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PROGRESS REPORT 1.

to the Office of Science Advisor
to the Administration

U.S. Agency for International Development
Washington, D.C.

U.S.A.I.D. Program Title:
Seagrass Restoration in Caribbean Nearshore Areas

Grant No. DAN-5542-G-SS-2102-00

Submitted by

Florida International University

Co-sponsored by

Natural Resources Conservation Department
Government of Jamaica

January 24, 1983

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Preface

In accordance with Item 1. Progress Reports, Section E. Reporting and Evaluation of the SCHEDULE for Grant No. DAN-5542-G-SS-2102-22 for the A.I.D. program titled"Seagrass Restoration in Caribbean Nearshore Areas," awarded August 31, 1982, the attached is PROGRESS REPORT 1 for the reporting period ending December 31, 1982.

As suggested in Item 1. Progress Reports, the Principal Investigator's overseas colleagues were involved in the preparation of this report by:

1. Historical research and collection of background materials in Kingston by B. Jupp, Ph.D. and NRCD staff;
2. Arranging for transfer of these background materials to the Principal Investigator's office by B. Jupp, Ph.D. and NRCD staff in Kingston;
3. Review and comments on the PROGRESS REPORT 1. during preparation at the Principal Investigator's office in Miami by B. Jupp, Ph.D.; and
4. Review and comments on the PROGRESS REPORT 1. before formal submission by B. Miller of the NRCD in Kingston.

Lastly, in accordance with Section E. Reporting and Evaluation of the SCHEDULE, the Grantee is requested to submit the Financial Status Report (SF-269) as an attachment to the PROGRESS REPORT. This report, prepared by the Controller's Office of Florida International University, is attached. The Grantee is also requested in this Section E. to reconfirm the dates of the reporting schedule: "Reports are due within 30 days of the reporting periods ending: December 31, 1982; June 30, 1983; December 31, 1983; and . . . a final report in 10 copies no later than the completion date of the grant which currently is estimated as June 30, 1984."
The Grantee hereby confirms these dates of the reporting schedule.

Respectfully submitted,

A. Thorhaug, Ph.D.
Principal Investigator

January 19, 1983.
(Four copies)

Acknowledgements

I wish to thank the Agency for International Development of the United States Government State Department for supporting this grant, and the Biology Department of Florida International University and the Natural Resources Conservation Department for sponsoring this grant.

I wish to thank Mr. Thomas Breslin and Ms. Catherine Kennedy of the Sponsored Research Department and Ms. Harriet Walsh of the Controller's Office of Florida International University for their rapid facilitation of this program.

In Jamaica, I wish to thank Mr. Dan Rathburn, A.I.D. Project Officer, and his assistant, Roberta Mattis, for their cooperation and assistance during our work there. Mr. Stan Johnson of the General Services Office and his assistant, Michel Lawson, are thanked for their assistance with processing the project equipment into Jamaica. Mr. William Brown Davis, U.S. Embassy Counselor, Information Services, is thanked for his personal interest and promotion of the project.

The Principal Director, Beverly Miller, and staff of the Natural Resources Conservation Department, Government of Jamaica, are gratefully acknowledged for their cooperation, assistance and support of this project. Ms. Elean R. Thomas, Director of Public Education at NRCD is thanked for her interest and promotion of the project.

Lastly, I specially thank the field biologists from FIU, UWI and the NRCD for their good work during the November 1982 planting. UWI Professor George Sidrak's long support of this project is appreciated and I thank him for it.

EMPHASIS OF U.S. A.I.D. JAMAICA SEAGRASS PROJECT

TECHNOLOGY: A. Thorhaug, Ph.D. from FIU shown planting seagrass

COOPERATION: Peter Gayle from NRCD in Jamaica and A. Thorhaug, Ph.D. from FIU in Florida.

EDUCATION: Donovan Henry, a Jamaican fisherman temporarily employed by the project, explains the project to other fishermen.

Seagrass Restoration in Caribbean Nearshore Areas

PROGRESS REPORT 1.

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Seagrass Restoration in Caribbean Nearshore Areas

PROGRESS REPORT 1.

I. Introduction

A. Purpose of Grant

The research will test whether one can accelerate the re-establishment of seagrass beds destroyed by natural disasters and man-made impacts in Kingston Harbor and other Jamaican sites, using seagrass restoration techniques developed in subtropical Florida and Texas.

B. Specific Objectives

1. To test whether shallow tropical estuarine Jamaica is capable of receiving seagrass restoration.

2. To test if successional seagrass stages (*Halodule* and/or *Syringodium* species) should be planted first (to provide ground cover and sediment stabilization) with the dominant species (*Thalassia*) planted later, or whether equal seccess and cost/benefit can be achieved by planting the dominant stage directly with no successional stage.

3. If the testing in Objective 1 is positive, to test whether seagrasses can be successfully rehabilitated into areas where one of the following is the case:

   a. One of the impacts below has occurred and has now been removed.

      1. Industrial accidental spills
      2. Land development induced impacts
      3. Urban run-off and urban abuse

4. To test the rate of recovery of restored versus non-restored seagrasses with associate animal community after impact to the area.

C. Jamaica's Uses of Coastal Resources

The coastline of Jamaica is 470 miles long and along it the varied uses frequently depend on the preservation of living natural resources. There are 128 public bathing beaches and 22 seaside parks for residents. Hotel beaches own six miles of coastline and attract over one-half million tourists each year. The coastlines serve a series of functions for recreational activities such as swimming, snorkeling, shelling and sunbathing as well as shallow water boating sports such as sailing, wind-surfing and rafting.

Fisheries is the chief employment for approximately 7,000 men launched from 140 fishing beaches. Forty million pounds of fish per year are caught (Wade 1972) which are worth about JA$3.00 per pound (US$1.71). This yearly catch is half of what Jamaica consumes -- the balance is not available because the waters have been overfished.

Construction of residences, hotels, industries and roads along the shoreline causes erosion problems in Jamaica. The resulting effect on the beaches and shoreline waters is a concern to Jamaicans.

Development utilizes coastal resources because most of the population lives within twenty miles of the coastline, port facilities and shipping lines all utilize harbors which include the specialized loading facilities for bauxite, cement and agricultural products, industries near the coast dump liquid wastes into estuaries and the two major cities dump sewage into the estuaries and ocean. The coastline is directly affected by dredge and fill operations that build waterfront real estate in Kingston Harbor, Montego Bay and Ocho Rios. Linking all these activities together are the support and transportation facilities such as roads, bridges, causeways and airports (both the airports in Kingston and Montego Bay required dredge and fill operations).

The continued conflict between development of industry, agricultural runoff, urbanization and tourism and the preservation of natural resources for present and future uses outlined above is not yet resolved in Jamaica. A potential key to the solution is the technology of restoration, rehabilitation and enhancement of natural coastal resources wherein old mistakes can be repaired and present public necessities for destruction of natural resources can move the threatened resource elsewhere.

In the first attempt anywhere in the tropics or anywhere in the developing world, this project is attempting to transplant seagrass which is intended to benefit the nearshore coastal resources.

D. Description of Jamaica's Seagrass Resources

The 470 miles of Jamaica's coastline is rich with numerous bays and estuaries containing mangroves, marsh shorelines, some sandy beach and rocky shoreline (in specific points on the north coast). The bays and estuaries themselves were originally heavily populated with seagrass meadows which extended from the shoreline seaward to the reef on the north shore and to deeper water (sixteen feet depth or more) on the south shore. Most bays and estuaries still have seagrasses in them. Many man impacted areas are barren.

The seagrasses function in several ways in the nearshore marine ecosystem.

1. They provide a major food source for the nursery stages of many commercially valuable species by providing the substrate upon which the food web is based.
2. Seagrasses provide a habitat for resident estuarine and juvenile organisms that require benthic shelter.
3. The roots and rhizomes of the grassbeds stabilize the marine sediments and help retard erosion.
4. The seagrass blades improve water quality by acting as baffles in the water column which allows suspended particles to sink into the sediment.
5. The seagrass beds appear to drive the decomposition loop of the food web with the large amount of biomass that dies and decays on a regular basis.
6. Lastly, the physiology of the plant system seems to drive the important sulfur cycle by transporting sulfur compounds from the sediment into the water column for assimilation by other organisms.

The larger seagrass beds are found along the south coast of Jamaica in the expansive estuaries and shallow coastal shelf. Since the south side of the island is leeward of the prevailing winds, the waters are calmer and consequently the seagrass beds are less disturbed by natural events. The north coast shoreline is quite narrow by comparison because of the close proximity of the sharp wall and drop-off. A map or assessment of the coastal resources of Jamaica has not been made, however, the NRCD plans to do so in the very near future.

II. Methods

To test the feasibility of large scale seagrass restorations in Jamaica, sixteen test sites around the coast were selected for planting. Site selection, demarcation, preplanting survey, design, plant material collection, transportation, preparation, planting, monitoring and data analyses are as follows.

A. Site Selection

The sites selected are where a single impact has long ceased and the area is physically and chemically recovering and where some level of past impact is still occurring. Obviously the former is more amenable to full recovery of dominant communities than the latter, however, some areas even now receiving some chronic impact may be amenable to seagrass cover with one of the three species. Some species are more tolerant to low salinity or low light than others (Thorhaug and Marcus 1981). Frequently the problem of recolonization stems from a lack of natural seeding due to unfavorable currents, wind patterns or donor beds. 100 percent success is not expected at some of the chronically polluted sites, but negative data will be as informative as positive data at these sites.

The sites selected represent one or more of the following impacts: industrial waste, dredge and fill, bauxite spill, oil spill, urban runoff, erosion, peat and thermal effluent. The sites selected are located around the coast of Jamaica clockwise from Kingston to Ocho Rios.

The actual planting site is selected on the basis of present bottom cover, sediment, light penetration, wave energy regime, water chemistry, proximity to impact, accessibility and depth. Past history of the site is researched and aerial photographs are examined to further the selection process.

B. Demarcation

Upon selection, the site is marked as follows. A 30" eye loop earth anchor is screwed into the bay bottom by a diver. Two 200' nylon-on-steel Keson surveying measuring tapes are attached and two legs of the rectangular test site are measured. The test site is 90'x 30' usually (or some combination of 30'x 30' or 15'x 30' subplots). The corners are then marked by two more earth anchors and measuring tapes attached to them. The fourth corner is measured and marked with an earth anchor at the appropriate intersection of the two tapes. Each earth anchor is then marked by a 7½" white styrofoam float and line. #36 orange Seine Twine is then strung around the perimeter of the test plot from anchor to anchor.

C. Preplanting Survey

The test site is surveyed by a diver biologist to note the dominant physical and biological characteristics of the site. The following parameters are noted: location, depth at mean low water, sediment type and depth, indigenous seagrasses, dominant algae, visibility, wave energy regime and currents.

D. Experiment Design

The test site usually measures 90'x 30'; the long dimension is divided to make six subplots 15'x 30'. The subplots are numbered sequentially 1 - 6 and identified as #XX.1 where #XX refers to site abreviation using two capital letters followed by the subplot number.

Each of the three species of seagrass are planted in two adjacent subplots. A different planting technique is attempted in each subplot. The four technique variables are plant seeds, shoots, plugs and anchors.

The plants are installed in a 3'x 3' matrix (except where noted) in the site. Each subplot contains 50 planted units (except where noted).

Plots of similar size will be designated as control at each site. The characteristics of the control will be similar to the test site. If normal seagrass areas are within a reasonable distance, a similar plot will be monitored as seagrass control, otherwise, Dr. Greenway's seagrass study of Kingston Harbor will be used (Greenway 1977).

E. Plant Material Collection

Halodule wrightii, *Thalassia testudium* and *Syringodium filiforme* is collected daily from nearby established donor beds if possible. If donor material is not available nearby, another location is selected if possible.

The plant material is collected in the following forms.

a. Shoots - single rhizomes with attached blade groups and an apical meristem are collected from the edge of actively growing grassbeds by digging.
b. Plugs - Sod with intact sediment is removed by a post hole digger.
c. Seeds - *Thalassia* seeds are collected from shallow nearshore catchments and nurseried until planting.

F. Plant Transportation

The shoots and seeds are transported in a large cooler filled with seawater. The plugs are placed in thin plastic bags and transported in containers.

G. Plant Preparation

The shoots are sorted by hand labor and either attached to 6" segments of ¼" steel rod with plastic covered wire or bundled and tied with plastic covered wire. The bundles of shoots are held by the diver as he selects three shoots for planting while underwater. The loose shoots are anchored by 3" V-shaped steel clips which the diver carries in a wristband while planting. The seeds are attached to the steel rod by a leader of plastic covered wire. The plugs are removed from the plastic bags immediately before installing them while underwater.

H. Planting

The plants are transported to the test site in a floating basket or basin. The plants are installed in a 3'x 3' matrix using the following method.

a. Measuring tapes are run along the long dimension of the site and attached to the fixed earth anchors.
b. A ¼" polypropylene planting line which has been marked in 3' sections with wire ties is anchored with 5 lb Bulldog anchors and placed perpendicularly to the measuring tapes at the appropriate measurement.
c. The diver installs the plants under the appropriate mark in the planting line by digging a shallow trench and placing the seagrass planting unit in it and covering it over with sediment. The plugs require a larger hole than the seeds or shoots.
d. Once the line is completely planted, it is moved to the next appropriate measurement until the entire subplot is planted. The tapes and lines are then removed.

I. Monitoring

Sampling at each site will consist of counting all the surviving planted units and measuring 25 percent of the planted units (every fourth plant) for length of blades, rate of rhizome laterial growth, number of blades per shoot, rate of blade growth and coalescence of plantings into homogeneous cover. Measurements will be made along line transects set over the planted rows.

Physical, chemical and biological parameters noted in the Preplanting Survey (location, depth, sediment type and depth, indigenous seagrasses, dominant algae, visibility, wave energy regime and current) will be noted during monitoring. In addition, oxygen, light penetration, salinity and temperature will be measured. Sediment cores will be taken from select sites for hydrocarbon residue and trace metal content analyses. Underwater and surface photographs will be made of the sites.

The contemplated schedule for monitoring is:

February 1 - 11, 1983

April 4 - 22, 1983

July 5 - 15, 1983

August 22 - September 2, 1983

October 28 - November 10, 1983

January 9 - 20, 1984

April, 1984.

The contemplated schedule for additional planting is:

April 4 - 22, 1983

August 22 - September 2, 1983

The April planting will consist of a spring planting at the same sites previously planted in November, 1982. The April sites will be adjacent, if possible, to the November sites and will use the same methodology. The August planting is for collecting and planting Thalassia seeds which are in season then. The seeds will be planted in the sites laid out in April.

J. Data Analyses

The location of the sites is documented with photographs, close-up and aerial. Underwater phototgraphs will also be taken during monitoring. The data from the monitoring will be statistically analyzed using a three level (15 x 3 x 2) nested analysis of variance test for independent comparisons (Sokal and Rohlf 1969). An arcsine transformation will be performed on percentage data for statistical analysis (Sokal and Rohlf 1969). This statistical analysis will indicate significant differences between sites, species of seagrass and planting technique.

K. Training

The NRCD and UWI personnel received intensive training in the techniques of site selection and representative area of the site, site demarcation and preplanting survey, seagrass plant material collection, transportation and planting and methods to assess survival. The personnel were further taught about seagrass biology including morphology, taxonomy and physiology, pollutant effects on seagrass, past seagrass restoration attempts (successes and failures) and agency permitting procedures.

Hands-on field demonstrations and practice were conducted by NRCD and UWI personnel concerning the collection, transportation, anchoring and planting of the three seagrass species. A review of Thalassia seed nursery procedures was also given.

In accordance with the U.S.A.I.D. contract, Task Relegation, Section D. Low Technical Employment Test, unemployed, unskilled workers were trained in two seagrass transplanting techniques. Several persons with past agricultural and fishing skills were trained in the collection and preparation of plant material and several persons with past diving experience were trained in the underwater planting and anchoring of the seagrass using Scuba and skin diving skills. Associated teaching included an explanation of the project goals, the relation of the project to fisheries nurseries and the other techniques available to transplant seagrasses. These persons all worked in teams with NRCD, FIU and UWI personnel.

L. Detailed List and Price of Equipment Used in Each Phase of the Seagrass Transplantation Process

Fifteen Test Sites, Three Test Plots per Site

Phase I: Site Selection, Demarcation and Preplanting Survey

Item	Number of Units	Price per Unit	Total Price
Site Selection			
Mask and snorkel	5	$ 25.00	$ 125.00
Weight belts	6	3.30	19.80
Swim fins	3	27.00	81.00
Lead weights (8 lb)	20	8.00	160.00
Dive knives	3	15.00	45.00
Dive boots	5	18.90	94.50
Wet suit tops	5	80.40	402.00
Dive flag	1	14.00	14.00
Regulators, Dacor 950 Pacer	6	160.00	960.00
Pressure gauge, U.S. Divers	6	39.95	239.70
Hose protectors	12	nc	nc
Scuba tanks, 80 ft^3 aluminum	6	115.00	690.00
Scuba tank backpacks	6	26.00	156.00
Buoyancy compensator devices	6	87.00	522.00
Clipboard, paper, pencil	5	2.00	10.00
Oxygen meter, YSI Model 51	1	386.40	386.40
Oxygen meter probe	1	125.60	125.60
Cable	1	68.00	68.00
Batteries	12	1.58	19.00
Demarcation			
Scuba dive gear (detailed in 1. Site Selection)			
Keson NR18200 200' nylon on steel measuring tape	2	73.50	147.50
Transgrid for corner ID tags on site	1 yd	13.50	13.50
#43 galvanized tubs	2	20.10	40.20
Brass clips, medium	2	2.65	5.30
Chance Keep Stake Earth Anchors	150	3.30	495.00
¼" Trap line, 1200'/box	3	21.08	63.24
A&G Polystyrene 7½" floats	275	.82	225.50
#36 orange seine twine (600'/roll)	8	7.60	60.80
Paper punches	2	1.26	2.52
Rebar	1000	nc	nc
Black markers	2	nc	nc
Propane torch and fuel	1	18.00	18.00

Equipment budget, continued

Phase I: Site Selection, Demarcation and Preplanting Survey

Item	Number of Units	Price per Unit	Total Price
3. Preplanting Survey (Equipment specified in 1. Site Selection and 2. Demarkation)			
Dive gear			
Measuring tapes			
floats and weights			
Clipboards, pencil and paper			

Phase II. Plant Collection, Transport & Preparation, and Planting

1. Plant Collection			
Dive gear			
Jacuzzi 3 hp 8M water pump	1	$ 291.00	$ 291.00
Pump hoses and connections	1	81.39	81.39
Mesh bags	12	7.35	88.20
Post hole diggers	2	25.60	51.20
Plastic bags		nc	nc
Gasoline fuel can	1	12.85	12.85
Floating shrimp baskets	2	nc	nc
2. Plant Transport and Preparation			
Captan fungicide (5 lb bag)	1		13.35
#5500 Gigantic Fish Box and Cooler	1		27.95
Dishpans	6		27.54
Garbage bags (40/box)	2		10.98
-8 scissors	2		9.96
¼" galvanized hardward cloth	25		68.75
Wire shears	1		11.65
1/8 oz lead weights (25 lbs)	1		33.00
Duct tape roll	1		1.79
Trash can	1		5.05
3. Planting			
Dive gear			
Mako Scuba tank air compressor	1	3000.00	3000.00
Mesh bags			
Measuring tapes			
Black top net buoys	4	49.12	196.48
Bulldog anchors (5 lb)	4	9.31	37.24
Brass clips, medium	4	2.65	10.60
Work gloves (pr)	5	2.75	13.75
Anchor pin bracelets (yd)	2	6.00	12.00

Equipment budget, continued

Major Equipment and Accessories

Item	Number of Units	Price per Unit	Total Price
1983 CG21305 3/4 Ton Chevy Van	1	$10949.00	$10949.00
Rustproofing, undercoating and polyglycoat paint	1	340.00	340.00
Air conditioning	1	450.00	450.00
Automatic transmission overhaul kit	1	125.00	125.00
Shock absorbers, spare set	1	112.00	112.00
Fuel injectors (8 per set)	1	400.00	400.00
Oil filters	6	6.00	36.00
Lightbulbs	12	1.00	12.00
Primary moisture filter	1	17.80	17.80
Secondary moisture filter	1	35.28	35.28
Air cleaner filter	1	21.00	21.00
Powerjump Battery Booster Cables	1	22.69	22.69
Alarm system for Van	1	150.00	150.00
Extra bench seat	1	150.00	150.00
Roof racks (pr)	1	35.00	35.00
13' Avon Inflatable Boat S400	1	1933.50	1933.50
Oars (pr)	1	30.00	30.00
Electic Inflator pump (DC voltage)	1	75.00	75.00
Anchor, 10 lb	1	18.27	18.27
Life cushions	4	9.00	36.00
½" polyproplyene line	100'	.12	12.00
½" nylon line	50'	.24	12.00
Waterproof flashlight	2	6.39	12.78
Flashlight batteries	2	3.59	7.18
Flashlight lightbulbs	4	.48	1.92
Fire extingisher	1	20.35	20.35
Brass clips, medium	4	2.65	10.60
Spring clip, galvanized	1	5.69	5.69
Boat tie downs (pr)	2	8.35	16.70
Fuel tank and line	1	64.75	64.75
25 hp Johnson Outboard Engine J25RCN, Manual, Short shaft	1	925.44	925.44

Equipment budget, continued

General Field Operations Support Equipment and Maintenance Equipment

Item	Number of Units	Price per Unit	Total Price
Brass padlocks	3	$ 7.55	$ 22.65
Master Security chains, 6'	2	20.79	41.58
Electrical connectors	2	1.15	2.30
Electrical tape	1	3.05	3.05
Stainless steel hardware	1	5.00	5.00
Duro stencils, 1" and 2"	2	1.69	3.38
Garden hose, 25'	1	5.89	5.89
Tool box	1	12.19	12.89
Tool set	1	127.85	127.85
Metal ID stamps	1	35.29	35.29
Spark plug feeler gauge and wrench	1	13.00	13.00
Outboard engine oil, case	1	59.00	59.00
Engine service manual	1	14.00	14.00
Spare propeller	1	37.35	37.35
Shear pins	12	nc	nc
OMC Triple Guard grease	1	3.05	3.05
OMC Gear Case Lube	3	6.96	20.88
Sparkplugs	4	2.40	9.60
Tire gauge	1	2.00	2.00
Shipping Container, 20'x8'x8' Ocean Freight to Kingston	1	1459.52	1459.52
Consignment fee	1	70.00	70.00
Loading and unloading container	1	300.00	300.00
Insurance on van	1	210.00	210.00
Insurance on cargo	1	225.00	225.00
Personal Equipment for Field Crew Support			
First Aid Kit	1	60.49	60.49
Rain gear (L)	3	37.50	112.50
Rain gear (XL)	2	38.50	77.00
Arctic Water Cooler	1	27.01	27.01
Insect Repellant	4	3.75	15.00
Misc. Equipment and breakage		4337.92	4337.92
TOTAL		31620.00	31620.00

III. Results

A. Sites Selected

1. Old Airport Site

The airport site is a dredge and fill area constructed decades ago to be a side to the "old airport" runway. The area was originally a shallow Kingston Harbor grassbed with a mangrove shoreline. A pit from removal of bottom sediments was made to the east of the site. Sediment and rock were removed to form the foundation of the runway. The dredging operation increased the silt and turbidity in the water in the pit and surrounding waters over the site.

The general degradation of water quality in Kingston Harbor has also lessened the ability of the area to naturally recover from disturbance. The major impacts to Kingston Harbor are: 1.) Sewage inflow at at rate of 10.5 million gallons per day from the Corporate Area; 2.) Increased turbidity of water from industrial byproducts (see Table 1.) including oil from bilging operations and ballast water from ships, and agricultural erosion; 3.) Urban runoff from streets and storm sewers; and 4.) Dredging of new airport runway.

