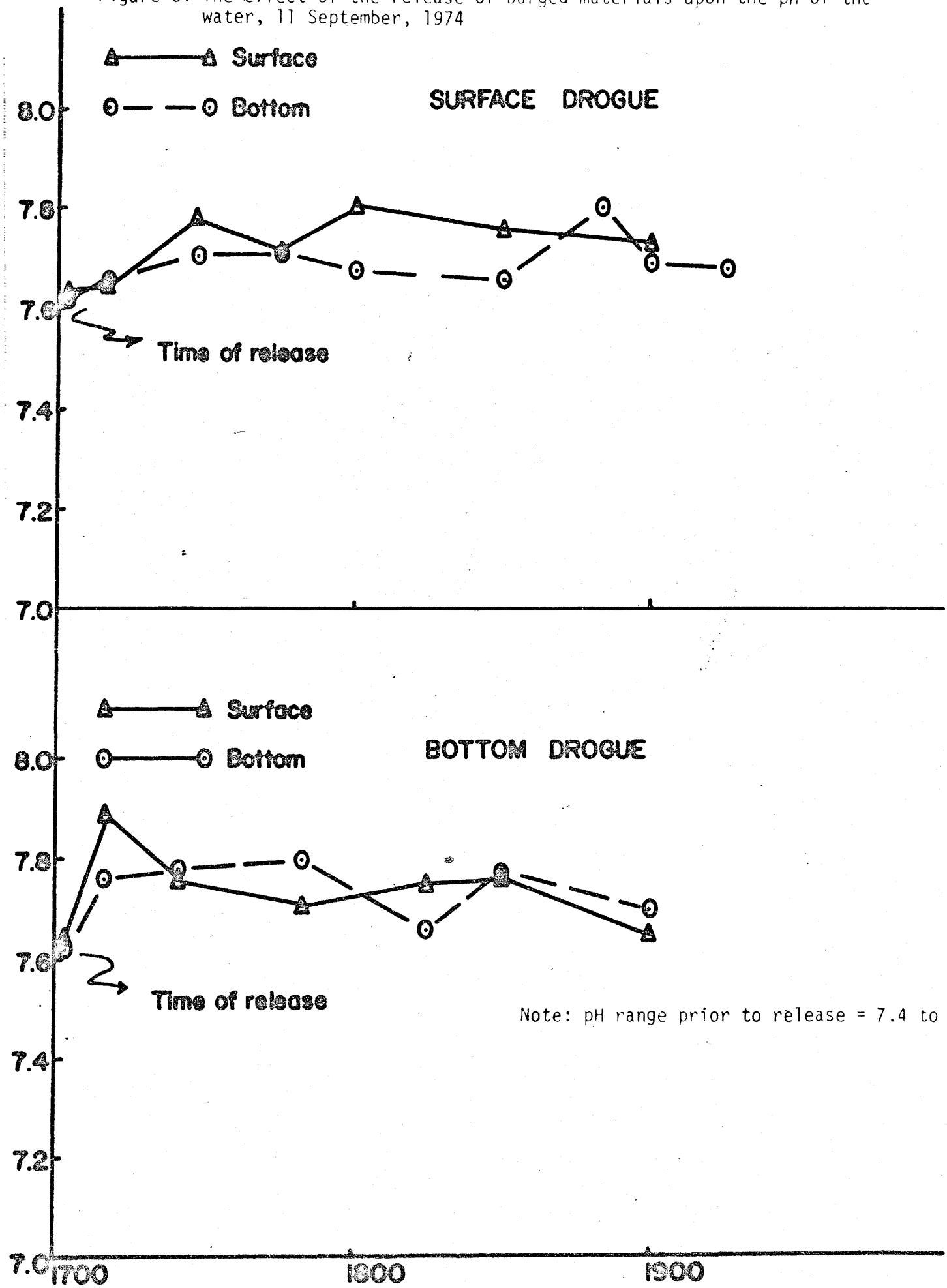
Table 1 shows the average concentration of total organic carbon present in the water column within 0.5 miles of the dump buoy, and at 1.0 and 2.0 miles.

Table 1: The average concentration (mg/ℓ) of total organic carbon present in the water column within 0.5 miles of the dump buoy and at a distance of 1.0 and 2.0 miles.

Distance	July	September	December
0.5 n.m.	25.8	62.5	14.7
1.0 n.m.	29.5	64.5	11.2
2.0 n.m.	27.0	25.3	11.4

In September, the increased concentration of total organic carbon within one mile of the dump buoy was significantly different from the concentrations present in late July and December. Beyond the 1.0 mile limit no significant differences existed between the July and September data. Organic carbon concentrations in December were low, uniform and statistically different from the rest of the data.

Figure 6: The effect of the release of barged materials upon the pH of the water, 11 September, 1974



