# KAUAI SHORELINE EROSION MANAGEMENT STUDY

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## EXECUTIVE SUMMARY

This study is a follow-up to the previous report entitled, the Hawaii Shoreline Erosion Management Study, completed in June, 1989. After describing a methodology for analyzing long-term shoreline changes, an analysis of two areas (Hanalei Bay and Haena-Wainiha) is conducted. On the basis of this analysis, some recommendations for improving the management of coastal areas on Kauai are provided. In addition, the results of an evaluation of the Poipu area, contained in the earlier report (Hawaii Shoreline Erosion Management Study) are summarized and presented along with management plans for the Poipu Beach County Park. The legal, economic and social impacts of the various proposed changes are discussed. Finally, the report concludes with some implementation methods for the recommended management plans.

Some of the key findings and recommendations of this study include:

(1) establishment of shoreline setbacks of not less than 75 feet for Hanalei Bay and not less than 60 feet for Haena;

(2) establishment of an 80 foot shoreline setback for the Poipu Beach Park area;

(3) creation of overlay Shore Districts as specified in the Kauai Comprehensive Zoning Ordinance (Sec. 8-13.1) for the Hanalei, Haena-Wainiha, and Poipu areas;

(4) development of a Shoreline Special Treatment Zone Plan to be adopted by the Kauai Planning Commission;

(5) development of Shoreline Structure inventory to be maintained and updated by the County of Kauai;

(6) removal of an illegal shoreline protection structures and stricter enforcement of all regulations affecting coastal development and beach preservation;

Many of the recommendations and findings of this report are similar to the results of previous studies. In general, non-structural remedies (zoning, setbacks, development regulations, etc.) are preferable to structural remedies (seawalls, revetments, offshore structures, etc.). Not only can the non-structural approaches be adjusted should new information regarding patterns or rates of erosion come available, but the "hardening of coastlines" is a problem which has been long recognized. Where structural remedies are absolutely necessary, buried revetments and beach nourishment are preferred methods of shore protection. Actions which are "proactive" rather than "reactive" are also preferable and any new actions need to take account of both the long-term, possibly cyclical aspects of erosion as well as the economic life of any building, dwelling, or facility built on the shoreline. Finally, this report brings attention to the importance of beach preservation, recognizing that dynamic beach systems are not only a basic aspect of the island's morphology, but also, an important, unique, and valuable resource which must be preserved.

The analysis of impacts associated with the adoption of the various proposed recommendations suggests, in general, that the public, long-term benefits outweigh the social, economic, and legal costs. Implementation of the proposed recommendations will require considerable effort on the part of elected and appointed officials. The report concludes with a discussion of which recommendations can be implemented through: 1) the administration actions of the Planning Director/Commission; 2) those which require approval of the County Council; 3) those which can be implemented by the various state agencies (Office of State Planning, Coastal Zone Management Program, etc.); 4) those which can be implemented through enactment of new state legislation; and 5) those which can be implemented through a collaborative effort between State and County agencies.

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# INTRODUCTION

## PROBLEM DEFINITION, STUDY PURPOSE AND SCOPE

The Hawaii Coastal Zone Management (HCZM) Program provides policy guidance for the use, protection, and development of land and ocean resources within Hawaii's coastal zone. Major objectives of the Hawaii CZM Act, Chapter 205-A, Hawaii Revised Statutes (HRS), are to provide coastal recreational opportunities accessible to the public, to reduce hazards to life and property from coastal erosion, to protect coastal resources uniquely suited for recreational activities, to elicit public participation into the coastal management process, to communicate adequate information on coastal hazards, to concentrate in appropriate areas the location of coastal development necessary to the state's economy, to minimize the adverse impacts of coastal development, to control development in areas subject to hazards, and to improve management of coastal area resources in the face of development pressures and overlapping jurisdictions.

Hawaii's beaches are among the State's most valuable resources, yet they are threatened by natural erosion processes, and by human attempts to solidify shorelines in order to protect coastal development. Shoreline solidification and development interferes with the natural, cyclic process typically observed in Hawaiian beach systems,[1] and threatens the existence of many beaches. Recognizing this threat, the State of Hawaii established statewide standard shoreline setbacks (Chapter 205A, Part III, HRS), and provided the authority to the various county governments to establish even larger shoreline setbacks, in order to control development along the shoreline so as to protect and preserve Hawaii's beaches, ensure adequate public access to all beaches, and pre-empt catastrophic losses of life and property. These statewide setbacks have proven to be inadequate as minimum standards, as beaches and access to beaches continue to be lost.

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1. R. Moberly and T. Chamberlain, Hawaiian Beach Systems, Hawaii Institute of Geophysics, University of Hawaii at Manoa, 1968.

Not only are the current statewide setbacks too small to accommodate natural cyclic beach migration in some areas, but they are often ignored and violated. The statewide setback is often too rigid to deal with the diversity of shoreline conditions in Hawaii.

In March, 1989, the Office of State Planning (OSP), as the lead agency responsible for administering the Hawaii CZMP, commissioned a report entitled the Hawaii Shoreline Erosion Management Study, which was completed in June 1989. Contained in this report were certain recommendations for revising the shoreline management regulatory regime in Hawaii, so that the objectives of the Coastal Zone Management Program could be more adequately realized. The recommendations were:

- The State CZM office should take the lead role in the development of a shoreline erosion management team involving federal, state, and local agencies as well as the general public. The CZM Office would provide technical assistance and overall coordination among government agencies, and financial support for local planning and management efforts.

- The State should commit resources necessary to establish an on-going system for monitoring beach erosion that includes routine data collection and analysis including aerial photography, computer mapping, and erosion rate projections. The CZM Office would be the lead agency in this effort. More detailed and reliable data, as well as an efficient and effective methodology, are needed on which to base erosion prediction and control programs.

- The littoral cell should be adopted as the appropriate management unit. The littoral cell concept is based on the idea that geophysically defined areas are subject to littoral processes that are specific to those areas. Determination of the boundaries of these littoral cells, the description of the littoral processes at work within these cells, and the adoption of management plans based on the erosion/accretion trends evident in these cells are necessary to prudently respond to unique variations of shoreline and beach erosion in Hawaii.

- The necessary financial resources must be committed by the State at both the State and County levels in order to guarantee adequate monitoring and enforcement efforts.

- Based on a program of data collection and analysis, beach and shoreline areas should be classified into stable and unstable areas (littoral cells) with appropriate shoreline setbacks. Setbacks would be based on both environmental criteria (rates of erosion, severity of erosion, beach integrity and quality) and economic criteria (service life of improvements, extent of development, cost of land), as well as the development policies for the area.

- Site-specific, long-term management plans should be developed for particular littoral cells rather than general, all-purpose plans which do not account for differences in shoreline and beach dynamics. These management plans would concentrate on non-structural solutions to shoreline erosion, and would include such strategies as rezoning parcels, increasing setbacks, and creating special overlay districts to pre-empt the problems associated with shoreline erosion and erosion control structures. In certain cases, erosion control structures would be a necessary limited component of the management plan.

- Management plans for littoral cells should include policies and programs for alternative management and financing of physical structures which could include the creation of special assessment districts, impact fees, and other cost-recovery techniques for financing improvements which benefit private property owners. Very often erosion problems occur in built-up areas. Individual property owners may act in isolation, seemingly made to bear the full costs of erosion control. In reality, these owners have only borne the cost of protecting their individual property, and often created new costs for adjacent property owners and public beachgoers. Management plans should include strategies for financing and sharing the full costs of improvements among all beneficiaries.

- Greater coordination and clarification of policy objectives is needed among various permitting agencies. Greater communication is needed among the levels of government with jurisdiction over erosion control.

- In-house expertise regarding coastal processes and coastal engineering principles should be developed and maintained by the various responsible regulatory agencies to expedite erosion data collection and analyses, and to ensure critical scrutiny of shoreline development proposals.

In addition to these statewide recommendations, particular recommendations were made to improve the management of shoreline erosion on the islands of Oahu and Kauai. Recommendations for the Kauai shoreline included:

- Establishment and adoption of a Shoreline Special Treatment Zone Plan, and concomitant establishment of Shore District Boundaries.

- Establishment of variable shoreline setbacks based on the erosion patterns evidenced within a particular littoral cell, the land use and degree of development within the land areas mauka of that cell, and the service life of improvements to the affected properties.

All of these recommendations were considered far-reaching in both scope and impact, and a corollary analysis of the impacts of regulatory changes for specific areas on the island of Kauai was requested.

In June 1990, the OSP commissioned a sequential study to examine erosion at additional shoreline areas on Kauai, to develop appropriate management recommendations for Kauai's shoreline areas, and to analyze the impacts of these recommendations. An additional purpose of this study was to develop specific shoreline erosion management plans for certain county parks on the island of Kauai. The results of case studies of two coastal areas supplement the case study results of the Poipu area that were contained in the 1989 study. These erosion studies were used to develop erosion mitigation and control methods applicable to the study sites.

Specific tasks included in this study are:

- Analysis of shoreline changes at Hanalei and Haena, and recommendations for shoreline erosion management in these areas;

- Impact analysis of proposed changes to the shoreline management regulatory regime for certain shore areas in Poipu and Hanalei;

- Development of specific shoreline erosion management plans for Poipu Beach County Park;

- Development of recommendations for the implementation of the shoreline management programs on Kauai.

This report presents the results of the study, organized in four chapters. Following this introduction, Chapter I, completed by Edward K. Noda and Associates, Inc. describes the analyses of case study sites at Hanalei and Haena, and includes recommendations for future erosion management controls for each site. Chapter II contains the legal, social, and economic impact analyses of the recommended regulatory changes to shoreline setbacks and adoption of the Constraint Shore District (S-SH) as an erosion management tool. Chapter III provides specific beach erosion management plans for Poipu Beach Park. Chapter IV discusses implementation aspects of the recommended management plans.

This is primarily a long-range resource management study, not a definitive erosion prediction study. These recommendations are based on historical erosion trend analysis. Estimates of past erosion trends have been used to produce conservative predictions of future erosion, and do not directly factor into account the exacerbative nature of some types of shoreline or beach erosion, the possibility of long-term rise in sea level, or cataclysmic erosion events such as hurricanes or severe Kona storms. While some of the management recommendations are based on these erosion predictions, others are based on the Coastal Zone Management Act (CZMA) and Kauai County policies which call for preservation of the natural shoreline (Shoreline Setback Rules and Regulations, Planning Department, County of Kauai, 1971) and for protection of the natural resources of the coastal zone (Chapter 205a, Part II, HRS), and are designed to strictly limit shoreline development which would threaten natural shorelines and beaches, regardless of the erosion rate.

Although a minimal impact analysis of structural measures as well as non-structural measures is presented, and quantified where possible in order to facilitate comparison of various management options, the type of analysis undertaken in this study is predominantly an impact forecast. "Forecasting consists of predicting the environmental impacts of alternative actions,"[2] as opposed to evaluation, which attempts to put relative values on

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2. L. Ortolano, Environmental Planning and Decision Making, Wiley and Sons, New York, 1984

different impacts, and establishes preference for various alternatives. Moreover, natural resources and concepts such as recreational enjoyment quotients are not market-valued in the traditional sense. No prices have been competitively established for these "goods" and services, and no formal markets exist which bring together buyers and sellers. Attempts to quantify such goods are subjective at best,[3] so no attempt was made. Instead, these environmental and non-market factors are presented as factors which decision makers should consider when making erosion management decisions.

The law firm of Moon, O'Connor, Tam & Yuen provided technical support in terms of the interpretation and analysis of various laws and regulations affecting shoreline development. In particular, attention is given to defining "hardship" and disposition of non-conforming structures. Their report is included as Appendix A.

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3. Bruce Lindsay and Helen Tupper, "Demand for Beach Protection and Use: A Contingent Valuation Approach" in Coastal Zone,89, Magoon et al. editors, American Society of Civil Engineers, New York, 1989.

# Chapter I

# CHAPTER I. ANALYSIS OF HANALEI AND HAENA-WAINIHA SHORELINE CHANGES

## I.1 METHODOLOGY FOR ANALYZING LONG-TERM SHORELINE CHANGES

A conventional method for the evaluation of historic shoreline movements involves the interpretation of aerial photographs by Coastal Engineers. Unlike land transact profiles which provide information along discrete lines, aerial photographs provide instantaneous spatial coverage over broad areas of the coast. Since changes can occur over short reaches along the shore, transacts may not accurately represent the general trend of shoreline change, particularly if the transect line is located in an area of anomalous shoreline movements. By digitizing continuous beachlines, variations in the shoreline can be averaged out to obtain a more appropriate estimate of long-term changes.

In the evaluation of beach shorelines using aerial photographs, it is sometimes difficult to accurately define the shoreline. Two reference lines should be defined: the vegetation line and the waterline. The vegetation line is an indicator of the seaward limit of fastlands (i.e. landward limit of active beach zone). The waterline is an indicator of the seaward limit of the beach zone. Both lines create special problems in terms of their definition on the photos and their use in estimating shoreline changes.

The vegetation line can reveal the erosion of fastlands, but cannot provide information on the beach width changes when accretion occurs. Another problem with vegetation lines is that they can sometimes be artificial or man-made (vegetative plantings or shore protection) and not reflective of the natural landward limit of dynamic shorelines. Where large trees line the shoreline, their canopies can also obscure the vegetation line.

The waterline, which is the point at which the water surface intersects the beach slope, is generally used to establish the seaward limit of the beach zone. This reference line has inherent problems associated with the tidal elevation and the wave run-up characteristics at the time of the photograph. The beach toe line, which is the point at which the beach slope intersects the shallow reef flat, is sometimes a more appropriate line to use for establishing the seaward limit of the beach zone, since it is not influenced by the water level fluctuations. For the case study sites, the waterline was a more consistent reference line to use for establishing the seaward limit of the beach.

Vertical aerial photos for the shoreline areas were obtained. The aerial photographs were enlarged to a scale of approximately 1 inch = 200 feet. Data from the photos (vegetation line, waterline, selected targets) were electronically digitized into a computer aided drafting (CAD) system relative to an arbitrary x,y coordinate system. By matching the target locations, the horizontal length scales were calculated and the digitized lines were rectified to a basic x,y coordinate system. Computer software was used to perform this rectification and to minimize distortion in the air photos. The information from various photos was overlayed and plotted to develop an understanding of the shoreline and beach changes.

The loss or gain of shoreline was quantified by calculating the area between the vegetation lines (or waterlines) of subsequent year photos. This area divided by the length of shoreline yielded the average horizontal change per unit length of shoreline for that shoreline reach over the time period between photos. Cumulative plots of these values will show the average accretion or erosion trends for the particular shoreline reach.

The area between the vegetation line and waterline is the active beach zone. When the beach width is highly variable along the shoreline reach over time, an average value representing the relative changes in the beach width is useful. To provide this measurement, the area between the vegetation line and waterline for each photo was estimated by numerical integration. This area divided by the length of beach provided a value representing the average beach width per unit length of beach within the shoreline reach. By using the earliest aerial photo as the base year, the net difference between the base year value and subsequent year values was used to determine the erosion or accretion trends within the beach zone.

Historical data on both the vegetation line and waterline provided complementary information on the long-term shoreline changes. Changes in beach zone width indicated the gain or loss of usable beach area. Horizontal movement of the vegetation line over long time frames indicated historical loss or gain of shoreline. The changes in horizontal movement of the vegetation line and waterline, as well as the changes in beach width, were evaluated to assess the potential for future long-term shoreline changes.

This technique for determining shoreline changes was used because it is an economical, relatively reliable methodology. It does have a number of limitations. Aerial photographs can be vulnerable to horizontal distortion, caused by the pitch and yaw of the aircraft doing the photogrammetric survey. <u>No "ground truth" survey measurements were made to confirm photographic scale</u>. Human error is a source of inaccuracy when delineating features during the digitization process. These factors, along with the inability to clearly distinguish either vegetation or water lines due to lack of resolution in the aerial photographs, combine to produce digitized maps that may have a substantial margin of error.[4] Finally, no provisions were made during photographic interpretation and digitization for tidal effects. Since tidal changes on Kauai average a daily fluctuation of 1.6-1.8 feet (National Oceanic and Atmospheric Administration, personal communication), and since even a slight vertical rise in sea level may produce substantial horizontal encroachment onto

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4. <u>Oahu Shoreline Setback Study</u>, November 1988, Sea Engineering Inc. and Wingert, Everett, Department of Cartography, University of Hawaii, personal communication.

the beach real potential exists for misinterpretation of beach changes. Despite these drawbacks, this methodology was determined to be the best available given the size of the study area and the nature of the study. The combination of analysis of historical aerial photographs with review of existing information about littoral conditions and processes provides a reasonable basis for predictions of future erosion. Therefore, estimates have been provided for beach loss/gain as well as for vegetation line accretion or recession. Estimated changes in the vegetation line may be relatively more accurate because the tidal fluctuations are not a factor, and the vegetation line is easier to distinguish than is the water line on the beach.

