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CHRONOLOGICAL RECORDS OF IN-SITU PHYSICAL AND BIOLOGICAL CONDITIONS OBTAINED BY DIVER SURVEY AT THE CENTRAL LONG ISLAND SOUND AND NEW LONDON DISPOSAL SITES

CONTRIBUTION # 9

SCIENCE APPLICATIONS, INC.

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1.0 INTRODUCTION

Visual observations of dredge material diposal sites by divers and remote television has been a major part of he Disposal Area Monitoring System (DAMOS) for several years. Recently, particular emphasis has been placed on specific areas in Long Island Sound. A major effort at the Central Long Island Sound site has been oriented toward evaluation of the capping procedues used in the Stamford-New Haven disposal operation. In addition to those studies, continued monitoring of the New London disposal site has taken place.

The major objectives of the visual observation were to:

- define characteristics of disposed dredged material
- document these characteristics and changes in the sediment surface through underwater photography
- conduct systematic sampling at specific locations to evaluate dredged material stability
- develop procedures for measuring the boundaries of dredged material mounds through visual observations
- evaluate the effectiveness of capping procedures in isolating contaminated dredged material
- investigate post-disposal recolonization, faunal behavior and biological reworking of surface sediment
- define characteristics of benthic environment surrounding disposal sites and monitor these areas for potential impact from disposal operations

The following sections will provide details of the procedures used and the results obtained from observations at the Central Long Island Sound and New London sites.

2.0 Central Long Island Sound Disposal Site

Prior to disposal of dredged material from Stamford and New Haven harbors, the Central Long Island Sound (CLIS) Disposal Site was surveyed in March and April 1979. These surveys were made to install diver transect cables and relocation aides, to provide baseline data on the sedimentary and biological features of the disposal area, and to establish stations for repetitive sampling during monitoring of the disposal operation. Between June and November 1979, these previously established stations were revisited in order to evaluate the efficiency and impact of the disposal and capping procedures.

The disposal management procedures used for the Stamford-New Haven operation resulted in the creation of two disposal mounds. The STNH-South site consited of approximately 38,000 m^3 of Stamford sediment covered by about 76,000 m^3 of New Haven silt. The STNH-North site, located 2000m due north, consisted of about 26,000 m^3 of Stamford material covered by 33,000 m^3 of sand from the New Haven breakwater area. A major objective of the DAMOS program is to evaluate the long term consequences of these capping pocedures; therefore, visual observations of both the physical and biological impacts of disposal were frequently made at both sites during 1979, and will continue through 1980.

Data and observations resulting from the March-April 1979 surveys and June-November 1979 surveys are presented in Sections 2.1 and 2.2. Table 2.0-1 contains a chronological record of diver observations at each site for all surveys. Table 2.0-2 lists the captions corresponding to the photographs which are

Table 2.0-1 Summary of diver observations at Central Long Island Sound Disposal Site.

Date	Site	Operation	Dive Observation
21 March 79	South Pre-Disposal	Deployed west-east transect line. (440 m), (SW 8 - SC - SE 8).	
22 March 79	South Vis. 4 feet		Pre-disposal on transect line. Bottom at SC cohesive but very soft. SC anchor buried to approximately .5 cm. At SE 1 to SE 3, bottom cohesive and firm. Boulder north of SE 1. Species - Homarus americanus in mud burrows (2) Corymorpha pendula (100+) Urophycis sp. (1) Psuedopleuronectes americanus (10) Cancer irroratus (25+) on surface. Pleurobrachia pileus Ctenophore. Bryozoan (Bugula turrita 2)
	North	Deployed west-east transect line (220 m), (NW 5 - NC - NE 5). Dives from SC to SW2 and SC to SE 1. Cores at SW 2, SC and SE 1. Calibrated stakes at SC, SW1, and SW 2. Photos taken along transect. Visual observations of surface sediment characteristic and macrofauna.	
23 March 79	North Vis. 3 feet	Dives from NC to NW 3 and NC to NE 1 Cores at NC, NW 1, NW 3 and NE 1. Calibrated stakes at NC, NW 1, NW 3 and NE 1. Epibenthic tow NC to NE 1. Photos taken along transect. Visual observation survey.	On transect line NE 1 - NW 3. Bottom soft and cohesive. Species - Cancer irroratus Asterias forbesi 5-10 cm Corymorpha pendula. Psuedopleuronectes americanus.
23 March 79	South Vis 3 feet	Dive at east end of site to SE 8. Epibenthic tow. Photos taken along transect. Visual observation survey.	At east end of transect line, SE 8. Surface ripple marks. Cylindrical vertical burrows - no lobster. Species - Scophthalmus aquosus (1) Pseudopleuronectes americanus (2) 15 cm. Corymorpha pendula - 15 ind./.25 m^2

Table 2.0-1 (continued)

Date	Site	Operation	Dive Observation
10 April 79	South Vis.12 feet	Interim Survey. Two dives made: A North-South transect and a southwest transect. Original transect lines found to be buried. Cores taken at SC on transect line and at southwest periphery of pile. Photos taken along transects. Visual observation survey.	Disposal in progress. Compass transect to SW of dump buoy and north-south. No distinct color difference between spoil and natural sediment. Possible silt veneer overlay on each tidal cycle. Cohesive clay clumps. 3 foot mounds at center. Height above original level 5 feet maximum. Clump splitting occurring (some due to benthic fauna). Debris on surface and partially buried (i.e. leaves, Phragmites, timber, aluminum, foil, plastic). Species - Pseudopleuronectes americanus (16) Urophycis sp. (4) 1 burrowed in side of clay clump. 1 adjacent to plastic debris on clump, excavating sediment. Myoxocephalus octodecemspinosus (8). Tautoga onitis (1) on base of dump buoy. Pagurus longicarpus (20) Libinia emarginata (9) Cancer irroratus (50) excavating clay clumps and surface sediment some burrowed over entire bottom. Crangon septemspinosa Mysids - over entire bottom. Shrimp - Pandalid shrimp. 2 cm vertical burrowed Galatheidae. Asterias forbesi Bugula turrita - on fouled clumps or eddy zone. Gastrodod on Laminaria blade Corymorpha pendula - none on spoil, buried at periphery (15/25 m^2) Gastropods - (10). Immediate colonization after dumping.
24 April 79	South	Grappled for and recovered end of west transect line, repositioned.	
25 April 79	South	Deployed north-south transect line to delineate north-south pile boundries. Dives to delineate spoil boundries. Loran C positions on divers surfacing at periphery locations. Located and buoyed (subsurface) calibrated stake south of SC clump. Photos along transects.	Dive on dump buoy to west periphery. Cable broken between SW 7 and SW 8. Divers did not find far end of cable. Concentration of Asterias forbesi in 20 m band at border of spoil 20-30 individuals. Divers surfaced after locating spoil periphery and Loran C fix obtained.

Table 2.0-1 (continued)

Date	Site	Operation	Dive Observation
25 April 79	South		Species - Pseudopleuronectes americanus (10) Myoxocephalus octodecemspinosus.(5-6) Syngnathus sp. (7) Urophycis sp. (5-7) Tautogolabrus adspersus - (2) Corymorpha pendula - 15-20/m^2 Uniform distribution 3-10 cm. height. Libinia emarginata (8). Cancer irroratus (25). North-South transect line deployed and followed to south periphery. Loran C position taken at surfaced diver positions. R/V UConn placed marker buoys at apparent east periphery (determined by Smith-McIntyre grab samples). Divers descended buoy and found Corymorpha evenly distributed over the area (apparently no spoil). The sediment had a 3 layered profile when diver excavated 10cm hole. The top layer was very loosely cohesive and aerobic. (Appeared to be organics that have adsorbed and settled on bottom). Beneath this is what appeared to be an anaerobic layer but may have been buried spoil and a clay layer under all.
26 April 79	North	Dives from dump buoy to north periphery (Loran C position on surfacing divers) and on NE periphery to visually delineate spoil periphery and compare to position found by grabs. Epibenthic tow at NE periphery. Photos along transect. Visual observation.	Divers descended dump buoy and headed on NNW compass course. At periphery, divers surfaced and a Loran C position obtained. An approximate 3 meter intermediate zone (patches of spoil and natural sediment) with sparse Corymorpha and clay clumps. Species - Cancer irroratus (6) Shrimp Crangon (2) Bryozoan Bugula turrita (3) Pagurus longicarpus (1) Pseudopleuronectes americanus (6) Nasaarius trivittatus (1) 6 cm burrow in spoil sediment and worm tubes near periphery.

Table 2.0-1 (continued)

Date	Site	Operation	Dive Observations
26 April 79	North		Descended approximately 200 feet east of dump buoy and followed edge of spoil to SE. Some debris noted from dumping observed on natural sediment surface past pile edge (i.e. Laminaria Anomia valves, clay clump). current transport of light debris further then heavier sediment. Corymorpha partially buried by surface sediments. Species - Urophycis sp. (3) Asterias forbesi (15) Pseudopleuronectes americanus (8) Tautogolabrus adspersus (5+) Homarus americanus (3) Shrimp Crangon (6+) Cancer irroratus (8) Bryozoan Bugula turrita (5) Pagurus longicarpus (4) Pagurus pollicaris (2) Corymorpha pendula - borders.
21 May 79	S/NH North Vis. 3 ft.	Interim survey - perimeter delineation on eastern border and visual observation survey. Epibenthic collections taken on and off spoil.	Located spoil border (Corymorpha as indicator) from east. Clay clumps were interspersed around a generally featureless surface sediment veneer. The 3 layer sediment strata condition still present. Corymorpha ubiquitous off spoil 25/.25 m^2 boundary area 10-15/.25 m^2. Urophycis - 3 Pseudopleuronectes 8 Scophthalmus - 1 Cancer irroratus - 7 Asterias - 15.

Table 2.0-1(continued)

Date	Location	Procedure	Observation and Data
19 June 1979	North site Essayons capping operation	Dive inspection of sediment surface effective coverage. South free transect survey from N buoy to SSE spoil perimeter.	Sand overlay continuous to beyond Stamford spoil; mud-clay spoil not detected over entire course. Depth of New Haven sand at central mound region greater than .7 m excavation; depth of sand cap at periphery approximately 5-10 cm. Clay fragments noted on top of sand obviously of New Haven origin. Extensive shell fragment layers noted 2/3 distance from disposal buoy. Suspension of disposal material evident at 40 foot depth with visibility reduced from 8 to 4 feet. Abundant Cerianthus americanus (burrowing amemones) further confirmed natural bottom/sand border at perimeter. Predominant species noted on new cap material: Pagurus longicarpus (20+) P. pollicarus (15+) Cancer irroratus (20+) berried female active excavation. Axius serratus (2+) Prionotus carolinus (1) Urophysis (sp.) (3) Scophthalmus aquosus (12+) Pseudopleuronectes americanus (1) Raja (1), Libinia (2), Natid snails (3) Ceriantus americanus (natural bottom density 1/m^2). Other: ribbon worm fragments, cylindrical burrows common, all sand cap colonization by mobil macrobenthos. T°C = 14°, 3-4 ft. visibility, ½ kt. E bottom current.

Table 2.0-1 (continued)

Date	Location	Procedure	Observation and Data
19 June 1979	N site	Dive inspection survey to SW from 50 m west of buoy to SW periphery.	Course sand coverage with thin surface veneer of silt. Sand cap overlay appeared to "float" atop soft clay spoil base; resiliance noted on diver depression with flat object. After excavation, sand "flowed" to fill surface furrow. Vertical burrows numerous (6-10+). This region revealed thin sand cap coverage and recommendation for additional Essayons capping in SW sector were performed. Predominant species observed: Urophysis (6+) C. irroratus (12) Libinia emarginata (7) Pagarus pollicarus (3) P. longicarpus (6+) Ceriantus americanus (5) Epibenthic samples (2): Central cap and 15 m west of cap perimeter. Core sample (1): natural bottom SW perimeter: LC = 26545.0/43999.9
19 June 1979	South site	Dive inspection of cap from buoy to north perimeter.	Bottom surface sediment of soft silt with intermittant clay mounds .3 - 1 m diameter. Mound topography disappeared at distances further than 20 m from N buoy; bottom from this point flat and featureless with no debris observed. Diver surfaced where Cerianthus americanus (spoil edge) first detectable; Loran C fix obtained on both dives. Predominant species: C. irroratus (3) active excavation L. emarginata (5) Urophysis (3) P. pollicaris (4) Raja (2) (Biota sparse in relation to north site).

Table 2.0-1 (continued)

Date	Location	Procedure	Observation and Data
19 June 1979	South site		Epibenthic samples (3): S buoy to N (30 sec); LC = 26542.5/43994.8; LC = 26543.5/43995.4. Core samples (2): mound/interspace sediment at: S buoy base, 50 m south of 26542.5/43994.8. Graduated stake placement: 0 mark 1 m south of buoy chain.
20 June 1979	South site	Diver orientation transect cable (E-W, post cap) deployed from R/V U'Conn. 450 m total length with 8 logarithmic stations on east and west legs.	Dive: tie ground line from S buoy base to transect cable at SW 4+. Survey of east (Stewart and Auster) and west (DeCoursey) cable placement. Predominant species observed: Asterias (2) P. long. (2) P. poll. (3) Scophthalmus aquosus (12+) (Benthos sparse, snail furrows and decapod tracks evident, vertical burrow density as high as $6/m^2$). Elevation stake placement (2): SE 4 set at 0 mark SW 4 set 1 m north of cable. Epibenthic samples (2): SE 6 to W (30 sec.). SW 4 - SW 5. Core samples (3) (mound/interspace): between SE 5 - SE 6 SW 1 50 m S of SE 4.
21 June 1979	South site	Dive photodocumentation of post-cap conditions in surveys to ENE and NNE from S buoy to post spoil periphery.	To investigate NE sector where bathymetry indicated thin cap coverage. Photo sequence obtained. Predominant species: P. americanus (4) juvenile S. aquosus (2) Libinia (4) Loligo pealei (20+) 1 cm juvenile

Table 2.0-1 (continued)

Date	Location	Procedure	Observation and Data
21 June 1979	South site		Crangon septemspinosa Nassarius trivittatus All 20+ with densities Pagurus longicarpus greatest at perimeter. Vertical burrows: 2/m^2 to 5/m^2 at border. Epibenthic samples (1): 26541.1/43994.4. Cores (mound/interspace) (1): 26541.1/43994.7. T°C = 15°, Vis.= 2 ft., Current = ½ kt W. flood.
21 June 1979	North site	New post-cap diver orientation cable deployed E-W. Five stations on each leg at 25, 30, 40, 60, 100 m from center. West leg cable and east leg kevlar.	Dive: to tie ground line from N buoy base to NW 3 station. (Few benthic organisms present, suction dredge mortalities- broken carapaces - noted for Cancer (6) and Libinia (3).
22 June 1979	South site	Photo survey along west transect leg SW 4 to SW 8.	Photography of sediment features, biota and elevation stake at SW 4. Current: ½ kt W to E. T°C =15°, Vis. = 2 ft. Species observed: C. irroratus (5+) Libinia (2) Scophthalmus aquosus (4) Photograph station at SW 5, SW 6, SW7.
	North site	Photo survey along west transect leg NW 3 - NW 5.	Photography of sediment features, biota directly south of each cable station. Hard packed sand along entire transect. Sand wave formation evident, alternate ripple burial of cable. Vertical burrows numerous to west of NW 5 on natural bottom, no abundant indicator species at NW border. T°C = 15° Vis. = 0-2 ft., Current = ½ kt. E Elevation stake placement at NE 2 to south of kevlar line.

Table 2.0-1 (continued)

Date	Location	Procedure, Observation and Data
19 July 1979	North site.	Sup 8 mm (50') along E-W transect on baseline cable; Placement of calibrated stakes at NW 3 and NW 4 (60 m). In-situ penetrometer measurements at NC, NW 4, and 75 m north of transect line on natural bottom; 200 m N of N pile buoy. Epibenthic samples (2): NW 1 (tie-in to NW 4), and 200 m N of buoy. Macrobenthos observations: predominant species: Axius burrow densities at location 200 m N of N buoy 15/m^2. Winter flounder, Pseudopleuronectes americanus (5-15 cm) 10+ Sand dabs, Scophthalmus aquosus - 4, Hermit crabs, Pagurus longicarpus - 6, P. pollicarus - 2, Starfish, Asterias - 15+ Snail, Natid (egg cases) - 3, Hydroids, Tubularia (on line)- 3.
	South site.	Sup 8 mm (50') along E-W transect cable leg (SW 3- SW 8); Placement of additional calibrated stake at SW 6. In-situ penetrometer measurements: SW 4, SW 6, SW 8; Epibenthic samples: SW 7 to W 30 sec, and 2-0 m N of S Buoy. Macrobenthos observation and 35 mm photography; attempts to sample Axius burrows on newly deposited spoil and obtain cast of burrow configuration. Hydrogen sulfide and "white slime" area 1 x 2 m noted at SW 5; Note and record pot trawl identification numbers deployed in immediate vicinity of both disposal sites. Hake, Urophysis - 6, Winter flounder, P. americanus - Sand dab - 2, Hermit crab, P. longicarpus - 4, Squid - 1 Hydroid Tubularia.
7 August 1979	50 m SE of N buoy.	Field trials of BOLT system: underwater inspection after deployment; photograph rotors, pod position in sediment, and surrounding surface terrain.
	South site.	Exchange south pile marker with hemispherial buoy.

Table 2.0-1 (continued)

Date	Location	Procedure, Observation and Data
7 August 1979	North site.	Photography (35 mm) and benthic sampling along west and east sections of transect cable: Calibrated stakes at NW 3 and NW 4 remain at 0 mark: Epibenthic sample NC to NW 3; Penetrometer measurements at NC, NW 4 and 10 m west of NW 5; spoil cap periphery determined to east at 50335.4 and 69703.7; Sediment profile photographs taken between NE 4 and NE 5 (1 m south of cable) and at NC tie in. Winter flounder, Pseudopleuronectes americanus - 10+, Sand dab, Scophthalmus aquosus, P. longicarpus - 200+, P. pollicarus - 6+, Busycon - 2, Mysids 9 worms.

