ENVIRONMENTAL ASSESSMENT REPORT
FOR
COLUMBUS LANDING: A MARINA, RESTAURANT, SHOPPING AND OFFICE COMPLEX,
AT
ESTATE MORNINGSTAR
ON
SUGAR BAY (SALT RIVER)
ST. CROIX, U.S. VIRGIN ISLANDS

Submitted To:
Division of Coastal Zone Management
Department of Conservation and Cultural Affairs
Virgin Islands Government

Submitted by:
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Kingshill, St. Croix, VI

Prepared by:
Coastal Consultants
Kingshill, St. Croix, VI

June, 1987

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AT
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ST. CROIX, U.S. VIRGIN ISLANDS

1.00 Applicant:

Haines Enterprises, Inc.
P.O. Box 2119 Kingshill
St. Croix, VI 00850

Telephone: 809-778-0945

2.00 Location of Project:

Plots 30 and 31, Estate Morningstar
Northside B Quarter
St. Croix, U.S. Virgin Islands

Geographical coordinates:
Latitude: 16°46'26" N
Longitude: 64°45'08" W

The project is located on the western shore of Salt River Bay, on the arm of known as Sugar Bay, and has public access by North Shore Road (Route 80), which runs through the project site.

2.01 Location and Agency Review Map:

This map is given in Figure 2.01.1 on page 2. The Coastal Zone Management Plan line between the first and second tiers is shown in Figure 2.01.2; the line passes through the project site, following the right-of-way for North Shore Road.

3.00 Abstract:

A two-story complex comprising a marina, cafe restaurant, shops and offices will be built on a 0.54 acre site on the western shore of Sugar Bay, an arm of Salt River Bay, St. Croix. The site is zoned W-1 (Waterfront-Pleasure), and all proposed uses of the site are compatible with that zoning. The land-based part of the project will consist of two two-story buildings connected by a one-story covered dining deck, and a one story building for storage, laundry and showers. Total square footage of building floor space is 2909 sq ft. The buildings will cover an area of 1881 sq ft; the elevated wooden decks and walks will cover 3732 sq ft. A 52-slip wooden pier in a T shape, having 594 linear ft of main deck, would extend approximately 320 ft into Sugar Bay. Phase I of the pier, 28 slips, would be built first, followed by Phase II, another 24 slips. A concrete boat ramp will be constructed to replace the currently-used dirt ramp, and off-street parking will be provided for two boat trailer rigs. There will be off-street parking for 19 additional vehicles. The site

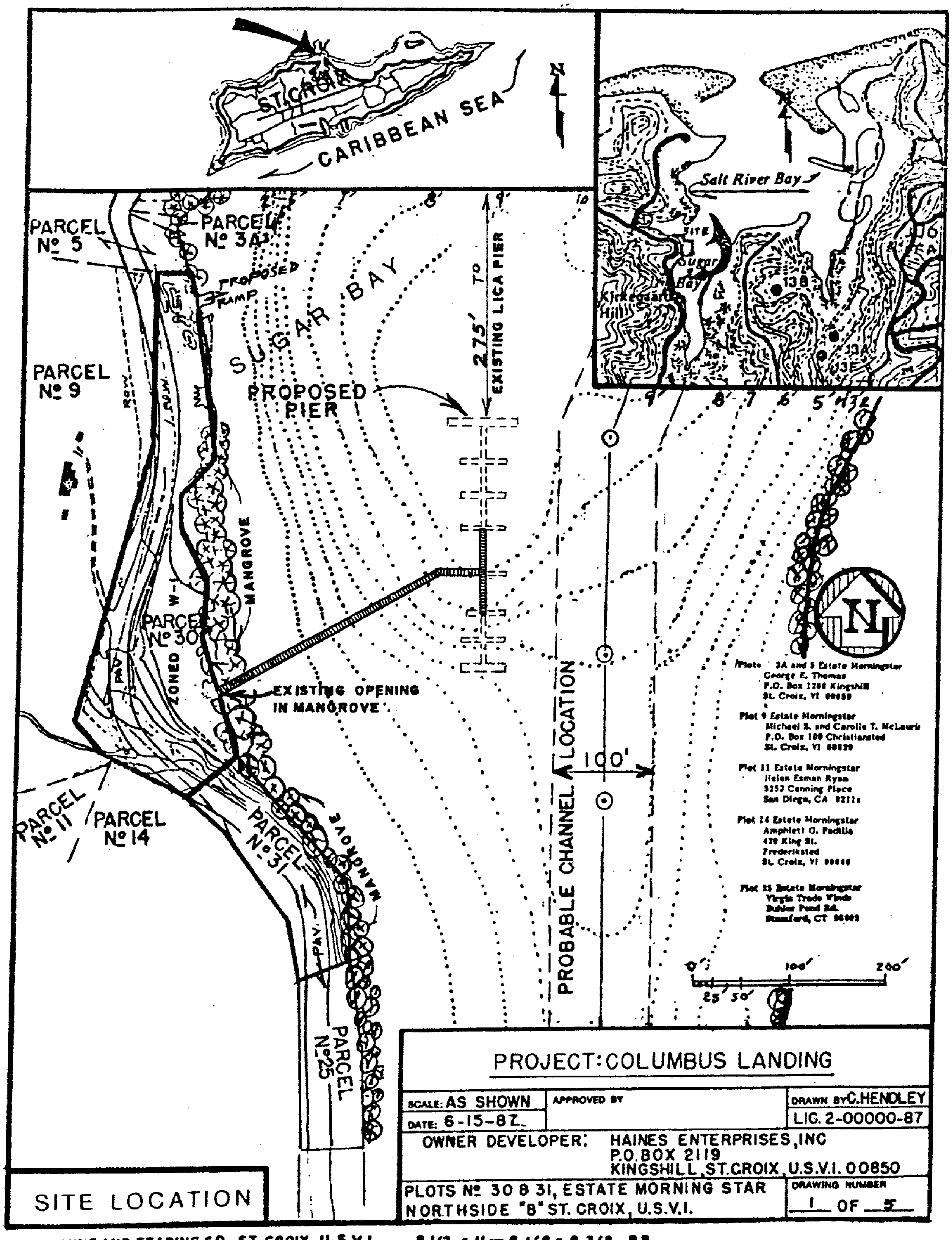


Figure 2.01.1 Location and Agency Review Map

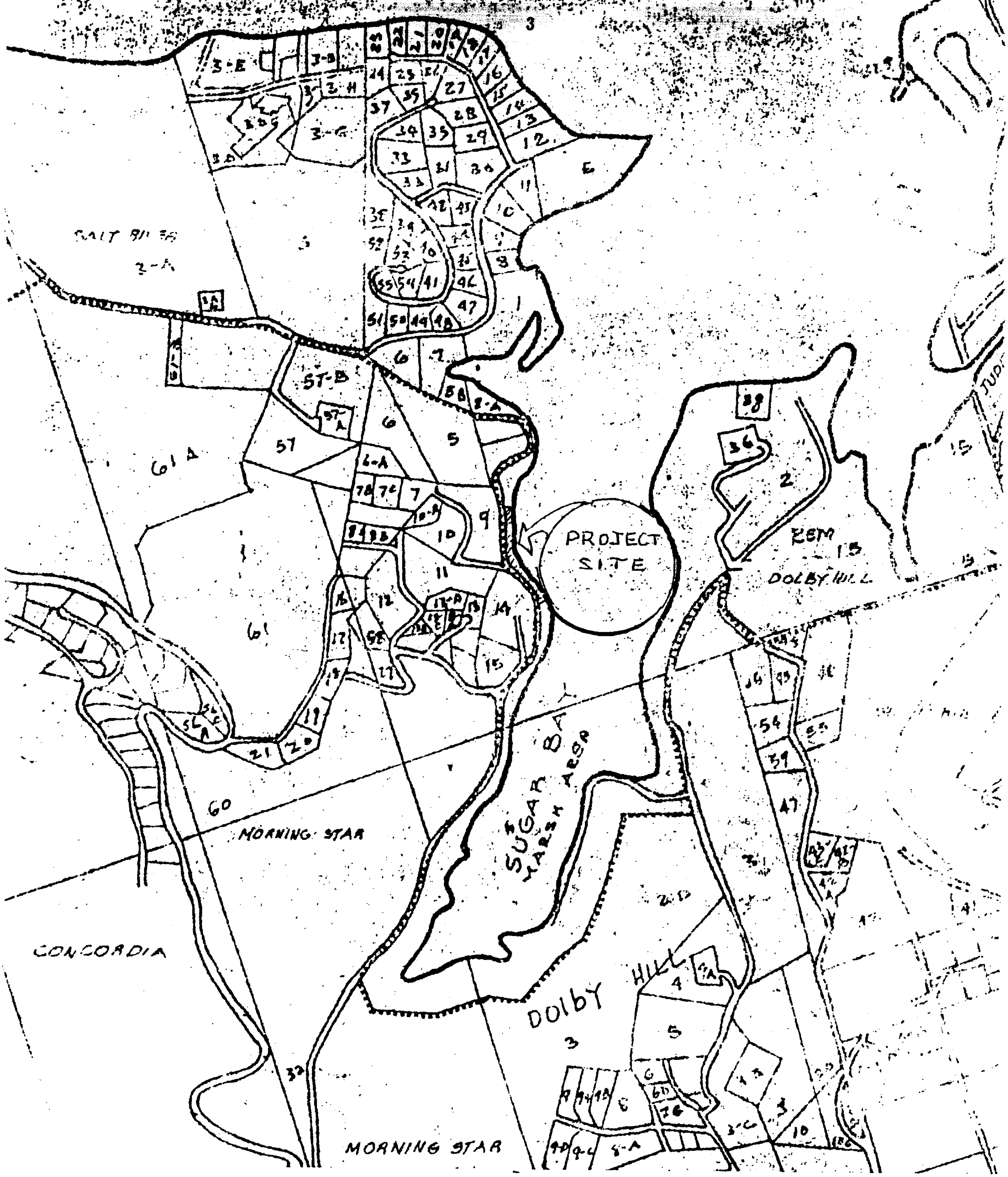


Figure 2.01.2. A section of the Coastal Zone Program Map for St. Croix, showing the location of the line between the first and second tiers, which appears as a dotted line following North Shore Road.

is subject to tidal flooding to +5 ft above mean sea level in a 100-year-frequency storm, so the buildings will be constructed with the first floor level at +6 ft. Surface runoff from the upland watershed bypasses the building site. A sedimentation basin to be installed at the northern end of the site will minimize the influx of large sediment particles into Sugar Bay. No mangroves will be removed as a result of the project; natural breaks in the red mangrove (Rhizophora mangle) fringe will allow the construction of the ramp and the pier. No freshwater resources exist in the area; a nearby well is brackish. A drilled well on the site will provide sanitary flushing water and washdown water for boats. Potable water will be collected from the roofs and stored in a cistern. Currents in the area of the proposed pier were primarily wind-generated and averaged 0.03 m/sec on a flood tide, and 0.04 m/sec on an ebb tide. Waves are typically less than one foot in height, and of short period, making the site a hospitable one for boats tied up to a pier. Marine water quality at a station 525 ft from the project site shows widely varying turbidity and salinity, due to freshwater runoff into the estuary from the upland 2881 acre watershed. The project is not expected to have a significant impact on turbidity. No dredging will be required for the project. A marine resources survey found a predominantly Thallasia-Halimeda (turtle grass-calcareous green algae) community in the area inshore, close to the mangroves to a depth of 2-3 ft; between 3 and 5 ft depth the predominant marine plants were green algae, and below 5 ft depth no plants or animals were found. Plants are not able to grow at this depth due to light limitation caused by turbidity in the water column. A terrestrial survey revealed a flora and fauna typical of St. Croix's protected shorelines. Burrowing land crabs are the most common animal; birds are frequently observed. A well-developed red mangrove fringe fronts the project site, backed by black (Avicennia nitida) and white (Laguncularia racemosa) mangroves having heights exceeding 9 m (30 ft). Those trees, large genips (Melicoccus bijugatus) and other species will be retained by the project. The upland scrub vegetation, consisting primarily of tan-tan (Leucaena leucocephala) and Acacia sp., had been cleared by hand. The buildings will be shorter in height than the surrounding trees. No wetlands will be filled, but some crab habitat will be occupied by buildings and parking lots. The elevated wooden decks and walks will provide protection of resident crabs from crabbers. No endangered species were found at the site. The project is not expected to have any significant impact on air quality, which is pristine. The project is compatible with the planned use of the Salt River area for recreation use, and will add facilities to support recreational activities. The pier, with the buildings, will provide marina space that is in short supply on St. Croix. Sewage pumpout will be provided to boats, and the sewage will be hauled off the site. The impact on traffic, roads, electricity demand and other public facilities and services is expected to be in insignificant. The project, fully developed, will cost appproximately $333,400 to construct and will generate $22,280 per year in rentals of space in the buildings and in the marina. Two full-time VI residents wil be employed to operate and maintain the completed project. No cultural resources were found on the site or underwater. No fuel will be dispensed at the marina, so no accidental spills are expected. No dredge spoils, nor effluents of any kind will be produced. No long-term adverse effects of the project are expected.

4.00 Statement of Objectives Sought by the Proposed Project:

The project will construct two two-storied buildings to house retail shops, a cafe/restaurant, and offices. A small single-story building will provide storage, maintenance, laundry and shower facilities. A 52-slip pier will be built to extend approximately 320 ft into Sugar Bay, to a depth of 9 ft, and a concrete boat ramp will be constructed to replace an existing unpaved area that is traditionally used by fishermen to launch boats.

5.00 Description of the Project:

Columbus Landing is a complex of retail shops, a seaside cafe restaurant, professional offices and a pier for pleasure and charter sail and motor boats, located on the Sugar Bay arm of Salt River Bay. There will be three buildings constructed: two two-storied buildings connected by a canopy-covered patio, and a single-story maintenance, storage, laundry and showers building. The buildings will cover an area of 1881 sq ft; elevated, uncovered or canopy-covered wooden decks, which serve as access boardwalks and cafe seating area, will cover 3732 sq ft. A concrete boat ramp 18 ft long by 15 ft wide will be built to replace an eroded unpaved area that has been traditionally used for launching small boats. Off-street parking will be provided for 19 automobiles and two boat trailer/automobile rigs. Storm runoff from the upland watershed onto the property will be channeled through a sedimentation basin before it enters Sugar Bay. No mangroves will have to be disturbed to accomplish the project. Many trees on the site (some to 2 ft in diameter and 40-60 ft in height) will be incorporated into the landscaping plan.

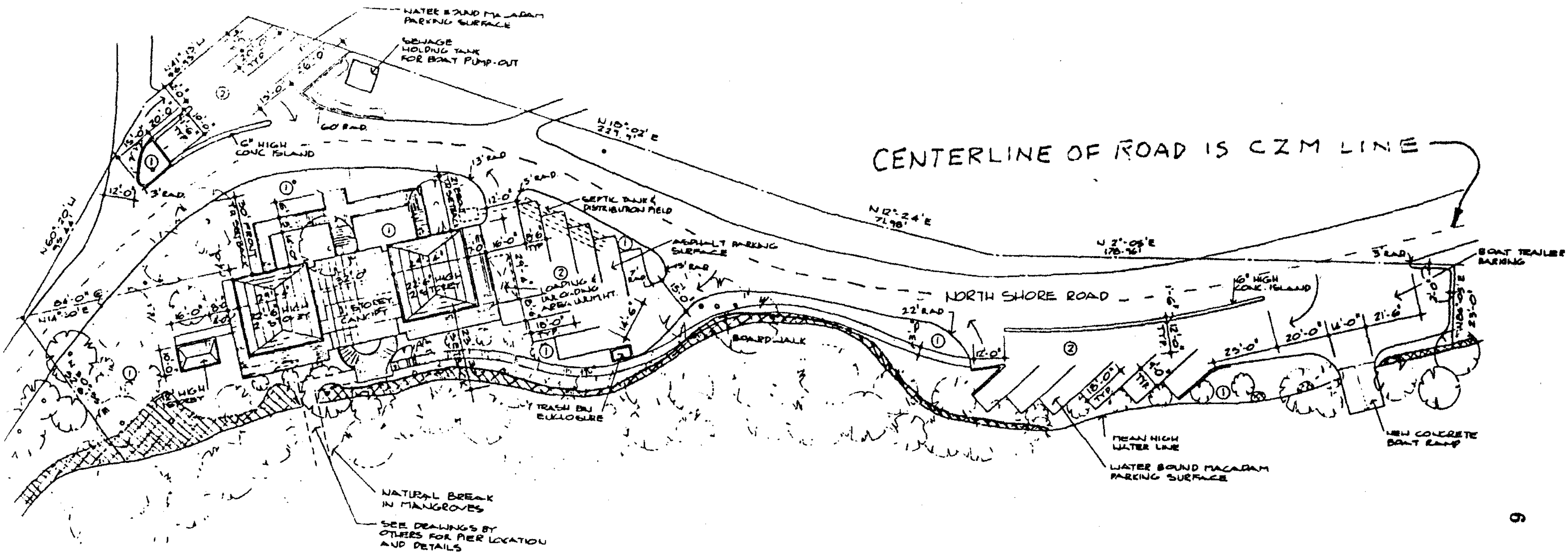
5.01 Proposed Dates of Construction:

The proposed starting date for construction is March 1, 1988, and the proposed completion date for the land-based part of the project is September 15, 1988. Construction on the pier is anticipated to begin about May 1, 1988 and be completed by October 1, 1988.

5.02 Drawings and Maps:

The land-based part of the project is shown in plan, elevation and sectional views in Figures 5.02.1, 5.02.2 and 5.02.3, respectively, and in larger scale in Appendix A. The floor plan, landscape plan and Erosion and Sedimentation Control Plan are shown in Appendix A.

The water-based part of the project is shown in Figures 5.02.4, 5.02.5, 5.02.6 and 5.02.7.



AREA OF MANGROVES ABOVE HIGH WATER LINE

BUILDING AREA

GROUND COVERAGE	1881 ⌀
TOTAL FLOOR AREA	2909 ⌀

USABLE OPEN SPACE	AREA	PERCENT	PERCENT OF TOTAL SITE
LANDSCAPED OR UNDISTURBED	13190 ⌀	56	51.7
PARKING AREA	10407 ⌀	44	40.8
TOTAL	23597 ⌀	100	92.5

BUILDING USE: OFFICE/RETAIL/RESTAURANT

PARKING SPACES

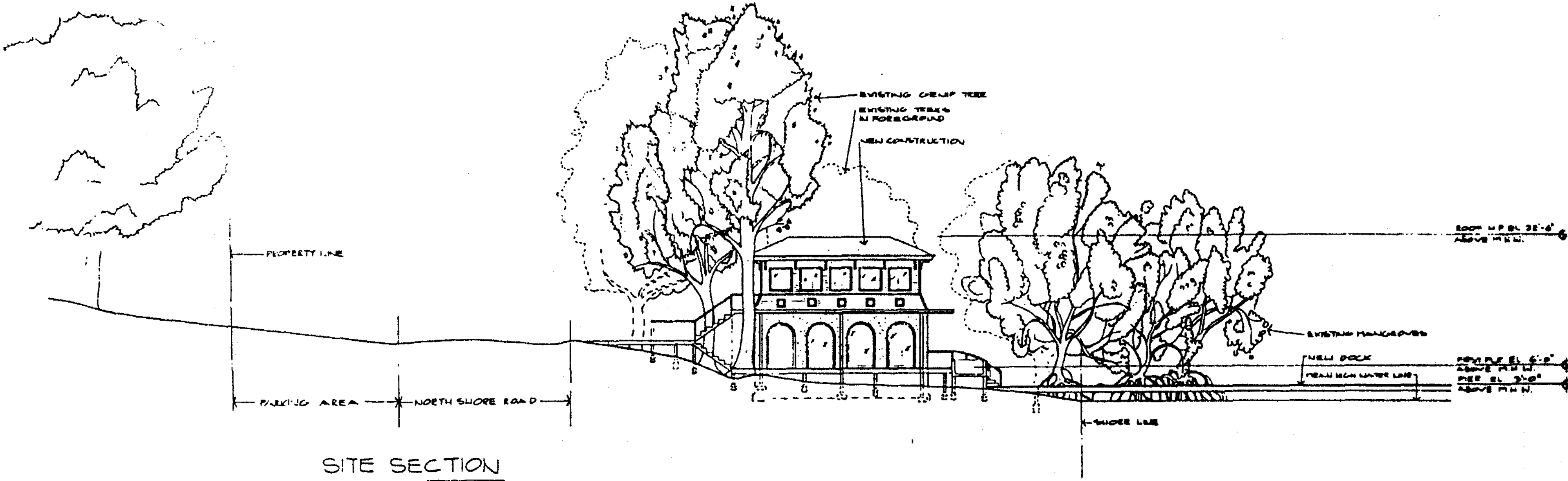
TYPE	REQ'D BY ZONING LAW	THIS PROJECT
EMPLOYEES OR PATRONS	19	19
LOADING/ UNLOADING	0	1

SUGAR BAY

N

Figure 5.02.1. Site plan.

PREPARED BY	OWNER/DEVELOPER	PROJECT	DRAWING TITLE	
STEVEN E. HUTCHINS / C. HENDLEY # 240 JUDITHS FANCY CHRISTIANSTED, ST. CROIX, U.S.V.I. (809) 773 8803 DRAFTSMAN LIC. Nº 2-01027-86	HAINES ENTERPRISES, INC. P.O. BOX 2119 KINGSHILL, ST CROIX, U.S.V.I. 00850 (809) 778-0945	COLUMBUS LANDING PLOT Nº 30 ESTATE MORNING STAR NORTHSIDE B ST CROIX U.S.V.I. W1 ZONED	SITE PLAN 0 10 20 30 FT DATUM ELEVATIONS ARE BASED ON SURVEY BY C. HENDLEY DATED 2.26.86	1



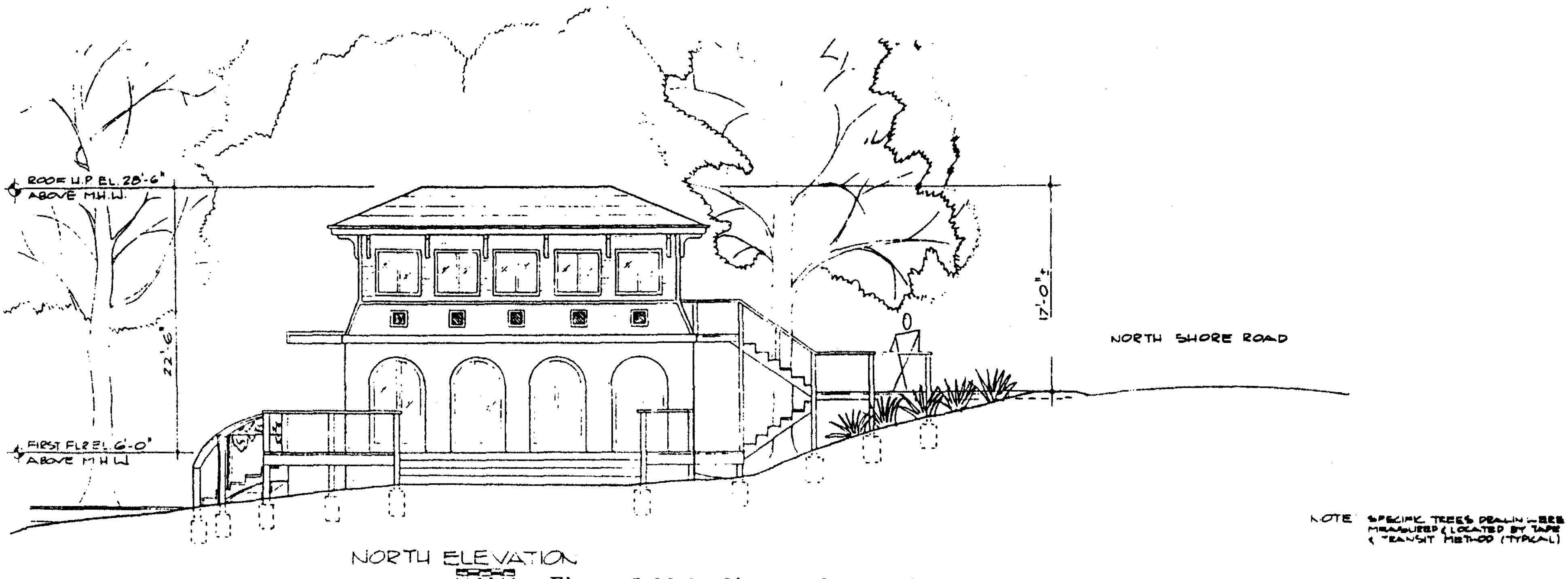


Figure 5.02.2. Site section and North elevation.