## I.2 CASE STUDY SITE #1 - HANALEI BAY

### GENERAL DESCRIPTION

The first study site is located on the north shore of the island of Kauai (Figure I-1). The Hanalei Bay study reach extends from Makahoa Point on the west end of the bay to Puu Poa Point on the east end, a shoreline reach of roughly 2.8 miles. Exhibit A (back pocket) provides the base maps for this case study site at a scale of 1 inch = 200 feet. Figure I-2 shows a reduced version of the base map for reference.

Nearly the entire shoreline reach is fronted by a sandy beach. The mild beach slopes in Hanalei Bay offer some of the most frequented beach areas on the north shore of Kauai. Protected waters during the summertime provide a popular offshore open anchorage area for transient boaters. Numerous wintertime surf spots include one world-famous break along the fringing reef on the east side of the bay.

Hanalei Bay is the largest embayment on the north shore, with a wide mouth roughly 1.25 miles across, bounded by rocky headlands and shallow coral reefs. The bay opens towards the north-northwest, and is one of a system of embayments along the sinuous coastline making up the eastern half of the north shore.

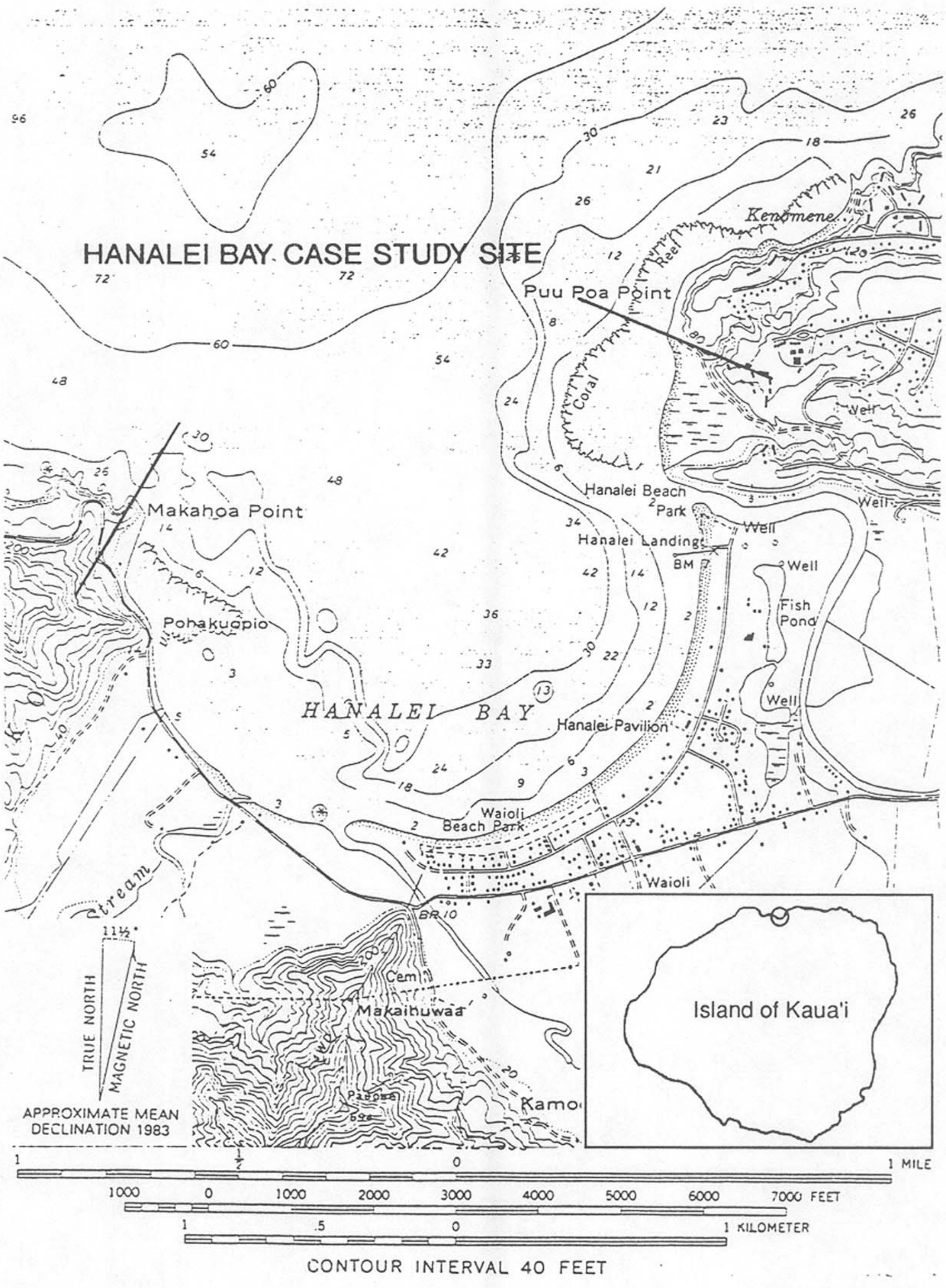


**Figure I-1**

## Hanalei Case Study Site

**Kaua'i Shoreline Erosion Management Study**

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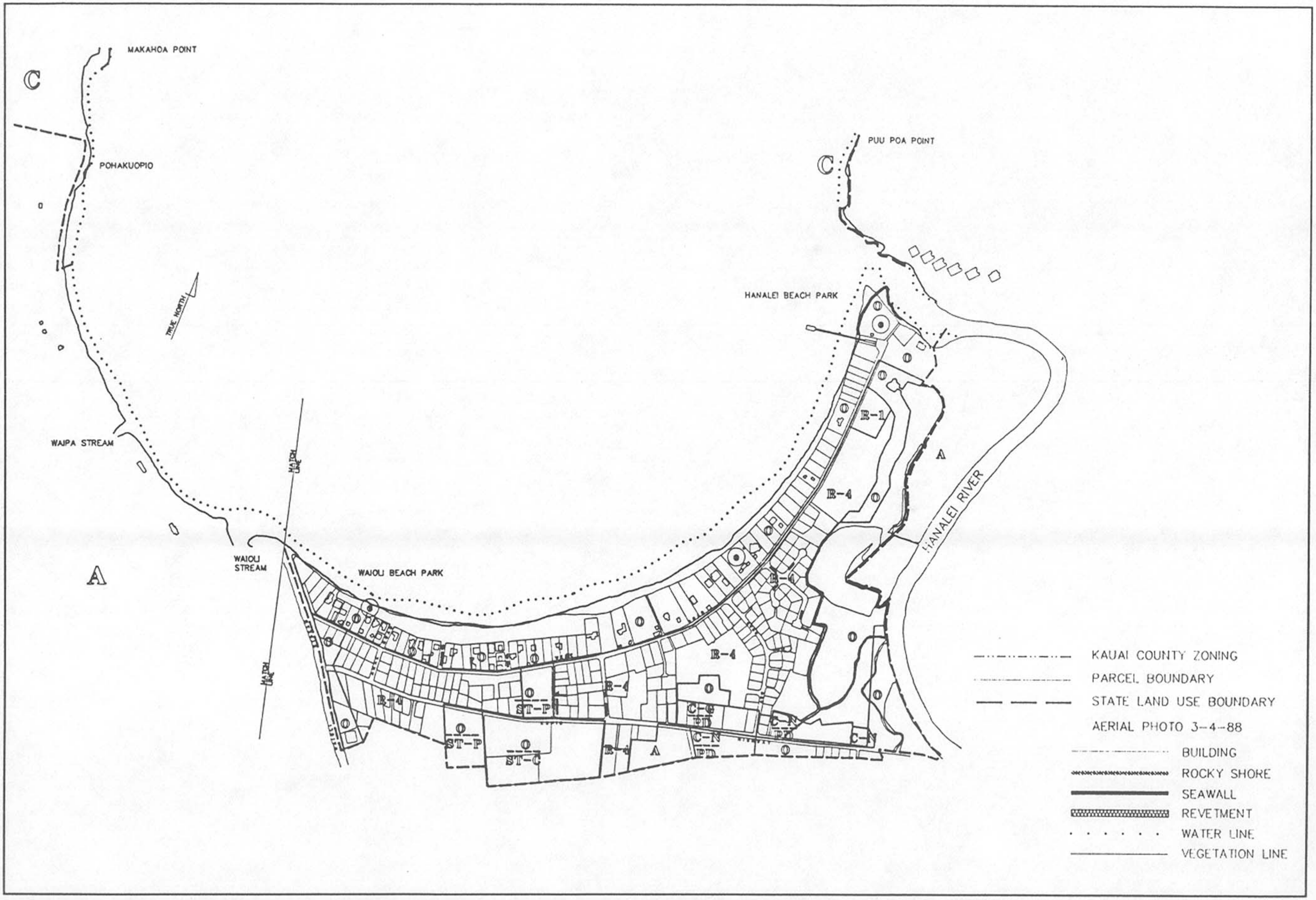


**Figure I-2**
**Hanalei Study Site Base Map**
**Kaua'i Shoreline Erosion Management Study**

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**Edward K. Noda and Associates, Inc.**

Westward from Hanalei Bay are the mountain ridges of the renowned Na Pali Coast. The majestic nature of the shear cliffs on the Na Pali Coast, however, is nearly equaled in Hanalei with its large lush valley behind the bay leading up to some of the island's highest mountain ridges towards the center of the island. The tremendous rainfall in this inland area, up to 400 inches a year in isolated rain forests, has a significant role in shaping the shoreline within Hanalei Bay where the mouths of three rivers are located: the Waipa and Waioli Streams and the Hanalei River. Detritus from these fresh water sources draining into Hanalei Bay make the beach sand significantly darker in color and more fine-grained than the cleaner calcareous sand beaches found in most other locations on the north shore of Kauai.[5]

Within Hanalei Bay, shallow reefs with depths of 5 feet or less extend in from the exterior margins of the bay from both Puu Poa Point and Makahoa Point. Beyond these reef formations, the depth contours within the bay generally parallel the arcuate shape of the shoreline, dropping off relatively quickly to greater than thirty-foot depths. The large central portion of the bay has a relatively flat, sand-covered bottom with depths between 35 and 45 feet. Outside Hanalei Bay, the sixty foot depth contour extends across the mouth of the bay, generally following the trend of the rocky coastline.

LAND USE AND DEVELOPMENT

The Hanalei case study area is located within the Hanalei District on the north-northwest coast of Kauai. It includes Hanalei town, a thriving low-density rural/residential community, and surrounding areas which are predominantly agricultural. The northeast section of the study area, on the eastern side of the Hanalei River, is physically a part of the resort area known as Princeville. The Hanalei District was the fastest growing area in the state throughout the 1980's, and had a 1989 resident

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5. Grain size characteristics described by Moberly and Chamberlain, Hawaiian Beach Systems, Hawaii Institute of Geophysics, HIG-64-2, July 1964.

population of 5,700 (DBED statistical department estimates, personal communication); current population figures for Hanalei will not be available until the results of the 1990 census are released.

The State Land Use designations for the study area include Urban, Agricultural, and Conservation (General, Limited, and Resource Use). The divisions between use designations correspond roughly to the particular geomorphological boundaries of the rivers and cliffs in the area. The oceanfront lands from Puu Poa Point to the eastern edge of the mouth of the Hanalei River are within the Conservation District, Limited Use. The town of Hanalei lies within the Urban District. That portion of the study area extending from the eastern edge of the mouth of the Waioli River halfway to Makahoa Point is contained within the Agricultural District. The remainder of the land in the study area on the western end of Hanalei Bay are within the Conservation District, General and Limited Use. The Land Use District Map for the vicinity is shown in Figure I-3. The Conservation District Subzone Map for the conservation-zoned lands in the area is shown in Figure I-4.

The case study area is located within the North Shore Special Planning Area which includes the District of Hanalei as described in Sec 4-1 (4) HRS, and portions of other watersheds draining to the ocean between Moloaa Stream and the Na Pali Coast. This area encompasses the entire northern section of the island of Kauai. Hanalei has been primarily a rural-residential area in the past, and retains a rural character to this day, but faces increasing development pressures. The North Shore Special Planning Area has been identified as an area where, "maintenance of the natural beauty, and ecological systems that characterize the North Shore

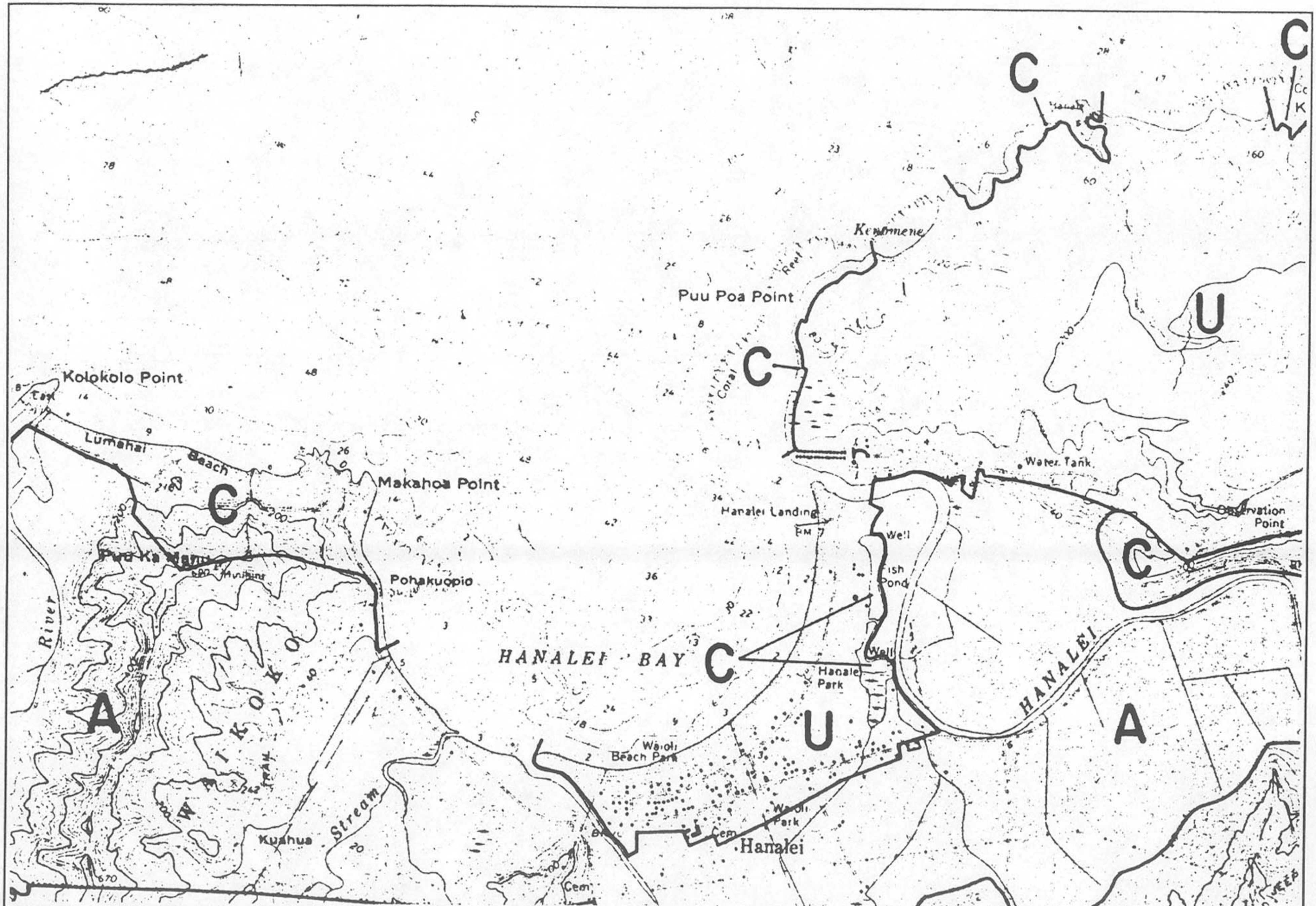


Figure I-3
**Hanalei State Land Use District Map**
**Kaua'i Shoreline Eroison Management Study**

