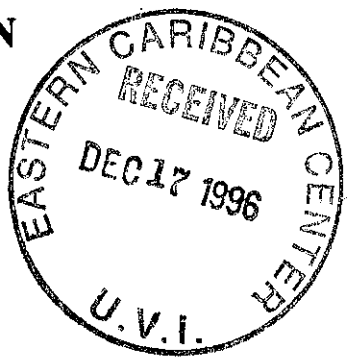
CHRISTIANSTED WATERFRONT AREA OF PARTICULAR CONCERN (APC)



A COMPREHENSIVE ANALYTIC STUDY

V.I. DEPARTMENT OF PLANNING AND NATURAL RESOURCES
Coastal Zone Management Program

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CHRISTIANSTED WATERFRONT
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LIST OF KEY ACRONYMS

Area of Particular Concern	APC
Base Flood Elevation	BFE
Coastal Barriers Resource System	CBRS
Coastal Zone Management Act	CZMA
Department of Housing, Parks, and Recreation	DHPR
Department of Planning and Natural Resources	DPNR
Department of Public Works	DPW
Division of Archaeology and Historic Preservation	DAHP
Coastal Zone Management	CZM
Division of Environmental Protection	DEP
Division of Fish and Wildlife	DFW
Federal Emergency Management Agency	FEMA
Million Gallons Per Day	MGD
National Ambient Air Quality Standards	NAAQS
National Flood Insurance Program	NFIP
National Park Service	NPS
National Register of Historic Places	NRHP
Sea Level Rise	SLR
Sewage Treatment Plant	STP
Significant Natural Area	SNA
Territorial Pollutant Discharge Elimination System	TPDES
U.S. Army Corps of Engineers	USACOE
U.S. Environmental Protection Agency	USEPA
U.S. Fish and Wildlife Service	USFWS
U.S. Geological Survey	USGS
Water and Power Authority	WAPA

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1. INTRODUCTION

1.1 General

Christiansted Waterfront is one of 18 Areas of Particular Concern (APC) designated by the Planning Office in 1979 after public nominations and comment had been received (Figure 1). The town is located on the north-central shore of St. Croix; its adjacent harbor is the largest embayment on the north coast. The harbor has a maximum length of 3.30 km and an average width of 2.70 km (total area 2.31 km^2). It is an open crescent, enclosed by a long, almost continuous barrier reef. A single opening in the reef permits entrance to the harbor, which is notoriously difficult to navigate due to its widely variable water depths.

Located within the APC boundaries are Altona Lagoon and Protestant Cay (Figure 2). Altona Lagoon is a tidal saline lagoon located 1 km east of Christiansted. It is connected to the harbor by only two culverts, and thus suffers relatively poor flushing capacity. Nevertheless, the Lagoon is rimmed with Red Mangrove *(Rhizophora mangle)* and provides important habitat for numerous aquatic bird species. The lagoon at one time supported a local shrimp fishery, however, all commercial fishing and shrimping are now prohibited.

Protestant Cay (7.1 acres) is located in the center of the harbor, north of the Christiansted public wharf. Protestant Cay and Green Cay (offshore from Southgate Pond, east of the APC) are the only known 'natural' habitats for the federally listed endangered St. Croix Ground Lizard *(Ameiva polops)*.

The Christiansted Waterfront APC, like urban waterfronts elsewhere, caters to a wide variety of human uses, from industry and utility services, to fishing and recreational pursuits. The harbor contains several swimming beaches, a marina, a commercial dock, power generating and water desalination plants, a concrete block plant, and numerous moorings for recreational vessels, some of which are live-aboards. Its shorefront is, generally speaking, rather dilapidated and under-utilized for the valuable property that it is. Several opportunities exist for improvements that would render the waterfront a more amenable and accessible place to visit, enjoy, and learn about the town and harbor's maritime history and cultural significance.

On July 26, 1991, the CZM Commission adopted the 18 APC's recommended in the Final Environmental Impact Statement (USDOC, 1979), which accompanies the Virgin Islands CZM Act. The Final Environmental Impact Statement notes "the importance of the entire coastal zone", but declares that "certain areas are of yet greater significance." It also establishes the criteria for the designation of Areas of Particular Concern which are as follows:

- Significant Natural Areas
- Culturally Important Areas
- Recreation Areas
- Prime Industrial and Commercial Areas
- Developed Areas
- Hazard Areas
- Mineral Resource Areas

In September of 1991, the Coastal Zone Management (CZM) Commission met and held public hearings on all three islands on the boundaries for all 18 APC's. The Commission met again on

October 1, 1991 and, based upon public input and staff recommendations, approved the boundaries of the APC's.

APC management requires knowledge of an area's ecosystem dynamics, energy linkages, historical development and traditional uses, and an action-oriented plan for the area's future utilization. This Study is intended to serve as the overall planning and management framework within which the various regulatory entities carry out their respective decision-making duties under their authority.

The APC planning effort recognizes that permit decision-making is most often reactive; that is, the decision to approve or disapprove a proposed development is made in response to a permit request, not in advance of it. The general goal of developing an APC management framework is to be able to make *a priori* decisions about the allowable extent of modification of an entire landscape unit. In other words, to raise the level of decision-making from the site-specific to that of natural landscape units and the maintenance of a wide array of interactive resource uses.

1.2 Relationship to Other Plans and Regulations

The Christiansted Waterfront APC Comprehensive Analytic Study was prepared under the authority of the Coastal Zone Management Commission. The Study is intended to serve as the overall planning and management framework within which the various planning and regulatory entities carry out their respective authorities. It is intended that the policy framework contained herein be incorporated into the policies and review criteria of those entities, including, but not limited to, the Department of Planning and Natural Resources (DPNR), the Department of Housing, Parks and Recreation (DHPR), the Port Authority, the Water and Power Authority (WAPA), the Department of Public Works (DPW), the National Park Service (NPS), the U.S. Fish and Wildlife Service (USFWS), the U.S. Army Corps of Engineers (USACOE), the U.S. Environmental Protection Agency (USEPA), and the Department of Property and Procurement. This Study will serve as a guide for future decisions concerning the area. Future development activity should be consistent with the Comprehensive Analytic Study and proposed Management Plan.

The intent of this Study is for all participating territorial and federal agencies to utilize the broad policy framework to guide planning and permit decisions with respect to their own authorities. For those agencies that issue permits or review and comment on permit applications, the Study or proposed Management Plan does not eliminate the authority of those agencies, but increases the predictability and timeliness of the permitting process since many of the issues that must be addressed in a specific permit application are already addressed in the Study and proposed Management Plan.

The issues surrounding any proposed use or activity within the coastal environment are complex. A proposed use immediately outside the boundary of the APC planning area may result in significant adverse impacts on the APC and impair the goals of the APC management framework described herein. This Plan contains several different forms of guidance, all of which should be considered in evaluating impact on an APC. Both the individual property owner who is considering a specific proposal and the decision-maker who is evaluating the proposal should follow the guidance of this Plan.

1.3 Historical Perspective and Overview

In 1733, the Danish West India and Guinea Company bought the island of St. Croix from the French. The town of Christiansted was founded by the Danes on the site of a former French village called Bassin.

The town was designed in a rectangular grid pattern. It was then subdivided and lots sold with the stipulation that buyers were to build within five years. In 1747, a strict building code was established to prevent the further construction of sub-standard housing; the code contributed to the high standard of buildings in the town.

In 1755, the capital of the Danish West Indies was transferred from Charlotte Amalie to Christiansted which sparked a population growth and expansion of the town. Christiansted developed as the local trading center and the Territory's principal maritime commerce center.

A triangular defense system was built to guard the single entrance into the harbor (Figure 3a). Fort Christiansvaern was the first fort to be constructed. It was built on the site of an older fortress constructed between 1672 and 1680 by the Danes (section 2.5.2). The original structure underwent major alteration in the 1730's as part of the triangular defense system, and was completed by 1749. Fort Louise Augusta and Fort Sophia Frederika were both completed in 1788. The latter two "forts" are perhaps more appropriately referred to as "batteries". Fort Christiansvaern is the only maintained historic fort of the three. It is owned by the U.S. Federal Government and managed by the National Park Service.

The population of Christiansted more than doubled between 1758 and 1786 (from 2175 inhabitants to 4787) [Island Resources Foundation, 1978a]. Later, the failure of Christiansted to grow in the 19th century was due to the decline in the sugar economy which set in after 1820. Economic decline continued into the early 20th century, and the population of Christiansted fell from 5483 inhabitants in 1901 to a low of 3767 persons in 1930. By 1949, the population had again begun to increase.

Christiansted was more fortunate than either Charlotte Amalie or Frederiksted in escaping the ravages of fire which destroyed so much of the latter two towns in the 19th century. On February 5-6, 1866, Christiansted suffered its only fire of major consequence. The fire was confined to about 36 lots in the Sunday Market area at the western end of town.

In September of 1989, Hurricane Hugo caused major destruction to the island of St. Croix, including Christiansted Harbor which suffered an oil spill that occurred after the storm. The following excerpt provides a glimpse of the hurricane's impacts on the harbor (Island Resources Foundation, 1991):

> During the storm, the Virgin Islands Water and Power Authority (WAPA) lost the containment wall on a storage tank, causing a major oil spill along the entire northeast coastline. No oil was visible in the main harbor the day after Hugo, but before long, the area from Fort Christiansvaern west to St. Croix-by-the-Sea was heavily oiled. Exposed oil-containing sediments were noted east of WAPA and at Pelican Cove. The low pressure of the storm also caused underground gas tanks to leak (apparently through their vents), and gasoline ran into Gallows Bay for at least three days after the storm.

Oil-saturated sand was removed from the beaches and never replaced. Other hurricane impacts included the following (Island Resources Foundation, 1991):

> Septic tanks failed, and raw sewage from the public system ran heavily for weeks until lift stations were repaired. Other sources of contaminants included marinas and industrial sites containing toxic fuels, paints, etc., plus sunken boats, transformers, and other debris fallen or dumped into the harbor, and disturbed bottom sediments.

Protestant Cay, an islet situated in Christiansted Harbor, is owned by the V.I. Government. The French Catholics, who were in possession of St. Croix from 1650-1696, buried Protestant Huguenots on the island, giving it the name Protestant Cay (Dammann and Nellis, 1992). As mentioned above, Protestant Cay is also the site of Fort Sofia Frederika, constructed on the eastern point of the Cay in the 1780's. The Island is now leased to a private company which owns and operates a hotel constructed in the late 1940's. Ferry service is available to and from Christiansted.

1.4 Other Classifications

Altona Lagoon, within the Christiansted Waterfront APC, is included in the Federal Coastal Barrier Resources System (CBRS) as site VI-03 (Figure 4). The Federal Coastal Barrier Improvement Act of 1990 established areas in the USVI as part of the CBRS. The purpose of the system is threefold (Island Resources Foundation, 1986):

1. to halt development in low-lying areas subject to natural disasters (flooding, hurricanes, etc.);
2. to stop wasteful expenditures in these areas; and
3. to protect valuable natural resources from being destroyed by unwise economic development.

By law, federal expenditures (e.g., grants, loans, federally backed insurance, etc.), including federal flood insurance, are prohibited for development projects within a designated CBRS site. The law does not, however, prevent projects from moving forward with private backing. Certain exemptions are allowable for park lands, recreational areas, public recreation infrastructure, and land acquisition.

The entire shoreline and some upland areas of the APC are situated within a designated 100-year floodplain (section 2.3.3) [Figure 5].

Altona Lagoon is also listed in 'A Directory of Neotropical Wetlands' (Scott and Carbonell, n.d.). Its significance as critical habitat for migratory aquatic bird species is described and discussed in the Directory (section 2.4.2).

Immediately outside of the APC boundary, the Christiansted National Historic Site, including Fort Christiansvaern, the waterfront area, and Government House, is described as a "priority historic site" in an early park and recreation plan for the U.S. Virgin Islands (National Park Service, 1960). The site is of national historic significance as an "excellent example of the Danish economy and way of life in the Virgin Islands" (National Park Service, 1977). Fort Christiansvaern received National Historic Landmark designation in 1977 (National Park Service, 1988). Overlapping the National Historic Site

is the Christiansted Historic District, created by the V.I. Government as an architectural control district to maintain the historic integrity of the buildings located therein (Figure 3a).

The same study (National Park Service, 1960) listed Altona Beach as a "priority recreation site". Later, the Virgin Islands Park System study (Alexander, 1981) listed the following areas within the APC as potential park sites:

Multi Resource Site:
Altona Lagoon

Natural Preserves and Wildlife Sanctuaries:
Altona Lagoon
Protestant Cay

Cultural Activity Areas/Program Sites:
King St., Christiansted
Gallows Bay Strand
Altona Lagoon Isthmus
Waterfront Boardwalk, Christiansted
Christiansted Central Market

Historic Site:
Fort Louise Augusta

Archaeological Site:
Richmond

Two sites within the APC were listed for potential inclusion in the Virgin Islands Territorial Park System: Long Reef/Little Princess and Altona Lagoon (Figures 6a and 6b). They were included as part of an assessment of coastal damages suffered during Hurricane Hugo (Island Resources Foundation, 1991). The sites are listed in that study as sites C3 and C22.

With the adoption of the territorial Coastal Zone Management Program in 1979, several sites in the Territory were identified as potential Significant Natural Areas (SNA's), including Altona Lagoon and Protestant Cay (Teytaud, 1980). Significant Natural Areas are defined as areas of unique, scarce, or fragile natural habitat or physical features; areas of high natural productivity; or essential habitat for living resources, including endangered species and the various levels of the food chain critical to their well being. Examples of significant areas are those which harbor unique or remnant plant and animal species of special interest; natural areas that provide scientific and educational value; and areas necessary for nesting, spawning, rearing of young, or resting during migration. Also included are areas needed to protect, maintain, or replenish coastal lands and resources (USVI Govt/DPNR, 1991).

An effort to survey and describe the major biological attributes of SNA's was initiated in 1989 by the DPNR/CZM. However, the project was terminated prior to completion, and as of yet no official designation of SNA sites has occurred.

Protestant Cay is listed as critical habitat under the federal Endangered Species Act, as one of only two remaining sites for the federally endangered St. Croix Ground Lizard (USVI Govt/DPNR, 1991).

2. DESCRIPTION OF THE SITE

2.1 APC Boundary

The boundary for the Christiansted Waterfront APC, established by the Coastal Zone Management Commission, is described as follows (Figure 2):

> Beginning at a point on the shoreline of Estate Richmond at the western boundary of the WAPA plant; continuing northwest along the shoreline to a point directly south of the westernmost point of Long Reef; then proceeding north to the northwest end of Long Reef; then east, passing to the north of Long Reef, to the easternmost point of Beauregard Bay; then south along the road bordering the Shoy Ruins; and then along the CZM Tier 1 Boundary (as shown on the official Coastal Zone Boundary Map) south of Altona Lagoon to the western boundary of the WAPA plant, the point of origin.

2.2 Ownership Summary

Fort Louise Augusta/Altona Lagoon/Gallows Bay:

The land between Altona Lagoon and Christiansted Harbor, known as Altona Beach, is owned by the V.I. Government (Figure 6a). Also, Little Bay is owned by the V.I. Government and is heavily utilized by older residents.

The radio tower on the hill overlooking Little Bay is owned and operated by WSTX radio station (Figure 9a).

Land above the waterline and bordering the north-eastern portion of Altona Lagoon is privately owned. A large portion of this land is adjacent to the golf course at the Buccaneer Resort and owned by the same company. Also, land above the waterline south of the lagoon remains virtually undeveloped and is privately owned (Figure 9a).

The marina in Gallows Bay, St. Croix Marine, is privately owned (Figure 9a).

The V.I. Port Authority owns and operates port facilities at Gallows Bay (Figure 9a).

A six-acre site known as Barrack's Yard is located east of the fort on the shore, extending to just west of Lobster Street in Gallows Bay. This centrally located plot is formerly a Department of Public Works (DPW) site. Several V.I. enforcement vessels are moored at the waterfront, including those from DPNR/DEE and the drug enforcement agency. Various government offices occupy the site, in addition to eighteen (18) privately owned parcels (Figure 9b).

Fort Christiansvaern to sea plane terminal:

This area is a mixture of public and private ownership. The Christiansted National Historic Site is under the control of the National Park Service. The Danish West India and Guinea Company Warehouse is managed by the U.S. General Services Administration. It houses the U.S. Post Office and Customs Service (Figure 3a).

Ownership of the wharf bulkhead and apron west of Fort Christiansvaern is in dispute between the VI Port Authority and the National Park Service (NPS). "In the early 1980's, NPS funded extensive repairs to the badly-deteriorated bulkhead. In doing so, the apron was extended northward approximately six feet. Upon completion of this project, the Virgin Islands Port Authority claimed the wharf bulkhead based on VI Government ownership of submerged and reclaimed land" (pers. comm, W. Cissel, NPS, 1993). Ferries which run between Christiansted and both Protestant Cay and Buck Island use this area for loading and unloading of passengers.

The Port Authority owns and leases the land for the sea plane terminal to Caribbean Airboats.

Protestant Cay, located 500 feet offshore of Fort Christiansvaern, is owned by the V.I. Government. A private company leases the land from the Government and operates a resort hotel on the cay (Figure 9a).

Western Christiansted Harbor:

The stretch of land between the sea plane terminal and the WAPA facilities in Richmond is owned by the V.I. Government. Twenty eight acres of Government-owned land, including this shoreline property, were cleared for a public park in 1991 (Figure 9b).

Areas inland of the western harbor are occupied by various housing projects owned and managed by the V.I. Housing Authority. The developments include the JFK Terrace, DeChabert, LBJ Gardens, and Water Gut Homes (Figure 9b).

The Virgin Islands Water and Power Authority owns and operates the Richmond power and desalination plants located in the western harbor. Immediately adjacent to the WAPA facilities is a cement bagging company, owned and operated by Mark 21/DEVCON. The DPW operates the LBJ sewage pump station which occupies the northwest corner of the Government-owned Richmond complex (Figure 9b).

Club St. Croix, Sugar Beach, Colony Cove and Mill Harbor are all privately owned hotel/condominiums, and occupy shorefront property heading west from the sewage pump station (Figure 9b).

A small privately owned low-density housing area is located within the APC boundary at Estate Little Princess. A portion of that Estate, located just south of the APC boundary, was willed to the Nature Conservancy by Mr. and Mrs. Shoemaker. It contains mid-18th century ruins (Figure 9b).

2.3 Physical Environment

2.3.1 Climate

Rainfall in the Virgin Islands generally with increasing elevation and exhibits a trend on each island of a dry-to-wet cline from east to west. Average rainfall data, compiled from several years of records at various stations can be misleading in that it probably poorly represents the available precipitation at a particular area in any given year. The U.S. Virgin Islands receive an average of 41 inches of rain per year (Bowden, 1968).

The wettest months are September to December, and the dry season is February to July. Most of St. Croix, including Sandy Point, receives 35-45 (average about 40) inches of rainfall per year. The northeast hills receive slightly more, and Annaly, the wettest area, receives an average of 52 inches per year (Bowden, 1970). Rainfall usually occurs in brief, intense showers of less than a few tenths of an inch.

Temperatures average an annual 79° Fahrenheit, with the winter low averaging 76° F and the summer high reaching an average of 84° F.

The Virgin Islands are located in the area of "easterlies" or "tradewinds" which circulate around the Bermuda high pressure area to the north. The wind and wave patterns of the islands are directly related to these patterns. Predominant winds are thus from the east-northeast and east (Island Resources Foundation, 1977). The intensification of the high results in severe winds occurring during the winter and hurricanes in the fall (Hubbard, *et al.* 1981). Hurricane season is from June to November, with peak activity occurring in September. The annual probability of a hurricane is once every 16 years (Bowden, 1974).

2.3.2 Geological Setting

St. Croix was formed from volcanic sediments deposited deep on the ocean floor in the late Cretaceous period (approximately 80 million years ago). The rocks which underlie the mountain ranges are sedimentary, formed by debris from eroding volcanic rocks (Whetten, 1974). Two predominant mountain ranges exist (the Northside Range and the East End Range), separated by a central sediment-filled valley. At one time, the two ranges were distinct islands, separated by a submerged lagoon, which during a later period of uplifting formed the present valley and single island of St. Croix.

In general, harbor sediments are mostly derived from the erosion of upland soils, and are comprised mainly of quartz and feldspar sand, carbonate mud, and organic detritus. In addition, sediment composition is influenced by scouring and dredging of older submarine strata, a harbor's biological productivity, and other suspended solids washed into a harbor or discharged at ocean outfalls. Fine carbonate sediments transported inward from deeper depths add to these deposits.

The sediments in Christiansted Harbor consist mainly of (1) muddy sand, (2) medium sand, and (3) coarse sand (Figure 7) [Nichols, *et al.*, 1972]. The predominant type of sediment throughout the inner and eastern harbor reaches is muddy sand. It covers the floor of the main channel from its outer entrance to its head in Gallows Bay, and also covers most shoals except Round Reef and the shoals

immediately north of Protestant Cay. The predominant type of sediment in the outer entrance in the channel and on the shoals is medium sand. Coarse sand is found mainly on the floor of the western harbor and on reefs. The predominant sediment in Altona Lagoon is mud (Nichols, *et al.*, 1972).

Historical seismicity in the USVI

As a result of convergence between the Caribbean and North American tectonic plates, the Virgin Islands are located in one of the most earthquake prone regions of the world. During the past 450 years, damage has occurred from earthquakes and associated tsunamis. Strong seismic shocks were recorded for the Virgin Islands in 1777, 1843, 1867, and 1918. Destructive tsunamis occurred in the U.S. Virgin Islands in 1867 and in 1918; the latter resulted in 116 deaths and economic losses estimated at $4 million (in 1918 dollars) [USGS, 1984]. The 1867 tsunami was reported to have a wave height of 27-feet above sea level (Geoscience Associates, 1984b).

Potential human and economic losses for a similar event occurring today would be several orders of magnitude higher. Scientists report high seismic potential for a major fault rupture in the Puerto Rico Trench north of Puerto Rico and the Virgin Islands (USGS, 1984). The Virgin Islands are classified as "Zone 4" for earthquake vulnerability, the highest damage zone and the same classification given to many parts of California (Brower and Beatley, 1988).

Studies prepared in 1984 estimated that an earthquake of MMVIII intensity (Modified Mercalli Scale) has a recurrence period of between 110 and 200 years for the St. Thomas/St. John area. The probability of such an earthquake occurring in the next twenty years is between 50 and 70 percent, and between 60 and 80 percent during the next 50 years (Geoscience Associates, 1984a and 1984b). It is not clear whether the same probabilities can be assigned to St. Croix, as St. Croix is situated on a different shelf platform than St. Thomas and St. John. Nevertheless, the waterfront areas of Charlotte Amalie and Christiansted are especially vulnerable to impacts from earthquakes due to substantial construction on recently filled (reclaimed) land. It is these areas where liquefaction and ground settling are likely to be the greatest. Buildings constructed on loose alluvial or man-made fill soils along the waterfront are at risk of destruction should an earthquake occur (Geosciences Associates, 1984b).

2.3.3 Hydrological Setting

Christiansted Harbor receives drainage from a watershed composed of eight sub-watersheds having a total area of 10.44 km^2 (Figure 8). This includes the 0.48 km^2 watershed of Altona Lagoon (USVI Govt/DCCA, c. 1980). A 472 acre watershed discharges to the harbor near the commercial dock at Gallows Bay; a 327 acre watershed discharges near the sea plane terminal.

Altona Lagoon is a tidal saline lagoon up to 5 m deep. It is located 100 m inland and is tidally flushed by two culverts connecting it to Christiansted Harbor. Historically, the lagoon was flushed through a stand of mangroves separating it from the harbor. Over time, dredge spoils from maintenance dredging of Christiansted Harbor have been deposited on the berm, and created a wider berm, or isthmus. This closure of the lagoon's natural connection to the sea necessitated the installment of the culvert.

Three of the eight watersheds have been extensively developed for residential and commercial purposes, increasing storm water runoff and decreasing natural water storage capacity. Areas which remain well vegetated retain or slow storm water runoff, whereas areas denuded of vegetation or replaced with non-permeable surface materials (e.g., paving, concrete, etc.) prevent percolation and increase the volume and rate of runoff. Flooding within the APC watershed has thus become a growing problem in recent decades, especially in three of the eight sub-watersheds. Drainage studies of the Contentment, Mount Welcome, and Tide Village watersheds are included in 'A Flood Damage Mitigation Plan for the U.S. Virgin Islands' (CH_2M Hill Southeast, 1979).