PREPARED BY	OWNER/DEVELOPER	PROJECT	DRAWING TITLE	
STEVEN E. HUTCHINS / C. HEN DUEY 8 2-10 JUDITHS FANCY CHRISTIANSTED, ST CROIX U.S.V.I. (809) 773-8803 DRAFTSMAN LIC NO. 2-01827-86	HAINES ENTERPRISES, INC PO BOX 2119 KINGSHILL, ST CROIX, USVI 00850 (809) 778-0145	COLUMBUS LANDING PLOT Nº 30 ESTATE MORNING STAR NORTHSIDE B ST CROIX, USVI W1 ZONED	SITE SECTION / ELEVATION SCALE AS NOTED	2

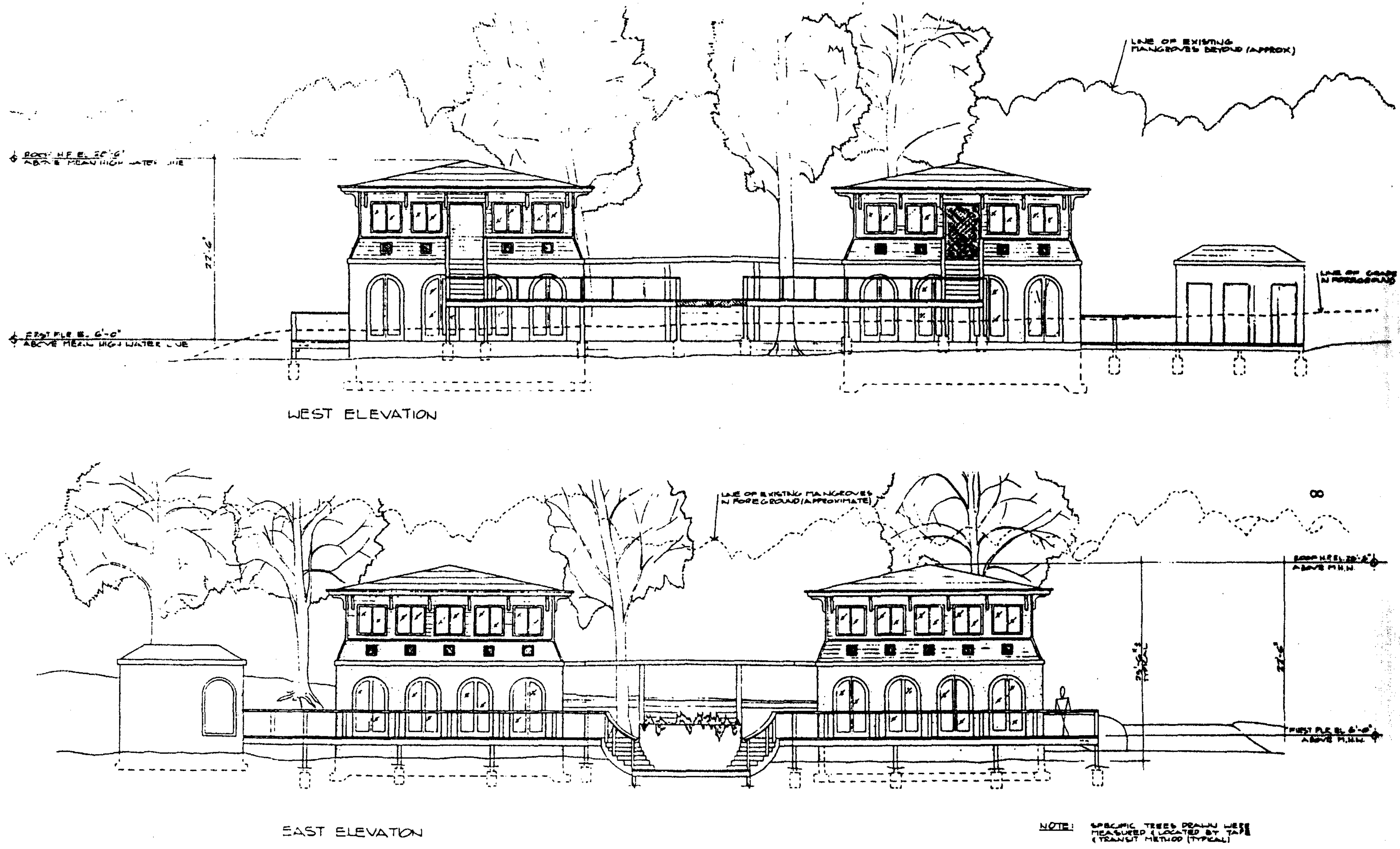
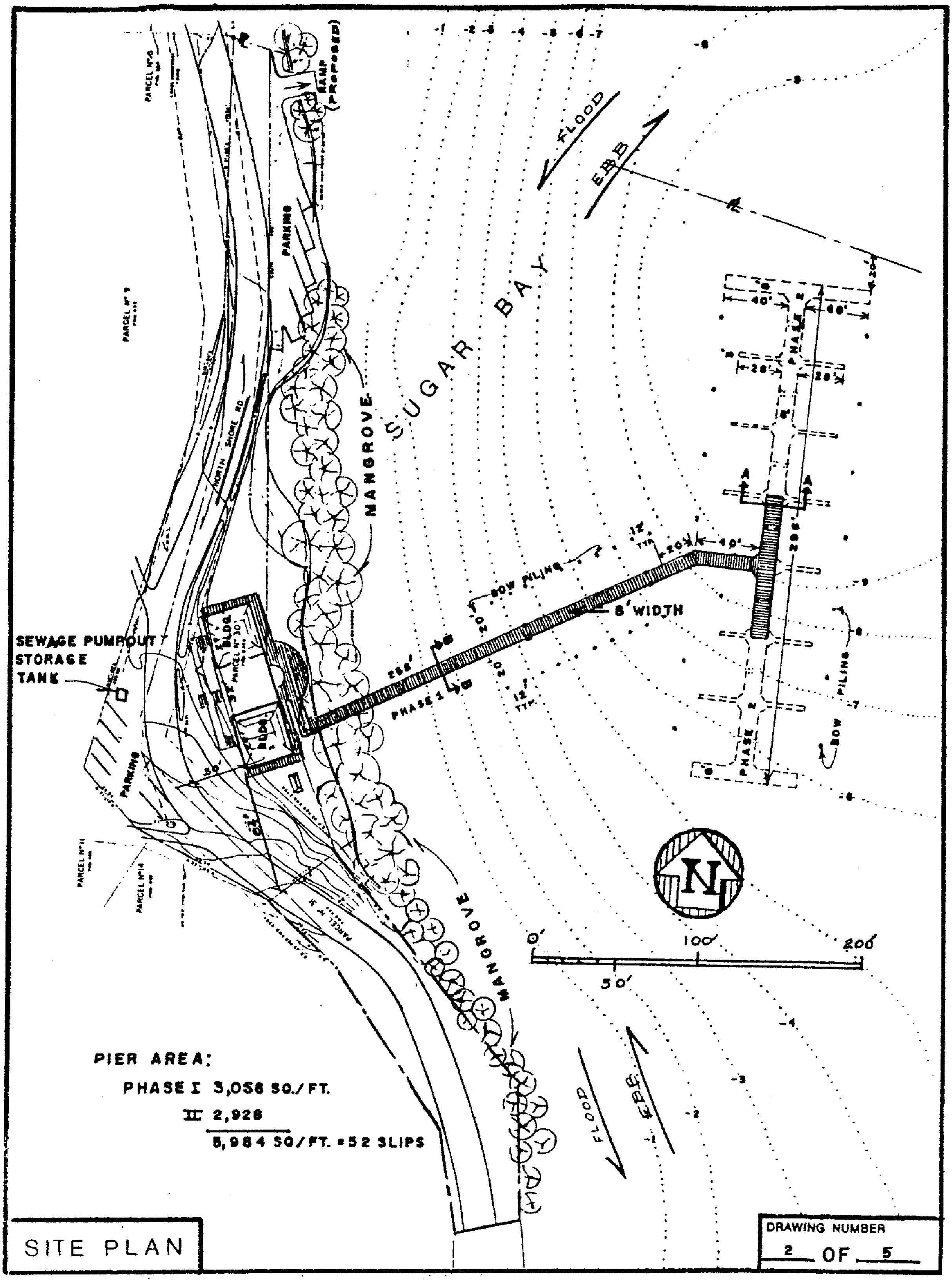


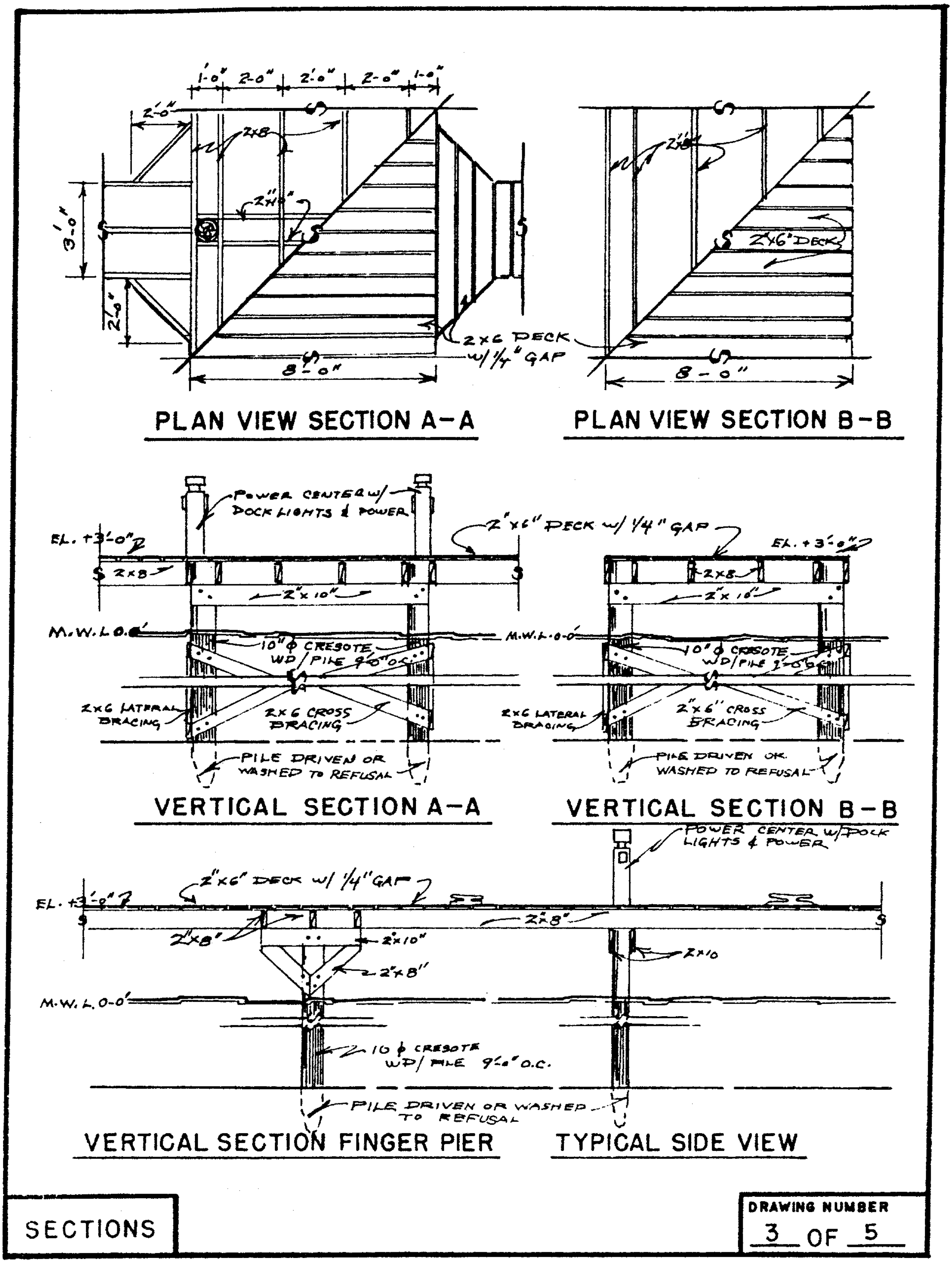
Figure 5.02.3. West and East elevations.

PREPARED BY	OWNER/DEVELOPER	PROJECT	DRAWING TITLE	
STEVEN E. HUTCHINS / C. HENDLEY #240 JUDITHS FANCY CHRISTIANSTED, ST CROIX, U.S.V.I. (809) 773 8803 DRAFTSMAN LIC Nº 2-01827-86	HAINES ENTERPRISES, INC. P.O. BOX 2119 KINGSHILL, ST. CROIX, U.S.V.I. 00850 (809) 778-0945	COLUMBUS LANDING PLOT Nº 30 ESTATE MORNING STAR NORTHSIDE B ST. CROIX U.S.V.I W1 ZONED	ELEVATIONS	3



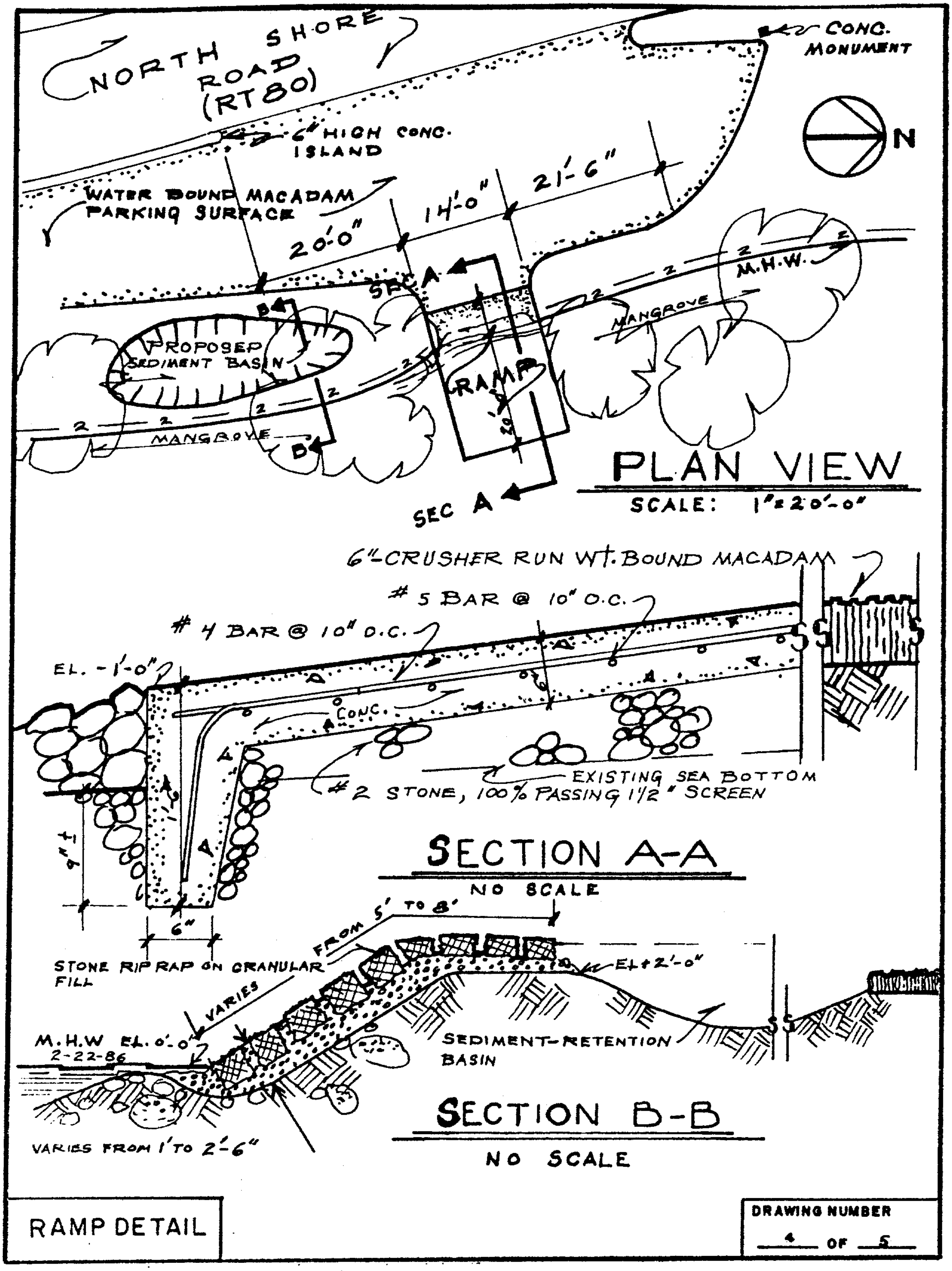
OCEAN MINE AND TRADING CO. ST. CROIX U.S.V.I. 8 1/2 x 11 — 6 1/8 x 8 3/8 PB

Figure 5.02.4, Plan view of the proposed pier.



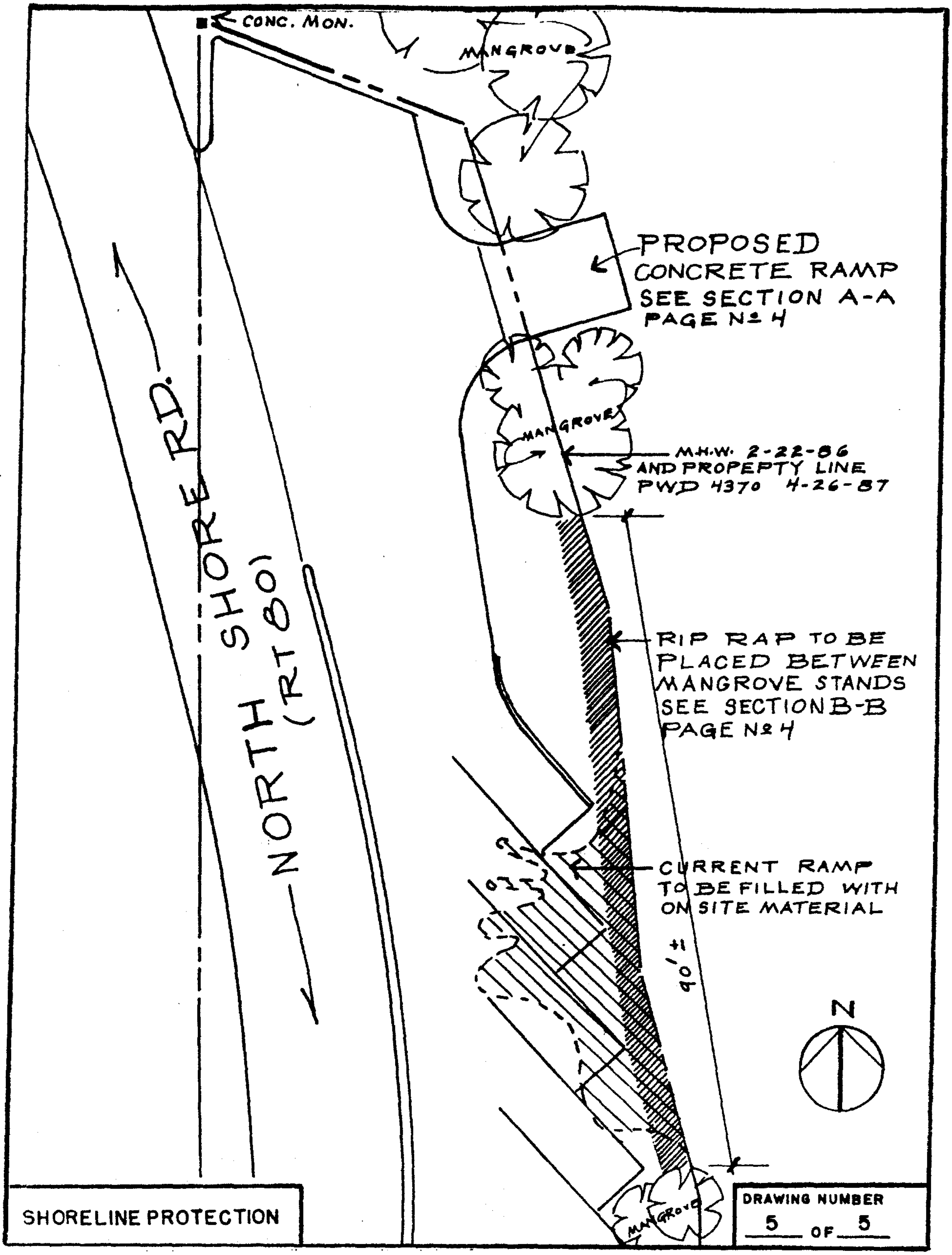
OCEAN MINE AND TRADING CO. ST. CROIX U.S.V.I. 8 1/2 x 11—6 1/8 x 8 3/8 PB

Figure 5.02.5. Section view of the proposed pier.



OCEAN MINE AND TRADING CO. ST. CROIX U.S.V.I. 8 1/2 x 11 — 6 1/8 x 8 3/8 PB

Figure 5.02.6. Ramp detail and rip-rap cross-section.



OCEAN MINE AND TRADING CO. ST. CROIX U.S.V.I. 8 1/2 x 11 — 6 1/8 x 8 3/8 PB

Figure 5.02.7. Location of concrete ramp and rip-rap

5.03 Project Work Plan:

The following sections give the Identification of Subprojects and Activities, and the Phasing of Subprojects and Activities for the project. These are presented here separately for the land-based and water-based parts of the project; the water—based part of the project (the pier) has been planned to be phased in its construction, with 28 slips being built first (Phase I), followed by 24 slips (Phase II) being constructed later. Depending on the phasing of financing, a decision may be made to construct both Phase I and Phase II simultaneously. The phasing for only Phase I of the pier is given here; Phase II would be similar to Phase II both in terms of subprojects and activities, and time for construction.

A. Identification of Subprojects and Activities

Land-Based

Subproject I: Preparation of Site
- Activity 1: Removal of trees/stumps by traxcavator
- Activity 2: Construct berm at East edge of building construction site
- Activity 3: Excavate for cistern
- Activity 4: Build entrance/exit ramps and South parking lot, using spoils from cistern excavation

Subproject II: Foundations and cisterns
- Activity 1: Dig footing trenches for all three buildings
- Activity 2: Set up forms and steel for cistern bottom
- Activity 3: Pour concrete footings and cistern
- Activity 4: Lay block foundation walls to first floor level
- Activity 5: Backfill cistern and foundation walls and rough grade around buildings
- Activity 6: Excavate for septic tank and drainage field; install same

Subproject III: Floors and Walls
- Activity 1: Pour concrete first floors on all buildings
- Activity 2: Lay concrete block walls for first story, cast bond bea and plaster inside and outside
- Activity 3: Install wood floors on second story of two large buildings
- Activity 4: Frame walls of second stories
- Activity 5: Install windows and doors
- Activity 6: Install rough wiring and plumbing

Subproject IV: Roofs and Decks
- Activity 1: Excavate footings for deck support posts
- Activity 2: Pour footings for deck support posts
- Activity 3: Install decks and railings around and between buildings and steps to second floor
- Activity 4: Install roof framing, planking and sheeting

Subproject V: Interior Finishing
- Activity 1: Tile ground floor
- Activity 2: Frame and panel movable interior walls
- Activity 3: Final trim and paint interior

Subproject VI: Exterior Finishing
- Activity 1: Final trim and exterior lighting installation
- Activity 2: Paint exterior of buildings
- Activity 3: Install boardwalk to North parking lot
- Activity 4: Install railings and grounds and deck lighting
- Activity 5: Final grade, plant and landscape grounds

Subproject VII: Boat Ramp
- Activity 1: Prepare washed stone bed for ramp slab
- Activity 2: Place reinforcing steel on crushed stone bed
- Activity 3: Tremmy 7-bag-mix, early high strength concrete onto crushed stone bed
- Activity 4: Pour concrete ramp apron

Subproject VIII: Parking Lots
- Activity 1: Install rip-rap at North Parking lot location
- Activity 2: Backfill rip-rap with crushed stone, then dirt fill
- Activity 3: Grade/fill North, South and West parking lots to final grade
- Activity 4: Install curbing, islands, trash bin enclosure
- Activity 5: Pave parking lots with water-borne macadam or asphalt
- Activity 6: Paint aisle stripes; install directional signs

Water-Based (Phase I)

Subproject I: Install Pier Piling
- Activity 1: Set alignment piles (by water-jet method) at proposed ends and corners of pier
- Activity 2: Stretch line between piles for aligning piles
- Activity 3: Set piles at planned spacing

Subproject II: Install Decking
- Activity 1: Add deck support members to piles
- Activity 2: Install electrical, water and sewage pumpout conduits
- Activity 3: Install decking
- Activity 4: Install cross-bracing between piles

Subproject III: Finish Details
- Activity 1: Install power/water distribution centers on pier
- Activity 2: Install cleats, fender boards, and lights
- Activity 3: Construct sewage pumpout tank
- Activity 4: Install sewage pump
- Activity 5: Landscape around sewage storage tank

B. Phasing of Subprojects and Activities

	Months:	1	2	3	4	5	6	7	8

Land-Based 1/1——————6/15

Subproject I: Preparation of Site 1/1-1/2
- Activity 1: Removal of trees/stumps by traxcavator
- Activity 2: Construct berm at East edge of building construction site
- Activity 3: Excavate for cistern
- Activity 4: Build entrance/exit ramps and South parking lot, using spoils from cistern excavation

Subproject II: Foundations and cisterns 1/2-1/16
- Activity 1: Dig footing trenches for all three buildings
- Activity 2: Set up forms and steel for cistern bottom
- Activity 3: Pour concrete footings and cistern
- Activity 4: Lay block foundation walls to first floor level
- Activity 5: Backfill cistern and foundation walls and rough grade around buildings
- Activity 6: Excavate for septic tank and drainage field; install same

Subproject III: Floors and Walls 1/16———3/16
- Activity 1: Pour concrete first floors on all buildings
- Activity 2: Lay concrete block walls for first story, cast bond beam and plaster inside and outside
- Activity 3: Install wood floors on second story of two large buildings
- Activity 4: Frame walls of second stories
- Activity 5: Install windows and doors
- Activity 6: Install rough wiring and plumbing

Subproject IV: Roofs and Decks 3/16-4/15
- Activity 1: Excavate footings for deck support posts
- Activity 2: Pour footings for deck support posts
- Activity 3: Install decks and railings around and between buildings and steps to second floor
- Activity 4: Install roof framing, planking and sheeting

Subproject V: Interior Finishing 4/1-4/30
- Activity 1: Tile ground floor
- Activity 2: Frame and panel movable interior walls
- Activity 3: Final trim and paint interior

Subproject VI: Exterior Finishing 4/30—6/15
- Activity 1: Final trim and exterior lighting installation
- Activity 2: Paint exterior of buildings
- Activity 3: Install boardwalk to North parking lot
- Activity 4: Install railings and grounds and deck lighting
- Activity 5: Final grade, plant and landscape grounds

Subproject VII: Boat Ramp 6/15-6/20

Activity 1: Prepare washed stone bed for ramp slab
Activity 2: Place reinforcing steel on crushed stone bed
Activity 3: Tremmy 7-bag-mix, early high strength concrete onto crushed stone bed
Activity 4: Pour concrete ramp apron

Subproject VIII: Parking Lots 6/20-7/15

Activity 1: Install rip-rap at North Parking lot location
Activity 2: Backfill rip-rap with crushed stone, then dirt fill
Activity 3: Grade/fill North, South and West parking lots to final grade
Activity 4: Install curbing, islands, trash bin enclosure
Activity 5: Pave parking lots with water-borne macadam or asphalt
Activity 6: Paint aisle stripes; install directional signs

<u>Water-Based</u> 4/1————————8/1

Subproject I: Install Pier Piling 4/1———6/1

Activity 1: Set alignment piles (by water-jet method) at proposed ends and corners of pier
Activity 2: Stretch line between piles for aligning piles
Activity 3: Set piles at planned spacing

Subproject II: Install Decking 6/1—7/1

Activity 1: Add deck support members to piles
Activity 2: Install electrical, potable water and washdown water conduits
Activity 3: Install decking
Activity 4: Install cross-bracing between piles

Subproject III: Finish Details 7/1—8/1

Activity 1: Install power/water distribution centers on pier
Activity 2: Install cleats, fender boards, and lights
Activity 3: Construct sewage pumpout tank
Activity 4: Install sewage pump
Activity 5: Landscape around sewage storage tank

6.00 ENVIRONMENTAL SETTING AND PROBABLE PROJECT IMPACTS ON THE ENVIRONMENT

The project is located on the west side of Sugar Bay, an arm of Salt River Bay. The site consists of two plots, Plot 30 and 31 Estate Morningstar. The land-based part of the project will be built only on Plot 30. The water-based part of the project (the pier) will be built over submerged lands bounded by extensions of the northern boundary of Plot 30 and the southern boundary of Plot 31. The environmental setting of the project and the expected impacts of the project on the site are detailed in the sections that follow.

6.01 Climate and Weather

The climate on St. Croix is subtropical and semi-arid. Temperatures vary between 70° and 85°F, with an annual mean temperature of about 79°F. Rainfall averages 40 to 45 inches per year for this section of St. Croix; nearly half of the annual rain falls during the months of August, September, October and November (Jordan, 1975) Rainfall is generally of short duration but high intensity, and can result in flash flooding in lowlands.

The wind regime in the Virgin Islands is dominated by the "Trade Winds" or "Easterlies" which vary seasonally and can be grouped into four seasonal modes: 1) December to February; 2) March to May; 3) June to August; 4) September to November (Brown and Root, 1974). These seasonal modes are given here as published in a technical document published by Island Resources Foundation (Island Resources Foundation, 1976):

December-February During the winter the trade winds reach a maximum and blow with great regularity from the east-northeast. Wind speeds range eleven to twentyone knots about sixty percent of the time. Speeds greater than twenty knots occur about twenty-five percent of the time in January. This is a period when the Bermuda High is intensified with only nominal compensating pressure changes in the Equatorial Trough.

The trade winds during this period are interrupted by "Northerners" or "Christmas Winds" which blow more thn twenty knots from a northerly direction in gusts from one to three days. Such outbreaks average about thirty each year. They are created by strengthening of high presssure cells over the North American continent which, in turn, allows weak cold fronts to move south-eastward over the entire Caribbean region. These storms are accompanied by intermittent rains, by clouds and low visibility for mariners.

March-May During the spring, the trade winds are reduced in speed and blow mainly from the east. Winds exceed twenty knots only thirteen percent of the time in April. The change in speed and direction mainly result from a decrease in pressure of the Equatorial Trough.

June-August Trade winds reach a secondary maximum during this period and blow predominantly from the east to east-southeast. Speeds exceed twenty knots twenty-three percent of the time during July. The trend for increasing winds results from the strengthening of the Bermuda High and a concurrent lowering of pressure in the Equatorial Trough. Trade winds during this period are interrupted by occasional hurricanes.

September-November During the fall, winds mainly blow from the east or southeast and speeds reach an annual minimum. Only seven percent of the winds exceed twenty knots in October. The low speeds result from a decrease in pressure in the Bermuda High with only a slight compensating pressure decrease in the Equatorial Trough. During this period, especially during late August through mid-October, the normal trade wind regime is often broken down by easterly waves, tropical storms and hurricanes.

Since 1900, 24 hurricanes have passed within fifty miles of the Virgin Islands. The hurricane season extends from June through October, with the peak frequency of occurrence during September. The predicted frequency of hurricanes affecting the eastern Caribbean is one in every 16 years (Bowden, 1974) However, back-to-back hurricanes (David and Frederick) over a five-day period in September, 1979 are proof that hurricane frequency is difficult to predict.

6.02 Landforms, Geology and Soil

The site is a narrow strip of land fronting on Sugar Bay, approximately 720 ft long and varying in width from 34 ft to 150 ft. A 36 ft wide right-of-way for North Shore Road (Route 80) runs through the entire length of the site, occupying 40% of the site. The elevation of Plot 30 varies from sea level to +18 ft. The elevation on Plot 31, on which no construction is planned, run from sea level to approximately +30 ft.

The lower-lying land, along the waterfront, is a combination of calcareous sand and clayey muck of marine origin, and terrigenous clay loam soils. Rivera et al. (1970) classed the soils along the water as tidal swamp (Ts) and the upper elevations as Descalabrado clay loam (DeF). Much of the soil appears to be have been disturbed by road-building activity. There is no evidence of landfill by dredge spoils, nor is there any evidence or historical record of dredging activity at the site.