Table 2.0-1 (continued)

Date	Location	Procedure, Observation and Data
8 August 1979	South site.	Dive observation, photography (35 mm) and sampling conducted along west transect cable SW 3 to SW 8 and east transect cable SW 3 to SE 5. Epibenthic samples: SW 3 to east 30 sec, SW 7 to SW 30 sec at periphery on natural bottom. Penetrometer measurements at SW 3 and SW 7. Calibrated stake reading remain at 0 mark at SW 3 and SW 6 stations.
	North site.	Photography (35 mm) along NW transect cable NW 3 - NW 5, 50 west. Sediment profile photos taken at point ENE of N buoy on natural bottom near cap periphery. Epibenthic sample at ENE location on natural bottom.
	Shellfish station (CG buoy)	Locate (sonic receiver) lost platform and service acoustic release and current meter. Note new dredge material in vicinity during platform sonic receiver search. Sampled Mytilus (3 bags) from retrieved platform.
7 November 1979	South site.	Search for tie-line, not located. Southeast survey conducted 16 mm (100') cinema sequence. New spoil border reached approximately 50 m SSE of S disposal buoy. Apparent new spoil overlaying station transect cable in 50 m diameter central mound area. 35 mm photography. Calibrated stakes not located - buried by recent dredge disposal.
	North site.	Dive search for north site transect cable (N disposal buoy lost). Loran fix and free transect to NW conducted. 16 mm (50') cinema sequence and 35 mm photography. Epibenthic sample at NW sand cap bank (30 sec to NE). Transect cable and stakes not located.

presented in Plates 2.0-1 to 22.

2.1 Stamford-New Haven (STNH) Disposal Site Monitoring (March-April 1979)

In-situ investigations at the Central Long Island Sound Disposal Site for both the STNH-South and STNH-North target areas commenced in March 1979. Initial monitoring efforts involved the installation of diver transect cables with station markers (Fig. 2.1-1) and baseline surveys.

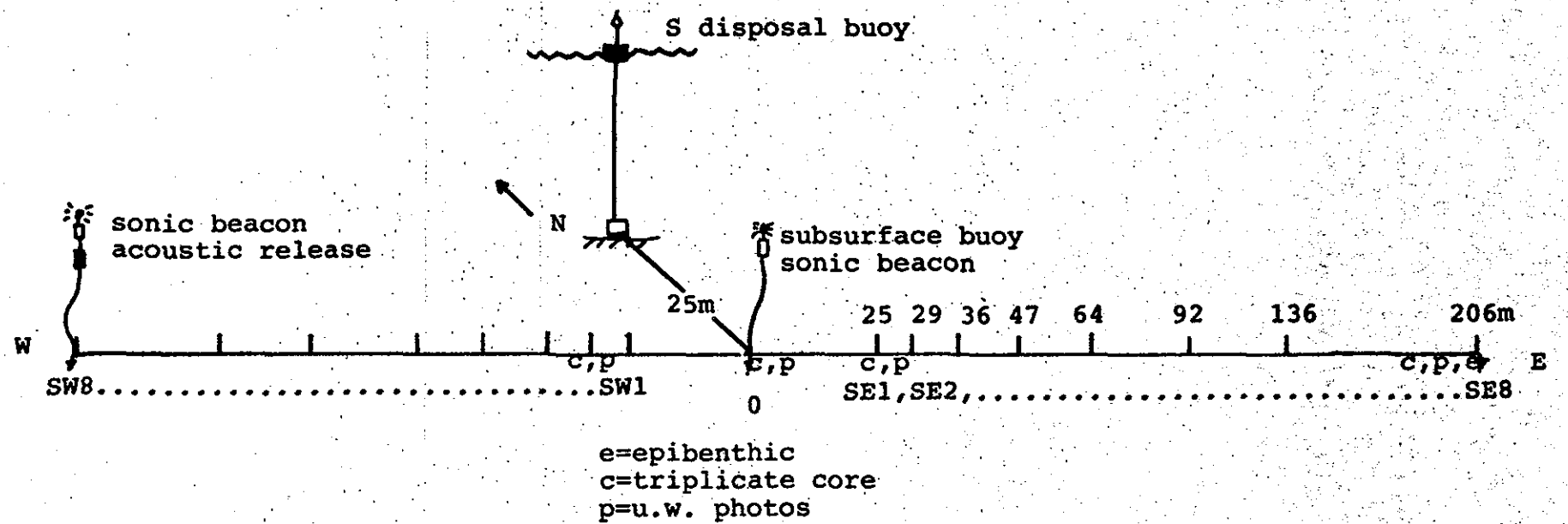
Diver orientation cables were laid E-W at the north and south sites on March 22-23, 1979. Underwater photographs, quantitative sediment core samples, and epibenthic net samples were collected at various sites along the established transects to supplement samples taken with a Smith-McIntyre grab operated from the ship. Diver collected core samples allowed discrete sampling of the soft sediment with exact reference to station location and benthic topography. The core sampling device consisted of three 7 cm (diameter) x 20 cm (height) plastic cylinders secured in line approximately 2 cm apart. Six plastic caps were cemented to short lines for closure of each core top and bottom immediately after complete sediment penetration.

In order to measure the depth of dredged material after disposal and to detect subsequent changes in the sediment surface, calibrated elevation stakes over one meter long, were placed along the transect cable at various stations. The stakes were installed such that 40 cm of calibrated marks were visible above the sediment surface at all stations at the time of installation.

Epibenthic net samples were also obtained. The 50 cm x 20 cm (1 mm mesh) net was diver operated over a 30 sec transect of

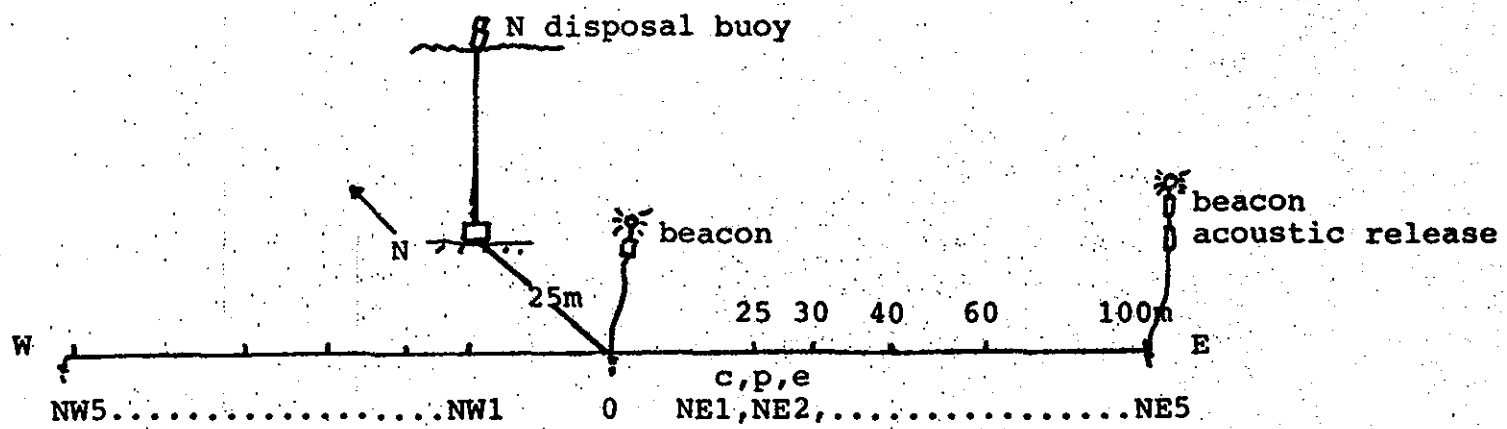
Fig. 2.1-1 CENTRAL LONG ISLAND SOUND DISPOSAL SITE

STNH-South - baseline transect cable and stations. March 1979



e=epibenthic
c=triplicate core
p=u.w. photos

STNH-North - baseline transect cable and stations



the bottom. Collection by this method allowed a standard timed course over known distance to be sampled. The net attitude was adjusted to fish over both extremely soft sediment and variable topography. A base bar depth of approximately 2 cm beneath the sediment surface was maintained throughout the transect sampling.

The pre-disposal sediment surface of both the STNH-North and South sites was found to be generally soft but cohesive. The SE transect at the South disposal site was, however, more consolidated.

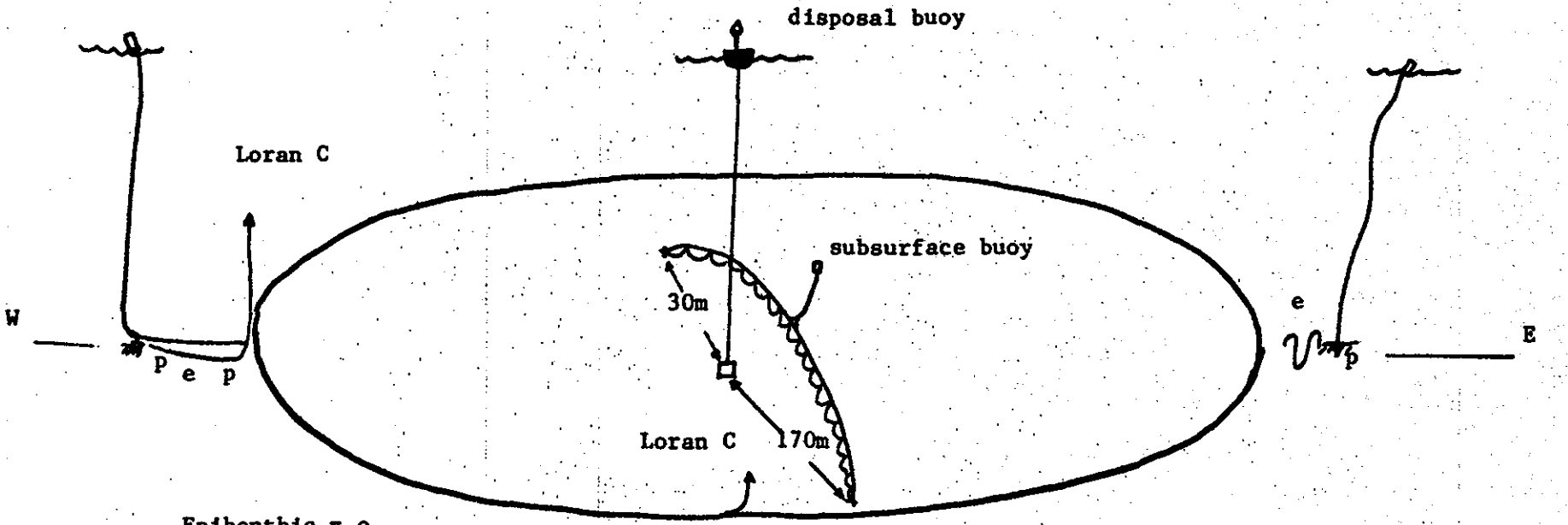
On 10 April 1979, a dive inspection of the STNH-South site provided evidence of the initial disposal operations resulting from Stamford dredging (Figure 2.1-2). The limits of the Stamford material distribution were indicated by the presence of cohesive clay mounds and slight textural and color differences from the natural bottom. However, the clearest evidence of the presence of new material was the absence of the solitary hydroid, Corymorpha pendula, which were buried by the disposal operation. Colonies of this ubiquitous hydroid were found inhabiting the adjacent bottom in densities averaging approximately 30 per m^2 (diver count).

Distribution of dredged material in the target area appeared to be the result of sequential dumping operations and not the result of dispersion due to current transport. The Stamford material observed on the bottom was characterized by cohesive clay masses with loosely consolidated interspace areas. This first phase material inspected in transect dives appeared stable, not prone to migration, and a distinct north and south perimeter could be detected. In general, Stamford material appeared more compact

Fig. 2.1-2 CENTRAL LONG ISLAND SOUND DISPOSAL SITE

Post Disposal Survey

STNH-South - Post Stamford disposal reference line. April 1979



Epibenthic = e

Photos = p

and of higher density than the surrounding natural sediment.

A gradual mounding occurred in the central target area, tailing out to greater than 50 m in the east, and greater than 100 m to the west. Irregular clay mound topography (1 m elevations) typified this central region which was approximately 50 m in diameter, located 25 m south of the disposal buoy.

Toward the perimeter of the mound, evidence of individual barge sections (2m mounds) were more common. Limits of E - W spoil coverage were not determined by diver survey, however, subsequent surveys were directed to assess the E - W spoil boundary and station characteristics on the transect orientation line. Visibility was exceptionally good (in excess of 3 m) and no evidence of spoil resuspension was noted in the course of the dive inspection.

At the spoil periphery, the normal flux of bottom silt veneer had migrated a horizontal distance of three meters onto the apron regions of the mound. (Considerable debris was observed to be incorporated in the Stamford material; i.e. steel bulkheads, pipe, rope, sheet metal, plastics, bottles, cans, etc.). Tracks of mobile epifaunal invertebrates were evident. Cohesive clay clump fragmentation and excavation about basal areas had occurred indicating a high degree of thigmotactic response from organisms recolonizing the site. In general, a greater representation and assemblage of megabenthic organisms was noted on and within Stamford material than had been observed in the baseline survey of this area on 22 March 1979.

From 24-26 April 1979, diver investigations were conducted at the STNH-South site following the completion of

disposal of material dredged from Stamford. A similarinvestigation was conducted at the STNH-North site to assemble baseline information prior to the disposal of additional Stamford material. All standard operations were completed including a biological census, epibenthic sampling, spoil border Loran-C location, and transect photography.

At the South site, an elevation line was staked down across the Stamford material, starting from the chain connected to the buoy marking the disposal site. The line extended 30 m to the north, and 170 m to the south (within 10 m of the southern perimeter of the dredged material). Stakes were used to position the line to indicate the horizon of the final Stamford disposal operation, and to provide a reference for New Haven capping effectiveness (Figure 2.1-2).

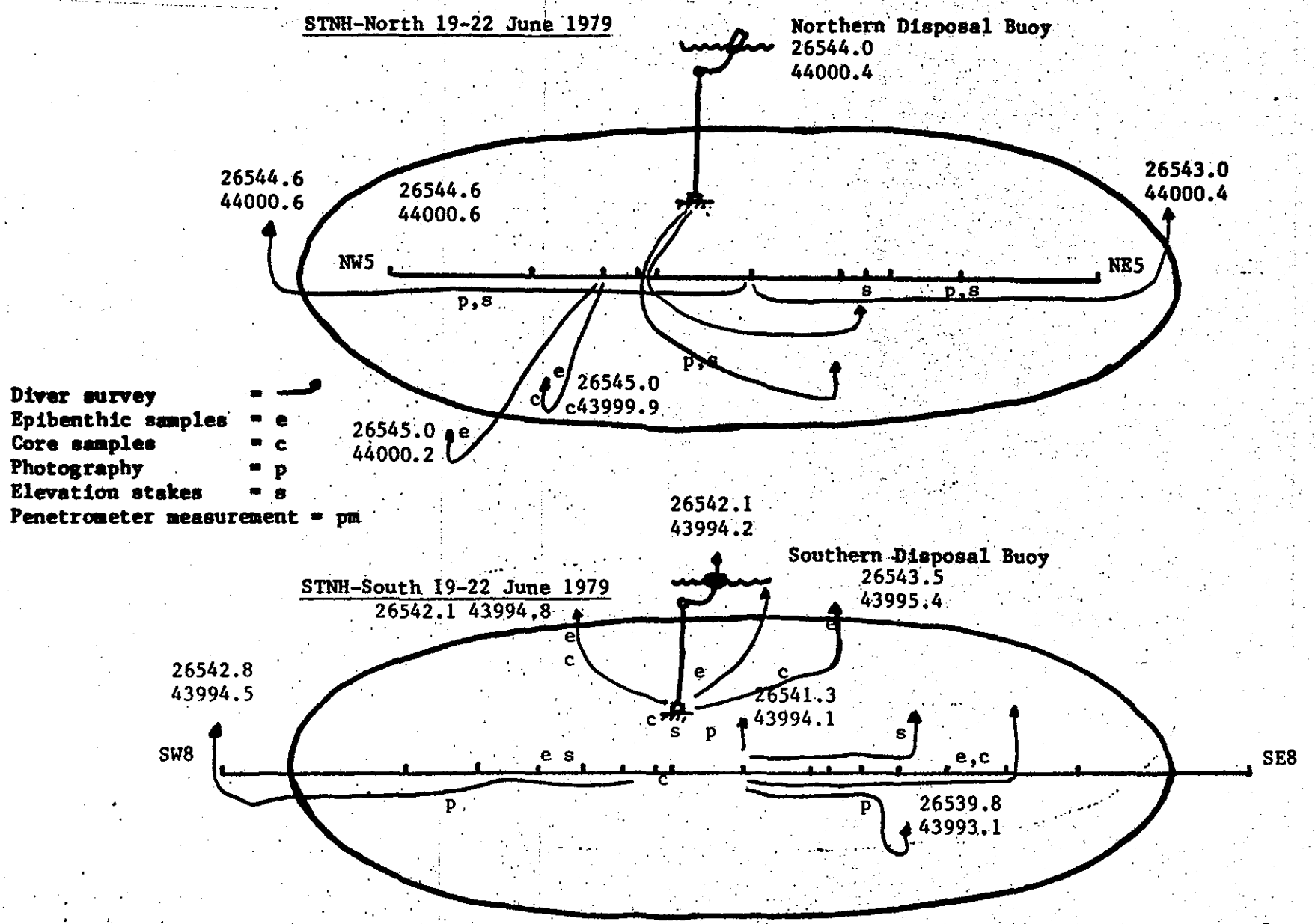
Reduced visibility in the central portion of Long Island Sound did not limit the divers' abilities to photograph benthic conditions or to perform biological inventories at either the North or South sites. Selected photographs representing features of the natural bottom sediment, topography of the disposed Stamford dredged material, epifauna and motile megabenthos occuring on both the North and South disposal sites are presented in Plates 2.0-1 to 16. See Table 2.0-2 for photograph captions.

2.2 Stamford-New Haven Disposal Site Monitoring (June-November 1979)

Following deposition of New Haven silt on the STNH-South site, and sand on the STNH-North site, both locations were surveyed in June 1979 (Figure 2.2-1) to evaluate the effectiveness of coverage of the Stamford sediment by the capping material.

Fig. 2.2-1 CENTRAL LONG ISLAND SOUND DISPOSAL SITE

Post Capping Survey



Objectives of the dive were to characterize the differences between sand and silt capping material, to assess the stability of the final 'cap' deposits, and to delineate the boundaries of the disposal mound at both sites.

At the STNH-North site divers performed a cap coverage survey at locations where bathymetry indicated a thin sand overlay. This condition was confirmed and additional dumping of New Haven sand by the hopper dredge Essayons achieved greater cap depth in those areas. Observations on the sand cap indicated a dense "resilient" sand layer on the disposal mound which would flow into and fill depressions in the surface. Consequently, a very smooth sand surface developed.