Note: pH range prior to release = 7.4 to 7.9

Figure 7a: The distribution of EH (mv), 31 July, 1974

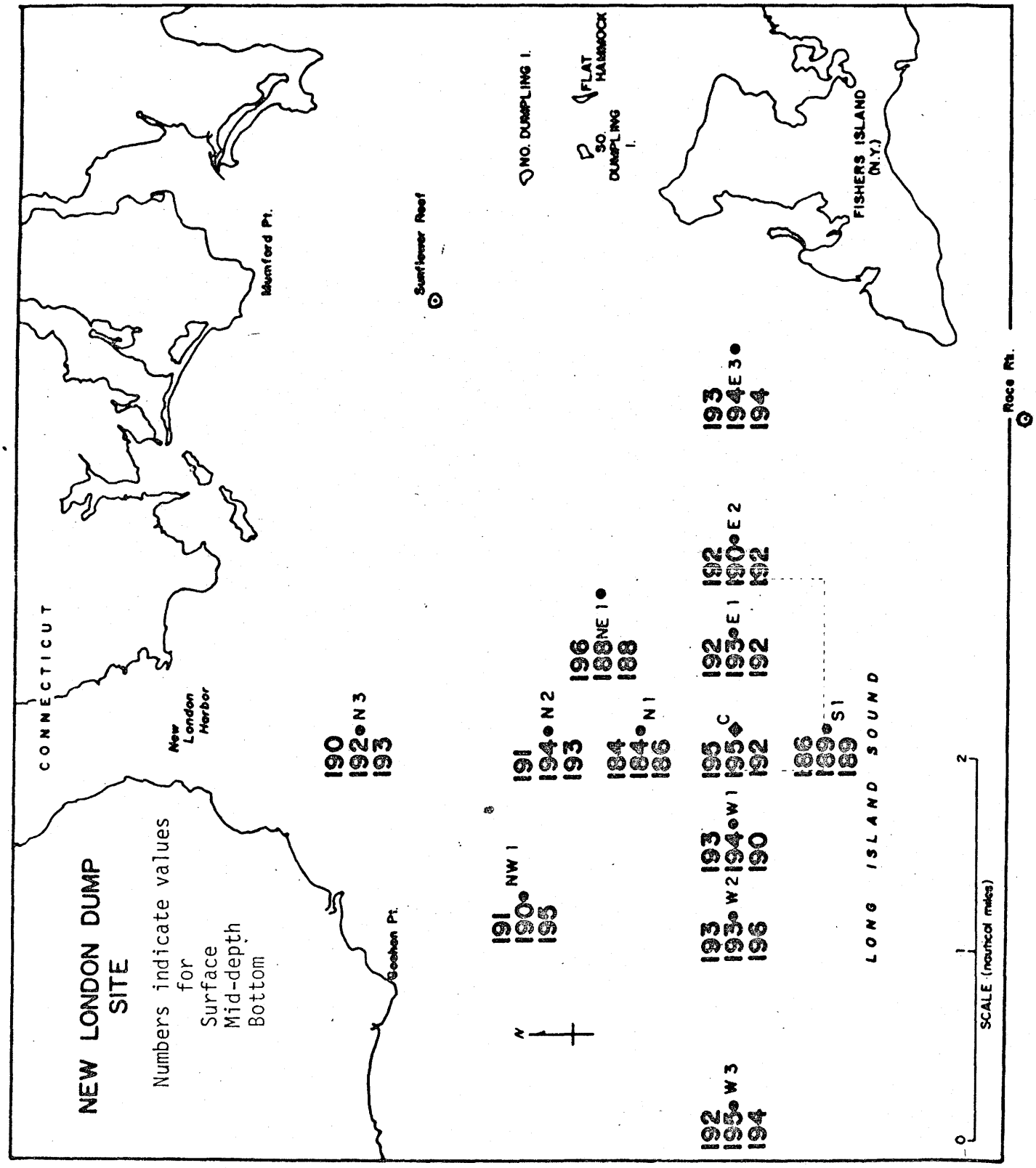


Figure 7b: The distribution of EH (mv), 11 September, 1974

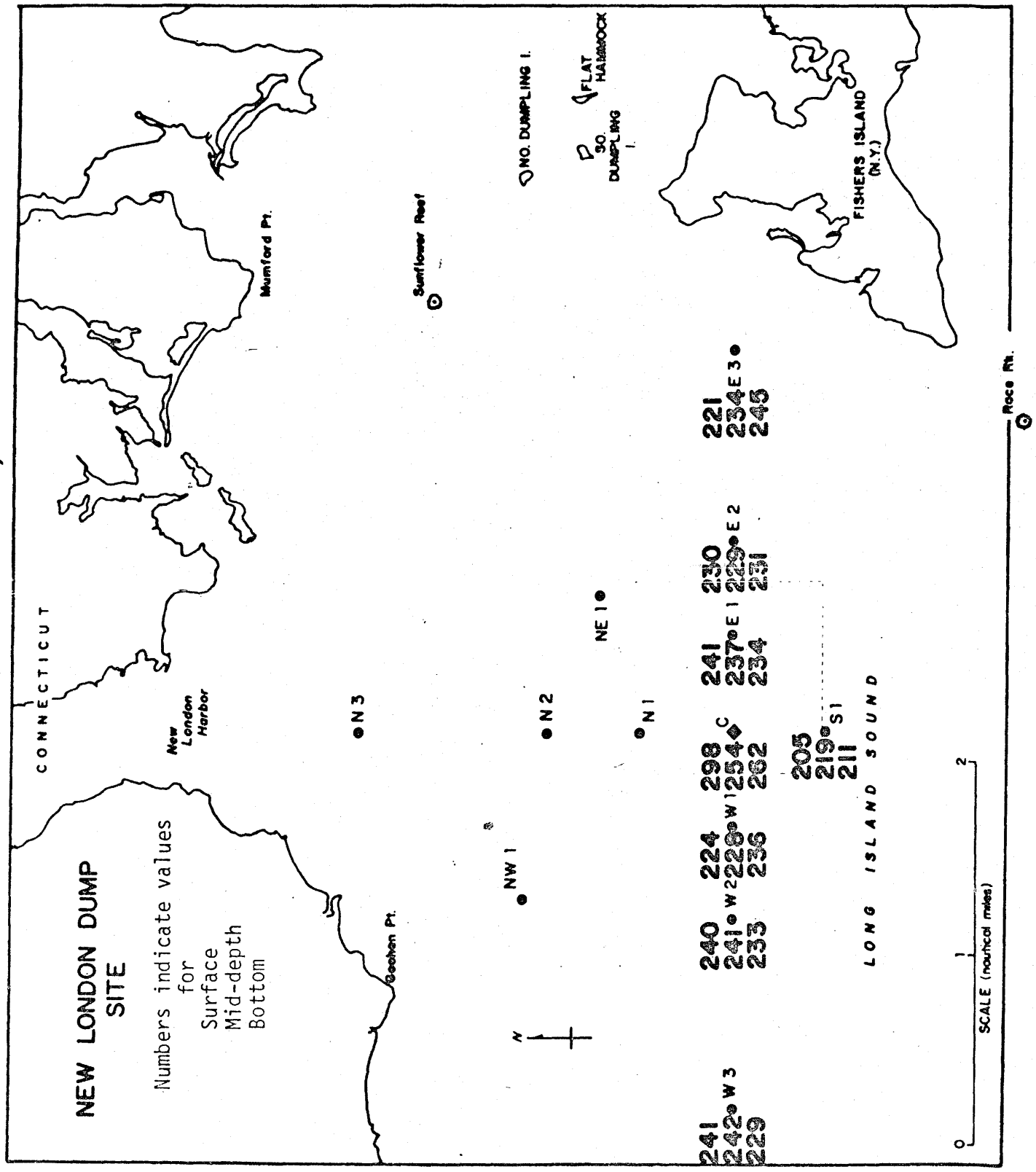


Figure 7c: The distribution of Eh (mv), 11 December, 1974

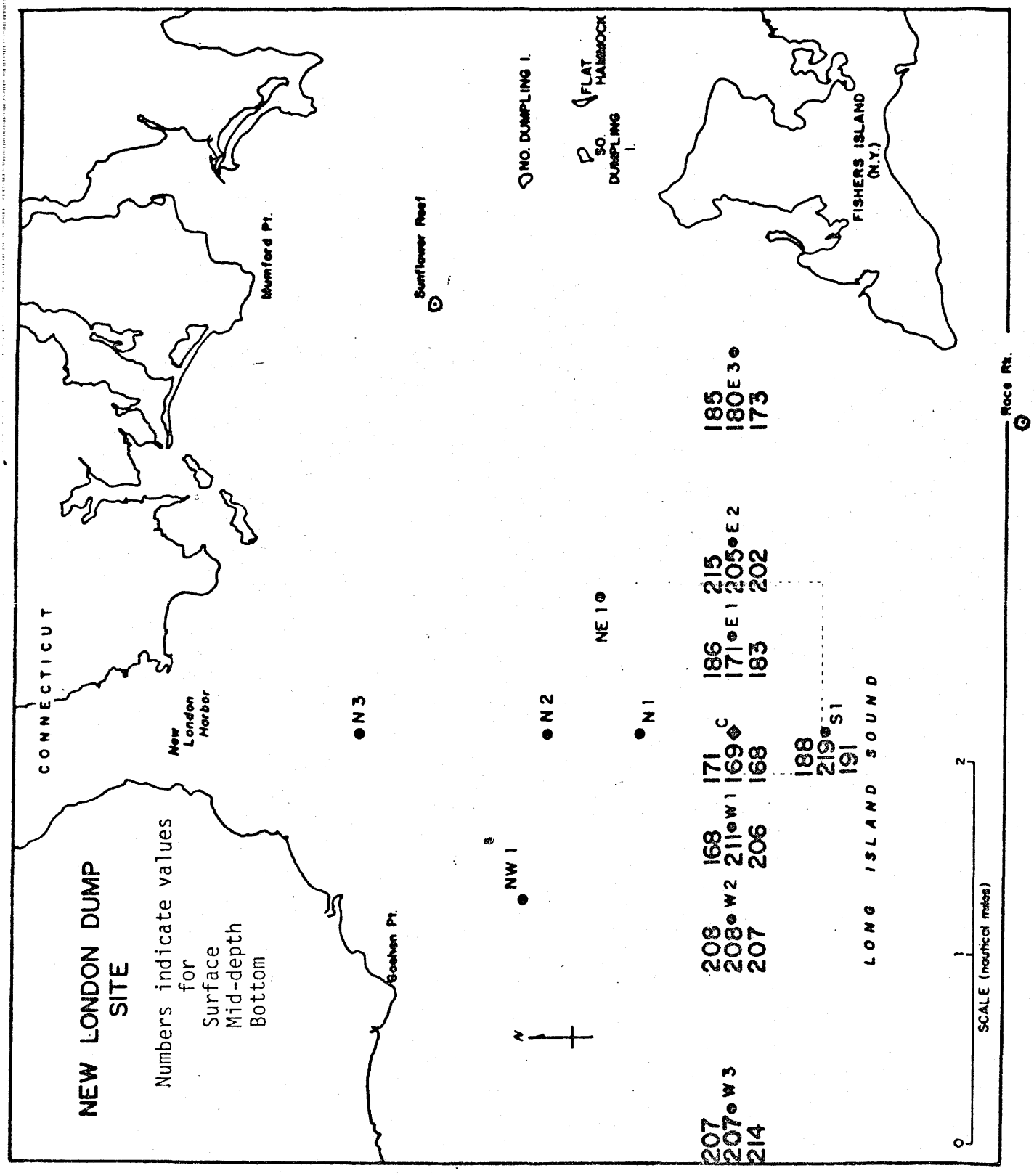


Figure 8: The effect of the release of barged materials upon the Eh (mv) of the water, 11 September, 1974