6.03 Drainage, Flooding and Erosion Control

A 100-year frequency tidal flood would raise mean sea level by as much as five feet and cause flooding of a large portion of the site. the building to be constructed will have their ground level elevations at +6 ft elevation above mean sea level. Figure 6.03.1 shows the pertinent portion of the Flood Insurance Rate Map for the project site.

The project site has a watershed area of 13 acres. The surface runoff from the entire watershed during a 100-yr frequency rainfall of 14 inches in 24 hours would rsult in a peak discharge of 213 cubic feet per second for a period of 0.1 hr (U.S. Dept. of Agriculture Soil Conservation Service, Christiansted, St. Croix; calculations in Appendix B). The runoff from the approximately 12 acres of watershed upland of the North Shore Road enters Sugar Bay at the site of the existing dirt boat ramp, led there by the slope of the road and berms along the east side of the road. This runoff is causing erosion of the boat ramp site. The project will install

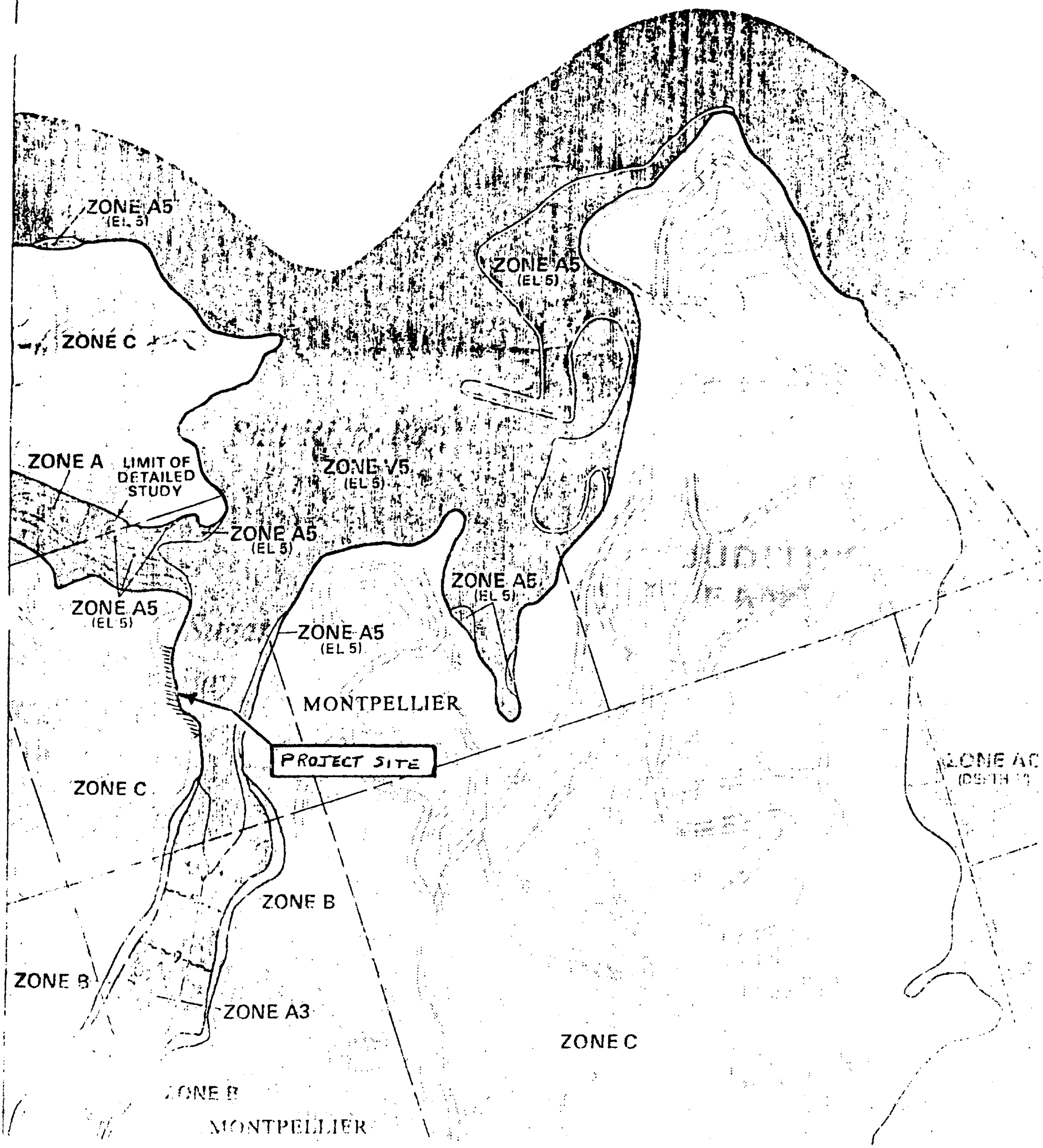


Figure 6.03.1. A portion of the Flood Insurance Rate Map for the project site. (Panel No. 780000 060C; Revised 3/18/87; Federal Emergency Management Agency)

a sedimentation basin into which the majority of the upland runoff will be lead. This basin will retain much of the runoff from frequent small rains, but will serve to catch only large sediment particles during heavy storms. The area of the existing dirt boat ramp is planned to be converted to a parking lot, and a concrete boat ramp will be built at the north end of the site. Erosion by runoff of rainfall on the project site will be controlled by use of vegetative groundcover of all undeveloped areas. No mangroves will be removed from the site, and the exposed shoreline on the northern end of the site, where the dirt boat ramp is located, will be protected from wave erosion by a rock revetment (rip-rap).

6.04 Fresh Water Resources

There are no existing surface freshwater resources in the area. There is a private drilled well located approximately 70 ft west of North Shore Road on Plot 5; it is 235 ft from the northwest corner of Plot 30. The well is presently inactive (the pump was stolen) but it was used as a source of brackish water for sanitary flushing (Mrs. G. Thomas, personal communication).

The project will utilize a drilled well to supply sanitary flushing water and boat washdown water. The well would most likely be located on the west side of North Shore Road, to locate it as far as possible from the sea.

6.05 Oceanography

6.05.1 Tides and Currents

Tidal fluctuations on St. Croix are primarily diurnal in character, one high tide and one low tide daily. Seasonal factors such as wind, sea state, weather and lunar cycle may result in periodic semidiurnal (two tides daily) tidal fluctuations. A typical tidal curve for Christiansted Harbor is given in Figure 6.05.1. The mean tide range is 0.24-0.34 m (0.8-1.1 ft).

The general pattern of water movement within Sugar Bay, Salt River study area was monitored over a 12-hr period on 17 March 1987 by using drift drogues and fluoroscein dye studies conducted at sampling stations shown in Figure 6.05.2. The rationale and methodology in employing drift drogues and fluorescein dye to determine water movement were described by Ecosystems (1980 and 1981) for Christiansted Harbor current studies. Replicate current measurements were made at each station location and the results are shown in Table 6.05.1. Current speed and direction, as indicated by drogue and dye movement, are represented as vectors in Figures 6.05.3 and 6.05.4. During the current measurement studies, the prevailing winds were from the northeast (045°) and varied in magnitude from 15-20 kts during the day to 5-10 kts at 1900 hrs. Offshore sea conditions were rough with seas of 1.0-2.0 m and easterly swells breaking on Salt River reef at 1.5-2.5 m. Water conditions in Salt River Bay and Sugar Bay at the study area had a moderate chop from gusty northeasterly winds and slight surge generated by the reformation of long period waves after intitially breaking on Salt River reef. Tidal fluctuations were recorded from a tide staff located on the Salt River Marina pier during the curent studies and are shown in Figure 6.05.5.

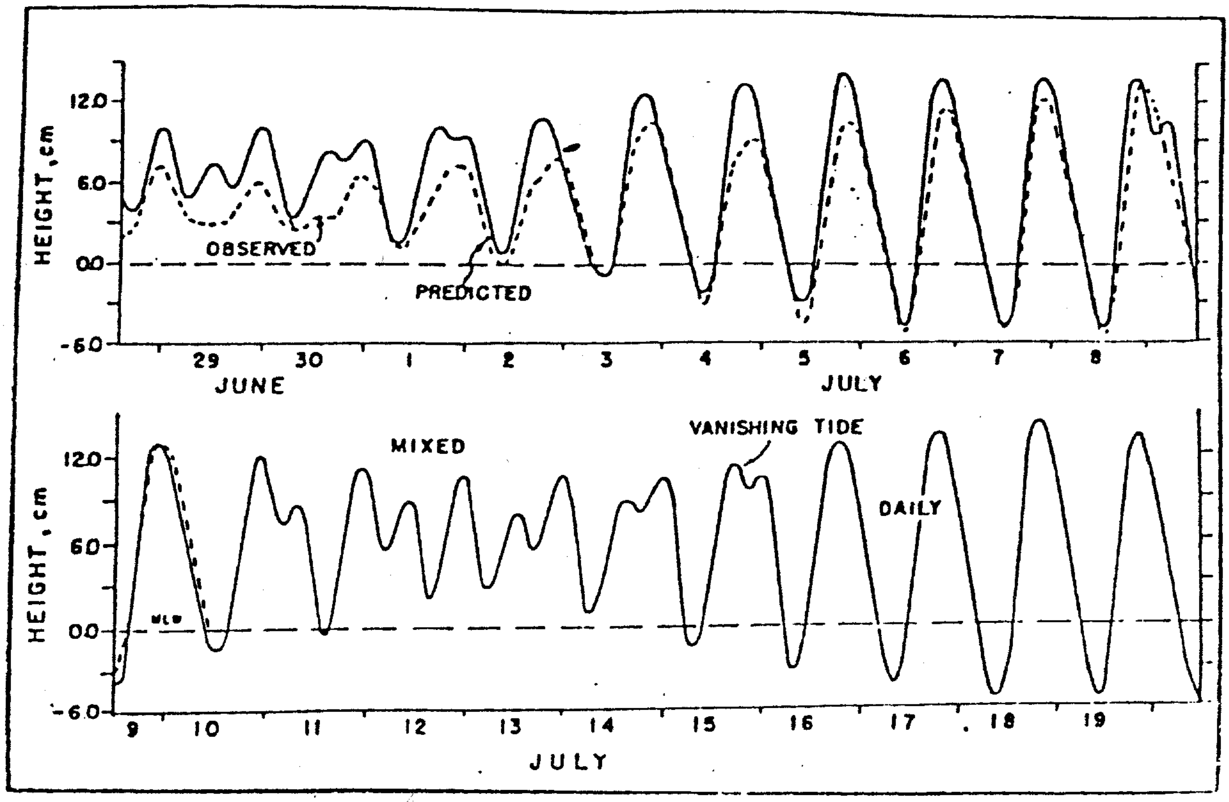


Figure 6.05.1. Tidal curve for Christiansted harbor.
(From Nichols et al., 1972)

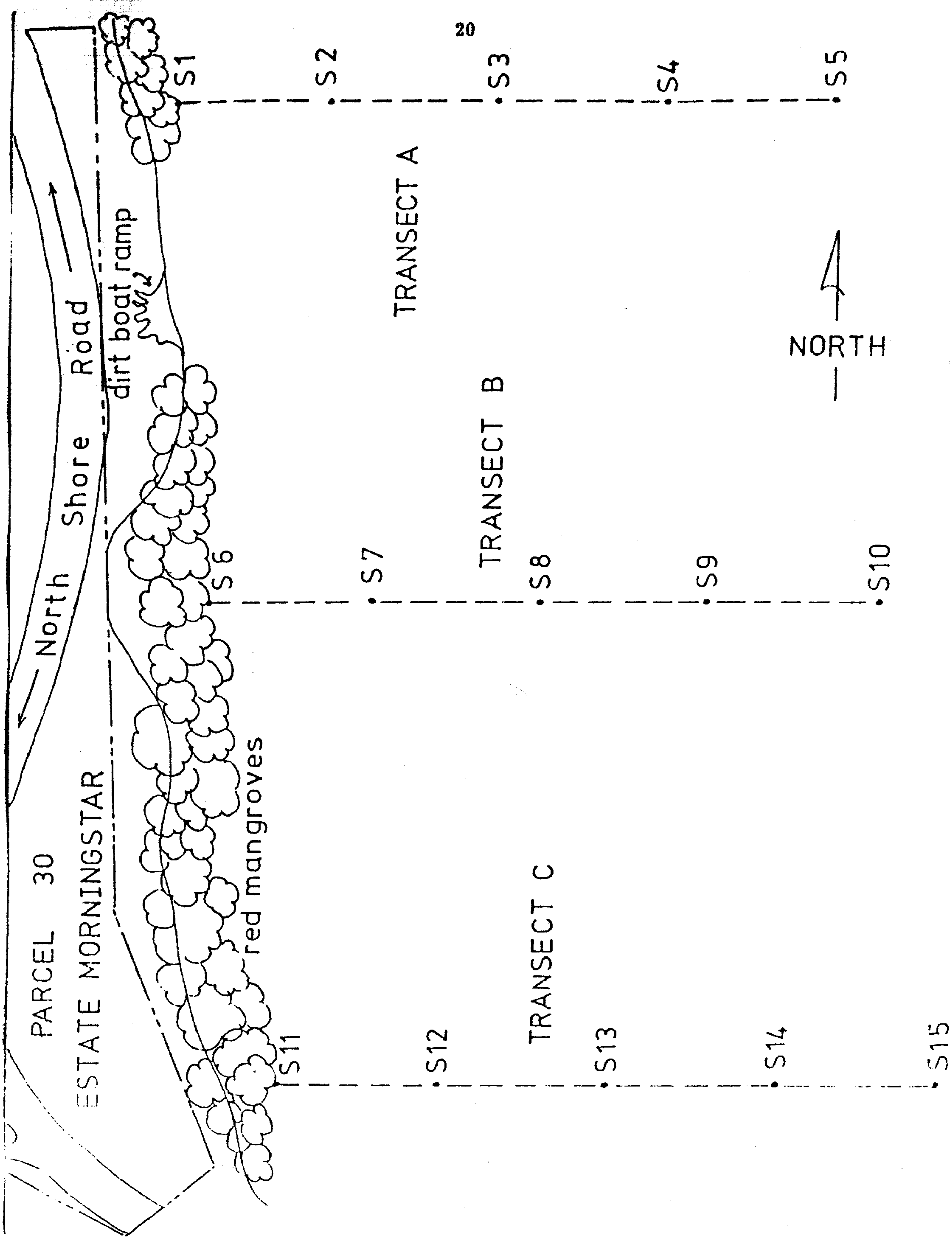


Figure 6.05.2. Location of transects and stations in Sugar Bay, Salt River, seaward of Plot 30 Estate Morningstar, where current studies were made on March 17, 1987.

TABLE 6.05.1 Data on distance, direction and speed of drift drogue and fluorescein dye patch movement at Stations 1-15 in the Sugar Bay, Salt River study area seaward of Plot #30 Estate Morning Star, 17 March, 1987. Station locations are shown in Figure 6.05.2. Data sets represent duplicate tests made between 0930 and 1830 hours.

STATION/ TIME	DEPTH (m)	DRIFT TIME (sec) Drogue	DRIFT TIME (sec) Dye	DISTANCE (m) Drogue	DISTANCE (m) Dye	DIRECTION (°) Drogue	DIRECTION (°) Dye	SPEED (m/sec) Drogue	SPEED (m/sec) Dye	COMMENTS
1/0930	0.60	101	180	3	3	310	052	.03	.02	Slight dispersal of dye;
		79	180			310	050	.04	.02	no movement
2/0945	0.7	86	129	5	2	245	260	.06	.02	
		85	180			252	240	.06	.01	
3/1000	0.9	41	175	5	3	245	235	.12	.02	
		60	180			245	235	.08	.02	
4/1015	2.0	58	180	5	2	245	220	.09	.01	
		48	180			245	220	.10	.01	
5/1035	2.7	41	80	5	5	245	275	.12	.06	
		41	74			245	260	.12	.07	
6/1115	0.4	60	158	3	5	220	160	.05	.03	
		39	124			200	160	.08	.04	
7/1130	1.0	34	78	5	5	225	220	.15	.06	
		33	91			225	200	.15	.05	
8/1145	1.5	21	88	5	5	220	245	.24	.06	Gusty winds (15-20 mph)
		24	80			220	245	.21	.06	from NE
9/1200	2.6	37	180	5	3/5	245	250	.14	.02	
		42	160			245	280	.12	.03	
10/1215	1.7	33	150	5	5/3	230	050	.15	.03	
		30	180			230	050	.17	.02	
11/1230	0.4	180	135	5	5	245	345	.03	.04	Slow movement to shore
		180	165			245	75	.03	.03	

(Cont.)

TABLE [illegible] Continued

STATION/ TIME	DEPTH (m)	DRIFT TIME (sec) Drogue	Dye	DISTANCE (m) Drogue	Dye	DIRECTION (°) Drogue	Dye	SPEED (m/sec) Drogue	Dye	COMMENTS
12/1245	0.6	143	74	5	5	210	150	.03	.07	
		146	145			210	030	.03	.03	
13/1300	1.2	93	180	5	5	210	310	.05	.03	
		85	99			210	210	.06	.05	
14/1315	1.1	30	76	5	5	225	225	.17	.07	
		24	145			225	235	.21	.03	
15/1330	1.1	27	180	5	5	210	030	.19	.03	
		23	162			210	030	.22	.03	
1/1500	0.6	57	180	3	2	285	106	.05	.01	Drogue movement towards mangroves; gradual dispersal of dye
		55	180			285	106	.05	.01	
2/1510	0.7	71	180	5	2/3	235	235	.07	.01	
		74	180			220	215	.07	.02	
3/1520	0.9	30	180	5	2/5	245	270	.17	.01	Wind dying
		59	180			245	245	.08	.03	
4/1530	2.0	32	92	5	5	230	205	.16	.05	
		32	68			250	265	.16	.07	
5/1540	2.7	36	121	5	5	240	240	.14	.04	
		76	118			260	270	.07	.04	
6/1610	0.4	118	137	5	5	230	175	.04	.04	
		53	180			200	175	.09	.03	
7/1620	1.0	68	180	5	2	195	195	.07	.01	
		44	180			195	195	.11	.01	
8/1630	1.5	36	141	5	3	220	290	.14	.02	
		30	180			225	230	.17	.02	

(Cont.)

TABLE 6.05.1 Continued

STATION/ TIME	DEPTH (m)	DRIFT TIME (sec) Drogue	Dye	DISTANCE (m) Drogue	Dye	DIRECTION (°) Drogue	Dye	SPEED (m/sec) Drogue	Dye	COMMENTS
9/1640	2.6	44 73	180 145	5	~~1~~ 5	220 210	030 030	.11 .07	.006 .03	Gradual dispersal of dye
10/1700	1.7	115 110	140 180	5	5	205 230	050 140	.04 .05	.04 .03	
11/1730	0.4	86 82	105 180	3	3	200 200	340 200	.04 .04	.03 .02	Gradual dispersal of dye
12/1745	0.6	109 180	180 140	5	5	230 230	255 285	.05 .03	.03 .04	
13/1755	1.2	77 108	180 180	5	5	215 205	330 030	.06 .05	.03 .03	
14/1810	1.1	87 85	94 90	5	5	255 255	270 270	.06 .06	.05 .06	
15/1820	1.1	49 84	150 129	5	5	260 260	265 240	.10 .06	.03 .04	

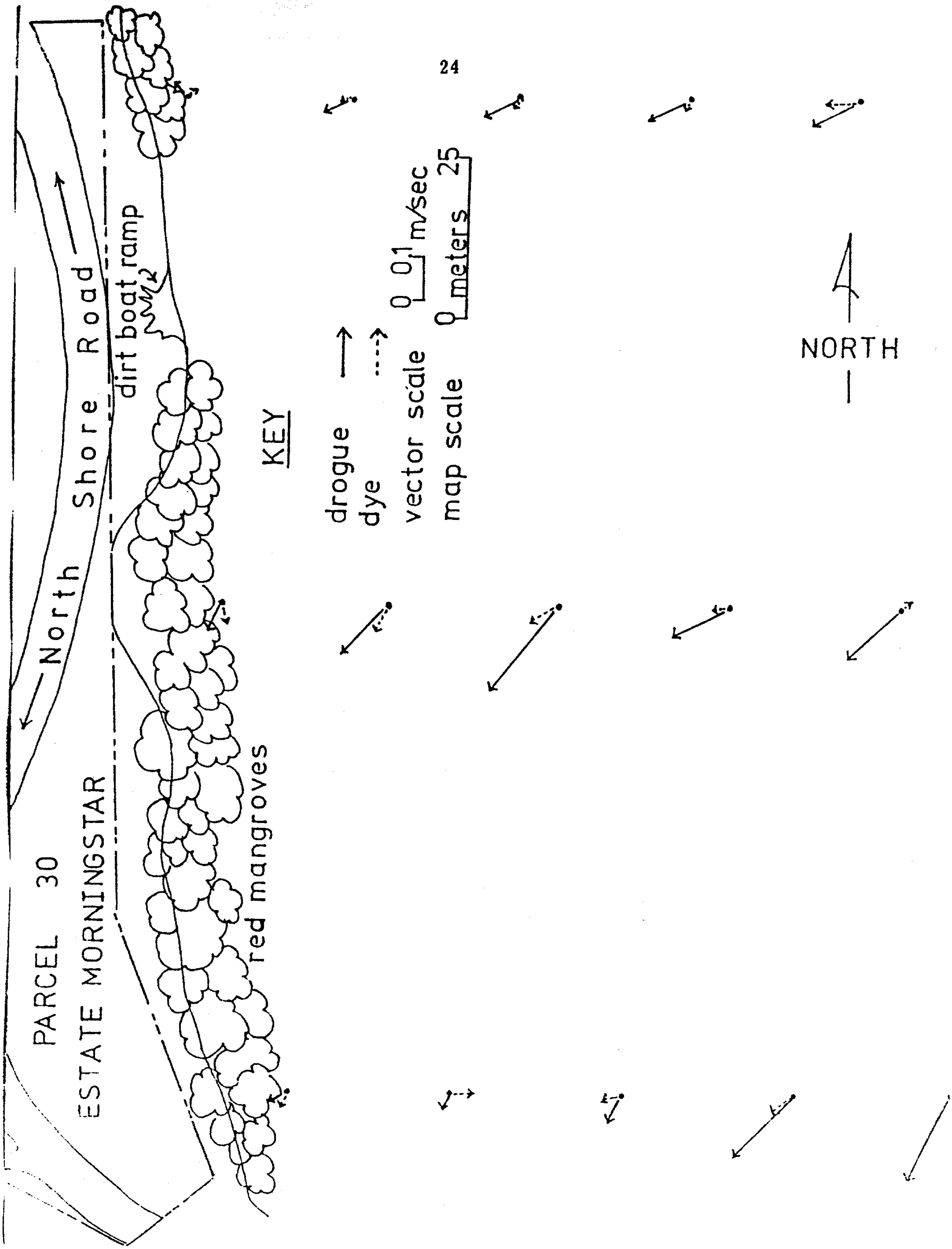


Figure 6.05.3. Ebb tide current pattern in Sugar Bay, Salt River, seaward of Plot 30 Estate Morningstar, 0930-1330 hrs, March 17, 1987.

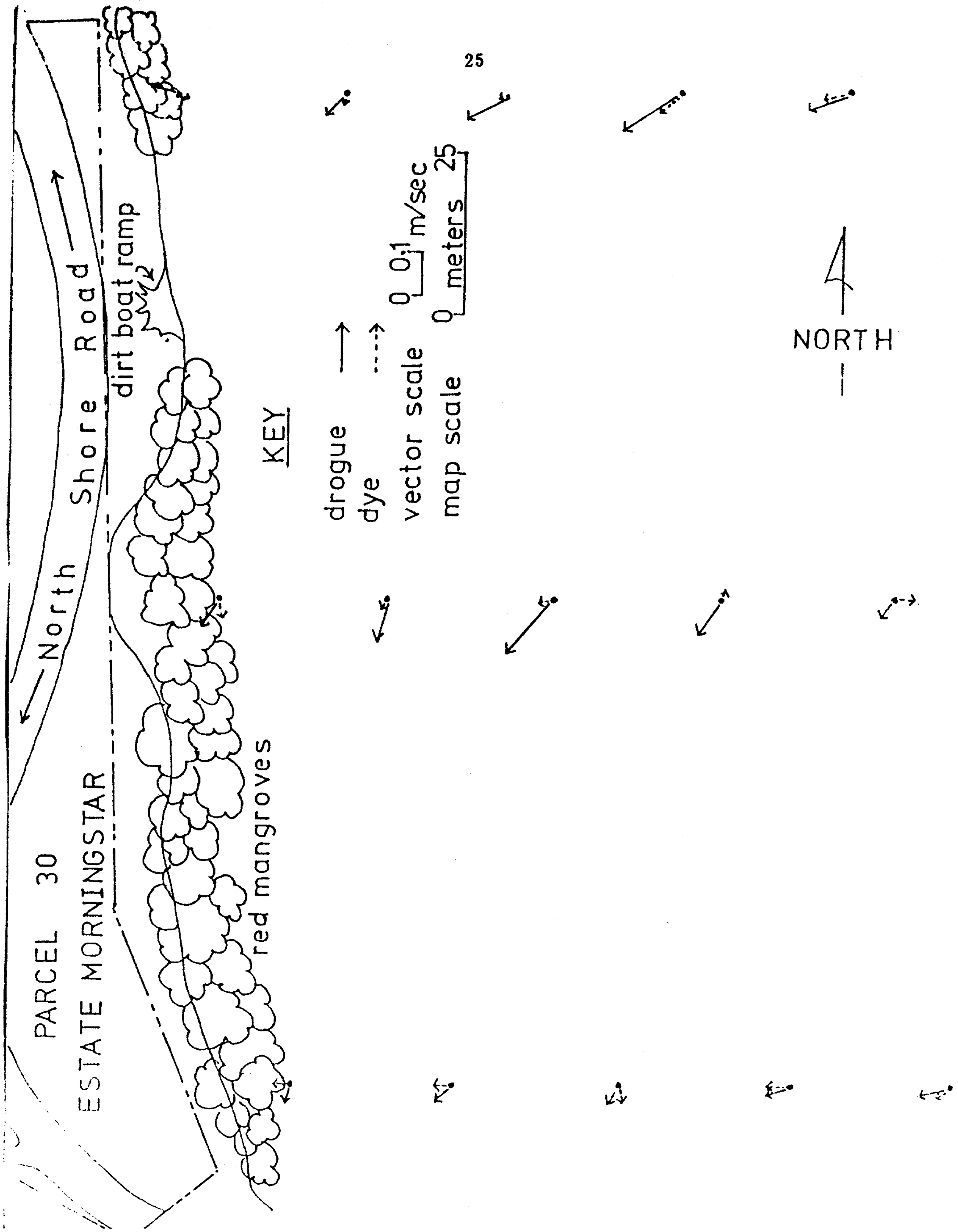


Figure 6.05.4. Flood tide current pattern in Sugar Bay, Salt River, seaward of Plot 30 Estate Morningstar, 1500-1830 hrs, March 17, 1987.