The exact environmental variables at the site have not yet been monitored. General characteristics include those outlined by Wade (1976). Table 2., column 3, "Inner Harbor," summarizes the available water chemistry data. The wind direction is generally southeast and east. April and September have stronger winds than usual. The current within the bay is chiefly wind-directed surface current which flows eastward and the bottom current generally flows westward. Flushing of the harbor at the east end is poor.

Water temperatures range from 26° to 30°C (Greenway 1977) and salinities range from 22 o/oo to 36 o/oo (Wade 1976). Dissolved oxygen, biological oxygen demand, phosphate and silicate (measured for other projects by other authors) concentrations are seen in Tables 3 and 4 and Figure 1.

a. Location

The Old Airport Site is located on the northeast side of a peninsula of land forming the Palisadoes, the southern boundary of Kingston Harbor, that was filled to make an airport runway (Figure 2.). The site is located 45 ft from shore in the middle of a large barren area adjacent to the runway. Blue paint markers were placed on the seawall to indicate the two ends of the site.

Table 1. Major sewage and industrial wastes discharged to Kingston Harbour (Compiled from Government of Jamaica Report, 1970) (Wade 1976).

Source	Estimated Average Flow	Characteristics
Sanitary Sewage Discharge	10,500,000 g/d	Undergone only primary treatment; not chlorinated; discharged near shore
Industrial Waste Discharges		
Type of Waste		
Soft Drink Bottling	225,000 g/d	High pH, suspended solids and B.O.D.
Vegetable and Fruit Canning	210,000 g/d	High suspended solids, colloidal and dissolved organic matter
Slaughterhouse	90,000 g/d	High organic matter, proteins and fats
Dairy Products	200,000 g/d	High organic matter, proteins, fats and lactose
Brewery	700,000 g/d	High dissolved organics, nitrogen and starches
Tannery	30,000 g/d	High solids, hardeners, salt, pH and B.O.D.
Oil Refinery	400,000 g/d	High B.O.D.
Detergents, Oils, Soaps	250,000 g/d	High B.O.D. and saponified soaps
TOTAL	12,605,000 g/d	

Table 2. Average values for nutrient chemistry and primary productivity measurements in the open ocean south of Harbour Head, in the Outer Harbour and in the Inner Harbour (Reproduced from Steven, 1965). (From Goodbody 1970).

Parameter	Open Ocean	Outer Harbour	Inner Harbour (Upper Basin)
C^{14} $mg/m^3/day$	2.84	58.23	117.52
Chlorophyll mg/m^3	0.10	0.85	1.88
Phytoplankton cells/l x 10^3	32.30	136.70	1351
Phosphate-P *µgA/l	0.023	0.084	0.232
Nitrate-N µgA/l	0.012	0.056	0.155
Nitrate-Nitrite-N µgA/l	0.12	0.78	1.14
Silicate-Si µgA/l	1.57	3.49	10.70
Zooplankton volume $ml/100\ m^3$	2.23	49.00	108.24
Zooplankton dryweight mg/m^3	3.89	74.05	------

*µgA/l - microgram atoms/litre.

Table 2a: A comparison of nutrient concentrations at the 5 metre depth at stations 1 (Outer Harbour) and 7 (Inner Harbour) for the periods 1962 - 64 (Steven, 1965), 1971 - 72, and 1973 - 75. All measurements are in uga/l.
(Wade 1976)

		1962-64	1971-72	1973-75	Overall Increase
Stn. 1:	$NO_3 + NO_2 - N$	0.78	(1.14)	-	46.1%
	$PO_4 - P$	0.08	(0.27)	0.36	450.0%
	$SiO_4 - Si$	3.49	(3.20)	5.35	53.3%
Stn. 7:	$NO_2 + NO_2 - N$	1.14	(1.23)	-	7.9%
	$PO_4 - P$	0.23	(0.54)	0.77	234.8%
	$SiO_4 - Si$	10.70	(3.65)	6.06	-43.4%

Data in parentheses were obtained by extrapolation from 4 profile measurements.

Table 3. The average values for all parameters at the five monitoring stations for the periods May to November 1973 and December 1974 to April 1975. (Wade 1976).

Parameter	(1) Sur.	(1) Bot.	(3) Sur.	(3) Bot.	(4) Sur.	(4) Bot.	(5) Sur.	(5) Bot.	(7) Sur.	(7) Bot.
Temp. (^{o}C)	28.13	28.27	27.75	28.69	28.48	28.40	28.46	28.33	28.64	28.47
Sal. ($^{o}/oo$)	34.51	35.61	22.34	34.77	34.44	35.58	35.08	35.51	35.15	35.56
Trans. (m)	4.83		0.97		3.79		5.95		6.54	
D.O. (mg/l)	6.05	5.13	7.70	3.68	5.87	4.34	6.16	3.60	5.94	3.02
BOD (mg/l)	4.36	2.67	7.94	6.57	5.94	4.17	4.74	4.42	4.60	3.50
PO_4-P (µgA/l)	0.41	0.54	7.63	0.84	0.82	0.89	0.51	0.96	0.58	1.75
SiO_4 - Si (µgA/l)	6.48	7.36	58.85	9.16	16.31	9.42	6.52	9.90	6.50	16.55

Table 4. A comparison of Phytoplankton concentration and B.O.D. (mg/l) in Kingston Harbour during normal conditions and plankton blooms. (Phytoplankton data from Steven 1966). (Wade 1976)

	Normal	Blooms	Increase
Phytoplankton (cells/m^3)	1120×10^6	7830×10^6	x 6.0
Chlorophyll a (mg/m^3)	2.57	13.70	x 4.3
B.O.D. (total)	5.2	16.3	x 2.1
B.O.D. (soluble)	4.5	7.7	x 0.7
B.O.D. (particulates	0.7	8.6	x11.3
B.O.D. (Phytoplankton)			approx. x 4 - 6
B.O.D. (Zooplankton and Faeces)			approx. x 5 - 7

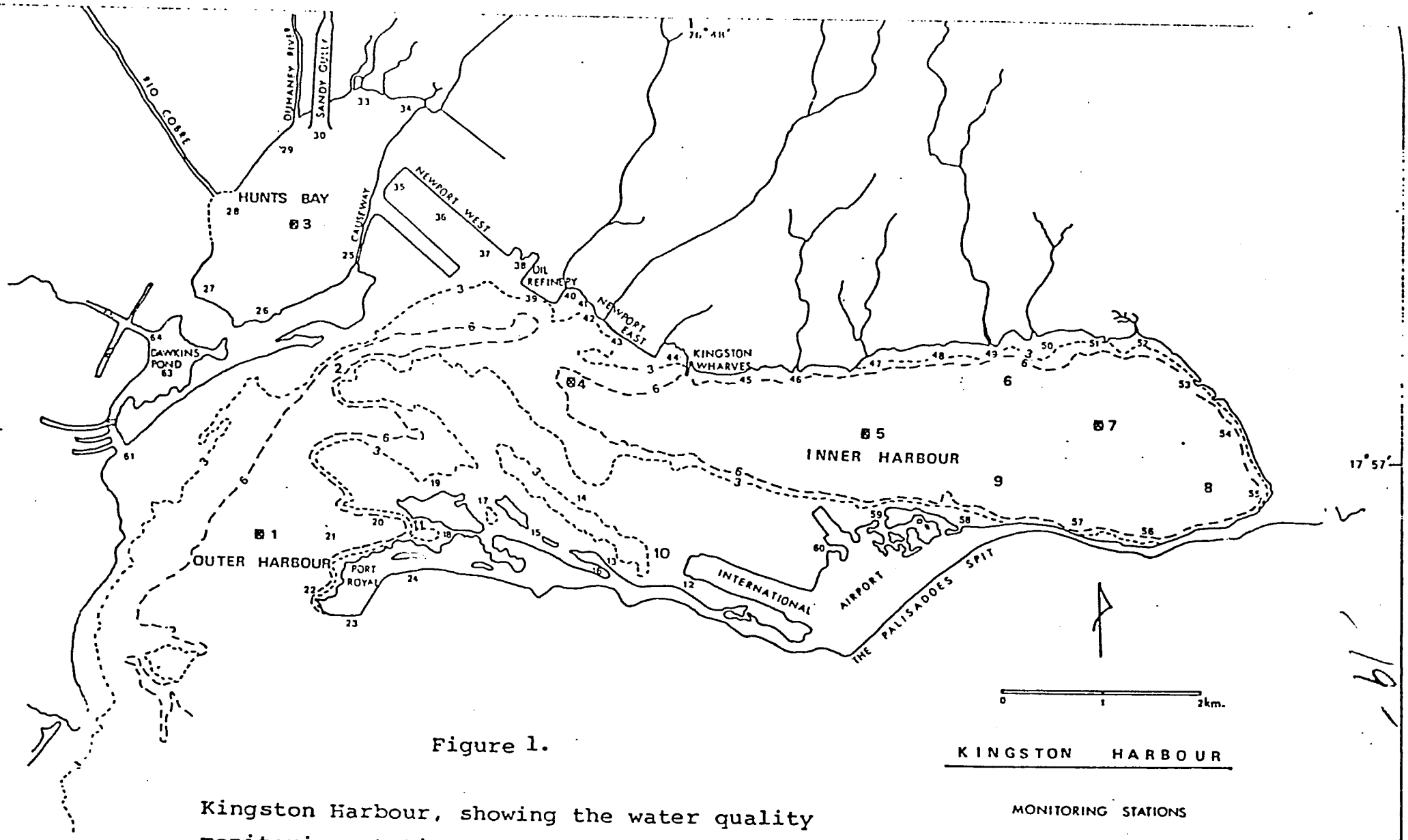


Figure 1.

Kingston Harbour, showing the water quality monitoring stations. The 5 main stations (1, 3, 4, 5 & 7) are circled. (Wade 1976).

b. Characteristics of the Site

The dimensions of the test site are 90'x 30' and the long dimension was divided into 15' lengths to make six subplots 15'x 30'. The long dimension is parallel to the seawall of the runway.

The mean low water depth at the site is approximately 6'. The sediment is coarse black sand and is more than 1.7' deep. The area is inhabited by many Diadema (spiny sea urchins) and numerous large shrimp burrows are present. There is a 2'x 3' patch of naturally existing vegetation (Thalassia) in subplot #OA.4 (Old Airport site, subplot 4).

c. Planting

On November 19, 1982, the site was planted by a team of diver biologists from the Natural Resources Conservation Department (NRCD) in Kingston, University of the West Indies (UWI), Florida International University (FIU) and an unemployed fisherman, Cortney Cunningham of Kingston. Figure 3. shows the experimental design in which the three species of seagrass were planted. Halodule plugs, 4"-6" in diameter, were planted in subplot #OA.1. 6" segments of ¼" steel rod were used to anchor 6" lengths of Halodule shoots which were planted in subplot #OA.2. Thalassia seeds anchored on ¼" steel rod were planted in subplot #OA.3; Thalassia shoots approximately 5" long were anchored on ¼" rod and planted in subplot #OA.4. 6" Syringodium shoots were anchored with 3" V-shaped pins and planted in subplot #OA.5; 6" Syringodium shoots were anchored with ¼" steel rod and planted in subplot #OA.6.

The Halodule plugs and shoots, the Thalassia shoots and the Syringodium shoots were all planted in 3'x 3' matrix in the subplots. Therefore, each subplot contains 50 planted units except subplot #OA.3. Subplot #OA.3 was planted with Thalassia seeds planted in a 1.5'x 3' matrix with one seed per planting unit: 100 planted units total.

The Halodule and Thalassia plant specimens were collected from an adjacent area and the Syringodium material was collected from a bed near Hellshire Point because none could be located near the Old Airport site.

Figure 2. Approximate location of Old Airport Site

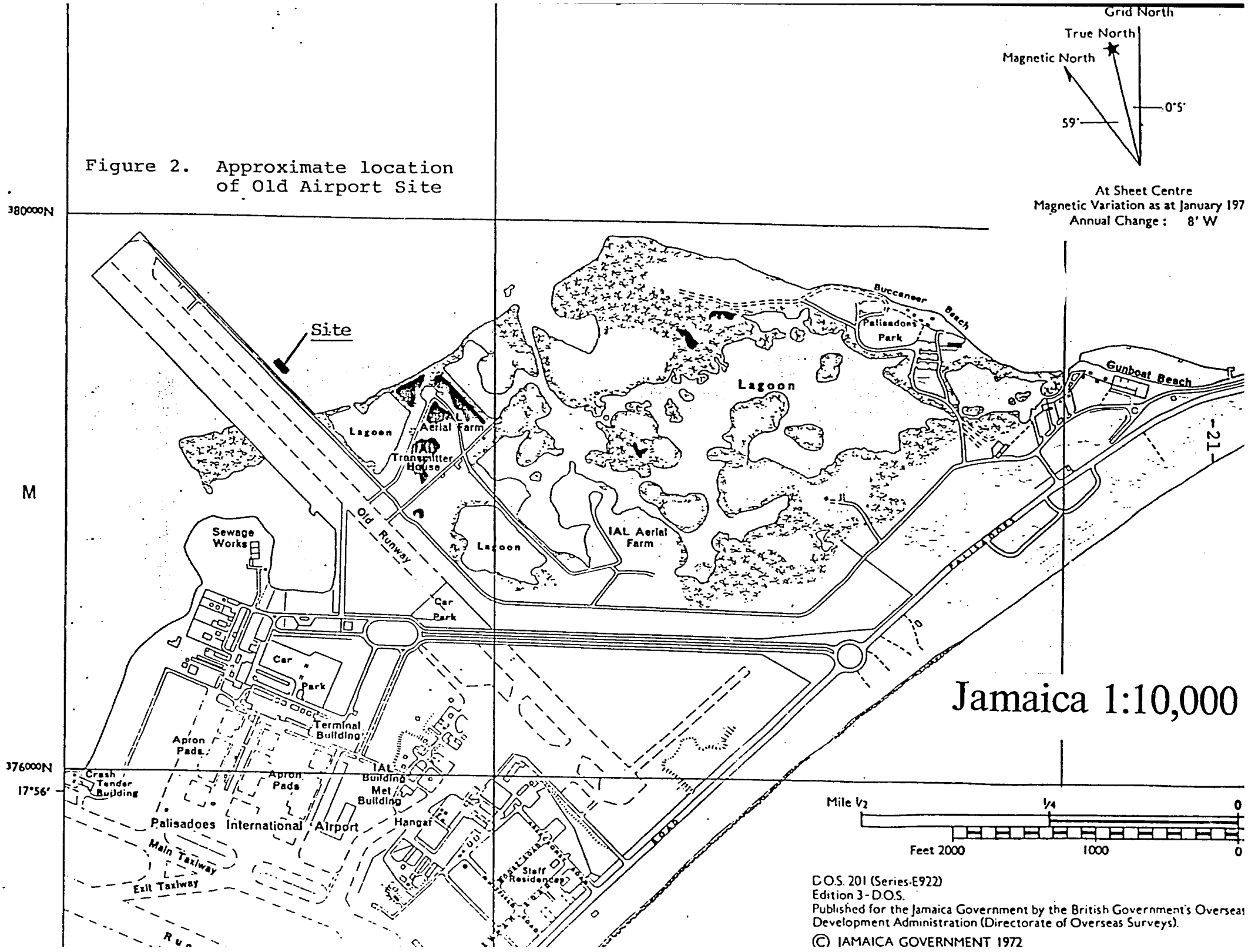
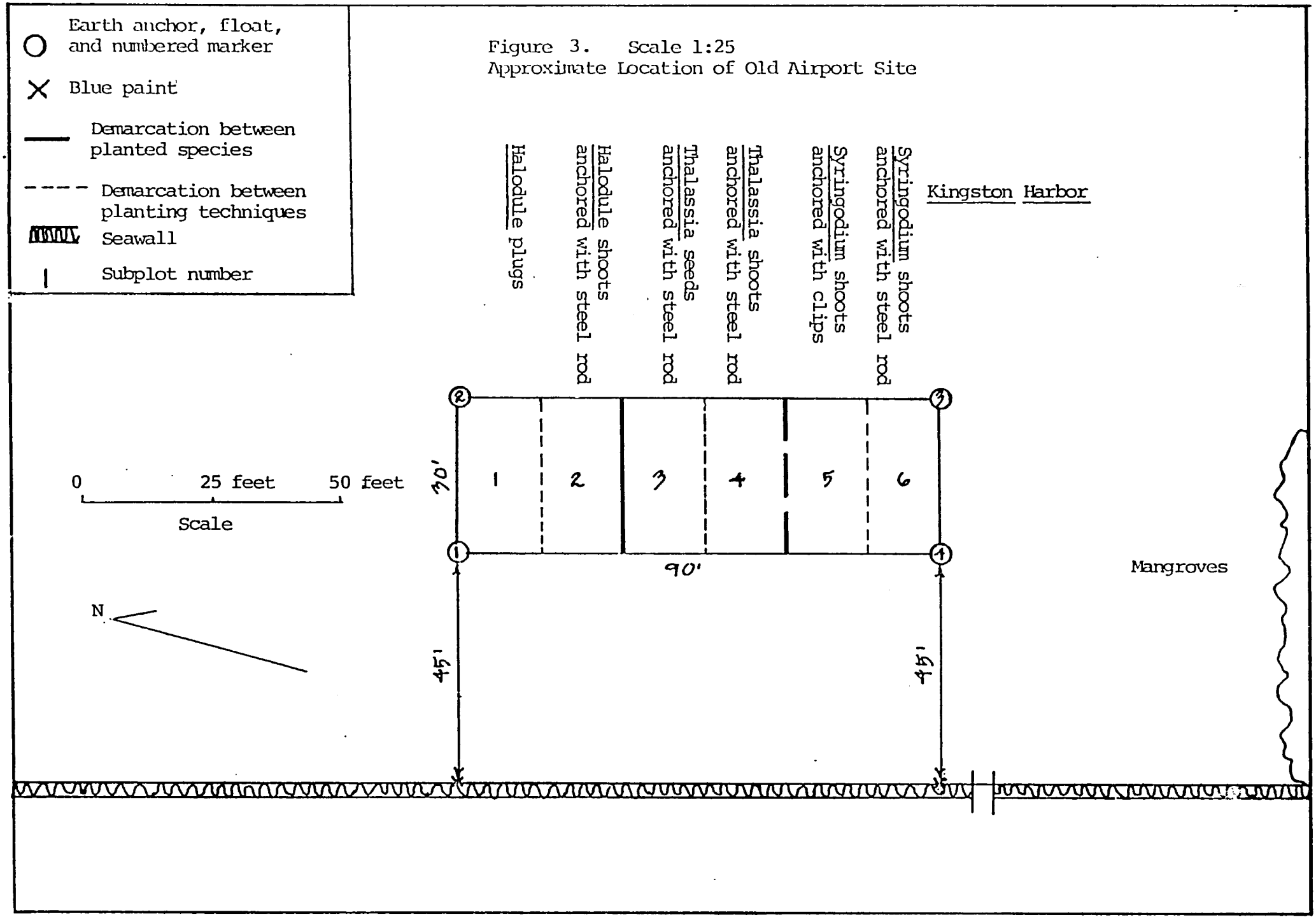


Figure 3. Scale 1:25
Approximate Location of Old Airport Site



2. Cement Factory Site

The shoreline on the city side of Kingston Harbor has undergone a series of modifications: dredging, filling, bulkheading and shoreline expansion. In 1961 the cement company filled with waste material from the plant a section of the shoreline near the southeast corner of Kingston Harbor seaward. Permission was given for expansion 400 feet to seaward from the original shoreline. Previously,in 1949 a lease of the government owned lands at _____was made between the Colonial Secretary and the Caribbean Cement Company. The conditions of the lease included filling in the shoal water in front of the mineral bath and commencement of construction.

The shoreline at the cement plant now extends out hundreds of feet from the adjacent shoreline and the sublittoral area is completely devoid of seagrasses. It is an area with steep slopes into deep water. There is some metal waste debris near the shoreline in the water and upon the embankment. Other impacts include runoff from unconsolidated piles of cement material during rains and winds and the resuspension of sediment particles caused by storms and ship traffic. This part of the harbor also recieves effluents from activities along the urbanized coastline.

The environmental parameters have not been measured at this site, but those quoted in several studies for the "Inner Harbor" are similar to those discussed for the Old Airport Site and seen in Tables 1.,2.,3. and 4.

a. Location

The cement factory site is located at the eastern end of Kingston Harbor approximately 1 mile northwest of Harbour Head (Figure 4.). The submerged area is completely barren due to filling with cement by-product material.

The site is located 8' seaward and parallel to the dirt embankment at the water's edge. The site is directly below the northernmost holding tank situated on the hillside above the site.

b. Characteristics of the Site

The site, as seen in Figure 5., is 90'x 30'; the long dimension was divided into 15' lengths to make six subplots 15'x 30'. The sediment is fine silt 2"- 5" deep which covers clay cement by-product. The fine silt is easily disturbed and visibility was often reduced to zero. The mean low water depth of the northeastern side of the site is approximately 0.5'. The depth increases sharply toward the southwestern side of the site to a mean low water depth of approximately 12'. No appreciable current was noted.

