SALT RIVER BAY AND WATERSHED (APR) AREA OF PARTICULAR CONCERN (APC)

AND

AREA FOR PRESERVATION AND RESTORATION (APR)

A COMPREHENSIVE ANALYTIC STUDY

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

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SALT RIVER BAY WATERSHED
APC/APR *COMPREHENSIVE ANALYTIC STUDY*
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Area of Particular Concern	APC
Base Flood Elevation	BFE
Coastal Barriers Resource System	CBRS
Coastal Zone Management Act	CZMA
Coastal Zone Management Program	CZMP
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
Division of Comprehensive and Coastal Zone Planning	CCZP
Division of Environmental Protection	DEP
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1. INTRODUCTION

1.1 General

The Salt River Bay and watershed is one of 18 Areas of Particular Concern (APC's) designated by the Planning Office in 1979 after public nominations and comment had been received. Located approximately 4.5 miles northwest of Christiansted on St. Croix's north shore, Salt River Bay is one of the most significant treasures of natural, cultural, scientific, and recreational resources in the U.S. Virgin Islands (Figures 1 and 2). The bay sustains the largest remaining area of mangrove forest in the Territory (0.237 square miles), and provides critical nursery habitat for a variety of commercially and recreationally important marine organisms, including fish and crustacea. As many as 26 bird species nest in the mangroves, while many others use the habitat for resting or foraging on their annual migrations between North and South America. One of the nesting species is the locally endangered White-crowned Pigeon (*Columba leucocephala*). At least 17 of the 108 bird species found in the area are locally listed as endangered. Federally listed endangered species utilize resources of the Salt River APC as well, including all three sea turtle species found in the U.S. Virgin Islands.

The bay is comprised of an estuarine ecosystem which involves and depends on complex interactions between the terrestrial and marine environments. An estuary is generally defined as a semi-enclosed coastal body of water that is connected to the open sea, into which freshwater flows from upland drainage (NPS, 1990). Salinity levels in the back portions of the bays fluctuate both higher and lower than normal sea water salinity, a function related to the intermittent and at times intense and voluminous runoff which characterizes Salt River. Sediment composition and transport mechanisms have been studied in detail for the area, including the deep, submarine Salt River Canyon located immediately offshore. The canyon connects to the even deeper Christiansted Canyon to the east. Sediment runoff and transport through the estuary are important factors in the dynamic processes which affect the health and composition of the bay's biological communities.

Numerous scientific studies have focused on the bay and its many natural and cultural resources. Thus, much is known about the area's several different types of terrestrial and marine ecosystems, which include dry forests, mangrove fringe forest, mangrove gallery forest, salt pond, freshwater marsh, seagrass beds, algal plains, and coral reefs. Cultural evidence suggests almost continuous human habitation of the area for at least 1600 years, encompassing all major cultural periods of the Territory. Much additional research, however, is needed to answer the many perplexing questions which remain about the rise and fall, and social systems, of the different human groups that have lived there, including the Taino, Caribs, Dutch, African, French, Spanish, and English.

Salt River Bay has received several different designations which draw attention to the area's unique mix of resources. One of the most important sites within the area is the Columbus Landing Site, the only documented site where men from the explorer Christopher Columbus' party landed on what is now U.S. Territory. Columbus' men confronted and attacked Island Caribs on the east arm of the bay, at a site which he later named Cabo de las Flechas, or "Cape of the Arrows". In 1958, the V.I. Legislature authorized the purchase of 50 acres on the west arm of the bay which included the Columbus Landing Site, although no funds were appropriated. In 1961, the V.I. Government purchased five acres of the 50 acre site, which included the Columbus Landing Site, aboriginal artifacts and remains dating from A.D. 350, village, a ceremonial center and ball court (the only ceremonial ball court ever discovered in the Lesser Antilles), and a 17th century fort known as Fort Sale. National Historic Landmark status was given to the five acre site in 1965. This status is generally given to sites having a higher level of significance than that associated with sites on the National Register of Historic Places. In 1971, the Nature Conservancy received a donation of 12.5 acres on the east side of Salt River Bay, and established the Triton Bay Wildlife Sanctuary. And in 1980, National Natural Landmark status was given to a 690 acre portion of Salt River Bay and its shoreline.

A major event for Salt River Bay occurred on February 24, 1992 when President George Bush signed Public Law 102-247, establishing the 912 acre "Salt River Bay National Historical Park and Ecological Preserve" (hereinafter referred to as the "Salt River Park"). The action followed years of public and private efforts to secure protection for this immensely valuable area, and marks the beginning of what now must become a concerted, visionary drive to put into place an effective resource management framework to ensure that further degradation of the area does not occur.

On July 26th, 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 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 guide for a planning and management framework within which the various regulatory entities carry out their respective decision-making authorities.

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 Salt River Bay APC Comprehensive Analytic Study was prepared under the authority of the Coastal Zone Management Commission. The Comprehensive Analytic 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 Comprehensive Analytic Study will serve as a guide for establishment of a Management Plan and for future decisions concerning the area. Future development activity should be consistent with and comply with the Management Plan formulated for the area.

The intent of this Comprehensive Analytic Study and proposal for a Management Plan 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 Comprehensive Analytic Study and proposal for a 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 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 Study suggests 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 Study.

1.3 Historical Perspective and Overview

Pre-Columbus (A.D. 50-1490)

While our understanding of the history of the Salt River Basin is incomplete, evidence suggests prehistoric inhabitation by the Pre-Taino (A.D. 50-650), Taino (650-1425), and Carib (1425-1600) civilizations. Location of artifacts within the Salt River basin suggests that human settlements occurred throughout the lowlands and extending into adjacent hills encompassing present-day Sugar Bay, Triton Bay, Cabo de las Flechas, Judith's Fancy, and Columbus Landing Site (NPS, 1990).

Igneri (Pre-Taino) migrations through the Lesser Antilles from South America occurred approximately A.D. 50. Igneri established a large village in the Salt River basin during their migrations; they practiced agriculture as well as utilized the estuary for hunting and gathering. Archaeological evidence supports the conclusion that Pre-Taino civilization at Salt River basin underwent a cultural decline around A.D. 650. By 700, smaller, more numerous villages had replaced larger villages. The period from 700 to 1425 is marked by cultural distinctions from the Pre-Taino civilization and has been classified as the Taino civilization (Office of Archaeological Services, n.d.).

Island Caribs migrated from South America northward through the Lesser Antilles displacing and dominating the Taino civilization, including the people living in Salt River. Through enslavement and warfare, the Caribs established their civilization on St. Croix around 1400.

Columbus' Voyage (1493)

Sailing from Guadeloupe on his second voyage to the Americas, Christopher Columbus' seventeen-ship fleet reached Salt River Bay on November 14, 1493. Upon anchoring, Columbus ordered an armed excursion party ashore to explore a small Carib settlement on the west bank of the bay and "hold speech to find out what they [the inhabitants] were." A

confrontation between Spanish explorers and Caribs in a canoe resulted in the injury and deaths of several Caribs and Europeans. During Columbus' excursion at Salt River, he claimed St. Croix as a Spanish possession. However, the Carib "reception" coupled with the lack of mineral resources led Spanish colonial efforts to be directed towards other areas in the Western Caribbean.

Post Contact (1509-1600)

For 150 years following Columbus' excursion there was no effort at European settlement in Salt River; however, from 1509 to 1525 Spanish immigrants engaged in several campaigns against the Caribs. Thereafter, initial Spanish attempts to secure cooperation of the Caribs on St. Croix (including Christianization) in 1509 was undone by an illegal slaving expedition carried out by other Spaniards the same year. Carib retaliation was in turn repaid by enslavement and extermination through military intervention from San Juan. The Spanish efforts eventually forced Carib withdrawal from St. Croix by 1590 (NPS, 1990).

Colonial (1641-1917)

In 1641, English colonists from St. Christopher began settling the island. Dutch settlers laid claim to St. Croix in 1643, erected an eleven-cannon earthwork fortification on the west side of Salt River Bay, and subjugated the English colonists who lived there. In 1645, an English uprising forced Dutch settlers to return to St. Maarten and St. Eustatius. From 1645 to 1647, English settlers embarked on ambitious building and development of the area. Spanish records recognize the fort, a governor's house, a ministers' house, and four farms on the east side of the bay (NPS, 1990).

In 1647, responding to a challenge to Spanish claims on St. Croix, Spanish soldiers from Puerto Rico engaged the English colony and were repelled. A successful second attempt with five ships and 1200 men in 1650 by the Spanish killed 25 English colonists and expelled the remaining colonists. Upon English departure, the Dutch attempted to recolonize St. Croix in two ships, but were repelled by a Spanish force of 60 men at the fortification (NPS, 1990).

In 1650, French forces from St. Christopher under Phillipe de Poincy, Lieutenant Governor of the French West Indies, seized the island from the Spanish. In 1651, de Poincy purchased St. Croix; ownership of the island was later transferred to the Knights of Malta (Order of St. John of Jerusalem), whose titular master was King Louis XIV of France. By 1655, du Bois was appointed Governor; he worked to reverse local depopulation and impoverishing economic trends; the main settlement remained at Salt River.

By 1663, the Salt River settlement had enlarged to include a stone governor's house, governmental buildings, walkways, gardens, parks, a sugar factory, stables, other buildings

farther inland, and two plantations (one located on present day Estate Judith's Fancy). Fort Sale, indigo vats, and a Dominican monastery, sugar factory, and two plantations were locate on the west. International economic and political developments concomitant with epidemics led to a general decline in prosperity for the settlement beginning in the 1670's. French colonists relocated from the Salt River basin to Port St. Jean (Christiansted). The trend concluded with all of the 143 white colonists and 623 slaves forced to abandon St. Croix for St. Domingue in 1696 (NPS, 1990).

In 1733, the Danish West India and Guinea Company purchased St. Croix from France. All that remained from previous Salt River settlements consisted of ruins, exotic plants, and fera animals. Within fifteen years all of the flat land in St. Croix was under cultivation employin 64 small sugar factories, 122 cotton plantations, 120 sugar plantations, and 1900 African slaves (Lewisohn, 1970). However, the Danish West India and Guinea Company stifled growth by excessive taxes and monopolistic shipping regulations. This led to petitions to th Danish Crown from planters and merchants, which paved the way for the Crown's takeover 1755. In 1755, the Danish West India and Guinea Company sold its stock and all its holding on St. Croix to the Danish Crown. During the next sixty years, the sugar and rum industry on St. Croix prospered, rivaling sugar production on Jamaica and Barbados. Several sugar plantations were situated in the Salt River basin.

By the 1820's, St. Croix's sugar industry was in decline due to several epidemics, hurricane damage, and the discovery and production elsewhere of sugar from sugar beets. Economic decline spurred by dramatic drops in sugar prices, excessive debt, emancipation of slaves, ar futures speculation continued until the early twentieth century. Concomitant with the economic hardships was emigration and population decline of the island. For a more detail account of this period, see Florence Lewisohn's work, *St. Croix Under Seven Flags*.

Salt River basin gradually assumed less significance with the growth of Christiansted and Frederiksted ports, as well as St. Croix's diminishing importance in the sugar market. In 1867, 1902 and 1916, the United States attempted to purchase the Danish West Indies; negotiations were concluded in 1917.

From 1917 to 1957 little change took place in the Salt River basin. The area remained divided among several large estates.

In 1958, the V.I. Legislature authorized the purchase of 50 acres at Columbus Landing Site. but, unfortunately, no funds were appropriated for land acquisition. Five acres were purchased in 1961. In July of 1988, Governor Farrelly signed a Memorandum of Agreemer with the National Park Service to conduct an alternatives study and to begin a planning process to establish a National-Territorial Park. After the Alternatives Study was completed (NPS, 1990), the Virgin Islands Delegate to Congress drafted and introduced legislation to

authorize the creation of a Salt River Bay Park. On February 24, 1992, the "Salt River Bay National Historical Park and Ecological Preserve" was officially created, signed into law as Public Law 102-247.

1.4 Other Classifications

In 1961, *National Historic Landmark* status was given to the five-acre Columbus Landing Site under Section 110 of the National Historic Preservation Act (P.L. 899-665) [Figure 3].

Comprising the southeast arm of Salt River Bay, the 12.5 acre *Triton Bay Wildlife Sanctuary* was established in 1971 by The Nature Conservancy. The land was a gift from John B. Faile of St. Croix, and consists of approximately 4.5 acres of mangrove forest and salt flat, plus about 8 acres of dry forest. It is also known as the *Triton Bay Rookery Preserve*.

With the adoption of the Coastal Zone Management (CZM) Program in 1979, the "Salt River Bay Complex" was identified as a potential *Significant Natural Area* (SNA) [Teytaud, 1980]. The exact boundary of the proposed SNA site is not clear, but it is believed that the designation was meant to include, as a minimum, the bay itself, all adjacent wetlands, and the Salt River submarine canyon.

The Coastal Zone Management Act (CZMA) makes frequent references to SNAs which itdefines as "... land and/or water areas within the coastal zone of major environmental value, including fish or wildlife habitat areas, valuable biological or natural productivity areas, and unique or fragile coastal ecological units or ecosystems which require special treatment and protection." The territorial CZM Program further elaborates the concept by adding the categories of:

1. natural areas that provide scientific and educational value;
2. areas necessary for nesting, spawning, rearing of young, or resting during migration; and
3. areas needed to protect, maintain, or replenish coastal lands and resources (Teytaud, 1980).

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

In February 1980, a 690-acre portion of Salt River Bay was designated as one of five *National Natural Landmarks* for the U.S. Virgin Islands included in the National Registry of Natural Landmarks. National Natural Landmarks are areas determined to possess national significance illustrating the natural heritage of the United States and Territories. Candidate

sites must be approved by the Secretary of the Department of Interior. Formal designation c a National Natural Landmark does not affect ownership, but is intended to encourage owners to employ sound conservation practices in the use, management, and protection of the designated area.

The 1960 Park and Recreation Area Plan for the Virgin Islands identifies one site, the *Greig Hill-Columbus Site*, as one having national historical significance and worthy of public acces improvements. The study identified an 80-acre tract, including and adjacent to the now designated 5-acre Columbus Landing Site, and called for recreational amenities "primarily passive in nature". Such features as an entrance portal and road, parking area, overlook foot trails, orientation-information shelter with comfort facilities, and limited picnic appurtenances were identified in the early study. In general, the study called for "national development an control with a balance between interpretation of an historical theme and controlled recreation development" (USDOI, 1960).

The 1981 Virgin Islands Park System Study offers general discussion of the technical criteria for selecting various types of sites to be included in a Territorial Park System (Alexander, 1981). The Study discusses Salt River Bay as a good candidate for inclusion in a Territorial Park System.

In 1990-91, the Island Resources Foundation undertook a post-Hurricane Hugo damage assessment of coastal areas in conjunction with a survey of selected sites for the Territorial Park System. Detailed field surveys were conducted within the Salt River Bay area. Human and hurricane-related impacts were recorded and both short- and long-term management recommendations offered. The study also offers preliminary recommendations for the development of park amenities at two locations.

On February 24, 1992, Public Law 102-247 was signed by President Bush, establishing the *Salt River Bay National Historical Park and Ecological Preserve*. The action was the culmination of several years of efforts by a number of individuals and public interest groups wishing to obtain park status for the Salt River estuary.

Public Law 102-247 did not include appropriated funds to purchase the approximately 300 acres of private fast lands within the authorized park boundary, but did mandate that the park is to be co-managed by the V.I. Government and the Federal Government (i.e., Department o the Interior, National Park Service). It provided that a 10-member Park Commission would be responsible for advising the Secretary of the Interior in the drafting of a General Management Plan (GMP) to guide the development and administration of the park.

Salt River Bay, its entire shoreline, and a major portion of the Salt River channel, are situated within a designated *100-year floodplain* (section 2.3.3) [Figure 4]. A-zones, B-zones, and V-zones are identified.

One site within the APC is included in the Federal *Coastal Barrier Resources System* (CBRS): Salt River Bay (site VI-01A) [Figure 5]. 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 (i.e., flooding, hurricanes, etc.);
2. To stop wasteful federal expenditures in these areas; and
3. To protect valuable natural resources from being destroyed by unwise economic development.

In addition to the above, Salt River Bay:

- has been the focus of much discussion concerning its significance and eligibility for nomination as a *World Heritage Site* (section 4.1);
- was identified by the U.S. Fish and Wildlife Service as a *potential National Wildlife Refuge;*
- was identified by the National Trust for Historic Preservation as *one of the 11 most endangered sites in the United States and Territories* (1990);
- was *included* in the Department of the Interior's *National Inventory of Critical Wetlands;*
- was *included* in the *Directory of Neotropical Wetlands*, and identified as a "priority area for protection";
- was *proposed* by the National Oceanic and Atmospheric Administration as a *National* Marine Sanctuary (along with the submarine canyon); and
- is the *only one* of over 2300 landmarks nationwide that *carries the joint designation of National Natural Landmark and National Historic Landmark.*

2. DESCRIPTION OF THE SITE

2.1 APC Boundary

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

> *Beginning at the northern-most point in Estate Judith's Fancy on the eastern shore of the entrance to Salt River Bay, the boundary encompasses the entire watershed of Salt River Bay, extending along the outer perimeter of the watershed to the highest elevation on Greig Hill; then the boundary extends in a straight line in a north-northeasterly direction to the highest elevation of the neighboring hill and continues in a straight line to the shoreline; then extends north to the outer shelf edge; then east along the shelf edge to a point directly north of the northern-most point in Estate Judith's Fancy; then south to the northern-most point in Estate Judith's Fancy, the point of origin.*

2.2 Ownership Summary

The majority of land within the APC is privately owned, with individual residences, smal subdivisions, and commercial retail or service sector businesses scattered throughout. Wi the Salt River Park boundary, several large parcels and groups of parcels are owned by various development corporations (Figure 6).

One of these is the 74.5-acre site of the proposed Virgin Grand Hotel (section 3.1). The located at Estates Judith's Fancy, is proposed for development by Sugar Bay Land Development Ltd. (a subsidiary of the Allen-Williams Corporation). Prior to the Sugar B Land Development Ltd. purchase of the land in 1985, the Government had settled with R Consulting Corporation to quiet title to some disputed reclaimed lands, by agreeing to exchange two acres of reclaimed land for approximately 41 acres of land at the headwate Triton Bay. The deed transferring the property to the Government of the Virgin Islands been executed and recorded and the Government, at present, is the record owner of two parcels of land at the head of Triton Bay.

There is a pending action by Sugar Bay Development Ltd. for access to its property. Su Bay Development Ltd. claims that the Government is obligated to obtain and provide acc to the site and filed suit in 1992 against the Government to obtain this access. This matt still under litigation. Until this question of access is determined, it remains virtually impossible for the developer to commence construction. (The developer asked the CZM Committee to allow it access by water in order to commence construction; this request w denied.)

The Nature Conservancy, a nonprofit, land trust organization dedicated to conserving ecologically important areas, owns the previously mentioned 12.5 acre Triton Bay Wildlife Sanctuary.

In addition to the approximately 41 acres at the head of Triton Bay, the V.I. Government owns a five acre parcel at Columbus Landing Site, which it purchased in 1961. All submerged lands that can be demonstrated to be tidally influenced are, by statute, government owned, including the bay itself and beachfront areas below the Mean High Water Mark.

2.3 Physical Environment

2.3.1 Climate

Rainfall in the Virgin Islands generally increases with increasing elevation and exhibits a trend on each island of a dry-to-wet from the east-to-west related to land elevations. 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 Salt River Bay receives 35-45 (average about 40) inches of rainfall per year. The western hills of the Salt River watershed receive slightly more. Estate Annaly, the wettest area of the island, 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° (degrees) Fahrenheit, with the winter low averaging 76° F and the summer high reaching an average of 84° F.

The Virgin Islands lie in the "easterlies" or "trade winds" which traverse the southern part of the "Bermuda" high pressure area; predominant winds are thus from the east-northeast and east (Island Resources Foundation, 1977). Trade winds average about 15 to 20 knots and vary seasonally, but most significantly during the late summer months when tropical depressions may form resulting in storms and/or hurricanes. 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 thus sedimentary, formed by debris from eroding volcanic rocks (Whetten, 1974). Two predominant mountain ranges exist (the Northside Range and the End Range), separated by a central sediment-filled valley. It was believed that the two ra used to be distinct islands, separated by a submerged lagoon, which during a later period uplifting formed the present valley and single island of St. Croix (see for example, Multe *al.*, 1977). More recent investigations (see for example, Gill, 1990), indicate that the isla may have always existed as a single island.