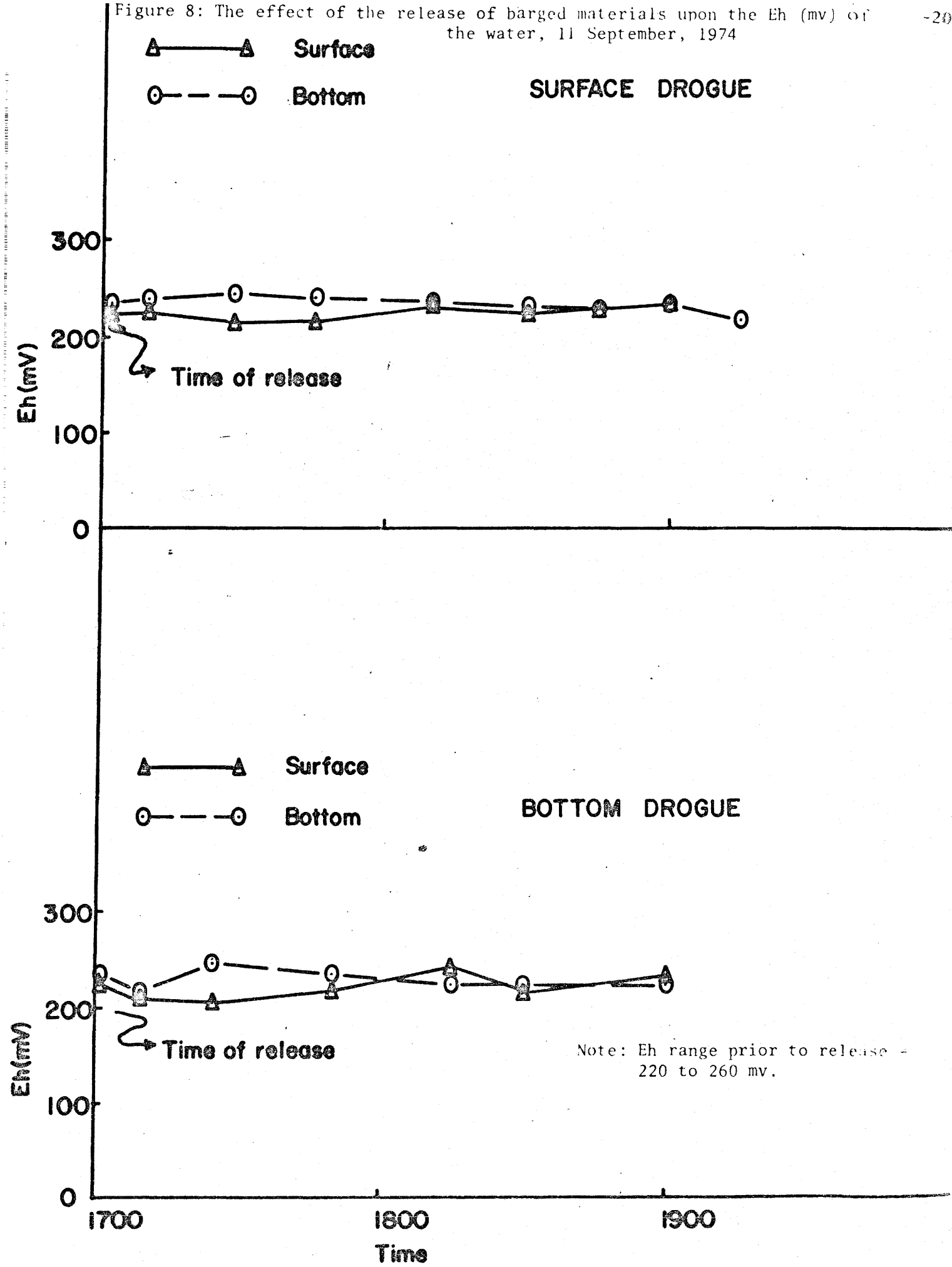


Figure 9a: The distribution of total organic carbon (mg/ℓ), 31 July, 1974

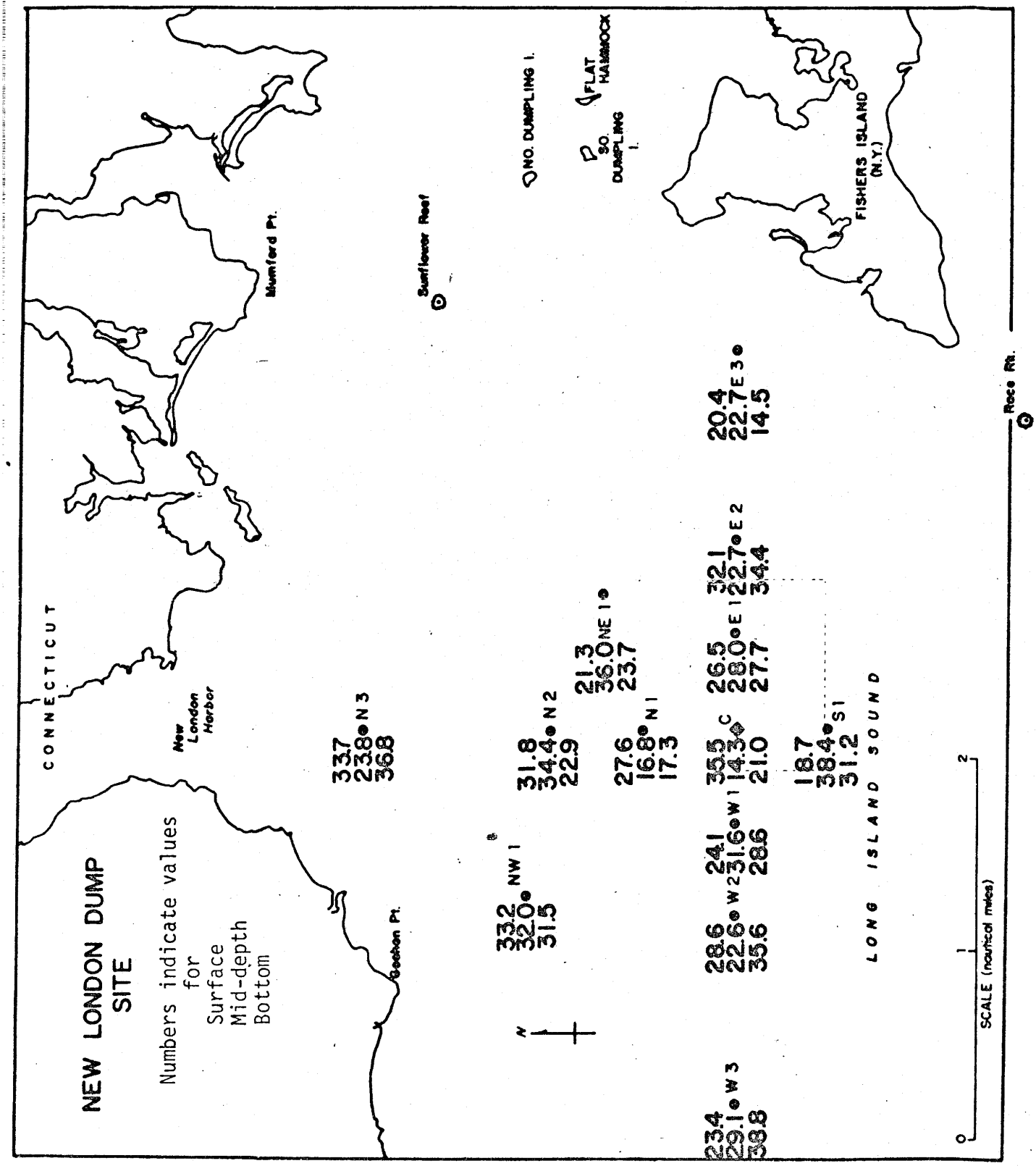


Figure 9b: The distribution of total organic carbon (mg/ℓ), 11 September, 1974

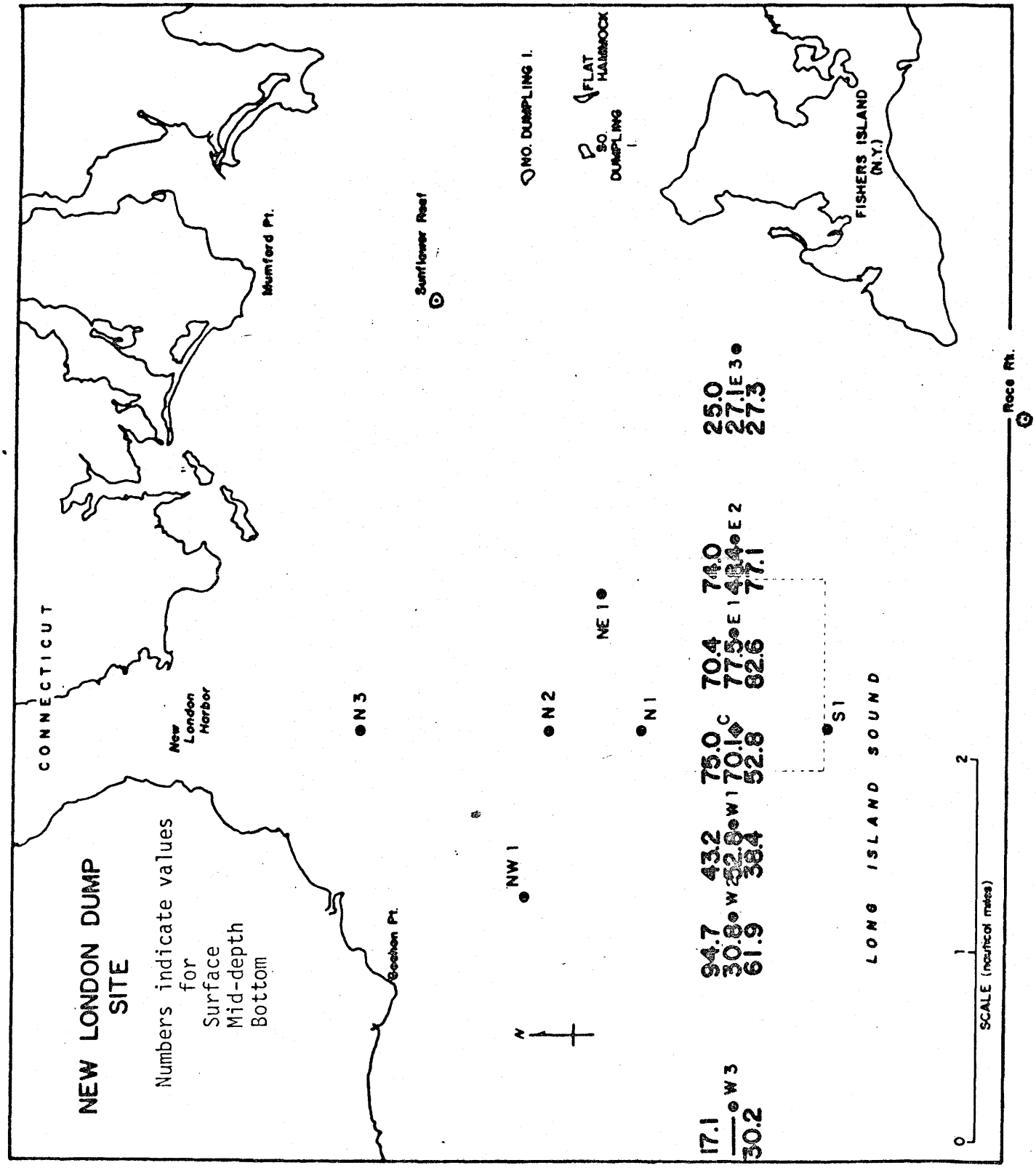
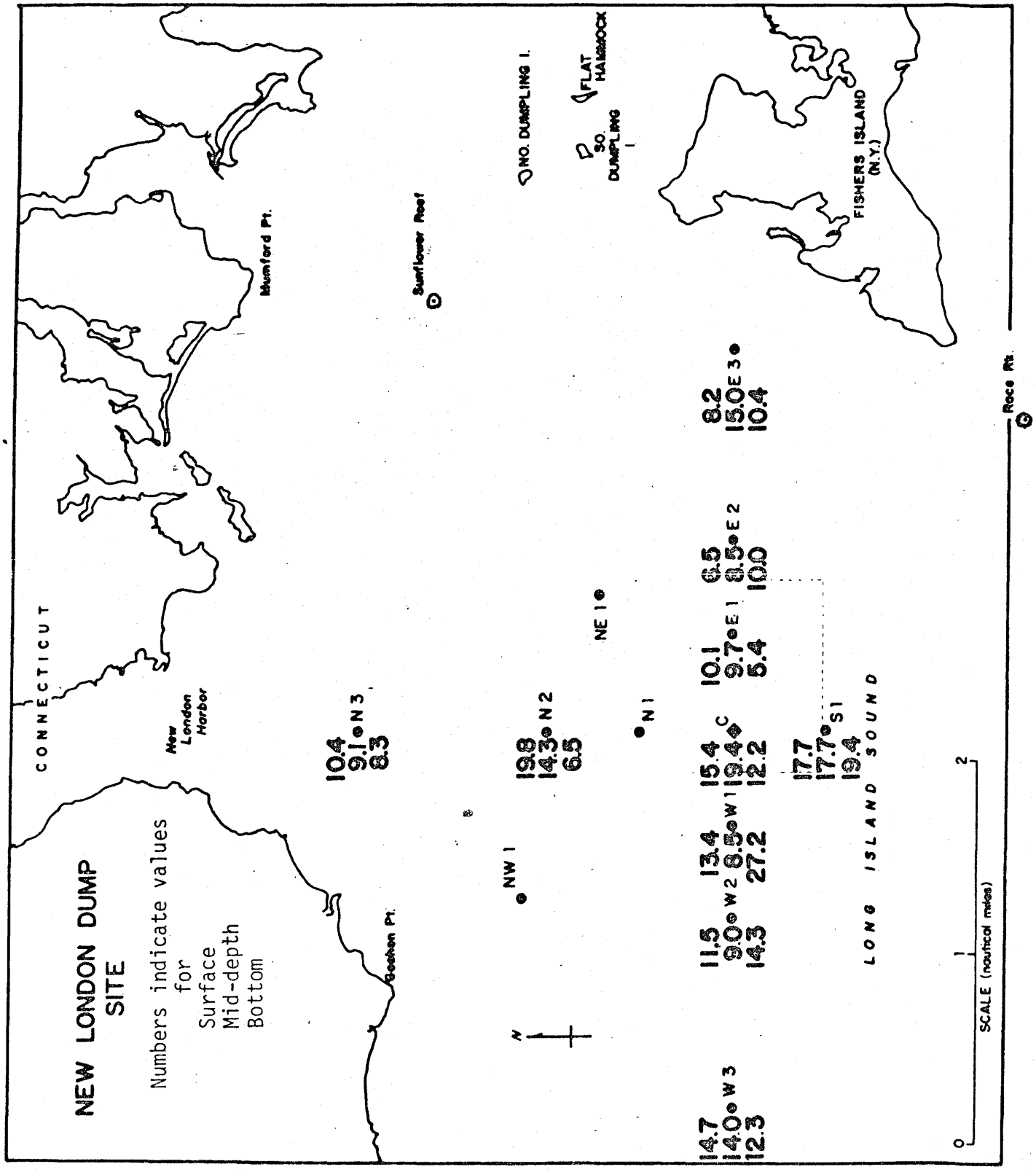


Figure 9c: The distribution of total organic carbon (mg/ℓ) 11 December, 1974



5. Suspended Solids. The distribution of suspended solids in July, September and December, 1974, is shown in Figure 10a, b, and c. An overall increase in the concentration of suspended solids occurred from July to December. For example, average concentration in July and September was 2.4 mg/ℓwhile in December the average concentration was 4.7 mg/ℓ. Significant differences were present in the amount of suspended solids present in the surface and bottom waters along the "N" transect in July, the "W" and "E" transects in September ("N" was not sampled due to heavy fog) and along the "N" and "E" transects in December only.