The Contentment watershed is located on the western edge of Christiansted and has a total area of 320 acres which discharges into the harbor near the sea plane terminal. Maximum elevations in the watershed are about 680 feet above mean sea level. The two locations which experience most frequent flooding within the watershed are (1) the Tropical Motors/Bassin Triangle area and (2) the developed area of Christiansted in the vicinity of the Water Gut housing project. Flooding in the latter area has been especially serious and the cause of substantial property damage (USVI Govt/DCCA, c. 1980).

The Mount Welcome watershed drains an area of approximately 470 acres into Gallows Bay through a small concrete channel. The watershed is prone to flooding in upland areas near Canegata Ball Park and in lowland areas near Gallows Bay.

The Tide watershed is subject to the flooding of upland areas. Tide Village, in particular, has sustained substantial property damage (USVI Govt/DCCA, c. 1980). Runoff is discharged into a mangrove swamp at Altona Lagoon.

A-Zone, B-Zone, and V-Zone floodplains exist within the APC (Figure 5). A-Zones are, in general, comprised of 100-year riverine floodplains. B-Zones are areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood (FEMA, 1992a and 1992b). V-Zones are areas of 100-year coastal flood activity with velocity (wave) action, within which base flood elevations (BFE) are determined. Virtually the entire shoreline within the APC is within the V-Zone (FEMA, 1992a and 1992b). Coastal flooding due to elevated storm waves may compound the flooding problems at Water Gut and Gallows Bay, although harbor storm waves are abated by Long Reef (USVI Govt/DCCA, c. 1980).

Groundwater provides approximately 43 percent of the potable water distributed through the public system on St. Croix (pers. comm., K. Thomas, WAPA). WAPA supplies 1 MGD of well water and 2.3 MGD of desalinated water to the system. Current demand is approximately 0.5 MGD within the distribution system, which is comprised of some 4,000 meters (customers). Supplies are not enough to meet demand, and periodic rationing is necessary (pers. comm., K. Thomas, WAPA). WAPA's principal desalination plant lies within the APC at the Richmond complex (Figure 9b).

2.3.4 Coastal Environment

Christiansted Harbor is protected by a major reef system comprised of Long Reef, Scotch Bank, and a smaller shoal which bisects the harbor entrance known as Round Reef (Figures 10a and 10b). These reefs provide protection to the harbor shoreline from incoming waves, especially the heavy northerly swells which are experienced several times a year.

The floor of the eastern harbor is wide and deep at the harbor's entrance. The outer entrance channel exhibits a v-shaped profile, incised into the shelf edge below the 16 m depth (Nichols, *et al.*, 1972). The channel sides are relatively steep, especially in deeper central parts. In contrast, the shoals are relative flat and extend over a broad area in the western harbor (Nichols, *et al.*, 1972). The winding pattern of the entrance channel renders it notoriously difficult to navigate. The substrate has been mapped for the harbor, and are depicted in Figure 7.

Water circulation in Christiansted Harbor follows a broad counterclockwise pattern directed eastward through the central and eastern harbor (Figure 11) [Nichols, *et al.*, 1972]. Water enters the harbor through shallow channels in the reef and exits through the main entrance channel. This counterclockwise current is driven by large-scale mass transport of waves breaking over Long Reef. Circulation of the currents is determined by the reef elevation, height of ocean waves, and tidal height. Longshore currents approach the harbor and inner shores from an easterly direction, and approach the shore at a slight angle, carrying sand along the shoreline to the west. Current and wave patterns are described in greater detail in Nichols, *et al.*, 1972; Dong, *et al.*, 1972; and V.I. Marine Advisors, 1986.

During fair weather, currents flow out of the harbor entrance at between 5 and 18 cm/sec (average 5-10 cm/sec); they are rarely landward-directed at the harbor entrance (V.I. Marine Advisors, 1986).

2.4 Biological Environment

Figures 10a and 10b depict the physical and biological resources of the APC.

2.4.1 Terrestrial

Unless otherwise cited, the following information for terrestrial biological resources summarizes that which is found in the 'Environmental Assessment of Proposed Dredging in Christiansted Harbor' (V.I. Marine Advisors, 1986).

Shoreline vegetation bordering the western-most extension of Altona Lagoon is dominated by three species of mangrove, White mangroves *(Laguncularia racemosa)*, Black mangroves *(Avicennia nitida)*, and Red mangroves *(Rhizophora mangle)*. Most of the trees are approximately 4.5 m high with some stands exceeding 7.6 m. Coconut palms *(Cocos nucifera)*, Tan-tan *(Leucaena glauca)*, and Seagrapes *(Coccoloba uvifera)*, are more abundant towards the east.

The beachfront area to the west of Fort Louise Augusta is dominated by various grasses and scattered Acacia *(Acacia farnesiana)*, Tan-tan, Coconut palms, Seagrape, and a few White mangroves.

Hurricane Hugo had a severe impact on the terrestrial resources of the area, especially the mangrove system in Altona Lagoon. Taller mangrove trees (above 3 m) suffered the greatest damage (Island Resources Foundation, 1991).

On Protestant Cay, several species of exotic plants have been planted around the hotel and in the small man-made ponds on the south side where Coconut palms have also been planted. Large Tamarind and Mahogany trees remain around the hotel, as well as mangrove trees which are present on the eastern shore. Tan-tan trees and various cacti are present on the east side (Dammann and Nellis, 1992). This

is also one of only two islands in St. Croix on which the federally endangered St. Croix Ground Lizard (*Ameiva polops*) naturally occurs.

Altona Lagoon is a known breeding site for White-crowned Pigeon *(Columba leucocephala), Bubulcus ibis,* Bahamian Duck *(Anas bahamensis),* and *Himantopus.* It is also a known roosting and feeding area for eight species of Ardeidae (herons and egrets) and 19 species of shorebirds, and a wintering area for many species of warblers (family Parulidae) [Scott and Carbonell, n.d.].

At Protestant Cay, Tilapia have been introduced to the small man-made ponds on the Cay (Dammann and Nellis, 1992).

2.4.2 Marine

A detailed description of the marine biological resources of Christiansted Harbor can be found in the "Environmental Assessment of Proposed Dredging in Christiansted Harbor" (V.I. Marine Advisors, 1986), from which the following information is summarized.

The two main coral communities of the harbor are eastern Long Reef and Round Reef. During a 1986 survey, live coral coverage for both areas was found to be at only 6-23 percent. This is low compared to other reefs in the area which had (at that time) an estimated 18-65 percent live coral cover. Researchers concluded that both eastern Long Reef and Round Reef provide environments that are sub-optimum for healthy coral growth, although they could not determine if such was the result of natural or man-made conditions (V.I. Marine Advisors, 1986).

Live colonies of coral on eastern Long Reef included *Agaricia agaricites, Porites astreoides, Favia fragum,* and some colonies of *Millepora alcicornis.* Live coral on Round Reef included *Acropora palmata, Diploria clivosa, D. strigosa,* and *Porites astreoides.*

A total of 59 species of fishes were observed at Long Reef and 58 species at Round Reef during the 1986 survey. This might suggest that the total number of fish species at these two reefs may not be significantly lower than other areas, despite the extensive areas with limited coral cover (V.I. Marine Advisors, 1986). Fish species found at Long Reef include species in the following families: Holocentridae (e.g., Squirrelfish), Lutjanidae (e.g., Mahogany Snapper), Pomadasyidae (e.g. French Grunt), Chaetodontidae (e.g., Foureye Butterflyfish), Pomacentridae (e.g., Sergeant Major), Labridae (e.g., Bluehead Wrasse), Scaridae (e.g., Striped Parrot), and Acanthuridae (e.g., Blue Tang).

Fishes found at Round Reef include species in the following families: Atherinidae (e.g., Silversides), Holocentridae (e.g., Squirrelfish), Carangidae (e.g., Bar Jack), Lutjanidae (e.g., Mahogany Snapper), Pomadasyidae (e.g., French Grunt), Pomacentridae (e.g., Dusky Damsel), Labridae (e.g., Spanish Hogfish), Scaridae (e.g., Striped Parrot), and the Scombridae (e.g., Cero Mackerel).

Altona Lagoon, and its connecting channel to the harbor, has historically been one of the major shrimping and fishing areas on St. Croix. These activities are now regulated by DPNR (section 4.2).

Sea grasses observed in the outer channel included beds of *Thalassia* and *Syringodium.* At the time of the survey, recorded densities fell within the range for relatively unstressed seagrass beds off the northeast shore of St. Croix. Substratum on both sides of the turning basin of the innermost channel

consisted of mounds of *Callinassa* in a moderately sorted, silty sand. Sparse algal cover on the east side of the channel consisted of scattered *Penicillus sp., Halimeda opuntia,* and *Halophila sp.*

Three species of sea turtles have been known to nest at two sites within the APC. The beach at New Fort (Little Bay) is used by Green and Leatherback sea turtles. Beauregard Bay has historically been used by Green and Hawksbills (Island Resources Foundation, 1978b).

2.4.3 Endangered Species

The U.S. Endangered Species Act defines "endangered species" to mean a species or subspecies that is in imminent danger of extinction throughout all or a significant portion of its range. "Threatened species" are those likely to become endangered in the foreseeable future unless current trends are reversed. Such species are protected by Federal law; neither the whole animal or any products from it may be taken, sold, or possessed. Alteration of the habitat in which any of these species occurs may be, in certain cases, prohibited or constrained.

The V.I. Legislature has also passed endangered species legislation. Known as the Indigenous and Endangered Species Act of 1990, the bill (Act 5665), signed into law in December 1990, authorizes the Commissioner of DPNR to promulgate a list of endangered and threatened species in the Virgin Islands. The V.I. Government, Department of Planning and Natural Resources, Division of Fish and Wildlife maintains a list of locally endangered or threatened species.

The following information for endangered species which occur within the Christiansted Waterfront APC was provided by William Knowles, Wildlife Biologist, DPNR/DFW.

Federally listed endangered species:

Green Turtle, *Chelonia mydas*
Hawksbill Turtle, *Eretmochelys imbricata*
Leatherback Turtle, *Dermochelys coriacea*
Brown Pelican, *Pelecanus occidentalis*
St. Croix Ground Lizard, *Ameiva polops* (Protestant Cay)

Federally listed threatened species:

Roseate Tern, *Sterna dougallii*

Locally listed endangered species:

Least Grebe, *Podiceps dominicus* (fresh water golf ponds)
White-tailed Tropicbird, *Phaethon lepturus*
Great Blue Heron, *Ardea herodias*
Great (Common) Egret, *Casmerodius (Egretta) albus*
Snowy Egret, *Egretta (Leucophoyx) thula*
Black-crowned Night Heron, *Nycticorax*
* Least Bittern, *Ixobrychus exilis*
Bahama Duck, *Anas bahamensis*
* Ruddy Duck, *Oxyura jamaicensis*
Clapper Rail, *Rallus longirostris*

* Caribbean Coot, *Fulica caribea* (fresh water golf ponds)
White-crowned Pigeon, *Columba leucocephala*
Fisherman Bat, *Noctilio leporinus*

Indicates that species is likely to occur in the APC, although few or none have been seen.

2.5 Cultural Resources

2.5.1 Prehistoric

Detailed locational information regarding the following prehistoric sites may be obtained from the DPNR/DAHP office on St. Croix. For a generalized location, refer to Figures 3a and 3b.

The Estate Richmond site dates to 500-1500 AD. The site has been disturbed by construction of the large-scale housing and industrial developments which presently occupy the area. It is thought that the site was a village and burial ground. Artifacts collected from the site include pottery sherds, celt fragments (prehistoric fragments shaped like axe heads), shell artifacts, stone artifacts and bones from birds and humans (USVI Govt/DPNR, 1982).

The Sugar Beach site dates from 900 to 1600 AD. Like the Richmond site, and many others on St. Croix, recent developments have disturbed the site. Condominiums presently occupy the area. Artifacts collected from the site include pottery and shell artifacts. Two conch middens have been observed eroding out of the coastal bank. This site is potentially significant, however, because it is the last remaining sample of prehistoric occupation in the Christiansted area that is not completely destroyed (USVI Govt/DPNR, 1982).

The Protestant Cay site probably dates anywhere from 300-700 AD. Artifacts collected from the site include sherds and shells. Because of the large proportion of stylistically complex material which has been observed from the site, it has possible social/ritual significance (USVI Govt/DPNR, 1982).

2.5.2 Historic

Located outside the APC boundary, the Christiansted National Historic Site consists of six historic structures located on 7.6 acres in downtown Christiansted (Figure 3a). The Site is listed on the National Register of Historic Places. The six historic structures are described as follows in the Christiansted National Historic Site Statement for Management (National Park Service, 1977):

Fort Christiansvaern: The original fortress, built by the Danes between 1672 and 1680, became the Danish "Government House", as well as the site for the Lutheran Church. Two early Governors were buried in the courtyard (National Park Service, (1988). Largely completed by 1749, the Fort was renovated again in 1874 and used as a prison, courthouse, and police station. Of the five remaining forts in the Virgin Islands, this 17th and 18th century Danish colonial military structure is the best preserved. In 1971, a portion of the Fort became the territorial Government's first museum of local history. Fort Christiansvaern received National Historic Landmark status in 1977.

Old Danish Customs House: Although part of the first floor dates back to 1751, most of the structure was completed between 1828 to 1830. After 1830 and until 1927, the Customs Service shared the building with the Post Office.

Scale House: Built in the 1850's, this structure replaced an earlier wooden building. The building housed the facilities for weighing and inspecting imports and exports. It also contained offices and quarters for the weighmaster.

Danish West India and Guinea Company Warehouse: This building was completed in 1749 and used to house provisions, offices and personnel. After 1833 the Danish military used it as a depot. Eventually it became a telegraph office. The U.S. Post Office and Customs Service is now housed in this building.

Steeple Building: St. Croix's first Lutheran Church, the Church of Our God of Sabaoth, was completed by 1753. The steeple was added about 1794. After 1831, the Government used the church as a military bakery, hospital, and school.

Government House: Originally two separate buildings constructed at different times, Government house was joined together as one in the 1830's. Part of the older central wing dates to 1747 and was once John Williams Schopen's residence. The western end of the building was built between 1794 and 1797 as the residence of planter and merchant, Adam Sobotker. Governor General Peter Von Scholten purchased it in 1828 for government offices, and later joined it to the Schopen house.

Fort Sophia Frederika and Fort Louise Augusta were gun batteries built by the Danes in the 1780's to complete the Christiansted Harbor defense system. Fort Sophia Frederika is located on the northeastern point of Protestant Cay. The retaining wall is the only remaining structure. A house now sits on what was the gun battery. Fort Louise Augusta overlooks Little Bay. WSTX Radio Station is located in the area where the fort once stood. Fort Christiansvaern is the only maintained historic fort of the three.

In the western portion of the APC, buildings located at Estate Little Princess are also listed on the National Register of Historic Sites.

2.6 Built Environment

2.6.1 Roads and Ports

Since the APC boundary basically follows the shoreline, there are no major roads within the APC. Unimproved dirt roads are the general rule in the Altona Lagoon and Little Princess areas, whereas paved roads service the majority of the waterfront from Gallows Bay to the western harbor. The only significant road development presently foreseeable is the Christiansted bypass road planned for construction in 1993 (Figure 8). The bypass road, although not within the APC, may have potential for significant adverse impacts on the harbor if nonpoint source pollution control measures are not employed (section 4.2).

The commercial dock and marina facilities of Christiansted Harbor are described in section 3.1. A dredging project was undertaken in the harbor from June 1990 to December 1991 to provide a straight

entrance channel to Gallows Bay (Figure 9a). Known as the 'new schooner channel', the goal of the project was to provide a new channel having a control depth of 18 feet below mean sea level and a width of 250 feet (USVI Govt/DPNR, 1992). The project required the removal of 122,000 cu. yards of bottom material, and destroyed approximately five (5) acres of seagrass (USVI Govt/DPNR, 1992). The dredging project received territorial CZM and USACOE permits, as well as a DPNR/DEP water quality certification.

2.6.2 Water Systems

Traditionally, water use on St. Croix has relied on rain catchment and storage in household cisterns. Since the late 1960's, several desalination plants have been commissioned, and a water supply distribution system is now operated by the V.I. Water and Power Authority. The public water supply is increasingly augmented by groundwater supplies. Hand-dug wells of the Danish colonial period have been replaced with a rapidly increasing number of modern drilled wells for both household and public supply use (Gill, 1990).

Potable water storage facilities are spread throughout St. Croix to maintain favorable pressure under normal and emergency conditions, and to accommodate water entering the system from public water supply well fields. The total capacity of these facilities is over 20.8 million gallons (MG). A major tank (10 MG capacity) is located at Richmond; 5 MG tanks are either under construction or planned for Kingshill and Estate Mountain (pers. comm., K. Thomas, WAPA). Other tanks, with capacities of 0.1 MG or less, are located at the Adventure, Fair Plains, Barren Spot, and Concordia well fields, as well as at Grove Place, Contentment, Peters Farm, New Street and Anna's Hope (Peebles, *et al.*, 1979).

The main potable water pumping station for the island is located within the APC at Estate Richmond. The facility presently has four pumps, each capable of pumping over one million gallons per day (MGD). Other pumping stations are located at the Concordia, Barren Spot, and Fair Plains well fields, and at Contentment and Adventure. The combined pumping capacity is over 6.6 MGD (Peebles, *et al.*, 1979).

Christiansted is served by a common pressurized distribution system that receives and distributes both desalinated and ground water (Peebles, *et al.*, 1979). The desalinated water produced at the Richmond plant is stored in the 10 MG tank at that site, where it is treated before distribution. WAPA has recently received a CZM permit for a new 1.3 MGD desalination plant at Richmond.

A secondary salt water system services the town of Christiansted for sanitary flushing and fire fighting. The salt water distribution system is operated by Public Works, and extends from Sugar Beach Condominiums east to Green Street. Salt water is pumped to the 0.03 MG tank at Queen Cross, and to the 0.1 MG tank at Orange Grove each morning (Peebles, *et al.*, 1979).

2.6.3 Wastewater Systems

All areas within the APC are serviced by the municipal sewage collection and treatment system operated by DPW. St. Croix's sewage system includes a primary sewage treatment plant (STP), built in 1972 at Estate Anguilla, and 14 pump stations. The STP was designed to handle flows of 4.0 MGD and, as of May 1992, flows averaged approximately 2.8 MGD (Tetra Tech, 1992). The STP operates

at 50 percent capacity on dry days, and at near full capacity during rainy periods, an indication of the amount of stormwater infiltration into sewer lines (Strategic Planning Group, 1991). The plant was producing water for recharge to groundwater. After the connection of Christiansted to the system, however, the salt (chloride) content of effluent began to exceed levels suitable for advanced treatment and recharge (Peebles, *et al.*, 1979).

The STP and four of the major pump stations, including the LBJ pump station at Richmond, require rehabilitative improvements (USEPA, 1992). The use of salt water flushing systems and the high wastewater strength (a result of limited water availability) have contributed to advanced deterioration of the entire system. The result has been several breakdowns during the past several years which have required that raw sewage be pumped directly into coastal waters while maintenance on the system is carried out. At such times, raw sewage is discharged from the LBJ pump station through an ocean outfall that extends seaward to the forereef of Long Reef (Figure 9b). This is done to mitigate the risk to public health by keeping sewer lines from overflowing into the Christiansted streets and from there to guts leading directly to the shoreline where dispersion would be slow. In the last 10 months there has been one such discharge over the reef (pers. com., M. Cornwall, 1993). DPW has replaced Hugo damage equipment at the pump station with a new motor control center and emergency generator unit. New pumps and valves will be installed using EPA grant funds. The dry and wet wells will be upgraded using local funds (pers. comm., M. Cornwall, 1993).

2.6.4 Energy Systems

Power for St. Croix is generated at the Richmond power plant on the western outskirts of Christiansted. The V.I. Water and Power Authority (WAPA) has aerial power lines located within the APC in the areas of WSTX Radio Station, Fort Louise Augusta, a portion of Gallows Bay, a portion of Christiansted Town, and a portion of Richmond and Water Gut Housing. These areas are served with 13,200 volt distribution feeders which provide power to both commercial and residential buildings (pers. comm., M. Smith, WAPA). There is a submarine power line cable that serves Protestant Cay. There are no underground power distribution lines within the APC.

Power outages are common. A new 22 megawatt (MW) power plant will be constructed during 1993 at the Southshore Industrial Area. The new power plant is badly needed, as WAPA has projected an average of 50 days/year of insufficient power supply given current supply/demand rates. In 1991, St. Croix experienced 304 hours, or 12.5 days, of insufficient supply (*Daily News*, 12 July 1992).

WAPA has obtained a permit for the construction of a new fuel storage tank at Richmond that will store fuel for its power plant (pers. comm., B. Berdan, CZM St. Croix).

2.6.5 Solid Waste Disposal Systems

St. Croix's only municipal solid waste landfill is located on the central south shore at Estate Anguilla. Most residents are responsible for disposing of solid waste in large roadside dumpsters which are transported to the landfill by a private contractor. Businesses are required to provide for their own solid waste removal. However, DPW has door to door curbside collection service for over thirty-five communities on St. Croix, including Camp Rico in this APC. Special bins were distributed by DPW for this purpose (pers. comm., M. Cornwall, 1993).

3. RESOURCE USE, USE CONFLICTS, AND ADVERSE IMPACTS

3.1 Resource Use

Fort Louise Augusta/Altona Lagoon/Gallows Bay

DPNR/DFW is currently working to improve boat launch facilities at Altona Lagoon. The project consists of a small (90-feet) pier, new ramp, extension of the old ramp, a turn-around, and paved parking in an area on the western edge of the berm separating Altona Lagoon from the sea (Figure 9a). The project is scheduled to be completed by March 1993 (pers. comm., W. Tobias, DPNR/DFW).

A study for Altona Lagoon, funded by the USFWS, is being carried out by DPNR/DFW and is scheduled to begin in April 1993. The objective is to determine the significance of the lagoon as a nursery for recreationally important fish species.

Two structures which were severely damaged by Hurricane Hugo are located on Altona Beach. One structure was once a bathhouse and the other was used for concessions; both are owned by DHPR. Altona beach was a popular recreational site prior to Hurricane Hugo. Dredge spoils were deposited in settling ponds on the beach during dredging operations for the new schooner channel. The dredged material has since been removed for various projects around the island including Fredriksted pier. The lagoon itself has traditionally been a recreational and commercial fishing and shrimping area. Fishery management regulations are now enforced by DPNR (section 4.2).

A radio station and tower are located on a hill immediately north of Altona beach, near the site of Fort Louise Augusta. The facilities are privately owned and operated by WSTX Radio Station. The tower collapsed during Hurricane Hugo. Several sections of the collapsed tower are still on the ground.

A significant portion of land bordering Altona Lagoon is privately owned and is part of the Buccaneer resort and golf course. Much of the land bordering the southern portion of the lagoon is privately owned and remains largely undeveloped.

Christiansted Harbor's only marina, St. Croix Marine, is privately owned and operated in Gallows Bay. The marina is comprised of a full service boat yard and dock facilities, including electricity, diesel, and water for recreational vessels up to 10-feet maximum draft. Haulout and repair facilities for commercial, recreational, and military vessels up to 300 tons and 125-feet in length are also available (pers. comm., M. Oliver, St. Croix Marine). The marina has 47 slips and a 200-feet long fuel dock. A small bar and restaurant is located at the marina, and shower and restroom facilities are also available. One dumpster is located on the property for all non-hazardous solid waste. There are no sewage pumpout facilities.

The marina maintains generally a 75 percent occupancy year-round, with approximately 35 boats docked long-term and at least 5 transient boats that come and go every week (pers. comm., M. Oliver, St. Croix Marine).