Gerhard and Bowman (1975) describe the underlying geology of the Salt River watershec comprised of two formations (Figure 7). "Most of the drainage basin is underlain by th Miocene Kingshill Marl, which appears to be lithologically transitional with the underlyir Jealousy Formation (Oligocene). The remainder of the drainage basin and exposed shore bedrock is Cretaceous Judith Fancy Formation. The Kingshill Marl and Jealousy Formati are mostly limestone with some clays and fine-grained clastics in the Salt River drainage the Judith Fancy Formation is a mixture of volcaniclastics, sandstone, mudstone, and containing a few small intrusive bodies, mostly dioritic or gabbroic."

There are three principal soil associations in the watershed. The eastern portion of the A is in the Aguilita-Fredensborg-Sion Association; the western portion of the APC is in the Descalabrado-Jacana Association; and alluvial soils are found in the central portion of th watershed belonging to the Fraternidad-Aguirre-Glynn Association (Rivera, *et al.*, 1970). majority of the soils within the APC are classified by the Soil Conservation Service (SCS having severe limitations for residences with individual septic tanks (McKinzie, *et al.*, 19

Sediments in Salt River Bay range from primarily fine-grained terrigenous sediments in t upper reaches of the estuary, to largely reef-derived carbonate sediments in the outer bay submarine canyon. The canyon diverts both terrestrial and carbonate sediments into the meter deep basin north of St. Croix (Hubbard, 1989).

Historical Seismicity in the USVI

As a result of convergence between the Caribbean and North American tectonic plates, th Virgin Islands are located in one of the most earthquake prone regions of the world. Du the past 450 years, damage has occurred from earthquakes and associated tsunamis. Stro 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) [US 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 vulnerable to impacts from earthquakes due to substantial construction on recently filled (reclaimed) land. Presumably this would be the case as well for construction on reclaimed lands in the Salt River Bay area. 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

The Salt River watershed, the second largest on St. Croix, drains an area of approximately 2880 acres (4 square miles) via the principal gut, Salt River, whose headwaters originate in the Northside Range; two smaller watersheds drain directly into the bay or the coast (Figure 8). Topography in the watershed is varied, and ranges from near flat land behind the mouth of Salt River to steep slopes in both the western and eastern portions of the watershed. Salt River is today an intermittent stream, although there is historical evidence that it was once a greater and more permanent source of freshwater discharge into Salt River Bay (Hubbard, 1989). Salt River Bay itself is comprised of three embayments: Sugar Bay, Salt River Bay, and Triton Bay.

The hydrology of the watershed has been significantly altered by a combination of clearing, filling, channelization, and road construction. The cumulative effect of such change has been both a reduction in the frequency of fluvial activity in Salt River, and an increase in stormwater carried sediments which discharge into the bay during episodic, intense rainfall events. The steep slopes combined with poorly drained soils result in short saturation times and relatively high runoff rates. Flash floods with flows of high velocity are not uncommon (NPS, 1990). Measurable and predictable changes in salinity and turbidity levels are a result,

with subsequent impacts on the composition and health of fauna and flora in and adjacent Salt River Bay (sections 2.3 and 2.4).

The entire shoreline and a significant portion of the Salt River basin lies within a 100-year and 500-year floodplain containing A-zones, B-zones, and V-zones (Figure 4). A-zones a in general, comprised of 100-year riverine floodplains. B-zones are areas between limits o 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 o square mile; or areas protected by levees from the base flood (FEMA, 1992a and 1992b). zones are areas of 100-year coastal flood activity with velocity (wave) action, within whic base flood elevations (BFE) of five feet have been determined.

Groundwater resources are significant within the Salt River watershed. The area contains three of the major groundwater areas of the island, and potential yields of as much as 15,(gallons per day (GPD) in the lower parts of the valley (above the mouth of Salt River Ba have been identified (NPS, 1990 as from Jordan, 1975). Teytaud (1981) reports an impor groundwater well field at Estate Concordia, adjacent to Salt River, and a potentially good field on the property of the Columbus Bay Marina at Estate Morning Star. Significant bc of sand and gravel alluvium can be found within the Salt River basin, capable of produci 10 to 50 gallons per minute (GPM) of groundwater (NPS, 1990).

2.3.4 Coastal Environment

Using Nichols and Kuo's bay closure index (1979), Salt River Bay is a partly-closed embayment, protected from the sea by a barrier reef with a natural channel opening. Por of the estuary, especially the back waters of Sugar Bay and Triton Bay, may function mo like a closed embayment however, due to poor flushing and the wave dissipating effect o barrier reef. Carbonate sands produced from the reef form a sill 5-7 feet deep (Figure 9) which further restricts water exchange. The sill, although at times a navigational hazard, an important feature in the bay's sediment filtration/depositional processes.

The relatively poor flushing capacity leaves the back waters of the estuary especially vulnerable to pollution effects, even more so since these same areas can experience extre salinity fluctuations as a result of intense, rapid stormwater discharge. A mass mortality mangrove-associated marine organisms in November 1974 was attributed to depressed sa levels (Teytaud, 1981 as from Forbes, 1975). Salinities of 29 parts per thousand (ppt) w recorded for the head of Sugar Bay during a rainy period in January 1976 (Schaefer and Tatnum, 1976 as from Hubbard, 1989). During most of the year, however, salinity leve range from 33-36 ppt; thus, in a strict sense, the bay is more properly classified as "restr marine" rather than "estuary" (Hubbard, 1989).

Tides within the bay are diurnal, with a tidal range of about 38 cm (1.25-feet) and an average of one foot (Teytaud, 1981). Hubbard (1989) indicates that water levels within the estuary can be elevated as much as 30 cm (1.0-foot) for brief periods during storms due to large waves breaking over the reef. Immediately after such events, strong currents rip through the channel opening, returning water to the sea and carrying sediments and organic material into the submarine canyon. In general, currents in Salt River Bay are driven by wind, waves, and, to a lesser extent, tides (see Hubbard 1989 for current diagrams). Currents off the north shore of St. Croix average 0.7 knot and most typically flow to the west, although reversals are known to occur.

Dredging and filling of Salt River Bay has considerably altered the natural shoreline configuration (Figure 10b). Such human activities include the following:

1. extensive dredging and filling (c. 1968) on the east side of the bay to construct a boat basin, boat ramp, and marina; the marina project was never completed due to conflicts with the V.I. Government over ownership of reclaimed lands and due to the absence of relevant U.S. Army Corps of Engineers (USACOE) permits;
2. dredging of a canal on the east side of Triton Bay, north of the Triton Bay Wildlife Sanctuary; this was part of the same marina development;
3. dredging in the extreme southern reach of Triton Bay (c. 1975) to create a small boat basin; the project was later abandoned;
4. dredging of a channel through a sand bar across the mouth of Triton Bay (1960's) to provide access to the NOAA Hydrolab base bulkhead; and
5. dredging on the west arm of Sugar Bay (c. 1973) to construct a marina; the project was later abandoned.

Salt River Canyon

Salt River Canyon is one of two deep, marine canyons on the north side of St. Croix (Figure 9). The canyon extends seaward from the reef enclosing Salt River Bay. It begins at a depth of 5 meters, and extends along the shelf in a northerly direction until it reaches depths of approximately 90 meters (295 feet). From there, the canyon floor falls precipitously to basin depths of 5000 meters (16,400 feet) (Hubbard, *et al.*, 1981).

Hubbard, *et al.* (1981) describe the geomorphology of the east and west canyon walls. The west wall is steep and often vertical, with caves and overhangs in some places. Sediment is transported into the canyon by vertical grooves and side tributaries cut into the wall. By contrast, the east wall is characterized by alternating zones of near-vertical rock wall and cobble-filled side tributaries. On the seaward edge, vertical walls dominate. Hubbard, *et al.* (1981) also provide a detailed description of sediment transport rates and processes within and

adjacent to the canyon. In general, strong downward currents flowing through the canyon a typical, along with large scale, down-canyon transport of carbonate and terrigenous sedimen

2.4 Biological Environment

As pointed out in the Alternatives Study (NPS, 1990), the Salt River area has been the subj of numerous, mostly uncoordinated, scientific research efforts.. The National Underwater Research Center operated a manned underwater habitat in the Salt River Canyon for approximately 10 years; the West Indies Laboratory of the Fairleigh Dickinson University located a branch of its research station in Triton Bay; and numerous private and governmer studies have variously described the fauna and flora of the area. This section provides a sketch of the biological resources as synthesized from various sources, and principally fron the above mentioned Alternatives Study, the most recent, systematic effort to describe the area's biological resources. Figure 9 depicts the principal physical and biological features the Salt River Bay APC.

2.4.1 Terrestrial

Gerhard and Bowman (1975) suggest that the entire shoreline of Salt River Bay was once fringed with mangroves prior to the arrival of Europeans. Today, Red Mangroves *(Rhizophora mangle)* can be found along the shores of Sugar Bay and Triton Bay, and mu of the west side of Salt River Bay. Behind the *Rhizophora*, a band of Black Mangroves *(Avicennia germinans)* and White Mangroves *(Laguncularia racemosa)* can be found in m places. Prior to Hurricane Hugo in September 1989, there had not been a major hurricane hit St. Croix for more than 60 years; thus, the area contained a number of old growth mangroves with closed canopies and heights to 6 meters or more. Many of the old growt trees were, however, destroyed or damaged in the hurricane (pers. comm., W. Tobias, DPNR/DFW). Although loss of the canopy has presumably affected the food chain throu major reduction in mangrove leaf litter, the dead trees serve some of the same important functions of live trees. Additionally, when the trees fall into the water, they increase the of shelter for fish. As of April 1993, mangrove recovery had progressed steadily. Altho recovery of the interior part of the mangrove stands is slow, much new growth of Red mangroves is evident along the perimeter of the bay.

Scattered throughout the *Laguncularia* and moving landward, a variety of trees typical o many coastal environments on St. Croix can be found, including Buttonwood *(Conocarpi erectus)*, Manchineel *(Hippomane mancinella)*, Acacia *(Acacia tortuosa)*, and Tan-Tan *(Leucaena glauca)*. A cattail dominated freshwater marsh exists at the lower reach of th Salt River floodplain where the river discharges to Sugar Bay, although most of this has plowed under by agricultural development. The uncommon swamp fern *(Achrosticum danaefolium)* can be found in the area.

The mangroves at Salt River Bay provide substrate and habitat for a wide variety of marine organisms (section 2.4.2), and have been identified as the best example of a mangrove ecosystem in the U.S. Virgin Islands by Gilberto Cintron, a renowned mangrove specialist of the Puerto Rico Department of Natural Resources (NPS, 1990). The Salt River mangroves also comprise the largest remaining mangrove area in the Territory, 0.237 square miles, as compared to the combined Benner/Cowpet/Vessup (St. Thomas) area of 0.217 square miles (USVI Govt/DPNR, 1992).

Numerous bird species nest in the Salt River Bay mangroves. The endangered White-crowned Pigeon (*Columba leucocephala*) nests here, along with at least 25 others of the 110 bird species found in the area. The mangroves are an important rookery for Cattle Egrets *(Ardeala ibis)*, Common Egrets *(Casmerodius albus)*, and Little Blue Herons *(Florida caerulea)*. Overall, 26 of the 44 bird species known to breed on St. Croix nest at Salt River (Sladen, 1988).

The importance of the estuary and its mangrove habitat for overwintering songbirds from North America cannot be overstated. The entire area is an essential habitat for songbirds during the winter months; they spend more time here than they do migrating or in their North American breeding grounds (Wauer, c. 1987). Several reports provide lists of bird species common to Salt River Bay; see for example Teytaud (1981); Wauer (c. 1987), Knowles and Amrani (1991); and NPS (1990).

Not all birds in the area utilize the mangroves exclusively. Frigate Birds *(Fregata magnificens)* and Ospreys *(Pandion haliaetus)* are common sights in the air above the bay or immediately offshore. A variety of shorebirds can be found on the narrow beach and shore front. The upland areas provide habitat for doves (*Columbina passereina* and *Zenaida aurita*) and pigeons *(Columba squamosa)*. Other bird species found in the watershed include Grey Kingbirds *(Tyrannus dominicensis)*, Red-tailed Hawks *(Buteo jamaicensis)*, Peregrine Falcons *(Falco peregrinus)*, Ospreys, Smooth-billed Anis *(Crotophaga ani)*, Pearly-eyed Thrashers *(Margarops fuscatus)*, Yellow Warblers *(Dendroica petchia)*, Banaquits *(Coereba flaveola)*, and hummingbirds *(Eulampis holosericeus)* [NPS, 1990].

Behind the mangroves in some places (including the Triton Bay Wildlife Sanctuary), are low-lying salt flat communities which are also subject, at least occasionally, to tidal influences. The salt flats provide habitat for an assortment of land crabs and snails that are an important food source for several bird species. Further inland, a mixture of grasslands, scrub, and dry forest is evident in various places throughout the watershed, depending on an area's successional stage of recovery since disturbance. Gallery moist forest grows along some of the undisturbed watercourses.

Several reptiles are either found or expected to be found in the area, including Anole lizards *(Anolis acutus)*, the dwarf gecko *(Sphaerodactylus macrolepis)*, and woodslaves (*Hemidactylus mabouia* and *Thecadactylus rapicauda*). Green sea turtles *(Chelonia mydas)* and Hawksbill sea turtles *(Eretmochelys imbricata)* are known to nest at beaches to the east and west of the bay mouth, and together with the Leatherback sea turtle *(Dermochelys coriacea)*, have been found feeding in the bay (NPS, 1990).

Invertebrates are represented around the bay by the large Land Crab *(Cardisoma guanhumi)* Ghost Crab *(Ocypode* spp.), Fiddler Crab *(Uca pugnax rapax)*, Rock Crab *(Grapsus)*, and Soldier Crab *(Coenobita clypeatus)* [NPS, 1990].

Mammals which inhabit or migrate through the APC include the White-tailed Deer *(Odocoileus virginianus)*, Mongoose *(Herpestes auropunctatus)*, and the Humpback Whale *(Megaptera novaengliae)*.

As previously mentioned, Salt River Bay and its watershed is unique in its continuum of habitats from higher elevation terrestrial to submarine canyon. Several terrestrial habitats c be identified in their various states of disturbance and succession or recovery. For site-specific descriptions of the flora of the geographic sub-units encompassing the Columbus Landing Site, Sugar Bay, Triton Bay, and Estate Judith's Fancy, see the Alternatives Study (NPS, 1990).

2.4.2 Marine

Salt River Bay has been described as the most productive nursery area for commercially ar recreationally important fish and crustacea on St. Croix, and perhaps in the Territory (Slad 1988). The nutrient-rich waters of the estuary support rich seagrass beds and a substantial phytoplankton community (responsible for the sometimes green color of the bay), which in turn is the base of a complex food chain involving at least 71 families and 324 species of (Dye, 1991). The large size of the estuary and close association of mangroves, seagrass b and coral reefs are the central reasons why Salt River Bay exhibits such high biological diversity and productivity compared to most other coastal environments in the Territory.

Larval or juvenile stages of the following commercially important fishes and crustacea ha been recorded: white mullet *(Mugil curema)*, dwarf herring *(Jenkinsia lamprotaenia)*, snoo *(Centropomus undecimalis)*, bonefish *(Albula vulpes)*, schoolmaster snapper *(Lutjanus apodus)*, gray snapper *(L. griseus)*, queen conch *(Strombus gigas)*, and Caribbean spiny lobster *(Panulirus argus)*. The mangrove cupped oyster *(Crassostrea rhizophora)* was onc abundant on the prop roots of mangroves, but, for reasons not entirely known, has decline and been replaced by the flat tree oyster *(Isognomen allatus)* [Sladen, 1988]. Mangrove p roots offer substrate for attachment of different kinds of algae, sponges, tunicates, mollusk

anemones, tube worms, and other invertebrates which, along with the various infaunal molluscs and crustacea of the bay's bottom sediments, add to the complex food chain of the estuary. The jellyfish (*Cassiopeia* sp.) is seasonally abundant in the warmer waters of the bay (pers. comm., W. Tobias, DPNR/DFW).

The benthic (bottom) environment of the bay is dominated by seagrasses (*Thalassia testudinum* and *Syringodium filiforme*) and various green algae, most notably *Halimeda* spp. and *Penicillus* spp. (Gerhard and Bowman, 1975). The abundance and location of seagrasses and algae is highly dependent on the amount of available light reaching the bay floor, a function of depth and turbidity. Seagrass beds provide feeding habitat for fish, shellfish, and two of the three species of sea turtle which occur in the bay (section 2.4.3), and act as sediment filters and wave dissipaters (Sladen, 1988). The upper reaches of the bays exhibit less prolific faunal communities, due to high turbidity levels at the water's edge. Areas of naturally occurring open sand and dredged areas largely devoid of life are found scattered throughout the bay as well. A silt-laden bottom largely devoid of seagrass or algae dominates a large area in the center portion of the bay, owing to past dredging, continued sediment loading, high turbidity and low light penetration (NPS, 1990).

The bay-barrier reef which extends from the nearshore of both sides of the bay is comprised of Finger coral (*Porites* spp.) and Elkhorn coral *(Acropora palmata)*. The reef has suffered sediment effects, and much of the healthy reef has been replaced by encrusting corals, sponges, and algae (NPS, 1990). The reef functions to dissipate wave energy (allowing for the luxuriant growth of seagrasses and mangroves) and to produce significant quantities of calcareous materials which are the source of much of the beach sand in the area.

For a more detailed description of the marine environments of Sugar Bay, Triton Bay, and Salt River Bay, see NPS, 1990.

Salt River Canyon

According to Hubbard, *et al.*, (1981), the dominant cover of both (east and west) canyon walls are scleractinian corals (true corals) and crustose coralline algae. Reports indicate a dominance of scleractinians (hard corals) on the west wall and plexaurids (gorgonians) on the east wall. Among the hard corals, *Agaricia* and *Montastrea* dominate. Both are well suited to the canyon depths. In shallower waters (30-50 feet depths), Elkhorn coral *(Acropora palmata)*, Brain coral (*Diploria* spp.), Fire coral (*Millepora* spp.), Boulder coral *(Montastrea annularis)*, and some Staghorn coral *(Acropora cervicornis)* are found. Black coral *(Euantipathes hirta)* is also found in the submarine canyon (Olsen and Wood, 1980). Sponges and gorgonians are found, as well as scattered seagrass beds.

The bay-barrier reef and the corals of the submarine canyon are described by Adey, *et al.* (1977); a brief overview is provided by Wells (1988). For a detailed description of the various bottom communities on either side of the canyon, including the nearshore algal areas, pavement zone, and forereef and drop-off wall, see NPS (1990). Detailed species lists of corals, fishes, and algae collected from the east and west walls of the canyon can be found in Rogers (1981) and Rogers, *et al.* (1983). For a comprehensive species list of fauna and flora found within Salt River Bay and its associated environs see NPS (1990). Detailed marine and terrestrial fauna/flora data for the site of the proposed Virgin Grand hotel is contained in Sugar Bay Land Development Ltd. (1986).

2.4.3 Endangered Species

The U.S. Endangered Species Act of 1973 (16 USC Sec. 1531) 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 endangered species are either known to occur, or have a reasonable probability of occurring, within the Salt River Bay APC (animals: pers. comm., W. Knowles, DPNR/DFW; plants: pers. comm., M. Hayes, Cruzan Gardens):

Federally listed:

[Animals]

1. Green sea turtle *(Chelonia mydas)*
2. Hawksbill sea turtle *(Eretmochelys imbricata)*
3. Leatherback sea turtle *(Dermochelys coriacea)*
4. Brown pelican *(Pelecanus occidentalis)*
5. Peregrine falcon *(Falco peregrinus)*
6. Roseate tern *(Sterna dougallii)*

Green and Hawksbill sea turtles have been observed nesting on beaches on both sides of the bay (Sladen, 1988). Occasionally, a leatherback turtle nests at the sandy beach at Columbus Landing (letter from W. Tobias dated 27 July 1993) In addition, the federally listed Humpback whale *(Megaptera novaengliae)* is known as an offshore migrant through the area.

There are no federally listed plants within the APC, although an unlisted species, related to the federally listed Prickly Ash, is found within the APC: Satin Wood *(Zanthoxyllum flavum)*.

