64560

The Southeast Peninsula Project in St. Kitts

Volume I: Resource Management Plans

DESFIL

Development Strategies for Fragile Lands

624 9th Street, N.W., 6th Floor, Washington, D.C. 20001

Development Alternatives, Inc.
Tropical Research and Development, Inc.

in association with:

Earth Satellite Corporation
Social Consultants International

VOLUME I
RESOURCE MANAGEMENT PLANS

by

Mark T. Brown Ph.D., Senior Editor

May 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

2

TABLE OF CONTENTS

VOLUME I: Resource Management Plans

Introduction
by Mark T. Brown, Ph.D.

1. **Terrestrial Resource Management Plan**
   by Mark T. Brown, Ph.D.

2. **Forestry Resources Management Plan**
   by John Buchter, M.S., L.L.D.

3. **Wildlife Resources Management Plan: Shorebirds**
   by Robert Norton, Ph.D.

4. **Wildlife Resources Management Plan: Mammals**
   by Robert Young, Ph.D.

5. **Wildlife Resources Management Plan: Sea Turtles**
   by Karen Eckert, Ph.D.

6. **Marine Resources Management Plan**
   by Evelyn Wilcox, M.S.

7. **Natural Resources Management Plan: Stormwater, Wastewater and Solid Waste Management**
   by Gregory L. Morris, Ph.D.

8. **Geodynamics, Land Stability, Earth Resources and Management Considerations**
   by Antony R. Orme, Ph.D.

9. **Morphodynamics, Sediment Characteristics, and Management Considerations**
   by Amalie J. Orme, Ph.D.

10. **Prospects for Marina Development**
    by Antony R. Orme, Ph.D.

11. **Scenic Vista Protection, Preservation and Management Plan**
    by Ted Baker, A.S.L.A.

INTRODUCTION

This document is the first volume in a three-volume set of planning documents prepared for the Southeast Peninsula Land Development and Conservation Board, St. Kitts. The volume contains reports prepared by scientists and planners who studied the environment and resources of the SEP. Their studies were intended to provide information and management suggestions to the Board to be used as the first step in preparing a regulatory framework with which the Board and Government may protect the special qualities and environmental resources and at the same time not unduly hinder development of the SEP.

Preface

Formerly accessible only from the sea or by jeep trail, the Southeast Peninsula was largely unknown and untrod by the great majority of Kittitians. For decades past, however, the prospect of opening the Peninsula to development was an ever present though elusive objective of both government and far-sighted entrepreneurs. Constituting almost 10 percent of the land area of St. Kitts and containing the best beaches, abundant wildlife and outstanding scenic vistas, development of the Southeast Peninsula offered the prospect of freeing St. Kitts from almost total dependence on sugarcane for its economic well-being. With careful planning to protect the natural resource environmental attributes of the area, the Peninsula offered the potential of generating a significant source of new income and revenue through major tourism development. The key to such development was the construction of a penetration road and the provision of related infrastructure.

While an earlier development effort in Frigate Bay proved that tourism could provide significant economic benefits, the potentials presented by the Southeast Peninsula dwarfed those of any previous undertakings. The dream became reality in September of 1986 when the Government of St. Kitts-Nevis concluded a loan agreement with U.S.A.I.D. for the construction of a 10 km. penetration road from Frigate Bay to Major's Bay. This long-term, low interest loan was supplemented by a grant for the preparation of a land use management plan and related uses. To ensure the effectiveness of the planning effort, the Southeast Peninsula Land Development and Conservation Board was created by statute, and came into operation on December 15, 1986. On October 12, 1987 a letter of commitment was signed by U.S.A.I.D. clearing the way for the beginning of road construction.

Technical assistance to St. Kitts through its Southeast Peninsula Development Board was provided by the Development Strategies for Fragile Lands (DESFIL) Project through a contract with Development Alternatives, Inc. Tropical Research and Development Inc. as subcontractor has been responsible for the St. Kitts SEP project. DESFIL assists the Latin American and Caribbean and Science and Technology Bureaus of U.S.A.I.D. in their regional programs to arrest the degradation of natural resources while encouraging increased development. This project was designed to:

1. Monitor the environmental impacts of the 10 km. road which will penetrate the Peninsula;
2. Provide support to the Southeast Peninsula Development Board in carrying out its function for land use management;

3. Implement the essential mitigation measures identified in the SEP Environmental Assessment Report prepared by the Island Resources Foundation (1986);
4. Train personnel in land use management and environmental protection;
5. Provide analysis of government policies regarding investments;
6. Develop a streamlined guidance system for the preparation, processing and approval of plans for peninsula related investments; and
7. Design and implement an environmental education program that will create an awareness of the value of natural resources throughout the island and the SEP in particular.

Background

In October of 1987 the government of St. Kitts/Nevis embarked on a program to build an access road from the main island of St. Kitts, south eastward over a here to fore undeveloped privately-owned peninsula known locally as the Southeast Peninsula. The road was funded through a low-interest loan to the government of St. Kitts/Nevis from U.S.A.I.D. These studies and the preparation of the land use management documents were funded through a grant to the government of St. Kitts/Nevis from U.S.A.I.D. Earlier work by the Islands Resources Foundation culminated in an Environmental Assessment Report (EAR) which suggested that attention be given to developing a planning and regulatory framework to control development that would surely follow completion of the road.

Undertaken to investigate three basic concerns related to environmental degradation, the EAR addressed:

1. Changes in biological diversity;
2. Loss of endangered species; and
3. Loss of aesthetic, recreational, archaeological, scientific, or economic values. The report concluded that the road construction should not provide unreasonable degradation provided certain conditions were met. The conditions included:

    a. An erosion control/sedimentation plan be implemented,
    b. A separate professional engineering contract for supervision of the road and adherence to environmental mitigation be instituted, and
    c. The initiation of an Environmental Management unit to design and implement a coastal zone management program. This project and the reports contained in this three-volume set are an out growth of that earlier work.

The overall objective of this project was to provide technical assistance that would guide and encourage development activities on the SEP so that the economy of St. Kitts/Nevis would be strengthened and at the same time the natural resources of the Peninsula were not degraded. The major challenge to the technical assistance team was to establish and gain the needed support from government and citizens to ensure that the objective became reality.

Development Issues

The issues surrounding development of the SEP might be summarized as follows:

1. Developmental impacts on terrestrial environments and wildlife;
2. Developmental impacts on marine resources;
3. Effective solid and liquid waste treatment and stormwater management;
4. Health and safety of SEP occupants resulting from geodynamics and land stability of the Peninsula;
5. Fiscal impacts on Government revenues and expenditures.

Effective and vital development of the SEP must create a balance between full development on the one hand and full preservation of the environment on the other. The balance sought is one of compatible development at a scale and intensity, and with appropriate environmental safe guards, that will ensure the long-term viability of the terrestrial and marine resources.

It has been suggested, and many plans have already been unveiled confirming these suggestions, that the main uses of the SEP in the future will be for tourist related activities and second (vacation) home sites. It is no secret that sustainable tourist development must have something special, something that is unique enough, attractive enough, to compete in the "market place" with other tourist destinations. The SEP is just that. A rugged, nearly undeveloped, tropical landscape with incredible scenic vistas and marine resources, and a wide variety of resident and migratory wildlife. However these very same attributes that act as the draw, can easily disappear. Just as it is obvious that the land of the SEP is not infinite in quantity, its special qualities and environmental resources are not infinite. Full development will detract and obliterate most scenic qualities and wildlife and insensitive development has the capacity to destroy most marine resources.

If it were only the finances and futures of a few private land owners that are at risk here, there would be no need for concern on the part of Government. However, the risk is much more wide spread and affects the livelihood of many more individuals. It may be said, that in the long run, the entire economy of the island is at risk. In the short run, taxes collected on land sales and increases in Gross Domestic Product resulting from construction activities will benefit Kittitians, but in the long run, the sustainability of the tourist based development and resulting Government revenues depends on a positive competitive position in the Caribbean tourism market place. "Upscale hotels" and a healthy, vital, and attractive environment are the key to maintaining a competitive position.

Ultimately, the affairs of humans, their economies and their social fabric depend on the surrounding environment. That tourism is dependent upon a healthy environment is quite obvious. Where environmental deterioration has occurred, and where environmental values are low, tourism does not flourish. The greater the environmental values, the greater the potential for tourism. That is why it is of utmost importance that the environment, both the terrestrial and marine environments, are protected and their continued health becomes the concern of all Kittitians.

6

Observations and inquiries concerning the best fishing and diving areas have lead to the inescapable conclusion that the marine environment of the SEP is the single most important commercial fishing and recreational diving area within the nation. The impact of a deterioration in the quality of the marine environment will not only affect tourism, but has the potential of affecting the livelihood of a large number of citizens of St. Kitts/Nevis whose source of income is directly dependent on the quality of the marine environment surrounding the SEP. Sustaining a healthy terrestrial environment, that is one that is productive, green, not prone to erosion, and that does not pollute the surrounding marine environment, is an integral part of balancing development with environmental protection. Increased pollution and erosion of the terrestrial environment ultimately means increased pollution and sedimentation of the marine environment.

It was with these implications in mind that the scientists and planners who were associated with this project embarked on a two year study of the social, cultural, physical, and biological environment of the SEP. The goals were to discover, study, and communicate the special qualities of the SEP that are important to the economy and citizens of St. Kitts/Nevis, and to develop management strategies, plans, and a regulatory framework that would protect those special qualities. Taken one at a time, each of the Resource Management Plans explores the issues, suggests sensitivities, and suggests management alternatives for individual aspects of the SEP. Taken as a whole, and searching through each for common suggestions and a collective approach to landscape management, we have produced the Proposed Land Use Management Plan and the Handbook of Development Guidelines and Considerations for the Southeast Peninsula that are published as Volume II of this three-volume set of planning documents. The following summary is a synthesis of the most critical issues and collective suggestions from each of the Resource Plans and is intended as an overview from which an overall strategy for balancing development interests and environmental protection may be derived.

SUMMARY AND RECOMMENDATIONS:
Issues and Management Suggestions

In this section, each of the five issues listed above are discussed separately and management suggestions and recommendations from all Resource Management Plans that may reflect on that issue are summarized. In this way, no matter where an issue is discussed and management suggestions made, they are summarized in one place for easy and quick reference.

ISSUE 1: Developmental Impacts on Terrestrial Environments and Wildlife

The value of natural lands and wildlife to tourist economies is increasingly recognized as more travelers seek out destinations that have not become overly developed. Natural lands and wildlife that are treated as an integral part of a tourist development plan become a no cost, self-sustaining amenity that has the potential to increase total number of tourists, number of tourist days, and ultimately total revenues received.

The loss of natural lands that may occur on the SEP as development grows will result from three different mechanisms. First there will be the direct losses associated with clearing of vegetation and cuts and fills for building sites, roadways and miscellaneous facilities. Second, there will be secondary impacts caused by erosion and sedimentation from newly cleared lands and uncontrolled stormwater runoff. And third, there will be impacts associated with increased human access.

Regulatory Suggestions:

1. Establish Wildlands Management Districts where development is controlled to insure that 90% of the district remains natural.
2. Establish National Parks through land purchase or donation around the most important natural lands and wildlife habitats. These include:

    a. Nag's Head
    b. Sir Anthony's Peak (upper lee slopes and Atlantic side)
    c. Salt Pond Hill (upper slopes and Atlantic side)
    d. Scotch Bonnet

3. Cluster development whenever and wherever possible to minimize the extent of above ground clearing.
4. Areas of most intense development should be located in the watersheds of salt ponds that act as sedimentation basins.
5. Develop performance criteria and regulations that control cutting of vegetation, extent of clearing, cutting and filling, etc.
6. Prohibit development of littoral forests, wetlands, and best examples of dry forests.
7. Prohibit indiscriminate cutting of vegetation and grazing in areas other than those dominated by Guinea grass.
8. Protect the scenic qualities of the SEP through regulations on the size and intensity and siting of development.

Management Suggestions:

1. Control burning throughout the SEP.
2. Establish a well-marked and accessible trail system and control indiscriminate hiking and horseback riding by limiting these activities to designated trails.
3. Begin a program of public education to reinforce in peoples minds the value of natural lands to wildlife and their scenic qualities.
4. Begin a program to control the spread of Guinea grass.

Losses of wildlife on the SEP as development grows will result from two mechanisms. First, direct conversion of natural lands to developed land will result in a decrease in habitat with a consequent decrease in the carrying capacity and numbers of birds, mammals and other animals. Second, increased human access will result in greater predation by both humans and their domesticated animals.

Regulatory Suggestions:

1. Prohibit hunting on the SEP.
2. Prohibit development of important shore bird habitat.
3. Declare the SEP a National Wildlife Sanctuary.
4. Establish a National Park and purchase if necessary the Rookery areas at Nag's Head.
5. Establish an Office of Natural Resource Management (ONRM). Staff and train two officers to provide public education, enforcement of natural resource regulations, and management of the resources of the SEP.

Management Suggestions:

1. Monitor wildlife populations (ONRM staff) of the SEP and permit hunting under strict supervision of some species depending on populations and potential for over population.
2. If dredging of salt ponds for marina development is allowed, require compensation for loss of shore bird habitat by creation of an equal area of habitat with proper placement of spoil.

ISSUE 2: Developmental Impacts on Marine Resources

The marine resources of the SEP are the basis for much economic activity and will surely form the basis for a vital and potentially important tourist economy. Therein lies the root for current and future use conflicts. The importance of the marine fisheries to the citizens of St. Kitts/Nevis cannot be over estimated. They form the basis for a significant portion of the local economy. Their importance to a healthy and sustainable tourist economy in like fashion cannot be over stated. Yet use and over use by each sector has the potential to eliminate use by the other. The balancing of use and successful conservation are the keys to insuring that the resource is maintained and all segments of the population and sectors of the economy have equitable access.

9

Regulatory Suggestions:

1. Enact and enforce proposed fisheries regulations.
2. Enact and enforce beach management regulations.
3. Establish, fund, and staff a National Marine Park.
4. Regulate construction and operation of any marina development.

Management Suggestions:

1. Fund the Fisheries Resource Division to carry out effective and much needed fisheries research and monitoring.
2. Establish an environmental and fisheries education program that will stress the importance of fisheries regulations to a sustainable fishery.
3. Develop marina/boating guidelines for the SEP marine areas that reflect use patterns by fishermen.

Turtles are a special resource, endangered as the result of over exploitation and loss of habitat, deserving of special attention. Their endangered status and their potential as a significant portion of a marine oriented tourist economy suggest that they should be given immediate protection.

Regulatory Suggestions:

1. Declare sea turtles a national treasure, a symbol of a healthy ecological balance of humans and nature, and an endangered species.
2. Declare a moratorium on hunting of turtle eggs and sea turtles, as is currently under consideration by the OECS.
3. Regulate the use of beaches to protect and enhance turtle nesting.
4. Fine the purchasers of turtle products.

Management Suggestions:

1. Develop environmental education programs that will teach the ecology, reproductive and behavioral patterns, and importance of conservation of sea turtles.
2. Enlist the cooperation of land owners and hotel interests in a turtle watch effort for the preservation and protection of sea turtles and nests.

ISSUE 3: Effective Solid and Liquid Waste Treatment and Stormwater Management

The environmental resources of the SEP are unique and irreplaceable. It is important to undertake development in an orderly manner to promote and maintain a competitive tourist industry and to conserve these environmental amenities for the enjoyment and economic utilization by future generations of Kittitians. Improper stormwater management, and liquid and solid waste disposal have the potential of causing irreparable damage to both terrestrial and marine resources, as well as significantly detracting from scenic qualities.

Regulatory Suggestions:

1. Prohibit disposal of commercial and residential solid wastes on the SEP.
2. Establish a site for construction wastes on the SEP to reduce haulage.
3. Establish several centralized wastewater treatment districts for the collection, treatment and disposal of wastewater.
4. Allow highest densities of housing and hotel units in areas served by a centralized wastewater treatment facility, otherwise limit densities to 1 unit per 2.5 acres for effective septic tank operation.
5. Require that all project drainage systems adequately handle runoff entering the project site form upslope, dispose of runoff generated on-site, and not cause damage to downstream areas.

Management Suggestions:

1. Either require hotel facilities to develop and maintain wastewater treatment systems with extra capacity to serve other anticipated development within the wastewater treatment district or fund as a public facility and collect operation and maintenance revenues to recoup construction and for operation expenses.
2. Consider the use of constructed wetlands wastewater treatment systems.
3. Haul all residential and commercial solid wastes to a facility on the main part of the island and explore potential for development of a sanitary landfill at a different location from the Conaree location.

ISSUE 4: Health and Safety of SEP Occupants Resulting from Geodynamics and Land Stability of the Peninsula

Development of the SEP of St. Kitts should be planned with careful consideration given to the possibilities and limitations presented by the physical environment. As a general principle, planning in the SEP should encourage ordered development of the area's potential while ensuring preservation of the best that nature has bequeathed and avoidance of unstable and other hazardous zones.

Regulatory Suggestions:

1. Prohibit development of slopes greater than 25 degrees, guts, alluvial lands downslope of unstable guts, sea cliffs, and storm surge prone areas.
2. Prohibit development of permanent structures on beaches by requiring a minimum setback of 100 meters behind the normal high water mark.
3. Require that all permanent structures be constructed with a minimum floor elevation at least 10 feet above mean sea level and not closer than 100 feet to the inland limit of the beach vegetation.
4. Prohibit sand mining on all beaches.

Management Suggestions:

1. Develop guidelines for construction practices that suggest avoiding heavy rainfall periods, construction of temporary sediment basins during construction, limit vegetation removal, etc.

2. Develop erosion and sediment control guidelines for developers and provide for development review by qualified individuals.

ISSUE 5: Fiscal Impacts on Government Revenues and Expenditures.

It is clear that under any realistic development scenario for the SEP, government revenues generated from development will far exceed government expenditures associated with the development. Current taxes and rates of taxation, including the special stamp taxes and property taxes on property transactions in the SEP will, without the need for any additional revenue measures, provide sufficient revenue to service the loans for road construction and utilities and finance all associated current and capital costs of the operating departments.

Regulatory Suggestions:

1. Adopt a budget that will allocate sufficient funds from the surplus generated on the SEP to create, staff and adequately fund the following:

   a. National Marine Reserve/Park system.
   b. National Wildlife Sanctuary and Park and Recreation system on the SEP.
   c. Office of Natural Resource Management.

2. Adequately fund the Fisheries Department to conduct fisheries research and monitoring.
3. Ensure that the revenue collection agencies are fully staffed, trained and equipped to collect the expected large amount of revenue and process the large number of taxpayers.
4. Adequately fund public works and health and sanitation departments to carry out their new duties related to the growth on the SEP.
5. Adequately fund the SEP Board to carry out development review of development proposals on the SEP.

Management Suggestions:

1. Establish a system to monitor development on a regular basis and report to the responsible authorities the fiscal impacts of each new private sector development.

In all, the issues and policy decisions facing the people of St. Kitts relating to development of the SEP are complex and will be difficult to make. The greatest concern and the toughest question is simply how to balance development interests and environmental protection. It is the same question faced by all developing regions and growing economies. The Resource Management Plans that follow were researched and written in the hopes that the detailed information they contain will be of value to the Southeast Peninsula Board and the citizens of St. Kitts/Nevis as they begin to make the difficult decisions necessary to ensure a robust economy and healthy environment. Each Resource Management Plan contains detailed analysis and discussion of issues and much greater detailed regulatory and management suggestions than are summarized here.

The second volume in this three-volume set of planning documents contains models for the Proposed Land Use Management Plan (PLUMP) and the Handbook of Development Guidelines and Considerations for the Southeast Peninsula (HDGCSP) that were derived from the information in these Resource Management Plans. If adopted, these models could form the basis to accomplish most of the regulatory and management suggestions given in the Resource Management Plans and summarized in the proceeding paragraphs.

13

TERRESTRIAL RESOURCE MANAGEMENT PLAN

by

Mark T. Brown Ph.D.

May 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

14

EXECUTIVE SUMMARY

Development of the Southeast Peninsula (SEP) will have three general effects on the terrestrial resources. First, direct impacts from clearing and cut and fill activities will affect the total area of natural communities, but may be minimized through decreasing the areas by increasing intensity of development in acceptable portions of the Peninsula. Second, secondary impacts from erosion and sedimentation have the potential of creating far more long-term damage, but can be controlled through proper management of construction activities. And third, indirect impacts that result from increased human access may be the most difficult to control.

The terrestrial resources survey of the Southeast Peninsula developed 10 classes of vegetation and ecological communities and their values and sensitivities are given. The 10 classes were: Salt Ponds, Beach, Dune, Mangrove, Guinea Grass, Grass/Acacia, Thorn Scrub, Dry Forest, Agriculture, and Developed.

Resource management strategies are suggested that approach the problem from two fronts. The first suggests that sensitive ecological communities be protected wherever they occur. The second suggests that a series of interconnected wildland management areas be designated and separate development controls be instituted to accommodate their special values and protect their wilderness character.

Eight wildland management areas are designated that include Friar's Bay, Salt Pond Hill, Sandbank Bay/ East Great Salt Pond, St. Anthony's Peak, Cockleshell Bay/Mosquito Bay Salt Ponds, Major's Bluff, Major's Bay Salt Pond, and Nag's Head Bluff.

Finally recommendations for development guidelines, techniques, and principles are given as means of guiding development and as the beginning of a regulatory framework.

TABLE OF CONTENTS

LIST OF MAPS ii

1.0 INTRODUCTION 2
- 1.1 Rationale 3
- 1.2 Landscape Issues of the Southeast Peninsula 4
  - 1.2.1 Direct Losses of Ecological Communities 4
  - 1.2.2 Secondary Impacts on Ecological Communities 4
  - 1.2.3 Indirect Impacts Resulting from Increased Access . . . 5
- 1.3 Scope of the Study 5
- 1.4 Definitions of Terms 6
- 1.5 Plan of Study 7

2.0 DESCRIPTION OF RESOURCE CHARACTERISTICS 9

3.0 MANAGEMENT ALTERNATIVES 15
- 3.1 Managing Natural Resources 15
  - 3.1.1 Ecological Communities 15
- 3.2 Wildland Management Areas 17
- 3.3 Managing Development Impacts 20
  - 3.3.1 Construction Criteria 21
  - 3.3.2 Planning and Design Criteria 21

4.0 SUMMARY AND RECOMMENDATIONS 23

5.0 REFERENCES 24

16

LIST OF MAPS

Map 1 Vegetation 1968 10

Map 2 Vegetation 1988 12

Map 3 Wildland Management Areas 18

17

PREFACE

In this report, two terms, WILDLANDS and MANAGEMENT, are used as a means of conveying to the reader a complex of ideas, concepts, theories, emotions, perceptions, and actions toward the use and protection of land. The term "wildlands" is used to connote lands that are not developed for agricultural, residential, commercial, or industrial uses. It is meant as an all-encompassing term to refer to that portion of any landscape that has not been developed. Wildlands may be composed of a mosaic of forests, prairies, wetlands, lakes, beaches and dunes, or entirely of one or the other of these ecological communities. The term has been introduced as a means of focussing attention to the need for wild areas (i.e., undeveloped areas) in an affirmative rather than in a negative way by calling attention to the essential characteristic of undeveloped lands...that is, their wild character. The term often used when referring to wildlands is "undeveloped" lands. While this term has general acceptance and there is little mistake as to its meaning, it connotes that the primary use for land is development. The term wildlands is intended to reverse this concept concerning wild portions of landscape. Wildlands are not wilderness for they generally occur in close proximity to developed regions, and are usually much smaller than a wilderness area. Nonetheless, wildlands should be a part of the developing landscape, and their wild character left intact.

The second term used in this report, "management", is used to connote the myriad of regulations, policies, and performance controls, as well as individual actions, that may be used to direct, supervise, or control development. To manage a landscape, or to institute a set of management strategies is to develop a set of policies, regulations and control actions that if implemented will affect the manner and direction in which land is developed. The various actions, regulations, and policies that might be implemented represent management alternatives.

1.0 INTRODUCTION

It has become obvious that a piecemeal approach to landscape management can only lead to an ever-increasing fragmentation of the landscape. This revelation has recently lead the author to propose a concept for landscape management that incorporates the best of physical land use planning related to growth management and landscape ecology (Brown, 1985, 1986, 1987, 1988). The concept has been termed "Wildlands Management" and has as its fundamental objective the identification and preservation of a landscape mosaic of wildlands that are large enough to provide significant wildlife habitat, are capable of buffering development impacts on adjacent lands, can contain sprawl and give definition to developed areas, and are ecologically diverse and relatively intact.

The motivation for Wildlands Management has developed as a result of observations of the rapid urbanization and conversion of landscapes throughout the world. As regions become more developed, small pieces of the landscape are left undeveloped either because they are "protected" or because they have been purchased for their potential as preserves. These fragments become islands in a sea of developed land. Often resented by their neighbors because they contain unwanted vestiges of the former landscape, these patches suffer from either neglect or overexposure. Most often they slowly deteriorate to the point that one must question if they could survive without massive doses of human management.

As long as there is development pressure, developed areas continue to sprawl ever outward in wider and wider circles of urbanization and land conversion, leaving in their wake remnants of the former wild landscape mosaic. Soon, if the development process is complete, developed centers begin to merge and the landscape becomes more dominated by altered lands with a smattering of 'protected' reserves, parks, and wildlife management areas. It is quite obvious that as development of the Southeast Peninsula (SEP) proceeds, wildlands will shrink and developed lands will expand. The importance of determining, prior to development, where the best wildland areas are and setting in place the guidelines and regulations to insure that they will remain intact cannot be overstated. Their value to wildlife, to economic vitality, and to future generations of Kittitians should not be overlooked.

Presumably, without a wider perspective, that is, without a landscape perspective, effective landscape planning and management that might preserve portions of the landscape mosaic as wildlands is not possible. The first stage in developing a landscape perspective is to identify mosaics of ecological communities that are relatively intact and that might serve as the beginnings of a peninsula-wide wildlands system. The second stage is to recommend development guidelines and a regulatory framework that will institutionalize the wildlands concept and ensure that development is consistent with the goals of wildlands management. This study is organized to first identify the types and locations of ecological communities found throughout the SEP and then to suggest methods to insure that the best and most important areas of the SEP be treated as large contiguous blocks of wildlands.

1.1 Rationale

The quality of an environment results from an interplay of both natural ecological communities like forests, wetlands, and grasslands and developed lands put to residential, commercial and agricultural uses. Often most emphasis is placed on the developed uses and little attention is given to maintaining a portion of the landscape in wild and scenic uses. Unfortunately, their values as wildlife habitat, visual relief, and an integral part of a self-sustaining landscape mosaic become less and less important as more and more of the landscape is transformed.

Sometimes it is quite difficult to express the value of wildlands to regions that are experiencing rapid development pressure, since wildlands are in great supply (and therefore little valued) and developed lands are in short supply (and therefore much valued). Through time, however, experience has shown that regions which have become relatively overdeveloped soon place high value on the small number of wildlands that remain. The problem is the realization often comes too late, when the costs of land are too high and the lack of earlier planning has left the landscape fragmented to such extent that only small patches of wildland still exist. Recreating a wild and scenic landscape under those circumstances becomes next to impossible to accomplish.

The value of wildlands to tourist economies is increasingly recognized as more travelers seek out destinations that have not become overly developed. Wildlands that are treated as an integral part of a tourist development plan become a no cost, self-sustaining amenity that has the potential to increase total number of tourists, number of tourist days, and ultimately total revenues received.

The Southeast Peninsula offers a unique environment that is rich in both marine and terrestrial resources that may become the basis for expansion of the national economy through increased tourist revenues. The importance of these resources to developing the tourist potentials of the SEP cannot be overstated. Sound resource management should involve (1) preservation of unique ecological communities, (2) preservation of important wildlife habitats, (3) development of a network of wildlands, (4) regulation of development impacts, (5) enhancement of existing ecological communities and wildlife habitats, and (6) encouragement of site-sensitive development patterns.

In this way, development of the Peninsula that will follow completion of the road can offer the opportunity to reverse continued decline in environmental quality (discussed in a following section) and actually enhance the terrestrial environment through careful development siting and management. The issues related to the development of the Southeast Peninsula can be grouped into three broad categories: those related to the direct losses of unique ecological communities and the mosaic of wildlands, those related to the secondary impacts of development, and those resulting from increased human access. Each of these issues are explored separately in the commentary that follows.

1.2 Landscape Issues of the Southeast Peninsula

1.2.1 Direct Losses of Ecological Communities

As lands are developed to accommodate human uses, by necessity the natural organization of vegetation cover is altered. For the most part, the development process clears lands of vegetation, recontours the land surface where necessary, and covers the land with roads, buildings and landscaping. As a result, portions of the landscape are directly converted from natural ecological communities to developed lands. With a given amount of housing units or hotel rooms, the area of land affected is related to the intensity (or density) of development. Low intensity development affects a wider area of land, since housing or hotel units are more widely spaced. High intensity development on the other hand directly affects a smaller area of land as units are concentrated in a smaller portion of the landscape.

Generally, the loss of ecological communities directly impacts wildlife that depend on these areas for feeding, breeding, and nesting sites. The more widespread development, the greater the area disturbed and the greater the losses of wildlife species. Compact development that leaves large contiguous areas of lands undeveloped helps to maintain ecological communities and wildlife populations. The wildlife habitat value in developing landscapes is more related to the size of undisturbed lands than to the total area. With a given area of undisturbed land, the best configuration is one that produces large blocks of interconnected wildlands instead of many small patches. Connections (or corridors) between wildlands help to increase their value as wildlife habitat. The increased mobility and exchange of wildlife species and individuals between wildland patches helps to ensure continued viability of wildlife populations and increased access to food and cover.

1.2.2 Secondary Impacts on Ecological Communities

Probably the most important secondary impact that may affect ecological communities results from the physical characteristics of the Southeast Peninsula. The terrain is relatively rugged, with many areas of extreme slope. The high relief, combined with sparse vegetative cover and highly erodible soils create conditions of soil instability that are easily aggravated. Areas that are cleared for development have the potential of affecting down slope areas if cuts, clearings and excess materials are not stabilized rapidly. Once soil surfaces are exposed, the energy in rainfall is not dissipated by vegetation and soil particles are easily lifted from the soil surface and carried down slope with surface runoff. Continued exposure to rainfall removes soil from the bases of rocks, eventually causing them to loosen and tumble down slope. In all, once erosion on the higher slopes begins, the effects on down slope ecological communities can be extremely devastating. First, eroded materials may be deposited in down slope locations in sufficient quantity to bury vegetation. Second, loosened rocks that have sufficient energy may clear a path in vegetation as they roll down slope exposing additional soil and increasing the potential for further erosion. And third, soil that is repeatedly exposed to rainfall may erode faster than vegetation can become established in sufficient quantity to stabilize the slope.

21

Secondary impacts can easily affect an area equal to or greater than the area that was originally cleared. Indeed, one of the greatest potential impacts is increased sedimentation and turbidity in nearshore waters (discussed by Wilcox) that may extend over several thousands of acres after a single rainfall event. Yet these impacts are easily controlled if proper development guidelines are implemented and land owners are encouraged to pay particular attention to erosion control measures.

1.2.3 Indirect Impacts Resulting from Increased Access

Indirect losses of environmental quality result from the secondary impacts of development, the greatest of which is the increased access to an area of previously undeveloped status that is afforded to a larger number of humans. In addition, the impacts of wastes like sewage effluent and garbage from an increasing population can cause significant deterioration. The indirect losses associated with increased human presence include trampling and cutting of vegetation, increased erosion, pollution, increased occurrence of fire, and the flight of wildlife.

Wherever human use of the landscape increases, the potential for a decline in the overall quality of the area is increased. Through increased traffic, waste, noise, and the like, greater stress is placed on the ecological communities of the area. Both vehicular and foot traffic trample vegetation and expose the soil to the actions of wind and rain. Increased gathering of wood, seeds and fruit, and wildlife may over exploit the resources and drive them to extinction. Waste by-products and increased noise have a detrimental effect on wildlife, driving them from areas of normal habitation. While these are just a few examples of the impacts of the effects of increased human presence, they serve to illustrate the complexity of the problem. Generally, the impacts are not just associated with one consequence of human use, but several. In other words, the increased access by humans to wildlands acts along numerous pathways to lower the quality of wildlands, and in so doing the impacts of each are magnified.

While the direct impacts of conversion are somewhat easier to visualize and generally are assumed to be of primary importance in maintaining a high quality environment, the indirect effects associated with development often have greater potential to compromise environmental quality. To minimize indirect impacts, access to selected areas of the SEP need to be controlled and the secondary impacts from waste products and erosion need to be regulated.

1.3 Scope of the Study

To better understand the ecological organization of the Southeast Peninsula and to develop resource management criteria that would be effective to best protect the resource, this study focused on landscape scale analysis of the area. The scope of this study was to identify the types and evaluate the condition of ecological communities of the Southeast Peninsula. Once an inventory was completed, analysis of the ecological

-22-

organization of the landscape and the physical limitations of soils and terrain combined with maps of unique and outstanding ecological communities were used to produced a final map of wildland reserves and unique communities as the first step in developing a natural resource based management plan entitled "A Proposed Land Use Management Plan for the Southeast Peninsula".

1.4 Definitions of Terms

WILDLANDS — A combination of the work "wild" (an uninhabited or uncultivated region; not domesticated, cultivated or tamed) and the word "land" (a topographically or functionally distinguished tract). Wildlands are lands that are integral components within developed landscapes yet are not developed for agricultural, residential, commercial or industrial uses. Wildlands may be composed of a mosaic of forests, prairies, wetlands, lakes, beaches and dunes, or entirely of one or the other of these ecological communities. A term in common usage often employed to refer to wildlands is "undeveloped" lands. While this term has general acceptance, it connotes that the primary use for land is development. The term wildlands is intended to reverse this concept. Wildlands are integral to and within developed landscapes and thus are not wilderness areas. Wildland areas are usually much smaller than wilderness areas. Wildlands are generally the habitats of wild life and thus qualify as wildlife habitat. A wildlands area may be designated as a conservation area or protected area, although conservation and protection areas do not in themselves have to be (and often are not) wild. Often areas in close proximity to developed lands are referred to as "natural areas". Wildlands areas are natural, and thus one might use the generic reference. In all, a wildlands area is a portion of the developed landscape that is set aside as wildlife habitat and a vestige of the previous unaltered landscape where human interference is kept to a minimum.

In this report, areas have been designated as wildlands management areas. In these areas development is not precluded. The suggestion is made that all development be concentrated into very small intense pockets and that at least 90% of the lands within each area remain wild. Further, it is suggested that roads and utilities not cross wildlands areas wherever possible, since to do so causes a fragmentation of the landscape.

CORRIDOR — (or wildlife corridor); a strip of unaltered land that connects larger areas of wildlife habitat whose purpose is to allow the movement of wildlife from one area to another with minimum amount of impedance.

23

MANAGEMENT	(or landscape management); regulations, policies, and performance controls, as well as individual actions, that may be used to direct, supervise or control development. To manage a landscape, or to institute a set of management strategies is to develop a set of policies, regulations and control actions that if implemented will affect the manner and direction in which land is developed. The various actions, regulations and policies that might be implemented represent management alternatives.
WILDLANDS MANAGEMENT	An approach to regulating the use and development of the landscape in such a way that portions of the landscape remain in a wild and scenic character. It is more regulation and control of the actions of humans than management of the wildland itself. Most wildlands are composed of self-sustaining ecological communities. However, in some situations it may be important to manage the wildlands area, or portions thereof, through actions like controlled burns, tree planting, reintroduction of wildlife, controlled hunting, etc.
WILDLANDS MANAGEMENT AREA	(or wildlands district); an area of landscape that is designated as a wildlands. It is a management area where special attention is given to ensuring that human uses and development actions do not detract from its wild and scenic character, thus human uses are minimized and controlled. Districts that are designated as Wildlands Management Areas do not preclude human uses for development or recreation, they are managed through development controls, regulatory actions, and in some cases through resource management to remain wild and scenic in character.

1.5 Plan of Study

To develop a resource management plan for the Southeast Peninsula, techniques and methods employed in the analysis of landscape scale organization were used first to develop insight and understanding of the Peninsula as a whole, and then field reconnaissance and evaluation of specific areas and ecological communities were conducted to gain information on unique and outstanding examples of communities. Baseline data were collected on the salt ponds to relate water levels, salinity, and other chemical characteristics to wading bird use. Vegetation transects were established and plant species identified with special emphasis given to species that might prove valuable in stabilizing road cuts and building sites.

To better understand the ecological organization of the SEP, past aerial photographs were obtained and new aerial photography was produced. Photography was interpreted, ecological communities identified, and vegetation maps drawn. To ground truth vegetation maps, detailed field reconnaissance was conducted through the Peninsula and characteristic plant species in each vegetation class were recorded. Once detailed maps were drawn, comparison of each was made to assess the degree of change in community

24'

organization during the 20-year period between 1968 and 1988 to suggest management alternatives that reflect the dynamic character of the Peninsula.

Using recent aerial photography, unique ecological communities and outstanding examples of other more common communities were located and field reconnaissance was conducted to ascertain their condition. Once the entire SEP was surveyed using both the aerial photography and field reconnaissance, a map of unique and outstanding ecological communities was drawn. A final map of wildland reserves and unique communities was drawn by connecting individual communities in broad wildland corridors as the first step in developing a natural resource based management plan entitled "A Proposed Land Use Management Plan for the Southeast Peninsula".

2.0 DESCRIPTION OF RESOURCE CHARACTERISTICS

During the first field reconnaissance in February 1988, a preliminary land use and cover map with 10 broad vegetation and land use classifications was produced from available photography. A reduced version of the map is included as Figure 1. The Land Use and Cover Classification Map was derived from 1968 aerial photography at an approximate scale of 1" = 6500'. This was the only available photography at the time of reconnaissance. Aerial photographs taken in August and September 1988 have been used to produce a second vegetation map. A reduced version of the 1988 vegetation map is included as Figure 2.

The community types identified on the land use and cover map were broad classes of vegetation associations that represent rather homogeneous stands of vegetation or human-dominated land uses. These broad classes of communities easily lend themselves to development of land use management controls that will best protect the resources. General descriptions of each community type are given next. The numbers proceeding each community type correspond to those on the map.

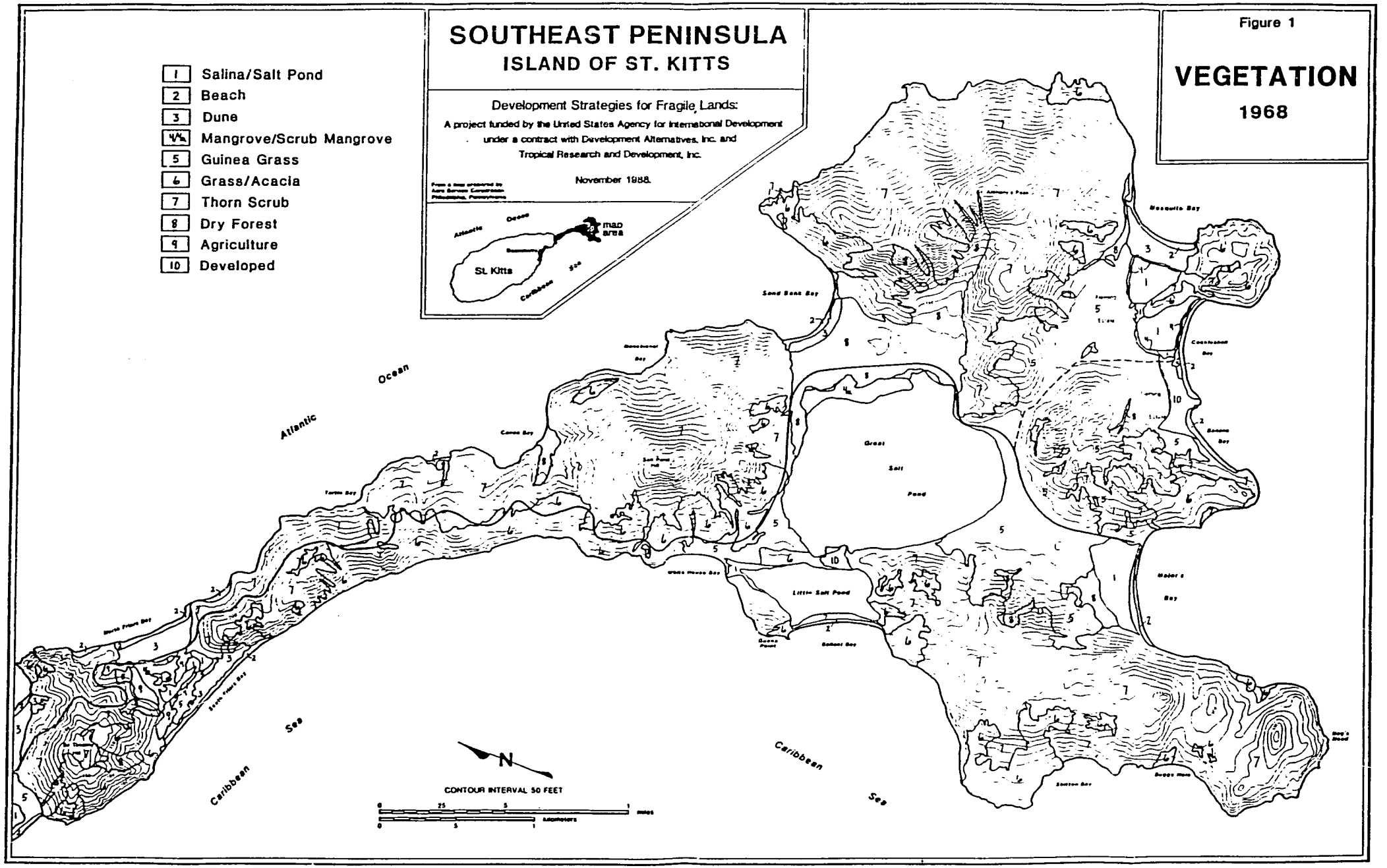
Ten major community types were identified in the study. These are described below.

1. Salina/Salt Ponds. Water bodies of varying surface area with characteristic high salinity as the result of high evaporation of runoff waters from catchment basins in surrounding hills. Generally, these ponds do not have surface water connections to open Caribbean Sea surrounding the Peninsula, but receive runoff and its associated sediment load during rainfall events. Because of their low elevations and the low profile, fragile nature of their seaward boundaries, it is probable that during extreme storm events, their seaward berms are breached with consequent flooding by sea water. The salt ponds are rather shallow basins, (most averaging less than 1 m. in depth during wettest portions of the year). Their shallow depths explain their high turbidity. The shallow waters are stirred continually by the winds, keeping sediments and particulate matter in constant suspension. The smaller ponds seem less turbid; a condition that seems to support the wind-mixing hypothesis, since their more or less protected locations and smaller wind fetch minimize wind induced stirring.

   There is evidence of historic salt production activities in the Little and Great Salt Ponds. Bird use of the nearshore edges and mud flats of the salt ponds was documented by Arendt (1985) and is being studied by R.Norton as part of this study.

   The measurements of the water depths of most salt ponds suggests that they vary from a maximum depth (Great Salt Pond) of approximately 4 ft. (1.2 meters) during the wettest times of the year to only several inches during the dry season.

26


SOUTHEAST PENINSULA
ISLAND OF ST. KITTS
Development Strategies for Fragile Lands:
A project funded by the United States Agency for International Development
under a contract with Development Alternatives, Inc. and
Tropical Research and Development, Inc.
November 1988.
map area
St. Kitts
Atlantic Ocean
Caribbean Sea
Figure 1
VEGETATION
1968
1 Salina/Salt Pond
2 Beach
3 Dune
4/4a Mangrove/Scrub Mangrove
5 Guinea Grass
6 Grass/Acacia
7 Thorn Scrub
8 Dry Forest
9 Agriculture
10 Developed
Great Salt Pond
Little Salt Pond
Sand Bank Bay
Mosquito Bay
Motor's Bay
N
CONTOUR INTERVAL 50 FEET
miles
kilometers

2. Beaches. Beaches are accumulations of sand composed of a mixture of quartz sand and carbonate fragments of marine organisms. On the windward side of the Peninsula, fringing reefs help to maintain sandy beaches by contributing marine organism fragments and minimizing destructive forces of storm waves. Rocky shores and coastal areas dominated by rocky beaches, with little or no sand are not classified separately, but included in the adjacent cover class.

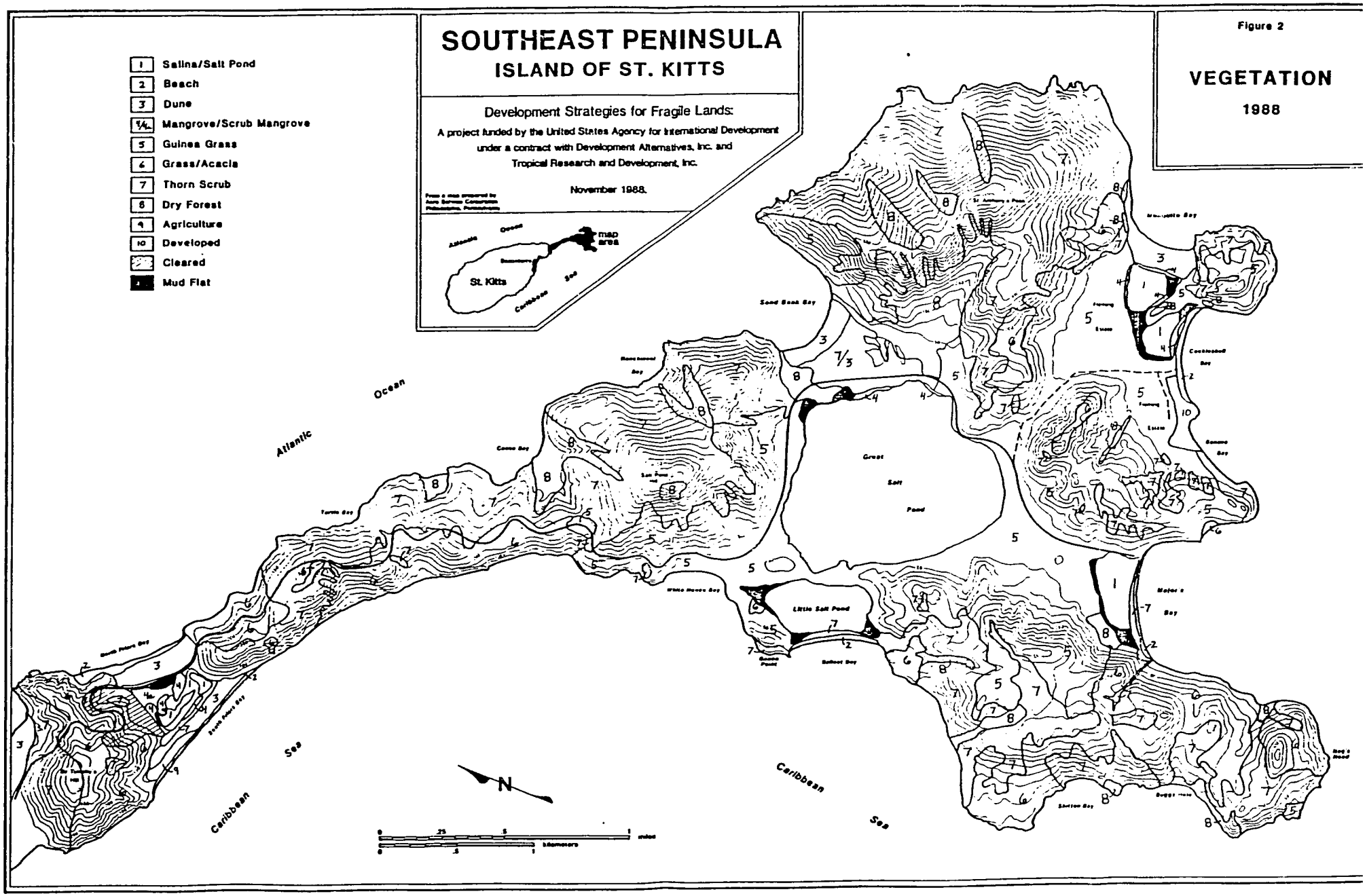
3. Dunes. In most instances dunes are found landward of sand beaches. The dune is usually slightly undulating and higher in elevation than lands further inland and is dominated by salt tolerant vegetation such as sea grape, *Salacornia*, etc. Dunes at most of the sand beaches are relatively small in spatial extent and have minor elevation.

   There are several older dunes that have higher elevations than the primary (or fore) dune. Two are located at Friar's Bay, and Mosquito Bay. A third older dune characterized by an area of rolling sands covered in part with a mature dry forest runs perpendicular to the beach at Sandbank Bay extending west to the margin of the Great Salt Pond.

4. Mangroves. Found principally on the margins of the salt ponds, typical species include red, black and white mangroves, where there are high salinities, red mangrove are rare. Red mangrove dominate the pond margins at Friar's Bay, with white and blacks occupying the more landward margins of the pond. Mangrove communities are important roosting and nesting sites for numerous resident and migratory avian species (Arendt, 1985). They are rare on the Peninsula, occupying the fringes of the salt ponds at Friar's Bay, Mosquito Bay, and Cockleshell Bay. There are some stands of white and black mangrove on the fringes of Great and Little Salt Ponds.

   A subclass (4a) was developed to separate areas of scrub mangrove at Friar's Bay and eastern Great Salt Pond from the more vigorous stands of mature mangrove.

5. Guinea Grass. Primarily found on the burned over, lower slope lands in the Great Salt Pond and Fleming Estate areas, this community is dominated by *Panicum maximum* (Guinea grass), an exotic to the island that was presumably introduced for as forage. While there are occasional trees and shrubs (especially Acacia) found standing as isolated individuals throughout the expanses of Guinea grass dominated landscape, their presence is probably short-lived since the community burns on a regular basis. Fires in this community are generally hot enough to kill most other vegetation that may be remnants of previous communities or that may be trying to colonize. There are numerous charred, dead tree species scattered throughout the Guinea grass areas; evidence that the more frequent and hotter fires have a significant impact on the communities of native vegetation.


SOUTHEAST PENINSULA
ISLAND OF ST. KITTS
Development Strategies for Fragile Lands:
A project funded by the United States Agency for International Development
under a contract with Development Alternatives, Inc. and
Tropical Research and Development, Inc.
November 1988.
Figure 2
VEGETATION
1988
1 Saline/Salt Pond
2 Beach
3 Dune
4 Mangrove/Scrub Mangrove
5 Guinea Grass
6 Grass/Acacia
7 Thorn Scrub
8 Dry Forest
9 Agriculture
10 Developed
Cleared
Mud Flat
map area
St. Kitts
Atlantic Ocean
Caribbean Sea
Great Salt Pond
Little Salt Pond
N

6. Grass/Acacia. This community dominates the leeward side of most of the Peninsula north of the Great Salt Pond area. The community is composed of a wide diversity of grasses and acacia, with agave and some cacti found as occasional individuals and small stands. In addition, occasional trees and shrubs that are characteristic of the thorn scrub and dry forest are found throughout the grass/acacia community as either free standing individuals or small fragment stands. Their stature is usually dwarfed and many are fire scarred as a result of the relatively frequent fires that burn through the community.

7. Thorn Scrub. Called a Dry Scrub Woodland by The Island Resources Foundation (1986), this community dominates the windward slopes and tops of the hills of the Peninsula. The Island Resources Foundation (1986) suggests that these areas were "...once forested, but now covered, for the most part, by dry scrub woodland vegetation -- principally acacia, agave, and columnar and Turks Head cacti..." It is somewhat doubtful that much of the area now dominated by thorn scrub was ever dominated by forests, for their exposed locations, and minimal top soil cover suggest somewhat harsh conditions for the development of mature forests.

8. Dry Forest. May be more appropriately termed a Scrub Forest since the vegetation of this community does not exhibit the diversity or stature of the Dry Forests common to other parts of the tropics. Where environmental and physical conditions are conducive to development of a mature canopy and cutting has not reduced the community to more scrubby conditions, the forest community achieves a more robust appearance and species diversity are somewhat higher.

9. Agriculture. Presence of a windmill and old house sites is evidence that agriculture played a more important role in the gently sloping areas near the Great Salt Pond. Agriculture areas in 1968 were confined to the Friar's Bay area where three small agricultural fields were interpreted from the aerial photographs. For the most part, these were the only areas in 1988 photography, although much reduced as the result of road construction. It may be suggested that the expanse of Guinea grass is an agricultural use of the Peninsula, however, these areas have been classified separately since their use for grazing seems only marginal at the present time.

10. Developed. Developed areas are those where native vegetation or cover have been removed and some human-dominated use predominates other than agriculture. There were two developed areas in 1968: an area at Cockleshell Bay related to hotel development, and an area at Little Salt Pond related to salt extraction.

30

At the present time (see Figure 2) the Peninsula shows signs of a continued decline in environmental quality. When compared with vegetation coverage in the 1968 map (Figure 1), the biggest change in vegetation is the extent of Guinea grass. This area has expanded as much as 30% in the 20-year period since 1968. The greatest expansion of the area of Guinea grass is westward toward the Shitten Bay and Nag's Head areas, northward along the western slopes of Salt Pond Hill, and the ridge between the Fleming Estate and the Dry Forest east of Great Salt Pond. The spread of Guinea grass is the result of fire. Guinea grass supports fire readily, burning quickly and spreading easily as a result of the constant winds. Once burnt, Guinea grass resprouts rapidly from underground rhizomes and can revegetate burnt areas within one growing season. Dry forests and thorn scrubs that share a common boundary with guinea grass are killed by the high temperatures and flames of the adjacent guinea grass and are easily taken over after fire by the fast growing grass.

Less obvious, and yet of equal importance are the effects of animal grazing on the structure and organization of the thorn scrub and dry forest communities. Throughout all forests on the Peninsula, no matter how remote, there was evidence of grazing pressure. Most of the lower branches of shrubs and trees were either completely removed by grazing or reduced in leaf area. The forest floor throughout most of the Peninsula was devoid of shrub vegetation and seedlings. The importance of ground cover in minimizing erosion is compromised when grazing pressure is excessive. Although at present, the forest canopy and root structure of the forested communities continue to bind soil and reduce the energy in rain drops thus somewhat minimizing erosion potential. More important is the loss of seedlings and the potential long-term impact of forest structure. Where grazing pressure is high, seedlings are reduced in number and survival is greatly curtailed so that there are few, if any, young trees to reach maturity and replace diseased or fallen trees. The long-term impacts of grazing are the slow reduction in diversity and total number of forest trees and shrub vegetation. If the SEP is to reach its full potential as a natural wildlands and tourist facility, continued grazing should be curtailed.

31

3.0 MANAGEMENT ALTERNATIVES

To manage the terrestrial resources of the Southeast Peninsula, a two-prong approach is suggested. First, the sensitivities and importance of the various vegetation communities are given with general suggestions for effective management. In this way particular requirements, regulations and guidelines can be tailored to ecological communities no matter where they are located within the SEP. Second, areas of the landscape are identified that are mosaics of ecological communities that, because of their ecological character, location, and potential for wildlife habitat, are designated as wildland management areas. It is suggested that these areas be given special consideration and treatment as whole units, with regulations, and guidelines for development tailored to minimize development and maximize wildland potential.

3.1 Managing Natural Resources

3.1.1 Ecological Communities

Community types that are important and/or have particular sensitivities to development and their value or reason for sensitivity are as follows:

1. Mangrove areas. Productivity, wildlife habitat value, and rarity. The most important mangrove areas are in the Friar's Bay Salt Pond, the eastern shore of the Great Salt Pond, and the southern and eastern shores of the Fleming Estate Salt Pond.

2. Salina/salt ponds. Suggested importance to migratory birds, some productivity for wading birds, shore nesting habitat. The Friar's Bay Salt Pond is a brackish pond that supports a large migratory population of ducks and assorted other wading birds. The remaining ponds are hypersaline (ranging in salinity from 115 to 180 parts per thousand) supporting a variety of both resident and migratory wading birds. A very important aspect of the Salt Ponds is the area of exposed mudflats along the periphery that accumulates large concentrations of shore and wading birds.

3. Dry forests. Rarity, seed source and wildlife habitat value. The most important dry forests are east of Great Salt Pond up the lee slopes of St. Anthony's Peak, north of Major's Bay and at the foot of the northern slope of Salt Pond Hill near Canoe Bay.

4. Beaches. Nesting endangered turtle species, and erosion potential. The beaches of the windward side of the Peninsula are higher energy and composed of mostly carbonate fragments of marine organisms; while the leeward beaches are lower energy and composed, for the most part, of sands of terrestrial origin. While the high energy windward beaches are exposed to wave and winds on a more frequent

basis, the leeward beaches on the whole have suffered from the effects of hurricane caused storm erosion and decline in sand supply.

5. Dunes. Erosion potential. The vegetated dunes, especially those of the windward beaches are subject to erosion from winds and storm waves. Their protective covering of vegetation acts to stabilize the dune sands and minimizes wind and to a lessor extent wave erosion. Denuded of vegetation, they are exposed and susceptible to wind erosion.

6. Guts. Severe erosion potential and reservoir of natural vegetation. While not a community type in themselves, the forested guts of the SEP are fragile; existing in a relatively precarious balance between fire and the forces of water erosion and vegetative stabilization. Because of their steep slopes, and the fact that they act as drainage ways, concentrating surface waters that runoff the ridges and side slopes of the surrounding hills, actions that disturb vegetative cover may cause significant erosion and down slope damage to both developed areas and ecological communities.

3.2 Wildland Management Areas

Several areas that represent the best mosaics of ecological communities are identified in Figure 3 and described in the following paragraphs (the numbers given correspond to the numbers used to designate areas in Figure 3):

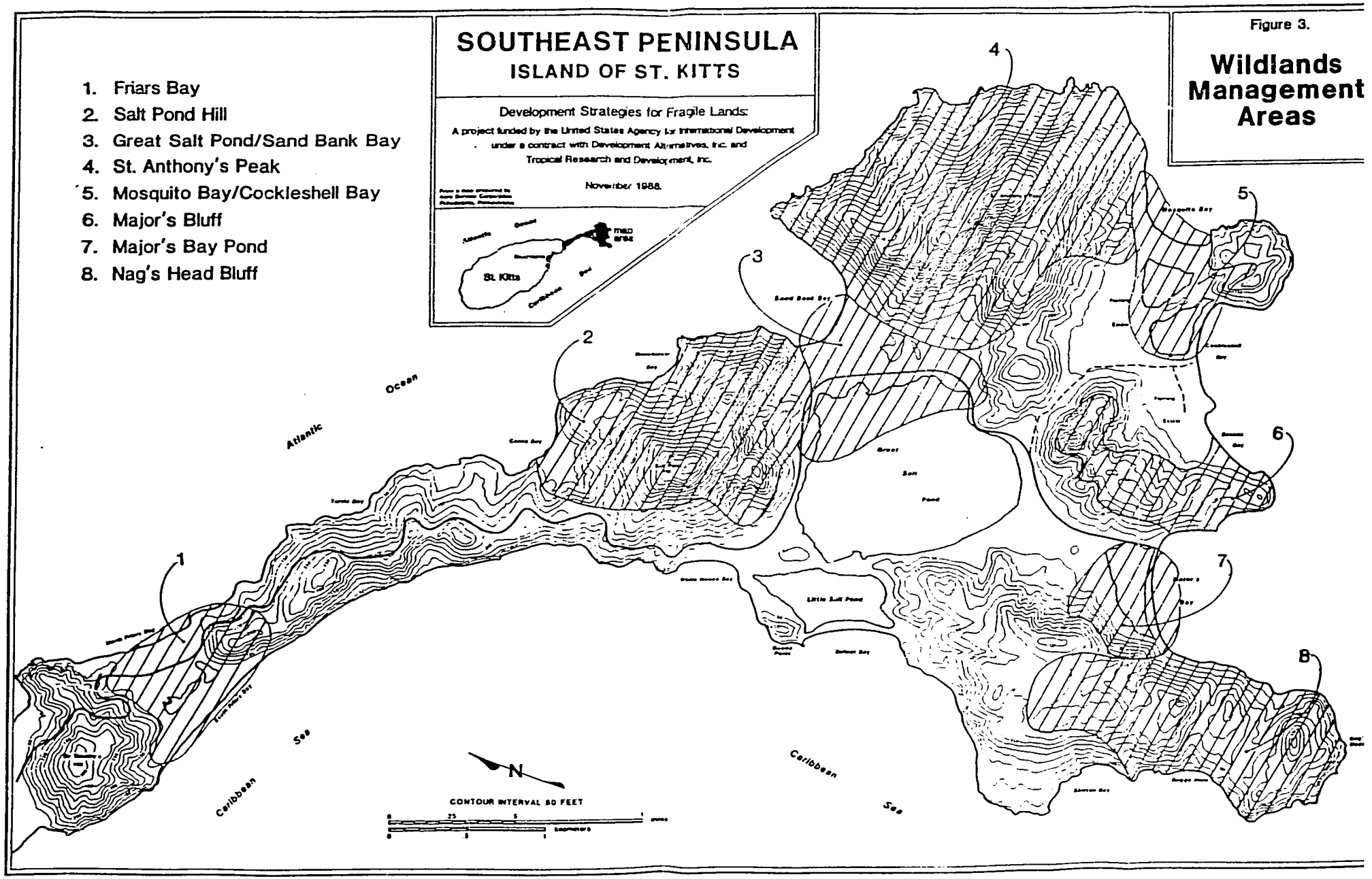
1. Friar's Bay Complex. The mosaic of ecological communities in and immediately surrounding Friar's Bay represents the single most diverse assemblage on the SEP. The salt pond supports a vigorous stand of red mangrove that intergrades into white and black mangroves near its landward margins. To the east of the roadway bed that has been elevated over the existing ground surface the area is occupied by an exceptionally diverse dune system forming the landward side of an extensive windward beach. The leeward beach dune is also dominated by some dune vegetation but most prominently by coconut palms. Remnants of the palm plantation occupy various portions of the area, but mostly on the leeward side of the salt pond. The hill slopes to the south of the salt pond are dominated by thorn scrub forests and are relatively intact.

   In all, the area is an exceptional mosaic of native and remnant agricultural communities that should be managed cautiously and developed to ensure the continuance of its unique character. Since the Friar's Bay area is also considered prime development lands, development proposals should be evaluated both for their value as an important commercial and residential center and its unique ecological diversity.

2. Salt Pond Hill. The northern slopes of Salt Pond Hill are dominated by one of the most intact, continuous stands of Thorn Scrub to be found on the SEP. Beginning at the southern edge of Canoe Bay, a fairly mature stand of Dry Forest intergrades into the northern slopes of the hill. The remaining portions of the hill including the western slopes near the 300-ft. contour and southern slopes down to the 200-ft. contour are relatively intact areas of Thorn Scrub. Two guts along the southwest and south sides of the hill exhibit rather mature stands of trees. The mosaic is a predominant aspect of both the approach from the north (the northern slope adjacent to Canoe Bay) and the area surrounding the Great Salt Pond (southern slopes).

3. Great Salt Pond to Sandbank Bay Complex. The complex of ecological communities between the eastern shore of the Great Salt Pond and Sandbank Bay is a mosaic of Mangrove Forests, Dry Forests, several successional stages of dune vegetation, and the Thorn Scrub. The vegetation of the area is some of the most mature and diverse found in the lowland areas of the southern portions of the Peninsula. Canopy heights of 20 ft. are common and many trees are greater than 8" DBH (Diameter at Breast Height). Because of the numerous dunes, both parallel and transverse to the beach at Sandbank Bay the vegetation in this community is relatively complex. There are numerous signs of wood cutting for

34


SOUTHEAST PENINSULA
ISLAND OF ST. KITTS
Development Strategies for Fragile Lands:
A project funded by the United States Agency for International Development under a contract with Development Alternatives, Inc. and Tropical Research and Development, Inc.
November 1988.
map area
St. Kitts
Figure 3.
Wildlands Management Areas
1. Friars Bay
2. Salt Pond Hill
3. Great Salt Pond/Sand Bank Bay
4. St. Anthony's Peak
5. Mosquito Bay/Cockleshell Bay
6. Major's Bluff
7. Major's Bay Pond
8. Nag's Head Bluff
Atlantic Ocean
Caribbean Sea
Caribbean Sea
Great Salt Pond
Little Salt Pond
N
CONTOUR INTERVAL 50 FEET

charcoal throughout the area, yet the diversity and maturity of the Dry Forest warrant special attention.

Because of the mosaic of community types in close proximity, the importance of the whole is much magnified. As in the Friar's Bay Complex, the close proximity of this array of communities increases their value as a natural wildlands management area.

4. St. Anthony's Peak. St. Anthony's Peak is the dominant feature of the SEP. Its stature, the Dry Forest areas that dominate the western slopes facing the Great Salt Pond and the remaining areas of Thorn Scrub create a significant ecological as well as visual element for the surrounding landscape. Its designation as a wildlands management area is of primary importance, first because of its relative size and inaccessibility, and secondly because of its potential for wildlife habitat. Because of it size and its key location (central to the southern peninsula), it will form the crucial central element in SEP wildlands management program.

5. Mosquito Bay/Cockleshell Bay Complex. The areas immediately surrounding the salt ponds of Mosquito and Cockleshell bays are an important ecological complex of Dune vegetation, salt ponds, Thorn Scrub and some small stands of Dry Forest and Mangrove Forest. While the diversity of ecological communities is not as great as the Friar's Bay Complex, the relatively fragile nature of the communities and their small spatial extent warrant special attention. Development in this area should work to preserve as much of the existing community structure as possible, by concentrating developed lands around the periphery of the salt pond and along its northern margins and southern slopes of St. Anthony's Peak.

   Scotch Bonnet Ridge has some significant stands of Thorn Scrub and Dry Forest along its western slopes that face the Fleming Estate. Their inclusion within this wildlands management area will enhance the overall ecological value of the complex. The northern slopes of Scotch Bonnet offer marvelous vistas of the surrounding landscape. If developed, development should be encouraged to concentrate in relatively small areas that will maintain the maximum amount of natural vegetation and community structure intact.

6. Major's Bluff. The ecological communities of the Major's Bluff provide an important link between the wildlands management areas of Nag's Head Bluff and Major's Bay Salt Pond to the west with the management areas to the north and east. The linkage of management areas is vital for the integrity of the entire system of wildlands. Large expanses of developed lands separating wildland areas effectively isolate resident populations of wildlife, decrease the mobility of species and individuals, and ultimately result in declines in population numbers and viability.

   The landward slopes of the bluff are increasingly becoming dominated by Guinea Grass, but the advance is most likely to decline in the more wind swept, southern

36

portions of the ridge. Regardless, portions of the ridge remain intact and offer important habitat.

7. Major's Bay Salt Pond. The environment of the Major's Bay Salt Pond, offers an important wildlife habitat for wading and shore birds. To the west, where Nag's Head Bluff abuts the Salt Pond, a relatively intact stand Dry Forest fringes the western edges of the pond. This area combined with the fringing dune and beach vegetation along the seaward margins of the pond provide community diversity important to numerous wildlife species as nesting cover.

8. Nag's Head Bluff. Actually this wildlands management area extends along bluff and western ridges of Bugg's Hole and Shitten Bay ending at the juncture with Green Point. The western slopes of the ridge system are dominated by one of the most diverse assemblages of Thorn Scrub vegetation on the SEP. Combined with the nesting and roosting sites for Brown Pelicans and Magnificent Frigatebirds, this area is one of the single most important mosaics of ecological communities and wildlife assemblages to be found on the SEP. Development within and adjacent to this area should be strictly regulated to ensure that it remain intact.

In general, contiguous blocks of lands have been designated as wildlands areas. Yet there are still several blocks that are not connected, but should be. Connections between the Mosquito Bay/Cockleshell Bay area and Major's Bluff and, in turn, between Major's Bay and Major's Bluff could be achieved through relatively narrow wildlife corridors. Harder to connect yet still important is Friar's Bay and Salt Pond Hill. The narrow, steep nature of this area makes establishment of a corridor particularly difficult. These corridors could form the basis of a peninsula-wide trail system. It is strongly urged that as the plan for parks and recreation is developed, it pay particular attention to developing a combined wildlife corridor and trail system throughout the Peninsula.

3.3 Managing Development Impacts

Development of the Southeast Peninsula can easily result in the decline of environmental quality through improper siting, secondary impacts and increased human access. On the other hand, development offers the potential to reverse recent trends in deterioration and enhance the overall environmental quality through controlled siting that has minimum impacts, minimum secondary impacts and that controls access to important wildland management areas. The following paragraphs outline generalized development techniques/principles that may be used to guide development and as the beginnings of a regulatory framework that will ensure the continued existence and enhancement of the terrestrial resources of the SEP.

31

3.3.1 Construction Criteria

1. Down slope wasting of cut material from roads and housing pads should be minimized under all circumstances.

2. Vegetation clearing of housing sites should be kept to a minimum with permits required for the cutting of any tree having Diameter at Breast Height of greater than 4 in., or stature greater than 12 ft.

3. Permits should be required for any excavation and or filling that involves greater than 25 cubic yards of material.

4. Wherever possible, access roads should follow the natural contours of the site to avoid unnecessary cutting and filling.

5. Cleared building sites should be revegetated with appropriate native plant species as soon as possible to avoid erosion and down slope sedimentation.

6. The potential for significant environmental degradation exists along the ridgetop between Turtle and Bennett's bays where the road alignment is designed to occupy the ridge. Access roadway cuts and cuts for housing pads along this ridge will be especially difficult with the potential of down slope impacts as a result of down slope wasting of excess cut material. Great care should be exercised within this area.

3.3.2 Planning and Design Criteria

1. To minimize unnecessary clearing and loss of ecological communities with subsequent loss of wildlife habitat, development density should be concentrated in as small a portion of the total site area as possible.

2. Because of the potential for significant erosion and increased sediment transported to the nearshore environment with consequent negative impacts on nearshore marine habitats, areas of intense development should be concentrated in the watersheds of salt ponds where sediments will be intercepted and will not contribute to nearshore turbidity.

3. The windward slopes of the SEP are dominated by vegetation that is in a constant state of stress from salt, drying winds, and destructive wind velocities. As a consequence, this stress adapted community existing in a relatively inhospitable environment, will not recover and recolonize disturbed areas as readily as other community types. Disturbance of the windward slopes should be minimized, and any development should be confined to small patches at low slope and low elevations. Clustered development with 80-90% of the vegetation left intact should be encouraged.

4. The wetlands (mangrove swamps, salt pond margins and mud flats) of the SEP represent a unique environmental resource. Their importance to the wildlife of the SEP and potential importance to the tourist industry should be weighed heavily before any proposals for their dredging or filling are approved.

5. Because of their rarity and their status as seed sources for reforestation of portions of the SEP, all Dry Forest areas should be considered as candidates for a conservation designation.

4.0 SUMMARY AND RECOMMENDATIONS

This resource management plan has stressed that the terrestrial resources of the Southeast Peninsula are a unique and integral part of the development that will follow the completion of the road to Major's Bay. It has suggested that an approach to resource management be taken that first recognizes the values and sensitivities of individual ecological communities and encourages development to accommodate them. And second, that a broader perspective be taken to manage terrestrial resources of the SEP as one complete unit of wildland management areas that are interconnected and in close enough proximity that they act as one unit and not as series single isolated reserves. Eight areas were designated as wildland management areas. Within these areas, development may still be accommodated, but should be subject to stricter controls that will insure that it will not interfere with the primary focus of the wildlands area. In this way the resources of the Peninsula are best protected for the long term.

Development of the SEP that takes a shorter view of the resources, or that is not cognizant of the values and sensitivities of ecological communities runs the risk of diminishing the natural appeal of the area. The goal of the regulatory framework should be the successful integration of developed lands with the terrestrial resources of the Peninsula. This is best achieved through a "partnership relationship" of humanity and nature.

5.0 REFERENCES

Arendt, W. 1985. Wildlife Assessment of the Southeastern Peninsula, St. Kitts, West Indies. U.S.A.I.D./Regional Development Office/Caribbean, Bridgetown, Barbados.

Brown, M.T. 1985. Managing Landscapes for Humanity and Nature: the role of wetlands in regional nutrient dynamics. Conference Proceedings: The wetlands of the Chesapeake. Environmental Law Institute. Washington D.C.

Brown, M.T. 1986. Cumulative impacts in Landscape Dominated By Humanity. in E.D. Estevez, J. Miller and R. Hamman (eds.), Proceedings of the Conference: Managing Cumulative Effects in Florida Wetlands. New College Environmental Studies Program Publication No. 37 Sarasota, FL.

E.D. Estevez, J. Miller, and R. Hamman (eds), Proceedings of the Conference: Managing Cumulative Effects in Florida Wetlands. New College Environmental Studies Program Publication No. 37 Sarasota, FL.

Brown, M.T. 1988. Forested Wetlands in Urbanizing Landscapes. General Technical Report No. SE-xx, The Southeastern Forestry Experiment Station. Clemson University, Charleston S.C. (in press).

FORESTRY RESOURCES MANAGEMENT PLAN

by

John Buchter, M.S., L.L.D.

May 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

42

EXECUTIVE SUMMARY

Factors affecting growth of vegetation and how microclimate determines vegetation type are of interest to developers.

The vegetation indicates hot dry sites, areas subject to occasional flooding, places of high salt content, and extremely windy, or protected situations, shallow-soil over rock or deep clay soils, depth of sand and many other site specific conditions.

The best examples of various phases of the tropical dry forest remaining on the Peninsula are on steep lands where development is not likely to interfere with them.

Guinea grass fires destroy tropical dry forest, but development is likely to result in more rocks, fire breaks and landscaped areas, hindering the spread of fire. Therefore development may protect the remaining tropical dry forest.

Fire breaks should be incorporated into landscaping where appropriate because guinea grass is a fire hazard. Revegetation efforts for erosion control should utilize Guinea grass only where other plants are not suitable.

Native plants are slow growing, so exotic plants should also be used for wind breaks, fire breaks and landscaping.

Certain lands should be protected from development, such as guts, historical areas, groves of large trees or wildlife areas because these features enhance or protect tourism values. The concept of a "Special Reserve" is introduced for consideration by the Southeast Peninsula Board (SEP).

Particular regulations pertaining to protection of trees, erosion control, fire control and animals are suggested for consideration and evaluation by the SEP Board.

TABLE OF CONTENTS

1.0 DESCRIPTION OF RESOURCE CHARACTERISTICS 1

1.1 Predominant Factors Which Affect Growth of Vegetation on the Peninsula 1

1.1.1 Moisture 1

1.1.2 Topography 1

1.1.3 Soil Conditions 1

1.1.4 Microclimate 2

1.2 Vegetation Cover Types 3

1.2.1 Barrier Dune 3

1.2.2 Littoral Forest 4

1.2.3 Sea Blast Areas 5

1.2.4 The Xerophytic Association 5

1.2.5 The Tropical Dry Forest 6

1.2.6 Guinea Grass 9

2.0 MANAGEMENT ALTERNATIVES 11

2.1 Particular Issues 11

2.1.1 Fire Hazard 11

2.1.2 Vegetation Cover and Erosion 11

2.2 Special Treatment Areas 11

2.2.1 Observation On Specific Features 11

2.3 Special Reserve Areas 12

2.4 Development Guidelines 13

2.4.1 Tree Protection 13

2.4.2 Gut Protection 14

2.4.3 Roadway Design and Construction 14

2.4.4 Fire Control and Wind Protection 15

FIGURE 1 17

1.0 DESCRIPTION OF RESOURCE CHARACTERISTICS

1.1 Predominant Factors Which Affect Growth of Vegetation on the Peninsula

1.1.1 Moisture

Moisture is a key factor affecting the growth of vegetation. Amount of precipitation and proximity to a suitable water source are largely determine the variety of vegetation established in a certain area. Various flora have different needs and respond to conditions in their environment according to the dictates of their species. Some are highly capable of adapting to conditions which are normally considered adverse to their species while others are of a more delicate constitution and can exist only under certain conditions. Moisture available to vegetation, however, hinges on topography, soil conditions, and the immediate site climate.

1.1.2 Topography

The topography influences available moisture in at least two ways:

1. Height. As air rises over a hill, it is cooled. The higher a hill, the more likely that precipitation will be induced by the saturated air cooling to the condensation point.

2. Position of Catchment. Water flows or seeps downhill. The ridge line is always the driest place, whereas drainages or guts are more damp, and the bottom of the slope or valley floor is the wettest.

1.1.3 Soil Conditions

Soil conditions such as soil depth and porosity, or moisture retention, are closely related to topography. Generally, ridges have the thinnest soil while farther downhill the slopes become less steep and there is more soil and more moisture.

Clay. Moist soil on the Peninsula is clay. The flat areas near salt ponds have clay deposits several feet deep. The clay is not very porous. The moisture retention capability is high but the infiltration rate is low. Therefore water takes a long time to seep through. The clay is part of the volcanic parent material. It is very erodible and much of it has been washed from the upper slopes down to the flat lands near the salt ponds. The clay soil on steep slopes is usually about four or five inches deep, held in place and protected by the scrubby growth of brush. Deeper soil, over a foot deep, can retain adequate moisture for the large roots of trees about four to six inches in diameter. Observation of road construction cuts indicate that roots from the vegetation usually do not penetrate into the thin clay veins in the fractures of the rock. This indicates that moisture and support must come from the thin top soil.

Sand. Sand near the beaches has accumulated into dunes in some places. Here high porosity and low moisture retention (the reverse of clay conditions) creates a dry situation with low water retention. However water is available just a few feet below it for growth of littoral forest plants like manchineel. The top inch of the sandy soil is dry and guinea grass will not easily grow in an environment with poor moisture retention.

1.1.4 Microclimate

Rainfall. Local climatic variation or microclimate, is the most interesting and complex variable affecting moisture availability. Rainfall may average about 35 inches per year, but it varies in different locations on the Peninsula. In some locations on the windward side of the Peninsula wind and salt spray create harsh conditions so growth is stunted, and the impact of wind-driven rain on the unprotected slopes has washed the clay soil away leaving only a pavement of gravel and stones. Beneath the pavement, adequate soil remains to support plants once they are established, but the constant wind increases moisture losses from transpiration.

Salinity. Near the sea, the plants must be salt tolerant. Higher up the slope less salt tolerant plants can survive. However, since not much water can infiltrate into the clay soil under the rocky pavement, most precipitation is lost in runoff. Moisture which is retained in the clay has a tendency to evaporate quickly in the windy site, although the rocky pavement may help inhibit evaporation. Water losses through transpiration are the determining factors for vegetation in these areas of sea blast. Only plants which can control their stomata to regulate moisture loss can survive in these locations. Buttonwood, a very salt tolerant plant with thick leaves like a succulent, is most common in these areas.

Wind. Farther up the hill, wind pruning shapes the vegetation and gives it the appearance of a moor. Plants of the tropical dry forest grow here, but they are dwarfed and stunted. Any trees planted on the Atlantic side must be salt tolerant. The prevailing wind comes from the east-southeast. In addition to the physical force of the wind, the increased evaporation and transpiration make these sites difficult for the growth of plants.

Temperature. A southern exposure gets more solar radiation than any other slope. This is true even in the tropics, where for several weeks around the time of the summer solstice the sun is in the north. Most of the time the sun is in the south, so yearly average soil temperatures are highest on the southern slopes. Maximum soil temperatures are lower than those experienced in summer in countries to the north due to the shorter day length and small size of the island. Air temperature is about 80°F throughout most of the year.

Evaporation. does increase with the increased temperature. Southern slopes are drier sites due to the increased evaporation resulting from increased soil temperature and corresponding increased air temperature. Century plant and cactus are prominent on

these drier southern slopes. Short grasses also inhabit this site because available moisture is insufficient to maintain a complete plant cover. The grasses require considerable light and are easily shaded out by taller vegetation.

1.2 Vegetation Cover Types

For the purposes of this report the forest resources on the Peninsula are classified or separated into six different vegetation types. They are:

1. Barrier Dune
2. Littoral Forest
3. Sea-blast Areas
4. Tropical Dry Forest
5. Xerophytic Association
6. Guinea Grass

Some blending or indistinct borders might occur, but the habitats are generally separate. The areas of xerophytic association and sea blast could be considered as phases of the tropical dry forest, but they are treated as separate and distinct types in this report because they are indicators of particular environmental conditions important to developers.

The different cover types can be distinguished by the dominant vegetation. The barrier dunes have a cover dominated by sea grape. The littoral forest in wet places behind the beach is characterized by manchineel and mangroves near salt ponds. A low scrubby growth of salt tolerant buttonwood survives in the harsh situation of sea blast. The xerophytic association of agave or century plant, acacia, cacti and light grasses inhabits areas too dry for tropical dry forest to shade out the grass. The tropical dry forest often has loblolly, lancewood and gum as dominants, in a variable habit depending upon available moisture, appearing as a thicket less than eight feet high in dry areas, but becoming a closed canopy forest sixteen feet high with adequate moisture in a protected site. Guinea grass is the sole species in the type; it was introduced for cattle feed and it is expanding its range.

1.2.1 Barrier Dune

The barrier dunes are composed of light coral sands piled behind beaches on the Atlantic side of the Peninsula. The sites are dry and salty because the sands are very porous and do not hold water well. Sea grape is most common here, forming a thick mat two or three feet high. In protected locations, such as in holes blown out by the wind or flowing water, the grape may attain the size of a tree.

Where the sand depth measures less than a couple of feet thick, trees of the littoral forest may grow if their roots can reach the water in the clay soil beneath the dune. Trees of the tropical dry forest may become established on the dune in competition with

47

the sea grape, particularly away from the beach, where the salt spray is not so severe. Climbing vines occasionally swamp emergent larger trees on the dune, eventually killing them and creating an opening in the vegetative cover when the vine dies. The wind can then blow the dry sand away from the exposed site and make a depression, piling the sand up a little further downwind.

The barrier dunes serve as a buffer for the island by confining large waves, not just from the rare hurricane, but also the big swells that come several times a year. Therefore activities which destroy the vegetative cover of the dune should be restricted by the Southeast Peninsula Board.

1.2.2 Littoral Forest

The littoral forest occurs on swampy lands adjacent to a salt pond or immediately behind a beach, such as behind Canoe Bay where a small salt pond was most likely filled in. Mangroves inhabit the very wet sites. Manchineel occupy a slightly drier areas where roots can reach adequate water.

Mangrove areas are unlikely to be preferred by developers, but are very important for maintaining wildlife important to tourism. Mangroves need fresh or brackish water for a short time every year. Survival of littoral forest cannot be guaranteed if ponds are flooded with sea water to make them more attractive during extended dry seasons. If flooded only occasionally, there would probably be no harm to the plant life. The littoral forest does not extend all the way around the Great Salt Pond. The littoral forest exists on the east side where fresh water seeps out from the sand bank and gut.

Fresh water from rain floats on top of the salt water for a while, so small ponds are occasionally brackish on the top. The waves on the Great Salt Pond mix the water faster, particularly on the west side.

Important reasons for not locating development immediately adjacent to a littoral forest are 1) the possibility of peculiar odors from decaying vegetation in the muck, 2) small flies found in this association and 3) machineel poisoning. Mosquito problems may be anticipated as well. Mosquitos breed in fresh or brackish water, but not in salt water. No mosquito problems have been experienced yet. However, if problems occur, the landowner with the problem is not likely to be the owner of the pond. Eventually, the SEP board may be asked to decide who should do what, and how control methods can best protect the littoral forest community.

Destruction of littoral forest should be discouraged. The loss of these areas on the Peninsula as a wildlife habitat could negatively affect the SEP's tourism industry.

1.2.3 Sea Blast Areas

The areas of sea blast indicate zones of harsh conditions where plant life has difficulty sustaining itself and are not truly considered a vegetation type.

Strong winds come out of the east southeast, carrying salt spray at low elevations, and impact the exposed slopes with great force. Most of the slopes which face this direction have little soil, only a pavement of stones and gravel remaining while the top soil and clay have been washed away.

The salt from the sea spray turns even the leaves of manchineel brown, but the salt tolerant buttonwood, which is very much like a succulent, can survive. Although transpiration losses from these windy areas can inhibit growth, the greatest effect comes from the sheer force of the constant wind.

Despite spectacular views, areas of sea blast should indicate to developers that these are not prime sites. Landscaping possibilities are extremely limited and construction, and maintenance of driveways would be expensive due to considerable rapid runoff during rains.

1.2.4 The Xerophytic Association

The xerophytic association occurs in the driest locations. It is distinguished by the presence of grasses and the prevalence of cacti, century plant and acacia. Dry forest species are often present. They appear in a dwarfed or shrub habit, not as a tree, and not close enough together to shade out the grass. There is often a gradual blending with dry forest at its limit. The forest becomes more sparse and less tall, with more balsam present. Eventually, grass becomes prevalent. However, the border between this association and dry forest may be quite distinct, perhaps due to fire.

The xerophytic association often burns, and the amount of grass will increase with frequent burning. This often occurs to the detriment of the dwarfed dry forest plants. Balsam seems ubiquitous, but it is removed by fire, along with frangipani or milk tree. However, fire is not necessary to maintain the xerophytic association. Introduced species which are fire hardy or which rapidly resprout from the roots after burning, such as casha or wild tamarind (leucaena), are increasing in some places where fires are common, such as along the Caribbean coast between Friar's Bay and White House Bay.

Fires on level ground are generally slow-moving and fairly cool. The grass cover is too short and thin to make a really hot fire. Most plants grow back quickly even should a fire occur. Shrubs, often dwarfed dry forest species, may be thinned or removed by fire. But if fire is excluded, the shrubs re-establish themselves. The association also appears in isolated patches or pockets where fire has never appeared. In these small locations the

dry conditions and scrub growth are caused by lack of soil, or in other spots by exposure to sun and wind. On these rocky outcrops or exposed places with no protection, the cacti and acacia can maintain themselves because other plants cannot shade them out.

1.2.5 The Tropical Dry Forest

The tropical dry forest is a low, closed canopy forest sixteen feet high. Stems average ten inches in diameter in a heavy understory where there is a protected site with adequate soil and moisture. In more exposed or drier sites the growth becomes a thicket about eight feet high. Where there is more moisture, it blends into the littoral forest on the Peninsula, and in drier areas it blends into the xerophytic association.

Growth, sufficient to form a closed canopy, requires adequate moisture and soil. Evaporation and transpiration are influenced by the shape of the hills, which in turn affect the amount of rain, sun and wind a site receives.

Most rain falls on the windward side of the higher hills. An air mass is most likely to precipitate moisture as it rises 800 or 1000 feet over the hills. However, the rain often falls slightly downwind as well. Examples are the lee sides of St. Anthony's Peak and the Salt Pond Hill.

The wind causes high rates of evaporation and transpiration on the windward side. As a result, the wettest places with the largest trees are in places protected from the wind such as the guts, and on the uppermost lee side.

1.2.5.1 Regeneration of Tropical Dry Forest

One of the best stands of trees is in the gut draining St. Anthony's Peak to the Great Salt Pond. It was once cleared for agriculture, but it has since grown back. The forest does regenerate, but growth is not rapid, and those regenerated stands in St. Anthony's Gut may be over a hundred years old. Resprouting from stumps or coppicing is common for several species, but this resprouting from the roots is not the same as growing from seed. The tropical dry forest on the Great Sand Bank behind the barrier dune is very resilient and has been cut for charcoal and posts for many years. It grows back quickly from stump sprouts because of the well-developed root system already in place. There is a freshwater lens under the sand bank so the roots have the resources ready for rapid growth after the tops are cut. Several shoots usually replace the cut stem, and shrubs with multiple stems are sometimes occur as a result of two or even three cuttings.
The dry forest trees generally have seeds in drupes, or small fleshy fruits like little berries. These are eaten by wildlife and germinate after they have passed through the digestive tract. Monkeys are now the primary agent for dispersal of many seeds. The birds which once helped disperse the seeds may have been depleted by man, monkey or mongoose or, more likely, by loss of habitat on this and other islands.

50

The biggest problem affecting germination of seeds from the tropical dry forest is competition from grasses which inhibit seeds from reaching suitable rooting soil, and which may burn therefore cremating the seedlings. On bare ground or sand the germinating seeds may get a start. If the seedlings can get adequate moisture to develop a decent root structure they might survive.

The forest in the St. Anthony's Peak gut had been cleared for agriculture hundreds of years ago. When the fields were abandoned, seeds washed down from the forest on the hill in the headwaters of the gut and became established in the sediment of the flood plain. Thus the forest quickly re-established itself.

During germination there is a period of very slow stem growth while the plant is developing an extensive root structure of very long thin roots. A consequence of this is the very patchy development of dry forest in the early stages of succession and the development of a long stage characterized by a large density of small stems.

The competition between these numerous stems for moisture and nutrients slows the growth because the production of the area is spread out over all the many individual stems. Stagnated growth with numerous stems per unit area is a typical situation on poor sites in tropical, temperate and boreal forests. Some stems (cut for purposes of this study) were little over a half inch in diameter and sixteen years old.

The slow growth of many native plants of the tropical dry forest species makes certain fast-growing exotic plants a more practical choice for landscaping. Seed collection of the native plants is more difficult and the particular methods for germination and growing are not well-known, while the techniques of growing the standard exotics are well-established. No time-consuming experimental program is necessary if species with proven reliability and rapid growth are used.

1.2.5.2 Species Composition of Tropical Dry Forest

The best closed canopy stands are on the north slopes of St. Anthony's Peak, on the west side of the peak in a protected gut, on the east side of the hill above Green Point, in a protected hollow and in from this hill leading down to Ballast Bay. North of Sugarloaf there is a good stand above the gut leading to Canoe Bay.

These stands have gum, loblolly, lancewood and ironwood as the most common dominant trees, and understory species are usually balsam, torchwood, limber caper, bushy spurge and Florida boxwood. Even in the moist sites an occasional agave, acacia or other plants associated with dry areas will be found, and Turk's head cactus may grow in rocks.

As sites become more exposed and drier, the trees and their leaves become smaller, the canopy becomes thinner allowing more light to reach the understory. The number of stems per unit area rises with the increase in light. The species names remain the same, but the numbers of balsam, cotorro, and other plants which do well in dry areas tend to increase while the numbers of manteguero and loblolly decrease.

51

The numbers of ironwood and casha tend to increase as moisture decreases and canopy height declines to eight or ten feet. The size of the leaves on lancewood and loblolly become smaller and the plants with thin leaves, like indigo, become scarce. The plant stems have a maximum of about four inches.

Eventually the cover becomes so sparse that plants cannot shade out grass. Grasses such as sour grass, goose grass and mesquite grass grow in with balsam and concha berry. Turk's head cactus has enough light that it can grow on the ground without needing rocks to create an open space. The cover is just an intermittent low thicket. Still, the same plants are often present. Gum, loblolly, lancewood, fish poison tree, frangipani, casha, croton, spiceberry eugenia, white cedar and many other plants can be found just about anywhere on the Peninsula. They are all larger where there is more moisture, and in dry areas, or xerophytic association they appear as dwarfed shrubs unless repeated fires have removed them altogether.

Fire will remove some of these shrubs or small trees. The more often the site burns, the more plants are removed until finally even casha can no longer maintain growth leaving only century plant and grass and an occasional cactus.

This Caribbean type of tropical dry forest has more than 30 species associated with it, appearing in various proportions across the moisture gradient of the dry forest. Some of these, as noted by Arendt in 1985 are:

Overstory

Loblolly or water mampoo	*Pisonia subcardata*
Loblolly or black mampoo	*Pisonia aculata*
Gum	*Bursera sineruba*
Ironwood	*Krugiodendron ferreum*
Lancewood	*Lonchocarnus pentaghyllus*
Fish poison tree	*Piscidia piscipula*
White cedar	*Tabebuia heterophylla*

Understory

Florida box wood	*Schaeffera frutescens*
Limber caper	*Capparis flexuosa*
Balsam	*Croton astroites*
Torchwood	*Amvris elemifera*
Bushy spurge	*Chamaesyce articulata*
Cotorro	*Adelia ricenello*
Manteguero	*Rapanea fernuyinea*
Casha	*Acacia tortuosa*
Frangipani	*Plumeria alba*
Spice berry eugenia	*Eugenia rhombea*
Concha berry	*Zanthoxvlum monophyllum*

Grasses

Sour grass	*Dichathium annulatum*
Goose grass	*Elcusine indica*
Mesquite grass	*Boutelocia americana*

1.2.6 Guinea Grass

About twenty-five years ago, Guinea grass was established around the Great Salt Pond in an effort to improve the available cattle feed. Guinea grass is reasonably good feed, best when it is young, and it grows well on the Peninsula.

Cattle raising has decreased largely due to the livestock disease dermatophytosis which entered the country several years ago. Transmittal of the disease is through ticks.

The Guinea grass is changing the face of the Peninsula. It grows four feet high in good soil, and two feet high on poor dry sites. The growth is so thick and rank that once it is established, nothing but an occasional milkweed can compete with it. The most significant thing about Guinea grass is that it burns hot. For example, heat produced from burning Guinea grass can kill plants 10 to 20 feet inside a protective stand of dry forest trees.

As the growth of Guinea grass creeps near the edge of a forest, dead burnt stems remain stand as a reminder that each time the grass burns, it will again push the forest back a few feet. Comparison of aerial photographs taken in 1946, 1968 and 1988 shows that the dry forest then was growing on many slopes around the Great Salt Pond where only Guinea grass appears now. The grass has steadily spread and is now beginning to get established on Sir Timothy's Hill, and on the west side of the isthmus. Some residual patches of dry forest are not going to stay there long. Guinea grass will run before the wind across the high valley on the Goldgar property, the old Payne estate,

and may even reach Ballast Bay and Shitten Bay in twenty or thirty years, if it burns every year or so.

Guinea grass has already converted an area of xerophytic association south of Sand Bank Bay and is moving across the face of St. Anthony's Peak above the Great Sand Bank. Movement here may be slow because it is sheltered from the wind.

On the floor of the valley of the Great Salt Pond there is a high stand of dry forest blended with littoral forest in the gut from St. Anthony's Peak. The grass has made extensive inroads in the forest in this area, as dead stems show it is pushing back a little farther every year or so.

Guinea grass is established above the road on the flanks of Sugar Loaf and is pushing back the scrub forest.

Guinea grass is not yet established on the isthmus nor in Friar's Bay. It should not be used as an erosion control method along the road on the isthmus where it would burn uphill and threaten any development built along the ridge.

2.0 MANAGEMENT ALTERNATIVES

2.1 Particular Issues

2.1.1 Fire Hazard

Planned development of the Southeast Peninsula could provide significant benefit in that it may help restrict wildfires. Road construction and development will divide sizable areas of Guinea grass and make large fires less likely. This, in turn, would slow the rate at which the grass spreads. Effective at decreasing the liklihood of fires would be landscaping features utilizing wind breaks and fire breaks of heat-resistant plants on the perimeter of development or in strategic locations.

The burned house on the promontory above the salt pond stands evidence that the spread of Guinea grass is a fire hazard.

Fire breaks made of clammy cherry and tamarind should be planted in this location to protect the existing forest cover from being killed by fire.

2.1.2 Vegetation Cover and Erosion

Although it is a fire hazard, Guinea grass is extremely effective for holding soil. After recent rains of more than three inches several small guts ran with clear water in them for a couple of days. There was no surface runoff from Guinea grass areas. The water was slowly seeping in the top couple of inches of clay and roots. Several days later, it was still seeping from a hill covered by Guinea grass.

Erosion from the hillsides and sedimentation in the Great Salt Pond was negligible. The pond rose approximately a foot but it was still clear. However, the water in Friar's Bay pond was muddy because of runoff from disturbed lands due to road construction. Under natural conditions, the salt ponds do not catch much sediment. If the ground cover is disturbed, erosion and sedimentation may increase dramatically.

2.2 Special Treatment Areas

2.2.1 Observation On Specific Features

Certain areas or features are particularly valuable for tourism and should be protected.

1. The St. Anthony's Peak Gut, where drainages from the steep west face of St. Anthony's Peak combine in a wide seep leading to the Salt Pond, has poor drainage and is subject to flooding. The largest trees on the Peninsula grow in this area with stems over a foot in diameter about sixty feet apart. Very attractive areas for development exist on either side of the gut. A protected width of at least a hundred feet would be appropriate along the gut.

65

2. Areas of sea blast have short vegetation in which it is difficult to hide any disturbance. The wind prunes the plant cover, forming lines along the flow of the air currents. The eye tends to follow these lines and the whole area has a visual texture. Development must be merged into the scene to avoid a glaring contrast. Replacement plants must be salt tolerant. The preferred species for roadsides would be native.

3. Barrier dunes should absolutely be protected. The vegetation cover must be strictly maintained to prevent blowing sand. The Sand Bank Bay dune may have been breached at the north end in times past. The wind is strongest there and a road has been there for about two hundred years. Waves apparently wash through there into the salt pond during storms with high water.

   Roads or paths across sand on barrier dunes are inevitable. The use of raised wooden walkways will concentrate traffic and allow sand to move and accumulate.

4. Guts should be protected. Even small ephemeral streams with a rocky bed a few inches wide will cause expensive problems for developers. Presently, with no disturbance in the watershed, guts run clear after heavy rains, suggesting little or no erosion and sedimentation is taking place. Development near guts will increase the potential for eroded materials to be washed down slope into the salt ponds and the ocean.

5. Above Sand Bank Bay Beach is a steep gut with large trees covered with vines. It is scenic and is valuable for tourism. It is possible that fire will threaten this gut eventually because every year guinea grass fires are burning closer to it. This gut serves to protect a potential valuable hotel site from rock falls. The planting of fire resistant plants would be advisable in order to slow or stop the spread of fires in this location.

6. Areas of littoral forest near small salt ponds in Friar Bay, Major's Bay and near Scotch Bonnet should not be developed, nor should they be used for dumps. These littoral forest areas (manchineel, mangroves, buttonwood and other trees) screen the ponds and mudflats, and provide important wildlife or habitat. These areas are inhabited by several types of shorebirds which nest on the ground or in the trees.

2.3 Special Reserve Areas

No roads or other development should be allowed in potential Special Reserve Areas until a final disposition of those areas is made by the SEP Board.

A Special Reserve Area should be established for Brown Pelican and Magnificent Frigatebird nesting areas. The government forester from the Agriculture Department,

in consultation with the appropriate representative of the Conservation Commission, might be asked to suggest boundaries to the Board.

After consultation with the Attorney General and the landowner, the SEP Board may recommend to the Minister that the creation of such a reserve tends to enhance the value of the owner's property, that the nesting areas are steep and unstable cliffs for the most part, and therefore unsuitable for structures.

A Special Reserve Area should be considered for the Atlantic side and the upper slopes of the lee side of St. Anthony's Peak. A special reserve area would be the best use of the area. It has a particularly wild and remote feeling, the elusive quality constituting a "wilderness experience" which is caused by the obvious power of the forces of the nature, the beautiful views of the sea, the strength of the wind, the absence of signs of man, the steep, difficult slopes and the diversity of landscapes. It is remarkable to have an area like that immediately adjacent to a resort site.

This special reserve area on St. Anthony's Peak would benefit the entire Peninsula development and tourism on St. Kitts, but would not particularly benefit the owner. Advice should be sought from societies and agencies interested in Wildland Conservation such as ECNAMP, the Caribbean Conservation Commission, the Wilderness Society, the St. Kitts Conservation Commission or others and the matter should be discussed with the owners.

2.4 Development Guidelines

2.4.1 Tree Protection

1. The cutting of live trees for charcoal production or for domestic purposes such as posts should be prohibited. This use is inappropriate in a resort area. The trees are worth more as an enhancement of tourism values in scenery and undisturbed wildland than they are as coal or posts. Cleanup of down material pushed over as a necessary part of construction is permissible and desirable.

2. All gum trees should be preserved. The particular appearance of the gum with its peculiar red bark is appreciated by tourists for its exotic look.

3. All trees over eight inches in diameter 48 inches above ground shall be preserved where practical, and in no case shall such trees be cut for the purpose of landscaping. All trees over 12 inches in diameter 48 inches above ground shall be strictly preserved, even to the point of relocating proposed development. There are not very many trees of this size so they should be incorporated into the design instead of being treated as an obstacle.

4. Groves of large trees should be preserved. There are few groves in likely areas of development, primarily near Green Point Hill, and near the St. Anthony's Peak Gut. These areas have patches of scrubby growth or Guinea grass near them

which are preferable spots for development. Areas with an 80% crown closure and stems over five inches DBH for every 200 square feet shall be preserved. The SEP Board may approve or deny an application to develop such a grove after consideration of comments from a Conservation Commission representative, the government forester and others.

2.4.2 Gut Protection

1. No construction or land clearing shall be done within 12 feet of any gut with a bare rock bed or clearly discernable bed five inches or more in width except that an access road may cross such a gut at a right angle to it on a concrete road dish or with an adequate culvert or bridge.

2.4.3 Roadway Design and Construction

1. Access roads shall have trees planted in irregular groups, at least 10 trees per hundred feet on the high side, and groups of at least 5 trees in every low spot where water runs off. Trees on the high side should be ornamental or shade trees where practical, or white cedar and shak-shak in dry or windy places. On the low side the trees should be clammy cherry where Guinea grass is prevalent. Neem, casaurina, flamboyant, leucaena, white cedar and other appropriate species may be used where Guinea grass is absent or controlled.

2. Below the outfall of culverts and road dishes, a pavement of rubble shall be laid or set so that a top rock overlaps and covers the inside half of the rock beneath. This rubble bed shall follow the diverted water course until it re-enters the old gut bed. If there is no old gut bed present, an apron of protective vegetation of khus-khus grass and trees may be used to spread the water. Sinks will not be used on the Peninsula.

3. All road fill slopes shall have khus-khus grass planted with sprigs one foot apart in rows along the contour which are less than three feet apart.

4. No 'Nevis type' half track roads with an unfinished center strip shall be constructed. Pathways across barrier dunes to the beach, whether created by management, the guests or the public, shall be raised above the dune surface on wooden walkways, and additional vegetation shall be established to confine traffic to the path.

5. Any road to the flat above Canoe Bay should be designed to have minimal side cast. It should also be made as level as possible with necessary change in elevation at either or both ends. A straight line across, in harmony with the horizon, would be preferable to biased slash across the face of the mountain, since this road will be in full view from the main highway.

55

6. Secondary roads shall be located so as to avoid cutting through areas of dry forest where possible. A road to Green Point will have to cut through dry forest and cross several small forests.

   The SEP Board should withhold approval of the road design and proposed subdivision until after consideration of comments presented by the St. Kitts government forester, a representative of the conservation commission and an engineer selected by the Board.

7. Access to the old Payne Estate should follow the old track leading from near the windmill to the obvious spur ridge, and along the ridge to the plateau. The road should absolutely not be located in the swale to the west of the spur ridge.

   An additional road may be appropriate leading out to the little salt pond from the Old Payne Estate. The location of this road will have to be considered carefully by the Board in a process similar to action for the Green Point Road. These roads all involve cutting through dry forest, crossing, guts and cuts and fills in areas of clay uphill from prime tourism spots.

2.4.4 Fire Control and Wind Protection

1. The burning of Guinea grass shall be strictly controlled. Any intentional fire set to burn or clear Guinea grass or to improve feed value or for other purposes shall be at moisture conditions sufficient to make a slow burning fire and shall be set to back into the wind.

2. Fire breaks of clammy cherry, tamarind and other fire resistant trees shall be planted on the upwind border of any developed property with Guinea grass.

3. Fire breaks and windbreaks shall be planted in an irregular or clumped line rather than a straight line. Several species of plants should be used in any particular planting.

4. Windbreaks may utilize casaurina, almond, coconut, and eucalyptus, but casaurina would be most effective. Combination windbreaks and fire breaks are possible, suitable species are casaurina, neem, clammy cherry, tamarind, shak-shak and leucaena. Additional plants like coconut, almond, flamboyant or golden shower can be used to thicken the line and add texture and color, but they are not good fire break trees.

5. Drip irrigation may be required for the establishment of windbreaks and fire breaks. The most difficult problem is competition from Guinea grass in the first five years. Planting large stock in gallon bags will shorten the time required for weeding. A water absorbent should be added to the soil in the planting hole.

6. Rooted gliricidia stakes over five feet high can be used to establish dominance over the grass and begin to shade it out. Gliricidia would need supplementary water in location above the valley floor.

7. Guinea grass must be removed from within 25 feet of any building.

2.4.4.1 Landscaping

1. Every building shall have shade trees established as part of the landscaping immediately upon completion of construction. Absentee owners shall make arrangements for the grounds to be maintained in their absence.

2. Landscaping shall utilize exotic ornamental plants which are known to be fast-growing and drought resistant. Salt tolerant plants would be used in appropriate places. Exotics would be used because their methods of propagation are known, they are selected for fast growth and beauty. Native plants are often drab, or uninteresting, but most importantly, they are slow-growing.

3. Every owner and developer shall do appropriate landscaping. Plans shall be presented to the SEP Board or its designated agent for approval. The Board may approve or reject any proposal for environmental or aesthetic reasons. The Board may recommend that the Minister impose sanctions upon any non-conforming owner or developer.

4. Guinea grass shall not be used for erosion control or for any landscaping for visual impact unless other considerations outweigh or minimize the fire hazard.

2.4.4.2 Animals

1. Grazing livestock has an apparent serious impact on the tropical dry forest. The animals keep paths open and slow regeneration by browsing. The Board should be prepared to consider controls or limits to the livestock population in the future and may entertain comments by landowners, business operators, or government officials such as the Department of Tourism, the Department of Agriculture, the Government Forester or the Conservation Commission.

2. All wildlife shall be protected. No hunting or trapping of deer, monkeys, turtles, birds or any other wildlife shall be permitted.

60

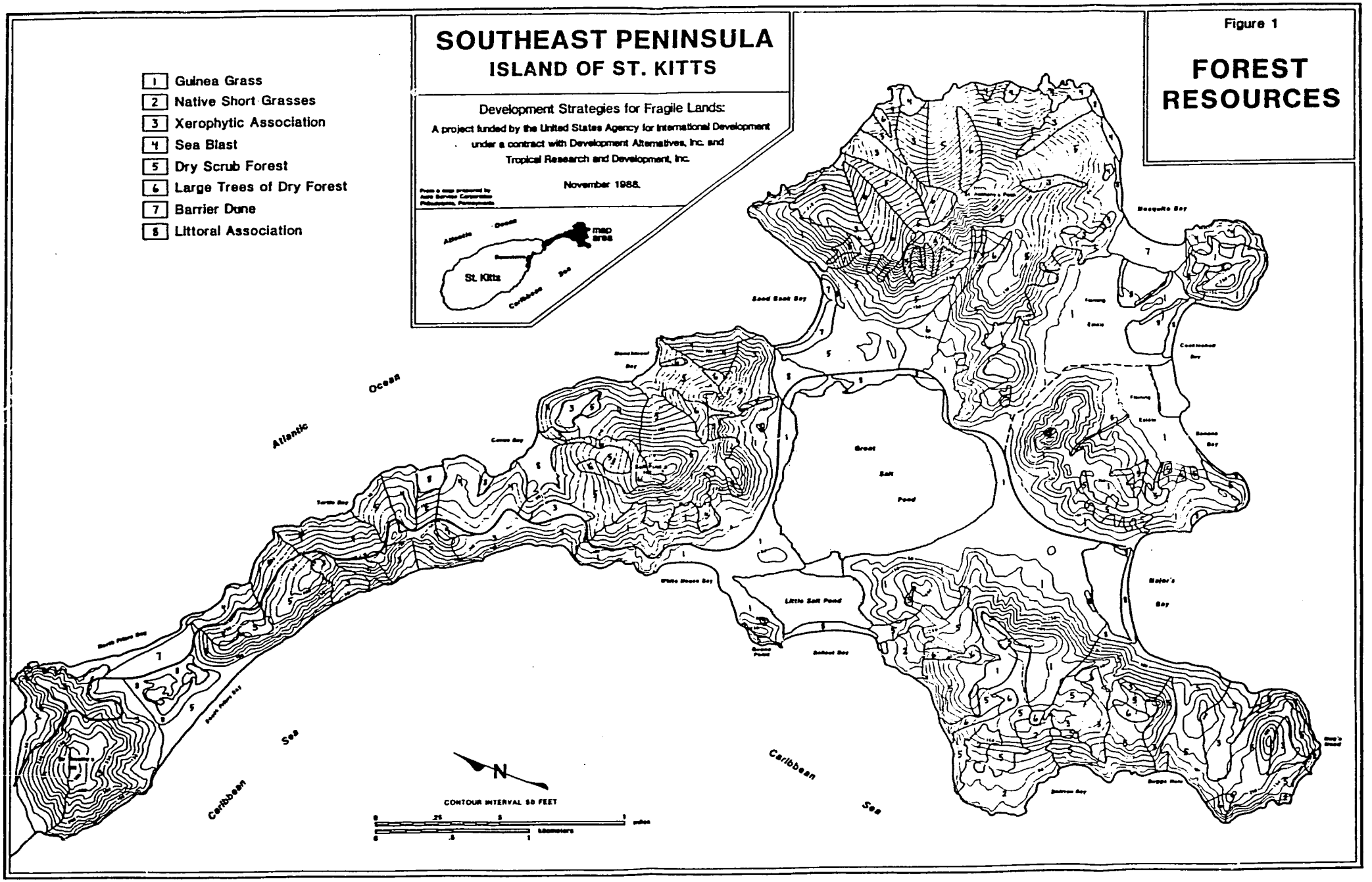


Figure 1
FOREST RESOURCES
SOUTHEAST PENINSULA
ISLAND OF ST. KITTS
Development Strategies for Fragile Lands:
A project funded by the United States Agency for International Development under a contract with Development Alternatives, Inc. and Tropical Research and Development, Inc.
November 1988.
1 Guinea Grass
2 Native Short Grasses
3 Xerophytic Association
4 Sea Blast
5 Dry Scrub Forest
6 Large Trees of Dry Forest
7 Barrier Dune
8 Littoral Association
map area
St. Kitts
Atlantic Ocean
Caribbean Sea
Great Salt Pond
Little Salt Pond
Mosquito Bay
Good Beach Bay
Cockleshell Bay
Sandy Point Bay
Turtle Bay
Cotton Bay
White House Bay
Sedwell Bay
Sugar Bay
Sailor's Bay
N
CONTOUR INTERVAL 50 FEET
miles
kilometers

6

WILDLIFE RESOURCES MANAGEMENT PLAN: SHOREBIRDS

by

Robert Norton, Ph.D.

May 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

62

EXECUTIVE SUMMARY

The Southeast Peninsula (SEP) of the island of St. Kitts is unique in the Lesser Antilles. No other island has the type of topography where a large area of wilderness and remoteness has remained relatively underdeveloped late in the 20th Century. Studies of wildlife resources and endangered species have been conducted there since the 1970s. Current studies confirm previous findings and have expanded scientific knowledge and understanding of the area's natural resources.

Wildlife resources of St. Kitts are of three types; introduced, native and migratory. Introduced wildlife include mongoose and monkeys, for example, which negatively impact native and certain migratory species. The most important native wildlife resource of the SEP is marine turtles, all of which are now considered threatened or endangered in the Caribbean and the world. Marine turtles use the expansive beaches of the SEP to lay eggs and the offshore seagrass and reef areas to feed. Also important to the SEP wildlife resource is the system of salt ponds for native and migratory endangered species.

The status of resident native and introduced land animals has been addressed in previous studies. These studies were limited, however, and indicated little regarding the diversity of species and resource value of the ponds. This report focuses on the particular use of the salt ponds by migratory birds and some native species. A species list has been developed, and its purpose is to indicate the diversity of fauna dependent upon the pond system of the SEP and where these species are predominantly found. In this way a compatible wildlife management and development plan may be implemented.

Options available for sustainable natural resource use of the SEP depend largely upon the integrity of the existing resource base. Compatible use of these resources is attainable throughout the life of the long-term investment. This suggests a commitment from the Government of St. Kitts to establish enforceable environmental laws and protective measures on behalf of the resources and sustainable growth of the SEP and the Nation.

The original, natural resources of the Peninsula, although somewhat depleted, ignored or threatened hold promise for sustainable use in the future. The area's wildness or remoteness may have suggested in the past that the SEP was of less value than the cash-crop areas to the north. Wild areas such as this will have increased recreational value in the future as similar areas in the West Indies, and indeed the world, are developed beyond the capabilities of the resource base to sustain economic value.

TABLE OF CONTENTS

LIST OF TABLES i

LIST OF FIGURES i

1.0 INTRODUCTION 1
- 1.1 Rationale 1
- 1.2 Scope of Study 1
- 1.3 Definition of Terms 1
- 1.4 Plan of Study 2

2.0 DESCRIPTION OF RESOURCE CHARACTERISTICS 3
- 2.1 Characteristics of the SEP 3
- 2.2 Resident Bird Species of the SEP 4
- 2.3 Migratory Birds Species of the SEP 4

3.0 MANAGEMENT ALTERNATIVES 7
- 3.1 Managing Natural Resources 7
- 3.2 Managing Development Impacts 8

4.0 SUMMARY AND RECOMMENDATIONS 9
- 4.1 Summary and Recommendations 9
- 4.2 Limitations and Suggestions 9

5.0 REFERENCES 17

LIST OF TABLES

Table 1 Resident Waterbirds of the Southeast Peninsula, St. Kitts 14

Table 2 Migratory Waterbirds of the Southeast Peninsula, St. Kitts 15

Table 3 Migratory and Resident Waterbirds of the Southeast Peninsula, St. Kitts 16

LIST OF FIGURES

Figure 1 Comparison of Rainfall St. John U.S. Virgin Islands and St. Kitts 11

Figure 2 Totals of All Shorebirds Observed in the USVI in 1982 12

Figure 3 Principle Wildlife Habitats of the Southeast Peninsula 13

64

1.0 INTRODUCTION

1.1 Rationale

The Southeast Peninsula (SEP) contains some of the most important natural resources of the Lesser Antilles. The geology of the SEP has provided St. Kitts with some of the most spectacular landforms found in the region. Expansive, open-access beaches and a system of hypersaline ponds enhance the natural resource base for a wide diversity of wildlife both marine and terrestrial. Until recent times, much of the SEP has been utilized by subsistence based animal husbandry, farming, charcoal production and salt gathering. A medium-scale, minimal impact resort is located at the terminus of the SEP.

Resource management of this juncture has been controlled largely by the remoteness of SEP and by marine resource users such as fishermen. The Government of St. Kitts to date has no agency that deals directly with natural resource management. Some legislation has been passed that controls the harvesting of certain wildlife species, but enforcement is lacking.

As the SEP is opened to greater public use as well as development, continued uncontrolled use of the natural resources will render the SEP void of much of its resource value. In this regard sustainable use of the area as a management goal may be defeated. Natural resource legislation should be considered and promulgated concurrently with the development plan of the SEP as a primary step toward sound management.

1.2 Scope of Study

The area of concern of this study is native and migratory wildlife resource use of the salt pond system of the SEP. Previous studies (Jackson 1981, Arendt 1985, Towle 1986) have focused on various aspects of terrestrial and marine wildlife resources of the SEP. The ponds are a dominant feature of the terminus of the Peninsula and therefore affect resident and migratory wildlife.

1.3 Definition of Terms

Waterbirds: any of a group of species that use water resources for feeding;

Shorebirds: aquatic bird species adapted to feed at the edge of or in the shallow waters of pond, stream, slough, or ocean shores by probing in the mud or soil;

Resident: species that breed at some time of year in habitats of the SEP;

Migratory: species that do not breed in the area and find use of the areas habitats on a temporary but often regular basis.

65

1.4 Plan of Study

Field visits to the salt ponds of the SEP were conducted at periods when resident and migratory bird species use was estimated to be the greatest in order to determine the diversity of species and relative abundance. Identification of species and numbers were recorded in July, September and October 1988.

2.0 DESCRIPTION OF RESOURCE CHARACTERISTICS

Wildlife resources of the Peninsula are either terrestrial or aquatic (fresh water or marine). Within these two broad categories wildlife may be defined as vertebrate or invertebrate. Invertebrate terrestrial wildlife is of little obvious economic value other than contributing to the ecology of the area. Invertebrate marine life on the other hand includes some of the most valued economic resources of St. Kitts, conch and lobster. These are more correctly covered in the fisheries section of the report. However, marine vertebrates such as turtles are considered here not for their value as fishery resource, but their place in the marine ecology and their status as rare and endangered animals. Terrestrial animals such as birds, mammals, reptiles and amphibians have been discussed by Jackson (1981), Arendt (1985) and Towle (1986). Marine turtles have been extensively covered by Towle (1986). Marine birds (seabirds) and waterbirds (ducks and shorebirds) have not been adequately discussed in previous studies with the exception perhaps of Arendt (1985), but are treated more fully here.

The wildlife of the Peninsula can be further characterized as resident, introduced or migratory. Resident wildlife are those species which breed in habitats of the island of St. Kitts or more specifically the SEP. These species are in general more important than the other two types: introduced or migratory. Migratory wildlife for the most part include bird species which breed on other islands in the Caribbean or continents and use habitats of the SEP or St. Kitts during the period when north temperate weather forces them to seek more productive winter season food and shelter. Migratory species can include birds, whales, certain fish species and bats. Some species may spend the entire winter period in the area of the Peninsula while others are temporary inhabitants. Migratory species may return to the Peninsula in the spring season on their way north to resume breeding activities.

2.1 Characteristics of the SEP

Few islands in the Lesser Antilles have large pond systems such as those found at the SEP, St. Kitts. Indeed, St. Kitts may be unique in having a very large pond which attracts great numbers of shorebirds and small satellite ponds form or to which birds may find food as each pond goes through its production process in accordance with fresh water recharge and nutrient loading. Small ponds of the SEP, including Little Salt Pond, Mosquito and Cockleshell bays, and Major's Bay are open and afford little cover from avian predators. The exception is the red mangrove swamp at Friar's Bay where there is cover for moorhens and ducks for nesting and feeding. Ponds that do not appear to be feeding sites for shorebirds, gulls, and ducks do, however, provide roosting sites.

The remoteness of the salt pond system of the SEP has limited extensive and timely survey work in the past. Few investigators have had the opportunity to investigate specific use of the ponds at times when maximum shorebird use is expected.

The field time in late July was chosen to sample resident species use of the ponds. Late September field time was chosen to sample migratory species use of the ponds. During

September, there were more shorebirds per linear foot of pond edge in the small ponds than the large salt pond. However, much of the shorebird activity on Great Salt Pond was concentrated in two areas; the shoreline abutting the Little Salt Pond and the area to the east where dead trees line the edge of the pond to near the intersection of roads of the Fleming Estate.

Abundance levels appeared to be equal to numbers this observer has recorded for St. Croix and Anegada in the Virgin Islands at similar times of year. Therefore, the ponds of the SEP are habitat to the same complement (diversity and abundance) of shorebirds observed at other important and remote sites of the northeastern Caribbean.

2.2 Resident Bird Species of the SEP

Resident land birds (Danforth, 1936) and other vertebrates of the SEP were studied by Arendt (1985). Resident shorebirds and seabirds of the SEP are listed in Table 1. The status of some species (*) is indicated as either threatened, endangered or of concern. A species of concern in this report indicates that its status is not completely understood. It means that a resident species may be new to this habitat, overlooked in the past, or partially successful as a resident species for unknown reasons (predation, poor quality of habitat, at extremity of local range). Few areas in the Lesser Antilles provide the type of expansive mudflat or saltpan habitat required by certain resident shorebird species. In particular, Snowy Plover and Willet appear to have found nesting habitat at the SEP during the summer of 1988.

Resident seabirds of the SEP include Brown Pelican and Roseate Tern listed in the Caribbean (U.S. Fish and Wildlife Service 1973 and 1987, respectively) as threatened. Species of concern include Magnificent Frigatebird and Least Tern which are also resident on the SEP. Migratory waterbirds (seabirds, ducks and shorebirds) are listed in Table 2.

2.3 Migratory Birds Species of the SEP

The diversity of shorebird species observed, particularly in September, was extraordinary. Twenty-five species were recorded during two days of field investigation. Prior to this, fourteen species had been recorded from 1936 to the present on St. Kitts. An estimate of 2,300 shorebirds was recorded in 10 hours during the two days afield. Shorebird diversity of the ponds of the SEP during this period of migration was unparalleled in the experience of this observer in the Lesser Antilles.

The species diversity, particularly species considered rare in the region, may have been the result of "fallout" from tropical storm Gilbert which passed through the eastern Caribbean in mid-September. Two major factors contribute to diversity and abundance of species seen at St. Kitts during the fall period. The principal element is weather which forces migratory shorebirds to leave their nesting grounds in the far north and provides the necessary freshwater resource along the migratory flyway in the Lesser

Antilles. Freshwater on the SEP, St. Kitts, for example, is provided by seasonal rainfall. During the fall months large systems of low pressure provide huge amounts of freshwater recharge to the ponds (see Fig. 1). The fresh water and sunlight in shallow ponds sets off blooms of phyto and zooplankton which migrating shorebirds take advantage of during the fall and winter and again in spring.

The diversity of the shorebirds (i.e., short and long billed species) observed at these ponds is a strong indication that food resources are available for a wide variety of species which use the pond resources without competition and indicates a rich resource capable of accommodating shorebirds, ducks, herons and other waterbirds during the breeding season and migration. The pond system of the SEP appears to be a resource of international importance based on the diversity and abundance of species recorded during this time-frame.

Migratory shorebird populations sampled during the spring migration 24 - 25 March 1989 at St. Kitts numbered fewer than during fall which is generally the pattern on the Eastern Caribbean (See Fig. 2). Species diversity remained high while density was generally lower (See Table 2) as a result of no cyclonic storms in the region forcing refuge at St. Kitts salt ponds. Some resident waterbird species (Yellow-crowned Night Heron, Wilson's Plover and probable breeder Willet's were present at Great Salt Pond in late March. One important factor, however, was demonstrated which connects St. Kitts to northern temperate zone shorebird habitat and species survival.

As described earlier, timing is everything. Spring migration for shorebirds tends to be less dramatic in terms of numbers because weather and migration patterns are usually not in conflict as they are in the fall when adult and immature birds pour out over the tropical Atlantic with the intent on making landfall in South America. Shorebirds migrating north to breeding areas, primarily in the Canadian Arctic, may choose one of three routes: up the Antillean archipelago, across the Caribbean Basin or north along the Central American isthmus to stopover habitats along major flyways to the High Arctic tundra. In other words, the return flight for shorebirds surviving the fall to early spring period is much more dispersed involving species populations which generally are at their lowest level.

Water levels in smaller ponds of the Southeast Peninsula appeared to be lower than during the fall survey (See Fig. 1). No shorebirds were even seen at Cockleshell Bay pond, Major's Bay pond or Little Salt Pond. Shorebirds were therefore concentrated at Great Salt Pond. Another factor which may have affected shorebird sampling in late March is the presence of avian migratory predators such as Peregrine Falcon (*Falco peregrinus*) and Merlin (*F. columbarius*). which tend to disperse concentrations of shorebirds.

The importance of St. Kitts salt ponds to migratory shorebirds using the Antillean archipelago was indicated with the sighting on 24 March 1989 of a white-flagged sandpiper which was traced to a banding project at Dorchester Cape, New Brunswick, Canada in the Bay of Fundy in July or August 1988 (P.W. Hicklin, Wildlife Biologist,

Canadian Wildlife Service, in litt.) This type of information is very important to international efforts for shorebird protection and management.

St. Kitts, known primarily for its lush mountain forests and sugar plantations, appears to be chosen by migratory shorebirds from North America, and perhaps Europe, as a stopover point during fall and spring passages. Few Leeward Islands in the Lesser Antilles provide the type of shallow pond habitat required for such a wide variety of the Northern Hemisphere's shorebirds as does the Southeast Peninsula of St. Kitts. The significance of shorebird habitat among the mountainous islands of the West Indies must therefore play a major role in migratory waterbird and shorebird life histories.

As a group, shorebirds are one of the fastest groups facing habitat loss, not only where they breed but where they spend the majority of their life history - on migration. Wetlands are among the world's most productive environments, providing tremendous natural and economic benefits. Shorebirds need these areas for their survival and serve as indicators to the quality of resource management. Shorebird studies over the last 17 years have revealed alarming declines in shorebird populations (Manomet Bird Observatory).

One of the mitigative actions suggested for Great Salt Pond is the deposition of dredge material to create islands in the center of Great Salt Pond. Great success has been demonstrated in Tampa Bay, Florida (National Audubon Society Newsletter, February 1989), using this technique for species (gulls and terns) which also occur at the SEP. Maintenance of the dredge spoil islands is required for sustainable use. This requires clearing of fast-growing pioneering plant species which may preclude annual use by nesting waterbirds. Posting and patrolling the islands as wildlife reserves as well as removing unwanted vegetation are requirements which must be agreed upon the SEP and government wildlife managers.

3.0 MANAGEMENT ALTERNATIVES

From the perspective of wildlife and natural resources, management alternatives are centered primarily on reducing the impacts of development action. A thorough summary of direct impacts and mitigation options has been produced by Towle (1986). Given in Figure 2 and summarized in the paragraphs that follow are the most significant wildlife habitats on the Southeast Peninsula.

3.1 Managing Natural Resources

Large numbers of shorebirds were observed at Great Salt Pond, the principal area of potential habitat change for resident and migratory species. Diversity and abundance factors, however, were greater in small ponds by comparison. Apparently more shorebirds were using the smaller ponds than the Great Salt Pond on a linear/foot of shoreline basis.

Each pond has its own characteristics and supports a variety of resident and migratory birds species over time. The quality of each pond in terms of supporting wildlife varies with climate (i.e., rainfall). A pond that is dry for significant periods of time will eventually provide an abundance of food for waterfowl and shorebirds after heavy rainfall. Thus, dry salt ponds which may appear to be barren or useless to wildlife, often provide a crucial food resource when seasonal weather patterns change.

Migratory waterfowl and shorebirds have been experiencing dramatic declines in recent years in their North American breeding areas because of climatic change. Their survival depends in large part on finding non-breeding habitats in the tropics where they spend more than half their life histories. The gradual or incipient loss of wetland habitat in the Lesser Antilles and elsewhere contributes to this decline.

Wildlife habitat in Great Salt Pond, the eastern shore from the corner of the Fleming Estate access road to the Sand Bank Bay access road represents the only nesting cover and shallow feeding substrate available for resident and migratory waterfowl and shorebirds. This area is on the lee side of a 1000-ft. hill and would probably represent an ideal anchorage or marina complex. However, this type of facility could also be placed on the north side of the pond, west of the Sand Bank Bay access road. Rather than dredge the whole of the Great Salt Pond, an area sufficient only to accommodate an access channel, turning basin, and a marina should be considered. The alternative would be the loss of this large pond as an important wildlife area in the eastern Caribbean.

Little Salt Pond, likewise should not be completely dredged if possible. The exposed mud flats are feeding and nesting habitat for a variety of shorebirds and terns. If the eastern edge of the pond is to be channeled, the western edge could remain as wildlife habitat and serve to maintain wildlife diversity of St. Kitts.

The salt pond at Frigate Bay is threatened by sedimentation, pollution and encroachment. The pond at Friar's Bay similarly is threatened as a wildlife habitat from sedimentation and encroachment although on a faster time scale.

At Nag's Head two important seabird rookeries occupy the southwest promontory. Arendt (1985) found nesting Brown Pelicans and Magnificent Frigatebirds nesting. Both species are important to local fishermen for locating schools of fish. The Brown Pelican is listed as threatened in the Caribbean. The Roseate Tern recorded in July with juvenile birds at White House Bay is also listed as threatened in the Caribbean and is presumed to have nested in the region of the SEP.

3.2 Managing Development Impacts

Development of Great Salt and Little Salt Ponds may not be compatible with wildlife use of these ponds resources. Water level for the Great Salt Pond is lower than that of Little Salt Pond. A channel from White House Bay to Great Salt Pond will raise the level of the pond and inundate the mud flats and feeding area in the northeast and east corner where large numbers of birds were encountered. Dredge material should be placed in the center of the pond to create habitat as a mitigation of that area lost by increased water level. It cannot be overemphasized that all the ponds of the Southeast Peninsula (SEP) form a system of habitats. Shorebirds were observed flying from one pond to another.

At Manchineel Hill the south side could accommodate low density condos, if that were the goal, but preferably not above 500-ft. contour and not on the north facing side of the hill. This area represents some of the most pristine undisturbed scrub forest on the entire SEP. Similarly, the east and northeast facing slopes of Fleming estate hill, east of Sand Bank Bay should not be developed and no development above the 500-ft. contour. If these areas are developed, caution should be taken to prevent sedimentation from reaching the pond. Sedimentation will affect water quality and character of the substrate in which invertebrate fauna form the basis of the food chain.

The practice of taking beach sand with front-end loaders by scraping off several inches of the beach must be monitored. The pressure of heavy equipment on turtle-nesting beaches will have an adverse effect on nests and hatchlings. The road will enhance turtle poaching by land. Enforcement of existing and proposed legislation should be established.

Development of Great Salt and Little Salt Ponds must therefore be considerate of the potential for upsetting the system of resource use by resident and migratory shorebirds.

4.0 SUMMARY AND RECOMMENDATIONS

- Prepare pond development strategies that include a natural resource base for continued use by resident and migratory shore and water bird species.

- Limit marine development schemes to one area (i.e., the Great Salt Pond) and protect small ponds for the diversity of species which themselves could form the basis for tourism of St. Kitts.

- Development schemes of the SEP should set aside ponds of the Mosquito, Cockleshell and Majors bays as wildlife conservation areas.

- Use dredge spoils to create an "island" for wildlife in the center of Great Salt Pond. Barge excess dredge spoils offshore for deep sea dumping.

- Disturb as few mangroves as possible.

- No development near the seabird colonies at Nag's Head. Establish rookery boundaries, fence areas where necessary, negotiate with landowners.

- Prepare species management/protection plan and monitor area.

- Protect rookery as park/reserve and post signs.

- Prepare wildlife recommendations to include seabirds and provide enforcement of protected status.