The observed increases in the concentration of suspended materials between each sampling interval were statistically significant.

The amount of time required for the suspended solids concentrations present in the water following a dump on 11 September, 1974, to return to background is shown in Figure 11a and b. (The movements of the surface and bottom droques during the ebbing tide is shown in Figure 3). The surface waters to the north and east of the dump buoy had returned to near background within 8 to 10 minutes. Bottom waters to the north of the buoy had essentially returned to near background within 50 minutes. The increase occurring at 1725 hours is attributed to the resuspension of bottom sediments following impact of the barged materials. Bottom waters to the east of the buoy required almost two hours to return to background. These settling processes were completed in less than 500 yards from the point of release during these tidal conditions.

Figure 10a: The distribution of suspended solids (mg/ℓ), 31 July, 1974

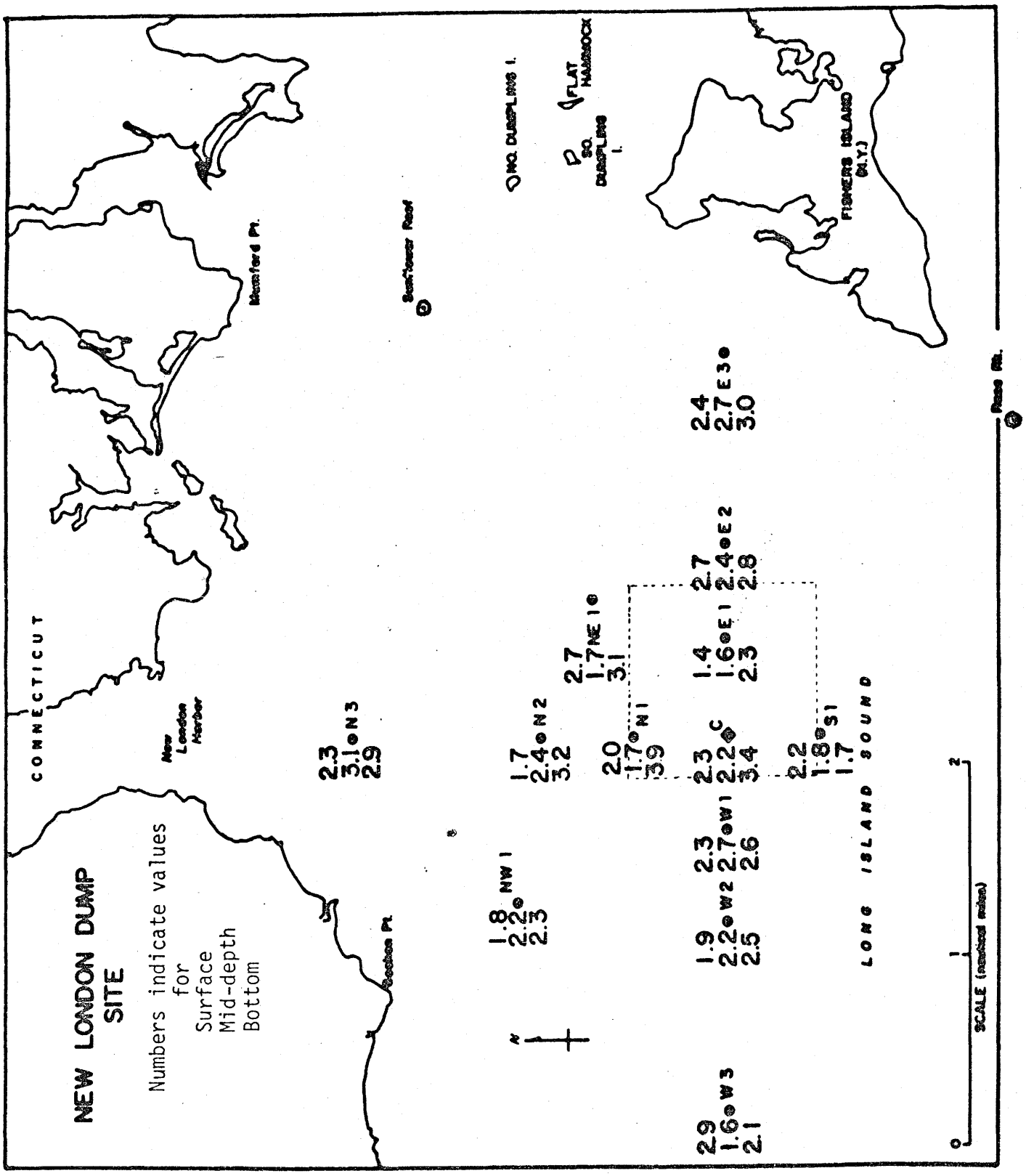


Figure 10b: The distribution of suspended solids (mg/ℓ), 11 September, 1974

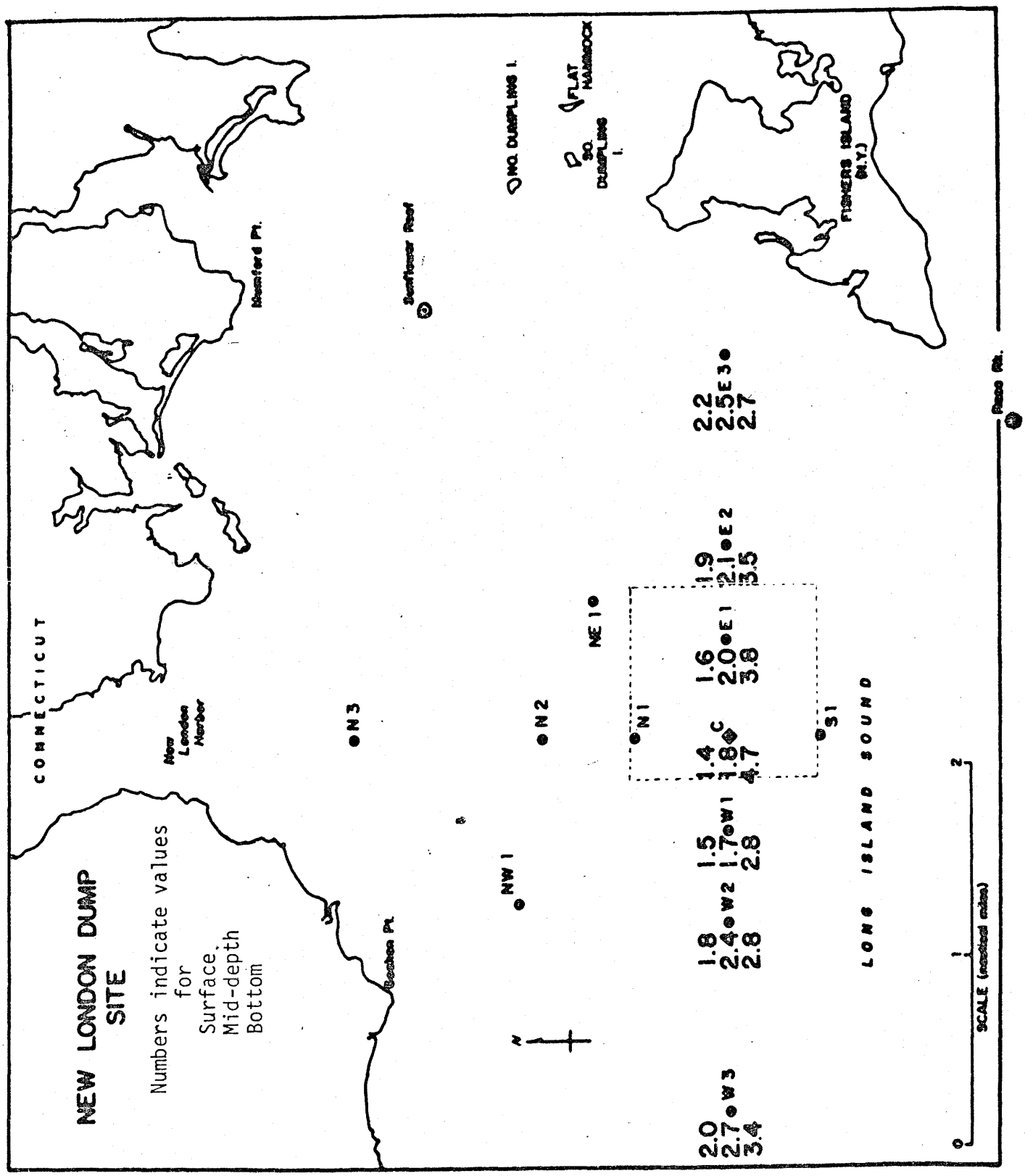


Figure 10c: The distribution of suspended solids (mg/ℓ), 11 December, 1974

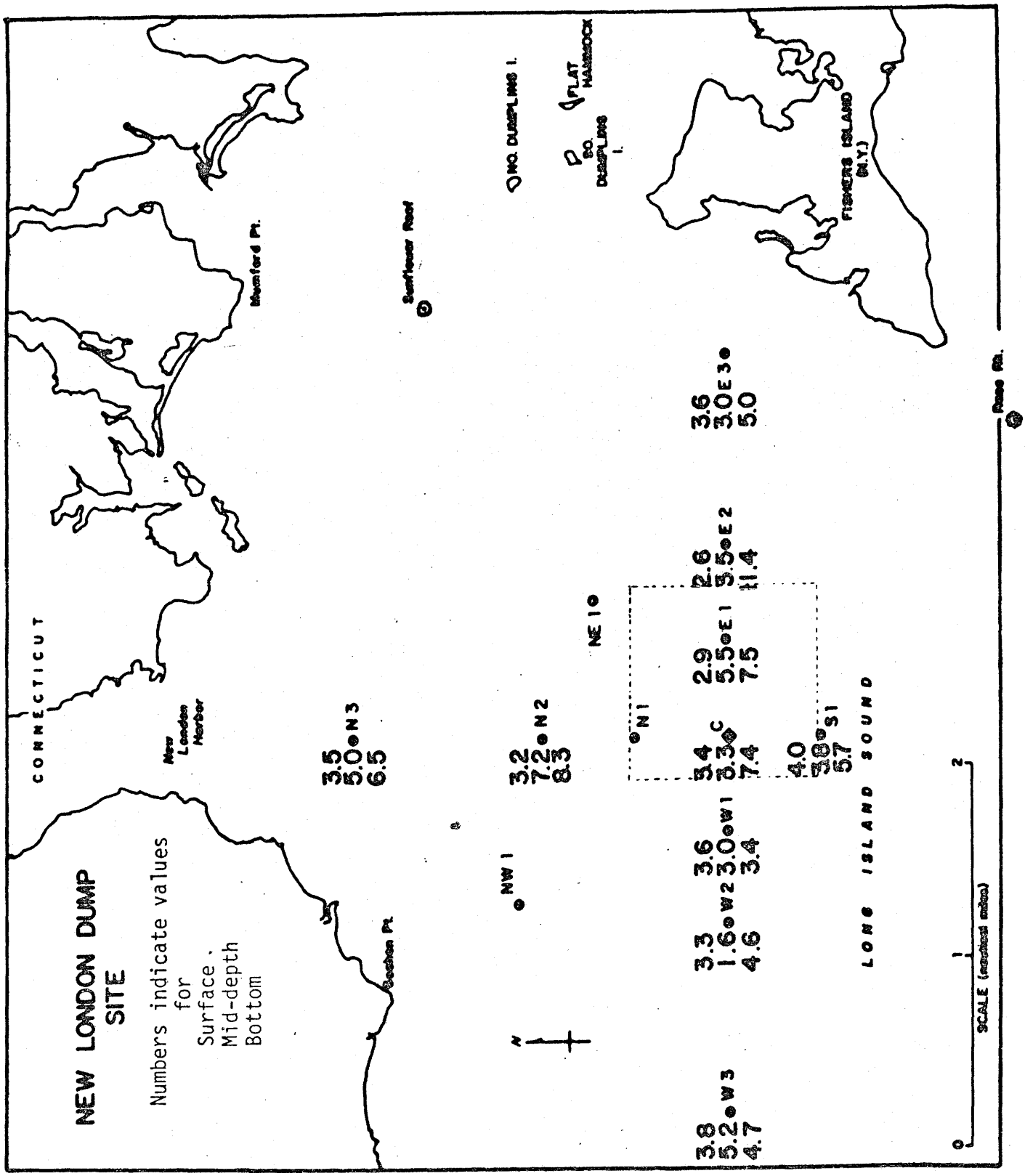


Figure 11a: Suspended solids versus time. 11 September, 1974

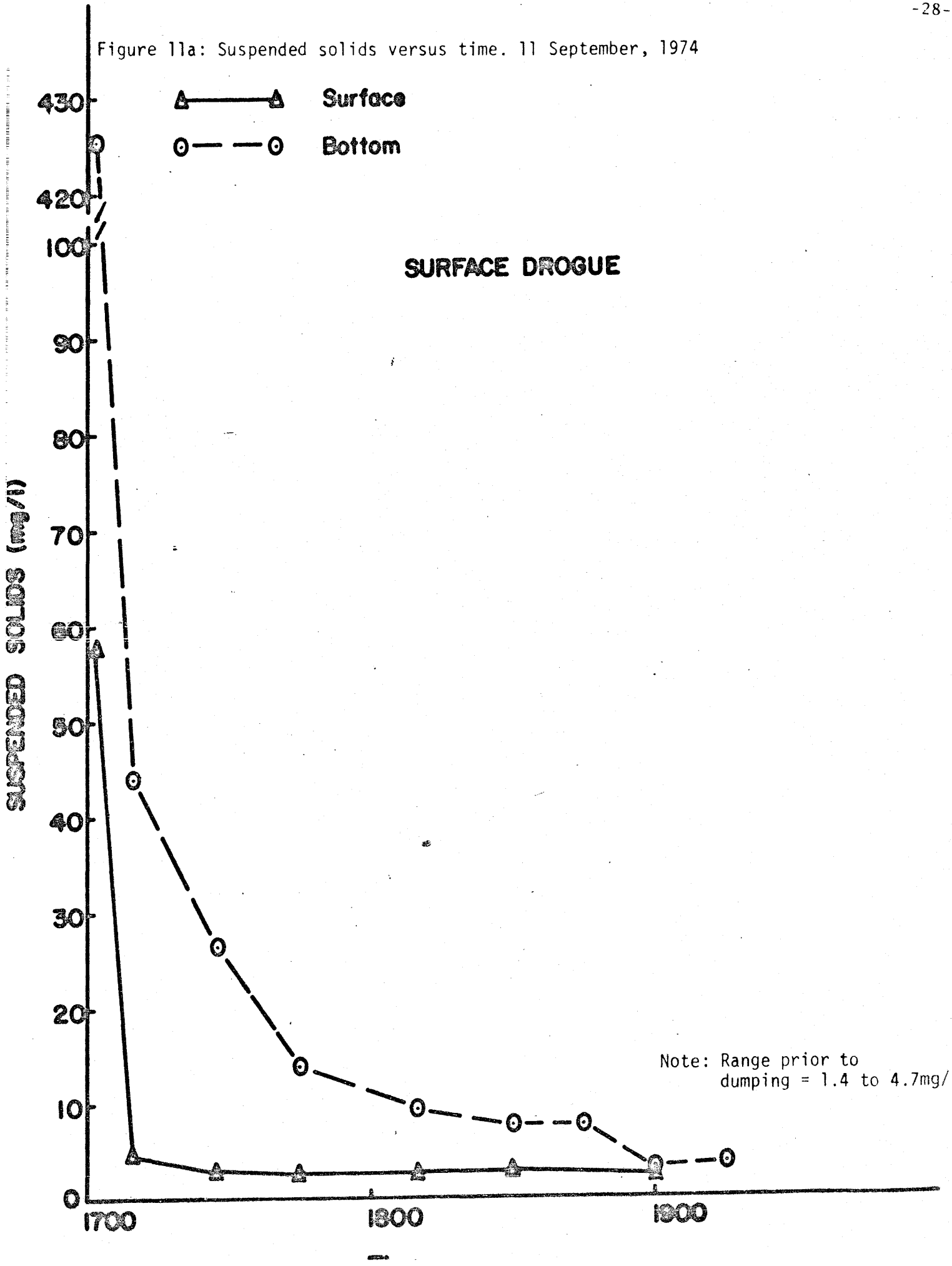