Locally listed:

[Animals]

1. Least grebe *(Podiceps dominicus)*
2. White-tailed tropicbird *(Phaethon lepturus)*
3. White-crowned pigeon *(Columba leucocephala)*
4. Least Tern *(Sterna antillarum)*
5. Great blue heron *(Ardea herodius)*
6. Great (common) egret *(Casmerodius albus)*
7. Snowy egret *(Egretta thula)*
8. Black-crowned night heron *(Nycticorax)*
9. Least bittern *(Ixobrychus exilis)*
10. Bahama duck *(Anas bahamensis)*
11. Clapper rail *(Rallus longirostris)*
12. Caribbean coot *(Fulica caribea)*
13. Snowy plover *(Charadrius alexandrinus)*
14. Willet *(Catoptrophorus semipalmatus)*
15. Audubon shearwater *(Puffinus iherminieri)*
16. Bridled quail dove *(Geotrygon mystacea)*
17. Fisherman bat *(Noctilio leporinus)*
18. Red fruit bat *(Stenoderma rufum)*
19. Cave bat *(Brachyphylla cavernarum)*

Although not listed as endangered, two species of butterfly, endemic to the Virgin Islands, are known to occur in the Salt River area and should be considered as rare. These include the Cassius Blue *(Leptotes cassius catalina)* and the Polydamas Swallowtail *(Battus polydamas thyamus)*, the second largest butterfly in the Territory (NPS, 1990).

[Plants]

1. Stinging Bush *(Malphigia infestissima)*
2. Wolly nipple *(Mammilaria nivosa)*
3. Egger's agave *(Agave eggersiana)*

4. *Epidendrum bifidum*
5. *E. ciliare*

The Stinging Bush is a candidate species for federal listing (Dye, 1991).

In addition, unlisted but endangered species of palms (e.g., *Cocothrinax alta*) and ferns (e.g., *Doriopterus* spp.) are known to occur within the APC, an endangered tree, *Coloselabium mangense*, and likely others as well.

2.5 Cultural Resources

The Salt River basin has witnessed over sixteen-hundred years of human habitation. Several prehistoric and historic sites located within the APC provide valuable insight to St. Croix's history and culture. Archaeological studies of Salt River Point, Cabo de las Flechas, Sugar Bay, and Triton Bay have revealed aboriginal and colonial artifacts. Cultural resource sites are depicted in generalized fashion in Figure 11; see also Figure 12 for additional information on English and French settlement sites.

2.5.1 Prehistoric

Archaeological investigations of the Salt River Point (Columbus Landing Site) reveal evidence of prehistoric settlement. Shell refuse middens, scattered surface artifacts, and remnants of a ceremonial ball court and/or plaza are present. The significance of the site is two-fold. The ruins of a ceremonial ball court are the only known example in the Lesser Antilles. Additionally, examples of the four major ceramic styles (Saladoid, 50-450; Ostionoid, 450-800; Elenoid, 800-1300; Chicoid, 1300-1600) have been unearthed; evidence of all four styles is rarely found in one area (Office of Archaeological Services, n.d.). This suggests continual prehistoric habitation of the area since approximately A.D. 350. Several acres adjacent to the site may contain additional buried, prehistoric archaeological resources.

Archaeological investigations in Sugar Bay and Triton Bay have discovered additional aboriginal sites containing ceramic fragments. At the head of Sugar Bay, a "multi-component" prehistoric site was discovered in the late 1980's on plot 33 of Estate Morningstar. On the bay's east side, an Amerindian burial ground, in use between A.D. 66 and 1015, is located adjacent to Cabo de las Flechas, and "may be the most significant find this nature in the Caribbean" (NPS, 1990).

Evidence of preceramic settlements dating as far back as 2000 B.C. have been unearthed at two locations in the Territory. One of these sites is located on Estate Betty's Hope on St. Croix's south shore; (the other is at Krum Bay on St. Thomas). Due to the highly attractiv resource potential at Salt River Bay, it would not be an unfair supposition that preceramic

peoples made use of the area, and that a preceramic settlement is yet to be discovered within the APC.

2.5.2 Historic

The Columbus Landing Site on Salt River Point is the only documented area within what is now United States territory in which an excursion party from Columbus' fleet landed. That party explored an Amerindian village located on this site in 1493.

The first bloody encounter between Amerindians and Europeans occurred at the same time off of Cabo de las Flechas. An excursion party from the Columbus fleet engaged in a skirmish with Amerindians while returning to their ships anchored off the western half of the entrance to Salt River. Thus, the skirmish site itself, although not a geographically defined site, is an historic site of educational interest.

Salt River Point is also the location of the remnants of an eleven-gun, earthwork fortification started in 1641 by English colonists. Known as Fort Sale (as renamed by the French who later took control), the site is part of a five-acre parcel owned by the V.I. Government. It is a "multi-component" site containing prehistoric levels, Columbus associations, early European sites (beginning 1641), and the Fort, considered to be the oldest and possibly the only earthen fort in the Americas (NPS, 1988).

Additional historic resources within the APC include the Danish Customs House (constructed in 1788 of stone and today overgrown by vegetation), scattered English and French plantation sites, a 17th century village site south of Columbus Landing Site, and an early 18th century shipwreck off of White Horse Reef.

The National Park Service conducted a magnetometer survey of Salt River Bay in preparation for the Alternatives Study (pers. comm., J. Ehrenhard, NPS). The area was found to be replete with metallic material, and although swimming and snorkeling reconnaissance was carried out for many areas, identification was not possible for much of the material found. Underwater archaeological materials that have been identified include historic ballast pipes, iron chains, cannon tubes, bricks, a cast iron grate, and ship fittings. A cannon and 17th-early-18th century anchor have been discovered on White Horse Reef at the entrance to the Bay (NPS, 1990). White Horse Reef is notorious for its destruction of vessels, and altogether some 26 shipwrecks are believed to exist on the Salt River reef.

2.6 Built Environment

2.6.1 Roads and Ports

There is currently one small boat marina in operation within the APC. Salt River Marina occupies the west arm of Salt River Bay.

Two major roads pass through the APC, the Northside Road (Route 75) and the North Shore Road (Route 80) [Figure 10a]. Northside Road is a major east-west thoroughfare with moderate to heavy use, while the North Shore Road is more of a secondary road used mostly by residents of communities on the north shore. Several smaller roads, both paved and unpaved, exist throughout the APC.

2.6.2 Water Systems

Individual rain water catchment systems are utilized throughout the APC; there is no municipal potable drinking water distribution system.

2.6.3 Wastewater Systems

Currently, only a small portion of the APC at Mon Bijou is serviced by the municipal sewage collection and treatment system. A lift station is located in the nearby gut which, during times of system breakdown, delivers raw sewage directly to Salt River. Otherwise, individual (on-site) septic tanks are used elsewhere within the APC. A leaking septic tank was reported to be posing problems for a Mon Bijou neighborhood in June 1993 (Freydberg, 1993). In general, however, no information is available on the number, type, and state-of-repair of most on-site systems.

2.6.4 Energy Systems

Electrical energy is available throughout the APC from the Water and Power Authority (WAPA). WAPA currently generates power for the entire island of St. Croix from its diesel powered generators located at Estate Richmond near Christiansted.

2.6.5 Solid Waste Disposal Systems

Solid waste is collected in the APC, as elsewhere in the Territory, by the Solid Waste Division of DPW. Private citizens are required to dispose of their household wastes in dumpsters located along the roadside at various points throughout the island. Commercial

businesses must provide for their own privately contracted waste disposal. Solid waste is currently disposed of at the municipal landfill located at Estate Anguilla.

3. RESOURCE USE, USE CONFLICTS, AND ADVERSE IMPACTS

3.1 Resource Use

Considerable dredging, filling, and bulkheading have been undertaken within the Salt River Bay area during the past three decades (section 2.3.4) [Figure 10b]. Thus, the original shoreline configuration is substantially altered, especially on the east arm of the bay along the site of the proposed Virgin Grand hotel development. Two marinas were initiated at that site in the late 1960's, and later abandoned before completion. Also abandoned, and still conspicuously present today, was a partially completed hotel and large (300,000 gallon) water cistern (Figure 10b).

A Major-CZM permit application for the Sugar Bay Land Development Ltd.'s proposed Virgin Grand development was initially submitted to DPNR in 1986 (Sugar Bay Land Development Ltd., 1986). The proposed development on 74.5 acres includes a 288-room hotel, 300-unit condominium, a convention center, a swimming pool, tennis complex, lobby building, related infrastructure, and the removal of an existing club house (the above mentioned abandoned hotel) at Plots No. 5, 72, and 73, Estate St. John, Plots No. 326, 327. 329, 331, 342, 343, 344, 347, and 348, Estate Judith's Fancy, St. Croix. In addition, the original proposal requested a CZM Permit to construct a 157-slip marina, involving the dredging of a channel 50-feet wide to a depth of 8-feet. The water use permit was denied; the land use permit was approved, and extended to December of 1993.

The Cabo de las Flechas area (and site of the proposed Virgin Grand development) is a popular hiking area for local residents. This portion of Estate Judith's Fancy is "wide open" and provides several good vantage points for viewing the expansive Salt River Bay below.

Along the east arm of Triton Bay, the Nature Conservancy maintains the 12.5 acre Triton Bay Wildlife Sanctuary. The area is enclosed in a 6-foot high chain-link fence, and is refuge for numerous bird species with its diverse mangrove, salt flat, and dry forest habitats (section 2.4.1). The site of the former J. Faile Marine Research Station of the Fairleigh Dickinson University is located on Triton Bay's west shore. (The NOAA Hydrolab submersible, operated by Fairleigh Dickenson University, was based here providing an underwater habitat allowing for extended periods of underwater research in the submarine canyon. The West Indies Laboratory was severely damaged during Hurricane Hugo and Fairleigh Dickenson University chose not to reopen the lab or support the Hydrolab project. The lab has since been sold and the NOAA Hydrolab project moved to the Florida Keys.) Nearby, at the

seaward tip of the Bay, a private dock has been constructed (unpermitted) sometime during the past two years.

At the lower reaches of the Salt River floodplain, privately owned land containing a freshwater marsh area, has recently been converted to agricultural use. The farming has altered the hydrology of the marsh and adjacent mangrove system, and likely increased the stress factors for these biological communities associated with sediment, nutrient, and chemical loading (pers. comm., W. Knowles, DPNR/DFW). An agriculture permit was issue for plots #33 and 33A Estate Morning Star in 1991. This permit specifically stipulated that "Wetland areas shall not be disturbed or impacted."

On the west shore of Sugar Bay, two fishing boat ramps are in use; one of these (located south of the other) is not as heavily used due to the shallow depths. The ramps are made of dirt and have suffered from vehicle use; they require improvements for optimum use, safety, and efficiency. The adjacent shoreline north of the northern-most ramp is, in places, strewn with scrap metal, derelict vessels, and other debris.

A shopping and office complex, restaurant, a 298' x 8' ft. pier with a 296' x 8' T extending 320' into Sugar Bay and a 52 slip marina (later modified to 28 slips) was proposed by a developer on the western shoreline. A major CZM permit was applied for and public hearin held, however, the developer failed to obtain the required water quality certificate and requested that the application be removed from active consideration.

Located on a dredged embayment at the west side of the mouth of Sugar Bay, the Salt River Marina is today the only marina in the APC. The marina includes 36 slips which are occupied approximately 60-70 percent of the time mostly by boats owned by local residents. A long, L-shaped dock is part of the marina, although it was severely damaged during Hurricane Hugo. Owners of the marina are currently considering the feasibility of re-building the dock, or at least that portion of the dock which was originally permitted (pers. comm., H. Bulkley, Salt River Marina). One commercial dive operator utilizes the marina o a daily basis. The marina currently has no sewage pump-out facility, nor does it supply fuel.

A boatyard, Gold Coast Yachts, is located immediately east of Salt River Marina. Approximately 4-6 wood/epoxy catamarans are constructed at the boatyard each year.

Two major residential developments, Mon Bijou and Glynn, are found in the upstream portio of the Salt River watershed. The Mon Bijou development is located upstream from Glynn at the confluence of Canaan Gut and Little Fountain Gut (Figure 10a). Canaan gut drains approximately 430 acres and some of the steepest slopes on the island, including the eastern portions of Mount Eagle and Blue Mountain. These two peaks are St. Croix's tallest at 1165 feet and 1090-feet above sea level respectively. By comparison, elevations in the Mon Bijou

and Glynn housing development areas range from 80-200 feet above sea level (CH_2M Hill, 1981). Flooding of these residential areas has been exacerbated by a poorly designed stormwater management system. Following a major storm event in 1977, which caused extensive flooding and damage, the area has been the subject of detailed hydrological studies and plans for flood mitigation (CH_2M Hill, 1981).

Another subdivision, the Tradewinds subdivision, was constructed in 1986-87 on Estate Morningstar and is poised for significant housing construction in the years ahead. The subdivision is comprised of approximately 100 acres, with 177 individual parcels. The road through the subdivision is paved, and currently only a few houses have been built or are under construction. The area drains via two watercourses which merge and flow through a single culvert near the junction of Routes 75 and 80.

In addition to the above uses, Salt River Bay supports a diversity of recreational uses, including fishing, camping, bathing, snorkeling, diving, sailboarding, and surfing. Of the seven dive shops in operation on St. Croix, four regularly use the two permanent moorings located on the bay-barrier reef offshore of Salt River Bay; one of these operations is based at the Salt River Marina.

As a general characterization, present interest and activity by several organizations involves the acquisition of lands contained within the authorized park boundary, through fee simple purchase, conservation easement, or other mechanisms. Institutional interest has also been expressed to reestablish a marine research station in the estuary, possibly at the same site of the former laboratory at Triton Bay.

3.2 Use Conflicts

There is a history of public opposition to the proposed Virgin Grand development. This represents one of the most significant "use conflicts" for the Salt River Bay APC. While the project proponents appear to have taken reasonable steps to ensure that the development is minimally disruptive of natural processes, the fact remains that a development of this type and scale is incompatible with the expressed public desire to maintain large portions of the area as open space and to protect the visual and historic integrity of the estuary and its shores.

The history of the area is replete with other use conflicts as well, many of which continue unresolved or unmitigated today. Some of these stem from the cumulative impacts of poorly planned and designed upper watershed developments, resulting in such downstream effects as flooding, sedimentation, turbidity, and the increased rapid discharge of large freshwater volumes to the estuary. Moreover, increased peak flows have washed out culverts, eroded stream channels, and destroyed vegetation along stream banks. This kind of piecemeal

degradation of habitat and natural flood control mechanisms is difficult to quantify. In the absence of a broadly supported, watershed management framework, it is also the likely resu of even the most well-intentioned development control efforts.

3.3 Adverse Impacts

3.3.1 Water Quality

The waters of the Salt River estuary are designated as Class 'B' under the Water Pollution Control Act. The best usage of these waters is given as "...propagation of desirable species marine life and for primary contact recreation (swimming, water skiing, etc.)" (V.I. Code, Title 12, Chapter 7, Subchapter 186). Salt River estuary is listed on the Territory's "long l of waterbodies which are impacted by discharges of toxic, conventional and unconventiona pollutants. This list was created by DPNR/DEP at the behest of EPA [CWA section 304(1)(a)(ii)].

In addition to monitoring the one basic water quality station in Salt River, DPNR/DEP has been performing intensive sampling in Salt River estuary since 1979. This includes sampl the water at 10 stations within the estuary for dissolved oxygen, turbidity, total suspended solids, salinity, temperature, and fecal coliform. DPNR has documented increasing amoun of bacterial contamination and has noted areas where there are continuously high turbidity low dissolved oxygen concentrations. According to DPNR, bacterial contamination occurs from septic tank leaching, vessel wastes, and point sources (USVI Govt/DPNR, 1992). O point source, in particular, was identified by DPNR as the sewage lift station previously described for the Mon Bijou area (section 2.6.3).

The marine sediments in the Salt River Marina area were tested in 1986, 1991, and 1992 a variety of metals. In 1986, 24 sites in the USVI were tested for priority toxic trace elements (Oostdam, 1986). In this study, marine sediments around the marina showed elevated levels of arsenic (2nd highest level in the study), beryllium (highest level found the study), and copper (2nd highest level). Water samples taken at this time showed leve arsenic, lead, copper and mercury in excess of the level set to protect salt water aquatic li (Oostdam, 1986).

The USEPA collected marine sediment samples in the vicinity of Salt River Marina in 19 (USEPA, 1993), and again in 1992 (USEPA, 1993a). Because there are no published sediment criteria, the results were compared to informal guidelines developed by the Nati 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 used by NOAA represents the concentration above which adverse effects may be observe

predicted among sensitive life stages and/or species, or as determined by sublethal tests (U.S. Department of Commerce/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 (U.S. Department of Commerce/NOAA, 1991).

In the 1991 study, the concentration of cadmium in the sediments at the Salt River Marina was the highest found on St. Croix and exceeded the ER-L and ER-M. The concentration of copper was also the highest found on St. Croix and exceeded the ER-L; the concentration of zinc exceeded the ER-L. Sediment data from the 1992 sampling showed an exceedance of the ER-L in copper and zinc.

A bacteriological study done in 1991 revealed that water taken from the vicinity of the Salt River Marina had elevated concentrations of *Staphylococcus aureus* in comparison to the rest of the estuary. The study found that the highest concentration of microbial bacteria was found where live-aboard boats were anchored (Coulston, *et al.*, 1991). This study also found the turbidity in the estuary to be much higher than in most other waters tested.

Although there are no permitted point source discharges into this waterbody, there are considerable amounts of pollutants introduced by nonpoint sources of pollution.

3.3.2 Air Quality

Air quality within the APC is generally considered to be excellent. The only source of pollution is from dust generated by boat sanding during the construction of boats at Gold Coast Yachts.

3.3.3 Noise Pollution

Aside from the typical levels of noise associated with motor vehicles, vessels, and boat construction, there are no known major sources of noise pollution within the APC.

3.3.4 Impacts on Biological Resources

There have been at least three boat grounds within the Salt River APC in recent years. One of these vessels, the *Cumulus*, grounded on White Horse reef in the late 1970's and broke up in high seas. The other grounded on the reef to the west of the entrance to Salt River Bay in 1992 and was abandoned. A third vessel was grounded for a week in 1992 on a seagrass bed inside the bay until towed off by a larger boat. The grounding inside the bay and subsequent towing damaged the seagrass beds. Removal of the vessel was not supervised by government

officials. The extent of damage to biological resources of all three groundings has not been determined.

Over 50 percent of the mangroves on St. Croix have been destroyed during the past 200 years; most within the past 50 years. This loss has primarily been caused by the dredge and fill activities at Krause Lagoon site of Hess Oil and VIALCO. Moreover, it is now known that at least 50 percent of all bird species found in the Territory are wetland-dependent for some aspect of their life cycle (i.e., food, shelter, and nesting) [Sladen, 1988]. Although the Salt River Bay mangroves have suffered decline, their loss has not been as great, and the area today is the largest remaining intact mangrove system in the Territory.

Hurricane Hugo resulted in some of the most dramatic and extensive damage to biological resources within the APC this century. As much as 70 percent of old-growth mangroves in Salt River Bay, especially in Sugar Bay, suffered serious damage or were killed. Virtually all types of habitat were affected, and a pronounced decline in bird populations has been visible during the past three years. Details of a post-hurricane damage assessment can be found in Island Resources Foundation (1991). Recovery of mangroves is underway, especially among the fringing Red Mangroves where new growth and the growth of new seedlings is evident.

A farming operation has altered hydrology in the lower floodplain of Salt River (section 3.1) and has adversely impacted a freshwater marsh at the site. Impacts to adjacent mangroves in Sugar Bay have not been studied. However, increased potentials for flooding, sedimentation, turbidity, and chemical pollutant loading can be expected.

The dredge and fill projects which have been carried out in Salt River Bay over the past three decades have impacted several acres of habitat, some of which are irreparably altered. Where dredging deepened the bay to 8 ft or more the bottom has remained largely devoid of seagrass and algae. The continual resuspension of fine particles into the water column from such sites adds to the high turbidity levels.

Illegal harvesting of the precious Black Coral has been reported to occur along the walls of the submarine canyon.

3.3.5 Impacts on Cultural Resources

Several cultural resources listed in section 2.5 are threatened by adverse impacts from human activities. Poor land development practices, uncontrolled recreational uses, and unauthorized collection of artifacts continue to degrade the historic and archaeological resources of the Salt River Bay APC.

The Taino village, ceremonial ballcourt, and Fort Sale, although located within the boundaries of a National Historic Landmark, currently receive no special resource protection or management attention. The Columbus Landing Site has been severely degraded for archaeological material (NPS, 1988), and small erosional areas on the adjacent low hill of the Site are evidence of continued unauthorized digging for exotic pottery shards (NPS, 1984). In fact, the entrance road to the site passes through the ceremonial ballcourt.