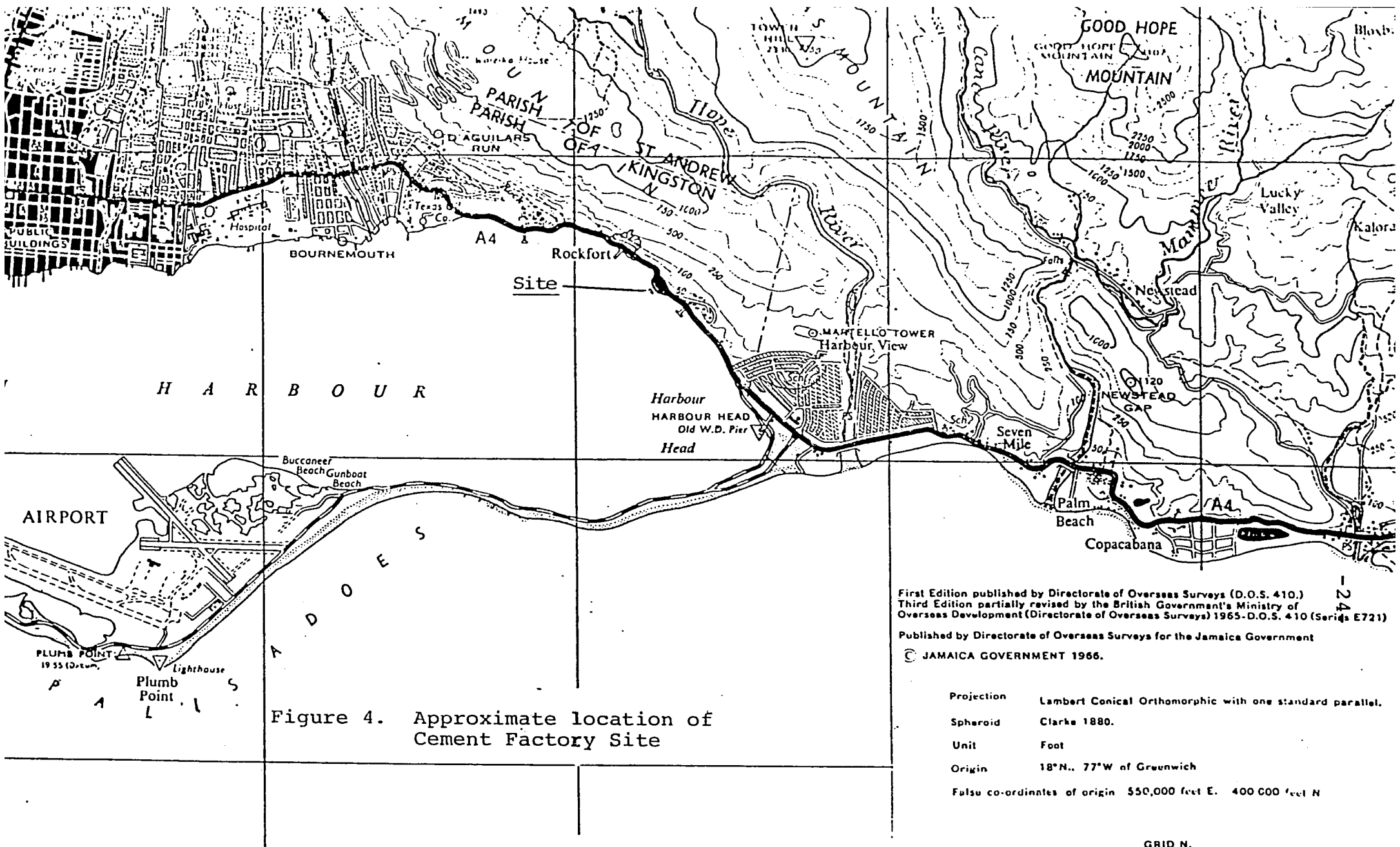
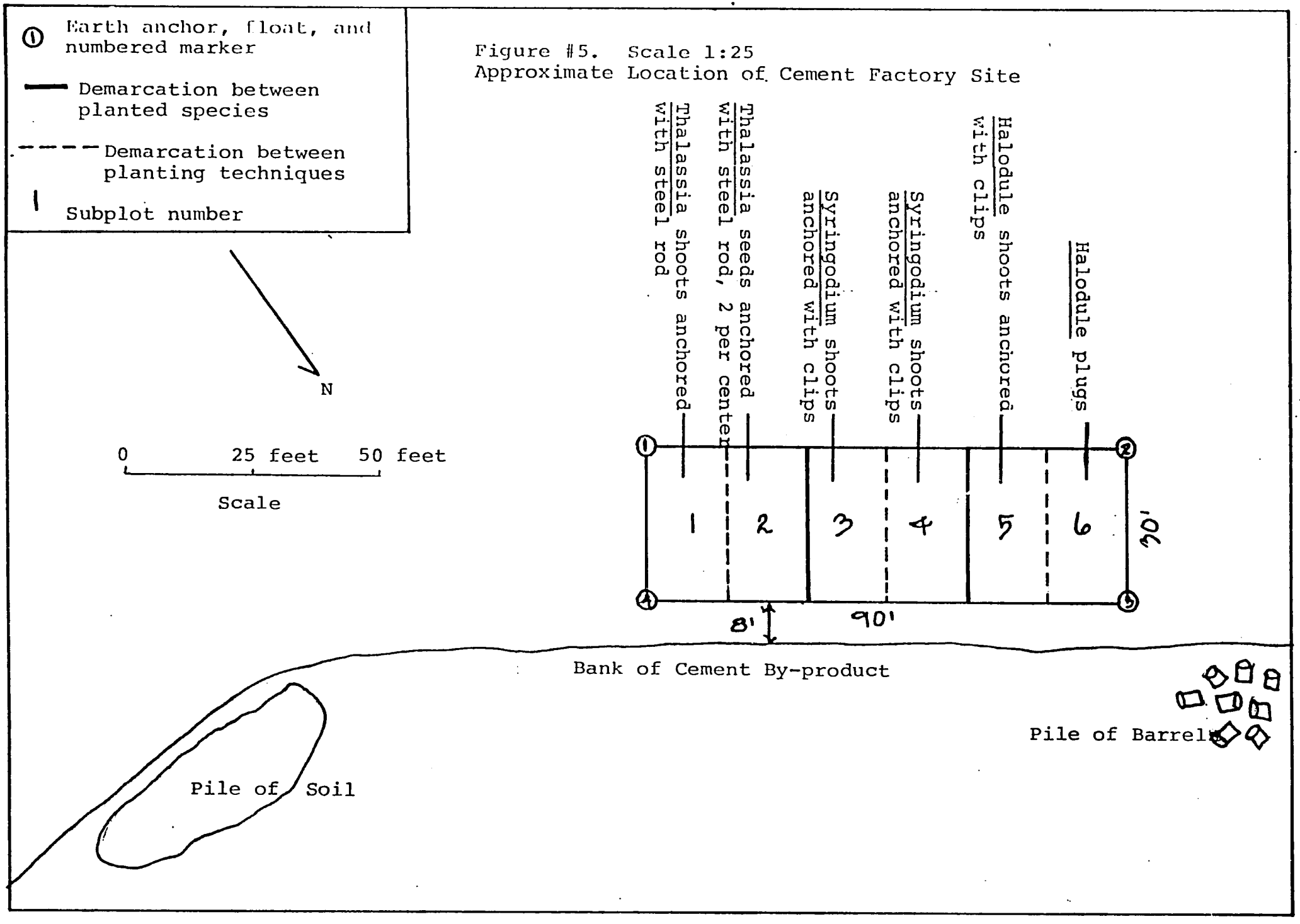


Figure 4. Approximate location of Cement Factory Site

Figure #5. Scale 1:25
Approximate Location of Cement Factory Site



c. Planting

On November 19, 1982 the site was planted by a team of diver biologists from the NPCD, UWI, FIU and an unemployed fisherman. Figure 5. shows the experimental design in which the three species of seagrasses were planted.

Thalassia shoots 5" in length were anchored with 3" V-shaped pins and planted in subplot #CF.1; Thalassia seeds anchored with 6" lengths of ¼" steel rod were planted in subplot #CF.2. Syringodium shoots 6" in length were anchored with pins and planted in subplots #CF.3 and #CF.4. Halodule shoots anchored with pins were planted in subplot #CF.5; Halodule plugs 4"- 6" in diameter were planted in subplot #CF.6. All the subplots were planted in a 3'x 3' matrix and contain 50 planting units each.

The Thalassia and Halodule specimens for planting were collected near the Old Airport Site and the Syringodium specimens were collected near Hellshire Bay. No Syringodium could be located in the immediate vicinity.

3. Gallows Point (Ft. Augusta Causeway)

The area sublittoral to the Causeway was a productive fisheries nursery with large seagrass beds prior to the construction of the Causeway by dredge and fill across the area. During this process, by direct fill and adjacent smothering by drifting sediments, large meadows of seagrass were removed or died leaving large barren areas. In some areas successional seagrasses have begun to grow. Some fishing has begun again in the area.

Further indirect impacts to the site come from the effluents draining into Kingston Harbor (listed under the Old Airport Site description) and from pollution in Hunts Bay which affects the area during outgoing tides with sewage and turbid water.

The area has a medium wave energy regime. A long fetch to the dominant south and southeast winds makes wave energy high on occasion. Sediment particles are of medium size. Tidal currents can be swift on high tides. Water from the open ocean is of good quality which affects the area on incoming tides.

a. Location

The Fort Augusta site is located on the southeast side of a causeway on the western shoreline of Kingston Harbor. The causeway separates Hunts Bay from Kingston Harbor. The site is approximately 0.25 mile north of Fort Augusta (Figure 6.). The submerged area is largely barren due to dredge and fill from the causeway construction as well as many types of pollution from the harbor, river and urban runoff.

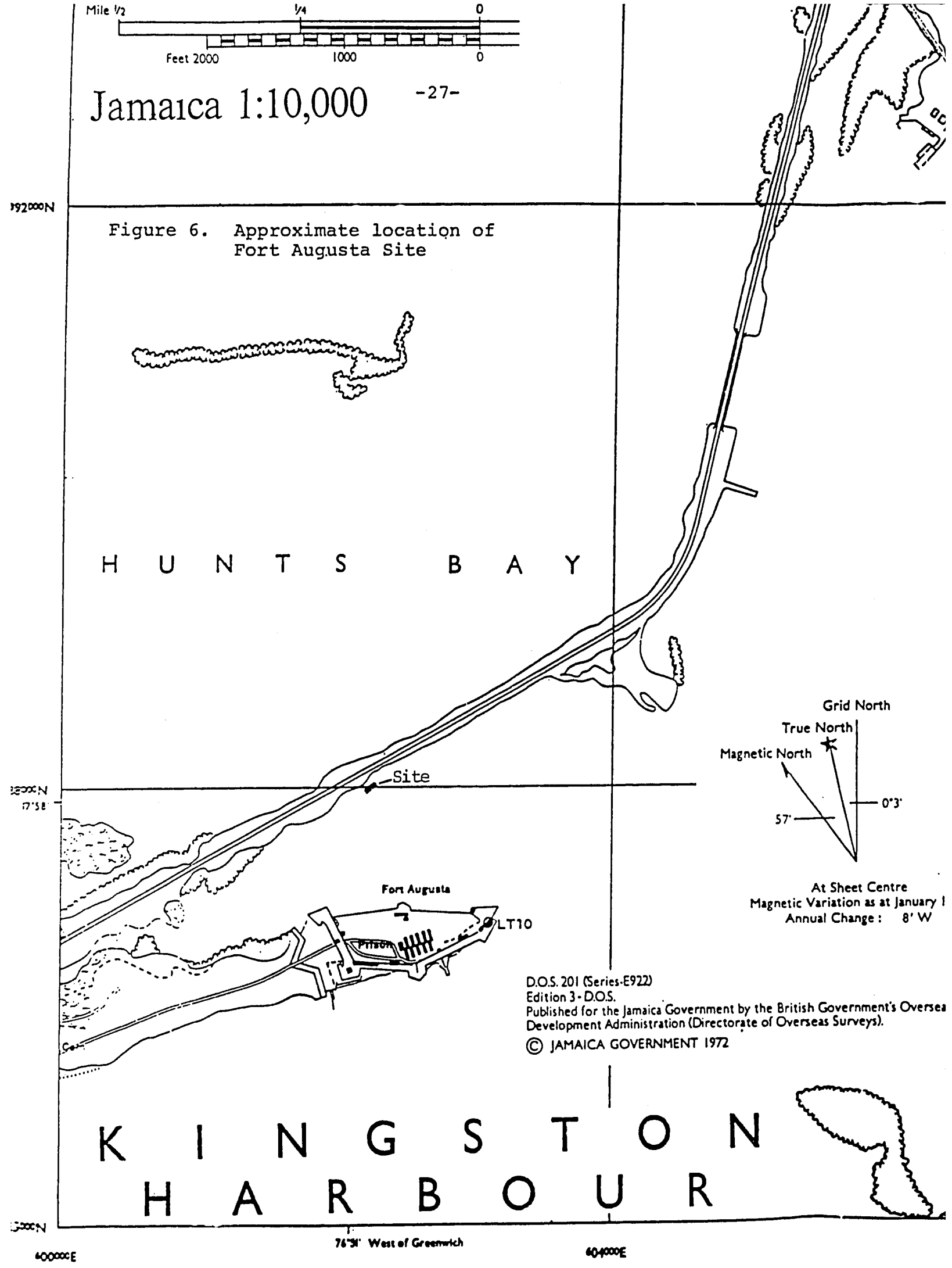


Figure 6. Approximate location of Fort Augusta Site

a. Location, continued.

The exact site is located 119.5' seaward of a large pipe 2' in diameter lying along the shore of the causeway (see Figure 7.).

b. Characteristics of the Site

The site as seen in Figure 7. is "L" shaped. The long dimension is 60' and the short dimension is 30'. The site is divided into 15'x 30' subplots. The depth of the mean low water is approximately 4 feet. The sediment is composed primarily of sand and fine organic material and is greater than 1.7' deep. A naturally occurring bed of Halodule 10'x 11' is in subplot #FA.1.

c. Planting

On November 18, 1982 the site was planted by a team of diver biologists from the NRCD, UWI, FIU and an unemployed fisherman, Oswald Creary. Figure 7. shows the experimental design in which the three species of seagrasses were planted. Thalassia shoots 5" in length were anchored with 6" sections of ¼" steel rod and planted in subplot #FA.1; Thalassia seeds were also anchored with the steel rod and planted in subplot #FA.2. Halodule shoots 4"- 6" long anchored with the steel rod were planted in subplot #FA.3; Halodule plugs 5"- 6" in diameter were planted in subplot #FA.4. Syringodium shoots 4"-6" long were anchored with the steel rod and planted in subplot #FA.5; Syringodium shoots 4"- 6" long were anchored with 3" V-shaped pins and planted in subplot #FA.6. All the subplots were planted in 3'x 3' matrix and contain 50 planting units each.

The Halodule plugs and shoots were collected from beds adjacent to the site and the Thalassia and Syringodium material was collected near Hellshire Point. No Thalassia or Syringodium could be found near the site.

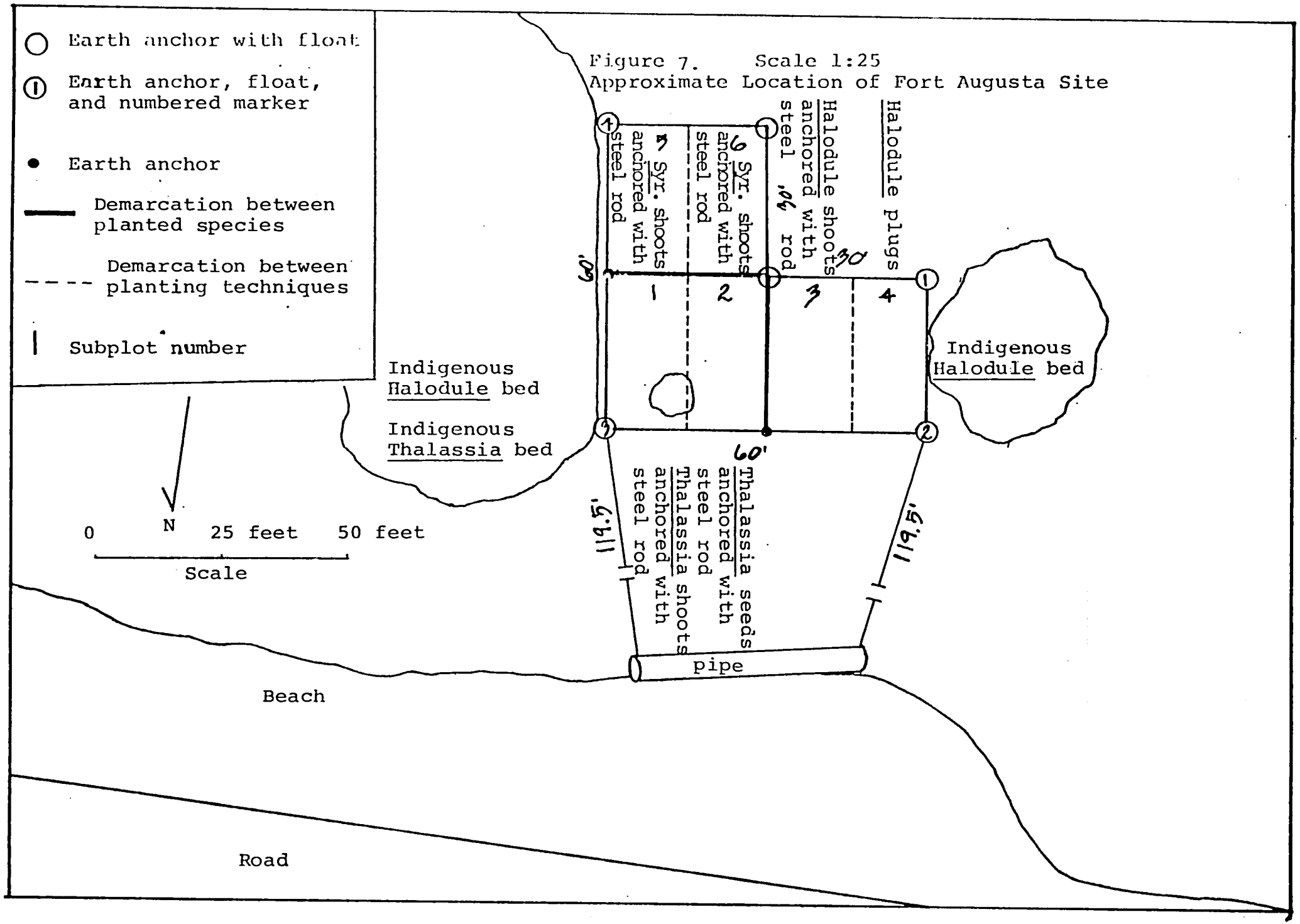


Figure 7. Scale 1:25
Approximate Location of Fort Augusta Site

4. Hellshire Beach Site

The Hellshire Beach Site is located on the outer side of Kingston Harbor opposite the Port Royal Harbor mouth (see Figure 8.). The area is quite exposed to open ocean wave energy and sea winds.

Man's effects are subtle here compared to other sites of industrial impact, nevertheless definite impact is occurring. Beach erosion and beach loss is rapidly occurring which is presently attributed to the removal of vegetation covering the dunes around the headlands. Vegetation removal has exposed the sand to direct wind action which blows the sand inland. A second factor is removal of seagrass beds by fishermen and bathers in an effort to use the beach as a recreational area. Increased transport of sediment particles when the binding seagrasses were removed continued the process of sand removal. Severe seagrass bed erosion is apparent in several areas.

Environmental conditions include general southeast to east winds with north winds during the winter months. Waves are 3 - 5 feet prior to shoaling with wave heights approaching 5 feet. Wave lengths are 30 - 40 feet. Shore formation and offshore sand bars tend to concentrate the wave energy in this area. The shallows near the shore are surrounded by a fringing reef. Thus, wave energy is dissipated somewhat by the reef and grass-beds before reaching the shore. Current velocities are generally 0.7 knots and rarely exceed 1.0 knot.

The sediment is medium coarse white sand in the barren areas. The beach slope is approximately 1:20. Dune widths are in excess of 10 feet.

Water chemistry conditions are generally oceanic with high water clarity, good oxygenation and general oceanic quality of other elements.

a. Location

The Hellshire Beach Sites are located on the southeast end of Hellshire Bay approximately 500' from the point of land separating Hellshire and Half Moon Bays (Figure 8.). Site A is parallel to the beach and 10' south of a beach house standing 20' into the water from the beach. Site B is parallel to the beach and 170' seaward from the beach house.

b. Characteristics of the Site

The sites seen in Figure 9. are 90'x 15'. They are divided into 15'x 15' subplots. Prevailing winds and long fetch make this a high energy site. Depth of the plot at Site A is 2'.

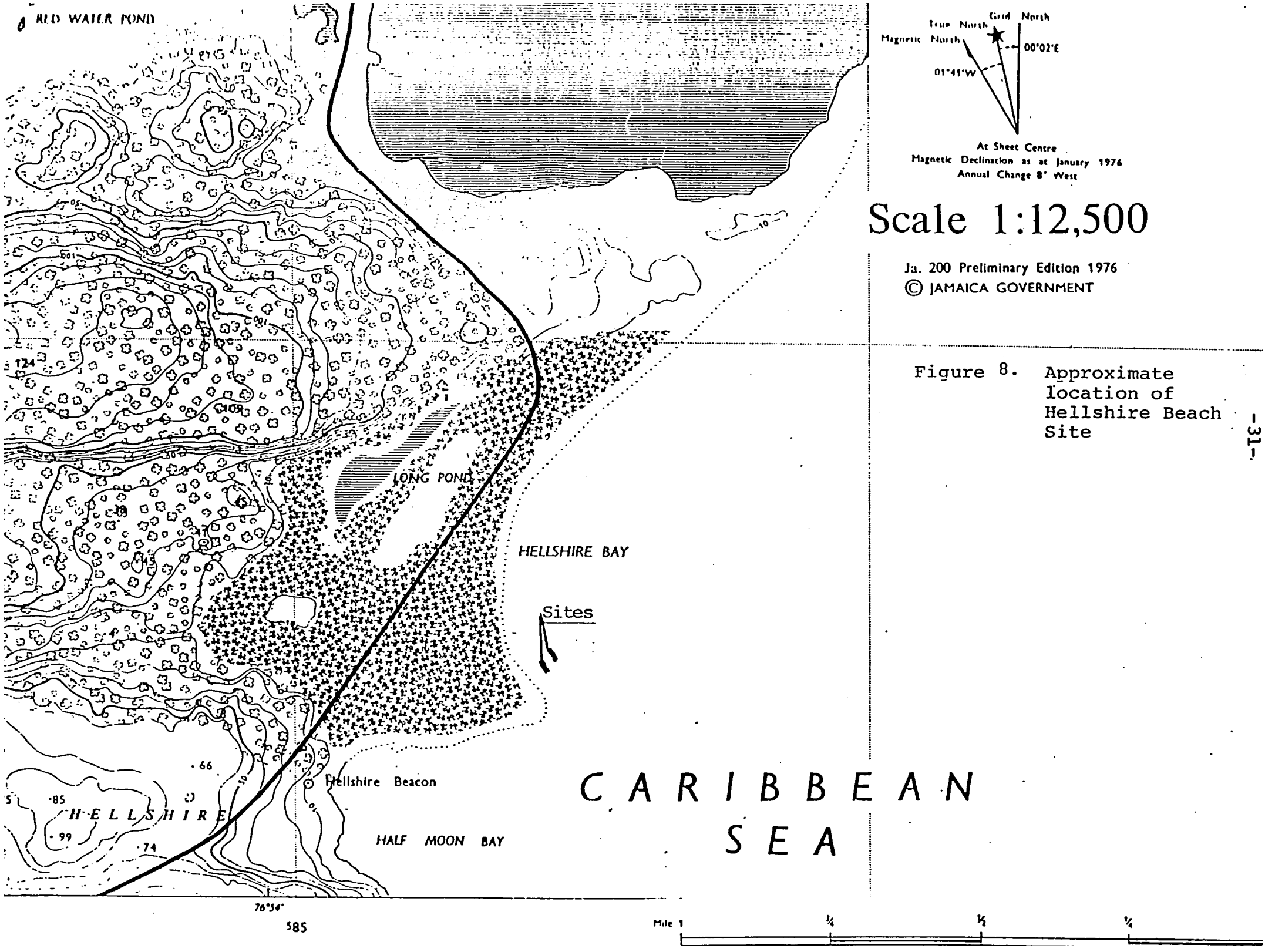


Figure 8. Approximate location of Hellshire Beach Site

Figure 9. Scale 1:25
Approximate Location of Hellshire Beach Site

b. Characteristics of Site, continued.

The depth at Site B is 5' mean low water. The sediment of coarse and medium sand is greater than 1.7' deep.

c. Planting

On November 16 and 17, 1982 the sites were planted by a team of diver biologists from the NRCD, UWI and FIU. Figure shows the experimental design in which the three species of seagrasses were planted. All the seagrasses were anchored with 6" sections of ¼" steel bar except the plugs. All the shoot material was 4" - 6" at the time of planting. Thalassia shoots were planted in subplots #HB.1A and #HB.1B; Thalassia seeds were planted in subplots #HB.2A and #HB.2B. Syringodium shoots were planted in subplots #HB.3A, #HB.3B and #HB.4A; Syringodium plugs were planted in subplot #HB.4B. Halodule shoots were planted in subplots #HB.5A, #HB.5B and #HB.6A; Halodule plugs were planted in subplot #HB.6B. All the planting units were planted in a 3'x 3' matrix and each subplot contains 25 planting units each.

All the planting material was obtained from seagrass beds adjacent to the site.

5. Old Harbor Power Plant Site

Impacts at this site are chronic and acute incidents of thermal effluents from the power plant that flow in the long-shore currents across extensive seagrass meadows. The effect of the heated effluents from the power plant on the seagrass beds depends on a series of factors including the number of generators on-line in the plant, the amount of coolant pumped through the plant, winds, tides, currents and ambient temperatures. Acute incidents have evidently occurred during the operation of the plant in the past when excess heat was dumped during high summer temperatures. Additional impact comes from the cleaning and anti-fouling chemicals in the coolant plus the normal load of trace metals from the piping in the plant. The initial impact was made during construction of the plant complex as well as the impact from construction and dredging of the Port Esquivel complex. (These indirect effects are still being researched.)

The environmental parameters at the Old Harbor Site have not been so well documented as the Kingston Harbor sites. Long-shore currents appear directly westward of the power plant where the effluent is released. A tidal wedge occurs under the long-shore currents induced in part by the power plant effluent resulting in a shallow themocline along the shoreline several hundred feet seaward. The chemistry of the water has not yet been examined.