Gallows Bay commercial dock is owned and operated by the V.I. Port Authority and has facilities to service small cargo vessels, naval vessels, and mini-cruise ships. Prior to the opening of the Port Authority's new Containerport at St. Croix's south shore, all containership traffic was handled in

Gallows Bay. The dock is 300-feet in length on its east side and 400-feet on its west side. The maximum allowable draft for vessels is 16-feet on one side and 12-feet on the other. A pedestrian walkway exists leading to a passenger lounge, telephones, parking, and taxi service. Facilities at the dock also include a small roll-on/roll-off ramp, warehouse, and Port Authority office. While the facilities handle a significant amount of maritime commerce including small inter-island freighters, local and visiting commercial fishing vessels, and vessels which are under contract to the U.S. Navy (USVI Govt/DPNR, 1991), the majority of incoming cargo for St. Croix is shipped via containers through the Containerport on the Southshore.

A sewage lift station is located near the Gallows Bay dock, adjacent to a concrete swale which drains a 472 acre watershed. Large amounts of sediment, originating from several unpaved roads in the watershed, enter the harbor at this location. Raw sewage is discharged into Gallows Bay when the lift station malfunctions or when sewer lines clog resulting in overflowing manholes (USVI Govt/DPNR, 1992). There has been one discharge emergency in the past ten months. A new emergency generator will be installed at the Gallows Bay lift station by January, 1994 (pers. comm., M. Cornwall, 1993).

Traditionally, Gallows Bay has been used by local fishermen. The area includes a strip of waterfront land, partly owned by the Port Authority, which lies adjacent to and west of the Gallows Bay commercial dock facility. Gallows Bay and beach are used for small boat mooring, boat repairs, and the sale of fish. Derelict vessels are evidenced along the beach, along with a varying collection of household furniture and temporary shacks.

A six-acre site, known as the Barrack's Yard, is a mix of residential, commercial, and governmental property (Figure 6a). The centrally located government plot is currently used by governmental marine enforcement agencies whose vessels are moored along the waterfront. The yard contains a salt water pumping station used to pressurize Christiansted's fire hydrants, as well as a sewage lift station. Other structures include two office trailers, masonry storage sheds, derelict fuel storage tanks, and various destroyed office building shells. A study, funded by EDA, was done by DeJong on the redevelopment of Barrack's Yard.

Fort Christiansvaern to the Sea Plane Terminal

Christiansted National Historic Site, including Fort Christiansvaern, is owned by the U.S. Government and managed by the National Park Service (section 2.5.2). The shorefront north of the Fort is bulkheaded, and is used by ferries to and from Protestant Cay and Buck Island. Port Authority manages the bulkhead and apron.

The urban area between Fort Christiansvaern and the sea plane terminal is a mixture of public and private property, mostly of commercial use. A short stretch of the waterfront in this area contains a pedestrian boardwalk.

The sea plane terminal, damaged by Hurricane Hugo, was scheduled for repairs in the first half of 1993, although by mid-year no work had taken place. Flights will be operated by a private company, Caribbean Airboats, Inc. The Port Authority owns the site, and plans to remove old underground storage tanks and repair the dock and ramp. Caribbean Airboats has obtained a CZM permit to demolish the old office building, construct a new one, and repair the existing hangar (pers. comm., B. Berdan, CZM St. Croix).

Protestant Cay is located 500 feet offshore of Fort Christiansvaern and is owned by the V.I. Government. A private company holds the lease and operates a resort hotel on the cay.

Just west of the cay, a designated permanent mooring area accommodates small vessels, some of which are live-aboards. These vessels normally discharge sewage to the harbor because there are no shoreside pumpout facilities anywhere within the harbor.

Western Christiansted Harbor

The shoreline property between the sea plane terminal and the WAPA plant is largely open space, the site of the as yet undeveloped West Side Park (Figure 6b). This piece of land is directly north and adjacent to the Water Gut and Ralph De Chabert housing projects. The 28-acre piece of shoreline property is owned by the V.I. Government and was cleared in 1991 in preparation for the community park project.

St. Croix's main power and desalination plants are located at Estate Richmond, west of the Park. The WAPA plant has a single outfall which discharges heated and hypersaline effluent into the harbor, plus effluents from the power generating plant. WAPA has received a CZM permit to construct a new 1.3 MGD desalination plant at Richmond, as well as a permit to construct a new fuel storage tank (pers. comm., B. Berdan, CZM St. Croix). A new fuel dock was built and dedicated in late 1992. The new dock facilitates off-loading of fuel which is barged by Hess Oil Company from its south shore refinery. There are no other planned facilities for the Richmond plant (pers. comm., K. Thomas, WAPA).

A cement bagging plant is located west of the WAPA plant. The owners of the plant, Mark 21/DEVCON, share dock space with WAPA. A barge delivers dry cement approximately once every three weeks to the plant where it is bagged and sold locally.

An area of retail and commercial land lies directly west of the WAPA plant, and includes the LBJ sewage pump station.

Further west, as shown in Figure 9b, private condominiums are sited along the waterfront, including the following (from east to west): Club St. Croix, Sugar Beach, Colony Cove (formerly Barrier Reef), and Mill Harbor. One of these, Club St. Croix, received a CZM permit in 1988 to build a total of 309 hotel rooms/condos, shops, tennis courts, etc. Fifty-four of the condo/hotel rooms, a dock, and some tennis courts have been built.

An area of low density housing exists along the shoreline in Estate Little Princess.

The U.S. Coast Guard has obtained a CZM permit to replace temporary navigational markers currently in place in the schooner channel with permanent structures (pers. comm. B. Berdan, CZM St. Croix).

3.2 Use Conflicts

There is no satisfactory pedestrian access between Gallows Bay and the town of Christiansted. Passengers from ships that stop in Gallows Bay must take taxis to town, although it would be a relatively short walk along the waterfront at Gallows Bay. This part of the harbor, however, is the site

of traditional fishing activities, including fish marketing, boat repair, and boat mooring. Although a boardwalk has been conceptually proposed, unless properly planned, with input from all user groups and the Gallows Bay community, such a project would interfere with activities of the fishing community. Also, according to W. Cissel of NPS (pers. comm., 1993), if the boardwalk is to include the northern (seaward) boundary of the Christiansted National Historic site, then it should have National Park Service approval. In the 1972 Agreement (Article IV, Paragraph 2) the Government of the VI agreed "to control incompatible uses of the surrounding wharf and to prevent construction of a roadway or other intrusive devices on the harbor side of the Historic Site."

Meanwhile, fishermen at Gallows Bay are frequently without running water which is needed for cleaning fish and gear. There are no public restrooms in the heavily used area.

The Gallows Bay commercial dock is used for both cargo and passengers. Although at present only one mini-cruise ship stops in Gallows Bay, passengers must walk along the same dock that is used for cargo. A rope separates the two uses, but a longer term solution, involving the separation of cargo and passenger facilities, would be desirable (pers. comm., D. Brin, Port Authority).

The Gallows Bay dock has severe structural damage and is in need of repairs. The use of the dock by commercial cruise ships and cargo vessels places additional stress on the deteriorating structure. At present there are no plans for reconstruction or repairs (pers. comm., D. Brin, Port Authority).

Houses which are located in proximity (as close as 100 feet) to the boilers at the Richmond power plant are adversely impacted by the noise resulting from plant operations.

Water quality in the western part of the harbor is, on occasion, affected by emergency sewage bypass discharge from the LBJ pump station. Although the outfall discharges seaward of Long Reef, currents carry the sewage back into the harbor. DPW is required to notify DPNR/DEP and USEPA orally with 24 hours of discovery of all noncompliances. This is a condition of the TPDES discharge permit. DPNR is the regulatory agency which is then responsible for determining if the effect on water quality is such that it is necessary to inform the public and close beaches (pers. comm., M. Cornwall, 1993). Odors from the sewage have been so offensive that, on one occasion, a restaurant had to cancel dinner reservations and eventually close because the smell was so bad (pers. comm., J. Washville, Mill Harbor). Beach closings by DPNR/DEP are not uncommon in the western harbor.

Meanwhile, WAPA is concerned about the same water quality issue, namely bacterial contamination in the western harbor. The Authority no longer uses a high-temperature desalination process, and so must rely on a dependable and adequate chlorination process for the production of potable water. High bacterial concentrations in the western harbor may conceivably place the municipal water supply at greater risk of bacterial contamination.

The following additional land and water use conflicts for the APC are adapted from the Comprehensive Land and Water Use Plan (Strategic Planning Group, 1991):

> **Fort Louise Augusta/Altona Lagoon/Gallows Bay:** Although most of St. Croix's incoming cargo is received at the Containerport on the south shore, a portion of it is received at the Gallows Bay dock. Gallows Bay also receives substantial traffic in small, inter-island vessels

and local fishing boats. Cargo movement to and from the area contributes to a traffic congestion problems in Christiansted.

Christiansted Waterfront: A number of hotels and tourist related shops are located in the downtown area. The development pattern along the waterfront has resulted in poor access to many areas of the shoreline. Waterfront access is primarily by means of numerous small alleyways which lead directly to the shore with pedestrian movement hindered or even blocked by buildings or fences. There are several small finger piers along the waterfront and the harbor is heavily used for small boat anchorage.

Downtown traffic congestion and lack of adequate parking are serious problems in the area and are impediments to waterfront redevelopment. The removal of some heavy cargo traffic associated with Gallows Bay Port has decreased this traffic congestion somewhat. At present, much of the last remaining open space in the downtown waterfront is used for parking. The shoreline parking area, especially surrounding the Scalehouse and adjacent to Hamilton Jackson Park, restricts pedestrian movement and is incompatible with the scenic character of the National Historic Site. Several alternate parking schemes and sites have been suggested as possible remedies to this and other parking problems in the downtown area.

Western Christiansted Harbor: This large area of undeveloped filled land extends westward from the sea plane shuttle facilities to the V.I. Water and Power Authority Plant. Much of the adjacent inland area is occupied by Housing Authority developments. At present, there are few recreational facilities available for nearby residents. Plans have been developed for this area (West Side Park), that include extensive land and water recreational facilities, including a bicycle path, pedestrian boardwalk, swimming and boating, tennis courts and playing fields.

The 28-acre site cleared for the West Side Park still remains vacant and is used by grazing horses. Garbage is strewn around, derelict vessels and at least one derelict structure remain at the site, and there is evidence of vehicular driving to and along the beach.

Boats docked at St. Croix Marine have experienced rougher than normal waters since construction of the new schooner channel. It is assumed by the marina managers that this is due to the now deeper waters and straighter line from the entrance channel. At least some protection from the swell is provided by a sunken barge, located approximately 50-75 meters east of the easternmost dock at the marina (pers. comm., M. Oliver, St. Croix Marine).

The mini-cruise ship and large cargo vessels which use the Port Authority dock stir up large amounts of silt when they run their engines while at dock. Over the past 3-4 years this has caused a build up of silt under the travel lift at St. Croix Marine. This has decreased the draft size of vessels that the marina is able to accommodate (pers. comm., M. Oliver, St. Croix Marine).

The entire Christiansted area is serviced by a municipal water supply system. The distribution system needs major repairs and renovation (pers. comm., K. Thomas, WAPA).

The Christiansted sewage system is old, collapsing, and corroding. Manholes and pipes are not easily inspected because many exist under buildings and, in some cases, inside restaurants (pers. comm., M. Cornwall, DPW).

3.3 Adverse Impacts

3.3.1 Water Quality

The waters of Christiansted Harbor are designated as Class C under the local Water Pollution Control Act. Christiansted Harbor is listed on the Territory's long-list of waterbodies which are impacted by discharges of toxic, conventional and unconventional pollutants. This list was created by DPNR/DEP at the behest of EPA (CWA Section 304(1) (a) (ii)). Although there is only one facility permitted to discharge wastewater into the harbor, there are many sources of pollutants impacting it.

A study completed for DPNR in 1986 showed elevated levels of copper, lead, and mercury in the marine sediments adjacent to the marina in Gallows Bay (Oostdam, 1986). The amount of copper was found to be 343 times that of copper found in the Hawksnest Bay control site. In addition, the copper concentration exceeded USEPA allowable 24 hour average for protection of salt water aquatic life (Oostdam, 1986).

The USEPA collected marine sediment samples in Christiansted Harbor in 1982 (USEPA, 1983) and again in 1991 and 1992 (USEPA, 1993). Because there are no published sediment criteria, the results were compared to informal guidelines developed by the National Oceanographic and Atmospheric Administration (NOAA) for evaluation of sediment data collected for the National Status and Trends Program. NOAA has two values for each chemical: an Effects Range-Low (ER-L) and Effects Range-Median (ER-M). The ER-L, as used by NOAA, represents the concentration above which adverse effects may be observed or predicted among sensitive life stages and/or species, or as determined by sub-lethal tests (NOAA, 1991). The ER-M values are used as the concentration above which effects were frequently or always observed or predicted among most species. For this determination, most biological measurements involved mortality as an endpoint. Other chronic effects may occur at levels lower than those associated with acute mortality (NOAA, 1991).

Sediment taken from Gallows Bay in 1991 showed levels of cadmium, copper, and lead greater than ER-L, and mercury at the ER-L. Samples taken in 1992 had levels of copper and zinc in excess of the ER-L. Sediment taken near the WAPA outfall had cadmium levels above ER-L in 1991 and levels of silver above the ER-M in 1992. Earlier sediment data (USEPA, 1983) suggest that metal levels have increased at these two stations. Results may not be comparable, however, due to uncertainty regarding analytical methodology.

Sediment collected at the WAPA outfall had levels of DDE (a degradation product of DDT) of 45.8 parts per billion (ppb) higher than both the ER-L and ER-M guidelines of 2 ppb and 15 ppb respectively. This organic compound biodegrades very slowly and has high potential for bioaccumulation. The concentration of phosphorus in the water at this site was also shown to exceed local water quality standards.

Point Sources

Only one facility (WAPA) is currently permitted to discharge pollutants into Christiansted Harbor. WAPA operates a power generation and water desalination facility under TPDES permit VI0000051. In 1992, WAPA combined four outfalls into one outfall which discharges at the end of a pier adjacent to the plant. The TPDES permit allows WAPA to discharge 70.86 MGD of wastewater into the

harbor, at a temperature of 15°F above the intake temperature, and a 48 hr. yearly maximum net difference of 20°F. WAPA has been granted a thermal mixing zone of 1650 feet (Figure 9b). Within this zone, water quality standards do not have to be met.

Title 12, Chapter 7, Section 186-6 of the local Water Pollution Control Act provides guidance on the size of mixing zones in surface waters. It specifies that "Mixing zones shall not intersect spawning or nursery areas, migratory routes, water intake nor...". It further states that "No discharge or combination of discharges shall be injurious to fish or shellfish or the culture or propagation of a balanced indigenous population thereof."

The EAR for the construction of the new WAPA pier clearly attributed the "rotting plant matter (fragments of *Thalassia testudinum* and *Syringodium filiforme*)..." to the WAPA's thermal discharge" (USVI Govt/WAPA, 1986). It would therefore appear that the WAPA outfall mixing zone is not in compliance with territorial law due to several factors, including: (1) the existing poor condition of the benthic community within the mixing zone, and the presence of as yet productive adjacent seagrass beds; (2) the outfall's proximity to important habitat at Long Reef; and (3) the proximity of the water intake pipe for the desalination plant.

According to DPNR/DEP, who is responsible for enforcing the conditions of WAPA's permit, WAPA often exceeds the effluent limits specified by their permit (pers. comm., M. Pacifico, DPNR/DEP).

As a condition of the TPDES permit, WAPA was required to document impacts occurring from the relocation of the outfall. According to the consultant who performed the work, there are no visible effects to the benthic community from the relocation of the outfall. However, she lists several other factors which adversely affect marine life in the area, including: (1) frequent bottom disturbances from the vessels that enter and leave the area; (2) large numbers of "ghost" or abandoned fish traps; (3) significant amounts of trash; and (4) the occasional presence, from an unknown source, of significant amounts of oil in the water (pers. comm., A. Dempsey, Bioimpact).

Another condition of the TPDES permit (Special Condition 1(f)), requires that a thermal plume study be conducted. A study submitted by WAPA to DPNR in September 1992 was found to be deficient. It was rejected by DPNR and, to date, WAPA has not satisfied this permit condition (pers. comm., M. Pacifico, DPNR/DEP).

Other illegal point sources can also be found within the APC. Several buildings in town discharge their air conditioning condensate and basement sump pumps into drainage guts. This flow is considerable at times and carries dirt and litter into the sea even during dry times.

Sewage for Hotel on the Cay is legally discharged into a 4" Schedule 40 PVC pipe that runs along the harbor bottom and is connected to the municipal sewer system (pers. comm., M. Walsh, 1993). This pipe is vulnerable to anchor and storm damage and should be regularly checked by divers employed by the hotel and periodically by DPNR/DEP for joint leaks and breakage.

Another facility whose illegal discharge affects the water quality of the harbor is DPW. At the western end of the harbor, DPW operates a major pump station (known as the LBJ pump station) which carries all sewage from Christiansted and east of town across island towards the treatment plant

at Estate Anguilla. The station suffers occasional breakdowns due to a variety of factors such as malfunctioning pumps and power outages.

When the pump station is down, DPW operates a small capacity pump to bypass the normal route and send the sewage out into the sea via an old, unpermitted ocean outfall. The outfall discharges raw sewage directly on the forereef (seaward side) of Long Reef. Waves and current carry the sewage back over the reef and into the western part of Christiansted Harbor (USVI Govt/DPNR, 1992).

Resorts located on the adjacent shore have filed numerous complaints with DPNR and USEPA (section 3.2). In response to these complaints, USEPA filed an Administrative Order (EPA-CWA-II-83-28) against DPW. This required DPW to terminate the discharge, install a new backup pump system, and provide for regular maintenance of the facility. A Consent Decree (Civil Action No. 84-104) was also filed in September 1985 which required DPW to address several deficiencies in the system. Meanwhile, DPNR filed several enforcement actions requiring DPW to upgrade their collection and pumping systems.

DPNR has found that emergency sewage bypass discharge from the LBJ pump station not only threatens public health, but destroys important habitat as well. A study completed by DPNR/DEP found reduced live coral coverage in the vicinity of the outfall (USVI Govt/DPNR, 1992). Environmental consultants working in the area have also confirmed that the area continues to be degraded (pers. comm., A. Dempsey and M. Coulston, Bioimpact).

DPW has a small lift station in Gallows Bay, adjacent to the shore near the commercial dock. When the pumps malfunction at this station, such as during extended power outages, sewage is bypassed directly into Gallows Bay. Similarly, sewage is bypassed into the bay from various manholes in the area when the sewage line is blocked or during heavy rains.

According to DPNR/DEP (pers. comm., R. Addley) there are several areas of the harbor which suffer from elevated levels of fecal coliform, presumably due to the inadequate sewage collection system. One such area is the shallow waters in the vicinity of Mill Harbor condominiums. From Serendipity Restaurant to Turquoise Bay, DPW has five manholes, all of which are located seaward of the Mean Low Water Line. A study done by DPNR/DEP in October and November 1992 showed that the waters surrounding these manholes have extremely elevated bacterial levels, especially after heavy rain and during operation of the emergency outfall. After heavy rain, bacterial levels of greater than 1000 colonies/100 ml have been recorded, exceeding both territorial water quality standards and the USEPA "swimmable" criteria. During dry conditions and when the emergency outfall is not in use, bacterial levels are approximately 30 colonies/100 ml (Tetra Tech, 1992). Additional water quality monitoring should be done by DPNR/DEP to verify the above correlations of high bacterial level to heavy rain and emergency bypasses.

DPW has done preliminary dye tests and conducted visual observations of leakage around the five manholes discussed above. The dye tests and observations have not detected any leakage. However, additional study is planned (pers. comm., M. Cornwall, 1993).

During heavy rain, water infiltrates the sewage collection system, resulting in leakage and, in some areas, combined sewage/stormwater overflows (CSO's) from manholes. During operation of the emergency outfall, increased pressure in the sewage intercept lines often results, because sewage

cannot be pumped fast enough through the outfall (due to the use of a small capacity emergency pump). In a December 1992 letter to DPW, DPNR/DEP requested that DPW investigate and eliminate the situation, and to notify the public whenever bypass discharges occur for more than eight hours at a time. DPW responded by indicating its action plans and protesting being given the responsibility of public notification as prescribed by DPNR. To date, DPNR has not responded to the letter (pers. comm., M. Cornwall, 1993).

DPNR/DEP has recognized for several years the need to assess the integrity of the sewage system and has included the requirement that DPW conduct an infiltration study as part of their 1991 Consent Order. According to item No. 13 of the corrective action plan, DPW is required "To analyze flow for excessive infiltration/inflow and overload conditions; to evaluate sewer line conditions; and to implement a prioritized sewer line replacement program." The completion date for actions under this condition was March 1992. DPW has developed plans to implement the above, but funding has not been available. The rehabilitation of all major pump stations, treatment plants and the installation of emergency power generators at all lift stations is proceeding with funding from federal and local sources. Funding has been and will continue to be sought and identified to complete the above study (pers. comm., M. Cornwall, 1993).

Other areas known for occasionally high fecal coliform levels are the Christiansted Wharf, Queen Cross Street, and, somewhat less frequently, Gallows Bay. It is not unusual to have bacterial concentrations in excess of 1000 colonies/100 ml at these areas. Further offshore, and even in areas containing high concentrations of live-aboard vessels, bacterial levels are much lower.

In addition to the areas mentioned above, during heavy rains sewage also bubbles up from several manholes in Christiansted. One of these is on the Club Comanche property. This makes several rooms unusable and contaminates adjacent harbor waters.

During Hurricane Hugo one of WAPA's fuel holding tanks was damaged and the subsequent spill contaminated approximately 3.5 miles of shoreline. This required a massive cleanup effort, including the removal of beach sands. The effect of this spill on marine biota has not been fully documented (section 1.3).

Much of the Hugo oil spill could have been avoided if the retention wall around the storage tank had not failed. As a result, the design of retention walls for future tanks will be improved. New tanks will be built to American Petroleum Institute (API) standards and have retention walls with more support beams and a carbon-steel floor connecting the tank and the retention wall. They will also be built to withstand category 5 storms.

Non Point Sources

Stormwater runoff has a significant impact on water quality in the harbor. Water Gut receives stormwater from a 327 acre watershed which discharges to the sea just west of the sea plane terminal. During heavy rains, an extensive plume emanates from this drainage ditch. The bottom sediments are fine and terrigenous. Bacterial concentrations of ambient waters near the drainage ditch are consistently high and often in violation of the Class C limit of 200 colonies/100 ml.

A survey to identify land-based sources of pollution in the Christiansted area was completed in 1986. The study looked at the principal guts in Christiansted, including all of the contributory and minor street drains. Several types of pollution were identified, including raw sewage from damaged, leaking, and overflowing sewer lines, gray-water discharges, kitchen refuse, garbage, trash, animal wastes, paint scrapings, waste oil, soil sediment, and various other debris (Hamlin, 1986).

Large amounts of sediments enter the large concrete swale in Gallows Bay during heavy rains. This is due to several unpaved roads within the upland watershed.

Vessel wastes

The area west of Protestant Cay is a popular anchorage for live-aboard boaters due to its proximity to a commercial area where services and supplies can be obtained. Despite the concentration of boats and the lack of pumpout facilities, the water quality in the area remains relatively good. This is likely due to the continuous flushing action of the currents in the harbor.

St Croix Marine, the largest and one of only two marinas on St. Croix, provides dockage, fuel, dry storage, and major repair facilities for small boats. The marina has a 100 ton marine railway to haul larger vessels for maintenance and repair. While boats are on the railway, paint chips and other scrapings and materials fall directly into the harbor.

Although the use of tributyltin (TBT) is prohibited in the U.S., it is not prohibited in many other countries. Foreign ships entering the harbor may utilize bottom paint containing TBT. West of the marina is the Gallows Bay commercial dock which services small cargo vessels and mini-cruise ships. Occasionally during fueling small oil spills can be observed (USVI Govt/DPNR, 1992).

Drinking water

WAPA uses approximately 30 MGD of sea water from the intake located approximately 150 feet offshore and east of the WAPA dock. The 3 MGD of potable water produced at the Richmond plant is mixed with well water and provides water for over 11,000 customers. Among their customers are the public schools and housing projects.

WAPA has installed a boom around its intake to prevent contamination from floatables. Although this water must pass through a 140°F desalination process, this does not kill coliform bacteria which can withstand high temperatures (pers. comm., T. Burns, DPNR/DEP). DPNR/DEP is concerned about the quality of the water entering the intake due to the following: (1) high water turbidity due to the intake's proximity to the surf zone; (2) contamination from the emergency sewage outfall and other sewage leakages; and (3) the WAPA wastewater outfall (pers. comm., T. Burns, USEPA).