The vast majority of land parcels within the APC are privately owned and thus vulnerable to future development pressure. Considerable development has occurred along the bay shoreline in recent years, with the likelihood that cultural resources have been destroyed in the process. Cabo de las Flechas has been disturbed by land use and development which perhaps have affected prehistoric deposits. Pre-Columbian sites and burials are known to occur within the area of the proposed Virgin Grand hotel (NPS, 1988). The burial site in question has been estimated to date back to A.D. 1150 and is a highly significant site (NPS, 1990). In addition, the proposed construction of condominiums as part of the same development threatens a 17th-century English village site.

Submerged cultural resources within the Salt River APC have been threatened by unauthorized recovery groups. A Florida-based, submerged treasure group tried to recover an anchor in 1991 that is perhaps several hundred years old. DPNR stopped the attempt, and a subsequent court ruling denied permission to the private group to recover the relic. The confrontation and ensuing legal battle highlighted the need for antiquities legislation in the Territory.

Recreational use of the estuary's shores has, on occasion, had adverse impacts to both cultural and natural resources. For example, during the 1993 Easter weekend, a time which is traditionally a popular weekend for camping, earthclearing activity was observed at the Columbus Landing Site (parcels 12-15 on Estate Salt River). This illegal and unpermitted activity was ostensibly for the clearing of tent sites in preparation for the long weekend. Because the activity occurred at the beginning of a five-day Government holiday, enforcement officials were not prepared to respond in a timely manner, and the clearing was not stopped in progress. A total area of approximately 1450 square feet was cleared (pers. comm., W. Cissel, NPS).

Dredge spoils have been disposed of along the shoreline between Columbus Landing Site and the Salt River Marina. This area is the site of a 17th century village; cultural material which may exist there is now covered under several feet of dredge spoils (pers. comm., W. Cissel, NPS).

4. MANAGEMENT RECOMMENDATIONS

4.1 Policy Framework

Development of administrative mechanisms to protect the many natural and cultural resourc found in the designated Salt River Park is necessary. This should be done as quickly as possible to halt further losses of these resources. For example, the invaluable, multi-component Columbus Landing Site continues to suffer degradation in the absence of a management plan or clear understanding of which agency has jurisdictional authority to manage the site. The Salt River Park Committee was formed more than a year ago by DP with representatives from DAHP contributing to bring together information on park resourc suggest management recommendations and develop grants for land purchases. Most of the following information and recommendations are taken from this committee's files.

As discussed below (section 4.4), the now designated Salt River Park awaits several developments which must occur prior to the actual implementation of a management strateg The Park Commission should develop and reach consensus on the overarching goals/objectives for the Park; it should advise the Secretary of the Interior in drafting a General Management Plan (GMP) which must be approved by the House Committee on Interior and Insular Affairs and the Senate Committee on Energy and Natural Resources. Funds should be appropriated and/or acquired from various sources to purchase private in-holdings within the authorized Park boundary (an estimated $23 M is needed). Park managers and rangers will have to be selected and trained in a wide array of skills. Efforts should meanwhile ensue to gain from both the general public and all relevant government agencies the necessary understanding and support for the goals and objectives of the Park.

The V.I. Government should take immediate steps to halt further resource degradation by establishing such management and enforcement measures as are necessary for interim resource protection (i.e., prior to the eventual implementation of a GMP), *including the assignment of a specific agency that will be responsible for interim management.* It should quickly take steps to reconfirm its commitment to manage the resources of the Park in a w which gives appropriate balance to the primary goals of resource conservation and recreational opportunity.

Further, the V.I. Government should begin now to identify its own means to raise funds to either acquire or obtain conservation easements for the most critically sensitive areas within the Park. Such a fund-raising effort should be multi-faceted and creative, employing a vari of mechanisms that will encourage landowners in the area and the general public at-large t participate in this territorial goal.

In addition to the five-acre Columbus Landing Site, at least two areas within the Park should be given priority status for acquisition or conservation easement: (1) the Amerindian archaeological site on plot 326 of Estate Judith's Fancy (owned by Sugar Bay Land Development Ltd.), and (2) a major "multi-component" archaeological site located on plot 33 of Estate Morningstar (owned by Columbus Bay Marina). These two sites were discovered during archaeological work in the latter half of the 1980's by the National Park Service as part of the Alternatives Study and Environmental Assessment for the Park, and should be considered as especially significant archaeological sites in need of protection.

The purchase of land for scenic vista points or for open/green space should be seen as an additional early goal.

The establishment of the Salt River Park and the interim (immediate) protection of its irreplaceable resources is a task in need of immediate action. An interim management strategy, by way of "Rules and Regulations" may be necessary. Regulations and recommendations regarding Salt River Park should:

1. offer an interim management policy of the V.I. Government, one that demonstrates long-term vision and that provides recognition of the function and duties of the Park Commission;
2. specify the Department of Planning and Natural Resources (DPNR) as the lead Territorial Department for Territorial Park System affairs (see below), and direct the Department to initiate the selection and training of park rangers, and otherwise establish by a specified date the framework for interim Park management and enforcement;
3. recommend incorporation of the applicable set of federal laws into the V.I. Code which will support the greatest possible resource protection (section 4.3), and if necessary enter into a cooperative agreement with the National Park Service for assistance;
4. establish strict standards and policies with respect to projects within and adjacent to the authorized park boundary, until such time as a GMP has been developed and can be used to guide the permit review process within the framework of an overall management plan (see below);
5. adopt a watershed and ecosystems approach to resource management, recognizing that the control of watershed development is essential if the downstream effects of sediment and pollutant loading are to be avoided for the Park;
6. recommend to the Legislature that, as a result of No. 5 above, the entire Salt River basin watershed (in effect, the entire APC) will be made subject to the CZM permitting process and the CZM Act;

7. recommend that the St. Croix CZM Committee consult with the Park Commission on all major permit applications involving the use of land within the watershed, and that the CZM Committee not issue permits for developments which will occupy any portion of the authorized Park boundary, without agreement of the Park Commission.

A long-term vision of the importance of biodiversity conservation is an essential component of a Territorial Parks System. The DPNR has the technical expertise -- and indeed the mandate for natural resource management -- needed to effect the planning, permitting, and enforcement framework that will ultimately decide the success or failure of such a conservation strategy.

A Territorial Park System must have, as a minimum, the following fundamental types of support:

- adequate legislation;
- a system management plan;
- financial resources;
- trained and motivated personnel; and
- public awareness and participation.

DPNR should be designated as the lead agency to coordinate with the Secretary of the Interior regarding the establishment of an interim resource protection plan for Salt River Park and call upon DHPR for its expertise as needed in the development and management of specific "amenity needs" (e.g., concessions, restrooms, etc.) for the Park.

It is essential that a watershed/ecosystem approach to resource management be adopted to guide planning and decision-making. Strict nonpoint source pollution control measures will be needed throughout the watershed, and existing and future stormwater management structures, and site-planning, must be cognizant of the cumulative impact potentials of inadequate drainage systems. Flooding within the Salt River basin has already become a significant problem.

Both the interim resource protection plan and the GMP should identify ways by which the management of a defined "buffer zone" around the Park can be carried out.

The interim resource protection plan must also address the key issue of enforcement. Additional enforcement presence is needed within the Salt River Park area if piecemeal degradation of the resources is to be avoided. Once again, DPNR is the agency within the Government of the Virgin Islands most experienced in the enforcement of natural and cultur resource regulations; it makes the most sense to build upon this existing institutional capacit

One of the early tasks of the Park Commission should be to advise the Secretary of the Interior on a Land Protection Plan (LPP). The National Park Service has begun preliminary work on the LPP. Completion of a LPP is a requirement under federal law before federal funds (Land and Water Conservation Funds) may be spent on land acquisition. The Park Commission should take this up as one of its first topics of concern.

Secondly, the Park Commission must begin to identify and reach consensus on the overarching goals and objectives of the Park. With the unique co-management approach to be undertaken at the Park, two specific criteria for successful Park management should be kept in mind:

1. Both sides of the co-management team must have a common, long-term vision concerning what activities and resource management goals should become the focus of the Park; and

2. Implementation of that vision is only as good as the competency of Federal and Territorial Park personnel; their employment must be based on a high level of interest in and willingness to learn about appropriate aspects of park operations, and a like commitment to consistently and fairly carry out applicable laws for the protection of the resources and service to the public.

The nomination process should be initiated for Salt River Park to receive World Heritage Site designation (under provisions of 36 CFR 73.17). (Requirements for the nomination process have been outlined in a letter from the National Park Service to the DPNR/Division of Coastal Zone Management (Cissel, 1992).) As seen above (sections 1.3, 2.4, 2.5), the area is of great importance for its natural and cultural resources, and has witnessed the entire span of human history in the West Indies, from pre-history (A.D. 350-1493), Contact (1493), post-Contact (1509-1600), and colonial periods (1642-1917). The representation of these periods in this small geographical setting is a unique occurrence in the West Indies and of international interest. Also as already discussed, the area is a continuum of ecosystems from forested watershed to submarine canyon, as well as habitat for endangered species. In short, it would appear that Salt River Bay possesses all the requirements for eligibility as a World Heritage Site; a designation that the Territory would be well-honored to have.

4.2 Planning and Permitting

Land Use and Zoning

The Salt River Bay APC is currently comprised of at least nine (9) different zoning designations (Figures 13a and 13b). Within the bay area, a large portion of Estate Judith's Fancy is zoned R-3 (residential medium-density), and the opposite (west) arm of the bay is

zoned R-1 (residential low-density). With the exception of the five-acres Columbus Landing Site which is zoned P (public), all other shorefront properties in the bay area are zoned W-1 (waterfront pleasure). Elsewhere in the watershed, lands adjacent to the W-1 zones of the bay are all zoned R-1, except for the upper areas of the Salt River drainage basin (the Mon Bijou and Glynn areas in particular) which are zoned according to Figure 13b. This area of the watershed is comprised of A-1 and A-2 zones (agricultural districts), as well as R-1, R-2, P, and C (commercial) zones. Permitted uses for these zones can be found in the V.I. Code, Title 29, Chapter 3, Section 228.

The Coastal Land and Water Use Plan (CLWUP) prepared by DPNR was adopted by the Legislature and Governor in 1978 and took effect February 1, 1979. The CLWUP 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 Salt River Bay APC, however, the CLWUP basically supported the earlier zoning designations, and provided new refinement of allowable water uses. It did, however, classify the entire Salt River Bay waterfront (with the exception of the Salt River Marina and the proposed marina area on Estate Judith's Fancy) as "Preservation".

Other land use and zoning issues that are either discussed elsewhere in the study or are self-explanatory include the need for:

1. inclusion the entire watershed in the jurisdiction of the CZM Act and subject to the permit control of the CZM Committee; all developments should be reviewed against Best Management Practices (BMP's) for nonpoint source pollution control (see "water quality" below), and for cumulative impacts from inadequate stormwater management designs;

2. a clear policy with respect to all major development proposals and spot zoning (or consideration of variance requests) within the 912 acre Park or a 100 meter strip surrounding the Park, until such time as a General Management Plan is prepared and implemented; only at such time can proposed developments be assessed for their compatibility with the goals and objectives of the Park;

3. strict surveillance and enforcement of all future development and existing activities;

4. inspection and remedial actions with respect to existing development, for example, the need for an inspection and maintenance program for on-site wastewater treatment systems;

5. some type of control on building design within park boundaries and buffer zone (ref., Handbook for Homebuilders and Developers) so that future developments do not diminish the scenic and historical integrity of the area;

6. an assessment of impacts from new developments on the blockage of view corridors where public, scenic vista points are involved;

7. the removal of shoreline debris, including the remainder of the damaged dock at Salt River Marina and all vessels left in the wake of Hurricane Hugo;

8. the timely development of a water use plan for Salt River Bay, and the establishment of an upper limit on the number of moored vessels allowed in the bay (see "water quality" below); this should be in conjunction with enforcement of new mooring regulations that were approved in November 1992 (which apply to Salt River Bay);

9. careful consideration of development to be located in the Glynn area, as this area has been identified as a significant groundwater recharge area and is also prone to flooding; and

10. the prohibition of farming activities at the lower reach of the Salt River floodplain (see "water quality" and "biological resources" below).

11. interim resource protection plan for the Park, and/or the General Management Plan, will need to consider, as a minimum, the following *prohibited activities* within the designated boundaries of the Salt River Park:

a. camping, until the park plan is in place; if camping is permitted, areas should be designated and support facilities such as freshwater and toilets installed;
b. open fires for any purpose;
c. driving any vehicles off roadways;
d. the use of certain size of motorboats with special attention to jet skis and water skis;
e. the use of horses;
f. hunting of all kinds and the possession of firearms by anyone other than law enforcement officers, property owners, and tenants who are licensed by the V.I. Police Department to own a firearm;

g. certain kinds of fishing, including spearfishing, and all kinds of commercial fishing (see "biological resources" below);
h. the uses of vehicles on beaches;
i. anchoring in unpermitted areas;
j. mooring of vessels at Salt River Marina or anywhere within the Salt River Bay, without the use of proper sewage holding and disposal facilities; and
k. vessel fueling facilities.

In addition, an interim resource protection plan for the Park, and/or the General Management Plan, will need to consider, as a minimum, the following *permitted activities* for Salt River Park:

l. day camping and picnicking in designated areas;
m. use of designated boat launching ramps;
n. mooring of vessels in designated areas, including use of pick-up moorings to avoid damage to sea grass beds;
o. "passive" water contact activities (e.g., swimming, snorkeling, diving, surfing, wind surfing, kayaking, etc.)
p. hiking on established trails;
q. limited use of motor water craft that conforms to no-wake requirements;
r. recreational fishing (catch-and-release with line only); and
s. scientific research;

Finally, an interim resource protection plan for the Park, and/or the General Management Plan, will need to *establish criteria* for the following:

t. permit requirements for day-use of public facilities by large groups;
u. permit requirements for concessions and commercial vending;
v. control of aircraft operating within Park air space;
w. control of marina operations and the development of a plan for vessel wastes (see "water quality" below);
x. regulations pertaining to the use of vehicles and vessels;
y. control of source-point noise pollution;
z. regulations pertaining to the repair of vessels; allowable types of repair in areas outside of licensed boat repair facilities;
aa. the development of a water use plan that will specify allowable anchorage areas; transient mooring areas; and other permissible water uses; permissible advertising/signage;
bb. general rules for permissible public conduct.

Note: federal regulations codified at 36 CFR speak to many of the above activities (Cissel, 1993).

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 preparing for and resorting to evacuation of people during a storm event, with its incumbent risk to human life. Third, and a better approach, coastal development can be directed or 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.

A coastal storm hazard mitigation policy and regulations should be developed for the Territory, and for the Salt River Bay APC on a site-specific basis. A "development management" alternative to hazard mitigation is recommended, and will require that implementing legislation be enacted soon in preparation for the next disaster. Future public and private developments should be directed away from high hazard areas. Redevelopment policies should be considered for existing shoreline development to minimize potential losses. and to establish a reconstruction plan prior to its need.

Although Salt River Bay is considered to be a "hurricane hole" for boats seeking refuge from a tropical storm, Hurricane Hugo demonstrated that the area is not safe during a storm of that magnitude.

As seen above (section 2.3.2), earthquake potential in the Territory is relatively high. Where landfilled areas are to be used for construction, logic suggests that certain compaction standards be adhered to and a certified engineer's report required for all major facilities.

Appropriate attention should be given the design of major facilities, especially those which will house large assemblies of people, so that injury and damage from seismic activity are minimized to the maximum.

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), FEMA/NFIP A-Zone and V-Zone floodplains exist throughout the area.

Strict adherence to National Flood Insurance Program 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.

Water Quality

As seen above (section 3.3.1). the water of Salt River estuary has been given a Class 'B' use designation pursuant to Title 12, Sections 186-3 (V.I. Code). The designated use for these waters is thus "... for the propagation of desirable species of marine life and for primary contact recreation". Activities which threaten the attainment of this use are inconsistent with Title 12, Section 186 and the policy and goals of the federal Clean Water Act (33 USC 1250 *et seq.*). Thus, the designated use is protected by both local (Title 12, Section 186-7) and federal (40 CFR Section 131.12) antidegradation regulations. Of particular significance for the Salt River estuary is that portion of the antidegradation regulations which state that:

Where high quality waters constitute an outstanding National resource, such as waters of National and State parks and Wildlife Refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.
The objective for the maintenance of water quality within the estuary should be that water quality parameters be maintained within their average natural range of variation.

Several reasons can be offered as to why the maintenance of the highest possible water quality within the Salt River estuary should be a central aspect of the review of existing and proposed developments:

1. The estuary is an important nursery ground for diverse populations of marine organisms.

2. The shape and bathymetric profile of the bay results in a low level of ocean-bay water exchange and thus relatively poor flushing capacity driven primarily by wind. The pollution susceptibility of this type of bay is considered to be high, and is discussed in Nichols and Kuo (1979). Under natural (unpolluted) conditions, restricted bays can be highly productive as nutrients under these conditions have a long residence time.

3. Water quality is strongly dependent on the velocity and volume of terrestrial runoff, and the natural range of most water quality parameters fluctuates more widely in Salt River Bay, as is characteristic of estuaries, than in well flushed bays or open coastlines. Inorganic nutrients, temperature, salinity, turbidity, and suspended solids show particularly wide natural variations (USVI Govt/DPNR, 1988).

4. Short-term or temporal changes can often be tolerated by marine biota, but inputs of sediment, nutrients, freshwater, and toxic compounds in the Salt River estuary have long residence times and hence more prolonged effects on biological communities (USVI Govt/DPNR, 1988).

General management objectives for restricted bays such as Salt River Bay include the following:

a. Maintain water quality within the average range of natural conditions and seasonal cycles.

b. Minimize inputs of suspended solids by stringently enforced erosion and sedimentation controls in upland areas. Minimize re-suspension of fine sediments by propeller wash from boats.

c. Enforce the antidegradation clause of the water quality standards for all projects.

d. Curtail inputs of toxic chemicals such as biocides, heavy metals, PCB's, TBT's, etc. (USVI Govt/DPNR, 1988).

It follows that the construction of additional marinas, or an expansion of existing marina space, should not be a permitted activity in Salt River Bay. Dredging should be a prohibited activity. Fueling stations should likewise not be allowed, nor should boat hull maintenance

operations that involve the scraping of paint. Boat hull maintenance presently occurs at random, uncontrolled sites along the shoreline. These activities should be stopped, and the owners provided with information concerning the location of certified boat repair facilities on the island. The development of a water use plan for Salt River Bay should be given priority. A water use plan for Salt River Bay is needed in anticipation of increased boat traffic that might result when the Park becomes officially established. Presumably the Park would become a greater focal point for cruising yachts than it is at the present time. As such, a water use plan is needed that will determine limitations on the types and numbers of moorings (transient, live-aboard, etc.) that the bay can accommodate. The relative contribution from live-aboard vessels on nutrient loading and/or bacterial concentrations should be assessed before a meaningful allocation of such mooring types can be made.

The marina and associated boat building facility should be regularly inspected to determine if all possible toxic or hazardous pollutant sources are properly stored. Liquid materials should be prevented from entering coastal waters at all costs. 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 water, diesel, kerosene, and mineral spirits should be available and clearly labeled;
3. marina patrons and employees should be instructed on proper disposal methods for these materials through signs, mailings, training, etc.

The amount of fuel and oil from boat bilges and fuel tank overflow/air vents entering marina and coastal waters should be absolutely 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 regularly and replace as necessary; recycle, if possible, or dispose of properly.

There is currently very few places for the public to dispose of waste oil in the Territory, and so it is often illegally disposed of on the land or in the sea (rather than kept in sealed

containers as is the "official" interim guideline). *The strictest enforcement actions and penalties should be instituted for persons caught illegally disposing of waste oil. Such actions should be undertaken in concert with a public awareness program on the environmental effects of improperly disposed oil.*

Nonpoint source pollution control measures for the Salt River watershed should include, as a minimum, the following: (adapted from Tetra Tech, 1991):

1. *regulate land use practices and behaviors that contaminate stormwater (e.g., waste oil disposal, establishment of green belts or infiltration areas on a portion of developed property, establishment of impervious surface limits);*
2. *impose routine inspection and management requirements for on-site (septic tank) wastewater systems;*
3. *develop treatment options for stormwater (e.g., retention basins, grassy swales, vegetative buffers, filtration through artificial or natural wetlands, etc.);*
4. *implement source control practices such as street sweeping where appropriate;*
5. *implement sediment control measures on all construction projects (e.g., vegetation buffer zones, retention basins, silt-curtains, diversion ditches, etc.);*
6. *implement Best Management Practices (BMP's) for watershed management, site planning, and construction design; on slopes greater than 20 percent, structures should be built on columns, rather than on a leveled platform; and*
7. *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.*

Finally, agricultural developments in the Salt River floodplain should be reviewed to ensure that downstream impacts associated with land disturbance, watercourse alteration, or use of agrochemicals are minimized to the maximum extent. The conversion of naturally occurring wetland areas, such as the freshwater marsh area at the lower reach of Salt River, should not be allowed for any purpose. Action should be taken to halt the ongoing farming of that particular area, and the area be restored to its original hydrological and biological condition.