The existing vegetation is in almost classic thermal plume alignment. A large barren area of sand exists several thousand feet seaward from the thermal effluent. The next zone is patchy Halodule in a tongue shape along shore. The third zone is medium density Halodule. Zone four is patchy Thalassia in Halodule beds; zone five is almost pure Thalassia; and zone six is mixed Syringodium and Thalassia. This zonation is caused by the thermal plume and the thermal tolerances of the seagrass species: as the heated water cools as it flows away from its source, the more heat tolerant successional species grades into the less heat tolerant climax species. The zones look like widening arcs radiating from the core plume.

a. Location

The Power Plant Site is located offshore from a stand of red mangroves approximately 1000' west of the cooling canal of Jamaica Public Service Company Power Station at Old Harbour Bay (see Figure 10). The submerged area is located in the thermal plume core and is largely barren.

The site is exactly located off the center of the stand of red mangroves 119' from and parallel to the shore. An opening in the mangrove stand is approximately even with the eastern edge of the site.

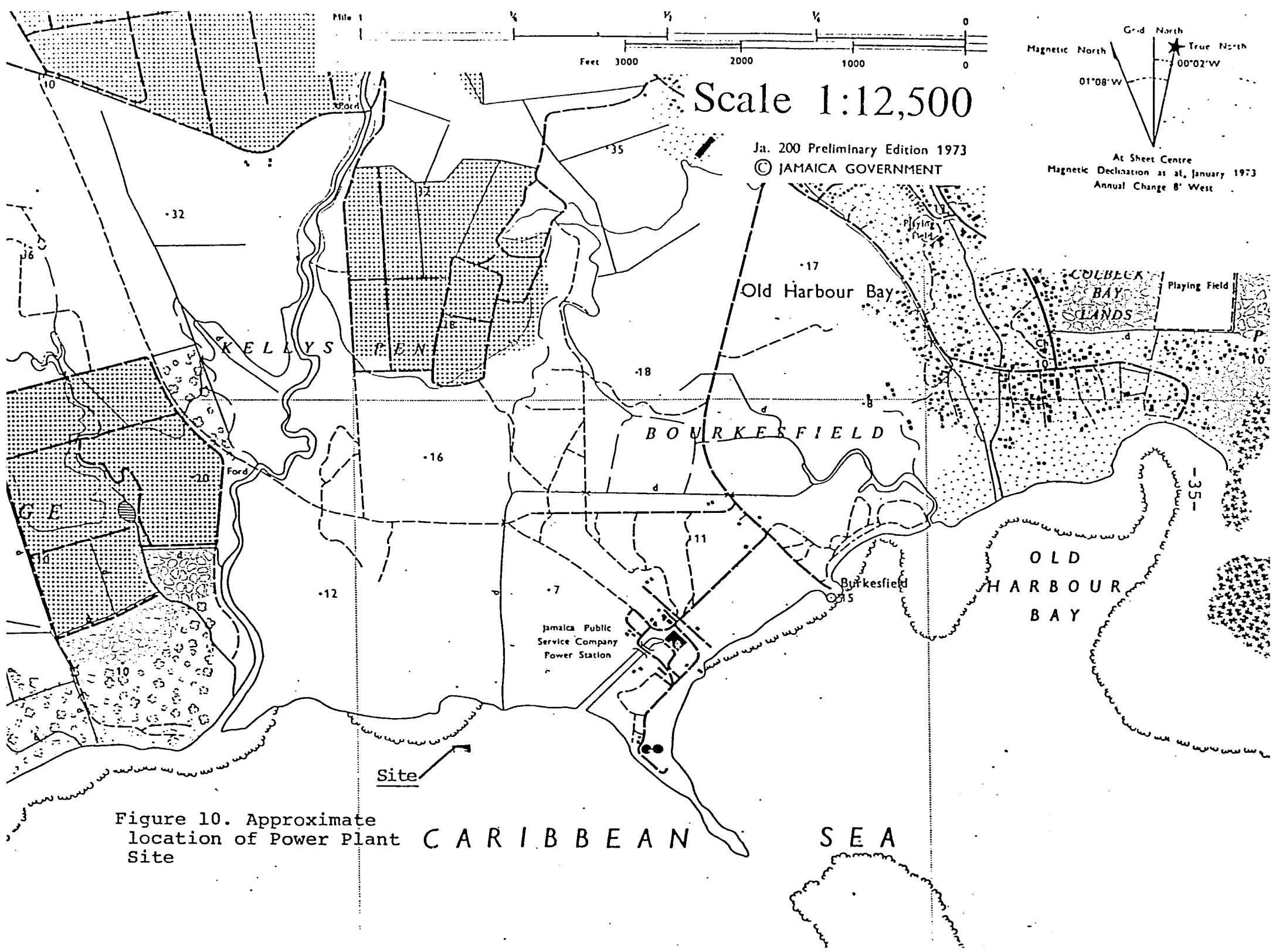


Figure 10. Approximate location of Power Plant Site

b. Characteristics of the Site

The site as seen in Figure 11. is 90'x 30'; the long dimension was divided into 15' sections to make 6 subplots 15'x 30'. The depth of the mean low water is approximately 2.5'. The sediment consists of 1" deep compacted sand and mud overlying soft sand and mud extending more than 1.7' deep. Some patchy naturally occurring Halodule exists in subplots #PP.3 and #PP.4. Visibility was 2' - 3' and a slow westerly current was noted.

c. Planting

On November 24, 1982 this site was planted by a team of diver biologists from the NRCD and FIU. Figure 11. shows the experimental design in which the three species of seagrass were planted. 3" V-shaped clips were used to anchor the shoots, and 6" segments of ¼" steel rod were used to anchor the Thalassia seeds. Halodule plugs were planted in subplot #PP.1; Halodule shoots were planted in subplot #PP.2. Syringodium shoots were planted in subplots #PP.3 and #PP.4. Thalassia seeds were planted in subplot #PP.5; Thalassia shoots were planted in subplot #PP.6. All planting units wer installed on a 3'x 3' matrix and each subplot contains 50 planting units each.

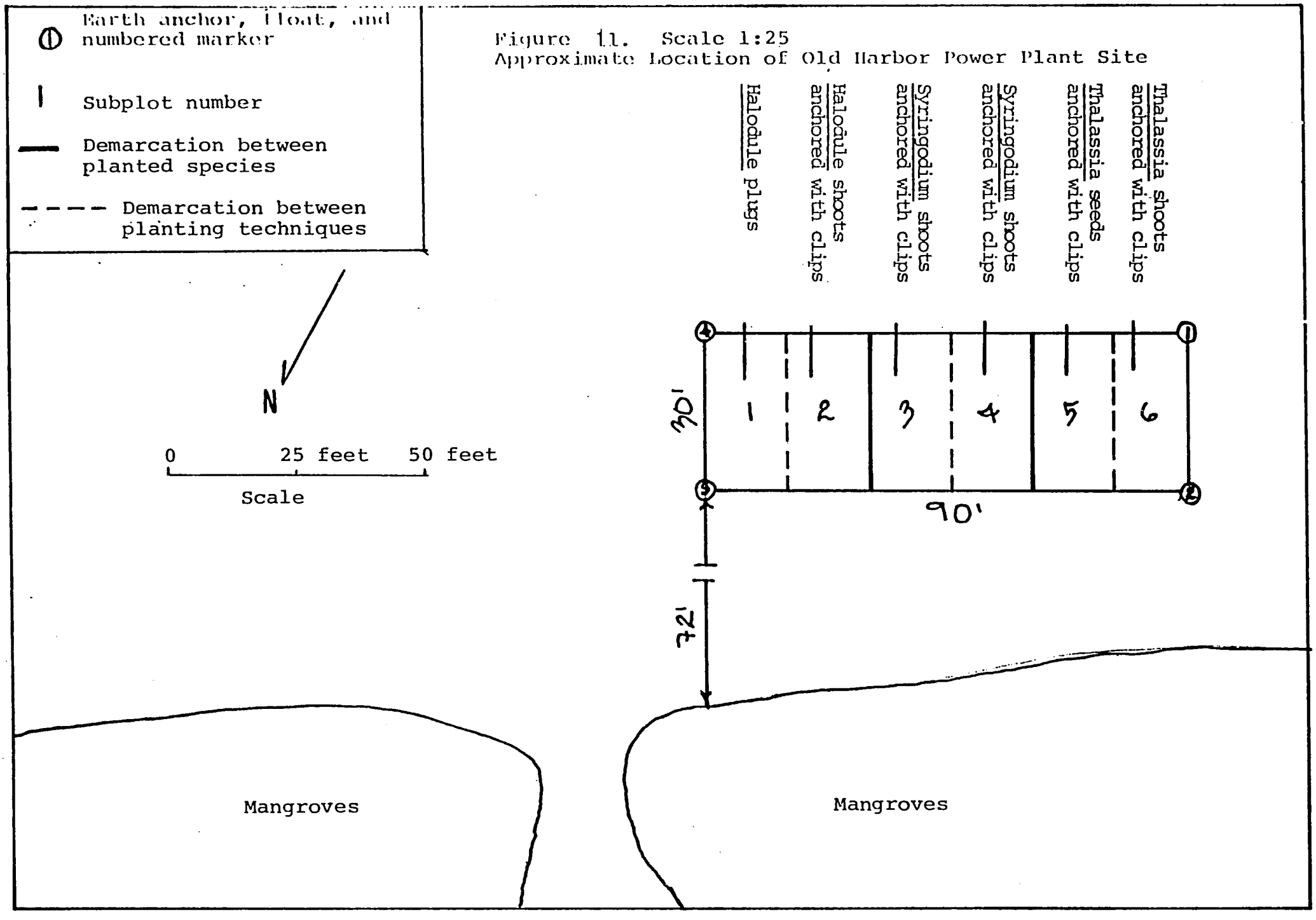
The Halodule plugs were taken from an adjacent bed, but all other specimens were collected near Hellshire Bay. No Thalassia or Syringodium could be located in an accessible bed near the site.

6. Port Esquivel Site (Alcan)

Alcan Alumina Ltd. of Canada and its subsidiary Alumina Jamaica Ltd. (merged to become Alcan Jamaica Ltd.) built the Port Esquivel complex in 19__. A dredged and filled spit of land was constructed to the west of the complex to inhibit the nearby river discharge from affecting their ship channel. A large loading pier was constucted at the complex and a barge channel was dredged to allow access. The site of the complex was raised in elevation before constuction. The waters surrounding this complex have been impacted by all these activities. In addition, indirect impacts to the area likely come from oil bilging by the ships and spills of ore during loading operations.

The environmental parameters have not been well documented in this harbor. Water chemistry conditions are generally oceanic with good water clarity, oxygenation and concentrations of elements are normal. The site is exposed to a long fetch and high wave conditions are common.

Figure 11. Scale 1:25
Approximate Location of Old Harbor Power Plant Site



a. Location

The Port Esquivel Site is located offshore from a point on the beach approximately 2,000' southwest of the Alcan plant (see Figure 12.). The site is 117' seaward of the mean high water line on shore. Two wooden stakes 50' above the water line lie directly in front of the site. Photographs of the site showing channel marker orientation also help locate the site. The southern edge of the site is even with the southern edge of the ship channel leading to Port Esquivel.

b. Characteristics of the Site

The site as seen Figure 13. is 90'x 30'; the long dimension was divided into 15' sections to make six subplots 15'x 30'. The long dimension of the site (90') lies parallel to the shore. The site slopes to seaward: the shoreline side is 6' deep mean low water and the seaward side is 8' deep mean low water. The sediment is composed of sand and fine mud and is 1.5' deep. A small number of Thalassia apical meristems poke into subplots #PE.1 and #PE.6. A large amount of the algae Gracilaria and Laurencia were found throughout the site. Visibility was approximately 8' and a slight southwestery long-shore current was noted.

c. Planting

On November 23, 1982 the site was planted by a team of diver biologists from the NRCD, FIU and an unemployed fisherman, Rennie Williams. Figure 13. shows the experimental design in which the three species of seagrass were planted. 3" V-shaped clips were used to anchor the shoots and 6" segments of ¼" steel rod was used to anchor the Thalassia seeds. Thalassia shoots were planted in subplot #PE.1; Thalassia seeds were planted in subplot #PE.2. Syringodium shoots were planted in subplots #PE.3 and #PE.4. Halodule shoots were planted in subplot #PE.5; Halodule plugs were planted in subplot #PE.6. All planting units were installed in a 3'x 3' matrix. Each subplot contains 50 planting units each.

7. Rocky Point Lagoon

The road and railroad to the Rocky Point industrial site has created an artificial lagoon (see Figure 14.), which evidently was once shallow tidal flats between mangrove islets. Beyond the dredged construction of the fill for the Rocky Point complex, a series of runoffs, oil spill accidents and effluents from the plant have drained into the lagoon. The NRCD has documented fuel oil slicks on the lagoon surface.

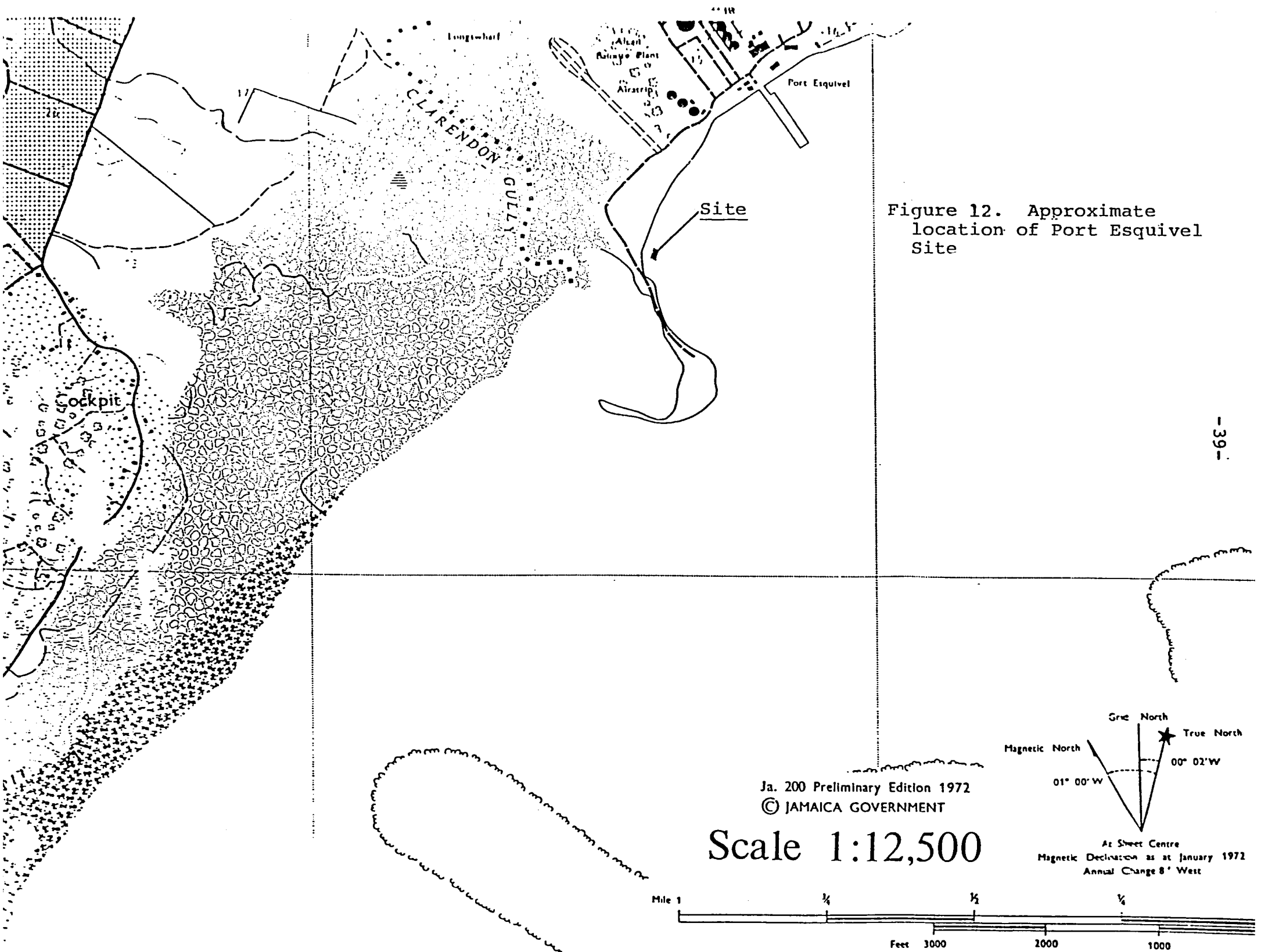
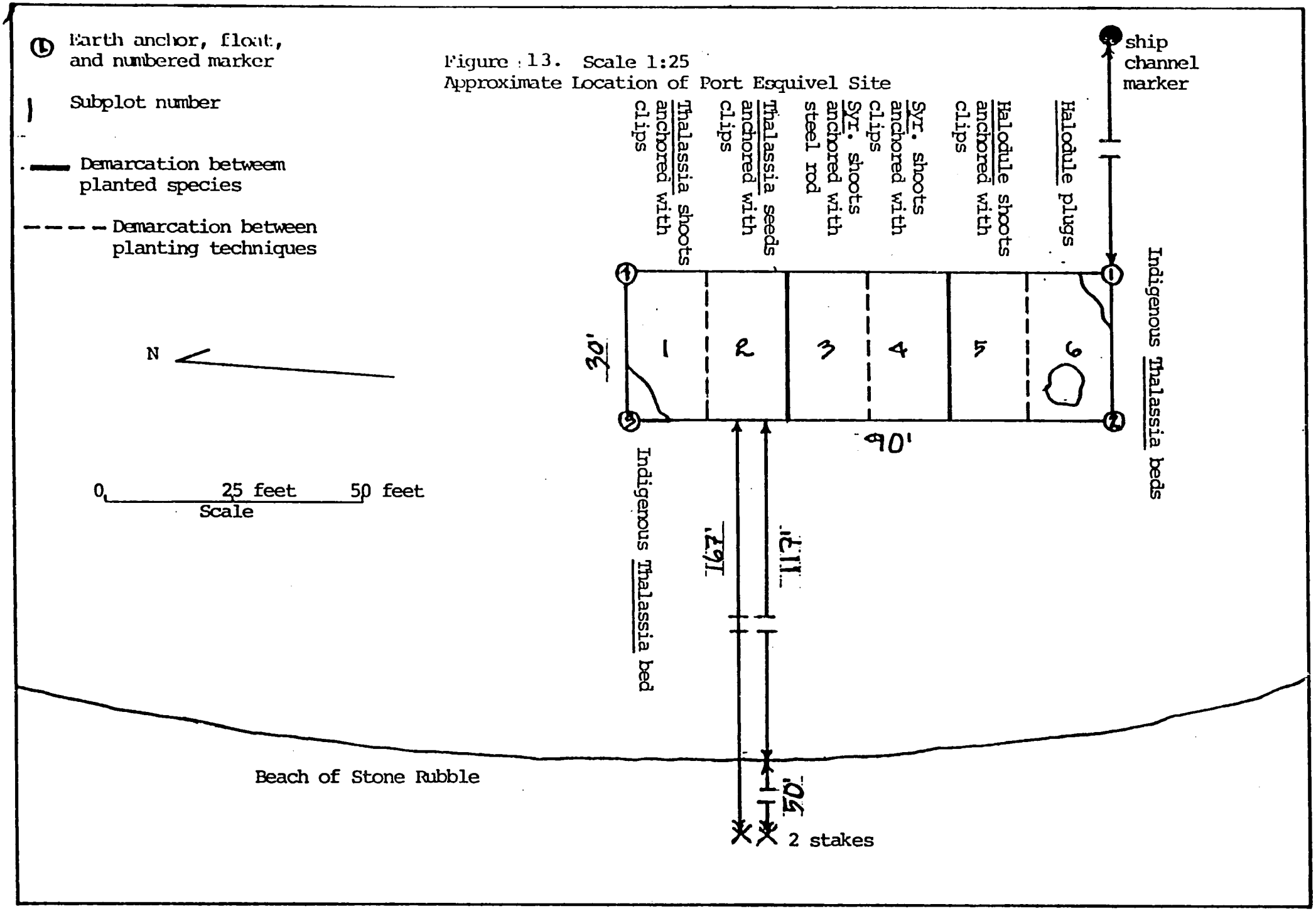


Figure 12. Approximate location of Port Esquivel Site

Figure 13. Scale 1:25
Approximate Location of Port Esquivel Site



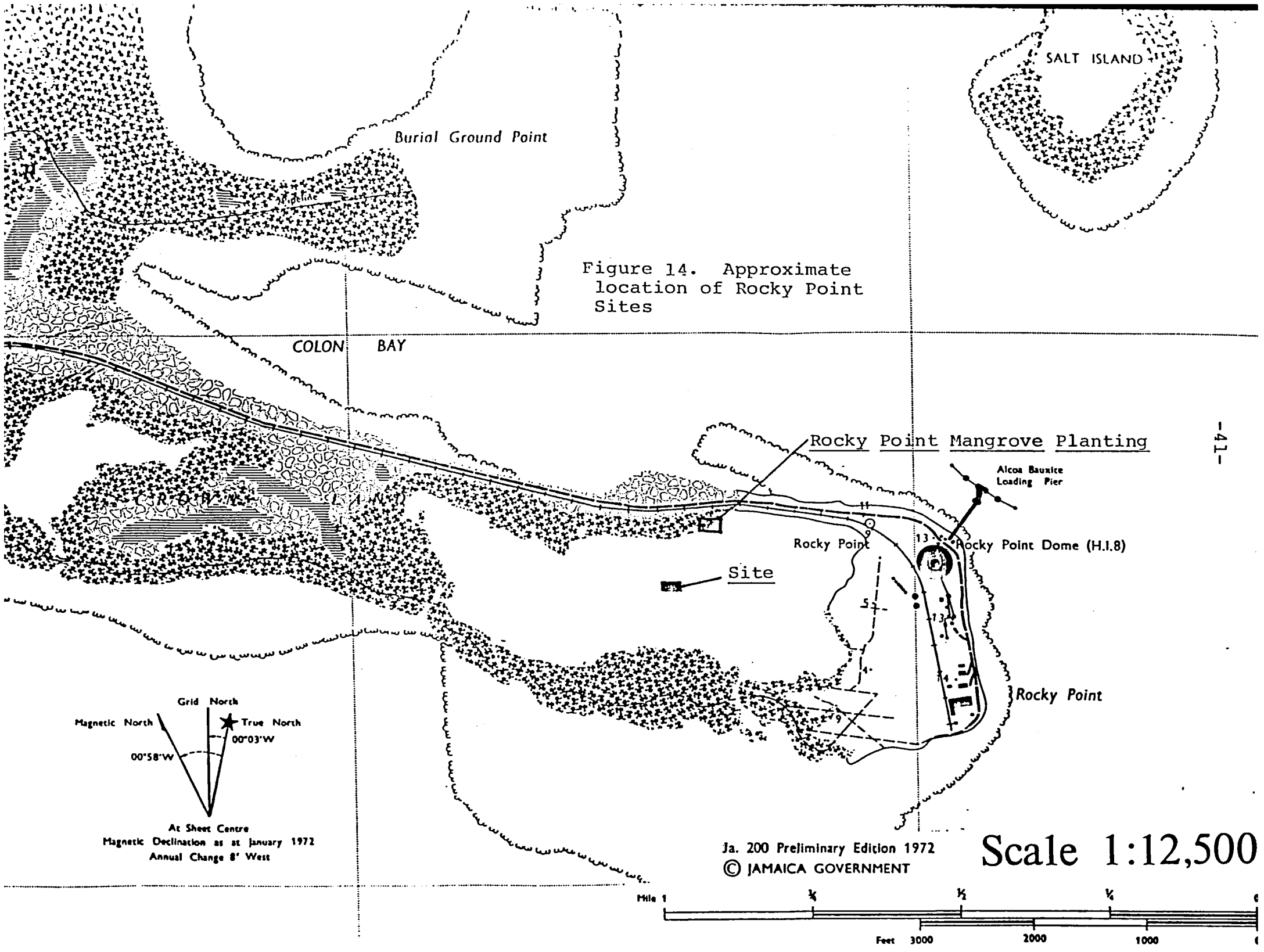


Figure 14. Approximate location of Rocky Point Sites

The lagoon is sheltered on all sides by mangrove islets and is quite calm. The tidal exhange occurs through one outlet to Old Harbor/Portland Bight. The water chemistry parameters have not yet been measured there.

a. Location

The Rocky Point Site is in a lagoon west of the Alcoa Bauxite loading pier at Rocky Point (see Figure 14.). The site is approximately 500' from the railway track servicing the pier and the eastern end of the site is even with the first telephone pole west of the entrance guard station.

b. Characteristics of the Site

As seen in Figure 15., the site is 90'x 30'; the long dimension was divided into 15' sections to make six subplots 15'x 30'. The depth of the site ranges from 1' mean low water at the eastern end to 2' mean low water at the western end. The site is oriented paralllel to the railway tracks. The sediment of fine sand and clay extending more 1.7' deep is covered by a ½" layer of dark black clay and a hard crust 1/8" thick (see accompanying photograph). The black layer about 1/16" thick in the top ½" is suspected to be oil. Sediment testing is planned. Naturally occuring Ruppia exists in subplots #RP.2 - #RP.6. Visibility was 4' - 6' but reduced to zero upon disturbance. No current was noted.

c. Planting

On November 23, 1982 the site was planted by a team of biologists from the NRCD and FIU. Figure 15. shows the experimental design in which the three species of seagrass were planted. The shoots were anchored with 3" V-shaped clips and the Thalassia seeds were anchored with 6" segments of ¼" steel rod. Halodule plugs were planted in subplot #RP.1; Halodule shoots were planted in subplot #RP.2. Syringodium shoots were planted in subplot #RP.3 and #RP.4. Thalassia shoots were planted in subplot #RP.5; Thalassia seeds were planted in subplot #RP.6. All the planting units were installed in a 3'x 3' matrix and each subplot contains 50 planted units.