At the STHN-South site there was some difficulty in distinguishing the New Haven silt cap from similar, previously deposited Stamford material, however, the occurence of numerous clay mounds with angular facets and extremely irregular topography was used as evidence of New Haven capping material. Later chemical analyses indicated that this was a consistent and valid indicator. The N-S ground line marking the N-S horizon and margins of the final Stamford mound (April 1979), was not found on the divers' search, and further confirmed cap coverage. At the periphery of the mound, new faunal activity (burrows, cones, mollusk trails, clay base excavations) suggested that sediment along the entire diver transect was of recent New Haven origin. At the north and south sites, new diver orientation cables were laid E-W identical in length and station interval to the original baseline orientation cables (Figure 2.2-1). All subsequent monitoring was referenced to these cable stations permanently

located over the final Stamford-New Haven capped surface.

The post-capping survey (July and August 1979) included standard biological and sediment observations with super 8 mm cinema film sequences along both north and south site orientation cables. Emphasis was directed on the placement of calibrated elevation stakes at several station locations and preliminary penetrometer tests (Figure 2.2- 2 and 3).

The penetrometer (Fig. 2.2-4) is a diver-operated device designed to measure the degree of consolidation of the surface sediments. It was designed and standardized using different vertical pressures (5 to 20 lbs.) and disc areas. Several substrate types were tested and a calibration curve was generated for the instrument. The operational specifications were 10 lbs. pressure with a 15 cm diameter disk selected to correspond to soft Central Long Island Sound sediments and dredged material. The location, dates, and actual data collected with the penetrometer are recorded in Table 2.2-1.

Documentation of transect cable conditions consisted of readings from previously placed elevation stakes. No detectable erosion or accretion was noted at any station locations and additional stakes were deployed along the transect cables to permit a more thorough evaluation. Elevation stake data appear in Table 2.2-2.

The fall (November 1979) survey revealed additional disposal on top of the STHN-South site. New sediment covered the distance from the bouy chain tie line to the diver orientation cable, thus normal cable station observations could not be performed. The disposal buoy marking the North site had broken

Fig. 2.2-2 CENTRAL LONG ISLAND SOUND DISPOSAL SITE

Post Disposal Monitoring Survey

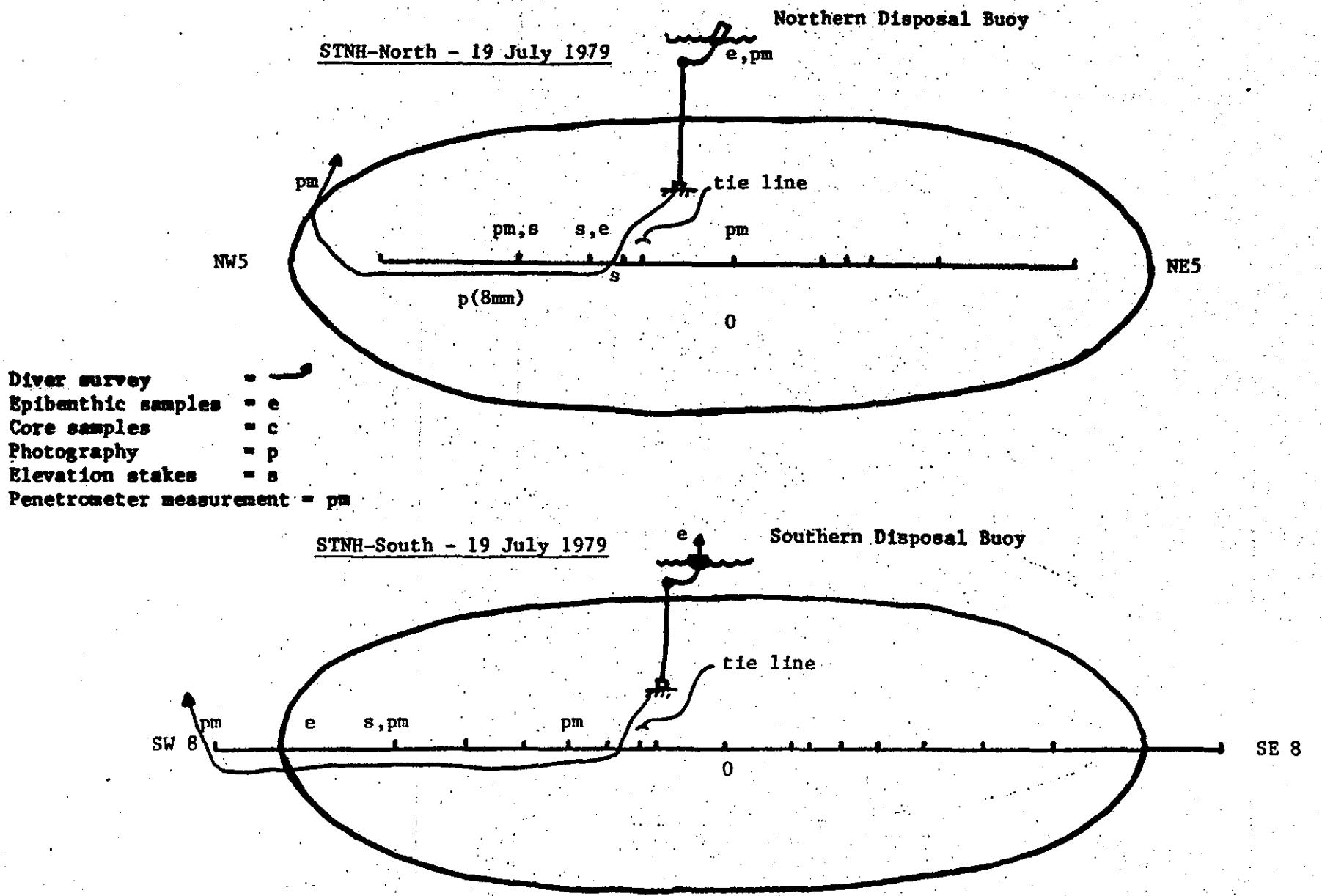
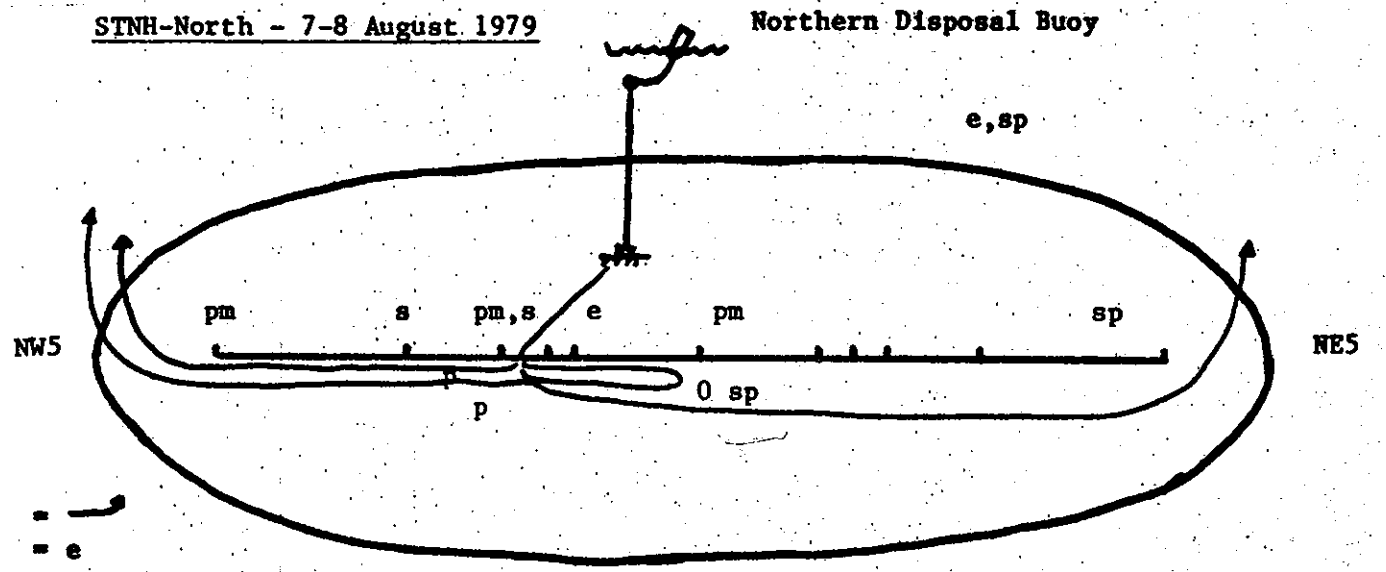


Fig. 2.2-3 **CENTRAL LONG ISLAND SOUND DISPOSAL SITE**

Post Disposal Montioring Survey



Diver survey = ⟿
Epibenthic samples = e
Core samples = c
Photography = p
Elevation stakes = s
Penetrometer measurement = pm
Sediment profile = sp

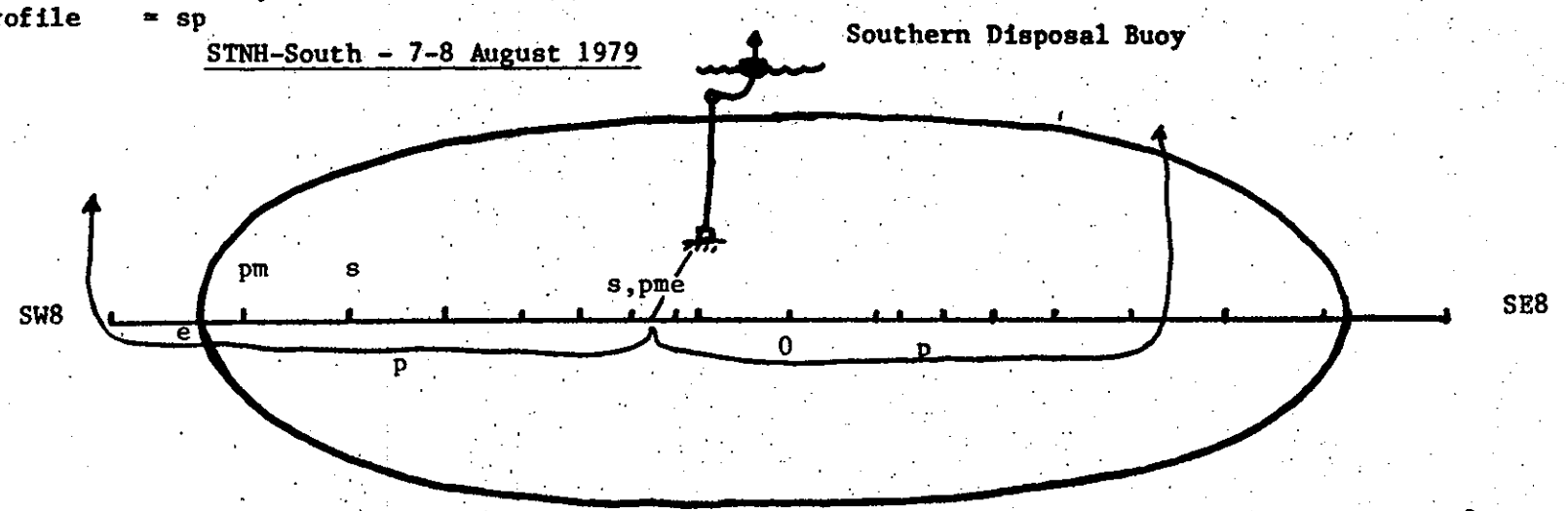


Fig. 2.2-4 | Schematic of diver-operated penetrometer, used for measuring relative sediment compaction values.

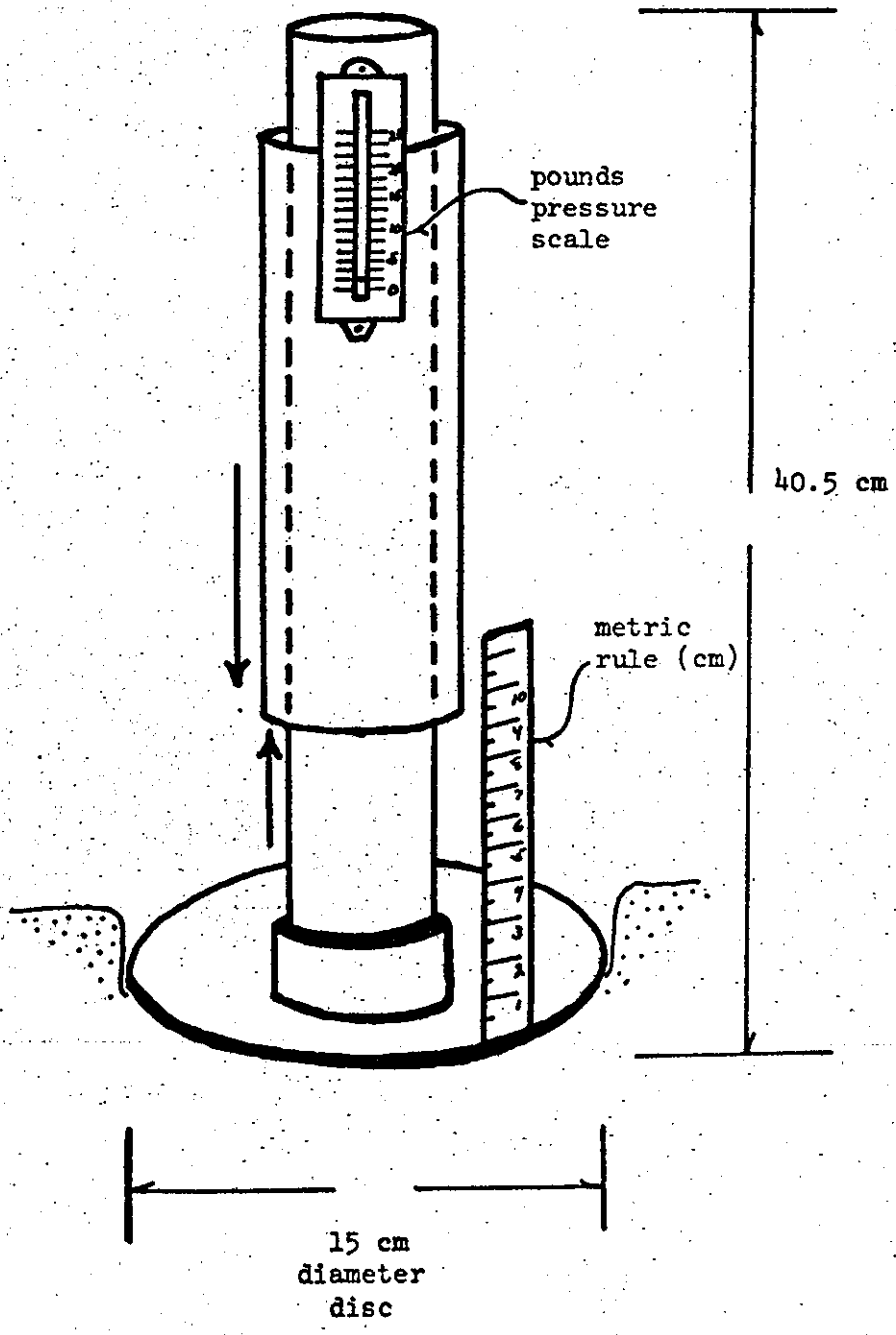


Table 2.2-1 *In-situ* penetrometer measurements at the Stamford-New Haven disposal sites in Central Long Island Sound (1979).

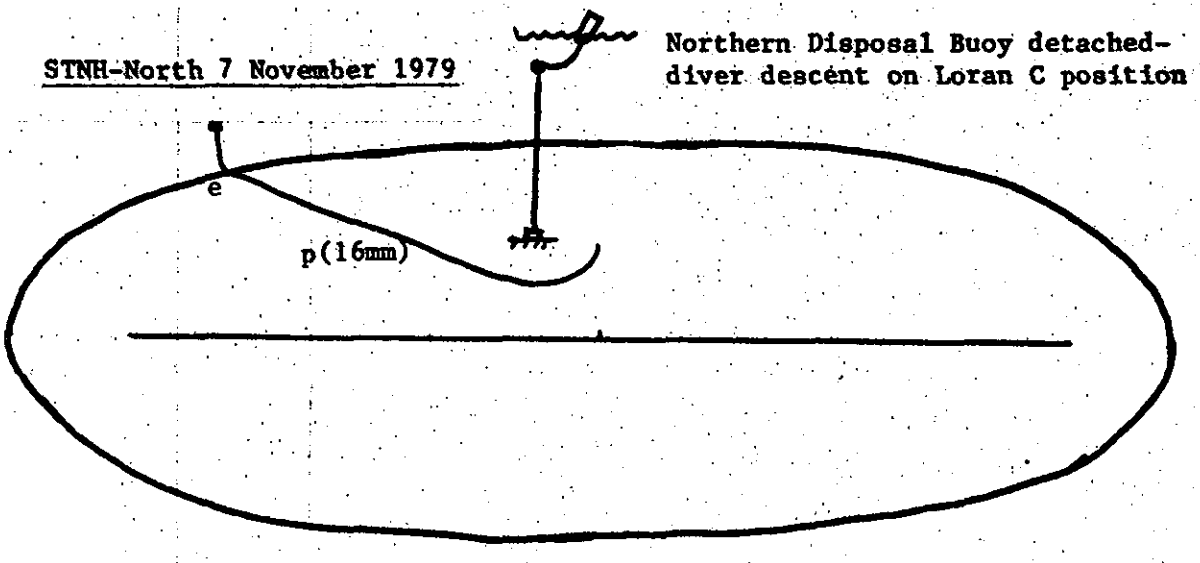
Date	Location	Lbs. pressure	Depth Depression (15 cm diam. disc.)
19 July 79	North site		
	NC tie (sand cap)	15	0.2 cm
	NW 4 (sand cap)	15	1.0 cm
	75 m N of		
	NW 5 (natural bottom)	15	3.0 cm
	South site		
	SW 4 (silt-clay spoil)	10	7, 8 cm (2 tests)
	SW 6 (" " ")	10	8 cm
	SW 8 (" " ")	5	4,5 cm (2 tests)
7 Aug 79	North site		
	NC (sand cap)	20	0.3 cm
	NW 4 (sand cap)	20	0.3 cm
	10 m W of NW 5 (apron)	20	1.0 cm
8 Aug 79	South site		
	SW 3 (spoil)	10	4,5,5 cm (3 tests)
	SW 7 (spoil)	10	6,8 cm (2 tests)

Table 2.2-2 Periodic stake readings at Stamford-New Haven disposal sites in Central Long Island Sound,

Station	Date Deployed	No. Stakes	Observation Date	Level
STNH North	23 March 79	4 (NC, NW1, NW 3, NE 1)	26 April 79	0 Baseline transect cable buried
	22 June 79	1 (NE w)		Post disposal cap 0
	19 July 79	2 (tie in NW 4)		0
			7 Aug 79	No change
			8 Aug 79	No change
			7 Nov. 79	Transect cable location lost -
STNH South	22 March 79	1 (SW 1)	10 April 79	No visibility - level. Transect line buried
	19 June 79	1 (south of buoy chain)		Post disposal cap 0
	20 June 79	2 (SE 4, SW 4)		0
			22 June 79	No change (SW 4)
			19 July 79	No change
			8 Aug 79	No change
			7 Nov 79	Transect line buried

free and similarily, a successful transect cable survey was not possible. Therefore, a free transect 16 mm cinema sequence was taken on both North and South sites (Figure 2.2-5).