Solid Waste Management

Better site planning is needed by the Department of Public Works where roadside trash dumpsters are placed to service the general public. In many situations, their location create traffic congestion from the lack of a turn-out area near the dumpster. Unsightly and unhealthy conditions develop during periods of heavy usage. The use of concrete pads for the dumpsters and a paved turn-out area for vehicles, along with a modest level of landscaping and perhaps fencing, would greatly improve the present situation at many sites.

Air Quality

Air quality in the Salt River Bay APC is of high quality. Nevertheless, future major developments should require an assessment of direct and cumulative air quality impacts as part of the EAR process.

Noise Pollution

Preparers of EAR's in conjunction with future developments should be required to assess cumulative noise impacts as they may affect particular target communities within an identifiable radius (or down wind corridor) of a proposed development. Certain activities related to noise impacts should be prohibited, including restrictions on the use of motorboats, jet skis and fixed-wing aircraft within a certain radius of the Park.

Biological Resources

Some of the most significant biological resources of the APC are associated with the shoreline mangrove systems found along the inner embayments of Triton Bay and Sugar Bay, and along much of the greater Salt River Bay area. As described above (section 2.4.2), the mangroves provide nursery habitat for a variety of commercially and recreationally important marine species. They also serve to maintain good water quality by filtering sediments and other suspended pollutants before they reach the bay. Together with the associated seagrass beds and coral reefs found at the mouth of the bay, the mangroves play a key role in the perpetuation of several different marine biological communities.

Management efforts should be especially cognizant of the need to preserve and enhance remaining wetland habitat (including salt ponds and salt flats) wherever it exists. A territorial wetlands management plan is needed, as is a site-specific plan for the Salt River Bay APC. Such a plan should accomplish as a minimum the following:

1. establish a legal territorial definition of wetlands that is more specific to the local ecosystems than the Federal definition (in consultation with the responsible federal agencies);
2. delineate existing wetland boundaries based on selected criteria (draft Federal wetland maps exist, but they need to be ground truthed and adjusted);
3. characterize individual wetlands for functions and values;
4. determine baseline status and trends;
5. devise an effective management framework;
6. develop mitigation and restoration targets; and
7. delineate agency and private citizen responsibilities.

In addition, and in conjunction with the coastal storm hazard mitigation policies discussed above, adequate shoreline setback standards, with no allowable bulkheading in mangrove areas, should be implemented to allow for future landward migration of wetlands in the event that sea level rises. As previously mentioned, the farming practice which is currently underway at the lower reaches of Salt River should be discontinued, with efforts made to assist the farmer(s) to relocate to more appropriate agricultural land. The hydrology of this freshwater marsh area should be restored, and natural patterns and volumes of freshwater runoff should be maintained throughout the bay.

Wetlands provide a number of additional functions, including educational (e.g., bird-watching) and scientific functions. The "development" of wetlands for educational or leisure purposes is possible with the construction of elevated boardwalks to avoid alteration of the natural hydrology and sediment flows of an area. Viewing platforms with interpretive signs can be conveniently accommodated in this fashion. Establish and obtain funding for a program to clean up the scrap metal, trash, and derelict vessels and vehicles that presently litter many of the shoreline areas.

Elsewhere in the watershed, all types of trails should be clearly marked to avoid unnecessary disturbance of surrounding vegetation; such trails should be sited only after the aforementioned field surveys of endangered flora have been completed.

Generally speaking, management of the Salt River Bay APC biological resources will require the same attention to cumulative impacts from piecemeal land conversion as is needed throughout the Territory. This Comprehensive Analytic Study and proposal for a Management Plan identifies that considerable potential exists for further development of the watershed, and thus for significant further loss of habitat (and increase in sediment loading in the bay). While there is a great need at the territorial level to develop and implement a Territorial Park System as the basis of a conservation strategy for representative ecosystems, more localized efforts in biodiversity protection are needed as well.

Biodiversity protection should become a principal component of the site-planning and permit approval process. In order to do so, more detailed surveys and identification of endangered flora and fauna are needed. The endangered and threatened species list needs to be updated, and specific management measures identified for both *in-situ* and *ex-situ* conservation of endangered plant species. This may necessitate some type of field marking by a qualified botanist as part of the permit review process. A greater understanding is needed of the natural history and habitat requirements for the two subspecies of butterfly previously mentioned (section 2.4.3). The introduction of exotic species (both flora and fauna), for whatever purpose, should be strictly controlled and subject to all provisions of the permit application and review process.

Site-clearing and excavation practices require modification to allow for only minimal disturbance of the landscape, and maximum conservation of naturally occurring biota. For example, house platforms or benches should not be cut on slopes greater than 20 percent (5:1); such homes should be built on pilings to significantly reduce the amount of excavation and leveling needed, and to allow for the structure's cistern to sit above ground, also with a minimum of excavation. Other guidelines for development on steep slopes can be found in Teytaud (1981), and should be strictly applied during site-planning, permit approval, and construction.

Managing sediment loading at its source is the best way to simultaneously achieve several natural resource management objectives. With the application of strict sediment control measures, several potential problems can be minimized or mitigated at the same time, including: habitat loss, top-soil loss, and sediment loading to receiving waters, with its consequent lethal or sub-lethal impacts to marine biological communities. Salt ponds, for example, generally have little capacity to absorb and store more sediments. It is therefore important to minimize anthropogenic (derived from human activity) sediment sources, that is, to stabilize sediment near its source in the watershed, in stream beds, on exposed banks, and alluvial slopes. Vegetation within and along watercourses should be maintained, and a minimum 50-feet setback distance required from the edge of a watercourse. Former impoundments and retention basins that are eroded through, or sediment-filled to capacity, should be renovated. Vegetation types with good stabilizing capability should be encouraged (Nichols and Brush, 1988).

As for the aquatic resources of the APC, a moratorium should be established against all forms of fishing within Salt River Bay, until such time as an effective enforcement mechanism is in place to allow for the establishment of a "controlled fishing area". Such controlled fishing should allow only recreational, catch-and-release, line fishing. All forms of commercial fishing should be prohibited, as well as the use of spearguns, fish traps, and gill nets. The area is simply too critical as a fish nursery habitat. The "controlled fishing area" should

extend to the 600-feet contour of the shelf edge. Thus, the entire Salt River Bay and offshore waters of the APC should be included in the proposed Marine Reserve System.

The taking of Black Coral which is prohibited should be strictly enforced. Management measures for the St. Croix Coral Reef System APC should apply as well to the reef area of Salt River Bay APC.

With the establishment of Salt River Park, the potential exists for increased vessel traffic in the bay. This will require the development of a water use plan for the bay, and designated mooring areas with permanent moorings where feasible. Mooring areas should be placed well away from seagrass beds and live coral reefs, and generally confined to the deeper areas of the bay (i.e., greater than 8-feet) where no seagrass beds exist. Channel markings would hopefully improve the record of safe passage through the narrow channel opening, and help to minimize further damage to seagrass beds and coral reefs. (The installation of navigational buoys or channel markers will require application to the U.S. Coast Guard (USCG) by an agency or group that is willing to be responsible for their regular maintenance. There may be the possibility that the USCG would be willing to install and maintain channel markers where a federal agency (e.g., the National Park Service) is involved (pers. comm., J. Reyes, USCG, Puerto Rico).) Propeller and anchor damage must be avoided if the system is to remain maximally productive.

Dredging, filling, or any further such alteration of the shoreline of the bay should be prohibited. No alteration of the sediment sill (section 2.3.4) should be permitted, as such would disrupt natural sediment transport and deposition processes, as well as diminish the sill's contribution to wave energy diffusion.

Cultural Resources

Just as the Salt River Bay APC represents a continuum of natural ecosystems, it also represents a continuum of human habitation. The importance of this unique situation in the West Indies should be recognized for its extraordinary research and educational potential, and all efforts made to ensure that the historical and archaeological integrity of the area is not further eroded.

The Division of Archaeology and Historic Preservation of DPNR (DPNR/DAHP) has already promulgated standards and guidelines for the conduct of cultural resource investigations in the Salt River Basin (Ehrenhard, 1987). In addition, the Commissioner of DPNR has issued a Public Notice regarding the fact that cultural resources located within submerged lands are held in trust for the people of the Virgin Islands, and that any conduct of investigations requires the prior approval of the DPNR (USVI Govt/DPNR, n.d.). These guidelines and requirements should be generally sufficient to guide the development control process, but

additional attention to monitoring and enforcement will be needed to prevent further degradation of cultural resources in the area.

Work should continue to identify the most significant cultural resources worthy of protection within the APC, and establish a priority acquisition list for possible future acquisition. Two such sites have already been mentioned (section 4.1), and certainly others need to be considered. At the same time, funding mechanisms should be explored to allow for such acquisition. An alternative to acquisition is the encouragement of private sector cooperation in conservation measures, stimulated by the appropriate incentive mechanisms offered by Government.

Meanwhile, an interim resource protection plan for Salt River Park should provide greater protection for Columbus Landing Site. Several recommendations in this regard have been already forwarded to the Governor from the Society of V.I. Historians, and include the following:

1. The boundaries and the significance of the Site should be properly identified.
2. An initial clean up should be done manually, without the use of heavy equipment.
3. The existing trash bin should be moved to a less prominent and sensitive location outside the perimeter of the Site.
4. Pits and holes should be filled, preferably with fine gravel and covered with topsoil.
5. No further digging or excavations should be allowed without an approved resource management plan for the Site.
6. Vehicular access to and on the Site should be restricted (only pedestrian use should be allowed and confined to well-marked trails); in no case should heavy equipment be allowed for work of any kind on this and other sensitive cultural sites;
7. The dirt roads approaching the earthwork fortification and the mangrove swamps along the Site's southern boundary should be closed, in compliance with a 1972 directive from the Commissioner, Department of Conservation and Cultural Affairs (now Planning and Natural Resources).
8. Any and all work to be performed on the Site must first be approved in part by a competent professional archaeologist, who must personally or by acceptable designee, also monitor the work.
9. The various territorial agencies having jurisdiction at the Site should coordinate their activities.

10. Existing and future regulations created to manage the Site should be published and then consistently and uniformly enforced by the appropriate agencies.

(The above recommendations are contained in a letter dated September 17, 1992 from W. Cissel, President of Society of V.I. Historians, to Governor Farrelly. They could be considered as the basis for immediate action under an interim resource protection plan.)

The Cabo de las Flechas site was inadvertently omitted from the existing National Historic Landmark boundary (i.e., Columbus Landing Site). This designation should be amended to include the Cabo de las Flechas site; it is an extremely valuable archaeological site and worthy of such national designation. Additional archaeological surveys of the area should be considered a relative priority (NPS, 1988). Pre-Columbian sites and burials are known to occur within the area proposed for development by the Sugar Bay Land Development Ltd.

As part of the Alternatives Study conducted by the National Park Service, a magnetometer survey was conducted for the majority of Salt River Bay (pers. comm., J. Ehrenhard, NPS). Although it may appear that additional magnetometer survey work may not be too fruitful (due to excessive electronic noise from various metallic debris in the bay), the barrier reef (especially west of the bay mouth) and submarine canyon areas have not been adequately surveyed in this manner. These areas should be considered for additional survey work. In addition, more intensive underwater survey work is warranted in the Fort Sale/Columbus Landing Site area (pers. comm., J. Ehrenhard, NPS). As always, it is imperative that such investigations be conducted by a qualified professional underwater archaeologist certified by the Society for Professional Archaeologists (SOPA), and coordinated with the DPNR/DAHP.

Section 4.3 below discusses the need for antiquities legislation in the Territory.

4.3 Legislative Change

There is a need for consolidation of all existing floodplain management regulations under a single Floodplain Development Ordinance. (Chapter IX, Performance Standards; Section L, Floodplain Performance Standards of the draft Virgin Islands Development Law provides for floodplain protection.) Such an ordinance should be ideally incorporated into a larger Coastal Growth Management Ordinance, which speaks to the long-term need to control growth and redevelopment in all high hazard areas. Flooding is a significant hazard potential for the Salt River Bay APC.

Owners of abandoned or derelict vessels should be required to remove their vessels within a specified time period, or face punitive measures.

The Legislature should examine the Submerged and Tidal Lands law as it relates to salt ponds, and/or it should reexamine Title 12, chapter 21 of the V.I. Code to further define and explicitly include salt ponds and suitable buffer zones as needed protected habitat.

Jet Skis are considered to be motor vessels. However, there are no specific standards (noise, speed, etc.) by which they operate, and no specific provisions in the law to consider the needs of other water users, including swimmers and various aquatic or wildlife species. As mentioned previously, the use of jet skis within the estuary is not compatible with the goals and objectives of the Park, and should be prohibited. This will require study and legislation since current law does not permit discrimination against "jet ski" and similar watercraft.

As mentioned previously (section 4.1), an interim resource protection plan for Salt River Park should include a comprehensive, coordinated review of all proposed developments within the Salt River watershed. Relevant federal laws which must guide any interim resource protection planning include:

1. National Historic Preservation Act (P.L. 899-665 80 stat. 915, 15 Oct 1966). The concept of eligibility is a powerful tool for cultural resource protection; that is, if the State Historic Preservation Officer (SHPO) recognizes the eligibility of a site for either Section 106 (National Register of Historic Places) or Section 110 (National Historic Landmark Program) status, he/she must perform a proper analysis of the site;
2. Preservation of Historic Properties Act (P.L. 89-665, 80 Stat. 915);
3. Archaeological Resources Protection Act (16 USC 470 aa);
4. Archaeological and Historical Preservation Act (P.L. 93-291, 88 Stat. 174);
5. Abandoned Shipwreck Act;
6. Abandoned Shipwreck Act Guidelines (55 F.R. 50116);
7. Endangered Species Act (16 USC Sec. 1531);
8. National Environmental Policy Act;
9. Protection of Wetlands (Executive Order 11990);
10. River and Harbors Act, as amended (33 U.S.C. 401-403);
11. Clean Water Act (P.L. 92-500, P.L. 100-433, and 1987 Federal Water Quality Act); and
12. Floodplain Management (Executive Order 11988).

4.4 Institutional Development

Successful management of the Salt River Bay APC will come about quicker and with more lasting results if the local community is drawn into the process in a way that promotes self-responsibility and accountability by the various user groups. Government should call upon the non-governmental community (the various associations, churches, and other commercial

and philanthropic organizations) to address certain specific components of the overall management framework, and even to finance certain elements that will have obvious payback benefits to the community.

An important component of Public Law 102-247 is the mandate that the U.S. Government and the V.I. Government are to be the two management entities responsible for the establishment and administration of Salt River Park. The Salt River Park Commission was formally established on January 15, 1993, with the Secretary of the Interior's appointment of the eight members of the Commission. The Governor of the Virgin Islands and the Secretary of the Interior are the designated Co-Chairmen. P.L. 102-247 mandates a three year deadline from the date funds are made available (Sec. 105 (c)) to develop and submit a draft General Management Plan (GMP) for the Park. The GMP shall include the following:

> Plans for management of the natural and cultural resources of the park, with a particular emphasis on the preservation of both the cultural and natural resources and long-term scientific study of terrestrial, marine, and archaeological resources, giving high priority to the enforcement of the provisions of the Archaeological Resources Protection Act of 1979 (16 U.S.C. 470aa *et seq.*) and the National Historic Preservation Act (16 U.S.C. 470 *et seq.*) within the park. The natural and cultural resources management plans shall be prepared in consultation with the Virgin Islands Division of Archaeology and Historic Preservation (Title I, Sec. 105 [2][c]).

The law establishes that the draft GMP shall be only an *advisory* plan. Exactly how the management recommendations it contains will become enforceable policy is not presently clear, but presumably the Commission will work to resolve that issue. Presumably, as well, the draft GMP will determine how the APC management plan, and indeed all other laws, policies, plans, and rules of both the federal and territorial government, will come to bear on the daily administration of the Park. Clearly, however, if any federal funds are to be spent on the Park, applicable federal laws pertaining to the management and protection of the Park's resources must be recognized and enforced (section 4.3).

The Commission, meanwhile, whether or not land acquisition funds are made available by the Federal Government, is mandated to proceed with management planning and resource protection efforts under the existing framework of the law.

DPNR has initiated the planning process for the draft GMP through a series of *ad hoc* Salt River Park committee meetings in 1992. The CZMP is working on the development of an interim management plan for the Park, that will, it is expected, serve as a departure point for Park Commission discussions. A major shortcoming of P.L. 102-247 is the absence of authority for interim management. It could thus be a minimum of three years before any

Park Authority is in place. Meanwhile, the CZM Commission will continue to act on first tier permit applications.

The Park Commission should be consulted on all matters relating to the use of land and water resources within the Park, and within an accepted (reasonable) buffer zone around the Park. The St. Croix CZM Committee should consult with the Park Commission on any proposed development, and should develop a cooperative, consensus approach to Park resource management as an interim management guideline.

In the long-term, the joint management effectiveness of the V.I. Government and the Federal Government will evolve, as will the training and development of park personnel capable of handling park administrative and enforcement needs. Nevertheless, interested NGOs and the public should have the opportunity to advise the Park Commission on matters pertaining to the Park. The Park Commission, for its part, should elicit the best management approach from all sources to ensure resource protection.

DPNR and NPS should jointly produce an interim management plan, and the selected management framework should be as close as possible to that which will eventually take shape under the GMP. Obviously, some "hybrid" institutional framework will be necessary to effect interim management, but DPNR and NPS should continue to work together and adopt a consensus management approach in all aspects of planning and decision-making so as not to undermine the spirit and intent of true "joint management" of the Park.

As part of its public information and participation strategy, DPNR should conduct a series of town meetings with all landowners within the APC to discuss the value of the Salt River Park, and ways by which the community can become integrally involved in the park planning process. Such fora could be used to promote the idea of individual responsibility in the stewardship of the area's natural and cultural resources.

Moreover, DPNR should recognize the opportunity inherent in the task of developing an interim management plan to strengthen local participation in the planning and management process, especially the individuals and NGOs which were instrumental in obtaining the Park designation. In this regard, a sense of "community ownership" of the Park should be seen as the goal.

5. CONCLUSION

It is difficult to overstate the importance and value of the vast treasures contained within the Salt River Bay APC. Numerous studies, reports, and plans have been prepared for the estuary and its environs; its natural and cultural resources are known to be many and highly significant. This Comprehensive Analytic Study and proposal for a Management Plan

attempts to synthesize what is known about the area -- its resources and their human use and conflicts -- and to encourage the expression of visionary leadership to effect immediate and meaningful resource protection. For in no other place in the Territory is there better opportunity for the people of the U.S. Virgin Islands to demonstrate their resolve to protect -- and find learning and enjoyment in -- the very best of their natural and cultural heritage.

With more than 50 percent of the mangroves of St. Croix now destroyed through human impact, the mangroves of Salt River Bay estuary represent an irreplaceable natural resource. This largest of the Territory's remaining mangrove areas is very likely the most productive as well, especially in terms of the diversity and biomass of commercially and recreationally important marine organisms which it supports. The nutrient rich waters of the estuary support a high rate of primary productivity, and a complex food chain that has evolved to survive the high natural variability in water quality that is characteristic of the estuary.

The bay depends on a combination of winds, currents, and, to a lesser extent, tides to achieve flushing. None of these factors exert very strong influence on the waters of this well-protected, semi-enclosed bay, and flushing capacity is consequently rather poor. This is good news for the phytoplankton which thrive on the long residence times of nutrients in the estuary. Unless, of course, nutrient inflow is excessive. Then, turbidity will increase and oxygen supplies become depleted, both adversely affecting the nursery function of the estuary. Unfortunately, long residence times also mean that pollutants can have pronounced lethal and sub-lethal effects on marine biota, as well.