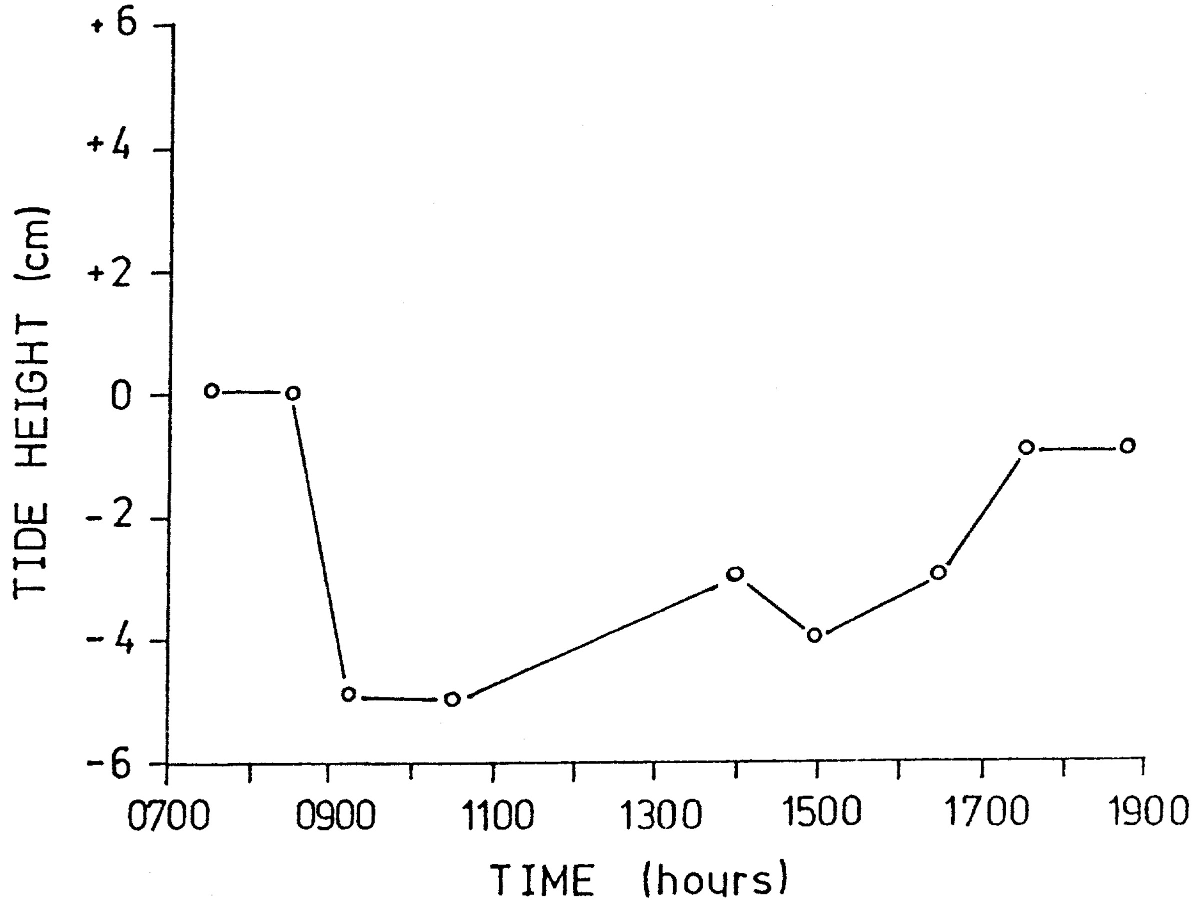


Figure 6.05.5. Observed tidal fluctuations as recorded from a tide staff located in the Salt River Marina, Sugar Bay, Salt River, March 17, 1987.

The ebb tide current pattern, as recorded seaward of Plot 30 Estate Morningstar between 0930 and 1330 hours on March 17, 1987 is shown in Figure 6.05.3. The flow of surface water movement, as determined by surface drift drogues along Transects A, B and C was to the southwest (235°), into the mangrove-fringed shoreline due to the northeasterly wind flow. The speed of this surface wind-generated current ranged from 0.03 m/sec to 0.22 m/sec in more open waters. The magnitude and direction of this surface flow remained uniform along the transects regardless of water depth, except in more protected areas along the shoreline. The mean speed of this wind-generated surface current was 0.11 m/sec (standard deviation = 0.07 m/sec). Subsurface currents, as determined by the movement of fluorescein dye, were much slower, ranging from 0.01 to 0.07 m/sec (mean = 0.04 m/sec; standard deviation = 0.02 m/sec). In water shallower than 1.0 m depth, subsurface currents were dominated by wind-generated surface currents with movement to the southwest. The deeper, offshore stations, such as No. 10 and 15, showed a slow subsurface current movement to the northeast (040°) at 0.03 m/sec.

The pattern of surface water movement during flood tide in the study area between 1500 and 1830 hrs on March 17, 1987 is shown in Figure 6.05.4. Drogue studies indicate a similar flow of surface water to the southwest (231°) due to the prevailing northeasterly winds; however, with the reduction of wind speed in the late afternoon, surface current speed was reduced to a mean of 0.08 m/sec (standard deviation = 0.04 m/sec). As in the current studies conducted at 0930-1330 hrs, subsurface currents in the shallow embayment waters were dominated by the stronger wind-generated surface current. As shown by the gradual dispersal of fluoroscein dye, subsurface currents were very slow, ranging from 0.006 to 0.07 m/sec (mean = 0.03 m/sec; standard deviation = 0.02 m/sec).

The generation of surface currents (and subsurface currents in shallow water) by the prevailing northeasterly wind is in general agreement with studies in Salt River Marina in 1982 (Antillean Engineers, 1983) and on the east side of Salt River Bay, at the proposed site of the Virgin Grand Beach Resort Hotel, Marina, and Condominiums (Sugar Bay Development, Ltd., 1986). However, differences in wind speed and tidal stages between these studies make any comparison among them unfruitful.

6.05.2 Wave Climate

Salt River estuary is a naturally sheltered embayment with a fringing reef at its mouth that protects Salt River Bay, Triton Bay and Sugar Bay from offshore seas and long period swells that normally approach the estuary mouth from the northeast and east. The waves and swells are refracted around the Judith's Fancy headland and Whitehorse Reef, which lies to the north of Judith's Fancy. Most of the energy of large waves and swells is absorbed when they break on the fringing reef, or upon refraction into Salt River Bay (Antillean Engineers, 1983; Sugar Bay Land Development, Inc., 1986). Under normal condition weather conditions, waves entering Sugar Bay (the location of the project) are primarily generated by easterly winds across the Salt River Bay; the waves are then refracted around the headland between Sugar Bay and Triton Bay. The waves are typically <0.3 m (1 ft) in height, and of short period. Fishermen launch small boats (less than 16 ft) from the shoreline at the project site at all times, regardless of the sea state offshore.

6.05.3 Marine Water Quality

The water quality in Sugar Bay has been measured intermittently since 1979 at a station (No. 7) located approximately 160 meters (525 ft) from the existing boat ramp on Plot 30. The data (in Appendix C) show widely fluctuating water quality, primarily related to the periodic influx of freshwater as a result of storm runoff from the surrounding watershed. As an example, during a five-month period of heavy runoff in June through October, 1979 (including hurricanes David and Frederick, which passed St. Croix three days apart), salinity ranged from the normal 34-35 ppt (parts per thousand) down to 4-7 ppt; Turbidity ranged from a typical low of 2.2 to a high of 98 FTU (formazine equivalent units; equivalent to NTU), due to the heavy sediment load brought into Salt River by the surrounding 2881-acre watershed. During the same period the suspended solids content ranged from 3.6 to 374 mg/l. This range of water quality values is quite remarkable, considering that the sampling was done only one day each month, and the peak values—which occurred during the periods of heavy runoff during storms—were most likely never measured.

Dissolved oxygen at Station 7 was 5 mg/l or greater 97% of the time, indicating close to saturation or super-saturation; this is not unexpected, due to the high algal standing crop that is a perennial feature of Sugar Bay and the greater Salt River basin. Forbes and Haines (unpublished data) found that turbidity values were highly significantly correlated ($P<0.001$) with particulate protein values in the water column in Salt River during the period March 1976 to January 1977, a period of low rainfall and runoff; this is no doubt due to the large standing crop of microalgae (phytoplankton) which comprises much of the turbidity during "low runoff" conditions.

The impact of the proposed project on marine water quality is expected to be short-term, as a result of bottom disturbance due to jetting-in of pilings during construction of the pier, and later due to propeller wash by boats maneuvering in shallow water. No significant increase in turbidity due to sewage discharge by live--aboards on boats is expected, due to the flushing of Sugar Bay by normal tidal exchange and periodic runoff from the watershed, and because pump-out for sewage holding tanks will be provided.. The capablility of Salt River to absorb discharges from boats is unknown, but based on casual observations at Green Cay Marina, which has 40 live-aboards (and no pump-out facilities) in an area less than 10% the size of Salt River, but acceptable water quality, it would seem that Salt River could adequately accomodate over 100 liveaboard boats without significant impact on water quality, even if pumpout facilities were not used.

The most serious potential threat to water quality in Salt River related to boating is that of oily bilge discharges, which are expressly forbidden by Federal and V.I. law. Immature mangroves and attached algae, seagrasses and other littoral organisms exposed during low tides are particularly sensitive to oil spills. The key to minimizing oil discharges is diligent enforcement of anti-pollution laws by CZM and the U.S. Coast Guard. The minimum federal fine for oil discharge is $5000, with half the fine earmarked as a reward for information leading to a conviction. Boats with inboard engines should be required to keep oil-absorbing devices (such as Bilge Oilzorb®,Marine Development & Research Corp., 116 Church St., Freeport, NY 11520) in their bilges, to keep oil leaked or spilled into the bilge from being pumped overboard either accidentally or intentionally. These water-repellant "mini oil boom" devices absorb up to two quarts of oil, and retail locally for $11.55.

The relocation of the boat ramp and diversion of runoff at the old boat ramp site into a sedimentation basin will have a positive impact on water quality through reduction of introduced turbidity in Sugar Bay, although the overall reduction of turbidity will likely be insignificant. The landscaping of the grounds with groundcover will reduce erosion by runoff.

A request for water quality certification has been submitted to the Division of Natural Resources (Appendix C). That request gives greater detail on the expected impact of the proposed project on marine water quality; it concludes that the project will not have a significant impact on water quality, and that the natural background turbidity makes the use of the water quality standards inappropriate in Salt River.

6.05.4 Sea Bed Alteration

There will be no alteration of the sea bed by dredging or filling in this project. The only alteration to the sea bed will be the building of the boat ramp and installing pilings by the water jet method. The impact of pile jetting is short-lived; any sediments brought to the sea bed surface by this operation would be recolonized by adjacent flora and fauna.

6.06 Marine Resources

INTRODUCTION

Parcel #30 (PWD 2364) Estate Morningstar is located on the west shore of Sugar Bay which is part of Salt River Estuary situated on the north-central coast of St. Croix (Fig. 6.06.1). The area surveyed for marine resources was a strip approximately 530ft along the shoreline of Parcel 30 and extending ENE approximately 240 to 280ft offshore. The mangrove border on Plot 30 comprises an estimated 80% of the shoreline. Mangroves along the shoreline vary from 0 to 40ft in width from the high water mark to a 3ft depth seaward. The water depth surveyed was 0 to 9.5ft.

METHODS

The area was surveyed 3/3, 3/4, 3/7 and 3/11/87. Underwater visibility ranged from 1 to 3ft and water temperature was recorded at 25.2°C at 0800 hrs. The field work and data analysis for the marine resources survey was done by Dr. Mary Lou Pressick-Coulston.

The mangrove swamp roots were examined to identify major fauna and flora and estimate abundance of organisms.

Survey markers were placed along the seaward side of the mangroves 20ft apart. At each of 26 stations (see Fig. 6.06.2) bottom samples were taken using a $\frac{1}{4}m^2$ grid to standardize sample size and area coverage. For each of these plots, percent cover was estimated along the shoreline in addition to calculating the relative density of benthic flora (RD = D/TD, where D is the density of a single species expressed as a percent of the total density of all species in the sample TD).

Nine transects were run from the outer edge of the mangrove seaward with samples taken approximately every 40ft to 280ft offshore and a maximum depth of 9.5ft. Figure 6.06.2 shows the location and compass headings of the transects and sampling plot numbers. Each offshore sample was taken from a boat using a garden rake modified with weights for dragging and grabbing bottom samples. Visibility did not allow for visual examination of the bottom to estimate percent cover, therefore, only the relative density of the bottom cover was able to be calculated. The shallow areas inshore and on the northern end of the survey area, were observed using snorkling gear.

Relative densities (expressed in percent) of benthic flora are recorded in Table 6.06.1 for all samples along with depth and substrate type. Percent cover was estimated only for the inshore samples where sample plots of known size could be observed.

Algae identification was done with the aid of the collection prepared by Nancy Ogden available at the Hydrolab facility of West Indies Laboratory and the descriptions and keys found in Taylor (1972). A reference collection has been preserved and available upon request.

RESULTS

Surface Sediments. Our findings are consistent with those described by Gerhard, 1978. The inshore sediments (up to 5ft depth) are a course-grain carbonate substrate consisting mostly of mollusc shells and Halimeda fragments. Fine-grain low percentage carbonate sediments are found offshore between 5-10ft and contain no macro plant or animal life (see Fig. 6.06.3 from Gerhard, 1978). Plant life below 5ft is limited throughout the estuary. Gerhard (1978) describes these areas as fine-grained "sinks" which are topographic lows causing a blockage of plant growth by excessive turbidity which reduces photosynthetic rates. Other surface habitats observed in this survey were rocky, sandy and thick mud, approaching anaerobic conditions, mixed with mangrove leaf litter (see table 6.06.1).

Mangrove Prop Roots and Benthic Fauna. Marine invertebrates were noticeably absent from the mangroves. A sparce population of the mangrove periwinkle, Littorina angulifera, was observed above the waterline with very sparce parches of the flat mangrove oyster, Isognomon alatus, and the barnacle, Tetraclita squamosa stalactifera, observed on some of the inshore roots below the waterline. The orange fire sponge, Tedania ignis, was observed in dense patches on less than 1% of the roots. One unidentified blue sponge was found densely packed on one mangrove prop root. A single featherduster worm, Sabellastarte magnifica, was observed in the mud between the prop roots. In other parts of the estuary, such as the southern part of Triton Bay, mangroves have a much greater diversity of associated invertebrates. This paucity of species is probably the result of dramatic salinity changes in Sugar Bay as a result of the influx of freshwater from the 600 acre watershed during times of heavy rainfall. These salinity fluctuations could cause significant mortality of the organisms. The area also experiences high turbidity from runoff and the re-suspension of fine-grain bottom muds, another dramatic environmental perturbation probably responsible for the reduced number of organisms.

Mangrove Prop Root Flora. The mangrove prop roots contain a moderate abundance of algal species mostly confined to the seaward and less shaded protions of the mangrove. The dominant algae found attached to the roots were Laurencia sp., Acanthopora spicifera, Gracilaria sp., Hypnea musciformis, and Dictyota sp. There was an abundance of brown algae, mostly Dictyota spp., found along the shoreline in less that 1ft of water.

Benthic and Mid-water Fauna. During the entire survey no fish or other mid-water organisms were observed. Patches of blue sponge, the same as found on the mangrove roots, were observed twice in bottom grabs. Numerous sandy mounds, presumably constructed by ghost shrimp, Callianassa sp., were observed in the shallow grassy areas.

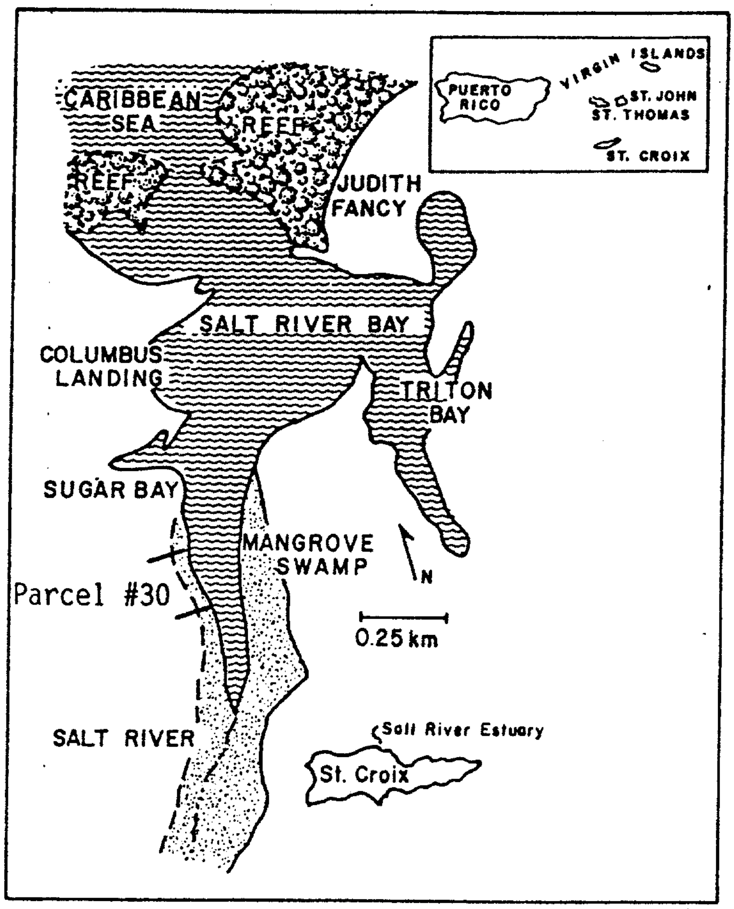
Benthic Flora. Figure 6.06.4 is a map outlining the various dominant marine vegetation zones. Inshore along the seaward portion of the mangroves the area is quite diverse and patchy. The seagrass, Thalassia testudinum, is found throughout the area along with very dense patches of the calcarious algae, Halimeda incrassata, which form patches of thick mats of almost 100% cover. In areas where the mud is thick and mixed with mangrove leaf litter, patches of Penicillus capitatus are dominant. In clearer areas with rocky substrate, patches of Caulerpa sertularioides dominate. In a few areas along the mangrove root edge, there are dense patches of red algae, Gracilaria spp. and Hypnea musciformis. These species, no longer attached to any substrate, are probably clumped in distribution as a result of current movement in the estuary.

There is an area where mangroves are absent from the shoreline and serves as a launch ramp for small fishing boats. The substrate here is sandy with scattered small rocks. The bottom flora here is quite different from that along the mangrove. Padina sancta-crucis and Dictyota spp. dominate with Penicillus capitatus, Schizothrix calcicola, Gracilaria sp., and Halimeda sparcely scattered throughout the area. This sandy area has only sparce plant cover (est. 25%) due partially to the boat traffic in this shallow area.

The area offshore at a depth of 2 to 3ft is dominated by a Thalassia-Halimeda community with occassional patches of Penicillus, Gracilaria and Dictyota.

In general, between 3 and 5ft offshore a Halimeda-dominated community exists where sparcely scattered patches of Caulerpa, Bryopsis, and Gracilaria can be found.

Below 5ft fine-grained mud exists and no macro fauna or flora are found here. Occassionally drift algae can be collected from this area, but they are unable to grow there due to light limitation and turbidity. Areas below 5ft are not favorable to sustain substantial and observable plant or animal life. Gerhard, 1975, also noted that low oxygen levels occur below 5ft in the southern part of Sugar Bay.



Map showing location of St. Croix, U.S. Virgin Islands, Salt River estuary on St. Croix, and geographic subdivisions of the Salt River estuary.

(Taken from Gerhard, 1978)

Figure 6.06.1. Location of Parcel #30, Estate Morningstar, proposed development site.

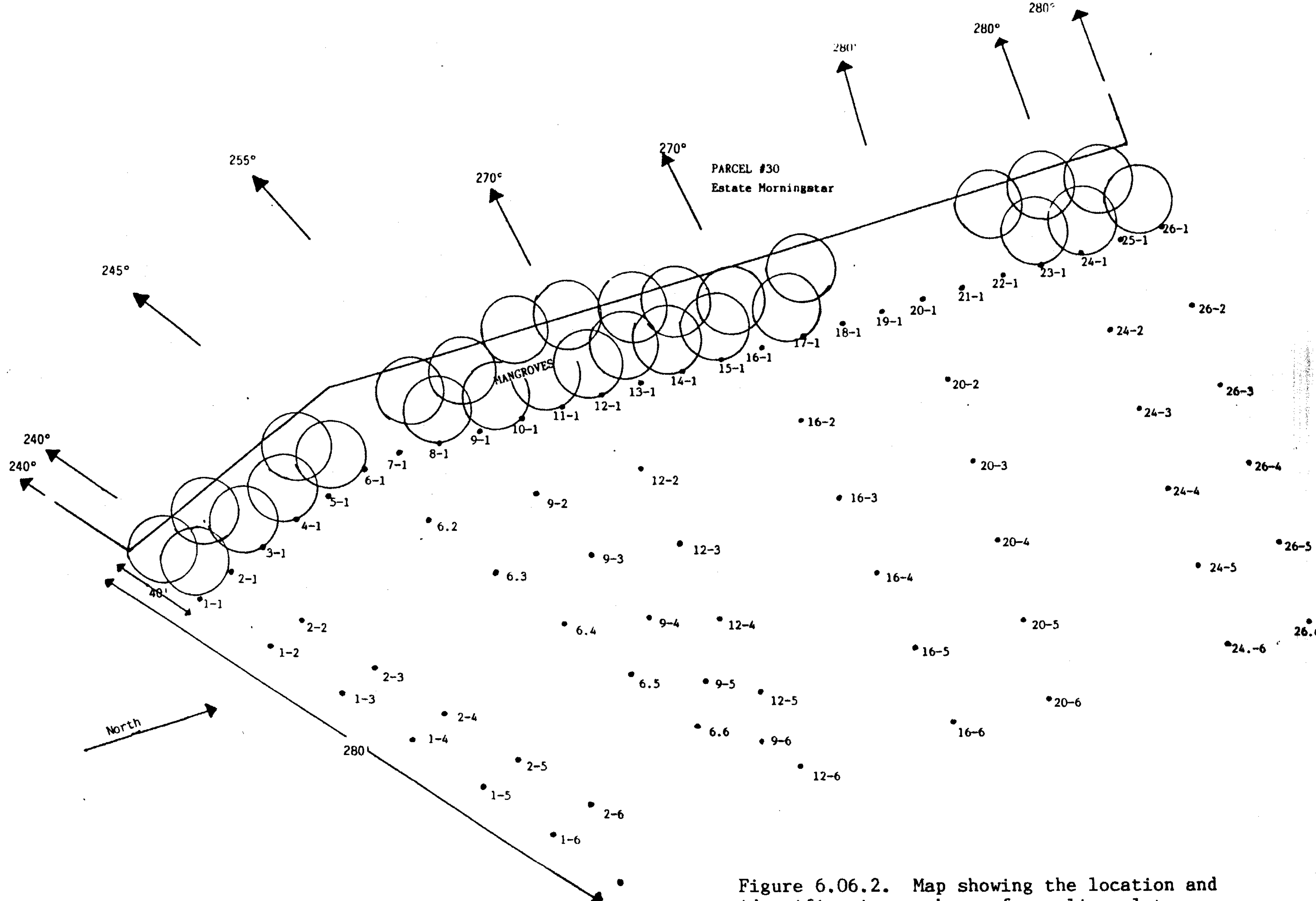


Figure 6.06.2. Map showing the location and identification numbers of sampling plots ENE of Parcel #30 Estate Morningstar.

Table 6.06.1. Summary of marine benthic flora at each sampling station, substrate type, depth, percent cover and relative density of species (RD = number of individuals as a percent of total individuals).

Sample Plot No.	Depth Feet	Percent Cover	Substrate Type 1/2/3/4/5	Relative density of flora species expressed as percent: Seagrasses: THALASSIA	SYRINGODIUM	Algae: HALIMEDA 1	HALIMEDA 2	CAULERPA	PENICILLUS	DICTYOTA	PADINA	SCHIZOTHRIX	GRACILARIA	HYPNEA	OTHER
1-1shore	1.0	20	1	50		50									
1-2	2.0		1	25		75									
1-3	3.5		1	50		50									
1-4	4.5		1	25		25		33					8		8
1-5	5.0		1			25							75		(Bryopsis 1)
1-6	8.2		1					50	17				33		
1-7	5.5		1			9		45					45		
2-1shore	1.5	5	1	50		50									
2-2	3.0		1				10								
2-3	4.5		1	33		33									33
2-4	5.0		1			10							90		(Bryopsis 2)
2-5	7.5		2	No macro fauna or flora											
2-6	8.0		2	No macro fauna or flora											
3-1shore	1.5	30	1	33		66									
4-1shore	1.5	30	1	9		45		45							
5-1shore	1.5	50	1	5		24		48					24		
6-1shore	1.0	80	1	48		48		2	2						
6-2	2.3		1	100											
6-3	3.0		1	50		50									
6-4	4.0		1			100									
6-5	9.0		2	No macro fauna or flora											
6-6	9.0		2	No macro fauna or flora											
7-1shore	1.0	80	1	48		48		2	2						
8-1shore	1.0	80	1	48		48		2	2						

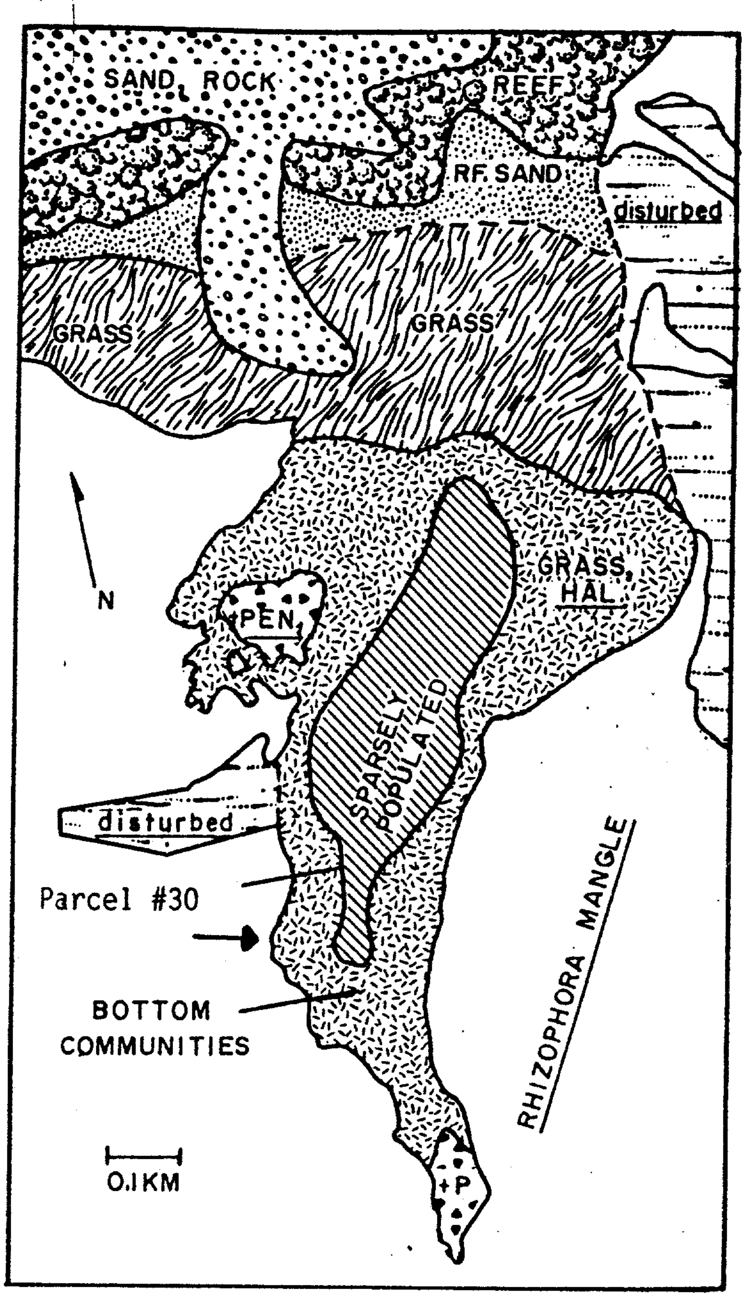
Table 6.06.1. continued

Sample Plot No.	Depth Feet	Percent Cover	Substrate Type 1/2/3/4/5	Relative density of flora species expressed as percent: Seagrasses: THALASSIA	SYRINGODIUM	Algae: HALIMEDA 1	HALIMEDA 2	CAULERPA	PENICILLUS	DICTYOTA	PADINA	SCHIZOTHRIX	GRACILARIA	HYPNEA	OTHER
9-1shore	1.0	20	5					100							
9-2	2.8		1			100									
9-3	3.5		1	30		70									
9-4	5.5		1			100									
9-5	9.0		2	No macro fauna or flora											
9-6	9.0		2	No macro fauna or flora											
10-1shore	1.5	20	3	50		50									
11-1shore	1.5	20	3	20									40	40	
12-1shore	1.0	20	1	33		33							33		
12-2	2.0		1	75		25									
12-3	3.0		1	25		75									
12-4	6.0		1			100									
12-5	9.0		2	No macro fauna or flora											
12-6	9.5		2	No macro fauna or flora											
13-1shore	1.5	80	1	20		40							40		
14-1shore	1.5	20	1					50					50		
15-1shore	1.5	10	3						100						
16-1shore	1.5	10	3										100		
16-2	2.5		1			100									
16-3	2.5		1	50		50									
16-4	5.0		1			50							50		
16-5	9.0		2	No macro fauna or flora											
16-6	9.0		2	No macro fauna or flora											
17-1shore	1.0	80	1										100		
18-1shore	1.0	0	3												
19-1shore	1.0	50	5							33		33	33		

Table 6.06.1. continued

Sample Plot No.	Depth Feet	Percent Cover	Substrate Type 1/2/3/4/5	Relative density of flora species expressed as percent: Seagrasses: THALASSIA	SYRINGODIUM	Algae: HALIMEDA 1	HALIMEDA 2	CAULERPA	PENICILLUS	DICTYOTA	PADINA	SCHIZOTHRIX	GRACILARIA	HYPNEA	OTHER
20-1shore	1.0	50	4/5	30					10	40	10		10		
20-2	2.8		1	50		50									
20-3	3.0		1			66			33						
20-4	3.5		1			100									
20-5	4.5		1			100									
20-6	6.0		1			100									(*Laurencia*)
21-1shore	1.0	100	4/5	10		80			2	2	4				2
22-1shore	1.0	90	4/5	50				5		40					5
23-1shore	1.0	80	1/3							33	33	33			(*Codium*)
24-1shore	2.0	100	1/3/5	10		80		5					5		
24-2	3.0	50	1/3	25				25		25					25
24-3	3.0	50	1			50		50							(*Acanthopora*)
24-4	2.0	20	1	20					100						
24-5	3.5		1	100											
24-6	4.0		1	25		25				50					
25-1shore	3.0	20	3	25		60			15						
26-1shore	3.0	10	3	25		50			25						
26-2	3.0	50	1/3						50				50		
26-3	2.5	50	1	40		40		10	10						
26-4	2.0	50	1	40		40		10	10						
26-5	1.5	50	1	90	10										
26-6	1.5	50	1	20		60		20							
shore drift				50	50										

Key:
Substrate 1: course-grained carbonate sediments (*Halimeda*/mollusc fragments)
Substrate 2: fine-grained mud
Substrate 3: fine-grained black mud with mangrove leaf litter
Substrate 4: course-grained sand
Substrate 5: rocky



Bottom communities of Salt River estuary. PEN and P = *Penicillus*, HAL = *Halimeda*, RF = Reef, GRASS is largely *Thalassia*; Disturbed = disturbed by human activity.