- Provide environmental education and training for St. Kitts office of natural resources management.

4.1 Summary and Recommendations

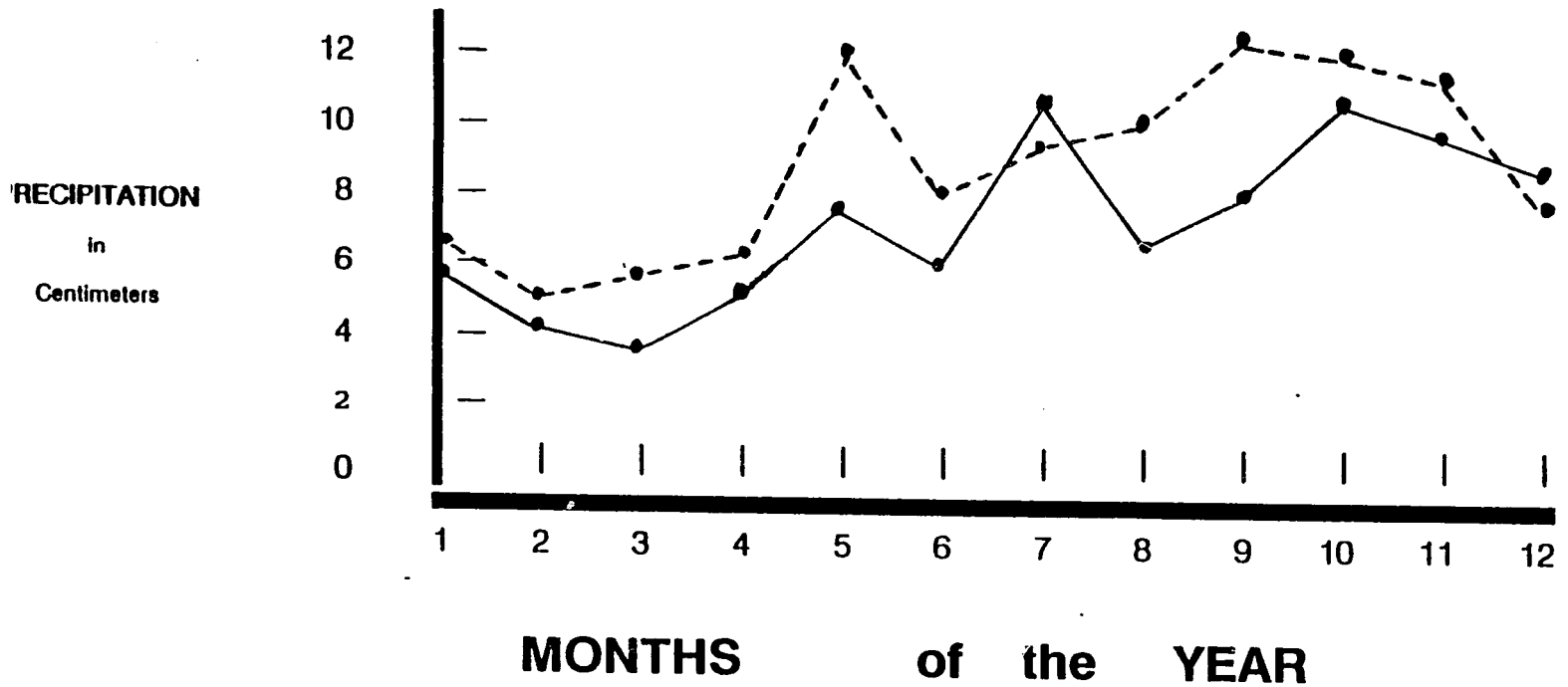
Compatible use of wetland habitats by developers and resource planners is essential for the Southeast Peninsula in order to maintain the quality of natural heritage and diversity of St. Kitts and economic variables for sustained eco-tourism. Development schemes of the SEP should set aside ponds of the Mosquito, Cockleshell and Majors bays as mitigative wildlife conservation areas. Development of hillsides should not exceed the 500-ft. contour and sedimentation traps must be installed to abate degradation of water quality of all ponds where construction is planned.

4.2 Limitations and Suggestions

St. Kitts has rainforest habitat to the north where West Indian endemic birds may be observed any time of year. The dry regime SEP affords accessible pond habitat for wildlife observers who can experience tropical island fauna with some extraordinary

opportunities. If St. Kitts' biodiversity and eco-tourism are equally important to the development of this area of the island, these diverse goals should be compatible. Wildlife conservation and parkland legislation must be considered *concurrently* with the SEP development plan in order to maintain sustainable use of the resources of the area. It is suggested that the St. Kitts government create a natural resources branch and identify individuals with the ability to be trained in wildlife and parks management. United States Agency for International Development (U.S.A.I.D.) and Development Authority funding should be made available to support training and development of government and non-government agencies to monitor the resources of the SEP.

FIGURE 1



---- St. John 60 year average (1920 - 1980)
—— St. Kitts 12 - 15 year average (1963 - 1977)

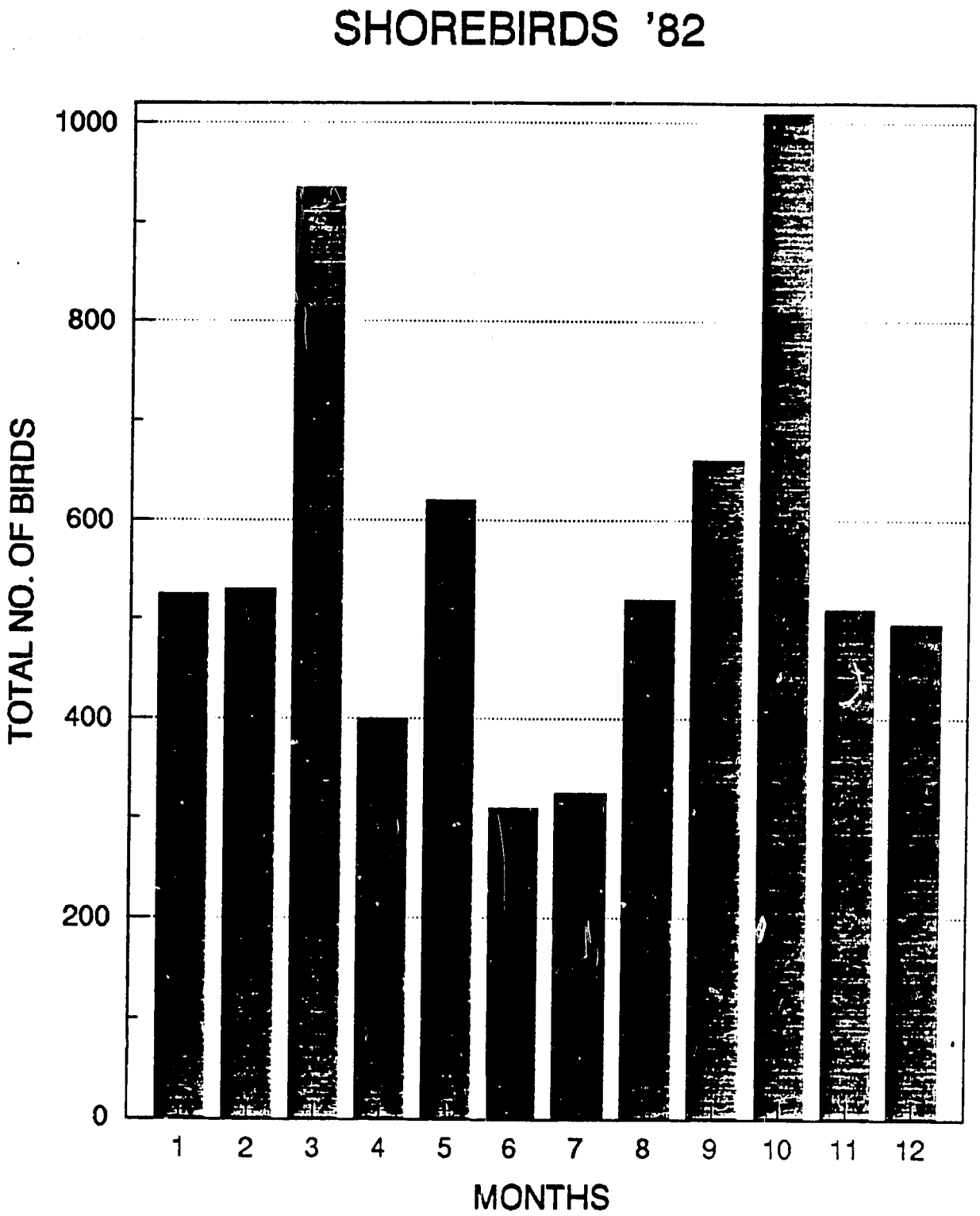


Figure 2. Totals of all shorebirds observed in the USVI in 1982

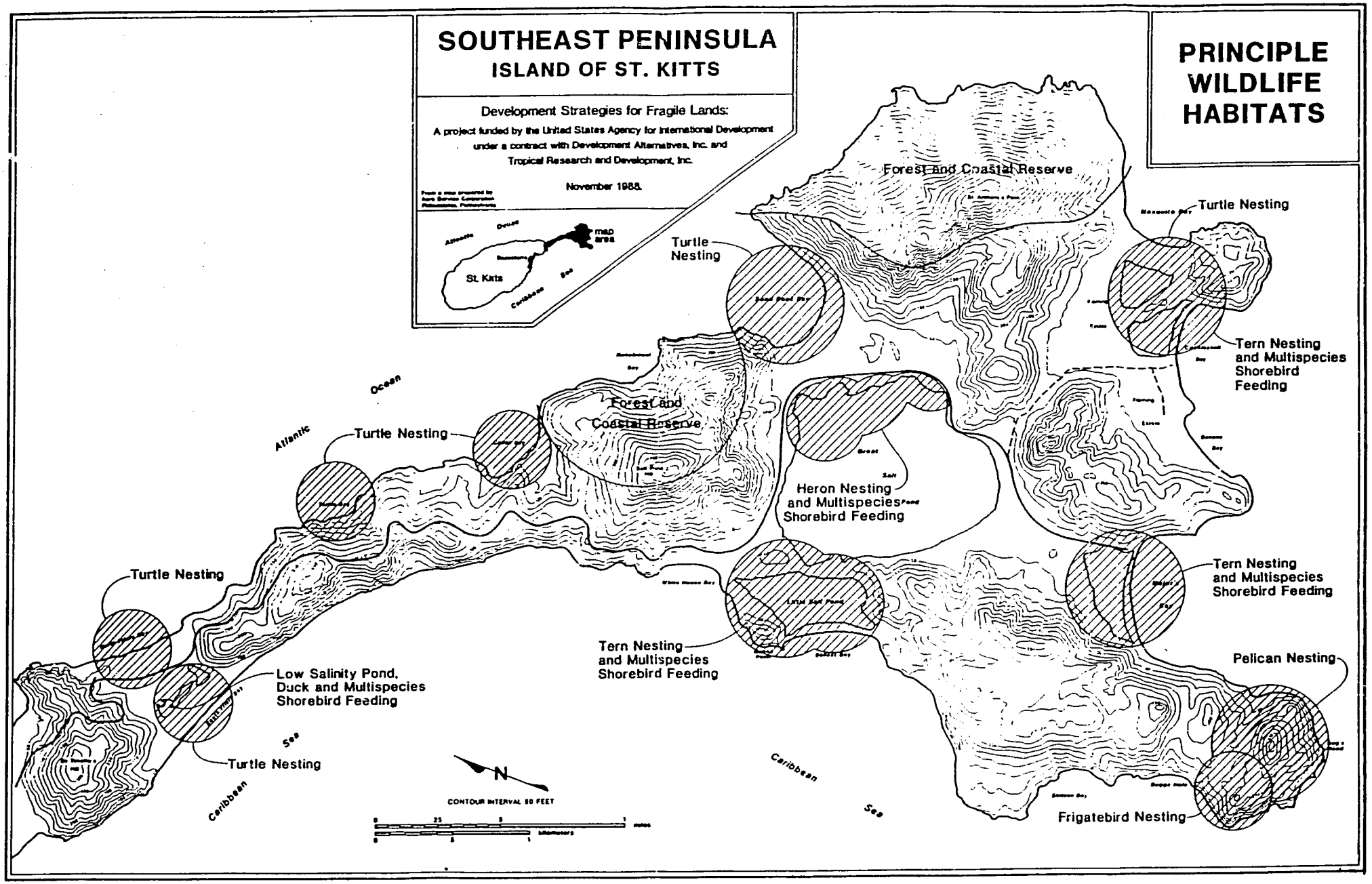

SOUTHEAST PENINSULA
ISLAND OF ST. KITTS
Development Strategies for Fragile Lands:
A project funded by the United States Agency for International Development
under a contract with Development Alternatives, Inc. and
Tropical Research and Development, Inc.
November 1988.
map area
St. Kitts
PRINCIPLE WILDLIFE HABITATS
Forest and Coastal Reserve
Turtle Nesting
Turtle Nesting
Tern Nesting and Multispecies Shorebird Feeding
Forest and Coastal Reserve
Atlantic Ocean
Turtle Nesting
Heron Nesting and Multispecies Shorebird Feeding
Turtle Nesting
Tern Nesting and Multispecies Shorebird Feeding
Tern Nesting and Multispecies Shorebird Feeding
Low Salinity Pond, Duck and Multispecies Shorebird Feeding
Pelican Nesting
Turtle Nesting
Caribbean Sea
Caribbean Sea
N
CONTOUR INTERVAL 50 FEET
Frigatebird Nesting

TABLE 1 RESIDENT WATERBIRDS OBSERVED AT THE SOUTHEAST PENINSULA, ST. KITTS

Species	Total Number Recorded
Family - *PELECANIFORMES*	
*Magnificent Frigatebird	15
**Brown Pelican	25
Family - *CICONIFORMES*	
Yellow-crowned Night-Heron (*Nyctanassa violaces)*	6
Family - *LARIDAE*	
Laughing Gull (*Larus atricilla)*	20
Royal Tern (*Sterna maxima*)	20
**Roseate Tern (*Sterna dougallii)*	12
*Least Tern (*Sterna antillarum)*	12
Family - *CHARADRIIDAE*	
Snowy Plover (*Charadrius alexandrinus)*	4
Wilson's Plover *(Charadrius wilsonia*)	11
Family - *HAEMATOPODIDAE*	
American Oystercatcher (*Haematopus palliatus)*	2
Family - *RECURVIROSTRIDAE*	
Black-necked Stilt *(Himantopus mexicanus)*	295
Family - *SCOLOPACIDAE*	
*Willet (*Catoptrophorus semipalmatus)*	12
Total observed	434

* Species of concern
** Threatened species

TABLE 2 MIGRATORY WATERBIRDS OBSERVED AT SOUTHEAST PENINSULA, ST. KITTS, SEPTEMBER 22-24, 1988

Species	Total Number Recorded
Family - *ARDEIDAE*	
Great Blue Heron *(Ardea herodius)*	1
Family -*CHARADRIIDAE*	
Black-bellied Plover *(Pluvialis squatarola)*	33
Lesser Golden-Plover *(Pluvialis dominica)*	1
Semipalmated Plover *(Charadrius semipalmatus)*	78
**Piping Plover *(Charadrius melodus)*	1
Family - *SCOLOPACIDAE*	
Greater Yellowlegs *(Tringa melanoleuca)*	34
Lesser Yellowlegs *(Tringa flavipes)*	354
Spotted Sandpiper *(Actitis macularia)*	16
Whimbrel *(Numenius phaeopus)*	8
Black-tailed Godwit *(Limosa limosa)*	1
Ruddy Turnstone *(Arenaria interpres)*	48
Red Knot *(Calidris canutus)*	15
Sanderling *(Calidris alba)*	6
Semipalmated Sandpiper *(Calidris pusilla)*	820
Western Sandpiper *(Calidris mauri)*	108
Least Sandpiper *(Calidris minutilla)*	245
White-rumped Sandpiper *(Calidris fusciollis)*	1
Pectoral Sanpiper *(Calidris melanotos)*	6
Stilt Sanpiper *(Calidris himantopus)*	168
Short-billed Dowitcher *(Limnadromus griseus)*	44
Long-billed Dowitcher *(Limnadromus griseus)*	1
Total observed	1989

** Endangered species

TABLE 3 MIGRATORY AND RESIDENT WATERBIRDS OBSERVED AT SOUTHEAST PENINSULA, ST. KITTS, 24-25 MARCH 1989

Species	Total Number Recorded
Family - *ARDEIDAE*	
Great Blue Heron *(Ardea herodius)*	1
*Yellow-crowned Night-Heron *(Nyctanassa violaces)*	8R
Family - *LARIDAE*	
Royal Tern *(Sterna maxima)*	1R?
Family -*CHARADRIIDAE*	
Wilson's Plover *(Charadrius wilsonia)*	8R
Family - *SCOLOPACIDAE*	
Greater Yellowlegs *(Tringa melanoleuca)*	7
Lesser Yellowlegs *(Tringa flavipes)*	103
Solitary Sandpiper *(Tringa solitaria)*	1
Spotted Sandpiper *(Actitis macularia)*	1
Ruddy Turnstone *(Arenaria interpres)*	12
Dunlin *(Calidris alpina)*	2
**Semipalmated Sandpiper *(Calidris pusilla)*	183
Western Sandpiper *(Calidris mauri)*	1
Least Sandpiper *(Calidris minutilla)*	12
Stilt Sanpiper *(Calidris himantopus)*	35
Willet *(Catoptrophorus semipalmatus)*	2R?
Total observed	377

* = two juveniles observed
** = at least one individual was marked with leg band and flag
R = Resident

5.0 REFERENCES

Arendt, W., 1985. Wildlife assessment of the Southeast Peninsula, St. Kitts, West Indies. U.S.D.A. Forest Service, Inst. of Trop. Forest, P.R. pp 42.

Danforth, S.T. 1936. The birds of St. Kitts and Nevis. Trop. Agric. 13:213-217.

Jackson, I. 1981. Southeastern Peninsula, St. Kitts: study of management alternatives. Final Project Report to the Government of St. Kitts-Nevis. A CCA/ECNAMP Project.pp. 48.

Towle, E.L. 1986. Environmental assessment report on the proposed Southeast Peninsula access road, St. Kitts, West Indies. Island Resources Fund.

WILDLIFE RESOURCES MANAGEMENT PLAN: MAMMALS

by

Robert Young, Ph.D.

May 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

EXECUTIVE SUMMARY

The Southeast Peninsula (SEP) of St. Kitts is one of the largest remaining, relatively unaltered ecosystems of its type in the Eastern Caribbean. Much of its flora and fauna has been documented since the early 1970s when activities were focused on scientific studies of the African Green Monkeys or Vervets (Cercopithecus aethiops). Recent field data on terrestrial fauna and previous studies of monkeys have been used to illustrate some of the unique aspects of wildlife in the SEP and a series of nature trails has been proposed.

Management programs for the conservation of wildlands and wildlife in the SEP will require a series of regulatory, monitoring and educational processes that include instituting enforceable guidelines for future development; creating a Wildlands Management Unit with individuals that are trained to monitor wildlife status and evaluate land use proposals; and preparing education programs that promote the biological diversity of the SEP and the wealth of its natural resources.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
- 1.1 Rationale 1
- 1.2 Scope of Study 3
- 1.3 Definition of Terms 3
- 1.4 Plan of Study 3

2.0 DESCRIPTION OF RESOURCE CHARACTERISTICS 5
- 2.1 Characteristics of the SEP 5

3.0 MANAGEMENT ALTERNATIVES 9
- 3.1 Managing the Natural Resources 9
- 3.2 Managing Development Impacts 9
- 3.3 Establishing Nature Trails 9
  - 3.3.1 Friar's Bay Complex 10
  - 3.3.2 Nag's Head Trail 10
  - 3.3.3 Scotch Bonnet Trail 11

4.0 SUMMARY AND RECOMMENDATIONS 13
- 4.1 Summary 13
- 4.2 Recommendations 13

5.0 REFERENCES 14

LIST OF MAPS AND TABLES

Map 1 Distribution of Monkey Troops (1986-1989) 6
Deer Sightings (1986-1988)
Feral Goat Sightings (1986-88)

Table 1 Monkey Population Estimates for SEP (1986-1987) 7

Map 2 Proposed Nature Trails 12

1.0 INTRODUCTION

1.1 Rationale

Few visitors to the Southeast Peninsula (SEP) of St. Kitts have not been impressed with its rugged beauty and spectacular vistas. Kittitians have long recognized its untapped potential to attract tourist dollars but few have ever visited or explored its remarkable variety of wilderness habitats. In his 1982 report to the Caribbean Conservation Association, Alan Putney declared the cactus-scrub zones, salt ponds and mangrove swamps some of the 'largest remaining contiguous areas of relatively unaltered ecosystems of their type. In addition, the region has a number of sand beaches with both Atlantic and Caribbean exposures, and several sections of closed-canopy tropical dry forest.

Until recently, access to the Peninsula was limited to travellers on foot, boats by sea or four-wheel drive vehicles along a narrow winding trail. The only human residents included a charcoal producer at each end of the Peninsula and in recent times, the Banana Bay Beach Resort at the southern terminus of the Peninsula. Honeycutters, monkey trappers and other mainland residents in search of whelk, bird's eggs or deer periodically travelled to the SEP but the principal activity over the last two decades has actually been the scientific study of monkey troops which reside in some abundance.

In 1974, McGuire published a monograph on the St. Kitts Vervet monkey (Cercopithecus aethiops) with detailed information on troop size, lifestyles, eating habits, behavior and territorial distribution. At the time of his work, there were an estimated 1,173 monkeys on the SEP but decades of trapping, killing and burning have reduced the population to fewer than 200 (Young and Morden, 1987). In his 1985 environmental assessment of the Southeast Peninsula, Arendt stated that the Vervet (or Green monkey) posed a threat to other terrestrial and arboreal wildlife but offered no substantive evidence. He also repeated local reports of 'hundreds or even thousands' of monkeys being present although his only observations never exceeded 2-6 individuals during the two weeks of study. Although monkeys are omnivorous, McGuire's extensive field work portrays the monkey as a leaf, fruit and seed eater with some time spent on the ground foraging for small insects, grubs and other tid-bits in the soil. Both McGuire (1974) and Young (1988) have observed monkeys in close association with other animals including birds and record no incidents of harassment or nest disturbance. Human poachers, on the other hand, have frequently been reported at bird and turtle nesting sites (Arendt, 1985; Young 1988) and the 1986 'South-East Conservation Act' of St. Kitts/Nevis provided summary conviction and fines for anyone willfully killing, wounding or capturing wild animals or birds on the SEP.

Another terrestrial vertebrate of considerable interest on the Southeast Peninsula is the Southern White-tailed Deer (Odocoileus virginianus). Brought to St. Kitts more than 50 years ago, a number of breeding pairs were released in the SEP and have continued to survive until the present day. Although their numbers are small (Young, 1988), perhaps no more than two dozen or so, they can frequently be observed in the early morning when they forage on sea purslane along the edges of the salt ponds or later in the day when they retreat to higher ground and dense forest cover.

Feral goats also occupy the SEP and can often be observed in the rocky bluffs near Major's Bay and Nag's Head. Like the deer, their population appears to be quite small and the foraging capacity of the area sufficient to support their numbers at the present time without evidence of overgrazing.

Another prominent animal on the Peninsula is the Small Indian Mongoose (Herpestes auropunctatus). Arendt (1985) reported that mongoose are 'known to greatly reduce or even exterminate populations of arboreal and terrestrial rats and animals such as frogs, lizards, snakes and ground nesting birds'. Since mongoose are diurnal and non-climbers, their effectiveness in exterminating arboreal and nocturnal animals is questionable, but their predation on ground birds, lizards, turtle eggs and other small animals is legendary. During previous field studies (Young, 1988), their numbers appeared to be small but frequent sightings were made during the current investigation of the SEP. It is to be expected that population densities will increase as human occupation begins to provide additional sources of food and water.

Anticipating the concerns that might arise from development of the SEP, the Government of St. Kitts/Nevis has prepared legislation that recognizes the economic and cultural value of the Peninsula. In the 1987 National Conservation and Environment Protection Act, the concept of nature reserve is introduced and described as an 'area containing outstanding or fragile natural features or life forms of national importance that need protection in an undisturbed state where the only permitted activities are management measures, controlled scientific research and educational study'. Much of the SEP falls into this category. The Act states that:

> '4. Any protected area designated under this Act shall have one or more of the following broad purposes and objectives: -
>
> (a) to preserve biological diversity of wild floral and fauna species...
>
> (b) to protect selected examples of representative or unique biological communities...
>
> (c) to sustain natural areas important for protection...
>
> (d) to protect selected natural sites of scenic beauty or of special scientific, ecological, historic or educational value....'

Clearly, the Government of St. Kitts/Nevis recognized the need to develop the SEP in order to provide the economic benefit that its citizens deserved, while at the same time protecting and preserving elements of its national heritage for all future generations. A national Conservation Commission has been created which will advise the Minister of Development as to the selection of protected areas, the conservation of natural features,

the control of construction and other salient features of land development and use. When the SEP is opened to public access and private development, it will be important that the government ensures that resource management plans are both in place and closely monitored.

It is often difficult to express the value of natural resources in economic terms but the value of wildlands for tourism is rapidly increasing as more travellers search for holiday trips that provide more than sandy beaches and hotel pools. If long-term sustainable development is to be achieved, then it will depend on close ties to the limited and irreplaceable resources provided by the natural features and wildlife of the region.

1.2 Scope of Study

Most regions of the SEP were revisited as a follow-up to previous studies in order to assess the effect of current road construction on wildlife communities and evaluate the possible effects of future land development. The scope of the study was to identify prominent non-bird, terrestrial vertebrates and integrate the information into a series of management strategies; to construct a system of nature trails; and to promote the concept of ecotourism as a viable option for long-term sustained development of the Southeast Peninsula of St. Kitts.

1.3 Definition of Terms

ECOTOURISM	a combination of the word "ecology" (the study of organisms and where they live) and "tourism" (the trade in travellers). This term describes a growing trend among North Americans, Europeans and Japanese to seek out unique cultures, wildlands and animals species in the context of a vacation or holiday.
FERAL	previously domesticated animals or cultivated plants which have become wild.
WILDLANDS	uninhabited or uncultivated regions.
WILDLIFE	non-domesticated or untamed animals and uncultivated plants.

1.4 Plan of Study

To determine the current status of animal populations and wildland regions, several excursions were made to the Southeast Peninsula during the period from March 29, 1989 to April 4, 1989. Areas were surveyed on foot and using a four-wheel drive vehicle. There were also opportunities to observe sections of coastal communities from the sea.

Periods of prior research on the SEP extend from March 1985 until August 1988 ; include over sixty days of work in the field. Although attention was principally focu on the population ecology of the Green monkey, other animal encounters were recor and habitats described. Data from these previous research projects (Young and Mord 1987; Young, 1988) were used to provide a baseline for comparison purposes and develop recommendations on management alternatives.

2.0 DESCRIPTION OF RESOURCE CHARACTERISTICS

2.1 Characteristics of the SEP

The Southeast Peninsula of St. Kitts is not only unique in that it has remained relatively undisturbed for centuries but it also possesses a remarkable variety of wildlife. The salt ponds, mangrove swamps, fields of guinea grass and acacia, dry tropical forests, cactus-scrub zones, beach-dune communities and rugged bluffs have supported an array of animals that include seashore, wading and woodland birds; lizards, crabs and nesting sea turtles; and exotic mammals like the African Green monkey and Southern White-tailed deer. All of this in the obvious absence of reliable sources of fresh water and in the presence of continued human pressure through poaching, trapping, hunting and burning.

Although the numbers of monkeys in the SEP have fluctuated dramatically over the last two decades, the territories that the troops have staked out remain relatively constant. Map 1 illustrates the present distribution of known monkey troops with the greatest density in the Friar's Bay region. Table 1 gives population estimates for each of the troops identified (Young and Morden, 1987). The monkeys typically select high ground and mature trees as a 'sleeping' area and then descend to lower levels during their morning foraging pattern. They tend to seek out any fruiting trees such as the clammy cherry or sea grape and will also search for soil organisms, seeds, and so forth. In the SEP, they are much more terrestrial than troops in the mountain and ravine area of St. Kitts. This habit makes sighting by tourists easier but also puts the monkey at risk from attack by dogs and trappers. An incident was recorded in the SEP (Young, 1988) where a young female monkey was killed by a dog near Scotch Bonnet. During the present study, two dogs had managed to 'tree' several monkeys, again in the Scotch Bonnet area. The current investigation revealed that most of the troops had remained in their 'home' territory in spite of road construction. An obvious exception may be those in the Sir Timothy Hill region where road cuts have removed significant portions of the hillside.

The tourist potential for guided tours of monkey habitats is extremely high since most visitors to this island have never seen a primate in the wild. Tour operators are familiar with the question, 'where can I see monkeys' and are frustrated by the elusive nature of monkeys in the forests and ravines. The SEP is an excellent location to observe monkeys as they come down from their 'sleeping trees' in the early morning and disperse throughout their foraging areas. Their daily routine is quite predictable and the monkeys are not secretive once they have habituated to human presence and learn they will not be disturbed by dogs or hunters.

-91'

SOUTHEAST PENINSULA
ISLAND OF ST. KITTS

Development Strategies for Fragile Lands:

A project funded by the United States Agency for International Development under a contract with Development Alternatives, Inc. and Tropical Research and Development, Inc.

November 1988.

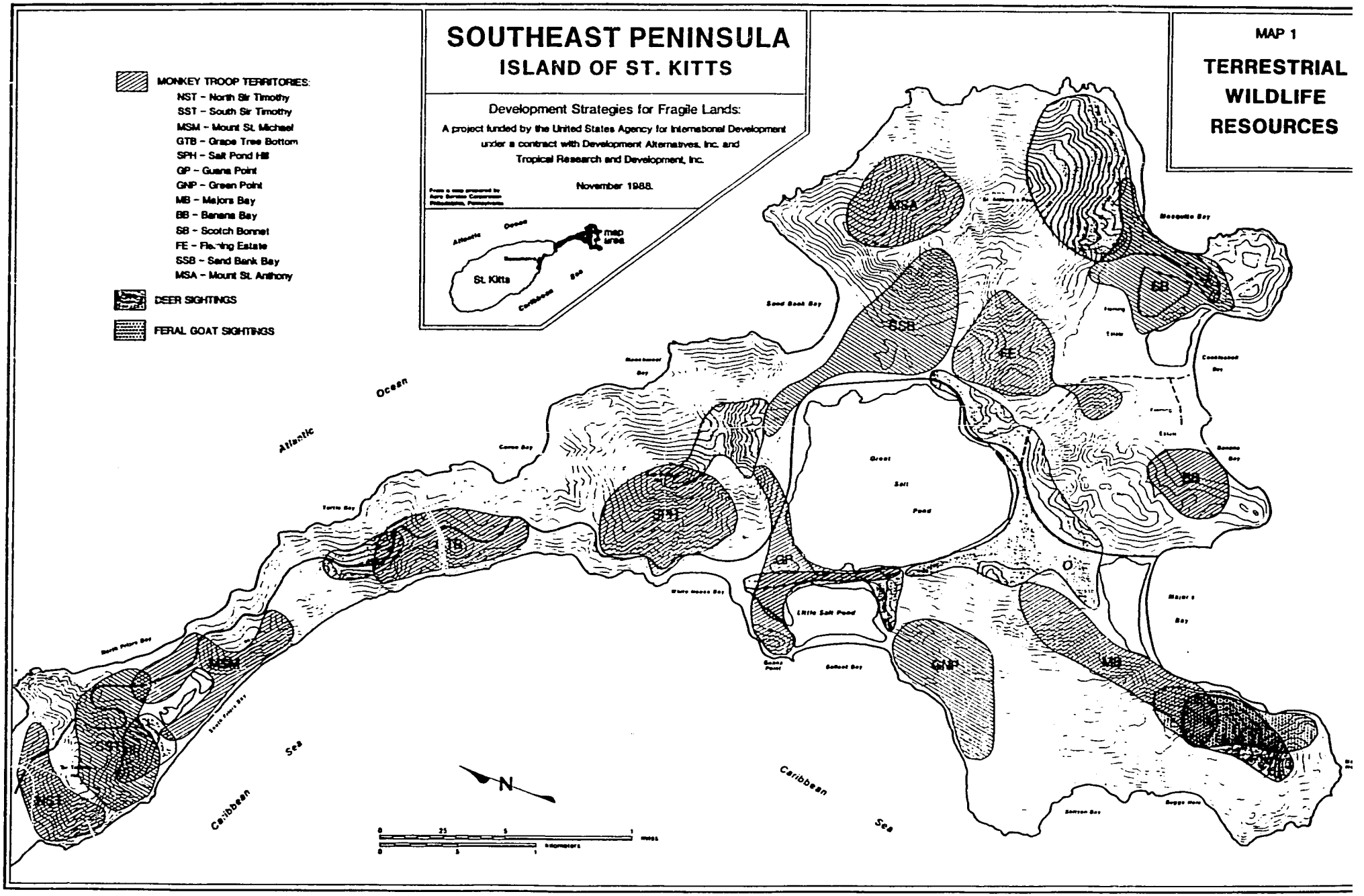
MAP 1

TERRESTRIAL WILDLIFE RESOURCES

MONKEY TROOP TERRITORIES:
- NST - North Sir Timothy
- SST - South Sir Timothy
- MSM - Mount St. Michael
- GTB - Grape Tree Bottom
- SPH - Salt Pond Hill
- GP - Guana Point
- GNP - Green Point
- MB - Majors Bay
- BB - Banana Bay
- SB - Scotch Bonnet
- FE - Fleming Estate
- SSB - Sand Bank Bay
- MSA - Mount St. Anthony

DEER SIGHTINGS

FERAL GOAT SIGHTINGS



90

TABLE 1 Monkey Population Estimates for SEP (1986-1987)

Troop Location		Estimated # Monkeys
NST	(North Sir Timothy)	6
SST	(South Sir Timothy)	20
MSM	(Mount St. Michael)	24
GTB	(Grape Tree Bottom)	8
SPH	(Salt Pond Hill)	28
GP	(Guana Point)	6
GNP	(Green Point	23
MB	(Major's Bay)	15
BB	(Banana Bay)	6
SB	(Scotch Bonnet)	12
FE	(Fleming Estate)	4
SSB	(Sand Bank Bay)	12
MSA	(Mount St. Anthony)	23
Total Estimated for SEP		187

91

Southern White-tailed deer are another favorite with tourists and during the present study foot prints were readily observed in the mud flats around the Little Salt Pond. Both adults and young have been spotted throughout the SEP (Young, 1988; Young and Morden, 1987) and locations are shown on Map 1. They were frequently seen at the borders of salt ponds where they browse on sea purslane and young grasses. Dawn and dusk are the two best times to spot the deer for they are extremely secretive and remain on high ground and dense cover during most daylight hours. Like the monkeys, the deer are extremely vulnerable to dogs and an incident was recorded in 1987 in which an adult was killed by dogs in the SEP and the fawn taken to a veterinary student to rear. It was reported that hunters often travel to the SEP in search of deer but this was not observed during any of the excursions to the SEP. Current legislation specifically protects the deer from hunting but stray dogs will continue to be a threat.

Feral goats were observed during previous studies (Young, 1988; Young and Morden, 1987) along the bluffs and ridges near Major's Bay and in the rugged hills of Nag's Head. Portions of a skeleton were recovered on Mount St. Anthony in January, 1987 but no animals were observed. Their foot prints can be readily observed in mudflats around salt ponds but they were never directly observed in any region other than that indicated on Map 1. Like the deer, feral goats are quite secretive and avoid human contact. Their history on the SEP is unknown but their extreme reluctance to be approached by humans suggests that they have been running wild for some time. The number of goats appears to be small and sightings limited to isolated individuals or herds of four to six animals. They do not appear to be overgrazing their territory but additional studies should be conducted to determine abundance and forage capacity. Like the monkey and deer, feral goats could prove to be a tourist attraction if guided tours are conducted through regions that they inhabit.

Q2

3.0 MANAGEMENT ALTERNATIVES

3.1 Managing the Natural Resources

Managing the natural resources of the SEP and fostering the development of ecotourism requires that there be a concerted effort to protect the various vegetation communities and implement wildlife management programs in order to monitor population densities and foraging capacity. The concept of wildlife corridors in which linkage is maintained between undeveloped areas will be critical for sustained breeding units of monkeys and deer as well as the myriad of other life forms that are key elements to the ecological balance.

Central to management will be the creation of a Wildlands Management Unit or Environmental Control Office which could assist in the development of land management guidelines, monitor on-going activities and prepare education programs that would be integrated into interpretive nature trails and used to increase public awareness of environmental concerns.

3.2 Managing Development Impacts

Perhaps the single most serious threat to SEP wildlife after habitat loss will be the increase in stray dogs. There is no effective dog control program on St. Kitts/Nevis and only the absence of available freshwater has restricted their numbers until now. Once housing development begins, there will undoubtedly be a dramatic increase which could have devastating effects on monkeys, deer, ground birds and nesting sea turtles. This hazard extends to man as well since dogs are known transmitters of a variety of diseases that directly affect human health and ultimately tourism. Although rabies is always listed as the primary concern, there are other diseases that can prove life-threatening or at least a major discomfort. A form of leptospirosis, known as Weil's disease, is readily spread by dogs and rats via urine contamination of food and water supplies and is fatal to humans if untreated. Other zoonotic diseases include visceral larva migrans and hookworms which can spread through contact between bare feet and sandy beaches where dogs have defecated. Dermatological disorders such as 'scabies' and 'ringworm' can also develop following contact with infected animals. For all of these reasons, it is in the best interest of all Kittitians to establish effective dog control measures so that health standards can remain high and to protect the growing tourist industry which has a vested interest in maintaining a safe, clean island for health-conscious travellers.

3.3 Establishing Nature Trails

The establishment of hiking trails and use of guided tours with individuals trained in nature interpretation could provide the link between tourist development and environmental conservation on the SEP. Wildlife regions connected by a system of corridors and documented trails would provide resort operators with an opportunity to

93

exploit the growing market in travellers interested in unique landscapes and exotic animals. In addition, long-term scientific study of these regions could be enhanced through their designation as Environmental Study Areas. This would allow trained biologists to regularly monitor flora and fauna and prepare environmental impact assessments on an on-going basis.

3.3.1 Friar's Bay Complex

The region that has the most to offer the curious visitor in terms of variety of wildlife is the zone bordered by North Friar's Bay, South Friar's Bay, Sir Timothy Hill and Mount St. Michael (see Map 2). The mangrove swamp located here has excellent examples of red, white and black mangrove trees and hosts an array of egrets, herons, ducks, stilts, plovers as well as land crabs, mud fiddler crabs, woodland bird species and foraging monkeys from the nearby slopes of Sir Timothy and Mount St. Michael. The ecological diversity continues as one moves toward the sandy beaches through plant communities dominated by sea grape, acacia and coconut palms. Foot paths could easily be established through the lower vegetation zones and up the slopes into dry tropical forests where monkey troops establish their 'sleeping' quarters. An enclosed boardwalk and observation platform could extend into the mangrove swamp which would allow observation without disturbing birds and other wildlife. A fine screen enclosure should be used so that visitors would not be exposed to the discomfort of mosquito and sandfly bites. The screen mesh would also act as a visual barrier so that animals would be relatively unaware of the human presence.

3.3.2 Nag's Head Trail

A hiking trail to Nag's Head could begin at Whitehouse Bay and proceed along the western border of the Little Salt Pond past Guana Point. There is a resident troop of monkeys in this region and their footprints, along with those of deer, can be reliably observed in the mudflats. Also of interest is the healthy community of black mangrove trees with their pencil-like roots or pneumatophores extending upward through the mud. The coastline is then followed along Ballast Bay to a small lagoon located at the southern end as one begins to follow the rocky shoreline toward Green Point. This small salt pond typically has a collection of wading and shore birds feeding on emerging mud fiddler crabs and other crustaceans. Solitary monkeys have also been observed here. Pelicans regularly ply the waters off Guana Point, Ballast Bay and Green Point. Upon reaching the dense, mature forests and cliff faces several monkey troops may be encountered, particularly late in the afternoon. An overland route to the ridge extending toward Nag's Head will introduce the hiker to guinea grass, cactus-scrub and dry, woodland forests. Deer and feral goats are frequently encountered and a ravine is used to descend to the western shore of Major's Bay. This ravine is also used by a troop of monkeys that occupies territory along Major's Bluff. The trail could then pass along the strip of vegetation and beach-dune communities that separate Major's Bay from a salt pond and fields of chest-high guinea grass. The route would then follow the western contours of the Great Salt Pond back to Whitehouse Bay.

3.3.3 Scotch Bonnet Trail

This trail would traverse a wide range in terrain beginning at Banana Bay and travelling along turtle nesting beaches at Cockleshell and Mosquito Bay. The short route between these two bays would take the hiker past Scotch Bonnet and one of the most easily observed monkey troops. The mangrove swamps and mud flats that border nearby Whaleback are good bird watching locations and the dry woodland areas host yellow warblers, grassquits, hummingbirds, grey kingbirds, and kestrels. Ground doves are frequently flushed from the guineas grass as one proceeds to Mosquito Bay and then along the beach and rocky coast to Mosquito Bluff. The view from this hundred foot high sea cliff is breathtaking and affords visual access to Booby Island, Scotch Bonnet and the neighboring island of Nevis a well as a look at the rugged windward side of Mount St. Anthony.

Returning to Mosquito Bay beach, the route then proceeds through the fields of guinea grass at Fleming Estate and then up over Saddle Back Ridge to the tropical forests on the western slope of Mount St. Anthony. After arriving at Sand Bank Bay, the trail would follow the beach and emerge near the road and Great Salt Pond. The return route along the salt pond and through Fleming Estate would bring the traveller back to Banana Bay and a well-deserved swim in the ocean. The snorkeling at Banana Bay is reported to be the best in the Peninsula.

SOUTHEAST PENINSULA
ISLAND OF ST. KITTS

Development Strategies for Fragile Lands:

A project funded by the United States Agency for International Development under a contract with Development Alternatives, Inc. and Tropical Research and Development, Inc.

November 1988.

Photo & map prepared by Aero Service Corporation Philadelphia, Pennsylvania

MAP 2

NEARSHORE CURRENTS

Atlantic Ocean

Caribbean Sea

Caribbean Sea

Sand Bank Bay

Mosquito Bay

Cockleshell Bay

Sandy Bay

Major's Bay

Great Salt Pond

Little Salt Pond

N

0 10 20 30 40

cm/sec

Current

4.0 SUMMARY AND RECOMMENDATIONS

4.1 Summary

As the Southeast Peninsula is opened to private development and public access, long-term sustainable development will depend on close ties to the natural environment. If the proposed management plans for the SEP are to be implemented, then an Environmental Control Office should be established to monitor changes, enforce existing legislation, regulation and codes, and increase public awareness through education programs and guided tours.

It is often difficult to calculate the economic value that wildlife and wildlands can provide but the 1990s are destined to become the decade of environmental concern and ecotourism will play an important role in the economy of governments who have the foresight to forsake short-term gain for long-term development.

4.2 Recommendations

It is recommended that prior to opening of the SEP to private development, the Government of St. Kitts/Nevis establish an Environmental Control Office.

In addition, there should be a country-wide dog control program with initial focus on the SEP.

Finally, land developers should work with wildlife biologists so that nature trails, wildlife corridors and wildland areas can be established as an integral part of tourism marketing.

5.0 REFERENCES

Arendt, W. 1985. Wildlife Assessment of the Southeastern Peninsula, St. Kitts, West Indies. U.S.A.I.D./Regional Development Office/Caribbean, Bridgetown, Barbados.

Chapman, C.A. 1987. Selection of Secondary Growth Areas by Vervet Monkeys (Cercopithecus aethiops). Amer. J. Primatology, 12:217-221.

McGuire, M.T. 1974. The St. Kitts Vervet. Contributions to Primatology, vol. 1.

Putney, A.D. 1982. Survey of Conservation Priorities in the Lesser Antilles. A Final Report. Caribbean Conservation Association, St. Croix, U.S. Virgin Islands.

St. Kitts/Nevis National Assembly. 1987. The National Conservation and Environment Protection Act, Government Headquarters, Box 186, Basseterre, St. Kitts.

Towle, E. 1986. Environmental Assessment Report for the South East Peninsula of St. Kitts, Island Resources Foundation, Red Hook, Box 33, St. Thomas U.S. Virgin Islands, 00802.

Young, R. and Morden J. 1987. Population Ecology of the St. Kitts Vervet (Cercopithecus aethiops). Report to Center for Field Research (Earthwatch), Boston, Mass.

Young, R. 1988. Field notes for a Survey of the Flora and Fauna of Nevis and the SEP of St. Kitts. Report to the Nevis Historical and Conservation Society, Charlestown, Nevis.

WILDLIFE RESOURCES MANAGEMENT PLAN: SEA TURTLES

by

Karen Eckert, Ph.D.

May 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

99

EXECUTIVE SUMMARY

Two species of marine turtle, the hawksbill and the green turtle, depend on the coral reefs and seagrass meadows surrounding the Southeast Peninsula (SEP), St. Kitts, West Indies, for food. These two species, as well as a third species (the migratory leatherback turtle), depend on the beaches of the SEP for nesting. All three are recognized to be in danger of extinction throughout their ranges (including the Caribbean) by the International Union for the Conservation of Nature (IUCN) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). There is also evidence that all three are declining locally in St. Kitts-Nevis and require immediate management attention.

There is no doubt that impending development of the SEP has the potential for eliminating sea turtle nesting on SEP beaches and significantly degrading offshore feeding grounds. Therefore, it is essential that regulatory guidelines be established to minimize adverse effects to these endangered animals. Experience elsewhere in the Caribbean demonstrates that 'ecotourism' (including the opportunity for guests to witness sea turtle nesting and hatching) can account for a significant amount of repeat business to hotels which offer it. If the following recommendations are incorporated into institutional and architectural plans for the SEP, coastal development, tourism and sea turtles will have the opportunity to coexist.

1. Waste disposal (solid, liquid), fires (recreational, charcoal production), sand mining, vehicular traffic, and the removal of vegetation should be prohibited on SEP beaches. Beach cleaning, when necessary, should be accomplished using hand tools (such as shallow rakes) and not heavy machinery or tools which deeply incise the sand and damage incubating eggs.

2. Beachfront lighting disorients emerging hatchlings and prevents them from reaching the sea. Artificial light sources should be positioned so that the source of light is not directly visible from the beach and does not directly illuminate areas of the beach. Low intensity, ground-level lighting is encouraged; low pressure sodium lights are recommended.

3. Indiscriminate mooring should be prohibited, only yachts and sailboats with proper sewage holding tanks should be admitted to offshore moorings, anchorages and marinas, and under no circumstances should offshore coral reefs (or algal ridges) be dynamited or dragged with chains in order to provide clear access for marine vessels.

4. In order to adequately safeguard important feeding and nesting areas, all SEP beaches should be declared Conservation Districts (as advocated by the Handbook of Development Guidelines and Considerations for the Southeast Peninsula and the Proposed Land Use Management Plan, Southeast Peninsula, St. Kitts) and the offshore zone between Nag's Head and White House Bay should be established as a Marine Reserve.

5. The roll-on roll-off ferry planned to connect St. Kitts with Nevis should be sited congruently with the SEP marina facility. Both are destined to do significant damage to adjacent onshore and offshore habitat, and this damage should be contained to the maximum extent possible. Considering the value of Major's Bay as a feeding area for marine turtles, as well as an important nursery area for conch and lobster, the northern extremity of Little Salt Pond is recommended for ferry/marina services.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
- 1.1 Rationale 1
- 1.2 Definition of Terms 2
- 1.3 Plan of Study 3

2.0 DESCRIPTION OF RESOURCE CHARACTERISTICS 4
- 2.1 Distribution of Sea Turtles 4
- 2.2 Cheloniidae 6
- 2.3 Dermochelyidae 7

3.0 MANAGEMENT ALTERNATIVES 9
- 3.1 Managing Sea Turtles 9
- 3.2 Managing Development Impacts 9
  - 3.2.1 **Protection of Nesting Habitat** 9
    - 3.2.1.1 Waste Disposal 9
    - 3.2.1.2 Beach Cleaning 10
    - 3.2.1.3 Coastal Construction 10
    - 3.2.1.4 Artificial Lighting 11
    - 3.2.1.5 Parking 12
    - 3.2.1.6 Vehicles 12
    - 3.2.1.7 Sand Mining 12
    - 3.2.1.8 Vegetation Cover 13
    - 3.2.1.9 Fires 13
    - 3.2.1.10 Beach Stabilization Structures 13
    - 3.2.1.11 Recreation 13
    - 3.2.1.12 Protection of Foraging Habitat 13
    - 3.2.1.13 Indiscriminate Mooring 14
    - 3.2.1.14 Waste Disposal 15
    - 3.2.1.15 Reef Destruction 15
    - 3.2.1.16 Exploitation 15
    - 3.2.1.17 Predation 16
    - 3.2.1.18 Law Enforcement 17
    - 3.2.1.19 Public Education 17

4.0 SUMMARY AND RECOMMENDATIONS 19

4.1 Summary and Recommendations 19
- 4.2 Limitations and Suggestions for Further Study 20

5.0 BIBLIOGRAPHY 22

APPENDIX 1 25

FIGURE 1 ERETMOCHELYS IMBRICATA 27

FIGURE 2 CHELONIA MYDAS 28

FIGURE 3 DERMOCHELYS CORIACEA 29

FIGURE 4 DISTRIBUTION OF SEA TURTLE NESTING AREAS 30

FIGURE 5 HIGH INTENSITY STREETLIGHT 31

FIGURE 6 WALL MOUNT FIXTURES 32

FIGURE 7 LOW PROFILE LUMINAIRES 33

103

1.0 INTRODUCTION

1.1 Rationale

There are six species of marine turtle reported from the Wider Caribbean. The hawksbill (Eretmochelys imbricata) and the green turtle (Chelonia mydas) are resident throughout the Caribbean. The leatherback (Dermochelys coriacea) is a temperate species which migrates into the Caribbean seasonally to nest. The loggerhead (Caretta caretta) is a vagrant in the West Indies and feeds and nests primarily in the Southeastern United States and Gulf of Mexico. The Kemp's ridley turtle (Lepidochelys kempii) is confined to the Gulf of Mexico and the olive ridley turtle (Lepidochelys olivacea) is virtually never recorded north of Trinidad. All six species are declining throughout their ranges, including the Caribbean. The hawksbill, green turtle, leatherback and, more rarely, the loggerhead, are reported from St. Kitts-Nevis (ECNAMP, 1980; Jackson, 1981; Meylan, 1983; Wilkins and Meylan, 1984; Arendt, 1985; Towle et al., 1986; Barrett, 1987, 1988; Wilkins and Barrett, 1987). The hawksbill, green turtle and leatherback, the most common species to nest in St. Kitts-Nevis, are recognized to be 'endangered species' by the International Union for the Conservation of Nature and Natural Resources (IUCN) and the Convention on Trade in Endangered Species of Wild Fauna and Flora (CITES).

All species of sea turtle, with the exception of the Australian flatback (Chelonia depressa), have declined over the last century as a result of direct exploitation and habitat loss. Today, the additional stresses of ocean pollution and the incidental catch and drowning of sea turtles in shrimp trawls, drift nets, longlines, and gill nets account for an increasing level of mortality each year. For centuries sea turtles have played an important role in the history, culture, and nutrition of West Indian people, but fishermen today report that fewer turtles are caught per unit effort and that those landed are, on average, smaller than in the past. With the decline of the turtle fishery, it is clear that future generations will never know turtles as their fathers and grandfathers once did. In an effort to prevent the complete loss of these ancient creatures, governments and nongovernmental organizations across the Caribbean are implementing measures to conserve and manage remaining stocks.

Planning for the conservation and management of sea turtles involves two steps: the identification of habitat upon which sea turtles depend, and the elaboration of criteria and implementation of regulations to ensure that habitat degradation is prevented and that all stages of the life cycle are protected to the greatest degree possible. The objectives of this document are to identify habitat areas on the Southeast Peninsula (SEP) of St. Kitts, West Indies, which are important to sea turtles, and to elaborate specific management recommendations which can be translated into regulatory action for the purpose of minimizing adverse affects to sea turtles arising from impending development of the SEP. Coastal development and sea turtles need not be mutually exclusive; however, care must be taken not to degrade nesting and foraging habitat.

Interestingly, sea turtles depend upon the same environmental parameters that support healthy fishing and tourist economies. Therefore, measures taken to reduce adverse effects to sea turtles will also have a profoundly positive effect on the long-term

104

economic prospects of the SEP. 'Ecotourism' is a relatively recent concept which is fast becoming a leading component of the tourism industry in the Caribbean. In addition to enjoying the clear water, diverse marine life, delicious seafood, and quiet beaches, more and more visitors are seeking experiences with wildlife that go beyond casual diving or hiking. For example, guided tours to the Rain Forest and Volcano in St. Kitts are increasingly popular.

In this context, it is noteworthy that efforts by hotels elsewhere in the Caribbean to expose guests to sea turtles have met with excellent success. Jumby Bay Resort, an exclusive hotel in Antigua, West Indies, initiated (in conjunction with WIDECAST and the Georgia Sea Turtle Research Cooperative) and continues to support a study of hawksbill sea turtles nesting on the hotel beach. With a qualified biologist in charge of the program, guests are quietly led in small groups to witness the nesting process. While this is not a program to be entered into lightly (bright lights and excited conversation can cause sea turtles to abort their nesting efforts), it is entirely possible for guests to witness this wonder of nature under the supervision of a competent guide. Jumby Bay guests return to the hotel year after year, often specifically because of this unique sea turtle program (James Richardson, personal communication).

The SEP constitutes very important sea turtle habitat in St. Kitts-Nevis. Wilkins and Barrett (1987) report that, "The beaches that are most used by turtles [in St. Kitts] are those beaches on the South East Peninsula." They also note that, "More turtles are observed in foraging areas close to nesting beaches on the Peninsula." If the simple recommendations delineated in this document (section III) are incorporated into the institutional and architectural plans for the SEP, coastal development and sea turtles will have the opportunity to coexist.

1.2 Definition of Terms

"Artificial light source(s)" shall mean any source of light emanating from a man-made device, including but not limited to, incandescent mercury vapor, metal halide or sodium lamps, spotlights, street lights, vehicular lights, construction or security lights.

"Beach" shall mean the zone of unconsolidated material that extends landward from the mean low water line to the place where there is a marked change in material or physiographic form, or to the line of permanent vegetation (usually the effective limit of storm waves).

"Beachfront lighting" shall mean all artificial lighting illuminating a beach.

"Coral reef" shall mean any benthic (bottom dwelling) marine community characterized by a calcium carbonate structure formed by colonial anthozoans.

"Ground-level barrier" shall mean any natural or artificial structure rising above the ground which prevents beach front lighting from shining directly onto the beach.

109

"Hatchling" shall mean any species of sea turtle, within or outside of a nest, which has recently hatched from an egg.

"Nest" shall mean the area in and around a place in which sea turtle eggs are naturally deposited in the sediments of the beach/dune system.

"Nesting season" has not been precisely defined for the SEP, but probably extends from 1 April to 30 November. Nesting is reported to peak in May (leatherbacks) and again in August-October (hawksbills and green turtles).

"Sea turtle(s)" shall mean any specimen belonging to the species Eretmochelys imbricata (hawksbill), Chelonia mydas (green turtle), or Dermochelys coriacea (leatherback).

"Seagrass meadow" shall mean any submarine plant community comprised solely or predominately of grasses belonging to the genera Thalassia, Syringodium, or Halodule.

1.3 Plan of Study

Direct observation (e.g., beach walks and/or aerial surveys during the nesting season) is the most accurate method for assessing the status and distribution of sea turtles, as well as important nesting and feeding habitats. However, the timing of this report precluded the author visiting the SEP during the nesting season; thus the information was gathered on beach walks/visual habitat assessment, literature accounts, and interviews with government officials (including Fisheries Officers on both St. Kitts and Nevis) and knowledgeable residents to identify habitats important to sea turtles on and around the SEP. The management recommendations are more or less standard, and were drawn from documented experiences in designing these recommendations (section III).

2.0 DESCRIPTION OF RESOURCE CHARACTERISTICS

There are three species of marine turtle that depend upon the Southeast Peninsula (SEP) of St. Kitts for feeding and/or nesting habitat. They are, in order of decreasing abundance, the hawksbill (Figure 1), the green turtle (Figure 2), and the leatherback (Figure 3) (Meylan, 1983; Wilkins and Barrett, 1987). Hawksbill and green turtles of various size classes are observed in the waters of the SEP year around. Green turtles feed in the seagrass meadows surrounding the peninsula and take refuge in adjacent coral reefs. Hawksbills both feed and rest in coral reef environments. Both species also nest on the beaches of the SEP. Leatherbacks are present only as breeding adults; only females are observed and they are known to be seasonal migrants (April-July). No estimates are available of the number of females nesting on the SEP, or the number of nests successfully deposited per annum, for any species of marine turtle.

The following sections include a summary of what is known about the distribution of sea turtle nesting and feeding habitats around the SEP (2.1), as well as brief discussions of sea turtle biology. Section 2.2 describes the hard-shelled sea turtles resident in St. Kitts-Nevis, including the SEP; namely, the hawksbill and green turtles (taxonomic family: Cheloniidae). Section 2.3 describes the 'soft-shelled' leatherback (taxonomic family: Dermochelyidae), a seasonal migrant to St. Kitts-Nevis, including the SEP.

2.1 Distribution of Sea Turtles

Available data suggest that the south (Caribbean) coast of the SEP is most important to sea turtles for feeding, while the north (Atlantic) coast is most important for nesting. Nonetheless, we cannot exclude the possibility that coral reefs along the Atlantic coast also serve as important feeding and refuge habitats, especially for the hawksbill turtle. Green turtles feed on seagrasses, while hawksbills eat sponges and other reef invertebrates (section 2.2). The most important feeding areas for green turtles appear to be Major's Bay and the Caribbean shore between Nag's Head and White House Bay. No data are available for hawksbills, but their distribution can be assumed to be more or less congruent with that of coral reefs. Leatherback turtles are suspected to feed on jellyfish and related animals in deep offshore waters during the nesting season (Eckert et al., 1989), but no information about potential feeding areas around St. Kitts-Nevis is available.

There are 10 sandy beaches on the SEP which appear to be stable over time (Figure 4). While all of them are used by nesting sea turtles, it is clear that some beaches are more important than others. Here is the summary of what is known about the distribution of sea turtle nesting on the SEP in Table 1. In each case, the last column, offers a rank which represents the importance of the beach as a sea turtle nesting area. Class I beaches are regarded as very valuable and Class II of intermediate value (see Figure 4 for beach location).

TABLE 1 DISTRIBUTION AND IMPORTANCE OF SEP SANDY BEACHES TO SEA TURTLES

Beach	Turtles	Source(s)	Class
North Friar's	G, H, L	Jackson, 1981 Wilkins and Meylan, 1984 Arendt, 1985 Towle et al., 1986 Audra Barrett, pers. comm.	II
unnamed #1	G	Robert Young, pers. obs. Campbell Evelyn, pers. obs. Audra Barrett, pers. comm.	I
unnamed #2	G, H	Towle et al., 1986 Robert Young, pers. obs. Audra Barrett, pers. comm.	I
Canoe Bay	G, H	Audra Barrett, pers. comm.	II
Sand Bank Bay	G, H, L	ECNAMP, 1980 Jackson, 1981 Meylan, 1983 Wilkins and Meylan, 1984 Towle et al., 1986 Audra Barrett, pers. comm.	I
Mosquito	G, H, L	ECNAMP,1980 Jackson, 1981 Meylan, 1983 Arendt, 1985 Towle et al., 1986 Campbell Evelyn, pers. obs. Audra Barrett, pers. comm.	I
Cockleshell	G, H, L	ECNMAP, 1980 Meylan, 1983 Wilkins and Meylan, 1984 Arendt, 1985 Towle et al., 1986 Audra Barrett, pers. comm.	I
Banana Bay	G, H	ECNAMP, 1980 Meylan, 1983 Audra Barrett, pers. comm.	I
Major's Bay	G, H	ECNMAP, 1980 Meylan, 1983 Wilkins and Meylan, 1984 Towle et al., 1986 Audra Barrett, pers. comm.	II
South Friar's	L G, H	Karen Eckert, pers. obs. Towle et al., 1986 Audra Barrett, pers. comm.	I

2.2 Cheloniidae

Hawksbill and green turtles are resident in the waters of St. Kitts-Nevis. Despite the fact that size classes ranging from small juveniles to breeding adults can be observed virtually year around, individual animals do not remain in the waters of St. Kitts-Nevis for the duration of their life cycle. Hatchlings emerging from the beaches of St. Kitts-Nevis enter the sea, orient offshore in a swimming frenzy that persists over a period of days (fueled by residual internal yolk), and soon enter offshore convergencies and weed lines. It is well known that sargassum rafts, for example, harbor a diverse, specialized fauna, including many kinds of little fishes, crustaceans, worms, mollusks, tunicates, and coelenterates; these presumably provide food for the little turtles (Carr, 1986). The turtles remain epipelagic (surface dwelling in the open sea) for an unknown period of time (perhaps 1-3 years), traveling more or less passively with the ocean currents, before returning to take up residence in continental shelf habitats.

Upon leaving the open sea existence that characterizes their earliest years, green turtles become herbivores and remain so for the rest of their lives (Bjorndal, 1985). They forage in seagrass meadows, such as surround the SEP (particularly the south and east shores). These meadows are comprised predominately of 'turtle grass' (Thalassia testudinum) and 'manatee grass' (Syringodium filiforme). Hawksbills, on the other hand, feed in coral reefs; in the West Indies they favor sponges (Meylan, 1984, 1988), though other prey items (algae, barnacles, mollusks) are also consumed (Witzell, 1983). Aside from differences in diet, green turtles and hawksbills have distinct morphologies. Green turtles can weigh as much as 230 kg, while hawksbills rarely attain 80 kg (Pritchard et al., 1983). The shell of the green turtle is very smooth, whereas the hawksbill shell is characterized by distinctly overlapping plates (scutes). Finally, the hawksbill, as its name suggests, has a narrow face and a pronounced over-bite (Figure 1).

Green turtles (and presumably hawksbills, though very few data are available for this species) travel extensively during the first decades of their lives. In the years preceding reproductive maturity the turtles move from one "developmental habitat" to another; that is, they take up temporary residence in a series of locations (Carr et al., 1978). They may travel thousands of kilometers, from one end of the Caribbean to the other, before the urge to reproduce impels them to migrate to mating and then to nesting grounds. Gravid (egg-bearing) females, regardless of species, are believed to return to their natal beaches to lay their eggs. Green turtles reach sexual maturity at 25-50 years of age (Frazer and Ehrhart, 1985); the exact age and size depending primarily on diet. There are no growth data available for the hawksbill but, for the present, maturation age is assumed to be comparable to that of the green turtle. Following reproduction, adults return to foraging grounds which are more or less defined for the balance of their lives. Therefore, the migratory movements of adult sea turtles are less extensive than those of juveniles; adults moving seasonally between relatively fixed foraging, mating, and nesting grounds.

The nesting season for green turtles and hawksbills has yet to be precisely defined in St. Kitts-Nevis, but Wilkins and Meylan (1984) suggest that the bulk of the nesting takes place between May and September. Towle et al. (1986) estimates that the nesting peaks

in August and September and suggests that some (low) level of nesting probably occurs year around. Undisturbed eggs hatch after approximately two months of incubation, with incubation temperature determining the sex ratio of the hatchlings (Mrosovsky, 1980; Morreale et al., 1982; Mrosovsky et al., 1984 a,b). It is believed that most eggs are harvested soon after they are laid (Audra Barrett, personal communication).

Hawksbills and green turtles are both listed as Endangered (Appendix I) by the Convention on International Trade in Endangered Species (CITES) and by the International Union for the Conservation of Nature (IUCN). Declines in the numbers of nesting females are reported throughout the Caribbean, and are attributed to loss of habitat, egg collection, and the slaughter of breeding adults. Green turtles are most often taken for meat, and secondarily for the shell. Hawksbills are prized both for meat and shell (known as 'tortoiseshell'), the latter used in making jewelry and other fashion items. Jewelry and trinkets made from tortoiseshell are widely available in St. Kitts, despite the fact that tourists often have these items taken from them as they attempt to reenter the U.S.A. or U.K., since the import of endangered species products into these countries is illegal. Section 3.23 summarizes the legal status of sea turtles (both nationally and internationally) with respect to St. Kitts-Nevis.

2.3 Dermochelyidae

The leatherback is the largest (280-500 kg) and of all marine turtles. It is morphologically and physiologically distinct; migrating further, diving deeper, and venturing into colder waters than any other marine reptile. It is an open ocean species, predictably venturing into continental shelf areas only when necessitated by the requirements of terrestrial (beach) nesting. The leatherback is easily recognized because it lacks a bony shell; hence the common names "leatherback" or "leathery turtle". The smooth, rubbery black skin is scaleless and liberally spotted with white. The body is streamlined (broad shoulders, tapering carapace) and the forelimbs are proportionally much longer than those of hard-shelled marine turtles (such as the hawksbill or green turtle). Bluntly serrated ridges extend along the back from head to tail.

The core body temperature is several degrees above ambient water (Frair et al., 1972) and may be due to several features, including a large body size (and consequently a low surface:volume ratio), a thick layer of subcutaneous fat, and countercurrent heat exchangers in the flippers (Greer et al., 1973). Broad thermal tolerances play a significant role in the species' distribution. Leatherbacks are reported from all major oceans ranging from 71xN to 47xS (Pritchard and Trebbau, 1984), and claim the most expensive biogeography of any reptile (Mrosovsky, 1983). The evidence currently available from tag returns and strandings suggests that adults engage in routine migrations between boreal, temperate, and tropical waters in order to optimize both feeding and nesting opportunities. The composition of epibiotic cirriped communities on Caribbean-nesting leatherbacks (that is, the types of barnacles that are found attached to the turtles) suggests that the gravid females embark from and subsequently return to temperate waters (Eckert and Eckert, 1988). The longest known migration for any marine turtle was that of an adult female leatherback who traveled a minimum of 5900

km. to Ghana, West Africa, after nesting in Suriname, South America (Pritchard, 1973).

With the exception of recent studies of diving behavior (Eckert et al., 1986, 1989), no information exists on the leatherback's habits at sea. The paths taken by hatchlings leaving their natal beaches are uncharted, and few juveniles are subsequently sighted. Wild growth rates are not available. The age structure of populations is not known. The stomach contents of slaughtered animals suggest that the diet consists primarily of medusae (jellyfish) and other soft-bodied invertebrates, such as siphonophores (Brongersma, 1969; den Hartog and van Nierop, 1984).

The leatherback is listed as Endangered (Appendix I) by the Convention on International Trade in Endangered Species (CITES) and by the International Union for the Conservation of Nature (IUCN). Approximately 115,000 breeding females are estimated to exist worldwide (Pritchard, 1982); half of these nest on the Pacific coast of Mexico. Nesting in the West Indies is predictable, but occurs nowhere in large numbers. Declines in the number of nesting females are reported throughout the region, and attributed to loss of habitat, egg collection, and the slaughter of breeding adults.

Adult females embark from temperate feeding grounds and arrive to nest on suitable Caribbean beaches, including those of the SEP, between April and July. They may deposit as many as ten clutches of eggs per season (Eckert, 1987). With the exception of two juveniles which washed ashore in Barbados in recent years after sustaining fatal shark wounds (Horrocks, 1989), only the adults of this species are recorded in the West Indies. They are seasonal migrants, returning to the North Atlantic in early July after the nesting season is over.

3.0 MANAGEMENT ALTERNATIVES

3.1 Managing Sea Turtles

There are several approaches which can be taken in the management of sea turtles. Nonetheless, the primary objective in any sea turtle management program is to prevent a decline in the reproductive success of a population. To achieve this goal, breeding adults should be afforded complete protection, the harvest of eggs and juveniles controlled or eliminated, and important feeding and nesting habitats protected from degradation. The objective of section 3.2 is to elaborate specific management recommendations which can be translated into regulatory action for the purpose of minimizing adverse affects to sea turtles arising from impending development of the SEP.

3.2 Managing Development Impacts

Several situations can be expected to arise as a result of the development of the SEP for tourism that will be detrimental to the survival of locally occurring sea turtle populations. Nevertheless, many adverse impacts can be avoided if simple guidelines are followed. The following sections, describing the protection of nesting habitat (section 3.21) and the protection of foraging (feeding) habitat (include 3.22), include such management concerns as waste disposal, sand mining, artificial lighting, and offshore mooring. The guidelines, if adhered to, offer an expectation that development can proceed without sacrificing sea turtles, and that such things as 'ecotourism' (section 1.1) can contribute substantially to the island economy.

3.2.1 Protection of Nesting Habitat

The beaches of the SEP are seasonally important to nocturnally nesting hawksbill, green, and leatherback sea turtles. A low level of nesting probably occurs virtually year around, although an annual high predictably occurs during May (leatherbacks) and again in August and September (hawksbills and green turtles). Stable beaches unobstructed by recreational equipment (chairs, sailboats), uncluttered by glass and other waste, and shielded from bright artificial lighting are essential for the survival of sea turtles on the SEP. On critically important beaches, such as South Friar's (Figure 4), it is recommended that development be concentrated at either end, leaving the mid-section relatively undisturbed.

3.2.1.1 Waste Disposal

Beach environments should not be used as waste disposal sites. It is clear from direct observation that Mosquito Bay Beach has been used for the disposal of garbage, including discarded refrigerators and other household objects, construction debris, and consumer waste (glass, plastic, paper, metal). One person interviewed reported having seen a truck from the Banana Bay Beach Resort drive to Mosquito Bay Beach and dump

Resort refuse both on the beach and in the nearshore waters; the incident took place in August 1988.

The fouling of beaches ultimately runs counter to the economic interests of SEP hoteliers. The waste is insulting aesthetically, both while on the beach and after washing into the sea. The reputation of the SEP for visitors will soon be damaged if beach walking and snorkeling are to be done amid discarded household and construction waste. In addition, glass and metal injure nesting sea turtles and larger objects obstructing the beach can prevent gravid females from finding adequate nesting sites. It is recommended that all garbage generated on the SEP be transported to a central landfill.

3.2.1.2 Beach Cleaning

Beach cleaning, when necessary, should be accomplished using hand tools (such as shallow rakes) and not heavy machinery or tools which deeply incise the sand. While the uppermost eggs in a green turtle or leatherback nest commonly incubate 20 cm or more beneath the surface of the sand, hawksbills construct shallow nests in which eggs may be protected by 10 cm or less of overlying sand. Damage to incubating eggs (or hatchlings awaiting an evening emergence) is easily effected by compaction or puncture arising from mechanized beach cleaning techniques.

3.2.1.3 Coastal Construction

All site development activities should be carried out in a manner designed to minimize potential impacts upon sea turtles or their nesting or feeding habitats. The positioning of buildings, recreational facilities, walkways, beach access points, parking lots and other features of the site should be predicated on minimizing operational impacts of these features on sea turtles. These recommendations do not prevent small-scale construction on the beach, although that would be the ideal, but only that patios, storage facilities, showers, etc., be sited such that they do not present hazards for sea turtles or hatchlings. These hazards include beach illumination (section 3.214) and potential traps (pits, open crawlspaces, permanent bodies of water). Buildings and large recreational facilities (such as tennis courts) should be placed well landward of the beach, both to minimize interference with sea turtle nesting and to protect these structures from shifting sands and storm wave damage.

At no time during the construction phase (or thereafter) should sand be removed from the beach (section 3.217). Simple, elevated walkways (generally constructed of wood) should be built over the primary dunes to direct foot traffic and prevent destruction of beach vegetation. Physical barriers which prevent sea turtles from entering construction areas are encouraged. Construction activities should be confined to daylight hours to avoid unnecessary disturbance to nocturnally nesting sea turtles. Construction debris should be properly disposed of (section 3.211).

113

3.2.1.4 Artificial Lighting

Sea turtles, especially hatchlings, are profoundly influenced by light. Baby sea turtles, freshly emerged from the nest, depend largely on a visual response to natural seaward light to guide them to the ocean. Consequently, in zones of coastal development, sources of artificial light distract hatchlings so that they turn away from the sea and crawl landward. Having done so, they never reach the sea and they die by the hundreds in the morning sun. Early studies implicated the shorter wavelengths of light (the blue end of the spectrum) as attractants to hatchlings; however, more recent studies suggest that hatchings respond to a higher intensity of light rather than to color hues. Raymond (1984) summarizes what is known about the interaction between sea turtle hatchlings and light.

Because it is unlikely that the light sources responsible for the disorientation of sea turtle hatchlings will be eliminated, it seems reasonable to either limit the light reaching the hatchlings or block or remove the light from their visual field. The brief paragraphs which follow are offered as guidelines to achieve the goal of blocking or removing light from the visual field of baby sea turtles. Some of the recommendations may appear complex, but in reality the are quite simple and will be readily understood by any experienced architect. The recommendations are adapted from successful regulations currently in effect in Martin County, Florida (USA).

It is essential that artificial light sources be positioned so that the source of light is not directly visible from the beach, does not directly illuminate areas of the beach, or emits wavelengths (560-620 nm) which do not disorient hatchlings. Modern alternatives, such as low pressure sodium lights, should be used to the maximum extent possible. Nighttime and security lighting be mounted not more than 15 feet above the ground, and not directly illuminate areas seaward of the primary dune or line of permanent vegetation (Figures 5, 6). Low intensity, ground- level lighting is encouraged both for aesthetic reasons and to minimize beach illumination (Figure 7). No lighting, regardless of wavelength, should be placed between sea turtle nests and the sea.

Natural or artificial structures rising above the ground should be used to the maximum extent possible to prevent lighting from directly illuminating the beach/dune system and to buffer noise and conceal human activity from the beach. Improving dune height in areas of low dune profile, planting native or ornamental vegetation, or using hedges and/or privacy fences is encouraged. Barriers between 76-85 cm high are sufficient to block the visual cues from artificial lights (Mrosovsky, 1970; Ehrenfeld, 1968). Ferris (1986) showed that a simple "fence" of black polyester material stretched between three posts between the nest and a disorienting light source (in this case a lighthouse) resulted in the hatchlings orienting correctly to the sea.

It is recommended that all lights on balconies be shielded from the beach, that lighting for decorative and accent purposes within line-of-sight of the beach (such as that emanating from spotlights or floodlights) be prohibited, and that the use of lights for safety and security purposes by limited to the minimum number required to achieve their functional roles. To prevent interior lights from illuminating the beach during the

114

nesting season, one or a combination of the following window treatments should be required on all windows of single and multi-story structures: blackout draperies, shade-screens, and/or window tint/film with a shading coefficient (the percent of incident radiation passing through a window) of 0.37 to 0.45.

Upon completion of the construction activities (and periodically thereafter), a registered architect, professional engineer or other authority designated by the government should conduct a site inspection, including a night survey with all the beachfront lights turned on. The purpose of this inspection is to verify that beach illumination is minimized and is in accordance with regulations designed to protect nesting, and especially hatching, sea turtles.

3.2.1.5 Parking

Parking lots and roadways, including any paved or unpaved areas upon which motorized vehicles will operate, should be designed and positioned such that vehicular headlights do not cast light toward the beach. Vehicular lighting should be shielded from the beach through the use of hedges, dune vegetation or other ground-level barriers.

3.2.1.6 Vehicles

The operation of all motorized vehicles (with the exception of emergency and law enforcement vehicles) should be prohibited on all beaches. The beaches of the SEP are all relatively short, rendering both ends accessible by foot. Where vehicles are used to transport heavy fishing gear, multiple access points can be provided and vehicles parked landward of the line of permanent vegetation. Driving for the purpose of waste disposal should be prohibited (section 3.211). Driving on the beach creates unsightly tire ruts, destabilizes the beach by exacerbating erosion, and compacts the sand above incubating sea turtle eggs (thus lowering hatch success). Tire ruts present a significant hazard to hatchlings traversing the beach. The tiny turtles drop into the ruts and cannot get out; they wander in the ruts (parallel to the sea) until morning, whereupon they die of exposure in the morning sun or fall prey to crabs, mongooses, birds or dogs.

3.2.1.7 Sand Mining

Sand mining is a leading cause of beach destruction throughout the Caribbean. This practice should be prohibited on all SEP beaches, and the prohibition strongly enforced. The removal of sand creates unsightly pits that can result in injury to humans and livestock. In addition, the pits accumulate water and serve as breeding areas for mosquitoes and other unwanted insects, they disrupt stabilizing vegetation, and they eventually undermine the delicate balance of sand erosion, accretion, and transport that keeps all sand beaches on the SEP stable and available for use by humans, sea turtles, and shorebirds.

115

3.2.1.8 Vegetation Cover

Vegetation above mean high tide should not be removed from the beach. Creeping vegetation (e.g., seaside purselane, Sesuvium portulacastrum; beach bean, Canavalia maritima; beach morning glory, Ipomoea pes-caprae) stabilizes the beach, offering protection against destructive erosion (wind, waves). Larger supralittoral vegetation, such as West Indian sea lavender (Mallotonia gnaphalodes), sea grape (Coccoloba uvifera), manchineel (Hippomane mancinella) and acacia (Acacia sp.), provides nesting habitat for the hawksbill sea turtle, as well as offering natural shielding for the beach from the artificial lighting of shoreline development (section 3.214).

3.2.1.9 Fires

Fires (recreational, charcoal production) should be prohibited on all SEP beaches. Fires are a hazard to the surrounding dry forest, create unsightly scars on the beach, scorch eggs and hatchlings beneath the surface of the sand, and disorient both hatchlings and nesting adults. Beach fires should be restricted to designated grill facilities.

3.2.1.10 Beach Stabilization Structures

Shoreline stabilizing structures, such as the placement of riprap (loose rock) or the construction of cement walls parallel or perpendicular to the sea, should be discouraged. Sand beach environments are naturally dynamic. Cycles of erosion (seasonal or storm induced) are naturally followed by cycles of accretion. Numerous case histories are available to document the fact that actions taken to disrupt these natural cycles, or the interdependence of the dune, beach, and offshore sand deposits, ultimately result in enormously expense maintenance activities, such as dredging and renourishment.

3.2.1.11 Recreation

Recreational equipment (lounge chairs, sailboats) should be removed from the beach early each evening during the nesting and hatching seasons (1 April-30 November) so as not to obstruct nesting or hatching sea turtles. It is sufficient that chairs be pulled onto lawn areas, or into designated shelters, and that larger objects be restricted to designated areas.

3.2.1.12 Protection of Foraging Habitat

Habitat protection for turtles involves not only the defense of nesting areas from adverse development, but also the protection of critical feeding areas. The seagrass meadows and coral reefs surrounding the SEP provide some of the most important feeding habitat for green turtles and hawksbills in St. Kitts-Nevis (Wilkins and Barrett, 1987; Wilcox, 1989a; Campbell Evelyn, personal communication). The objective of this section is to

identify three critical areas of concern with respect to the integrity of seagrass meadows and coral reefs surrounding the SEP; they include damage resulting from indiscriminate mooring, waste disposal, and the use of chemicals, dynamite or chains to eliminate portions of an offshore reef to accommodate marine vessels.

3.2.1.13 Indiscriminate Mooring

Anchor damage is a leading cause of destruction to seagrass meadows and coral reefs throughout the West Indies. At present, anchor damage seems minimal in the nearshore waters of the SEP. The Atlantic coast appears to be too windy and rough throughout most of the year for anchoring and while the channel has some protection (i.e., Major's Bay), winds and currents seem to preclude a calm anchorage. The bays on the Caribbean coast afford some protection but as yet do not attract many yachts for overnight anchorages (Wilcox, 1989b).

Presumably the demand for overnight anchorage will increase with the development of tourism activity on the SEP. It is essential that yachts and vessels of all sizes be required to either anchor in designated sand bottom areas, or tie in at approved moorings in coral reef areas. The provision of an adequate number of secure moorings should be given highest priority before marine vessels are allowed to anchor off the SEP. John Halas (Key Largo National Marine Sanctuary, 172 Lorelane Place, Key Largo, Florida 33037 USA) has designed a simple and extremely cost-effective mooring system (US$100-200 per mooring) which has proven adequate for holding yachts and live-aboard dive boats <100 feet in length both in Florida and in the West Indies (e.g., Saba, Netherlands Antilles). He has expressed his willingness to provide a demonstration of his technique to the government and/or development community of St. Kitts upon request.

Small cruise ships (including 'mini-cruisers') are increasingly popular in the Caribbean and will surely be visiting the SEP on a regular basis. Adequate moorings should be provided to these vessels for the duration of their stay. If this is not possible, they should be required to remain offshore, beyond the zone of coral and seagrass (>30 meters in depth). At this time, there are few cost-effective systems for mooring larger vessels such as cruise ships. Consequently, large cruise ships (>200 feet in length) should not be allowed to anchor off the SEP. The Deep Water Port is only 15 minutes by launch (or taxi) from the SEP and greater economic (and environmental) benefits can be realized by transporting tourists by water or ground transfer from the Port to the SEP.

In the absence of secure moorings, the demolition of coral reefs and the uprooting of seagrasses by anchors will be quick and can be permanent (Williams, 1987; Rogers, 1986). In addition to providing important foraging habitat for sea turtles, the nearshore zone along the south coast of the SEP (including Major's Bay) is seen as essential habitat for juvenile fishes, conch, and lobster (Ralph Wilkins and Audra Barrett, personal communication). Water sports, especially SCUBA, will be also be adversely affected if coral reef environments are degraded.

117

3.2.1.14 Waste Disposal

One environmental cost of accommodating boat traffic is the dumping of raw sewage and garbage into the water from boats. This practice adds nutrients to the water which results in eutrophication and algae overgrowth in shallow nearshore areas. One way to encourage boats to install and use holding tanks would be to admit only yachts and sailboats with proper holding tanks to the offshore moorings or planned marina(s).

The dumping of solid waste, such as plastics, into the sea should be prohibited. In addition to degrading the general environment for the residents of St. Kitts-Nevis, sea turtles mistake plastic bags for jellyfish and ingest them. Often this kills the turtle (e.g., Balazs, 1985; Carr, 1987).

3.2.1.15 Reef Destruction

Under no circumstances should offshore coral reefs (or algal ridges) be dynamited or dragged with chains in order to provide clear access for marine vessels. In the absence of the sheltering influence of offshore reefs, shorelines are often severely altered, resulting in great economic losses. The practices of using bleach (and other chemicals) or dynamite for the purpose of stunning fish for harvest should be prohibited at all time and under all circumstances. The destruction of coral reefs resulting from these practices is complete and irreversible.

3.2.1.16 Exploitation

St. Kitts-Nevis law currently permits the harvest of sea turtles between 1 October and 31 May. Barrett (1987) reports that approximately 20 fishermen fished for turtles full-time during the 1986-1987 season, the total catch was about 110 turtles (mainly hawksbill and green turtles), and the average weight of turtles landed was about 65 pounds. Leatherbacks are caught occasionally, but often released as there is virtually no market for the meat (though there is a limited market on St. Kitts for oil rendered from the leatherback; Ralph Wilkins, personal communication). The meat of both hawksbill and green turtles is sold mostly to hotels; the shells are used for decoration and jewelry. The following year (1987-1988), only eight fishermen were directly engaged in turtle fishing, and turtle stocks were reported to be on the decline as a result of harvesting both eggs and turtles (Barrett, 1988). A total of 552 pounds of turtle meat was sold to hotels and restaurants, and 1000 pounds of meat as well as some shells were exported to St. Barthelemew (Barrett, 1988). Currently, no fishermen make their sole living from turtles or turtle eggs.

With the recognition that sea turtles are declining in St. Kitts- Nevis (Meylan, 1983; Audra Barrett, personal communication), sea turtles should be recognized as threatened or endangered species in St. Kitts-Nevis and measures implemented to ensure their survival. Restaurants and hotels should be made aware of the endangered status of sea

turtles, and encouraged not to purchase sea turtle meat. Stiff fines should be levied against fishermen who catch, and restaurants which offer, sea turtle meat during the closed season (1 June 31 September).

In addition to the management recommendations outlined in section 3.2, St. Kitts-Nevis law should be amended to prohibit the harvest of adults at all times and under all circumstances. Breeding adults require several decades to reach maturity (sections 2.2, 2.3) and are especially difficult for a population to replace. Their removal potentially eliminates more than a decade of egg production, thus contributing to sharply reduced recruitment. In the absence of a moratorium on the take of sea turtles, Fisheries regulations should establish a maximum size limit, perhaps 40 cm (=15 inches) shell length, for turtles landed as opposed to a minimum size limit. Again, the older (larger) the turtle, the more valuable it is to the survival of the population (Crouse et al., 1987). The IUCN recognized this basic biological principle in a recent resolution (Appendix I).

The take of eggs (which is reported to be very extensive on both St. Kitts and Nevis; Fisheries personnel, personal communication) should either be prohibited or strictly controlled. If it is not feasible the eliminate the harvest at this time, a system should be established whereby egg collectors are licensed by the Fisheries Department (that is, they pay a fee for the opportunity to harvest eggs) and abide by an annual harvest quota. Prior to licensing egg collectors, a 3-year moratorium on the take of eggs should be mandated in order that the number of eggs laid per year can be assessed. Once this information is available, harvest should not exceed 5% of annual productivity. There are examples all over the world (most recently in Malaysia) where the continued uncontrolled harvest of sea turtle eggs has resulted in the steep decline or extinction of locally nesting sea turtle populations. In order to effect enforcement of new regulations concerning sea turtles and their eggs, it is clear that the Fisheries Department will need augmented support in the form of both personnel (e.g., Extension and/or Enforcement Officers) and equipment (e.g., a patrol boat).

At the same time that St. Kitts-Nevis is considering strengthening protection of sea turtles nationally, strong consideration should be given to ratification of international treaties and conventions which offer protection to sea turtles and other endangered species. It is notable that St. Kitts-Nevis is one of a handful of countries left in the world that have not ratified the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). St. Kitts-Nevis is encouraged to accede to CITES as soon as is practicable, recognizing that accession has no bearing whatsoever on national law; that is, local seasons of harvest are fully compatible with ratification of CITES, the latter only governing international trafficking in sea turtles.

3.2.1.17 Predation

Natural causes of mortality differ among life stages, but it can be assumed that beach erosion, crabs (ghost crab, Ocypode quadratus; great land crab, Cardisoma sp.) and birds (yellow-crowned night heron, Nyctanassa violacea) result in the loss of eggs and hatchlings, sea birds and reef fishes consume hatchlings, and sharks take juvenile and

119

adult sea turtles. In many areas of the Caribbean, exotic species such as mongooses (Herpestes auropunctatus) and domestic dogs pose a significant threat to sea turtles. Both these species consume large amounts of eggs and hatchlings, and dogs also have the potential to frighten away nesting females. There is no evidence that monkeys (Cercopithecus aethiops) resident on the SEP pose any threat to sea turtles, eggs or hatchlings.

It is recommended that exotic mammals, such as rats and mongoose, be controlled to the extent possible [remembering that indiscriminate poisoning and trapping can also kill dogs, cats, and children]. Garbage should be properly disposed of well away from living quarters and beach habitats (see also section 3.211) so as not to unnecessarily attract these pests. Ideally, dogs should be kept off the beach at night and not be allowed to harass nesting sea turtles or to consume eggs or hatchlings. Feral dogs (dogs which call nowhere home and run wild, generally in packs) are lethal to a wide variety of wildlife species, including monkeys, deer, birds, and sea turtles, and should be eliminated.

3.2.1.18 Law Enforcement

In order to effect compliance with the above recommendations, it will be necessary to provide for natural resource law enforcement on the SEP. This would be best accomplished by the appointment of a Wildlife Officer (or some other natural resource management official) who would be responsible for monitoring compliance, as well as initiating regular wildlife and wildlands surveys to assess the health of species and habitats of concern (including sea turtles). Institutional (governmental) support for law enforcement and wildlife management cannot be overemphasized. Short courses and training opportunities for candidates are available from the University of the West Indies, as well as from various national and regional agencies (e.g., CIDA, CCA, OECS).

3.2.1.19 Public Education

It is widely known and intuitively obvious that enforcement is impractical, if not impossible, in the absence of public support for the law(s) being enforced. Citizen input and involvement in wildlife and general marine conservation is essential if regulations governing the use of these natural resources are to be obeyed. Education is prerequisite, as is the emergence of conservation advocacy groups in St. Kitts-Nevis. Throughout the Caribbean, local advocacy groups are monitoring compliance with wildlife regulations and getting involved with teaching their fellow citizens the value of wildlife, wildlands, and a clean, healthy environment. Dive operators (SCUBA), libraries, youth groups (such as the Youth Council in St. Kitts-Nevis), the Nevis Historical and Conservation Society, Fisheries Department personnel, and related groups should come together in the common goal of protecting the environment of St. Kitts-Nevis against decay.

Sea turtles are a symbol of the health of the coastal zone, both marine (coral reefs and seagrass meadows) and terrestrial (sandy beaches). Educational programs focusing on sea turtles can be very effective, because people identify easily with the turtles. Many

have seen turtles in one setting or another, and it is easy to see the connection between protecting sea turtles and protecting large segments of the economic base of St. Kitts-Nevis (i.e., fisheries and tourism). Local projects to design educational materials get children (and adults!) thinking about the interconnectedness of their natural resources and their economic and cultural integrity. Educational efforts such as these are currently underway under the auspices of the Southeast Peninsula Board, the Fisheries Department, the Nevis Historical and Conservation Society, and the Nevis public library. The Wider Caribbean Sea Turtle Recovery Team (WIDECAST) has slide shows, brochures, and educational materials available upon request for use in the West Indies (contact Dr. Karen Eckert, Department of Zoology, University of Georgia, Athens, Georgia 30602 USA).

It has been suggested by some members of the fishing community that a 15 minute radio program each day, which discusses sea turtles and urges residents not to kill them or take their eggs, would be successful on St. Kitts-Nevis. This type of natural resource programming could be expanded to include information on waste disposal and pollution, the biology of native birds and mammals, the importance of fragile habitats (such as the rain forest and coastal wetlands), and issues of interest to the fishing community.

121

4.0 SUMMARY AND RECOMMENDATIONS

4.1 Summary and Recommendations

Two species of marine turtle, the hawksbill and the green turtle, depend on the coral reefs and seagrass meadows surrounding the Southeast Peninsula (SEP), St. Kitts, West Indies, for food. These two species, as well as a third species (the migratory leatherback turtle), depend on the beaches of the SEP for nesting. All three are recognized to be in danger of extinction throughout their ranges (including the Caribbean) by the International Union for the Conservation of Nature (IUCN) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). There is evidence that all three are declining locally in St. Kitts-Nevis and require immediate management attention.

There is no doubt that the impending development of the SEP has the potential for eliminating sea turtle nesting on SEP beaches, as well as significantly degrading offshore feeding grounds. Therefore, it is essential that regulatory guidelines be established to minimize adverse effects to these endangered animals. Experience elsewhere in the Caribbean demonstrates that 'ecotourism' (including the opportunity for guests to witness sea turtle nesting and hatching) can account for a significant amount of repeat business to hotels which offer it. If the following recommendations are incorporated into the institutional and architectural plans for the SEP, coastal development and sea turtles will have the opportunity to coexist.

1. Waste disposal (solid, liquid; section 3.211), fires (recreational, charcoal production; section 3.219), sand mining (section 3.217), vehicular traffic (sections 3.215, 3.216), and the removal of vegetation (section 3.218) should be prohibited on SEP beaches. Beach cleaning, when necessary, should be accomplished using hand tools (such as shallow rakes) and not heavy machinery or tools which deeply incise the sand and damage incubating eggs (section 3.212).

2. Beachfront lighting disorients emerging hatchlings and prevents them from reaching the sea. Artificial light sources should be positioned so that the source of light is not directly visible from the beach, does not directly illuminate areas of the beach, or emits light wavelengths (560-620 nm) which do not disorient hatchlings. Low intensity, ground-level lighting is encouraged; low pressure sodium lights are recommended (section 3.214).

3. Indiscriminate mooring should be prohibited, only yachts and sailboats with proper sewage holding tanks should be admitted to offshore moorings, anchorages and marinas, and under no circumstances should offshore coral reefs (or algal ridges) be dynamited or dragged with chains in order to provide clear access for marine vessels (sections 3.221, 3.223).

4. In order to adequately safeguard important feeding and nesting areas, all SEP beaches should be declared Conservation Districts (as advocated by the Handbook of Development Guidelines and Considerations for the Southeast Peninsula and

122

the Proposed Land Use Management Plan, Southeast Peninsula, St. Kitts) and the offshore zone between Nag's Head and White House Bay (as far as the ferry/marina site should Little Salt Pond be so designated) should be established as a Marine Reserve.

5. The roll-on roll-off ferry planned to connect St. Kitts with Nevis should be sited congruently with the SEP marina facility. Both are destined to do significant damage to adjacent onshore and offshore habitat, and this damage should be contained to the maximum extent possible. Considering the value of Major's Bay as a feeding area for marine turtles, as well as an important nursery area for conch and lobster, the northern extremity of Little Salt Pond is recommended for ferry/marina services.

Further considerations, including coastal construction (section 3.213), beach stabilization structures (section 3.220), parking and recreation (section 3.221), should be included in planning for development of the SEP. There is no question, however, that beachfront lighting presents the most serious concern (section 3.214). The placement and type of exterior lighting should be given high priority in the review of architectural plans for the SEP. It is notable that the recommendations herein proposed to mitigate the effects of beachfront lighting are entirely feasible and have been successfully incorporated into coastal architecture in Florida (USA).

4.2 Limitations and Suggestions for Further Study

It would be very useful if systematic study were initiated of the sea turtles in St. Kitts-Nevis. Mr. Ralph Wilkins (Fisheries Officer, St. Kitts) and Mr. Audra Barrett (Assistant Fisheries Officer, Nevis) have been collecting and compiling data on sea turtle sightings, nestings, and landings. Their work is commended; hopefully with the support of WIDECAST, WATS (Western Atlantic Turtle Symposium) or other regional groups it will be expanded. Specifically, coordinated surveys should be made of sea turtle nesting and feeding areas. The habitats and community structure, as well as the type and intensity of sea turtle activities, within each area should be summarized. A listing of natural and human-related perturbations occurring within or near each habitat should be compiled. By identifying the habitats, the nature of sea turtle activity, and perturbations (threats), priority areas can be selected for protection.

Sea turtles are long-lived animals, much like human beings. They are part of the heritage and culture of St. Kitts-Nevis, and should not be sacrificed in the name of "development" or "progress". The people of St. Kitts-Nevis have, in a sense, a prior commitment to the survival of these gentle creatures. They were born here, and some of them breeding today have been alive longer than many Kittitians. Turtles hatched on the beaches of the SEP 20-30 years ago are just now returning to lay eggs of their own, and they will continue to return for the purpose of nesting for a decade or more. Thus it is important that the degradation of sandy beaches (sand mining, lights, vehicles, garbage, noise and traffic) be kept to an absolute minimum -- now and over the long term.

123

In addition to the significance of sea turtles to the history (and future) of St. Kitts-Nevis, sea turtles nesting on the beaches of the SEP represent a significant source of income to hoteliers willing to follow the guidelines recommended herein and maintain sandy beaches as nesting grounds for sea turtles. Offering the (supervised) experience of watching nesting and hatching sea turtles has been a major selling feature for hotels elsewhere in the region. Dr. James Richardson (Institute of Ecology, University of Georgia, Athens, Georgia 30602 USA) has had experience designing sea turtle programs for hotel guests in the Caribbean, and is available upon request to do so in St. Kitts. The accommodation of sea turtles in the planning stages of SEP development is crucial. Once the damage is done and the turtles are gone, they are gone forever.

5.0 BIBLIOGRAPHY

Arendt, W. 1985. Wildlife assessment of the Southeastern Peninsula, St. Kitts, West Indies. U. S. Agency for International Development/Regional Development Office/ Caribbean, Bridgetown, Barbados.

Balazs, G. H. 1985. Impact of ocean debris on marine turtles: entanglement and ingestion. Pp.387-429. In: R. S. Shomura and H. O. Yoshida (eds), Proc. Workshop on the Fate and Impact of Marine Debris. NOAA Tech. Memo. NOAA-TM-NMFS-SWFC-54.

Barrett, A. 1987. Status of the turtle fishery and research project, 1986-1987. Ministry of Agriculture, Department of Fisheries, St. Kitts-Nevis.

Barrett, A. 1988. Update report on the turtle research project, 1987-1988. Ministry of Agriculture, Department of Fisheries, St. Kitts-Nevis.

Bjorndal, K. A. 1985. Nutritional ecology of sea turtles. Copeia 1985:736-751.

Brongersma, L. D. 1969. Miscellaneous notes on turtles, IIA. Koninkl. Nederl. Akademie van Wetenschappen--Amsterdam. Reprinted Proc. Series C, 72, No. 1:76-89.

Carr, A. 1986. Rips, FADS, and little loggerheads. BioScience 36(2):92-100.

Carr, A. 1987. Impact of nondegradable marine debris on the ecology and survival outlook of sea turtles. Mar. Pollut. Bull. 18(6 PartB):352-356.

Carr, A., M. H. Carr, and A. B. Meylan. 1978. The ecology and migrations of sea turtles, 7. The west Caribbean green turtle colony. Bull. Am. Mus. Nat. Hist. 162(1):1-46.

Crouse, D. T., L. B. Crowder and H. Caswell. 1987. A stage-based population model for loggerhead sea turtles and implications for conservation. Ecology 68(5):1412-1423.

Eckert, K. L. 1987. Environmental unpredictability and leatherback sea turtle (Dermochelys coriacea) nest loss. Herpetologica 43(3):315-323.

Eckert, K. L. and S. A. Eckert. 1988. Pre-reproductive movements of leatherback sea turtles (Dermochelys coriacea) nesting in the Caribbean. Copeia 1988:400-406.

Eckert, S. A., K. L. Eckert, P. Ponganis and G. L. Kooyman. 1989. Diving and foraging behavior of leatherback sea turtles (Dermochelys coriacea). Can. J. Zool.: in press.

Eckert, S. A., D. W. Nellis, K. L. Eckert and G. L. Kooyman. 1986. Diving patterns of two leatherback sea turtles (Dermochelys coriacea) during internesting intervals at Sandy Point, St. Croix, U.S. Virgin Islands. Herpetologica 42(3):381-388.

125

ECNAMP. 1980. St. Kitts: Preliminary Data Atlas. Eastern Caribbean Natural Area Management Program, Caribbean Conservation Association, and the School of Natural Resources of the University of Michigan. 20p.

Ehrenfeld, D. W. 1968. The role of vision in sea-finding orientation of the green turtle (Chelonia mydas) II: Orientation mechanism and range of spectral sensitivity. Anim. Behav. 16:281-287.

Ferris, J. S. 1986. Nest success and the survival and movement of hatchlings of the loggerhead sea turtle (Caretta caretta) on Cape Lookout National Seashore. CPSU Tech. Rept. 19, U.S. Natl. Park Ser. 40p.

Frair, W., R. G. Ackman and N. Mrosovsky. 1972. Body temperature of Dermochelys coriacea: warm turtle from cold water. Science 177:791-793.

Frazer, N. B. and L. M. Ehrhart. 1985. Preliminary growth models for green, Chelonia mydas, and loggerhead, Caretta caretta, turtles in the wild. Copeia 1985:73-79.

Greer, A. E., J. D. Lazell and R. M. Wright. 1973. Anatomical evidence for counter-current heat exchanger in the leatherback turtle (Dermochelys coriacea). Nature 244:181.

Hartog, J. C. den and M. M. van Nierop. 1984. A study on the gut contents of six leathery turtles, Dermochelys coriacea (Reptilia:Testudines:Dermochelyidae) from British waters and from the Netherlands. Zool. Verh. (Leiden), 209:1-36.

Horrocks, J. A. 1989. Leatherback injured off Barbados, West Indies. Marine Turtle Newsletter 46:in press.

Jackson, I. 1981. Southeastern Peninsula, St. Kitts, study of management alternatives. Caribbean Conservation Association/ Eastern Caribbean Natural Areas Management Program in collaboration with the Government of St. Kitts-Nevis.

Meylan, A. B. 1983. Marine turtles of the Leeward Islands, Lesser Antilles. Atoll Research Bulletin No. 278.

Meylan, A. B. 1984. The ecology and conservation of the Caribbean hawksbill (Eretmochelys imbricata). Final Report W.W.F. Project #1499.

Meylan, A. B. 1988. Spongivory in hawksbill turtles: a diet of glass. Science 239:393-395.

Morreale, S. J., G. J. Ruiz, J. R. Spotila, and E. A. Standora. 1982. Temperature-dependent sex determination: current practices threaten conservation of sea turtles. Science 216:1245-1247.

Mrosovsky, N. 1970. The influence of the sun's position and elevated cues on the orientation of hatchling sea turtles. Anim. Behav. 18:648-651.

126

Mrosovsky, N. 1980. Thermal biology of sea turtles. Am. Zool. 20:231-547.

Mrosovsky, N. 1983. Conserving sea turtles. The British Herpetological Society, London. 176p.

Mrosovsky, N., S. R. Hopkins, and J. I. Richardson. 1984a. Sex ratio of sea turtles: seasonal changes. Science 225:739-741.

Mrosovsky, N., P. H. Dutton, and C. P. Whitmore. 1984b. Sex ratios of two species of sea turtle nesting in Suriname. Can. J. Zool. 62:2227-2239.

Pritchard, P. C. H. 1973. International migrations of South American sea turtles (Cheloniidae and Dermochelyidae). Anim. Behav. 21:18-27.

Pritchard, P. C. H. 1982. Nesting of the leatherback turtle, Dermochelys coriacea, in Pacific Mexico, with a new estimate of the world population status. Copeia 1982:741-747.

Pritchard, P. C. H. and P. Trebbau. 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles.

Pritchard, P. C. H. et al. 1983. Manual of Sea Turtle Research and Conservation Techniques, Second Edition. K. Bjorndal and G. Balazs (eds.). Center for Environmental Education, Washington D.C. 125p.

Raymond, P. W. 1984. Sea Turtle Hatchling Disorientation and Artificial Beachfront Lighting. Center for Environmental Education, Washington D.C. 72p.

Towle, E. L. et al. 1986. Environmental Assessment Report on the Proposed Southeast Peninsula Access Road St. Kitts, West Indies. Prepared for the Government of St. Kitts-Nevis by The Islands Resources Foundation, St. Thomas, USVI.

Wilcox, E. 1989a. Marine Resources Management Plan. Prepared for the Southeast Peninsula Board, St. Kitts, by Tropical Research and Development, Inc. (draft)

Wilcox, E. 1989b. Marine Park Recreation Plan for the Southeast Peninsula of St. Kitts. Prepared for the Southeast Peninsula Board, St. Kitts, by Tropical Research and Development, Inc.

Wilkins, R. and A. B. Meylan. 1984. Western Atlantic Turtle Symposium National Report for St. Kitts-Nevis. In: Hirth, H., et al. (eds.), Proceedings of the Western Atlantic Turtle Symposium, San Jose, Costa Rica. Vol. 2. RSMAS Printing, Miami, Florida.

Wilkins, R. and A. Barrett. 1987. Western Atlantic Turtle Symposium National Report for St. Kitts-Nevis.

Witzell, W. N. 1983. Synopsis of biological data on the hawksbill turtle, Eretmochelys imbricata (Linnaeus, 1766). FAO Fisheries Synopsis No. 137. Rome, Italy. 78p.

APPENDIX 1

RECALLING that Kemp's ridley (Lepidochelys kempii) sea turtle was included in IUCN's [International Union for the Conservation of Nature] Species Survival Commission's list of twelve most endangered species in 1986, and that their continued decline is largely due to the numbers drowned in shrimp trawl nets;

FURTHER RECALLING the effectiveness of the turtle excluder device (TED) in the prevention of sea turtle incidental catch by shrimp trawlers;

CONSIDERING that legal action has been taken to invalidate the United States Government's promulgation of the TED Regulations;

RECOGNIZING the importance of the IUCN General Assembly providing support to the United States Government for this valuable effort in what is a world-wide problem in sea turtle conservation;

CONCERNED that many sea turtle populations continue to decline as a direct result of human exploitation;

FURTHER CONCERNED that the level of international trade in sea turtle products, particularly of the shell and skin, remains very high, and that in many countries the level of national trade, particularly in meat and eggs, continues unabated;

RECOGNIZING that there are many other contributing factors to population declines, such as disturbance and destruction of the nesting and foraging habitats, ingestion of ocean debris and toxic pollutants, and incidental catch in different types of fishing gear;

CONSIDERING that scientists are currently unable to predict sustainable levels of exploitation due to insufficient knowledge of vital parameters of sea turtle biology;

NOTING that the immature stages of the life cycle are the most susceptible to natural predation, and that it is the breeding adults, rather than the young, that are most important for the survival of the population, and therefore most damaging to exploit;

RECALLING that most examples of sea turtle management have followed traditional fishery patterns and established minimum size limits to protect the juvenile age classes;

The General Assembly of the IUCN, at its 17th Session in San Jose, Costa Rica, 1-10 February 1988:

1. URGES the United States to oppose any delay in implementation of federal regulations requiring the use of TEDs needed to prevent the capture and drowning of the critically endangered Kemp's ridley sea turtle or any other species of sea turtle.

128

2. URGES member governments to enact and enforce national legislation to increase the conservation of sea turtles:

   a. Institute maximum size limits to ensure that no turtles of breeding age are killed, and study the possibility of establishing quotas for the capture of juveniles where it is culturally inappropriate to provide full protection for all age classes of sea turtles;

   b. Restrict egg collection to minimize the negative impact on the population where it is culturally inappropriate to prevent the collection of sea turtle eggs altogether;

   c. Protect the nesting beaches and foraging habitats to minimize disturbance, damage and other activities disruptive to sea turtle reproduction;

   d. Where sea turtles are present, require use of TEDs by shrimp trawlers, and control all other fishing methods as needed to minimize incidental catch, particularly off the nesting beaches during the breeding season.

3. RECOMMENDS that IUCN members initiate research programmes in consultation with the Species Survival Commission to determine the long-term trends in the sea turtle populations wherever exploitation occurs, in particular, the impact of exploitation on the different age classes.

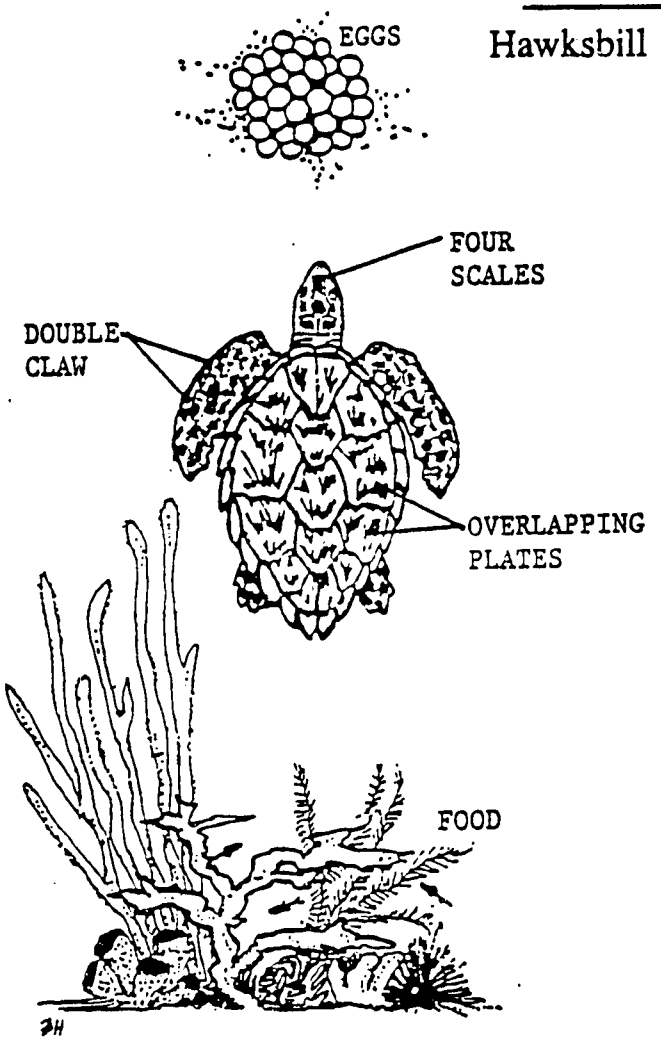
4. FURTHER RECOMMENDS that IUCN members initiate educational programmes in sea turtle conservation to ensure the understanding and participation of the local people in the implementation of the above.

5. CALLS UPON member governments in accordance with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) to cease all commercial international trade in sea turtles, their parts and derivatives, especially tortoiseshell derived from the hawksbill sea turtle (Eretmochelys imbricata).

129

Eretmochelys imbricata

Hawksbill Turtle, Tortuga Carey



General Description

Oval shell beautifully mottled with brown, orange, yellow, red; the plates that cover the shell (=scutes) overlap one another; distinct scales (dark brown with yellow margins) on head and flippers; 4 scales between the eyes; adults 70-90 cm carapace length; to 80 kg; 2 claws on each front flipper; narrow, pointed face and beak; coral reef habitats

World Status

Endangered (IUCN Red Data Book; U.S. Endangered Species Act)

Distribution

Circumglobal, tropical; major breeding rookeries: Cuba, Panama (Caribbean); the Guianas (French Guiana, Guyana, Surinam); Brazil; Seychelles; Maldives; Sudan; Oman; Australia

Diet

Invertebrates (sponges, crabs, hydrozoans, bryozoans, clams, gastropods, tunicates); algae

Nesting Habitat

Beach often flanked by nearshore coral reef or rock; nest often well hidden within the beach forest; asymmetrical crawl 0.5-0.8 m across

Eggs and Hatchlings

Eggs white and spherical; eggs 35-40 mm diameter; nest depth 40-45 cm; 50-200 eggs per clutch; 3-6 clutches per annum; 55-72 days incubation; Hatchlings 40-45 mm (shell length); uniformly gray or reddish brown; asymmetrical crawl

Threats

Traditionally killed for meat and shell; shell ("tortoiseshell", "carey", or "bekko") sold, often illegally, for ornamentation; eggs harvested; drowning in shrimp trawl nets and set nets; degradation of nesting and foraging habitats

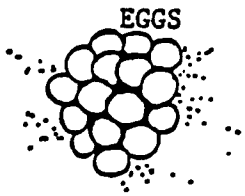
Wider Caribbean Sea Turtle Recovery Team and Conservation Network
Red para la Conservación de las Tortugas Marinas en el Gran Caribe
Reseau de Conservation des Tortue Marines dans la Region Caraibe

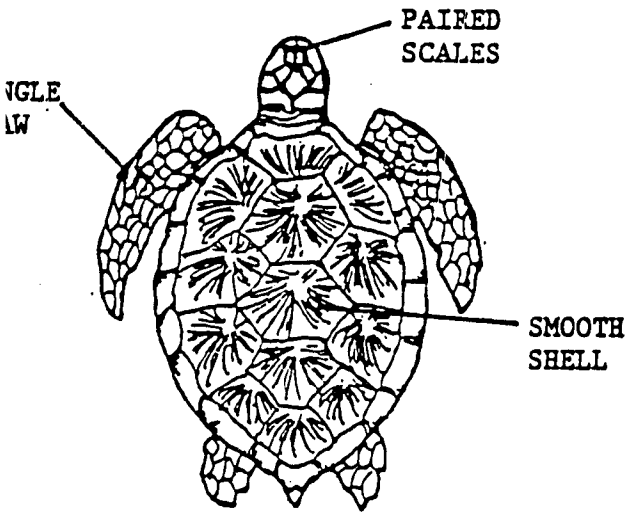
"WIDECAST"

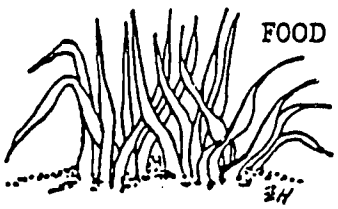
Director, Widecast Secretariat
Department of Zoology
University of Georgia
Athens, GA 30602

Chelonia mydas

Green Turtle, Tortuga Verde







General Description

Olive brown shell (=carapace) with darker streaks; underside yellow; epifauna (barnacles) rare; distinct scales on head and flippers; 2 scales between the eyes; adults 95-120 cm carapace length; up to 230 kg; single claw on each front flipper; rounded jaw, slightly serrated; seagrass meadows (feeding), reefs (sleeping); highly migratory

World Status

Endangered (IUCN Red Data Book; U.S. Endangered Species Act)

Distribution

Global tropical and subtropical seas; highly migratory; major breeding rookeries: Mexico (Pacific), Ecuador, Costa Rica (Caribbean), Brazil, Isla Aves, Surinam, Australia, Ile Europa, Seychelles, Philippines

Diet

Herbivore: seagrasses (Thalassia, Syringodium, Halodule), algae; may graze the same area for many months, moving only when the grass becomes stressed; feeding and breeding areas often separated by 100s or 1000s kms

Nesting Habitat

Prefers an open beach platform; often leaves deep nesting pit (1.5 m wide, 0.5 m deep); symmetrical crawl 1-1.5 m across; nesting nocturnal

Eggs and Hatchlings

Eggs white and spherical, 48-50 mm diameter; nest depth 45-50 cm; 120-150 eggs per clutch; 3-6 clutches per annum; incubation 55-72 days; Hatchlings 50-55 mm (shell length); black dorsal, white ventral; asymmetrical crawl

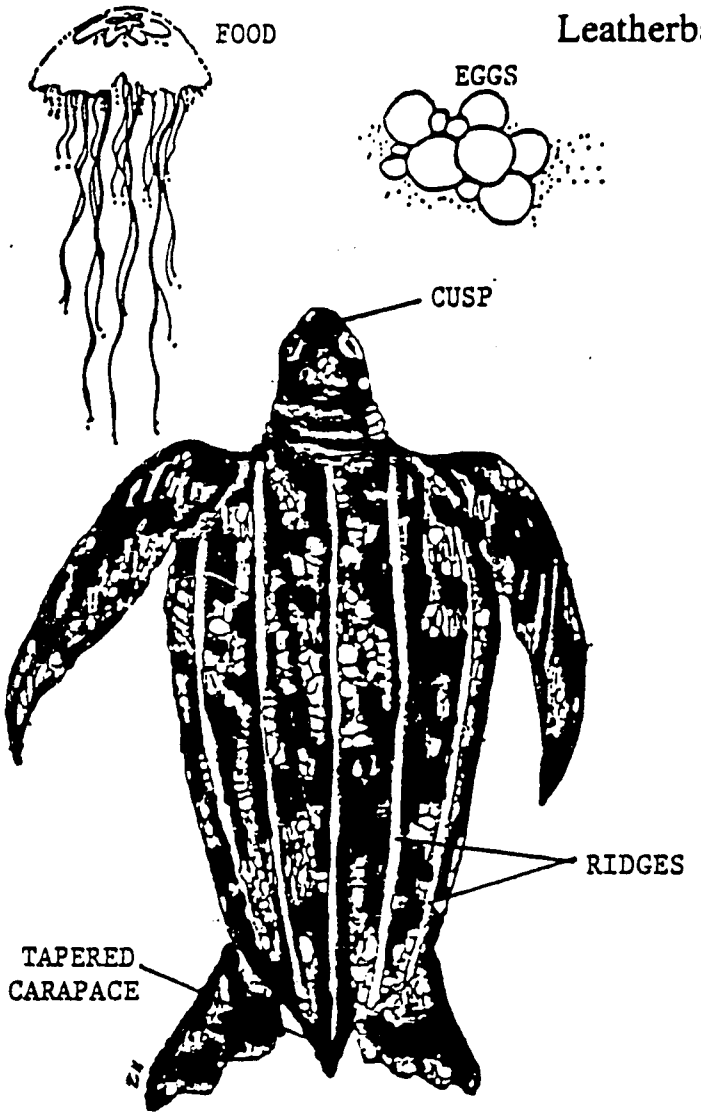
Threats

Traditionally killed for meat and oil; eggs harvested; drowning in shrimp trawl nets and set nets; degradation of nesting beaches and foraging areas

Director, Widecast Secreta
Department of Zoology
University of Georgia
Athens, GA 30602

Dermochelys coriacea

Leatherback, Laud



General Description

Largest of the marine turtles; black with white spots; no bony shell; the smooth skin of the adult lacks scales or claws; the leathery "shell" is strongly tapered to the rear and is raised into seven prominent ridges; 130-165 cm carapace length; 260-500 kg; two sharp cusps on upper jaw; powerful swimmer, deep diver; open water habitat

World Status

Endangered (IUCN Red Data Book; U.S. Endangered Species Act)

Distribution

Global 71°N to 47°S; temperate resident, tropical nester; major breeding rookeries: Mexico (Pacific); Costa Rica (Caribbean) Terengannu, Malaya; the Guianas (French Guiana, Guyana, Surinam)

Diet

Primarily jellyfish and other soft-bodied invertebrates; may feed at the surface or at depth

Nesting Habitat

Prefers an open beach platform, offshore access unobstructed by reef or rock formations; nesting disturbance 3-10 m in length; symmetrical crawl 2 m across

Eggs and Hatchlings

Eggs white and spherical; fertile eggs 50-54 mm diameter (infertile eggs smaller, variable in size); nest depth 65-75 cm; 60-120 fertile eggs per clutch; 3-11 clutches per annum; incubation 55-72 days; Hatchlings 60-65 mm (shell length); black with white-margined flippers and white dorsal stripes; symmetrical crawl

Threats

Traditionally killed for meat and oil; eggs harvested; plastic ingested (mistaken for jelly-fish); drowning in longlines, shrimp trawl nets, and gill nets; degradation of nesting beaches

Director, Widecast Secretari
Department of Zoology
University of Georgia
Athens, GA 30602

FIGURE 4. Distribution of sea turtl
nesting areas (sand beaches) on
the Southeast Peninsula, St. Kit
West Indies. Class I beaches are
regarded to be very valuable as
nesting grounds for sea turtles;
Class II beaches are of intermed
value. G=Green turtle nesting,
H=Hawksbill, L=Leatherback (Table

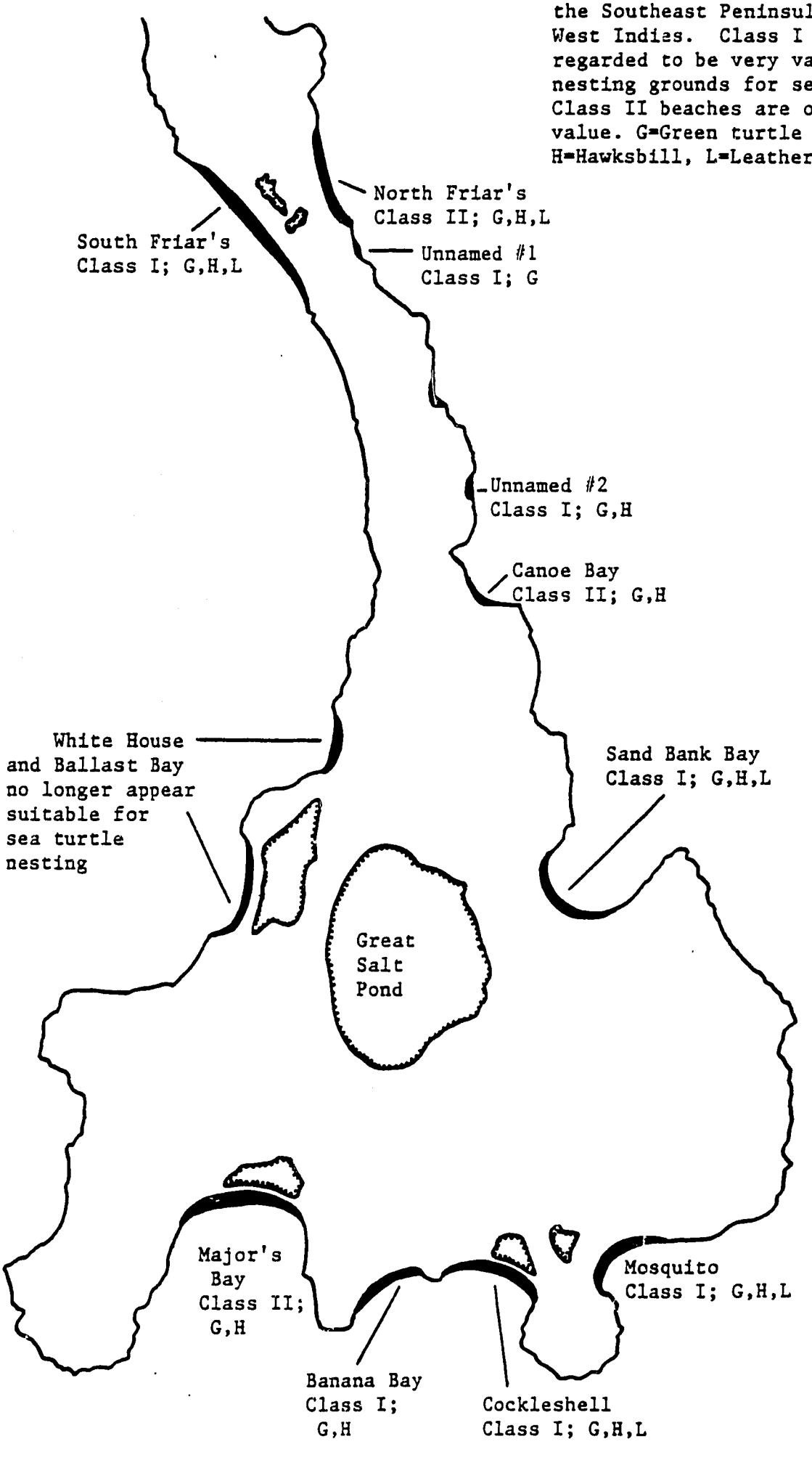
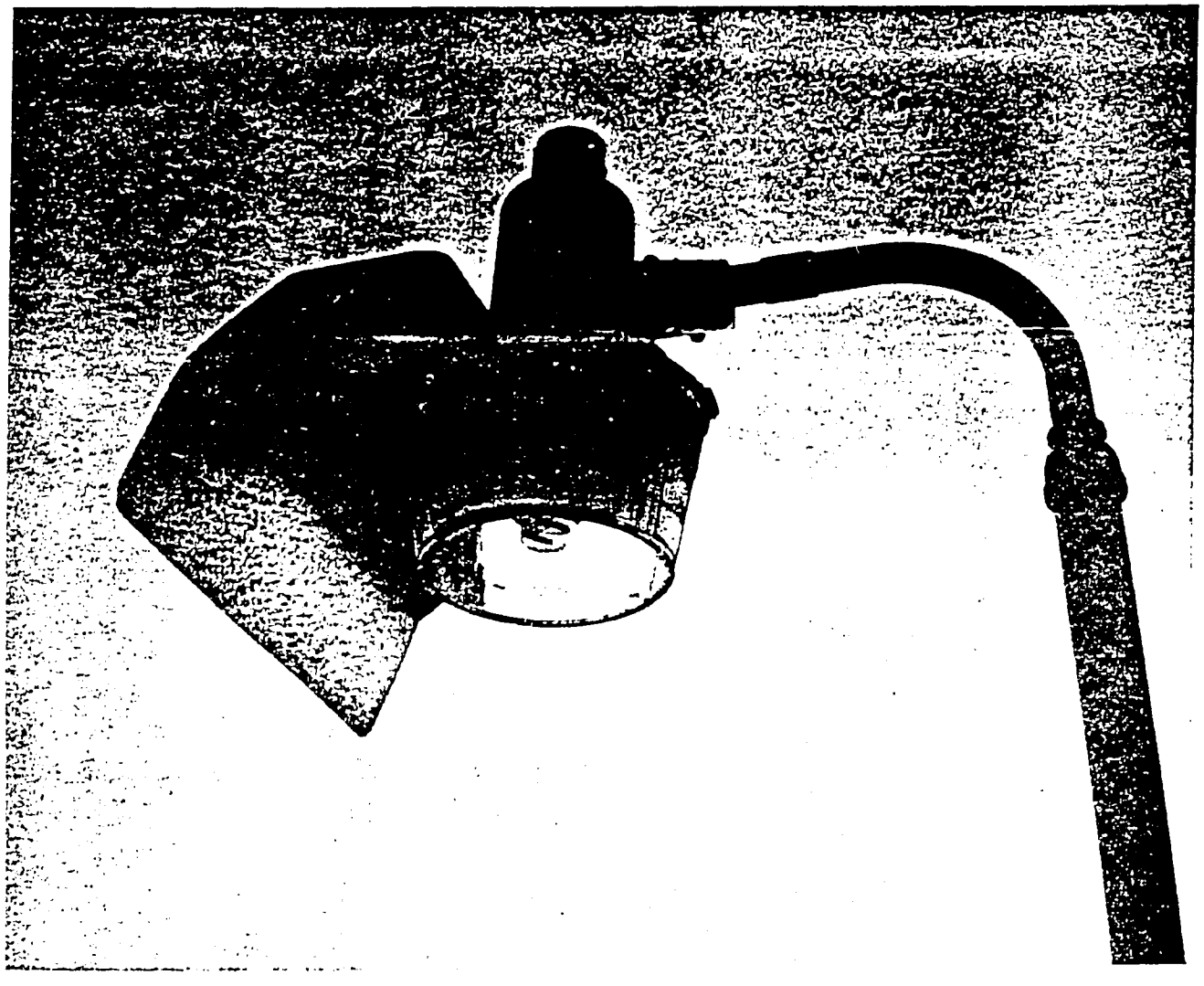


FIGURE 5

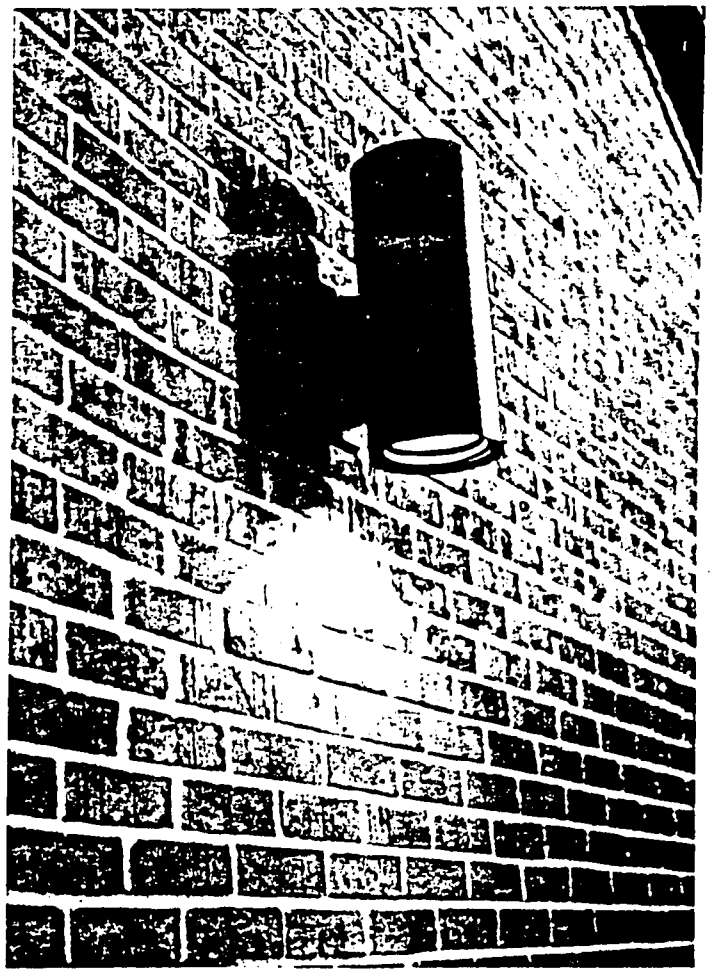


High intensity streetlights can be fitted with metal shields to prevent direct light from being cast on the beach.

Source: Raymond, P.W. 1984. Sea turtle hatchling disorientation and artificial beachfront lighting. Center for Environmental Education, Washington D.C. 72p.

Rationale: Hatchling (baby) sea turtles, and nesting adults to a lesser extent, are very sensitive to light. Light shining on the beach disorients turtles away from the sea. Having been disoriented, they wander landward (toward hotels, dining areas and other sources of artificial light) until they die in the morning sun (see section 3.214).