3.3.2 Air Quality

There are no "non-attainment areas" in the U.S. Virgin Islands with respect to compliance with National Ambient Air Quality Standards (NAAQS). However, three areas in the Territory, including Christiansted, are potential non-attainment areas and deserve further ambient air studies from an area-wide, cumulative impact perspective. There is a need for collection of ambient air quality baseline data at these sites (pers. comm., T. Shank, DPNR/DEP).

Impacts from the WAPA Richmond plant are mostly downwind to the west. The power plant is operating without federal air permits, and is reportedly in violation of conditions imposed on territorial permits (pers. comm., T. Shank, DPNR/DEP).

3.3.3 Noise Pollution

Perhaps the most significant noise pollution source within the APC is the WAPA Richmond power and desalination plant. A noise level study was completed in October 1988 for WAPA (Hamlin, 1988). The purpose of the study was to measure the noise levels as perceived by residents of the nearby DeChabert Housing Project and other residents in proximity. The study showed that residents in proximity to the plant are subjected to noise levels in the "annoyance range" (70dBA) on the outside of the buildings. Inside the buildings, the level was characterized as a 'noisy urban residential environment' (58 DBA). During operation of the pressure relief valves, noise levels were on the pain threshold of human hearing (127.3 DBA). The venting of the steam release valves does not occur on a regular basis, but is caused by system upsets such as unscheduled shutdowns of a desalination unit or a rapid decrease in electric load, for which the boiler fuel control mechanisms cannot respond quickly enough (Hamlin, 1988).

As part of the CZM permit for the new desalination plant (2.6.2), one condition requires that WAPA construct an acoustic sound barrier wall extending the length of the building to decrease adverse impacts of noise on the nearby housing community (pers. comm., B. Berdan, CZM St. Croix). Other specific noise sources within the APC have not as yet been identified.

3.3.4 Impacts to Biological Resources

The Port Authority dredged the harbor channel during the period from June 1990 to December 1991 in order to provide a more direct and deeper channel for ships (section 2.6.1). During this project, approximately five (5) acres of seagrass were removed (USVI Govt/DPNR, 1992).

The Southern pink shrimp, *Penaeus notialis*, is found in significant numbers at only two sites in the Territory, Great Pond (on St. Croix's southeast shore) and Altona Lagoon. In order to protect this resource, in July of 1992, DPNR established the "Shrimp Management -- Altona Lagoon and Great Pond" regulation under the Virgin Islands Code (Act 3330). Fishing regulations now posted at Altona Lagoon include the following:

1. All seine nets, gill nets, and traps are prohibited in Altona Lagoon, Great Pond, and their respective connecting channels to the sea.

2. All seine nets, gill nets, and traps are prohibited in Christiansted Harbor within 100 yards of the mouth of Altona Lagoon channel. All seine nets, gill nets, and traps are prohibited within 100 yards of the mouth of Great Pond channel.

3. No motorized vessels are allowed in Altona Lagoon, Great Pond, and their respective connecting channels to the sea.

4. Monofilament or nylon cast nets of 3/8" square mesh (3/4" stretch) may be used to harvest shrimp in Altona Lagoon and Great Pond channels. Cast nets of knotless nylon netting are prohibited.

5. Cast nets of 1" square (2" stretch) may be used to harvest fish in Altona Lagoon and Great Pond channels. Cast nets of knotless nylon netting are prohibited.

6. A recreational shrimp fishing license is required to harvest shrimp on St. Croix. Annual fee is $10.00.

7. Sale of Southern pink shrimp is prohibited. Vendors selling shrimp must have a Certificate of Origin for the shrimp.

8. Use of lights to attract fish for harvest is prohibited.

9. Recreational hand line and rod and reel fishing is permitted in Altona Lagoon, Great Pond, and their respective connecting channels to the sea.

The St. Croix Fisheries Advisory Committee recently voted to make recommendations to the Commissioner to further limit the fishery in this area. They want vessels and fishing of all types banned from the Lagoon, and size restrictions for harvesting barracuda (pers. comm., T. Tobias, DPNR/DFW).

Altona Lagoon received a pulse of fine sediments when a settling pond at Altona Beach failed in June 1990 during construction of the new schooner channel. Although the lagoon is known to be of poor flushing capacity, actual impacts from the resulting prolonged turbidity can only be conjectured. As a mitigation measure for dredging the new channel, the USACOE required that a larger culvert be installed to improve the lagoon's flushing capacity. Historical aerial photos indicate that the lagoon was once connected to the sea along its northeast side.

Other impacts to biological resources are predictable, if difficult to quantify. Sediment loading to the harbor is thought to be a relatively significant issue, as much of the upland watershed servicing the APC is comprised of unimproved dirt roads. Lethal and sub-lethal sediment effects on corals, seagrass, and other marine organisms have been well-demonstrated elsewhere, and no doubt occur within the Altona Lagoon/Christiansted Harbor receiving waters.

Even well intentioned beach cleanups can have negative impacts if care is not given to let shoreline vegetation remain in place to provide wave protection and habitat. Cleanups can be especially damaging when heavy equipment such as a bulldozer is utilized.

3.3.5 Impacts to Cultural Resources

Christiansted Harbor has not been subject to a comprehensive and systematic magnetometer survey to locate shipwrecks, with the exception of that which was undertaken in preparation for the schooner channel project (Island Resources Foundation, 1988).

An example of the loss of a valuable cultural resource occurred in 1988 when a tourist, diving on the west side of Protestant Cay, found an old elephant tusk. The tusk was approximately 18 inches in length, and most likely originated from a late 1700's ship participating in the triangular trade in slaves and cargo. There being no antiquities law at the time (a situation which continues to exist today), officials were powerless to prevent the tourist from leaving the country with the valuable find (pers. comm., W. Cissel, National Park Service).

The Richmond, Sugar Beach, and Protestant Cay prehistoric sites have all been disturbed by development to at least some degree.

4. MANAGEMENT RECOMMENDATIONS

4.1 Policy Framework

Establishing a comprehensive policy framework to guide decision-making for improvements and future development of the Christiansted Waterfront APC is a crucial and fundamental process to be undertaken if the "gentrification" of similar ports and urban waterfronts elsewhere is to be avoided. Private citizens, elected leaders, citizen action groups, other community groups, and the business community must all participate in the planning and goal-setting process, and reach consensus on the best strategy to pursue to ensure that the Christiansted Waterfront APC develops with vitality and sound planning, and in a way that does not lose sight of its maritime heritage and continuing recreational, commercial, and cultural importance.

One avenue to pursue in this regard is the development of a comprehensive "Port and Waterfront Revitalization Plan". In such a plan, multiple goals must be simultaneously explored, and specific implementation strategies adopted (addressing the issues of funding and leadership) if concerted action is to prevail.

It has been almost twelve years since an original management plan for the APC was drafted. Many of the recommendations contained in that report remain valid today. Unfortunately, the costs to carry out many of those recommendations have increased.

The first concern should be to assess the need to establish an appropriate body to tackle the unique problems of Christiansted Harbor and town. A Waterfront Revitalization Commission that brings together government agencies, the business community and residents to formulate plans, raise funds through the government and community, and finally ensure implementation of plans.

Without such a local body, the prospects would not seem good for coordination of multi-sectoral planning issues that must be addressed in a "Port and Waterfront Revitalization Plan. Community organizing is simply too time-consuming and process-oriented to be undertaken as an added responsibility of an existing agency whose focus is the entire Territory.

The Christiansted harbor and waterfront should continue to serve the local community, both residents and visitors alike, by providing the facilities and services for water-dependent industry and navigation, and by providing ample opportunities for recreation and enjoyment of the unique cultural, historical,

and scenic qualities of this regional port, while sustaining clean waters and healthy fish and wildlife habitat, and ameliorating coastal hazards wherever they exist.

Specific goals in support of the foregoing may focus on the following list of opportunities in the revitalization effort:

1. *improve public access, both visual and physical, to the waterfront and all its amenities, and expand on the area inland which can enjoy waterfront benefits (i.e., through strict controls on building height and orientation); begin work immediately to assess the feasibility of constructing a pedestrian boardwalk and land based walkway connecting the waterfront from Gallows Bay to West Side Park.*
2. *enhance economic activity in a sustainable manner which provides the appropriate level of services and facilities to residents and visitors alike; achieve an appropriate mixed-use of land resources that allows for the optimum use of land with minimum reliance on automobile transportation;*
3. *preserve the historic and cultural character of Christiansted to the maximum extent possible;*
4. *enhance public safety through rehabilitation of dilapidated portions of the waterfront and through improvements to transportation and pedestrian systems that will allow the more efficient (i.e., decreased costs and time) and safe movement of goods and people on both land and water;*
5. *reduce the potential for loss of life and property due to natural hazards through a combination of growth management policy and maintenance of existing shoreline protection structures;*
6. *improve water quality within Christiansted Harbor and preserve and enhance remaining aquatic and wildlife habitat;*
7. *inject new life and energy into the harbor and town area, recognizing that it is the combination of waterfront activities and the unique character of Christiansted that attract residents and visitors, and which represent great potential for simultaneous recreational enjoyment and achievement of governmental, business, trade, and commerce needs;*
8. *improve efficiencies in the various port operations, including the development of management plans to deal with the transportation, storage, and handling of hazardous and toxic cargo, and the development of spill management plans with trained personnel and proper equipment ready for response at all times.*
9. *promote the establishment of community planned, constructed, and managed recreational parks at both West Side Park and Altona Beach; begin work on the longer-term objectives of establishing the Altona Lagoon Territorial Park for both recreational purposes and preservation of important wildlife/aquatic habitat; minimize conflicts between user groups (e.g., between swimmers and jet ski operators) by separating such uses where possible.*
10. *undertake a water use plan for the harbor with recognition that both navigational safety and the efficiencies involved in transporting people and goods throughout the harbor need to be addressed; identify specific land/water "nodal points", where the movement of people and goods from land to water can occur with minimal disruption of other activities, and with plenty of space to render such operations safe and*

efficient; consider the concept of a "gateway" for mini-cruise ship passengers to be constructed along the waterfront east of Fort Christiansvaern.

Given that waterfront planning should **not** work in isolation of the nearby town center, public access policy should strive to allow the benefits derived from the waterfront (i.e., scenic vistas, open space, fresh air, general human interest) to be enjoyed as far inland as possible. This suggests that future developments should be oriented perpendicularly rather than parallel to the shoreline to enhance view corridors to the sea, and that stricter height and space limitations be placed on buildings closer to the waterfront (of course, height limitations on all buildings should always be considered in relation to the architectural context of the area). Successful urban waterfront areas generally have plenty of open space, or "green" space, to accomplish this goal. Both physical and visual access to the shoreline must always be considered.

The Christiansted Waterfront has several opportunities for improvement in this regard. Arriving visitors are struck by both the natural beauty of the harbor and by the architectural and historic interests evident throughout the town and waterfront. Unfortunately, pedestrian access to the waterfront is severely limited by fences and/or buildings that terminate on the shorefront with no means for passage along the waterfront. Even areas that were once serviced by a pedestrian boardwalk are in disrepair following Hurricane Hugo and/or through the general neglect of government-owned property.

Pedestrians are attracted to facilities which cater to their needs, and careful planning is needed to ensure that commercial potentials are fully realized for all parts of the waterfront. The following is a list of some ideas for pedestrian amenities to enhance the Christiansted Waterfront:

1. shaded rest stops and harbor look-out areas with benches and awnings;
2. tree-lined walkways and/or a joggers trail to tie-in the boardwalk with outlying areas;
3. public restroom facilities;
4. drinking fountains;
5. appropriate night lighting;
6. scenic vista points and/or "interest" points with interpretive signs of the area's natural, cultural, and maritime heritage; and
7. a public information center.

The goal is to make the Christiansted Waterfront a safe and enjoyable experience for both residents and tourists of St. Croix. The boardwalk should be repaired and extended, as it is the only available access to the waterfront and a unique opportunity to improve an otherwise dilapidated and under-utilized shoreline. Recreational opportunities exist at both Altona Beach and the West Side Park. These areas should be developed and managed as public parks.

Preferred "Town Center" Concept

This planning concept calls for the return to a development pattern which is more traditional. Such an approach emphasizes a more compact urban settlement pattern with a strong neighborhood focus and identification.

This concept requires the retention of the primary agricultural lands for crops and pasture, as well as the preservation of the steeply sloped lands and floodplains. There are sound environmental and economic reasons for implementing such a land use pattern, and there is the additional benefit of creating an aesthetically pleasing environment.

To achieve the greatest measure of efficiency and highest level of positive impact from this concept will also require that the most intensive development be located in areas already serviced by roads, water and sewer, or where these facilities can easily be extended. It will also be necessary to more severely restrict urban growth outside of the growth centers. This is not to say that development would be prohibited outside of the proposed town centers; rather, it is suggested that Government initiatives, programs, resources, and energies be directed in support of this concept by upgrading and expanding the infrastructure in and around Grove Place, Sion Farm/Sunny Isles, Frederiksted, and Christiansted. At the same time, other policy and regulatory measures would be taken to discourage development in prime agricultural areas, floodplains, steeply sloped lands, and other environmentally sensitive areas. These might include discouraging the expansion of water, sewer, or roadway development in certain areas.

Christiansted would continue to be the primary urban center on the island. Urban growth and development is envisioned to expand under this scenario southward to the ridge line in the area of Peters Farm, Friedensthal, and Orange Grove. The growth that occurs in Christiansted should take the form of increased amounts of mixed used development. Mixed use, within an urban context, refers to one building having a number of different, but compatible, activities under one roof (for example, shops on the first floor and housing located above it).

Within the context of any expansion or redevelopment of Christiansted, care must be taken to preserve the integrity of the historic structures. This community contains many buildings that date back to the island's colonial past. Some have been carefully restored to their original state, and others have been carefully changed from their original use so that the architectural integrity has been maintained.

The development of a Port and Waterfront Revitalization Plan should place special emphasis on the provision of community recreational opportunities within the APC. Altona Beach and West Side Park offer exceptional potential for the development of community self-managed parks. In this regard, it is encouraging that the community has organized to do just that at the Christiansted West Side Park. Organizers have prepared a conceptual plan, a budget, and fund raising goals to construct the park, which will utilize the 28 acres of beachfront property as a Community Cultural Heritage Park. Organizers have proposed to develop, administer, and maintain the park in conjunction with territorial government agencies. The proposed development will include landscaping, picnic areas, a boardwalk, two swimming docks, two tennis courts, a pavilion, a basketball court, a baseball field, parking, and lighting. These are ambitious and meritorious goals for the community organization, and Government should endeavor to provide full support for this activity at each step of the way.

There is one element of the proposed park, however, that is perhaps deserving of additional thought. The conceptual plan calls for a horse race track and stables, which deserves at least a question concerning the logic of using this extremely valuable waterfront property in such a manner. A horse race track is not a water-dependent activity; it could be sited elsewhere without compromising the activity in any way whatsoever. This shorefront property, which has been developed at great expense

and effort of the entire community, should be reserved for the recreational enjoyment of all citizens, both present and future generations. Special regard should be given first to the needs of various user groups (i.e., handicapped, senior citizens, youth, toddlers, etc.). A longer-term vision is called for that recognizes that as the population grows, so will the needs of the urban community with respect to recreational and leisure opportunities for all segments of society.

On the east side of the APC, Altona Lagoon and its adjacent beach on the harbor waterfront offer an exceptional opportunity as a multiple-use park, one that could offer a variety of passive recreational and educational activities. The lagoon, along with the Salt River estuary, is the second largest wetland on the north coast of the island. Mangrove swamp and wetland habitat provide for several important physical and biological functions (section 4.2). The establishment of a Territorial Park at Altona Lagoon would provide educational opportunity for local youth to learn more about their natural environment, while at the same time serve to protect critical habitat for a variety of wildlife and aquatic species. Moreover, the lagoon in its natural condition serves to filter sediments and other pollutants contained in stormwater runoff before they reach the harbor.

Recognizing the many potentials of the Christiansted Waterfront APC is only the first step; action must be predicated on an area-wide plan, community consensus on goals and objectives, and of course the necessary level of administrative and financial capability. Funds will be necessary to effect needed improvements to the waterfront, including repairs and extension of the boardwalk and other improvements such as beach renourishment. Significant quantities of oil-contaminated beach sand were removed following the oil spill during Hurricane Hugo (section 1.3). Maintenance of waterfront protective structures must be given continual attention if long-term costs are to be minimized.

4.2 Planning and Permitting

The Christiansted Harbor is currently comprised of several different zoning designations (Figures 12 and 13). From Altona Lagoon to Fort Christiansvaern, areas within the APC are zoned W-1 (waterfront pleasure), R-3 (residential medium density), W-2 (waterfront commercial-industrial) and P (public). From Fort Christiansvaern to the sea plane terminal, the zoning consists of P (public), B-1 (business central business district), R-3 (residential medium density), and W-2 (waterfront commercial-industrial). Western Christiansted Harbor zoning consists of R-3 (residential medium density), and W-2 (waterfront commercial-industrial). Protestant Cay is zoned as W-1 (waterfront pleasure). Permitted uses for these zones can be found in the V.I. Code, Title 29, Chapter 3, Section 228.

In the early 1980's, DPNR/CZM prepared and adopted the Coastal Land and Water Use Plan (CLWUP), which designates all coastal areas of the Territory as one of ten (10) classifications. The CLWUP designations were, in some locations in the Territory, in conflict with the existing zoning designations. For the Christiansted Harbor and Waterfront APC, however, the CLWUP basically supported the earlier zoning designations, and provided new refinement of allowable water uses.

Since the late 1980's, DPNR/Comprehensive Planning staff have worked to prepare a Comprehensive Land and Water Use Plan that will re-designate all land and water in the Territory as one of ten (10) new designations, known as "Intensity Districts". The goal of the Comprehensive Plans is to ensure that the quality of life for island residents is maximized.

Natural Hazards Mitigation

There is a need in the Territory for an effective coastal storm hazard mitigation policy and plan. The siting of facilities along the coast increases a cumulative threat potential with respect to three types of coastal storm impacts: (1) threats to public health, safety, and welfare; (2) costs to tax payers for disaster relief and protection; and (3) losses of irreplaceable natural resources (Godschalk, *et al.*, 1989). Compounding the potential for catastrophic losses due to coastal storms is the possibility of significant sea level rise (SLR) in the decades ahead.

While average SLR over the last century has been less than one-foot (10-15 cm), an increase in that much or more (10-20 cm) is projected by 2025, and of between 1.5 and 6.5 feet (50-200 cm) by the year 2100. Using an average of 1 meter of shoreline erosion per cm of SLR, the resulting average by 2025 would be 33 to 66 feet (10-20 meters) [Godschalk, *et al.*, 1989].

There are generally three strategies that may be adopted to mitigate coastal storm hazards and SLR impacts. First, the natural coastline can be "hardened" by using designed protective structures, such as bulkheads, revetments, gabions, etc. Second, facilities and structures built in high hazard areas can also be hardened through the use of stricter building standards to achieve increased wind and/or flooding resistance. These strategies often require resorting to and preparing for evacuation of people during a storm event, with its incumbent risk to human life.

Third, and a better approach, coastal development can be redirected away from high hazard areas through the use of shoreline setback standards and/or re-zoning of high hazard areas to achieve simultaneous risk reduction and other objectives such as open space preservation or wildlife management.

This "development management" strategy, is generally the most cost-effective option. As with the use of stricter building codes, increased costs associated with the alteration of land use patterns to reduce the exposure of people and property to storm damage are generally offset by long-term savings (from less damage) and reduced insurance rates.

> *A coastal storm hazard mitigation policy and regulations should be developed for the Territory, and for the Christiansted Harbor and Waterfront on a site-specific basis. A "development management" alternative to hazard mitigation is recommended in preparation for the next disaster. Direct future public and private developments away from high hazard areas. For existing development, consider policies and regulations that can be implemented now to minimize losses during the next storm. Finally, establish now (i.e., prior to its need) a plan to guide reconstruction following the next storm so that design and siting mistakes are not repeated.*
>
> *Moreover, proposed developments within the designated Coastal Barrier Resources System should be required to pass a strict "public need" criteria test, and approved* ***only*** *if no alternative site for the same use can be found.*

As seen above (section 2.3.2), earthquake potential in the Territory is high. Slopes on lands adjacent to the APC boundary are considerable, while portions of coastal development in the APC sit on man-made fill.

Appropriate attention should be paid in the design of major facilities, especially those which will house large assemblies of people, so that threats from seismic activity are absolutely minimized.

Although the liquefaction potential of landfill soils has not been determined for any landfills in the Territory, logic suggests that certain compaction standards be adhered to and a certified engineer's report required for all major facilities.

Within the APC watershed, seismic hazards should be incorporated into subdivision regulations, with strict controls on development in high hazard areas.

Flooding mitigation will be an ongoing concern for new developments in many locations in the APC and its watersheds. As mentioned above (section 2.3.3), A-Zone, B-Zone, and V-Zone floodplains exist throughout the area, and the entire Altona Lagoon area is a designated site in the Coastal Barrier Resources System.

Strict adherence to National Flood Insurance Program (NFIP) policies and regulations is recommended, and new developments restricted where the hydrology and flooding potential of an area may adversely affect important wildlife habitat or other natural features. Channelization for flood control should be avoided wherever possible, and new developments directed away from floodplain hazard areas. Cumulative impacts from the increased use of non-porous surface materials should be assessed, and guidelines established for the use of "grassphalt" and other porous surface materials on access roads, parking lots, and other suitable areas.

In addition to the above efforts for flood mitigation, an update of the 1979 stormwater management study (CH_2M Hill, 1979) should be considered for funding and implementation. Regular maintenance of drainage systems, and an assessment of proper culvert sizing should be given priority (see also nonpoint source controls below).

Water Quality

The waters of Christiansted Harbor are designated by the V.I. Government as Class "C" (i.e., for the propagation of marine life and primary contact recreation). This designation provides the least level of protection given by territorial water quality standards (USVI Govt/DPNR, 1992). Despite this designation, the maintenance of acceptable levels of water quality should be seen as a primary goal for the APC. In contrast to some of the other urban ports and harbors in the Territory, the Christiansted Harbor is used regularly by both locals and visitors for swimming, diving, and consumption of recreationally caught fish.

As seen above (section 3.3.1), water quality in the harbor has suffered considerably from continued pollution loading. The single TPDES-permitted outfall in the harbor, the WAPA outfall, is a significant (albeit not the only) contributor to overall pollution loading. The occasional bypass of sewage discharge from the LBJ pump station is a significant problem as well. Marina operations at Gallows Bay are a source of heavy metals that deserves closer assessment and follow-up. In general, the biological surveys and water sampling (principally for bacteria and heavy metals) suggest that there is reason for more than just casual concern about water quality in the harbor.

The significantly elevated heavy metal concentrations, for example, are worthy of further analysis, including a risk assessment to determine potential adverse effects on human health. Sediment sampling for heavy metals and fish tissue bioassays should be carried out annually to determine trends. Site-specific management plans for heavy metals, including the treatment of stormwater runoff where necessary, should be required of contributory facilities. In this regard, all boat repair facilities in Gallows Bay should undergo close inspection.

A targeted monitoring program for DDE (a degradation product of DDT) in the sediments and phosphorus in the water should also be planned and implemented.

Thermal effluents from power plants and other industrial processes, can result in adverse impacts to biological communities, both through temperature intolerance and the use of chemicals used to reduce biofouling of cooling systems. Thus, every energy conservation effort to reduce demands on public power plants will pay dividends for the coastal environment. In addition, thermal effluents should be adequately cooled, and chemicals that are used to reduce biofouling evaluated for their possible toxic or sub-lethal effects on the marine environment.

Impacts from the operation of desalination plants result from the discharge of warm hypersaline brine and associated chemicals used to reduce biofouling in the cooling systems. The type of desalination process used, the volume of water undergoing treatment, and the location of discharge outfalls determine the type and severity of environmental impact. As with effluents from power plants, a reduction (through conservation measures) in the volume of water undergoing treatment may in the long-term pay dividends for the protection of distinctive or valuable marine habitat. At the very least, hypersaline effluents should be adequately diluted with fresh sea water and cooled prior to discharge (Tetra Tech, 1991).