The Halodule was collected near the site and the Thalassia and Syringodium were collected near Hellshire Bay. Those two seagrasses could not be found near the site.

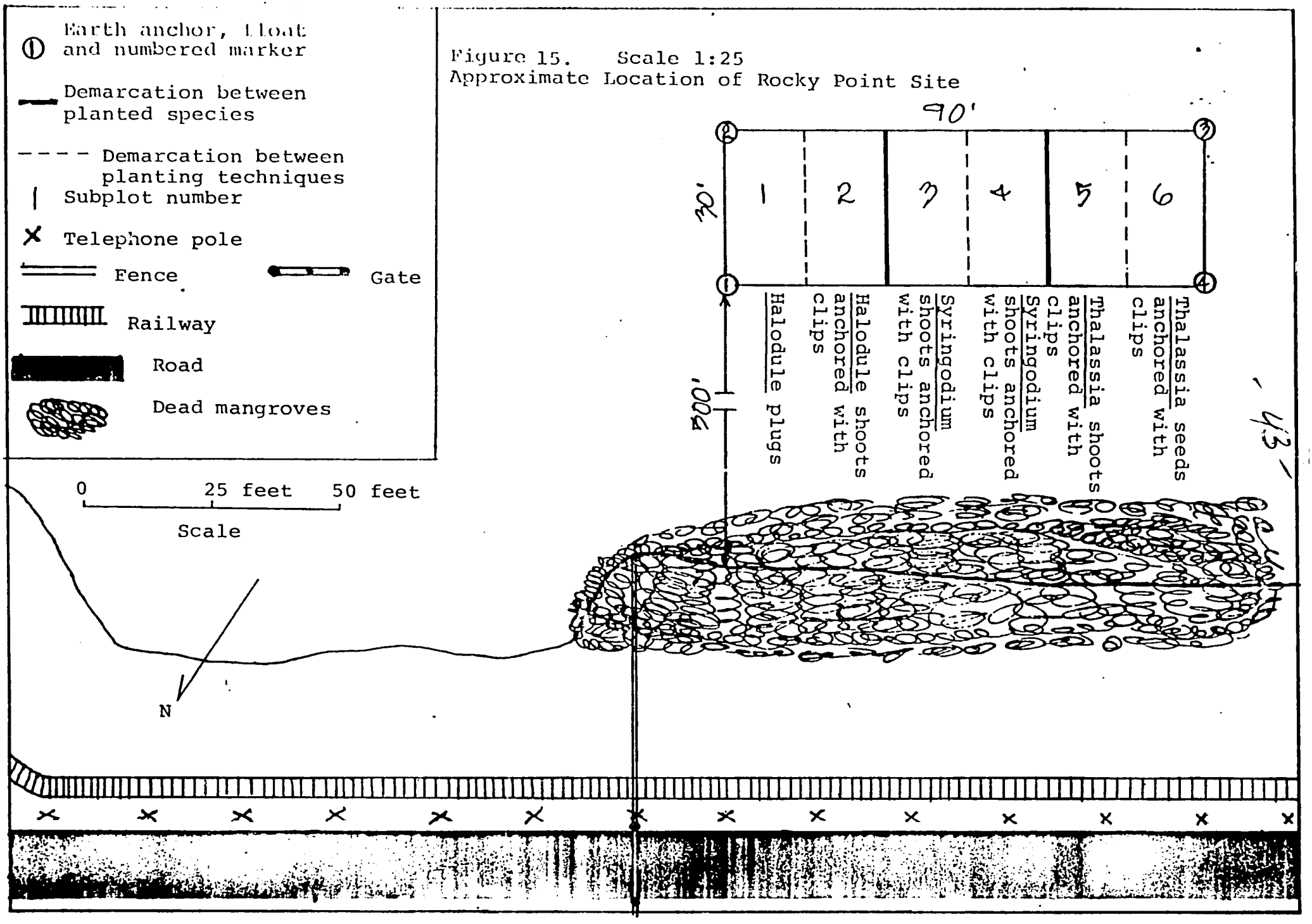


Figure 15. Scale 1:25
Approximate Location of Rocky Point Site

8. Rocky Point Mangrove Planting Site

a. Location

The Rocky Point mangrove planting is located in the lagoon west of the Alcoa Bauxite plant and Rocky Point (see Figure 14.). The lagoon is surrounded by dead mangroves. The planting site is among some of the dead trees immediately west of the fence that marks the entrance to the plant.

b. Characteristics of the Site

The sediment is sand and mud which is more compacted above the mean low water line than below it. Ruppia was found growing below the mean low water line. The sediment is more than 1.7' deep.

The mangroves were planted in three subplots. Subplot #RPm.1 is above the mean low water line and measures 30'x 15'; the long dimension is parallel to the shore. Subplot #RPm.2 is at the water line, parallel to the shore and measures 75'x 15'. Subplot #RPm.3 is below the water line and adjacent to subplot #RPm.2. The short dimension is parallel to the shore and measures 21'x 24'. The rows of trees run parallel to the shore in all three subplots.

c. Planting

On November 24, 1982 the site was planted by a team of biologists from the NRCD and FIU. As seen in Figure 16., the site was divided into three subplots. The mangrove seedlings and propagules were not anchored. 50 black mangrove seedlings (Avicennia nitida) 5" - 12" in height were planted in subplot #RPm.1. The seedlings were planted 10 trees to a row in 5 rows. All the mangrove seedlings were planted in a 3'x 3' matrix. 125 red mangrove seedlings and propagules (Rhizophora mangle) 8" - 18" in height were planted in subplot #RPm.2. The seedlings were planted 25 trees to the row in 5 rows. 56 red mangrove seedlings 18" - 24" in height were planted in subplot #RPm.3. The seedlings were planted 7 trees to the row in 8 rows.

The black mangrove seedlings were collected along the northwestern side of the Fort Augusta Causeway. The red mangrove seedlings were collected from mature stands of red mangroves along the road to Hellshire Bay and from stands of red mangroves near the Power Plant Site.

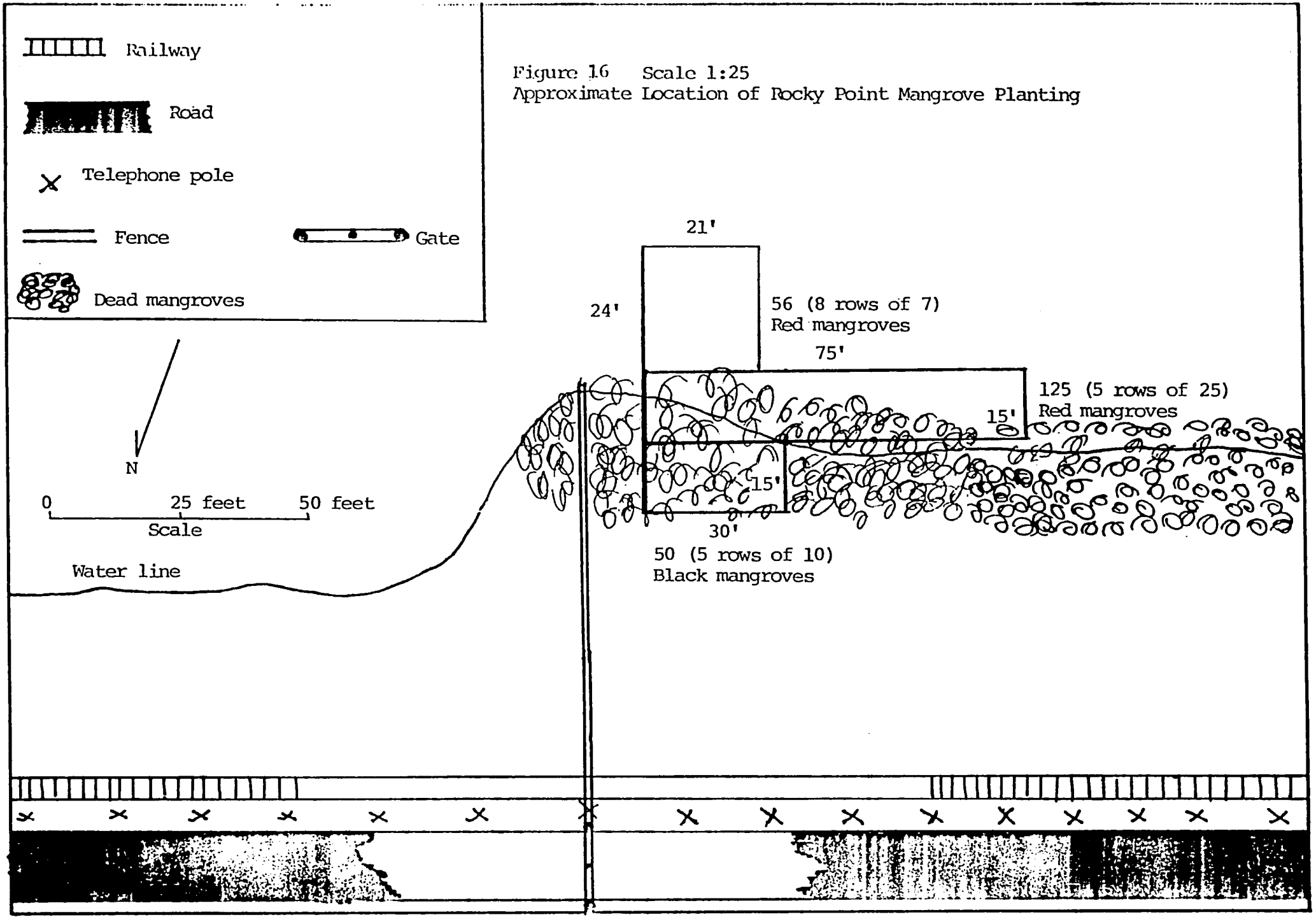


Figure 16 Scale 1:25
Approximate Location of Rocky Point Mangrove Planting

9. Negril Point Site

Aerial photographs from slightly more than a decade ago show a seagrass bed at this point, now barren. The bay bottom is covered with refuse and flocculent material. This debris and apparent current patterns suggest that this may be a point of precipitation for the river. Thus, increased use of the river would increase impact here. The bay bottom and vegetation is very different from the surrounding area.

The site is exposed to the open ocean, but in the lee of the prevailing winds. The water chemistry parameters have not been measured here yet, but would be expected to vary considerably depending on the tide and consequently the river flow. The exact impacts at this site are unknown at this time.

a. Location

The Negril Point Site is located approximately 300' offshore from the second point of land protruding into the sea west of the South Negril River (see Figure 17.). The submerged area is largely barren due, in part, from river sediments smothering the vegetation.

b. Characteristics of the Site

The site as seen in Figure 18. is 90'x 30'; the long dimension was divided into 15' sections to make six subplots 15'x 30'. The depth of the site is 23' mean low water. The sediment is composed of 1.3' of fine mud over a deep layer of sand. Shrimp burrows were noted as well as a light cover of blue green algae and clumps of red algae. The site is exposed to occasional winter storms. Visibility was 20' and no current was noted.

c. Planting

On December 2, 1982 the site was planted by a team of diver biologists from the NRCD, FIU and an unemployed Jamaican fisherman, Stanley Woolery. Figure 18. shows the experimental design in which the three species of seagrasses were planted. 6" sections of ¼" steel rod were used to anchor Thalassia shoots 5" in length planted in subplot #NP.1; Thalassia seeds were anchored with the rod (1 seed per planting unit) and planted in subplot #NP.2. Syringodium shoots 5" in length were anchored with the rod and planted in subplot #NP.3; 3" V-shaped clips were used to anchor Syringodium shoots and planted in subplot #NP.4. Halodule shoots 5" in length were anchored with the rod and planted in subplot #NP.5; Halodule shoots anchored with the clips were planted in subplot #NP.6. All the planting units were installed in a 3'x 3' matrix and each subplot contains 50 planting units.

All the planting material was collected from seagrass beds along the Negril beach.

Figure 17. Approximate location of Negril Point Site and the South Negril River Site

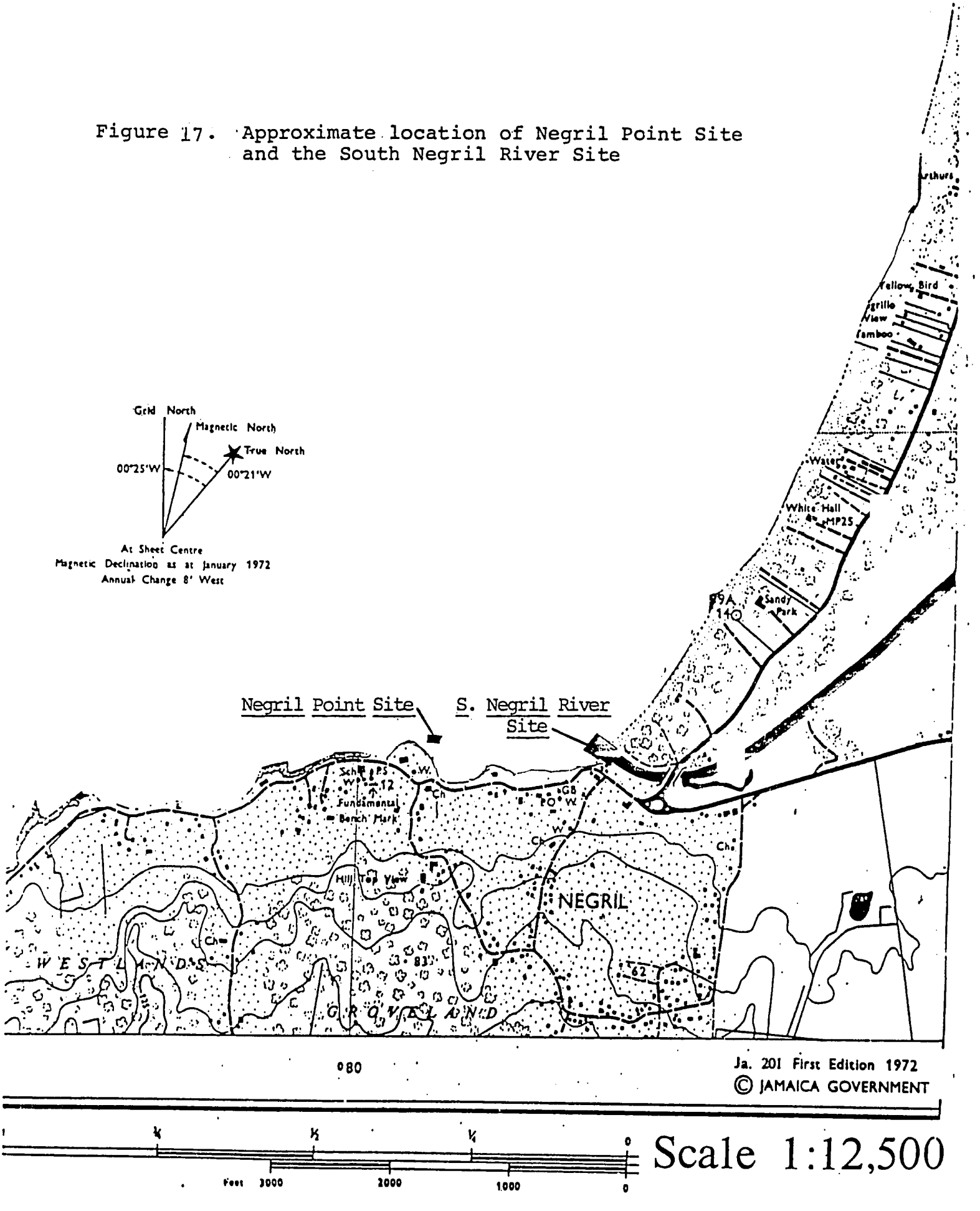
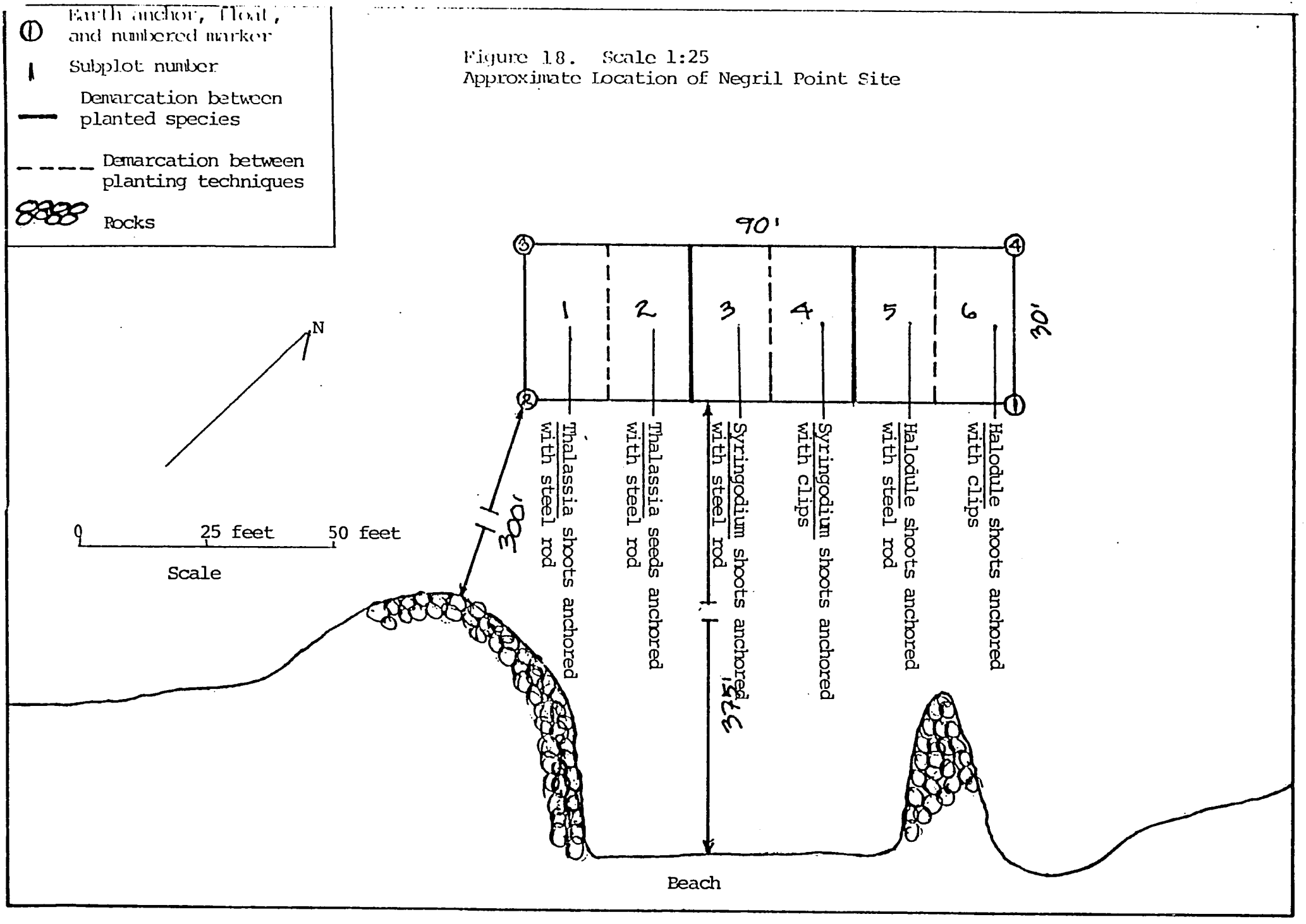


Figure 18. Scale 1:25
Approximate Location of Negril Point Site



10. South Negril River Site

The mouth of the South Negril River has been bulkheaded and riprapped on both shores. Concrete bulkhead jetties extend the mouth of the river into the ocean approximately 150'. A bridge several hundred feet up the river was constructed for road traffic. Small craft traffic is heavy in the river and some sewage is released into the river from the town of Negril. The river has been studied in conjunction with peat extraction from the "The Great Morass" up the river. Water chemistry parameters are available from this study, but no data are included at this time.

a. Location

The South Negril River Site is located between the jetties protruding into the ocean (see Figure 17.). The southeast edge of the site is parallel to and approximately 30' from the southwest jetty. The northeast edge of the site is approximately 25' up the river from the seaward edge of the jetties.

b. Characteristics of the Site

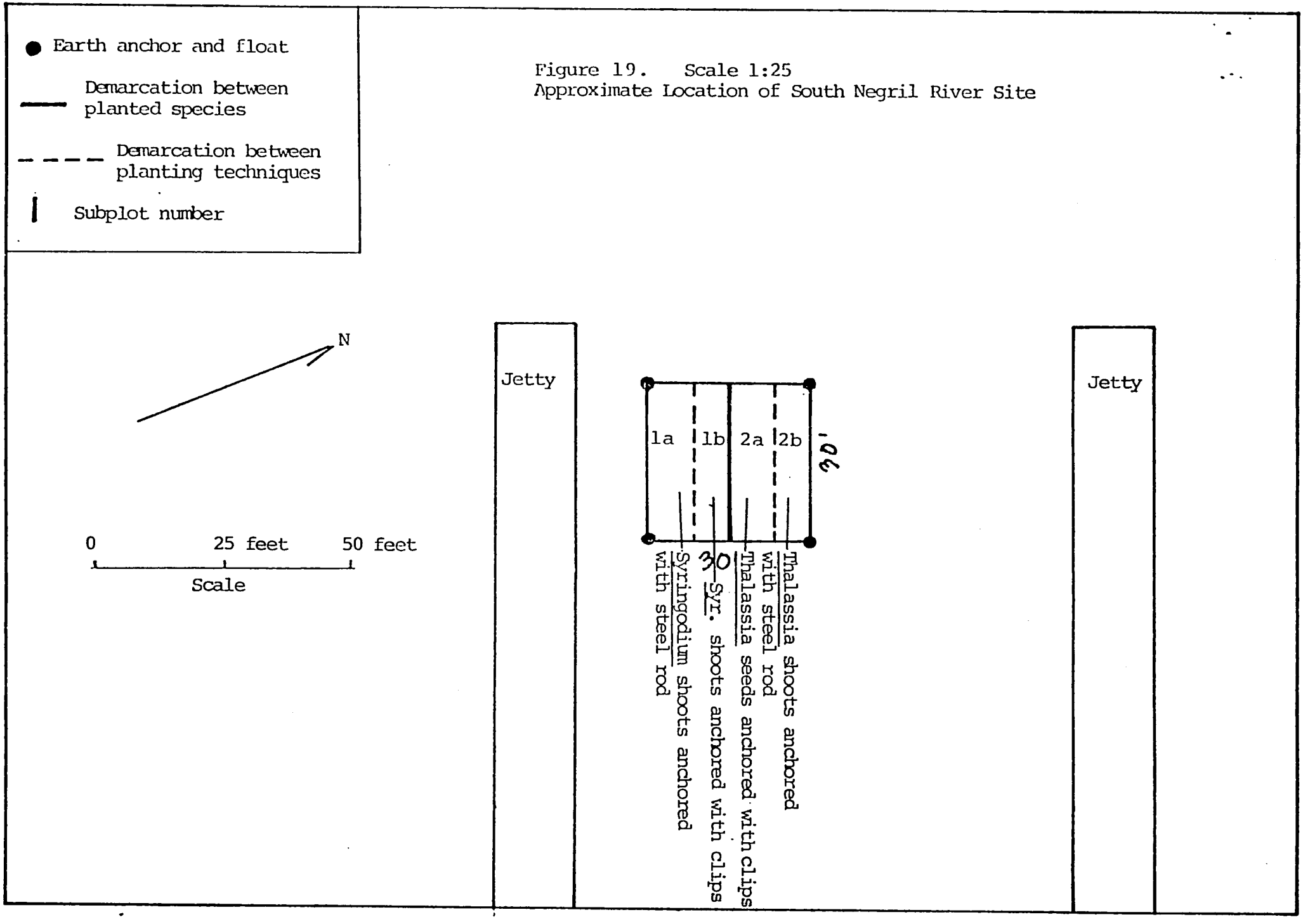
The site as seen in Figure 19. is 30'x 30'; the side of the site perpendicular to the jetties was divided in half to make two subplots 15'x 30'. The long dimension of the subplots is parallel to the jetties. The depth of the water at the site is 5' mean low water. The sediment is composed chiefly of coarse sand and is deeper than 1.7'. Visibility depended on the tide: on a rising tide it was +25' and on a falling tide it was 1' in the top layer of fresh river water and 15' in the lower layer of salt water. The site is subject to strong tidal and river currents.

c. Planting

On December 2, 1982 the site was planted by a team of diver biologists from the NRCD, FIU and an unemployed fisherman, Stanley Woolery. Figure 19. shows the experimental design in which the two species of seagrasses were planted. 6" sections of ¼" steel rod were used to anchor 30 planting units of Syringodium shoots 5" in length planted in subplot #NR.1a; 3" V-shaped clips were used to anchor 20 planting units of Syringodium shoots in subplot #NR.1b. The steel rod was used to anchor 60 planting units of Thalassia seeds (1 seed per anchor) planted in subplot #NR.2a; steel rod was also used to anchor 20 planting units of Thalassia shoots 5" in length planted in subplot #NR.2b. The planting units were installed in a 3'x 3' matrix with one planting unit per matrix element except the Thalassia seeds which were installed with two planting units per matrix element.