Figure 6.06.3. Bottom communities in Salt River Estuary. (Modified from Gerhard, 1978)

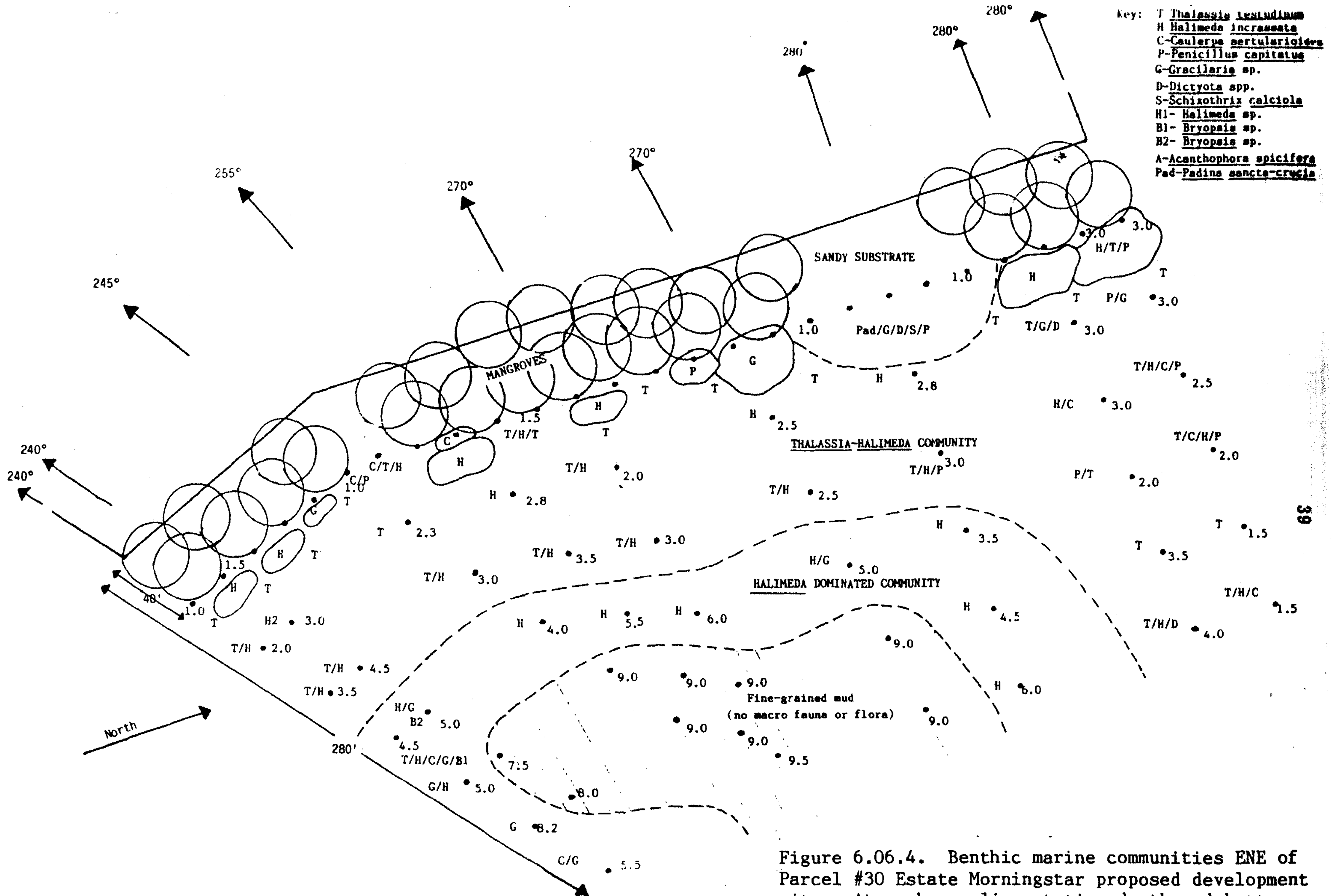


Figure 6.06.4. Benthic marine communities ENE of Parcel #30 Estate Morningstar proposed development site. At each sampling station depth and bottom flora are indicated. The area is partitioned according to flora community compostion.

Table 6.06.2. Checklist of marine plants observed in the proposed Estate Morningstar development site.

PHYLUM CYANOPHYTA (blue-green algae)

SPECIES

Schizothrix calciola

PHYLUM CHLOROPHYTA (green algae)

SPECIES

Bryopsis sp., one sample at 4.5ft transect 1

Bryopsis sp., one sample at 4.5ft transect 2

Caulerpa sertularioides, abundant but patchy throughout shallow areas

Chaetomorpha sp., green mats floating on surface inshore

Codium sp., single sighting along mangrove

Halimeda incressata, dominant bottom cover in dense mats to 5ft

Halimeda sp., one sample at 4.5ft

Penicillus capitatus, dominant and dinse on fine-grained muds

PHYLUM PHAEOPHYTA (brown algae)

SPECIES

Dictyota spp., numerous species on mangrove roots and shallow water

Padina sancta-crucis, along shoreline in shallow sandy substrate only

PHYLUM RHODOPHYTA (red algae)

SPECIES

Acanthopora spicifera, dominant on and below mangrove roots

Gracilaria sp., on mangrove roots and drifting

Laurencia sp., on mangrove roots

Hypnea musciformis, drift algae

PHYLUM SPERMATOPHYTA (seagrasses)

SPECIES

Thalassia testudinum, found in all areas up to 3ft

Syringodium filiforme, found only in drift material along shoreline

Table 6.06.3. Checklist of marine invertebrate species found in the proposed Estate Morningstar development site.

PHYLUM PORIFERA (sponges)

SPECIES

Tedania ignis, occassional on mangrove roots

unidentified blue sponge, mangrove roots and bottom, very sparce

PHYLUM ANNELIDA (polychaete worms)

SPECIES

Sabellastarte magnifica, one sighted in mud under mangrove

PHYLUM MOLLUSCA

SPECIES

Littorina angulifera, mangrove roots above waterline

Isognomon alatus, mangrove roots below waterline, sparce

Tetraclita squamosa stalactifera,mangrove roots below waterline

PHYLUM ARTHROPODA

SPECIES

Callianassa sp., mounds sighted in Thalassia regions

6.07 Terrestrial Resources

Overview

This property lies on the western shore of Sugar Bay, the western arm of the Salt River estuary and is therefore part of the Salt River Area of Particular Concern described by Teytaud (1981) in an unofficial Coastal Zone Management document. The property surveyed by the writer, Carolyn Ehle-Jewett, for this section of the report consisted of Plots 30 and 31, Estate Morningstar. However, it is understood that only Plot 30 will be built upon by the owners. Approximately 40% of Plots 30 and 31 is a public road and right-of-way, commonly called North Shore Road or Salt River Road (Route 80).

The shoreline is fringed with mangroves except for an area about 75 ft wide that is used for boat launching. The associated plant and animal community is fairly typical(though somewhat depauperate) of St. Croix's low, protected shoreline area comprising mostly terrigenous soils and sediments. Land crabs (primarily Cardisoma guanhumi) are the most common animal. The adjacent road provides such easy access that large crabs are easily collected and thus most burrows are relatively small.

The natural boat ramp is important to numerous full- and part-time fishermen. This use is threatened by bank erosion due in part to traffic (vehicles putting boat trailers in and out of the water) and also to runoff from the road.

A review of old Salt River maps indicates that the shoreline in this area has changed over the years, accreting in some areas, receding in others. Human-induced changes in runoff patterns, road building through the project site, and deforestation over the centuries have no doubt influenced the rate of sediment deposition along the shoreline. Certainly the continued integrity of the mangrove fringe and the abundance of mangrove seed stock to windward have helped protect this shore from erosion. Mangroves are often said to be land builders, but although they clearly stabilize rapidly accreting banks, their role in actually promoting accretion is uncertain (Cintron, 1983). Salt River estuary is the product of rising sea levels during the Holocene drowning a river and estuary. In the past hundred years, sea level worldwide has risen four to six inches (10 to 15 cm) (Gornitz, Lebedeff and Hansen, 1982); the rise in sea level is expected to continue, though deposition of terriginous sediments and other factors can offset shore losses.

Salt River estuary is probably St. Croix's most important nursery area for commercially valuable fish and shellfish, and is a major nutrient source for offshore reefs and grassbeds. Any development decisions must carefully weigh the health of the entire estuary as well as the present and potential beneficial uses of the site. Stabilization of the boat launch area is necessary soon to protect the adjacentg mangroves, the public road itself, and the natural launching facility so important to fishermen. For so small an area, Plots 30 and 31 currently provide multiple beneficial uses for man and wildlife. Sensitive management could conceivably correct the runoff problems and traffic erosion threatening the launch area, preserve the wildlife uses of Plot 31 (detailed later) and the large trees of Plot 30, and retain the mangrove fringe essential to the estuary while providing facilities of the public through a small locally-owned business.

Materials and Methods

Over 13 hours were spent on the site from December 1986 to mid-March 1987. Several sunsets were included to evaluate bird roosting behavior. All animals seen were noted and the area searched for nests, burrows, and other wildlife sign. The entire area was walked to evaluate the flora, and dominant or unusual plants were noted and collected. Positive identifications on the many plants not flowering or fruiting was impossible, but vegetative samples were collected for later comparisons if necessary. Three detailed east-west transects one foot wide were also made across the property. One ran about halfway between the boat ramp and the northern property boundary. Another ran south of the area in Plot 30 where the shore and road are about 15 feet apart. The third transect was in Plot 31. The text includes pertinent transect data; full details are available on request. To simplify discussion, Plot 30 was divided as follows:

Area 1: west of the road, north of the northern driveway;

Area 2: west of the road, south of the northern driveway;

Area 3: east of the road, including the boat ramp and parts northward;

Area 4: east of the road, south of the boat ramp.

Bird nomenclature follows Sladen (unpublished data, 1986). Philobosian and Yntema (1977) provided vertebrate common and scientific names. Scientific names for invertebrates mentioned are primarily as in Multer and Gerhard (1974). Due to the limited description of St. Croix flora, all botanical identiriations should be regarded as tentative and nomenclature does not rely on a single source.

Results and Discussion

Area 1. This steep and narrow strip is north of an unused driveway and west of the public road. The project plans call for no changes here. Along the road, guinea grass (Panicum maximum) dominated and leaf litter accumulations of approximately 2 inches were found, along with considerable human litter. Tan-tan (Leucaena leucocephala) and ginger thomas (Tecoma stans) were the most common of the numerous trees and shrubs covering the rocky hillside. Most stems were 1-2 inches dbh (diameter breast high). Several small individuals of a tree tentatively identified as the gri-gri (Bucida buceras) were seen. Other small trees included genip (Melicoccus bijugatus), red manjack (Cordia collococca), white manjack (Cordia alba), bread and cheese (Pithecellobium unguis-cati), and gumbo-limbo (Bursera simaruba), all species frequently dispersed by animals such as birds, bats and humans. Shrubs included Limber and Jamaican capers (Capparis flexuosa and C. cynophallophora), Eugenia sp., Acacia tortuosa, limeberry (Triphasia trifolia) and maran (Croton rigidus). Ginger thomas flowers attracted bananaquits (Coereba flaveda), a green-throated carib (Eulampis holosericeus), and Antillean crested hummingbirds (Orthorhynchus cristatus). Zenaid doves (Zenaida aurita) and the ubiquitous anole lizards (Anolis acutus) were also noted.

Area 2. This relatively wide area between the driveways west of the main road is fairly flat and fringed by trees, mostly genips in the 8-12 in dbh range. Grasses, dense clumps of snake plant (Sansevieria sp.), and assorted 2-6 ft herbs and saplings covered most of the area. One coconut palm (Cocos nucifera) and one West Indian almond (Terminalia catappa) grew near the southern driveway.

Many common St. Croix "weeds" grew in Area 2 or along the roadside of other areas, including yellow sweet pea (Crotalaria sp.), wild physicnut (Jatropha gossypifolia), Merremia quiquefolia, Ipoema spp., Cissus sp., butterfly pea (Clitoria ternatea), Stachytarpheta jamaicensis, Bidens sp., Sida acuta, cow-itch (Malpighia woodburiana), stinging nettle (Laportea sp.), Rivina humilis, Boerhavia coccinea, etc. Young genip, white manjack, limber caper, tan-tan limeberry, gri-gri and Eugenia were among the shrubs scattered over the site.

Thrushees, or pearly-eyed thrashers (Margarops fuscatus) zenaida doves, and scaly-naped pigeons (Columba squamosa) were observed in the taller trees. Ground doves (Columbina passerina), banana and grass (Tiaris bicolor) quits, and kingbirds (Tyrannus dominicensis) were also noted. There was considerable bird traffic between southern Area 2 and Plot 31 and the southern part of Plot 30. Scaly-naped pigeons appear to use the trees along the driveway for night roosts.

A parking area is proposed for this section. Enough of the larger trees could probably be retained to offer the almost continuous cover apparently preferred by scaly-naped pigeons as they move from place to place. Some saplings and shrubs could be relocated to provide attractive, inexpensive landscaping of high wildlife value. Just west of the property is a dirt wall (an earthen dam) pierced by a culvert about 10 ft above ground level; the natural contours of a gut can be seen behind this wall, forming a pond area which the culvert would presumably drain during heavy rains. However, the runoff from this section of Kierkegaard hill, is diverted away from this pond by the driveway running along the south side of the gut. The former owner of the adjacent Plot 9 had intended to divert the runoff into the pond via a culvert under the driveway, but this was never done. Runoff follows the driveway to the public road, which it then crosses and runs northward along the edge of the road, prevented from entering Plot 30 by the berm paralleling the road. Further on, the runoff crosses back to the west side of the road and flows north toward the boat ramp, where it crosses the road again and flows into Salt River Bay, further eroding the boat ramp area. It is likely that much of the runoff entered Plot 30 further to the south, prior to the paving of the public road in about 1970 and the later paving of the driveway. The present drainage will be better managed to prevent the roadside erosion near the current dirt boat ramp, and to minimize sediment load entering the bay, by installing a concrete boat ramp and utilizing a sedimentation basin between the road and the bay, landward of the mangrove fringe.

Area 3. The area around the boat ramp was very eroded and for some 25 feet north there were no mangroves. Further north th mangorve fringe exted about 25 to 35 ft into the water. A single bread-and-cheese leaned over the water also. Between the mangroves and road were several mounds of soild, presumably left from previous road work. Land crab holes were found throughout the area, including the mound tops (elevation 4-6 ft). The soil surface at the water's edge was a fine gravel and soil mix, with a 2-inch sill at the high-water mark. The mounds, which began about five feet from the water's edge, were of coarser soil and rock. Crab diggings indicated a fine gray clay beneath the mounds near the road.

Seaside maho (Thespecia populnea), tan-tan, manchineel (Hippomane mancinella) and Acacia sp. were the most common trees other than red mangrove (Rhizophora mangle). The northern edge of the property had the largest tres. Between mounds considerable tree litter collected, including leaves, twigs and many tan-tan manchineel and maho seeds. Some seedlings were present, but many had been clipped off, presumably by crabs. Dwarf geckos (Sphaerodactylus macrolepis), anole lizards and the cotton stainer bugs associated with maho were common. Zenaida doves and banana quits were the most common birds. A little blue heron (Egretta caerula) was seen just offshore.

Most human use of the proposed project area was at the boat launch site, although severe erosion has impaired the site's utility. It is common to see vehicles with loaded boat trailers being assisted by a second vehicle to move the boat trailer up the ramp. During the study period, vehicles stopped at the ramp location about three times an hour. Tourists took pictures and admired the view (this is the first water view including boats while traveling north on the public road), fishermen launched their boats, and birdwatchers scanned the bay. Owners of boats moored offshore in Sugar Bay checked on their vessels or ferried passengers and gear to waiting vehicles. One fisherman searched for a boat which had vanished from its mooring just offshore

Interviews with several fishermen revealed the importance of the Salt River ecosystem to humans. One man usually launches his fishing boat at Altona in Christiansted, but comes to Salt River occasionally, especially when he also seeks crabs. Another man has used the ramp about every three days for years. His main catch is lobster (Panulirus argus). This man has supplied numerous seafood restaurants for at least four years, one of which (among Christiansted's largest) gets about one-third of their lobsters from him. Another person has spent over 20 years fishing and crabbing the area. His catches and techniques vary, including lobstering, fish trapping, gill netting, and crab trapping. He averages about four dozen crabs a week from the Salt River area, which he sells, after purging, for $15 per dozen. He releases small crabs and "de woman crabs wa' could make babies". He claims to know at least 50 individuals making their living solely on crabs. He demonstrated remarkable awareness of his prey's ecology, offering details about the estuary's importance to juvenile lobster and fish species that would put many more educated folk to shame. These were not people likely to attend a CZM hearing, but the estuary as a whole and the boat ramp are essential to their lifestyles.

This project proposes to retain and enhance the boat launch facility, but many factors must be weighed to determine the best location. The current site is highly eroded due to traffic and the runoff pattern. There is little room to maneuver vehicles without using the road. A concrete ramp has obvious advantages, although possible scouring effects by wave reflection should be evaluated. If the ramp were put farther north, where there is a natural break in the mangrove fringe, no mangroves would have to be disturbed (other than trimming limbs that would hang over the new ramp), and vehicles would have more room for backing. If part of the runoff eroding the present launch site was rerouted, it might be possible to halt the erosion by planting trees. If gravel was used instead of pavement for parking lots, the percolation of runoff would promote tree growth and retain sediment. These and other such considerations should be integrated into the final plans should the project be approved.

Area 4. Plot 30 south of the boat ramp was dominated by the shoreline fringe of the mangrove community, by the large roadside trees, and the land crab community. Just south of the launch a line of trees curved west from the shore and ran southward bordering the road. Common tree and shrub species here included tan-tan, acacia, white manjack, red manjack, genip, maho, manchineel, Capparis spp. bread-and—cheese, limeberry, ginger thomas, Eugenia, and gri-gri. Where the shoreline cut to with 15 ft of the road, the roadside tree association included a huge black mangrove (Avicennia nitida) and large manchineel near a solitary Malpighia infestissima (L. Rich ex Niedenza), a shrub species nominated for federal endangered species status. This plant and its neighboring large manchineel and black mangrove trees, which shade a large area, would be preserved by the proposed project, for they would border the entrance drive proposed for the south part of Plot 30.

The red mangrove community mingled with the roadside tree community near the ramp and ran southward continuously except for one break about 85 feet north of the southern boundary of Plot 30. This break is the proposed location of the shoreline terminus of the proposed boat pier. Red mangroves extended 15 to 35 ft into the water with an intricate prop root network. Trunks varied in size but most were under 12 in. dbh. the age of this stand is unkown, but Cintron (1983) noted that Puerto Rican red mangroves 36 years old had mean diameters of 8 inches. Along this lee shore of Sugar Bay many red mangrove, black mangrove, maho and manchineel seeds were found among the prop roots, especially along the high waterline. Masses of floating seaweed (mostly turtle grass [Thalassia testudinum] and manatee grass [Syringodium filiforme] seemed to help trap the seeds and propagules among the root network. One 2 ft by 3 ft clump of rooted red mangrove propagules contaned over 80 trees up to four feet tall; the crowns of over ten had died, about ten had lost their primary shoot tips, but had sprouted new branches. At the water's edge the ground was mostly fine terrigenous soil and broken rock. Many tree roots ¼ to 2 inches in diameter ran along the ground—most paralleled the waterline. for most of the shore the mean h igh water mark was a 4- to 6-inch sill of sandy clay. Fresh crab diggings were evident every few feet from the sill to approximately the six-foot contour, with a few holes at higher ground. Large piles of dark grey clay and sand, scattered leaves and twigs and numerous (often ten per square foot) manchineell seeds were the main features of this crab zone. Seedlings of manchineel, black mangrove, maho, and tan-tan trees were seen occasionally, but most had apparently been clipped by crabs even before the first true leaves had unfolded. Most crab holes were only 1-w inches in diameter, presuably due to heavy crabbing pressure having eliminated the larger crabs. One trap and numerous human diggings (presumably for crabs) were seen. Some Cardisoma crab holes near the water had smaller holes branching off them where fiddler crabs (Uca pugnax rapax) could be seen. Scattered among the landward red mangroves were other trees, primarily black mangrove, manchineel, maho, tan-tan, acacia and white mangrove (Laguncularia racemosa). In more open area of the shore a few seaside herbs such as sea purslane (Sesuvium portulacastrum) and sea-rocket (Cakile lanceolata) seemed heavily cropped by crabs.

The roadside and shoreside tree canopies merged over much of this area with tree heights in the 30- to 60-ft range. Throughout the crab community, 1-to 4-inch dbh trees were scattered, mostly manchineel, tan-tan, and acacia. Some of these had been cut recently. Drift lines of dead vegetaion were noted, indicating marine flooding at lower elevations (ca +2 ft).

Above the approximate 6-ft elevation more vegetation and fewer crab holes were found. The vegetation was much as described for Area 2, although more genip and tan-tan seedlings and saplings and more bread-and-chees and Capparis spp. were found.

Most Area 4 bird traffic was along the road edge (quits, hummingbirds, kingbirds, and a mockingbird, Mimus polyglottos) and in the cluster of large trees (genip and gri-gri) opposite the southern driveway, where sightings included zenaida and ground doves, thrushees and scaly-naped pigeons. A thrusee was reporeted drinking from a crotch in one of the genip trees. At sunset, scaly-naped pigeons were seen assembling here and then moving across the road to the tall trees along the driveway, where thrushees could be heard. Among the mangroves a northern waterthrush (Seiurus noveboracensis) was seen and pigeons, prbably scaly-naped, moved surreptitiously through the trees.

Evidence of human uses included the crabbing signs and litter washed or dumped ashore, including tires, plastic bags, a car battery (a source of toxic bio-accumulating metals such as lead and zinc). Near the southern boundary of Plots 30 and 31, someone, reportedly a condominium's contractor, dumped a truckload or two of building debris, mostly concrete roofing tiles..

Preliminary plans for this area include a boardwalk connecting a parking area (where the dirt boat ramp is currently located) to the shore end of a boat pier set in the existing notch in the mangrove fringe. A building has been designed to fit between the larger trees now there. The seven largest adjacent trees, mostly genips, range from 24 to 59.7 ft in height (34 to 66 ft above sea level). A second parking area is planned for the low-elevation (+2-6 ft) area between the road and the mangroves. Presumably fill would be required under the building and for the parking areas. Assuming maximum vegetative cover was retained or enhanced wherever possible, the main habitat loss would thus be to crabs. It is not known whether the heavy trapping pressure here permits crabs to reach reproductive age. However, the important role that crabs play in enhancing soil conditions for the mangroves should be considered. The building itself plus any paving will reduce the freshwater contributions to the soil behind the mangroves. The freshwater and nutrient input from the building's septic tank leaching field beneath the parking lot will partially offset this loss. Mangroves will not tolerate fill around them. A one-foot deep layer of sand killed all mangroves in a Puerto Rican forest (Cintron, 1983). It would be desirable to maximize the fill-free zone near the mangroves to retain crab habitat and thus preserve the natural water and soil dynamics. Fill edges would need protection from fresh or saltwater erosion by careful construction and drainage. The use of gravel rather than paving for parking areas should be evaluated; the ecological advantages include percolation of water into soil, sediment and nutrient retention, and the trapping of oil residues to which mangroves are extremely sensitive. The use of elevated (rather than on-the-ground) walkways and decks retains crab habitat beneath.

Given the environmental awareness and expertise of the developer, it seems feasible to construct this project without jeopardizing the mangrove community integrity or the terrestrial ecology. Previous human errors affecting freshwater runoff and erosion might even be corrected, and a valuable access to Sugar Bay enhanced. Information from this small-scale project could aid in future management decisions for other island areas.

Plot 31. No terrestrial development is planned on this site, which is extremely steep (45 degree slope) and narrow. The vegetation reflected dryer conditions, with tan-tan, Jamaican caper and limber caper, genip, bread-and-cheese, ginger thomas, acacia, and guinea grass the most common species. Much of the ground was bare soil and gravel, with several rocky outcrops. One mongoose burrow was found under a WAPA pole and several mongooses were sighted. Where the ground leveled off about 10 to 15 feet from the water, gravel, small rocks and leafe litter had accumulated. Assortred jetsam and some coral rubble were mixed with the terrigenous material, and only the occasional crab hole was seen. The shoreline tree comunity was similar to that northward, but less dense. Near where the bedrock extends into the bay a single Jacquinea arborea tree was found.

This area is quite popular with all the bird specis mentioned above except the little blue heron. The dense vegetation made positive identification of the columbids difficult (species other than zenaida and ground doves generally move as inconspicuously as possible). Scaly-naped pigeons were definitely present. Birds frequently moved from this area to directly across the road, to the south, or towards the southeast corner of Plot 30 and along the driveway across the street. Current road traffic looks down on most of the Plot 31 canopy where pigeons might nest, and no pigeon nests were seen. Offshore traffic would probably not further affect potential nesting or feeding, if the vegetation was left undisturbed. Protection of this plot as planned by the project would retain the best all-around bird habitat on the site.

6.08 Wetlands

Wetlands are defined as "those areas that are periodically inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, bogs, marshes and similar areas." (U.S. Army Corps of Engineers, Jacksonville District, Public Notice dated May 22, 1986). Mangroves are considered wetlands because they are adapted to soil conditions ranging from saturation with full-strength seawater to hyper-saline soils resulting from evaporation of seawater-flooded ponds. Mangroves serve multiple functions as builders of land, control of shoreline erosion, primary producers for marine food chains based on foliar detritus dropped onto the mud substrate or into the seawater, forming habitat for waterfowl, fish and crabs, etc. The mangroves on the project site (described in section 6.07) will not be disturbed, nor will there be any filling around mangroves. The boat pier access boardwalk and the concrete boat ramp will be located at natural breaks in the mangrove fringe.

6.09 Rare and Endangered Species

The endangered green (Chelonia mydas) and hawksbill (Eretmochelys imbricata) sea turtles are known to use the estuary offshore, in the outer reaches of Salt River Bay, but it is doubtful that the proposed project would have any detectable impact on offshore grass beds. The sandy beach on public land to the north is a turtle nesting site (Towle, 1978), but there is no record of turtles nesting in the study area and no likely nesting areas (no sandy beaches). A single speciment of the shrub Malpighia infestissima is located on the site and will be preserved; this species has been nominated for federal endangered species status, but is not rare on St. Croix. Another specimen is located about 1000 ft south of the project site, at the roadside.