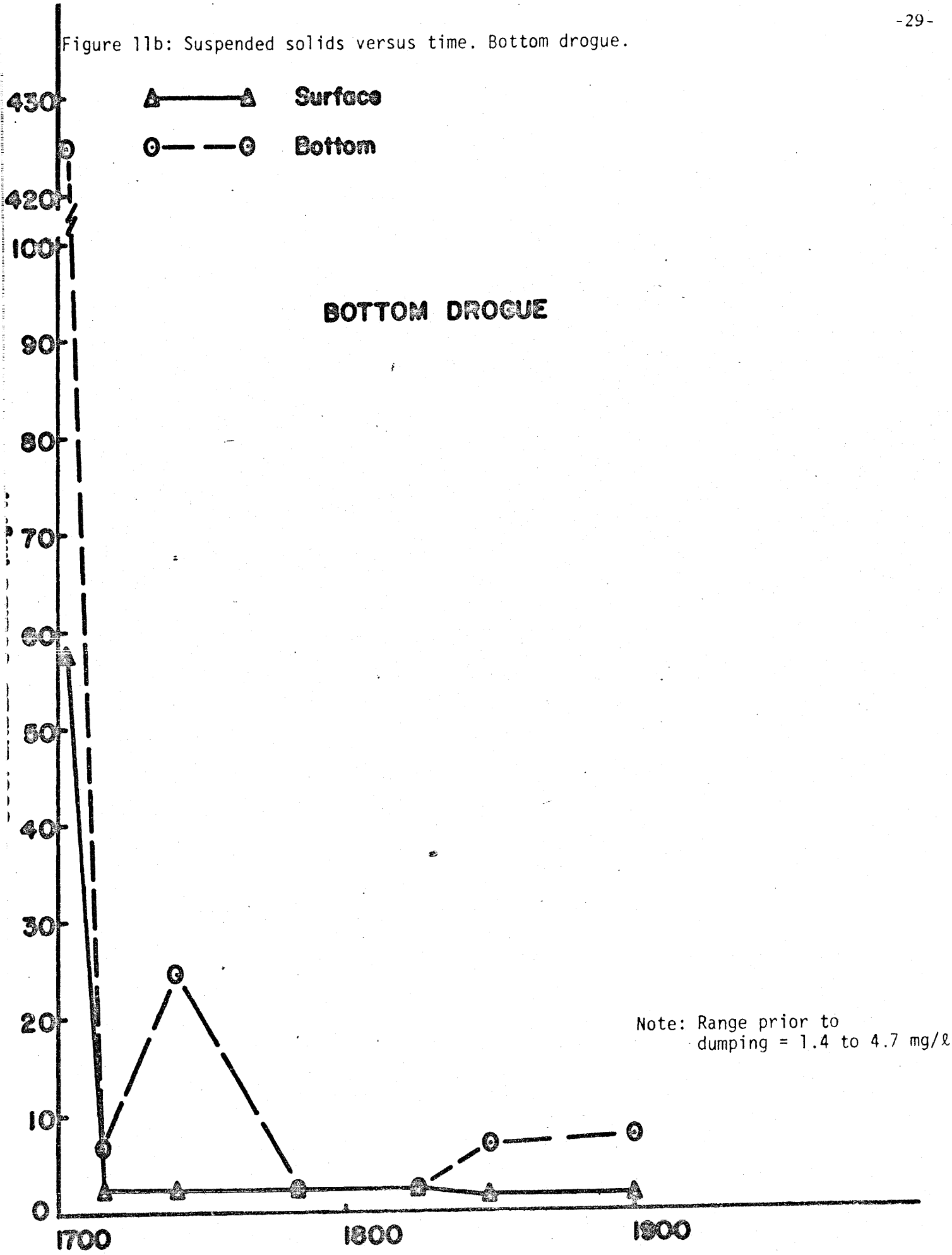


Figure 11b: Suspended solids versus time. Bottom drogue.



6. Volatile Solids. The distribution of volatile solids in July, September and December, 1974 is shown in Figure 12a, b, and c. An overall decrease in the amount of volatile solids present in the water column occurred from July to December. For example, the average concentration of volatile material in July, September and December constituted 71, 41 and 21 percent of the total amount of suspended material present. Significant differences were present in the amount of volatile materials in the bottom waters of the "W" and "E" transects in July; the surface waters of "W" and "E" in September and between the surface waters of the "N" and "W" transect as well as the "W" and "E" transect in December. No clear explanation is available for these differences at this time.

The amount of volatile material remaining in the water column following a dump is shown in Figure 13. As indicated in the figure, the surface waters to the north of the buoy returned to background levels within 15-20 minutes. Volatile solids in the surface and bottom waters to the east of the buoy had not reached conditions prior to dumping after two hours, which reflects the increased amounts of inorganic materials in suspension. This is especially apparent during the initial recovery from the dump.