It is therefore imperative that natural resource management of Salt River estuary be founded upon a watershed management approach. The absolute minimization and/or elimination of terrestrial sources of marine pollutants must be seen as a central goal and, to this end, the Study calls for the adoption of a single-tier permitting system for the entire watershed. Sediment delivery to the estuary from poorly planned and executed upslope development has been already demonstrated. Moreover, the lethal and sub-lethal effects of sediments on corals, seagrass beds, and mangroves through turbidity, sedimentation, and/or eutrophication are now fairly well understood. A watershed approach to management is the only hope for dealing with the cumulative impacts that can be expected from further land use in the watershed. Such an approach also represents the Government's best opportunity to plan for and design effective stormwater management systems before they add to the existing flooding potential of the Mon Bijou and Glynn areas.

A coordinated review process of all planned developments is necessary, as is increased attention to and investment in the monitoring and enforcement functions of the development control process.

In recognition of Salt River Bay's multitude of natural and cultural resources, the Salt River Bay National Historic Park and Ecological Preserve was created on February 24, 1992 with the signing of Public Law 102-247. The creation of the Park represents in itself a significant milestone in the history of the area, and the beginning of what now must become a concerted effort to afford maximum protection to this national and international treasure. The Study describes the steps that must be taken to effect the intended co-management of the Park by the V.I. Government and the U.S. Government. But until success in those efforts can be achieved, and regardless of the ability of national and territorial groups to raise funds for the acquisition of authorized park lands, the fact remains that resource protection must begin today, if further loss and degradation of the area's resources is to be avoided. The design and implementation of an interim resource protection plan should thus be seen as a top priority of the V.I. Government.

This Study offers guidelines for the development of an interim resource protection plan. It is argued that the Department of Planning and Natural Resources is best qualified on such matters as natural and cultural resource protection, and that authority and the mandate for implementation of an interim resource protection plan be granted to it. Finally, the Study describes the intended function of the Park Commission (as mandated by P.L. 102-247), and the importance of the establishment of an early consensus of the goals and objectives for Park management. Thus, the spirit of joint management and joint jurisdiction should guide the development of an interim resource protection plan, with full consultation between DPNR and the National Park Service.

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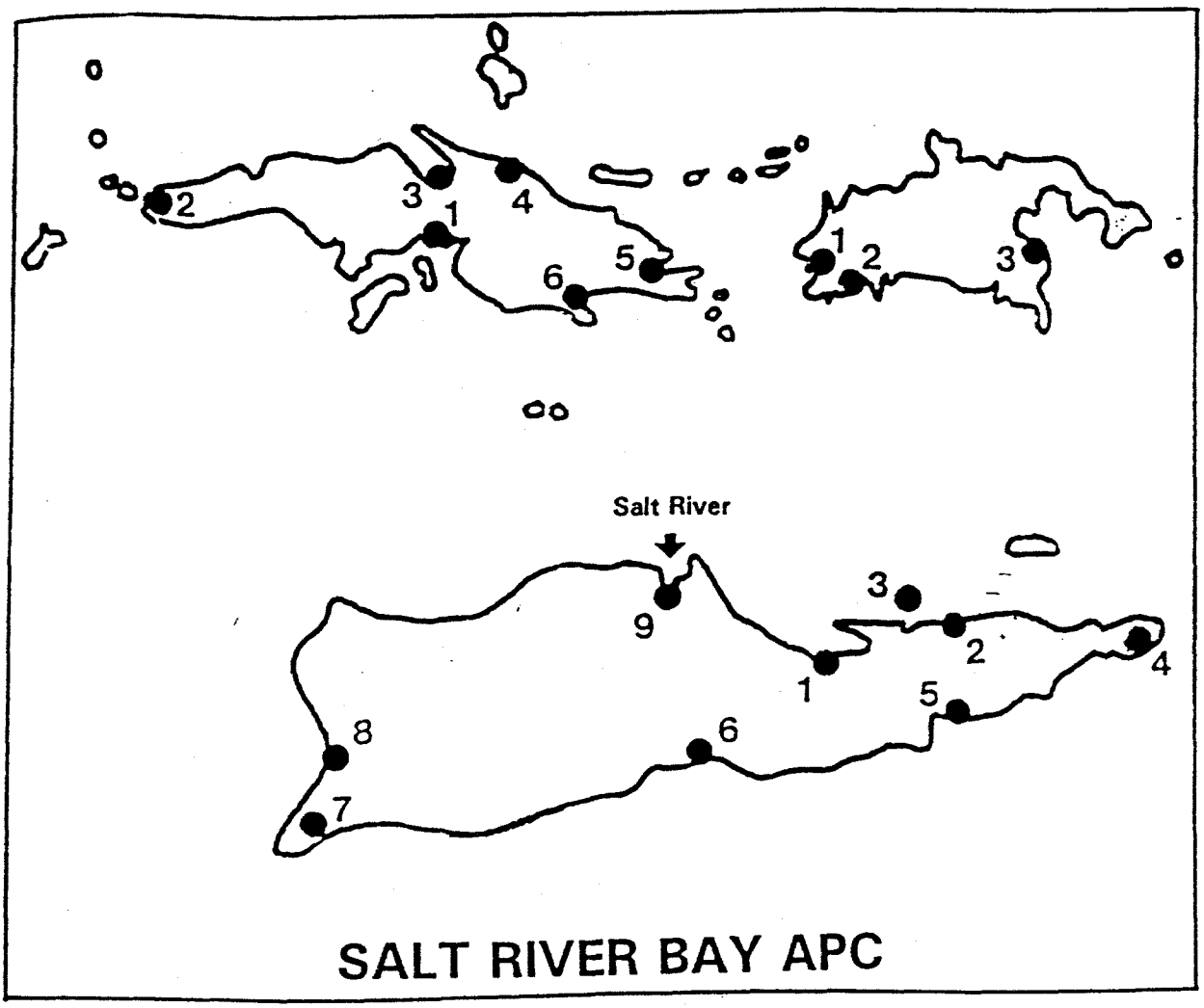
Regional APC Map



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

SALT RIVER BAY APC

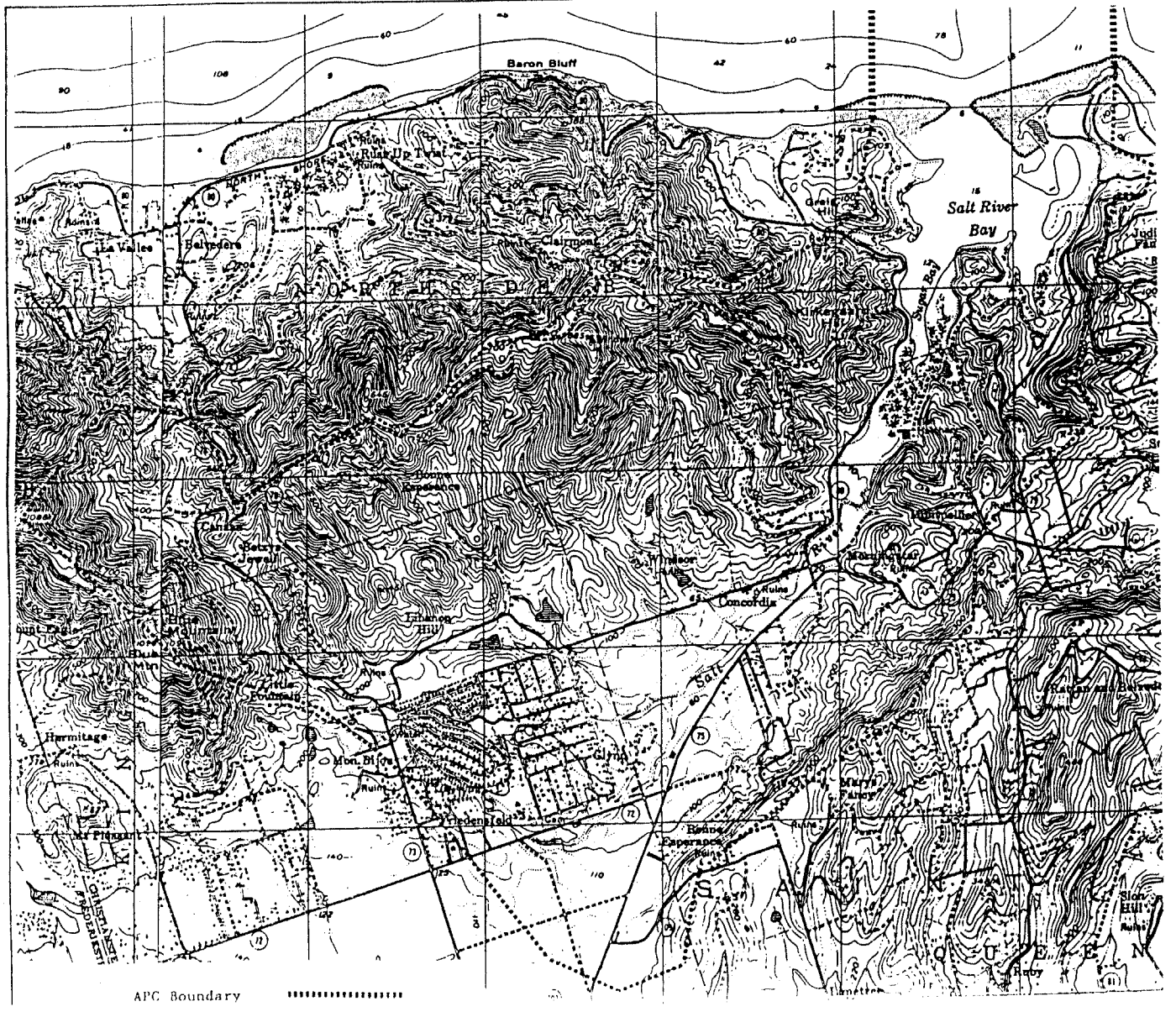


Figure 2
APC Boundary Map
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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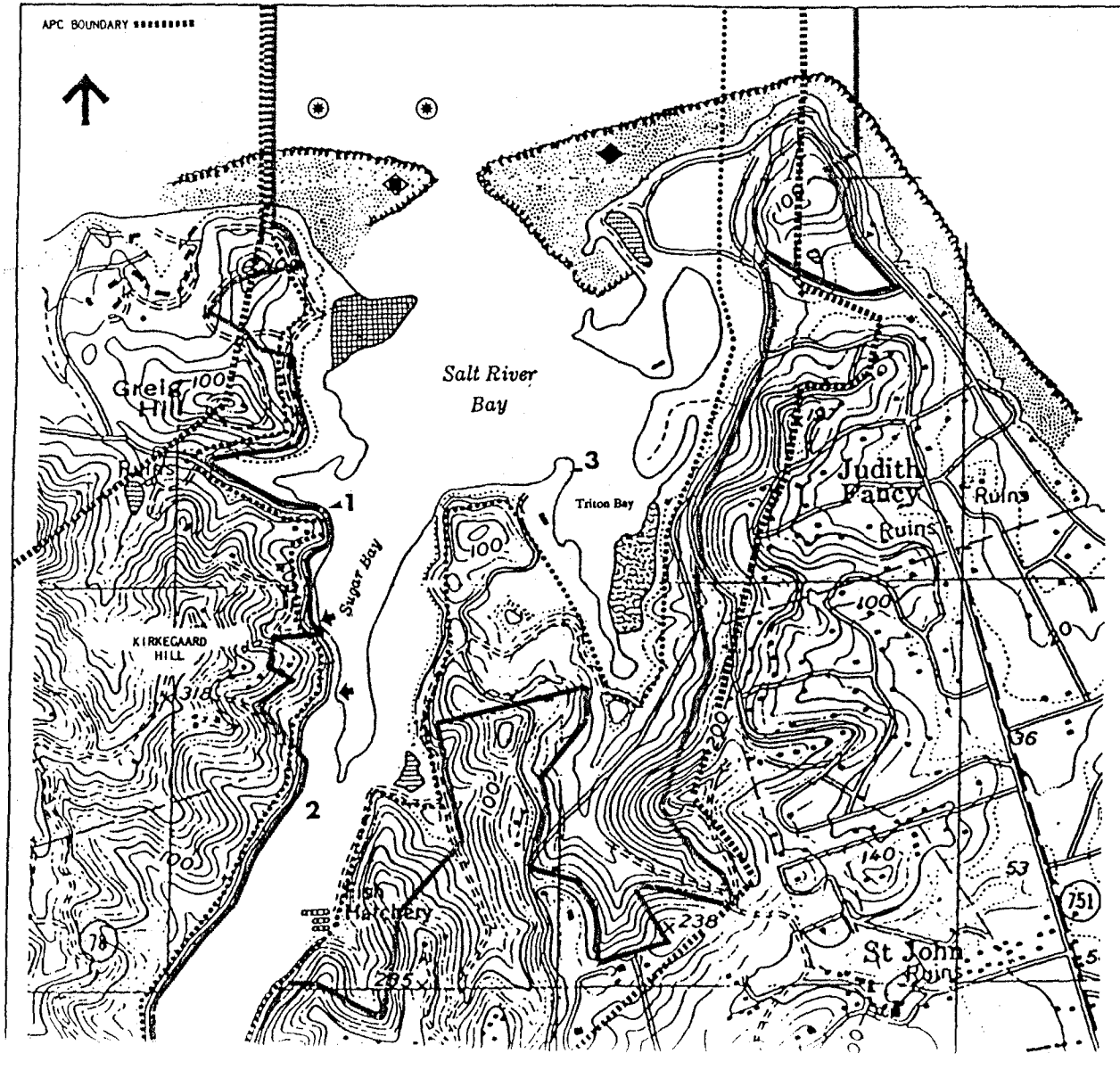

SALT RIVER BAY APC

OPPORTUNITIES AND CONSTRAINTS

1	Derelict dock; should be removed completely, along with derelict vessels on shoreline
2	Freshwater marsh altered by agriculture; area should be restored with no farming allowed
3	Location of illegally constructed private dock following Hurricane Hugo; should be removed
	Fishermen's boat ramp: improvements needed (e.g. lighting, concrete ramp, limited facilities)
	Vessel grounded (1979)
	Sailboat grounded (late 1992); no fine issued
	Permanent moorings (20'- 30' depth)
	Trinton Bay Wildlife Sanctuary
	National Historic Landmark Boundary (Columbus Landing Site)
	National Natural Landmark Boundary
	Salt River National Historic Park and Ecological Preserve Boundary

Figure 3
Opportunities and Constraints
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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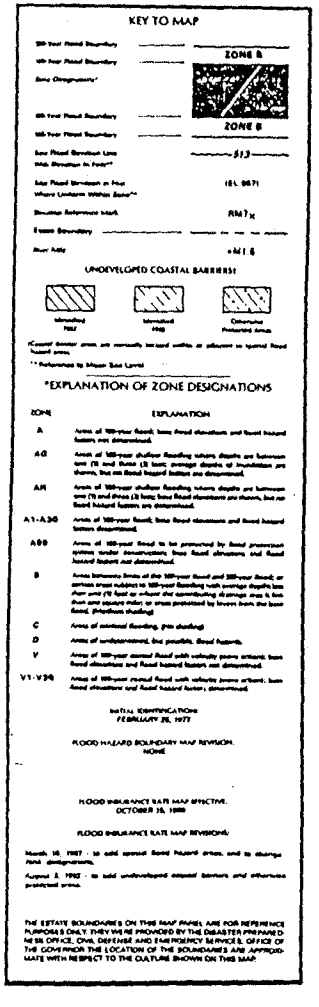
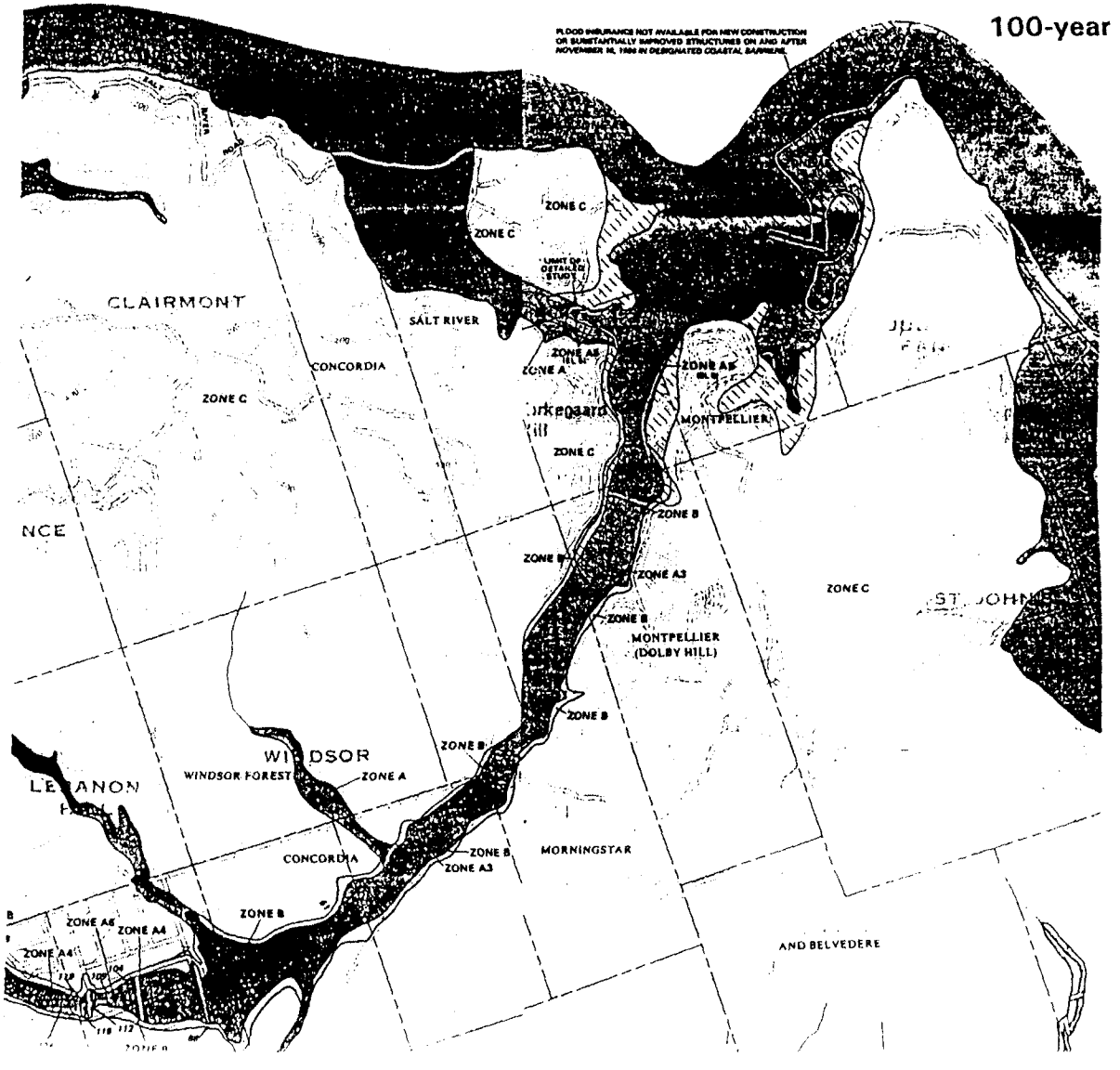