6.10 Air Quality

Because of its location on St. Croix's north shore, the project site has excellent air quality. The prevailing winds bring to the site air which has travelled across the Atlantic Ocean, so that it is virtually pollution-free. The Environmental Protection Agency has designated all of St. Croix, except the Southern Industrial Complex, as a Class II area that is in compliance with National Ambient Air Quality Standards. The nearest area designated Class I (pristine) is Buck Island National Park, approximately seven nautical miles to the east of the project site. However, because of its proximity to the sea and the prevailing northeast to east direction of the winds, the air at the site is, in fact, pristine.

During the construction phase of the project there will be some air pollution due to heavy equipment moving earth and materials on the project site and on the access roads to the site. This is unavoidable, but will be temporary. A small portable generator may be located on the premises to provide emergency power for water pumps only, and is not expected to have a significant impact on air quality.

6.11 Land and Water Use Plans

The project site is zoned W-1 (Waterfront—Pleasure); a portion of the zoning map for the project site is shown in Figure 6.11.1. The proposed structures of the project are approved uses of the site under the existing zoning as listed in the Virgin Islands Zoning and Subdivision Law (Title 29, Chapter 3, Virgin Islands Code).

The entire project site is located within the "first tier" or area of CZM authority over land use. The landward limit of the first tier is located along the North Shore Road; the CZM line between the first and second tiers is shown in Figure 6.11.2 as a dotted line running along the North Shore Road.

The Salt River area, including the mangrove swamps, coral reefs, the offshore canyon and much of the privately-owned land bordering on Salt River estuary, including the project site, was designated an Area of Particular Concern (APC) by CZM. This designation was given to 18 coastal areas in the Virgin Islands that were considered to have special features that need detailed land use planning and guidance for managing the resources of the APCs. The goal of APC management is "to reconcile and harmonize conflicting uses so that a) the physical, biological, cultural and

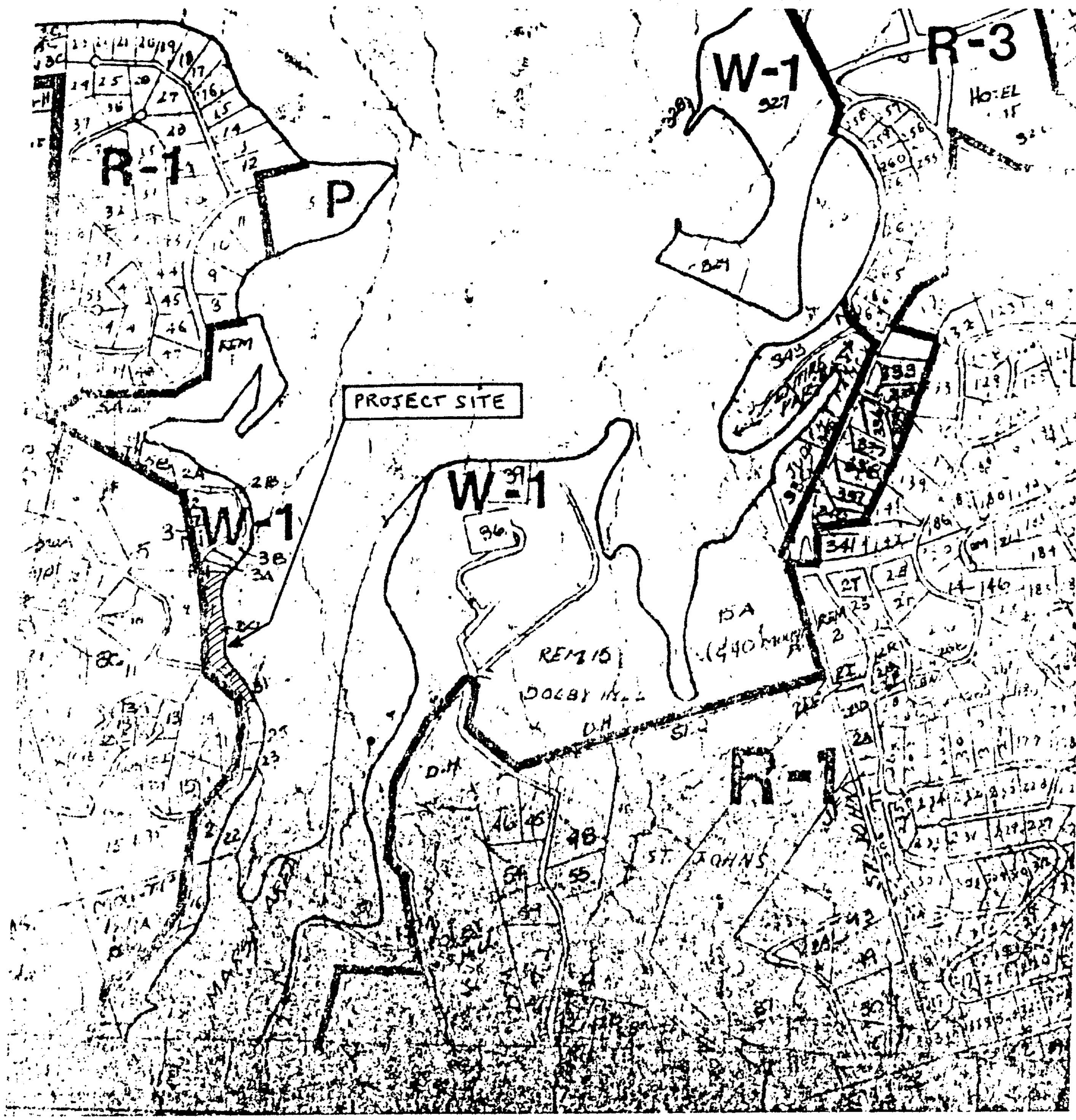


Figure 6.11.1. A portion of the V.I. Planning Board Zoning Map showing the zoning in the area of the project.

aesthetic resources within the APC may be maintained, protected and enhanced; b) human use of the resources may be maximized in a manner consistent with their capabilities to sustain such uses; and c) the coexistence of multiple uses within the area may be facilitated (Teytaud, 1981). The APC designation for the Salt River area does not appear to have been officially adopted by CZM: guidelines for projects in APCs are listed in the Introduction section of CZM's Handbook for Homebuilders and Developers, but they were omitted from the text and the Table of Contents. The Salt River APC designation has never been recommended by the Coastal Zone Commission, nor been presented at a public hearing and adopted by the Legislature, as required by the CZM law (Title 12, §909, V.I. Code)

The Salt River APC is at the seaward end of a large coastal ecosystem whose limits are defined by its watershed area. The watershed area is approximately 2881 acres, and extends beyond the "first tier", which is regulated by CZM, into the "second tier", which is regulated by the Department of Public Works. The Salt River APC is the largest surviving example of an estuary on St. Croix (Teytaud, 1981). It consists of a main body of water at the seaward end, Salt River Bay, and two arms extending southward. The eastern arm is called Triton Bay, and the western one is called Sugar Bay. "Salt River" is the colloquial name given to these contiguous bodies of water, but it is also the name for the intermittent stream that drains the largest part of the watershed to the southwest of the APC. Much of the APC is within the boundary of the 100-year-frequency coastal flood, as are large areas along the water course, Salt River gut, in the second tier. The Salt River APC experiences heavy impact by sediment in runoff from the watershed into Salt River Bay and Sugar Bay. The extensive stands of mangroves in Salt River serve an important function of acting as traps for sediments carried there by runoff. However, in very large storms, such as hurricanes, the whole surface of Salt River Bay fills with a sediment plume that lasts for several days.

The mangroves, seagrass beds, salt ponds and reefs at the mouth of Salt River support a diverse assemblage of marine and terrestrial wildlife, and the area is believed to be used as a spawing and nursery area by many species of fish, crustaceans and birds (Ibid.). Mussels and oysters are periodically abundant on mangrove roots, pilings, and marina bulkheads. Major changes in the attached biota of Salt River occur during periods of heavy runoff, when the entire estuary changes from predominantly salt water to predominantly freshwater. However, the dynamics of the biological community in Salt River has not been adequately documented. The estuary has been designated by the U.S. Department of the Interior as a National Natural Landmark (Ibid.), and was nominated for designation as a National Marine Sanctuary. A detailed description of the biology and geology of Salt River is summarized by Teytaud (1981) and given in appendices therein.

There is a 22 acre Nature Conservancy wildlife refuge on the east side of Salt River and a National Undersea Research Program (funded by the National Oceanographic and Atomospheric Administration, NOAA) has been conducted since 1977 by West Indies Laboratory of Fairleigh Dickinson University from a saturation diving habitat on the floor of Salt River Canyon, outside the barrier reef at the mouth of Salt River. A new habitat is scheduled for deployment in the canyon in mid-1987.

The primary CZM management isssue for Salt River is the potential for degradation of water quality as a result of expanding development in both coastal and upland areas. The following is a list of the major impacts by man on Salt River:

1) Dredging and filling activity on the east side of Salt River Bay to create a basin, finger channel and filled land; this is the proposed location for a resort community consisting of 588 hotel and condominium units and a 157 slip marina, to be called The Virgin Grand St. Croix Resort. The Virgin Grand development would call for additional dredging to re-open the access channel into the basin, and to deepen the basin;

2) A small boat basin dredged at the southern end of Triton Bay, now abandoned;

3) A channel dredged through a sand bar across the mouth of Triton Bay;

4) A dredged and bulkheaded marina on the west side of Sugar Bay (Salt River Marina). This marina expanded in 1986 from a capacity for about 25 boats, to accomodate about 55 boats after adding additional docks.;

5) Poorly planned dense residential development in the second tier, at Mon Bijou and Glynn, has increased runoff and the sediment load entering Salt River. Vegetation along the banks of watercourses in the watershed has been indiscriminately destroyed, resulting in increased channel erosion (Ibid.).

The Guidelines for the Salt River APC recommend that active erosion sites be identified and that control measures be implemented, in order to minimize sediment contribution of these areas by runoff into Salt River. This has not been achieved for the most part, and high turbidity in Salt River following heavy rains continues to be a problem. As an example, erosion of a dirt driveway immediately west of Salt River Marina is the source of several tons of dirt that wash down on the Salt River Road during every heavy rain storm. Much of the heavy material settles out on the road, but the finer material pours directly into Salt River Marina, turning the entire marina basin a coffee-with-cream color. The proposed project will employ a sedimentation basin to control runoff from upland areas; this is shown in the Erosion and Sedimentation Control Plan in Appendix A.

7.00 IMPACT OF THE PROPOSED PROJECT ON THE HUMAN ENVIRONMENT

7.01 Visual Impacts

The visual impact of the land-based part of the project will be minimal due to the low profile (two stories, instead of the zoning-allowed three) and the plan to retain a large number of tall trees on the project site. In fact, the buildings will have trees on all four sides that are taller than the highest rooftop. Also, the building site is below the grade of the road through the site, so that its apparent size, as perceived to the passerby on the road, is reduced. The architecture is Spanish style, with the buildings designed to resemble the superstructure at the stern of a spanish galleon. The construction is of stuccoed masonry on the first floor, with arched opening doors and windows of contrasting dark hardwood. The second floor will be of wood construction, including hardwood open beam ceilings. Interior non-load-bearing walls will be moveable wood-veneered panels, for flexibility in accomodating tenants' space requirements. All undeveloped land will be attractively landscaped in groundcover and shrubbery.

The boat pier will be oriented parallel to and about 320 ft offshore, so that the view from the shoreline will not be blocked by boats. The view to the mouth of Salt River from the present dirt boat ramp will not be changed.

7.02 Impacts on Public Services

The expected impacts on public services are given in the following sections:

7.02.1 Potable Water Supply

Potable water will be supplied from a 21,800 gallon cistern fed by rainfall collected on the roofs. Sanitary flushing water will be supplied from a brackish water well on the premises. Additional potable water, if needed, will be purchased from commercial suppliers, who will truck it to the site.

7.02.2 Sewage Disposal

Sewage disposal will be to an on-site septice tank with a draiange field system located under the parking lot. A sewage pumpout system will store boat sewage in a 3700 gallon tank located on the west side of the road; this tank would be screened from view, with shrubbery. The sewage would be periodically trucked to municipal primary treatment sewage plant at Estate Anguilla. An estimated 3000 gallons (one truckload) per month would be hauled from this tank.

7.02.3 Solid Waste

Solid waste would consist of trash from the offices, shops, restaurant and boats. Trash would be stored in a bulk container behind a gated enclosure. The container would be emptied by a commercial hauler weekly, or as needed. Smaller trash containers for single item disposal would be strategically placed around the premises.

The volume of solid waste expected per day is:

Source		Pounds per day
Restaurant (40 seats @ 2 lb/day)		80
Offices & Shops (2380 sq. ft. @ 1%)		24
Marina (52 slips @ 2 lb/day)		104
	Total	208

7.02.4 Roads, Traffic and Parking

Parking

Twenty-one off-road parking spaces will be provided in the project, as shown on the site plans in Appendix A. The spaces were distributed among the project components as follows:

Use	Unit	No.	Ratio	No. of Spaces
Restaurant	Seats	40	10:1	4
Offices & shops	Sq. ft.	2321	500:1	5
Marina	Slips	52	5:1	10
Boat Ramp	Vehicle & Trailer	2	1:1	2
			Total	21

Traffic and Roads

The traffic on the public road through the project site is light, consisting of traffic to Gentle Winds Condominiums, Salt River Marina, and homes in the area. Also, some traffic is tourists travelling along the north shore toward Cane Bay and Davis Bay. On weekends, additional traffic is due to beachgoers headed for Salt River beach and Cane Bay. Tour buses ferry passengers from cruiseships in Frederiksted along North Shore Road for a view of Columbus' landing sight. Traffic flows smoothly and without stopping along North Shore Road. The project is not expected to significantly add to the traffic load.

7.02.5 Electricity

Electrical demand for the project is estimated at 137 KW, as follows:

Element	Unit	No.	Rate (KW)	Sub-total (KW)
Offices & Shops	1000 sq.ft.	2.3	45	104
Marina	slips	52	0.25[a]	13
Grounds	acres	1.0	20	20
			Total:	137

[a] Assumes that about half the boats will not use electricity.

7.02.6 Schools

The project is not likely to impose any burden on island schools, as people working on the project site or keeping their boats there will live elsewhere and have any children already enrolled in school. Very few liveaboards are expected (less than ten) and these would primarily be transients without children.

7.02.7 Fire and Police Protection

The project will depend on local fire-fighting and police forces. The nearest fire station is at Estate Richmond, approximately 7 miles away. The nearest police station is at Estate Ville LaReine, approximately 3 miles away. Fire extinguishers will be kept available in all offices, shops, the restaurant and on the pier. A night watchman will be on duty, and the grounds will be kept lighted. Offices and shops will be equipped with electronic burglar alarm systems.

7.02.8 Public Health Facilities

There is expected to be no impact on public health facilities by the project.

7.03 Social Impacts

The proposed project will help to fill current and projected needs for boat docking space on St. Croix. It will also bring a restaurant, convenience store, and gift shops to an area that is receiving increased attention from tourism because of the 500th anniversary celebration of the landing of Christopher Columbus on St. Croix in 1493.

Although there is no overall shortage of dock space now, there is a shortage of dock space in some locations on St. Croix. Green Cay Marina, opened in mid-1985 with 150 slips, was filled in late 1986. Salt River Marina has only five open slips as of June 10, 1987. Unavailability of dock space is a detriment to the growth of St. Croix's boating industry and to the access of the public to marine waters. The proposed restaurant and convenience store will be facilities that make docking in Salt River attractive, as well as being available to residents of the area and tourists. There is a restaurant planned for Salt River Marina, but there is no place for a boater to purchase food staples, or to do laundry. The project will fill these needs.

The project will preserve and improve a traditional small boat launching site—the only one that is eaily accessible—and allow it to be used by the public at no cost. This will help to retain Salt River as a location where fishermen can launch their boats regardless of sea state or weather conditions.

The project will occupy an area that has traditionally been used for crabbing. The crabbing has been intense in this area because of its proximity to the public road and the dirt boat ramp (see Section 6.07 for details on crabbing). The project may in fact convert the site to a crab refuge, because much of the area currently occupied by crab habitat would be protected from crabbing by overlying decks or wood walkways. Crabs can co-exist with human habitation, if they are not over-harvested. An example of this can be seen at Salt River Marina, where, despite daily use of the dock area, crabs are still thriving seven years after the marina was opened.

In summary, except for crabbing, the project will not displace any other traditional uses of the area, will enhance the boat ramp facility for public use, and will not disturb the mangrove ecosystem that lines the shore of Salt River.

7.04 Economic Impacts

The economic impact of the project will be through expenditures for construction and revenues from operations and taxes. The estimated cost of the project is $105,00 for the pier and $228,400 for the buildings and other land-based facilities, or a total of $333,400. The economic impact of the project will be spread throughout the St. Croix community, because the office, restaurant, and shop space will be rented out to loccal businesses. It is difficult to estimate the taxable revenues that will be generated by renting businesses, but easier for the marina and buildings.

The marina will generate income from slip rentals and maintenance services provided by local tradesmen from outside the marina. The average cost of maintaining and servicing a boat in St. Thomas ranges from $3,143/year for private boats to $17,513/year for charter vessels (McComb Engineering, 1982, quoted by Antilles Engineering, 1983). A number of charter vessels (sailboats, sportfishing boats and at least one dive boat) are expected to use the proposed marina.

Revenues to the V.I. Government through taxes and fees imposed on the project, and rental of marina slips and offices and retails space, are expected to amount to $22,820 per year. This does not include gross receipts taxes or income tax revenues from business activity in the offices, shops and restaurant, as the amount of taxable income depends on too many factors to allow an estimation of tax revenues. Table 7.04.1 lists the various categories of taxes and fees, and the expected revenues. The project will employ two people full-time in the operation and maintenace of the buildings, grounds and marina. It is estimated that the renting business employ up to ten people.

TABLE 7.04.1

ESTIMATED ANNUAL TAXES GENERATED BY THE PROJECT

		Phase I (28 slips)	Phase I +II (52 slips)
MARINA			
Tax Category			
Submerged Lands Lease (Pier)		$917	$1,795
Submerged Lands Lease (Slips)		1,992	5,322
Gross Receipts Tax[a]		0[b]	1,102[c]
Submerged Lands Sublease (10% of all slip rentals[a])		4,666	8,986
Employees' wages income tax (15%)		1,560	3,120
Real Estate Tax (1.25% of 60% of appraised value[d])		229	788
	Subtotals:	$9,364	$21,113
BUILDINGS			
Gross Receipts Tax (4% of projected rental revenues of $65,668 per year[a])		$223	$223
Real Estate Tax (1.25% of 60% of appraised value, $228,400)		1713	1713
	Subtotal:	$1936	$1936
MARINA + BUILDINGS	**Total:**	**$11,300**	**$23,049**

[a]Based on 80% occupancy; $5000 of monthly income exempt from gross receipts tax. Assumed: Average boat length in 20 small slips is 20 ft, and average boat length in 8 (Phase I) or 32 (Phase II) large slips is 35 ft.; Slip rental rate = $6/ft of length/month.

[b]Phase 1 slip rentals projected at $39,168 per year.

[c]Phase I+II slip rentals projected at $87,552 per year.

[d]Estimated appraised values: Phase I, $30,500; Phase I+II, $105,000.

7.05 Impacts on Historical and Archaeological Resources

A Phase IA terrestrial and submerged cultural resources survey was conducted on the project site (Plots 30 and 31) and on the area of Sugar Bay immediately offshore the project site. The survey (Cultural Resources, Inc., 1987) included a 100% surface reconnaissance on land, and an underwater metal detector (White Electronics, model PI 1000) survey along transects parallel to the shore at 50 ft intervals to a distance 450 ft from shore. The metal detector is capable of detecting objects buried to a depth of a few feet in sand or mud. One-cubic-foot bottom samples taken at 50 ft intervals along the transects were screened through a 1/8" mesh to collect any artifacts in the samples. A literature search of historical records, which was a part of the survey, indicated a very low probability of locating significant cultural resources on the project site.

The following paragraph summarizes the results of the survey, and is taken verbatim from the abstract of the referenced Cultural Resources report:

"Both the terrestrial and submerged studies failed to locate significant cultural resources. The only signs of humans, other than modern garbage and a few scattered historical pottery fragments, were some conch shells with apical perforations behind the mangrove swamp on the boundary betwen the two plots—these are as likely contemporary as ancient, and lack associated artifacts. No further archaeological work is recommended."

Copies of the survey report (Cultural Resources, Inc., 1987) have been submitted to CZM, to the Office of Archaeological Services, VI Department of Conservation and Cultural Affairs, and to the Division for Archaeology and Historic Preservation at the Virgin Islands Planning Office.

7.06 Recreation Use

The project will cause very little adverse impact on recreational use of the area. One or two boats on illegal (unlicensed) moorings would be displaced by the construction of the pier. Current recreational uses of the project site include crabbing, launching of boats at the dirt boat ramp, and fishing from the shore with handlines. Crabbing would be reduced due to occupation of much of the site by buildings, walks and parking lots. However, as discussed in section 7.03, the reduced harvesting pressure on crabs on the site could make this a refuge for a breeding population that would restock adjacent, heavily-crabbed areas. The use of the site for launching boats would be greatly enhanced through the construction of a concrete boat ramp at the northern end of the site; this ramp and two parking spaces for vehicles with trailers would be available for public use at no charge. fishing from the shore would not be impacted by the project.

7.07 Waste Disposal

Construction debris will be hauled to the municipal landfill at Estate Anguilla. Sewage generated on land will be treated on site by a septic tank system with percolation into the ground via a drainage field. Boat-generated sewage will be pumped by means of a portable pump or by a stationary vacuum pump to a sewage holding tank prior to trucking it to the primary treatment plant at Estate Anguilla. Overboard pumping of marine toilets will not be permitted at the marina. No dredge spoils will be generated by the project, and no thermal, saline or chemical efluents will be produced on the site.

7.08 Accidental Spills

The project will not have any fuel storage or dispensing facilities on the site, so there can be no spills of fuel other than by boat owners adding fuel to their boats from portable containers. Portable outboard boat fuel tanks are filled off the site and carried to the boat, or filled in the boat at a fuel-dispensing facility. Fueling facilities are under construction at the nearby Salt River Marina.

The marina will enforce U.S. Coast Guard regulations against discharging oil or fuel into marine waters.

7.09 Potential Adverse Effects Which Cannot Be Avoided

The following are potential adverse effects which cannot be avoided:

1. There will be a reduction in potential crab habitat by approximately 12,000 sq ft—the area of the building footprint and parking lots, and the loss of Plot 30 as a crabbing site.

2. There will be a short-term increase in turbidity in the water as a result of jetting piles into place during construction of the pier. This increase in turbidity will be similar to but less than occurs as a result of runoff carrying sediment into the bay during a heavy storm, and is expected to last only a day or two.

3. The pilings will occupy some bottom area, but this reduction in substrate availability will be offset by the increase in surface area created by installing the pilings. There will also be some shading of the bottom by the pier, but due to the high natural turbidity and very low abundance of benthic plants—especialy in water depths greater than 5 ft—the effect will be minimal. The pilings will become colonized near the water-surface by macrophyte seaweeds and other flora and fauna a few months after installation. In the deper areas of the bay (5-9 ft depth) the submerged parts of the pier will provide habitat where noe existed before.

8.00 ALTERNATIVES TO PROPOSED ACTIONS

The alternatives to the proposed project include:

1. Building the proposed project, but on a reduced scale for the land-based portion or the water-based portion, or both.

2. Building the land-based part of the project without the water-based part.

3. Building the water-based part of the project without the land-based part.

The buildings proposed will allow space for the kinds of activities that make a marina attractive to boaters, as well as provide services to residents and tourists. A reduction in the amount of retail and office space would probably make the project unviable as an investment and jeopardize the success of the marina. The pier requires certain shore-based support facilities, and these cannot be provided if the space is not provided for them. The construction of the buildings without the marina would allow successful operation of the project, but would fail to address the need for additional marina space on St. Croix.

9.00 RELATIONSHIP BETWEEN SHORT TERM AND LONG TERM USES OF MAN'S ENVIRONMENT

The project is not expected to have any significant impact on the integrity of the Salt River ecosystem, and will provide facilities for expanding man's use of Salt River for recreation. The project will enhance the access to Salt River for fishermen and others seeking to launch their boats here, as well as those wishing to keep their boat at a marina. The proposed retails space will increase the range of services locally available to residents, tourists and boaters. the project would achieve the goal of expanding man's use of the Salt River area for recreation, while having minimal impact on the environment.