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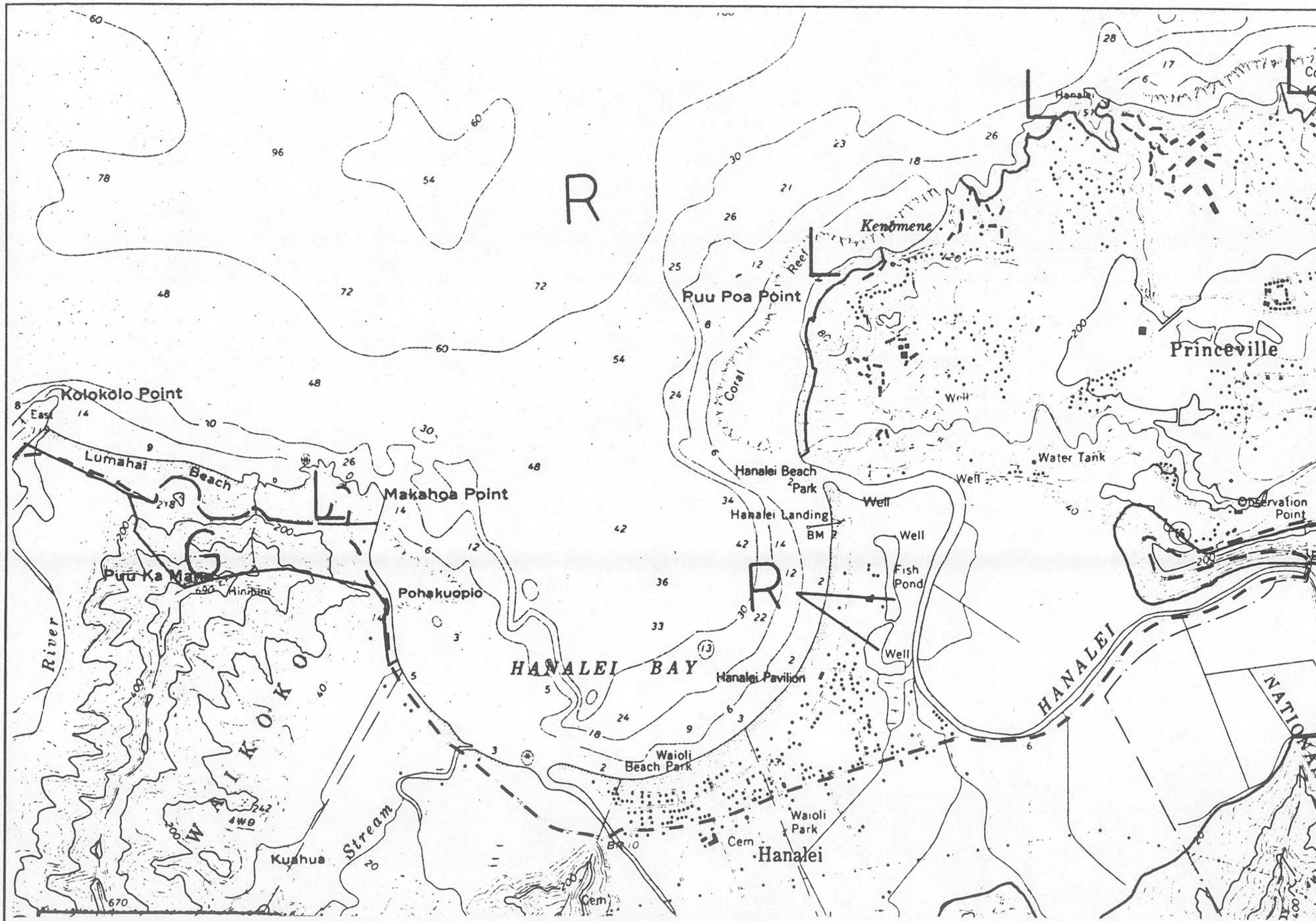


Figure I-4
**Hanalei State Conservation District Subzone Map**
Kaua'i Shoreline Eroison Management Study

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must take priority over any new development."[6] The County General Plan Update of 1982 designates the entire Hanalei Bay case study area from Puu Poa Point to Makahoa Point as Open.

Property immediately mauka of the Open-zoned beachfront parcels within the Urban District is generally zoned R-4. An exception is the Resort-zoned property in Section 7. Figure I-5 depicts the zoning districts for the vicinity. The beach areas fronting the SLUC Conservation District Lands have no county zoning designation, nor do the Agricultural or Conservation District lands. All beaches in Hawaii are zoned Conservation by the SLUC, and generally all lands makai of the certified shoreline are considered to be in the Resource Subzone.

NEARSHORE WAVE CLIMATE

The study site is exposed to deepwater wave energy from only the northwest-north-northeast directional sector. Waves from all other origins are significantly blocked by the land mass. Two dominant wave types approach from this sector of exposure: winter swell originating in the North Pacific and tradewind-generated waves from the northeast which may be present at any time of the year although most persistent during the summertime. "Kona" storm waves that are generated by extra-tropical storms from the southwesterly direction can also affect the site if the storms track north of the Hawaiian Islands. However, these waves would undergo significant refraction effects prior to reaching the site, resulting in much reduced wave energy within the bay. Moreover, these events are very infrequent.

North Pacific swell originate in the large sub-arctic low pressure winter storm systems near the Aleutians and the smaller mid-latitude low pressure systems. They approach the Hawaiian Islands from the northwest to northerly direction as

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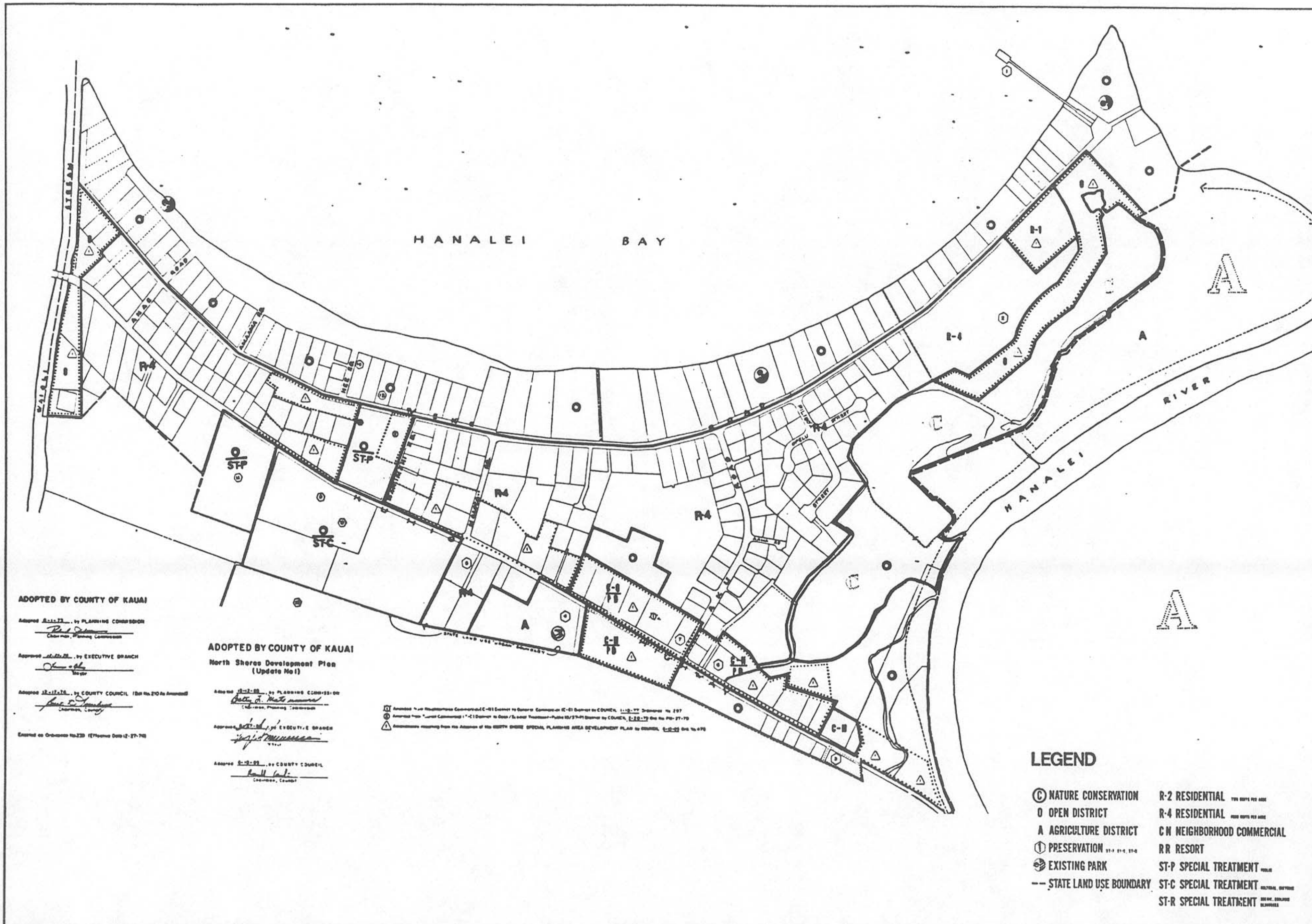
6. North Shore Development Plan Update, December 1980, Wilson Okamoto and Associates, Inc.)




# Figure I-5
## Hanalei Zoning Map
### Kaua'i Shoreline Eroison Management Study

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broad-crested swell with typical wave periods in the 10-16 second range and deepwater wave heights as large as 20 feet. These swell create the large breaking conditions favorable for surfing. The bathymetry contours offshore and within Hanalei Bay result in significant refraction effects as the waves approach shore, resulting in relatively higher wave energy levels towards the outer shoreline reaches of the bay around the points, and lower levels along the inner shoreline reaches. Depending on the wave approach direction and the wave height and period characteristics, the refraction and shoaling effects as the waves approach shore can result in distinct variation in the nature of the wave-breaking phenomenon both on the shallow reefs at the sideward margins of the bay and along the interior beach shoreline. With breakers on the nearshore reefs capable of attaining breaking heights of almost twice the deepwater wave heights, their influence on sediment transport processes can be significant. However, it should be noted that, although reported by local residents to be occasionally as large as 25 feet, breaking wave heights in Hanalei Bay do not attain the largest breaking conditions found on the north shore of Oahu. North Pacific swell energy arrives in the Hawaiian Islands anytime between the months of September and May, however it occurs with greatest frequency during the months of December through February.

The predominant tradewinds blow from the northeast through easterly directions, generating typical deepwater heights of 4-8 feet with periods of 5-8 seconds. These waves may be present throughout the year but are largest and most dominant during the summer months when the tradewinds are strong and persistent. The northeasterly tradewind wave energy can propagate inside Hanalei Bay, however with much reduced heights due to refraction effects and the northwesterly orientation of the bay. Most of Hanalei Bay is calm during tradewind conditions, thus attracting boaters to the safe anchorage during the summertime. Most inner parts of the bay experience wave heights of 1 foot or less during typical tradewind conditions, although breakers on the seaward margins of the shallow reefs, particularly towards the west side of the bay, may reach 3 feet in height.

COASTAL CHARACTERISTICS

Because of the concave shape of the shoreline reach within this study site and the variable reef, beach, and stream mouth features within this embayment, the coastal processes affecting certain segments of the shoreline varies. Thus, for the purposes of discussion and analysis, the Hanalei Bay study site was divided into coastal segments based on physical features of the coastline and bathymetry, along with observations of dynamic features. Seven sections were identified, with the largest interior beach section further subdivided in two sub-sections, as depicted in Figure I-6. A brief description of the characteristics within each shoreline segment is provided below. The typical beach widths indicated for each segment (measured as the distance between the vegetation line and the water line), were taken from the January 1983 color aerial photograph to provide a reference for comparison between the different shoreline sections. However, the numbers are not necessarily representative of the relative changes in a historical sense for the respective segments.

**Section 1**

Section 1 extends roughly 1,300 feet from the west end of the study site at Makahoa Point to Pohakuopio Point. The sandy beach, which is continuous inside Hanalei Bay all the way to the Hanalei River, begins several hundred feet south of the rocky Makahoa Point. In the middle of Section 1, the beach widens behind a natural breakwater formed by exposed reef rock. The reef line is nearly perpendicular to shore at this location, extending southeastward nearly 2,000 feet as a shallow fringing reef flat, then deepening and becoming more variable until it ends near the mouth of the Waioli Stream. This reef is an important feature as wave-breaking occurs throughout its length during large winter swell, and even tradewind waves break at its

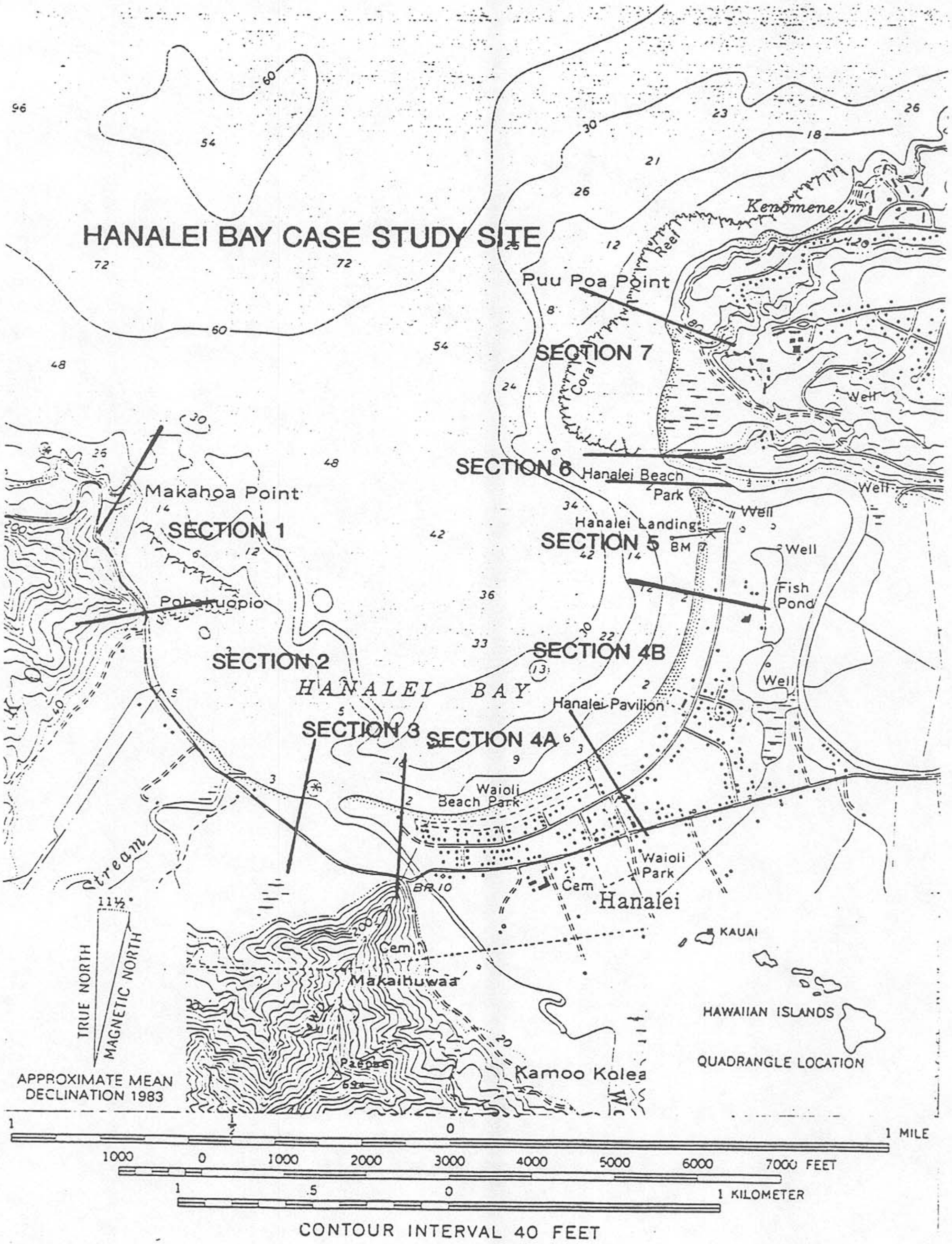



**Figure I-6**

## Coastal Segments of Hanalei Case Study Site

**Kaua'i Shoreline Erosion Management Study**

**Edward K. Noda and Associates, Inc.**

outermost margin. Water depths on the reef vary from 1-6 feet. The beach width narrows, but is continuous, around Pohakuopio Point at the border between Section 1 and Section 2. There are no shore protection structures in Section 1, and the typical beach width is 50 feet.