Figure 4
100-year Floodplain

SALT RIVER BAY APC

100-year Floodplai



Coastal Barrier Resources Syste

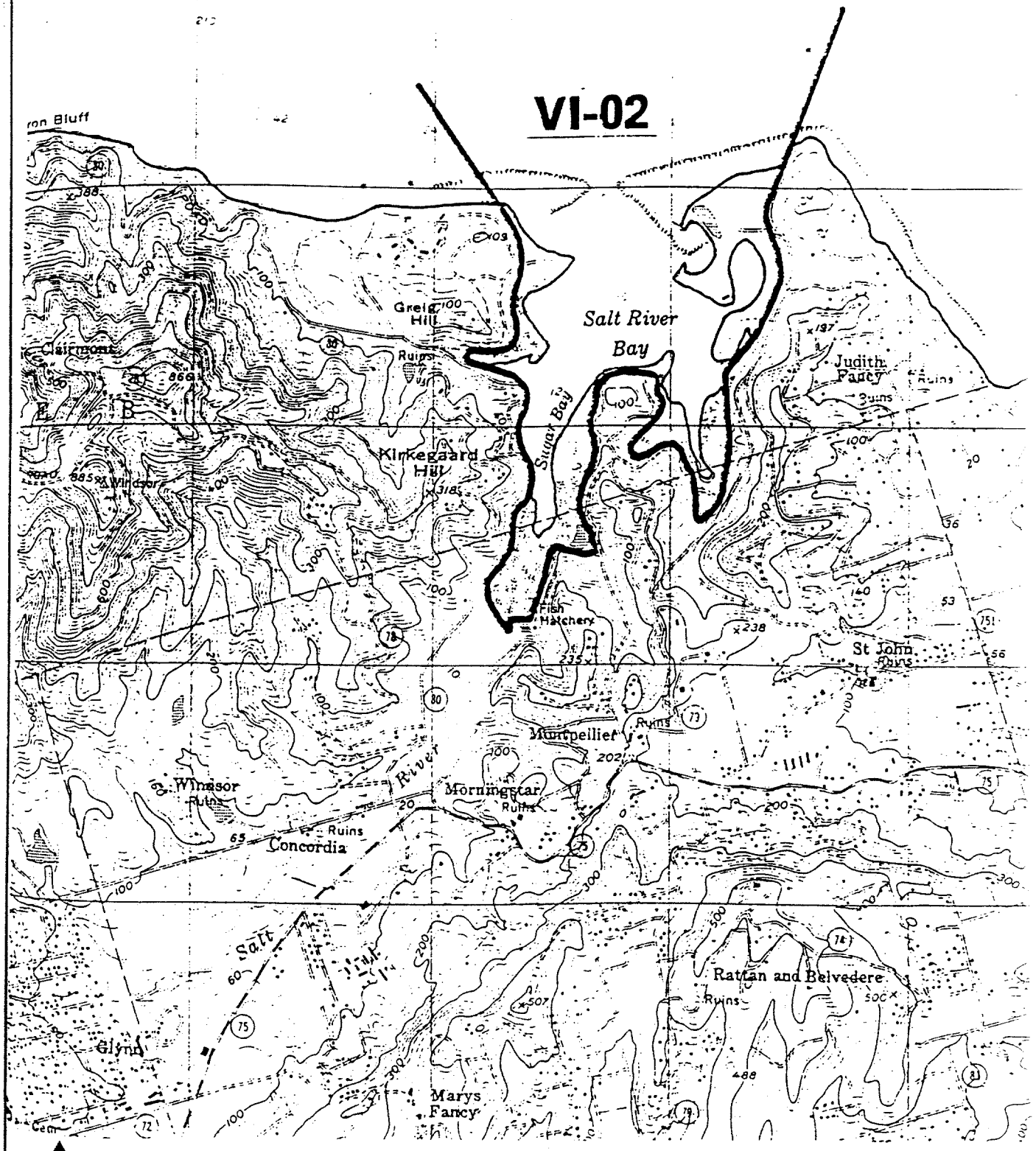


Figure 5
Coastal Barrier Resources Syste
Adapted from: USFWS, 1990
Island Resources Foundation, 19

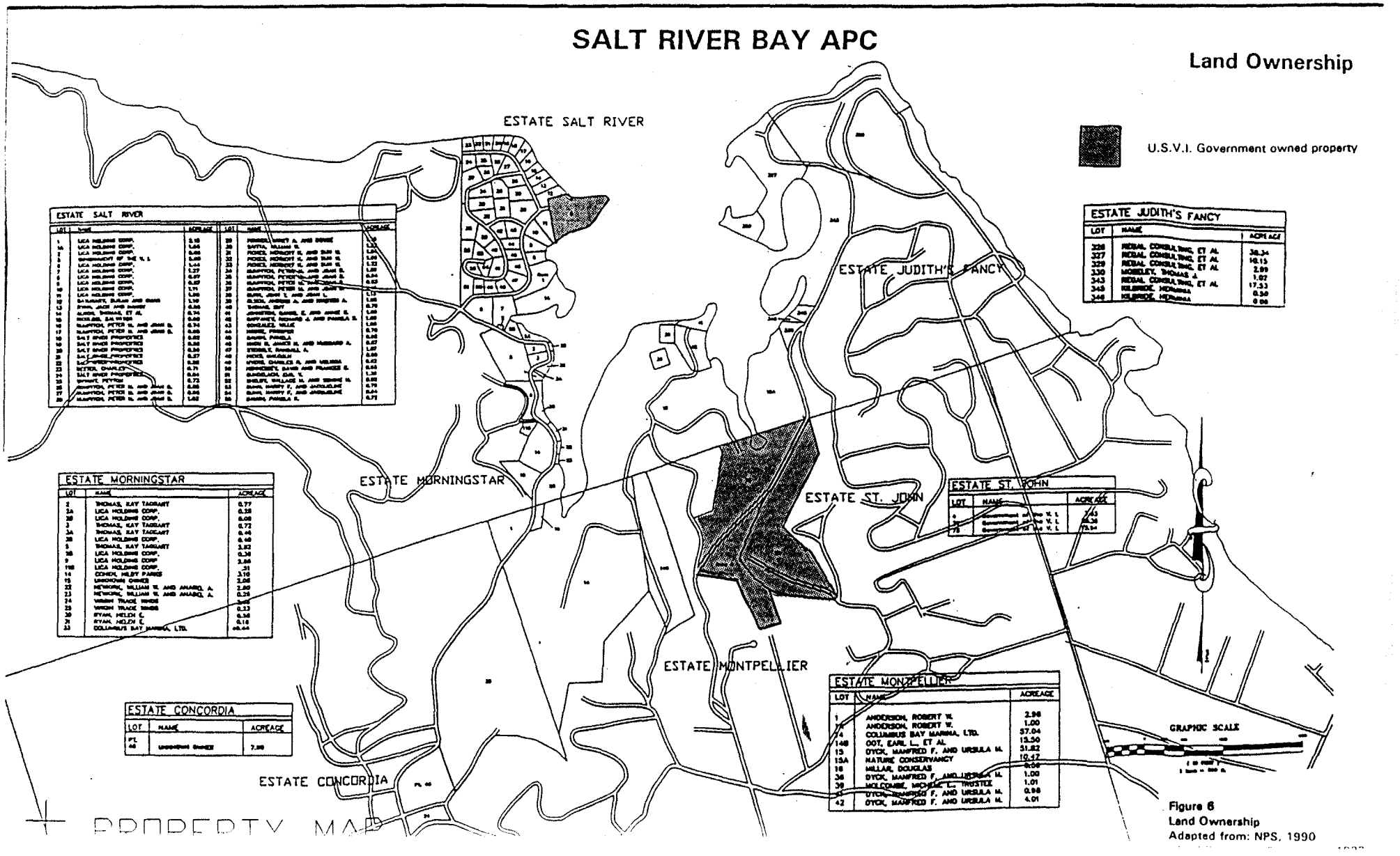
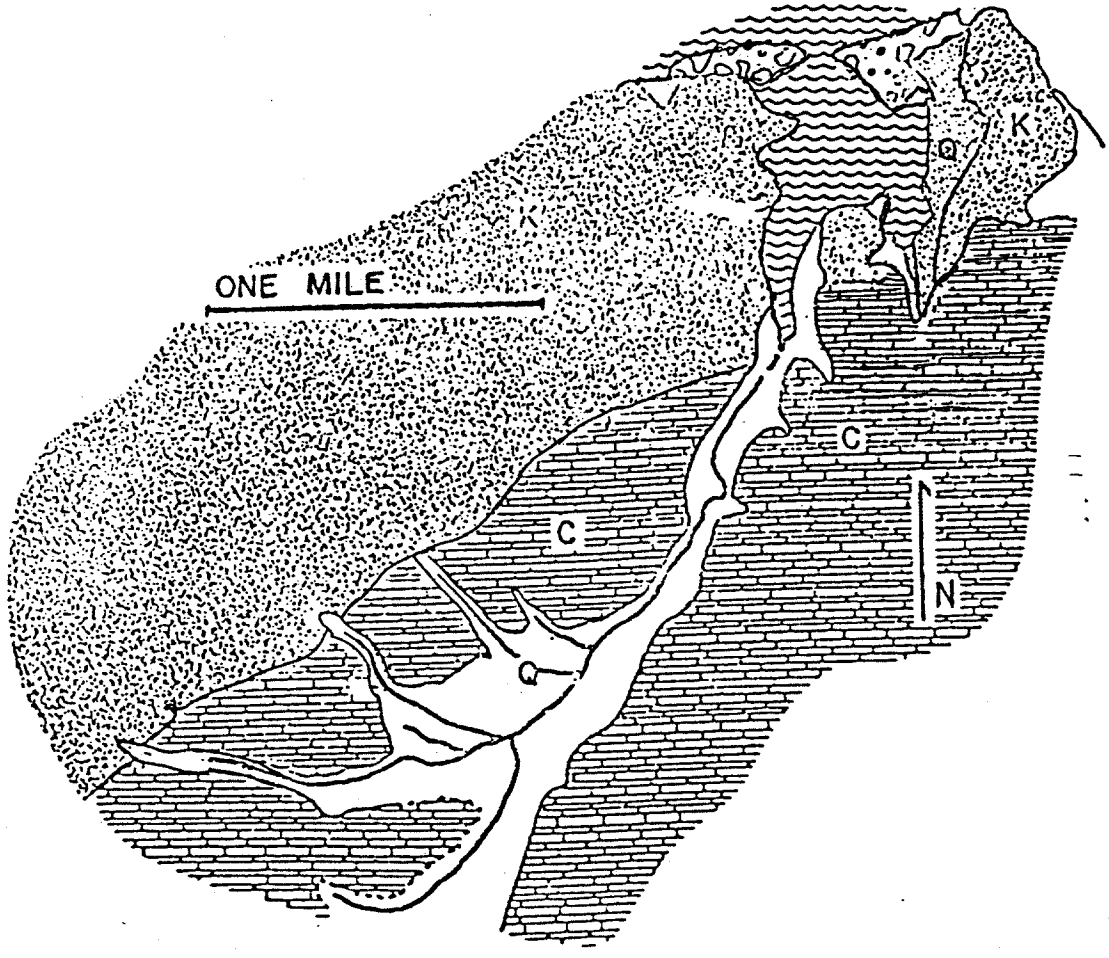


Figure 6
Land Ownership
Adapted from: NPS, 1990

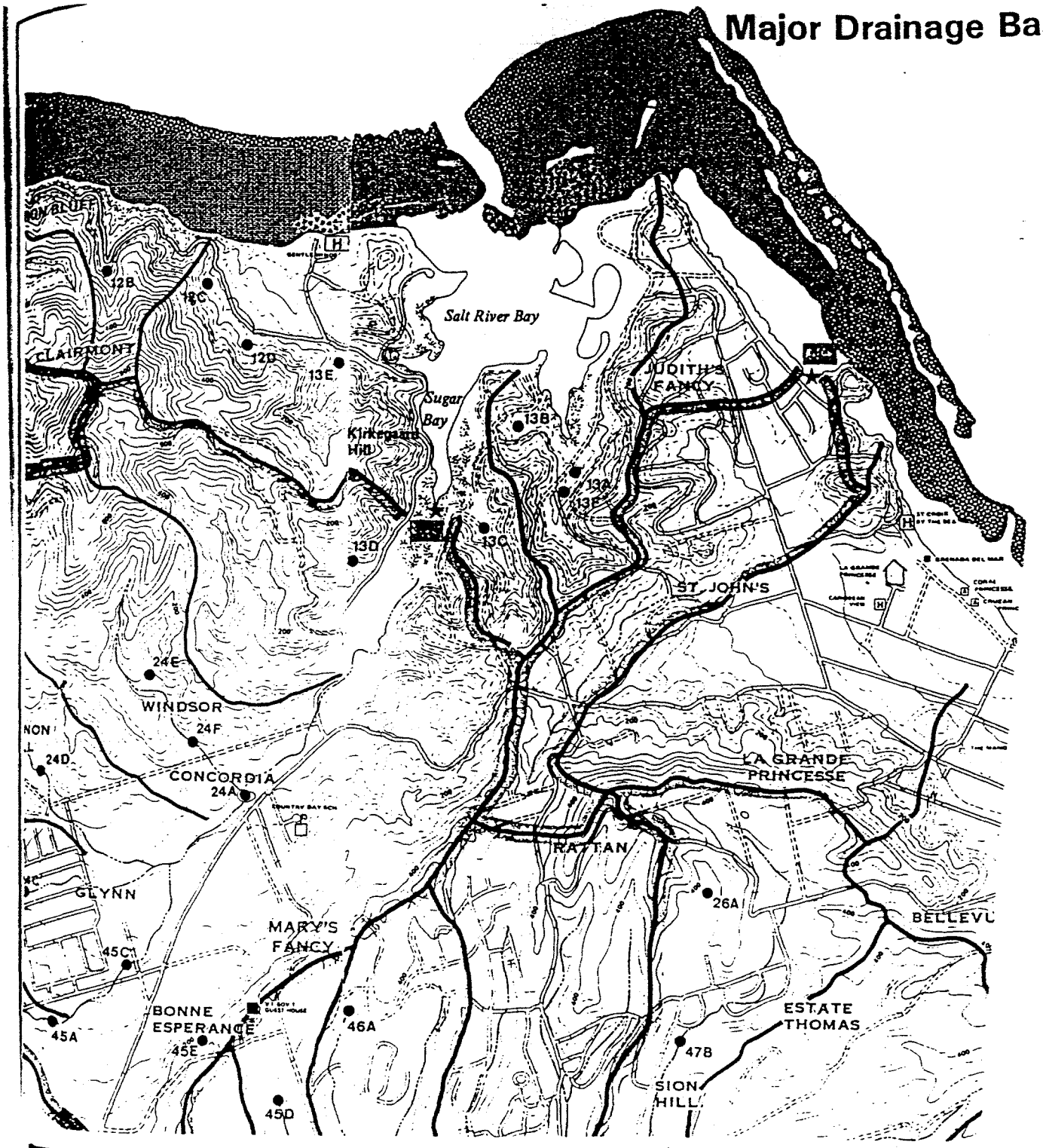
SALT RIVER BAY APC
Geology of Salt River Basin



Generalized geologic map of Salt River drainage on St. Croix. K (stippled area) is Cretaceous Judith Fancy Formation, C (block patterned area) is Oligocene Jealously Formation and Miocene Kingshill Marl undifferentiated, and Q is surficial sediment. Fine stipple with Q is beach deposit. Wavy pattern is Salt River estuary and Caribbean Sea.

Figure 7
Geology of Salt River Basin
Adapted from: Gerhard & Bowman, 1975
Island Resources Foundation, 1993

Major Drainage Basi



LAND SYMBOLS

- Significant Drainage Divides
- Boundary of Major Drainage Basins
- ★ 789 acres — Area of Major Basins as Measured to Star

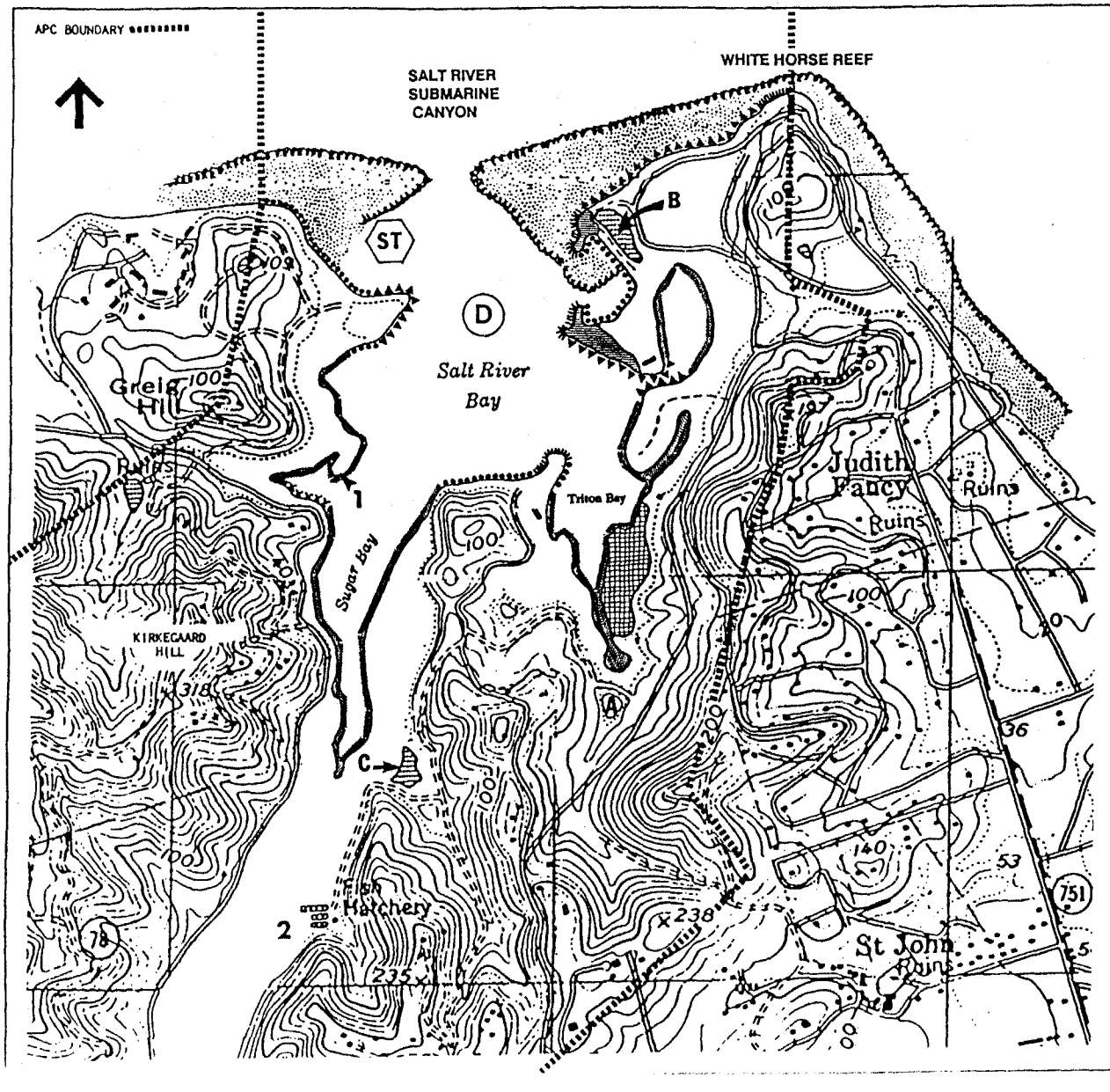
REEF SYMBOLS

- Pavement
- Deep Reef
- Shallow Fore Reef
- Mixed Corals
- Algal Ridge

Non-reefoid areas have been left blank. These include sand, mud, and terrigenous rubble.