10.00 ORGANIZATIONS AND PERSONS CONSULTED

Benjamin Nazario	Director, Coastal Zone Management Program Dept. of Conservation & Cultural Affairs V.I. Government Building 111 Watergut Christiansted, St. Croix
Nora Santana	Program Analyst Coastal Zone Management Program Dept. of Conservation & Cultural Affairs V.I. Government Building 111 Watergut Christiansted, St. Croix
Bruce Tilden	Acting Archaeologist Office of Archaeological Services Dept. of Conservation & Cultural Affairs No. 3 Lagoon Street Complex Frederiksted, St. Croix 00840
Marcia Gilnack	Supervisor, Ambient Monitoring Program Division of Natural Resources Dept. of Conservation & Cultural Affairs Building 111 Watergut Christiansted, St. Croix 00820
Carolyn Ehle-Jewett	Terrestrial Ecologist P.O. Box 1775 Christiansted St. Croix, VI 00850

Alfredo Figueredo	Archaeologist Cultural Resources, Inc. P.O. Box 938 Kingshill St. Croix, VI 00850
Kenneth C. Haines,Ph.D.	Environmentalist Coastal Consultants P.O. Box 2119 Kingshill St. Croix, VI 00850
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Mary Lou Pressick-Coulston, Ph.D.	Marine Ecologist Ocean Systems Research, Inc. P.O. Box 4533 Christiansted St. Croix, VI 00820
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William Newkirk	Caribbean Surveys Estate Morningstar Christiansted, St. Croix
Claus Corvinus	Manager, Green Cay Marina Estate Southgate Christiansted St. Croix, VI 00820
Harry Jacobs	General Manager St. Croix Marine P.O. Box 3842 Christiansted, VI 00820
Mario Bojola	Owner Salt River Marina P.O. Box 1546 Kingshill St. Croix, VI 00850

Jesse Thompson
Chairman
Christopher Columbus Jubilee Committee, Inc.
16AA Church Street
Christiansted, St. Croix 00820

William C. Walt
Registered Engineer
42-43 Strand Street
Christiansted, St. Croix 00820

11.00 OWNERS OF ADJACENT PROPERTIES

The following are the names and addresses of owners of property within 150 ft of the project site, as listed at the office of the Recorder of Deeds in Christiansted, St. Croix on April 6, 1987:

Plots 2, 3A and 5 Estate Morningstar
George E. Thomas
P.O. Box 1208 Kingshill
St. Croix, VI 00850

Plot 3B Estate Morningstar
LICA Holding Corporation
P.O. Box 2981 Christiansted
St. Croix, VI 00820

Plot 9 Estate Morningstar
Michael S. and Carolle T. McLaurin
P.O. Box 100 Christiansted
St. Croix, VI 00820

Plot 11 Estate Morningstar
Helen Esman Ryan
5253 Canning Place
San Diego, CA 92111

Plot 14 Estate Morningstar
Amphlett G. Padilla
429 King St.
Frederiksted
St. Croix, VI 00840

Plot 23 Estate Morningstar
Helen E. Ryan
5253 Canning Place
San Diego, CA 92111

Plot 25 Estate Morningstar
Virgin Trade Winds
Buhler Pond Rd.
Stamford, CT 06902

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APPENDIX A

Drawings (blueprints) of the land-based part of the project

(Attached)
6 sheets

APPENDIX B

Peak Rate Discharge From the Watershed Onto the Project Site

(Calculations by the Soil Conservation Service)

3 pages

TR-55 GRAPHICAL DISCHARGE METHOD VERSION 1

Project : PHASE 1 DOCK User: HAIN Date: 03-30-
County : ST. CROIX State: VI Checked: ____ Date: ______
Subtitle: KENNETH C. HAINES

Data: Drainage Area : 13 * Acres
Runoff Curve Number : 73 *
Time of Concentration: 0.10 Hours
Rainfall Type : II
Pond and Swamp Area : NONE

Storm Number	1	2	3
Frequency (yrs)	100	50	25
24-Hr Rainfall (in)	14	12.2	10.8
Ia/P Ratio	0.05	0.06	0.07
Used	0.10	0.10	0.10
Runoff (in)	10.37	8.66	7.36
Unit Peak Discharge (cfs/acre/in)	1.578	1.578	1.578
Pond and Swamp Factor 0.0% Ponds Used	1.00	1.00	1.00
Peak Discharge (cfs)	213	178	151

* - Value(s) provided from TR-55 system routines

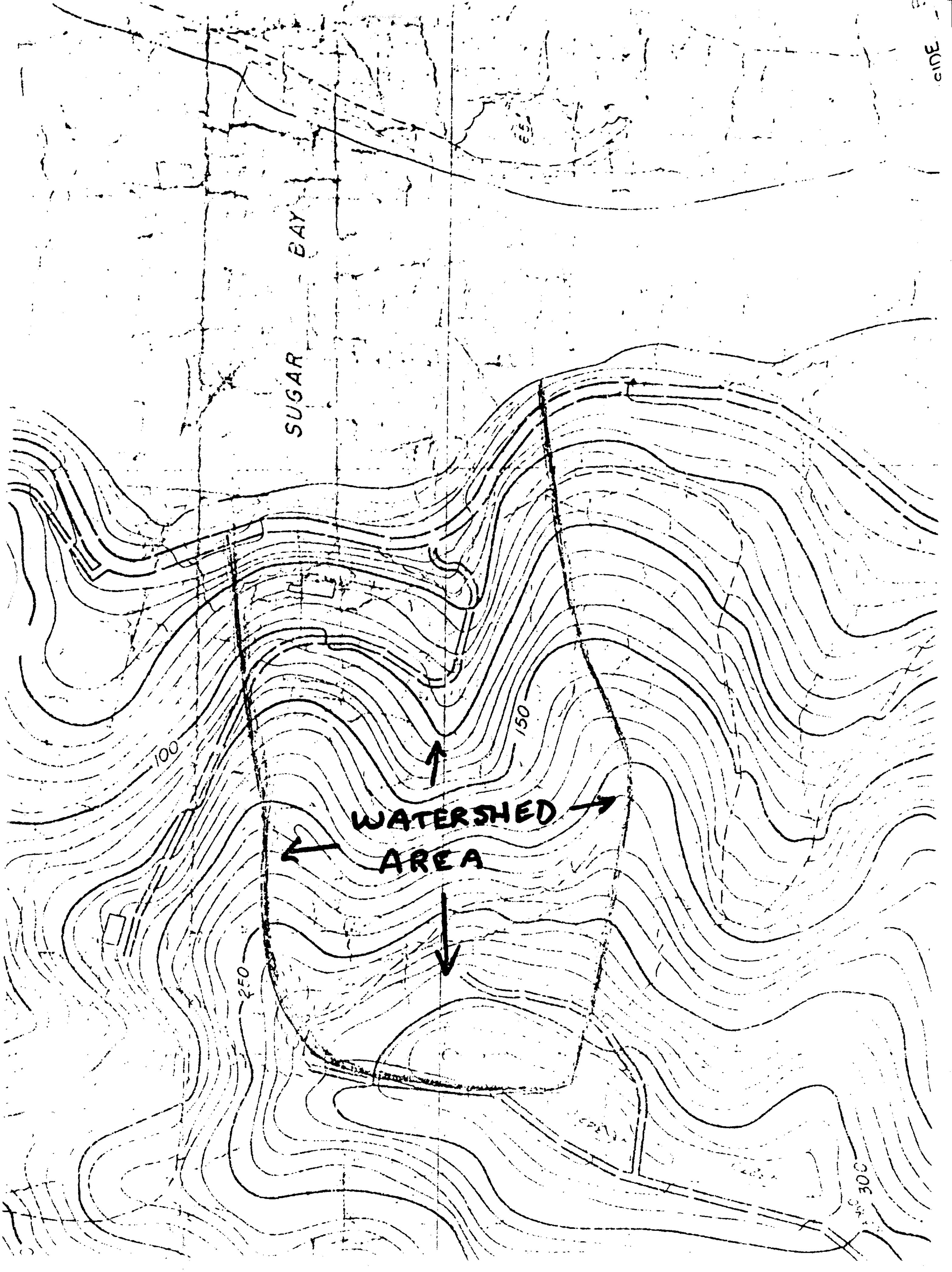
TR-55 CURVE NUMBER COMPUTATION VERSION 1.1

Project : PHASE 1 DOCK User: HAIN Date: 03-30-8
County : ST. CROIX State: VI Checked: ____ Date: _______
Subtitle: KENNETH C. HAINES

COVER DESCRIPTION	Hydrologic Soil Group A	B	C	D
	Acres (CN)			
OTHER AGRICULTURAL LANDS				
Brush - brush, weed, grass mix good	-	-	-	13(73)
Total Area (by Hydrologic Soil Group)				13 ====

TOTAL DRAINAGE AREA: 13 Acres WEIGHTED CURVE NUMB

* Generated for use by GRAPHIC method


SUGAR BAY
100
150
250
300
WATERSHED AREA

APPENDIX C

Request for Water Quality Certification

17 pages

Coastal Consultants

Box 2119 • Kingshill, St. Croix
U.S. Virgin Islands 00850
Tel. (809) 778-0945

July 30, 1987

Mrs. Marcia Gilnack Taylor
Supervisor, Ambient Monitoring Program
Department of Planning and Natural Resources
V.I. Government
Bldg 111 Watergut
Christiansted
St. Croix, VI 00850

Subject: Request for water quality certification for Columbus Landing Marina, at Plots 30 and 31 Estate Morningstar, on Sugar Bay, St. Croix.

Dear Mrs. Taylor,

I am writing to request water quality certification for construction of a 52-slip marina to be called Columbus Landing. Separate major permit applications for the water- and land-based parts of this project were filed with CZM on June 30, 1987. Certification that the project will be in compliance with the Virgin Islands territorial water quality standards is required under Title 12, Chapter 21, §911 (c) (5) of the the V.I. Code. The applicable water quality standards are found at Title 12, Chapter 7, §186-1 to -12. Proposed amendments to the water quality standards, dated August 3, 1984, have not been adopted by the Legislature and are therefore not applicable at this time.

The waters at the site are "Class B", as defined by §186-11. The water quality criteria for Class B waters are listed below, followed by a discussion of the extent that the site meets (or does not meet) the listed criterion, and relating this to §186-10, which states: "Natural waters may, on occasion, have characteristics outside of the limits prescribed by these criteria. the criteria contained herein do not relate to violation of standards resulting from natural forces."

<u>§ 186-3. Class B (b) Quality criteria:</u>

"(1) **Dissolved oxygen:** Not less than 5.5 mg/l from other than natural conditions.

(2) **pH:** Normal range of pH must not be extended at any location by more than ±0.1 pH unit. At no time shall the pH be less than 7.0 or greater than 8.3.

(3) **Temperature:** Not to exceed 90°F. [32.2 °C] at any time, nor as a result of waste discharge to be greater than 1.5°F. above natural. Thermal policy section 186-5 shall also apply.

(4) **Bacteria:** Shall not exceed a geometric (log) mean of 70 fecal coliforms per 100 ml. by MF or MPN count.

(5) **Dissolved gas:** Total dissolved gas pressures shall not exceed 110 percent of existing atmospheric pressure.

(6) **Phosphorus:** Phosphorus as total P shall not exceed 50 ug/l in any coastal waters.

(7) **Suspended, colloidal, or settleable solids:** None from waste water sources which will cause disposition or be deleterious for the designated uses.

(8) **Oil and floating substances:** No residue attributable to waste water nor visible oil film nor globules of grease.

(9) **Radioactivity:**

(A) **Gross beta:** 1000 picocuries per liter, in the absence of Sr 90 and alpha emitters.

(B) **Radium-226:** 3 picocuries per liter.

(C) **Strontium-90:** 10 picocuries per liter.

(10) **Taste and odor producting substances:** None in amounts that will interfere with the use for primary contact recreation, potable water supply or will render any undesirable taste or odor to edible aquatic life.

(11) **Color and turbidity:** A Secchi disc shall be visible at a minimum depth of one meter."

(The above reprinted from "Environmental Laws and Regulations of the Virgin Islands, Department of Conservation and Cultural Affairs, St. Thomas, Virgin Islands, 1979.)

Discussion of water quality parameters at the site and Class B quality criteria:

The data used in this discussion are those listed in the attached sheets for station No. 7 (=33D) from the Division of Natural Resources (DNR), in Appendix A, for the period 1979-1986, and an unpublished 11-week data set obtained from a study of oyster larvae setting in Salt River in 1976 (Forbes, M.L. and K.C. Haines, 1976), in Appendix B. The sampling rate for the data from DNR varied from one sample per year (1982 and 1984) to 12 samples per year (1980).

Dissolved Oxygen (DO)

DO values at the site fell below the criteria standard of 5.5 mg/l in 4 of 33 samples, or in 12% of the samples, in the 1979-1986 time period. No other data on DO are available. DO is not a reliable parameter of water quality because its measured value depends on rates of several independent biological and physical processes that occur simultaneously in a given body of water. Photosynthesis by suspended micro-algae (phytoplankton) is thought to be the primary source of oxygen found in highly productive waters such as those in the turbid southern end of Sugar Bay, where light penetration is reduced to the extent that seagrasses cannot be found at depths greater than five feet (Haines Enterprises, 1987). The rate of photosynthesis is directly dependent on light, so that oxygen production drops to zero at night. Consumption of oxygen occurs due to respiration by the very plants that produce oxygen during the day, so that the producers become consumers of DO in the dark, as well as by other microorganisms, fish, invertebrates, sea grasses, and fish. Typically, a plotted curve of DO versus time shows a peak concentration at mid-day, when oxygen production greatly exceeds consumption by respiration, and a minimum at dawn. In waters heavily polluted by organic waste with a high potential for consumption of oxygen, DO can go to zero and result in fish kills and, if prolonged, can result in anaerobic production of methane and hydrogen sulfide.

The level of DO measured would depend on the historic trend for several characteristics of the waters being sampled. These include the amount of nutrient-rich runoff in the previous few days or weeks; algal populations and their physiological states (i.e., metabolically active or moribund); the time of day that the sample is taken; the amount of solar insolation on the day of sampling and the previous day; the amount of non-photosynthetic suspended matter, which largely influences the amount of light penetration of the water column; and the rate of flushing of the bay by non-turbid ocean water, which is largely dependent on wind-generated currents in Salt River (Sugar Bay Land Development, 1986). In such a dynamic system, it is inevitable that under some sampling circumstances an instantaneous sample may show a depressed DO value. A better indication of pollution by biodegradable organics is the BOD method, which measures the rate of oxygen depletion by respiration associated with biological degradation of organic compounds or particles in the sample over a 5-day period.

In summary, random instantaneous DO measurements are not reliable indicatiors of water quality. The proposed marina project is not expected to negatively impact DO, as sewage pumpout facilities will be provided, and their use will be required for live-aboards.

pH

This parameter was measured in 1980 only, by DNR, and values were found outside the permitted range 100% of the time. Measurement of the parameter was discontinued due to problems with the analysis (M.G. Taylor, pers. commun.). This parameter is intended for use in monitoring wastes receiving industrial waste, which can be highly acidic or basic. Seawater is a very good pH buffer and generaly ranges between 8.1 and 8.5 in natural waters. The measurement technique suffers from the requirement for an unusually long equilibration period in the seawater sample after standardizing with the distilled water/phosphate buffer standard. This parameter should be dropped as a criterion, except for holders of TPDES discharge permit holders. No acidic or basic wastes are expected from the proposed marina.

Temperature

Temperature ranged from 25.0 to 31.0°C (77-97.8°F) during the period 1979-1986. This is well below the 90°F limit. The proposed marina is not expected to have any measurable impact on temperature of the water.

Bacteria

There are no data available for the site. The marina will provide sewage pumpout facilities, and will require that liveaboard boats use holding tanks between pumpouts. Violators will be asked to leave the marina.

Dissolved Gas

This parameter is not being monitored in the Virgin Islands (pers. commun., M. G. Taylor).

Phosphorus

No data on phosphorus (total P) are available for the site. However, measurements of inorganic phosphate phosphorus (PO_4) ranged between undetectable and 15.3 ug/l (1.02 ug-at/l) at six stations during an eight-week period in 1976 (Appendix B). It is unlikely that total P would be more than 50% higher than PO_4. No significant additions of phosphorus by activity at the marina are expected, due to the use of sewage holding tanks and pumpout facilities.

Other nutrients were also measured during the above mentioned period in 1976, and were found to be present in extemely low concentrations, suggesting that Salt River is not polluted by sources of nutrients, such as sewage. Nutrients tended to be higher at the extreme southern end of Sugar Bay, perhaps because this was the station closest to the intermittent stream that enters there. (See Appendix B)

Suspended, colloidal or settleable solids

This parameter shows a wide range of values at the site, due to the natural input of terrigenous sediments into Salt River Bay by runoff from the 2800± acre watershed of Salt River (Teytaud, 1981). The primary contribution of sediments to the runoff is from poorly regulated land clearing and drainage practices in the first and second tiers (agricultural land clearing is exempt from the CZM permitting process). As an example, a single steep dirt driveway to the west of Salt River Marina is the major contributor of sedimentation to that marina's inner basin. However, the geological record indicates that Sugar Bay has been turbid for millenia; this is shown by the absence of calcareous sediments (produced by photosynthesizing macroalgae) in cores taken in deep waters in Sugar Bay (Gerhard and Bowman, 1975).

The range for the DNR samples at the station nearest the site of the proposed marina is 2.0 to 374.4 mg total suspended solids per liter. A corresponding measure of turbidity, masured with a nephelometer, is the NTU (= nephelometer turbidity units) or FTU (= formazin turbidity unit); NTU and FTU are essentially equivalent, the difference being in the reference standard composition. The range of NTU values was 1.9 to 98 NTU. These extreme values were found in the same samples exhibiting the extreme values for total suspended solids. No quantitative limits exist for this criterion, except for waste water sources, but a limit of 3.0 NTU has been proposed in a 1984 (unadopted) version of the Rules and Regulations. A limit of 3.0 NTU would be exceeded frequently through natural levels of turbidity; further discussion of turbidity is found in the Color and Turbidity section below.

Discharges of solids are expected to be decreased by the project. The project will decrease a current minor source of sediments washing into Sugar Bay by relocating the present dirt boat "ramp" which is eroding through vehicular wear and tear and due to erosion by runoff from Northshore Road. The relocated ramp will be constructed of concrete and the old ramp site will be converted to paved parking and the shore lined with rip-rap to prevent wave erosion of the bank. A sedimentation basin will be installed to retain sediments that presently wash into the sea as a result of upland erosion.

Oil and floating substances

The project site is upwind from a soon-to-be-activated fueling facility at Salt River Marina. Any oil or fuel spills at Salt River Marina (except from boats at the southern end of the easternmost pier) would be trapped in the basin at Salt River Marina. No fuel will be dispensed by the proposed marna, so that boats will have to refuel at Salt River Marina or another marina, or be refueled by hand-carrying fuel. Hand-refueled boats are less likely to have significant fuel spills, and any spills are generally limited to a few cups at most, and this is usually retained onboard the refueling boat. The fueling practice at the proposed marina will be very much like it has been for the past approximately five years at Salt River Marina, so it is useful to point out here the absence of any deleterious effects due to boating activity on the mangroves inside Salt River Marina. Juvenile red mangrove (Rhizophora mangle) seedlings, which are more sensitive than mature trees, are common among the roots of the mature trees. The mature trees show vigorous growth and produce seeds.

Discharge of oily bilge water from inboard engines is the most serious water quality concern of the proposed marina. Such discharges are forbidden by VI and Federal laws, and the violator is liable for a minimum fine of $5000 plus clean-up expenses. The marina will actively support this law and encourage the use of oil-absorbent materials in boat bilges.

Radioactivity (Gross Beta, Radium-226, and Strontium-90)

These parameters are not monitored in ambient waters, but their analysis is required for some TPDES permit holders. No radioactivity of any kind is expected to be contributed by the proposed marina.

Taste and Odor Producing Substances

No taste or odor producing substances in amounts that will interfere with primary contact recreation or potable water supply or will render any undesirable taste or odor to aquatic life is expected from the project.

Color and Turbidity

This criterion requires that a secchi disc be visible at a depth of not less than one meter depth. At the site nearest the proposed marina, the DNR data show the secchi disc depth varied from about 2-3 meters (bottom) to as little as 0.1 m (coincident with a total suspended solids value of 374.4 mg/l and an FTU reading of 98). The secchi disc depth was less than one meter in 63% of the samples. The cause of this exceedance of the criterion turbidity is the naturally high turbidity that is characteristic of the natural conditions in this arm of Sugar Bay, and is related to poor flushing of the southern portion of Sugar Bay by clear ocean water. The outer portion of Salt River Bay is flushed by wind-generated currents that predominantly enter the bay over the reef on the east side of the mouth of Salt River Bay and exit on the west side (Sugar Bay Land Development, Ltd., 1986). This type of flushing is minimal at the site of the proposed marina; instead, tidal flushing is probably predominant. Because of the semi-enclosed nature of this arm of the bay, a given parcel of water has a longer residence time here than it would if it was in the outer bay. The increased residence time, coupled with increased nutrient levels due to 1) inputs from land runoff, 2) regeneration from bottom sediments under a shallow water column, and 3) from decaying detritus in the mangrove swamps lining the entire shoreline here, result in a perpetual standing crop of algae that keeps the concentration of dissolved nutrients at very low levels. In effect, this arm of the estuary is behaving like a "chemostat", a type of continuous culture whose algal concentration is limited by the rate at which one or more nutrients enters in the incoming stream of culture medium. This scenario is supported by the results from a study of a station at the head of Sugar Bay in 1976 over a period of eight weeks, in which a highly significant correlation was found between algal crop (particulate protein) and turbidity, but no significant correlation was found between standing algal crop (particulate protein) and the concentrations of nutrients ammonia-nitrogen, nitrate+nitrite-nitrogen, inorganic phosphate, or silicate (Forbes and Haines, 1976; Appendix B). Nutrient levels were always very low, kept low by the standing crop of phytoplankton. Unfortunately, the study did not measure rates of nutrient uptake, which would have been necessary to sort out which nutrient(s) was growth rate limiting.

It should be noted that the above referenced 1976 study was carried out when only one or two boats were located in Sugar Bay and before Salt River Marina opened in the early 1980s.

In summary, the secchi disk criterion appears to be an inappropriate one to use for Sugar Bay, due to the naturally high turbidity. The influence of propellor wash on turbidity is given in the following paragraphs.

Propellor wash

The project has been designed to put the boats in water as deep as the site allows, to minimize any impact that operation of boats' propellors may have in resuspending sediments in shallow water. It has been the writer's experience in five years of operating a boat out of Salt River Marina's inner basin (which has an average depth of about 6 ft) that resuspension of bottom sediments by propellor wash is a shorter-lived phenomenon, compared to turbidity caused by terrestrial runoff. At Salt River Marina, runoff from heavy rains carries brown, sediment-laden water from west of the marina into the marina basin and turns the basin water the color of coffee-with-cream-added in a matter of a few hours. The color gradually turns back to a greenish color over the next two or three days as the heavier sediment particles settle out in the basin, and the lighter particles are carried out of the basin by tidal flushing.

Sediments are stirred up by propellor wash generally only when a boat is not moving—either when starting to leave the slip or trying to stop by reversing the propellor rotation, or when the boat is tied in the slip but the propellor is operated to test the drive train. The sediment stirred up is a different color than what comes into the basin with the runoff, probably because it is now a mixture of silt particles, algae, other microorganisms, and detritus from floating vegetation that is brought into the basin by the prevailing easterly winds. The bottom of the basin is in effect a compost heap consisting of the above listed components. When this conglomeration of intermingled material is disturbed by propellor wash, it has a tendency to settle out of the water column faster than terrigenous sediment alone, because of the large average particle size. The settling process is essentially complete in about an hour's time, and the effect is localized to immediately adjacent slips. A careful boater can maneuver in and out of his slip without stirring up bottom sediments, by using minimum engine speed. Of course, the deeper the water and the smaller the engine, the less effect there will be on the bottom. The proposed marina is planned to locate the larger boats (with larger engines) in the deepest slips. Half of the widest slips will have a draft greater than nine feet; no bottom disturbance is expected in these slips. In shallow water (<3 ft), propellor wash will have less effect on sediments because the bottom is partly colonized by the seagrass/seaweed community (Thalassia and Halimeda) there. Data on the shallow water community is to be found in the EAR for the project.

Summary

The water quality criteria have been addressed as they apply or are affected by the proposed marina, and the best practical methods to limit impacts on water quality will be used. Sugar Bay is a naturally turbid water body for which some water quality criteria are inappropriate. Operation of the marina is not expected to significantly degrade water quality in Sugar Bay. Because the observed violations of water quality standards in the past appear to result from "natural forces", §186-10 appears to apply to the site, and water quality certification should not be denied for the reason that the water quality criteria have been exceeded at times in the past.

If you have any questions concerning this request for water quality certification, please call me.

Sincerely,

Kenneth C. Haines, Ph.D.
President

Enclosures:
Appendices A & B
Drawings of the project

References

Forbes, M.L. and K.C. Haines. 1976. Effects of environmental factors on spatfall and growth in mangrove oysters. Unpublished data.

Gerhard, L.C. and J. Bowman. 1975. Sedimentation in the Salt River estuary, St. Croix, U.S. Virgin Islands. West Indies Laboratory Special Pub. No. 8. 56p.

Haines Enterprises, Inc. 1987. Environmental assessment report for Columbus Landing: A marina, restaurant, shopping and office complex at Estate Morningstar on Sugar Bay (Salt River), St. Croix, U.S. Virgin Islands. 63 p.

Sugar Bay Land Development, Ltd. 1986. Environmental assessment report for the proposed Virgin Grand Beach Resort Hotel, Marina and Condominiums. 332 p.

Teytaud, A. R. 1981. Guidance plan for the Salt River area of particular concern, St. Croix, U.S. Virgin Islands. 29 p. plus references and appendices.

Appendix A

(Summary of Water Quality Data, from Division of Natural Resources)

SUMMARY OF WATER QUALITY DATA

ST. CROIX

STATION No. 7 33 D

LATITUDE:

LONGITUDE:

[illegible] Inlet - off [illegible]

YEAR	1979	1979	1979	1979	1979	1979	1979	1979	1979	1980	1980
DATE	5/24	6/22	6/29	7/19	8/[illegible]	9/17	10/30	11/[illegible]	12/17	1/10	[illegible]
Temp. °C.		29.5	26.5	29.0	30.1	27.5	30.5	26.0	27.8	[illegible]	25.5
Salinity ppt			04.83	6.46	31.53	6.32	34.29	7.83	27.49	28.01	34.[illegible]
Diss.Oxy. mg/1			7.24	5.99	5.93	7.25	[illegible]	7.35	7.50	6.16	7.1
Susp. solids mg/l	5.7	2.0	21.4	12.4	3.6	5.4	—	19.4	7.7	8.3	6.0
Turbidity FTU		6.5	42	13.7	2.2	5.0	3.2	23.0	3.1	[illegible]	[illegible]
Secchi meters		.7	.10		1.0	1.0	1.5	0.4	0.1	.9	1.5
Fecal Col per 100ml											
Sea State		1-6'			0-1'	1-3'	0-1'	1-3'	0-1'	1-3'	1-3'
Wind kts.		10-15		15-20							10-12
Clouds %		60	over-cast		30%	over-cast				70	20
			After rain								

YEAR	1980	1980	1980	1980	1980	1980	1980	1980	1980	1980	
DATE	3/10	4/14	5/2	6/20	7/31	8/[illegible]	9/5	10/[illegible]	11/28	[illegible]/19	
Temp. °C.	26.6	27.7	28.8	30.6	30.1	29.6	29.3	31.0	27.0	26.0	
Salinity ppt	35.27	34.12	36.01	36.2	36.2	36.8	35.9	34.6	32.5	34.2	
Diss.Oxy. mg/1	6.6	6.4	5.97	5.5	6.1	6.6	4.0	5.7		6.0	
pH	[illegible]	10.[illegible]	11.8	11.1	3.1	11.0	7.7	6.9	5.7	9.5	
Turbidity FTU	2.4	4.6	4.1	4.5	4.2	4.4	3.0	2.7	[illegible]	3.3	
Secchi meters	0.8	0.9	0.4	0.8	0.7	0.8	1.0	1.1	0.4	1.0	
Fecal Col per 100ml											
Sea State	0-1	1-3	0-1	1-3	0-1	0-1	flat	0-1	1-2'	[illegible]	
Wind kts.	E 15	[illegible]	S 8	E 12-15	E 8-10	E 10-12	E [illegible]	E 8-10	[illegible] 10-[illegible]	E [illegible]-12	
Clouds %	40	10	60	80	20	90	70	90	20-50	20-50	

330

SUMMARY OF WATER QUALITY DATA

ST. CROIX

STATION NO. 7, West Inlet - off old road   LATITUDE: ____________   LONGITUDE: ____________

YEAR	1981	1981	1981	1981	1981	1981	1981	1981	1982	1983	1983	19[illegible]
DATE	1/2	2/5	3/3	4/9	5/8	7/28	9/11	11/12	11/12	3/10	5/[illegible]	7/[illegible]
TEMP. OC	25.2	26.0	26.6	26.9	29.0	30.9	28.0	27.7	27.0	25.0	26.0	31[illegible]
SALINITY PPT	35.8	35.8	36.0	36.4	34.4	35.0	35.3	34.6	—	35.43	34.6	—
DISS. OXY mg/1	6.4	6.4	6.2	6.5	6.4	6.6	5.2	6.5		6.73	6.55	
Susp Solids (mg/l)	6.4	10.6	13.7	17.0	13.4		11.0	7.7	2.0	13.6	13.8	9.[illegible]
TURBIDITY FTU	5.4	5.3	7.3	7.9	8.4	8.8	5.2	3.9	1.9	22.5	6.05	4.[illegible]
SECCHI METERS	0.8	1.0	1.0	0.8	0.7	0.6	0.9	0.9	1.5	0.5	1.[illegible]	—
FECAL COL PER 100ML										—	0	
SEA STATE	1-3	1-3	1-3	3-5	0-1		—	1-3	-	—	2-[illegible]	[illegible]
WIND KTS.	E 18	E 8	E 10-15	NE 15	E 8	E 8	—	E 12	-	ESE 8-10	[illegible]	[illegible]
CLOUDS %	5-20	20-50	20-50	50-80	50-80	20-50	—	80	-	20	5	5

YEAR	1983	1983	1984	1985	1985							
DATE	9/16	11/10	6/27	1/16	10/17							
TEMP OC	29.9	29.2	30.5	25.8	29.0							
SALINITY PPT	35.8	34.9		35.5	34.86							
DISS. OXY mg/1	5.5	6.4	5.0	6.5								
Susp. Solids	13.13	5.3	8.8	6.8	29.6							
TURBIDITY FTU	4.3	4.6	5.8	5.0	12.2							
SECCHI METERS	1.5	1.5	1.0	B	0.7							
FECAL COL PER 100ML												
SEA STATE			1E									
WIND KTS.			E10									
CLOUDS %			30									