Figure 12a: The distribution of volatile solids (percent of total solids)
31 July, 1974

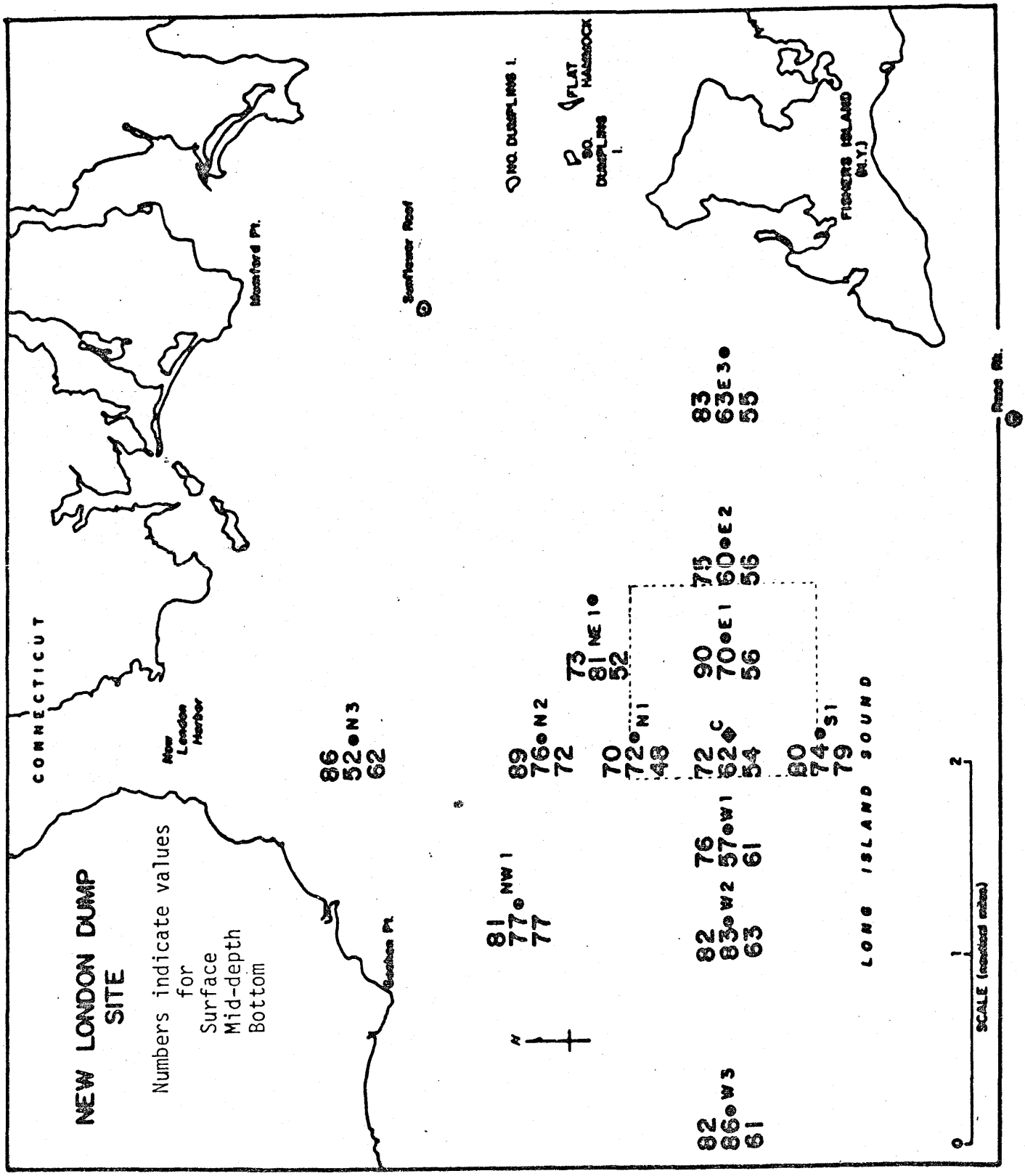


Figure 12b: The distribution of volatile solids (percent of total solids)
11 September, 1974

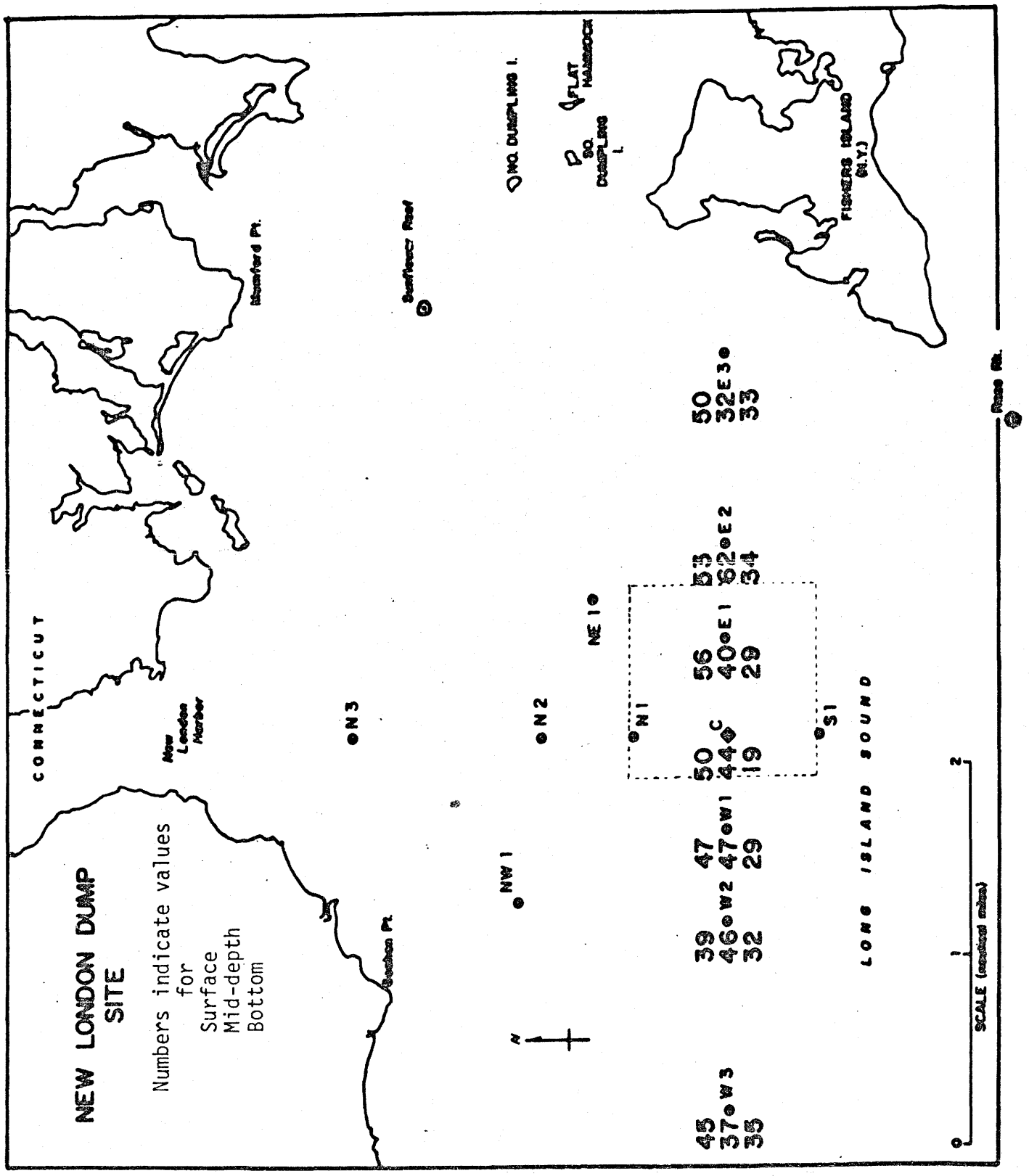


Figure 12c: The distribution of volatile solids (percent of total solids)
11 December, 1974