As a planning goal, WAPA should be encouraged in the long-term to transfer all power generation activities to the south shore plant. If such a proposal is not supported by cost/benefit analysis and environmental impact assessment, consideration should be given to extend the WAPA outfall to beyond Long Reef, to a depth and location sufficient to allow adequate mixing and dilution of the effluent. Until such action, and upon renewal of the TPDES permit, DPNR should decrease the size of the mixing zone to protect marine life and minimize effluent contact with swimming beaches and Long Reef in the western harbor. The Authority should be required to undertake ambient monitoring of its approved mixing zone, and regularly provide data and analysis to DPNR/DEP. Consideration should be given to moving the water intake pipe for the desalination plant to a less impacted area, perhaps beyond Long Reef. WAPA should be required to complete and resubmit to DPNR the required thermal plume study. Moreover, DPNR/DEP should move to vigorously enforce conditions of the existing permit, and consider the need to increase overall enforcement efforts to include an assessment and elimination of all sources of unpermitted discharges within the APC.

Although not the same type of (water quality) issue, the concrete plant should similarly be encouraged to relocate to a less populated site on the island, towards the longer-term goal of opening up coastal areas for water-dependent use.

Proper attention must be continue to be given to Operation and Maintenance (O&M) procedures for Municipal wastewater treatment facilities, not only to ensure that discharged effluent meets TPDES requirements, but that the collection system is leak-proof and of sufficient capacity to handle peak flows. To achieve this goal, the Department of Public Works should:

1. *Continue to use proper O&M at the WWTP. The daily operations include logging, sampling and analysis to provide the department with information with which to evaluate its capabilities to meet TPDES permit requirements;*
2. *Continue the program to promote efficient operations, maintenance, and replacement of equipment by training and certifying operators, hiring certified operators and contracting specialty maintenance services. The comprehensive sewer line rehabilitation program that is currently under development (pers. comm., M. Cornwall, 1993) should be implemented. User charges continue to be used to purchase equipment supplies and materials for repairs and replacement (pers. comm. M. Cornwall, 1993); and*
3. *Anticipate future needs for planning, design, and construction of facilities required to replace, upgrade, or expand existing facilities to maintain compliance. Currently, funding of over $4.0 million is earmarked for a major rehabilitation of the St. Croix sewage treatment system, including new pumps and valves at the Lagoon Street pump station. Additional funding is being sought in the federal FY95 budget through the Department of the Interior (pers. comm., M. Cornwall, 1993).*

Specific short-term objectives should include:

1. *High priority should be given to an inspection program for the sewer collection system in the Christiansted area.*
2. *Leaks and/or upgrade with new pipes where needed.*
3. *Establish an inspection system for all on-site sewage treatment systems (septic tanks).*

In the interim, a more intensive monitoring program that will protect bathers from fecal contamination associated with the sewage system should be considered.

Another problem is waste oil. *Government has elevated to a top priority the establishment of facilities to receive waste oil.* Partnerships with the business community, especially with those companies involved in the supply and distribution of petroleum products, are being negotiated with in an attempt to have them become drop-off points for the receipt of waste oil. This is being accomplished through the revision of the Territory's Oil Spill Prevention Act. These actions will be undertaken in concert with a public awareness program on the environmental effects of improperly disposed of waste oil.

Nonpoint source pollution is a significant contributor to the overall degradation of nearshore environments in the U.S. Virgin Islands (Tetra Tech, 1991). Although the islands have no perennial streams or rivers, episodic events of intense rainfall deliver pulses of fresh water laden with sediments, nutrients, organic matter, and potentially toxic chemicals to nearshore receiving waters. Control of nonpoint source pollution may have significant positive effects on pristine and otherwise valuable marine habitat. Both DPNR/DEP and DPNR/CZM currently operate nonpoint source pollution control programs.

The APC watersheds will likely experience considerable growth in the years and decades to come, especially if the proposed Comprehensive Plan is approved and carried out accordingly. The Christiansted bypass road, slated for construction in 1993, will likely be a considerable source of sediment loading for the harbor if utmost care is not taken in the design and excavation of the road.

As a general goal, Christiansted Harbor should be included as a priority waterbody in DPNR's new nonpoint source control program. The following list of recommendations for nonpoint source discharge control is adapted from Tetra Tech, Inc. (1991):

1. *separate storm and sanitary sewers;*
2. *collect and treat combined Sewer Overflows (CSO's), using infiltration trenches/basins or chemical or filtration treatment systems;*
3. *regulate land use practices and behaviors that contaminate stormwater (e.g., waste oil disposal, establishment of green or infiltration areas on a portion of developed property, establishment of impervious surface limits);*
4. *impose routine inspection and management requirements for on-site (septic tank) wastewater systems;*
5. *develop treatment options for stormwater (e.g., detention basins, grassy swales, vegetation buffers, artificial wetlands);*
6. *implement source control practices such as street sweeping;*
7. *implement soil conservation measures on all construction projects (e.g., vegetation buffer zones, retention basins, silt-curtains, diversion ditches, etc.); and*
8. *establish performance standards to reduce the total area of non-porous surface materials used on access roads, driveways, and parking areas; encourage the use of permeable materials such as "grassphalt", gravel, or appropriate vegetation.*

Another issue for water quality in the harbor relates to turbidity due to propeller wash of bottom sediments and stormwater runoff. Mitigation techniques for propeller wash are rather limited, however small-scale, site-specific mitigation can be accomplished for other suspended sediment sources through the use of siltation curtains, weirs, cascaded settling ponds, and improved dredging practices. Such devices should be routinely used on dredge and fill operations. Dredging can result in resuspension of fines and contaminant-laden sediments, with significant adverse impacts on coral reefs, seagrass beds, and other benthic communities. Routine maintenance dredging (utilizing siltation curtains) in the harbor's major channels could serve to maintain sufficient depths to minimize turbidity effects from propeller wash.

Coastal water quality is adversely affected by oil spills and the potential for a major oil spill is relatively high for the Christiansted Harbor. Oil spill contingency plans are under preparation by both the V.I. Government (DPNR/DEP) and the U.S. Coast Guard. The DPNR/DEP currently awaits USEPA approval on a draft oil spill contingency plan. As for the USCG plan which will be developed in coordination with the relevant federal and local agencies, it will be a revision of an earlier plan (Oil and Hazardous Materials Response Plan for Puerto Rico and the U.S. Virgin Islands), and has a July 1993 scheduled completion date as stipulated under the Oil Pollution Act (OPA) of 1990 and its regulations.

Under the new OPA regulations, vessels and facilities that handle any kind of oil are required to demonstrate that response capability exists. Personnel training, equipment, and exercise drills are required components. As such, the private sector is in large part joining forces to support the development of "cooperatives" that will provide the required "on-call" oil spill response capability. One of these cooperatives, the Marine Spill Response Corporation (MSRC) will have facilities, including a 210' vessel, located at the Hess Oil refinery on the south shore.

Government facilities (including the WAPA power plant at Richmond) must in the near future also meet the requirement to develop a site-specific oil and hazardous material spill response plan. Thus, it may be

prudent for Government to investigate the development, in conjunction with the relevant private sector entities, of something like an oil spill cooperative for Christiansted Harbor.

Marina fueling and boat repair services in the APC must be designed, maintained, and operated to reduce the risk of accidental spill and to facilitate clean-up in the event of a spill. Design practices include as a minimum:

1. *design boat hull maintenance areas to minimize contaminant-laden runoff;*
2. *locate and design fueling station and maintenance areas so that spills can be contained in a limited area;*
3. *implement source control practices such as vacuuming of impervious areas; use of tarpaulins to collect paint chips, sandings, and paint drippings; and use of sanders with vacuum attachments to collect hull paint sandings;*
4. *design spill contingency plans; and*
5. *design areas to include appropriate spill containment equipment.*

Liquid materials (i.e. oil, solvents, antifreeze, paints, etc.) should be prevented from entering coastal waters. Appropriate storage, transfer, containment, and disposal facilities should be provided and maintained, and recycling of liquid materials (especially oil) should be encouraged. Possible practices to implement these goals include as a minimum:

1. *build curbs, berms, or other spill containment barriers around areas used for liquid material storage. Store liquid materials in areas that are impervious to those materials;*
2. *separate containers for disposal of waste oil, waste gasoline, used antifreeze, and oil-contaminated water; diesel, kerosene, and mineral spirits containers should be clearly labeled;*
3. *marina patrons and employees should be directed as to proper disposal methods for these materials through signs, mailings, training, etc.*

The amount of fuel and oil from boat bilges and fuel tank air vents entering marina and coastal waters should be minimized. Practices to implement this goal include as a minimum:

1. *use the best available technology (BAT) on air vents or tank stems of fuel tanks to prevent fuel from overflowing through tank air vents and spilling into coastal waters; and*
2. *place oil-absorbing materials in bilge areas of all boats with inboard engines; check these once a year and replace as necessary; recycle, if possible, or dispose of properly.*

Additional management measures for the control of pollution associated with marinas may be found in the (draft) 1993 Nonpoint Source Management Measures, co-produced by the USEPA and NOAA (available at DPNR/CZM).

For several years, the Government has recognized the growing (and cumulative) problem of vessel waste discharges to the marine environment. In 1983, a Vessel Waste Control Plan (Wernicke and Towle, 1983) was prepared for the Department of Conservation and Cultural Affairs. The Plan's three principal recommendations are excerpted here in their entirety, as they remain valid and significant recommendations today, a decade later.

1. The first step, and the most important, is a clarification of goals. It is impossible to return the coastal embayments (now vessel anchorages and marina sites, etc.) to their original pristine environmental or ecological condition, and it is equally impossible to reduce environmental risks or even pollutant inputs to zero. Stating (or pursuing) unrealistic goals is counter productive. It encourages both a crisis orientation (short-term fixes to long-term problems) and, worse still, confrontations -- since environmentalists want the whole protective strategy now and Virgin Islands users (residential, commercial, industrial) see no point in taking costly steps toward an unreachable goal.

2. A second step requires the improvement of the scientific basis of DPNR, the Port Authority, the Department of Public Works, and other V.I. agencies making decisions regarding uses of the natural resource base -- realizing that resources have limits of use (i.e., carrying capacities).

   Agencies can, with scientific help, quantify risks. But the scientific basis of agency decisions can be improved without significant increases in costs or delays. Most important of all, the decision making process is rendered more realistic and defensible.

3. The third step involves improved implementation and enforcement of environmental protection strategies. There are limits, however, to DPNR's monitoring and enforcement responsibilities regarding existing standards for water quality and other environmental indicators. These responsibilities are hampered by personnel limitations, logistic costs, and jurisdictional constraints. Perhaps an alternative exists, even if partial, that would involve the corporate (and government agency) user conscience -- plus the threats of adverse publicity and lawsuits -- to promote and develop widespread compliance with suggested "voluntary" standards. Further, substituting economic incentives, such as a sewage waste discharge tax on vessel discharges or on unacceptable MSD's (Marine Sanitation Devices) -- in certain designated anchorages -- could improve targeted vessel waste enforcement, lower its costs, and generate revenue to pay for the "enforcement" activity.

Solid Waste Management

The international MARPOL treaty requires that member governments provide at least the *potential* to receive vessel wastes, in accordance with applicable regulations. The Animal And Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture is the Federal agency responsible for regulating receipt of foreign-sourced solid wastes entering the Territory. Thus, certain food products purchased down island, for example, if brought back into the Territory aboard a yacht, are classified as foreign-sourced wastes, and are subject to USDA inspection and regulation. The USCG is responsible for implementing MARPOL regulations, and has required the V.I. Port Authority to provide refrigerated containers to receive foreign-sourced solid wastes (since proper processing facilities are not available in the Territory); these wastes must be shipped to Puerto Rico for processing. USDA handles processing and transfer of these wastes.

The above requirements will be difficult to meet on a recurrent budgetary basis, and the V.I. Government should explore the possibility of contracting with a private firm to provide such service in accordance with regulations when and if it is needed. The V.I. Government could then demonstrate to the USCG that it

has secured the necessary arrangements to provide such service. All expenses should be passed on to the vessel operator who has imported foreign-sourced wastes. Fortunately, most new (large) vessels are now self-contained with respect to liquid and solid wastes, and so the cruise ship industry should generally not require such service in the USVI.

With respect to municipal solid waste, the public must dispose of household waste in roadside dumpsters provided by Public Works. These dumpsters should be placed on concrete pads with adequate vehicle access. Landscaping and fencing should be considered for each dumpster location.

Air

Foul odors have been reported by the managers of condominiums down wind of the LBJ pump station, especially during times of emergency bypass operations (section 3.3.2). Mitigation measures for this impact are the same as for resolving the problem in the first place, namely to rehabilitate and maintain the entire sewage system so as to obviate the need for emergency bypass discharge. DPNR/DEP should consider the need to initiate an ambient air quality monitoring program for the Christiansted area, especially for inhalable particulates originating from vehicular and vessel traffic. Future major development should require an assessment of air quality impacts as part of the EAR process.

Noise

Preparers of EARs should be required to assess cumulative noise impacts as they may affect particular target communities within an identifiable radius (or down wind corridor) of the proposed development. In addition, an increasing use of jet skis in the waters around Protestant Cay is a source of noise pollution that warrants monitoring and, if necessary, some type of control. Perhaps the largest source of noise pollution, however, is WAPA's facility at Richmond. Mitigation measures for construction of a new desalination plant are discussed in section 3.3.3.

Biological Resources

Inhabitants of Protestant Cay should be made aware of the endangered status and habitat requirements of the St. Croix Ground Lizard.

Recreational fishing in Altona Lagoon should be restricted. Commercial fishing and shrimping have already been banned, but it should be recognized that recreational fishing has the same if not greater potential for cumulative impact on fish stocks. The lagoon is a limited resource with severely restricted flushing capacity. All inputs to the lagoon, both land-based and water-based, must be avoided. In this regard, discussions are warranted with the owners/managers of the nearby golf course to ensure their cooperation in utilizing the best available technologies (and lawn care products) to absolutely minimize the potential for adverse effects which might stem from runoff into the lagoon. Maintenance of the nursery value of the lagoon should be given highest consideration in any land or water use decisions. In this regard, the establishment of a Territorial Park at Altona Lagoon should focus more on its use as an "outdoor classroom" than on any other, more intensive recreational pursuits.

Similarly, the preservation of Long Reef as a valuable "marine outdoor classroom" for Christiansted residents should be given serious consideration. Long Reef is an important component of the entire marine ecosystem both within and without the APC. Its value in providing a natural buffer against

northerly storm swells should not be discounted. Thus the need to maintain a biologically productive reef should be given relative management priority.

Organizers of beach cleanups need to be cognizant of the need to leave vegetation in place. Heavy equipment and/or vehicles should never be allowed on beaches, be they to facilitate cleanups or not.

Cultural Resources

Efforts should be made to locate, assess, and prioritize the most significant prehistoric resources worthy of protection within and adjacent to the APC. At the same time, funding mechanisms should be explored to allow for future acquisition of priority sites. Meanwhile, the private sector should be encouraged to cooperate and directly assist with cultural resource conservation efforts (both historic and prehistoric sites), with appropriate incentive mechanisms.

In the event that cultural sites are to be removed or damaged as part of a proposed development, mitigation measures should be designed, implemented, and fully enforced. These should include the requirement for a qualified archaeologist or historian (as appropriate) to direct such mitigation and/or data recovery efforts. In addition, once the SCHPP has clearly established cultural resource protection policy, additional, specific, pieces of legislation should be drafted and sent to the Legislature for approval. For example, there is a long standing need for the Territory to adopt antiquities preservation legislation (section 4.3). In general, greater attention to the enforcement of permit conditions needs to take place, as well as greater coordination on cultural resource protection efforts with other relevant agencies (e.g., the USACOE, the V.I. Port Authority, etc.).

The Richmond, Sugar Beach, and Protestant Cay sites (section 2.5.1) have been recommended for further archaeological study (USVI Govt/DPNR, 1982). The surface survey of the Sugar Beach site in 1982 indicated a large settlement which may contain *in situ* deposits of cultural material. Although additional damage has occurred to these sites (especially the Sugar Beach site), this fact does not obviate the need for comprehensive assessments of these and other sites not mentioned in this Study.

Of great concern are the underwater historic resources of the harbor. It is very likely that many valuable, submerged artifacts remain in the harbor, however, there has never been a systematic magnetometer survey of the harbor, with the exception of those surveyed in preparation for dredging of the Old Schooner Channel (Island Resources Foundation, 1988). Consequently, very little is known about the marine archaeological resources that may be found there.

For several years, DPNR/DAHP has been collecting information to nominate historic resources to the National Register of Historic Places. As a first step, the DAHP commissioned an inventory of recorded shipwrecks in Virgin Islands waters. The inventory currently contains more than 600 entries. Only a few of these, however, have been located or verified by physical survey and examination.

Before any potentially disturbing activity, including dredge activities, treasure diving and recovery, and/or the archaeological excavation of wrecks, is permitted, an initial systematic survey utilizing non-destructive investigative means should be conducted of the underwater resources of the APC.

Further recommendations regarding cultural resources management are found below (section 4.3).

GEOGRAPHICALLY SPECIFIC RECOMMENDATIONS

Fort Louise Augusta/Altona Lagoon/Gallows Bay

1. Altona Lagoon and its adjacent land area (Figure 6a) should be considered for Territorial Park status, with strictly passive, low-intensity recreational pursuits allowed. As mentioned previously, this important fish nursery area must be given maximum protection; fishing of all types should be prohibited within the lagoon.

2. Beauregard Bay and Little Bay should be protected as sea turtle nesting areas. Any permitted development that may impact these areas should be required to include "turtle sensitive" lighting as follows: only low-pressure, long-wavelength, sodium-vapor lamps (of either low of high intensity) should be allowed, and they should always be shielded to direct illumination away from turtle nesting areas. Signs should be posted which instruct the public as to applicable regulations.

3. The existing structures at Altona Beach should be removed or reconstructed. A well designed and maintained public restroom facility is needed at this location. Discussions should ensue with the Department of Housing, Parks and Recreation to include this beach area as part of the Altona Lagoon Territorial Park, with appropriate management measures and control of people and vehicles throughout the area.

4. Dock repairs are needed at Port Authority's commercial dock at Gallows Bay. These repairs should be given priority consideration for next fiscal year.

5. The Gallows Bay area is a traditional fishing and picnicking spot for local residents. Conditions at Gallows Bay are unsanitary due to the lack of running water for cleaning fish and equipment and the absence of public restroom facilities. It is recommended that water service be returned to the area as soon as possible. Consideration should be given to the construction of public restrooms on land adjacent to the sewage pump station.

6. Further to this recommendation for Gallows Bay is the following excerpted from the U.S. Virgin Islands Comprehensive Land and Water Use Plan (Strategic Planning Group, 1991):

   It is recommended that the Gallows Bay area be redeveloped primarily for recreational boating. New or expanded marina sites should be relocated to the Southport locations. Adequate docking and storage area for the small inter-island trading vessels should be maintained. The area used for small fishing boats should be improved by developing adequate docking, mooring, and land based facilities.

Fort Christiansvaern to Caribbean Airboats Terminal

1. The existing boardwalk should be extended west to the sea plane terminal. The boardwalk and its small finger piers for moderately-sized recreational vessels represents an immensely important promenade for public use.

2. Any future considerations for waterfront redevelopment in areas adjacent to the National Historic Site should proceed only with consultation with National Park Service personnel. Such

development must be compatible with the historical integrity of the area, and should require extensive archaeological research and survey work prior to permit approval. In a 1952 (Article II.g.) agreement, the V.I. Government agreed to ensure the exterior integrity of historic buildings within a distance of 200 yards outside the boundaries of the National Historic Site through maintenance and enforcement of zoning legislation (pers. comm., W. Cissel, NPS, 1993).

3. Parking within and adjacent to the National Historic Site in downtown Christiansted should be relocated according to the various Memoranda of Agreements between the V.I. Government and the National Park Service. This will require the cooperative efforts of both governments. Furthermore, all utility lines within the Historic District (which includes the National Historic Site) should be buried to restore the historical character of these important cultural resource areas. In the 1977 Agreement (Section 1, Paragraph D) between the VI Government and NPS, the NPS was to restore the grounds and place utility lines underground to effect an historic appearance within the National Historic Site once the VI Government relocated parking that is now within the boundaries of the National Historic Site. NPS allocated money for this in 1988, but the VI Government was unable to relocate the parking (pers. comm., W. Cissel, NPS, 1993).

4. Consideration should be given to restrict domesticated animals from Protestant Cay as they may be a threat to the St. Croix Ground Lizard, *Ameiva polops*. Protestant Cay and Green Cay are the only remaining habitats for this species.

5. Repairs should be completed for the sea plane terminal as soon as possible. Access around the terminal site should be maintained to allow for pedestrian passage from West Side Park to the downtown area along the waterfront.

6. Further to these recommendations for Christiansted waterfront is the following from the U.S. Virgin Islands Comprehensive Land and Water Use Plan (Strategic Planning Group, 1991):

   It is recommended that pedestrian access to the downtown area be improved by constructing a walk-way along the waterfront. Safe, continuous pedestrian movement should be provided by extending and improving the existing boardwalk westward to the limits of existing waterfront commercial development. Existing parking areas along the waterfront near the Scalehouse should be relocated to insure that the integrity of the Historic Site is maintained and that safe and adequate access to the entire waterfront is available. Any maintenance dredging which may be required should be undertaken only after careful study. To protect the remaining habitat for the endangered wildlife and to maintain the scenic quality of the waterfront, it is recommended that any development activities that take place on Protestant Cay be carefully designed and sited.

Western Christiansted Harbor

1. Presently, the West Side Park remains a cleared piece of land without park improvements. Efforts should soon be made to implement the planned improvements. Vehicles and grazing horses should be prohibited. Derelict vessels on the shoreline and the single structure on the park's south side should be removed. Steps should be taken to improve the quality and management of the beach and adjacent waters.

2. The entire shoreline should be examined in detail to determine areas where surface runoff to the sea can be reduced or eliminated. In cases such as the guts east of the WAPA facility, a few wheel barrow-loads of seaweed/sand mixture (most hotels have plenty) would restore a berm crest, provide seedlings, prevent wind erosion and trap marine sand and terrestrial sediment.

3. Some targeted sampling of seafood for toxins such as heavy metals, PCB's, and hydrocarbons should occur immediately. The possible, even probable concentration of toxins in the food chain must be evaluated, or serious public health consequences may result. Possible sources of technical and financial assistance include federal agencies responsible for public health such as the Food and Drug Administration or the Center for Disease Control. Because Hugo caused so many different toxic releases, the issue of liability is not applicable.

4. The Nature Conservancy has a site in Little Princess. The site could be used as the headquarters for the management team responsible for the Long Reef-Little Princess-Altona Lagoon Territorial Park areas. The location is fairly central to this site and offers an overview of the reef in front.

4.3 Legislative Change

There is no V.I. law specifically regulating the use of jet skis. Although they are considered to be motor vessels, there are no standards (especially noise), other than that pertaining to motor vessels by which they operate, and no provisions in the law to consider the needs and safety of other water users, including swimmers and various aquatic or wildlife species.

The Division of Archaeology and Historic Preservation is currently working on an Antiquities Legislation Bill that will be submitted to the Legislature for approval. This bill will address the requirements for archaeological work in the Territory.

The Antiquities Legislation Bill will bring greater clarification to the question of overlapping jurisdictions on historic protection matters, and will generally strengthen the overall authority and mandate of the Historic Preservation Commission (HPC).

5. CONCLUSION

The Christiansted Waterfront APC is comprised of a multitude of irreplaceable historical, cultural, and natural resources. The APC itself encompasses a large area, from Altona Lagoon in the east to Estate Little Princess and Long Reef in the western harbor. The largest metropolitan area on St. Croix lies in between these two important natural and cultural resource areas. Christiansted and its environs represent a diverse mix of residential, commercial, public utility, and industrial uses.

As with urban waterfronts anywhere, the challenge of resource management and user conflict resolution lies in the recognition that a long-term, visionary outlook for the area's future must be first forged and supported through community consensus. Without such common vision, efforts to protect dwindling resources will be fragmented and largely ineffective. With an agreed upon future vision of the Christiansted Waterfront and Harbor, however, overarching goals are more easily called upon to guide community action, and the development control process.