Section 2

Section 2 extends roughly 3,200 feet from Pohakuopio Point to the western limit of the sand delta formed by the Waioli Stream. State Route 56 directly borders the shoreline along the northern half of Section 2, with little land margin between the road and the fronting beach. The mouth of the Waipa Stream is located in the southern half of Section 2, and a smaller stream exits under Route 56 in the northern half of this reach. Except during rainy periods, it appears that these stream mouths are typically plugged with beach sand. The reef flat extends about 1,500 feet offshore along this entire reach. There are no shore protection structures in Section 2, and the typical beach width is 65 feet.

Section 3

Section 3 is a short segment which extends roughly 1,100 feet, encompassing the delta formation at the mouth of the Waioli Stream. The reef flat continuing across from Section 2 ends immediately offshore from the stream mouth, as the deeper central area of the bay begins here. Similar to the area around the Hanalei River, large beach sand deposits extend both into the river mouth and offshore in a delta formation, as the interactions between breaking waves and the river discharge flows are capable of moving large sand volumes in short time periods. The course of the stream across the delta changes frequently, however, it does appear always to maintain at least a marginal flow. Typical beach width at the widest point of the stream delta in Section 3 is 200 feet, however the beach narrows quickly to less than 100 feet at the endpoints of the section. There are no shore protection structures located in Section 3.

## Section 4

Section 4 extends roughly 5,200 feet along the wide interior section of the bay. Section 4A is the entire shoreline reach fronting Waioli Beach Park. Section 4B is the remaining reach extending northward. Facing northwestward with no protective reefs fronting the beach, large waves break close to shore forming turbid whitewater areas, strong longshore and rip currents, and large run-up zones, all of which create hazards for swimmers during periods of high swell. Section 4 also contains the highest density of residential development close to the shoreline as the population base from the town of Hanalei has expanded over the years. There are no shore protection structures in Section 4 and typical beach width is 125 feet.

## Section 5

Section 5 extends for roughly 1,200 feet northward to the Hanalei River mouth. The Hanalei River marks the end of the continuous beach in Hanalei Bay which extends all the way from near the start of Section 1 at Makahoa Point. Hanalei Pier is situated near the middle of this segment, extending roughly 500 feet directly off the shoreline. The pier is situated on piles and has little, if any, effects on the sediment transport processes along this section. The Hanalei River maintains an open mouth throughout the year and, as the main drainage system for the extensive Hanalei Valley, carries the largest discharge into Hanalei Bay. However, the sand spit that forms at the end of this beach section can nearly close the river mouth at certain times when river discharge is low and the beach is in an accreted state. Between the river mouth and the pier, wave size and breaker zones are typically limited in size due to a protective margin of extensive reef flat. This reef extends across the Hanalei River mouth and around Puu Poa Point. It is very shallow and widest fronting Section 7.

Shore protection structures line the Hanalei Beach Park shoreline north of the pier. A revetment constructed on the seaward shoreline of the park has suffered damage during periods of exposure, resulting in large boulders scattered along the original alignment of the structure. When the beach is in an accreted state, the revetment lies mostly buried. The north-facing shoreline of the park along the Hanalei River bank is also protected with a rock revetment. Along a 500-foot reach south of the pier, logs were placed along the vegetation line as an emergency measure to prevent erosion of fastlands during a period of extreme beach erosion. When the beach is in an accreted state, this structure is completely buried. The typical beach width north of the pier in Section 5 varies dramatically between less than 50 feet to more than 200 feet. South of the pier, a typical beach width is 75 feet.

**Section 6**

Section 6 extends for roughly 1,000 feet along the northern bank of the Hanalei River near the mouth. Depending on the width of the beach along the seaward shore of the park within Section 5, the exposure at Section 6 varies from being largely enclosed within the Hanalei River mouth to being more than half open facing southward toward the central shoreline reaches within the bay. The shoreline in Section 6 is mostly armored with revetment-like structures consisting of loosely dumped rubble in some places, and uniformly placed boulders in others, molding small pocket beaches along the river bank. At elevations between 50 and 100 feet above sea level, unfinished condominium structures line a small ridge overlooking the Hanalei River.

**Section 7**

Section 7 extends roughly 1,000 feet along the seaward shore north from the Hanalei River mouth to Puu Poa Point. There is a dramatic contrast in the beach sand characteristics between Section 7 and all the other Sections in the study area. The beach here consists of clean, coarse-grained calcareous sand with minimal detrital component. This is possibly due to the high wave exposure and wide shallow fringing reef, which discourages northward transport of sediments from the Hanalei River and beach areas within the embayment. Behind the beach, a sizeable wetland marsh is contained between the ridgeline overlooking the Hanalei River and the broad ridge on which the Princeville development is situated. The beach faces open ocean to the west, but it is protected throughout its length by expansive fringing reef flat. Although massive breakers often form near the outer edge of the reef, wave heights at the shoreline are limited by the less than 5-foot depths persisting over most of the reef flat. There are no shore protection structures located along this reach, and typical beach width is 50 feet.

COASTAL PROCESSES

Hanalei Bay is a relatively deep, large, circular-shaped embayment. The patterns of erosion and accretion along the shoreline within the bay are functions of the wave height, wave period, and directional characteristics of the seasonal wave types. With the headlands bounding the mouth of this highly embayed shoreline, and relatively deep depths within the bay, it is apparent that little sediment exchange occurs outside of the bay. Hence, with respect to littoral transport, Hanalei Bay can be considered as one large independent littoral cell.

Furthermore, typical of many north-facing beaches on the north shores of the Hawaiian Islands, there is a clear trend towards erosion during the winter followed by accretion in the summer season. When steep, high energy, winter waves attack the beach, the turbulence in the surf zone puts considerable quantities of sediment in suspension, where they are carried off the beach toe and transported offshore. Conversely, smaller waves with less breaking turbulence on the beach during the summer season, can restore sediment from offshore back onto the beaches. The reef flats and sand bottom interior of Hanalei Bay are sand storage areas for beach sediment. Sand in the nearshore areas are in a continuous state of flux under the offshore/onshore transport forces occurring during both the winter and summer seasons.

The circular-shaped embayment also influences the patterns of erosion and accretion due to longshore transport occurring along various sections of the shoreline. The bathymetry contours cause waves to refract as they approach from deep water. If the offshore slopes are gentle, wave crests will align themselves nearly parallel with the bottom contours. Convex-shaped contours will cause wave energy to converge (increasing the energy per unit length of wave crest), while concave-shaped contours will cause wave energy to diverge (decreasing the energy per unit length of wave crest). For shoreline segments that are fronted by shallow reefs, wave-breaking occurs near the seaward margin where water depths rapidly shoal up to the reef flat. Secondary waves formed on the reef flat will continue to propagate towards shore generally along the alignment of wave breaking, although irregular depths over the reef flat will cause continued refraction of the secondary waves as they propagate over the reef.

Generally, if wave crests approach parallel with the shoreline, there will be little induced longshore transport. Sediment transport will tend to be directed in onshore/offshore movements, with large steep waves eroding beach sediments and smaller, more gently rolling waves redepositing the sediments back onto the beach. However, as soon as incoming wave crests approach at an angle to the shoreline, breakers at the beach toe induce longshore sediment transport in the direction of wave breaking. Because the water depths within the bay are relatively deep, the refraction characteristics for short-period waves can be very different than for long-period waves, even if they approach from the same deepwater direction. Also, because of the extreme curvature of the bay shoreline, slight changes in deepwater approach direction can result in very different refraction effects and wave characteristics along the shoreline. Therefore, the angle of incidence of incoming wave energy may have opposite components of longshore transport along certain shoreline reaches during different wave seasons. Also, since the seasonal wave climate can vary from year to year, the net effects of the varying transport processes over a yearly winter and summer season typically may not compensate each other, resulting in observed changes in beach width and in the position of the vegetation line over the short term as well as over the long term.

LONG-TERM SHORELINE CHANGES

Historical aerial photos were analyzed to determine the long-term fluctuations of the vegetation line and waterline, using the technique described in the previous section of this chapter on case study sites. For the Hanalei Bay study site, the vegetation line was typically clearly defined by the dark border at the back of the lighter-colored beach area. The waterline was often more difficult to delineate, especially if breakers were present along the shoreline. In this case, the waterline was digitized within the wave runup zone at the estimated calm water position.

It was possible to obtain eight vertical aerial photographs spanning a 25-year time period from 1963 through 1988. The dates of the historical aerial photos used in this analysis are:

October 1963
April 1975
February 1977
January 1983
February 1986
July 1987
March 1988
December 1988

Overlays of the historic shorelines digitized from the aerial photos are contained in Appendix B for each of the shoreline sections within the Hanalei Bay study site.

The paucity of available photos cannot reveal seasonal variability in the shoreline changes. Most of the photos were taken during the winter season, when high wave conditions have maximum influence on the littoral transport processes. Thus, the historical long-term trends revealed by this analysis tend to be conservative. However, caution must be exercised in interpreting the data because of the uneven time frame distribution of the photos. For example, there is a 12-year gap between the 1963 and 1975 photo, with very short time periods separating the next six photos spanning the most recent 13-year period. Therefore, extrapolation of trends shown by the data points would be influenced by the high density of data within the most recent 13-year period.

In addition, it is important to emphasize that the photos represent eight instantaneous "snapshots" during the 25-year time period, of a very dynamic beach and shoreline reach. During any time period between the photos, the shoreline could have existed in much more eroded or accreted conditions than exhibited by the photographs. A case in point is the shoreline reach in Section 5 near the Hanalei River, where ground photos taken in October 1986 show no dry beach fronting the Hanalei Beach Park, while the February 1986 aerial photo shows at least some beach width. It can only be said that the aerial photographic record indicates relative long-term trends and the minimum range of changes.

Figures I-7 through I-9 graphically depict the cumulative average erosion (-) or accretion (+) changes for each of the shoreline sections (excluding Sections 6 and 7 which are on the north side of the Hanalei River). By establishing the earliest photo as the zero baseline, the cumulative plots of shoreline loss (movement towards the land) or gain (movement towards the ocean) are indicative of the horizontal position of the shoreline relative to the earliest photo position. The values represent average changes over the entire length of each shoreline section. On each figure, simultaneous displays of the data for each section show changes to the vegetation line (Figure I-7), waterline (Figure I-8), and beach width (Figure I-9).