Fig. 2.2-5 CENTRAL LONG ISLAND SOUND DISPOSAL SITE
Post Disposal Monitoring Survey



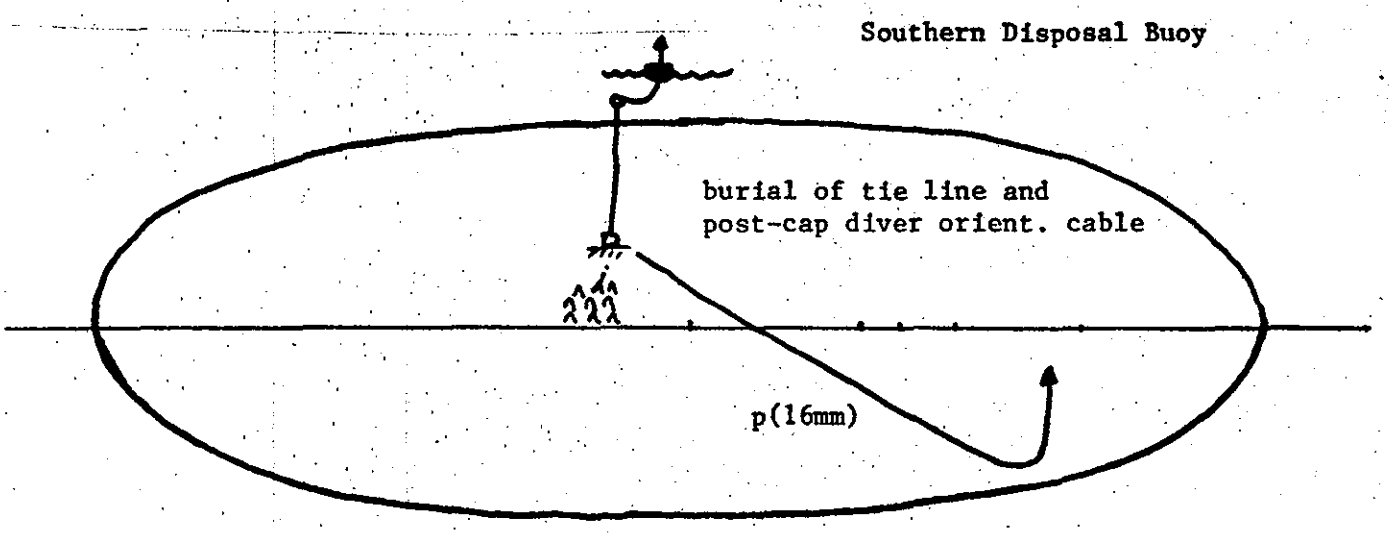


Table 2.0-2 | List of captions corresponding to Plates 2.0-1 to 2.0-22 at Central Long Island Sound Disposal Site.
- Underwater photography

PLATE#	
2.0-1	22 March 79. South site, west transect. HFVP - 15". Abundant juvenile flounder, Pseudopleuronectes americanus, were observed on natural bottom at N and S sites during predisposal inspection.
2.0-2	23 March 79. South site. SE 8 vicinity. HFVP - 15". Plastic cohesive nature of the natural sediment surface is demonstrated by creation of lateral fin-ray depressions of the sand dab, Scophthalmus aquosus.
2.0-3	22 March 79. South site. West transect. HFVP - 8". The stalked solitary hydroid, Corymorpha pendula ubiquitous at all pre-disposal sites, occurred in sufficient densities on natural bottom to be used as evidence of spoil coverage limits during initial disposal phases.
2.0-4	23 March 79. South site. SE 8 vicinity. HFVP - 4". Close microtopographic detail of sediment surface illustrates Corymorpha with fecal mound discharge from infaunal polycheates. Note fecal ribbons collected at base of Corymorpha stalk.
2.0-5	22 March 79. South site. Transect baseline. HFVP - 12". Unconsolidated surface veneer is illustrated after passage of the rock crab, Cancer irroratus through a Corymorpha community with cast agglutinated tubes scattered on surface.
2.0-6	22 March 79. South site. Mid west transect. HFVP - 8". Other structural and textural features (fecal mounds, agglutinated tubes, burrows) of the natural bottom provided additional means for differentiation between natural and spoil bottom. Juvenile hake resides in vertical hole in inverted position.
2.0-7	23 March 79. North site. Station "NC". Elevation stake. HFVP - 4". Placement of calibrated (cm) elevation stakes, located at selected station markers, were to provide reference on depth of initial spoil overlay at distant stations.
2.0-8	23 March 79. North site, Station NC - N3. HFVP - 6". The diver orientation cable with logarithmically spaced station markers, was often buried by its own weight in the soft natural sediments.
2.0-9	10 April 79. South site. Stamford spoil interim inspection. HFVP - 24". Immediate disposal surface topography consisted of large clay block with soft interspace sediment. Stamford material was black and coarse granular sediment with a high quantity of detrital material.

Table 2.0-2 cont.

PLATE#	
2.0-10	10 April 79. South site. Stamford spoil interim inspection. HFVP - 12". The most prominent crustacean species to assume residence on newly deposited spoil were Cancer irroratus and Libinia emarginata.
2.0-11	10 April 79. South site. Stamford interim. HFVP - 9". Partial burial of Corymorpha basal stalk was indication of spoil dispersion limits in most sectors surrounding the N and S piles. Border regions revealing this condition could be followed by diver for several (10-100) meters.
2.0-12	10 April 79. South site. Stamford interim. HFVP - 9". The surface textural features of underlying sediment are barely evident at the northern spoil apron and .5 cmof Stamford material abuts the base of Corymorpha.
2.0-13	25 April 79. South site. 150 m to east of S disposal buoy. HFVP The three strata layer conditions evident due to diver excavation (sediment profile) at peripheral regions in the S site eastern sector.
2.0-14	25 April 79. South site - buoy base post Stamford HFVP - 24". Fractured clay mounds (.5 - 1m), coarse sand mixtures, and soft interspace silt characterized the range of post disposal sediment type.
2.0-15	25 April 79. South site - 150 m East of buoy - HFVP - 9". Dense concentrations of Corymorpha were typical at the immediate border regions.
2.0-16	26 April 79. North site - northeast sector. HFVP - 6". Juvenile hake, Urophysis, were observed in niche space available on new spoil irregular topography.
2.0-17	19 June 79. North site - Southeast transect to border. HFVP - 10". The mud shrimp. Axius serratus, observed alive on recently deposited spoil. These crustacea excavate vertical cylindrical burrows to 3m depths.
2.0-18	19 June 79. North site - southwest transect. HFVP - 12" The sand dab, Scopthalmus aquosus, utilized the soft spoil surface for camoflage and as resting depressions.
2.0-19	7 August 79. North site - 100 m east of N buoy BOLT vicinity - HFVP - 15" Isolated clay mounds were rapidly colonized by dense clusters of tube-building polycheates.

Table 2.0-2 cont.

PLATE#	
2.0-20	8 August 79. North site- station NW 3 - NW 4. HFVP - 4" The hermit crab, Pagurus longicarpus, was abundant (20/½m^2) and actively probed the sand cap surface scavanging for food. Note granular surface texture and shell components.
2.0-21	8 August 79. North site - station NW 3 - NW 4. HFVP - 4". The mud snail (Nassarius trivittatus) was also observed on the sand cap surface in dense concentrations (~ 20/¼ m^2). Patch areas of the sand cap exhibited a "shell hash" layer comprised of Anomia, Crepidula and Crassostrea valves.
2.0-22	20 June 79. South site - E transect line. HFVP - 12" The kevlar diver orientation cable provided a reference to revisit marked stations and observe sediment changes in the post disposal period.

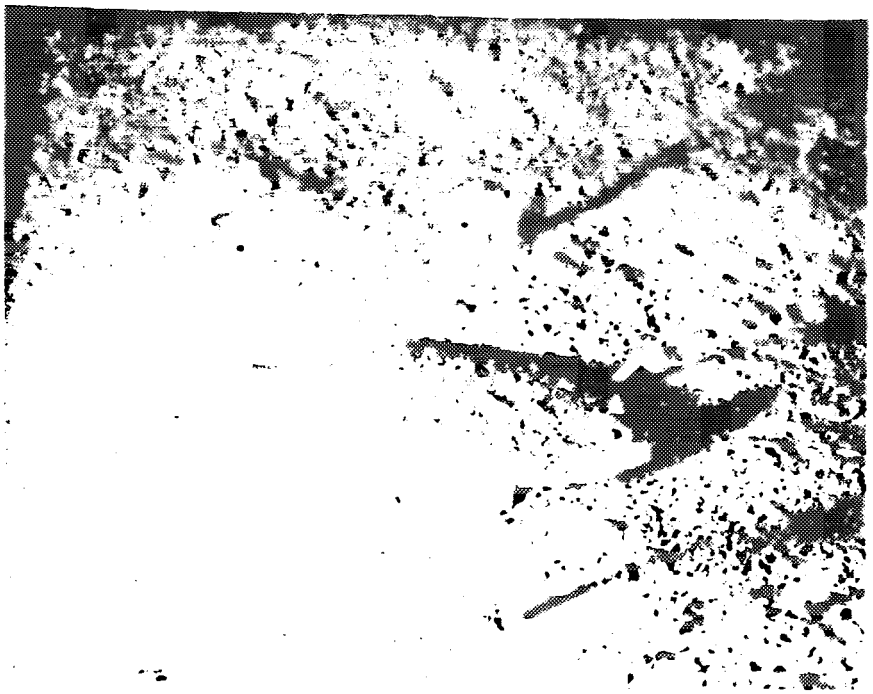


PLATE 2.0-1

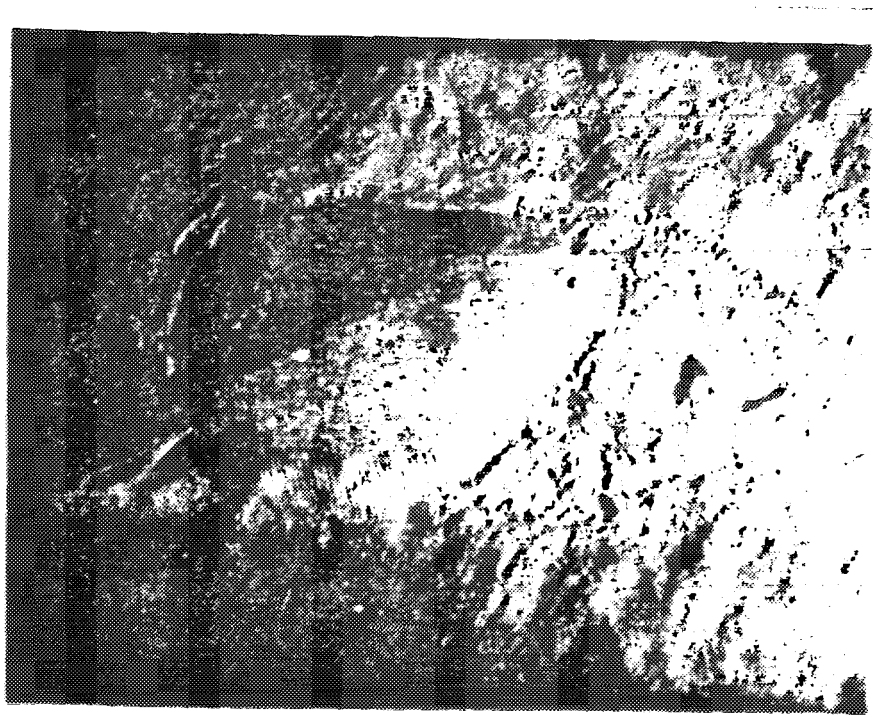
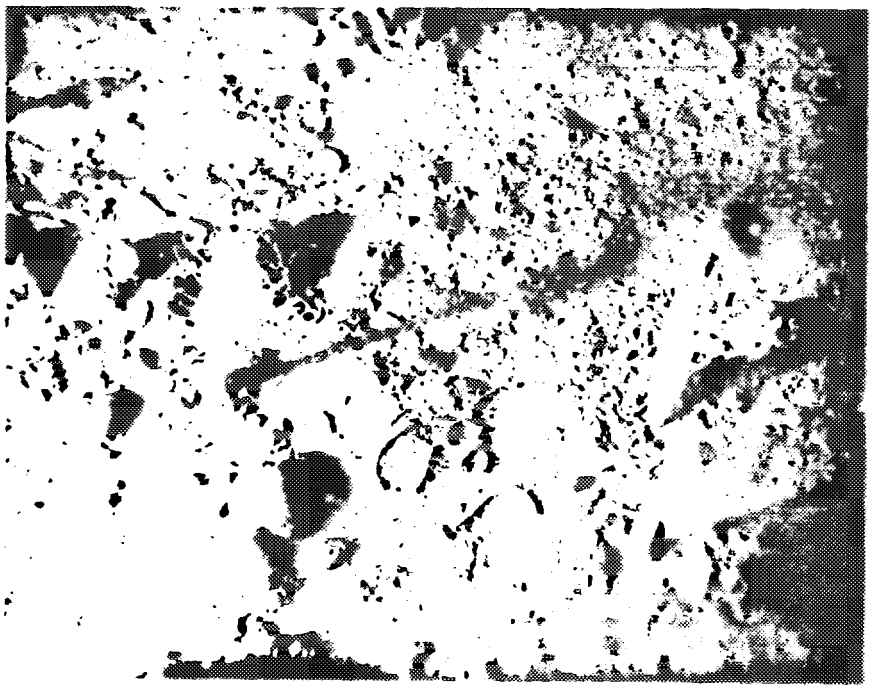


PLATE 2.0-2



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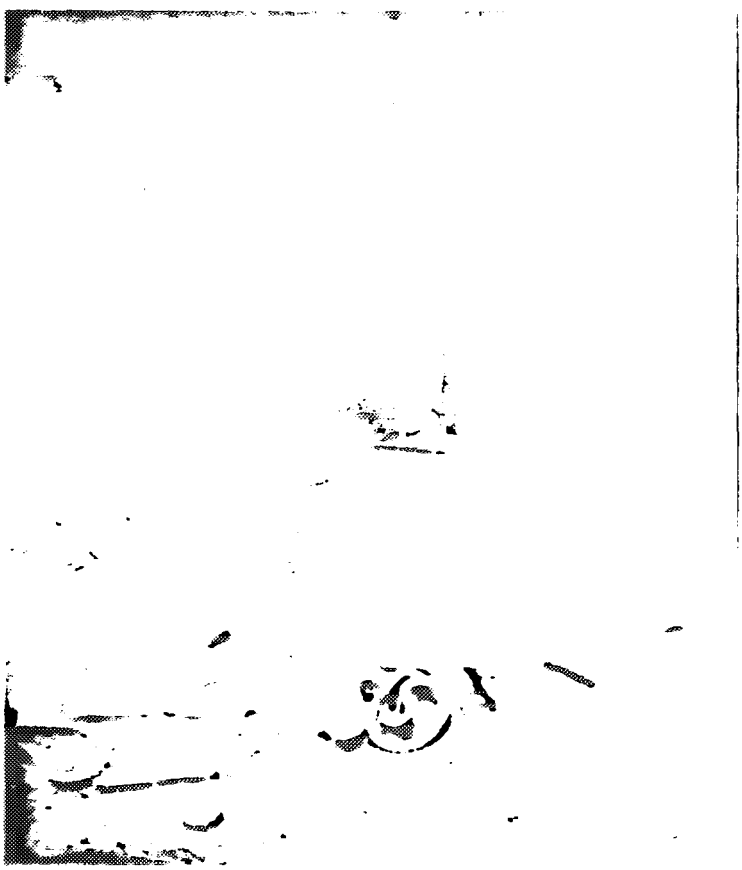

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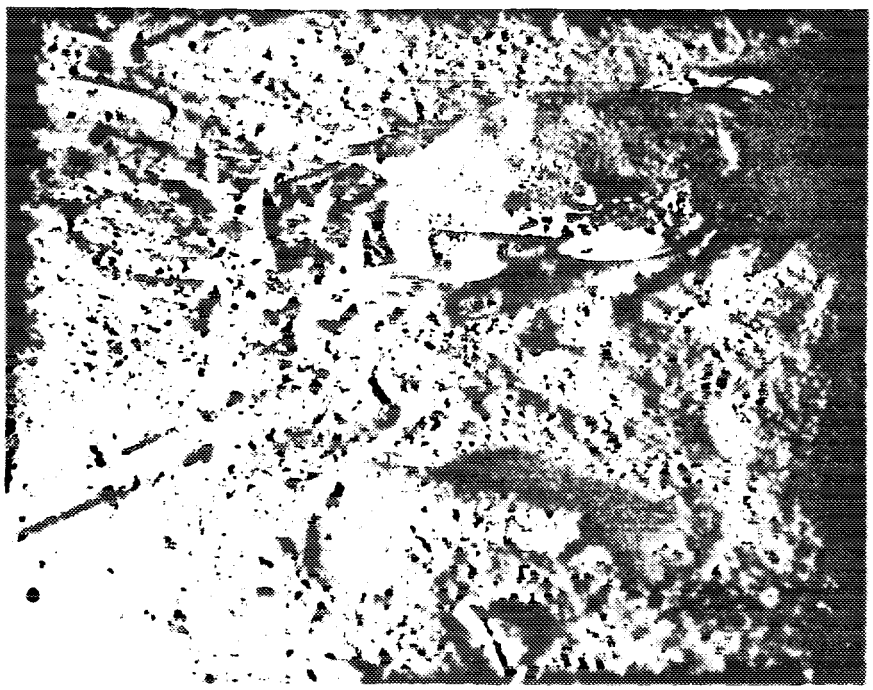