This APC Comprehensive Analytic Study and proposed Management Plan calls for the development of a "Port and Waterfront Revitalization Plan" to serve as the community consensus-making tool to guide the area's development for years and decades to come. It is believed that only through community dialogue and an action-planning process, will tangible results come about to preserve and enhance the area's resources and human environment. The Study and proposed Management Plan describe the area's existing and proposed land and water uses, and attempts to reveal the urgency in resolving at least three outstanding issues: (1) the need to revitalize the downtown waterfront area by repairing dilapidated portions and restoring pedestrian access to and along the waterfront with the construction of a boardwalk along the entire shorefront; (2) the need to move quickly forward on the creation of new recreational opportunities at Altona Beach and West Side Park, and to examine the feasibility of giving Territorial Park status (as "outdoor classrooms") to Altona Lagoon and Long Reef; and (3) the need to control land-based sources of waste inputs to Christiansted Harbor, especially sediment loading associated with stormwater runoff; heavy metal and oil/grease loading from boat repair operations; industrial effluents from the WAPA outfall; and emergency sewage bypass discharges which contribute to extraordinarily elevated bacterial levels within the harbor.

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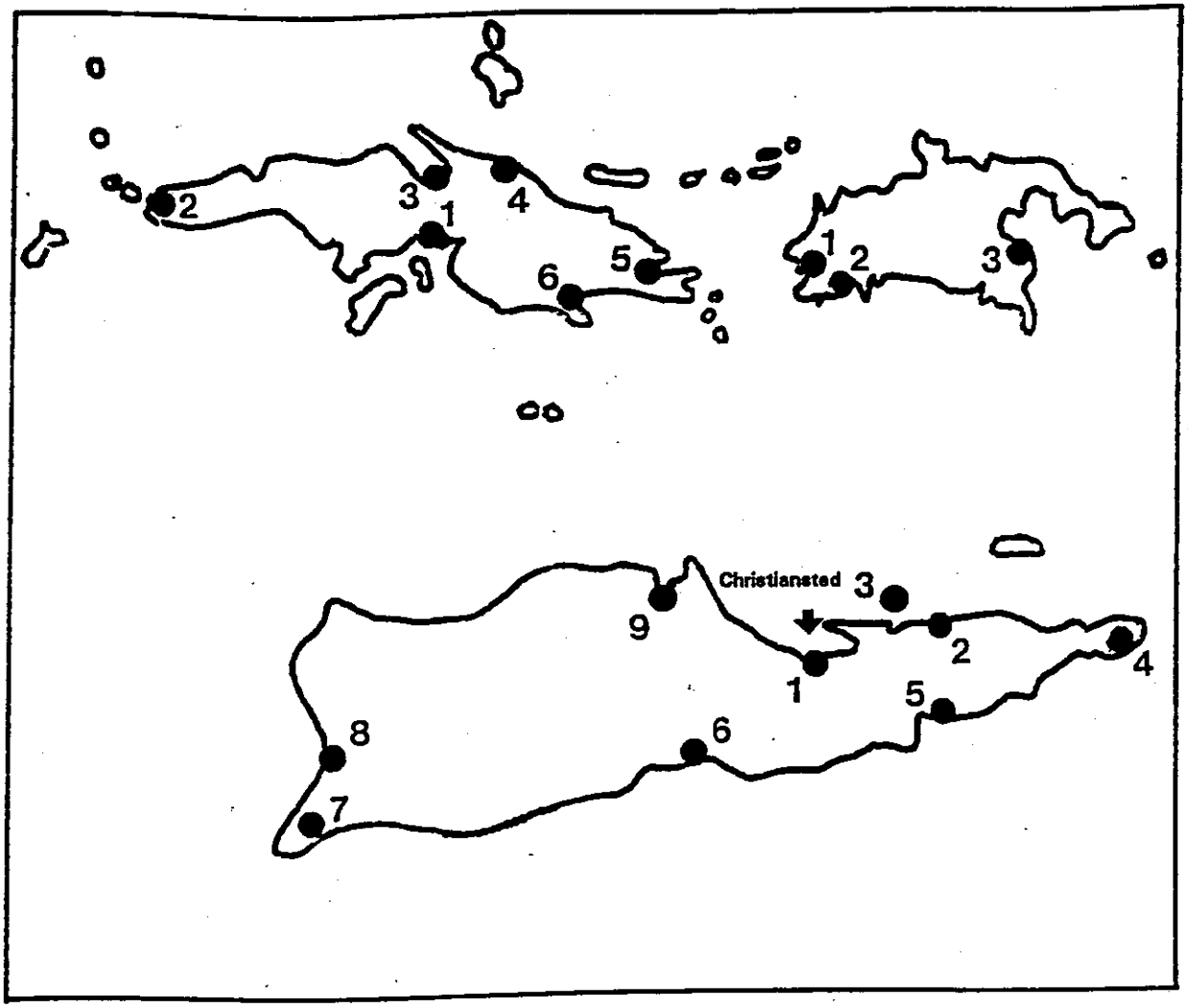
CHRISTIANSTED WATERFRONT APC



AREAS OF PARTICULAR CONCERN

St. Thomas

1) St. Thomas Harbor and Waterfront
2) Botany Bay (APR)
3) Magens Bay and Watershed
4) Mandahl Bay (APR)
5) Vessup Bay - East End
6) Mangrove Lagoon - Benner Bay (APR)

St. John

1) Enighed Pond - Cruz Bay
2) Chocolate Hole - Great Cruz Bay (APR)
3) Coral Bay (APR)

St. Croix

1) Christiansted Waterfront
2) Southgate Pond - Chenay Bay (APR)
3) St. Croix Coral Reef System (APR)
4) East End (APR)
5) Great Pond and Great Pond Bay (APR
6) Southshore Industrial Area
7) Sandy Point
8) Frederiksted Waterfront
9) Salt River Bay and Watershed (APR)

Figure 1
Regional APC Map
Adapted from: USDOC, 1979

CHRISTIANSTED WATERFRONT

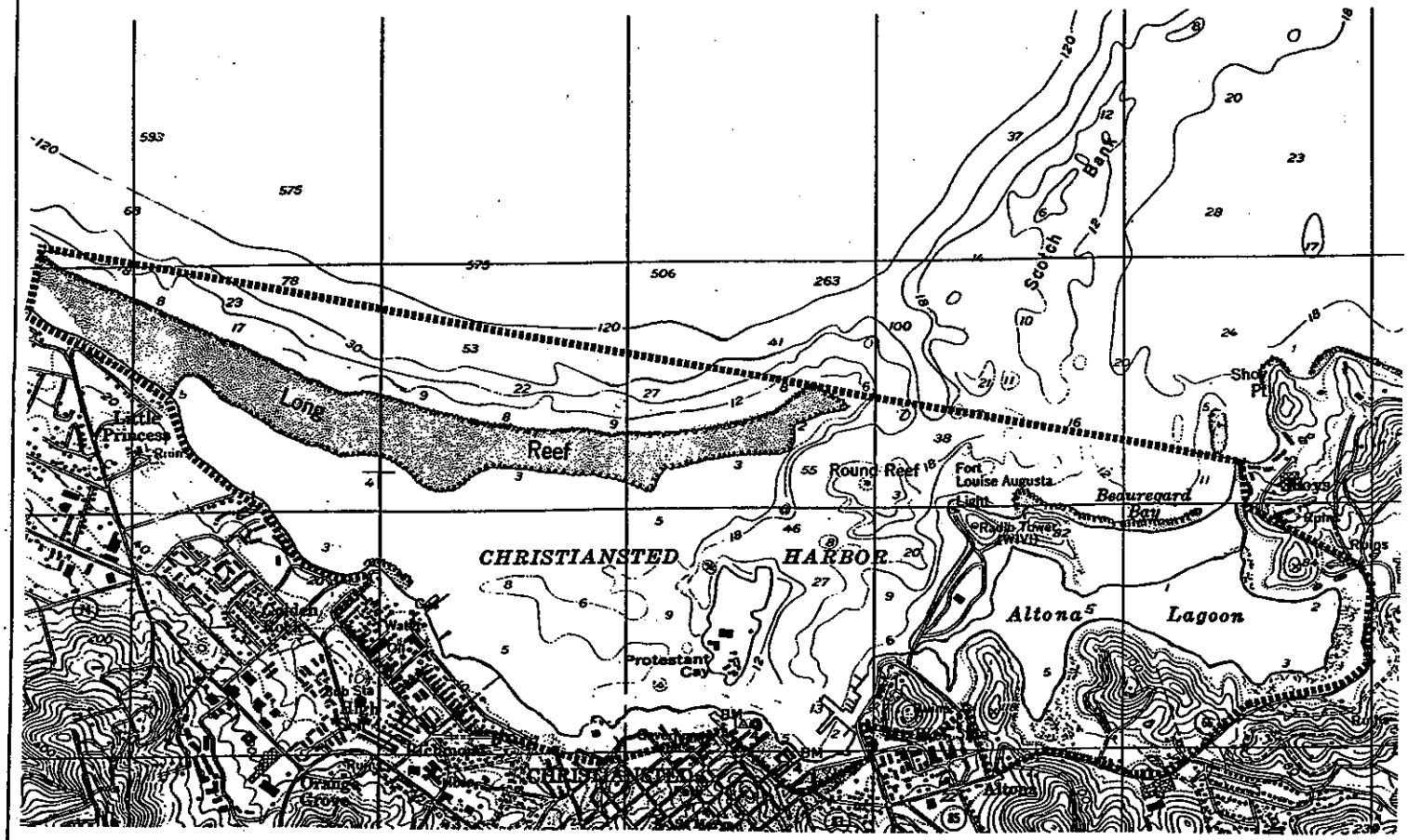


Figure 2
APC Boundary Map
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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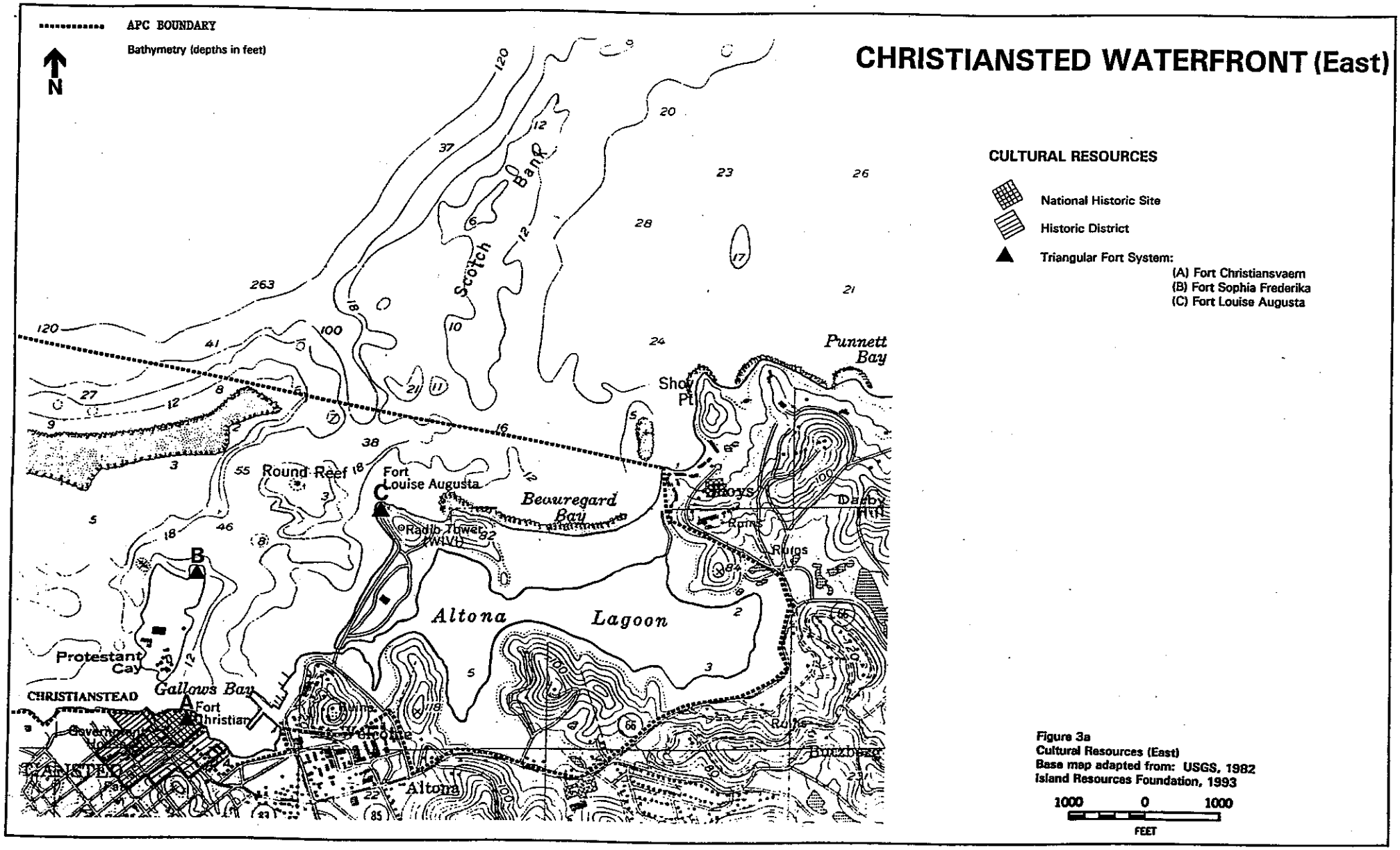
APC BOUNDARY
Bathymetry (depths in feet)
N
CHRISTIANSTED WATERFRONT (East)
CULTURAL RESOURCES
National Historic Site
Historic District
Triangular Fort System:
(A) Fort Christiansvaern
(B) Fort Sophia Frederika
(C) Fort Louise Augusta
Scotch Bank
Punnett Bay
Shoy Pt
Round Reef
Fort Louise Augusta
Beauregard Bay
Radio Tower (WIVI)
Altona Lagoon
Protestant Cay
Gallows Bay
CHRISTIANSTED
Fort Christian
Altona
Ruins
Figure 3a
Cultural Resources (East)
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993
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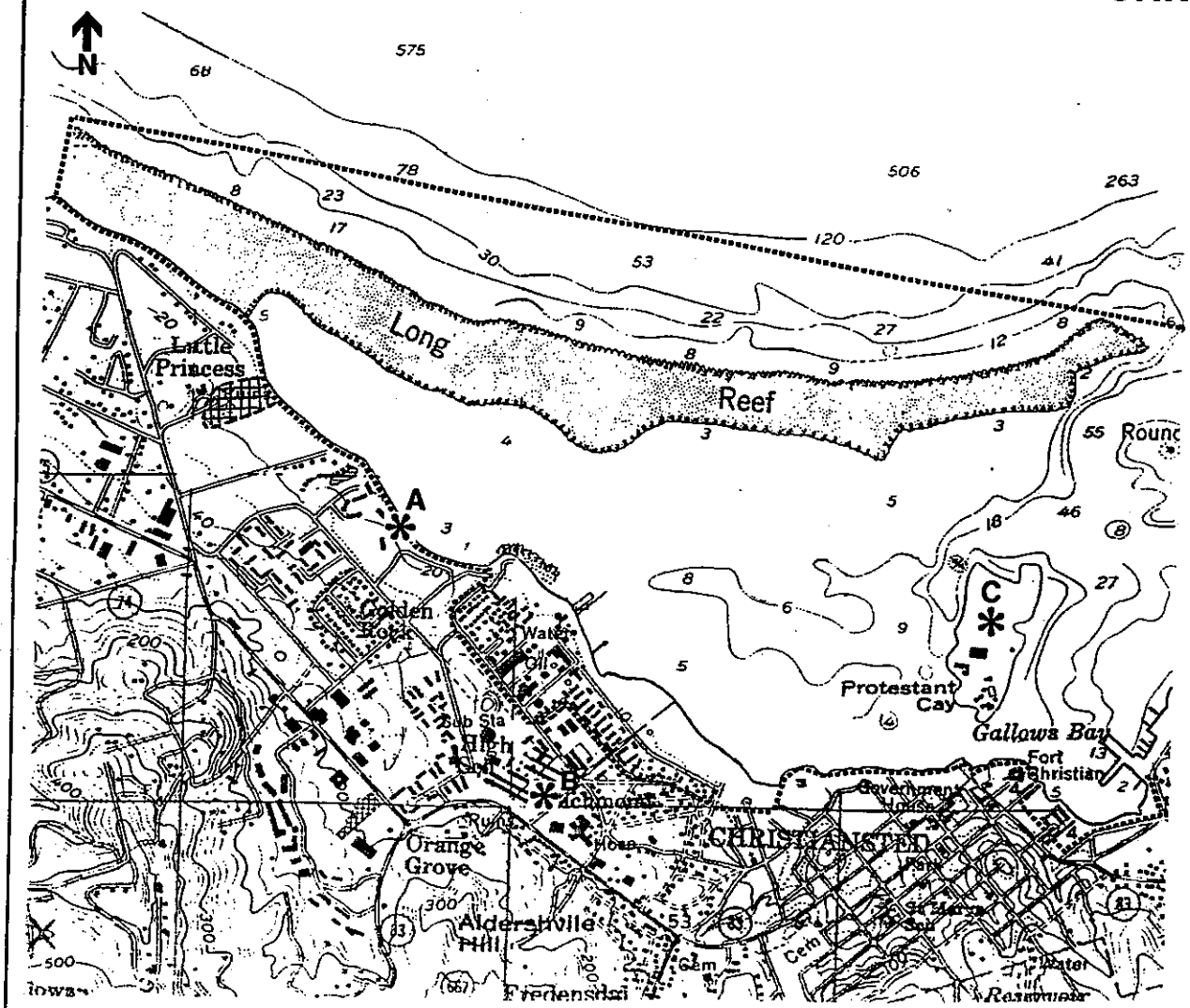
CHRISTIANSTED WATERFRONT (West)

APC BOUNDARY

Bathymetry (depths in feet)



CULTURAL RESOURCES

- Prehistoric sites:
  - (A) Sugar Beach
  - (B) Richmond
  - (C) Protestant Cay
- Mid-18th century ruins (TNC)

Figure 3b
Cultural Resources (West)
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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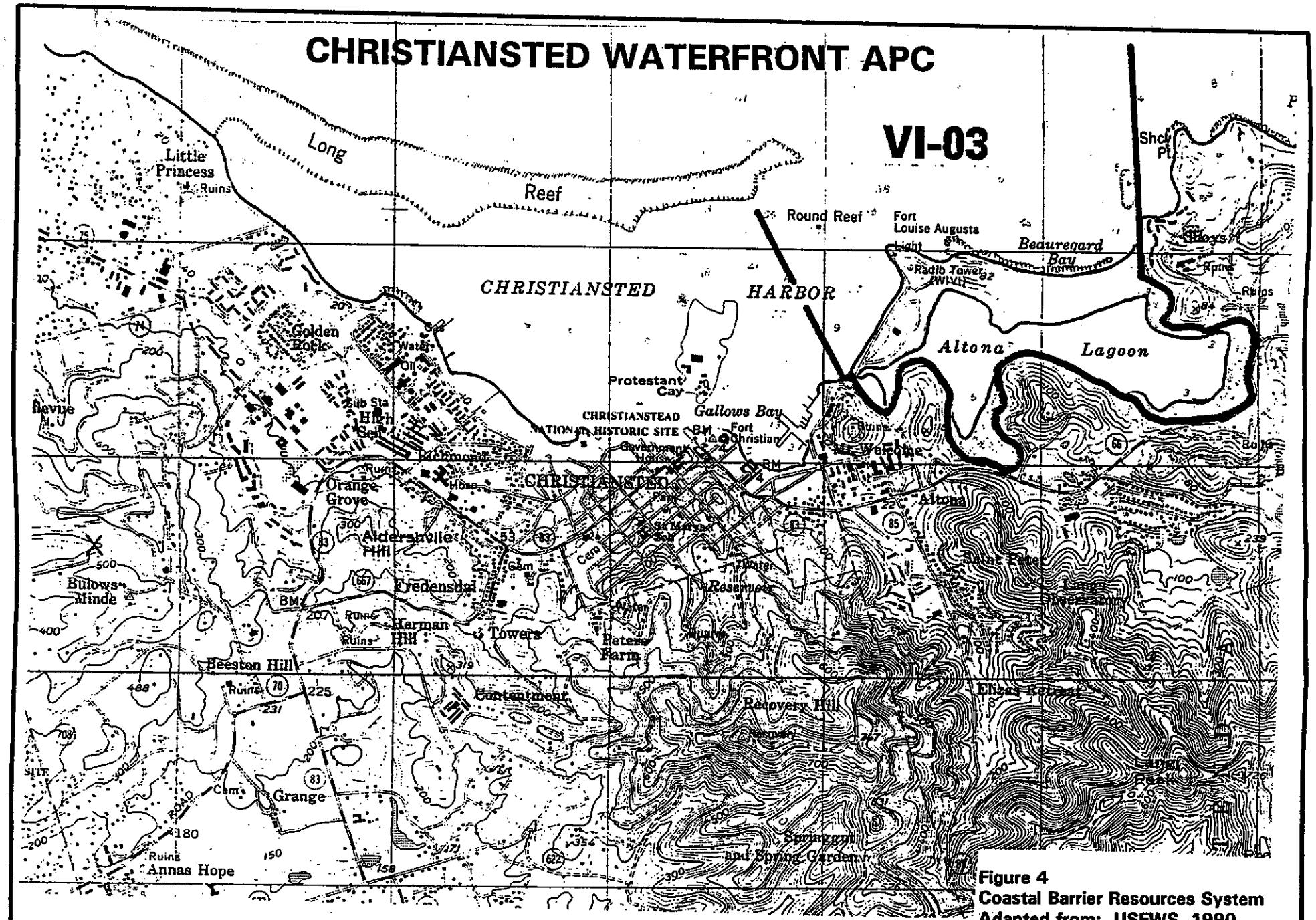


Figure 4
Coastal Barrier Resources System
Adapted from: USFWS, 1990
Island Resources Foundation, 1993