MARINE WATER QUALITY DATA

Virgin Islands Department of Conservation and Cultural Affairs

Division of Natural Resources Management

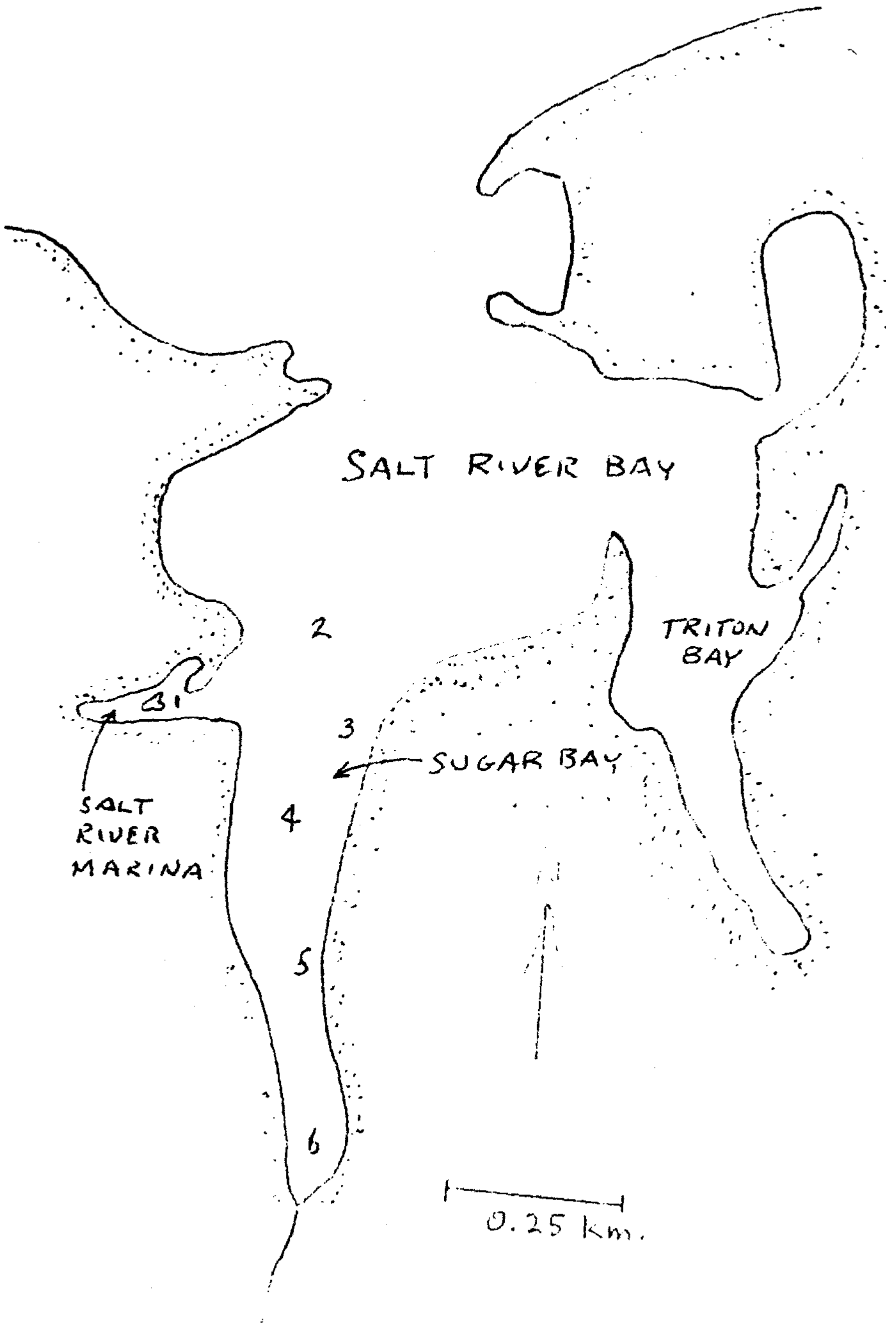
Station No. 33D   Location: Salt River (Sugar Bay)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Year								1986				
Day								27				
Temperature deg. C								29.0				
Salinity ppt.												
Dissolved Oxygen mg/l								3.8				
Turbidity n.t.u.												
Secchi Depth m								1.1				
F. Coliform per 100 ml												
Suspended Solids mg/l								2.5				
Nitrate mg/l												
Nitrite mg/l												
Phosphorus Total mg/l												

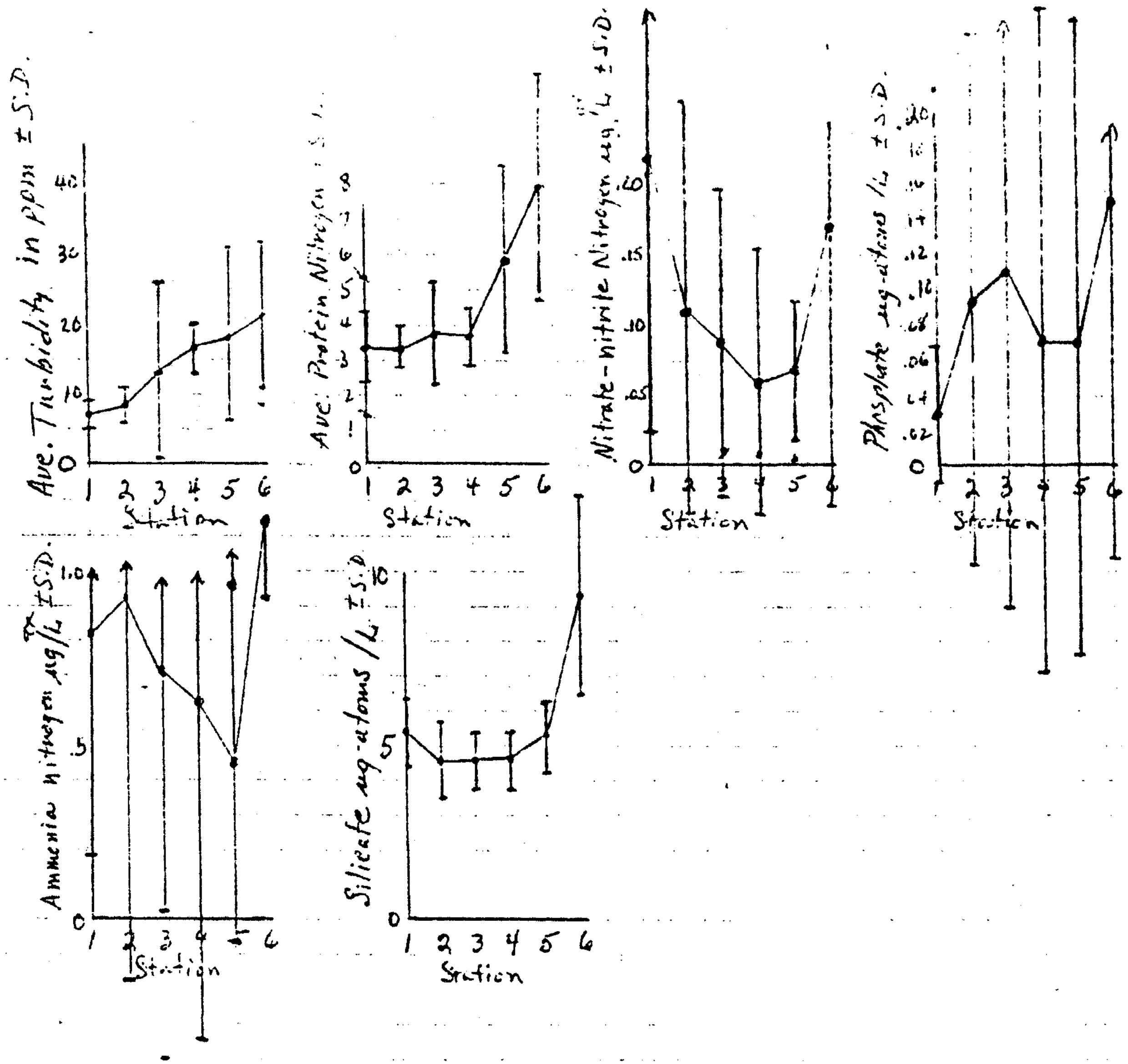
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Year												
Day												
Temperature deg. C												
Salinity ppt.												
Dissolved Oxygen mg/l												
Turbidity n.t.u.												
Secchi Depth m												
F. Coliform per 100 ml												
Suspended Solids mg/l												
Nitrate mg/l												
Nitrite mg/l												
Phosphorus Total mg/l												

Appendix B

(Unpublished data from Forbes and Haines, 1976)

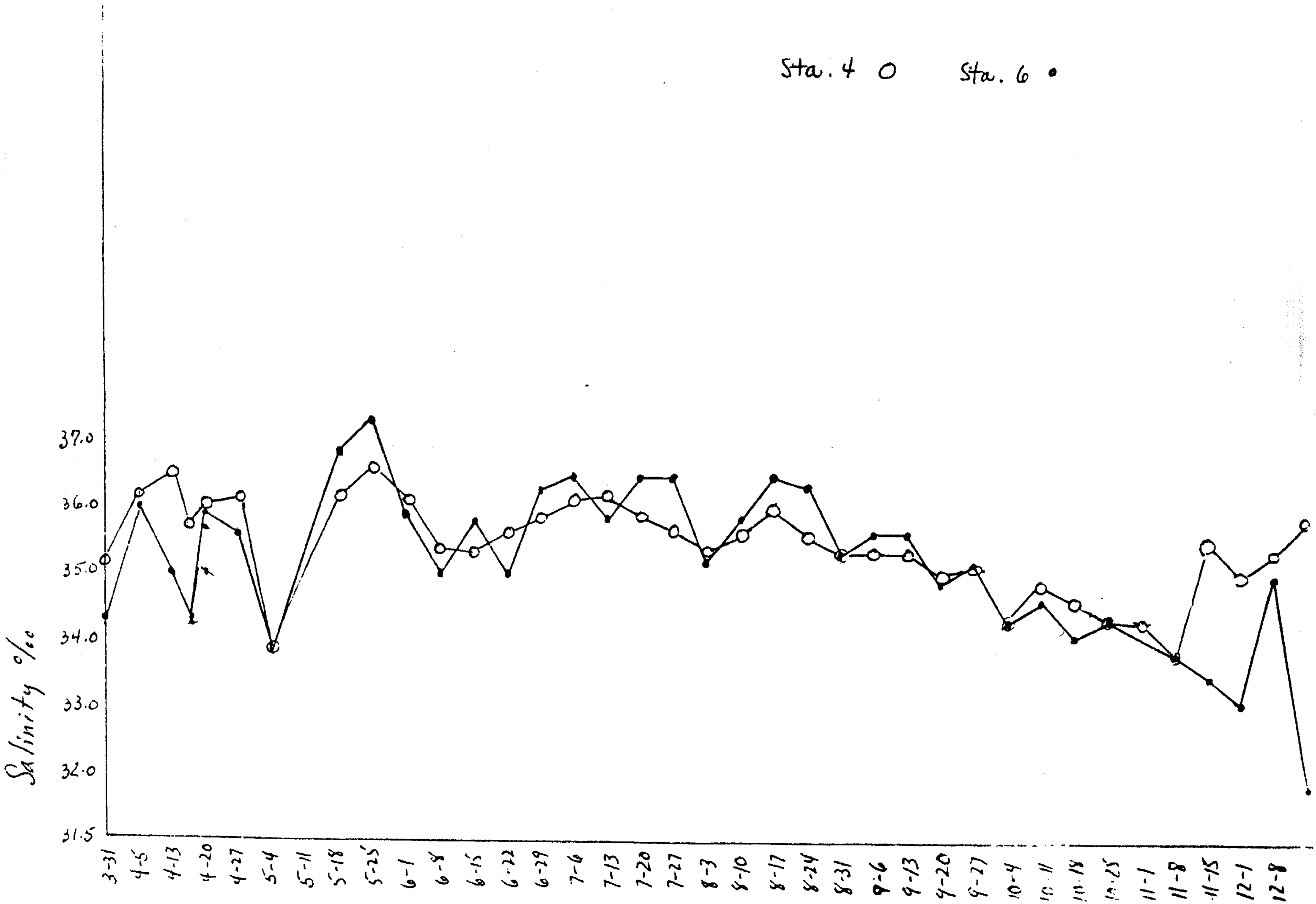


LOCATION OF STATIONS IN SUGAR BAY



SUMMARY OF DATA COLLECTED WEEKLY AT SIX STATIONS IN SALT RIVER, MARCH 31 - JUNE 8, 1976.

(FORBES & HAINES, 1976, UNPUBLISHED DATA)



SURFACE SALINITY AT TWO STATIONS IN SALT RIVER IN 1976-1977

Test of Correlation between Environmental factors in Salt River
(From Forbes & Haines, 1976; unpublished data)

Sta. 6.

→ Salinity (x) vs. turbidity (y)

$N=39$ $b_{yx}=-3.658$ $a_y=149.15$ $r=-.3865$ $P<.02$ (Significant)

$b_{xy}=-.041$ $a_x=36.08$

Salinity vs. Protein

$N=38$ $b_{yx}=-.4763$ $a_y=24.7$ $r=-.1581$ $P>.05$ Not Sig.

$b_{xy}=-.0525$ $a_x=35.7$

Salinity ~~vs~~ ~~protein~~ of previous week vs protein

$N=37$ $b_{yx}=-.377$ $a_y=21.2$ $r=-.1255$ $P>.05$ Not sig

$b_{xy}=-.042$ $a_x=35.6$

Salinity vs. NO_2-NO_3.

$N=35$ $b_{yx}=-.030$ $a_y=1.230$ $r=-.159$ $P>.05$ Not sig.

$b_{xy}=-.835$ $a_x=35.4$

Salinity vs NH_3

$N=35$ $b_{yx}=-.071$ $a_y=3.65$ $r=-.086$ $P>.05$ Not sig.

$b_{xy}=-.106$ $a_x=35.4$

Salinity vs PO_4

$N=36$ $b_{yx}=-.010$ $a_y=.5$ $r=-.0426$ $P>.05$ Not sig.

$b_{xy}=-.176$ $a_x=35.4$

Reg. 04 = 5.63 R03 = 1271.9 R05 = 44973.81 R06 = 3.0291

R07 = 198.532 R08 = 36

Salinity vs ~~[illegible]~~ SiO_3

$N=34$ $b_{yx}=-.038$ $a_y=10.6$ $r=-.013$ $p>.05$ Not Sig.

$b_{xy}=-.004$ $a_x=-.004$

APPENDIX D

Photographs of the Project Site

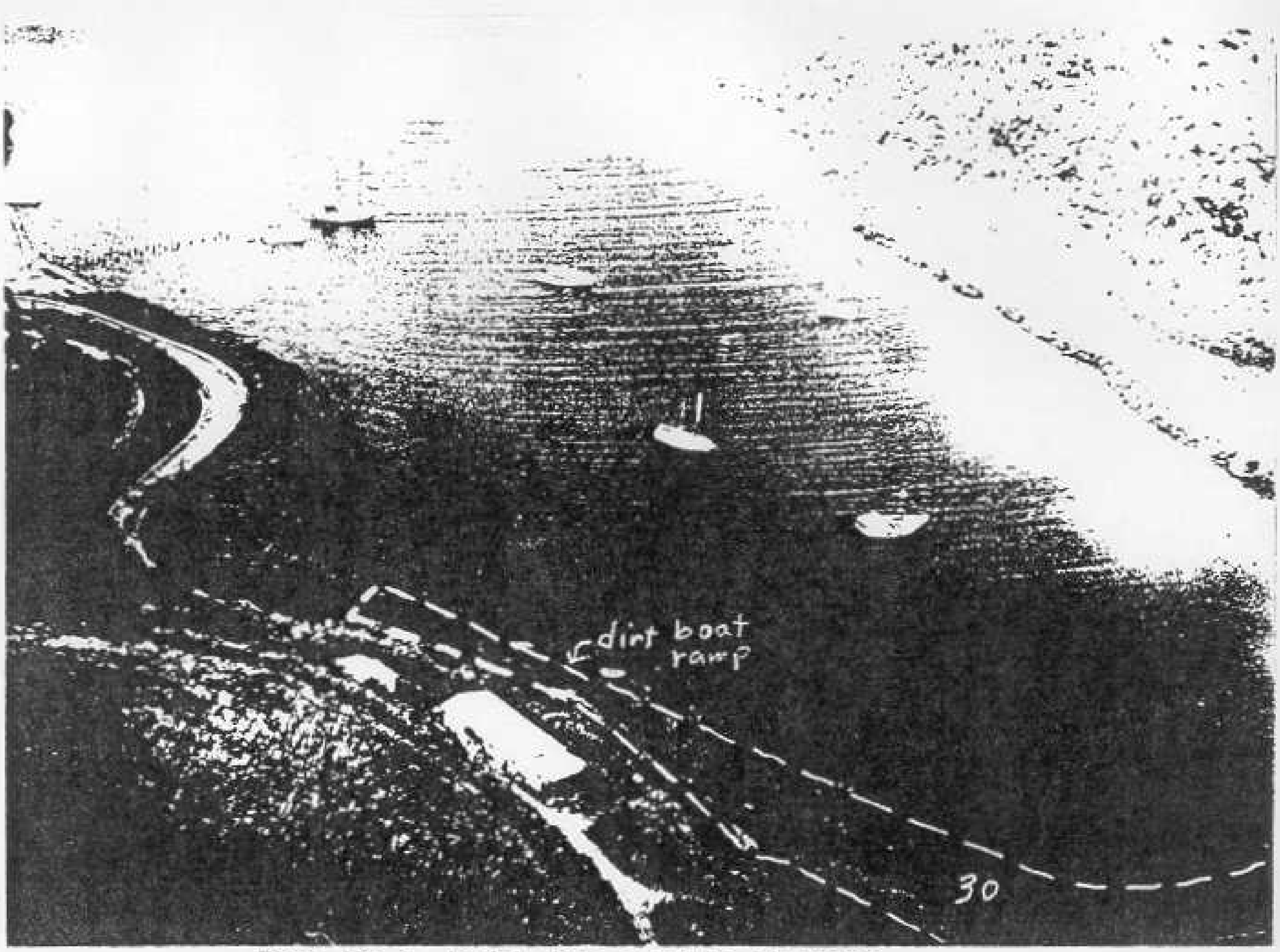


Photo No. 1. Aerial view toward the northeast of part of Plot 30 (outlined with dashed line). Photo taken March 23, 1987.

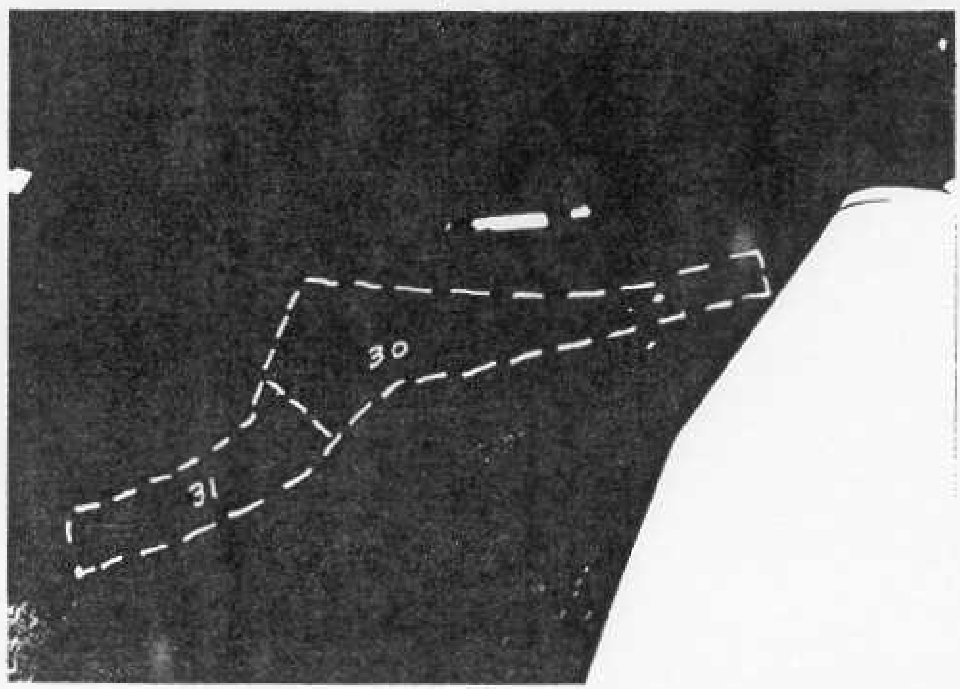


Photo No. 2. Aerial view toward the west of Plots 30 and 31 (outlined by dashed line.) Photo taken March 23, 1987.

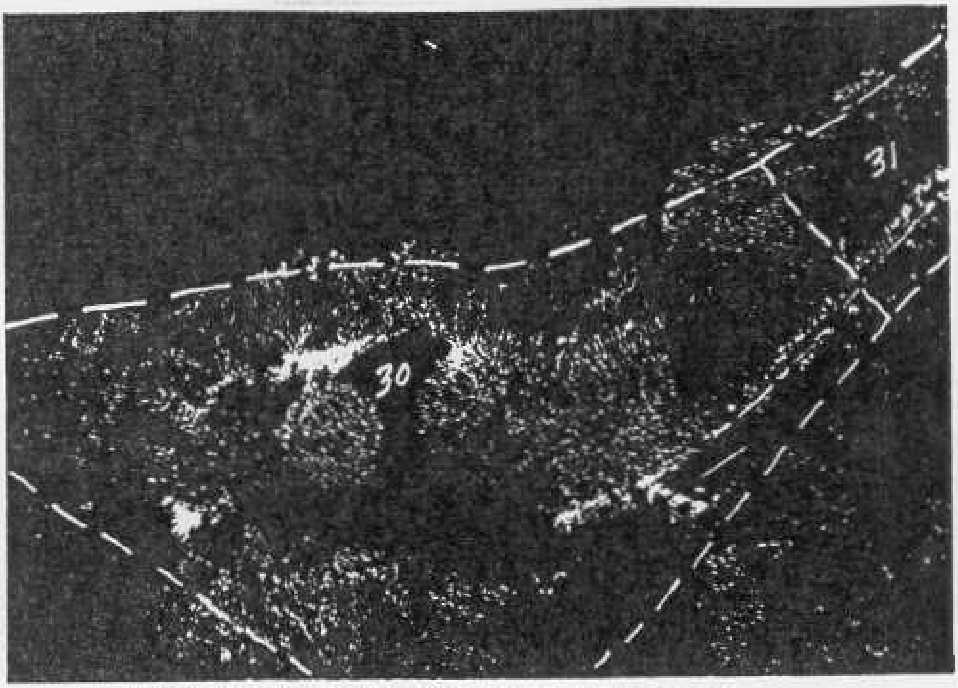


Photo No. 3. Aerial view of central part of Plot 30 after hand-clearing of some upland vegetation. Photo taken March 23, 1987.

Photo No. 4. View of dirt boat ramp, looking toward the northeast. Salt River Bay is behind boats. Photo taken April, 1986.

Photo No. 5. View of dirt boat ramp, looking toward southeast. North Shore Road on right side, Sugar Bay on left. Photo taken April, 1986.

Photo No.6. View to north from near southern boundary of Plot 31, after hand clearing of vegetation. Photo taken March 23, 1987.

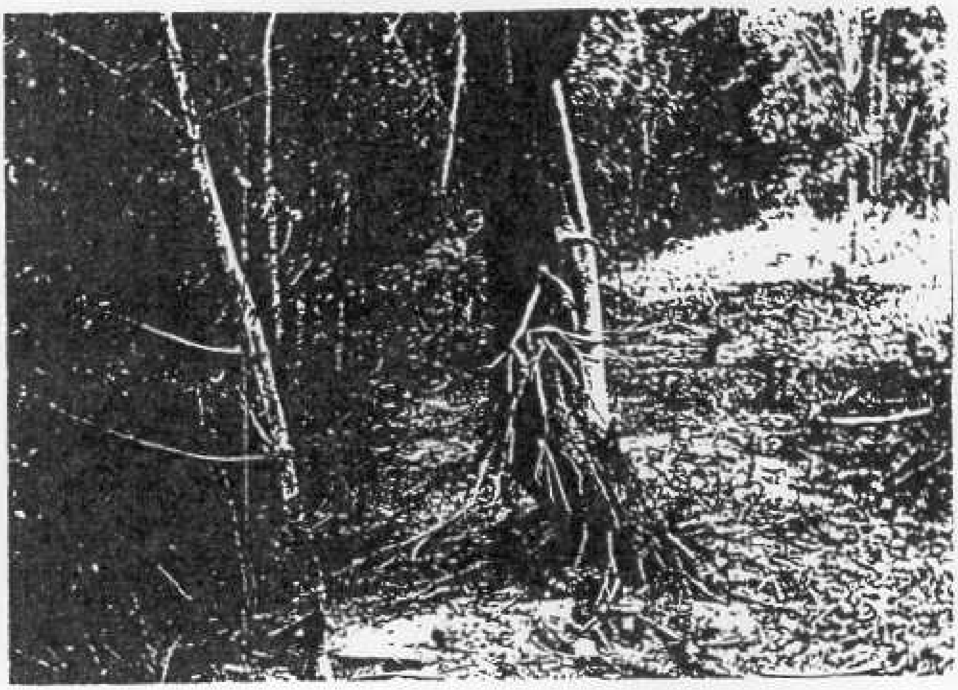


Photo No. 7. View to north on Plot 30, showing large manchineel trees in center background, red mangroves on right. Photo taken March 23, 1987.

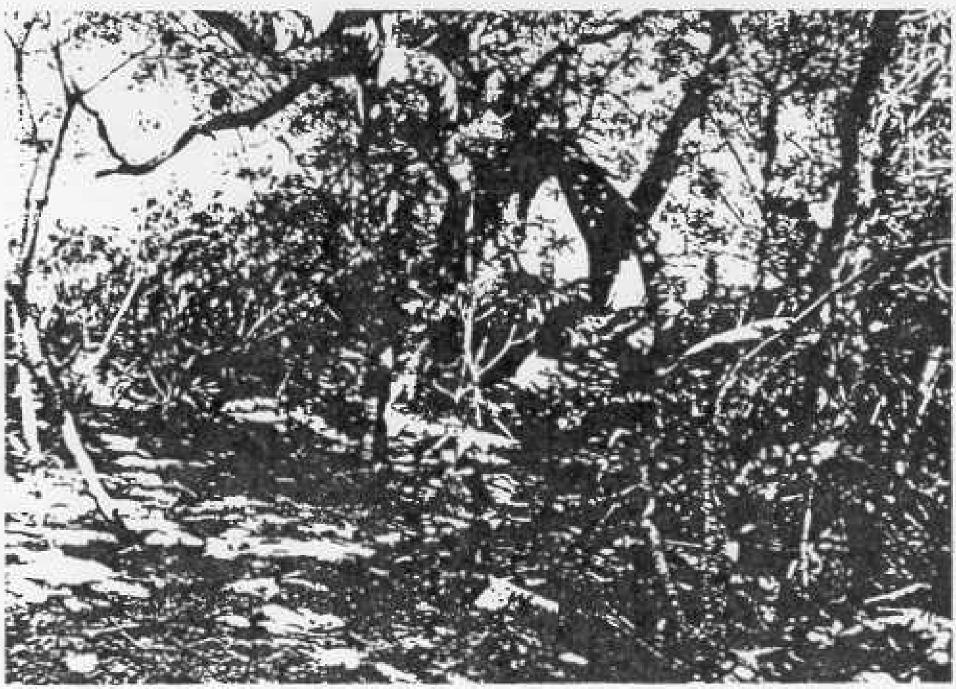


Photo No. 8. View south on Plot 30, showing a large black mangrove tree located about three feet from the high tide line. Red mangroves to the left. Photo taken March 23, 1987.

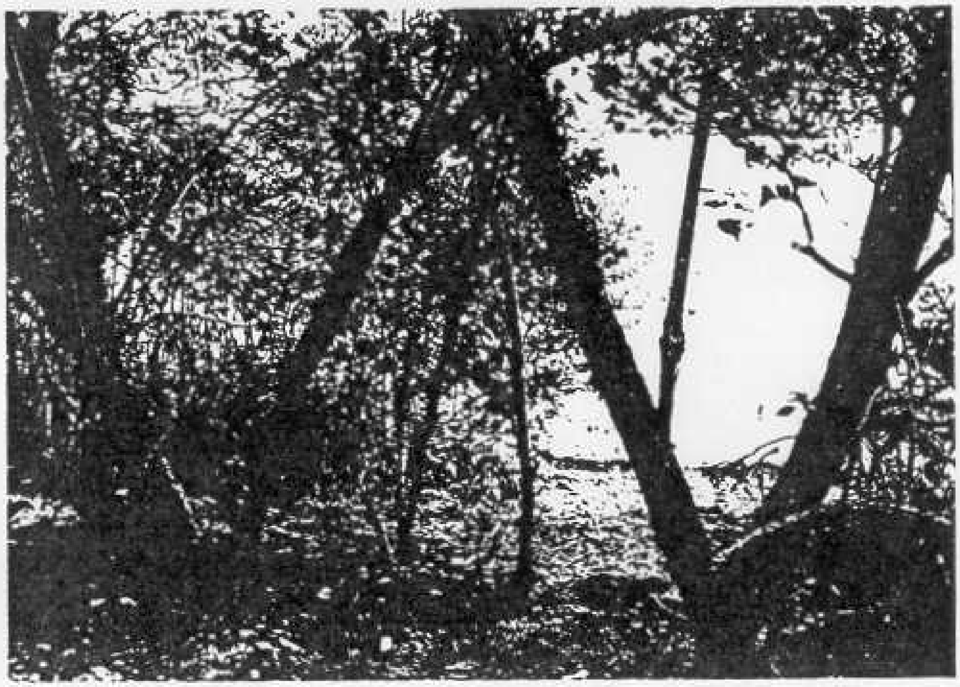


Photo No. 9. Natural break in red mangroves, where access walk to pier will be placed. Maho trees in foreground. Photo taken March 23, 1987.