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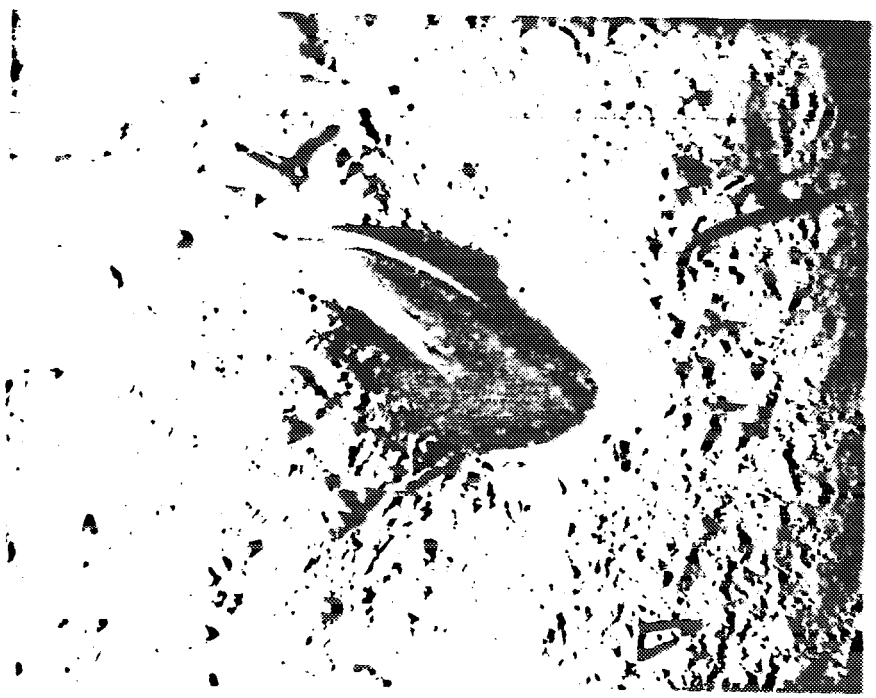

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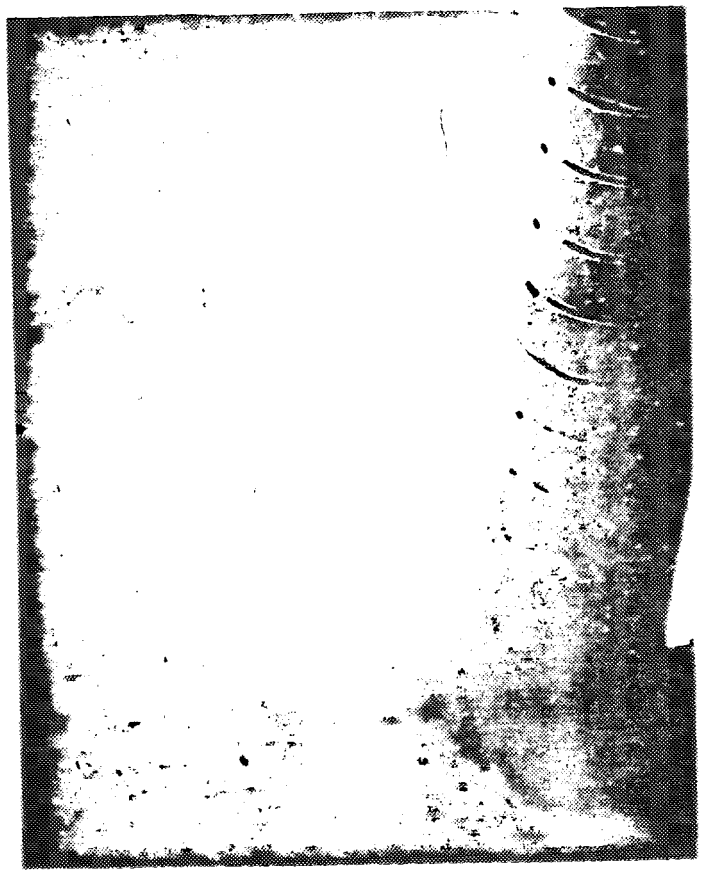
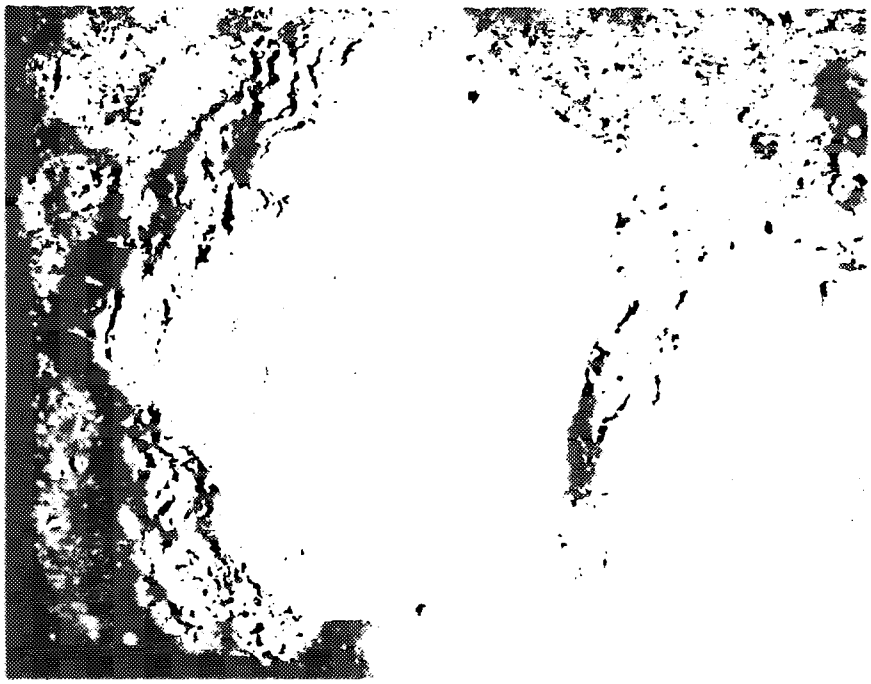


PLATE 2.0-7

PLATE 2.0-8



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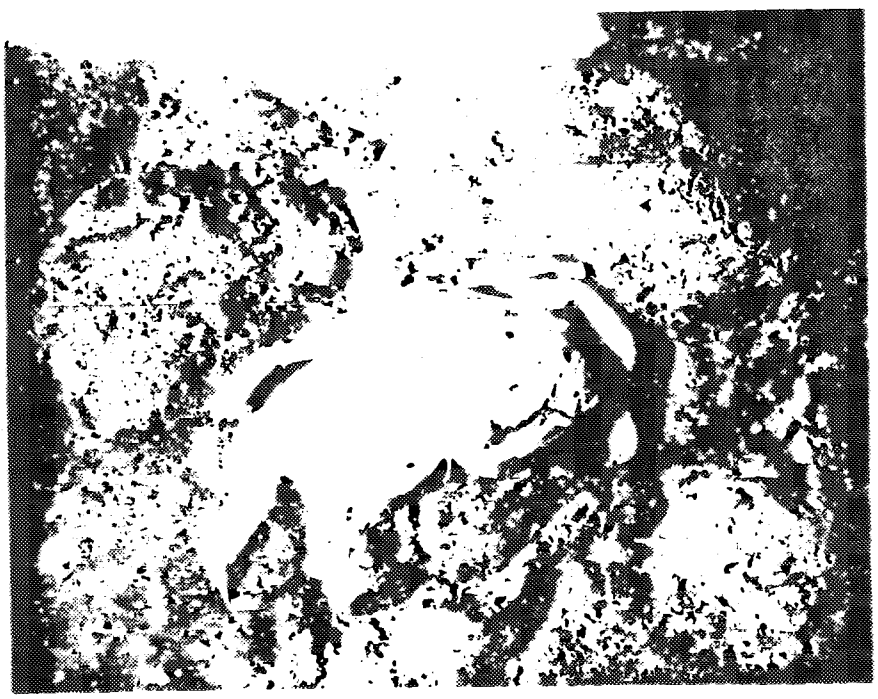
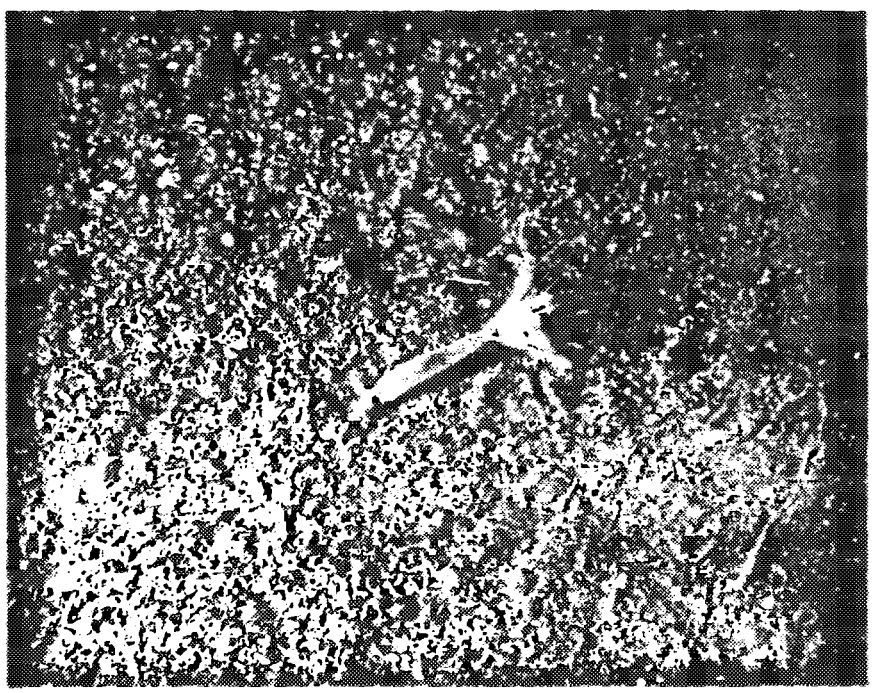


PLATE 2.0-10

PLATE 2.0-11



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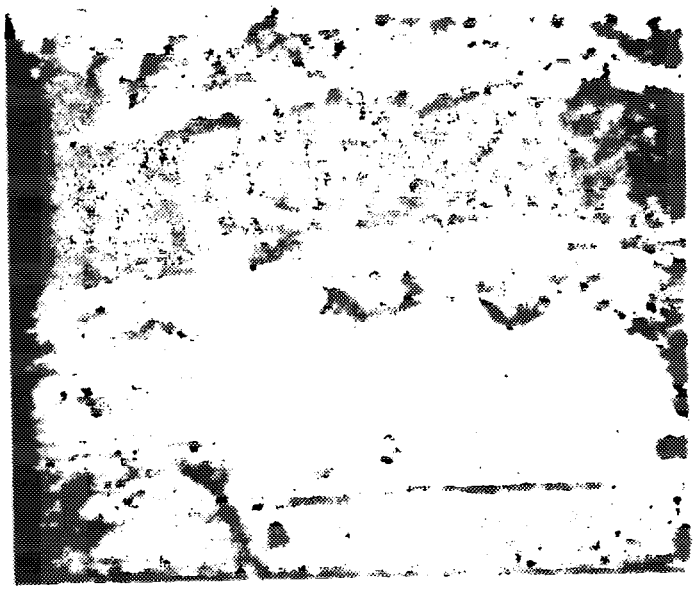


PLATE 2.0-13

PLATE 2.0-14

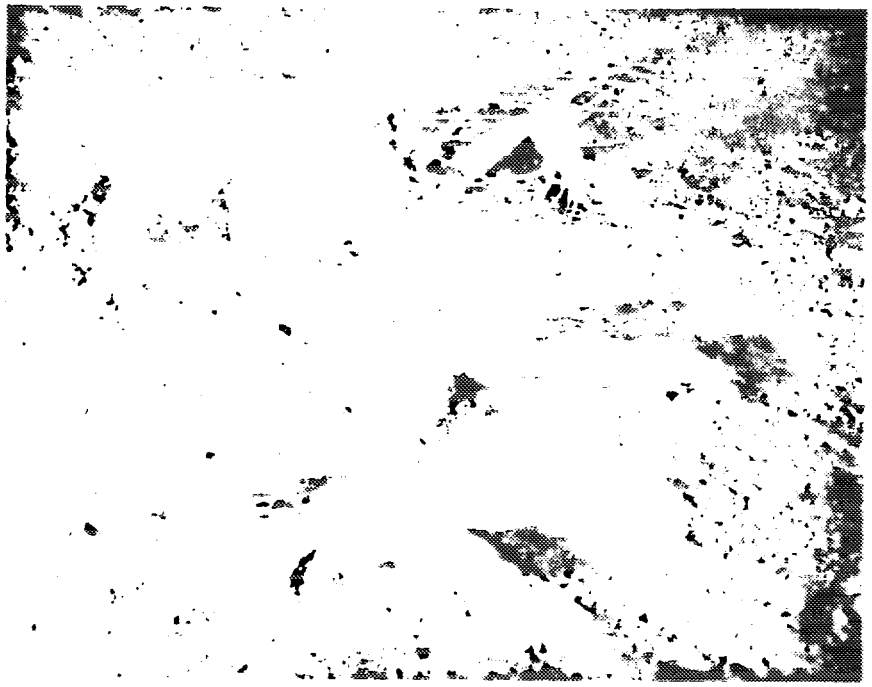
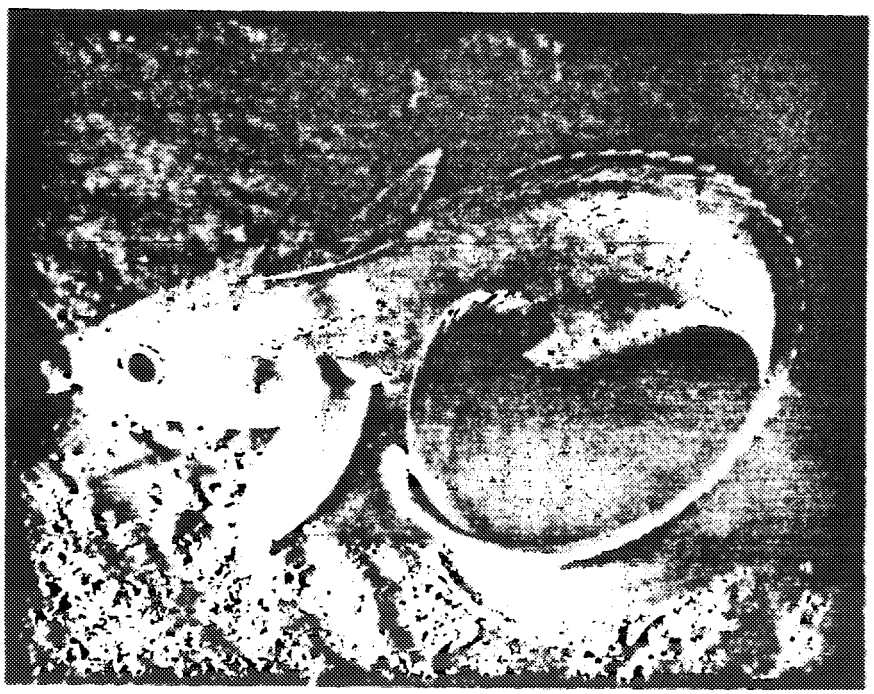


PLATE 2.0-15



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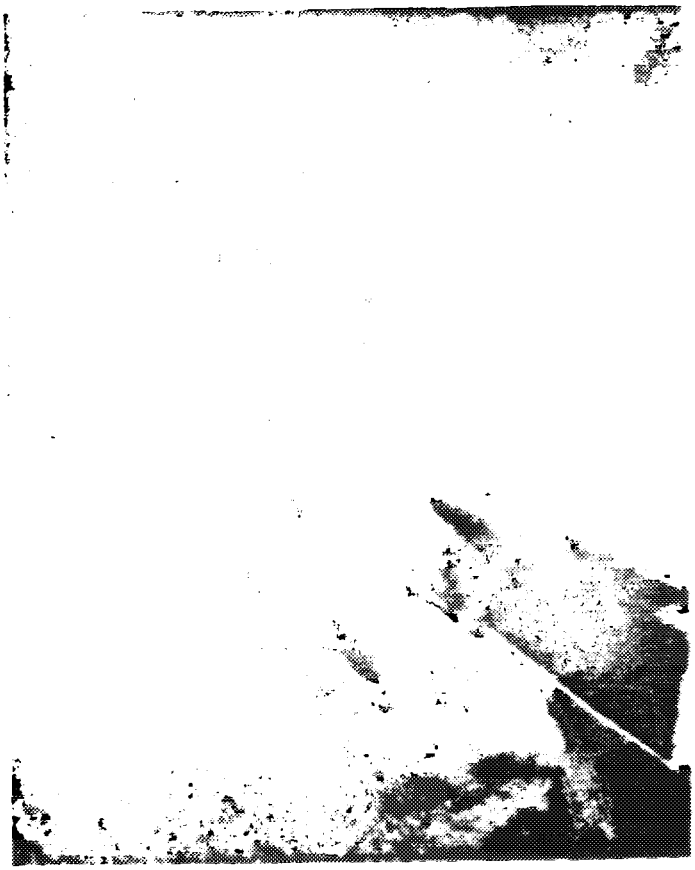