FIGURE I-7

# HANALEI BAY: SECTIONS 1-5

## CUMULATIVE CHANGE IN VEGETATION LINE

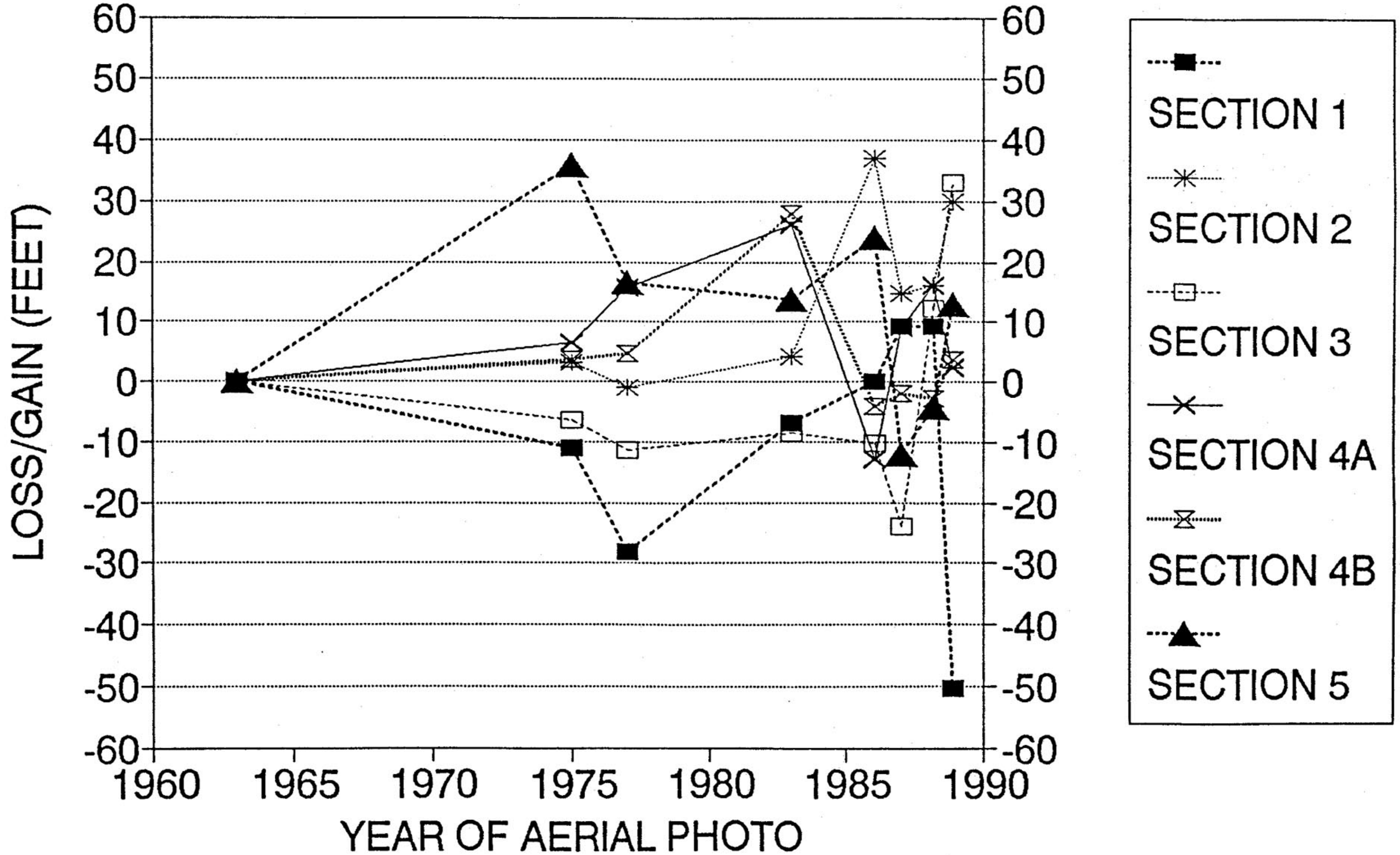


FIGURE I-8

# HANALEI BAY: SECTIONS 1-5

## CUMULATIVE CHANGE IN WATER LINE

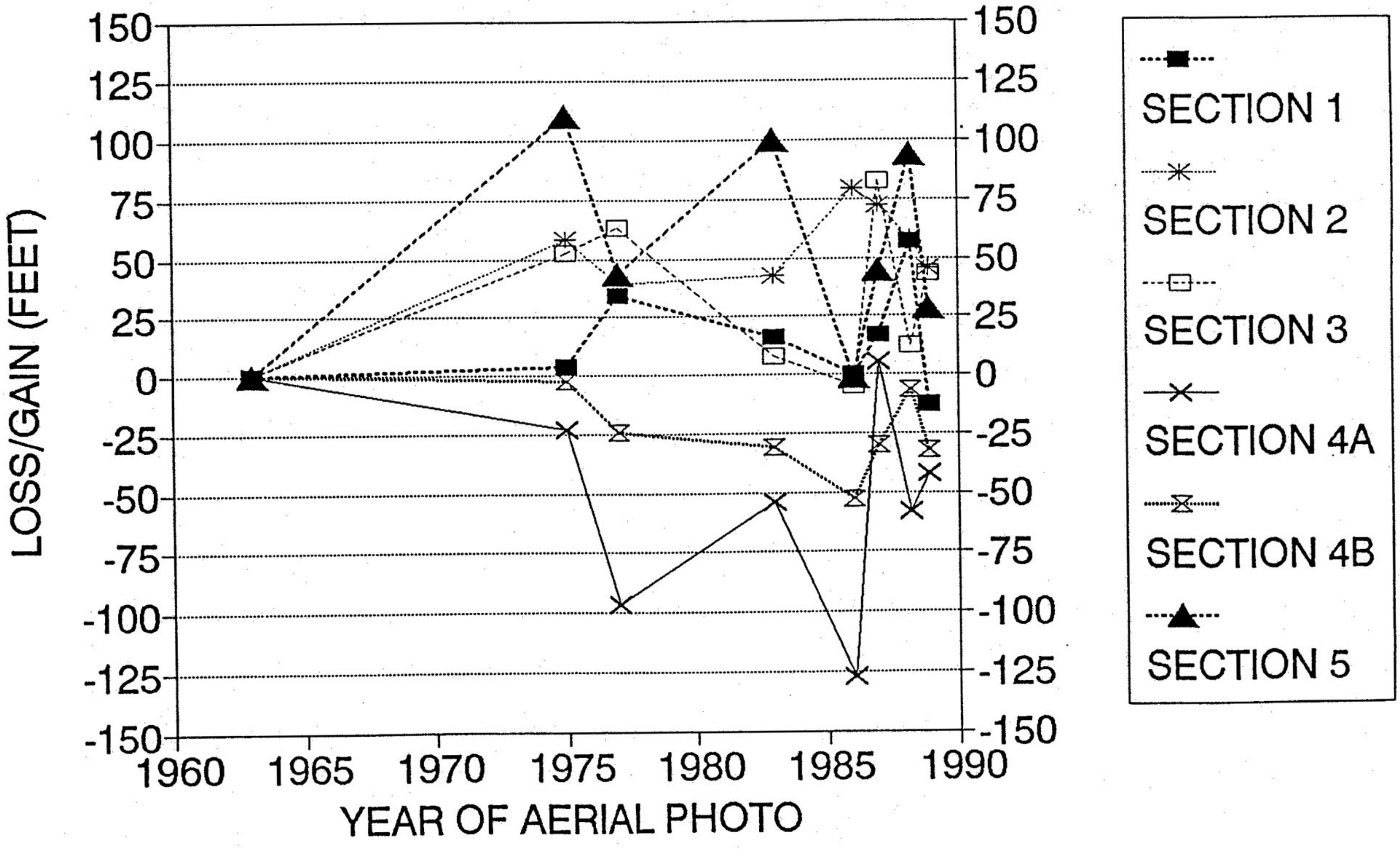
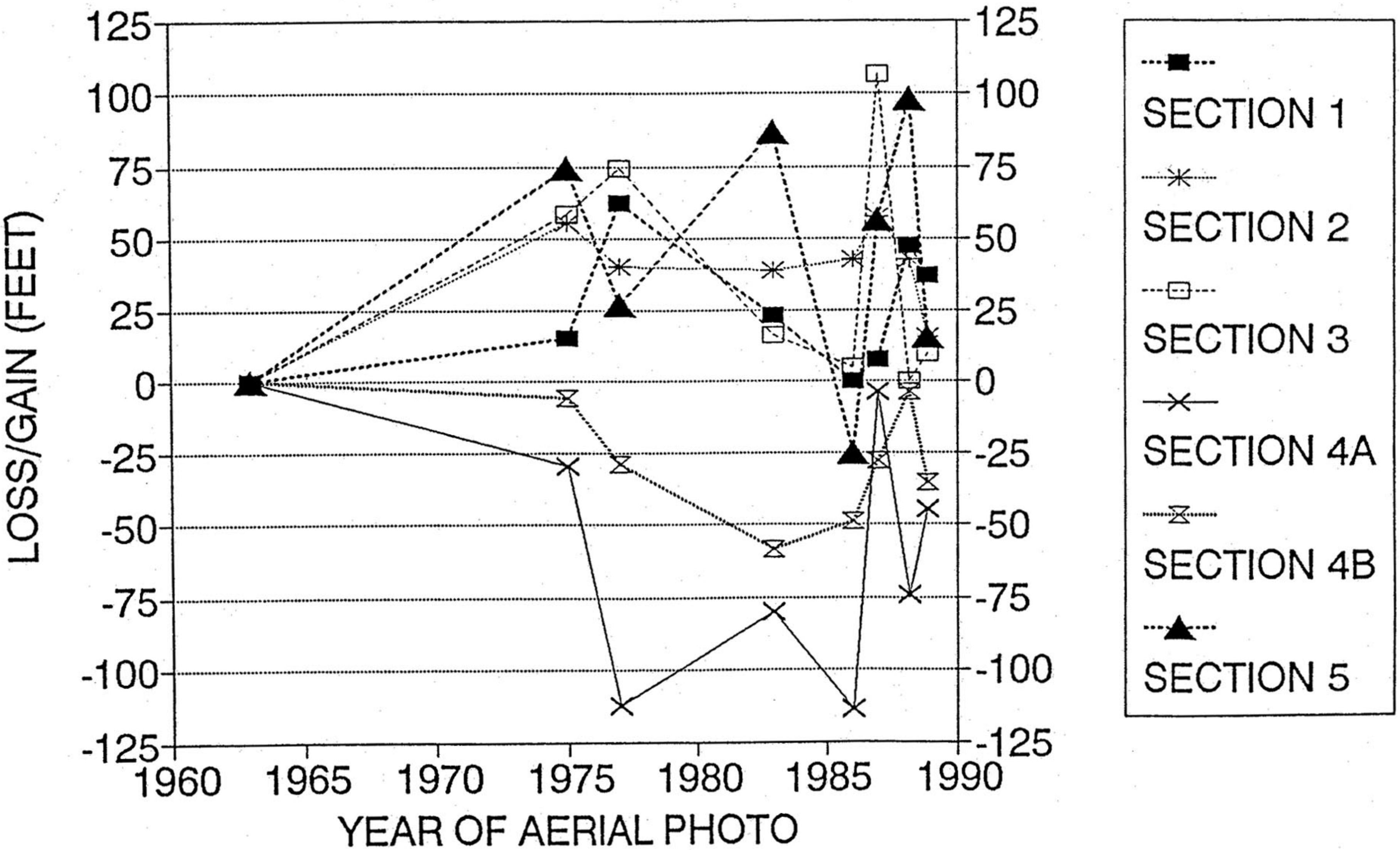


FIGURE I-9

# HANALEI BAY: SECTIONS 1-5

## CUMULATIVE CHANGE IN BEACH WIDTH



The information viewed as a whole is somewhat confusing and shows no consistent trends for the entire study site. This is expected since the sediment transport processes for various shoreline reaches within the bay can be quite different. What is evident from these figures, however, is that the range of changes (envelope of the data) is smaller for the vegetation line than for the waterline and beach width. This would indicate that the beach is highly dynamic, and that there is substantial sand storage in the beach zone to serve as a buffer to minimize changes to the vegetation line.

Table I-1 summarizes pertinent parameters which are helpful to interpret the data displayed in the figures. Because of the highly fluctuating nature of the changes, the envelope of the changes indicates the range of maximum fluctuation over the 25-year period of record. "Range" indicates the maximum change above and below the baseline, and "difference" is the magnitude of this envelope. The long-term trend is indicated by the "average rate" of change using linear regression techniques to obtain the best fit line to the data. While the deviation of the data about the line is large in some cases, the slope of the line does provide an indication of the long-term tendency towards erosion or accretion. The "net change" is the cumulative change between the earliest photo and the most recent photo, which indicates how much the 1988 shoreline position has changed relative to its position in 1963. The "General Classification" indicates the future tendencies towards erosion or accretion based on the long-term historical characteristics as revealed by the data.

The General Classification was determined as follows:

- o If both the average rate and net change were very small, then the classification was "stable".
- o If both the average rate and net change showed loss, then the classification was "erosion".

# TABLE I-1

| | HANALEI BAY CASE STUDY SITE | | | | | |
|---|---|---|---|---|---|---|
| | RANGE[1] (FT) (CYCLES) | DIFF[2] (FT) (CYCLES) | AVG RATE[3] (FT/YEAR) (TREND) | 30-YR RATE[4] (FT) (TREND) | NET CHANGE[5] (FT) (1963-1988) | GENERAL CLASSIFICATION |
| **VEGETATION LINE:** | | | | | | |
| Section 1 | +9/-50 | 59 | -0.3 | -9 | -50 | Erosion |
| Section 2 | -1/+37 | 38 | +1.1 | +33 | +30 | Accretion |
| Section 3 | -24/+33 | 57 | +0.4 | +12 | +33 | Accretion |
| Section 4A | +26/-13 | 39 | +0.1 | +3 | +2 | Stable |
| Section 4B | +28/-4 | 32 | -0.01 | -0.3 | +4 | Stable |
| Section 5 | +36/-12 | 48 | -0.2 | -6 | +13 | Cyclical |
| Section 6 | +3/-32 | 35 | -0.6 | -18 | -10 | Erosion |
| Section 7 | +29/-53 | 82 | -0.9 | -27 | -53 | Erosion |
| **WATER LINE:** | | | | | | |
| Section 1 | +57/-13 | 70 | +0.7 | +21 | -13 | Cyclical |
| Section 2 | 0/+80 | 80 | +2.1 | +63 | +45 | Accretion |
| Section 3 | -5/+82 | 87 | +0.6 | +18 | +43 | Accretion |
| Section 4A | -127/+5 | 132 | -1.7 | -51 | -42 | Erosion |
| Section 4B | 0/-53 | 53 | -1.2 | -36 | -32 | Erosion |
| Section 5 | +110/-1 | 111 | +0.9 | +27 | +29 | Accretion |
| Section 6 | 0/-27 | 27 | -0.6 | -18 | -7 | Erosion |
| Section 7 | 0/-48 | 48 | -1.2 | -36 | -48 | Erosion |

[1] Range = Envelope of extreme changes.

[2] Difference = Absolute magnitude of change within envelope.

[3] Using linear regression techniques to obtain best fit line. Slope of line yields average rate: (-) erosion, (+) accretion.

[4] Average rate * 30 Years = extrapolated rate over next thirty years.

[5] Net Change = Cumulative change from 1963 position to 1988 position.

- If both the average rate and net change showed gain, then the classification was "accretion".
- If the average rate and net change showed different tendencies, and the range of change was substantial, then the classification was "cyclical".

The parameters summarized in Table I-1 clearly show the smaller range and average changes in the position of the vegetation line compared to the waterline changes. It is also apparent that the long-term average rate extrapolated to 30 years is typically much smaller than the potential magnitude of change indicated by the fluctuating shoreline changes over the period of record.

The changes in beach width, while not summarized in the table, reflect similar characteristics to the waterline changes. Since the beach width change is a measure of the relative change between the vegetation line and waterline positions, the extreme range of the waterline changes compared to the vegetation line changes would reflect similar range of variability in the beach width changes. The average rate of change of the beach width is the relative difference between the average rates of vegetation line and water line changes.

The parameters summarized in Table I-1 for each section substantiate the variability of the changes between the designated shoreline sections. There is no obvious trend of accretion or erosion occurring uniformly throughout the entire length of shoreline within the study site; some sections showing accretion trends and others showing erosion trends. However, the overall changes in the position of the vegetation line and waterline, when averaged over the entire length of the shoreline, are very small and can be considered insignificant in the context of shoreline changes:

| | | |
|---|---|---|
| Avg rate for entire shoreline: | vegetation line | +0.2 ft/yr. |
| | waterline | <0.01 ft/yr. |
| Net change for entire shoreline: | vegetation line | +3 ft |
| | waterline | -3 ft |

Thus, while various sections of the bay may show different shoreline changes due to the complex and dynamic sediment transport processes occurring throughout the bay, the shoreline as a whole has maintained an equilibrium condition over the 25-year period of record.

To gain insight into the dynamic interaction between the different shoreline sections within Hanalei Bay, it is useful to compare the time series of beach width changes for certain sections, as given in Figures I-10 through I-13.

Figure I-10 compares the beach width changes for Sections 1 and 2. The envelope of beach width changes for both sections is roughly 60 feet. These two sections on the west side of the bay are fronted by a protective reef flat, being much shallower fronting Section 1 than Section 2. Winter northwesterly swell undergo considerable refraction effects prior to reaching the reef edge, while northeasterly tradewind waves approach more directly with lesser reduction in deepwater energy. Aerial photos exhibiting high winter swell conditions reveal much reduced levels of wave activity along Section 2 compared to the central portion of the bay shoreline.

These waves break at the edge of the shallow reef fronting Section 1, dissipating most of their energy prior to reaching the beach. However, secondary wave energy can transport sediments on the reef flat towards shore and along shore in the southerly direction along Section 1. From Table I-1, the vegetation line shows a long-term trend towards erosion within Section 1. Within Section 2, the offshore reef flat is deeper, allowing more wave energy to propagate across the reef and resulting in more onshore transport of sediment from the reef areas to the beach. Aerial