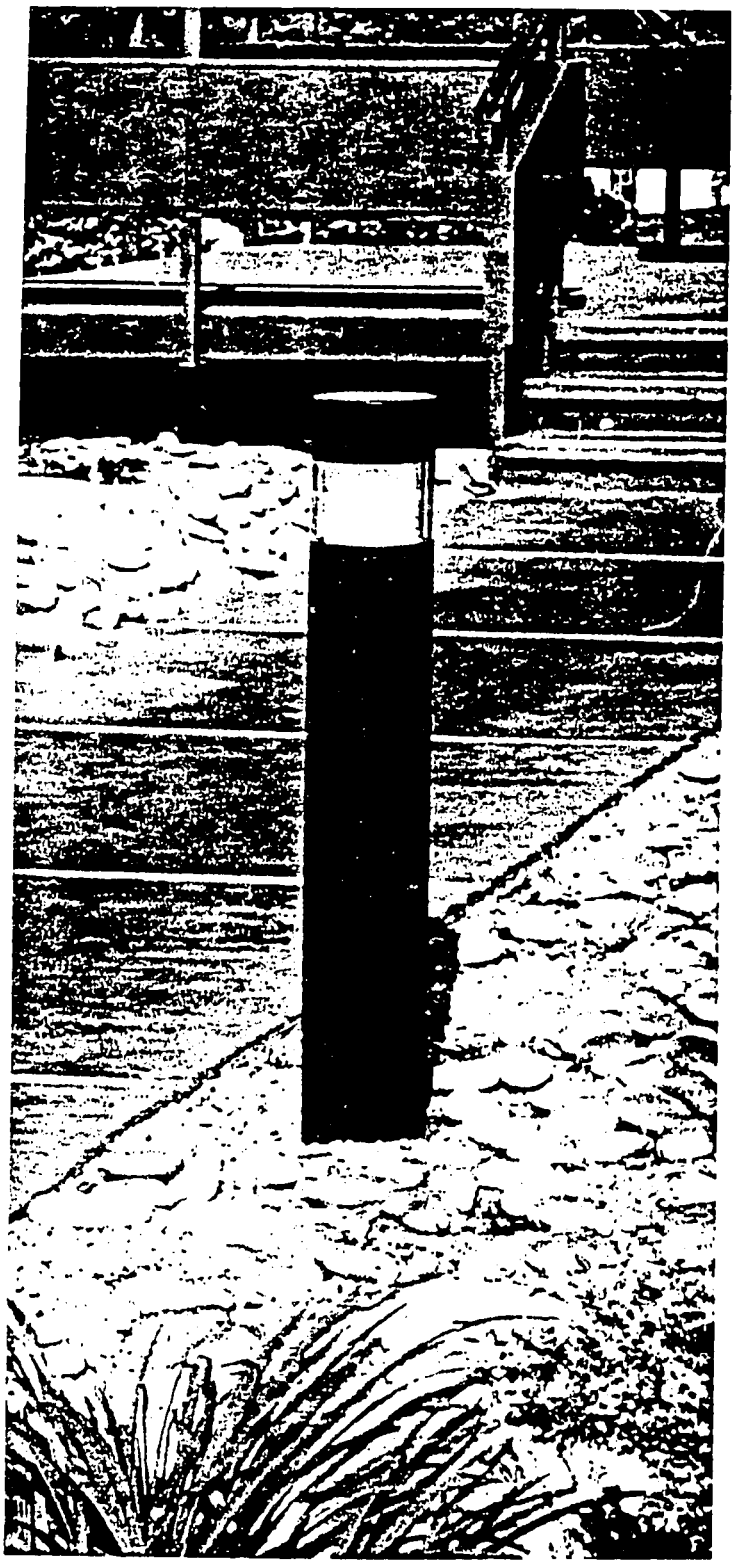
FIGURE 6

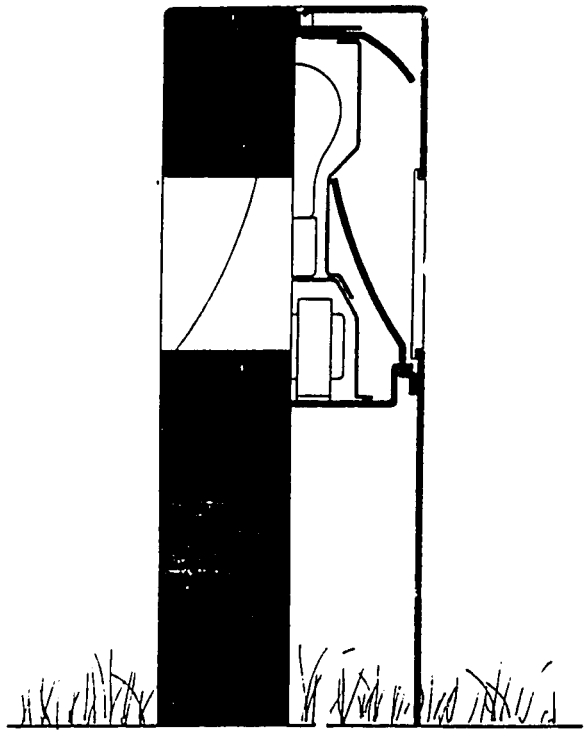


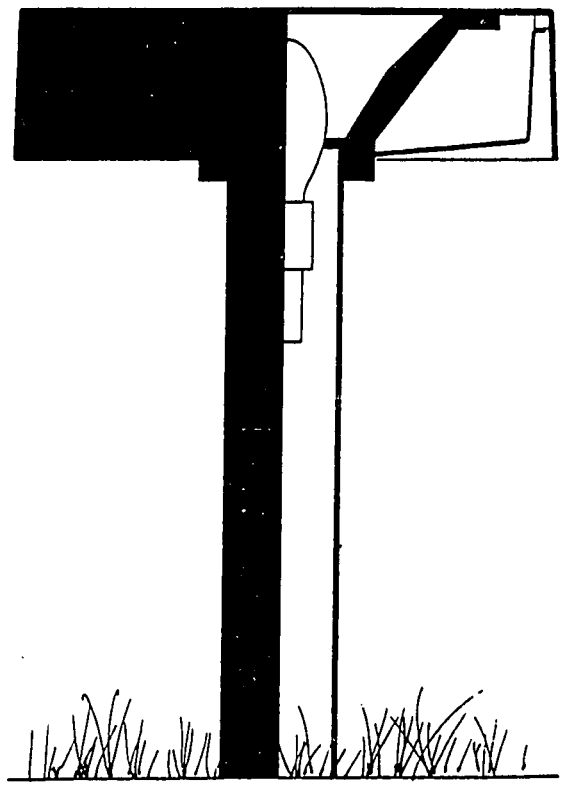
Wall mount light fixtures can be fitted with hoods to eliminate excess illumination.

Source: Raymond, P.W. 1984. Sea turtle hatchling disorientation and artificial beachfront lighting. Center for Environmental Education, Washington D.C. 72p.

FIGURE 7







Low-profile luminaires suitable for illuminating beach walkways and landscape areas. Multiple reflectors redirect light downward from a hooded lamp source. (Illustrations from Lightolier, Coltsneck, New Jersey)

Source: Raymond, P.W. 1984. Sea turtle hatchling disorientation and artificial beachfront lighting. Center for Environmental Education, Washington D.C. 72p.

MARINE RESOURCES MANAGEMENT PLAN

by

Evelyn Wilcox, M.S.

May 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

137

EXECUTIVE SUMMARY

The steep, erodible nature of the Southeast Peninsula, with infrequent but heavy rainfall and storms, complex offshore currents and strong trade winds, combined with unique natural resource value, seem to command a development plan of carefully controlled, small-scale tourism. Larger scale development will change run-off patterns, introduce pollutants into nearshore waters and increase coastal erosion. This movement of soil, beach sand and pollutants can impair the functioning of seagrass and coral reef systems on which fisheries and tourism depend.

There is an immediate need to adopt a plan for management of the nearshore waters and shoreline of the Peninsula for marine conservation purposes. The proposed construction and operation of hotels and other tourist facilities, along with the continuing depletion of fish resources from damaging fisheries practices, threaten to upset the marine ecological balance.

Marine Resource Management Plan and Recommendations:

1. Establish a St. Kitts/Nevis National Marine Park/Reserve around the entire Peninsula, from high tide to the 30 m. depth contour, to provide a focal point for marine management, provide an administrative means to attract and receive external funding and establish an overall conservation and development approach to the Peninsula at large. Guidelines and rules for land developers, fishermen and tourists are found in the Summary and Recommendations section of the report.

2. Establish protected areas within the park/reserve.

   Area I. The Atlantic Coast: Protect sea turtle habitat. Encourage low density use of beaches and dunes. Develop use regulations to protect turtle nesting.

   Area II. The Channel: Fish breeding, spawning, nursery productivity and protection. Establish a fish reserve to enhance fish productivity and provide an area for research.

   Area III. Nag's Head: Seabird habitat protection. Designate Nag's Head as a National Seabird Refuge.

   Area IV. The Caribbean Coast: Protect marine resources from over harvesting and incompatible recreational use.

3. Gazette the National Conservation and Environmental Protection Act of 1987, to grant St. Kitts/Nevis government the authority to manage development impacts along the shore.

4. Implement the 1986 fisheries regulations and amendments which include measures for conservation of lobsters, turtles and conch, regulation of marine recreational use and provisions for management of fisheries such as closed areas and seasons, and include these as the basis for management of fisheries and recreational use within the park/reserve.

TABLE OF CONTENTS

LIST OF MAPS iii

LIST OF TABLES iii

1.0 INTRODUCTION 1
- 1.1 Plan of Study 1
- 1.2 Survey Methodology 1

2.0 THE MARINE RESOURCES OF THE SOUTHEAST PENINSULA 3
- 2.1 Environment of the Eastern Caribbean and the Southeast Peninsula 3
  - 2.1.1 **Winds, Currents and Tides** 3
  - 2.1.2 **Hydrography and Coastal Erosion** 4
- 2.2 Social and Economic Forces at Work 4
  - 2.2.1 **Principal Users of the Marine Environment** 4
    - 2.2.1.1 Fishermen 4
    - 2.2.1.2 Tourism: A Competing Resource Use . . . 6
  - 2.2.2 **Resource Use Conflicts in the Coastal/Marine Environment of the Southeast Peninsula** 8
    - 2.2.2.1 Net Seining and Yacht Anchoring 8
    - 2.2.2.2 Solutions to User Conflicts 8
    - 2.2.2.3 Fish Traps and Snorkeling and SCUBA Diving 9
  - 2.2.3 **Cost-Benefit Considerations of Tourism and Fisheries** 9
    - 2.2.3.1 Results of the 1987 Agricultural Census . 9
    - 2.2.3.2 Fisheries Division Survey of 1983, 1984 . . 10
- 2.3 The Coastal Marine Habitats of the Southeast Peninsula 11
  - 2.3.1 **Beaches** 11
  - 2.3.2 **Seagrass Beds** 11
  - 2.3.3 **Coral Reefs** 12
    - 2.3.3.1 Coral reefs along the Atlantic Coast . . . 13
    - 2.3.3.2 Coral Reefs Along The Caribbean Coast 14
    - 2.3.3.3 Currents 14
    - 2.3.3.4 Bottom Topography and Substrate Cover 14
    - 2.3.3.5 Coral Reefs in the Channel: Monkey Shoals 15

3.0 MANAGEMENT ALTERNATIVES 16
- 3.1 Managing the Marine Resources 16
  - 3.1.1 **Area I The Atlantic Coast** 16
  - 3.1.2 **Area II The Channel** 17

3.1.2.1 Marine Management Recommendations . 17
3.1.3 **Area III Nag's Head** 18
3.1.3.1 Marine Management Recommendations . 18
3.1.4 **Area IV The Caribbean Coast** 19
3.1.4.1 Marine Management Recommendations . 19
3.1.4.2 Objectives 20
3.1.4.3 Actions to be Taken to Establish the Park 20

4.0 **SUMMARY AND RECOMMENDATIONS** 22
4.1 **Create a National Marine Park/Reserve for St.Kitts/Nevis** 22
4.1.1 **Objectives** 22
4.1.2 **Boundaries of the Park Reserve** 23
4.1.3 **Enabling Legislation** 23
4.1.4 **Administration** 23
4.1.5 **Funding** 24
4.1.6 **Park/Reserve Guidelines and Use** 24
4.1.6.1 Guidelines for Recreational Use 24
4.1.6.2 Guidelines for Land Developers 24
4.1.6.3 Guidelines for Fisheries Use 25
4.1.7 **Special Protected Areas Within the Park/Reserve** 25
4.2 **Gazette the National Conservation and Environmental Protection Act of 1987** 26
4.2.2 **Institute a Fisheries Management Program as Part of the Park/Reserve** 26
4.3 **Conclusion** 29

REFERENCES 30

LIST OF FIGURES

Figure 1 Distance Along Transect 1 - 3 35
Figure 2 Distance Along Transect 4 - 6 36
Figure 3 Distance Along Transect 8 - 11 37
Figure 4 Distance Along Transect 12 - 15 38

LIST OF MAPS

Map 1 Marine Transect Locations 32
Map 2 Nearshore Currents 33
Map 3 Marine Protection Areas 34

LIST OF TABLES

Table 1 The Percentage of Cover Attributable to Each Substrate Category Within the SEP for the 15 Transects 39
Table 2 Substrate Cover and Diversity 40

1.0 INTRODUCTION

1.1 Plan of Study

The study to develop a Marine Resources Management Plan for the Southeast Peninsula included the coastal and marine habitats of the Peninsula in the context of the users and uses of the marine resources. The outer limit of the area considered for the plan was the 30 m. contour, generally accepted as the approximate seaward limit of seagrasses and coral reefs. Seagrasses and coral need sufficient light to grow well. This usually restricts significant coral development to less than 30 m. in the clearest seas and less in turbid areas. Marine resources were defined as all species and habitats that depend on and contribute to the ecological system of the marine environment. Following site visits and evaluation, the Peninsula was divided into four sub-areas, based on ecological and socio-economic characteristics for further evaluation. These areas are discussed in detail in section 3.0 Mangement Alternatives.

Environmental guidelines for development, scientific studies of natural conditions and resources, assessments of the economic value of Caribbean fisheries and tourism and legislative considerations for management and protection of the natural resources of the Eastern Caribbean have already been written and were available to the study. Government officials and private citizens were also consulted and contributed greatly to a deeper understanding of the issues. Three major reports, specific to the issue of development of the Southeast Peninsula were carefully read and analyzed: "Southeastern Peninsula, St. Kitts Study of Management Alternatives", prepared in February, 1981, by the Caribbean Conservation Association/Eastern Caribbean Natural Area Management Programme Project in collaboration with the Government of St. Kitts/Nevis, "Environmental Assessment Report on the Proposed Southeast Peninsula Access Road St. Kitts, West Indies," prepared for the government by the Island Resources Foundation (IRF), and the Land Use Management Plan also prepared by the IRF, in 1986.

In order to further assess the marine resources of the Peninsula, a limited marine biologic survey was conducted of selected areas offshore. Non-quantitative observations of two bays on the windward side of the Peninsula; Canoe Bay and Sand Bank Bay; and two bays in the channel area; Cockleshell Bay and Major's Bay were made.

Because of the potential for development, the Caribbean side of the Peninsula and Major's Bay, on the channel, were the subject of a more intensive survey using a boat and divers. This survey was conducted with the participation of the St. Kitts Coast Guard, primarily to assess the benthic cover within the bays of the Caribbean coast and Major's Bay.

1.2 Survey Methodology

The survey to determine the major benthic components of the nearshore waters of the Caribbean bays and Major's Bay, the location of coral reefs, nearshore current direction and dominant species, (if possible), consisted of running fifteen transects approximately

perpendicular to shore from South Friar's Bay to and including Major's Bay (See map 1). Transects began approximately 10 m. from shore and extended to approximately the 30 m. depth contour. Non-quantitative observations were also made of the health status of the marine ecological system.

To begin the survey, a compass direction was chosen to be followed by the coxswain. Moving at low speed (800 to 1200 rpm) the boat towed a diver behind the boat on the water's surface. The diver used hand signals to describe each of the major benthic components of the nearshore waters such as sand, manatee grass (Syringodium), turtlegrass (Thallassia), reef and rock or rubble. A special hand signal was used if the bottom was covered by more than 80% of one of the categories. An observer on the boat recorded this information, the total time it took to complete the transect, the time spent over each substrate or substrate combination and the depth recorded by the fathometer. The diver was towed until the bottom was no longer visible (usually less than 50 feet deep). At the end of the transect, the boat was anchored and its position fixed by compass readings. Subsequently, the length of the transect was measured and the distance (cover) of each substrate category and depth of each benthic component were calculated for each transect and each bay by the time measurements and the number of substrate categories per unit time. If two substrate categories were signaled then each was assigned 50% cover for the measured time period. Bottom profiles were made by converting time into distance measurements and plotting them against depth. (Figures 1 through 4).

At the beginning and end of each transect a current meter was used to measure current speeds and direction at a depth of one meter. The current meter measured speed but direction was estimated by turning the "head" of the meter around until the maximum current speed was found. This direction was then taken with a magnetic compass and used to estimate current direction. The survey was conducted by Tim McClanahan, Center for Wetlands, the week of November 12, 1988.

142'

2.0 THE MARINE RESOURCES OF THE SOUTHEAST PENINSULA

2.1 Environment of the Eastern Caribbean and the Southeast Peninsula

To develop a long-term management plan for the marine resources of the St. Kitts Southeast Peninsula, it was important to understand the natural forces of wind, currents and tides, wave action, coastal erosion and hydrography which are and will continue to significantly affect the coastal and marine environment of the Peninsula. St. Kitts is one of several active volcanic islands in the Eastern Caribbean and belongs to the Lesser Antilles island chain. The natural forces at work in the Eastern Caribbean, summarized below, are characteristic of the coastal and marine environment of the Southeast Peninsula of St. Kitts and have been considered in the Marine Resources Management Plan (MRMP) presented here. Nearshore current direction and speed information from the field survey is found in the section on "Coral Reefs Along the Caribbean Coast" and in Map 2. Specific information on St. Kitts and the Peninsula is added where applicable.

2.1.1 Winds, Currents and Tides

In the Eastern Caribbean, there is a slight variation in the general wind direction resulting from changes in the position of the Inter Tropical Convergence Zone. The annual wind regime may be thus divided into four seasons.

December to February: Winds have the greatest constancy, coming from the east and northeast 90 to 95% of the time. These winds are known as the Easterlies or Trade Winds.

March through May: Winds come mainly from the east.

June through August: Wind direction varies from east-northeast to east-southeast, and back from northeast to southeast as easterly waves pass over.

September through November: Wind direction often shifts east-southeast to south-southeast.

Gale force winds are relatively infrequent in the Eastern Caribbean, although squalls are quite common, especially during the rainy season from May to November. Tropical storms and hurricanes are unpredictable and two hurricanes may affect one island in one year. For example, St. Kitts/Nevis was affected by two hurricanes, David and Frederick, in 1979. The average frequency of hurricanes in St. Kitts/Nevis, however, is one in 4.5 years.

The East Caribbean islands are affected by the North Equatorial Current which flows westward though the passages between the islands into the Caribbean Sea. In these islands, the flood tide is westward flowing and the ebb tide is eastward flowing. However, the east-going tidal stream is often entirely overcome by the current. Although

the significant longshore currents off the coast of the Southeast Peninsula are moving northwestward along both coasts, and west through the channel between Nevis and St. Kitts at the sou hern end of the Peninsula, the dominant sediment transport is onshore, offshore (Ormes, 1988).

Wind speed and direction, influenced by the "Easterlies" or Trade Winds dominate wave conditions. The east coasts, to the windward, experience high energy wind-driven waves most of the year. The west coasts, in the lee of the trades, experience lower wave energy but receive some wave energy from U.S. Ave resulting from intense frontal storms in the

North Atlantic and can adversely affect the coasts of the Eastern Caribbean islands chain. The tides are minimal. The tidal range of the Southeast Peninsula averages .3 to .4 m. on the beaches of the Peninsula (Ormes, 1988).

2.1.2 Hydrography and Coastal Erosion

The volcanic islands of the Lesser Antilles feature steep cliffs and small bayhead beaches. They have a radial pattern of swiftly flowing mountain streams, sometimes with steep gorges rather than river systems. In St. Kitts, the stream channels are mainly dry except after a heavy rainfall. The rainfall in St. Kitts varies from 100 cm. on the Peninsula to 380 cm. in the central mountains.

Although the level of the sea reached its present level about 5,500 years ago, it is most likely that some land sea level adjustments are continuing, particularly in volcanic islands like St. Kitts where active volcanism is present. (Cambers 1985).

Widespread coastal erosion has been increasing since 1968, in the Eastern Caribbean as well as the Gulf and East coasts of the United States, according to an overview of coastal zone management of six East Caribbean islands, including St. Kitts, in April of 1985. Although the causes are not fully understood, evidence is mounting that a rise in sea level resulting from increased melting of the ice sheet caused by the "Greenhouse" effect is the problem.

2.2 Social and Economic Forces at Work

2.2.1 Principal Users of the Marine Environment

2.2.1.1 Fishermen

Historically, the fishermen of the Caribbean have always seemed to be apart from the mainstream of island development. Beginning with slavery, fishermen were treated differently from the majority of the slaves who farmed the land. They were granted greater freedom of action and thus gained the respect of their fellow slaves (Goodwin et al., 1985). However, after slavery, their separation from the mainstream of island

140

life, combined with the unpredictable nature of the Caribbean environment and of fishing, has led to the present lack of organization and progress in fishing techniques and has resulted, in many cases, in marginal economic returns. Consequently, traditional fisheries in Caribbean coastal habitats such as conch, spiny lobster, and reef fishes are presently nearly all overexploited.

Juvenile fish are often taken in nearshore areas both in fish traps and nets. Immature lobsters and conch are also often taken. Consequently, large numbers of fish and shellfish do not live long enough to spawn. As the catch relies more and more on juvenile fish, the fishermen use smaller mesh sizes which increase even more the number of juveniles that are taken. Eventually, recruitment of species is needed from other areas to keep certain species from disappearing entirely from traditional fishing grounds.

There are four types of nets used in St. Kitts/Nevis; beach seine or ballaho nets, gill nets, trammel or tangle nets and cast nets. Gill and tangle nets are specifically used to catch pelagics such as jacks, mackerel, bonito entering the nearshore areas seasonally. The tangle net is considered destructive by the Fisheries Division. The cast net is used for catching bait fish ("frys and sprats") and carries mesh sizes from 1/2 inch down. The ballaho or beach seine can be particularly damaging to fish stocks when it is pulled up on the beach and causes large amounts of juvenile fish to be left to die, unwanted.

The size of landings from fish traps are on the decrease. (Fisheries Division, personal communication). The regulations specify 2.5 mesh. The fishermen mainly use 1.25 inch mesh.

In the latest agricultural census, there were 158 full-time fishermen in St. Kitts/Nevis, 362 part-time fishermen and 111 who fish but do not fit either the full or part-time category. Fishing is part of the culture and tradition of these islands. The Southeast Peninsula is fished primarily by the fishermen from Basseterre. The majority use wire fish traps and handlines. About 25 boats are used for seine fishing. More than 16 boats now specialize in lobster and conch fishing, usually with SCUBA equipment. Most of the shallow, easily accessible areas off the Peninsula have now been depleted of conch and lobster. Many Basseterre fishermen now travel 10 to 11 miles to the fishing banks near St. Eustatius to dive for conch and lobster (Heyliger, personal communication).

Because of the difficulty in finding enough lobster to earn a living, local fishermen have been capturing and selling undersized and egg-bearing lobsters. In response to the general concern of fishermen and local conservation groups in St. Kitts/Nevis, the Fisheries Division recently initiated a comprehensive management program for local spiny lobster stocks. This program is being conducted with the cooperation of the Caribbean Regional Spiny Lobster Management Program.

The main objective is to protect reproductive stocks, juvenile lobster and critical nursery areas. It is believed, by those working on the program, that the southern and western marine areas of St. Kitts, with their shallow seagrass beds and adjacent deep water reefs are good lobster habitat and that the deeper areas might constitute a major breeding reserve.

It is important to note that the long and complex larval stages of spiny lobster have prevented successful mariculture of this species. It therefore becomes even more essential to maintain known habitats and reproductive stock. Sponges, mangrove roots and spaces between the spines of black sea urchins are known as natural habitat for juveniles. Older juveniles are typically found in shallow seagrass beds or coral rubble. As they grow, juveniles tend to move from shallow waters to reefs in deeper waters. In St. Kitts/Nevis, the highest densities of mature spiny lobsters have been located on healthy coral reefs, usually in depths of 50 ft. or more. Both seagrass and coral reef areas are critical to maintaining spiny lobster populations. Suitable deep water reef habitats are clearly important to shallow water dwelling juveniles.

Most of the fish and shellfish are sold on the island. Lobster, conch, snapper, dolphin, bonito, tuna and king fish,(in season), are sold to local hotels and restaurants. Other smaller reef fish such as grunts, goat fish, parrot fish, ballyhoo and gar are sold to local residents at the market on Saturday and during the week by both Basseterre and Nevis fishermen.

There is substantial evidence that the reefs within the study area are overfished, both from the size and species of fish that are caught and the condition of the reefs. There was a notable abundance of brown algae, lack of herbivorous fish and sea urchin densities of less than 1/15 m^2 on most of the leeward reefs visited. The mass mortality of the Black Sea Urchin *Diadema* may have resulted in the present day increase in brown algae throughout the Caribbean. However, with overfishing, other species of sea urchin and herbivorous fish have not been able to stem the spread of the algae.

2.2.1.2 Tourism: A Competing Resource Use

Tourism is on the rise in the Caribbean. Most of the tourist industry is concentrated in coastal areas where large-scale development, without regard for the ecology of the area, has damaged marine resources. Development of marinas and harbor facilities has added to the problems of pollution from coastal development, by destroying mangroves which act as a filtering system of pollution, disposing of human waste into the nearshore waters, silting nearshore reefs and causing physical damage to coral reefs and seagrass beds by boat anchorings and oil leaks from engines.

The completion of the road from Frigate Bay to Major's Bay will signal the beginning of tourism development which will undoubtedly be marine-oriented. Decisions will have to be made concerning development proposals including those of major hotel development (200-300 rooms) and/or condominium development in Friar's Bay, Sand Bank Bay, parts of Mosquito Bay and Banana/Cockleshell Bay; a marina/safe anchorage harbour either at Little Salt Pond or Great Salt Pond or perhaps a marina at Friar's Bay salt pond; residential development in selected areas; a range of support services, e.g. a service station supermarket or shopping center, restaurants; a public jetty or landing and other appropriate public facilities.

Major impact on marine resources from such development can be expected to include: Increased runoff from greatly increased impervious surface area (i.e. access roads, parking lots, sidewalks) resulting in siltation and smothering of nearshore fringing reefs and seagrass beds, smothering of filter-feeding animals, reduction of light penetration impairing seagrass and coral reef production, and the transport of pollutants such as herbicides and pesticides to offshore reefs; introduction of domestic sewage into nearshore waters, which may interfere with physiological processes of marine ecological systems.

Introduction of pollutants from construction and operation of tourist facilities known to abort larval development and change the texture of the habitat, making areas unsuitable for recruitment or settlement of new individuals.

Although the Peninsula is largely undeveloped, it has not gone unnoticed by the citizens of St. Kitts. In 1981, 69% of the persons interviewed for the "Study of Management Alternatives" prepared by the Caribbean Conservation Association had visited the Peninsula at one time or another. Today, in Basseterre, there is a successful dive shop, taking snorkelers and SCUBA divers to the reefs of the Peninsula. At Banana Bay there is a small-scale but highly successful resort.

2.2.2 Resource Use Conflicts in the Coastal/Marine Environment of the Southeast Peninsula

2.2.2.1 Net Seining and Yacht Anchoring

From May to November, pelagics (those fish that spend their adult lives in the water column), such as several species of tuna, i.e. Albacore and Yellowfin, dolphin fish and jacks, move into shallow waters to feed on the "bait fish" which are particularly found along the shores of the Caribbean coast of the SEP, from South Friar's Bay to Nag's Head. Basseterre fishermen catch these large schools of fish with large seine nets. When yachts are anchored in the White House Bay, Ballast Bay, Shitten Bay areas, they can present a problem for net fishermen.

If Little Salt Pond becomes a marina, there will be a constant stream of large yachts entering and leaving White House Bay via a channel marked by buoys. Here again, this boat traffic might interfere, seasonally, with the netting of these schools of pelagics as they follow the "bait fish".

2.2.2.2 Solutions to User Conflicts

To avoid future conflicts between net fishermen and yachtsmen it is proposed that anchorage areas be designated, and marked by buoys, to guide boats to anchor in areas away from major areas of seining. These areas would be agreed upon by leaders of the fishing community, representatives from the yachting community and Government. This may not always, however, solve the problem. Fish movement is not predictable and they may move into the very areas designated as anchorages. Park Management which was proposed in the MRMP and the Park Recreation Plan for the SEP (Wilcox, 1989), would then be called in to solve this problem. Park wardens or Coast Guard would direct yachtsmen to areas out of the way of the nets.

The impacts of the marina on the fishing in White House Bay and the Caribbean coast, could be a more serious one. It is difficult to find solutions before the design of the marina is known. Once the entrance and slip capacity are proposed, however, the impacts on fishing activity should be taken under consideration. In the meantime, Park management could begin to field some research to assess the economic benefits of the net fishing in the area and work with land owners to minimize impacts from a marina and other developments on the SEP.

The impacts of raw sewage and garbage from yachts, the oil that comes from boat motors and other pollutants from the marina pose another serious question for fisheries. The seagrass beds and coral reefs, in the area of the proposed marina, or for that matter any proposed marina on the SEP, are habitat to the target species of fish being caught. The impacts of pollution, however, can be reduced if the marina is designed and maintained properly.

2.2.2.3 Fish Traps and Snorkeling and SCUBA Diving

There have already been reported instances of recreational divers damaging fish traps and letting fish go in the Sandy Point area. The problem of large dive boats and mid-range cruise ships, anchoring in territorial waters and allowing large numbers of divers and snorkelers to use the area without supervision or knowledge of the regulations is, apparently, Caribbean-wide. To resolve this serious problem, Government has decided to charge "liveaboard" dive boats who use St. Kitts/Nevis waters a fee and to put an observer on board to prevent any further vandalism. This is the best way to resolve this problem in Peninsula waters.

It was proposed, in the SEP Park Recreation Plan, that an Observer Corps be trained by Park management and funded by the fees that would be collected from the dive boats. It will be important to have well-trained observers on these boats representing Government. park management might also sponsor fishermen or other residents who wish to become certified divers.

2.2.3 Cost-Benefit Considerations of Tourism and Fisheries

Cost-benefit studies comparing the socio-economic benefits of fishing and tourist revenues usually fail to satisfactorily give a true picture because of the nature of the two economic sectors. This is especially true of the Caribbean.

There are numerous socio-economic and financial studies available of the costs and benefits of hotels, condominiums, second home land sales, etc. The economics of land development are measurable and lend themselves to economic analysis. On the other hand, the socio-economic costs and benefits of fisheries, particularly the artisanal and small-scale fishing of the Caribbean, are hard to measure. Fish yields, per pound, are difficult to obtain under the present system. Without a middleman in many instances, or a market structure, it is also difficult to determine the income derived from the catch.

The following information is available to estimate the number of resident fishermen of Basseterre who depend on the SEP for their employment and who would benefit from increased income as a result of better management if the fisheries.

2.2.3.1 Results of the 1987 Agricultural Census

In the 1987 census, there were 158 full-time fishermen in St. Kitts/Nevis, 362 part-time fishermen and 111 who fish but do not fit either the full-time or part-time category. In the Basseterre area in St. George, there were 34 full-time, 103 part-time fishermen and 45 others whose income was in some way related to fishing. This fishing community represented 182 households out of a total of 639 households. In the Cayon and Connaree areas in St. Mary's and the Key, there were three full-time, 18 part-time

fishermen and 18 other individuals, representing 39 households out of a total of 157 households.

2.2.3.2 Fisheries Division Survey of 1983, 1984

A survey was conducted by the Fisheries Division between November 1983 and February 1984 to determine the number of full-time and part-time fishermen and boats from each community on St. Kitts/Nevis. This survey was not part of the agricultural census, but rather in preparation of a proposal to obtaining funding for some fisheries infrastructure for the country. The results for the Basseterre area, or that area that fishes the Southeast Peninsula area were as follows:

East Basseterre	25 boats	34 full-time	13 part-time
West Basseterre	12 boats	8 full-time	12 part-time
Connaree	5 boats	6 full-time	11 part-time
Keys Village	6 boats	3 full-time	5 part-time
Total	48 boats	51 full-time	41 part-time

Thus, in the beginning of 1984, there were 51 full-time and 41 part-time fishermen, fishing the SEP, and in 1987, there were 37 full-time, 121 part-time and 63 others who did not fit the part-time or full-time category. Without a socio-economic study of the fishing community, it is difficult to interpret these numbers. Information is needed on the factors of production; numbers of boats; numbers and types of nets and fish traps; fishing territories; working relationships among full-time and part-time fishermen; and the distribution and marketing system. It does reveal, however, that full-time fishermen, who tend to be more aware of the need to maintain the marine resource base, is declining and part-time fishermen who have less investment and knowledge in managing the resource wisely, for the long term, is increasing.

The '83, '84 survey also provided statistics on conch and lobster catches. East Basseterre contributed 600 pounds per week of conch out of a country-wide weekly total of 725 pounds, and West Basseterre, Connaree and Keys village contributed 330 pounds of lobster out of a weekly country total of 755 pounds. This is one other indication of the potential value of the SEP and the fishing population of the SEP area available to exploit it.

As described in the Park Recreation Plan and Marine Resources Management Plan, user conflicts could be minimized with the appointment of an Advisory Committee for a National Land and Marine Park for the Peninsula, composed of representatives of both tourism and fisheries. St. Kitts/Nevis is fortunate, in a sense, because there is no major confrontational atmosphere at present and understandings between the two sectors can be gradually achieved as the SEP is being developed. An Advisory Committee or some other appropriate means of allowing representatives of the two groups to talk to one another would help alleviate tensions and hopefully lead to solutions.

2.3 The Coastal Marine Habitats of the Southeast Peninsula

2.3.1 Beaches

There are nine main beaches along the coast of the Peninsula, located at the heads of the bays, and smaller, unnamed beaches, interspersed along the shoreline. The coastline of the Peninsula is a dynamic zone, affected by waves, currents and winds under average and storm conditions including those of hurricane force. Coastal erosion in the Eastern Caribbean has been increasing since 1968. Any disturbance from development to the beaches and dunes along the coast, may accelerate coastal erosion and alteration of the present natural system of accretion and erosion of sand along the shore. Changes in sediment transport can smother living coral reefs and seagrass beds in the productive nearshore environments, thereby reducing fisheries resources and causing far-reaching changes in the ecological system. Some beaches could disappear entirely. Vegetation now found on the dunes, such as seagrapes, helps to stabilize and keep the dunes from disappearing.

High algal biomass was noted on many of the visited reefs around the entire Peninsula. Other areas in the Caribbean are experiencing the same acceleration of algae growth, which is causing the death of corals, particularly the slower growing varieties. Various hypotheses have been advanced for this phenomenon. In the case of Peninsula waters, it is probably the absence of herbivores such as reef fish grazers (e.g. Surgeonfish and Tangs) and sea turtle. For example, Hawksbill and Green Sea Turtles, found in St. Kitts waters, feed on both plants and animals. Disturbing their nesting beaches on the Peninsula may further deplete the sea turtle population that exists now, further reducing the herbivore population and encouraging the growth of fleshy algae.

2.3.2 Seagrass Beds

Seagrasses are unique among submerged marine and estuarine plants. They are higher plants that have returned to the sea, thus possessing an extensive root and rhizome system and reproduce by flowers, fertilized by waterborne pollen. Because of their extensive root system, high growth rates and dense leaf cover, they exert considerable influence over their environment. They have a rapid rate of growth and high organic productivity rivaling some of the most intensive agricultural crops. This exceptionally high productivity is supplemented by also maintaining other food sources for marine animals such as algae and associated benthic and planktonic micro-algae. Seagrasses not only take in nutrients from the sea for their own use, but pump nutrients back into the water for use by other benthic communities.

Turtle grass (*Thalassia testudinum*) with its dense, broad blades of grass and the thinner bladed manatee grass (*Syringodium filiforme)*, are particularly vital as a nursery for finfish, shellfish and invertebrates who depend on grassbed habitat for continued survival. Seagrasses, with their extensive root system prevent the suspension of sediments, thus stabilizing sand and other sediments. The leafy canopy slows water movement and filters

the water column. Once the seagrass cover is lost, it is often difficult to restore. When the water-cleansing properties of the seagrasses are lost and turbidity is increased, it becomes difficult if not impossible for seagrasses to recolonize these areas.

The safest and least expensive way to manage seagrasses to ensure their continued productivity is to conserve existing seagrass resources. Although there are no definitive studies, at present, which answer how much seagrass can be lost and still maintain fisheries production, the marine resource management plan for the Southeast Peninsula must minimize, at all cost, seagrass destruction.

In the "Survey of Conservation Priorities in the Lesser Antilles Final Report", October, 1982, the seagrass beds of the Southeast Peninsula of St. Kitts (1200 ha) were singled out as important marine habitat regionwide, and selected as priority areas for protection, as representative samples of Lesser Antillean Ecosystems. The Queen Conch and the Spiny Lobster, which depend on the seagrass beds as feeding, nursery areas were listed as endangered by the Survey.

Tables 1 and 2 on page 11 identify percentages of seagrasses present for Friar's Bay South, the Cliff area below Friar's Bay South, White House and Ballast Bay, Shitten Bay and Major's Bay.

2.3.3 Coral Reefs

Coral reefs are an important feature along the insular shelf of the Eastern Caribbean chain. Within recent geological time, coral growth has taken place here against a background of fluctuating sea level, largely determining their location and type of structure. The barrier type of reef continually acts to reduce incoming wave energy and provides a source of beach sand from the erosion due to wave action. To grow and flourish, coral reefs need clear, clean water and relatively high wave energy.

The coral reef is part of a reef ecological system which extends beyond its physical boundaries to include neighboring habitats with which it interacts. Coral reefs are intimately linked by dynamic processes such as currents and species movement to distant areas and can be influenced by activities far from their locations. At a critical minimum reef area, the diversity of coral and presumably other reef species, begins to decrease. Therefore the management area to protect the coral ecosystem must be large enough to preserve the high diversity of the reef biota.

There are approximately sixty species of corals in the Caribbean including about six dominant primary reef builders. Individual corals grow at rates ranging from 1-30 cm. per year. Caribbean coral reefs represent about 10,000 years of coral growth (Goodwin, et al., 1986). The term "coral reef", is understood to include reefs formed by corals, as well as coral veneers on other substrates such as rocky boulders.

Coral reefs are the habitat of the majority of bottom-dwelling or demersal fish living in nearshore areas in the Caribbean. More than 300 fish species are found on Eastern

Caribbean coral reefs. Approximately 180 of these are used for human consumption (Goodwin et al., 1986) Only a small percentage of these species however, make up the catch of the average fisherman.

Judging from a set of 1968 aerial photographs, there may be offshore reefs off the Peninsula. In fact, it is likely that there may be reefs, such as these, in discrete areas, surrounding the entire Peninsula which are contributing to the overall health of the ecological system and deserving of conservation and protection.

2.3.3.1 Coral reefs along the Atlantic Coast

Both of the visited windward reefs were very similar in their general physical structure and species composition. Both reefs were formed from consolidated rubble and dead coral and were covered on the fore reef and reef flats by less than 5% living coral. Living coral was almost exclusively *Acropora palmatta* on the flat and forereef sides. In back reef sheltered areas coral cover increased to approximately 20% and included a greater variety of coral species from the genera *Diploria, Montastrea, Siderastrea*, and *Porites*. In back reef sheltered areas coral cover increased to approximately 20% and included a greater variety of coral species such as *Diploria, Montastrea, Siderastrea* and *Porites*. Sea fans and whips were also more abundant within the protected areas. The overall area of these protected reefs were small and composed less than 10% of the total reef area. Reef flat and slope cover was dominated largely by fleshy brown algae of the genera *Turbinaria* and *Sargassum* which appeared to have a zonation pattern with *Sargassum* more common on the flat and *Turbinaria* more common on the fore reef edge. There was a conspicuous absence of herbivores with the exception of the sea urchin *Echinometra lucunter* which was common but restricted to the wave-washed reef flat areas. Densities probably reached as high as 50 m^2. Other sea urchin and fish grazers were rarely observed and this may, in part, be the cause of the high algal biomass. The reefs were exposed to strong wave action and probably experience very strong waves during storms.

These reefs, at present, are in an erosional state and exhibit low diversity and living coral cover. Although their tourist value is limited, they do act as barriers to the shoreline which protects the sandy beaches, particularly in Sand Bank Bay. The causes for their low coral cover, diversity and absence of grazers, such as sea urchins, may be a result of a number of factors. First, they are exposed to heavy wave action. Recent hurricanes such as Klaus, in 1986, may have exacerbated this situation. Additionally, the massive *Diadema antillarum* sea urchin die off in 1984 and fishing may account for the lack of sea urchins. However, fishing is probably not heavy in this area due to the distance from a fishing community and the rough conditions.

2.3.3.2 Coral Reefs Along The Caribbean Coast

According to the Environmental Assessment Report there are two distinct series of reefs found parallel to the shore. The first series rises from a depth of about 12 m. to 9 m. while the second is approximately 15 m. on top and 21-24 m. at the base.

For a more complete understanding of the leeward coral reef environment, current direction and speed, bottom topography and substrate cover were examined during the field work.

2.3.3.3 Currents

Current measurements on the leeward side support the general observation that a dominant southerly current travels offshore, but this is overly simplistic for understanding nearshore currents (See Map 2). Nearshore areas such as Shitten Bay, Ballast Bay and South Friar's Bay appear to have counter currents which move from the north. Faster southerly currents are most frequent offshore with slower offshore or northerly currents nearshore. Nearshore areas may have gyres created from the bottom topography and shoreline. Nag's Head and Green Point may be specific areas where these gyres are created. White House Bay appears to have unusual currents and may be an area of upwelling. Strong southerly winds blowing through the Peninsula appear to be channeled through the topographically low White House Bay area and their movement offshore in this area may create some upwelling conditions. A more complete current study requires further measurements during other seasons and weather conditions and at variable depths but it is clear that one cannot always assume a southerly current nearshore. This should be considered when releasing sediments into the bays and considering the position of the reefs likely to be affected by sediment discharge.

2.3.3.4 Bottom Topography and Substrate Cover

Results of the bottom topography study indicate that there are large differences in bottom topography (See Figures 1-4). In general, the steepness of the bottom slope increases from north to south along the Peninsula. Friar's Bay is a shallow bay dominated by seagrass and sand out to between 700 and 1000 m. offshore where a submerged coral barrier is found at a depth of between 35 and 40 ft. deep. Beyond the coral reef the water depth increases rapidly beyond the light penetration point. The cliff area south of Friar's Bay is also shallow offshore but only one patch reef was found at 30 ft. at the southern end. White House, Ballast and Shitten bays all drop off fairly rapidly. A number of reefs, as well as shallow rock formations, are located off of Guana Point between White House and Ballast bays. A single small (approximately 300 m^2) patch reef is located at 25 ft. in Shitten Bay. Major's Bay and other bays in the channel area are all shallow and composed of very thick seagrass cover. The total cover for the studied leeward side indicates that approximately 35% of the substrate is bare sand, 50% seagrasses and 15% reef and rock or rubble (See Tables 1 and 2). This cover appears to have a consistent zonational pattern with bare sand prevalent very close to shore

followed by manatee grass, then a mixture of manatee grass and turtlegrass and lastly pure turtlegrass which evenly thins out at 40 ft. deep and is followed by bare sand and rubble at the deepest studied sites.

The leeward reefs appear to be predominantly small patch reef at depths between 30 and 40 ft. unlike Monkey Shoals or the windward reefs. *Millepora* is clearly the dominant coral in the shallow reefs but small heads of *Diploria*, *Dendrogyra*, *Montastrea* and *Porites* are also found. Sea fans and whips are also common components of these reefs. There is a paucity of herbivorous fish and sea urchin densities are low for both *Diadema* and *Echinometra*. *Diadema* densities are less than $1/15m^2$. There were signs of fishing traps and lines within most of these reefs. Three Green turtles, one Leatherback and four bat rays were seen among the reefs between Guana Point and Shitten Bay during the four hours of diving and snorkeling on the Peninsula.

Leeward reefs have probably experienced a number of human and natural factors which can explain their present state. From conversations with the local people there was a unanimous consensus that these nearshore reefs have been overfished for quite some time. This overfishing may have resulted in the reduction of herbivorous fish and an imbalance in the ecological system, which among other results, encourages the overgrowth of brown algae. In many places this brown algae is very thick and may be outcompeting hard corals. The dominance of *Millepora* remains unknown.

2.3.3.5 Coral Reefs in the Channel: Monkey Shoals

Monkey Shoals is a submerged reef approximately one kilometer south of Nag's Head. The round shape of this reef suggests that it was formed on the top of a rising or subsiding volcanic mountain which may be part of the island's volcanic chain. The maximum depth is approximately 28 ft. and was the most extensive of the visited reefs; probably over 1 km^2 in area. The area between 28 and 60 ft. deep is biologically rich and was the most spectacular of any of the visited reefs. Hard coral cover is between 20 and 30% and composed of many small heads of encrusting and massing coral such as *Porites*, *Diploria* and *Montastrea*. There is an extremely rich species abundance and cover of sea fans, sea whips and sea sponges. Fish were also common and there was a lack of fleshy and brown algae and few if any sea urchins. Below 60 ft. the cover and abundance of coral and other life forms decreased rapidly. There were few signs of fishing as only one broken wire trap was seen during the 40-minute dive.

This area remains one of the least disturbed and biologically rich of the visited reefs. The abundance of coral and fish and the lack of sea urchins and fleshy brown algae suggests that the reef is not overfished. Its distance from the shore and the southerly current would suggest that it is unlikely to be impacted by development on shore. Yet, development on shore could increase the demand for fish from this reef which could lead to overfishing. The area offers a potentially valuable SCUBA diving site for tourists, however the depth precludes the possibility of snorkeling. Management of this site should insure that fishing intensity does not increase beyond its present levels.

155

3.0 MANAGEMENT ALTERNATIVES

3.1 Managing the Marine Resources

For the purpose of developing management objectives and recommendations for the MRMP, the Peninsula was subdivided into four smaller geographic areas with certain similar characteristics. Management objectives and options were then prepared for each of these areas. Some management recommendations apply to all four areas. Others, dependent on a very narrow set of circumstances, are site specific. The special management areas are: The Atlantic Coast; the Channel; Nag's Head; and the Caribbean Coast (See Map 3).

3.1.1 Area I The Atlantic Coast

The Atlantic coast (east coast) from North Friar's Bay to Mosquito Bluff is the windward side of the Peninsula, buffeted by trade winds most of the year. The beaches experience wave approaches primarily from the east-northeast, with heights ranging from .8 to 4.0 m. Although strong currents have not been reported in this area (EAR, 1985), all of the bays are seasonally subjected to heavy wave action. This seems to make it unsuitable for recreational swimming, sailing, and all except the most advanced SCUBA divers. Although nearshore reefs appear to be eroding reefs with low coral cover and diversity, they do protect and enhance the sandy beaches and reduce impacts from storms to the coast. It would be in the best interests of land owners to cooperate in the protection of these reefs.

There are seven fishing boats from St. Mary's County who fish the area with traps (Heyliger, personal communication). Sea turtles (Greens, Hawksbills and Leatherbacks) continue to nest on North Friar's Bay, Canoe Bay, Sand Bank Bay, and Mosquito Bay. Turtle eggs are harvested from the nesting beaches and females who enter the beaches to lay eggs are sometimes killed for their meat and shells.

Most of the slopes along the Atlantic Coast are quite steep and highly erodible with fragile, easily damaged vegetation on the slopes.

3.1.1.1 Marine Management Recommendations

1. Encourage low density use of the beaches and dunes, with boardwalks to protect vegetation.

2. Develop use regulations for beaches to protect and enhance turtle nesting.

3. Develop environmental education programs to help prevent further destruction of the sea turtle populations.

151

4. Include St. Anthony's Peak Forest Reserve within this special Management Area. (The Atlantic side and upper slopes of the leeside of St. Anthony's Peak, have been selected by the team's Forester as a special forest reserve area. This forest reserve could be tied into an Atlantic Coast Special Marine Management Area with the use of foot trails and interpretive education.

5. Enact and enforce proposed fisheries regulations.

6. Include the windward reefs in a coral reef management protection plan.

3.1.2 Area II The Channel

The south coast of the Southeast Peninsula faces the St. Kitts/Nevis Channel, with depths exceeding 10 m only in the area adjacent to Nag's Head. The three channel bays; Cockleshell Bay, Banana Bay and Major's Bay contain highly productive, seagrass beds which provide feeding, spawning, nursery areas for many of the fish, shellfish, mollusks and invertebrates of the Southeast Peninsula marine system.

Major's Bay is known as a foraging area for Green and Hawksbill sea turtles and a significant nursery area for Spiny Lobster. The marine survey revealed that Major's Bay has approximately 83% cover of turtle grass and 12% of manatee grass making it the richest seagrass bay systematically surveyed. The side of Major's Bay nearest Nag's Head is steep and forested. Bugg's Hole, a slight indentation along the coast below this slope, is a favored feeding area of seabirds, particularly the Brown Pelican, who feed on schools of small fish in shallow pools. Nonquantitative observations of Cockleshell Bay indicated that it has almost 100% seagrass cover as well, although very few conch and other grass dwelling species were sighted.

Rock, sand, and seagrasses, within the bays, are the dominant substrate and rubble pavements are common on the current swept floor of the channel (EAR, 1985). Reefs are not well-developed here, although coral cover on large submerged rocky boulders and a moderately sized population of reef fish were observed at Scotch Bonnet.

This is an area that has been heavily exploited for conch by St. Kitts/Nevis fishermen. Excellent habitat remains but the conch have been greatly depleted.

Farther out in the Channel, the area around Monkey Shoals deserves further investigation. The one reef system which was surveyed demonstrated great potential as a tourist site for SCUBA and could also be a productive reef for fisheries.

3.1.2.1 Marine Management Recommendations

1. Major's Bay is a rich contributor to the fisheries resource of the area. Major's Bay has been mentioned as a prospective site for a roll-on roll-off ferry for cars and trucks. Although from a practical point of view, this site seems the logical

place to put a ferry, connecting St. Kitts and Nevis, if it is decided that one is warranted, alternative locations are available along the channel and should be explored.

2. Retain the salt pond and mangroves at Major's Bay. This salt pond acts as a catchment basin for silt from the surrounding hills. If development occurs in this vicinity, the pond and mangroves could act as a valuable natural sink for siltation from construction, which in turn would protect the seagrasses at Major's Bay.

3. Manage all three bays as valuable nursery areas for juvenile species.

4. Work with the Fisheries Division and the fishing community to identify a fish reserve in this area, to enhance fisheries productively and provide a research site for the Fisheries Division.

5. Enact and enforce proposed fisheries regulations.

6. Inclusions of coral reefs in a coral reef protection plan.

3.1.3 Area III Nag's Head

The area under consideration is Green Point to the gut directly west of Major's Bay. The tip of the Southeast Peninsula was listed as an area of particular concern in 1982, by the Lesser Antilles Atlas of Conservation Priorities. The rocky shore from Green Point to the tip of Nag's Head offers a healthy tide pool environment and the steep cliffs sometimes exceeding 45 m., provide unique seabird roosting, nesting areas. Well known for many years as a rookery for a large colony of Brown Pelicans, the St. Kitts/Nevis national bird, it also appears to provide critical nesting and feeding habitat for the Magnificent Frigate Bird and the Roseate Tern (Federally listed as threatened in the Caribbean), the Brown Booby, and the Yellow Crowned Night Heron, among others.

3.1.3.1 Marine Management Recommendations

1. Establish a seabird refuge at Nag's Head.

2. Ban the placement of fishing nets in the vicinity of the feeding, roosting areas of seabirds. The extent of the restricted area should be determined by the Wildlife Biologist and the Fisheries Division.

3. Eliminate landing by boat at the refuge. Viewing could be done by boat tours and private craft, originating from Basseterre of from marine park headquarter in the Little Salt Pond area.

4. Establish boundaries which would stretch along the coast from the gut west of Green Point to the gut on the western side of Major's Bay and to a point inland.

The leeward boundary would have to be worked out with the present land owner by way of easement or special dispensation. Both leeward and seaward boundaries would be established with the expert advise of the Wildlife Biologist and the St. Kitts planning office.

3.1.4 Area IV The Caribbean Coast

The area under consideration is Green Point to South Friar's Bay. Sheltered from the trade winds, these bays and rocky coastal areas generally have low wave heights, less wind and moderate currents. However, when the wind direction shifts and strong winds come out of the southeast, this area is subjected to stormy seas.

Coral reefs on the Caribbean side of the Peninsula are better known than those on the Atlantic coast. A number of reefs are located within the areas off Guana Point between White House and Ballast Bay. A single, small (approximately 300 m^2) patch reef, at 25 ft., is located offshore in Shitten Bay.

The rocky tide pools and other areas close to shore between South Friar's Bay and Nag's Head Green are the habitat of large schools of minnows, which are food for sea birds and needlefish such as ballyhoo. It is these fish which attract seasonal migrations of deeper water species such as dolphin, albacore tuna, and king fish, between April and November (Kenneth Samuel, personal communication). There is real concern among the fishermen that a marina at Little Salt Pond would encourage major boat traffic during the migration of these fish, precluding the use of nets.

This area will be impacted the most by development and yet is also the area most appropriate for a recreational marine park. The reefs off Guana Point have the highest tourist value due to their topographic coral cover and diversity, nearness to shore and shallowness. Although under stress from overfishing, they could recover their diversity with appropriate management. Their proximity to Little Salt Pond and Great Salt Pond also make them most susceptible to cutting a channel from the salt ponds into the bay and from the impacts of construction and operation of a marina. Measures should be taken to avoid sediment discharges near the area and fishing should be regulated to give these reefs a recovery period to increase their attractiveness to park visitors.

3.1.4.1 Marine Management Recommendations

1. Enact and enforce fisheries regulations.

2. Include the reefs in a protection plan.

3. Develop marina/boating use guidelines to take into account the seasonal fishing needs of the fishermen.

Note: A marina, if constructed, should be a small-scale harbor for sailboats and other small boats and serve as the focal point for water-oriented sports. A full service marina would encourage large boats and boat traffic that would quickly impair the natural marine resources and consequently their tourist and fisheries value. Large boats and port-type services should remain in Basseterre.

4. Enact and enforce beach management guidelines.

5. Protect and manage seagrass beds through the development of guidelines and regulations for water-oriented use of the bays.

6. Establish a national recreational marine park in the White House/Ballast Bay Area between the "National Seabird Refuge" to the south and the point northwest of White House Bay to the north and out to the 30 m contour.

3.1.4.2 Objectives

1. To provide passive, marine-oriented recreation and environmental education to tourists and act as a tourist attraction.

2. To generate income for marine management.

3. To protect the coral reefs from incompatible uses and damage from anchoring and fishing.

4. To provide a research center which could seek funding from international organizations to study in greater detail the coral reefs surrounding the Southeast Peninsula.

3.1.4.3 Actions to be Taken to Establish the Park

1. Design as a multiple-use area. Fishermen would serve on a steering committee for the park and would fish in the park, according to adopted fisheries management guidelines and regulations. Their knowledge and experience in the marine environment would be invaluable to the development of a management plan for the park/reserve.

2. The working committee for the park might consist of the following:

   a. A representative of the St. Kitts Hotel Association or other suitable Tourism Representative.
   b. A representative from the St. Kitts Government, Fisheries Division.

   c. A representative of the fishermen.

160

d. A representative from the Conservation Commission (to be established when the National Conservation and Environmental Protection Act, 1987 becomes operational).

e. A representative of the dive shop community.

f. A representative from the marina (if one is constructed).

g. A representative of the land-owners of the area development around the Great Salt Pond.

3. Proposed boundaries would be approved and delineated by the working committee.

4. A full-time manager would be hired and based at the development area near the Great Salt Pond. A small visitor's center could be set up and provide environmental information on the park. The manager would be hired by the park committee with the approval of government and also serve as a staff to collect fees.

4.0 SUMMARY AND RECOMMENDATIONS

The following proposed actions are recommendations for the Marine Resources Management Plan of the Southeast Peninsula.

4.1 Create a National Marine Park/Reserve for St.Kitts/Nevis

There is an immediate need to manage the nearshore waters and shoreline for the purposes of conservation of marine resources. The coral reefs and seagrass beds of the Southeast Peninsula are still in relatively good health. Special management rules such as those listed above, along with an overall fisheries and recreational management program for the surrounding waters of the Peninsula, could help to ensure long-term use of the renewable marine resources.

Special protected areas could be best administered within the overall umbrella of a national marine/park preserve in the Southeast Peninsula. Furthermore, the park/reserve concept is compatible with its designation as a conservation area by virtue of The Southeast Peninsula Land Development and Conservation Act, 1986-12. It is also compatible with the desires of the Government of St. Kitts to attract tourism dollars and thereby stimulate the economy. Many island nations around the world have established marine parks and reported their economic benefits.

Designating a multiple-use, national marine park/reserve surrounding the Peninsula would help to establish an overall conservation and development approach to developing the area which would be consistent with the high value of the resources and the unique and fragile nature of its environment.

4.1.1 Objectives

1. To promote sustainable development of marine resources.

2. To preserve the scenic value and natural character of the area.

3. To separate incompatible activities and resolve conflicts among user groups by zoning.

4. To preserve a representative sample of the coral reef ecosystem and a variety of its component and associated habitats and biotic communities.

5. To safeguard the breeding stocks of commercial species for replenishment of depleted areas.

6. To protect endangered, depleted or rare species.

7. To preserve the ecological processes and support systems on which the integrity of the coral reef ecosystem depends.

8. To maintain the social and economic benefits of the area.

9. To limit uses to sustainable levels.

10. To control access to biologically and environmentally sensitive habitats.

11. To regulate anchoring on reefs.

12. To periodically review and revise the management needs and procedures.

13. To facilitate interpretation by special lectures and films, interpretive publications.

4.1.2 Boundaries of the Park Reserve

Marine conservation of Southeast Peninsula coastal waters can best be achieved by creating a national marine park/reserve in the surrounding waters of the Peninsula from high tide out to the 30 m. depth contour. When park management and enforcement take place within boundaries that can only be described legally on a nautical chart, enforcement becomes understandably difficult. Experience in marine park development has shown that it is easier to manage and enforce rules where boundaries are clearly understood. Establishing a large park area out to the 30 m. contour and applying the rules and regulations throughout, simplifies the task of enforcement.

Delineating an area of this size will also help to preserve the diversity of reef biota. The park/reserve will contain many different habitats to ensure a varied and steady supply of larvae to replace dead or emigrated organisms. It will also include the three kinds of habitats which must be included in a protected area if protection of coral reefs is to be successful: coral habitat, adjacent coastal habitat (i.e. submerged, intertidal, or above water) and distant linked habitats such as reef flats; seagrass beds and sand flats.

4.1.3 Enabling Legislation

"Part III, Marine reserves and Conservation Measures, Section 23 (1) a-d), of the Fisheries Act of 1984 "is operational and can act as the enabling legislation.

4.1.4 Administration

Although St. Kitts does not now have a park authority within the government, there are precedents for national parks, such as the one established in 1965 at Brimstone Hill. Administration for a Southeast Peninsula National Marine Park could be entirely by

private individuals, or could be administered by a combination of private and public officials.

4.1.5 Funding

Funding for the park/reserve could come from a variety of sources. Fees can be collected from the recreational park in the White House Bay/Ballast Bay area. Funding can most certainly be solicited from the international donor community, once the park is established and an administrator is in place.

4.1.6 Park/Reserve Guidelines and Use

4.1.6.1 Guidelines for Recreational Use

1. Strictly control use of Atlantic beaches to protect nesting turtles.

2. Regulate use of all beaches to prevent damage to vegetation and habitat of shoreline species.

3. Allow only passive use of the marine resources within the park (i.e. no taking of coral, shells).

4. Establish guidelines for recreational boats (to help keep boats out of shallow fragile reef areas and prevent dumping of wastes in the nearshore waters of the park).

5. Prescribe seasonal rules for recreational boats using Caribbean coastal waters to allow for seasonal take of migratory species by the fishermen.

4.1.6.2 Guidelines for Land Developers

1. Minimize seagrass destruction.

2. Prohibit all beach and berm sand extraction.

3. Prohibit the removal of strand vegetation from dune systems.

4. Encourage the use of wooden walkways or boardwalks for foot passage to the beach.
5. Designate anchoring areas for recreational boats in high use areas.

6. Site development with sufficient setbacks from beaches and dunes.

164

7. Minimize development of the slopes due to the slope, soil, vegetation characteristics which could cause major coastal erosion and siltation of marine areas.

8. Retain, as much as possible, the salt ponds and mangroves on the Peninsula which act as natural retention ponds of sediment from natural and man-induced runoff.

9. Minimize damage to coral reefs.

10. Prevent introduction of pollutants and sewage into coastal waters by installing efficient package treatment plants and onsite retention and treatment of liquid wastes.

4.1.6.3 Guidelines for Fisheries Use

1. Adopt St.Kitts/Nevis proposed fisheries regulations for regulation and management of fisheries in the park/reserve ("Saint Christopher and Nevis Statutory Rules and Orders, 1986"). These rules regulate fishing practices to sustain fisheries development and restore depleted species. These regulations also cover most of the major concerns of fisheries management of the Peninsula.

2. Sustainable use of the fisheries resource is not an incompatible use in a marine park. A marine park is often the traditional fishing grounds of a fishing community. Working with the community to establish sustainable fishing practices, within the context of a park/reserve, can benefit conservation of marine resources more effectively than banning fishing from the area.

4.1.7 **Special Protected Areas Within the Park/Reserve**

Area I Sea turtle habitat protection.
Encourage low-density use of the beaches and dunes. Develop use regulations to protect and enhance turtle nesting.

Area II Fisheries breeding, spawning and nursery protection.
Establish a fish reserve to enhance fisheries productivity and provide an area for research.

Area III Seabird habitat protection.
Designate the Nag's Head area as a National Seabird Refuge.

Area IV Protection of the marine resource from overfishing and potentially incompatible recreational use. Create a recreational park bounded by the National Seabird Refuge to the south and to the north by the point northeast of White House Bay.

165

4.2 Gazette the National Conservation and Environmental Protection Act of 1987

The success of the park/reserve will depend on management and control of development in the coastal zone. There is such a strong link between coastal processes of beaches, dunes, salt ponds and mangroves, tide pools that management of marine resources within a marine park, without management of development impacts along the coast, will result in little progress towards conservation.

Action recommended: Resolve the definition of "foreshore" and "coastal zone" in the National Conservation and Environmental Protection Act, passed by the legislature in 1987, and gazette it as quickly as possible so that it becomes operational.

It appears that the definition of "foreshore" and "coastal zone" in the National Conservation and Environmental Protection Act, passed by the legislature in 1987, still needs to be resolved before this law becomes operational. These definitions are critical, both to the Southeast Peninsula Land Development and Conservation Board who will be evaluating proposals, and to the landowners who will be submitting development proposals. Final passage of this law will also enable the government of St. Kitts to enact and enforce management controls of development impacting the coastal habitats on which the marine resources depend.

4.2.2 Institute a Fisheries Management Program as Part of the Park/Reserve

Fisheries management to conserve the fisheries resources and their habitat can only be achieved with the cooperation of the fishermen. Working with the fishing community to establish simple ground rules and regulations that can be enforced seems to be the only way to protect the resource over the long term. In order to accomplish this, the Fisheries Resource Division needs a larger budget and more staff which could come, in part, from park/reserve funding.

The fisheries regulations recommended below are those that have been proposed by the Fisheries Division and other knowledgeable fisheries specialists to protect reproductive stocks of juvenile fish. Most of them are either in the proposed 1986 Fisheries Regulations of St. Kitts or in subsequent amendments to those regulations.

Part V. Lobster Fishery Conservation Measures

13. Lobster
    - (1) in this Regulation "undersize" means:
        - (a) a carapace length of less than 95 millimeters measured from immediately behind the rostral horns to the maximum concavity of the rear edge of the carapace as illustrated in Schedule 10 to these Regulations: or
        - (b) less than one and a half pounds (680 grams) in weight; or
        - (c) having a tail weighing less than 200 grams.

(2) No person shall harm, take, have in his possession, sell or purchase;
(a) any lobster carrying eggs; or
(b) any lobster which is undersized; or
(c) any lobster which is molting

(3) No person shall capture any lobster other than by hand, loop, pot, or trap.

(4) No person shall have in his possession or sell any lobster that has been speared, hooked, or otherwise impaled.

(5) No person shall remove the eggs from a lobster, or have in his possession, sell or purchase a lobster from which the eggs have been removed.

(6) The Minister may by notice publish in the Gazette, declare any season as a closed season for lobsters.

(7) No person shall fish for lobster during the period of a closed season for lobsters.

(8) No person shall land from a fishing vessel any lobster that is not whole.

14. Turtles, No person shall
(a) fish for, take, sell, purchase or have in his possession any turtle or part thereof;
(b) disturb, take, sell, purchase or have in his possession any turtle eggs; or
(c) interfere with any turtle nest.

15. Conch
(1) No person shall take, sell, purchase, or have in his possession any "immature conch".

(2) The Minister can declare any period a closed period for conch.

(3) No person shall fish for conch during the period of a closed season for conch.

(4) In the regulation, "immature conch" means ,
(a) a conch the shell of which is smaller than 22 centimeters in length; or
(b) a conch the shell of which does not have a flared lip; or
(c) a conch with a total meat weight of less than 225 grams after removal of the digestive gland.

16. Coral. No person shall take or collect coral from the fishery waters except with the written permission of the Fisheries Officer in accordance with such conditions as he may specify.

17. Aquarium fish. No person shall import, sell or export any aquarium fish except with the permission of the Fisheries Officer and in accordance with such conditions as he may specify.

18. Fisheries Research. This part of these regulations shall not apply to fishing operations which are conducted solely for the purpose of fisheries research provided that permission has been granted in respect of such operations by the Fisheries Officer under Section 24 of the Act and that the operations are carried out in accordance with the conditions of such permission.

Part VI. Miscellaneous Provisions

19. Offenses and Penalties. Any person contravening any of the provisions of those regulations shall be guilty of an offense and shall be liable on summary conviction to a fine not exceeding five hundred dollars or the confiscation of the boat used for such contravening or both.

Note: The following amendments, sent to the Minister by the Attorney General, in 1986, and taken to the Legislature and the Cabinet by the Minister, should be incorporated in the Fisheries Regulations, listed above.

V. 14. "turtle" should be changed to "sea turtle".

V. 15. (5) Conch fishing should be prohibited in Friar's Bay South Basseterre Bay, and all areas in between. (This closed area is bounded on the east by the 100 fathom contour, on the north by 17° 16.2 N latitude. The intention is to maintain this area as a breeding reserve for a period of several years, after which the area may be re-opened to fishing and other areas declared closed.)

V.17. "Aquarium fish" is not defined and may be easily misinterpreted. It is suggested that the term be defined, or that "live fish" be used instead, as this is less ambiguous and is in keeping with the intention of the regulation.

V. Ornamental Species. A paragraph should be added prohibiting the collection, sale or export of shelled mollusks (other than conch or *Echinoderms*) except with the permission of the Fisheries Officer and in accordance with such regulations he may specify.

Mesh Size
Minimum mesh size for both gill and tangle nets not less than 3.5 inches to allow the escape of juveniles.

Minimum mesh size for ballahoo or beach seines should be 1.5 inches and uniform throughout. These nets are not permitted to be pulled up on beaches.

4.3 Conclusion

In the last analysis, the success of a Marine Resources Management Plan for the Southeast Peninsula depends on administrative, funding and enforcement capability. These elements of a successful program can best be obtained, in the opinion of the author, by the establishment of a national marine park/reserve. This action will help to provide a focus for marine management of fisheries and recreational use of marine waters; attract funding from outside the limited resources of the government, and establish a development through conservation approach to the overall plan of the Peninsula. The plan presented here is a guide to action. Once the concept has been approved, the plan will need to be tailored more specifically to the development decisions of the Southeast Peninsula Development Board.

REFERENCES

"Approaches to Saint Christopher and Nevis, Montserrat, and Redonda" (Chart). Washington, D.C.: Defense Mapping Agency, Hydrographic/Topographic Center. August, 1987.

Buchter, John. "Forestry Resources Management Plan". Basseterre, St. Kitts. September 1988.

Cambers, Dr. G. Coastal Erosion in St. Kitts - Nevis, vol. 1, St. Kitts. Barbados: Caribbean Oceanographic Consulting Co. August 1983.

Cambers, Dr. G. "An Overview of Coastal Zone Management in Six East Caribbean Islands". Report to Unesco Regional Office for Science and Technology for Latin America and the Caribbean. Montevideo. 1985.

Caribbean Conservation Association. "Guidelines for Integrated Marine Resource Management in the Eastern Caribbean, Technical Report No. 2".

"Environmental Assessment Report on the Proposed Southeast Peninsula Access Road St. Kitts, West Indies". Island Resources Foundation: St. Thomas, U.S. Virgin Islands. February, 1986.

"Fish Landing Statistics", St. Kitts Fisheries Division. June -October 1988.

The Fisheries Act, 1984, Saint Christopher and Nevis, No. 4 of 1984. St. Kitts, West Indies: Government Printery.

Fraites, Junier. "The Government of St. Kitts/Nevis Perspectives on Environment Impact Assessment". Barbados. May, 1985.

Gibson, John. "Foreshore: A Concept Built on Sand". Centre for Marine Law and Policy, UWIST, Cardiff.

Goodwin, M. H.; Heyliger, S. J.; and Wilkins, R. M. "Progress Report on Development of a Management Plan for the St. Kitts/Nevis Spiny Lobster Fishery". Basseterre, St. Kitts. May, 1986.

Goodwin, M. H. "Fishery Sector Assessment for the Eastern Caribbean". Island Resources Foundation: St. Thomas, U.S. Virgin Islands. August, 1985.

Heyliger, Samuel. Fisheries Division. St. Kitts, West Indies. Interview, November 1988.

Island Resources Foundation, Edward L. Towle, Ph.D., Team Leader. "Land Use Management Plan for the Southeast Peninsula St. Kitts, West Indies". U.S. Virgin Islands. July, 1986.

Management of Coastal Resources in SKN, 3SKN, Plan of Operation for the Coastal Resources Management Project - St. Kitts-Nevis. St. Lucia, West Indies: The Organization of Eastern Caribbean States - Natural Resources Management Project. January, 1988.

Mendis, D. L. "Coastal Zone Management Law". Paper presented at Tortola Coastal Zone Management Legislation Conference. February, 1988.

National Conservation and Environment Protection Act, 1987, Saint Christopher and Nevis, No. 5 of 1987. St. Kitts, West Indies: Government Printery.

Putney, Allen D. Survey of Conservation Priorities in the Lesser Antilles, Final Report. St. Croix, U.S. Virgin Islands: Caribbean Conservation Association. October, 1982.

"Saint Christopher and Nevis Statutory Rules and Orders (proposed), 1986". Made by the Minister under Section 40 of the Fisheries Act, 1984 (No. 4 of 1984). St. Kitts, West Indies.

Salm, Rodney V. Marine and Coastal Protected Areas: A Guide for Planners and Managers. Gland Switzerland: International Union for Conservation of Nature and Natural Resources. 1984.

Samuel, Kenneth. Owner and Operator, Dive Shop. Basseterre, St. Kitts, West Indies. Interview, November 1988.

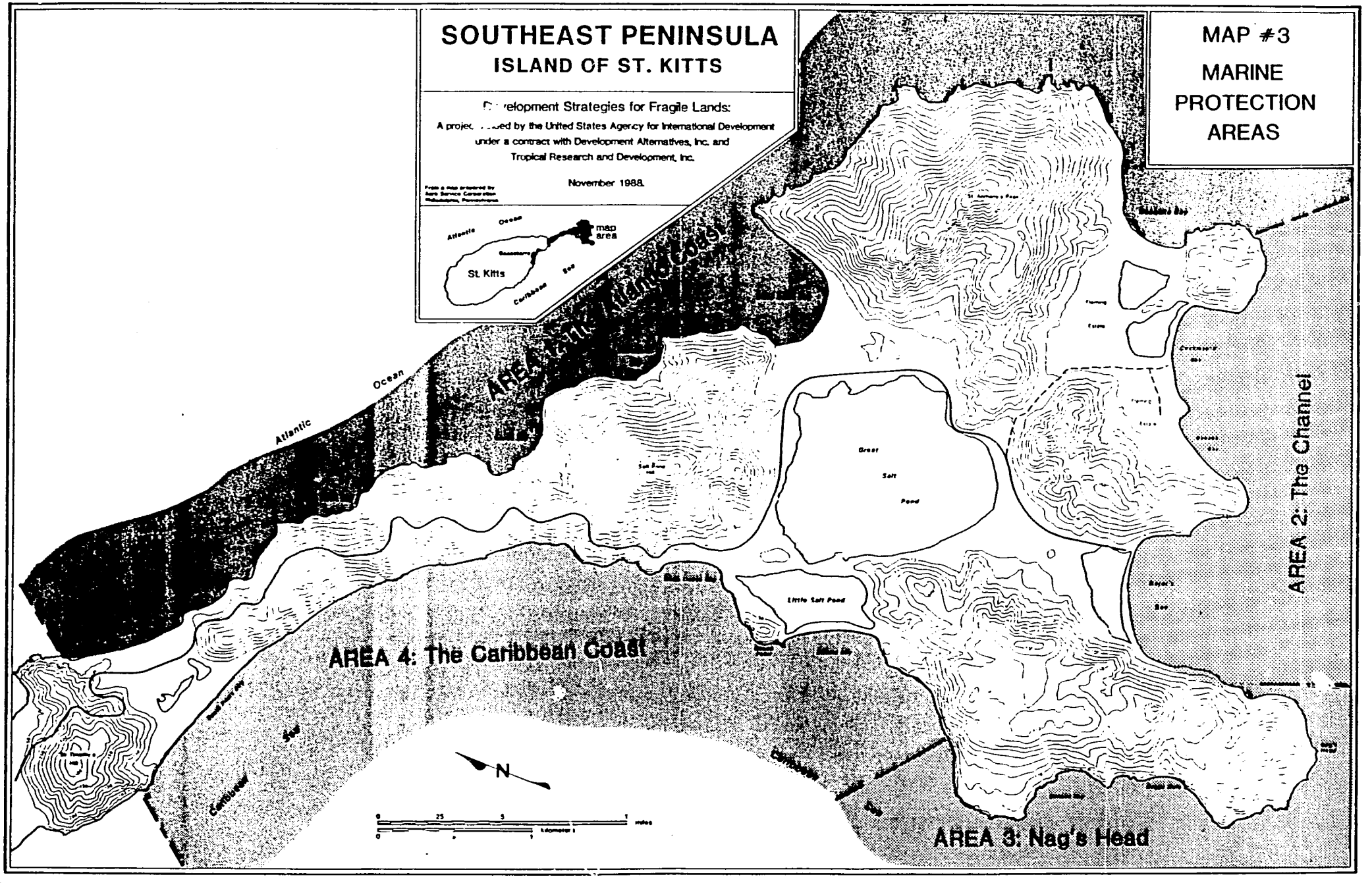
South-East Peninsula Land Development and Conservation Act, 1986, Saint Christopher and Nevis, No. 12 of 1986. St. Kitts, West Indies: Government Printery.

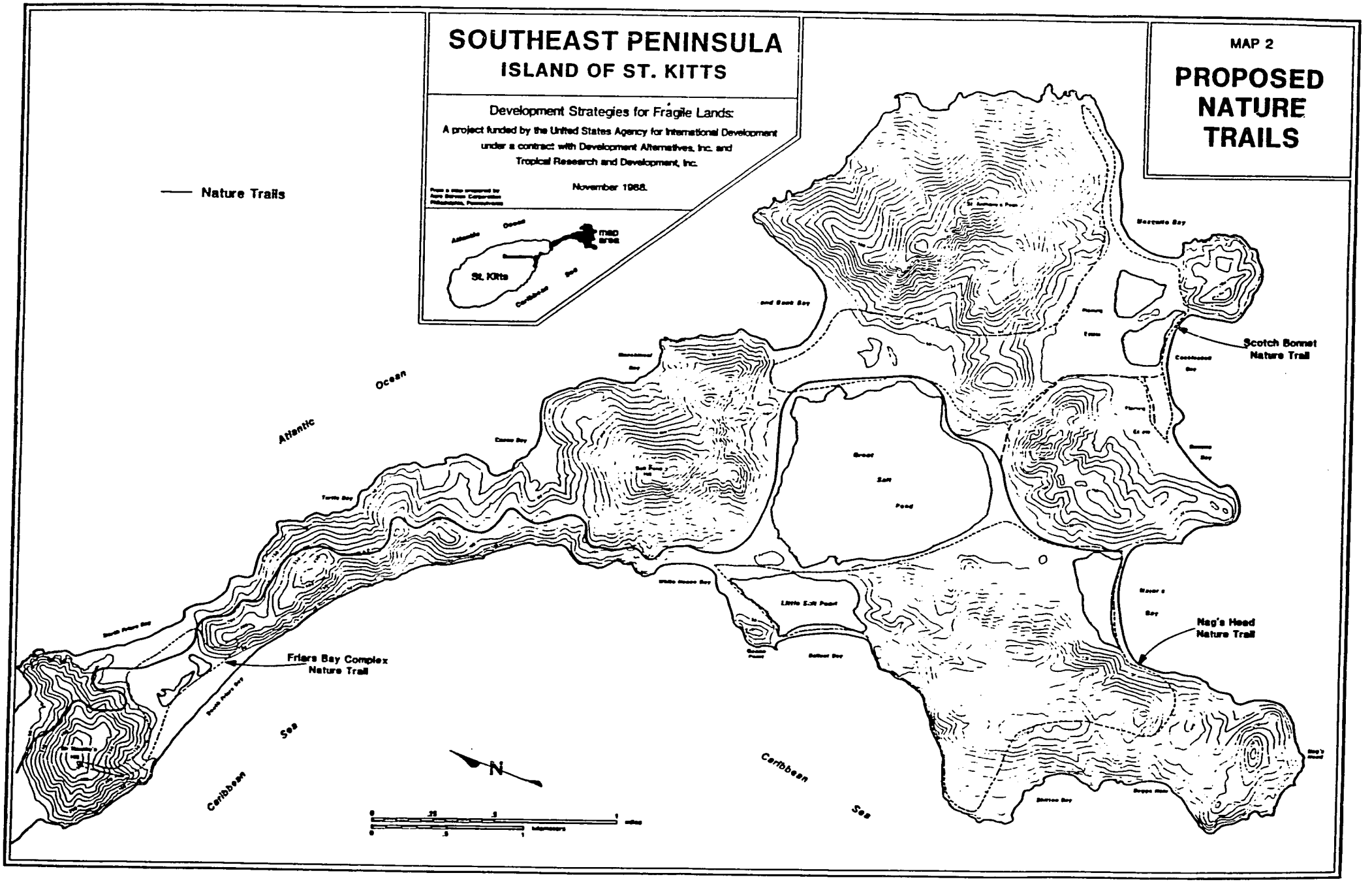
Southeastern Peninsula Project Team, Ivor Jackson, Project Leader. Southeastern Peninsula, St. Kitts, Study of Management Alternatives. St. Kitts, West Indies: Caribbean Conservation Association. February, 1981.

United States Agency for International Development. Caribbean Marine Resources: Opportunities for Economic Development and Management. Washington D.C.: United States Department of Commerce. March, 1987.

Wilkins, Ralph. Fisheries Division. St. Kitts, West Indies. Interview, November 1988.

Williams, Victor O. "Country Summary: St. Kitts-Nevis, Presented at the Workshop on Biosphere Reserves and Other Protected Areas for Sustainable Development of Small Caribbean Islands". St. Johns, U.S. Virgin Islands. May, 1983.


SOUTHEAST PENINSULA
ISLAND OF ST. KITTS
Development Strategies for Fragile Lands:
A project funded by the United States Agency for International Development
under a contract with Development Alternatives, Inc. and
Tropical Research and Development, Inc.
November 1988.
map area
St. Kitts
Atlantic Ocean
Caribbean Sea
MAP #3
MARINE
PROTECTION
AREAS
AREA 1: The Atlantic Coast
AREA 2: The Channel
AREA 3: Nag's Head
AREA 4: The Caribbean Coast
Great Salt Pond
Little Salt Pond
N


SOUTHEAST PENINSULA
ISLAND OF ST. KITTS
Development Strategies for Fragile Lands:
A project funded by the United States Agency for International Development
under a contract with Development Alternatives, Inc. and
Tropical Research and Development, Inc.
November 1988.
map area
St. Kitts
Atlantic
Ocean
Caribbean
Sea
MAP 2
PROPOSED NATURE TRAILS
Nature Trails
Scotch Bonnet Nature Trail
Nag's Head Nature Trail
Friars Bay Complex Nature Trail
Great Salt Pond
Little Salt Pond
N

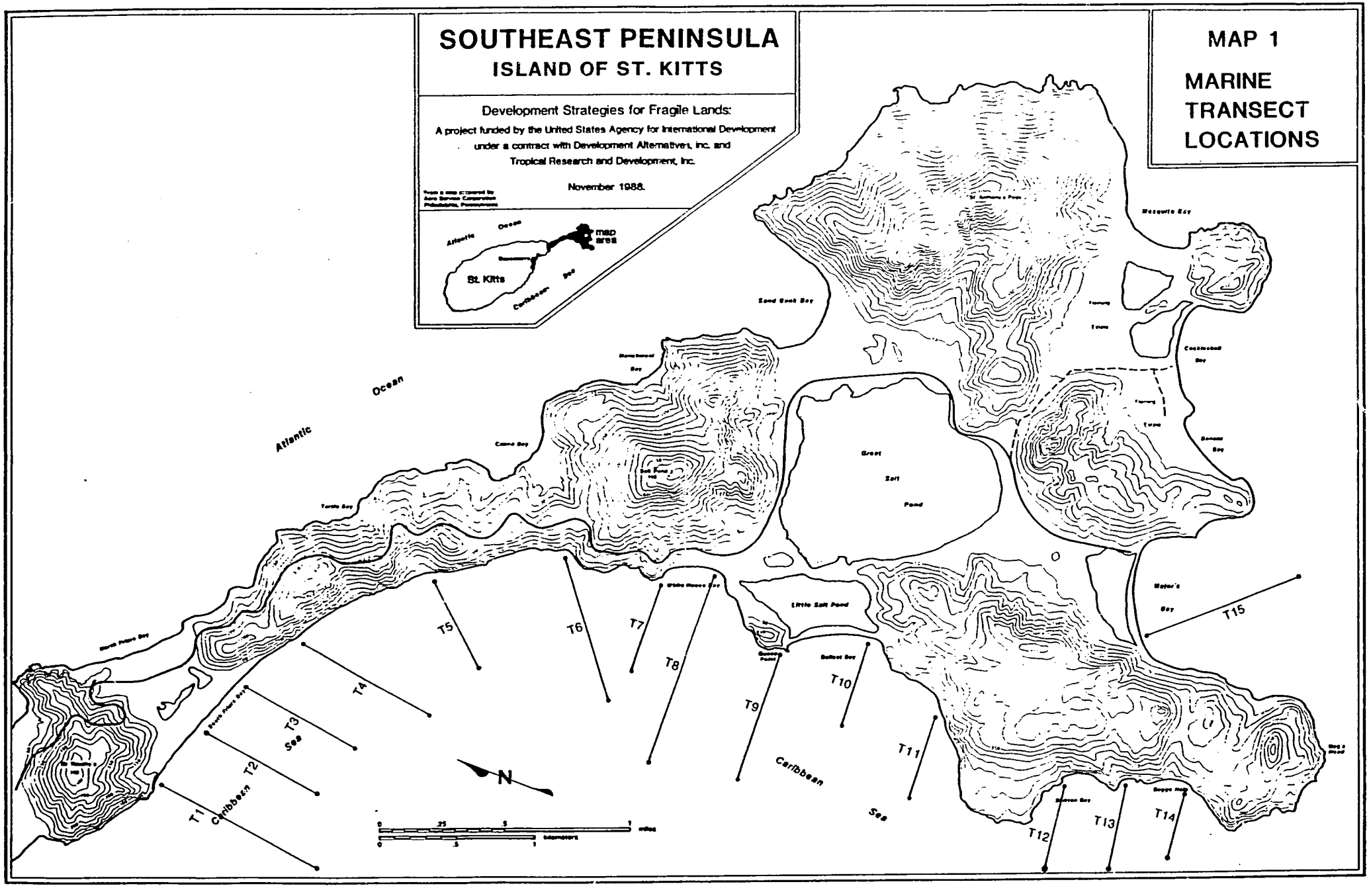

SOUTHEAST PENINSULA
ISLAND OF ST. KITTS
Development Strategies for Fragile Lands:
A project funded by the United States Agency for International Development
under a contract with Development Alternatives, Inc. and
Tropical Research and Development, Inc.
November 1988.
map area
St. Kitts
Atlantic
Ocean
Caribbean
Sea
MAP 1
MARINE
TRANSECT
LOCATIONS
Sand Spit Bay
Mosquito Bay
Cockleshell Bay
Sandy Bay
Great
Salt
Pond
Little Salt Pond
Water's Bay
Ballast Bay
Turtle Bay
Cotton Bay
Sand Spit
North Friars Bay
South Friars Bay
Frigate Bay
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
N
miles
kilometers

FIGURE 1

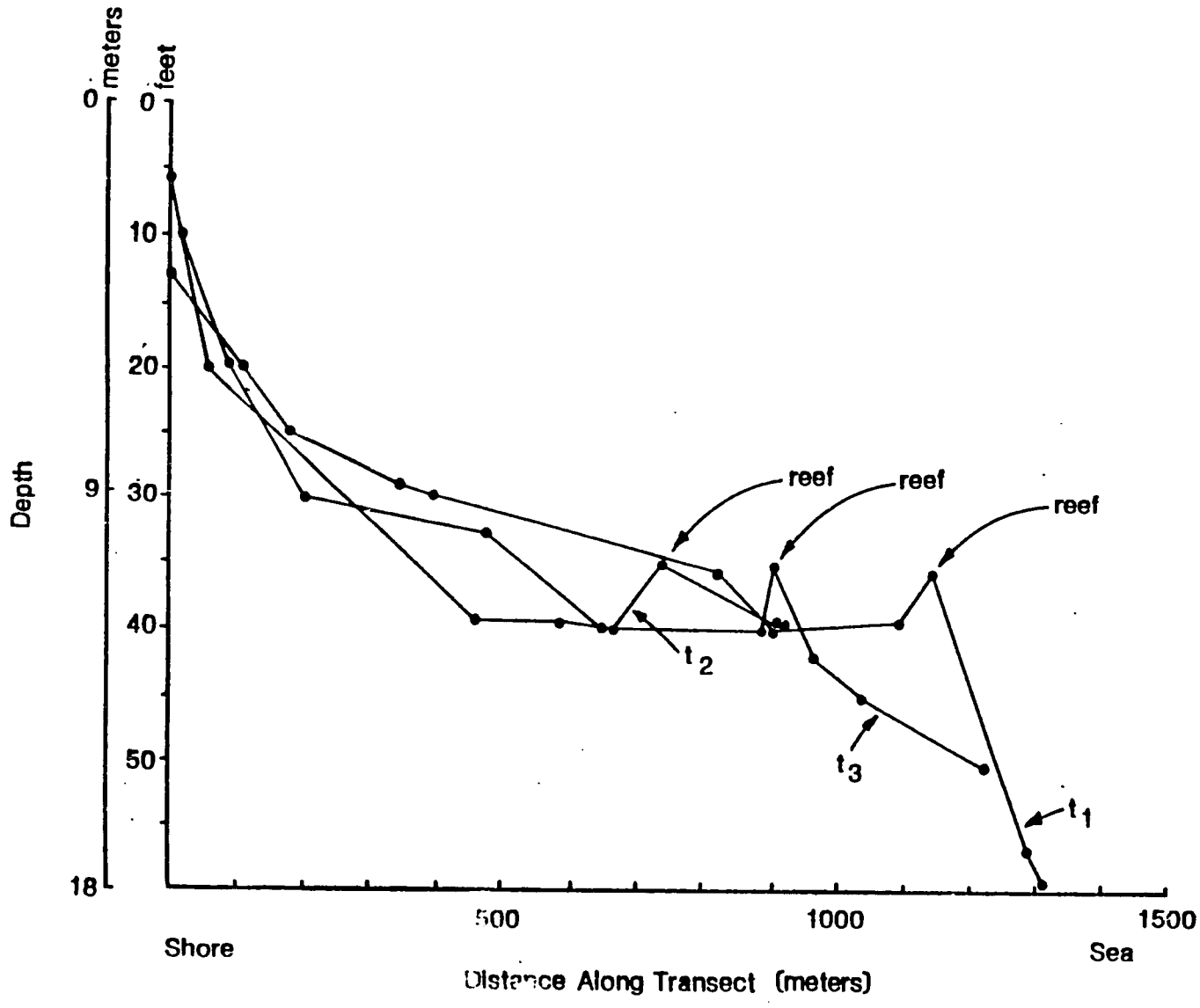
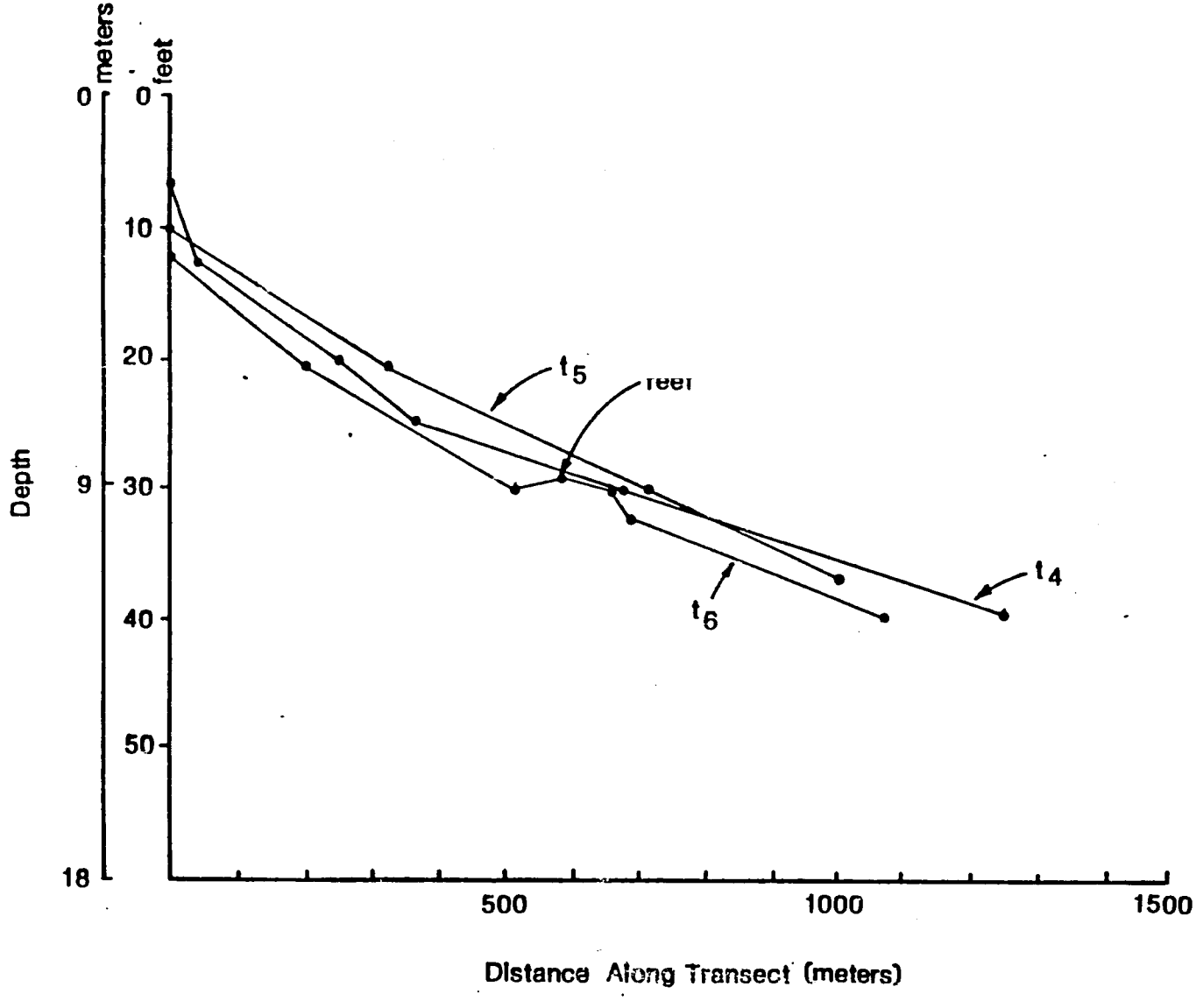

meters
feet
0
0
10
20
9
30
40
50
18
Depth
reef
reef
reef
t_2
t_3
t_1
500
1000
1500
Shore
Sea
Distance Along Transect (meters)

FIGURE 2


meters
feet
0
0
10
20
30
40
50
9
18
Depth
t_5
t_4
t_6
500
1000
1500
Distance Along Transect (meters)

176

FIGURE 3

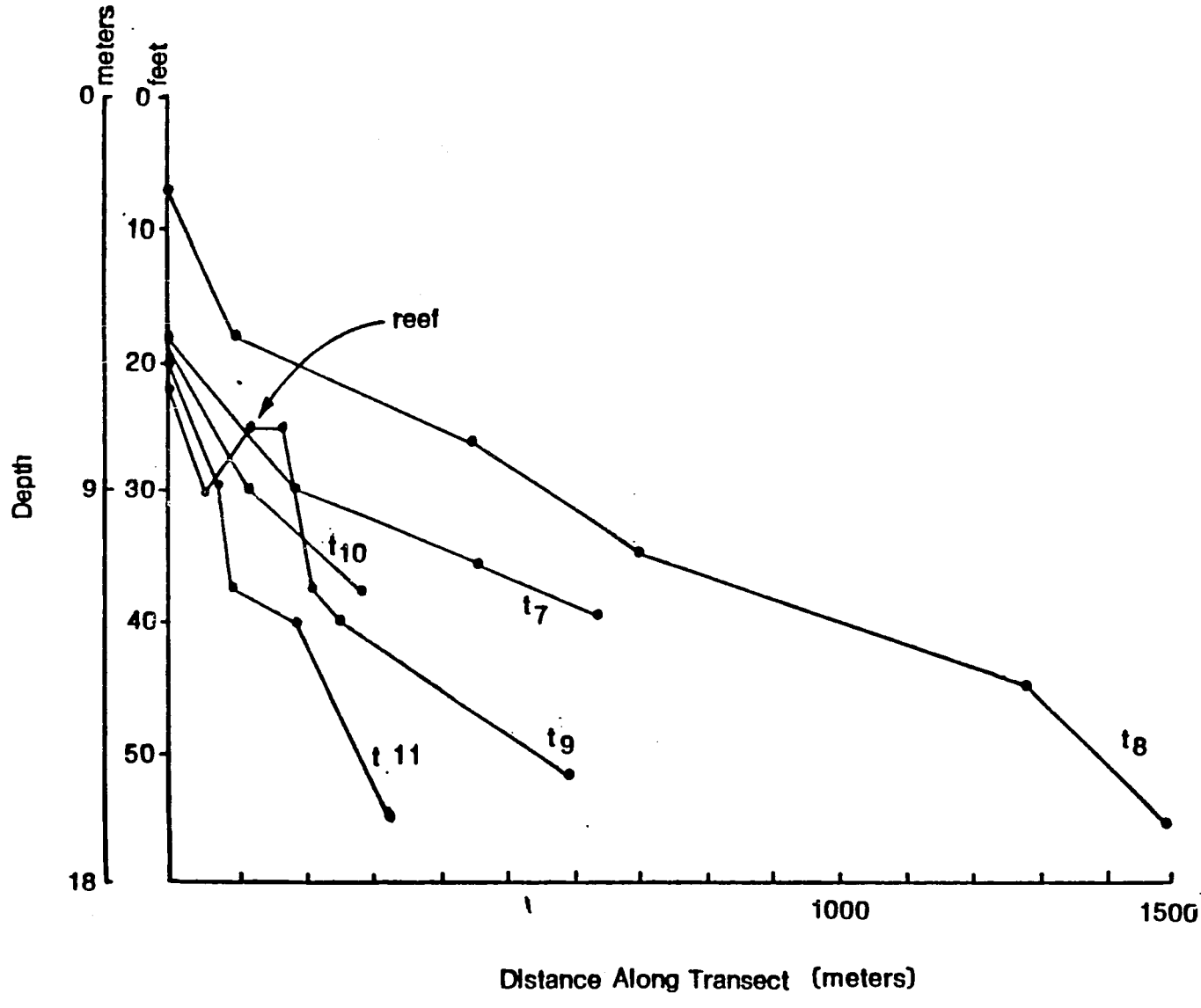

meters
feet
0
0
10
20
30
40
50
9
18
Depth
reef
t10
t7
t9
t 11
t8
1000
1500
Distance Along Transect (meters)

FIGURE 4

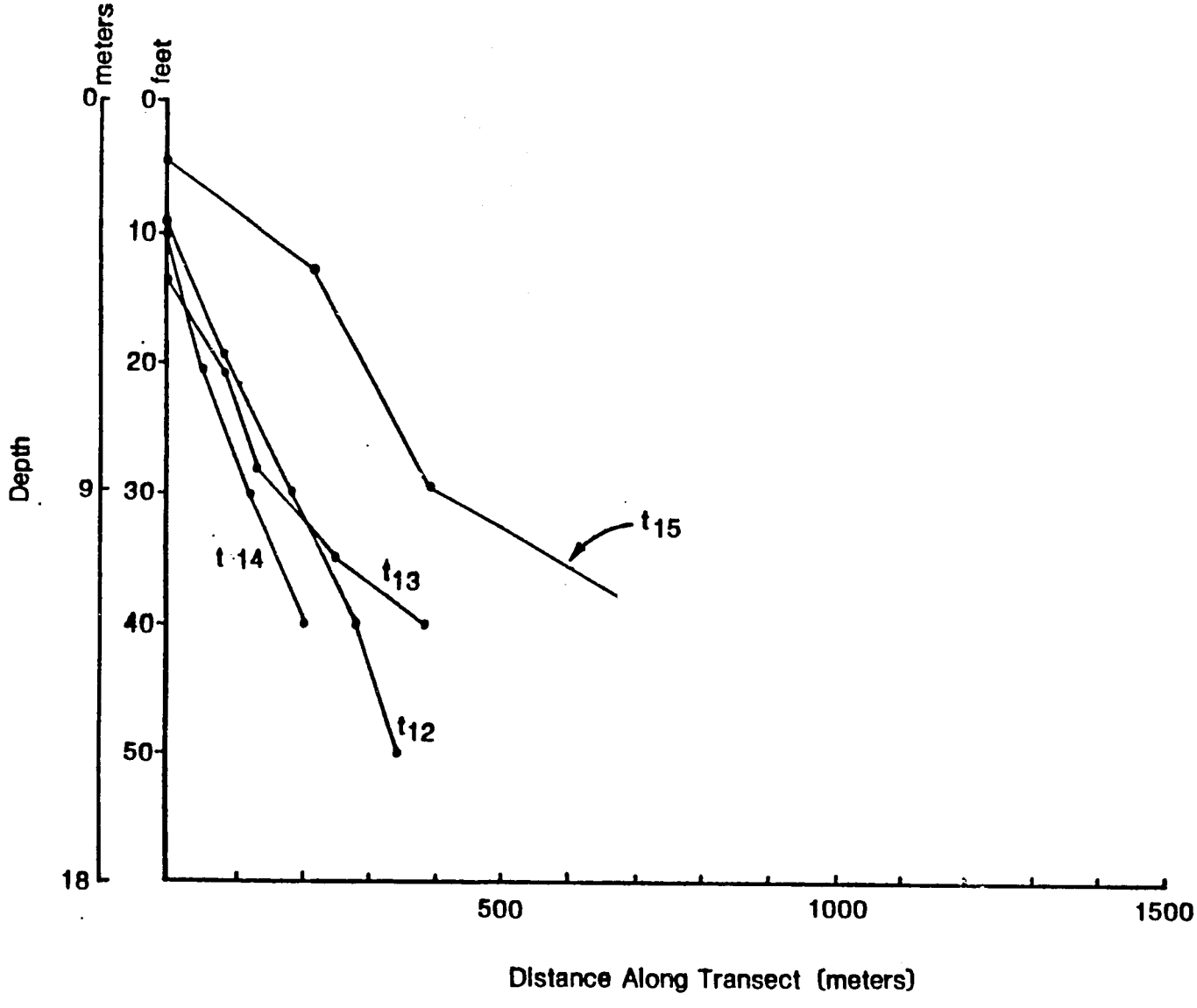

Depth
0 meters
9
18
0 feet
10
20
30
40
50
t15
t13
t14
t12
500
1000
1500
Distance Along Transect (meters)

Table 1: The Percentage of Cover Attributable to Each Substrate Category Within the SEP for the 15 Transects.

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15
Sand	27.0	52.3	20.96	8.46	43.15	33.96	5.4	42.5	56.0	83.3	63.1	56.6	52.3	10.3	4.54
Manatee grass	13.0	29.0	8.3	15.77	18.91	14.29	14.1	2.64	0	0	0	15.90	18.6	46.6	12.03
Turtle grass	45.5	9.62	43.3	75.8	37.90	15.0	80.4	16.2	0	0	20.9	37.27	7.6	43.0	83.4
Reef	12.1	9.0	5.25	0	0	17.54	0	17.6	15.1	0	13.8	0	21.5	0	0
Rock	2.5	0	22.1	0	0	19.2	0	20.9	28.9	16.7	2.21	0	0	0	0

Averages and Standard Deviations

	Mean%	S.D.
Sand	34.6	23.9
Manatee grass	15.9	14.8
Turtle grass	34.3	28.1
Reef	7.6	8.3
Rock	7.5	10.6

Table 2 Substrate Cover and Diversity (Mean ± Standard Deviation) Within Bays

	Friar's Bay South	Cliff Area	White House & Ballast Bay	Shitten Bay	Major's Bay
Sand	33.4 ± 16.7	28.5± 17.98	50.1 ± 29.0	26.43 ± 22.6	4.54
Manatee Grass	16.8 ± 10.9	16.3 ± 2.35	3.35 ± 6.12	37.0 ± 15.98	12.0
Turtle Grass	32.8 ± 20.1	42.9 ± 30.7	23.5 ± 33.2	29.3 ± 19.0	83.4
Reef	87 ± 3.4	5.8 ± 0.1	9.31 ± 8.61	7.17 ± 12.41	0
Rock	8.2 ± 12.0	6.4 ± 4.0	13.78 ± 12.4	0 ± 0	0
Diversity, Simpson's Index	.74	.70	.583	.70	.29

NATURAL RESOURCES MANAGEMENT PLAN: STORMWATER, WASTEWATER AND SOLID WASTE MANAGEMENT

by

Gregory L. Morris, Ph.D.

May 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

EXECUTIVE SUMMARY: CONCLUSIONS & RECOMMENDATIONS

STORMWATER & FLOODING

Issues. When heavy rainfall from tropical storms falls on the relatively impermeable soils of the SEP they can produce flash flooding and damage structures. Similarly, hurricane-driven waves can damage or destroy structures located near the shore. The potential for coastal flood damage is further enhanced by the "greenhouse effect", which is causing global warming and a gradual rise in sea level.

Recommendations. Implement simple preventive measures to protect new development against damage from stormwater. All developers should be required to: (a) identify the natural guts in the vicinity of areas to be developed and show them on the site plan, (b) compute the peak runoff for each gut for the 50-year storm, and (c) demonstrate that any proposed structures will not obstruct a gut or be adversely affected by the runoff from the 50-year storm. All permanent or habitable structures should have a minimum floor elevation exceeding 10 feet above mean sea level to provide protection against hurricane storm surge and rising sea level.

WASTEWATER TREATMENT & DISPOSAL

Issues. Wastewater disposal presents a problem on the SEP because soils are typically very shallow or impermeable. The septic tank systems typically used on St. Kitts will not function properly on the SEP. Conventional sewage treatment plants to serve areas of concentrated development are costly to build and difficult to operate.

Recommendations. Special design and construction criteria must be used for all septic tanks on the SEP. Septic tanks should be used wherever feasible. Septic tank design and construction criteria are presented in the text of this report.

An innovative sewage treatment system is recommended for centralized sewage treatment on the SEP consisting of primary treatment followed by a constructed wetland. This type of system is inexpensive to build and operate, and can provide secondary levels of treatment. Anaerobically digested primary sludge may be applied to about five acres of sugarcane land and provide fertilizer benefits.

Two effluent disposal alternatives appear to be both environmentally feasible and economical. One alternative would be to discharge effluent into the wetland areas, including the Great Salt Pond. The second alternative would be to use wastewater for irrigation, providing both irrigation and fertilizer benefits. However, due to the potential health hazard, disinfection controls that are MUCH MORE STRICT than current practice on St. Kitts must be implemented for the irrigation alternative to be made feasible.

SOLID WASTE MANAGEMENT

Issues. Development activities on the SEP will produce about 168 cubic yards/week of solid waste with approximately 1300 units occupied. If not disposed of properly this waste will detract from the natural amenity of the area and reduce tourism potential.

Recommendations. Construction and landscape wastes (eg. shrubbery cuttings) may be disposed of on the SEP to reduce haulage. A recommended disposal site is located in Figure 5. Commercial wastes (paper, kitchen waste, etc.) should be hauled to the Conaree dump.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
- 1.1 Issues 1
- 1.2 Scope 1
- 1.3 Study Methodology 1
- 1.4 Background Assumptions 2

2.0 DESCRIPTION OF RESOURCE CHARACTERISTICS 4
- 2.1 Rainfall 4
- 2.2 Soils 5
  - 2.2.1 Hydrologic Groups 5
- 2.3 Peak Stormwater Runoff 6
- 2.4 Sea Level Rise 7

3.0 MANAGEMENT ALTERNATIVES 8
- 3.1 Management Objective 8
- 3.2 Management for Flood Control 8
  - 3.2.1 Stormwater Runoff 8
  - 3.2.2 Coastal Flooding 9
- 3.3 Septic Tank Systems 10
  - 3.3.1 Limitations on the SEP 10
  - 3.3.2 Shallow Soils on Slopes 11
  - 3.3.3 Deep and Poorly Permeable Soils 13
- 3.4 Centralized Wastewater Treatment Systems 15
  - 3.4.1 Treatment Strategy 15
  - 3.4.2 Primary Treatment 16
  - 3.4.3 Constructed Wetlands 18
  - 3.4.4 Effluent Disposal 20
- 3.5 Solid Waste Management 22
  - 3.5.1 Solid Waste Volumes 22
  - 3.5.2 Disposal Alternatives 22
  - 3.5.3 Potential Disposal Sites 23
  - 3.5.4 Recommended Disposal Alternatives 24

4.0 REFERENCES 25

LIST OF TABLES

Table 1 Projected Growth of the Tourist Industry on St. Kitts 3

Table 2 Computations of Water Needs on the Southeast Peninsula Assuming Full Projected Development 20 Years 3

Table 3 Depth-Duration Relations for the Eastern Portion of St. Croix, U.S. Virgin Islands 4

Table 4 Summary Characteristics of Selected Drainage Basins on the Southeastern Peninsula, St. Kitts 6

Table 5 Results of Percolation Tests on St. Kitts 11

184

LIST OF FIGURES

Figure 1	Site Location Map	27
Figure 2	Monthly Rainfall at Cockleshell Bay on the Southeast Peninsula compared to that at the Agronomy Station near Basseterre	28
Figure 3	Generalized Relationship Between Stormwater Runoff and Tributary Drainage Area	29
Figure 4	Historical Global Sea Level Rise and Scenarios for the Future Rise	30
Figure 5	Percolation Location Map and Recommended Sites for Solid Waste Disposal	31
Figure 6	Schematic Diagram of a Septic Drainfield on Sloping Shallow Soils	32
Figure 7	Recommended Drainfield Sketch for Septic Tank Effluent When Soils are at Least Five Feet Deep	33
Figure 8	Submerged Gravel Bed and Constructed Wetland	34

LIST OF APPENDICES

Appendix 1	Available Data on Monthly Rainfall at Cockleshell Bay, St. Kitts	35
Appendix 2	Range for Test Results and Averages	36
Appendix 3	How to Run a Percolation Test	37

1.0 INTRODUCTION

1.1 Issues

Tourism in the Caribbean depends heavily on environmental amenities such as white sand beaches, clean water, and yacht harbors. These amenities are not uniformly distributed among the islands and St. Kitts has a relative scarcity of these resources. There is no yacht harbor in St. Kitts-Nevis, and on St. Kitts there is only one truly "tourist quality" beach area currently accessible by road: Frigate Bay.

The Southeast Peninsula, which has been virtually undeveloped to date, has the environmental amenities required to support a substantial tourist industry. It offers several high quality sand beaches plus the potential to create a secure yacht harbor by dredging in the vicinity of the Great Salt Pond. To provide improved economic opportunity, it is desired to develop the Southeast Peninsula (south of Sir Timothy's Hill) as a resort area.

The environmental resources of the Southeast Peninsula are unique and irreplaceable. It is important to undertake development in an orderly manner to promote and maintain a competitive tourist industry and to conserve these environmental amenities for the enjoyment and economic utilization by future generations of Kittitians.

1.2 Scope

This report focuses on the Southeast Peninsula extending south from Sir Timothy's Hill for a distance of about four miles, as shown in Figure 1. This report:

* Identifies environmental issues which need to be addressed during development to maintain the highest quality of natural environment, consistent with sustaining a tourist industry based on the enjoyment of this environment.

* Suggests development strategies which are economical to implement, promote sustainable development, and protect the environment.

The recommendations contained herein are necessarily generalized; specific recommendations would require knowledge of specific development plans and development sites. This information was not available.

1.3 Study Methodology

This report was prepared on the basis of several visits to the SEP during 1988, limited field testing on the SEP (percolation tests), meetings with government officials and representatives of private enterprise, references to published reports, and the author's experience in the Caribbean.

1.4 Background Assumptions

For the purpose of establishing a baseline for evaluating future conditions and infrastructure needs, this study has used the "manageable growth" scenario prepared by Towle (1986b) and reproduced as Table 1. This table was prepared simply based on the selection of a percentage rate of growth, and the apportionment of this growth among the various parts of the island. Because there is potential for the early development of one or more hotels having more than 100 rooms during the initial phase of development on the Peninsula, early growth could exceed that which is projected in Table 1.

Water needs and consumption were previously projected by Morris (1988) based on Towle's projection presented in Table 1. The water demand computations made in the previous report were made on the following basis.

> "Water use at the existing rental units on the Southeast Peninsula is on the order of 50 gallons per capita per day (gpcpd)[1]. Water use at Frigate Bay[2] was estimated at 50 imperial gallons per capita per day, equivalent to 60 U.S. gpcpd. Mr. Rawlings[3] indicated that 100 gpcpd (per guest) should be used as a planning number for water demand, exclusive of irrigation needs."

Table 2 presents the water use projections, which have also been used as the basis for estimating future wastewater treatment needs using the assumption that 100% of water deliveries to living units appears as wastewater.

---

[1] Colin Pereira, Managing Director, Ocean Terrace Inn.

[2] William Liburd, Managing Director, Frigate Bay Dev. Corp.

[3] Director, Water Department

187

TABLE 1 **PROJECTED GROWTH OF THE TOURIST INDUSTRY ON ST. KITTS**
(Source: Towle 1986b)

	Now	Projections 5 Yrs	10 Yrs	15 Yrs	20 Yrs
Southeast Peninsula:					
Hotel Rooms	22	62	158	586	1157
Condominiums	0	0	0	0	137
2nd Homes	2	2	2	2	23
Frigate Bay:					
Hotel Rooms	415	594	853	975	1150
Condominiums	54	78	111	160	205
2nd Homes	14	31	48	67	85
Other St. Kitts:					
Hotel Rooms	160	200	207	220	225
Condominiums	0	0	0	0	0
2nd Homes	0	0	0	0	0
Total St. Kitts:					
Hotel Rooms	597	856	1059	1781	2532
Condominiums	54	78	111	160	342
2nd Homes	16	33	50	69	108

TABLE 2 **COMPUTATIONS OF WATER NEEDS ON THE SOUTHEAST PENINSULA ASSUMING FULL PROJECTED DEVELOPMENT 20 YEARS**

	Number of Units a/	Water Demand Per Unit	Total (US gal/day)
Hotel rooms	1157	200 b/	231,400
Condominium	137	200 b/	27,400
2nd Homes	23	400 c/	9,200
Golf course		d/	300,000
TOTAL			568,000

a/ Projected Year 20 values from Table 1.

b/ Daily requirement in U.S. gallons assuming 100% occupancy at 2 persons per unit and 100 gpcpd. Does not include irrigation.

c/ Daily requirement in U.S. gallons assuming 100% occupancy and 200 gal/day water use. Includes limited irrigation.

d/ Irrigation demand equivalent to one golf course based on the allocation of water to the 18-hole course at Frigate Bay. Part of the irrigation demand could be met through recycling of treated wastewater.

48

2.0 DESCRIPTION OF RESOURCE CHARACTERISTICS

2.1 Rainfall

Darby et al (1987) reported average rainfall on the Southeast Peninsula to be less than 40 inches/year. Rainfall at Cockleshell Bay (Appendix A) averaged 35 in/yr for the period 1963-1971. The Cockleshell Bay record is presented in Figure 2 and is compared to the rainfall for the corresponding period registered at the Agronomy Station near Basseterre. The figure shows that the seasonality of rainfall on the SEP is similar to that in the Basseterre area, but lower in magnitude.

Rainfall is lower on the SEP because it lacks hills of sufficient elevation to create orographic rainfall.

There are no data for rainfall of short duration for the SEP. For comparative purposes, rainfall depth-duration estimates prepared for the eastern portion of St. Croix, U.S. Virgin Islands, are presented in Table 3. Total annual rainfall and the topography on St. Croix is similar to the SEP, both are affected by similar weather patterns, and as a result they probably experience similar patterns of extreme rainfall. This data may be useful for developers to estimate runoff from small areas.

TABLE 3 DEPTH-DURATION RELATIONS FOR THE EASTERN PORTION OF ST. CROIX, U.S. VIRGIN ISLANDS (Source, U.S. Dept. of Commerce, 1961).

Duration	Point Precipitation Return Interval	Point Precipitation Depth (inches)
30 Minutes Duration:	1-year	0.75
	2-year	1.0
	5-year	1.4
	10-year	1.6
	25-year	2.0
	50-year	2.2
	100-year	2.5
	Probable Maximum	not avail.
60 Minutes Duration:	1-year	1.0
	2-year	1.3
	5-year	1.8
	10-year	2.1
	25-year	2.5
	50-year	2.9
	100-year	3.1
	Probable Maximum	9.0

Note: Given the small size of watersheds on the Southeast Peninsula of St. Kitts, the "time of concentration" will be on the order of 1 hour or less.

184

2.2 Soils

2.2.1 Hydrologic Groups

Soils are grouped into hydrologic classes "A" through "D" in order of decreasing infiltration capacity (i.e., increasing runoff potential). A soil in the "A" group has greater infiltration capacity, and will produce less runoff, than soils in the higher letter groups. The description of each group, as taken from Darby et al, is given below:

Group A: These soils have a high infiltration rate. They are chiefly deep, well-drained sands or gravels with low runoff potential.

Group B: These soils have a moderate infiltration rate when thoroughly wet. They are usually moderately deep, well-drained soils of moderately fine to moderately coarse texture.

Group C: These soils have a slow infiltration rate when wet. They are soils with a layer that impedes downward movement of water and soils of moderately fine to fine texture.

Group D: These soils have a very slow infiltration rate. They are chiefly clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan at or near the surface, and shallow soils over nearly impervious material. They have high runoff potential.

Soils on St. Kitts were mapped by Lang and Carroll (1966). According to their mapping, most flat soils on the SEP were reported to be sandy and to fall in Hydrologic Group "A". The remaining soils (on the slopes) were typically classified in Hydrologic Group "B".

However, on-site inspection of the soils on the Peninsula and the results of percolation tests indicated that the soils on hills are typically very shallow and bedrock lies at depths on 1/2 to 2 feet. Soils in flat areas contain a high clay content and have very low percolation rates. In either case they should be assigned to hydrologic group "D". The one significant exception is the sandy soil the area of the Great Sand Bank where a hydrologic classification of "A" is appropriate.

Soil tests made along the alignment of the road between White House Bay and Major's Bay further confirm the generally poor permeability of the deeper soils on the flatter areas. The soils report characterize these soils as follows, "As for drainage properties, it can be considered fair to practically impervious." (Appendix 2)

2.3 Peak Stormwater Runoff

Peak runoff from the principal watersheds on the Southeastern Peninsula were estimated by the author in an earlier report (Morris 1988) using the "Curve Number" technique developed for St. Kitts in Darby et al 1987 and soils mapping by Lang and Carroll. However, information developed during the present consultancy indicated that soils are actually less permeable than originally mapped, the estimates of peak runoff have been revised upwards using the "curve number" value appropriate to soils in hydrologic category "D". The revised calculations are presented in Table 4.

TABLE 4 SUMMARY CHARACTERISTICS OF SELECTED DRAINAGE BASINS ON THE SOUTHEASTERN PENINSULA, ST. KITTS a/

	Pond Area	Upland Area	Weighted Curve	Return Interval and Peak Discharge cfs)			
Basin	(acres)	(acres)	Number	10-yr	25-yr	50-yr	
S. Friar's Bay	10	95	78	313	558	727	b/
Canoe Bay	0	125	78	348	620	808	
Sand Bank Bay	0	96	78	317	564	735	
Mosquito Bay	18	362	78	696	1240	1616	
Cockleshell/Banana Bay	14	209	78	557	992	1293	
Major's Bay	22	183	78	487	868	1131	
Great Salt Pond c/	270						
NORTH	121	78	334	595	776		
WEST	56	78	202	360	469		
SOUTH	166	78	452	806	1050		
EAST	307	78	661	1178	1535		

Notes:

a/ This is an update of the same table presented in an earlier report by this author (Morris, 1988), which has been corrected to show higher curve number values due to the poor permeability and shallowness of soils on the Southeast Peninsula.

b/ Peak discharge values for all basins refers to discharge from the slopes; it does not include the additional contribution of rainfall onto the salt pond area.

c/ Several smaller watersheds drain radially into the Great Salt Pond.

A generalized relationship between drainage area and peak runoff was developed by applying the method of Darby assuming that ALL soils in the tributary area are in hydrologic group "D". This relationship, presented as Figure 3, should be useful for estimating peak runoff on the Peninsula.

191

2.4 Sea Level Rise

The increasing concentration of "greenhouse" gases in the atmosphere (principally carbon dioxide) is expected to increase global temperatures. One of the consequences of global warming will be the gradual thermal expansion of ocean water causing a global rise in sea level. Higher sea levels will increase the water surface elevations associated with coastal flooding. In coastal areas they will also increase water levels in coastal stormwater drainage systems because their discharge will be impeded by higher sea levels. Another anticipated consequence of global warming is an increase in the frequency and intensity of hurricanes.

Figure 4 compares the historic rise in global sea level (about 14 cm in the past century) against scenarios of future sea level rise as predicted by the U.S. Environmental Protection Agency. A significant (eg. one foot or 0.35 m) sea level rise may be apparent after about 35 years, and a rise of 2 feet (0.6 m) may occur within 50 years. The buildings being constructed today should be expected to still be in use 50 years in the future, and expected sea level rise should be incorporated into their design.

The apparent sea level change in St. Kitts will differ from the global average to the extent that it is affected by local tectonic uplift or subsidence of the island landmass. The change in apparent sea level in St. Kitts has not been analyzed to date.

No guidelines have yet been established for the implementation of measures to protect against the effects of sea level rise. Furthermore, as Figure 4 suggests, there is considerable uncertainty with respect to the rate and magnitude of future sea level rise. Nevertheless, that the sea level will rise is generally accepted in the scientific community and should be considered in development plans.

Based on the available information, it is recommended that minimum elevations in areas potentially affected by sea level rise should be increased by a minimum of 1.5 feet above the level indicated in the absence of sea level rise, and a 3-foot increase in minimum elevation would be preferable for permanent structures.

3.0 MANAGEMENT ALTERNATIVES

3.1 Management Objective

Problems in the management of stormwater, wastewater and solid waste are cheaper to avoid than to correct after the problem is recognized. For instance, a flooding problem that could have been prevented prior to development by appropriate siting of structures, may render a $50,000 house unfit for habitation. Similarly, the application of appropriate designs and construction practices can mean the difference between the successful operation or the failure of a costly wastewater treatment system.

Today the SEP is virtually undeveloped. This presents a singular opportunity to apply sound development guidelines which can prevent costly problems in the future.

3.2 Management for Flood Control

3.2.1 Stormwater Runoff

It should be relatively easy to protect development on the SEP against damage from stormwater runoff. No structures on the Peninsula are presently subject to damage by stormwater runoff, and proper building location and site design can easily prevent future structures from being damaged by runoff. However, because the Peninsula is usually dry, it is easy to forget the intense rainfalls that accompany tropical depressions will create runoff torrents that can devastate improperly located structures.

The following principles should be implemented to minimize or prevent damage of infrastructure by stormwater runoff.

1. At each proposed development site, identify the watershed boundaries and all natural drainageways and show these on development site plans. (The natural drainageway may be difficult to locate, since the guts on the SEP are not as well defined as guts elsewhere on St. Kitts.)

2. Compute the peak 50-year runoff where these natural drainageways cross the area to be developed, and demonstrate how this volume of runoff will be routed across the area to be developed. The relationship presented in Figure 3 may be used in undeveloped areas. However, if substantial development occurs upstream, the impermeabilization of soil by pavement and the increased efficiency of the drainage network can increase peak runoff to values even greater than those shown in Figure 3. Therefore, the 50-year runoff should be computed using expected future land use conditions if significant development of upstream areas is anticipated.

3. Do not construct structures that will obstruct the natural flow of floodwaters down guts. (Although this preventive measure sounds obvious, there is a hillside

193

development immediately south of the Monkey Bar at Frigate Bay that is constructed directly across a drainage gut).

4. When making hydraulic computations in areas where drainage is affected by the level of the sea, it should be assumed that the ocean is above its present normal level. There are two reasons for assuming the ocean will stand at a higher level. First, high rainfalls are often associated with tropical storms that produce high tidal levels. Second, the level of the ocean is projected to gradually rise over the coming decades. In making these drainage computations it might be reasonable to assume that the ocean level is three feet higher than today's normal level.

5. Require that each project engineer certify that the storm drainage system will adequately handle runoff entering the site from upslope, will dispose of runoff generated on-site, and will not cause damage to downstream areas.

6. Examine the consequences of a failure of each drainage system, and improve those designs where failure of the drainage system would cause substantial damage.

The last item can be particularly important but is commonly overlooked in drainage design. In the planning of drainage systems it is always important to keep in mind the consequences of "failure" of the drainage system. For instance, culverts may be designed for an event having a 10-year return interval, and its discharge capacity will be exceeded (the system will "fail") when a larger event occurs, such as the 50-year storm. Failure can also occur if lack of maintenance permits portions of the drainage system to become clogged with sediment or excessive vegetation. If the consequence of this failure is to simply flood the road for an hour or two then the design is acceptable. However, if the failure could cause houses or businesses to be flooded, this is not an acceptable consequence and the design must be improved.

3.2.2 Coastal Flooding

The high tidal levels associated with hurricanes can cause flooding of low-lying coastal areas. Areas near the beach may also be affected by substantially higher levels caused by wave action. Under the proper set of circumstances, the combination of high tide and hurricane waves can produce water levels on the order of 10 or more feet above mean sea level.

The determination of coastal flooding levels requires the availability of detailed nearshore bathymetry and the application of sophisticated computer models. Furthermore, bathymetry and modelling would be required for each individual beach on the SEP, since each is quite distinct in terms of both direction of exposure and the bottom profile. This work was beyond the scope of this report. Therefore, very general guidelines will be offered based on experience in Puerto Rico.

In the absence of local storm surge studies, and taking into consideration the devastating effect of a major hurricane, plus the problem of a gradually rising sea level, it is

recommended that substantial and permanent structures, including all structures used for human habitation, be constructed with a MINIMUM floor elevation at least 10 feet above mean sea level and not closer than 100 feet to the inland limit of the beach vegetation. Higher elevations and greater setback would be preferable.

In beach areas the primary dune protects inland areas from wave attack. To protect inland areas against storm surge and wave attack, as well as to preserve the favorable sediment balance needed to maintain beaches: (1) the primary dune should be absolutely protected against sand extraction, (2) vegetation on the dune should be maintained to prevent erosion, and (3) structures should not be constructed on the dune.

Although it has been many years since St. Kitts has seen a major hurricane, these storms do traverse the Caribbean and it is prudent to learn from the unfortunate experiences of others and build major structures at high enough elevations so that storm damage will be minimized. The problems of flooding and storm damage to structures that are common in built-up areas can be avoided on the SEP by using a conservative approach to the establishment of minimum building elevations. The projected rise in sea level is only one factor to be considered in establishing a minimum elevation. Another important factor is the lack of definitive information on the storm surge elevation for St. Kitts.

Given that the SEP has not yet been developed, and that there are high elevation sites available on virtually all areas of the Peninsula, it would be wise to use a somewhat conservative value for the minimum building elevation. Given the uncertainties in storm surge elevation, and the availability of high ground, no justification is seen for constructing on the lowest sites.

These setback and elevation restrictions would not apply to expendable wooden structures, such as the waterfront service structures occasionally used in resorts.

In the case of a substantial structure, such as a hotel, mathematical modelling should be undertaken to determine with greater certainty the recommended minimum elevations and setbacks required to provide the desired level of protection against storm waves. Marina design should also be based on detailed coastal engineering studies.

3.3 Septic Tank Systems

3.3.1 Limitations on the SEP

Septic tank systems are used for treatment and disposal of domestic wastewater throughout St. Kitts. The two-chamber septic tank design specified by the St. Kitts Dept. of Health and the sizing criteria of 40 gpd/person appear adequate for use on the SEP.

However, soil conditions on the SEP are quite different from the rest of St. Kitts and problems are anticipated on the SEP with respect to disposition of the wastewater. Two principal problems inhibit the disposal of septic tank effluent on the SEP: (1)

shallow soils on steep slopes, and (2) low permeability on flatter and deeper soils. Special attention must be given to the location, design, and construction of septic drainfields to prevent clogging of the drainage system or unsanitary ponding of wastewater on the soil surface.

Shallow Soils. A minimum soil depth of 5 feet is normally recommended for septic tank drainfields. Application of this standard would effectively prohibit the utilization of septic tanks on virtually any sloping soil on the SEP, where soils are normally less than two feet deep overlying bedrock. The use of mound systems can be used to overcome limitations of high water table or shallow soils, but only when soil slopes are about 10% or less. Most of the shallow soils on the SEP are MUCH steeper than 10%, which means that mound systems do not present a solution.

Poor Permeability. Percolation tests were performed at five sites on the SEP (see Table 5 and Figure 5). In the sandy soils at site #4 in the Great Sand Bank percolation rates were predictably high, requiring less than one minute to percolate 1 inch of water. However, at the other sites percolation rates were very low, typically requiring 60 minutes or more to percolate 1 inch of water. Special precautions must be taken to construct septic tanks on soils with such low percolation rates because drainfields have low capacity and will easily clog.

TABLE 5 RESULTS OF PERCOLATION TESTS ON ST. KITTS

Site	Percolation Rate (inches per minute)
Test Hole #1 (SE of Great Salt Pond)	76
Test Hole #2 (S of Great Salt Pond)	92
Test Hole #3 (nr. Cockleshell Bay)	58
Test Hole #4 (Great Sand Bank)	<1
Test Hole #5 (nr. White House Bay)	76

Note: Test hole sites are given in Figure 5.

This section analyzes both types of soil restrictions and recommends strategies for overcoming these limitations.

3.3.2 Shallow Soils on Slopes

The objective of a septic tank drainfield is to disperse the wastewater underground where waste materials are decomposed and pathogens are immobilized through the biological process that occur in the soil. Septic tank effluent should always remain below the soil surface to eliminate the potential for the transmission of disease.

As a compromise between the desire to permit at least limited development on slopes, and the need to provide a safe means of effluent disposal, a non-conventional wastewater disposal system has been designed for sloping soils on the SEP. The objective of the system is to introduce septic wastewater into the shallow sloping soil and allow it to percolate down-slope within the plant root zone, until it is completely evaporated by natural vegetation within a "buffer zone".

This unconventional disposal method is expected to function adequately on the SEP based on the combination of steep soil slopes, generally adequate percolation characteristics within the soil root zone, limited rainfall coupled with high rates of evapotranspiration, no access into the buffer zone, low development density (about 1 unit per 2 acres), and reduced hydraulic loads as a result of using low volume toilets. The proposed system has been designed using a large safety factor.

A schematic diagram of the recommended system is presented in Figure 6 and design and construction recommendations are given below:

1. The soil slope should exceed 10% to promote drainage away from the distribution pipe.

2. The hydraulic load should not exceed one gpd per linear foot of drain.

3. Provide a buffer zone of 300 feet of natural undisturbed vegetation between the drainage trench and the adjacent downslope property. This buffer largely prevents wastewater from entering adjacent property via conduits such as rock fracture. If experience indicates that the loading rate on the distribution pipe is excessive, the buffer zone provides land area for installation of a drop box and the construction of another set of distribution pipes downslope.

4. The distribution pipe should be laid on the contour. It should consist of 4 inch diameter PVC with 1/2 inch diameter perforations on the bottom and sides at intervals of about 4 inches.

5. Install water-conserving toilets (less than 2.5 gal per flush) to reduce the hydraulic load on the drainfield.

This system has been designed incorporating a large safety factor and should work well if installed as designed. However, it is an unconventional system and the first systems that are installed should be inspected and carefully monitored by the Dept. of Health to verify the adequacy of their construction and operation. Experience may dictate changes in the design.

147

3.3.3 Deep and Poorly Permeable Soils

Most of the relatively flat and deep soils on the SEP have very low percolation rates. The basic strategies that may be used to overcome this limitation are: (1) location of drainage fields in the areas of highest percolation, such as in guts; (2) limit hydraulic loads by using low volume toilets and shower heads; (3) provide adequately sized drainfields; and (4) use extreme caution during drainfield construction to prevent compaction of the soil.

Both the potentials and problems of septic tanks on the SEP are illustrated by two systems operating at Banana Bay. The drainfield for one of these systems was located in an area of gut sand with good percolation properties. Because it took advantage of localized soil conditions which offered good drainage, this system works properly, even though the surrounding soils are clayey and drain poorly.