PLATE 2.0-17

PLATE 2.0-18

PLATE 2.0-19

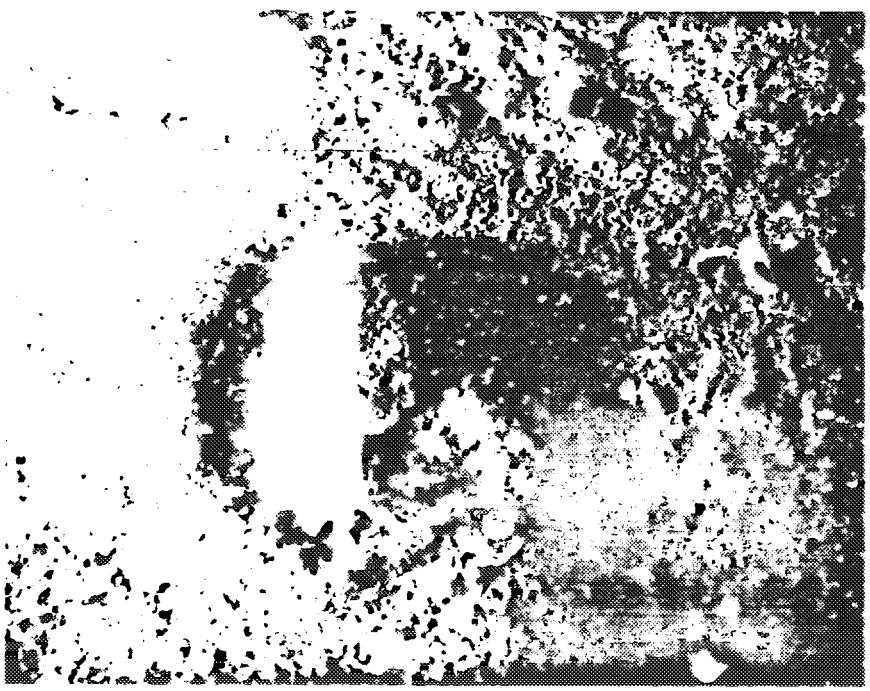


PLATE 2.0-20

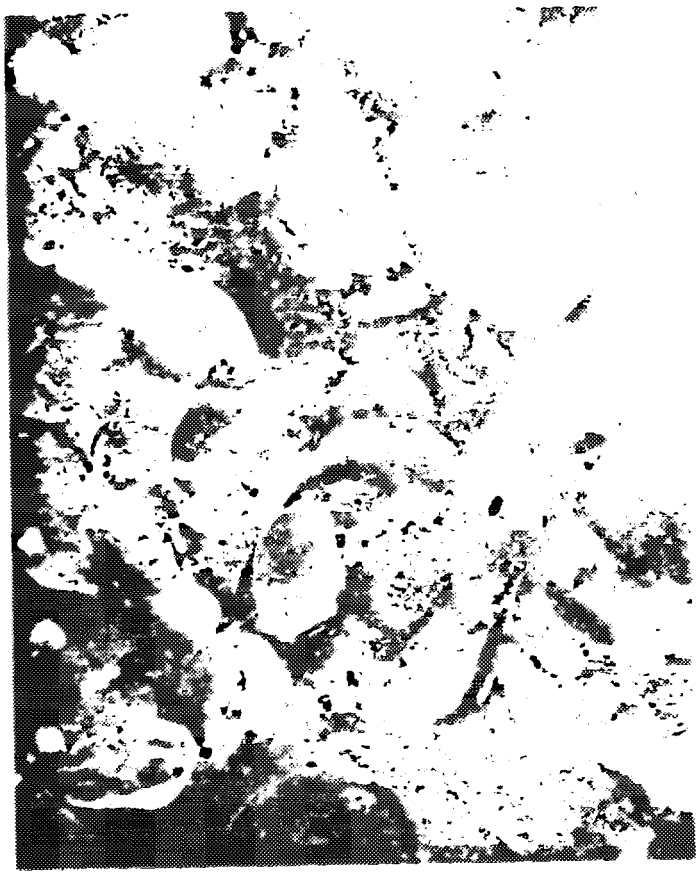


PLATE 2.0-21

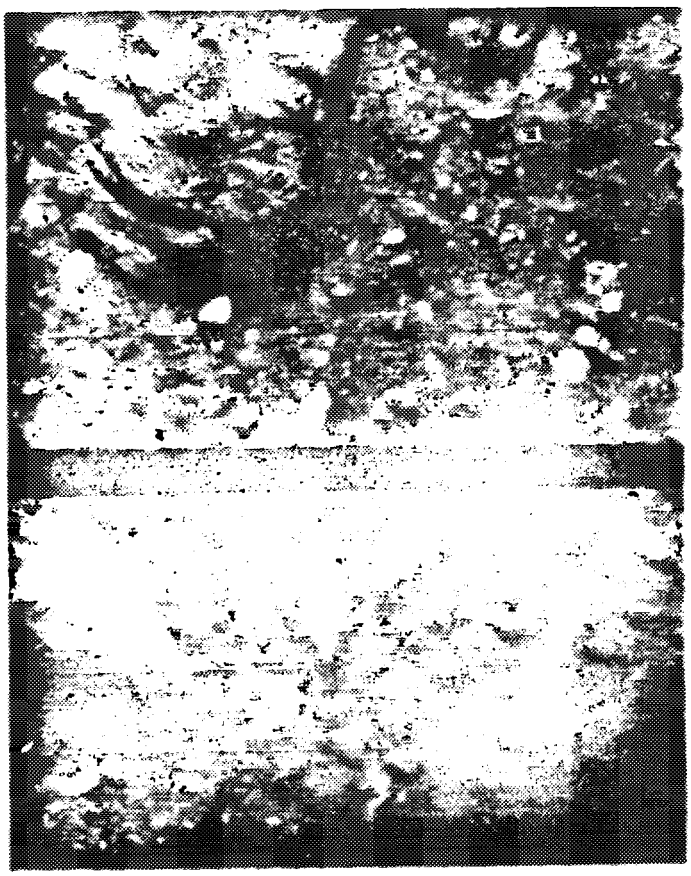


PLATE 2.0-22

3.0 New London Disposal Site

The New London disposal site was surveyed in 1977-78 to determine the boundaries of Phase I and II dredge material (DAMOS 1979, Vol. II, Biological Observations). Additional studies at New London in 1979-80, included mapping of Phase III and IV disposal margins, measurement of erosion or accretion on the disposal mound, penetrometer tests, and epifaunal observations and identification. A chronological summary of dives and observations made at the New London Site is presented in Table 3.0-1, and underwater photographs of the area are shown in Plates 3.0-1 to 13. Table 3.0-2 lists the captions corresponding to these photographs.

In July, 1979, the perimeter of the disposal mound was examined and permanent stations were established on the NW, SW and SE margins of dredged material (Fig. 3.0-1). At each of these stations a 50 m length of line was staked to the bottom perpendicular to the dredge material boundary and marked at five meter intervals to indicate movement of the boundary. Graduated elevation stakes were installed along the line and the entire station was positioned according to Loran-C coordinates and marked with an acoustic beacon. These stations were continually monitored during 1979 and 1980.

A calibrated Loran-C grid, using the 9960 GRI chain, was established over the disposal site and used to monitor the margins

Table 3.0-1 Summary of diver observations at the New London Disposal Site - Underwater Photography June 1979 - September 1980.

Date	Station	Time	Transect location and Distance	Physical Condition (Depth, Temp. Vis. Tide Bottom Type)	Biological Observations
13 June 79	NW corner	1012-1044	NW corner of dumpsite on and off spoil at perimeter	Cur. E-W 1-1.5 kt. 14.5°C vis 8-10 ft. Natural bottom hard sand/silt type. Spoil material soft silt/clay.	Amphipod tubes and epifauna abundant over both natural substrate and spoil. Tautog - 1 (8 lbs.) Pseudopleuronectes 12-16 Urophycis - 3 Burrow 8-15 cm dia. Naticid egg collars 1-3/m^2.
	NL Buoy	1148-1154	NL buoy to SW	Cur. E to W 1 kt. 14.5°C. vis. 8 ft. Soft cohesive silt/clay sediments. Clay clumps on substrate surface fracturing. Clay balls present.	Psuedopleuronectes - 5
	SW Perimeter Station	1226-1240	Along transect line	Cur. E to W .5 kt. 14.5°C vis. 8-10 ft.	Epiphytes ubiquitous where substrate available. Psuedopleuronectes - 4 Tautogolabrus - 15 Tautog - 1.
24 July 79	NW Perimeter Station	1033-1047 1100-1125	Deploy transect line	Near flood vis. 6-10 ft. Cur E-W .25 kt. Spoil typical soft cohesive silt/clay. Perimeter distinct with 3 4' high ridges, running E-W. Bottom north of these ridges was flat, featureless and composed of coarse gravel. Encountered sediment cloud. Vis. dropped from 10-6 ft. due to large dump.	Patchy areas on spoil with extensive burrowing. (Homarus and Urophycis). Burrows ended at spoil perimeter. Homarus - 6+ Urophycis - 4 Psuedopleuronectes - 10 Pagurus pollicaris - 4 Busycon - 3 Crangon ubiquitous. Epiphytes in all areas with available substrate.

Table 3.0-1 (Cont.)

Date	Station	Time	Transect location and distance	Physical Condition (Depth, Temp. Vis. Tide & Bottom Type)	Biological Observations
20 Sept 79	SE perimeter station	-	Set fyke net & fish trap at Phase III spoil periphery. Search for sonic beacon and 50 m transect line. Sample Mytilus bed 100 m to SW for shell growth.	No recent spoil overlay or border advance. New spoil deposited over SW border station approximately .5-1 m deep.	Amphipod colonization dense. Only C. irroratus (2) evident and new Mytilus set on recent spoil.
24 Sept 79	SE perimeter station	-	Retrieve fyke net and trap and 4 day collection.	Photograph elevation stake, sediment features.	Photograph stations along transect cable.
17 Oct 79	SE perimeter station	1030-1100	Along transect line.	Cur. NW to SE .25 kt. 14.5°C vis. 10 ft. Sand bottom.	Psuedopleuronectes - abundant. Detached Laminaria fouling transect line. Photo stations SE1 and SE 10. Epibenthic samples SE 1-4, SE 10-7.
	NW perimeter station	1230-1300	Transect line detached.	Cur. NW to SE .5 kt. 14.5°C vis. 15 ft. Tend sonic beacon	Extensive burrowing and excavation of spoil material by Cancer borealis and HØmarus. ← Epibenthic samples on and off spoil.
31 Oct 79	SE perimeter station	AM	Set fyke net for motile species sample.	- -	- -
	NW border station	PM	SE free transect to new spoil.	Old spoil toward new spoil deposit.	35 mm photo along SE transect record burrows Amphipod densities.
5 Nov 79	SE perimeter station	AM	Retrieve fyke net and 5 day collections.	- -	- -
	New Disposal Buoy	PM	ESE transect	From new spoil toward eastern border.	Photodocumentation of new spoil surface and transient biota.
14 Feb 80	SW Mussel Bed		Collect natural Mytilus sample for growth and heavy metal analysis.		

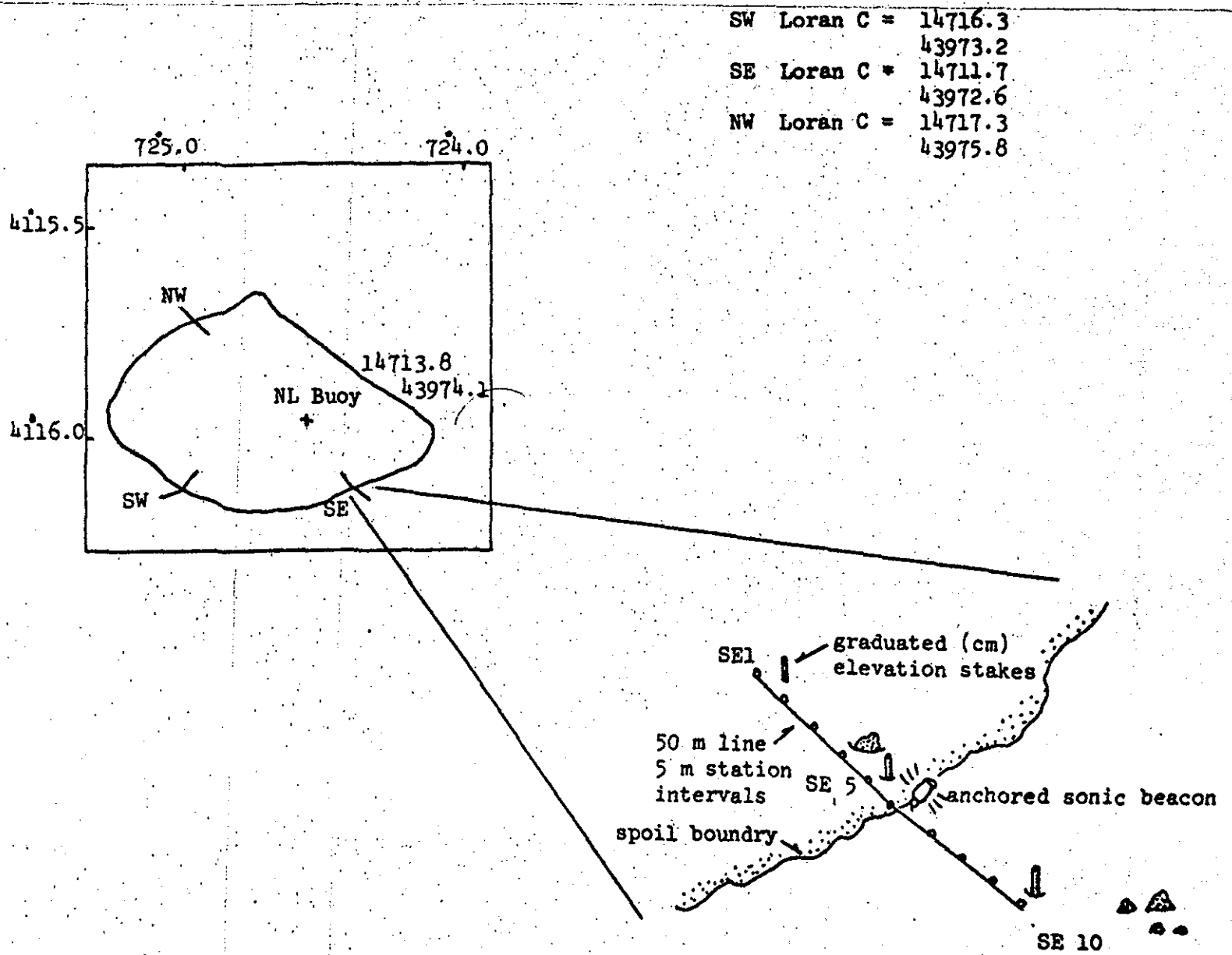
Table 3.0-1 (Cont.)

Date	Station	Time	Transect location and Distance	Physical Condition (Depth, Temp.Vis.Tide Bottom Type)	Biological Observations
25 March 1980	Temporary Disposal Buoy		DPV border delineation on NW transect approximately 250 m.	E - W Cur. Did not circumscribe circle but ran direct line NW towards NL harbor.	
	SE corner new pile		DPV border delineation on transect to ESE.	E - W Cur. DPV - low batteries. New spoil. Soft cohesive material flattening out on apron - no clay clumps.	
	Temporary Disposal Buoy	1434-1458	Transect 90 meters to East of buoy.	At buoy - clay clumps on spoil surface (20-70 cm dia.) 70-100 cm apart). 20 meters to E - size and frequency diminish (200 cm apart 20-60 cm dia.) eroding and fragmenting. 70 meters to E - large boulder size clumps (70-90 cm height, 70-120 cm length) many adjacent. Evidence of individual dumps. Fracture lines through spoil surface opening/closing. Sediment surface "pulsing" with surface swell (7-10 sec. period).	No organisms observed on spoil.
	SE perimeter station		25 m on transect line.	No surface buoy present. Located station on bottom with receiver. New buoy secured.	Species on spoil perimete Naticid snails, Cancer borealis, C.irroratus, Pagurus pollicaris.

Table 3.0-1 (Cont.)

Date	Station	Time	Transect Location and Distance	Physical Condition (Depth, Temp, Vis. Tide Bottom Type)	Biological Observation
26 March 1980	SE perimeter station.	0959-1021	Along transect line.	Difficult to discern spoil and natural sediment boundaries. All available substrate colonized. Vis 8-10 ft. Temp. 5°C. 1/2 kt. E. 70 ft.	Amphipod tubes ubiquitous. Pagurus longicarpus and Pagurus pollaris very dense P.pollicaris individuals still burrowed but some already active. Cancer irroratus - active. Lunatia heros active and burrowing. Asterias forbesi present. Coryphella sp. and Tubularia couthouyi on hard rock substrate.
	Temporary Disposal Buoy	1041-1102	75 m E and W of buoy.	Cur. 1/2 kt. E . Vis 8-10 ft. 60 ft. depth. Large clay clumps 70-120 cm lenth, 1.5 m apart. No spoil "pulsing" observed as on previous dive. Greater frequency of clumps closer to buoy. Some degree of sorting of coarse grain sediment at base of clumps. 75 m from buoy showed more signs of a flattening apron effect. Clumps showed less fracturing then on previous day. Evidence of recent dumping operations.	Mytilus edulis embedded in some clay clumps. Actively respiring. Metridium senile attached to one clump of mussels.
18 April 1980	Coast Guard buoy.		100-150 m N of Buoy. Search for sediment/ current meter array.	During search encountered boulder and cobble area. Bottom relief on order of 5-8 ft. with 4' wide troughs- probably due to individual dumps. Some debris noted; plastic, wood, tree stumps.	Some rocks and cobble with Cliona colonizing. Some consolidated sediment with amphipod tubes. Asterias forbesi. Homarus americanus. Naticid snails.

Fig. 3.0-1 Location of benthic perimeter stations at the New London Disposal site. July 1979. Detail of SE station.



of the mound while controlling diving operations. A diagram of this grid relative to pertinent disposal area features is presented in Figure 3.0-2.

Monitoring of the established perimeter stations showed no change in the sediment horizon, relative to the elevation stakes, at the NW and SE border stations 1980, and no evidence of sediment border advance or elevation change was found at the SW station for a 10 month period (September 1978 - June 1979). However,inspection of the SW border station in September, 1979, indicated recent burial by Phase IV sediment precluding further long-term monitoring at this location. The dredged material cover extended in a SW direction for approximately 100 m to a depth of .5-1.0 m over natural bottom. Results of elevation stake readings are presented in Table 3.0-3. Transects across the disposal mound showed that the center of the area was characterized by scattered clay mounds overlaying various sediment matrix material ranging from fine silt and clay to a coarse shell hash. The margins of the mound in the NW area consisted of three E-W oriented ridges colonized by various species of epibenthic crustaceans (e.g. Pagurus, Homarus, Cancer, Crangon).