All the plant material was collected from seagrass beds along the Negril beach.

Figure 19. Scale 1:25
Approximate Location of South Negril River Site



11. Montego Bay Seawinds Site

The Montego Freeport was filled with dredge spoil from a series of nearby islands during the last two decades. The dredge and fill was not done carefully with consideration for drifting suspended sediments or erosion control from upland. In addition, significant channel dredging has occurred around the piers at the Montego Freeport. As an apparent consequence of these operations, aerial photography documents a reduction in the size of the seagrass beds surrounding the Montego Freeport.

Water chemistry parameters have not been measured at this site, however, the site is exposed to the open ocean and water quality appears to be of good oceanic quality.

a. Location

The Seawind Site is located on the northwest side of the Montego Freeport approximately 300' southwest of the Seawind Hotel. The northeast corner of the site is 51' seaward of a blue paint mark on the stone riprap on shore. The southeast corner is 57' from a right angle made by the stone riprap as it turns southeast away from the sea (see Figures 20 and 21.)

b. Characteristics of the Site

The site as seen in Figure 21. is 90'x 30'; the long dimension was divided into sections to make six subplots 15'x 30'. The long dimension of the site is parallel to the shore. The site slopes down to seaward: depth along the shore side is 4' mean low water and depth along the seaward site is 6' mean low water. The sediment is composed of sand and rock and varies in depth from .5' - 1.0'. The nearby island has been extensively filled and the surrounding bay bottom is quite unstable. Numerous Diadema were noted and removed from the site. Visibility was +25' and no currents were noted.

c. Planting

On December 1, 1982 the site was planted by a team of diver biologists from the NRCD, FIU and two unemployed fishermen, Donovan Henry and Stanley Woolery. Figure 21. shows the experimental design in which the two species of seagrasses were planted. 6" sections of ¼" steel rod were used to anchor Thalassia shoots 5" in length planted in subplot #SW.1; the rod was used anchor Thalassia seeds (2 per planting unit) planted in subplot #SW.2. The rod was used to anchor Halodule shoots 5" in length planted in subplot #SW.5; Halodule plugs were planted in subplot #SW.6. No Syringodium could be located in the area to plant. The Thalassia and Halodule was collected near Rose Hall because no other accessible beds could be located near the site.

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SHEET HISTORY

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Field Survey Data supplied by Survey Department, Jamaica.
Air Photography by Spartan Air Services Ltd., Canada, January and March 1968.
Field Completion by Survey Department Jamaica, May 1970.

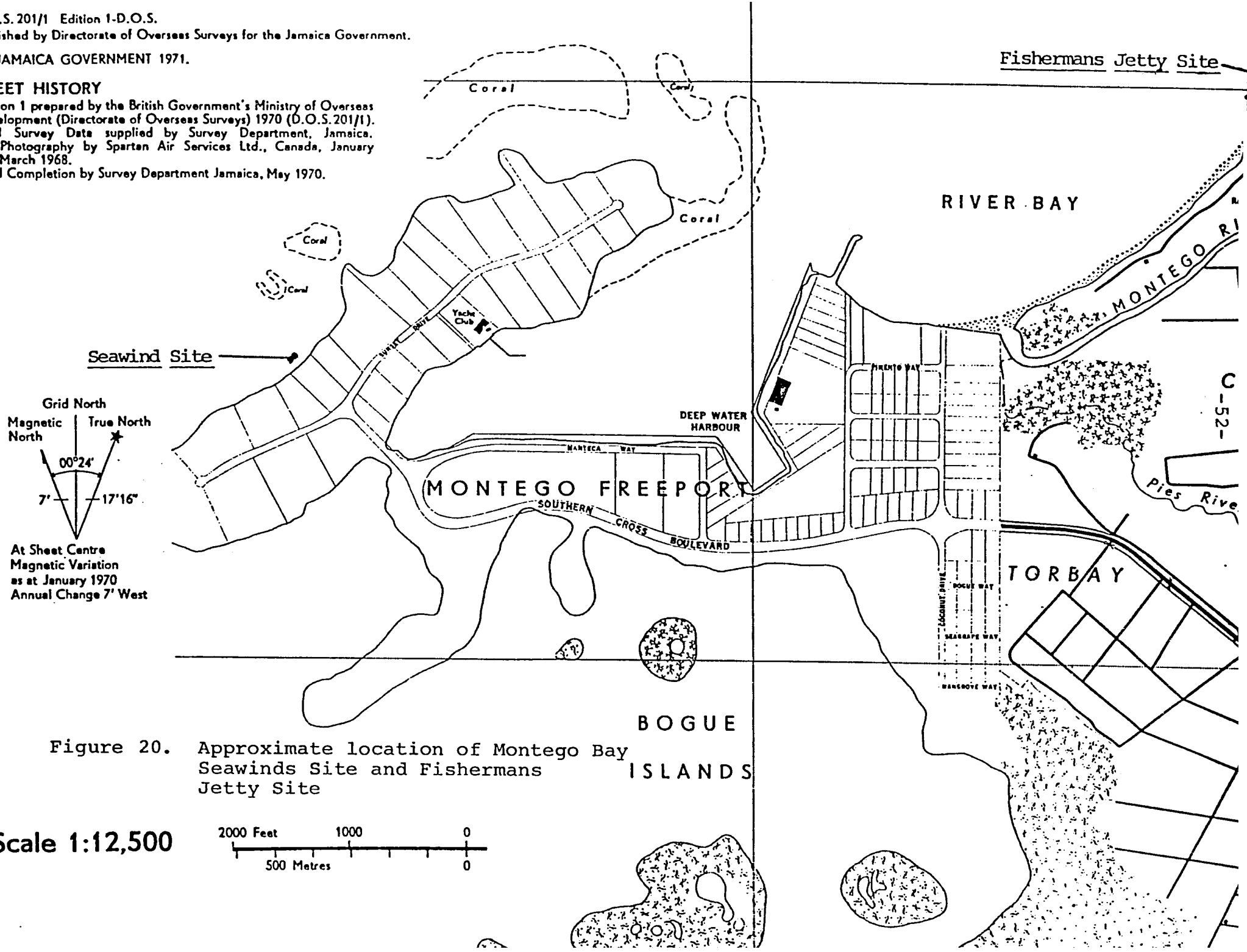
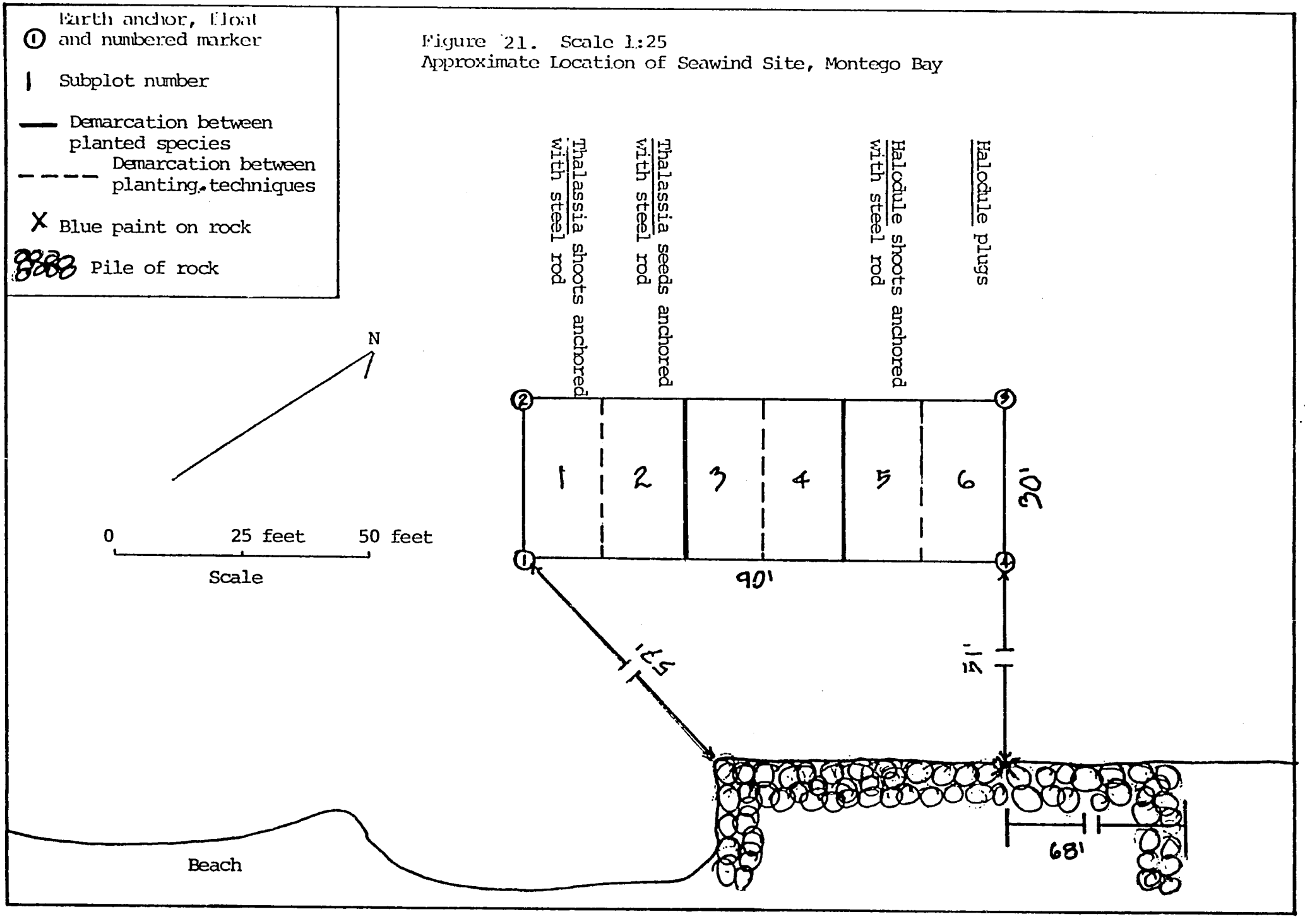


Figure 20. Approximate location of Montego Bay Seawinds Site and Fishermans Jetty Site

Figure 21. Scale 1:25
Approximate Location of Seawind Site, Montego Bay



12. Fishermans Jetty Site

The impact of building the riprap bulkhead for the jetty on both sides of this site directly affected the seagrass at this site, however, there had been several previous impacts. The filling of the waterfront downtown Montego Bay to seaward no doubt had an impact on the grass beds. In addition, old wharves originally present at this site could have had an impact. The massive dredge and fill of the Montego Bay Freeport which is several thousand feet from this site may have further impacted the site. The river outflow and sewage plant located near the mouth of the river have increased the turbidity and decreased the water quality of the surrounding waters which flow over the site.

No water chemistry parameters have been measured at this site. The area is estuarine and receives a significantly large amount of river water from the Montego River during the rainy season. The area is calm due to the jetties, but almost no seagrass is present in the lagoon.

a. Location

The Fishermans Jetty Site is located off a jetty at the northeast end of the River Bay Beach in Montego Bay (see Figure 20.). The site is 6' north of the jetty and 15' east of the shoreline riprap bulkhead.

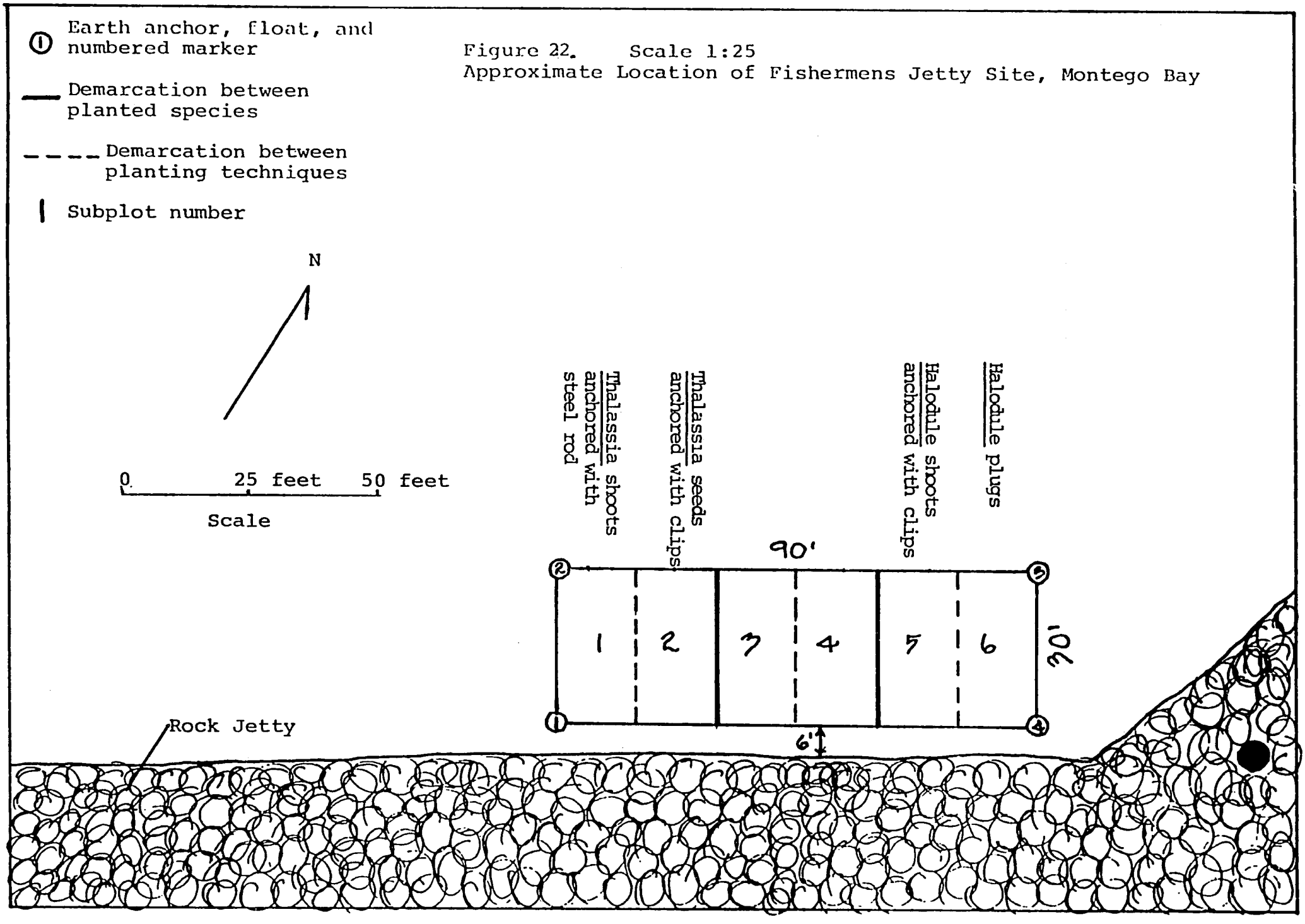
b. Characteristics of the Site

The site as seen in Figure 22. is 90'x 30'; the long dimension was divided into sections to make six subplots 15'x30'. The long dimension of the site is parallel to the jetty. The depth of the site increases toward the lagoon: on the jetty side the depth is 3' mean low water and on the lagoon side the depth is 6' mean low water. The sediment is composed of black sand and rich organic ooze more than 1.7' deep. Many small shrimp burrows were noted. Visibility was 3' and no current was noted.

c. Planting

On December 1, 1982 the site was planted by a team of diver biologists from the NRCD, FIU and unemployed fishermen, Donovan Henry and Stanley Woolery. Figure 22. shows the experimental design in which the two species of seagrasses were planted. 6" sections of ¼" steel rod was used to anchor Thalassia seeds in subplot #FJ.1; 3" V-shaped clips were used to anchor Thalassia shoots 5" in length planted in subplot #FJ.2. Halodule shoots 5" in length were anchored with the clips and planted in subplot #FJ.5; Halodule plugs were planted in subplot #FJ.6. No Syringodium could be found to plant here. The plant material was collected at Rose Hall beach.

Figure 22. Scale 1:25
Approximate Location of Fishermens Jetty Site, Montego Bay



13. Pelican Jetty Site

In an effort to develop waterfront of Montego Bay, a series of extensive jetties were built to provide a breakwater for areas behind them. The shoreline was filled with sand, some of which may have migrated seaward. The extensive naturally existing vegetation seen in aerial photographs was removed during construction. Some light covering of patchy successional seagrass has appeard in the decade since the jetties were built. Little progress toward the original state of the beds has been made.

The resulting lagoon made by the jetties is calm and protected. The site is exposed to the ocean and water quality is of oceanic standards. No water chemistry parameters have been measured here.

a. Location

The Pelican Jetty Site is between the northernmost and second jetty in a series of four jetties recently built along the shoreline south of the Cornick Road and Glouster Blvd. intersection in Montego Bay (see Figure 23.). The northeast corner of the site is 52' from the northern jetty and 50' from the shoreline.

b. Characteristics of the Site

The site as seen in Figure 24. is 90'x 30'; the long dimension was divided to make six subplots 15'x 30'. The long dimension of the site is parallel to the shoreline. The depth of the site increases from 4' mean low water at the northeast corner to 10' mean low water at the southwest corner. The sediment is composed of medium grain sand that was brought in for fill and is eroding from the beach. The depth of the sediment exceeds 1.7'. Many shrimp burrows were noted. Existing vegetation included blue green algae in subplot #PJ.1, red algae in subplot #PJ.2 and #PJ.3 and sparse Halodule in subplot #PJ.6. Visibility was 5' and no current was noted.

c. Planting

On November 30, 1982 the site was planted by a team of diver biologists from the NRCD, FIU and an unemployed fisherman, Donovan Henry. Figure 24. shows the experimental design in which the two species of seagrass were planted. 6" sections of ¼" steel rod was used to anchor Thalassia shoots 5" in length planted in subplot #PJ.1; rod was used to anchor Thalassia seeds planted in subplot #PJ.2. Halodule shoots 5" in length were anchored with steel rod and planted in subplot #PJ.5; Halodule plugs were planted in subplot #PJ.6. No Syringodium could be found to plant. Other plant material was collected near Rose Hall beach.