However, a second system serving the kitchen and adjacent to the beach has been plagued by wastewater ponding due to a combination of high hydraulic load, clayey soils, and possibly high groundwater level (the drainfield is close to sea level). To correct this problem the drainfield has been enlarged and sand about one foot deep spread over the area of ponding water, and this mound is now colonized by moisture-loving vegetation. Despite these improvements and limited use due to the low tourist season (summer), moisture was still evident on top of the soil.

The following procedures are recommended for designing a septic drainfield on the SEP:

1. First use a soil auger to locate areas on the development site with the coarsest soil structure (most sand, least clay) and, therefore, most likely to have the highest percolation rates. Permeable soils are most likely to be found in the guts.

2. Run percolation tests to determine the percolation rate. Soils having a percolation rate slower than 120 mpi are NOT SUITABLE for a disposal field. Appendix "C" presents percolation test procedures.

3. Use drainfield trenches of the design shown in Figure 7.

4. Reserve room on the site for construction of a second disposal system if the first fails. These two systems can be used alternately, since a prolonged resting period can possibly restore the capacity of the clogged drainfield.

5. Keep the area of the drainfield vegetated, since the plant roots will help evaporate the water.

198

6. Size drainfield trenches based on 40 gallons of wastewater per capita per day, and using the application rate from the table below based on the percolation test results:

Percolation Test Rate (min/inch)	Wastewater Application Rate (gpd/ft^{2}trench)
<1	not suitable
1 - 5	1.5
6 - 15	1.0
16 - 30	0.75
31 - 60	0.55
60 - 120	0.33
> 120	not suitable

Wastewater generation can be based on 25 gallons per capita per day if BOTH a water-conserving toilet (less than 2.5 gallons per flush) and water-conserving shower heads are installed.

(Note: Very sandy soils which require less than one minute to percolate one inch of water are unsuited for septic drainage because they are too permeable to provide treatment of the wastewater.)

7. Dig the drainfield only when the soil is relatively dry (the soil moisture must be less than the plastic limit). If a small piece of soil from the depth of the proposed excavation can be easily rolled into an 1/8 inch diameter thread, then the soil is too moist for drainfield construction. Excavation and other construction work will cause severe compaction of the soil and the drainfield will be ruined.

8. Never allow the wheels or tracks of any construction equipment to touch the bottom of the drain trench since this will compact the soil. Roughen the bottom and sides of the trench with a rake prior to placing the sand and gravel, and remove the loose soil.

9. To help increase percolation, place a layer of coarse sand at six inches thick on the bottom of the trench, and place trench rock on top of this sand, as illustrated in Figure 7.

Using the above criteria, a house for a family of five with water-conserving plumbing fixtures installed would generate 150 gpd of wastewater and would require (150/0.33) = 455 square feet of trench area. Assuming the trench is 1.5 feet wide, a total of 303 linear feet of trench would be required using three laterals, each 100 feet long.

199

3.4 Centralized Wastewater Treatment Systems

3.4.1 Treatment Strategy

Ideally, a centralized wastewater treatment system should: be inexpensive to construct and operate; provide an acceptable level of treatment on a reliable basis; be simple to operate and maintain; have minimal dependence on difficult-to-obtain replacement parts; and be easily expandable. The closest to this idealized system that is suitable for use on St. Kitts is a wastewater treatment system consisting of primary treatment followed by a constructed wetland.

The alternative of using a conventional mechanical wastewater treatment system was examined in a prior report (Morris 1988). In that report it was noted that the experience with conventional treatment systems in the Caribbean (including St. Kitts) has been poor. Although the conventional mechanical systems are capable of providing high levels of treatment, they usually don't because of lack of maintenance and poor operation. Similar observations were contained in reports by Towle (1986a) and UNEP (1985). A section of the UNEP report is reproduced below:

> "Sewage disposal by hotels is a serious problem throughout the region, particularly where the scale of the project is such that the local capacity for handling it is insufficient. On occasion, hotels establish their own treatment plants which may or may not operate efficiently. The result, in many cases presented to the meeting, is pollution of the very beaches on which tourism depends." (p. 5,6)

> "Secondary treatment sewage package plants are commonly used methods for the treatment of sewage in the tourist industry. Although most package plants are designed as temporary facilities not meant to last more than a few years, in practice these plants are used permanently at the development site. However, malfunctioning of these plants has resulted in sewage pollution being evident at many of the beaches used by tourists and residents. The malfunctioning of these plants is due to inadequate maintenance of the plants both in terms of day-to-day maintenance and of the replacement of parts on a regular basis. In many instances inadequate daily maintenance is due to the fact that untrained people are required to operate the plants." (p. 9)

As an alternative to mechanical treatment systems, "constructed wetlands" can be used to provide secondary treatment of municipal wastes. This new and innovative technology can offer important advantages to St. Kitts:

1. Construction costs (including land purchase) are approximately half that of a conventional waste treatment plant.

2. Treatment systems can be designed to eliminate all moving mechanical equipment.

200

3. Sludge production in the secondary treatment phase is zero.

4. Lacking mechanical equipment, operating and maintenance costs are very low and energy utilization is virtually zero.

5. The use of smaller treatment plants is facilitated, potentially eliminating the need for force mains to a centralized treatment unit.

Constructed wetlands require primary level pre-treatment, and can be used to achieve secondary or tertiary treatment levels.

The use of constructed wetlands is a technology approved for use in the United States by the U.S. Environmental Protection Agency having demonstrated effectiveness in the treatment of municipal wastes and certain industrial wastes in temperate areas. As an advantage to St. Kitts, this technology is probably more appropriate to tropical conditions with year-around warm temperatures.

Experience to date indicates that constructed wetlands are relatively immune to upsets by peak hydraulic loads, as occur in areas with infiltration problems in the sewer collection system.

As a potential disadvantage, constructed wetlands require approximately 10-20 acres of land area to treat one mgd of wastewater[4]. (Loading rates ranging from about 5-20 acres/mgd have been used on the United States mainland.) However, a constructed wetland can be developed as an aesthetically pleasing odor-free green space, in contrast to unsightly mechanical treatment plants.

Wetland treatment systems are similar to trickling filters; treatment is provided by organisms growing on a fixed substrate. In the case of constructed wetlands the substrate consists not only of rocks, but also of plant material. The wetland plants make an important contribution to treatment efficiency by creating a large surface area for the growth of attached organisms that actually break down the wastewater, and they also assist in oxygen transfer. Performance of the systems improves over time as the vegetation becomes better established. For more information see Dinges (1982), Reed et al (1986), Wolverton and McDonald (1982), Wolverton et al (1984), and Reddy and Smith (1987).

3.4.2 Primary Treatment

A wide range of primary treatment systems may be used prior to a constructed wetland. Small constructed wetlands may use a conventional septic tank and larger systems may use a conventional primary clarifier of Imhoff tank. Such systems are typically capable of removing about 30% of the influent BOD load. Some systems have used a high

[4] The projected 20-year wastewater load on the SEP is around 0.3 mgd.

201

efficiency anaerobic primary reactor, capable of consistently removing as much as 70% of the influent BOD (Harris et al, 1985).

There are two basic alternatives for septage disposal. The first alternative would be to discharge septage into an enlarged wastewater treatment facility that may be constructed at Frigate Bay. (This would not eliminate the sludge disposal problem, because this strategy would increase the volume of sludge produced at Frigate Bay, which in turn must be disposed of somewhere).

The second alternative is land spreading, such as in agricultural areas north of Frigate Bay. The land application of digested sludge is an accepted practice and is used in some of the larger U.S. cities such as Chicago and Denver (Culp, 1979).

Because of the large area of agricultural land on St. Kitts in relation to the expected septage volumes, combined with the high rates of organic decomposition under tropical conditions, no difficulty is foreseen with the land spreading of anaerobically digested sludge (septage) in sugarcane areas.

It is recommended that the sludge be applied to sugarcane lands because it can act as a soil conditioner and fertilizer. The most limiting constituent in the sludge will probably be nitrogen. Anaerobically digested sludge can be expected to contain about 50-70 pounds of Nitrogen per ton on dry sludge. Assuming 2% solids in the sludge and 60 lb•N/dry ton, each acre-foot[5] of sludge will contain about 1630 lb of Nitrogen. (Each 1000 U.S. gallons of sludge will contain about five lb of Nitrogen). The amount of nitrogen that can be applied to sugarcane is limited, and it is common practice to reduce eliminate nitrogen applications prior to harvest to stimulate the production of sugars.

Assuming that 200 lbs of nitrogen are to be applied to an acre each year, this is equivalent to the application of 0.12 acre-feet (40,000 gallons) of sludge per year on one acre. In other words, this is equivalent to the application of sludge to a depth of 1.5 inches.

Sludge production depends on the type of primary sedimentation process and the level of digestion achieved. Warm tropical temperatures plus long storage times both tend to favor more complete digestion. Assuming that primary tanks are used in which sludge is digested in place (eg. a septic tank or Imhoff tank), each 1.0 mgd of wastewater will produce about 120-250 ft^3 of liquid anaerobically digested sludge (Babbitt and Baumann, 1958, p 573). Using the higher value of 250 ft^3/MG, and a daily sewage discharge of 0.3 mgd for the SEP, this results in daily liquid sludge production on the order of 75 ft^3 (561 gal) per day. Over one year the sludge production would be about 205,000 gallons. In other words, all the primary sludge projected to be produced on the SEP 20 years in the future could be disposed on five acres of sugarcane land.

---

[5] An acre-foot contains 325,800 U.S. gallons.

202

If it is inconvenient to incorporate this into a sugarcane planting, the sludge disposal area could be used for other purposes, such as production of forage. (Sludge should not be applied to lands where crops such as vegetables will be consumed by humans without processing.) Where nitrogen loading is not considered a problem, the sludge loading can be greatly increased. For instance, Culp (1979) indicates that the Philadelphia, Pennsylvania northeast water-pollution-control plant uses land application rates equivalent to 11 inches of sludge/year, about seven times the application rate of 1.5 inches/year discussed above for sugarcane on St. Kitts). The limiting factor in the Philadelphia case it that nitrate-nitrogen leaching into groundwater should not exceed 10 mg/l.

The opportunity for land disposal of septage within the SEP is limited primarily by conflicts with tourist oriented development and concerns about potential runoff of nutrients into nearshore waters as a result of heavy rainfall on the sludge farm area. The limited permeability of the SEP soils also poses a potential problem that could limit sludge loading rates.

3.4.3 Constructed Wetlands

A constructed wetland is a system that is wetland system specifically constructed to facilitate wastewater degradation by microbial action; it does not use existing natural existing wetlands for treatment.

Constructed wetlands would be fed fresh wastewater, not the brackish or saline water now found on the SEP. The constructed wetland would be an "artificial" system, different from the high salinity wetlands that occur naturally on the SEP. Cattails or other freshwater species (eg. sedges, bulrush) that currently do not grow in the SEP would grow in these constructed freshwater wetlands.

Different types of constructed wetlands have been used. Two alternative types of system can be considered in St. Kitts: (1) submerged gravel bed, and (2) open water surface wetland.

Submerged Gravel Bed. Physically, this system consists of a shallow gravel bed about 2 feet deep. The bottom layer of gravel is typically in range of 1.5-3 inch diameter and is covered with pea gravel to a depth of about 6 inches. The system is sized to provide a minimum of 24 hours detention within the bed with the water surface about 4-6 inches below the top of the gravel. Disinfection of the effluent is required for control of potential pathogens. A schematic diagram of a typical system is presented in Figure 8.

In the submerged bed system, a number of researchers consider the "rhizosphere" (zone surrounding root hairs) to be particularly important in the complete degradation and mineralization of solids within the gravel bed. Although the gravel bed is generally anaerobic, the root surfaces of wetland plants provide aerobic micro-sites and an associated high level of biological activity which is effective in waste degradation.

Typical operating parameters for gravel-bed constructed wetland systems (temperate zone) are:

Pre-treatment	Primary.
BOD Loading rate	100 lb/acre-day (higher rates have been used)
Min. Detention time	24 hours within the bed
Gravel depth	2 feet
Effluent quality	Meet or exceed 30/30 limits for BOD_5 and TSS

Submerged gravel bed wetland systems for treating municipal wastewater have been constructed in sizes ranging from individual homes (treating septic tank effluent) to a 4 mgd system that is now entering service in Denham Springs, Louisiana.

Open Water Surface Wetland. In this system the wetland consists of a body of shallow water, about one foot deep, in which wetland plants grow. In St. Kitts this system would be most likely entirely colonized by typha (cattail). Because the water surface is exposed to the atmosphere the water tends to be oxidized. These systems generate no odor and may be used by wildlife. The open surface systems in temperate regions require approximately 20 acres to treat a flow of 1 mgd, which is about double the land requirement of the submerged gravel bed to achieve the same level of treatment. In a tropical environment with year-around warm temperatures this land requirement might be reduced to 15 acres/mgd. Primary pre-treatment is required as is disinfection of the effluent for pathogen control. These systems have been constructed at a number of sites in the southern U.S. to provide secondary treatment.

Land utilization. A constructed wetland uses between 10-20 acres to provide treatment for 1 mgd of wastewater. The projected wasteload on the SEP is about 0.3 million gallons per day (0.3 mgd), meaning that about 3 to 6 acres of land will be needed. This is a small land requirement compared to the availability of land on the SEP.

Flooding during a storm. Constructed wetlands used for wastewater treatment are built with a small perimeter berm or dike to prevent surface runoff from entering them. The only water that enters is from the sanitary sewer plus rainfall directly on the surface of the wetland. Thus, the only hydraulic loads that they will be subjected to from the storm are rainfall on their surface and rainfall infiltration into the sewer system. Experience to date with constructed wetlands indicates they are more resistant to hydraulic overloads than conventional wastewater treatment systems, and thus will perform better in response to sewer infiltration than a conventional treatment plant. The hydraulic load of rainfall on the wetland surface is not considered a problem.

Effluent water quality monitoring. The quality of effluent from all sewage treatment plants should be monitored.

The constructed wetland was selected because it does not require sophistication to operate and it does not use mechanical equipment (except for disinfection). Monitoring requirements would be less critical than for a conventional treatment plant.

204

Mosquito control. The "submerged gravel bed" system (Figure 8) does not have an open water surface, so there is no place for mosquitoes to breed and no mosquito problem can be created. The submerged gravel bed uses less land area than an open water wetland but is more costly to construct.

The open water surface wetland does have open water and mosquitoes could become a problem, depending on local circumstances and the mosquito species present. For instance, the mosquito species that inhabit the brackish or saline water in mangroves may not reproduce in the fresh water within a constructed wetland. Mosquitoes have not been reported to be a problem in constructed wetlands in the southeastern United States. This issue should be addressed in future work if it is desired to use an open water surface type wetland.

3.4.4 Effluent Disposal

This section discusses several of the effluent disposal alternatives that have been considered on the SEP. The basic objectives are to dispose of secondary effluent (treated wastewater) in a manner that does not pose a potential heath hazard and that does not significantly increase nutrient levels in the nearshore environment.

High rate land application and infiltration. The alternative of land application and percolation is not feasible because of the poor infiltration capacity of the soils.

Deep well injection. Deep well injection is useful where there is a permeable bedrock, such as the deep limestones in Florida or Puerto Rico which have developed high secondary permeability. However, the rock formations in St. Kitts are of poorly permeable volcanics. The only possibility for an injection well would be to find a zone of substantial fracture, this prospect is not likely to be good. Accordingly, the potential for deep well injection is considered very low.

Ocean disposal. Effluent discharge to the ocean through a long outfall is a good disposal alternative. Unfortunately, outfalls are very expensive, especially if there will be several distributed sewage treatment plants, each requiring its separate outfall.

The strategy of a centralized sewage disposal system (with one outfall) has been eliminated due to the high cost of transmission and pumping from the various parts of the SEP to the central sewage treatment plant location. For instance, not only is Friar's Bay several kilometers from Fleming Estate, but there is also a mountain range separating the two (very high transmission costs). Thus, waste disposal to the ocean would require not just one, but at least two outfalls, with a corresponding escalation in costs.

Because the wastewater volumes anticipated on the SEP are relatively small, wastewater sources will be dispersed, and other disposal alternatives are available, the alternative of a long ocean outfall is discarded.

A short outfall would result in disposal into the nearshore marine environment. Use of a short outfall in unacceptable for two reasons: (1) it could also pose a sanitary hazard to bathers, and (2) it could cause nutrient enrichment and undesirable algae growth in the nearshore coral and rock formations which are accessible to tourists with snorkel gear.

Land application. The land application of treated wastewater (irrigation) is a good effluent disposal alternative and would be technically feasible on the SEP. It has two strong advantages: (1) it provides irrigation water in an area deficient in rainfall, and (2) it provides fertilizer to the golf course, in substitution of the purchase of commercial fertilizers.

An irrigated (eg. a golf course) will probably be able to use about 90 inches of irrigation per year (based on the application of 1/4 inch/day). Sprinkler irrigation is the only type that will be feasible. A 9-hole golf course could probably use all the 0.3 mgd of wastewater expected to be produced on the SEP. (One quarter inch per day over 50 acres is 0.34 mgd.)

Irrigation would occur at night when the course is not in play. It would be necessary to provide a temporary storage lagoon for the wastewater. To dispose of the wastewater it would be necessary to irrigate year-around, even when it is raining. Because of the low permeability of the soil, it is possible that a lower irrigation rate than that mentioned above would be more appropriate, and during rainy periods irrigation may need to be curtailed to allow the course to dry out. This would mean that an alternative disposal area may be needed for periods when irrigation could not be practiced.

Other landscaped areas in addition to or instead of the golf course could be considered for the land application of treated sewage. The application of wastewater to several separate landscaped areas, each near a sewage treatment plant, would eliminate the problem of the cost of transmitting treated wastewater from the treatment site(s) to the irrigation site(s). Most of the sewage may not be generated near the golf course, which will require costly pipelines and pumping.

The principal impediment to land application is institutional. The use of wastewater for irrigation would require that the control over disinfection be MUCH MORE STRICT than what is being done on St. Kitts at present to prevent the spread of disease, or even the APPEARANCE of spread of disease. The use of treated wastewater for irrigation can be recommended, only if very strict disinfection standards are conscientiously applied with twice-daily monitoring and record-keeping by plant operating personnel and weekly surveillance and testing by the Department of Heath for as long as the system is in use.

Discharge to salt ponds. The alternative of disposal to the salt ponds has been selected as a "compromise" effluent disposal alternative.

The discharge of wastewater into salt ponds will cause ecological changes. The nutrient loading will increase the growth rates of algae in the high salinity areas, or mangroves in areas of lower salinity. The wastewater will also decrease salinities, which would

promote the growth of mangroves in the salt ponds. Although the growth of mangroves is generally considered to be ecologically "good", the spread of mangroves in the smaller salt ponds would reduce the feeding area for migrating shorebirds (which tend to feed in shallow open waters but not mangroves), and this could be interpreted as ecologically "bad".

The Great Salt Pond is currently of relatively little ecological value due to its high salinity which severely limits biological productivity. Disposal of effluent into the great salt pond would probably be "good" ecologically because it would reduce salinities. However, the waste volume would probably not be sufficient to significantly affect the high salinities; evaporation is estimated at 1.75 mgd[6] and only 0.3 mgd of sewage will be available. Salinities could only be reduced significantly by connecting the Great Salt Pond to the ocean, as would occur if it were used as a marina.

It is anticipated that the problem of algal blooms in the Great Salt Pond would be controlled by the high salinity.

3.5 Solid Waste Management

3.5.1 Solid Waste Volumes

Residential & Hotel Wastes. Within 20 years there may on the order of 1150 hotel units on the SEP, with an additional 150 condominium and house units (Towle 1986b). Information from OTI (Basseterre) and the Jack Tar Hotel (Frigate Bay) suggests that during operation a compacted solid waste volume of approximately 0.3 -0.5 ft^3/day could be anticipated from each occupied unit. Using the higher figure of 0.5 ft^3/day and the rate of growth projected by Towle, this is equivalent to a daily waste volume of 24 cubic yards within 20 years. This works out to 168 cubic yards/week, which will require 3 trips/day by a 10-yard compactor truck, five days per week, to transport to Conaree.

Other Solid Wastes. An additional volume of waste will be generated by commercial establishments and marina activities at the proposed Town Center. However, no projections of commercial activity are available on which to base solid waste projections. There is no basis for estimating landscape wastes.

3.5.2 Disposal Alternatives

Most solid wastes in St. Kitts are disposed at the Conaree dump immediately east of the airport runway. The Conaree site, the principal solid waste disposal site on St. Kitts, is operated as an open dump where burning is practiced. It receives a variety of wastes which can be classified into four principal categories: sugarcane bagasse, construction

---

[6] Based on annual average pan evaporation of 88 inches/year measured for similar climate at Aguirre on the South Coast of Puerto Rico, and 270 acres of pond area.

20

rubbish, landscape rubbish, and commercial and residential wastes including paper and kitchen waste. Burning dramatically reduces the volume of the waste. Conaree is the closest waste disposal site to the SEP.

Three basic alternatives for the disposal of wastes from the SEP were considered: landfill on the SEP, disposal at the existing Conaree dump, and incineration.

Disposal at Conaree. As an advantage, wastes will be removed from the SEP and will be disposed at a site which has already been impacted by wastes.

The principal disadvantage to disposal at Conaree is the cost of haulage. The distance from the Great Salt pond to Conaree will be approximately eight miles (each way) when the new road is completed.

Disposal on the SEP. As a benefit, this alternative would reduce, but not eliminate, haulage. However, if it is desired to emphasize the environmental amenities on the SEP, then this is not the place to site a solid waste site. Experience at Conaree (eg. lack of equipment and supervision) suggests that sanitary landfill procedures will be difficult to implement on the SEP. A new disposal site on the SEP may simply become an unsightly dump with open burning, similar to the existing situation at Conaree.

Incineration. The alternative of using incineration equipment has been discarded for the SEP primarily because incineration equipment will be relatively costly to purchase, and there is no assurance that it will be maintained and operated properly for a long period of time. Also, incineration would not eliminate haulage; to operate an incinerator would require a truck plus an incinerator

3.5.3 Potential Disposal Sites

The SEP area was examined for a potential soil waste disposal site using the following principal criteria:

1. The site should not overlie highly permeable soils where landfill leachate would contaminate downstream groundwater or nearshore ecosystems.

2. The site should be relatively hidden so it will not detract from the scenic amenities of the Peninsula.

3. The site should be located so that odors or smoke will not create aesthetic problems.

4. The site should be centrally located and accessible.

5. The site should have a relatively thick layer of soil to permit shallow trenching and burial.

The site shown in Figure 5 most nearly met all of these criteria. Although it is upwind of potential development areas around the Great Salt Pond, it does have the advantage of being separated from the Great Salt Pond by a ridge. If burning occurs at this location, the smoke will be dispersed aloft as it is blown over the ridge by the prevailing easterly tradewinds. Furthermore, this ridge is unsuited to development due to steep slopes and the lack of access. This site may be considered for disposal of construction and landscaping wastes, as described in the next section.

3.5.4 Recommended Disposal Alternatives

Construction rubbish. The refuse generated during the process of construction may include vegetation and topsoil, wood and other residue from concrete formwork, metal, concrete, and of containers such as bags and cans. This rubbish is generated only at the time of construction.

Construction rubbish can either be buried on the SEP or hauled to Conaree. Some construction waste (especially topsoil and vegetation removed during the site clearing) may have buried beneath earthen mounds created as parts of the site landscaping. Haulage to an approved off-site disposal site should be the responsibility of the contractor.

Landscape wastes. The vegetative rubbish generated year-around as a result of pruning and other landscaping tasks can be disposed on the SEP because it will not be large in volume, is not unsightly, and does not present special problems from the aspect of vermin, etc.

Some of the wastes generated during landscaping procedures can include pesticides. Special disposal precautions are generally imprinted on the container.

Residential/commercial waste. These wastes will consist largely of paper and kitchen wastes, and it is recommended that they be hauled to Conaree for disposal. Their disposal on the SEP will be problematic because of their large volume, paper can be carried by the wind, potential odor problems, vermin, and open burning.

Conaree Dump. There are problems with the operation and location of the Conaree dump. For instance, its location at the end of the runway and alongside the highway virtually insures that it will be seen by tourists. Agricultural wastes (sugarcane bagasse) was observed at the dump, whereas this material would be better used by being re-applied to the soil rather than occupying space at the dump. Also, the dump is encroaching onto a mangrove forest. The potential for re-placement of the Conaree dump with a sanitary landfill at another site should be investigated.

4.0 REFERENCES

Babbitt, Harold E. and E. Robert Baumann. 1958. Sewerage and Sewage Treatment. John Wiley & Sons. New York.

Culp. Gordon L. 1979. Handbook of Sludge-Handling Processes. Garland Publishing Inc. New York.

Darby, Gerald, James Fisher, John Geter and Richard Highfill. 1987. "St. Kitts Soil Conservation Planning Guide and Handbook" Prepared by Devres Inc. for Ministry of Agriculture, St. Kitts.

Dinges, Ray. 1982. Natural Systems for Water Pollution Control. Van Nostrand Reinhold. New York.

Harris, Michael T., Terrence L. Donaldson, Richard K. Genung, Angel L. Rivera and Charles W. Hancher. 1985. "The Loves Creek Anaerobic Upflos (ANFLOW) Pilot Plant: Performance Summary". U. S. Environmental Protection Agency, EPA/600/S2-85/040. Cincinnati.

Kaplan, Benjamin O. 1987. Septic Systems Handbook. Lewis Publishers, Chelsea, Michigan.

Lang, D. M. and D.M. Carroll. 1966. "Soil and land-Use Surveys No. 16: St. Kitts and Nevis." Imperial College of Tropical Agriculture, Trinidad, W.I.

Machmeier, Roger E. 1981. "Town and Country Sewage Treatment" Univ. of Minnesota, Extension Bulletin 304. St. Paul.

Morris, Gregory L. 1988. "Water-Related Environmental Issues: Development of the Southeastern Peninsula, St. Kitts, West Indies." Report to Tropical Research & Development, Gainesville, Florida and the Southeast Peninsula Board, St. Kitts. U.S.A.I.D., Barbados.

Reddy, K.R. and W.H.Smith (eds.) 1987. Aquatic Plants for Wastewater Treatment and Resource Recovery. Magnolia Publishing Inc., Orlando, FL.

Reed, Sherwood C., E. Joe Middlebrooks and Ronald W. Crites. 1986. Natural Systems for Waste Management and Treatment. McGraw-Hill. New York.

Towle, Edward L. et. al 1986a. "Environmental Assessment Report on the Proposed Southeast Peninsula Access Road, St. Kitts, West Indies." U.S.A.I.D./Barbados funded Report by Island Resources Foundation, St. Thomas, prepared for Govt. of St. Kitts and Nevis.

Towle, Edward L. et. al 1986b. "Land Use Management Plan for the Southeast Peninsula, St. Kitts, West Indies." U.S.A.I.D./Barbados funded Report by Island Resources Foundation, St. Thomas, prepared for Govt. of St. Kitts and Nevis.

United Nations Environment Program (1985). "Report of the Wider Caribbean Expert Meeting of Tourism and Environment in Caribbean Development." Report of the Econ. Com. for Latin America and the Caribbean on the meeting 2-4 Dec. 1985, Port-of-Spain, Trinidad and Tobago.

U.S. Dept. of Commerce. 1961. "Technical Paper 42: Generalized Estimates of Probable Maximum Precipitation and Rainfall-Frequency Data for Puerto Rico and Virgin Islands". Superintendent of Documents, Washington, D.C.

U.S. EPA. 1980. "Design Manual, Onsite Wastewater Treatment and Disposal Systems". Office of Water Program Operations, Report EPA 625/1-80-012, Washington, D.C.

Wolverton, B.C. and R. McDonald. 1982. Basic Engineering Criteria and Cost Estimations for Hybrid Microbial Filter-Reed (Phragmites communis) Wastewater Treatment Concept. NASA Space Technologies Lab. Mississippi.

Wolverton, B. C., R. C. McDonald, C.C. Myrick and K. M. Johnson. 1984. "Upgrading septic tanks using microbial/plant filters. Jour. MS Acad. Sci. 29:19-25.

211

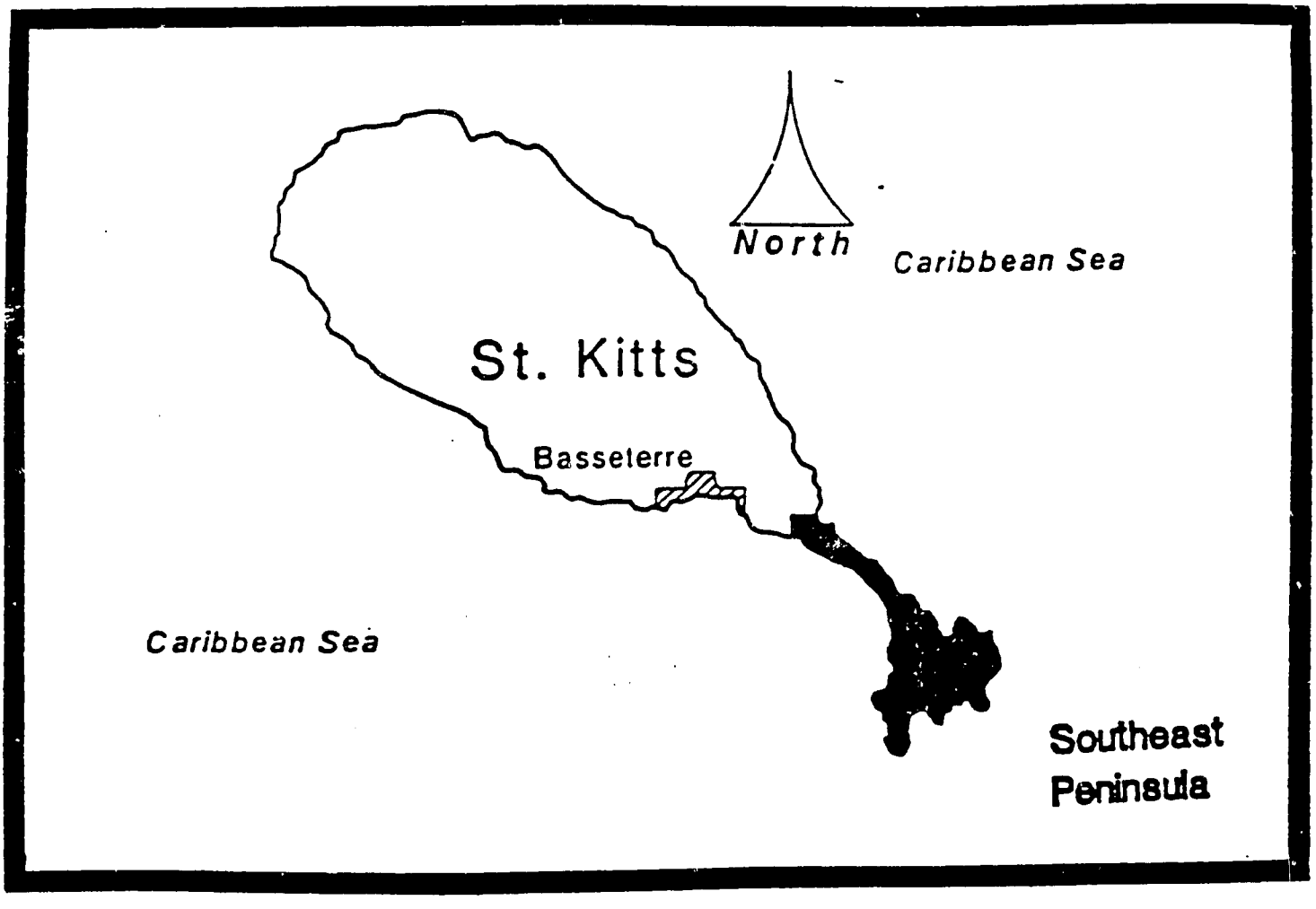


Figure 1: Site location map.

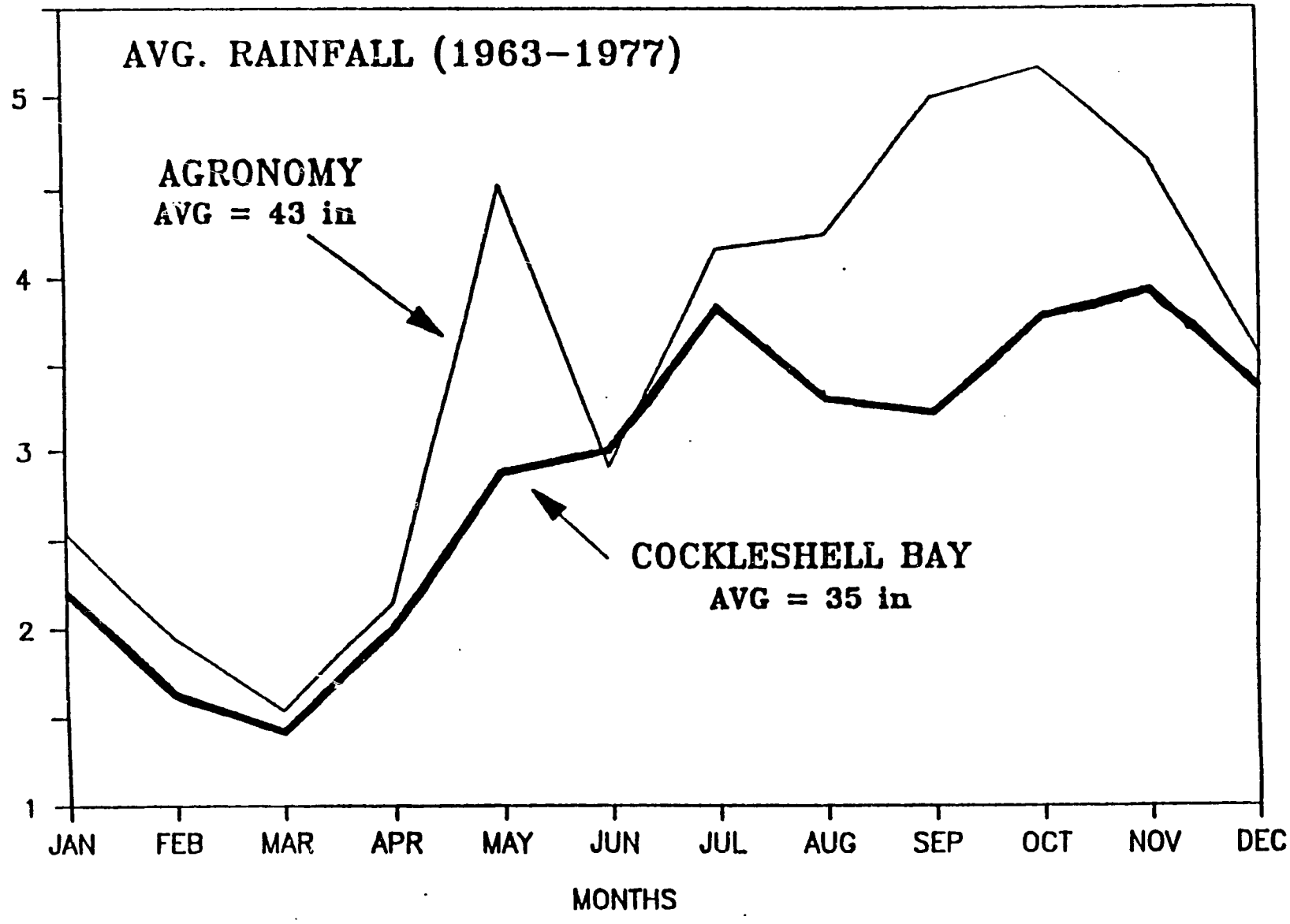


Figure 2: Monthly rainfall at Cockleshell Bay on the Southeast Peninsula, as compared to rainfall during the same period at the Agronomy

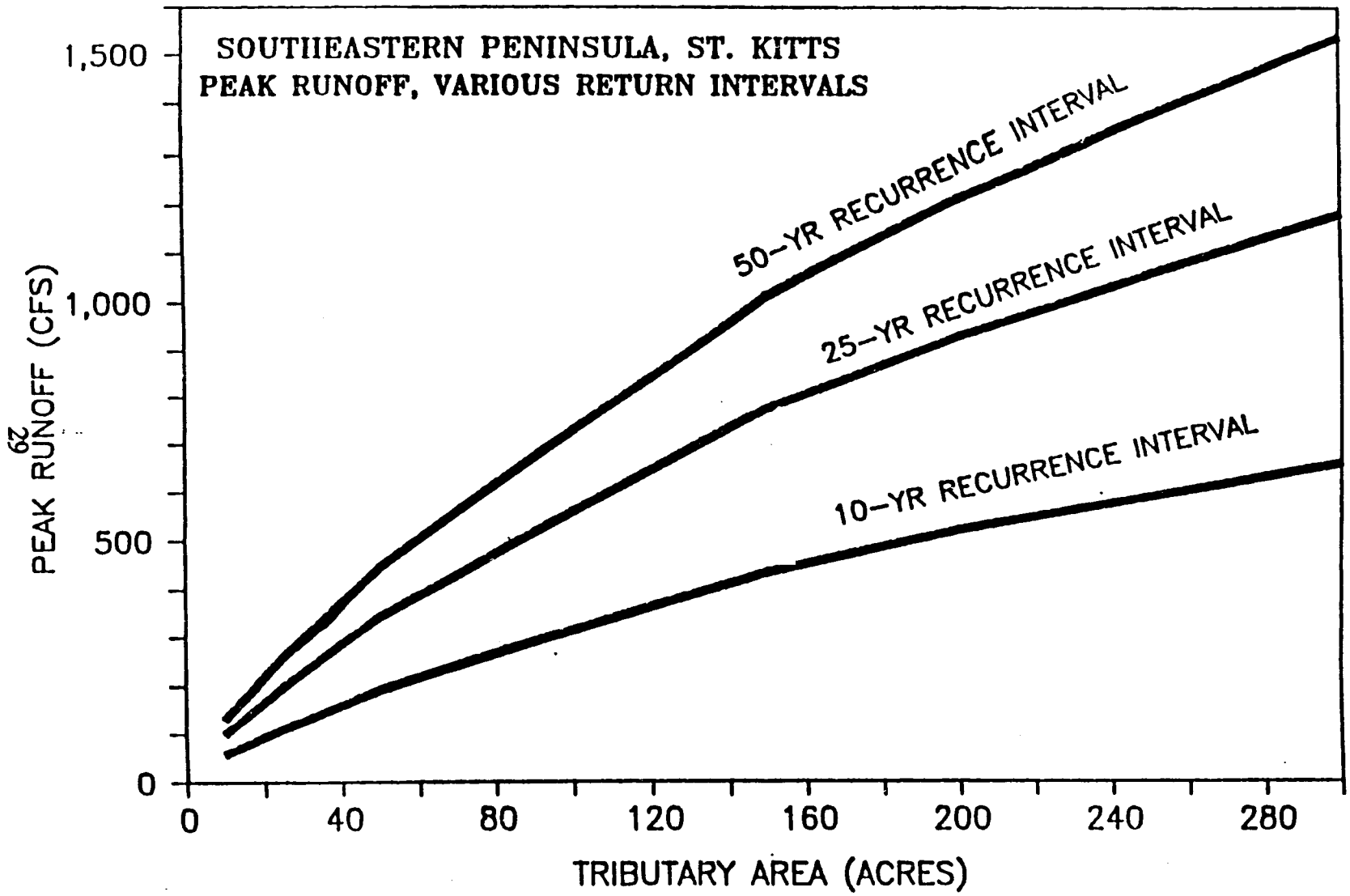


Figure 3: Generalized relationship between stormwater runoff and tributary drainage area, for use on undeveloped areas of the southeast peninsula of St. Kitts.

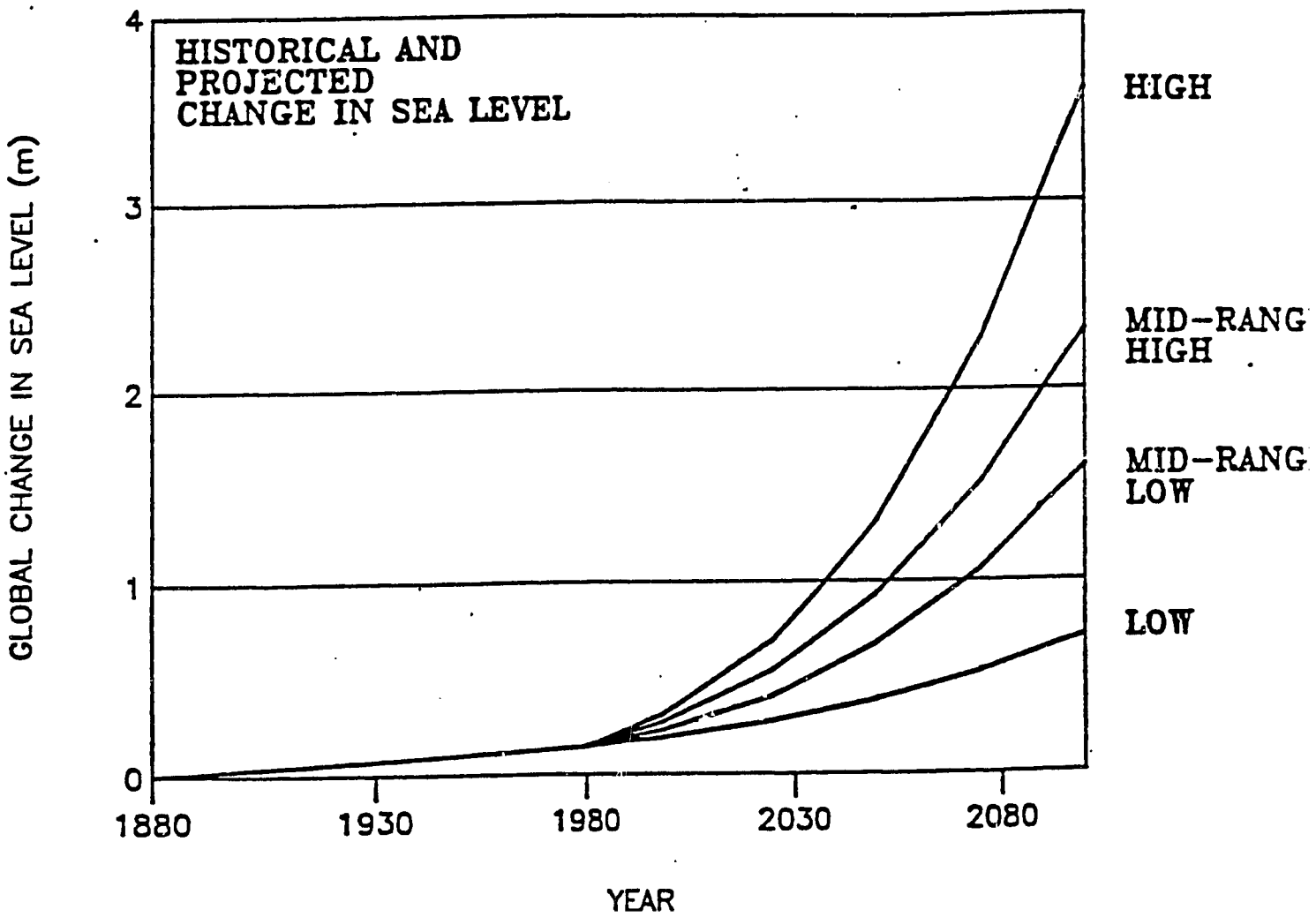


Figure 4: Historical global sea level rise and scenarios for future rise in sea level. Source: Hoffman et al, 1983.

215

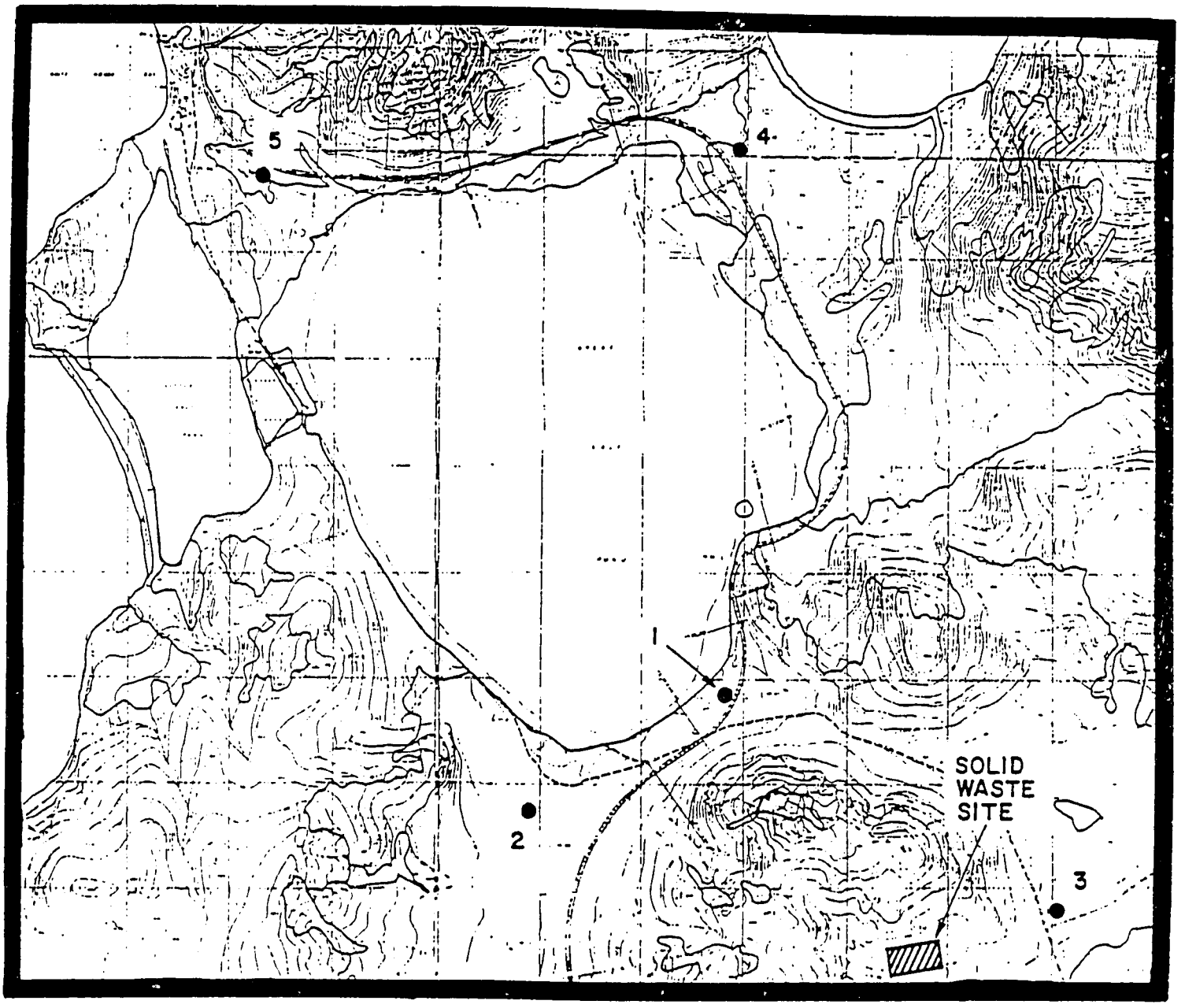


Figure 5: Location map showing sites of percolation tests and recommended site for solid waste disposal.

216

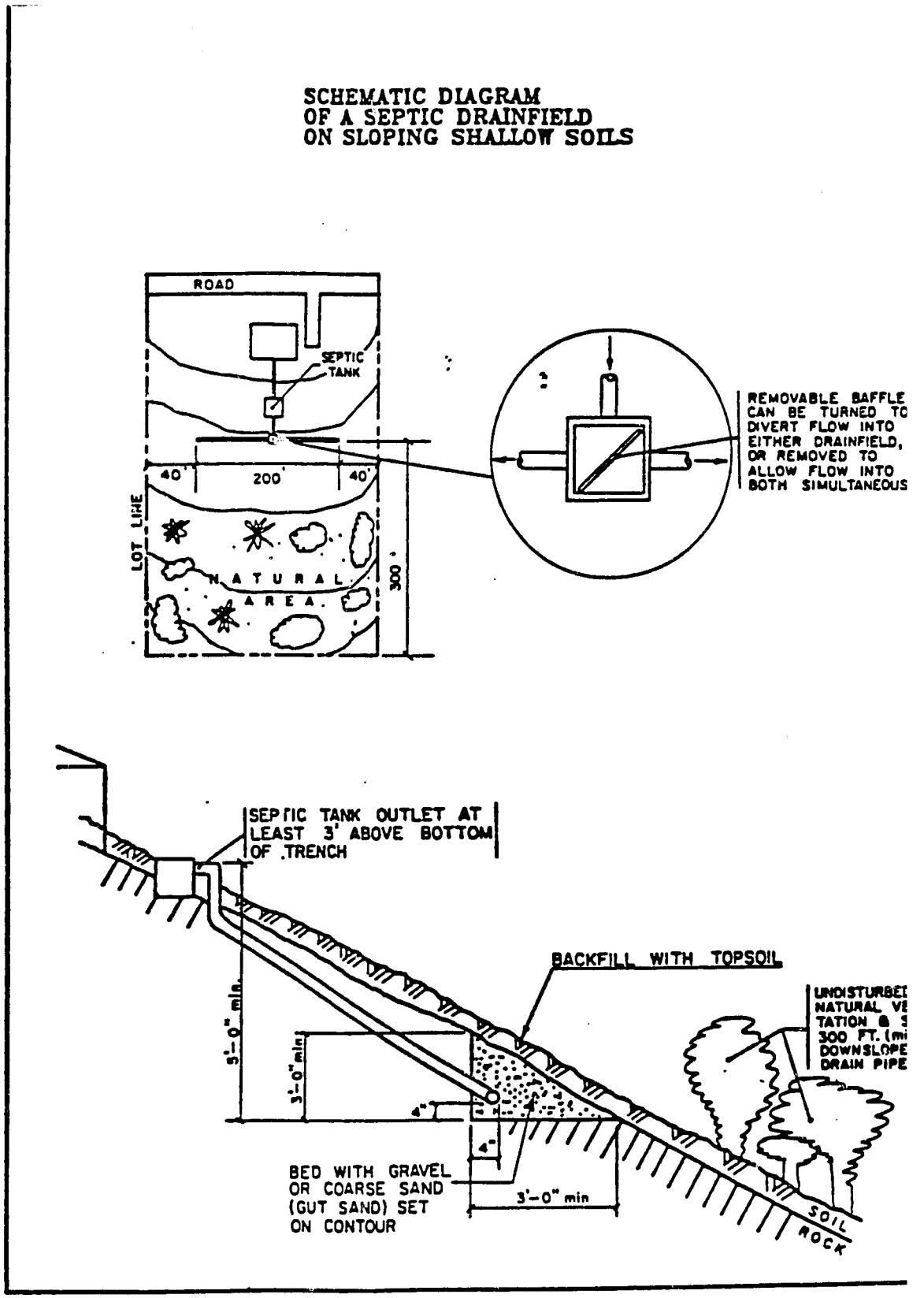
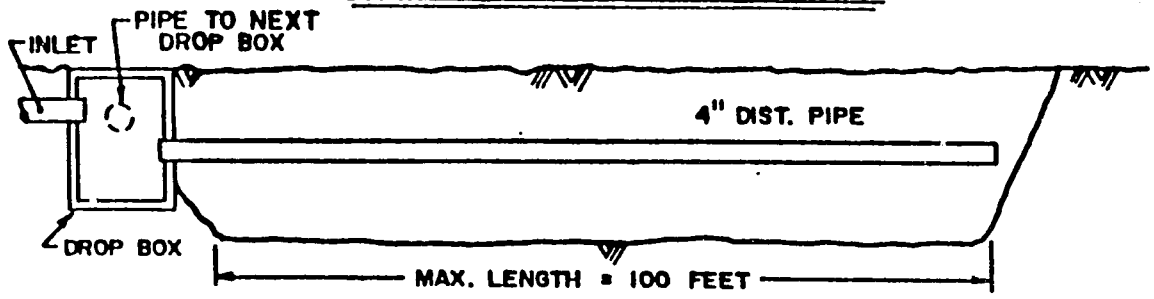


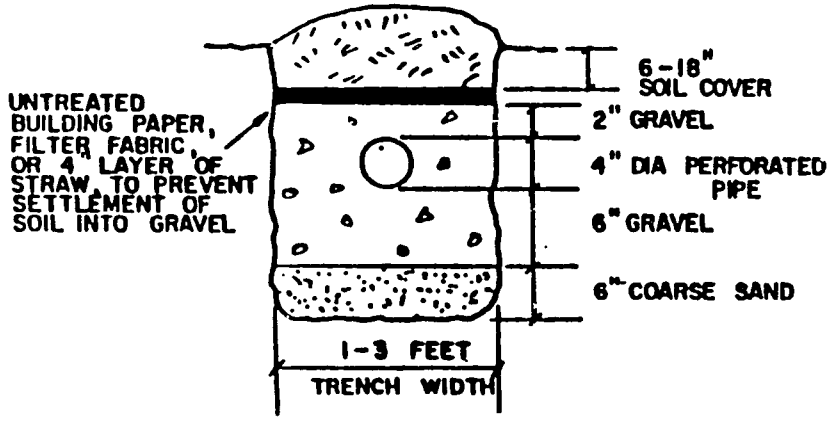
Figure 6: Sketch of non-conventional drainfield for septic tank effluent, for use on steeply sloping soils between 1 and 5 feet deep.

217

SOUTHEAST PENINSULA, ST. KITTS
SEPTIC TANK DRAINFIELD.

TRENCH CONSTRUCTION DETAILS





NOTES:

1. BOTTOM OF TRENCH MUST BE FLAT ALONG LENGTH

2. SLOPE ON DISTRIBUTION PIPE IS BETWEEN LEVEL AND 4 INCHES PER 100 FEET. RECOMMENDED SLOPE IS 1 TO 2 INCHES PER 100 FEET.

3. DISTRIBUTION PIPE CAN BE PERFORATED PLASTIC WITH 1/2 INCH OR LARGER HOLES. ONE OF THE ROWS OF HOLES MUST BE LOCATED ALONG THE BOTTOM OF THE PIPE.

4. SCARIFY TRENCH BOTTOM AND SIDEWALLS TO THE LEVEL OF THE DRAIN PIPE TO EXPOSE NATURAL SOIL. REMOVE LOOSE DIRT BEFORE PLACING SAND.

Figure 7: Sketch of recommended drainfield for septic tank effluent, for use when soils are at least 5 feet deep.

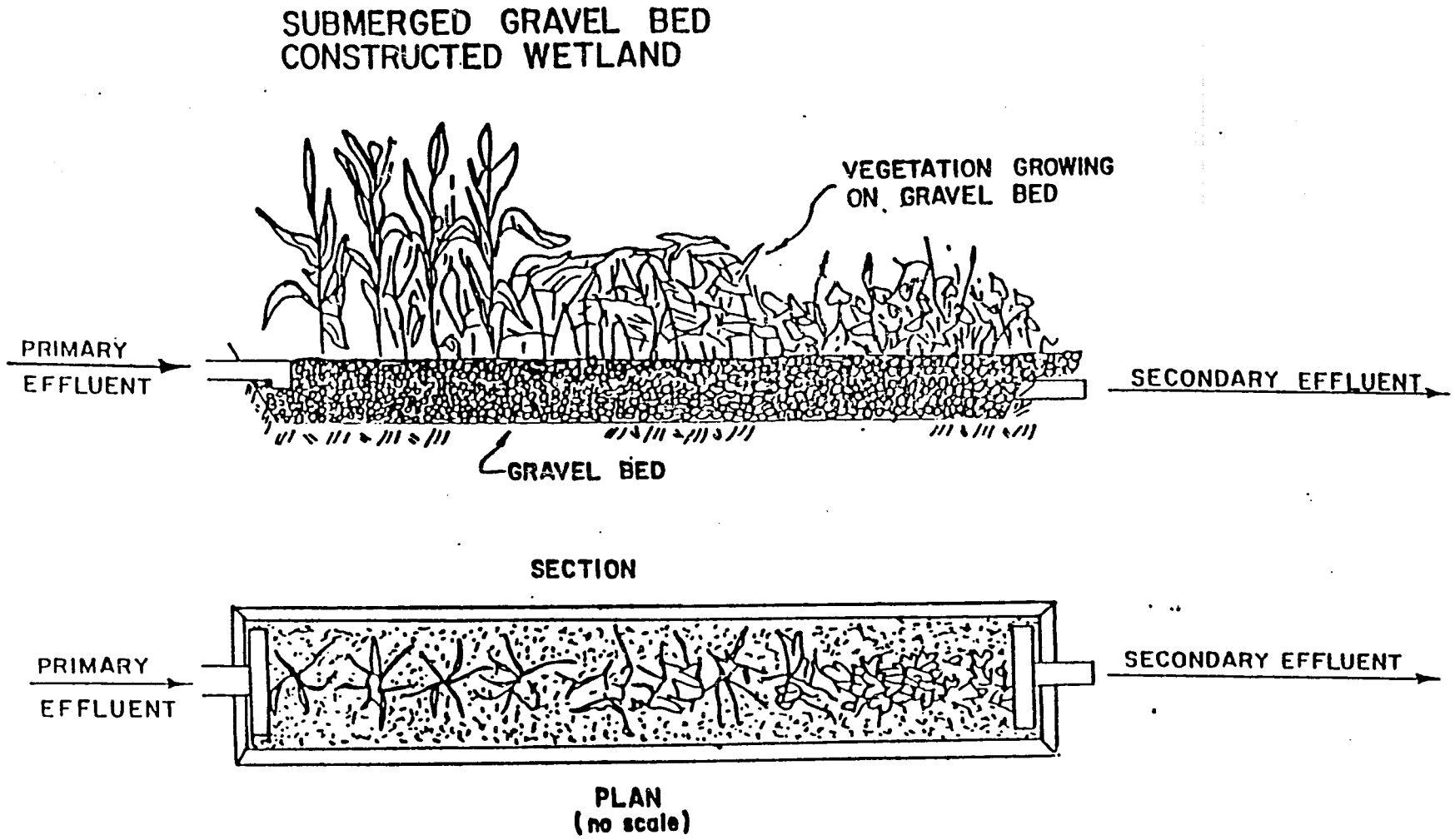


Figure 8: Schematic diagram of submerged bed type

APPENDIX 1

AVAILABLE DATA ON MONTHLY RAINFALL AT COCKLESHELL BAY, ST. KITTS

AVAILABLE DATA ON MONTHLY RAINFALL AT COCKLESHELL BAY, ST. KITTS.

	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC	YEAR
1963	1.95	1.25	0.66	1.15	3.09	2.30	5.02	3.94	2.41	2.24	4.15	1.03	29.17
1964	2.39	0.60	2.08	3.39	1.68	3.83	3.13	0.71	3.52	1.35	-	-	
1965	4.84	0.84	1.12	2.72	5.16	2.92	7.35	0.84	7.58	3.45	3.22	2.68	42.72
1966	0.67	0.66	1.53	1.88	6.29	0.49	5.81	1.87	2.46	3.09	5.55	2.55	32.90
1967	0.87	0.66	2.65	0.57	2.23	1.13	2.68	2.80	3.26	3.95	2.99	2.50	26.29
1968	1.36	0.38	1.15	1.77	2.40	4.11	3.60	2.68	0.97	2.24	2.87	4.87	28.40
1969	3.26	0.16	1.20	1.80	7.35	1.30	3.11	2.86	3.17	3.97	5.24	3.01	36.43
1970	1.03	0.56	1.08	2.06	7.10	6.33	3.12	5.09	5.51	5.30	8.62	7.87	53.67
1971	1.44	4.49	0.93	0.95	1.94	1.50	4.66	3.37	0.31	3.32	1.92	3.11	27.94
1972	2.04	2.06	2.56	1.63	1.33	2.87	5.30	-	-	8.07	2.28	4.21	
1973	2.29	2.44	1.08	4.23	0.38	2.13	3.20	4.52	3.60	5.88	0.64	3.72	34.11
1974	6.00	1.38	1.37	1.57	-	-	-	-	-	-	1.60	1.29	
1975	1.80	1.34	0.61	1.30	0.99	-	-	-	-	-	-	6.64	
1976	2.84	7.01	2.69	3.36	1.16	1.17	0.93	2.91	3.69	6.43	4.17	2.42	38.78
1977	0.54	0.63	0.56	1.55	0.48	-	-	-	-	-	7.07	2.01	
1978	2.06	-	-	-	-	-	-	-	-	-	-	-	

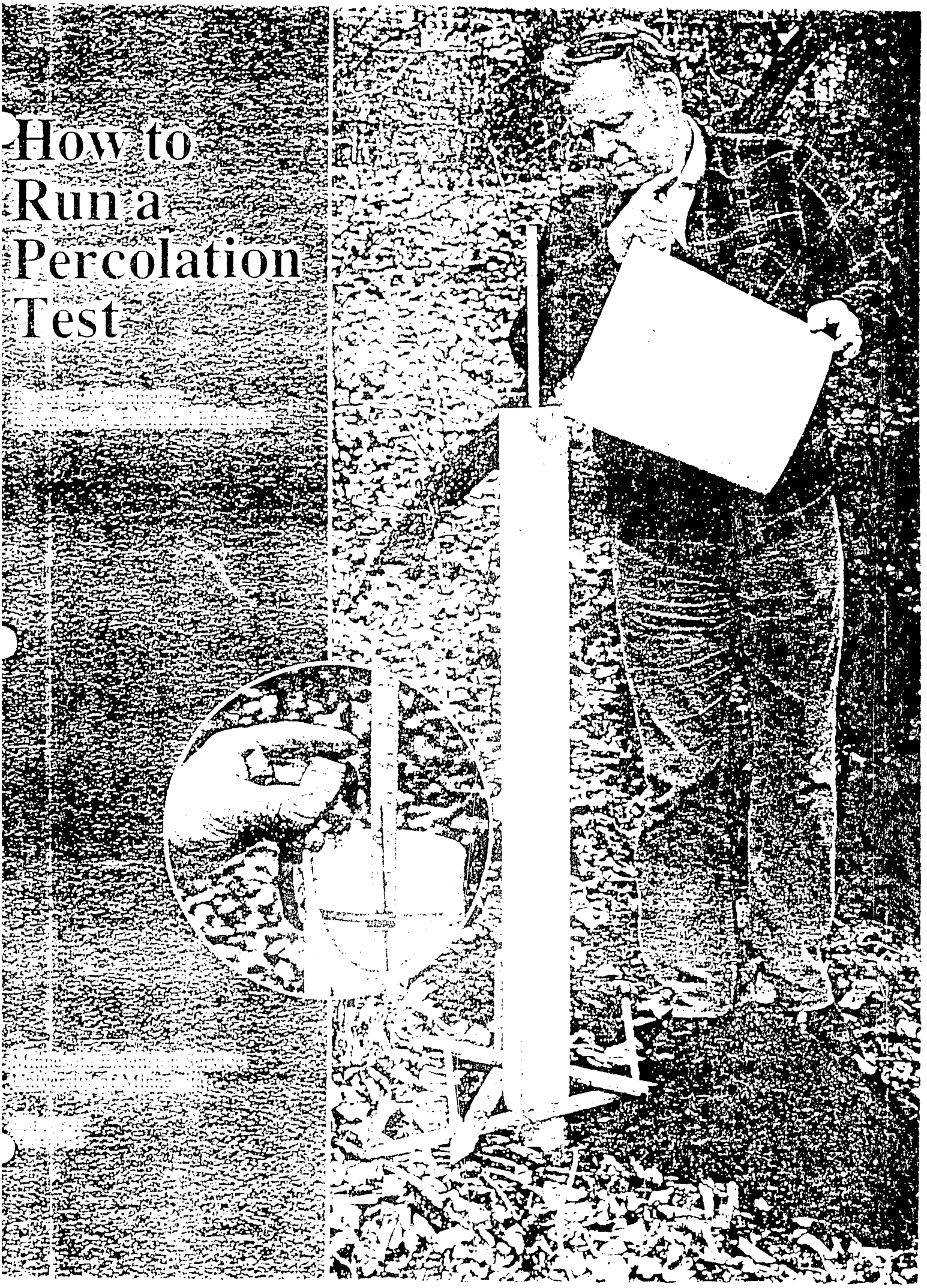
APPENDIX 2 RANGE FOR TEST RESULTS AND AVERAGE

DATE: 88-02-08

(1)	STA 6 + 312 to STA 6 + 962	(a) Dry Density lb/ft^3	96 - 103	Avg 100 lb/ft^3
		(b) Moisture Content (%)	17 - 21	Avg 19 %
		(c) CBR %	6 - 12	Avg 9 %
(2)	STA 7 + 212 to STA 7 + 862	(a) Dry Density lb/ft^3	78 - 101	Avg 88 lb/ft^3
		(b) Moisture Content (%)	17 - 28	Avg 22 %
		(c) CBR %	5 - 13	Avg 7.5 %
(3)	STA 8 + 300 to STA 8 + 680	(a) Dry Density lb/ft^3	85 - 94	Avg 89 lb/ft^3
		(b) Moisture Content (%)	20 - 31	Avg 25 %
		(c) CBR %	4 - 6	Avg 5 %
(4)	STA 9 + 012 to STA 9 + 912	(a) Dry Density lb/ft^3	93 - 106	Avg 101 lb/ft^3
		(b) Moisture Content (%)	15 - 21	Avg 18 %
		(c) CBR %	5 - 15	Avg 8.5 %

APPENDIX 3 **HOW TO RUN A PERCOLATION TEST**

How to Run a Percolation Test



Successful design of an on-site sewage treatment system depends on an adequate site evaluation. The percolation test is only one small part of a complete site evaluation. Refer to *Locating On-Site Home Sewage Treatment Systems*, CD-FO-0797, for the complete site evaluation procedure.

Suitable soil is the key to providing adequate on-site sewage treatment. Soil which is too coarse will not do a good job of removing nutrients and bacteria. Loam or clay loam soil will do an excellent job of nutrient and bacteria removal but will require a relatively large soil treatment area. Seasonal saturation of a soil will cause sewage to back up if the trenches are constructed too deep.

1. Use soil borings to locate a suitable area.

Soil borings should be at least 3 inches in diameter and at least 3 feet deeper than the bottom of the proposed soil treatment system. A boring may stop as soon as evidence of seasonal soil saturation or bedrock is encountered. Number the soil boring holes and locate them on a scale map of the site.

Evaluate the soil texture (sand, loamy sand, sandy loam, loam, silt loam, clay loam, etc.) for every foot of depth or at least where a change in soil texture occurs (see figure 2). Record this data on a log sheet of the boring hole. If you encounter seasonally saturated soil or an impervious layer (rock or clay) at a depth of 3 feet or closer to the ground surface, the area is not suitable for a subsurface soil treatment unit. A sewage treatment mound, however, could be installed at such a location if other factors such as slope were suitable. If saturated soil or a restricting layer is encountered between 3 and 4.5 feet, you can add fill over the entire site to bring the final ground surface elevation to at least 4.5 feet above the restricting layer.

Figure 2. A hand-operated bucket auger collects a relatively undisturbed sample, allowing proper evaluation of soil texture and observance of possible mottling.

Seasonal saturation of soil is indicated by a gray background color together with red streaks or splotches and is called mottling. The bottom of the drainfield trench should be located no closer than 3 feet from the mottled soil. Even though the hole may be dry when you make the soil boring, the soil will be saturated during wet conditions and during the operation of the sewage treatment system. The system will fail in clay soil or inadequately treat sewage in coarse soil.

The lawn area required for the soil treatment unit depends on the percolation rate of the soil and the amount of sewage discharged by the proposed or exisiting residence. Table 1 estimates the required lawn area according to soil texture for a three-bedroom home discharging 450 gallons of sewage per day and using 3-foot wide trenches spaced 10 feet on centers. Refer to your local sanitary code for required setbacks from buildings, property lines, water supply wells, etc. Take at least four soil borings in each soil texture in order to locate lawn area of adequate size. It is an excellent idea to locate an area twice as large as those specified in table 1 so that room for future expansion of the soil treatment unit will be available.

Table 1. Lawn area in square feet required for a drainfield trench system

Soil texture	Estimated percolation rate, minutes per inch	Area required for a three-bedroom home (square feet*)	Add for each additional bedroom (square feet)
Fine to medium sand	0.1 to 5	1,245	415
Fine sand and silt	6 to 15	1,905	635
Silty sand, little clay	16 to 30	2,505	835
Silty sand, some clay	31 to 45	3,000	1,000
Considerable clay	46 to 60	3,300	1,100

*Based on 150 gallons of sewage per day per bedroom and 3-foot-wide trenches spaced 10 feet center to center.

2. Make an adequate number of percolation test holes.

If the soil texture is uniform over the selected site, use at least two and preferably three percolation test holes. If the soil texture changes within the site, make at least two percolation test holes in each soil texture. Space the percolation test holes uniformly over the area proposed for the soil treatment unit.

3. Dig test holes.

The test holes should be round and at least 6 inches, but no larger than 8 inches, in diameter. Dig each test hole as deep as you intend to excavate the soil treatment trench. The bottom of the percolation test hole must be at least 3 feet above the level of seasonally saturated soil or an impervious layer. A clam shell-type post hole digger can be used (see figure 3). If you use a 6-inch auger, it is a good idea to drill a pilot hole with the 3-inch auger. Observe and record the soil texture as the percolation test hole is being dug.

4. Prepare the percolation test holes.

The auger or post hole digger is likely to smear the soil along the sidewalls of the test hole. Therefore, the bottom 12 inches of

Cover: An adequate site evaluation is essential to the successful design of an on-site sewage treatment system. The percometer shown is a convenient device for measuring the percolation rate. Inset: A stop watch measures the drop in water level.

the sidewalls and the bottom of the hole should be scratched or scarified with a sharp, pointed instrument such as a knife. Nails driven into a 1 × 2-inch board as shown in figure 4 will do a good job of scarifying the hole to provide an open, natural soil into which water may percolate. Remove all loose soil material from the bottom of the test hole. Add 2 inches of one-fourth to three-fourths inch gravel to protect the bottom from scouring when water is added. The gravel can be contained in a nylon mesh bag as shown in figure 5 in order to be removed after the test is performed and used for additional percolation tests.

5. Distinguish between soil saturation and soil swelling.

Saturation means that the voids between soil particles are full of water. This can happen in a short time.

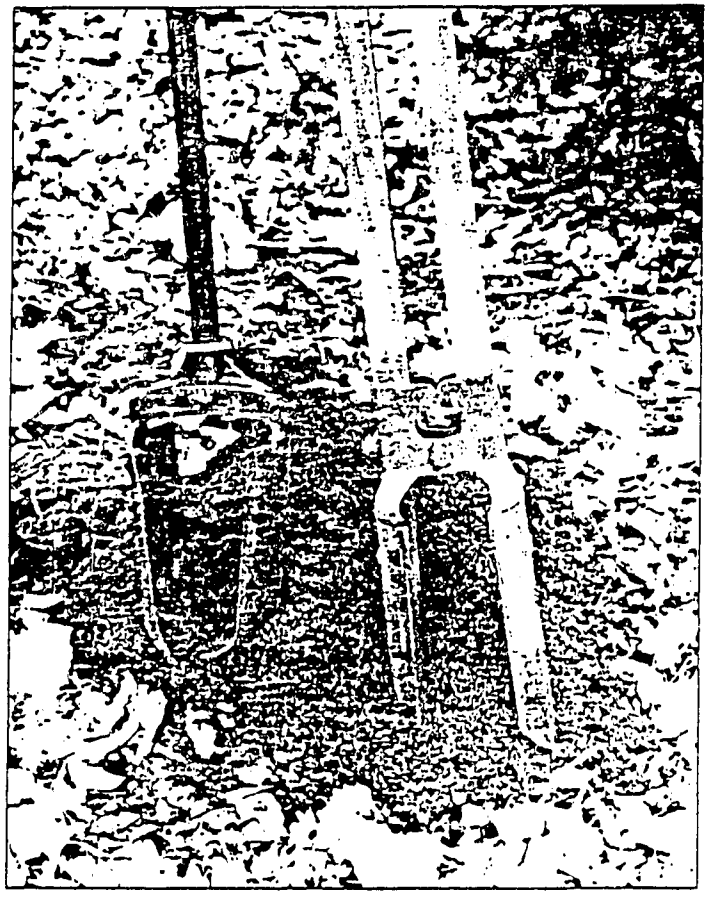
Swelling is caused by intrusion of water into individual soil particles. This is a slow process, especially in clay soils, and is why a prolonged soaking period is necessary for some soils.

Carefully fill the percolation test hole with clear water to a depth of at least 12 inches above the soil bottom of the test hole. Use a hose to prevent the water from washing down the sides of the hole or add the water directly into the percometer as shown in figure 7. A 6-inch diameter hole requires about 1.5 gallons per foot of depth

Sandy soils containing no clay do not swell. The percolation test may proceed immediately if the 12 inches of water seeps away in 10 minutes or less. The percolation test procedure for sandy soils is described under step 6C.

For prolonged soaking of the soil, keep the 12-inch depth of water in the hole for at least four hours, and preferably overnight. Add water as necessary. You may use an automatic

Figure 3. Either a post-hole auger or a clam shell digger can be used to dig the percolation test holes.



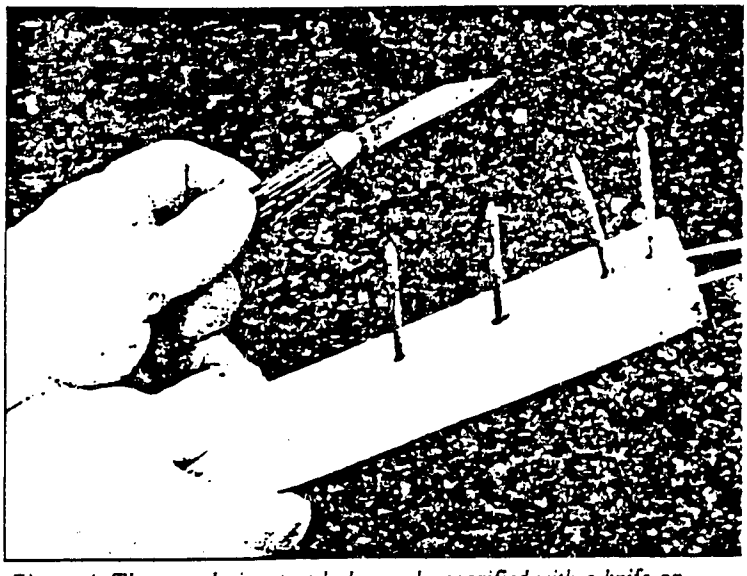
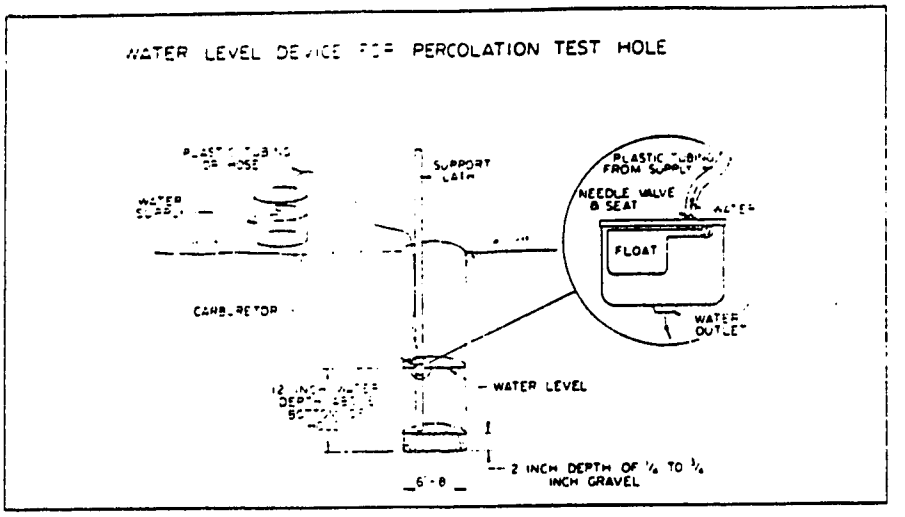


Figure 4. The percolation test hole can be scarified with a knife or nails driven into a 1" × 2" board.

Figure 5. If the gravel which protects the hole bottom from scouring is contained in a nylon mesh bag, it can be removed and reused.

Figure 6. Water level device for percolation test hole.



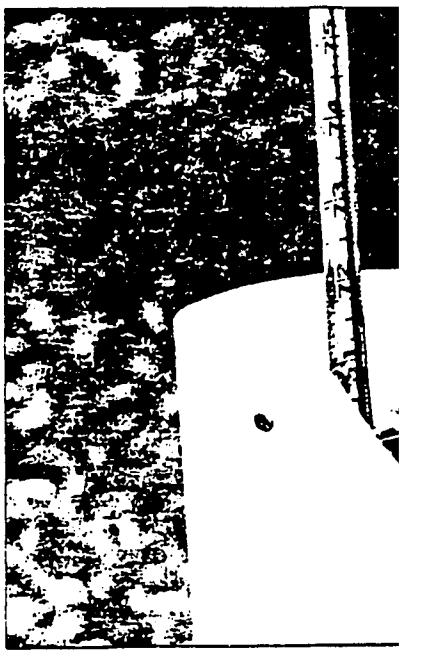


Figure 7. Cutting the top of the percome

Figure 8. A small engine carburetor attached to a support controls the siphon and maintains a constant water level in the test hole.

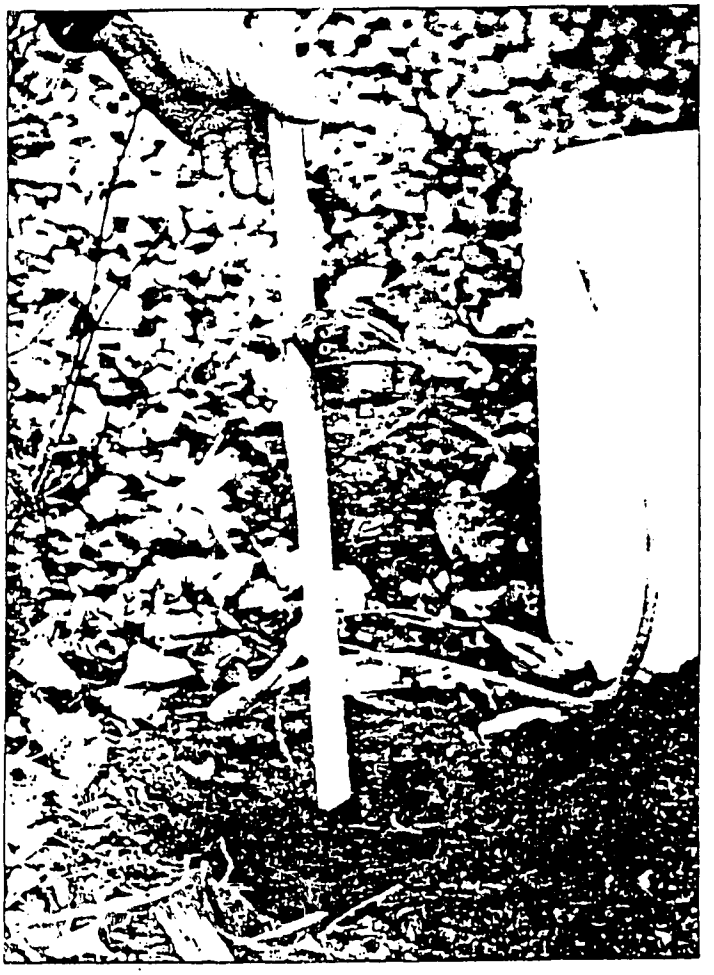
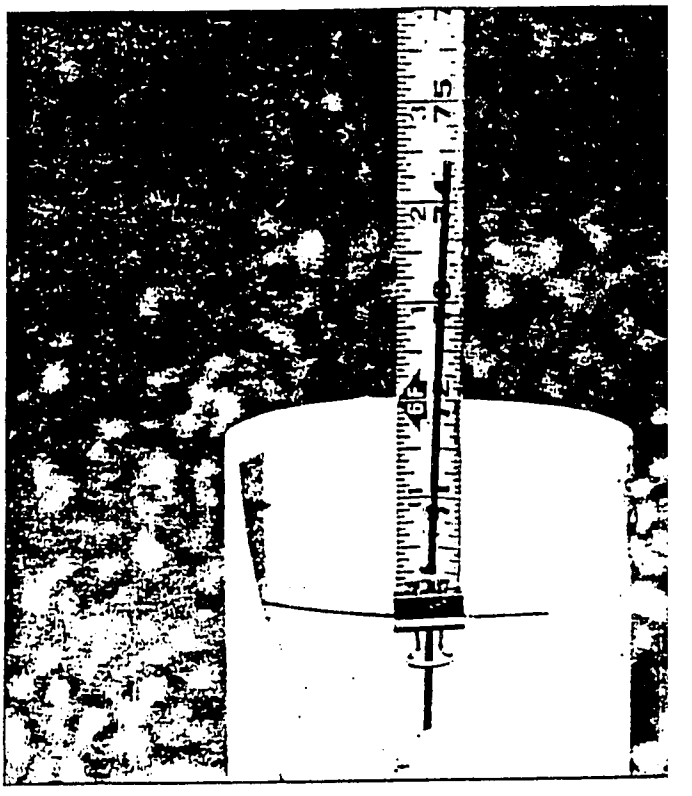


Figure 9. The liquid level in a percolation test hole can be observe directly at the top of the rod attached to the float. This is the most co venient way to observe the drop in water level.



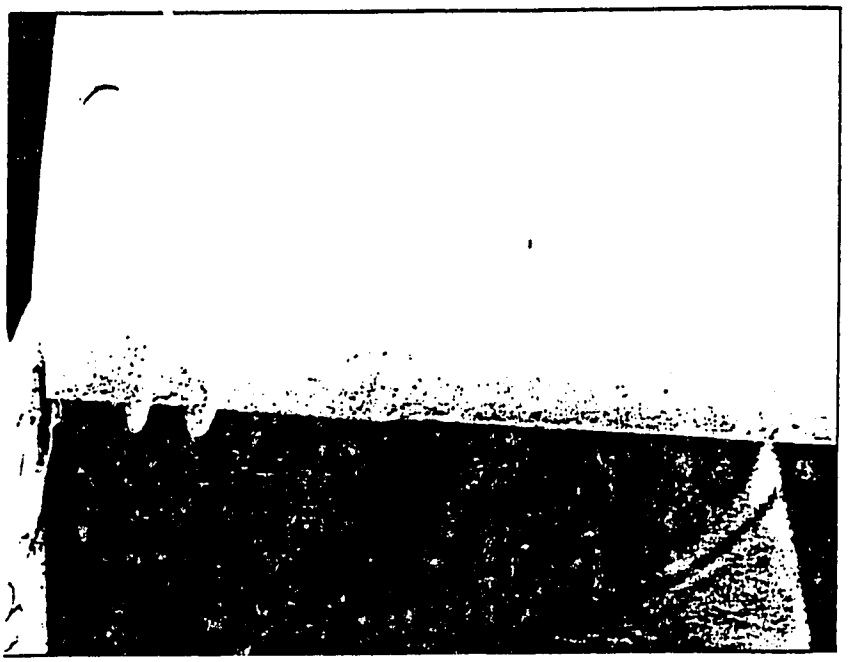
siphon or valve to maintain the 12-inch water depth (figure 6). A valve made from the carburetor of a small engine is shown in figure 8.

6. Measure percolation rate.

Except for sandy soils, make the percolation rate measurements the day after completing step 5.

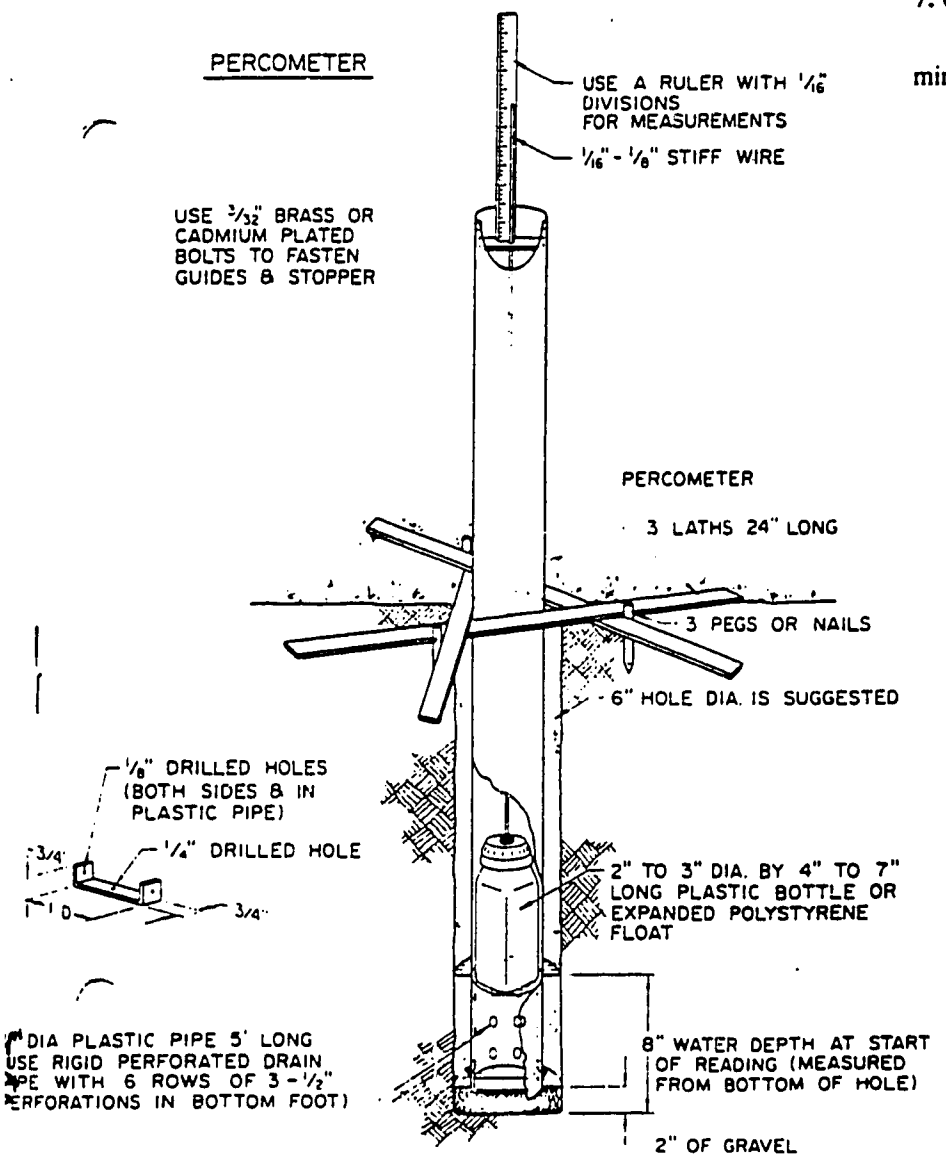
A. If there is more than 6 inches of water in the hole after th overnight swelling period, bail out enough water so that inches of water remains above the gravel (8 inches if mea sured from the bottom of the hole). Measure the drop in th water level to the nearest ⅛ inch (preferably the nearest ¼ inch) approximately every 30 minutes (figure 9). If possible use a percometer to determine the change in water level (fig

226



at an angle allows for the convenient addition of water.

Figure 10. Construction and use of a percometer.



ure 10). A batter board can also be used as a reference together with a hook gauge to accurately locate the surface. The hook can be made from stiff wire or an 8d After each measurement, refill the water in the hole s the liquid depth is 6 inches above the gravel. Continue t measurements until three consecutive percolation rates by a range of no more than 10 percent (see sample notes, page 7).

B. If no water remains in the hole after the overnight swe period, add 6 inches of clear water above the gravel. sure the drop in the liquid level to the nearest 1/8 inch (pr ably 1/16 inch) approximately every 30 minutes. After measurement, refill the water to a depth of 6 inches abov gravel. Continue the water level drop measurements three consecutive percolation rates vary by no more th percent.

C. In sandy soils, or other soils in which the first 6 inches o ter seep away in less than 30 minutes after the over swelling period, allow about 10 minutes between me ments. On some very sandy soils, use a stop watch and sure the time in seconds for the water level to drop fron 5 inches (figure 11). Refill the percolation test hole each measurement to bring the water to 6 inches abov gravel. Continue taking readings until three consecutive colation rates vary by no more than 10 percent.

7. Calculate percolation rate.

Divide the time interval by the drop in water level to d mine the percolation rate in minutes per inch (MPI).

Figure 11. The percolation rate is determined by m ing the rate of water drop over time. For sandy soils watch can be used to measure the drop in water leve six to five inches.

Examples:

A. If the drop in water level is $^5/_8$ inch in 30 minutes, the percolation rate is

$\frac{30}{5/8} = 30 \times \frac{8}{5} = 48$ MPI or $\frac{30}{5/8} = \frac{30}{0.625} = 48$ MPI

B. If the drop is $2^1/_2$ inches in 10 minutes, then the percolation rate is

$\frac{10}{2\frac{1}{2}} = \frac{10}{\frac{5}{2}} = 10 \times \frac{2}{5} = 4$ MPI or $\frac{10}{2\frac{1}{2}} = \frac{10}{2.5} = 4$ MPI

Calculate the percolation rate for each reading (see sample field notes). When three consecutive percolation rates vary by no more than 10 percent, use the average value of these three readings to determine the percolation rate for that test hole. Percolation rates determined for each test hole should be averaged in order to determine the design percolation rate. For reporting the percolation rate, worksheets showing all measurements and calculations should be submitted with the site evaluation report. You can reproduce the blank form in this folder for use in recording percolation test data.

Note that a percolation test should not be run where frost exists in the soil below the depth of the proposed sewage treatment system.

8. Determine the trench bottom area.

Table 2 shows sewage flows and soil treatment areas. The amount of trench bottom area required depends on the porosity of the soil as measured by the percolation rate, the daily sewage flow, and the depth of rock placed below the distribution pipe.

The daily amount of sewage wastes must be estimated in order to size the soil treatment unit. For residences, the daily amount of sewage flow is based on the number of bedrooms and the type of residence. A luxury, three-bedroom house likely will generate more sewage than a more modest house. Sewage flows for different types of houses can be estimated from table 2. Using a large sewage flow provides a factor of safety in sizing the soil treatment unit. Also consider future house expansion.

To illustrate the use of table 2, determine the amount of trench bottom area required for a three-bedroom, type I dwelling. The soil percolation rate, as measured by the percolation data presented on page 7, is 27.3 MPI. From table 2, a three-bedroom, type I dwelling is estimated to generate 450 gallons of sewage per day. The trench bottom area required for a percolation rate in the range of 16 to 30 is 1.67 square feet per gallon of waste per day.

Thus, the total required bottom area is 1.67 × 450 = 750 square feet for trenches with 6 inches of rock below the distribution pipe. If 12 inches of rock is used as recommended, the trench bottom area can be reduced by 20 percent (see footnote c, table 2). The required trench bottom area is then 0.80 × 750 = 600 square feet.

The trench bottom area can be reduced by 34 percent for 18 inches of rock below the distribution pipe and by 40 percent for the maximum rock depth of 24 inches. As rock depth increases, the required trench bottom area decreases, because more soil is exposed along the trench sidewall and a greater liquid depth increases the flow through the trench bottom.

The minimum trench width is 18 inches; the maximum width is 36 inches. Using 36-inch wide trenches on the above example, total trench length with 12 inches of rock below the distribution pipe is 200 lineal feet (600 ÷ 3). No single trench can be longer than 100 feet. Thus, the 200 lineal feet should be divided into two or more trenches.

The sewage effluent should be distributed between the trenches by means of drop boxes. Proper trench construction and drop box operation are explained fully in *Town and Country Sewage Treatment*, AG-BU-1360.

Table 2. Sewage flows and soil treatment areas

Estimated sewage flows in gallons per day					Soil treatment areas in square feet	
Number of bedrooms	Type of residence[a]				Percolation rate, minutes per inch	Soil treatment area in square feet per gallon of waste per day[c]
	I	II	III	IV		
2	300	225	180	60% of values in Type I, II, or III columns	Faster than 0.1[b]	Soil too coarse for sewage treatment[b]
3	450	300	218		0.1 to 5	0.83
4	600	375	256		6 to 15	1.27
5	750	450	294		16 to 30	1.67
6	900	525	332		31 to 45	2.00
7	1050	600	370		46 to 60	2.20
8	1200	675	408		Slower than 60[d]	Refer to information on mounds and alternative systems

[a]Type I: The total floor area of the residence divided by the number of bedrooms is more than 800 sq. ft. per bedroom, or more than two of the following water-use appliances are installed—automatic washer, dishwasher, water softener, garbage disposal, or self-cleaning humidifier in furnace.

Type II: The total floor area of the residence divided by the number of bedrooms is more than 500 sq. ft. per bedroom and no more than two of the water-use appliances are installed.

Type III: The total floor area of the residence divided by the number of bedrooms is less than 500 sq. ft. per bedroom, and no more than two of the water-use appliances are installed.

Type IV: No toilet wastes flow into sewage treatment system.

[b]Soil is unsuitable for standard soil treatment units. Refer to information on mounds and alternative systems.

[c]For trenches only; the bottom areas may be reduced if more than 6 inches of rock is placed below the distribution pipe, for 12 inches of rock below the distribution pipe the bottom areas can be reduced by 20 percent; a 34 percent reduction for 18 inches; and a 40 percent reduction for 24 inches.

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Patrick J. Borich, Dean and Director of Minnesota Extension Service, University of Minnesota, St. Paul, Minnesota 55108. The University of Minnesota, including the Agricultural Extension Service, is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, religion, color, sex, national origin, handicap, age, or veteran status.

PERCOLATION TEST DATA SHEET

Percolation test readings made by R. Machmeier on 9/14/84 (date) starting at 1:30 ~~a.m.~~ p.m.

Test hole location T & C Estates Lot 14. Hole number 3. Date hole was prepared 9/13/84

Depth of hole bottom 30 inches. Diameter of hole 7 inches

Soil data from test hole:

Depth, inches	Soil texture
0-6	Silt loam
6-18	Loam
18-30	Sandy loam

Method of scratching sidewall 1x2 with 8d nails

Depth of gravel in bottom of hole 2 inches

Date and hour of initial water filling 9/13, 10am. Depth of initial water filling 12 inches above hole bottom

Method used to maintain at least 12 inches of water depth in hole for at least 4 hours Automatic siphon

, Maximum water depth above hole bottom during test 8 inches

Time	Time interval, minutes	Measurement, inches	Drop in water level, inches	Percolation rate, minutes per inch	Remarks
1:30		5 7/8			Fill
2:00	30	4 1/2	1 3/8	21.8	
2:02		6			Refill
2:34	32	4 5/8	1 3/8	23.3	
2:35		5 15/16			Refill
3:03	28	4 7/8	1 1/16	26.4	
3:05		6			Refill
3:39	34	4 3/4	1 1/4	27.2	
3:40		5 7/8			Refill
4:10	30	4 13/16	1 1/16	28.2	
	Ave =	$\frac{26.4 + 27.2 + 28.2}{3}$		= 27.3	

Percolation rate = 27.3 minutes per inch.

PERCOLATION TEST DATA SHEET

Percolation test readings made by_____on_____(date) starting at_____ a.m. p.m.

Test hole location_____. Hole number_____. Date hole was prepared_____

Depth of hole bottom_____inches, Diameter of hole_____inches

Soil data from test hole:

Depth, inches	Soil texture

Method of scratching sidewall_____

Depth of gravel in bottom of hole_____inches

Date and hour of initial water filling_____, Depth of initial water filling_____inches above hole bottom

Method used to maintain at least 12 inches of water depth in hole for at least 4 hours_____

_____, Maximum water depth above hole bottom during test_____inches

Time	Time interval, minutes	Measurement, inches	Drop in water level, inches	Percolation rate, minutes per inch	Remarks

Percolation rate = _____minutes per inch.

GEODYNAMICS, LAND STABILITY, EARTH RESOURCES AND MANAGEMENT CONSIDERATIONS

by

Antony R. Orme, Ph.D.

May 1989

Prepared for the U.S. Agency for International Development
under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

231

EXECUTIVE SUMMARY

A Land Stability Map is presented as the physical basis for planning and development in the Southeast Peninsula of St. Kitts. The map incorporates the results of field investigations into bedrock and surficial geology, geodynamic processes, and slope categorization. Episodic mass movement and ephemeral fluvial activity related to gut flooding, erosion and sedimentation are the principal geodynamic processes at work in the Peninsula. Wind action is locally important while the coast is shaped by wave and wave-related currents. The Land Stability Map recognizes three categories of land suitability:

(1) stable areas with slopes of less than 10°
(2) potentially unstable areas with slopes of 10° to 25°
(3) unstable areas with slopes above 25°.

Wetlands and coastal dunes are also considered potentially unstable. Seacliffs and beaches are unstable forms. Earth resources were also investigated with specific reference to potential building materials. Volcaniclastic deposits suitable for coarse aggregate are widespread but economically viable accumulations are confined to the slopes of Sir Timothy's Hill and the north flanks of St. Anthony's Peak, and it is recommended that before these sources are used the availability of surplus aggregate from the construction of the peninsular road be evaluated. Sand for construction purposes is very limited, the most likely source being the medium to fine sand found in the inner dunes behind Sand Bank Bay. Under no circumstances should beach sand be mined because beaches not only form a valuable recreational asset but they also protect the backshore and wetlands from erosion associated with storm seas.

Management considerations involve recognition of the land stability classes and erosion and sediment control needs within the Peninsula. Avoidance of unstable land and major erosion and sediment hazards is deemed essential. Where such hazards may occasionally impact developable areas, notable in the otherwise stable category of land, structural and vegetative controls can be designed to mitigate the hazard. A zoning ordinance should be prepared that integrates considerations of land stability and hazard control. All development plans should be reviewed prior to implementation by personnel qualified in geomorphology, hydrology and engineering.

TABLE OF CONTENTS

LIST OF FIGURES ii

1.0 INTRODUCTION 1

2.0 DESCRIPTION OF RESOURCE CHARACTERISTICS 2
- 2.1 Geodynamic Processes 2
  - 2.1.1 Mass Wasting 2
  - 2.1.2 Fluvial Processes 4
  - 2.1.3 Aeolian Activity 5
- 2.2 Land Stability 5
  - 2.2.1 Stable Areas 6
  - 2.2.2 Potentially Unstable Areas 7
  - 2.2.3 Unstable Areas 7
- 2.3 Earth Resources 8
  - 2.3.1 Volcaniclastic Aggregate Sources 8
  - 2.3.2 Construction Sand Sources 9

3.0 MANAGEMENT CONSIDERATIONS 11
- 3.1 Principles 11
- 3.2 Practical Considerations 11
  - 3.2.1 Land Stability and Development Location 11
  - 3.2.2 Erosion and Sediment Control 13

4.0 SUMMARY AND RECOMMENDATIONS 16
- 4.1 Considerations for Further Study 17

233

LIST OF FIGURES

Figure 1	Location
Figure 2	Geomorphology
Figure 3	Land Stability
Figure 4	Earth Resources
Figure 5	Asymmetric Profile of the Isthmus
Figure 6	Green Point Terrace
Figure 7	Nag's Head - Rockslide and Rockfall
Figure 8	Nag's Head - Small Gully
Figure 9	Salt Pond Hill
Figure 10	Great Salt Pond
Figure 11	Nag's Head - Andesite
Figure 12	Sir Timothy's Hill - Volcaniclastic Debris

234

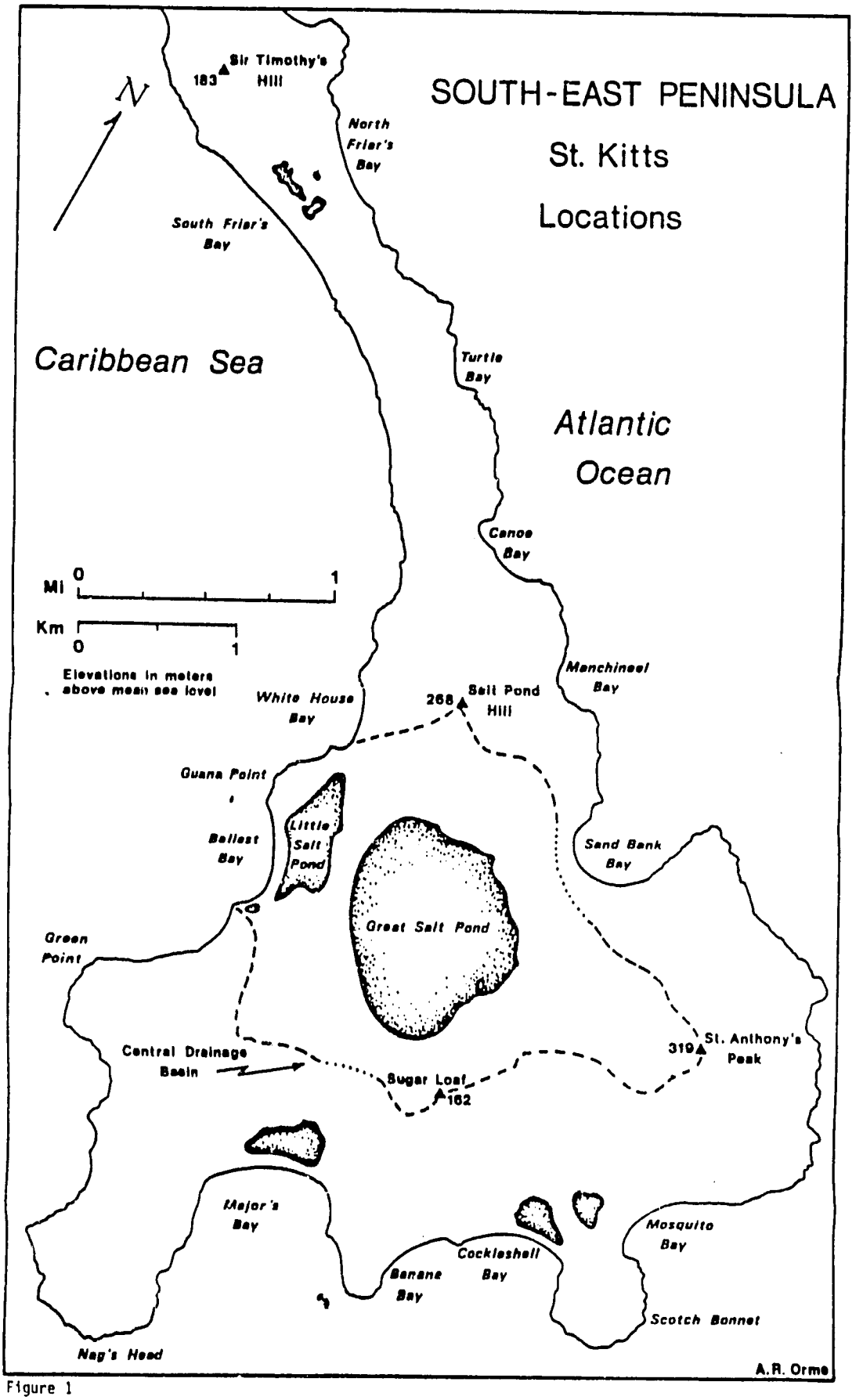
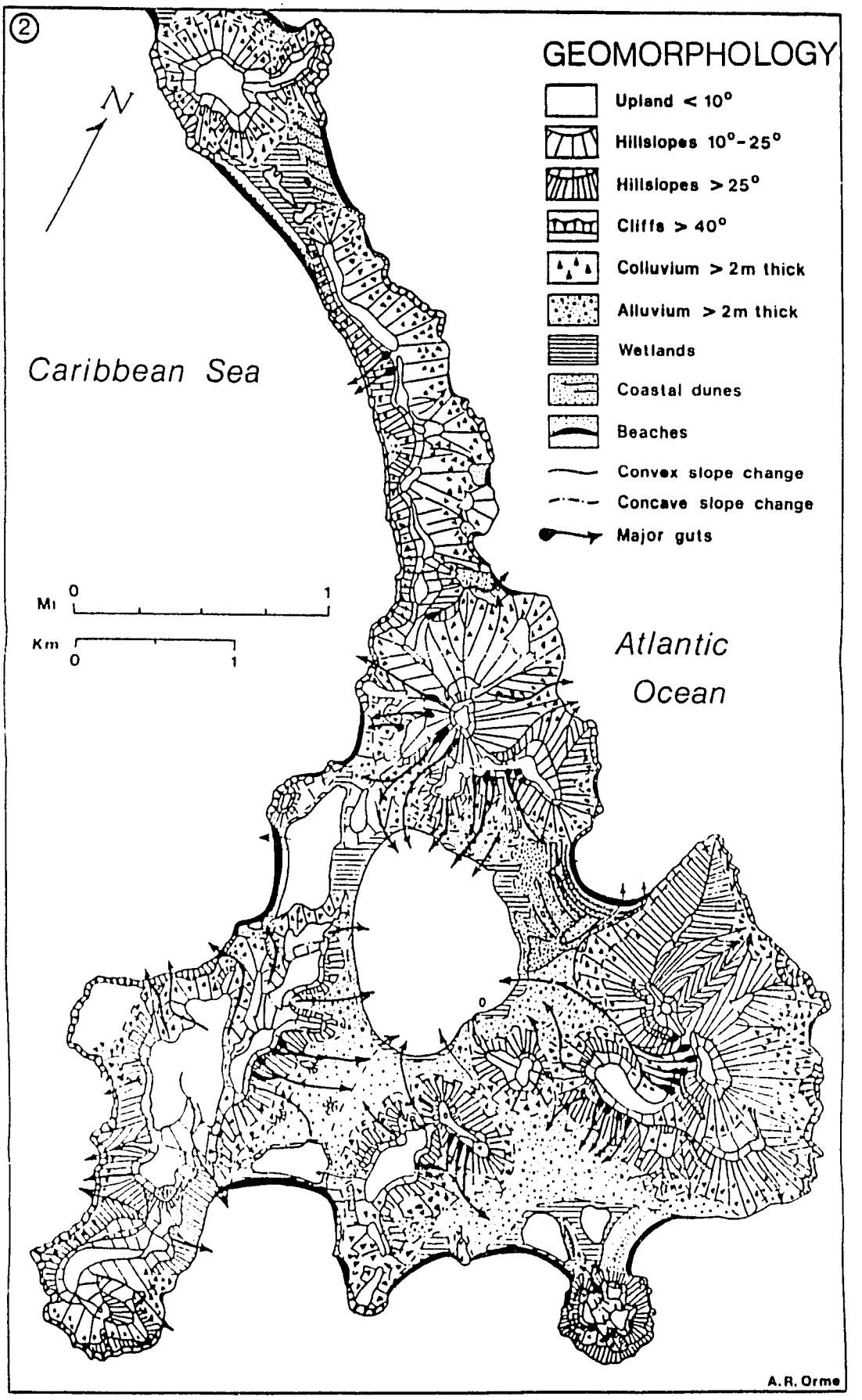
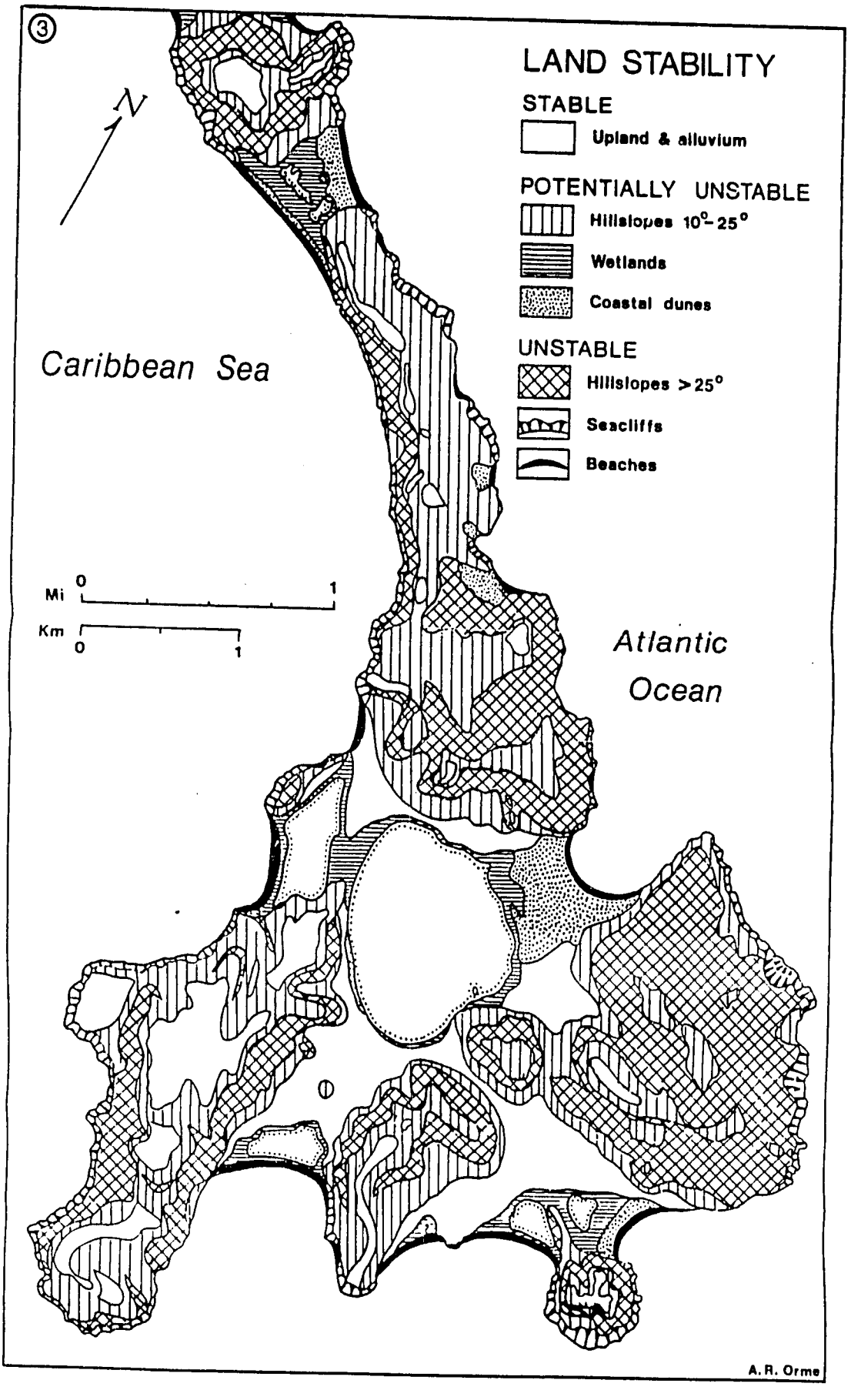
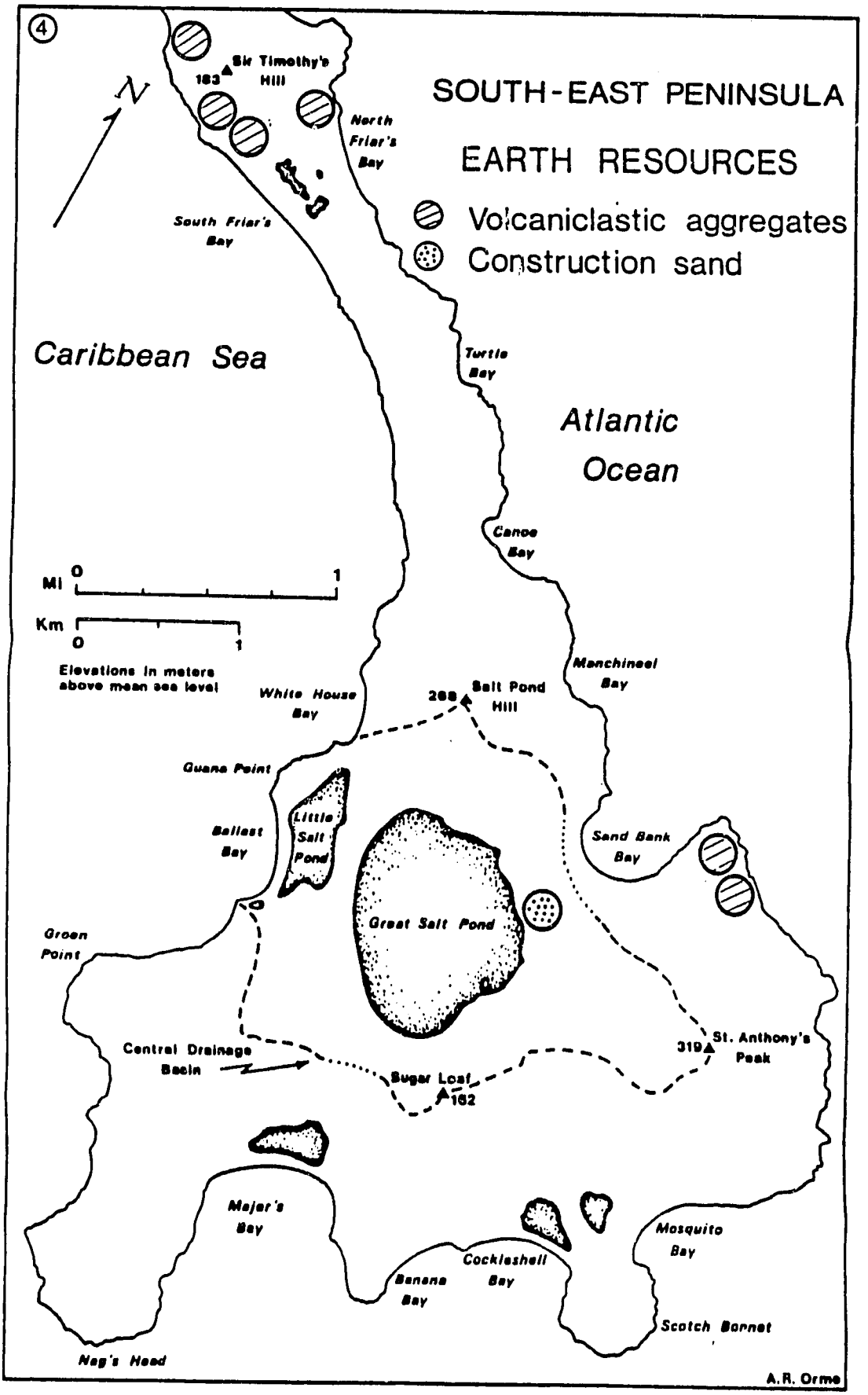

SOUTH-EAST PENINSULA
St. Kitts
Locations
N
Sir Timothy's Hill
183
North Friar's Bay
South Friar's Bay
Caribbean Sea
Turtle Bay
Atlantic Ocean
Canoe Bay
Mi 0 1
Km 0 1
Elevations in meters above mean sea level
Manchineel Bay
White House Bay
268
Salt Pond Hill
Guana Point
Ballast Bay
Little Salt Pond
Great Salt Pond
Sand Bank Bay
Green Point
Central Drainage Basin
Sugar Loaf
162
319
St. Anthony's Peak
Major's Bay
Mosquito Bay
Cockleshell Bay
Banana Bay
Scotch Bonnet
Nag's Head
A.R. Orme

Figure 1


2
GEOMORPHOLOGY
Upland < 10°
Hillslopes 10°-25°
Hillslopes > 25°
Cliffs > 40°
Colluvium > 2m thick
Alluvium > 2m thick
Wetlands
Coastal dunes
Beaches
Convex slope change
Concave slope change
Major guts
N
Caribbean Sea
Atlantic Ocean
Mi 0 1
Km 0 1
A.R. Orme

231


③
LAND STABILITY
STABLE
Upland & alluvium
POTENTIALLY UNSTABLE
Hillslopes 10°-25°
Wetlands
Coastal dunes
UNSTABLE
Hillslopes >25°
Seacliffs
Beaches
N
Caribbean Sea
Atlantic Ocean
Mi 0 1
Km 0 1
A.R. Orme


4
SOUTH-EAST PENINSULA
EARTH RESOURCES
Volcaniclastic aggregates
Construction sand
N
Sir Timothy's Hill
183
North Friar's Bay
South Friar's Bay
Caribbean Sea
Turtle Bay
Atlantic Ocean
Canoe Bay
Mi 0 1
Km 0 1
Elevations in meters above mean sea level
Manchineel Bay
White House Bay
288
Salt Pond Hill
Guana Point
Ballast Bay
Little Salt Pond
Sand Bank Bay
Great Salt Pond
Green Point
Central Drainage Basin
Sugar Loaf
162
319
St. Anthony's Peak
Major's Bay
Mosquito Bay
Cockleshell Bay
Banana Bay
Scotch Bonnet
Nag's Head
A.R. Orme

1.0 INTRODUCTION

Development of the Southeast Peninsula of St. Kitts should be planned with careful consideration given to the possibilities and limitations presented by the physical environment. This environment may be broadly understood in terms of three groups of variables, namely the resisting framework, the geodynamic forces, and the landform response.

The resisting framework is represented by the relative strength and weakness of the underlying volcanic and volcaniclastic rocks, of which the andesites tend to resist weathering and erosion to a greater extent than other materials. The geodynamic forces at work in the Peninsula are primarily mass wasting and fluvial processes whose attack on the resisting framework is conditioned by such climatic factors as the frequency, persistence and magnitude of rainfall. The landform response to the impact of geodynamic processes on the resisting framework is best characterized by slope and the stability of different slope components. Other forces of more local significance include aeolian (borne, deposited, produced or eroded by the wind) activity, most effective where unconsolidated sediments are exposed to onshore winds, and a variety of coastal processes around the margins of the Peninsula.

In order to provide a framework for planning and development within this physical environment, the following study focussed primarily on the geodynamic processes and land stability, both summarized in detailed maps. When viewed together, these maps provide an indication of the relative stability or hazard rating for each terrain component on the Peninsula. In general terms, development should focus on stable areas of low hazard rating, and avoid unstable areas characterized by high hazards. An intervening range of terrains between these extremes should be avoided where possible and at all times treated with care. This study also contains an evaluation of two earth resources relevant to the planning and development process, namely volcaniclastic aggregate and sand sources. The study concludes with management considerations and recommendations.

All conclusions presented in this study are based on detailed field investigations and mapping, supported by laboratory analyses.

2.0 DESCRIPTION OF RESOURCE CHARACTERISTICS

2.1 Geodynamic Processes

The Lesser Antilles comprise a classical island-arc system of Cenozoic age, with a younger volcanic inner arc and an older volcanic outer arc thickly mantled with carbonate rocks. These arcs have formed where the westward-moving Atlantic Plate is underthrusting the Caribbean Plate. St. Kitts is one of several active or dormant volcanic islands along the inner arc and, together with St. Eustatius and Nevis, lies along a NW-SE trending submarine ridge whose shape is well defined by the 200 m isobath. The Southeast Peninsula of St. Kitts is formed in the oldest volcanic rocks of the island, mostly andesite flows and various pyroclastic rocks. Structural attitudes, notably the dip of the pyroclastic deposits, indicate the presence of two or more formerly active volcanic conduits, the largest of which is now occupied by the Great Salt Pond. There is no evidence of recent volcanism on the Peninsula, although high seismicity and earthquake activity remain potential hazards consistent with an active island-arc system.

The Southeast Peninsula comprises two parts: a rocky isthmus 4.5 km long and up to 0.5 km wide that extends southeast from Sir Timothy's Hill to Salt Pond Hill, and a broad digitate peninsula 5 km across, comprising eroded volcanic hills linked by alluvial lowlands (Figure 1). Inland from the immediate coast, the principal geodynamic processes now shaping the Peninsula are mass wasting and ephemeral fluvial activity associated with the passage of rain-bearing storms. Wind action is locally important. Slope stability is closely related to the impact of mass wasting and running water on volcanic rocks of highly variable composition and structure.

The following discussion of geodynamic processes is based on field investigations, and the resulting geomorphic components of the environment are depicted in Figure 2. Particular attention in the planning and development process should be given to the location of major guts and related slope failures, as these should be avoided or mitigated in any development scenario.

2.1.1 Mass Wasting

Rock weathering throughout the Peninsula is highly variable, reflecting as it does the interaction between water and rocks of varying mineralogical composition and crystal structure. In general terms, the andesite flows and minor intrusive rocks are typically fine-grained materials commonly associated with the calc-alkaline suite of active island-arcs. Basaltic andesites and rhyolites are also present, indicating a range of silica and calcium values. These rocks weather relatively slowly and thus form most of the more prominent hills, such as Sir Timothy's Hill. Where mafic materials are more common, especially those rich in iron, weathering is more rapid and oxidation of surface exposures is widespread. The durability and density of these mafic minerals, notably the oxides ilmenite and magnetite, and horneblende from the amphibole group, make them common constituents of the Peninsula's beaches.

246

In contrast, the pyroclastic rocks that are widespread throughout the Peninsula are much more readily weathered and eroded than the andesites, primarily because bedding and fracture planes promote easy separation of clasts from matrix. Tephra or air-fall deposits form agglomerates, breccias and tuffs that lie interbedded with pyroclastic flows (ignimbrites) and other volcanic rocks, all testifying to the periodically violent volcanic history of the Peninsula. On weathering, these pyroclastic rocks commonly move downslope to be redeposited as epiclastic colluvium.

Simple rockfall is, and has long been, a significant process of debris production, both on seacliffs and inland cliffs. There are two main reasons for this. First, a major portion of the volcanic terrain comprises pyroclastic flows and air-fall deposits whose larger clasts are poorly restrained by a matrix of sand and ash. Weathering of this matrix, especially by salt weathering along the coast, liberates large angular to sub-rounded clasts that fall gravitationally downslope. Second, occasionally intense heavy rains and periodic fires serve to dislodge clasts from pyroclastic rocks and from fractured andesite. Most hillslopes are thus mantled with rock debris that has moved gravitationally from farther upslope, to such an extent that the bedrock geology is commonly concealed from view. There is no effective control over the rockfall process other than to lay slopes back to gradients of less than 10°, an approach that is neither feasible nor cost-effective.

Landslides range in size from a large number of slips and skin failures a few meters in width, to some large slides and rotational slumps. The eastern slopes of St. Anthony's Peak are particularly prone to mass movement where wave action is undermining the base of seaward-dipping rocks. There are two large slumps north of Mosquito Bluff which reveal a history of repeated failure, but pose no threat in what is presently an uninhabited area. The western slopes of the Nag's Head Peninsula also reveal several areas of rockfall and slope failure, processes that can be expected to continue. A possible large rotational slump may exist on the slope between Salt Pond Hill and White House Bay, where a series of rock cliffs is succeeded downslope by hummocky terrain indicative of past mass movement. As the peninsular road crosses this area, this feature merits further investigation but it does not appear to have been active during historic time.

Debris flows and debris avalanches are observable on many steeper hillslopes, the former on slopes between 10° and 25°, the latter in guts and rocky clefts steeper than 25°. By definition, such features are triggered by heavy rains on steep terrain underlain by pyroclastic debris or colluvium. Debris flows are particularly troublesome because they are not necessarily confined to existing guts but may occur across colluvial slopes and on alluvial fans wherever rainfall is heaviest or rock debris least stable. There are numerous colluvium-filled hollows in the Peninsula that attest to the activity of former debris flows and debris avalanches, and some alluvial fan deposits were laid down by debris flows.

Most guts in the Peninsula trace their origins to small, semicircular hollows high on hillslopes which appear to represent slope failures followed by debris avalanche or debris flow activity. The distribution of these failures, as shown on Figure 2, emphasizes southerly and westerly aspects, suggesting that these slopes fail during tropical storm or

241

hurricane activity when heavy rains are driven against the hills by winds from that quadrant. Slopes facing east and north appear less influenced by slope failures of this nature, presumably because they are better adjusted to incident rainfall driven by the prevailing easterly winds.

2.1.2 Fluvial Processes

Fluvial processes are normally associated with moderate to heavy rainfall, gentle rainfall being absorbed into the commonly porous soils and permeable bedrock of the Peninsula. It seems likely that such processes were more significant in the past when the Southeast Peninsula stood a few hundred meters higher relative to base level, either because of lowered sea levels during Pleistocene cold stages or prior to tectono-volcanic subsidence. There is no major drainage artery on the Peninsula. Instead, a large number of poorly integrated guts drain the isthmus and the Peninsula's five hill masses either directly to the sea or to the Great Salt Pond. The largest and probably most troublesome gut drains St. Anthony's Peak westward to the Great Salt Pond across the line of the proposed Peninsula road, and in recent times has also spilled northwards along the eastern margin of the sand dunes to reach Sand Bank Bay. This gut has its source in several debris-avalanche hollows immediately below St. Anthony's Peak and probably carries surface flow for several days after rains. Other guts often have similar origins in slope failures and avalanche scars high in the hills and, though shorter than the aforementioned gut, their steep channels and the availability of sediment present a significant hazard during and immediately after rainstorms. Areas particularly prone to flash flooding from these guts include the slopes leading south from Salt Pond Hill to the Great Salt Pond and the eastern slopes of the Nag's Head Peninsula extending south from the Great Salt Pond to Major's Bay. Significant guts also drain the south slopes of St. Anthony's Peak and radiate from the Sugar Loaf, but their flows are likely to be absorbed more readily in the piedmont run-out zone beneath these hills. Elsewhere, guts generally flow directly to the sea and thus pose no significant problems to the flatter, more developable lands.

The frequency and magnitude of streamflows during and after storms are difficult to evaluate in the absence of measurements. An intermittent record of rainfall obtained at Cockleshell Bay between 1963 and 1978 show annual rainfall to range from 67 cm to 136 cm, with the largest monthly total likely to occur in any month. Owing to orographic enhancement, rainfall on nearby hills is likely to be between 20% and 100% greater, especially on windward coasts. Such data are of some interest ecologically but are of little use in determining the role of the most important hydrologic events, namely high intensity rains of relatively short duration that are capable of generating slope failures and flash floods. Extrapolating from more continuous data obtained from other islands in the Lesser Antilles, it seems likely that a storm yielding 10 to 15 cm/day of rainfall might recur once every 10 years. Such a storm would generate widespread slope failure on the higher hillslopes, followed by debris flows and flash flooding in the guts. The field evidence suggests that such processes to recur infrequently and any development scenario should thus treat the flood potential of the guts with great care.

2.1.3 Aeolian Activity

Aeolian activity is widespread throughout the Peninsula but is most evident on the windward Atlantic coast where beach sand has been winnowed and blown inland to form dunes, notably at North Friar's Bay, Sand Bank Bay, and Mosquito Bay. Because of the permissively warm humid vegetative environment, such sand is readily stabilized by dune-building plants and is thus not a significant problem farther downwind. Conversely, should the vegetation be removed, reactivation of these dunes is likely to follow. Thus any development scenario should seek to minimize disturbance of the dune vegetation.

Routine wind data are not available for the Peninsula. Use of a hand-held anemometer during July 1988 yielded noon velocities of 7 to 11 m/s at 2m above ground level immediately seaward of the three dune sites along the Atlantic coast. This is well above the threshold velocity for sand entrainment and transport and suggests that, given a continued supply of sand, dune construction remains a very active process just as dune destruction could be readily initiated by vegetation removal. Wind velocities will of course vary greatly with elevation, location, and time of day. Data from other islands in the region indicate that St. Kitts will likely experience about 50% of all winds from the eastern octant, with 30% from the northeast octant and 10% from the southeast octant.

2.2 Land Stability

In order to define land stability in the Southeast Peninsula, slopes were characterized as Stable, Potentially Unstable, and Unstable. The latter two categories were also expanded to include other potentially unstable or unstable terrain along the coast and around the salt ponds. Unstabel areas with slopes of less than 10^0 would include all slopes developed on unconsolidated deposits prone to occasional or frequent reworking, namely beaches, dunes and stream courses. Beaches are subject to frequent reworking and have been placed in the unstable category; dunes are less frequently reworked and largely stabilized by vegetation - thus they were placed in the potentially unstable category; stream courses were not specifically identified on the Land Stability map but major guts were designated on the Geomorphology Map and defined as areas to avoid. Elsewhere, hillslopes on hard rock or colluvial/alluvial deposits are considered stable at slopes less than 10°, subject to close inspection during the development process. Clays were not observed on such slopes during the field investigations, but should pockets of unusually altered volcanic materials be exposed in the future they should be evaluated.

There are indeed stable areas with slopes above 10^0 and this arbitrary limit should be treated as a general guide rather than a definitive rule. Certainly, there are many slopes up to 12^0, sometimes up to 15^0, that are relatively stable. However, it is cautioned that gravitational forces increase exponentially with increased slopes and this implies an increased incidence o sediment transport and erosion. At this stage it is desirable to treat the Land Stability Map as a guide for development. Once specific areas for development have been recognized, more detailed land suitability maps can be prepared. There is also the question of scale: short steep slopes in hard rock, say a few meters

in length, pose no problem and can be removed during development; but long slopes of moderate declivity should be considered potentially unstable above about 10°. These categories will now be discussed with reference to Figure 3, the map of Land Stability, which clearly illustrates where development should or should not be directed.

2.2.1 Stable Areas

Stable areas are generally lowland, piedmont and upland terrain with slopes of less than 10°, although this value may range from 8° to 12° in specific locations. Of the lowland and piedmont areas, four zones of alluvial and colluvial terrain are noteworthy:

(1) The south-facing piedmont between Salt Pond Hill and the Great Salt Pond. This area, which will be traversed by the Peninsular road, is prone to occasional flooding and sediment deposition from guts draining Salt Pond Hill, but offers scope for limited development.

(2) The alluvial slopes and inner aeolian dunes between St. Anthony's Peak and the Great Salt Pond. As previously noted, the largest and most troublesome gut in the Peninsula drains from St. Anthony's Peak through this area but it should be possible to develop to either side of the gut, and also to develop on the innermost portion of the sandy area inland from Sand Bank Bay once the sand is lowered or removed.