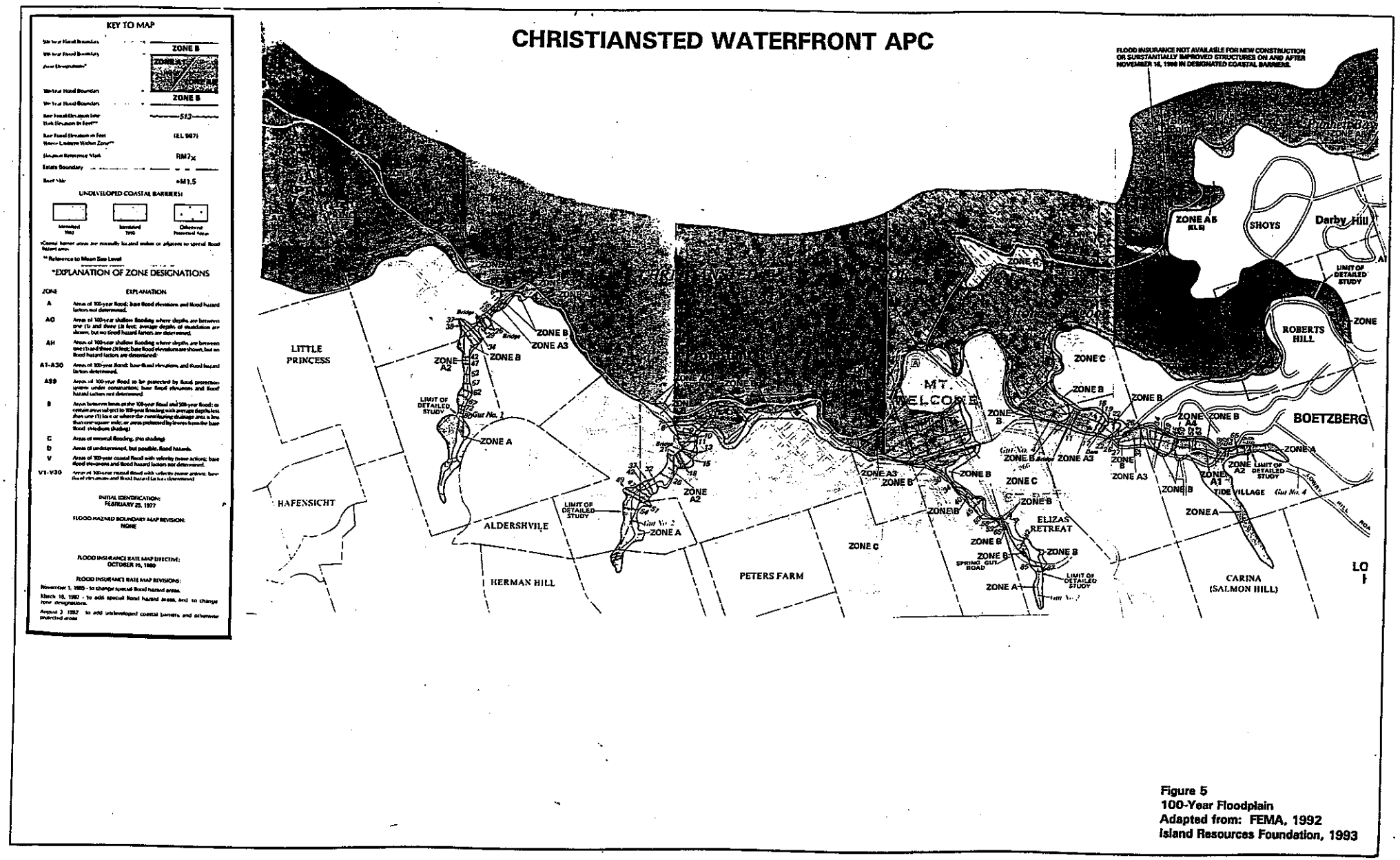
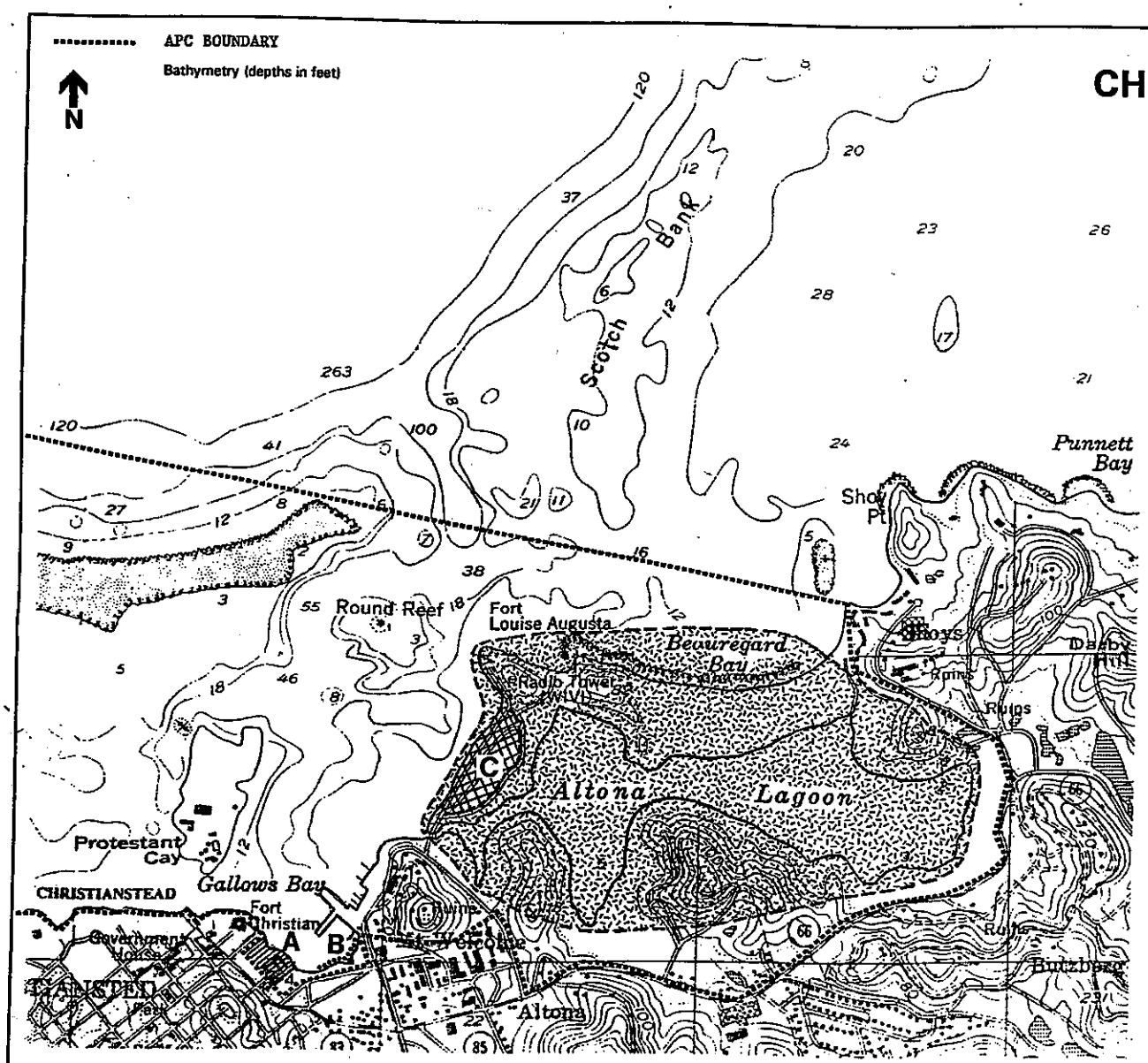


Figure 5
100-Year Floodplain
Adapted from: FEMA, 1992
Island Resources Foundation, 1993



CHRISTIANSTED WATERFRONT (East)

OPPORTUNITIES AND CONSTRAINTS

A Government yard: remove derelict storage tank and other debris.

B Public beach: remove derelict vessels; restrict or control beach use

C Altona beach park: improved parking recently added; add beaches, shelters, tables and restroom

Territorial Park potential

Figure 6a
Opportunities and Constraints (East)
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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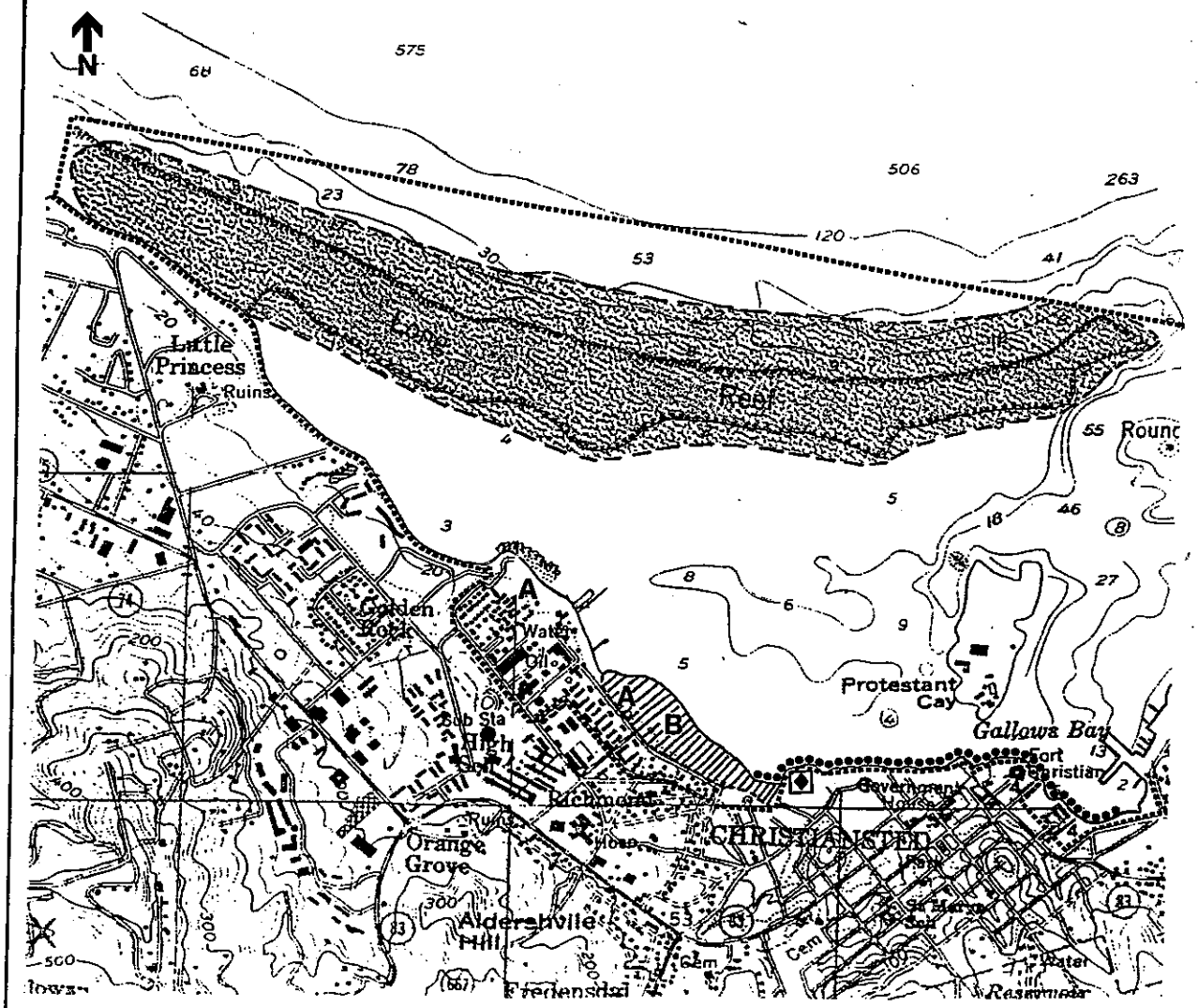
CHRISTIANSTED WATERFRONT (West)

APC BOUNDARY

Bathymetry (depths in feet)



OPPORTUNITIES AND CONSTRAINTS

A Public basketball courts; need repairs

B Westside Park:

1. restrict vehicular access
2. improve boat launch area, but restrict to one end of park or the other
3. remove derelict structure and derelict vessels along shorefront
4. provide trash receptacles
5. improve lighting
6. improve landscaping

Airboat terminal: valuable waterfront property in need of repair

●●●●● Improve waterfront pedestrian passageway; consider boardwalk, pedestrian access points, and amenities

Long Reef: preserve and protect; use as an environmental/resource management study area

Figure 6b
Opportunities and Constraints (West)
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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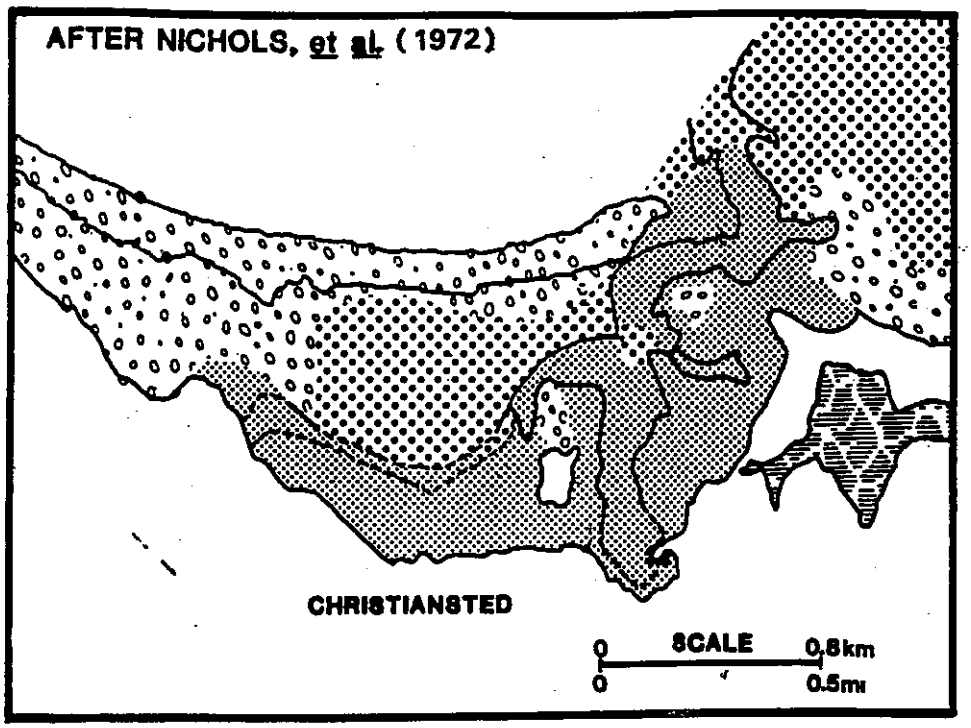
CHRISTIANSTED WATERFRONT APC



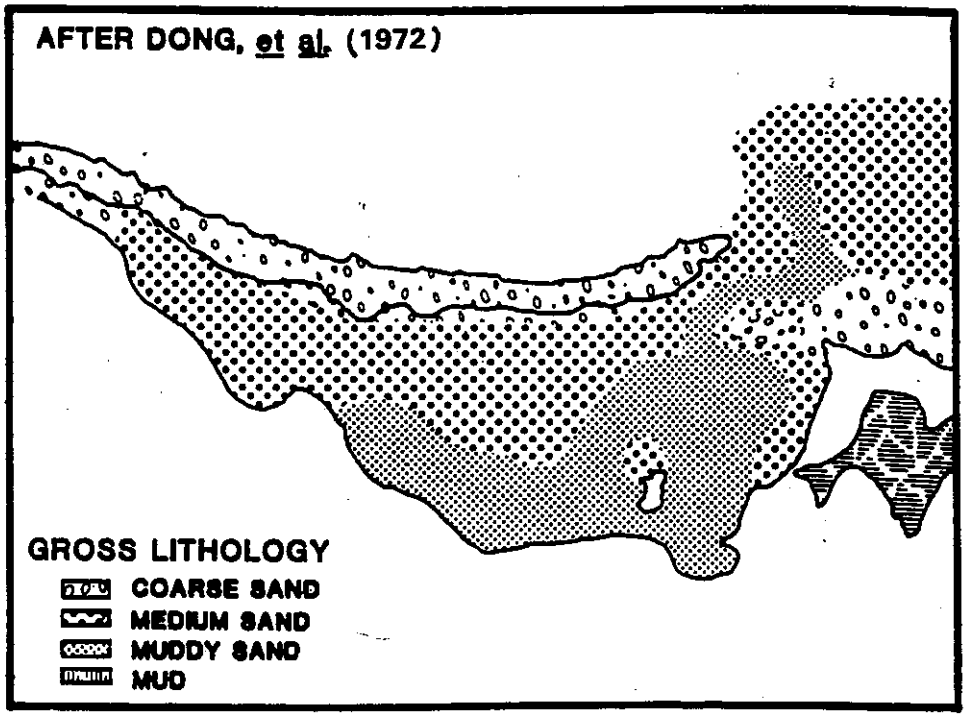


Figure 7
Harbor Lithology, 1972 Variations
Adapted from: VI Marine Advisors, 1986
Island Resources Foundation

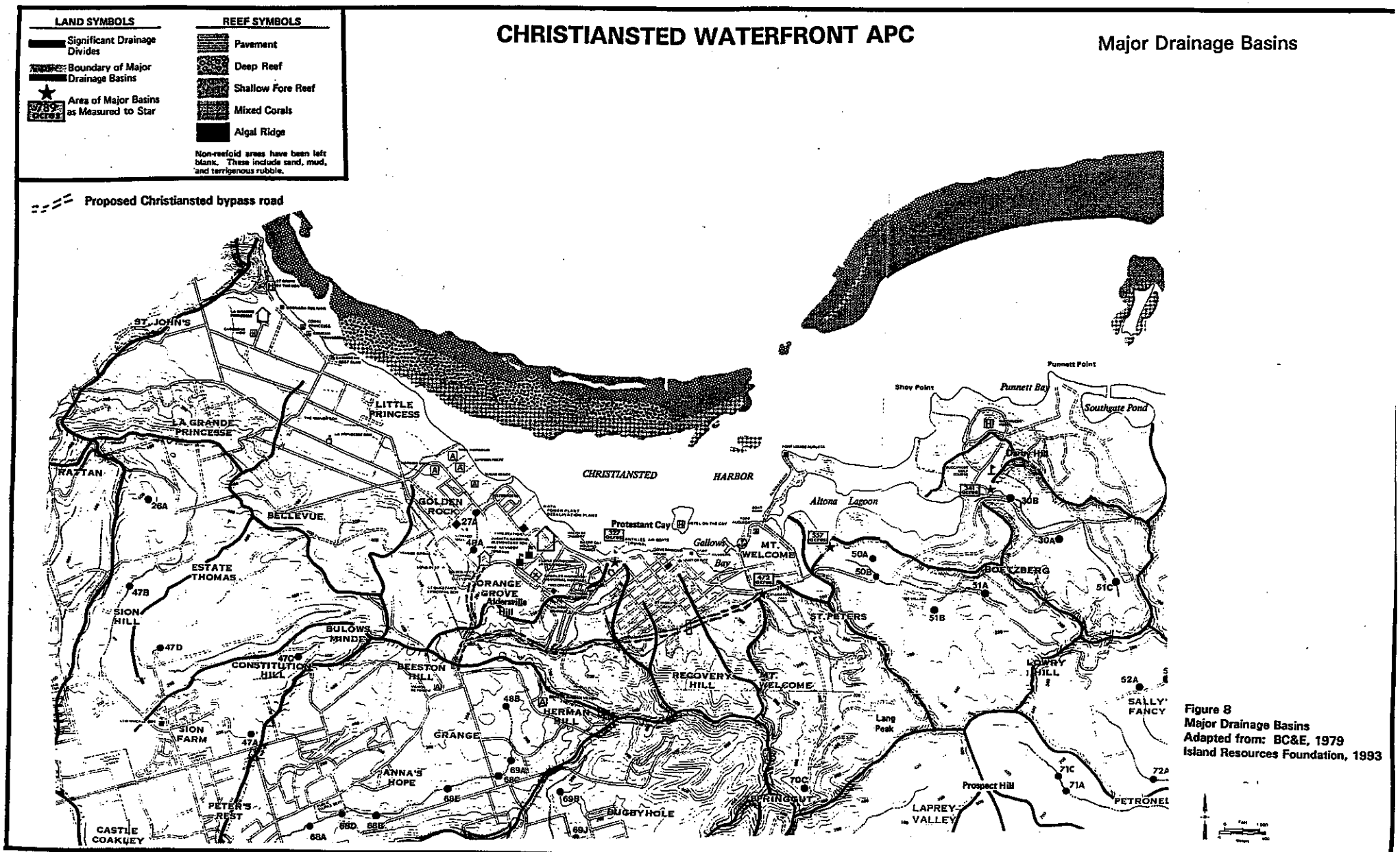
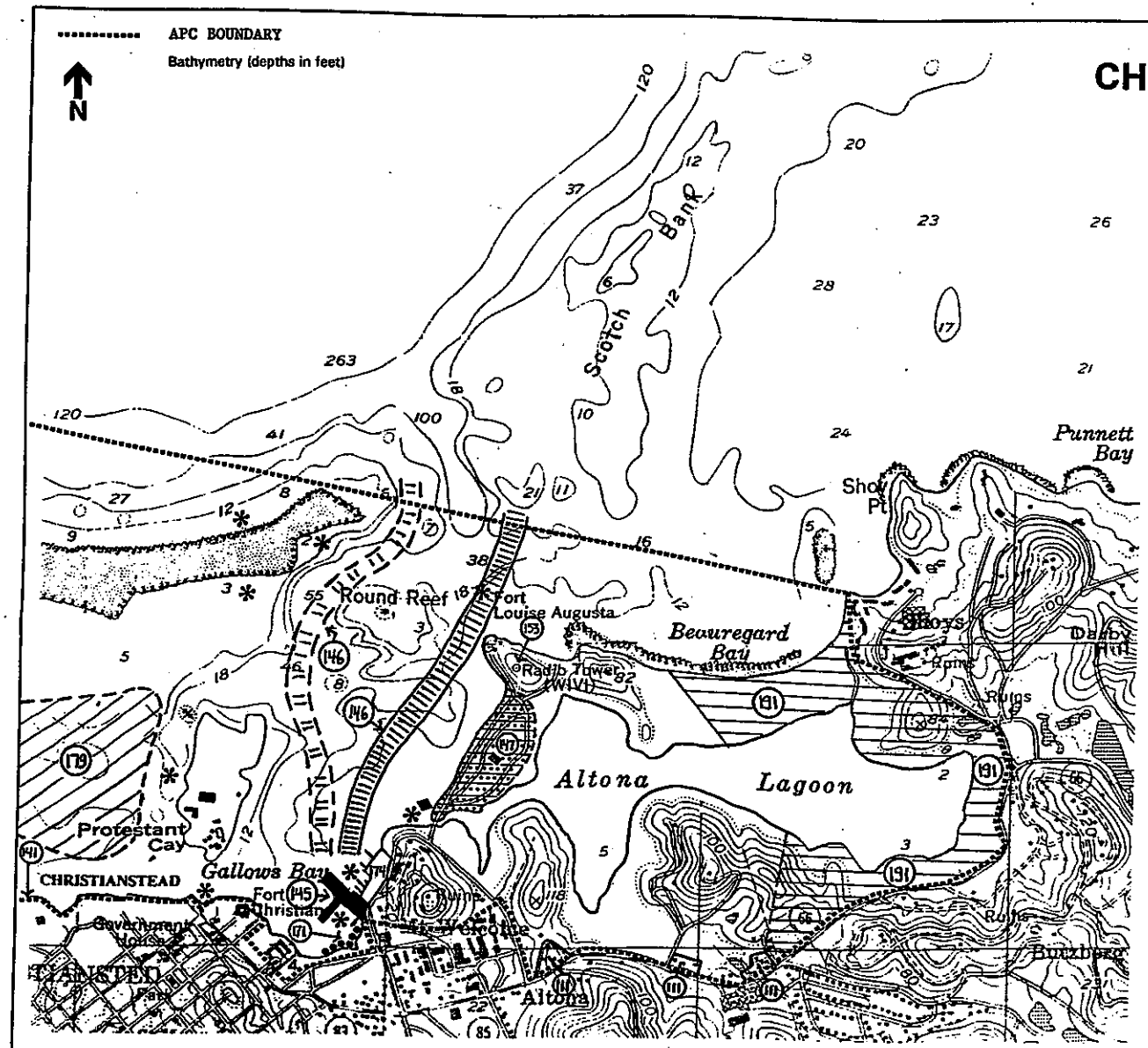


Figure 8
Major Drainage Basins
Adapted from: BC&E, 1979
Island Resources Foundation, 1993



CHRISTIANSTED WATERFRONT (East)

Figure 9a
LAND AND WATER USE

Residential

111 Single unit (low density)

Transportation

141 Sea plane terminal
145 Port facility (Port Authority commercial dock)
146 Navigable waterways
Old schooner channel
New schooner channel
147 Parking facility (parking for fishermen)