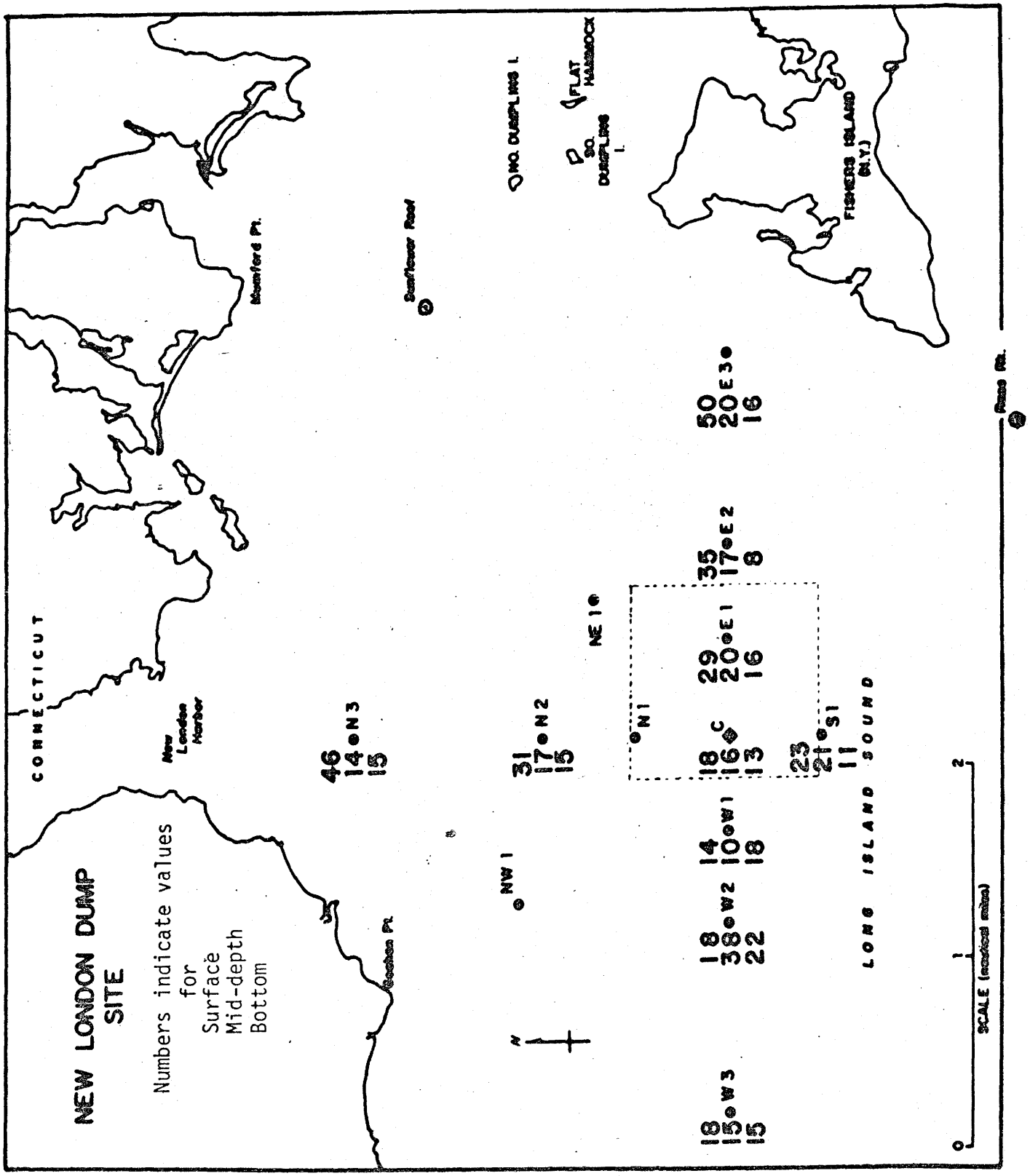
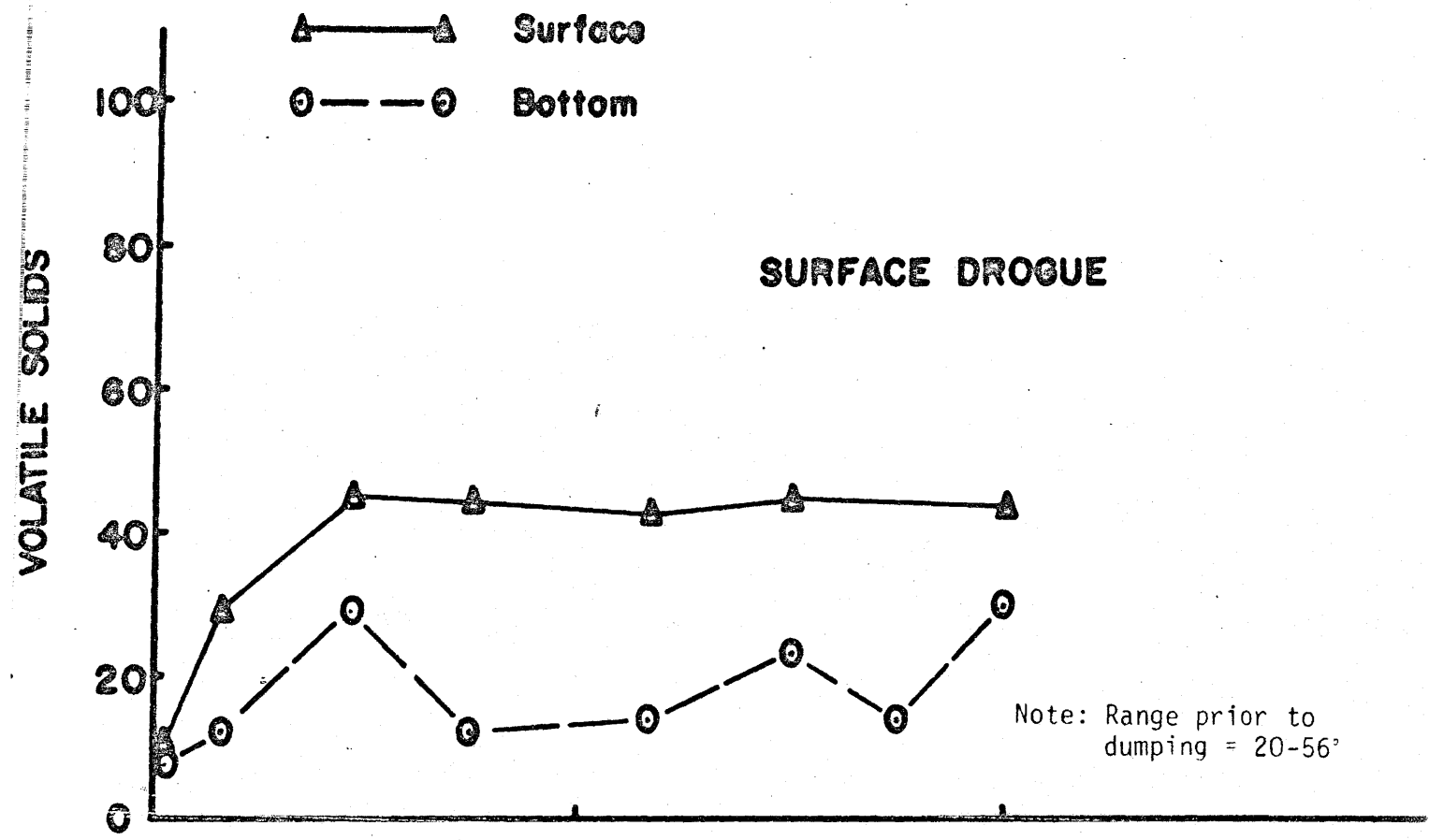
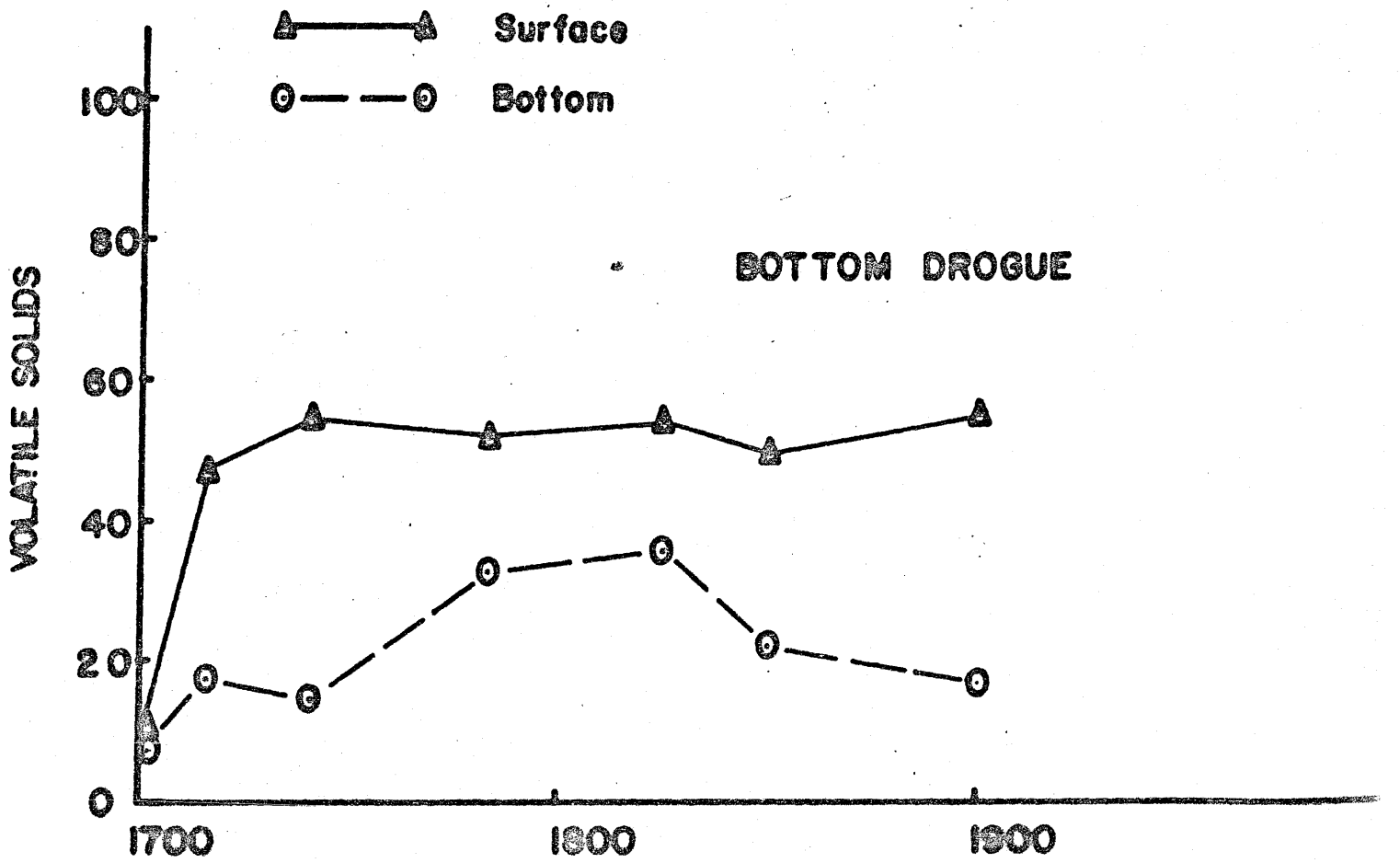


Figure 13. Volatile solids (as percent of total solids) versus time (11 September, 1974)





B. Organisms

1. Seston. Table 2 lists the average metal concentrations present in the freeze dried seston samples collected in July, September and December, 1974 at the various stations. Sample sizes were especially limiting in July (the presence of large quantities of jellyfish in the water made the seston collecting difficult) and extensive compositing was necessary. Concentration ranges have been used as an estimate of variability. No significant differences between the three sampling periods, or where available, between the stations, were found.

2. Benthic Organisms. Table 3 lists the metal content of six species of benthic organisms collected during July, 1974. These samples were provided by the Sandy Hook laboratory. Substantial compositing of the various samples and stations was necessary to obtain sufficient material for analysis. In one instance (*Mercenaria* sp.) sufficient organisms were available to obtain an estimate of the variability between organisms at one station and between stations. Although not statistically rigorous, these variabilities are similar. As additional samples become available a more rigorous statistical analysis will be conducted. In lieu of these data the ranges of values obtained have been listed as an estimate of the variability.

Table 2 . Average Heavy Metals Content of Seston in the New London Dump Area (ppm, dry wt.)

Sampling Date	Cd		Cu		Fe		Ni		Pb		Zn	
	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range
July, 1974 (2 spls)	2.2	2.1-2.2	22	11-33	1400	410-2400	9	5-13	6	<4-9	650	520-790
Sept., 1974 (7 spls)	3.9	0.5-13.2	73	43-156	6400	3000-12,200	38	18-54	21	<4-42	740	190-1110
Dec., 1974 (6 spls)	1.6	0.4-2.9	110	34-374	7400	1600-16,200	38	9-68	34	<4-112	670	410-1050

Table 3 : Heavy Metals in Benthic Organisms
New London Dump Site - July Samples
ppm (dry wt.)

Organism	Cd		Cu		Fe		Hg		Ni		Pb		Zn	
	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range
Mercenaria	<2	-	46	24-147	840	380-1780	1.4	0.3-2.1	9	5-12	6	<4-13	241	168-295
Polychaeta (2 composite spls)	<2	-	52	27-77	2700	1300-4100	1.3	1.2-1.4	23	10-36	15	12-19	166	132-200
Cardita (1 composite spl)	7	-	60	-	1000	-	1.2	-	8	-	10	-	96	-
Astarte (1 composite spl)	<2	-	73	-	510	-	-	-	7	-	<4	-	122	-
Halichondria 1 individual spl)	<2	-	26		6900	-	0.9	-	7	-	20	-	68	-
Cliona (2 individual spl)	<2	-	30	27-32	4400	2600-6200	<0.2	-	<2	-	13	11-15	128	81-174

C. Sediments

1. Chemical oxygen demand, nitrogen and phosphorus. Table 4 lists the C.O.D. of the composited sediments in July and October, 1974. The average confidence limits for these data is ±10.7 percent. Increased amounts of data are now being collected to allow for an estimate of the variance between grab samples collected at a station.