FIGURE I–10

# HANALEI BAY: SECTIONS 1,2

## CUMULATIVE CHANGE IN BEACH WIDTH

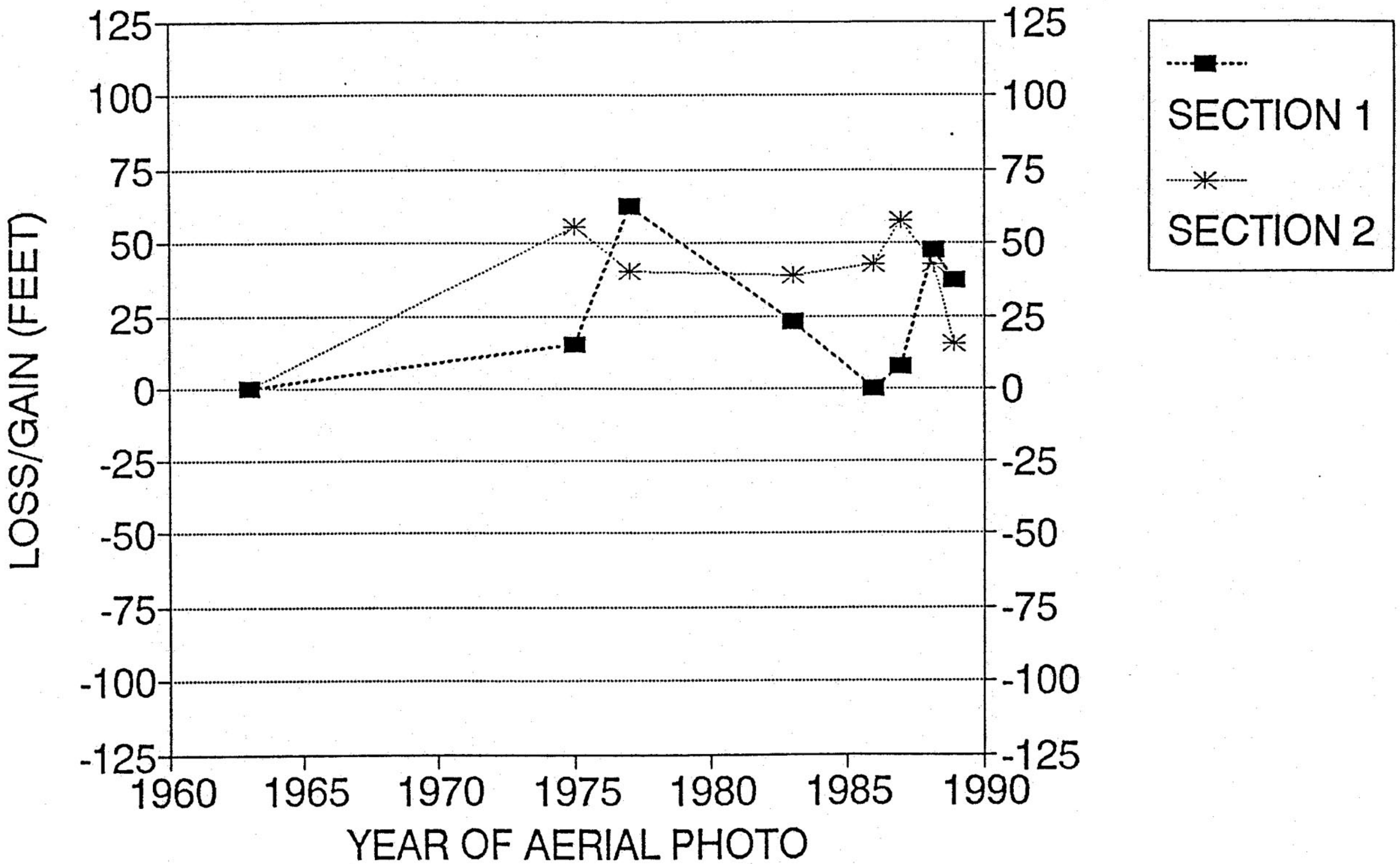


FIGURE I-11

# HANALEI BAY: SECTIONS 3,5

## CUMULATIVE CHANGE IN BEACH WIDTH

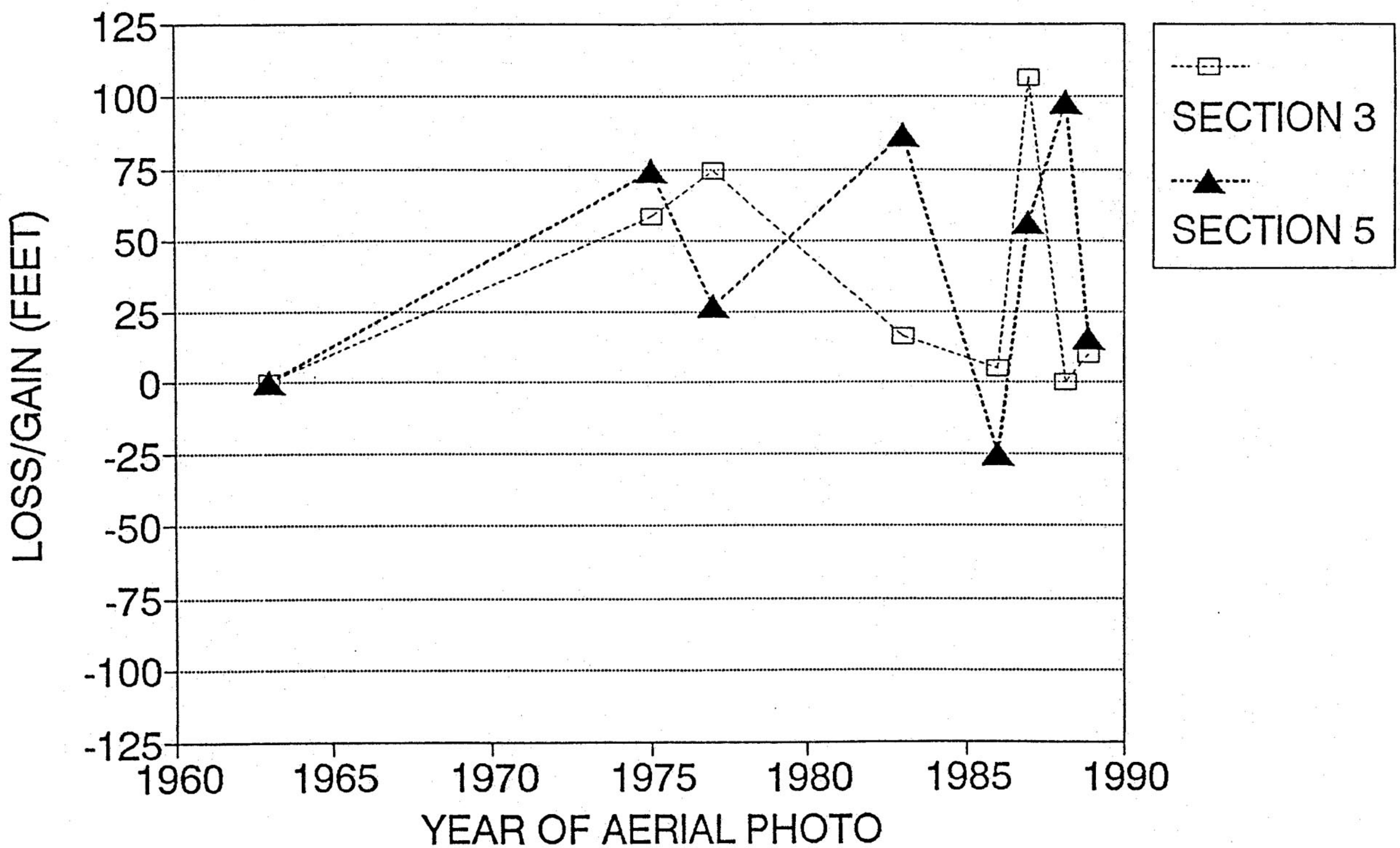


FIGURE I-12

# HANALEI BAY: SECTIONS 4A,4B

## CUMULATIVE CHANGE IN BEACH WIDTH

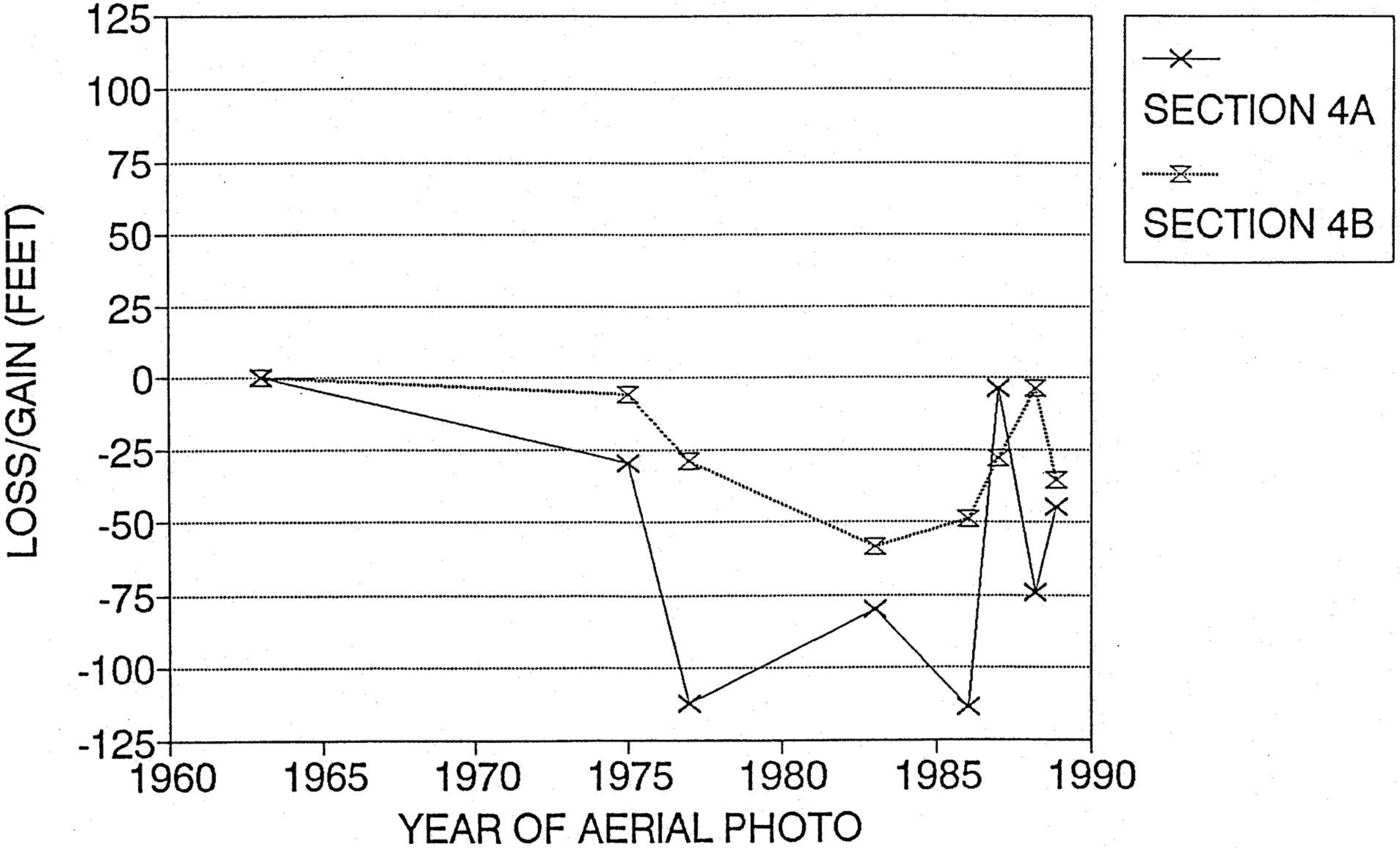
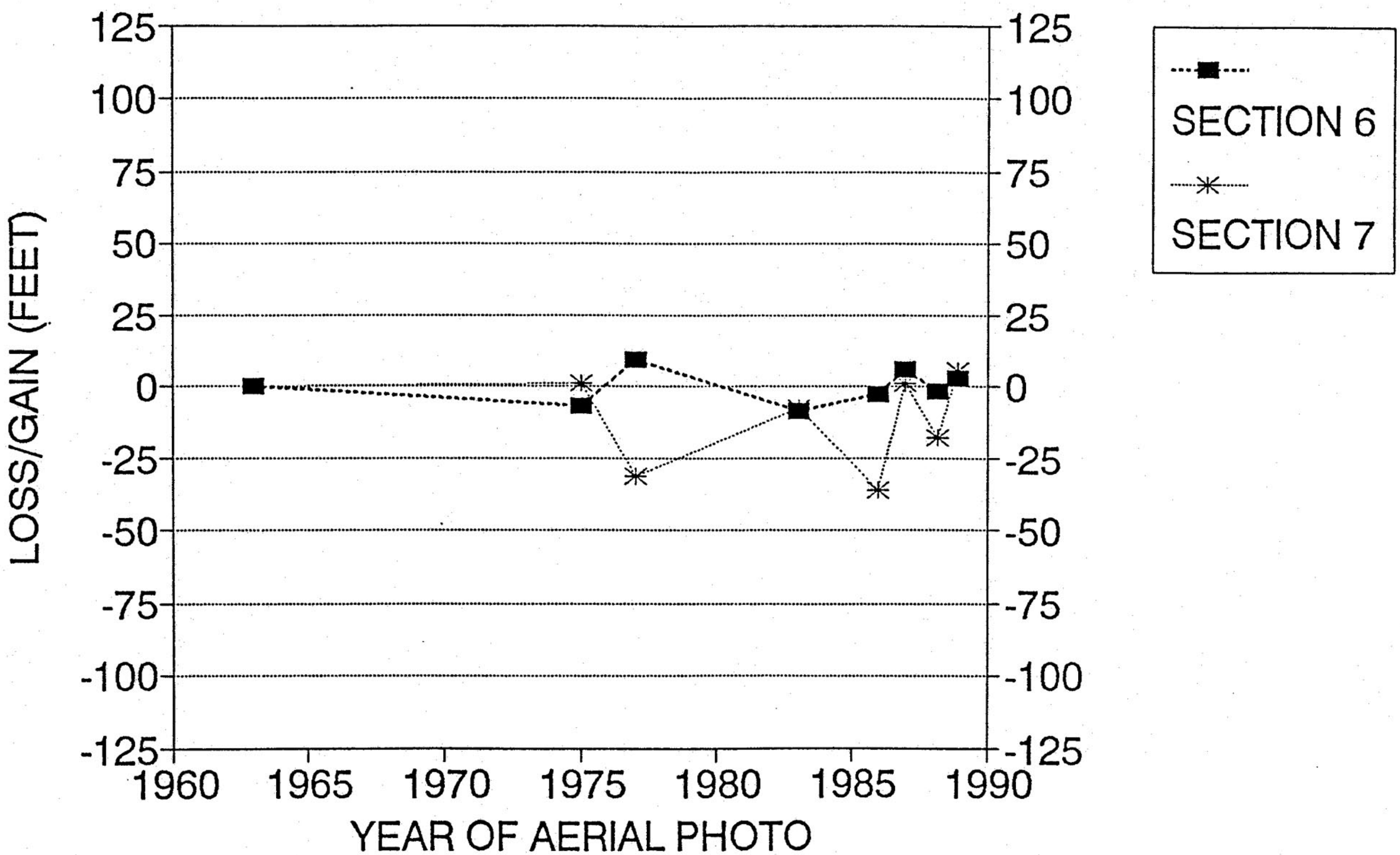


FIGURE I-13

# HANALEI BAY: SECTIONS 6,7

## CUMULATIVE CHANGE IN BEACH WIDTH



photos show considerable sand storage on the nearshore reef fronting Section 2. Figure I-10 shows a more consistent gain trend for the beach width within Section 2 than within Section 1, and Table I-1 indicates long-term accretion trends for both the vegetation line and waterline within Section 2.

The reef flat ends abruptly just beyond Section 2, on the west edge of the Waioli Stream mouth. Aerial photographs exhibiting high swell conditions show a sediment plume extending offshore the stream mouth. This offshore transport is driven by the converging longshore currents in the vicinity of the stream mouth, and can be enhanced by strong discharge flows from the stream. The abrupt reef edge and delta formation at the stream mouth within Section 3 effectively isolates the beach areas of Section 2 from Section 4.

Figure I-11 compares the beach width changes for Sections 3 and 5. The envelope of beach width changes for both sections is greater than 100 feet. The large variability of the beach width is expected since both sections encompass delta formations at major stream/river mouths, they bound the central interior beach areas of Section 4, and they are adjacent to the reef flat areas which form the east and west boundaries of the bay. While there can be large fluctuations in the beach width within Section 3 and 5, Table I-1 indicates a general long-term trend towards moderate accretion of the waterline.

The dynamic interactions between the stream discharge flows and the wave forces result in a constantly changing delta formation in Section 3. During winter swell activity, longshore transport is apparently southward from Section 2 towards Section 3, and westward from Section 4A towards Section 3. These longshore currents converge in Section 3, forming the pronounced deltaic shape at the stream mouth. If wave activity is high, the strong longshore currents can carry sediments offshore from the stream mouth. Milder wave activity can restore sediments to the beach area. The convergence of longshore transport helps to stabilize this section over the long term.

Within Section 5, the dynamic interactions between the river discharge flows and the wave forces also result in large changes in the beach width. However, the sediment transport processes are somewhat different than in Section 3 due to the westerly exposure of the shoreline and larger flushing capacity of the river. Longshore transport of sediments is predominantly northward along this section, at times forming a large sand spit nearly closing off the river mouth. During periods of heavy rain, strong discharge flows can flush the river mouth, transporting sediments offshore in large plumes. High winter swell activity can also scour the beach and transport sediments offshore. Therefore, this shoreline section is highly susceptible to loss of beach width during winter seasons, when both rainfall and wave activity are most intense. The beach is eventually replenished by onshore and longshore transport. Over the long-term, Table I-1 indicates a moderate accretion trend for the waterline, however, the scale of transport has caused cyclical loss to the vegetation line.

Figure I-12 compares the beach width changes for Sections 4A and 4B. The envelope of beach width changes for Section 4A is twice as large as for Section 4B, and of the same order of magnitude as Sections 3 and 5. However, in contrast to the accretion tendencies of the waterline within Sections 3 and 5, Sections 4A and 4B both show a long-term erosion tendency. The greater fluctuation in beach width for Section 4A is consistent with the observation on the aerial photographs that the surf zone is wider along Section 4A than 4B. This greater wave-breaking activity in Section 4A suspends larger quantities of sediment, which can be transported off the beach by stronger induced currents. The direct northwesterly exposure of this shoreline reach would indicate a dominant onshore-offshore mode of sediment transport in the central segment. While some aerial photos indicate longshore transport southward from Section 4B to 4A, there are other indications that longshore transport can also occur in the opposite direction. While Table I-1 indicates a long-term recession of the waterline, uncertainties in the determination of the waterline due to the large wave runup zones on the beach slope would dictate caution in interpretation of this apparent erosion trend. Table I-1 indicates that the entire reach within Section 4 has displayed a long-term trend of stability in the position of the vegetation line.

Figure I-13 compares the beach width changes for Sections 6 and 7. While these two reaches have very different coastal characteristics, they have been plotted together merely because the two areas are located adjacent to each other inside of the wide reef flat on the eastern margin of Hanalei Bay, and they show similarly small scales of beach width changes. Section 6 is largely an artificially-stabilized rocky shoreline located, in part, within the Hanalei river mouth. Section 7 contains a continuous sandy beach along the landward margin of a wide, shallow reef flat, facing westerly to the open ocean.