When the New London disposal site marker bouy was lost in February, 1980, less controlled disposal of Phase IV dredged material took place in the northeast sector of the disposal site. A dive survey with a battery-powered diver propulsion vehicle (DPV) to determine the extent of coverage indicated extension of the mound border a considerable distance to the north and east of the designated target area. Circumnavigation of the perimeter was not possible in the NE sector and final position of the diver

NEW LONDON DISPOSAL SITE

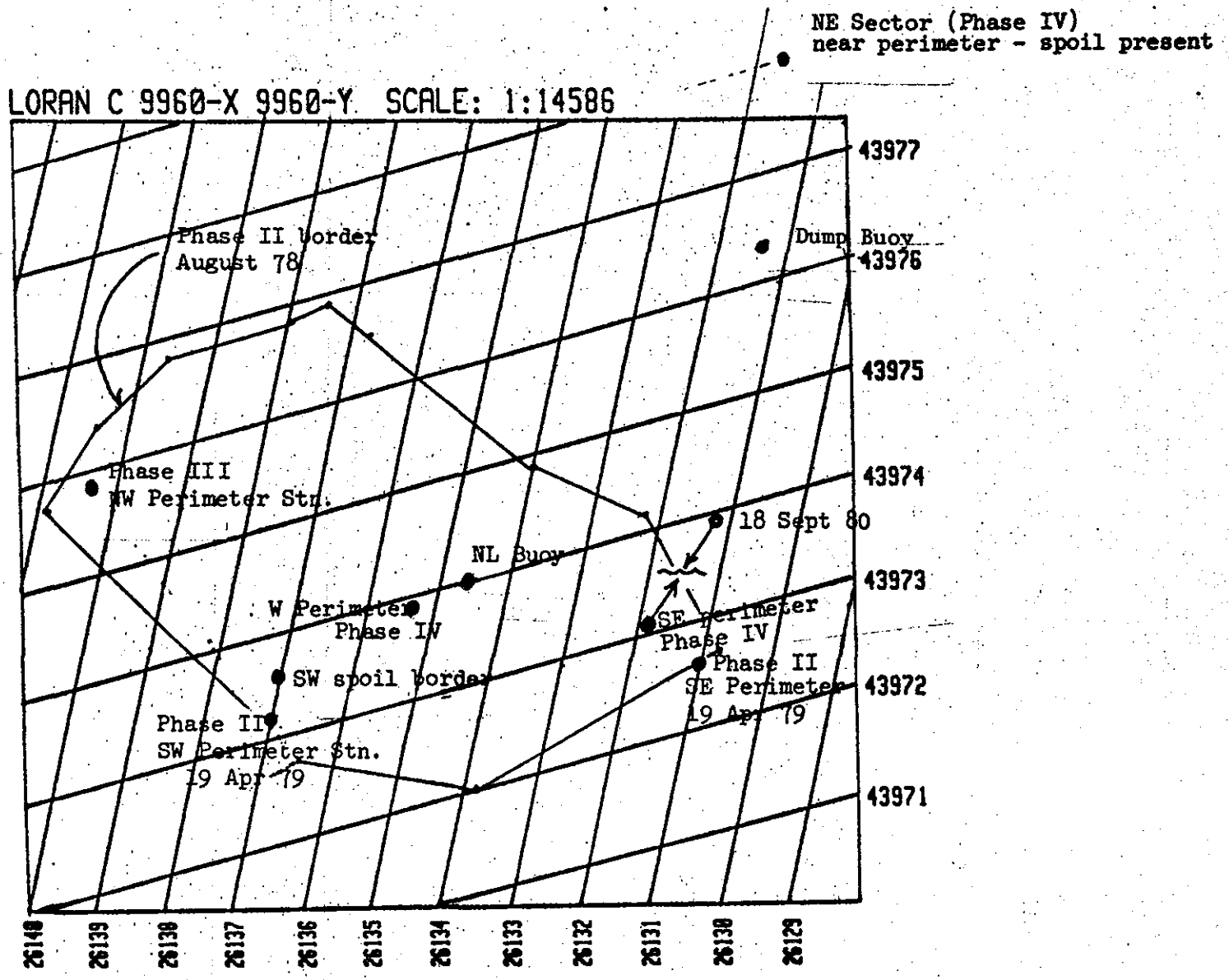


Fig. 3.0-2 Loran-C grid indicating perimeter limits and permanent benthic border stations established on the New London Disposal Site.

Table 3.0-3 Periodic elevation stake reading at the SW, NW and SE permanent border stations at the New London Disposal site.

Station	Date Stakes Deployed	# Stakes	Observation Date	Level
SW border station	6 Sept. 78	3		0 cm
			10 Jan 79	no change
			19 Apr 79	no change
			13 June 79	no change
NW border station	6 Sept. 78	3		0 cm - stn. lost
SE border station	18 May 79	3 SE 1, SE 5 SE 10		0 cm
			17 Oct 79	no change
			25 Mar 80	no change SE 5 disturbed reset "0

Table 3.0-4 Distribution of nocturnal species collected with stationery passive fishing gear at New London Disposal Site (SE station). September - November 1979

	9/10	9/24 fyke	9/24 wire	10/31	11/5 fyke
Busycon sp. (whelk)			2		1
Callinectes sapidus (Blue Crab)					1
Cancer borealis (Rock crab)					5
Homarus americanus (Lobster)					3
Libinia emarginata (Spider Crab)					12
Pagurus pollicaris (Hermit Crab)					1
Mustelus canis (Sm. Dogfish)		4		8	
Conger oceanicus (Conger eel)			1		
Hemitripterus americanus (Sea Raven)					3
Prionotus carolinus (C. Sea Robin)		11			1
Pseudopleuronectes americanus (Wtr. Flounder)		2			1
Scophthalmus aquosus		1			
Stenotomus chrysops (N. Scup)		16	4		1
Tautoga onitis (Tautog)	1				
Tautogolabrus adspersus (cunner)					1
Urophysis sp. (hake)					3

track indicated a .5-1 meter thickness of dredged material over natural bottom (Figure 3.0-2).

A diver survey on 25 March, 1980, at the temporary disposal buoy deployed to control disposal during refit of the original buoy, provided unique observations on dredged material behavior following storm conditions (1-1.5 meter swell; 50 m wave length). "Fissure lines" (4-5 m long) were observed in three separate areas on the surface (Plate 3.0-10). The effect of the swells, at the 15 meter depth, was to produce a .5 - 1 cm movement of material along the fissure line. Masses of sediment were observed to separate, creating a 1 cm wide, 30-50 cm deep fissure line, which merged together repeatedly on a 7-10 second cycle. No extreme resuspension was noted due to current transport, however, a 10 - 20 cm vertical extrusion of turbid silt was emitted from the fissure on each closure.

Another type of sediment mass oscillation was observed which can be described as a "slip line", with one density of dredged material rising and resettling on a 30 - 45^{o} plane over adjacent material. No turbidity resulted from this sediment movement since the material resettled as a cohesive unit. The net effect of this spoil "slippage" appeared to be compaction of the pile.

The site was revisited by divers the following day (26 March) to determine whether any large scale changes in topography had occurred. The pulsing and fracturing of the spoil surface, observed on the previous day, had ceased, coinciding with abatement of surface swells. Densely concentrated, large (20-70 cm diameter) clay mounds were found directly around the disposal

buoy. Approximately 20 m east along a 90 meter transect from the buoy, clay mounds were more scattered and smaller. Approximately 70 meters along the same transect, very large (70 - 120 cm diameter), clay mounds were found, indicative of individual dumps.

The perimeter of the disposal pile was often difficult to distinguish from surrounding natural bottom over the entire survey period. Occasionally, gross differences in sediment texture, the occurrence of Corymorpha pendula, the obvious burial of mussel (Mylilus edulis) clusters, or the presence of amphipod communities allowed the delineation of spoil boundaries.

There was considerable evidence of biological recovery during the 1979-80 survey period at the New London disposal site. From the period when Phase III disposal operations ended until May 1979, a pattern had persisted of low species diversity and abundance at the center of the pile. After May 1979, increasing, and similar, numbers of species and individuals were found on the mound apron and adjacent natural bottom (DAMOS 1979, Vol.II, Biological Observations). Species composition differed between these two regions which is possibly attributable to differences in substrate (grain size).

On the June 1979 survey, tubiculous amphipod communities (Ampelisca spp.) were noted on Phase III apron regions. In the Fall of 1979, numerous amphipod clusters were found along transects heading toward active Phase IV disposal sites in the NW and SE sectors. Photographic estimates of amphipod density on the spoil margin indicated densities approaching 9000 per m^2. The numbers of amphipod parchment tubes resembled those first observed during the predisposal reconnaissance of the NE sector in June

1974, indicating successful recolonization. Through the 1979 surveys, recolonization was observed principally on old disposal surfaces, margins of the new dredged material, and on the adjacent natural bottom. The reappearance of Ampelisca communities is significant since ampeliscids, and other tubiculous organisms, stabilize the substrate, their tubes acting as a securing system as well as providing habitat and food for other organisms.

Further evidence of the repopulation of the New London disposal site was the widespread spawning of large, carniverous snails (Lunatia, Polinicies, Busycon) observed during the June 1979 survey. The presence of these snails coincided with the reappearance of the dense populations of amphipods. The mussel (Mytilus edulis), which was found to be an abundant organism at the New London reference site in previous survey years (1977-79), was generally absent from the disposal site itself. A population of juvenile mussels was found in the SW sector on old phase II spoil in July 1977 and monitored through maturity in September 1979.

This population displayed a continuous increase in the mean shell length over the 1.5 year sampling period to a length of 55.9 mm. Furthermore, this population persisted although subject to intense predation. Mussel clusters occur in an interconnected net pattern over 50% of the entire 200-300 m SW region. Phase IV material was deposited on the SW sector in September 1979 which prevented further observation of this population. However, diver surveys of the SW, SE, and NW sectors revealed populations of 0 (zero) year class (5-10 mm shell length) mussels on Phase III sediment extending onto recent Phase IV material. Assuming these

populations of Mytilus survive to maturity on the dredged material, they serve to stabilize the unconsolidated sediment with their byssus threads and provide microhabitat for other organisms.

In contrast to organisms which stabilize the surface sediment, another biological mechanism of substrate modification is burrow excavation. The most conspicuous, large burrowing organisms are hake (Urophysis spp.), various crustaceans (Homarus, Cancer, Axius, Squilla, Crangon), winter flounder (Pseudopleuronectes) and mollusks which conceal themselves in shallow depressions. Burrowing activity promotes and accelerates aeration of the underlying sediment which, consequently, makes the substrate availabe for recolonization by infaunal organisms.

The June and July 1979 surveys provided evidence of extensive burrow formation by Homarus, Cancer and Urophysis at the NW, SW, and SE perimeter stations. The winter flounder (Pseudopleuronectes americanus) and the squirrel hake (Urophysis chus) were the most abundantly seen fish species on the disposal mound, probably attracted by the irregular topography affording concealment, and the availability and abundance of prey species (epi- and infaunal invertebrates). Passive fishing gear (fyke nets, wire fish traps) was deployed at the SE perimeter station between September and November 1979 in order to gauge the abundance and distribution of nocturnal fish species (Table 3.0-4). The smooth dogfish (Mustelus canis), conger eel (Conger oceanicus), and sea raven (Hemitripterus americanus) were the only species captured which were not observed at the disposal site during the day.

Epibenthic net samples have been obtained by divers at

the New London site since the initiation of the program in 1977. A record of collections which have been preserved, sorted and archived are presented in Table 3.0-5. A summary of the species identified in each sample is complete through May, 1979, and presented in Table 3.0-6. The data show a trend of increasing species diversity moving away from the pile center with peripheral areas colonized by numbers of organisms approximating that of natural bottom. Future epibenthic sampling reports will include a contrast of species present on dredged material versus natural sediment.

Table 3.0-5 Date and location of epibenthic net dive collections, New London Disposal Site

	Date	Location
1.	30 Sept. 77	Station #1 75'
2.	28 Oct. 77	Station #3 60'
3.	16 Dec. 77	N.L. Buoy Chain - mid-depth - 40'
4.	29 Mar. 78	200 meters W of N.L. Buoy - 70'
5.	29 Mar. 78	½ mi NNE of N.L. Buoy - 55'
6.	30 Mar. 78	Station #3 - 60'
7.	18 April 78	½ mi S of N.L. Buoy (Mussel bed) - 75'
8.	25 April 78	100 yds. N of Station #1 - 78'
9.	25 April 78	½ mi NNE of N.L. Buoy - 60'
10.	25 April 78	100 yds. NE of N.L. Buoy (New spoil material) 62'
11.	1 June 78	.5 mi E of N.L. Buoy (New spoil material).
12.	1 June 78	.5 mi NW of N.L. Buoy
13.	21 June 78	.5 mi SSW of N.L. Buoy
14.	23 Aug. 78	NW corner of spoil pile at marker buoy (45 sec.) - 70'
15.	23 Aug. 78	SW corner of spoil pile at marker buoy (45 sec.) - 80'
16.	1 Sept. 78	Station #1 (45 sec.)
17.	1 Sept. 78	Station #2 - 78' (45 sec.)
18.	15 Nov. 78	½ mi SE of N.L. Buoy near perimeter station on mussel bed
19.	15 Nov. 78	NW perimeter station on spoil
20.	1 March 79	Station #2
21.	9 March 79	SW section of NL Dumpsite on Mussel Bed
22.	9 March 79	SW perimeter
23.	19 April 79	SE 10 to SE 8 at perimeter station (on pile)
24.	19 April 79	SE 1 to SE 3 at perimeter station (off pile)
25.	19 April 79	SW 4 to SW 3 at perimeter station (off pile)
26.	19 April 79	SW 7 to SW 10 at perimeter station (on pile)
27.	18 May 79	25 m W of N.L. Buoy (15 m tow)
28.	18 May 79	50 m N of SE 10 on pile (15 m tow)
29.	18 May 79	SE 7 to SE 10 on pile periphery (15 m tow)
30.	18 May 79	SE 1 to SE 3 periphery off pile (15 m tow)
31.	18 May 79	50 m S of SE 1 off pile (15 m tow)

Table 3.0-5 (Cont.)

Date	
13 June 79	NW corner - on spoil
	NW corner - off spoil
	N.L. buoy to SW
	SW perimeter station SW 10 - SW 7
	SW perimeter station SW 8 - SW 5
20 Sept 79	SE perimeter station SE 1 - SE 4
	SE perimeter station SE 10 - SE 7
	NW perimeter station - off spoil
	NW perimeter station - on spoil
25 March 80	20 yards east of temporary disposal buoy.
26 March 80	SE 10 to N - on spoil
	SE 1 to S - off spoil

Table 3.0-6 Species distribution from epibenthic net (diver) collections at the New London Disposal Site.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
PHYLUM PROTISTA																															
Foraminifera sp.						1						1																			
PHYLUM PORIFERA																															
Porifera sp.		+																													
PHYLUM CNIDARIA																															
Cl. Hyrozoa																															
Campanularia sp.									+			+													+			+		+	
Corymorpha pendula								1	2			2																			
Eudendrium sp.																											+		+		+
Halecium sp.																			+												
Hydrozoan sp.																		+	+												
Thuiaria sp.		+							3														+						+	+	
Tubularia sp.																										+					
PHYLUM NEMATODA																															
NEMATODE sp.		+													1												A	C	A	B	C
PHYLUM RHYNCHOCOELA																															
RHYNCHOCOEL sp.		2							1			2														1					
PHYLUM MOLLUSCA																															
Cl. Polyplacophora																															
Chiton sp.										1																					
Cl. Gastropoda																															
Anachis translirata	+													2																	
Anachis sp.													4								1			1			2			1	
Crepidula sp.														1						1	1										
Eupleura caudatus																															
Lunatia heros									2			1																	1		
Lunatia triseriata																													1		
Nassarius trivittatus	1	1		5		10	4	3		1	4	23	14	12			1		1	14	12	9	10	12	5	8		5	11	4
Nudibranch sp.							1	6				1																1		
Cl. Pelecypoda																															
Astarte sp.	+	4					+	4				4							1	2			3				2		1	1	
Cerastoderma pinnulatum															1								1						1		
Crassostrea virginica													1																		
Cyclocardia borealis		2						6	3			1									1		3	4						1	1
Macoma tenta															2									1							
Mercenaria mercenaria																										+					
Mytilus edulis						1						+		1				+			12										
Nucula proxima			2				7	2					1																		
Pandora gouldiana																										3					
Pitar morrhuana				1						1								1				1				1					
Tellina agilis																			+												
Tellina sp.																				1											
Yoldia limatula																			1	1											
PHYLUM ANNELIDA																															
Cl. Polychaeta																															
Ampharete sp.												1																			
Amphitrite cirrata															1																
Amphitrite sp.					2																										
Clymenella torquata						2	4																								

Table 3.0-6 (Cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Clymenella sp.					1	1																									
Glycera sp.					1																										
Glycerid sp.							2																								
Hesionid sp.							1																								
Hispaniola grayi														1					2			1				+				
Lepidonotus squamatus		+												+							12									
Lepidonotus sp.													1					3												
Lumbrineris sp.							1						1																		
Maldane sava					1		1						1																		
Maldane sp.						1																									
Maldanopsis elongata																															
Maldanid sp.											1																				
Nephtys incisa													1																		
Nephtys sp.							1	+	1	5	5								+	1		1									
Nereis sp.							3					1	6	4	3		1	2				1	1			3					
Opheliid sp.											2												1								
Orbiniid sp.	+																														
Owenia sp.						1																									
Phyllidoce sp.		2																													
Potamilla reniformis		2												1																	
Sabella sp.												3																			
Sabellaria vulgaris		1																													
Sabellariid sp.									1					1																	
Spirorboris sp.													1																		
Hermathoe sp.																															1
Terbellid sp.							1																								
Tharyx sp.							2																								
Polychaete sp.					9	2		2								2															
PHYLUM BRYOZOA																															
Bicellariella sp.												+																			
BRYOZOAN sp.														+			+			+				+	+	+	+				
Bugula harmsworthi	+													+	+		+	+	+												
Bugula sp.													+																		
Crisia sp.									+																	+					
Microporella sp.		+		+					+			+	+		+												+			+	
Schizoporella sp.	+												+	+						+		+								+	
PHYLUM ARTHROPODA																															
S.C. Copepoda																															
Copepod sp.																										3		1			
S.C. Cirripedia																															
Balanus sp.											1																				
S.C. Malacostraca																															
O. Amphipoda	5	25	6+	2+	46		27		9	6		12	4	2		1	1	6	38	1		15	7	4		4		9		+	+
Aeginina longicornis		1																													
Ampelisca vadorum					+																										
Ampelisca sp.													3	1		1										3	3				
Amphipod sp.																															
Caprella sp.																										+					
Gammarus annulatus			+																												
Gammarid sp.				+	+																										
Ischyrocerus anguipes			5											1				2		1											
Leptocheirus pinguis				+																											
Photis dentata					+																										
Unicola irrorata					+																										
					+																										