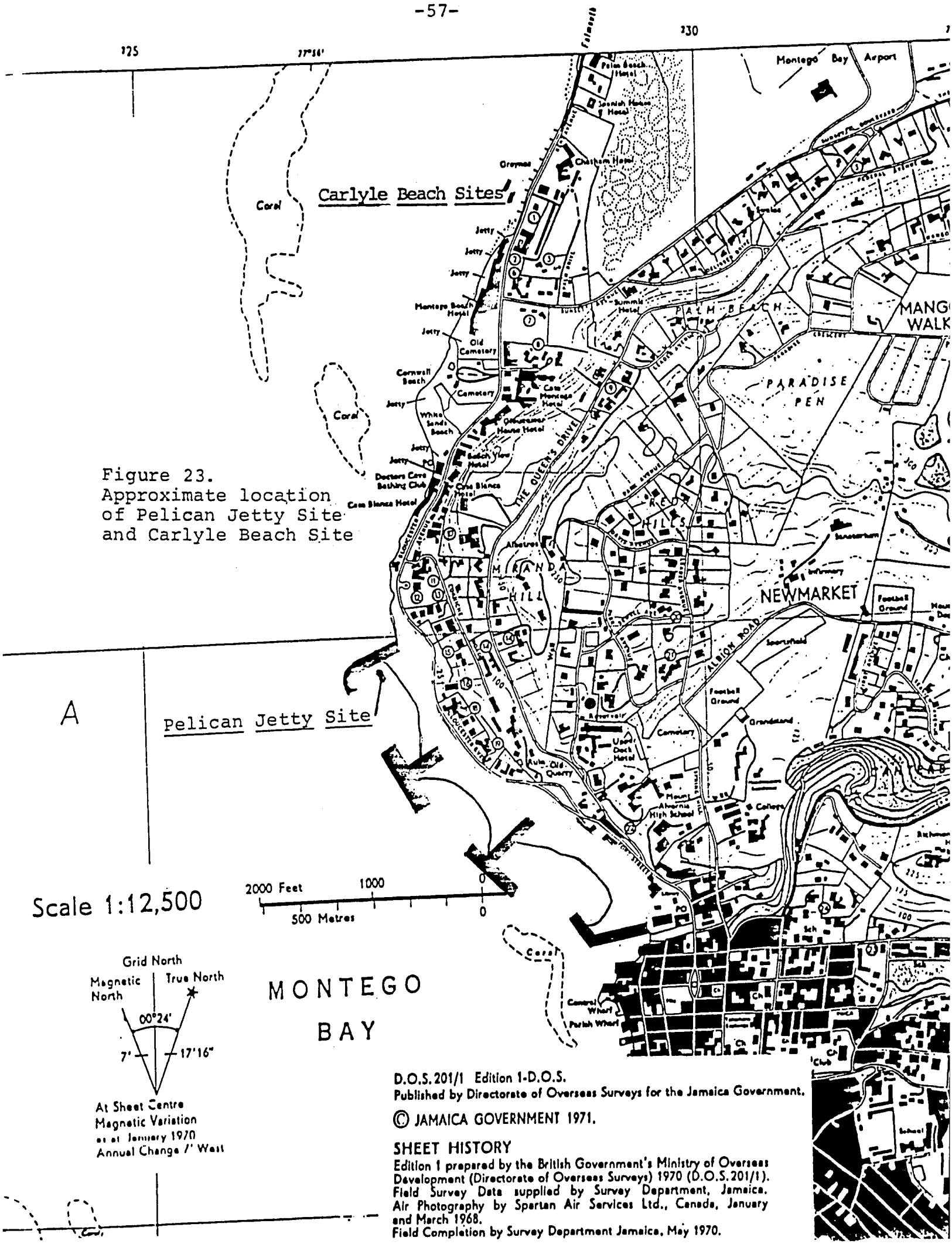


Figure 23.
Approximate location of Pelican Jetty Site and Carlyle Beach Site

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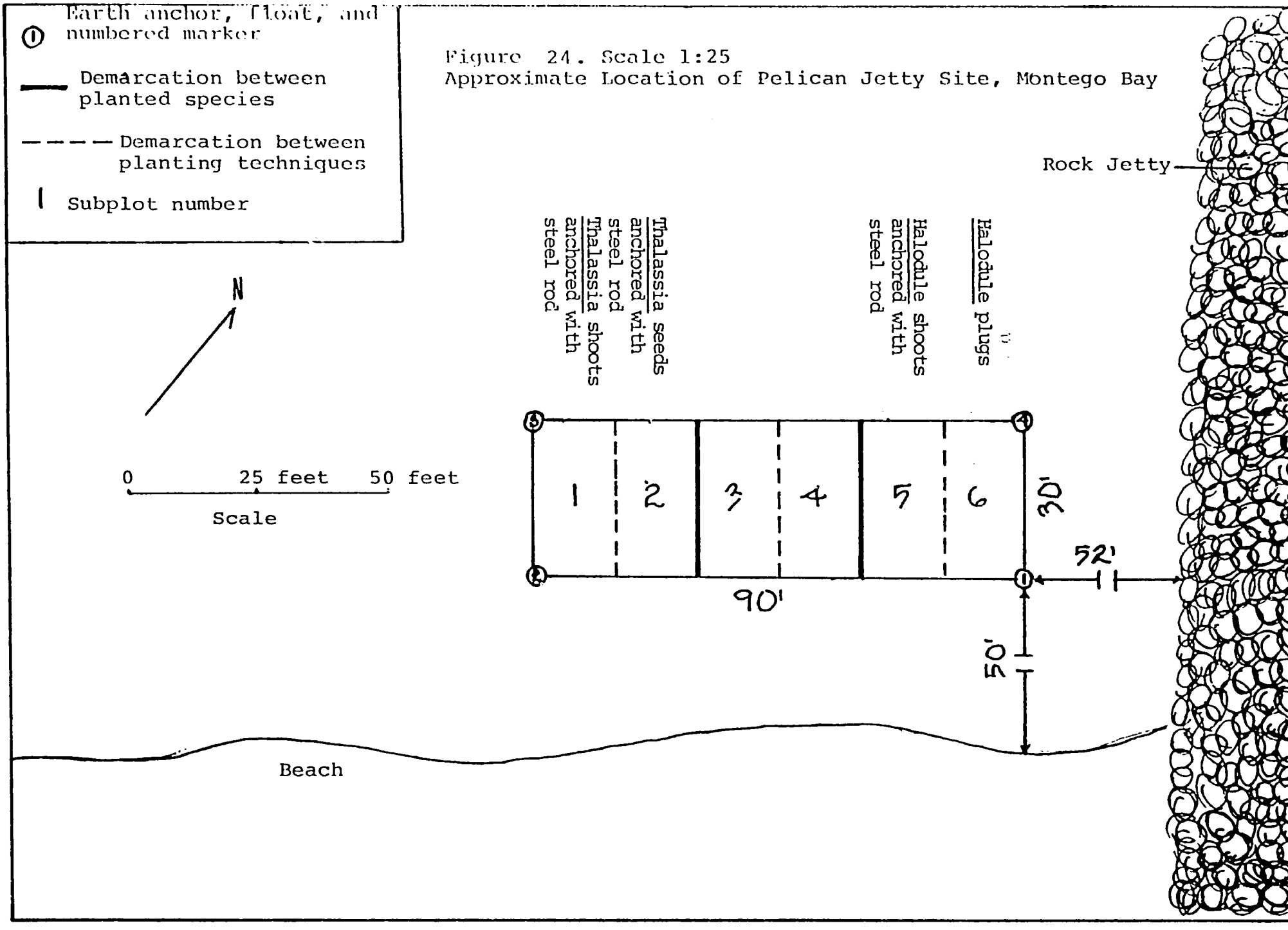
Field Completion by Survey Department Jamaica, May 1970.

Figure 24. Scale 1:25
Approximate Location of Pelican Jetty Site, Montego Bay



14. Carlyle Beach Site

This site is at the junction of a group of waterfront hotels and a road built along the shoreline near the airport in north Montego Bay. The area is bulkheaded by a seawall along the shore and backfilled to support the roadway. The airport dredge and fill was approximately six blocks to the north of the site. The sediment suspended by the airport fill may have mildly affected this area. Piers from the seawall were built, but they are short -- impact to site minimal. It is thought that extra beach fill may have been added to some of the hotel beaches and the consequential erosion may have impacted the area somewhat. Other indirect impacts from the waterfront construction in Montego Bay may also have mildly impacted the site.

Aerial photography from slightly more than a decade ago show seagrass beds in now barren areas. Large amounts of beach sand erosion has been noted and is being studied by the NRCD.

The site is exposed to the ocean and good water quality exists here. Water chemistry parameters have been measured by the NRCD and their results are shown in Table 5.

a. Location

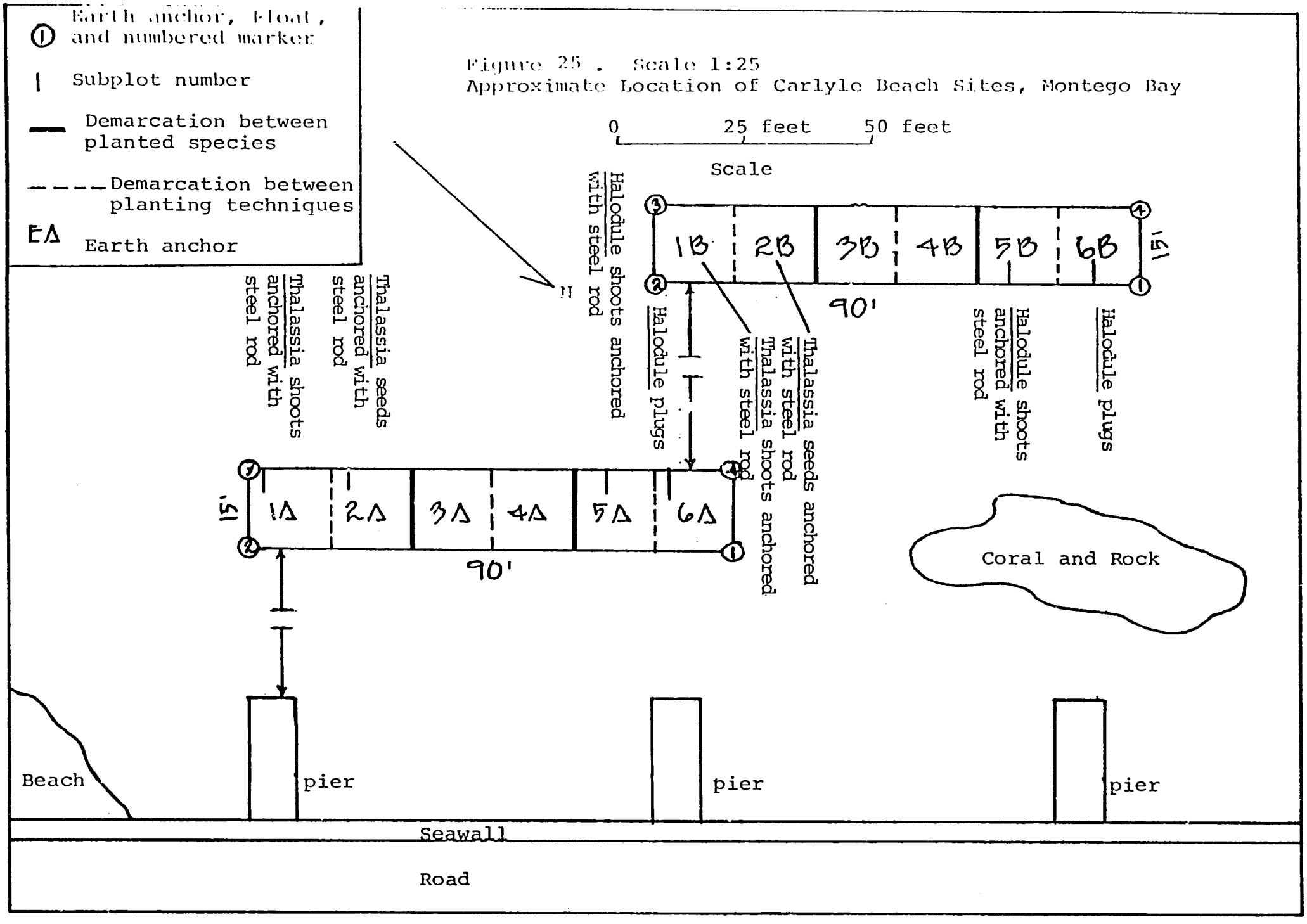
The Carlyle Beach Site is located approximately 300' north of the Carlyle Beach Hotel in Montego Bay. The usual 90'x 30' site was divided into two 90'x 15' sites to accomodate the rocky bottom and differing water depths at the site. Site A is directly out from and between the parallel lines made by the first and second of a series of short piers that extend into the ocean going north along Gloucester Avenue from the Carlyle Beach Hotel. Site B is farther from shore than Site A and is positioned between the parallel lines made by the second and third short piers extending from the seawall (see Figure 23 .).

b. Characteristics of the Site

The site as seen in Figure 25 . is two 90'x 15' Sites A and B; the long dimension of site was divided to make six subplots 15'x 15'. The depth of Site A is 6' mean low water and Site B is 7.5' mean low water. The sediment is composed chiefly of coarse white calcareous sand 3" - 6" deep at Site A and 6" - 10" deep at Site B. The substrate is quite rocky. Diadema (spring sea urchins) were numerous at the sites. The site is exposed to the open ocean and subject to occasional heavy winter storms. Visibility was +25' and no currents were noted.

TABLE 5. NRCD DATA ON WATER CHEMISTRY FROM CARLYLE BEACH SITE GOES HERE. TO BE OBTAINED FROM PETER GAYLE AT NRCD, KINGSTON.

Figure 25 . Scale 1:25
Approximate Location of Carlyle Beach Sites, Montego Bay



c. Planting

On November 30, 1982 the site was planted by a team of diver biologists from the NRCD, FIU and an unemployed fisherman, Donovan Henry. Figure 25. shows the experimental design in which the two species of seagrass were planted. 6" sections of ¼" steel rod were used to anchor Thalassia shoots 5" in length planted in subplots #CB.1A and #CB.1B; steel rod was used to anchor Thalassia seeds planted in subplots #CB.2A and #CB.2B. Steel rod was used to anchor Halodule shoots 5" in lenght planted in subplots #CB.5A and #CB.5B; Halodule plugs were planted in subplots #CB.6A and #CB.6B. No Syringodium could be found in the area to plant. The other plant material was collected near Rose Hall beach. The plants were installed in a 3'x 3' matrix and each subplot contains 25 planting units.

15. Discovery Bay Bauxite Terminal

The impact of the bauxite facility at the southwest corner of Discovery Bay has come from the construction of a large pier, repeated dust and ore releases during loading operations, limited dredging for ship access and reported oil slicks (perhaps from ship bilging). The facility for the Kaiser Jamaica Bauxite Company has an annual rated capacity of 6,000,000 tons -- one of the world's largest operations. The ore is mined, transported, dried and stored in the 300,000 ton capacity dome for loading into 35,000 ton ore carriers bound for alumina plants in the United States.

Some environmental studies of the bay have been done through the proximate Discovery Bay Marine Laboratory of UWI.

a. Location

The Discovery Bay Site is located approximately 800' east of the pier at Port Rhodes in Discovery Bay (see Figure 26.). The site is approximately 150' seaward from the northern shoreline. Blue paint marks on the shoreline cliff mark the two ends of the site. The long dimension of the site is parallel to the shore.

b. Characteristics of the Site

The site as seen in Figure 27. is 60'x 30'; the long dimension was divided to make four subplot 15'x 30'. The depth of the site is 10' mean low water. The sediment is composed chiefly of hard calcareous sand and extends more than 1.7' deep. There are small patches of natually occurring Thalassia in subplots #DB.1, #DB.3 and #DB.4 and sparse Halodule in subplots #DB.1, #DB.2, #DB.3 and #DB.4. The animals noted were Diadema (spiny sea urchin), shrimp burrows and Lytechinus (common sea urchin) The site is somewhat sheltered by the outer reef and lagoon, but is subject to occasional winter storms. Visibility was +25' and no current was noted.

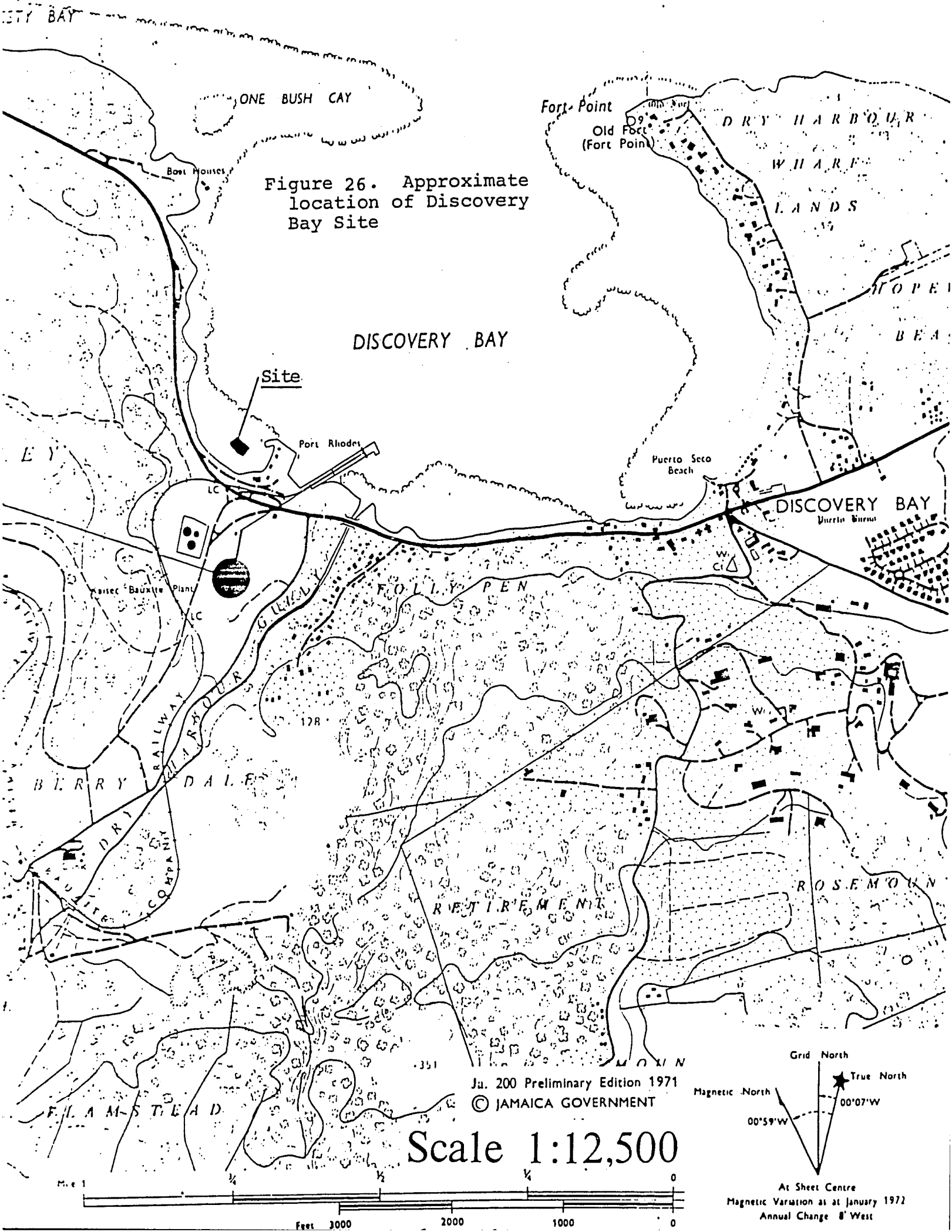


Figure 26. Approximate location of Discovery Bay Site

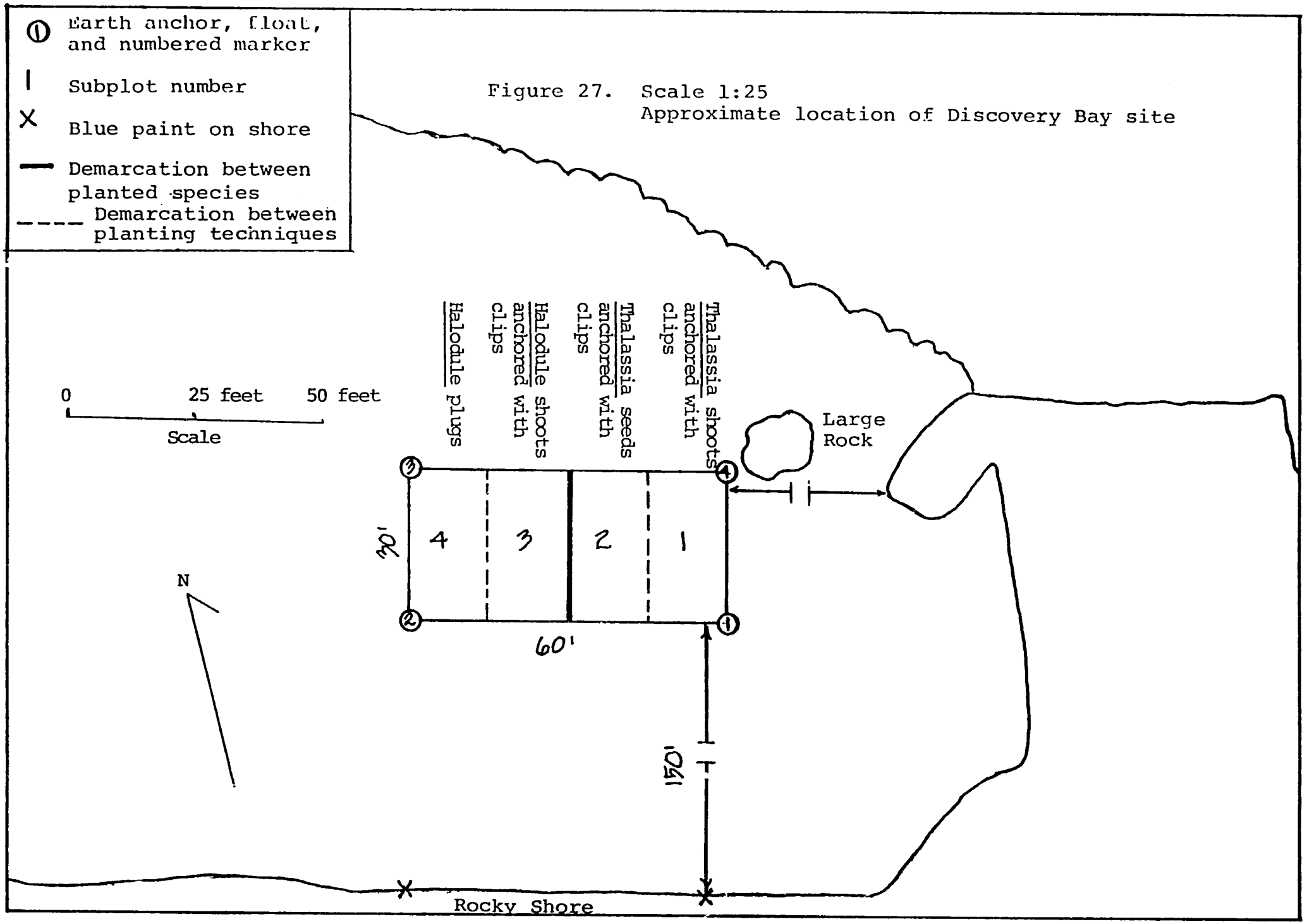


Figure 27. Scale 1:25
Approximate location of Discovery Bay site

c. Planting

On November 29, 1982 the site was planted by a team of diver biologists from FIU. Figure 27. shows the experimental design in which the two species of seagrass were planted. 3" V-shaped clips were used to anchor Thalassia shoots 5" in length planted in subplot #DB.1; clips were also used to anchor Thalassia seeds planted in subplot #DB.2. Clips were used to anchor Halodule shoots 5" in length planted in subplot #DB.3; Halodule plugs were planted in subplot #DB.4. All the planting units were installed in a 3'x 3' matrix and each subplot contains 50 planting units. No Syringodium could be found to plant here. The other plant material was collected from an unnamed bay approximately five miles west of the site.

16. Ocho Rios Site

The bauxite terminal at Ocho Rios impacted the area by building a pier and dredging a ship channel which seems to have changed certain environmental conditions in the southeast corner of the bay. Dust emissions and other by-products from the loading process and ships appear to have impacted the water quality on occasions. At the east end of the bay seaward, a major fill operation appears to have occurred within the last decade and a half which resulted in dock facilities and a park. The fill and dredge probably increased the suspended particle load in the water.

The water chemistry parameters may be quite similar to the Discovery Bay Site. A fresh water inflow from Dunns River could change the conditions somewhat from the Discovery Bay Site however. The site is exposed to the open ocean and water quality appears to be that of ocean standards. The energy regime is quite high here.

This site will be planted in the spring 1983. No fall 1982 planting was attempted because the water was too rough.

B. Summary Tables of Impacts at Sites and Scientific Goals Met to Date

Table 6. summarizes the types of impacts, both natural and artificial, found at each of the fifteen seagrass restoration sites(except for Ocho Rios) and the mangrove planting site. Industrial waste, urban runoff and suspected oil spills impacted 63 percent of the sites; dredge and fill and river runoff impacted approximately 41 percent of the sites; bauxite spills and erosion impacted approximately 22 percent of the sites;and peat and thermal effluents impacted approximately 10 percent of the sites.

Tables 7. and 8. summarize the scientific goals met to date. Table 7. shows the sediment type and depth, water depth, and the number, species and anchoring method for the seagrass species planted. Table 8. shows the indigenous seagrasses and algae found at the sites, the dominant animals present, the planting personnel and the donor site of the plant material.

These tables should be helpful for gaining a general overview of the November 1982 planting and as baseline data to which the monitoring reports can be referred.