Section 6 is predominantly affected by the magnitude of the discharge flows from the Hanalei River. Strong flows tend to scour the shoreline while minimal flows permit greater infilling by sediments transported shoreward by the wave activity.

While the beach width in Section 7 shows relative stability over the long-term, Table I-1 indicates erosion trends for both the vegetation line and waterline of roughly the same magnitude. This suggests that the shoreline is susceptible to erosional processes during both winter swell and predominant tradewind conditions. While longshore transport southward from Section 7 can be expected, there is no indication that northward transport into Section 7 occurs. Therefore, the apparent deficit of sand source on the reef flat and shoreline areas north of Section 7 has resulted in net long-term erosion to this shoreline section.

## SUMMARY

The above discussion illustrates the complexity of the changes occurring along specific shoreline reaches within Hanalei Bay. In most cases, the range of change in the waterline position is much greater than the range of change in the vegetation line. Thus, it would be appropriate to provide estimates of long-term change weighing the range of variability (whether accretionary or recessionary) as well as the average trends. Based on the above discussion of long-term shoreline changes for the various designated sections within the study site, estimates of future shoreline change for a thirty year period are as follows:

**Section 1:** Figure I-14 shows the cumulative change of the vegetation line and waterline positions over the period of record for Section 1. The variability of change is given by the maximum range of vegetation line changes:

Max range of vegetation line accretion/erosion
= +9 feet to -50 feet = 59 feet
Trend-derived 30-year change = -9 feet
Max range of waterline accretion/erosion
= +57 feet to -13 feet = 70 feet
Trend-derived 30-year change = 21 feet

USE: Max 60 feet for 30 year period

**Section 2:** Figure I-15 shows the cumulative change of the vegetation line and waterline positions over the period of record for Section 2. While conditions of accretion are indicated, field reconnaissance revealed extensive undercutting at the vegetation line, warranting a conservative estimate:

Max range of vegetation line accretion/erosion
= -1 feet to +37 feet = 38 feet
Trend-derived 30-year change = 33 feet
Max range of waterline accretion/erosion
= 0 feet to +80 feet = 80 feet
Trend-derived 30-year change = 63 feet

USE: Max 50 feet for 30 year period

FIGURE I-14

# HANALEI BAY: SECTION 1

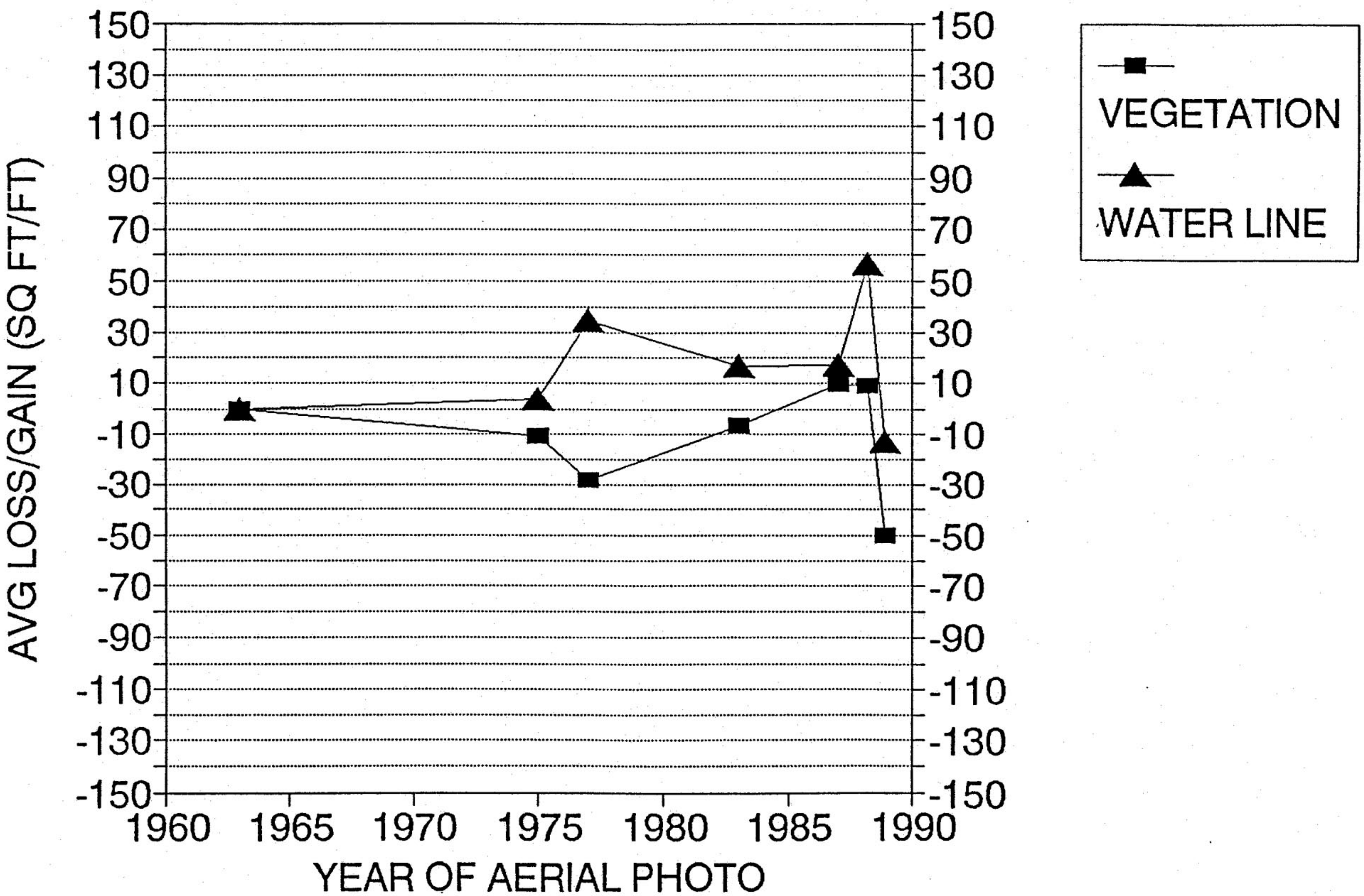
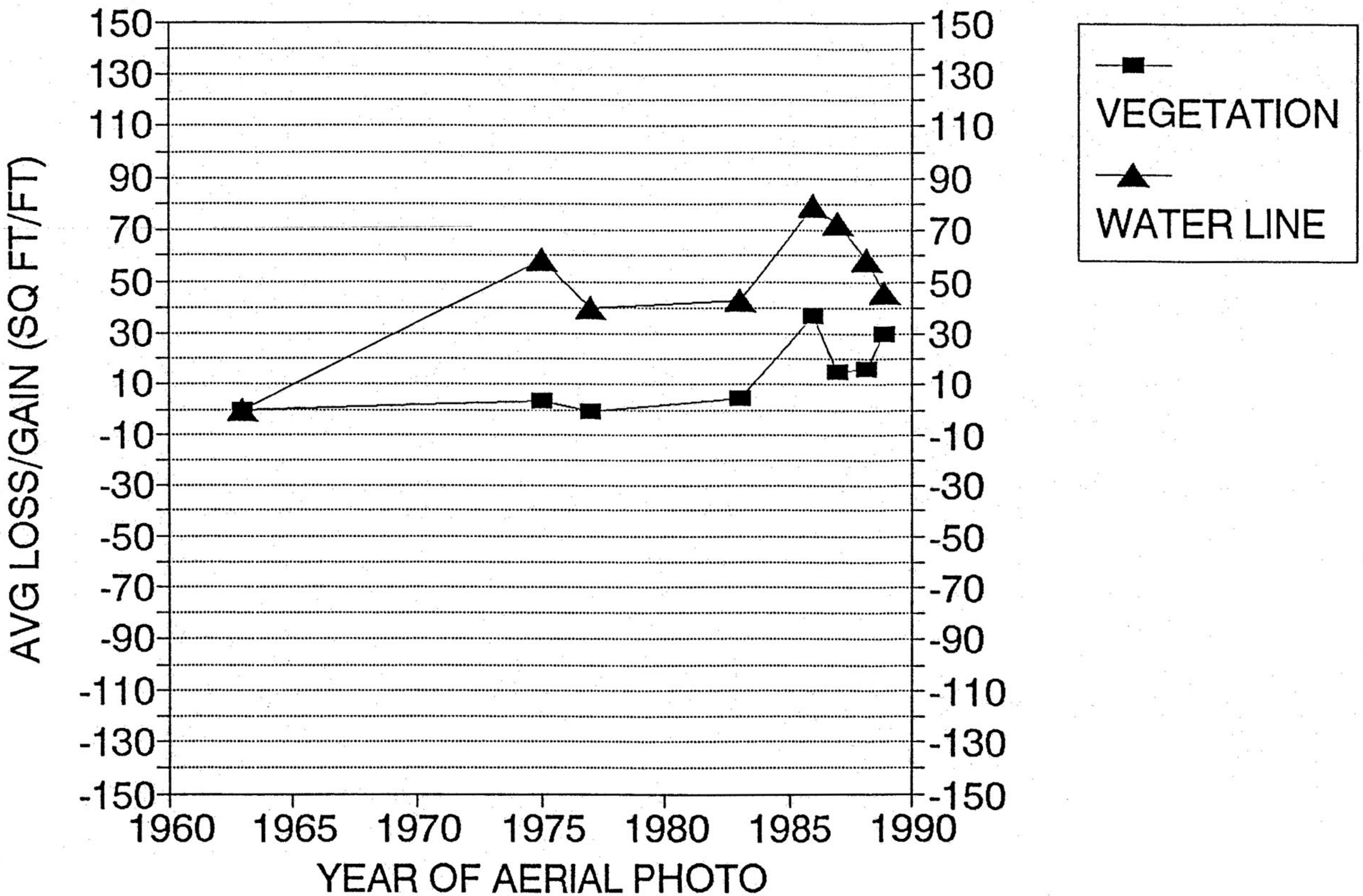


FIGURE I-15

# HANALEI BAY: SECTION 2



**Section 3:** Figure I-16 shows the cumulative change of the vegetation line and waterline positions over the period of record for Section 3. While conditions of accretion are indicated, the extreme variability of the shoreline changes warrants a conservative estimate:

Max range of vegetation line accretion/erosion
= -24 feet to +33 feet = 57 feet
Trend-derived 30-year change = 12 feet
Max range of waterline accretion/erosion
= -5 feet to +82 feet = 87 feet
Trend-derived 30-year change = 18 feet

USE: <u>Max 60 feet for 30 year period</u>

**Section 4A:** Figure I-17 shows the cumulative change of the vegetation line and waterline positions over the period of record for Section 4A. A conservative estimate exceeds the range of vegetation line change, weighted towards the average erosion trend of the waterline:

Max range of vegetation line accretion/erosion
= +26 feet to -13 feet = 39 feet
Trend-derived 30-year change = 3 feet
Max range of waterline accretion/erosion
= -127 feet to +5 feet = 132 feet
Trend-derived 30-year change = -51 feet

USE: <u>Max 60 feet for 30 year period</u>

**Section 4B:** Figure I-18 shows the cumulative change of the vegetation line and waterline positions over the period of record for Section 4B. A conservative estimate exceeds the range of vegetation line change, weighted towards the waterline changes:

Max range of vegetation line accretion/erosion
= +28 feet to -4 feet = 32 feet
Trend-derived 30-year change = <1 foot
Max range of waterline accretion/erosion
= 0 feet to -53 feet = 53 feet
Trend-derived 30-year change = -36 feet