(3) The alluvial slopes extending inland from Banana, Cockleshell and Mosquito bays, but excluding the adjacent wetlands. This is a relatively broad area, formerly part of the Fleming Estate's sugar cane and cotton production. Guts from St. Anthony's Peak and Sugar Loaf drain onto these slopes but their watersheds are small and much of the energy and sediment of a flash flood will likely be absorbed by the coarse alluvium.

(4) The alluvial corridor between the Great Salt Pond and Major's Bay. This corridor comprises two converging bajadas, one extending east from the Nag's Head Peninsula, the other extending west from the Sugar Loaf. Although there is some indication of gut erosion and deposition in recent years, these bajadas are relatively undissected and well drained.

Each of the above areas is characterized by generally gentle slopes veneered with variable thicknesses of alluvial and colluvial debris. Streams issuing from adjacent uplands occasionally cross all these areas en route to the coast or the Great Salt Pond. As such stream courses should be avoided in any development scenario and appropriate measures taken to constrain stream channels in the event of storm runoff.

Certain upland areas may also be considered relatively stable, most notably the broad upland of the Nag's Head Peninsula including the Green Point terrace, and the ridge between Banana Bay and Major's Bay. These areas could be accessed by roads without

204

significant problems. A small area on Scotch Bonnet and a spur on the southwest flanks of St. Anthony's Peak also offer some stable terrain.

2.2.2 Potentially Unstable Areas

Potentially unstable areas include hillslopes between 10° and 25°, wetlands and coastal dunes. The hillslopes generally form steeper piedmont terrain around residual volcanic hills and are developed on colluvial or alluvial deposits of variable thickness. The colluvial hillslopes are typified by blocky colluvium averaging 1 to 6 m deep, with individual clasts often of boulder size. Surface boulders are commonly unstable and are retained only by Guinea grass and associated vegetation. After heavy rains or fire, such debris moves downslope, both as individual clasts and in debris flows. Clearance of such areas for development should generally be avoided. Elsewhere on these colluvial slopes, there is widespread evidence for episodic shallow soil slips, debris flows, and rock falls. Whereas the land may be perceived as stable under dry vegetated conditions, such areas are more correctly classified as potentially unstable. The higher portions of alluvial fans must likewise be categorized as potentially unstable, especially where there is evidence of recent gut erosion.

The wetlands in and around the Great Salt Pond, the Little Salt Pond, and behind Mosquito, Cockleshell, Banana, Major's, and South Friar's bays are also potentially unstable by virtue of their high water content. Although water content will vary seasonally and in response to storm rainfall, the wetlands are formed in sands, sandy silts, silts, and clays, and thus have the potential to become thixotropic, especially during seismic tremors. In some instances, notably near their margins, these wetlands lie on rock at shallow depth and thus pose no significant problems. However, all wetlands are presently assigned to the potentially unstable category until coring data reveal more completely the nature and possible behavior of their bottom sediments.

The coastal sand dunes, notably on the Atlantic Coast at North Friar's Bay, Sand Bank Bay and Mosquito Bay, are also designated as potentially unstable because, as has been pointed out, removal of their protective vegetation would surely lead to reactivation of the exposed sand. Several episodes of dune development during later Holocene time are represented, especially behind Sand Bank Bay, and it is likely that the older, more indurated dunes are relatively stable. Nevertheless, deprived of vegetation, all dune sand is prone to erosion and redistribution.

2.2.3 Unstable Areas

Unstable areas comprise hillslopes steeper than 25°, seacliffs and beaches. Slopes that exceed 25° commonly bear witness to ongoing mass movement in the form of rock falls, planar and rotational slips, debris flows and debris avalanches. The steep slopes combine with often pervasively fractured bedrock or poorly consolidated pyroclastic deposits to promote frequent movement, especially after heavy rains and fires. Such slopes are characterized inland by numerous rock exposures and locally extensive cliffs, for example

245

below the eastern crest of the Nag's Head Peninsula. Steep rock-girt guts also characterize these slopes, many of them active within the past one or two years even though there is now little downstream evidence of recent deposition. All such areas should be avoided in any development scenario, including road construction.

Seacliffs fall within this unstable category because they are subject to episodic erosion and mass movement. Although some cliffs appear stable beneath a thick cover of Guinea grass or acacia scrub, this is misleading because the structure of the underlying volcanics is commonly seaward and both slip and flow phenomena are recurrent events.

Beaches are placed within the unstable category because they are either very active at the present time or are composed of relatively narrow ribbons of sand and shingle which are unable to sustain interference. Furthermore, there is reason to believe that several beaches, notably on the southern and western shores of the Peninsula, are no longer receiving sufficient fresh sediment from beyond the beach cell to offset losses occasioned by natural erosion or sand mining. Thus, under no circumstances should development be permitted on or near any beach, other than in the form of permeable structures such as piers, nor should sand mining be allowed. Strict setbacks should be established for developments behind the backshore.

2.3 Earth Resources

In order to address the potential need for coarse aggregate and construction sand for development in the Southeast Peninsula, the geology of the area was investigated from the land and from a coast guard cutter close inshore. This investigation was restricted by the extensive cover of vegetation in the Peninsula and by the variable mantle of colluvial and alluvial deposits on bedrock.

2.3.1 Volcaniclastic Aggregate Sources

Volcaniclastic materials are commonly composed of coarse angular to subrounded fragments in a sandy matrix and, except where welded, are readily weathered and eroded, and thus suitable for mining. The clasts are a useful source of coarse aggregate for road construction and building pads.

Coastal exposures of all volcanic rocks and surficial deposits have been identified and mapped. Inland exposures have been mapped where evident, for example in natural cliffs and along the Peninsular road cuts. From this reconnaissance mapping, andesite, basaltic andestite, and rhyolite are seen to underlie the major hills of the Peninsula and to reach the coast along wide fronts. For example, much of the Nag's Head Peninsula south of Ballast Bay is composed on well-jointed andesite flows, with minor andesitic air-fall deposits, volcanic breccias, tuffs, and lahar materials. There is no observable source of abundant volcaniclastic material. Much the same is true of the east coast of the isthmus and large areas of St. Anthony's Peak.

Two significant sources of volcaniclastic material area presently recognized:

(1) Sir Timothy's Hill: although the hill itself is composed mostly of andesite, the margins of the hill overlooking North and South Friar's bays and North and South Frigate bays are mantled by reasonably extensive volcaniclastics comprising breccias and agglomerates and colluvial debris derived from these deposits. This material is readily accessible and could be used to satisfy aggregate needs for local roads and building pads.

(2) The northern flank of St. Anthony's Peak, east of Sand Bank Bay: on the northeast-facing coast there is a 400m exposure of poorly consolidated agglomerate and volcanic breccia, with a much longer exposure of similar rocks interbedded with thin, well-fractured andesite flows. This source would be accessible from Sand Bank Bay and mining of the northeast-facing exposure would not be visible from that bay. The material is hydrothermally altered in several places and could probably be ripped rather than blasted. Mining from these two sources should be conducted with care, especially with respect to possible deleterious impacts on nearshore coral reefs arising from sidecast debris.

In addition to volcaniclastic materials, the debris found in alluvial fans and bajadas, and mantling most hillslopes, offers a further source of coarse aggregate, although often dispersed. Development along the corridor between the Great Salt Pond and Major's Bay would likely disturb much useful material which could be used locally.

It should be added that construction of the Peninsular road is in itself generating vast amounts of coarse aggregate from cut slopes. Some of this is being crushed to provide aggregate of varying sizes, but a large amount is being sidecast along the isthmus and could be salvaged for further use. It is recommended that the quantities generated from this source be evaluated.

2.3.2 Construction Sand Sources

There is a paucity of good construction sand on the Peninsula. Nowhere are there gut sedimentary deposits of old alluvium comparable in thickness to the gut deposits available on the lower slopes of the main part of the island. Most alluvial debris is coarse and sand extraction from the matrix would be difficult and uneconomic. Defining sand as that material between 2 mm and 0.063 mm in diameter (-1 to +4 Φ), there is only one major usable source, namely the sand dunes behind Sand Bank Bay.

The dunes at Sand Bank Bay comprise four main phases of deposition, all of later Holocene age. The most recent transverse dunes which form five ridges parallel with the modern beach, should not be touched as they afford natural protection against the sea. The next oldest deposit, a large parabolic dune that developed on the southeast side of the corridor to the Great Salt Pond, should likewise not be touched because it affords protection against gut erosion. Farther inland, and reaching to the shores of the Great Salt Pond, is a large area of older dune sand of no particular geologic value (although

-247

it may afford useful habitat). The Peninsular road will cut through this dune and it seems reasonable to use sand from this source for certain purposes. However, this sand is strongly unimodal and peaks in the 0.250 to 0.125 mm range (+2 to +3 Φ), thus limiting its use to plastering. There is no coarse sand ideal for mortar in these dunes. Furthermore, this sand is composed in varying measures of skeletal and peletal fragments of $CaC0^3$ thereby forming a natural but weak cement.

It was originally thought that the various salt ponds might provide a source of sand, based on a report by David Lashley and Partners to the St. Kitts-Nevis-Anguilla government concerning Solar Salt Production on St. Kitts. That report recognizes 'volcanic sand' beneath the Great Salt Pond and the Little Salt Pond, apparently grey in color and 5 m or more deep. Although some accompanying parts of that report were soon found to be wrong, this investigator considered it worthwhile to conduct a shallow coring program in these salt ponds to ascertain the quality and quantity of any sand available.

The results of two cores that penetrated the salt ponds to a depth of just over 7 m were disappointing. No 'volcanic sand' was found and, although grey sediment was found throughout, the ponds were found to be underlain by a mixture of shell sand, sandy silt, silt and organic-rich clays, but mostly by a lime mud peaking in the silt range. No terrestrial sediments consistent with alluvial debris flushed from the surrounding volcanic hills were located. Such debris may exist at greater depths or at other locations, but mining at greater depths (below sea level) would be both difficult and uneconomic. There is a possibility that useful sand may lie at shallow depths beneath the more southerly salt ponds but this could only be confirmed one way or the other by further coring. The results of the coring project in the Great and Little Salt Ponds will be presented separately.

243

3.0 MANAGEMENT CONSIDERATIONS

3.1 Principles

The beaches, dunes, salt ponds, lowlands and hill country of the Southeast Peninsula are an alluring national resource, amenable to selective development for recreation and tourism, supported by an appropriately localized service infrastructure. Any development scenario, however, must take full account of both the possibilities and limitations presented by the physical environment, so that planning and regulation can be directed along reasonable lines.

As a general principle, planning in the Southeast Peninsula should encourage ordered development of the area's potential while ensuring preservation of the best that nature has bequeathed and avoidance of unstable and other hazardous zones. Particular care should be taken during the development process to avoid aggravating potential problems in stable and potentially unstable areas, and to minimize anticipated increases in erosion and sedimentation arising from vegetation clearance, road construction, grading operations and site preparation.

To this end, a zoning ordinance should be prepared as a legal tool through which government agencies can implement a development plan. For zoning to be successful, there must be a combination of enlightened planning, good administration, and a thorough understanding of what is required for good environmental management. The zoning ordinance should include designation not only of various categories of developable areas but also of areas which should be avoided by reason of their high hazard rating or other limitations.

3.2 Practical Considerations

Development of and within the Peninsula's physical environment is now discussed in two categories: the location of development, and erosional and sediment control during and after development.

3.2.1 Land Stability and Development Location

The Land Stability Map (Figure 3) is based on careful slope mapping and characterization developed in consort with the recognition of geodynamic processes and related landforms shown on the Geomorphology Map (Figure 2). The Land Stability Map is amenable to fine tuning, particularly because boundaries are based primarily on arbitrary slope classes. Nevertheless, in general outline, it affords the best available framework for the direction of development, and will now be discussed in this context.

(a) Unstable areas should be avoided in any development scenario. They are defined as having slopes greater than 25° and as such are sites of episodic mass movement and gut erosion. These slopes are probably too steep for any development and

249

their use is best devoted to outdoor recreation such as walking and climbing designed to savor the scenic and ecological qualities of these environments. Frequent rock exposures in coastal and inland cliffs are prone to rockfall, but often provide useful habitat for relict plant and animal life. Beaches also fall within this category because they represent perhaps the Peninsula's most valuable resource, as well as offering protection to wetlands or salt ponds inland. Development behind the backshore is probably feasible but the sand and shingle ribbons that characterize these narrow beaches should not become the site of permanent or impermeable structures.

(b) Potentially unstable areas comprise hillslopes between 10° and 25°, wetlands and coastal dunes. The hillslopes are mostly stable under dry conditions but during and after heavy rains or fires, or both, they have the potential for mass movement, erosion, flooding and deposition. In general terms clearance of these moderately steep areas for development should be avoided. If some development is considered, for example for road access or very low density housing, the difficulties of working such areas should be acknowledged and potential hazards should be met by appropriate erosion and sediment control devices. The lower boundary, around 10°, is relatively flexible, but the upper boundary merges with generally unstable terrain.

The wetlands in and around the salt ponds are presently assigned to this category, at least until more is known about their sedimentary sequences, fluctuating water tables, and behavior under loads and seismic shaking. Where wetlands overlap onto bedrock at shallow depth, for example around stretches of the Great Salt Pond, they can probably be transferred to the stable category, but other issues such as mangrove and bird habitat may be important to the overall development scenario.

Coastal sand dunes are prone to erosion once their protective vegetation cover is removed. As such the most seaward dunes should not be developed as these provide natural protection against extreme surf conditions. The older innermost dunes at Sand Bank Bay may however offer a source of medium to fine sand for some construction purposes such as plastering. Dunes are also important habitat for certain plants and animals.

(c) Stable areas designated on the Land Stability Map should be the primary focus of development. Of the four broad areas recognized, the alluvial slopes around Banana, Cockleshell and Mosquito bays, and the alluvial corridor from the Great Sand Pond to Major's Bay offer the most scope for development with the least hazard potential. The south-facing piedmont below Salt Pond Hill is prone to occasional gut erosion and deposition but broadens westward between the Great Salt Pond and White House Bay, an area that could support modest development at the south end of the road along the isthmus. The alluvial slopes east of the Great Salt Pond are also developable but will need provision for erosion and sediment control for the major gut draining westward from St. Anthony's Peak.

260

If the guidelines indicated by the Land Stability Map are followed, then the needs for erosion and sediment control are minimized. In essence the guidelines recommend avoidance of areas prone to mass movement and erosion, although the products of erosion will likely be distributed farther downslope and both water and sediment can be expected to move occasionally through parts of the stable area.

3.2.2 Erosion and Sediment Control

The provision of erosion and sediment control structures does indeed suggest that there will be significant public infrastructure costs. However, these costs may be partly or largely offset by appropriate management decisions. For example, the main Southeast Peninsula Road will be provided with such structures as culverts and side drains during its construction. Further, should one or more non-government corporations be involved in a hotel-recreation complex or some similarly large-scale development, corporations should be encouraged to provide erosion and sediment control structures on all guts leading to, as well as on, their properties. This would be in the interest of good watershed management. However, this suggestion depends on what arrangements are negotiated between the Board and outside corporations or agencies. Recognizing the presence of much alluvial and colluvial rubble in and adjacent to stream courses, skilled use of a bladed tractor could readily produce deeper and wider channels and chevron levées as necessary.

As stated above, mass movement and erosion are likely to be significant if episodic hazards in the areas designated as Unstable, namely the steep inland slopes, seacliffs, and in terms of erosion alone the beaches. These areas should be avoided by development. Much the same applies to the Potentially Unstable areas where, again, avoidance of hazard is better than cure after the event. Acknowledging, however, that there may be some development in this zone, as well as in the Stable areas, the following guidelines are suggested.

(a) Review of development plans: to avoid possible problems and achieve effective control over erosion and sedimentation, all proposed plans for development, including grading plans, must be reviewed by qualified personnel. Such personnel should include individuals with engineering experience, but above all a thorough review should be conducted by persons qualified in geomorphology and hydrology. The review would ensure that correct decisions are being taken, that temporary and permanent control measures are included in the plan as necessary, and that field inspections during development assure compliance with approved plans.

(b) Structural controls: erosion and sedimentation control measures can be either structural or vegetative or a combination of both. Structural measures are designed to control water runoff, erosion and sedimentation by use of a variety of engineered structures. They can have mixed results.

Some years ago, conventional wisdom suggested that guts and similar canyons elsewhere would be provided with check dams to offset the effects of flash floods

and debris production, while downstream areas could be given larger debris basins. Such wisdom has not in most cases proved cost effective - check dams have been quickly filled to overflowing and debris basins have been filled more slowly but by vast accumulations of sediment. Today, it seems advisable to confine flash floods to definite channels, as much as is possible, but to allow water and sediment to flow downslope to a natural sump which, in the Southeast Peninsula, would be a salt pond or the sea. In areas designated for development, it thus becomes important to recognize a few major guts or drainage lines across alluvial slopes, to deepen and widen these so as to encourage the next several floods to flow within these channels rather than to break their banks, and thus to encourage water and sediment to move as quickly as possible to the sump. Once recognized, these natural channels should be avoided by development by the use of setbacks, but landscaped for aesthetic and recreational purposes. In order to encourage water and sediment to flow into the upper ends of these channels, chevron levees of local debris offer the most cost-effective means of countering the problems of overbank flow. The above suggestions can be implemented as structural devices but without the use of concrete and could be applied to potentially hazardous guts and alluvial-fan networks on the Southeast Peninsula. The precise location and design of such structures must of course await the development of a more definitive Development Plan.

Road construction in the Southeast Peninsula, including local access roads, should be undertaken with great care. Impermeable surfaces such as roads commonly concentrate surface drainage and interfere with the natural drainage of an area. This water should be carefully controlled and removed by a combination of berms, ditches, side-drains and culverts, with energy dissipators such as rock aprons used at culvert outlets and other points of high energy water discharge so as to reduce erosion. Ideally culverts should be redirected towards existing natural drainage lines, and the latter then treated as stated in the above paragraph. Under no circumstances should road drainage be allowed to accumulate on a road or to flow over a fill slope that has not been prepared for its receipt. These can lead to road failure through the undermining of the fill slope, while abundant debris is readily entrained and moved downslope, possibly into developed areas.

(c) Vegetative controls: Vegetation is an important control over surface erosion, in part because it intercepts rainfall and thus dissipates its impact before reaching the ground, and in part because it retards overland flow and shallow sub-surface flow by virtue of its root systems. In both instances, erosion is normally reduced. Conversely, removal of vegetation allows for direct raindrop impact on bare soils and for the easier entrainment and transport of surface debris, leading to accelerated erosion and deposition.

Construction during development commonly causes vegetation to be removed. Furthermore topsoil and subsoil may also be stripped making revegetation difficult because of the unsuitable nature of the exposed mineral soil or bedrock. Nevertheless, it is important to reestablish a vegetation cover as quickly as possible. To do this, straw mulch, wire mesh, jute matting, asphalt emulsions, and

other stabilizing agents can be used to hold soil in place while plants become established. Hydroapplications of fertilizer, seed and mulch in one operation may also be used. Plants must of course be selected which grow rapidly and are adaptable to the conditions of the site.

(d) Construction practices: Development implies construction, construction implies some destruction of the surface and an enhanced likelihood of erosion and sediment yields. Problems of this nature can be offset in several ways: by timing construction to avoid periods of heavy rains, by constructing temporary sediment basins at construction sites, by avoiding concentrations of runoff likely to cause erosion, by protecting soil and sediment stockpiles from excessive erosion by water and wind, by limited vegetation clearance to relatively small areas at a time and reestablishing vegetation quickly after construction, by restricting equipment movement especially in guts during rains, and by removing waste (including plastic materials and toxic wastes) promptly from construction sites.

(e) Mining: Mining activities in the Peninsula should be carefully controlled. Some quarrying of rock materials for foundations is likely but this should be concentrated at discrete locations and abandoned quarries should be landscaped. Sand mining is a possibility in the innermost sand dunes behind Sand Bank Bay but this should pose not significant physical problems. Under no circumstances should beach sand be mined. Beaches are natural barriers and, although they may contain sand grades suitable for construction, they are far more important as protection for developments behind the backshore.

An example of application of these categories and controls in terms of development might be taken on Sir Timothy's Hill. The most serious problems seem likely to develop on Sir Timothy's Hill where cut slopes remain dangerously steep and the volcanic and volcaniclastic rocks are highly variable. Before the road in that area is finished, every attempt should be made to ensure cut-slope stability to the extent that is practicable and cost-effective. Vegetation alone is unlikely to promote slope stability, either in the cuts or on the disturbed slopes above.

4.0 SUMMARY AND RECOMMENDATIONS

From the perspective of the physical environment, the Southeast Peninsula offers attractive possibilities for development, provided the natural constraints and limitations of the environment are recognized. In conclusions, it is recommended that:

(1) The Land Stability Map be employed as the physical basis for development within the Peninsula. The Map will need fine tuning as more information becomes available, but presently offers the best framework for planning.

(2) The Geomorphology Map and its implicit or explicit representation of geodynamic processes be employed as a measure of the physical processes at work in the Peninsula, particularly with respect to the location of guts and the shallow slope failures that trigger gut erosion.

(3) The Earth Resources of the Peninsula are limited in number and distribution, and, although two important sources of volcaniclastic aggregate have been located, it is recommended that the quantity of coarse aggregate generated by the construction of the Peninsula road be evaluated for first use in construction. Such material should not be left in unstable form on hillslopes. Sand resources are modest, but sand for plastering purposes may be obtained from the inner sand dunes behind Sand Bank Bay. Beach sand must not be mined.

(4) A zoning ordinance should be prepared that defines stable, potentially unstable, and unstable land, and then further categorizes the stable or developable land in terms of flooding and erosion hazards on the one hand and interfluve areas on the other hand. It is these latter areas, gentle slopes between or above the zone of gut erosion and deposition, that are most amenable to development.

(5) Erosional and Sediment Control should be approached in three stages:

   (a) Avoidance of areas demonstrated to have serious problems, namely those areas already designated as unstable, and the higher slopes of the potentially unstable category.

   (b) The provision of deeper and wider stream courses along guts with a known history of flooding, with chevron levees but without concrete structures. These should provide good protection from floods and debris production, provided setbacks are established and, where necessary, bridges with sufficient freeboard are designed.

   (c) The provision of water and sediment control structures along and adjacent to all roads in the Peninsula. If these cannot be provided on minor roads, then to road surface should be outsloped to avoid water concentrations. In addition, removal of vegetation should be undertaken only where absolutely necessary, and revegetation should be implemented during or

immediately after development. Guidelines for construction practices should be designed, if they do not already exist.

(6) All development plans, especially those that address the specifics of construction and road building, should be reviewed by personnel qualified in geomorphology, hydrology and engineering, so as to minimize deleterious impacts on the environment.

4.1 Considerations for Further Study

The foregoing study was compiled from field observations in the Southeast Peninsula during July and September 1988. In September, was probed the Great Salt Pond in two cores and a short report on my findings will be forwarded as soon as C^{14} dating of included sediments is complete. A limitation to the study is posed by the absence of quantitative data regarding long-term rainfall, wind, runoff and sediment yields for the Peninsula. These limitations can be offset to some extent by modelling but there are too many unknown values for such a model to be truly useful at this time. Further study of the physical environment of the Southeast Peninsula would be assisted by the following:

(1) Establishment of a fully automatic weather station at some convenient location in the Peninsula, designed to record a series of weather and climatic data including precipitation and wind. Short-term weather stations could be established in less accessible locations for calibration purposes.

(2) A small network on monumented cross-sections with stream-gauging and sediment-gauging equipment in two or three of the largest guts. This equipment would provide some measure of the significance of streamflow and sediment yields during storms.

(3) A deep-coring program and/or seismic survey of the Great Salt Pond and other salt ponds in the Peninsula in order to learn more about:

   (a) Long-term sedimentation rates on the Peninsula.

   (b) Geohydrologic conditions in these ponds, including the relationship between fresh meteoric water, connate water, and salt-water intrusion, so as to assess the likely potable water resources in and adjacent to these ponds.

   (c) The likely occurrence of construction sand of non-carbonate origin.

(4) A survey and monitoring program extending from the wetlands into the offshore zone to a depth of at least 10 m, designed to reveal the nature and behavior of sediments and their exchange between offshore, beach and wetland, to evaluate processes in these environments, and to prepare for the likely development of a marina facility. A more comprehensive approach to the relationship between

255

offshore, beach and wetland or interior environments is necessary before final decisions are made regarding a marina.

Figure 5. The asymmetric profile of the isthmus reflects the underlying geological structure wherein andesites and interbedded pyroclastics dip northeast (left) in this view looking across Friar's Bay. The northeast-facing slope is potentially unstable, whereas the steeper southwest-facing slope is unstable.

Figure 6. The Green Point terrace, which protrudes westward from the Nag's Head peninsula, is characteristic of gently sloping stable terrain amenable to development.

Figure 7. This combination of rock-slide and rockfall on the west side of the Nag's Head Peninsula is typical of the many coastal slope failures around the Southeast Peninsula. For such reasons, development should be set back from the clifftop.

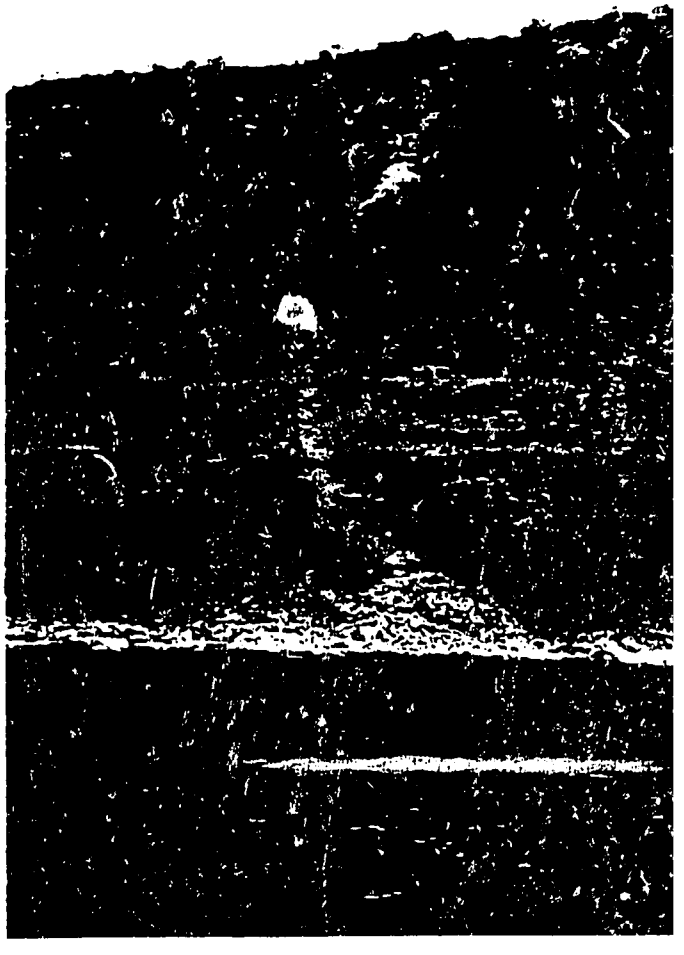


Figure 8. This small gully on the west side of the Nag's Head peninsula has been the site of repeated small debris flows and dry ravel. Once such chutes are established, they persist for long periods. Although this particular site presents no danger, similar chutes inland should be carefully avoided during development.

Figure 9. Salt Pond Hill is a rugged andesite mass that rises north of the Great Salt Pond. The two guts observable on its slopes are the sources of alluvial debris that has formed the fan at its base. The guts originate in slope failures and during heavy rains witness a combination of debris avalanches, debris flows and fluvial processes which pose a hazard to the relatively stable land below.

Figure 10. The Great Salt Pond is separated from the Atlantic ocean by a sand-dune complex lying inland from Sand Bank Bay. The innermost dunes are a possible source of construction sand but the outer dunes are important for coastal protection. To the left, several guts emerge from Salt Pond Hill.

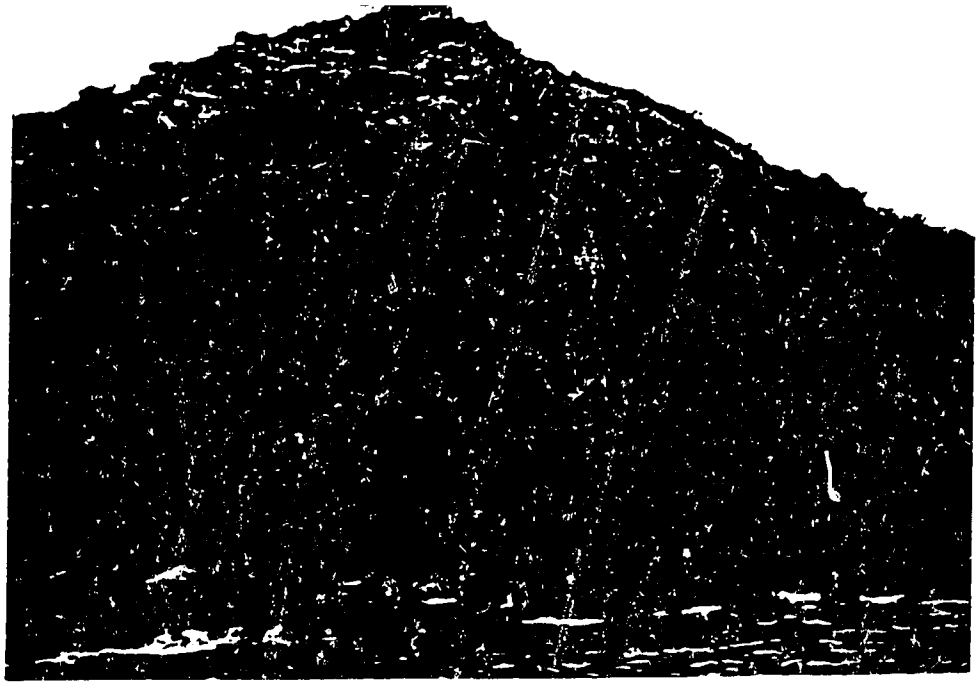


Figure 11. Andesite forms the core of most hills in the Southeast Pensinsula. It is mostly well-jointed, allowing weathering and erosion to detach large and small clasts which mantle hillslopes as colluvium and locally reach the shore, as here on the Nag's Head peninsula.

Figure 12. Volcaniclastic debris is widespread around the Southeast Peninsula but is normally interbedded with more massive or fractured andesite, basaltic andesite and rhyolite. Locally, however, as here on the southern slopes of Sir Timothy's Hill, there are considerable thicknesses of pyroclastic and epiclastic material, of potential value as construction aggregate.

MORPHODYNAMICS, SEDIMENT CHARACTERISTICS, AND MANAGEMENT CONSIDERATIONS

by

Amalie J. Orme, Ph.D.

May 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

261

EXECUTIVE SUMMARY

The beaches of the Southeast Peninsula are evaluated in terms of morphodynamics (the energy environment), profile geometries, contributing materials, and vegetation cover in order to provide the framework for a beach management plan and proposals for sound use of the coastal resource.

The wave and current environment is examined using a variety of energy factors including wave height, period, length and approach; current direction and speed; and wind direction and speed. Profiles are established for each beach and surveyed from a minimum 30 m seaward of the berm to the crest of the first coastal dune or salt pond backing each beach. Profiles reveal nearshore bottoms which exhibit a series of bedforms ranging from a planar bed to lunate megaripples and ridges and runnels. Several episodes of past storm events are evidenced by the presence of one or more erosional nips, ridges and swales, and exposed beachrock on the foreshore and backshore. Using mechanical, chemical, and microscope analyses, provenance, residence time, and beach equilibrium are established. Statistical analyses for particle size, sorting, and skewness are used to determine the strength and range of dominant beach processes. Particle size ranges for Caribbean beaches are -1.0Φ to +4.0Φ, with moderate to good sorting and a dominance of inorganic materials. Particle size ranges for Channel beaches are -2.0Φ to +4.0Φ, excellent sorting, and a dominance of organic (coral, shell, algal) materials. Particle size ranges for Atlantic beaches are -1.0Φ to +4.0Φ, moderate to good sorting, and a dominance of organic materials, especially coral. Sediment movement appears to be primarily onshore-offshore. Dune vegetation is identified for the sand strand, barriers and dunes, and the mangrove community. Blowouts are common on Atlantic-facing beaches while soil development on all dune systems is poor. Dunes afford significant protection against wave attack especially on the Atlantic coast.

A beach management plan is presented which outlines six objectives: repeated surveys of beach profiles; monitoring of nearshore energy factors; quantification of sediment budgets; evaluation of material exchange between the offshore and beach system; coral reef systems. Seven proposals for the maximization of human use and minimization of deleterious impacts on the coast are suggested. These address the matters of mining of beach materials; engineering structures; access; design wave criteria; design setback; coral reef protection; and dumping and removal of waste.

TABLE OF CONTENTS

LIST OF FIGURES ii

1.0 INTRODUCTION 1

2.0 DESCRIPTION OF THE RESOURCES CHARACTERISTICS 2
- 2.1 Beach Morphodynamics 2
  - 2.1.1 The Wave and Current Environment 2
    - 2.1.1.1 Caribbean Beaches (South Friar's Bay, White House Bay, Ballast Bay) 2
    - 2.1.1.2 Channel Beaches (Major's Bay, Banana Bay, Cockleshell Bay) 2
    - 2.1.1.3 Atlantic Beaches (Mosquito Bay, Sand Bank Bay, North Friar's Bay) 2
    - 2.1.1.4 Relative Sea-level Rise 3
  - 2.1.2 Beach Profiles 5
    - 2.1.2.1 Caribbean Beaches* 5
    - 2.1.2.2 Channel Beaches 10
    - 2.1.2.3 Atlantic Beaches 15
- 2.2 Beach Sediment 21
  - 2.2.1 Caribbean Beaches 21
  - 2.2.2 Channel Beaches 24
  - 2.2.3 Atlantic Beaches 31

3.0 MANAGEMENT ALTERNATIVES 37
- 3.1 Engineering Needs and Impact 37
- 3.2 Dune Vegetation 37

4.0 BEACH MANAGEMENT PLAN 38
- 4.1 Management Proposals 39

5.0 SUMMARY AND RECOMMENDATIONS 43

APPENDIX 1 EXPLANATION OF SYMBOLS USED IN FIGURES 44

APPENDIX 2 TECHNICAL GLOSSARY 45

262

LIST OF FIGURES

Figure 1	Location Map
Figure 2	South Friar's Bay Profiles
Figure 3	White House Bay Profiles
Figure 4	Ballast Bay Profiles
Figure 5	Major's Bay Profiles
Figure 6	Banana Bay Profiles
Figure 7	Cockleshell Bay Profiles
Figure 8	Mosquito Bay Profile
Figure 9	Sand Bank Bay Profiles
Figure 10	North Friar's Bay Profiles
Figure 11	South Friar's Bay
Figure 12	Ballast Bay
Figure 13	Major's Bay
Figure 14	Banana Bay
Figure 15	Cockleshell Bay
Figure 16	Mosquito Bay
Figure 17	Sand Bank Bay
Figure 18	North Friar's Bay

264.

1.0 INTRODUCTION

The Lesser Antilles comprise a classical island-arc system of Cenozoic age, with a younger volcanic inner arc and an older volcanic outer arc thickly mantled with carbonate rocks. These arcs have formed where the westward-moving Atlantic Plate is under thrusting the Caribbean Plate. St. Kitts is one of several active or dormant volcanic islands along the inner arc and, together with St. Eustatius and Nevis, lies along a NW-SE trending submarine ridge whose shape is well defined by the 200 m. bathymetric contour. The Southeast Peninsula of St. Kitts is formed in the oldest volcanic rocks of the island, mainly andesite flows and various pyroclastic agglomerates and tuffs. The immediate offshore area is composed of more recent coral reefs and a veneer of coral, algal, and inorganic materials. The beaches of the Southeast Peninsula are pocket beaches with the possible exception of White House Bay Beach. While there is the presence of significant longshore currents moving northwestward along both the Atlantic and Caribbean beaches and moving westward thorough the Channel, dominant sediment transport is onshore-offshore.

The development of the Southeast Peninsula should be planned with careful consideration given to the potential benefits and limitations of the coastal environment. Sound management of the beach resource can be evaluated through an investigation of beach morphodynamics, the materials which comprise the backshore, beach and nearshore environments, and the spatial and temporal responses to these physical factors.

Beach morphodynamics are represented by the energy variables responsible for shaping the coastline in the past, present, and future. These include wave height, period, length, and approach; current direction and speed; and wind direction and speed. The compositional properties of these environments are derived from local cliff and inland sources and from the destruction of nearshore and locally offshore coral reefs and algal accumulations. The landform responses to the impact of these processes and materials is best demonstrated by the geometry of the beaches and changes across the backshore, beach, and nearshore zones.

In order to provide guidelines for planning and development within the coastal environment, the following study focussed on the morphodynamics and profile responses on nine major beaches of the Southeast Peninsula. Eighteen sediment samples were analyzed for size, provenance, and responses to energy variables in order to determine beach stability and potential change over time. Dune vegetation was evaluated in terms of species present within discrete portions of the coastal zone and the role of such vegetation on beach stability. A beach management plan with proposals for the sensible use of the beach resource was assembled using the physical data collected, analyzed, and interpreted.

All conclusions presented in this study are based on detailed field survey, collection of samples and subsequent laboratory analysis within the time allotted by Tropical Research and Development, Inc.

2.0 DESCRIPTION OF THE RESOURCES CHARACTERISTICS

2.1 Beach Morphodynamics

2.1.1 The Wave and Current Environment

The beaches of the Southeast Peninsula are subject to a variety of energy factors including wave height, period, length, and approach under both average and storm conditions; current direction and speed; and wind direction and speed. Tidal range averages 0.3-0.4 m.

2.1.1.1 Caribbean Beaches (South Friar's Bay, White House Bay, Ballast Bay)

Primary wave approach for the Caribbean Beaches is from the south with average wave heights <0.5 m. Longshore current direction is from south to north. Field observations during July 1988 revealed two wave systems present at South Friar's Bay:

1. Chop: 0.2 m. waves approaching 30° to shore (18° wave window approach), 1.0 m. wavelength, 1.5 s^{-1} period.

2. Deep water waves: 5° approach to shore (200° wave window approach), 30 m. wavelength, 15 s^{-1} period.

2.1.1.2 Channel Beaches (Major's Bay, Banana Bay, Cockleshell Bay)

Wave approach for the Channel Beaches is from the south-southeast with average heights of 0.3 m. Field observations at Banana Bay and Cockleshell Bay revealed waves of 0.1-0.2 m. with a 5-6 s^{-1} period. Longshore current motion is weak (0.03 m. s^{-1}), moving in a westerly direction. It should be noted however, that the Channel Beaches are subject to considerable southerly storm wave energy associated with the passage of tropical depressions.

2.1.1.3 Atlantic Beaches (Mosquito Bay, Sand Bank Bay, North Friar's Bay)

Atlantic Beaches experience wave approaches primarily from the east-northeast with heights ranging from 0.8-4.0 m. These higher energy beaches also have the potential for significantly greater wave heights associated with windward coast storm systems. Observations in July 1988 revealed 1.1 m. waves with a 5.5 s^{-1} period and 90° approach to shore at North Friar's Bay. Also present were 8 rip currents with a 15 m. spacing. Waves of 1.0 m. with a 7.8 s^{-1} period and the presence of 7 rip currents with 12 m. spacing were recorded at Sand Bank Bay.

266

Wind speeds of 7-11 m. s^{-1} (steady at 10 m. s^{-1} for 30 s) were recorded. Mosquito Bay experienced 0.3-0.5 m. waves, 5.5 s^{-1} period, 90° approach to shore, and 6 rip current systems with 15-20 m. spacing.

All beaches cited in this report may be found on the location map (Figure 1).

2.1.1.4 Relative Sea-level Rise

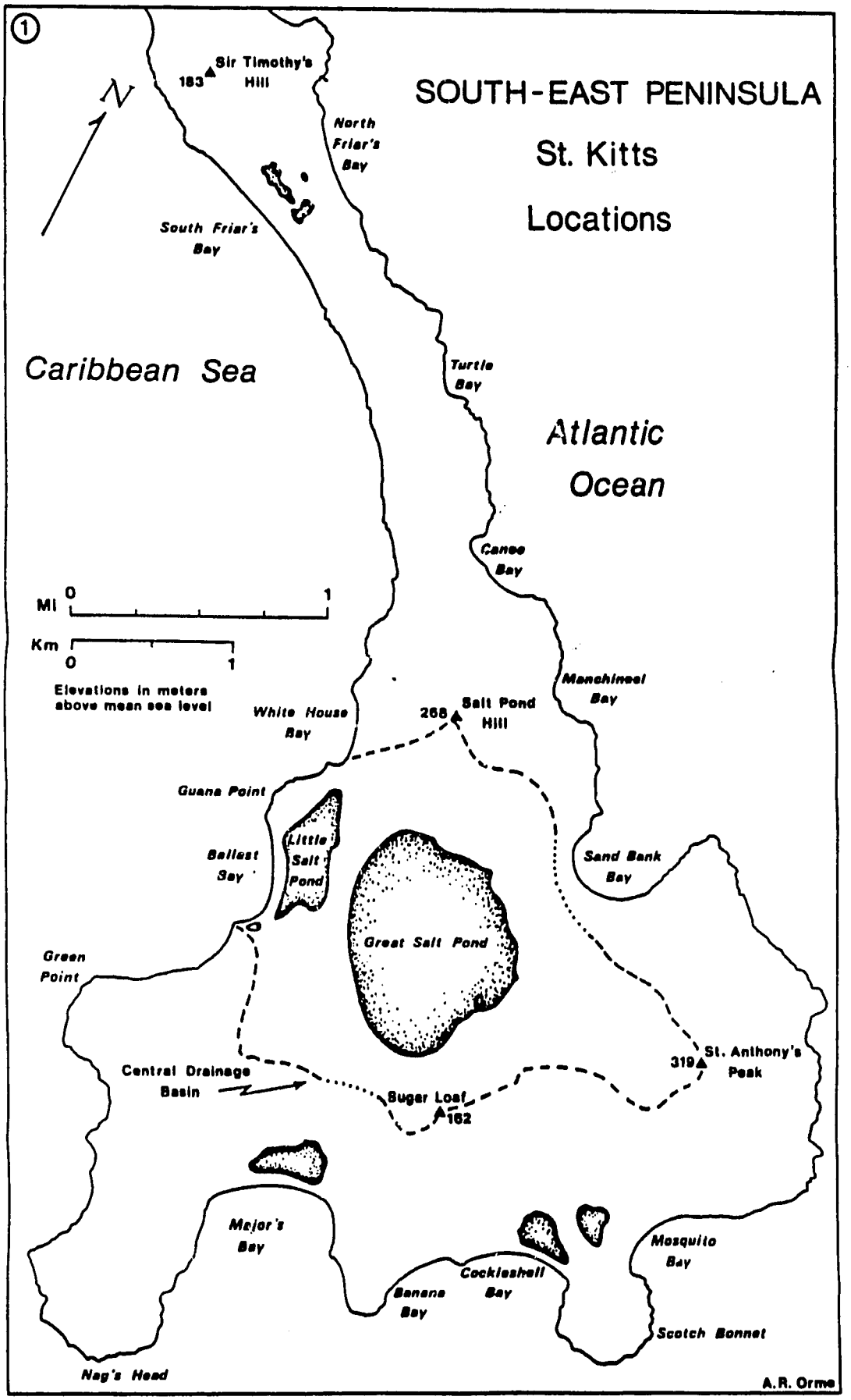
The authors are fully cognizant of the current debate on possible sea-level rise and indeed are conducting investigations on this theme. At the outset, it should be emphasized that, as a result of some mediocre science and much media attention, an alarmist image has been created with respect to sea-level rise, an image which for example portrays the widespread inundation of coastal areas in the next century. A more balanced judgment based on careful evaluation of the tide-gauge data indicates that the predictable rise of sea level is likely to be highly variable in space and time, and very small compared with the temporary but nonetheless damaging effects of a storm surge. However, it is entirely reasonable to address the issues involved.

Sea-level changes are the product of several interacting forces: eustatic (global change associated with global or regional changes in the earth's ice-water-vapour budget); isostatic (regional flexuring of the earth's crust attributable to loading b ice, water or sediments or unloading by removal of such masses); tectonic (regional or local deformation associated with earth movements, including volcanism); and other forces related to such variables at atmospheric pressure, atmospheric and oceanic temperatures, and geoidal and tidal effects. Thus, it is usual to speak of relative sea-level change because the actual change at any one locality may be a composite product of sea-level rise and land subsidence.

Comparison of air bubbles trapped in Antarctic ice cores with present atmospheric composition reveals that the concentration of CO_2 and other gas in the atmosphere has increased significantly over the past 200 years. This has produced discussions on the so-called 'greenhouse effect' responsible for atmospheric and oceanic warming, glacier melting and consequent sea-level rise. A global rise of 1.0 to 1.5 mm/yr (0.1 to 0.15 m/100 yrs.) has been inferred from considerations of glacio-eustatic and steric (thermal) effects.

However, the record from long-term (<60 yr.) tide gauges around the North Atlantic reveals a more complex pattern. In essence, sea level is changing at different rates from place to place and from time to time. Much of this change is because the ocean surface is itself irregular, for example, across the Gulf Stream, and this creates fluctuations of up to 10 cm. over a five-year period, or 20 times the alleged global change. Removing all regional factors from the equation still leaves a temporal pattern that is far form simple. For example, it appears that sea level rose on both sides of the Atlantic from 1920-1950 but has been stable or falling since, except in areas where isostatic or tectonic subsidence is occurring, as around the western Gulf of Mexico.

267


1
SOUTH-EAST PENINSULA
St. Kitts
Locations
N
Sir Timothy's Hill
183
North Friar's Bay
South Friar's Bay
Caribbean Sea
Turtle Bay
Atlantic Ocean
Canoe Bay
Mi 0 1
Km 0 1
Elevations in meters above mean sea level
Manchineel Bay
White House Bay
Salt Pond Hill
268
Guana Point
Ballast Bay
Little Salt Pond
Great Salt Pond
Sand Bank Bay
Green Point
St. Anthony's Peak
319
Central Drainage Basin
Sugar Loaf
162
Major's Bay
Mosquito Bay
Cockleshell Bay
Banana Bay
Scotch Bonnet
Nag's Head
A.R. Orme

265

What is the pattern in the Caribbean and specifically in St. Kitts? Presently, it is not known for sure and for that reason alone it is wise to err on the side of caution. St. Kitts is a volcanic island in an active tectonic setting, surrounded by a carbonate platform on a volcanic base. Because these volcanic and carbonate rocks have probably loaded the crust, there may be a tendency towards relative sea-level rise over the long term. On the other hand, the apparent stability of the Great and Little Salt Ponds over the past 4500 years (see Antony Orme's separate report on this topic with respects to marina development), suggests that the Southeast Peninsula has been relatively stable with respect to sea level during this time.

Concerns about sea-level rise should be placed in perspective. First, the worst-case scenario of a global rise of three m. over the next century (Hoffman et al., as presented by G.L. Morris) is highly unlikely. Even the rapid rise of sea level at the close of the last glaciation never exceeded 1 m/100 yrs. The low rate of rise presented by Hoffman of 0.5 m./100 yrs. is based on erroneous data and is a global value not supported by data from the 1950 to 1985 period. However, it and similar papers in the early 1980s certainly attracted much attention and that is good. In the circumstances, it is prudent to acknowledge the possibility of a gross rise in the sea level attributable to global warming, while planning for the more predictable and much larger impacts of hurricane surges by creating adequate setbacks. Much of the concern for sea-level rise in the United States focusses on low-lying coasts where wetlands may be inundated, even as new wetlands develop beyond the present tidal limits. In St. Kitts, a relative rise of sea level would probably build the coastal sand and gravel barrier beaches somewhat higher and raise water levels in the salt ponds and in the ground, but the revised estimates discussed above suggest that this will not be more than 10 to 15 cm. over the next century, a magnitude or two less than a typical storm surge at present.

2.1.2 Beach Profiles

Profiles were established for each beach extending from the nearshore bottom at least 30 m. seaward of the berm to the crest of the first coastal dune on fringing beaches and to the salt ponds on the barrier beaches. At least one profile was surveyed for each beach with two to three profiles established on either larger or sensitive beaches included in the study. Profiles were surveyed in order to describe beach morphology and to establish baselines from which future change could be recorded.

2.1.2.1 Caribbean Beaches*

South Friar's Bay (Figure 2). Profiles were surveyed on the north (55 m.), middle (44 m.), and south (42 m.) sections of the 1150-m. long South Friar's Bay barrier

269

beach. The nearshore bottom extends seaward from the lower beach face at approximately 0.3 m. below sea level. It is characterized by irregular bottom topography which includes ripple and dune sequences which become progressively broken in a southerly direction. A 3° seaward dip was recorded at the time of survey. The beach face extends seaward from the lower foreshore to the inner nearshore zone over 3-4 m. It is characterized by discontinuous ripples and dunes as well as by subtidal cusp development which becomes degraded towards the south portion of the beach. A 7° seaward dip was recorded at the time of survey. The foreshore extends seaward from the first backshore berm to the upper beach face over a width of 5 m. It is characterized by a smooth face with an average 7° seaward slope on the north and middle profiles, and a 9°-12° dip on the south profile. Erosional nips of 0.2 m. are found on the north and middle sections of the beach, while a 0.65 m. nip is present on the south portion of the beach.

The backshore of South Friar's Bay beach is characterized by a series of 4-5 erosional nips and berms which coalesce and degrade towards the south. Small 0.1-0.2 m. dune accumulations are present on each of these berms and appear to be incorporated within the ubiquitous *Ipomoea pescaprae* and *Distichlis spicata*. The face of the first dune ridge on the north section is 30 cm. high while those of the middle and south sections are 70 cm. and 2 m. respectively. By the very nature of this barrier complex as well as the presence of a series of fresh berms and dune faces, overwash processes are active and seem likely to be in the future.

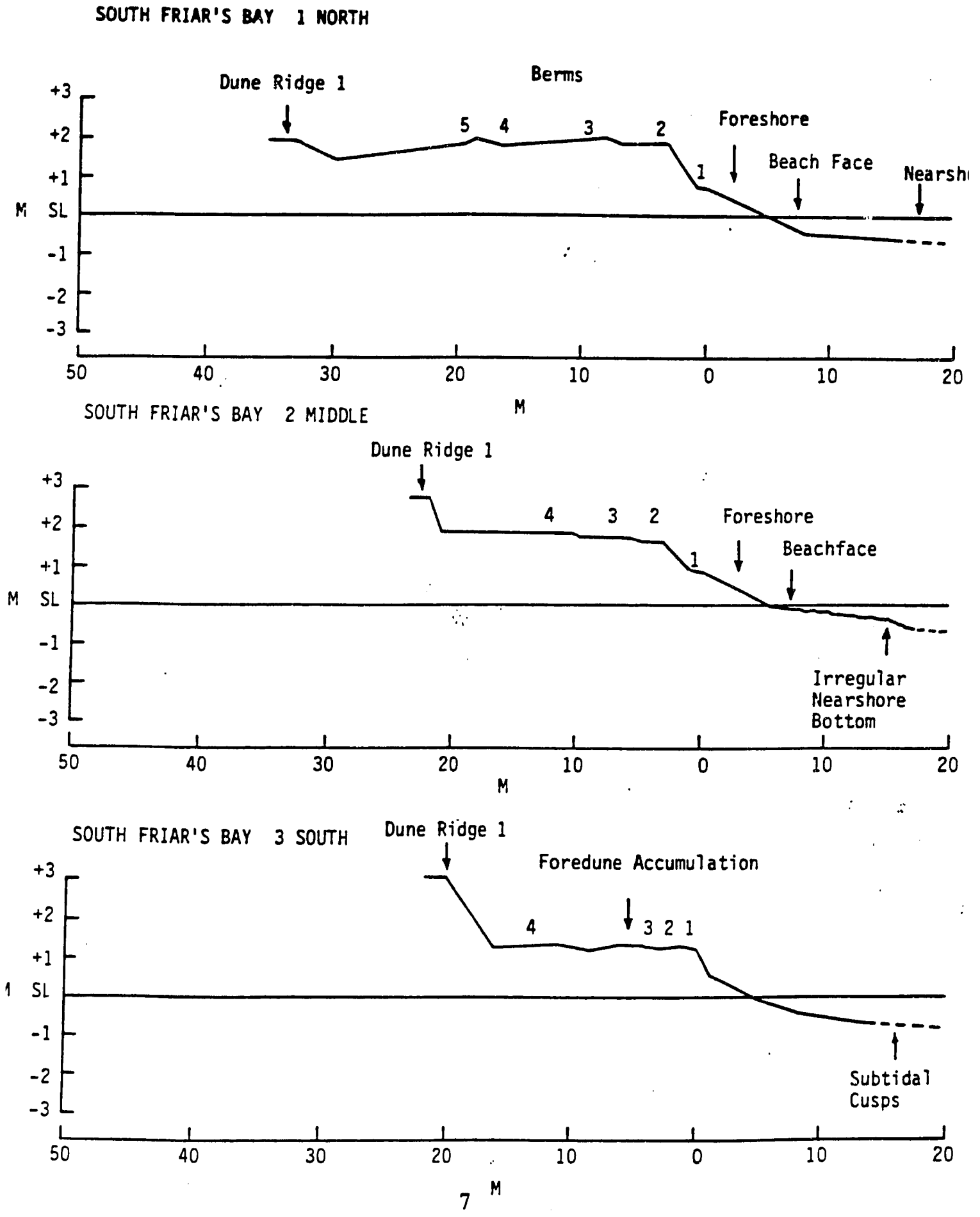

SOUTH FRIAR'S BAY 1 NORTH
Dune Ridge 1
Berms
5 4 3 2 1
Foreshore
Beach Face
Nearsh
+3
+2
+1
M SL
-1
-2
-3
50 40 30 20 10 0 10 20
M
SOUTH FRIAR'S BAY 2 MIDDLE
Dune Ridge 1
4 3 2 1
Foreshore
Beachface
Irregular Nearshore Bottom
+3
+2
+1
M SL
-1
-2
-3
50 40 30 20 10 0 10 20
M
SOUTH FRIAR'S BAY 3 SOUTH
Dune Ridge 1
Foredune Accumulation
4 3 2 1
Subtidal Cusps
+3
+2
+1
SL
-1
-2
-3
50 40 30 20 10 0 10 20
M

Figure 2

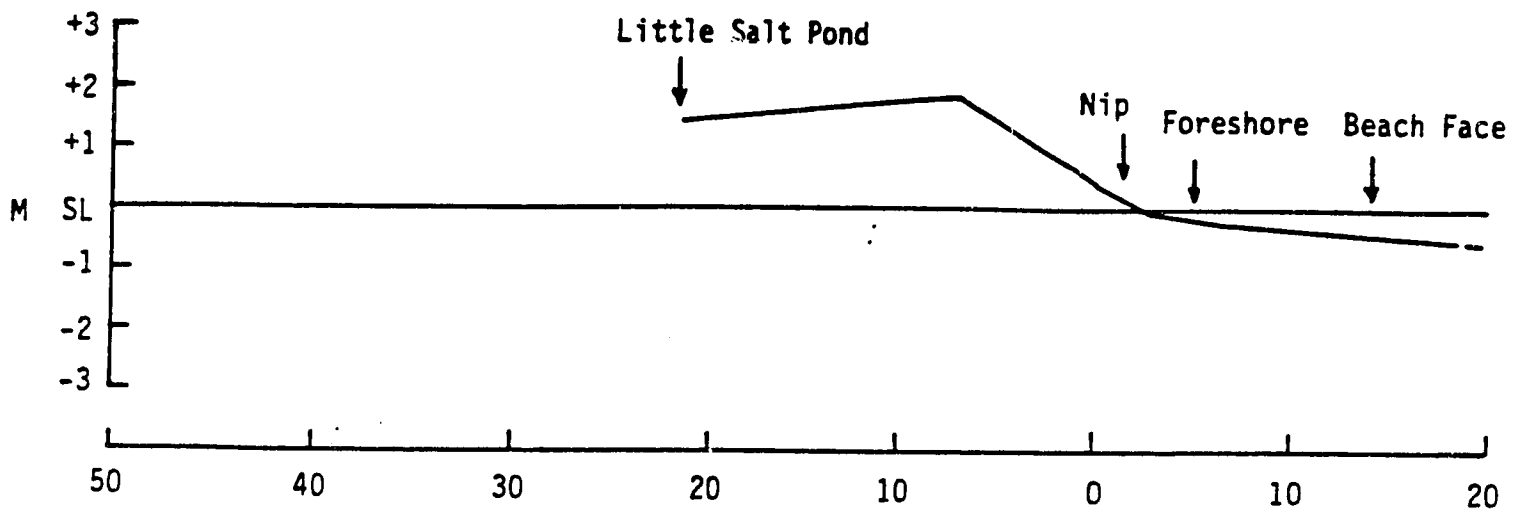
White House Bay (Figure 3). Profiles were surveyed on the middle (40 m.) and south (27 m.) sections of the 500-m. long White House Bay barrier beach. The nearshore bottom extends seaward from the lower beach face at approximately 0.3 m. below sea level and is characterized by the presence of cobble and boulder-size material. The beach face extends seaward from the lower foreshore to the inner nearshore zone over a length of 3-4 m. and is covered with pebble, cobble, and boulder-size material. The foreshore extends seaward from the first backshore berm or erosional nip over a width of 3 m. It is characterized by seaward slopes ranging from 5°-11°. The upper foreshore of Profile 1 (middle) reveals a 40-cm. high erosional nip which degrades towards the south and is no longer present at Profile 2.

The foreshore is covered with intermittent deposits of sand-size sediments and abundant carbonate fragments adhering to both volcanic and coral cobble to boulder size materials. The backshore in the middle section of White House Bay beach extends 3 m. from the 15° seaward face of the barrier to the crest of the 40-cm. high erosional nip. The backshore of the south section extends seaward to the upper foreshore over 8 m. and is backed by 4 to 5-m. high cliffs composed of hydrothermally altered volcanics. The backshore is characterized by cobble to boulder size andesite and coral materials which in the south section of the beach form a series of 14 ridge and swale features, emplaced at 5-m. intervals perpendicular to beach aspect.

The barrier, with a 2° landward dip is composed of pebble to cobble-size deposits and extends 15 m. from the backshore to the edge of the Little Salt Pond. It is populated with *Distichlis spicata*, *Sesuvium*, and *Acacia tortuosa*. White House Bay beach has undergone significant erosion as evidenced by the presence of storm beach deposits, the fresh appearance of the barrier and cliff faces, and the absence of materials smaller than cobble-size. It has been noted by local residents that prior to Hurricanes David and Frederick (1979) White House Bay was characterized by sand-size material covering the beach. At the time of this report, only a small (10 m.) stretch of sand deposits are found at the north section of the beach. Without any significant northern headland to entrap sand-size materials it is possible that potential deposits have drifted north towards South Friar's Bay. However, more nearshore and offshore studies need to be implemented to determine the nature and rate of littoral drift as well as the importance of onshore-offshore sand movement.

272

WHITE HOUSE BAY 1 MIDDLE



WHITE HOUSE BAY 2 SOUTH

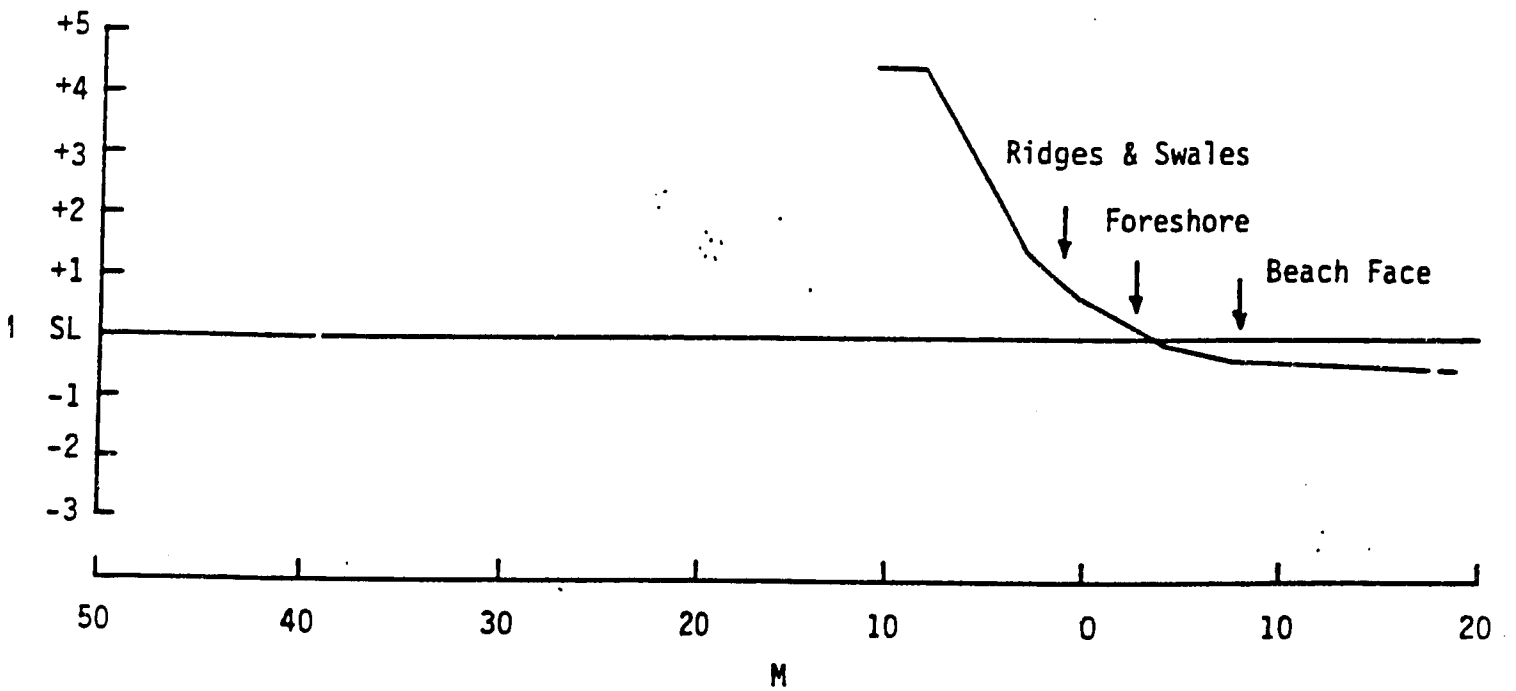


Figure 3

213

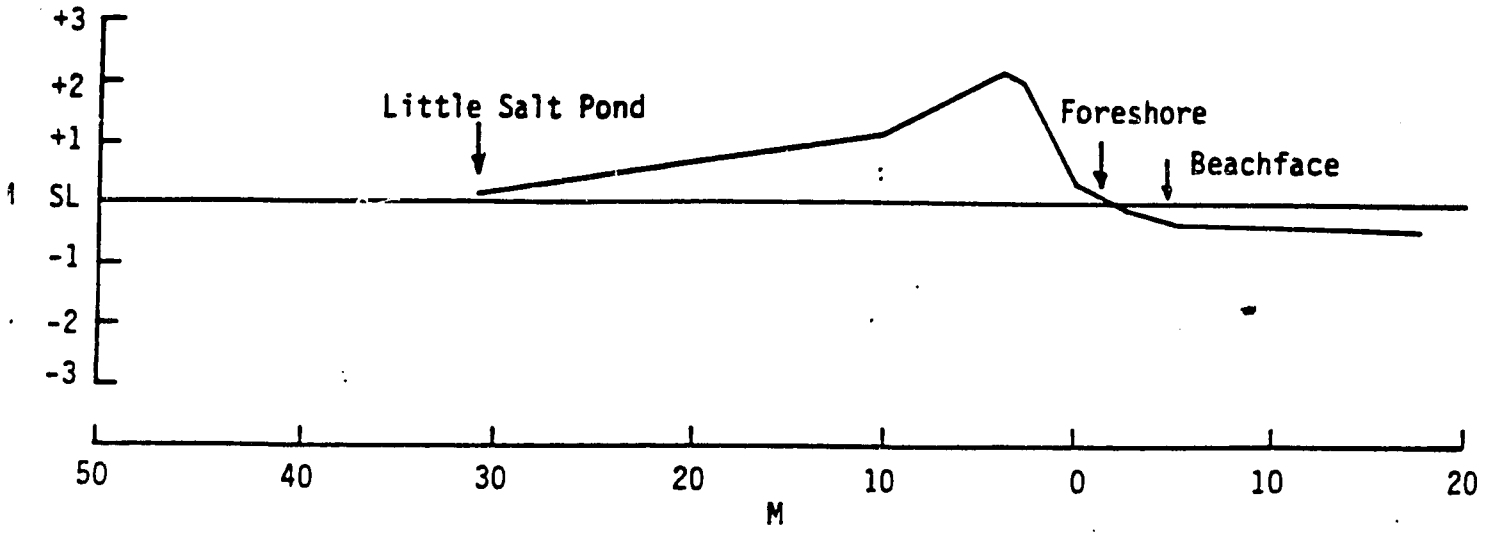
Ballast Bay (Figure 4). Profiles were surveyed on the north (48 m.) and middle (62 m.) sections of the 600-m. long Ballast Bay barrier beach. The nearshore bottom extends seaward from the lower beach face at 0.3-0.4 m. below sea level and is characterized by the presence of andesite boulders, pockets of sand, and a modest, broken rock reef populated with coral. The beach face extends seaward from the lower foreshore to the inner nearshore zone with a 3°-4° slope over 3-5 m. It is characterized by cobble to boulder-size materials as well as pockets of fine sand. The foreshore extends seaward from the first erosional nip to the upper beach face over 2 m. It is characterized by a 10° seaward slope and the presence of boulders and fine sand in the north section, grading to dominantly cobble to boulder-size (0.5-1.5 m. a-axis) deposits towards the south. A 1.5-m. high erosional nip leading to a 1-m. wide backshore is found on the north profile while the backshore of the middle profile is characterized by a series of 5 berms with 0.2-0.5 m. high nips extending over 10 m. The north section barrier face has a 25° seaward slope, leading to the barrier crest at 2.0 m. above sea level. A 10° landward slope extends for 27 m. to the edge of the Little Salt Pond. The middle section of Ballast Bay beach reveals a 2.0-m. high barrier crest extending 8-10 m. inland with a 7° landward slope continuing 25 m. to the edge of the Little Salt Pond. The barrier is characterized by andesitic cobbles and boulders which exhibit considerable flattening. A small entrance channel is found cutting through the north section of the Ballast Bay barrier but no channel is present on the middle or south sections. Vegetation on the barrier increases in density towards the south and is dominated by guinea grass and acacia. Ballast Bay beach appears to have undergone considerable erosion as evidenced by the presence of cobble to boulder-size deposits as well as several erosional nips and berms. Overwash processes are persistent and responsible for the complex morphology of the beach.

2.1.2.2 Channel Beaches

Major's Bay (Figure 5). Profiles were surveyed on the west (55 m.) and east (32 m.) sections of the 775-m. long Major's Bay barrier beach. The nearshore bottom extends seaward from the lower beach face at 0.3-1.0 m. below sea level and is characterized by ridges and cobble-filled runnels with 30-cm. wavelengths, as well as ripples on the west section of the beach. By contrast, the nearshore bottom in the east section reveals the presence of cobble and boulder-size materials. The beach face extends seaward from the lower foreshore to the inner nearshore zone over 2-6 m. It is characterized by a seaward dip of 8° in sand on the west section and a dip of 11° in cobbles on the east section.

The foreshore extends seaward from the 1.5-m. high erosional nip on the west section and from the edge of an old storm beach on the east section. Sand-size materials characterize the 18° upper foreshore slope on the east profile. The backshore area of west Major's Bay beach reveals the inner limit of the last storm surge and the outer limit of effective tree growth at 7 m., rising to the barrier crest, 11 m. inland from the erosional nip. The barrier back, composed of sand, pebbles, and cobbles, has a 5° landward dip, extending 24 m. to the edge of Major's Bay Salt Pond.

BALLAST BAY 1 NORTH



BALLAST BAY 2 MIDDLE

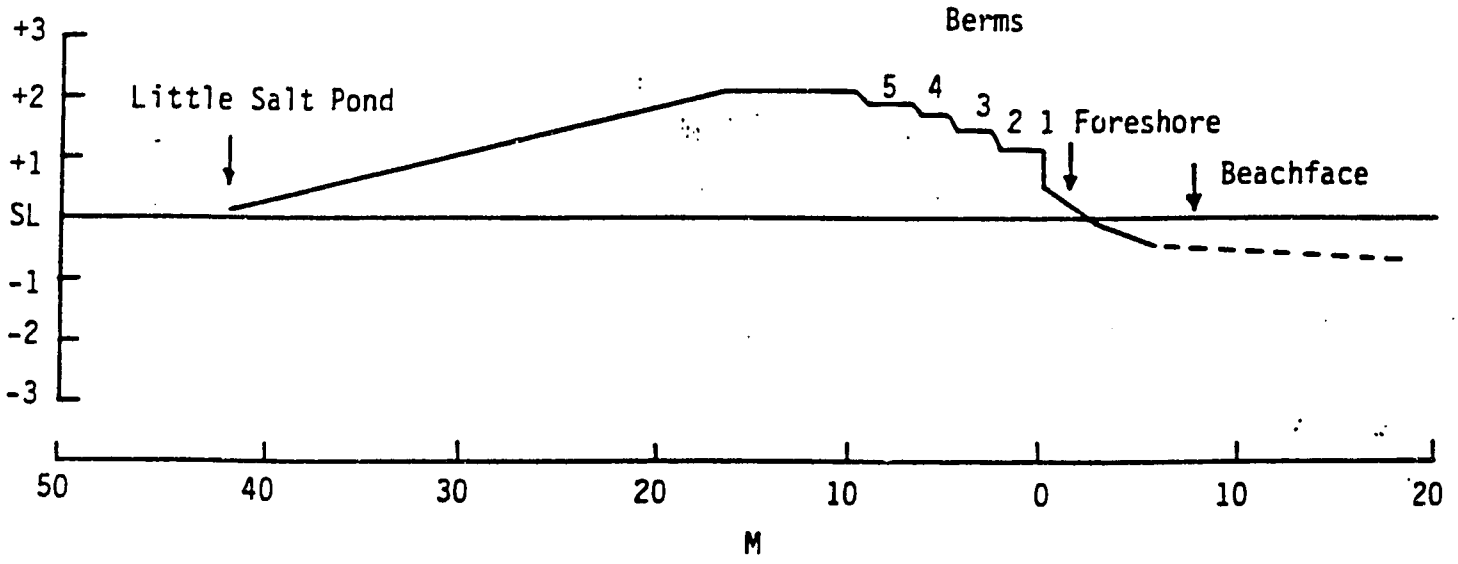
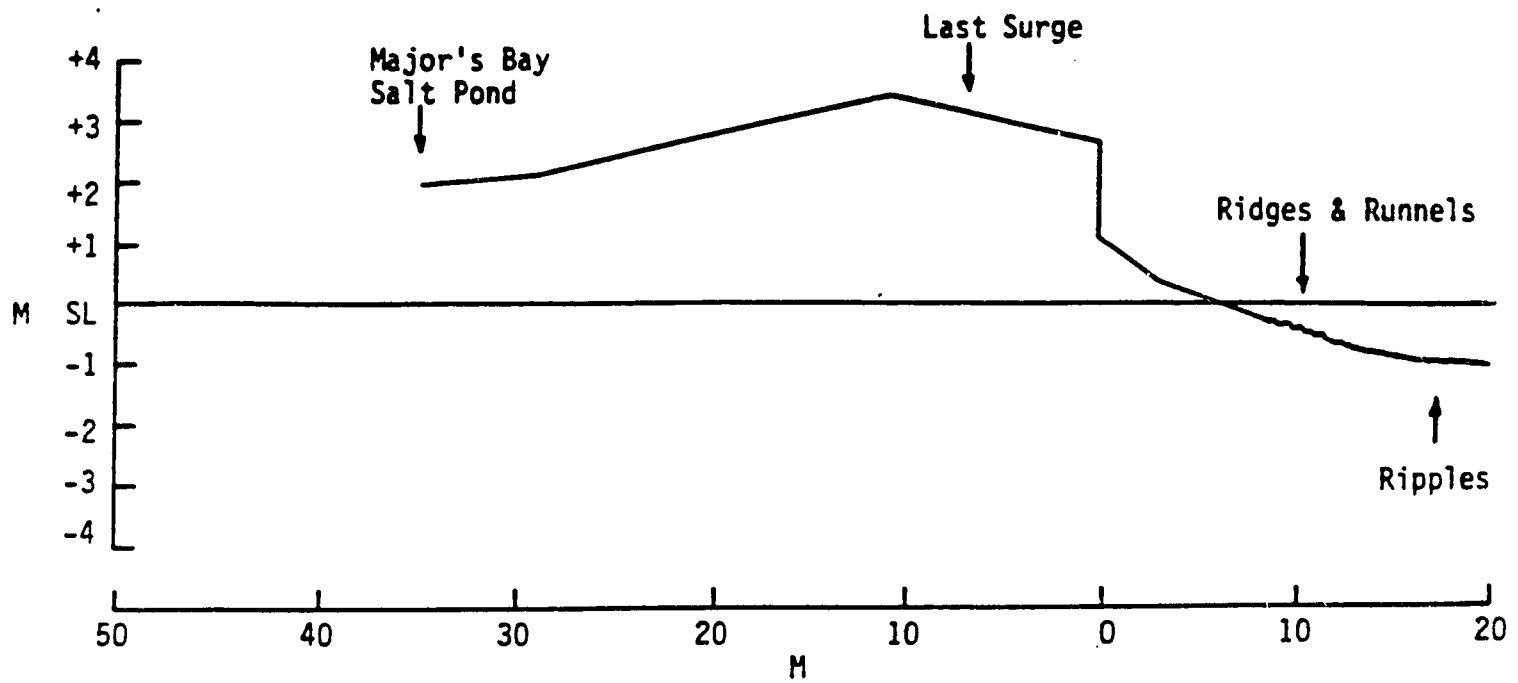


Figure 4

MAJOR'S BAY 1 WEST



MAJOR'S BAY 2 EAST

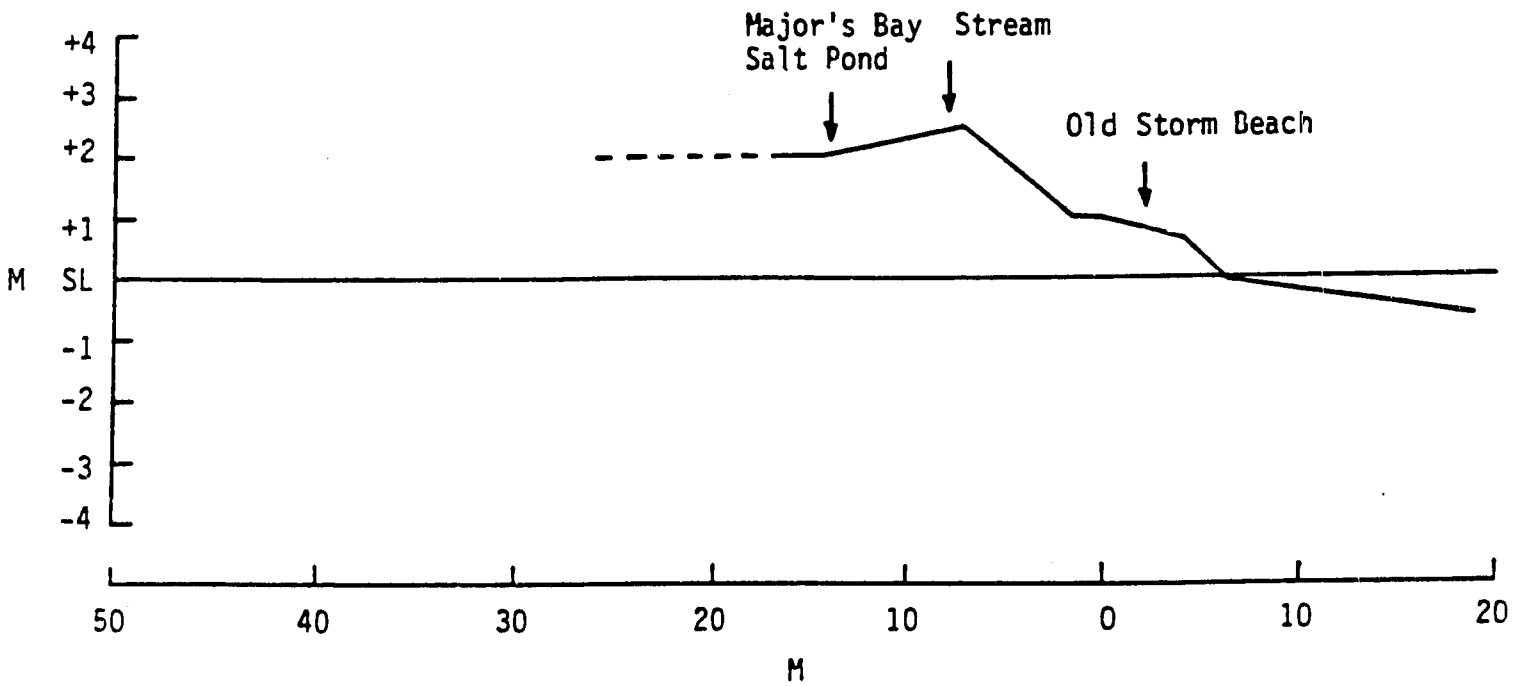


Figure 5

276

The barrier is populated with *Acacia tortuosa*, *Distichlis spicata*, *Coccoloba uvifera*, and Manchineel. The backshore on the east profile reveals a storm beach (one year) with incipient cusp development rising 1 m. above sea level. The crest of the barrier lies 2.5 m. above sea level, while the backslope of the barrier is disrupted by a small stream issuing from the catchment and pond area adjacent to the beach. The barrier back on the eastern profile extends only 7 m. until reaching the Major's Bay Salt Pond. The presence of a cobble and boulder dominated east section of beach which grades into a sand dominated west section of beach, coupled with the occurrence of cusps and a prominent erosional nip, suggest recent storm surge processes at work. This susceptibility to significant beach stripping is further borne out by the backshore accumulation of coral boulders as well as the presence of cobble-filled runnels. While portions of the west section of Major's Bay beach may be undergoing partial recovery, continued episodes of higher energy inputs associated with southerly storm waves disrupt the recovery process.

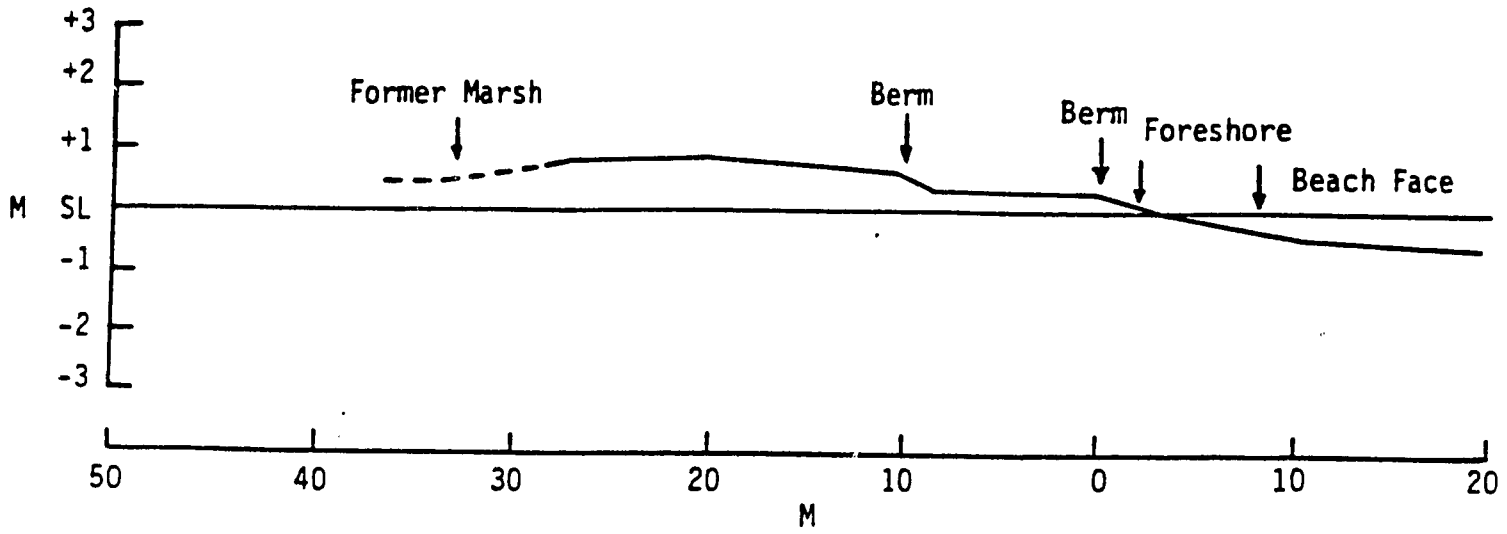
Banana Bay (Figure 6). Profiles were surveyed on the west (61 m.) and east (54 m.) sections of the 500-m. long Banana Bay barrier beach. The nearshore zone extends seaward from the lower beach face at 0.3-0.3 m. below sea level. On the west profile it is characterized by pockets of sand as well as beachrock. The east profile reveals a series of lunate ripples. The beach face extends seaward from the lower foreshore to the inner nearshore zone over a distance of 6-10 m. and average 3°-4° seaward dip. The west profile is characterized by beachrock occurring in situ and as detached slabs while the east profile reveals bars and troughs at 0.35 m. intervals.

The foreshore extends from the first backshore berm or barrier front, including swash, over 3 m. Foreshore slopes on the west profile average 7° while those on the east profile average 14°. The backshore extends 13-20 m. from the erosional nip and contains two berms rising to the crest of the barrier at 1.8 m. above sea level. The west barrier back extends 18 m. with a 1° landward slope while the east barrier back extends 15 m. with a 2° landward dip.

The west section of the barrier is populated with Manchineel, *Acacia Distichlis spicata*, *Coccoloba*, and guinea grass. The east section barrier contain three lines of *Cocos nucifera* behind which is found a former marshy area 1.0 m. above sea level. Banana Bay beach is susceptible to significant overwash processes as evidenced by the nature of the barrier, deposits of seagrass on the western barrier crest and back, exposed beachrock, and cobble to boulder-size coral blocks on the backshore. It is apparent that beach width has undergone change as indicated by the pockets of heavy mineral assemblages found exposed on the present beach.

217

BANANA BAY 1 WEST



BANANA BAY 2 EAST

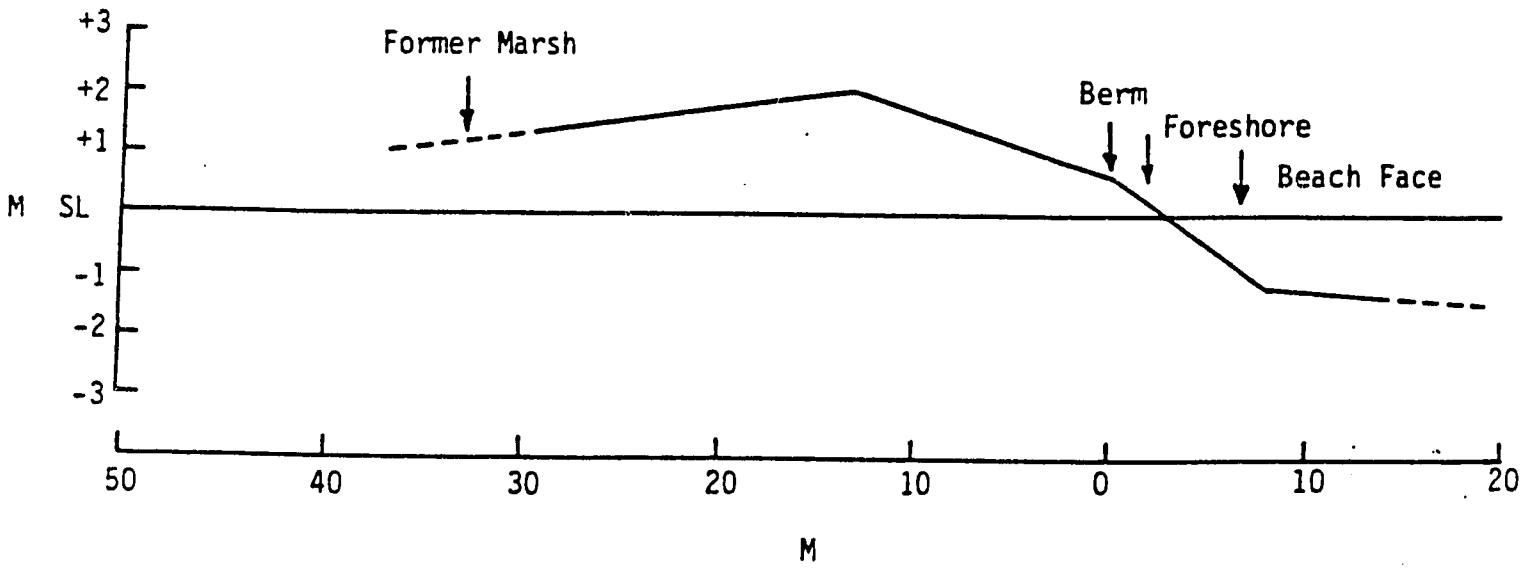
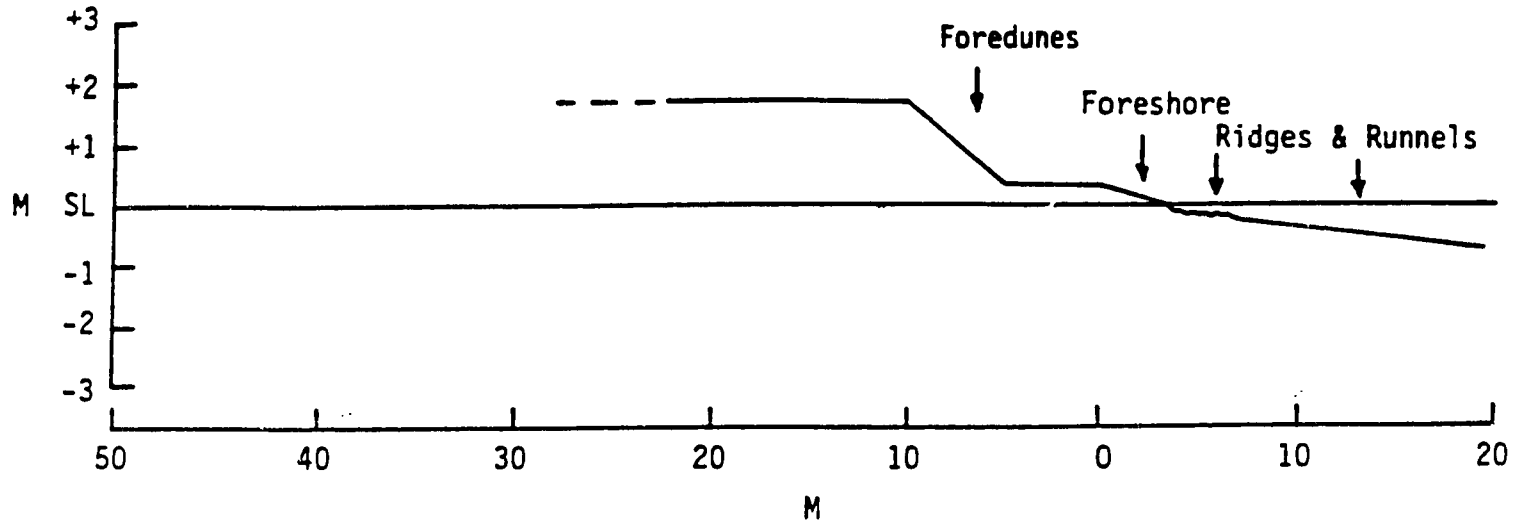
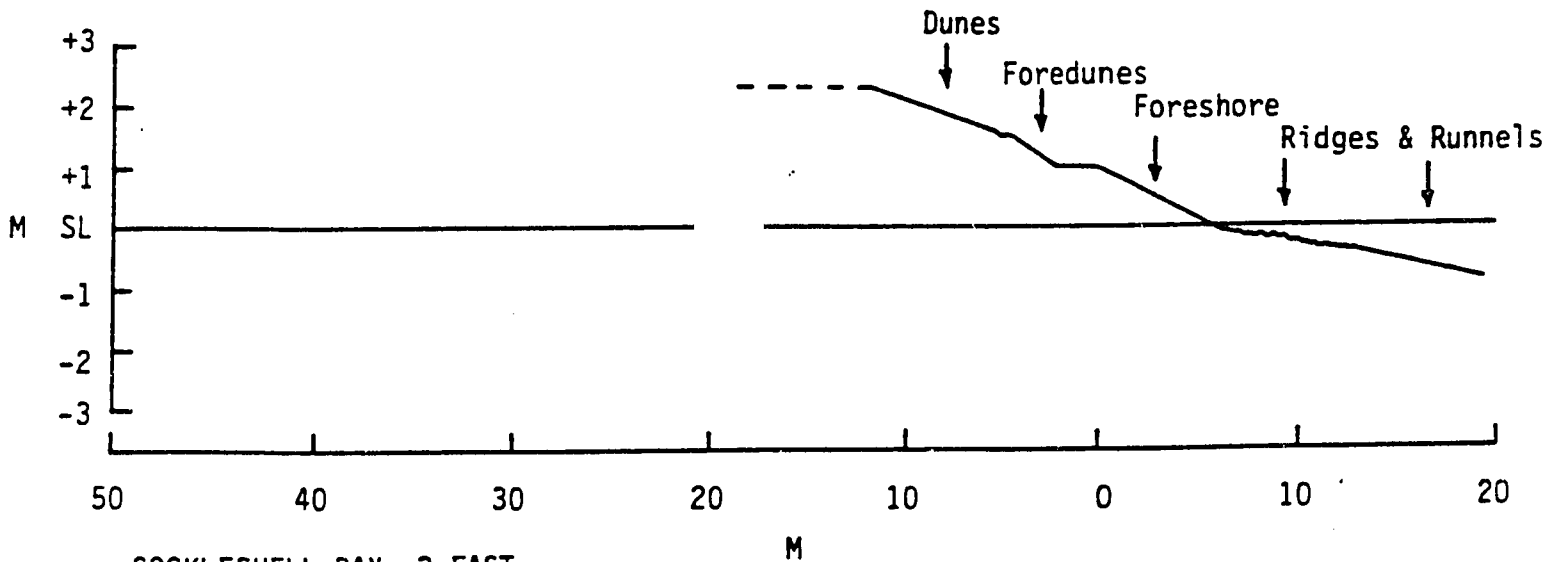


Figure 6

COCKLESHELL BAY 1 WEST



COCKLESHELL BAY 2 MIDDLE



COCKLESHELL BAY 3 EAST

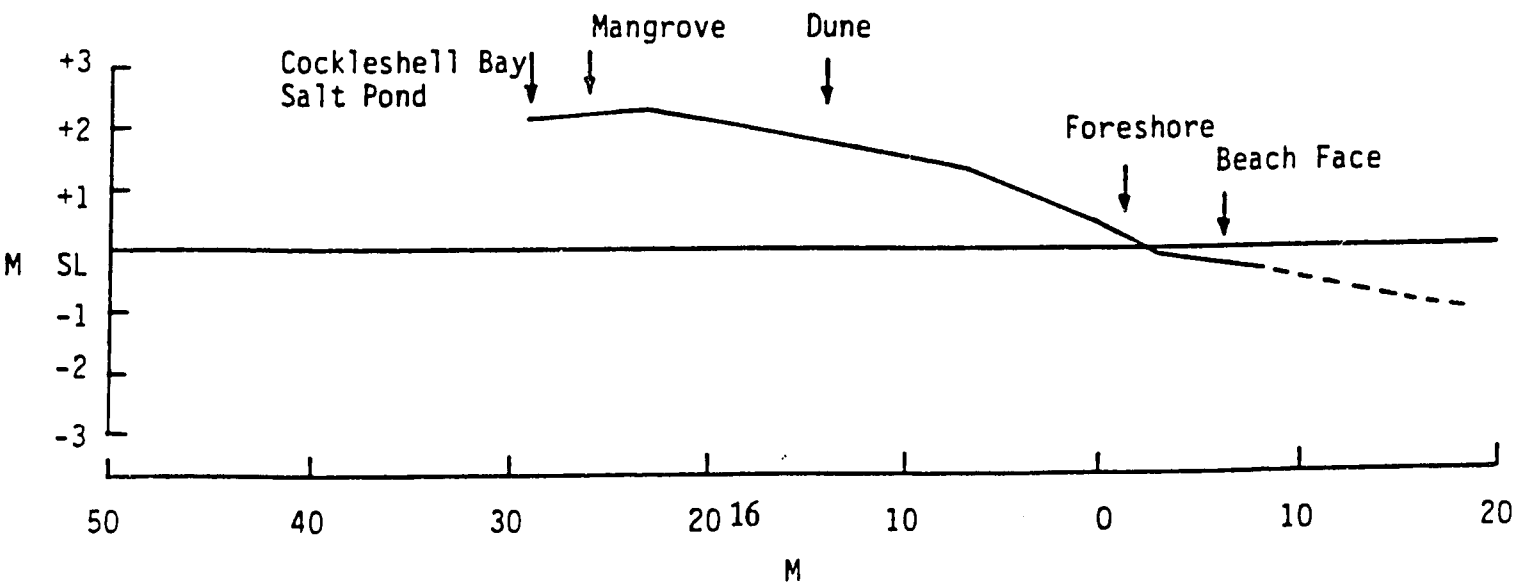


Figure 7

MOSQUITO BAY BEACH

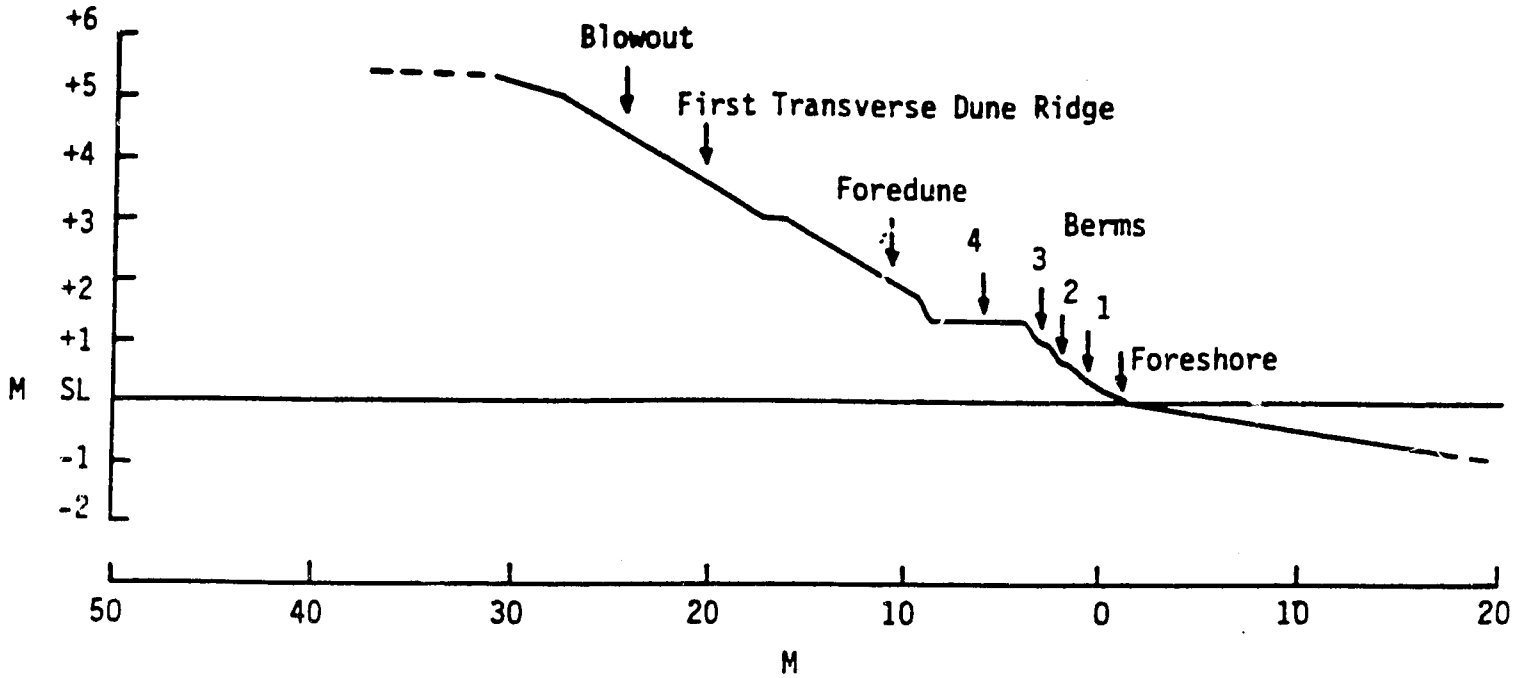
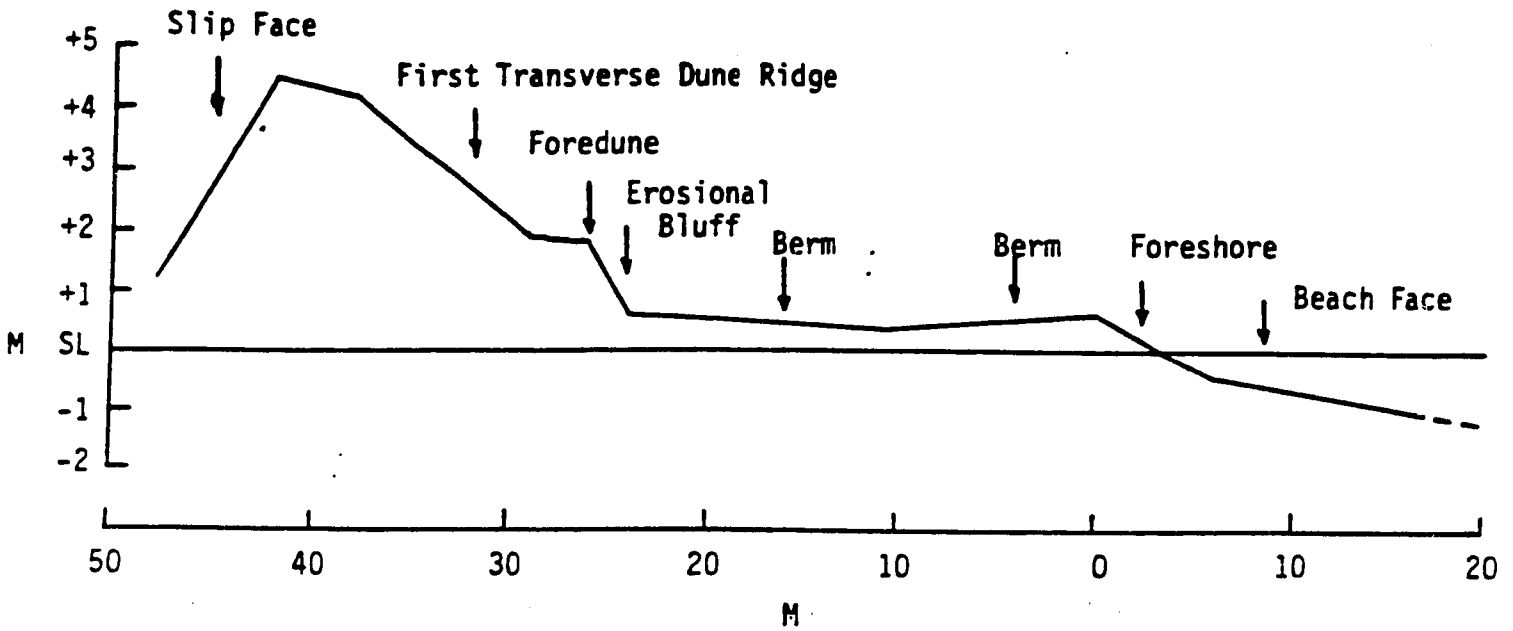


Figure 8

280

SAND BANK BAY



SAND BANK BAY (CONTINUED)

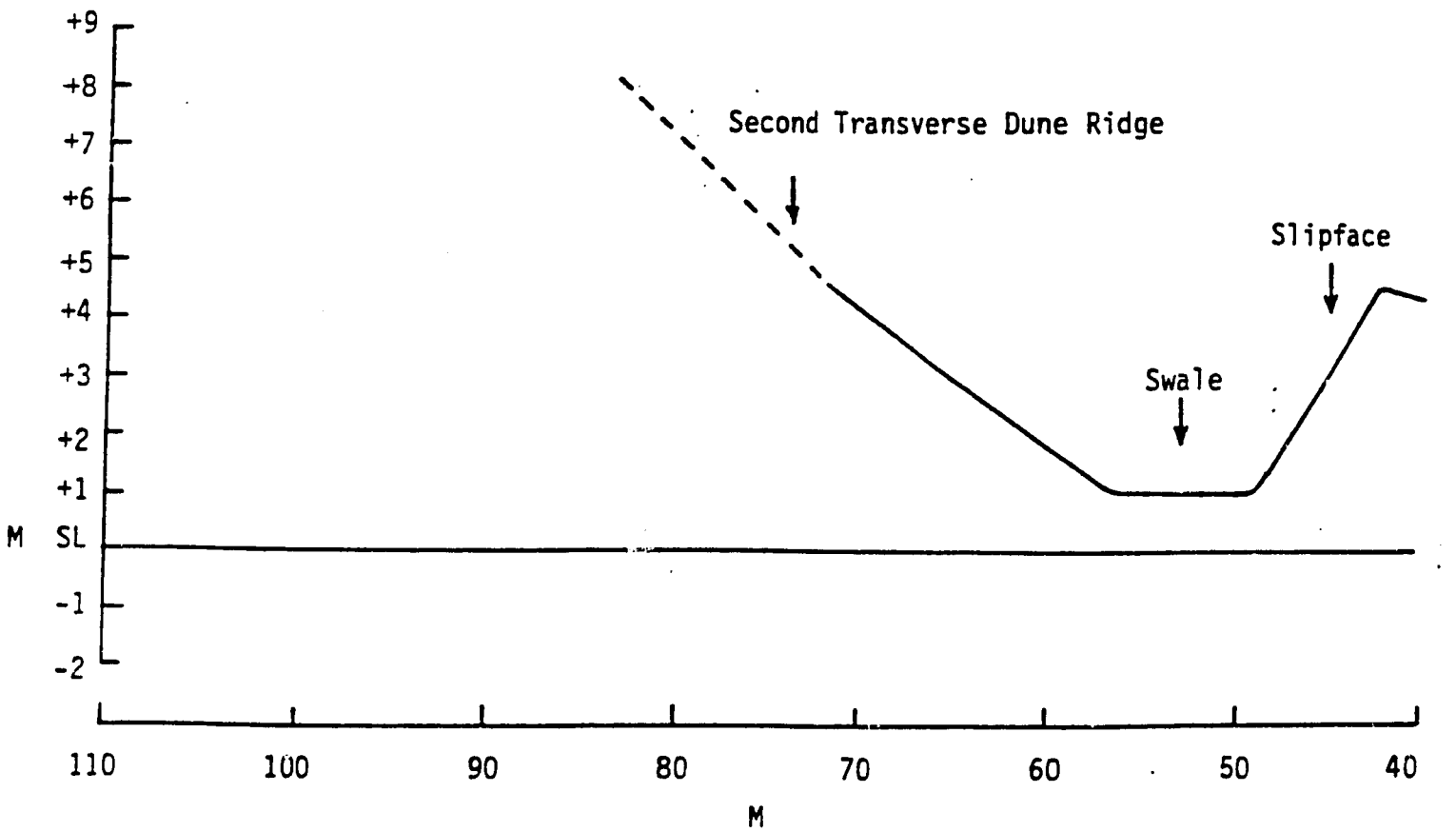


Figure 9

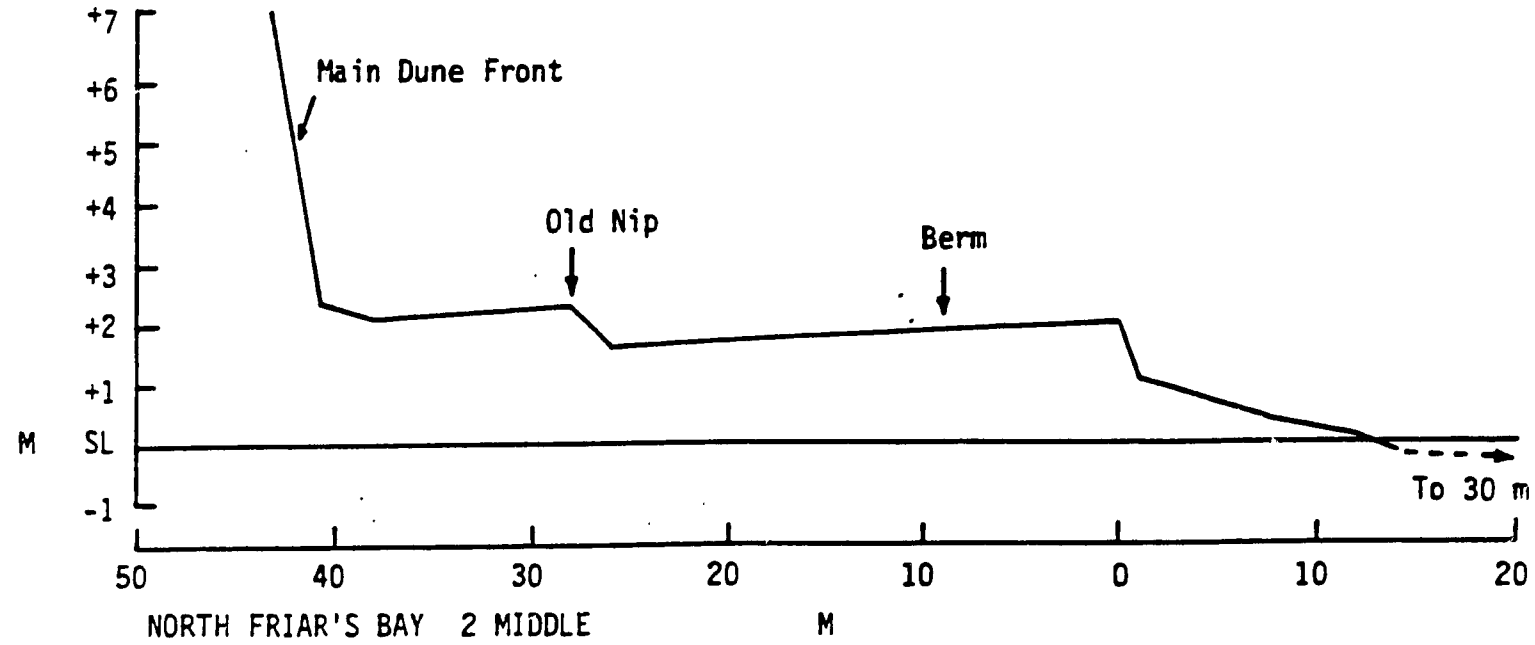
The foreshore width extends 6 m. seaward from the first erosional nip (0.1 m. high). Foreshore slopes range from 13° (upper) to 8° (lower). The backshore is characterized by a 10-m. wide berm with a 2° landward slope which grades into a second 0.4-m. wide berm with a 1° seaward slope. A 1. 1-m. high erosional bluff 24-26 m. inland from the first erosional nip leads to a 3-m. wide foredune complex.

The first transverse dune rises to 5 m. above sea level and is dominated by *Coccoloba uvifera.* An 8-m. wide swale separates the first transverse dune from the second transverse dune which rises 8-10 m. above sea level and is populated with dense shrub growth. As expected on a higher energy coast, wave overwash and erosion are active as evidenced by the presence of several nip and berm series.

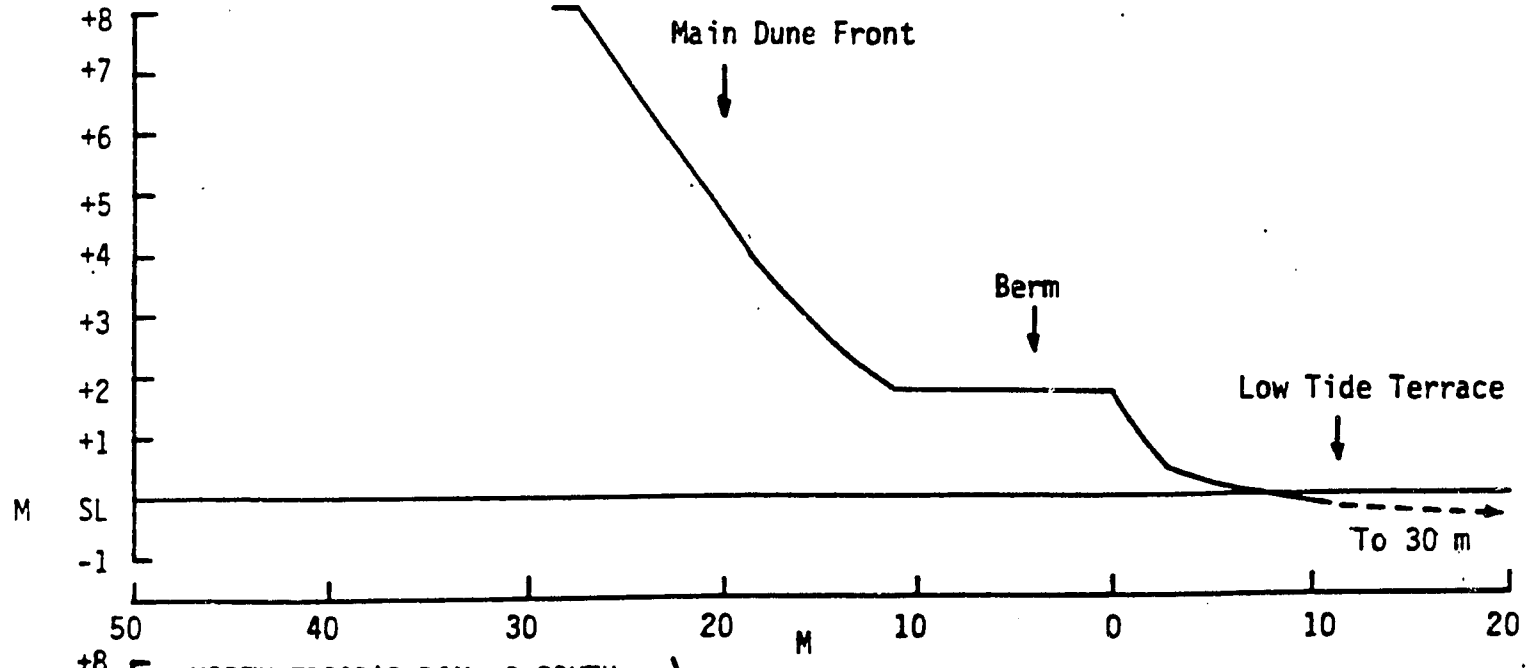
North Friar's Bay (Figure 10). Profiles were surveyed on the north (73 m.), middle (58 m.), and south (44 m.) sections of the 800-m. long North Friar's Bay fringing beach. The beach face extends seaward from the lower foreshore to 30 m. offshore at a depth of 0.1-0.8 m. below sea level. It is characterized by an irregular bottom topography as well as a low tide terrace.

The foreshore width averages 8 m. with slopes of 5° (upper, north section), 11° (upper, middle and south sections), 5°-7° (middle, all sections), and 3° (lower, all sections). Steep upper foreshore ramps lead to the first erosional nip which averages 1.4 m. in height. The backshore is characterized by the presence of two broad (26 m. and 12 m.) berms on the north profile and a 1-m. high nip at the seaward edge of the first dune ridge on the south profile.

The main dune front rises 8 m. above sea level. North Friar's Bay is subject to significant erosion as evidenced by the presence of several fresh nips and berms on the backshore. Moreover, the occurrence of the older erosional nip 26 m. inland from the seaward edge of the backshore on the north section and the 1-m. high nip at the foot of the first main dune ridge on the south section indicate significant wave energy in the recent past.



NORTH FRIAR'S BAY 2 MIDDLE



NORTH FRIAR'S BAY 3 SOUTH

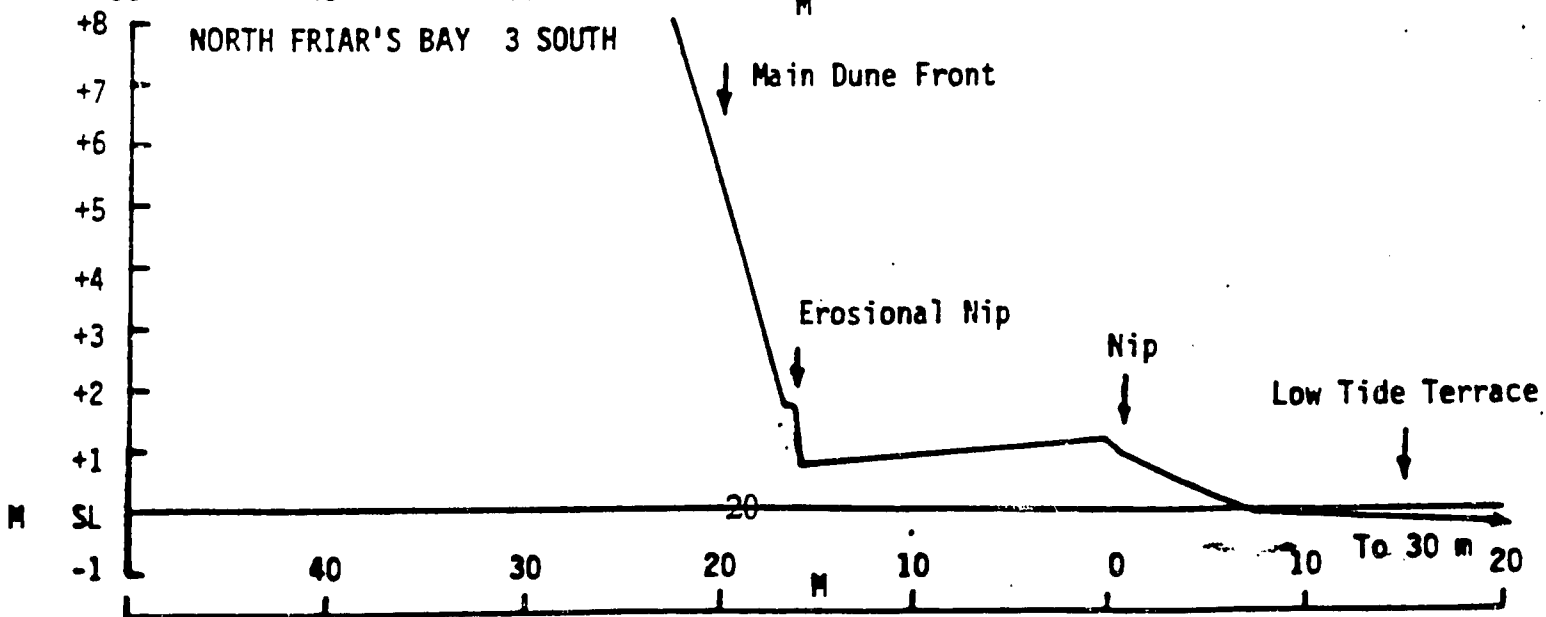


Figure 10

2.2 Beach Sediment

Sediments were collected from each beach in the survey, generally from the middle foreshore at most locations and locally from beach face, offshore, and backshore areas. A total of 18 samples were analyzed mechanically for size to determine beach adjustment to past and prevailing energy conditions. Chemical and microscope analysis were used for content, shape, color, and degree of weathering to determine provenance, residence time, and response to energy conditions and beach equilibrium. Subsequent statistical analysis for particle size (range and mean), sorting, and skewness values was undertaken to determine the strength and range of dominant beach processes. Cumulative curves and histographs illustrating these data are presented below.

2.2.1 Caribbean Beaches

South Friar's Bay. South Friar's Bay reveals particle sizes ranging from fine to medium sand which is moderately to well-sorted. Skewness values indicate near symmetrical distributions though the north section contains a strong fine tail while the south section contains a suggested coarse tail. Coral and shell material account for 49%-89% of the content of the north and middle sections, while the south section is characterized by some 88% inorganic content. Dominant mineral content found in significant quantities in the smaller Φ range includes volcanic glass, hornblende, magnetite, and aggregates of the above. Proximity to major outcrops of andesite as well as ash fall and flow deposits both on the beach and in the small headlands bracketing the beach could well account for such assemblages. Coral and shell matter are well washed, polished, and subrounded, indicative of persistent reworking by swash and some considerable residence time in the nearshore environment. The absence of fresh coral material is notable and suggests, in terms of beach replenishment, that this source of material is now less abundant.

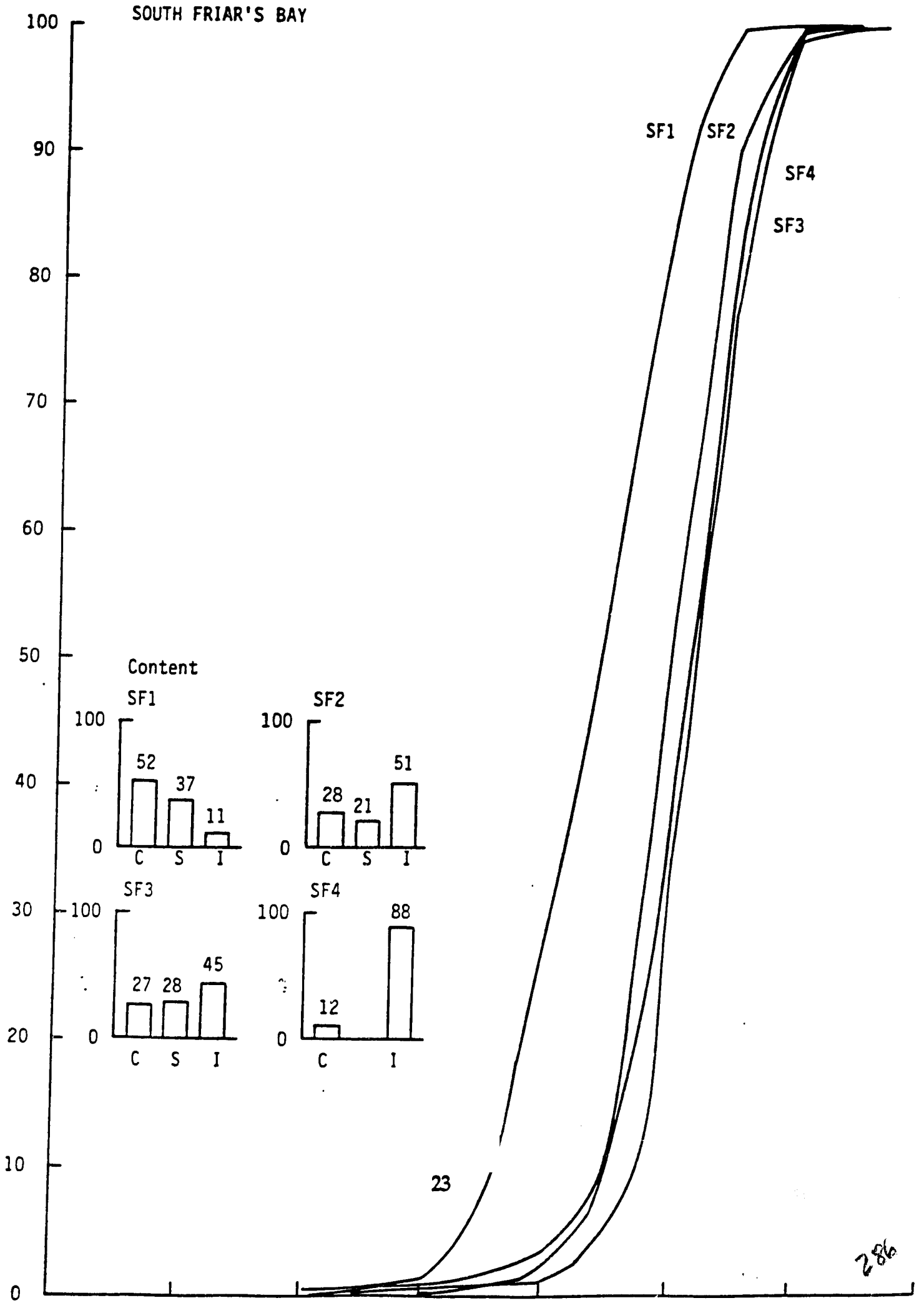
South Friar's Bay (Figure 11)

Sample Code	Section	Location	Size Mean Φ	Range Φ	Sorting δ	Skewness	Shape
SFI	North	Berm 3-4 Middle F.S.	+1.383	-1.0- +3.5	0.580	-0.016	0.25- 0.60
SF2	North	Middle F.S.	+2.066	0.0 +4.0	0.456	-1.003	0.25- 0.60
SF3	Middle	Middle F.S.	2.150	-1.0- +4.0	0.475	-0.075	0.25- 0.60
SF4	South	Middle F.S.	+2.250	-0.5- +3.5	0.383	0.100	0.25- 0.60

Color: 7.5YR 6/4 (SF1-3) 1OR 2/1 (SF4)

White House Bay. White House Bay beach and barrier are characterized by an assemblage of cobble to boulder-size materials composed largely of andesite and severely degraded coral debris. The absence of any measurable quantity of smaller size material at or near the surface is attributed to the effects of Hurricanes David and Frederick (1979) which generated waves capable of stripping the sand cover over this 400-m. long beach. Sand and finer materials have yet to replenish the beach face, foreshore, and backshore.

A pocket beach is typically found where bold headlands form a bay whose beach sediments are not readily removed from the bay. Major's Bay and Sand Bank Bay are good examples of such systems, 'closed' in the sense that the sediment budget of the embayment is not exchanged beyond the bay. Where enclosing headlands are less prominent and the offshore shelf relatively broad, beach and nearshore sediments are moved readily into and out of the system by wave-induced currents. White House Bay appears to be such an 'open' system in that its bounding headland to the north does little to interrupt the flow of sediment northward, while littoral drift is readily accomplished over the shallow shelf which ranges form 600 to 800 m. wide between White House Bay and South Friar's Bay (the shelf edge is defined arbitrarily at the -10 m. submarine contour, this being within the depth at which larger waves can disturb bottom sediments and related currents shift these sediments northward). Thus any solid waste or other pollutants that find their way into White House Bay would move northward to impact South Friar's Bay and probably South Frigate Bay. There may also be some leakage northward from Ballast Bay around Guana Point. Some exchange of sediment also occurs between Cockleshell and Banana bays, and between these bays and the shallow waters of The Narrows.


SOUTH FRIAR'S BAY
100
90
80
70
60
50
40
30
20
10
0
SF1
SF2
SF4
SF3
23
Content
SF1
100
52
37
11
0
C S I
SF2
100
28
21
51
0
C S I
SF3
100
27 28
45
0
C S I
SF4
100
88
12
0
C I
286

Ballast Bay. Ballast Bay reveals an average particle size of medium sand which is well-sorted with near symmetrical skewness. However, the distribution of particle sizes on Ballast Bay is bimodal with the other portion of the sample ranging from large cobbles to boulder-size material. The larger fragments, which are found on the barrier, are composed of andesite and exhibit considerable flattening (3.5-4.4Φ). Coral material found on the foreshore comprises only 23% of the total sample content, shell fragments 1%, with volcanic glass, hornblende, magnetite, and aggregates dominating all fractions of the sample. Proximity to Guana Point headland as well as the adjacent hillslope and stream systems whose content and load are primarily andesite would account in part for this composition. Secondly, the more open coastal aspect would likely deter favorable mollusc habitat. Thirdly, the lower beach face and nearshore environments reveal coral growth on submerged, in situ andesite outcrops.

Ballast Bay (Figure 12)

Sample Code	Section	Section	Size Mean Φ	Range Φ	Sorting δ	Skewness	Shape
BLI	Middle	Middle	F.S.+1.733	0.0-+4.0	0.419	-0.0986	0.25-0.40

Color: 10YR 3/1

2.2.2 Channel Beaches

Major's Bay (Figure 13). Major's Bay West is characterized by coarse sand which is moderately well-sorted, with a strong coarse skewness. Content of the sediment is 36% coral, 28% shell, and 36% inorganic. Dominant minerals include volcanic glass, magnetite, and ilmenite. The freshness and tripartite nature of the material as revealed by shape analysis suggests two sources: the immediate nearshore environment with coral growth and mollusc habitat; and the neighboring catchment and its streams which deliver andesitic materials, as well as the adjacent seacliffs. By contrast, East Major's Bay beach is composed of andesite pebble and cobble-size materials (4-132 mm. α-axis) with some larger boulders (0.2-0.8 m. α-axis). Coral erratics (0.5-0.8 m. α-axis) are also found on the backshore of the East-Middle section of the beach. Provenance of the andesite boulders is found in the coterminus seacliffs and coastal bevel on the eastern flank of Major's Bay, while the coral boulders are derived from the immediate offshore area. The marked contrast between the boulder-dominated eastern barrier-beach system and the coarse sand foreshore-beach face of the western barrier suggests a beach which has undergone significant erosion with only partial recovery. Backshore and upper foreshore cusps also suggest high energy conditions, possibly edge waves generated during southerly storm swell through a fairly wide wave window. Discussions with local residents in the neighboring channel-facing Banana Bay

indicate three periods of significant wave activity associated with Hurricanes David and Frederick (1979) and Hurricane Klaus (1984).

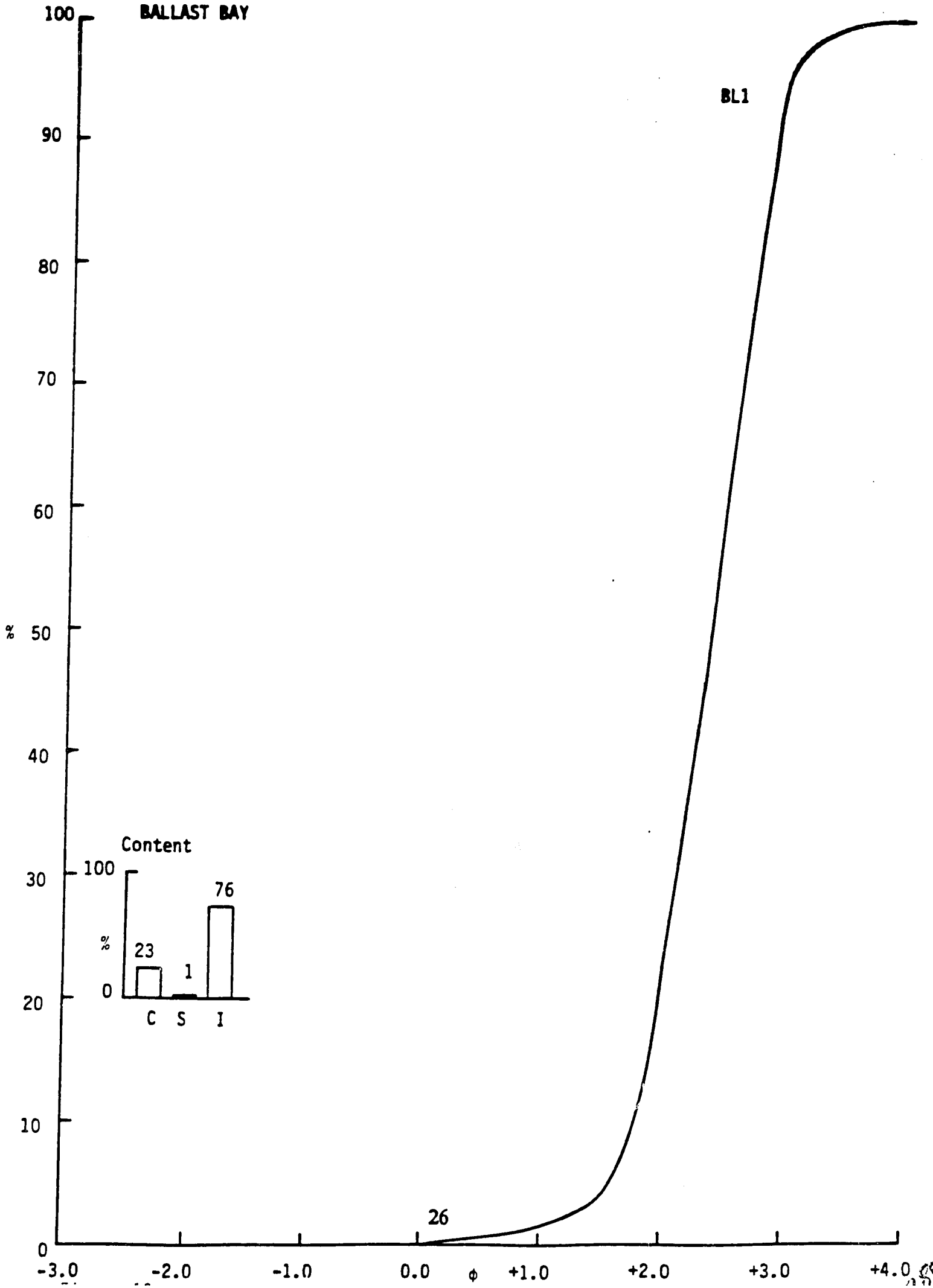
Major's Bay (Figure 13)

Sample code	Section	Location	Mean Φ	Range Φ	Sorting δ	Skewness	Shape
MBI	West	Beach Face	+0.066	-2.0-+4.0	0.5975	-0.326	0.15-0.40

Color: 10YR 8/1

Banana Bay. (Figure 14) Banana Bay reveals particle sizes ranging from fine to coarse sand which is moderately to very well-sorted with nearly symmetrical distributions, though a coarse tail is found in the west section and fine and coarse tails found in the east section. The content of the sand is dominated by coral (56% and 69% in the east and west sections respectively) and to a lesser degree by shell matter (15% east section; 20% west section) and minerals (29% east section; 11% west section). Sample BBI exhibits limited coral (11%) and shell (6%) content, with 83% of the sample being magnetite, volcanic glass, and ilmenite. This sample represents a swash lag of heavy minerals which are now maintained on a 14° beach. The angularity and freshness of the coral and shell fragments reflect the coral and mollusc habitat in the nearshore environment as well as the presence of actively forming algal lime on beach rock in the west section. The outer edge of the beach rock is fretted by erosion while the middle and upper portions are relatively fresh.