Table 6. Impacts at 17 Test Sites

Site	Industial Waste	Dredge and Fill	Bauxite Spills	Oil Spills	Urban Runoff	River Runoff	Erosion	Peat	Thermal Effluents
Hellshire A and B					X		X		
Fort Augusta	X	X		X	X	X			
Old Airport	X	X		X	X	X			
Cement Factory	X			X	X	X			
Rocky Point	X		X	X					
Port Esquivel	X		X	X					
Power Plant				X					X
Discovery Bay			X	X	X				
Carlyle Beach	X	X			X		X		
Pelican Jetty	X	X		X	X	X			
Fishermens Jetty	X	X		X	X	X			

Table 6., continued: Impacts at 17 Test Sites

Site	Industrial Waste	Dredge and Fill	Bauxite Spills	Oil Spills	Urban Runoff	River Runoff	Erosion	Peat	Thermal Effluents
Seawind	X	X			X		X		
Negril Point						X		X	
Negril River						X		X	
Rocky Point Mangrove Planting	X		X	X					

Table 7. Scientific Goals Met to Date

Station	Date Planted (1982)	Sediment Type	Sediment Depth	Water Depth	# Syr. plugs	# Syr. shoots rebar	# Syr. shoots
Hellshire A	11/16	coarse sand	20+ inches	2 feet	0	50	0
Hellshire B	11/17	coarse sand	20+ inches	5 feet	25	25	0
Fort Augusta	11/18	sand and organics	20+ inches	4 feet	0	50	50
Old Airport	11/19	coarse particles	20+ inches	6 feet	0	50	50
Cement factory	11/19	fine silt	2-5 inches	3-12 feet	0	0	100
Rocky Point	11/23	clay crust fine silt	20+ inches	1-2 feet	0	0	100
Port Esquivel	11/23	muddy sand	18 inches	6-8 feet	0	0	100
Power Plant	11/24	muddy sand	20+ inches	2-3 feet	0	0	100
Discovery Bay	11/29	calcareous sand	20+ inches	10 feet	0	0	0
Carlyle Beach A	11/30	coarse sand	3-6 inches	6-7 feet	0	0	0
Carlyle Beach B	11/30	coarse sand	6-10 inches	7-8 feet	0	0	0
Pelican Jetty	11/30	coarse sand	20+ inches	4-10 feet	0	0	0
Fishermens Jetty	12/1	black sand	20+ inches	3-6 feet	0	0	0
Seawind	12/1	sand	6-12 inches	4-6 feet	0	0	0
Negril Point	12/2	fine mud over sand	16 inches	20 feet	0	50	50
Negril River	12/2	coarse sand	20+ inches	5-6 feet	0	30	20
Rocky Point Mangrove Planting	11/24	muddy sand	20+ inches	0-2 inches			

Table 7. Scientific Goals Met to Date

Station	# Hal. plugs	# Hal. shoots rebar	# Hal. shoots pin	# Thal. shoots rebar	# Thal. shoots pin	# Thal. seeds rebar	# Thal. seeds pin
Hellshire A	25	25	0	25	0	25 P.U.* 2/center	0
Hellshire B	25	25	0	25	0	25 P.U.* 2/center	0
Fort Augusta	50	50	0	50	0	50 P.U.* 2/center	0
Old Airport	50	50	0	50	0	100 P.U.* 1/center	0
Cement Factory	50	0	50	0	50	0	50 P.U.* 2/center
Rocky Point	50	0	50	0	50	0	50 P.U.* 2/center
Port Esquivel	50	0	50	0	50	0	50 P.U.* 2/center
Power Plant	50	0	50	0	50	0	50 P.U.* 2/center
Discovery Bay	50	0	50	0	50	0	50 P.U.* 2/center
Carlyle Beach A	25	25	0	25	0	25 P.U.* 2/center	0
Carlyle Beach B	25	25	0	25	0	25 P.U.* 2/center	0
Pelican Jetty	50	50	0	50	0	50 P.U.* 2/center	0
Fishermens Jetty	50	50	0	0	0	50 P.U.* 2/center	50 P.U.* 2/center
Seawind	50	50	0	50	0	50 P.U.* 2/center	0
Negril Point	0	50	50	30	20	50 P.U.* 2/center	0
Negril River	0	0	0	20	0	30 P.U.* 2/center	0
Rocky Point Mangrove Planting	50 Black Mangroves		181 Red Mangroves				

* P.U.= Planting Unit

Table 8. Scientific Goals Met to Date

Station	Indigenous Seagrasses Present	Animals Present	Planters	Donor Site
Hellshire A	None	None	NRCD, UWI, FIU	Same*
Hellshire B	Light Halodule in subplots 4-6	None	NRCD, UWI, FIU	Same*
Fort Augusta	10' by 11' Halodule in subplot 1	None	NRCD, UWI, FIU, UE**	Hellshire* Plugs same
Old Airport	2' by 3' Thalassia in subplot 4	Shrimp and Sea Urchins	NRCD, UWI, FIU, UE**	Same* Syr. Hellshire
Cement Factory	None	None	NRCD, UWI, FIU, UE**	Syr. Hellshire the rest same*
Rocky Point	Ruppia	None	NRCD, FIU	Hal. same* the rest Hell
Port Esquivel	Thalassia in subplots 1+6	Shrimp and Sea Urchins	NRCD, FIU	Syr. Hellshire the rest same*
Power Plant	Light Halodule in subplots 3+4	Shrimp and Sea Urchins	NRCD, FIU, UE**	Syr. Hellshire the rest same*
Discovery Bay	Thalassia in subplots 1+3 Light Halodule in subplots 1-4	Shrimp and Sea Urchins	FIU	Unknown Bay*
Carlyle Beach A	None	Sea Urchins	NRCD, FIU, UE**	Rose Hall Beach*
Carlyle Beach B	None	Sea Urchins	NRCD, FIU, UE**	Rose Hall Beach
Pelican Jetty	Light Halodule in subplots 5+6 Blue Green Algae in subplots 1+2	Many Shrimp	NRCD, FIU, UE**	Rose Hall Beach*
Fishermens Jetty	None	Many Shrimp and a few worms	NRCD, FIU, UE**	Rose Hall Beach*
Seawind	None	Many Sea Urchins	NRCD, FIU, UE**	Rose Hall Beach*
Negril Point	Light Blue Green Algae Clumps of Red Algae	Shrimp and many small fish	NRCD, FIU, UE**	Negril Beach*
Negril River	None	Crabs on surface	NRCD, FIU, UE**	Negril Beach*
Rocky Point Mangrove Planting	Ruppia	None	FIU	
	Black mangrove NW side of Fort Augusta Causeway, red mangroves along the road to Hellshire and near the power plant site.			

* All Thalassia seeds were collected at Priory on the North Coast ** Unemployed Jamaicans

C. Training

1. NRCD and UWI personnel

The skills necessary for the collection, transportation, preparation and planting seagrass were successfully taught to two biologists from the NRCD, Mr. Peter Gayle and Mr. Everton Kelly, and overview explanations were given to NRCD supervisors, Ms. Barbara Chow, Mrs. Beverly Miller (Director of NRCD) and Mr. Paul Carroll (Acting Chief Aquatic Resources Division). Dr. Barry Jupp from UWI received this training also. The biologists Mr. Gayle and Kelly successfully planted the last two sites by themselves.

Management of logistics, relations with industry, purchase and assembly of equipment, site selection and history were discussed and done by Mr. Peter Gayle, Ms. Barbara Chow and Dr. Jupp. Mr. Gayle managed and checked the last two sites.

2. Low Technical Employment Test

The following persons worked with this project during the November 1982 planting in the capacity described in Section II Methods, K. Training, in this report. Overall, they performed well, were eager to work, learned quickly and seemed to understand the purpose of this project.

Oswald Creary
P.O. 200, Wease Road, Windsor Lodge, Bull Bay 10 Miles
Experience: 34 years fishing

Cortney Cunningham
5 Payton Place, Kingston 7
Experience: 10 years fishing, 3 years agriculture

Rennie Williams
Kelly Pen, Old Harbor Bay
Experience: 16 years fishing

Donovan Henry
Flankers White Sand P.O., Montego Bay
Experience: 2 years fishing, 5 years diving

Stanley Woolery
Al Coastal Road, Hopewell
Experience: 10 years fishing, 8 years diving

D. Public Exposure and Education

Figure 28., 29. and 30. show the beginnings of a public education effort done in part through newspaper exposure. It is hoped similar articles will appear as the project proceeds.

E. Equipment Status

All the project equipment shipped to Kingston, Jamaica on November 5, 1982 arrived undamaged and accounted for by U.S.A.I.D. and NRCD staff. The few remaining pieces that were not available at that time are available now and will be delivered in February 1983. The equipment is currently stored and maintained at the NRCD in Kingston.

Figure 28. Newspaper article from the Daily Gleaner, December 2, 1982, page 15, Kingston, Jamaica.

U.S. $170.000 seagrass project underway

A US$170,000 project to examine the potential for using seagrass to restore environmentally damaged nearshore areas has been launched by the Aquatic Resources Division of the Natural Resources Conservation Department (NRCD).

The seagrass restoration project is to be carried out on some 17 costal sites across the island over the next 18 months and is being funded by the Florida International University (FIU), U.S. AID and the Natural Resources Conservation Department, according to a Jamaica Information Service (JIS) release.

Outlining the project on Monday, the Principal Director of NRCD, Mrs Beverly Miller, pointed to various types of marine pollution, including urban abuse, industrial accidents; bauxite and oil spills, which have contributed to the degradation of the island's costal resources.

The project, Mrs Miller said, was important in that seagrasses provided a nursery for the nearshore coastal eco-system. It helped to stabilise nearshore sediment, including beaches and shorelines, and the disappearance of the seagrass would mean the disappearance of a large portion of the nearshore marine life.

Dr Anitra Thorhaug, marine biologist at FIU and consultant to the project, explained that the project would seek to determine which of the three types of seagrasses present in Jamaica survived better under adverse conditions and was more easily restored after an industrial accident. This knowledge would not only help to reverse past damage but develop new techniques for preventing future damage to seagrass and the nearshore marine environment

She further noted that the success of this project would not only provide the country with a cheaper source of protein from nearshore fishing, but would also provide a model for other Caribbean countries to adopt.

A similar project was successfully carried out in Florida by a team from FIU headed by Dr Thorhaug, but Jamaica is the first Caribbean country to carry out such an experiment and if successful, it could provide employment opportunities in a new wetland industry, the JIS said.

The sites chosen for the project include sections of Kingston Harbour, Montego Bay Discovery Bay, Portland Blight, Alligator Pond, Ocho Rios, Old Harbour, Hellshire and Negril.

The project is being coordinated with the assistance of Dr Barry Jupp, consultant to the NRCD and lecturer in the Department of Botany at the U.W.I.

Figure 29. Newspaper photograph and caption from The Star, December 7, 1982, Kingston, Jamaica.

SEAGRASS PROJECT:.
Dr. Anita Thorhaug, Marine Biologist at Florida International University(FIU) examines a handful of seagrass as part of a USAID-sponsored project to restore environmentally near-shore areas, across Jamaica. The Seagrass Restoration Project is to be carried out on some 17 coastal sites across the Island over the next 18 months at a cost of about U.S. $170,000. The project is being co-ordinated by the Natural Resources Conservation Department (NRCD), Florida International University, and the Department of Botany, UWI. Looking on are (from left to right), Mr. Paul Carroll,(NRCD); Mrs. Beverley Miller, Principal Director, NRCD and Mrs. Barbara Chow and Mr. Everton Kelly also from the NRCD.

Figure 30. Newspaper photograph and caption from The Jamaica Daily News, December 7, 1982, Kingston, Jamaica.

The Jamaica Daily News Tuesday, December 7, 1982

Seagrass restoration

Natural Resources Conservation Department [NRCD] worker Peter Gayle [Centre] using a 'Post Hole Digger' to assist Dr. Anita Thorhaug [left], a Marine Biologist in retrieving a sample of seagrass from the floor of the Kingston Harbour recently. Everton Kelly also of the NRCD is at right. Dr. Thorhaug is the consultant to the USAID-sponsored project for restoring environmentally damaged near shore areas. The Seagrass Restoration project is to be carried out on some 17 coastal sites across the island, at a cost of US$170,000 over the next 18 months. The project is being co-ordinated by the Natural Resources Conservation Department, Florida International University and the Department of Botany, UWI.

JIS photo

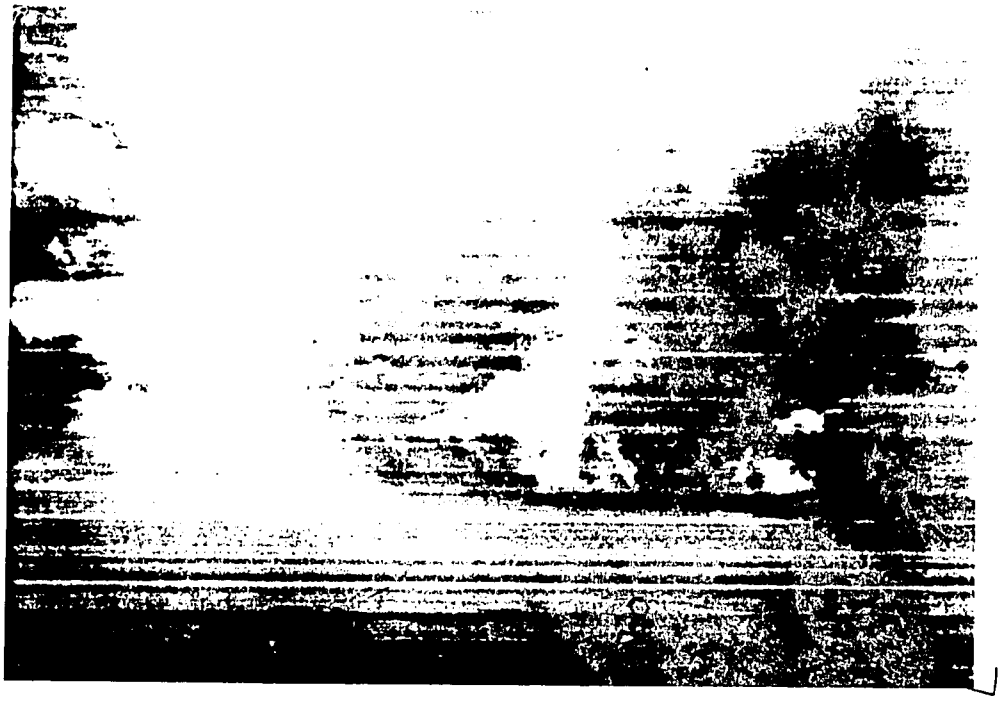


Photo 4. Kingston Harbor and approximate location of four test sites (from left to right): Old Airport, Cement Factory, Hellshire Beach and Fort Augusta.

Photo 5. Old Airport site, downtown Kingston in the background. Biologists from FIU, NRCD and UWI are taking plugs of seagrass for transplantation.

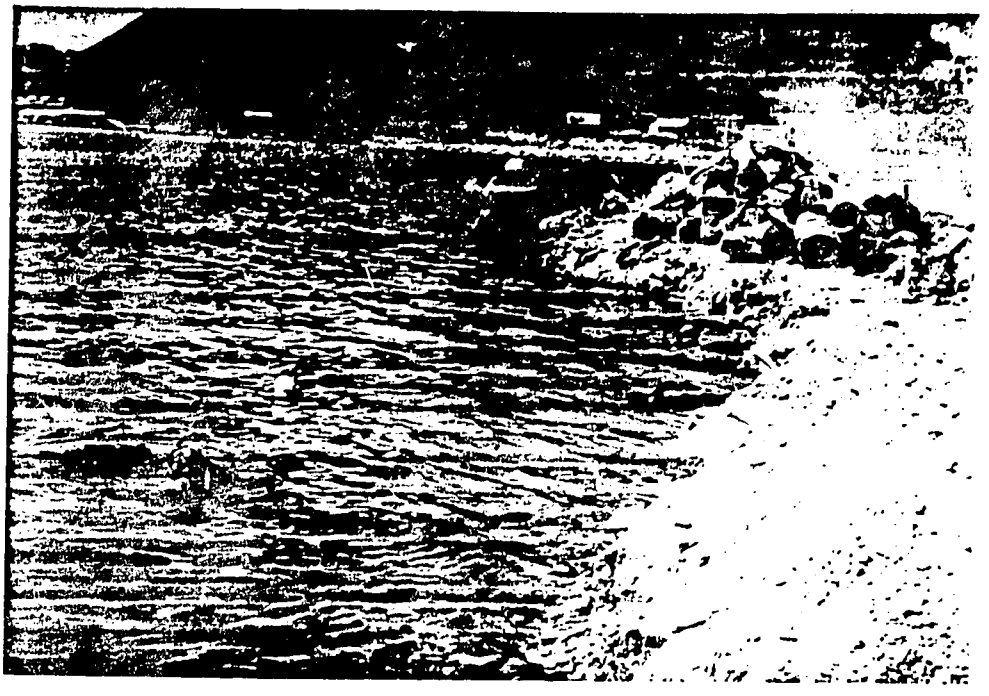


Photo 6. Cement Factory site. Shows metal debris and cement by-product which erodes into the water or is used as fill.

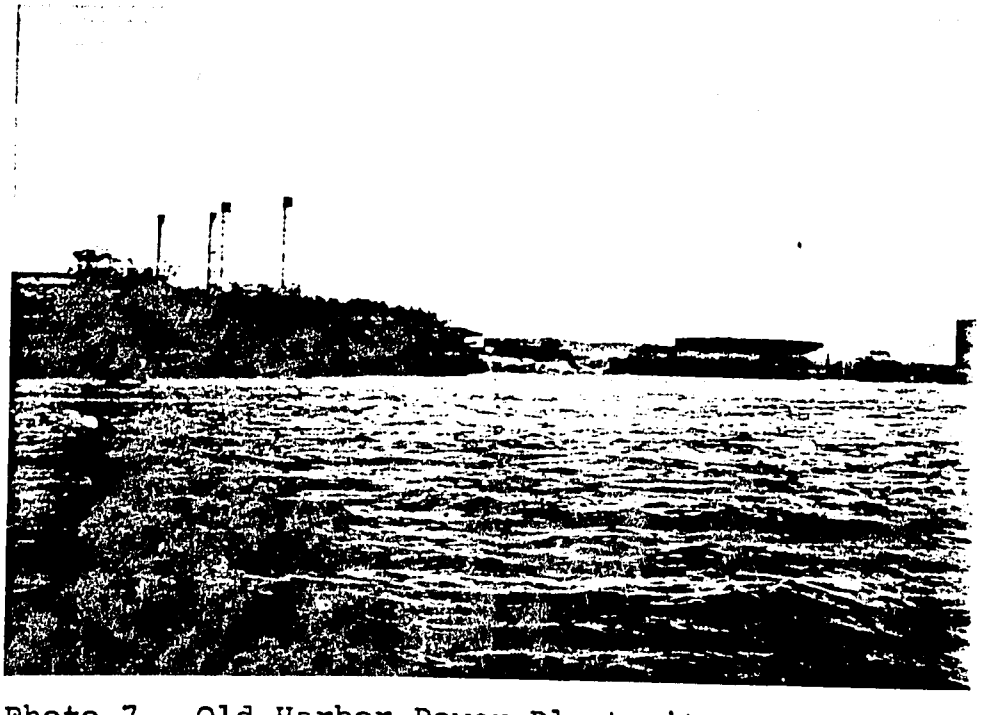


Photo 7. Old Harbor Power Plant site. Planting site marked by white floats. Area impacted by heated water discharge from power plant seen in background.

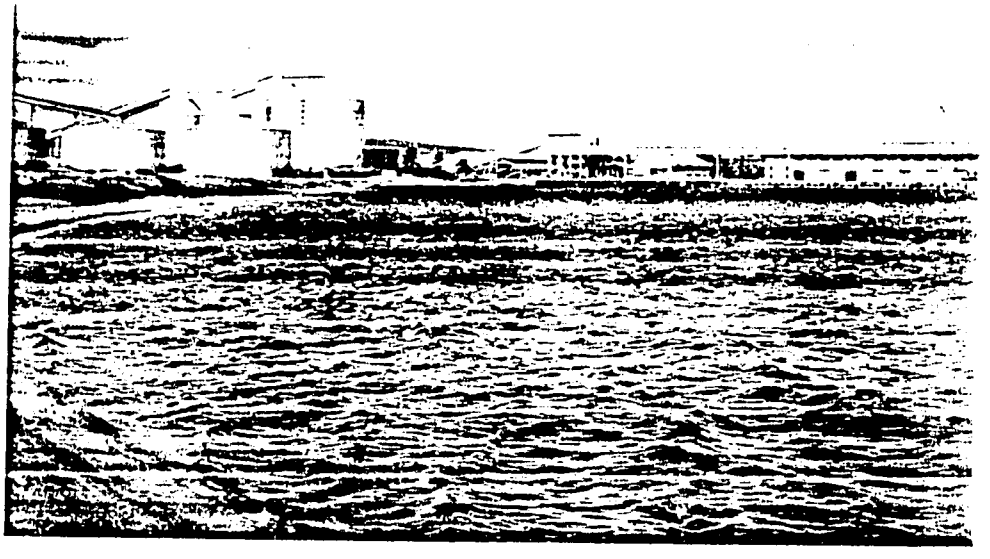


Photo 8. Port Esquivel site. Site marked by white floats in center of photo. Bauxite loading and storage facilities in background.

Photo 9. Rocky Point site. Biologists from NRCD and FIU shown planting seagrass in a shallow lagoon inside the bauxite storage and loading facility.

Photo 10. Sediment core from Rocky Point. Shows sediment of clay and sand. Black material at the top of the core is suspected to be oil.

Photo 11. Discovery Bay site. Planting site located in lower left lagoon marked by black circle. Kaiser Jamaica Bauxite Company storage dome and loading pier.

Photo 12. UWI biologist Barry Jupp, Ph.D. (left) and FIU biologist Mike Elliott (right) shown taking plugs of seagrass (Halodule) from a donor bed with a post hole digger. The plugs are bagged for transport to the planting site.

Photo 13. Planted plugs of seagrass (Halodule) shown in foreground. The plugs are planted in a 3'x 3' matrix. Biologists from NRCD and FIU shown in the background planting shoots of seagrass at the Rocky Point site.

Photo 14. NRCD biologist Peter Gayle and FIU biologist A. Thorhaug shown planting shoots of seagrass (Syringodium) at the Rocky Point site.

Photo 15. NRCD and FIU biologists shown moving a marked planting line at the Rocky Point site. Floating basket in foreground is used to transport plants and equipment to the planting site.

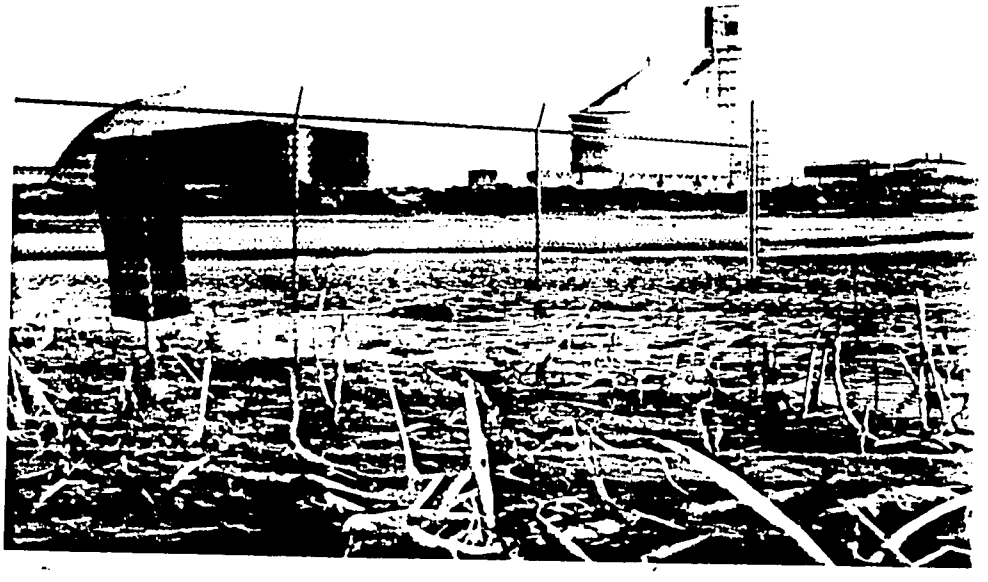


Photo 16. Mangrove planting at the Rocky Point site. Black mangrove seedlings were planted in the exposed shore among the dead mangrcve trees. Red mangrove propagules and seedlings were planted along the water line and in the submerged sediment.

Photo 17. Mangrove planting at Rocky Point. Red mangrove seedlings and propagules shown in foreground. Former mangrove stand shown in background. An oil spill may have killed these trees.

Photo 18. An unemployed Jamaican fisherman, Oswald Creary, (center) is shown with UWI, NRCD and FIU biologists as he learns how to prepare seagrass shoots for planting at the Fort Augusta site in Kingston.

Photo 19. A Jamaican fisherman, Donovan Henry, explains to other Jamaican fishermen the reasons and goals of the work he's doing at the Seawind Hotel site in Montego Bay.