No significant changes in the chemical oxygen demand of the sediments occurred between July and October. This lack of significance holds whether the entire population of samples was contrasted or the individual transects were compared between the two sampling intervals.

Table 4 also lists the total nitrogen and phosphorus content of the composited sediments in July and September. The average confidence limits for these data are ±14 percent. Additional data are now being collected to allow for an estimate of the variances between grab samples collected at a station.

No significant differences were present when the nitrogen and phosphorus data in July were contrasted with those from October.

Table 4. The chemical oxygen demand, Kjeldahl nitrogen and total phosphorous concentration of the sediments - Composite samples, New London Dump Site.

Station	C.O.D. (mg/kg)		Kjeldahl Nitrogen (mg/kg)		Total Phosphorus (mg/kg)	
	July	October	July	October	July	October
A 1	1670	2020	120	170	1.2	1.9
2	7140	3090	310	230	1.9	1.2
3	15700	10400	660	460	1.1	1.5
4	50700	23100	940	950	7.3	1.2
5	36300	14300	1350	640	1.7	1.2
7	63200	39500	1220	1850	0.6	4.3
8	48400	71100	1020	1440	7.6	3.1
9	20300	6150	380	560	2.2	1.2
10	N.S.	13300	N.S.	360	N.S.	1.6
B 1	20400	10300	1080	500	4.2	1.2
2	13100	25100	470	640	0.6	1.9
3	29600	13600	1110	780	0.5	1.5
C 1	3600	16900	130	950	1.0	0.6
2	3450	3930	130	120	5.1	0.3
3	25300	18400	950	770	1.0	1.5
4	17700	24900	660	930	7.3	4.0
5	42800	29100	1180	1490	0.6	2.5
6	38600	65800	1140	1700	1.0	6.2
7	29700	31500	920	1290	1.1	2.2
8	23800	17300	790	700	0.6	1.6
9	19700	23100	800	1100	1.1	4.6
D 1	930	N.S.	50	N.S.	0.5	N.S.
2	1390	1630	40	40	1.1	0.3
3	23400	16200	640	680	4.6	4.9
E 1	4990	3480	130	120	1.5	0.9
2	6890	19200	280	480	6.3	1.2
3	N.S.	51300	N.S.	840	N.S.	1.5
4	21400	35600	750	1570	3.8	1.2

Table 4 (cont'd.)

Station	C.O.D. (mg/kg)		Kjeldahl Nitrogen (mg/kg)		Total Phosphorus (mg/kg)	
	July	October	July	October	July	October
E 5	40400	39500	1310	1180	0.6	0.3
7	50500	34400	1600	1300	2.1	3.1
8	28900	21300	990	1770	0.5	1.5
9	N.S.	17700	N.S.	780	N.S.	2.5
F 3	36500	15200	900	540	5.5	1.2
4	73200	55900	850	1280	4.3	1.9
5	52000	71200	1440	2020	5.1	1.5
7	81300	51100	3060	1840	2.7	0.6
8	20100	15100	810	780	1.6	1.2
9	10600	12800	760	720	1.1	1.2

2. Metals. Table 5 lists the "acid-soluble" metals present in the sediments during July and October, 1974. "Acid-soluble" rather than total metal concentrations were determined since the former are presumably of more biological interest than those incorporated into the internal structure of the sediment particles.

The confidence intervals (and minimum detectable concentrations) shown in the table are based solely on the repeatability of the atomic absorption reading. Data is now being collected to allow for an estimate of the total analytical variance and the variance between grab samples at any one station.

Since a good measure of variance is not, as yet, available, the significance of the increases or decreases in metal concentrations between July and October was tested by the "sign test". When all of the data were considered, regardless of station, significant (90%) increases in mercury and copper concentrations and to a lesser (75%) extent, nickel and lead (decreases) were found. The zinc and iron changes found are random.

When the changes are plotted however, as + or - on a station location chart a preponderance of the increases are found to be present in an irregular pattern around the dump buoy (Station C-6). Limited data shows that the concentration of all metals, except cadmium, are higher in the sediments from river stations than in the dump area.

In conclusion, no major unexpected changes have occurred in the water column, the organisms or the sediments which can be solely attributed to the dumping activities.

Table 5: Acid Soluble Metals in Sediments - Composite Samples
New London Dump Site

	Cd, ppm		Cu		Fe		Hg		Ni		Pb		Zn	
	July	Oct.	July	Oct.	July	Oct.	July	Oct.	July	Oct.	July	Oct.	July	Oct.
Conf. Interval	±2 ppm		±0.5		0.08×10^3		-		±1		±7.5		±0.6	
Min. Detect.	4 ppm		1 ppm		2 ppm		0.1		2 ppm		15 ppm		1.2	
Station					$\times 10^3$									
A1		<4		3.8		6.17	0.3	0.402		5		<15		27.3
2		<4		1.6		5.08	0.5	0.402		<2		<15		18.3
3	<4	<4	4.6	6.8	5.60	6.58	0.1	1.0,0.3	6	3	45	<15	39.0	33.5
4	<4	<4	18.0	14.0	12.1	8.46	<.1	0.5	4	10	30	30	93.0	50.3
5	<4	<4	11.6	14.5	7.69	5.66	0.2,0.1	0.6	<2	8	<15	<15	60.1	31.0
7	<4	<4	9.8	22.8	9.64	16.0	0.1,0.2	0.4,0.7	<2	11	<15	15	61.1	57.8
8	<4	<4	9.3	44.1	9.04	12.0	<.1	1.0	9	10	<15	30	69.9	91.7
9	<4	<4	4.6	7.8	7.21	6.52	<.1	0.3,0.2	6	5	<15	15	52.8	38.1
10		<4		4.6		4.01		0.9,<.1		<2		<15		28.5
B1	<4	<4	36.4	6.4	16.9	5.76	<.1,0.2	<.1,<.1	14	8	25	<15	122.2	33.2
2	<4	<4	22.2	9.2	11.2	6.90	0.2,0.2	<.1,0.1	9	<2	30	<15	73.2	42.6
3	<4	<4	13.8	7.1	10.8	5.44	<.1,0.1	0.6,0.2	5	5	20	<15	58.2	32.5
C1	<4	4	<1	6.7	2.47	4.95	0.1	0.6,0.1	<2	7	<15	<15	11.6	30.9
2	<4	<4	18.1	<1	9.36	2.69	<.1	0.2	4	4	20	<15	63.2	12.9
3	<4		10.6		4.88		0.1	0.2,0.1	<2		30		47.0	
4	<4	<4	9.3	10.8	6.76	6.79	<.1	0.6,<.1	<2	6	45	25	37.2	39.2
5	<4	<4	12.9	15.3	9.93	8.18	0.2	0.1	<2	8	25	15	76.5	48.2
6	<4	<4	5.9	20.1	8.15	23.0	<.1	3.9,1.6	<2	16	35	<15	59.3	46.9
7	<4	<4	8.9	19.5	6.88	9.84	0.1	0.3	11	12	45	30	44.7	63.9
8	<4	<4	7.1	9.3	5.36	5.73	0.1	0.3	<2	4	<15	<15	37.3	37.2
9	<4	<4	5.1	10.6	6.88	9.78	0.1	<.1,0.1	10	4	20	<15	51.5	55.9
D1	<4		< 1		1.29		<.1		<2		15		3.5	
2	<4	<4	< 1	<1	2.04	1.34	0.1	0.1,<.1	<2	<2	<15	<15	9.9	7.4
3	<4	<4	2.1	8.3	7.84	10.1	<.1	0.7,0.2	<2	8	30	<15	51.2	48.5
E1	<4	<4	11.7	1.5	10.1	1.94	0.1	4.2,<.1	<2	3	30	<15	41.5	8.1
2	<4	<4	<1	4.1	2.40	3.55		<.1	<2	<2	<15	<15	7.8	19.4
3		<4		9.2		15.5	0.1	0.3		8		<15		61.2
4	<4	<4	<1	55.5	3.11	10.3	0.2	1.1	<2	11	<15	35	16.9	217.9
5	<4	<4	52.2	15.8	10.3	10.4	0.2,<.1	0.5	16	11	55	<15	201.1	57.8
7	<4	<4	23.4	16.9	12.4	10.8	0.1,0.1	0.2	14	8	25	20	76.0	56.2
8	<4	4	3.7	10.6	7.74	5.88		1.0	12	5	25	25	56.0	41.2
9		<4		6.2		5.75		<.1		6		<15		35.4

Table 5 (cont.)

	Cd, ppm		Cu		Fe		Hg		Ni		Pb		Zn	
	July	Oct.	July	Oct.	July	Oct.	July	Oct.	July	Oct.	July	Oct.	July	Oct.
Conf. Interval	±2 ppm		±0.5		0.08×10^3		-		±1		±7.5		±0.6	
Min. Detect.	4 ppm		1 ppm		2 ppm		0.1		2 ppm		15 ppm		1.2	
Station					$\times 10^3$									
F5	<4	9	<1	17.0	1.27	6.37	0.2	0.8	<2	3	<15	<15	5.0	29.4
4	<4	<4	1.24	23.2	6.72	10.6	0.1	0.6	4	4	25	25	39.7	56.3
5	<4	<4	19.5	31.2	10.6	15.8	0.3,0.1	1.2	4	10	35	35	56.9	71.8
7	<4	<4	5.0	30.2	3.67	12.5	<.1	1.8	<2	11	20	40	14.9	102.5
8	<4	<4	9.6	7.4	5.50	4.73	0.1	0.1	<2	6	<15	20	38.6	38.2
9	<4	<4	5.7	6.3	6.56	6.81	0.2	0.1	<2	6	35	<15	38.11	30.1

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APPENDIX E

SCHEDULE OF FIELD ACTIVITIES FOR 1975

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.
MACFC												
Macrofauna - sediment surveys	XX	X		X	XX	X	XX		XX	X		
Dive Surveys		X			X		X			X		
Microbiological Surveys	X			X			X			X		
UCONN												
Suspended materials: monthly surveys	X	X	X	X	X	X						
Higher resolution surveys (Also Plan 2-3 Surveys after major storms			X			X						
Geofungi sampling	X	X	X	X	X	X	X					
Dissolved oxygen, heavy metals, phytoplankton measurements	X			X			X			X		
Shellfish surveys	X			X			X			X		
Chlorophyll measurements				X			X					
NYOSL												
Finfish assessment		X			X		X			X		
		X			X							

Physical, chemical Oceanography of Dump Site