In places, the beach rock is well-stratified and occupies 80% of the foreshore, incorporating magnetite, ilmenite, and hornblende, as well as chiton shells (5-7 cm. a-axis) and other super-elevated coral debris. Provenance of beach materials at Banana Bay is clearly local in nature. Sand-size materials are temporarily stored in the nearshore *Thalassia* and *Syringodium* sea grass community, to be reworked under favorable energy conditions; sand sources for the beach are limited and dependant on a clear well-aerated nearshore environment. During 1987 at least 3.0+ m. of foreshore growth occurred in the eastern section of Banana Bay beach, but one year later only 0.5 m. of these deposits remain.


BALLAST BAY
BL1
100
90
80
70
60
% 50
40
30
20
10
0
26
-3.0
-2.0
-1.0
0.0
φ
+1.0
+2.0
+3.0
+4.0
Content
100
%
0
23
1
76
C
S
I

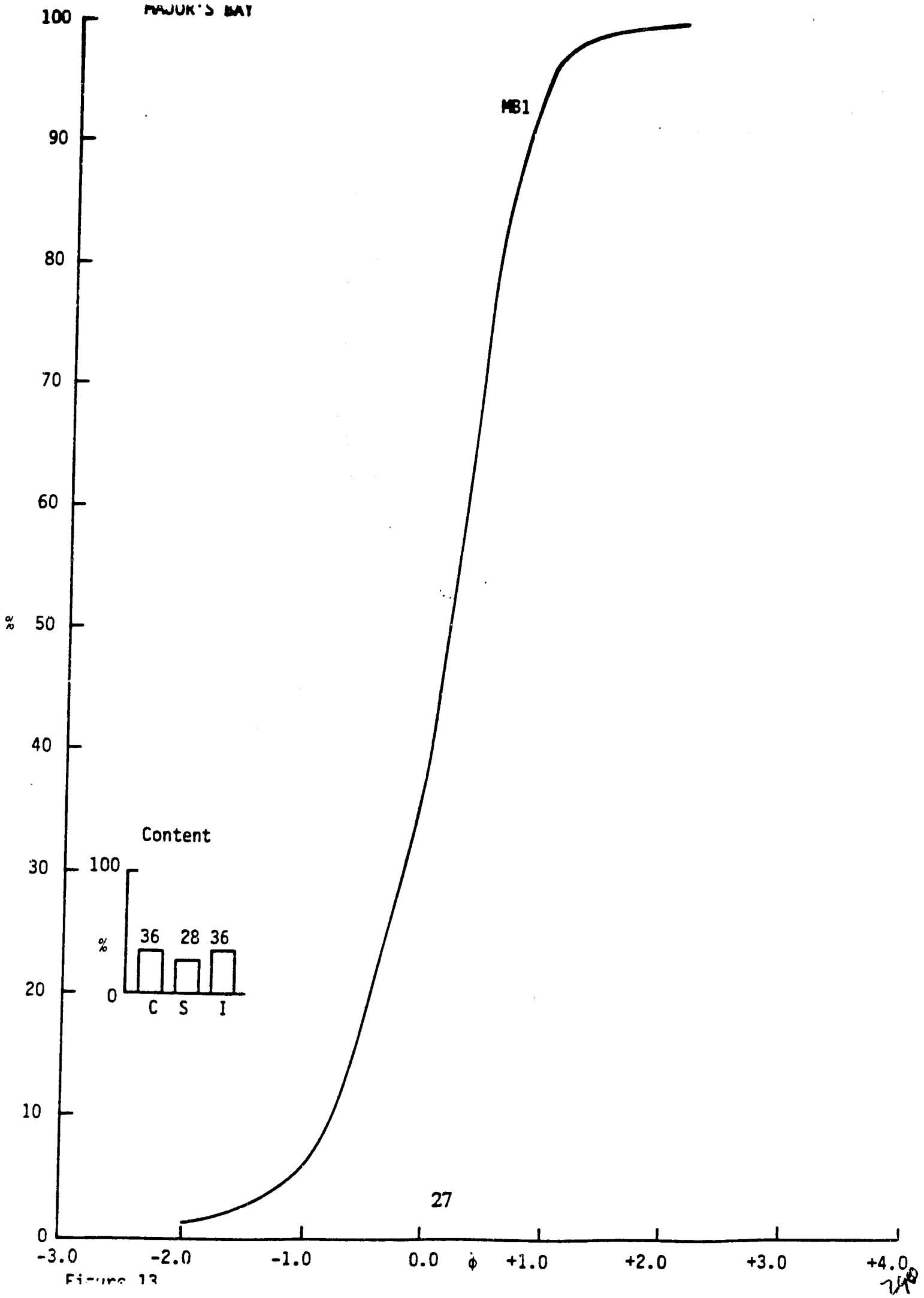

MAJOR'S BAY
MB1
%
100
90
80
70
60
50
40
30
20
10
0
Content
100
%
36
28
36
0
C
S
I
-3.0
-2.0
-1.0
0.0
ϕ
+1.0
+2.0
+3.0
+4.0

Figure 13

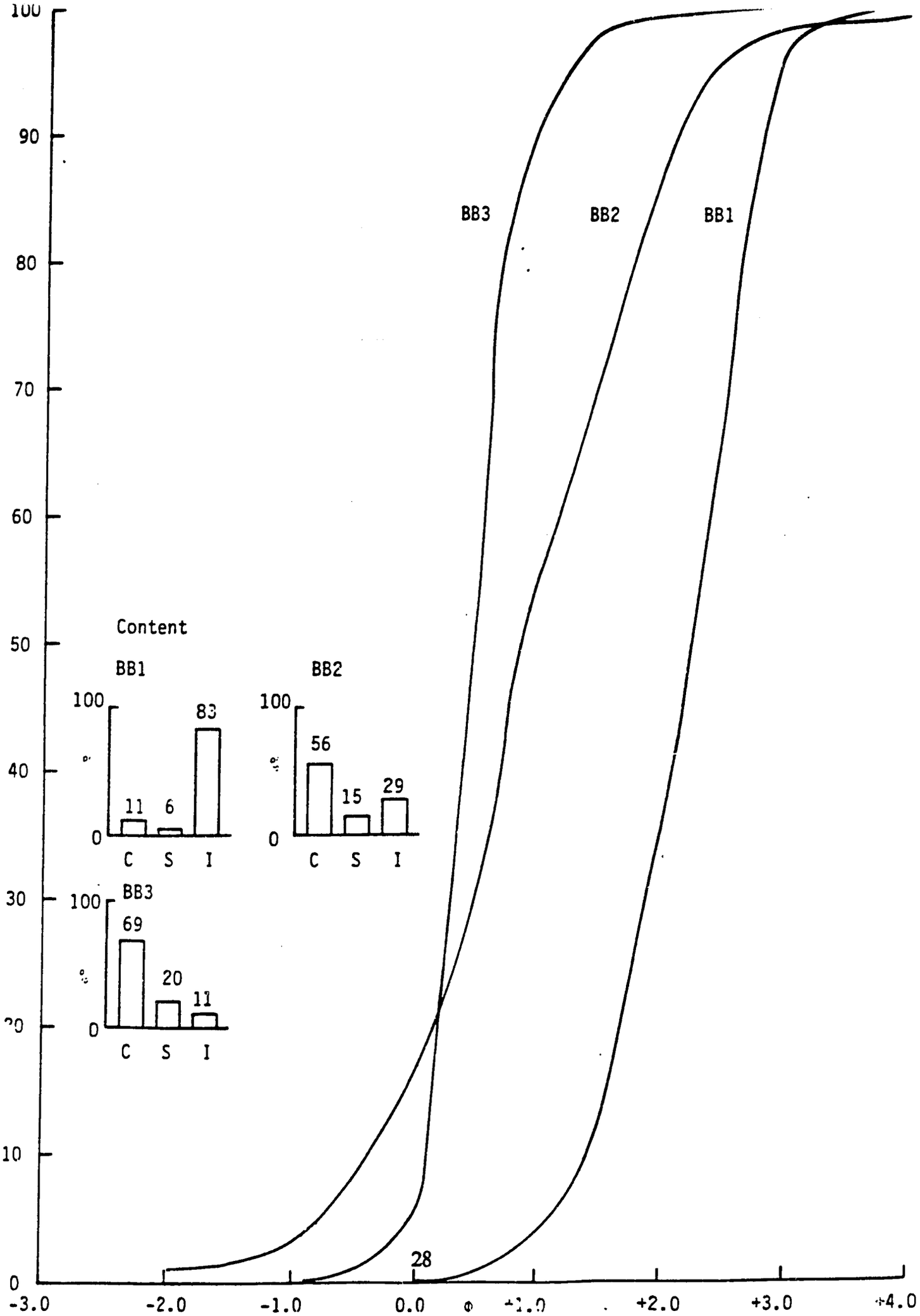

100
90
80
70
60
50
40
30
20
10
0
BB3
BB2
BB1
Content
BB1
100
83
11
6
0
C S I
BB2
100
56
15
29
0
C S I
BB3
100
69
20
11
0
C S I
28
-3.0
-2.0
-1.0
0.0
+1.0
+2.0
+3.0
+4.0

Figure 14

Banana Bay (Figure 14)

Sample Shape Code	Section	Location	Size Mean Φ	Range Φ	Sorting δ	Skewness
BBI	Middle 0.10-0.40	Upper F.S.	+2.166	0.0-+4.0	0..547	-0.156
BB2	East 0.10-0.40	Lower B.F.	+0.933	-2.0-+4.0	0.959	-0.005
BB3	West 0.10-0.40	Middle F.S.	+0.466	-1.0-+3.5	0.331	0.0003

Color: 2.5YR N2/0 (BBI) 2.5YR 8/2 (BB2-3)

Cockleshell Bay. (Figure 15) Cockleshell Bay reveals particle sizes ranging from fine to coarse sand with sorting values ranging from poorly-sorted in the lower foreshore-beach face to well sorted in the upper foreshore. Skewness reveals a strong coarse tail. Upper foreshore coral and shell fragments are, respectively, 27% and 30% of the sample, with volcanic glass, hornblende, and magnetite as the principal mineral components, comprising the remaining 43% of the sediments. The strong showing of the heavy mineral assemblage occurs as a swash lag. Lower foreshore coral and shell fragments comprise 34% and 43% of the sample, with only 23% inorganic content. Under higher energy conditions, the lower foreshore-beach face environment suspends the mineral fraction in the water column and under quieter conditions these are deposited in the swash zone. Ridges and runnels occupy the beach face, with the 0.1-m. high ridges characterized by medium coarse shell fragments and moderately-rounded coral debris. Runnels maintain medium shell and coral fragments. As in the case of Banana Bay, the provenance of the beach materials on the west section of Cockleshell Bay is local, being derived from nearshore coral and molluscs, later stored and reworked through the seagrass beds. There appears to be very limited littoral drift of materials from Cockleshell Bay westward to Banana Bay. Tracer dyes reveal a dominant but weak longshore current of 0.03 m. s-1 150 m. east of the Bay's western end but this faded away against the nearby headland. Eastern Cockleshell Bay beach reveals coarse sand and pebble to cobble-size andesite and rhyolite materials derived some time in the past from Scotch Bonnet, emplaced along the barrier fronting Cockleshell Pond, and revealed owing to exposure from southerly swells.

292

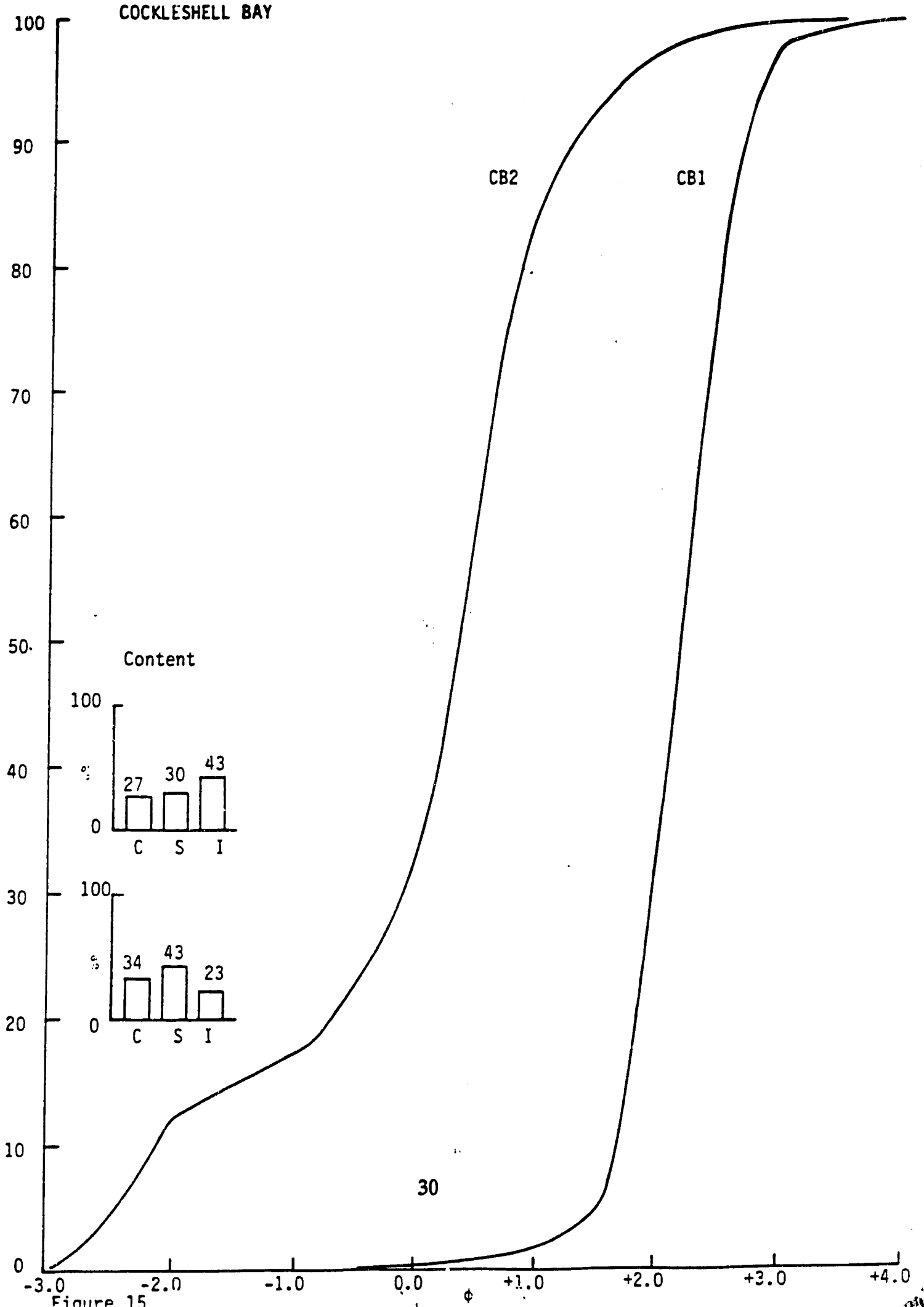

COCKLESHELL BAY
100
90
80
70
60
50
40
30
20
10
0
CB2
CB1
Content
100
%
27
30
43
0
C
S
I
100
%
34
43
23
0
C
S
I
30
-3.0
-2.0
-1.0
0.0
+1.0
+2.0
+3.0
+4.0
Φ

Figure 15

Cockleshell Bay (Figure 15)

Sample Shape Code	Section	Location	Mean Φ	Size Range Φ	Sorting δ	Skewness
CBI	West 0.15-0.40	Upper F.S.	+2.22	-0.5-+4.0	0.412	-0.16
CB2	West 0.15-0.40	Lower F.S.	+0.05	-2.0-	1.158	-0.439

Color: 2.5YR 6/2 (CBI) 10YR 8/3 (CB 2)

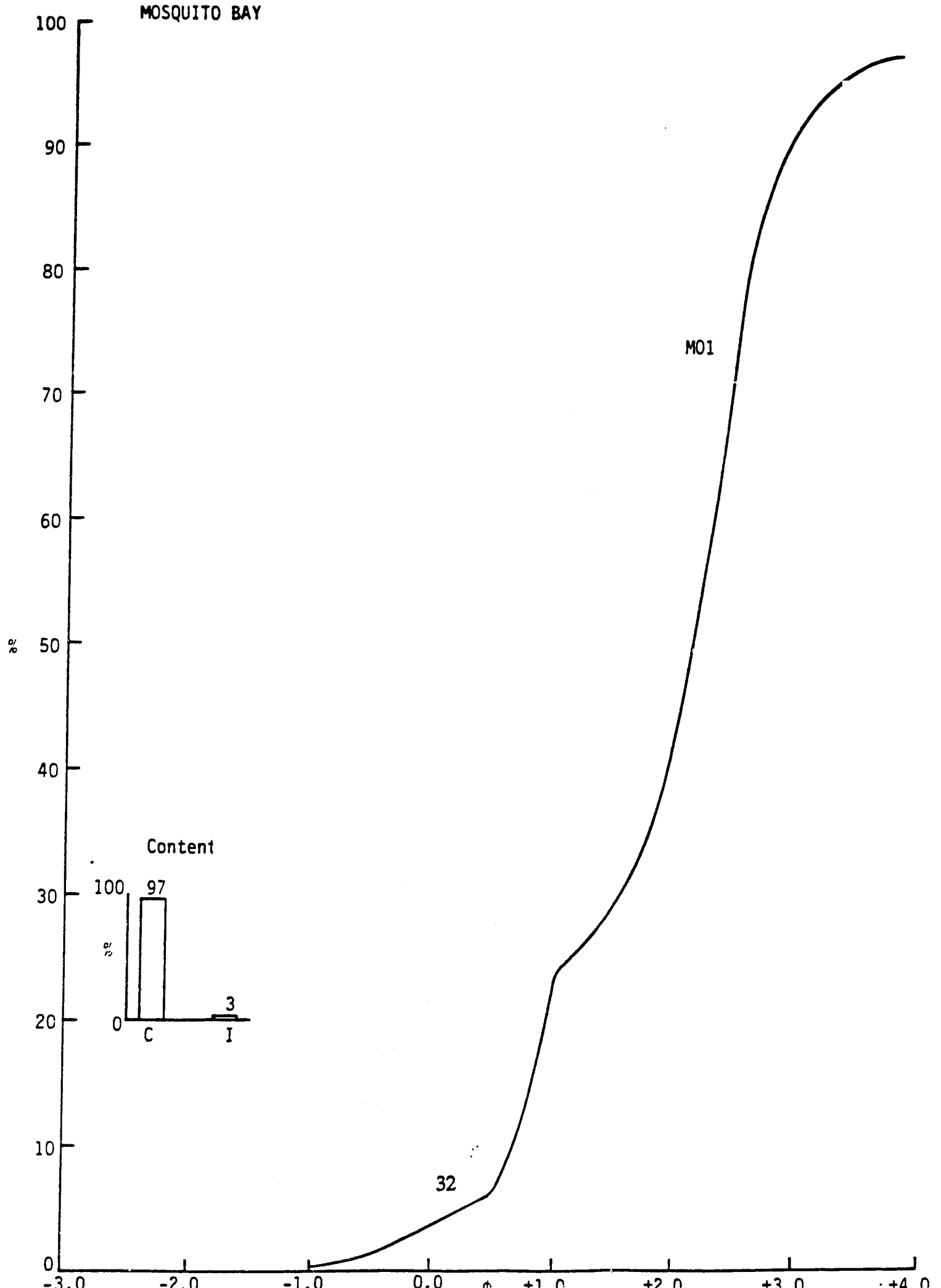
2.2.3 Atlantic Beaches

Mosquito Bay. (Figure 16) Mosquito Bay reveals medium sand size materials which are moderately-sorted with a coarse tail. Coral fragments dominate the beach, comprising 97% of the sample. Mineral lags of 3% are composed of magnetite, hornblende, and volcanic glass. All materials appear well-washed and polished with rounded to well-rounded clasts. Provenance of the beach materials is found in a degraded reef system located offshore as well as debris derived from the adjacent Scotch Bonnet to the south and in smaller quantities from St. Anthony's Peak catchment to the north. The polished and well-rounded appearance of the coral sand, as well as the absence of shell debris, reflect persistent moderate to high energy conditions. Observations during the survey revealed 5.5 s-1 waves with heights of 0.3-0.5 m., 90° approach, and the presence of 6 rip currents spaced 15-20 m.

Mosquito Bay (Figure 16)

Sample Shape Code	Section	Location	Mean Φ	Range Φ	Size Sorting δ	Skewness
MOI	Middle 0.40-0.80	Berm	+1.933	-1.0-+4.0	0.937	-0.244

Color: 10YR 7/1


MOSQUITO BAY
100
90
80
70
60
50
40
30
20
10
0
%
MO1
32
Content
100
97
%
0
3
C
I
-3.0
-2.0
-1.0
0.0
+1.0
+2.0
+3.0
+4.0

Sand Bank Bay. (Figure 17) Sand Bank Bay is characterized by fine to medium sand which is moderately well-sorted. Skewness ranges from near symmetrical on the low tide terrace to a coarse tail in the middle foreshore, to a fine tail at the first transverse dune crest (5 m. asl). The beach material is dominantly coral (93%-98%) with the mineral component only 2%-7% of the total sample. It is noteworthy, however, that the mineral component contains the familiar assemblage of hornblende, ilmenite, and volcanic glass as well as traces of rutile and olivine, heretofore not found on other Southeast Peninsula beaches. Such tracer minerals suggest not only the presence of andesite but possibly other volcanic or hypabyssal rocks. The isolated occurrence of these accessory minerals suggests the true pocket nature of Sand Bank Bay beach with dominant onshore-offshore flow. The heavy minerals occur as swash deposits on the foreshore. The well-washed and rounded-to-subrounded appearance of the coral sand is indicative of a nearshore-beach system which is presently reworking materials in the Bay, as well as a moderate to high energy environment.

Sand Bank Bay (Figure 17)

Sample Shape Code	Section	Location	Mean Φ	Range Φ	Size Sorting δ	Skewness
SB1	Middle 0.40-0.80	Outer edge L.T. terrace	+2.216	0.0-+4.0	0.562	-0.097
SB2	Middle 0.40-0.80	Middle F.S.	+2.366	0.0-+4.0	0.545	-0.196
SB2	Middle 0.40-0.80	First Transverse Dune Ridge	+1.966	-0.5-+4.0	0.600	+0.245

Color: 7.5YR 7/2 (SB1-2) 10Y 8/4 (SB3)

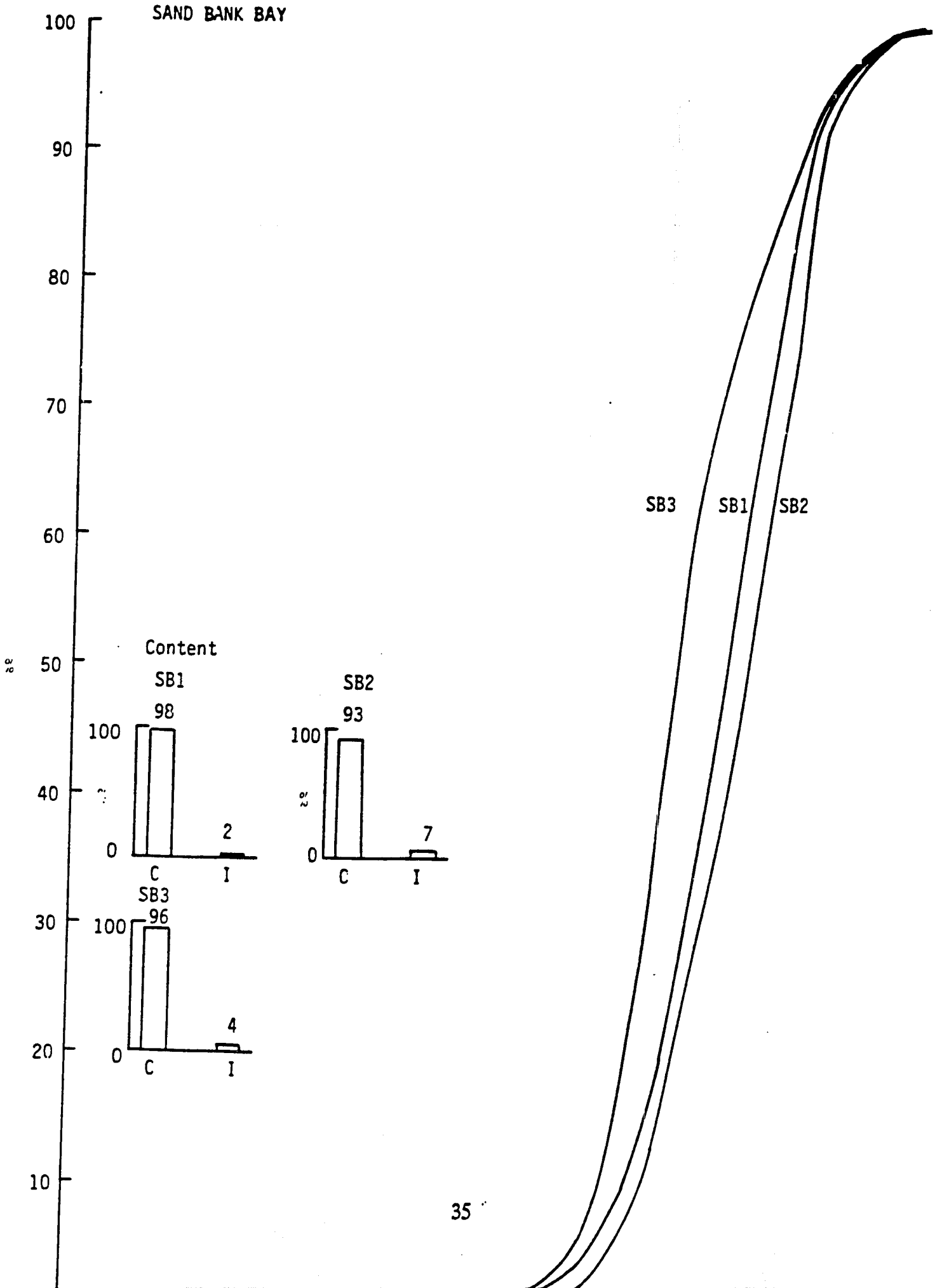
North Friar's Bay. (Figure 18) North Friar's Bay is characterized by fine to medium sand which is moderately-well to well-sorted. Skewness finds a near symmetrical distribution in the north section to a strong fine tail in the middle and south sections. Coral sand dominates the middle foreshore of the north and

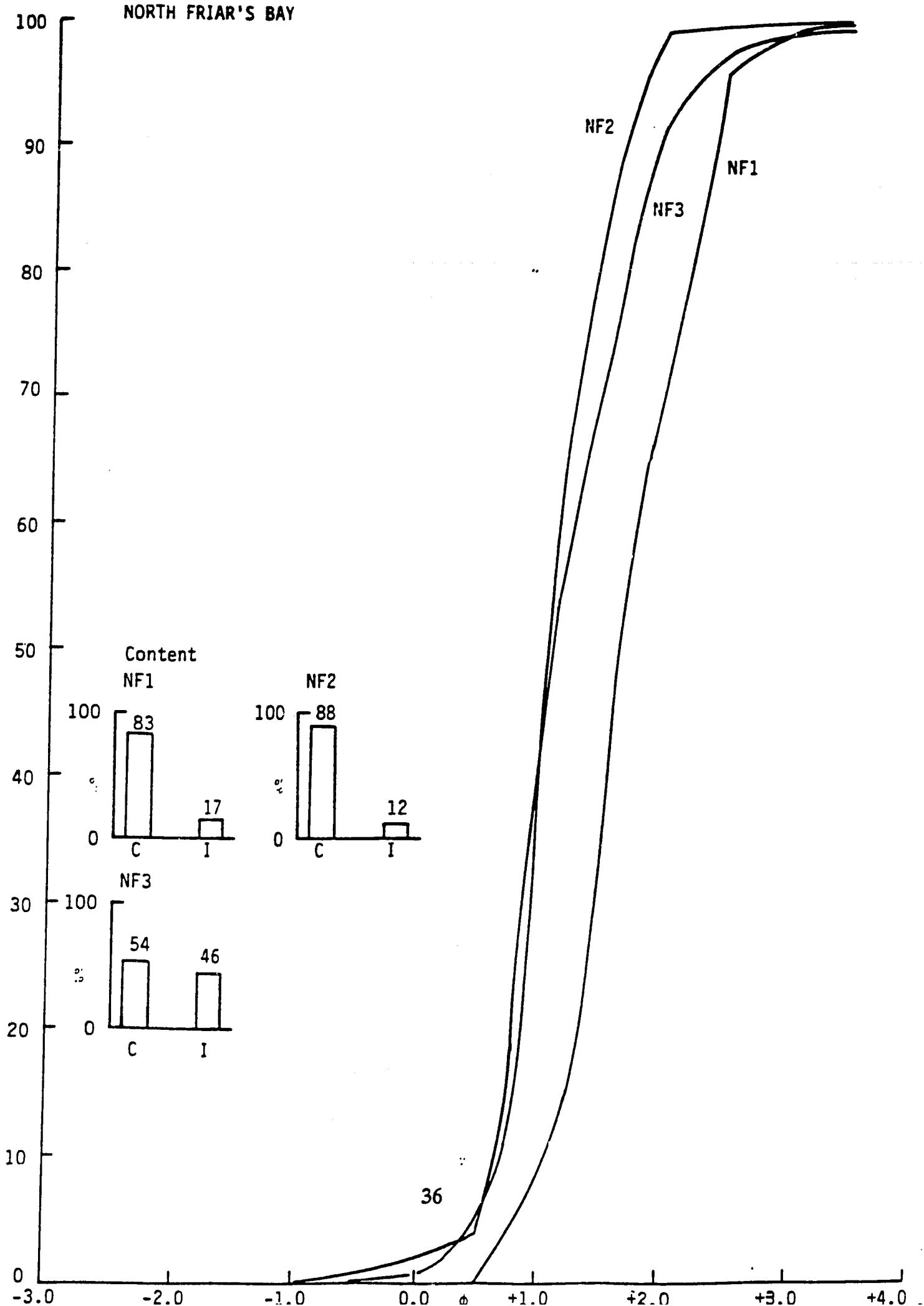
middle sections (83% and 88% respectively) with only 17% and 12% inorganic content respectively. The south section reveals 54% coral and 46% inorganic content. Dominant minerals include hornblende, ilmenite, magnetite, and volcanic glass. Sediment transport within this cell is mostly onshore-offshore but the composition of the sands suggests a slight dominance of northerly drift. Rounded-to-well rounded particles which are well polished characterize the coral fragments and suggest persistent reworking in a high energy environment. This is compounded by the presence of a steep foreshore ramp leading to a 1-m. erosional nip present in the middle and south sections, as well as additional erosional nips and berms in the north section.

North Friar's Bay (Figure 18)

Sample Shape Code	Section	Location	Size Mean Φ	Range Φ	Sorting δ	Skewness
NFI	North 0.40-1.00	Middle F.S.	+1.766	+0.5-+3.5	0.431	0.171
NF2	Middle 0.40-1.00	Middle F.S.	+1.116	-0.5-+3.5	0.392	+0.362
NF3	South 0.40-1.00	Middle F.S.	+1.216	-1.0-+3.5	0.512	+0.333

Color: 7.5 YR 7/6 (NF1-3)


SAND BANK BAY
100
90
80
70
60
50
40
30
20
10
%
SB3
SB1
SB2
Content
SB1
98
100
%
0
2
C
I
SB2
93
100
%
0
7
C
I
SB3
96
100
0
4
C
I


NORTH FRIAR'S BAY
NF2
NF1
NF3
Content
NF1
83
17
C
I
NF2
88
12
C
I
NF3
54
46
C
I
36
100
90
80
70
60
50
40
30
20
10
0
-3.0
-2.0
-1.0
0.0
+1.0
+2.0
+3.0
+4.0

3.0 MANAGEMENT ALTERNATIVES

3.1 Engineering Needs and Impact

There is considerable potential for deleterious impact on beach and barrier systems following emplacement of artificial structures. Beach nourishment is not seen to be important at the present time, nor in the light of recent experiences is there any certainty that nourishment would afford added practical benefits. As no specific structures have been proposed at this time, an evaluation of such impacts awaits proposals and the collection of baseline data.

3.2 Dune Vegetation

Sand dunes are found on all of the Southeast Peninsula Beaches examined in this report, with the exception of the beaches at White House Bay and Ballast Bay. Listed below are some of the more common species found on the barrier-beach systems.

1. **Sand strand** (High water mark to coastal coppice)

   Distichlis spicata
   Ipomoea pes-caprae
   Ipomoea stolonifera
   Sesuvium portulacastrum

2. **Barrier and Dunes**

   Acacia tortuosa
   Coccoloba uvifera
   Cocos nucifera
   Iva imbricata
   Scaevola plumieri
   Uniola paniculata

3. **Mangrove Community**

   Avicennia germinan
   Laguncularia racemosa
   Rhizophora mangle

Vegetation does not provide a complete cover, even on the innermost dune systems. Blowouts are common on Atlantic-facing beaches, often showing only incipient colonization and restabilization. Soil development within the dunes is poor. Accordingly, the dunes are vulnerable to erosion. Because the dunes do afford a significant protection against wave attack, especially on the Atlantic coast, any traffic through the dunes should be restricted to boardwalks and overpasses.

4.0 BEACH MANAGEMENT PLAN

The primary objective of beach management is to preserve the form and composition of the environment inherited from nature so as to maximize the human use of this resource while minimizing the deleterious human impacts.

To achieve this primary objective six considerations are important:

1. Categorization of beach morphodynamics under the range of conditions likely to be experienced at each beach location. This should include repeated surveys of monumented beach profiles especially before, during, and after major storms.

2. Categorization of nearshore energy factors under the range of conditions as stated above at each beach location. This will involve periodic monitoring of wave parameters, onshore currents, and seaward return flows, especially before, during, and after major storms.

3. Quantification of beach sediment budgets likely to be expected over the medium to long term, including seasonal changes and changes attributable to cyclic and non-cyclic variations in energy factors, including extreme events associated with storm wave runup during hurricanes and tsunami effects. In this context it is important to quantify the sources of sediments contributing to beaches at the present time and to assess the extent to which these have changed since the culmination of the main Holocene transgression.

4. Evaluation of the offshore-beach-backshore system in terms of the exchange of materials between these environments and the changes likely to be incurred as the result of human impacts.

5. Assessment of beach-carrying capacity for each beach locality within the Southeast Peninsula and the likely impact of beach use on the natural system.

6. Coral reefs: The relative vigor of each coral reef component of the shoreline should be assessed as these reefs are an important source of beach forming material.

The foregoing study has addressed each of these elements to as great an extent as possible. As the beaches represent some of the Southeast Peninsula's most important resources, longer term investigations along the lines indicated above are considered necessary before final decisions are made.

4.1 Management Proposals

The following proposals are suggested in order to preserve the valuable beach resources of the Southeast Peninsula and to manage these so as to minimize the negative impacts of development.

1. Mining: No mining of beach sand should be permitted under any circumstances. Beach sand is a finite resource that is not being replenished at the present time at a rate commensurate with past deposition. Thus beach mining implies beach loss. Furthermore, no mining of dune sand should occur in the most seaward dunes at North Friar's Bay, Sand Bank Bay, and Mosquito Bay because these dunes afford protection to wetland habitat and other backshore environments. Sand may however be mined from the innermost dunes between Sand Bank Bay and the Great Salt Pond as these are old dunes bearing no physical significance to shoreline stability. Also, no mining of sand should be permitted in the offshore or nearshore zones as this material is important to beach maintenance.

2. Engineering structures: No permanent impermeable engineering structures should be placed on the beach or the nearshore zone. Although such structures have been widely used elsewhere, it is evident that they commonly have a negative impact on beach stability and sediment budgets. Such structures would involve breakwaters, jetties, impermeable groins, and seawalls. Indeed, at the present time there would appear to be no need for such structures, but development may suggest their inclusion -- a factor that should be countered by denial. The possible development of a marina may be engineered without recourse to entrance jetties that significantly impact littoral drift and beach stability. Permeable structures such as piers are permissible.

3. Access: Access to beaches should be confined to specific locations and strictly regulated so as to minimize destruction of backshore vegetation and beaches by trampling and vehicular use. For example, access to Sand Bank Bay can be achieved by widening the existing path and by providing adequate parking facilities at least 50 m. behind the innermost limits of storm surges.

4. Design wave criteria: It is important to establish criteria with respect to the maximum elevations likely to be experienced during storm surges associated with hurricane passage in the region. This will indicate an elevation above sea level, below which no permanent structures should be built. These criteria can be expected to reflect the damage likely to be caused to the beach and backshore environment during a major storm.

   Determination of the design wave relies on a combination of hindcasting and forecasting and thus a consideration of synoptic weather charts, wind and

fetch data, and nearshore and offshore depth and slope. Design wave height directions and conditions include an analysis of breaking, non-breaking, and broken situations. Moreover, the fluctuation of water levels needs quantification as well as the surge differences associated with severe storms on the open coast and within embayments. Therefore, refraction and diffraction analysis should be included to determine the severity of water impact along geomorphically different portions of the coast. Significant wave height and period in addition to total energy per unit surface area should be included in design wave analysis. The role of wind in wave development and acceleration should consider an estimate of the mean free air and mean surface wind speed and direction.

Ideally a wave-rider buoy, fixed gauge, or nearshore array should be installed to obtain deep and shallow water wave data. Such data should be supplemented with a daily Littoral Environment Observation (LEO) record. Finally, these data should be used in conjunction with a continuous recording field (1-8 channel) logger linked to a compact mobile meteorological station which includes wind speed and direction, barometric pressure, solar radiation disk, and a precipitation gauge.

5. Design setback: Setback limits should be defined for each beach based on design wave criteria and beach and backshore characteristics. As a reasonably safe setback, a distance of 100 m. behind the normal high water mark and above the design wave criteria is recommended. Such a setback will provide for vegetated areas including lawns and dunes between hotels, homes and similar structures, and the beach proper. Specific setbacks should be defined for each beach based on design storm criteria and beach and backshore characteristics. The issue of setbacks is in part a physical consideration, in that coastal developments need to be protected from storm surges, and in part a human consideration in that setbacks can consume valuable beachfront property. The issue is approached primarily from the physical perspective with the 100-m. setback considered to be optimal for general discussion purposes. Arguments for lesser setbacks, particularly as proposed by developers the United States, can be countered in aesthetic and social terms. Not only is there a need to protect coastal properties but also to prevent overcrowding of the shorezone by beachfront development which is aesthetically undesirable (except for a handful of beachfront residents) and socially exclusive, in that developments close to the beach prevent access to the shore by the larger population. Examples of this serious problem of beach access for the community at large is as close as in the United States. These socio-economic and aesthetic issues are problems with which the Board must rightly deal. Thus the remainder of this section is devoted to the physical basis for setbacks.

An optimal setback of 100 m. is recommended for the Atlantic beaches where storm surges may be superimposed on wave trains driven by the prevailing easterly winds. The issue is most acute at the larger, more

developable beaches at North Friar's Bay, Sand Bank Bay and Mosquito Bay, each of which has a very active foreshore, a backshore of variable width, and one more transverse dune ridges which protect the low-lying interior. For example, the north end of North Friar's Bay beach suffered 26 m. of lateral erosion in summer 1988 and the foreshore throughout the beach retreated to within 10-15 m. of the primary dune front. This occurred under normal conditions and such mobility in terms of cut and fill must be considered part of the natural system. Under hurricane storm surges, beach erosion and dune retreat would be significant. Thus in these localities, the setback should include the variable backshore, the foredunes and the first or primary main dune, with access to the beach being provided by elevated walkways or narrow zig-zag paths over or through the dunes. The other Atlantic beaches, not backed by lagoons or low-lying terrain, do not pose a comparable problem and setbacks in these cases, for example at Canoe Bay, could be less than 100 m., depending on slope.

On the channel beaches (Major's Bay, Banana Bay and Cockleshell Bay), the impact of storm surges is likely to be less dramatic but there is a window between Nag's Head and the Nevis west coast through which significant storm waves can approach, as happened during tropical storm Gilbert's development in September 1988. Furthermore, each beach is essentially a narrow barrier backed by lagoons or lower land which should not be interfered with. Thus the setback should really be established at the leading edge of rising ground farther inland.

On the Caribbean beaches, normal wave action is less dramatic but hurricane surges can still cause significant erosion and overwash of the barrier beaches at Ballast Bay and South Friar's Bay. Once again, the barriers should remain intact (except for considerations of marina development discussed elsewhere).

It should be stressed that the 100 m. setback is recommended for general consideration and may be modified to suit local conditions. It does not apply to hillslopes between beaches, where coastal slopes and seacliffs afford natural protection against storm surge. In these situations, height above sea level can be substituted for distance inland, and setbacks should be established primarily to avoid development close to unstable cliff-tops or on ground subject to mass movement, for example, east of St. Anthony's Peak. Specific setbacks for all possible situations have not been developed in this study, but specific design values can be developed in consort with the Board's deliberations.

6. Coral reef protection: No development should occur which impacts negatively on the vigor of the coral reefs. Some reefs are already dead and are relict forms from the past, for example, along the southeast side of Sand Bank Bay. Other reefs, for example those across the mouth of Sand Bank Bay afford protection to the beach from storm waves and swells. No

collecting from the living reef should be permitted. No dumping of sediment or toxic wastes should be permitted near reef environments. These reefs, like the beaches, are a valuable resource for tourism. A dead reef is of no value.

7. Dumping: No dumping should be permitted within the nearshore, beach, dune, or wetland environment of the shorezone. Such dumping as has already occurred, notably at Mosquito Bay, should be subject to immediate cleanup. Trash cans and regular pickup should be provided at all beaches.

5.0 SUMMARY AND RECOMMENDATIONS

In conclusion, the compositional properties of these beaches suggest that most are essentially pocket beaches formed of materials from local cliff and inland sources and from the destruction of nearshore and locally offshore coral reefs. Despite the presence of significant longshore currents moving northwestward along both the Atlantic and Caribbean beaches, containing headlands limit the amount of material moving out of each beach cell, or into a beach cell from farther southeast. Dominant sediment movement is onshore-offshore, with moderate to high energy conditions being responsible for coral sediment derived from the destruction of active and certainly relict coral reefs. Whereas storm waves may move materials offshore, under low energy conditions associated with spilling and surging breakers, much of this sediment moves back onshore. Under calm conditions much sediment is stored in the nearshore zone in seagrass banks composed of Thalassia and Syringodium, particularly the latter. White House Bay is probably not a pocket beach because it appears that sediment can move out onto the coral reefs and thence northwards towards South Friar's Bay with comparative ease. The south-facing beaches at Cockleshell, Banana, and Major's bays are true pocket beaches.

Under high energy conditions with plunging breakers, however, the offshore component predominates and beach sand is removed through the nearshore zone to depths of at least 10 m. It is clear, for example, that southerly storm waves generated by tropical depressions will impact south-facing and west-facing beaches (South Friar's to Cockleshell beaches) during the passage of the storm either north or south of St. Kitts. More information is needed regarding bed load and suspended load movement in the nearshore and offshore zones, but it seems likely that wave-induced, tide-induced, and density currents may all combine to promote a net northwestward littoral drift. Thus, under severe storm or hurricane conditions, sediment that moves seaward beyond the confining headlands, and especially that portion that moves onto offshore reefs, can be lost from local beaches. As much of the sediment may have been originally introduced to beach cells during a positive sea-level change, such losses are of considerable concern and are a major reason why there should be no mining or development that impacts the sand budget. Whereas prohibition of sand mining and development should be a general rule, sediment concentration which will involve the use of jetties or similar structures should only take place after considerable study and understanding of the processes and responses found in the beach and nearshore environment. Such studies should be conducted by persons fully conversant with coastal processes and engineering impacts.

APPENDIX 1 EXPLANATION OF SYMBOLS USED IN FIGURES

α Long axis

Φ Phi grain size

δ Graphic sorting coefficient

Color codes based on Munsell Soil Color Charts

C Coral

S Shell

I Inorganic

APPENDIX 2 TECHNICAL GLOSSARY

AGGREGATE	Mineral Material such as sand, shells, slag, broken stone or combinations thereof held together by other substances such as lime.
ANDESITE	A volcanic rock composed of plagioclase [(Na,Ca)Al(Si,Al)Sio_8] and one or more mafic constituents (e.g., pyroxene, hornblende, and/or biotite).
BARRIER BEACH	An elongate ridge composed of unconsolidated materials rising above high tide level and extending parallel with the coast, created by wave activity.
BEACH NOURISHMENT	The process of replenishing a beach which may be brought about naturally, by a longshore transport or artificially, by the deposition of fill (borrowed) materials.
BARS AND TROUGHS	Shore-parallel accumulations of unconsolidated sediments (bars) separated by swales or hollows (troughs) with $\geq$ 1.0 m. total height difference, occurring seaward of the foreshore, though capable of onshore migration.
BEACHROCK	An accumulation of organic and/or inorganic sediments cemented together normally by lime from sea shells or corals, beach nourishment.
BERM	A nearly horizontal part of the beach or backshore formed by the deposition of material by wave action.
CATCHMENT	Drainage basin.
CENOZOIC	The latest of the four geologic eras extending from 65 my BP up to and including the present.
CUSP	One of a series of low mounds of beach material separated by crescent-shaped troughs spaced at more less regular intervals along the beachface.
DESIGN SETBACK	Minimum distance landward from HWM that man-made structures should be placed (HWM = high water mark).
DESIGN WAVE	Hypothetical wave, similar in context to significant wave, normally the average of the highest 1/3 of the range of wave heights used for planning purposes.

DIFFRACTION	The phenomenon by which energy is transmitted laterally along a wave crest. When a part of a train of waves is interrupted by a barrier, such as a breakwater, the effect of diffraction is manifested by propagation of waves into the sheltered region within the barrier's geometric shadow.
FRINGING BEACH	An accumulation of unconsolidated beach materials attached directly to the mainland coast and not backed by a lagoon as in the case of a barrier beach.
HOLOCENE TRANS-GRESSION	The rise of sea level during the past 10,000 years associated with the melting of the most recent ice sheets. The transgression began in Late Pleistocene times about 18,000 years ago but the later or Holocene part is most important.
HORNBLENDE	Rock-forming mineral of the amphibole group, consisting of $(Ca,Na)_3Mg,Fe'',AlTi_5(Si,Al)_8O_{22}(OH,F)_2$' monoclinic.
ILMENITE	The mineral $FeTiO_3$; hexagonal rhombohedral.
ISLAND ARC	Curved chain of islands along a tectonic plate boundary, margined by a submarine trench and enclosing a deep sea basin.
LUNATE MEGA-RIPPLES	Constructional forms on the shallow seabed greater than 0.5 m. in height and 10 m. long, formed by high energy waves and currents into crescentic lunate shapes.
LUNATE RIPPLES	Similar in size and shape to lunate megaripples but less than 0.5 m. high and less than 10 m. long, indicative of low wave and current energy.
MAGNETITE	A mineral of the spinel group $Fe''Fe_2O_4$, isometric, black in octahedrons; an accessory mineral of igneous rocks.
MORPHO-DYNAMICS	The interrelation between the shape of landforms and the dynamic forces that shape them; commonly used in relation to beach morphology and fluid dynamics.
OLIVINE	Rock-forming mineral common in mafic and ultramafic rocks, with solutions of Mg_2SiO_4 and Fe_2SiO_4.
PHI	A logarithmic transformation of the Wentworth grade scale for size classifications for sediment grains based on the negative logarithm to the base of 2 of the particle diameter (-log2d); mathematically more flexible for statistical analysis.

PLANAR BED	The bed of a nearshore, shelf or stream channel planed more or less level by currents.
REFRACTION	The process by which the direction of a wave moving in shallow water at an angle to the contours is changed. The part of the wave advancing in shallower water moves more slowly than that part still advancing in deeper water, causing the wave crest to bend toward alignment with the underwater contours.
RHYOLITE	An aphanitic (crystalline constituents distinguished by microscope) volcanic rock with alkalic feldspar, quartz, sodic plagioclase, and smaller amounts of muscovite, biotite, or hornblende.
RIDGES AND RUNNELS	Relatively narrow shore-parallel accumulations of unconsolidated sediments (ridges) separated by swales or hollows (runnels) with less than 1 m. total height difference; occurring on the foreshore.
RIP CURRENT	A high-velocity seaward return flow consisting of feeder currents flowing parallel to the shore inside the breakers; the neck, where the feeder currents converge and flow through the breakers in a narrow band or "rip"; and the head, where the current widens and slackens outside the breaker line.
RUTILE	A mineral (TiO_2) found in considerable quantities in black sands with ilmenite and magnetite.
SKEWNESS	The quality of a statistical frequency distribution of being grouped together on one side of the average and of tailing out on the other side; results from the lack of coincidence of the mode, median and mean of the distribution; used interpretively to distinguish physical processes and their relative strengths.
SORTING	A measure used to describe the distribution of grain sized in sample of unconsolidated material, similar to the statistical concept of a standard deviation; used interpretively to distinguish physical processes and their relative strengths.
SUBSTRATE	The underlayer of stratum, as of earth, rock or sediments lying immediately under another.
SWASH	The uprush of water onto the beachface following the breaking of a wave.

310

TSUNAMI	A long-period wave caused by an underwater disturbance such as a volcanic eruption or earthquake.

311

PROSPECTS FOR MARINA DEVELOPMENT

by

Antony R. Orme, Ph.D.

May 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

3/2

EXECUTIVE SUMMARY

The prospects for marina development on the Southeast Peninsula of St. Kitts are evaluated against general principles and with respect to choice of site. Focussing primarily on physical and ecological considerations, eight principles of marina location are defined, namely: site availability, sea approaches, entrance from the sea, land approaches, immediate marina hinterland, water circulation within a marina, disposal of dredge spoil and environmental compatibility. With these principles in mind, it is evident that there is no site on the Atlantic coast suitable for marina development, and the ensuing discussion focusses on the Caribbean and channel coasts.

There are basically two categories of potential marina site: onshore sites involving the breaching of a barrier beach and the dredging of a salt pond; and offshore sites involving creation of a marina by construction of a protective breakwater. The best potential onshore site is provided by the Little Salt Pond, more specifically the northern part of that pond with an entrance channel from White House Bay. Considerable attention is then devoted to the physical and ecological character of that site, including its history over the past 4,500 years. Major's Bay salt pond offers the second-best site but eight reasons are presented to explain why it is not more attractive. Cockleshell Bay is ranked a distant third. South Friar's Bay salt pond is considered in view of past interest in this site, but compelling reasons are presented for rejecting it as a potential location. An offshore site at White House Bay, associated with the construction of a detached breakwater, is presented as an attractive alternative to an onshore site. Despite some negative impacts associated with breakwater construction, the advantages of an offshore site include little dredging, better water circulation, less disturbance of valuable onshore land and habitat, and perhaps reduced costs.

Fourteen recommendations are presented for marina location and design. Among these, it is felt that a water area of some eight hectares (20 acres) with slips for between 200 and 400 boats depending on vessel size, should be considered as a basis for further discussion, and that only one marina may be considered at this time. In order to evaluate thoroughly the potential and problems of the onshore site at the Little Salt Pond and a possible offshore site in White House Bay, a research program focussing on the physical and ecological character of this area is recommended before final decisions are made.

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 CONSIDERATIONS IN MARINA DEVELOPMENT 2
- 2.1 Marina Site Availability 2
- 2.2 Sea Approaches 2
- 2.3 Entrance from the Sea 2
- 2.4 Land Approaches 2
- 2.5 Immediate Marina Hinterland 3
- 2.6 Water Circulation Within a Marina 3
- 2.7 Disposal of Dredge Spoil 4
- 2.8 Environmental Compatibility 4

3.0 CHOICE OF MARINA SITE 6
- 3.1 Little Salt Pond 6
- 3.2 Major's Bay 11
- 3.3 Cockleshell Bay 13
- 3.4 South Friar's Bay 14
- 3.5 White House Bay Offshore 15

4.0 RECOMMENDATIONS AND FURTHER STUDY 17
- 4.1 Recommendations 17
- 4.2 Considerations for Further Study 19

.314

1.0 INTRODUCTION

From the physical perspective, it is feasible to construct one or more marinas in the Southeast Peninsula of St. Kitts, but such development is not without significant environmental impacts. The following discussion first examines some considerations involved in marina development generally, then investigates and ranks various sites for marina development in the Southeast Peninsula, and concludes by outlining the categories of further information needed before final decisions should be taken with respect to the more favorable sites.

The following report should be read against the background provided by three reports already submitted to the Southeast Peninsula Board, namely:

Geodynamics, Land Stability, Earth Resources and Management Considerations, Southeast Peninsula, St. Kitts, by Antony R. Orme, March 1989;

Morphodynamics, Sediment characteristics, and Management Considerations, Southeast Peninsula Beaches, St. Kitts, by Amalie Jo Orme, March 1989;

Marine Resources Management Plan, by Evelyn Wilcox, March 1989.

These reports detail management considerations relating to the hinterland, shore-zone and offshore areas of various marina sites.

315

2.0 CONSIDERATIONS IN MARINA DEVELOPMENT

The following discussion outlines some general considerations that should be addressed with respect to location and development of marinas generally. It focusses primarily on physical and ecological considerations, rather than the socio-economic aspects of marina development which should be addressed by others more directly concerned with policy.

2.1 Marina Site Availability

Ideally, a site should be available wherein the immediate and continuing benefits of marina construction will outweigh the costs of site development and maintenance. In general terms, ideal sites include sheltered bays, estuaries and lagoons in direct connection with a relatively low energy ocean environment, and wetlands (mangrove swamps, salt marshes, salt ponds and barren tidal flats) that can be wholly or partially dredged at moderate environmental and financial cost.

2.2 Sea Approaches

The approach to a marina from the sea should be located and designed to minimize the possible effects of high waves, dangerous tidal forces, and swift currents. Sea approaches should also be clear of obstacles such as submerged or emergent rocks, coral reefs and sand bars on which pleasure craft can easily founder. Thus high energy marine environments with persistent onshore winds, such as the Atlantic coast of St. Kitts, should be avoided where possible.

2.3 Entrance from the Sea

Ideally, a marina entrance should be designed to provide for safe navigation of a specified boat size, while also minimizing the use of engineering structures that will likely have a deleterious impact on the shore-zone. Large gravity structures, such as breakwaters and jetties, are often provided on moderate to high energy coasts where no alternative sites for marina development are available. Apart from the high initial cost, such structures commonly disrupt the nearshore sediment budget and promote shoaling in the very entrance they are designed to provide. Marina development on the Atlantic coast of St. Kitts, even if it was feasible in other respects, could not be achieved without substantial investment in engineering structures. Marinas on the channel coast would likely need some modest structures as protection from southerly seas associated with tropical storms and hurricanes.

2.4 Land Approaches

A marina should have ready land access to its hinterland for the provision of goods and services to the marina community. Such goods would include petroleum products, bulk

316

food and drink, sails and the occasional replacement marine engine. Services would include the provision of fresh water, electrical power, and refuse collection. Completion of the Southeast Peninsula road more or less ensures that a marina on the Peninsula will have access to the international airport and deepwater port at Basseterre for the transfer of air or sea freight in bulk. However, an assessment should be made of the additional traffic likely to be generated by a marina of a specified size at a given location, bearing in mind the hilly curving nature and often restricted width of the peninsular road north of the Great Salt Pond.

2.5 Immediate Marina Hinterland

A marina is a small-boat harbor designed to provide shelter and support services to visiting boats and their occupants. As a water-oriented venture, it is rarely desirable to reclaim extensive bodies of water for the supporting infrastructure.

Ideally, therefore, a marina should be developed adjacent to flat or gently sloping terrain, above highest predicted storm effects, with sufficient space for slips, repair shops, warehouses, residential development, shops, restaurants and hotels. The marina in turn can become an interesting focal point for a community, a place of work, and a small center for tourists generally. Because marinas are rarely developed without supporting infrastructure, this implies that marina development on the Southeast Peninsula of St. Kitts should be seen as an integral part of local service center, with sufficient space for such development. The Southeast Peninsula Board and the Government of St. Kitts will presumably define the limits to marina and community development, but space and terrain constraints alone limit the choice to four localities: Little Salt Pond, Major's Bay, Cockleshell Bay, and South Friar's Bay. Other constraints are of course also operative.

2.6 Water Circulation Within a Marina

Poorly designed marinas commonly accumulate stagnant water, unwanted weed growth, and a flotsam and jetsam of petroleum products, non-biodegradable plastics, wood and other wastes. Flotsam and jetsam can be offset, at least theoretically, by ordinances against negligent disposal of wastes, but gasoline films and sewage are more insidious problems that may ruin an otherwise good marina as well as nearshore beaches. Thus marina development must involve considerations of both water circulation and cleanup. On macrotidal coasts (spring tidal range greater than 4 m.) and mesotidal coasts (spring tidal range greater than 2 m.), tidal ebb and flow generally provide excellent flushing action in marinas (although posing additional costs in other respects). Elsewhere, outflowing river waters may flush through an estuarine marina. St. Kitts, however, lies within a microtidal environment with an average tidal range of 0.3 m., there are no perennial rivers in the Southeast Peninsula, and the occasional flash flood is more likely to introduce unwanted sediment into a marinas than to provide flushing action. In such an environment, a marina must be carefully designed to promote good circulation (including both water and aeration and flushing action). This may be accomplished in

part by careful location of the entrance channel, but will commonly involve construction of one or more subsidiary drainage culverts. A variety of designs may be considered, but these are beyond the immediate purpose of this report. In addition, cleanup facilities should be considered in the marina design, for example, floating booms and appropriate skimmers.

2.7 Disposal of Dredge Spoil

Except in the case of some marinas composed of floating pontoons, marina development usually involves some dredging, if only to deepen entrance channels or berths, or to provide for deep water at slips and quays. Marinas developed in wetlands may involve considerable dredging, with all the attendant problems of spoil disposal. In some instances, spoil is used as fill behind jetties and quays but this implies costly construction of retaining bulkheads or revetments. In other cases, it may be used to create artificial islands which can then be landscaped and either transformed into nature sanctuaries or otherwise developed. In some instances, spoil of sand-size caliber has simply been placed on nearby beaches and then slowly removed by wave action. Sometimes, spoil is removed at great cost to offshore dumping grounds or to developments farther inland. Many states and nations now have ordinances against the dumping of spoil by one or more of these means. In areas such as St. Kitts, with valuable marine resources close to shore, any beach or ocean dumping should be rigorously avoided. In those circumstances, marinas should be carefully designed to minimize dredging and the proposed development should include a spoil-disposal plan that is environmentally compatible. This plan will of course reflect the volume of spoil to be disposed and thus the dimensions of the proposed marina. Among the most attractive alternatives for the Southeast Peninsula is the creation of one or more landscaped islands or shoreline terraces in or around a salt pond, assuming that a salt pond will be used as the site for a marina (which is not absolutely essential).

2.8 Environmental Compatibility

Where a marina is an intrusive element in a relatively natural or modestly altered environment, every attempt should be made to minimize its impact on the flora and fauna, and on other elements of the natural scene, both marine and terrestrial. No marina can be built without some disruption of the environment but elements of that environment deemed worthy of protection should be carefully identified and then accommodated in the development plan. On the Southeast Peninsula, the offshore coral reefs and seagrass beds are important marine resources and should, in all but the most exceptional cases, be protected. Mangrove habitats around the various salt ponds should be similarly protected, as should turtle nesting sites. However, it should be recognized at the outset that the development of a marina will cause some disruption, even destruction of the environment. Acknowledging that, it then becomes a matter of minimizing potential damage while also maximizing protection of the best that nature has bequeathed.

The foregoing discussion has presented eight considerations that should be evaluated with respect to marina development. Neither the list nor the discussion are exhaustive, but they serve to set the scene for the evaluation of likely marina sites that follows. A marina is an intrusive element in any environment, with significant ecological and socio-economic implications. In the Southeast Peninsula, however, there is scope for marina development as a focal point for both residents and tourists, a force for good - provided the ecological impact of such development is minimized by judicious planning.

319

3.0 CHOICE OF MARINA SITE

A marina in the Southeast Peninsula should be located and designed so as to provide a safe approach to a small-boat harbor adjacent to flat or gently sloping terrain of sufficient extent to permit infrastructure development and good access. The environmental impact of the marina should be minimized to the extent possible by careful placement of the entrance channel, cautious dredging, wise disposal of dredge spoil, and provision of adequate water circulation. Careful attention to environmental impacts may also limit construction cost, for example, by restricting the use of engineering structures such as entrance jetties.

Bearing the above considerations in mind, there is no site on the Atlantic coast suitable for marina development. The coast is exposed to strong swells and periodic storm seas driven by persistent easterly winds such that any anchorage would be to the lee shore before the wind. Coral reefs and submerged rocks are locally extensive. Where lowland lies behind the immediate coast, as at North Friar's Bay, Sand Bank Bay and Mosquito Bay, extensive sand dunes separate these lowlands from the shore. Only Sand Bank Bay offers a relatively sheltered anchorage but its approaches are rendered dangerous by an extensive shallow reef across the bay entrance and by supratidal reefs along the east shore. It may reasonably be left as a natural anchorage for occasional use under relatively calm conditions.

The Caribbean and channel coasts offer a number of possibilities for marina development and these will now be discussed in order of importance. There are basically two categories of site: (1) onshore sites involving the breaching of a barrier beach and the dredging of a salt pond, and (2) offshore sites involving creation of a marina by the construction of a protective breakwater. Discussions with others involved in this planning process have focussed entirely on the first series of alternatives, but for the sake of completeness this report also outlines some of the benefits and disadvantages of an offshore location.

3.1 Little Salt Pond

The Little Salt Pond offers the best onshore potential for marina development for a number of reasons. It is a relatively sheltered location close to the low energy Caribbean shore from which it is separated by low barrier beaches to Ballast Bay and White House Bay, either of which could be breached for an entrance channel. It is underlain by unconsolidated sediments that could be dredged to a required depth, and it is flanked to the northeast by gently sloping land leading to the peninsular road. It is also a relatively sterile salt pond whose principal life forms are algal growths and seasonal plankton blooms, although the latter are important to a variety of bird life whose needs should be considered in any potential development. The neighboring mangroves, grassland and shrubs are also ecological resources of varying significance to birds and terrestrial animals.

320

The Little Salt Pond covers approximately 20 hectares (50 acres) and, assuming a boat density of 25 to 50 boats per hectare (10 to 20 boats per acre), could accommodate a marina for 500 to 1000 boats. As a marina of this size would probably far exceed likely boat usage, a portion of the Little Salt Pond could be used for a smaller facility, with appropriate reductions in environmental impact. With this in mind, an evaluation of the physical characteristics of the Little Salt Pond and its vicinity was conducted.

In order to discover the nature of the materials underlying the Little Salt Pond and its larger neighbor to the east, the Great Salt Pond, two reconnaissance boreholes were drilled using both coring and screw auger devices on September 23 and 24, 1988. The location of these boreholes and the stratigraphy observed are presented in Figure 1.

The first borehole was drilled on the northeast shore of the Great Salt Pond, at approximately mean sea level and 350 m. inland from Sand Bank Bay. The top 2.8 m. were cored and the extracted core removed and carefully examined. This revealed alternating bands of fine sand and silt, medium to light grey in color, with occasional fragments of shell and coral, and towards the surface some charcoal fragments. A further 3.7 m. of sediment were then augered, revealing material of similar character but without charcoal. The borehole reached a maximum depth of 6.5 m. below the surface (or below mean sea level). The sediments were highly calcareous throughout and could best be described as lime muds with occasional shell debris. On drying, these lime muds formed a natural but weak cement. Lime muds of this nature are typical of carbonate deposition in shallow water in the tropics and subtropics, commonly associated with small animals, notably suspension feeders and detritus feeders, that extract organic and inorganic debris from the water column and process it into fecal pellets which settle more readily than individual clay and silt particles. Occasional siliciclastic debris, mostly heavy minerals of volcanic origin, were also found in these lime muds, but never comprised more than five percent of the samples taken. The charcoal flecks in the uppermost 20 cm. of the core are attributable to charcoal burning in the area within the relatively recent past, the material being reworked by wave action across the shore.

The second borehole was drilled to a maximum depth of 7.32 m. below the surface (7.82 m. below mean sea level) on the east side of the Little Salt Pond some 400 m. of Ballast Bay and 50 m. west of a rough was flanking old salt evaporation ponds. A core was retrieved from the top 2.2 m. to reveal a mostly calcareous, organic mud with abundant clay an some thin sand lenses, topped off by a 10 cm. thick algal mat. Lime mud - algal mat sequences often occur in shallow water in the Caribbean region. Between 2.2 m. and 6.45 m. below the surface, augering revealed a light grey sandy silt composed mostly of peletal carbonates. A second core retrieved from between 6.45 m. and 7.32 m. revealed similar material with a lens of shells between 6.50 m. and 6.56 m. The shells, which contained both whole valves of some bivalve specimens and some coral fragments, were sent to Beta Analytic, Inc., Coral Gables, Florida, for C^{14} dating. The shells were pretreated with dilute acid to etch away the outer layers and then further treated with acid to produce CO_2 which was used as the carbon source for dating purposes. The material yielded an age of 4530 plus or minus 100 radiocarbon years before 1950 AD (RCYBP), a somewhat remarkable finding.

From these data it appears that the Great and Little Salt ponds were occupied by sea water of normal salinities at least 4530 years ago and that their subsequent history was as water bodies in connection with the open ocean, permanently or intermittently, until relatively recent times. Certainly, the peletal lime muds, skeletal remains and shell fragments found throughout both boreholes testify to the dominance of shallow-water marine environments. They also indicate that the hypersaline conditions commonly found in the salt ponds today are a relatively recent occurrence, possibly attributable to human restrictions imposed on the ocean-water links in order to stimulate salt production during the historic past.

These findings reveal several features of importance to possible marina development. First, the Little Salt Pond is floored by saturated but unconsolidated shallow-water carbonate marine sediments to a depth of at least 7.8[illegible] m. (almost 26 feet) below sea level. Although more proves must be made to confirm the pattern of sedimentation and the location of bedrock around the pond's margins, this suggests that the floor of the Little Salt Pond is readily capable of excavation. Second, the Little Salt Pond appears to have had a recent history of relative stability, both in terms of structural stability and in the absence of terrestrial sediments. Thirdly, the lime muds found beneath the pond are compatible with similar lime muds forming in shallow water offshore, creating less of a problem for offshore disposal of dredge spoil should this be considered necessary. However, these lime muds could also be fashioned into one or more islands of dredge spoil within one or both salt ponds, creating habitat compatible with the underlying substrate.

One surprising result of these borehole investigations is the absence of volcanic sediments from either borehole, except as traces in otherwise marine sediments. David Lashley and Partners investigated the salt ponds for the St. Kitts - Nevis - Anguilla governments some years ago and, in a schematic cross-section from Sand Bank Bay to Ballast Bay, showed the ponds to be underlain by 1.5 m. of organic silt/ooze lying on more than 5 m. of grey volcanic sand, lying in turn on volcanic rock. No grey volcanic sand was located in the two boreholes noted above and it seems likely that the Lashley investigators speculated on its presence or misinterpreted the grey lime mud with its fine sand and silt content as a terrestrial volcanic deposit. Indeed, their text suggests that they probed up to 2 m. of organic-silt/ooze (presumably lime mud) to reach a somewhat firmer layer of what they presumed was weathered volcanic material but were unable to confirm. The Lashley cross-section and accompanying text should be disregarded in the light of my findings concerning the bottom sediments. However, further investigation of the bottom sediments of the likely marina site should be undertaken.

In order to understand more about the recent history of the Great and Little Salt ponds, twelve historic maps dating from 1650 to 1959 were examined. Care should be taken when reading early maps not produced by detailed ground or photogrammetric survey, but general relationships depicted on such maps may often be useful. Sanson's Carte de l'Isle de Saint Cristophe (1650) gives a vague representation of separate Great and Little Salt ponds. Herman Moll's The Island of Saint Christophers (1708) also showed separate salt ponds with the Grand Saline to the east of Les Sal. In a later map (1729), Moll again depicted separate salt ponds with no connection between them, and showed

326

an outlet from the salt pond behind South Friar's Bay. Bowen's 1752 map and Gellin's 1764 map show The Great Salt Pans and La Grande Saline respectively but with no connection, while the latter showed salt ponds behind Major's, Cockleshell and Mosquito bays. Anthony Ravell's map of 1775, the standard eighteenth century map of St. Kitts, contains much detail and shows links between Grande Saline and the Little Salt Pond, and between the latter and the careening place (Ballast Bay) along the southern edge of the Little Salt Pond and Ballast Bay beach. Bryan Edwards' map of 1794 again shows a connection between the Grande Saline and the Little Salt Pond, but not between the latter and Ballast Bay. A small salt pond is also shown behind Banana Bay. Thomson's maps of 1814, probably based on Ravell, show a larger connection between the Great and Little Salt ponds. Similarly, the map of St. Kitts shown in George Philip's Commercial Atlas of the World (1856) shows a connection between the salt ponds but no sea connection. More recent maps depict the canal cut between Little Salt Pond and White House Bay, and also the nature of the salt evaporation ponds in use earlier this century.

From the subsurface evidence, the above maps, and an understanding of Holocene sea level changes, it is concluded that the sea entered the Great and Little Salt ponds at least 4530 years ago and that sufficient connection with the sea probably persisted into late prehistoric time to permit accumulation of mostly marine carbonates. This is consistent with the global picture of Holocene sea level rise followed by the gradual stabilization of barrier beaches. Although there may have been occasional breaches in the Ballast Bay barrier beach in historic time, some possibly engineered, others caused by hurricane effects and heavy rainfall inland, it seems likely that much seepage would have occurred through the highly porous and permeable barrier beach. A connection between the Great and Little Salt ponds has probably long existed but it was probably widened artificially as salt production became more important in the mid-eighteenth century, which would explain the appearance of a connection on Ravell's map but not earlier.

The barrier beach at Ballast Bay is bimodal in composition, comprising large cobbles to boulder-size material set in a matrix of well-sorted medium sand (Amalie Jo Orme, 1989). The coarse fraction comprises mostly flattened andesite cobbles and boulders which have clearly been shaped by several thousand years of surge-zone activity. These materials are likely to yield high porosities, perhaps 25 to 40 percent, and when the sand matrix is removed by storm action, sea water should move fairly freely through the barrier to replenish the salt ponds. In agreement with the Lashley report it appears that a recharge of about 260 m^3/day would represent a minimum value for the movement of sea water through the barrier into the little Salt Pond, with no additional inputs by overwash during storm episodes, particularly at the north and south ends of the beach where the barrier is only 1 m. above mean sea level. Natural recharge from White House Bay would be small because of the narrowness of the barrier beach along shore and the presence of less permeable materials, including volcanic rocks, at shallow depth and to either side of the beach. There may be some recharge from Sand Bank Bay to the Great Salt Pond but there is no firm evidence of this at present.

The catchment area of the Great and Little Salt ponds approximates 315 hectares, and the Great Salt Pond in particular is the sump for centripetal drainage derived from the surrounding hills. During heavy rains, surface waters may reach the Great Salt Pond and these may transport terrigenous debris, most notably in the large gut that descends from St. Anthony's Peak to the east side of the pond (Antony R. Orme, (1989). The Little Salt Pond has a very small contributing catchment area and no major gut drains directly into the pond. This is an asset for marina development in that a harbor may be formed that is relatively free of inputs of terrigenous sediment.

What do the foregoing observations mean in terms of marina development in the Little Salt Pond? If it is assumed for discussion purposes that the proposed marina should accommodate 200 boats with liberal spacing of 25 boats per hectare, then only eight hectares or 40 percent of the Little Salt Pond would be needed to form the marina's water body. This value could be decreased further by increasing the density of boats, allowing more space for infrastructure development at least partially on reclaimed land. Again, assuming that eight to ten hectares would be more than sufficient for a 200-boat marina, this facility would be best located in the northern half of the Little Salt Pond with a sea entrance close to the derelict canal formerly used for the salt works. A secondary inlet-outlet culvert could then be built at the north end of the Ballast Bay barrier beach, preferably as a pipe through the beach rather than as an open cut. A pipe or pipes, whose dimensions would be determined after further study, would be located at mean sea level to permit flushing activity associated with the modest tidal range and wave set-up. A drainage pipe buried in this way would maintain the integrity of the barrier beach as natural protection against storm surges from the west.

The main entrance to the marina from White House Bay would be located only after careful subsurface investigations of volcanic and overlying sedimentary materials. Although Guana Point is composed of resistant andesite, the lower land along the coast to the northeast is composed of hydrothermally altered volcanics and possible some metasediments that are relatively weak and thus more readily excavated. The extent of these weaker rocks both onshore and offshore, and the nature and extent of onshore alluvial/colluvial deposits and offshore reefs should be determined from such a survey.

No marina can be developed without some impact on both offshore and onshore resources of ecological and tourist importance. However, by confining a marina, at least initially, to the northern half of the Little Salt Pond, the impact can be minimized in several ways:

1. The significant impact of the sea approaches and marina entrance can be confined to White House Bay which has one of the least attractive tourist beaches on the Peninsula.

2. The integrity of the Ballast Bay barrier beach, including the mangrove community on its landward side, can be largely maintained, with the exception of the drainage pipe or pipes for which some excavation would be necessary prior to their covering with barrier materials.

324

3. The important coral reef and rock habitats off Guana Point, significant as both fish habitat and tourist attractions, can be protected by defining a NW-SE approach to the marina entrance with marker buoys to a depth of at least 10 m. This would also serve to protect local fishery.

4. The southern half of the Little Salt Pond can remain in its present state, at least for the time being, provided a berm or some other form of impermeable barrier is placed at the south end of the marina. The pond would continue to be replenished by seepage through the Ballast Bay barrier beach, and thus provide habitat for bird life.

5. The Great Salt Pond would remain much as it is at present, except if it is decided to construct artificial islands from dredge spoil.

Minimizing the impact on such a marina would depend on several factors for which more information is needed before decisions can be made. These include the precise location and nature of the entrance channel and drainage pipes, the efficiency of the circulation system and cleanup facilities, the nature and location of the southern boundary to the marina, and the volume and placement of dredge spoil. Of these, the entrance channel and drainage pipes can be designed to keep environmental impacts to a minimum, for example by avoiding the use of impermeable entrance jetties, Furthermore, the dredge spoil can be used in a manner that is compatible with medium-term environmental goals. However, circulation within the marina is likely to pose problems in view of the negligible tidal range, but this will be true of any marina built onshore within the Peninsula. The nature and location of the marina's southern boundary are also problematic. A marina that is dredged to a desired depth but left open to the south will allow sea water to enter and dilute the waters of the Little Salt Pond and its larger neighbor although, because of high evaporation rates, salinities will remain above sea water values, especially along the inner or eastern margins of the Great Salt Pond. The water level in these ponds will, however, be permanently raised. Slippage of sediment from the undredged to the dredged area of the Little Salt Pond will also occur, requiring periodic maintenance. The provision of some impermeable southern barrier will inhibit these impacts but will also render more costly both the initial construction and any subsequent expansion of the marina.

3.2 Major's Bay

The 10 hectare (25 acre) salt pond at Major's Bay offers the second-best potential for onshore marina development in the Southeast Peninsula. The site is in a relatively sheltered location along the inner margins of a bay characterized mostly by low to moderate energy conditions. It is underlain by unconsolidated sediments which, although not as yet investigated in depth, are probably capable of being excavated to the required depth. The barrier beach to seawards could be readily breached for an entrance channel and the immediate approaches within Major's Bay are satisfactory. The salt pond is bounded inland by sufficient flat and gently sloping land for infrastructure development, and its eastern margin is the terminus of the Peninsula road and the proposed site of

a ferry terminus for connection with Nevis. Unlike the Little Salt Pond, a permanent link to the sea at Major's Bay would not have likely environmental impacts beyond the immediate marina area.

For a number of reasons, however, marina development at Major's Bay is less attractive:

1. The outer sea approaches would require small boats to navigate in the channel between St. Kitts and Nevis, exposed to higher seas and swells driving westward before the easterly trade winds. Whereas this should not pose problems for larger boats or good sailors, it could cause difficulties for others, especially in seas generated by squalls passing through the channel. Major's Bay is also exposed to southerly seas generated by tropical depressions moving into the Caribbean from the Atlantic, as tropical storm Gilbert demonstrated in September 1988.

2. The inner sea approaches through Major's Bay are sufficiently deep for the size of boats likely to use a marina but the bay floor is extensively mantled in the sea grasses Thalassia testudinum and Syringodium filiforme. According to Evelyn Wilcox (1989), these seagrass beds provide feeding, spawning and nursery areas for many fish, mollusks and invertebrates, and are the richest such beds surveyed by her in the Southeast Peninsula. Major's Bay is also a foraging area for Green and Hawksbill sea turtles and a significant nursery area for spiny lobster.

3. The entrance channel would of necessity be cut through a barrier beach, probably near its eastern and close to the proposed ferry terminal so as to minimize environmental impacts elsewhere in the bay. Although the materials of this beach are largely relict (i.e., they were emplaced in a pocket beach location as a result of the most recent marine transgression), they are subject to considerable mobility during storm events and erosional nips are slow to recover. During summer 1988, the eastern part of the barrier was seen to be composed of cobbles and boulders, presumably exposed by relatively recent storm activity, while the western part was mantled with sand (Amalie Jo Orme, 1989). Creation of an entrance channel would not only weaken the structural integrity of the barrier but would probably generate maintenance problems for the entrance itself as shoaling occurs in response to southerly storm seas.

4. The proposal to construct a ferry terminus at the south end of the peninsular road could, if a marina was also built in the nearby salt pond, lead to considerable congestion and attendant pollution problems.

5. In order to prevent offshore pollution and minimize construction costs, it would probably be necessary to dispose of dredge spoil locally, for example behind bulkheads around the marina's margin. Whereas this is not bad, it implies a greater commitment to engineering structures than would necessarily be the case in the Little Salt Pond. Alternatively, dredge spoil could be removed to the Great Salt Pond for the creation of artificial islands but this would escalate costs. One means of removing dredge spoil which should be considered for all potential

326

sites is the provision of a pipeline for removal as a slurry to a proposed dumping site.

6. The likely impact of marina development on local plant ecology would include virtual elimination of the narrow mangrove habitat along the inner side of the barrier beach, with consequences for the dependent fauna.

7. Major's Bay salt pond is flanked to east and west by hills drained by guts which have from time to time introduced sediment to the pond which therefore acts as a natural sump. During major storm events, a steep gut at the extreme western margin of the barrier sometimes flushes sediment directly to the bay, while a smaller gut near the road terminus flushes sediment into the pond's southeast corner. Such sediment would not only have a deleterious impact on the marina but, with an open entrance channel, would likely be flushed seawards with significant ecological consequences.

8. The barrier beach is relatively narrow and is presently crowned above normal swash limits by Acacia tortusa, Coccoloba uvifera and machineel, all of which tend to discourage penetration and use of the barrier. Nevertheless, the barrier has excellent potential as a tourist beach with relatively safe swimming and snorkeling offshore, particularly in view of the excellent access provided by the peninsular road. Whereas marina development onshore and beach recreation are not entirely incompatible with one another, boats and other marina facilities do cause added congestion, including danger to swimmers who venture too near the approaches and entrance channel, and pollution problems.

Thus, while Major's Bay salt pond offers a useful alternative site for marina development, there are several reasons why it is a far less attractive location than the Little Salt Pond.

3.3 Cockleshell Bay

The approximately ten hectare (25 acre) salt pond behind Cockleshell Bay offers the third-best potential for onshore marina development in the Southeast Peninsula. Like Major's Bay, the site is a relatively sheltered location behind a barrier beach along a low to moderate energy coast. Its underlying sediments, although not investigated in detail, are probably capable of excavation to the required depth, and the barrier beach could be easily breached for an entrance channel whose offshore approaches would be satisfactory. Inland, the salt pond is flanked by a relatively large area of flat and gently sloping land. Although not on the main peninsula road, it is probable that a surfaced secondary road would provide access to the former at the Great Salt Pond.

A marina at Cockleshell Bay salt pond would, however, present many of the same problems already discussed for Major's Bay: a more difficult outer sea approach than a Caribbean site, an inner sea approach over extensive seagrass beds of considerable ecological importance, disruption of a barrier beach, virtual elimination of the mangrove

327

vegetation around the salt pond, and potential conflict with other uses such as swimming and snorkeling. The barrier beach is somewhat less exposed to southerly swells than at Major's Bay but for the reason its wave-constructed width and height are also lower, providing less width for other recreational activities and less protection against infrequent high energy storms. Its mobility is demonstrated by the exposure during summer 1988 of volcanic pebbles and cobbles along its eastern margin, while fine to coarse sand composed largely of coral, shell and volcanic clasts still mantled these larger materials farther west (Amalie Jo Orme, 1988). This suggests that longshore drift is a significant component of the circulation systems here, with attendant problems of shoaling in a marina entrance. Disposal of dredge spoil would not be a major problem here as it could be used in several ways: to construct an artificial island here or behind Mosquito Bay, to raise presently swampy areas around the salt pond's inner margins to a level where they could become useful land, or to spread thinly across abandoned farmlands inland. The salt pond is not subject to much terrestrial drainage or sediment influxes.

From the above considerations, the Cockleshell Bay salt pond is ranked in third place as a potential marina site, to be investigated further only if the first and second sites present insoluble problems. The small salt pond behind Banana Bay has long since been reclaimed to meadow and there is no reason to resurrect this locality as a potential site. The salt pond behind Mosquito Bay has already been dismissed owing to the difficulties of small-boat navigation on the Atlantic coast. Although it could be reached from the Cockleshell Bay salt pond, this approach offers no additional benefits, only greater costs.

3.4 South Friar's Bay

The six hectare (15 acre) salt pond behind South Friar's Bay is ranked fourth as a potential onshore marina location and is evaluated here only because it emerged as a potential site in prior discussions. Certainly, the salt pond could accommodate a small to medium size marina behind a barrier beach, adjacent to some flat and gently sloping land with easy access to the Peninsula. The outer and inner sea approaches are open, although some important seagrass areas lie inshore of a coral reef 10 to 12 m. deep some 700 to 1000 m. offshore (Wilcox, 1989). The barrier beach may be breached for an entrance channel and the salt pond's soft sediments may be readily dredged, although the volcanic rocks of Sir Timothy's Hill to the northwest and the bounding hill to the southeast are probably present at shallow depth beneath the pond's margins and would limit marina dimensions.

South Friar's Bay, however, offers by far the least desirable onshore marina site of the four considered in the Southeast Peninsula, and for four very good reasons:

1. The barrier beach is among the finest, as yet undeveloped, recreational beaches on St. Kitts and is best used for that purpose.

2. The beach is not a pocket beach but receives sediment from the southeast and loses it to the northwest in the predominant littoral drift from the southeast. This is reflected in the composition of the beach which in the south is 88 percent

328

volcanic minerals (obsidian, horneblende, magnetite and various aggregates) derived from the cliffs farther south, while farther north coral and shell fragments become increasingly important as distance from the feeder cliffs increases (Amalie Jo Orme, 1989). In addition, the beach face is subject to significant erosion from southerly seas, as happened during the passage of tropical storm Gilbert in 1988 when the berm retreated 11 m. before a 2 m. high erosional nip. Some 25,000 $m.^3$ of sand were lost from the beach face along a 1150 m. front, a significant portion of which was moved offshore and transported northwards towards South Frigate Bay (Antony R. Orme's September resurvey of Amalie Jo Orme's July survey, 1988). The remaining offshore sand seemed likely to move onshore again under favorable conditions. The implications for marina development are significant in that, on a shoreline dominated by northward-flowing littoral drift and occasionally strong onshore seas from the south, an entrance channel would need the protection of two jetties, ideally at right angles to the shore. However, the more southerly of the jetties would likely restrict littoral drift, promoting shoaling in the marina entrance while depriving the more northerly beach section of replenishment sand. Jetties could indeed be designed to offset, at least in part, these negative effects, for example by designing a low permeable structure and pre-filling against the northern jetty, but shoaling would continue to be a problem and would require periodic dredging or, more expensively, a modest sand by-passing operation.

3. Ecologically, South Friar's Bay has been a nesting site for Green and Hawksbill turtles, although these animals would likely be disturbed by any recreational development. Furthermore, the backshore area is characterized by a mized scrub merging towards the salt pond with good mangrove habitat. These mangroves have also been impacted in part by nearby road construction and would likely be reduced further by hotel or other development. They would probably be destroyed entirely in any marina development.

4. In view of competing needs, for example the Peninsula road and the need to preserve an excellent recreational beach, there is only limited space for marina development accompanied by an appropriate infrastructure. It would seem desirable to maximize use of this space with some environmentally compatible developments.

For the above reasons, South Friar's Bay is not recommended as a marina site. The discussion has been presented simply to address issues raised by others, rather than to advocate this location.

3.5 White House Bay Offshore

Although not raised by others, experience with coastal geomorphology and related engineering structures suggests that it would be remiss not to mention one further alternative, namely an offshore marina. On many coasts around the world where natural harbors are lacking, offshore marinas and less formal anchorages are sometimes designed

329

to good effect. Ideally, they are developed in relatively low energy environments with good sea approaches and land access. St. Kitts has at least one such anchorage at Fisherman's Wharf at the west end of Basseterre Bay, although that facility suffers somewhat from being at the downstream end of Basseterre Bay with its attendant pollution problems.

In the Southeast Peninsula, the best location for an offshore marina would be White House Bay, especially that part north of the old salt pond canal. The creation of a marina in this location would involve using six to ten hectares of shelf for the marina, approximately 500 m. of shorefront on either side of the present pier for marina-related services, and further flat land behind for supporting services. Central to the development of such a marina would be the construction of an offshore breakwater, 200 to 300 m. in length with a design height sufficient to withstand a design-storm surge. In order to promote free water circulation and inhibit pollution, the breakwater would be a free-standing gravity structure separated at both ends from the adjacent coast (a solution that might also alleviate some of the above-mentioned problems at Fisherman's Wharf). The immediate shorefront would be provided at a number of piers or floating pontoons projecting seawards from this shorefront, and access could be provided by marked channels around and behind the breakwater. In other respects, the location of such a marina would share the benefits of a good sea approach on a sheltered coast already noted for the Little Salt Pond.

In addition, the advantages of such a marina include: (1) little or no dredging and therefore little or no problem of dredge spoil disposal; (2) much better circulation and therefore less pollution potential than an onshore site; (3) probably reduced construction and maintenance costs, although the breakwater represents a major investment; (4) ready availability of rocks of various sizes from the peninsular road construction which would be suitable for the breakwater; (5) minimal disturbance of valuable onshore land and habitat, which could therefore be released for alternative use or preservation.

The main disadvantage, namely the placement of an offshore breakwater in White House Bay, may in fact be less significant than at first appears. Certainly the breakwater would cover a linear area of seafloor in what is known to be an important fishing area. Care would have to be taken to minimize impacts on the reefs off Guana Point during construction, but the use of hard rock would yield less deleterious sediment than, say, the opening of an entrance channel to an onshore marina. Furthermore, once in place, the breakwater would in turn offer valuable habitat for small fish and crustaceans, and would likely support seagrass and perhaps eventual coral growth on its seaward side. In several parts of the world, ecologists have had considerable success with habitats provided by artificial reefs offshore, even using old cars! Some existing sea floor would indeed be lost but the compensating advantages are not inconsiderable.

4.0 RECOMMENDATIONS AND FURTHER STUDY

4.1 Recommendations

1. A marina on the Southeast Peninsula should be a small-boat harbor whose location affords a safe approach from the sea, good land access, and sufficient adjacent land for infrastructure development. Its construction should minimize environmental impact by careful placement of the entrance channel, cautious dredging, wise disposal of dredge spoil, and provision of adequate water circulation.

2. The Little Salt Pond and its environs offer the best potential site for onshore marina development for reasons stated, and should a second marina be considered desirable now or in the future, this location should also be subject to further detailed investigations.

3. Major's Bay offers the second-best potential site for onshore marina development and, should a second marina be considered desirable now or in the future, this location should also be subject to further investigation.

4. Other potential onshore sites, such as Cockleshell Bay and South Friar's Bay, offer fewer advantages and more disadvantages as marina locations, and should not be seriously considered further.

5. White House Bay offers the best potential offshore site for marina development associated with an offshore breakwater, with advantages that outweigh disadvantages. It should be investigated further in this context, particularly as such an investigation could be linked with further studies of the Little Salt Pond and its approaches without greatly increasing costs.

6. It is recommended that only one marina be developed in the Southeast Peninsula in the near future and that, assuming a liberal spacing of 25 boats per hectare, a water area of some eight hectares (200 boats) be reserved for this purpose. Should the emphasis be on small boats only, the same water body could accommodate 400 boats at 50 boats per hectare. Any combination of large and small boats could similarly be accommodated by an adjustment in berth size within the same water area. Although such a marina may appear somewhat ambitious at this time, the above values can be used for discussion purposes. Certainly, there would seem to be little need for a second marina in the near future, and it would appear desirable to focus all marina facilities in one location so as to leave other areas available for alternative uses or preservation.

7. The entrance channel for an onshore marina and the access channel for an offshore marina should be designed to accommodate boats drawing approximately 2.5 m. of water, namely to a depth of 3.5 m.

8. Ideally, the design marina should have slips of length varying from 10 m. to perhaps 30 m., although the decision of maximum boat size desirable should await further studies.

9. An onshore marina basin should be contained by vertical seawalls or timber bulkheads to provide berthing and also to prevent slippage of terrestrial or salt-pond sediments into the marina. An offshore marina should have shorefront of similar design.

10. Excavation of an onshore marina should take place behind a low coffer dam so as to prevent the release of salt-pond sediments to nearby ecologically sensitive areas such as offshore coral reefs. Ideally, removal of dredge spoil should be achieved by pumping a pipeline slurry directly to one or more deposition sites.

11. Construction of an offshore breakwater, if needed, should be achieved with minimal impact on the neighboring environment.

12. An onshore marina should be designed to maximize water circulation and be provided with additional cleanup facilities such as floating booms and skimmers. Stagnant water and pollution are likely to pose serious problems for an onshore marina, but not for an offshore facility provided with a detached breakwater.

13. The marina infrastructure should include provision of piers or floating pontoons, a fire protection system appropriate to a marina, sewage pumpout stations, repair shops, and a security system including customs and police.

14. A marina ordinance should be created which includes regulations with respect to boat speed, right of way, discharges from boats, and related rules.

332

4.2 Considerations for Further Study

Much of the foregoing narrative has been presented as a basis for further discussion by the Board, the Government and various consultants. The science is sound but there are other issues related to the socio-economic aspects of marina development which need to be addressed by those more directly concerned with policy. Above all, there is a need for market research on the potential users of a small-boat marina on the Southeast Peninsula so that overall size and interior organization of the proposed facility can be more accurately defined. If the largest marina in the British Virgin Islands is under 200 slips, this gives one measure of useful optimum size, but more information is needed. Furthermore, how many marinas presently exist or are being planned in the Lesser Antilles and what is their likely spacing? If there is likely to be competition from a marina on another island relatively nearby, what special attractions or inducements will the marina in St. Kitts offer?

In conclusion, and returning to the basic science involved, a detailed research program should be conducted in the vicinity of the Little Salt Pond but including White House Bay, Ballast Bay, the offshore shelf neighboring parts of the mainland and the Great Salt Pond. This program would be designed to answer specific questions raised in this report with respect to both the Little Salt Pond and the offshore site. It would focus on the following:

1. Detailed bathymetry of the offshore zone from White House Bay to Ballast Bay in order to provide a detailed contour map of the bottom topography as a basis for defining approaches.

2. Detailed evaluation of circulation patterns and sediment transport in the above offshore zone at least to the 10 m. depth so as to define accurately the system's hydrodynamics and sediment mobility.

3. Detailed evaluation of subsurface geology of the barrier beaches at Ballast Bay and White House Bay, and beneath Little Salt Pond, so that decisions on foundations, entrance channel, and circulation system can be made.

4. Detailed mapping and evaluation of all marine and terrestrial resources in the area including, but not confined to, the coral reefs off Guana Point, the mangrove habitat, the fishery and its potential for disruption, and the ecology of resident and migrant birds and other animals.

SCENIC VISTA PROTECTION, PRESERVATION AND MANAGEMENT PLAN

by

Ted Baker, A.S.L.A.

May 1989

Prepared for the U.S. Agency for International Development
under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

334

EXECUTIVE SUMMARY

The Southeast Peninsula of St. Kitts is a unique visual habitat, offering a diversity of experience within a limited physical area ensuring limitless access for the tourist. This diversity offers a variety of existing physical resources, including:

* Salt Ponds
* Beaches
* Vegetation
* Guts
* Adjacent Waters
* Mountains
* Cliffs and Escarpments
* Main Southeast Peninsula Road

In addition, the anticipated introduction of development to the Peninsula will add a number of man-made resources, including:

* Secondary Roads
* Buildings
* Parking
* Vehicular Overlooks
* Pedestrian Overlooks and Trails
* Utilities

This report recommends Government and Developer levels of assessment, valuation and planning for the Peninsula and, in addition, suggests a process of Government review of developer proposals. Generally, the Government's responsibility includes:

* Location and development of six overlooks adjacent to the Southeast Peninsula Road,

* Preservation and protection of vistas and views encompassing adjacent waters,

* Preservation and protection of vistas and views encompassing the geographic domain of more than one ownership.

The Developer's responsibility includes implementation of the Ordinal Combination Method of generating Factor Suitability Maps for developments of:

* A single or multi-phase development with primary impact in a particular geographic setting but with existing or potential visual and/or physical interrelationships to adjacent parcels.

ACKNOWLEDGEMENTS

I wish to especially acknowledge the valuable, tested and proven research of the United States Forest Service, Department of Agriculture, upon which the Government Level of administration of this SCENIC VISTA PROTECTION, PRESERVATION AND MANAGEMENT PLAN is based. Appropriate acknowledgement of elements of the Forest Service methodology for scenic vista valuations presented in this report is here noted.

The consideration of methodologies applicable to such valuations, including those supported both by the research and case studies of McHarg, Steinitz, Lewis and others, indicated in each instance a well-founded process. However, the Forest Service process was selected for recommended implementation due both to its repeatedly-successful record of application in an ongoing management setting and its record of significant accomplishment in the face of notable external pressure of a predominantly-economic nature.

Special acknowledgement is made of the support and commentary of all team members.

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 THE VISUAL RESOURCES OF THE SOUTHEAST PENINSULA 3
- 2.1 Resources Identified 3
- 2.2 Resources Defined 4
  - 2.2.1 Salt Ponds 4
  - 2.2.2 Beaches 4
  - 2.2.3 Cliffs and Escarpments 5
  - 2.2.4 Guts 5
  - 2.2.5 Adjacent Waters 5
  - 2.2.6 Mountains 5
  - 2.2.7 Vegetation 6
  - 2.2.8 Main Southeast Peninsula Road 6

3.0 MANAGEMENT ALTERNATIVES 8
- 3.1 Identifying and Evaluating Resource Combinations 8
  - 3.1.1 The Government's Responsibility 8
  - 3.1.2 Landscape Management 9
    - 3.1.2.1 Class A Distinctive 9
    - 3.1.2.2 Class B Common 9
    - 3.1.2.3 Class C Minimal 10
  - 3.1.3 The Developer's Responsibility 13
  - 3.1.4 Vegetation 13
  - 3.1.5 Beach 13
  - 3.1.6 Cliffs and Escarpments 14

4.0 SUMMARY AND RECOMMENDATIONS 16
- 4.1 Secondary Roads 16
  - 4.1.1 Overlooks 16
  - 4.1.2 Buildings 16
  - 4.1.3 Parking 16
  - 4.1.4 Utilities 16
- 4.2 Recommended Design Controls 16
  - 4.2.1 Secondary Roads 16
  - 4.2.2 Overlooks 17
  - 4.2.3 Buildings 18
  - 4.2.4 Parking 19
  - 4.2.5 Utilities 19
  - 4.2.6 General 19

5.0 REFERENCES 20

APPENDIX 1 TECHNICAL GLOSSARY 21

1.0 INTRODUCTION

Man possesses a visual and functional appreciation of nature and the landscape. This landscape provides shelter, food, comfort, security and beauty. The creationist and Darwinian theories are rooted in natural settings: the Garden of Eden versus the oceans, rivers and land forms of our Earth. It is, of course, from knowledge of such settings that generates the desire to be within them and to absorb their abundant charm and beauty. And, with his ever-increasing mobility, man has at his disposal the means to experience such locales and it is his desire for such experiences which helps drive the tropical tourism industry.

Our utilization of the landscape has been diverse, namely: it includes the utilization of its special and unique features as a defense in battle (Mont St. Michel, Brimstone Hill, The Everglades), agricultural applications, and for aesthetic pleasure (the gardens of the Moors, Italians, French and English). The works of Olmsted, Vaux and Eliot reflect the traditional qualities and values of the natural landscape, reflecting an appreciation of broad scenic vistas of natural character and intimate, man-made spaces. The English Natural Gardens and Olmsted's work at Yosemite National Park and Central Park in New York City provide some of the finest physical examples of the recognition of the desire to be absorbed by the natural landscape.

A common fascination with and commitment to recording the natural landscape exists in the works of noted landscape architects Olmsted and Eliot, with landscape painters including Constable and the Hudson River School, and with writers such as Ralph Waldo Emerson (Nature), Henry David Thoreau (Walden), and George Perkins Marsh (Man and Nature). Their personal and philosophical interests suggest a response to the broader public curiosity.

Over time, man has developed not only a respect for and need to utilize the natural landscape, but a fascination with its vast array of visual resources as well (i.e., forms, colors, textures, views and vistas). These concepts have been incorporated into contemporary landscape architectural settings such as the design and development of public parks, college and university campuses, town centers, office parks and, particularly, into the design and development of facilities of the burgeoning tourism industry throughout the world. Desired preservation and protection of the landscape can be ensured through careful planning and site design of the highest quality. Also, in this manner, land stewardship is best served.

The concern for preservation and protection of the landscape is partially due to the emotional and psychological impacts resulting from land use. Studies addressing issues of crowding and overpopulation have been undertaken, and the impact of the natural landscape (trees, shrubs, mountains, lakes, rivers, beaches, views, vistas, etc.) on man is of growing interest to a burgeoning group of researchers. A cross section of environmental psychologists and planners are exploring the idea of the landscape as a critically observed and essential part of societal well-being. Such intangible factors, associated with the landscape, bear an import equal to its physical image. Dominant among them are emotional responses and the psychological impact of the landscape.

While landscape assessment and valuation terminology, and scientific processes vary among researchers, the goals of such evaluations tend to be parallel: a desire to identify, inventory and analyze a variety of landscape components contributing to the human fascination with landscape.

Appleton, in "The Experience of Landscape", writes of the prospect and refuge in a contrived, man-influenced landscape. These two components are essential parts of the natural, undisturbed landscape and they play a dominant role in any endeavor to address a process of scenic vista protection and preservation.

The works of Stephen and Rachel Kaplan, noted environmental psychologists, use a different terminology to describe similar characteristics: they refer to the mystery of the landscape, researched through viewer valuations of a series of photographs reflecting landscapes of variety. In "The Green Experience", Rachel Kaplan describes preferences of viewing groups and proffers:

> " Out of the set of fifty-six slides, the ones that could be categorized as 'nature' were vastly preferred by the eighty-eight freshwomen participating in the study."

Kaplan describes an intangible perception of the opportunity to explore the landscape, to go beyond view: around a mountain, beyond the visual limit of a curving beach, along a path or road disappearing to the left or right beyond a cluster of trees. Mystery in the landscape serves an important purpose for it draws people into an immediate observation and strongly encourages a continued exploration of the landscape beyond the initial view. This mystery and the desire for exploration are important planning and design tools available for dealing with issues of scenic vista protection and preservation on the Southeast Peninsula.

Interestingly, Kaplan further relates that:

> " Particularly striking, perhaps is the importance of having nature 'near by' and yet the primary relationship is one of "appreciation" rather than 'use'."

This observation reinforces the assumption that visual quality of the natural landscape is of greater import than its actual use. The character, cleanliness, vistas, views and overall natural charm of a landscape are judged to be as important as the actual use of these natural amenities and, according to Kaplan, more so.

Kaplan's view is echoed across the disciplinary boundaries of landscape architecture, literature, and psychology and documents the value and necessity for landscape protection and preservation. Scenic vista protection and preservation is without question an appropriate action for the Southeast Peninsula of St. Kitts. Such an undertaking will ensure the delivery of a combined natural and man-made environment of the highest visual and functional quality.

2.0 THE VISUAL RESOURCES OF THE SOUTHEAST PENINSULA

2.1 Resources Identified

The primary objective of landscape protection and preservation efforts must be concern for scenic vistas. Scenic vistas will not exist without the landscape, and it is these land and water elements which are the resources of this study. Clearly, this part of the overall report is not intended to investigate specific scientific components which are addressed elsewhere. Rather, it evaluates them on the basis of their independent and interdependent visual values in the natural and man-made environment.

The existing physical resources of the Southeast Peninsula addressed under the Scenic Vista Protection, Preservation and Management Plan include:

* Salt Ponds
* Beaches
* Cliffs and Escarpments
* Guts
* Adjacent Waters
* Mountains
* Vegetation
* Main Southeast Peninsula Road

In addition, there are those elements to be introduced which will bear consideration in the development of the Scenic Vista Protection, Preservation and Management Plan. They include, but are not limited to, the following:

* Secondary Roads
* Overlooks - Vehicular and Pedestrian
* Buildings
* Parking
* Utilities

The location of proposed elements during the initial planning process and, ultimately, in construction will have critical visual impact on a changing Peninsula. The existing character of the Peninsula is the product of its inherent beauty created as the result of the juxtaposition of beach, vegetation, mountains, salt ponds, guts, cliffs and adjacent waters. As the primary attractions for tourism, these elements must be carefully and cautiously protected to maintain the Peninsula's outstanding visual character. Insensitive, haphazard, poorly designed, and ill-conceived land development will ensure the demise of the tourism industry it is intended to foster, and the destruction of the physical presence of the Southeast Peninsula will result. Further, the degradation of the surrounding waters will inevitably follow such development, and this interdependent natural system will cease to function, seriously impacting resources of the island nation.

The Scenic Vista Protection, Preservation and Management Plan serves as guide for the developmental process, because it recognizes the intrinsic value of all of the physical

340

components of the Peninsula which possess visual values, and considers each in equitable context. The parameters of impact are not weighted on an arbitrary basis. Rather, they are viewed in a contextual matrix assigning a value to each physical component based on quantity, quality, and distribution within a study area.

2.2 Resources Defined

The existing physical resources of the Peninsula have been identified, and in defining their physical limits we are able to address the means and the methodologies which the Plan requires and to deal with each of these components as elements of a Scenic Vista Protection, Preservation and Management Plan.

2.2.1 Salt Ponds

Salt Ponds are composed of relatively shallow seasonal waters, mud flats and marsh areas. They serve in varying degrees as habitat for a variety of wildlife, and function as sediment basins in collecting and filtering rainwater runoff from immediately adjacent upland areas. Their shape and character change seasonally, in accordance with variations in a number of contributing factors, but generally their total area on the Southeast Peninsula comprises between 400 and 500 acres.

Their changing form and character are a primary contribution to visual interest, which is as well reinforced by the wildlife activity occurring in and around them. While efforts to create littoral zone plantings along the shorelines of the Salt Ponds should be explored as these may increase both filtration of run-off and wildlife habitat and activity, thus increasing visual interest and quality, the seasonal changes in water level may render such an endeavor marginally successful. The Salt Ponds include:

1. North and South Friars Bay Salt Pond
2. Little Salt Pond
3. Great Salt Pond
4. Mosquito Bay Salt Pond
5. Cockleshell Bay Salt Pond
6. Major's Bay Salt Pond

2.2.2 Beaches

The beaches of the Southeast Peninsula undergo continuing change which is made a more critical issue as some of these beaches are not renewing by natural processes. Generally, the more exposed windward beaches are narrower and subject to greater erosion and instability than the leeward beaches. As a dominant element in a tropical, tourism-driven market, beaches are subject to great expectation and any natural and man-made stress imposed on their character will quickly negate their positive visual impact.

341

Appropriate protection of beaches thus is a primary concern to the Scenic Vista Protection, Preservation and Management Plan. The identified beaches include:

1. North Friar's Bay
2. South Friar's Bay
3. Canoe Bay
4. Sand Bank Bay
5. Mosquito Bay
6. Cockleshell Bay
7. Banana Bay
8. Major's Bay

2.2.3 Cliffs and Escarpments

These prominent features, identified geographically in the Geomorphological studies, are generally found along the faces of the mountains and in other dominant land masses along the coastlines of the Peninsula. They are rock features characterized by steep slopes and vertical faces, are highly susceptible to erosion and varying degrees of movement, and are a continuously linking visual element in the landscape.

2.2.4 Guts

Guts are found as continuous ravines along the faces of the mountains and lower meadows of the Peninsula. They have developed by functioning as courses carrying runoff to retention areas, including salt ponds, and to adjacent waters. In many instances their upper, more protected reaches are furnished with a canopy of native hardwoods.

2.2.5 Adjacent Waters

The waters surrounding the Peninsula are comprised of the Caribbean Sea and the Atlantic Ocean and, in immediate proximity to the shore, by a number of bays. The range of color of these water bodies when viewed particularly from higher elevations coupled with the almost limitless variety of shoreline characteristics, render these water features a significant element in the development of the Scenic Vista Protection, Preservation and Management Plan.

2.2.6 Mountains

The mountains of the Peninsula assume a primary role in defining major vistas and views, as it is from these vantage points along the Main Southeast Peninsula Road that the visitor is first able to view the intriguing and varied Peninsula landscape. This course of access offers not only the most impressive visual experience, but permits a

- 342

continuing physical orientation with the landscape as it is traversed, through visual notation or 'mapping' of landmark points along or adjacent to the main road. Mountains of the Peninsula include:

1. Sir Timothy's Hill
2. St. Anthony's Peak
3. Long Hill
4. Rock Hill
5. Sugar Loaf Hill
6. Salt Pond Hill

2.2.7 Vegetation

The vegetation of the Peninsula considered for this presentation solely on the basis of its visual impact can be generally defined as occurring in six distinct but very general categories subject, however, to more detailed inventory and mapping:

1. Upper ranges of mountains
2. Native hardwood tree canopy at upper reaches of guts
3. Steep and medium slope scrub vegetation
4. Grasses
5. Mangroves
6. Beach vegetation, including coconut palms

Each vegetative group possesses a certain intrinsic visual value based on its form, texture, color, and massing. In addition, the landmark quality (what it precisely represents to the viewer or user) is the result of combining its intrinsic visual value with its locational value: coconut palms on the beach would present the 'tropical paradise' image while in plantation groves as found along the north shore of St. Kitts they provide a more agricultural image. Thus, each of the six vegetative categories identified possesses a significant and independent visual value.

2.2.8 Main Southeast Peninsula Road

The road traverses the Peninsula on its longitudinal axis, generally along the ridge line of the mountains and centrally along the lower areas, until it reaches the Great Salt Pond, where it swings easterly around the Pond, continuing to Major's Bay.

The location provides an opportunity to view the surrounding landscape, though parts of that landscape including some of its beaches, salt ponds, bays, escarpments, and upper reaches of its guts are only marginally visible. These views, vistas and glimpse contribute to the mystery, prospect and refuge of the Peninsula and render a dynamic and varied visual object.

Proposed along the route of the Main Road are a series of six major vehicular oriented overlooks, three offering views of the Atlantic Ocean side, one offering views of the Caribbean side, one located on Sir Timothy's Hill, and one at White House Bay providing a panorama of the southern end of the Peninsula from the Atlantic Ocean to the Caribbean Sea. The road construction firm has also built outlooks at other points.

3.0 MANAGEMENT ALTERNATIVES

3.1 Identifying and Evaluating Resource Combinations

The visual value of areas of the Peninsula increases in direct proportion to the number of identified visual resources within that area, the quantity of each of those resources (number or massing of trees, area and variety of beach, variety of adjacent water bodies, size and scale of escarpments), and the quality of those resources, and their relationship one to another.

The potential visual value of an area in an undisturbed state or following development, should be based on a system assigning relative ratings to natural features within defined geographic areas. Before such a system of evaluation is determined, however, we must recognize that there exist two physical levels of the Peninsula which require visual evaluation.

The first, or Government level, addresses visual issues related to the overall Peninsula which generally include, but are not necessarily limited, to the following three areas of concern:

1. Public overlooks adjacent to the main Peninsula road;
2. Vistas and views which encompass adjacent waters;
3. Vistas and views which include the geographic domain of more than one property owner.

The task of evaluation at the first level rests with the Government and must address the overall image and visual continuity of the Peninsula. Defining appropriate methods for preservation and protection of the natural environment is particularly essential to ensure the homogeneous visual and physical development of the Peninsula.

The second, or Developer level, addresses visual issues of concern to a single or multiphase development under one ownership or interest the primary impact of which may be within that geographic setting, but which also possesses existing or potential interrelationships with other parcels which may not be addressed in visual evaluation at the Government level. This second level process addresses the more detailed evaluations of natural feature combinations, and at a more intimate scale.

3.1.1 The Government's Responsibility

It is the broader responsibility of the Government to encourage, monitor, and guide sound development responsive not only to economic concerns but to visual factors as well, which must be founded in a sound valuation process considering the entire Peninsula and all of its unique and diverse features. While any one parcel of developable land within the Peninsula may possess only limited visual diversity and the task of evaluation is simple, the combination of natural features of all parcels comprising the Peninsula is extraordinarily diverse.

The process of evaluation established by the Forest Service of the United States Department of Agriculture has been proved over time to be orderly, sensitive and effective in dealing with those precise issues of valuation which must be addressed by the Government in the Southeast Peninsula, and it is consequently the recommendation of this report that the Government adopt this proven methodology in administering its overview responsibility.

As discussed earlier, visitors to new locales have an image of what they expect to see. In addition, these visitors possess a level of aesthetic concern which they assume will be satisfied in some measure by their anticipated experience. Coupled with these human expectations, the U.S. Forest Service identifies three dominant physical characteristics which contribute more than any others to unique visual quality: they comprise a trinity of visual assessment and include the **diversity of the landscape, the presence of water,** and **the distance of views and vistas.** Clearly, the Peninsula possesses all three.

The existing physical resources (salt ponds, beaches, cliffs and escarpments, guts, adjacent waters, mountains, vegetation and the Main Southeast Peninsula Road) independently and in combination create **the characteristic landscape, the distance zones,** and **the dominance elements.** Coupled with management activities, these factors define the variety classes identified in the U.S. Forest Service publication "National Forest Landscape Management".

3.1.2 Landscape Management

"Landscape Management determines those landscapes which are most important and those that are of lesser value from the standpoint of scenic quality. This classification is. based on the premise that all landscapes have some value, but those with the most variety or diversity have the greatest potential for high scenic value. There are three variety classes which identify the scenic quality of the natural landscape:

3.1.2.1 Class A Distinctive

Those areas where features of landform, vegetative patterns, water forms and rock formations are of unusual or outstanding visual quality. They are usually not common in the character type.

3.1.2.2 Class B Common

Those areas where features contain variety in form, line, color, and texture or combinations thereof but which tend to be common throughout the character type and are not outstanding in visual quality.

3.1.2.3 Class C Minimal

Those areas whose features have little change in form, line, color, or texture. Includes all areas not found under Classes A and B."

A potential matrix by which to evaluate the variety classes of the Peninsula, should be structured as follows:

Feature	Class A Distinctive	Class B Common	Class C Minimum
Salt ponds	Over 10 acres. Those smaller than 10 acres with one of the following: (a) unusual shoreline (b) islands (c) reflects features	5 to 10 acres. Some shoreline irregularity. Minor feature reflection.	0 to 5 acres. No shoreline irregularity. No feature reflection.
Beaches	At least 100' in width and 300' in length with one of the following: (a) vegetated dunes (b) irregular shoreline (c) adjacent cliffs and escarpments.	From 50' to 100' in width and less than 300' in length. Minor dune structure, irregularities in shoreline and presence of cliffs and escarpments.	Less than 50' in width and less than 200' in length. No dune structure, few irregularities in shoreline, no presence of cliffs and and escarpments.
Cliffs and Escarpments	20' or higher vertical face and minimum with (a) plant outcrops and/or (b) veneer variegation.	10' to 20'vertical face and and length of 50' to 100' with few plant crops and minimal veneer variegation.	Less than 10' vertical face and length of___ with no with no plant outcrops and minimal to no veneer variegation.
Guts	In excess of 30' in depth and 100' in width at the crown, with (a) native hardwood tree canopy (b) varied understory.	From 20' to 30'in depth and 80' in width at the crown with some native hardwood tree canopy and slightly varied understory.	From 10' to 20' in depth and less than 80' in width at the crown, with no native hardwood tree and with singular understory.
Adjacent Waters	Bays to 100 acres, enframed by vegetation or landform.	Bays from 100 to 300 acres partially enframed.	Open waters not enframed.
Mountains	Over 60% slopes dissected, uneven, with rock outcrops, or large dominant features.	30% to 60% slopes which are slopes which are somewhat dissected or rolling.	0% to 30% slopes which have little variety. No dissection nor dominant features.
Vegetation	High degree of pattern in vegetation.	Continuous vegetative cover with interspersed patterns.	Continuous vegetative cover with little or no pattern.
Main Road	Mountain promontories. and slopes.	Mid-reaches of elevation	Lowland, level range.

By plotting each variety class for each feature, a composite map reflecting variable values for existing physical features of the Peninsula is produced.

347

A similar process, applied to sensitivity levels and quality objectives, will ensure that the Government has addressed paramount issues of visual quality for the Peninsula. Sensitivity levels generally are a measure of people's concern for scenic quality and are determined by those who:

1. Travel on developed roads of the Peninsula, and
2. Use tourist accommodations and visitor centers, and
3. Are recreating on beaches and adjacent waters.

Addressed in a matrix, they would be viewed as follows:

	Primary Importance	Secondary Importance
Travel Route	National significance High use volume Long use duration Peninsula road	Local significance Low use volume Short use duration Project roads
Use Areas	National significance High use volume Long use duration Large size	Local Significance Low use volume Short use duration Small size
Water Bodies	National significance High fishing use High boating use High swimming use	Local significance Low fishing use Low boating use Low swimming use

Quality objectives are those whose measurement will allow for the visual management of the landscape in response to diversity of natural features (variety classes) and scenic quality (sensitivity levels) and are 'represented by five terms which can be defined as visual resource management goals'. They each describe a 'different degree of acceptable alteration of the natural landscape based upon the importance of aesthetics which is measured in terms of visual contrast with the surrounding natural landscape.

Preservation: Allows ecological changes only; management activities of any type are prohibited.

Retention: Allows management activities not visually evident which parallel the form, texture, color and line of the characteristic landscape.

Partial Retention: Activities which remain visually subordinate to the characteristic landscape while introducing changes in their qualities of size, amount, intensity, direction, pattern, etc.

Modification: Visual quality management activities may visually dominate the original characteristic landscape.

Maximum Modification: Management activities of vegetative and landform alterations which dominate the characteristic landscape. As background the visual characteristics must be those of natural occurrences and, as

349

foreground or middle ground, they may not appear to completely borrow from naturally established form, line, color or texture.'

Unacceptable activities which would be considered excessive modification would include one or more of the following:

1. Size of activities is excessively or poorly related to scale of landform or vegetative patterns in characteristic landscape.

   Example: Building masses are linear rather than in clusters, not relating to vegetative masses or unique landforms.

2. Overall extent of management activities is excessive.

   Example: A series of cuts for construction pads which do not feather acceptably nor appropriately to surrounding existing grades.

3. Activities or facilities that contrast in form, line, color, or texture are excessive. All dominance elements in the management activity are visually unrelated to those in the characteristic landscape.

   Example: Power line clearing producing a clearcut unrelated to the characteristic landscape.

In addition, the concept of rehabilitation must also be considered, particularly for portions of the Main Southeast Peninsula Road. This rehabilitation should be used to restore landscapes containing undesirable visual impacts to a desired visual quality, and should include the following activities:

1. Vegetative alternatives to eliminate obtrusive edges, shapes, patterns, colors, etc.

2. Terrain alterations to blend better with natural slopes.

3. Revegetation of cut and fill slopes.

4. Alteration, concealment, or removal of construction debris.

The plotting on Peninsula base sheets of a variety class map and a sensitivity level map will create a composite map of visual quality objectives. This document is most appropriate to govern developmental activities in areas of the Peninsula with overlooks, adjacent waters, or under the control of more than one property owner.

-219

3.1.3 The Developer's Responsibility

A series of suitability maps should be prepared by the developer, recording the geographical limits of an existing physical resource, such as salt ponds, beaches, cliffs and escarpments, guts, adjacent waters, mountains, and vegetation within a defined geographical area. Each factor suitability map would then be rated. For example, the vegetation factor suitability map would indicate area limits of a variety of vegetation including perhaps coconut palms, sea oxeye daisy, mangroves, seagrape, railroad vine, buttonwood, Australian pine and other groups of vegetative cover. Each would be assigned a relative value on the basis of its visual impact, quantity, and quality. For example, the visual value and impact to the beach setting of a cluster of 60 coconut palms, of excellent health and varied height and form with an understory of seagrape, would logically be judged of greater value than a cluster of seven, twenty-foot Australian pines with no understory. By assigning such values to factor suitability maps (see illustrations, page 15), we are able to proceed in an objective manner to evaluate and rate what are otherwise viewed as esoteric judgments. What we thus observe is that the degree of diversity of the natural landscape contributes not only to its intrinsic beauty, but also to our ability to execute a visual evaluation of that landscape in an orderly manner.

The illustrations on page 15, conceptualized for the South Friar's Bay recreation area, address only three of the numerous potential factors suitable for evaluation: vegetation, beach, and cliffs and escarpments. A brief explanation of the ratings in each suitability map will aid in understanding the overall process. Note that the most valuable resource receives the highest rating.

3.1.4 Vegetation

The vegetation atop the north and south escarpments is generally nondescript: no vegetation in these areas is particularly striking, and that which does exist neither provides a sense of scale nor does it necessarily contribute to an expected tropical setting. Similarly, the stand of mixed vegetation on the flats behind the dune is somewhat uniform with no outstanding characteristic. The items rated level 2 are Mangroves located adjacent to the fringe of the salt pond. They are considered of higher scenic value for their uniquely tropical sculptural quality and their utilization by a variety of wildlife, particularly birds. The two areas rated level 3 are clusters of Coconut Palms, which inherently establish a tropical ambiance expected by tourists. Their relationship to the beach reinforces this image, and they are considered the most critical visual element among the vegetative types identified.

3.1.5 Beach

The two areas receiving a rating of 1 are a linear dune at the back edge of the beach, beneath the larger stand of coconut palms, and portions of the west faces of the north and south escarpments where they meet the water. Both features are remote from initial

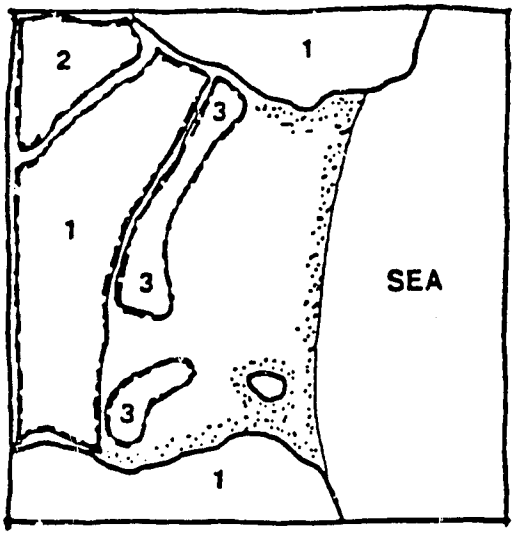
viewing. Of greater visual value are those areas receiving a rating of 2: a butte toward the north end of the beach and visible points at which the north and south escarpments meet the beach: the diversity here is greater than level 1 features. The highest rating, a 3, is assigned to the waters edge, not because of greater diversity, but due to the traditional tourism image of a strong connection between sand beach and water oriented recreational activities: this is the essence of the tropical vacation experience.

3.1.6 Cliffs and Escarpments

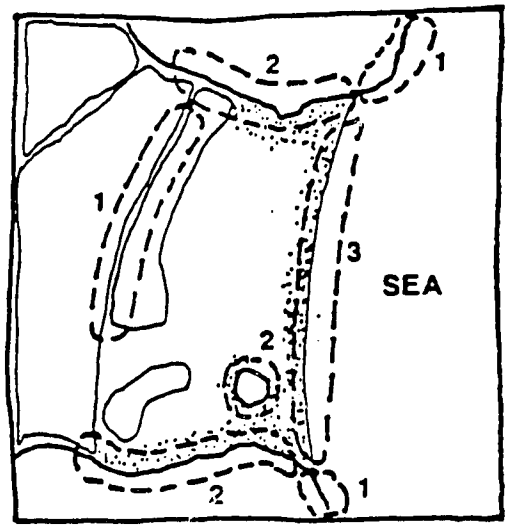
The most visible and dramatic portions of the north and south escarpments are awarded a level of 3. These escarpments are eroded, revealing fascinating geomorphologic patterning, some of the upper reaches are cantilevered over the beach due to erosion, and many nooks and crannies in the faces exist. Those portions allocated a rating of 2 are not as dramatic nor quite as visible from a distance as those previously described. The area receiving a rating of 1, while of interest, is less accessible to immediate observation.

Following the allocation of ratings to the various Factor Suitability Maps on the basis of the judgments described above, a Composite Map is prepared. For each sector of this map - the more sectors into which the composite map is divided, the more precise and accurate and thus reliable the composite ratings - the rating is taken from each of the three Factor Suitability Maps and totaled, providing a rating or value of scenic quality for that sector (in instances where two ratings from the same FSM fall within a sector, only the higher rating is used). The conceptual example illustrated on page 15 provides a range of total rating from a high of 8 to a low of 2: thus, it could be assumed that the sector with the value of 8 is of highest scenic value and the area receiving 2 (or less) holds the least scenic value.

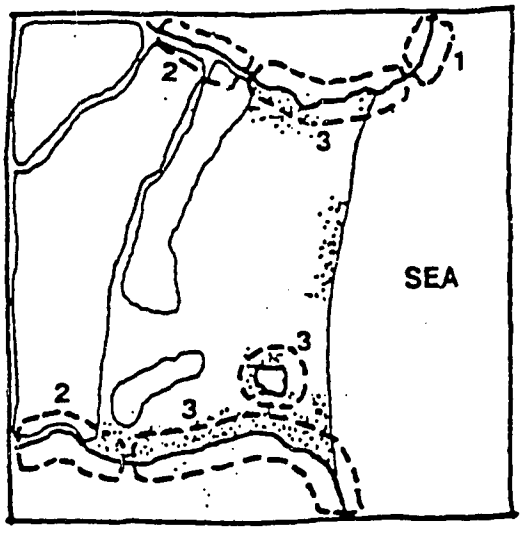
By implementing this simple methodology, a sound basis for scenic evaluations within proposed development areas is established. When coupled with similar valuations from other areas of study identified in this report (slope stability and soil percolation as examples) a highly reliable data base responsive to the broad range of natural factors of the Peninsula will exist to govern development.



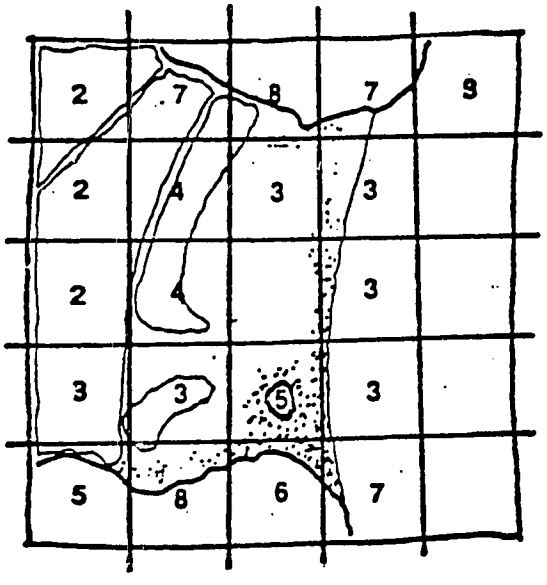
VEGETATION



BEACH



CLIFFS and ESCARPMENTS



COMPOSITE

Conceptual Factor Suitability Maps

Linear Combination Method / South Friar's Bay

4.0 SUMMARY AND RECOMMENDATIONS

The imposition of man-made features requires careful planning, design and implementation, to ensure that their maximum visual compatibility with existing natural features has been identified. They generally include:

4.1 Secondary Roads

Roads other than the Main Peninsula Road providing vehicular access for private, taxi, bus, and service vehicles.

4.1.1 Overlooks

Locations of observation overlooks both along the Government-owned Peninsula Road and on privately owned lands.

4.1.2 Buildings

Recreation facilities, including courts, pools, pool decks, promenades and structures; restaurants; shops; condominium units including detached units; duplex, triplex and quadriplex units; apartments, including one to four-story structures; service buildings; garages; public buildings, including police, fire and emergency services, and schools; marinas and supporting facilities.

4.1.3 Parking

Parking of rental, service, bus, and privately owned vehicles, both short and longer term.

4.1.4 Utilities

Including power lines above and below grade; transformers and other on-grade structures such as lift and pumping stations; fuel storage; cooking gas tanks; sanitary waste lines and facilities; water lines; trash and refuse.

4.2 Recommended Design Controls

4.2.1 Secondary Roads

1. One way traffic: 14'0" in width
   1' shoulder first side

3' shoulder second side
18'0" maximum clear and grade

2. Two way traffic: 24'0" in width
3' shoulder each side
27' maximum clear and grade

3. Pavement:
For roads perpendicular to contours, cross slope at option of designers to drainage structures.

4. Pavement:
For roads parallel to contours, cross slope inside edge of pavement to drainage structures.

5. Stabilize, mulch and plant as necessary all cleared land areas for roads which are not paved, to return to natural visual state.

6. For roadway lighting, provide post lights to maximum overall height of 14', or bollard lights to maximum height of 36", with deflectors.

7. Provide approximately every 200' on one way roads and approximately 400' on two way roads, vehicle pull-off areas approximately 25' in length and 10' in width, and pave in a pervious material (not asphalt or concrete). On roads parallel to contours, provide pull-off areas on inside edge of pavement.

8. Where feasible and conducive with existing landscape, provide irregularly shaped uncurbed medians of native vegetation within two way roads and at intersections.

9. Where possible, intersect roads at right angles to avoid extensive clearcuts for line of sight.

4.2.2 Overlooks

1. Vehicular:
Provide six overlooks along the main Peninsula Road. Additional overlooks accommodating tourism interests may be desired.

2. Provide for a minimum two vehicles and a maximum of five vehicles. Dimensions should be approximately 30' in depth and 60' in width.

3. Provide seating oriented toward vistas and views, preferably of a material which will not retain dampness (fiberglass, metal mesh).

354

4. Provide orientation maps (silkscreen on color plexiglass is most suitable for necessary detail) indicating points of interest including mountains, salt ponds, escarpments, beaches and bays, and historical, flora and fauna data.

5. Pedestrian:
Provide small overlooks along hiking trails, to include space to accommodate six people.

4.2.3 Buildings

1. Structures should not exceed four stories in height from averaged finished grade at perimeter of base of the building.

2. Buildings may not project above any actual or imagined ridge line of any mountain (as viewed from the six main Peninsula Road overlooks).

3. To establish a landmark quality building, elements such as bell, clock, or observation towers shall be utilized. Such elements should not exceed five stories in height.

4. Buildings should be located in clusters and follow the convex and concave faces of the mountains. In no instance shall there be any building footprints in a reserve area measured a distance of 350' downward from the crown of ridge of each mountain or mountains and described by an imaginary perimeter line plotted on a site map.

5. Buildings should not exceed 150' in length and 60' in width, and recesses, openings, breezeways and height variations shall be utilized to minimize mass.

6. Building pads shall be designed to balance cut and fill as nearly as possible, while causing the minimum disturbance necessary to the surrounding natural landscape. Preference shall be given to cutting into slopes for necessary building pads over the placement of new fill beyond existing slope lines.

7. Contain all rainwater runoff in drainage structures to prevent erosion.

8. Protect all sensitive landscape elements during construction by placement of 6' high chainlink protective fencing in a perimeter at least 10' away from outer limits of the feature.

9. Maintain clean construction sites and dispose of debris properly. Do not deposit construction or other debris in excavated "burying pits" on the Peninsula.

4.2.4 Parking

1. Parking spaces should be clustered in maximum counts of 20 to 30 vehicles, and shall be screened with a minimum 15' wide planted buffer on all sides.

2. Suitable parking spaces for rental, bus and service vehicles should also be provided, again separated by a minimum 15' wide planted buffer on all sides.

3. Parking areas should be lighted, utilizing fixtures similar to roadway lighting.

4. Contain all rainwater runoff in drainage structures to prevent erosion.

5. Clear only 10' beyond limits of pavement on all sides of proposed parking areas and, on completion of work, restore landscape to natural condition through use of native vegetation.

4.2.5 Utilities

1. Install all site underground utilities within a single clearcut, with a maximum width of 15' and a minimum width of 7'.