SALT RIVER BAY AP

Figure 8
Major Drainage Basins
Adapted from: BC&E, 1979
Island Resources Foundation, 199



SALT RIVER BAY APC

PHYSICAL AND BIOLOGICAL FEATURES

• • • •	Fine-grained sand beaches
▲▲▲▲	Mixed sand and gravel beaches
ıllıllıllı	Gravel beaches and exposed riprap
XXXX	Coastal structures and rocky shores
▬▬	Sheltered mangroves (does not depict landward areal extent of mangroves)
A	Freshwater pond; man-made, migratory aquatic birds
B	Salt pond; man-made
C	Salt pond; White mangroves
D	Shallow sediment sill
1	Bird nesting; cattle egrets, little blue herons
2	Swamp fern (Achrosticum danaefolium)
	Triton Bay Wildlife Sanctuary; mangroves, salt flats, and dry forest
	Least tern *(Sterna antillarum)* nesting grounds
ST	Sea turtles (nesting on sand beaches)

Figure 9
Physical and Biological Features
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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SALT RIVER BAY APC

LAND AND WATER USE

Residential

111 Low density
112 Medium density

Commercial & Services

120 Retail services / commercial

Institutional

160 Public institutions & public facilities

Recreational

177 Outdoors recreational facilities

Agriculture

210 Cropland / pastureland

Figure 10a
Land and Water Use (entire watershed)
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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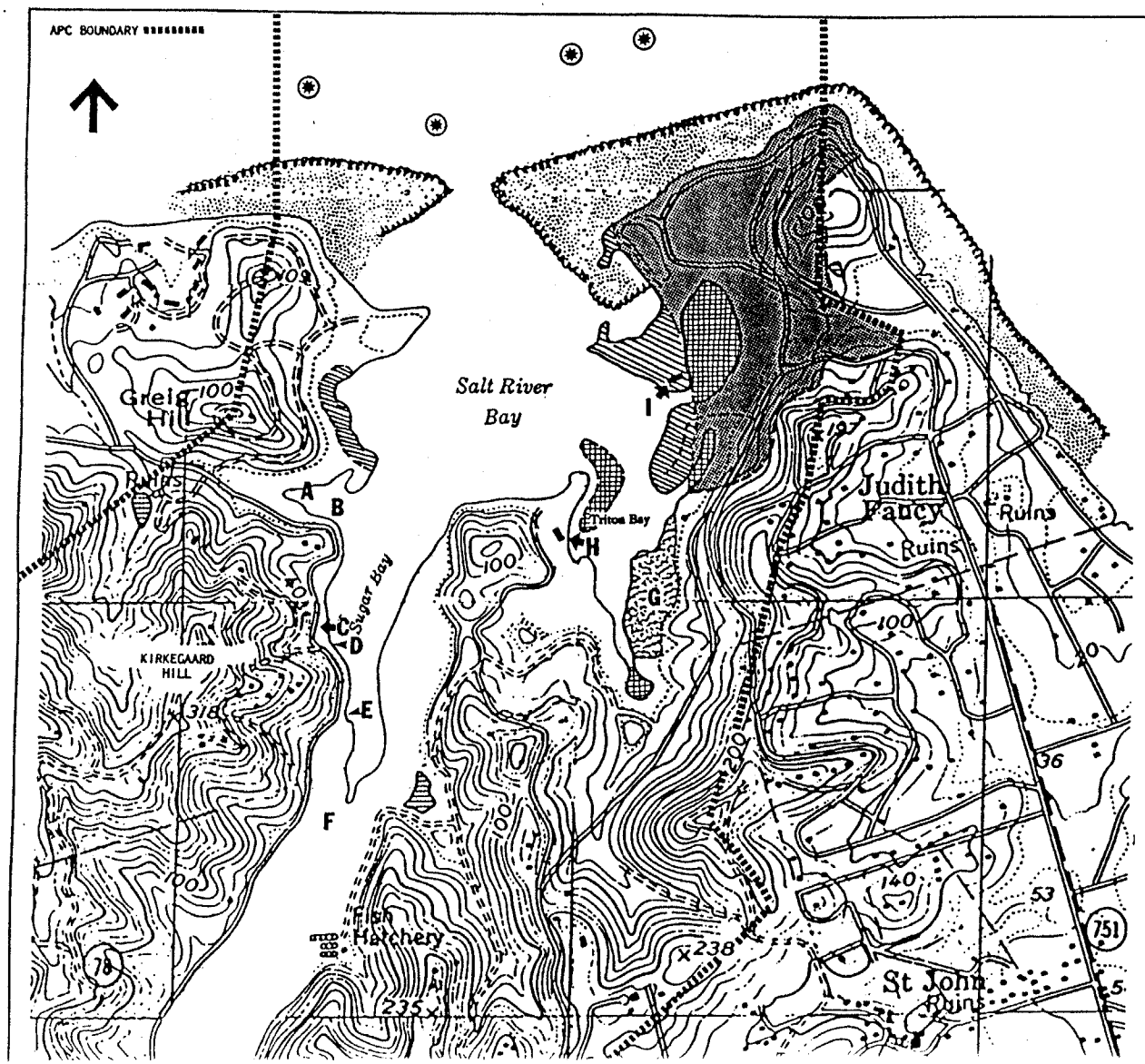
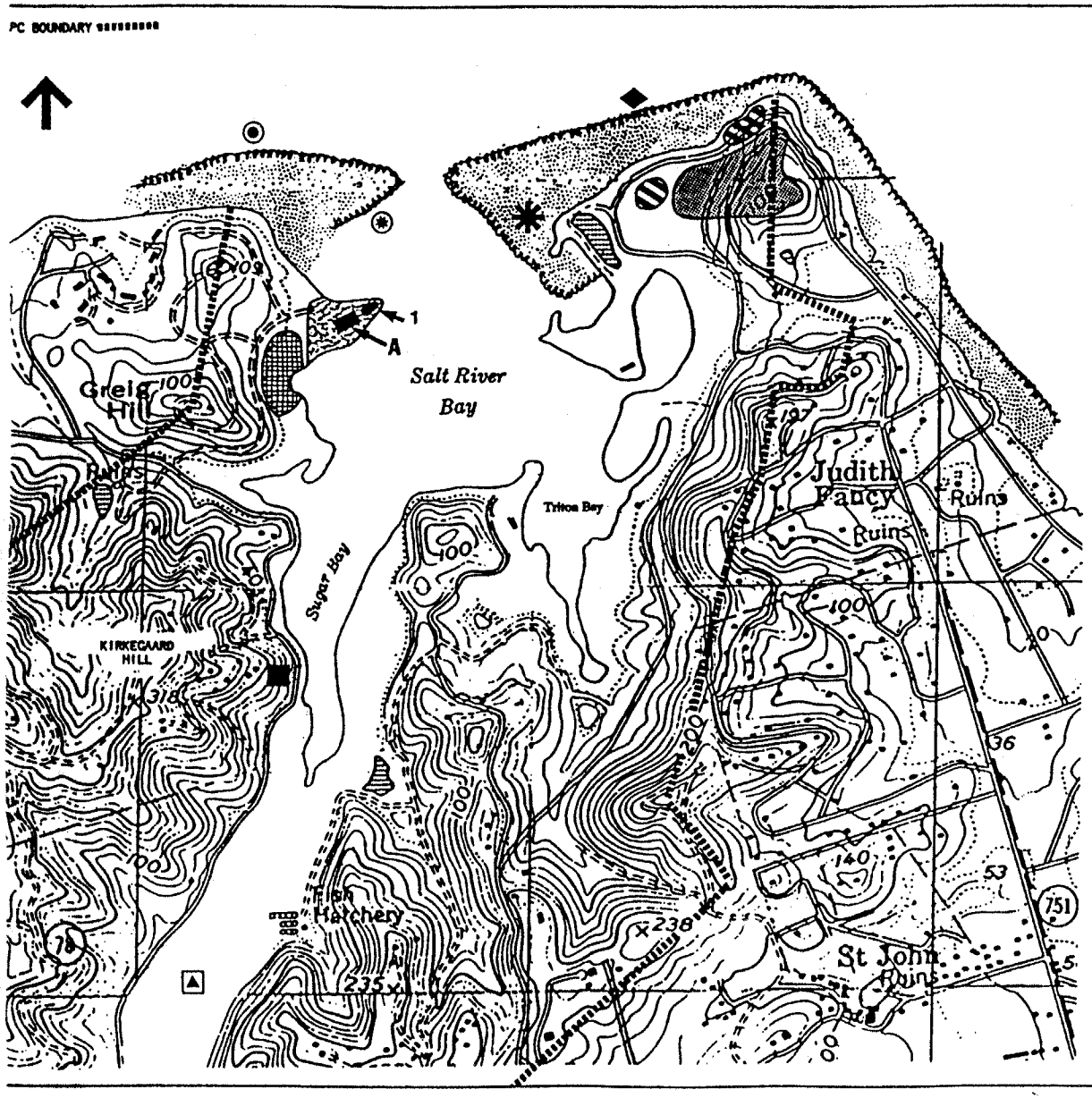


SALT RIVER BAY APC

LAND AND WATER USE

A	Salt River Marina; involves dredging, filling, and bulkheading; boat building activities.
B	Derelict dock (destroyed by Hurricane Hugo); was part of Salt River Marina.
C	Proposed development: Columbus Landing; CZM permit application currently on-hold; includes marina, restaurant, shopping and office complex.
D	Fishermen's boat launch ramp
E	Fishermen's boat launch ramp
F	Agriculture in lower floodplain; has altered hydrology of freshwater marsh and adjacent mangrove system.
G	Triton Bay Wildlife Sanctuary (TNC); mangroves, dry forest, and salt flat.
H	Former site of the J. Faile Marine Research Station and dock for Hydrolab
I	Derelict structure; hotel and large cistern partially completed, abandoned.
	Permanent moorings (20'-30'depth); heavily used by commercial dive operators.
	Dredge areas
	Filling or dredge disposal
	Proposed Virgin Grand development

Figure 10b
Land and Water Use (Salt River Bay Area)
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993



SALT RIVER BAY APC

CULTURAL RESOURCES

Prehistoric Sites

A — Taino Village and Ballcourt

Cabo de las Flechas

Indian Burial Grounds/Settlements (entire general area)

Multi-component archaeological site

Historic Sites

1 — French Settlement Site/Fort Sale

Danish Customs House

17th Century Village Site

17th/early 18th Century Anchor

1493 Skirmish Site

Early 18th Century Shipwreck

Anchorage of Columbus Flotilla (1493)

Columbus Landing Site; National Historic Landmark

Figure 11
Cultural Resources
Base map adapted from: USGS, 1982
Island Resources Foundation, 1993

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SALT RIVER BAY NATIONAL HISTORICAL PARK AND ECOLOGICAL PRESERVE

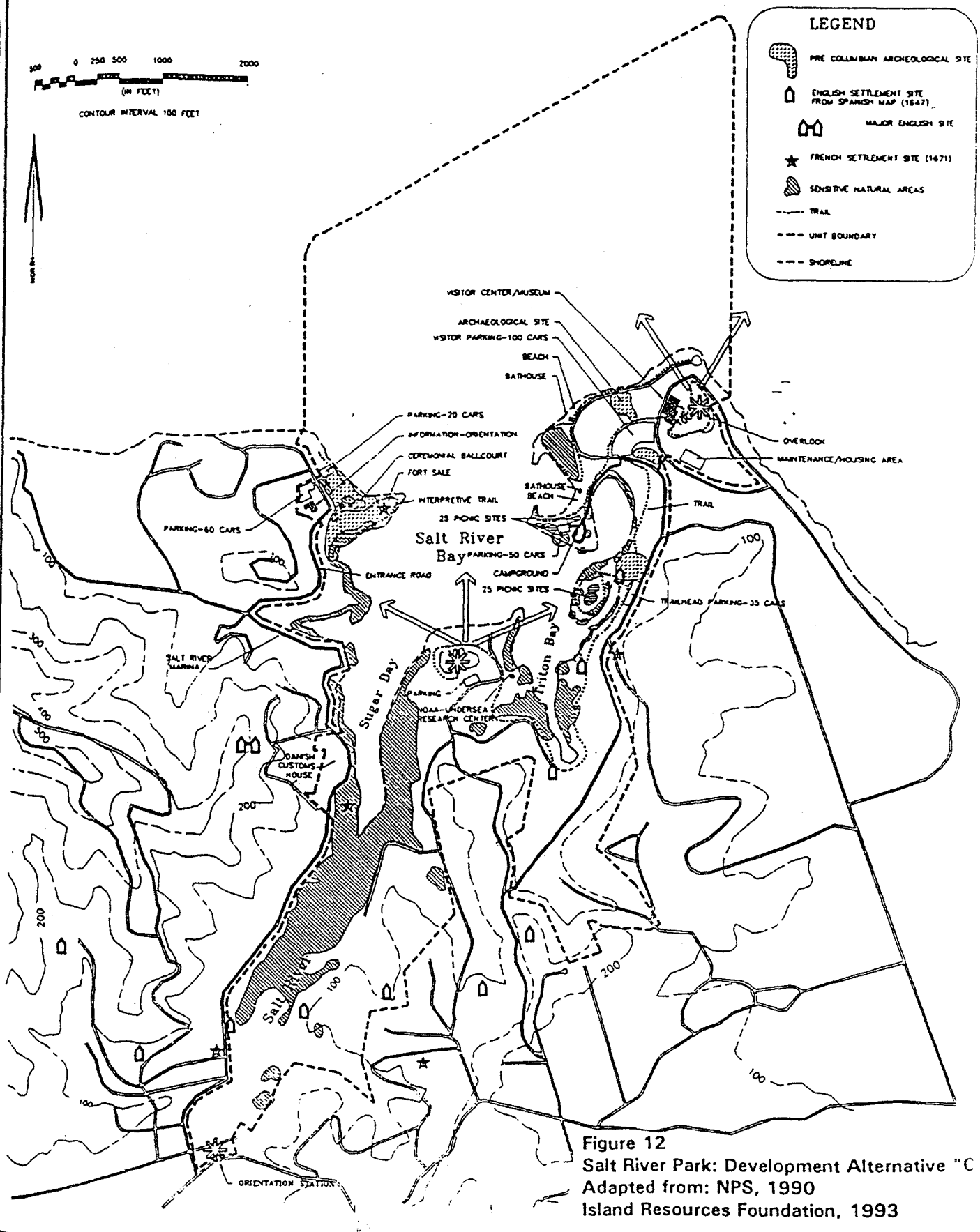

Figure 12
Salt River Park: Development Alternative "C
Adapted from: NPS, 1990
Island Resources Foundation, 1993

SALT RIVER BAY APC

Existing Zoning
(lower watershed)

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

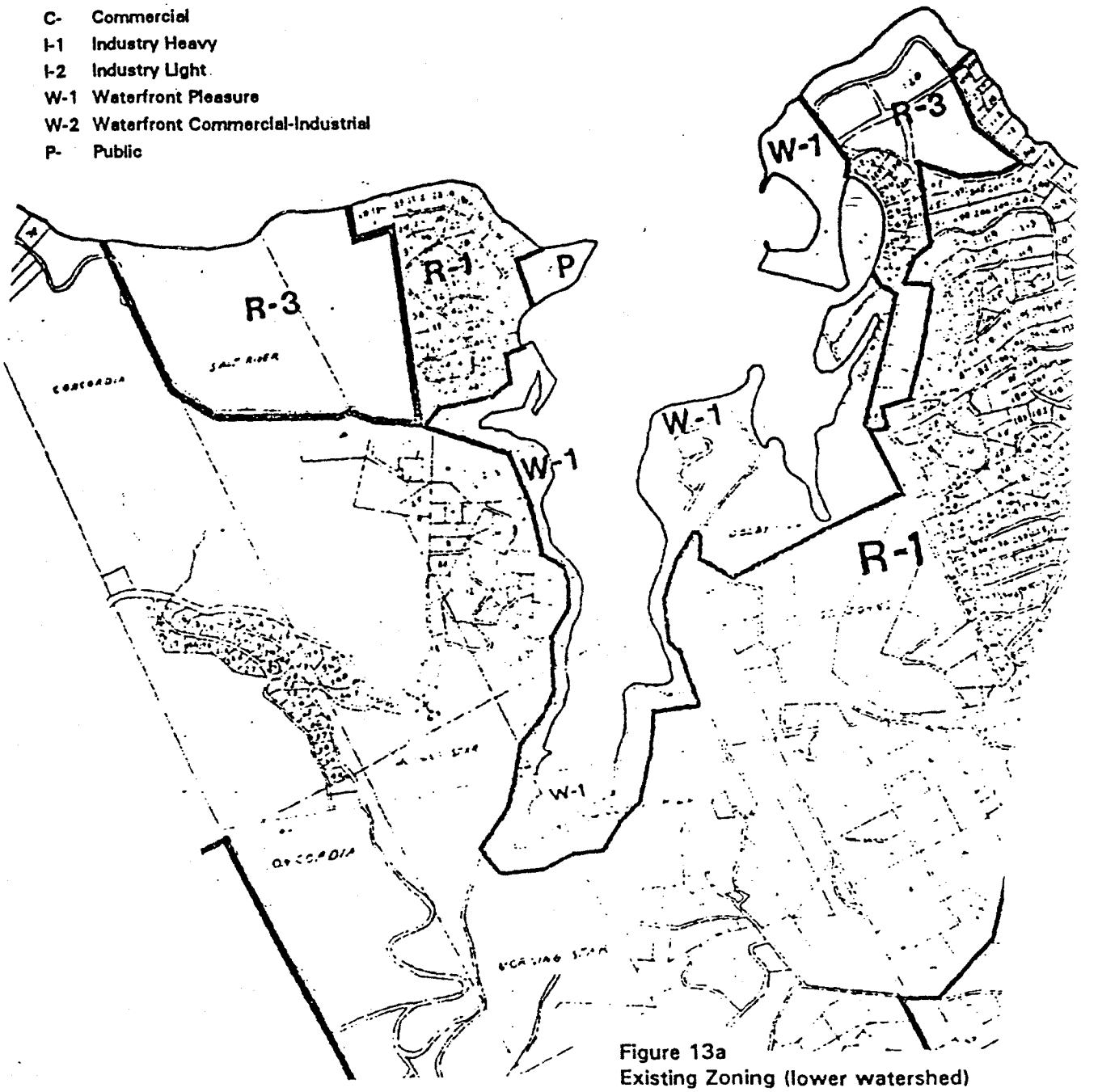

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Figure 13a
Existing Zoning (lower watershed)
Adapted from: Real Estate Data, Inc., 198
Island Resources Foundation, 1993

SALT RIVER BAY APC

Existing Zoning
(upper watershed)

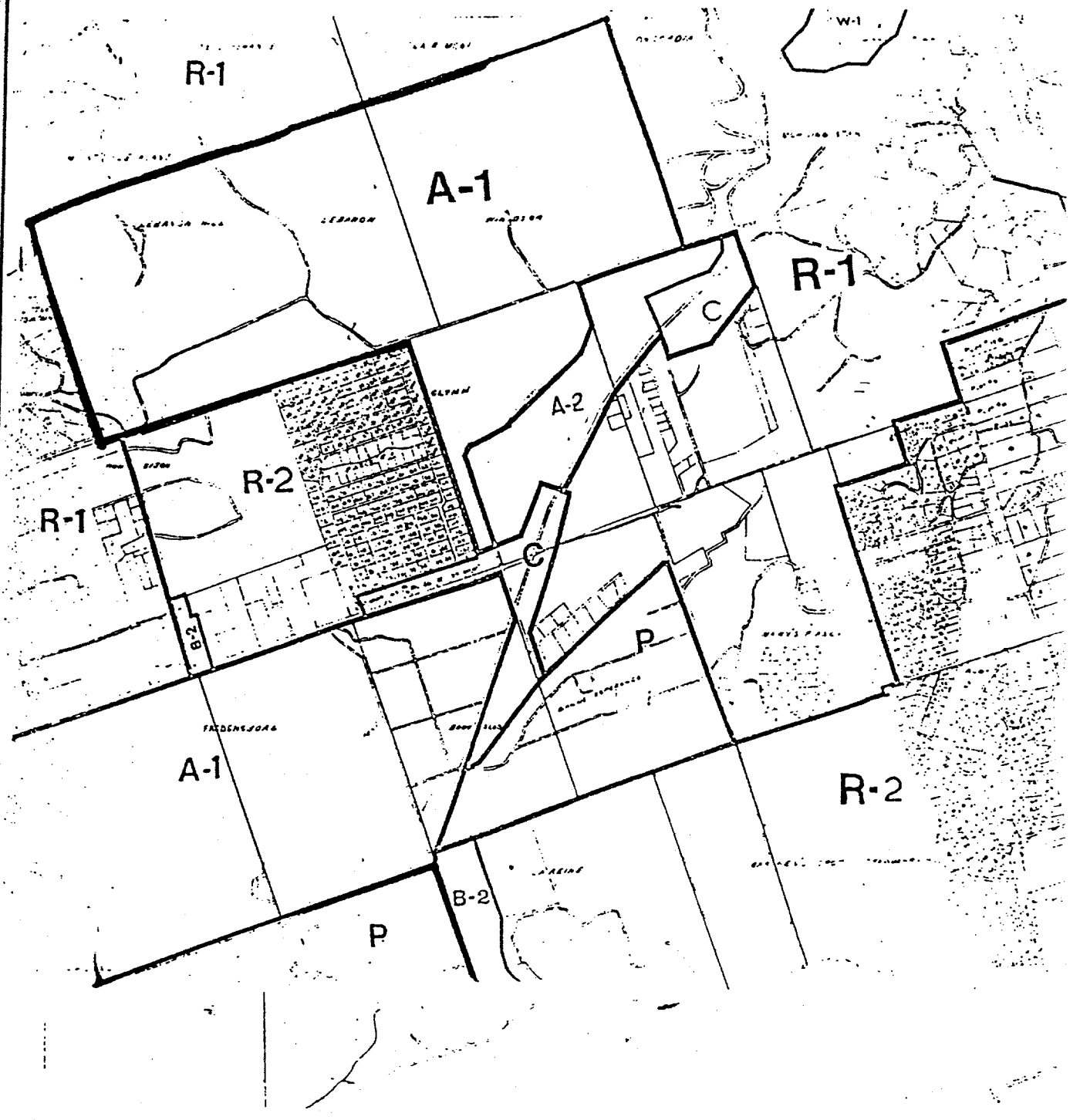

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Figure 13b
Existing Zoning (upper watershed)
Adapted from: Real Estate Data, Inc., 198
Island Resources Foundation, 1993