Communication

153 Radio tower (WSTX)

Recreational

171 Public beach ●●●●
174 Marina
179 Designated mooring area (fees collected)

Openland

191 Private, undeveloped land

Other

Dredge spoil area; parking for fishermen; park potential

◆ Fishing dock

✱ DPNR/DEP's Water monitoring stations

Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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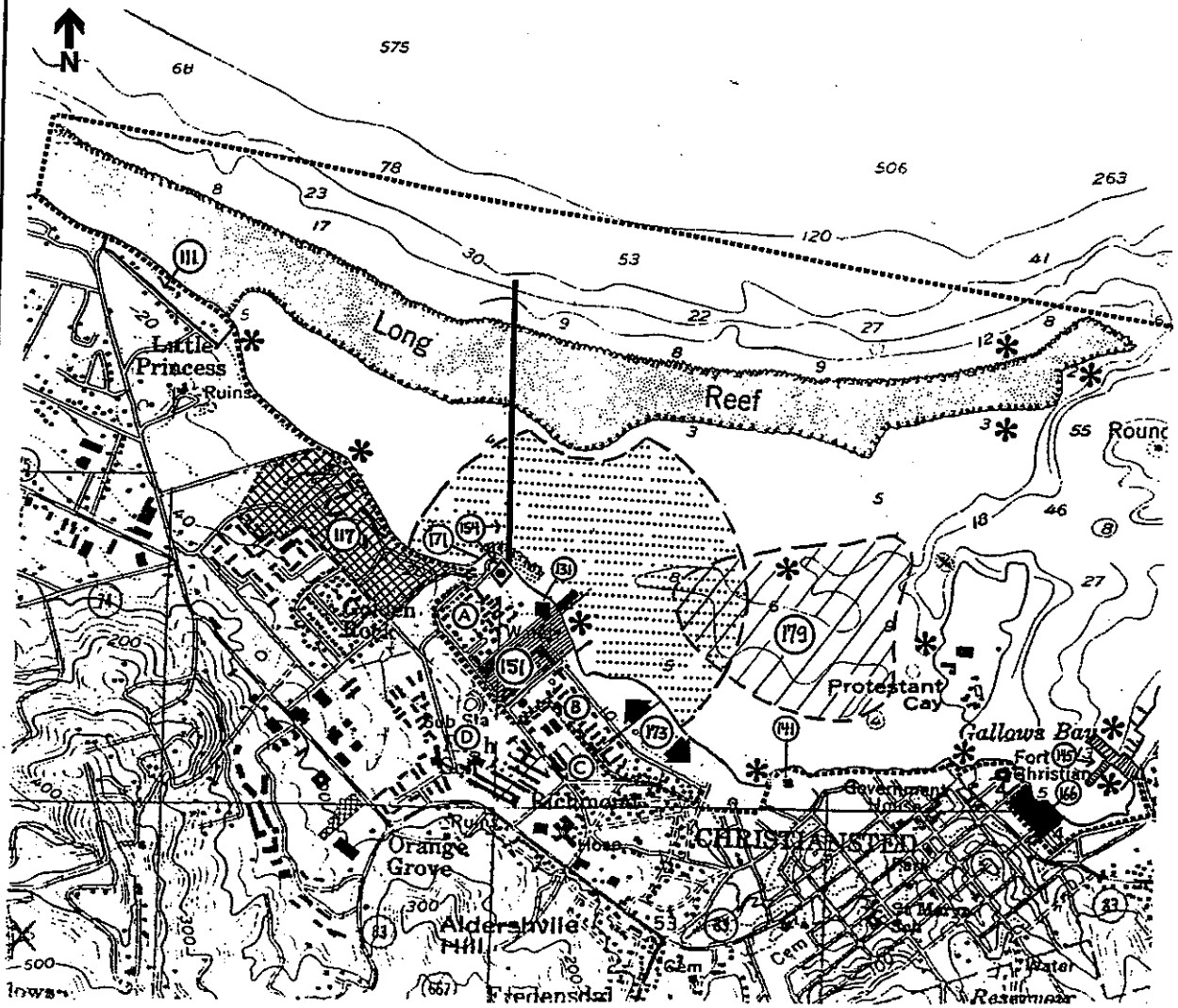

CHRISTIANSTED WATERFRONT (West)

Figure 9b
LAND AND WATER USE

Residential

111 Single units (low density)
116 Multiple dwelling "housing projects" (medium to high density)

(A) LBJ Gardens
(B) De Chabert
(C) Water Gut
(D) JFK Terrace

117 Multiple dwelling condominiums (high density)

Transportation

141 Sea plane terminal
145 Port facility (Port Authority commercial dock)

Industrial

131 Cement bagging plant

Utilities

151 WAPA power and desalination plants; new dock and outfall
Mixing zone boundary for WAPA's outfall
154 LBJ pump station and bypass outfall

Institutional

166 Government facility "Barrack's yard"; government offices/vessels

Recreational

171 Private dock; popular swimming/diving site for local residents
173 Westside Park
179 Designated mooring area

Others

* DPNR/DEP's water quality monitoring station

Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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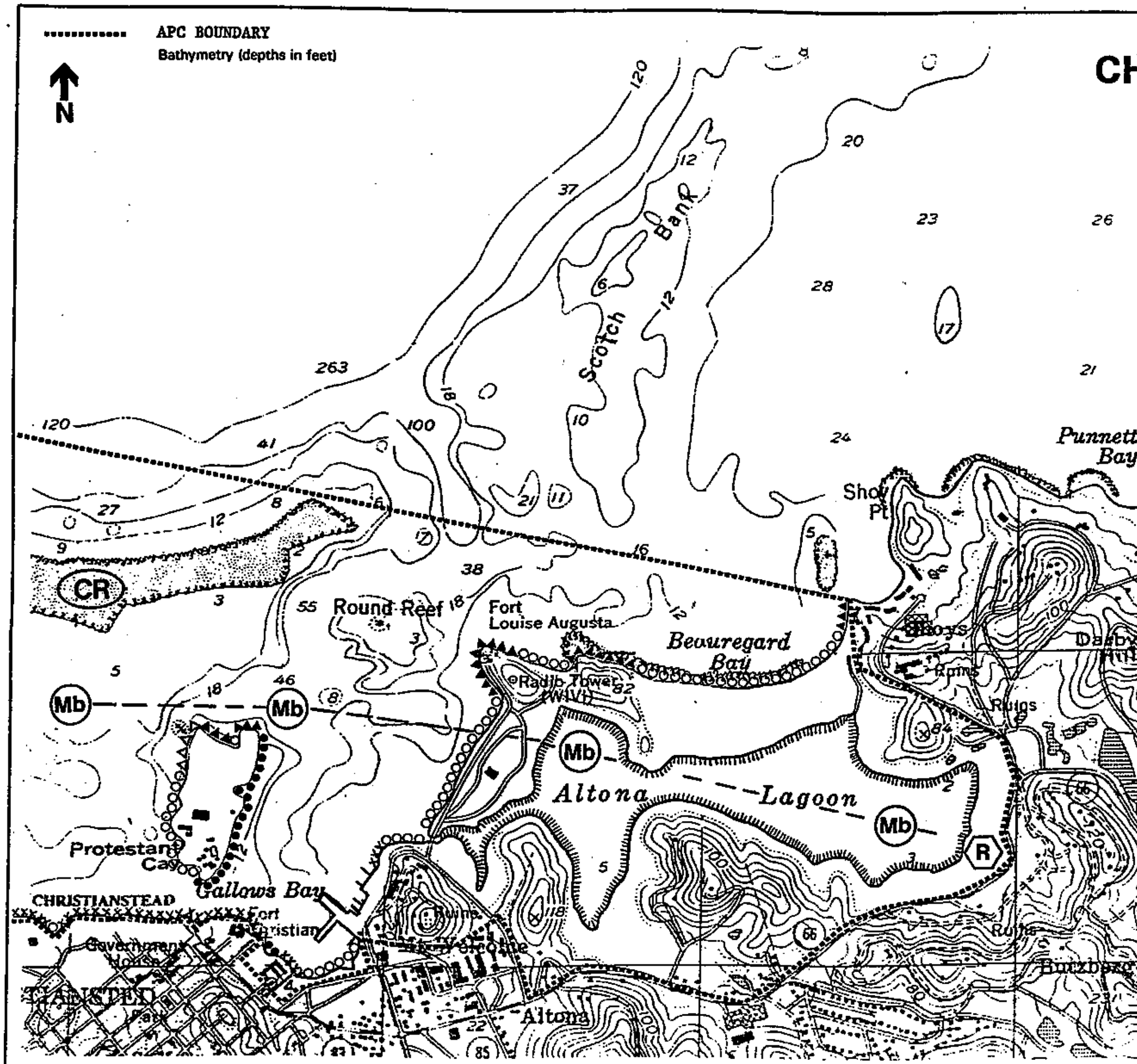

CHRISTIANSTED WATERFRONT (East)

PHYSICAL AND BIOLOGICAL RESOURCES

Physical Resources

- ▲▲▲ Exposed rocky shores and vertical seawalls
- OOO Fine-grained sand beaches
- ΔΔΔ Exposed gravel beaches and riprap
- ● ● ● Mixed sand and gravel beaches
- XXXX Sheltered coastal structures and rocky shores

Biological Resources

- Sheltered fringing mangroves
- (CR) Major coral reef community
- (Mb) Marine birds - roosting and/or nesting sites
- (R) Raptors - includes Osprey and Peregrine falcon

Figure 10a
Physical and Biological Resources (East)
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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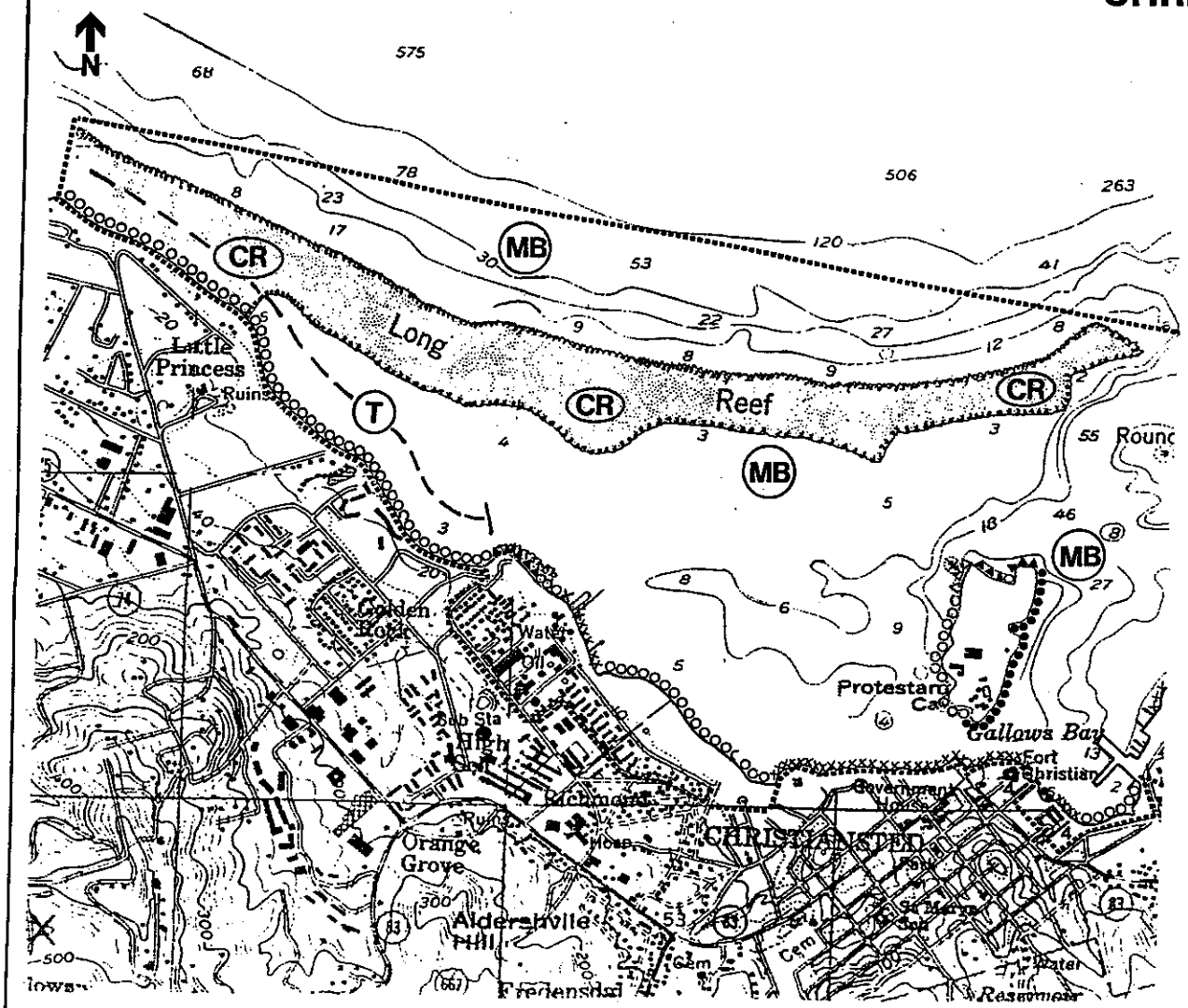
CHRISTIANSTED WATERFRONT (West)



PHYSICAL AND BIOLOGICAL RESOURCES

Physical Resources

- ▲▲▲ Exposed rocky shores and vertical seawalls
- OOO Fine-grained sand beaches
- △△△ Exposed gravel beaches and riprap
- ●●● Mixed sand and gravel beaches
- XXX Sheltered coastal structures and rocky shores

Biological Resources

- (CR) Major coral reef community
- (MB) Marine birds - foraging area
- (T) Sea turtle nesting area (Hawksbill)

Figure 10b
Physical and Biological Resources (West)
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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CHRISTIANSTED WATERFRONT APC

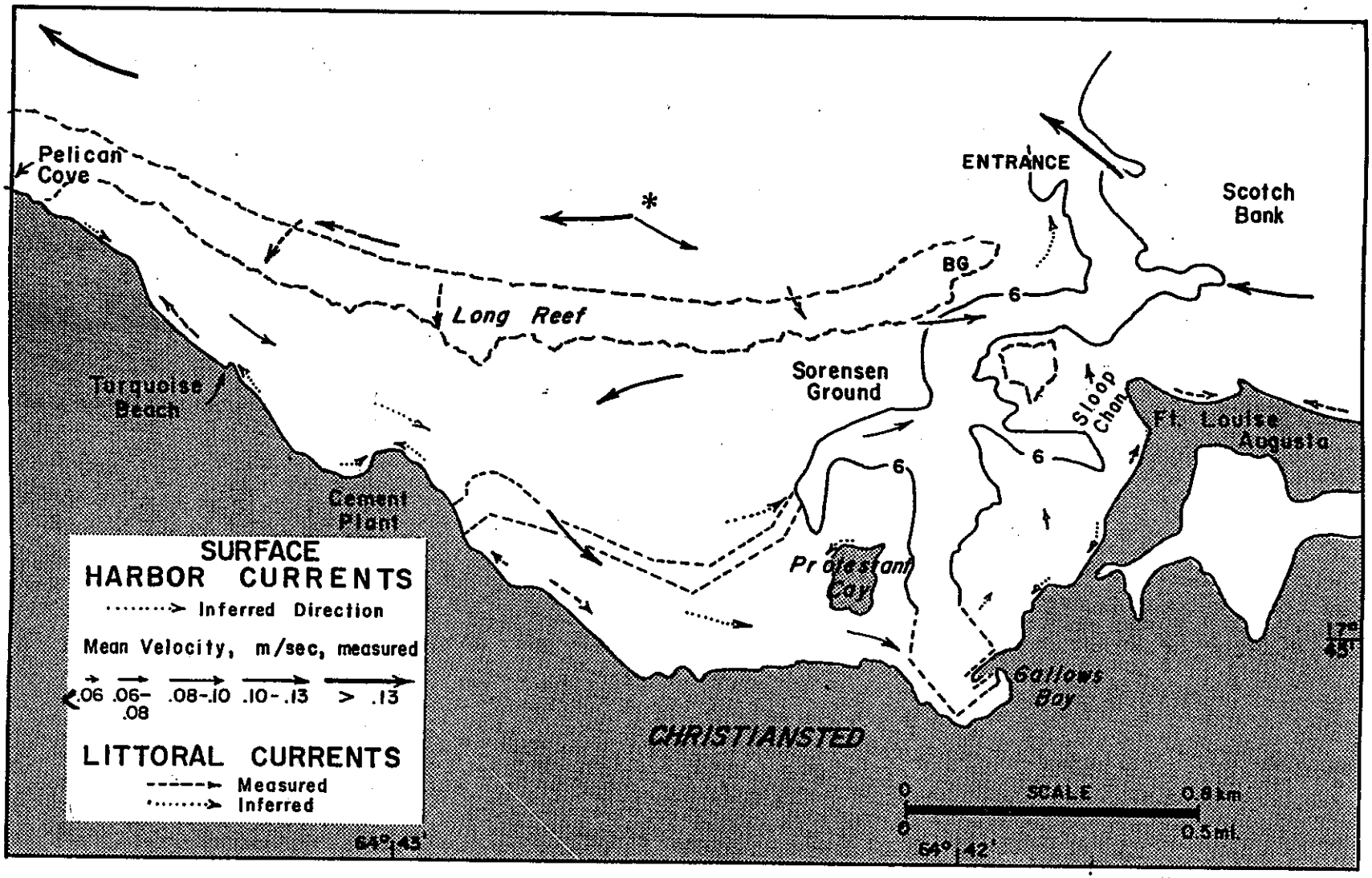


Figure 11
Surface/Littoral Currents
Adapted from: Caribbean Research Institute, 1972
Island Resources Foundation, 1993

CHRISTIANSTED WATERFRONT APC

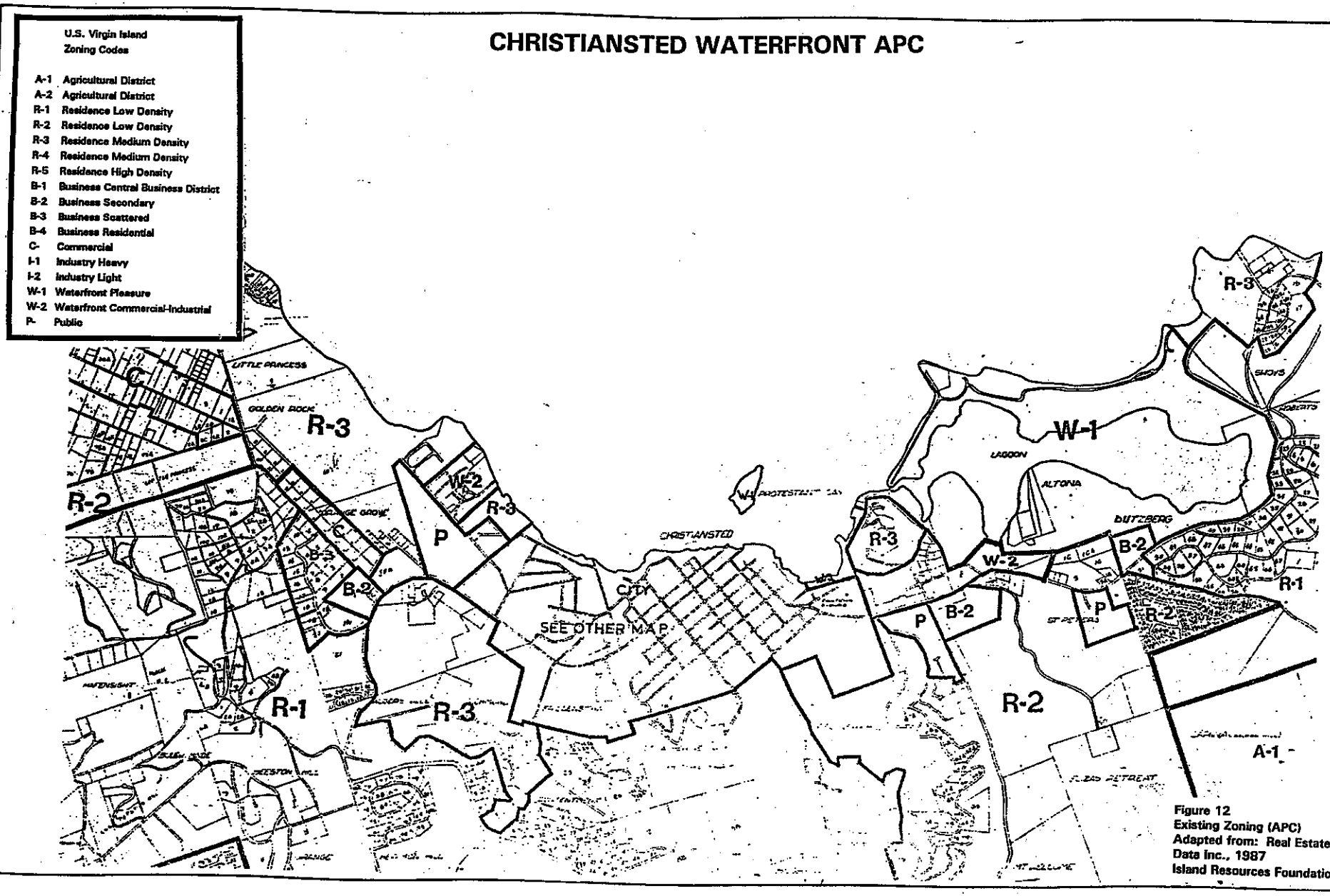
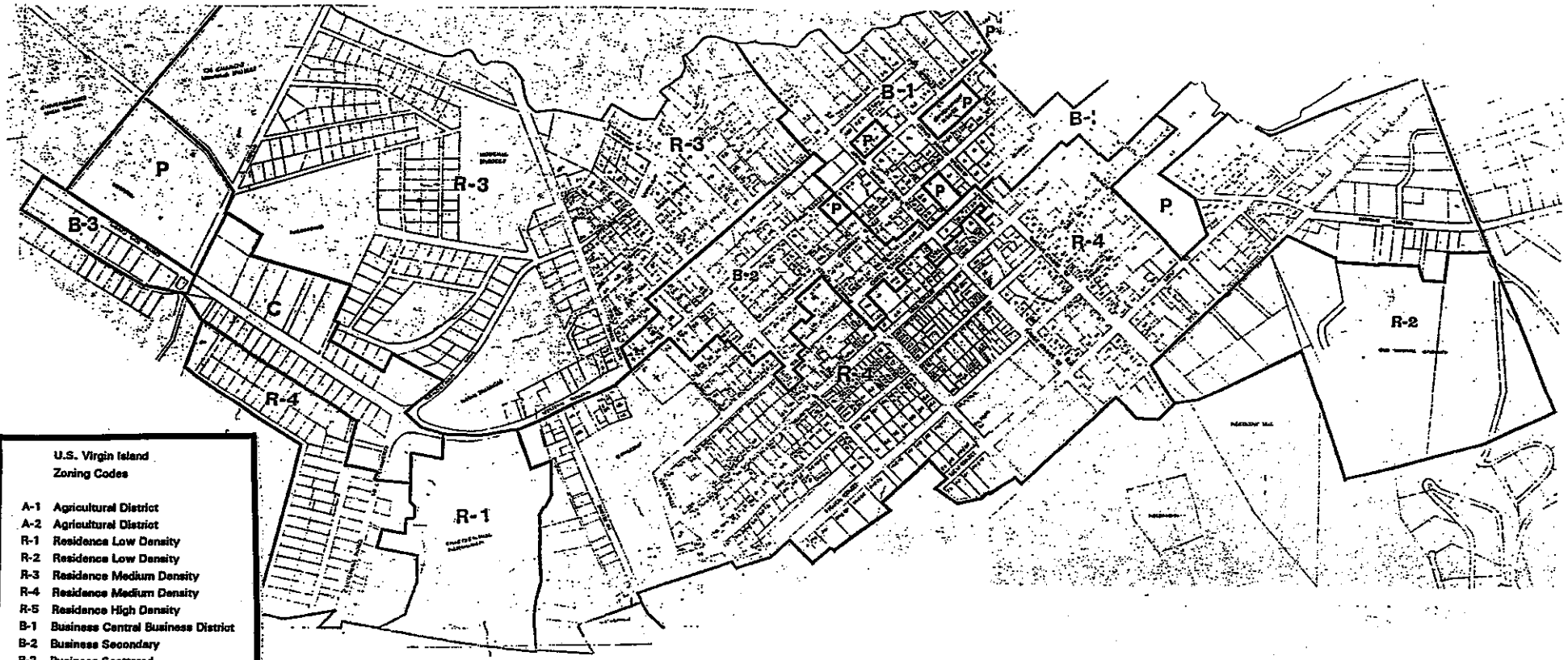


Figure 12
Existing Zoning (APC)
Adapted from: Real Estate Data Inc., 1987
Island Resources Foundation, 1993

CHRISTIANSTED WATERFRONT APC



U.S. Virgin Island
Zoning Codes

A-1	Agricultural District
A-2	Agricultural District
R-1	Residence Low Density
R-2	Residence Low Density
R-3	Residence Medium Density
R-4	Residence Medium Density
R-5	Residence High Density
B-1	Business Central Business District
B-2	Business Secondary
B-3	Business Scattered
B-4	Business Residential
C-	Commercial
I-1	Industry Heavy
I-2	Industry Light
W-1	Waterfront Pleasure
W-2	Waterfront Commercial-Industrial
P-	Public

Figure 13
Existing Zoning (Christiansted Town)
Adapted from: Real Estate
Data Inc., 1987
Island Resources Foundation, 1993