2. Utility clear cuts shall be random and irregular in form, and designed to work in harmony with existing grades and natural landscape features. Careful mapping and design of said installations shall be undertaken with utmost care, and a pre-evaluation of the route for said utilities shall be completed for Government review and approval.

3. All utility clear cuts shall be revegetated with native species.

4. A 25' wide densely planted native plant buffer shall be maintained around all surface utility structures such as lift stations, pumping stations, and trash collection stations.

5. All electrical, cable TV and other distribution lines within developments shall be underground, and TV dishes shall be properly buffered and screened by a 25' wide native plant buffer.

4.2.6 General

1. Setbacks of all buildings from natural water features, beaches, escarpments, and gut hardwood vegetation shall be a minimum of 75'.

2. Use of sensitive or fragile natural areas, as defined in other portions of this report, shall occur only with proper precaution (boardwalks, elevated observation decks, etc.).

356

5.0 REFERENCES

Appleton, Jay. 1986. The Experience of Landscape. Hull: Hull University Press.

Battelle Memorial Institute. 1971. Design of an Environmental Evaluation System. Springfield, Virginia: NTIS, PB 201 743.

Higuchi, Tadahiko. 1973. The Visual and Spatial Structure of Landscapes. Cambridge: The MIT Press, 1983.

Hopkins, Lewis D. 1977. "Methods for Generating Land Stability Maps: A Comparative Evaluation". Journal of AIP, October, 386-400.

Jakle, John A. 1987. The Visual Elements of Landscape. Amherst: The University of Massachusetts Press.

Kaplan, Stephen and Kaplan, Rachel. 1982. Cognition and Environment. New York: Praeger Scientific. Humanscape. Ann Arbor: Ulrich's Books, Inc.

Lyle, John and von Wodtke, Mark. 1974. "An Information System for Environmental Planning" Journal of AIP, 40, 6: 394-413.

McAllister, Donald M. 1980. Evaluation in Environmental Planning Cambridge: The MIT Press.

McHarg, Ian L. 1969. Design With Nature. New York City: Natural History Press.

Preiser, Wolfgang F.E., ed. 1973. Environmental Design Research. Volume Two: Symposia and Workshops. Stroudsburg: Dowden, Hutchinson & Ross, Inc.

Steinitz, Carl, et al. 1977. Visual Resource Evaluation. Soil Conservation Service, Lisle, Illinois.

U.S. Forest Service. 1974. National Forest Landscape Management: The Visual Management System. Department of Agriculture, Handbook 462. Washington, D.C.

U.S. Department of Transportation Federal Highway Administration. 1976-79. Visual Impact Assessment for Highway Projects. American Society of Landscape Architects.

Ward, Wesley S. and Grant, Donald P. 1971. "A Computer Aided Space Allocation Technique" In 'Proceedings of the Kentucky Workshop on Computer Applications in Environmental Design'. Edited by Michael Kennedy. Lexington: University of Kentucky.

APPENDIX 1 TECHNICAL GLOSSARY

CHARACTERISTIC LANDSCAPE	A naturally-established landscape within a scene or scenes, being viewed.
DESCRIPTIVE CONTEXT	Verbal or graphic descriptions implemented to explain the relationship between one or more landscape features.
DISTANCE ZONES	Areas of landscape denoted by specific distances from viewer including generally foreground, middleground, and background.
DOMINANCE ELEMENTS	Includes form, line, color and texture which are recognizable visual parts comprising the characteristic landscape.
ENGLISH NATURAL GARDENS	Gardens of the approximate period from 1730 (Bridgeman) to 1790 (Brown), reflecting and encompassing natural landform/landscape characteristics.
INTRINSIC VISUAL VALUE	The visual character held or possessed by an object or objects within the landscape.
LANDMARK POINTS	Special memorable physical features in the landscape such as a bluff, dune, or cluster of unique vegetation.
LANDMARK QUALITY	What something viewed represents to the viewer.
LANDSCAPE MYSTERY	Intangible perception that there is the opportunity to explore that part of the landscape which lies beyond initial observation.
LINEAR COMBINATION	A rating system which assigns a value to various landscape resources based upon their level of character. A weighting multiplier, responding to the relational value of the several resources, is established by which these ratings are further defined. (Note that the graphic example preceding page 29 has not been weighted.)
LOCATIONAL VALUE	Physical setting of an object or objects within a descriptive context.
NATURAL LANDSCAPE	A term implying a land area untouched by man.
PROSPECT	An unimpeded opportunity in the landscape to view or observe.

QUALITY OBJECTIVES	Measurable standards for the visual management of the landscape.
REFUGE	An opportunity to observe in the landscape without being seen by that observed: the opportunity to study, unrestricted by intrusion.
RESOURCE COMBINATIONS	The combination of two or more identified visual resources: for example, dune and escarpment, or vegetative stand and water.
SENSITIVITY LEVELS	Degree or measure of viewer interest in the scenic qualities of the landscape.
VARIETY CLASS	Particular level of visual variety or diversity of landscape character.
VISUAL	A mental image obtained by sight.
VISUAL NOTATION/ VISUAL MAPPING	Visual recognition and inventory of landscape features, either independently or as resource combinations.
VISUAL VALUE	Specific relative numerical values assigned to a variety of physical resources, each such value based upon the quantity, level of character, and relational setting of that being valued.

359

PN-ABE-181

The Southeast Peninsula Project in St. Kitts

Volume II: Constraints and Opportunities--A Synthesis of the Planning Process

DESFIL

Development Strategies for Fragile Lands

624 9th Street, N.W., 6th Floor, Washington, D.C. 20001

Development Alternatives, Inc.
Tropical Research and Development, Inc.

in association with:

Earth Satellite Corporation
Social Consultants International

460

VOLUME II
CONSTRAINTS AND OPPORTUNITIES:

A Synthesis of the Planning Process for the Southeast Peninsula, St. Kitts/Nevis

by

Mark T. Brown, Ph.D., Senior Editor

June 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

361

TABLE OF CONTENTS

1.0 INTRODUCTION 1
- 1.1 SEP Goals and Objectives 1
  - 1.1.1 Goals and Objectives 2
- 1.2 Data Collection and Synthesis 3

2.0 SYNTHESIS: RESOURCE MANAGEMENT PLANS 4
- 2.1 Terrestrial Resources Management Plan 4
- 2.2 Forestry Resources Management Plan 5
- 2.3 Wildlife Resources Management Plan: Shorebirds 5
- 2.4 Wildlife Resources Management Plan: Mammals 6
- 2.5 Wildlife Resources Management Plan: Sea Turtles 7
- 2.6 Marine Resources Management Plan 7
- 2.7 Natural Resources Management Plan: Stormwater, Wastewater and Solid Waste Management 8
- 2.8 Geodynamics, Land Stability, Earth Resources and Management Considerations 9
- 2.9 Morphodynamics, Sediment Characteristics, and Management Considerations 10
- 2.10 Prospects for Marina Development 10
- 2.11 Scenic Vista Protection, Preservation and Management Plan 11
- 2.12 Summary: Resource Management Plans 11

3.0 SYNTHESIS: CONSTRAINTS AND OPPORTUNITIES 13

4.0 PLAN GENERATION 14
- 4.1 The Regulatory Framework 14
- 4.2 The Future Land Use Map 14
- 4.3 Land Development Intensity Districts 15
- 4.4 Overlay Districts 18
- 4.5 Summary: Plan Generation 19

362

1.0 INTRODUCTION

Planning begins with a desire to control the future, is driven by articulated goals and objectives, and sustained by a process of information gathering and synthesis. In its most general sense, planning controls the future. Through the process of making visible the goals of the community, analyzing alternative futures, collecting all relevant information, and developing a course of action, a plan has the ability to organize present actions to achieve desired goals.

Most often, when change is a dominant aspect of the present and foreseeable future, there is greater desire for more control over how things change, in what direction things will head, and what form things will have at some future time. To accomplish some measure of control over change requires a careful analysis of possible futures and then selective decision-making regarding which are most acceptable and which are unacceptable; in other words, an articulation of acceptable goals. Once desirable goals are understood and articulated, the next steps in the process are as follows: (1) gather relevant information about that which is the subject of the planning effort, (2) organize the information into some coherent package, (3) sift through the information to determine the most important parts, (4) use the most relevant and important information to develop an understanding of the constraints and opportunities related to the subject, and (5) develop a "plan" that reflects what is known about all aspects of the question, and that if followed will achieve the stated goals and objectives.

The exact future of the Southeast Peninsula is uncertain; however, there is no question that its present relatively undeveloped status will change once the road is completed. Planning for the future and controlling the direction that development takes and ultimately the final form of development on the SEP is the subject of this document and the studies upon which it is based. They are an outgrowth of a concern expressed by citizens and public officials of St. Kitts/Nevis. Of primary concern is the protection of environmental resources and the health, welfare and safety of the population. With proper planning and the adoption of a regulatory framework that has the potential to control the shape and direction of development on the SEP, the future may be known and acceptable.

1.1 SEP Goals and Objectives

The process of developing the set of planning documents for the Southeast Peninsula followed the general outline of: (1) goal articulation, (2) data collection and synthesis, and (3) plan generation. Earlier work by the Islands Resources Foundation, and the Chief of Party for the project established general goals and objectives, and combined with site visits and interviews conducted by the author, Greg Morris, and Earl Starnes on various occasions, a final list of goals and objectives were articulated. The final goals and objectives were made a part of the Proposed Land Use Management Plan (PLUMP) that is the second part of this volume, and are restated here as follows:

363

1.1.1 Goals and Objectives

1. The SEP Board recognizes that the SEP has unique environmental resources, the conservation of which is essential to maintain the natural diversity of plant and animal species and habitat, including those of economic value such as commercial and sport fisheries.

2. The SEP Board recognizes that to maximize tourism and related development opportunities, it is critical to create a secure, safe and aesthetically pleasing land management and community environment; and is critical to minimize damage to structures by natural events such as hurricanes.

3. The SEP Board adopts the following goals for the PLUMP and the Handbook of Development Guidelines and Considerations for the Southeast Peninsula (HDGCSP).

   a. It is the goal of the SEP Board to adopt, amend as appropriate, and annually review the PLUMP, to monitor and evaluate the progress of land development and environmental protection of the SEP and to enforce the provisions of the PLUMP during the planning period of the next twenty years following the PLUMP adoption.

   b. It is the goal of the SEP Board to achieve the development of the SEP that promotes the economic and social welfare of present and future populations and visitors of St. Kitts by means of conservative and judicious utilization of the irreplaceable natural resources of the SEP.

   c. It is the goal of the SEP Board to guide development in a manner that preserves the environmental integrity, species diversity and scenic quality of the SEP, and to promote development patterns that avoid areas of natural hazard, and to minimize costs and maintenance of public facilities and infrastructure requirements.

In addition to these three goals, the planning team recognized nine objectives that it felt were important to achieve sustainable and environmentally compatible development of the SEP. These objectives were the driving force behind the analysis of the SEP resources, development of the Resource Management Plans (RMP), analysis of fiscal impacts of development, and ultimately the formation of the PLUMP and HDGCSP. The objectives are summarized as follows:

1. Establish resource protection districts
2. Establish marine resource protection districts
3. Create development patterns that protect scenic vistas and aesthetic quality and that are consistent with historic architectural traditions.
4. Plan for and provide proper level and timely public facilities and services.

264

5. Establish policies and regulations to minimize potential damage to property and life resulting from natural hazards.
6. Maximize positive economic and social benefits of development and integrate within national socio-economic interests.
7. Balance land management and environmental protection with accommodation of vested rights of landowners and citizens.
8. Monitor, evaluate, and change PLUMP and HDGCSP as needed.
9. Develop procedures and assist the Minister in administration of laws regarding land development and environmental protection of the SEP.

1.2 Data Collection and Synthesis

Articulation of goals and objectives determined what aspects of the SEP were most important. To develop a regulatory framework that would achieve resource protection and maximize development potential at the same time, it was necessary to develop an overview of the various physical and biological components and processes that were characteristic of the SEP. Analysis was undertaken to document the existing condition and characteristics of terrestrial resources (including forest and wildlife resources), marine resources (including fisheries and turtles), and the physical environment related to geodynamics and land stability, as well as morphodynamics and sediment characteristics of beaches. In addition to these studies of the biological and physical environment, an analysis of the scenic qualities of the SEP was undertaken and potentials for marina development were explored. Two other supporting studies related to the analysis of fiscal impacts of development and trends in Caribbean tourism were completed to aid in analysis of the sustainability of SEP development.

Resource studies culminated in Resource Management Plans. These reports documented the characteristics and condition of the various resources and most importantly suggested management alternatives for effective resource protection. These reports are included in Volume I of the three-volume SEP Planning Document series. Characteristics of each resource and the recommendations made concerning their protection became the basis for constraints and opportunities for development of the SEP. In the following sections, each Resource Management Plan is summarized and the most important issues and management recommendations are given as a means of developing a synthesis.

365

2.0 SYNTHESIS: RESOURCE MANAGEMENT PLANS

Six Resource Management Plans relating to the terrestrial and marine resources of the SEP were compiled and written by a team of scientists and planners and are given as Volume 1. They covered terrestrial ecological resources, forestry resources, wildlife resources, and marine resources. Several studies of the physical characteristics of the SEP including waste and stormwater management, geodynamics and land stability, beach characteristics, suitability for marina development, and scenic qualities were also conducted.

In the sections that follow the main issues relating to the different resources are summarized and then general recommendations are also summarized. The information presented for each resource management plan is a very broad summary in very general terms of relatively detailed discussions of the issues and recommendations contained in the original RMPs. To better understand the sensitivity of the resources and their management, the reader is referred to the technical documents contained in Volume I. These summaries serve only as a most general synthesis to these more complex and lengthy documents.

2.1 Terrestrial Resources Management Plan

ISSUE 1:
The value of natural lands to tourist economies is increasingly recognized as more travelers seek out destinations that have not become overly developed. Natural lands that are treated as an integral part of a tourist development plan become a no-cost, self-sustaining amenity that has the potential to increase total number of tourists, number of tourist days, and ultimately, total revenues received.

ISSUE 2:
Fragmented landscapes that result from uncontrolled development soon lose their natural character and their habitat value for wildlife. When previously undeveloped lands are developed, the opportunity exists to plan for and incorporate large segments of natural areas (termed "wildlands") into the development pattern and thus preserve their habitat value and give the developed landscape a balance of developed and undeveloped lands.

Recommendations:

1. Preserve best quality natural ecological communities
2. Control development to minimize impacts on vegetation by clustering development.
3. Develop a system of "wildlands" and interconnecting wildlife corridors that also serve as the basis for foot and bridle paths.
4. Develop educational materials for Kittitians and visitors describing the terrestrial resources of the SEP.
5. Develop construction guidelines that will control and minimize negative impacts from sedimentation resulting from inappropriate cuts and fills and land clearing.
6. Consider prohibitions against grazing of livestock within the confines of the SEP.

2.2 Forestry Resources Management Plan

ISSUE 1:
The forest resources of the SEP represent a unique assemblage of species not found elsewhere on St. Kitts. Their value as scenic quality and wildlife habitat should be considered and weighed against their value once developed. Protection of the forest resources of the SEP will enhance the visual qualities of the landscape and encourage ecologically oriented tourism.

ISSUE 2:
The introduction of Guinea grass and livestock grazing has increased the decline of the quality and extent of the dry forests on the SEP. Control of the spread of Guinea grass and fire is most desirable to preserve the spatial extent of forests. Control of livestock grazing will help in preservation of remaining forests and the regeneration of existing forests.

Recommendations:

1. Protect the remaining stands and groves of large trees.
2. Prohibit cutting of trees greater than 12" diameter at breast height (DBH) and all gum trees.
3. Prohibit development of guts and immediately adjacent areas.
4. Minimize cuts and fills associated with access roadway construction, revegetate all cuts and fills with appropriate ground cover.
5. Control burning throughout the SEP and establish fire and wind breaks as part of development plans and remove Guinea grass surrounding buildings to protect life and property.
6. Encourage acceptable landscaping in all developed areas with species adapted to the soils and xeric conditions of the SEP.
7. Protect wildlife and control the grazing of livestock on the SEP.

2.3 Wildlife Resources Management Plan: Shorebirds

ISSUE 1:
The SEP is unique in the Lesser Antilles. No other island has the type of topography where a large area of wilderness and remoteness has remained relatively undeveloped late into the 20th century. The shorebird resources of the SEP are of two types: resident and migratory. Although somewhat depleted, these resources hold promise for sustainable use in the future. Wild areas such as this will have increased recreational value in the future as similar areas in the West Indies are developed beyond the capabilities of the resource base to sustain economic value.

ISSUE 2:
As the SEP is opened to greater public use as well as development, continued uncontrolled use of the natural resources will render the SEP void of much of its resource value. In this regard sustained use of the area as a management goal may be

367

defeated. Natural resource legislation should be considered and promulgated concurrently with the development plan for the SEP as a primary step toward sound management.

ISSUE 3:
The shorebird resources of the SEP are concentrated in areas of greatest productivity around salt ponds and along the leeward side of the peninsula. Several nesting and roosting areas along the leeward side of the Peninsula are extremely important to pelicans and great frigate birds. Loss or disruption of these areas may cause significant declines in the sustainability of these species.

Recommendations:

1. Prepare salt pond development strategies that recognize their value to shore bird populations and strive to achieve a balance between development and wildlife utilization.
2. Prepare species management plans, rookery management plans and reserves for resident and migratory birds.
3. Minimize development of mangroves and use wherever possible dredge spoil to create and enhance shorebird habitat.
4. Development environmental education and training for the St. Kitts Office of Natural Resources Management.

2.4 Wildlife Resources Management Plan: Mammals

ISSUE 1:
As the Southeast Peninsula is opened to private development and public access, long-term sustainable development will depend on close ties to the natural environment. While it is often difficult to calculate the economic value that wildlife and wildlands can provide, the 1990s are destined to become the decade of environmental concern and ecotourism will play an important role in the economy of governments who have the foresight to forsake short-term gain for long-term sustainable development.

ISSUE 2:
The SEP is not only unique in that it has remained relatively undisturbed for centuries, but it also possesses a remarkable variety of wildlife. The unparalleled variety of ecological communities found on the SEP have supported an array of animals that include seashore, wading, and woodland birds; lizards, crabs, and nesting sea turtles; and exotic mammals like the African Green monkey and Southern White-tailed deer. Development threatens all wildlife through loss of habitat and increased human presence, but in particular the terrestrial habits of monkeys combined with the relatively lower densities of vegetation on the SEP suggest that these animals are at greater risk and may require special protection.

Recommendations:

1. Establish a system of wildlands, wildlife corridors, and hiking trails to protect and preserve wildlife, provide educational and research opportunities, and provide the link between tourist development and environmental conservation.
2. Develop a country-wide dog control program with initial focus on the SEP.
3. Establish an Office of Environmental Control or Office of Environmental Management that can monitor environmental changes, enforce existing legislation and increase public awareness through education programs and guided tours.

2.5 Wildlife Resources Management Plan: Sea Turtles

ISSUE 1:
Three species of marine turtles depend on the coral reefs, sea grass meadows, and beaches of the SEP for food and nesting. All three species are recognized to be in danger of extinction throughout their ranges. There is substantial evidence that all three are declining locally in St. Kitts-Nevis and require immediate management attention.

ISSUE 2:
There is no doubt that impending development of the SEP has the potential for eliminating sea turtle nesting and significantly degrading offshore feeding grounds. Therefore, it is essential that regulatory guidelines be established to minimize adverse effects to these endangered animals. Experience elsewhere in the Caribbean demonstrates that ecotourism especially related to sea turtle nesting and hatching, can account for a significant amount of repeat business to hotels fortunate enough to offer it. Through wise protection of this valuable resource, ecotourism may be greatly enhanced.

Recommendations:

1. Control waste disposal, fires, sand mining, vehicular traffic, beach cleaning and removal of vegetation on SEP beaches.
2. Control beachfront lighting.
3. Control yacht mooring by providing designated mooring locations.
4. Designate all beaches as Conservation Districts.

2.6 Marine Resources Management Plan

ISSUE 1:
The steep, erodible nature of the Southeast Peninsula, with infrequent but heavy rainfall and storms, complex offshore currents and strong trade winds, combined with unique marine resources, seem to command a development pattern of carefully controlled, small scale tourism.

ISSUE 2:
There is substantial evidence that the reefs and near shore waters of the SEP are over-fished, both from the size and species of fish that are caught and the condition of reefs in the area. Increased tourism development will increase demand for most species that are already showing signs of over-fishing.

ISSUE 3:
The potential for significant, marine based tourism development on the SEP is obviously a major factor that should be cultivated. Increasingly, tourists seek destinations that offer easy access to quality marine environments. Yet insensitive development and resource use can easily result in losses of the very marine resources that are so much in demand.

Recommendations:

1. Enact development guidelines for the SEP that protect water quality and ensure that increased turbidity and sedimentation does not occur along the entire leeward coastline.
2. Encourage low density use of the beaches and dunes.
3. Create a national marine park/reserve system for St. Kitts/Nevis and institute a fisheries management program as part of the park/reserve to enhance marine oriented recreation, generate income for marine management, and protect the marine environment.
4. Manage the various bays of the SEP as valuable nursery areas for juveniles of important marine species.
5. Identify and establish a fish reserve area to enhance fisheries productivity and increase fisheries research.
6. Gazette the National Conservation and Environmental Protection Act of 1987.

2.7 Natural Resources Management Plan: Stormwater, Wastewater and Solid Waste Management

ISSUE 1:
When heavy rainfall from tropical storms falls on the relatively impermeable soils of the SEP they can produce flash flooding and damage structures. Similarly, hurricane-driven waves can damage or destroy structures located near the shore.

ISSUE 2:
Wastewater disposal presents a problem on the SEP because soils are typically very shallow or impermeable. The septic tank systems typically used on St. Kitts will not function properly on the SEP. Conventional sewage treatment plants to serve areas of concentrated development are costly to build and difficult to operate.

ISSUE 3:
Development activities on the SEP will produce about 168 cubic yards/week of solid waste with approximately 1300 units occupied. If not disposed of properly, this waste

will detract from the natural amenities of the area, represent a potential health hazard, and reduce tourism potential.

Recommendations:

1. Implement development guidelines that minimize or prevent damage to buildings and infrastructure resulting from stormwater runoff by:
   a. routing stormwater in a safe manner, and
   b. not obstructing natural stormwater flow ways.
2. Implement development guidelines that require that all permanent structure have a minimum floor elevation exceeding 10 feet above mean sea level.
3. Implement special design and construction criteria for all septic tanks that recognize the topography and relatively impermeable nature of the soils of the SEP.
4. Develop a sanitary land fill site off the SEP for disposal of household and commercial solid wastes.
5. Develop a landfill site on the SEP for construction and landscape wastes to reduce haulage.

2.8 Geodynamics, Land Stability, Earth Resources and Management Considerations

ISSUE:
The beaches, dunes, salt ponds, lowlands and hill country of the Southeast Peninsula are alluring national resources, amenable to selective development for recreation and tourism, supported by an appropriately localized service structure. Any development scenario, however, must take into full account both the possibilities and limitations presented by the physical environment so that planning and regulation can be directed along reasonable lines. As a general principle, planning in the SEP should encourage ordered development of the area's potential while ensuring preservation of the best that nature has bequeathed and avoidance of unstable and other hazardous zones. Particular care should be taken during the development process to avoid aggravating potential problems in stable and potentially unstable areas, and to minimize anticipated increases in erosion and sedimentation arising from vegetation clearance, road construction, grading operations and site preparation.

Recommendations:

1. Unstable areas should be avoided in any development scenario.
2. Potentially unstable areas comprised of hillslopes between 10 and 25 degrees, wetlands, and coastal dunes offer significant impediments to development and should be developed with great care.
3. Stable areas should be the primary focus of development.
4. Implement construction and development guidelines that will avoid possible problems and achieve control over erosion and sedimentation.
5. Mining activities for sand and rock should be carefully controlled.
6. Control erosion and sedimentation through the use of vegetative controls and the judicious use of structural controls.

2.9 Morphodynamics, Sediment Characteristics, and Management Considerations

ISSUE 1:
Most beaches of the SEP are pocket beaches formed of materials from local cliff and inland sources and from the destruction of nearshore and local offshore coral reefs. Dominant sediment movement is onshore-offshore, despite the presence of significant longshore currents moving northwestward along both Atlantic and Caribbean beaches. Under severe storm or hurricane conditions, sands may move seaward beyond the confining headlands and be lost from local beaches. Such losses are of considerable concern and are the major reason why there should be no mining or development that impacts the sand budgets of each beach.

ISSUE 2:
There is considerable potential for deleterious impact on beach and barrier systems should artificial structures be placed within the beach and nearshore areas. The dynamic processes that control sand movement and ultimately sand budgets for each beach are extremely complex. Any activity that may interrupt or otherwise change the normal patterns should only take place after considerable study and understanding of the processes and responses found in the beach and nearshore environment.

Recommendations:

1. Sand mining of beaches and dunes should not be permitted under any circumstances.
2. No permanent impermeable engineering structure such as breakwaters, jetties, groins, and seawalls should be placed on the beach or nearshore environment.
3. Establish minimum floor elevations based on maximum sea level elevations expected during storm surges associated with hurricane passage.
4. Establish minimum setback limits for each beach. In the absence of other criteria, a set back of 100 meters is reasonably safe.
5. Control development in the coastal zone to ensure that reefs which are an important source of sand are not negatively impacted.
6. Control dumping in the nearshore, beach, dune, and wetland environments of the shore zone.

2.10 Prospects for Marina Development

ISSUE 1:
From a physical perspective, it is feasible to construct one or more marinas in the SEP, but such development is not without significant environmental problems and should only be undertaken after careful evaluation of environmental impacts.

ISSUE 2:
A marina in the SEP should be located and designed so as to provide a safe approach to a small-boat harbor adjacent to flat or gently sloping terrain of sufficient extent to permit infrastructure development and good access. The environmental impact of the

marina should be minimized to the extent possible by careful placement of the entrance channel, cautious dredging, wise disposal of dredge spoil, and provision of adequate water circulation.

Recommendations:

1. The Little Salt Pond offers the best onshore potential for marina development on the SEP, followed by Major's Bay, and Cockleshell Bay, while South Friar's Bay offers the least desirable location of the four considered.
2. White House bay offers the best potential offshore site for marina development associated with an offshore breakwater, with advantages that outweigh disadvantages.
3. It is recommended that only one marina be developed in the SEP that would accommodate approximately 2000 boats and comprise a water area of approximately 8 hectares.
4. To more fully asses the potentials and limitations of marina development in the Little Salt Pond and White House Bay area it is recommended that detailed studies of the physical and ecological environments be undertaken prior to any engineering and design.

2.11 Scenic Vista Protection, Preservation and Management Plan

ISSUE:
The scenic qualities of the SEP in contrast to the main portion of the island result from vistas of uninterrupted natural landscapes. The existing character of the Peninsula, the product of its inherent beauty resulting from the juxtaposition of beach, mountains, salt ponds, vegetated guts, cliffs and escarpments and the adjacent waters, is the basis for much tourist related attraction. These elements must be carefully and cautiously protected to maintain the Peninsula's outstanding visual character. Insensitive, haphazard, poorly designed, and ill- conceived development will ensure the demise of the visual attraction of the Peninsula and seriously threaten the developing tourist industry.

Recommendations:

1. Implement development guidelines that ensure visual compatibility of access roads, buildings, parking areas and utilities.
2. Establish scenic overlooks where scenic values are particularly high and protect their quality be implementing scenic district development guidelines.

2.12 Summary: Resource Management Plans

In all the Resource Management Plans outlined issues pertinent to each of the various resources or physical attributes of the SEP and provided detailed management recommendations that gave suggestions of how best to integrate development and natural resources to minimize negative consequences. The key to generating an effective plan

hinged on combining these management suggestions into a coherent set of development guidelines and to utilize the spatial information generated in the various RMPs in a manner that would lead to a physical plan that "zoned" the SEP into differing compatible land use intensities and overlay districts.

Spatial information given in the RMPs were used to develop the land use intensity districts map and the various overlay districts map. To minimize the number of land use districts, multiple use districts were used that allowed various uses, but controlled intensity to ensure compatibility and to minimize environmental deterioration that may result from over development in sensitive areas. Development of the land use districts map and overlay maps is explored in greater detail in the next section.

314

3.0 SYNTHESIS: CONSTRAINTS AND OPPORTUNITIES

There are two aspects of a land use management plan that work in conjunction to achieve the Plan's desired goals: physical plans or maps that indicate the areal extent of development, districts of different uses and intensities and districts for conservation and protection of resources, and a set of written criteria or regulations that give detailed descriptions of construction techniques, and site planning, building design, and operational requirements.

The first and primary planning map in the PLUMP is the Future Land Use Management Plan (Map 3.5.1) which sets forth districts of land use intensity. The driving factors from which this map was derived were primarily physical limitations of geodynamics and land stability and the determination of runoff characteristics and sediment trapping abilities of watersheds. Those lands that exhibited slope limitations, sea cliffs and beaches were classified as unstable and not suitable for development. Intensity districts were organized around watersheds so that maximum intensities were located in salt pond watersheds and at lowest slopes as a means of naturally protecting marine resources from sediments.

The process of developing the land use districts map synthesized the spatial information generated in each of the relevant Resource Management Plans into a master Constraints and Opportunities Map. Through a process of overlaying each of the most important limiting factors derived from the RMPs the Constraints and Opportunities Map (given as Map 1) was developed. It results from the interplay of the spatial data that was mapped in the various RMPs. When the constraining spatial data are overlaid, the resulting map indicates lands having varying degrees of limitations to development in varying shades of gray. The darkest areas are those that have the greatest limitations while the white areas are those having fewer limitations.

The added constraint of proper wastewater disposal governed housing unit densities in areas that could not be served by a centralized wastewater system. Lands outside of easily identifiable wastewater districts had to be served by septic tank systems and thus required greater land area per unit for the required septic tank and drainfield. A minimum of 2.5 acres per unit was suggested to ensure proper septic tank drainfield function to minimize health and safety risks. The bold lines and arrows shown on the Constraints and Opportunities Map indicate the various wastewater collection districts.

4.0 PLAN GENERATION

A land use management plan is composed of two interrelated elements: a set of maps or physical plans that indicate the spatial arrangement of proposed land use zones and districts and a written set of guidelines that describe design, construction and operation regulations. Together, these two elements comprise the "regulatory framework" by which development is controlled and growth is managed. In addition if the framework is to have the force of law it needs to have a legislative component.

4.1 The Regulatory Framework

To generate the written component of the plan, management recommendations from each RMP were coalesced into development guidelines and related to the various stages of the development process. Specific recommendations that related to design issues were grouped, those relating to construction practices were grouped, and those relating to site planning and site development were grouped. Recommendations were then written in the form of regulations based on the various development stages (design, site planning, site development, and construction) using a formal language giving them a sense of legal force. The language and style were copied from regulations and legislation that are currently in use by government. The regulations were written in this format to make their adoption as a legal and binding regulatory framework easier. Otherwise, had the recommendations remained as isolated resource management recommendations, without a coherent format and legal framework, their effectiveness may be greatly diminished.

It has been our experience that suggestions and mere guidelines without the force of law are often ignored, at worst, or only selectively utilized, at best. While the language and style may seem overly restrictive, the level of regulation suggested in these documents is quite the contrary; they are relatively permissive. Only the simplest of requirements with a minimum of permitting is required of those seeking to develop the SEP. The intent was not to generate a complex regulatory framework that would baffle or confuse, but to provide a model framework that was not overly restrictive (especially of small scale landowners and those wanting to build single family residences) but that adequately protected the environment and the health and safety of the public.

4.2 The Future Land Use Map

The Future Land Use Map that is made a part of the PLUMP gives detailed spatial zoning of the developable portions of the SEP. Zones, or districts, are organized as intensity districts where multiple uses are allowed within districts as long as intensities are compatible. In general decisions of compatibility will rest with the Board. Highest intensities of use are located on the least sensitive lands, while lowest intensities are located on those lands where centralized wastewater systems are not appropriate or where environmental sensitivities limit the intensity of development. Areas precluded from development are only those areas where slopes, soil types, and/or other hazards

316

exist that development would seriously jeopardize the structure and health and safety of the public.

Developable portions of the SEP are shown on the Future Land Use Management Plan Map in varying shades of gray. Areas that are intended for little or no development are those areas that remain as white background. They are indicated as undevelopable and should remain without development because of one of several factors that will limit their safe and environmentally benign conversion to some human use. First and foremost is safety. Much land on the SEP has been classified as geodynamically unstable, while other areas have been classified as either potentially unstable, or hazardous zones resulting from potential downslope transport of earth and rocks from higher unstable areas. In addition, hazardous zones exist where the threat of storm surge is prevalent. Within these areas, which are classified as undevelopable and shown on the Future Land Use Map as white areas, there may be some small pockets of developable lands that are not restricted by slope, or land stability problems. Yet, access is greatly hindered because of the degree of limitations on lands that may surround them. In the best judgment of the planners and scientists who have developed the plan, these small areas were not considered developable. It may be equally valid to consider development proposals in these areas on a case by case basis where landowners and developers demonstrate to the satisfaction of the Board that they may be safely developed.

Two prominent areas come to mind. The first is an area atop Nag's Head, where slope and stability criteria suggest that there may be developable lands present, and the second is the Scotch Bonnet promontory. They have not been included in one of the land use intensity districts for several reasons: (1) access is problematic, since roadways would have to transverse relatively sensitive lands; (2) they occupy extremely prominent features of the SEP and their development would significantly detract from scenic qualities; and (3) in the case of Nag's Head, the area in question occupies lands in close proximity to the important rookery and wildlife area. Development here would severely compromise its value as a rookery. Should the Board entertain proposals for development of Scotch Bonnet and Nag's Head, it should do so in an extremely judicious manner, with the full knowledge that limitations and sensitivities suggest that their development may lead to irreparable losses of environmental and visual quality, and the loss of a significant bird rookery area.

4.3 Land Development Intensity Districts

It is intended that the Future Land Use Management Plan Map, the PLUMP, and HDGCSP foster a development pattern that is in keeping with the character and scale of other areas of St. Kitts/ Nevis. Districts of land use intensity that do not zone land uses but only indicate intensity of use are utilized as a means of providing a great amount of flexibility to developers in their plans, and to the Board in their ability to regulate development. The first two districts (LDI.I and LDI.II) are reserved for residential uses, however, the remaining districts (LDI.III, LDI.IV, LDI.V, and LDI.VI) allow most land use activities with fewer restrictions as intensities increase. The flexibility that is allowed with such a system of land use controls is extensive. The

pattern of development, with mixed uses contributing to a vital, socially and economically integrated community has the potential of establishing a community...a goal that has been at the forefront of concern since the beginning of this planning exercise.

Table 1 summarizes the acreage and number of dwelling units that may occur in each of the LDI districts. Assuming maximum buildout in each of the LDI districts, a total of over 7600 residential units could be accommodated within the delineated districts within the SEP. This number is an overestimate since much of LDI.IV, LDI.V, and LDI.VI is anticipated to be developed for hotel and commercial uses. A more conservative estimate using the maximum allowable for LDI.I and LDI.II and an average of 4 units per acre in the remaining districts still yields a total residential buildout of over 4100 dwelling units.

Intensities of hotel development have been purposely limited within LDI.III, LDI.V and LDI.VI, only from the standpoint of number of rooms allowed within each hotel complex. Table 2 summarizes the number of hotel units that may be built within LDI.III, LDI.IV, LDI.V and LDI.VI assuming maximum buildout at the anticipated FAR ratio. The total number of hotel rooms assuming maximum buildout is over 8400 rooms. A more conservative estimate, assuming approximately half of the available land area of each district is given over to commercial and residential uses still would total well over 4000 hotel units. This total FAR is in excess of the number of units that recent studies have anticipated as capable of being sustained by expected tourist arrivals.

It is the expressed desire of the planning team to limit the size of hotel complexes within these districts as a means of accomplishing two very important goals: (1) the scale of development is in keeping with the urban scale prevalent on other portions of the islands, and (2) small-scale hotel development fosters involvement of local citizens, limits extensive development by multinational hotel chains and ensures that a substantial portion of wages, expenses and profits are cycled through the local economy instead of off island. Experience elsewhere in the Caribbean Basin has shown that while large-scale hotel complexes are favored by multinational hotel chains and that while the trends are toward bigger "all-inclusive" hotels, they tend to discourage non-hotel tourist expenditures and develop negative social reaction.

Limits on the number of large hotel complexes seem entirely appropriate. If demand for hotel rooms is sufficient, four 50-room hotels can easily satisfy the needs of the same number of tourists as one 200-room hotel, only with more diversity of choice, a better sense of scale, and better ability to fit the social fabric of the island. The goal is to intensely develop these districts, yet reflect the townscape feeling of Basseterre and Charlestown. The number of hotel rooms, and thus total number of tourist days can easily be accommodated within an intensely-developed mixed-use, townscape pattern of residential, commercial, and small-scale hotels. With sufficient creativity, several small hotels could easily band together to offer incentives and vacation packages that would rival those offered by the larger chains.

Some have criticized the concept of small-scale owner operated hotels as hopelessly inadequate and antiquated...that the future lies in large-scale, "all-inclusives". The

planning team strongly urges the Board and GOSKN to take a extremely cautious view of these arguments. Tourism in the Caribbean has been based for many decades on destinations that were townscapes composed of mixed uses of residential, commercial, and small-scale hotel complexes. In essence, the Caribbean's reputation was built on, and in large measure depends on, the more human scale pattern characteristic of diverse townscapes and not the large-scale hotel development that is currently in vogue.

Table 1 Maximum Potential Residential Buildout For Districts of the Future Land Use Management Plan Map

District	Acreage (acres)	Allowable Dwelling Units	Total Dwelling units
LDI.I	591	1 DU/2.5 acres	236
LDI.II	227	2 DU/ acre	454
LDI.III	144	12 DU/ acre	1728
LDI.IV	290	12 DU/ acre *	3480
LDI.V	22	12 DU/ acre *	264
LDI.VI	122	12 DU/ Acre *	1464
Total			7626

* There are no restriction on the number of dwelling units per acre, a maximum number of 12 units per acre was used.

Table 2 Maximum Potential Hotel Buildout For Districts of the Future Land Use Management Plan Map

District	Acreage (acres)	Allowable * Hotel Units	Total Hotel units
LDI.I	591	NA	NA
LDI.II	227	NA	NA
LDI.III	144	10 HU/ acre	1440
LDI.IV	290	10 HU/ acre	2900
LDI.V	22	20 HU/ acre	440
LDI.VI	122	30 HU/ Acre	3660
		Total	8440

* Estimates of allowable hotel units were based on the following Floor Area Ratios and Maximum Parcel Coverages:

LDI.IV	FAR = 0.75	MPC= 50%
LDI.V	FAR = 2.00	MPC= 75%
LDI.VI	FAR = 3.00	MPC= 100%

4.4 Overlay Districts

Overlay districts were generated as a means of further modifying land use intensity districts and to provide additional information to the Board and to the public. The Public Facilities Districts Map and Recreational Districts Map fall into this latter category. The Conservation Districts Map and the Wildlands Districts Map are overlay districts that affect land use and spatial organization of permissible land uses. When overlaid on the Future Land Use Map, conservation districts have some added regulations

that need be observed. The wildlands overlay districts require that as much land as possible be left in a natural state, but do not reduce allowable number of units or area of commercial uses.

The overlay districts allow greater flexibility than would otherwise be possible with only one map of land use zones. Their boundaries may be altered, they may be changed and updated at will, and their accompanying criteria may be altered without the need to alter the Future Land Use Map. In this way, the overlay districts act as modifiers that may be constantly updated and refined as new information is generated and development occurs. Yet the Future Land Use Map can remain intact and the confusion of altering the principal planning map is avoided.

A second advantage of the overlay districts is the simplicity that is created. The Future Land Use Map is relatively simple in comparison with other land use maps, and the primary reason is that fewer zones are needed to adequately address both questions of land use compatibility and environmental protection. Environmental protection is addressed primarily by the overlay zones, freeing the Future Land Use Map and its zones for addressing questions of land use compatibility.

4.5 Summary: Plan Generation

Accommodating intense development and at the same time protecting unique national treasures of marine and terrestrial resources like those of the SEP is a complex undertaking. It is a question of balance. The planning documents in this three volume set are an attempt to organize the articulated goals and objectives of the citizens and government of St. Kitts/Nevis and the information generated as the result of studies performed by scientists and planners over the past year and a half into a balanced regulatory framework, a "Plan for the Future". These plans are models. They are a balance between development on the one hand and resource preservation on the other. If adopted, in whole or in part, they will help in the complex undertaking of managing the SEP for future generations of Kittitians as well as the thousands of off-islanders that will come to appreciate its beauty.

381

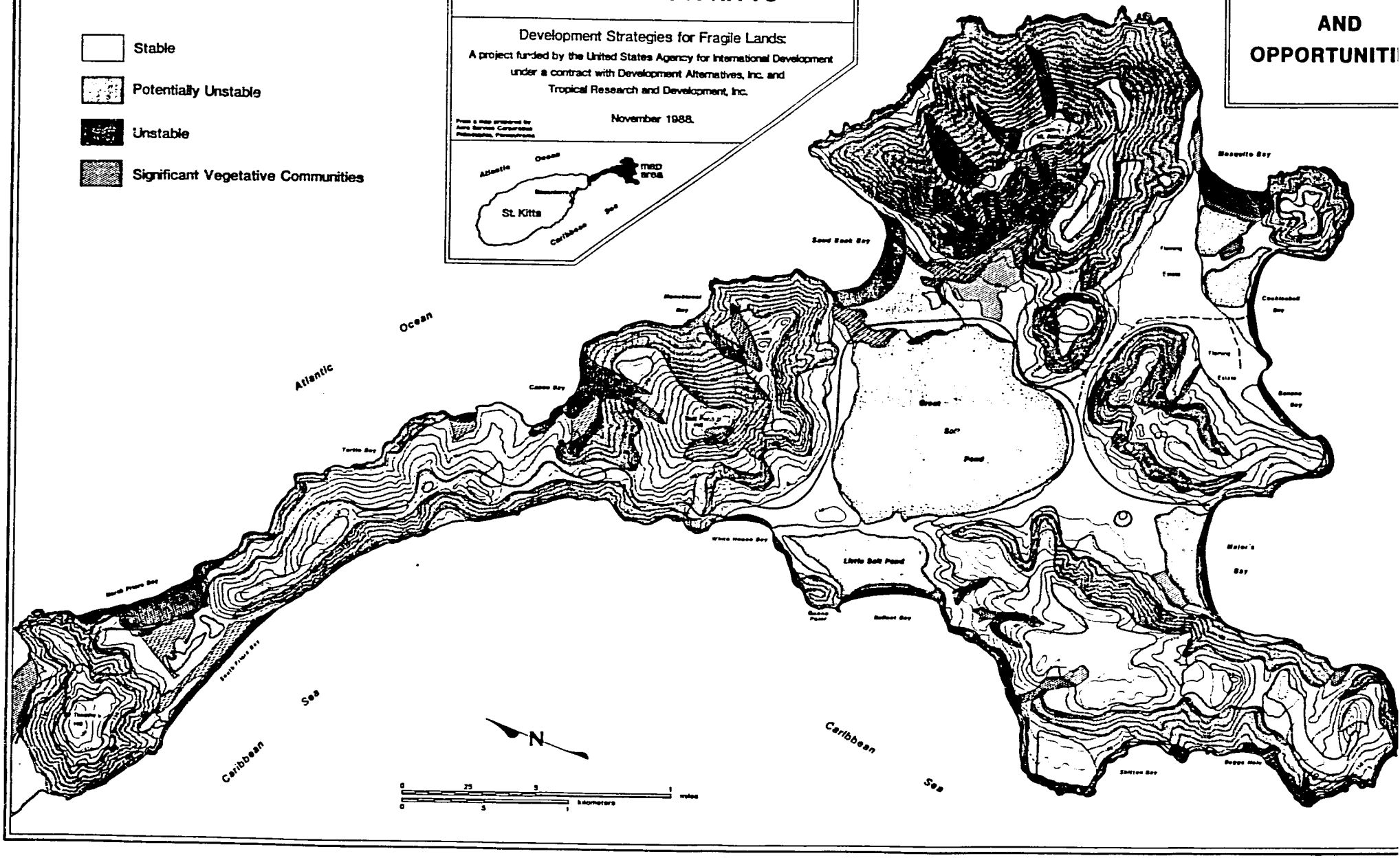
SOUTHEAST PENINSULA
ISLAND OF ST. KITTS

Development Strategies for Fragile Lands:
A project funded by the United States Agency for International Development under a contract with Development Alternatives, Inc. and Tropical Research and Development, Inc.

November 1988.

MAP 1
CONSTRAINT AND OPPORTUNITI

- Stable
- Potentially Unstable
- Unstable
- Significant Vegetative Communities



PROPOSED LAND USE MANAGEMENT PLAN

by

Earl M. Starnes, Ph.D.
Mark T. Brown, Ph.D.
Greg Morris, Ph.D.

June 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

ACKNOWLEDGEMENTS

Persons Actively Engaged in Review of Documents

1.	Senator Ralph Gumbs	-	SEPLD&CB Chairman
2.	Mr. Colin Pereira	-	SEPLD&CB Vice-Chairman
3.	Mr. Larkland Richards	-	SEPLD&CB Member/Permanent Secretary, Min. of Tourism
4.	Mr. Athil Rawlins	-	SEPLD&CB Member/Chief Water Engineer
5.	Mr. Eldon Jones	-	SEPLD&CB Member/Civil Engineer
6.	Mr. Patrick Williams	-	Project Officer/Secretary, SEPLD&CB
7.	Mr. Ralph Field	-	Chief of Party/TRD
8.	Mr. Randolph Walters	-	Environmental Manager/TRD
9.	Mr. Douglas Chiriboga	-	USAID
10.	Mr. Brinley Selliah	-	USAID
11.	Mr. Andre De George	-	USAID

Information and Assistance

1.	Dr. Keith Archibald	-	Director of Agriculture
2.	Mr. Ralph Wilkin	-	Fisheries Assistant, Department of Agriculture
3.	Mr. Earl Sanders	-	PCV, Fisheries Department
4.	Mr. James Hodge	-	Chief Public Health Inspector
5.	Mr. Kenneth Samuel	-	Dive Boat Operator
6.	St. Kitts-Nevis National Coast Guard		
7.	Mr. Charles Wilkin	-	Attorney
8.	Mr. Reginald Oldham	-	Realtor
9.	Hon. Tapley Seaton	-	Attorney General
10.	Hon. Hugh Heyliger	-	Minister of Agriculture, Lands, Housing & Development
11.	Mr. Eugene Petty	-	Permanent Secretary, Ministry of Agriculture, Lands, Housing & Development

TABLE OF CONTENTS

1.0 INTRODUCTION AND PURPOSE 1
- 1.1 Background Information 1
- 1.2 Handbook of Development Guidelines and Considerations for the Southeast Peninsula 2

2.0 LEGAL AUTHORITY 3
- 2.1 Proposed Land Use Management Plan and Handbook of Development Guidelines and Considerations for the Southeast Peninsula 3
- 2.2 Related Acts 3

3.0 THE PROPOSED LAND USE MANAGEMENT PLAN 4
- 3.1 Land Use Management Plan Concept 4
- 3.2 Definitions 4
  - 3.2.1 Proposed Land Use Management Plan (PLUMP) 4
  - 3.2.2 Applicable Terms: National Law 5
- 3.3 Land Development Intensity Overlay Districts 7
  - 3.3.1 Land Development Intensity Districts 7
  - 3.3.2 Overlay Districts 9
  - 3.3.3 Terms Used in Section 3.3 11
- 3.4 Goals and Objectives 12
  - 3.4.1 Goals 12
  - 3.4.2 Objectives 13
- 3.5 Proposed Land Use Management Plan Maps 15
  - 3.5.1 Future Land Use Management Plan Map 16
  - 3.5.2 Conservation Districts Map 17
  - 3.5.3 Scenic Vista Districts Map 18
  - 3.5.4 Wildlands Management Areas Map 19
  - 3.5.5 Natural Hazards Map 20
  - 3.5.6 Recreation Area Map 21
  - 3.5.7 Public Facilities Map 22
- 3.6 Procedural Requirements 23
  - 3.6.1 Adoption 23
  - 3.6.2 Amendments 23

1.0 INTRODUCTION AND PURPOSE

The development of the Southeast Peninsula (SEP) of St. Kitts has broad and important environmental, social and economic benefits for St. Kitts and Nevis. Sound economic and cautious land development of the SEP can benefit from the great natural amenities of the SEP. The development potential, however, is limited by several physical constraints. Important constraints include the limited amount of potable future water supply, the soils, topography and geologic formations and limitation of potentially useful beaches and other recreation resources for tourist development. Excessive development intensities will result in environmental and visual degradation and result in a loss of its attractiveness as a tourist destination.

Given these considerations, the Proposed Land Use Management Plan (PLUMP) and the Handbook of Development Guidelines and Considerations for the Southeast Peninsula (HDGCSP) attempt to accommodate an attainable level of development over the next twenty years on safe most aesthetically pleasing and careful planning manners for sustaining a healthy and economically sound tourism economy. Thus, the PLUMP and the HDGCSP are designed to guide development to the most suitable areas of the SEP.

The PLUMP and the HDGCSP are companion documents and shall be considered by the Southeast Land Development and Conservation Board (SEP Board) as having complementary provisions. The Proposed Land Use Management Plan sets forth goals and objectives designed to manage the development and protection of the lands, resources and adjacent waters of the Southeast Peninsula of St. Kitts. The HDGCSP contains specific policies, standards and guidelines for the implementation of the PLUMP. It includes standards for development proposals, review procedures and development permitting by the SEP Board. The purpose of the PLUMP and the HDGCSP is to provide the general and specific goals, objectives, policies and regulations for the land use management and environmental protection of the Southeast Peninsula of St. Kitts.

1.1 Background Information

This PLUMP and HDGCSP result from studies beginning in 1986. These studies cover a full range of environmental aspects of the SEP and adjacent waters of the Atlantic Ocean and Caribbean Sea. In addition, aesthetic, economic, political and social issues regarding the future of the SEP of St. Kitts, were considered The Government of St. Kitts and Nevis and the Southeast Peninsula Land Development and Conservation Board, authorized and participated in these studies.

The studies have been performed by a team of scientists and resource planners brought together under a program sponsored by the United States Agency for International Development (U.S.A.I.D.), DESFIL Contract No. DHR-5438-C-00-6054-00 and Tropical Research and Development, Inc. of Gainesville, Florida, U.S.A. The reports and

recommendations of the team are the basis for preparing the PLUMP and HDGCSP. These reports are Volume II of the Resource Management Plans, Southeast Peninsula, St. Kitts.

The SEP comprises two parts: a rocky isthmus that extends southeast from Sir Timothy's Hill to Salt Pond Hill, and a broad digitate peninsula surrounding the Great Salt Pond. The SEP is approximately 3800 acres in land and water area, including approximately 450 acres of salt pond.

There are ten major environmental community types on the SEP: salina/salt ponds, beaches, dunes, mangroves, guinea grass, grass/acacia, thorn scrub, dry forest, agriculture and developed areas. The SEP landforms are accented by the rising of significant peaks in juxtaposition to lower lands at Friar's Bay, Great Salt Pond and the Fleming Estate areas. This diversity of landforms, natural habitats and the surrounding seas result in a unique and marvelous resource that can be maintained through environmentally sound development. The major human actions that have impacted the SEP are the long history of salt production, of land clearing and burning for agriculture and pasture, and most recently the construction of the access road from Frigate Bay to Major's Bay. Other interventions include a boat dock and a very limited shore facility at White House Bay and a small resort at Cockleshell Bay and Banana Bay.

1.2 Handbook of Development Guidelines and Considerations for the Southeast Peninsula

The HDGCSP is the regulation which establishes how the goals and objectives of the Proposed Land Use Management Plan are to be achieved. The regulation covers development review and permitting procedures complete with policies, guidelines, and standards controlling land development and the protection and conservation on the SEP. The HDGCSP is part of the PLUMP, but is treated as a separate document for convenience . While the material it contains may have wider applicability to the development of St. Kitts-Nevis, its provisions have been expressly tailored to protect and enhance the natural and man-made environment of the SEP.

2.0 LEGAL AUTHORITY

2.1 Proposed Land Use Management Plan and Handbook of Development Guidelines and Considerations for the Southeast Peninsula

The legal authority for the adoption, amendment and administration of the PLUMP and the HDGCSP by the Southeast Peninsula Land Development and Conservation Board, is predicated upon the provisions of law in the Southeast Peninsula Development and Conservation Act, 1986.

2.2 Related Acts

Related acts include the National Conservation and Environment Protection Act, 1987, when this Act becomes effective by Notice published in the Gazette, the Land Development (Control) Act, 1966 and any other national act that may subsequently be enacted by the National Assembly of St. Kitts and Nevis and published in the Gazette.

3.0 THE PROPOSED LAND USE MANAGEMENT PLAN

3.1 Land Use Management Plan Concept

3.1.1 The PLUMP seeks to provide long-term benefits to the economy of St. Kitts and Nevis by managing development on the SEP to maintain the natural resources and aesthetic values that make it attractive as a tourist destination. It is designed to identify the suitability of the lands on the SEP for different types of development and conservation including: tourism and related facilities; retail and marine related commerce; a full range of housing opportunities and the generalized location of streets and transport facilities; parks, public facilities and recreation areas; and, natural areas to be protected from development for economic, public safety, ecological and aesthetic reasons.

3.1.2 Based on an analysis of environmental constraints, the permissible land development intensity compatible with sound development practice has been established for the most SEP. The land development intensities are intended to be a general guide to future land development. In addition to the land development intensity districts, overlay districts have been established for the location of public facilities and resource protection.

3.1.3 In general, the PLUMP focuses the greatest concentration of development in The Great Salt Pond, Major's Bay, White House Bay, Cockleshell and Banana Bay areas of the SEP. This will provide a long range opportunity for the development of a Town Center in the Great Salt Pond area. Friar's Bay and Fleming's Estate are additional areas of tourist-oriented concentrations for development.

3.2 Definitions

3.2.1 **Proposed Land Use Management Plan (PLUMP)**

3.2.1.1 "Board" or "SEP Board," means the Southeast Peninsula Land Development and Conservation Board established under section 3 of the Southeast Peninsula Land and Conservation Act, 1986.

3.2.1.2 The PLUMP is this legal document including parts I, INTRODUCTION; II, LEGAL AUTHORITY; and III, PROPOSED LAND USE MANAGEMENT PLAN. For purposes of interpretation of the PLUMP the SEP Board shall consider the parts in their entirety including maps, graphics or other materials specifically included in these parts.

3.2.1.3 "Minister" means the current Minister being charged with the subject of Planning and Development.

3.2.1.4 "Shall" as used in the PLUMP means imperative or as interpreted by the SEP Board to further the goals and objectives of the PLUMP.

3.2.1.5 "Should" as used in the PLUMP means the conditional of "shall" implying duty and obligation and is not synonymous with "may".

3.2.1.6 "Southeast Peninsula", or "SEP", means the area in the Parish of St. George, Basseterre extending from the boundary of the Frigate Bay Development Area to the extremities of Nag's Head and Scotch Bonnet, such area to be more particularly designated by the Minister by Order made under the Southeast Peninsula Land Development and Conservation Act, 1986.

3.2.1.7 "Wild animal" means any deer or other animal designated by the Minister by Order under the Southeast Peninsula Land Development and Conservation Act, 1986.

3.2.1.8 "Wild bird" means any bird specified in the Schedules to the Wild Bird Protection Act.

3.2.2 **Applicable Terms: National Law**

3.2.2.1 "Building" includes any structure of whatever material and in whatever manner constructed or any part of a building, and where the context so permits, includes the land on, in or under which the building is situated;

3.2.2.2 "Building operations" includes any road works preliminary or incidental to the erection of buildings;

3.2.2.3 "Development" in relation to any land includes any building or rebuilding operations and any use of the land or any building thereon for a purpose which is different from the purpose for which the land or building was last being used, or the sub-division of any land, and "develop" shall be construed accordingly;

3.2.2.4 "Land" includes land covered with water and also includes incorporeal as well as corporeal hereditaments of every tenure or description, and any interest therein, and also an undivided share in land;

3.2.2.5 "Owner", in relation to any building or land, means a person other than a mortgagee not in possession, who is for the time being

290

entitled to dispose of the right of ownership of the building or land, whether in possession or reversion, and includes also a person holding or entitled to the rents and profits of the building or land under a lease or agreement the unexpired term whereof exceeds ten years.

3.2.2.6 "Authorised officer" means any police officer, forest officer or any other person appointed for purposes of this act.

3.2.2.7 "Beach" means the sloping area of unconsolidated material, typically sand, that extends landward from the mean high water mark to the area where there is a marked change in material or natural physiographic form or when there is no such marked change in the material or natural physiographic form, the beach shall be deemed to extend to a distance of twenty metres landward from the high water mark or such lesser area as may be determined by the Minister in consultation with the Conservation Commission and in all cases shall include the primary sand dune;

3.2.2.8 "Coast conservation" means the protection and preservation of the coast from sea erosion or encroachment by the sea, and includes the planning and management of developmental activity within a coastal zone;

3.2.2.9 "Coastal zone" means any area having an elevation less than 15 metres above sea level within a limit of one hundred metres of the mean high water mark and a limit of two kilometres seaward of the mean low water mark and shall include the foreshore and the floor of the sea;

3.2.2.10 "Environment" means the physical factors of the surroundings of human beings including the land, soil, water, atmosphere, climate, sound, odours, tastes, and the biological factors of animals and plants of every description;

3.2.2.11 "Foreshore" means that portion of the coastal zone which lies between the low water mark of the sea and landward to the vegetation line found thereon or in the absence of vegetation, the high water mark;

3.2.2.12 "Historic site" means a place or site which is historic by reason of an association with the past and is part of the cultural or historical heritage of St. Kitts and Nevis, and such a classification may include archeological sites, historic landmarks, and areas of special historic or cultural interest;

3.2.2.13 "Marine reserve" means an area as provided in Section 23 of the Fisheries Act, 1984;

3.2.2.14 "National park" means an area consisting of a relatively large land or marine area or some combination of land or sea, containing natural and cultural features or scenery of national or international significance and managed in a manner to protect such resources and sustain scientific, recreational and educational activities on a controlled basis;

3.2.2.15 "Pollution" means any direct or indirect alteration of the physical, thermal, chemical, biological or radioactive properties of any part of the environment by the discharge, emission, or the deposit of wastes so as to affect any beneficial use adversely or to cause a condition which is hazardous to public health, safety or welfare, or to animals, birds, wildlife, marine life or to plants of every description;

3.2.2.16 "Protected area" means a national park, nature reserve botanic garden, historic site, scenic site or any other area of special concern or interest designated under section 3(1) of this Act;

3.2.2.17 "Scenic site" means an area containing a scenic feature of national or local importance.

3.3 Land Development Intensity Overlay Districts

3.3.1 Land Development Intensity Districts

Each Land Development Intensity District (LDI) describes the types and intensities of land uses permitted in the district and planning policies for the development of the district. LDI boundaries are shown on the Future PLUMP Map (Map # 3.4.1.) and shall be interpreted to be generalized except where boundaries are coincident with center lines of road or right of way or with naturally occurring geographic boundaries. The SEP Board shall be the interpreter of any boundary issues, and guided by its judgement as to the consistency of its interpretation to the overall goals and objectives of the PLUMP.

3.3.1.1 Land Development Intensity District I. (LDI.I) The following uses shall be permitted in LDI.I districts: single family detached residential and related uses. Such uses shall be located on individual lots or aggregated sites in which the density of dwelling units per acre shall be equal to or less than 1 dwelling unit per 2.5 acres.

3.3.1.2 Land Development Intensity District II. (LDI.II) The following uses shall be permitted in LDI.II districts: single family detached or clustered detached residential and related uses. Such uses shall be

392

located on individual lots or aggregated sites in which the density of dwelling units per acre shall be equal to or less than 1 dwelling unit per .5 acre, but not be less than 1 dwelling unit per 2.5 acres.

3.3.1.3 Land Development Intensity District III. (LDI.III) This district category is reserved for planned unit developments. LDI.III districts shall be permitted only on sites equal to or greater than 5 acres and shall be subject to individual proposal review and approval as provided for in the HDGCSP. Planned unit development (PUD) is a development of one or more uses that is planned by a developer as a single coherent and comprehensive land use and public facilities plan for a given site. In this LDI III district, innovative design and planning is encouraged. The PUD should embody mixed compatible uses to increase variety and aesthetic quality and to permit the integration of open spaces with building masses. Height of buildings shall be limited to 35 feet. Density shall not exceed 12 dwelling units per acre and lot coverage shall not exceed 40% of the land area. The following uses may be approved in the LDI.III district: primarily residential, with related commercial, marine related, tourist facilities including hotels of 50 rooms or less and any use that is compatible with uses in LDI.I and LDI.II.

3.3.1.4 Land Development Intensity District IV. (LDI.IV) The following uses shall be permitted in LDI.IV districts: single hotel or tourist facilities, commercial retail related to tourist facility, and multi family residential uses. The floor area ratio shall not exceed 0.75. Floor area ratio means the ratio of the floor area of all buildings to the total area of the site (floor area/ site area = floor area ratio). Height of buildings shall be limited to 35 feet.

3.3.1.5 Land Development Intensity District V. (LDI.V) The following uses shall be permitted in LDI.V districts: this district shall be known as the marine related district and includes water and marine related uses, commercial retail, attached and multi family residential and hotels of 25 rooms or less. The floor area ratio shall not exceed two. Floor area ratio means the ratio of the floor area of all buildings, except open docks and quays, to the total area of the site (floor area/ site area = floor area ratio). Height of buildings shall be limited to 25 feet with care to preserve vistas over the water for inland development, as may be approved by the SEP Board.

3.3.1.6 Land Development Intensity District VI. (LDI.VI). This district shall be known as the Town Center. The following uses shall be permitted in LDI.VI districts: mixed and multiple uses including hotels of 25 rooms or less, commercial retail, commercial wholesale not exceeding 10 percent of all commercial floor area, attached townhouses and multi family residential, churches, professional and

other personal services, automobile services limited to sites which minimize conflicts with residential uses, governmental services and other uses that in the determination of the SEP Board would be compatible with the Town Center concept. The floor area ratio shall not exceed 3. Floor area ratio means the ratio of the floor area of all buildings to the total area of the site (floor area/ site area = floor area ratio). Height of buildings shall be limited to 35 feet with care to preserve vistas and open space, as may be approved by the SEP Board. The LDI.VI district requires very special care in site planning, architectural and aesthetic quality according to standards and procedures that shall be developed by the SEP Board.

3.3.2 **Overlay Districts**

Overlay districts are described below. The overlay district is not a land development intensity district but a district which identifies future public facilities service areas, recreation areas, or natural resource protection districts. The overlay indicates that special considerations for future land development are required to forward the goals and objectives of the related PLUMP and the policies and standards of the HDGCSP. Boundary issues related to the overlay districts will be resolved by the SEP Board. The SEP Board will be guided by the natural characteristics and sensitivity of environmental conditions in the resolutions of boundary issues and further guided by its judgement as to the consistency of its interpretation to the overall goals and objectives of the PLUMP.

3.3.2.1 Public Facilities District. (PFD) The Public Facilities District shall include specific sites for police services, health facilities, library, school, solid waste management facility and sewage treatment facilities. These sites are generally located on the Public Facilities Map (Map # 3.5.7.) by dots of various shape according to a key on the Map. Service areas for sewer, storm drainage and other infrastructural elements are shown as areas on the Map. The locations and service areas may vary slightly as determined by the SEP Board.

3.3.2.2 Natural Resource Protection Districts. The following districts shall be considered overlay districts requiring very special attention and application of goals, objectives, policies and regulations found in the PLUMP and the HDGCSP. The boundaries of these districts are identified on the appropriate maps included in the PLUMP.

a. Conservation District. (CD) All areas indicated on the Conservation Districts Map (MAP # 3..2.) are dominated by significant vegetation associations or

394

species of special concern, or are districts where wildlife species of rare, endangered, or special concern status are known to breed, feed, or roost. All uses within the conservation district shall conform to the policies and regulations of the HDGCSP.

b. Natural Hazard District. (HD) The areas indicated on the Natural Hazard Districts Map (Map # 3.5.5.) are characterized by natural hazards such as flooding and land slippage, which makes these areas unsafe and unsuitable for construction. Residential or commercial structures shall not be constructed in Hazard Districts, and public utilities and infrastructure shall cross through a Hazard District only when no alternative route is feasible.

c. Recreation District. (RD) All areas indicated as important recreation districts on the Recreation Districts Map (MAP # 3.4.6.) are reserved for recreational purposes resulting from existing or potential resource characteristics. Special areas such as beaches, golf course and marine related activities are indicated on the map. In addition a table is provided in the HDGCSP indicating the set aside acreage for public parks. These parks shall be designed in the project plans to be coherent, connected and appropriate for open space and park uses. Areas should be adequate for the intended use. All uses within recreation districts should conform to the policies and regulations of the HDGCSP.

d. Scenic District. (SD) Scenic Districts are indicated on the Scenic Vista Districts Map (MAP # 3.4.3.), and are areas where visual intrusion of structures or utilities shall not detract from the natural scenic beauty of the area.

e. Wildlands Management Areas. (WD)
Wildlands Management Areas are overlay districts. Allowable uses and numbers of dwelling units, hotels or commercial uses as indicated on the Future Proposed Land Use Management Plan (Map # 3.5.1) are not precluded, however allowable development shall be encouraged to cluster such that at least 90 percent of the district, parcel by parcel, remains in an unaltered state. In addition, roads and utility corridors shall be constructed so as to minimize disruption of

the natural vegetative cover. Modifications of existing vegetation, land or water and wildlife habitat shall be allowed only in conjunction with a permitted development activity. The boundaries of Wildlands Management Areas are shown on the Wildlands Management Areas Map (Map # 3.5.4.).

3.3.3 **Terms Used in Section 3.3**

3.3.3.1 "Attached residential uses" means the use of common walls between or connecting dwelling units.

3.3.3.2 "Cluster housing" means assembling several detached dwelling units in close proximity to each other in a unified development plan on a single site, thereby preserving the density permitted in the particular land development intensity district while creating larger open spaces. The units may be connected by landscaping, walls or other unifying architectural elements.

3.3.3.3 "Commercial retail" means businesses established for retail sales of finished goods and products, including but not limited to food sales, restaurants, and related goods, and service including limited fuel for automobile services.

3.3.3.4 "Commercial wholesale" means limited warehousing and distribution businesses established to serve the supply needs of the retail, hotel and tourist market. Light manufacturing may be permitted by the SEP Board.

3.3.3.5 "Wildlands" means a portion of the landscape that is left undeveloped and set aside as wildlife habitat and remains a vestige of the previous unaltered landscape where human interface is kept to the minimum.

3.3.3.6 "Density" means the count of residential dwelling units permitted on the land and is always in terms of dwelling units per acre. For purposes of the PLUMP the land measure should include drive and road rights of way, automobile parking and service areas, building area, open space and recreational areas internal to the site.

3.3.3.7 "Detached residential uses" means traditional single family dwelling units built as separate structures.

3.3.3.8 "Floor area ratio" means the ratio of the total floor area of all buildings floors to the total area of the site or parcel (floor

area/site area=floor area ratio. FAR). The same unit of area must be used eg. square feet.

3.3.3.9 "Height of building" or "building height" means the height measured from the mean grade between highest and lowest grade at the base of the building to the upper most point of the roof or parapet wall. Excluded from the height shall be elevator rooms, solar collectors or other untenable roof structures.

3.3.3.10 "Hotel" means any building or group of buildings the business of which is letting rooms or suites to guests for short or long stays and the related facilities to provide complete guest services.

3.3.3.11 "Lot coverage" means the area of land occupied by the building.

3.3.3.12 "Multi-family" means any building or group of buildings containing two or more residential dwelling units including kitchen facilities, that is not a townhouse or cluster housing development.

3.3.3.13 "Professional and personal services" means the practice of law, medicine, pharmacy, architecture, engineering and other professional practices and the provision of services such as barbering, cobbling, laundering and dry cleaning and other services to individuals.

3.3.3.14 "Tourist facility" means commercial retail and services such as, but not limited to, boat, automobile, diving gear rental and guide services, all of which is related to sales and services provided for tourists.

3.3.3.15 "Townhouse residential" means individual dwelling units built with common walls separating units in a row or similar connecting configuration.

3.3.3.16 "Corridor", or wildlife corridor is a strip of unaltered land that connects larger areas of wildlife habitat which purpose is to allow the movement of wildlife from one area to another with minimum amount of disturbance or impedance to wildlife activity.

3.4 Goals and Objectives

3.4.1 Goals

3.4.1.1 The SEP Board recognizes that the SEP has unique environmental resources, the conservation of which is essential to maintain the natural diversity of plant and animal species and habitat, including those of economic value such as commercial and sport fisheries.

3.4.1.2 The SEP Board recognizes that to maximize tourism and related development opportunities, it is critical to; maintain diversity and aesthetic quality of the SEP; create a secure, safe and aesthetically pleasing land management and community environment; and minimize damage to structures by natural events such as hurricanes.

3.4.1.3 The SEP Board adopts the following goals for the PLUMP and the HDGCSP.

a. It is the goal of the SEP Board to adopt, amend as appropriate, and annually review the PLUMP, to monitor and evaluate the progress of land development and environmental protection of the SEP and to enforce the provisions of the PLUMP during the planning period of the next twenty years following the PLUMP adoption.

b. It is the goal of the SEP Board to develop the SEP in a manner that promotes the economic and social welfare of present and future residents and visitors of St. Kitts by means of conservative and judicious utilization of the irreplaceable natural resources of the SEP.

c. It is the goal of the SEP Board to guide development in a manner that preserves the environmental integrity, species diversity and scenic quality of the SEP; promotes development patterns that avoid areas of natural hazard, and minimizes cost and maintenance of public facilities and infrastructure.

3.4.2 **Objectives**

3.4.2.1 In order to achieve the goals of the PLUMP as far as is possible the SEP Board further adopts the following objectives for the PLUMP and the HDGCSP.

a. It is the objective of the SEP Board to preserve and protect natural habitat areas adequately to maintain the present diversity of plant and animal species on the SEP, including migratory wildlife such as birds and sea turtles, by establishing districts for resource protection.

b. It is the objective of the SEP Board to maintain the present high quality and cleanliness of coastal waters, thereby preserving the habitat necessary for such irreplaceable resources as coral reefs and commercial and sport fisheries by establishing districts for resource protection.

c. It is the objective of the SEP Board to create development patterns and land uses which contribute to: the preservation of scenic vistas, the aesthetic quality of development, and the efficiency and convenience of both public and private services and commerce. Additionally, to encourage development that is coherent in design, complementary to existing and planned development, and of an architectural quality consistent with the historic traditions of St. Kitts and the values of its natural setting.

d. It is the objective of the SEP Board to plan for locations and, as appropriate, provide the proper level and timely provision of public facilities and services for sewage collection and treatment, water supply, storm drainage, flood protection, solid waste management, culture and recreation, education, health care and governmental administration.

e. It is the objective of the SEP Board to establish policies and regulations covering the location, design and construction of buildings and structures to minimize the potential for damage to property and life by events such as wave action and storm surge, flooding, land slippage, wind and fire. In the case of public facilities, the objective is also to minimize the need for costly repair and maintenance.

f. It is the objective of the SEP Board to maximize the positive economic and social benefits of development to the Nation and integrate the development of the SEP within the overall context of National socio-economic interests.

g. It is the objective of the SEP Board to balance the need to protect the natural environment and to manage land development for the benefit of the nation, against the need to accommodate the vested rights of landowners and citizens.

h. It is the objective of the SEP Board to monitor and evaluate the implementation of the PLUMP and the HDGCSP and make appropriate changes over time in the substance and enforcement measures as needed to achieve these goals and objectives.

i. It is the objective of the SEP Board to develop appropriate procedures to accomplish these goals and objectives and assist the Minister in the administration of other National laws regarding land development and environmental protection of the SEP.

3.5 Proposed Land Use Management Plan Maps

The maps in this section are an integral part of the PLUMP and the HDGCSP and shall be considered as complementary provisions, including map notes and descriptive material. Boundaries shown on the maps shall be considered to be generalized for the scale is a limiting factor. Any specific interpretations will be resolved by the SEP Board or the Minister. The PLUMP maps are based on the reports and recommendations of the scientists and consultants found in the Resource Management Plans, November 1988.

3.5.1 **Future Land Use Management Plan Map**
3.5.2 **Conservation Districts Map**
3.5.3 **Scenic Vista Districts Map**
3.5.4 **Wildlands Management Areas Map**
3.5.5 **Natural Hazards Map**
3.5.6 **Recreation Area Map**
3.5.7 **Public Facilities Map**

MAP 3.5.1

FUTURE LAND USE MANAGEMENT PLAN

SOUTHEAST PENINSULA
ISLAND OF ST. KITTS

Development Strategies for Fragile Lands:

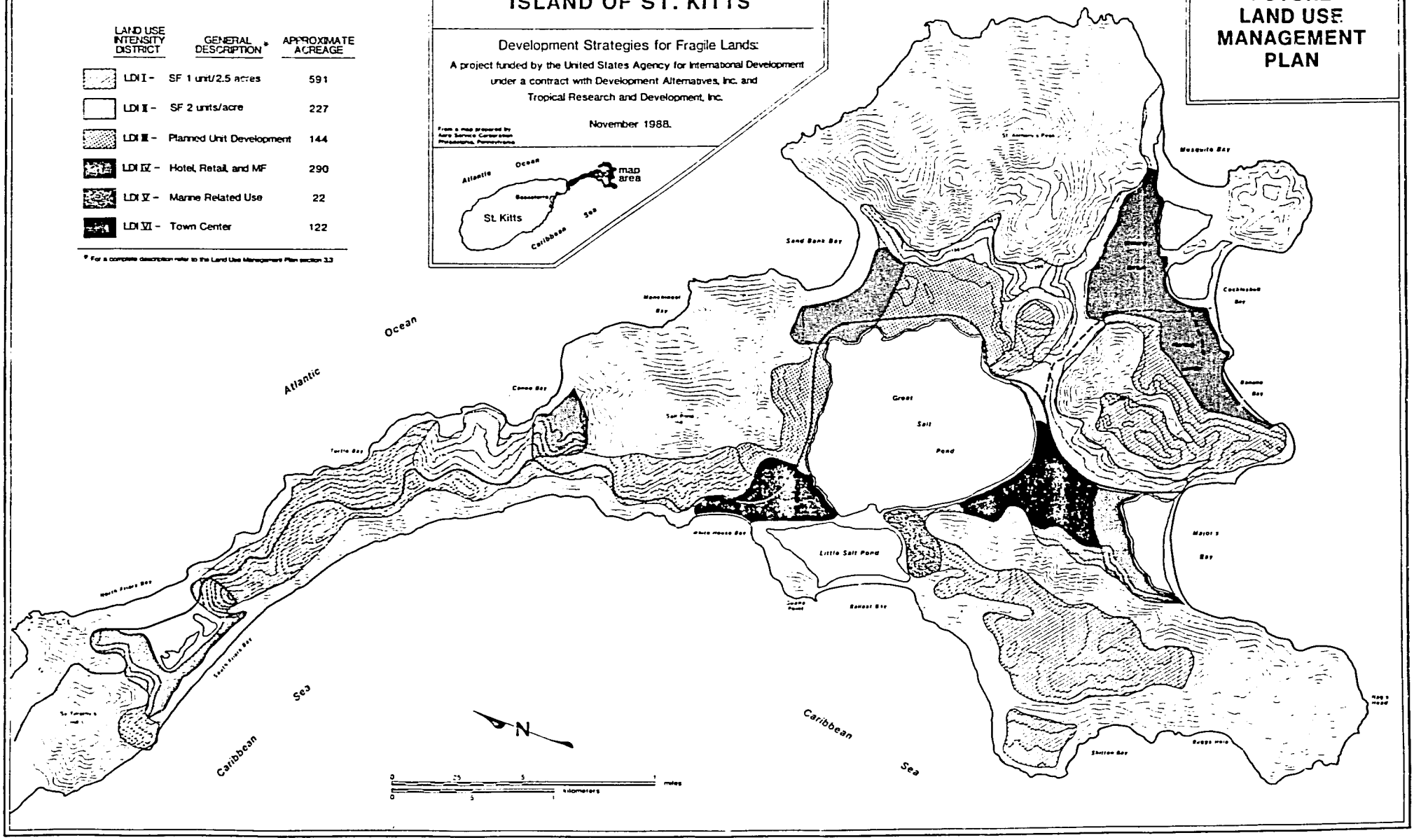
A project funded by the United States Agency for International Development under a contract with Development Alternatives, Inc. and Tropical Research and Development, Inc.

November 1988.

From a map prepared by Aero Service Corporation Philadelphia, Pennsylvania

LAND USE INTENSITY DISTRICT	GENERAL DESCRIPTION *	APPROXIMATE ACREAGE
LDI I -	SF 1 unit/2.5 acres	591
LDI II -	SF 2 units/acre	227
LDI III -	Planned Unit Development	144
LDI IV -	Hotel, Retail, and MF	290
LDI V -	Marine Related Use	22
LDI VI -	Town Center	122

* For a complete description refer to the Land Use Management Plan section 3.3

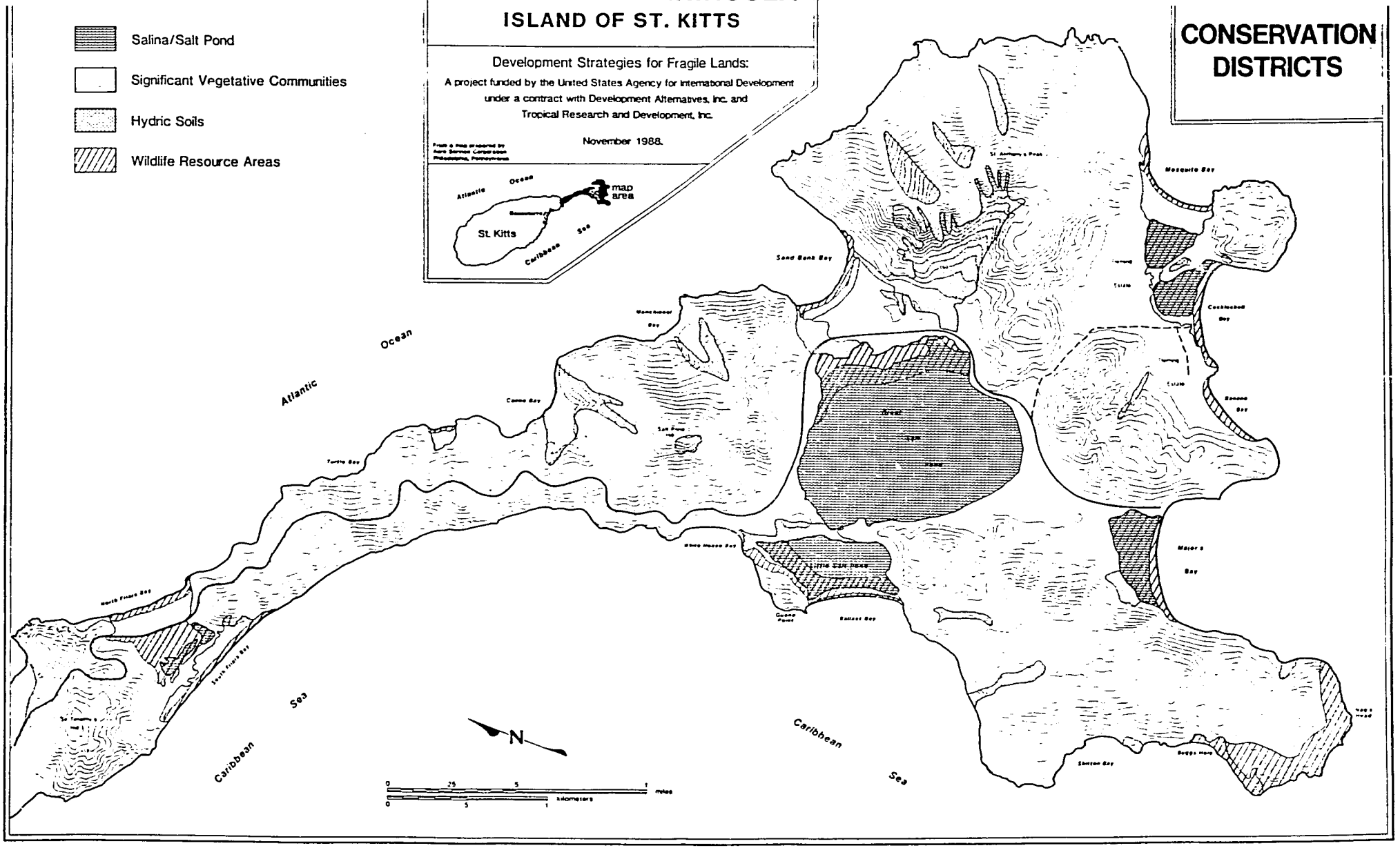


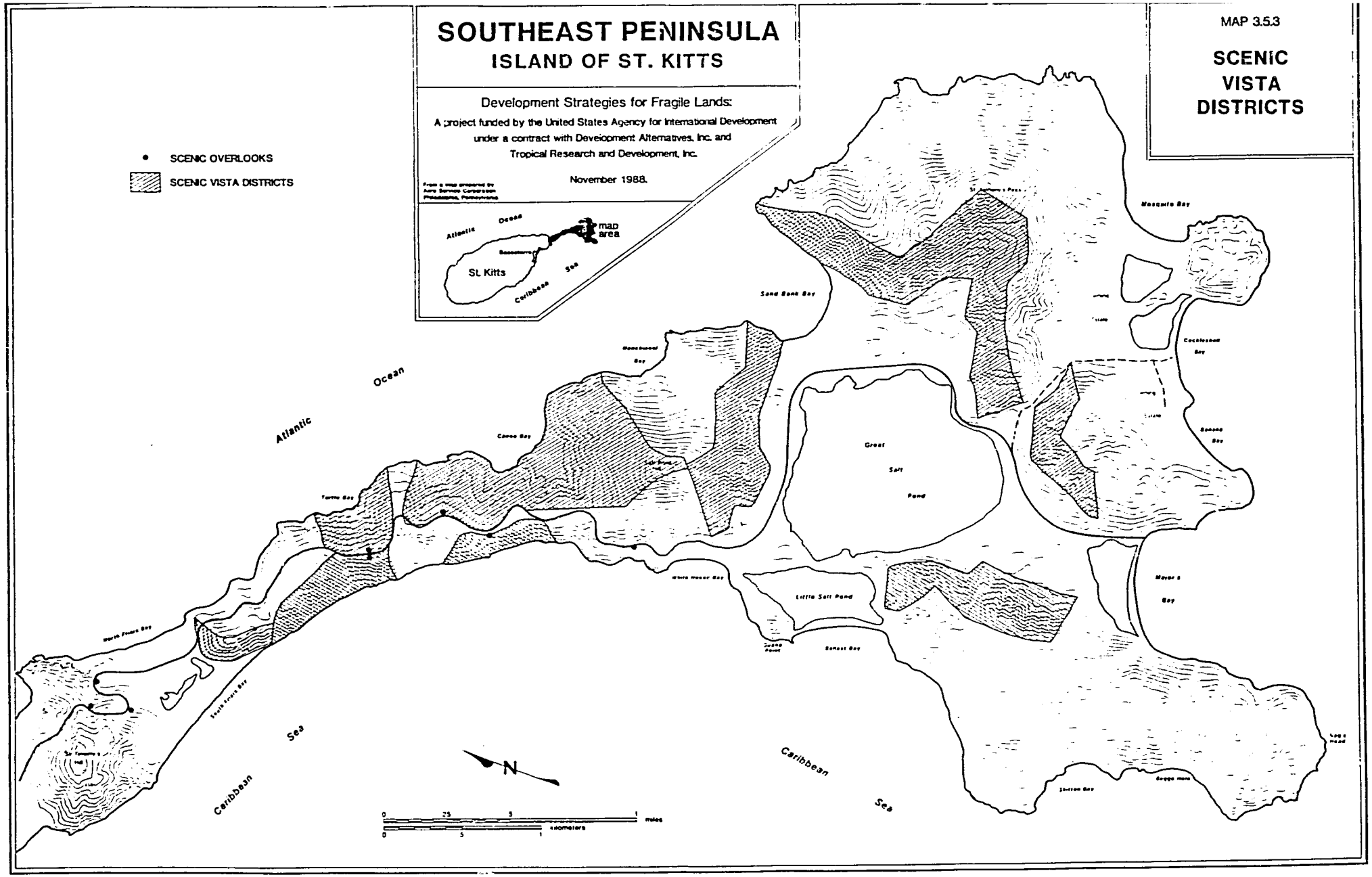
SOUTHEAST PENINSULA
ISLAND OF ST. KITTS

Development Strategies for Fragile Lands:

A project funded by the United States Agency for International Development under a contract with Development Alternatives, Inc. and Tropical Research and Development, Inc.

November 1988.




SOUTHEAST PENINSULA
ISLAND OF ST. KITTS
Development Strategies for Fragile Lands:
A project funded by the United States Agency for International Development
under a contract with Development Alternatives, Inc. and
Tropical Research and Development, Inc.
November 1988.
MAP 3.5.3
SCENIC VISTA DISTRICTS
SCENIC OVERLOOKS
SCENIC VISTA DISTRICTS
map area
St. Kitts
Atlantic Ocean
Caribbean Sea
Sand Bank Bay
Mosquito Bay
Cockleshell Bay
Great Salt Pond
Little Salt Pond
Mayor's Bay
Sunset Bay
Shelton Bay
Turtle Bay
North Frigate Bay
South Frigate Bay
N
0 .25 .5 1 miles
0 .5 1 kilometers

MAP 3.5.4

WILDLANDS MANAGEMENT AREAS

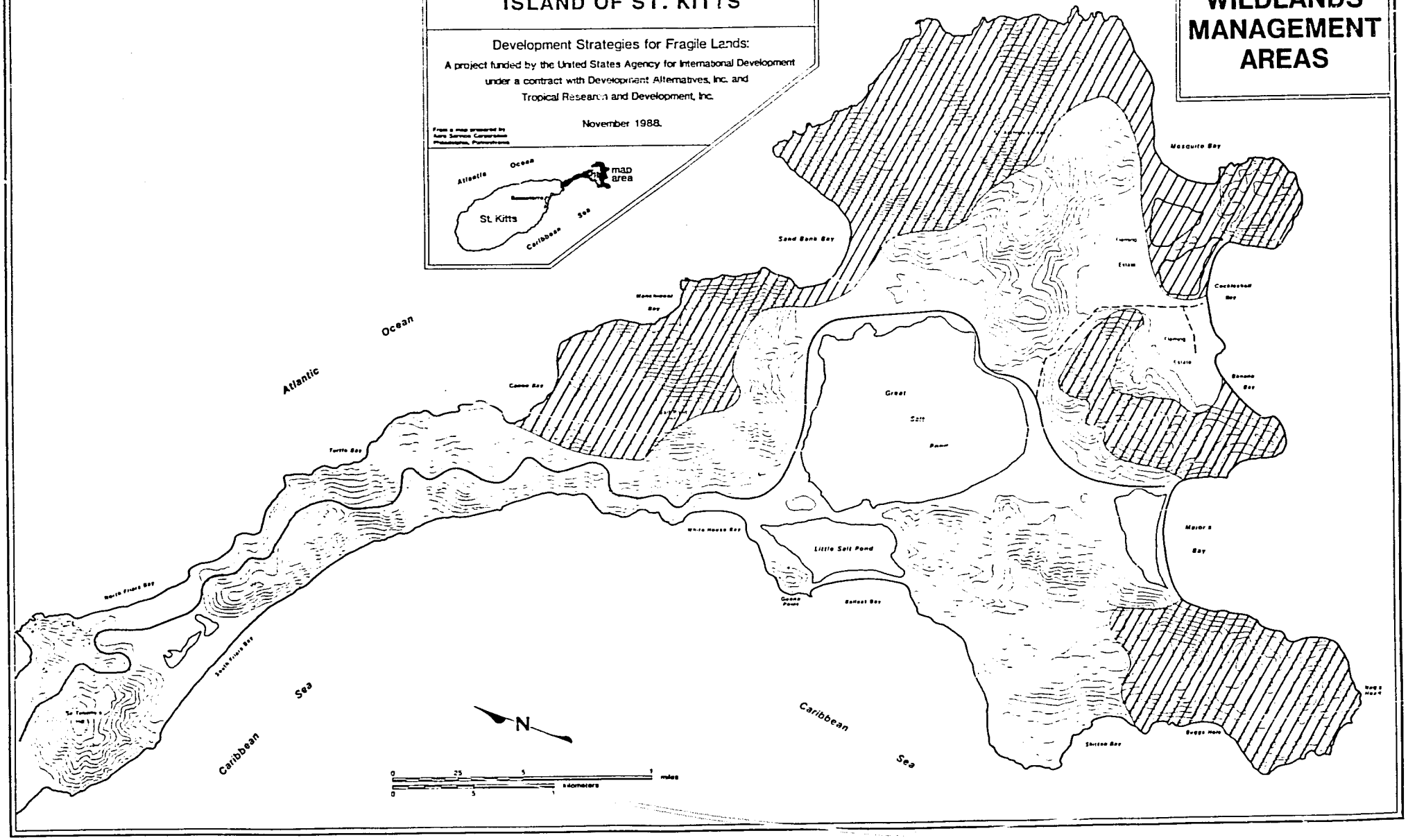
SOUTHEAST PENINSULA
ISLAND OF ST. KITTS

Development Strategies for Fragile Lands:

A project funded by the United States Agency for International Development under a contract with Development Alternatives, Inc. and Tropical Research and Development, Inc.

November 1988.

From a map prepared by Aerial Services Corporation Philadelphia, Pennsylvania



SOUTHEAST PENINSULA
ISLAND OF ST. KITTS

Development Strategies for Fragile Lands:

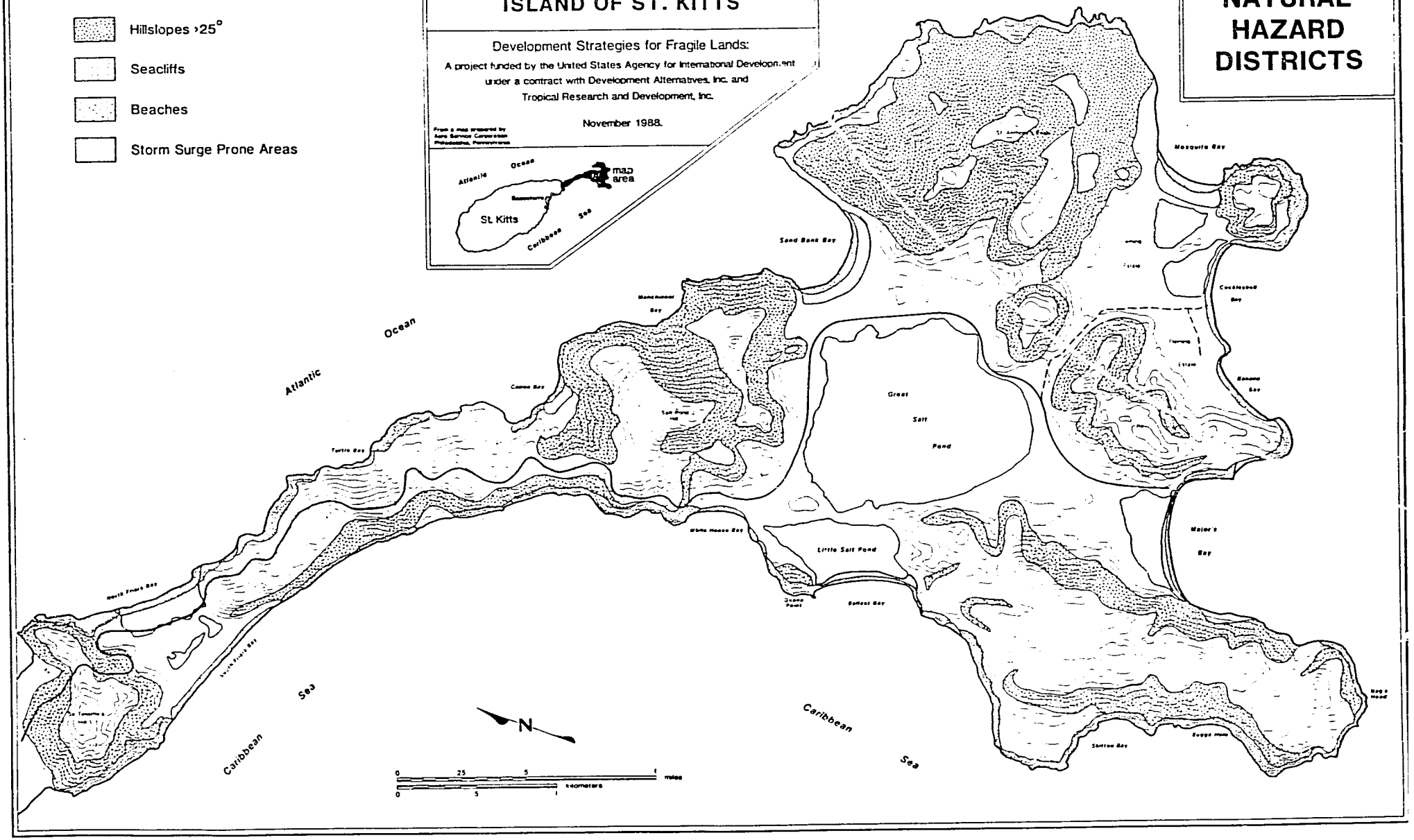
A project funded by the United States Agency for International Development under a contract with Development Alternatives, Inc. and Tropical Research and Development, Inc.

November 1988.

From a map prepared by Aero Service Corporation Philadelphia, Pennsylvania

NATURAL HAZARD DISTRICTS

- Hillslopes >25°
- Seacliffs
- Beaches
- Storm Surge Prone Areas



MAP 3.5.6

SOUTHEAST PENINSULA
ISLAND OF ST. KITTS

Development Strategies for Fragile Lands:

A project funded by the United States Agency for International Development under a contract with Development Alternatives, Inc. and Tropical Research and Development, Inc.

November 1983.

From a map prepared by Aero Service Corporation Philadelphia, Pennsylvania

RECREATION DISTRICTS

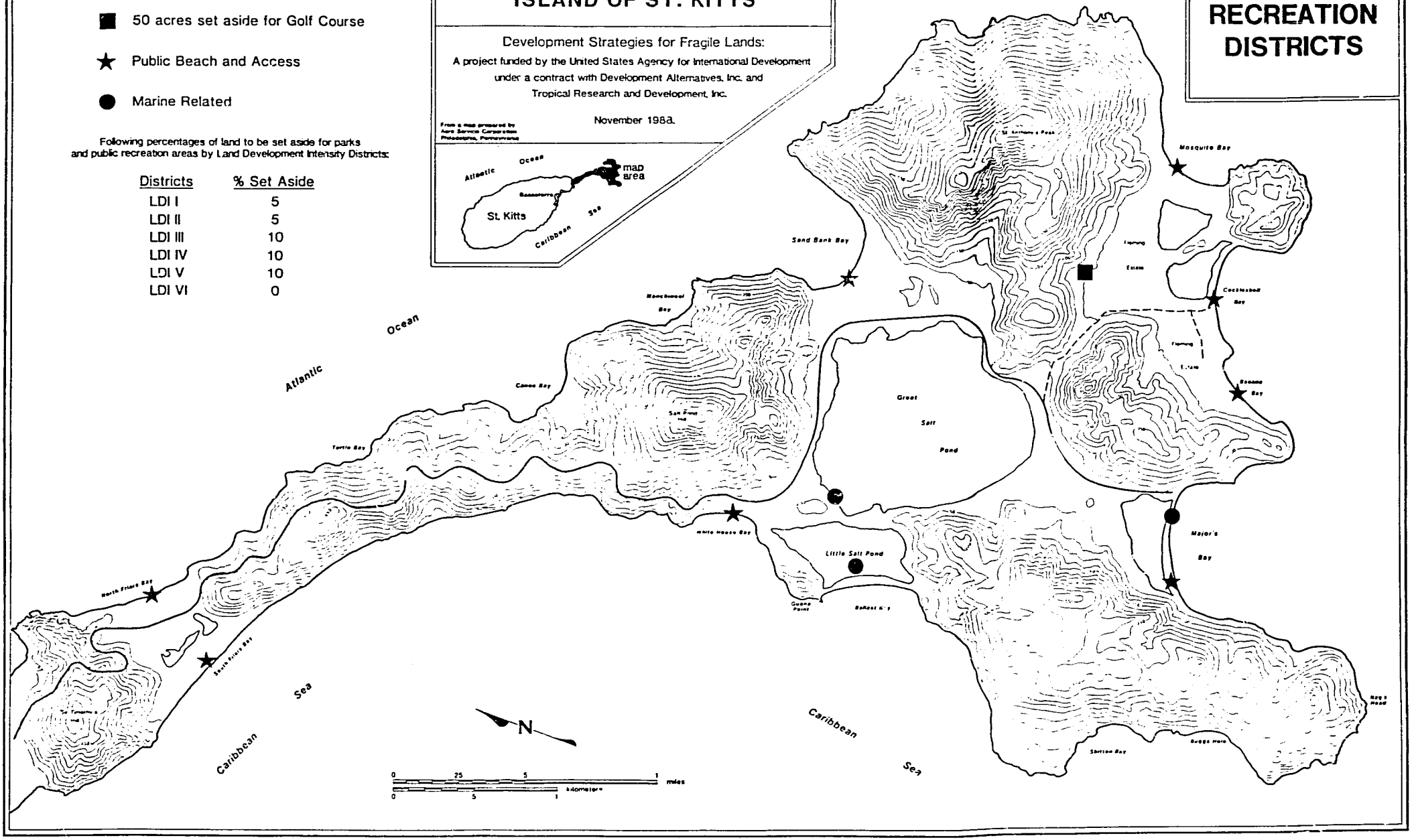
■ 50 acres set aside for Golf Course

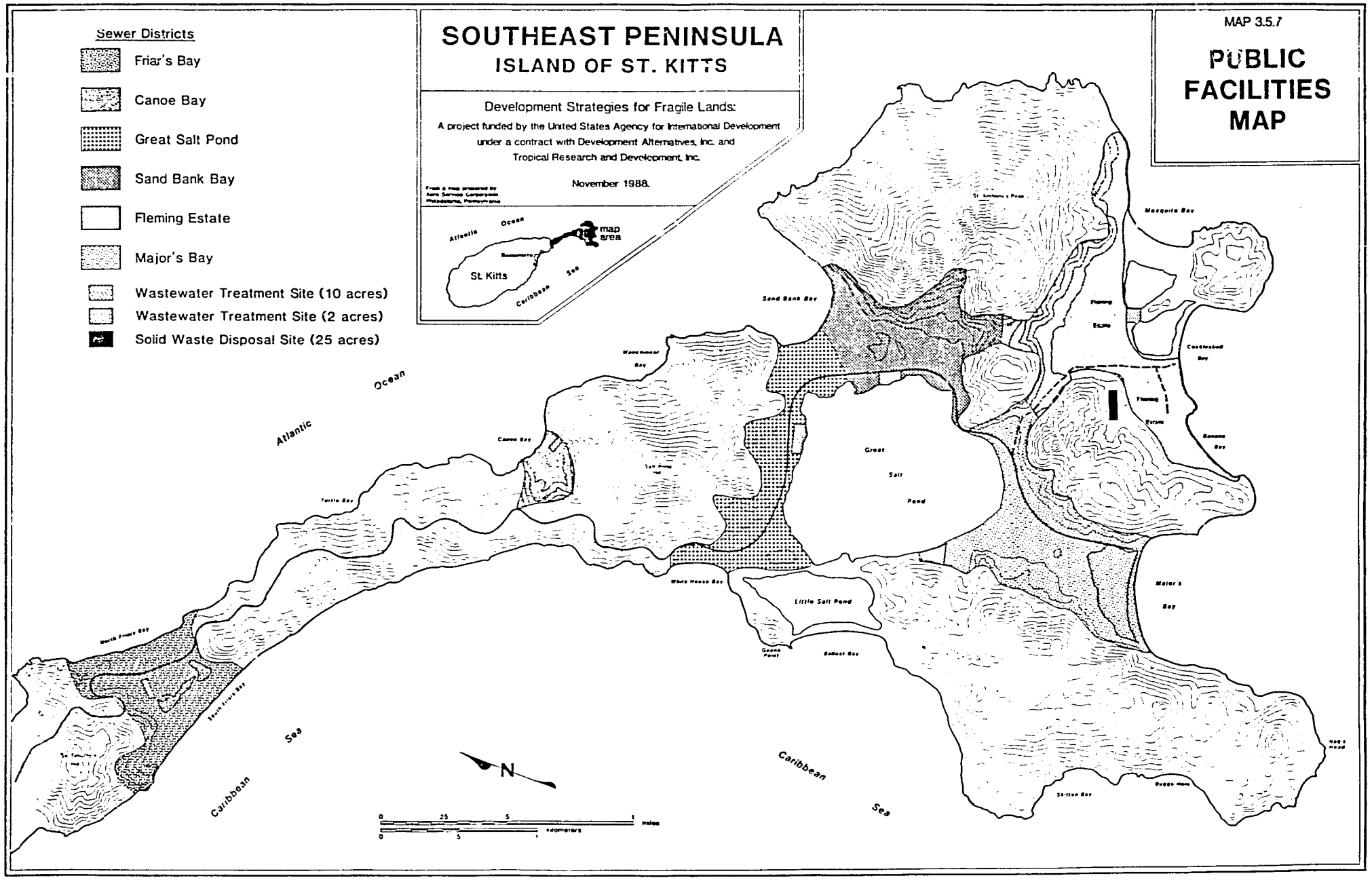
★ Public Beach and Access

● Marine Related

Following percentages of land to be set aside for parks and public recreation areas by Land Development Intensity Districts:

Districts	% Set Aside
LDI I	5
LDI II	5
LDI III	10
LDI IV	10
LDI V	10
LDI VI	0




MAP 3.5.7
PUBLIC FACILITIES MAP
SOUTHEAST PENINSULA
ISLAND OF ST. KITTS
Development Strategies for Fragile Lands:
A project funded by the United States Agency for International Development under a contract with Development Alternatives, Inc. and Tropical Research and Development, Inc.
November 1988.
Sewer Districts
Friar's Bay
Canoe Bay
Great Salt Pond
Sand Bank Bay
Fleming Estate
Major's Bay
Wastewater Treatment Site (10 acres)
Wastewater Treatment Site (2 acres)
Solid Waste Disposal Site (25 acres)
Atlantic Ocean
Caribbean Sea
St. Kitts
map area
Sand Bank Bay
Canoe Bay
Turtle Bay
North Friars Bay
Great Salt Pond
Little Salt Pond
White House Bay
Major's Bay
Mosquito Bay
Cockleshell Bay
Banana Bay
N
0 25 5 1 miles
0 5 1 kilometers

3.6 Procedural Requirements

3.6.1 Adoption

The PLUMP is hereby recommended for adoption by the SEP Board pursuant to the provisions of the Southeast Peninsula Land Development and Conservation Act, 1986, particularly Section 5. The SEP Board shall submit the PLUMP to the Minister in accordance with the provisions of the Land Development (Control) Act, 1966, and with the approval of the Minister, the SEP Board shall regulate developmental activity in the Southeast Peninsula. During the evaluation and review process and with the approval by the Minister, the SEP Board may make the PLUMP available for public inspection and may receive written comments or recommendations.

3.6.2 Amendments

3.6.2.1 The PLUMP may be amended by the SEP Board based on application by a citizen or upon an action by the Minister or other appropriate government official or upon an action by the SEP Board. The SEP Board shall not act upon applications more frequently than annually, except in the event of an emergency that may affect the safety, health and welfare of the citizens of St. Kitts and Nevis.

3.6.2.2 Any amendment application, or action, shall be supported by an application for PLUMP amendment showing specifically the nature of the request, the specific proposed amendment to the PLUMP and a written report setting out the reasons and justifications for the proposed amendment. The SEP Board shall accept, modify, or reject the amendment in a timely fashion. The SEP Board shall provide written findings and conclusions in support of its action. Any amendments to the PLUMP shall be subject to the adoption process as provided for in 3.6.1 above.

3.6.2.3 Any amendments that are adopted in the PLUMP shall be reviewed for necessary changes in the HDGCSP and the SEP Board shall take appropriate steps to restore consistency between the provisions of the PLUMP and the HDGCSP.

3.6.3 An annual review of the PLUMP shall be prepared by the SEP Board at the end of each calendar year. The review shall be written in a report to the Minister and shall contain an evaluation of the development of the SEP, the effectiveness of the provisions in the PLUMP, changes PLUMP and changes in the HDGCSP made during the review period and practical experience with the enforcement of the regulations.

HANDBOOK OF DEVELOPMENT GUIDELINES AND CONSIDERATIONS FOR THE SOUTHEAST PENINSULA

by

Earl M. Starnes, Ph.D.
Mark T. Brown, Ph.D.
William Timmins

June 1989

Prepared for the U.S. Agency for International Development under U.S.A.I.D. Contract # DHR 5438-C-00-6054-00

409

TABLE OF CONTENTS

1.0 INTRODUCTION 1
- 1.1 Purpose 1
- 1.2 Relationship Between HDGCSP and PLUMP 1
- 1.3 Legal Authority 1
- 1.4 Related Acts 2
- 1.5 Adoption 2
- 1.6 Amendments 2
- 1.7 Severability 2
- 1.8 Policies of the HDGCSP 2
  - 1.8.1 Create and Preserve a Quality Environment 3
  - 1.8.2 Promote Economic Growth 3
  - 1.8.3 Sustain Long-Term Development for the Future of St. Kitts-Nevis 3
  - 1.8.4 Balance Public and Private Interests 3
  - 1.8.5 Protect Environmental Values 4
  - 1.8.6 Conservation District (CD) 5
  - 1.8.7 Recreation Districts (RD) 6
  - 1.8.8 Scenic Vista District (SVD) 7
  - 1.8.9 Wildlands Management Areas (WD) 7
  - 1.8.10 Hazards Districts (HD) 8
  - 1.8.11 Marine Resources 8

2.0 DEFINITIONS 10
- 2.1 Reference to PLUMP 10
- 2.2 HDGCSP Definitions 10
- 2.3 Rules of Interpretation 11

3.0 PROCEDURAL REQUIREMENTS FOR DEVELOPERS 12
- 3.1 General Procedures and Requirements 12
- 3.2 Application for Development Approval 13
  - 3.2.1 Procedure for Development Approval 13
  - 3.2.2 Required Submissions for Application for Development Approval 14
- 3.3 Application for Site Development Permit 18
  - 3.3.1 Procedure for Site Development Approval 18
  - 3.3.2 Required Submissions for Site Development Approval 19
- 3.4 Appeals to Regulation 21
- 3.5 Enforcement 21

4.0 LAND DEVELOPMENT REGULATIONS 22
- 4.1 Land Subdivision 22
- 4.2 Public Facilities Requirements 22

4P

4.2.1 **Access, Internal Development Roads, Foot Paths, and Bicycle Trails** 22
4.2.2 **Water and Sewer** 24
4.2.3 **Electric and Telephone Services** 25
4.2.4 **Drainage** 25
4.2.5 **Solid Waste Disposal** 26
4.2.6 **Caribbean Uniform Building Code** 26

5.0 SITE DEVELOPMENT REGULATIONS 27
5.1 General Regulations for Site Development 27
5.1.1 **Buildings and Sites** 27
5.1.2 **Parking Requirements - General** 27
5.1.3 **Landscaping Regulations** 28
5.1.4 **Fire Fighting Provision** 29
5.1.5 **Slopes** 30
5.2 Land Development Intensity Districts 30
5.3 Public Facilities Districts 31
5.3.1 **Sewer Districts** 31
5.3.2 **Solid Waste Disposal Site** 32
5.3.3 **Water Distribution** 32
5.4 Natural Resource Protection and Recreation Districts 32

4/11

1.0 INTRODUCTION

1.1 Purpose

The Handbook of Development Guidelines and Considerations for the Southeast Peninsula (HDGCSP) contains the Southeast Peninsula (SEP) development policies and regulations. These policies and regulations are complementary to the goals and objectives of the Proposed Land Use Management Plan for the Southeast Peninsula (PLUMP) and have been established to guide the development of the SEP natural resources to protect important amenities for enjoyment by local residents and tourist guests, and to permit development in a safe, economical, organized, and environmentally sound manner.

1.2 Relationship Between HDGCSP and PLUMP

These policies have been established to achieve the types of desired development patterns outlined in the PLUMP. It is the PLUMP that establishes the overall land management goals and objectives and the HDGCSP that provides specific policies and regulations to be followed to achieve the goals and objectives. Together these documents should result in siting, design and construction practices that are in harmony with both human and natural environmental needs, resulting in successful development. The maps in Section 3 of the PLUMP are part of this HDGCSP.

1.3 Legal Authority

1.3.1 The Southeast Peninsula Land Development and Conservation Board (SEP Board) is a government authority created by an Act of the National Assembly of the Government of St. Kitts and Nevis (The Southeastern Peninsula Land Development and Conservation Act, No. 12 of 1986); the Act provides for the rational development, conservation and management of that area in the Parish of St. George, Basseterre extending from the boundary of the Frigate Bay Development Area to the extremities of Nag's Head and Scotch Bonnet, on the island of St. Kitts.

1.3.2 With the concurrence of the Minister for Planning and Development, the provisions of this HDGCSP are binding on all parties engaged in building, developing or otherwise altering the physical and biological attributes of the SEP unless and until overruled by higher authority or modified by the SEP Board with regard to a specific request for variance in accordance with provisions stipulated in Section 3.4.

1.4 Related Acts

1.4.1 Related acts include the National Conservation and Environment Protection Act, of 1987, when this Act becomes effective by Notice published in the Gazette. Development framework is established in the Building Act (Ch. 284, 1943), the Roads Act (Ch. 268, 1912) and the Land Development (Control) Act (No. 15, 1966).

1.4.2 Land developers are advised that these National Laws may have procedures and requirements that supercede the HDGCSP and the PLUMP.

1.5 Adoption

The HDGCSP is adopted by the SEP Board in accordance with the statutory provisions of the Southeast Peninsula Land Development and Conservation Act, 1986. This Act requires the SEP Board to review and advise the Minister on all matters having to do with development on the SEP, and specifically with regard to land use management regulations, environmental protection, and land use guidelines in accord with Sections 4-8 of the aforementioned Act.

1.6 Amendments

There shall be a regularly scheduled review and evaluations by the SEP Board of the development guidelines with the objective of continually updating the guidelines to keep pace with new situations as they arise and to incorporate any changes the SEP Board may recommend to the PLUMP. In the event that such situations arise within a proposed development which is not fully dealt within the guidelines, the SEP Board reserves the right to present recommendations to deal with these situations. These recommendations will be binding.

1.7 Severability

If for any lawful reason regarding conflict with National Law or adjudication any section or subsection is found to be in violation of such National Law or court order, it shall not affect the remainder of the provisions of the HDGCSP.

1.8 Policies of the HDGCSP

The policies of the HDGCSP are drawn from the goals and objectives of the PLUMP and are considered minimum policies to forward the intent of PLUMP.

1.8.1 **Create and Preserve a Quality Environment**

1.8.1.1 Preserve the outstanding natural features and environmental attributes of the SEP and the uniqueness of its physical setting in the Caribbean region, making the area a showpiece of innovative development.

1.8.1.2 Protect the fragility of the natural environment of the SEP and its near shore waters because of topographic features, microclimate considerations, and edaphic features.

1.8.1.3 Enable St. Kitts-Nevis to create a world-class example of quality development through the actions of a Government committed to exercising firm controls over development to ensure sustainable long-term benefits.

1.8.2 **Promote Economic Growth**

1.8.2.1 Develop the SEP to create significantly higher levels of job and income generation for St. Kitts-Nevis, and improve stability of income and employment opportunity.

1.8.2.2 Develop the SEP to create positive secondary impacts on the entire St. Kitts-Nevis economy.

1.8.2.3 Develop opportunities for training in order to upgrade labor force skills in the construction, services and management sectors, of the St. Kitts-Nevis economy.

1.8.3 **Sustain Long-Term Development for the Future of St. Kitts-Nevis**

1.8.3.1 Strike a balance between economic growth and environmental protection by following a disciplined and even-handed approach to the development of the SEP.

1.8.3.2 Make development decisions, taking the long-view, incorporating a nation-building perspective that recognizes the SEP as an irreplaceable natural asset which, if carefully managed, will accrue to the peoples of St. Kitts-Nevis for generations to come.

1.8.4 **Balance Public and Private Interests**

1.8.4.1 The SEP should be regarded as a public trust. Even though the land is privately owned, its commercial value is solely the result of Government investments and bilateral international assistance intended to benefit the Nation as a whole.

Regulation is needed to protect the public interest. The guidelines incorporated in the HDGCSP are not intended to create a bureaucratic maze which discourages development. Its procedures stress the importance of even-handedness; of requiring high quality design and infrastructure of all developers; and of requiring the participation of qualified and objective professionals in reviewing developer plans before they are presented to the SEP Board.

1.8.4.2 Explore opportunities for innovation and creative design. The best developers will insist on--not resist--high standards in order to protect their own investments. There are already ample indications that some of the most talented architects and landscape architects are being retained as consultants by the private sector in developing plans and proposals to bring development to the SEP.

1.8.5 **Protect Environmental Values**

1.8.5.1 Areas that have natural limitations to development or sensitive environmental characteristics that deserve protection shall be developed only within the constraints of those natural limitations. Examples of these areas include guts, wetlands, prime examples of dry forest, wildlife resource areas, beaches and dunes, areas of significant scenic quality, and salt ponds. The following overlay districts are created in the PLUMP to protect these resources:

a. Conservation District (CD);
b. Recreation District (RD);
c. Scenic Vista District (SVD);
d. Wildlands Management Areas (WD);
e. Hazard District (HD)

1.8.5.2 Removal of vegetation and trees within SEP shall be discouraged to prevent erosion and protect scarce vegetation resources, except as needed for permitted development activities.

1.8.5.3 Significant archaeological sites shall be identified and protected from destruction, or their destruction shall be mitigated by data recovery by a qualified archaeologist.

1.8.5.4 Habitats of endangered plants and animals shall be protected from encroachment by development.

1.8.5.5 Development occurring along the edges of Conservation, Recreation, Scenic Vista, and Wildlands Management Areas shall be designed to

protect and minimize the impact of development on the adjacent district.

1.8.5.6 The significance of topography, vegetation, soils, and wildlife resources for a particular site will be determined during the development review process, through an application for development approval submitted by the applicant for the development.

1.8.5.7 The spread of wildfires shall be discouraged by the effective incorporation of fire breaks in the design of roadways and other development. Vegetation shall be maintained to mitigate the potential of wildfire in areas where fire hazard is significant.

1.8.6 **Conservation District (CD)**

1.8.6.1 Land is deemed to be a conservation district if it possesses one or more of the following characteristics:

a. Vegetation - areas containing the following vegetation communities:

1. mangroves
2. mature dry forests
3. beach and dune vegetation

b. Soils - areas containing hydric soils

c. Wild Animal Areas - areas of known significant use for breeding, nesting, or feeding by wild animals or birds.

1.8.6.2 The following uses will be permitted in Conservation Districts:

a. Public and private recreation and open space uses that do not significantly alter natural vegetation and topography, except as otherwise provided for in Section 1.8.10.2.

b. Public and private wildlife preserves and refuge areas.

1.8.6.3 Developable land deemed to be a Conservation District within a proposed development or parcel of land shall be considered Land Development Intensity District I, even if not shown as such on PLUMP Map 3.5.1. However, the protection of conservation districts shall be implemented through the transfer of density from the Conservation District to other portions of the parcel or development, or other contiguous property under the same ownership.

416

1.8.6.4 Where development is permitted, the following conservation policies shall apply:

a. All site alterations shall be confined to the area with the least environmental constraints;

b. Site alterations and/or coverage by access roads, foot or bridle paths, and minor structures shall be limited to 5% of the total area within the Conservation District;

c. Existing vegetation shall be incorporated within proposed developments to the greatest extent possible;

d. Storm water runoff from developed areas shall be detained and directed to prevent erosion.

1.8.6.5 The extraction of sand or rock for any purpose from a Conservation District shall be considered inconsistent with sound conservation practices and shall not be allowed.

1.8.6.6 As a singular exception the development of marina facilities may be permitted in a conservation district subject to the limitation and standards in section 5.4.7.

1.8.7 **Recreation Districts (RD)**

1.8.7.1 Land is deemed to be a Recreation District if it possesses the following characteristics:

a. Designated portions of beaches - a measured portion of each beach (at least 10% and not more than 15%) shall be allocated for recreational purposes which may conflict with sound conservation practices. The remaining portions of each beach shall be a classified as a Conservation District;

b. Designated areas for golf courses as shown on PLUMP Map 3.5.6; and

c. Other areas as shown on PLUMP Map 3.5.6.

1.8.7.2 The following uses may be permitted within Recreation Districts:

Public and private recreational uses that significantly alter natural vegetation and topography such as: golf courses, tennis courts, ball playing fields, and intense use public beaches.

417

1.8.7.3 Where development is permitted, the following environmental policies shall apply:

a. All site alterations shall be confined to areas with the least environmental constraints;

b. Existing native vegetation shall be incorporated within proposed developments to the greatest extent possible; and

c. Storm water runoff shall be directed so as to insure that erosion or sedimentation of nearby and downstream areas does not occur.

1.8.7.4 The development of private lands for public recreational purposes shall be encouraged.

1.8.8 **Scenic Vista District (SVD)**

1.8.8.1 Land deemed to be within Scenic Vista Districts is depicted on the Scenic Vista District Map 3.5.3. In addition to the areas shown on the Scenic Vista Districts Map, the following areas and land features shall be considered visual amenities of special importance and shall not be developed except as the SEP Board may approve:

a. Bluffs;
b. Cliff faces;
c. Sea cliffs;
d. Ridge tops; and
e. Hill tops.

1.8.8.2 The scenic and visual qualities of coastal areas and identified hill sides, cliffs and bluffs shall be considered and protected as a resource of public importance. Permitted development shall be sited and designed to protect views, to be visually compatible with the character of surrounding areas, and shall not obstruct or otherwise interfere with views of designated scenic vista districts.

1.8.8.3 There shall be no development of the top 350 feet of all hills and ridges within scenic vista districts, unless specifically approved by the SEP Board.

1.8.9 **Wildlands Management Areas (WD)**

1.8.9.1 Lands designated as Wildlands Management Areas are important environmental resources.

118

1.8.9.2 The construction of arterial roads, and public facilities that cross wildlands areas shall be discouraged to the maximum extent possible.

1.8.9.3 The removal of vegetation, cutting of trees, land clearing, or burning of vegetation shall be discouraged to the maximum extent possible, and shall be allowed only in conjunction with a permitted development activity.

1.8.10 **Hazards Districts (HD)**

1.8.10.1 Hazards Districts are shown on PLUMP Map 3.5.5. Land is deemed to be a Hazard District if it possesses one or more of the following characteristics:

a. Topography - slopes greater than 25 degrees or 47%, and alluvial lands downslope of unstable guts;

b. Sea cliffs;

c. Storm surge prone areas.

1.8.10.2 Development inconsistent with prudent construction standards relative to slope, topography, coastal flooding and erosion shall be prohibited within hazard districts.

1.8.11 **Marine Resources**

1.8.11.1 Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.

1.8.11.2 The biological productivity and quality of the marine environment shall be maintained through, among other means, minimizing adverse effects of waste water discharges, encouraging waste water reclamation, controlling sedimentation from runoff, preventing substantial interference with surface water flows, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of near shore beaches, rocky shores and other habitats.

419

1.8.11.3 The diking, filling, or dredging of open coastal waters, wetlands, estuaries, and salt ponds shall be permitted in accordance with other applicable provisions, where there is no feasible less environmentally damaging alternative, and where feasible mitigation measures have been provided to minimize adverse environmental effects. These activities shall be limited to the following:

a. The construction of new marine related facilities designed and constructed in accordance with the PLUMP and HDGCSP as approved by the SEP Board.

b. Maintaining existing, or restoring previously dredged depths in existing navigational channels, turning basins, vessel berthing and mooring areas, and boat launching ramps.

c. In open coastal waters, the placement of structural pilings for public recreational piers.

d. Incidental public service purposes, including but not limited to, burying cables and pipes, inspection and maintenance of piers, and placement of navigational pilings or buoys.

1.8.11.4 Dredging and spoil disposal shall be planned and carried out to avoid significant disruption to marine and wildlife habitats and water circulation.

4/20

2.0 DEFINITIONS

2.1 Reference to PLUMP

All of the definitions found in Sub-section 3.2. and 3.3, of the PLUMP are made a part of HDGCSP and are binding as if they were incorporated herein.

2.2 HDGCSP Definitions

2.2.1 "Applicant" means a property owner or a representative authorized by the owner to speak or act on the owner's behalf.

2.2.2 "Application For Development Approval" means a written request for approval of a proposed use and development plan and for issuance of a development order.

2.2.3 "Application for Site Development Approval" means a written request for approval of a proposed development on a specific site and for a site development permit.

2.2.4 "Building Area" means an area within and bounded by the building lines (footprint) established by required yards and setbacks.

2.2.5 "Developer" is any land owner, agent for a land owner, person, or business entity, who proposes or causes any development to occur on the SEP.

2.2.6 "Dwelling unit" means one accommodation of one or more rooms arranged in a single structure housing a family, or closely related persons with provisions for preparing food, sleeping and other life necessities.

2.2.7 "Hydric Soils" means soils that are saturated more than two months of the year in seven out of 10 years, and are generally found within and adjacent to water bodies and wetlands.

2.2.8 "Parcel" means a particularly surveyed land area under a single ownership.

2.2.9 "Parking space" means a portion of the vehicle accommodation area specifically and permanently set aside for the parking of one (1) vehicle.

2.2.10 "Setback" means the minimum horizontal distance between the street, rear or side line and the front, rear or side lines of the building, including steps, terraces, or any projection thereof. When two (2) or more lots under one (1) ownership are used, the exterior property lines so grouped shall be used in determining setbacks.

421

2.2.11 "Sewer System" means any plant, system, facility or property used or useful or having the present capacity for future use in connection with the collection, treatment, purification or disposal of sewage and sewage effluent and residue from more than one dwelling or from any commercial or industrial establishment, and without limiting the generality of the foregoing definition, embraces treatment plants, pumping stations, intercepting sewers, pressure lines, mains, laterals and all necessary appurtenances and equipment and shall include all property, rights, easements and franchises relating to any such system and deemed necessary or convenient for the operation thereof.

2.2.12 "Signs" means any device, placard, billboard used for advertising sales or services at point of sale. No other signs will be approved except road and public notices.

2.2.13 "Site" means a specific surveyed building or development parcel of land.

2.2.14 "Transfer of Density" means that allowable land development densities in land development intensity districts may be transferred within the same parcel if an overlay district is more restrictive to development.

2.3 Rules of Interpretation

2.3.1 General. All provisions, terms, phrases and expression contained in these regulations shall be liberally construed in order that the true intent and meaning of the SEP Board may be fully carried out. Terms used in these regulations, unless otherwise specifically provided, shall have the meanings prescribed by the statutes of St. Kitts.

2.3.2 Computation of time. The time within which an act is to be done shall be computed by excluding the first and including the last day; if the last day is a Saturday, Sunday or legal holiday, that day shall be excluded.

2.3.3 In Writing. The term "in writing" shall be construed to include any representation of words, letters or figures, whether by printing or otherwise.

2.3.4 Boundaries. Interpretations regarding boundaries of land use districts shall be made in accordance with the following:

a. Boundaries shown as following or approximately following any street shall be construed as following the centerline of the street.

b. Boundaries shown as following or approximately following any plotted lot line or other property line shall be construed as following such line.

3.0 PROCEDURAL REQUIREMENTS FOR DEVELOPERS

3.1 General Procedures and Requirements

The procedural requirements for the orderly development of the SEP that will insure the timely and thorough review of development proposals involve a two step process. All development projects involving land parcels greater than 10 acres, involving the subdivision of a parcel into more than two parcels, or the construction of 2 or more dwelling units on a single parcel are subject to the procedures as set forth in Section 3.2 of the HDGCSP. All development projects of a single land parcel or unity of parcels combined for purposes of development are subject to the site development permit procedures as set forth in Section 3.3 of the HDGCSP. No Site Development Permit shall be reviewed or considered unless an approved Development Approval Permit is in order. The Site Development Permit Application may be considered simultaneously with the Development Approval Permit Application, if the SEP Board approves of the simultaneous review as provided in Subsection 3.1.3. of the HDGCSP.

3.1.1 Application for Development Approval. The first step in acquiring development approval is a written Notice of Intent submitted to the SEP Board. The second step is a meeting between the applicant and the SEP Board to provide the applicant with the necessary information that must be submitted for development approval. The third step in the development approval is the submission of an Application For Development Approval. The application shall contain pertinent information on the size and scope of the development and its environmental impact and other information enabling the SEP Board to evaluate the proposed development and insure that the development project is in keeping with the goals and objectives of the PLUMP and policies and regulations of the HDGCSP.

3.1.2 Application for Site Development Permit. The second permit required results from the submission of an Application for Site Development Permit. The application shall contain more detailed information on land use, landscaping, roads and parking, public facilities, building uses, and construction techniques and engineering, among other things. The review process for a Site Development Permit insures that the development project is in keeping with the development Approval Permit and the regulations for subdivision of lands and the regulations for site development of the HDGCSP.

3.1.3 Combined Applications for Development Approval and Site Development Permit. Under some circumstances it may be advantageous to submit an Application for Development Approval and Site Development Permit simultaneously. Where the development project is small in scale it may be appropriate to combine the applications. The SEP Board may review both applications simultaneously. However, the developer should be forewarned that combined applications require significant expenditures of time and money on detailed development design and engineering that may be

rejected, or endorsed with conditions. The two step process is designed to facilitate review and approval of development schemes to insure that the development project adheres to the goals, objectives and policies and regulations of the PLUMP, the HDGCSP, and the SEP Board, prior to undertaking detailed site design and engineering.

3.1.4 Each application received will be considered in relation to the PLUMP for the development of the Southeast Peninsula.

3.1.5 All plans and descriptive development notes may be viewed at the office of the SEP Board.

3.2 Application for Development Approval

3.2.1 Procedure for Development Approval

3.2.1.1 All developers shall apply to the SEP Board for development approval. The SEP Board shall receive a "notice of intent" in writing from the applicant for a proposed project.

3.2.1.2 Within 14 days a representative of the SEP Board at the option of the applicant shall meet with the applicant to review the proposed project.

3.2.1.3 A formal development application, based on the HDGCSP, including an Environmental Impact Assessment (EIA), shall be submitted to the SEP Board by the developer.

3.2.1.4 Within ten (10) working days after an Application for Development Approval has been received, the SEP Board shall determine whether the application contains all required information.

a. If the SEP Board determines that the application is not complete, a written notice shall be served on the applicant specifying the applications deficiencies. The SEP Board shall take no further action on the application unless the deficiencies are remedied.

b. If the application is determined to be complete, the SEP Board shall notify the applicant and review the project application. The evaluation focuses on the projected economic, social and environmental impacts of the proposed project; meetings might be held between SEP Board members or advisory personnel and the developer to secure additional information or to explore alternative development options.

3.2.1.5 Within 60 days, the SEP Board shall forward its rejection, endorsement, or endorsement with conditions, of the proposal to the Minister, along with the recommendations of any advisory personnel or agency.

3.2.1.6 The Minister may issue a Development Approval Permit based upon the SEP Board recommendations, or take a decision that is deemed lawfully appropriate.

3.2.2 **Required Submissions for Application for Development Approval**

3.2.2.1 Each application shall have seven (7) sets of plans, drawings, and reports accompanied by development and descriptive notes. These shall be deemed the Application.

3.2.2.2 All maps or site plans submitted to the SEP Board must include a north arrow and scale bar, legend showing all symbols, name of designer, project name, and owner's or developer's name. The following maps shall be required:

a. Location Map

b. Survey scale not less than 1:1000, showing position of the parcel or parcels in relation to the surrounding area and adjacent land within 1000', showing the names of adjacent property owners and property boundaries.

c. Topographical Map

Scale not less than 1:1000, preferably at the same scale as the location map, showing at a minimum 5 feet contour intervals for the land and surrounding area and adjacent land within 100'. The topographic map shall indicate all hazard areas including but not limited to, flood zones, gutts, cliffs, bluffs, and beaches. It also show any significant environmental features, such as hydric soils, sandy soils, trees and forest areas, and infrastructure such as roads, tracks and utilities.

d. Land Use Districts Map

Scale not less than 1:1000, preferably at the same scale as the previous maps, showing Land Use Intensity Districts and all other Districts from the PLUMP Maps found in the PLUMP.

e. Development Plan

Scale not less than 1:1000, preferably at the same scale as the previous maps, showing:

(1) Property boundary and ownership lines.
(2) General areas to be developed and affect on earth movement.
(3) Areas that are not to be developed
(4) Site ingress, and egress
(5) Locations of major infrastructure facilities such as access roads, internal roads, storm water system, sewage system, and other facilities including recreation areas.