Table 3.0-6 (Cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
O. Mysidacea																															
Heteromysis sp.	+																	+													
Mysid sp.							1	2		1			5	2	10			3													
Neomysis americana																				1							9		1	1	2
O. Decapoda																															
Cancer irroratus		4		+								+		4				1	1		2					1					
Crangon septemspinosa	4	39					+	4	2	2		15	3	13	7		16	3	13	2		3	8	15	12	10	45	20	6	20	37
Dichelopandalus sp.	1		+																						3	+					
Pagurus longicarpus		8					2	2	3			14	9	7	+		7	11	+	12	11	3	3	8	5	2	14	2	1	17	
Pagurus pollicarus		1											3																	2	
PHYLUM ECHINODERMATA																															
Cl. Echinoidea																					+										
Asterias forbesii																															
Asteroid sp.													2	1				1													1
Henricia sanguinolenta		+													1																
Ophiopholis sp.												2																			1
Ophiuroid sp.							1																								
Pedicellaster typicus													1																		
														1																	
PHYLUM CHORDATA																															
Cl. Pisces																															
Pseudopleuronectes sp.													2													+					
juvenile flounder																												+			
Raja sp.																															1

NOTE: + - indicates the occurrance of a species at a particular site, number of individuals present not determined

A - 750 individuals
B - 730 individuals
C - 7100 individuals

Table 3.0-2 List of captions corresponding to Plates 8.3-1 to 14 at the New London Disposal site - Underwater Photography June 1979 - July 1980

PLATE #	Date	
3.0-1	June 79	Diver collecting SW mussel bed sample.
3.0-2	June 79	Sonic beacon placement at permanent benthic station.
3.0-3	18 May 79	75 m N of Station SE 10. HFVP - 6". Sediment profile photograph of phase III spoil north of permanent SE border station; a relatively homogeneous sediment type with a 2 cm "conditioned" surface layer.
3.0-4	13 June 79	Spoil border Station SE 1. HFVP - 6". Sediment profile photograph illustrating layer strata of natural substrate.
3.0-5	9 Aug. 79	50 m east of NL buoy. HFVP - 15". Typical "shell hash" deposits on spoil surface occur shortly (1 - 2 months) after disposal.
3.0-6	31 Oct. 79	SE transect from NW border station. HFVP - 14". Adjacent burrows (Homarus and Cancer) excavated in clay banks on the spoil surface demonstrate substrate cohesiveness. Extensive amphipod communities (tubes protruding from sediment) have repopulated the SE and NW spoil sectors.
3.0-7	5 Nov. 79	SE border station SE 5. HFVP - 6". At the transition from natural to spoil sediment, densities of amphipod tubes approach 250 individuals per 15 x 15 cm square area, as illustrated. Their occurrence in similar concentrations was noted throughout the SE sector.
3.0-8	31 Oct. 79	NW border station SE transect. HFVP - 10". Turbidity cloud is produced by Cancer irroratus excavation beneath Mytilus growth on a 5 month old spoil surface.
3.0-9	5 Nov. 79	SE transect from NW border station. HFVP - 15". Patch areas (10-15 m) exhibit coarse gravel/sand mixtures on spoil surface. Exposed sediment of this type is rarely observed (5 - 10%) in contrast to the silt-clay clump spoil type.

TABLE 3.0-2 (Cont.)

Plate #	Date	
3.0-10	26 Mar. 80	Temporary disposal buoy (East transect). HFVP - 12". A "fissure line" and .5 m deep chasm observed on recent (~ 1 week old) soft spoil surface. The open-closure cycle associated with overhead storm swell conditons, appeared to function as a spoil mass consolidation mechanism.
3.0-11	26 Mar. 80	Temporary buoy east transect. HFVP - 20". The sharp angular faceted surface of new spoil (~ 2 days) can be distinguished from the weathered smoothed surfaces of older spoil.
3.0-12	26 Mar. 80	Temporary buoy. HFVP - 4". Immediate physical fracturing and particle formation of clay mounds was evident on two day old spoil surfaces.
3.0-13	26 Mar. 80	SE border station SE 4. HFVP - 6". Cluster concentrations of the hermit crab, Pagurus longicarpus displayed constant grazing and surface substrate manipulation.

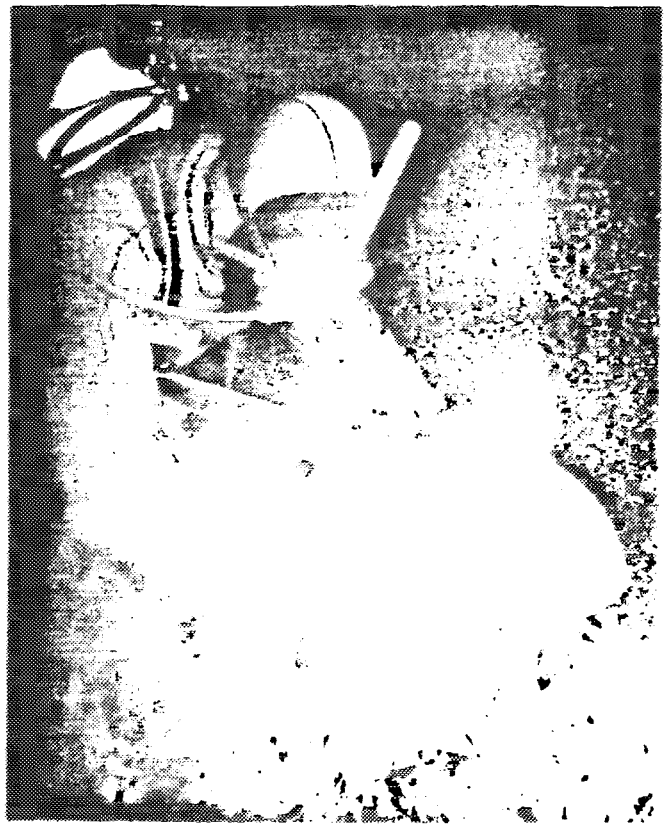


PLATE 3.0-1

PLATE 3.0-2

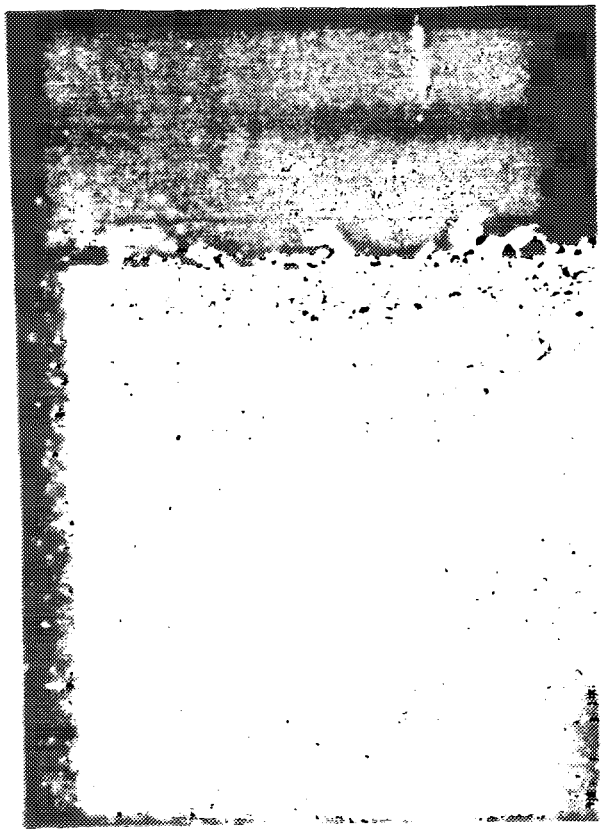


PLATE 3.0-3

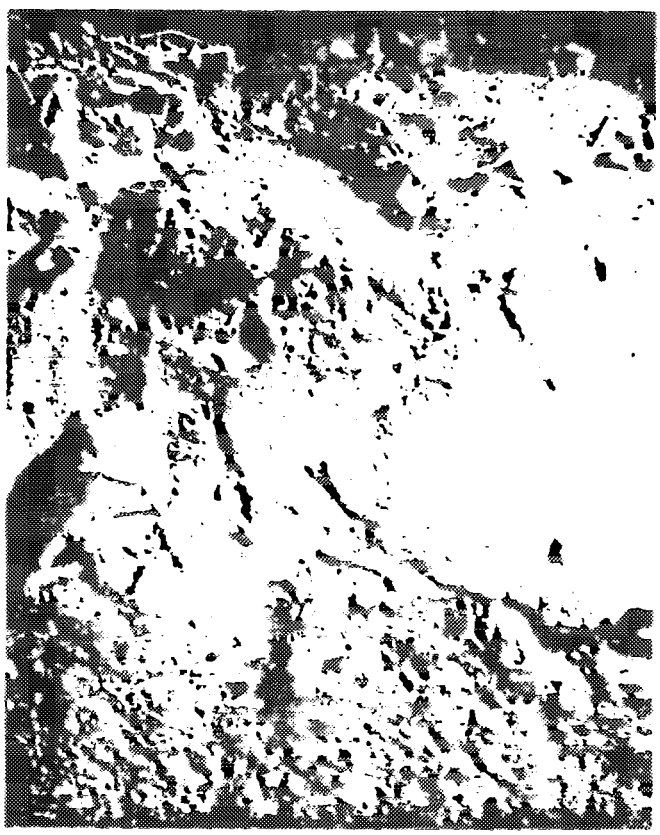


PLATE 3.0-4

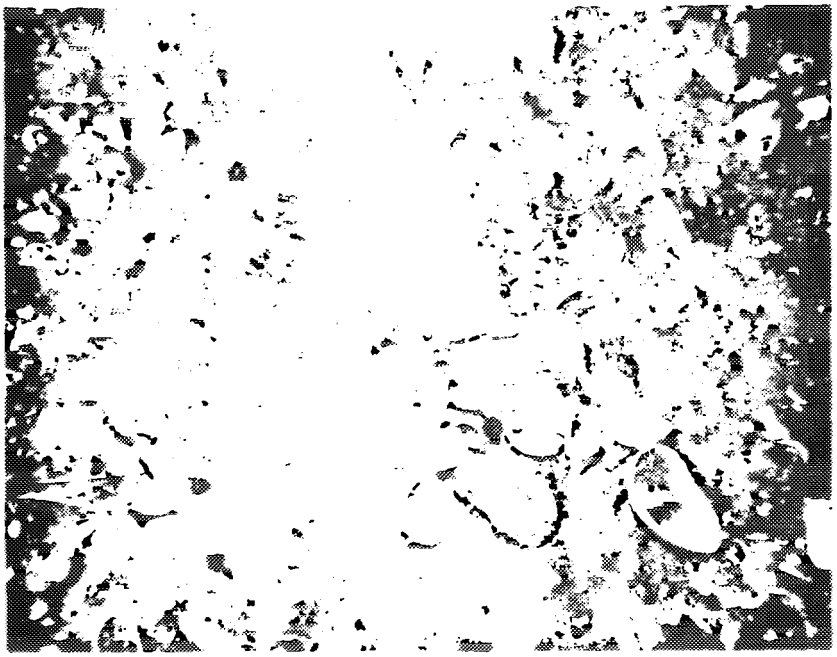


PLATE 3.0-5

PLATE 3.0-6

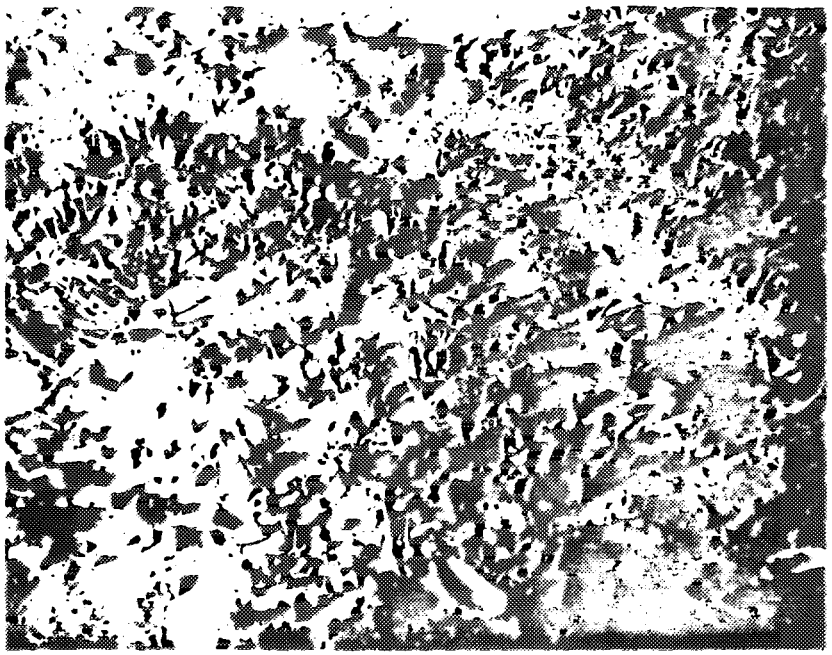


PLATE 3.0-7

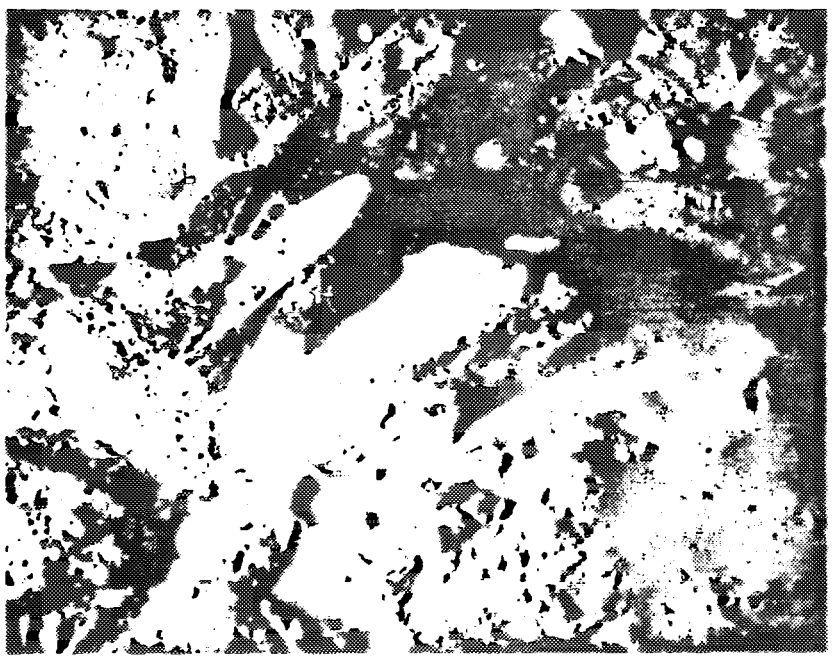


PLATE 3.0-8

PLATE 3.0-9

PLATE 3.0-10

PLATE 3.0-11

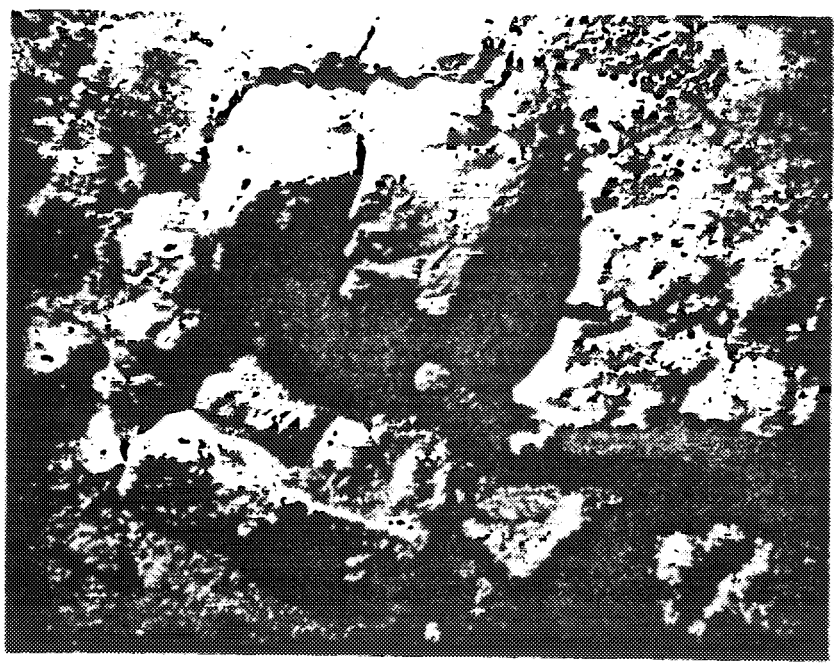


PLATE 3.0-12

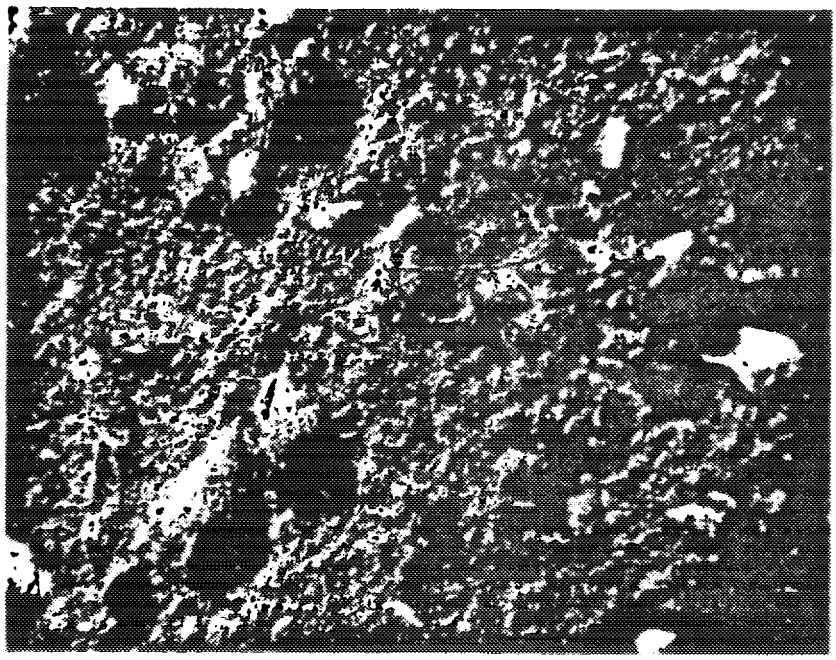


PLATE 3.0-13