3.2.2.3 Development or descriptive notes and reports shall include the following information:

a. Name of development
b. Name, address and telephone number(s) of owner(s) and/or developer(s) or local agent
c. Date of application
d. Description of the development to include:
(1) total land area;
(2) total existing and proposed development area;
(3) total proposed undeveloped area;
(4) total areas of various PLUMP designated land uses and proposed land uses;
(5) total number of proposed dwelling units and other buildings by type, use, and approximate floor area;
(6) calculation of floor area ratios;
(7) approximate cost of development;
(8) expected commencement date and completion date;
(9) project phasing and financial plan;
(10) for significant projects an economic impact analysis which shall include the impact on temporary and permanent employment, any special training programs for temporary or permanent employees, sources of development services and construction materials, governmental revenues to be generated by year of development, governmental costs to be incurred by year of development and estimated costs and benefits to the National economy during development and upon development completion;
(11) other relevant information.

e. A completed Environmental Impact Assessment (EIA). Which specifically addresses the following issues:

1. Flooding and drainage. Have watersheds been delineated and drainageways been located?

   Has the peak 50-year runoff flow been computed for each drainageway assuming that the upstream tributary area is fully developed?

   Has the peak runoff been routed through the existing and proposed guts to determine the depth of flooding? Will any of the proposed structures be affected by this flooding? Will there be a significant potential for loss of life in the event of flash flooding?

   What assumption has been used for the water level at the point of discharge for computation of flood flows? (The water level in the receiving body should be assumed to be higher than normal, as is likely to be the case during a severe flood.)

   Is the floor elevation of all living structures high enough to provide protection from flooding due to rainfall runoff or hurricane storm surge?

2. Conformance with the Proposed Land Use Management Plan for the Southeast Peninsula

   Is the proposed use and density compatible with the land use intensities?

   Is the required public access to the beach provided?

   Do structures comply with the minimum setback requirements?

   Does the planned development confirm with the requirements of overlay districts?

3. Environmental Protection: Wildlife

   Have adequate measures been taken to preserve wildlife? For instance, what shields and other lighting restrictions will apply on those beaches important for turtle nesting?

Who will be responsible for compliance, and what monitoring procedures will be used to insure that the proposed environmental controls are complied with?

4. Environmental Protection: Sediment Control

Submit a plan for sediment control, outlining the procedures to be used to minimize erosion and sedimentation during the construction and operational phases of the project. All areas affected by earth movement must receive permanent erosion protection. Areas not covered by concrete or asphalt must be re-vegetated. In the portion of the EIS addressing the sediment control plan, identify the plant species to be planted and whose responsibility it will be to undertake site re-vegetation.

Will stormwater discharges have any foreseeable adverse impact, such as sediment discharge to the reefs?

Is runoff from parking areas handled so that the potential for erosion will be minimized?

Does the grading plan minimize destruction in vegetation and changes in topography? Does it preserve sand dunes and the vegetation that protects the dunes?

Is the design of roadways and gut crossings satisfactory in terms of drainage and erosion control?

5. Traffic

Has adequate parking area been provided for the projected number of guests, employees and visitors? Is there a parking area available for public beach areas?

Is the design of roadways satisfactory in terms of safe and convenient transit?

6. Solid Wastes

Where will construction wastes be disposed of and who will be responsible for haulage to the disposal site?

What will be the solid waste volume generated during project operation? Will waste containers be placed at convenient places on the beach and other public areas? How frequently will wastes be collected and who will collect and haul the wastes?

7. Water and Sewer

Compute daily water use and indicate the reserve cistern capacity that is to be provided on-site.

Will pressure from the main water line be adequate, or will pumping and a storage tank be required to service high elevations? If a pump station and tank are provided, does the tank provide a two-day reserve?

How will liquid wastes be disposed of?. Is the proposed system of adequate size?

For septic tank systems, present the results of percolation tests and sizing computations.

What will be the sanitary and environmental consequences if the system does not operate as efficiently as designed? The treated effluent should be discharged into an area where the potential for human contact is minimized.

8. Construction Material

How much sand will be required for concrete and where will it come from?

3.3 Application for Site Development Permit

3.3.1 Procedure for Site Development Approval

All developers shall apply to the SEP Board for site development approval.

3.3.1.2 Within 14 days a representative of the SEP Board at the option of the applicant shall meet with the applicant to review the proposed project.

3.3.1.3 A formal site application, based on the HDGCSP, shall be submitted to the SEP Board by the applicant.

3.3.1.4 The site development application shall be referred to the SEP Board for study, evaluation and recommendations within 30 days according to procedural guidelines established by the SEP Board.

3.3.1.5 The SEP Board shall forward its rejection, endorsement, or endorsement with conditions, for the site plan to the Minister, along with the recommendations of any advisory personnel or agency.

3.3.1.6 The Minister may issue a Development Approval Permit based upon the SEP Board recommendations, or take a decision that is deemed lawfully appropriate.

3.3.2 **Required Submissions for Site Development Approval**

3.3.2.1 Seven (7) complete sets of drawings, or a number of sets as determined by the SEP Board, and site specifications shall be submitted to the SEP Board with descriptive development notes.

3.3.2.2 The applicant shall include evidence of the Development Approval Permit and all general and special conditions contained therein.

3.3.2.3 Drawings submitted to the SEP Board must include a north arrow and scale bar, legend showing all symbols, name of designer, project name, and owner or developers name. The following maps shall be required:

a. Location Plan

Scale not less than 1:1000, showing position of the site or parcel in relation to the surrounding area and adjacent land within 500'. This plan shall include approved land use intensity districts, overlay districts and leasehold/ownership boundaries.

b. Stormwater Drainage Map

Scale not less than 1:1000, preferably at the same scale as site plan, showing natural drainageways, computed 50 year peak discharge, and the principle aspects of the storm drainage system.

c. Vegetation Map

Scale not less than 1:1000, preferably at the same scale as the site plan, showing major vegetation communities, including but not limited to, mangroves, dry forests, scrub forests,

grass/acacia communities, areas dominated by guinea grass, salinea, dune vegetation communities, and open water.

d. Site Plan

At a scale not less than 1:1000, show:

(1) Boundary lines and dimensions along with all pertinent data regarding the lot and legal description;
(2) Building(s) and other structure locations, required setbacks, clearing lines, floor elevations, general overall dimensions of building(s), floor areas and uses, any other important features, and in dotted lines the layout of any planned additions;
(3) All utility lines on the property and connections to street utilities for water, telephone service and electricity;
(4) All existing physical features whether to remain or to be removed;
(5) Fences, structural retaining walls, walkways and pools;
(6) Storm drainage on both paved and unpaved areas. water catchment and drains;
(7) Sewage disposal: location of proposed system;
(8) Existing and finished ground elevations;
(9) Access to building(s) from off site roads or internal roads;
(10) Prevailing wind direction;
(11) Parking provision;
(12) Legend showing all symbols and construction materials to be used on the site;
(13) Name of designer;
(14) North arrow and scale box;
(15) Proposed vegetation removals and landscaping plan;
(16) Topography; and
(17) All other relevant information.

3.3.2.4 Descriptive development notes shall include information on the following:

(1) Name of development;
(2) Name, address and telephone number(s) of owner(s) and/or developer and/or local agent and date;
(3) Total land area of the proposed development;
(4) Computation of the 50 year runoff on all drainageways that cross the developed areas of the site and

demonstration of how this volume of runoff will be retained and routed across areas to be developed;

(5) Breakdown of land use intensities districts and overlay districts, land area under the various districts uses and leasehold/ownership map;

(6) Types and sizes of units and number of units including:
   (a) Floor area ratios
   (b) Number of stories (specifying height)
   (c) Density of dwelling units

(7) Approximate cost of building(s);

(8) Project phasing considerations;

(9) Expected commencement date;

(10) Statement of intended use of the site;

(11) Computation of water use and waste water generation, including water use for irrigation of landscaping.

(12) Solid waste disposal plan

(13) Completed environmental check list.

(14) All other relevant information.

3.4 Appeals to Regulation

3.4.1 Variances based on legal hardship from these guidelines may be granted by the SEP Board providing that the developer can satisfy the SEP Board, based on an advisory opinion of its professional staff, that the purposes and intent of these guidelines can only be achieved by the use of measures, techniques or approaches that differ from those which are specified in the HDGCSP or the PLUMP and that the application of these provisions is unique to the particular site and that the uniqueness is not self imposed.

3.4.2 In cases where the SEP Board does not approve of a developer's plan, the Minster may review the proposed project.

3.5 Enforcement

Any willful deviation from the policies and regulations in the HDGCSP without the express permission of the Minister will be considered a violation of the law of St. Kitts-Nevis and will be subject to administrative and/or judicial prosecution including but not limited to forfeiture of performance bonds or other such surety that may be required as a condition for proceeding with development. All developers applying for a Development Approval Permit or a Site Development Approval Permit shall be bound by all sections of the HDGCSP.

4.0 LAND DEVELOPMENT REGULATIONS

4.1 Land Subdivision

The subdivision of land into parcels shall be regulated in minimum sizes and dimensions of parcels as required in the detailed regulations for LDI Districts found in Subsection 5.2 of the HDGCSP. For purposes of ownership and parcel identification, a parcel numbering system and subdivision identification system shall be approved by the SEP Board. No subdivision of land into 2 or more parcels shall be permitted without conforming to all requirements of Sections 4 and 5 of the HDGCSP and without having an approved Development Permit.

4.2 Public Facilities Requirements

4.2.1 Access, Internal Development Roads, Foot Paths, and Bicycle Trails

4.2.1.1 Access, or curb cuts, to the Main SEP road shall be no closer than 2500' on one side and shall be located in such a manner as to be opposite any existing or proposed access point. If more access points are needed in a development, the developer shall be required to construct an internal development road.

4.2.1.2 All roads, except the main SEP road, shall be considered internal development roads, whether major, or minor two lane, or one lane. The pattern of road layout shall provide for efficiency, safety, including access for emergency and service vehicles, and access to all private parcels of land. The pattern shall provide for cross roads where necessary to be in alignment; no jogs. Cul-de-Sacs are encouraged in residential LDI Districts.

4.2.1.3 Major internal development roads having two lanes shall have a road reserve of 30 feet with a carriageway of 18 feet.

4.2.1.4 Minor internal development roads having two lanes shall have a road reserve of 24 feet with a carriageway of 16 feet.

4.2.1.5 One lane internal development roads shall have a road reserve of 18 feet with a carriageway of 8 feet.

4.2.1.6 Typical cross sections shall be approved by the SEP Board. Drawings shall be submitted for the different types of access roads showing relative elevations at centerline, edge of pavement or gutter line, top of curb or bottom of ditch, back of sidewalk or natural grade, as well as fallouts for surface course, base course, subsurfaces preparation or subgrade, curb and gutter and sidewalk material and thickness.

4.2.1.7 The SEP Board may determine the points of access from the road to the development's lots. Buildings, fences, walls or hedges that are located close to or on road corners or road junctions must be aligned and constructed in a manner that would not restrict the view of vehicles on the roads, or emerging from the lots.

4.2.1.8 Access roads shall have trees planted in irregular groups, at least 10 trees per hundred feet on the high side, and groups of at least five trees in every low spot where water runs off. Trees on the high side should be ornamental or shade trees where practical, or white cedar and shak-shak in dry or windy places. On the low side the trees should be clammy cherry where guinea grass is prevalent. Neem, casaurina, flamboyant, leucaena, white cedar and other appropriate species may be used where guinea grass is absent or controlled. Access roads should follow the natural contours of the site to avoid unnecessary cutting and filing.

4.2.1.9 Below the outfall of culverts and road dishes a pavement of rubble shall be laid or set so that a top rock overlaps and covers the inside half of the rock beneath. This rubble bed shall follow the diverted water course until it re-enters the old gut bed. If there is no old gut bed present, an apron of protective vegetation of khus-khus grass and trees may be used to spread the water.

4.2.1.10 All road fill slopes shall have khus-khus grass planted with sprigs one foot apart in rows along the contour which are less than three feet apart.

4.2.1.11 The SEP Board shall have road design and proposed subdivision layout reviewed by the St. Kitts government forester, a representative of the conservation commission, and an engineer selected by the SEP Board.

4.2.1.12 Internal development roads shall be located so as to avoid cutting through areas of dry forest where possible.

4.2.2.13 Roads shall be constructed to the widths shown in Subsections 4.2.1.3., 4.2.1.4., and 4.2.1.5. in the HDGCSP. Surface paving material shall be 2" thick asphaltic concrete, or 4" thick reinforced Portland Cement concrete. Base shall be 8" loose to 6" rolled and compacted base material that is acceptable to the Minister. For the asphaltic concrete surface, a complete hot asphalt tack coat shall be used. Curbs, gutters and water control structures where required to control storm water shall be made of reinforced Portland Cement concrete. The one lane access roads in residential districts are exempt from this paving provision if the SEP Board is assured that excessive

134

erosion will not result from the exemption. All roads shall have a minimum four-foot wide sidewalk. Where such extra width may cause additional damage to slopes or vegetation, the walk may be separated from the road paving and allowed to meander. All roads and sidewalks shall be lighted with acceptable standards and signed and marked for safe vehicle and pedestrian movements. Lighting shall be modified or eliminated on beaches where sea turtles may nest.

4.2.2.14 Foot Paths and Bicycle Trails. Foot paths shall be constructed in a manner which avoids, or mitigates the effect of storm water runoff. Bicycle trails shall be constructed of materials which provide for the safe and efficient use of the vehicle.

4.2.2 **Water and Sewer**

4.2.2.1 Providing a water distribution system with connections to all lots shall be the responsibility of the developer. Pipe sizes and construction techniques shall conform to the specifications and requirements of the St. Kitts Water Department.

4.2.2.2 Within Sewer Districts, and where an adequate sanitary sewer is reasonably accessible, each lot in a subdivided area shall be provided with a connection to the centralized system.

4.2.2.3 In all areas of the SEP the installation of low volume water conserving toilets shall be mandatory.

4.2.2.4 On shallow soil of sloping terrain where septic tank systems are allowed the following regulations shall apply:

(1) Septic tank systems shall consist of a two-chamber tank with appropriate drainfield, and sized using a average treatment capacity of 40 gpd/person.
(2) Septic tanks shall not be constructed on slopes greater than 10°.
(3) Hydraulic load shall not exceed 1 gpd/linear foot of drain.
(4) Drainpipe shall be installed along hill contours, and shall be 4 inch diameter PVC pipe with 1/2 inch diameter holes on the bottom and sides at intervals of at least four inches, or equivalent.
(5) A buffer zone of 300 feet of natural undisturbed vegetation between the drainage field and adjacent downslope property shall be maintained.

4.2.2.5 In areas of deep, poorly permeable soils where septic tanks are allowed, the following regulations shall apply:

135

(1) Drainfields shall be located in the highest percolation areas.

(2) Size drainfields trenches based on 40 gallons of wastewater per person per day, and using the application rate from the table below:

Percolation Test Rate (min./inch)	Wastewater Application Rate (gpd/ft² trench)
<1	not suitable
1-5	1.5
6-15	1.0
16-30	0.75
31-60	0.55
60-120	0.33
>120	not suitable

(3) When both water conserving toilets (less than 2.5 gallons per flush) and water conserving shower heads are installed, wastewater generation may be based on 25 gallons per person per day.

4.2.3 Electric and Telephone Services

Electric and telephone distribution lines and cables shall be located underground.

4.2.4 Drainage

4.2.4.1 Rainfall on a development site must be permitted to enter the natural drainage system as if the site were not developed. This water should not be led to the end of the site and discharged of, on or in front of a site that is owned by another, excepting discharge to a natural drainageway.

4.2.4.2 Watershed boundaries for all drainageways that cross a development site shall be delineated and peak 50-year runoff shall be calculated for each. The peak runoff calculations shall assume full development of all upslope portions of watersheds.

4.2.4.3 Detailed stormwater management plans shall be submitted by the project engineer certifying that the storm drainage system will adequately handle runoff entering the site from upslope, will dispose of runoff generated on-site, and will not cause damage to downstream areas due to excess water, or erosion.

430

4.2.4.4 In coastal and marine areas, hydraulic calculations for drainageways affected by the level of the sea shall be made by assuming a sea level three feet higher than its present normal level.

4.2.5 **Solid Waste Disposal**

4.2.5.1 Provision shall be made for a concealed bin storage of adequate capacity in an area or areas and provide access for removal.

4.2.5.2 The developer shall be responsible for providing garbage bins with suitable covers, which must be suitably protected against damage, spillage, and wildlife.

4.2.5.3 The developer shall make operational provisions for solid waste collection and disposal as approved by the SEP Board.

4.2.6 **Caribbean Uniform Building Code**

All construction of buildings shall conform to standards and methods adopted in the Caribbean Uniform Building Code; latest edition.

5.0 SITE DEVELOPMENT REGULATIONS

5.1 General Regulations for Site Development

The following matrix of Land Development Intensity (LDI) District site standards is given as a means of summarizing pertinent site development information concerning LDI Districts.

5.1.1 Buildings and Sites

5.1.1.1 Building Use. An application to the SEP Board is necessary for changing the use of the building.

5.1.1.2 Setbacks. Dwelling houses in LDI I and LDI II will be restricted as to the distance that will be allowed between the building and the boundaries containing the site. In all cases buildings must be set back enough to prevent a loss in the amount of daylight, view or to prevent harm to adjacent buildings. Cluster plans approved by the SEP Board may be exempt.

Front Setback - 10 ft. minimum
Side Setbacks - 10 ft. minimum
Rear Setback - 30 ft. minimum

5.1.1.3 Minimum Floor area. The minimum net floor space for individual residential units shall be 500 sq. ft. This should not include garage spaces, patios, balconies, porches, or terraces. The SEP Board will introduce flexibility when dealing with minimum size for hotel room units or condominium units. The SEP Board reserves the right to reject a proposal based on inadequate room sizes.

5.1.2 Parking Requirements - General

5.1.2.1 Parking spaces shall be clustered in maximum counts of 20 vehicles, and shall be screened with a minimum 15-foot planted buffer on all sides.

5.1.2.2 All stormwater runoff from parking areas shall be contained in drainage structures to prevent erosion.

5.1.2.3 Parking areas shall be lighted, utilizing fixtures similar to roadway lighting, as may be required by the SEP Board.

5.1.2.4 In multi-family development there shall be one parking space for each unit, to be provided on the development site in close proximity to the units.

5.1.2.5 In hotel development there shall be one parking space for every two hotel units. Parking spaces shall be at least 9" wide except that a parking space adjoining a walkway shall be at least 10'.

5.1.2.6 Restaurant development shall require one parking space for every 100 sq. ft. of public floor space or the part thereof. Parking spaces should be on a properly prepared surface that has been well compacted, or on a porous or grassed area.

5.1.2.7 Provisions shall be made for parking rental, bus and service vehicles on roads, or public or private parking areas in LDI districts LDI.IV through LDI.VI.

5.1.2.8 Surfaces of all required parking lots and areas shall be of materials that will avoid erosion, prevent dust and permit safe usage. It is recommended that porous surfaces be considered as an alternative to paving.

5.1.2.9 Automobile parking space where required shall be a minimum of 9 feet wide by 18 feet deep, (9' X 18'), except where adjacent to a walkway, then width shall be 10'.

5.1.3 **Landscaping Regulations**

5.1.3.1 No excavation and/or filling that involves greater than 10 cubic yards of material shall be permitted without a detailed analysis of the impacts on the site and subsequent approval by the SEP Board.

5.1.3.2 Every building shall have shade trees established as part of the landscaping immediately upon completion of construction. These trees must be maintained and replaced if they die. Cleared building sites should be revegetated with appropriate native plant species as soon as possible to avoid erosion.

5.1.3.3 Landscaping shall utilize plants which are known to be fast growing and drought resistant. Salt tolerant plants should be used in appropriate places.

5.1.3.4 On hillsides, the clearing of trees and bushes should be minimized to reduce the likelihood of soil erosion and landslides. Site Development Permits shall be required for the cutting of trees with a diameter over 8" at DBH (diameter at breast height) above the ground or a stature greater than 12 feet and in no case shall such trees be cut for the purpose of landscaping. All trees over 12" in diameter 48" above the ground shall be strictly preserved, even to the point of relocating proposed development. Areas with 80%

439

crown closure and stems over five inches DBH for every 200 sq. ft. shall be preserved. DBH means diameter at breast height.

5.1.3.5 Guinea grass may not be used for erosion control or landscaping unless other considerations outweigh or minimize the fire hazard.

5.1.3.6 Primary dunes shall be absolutely protected. Paths across sand on primary dunes are inevitable. The use of raised wooden walkways shall be used to concentrate traffic and allow sand to move and accumulate, and prevent erosion of the dune and destruction of the dune revegetation.

5.1.3.7 No construction or land clearing shall be done within 12 feet of any gut with a bare rock bed or clearly discernable bed five inches or more in width, except that an access road may cross such a gut at a right angle to it on a concrete road dish or with an adequate culvert or bridge.

5.1.3.8 To minimize soil erosion, vegetation and soil should only be removed in a phased manner to correspond with phasing of development, whether it be a single building or a group of buildings. The sequence of land clearing should be submitted in detailed note form or presented in drawing form.

5.1.4 **Fire Fighting Provision**

5.1.4.1 Buildings must be 100' or less from a street, road or driveway to provide access for fire fighting equipment.

5.1.4.2 Fire hydrants shall be provided at distances not more than 300 feet along roads internal to developments. Internal fire hydrants may be incorporated as standpipes as part of buildings. The main size shall not be less than 4" inside diameter.

5.1.4.3 The burning of guinea grass shall be strictly controlled. Guinea grass must be removed within 25 feet of any building.

5.1.4.4 Fire breaks of clammy cherry, tamarind and other fire resistant trees shall be planted on the upwind border of any developed property adjacent to guinea grass. Fire breaks and windbreaks shall be planted in an irregular or clumped line rather than a straight line using several species of plants in any particular planting, where feasible. Windbreaks may utilize casaurina, almond, coconut, eucalyptus, or other species at the discretion of the developer.

440

5.1.5 **Slopes**

Development on slopes exceeding 47% (25 degrees) shall be prohibited. Specific site analysis for development on slopes greater than 18% (10 degrees) is required.

5.2 Land Development Intensity Districts

5.2.1 General Description. Each Land Development Intensity District (LDI) describes the types and intensities of land uses permitted in the district and planning policies for the development of the district. LDI boundaries are shown on the Future PLUMP Map (Map # 3.5.1.) and shall be interpreted to be generalized except where boundaries are coincident with center lines of road or rights of way or with naturally occurring geographic boundaries. The SEP Board shall be the interpreter of any boundary issues. The following matrix summarizes allowable uses within Land Development Intensity Districts:

5.2.1.1 Land Development Intensity District I. (LDI.I) The following uses shall be permitted in LDI.I districts: single family detached residential and related uses. Such uses shall be located on individual lots or aggregated sites in which the density of dwelling units per acre shall be equal to or less than 1 dwelling unit per 2.5 acres.

5.2.1.2 Land Development Intensity District II. (LDI.II) The following uses shall be permitted in LDI.II districts: single family detached or clustered detached residential and related uses. Such uses shall be located on individual lots or aggregated sites in which the density of dwelling units per acre shall be equal to or less than 1 dwelling unit per .5 acre, but not be less than one dwelling unit per 2.5 acres.

5.2.1.3 Land Development Intensity District III. (LDI.III) This district category is reserved for planned unit developments. LDI.III districts shall be permitted only on sites equal to or greater than five acres and shall be subject to individual proposal review and approval as provided for in the HDGCSP. The following uses may be approved in the LDI.III district: primarily residential, with related commercial, marine related, tourist facilities including hotels of 50 rooms or less and any use and density that is compatible with uses in LDI.I and LDI.II.

5.2.1.4 Land Development Intensity District IV. (LDI.IV) The following uses shall be permitted in LDI.IV districts: single hotel or, tourist facilities, commercial retail related to tourist facility, and multi family residential uses. The floor area ratio shall not exceed 0.75. Height of buildings shall be limited to 35 feet.

5.2.1.5 Land Development Intensity District V. (LDI.V) The following uses shall be permitted in LDI.V districts: this district shall be known as the Marine Related District and includes water and marine related uses, commercial retail, attached and multi family residential and hotels of 25 rooms or less. The floor area ratio shall not exceed 2. Height of buildings shall be limited to 25 feet with care to preserve vistas over the water for inland development as may be approved by the SEP Board.

5.2.1.6 Land Development Intensity District VI. (LDI.VI). This district shall be known as the Town Center District, the following uses shall be permitted in LDI.VI; mixed and multiple uses including hotels of 25 rooms or less, commercial retail, commercial wholesale not exceeding 10% of all commercial floor area, attached townhouses and multi family residential, churches, professional and other personal services, automobile services limited to sites which minimize conflicts with residential uses, governmental services and other uses that in the determination of the SEP Board would be compatible with the Town Center concept. The floor area ratio shall not exceed 3. Height of buildings shall be limited to 35 feet with care to preserve vistas and open space, as may be approved by the SEP Board. The LDI.VI district requires very special care in site planning, architectural and aesthetic quality according to standards and procedures that shall be developed by the SEP Board.

5.3 Public Facilities Districts

Public Facilities Districts have been established to set-aside land to insure proper and adequate treatment and disposal of wastes.

5.3.1 Sewer Districts

5.3.1.1 Sewer Districts have been delimited within contiguous areas designated for high density development. The use of septic tanks within these areas is not compatible with the proposed high development densities, and is prohibited. All wastewaters generated within sewer districts shall be conveyed to a community wastewater treatment system for treatment and disposal.

5.3.1.2 Areas located outside of the sewer districts have the option to construct septic tanks with drain fields, or to discharge to a sewer district.

5.3.1.3 All developers shall submit to the SEP Board the financial, engineering, construction, operational and development plans for

sewer districts. The SEP Board will review these plans with the Development Approval Application for adequacy and conformance with the PLUMP and the HDGCSP.

5.3.1.4 Wastewater Treatment Sites. A wastewater treatment site has been located within each sewer district. These sites may be relocated if the Board determines this to be in the public interest and approves said relocation.

5.3.2 Solid Waste Disposal Site

A single 25-acre solid waste disposal site has been proposed on the SEP, and is subject to review by the SEP Board. This site shall be used for the disposal of construction rubbish and landscaping wastes exclusively. This site shall not be used for the disposal of residential, commercial, industrial, agricultural, or other wastes. A vegetated buffer zone 50 feet wide shall be maintained around the entire periphery of the solid waste disposal site.

5.3.3 Water Distribution

All developers shall submit to the SEP Board complete financial, engineering, construction, operational and development plans for water distribution proposed for any development. The SEP Board will review these plans with the Development Approval Application for adequacy and conformance with the PLUMP and the HDGCSP.

5.4 Natural Resource Protection and Recreation Districts

5.4.1 Tree cutting and vegetation removal shall be regulated when these activities are carried out within the SEP. At no time shall the aerial extent of permitted removal of vegetation be greater than 75% of a building site or development, except in LDI.X Districts.

5.4.2 Land deemed to be a Recreation District within a proposed development or parcel of land shall be considered as having an LDI equal to 1/2 of the allowable LDI. Said density may be transferred from the Recreation District to other portions of the parcel or development, or other contiguous property under the same ownership provided that the densities in the receiving areas do not exceed by 20% the allowable density.

5.4.3 The following percentages of land are to be set aside for public parks and recreation areas by land development intensity districts:

District	% Set Aside	Use
LDI.I	0	Parks
LDI.II	10	Parks
LDI.III	10	Parks
LDI.IV	10	Parks
LDI.V	10	Parks
LDI.VI	10	Parks

443

5.4.4 The following scenic vista protection standards shall apply to permitted development within Scenic Vista Districts:

5.4.4.1 Use of natural topographic features to locate development. Hills and bluffs should be used, where feasible, to buffer habitat areas. Where otherwise permitted, development should be located on the sides of hills away from views and scenic vistas.

5.4.4.2 Maximum building heights. Structures shall not exceed 25' in height from the averaged finished grade at the perimeter of the base of the building envelope.

5.4.4.3 Projection above ridge lines. The roof lines of buildings shall not project above any ridge line (viewed from the six main Peninsula road overlooks) more than one story.

5.4.4.4 Use of vegetation screens. Natural and planted vegetation screens or visual buffers shall be incorporated into landscaping plans to buffer habitat areas, wherever feasible.

5.4.4.5 Building materials and exterior finishes. The use of natural wood and masonry painted in pastel colors should be encouraged. Roof covering materials should be light in color to minimize heat gain and add to visual quality. The use of bright, dark, or obtrusive exterior finishes shall be prohibited.

5.4.4.6 Revegetation of clear cuts and disturbed areas. Cuts and fills on hill slopes shall be minimized. There shall be no wasting of cut soil materials onto down slope areas. All clear cuts and disturbed areas shall be revegetated with appropriate plant species within one growing season.

5.4.4.7 Access roads. Where ever possible access roads shall run parallel to hillside contours.

5.4.5 The following resource protection standards shall apply to permitted development within Wildlands Management Areas.

5.4.5.1 Permitted development shall occur in clusters such that allowable densities overall are not exceeded, but cluster density may exceed LDI of any site within the development or parcel, provided that 90% of the development site or property remains in an unaltered condition.

5.4.5.2 Access roads and utility corridors shall be minimized. Clustered development shall be located so as to minimize the length and extent of the access roads and utility corridors.

5.4.5.3 Public park and recreation area set asides as provided for in section 5.4.3 shall not apply within Wildlands Management Areas.

5.4.5.4 Where allowable development would cause a break in the natural vegetative cover such that a contiguous wildlands district would be severed into two districts, the land owner shall designate a connecting strip of land at least 100 feet wide as a wildlife corridor connecting the Wildlands Management Areas that have been severed. The wildlife corridor shall be maintained in an unaltered natural vegetative cover.

5.4.5.5 Land owners of lands within Wildlands Management Areas shall be encouraged to develop systems of natural trails throughout areas not disturbed by developed uses.

5.4.6 No development shall be allowed within Natural Hazard Districts.

5.4.7 In the Little and Great Salt Ponds and possibly the Major's Bay Salt pond, uses for boating facilities may be allowed, provided a substantial portion of the salt ponds are maintained in a biologically productive capacity. The size of the salt pond area used for boating facilities, including berthing space, turning basins, necessary navigation channels, and any necessary support facilities, shall not exceed 25% of the salt pond.

445

MATRIX OF LDI DISTRICT SITE STANDARDS

Land Develoment Intensity Districts	Parking	Setbacks: Front	Rear	Side	Minimum Parcel Frontage	Maximum Parcel Coverage	Minimum Parcel Size (Acre)	Maximum Bldg. Height (Ft.)
LDI.I	2 spaces/unit	10	10	30	100'	20%	2.5	25
LDI.II	2 spaces/unit	10	10	30	100	20%	0.5	25
LDI.III	1 space/unit	0	0	0	100'	40%	5.0	25
LDI.IV	1 space/unit	0	0	0	50'	50%	NA	35
LDI.V	SEP BOARD *	0	0	0	25 **	75%	NA	25
LDI.VI	SEP BOARD *	0	0	0	25 **	100%	NA	35

* Parking requirements shall be determined by the SEP BOARD.
** Alleyways for service should be provided.

446

MATRIX OF LDI DISTRICTS ALLOWABLE USES

District	Residential	Commercial	Marine	Hotel	F.A.R.**
LDI.I	1 DU/2.5	NA	NA	NA	NA
LDI.II	1 DU/.5 to 2.5 acres	NA	NA	NA	NA
LDI.III	12 DU/acre	250 sq.ft/25 units	NA	50 rms.	NA
LDI.IV	Hotels and related residential	allowed	allowed	Unlimited	.75
LDI.V	Unlimited	allowed	allowed	25 rms.	= or < 2.0
LDI.VI	Unlimited	allowed *	allowed	25 rms	= or < 3.0

* Wholasale commercial is allowed but shall not exceed 10% of all commercial floor area.
** F.A.R. (Floor Area Ratio) the ratio of the floor area of all buildings to the total area of the site (floor area/site area = Floor Area Ratio)

PN-ABE-181

The Southeast Peninsula Project in St. Kitts

Volume III: Parks and Recreation Plans

DESFIL

Development Strategies for Fragile Lands

624 9th Street, N.W., 6th Floor, Washington, D.C. 20001

Development Alternatives, Inc.
Tropical Research and Development, Inc.

in association with:

Earth Satellite Corporation
Social Consultants International

46

VOLUME III:

PARK AND RECREATION PLANS

August 1989

Prepared for the U.S. Agency of International Development
under USAID Contract # DHR 5438-C-00-6054-00

c.149

TABLE OF CONTENTS

I. Terrestrial Park and Recreation Plan for the Southeast Peninsula, St. Kitts/Nevis

II. Marine Park and Recreation Plan for the Southeast Peninsula, St. Kitts/Nevis

TERRESTRIAL PARK AND RECREATION PLAN FOR THE SOUTHEAST PENINSULA OF ST. KITTS/NEVIS

by

Mark T. Brown, Ph.D.
Robert Norton, Ph.D.

August 1989

Prepared for the U.S. Agency for International Development
under USAID Contract # DHR 5438-C-00-6054-00

TABLE OF CONTENTS

ACKNOWLEDGEMENTS iii

EXECUTIVE SUMMARY iv

LIST OF ACRONYMS vi

1.0 INTRODUCTION 1
- 1.1 Background 1
- 1.2 Procedure 1

2.0 THE PRESENT SITUATION 2

3.0 DEVELOPMENT OF THE SYSTEM 4
- 3.1 Justification 4
- 3.2 Goals and Objectives 4
- 3.3 Site Selection 6
  - 3.3.1 Protection and Conservation Areas 6
    - 3.3.1.1 National Monuments 8
    - 3.3.1.2 Nature Conservation Reserves 8
    - 3.3.1.3 Protected Landscapes 9
    - 3.3.1.4 Community and Urban Parks 9
  - 3.3.2 Hiking and Riding Trails Network 9

4.0 MANAGEMENT REQUIREMENTS 12
- 4.1 Implementation 12
- 4.2 Management Categories 13
- 4.3 Management Infrastructure 14
  - 4.3.1 Staffing 14
  - 4.3.2 Physical Plant 15
- 4.4 Revenue and Budget 16
- 4.5 Cooperative Agreements and Concessions 16
- 4.6 Liability 17
- 4.7 Contributions from Government Agencies 17
- 4.8 Inclusion of Private Lands 17

5.0 MANAGEMENT PROGRAM 19
- 5.1 Research and Planning 19
- 5.2 Information 20
- 5.3 Education and Awareness 20
- 5.4 Institutional Development 21
  - 5.4.1 Fundraising 21
  - 5.4.2 Infrastructure 22

6.0 SUMMARY 23

7.0 BIBLIOGRAPHY 24

452

ACKNOWLEDGEMENTS

The authors wish to recognize the extensive use of the Parks and Protected Areas System Plan of the British Virgin Islands (BVI) prepared by British Virgin Islands National Parks Trust, Eastern Caribbean Natural Areas Management Program, and The British Virgin Islands Ministry of Natural Resources in the preparation of this plan. The Plan and Policy for a System of National Parks and Protected Areas, Government of Grenada and the General Secretariat, Organization of American States (OAS), Grenada and the National Park Planning for Tourism Development and Coordination Guidelines and Case Study for OAS Experiences in St. Lucia were also useful models for the development of this plan.

EXECUTIVE SUMMARY

The establishment and maintenance of a sustainable tourist industry based on the resources of the islands of St. Kitts/Nevis requires that considerable attention be given to the development of a National Parks and Protected Areas System (NPPAS). The Southeast Peninsula is suggested as one component in the NPPAS. Certain lands that are demonstrated worthy of special development regulations because of their unique character or natural resource value need to be protected to accomplish the goals and objectives of the National Conservation and Environmental Protection Act (NCEPA). A framework for a nationwide system of parks and protected areas is presented in this report. Management policies are reviewed, categories of lands for management alternatives are suggested and a management program is outlined.

Four management categories are defined and mapped on the SEP as follows:

1. National Monuments
2. Nature Conservation Reserves
3. Protected Landscapes
4. Community and Urban Parks

Within each category, lands on the SEP are recommended for inclusion as follows:

1. National Monuments

    a. The escarpment and peak area of St. Anthony's Peak
    b. St. Anthony's Hill Gut
    c. The Scotch Bonnet promontory

2. Nature Conservation Reserves

    a. The mangrove community of Friar's Bay
    b. The windward slopes of Salt Pond Hill
    c. The mangrove community of the eastern shore of the Great Salt Pond
    d. The windward slopes of St. Anthony's Peak
    e. The Frigatebird and Brown Pelican nesting areas of Bugg's Hole and Nag's Head

3. Protected Landscapes (includes all of the SEP)

4. Community and Urban Parks (includes all designated small parks, recreation areas, and open space set asides)

A system of nature trails and bridle paths are described and mapped. The system is designed in such a manner that access to all protected areas and parks is fostered. In addition, the system is interconnected so that, while each segment is an individual trail experience, it is possible to hike the entire length of the SEP on the trail system.

Included are management requirements for implementation and recommendations for an NPPAS Authority that is a non-governmental organization (NGO). The non-governmental status of the NPPAS Authority is important in light of its ability to attract and secure funding from private individuals, foundations and bilateral organizations.

Finally, suggestions are given for the management program that include a research and planning component, an education component, and an institutional development component.

LIST OF ACRONYMS

BVI	British Virgin Islands
CIDA	Canadian International Development Agency, Canada
GOSKN	Government of St. Kitts/Nevis
IUCN	International Union for the Conservation of Nature and Natural Resources
NCEPA	National Conservation and Environmental Protection Act
NCR	Nature Conservation Reserves
NGO	Non-governmental Organization
NM	National Monument
NPPAS	National Parks and Protected Areas System
OAS	Organization of American States
PL	Protected Landscape
PLUMP	Proposed Land Use Management Plan
SEP	Southeast Peninsula
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development

1.0 INTRODUCTION

As part of a larger effort to provide guidelines and development documents to the Southeast Peninsula Land Development Board, scientists and planners conducted surveys and resource management guidelines. Recommendations for resource management, and most importantly, surveys of the best wildlife habitats and terrestrial resources are included within these resource plans. From these documents, we have developed this Parks and Recreational Plan. First, this plan lays the groundwork for a National Parks and Protected Areas System (NPPAS) for all of St. Kitts/Nevis and second, it develops detailed recommendations related to the SEP as if it were part of this larger system. Development of a park and protected areas system on the SEP is suggested as the precursor and stimulus for the eventual development of a nationwide system. Both management recommendations and implementation strategy are included for both a national system and, more specifically, for the SEP system. A suggested management program is also offered.

1.1 Background

In the last decade or two, government and non-governmental agencies have increased their efforts to establish parks or protected areas in the Caribbean and have established strategies based upon national legislation to accomplish this goal. Conservation of declining natural resources is the primary rationale for establishing a system of parks and/or protected areas. Greater needs to exploit these natural resources and more leisure time to experience natural areas increase with a rise in resident population. This, coupled with 1) expanding tourism in the region demanding multi-faceted natural and cultural experiences and, 2) the pressure on undeveloped resources, has given rise to a sustainable yield concept of natural resources management. Parks and protected areas appear to provide a national strategy for sustaining foreign exchange as well as engendering national pride in natural resources (i.e. unique flora and fauna, geology) and maintaining this relationship for the long term.

Not only have natural resources throughout the region declined in recent years, but cultural and historical landmarks have been ignored and have deteriorated to a point where current human resources are unable to recreate or maintain important national and international sites. A parks and protected areas system for St. Kitts, which includes the natural and cultural resources of the Southeast Peninsula, may hold as much promise for the economy as similar areas have for other nations in the eastern Caribbean.

1.2 Procedure

A plan for a system of parks and protected areas must be defined for the entire nation of St. Kitts. A park or protected areas plan for one portion of the country (i.e. Southeast Peninsula), which does not represent components of the entire country, cannot be an effective national strategy of resource protection and sustainable yield through tourism. However, national forests or areas currently managed by government, for example, are immediate candidates for inclusion into a system of parks or protected areas whose beginning was fostered by the development of the park system of the SEP.

2.0 THE PRESENT SITUATION

The groundwork has been laid for the beginnings of an NPPAS. In the 1987 National Conservation and Environmental Protection Act (NCEPA), the concept of a protected area is introduced and described as an "area containing outstanding or fragile natural features or life forms of national importance that need protection in an undisturbed state where the only permitted activities are management measures, controlled scientific research and educational study." In this plan, we develop and suggest four protected areas categories of varying management intensity.

While the NCEPA introduces the concept of protected areas, there is no mention of an administrative authority that could set up and determine management policy for protected areas within the Government of St. Kitts/Nevis (GOSKN). Further, the NCEPA provides for an institutional framework for the management, planning development and conservation of the natural and historic resources of St. Kitts/Nevis, yet administration of the program is not specified. The act calls for these programs and sets the framework for an NPPAS. The act was gazetted in July 1989.

As part of a comprehensive plan to develop a unified NPPAS that includes the marine resources of the island, it is recommended that an NPPAS Authority be appointed by GOSKN to administer and plan a national system. This may require additional enabling legislation. This document contains suggestions for components of legislation that would establish an NPPAS and the Authority. An organizational chart of authority within the NPPAS is given in Figure 1.

It is important that the overall administration of the NPPAS be accomplished by a non-governmental organization (NGO). We suggest an NPPAS Authority that is composed of government officials and private citizens. An NGO enhances the ability to acquire funds from private individuals, foundations, international bilateral organizations, etc.

The SEP is suggested as the first and primary inclusion in the proposed NPPAS as a Protected Landscape. PLs are one of several designations of land management categories within the proposed NPPAS. The NPPAS provides for a committee or board of appointed citizens to make management policy decisions related to the overall management of the area. The SEP Land Development and Conservation Board could easily, and in fact does, fill these requirements.

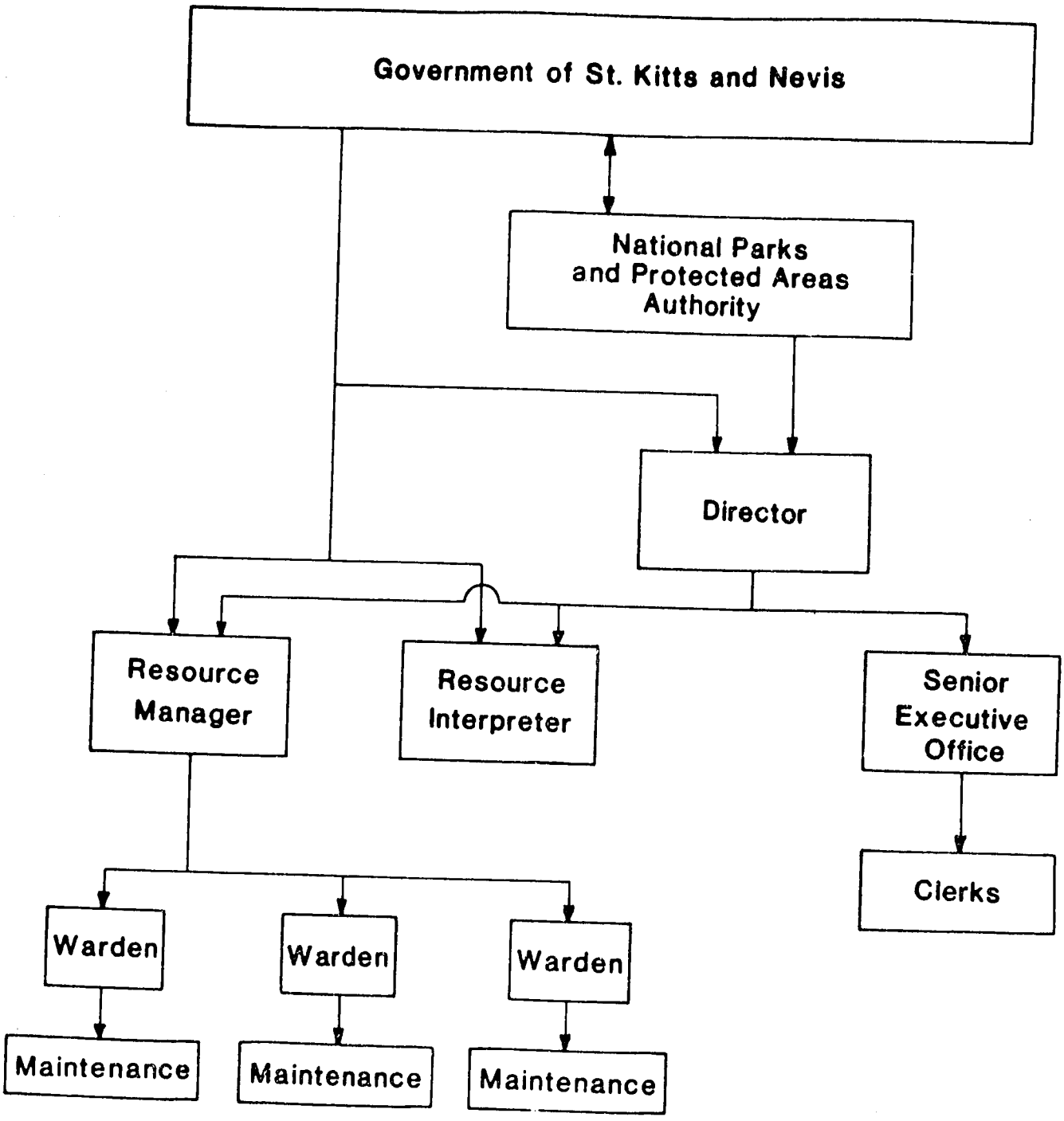


Figure 1. Organizational Chart: National Parks and Protected Areas System.

3.0 DEVELOPMENT OF THE SYSTEM

3.1 Justification

The SEP of the island of St. Kitts is a diverse landscape of terrestrial communities and marine resources that is now under development pressure. An important goal is the designation of a National Park System (NPS) within the SEP that preserves the most important resources and provides for effective education of visitors and citizens. Recent trends in tourism suggest that future expansion will depend heavily upon the environmental quality of chosen destinations. Increasingly, tourists are seeking destinations that offer a wide variety of marine and land based natural environmental values. The SEP can easily offer significant amenities such as scenic vistas, wildlife, marine resources and interesting vegetation communities. In addition, the development of a peninsula-wide trail system will help to expose visitors and citizens to the wide variety of wildlife and plant communities that can be found on the SEP.

If government waits until development has occurred throughout the Peninsula before acting to set up a network of parks and trails, the task is made much more complex and success is questionable. By designating a system of protected areas prior to development, government may move forward in negotiations with landowners to achieve implementation of the plan. In conjunction with the park system, it is suggested that a series of trails on both public and private lands be developed and maintained by government. This will require some legal agreements with landowners whose lands they may transgress. Again, these negotiations should proceed as quickly as possible to ensure their fruition. Landowners and potential landowners should be made aware as soon as possible that the protected areas and trail systems are considered important parts of tourism development on the SEP and that they will be designated and constructed as indicated on the map accompanying this plan. In this way, as planning for individual developments proceeds, planners and architects may take into account the right-of-ways that are required for protected areas and the integrated trail system.

3.2 Goals and Objectives

The overall goals and objectives of the Southeast Land Development and Conservation Board (SEP Board) have been articulated in the Proposed Land Use Management Plan (PLUMP) and those that are of particular relevance to the Parks and Recreation Plan are given below:

Goals:

1. The SEP Board recognizes that the SEP has unique environmental resources, the conservation of which is essential to maintain the natural diversity of plant and animal species and habitat, including those of economic value such as commercial and sport fisheries.

2. The SEP Board recognizes that to maximize tourism and related development opportunities, it is critical to create a secure, safe and aesthetically pleasing land management and community environment; and it is critical to minimize damage to structures by natural events such as hurricanes.

In addition to the these two goals, several objectives were recognized that are important to achieve sustainable and environmentally compatible development of the SEP and that are considered pertinent to the Parks and Recreation Plan as follows:

a. Establish resource protection districts
b. Establish marine resource protection districts
c. Create development patterns that protect scenic vistas and aesthetic quality and that are consistent with historic, architectural traditions
d. Balance land management and environmental protection with accommodation of vested rights of landowners and citizens
e. Develop procedures and assist the Minister in administration of laws regarding land development and environmental protection of the SEP

These goals and objectives were the driving force behind the development of the overall resource protection strategy that led to a Park and Recreation Plan. They were further refined into a single goal and two objectives for a national park system that, if implemented locally, will ensure the vitality of the environment and economy of the SEP and if extended to the remainder of the island will act to unify the recreational and resource protection efforts of government. The comprehensive goal of the national parks and protected areas system is as follows:

Goal:

It is recognized that the vegetation communities, wildlife, beaches, and scenic qualities of St. Kitts/Nevis are a unique national treasure that are of special importance to the economic development of the islands of St. Kitts/Nevis. It is the overall goal of the GOSKN to develop a system of national parks, protected areas, and trails that will protect and enhance these resources and help to educate citizens and visitors alike of their importance and unique character.

Further, the following two objectives are recognized as important to achieve an integrated approach to the management of a national park system on the SEP:

Objective 1:

To manage important natural resource areas in ways that will contribute to their quality, and to the quality of life of inhabitants and visitors to St. Kitts/Nevis. Management of the National Park System in general and the SEP in particular is vital to:

a. the productivity of commercial marine species that depend to some degree on a high quality terrestrial environment for breeding and feeding activities, and/or juvenile life stages;

b. the protection of endangered species and life patterns of other wildlife species;
c. retaining unaltered examples of the island's natural heritage;
d. continued economic development, particularly tourism and fisheries; and
e. the study and interpretation of St. Kitts/Nevis natural and cultural heritage.

Objective 2:

Encourage, through educational and interpretative programs an understanding and awareness of conservation issues and needs as well as the enjoyment of the natural environment.

3.3 Site Selection

There are two aspects to site selection in this park and recreation plan. The first is the establishment of suggested boundaries of protected areas, and the second is the establishment of an integrated system of hiking and horseback trails that will interconnect scenic overlooks and protected and conservation areas as well as the best examples of natural, vegetative communities.

3.3.1 Protection and Conservation Areas

Boundaries for protected and conservation areas originated in field investigations by the terrestrial and shorebird wildlife specialists, the forest specialist, the landscape architect, environmental planner, and land use planner. Their input and recommendations were sought to help determine the most important areas that should be set aside as national treasures and thus incorporated into a national park and protected areas system. Additionally, those areas in need of special attention because of their unique character or some other special feature were identified and included as national monuments. Map 1 shows the various protected areas that have been developed for the SEP. There are four categories of land management in the national park system that are found on the SEP, they include:

1. National Monuments
2. Nature Conservation Reserves
3. Protected Landscapes (all of the SEP)
4. Community and Urban Parks

Recommendations for lands that should be included in each of these categories and boundaries necessary for their establishment are discussed separately in the paragraphs that follow.

SOUTHEAST PENINSULA
ISLAND OF ST. KITTS

Development Strategies for Fragile Lands:
A project funded by the United States Agency for International Development under a contract with Development Alternatives, Inc. and Tropical Research and Development, Inc.

November 1988.

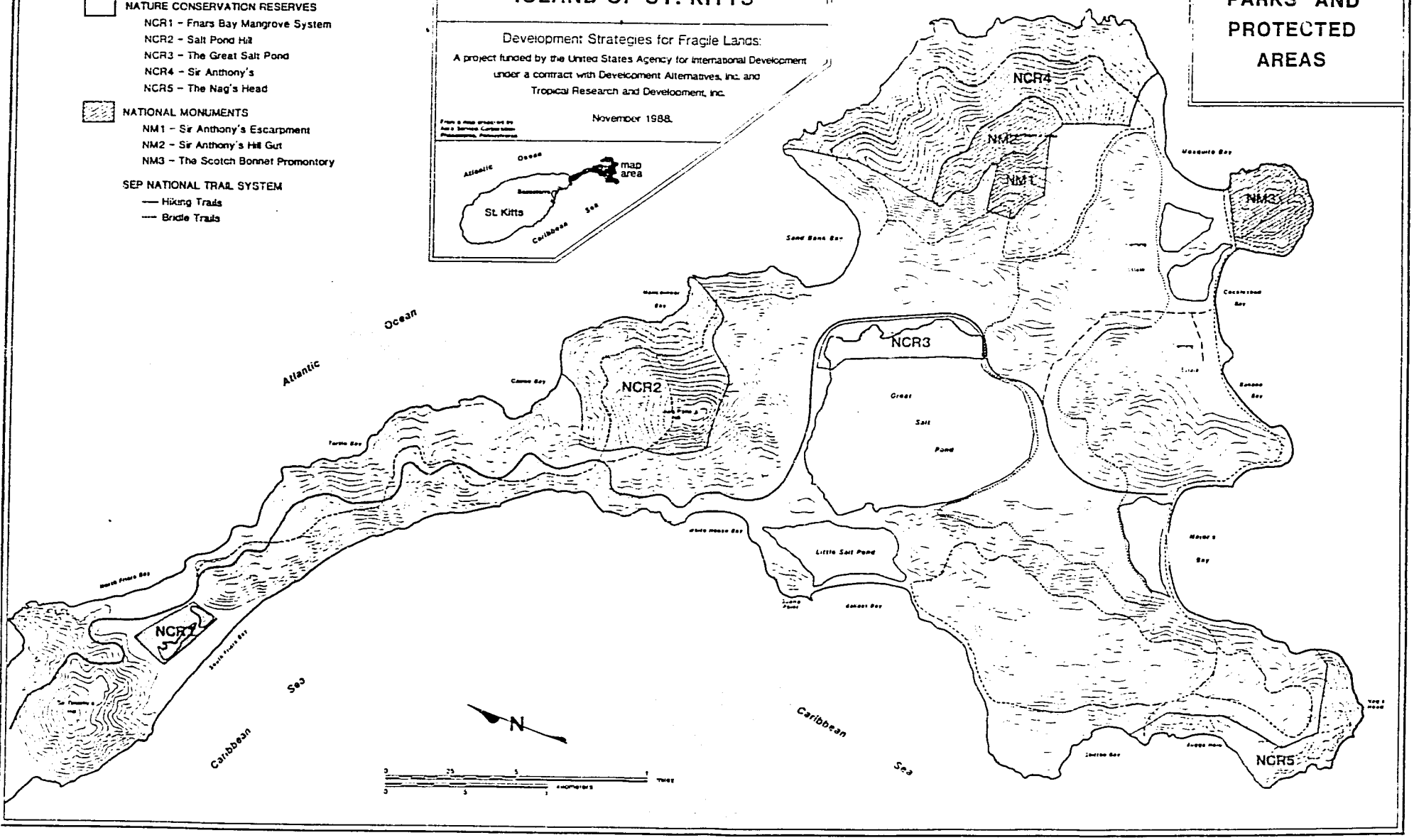
MAP 1

PARKS AND PROTECTED AREAS

NATURE CONSERVATION RESERVES
- NCR1 – Friars Bay Mangrove System
- NCR2 – Salt Pond Hill
- NCR3 – The Great Salt Pond
- NCR4 – Sir Anthony's
- NCR5 – The Nag's Head

NATIONAL MONUMENTS
- NM1 – Sir Anthony's Escarpment
- NM2 – Sir Anthony's Hill Gut
- NM3 – The Scotch Bonnet Promontory

SEP NATIONAL TRAIL SYSTEM
- — Hiking Trails
- --- Bridle Trails



3.3.1.1 National Monuments

There are three National Monuments (NM) within the SEP that require special attention and should be protected in accordance with the management recommendations given in section 4.0. NMs are discrete features, such as significant natural or historic features, that because of their special interest or unique characteristics should be protected or preserved and incorporated into a national protected areas system.

The first NM is the escarpment and peak area of St. Anthony's Peak as viewed from the area surrounding the Great Salt Pond. The dominant position, its size, and grandeur make it a significant feature of the area of the developable lands around the Great Salt Pond. Its wild and scenic quality should be protected.

The second NM is St. Anthony's Hill Gut where drainages from the steep west face of St. Anthony's Peak combine in a wide seep leading to the salt pond. The largest trees on the Peninsula grow in this area. Its reserve quality as a special example of the vegetation communities that were characteristic of the SEP suggests that it should designated as an NM and appropriate management actions taken to ensure that further declines in its quality and ecological integrity do not occur.

The third NM is the Scotch Bonnet promontory. Its prominent location and scenic quality as an undeveloped component of the entire Fleming Estate area should be preserved.

3.3.1.2 Nature Conservation Reserves

There are five Nature Conservation Reserves (NCR) on the SEP. Nature Conservation Reserves are areas established to ensure that areas of nationally significant species or biotic communities are preserved.

The first NCR is the exceedingly important area of mangrove and open water that is known as Friar's Bay Salt Pond. These mangrove forests and associated waters comprise a major portion of the total area of mangrove forests on the island. Mangroves are ecologically important to both resident and migratory water fowl and some species of fish. The mangrove habitat at Friar's Bay should be incorporated into the NPPAS.

The second NCR is the windward slopes of Salt Pond Hill including the slopes closest to Canoe Bay. This area represents some of the best examples of uninterrupted, and little impacted, Dry Forest and Dry Scrub Forest found on the Southeast Peninsula. Its scenic quality is unparalleled from the road as one drives south from the main island. It should be treated as an NCR with strict development controls to ensure its protection.

The third NCR is located on the eastern edge of the Great Salt Pond and includes the free standing dwarfed and dead mangroves in the open waters and the mangrove fringe along the eastern shore. This area is extremely important as nesting habitat to resident heron and several shorebird species.

The fourth NCR is the windward slopes of St. Anthony's Peak. The wild and scenic qualities such as a prominent wildlands area and wildlife corridor belong to the Sea Blast area, which is interdigitated with areas of dry scrub and dry forest in the more protected areas.

The fifth NCR is located along the coastline area of Bugg's Hole and Nag's Head. These areas have been repeatedly singled out as important nesting locations for the Magnificent Frigatebird and Brown Pelican. Their preservation and inclusion in an NPPAS will ensure the attention necessary to minimize human interference.

3.3.1.3 Protected Landscapes

The entire Southeast Peninsula has been classified as a Protected Landscape (PL). PLs are areas established to maintain and retain nationally important natural and scenic values for public enjoyment and economic development through recreation and tourism. The designation of the SEP as a PL is consistent with the IUCN standardized categories since there is an appointed Board whose role is development of management policy.

The designation of the SEP as a PL does not preclude development or recreational uses. It ensures that the SEP takes its rightful place as an important national treasure within the NPPAS, and that the functions and duties of the Board may become the cornerstone of several boards that set management policy for a network of PLs. The set of land use documents that will become the working plans by which the Board will make decisions will become the policy by which the SEP will be managed as a PL.

3.3.1.4 Community and Urban Parks

Community and Urban Parks are small parks and gardens in developed areas. The PLUMP suggests that lands be set aside for public parks and recreation areas that range from five to ten percent of the total area. These park set-asides will require that an agency operates and maintains them and makes decisions concerning location and facilities. In some instances, it may be appropriate to request that park set-asides be clustered to form larger recreational amenities or central open space commons areas. Once lands are set aside, ownership title should divert to government as part of the NPPAS. This management category will include those areas that are designated as park and recreational set-asides.

3.3.2 Hiking and Riding Trails Network

A system of hiking and riding trails have been developed that provide access to and link together the various protection and conservation areas and other natural amenities. The intent is to provide an integrated network of trails that encompass the entire length of the SEP, that allow access at varying points along the road and through out the lower areas of the Peninsula, and that is composed of trip lengths of varying duration. The trail system

is illustrated on Map 1. It has been divided into segments of varying length and given a name that will help in identification. It is recommended that these names or similar names derived from local place names be used to designate trails to ensure that local historical references are not lost.

Trails have been designed for both hiking and horseback riding. In general, while horse trails may be utilized as foot paths, it is not recommended that horse and foot paths be combined. Horse trails tend to develop relatively uneven surfaces and often contain large amounts of manure that may make their use by hikers less than desirable. The steep slopes and rocky nature of some hiking trials preclude their use by horses and inexperienced riders. In general, designated trails for hiking and horseback riding should be enforced for the health and safety of those using the trail system. The following paragraphs describe each of the trails in detail.

Trail 1: Friar's Bay to Canoe Bay. This hiking trail follows the spine of the Southeast Peninsula beginning on the eastern shore of the Friar's Bay Mangrove Conservation Reserve. The trail follows the ridge top and old road alignment, where it still exists, connects all scenic overlooks along the length of the road and ends at the overlook upslope from Canoe Bay.

Trail 2: Windward Salt Pond Hill. This hiking trail is actually two trails. A short hike along the segment called Canoe Bay Overlook can be accomplished by turning upslope along the windward ridgeline and circling back to the point of beginning. The longer hike continues along the windward side of Salt Pond Hill, over looks Manchineel Bay, and descends to the beach at Sand Bank Bay.

Trail 3: Windward St. Anthony's Peak. This hiking trail begins at either Sand Bank Bay or Mosquito Bay and transverses the windward side of St. Anthony's Peak, and then returns along the leeward side of the peak across the saddle between St. Anthony's and Little Pasture Hill.

Trail 4: The Channel Beaches. This trail is designed to allow a leisurely hike along the channel from Mosquito Bay to Major's Bay. The most difficult portion of the hike is the climb over the hill to the west of Banana Bay. A side trail onto Scotch Bonnet may be included, or used as a separate trail. The short climb onto Scotch Bonnet affords elevated views of the Fleming Estate, Mosquito Bay, Cockleshell Bay, the channel, and Nevis.

Trail 5: Nag's Head. This hiking trail is probably the most difficult of all the trails. It begins at the western end of Major's Bay and climbs to the top of Nag's head. From there, the trail follows the upper portions of the ridge toward Bugg's Hole and Shitten Bay, circles back across the ridge, and ends again at Major's Bay.

Trail 6: Ballast Bay Overlook. This hiking trail begins at the southern end of Little Salt Pond and hugs the coast until it ascends the hill, meets the Nag's Head Trail, and circles back at higher elevation to return to the Little Salt Pond.

Horseback Riding Trail In essence, there is only one horseback riding trail that circumnavigates the lower slopes on the southern portions of the SEP. Access can be afforded wherever stables are located within the Fleming Estate or Major's Bay area. It is recommended that the bridle path not return over the same ground. The weakest link in the bridle path system is the portion that hugs the southern shoreline of the Great Salt Pond and roadway edge for a short distance before it crosses the road and returns to the Fleming Estate area. At this point the bridle path and hiking trail share the same right of way for some distance.

4.0 MANAGEMENT REQUIREMENTS

4.1 Implementation

Implementation of a peninsula parks and protected areas system will require an active partnership between the GOSKN and the SEP Board or other authorized natural resource agency. It is suggested that this resource agency be an NGO. The Board will be responsible for implementing the system on the SEP. Government will be responsible for acting on the Board's recommendations.

Legislation establishing an NPPAS should be drafted with the assistance of an environmental law specialist. The new legislation should spell out the management categories proposed above, provide the Board and or other resource management agencies with enforcement authority, and establish procedure. It should be accompanied by general regulations for management of parks and protected areas. New legislation should establish procedures for commercial activities operating in parks whether terrestrial or marine including the levying of use fees, and establishment of concessions procedures. Regulations applicable to all protected areas should be established under this ordinance.

The following guidelines may be used by the GOSKN in developing an NPPAS of which the parks and protected areas of the SEP will be a part:

1. Legislation should be enacted or modified to create the NPPAS and a clearly defined set of land management categories. Recommended management categories are described in Section 4.2. Overall management and policy formulation for the NPPAS should be through a semi-autonomous Authority of appointed public officials and private citizens. Organizational structure below the Authority that will be responsible for delivery of services and system management can follow the pattern of other departments of Government responsible for carrying out government service delivery. An organizational chart is given in Figure 1.

2. Funding sources should be sought and applications to private foundations, bilateral organizations and other world conservation organization should be developed.

3. Studies of St. Kitts and Nevis should be implemented to determine appropriate candidate historic and ecological areas for inclusion into the system. The following process should be used to add new areas to the NPPAS:

    a. Consideration of new areas should be brought to the NPPAS Authority and evaluation and ranking based on the criteria established in the system plan. Priority should be given to areas already identified and which have the greatest urgency for management.

    b. The NPPAS Authority should direct studies of management alternatives for the proposed area, indicating the range of ways in which the area could be managed and determining a preferred alternative.

c. The Authority should present the preferred alternative to resource users, local inhabitants, relevant government departments, and the public at large.

d. Based on the input received, the appropriate management category should be selected and a single management strategy produced and recommended to the GOSKN.

e. The GOSKN should then study the proposal and legally establish the area, or reject the proposal.

4. Once established, areas should be managed according to the objectives stated for their creation. Management should be guided by a plan prepared by the Authority and approved by the GOSKN.

4.2 Management Categories

The objectives for management of the proposed areas will vary. Certain objectives will stress conservation of endangered species, some will stress recreation or research and education, while others will aim to protect important habitat. It is, therefore, necessary to establish categories of protected areas that will reflect this diversity of objectives.

Because of the proliferation of names for protected areas worldwide, the International Union for the Conservation of Nature and Natural Resources (IUCN) has adopted a standardized series of categories (IUCN 1978). Using the IUCN recommendations as a guideline, and taking into account the particular local circumstances, the following categories are recommended for the parks and protected areas of St. Kitts.

1. National Park. Relatively large, natural, and scenic areas of national significance for recreational, educational, and scientific value. They contain large areas and entire ecosystems that are less altered by human exploitation and occupation. National Parks are managed to prevent adverse human impacts on the area and to enforce respect for the ecological, geomorphological, or aesthetic features which have led to their establishment. A national park is managed and developed so as to permit human use for research, education, recreation, and tourism on a controlled basis while being maintained in a natural or near-natural state. Portions of the area should be devoted to preserving in an unaltered state representative samples of physiographic regions, biotic communities and genetic resources, and species in danger of extinction.

2. National Monuments. Nationally significant natural and historic features. This category normally contains one or more discrete features such as a geological formation, a unique natural site, or an historical property. Natural features to be protected ideally have little or no evidence of man's impact. These areas may be of any size and generally do not contain a diversity of features or representative ecosystems to justify their inclusion as national parks, but have particular importance for public education and appreciation. Although they have recreational and touristic

value, these areas should be managed in such a way as to remain relatively free of human disturbance and retain their inherent features unimpaired for the long term.

3. Nature Conservation Reserves. Areas of nationally significant species or biotic communities. The size of the area will depend on the habitat requirements or specific characteristics of the species or community to be protected. Relatively small areas, such as nesting sites, mangroves, or other communities of special interest may be included in this category. Human intervention or habitat manipulation may be required to provide optimum conditions for the species or community according to individual circumstances. Limited portions of the area may be developed for public education. Non-exploitative recreational activities may be permitted in some areas.

4. Protected Landscapes. Areas which retain nationally important natural and scenic values for public enjoyment and economic development through recreation and tourism. The normal lifestyle and economic activity of the area is maintained, but the preservation and development of natural and scenic resources, traditional landscapes and resource uses and historic and archaeological features are promoted for cultural, educational, and scientific purposes, as well as tourism development. Given the importance of these areas to local communities, management policy is developed by a committee made up of local residents, resource users, relevant government departments, and the NPPAS Authority. The area should be large enough to maintain its special natural, cultural and scenic qualities.

5. Community and Urban Parks. This category has been established for small parks and gardens in developed areas. This includes National Parks Trust areas that have been significantly altered from their natural state and that are managed for local recreation and education.

4.3 Management Infrastructure

4.3.1 Staffing

The suggested NPPAS will be responsible for the management of parks and protected areas and should be maintained at a minimum staffing level and required to organize and supervise management activities. Actual research, planning and implementation activities should be carried out through cooperative agreements with the other government departments, NGOs, regional and international organizations and resource-user groups. The full staff required to manage the expanded system will have to be phased in, perhaps, incrementally as funding allows. The final staff suggestions to manage the NPPAS should be as follows:

1. One Director (professional): overall supervision
2. One Resource Manager (professional): coordination of research, supervision of resource management projects
3. One Senior Executive Officer (technical): accounting, office management, logistics

4. One to two Interpreters (professional): oversight of research and public awareness and training
5. One to five Park Wardens: coordination of infrastructure construction and maintenance (number depends on number of parks within the system)
6. Five to twenty Maintenance (basic) (number depends upon the number of parks within the system)
7. One to two Clerks (basic)

This core staff should be supplemented by collaborative agreements with other government departments. Agreements might be established with:

- Fisheries (marine resource assessment, monitoring, planning)
- Ministry of Agriculture (resource assessment, monitoring, planning)
- Customs and Police (law enforcement)
- Planning (planning)
- Education (education and participation)
- Public Works (infrastructure and maintenance)
- Water and Sewage Department (infrastructure and services)

Staffing required for the SEP parks and protected areas system as a precursor to the NPPAS is a much reduced staffing level as compared to that of the national system. The suggested staffing for the SEP system is as follows:

1. One Resource Manager (professional): coordination of research, fund raising, and system management.
2. One Resource Interpreter (professional): coordination of public education and information transfer.
3. One Park Warden (semi-professional): coordination of construction, maintenance, daily operations.
4. Two Maintenance Personnel (basic): general maintenance of overlooks, trails, information center, and fences.
5. One Clerk (basic): general office duties including limited typing, phone, and limited interaction with public.

4.3.2 Physical Plant

Requirements for physical plant for the entire NPPAS are difficult to determine at the outset since the number and scope of parks and protection areas is unknown at this time. The following is a generalized list:

1. Headquarters/information center
2. Park warden office/information center at each major park
3. Transport vehicles and launches
4. Information panels and trails as required by individual parks

Physical plant requirements for the SEP parks and protected areas system should include the following:

1. **Park warden office/information center located near Great Salt Pond and White House Bay area**
2. One vehicle (four-wheel drive truck)
3. Information panels and trail signs
4. Fencing

4.4 Revenue and Budget

The finances of the NPPAS should be met through Government subventure, donations, technical assistance projects, international bilateral agencies, and revenues raised through concessions. The size of the nation severely limits the local revenue available to the Authority and so will limit its scale of operation. Fundraising must be a major and permanent aspect of the Authority's program, and all the above sources of revenue and any new sources that become available in the future, direct-user fees for example, should be pursued to the fullest extent possible. It is unreasonable to expect that any one source can or should be relied on to provide the revenues required.

In order to implement the NPPAS plan for the first year, about US $350,000 will be required (see Appendix 1) . Given in Appendix 2 are the estimated costs associated with development and first-year operation of the parks and protected areas of the SEP. The total estimated costs are about US $118,000. The SEP parks and protected areas system might be funded through allocation of a portion of annual land tax collected. Additional funds for specific management programs should be sought from local sources, private foundations, and international agencies.

4.5 Cooperative Agreements and Concessions

As a matter of policy, resource users and government departments should be encouraged to participate in the planning and management of the areas in the system. Cooperation should be actively sought with the appropriate government departments and non-governmental groups. Cooperative activities must be structured within the framework of the overall parks and protected areas system approach. The Protected Landscape category approach, for example, should be managed by a committee (SEP Board) comprised of relevant government departments, resource users and members of the local community. Users cannot be given direct and formal law enforcement authority, however, areas of cooperation in exchange for a waiver or reduction of concessions fees may include assistance from concessionaires in maintaining moorings or removing garbage, assistance in research, studies of management alternatives, management planning, monitoring, evaluation and interpretation and education.

Concessions from commercial users of park areas could provide a major source of revenue for park management activities. The major commercial users involved would be charter and dive boat operators, nature tour operators and restaurants and shops within Park areas.

4.6 Liability

The NPPAS Authority should be considered a corporate body which has the ability to sue and/or the responsibility of being sued. Although the legal owner of park lands, the Authority by common law is the legal occupier and, thus, responsible for activities within park areas. The Authority has a common law duty to take "reasonable care" to ensure that visitors are "reasonably safe" using parks for the purpose for which they are intended. As long as the Authority exerts such reasonable care, it cannot be liable for accidents or injury to visitors. Reasonable care included the issuance of warnings of dangers, signs and, in some cases, closure of dangerous areas. In order to further limit its liability, the Authority should secure insurance coverage.

4.7 Contributions from Government Agencies

The Authority should not duplicate the duties of government ministries. Specifically, cooperative agreements should be made between the Authority and relevant Ministries for sanitation, certain types of maintenance and law enforcement. For example, the Ministry of Agriculture could provide personnel and administrative assistance to the Authority for management of forested parks and marine-related research, and the coast guard could provide enforcement personnel for marine-related activities.

4.8 Inclusion of Private Lands

Private lands and whole communities may, in some areas, be included within the boundaries of parks and protected areas. For the PL designation, for example, community development is in fact an important management objective. Under this designation, protected areas should be managed by committees on which private landowners and local residents are adequately represented. As the first area to be included in the NPPAS, the SEP will be the flagship of the system. Its designation as a Protected Landscape provides for the appointment of a Board to sit as a management committee. The present SEP Board can easily fulfill this requirement. Their duties as part of the NPPAS will be to evaluate suggested lands and management categories, negotiate with landowners on behalf of the Authority, and set overall management policy for the SEP.

It may be valuable to include private lands as part of park or protected areas. Since it is unrealistic to expect government to purchase all private lands within the boundaries of protected areas, other means of obtaining lands for public purposes should be explored. Such things as tax incentives, transfer of development rights and outright gifts may be considered when privately held lands appear to be critical for habitat or species preservation.

Any new legislation relative to a parks and protected area system should provide for the right of landowners to appeal inclusion of private land in protected areas should occur only after landowners and the Authority have reached consensus on management of these lands. The Authority's position on these negotiations must be based on a respect for the rights of the landowners, but should also consider the environmental integrity of the area in question. If consensus cannot be reached, the private lands will not be included in the park boundaries. Once consensus is reached, the Authority, the Planning Office, and the landowners involved will work together to establish covenants that ensure the integrity of the protected area.

5.0 MANAGEMENT PROGRAM

The following suggested management program for the SEP protected areas system can easily be expanded to encompass the larger NPPAS. Categories of management tasks are given, then those responsible for conducting the work, and finally, specific suggestions related to managing the resources of the SEP.

5.1 Research and Planning

Responsibility: Senior Executive Officer.
Resource Manager.

General Statement:

The Authority's research program should concentrate on applied research, first, on existing management problems and second, on subjects relevant to management that may be related to existing problems or may lead to later problems. Research needs for established protected areas should take priority over those for proposed areas, except in cases in which the establishment of an area is, in itself, a priority. The Authority should make every effort to encourage and facilitate research that is related to management problems of the system.

SEP Recommendations:

The limited staff available to carry out research and planning on the SEP will limit the amount of research in which the staff can be directly involved. The most needed research in the early phases of the program is related to detailed documentation of the existing resources and the planning and design of specific management programs. There are three areas of research and planing that should be carried out as soon as possible during these early establishment phases. They are as follows:

1. Develop a detailed inventory of the floral and faunal composition of the SEP, focusing, at first, on those areas that are included in the NPPAS.

2. Refine the boundaries of parks and protected areas, and the alignment of hiking and bridle trails.

3. Begin to research and implement a management program for feral goats and guinea grass designed to control the spread of the grass and to keep the goats out of park and reserve areas.

5.2 Information

Responsibility: Resource Interpreter.

General Statement:

Information should be readily available to the public and visitors. Topics covered at both the system and protected area levels should include logistics (how to get there, what to see, costs involved, etc.), background information (major habitats and species, history, value and use of the resources), environmental understanding (importance of resources to human welfare and problems associated with misuse), and regulations for visiting the areas (permitted and restricted activities and why).

SEP Recommendations:

The information needs of residents and visitors are great. Of primary importance is the generation of information about the peninsula park and protected areas system and how it fits within the larger NPPAS. This information should be organized and written in such a way that it may be used as a means to secure funding from external sources for development and enrichment of the program. Of equal importance is the development of information and interpretive materials for the public. Such material should detail the parks and protected areas system and the system of hiking and bridle trails available and be in the form of pamphlets for distribution at the information center and through tour operators as well as graphic maps of the Peninsula showing locations and ecological information on parks and trails that should be displayed in the information center and at hotels throughout the Peninsula.

5.3 Education and Awareness

Responsibility: Senior Executive Officer.
Resource Manager.
Resource Interpreter.

General Statement:

Elements of the program will include regular presentations to the nation's schools, workshops for interested civil servants, and workshops for commercial users such as tour guides and charter boat and dive tour operators. Probably of greatest importance are presentations and dialogue with landowners and developers of lands within and adjacent to parks and protected areas.

The thrust of the program should be on the contribution of protected areas to development and resource management and the location and value of individual protected areas. Target groups by priority should be communities in or near protected areas, resource users, relevant Government officials, schoolchildren, general public.

SEP Recommendations:

The development of materials for presentations to landowners and developers of the SEP is of primary concern. Materials should include general presentations on the scope of and value of the parks and protected areas system and the trail system, the values of natural vegetation on lands other than protected areas, wildlife values and management concerns, and information concerning the need for cooperative agreements where the trail systems cross private lands. The Resource Manager and to a lesser degree, the Resource Interpreter should be involved as much as possible in the planning and design of all development projects on the SEP so that the welfare of the parks and protected areas System is injected into the development process. Often many conflicts can be avoided if a dialogue is initiated early in the planning and design process.

5.4 Institutional Development

5.4.1 Fundraising

Responsibility: The NPPAS Authority.
Senior Executive Officer.

General Statement:

Emphasis should be placed on sources of bilateral and multilateral assistance, such as Canadian International Development Agency (CIDA), United States Agency for International Development (USAID), and United Nations Educational, Scientific and Cultural Organization (UNESCO), and on other major private foundations, especially in the U.K. and U.S. As projects are identified by NPPAS staff, proposals for funding assistance should be drawn up and submitted. Appeals for general support of NPPAS should be aimed at the community, businesses, and the general public.

SEP Recommendations:

The successful development of the SEP parks and protected areas systems as the precursor to a national system will depend in great measure on the ability of the SEP Board to garner the support (both financial and philosophical) of the GOSKN, business, and the public. Immediate funding for the SEP system should be sought from the GOSKN to hire the necessary staff and to fund initial expenses. Once hired, the Resource Manager and Resource Interpreter can then begin to develop information and appeals/proposals to outside funding agencies that may make it possible to quickly expand the SEP system into a national system. Working with developers, business interests and the public, the staff may be able to secure much funding and contributions of time, materials, and labor to significantly enhance both the information center and the trail system, since both of these amenities are extremely important to most tourism development on the Peninsula.

5.4.2 Infrastructure

Responsibility: NPPAS Authority.
Senior Executive Officer.

General Statement:

Infrastructure needs should be addressed, first at the system level, then at the specific protected area level, then at the level of site plans for a development area within a protected area, and finally, at facility design.

SEP Recommendations:

Immediate needs for infrastructure are permanent interpretive signs and displays at roadway scenic overlooks, improvements along the trail system (steps, erosion control, handrails, etc.) and signs and trail markings. The largest expense will be the construction of a combined staff headquarters and information/interpretive center. The center should be located at some important, easily accessible location that will serve as the focal point of the park and trail system. Suggested location is in the town center along the access road in the area adjacent to the Great and Little Salt ponds near White House Bay.

473

6.0 SUMMARY

The maintenance of environmental quality can have very positive economic benefits; thus good planning that minimizes negative impacts on environmental systems makes good economic sense. Yet environmental protection at the planning level is not enough. The preservation of lands in national parks and forests, the education of the general public and visitors in the wise use of lands and resources, and the provision of access to natural resources are extremely important means of developing a sustainable resource base from which the culture may grow and tourism may flourish. The future availability of lands as wild and scenic parks and protected areas depends on adequate protection today.

While it is important to develop a system of parks and protected areas on the SEP, now, as development begins, it is imperative to begin the task of developing a nationwide parks and protected areas system. This document recommends that a system be developed immediately for the SEP and that it be used as the precursor to a national system. Once the seed is planted and has had the time to mature on the SEP, it will not only be possible, but the job made much easier to develop a system throughout St. Kitts/Nevis. Attention must be given to the forested hillslopes throughout the nation that are much taken for granted. Salt ponds and mangroves are little understood as the habitat basis for much wildlife including both resident and migratory bird species. Beaches must be protected as turtle nesting areas, and the taking of turtle eggs and the selling of turtle meat must be outlawed. The best examples of all ecological community types need to be set aside as national treasures for future generations to better understand their national heritage and the basis for their long years of economic development. An NPPAS, if implemented now, will ensure that future generations have the opportunity to view, learn, and benefit from a healthy environment.

Development of the NPPAS will take much commitment and creative energy on the part of Government, interested citizens, and the SEP Board, for it will be through the commitment of the Board that the SEP parks and protected areas system will become reality. It will require serious dialogue with those individuals wishing to develop the Peninsula to convince them that it is in their best interests and in the best interests of the nation to preserve and protect portions of the Peninsula that have been deemed monuments or protected areas. It will require a great deal of patience to put together an integrated hiking and bridle trail system from parts and pieces of land. Yet, if the Board has the capacity and foresight to realize how important it is to set aside parks and protected areas now instead of later, the rewards will be great and everlasting.

7.0 BIBLIOGRAPHY

A Parks and Protected Areas System Plan for the British Virgin Islands. September 1986. British Virgin Islands National Parks Trust and Eastern Caribbean Natural Area Management Program with the assistance of the British Virgin Islands Ministry of Natural Resources and the British Virgin Islands Town and Country Planning Office.

Categories, objectives and criteria for protected areas. August 1978. International Union for Conservation of Nature and Natural Resources (IUCN). A final report prepared by Committee on Criteria and Nomenclature, Commission on National Parks and Protected Areas. Morges, Switzerland.

APPENDIX 1

Total Consolidated Budget (US$) for First Year, for the National Parks and Protected Areas System

Item	Cost	GOSKN	Priv.	Bilat.	Other
Personnel					
Director	23,000	50%	50%		
Resource Manager	15,000	100%			
Senior Executive Officer	13,000	100%			
Resource Interpreter	12,000	50%	50%		
Park Wardens (3)	27,000	50%	50%		
Maintenance (10)	70,000	100%			
Clerks (2)	16,000	100%			
Technical Assistance					
Resource Manager	15,000		50%	50%	
Planner	15,000				100%
Forester	20,000		50%		50%
Horticulturist	19,000		50%	50%	
Local Transport					
Equipment					
Minicomputer	5,000				100%
Office Furniture	5,000				100%
Vehicle (four-wheel drive)	15,000				100%
Education and Awareness					
Newsletter	4,000		100%		
Brochures/Booklets	8,000	25%	25%	25%	25%
Publications	10,000		25%	25%	50%
Management Plans	5,000		50%	50%	
Exhibits/Signs	3,000				100%
Capital Works/Trails					
Information Center	30,000			50%	50%
Trail Improvements	2,000	50%		25%	25%
Maintenance					
All areas	20,000	50%			50%
Total	327,200	159,300 (45%)	71,600 (20%)	39,500 (11%)	86,800 (24%)

USI

APPENDIX 2

Total Budget (US$) for First Year, for SEP Parks and Protected Areas System

Item	Cost
Personnel	
Resource Manager	15,000
Resource Interpreter	12,000
Park Warden (1)	9,000
Maintenance (2)	14,000
Clerks (1)	7,000
Equipment	
Miscellaneous Equipment	3,000
Office Furniture	2,000
Vehicle (four-wheel truck)	10,000
Education and Awareness	
Brochures/Booklets	4,000
Exhibits/Signs	10,000
Capital Works/Trails	
Information Center	20,000
Trail Improvements	12,000
Total	$118,000

MARINE PARK AND RECREATION PLAN FOR THE SOUTHEAST PENINSULA OF ST. KITTS/NEVIS

by

Evelyn Wilcox, M.S.

August 1989

Prepared for the U.S. Agency for International Development
under USAID Contract # DHR 5438-C-00-6054-00

EXECUTIVE SUMMARY

Recreational opportunities in a healthy environment are essential to the overall marketing strategy of attracting tourists to Caribbean islands. Park recreation for the Southeast Peninsula thus becomes an important consideration in the Proposed Land Use Management Plan. St. Kitts/Nevis administrative and funding options for initiating and managing recreation programs and protecting natural resources are limited at the present time. Yet the need for park management at the Southeast Peninsula (SEP) is immediate. Once the road is open to the general public, there will be a need to manage and protect the high quality of the natural resources and avoid unnecessary damage to the Southeast Peninsula environment before and during development.

To accomplish the objectives of the Southeastern Peninsula Land Development and Conservation Act, it is recommended that the Marine Park and Recreation Plan be considered in the context of a Southeast Peninsula National Marine Park, under the administration of the Conservation Commission and funded, at least at first, by the international environmental donor community. There are precedences for this type of institutional arrangement, including that of the Bahamas National Trust, a nonprofit, non-governmental organization (NGO) composed of private and public individuals. Recreational opportunities depend on a continuing healthy ecological system. A national park system which protects fundamental resources and offers high quality recreation would be appropriate for the SEP.

Recommendations for the Marine Park and Recreation Plan are found in the Draft Management Plan for the Southeast Peninsula National Marine Park in Section 3.0. These recommendations include park designation, administration, management; suitable park programs, park guidelines and regulations for users, enforcement, and educational tours to inform the public and attract tourists.

TABLE OF CONTENTS

LIST OF ACRONYMS iii

1.0 INTRODUCTION 1
- 1.1 Tourist Population Projections for St. Kitts/Nevis 1
  - 1.1.1 Landbased 1
  - 1.1.2 Waterbased 1
- 1.2 Recreational Opportunities 1
- 1.3 Protection of the Natural Resource 2

2.0 A MARINE PARK RECREATION PLAN FOR THE SOUTHEAST PENINSULA 4
- 2.1 Marine Park and Recreation Issues 4
- 2.2 Administrative Alternatives for Managing and Directing a Marine Park and Recreation Plan 4
- 2.3 The Bahamas National Trust 5

3.0 DRAFT MANAGEMENT PLAN FOR SEP NATIONAL MARINE PARK 6
- 3.1 Designation 6
- 3.2 Boundaries 6
- 3.3 Objectives 6
- 3.4 Park Administration 7
  - 3.4.1 Suggested Composition of the Advisory Committee 7
- 3.5 Management 8
  - 3.5.1 Existing and Potential Uses of the Marine Park 8
  - 3.5.2 SCUBA Diving and Snorkeling 8
  - 3.5.3 Beach Use 9
  - 3.5.4 Sea Turtles 9
  - 3.5.5 Sailing 10
  - 3.5.6 Yachts 10
  - 3.5.7 Anchoring 11
  - 3.5.8 Cruiseships, Mid-range Cruiseships 12
- 3.6 Park Regulations 12
  - 3.6.1 Fish, Shellfish, Coral Reef Species Conservation 12
    - 3.6.1.1 Fishing Gear and Equipment 12
    - 3.6.1.2 Taking of Juvenile Fish and Shellfish 13
    - 3.6.1.3 Taking of Sea Turtles; Green, Hawksbill, Leatherback 13
    - 3.6.1.4 Taking of live fish, coral, other reef species for commercial purposes 13
    - 3.6.1.5 Waste Disposal 13
    - 3.6.1.6 Beaches 14
    - 3.6.1.7 Penalties 14

4.0 PARK PROGRAMS 15
- 4.1 Enforcement 15

485

4.1.1 Enforcement Unit 15
4.1.2 Licensing 15
4.2 Fisheries 16
4.2.1 Observer Corps 17
4.3 Resource Management 17
4.3.1 Quantitative Monitoring of Fish Populations 18
4.3.2 Estimation of Conch Densities and Population Structures 18
4.3.3 Evaluation of the Health Status of Coral and Other Benthic Organisms 18
4.4 Environmental Education and Interpretation 19
4.4.1 Marine Environment 19
4.4.2 Visitors Center 20
4.5 Training Program for Park Management and Staff 21

5.0 CONCLUSION 22

6.0 BIBLIOGRAPHY 23

456

LIST OF ACRONYMS

GOSKN	Government of St. Kitts/Nevis
IRF	Island Resources Foundation
NCEPA	National Conservation and Environmental Protection Act
NGO	Non-governmental Organization
SCUBA	Self-contained Underwater Breathing Apparatus
SEP	Southeast Peninsula

1.0 INTRODUCTION

1.1 Tourist Population Projections for St. Kitts/Nevis

1.1.1 Landbased

According to recent marketing studies, the Caribbean islands can expect an increasing number of tourists to visit their shores in the next decade. If conditions and trends continue and St. Kitts/Nevis maintains its share of the international tourism market of just under .02%, it will almost double its tourist arrivals by 1999; from 64,600 in 1987 to 123,000 in 1999 (Jackson, 1989). However, if expansion at Frigate Bay, the construction of the Four Seasons Hotel on Nevis, and development of the Southeast Peninsula (SEP) occur, St. Kitts room capacity could double before 1999. These events will undoubtedly have a major effect on present tourist projections and the need for recreation and protection of the environment.

1.1.2 Waterbased

The Caribbean is the most popular cruiseship destination, especially for ships operating from U.S. ports. "Super" cruiseships, mid-range cruiseships, private yachts, bareboat charters, crewed chartering and "liveaboard" dive boats for self-contained, underwater breathing apparatus (SCUBA) divers and snorkelers all contribute visitors from the sea. Fifteen ships that are actually mini-cruiseships or large yachts account for 2.6% of the berths in the Caribbean (Jackson, 1988). These ships offer passengers the advantage of direct access, because of size (less than 250 ft. and draft sometimes of only 8.5 ft.), to dive sites and other interesting nearshore features. Some of these visitors utilize the marine areas and leave without coming to shore. Others come ashore to shop, dine, take advantage of landbased tours and seek provisioning and maintenance of their ships.

According to the Caribbean Tourist Recreation Center in Barbados, 31,400 cruiseship and yacht passengers visited St. Kitts/Nevis in 1987. Government statistics reveal that the increase of cruiseship and yachting passengers for the past few years has not been constant, although total Caribbean cruiseship arrivals have reportedly increased steadily since 1982.

1.2 Recreational Opportunities

Recreational activities in the Caribbean, as elsewhere, are offered by a variety of private and public sources; some are open only to hotel and other guests, others are offered by private businesses catering to the recreational-minded public and some are park related, offered by government. Privately run facilities open to the general public include golf courses, tennis courts, SCUBA and snorkeling dive centers, boat rentals, and water sport centers.

There are recreational opportunities now for visitors to St. Kitts. There are popular guided tours of the island by taxi, and well attended, private company guided tours of the Volcano

and the Rain Forest with four-wheel drive vehicles. A 48-foot catamaran, Caona, takes picnickers and snorkelers on a day's outing. It leaves from the Deep Water Port to sail the waters between St. Kitts and Nevis to take picnickers and snorkelers on a day's outing.

Frigate Bay, on the northern side of Timothy Hill from the SEP, offers the only major water sports and recreational area on the St. Kitts coast, and provides a variety of mostly marine-related recreational opportunities to both visitors and residents of St. Kitts. The Caribbean beach, at Frigate Bay South, is used for swimming, sunbathing, and as a departure point for water sports such as snorkeling and SCUBA diving, wind surfing, and boating. Snorkelers have the option of snorkeling close to shore or taking a dive boat to areas beyond the immediate beach area. There are private concessions, along the beach, such as a snack bar, an equipment store for snorkelers and SCUBA divers, a rental business of boats and wind surfers and a bar. The beach, at Frigate Bay North, is also used for swimming and snorkeling by those staying in the properties on the Atlantic side of Frigate Bay but use is somewhat limited because of rough waves and strong winds. Frigate Bay South, on the Caribbean side, is popular for beach picnics and can be quite crowded during public holidays when as many as 3,000 people arrive (Liburd, 1989).

Although access to the SEP has not been easy, 69% of the citizens of St. Kitts, interviewed during a prior study in 1981, had visited the Peninsula at one time or another. Residents camp overnight, hike in the hills and in the areas of the salt ponds, watch monkeys, deer, and birds, and walk along the beaches and rocky shores. There are daily, private boat excursions to White House Bay and Banana Bay. SCUBA diving and snorkeling expeditions originate in Basseterre, Frigate Bay and Nevis. There is a low-rise, successful resort at Banana Bay with opportunities for snorkeling right offshore and swimming and other water sports at the Banana Bay beach in the channel area.

1.3 Protection of the Natural Resource

In the Caribbean today, small island governments such as St. Kitts/Nevis, are being asked by the environmental community to protect those natural resources used and admired by tourists while developing their islands to benefit their economy. There is a new awareness on the part of government and those who develop tourism to avoid damage to the ecology. Unfortunately, there are few success stories of being able to preserve the environment while expanding tourist facilities. There is inadequate government funding and staffing for the review of site plans, the monitoring and enforcement of local laws during site preparation and construction and the enforcement of local laws, once the resorts become operational. Furthermore, the size and complexity of resort development is changing, making it even more difficult to control and minimize damage to the environment. The laws and regulations to protect the natural resource base are in place but, in the Caribbean as elsewhere, the system of controlling impacts of development seems to be failing.

The Frigate Bay Project, directly north of the SEP, has been developing its natural resources for tourists since the early seventies. Certain environmental problems were noted in a 1985 study which examined environmental changes on the land and in the waters off Frigate Bay as a result of development (Island Resources Foundation-IRF, 1985). These

conclusions are useful and quite relevant to the Marine Park and Recreation Plan for the SEP because they point out administrative and enforcement weaknesses which need to be avoided if the SEP is to retain its present high resource value. The following recommendations were selected from the study for their relevance and timeliness to the development of a Marine Park and Recreation Plan for the Peninsula.

1. Hire a full-time environmental management expert to advise on development which impacts ponds, mangroves, coastal/marine systems, other wildlife habitat and the construction of systems such as sewage treatment facilities to act as an advocate for the environment. Apparently, environmental interests were not being adequately served the at the decision-making level.

2. Erect signs and markers to point out special, interesting wildlife areas/natural areas and areas where access must be restricted for environmental reasons.

3. Begin to gather baseline information on the ecology of the area for use in planning and making decisions on development.

4. Initiate a campaign to stop beach sand mining and vegetation removal to preserve the beaches.

5. Initiate a public education program to prevent the disposal of solid waste (air conditioners, golf bags etc.) in unauthorized areas, including mangrove wetlands.

6. Control the spreading of poison bait for rats, control the use of herbicides and control the packs of dogs which roam freely in wildlife areas.

7. Educate visitors to the importance and need for safety and protection of sea turtles who nest on the beaches of Frigate Bay North and South.

8. Designate horseback riding areas away from the beach.

9. Prohibit "joy riding" with four-wheel drive vehicles on the beaches.

2.0 A MARINE PARK RECREATION PLAN FOR THE SOUTHEAST PENINSULA

2.1 Marine Park and Recreation Issues

The SEP offers marine recreation in clean, clear water, free of silt and chemical pollution; a healthy coral reef environment; biological diversity in flora and fauna; scenic vistas, unique variety in topography such as rocky cliffs and undisturbed, forested mountain peaks, abundant coastal wildlife such as shorebirds and seabirds, interesting tide pools and other rich natural habitats along the coast.

The SEP Park and Recreation Plan must try to balance the need to protect private interests with the need to wisely control and manage the use of the lands and waters. It must also uphold the SEP Board's decision to try to create an "up-market" destination, featuring resort properties and villas catering to those who appreciate natural land and water resources in healthy condition such as sports enthusiasts, SCUBA divers, snorkelers, yachtsmen and others seeking exclusiveness and seclusion.

Most of the land is owned privately. The waters and the floor of the sea belong to the Government of St. Kitts/Nevis (GOSKN). There are still unresolved issues concerning ownership and public access to the beaches. The main road, some of the secondary roads cleared during the building of the road and the overlooks, along the road, belong to the GOSKN.

2.2 Administrative Alternatives for Managing and Directing a Marine Park and Recreation Plan

Administrative arrangements for recreation programs and park programs in the Caribbean vary greatly. Park administration can include that of a national park service, a private non-governmental organization (NGO), or a combination of an NGO and a government unit.

There is no recreational authority or park authority within GOSKN at this time. The National Conservation and Environmental Protection Act -- No. 5 of 1987 (NCEPA) provides an institutional framework for the management, planning, development and conservation of the Country's natural and historic resources but it does not specify which part of the GOSKN will administer park areas which can be so designated by the Minister. Furthermore, it was gazetted by the Minister in July 1989. The South Eastern Peninsula Land Development and Conservation Act (No. 12 of 1986) provides for a semi-autonomous government authority, with specific powers to prepare a land use management plan for, among other things, preservation and management of scenic and other natural resources but again, the administration of these areas is not specified.

In the absence of specific St. Kitts/Nevis administrative options, the proposed SEP Park and Recreation Plan has been developed around the concept of designating a Southeast Peninsula National Marine Park, for the following reasons. The Marine Park and Recreation Plan, administered within a national park context, is more likely to begin as soon as possible, offering some control of visitation once the road to the Peninsula is

opened, and offers some real possibilities of attracting funding from the international environmental community to get park management established.

The national park proposal satisfies both the objectives for marine reserves under the Fisheries Act of 1984 and the objectives of the NCEPA of 1987 to set aside protected areas. It meets most of the criteria for areas worthy of protection listed in Part II Establishment of Protected Areas Section 4 (a) through (e) including the following:

> "to preserve biological diversity of wild flora and fauna species that may be endemic, threatened, or of special concern and the land and marine habitats upon which the survival of these species depend;
>
> to protect selected examples of representative or unique biological communities, both on land and in marine areas, and their physical environments;
>
> to protect selected natural sites of scenic beauty or of special scientific, ecological historic or educational value, including sites that are already degraded and need protection for restoration or sites that may become degraded if not protected; "

The park also provides the basis for management of marine areas for the recreational enjoyment of local residents and visitors.

2.3 The Bahamas National Trust

In the Bahamas, the Bahamas National Trust, composed of private citizens and public officials, acts as the legal authority and administrator of eight land and water parks. It seeks membership and contributors from outside the country, boasting a present membership of 1,700, a significant increase from 88 members in 1962. It works with the schools, the public, and special interest groups to manage the national park system and keep the Bahamas beautiful by sponsoring anti-litter and pollution programs etc. Its Exuma Cays Land and Sea Park, encompassing 176 square miles, is famous for its pristine beauty and marine environment.

The Trust employs three full-time wardens who are trained to give information and guidance rather than fines. One warden lives on board a boat in her district. The Executive Director is a former marine biologist with the U.S. Park Service. The statutory members of the Advisory Council are as follows: three members from the international conservation community, the New York Zoological Society, the U.S. Park Service, the National Audubon Society and eight members from the Bahamas. Funding comes from a government donation of $15,000 annually and from the membership, the private sector, and external government funding.

3.0 DRAFT MANAGEMENT PLAN FOR SEP NATIONAL MARINE PARK

This section is actually a proposed model of a draft management plan for the Southeast Peninsula National Marine Park, which can be used if and when St. Kitts/Nevis wishes to begin the process of establishing a national park and applying for funding. There are missing pieces of information that will need to be supplied by the Conservation Commission or by the SEP Board or whomever else takes the lead in creating the Park.

3.1 Designation

It is proposed that, subject to section 5 of the NCEPA, 1987, the Southeast Peninsula Marine Park be designated, by Notice, published in the Gazette by the Minister, in consultation with the Conservation Commission, as provided in that Act.

Note: As stated in the SEP Marine Resources Management Plan of December 8, 1988, the legal establishment of the national marine park can also be achieved by using the Fisheries Act of 1984, Part III, Marine Reserves and Conservation Measures, Section 23 (1) (a-d) if the NCEPA, 1987 fails to become operational. However, it is more likely that park activity, under the auspices of the Conservation Commission (as provided for in the NCEPA) could begin immediately, whereas under the Fisheries Act, the Fisheries Division which is already understaffed and underbudgeted would have the additional burden of getting the Park established.

3.2 Boundaries

The boundaries of the marine component of the park are proposed as follows:

From high tide at the boundary of the Frigate Bay Development Area to the extremities of Nag's Head and Scotch Bonnet and seaward out to the 30 m depth contour or two miles maximum around the entire Peninsula whichever comes first. These boundaries will allow the GOSKN to manage and control the use of SEP waters containing most of the productive seagrass beds and coral reef systems of the offshore waters of the SEP.

3.3 Objectives

1. To Protect the Natural Resources of the Southeast Peninsula Through Effective Park Management for the Benefit of the Residents and Visitors of St. Kitts/Nevis.

2. To Provide Suitable Recreational Opportunities for the Residents and Visitors of St. Kitts.

3. To Enhance the Value of Fisheries in the Waters of the Southeast Peninsula.

4. To Provide a Multihabitat Marine Area for Education and Research.

3.4 Park Administration

In the case of the Southeast Peninsula National Marine Park, it is recommended that the park be administered by the Conservation Commission, as provided for in the NCEPA for the management of protected areas. Selection of the Conservation Commission as the administrator would serve several important purposes. It is an official group, recognized by the GOSKN; it represents private citizens of St. Kitts interested in environmental protection and knowledgeable of the island environment, and it appears to have the time to set up park management; hire a park manager; and write proposals for funding of various park activities.

The daily operations of the park would rest with the Park Manager hired by and responsible to the Conservation Commission. Staff, such as a marine biologist, secretary and park wardens, would be hired by the park manager in consultation with the Conservation Commission, once funding is assured. An Advisory Committee, composed of one representative of each major user of the marine resource, and of the appropriate government agencies would be appointed by the Minister, in consultation with the Conservation Commission to work directly with the Park Manager, to make recommendations for park programs and to resolve differences among users. This Advisory Committee would be chaired by a member of the Conservation Commission and would meet on a regular basis.

3.4.1 Suggested Composition of the Advisory Committee

Chairman: from among the Conservation Commission Members
Members:

1. Representative of the Fishing Community
2. Representative of the Ministry of Agriculture
3. Representative of the Ministry of Labor and Tourism
4. Representative of the Chamber of Commerce
5. Representative of the SCUBA diving industry
6. Representative of the Landowners of the SEP
7. Representative of the Coast Guard

3.5 Management

3.5.1 Existing and Potential Uses of the Marine Park

There is limited recreational use of waters surrounding the Peninsula. The possibilities for recreational activities include: SCUBA divers and snorkeling, sailing, beach activities, water skiing, wind surfing, sport fishing, scenic tours by boat.

3.5.2 SCUBA Diving and Snorkeling

The SCUBA diving and snorkeling industry is considered by some to be the fastest growing sub-sector of the tourism industry in the Caribbean. According to the latest Skin Diver Magazine Subscriber survey, sixty percent of U.S. divers vacation overseas. The average diver household income is US $48,000. The average stay is 7.3 days and the average expenditure is US $1,598. The most popular destination is the Bahamas where a National Trust is operating a marine park of 176 acres and various land properties. There has been a steady growth in shorebased diving operations, many of which are located at resorts. "Liveaboard" dive boats are increasing. Multi-destination packages are expected to become a major feature of liveaboards in the future. Collaboration between the media such as Skin Diver Magazine, SCUBA diving operations and governments to promote Caribbean destinations is also expanding.

There are several dive operations using the area. The major dive shop is located at Basseterre and operates out of the Deep Water Port and South Frigate Bay Beach. There are at least two liveaboard dive boats, the Sea Dancer (104 ft) with 15 passengers, and the Caribbean Explorer (120 ft.) with 18 passengers. Both use St. Kitts waters but not necessarily the SEP.

In Area IV of the Marine Resources Management Plan for the SEP, the Caribbean coast, there are suitable snorkeling areas along the shores where submerged boulders and other large rocks, originating from land, have created interesting substrate for coral and fish habitat. There are two barrier reef systems a mile, and a mile and a half offshore of South Friar's Bay, rising approximately 20 ft. from the sea floor in some areas and as little as 4 ft. in other areas in about 50 to 60 ft. of water (Samuel, 1989). Reports from divers indicate that these reefs have a high potential for recreational diving for both intermediate and advanced SCUBA divers. Their proximity to South Friar's Beach which, by all indications, will be the first choice as a recreational beach and water sports area for both private hotel guests and the general public, makes them a desirable area to explore further and cultivate as an underwater diving area within the Park.

There is a well-marked, shallow area and deeper reef area off Guana Point, between White House Bay and Ballast Bay which, because of its proximity to land and the relatively protected nature of its waters, makes it an ideal spot for a marked diving and snorkeling area. This area, which might be named Guana Point Recreational Area, is proposed as a zone for recreational divers where fishing would be banned in a one square mile area and

marked by a buoy. There would be passive use only, making it the equivalent of a fish reserve and serving to enhance efforts to restore and balance fish populations. For example, there are seagrass beds within this one square mile area which are serving as nursery areas for adjacent reef dwelling species.

3.5.3 Beach Use

Park management and landowners, with the assistance of the Advisory Committee and the Conservation Commission will have to make some hard decisions regarding the level and kind of uses permitted at the beaches. With so many fine beaches, it would probably be wise to vary the uses to accommodate resource management objectives and recreational objectives.

South Friar's Bay beach is well suited for swimming and water sports nearshore, because the seagrass beds are separated from the swimming, recreational zone by a fairly wide sandy bottom. There are no nearshore coral reefs; only some coral cover on the rocks at either end of the beach. Water skiing, jet skis and boating would probably not disturb the seagrass beds in Friar's Bay South since the beds are located in deeper water. However, if park management is available when the site plans are submitted, it could assist the SEP Planning Board in the review of site plans, to help to ensure that the seagrass beds are safe from any disturbance. This has been identified as an extremely rich nursery area for conch and should be managed in such a way as to benefit the fishing community as well as the recreational users. Any conflicts among the users could be discussed at the Advisory Committee meetings.

Adequate areas for public parking should be carefully set aside in the master plan and marked well, on site, to prevent indiscriminate parking on or near the vegetated back dunes or in the grove of coconut trees, as is currently the case at Frigate Bay where no provision was made for public parking in the master plan (Liburd, 1989). The thick cover of seagrapes and other vegetation should be protected during construction and treated as a valuable resource during the operation of recreational facilities at this beach and at the other beaches. Elevated walkways should be provided by the owner, for guests, and for those who come to use the recreational facilities offered by the owner. These guidelines for beach use are applicable to all beaches to be used for recreation.

Development setbacks in beach areas, should also be required. These setbacks will, in the long run, pay off since any disturbance to beach dynamics could change beach configuration and cause beaches to be reduced in size and quality. Wide, natural beaches such as Friar's Bay South are a very valuable asset. In many coastal areas in the Caribbean, sand must be dredged offshore and deposited on the shore to establish a beach.

3.5.4 Sea Turtles

All beaches on the SEP have been used by nesting sea turtles and are potential sea turtle nesting beaches (IRF, 1985). The remote, wind-swept beaches of the Atlantic coast are less

496

favored by people and would be the easiest beaches to use in a sea turtle conservation program. However, Hawksbills and Greens prefer quieter waters and beaches. Setting aside beaches to encourage nesting on the Atlantic Coast would be a great step forward, especially for Leatherbacks who prefer high energy environments, but a sea turtle education program will also be necessary to make a difference in sea turtle conservation on the Peninsula.

Ongoing sea turtle environmental education programs are successful in Florida where hotel guests and second-home owners participate in programs for the protection of sea turtle egg-laying females and their hatchlings. For example, from May through August, during the nesting season, the residents of Palm Beach County, Florida are asked to turn off the lights that shine on the beaches at night and follow several simple rules. From July through October, during the hatching season, they are asked to follow simple rules to ensure that some of the tiny turtles will survive to make it to the ocean.

The sea turtles in the surrounding waters of St. Kitts/Nevis are part of the natural ecology and the natural heritage of the country. It has been suggested by some members of the fishing community, that a 15-minute radio program each day, which discusses sea turtles and urges residents not to kill them or take their eggs would be successful on St. Kitts/Nevis. This programs could also make announcements regarding national park sea turtle regulations, in effect on the Southeast Peninsula.

3.5.5 Sailing

Docking and anchoring options for yachts, cruiseships and other ships and boats visiting the Southeast Peninsula.

3.5.6 Yachts

Although the leeward islands of the Eastern Caribbean are considered good sailing by the yachting industry, sailing conditions require yachts with deep drafts to weather strong winds and complex currents. Tropical storms, although infrequent, can be quite devastating to the region and safe anchorages are essential. St. Kitts/Nevis has never been very popular with yacht owners due to a lack of good anchorages. Overnight anchorages along the west coast of St. Kitts often tend to be uncomfortable due to the swells which often occur (Bradshaw, 1989). However, when the wind is blowing from the east, it is possible to overnight in one of the bays along the Caribbean coast of the SEP (Hart and Stone, 1976). Basseterre harbor is a possible anchorage when the wind and swell originate in the north. The Deep Water Port is probably the safest area for anchoring.

Most experienced captains do not often anchor overnight in relatively exposed bays in the Eastern Caribbean such as the White House/Ballast Bay area. Consequently yachting passengers frequenting a commercial center, such as the one proposed for the White House Bay area, might only spend daylight hours ashore leaving for safe anchor elsewhere by early afternoon, if they came at all.

497

If St. Kitts/Nevis decides that it is in the best economic and environmental interests of the country to provide safe anchorage for these deep draft yachts it will be necessary to either build a marina or upgrade the Deep Water Port as an attractive marina and provide land and water transportation to the SEP. Prior and present plans for the SEP call for a marina in the Little Salt Pond. Because of the natural resources surrounding this area and the known adverse impacts of marinas, the private owners must plan carefully in consideration of physical and environmental constraints as well as economic returns if this area is to remain a viable fishing and recreational area.

An environmental assessment is mandatory before construction begins. The design of the marina should be influenced by the amount of dredging necessary, the manner and location of disposing of dredge spoils, the supply and availability of electricity and water for boats and the financing available to build a waste facility for boats pumping out their holding tanks. One environmental cost of accommodating boat traffic is the dumping a raw sewage and garbage into the water from boats, which adds nutrients to the water and causes eutrophication and algal overgrowth in shallow nearshore waters. One way to encourage boats to install and use holding tanks would be to admit only yachts and sailboats with proper holding tanks to the marina.

Suggestions have also been made that a sports/restaurant complex would be better attended by yachting and cruiseship passengers than a shopping center. Apparently, there are too many duty free shopping stopovers for the cruising industry now and not enough sports facilities such as tennis courts, golf courses, volleyball courts etc. (Bradshaw, 1989).

It is commonly believed that St. Kitts fails to attract yachtsmen because marina facilities and services are lacking. This seems to be debatable and any investment to put in marina facilities and services for yachts should be preceded by a non-biased, careful marketing study, including the revenues obtained from marinas in the Caribbean.

3.5.7 Anchoring

Anchor damage to seagrass beds and coral reefs from sail and power boats seems minimal in the nearshore water of the SEP. The Atlantic coast appears to be too windy and rough throughout most of the year for anchoring; Major's Bay, on the channel has some protection but the winds and currents seem to preclude a calm anchorage. The bays on the Caribbean coast afford some protection but do not attract many yachts for overnight anchorages.

Once a marine park is established and the SEP begins to develop, the demand for anchoring and mooring areas may change. At the present time, however, there is no reason to consider mooring buoys as part of a Marine Park and Recreation Plan. If mooring buoys becomes an issue because of increased boat traffic, a feasibility study should be made to determine first, the viability, and secondly, the areas most secure for the mooring of yachts on the west coast and which will not interfere with the seining of fish.

3.5.8 Cruiseships, Mid-range Cruiseships

Anchoring of cruiseships and other large vessels in White House Bay and Ballast Bay, with launches going to shore, although probably possible, may not be environmentally feasible. Both White House Bay and Ballast Bay are rich nursery areas for conch, lobster, and reef fish and feeding areas for migratory pelagics such as albacore tuna and bonito. Large ships, anchoring in this area, could quickly reduce both the fisheries value and the recreational value of these waters for SCUBA divers and snorkelers, sport fishermen, the fishing community and the tourists staying on the Peninsula. Complex currents in this area might very likely carry waste discharges from these ships to the rich seagrass bed nurseries in the nearshore waters of the SEP. The Deep Water Port is only 15 minutes by launch from the SEP and perhaps 15 minutes, at most by taxi. Economic benefits from cruiseship passengers can also be realized by transporting them by water taxi and ground transfers to the SEP.

Serious consideration should be given to improving the Deep Water Port area and containing the cruiseships and mid-range cruise ships there. Sufficient cruiseship docking fees should be charged to allow improvement of the St. Kitts Deep Water Port facilities for cruiseship visitors. It is reported that some cruiseships pay upwards of a $1,000 docking fees.

This would be a good place to put the SEP National Park Visitors Center. It would attract cruiseship passengers right off the ship, inform them of the programs and recreational opportunities of the SEP, sponsor tours and serve to control visitation to the Peninsula, which may at some point become necessary to preserve the peaceful, scenic quality for all visitors. Entry fees and cruising permits for the Park could also be collected here to be used for Park management and administration.

3.6 Park Regulations

3.6.1 Fish, Shellfish, Coral Reef Species Conservation

3.6.1.1 Fishing Gear and Equipment

1. No beach seining permitted within park boundaries except with the permission of the park manager.

2. No seining of fish in waters less than 10 ft.

3. Only fish trap and net meshes allowed inside the park which have been approved by the Fisheries Division.

4. No spearfishing allowed.

5. No trammel nets allowed.

499

3.6.1.2 Taking of Juvenile Fish and Shellfish

6. No taking, selling, purchasing or possession of juvenile conch (conch that does not have a flared lip).

7. No taking, selling, purchasing or possession of
   a. any lobster carrying eggs; or molting.
   b. any undersized lobster (less than a pound and a half).

3.6.1.3 Taking of Sea Turtles: Green, Hawksbill, Leatherback

8. No taking, selling, purchasing or possession of sea turtles or sea turtle eggs.

9. No interference with turtle nests.

3.6.1.4 Taking of live fish, coral, other reef species for commercial purposes

10. No taking, selling, or exporting of live fish except with the permission of the park manager.

11. No collecting of coral and other reef species for souvenirs or commercial purposes.

12. No taking or collecting of coral except with the permission of the park manager.

13. No taking, collecting, selling or export of ornamental species (shelled mollusks other than conch or Echinoderms) except with the permission of the park manager.

3.6.1.5 Waste Disposal

14. No disposal of waste from land into marine waters of the park.

15. Disposal of solid waste, on land, only in authorized sites and containers.

16. Disposal of wastes from pleasure boat holding tanks only in an authorized shorebased facility.

500

3.6.1.6 Beaches

17. No sand mining without permission of park management.

3.6.1.7 Penalties

Fines and other penalties will have to be determined by the Minister, the Conservation Commission, Park management and the Advisory Committee. Monies from fines would go into park management funds.

501

4.0 PARK PROGRAMS

4.1 Enforcement

Goal: To Enforce the Regulations of the National Park.

4.1.1 Enforcement Unit

It is recommended that enforcement of the regulations of the marine park be carried out by the St. Kitts Coast Guard. At present, the Coast Guard has a Coast Guard cutter, 110 feet in length and two Boston Whalers, 22 ft. each with 2,500 cc engines. Included in their duties is the regular patrol of the St. Kitts coastline. There are 30 trained men in the Coast Guard, many of whom have been trained either in the U.S. or Canada. The majority of their budget comes from the United States.

The marine park will need the enforcement presence of the Coast Guard. It is assumed that regular patrolling would only extend to the Caribbean and channel areas of the SEP, since there would, by the nature of the Atlantic coast, be very limited activity. The need for an enforcement presence will be particularly true if increased boating use of the waters of the Peninsula results from park publicity and new land development.

Coast Guard duties, in the Park, would be the same as their present duties island-wide: to be available in boating emergencies and to enforce the laws of St. Kitts. As soon as possible, however, it is proposed that park wardens be hired and trained to also patrol daily, in park waters, to inform and counsel those who use the park of the rules and the need for the rules. These wardens would have the use of a small boat and motor, supplied by the Park, that would be more economical to run than the high powered engines of the Coast Guard.

Land patrolling and enforcement will be more difficult in those areas that are eventually designated as land parks on the Peninsula. Control and management of these areas could be better accomplished by signs and markers, designated parking and picnic areas and other means of controlling visitation. Educational, recreational tours can also go a long way in informing visitors and residents of the rules and need for the rules in National Park areas such as nature trails and shorebird, seabird refuges.

4.1.2 Licensing

Licensing of commercial boats using park waters of the marine component of the park would serve three major purposes. It would allow park management to better control cruiseships, mid-range cruiseships, liveaboard dive boats and other commercial boats and their passengers, would give park management the opportunity to educate passengers aboard these boats about the rules and reasons for conserving the marine resources, and would bring in revenues to help fund park management and activities.

502

Licensing of individual fishermen would allow the St. Kitts Fisheries Division to operate their fisheries programs more efficiently by keeping better records on the fishing industry. No extra charge would be made for licenses to fish in park waters. However, a license could be revoked if a fisherman consistently violated the regulations. Individual yachts would also need a license. At the time of purchase, they would receive information on the Park.

Hotel guests, day visitors and second-home owners of the SEP would receive a brochure and other written materials which would discuss the recreational opportunities and rules of the national park. The emphasis would be on the enhancement of their stay on the SEP by offering interesting recreational programs and encouraging those who were so inclined to participate. No license would be required of tourists staying on the SEP. However, a small entry fee or donation would be in order for park developed land areas.

Licensing procedures for the Park will have to be worked out with the Customs and Immigration Authorities, located at the Deep Water Port. Customs has jurisdiction for docking fees for cruiseships as well as other requirements for ships landing on St. Kitts/Nevis.

4.2 Fisheries

Goal: To Conserve the Fisheries Resources for the Benefit of the Fishing Community of St. Kitts/Nevis By Protecting the Marine System.

Traditional fishing practices, over the years, have depleted fish stocks in the nearshore waters of St. Kitts/Nevis. There is an immediate need to prevent further decline of fish and shell fish by managing the resource.

Throughout the Caribbean, it is becoming necessary to work with the fishermen to assist them to earn a living from fishing and to conserve the marine resources. Traditional fisheries in St. Kitts coastal habitats such as conch, spiny lobster, and reef fish are presently nearly all overexploited. Juvenile fish, undersized lobster and conch are often taken. Mesh sizes for seine nets are too small, beach seining is removing juvenile fish from shallow waters.

Coral reef habitat for fish stocks is being damaged by the overgrowth of filamentous algae due to the overfishing of grazing fish and disturbance of the ecology. Some fish, shellfish stocks are being drastically reduced.

The St. Kitts Fisheries Division has been working with the commercial fishermen to help them protect their resource base, particularly in the areas of spiny lobster and conch; two economically important species. Some research has already been completed which indicates that Friar's Bay South and Major's Bay are rich nursery areas for conch and lobster respectively.

97

It is apparent that all the coastal waters of the Peninsula are a vast, nursery area for juvenile fish and shellfish. Therefore, the main fisheries objective of the park program will be to enforce the regulations of the park to protect this resource base and to find viable economic alternatives for loss of income from the enforcement of such regulations. The park management should work with the Fisheries Division and other marine park managers throughout the Caribbean to bring appropriate new ideas and methods to St. Kitts to improve the incomes of the fishermen. These new methods of fish production include FADS; Fish Aggregating Devices, and for the full-time fishermen, opportunities through better equipment to fish pelagics in deeper water beyond the nearshore. Setting aside fish reserves, although not recommended at first as methods for regeneration of fish stocks, should be considered by the Advisory Committee for future action.

The fishermen will participate in park management through their member on the Advisory Committee. The Fisheries Division will probably also be a member of the Advisory Committee.

Once park management is in place, it is recommended that fishermen be recruited and trained to act as assistants to the research biologist, the park wardens and to serve as members of an Observer Corps on the liveaboard dive boats.

4.2.1 Observer Corps

Because of the present difficulties with the liveaboard dive boats using St. Kitts waters and interfering with fish traps and other fishing gear, the GOSKN has decided to charge a fee per dive boat while in St. Kitts waters, and to place, on board, an observer, who would be, if possible, a certified diver. This observer would be paid by the GOSKN out of the fee. The purpose of this observer would be to stop any vandalism of fish traps and other gear by recreational divers.

This licensing procedure, if adopted by the GOSKN, would also be adopted by the National Marine Park of the SEP. To assist the Government and the fishermen, it is recommended that observers be trained through a park management program, developed by the Advisory Committee and park staff and be selected from among recreational divers and fishermen of St. Kitts/Nevis.

4.3 Resource Management

Goal: To Identify and Recommend Projects of High Priority for Immediate Implementation.

There is a need to learn more about the marine resources of the SEP for purposes of fisheries management; visitor management; developing recreational programs for tourists, and environmental education programs for residents and visitors. The following baseline and monitoring studies are recommended for the marine park program.

504

4.3.1 Quantitative Monitoring of Fish Populations

Suggested Method:

Use a stationary visual census to estimate the abundance, sizes, and species of fish, shellfish found in different habitats and in different areas. This will help to assess the effects of the ban on fishing in the recreational sites. A diver chooses a random point, within a single habitat such as coral reef, seagrass, sand, etc. The diver then rotates 360 degrees around this point for five minutes, noting all fish species within an 8 m radius. These species are recorded on an underwater slate as they are seen. At the end of the five minutes, fish of each species are counted and maximum, minimum and average of mean lengths are recorded. Using this method, species are identified rapidly for listing purposes and large numbers of samples can be easily obtained for statistical use.

4.3.2 Estimation of Conch Densities and Population Structures

Suggested Method:

Use the visual, swim transect method. Transects are 50 m long and set in the seagrass/sand areas of the Park. One diver places a stake in the sea floor at a chosen, beginning point. He then holds the one end of the string while a second diver swims with the string until it is tight. At this point a second stake is placed. Both divers then tie the string to the stakes. Next, a diver swims the 50 m length, counting conch and determining whether the lip of the conch is flared and recording on an underwater slate all conchs within 2 m on each side of the transect. Permanent transects can also be used although it sometimes proves difficult to use permanent transects in anything less than clear, quiet waters.

4.3.3 Evaluation of the Health Status of Coral and Other Benthic Organisms

Suggested Method:

Use the linear-transect method by using temporary linear-transects of 10 m each. A diver holds an end of a plastic tape measure while another diver swims with the other end. Stakes are then placed at each end of the transect and a light-weight chain is allowed to fall as exactly as possible along the contours of the substrate. All coral and other reef components immediately underneath the chain are identified, measured by counting chain links, and recorded on an underwater slate by the diver. Permanent transects of 20 m long are set in the same way as the temporary transects and marked permanently with stakes at each end. Underwater photographs of these areas are also taken to be used as visual comparisons over time.

All methods can be adapted to specific conditions such as high turbidity, the need to count cryptic species, etc. As park/reserve management becomes more knowledgeable of the

505

area, changes in methods can and will be made and more constructive methods of sampling will be discovered through trial and error.

Use of the Results

Assess the effectiveness of the fishing management techniques such as the regulations.

Assist the fishermen in obtaining larger catches and a greater return for their fishing efforts.

Assess the percent of living coral, number of coral species and relative abundance of each, percent of corals with filamentous algae overgrowth/ percent per individual species, percent of bleached corals/percent per individual species, and topographical relief.

Select and recommend certain snorkeling and SCUBA diving areas for tourists and those in the SCUBA and snorkeling diving industry.

4.4 Environmental Education and Interpretation

Goal: To Inform Visitors and Residents of St. Kitts of the Value of the Natural Resources at the Southeast Peninsula.

Natural and political history tours in St. Kitts/Nevis are well received by tourists to St. Kitts. It is recommended that this tradition of private tours be adopted by the park environmental education program.

Teachers from the St. Kitts/Nevis school system and interested leaders in local communities should be invited to attend these tours at no charge to them. Eventually, park management should offer programs for children in the schools after consultation with the school system and the GOSKN.

4.4.1 Marine Environment

The opportunities for marine education in the waters of the SEP are unlimited. Snorkeling expeditions, beach walks, boat tours to view the rocky shores and cliffs from the sea could easily be organized by park management and led by the marine park biologist or by private tour groups. Because park management and staff would be limited, private tour groups would be encouraged to utilize the natural areas of the Peninsula and park brochures and other educational materials, if available, would be shared with private tours to assist them in interpreting the marine environment to SEP visitors.

506

The following tours are illustrative of tours that could be offered in the National Marine Park:

Snorkeling Tour Off Guana Point: Teaching could be done from a boat for small snorkeling groups or from a point on the land near the White House Bay pier or, in the future, in the proposed village. The coral reef area here is quite close to the surface and populated by good biological diversity of corals and other reef invertebrates as well as a variety of fish. Marina development in the Little Salt Pond, however, may have an adverse impact on this unique area, both during construction and operation. Park management will need to be represented during discussions concerning the design and capacity of the marina.

Rocky Shore Tour: Along the rocky beaches of the White House Bay area are abundant coastal life in the shallow tide pools and among the rocks. Private tour operators and/or a park naturalist could develop this beach walk to complement the snorkeling tours off Guana Point.

Seagrass Bed Snorkeling Tour off Cockleshell Bay: In the channel area, there are opportunities for snorkeling tours in the calm, shallow-water seagrass beds, particularly offshore of Cockleshell Bay. This is a protected area suitable for beginning snorkelers and swimmers. " Turtle grass" or seagrass is rich in marine life. These "meadows of the sea" support numerous interesting and colorful fish, small corals, and fascinating species such as the Queen Conch, Sea Stars, Sea Urchins and Stingrays.

Sandy Beach Walk: The beaches of the SEP are ecologically rich areas, some quite unique in their remoteness and freedom from the impacts of man. This tour could include a discussion of the need for protection of turtle nesting and habitat for juvenile turtles. Turtle tracks might be spotted or even baby turtles as they emerge from the shell. The park naturalist or private tour guides could talk to visitors about the conservation of beach ecology, pointing out the interesting vegetation on the back part of the beach; and the rich variety of marine and terrestrial life which are part of the ecology of the beach zone.

4.4.2 Visitors Center

Siting the Visitors Center at the Deep Water Port would fit into the recommendations of the Tourism Study prepared by Tropical Research and Development which included:

1. Make St. Kitts/Nevis a more competitive port of call.

2. Develop the total St. Kitts/Nevis product of attractions, infrastructure and services.

3. Ensure the safety for the passengers.

4. Minimize the disruptive effects that cruise ship passengers can have on quiet resorts by carefully organizing and planning tours of the SEP.

5. Provide an impetus to improve the site as a port of call and give the GOSKN a rationale for applying for funding to improve the environmental quality and aesthetics of the port.

6. Improve the terminal facilities.

7. Offer a convenient location or departure point for tours capitalizing on the natural heritage of the SEP as well as other natural and cultural heritages of St. Kitts /Nevis throughout the island.

4.5 Training Program for Park Management and Staff

Goals: To Learn Managerial, Enforcement, and Educational Techniques

1. Increase the number of certified SCUBA divers in the vicinity of the park

2. Train observers on dive boats and instructors to others in the park.

3. Become more effective in training park wardens, teaching children and other visitors and residents.

The trend in protecting the environment is away from regulation and toward environmental education and training; toward involvement of the local people such as fishermen and away from exclusion of local residents from protected areas. There are "mobile seminars" offered in the Caribbean and in the United States which enable park managers, biologists and wardens to visit other parks and facilities and learn from them. For example, successful personnel exchanges have been made between the Hol Cban Marine Park at Belize and the Key Largo Marine Sanctuary in the United States.

5.0 CONCLUSION

The establishment of the Southeast Peninsula National Land and Marine Park will enable the GOSKN to obtain the administrative, funding and enforcement capability it needs to maintain the high recreational and natural resource value of the Peninsula. It will provide long-term protection of the recreational opportunities sought after by the tourist industry and add substantially to the tourist marketing strategy. Without the July 1989 gazetting of the NCEPA of 1987, which provides a rationale for the Park and activates the Conservation Commission that could assist the Minister in the numerous tasks involved with the establishment of the Park and the Marine Park and Recreation Plan, long-term protection could not have been achieved.

509

6.0 BIBLIOGRAPHY

Berwick, Nora L. "The Effect of Tourism on the Shallow Marine Environment of the St. Vincent Grenadines." Conservation Systems. Washington, D.C. August 1986.

Birchard, William Jr. and Robert D. Proudman. Appalachian Trail Fieldbook, A Self-Help Guide For Trail Maintainers. Harpers Ferry, West Virginia. 1982.

Blount, Steve. Diving and Snorkeling Guide to the Bahamas: Nassau and New Providence Island, New York: Pisces Books. 1985.

Bradshaw, Malcolm. Charter boat captain of The Flying Scotsman, and racing yachtsman, Eastern Caribbean. Interview, February 1989.

Center for Environmental Education, Sea Turtle Rescue Fund. "For the Residents of Palm Beach County." Washington, D.C.

Environmental Protection Agency, Region IV. Atlanta, Georgia. Coastal Marinas Assessment Handbook. Atlanta, Georgia. April 1985.

Hart, Jerrems C. and William T. Stone. A Cruising Guide to the Caribbean and the Bahamas. New York. Dodd, Mead and Company. 1976.

Heyliger, Samuel. Fisheries Division. St. Kitts, West Indies. Interview, February 1989.

Jackson, Ivor L. "Conditions and Trends in Caribbean Tourism Influencing the Development of the Southeast Peninsula (SEP), St. Kitts." Tropical Research and Development. Gainesville, Florida. December 1988.

Larson, Gary. Executive Director. Bahamas National Trust. Interview, February 1989.

Raymond, Paul W., Sea Turtle Hatchling Disorientation and Artificial Beachfront Lighting. Orlando, Florida. March 1984.

Rogers, Caroline S., Larry McLain, and Evonne S. Zullo. "Recreational Uses of Marine Resources in the Virgin Islands National Park and Biosphere Reserve: Trends and Consequences."

Biosphere Reserve Report No. 24. U.S. Park Service and Virgin Islands Resource Management Cooperative. September 1988.

Samuel, Kenneth. Owner and Operator, Kenneths Dive Shop. Basseterre, St. Kitts, West Indies. Interview. February 1989.

Towle, Edward, William Rainy, Ricky Skerritt, and Victor Williams. "Tourism and the Environment, A Case Study of Frigate Bay, St, Kitts." Island Resources Foundation, St. Thomas, U.S. Virgin Islands. November 1985.

90

U.S. National Oceanic and Atmospheric Administration, Sanctuaries Programs Division. "Key Largo National Marine Sancturary Mooring Buoy System." Florida.

Wilcox, Evelyn S. "Marine Resources Management Plan for the Southeast Peninsula of St. Kitts." Tropical Research and Development. Gainesville, Florida. December 1988.

Wilkins, Ralph. Fisheries Division. St. Kitts, West Indies. Interview, February 1989.