USE: <u>Max 50 feet for 30 year period</u>

FIGURE I-16

# HANALEI BAY: SECTION 3

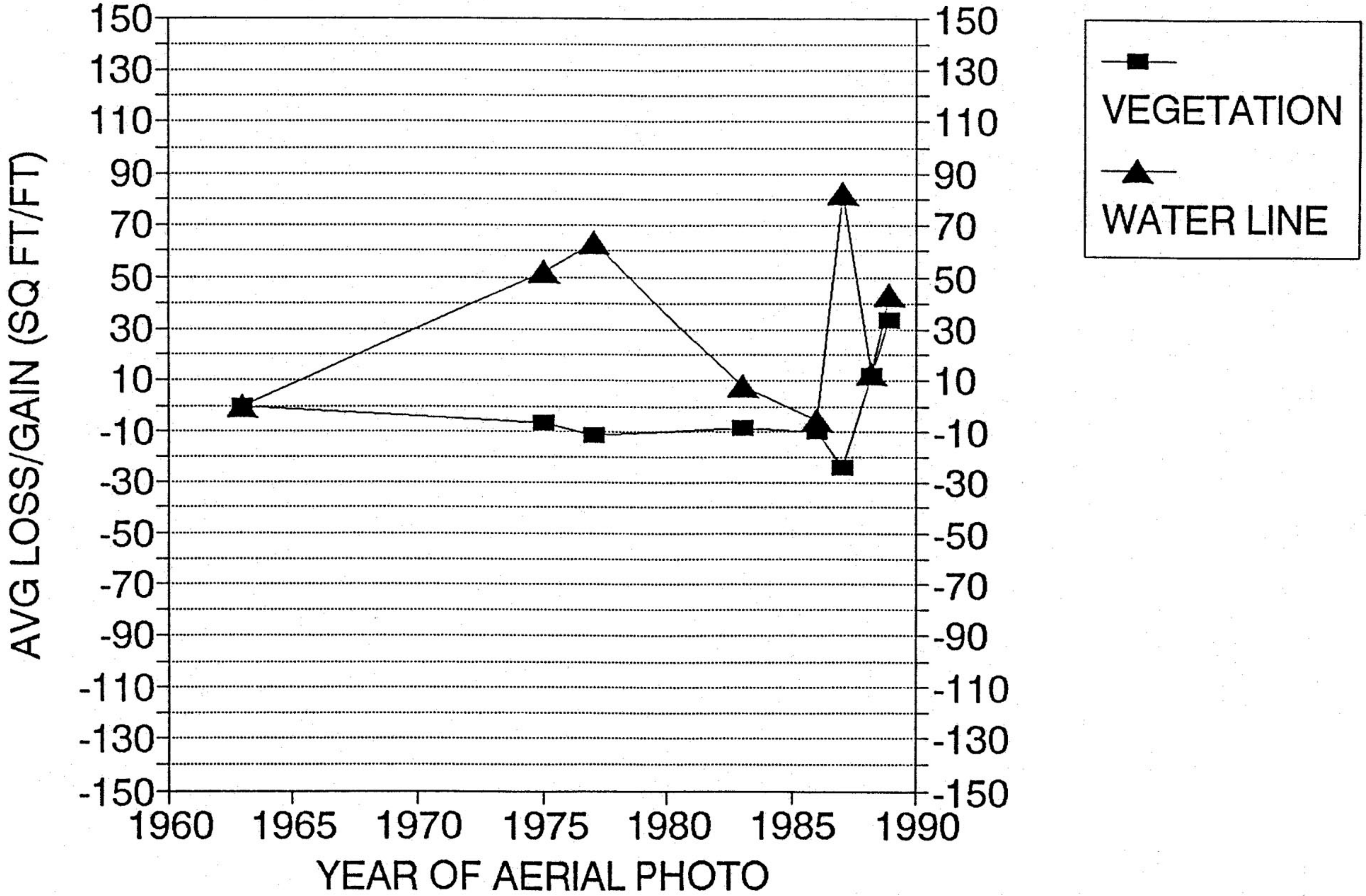


FIGURE I-17

# HANALEI BAY: SECTION 4A

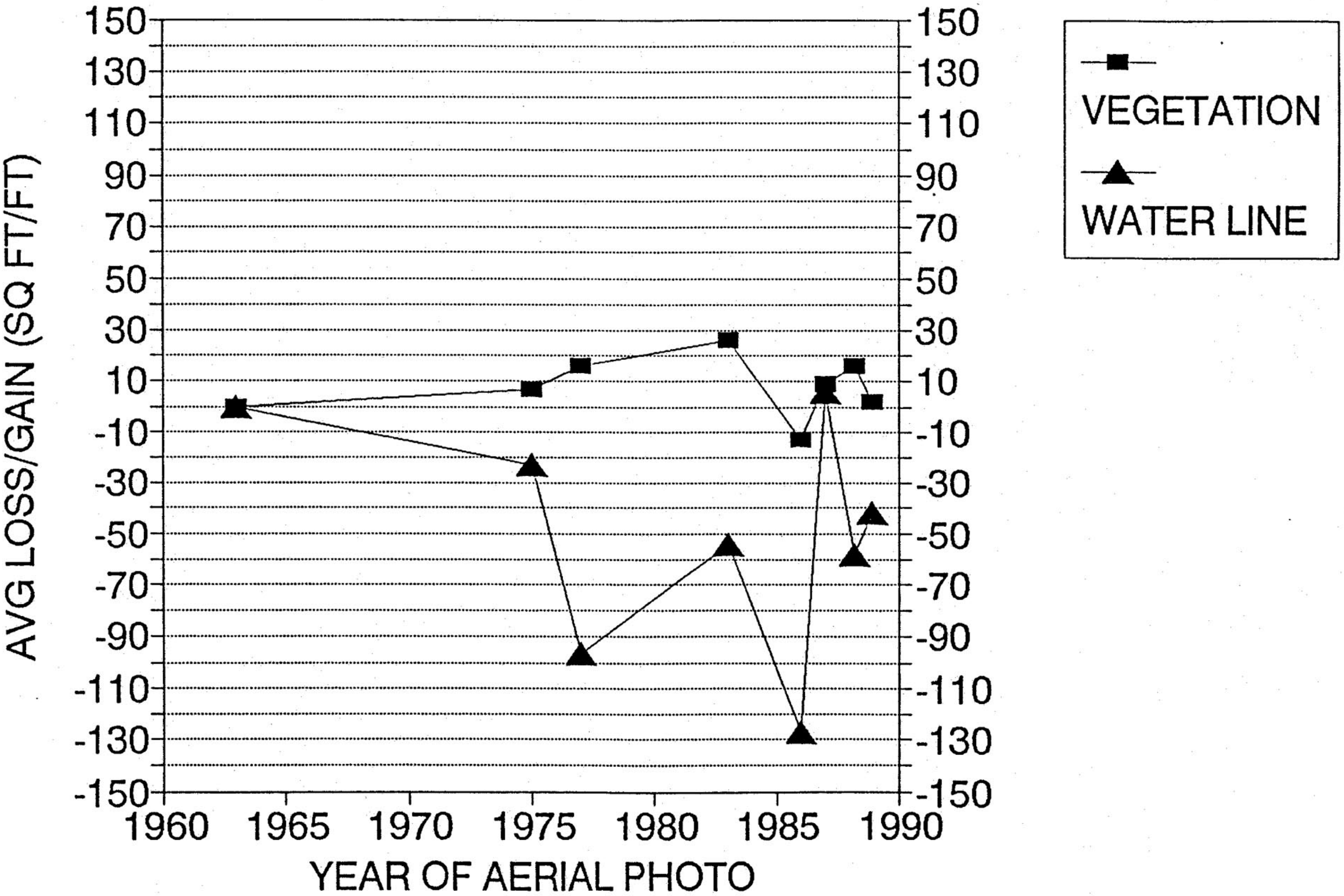
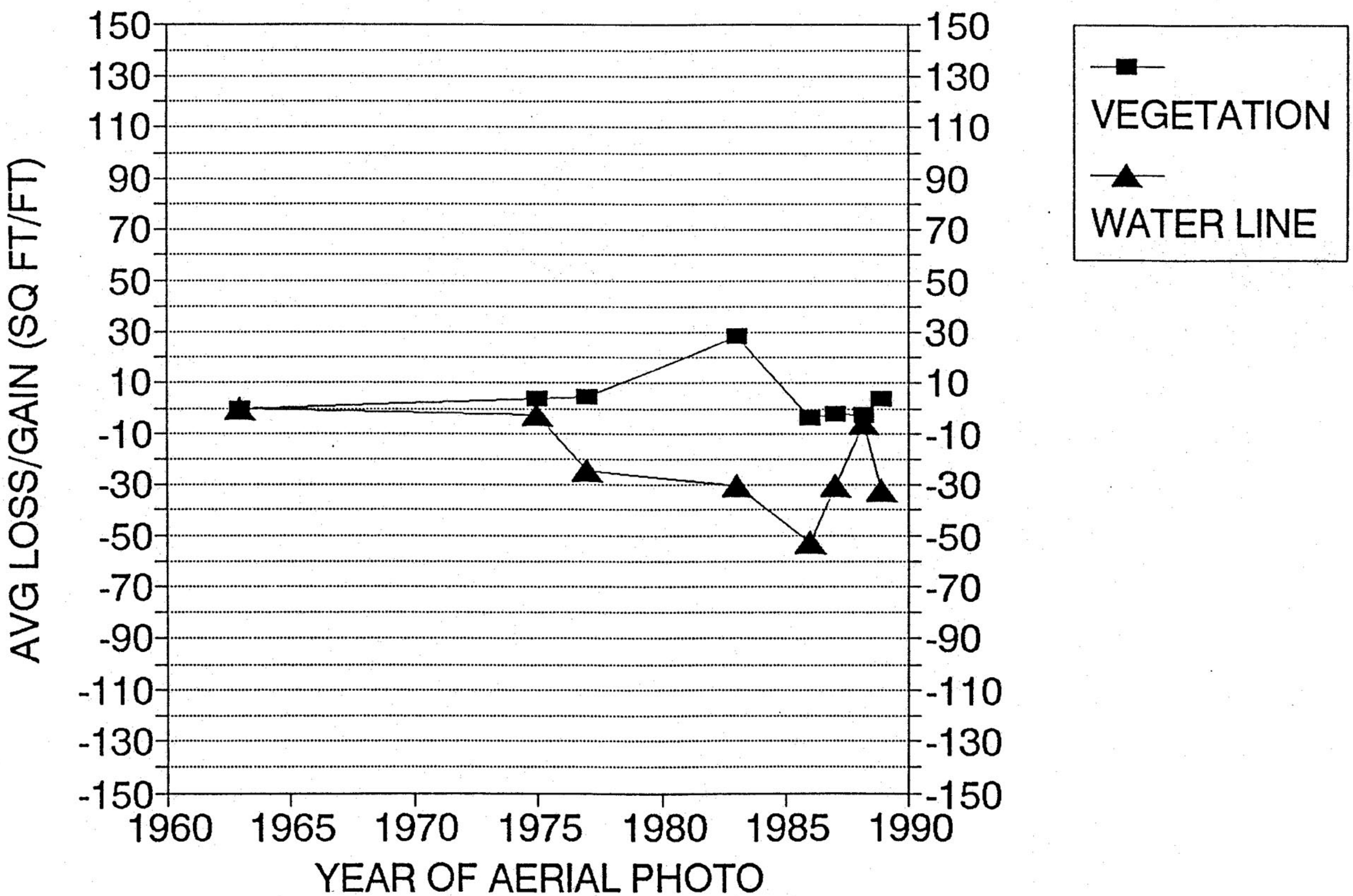


FIGURE I-18

# HANALEI BAY: SECTION 4B



**Section 5:** Figure I-19 shows the cumulative change of the vegetation line and waterline positions over the period of record for Section 5. Notwithstanding the average condition of accretion of the waterline, the extreme variability of change warrants a conservative estimate that exceeds the range of vegetation line change:

Max range of vegetation line accretion/erosion
= +36 feet to -12 feet = 48 feet
Trend-derived 30-year change = -6 feet
Max range of waterline accretion/erosion
= +110 feet to -1 foot = 111 feet
Trend-derived 30-year change = 27 feet

USE: Max 60 feet for 30 year period

**Section 6:** Figure I-20 shows the cumulative change of the vegetation line and waterline positions over the period of record for Section 6. Placed rock has essentially stabilized this shoreline reach.

Max range of vegetation line accretion/erosion
= +3 feet to -32 feet = 35 feet
Trend-derived 30-year change = -18 feet
Max range of waterline accretion/erosion
= 0 feet to -27 feet = 27 feet
Trend-derived 30-year change = -18 feet

USE: Max 30 feet for 30 year period

**Section 7:** Figure I-21 shows the cumulative change of the vegetation line and waterline positions over the period of record for Section 7. The overall erosion condition warrants conservatism in this ecologically sensitive area containing upland marshes.

Max range of vegetation line accretion/erosion
= +29 feet to -53 feet = 82 feet
Trend-derived 30-year change = -27 feet
Max range of waterline accretion/erosion
= 0 feet to -48 feet = 48 feet
Trend-derived 30-year change = -36 feet

USE: Max 100 feet for 30 year period

FIGURE I-19

# HANALEI BAY: SECTION 5

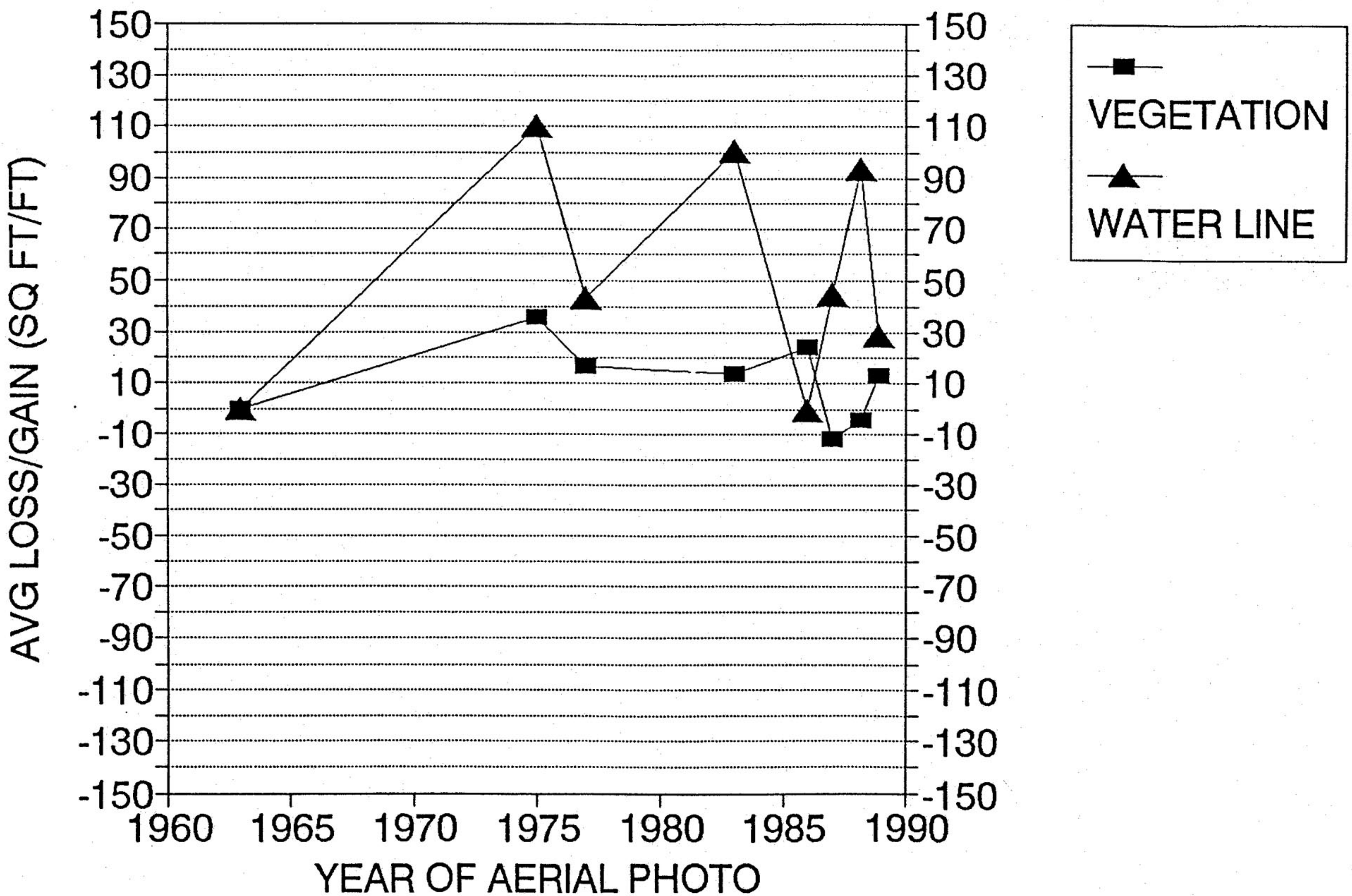


FIGURE I-20

# HANALEI BAY: SECTION 6

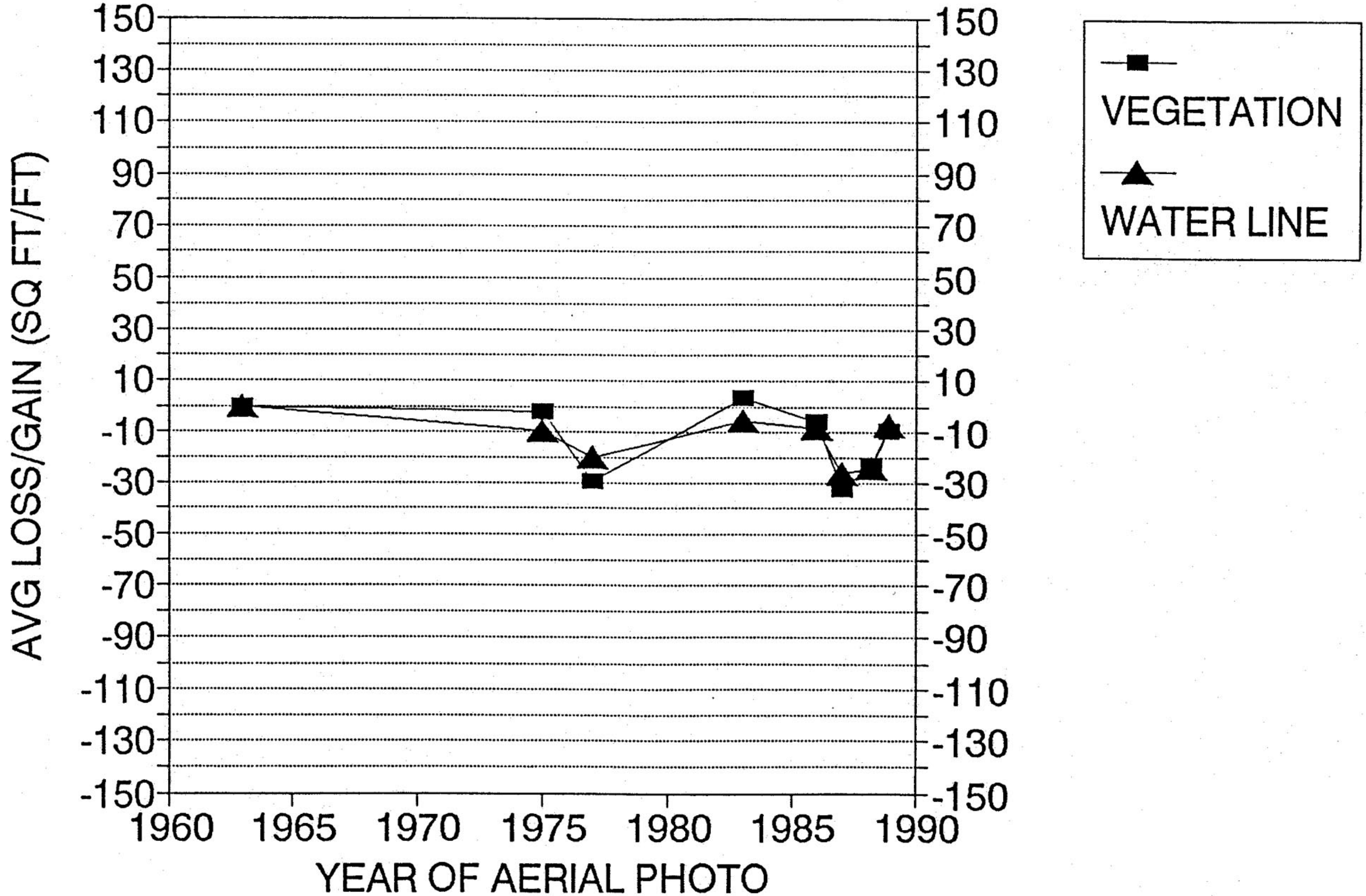
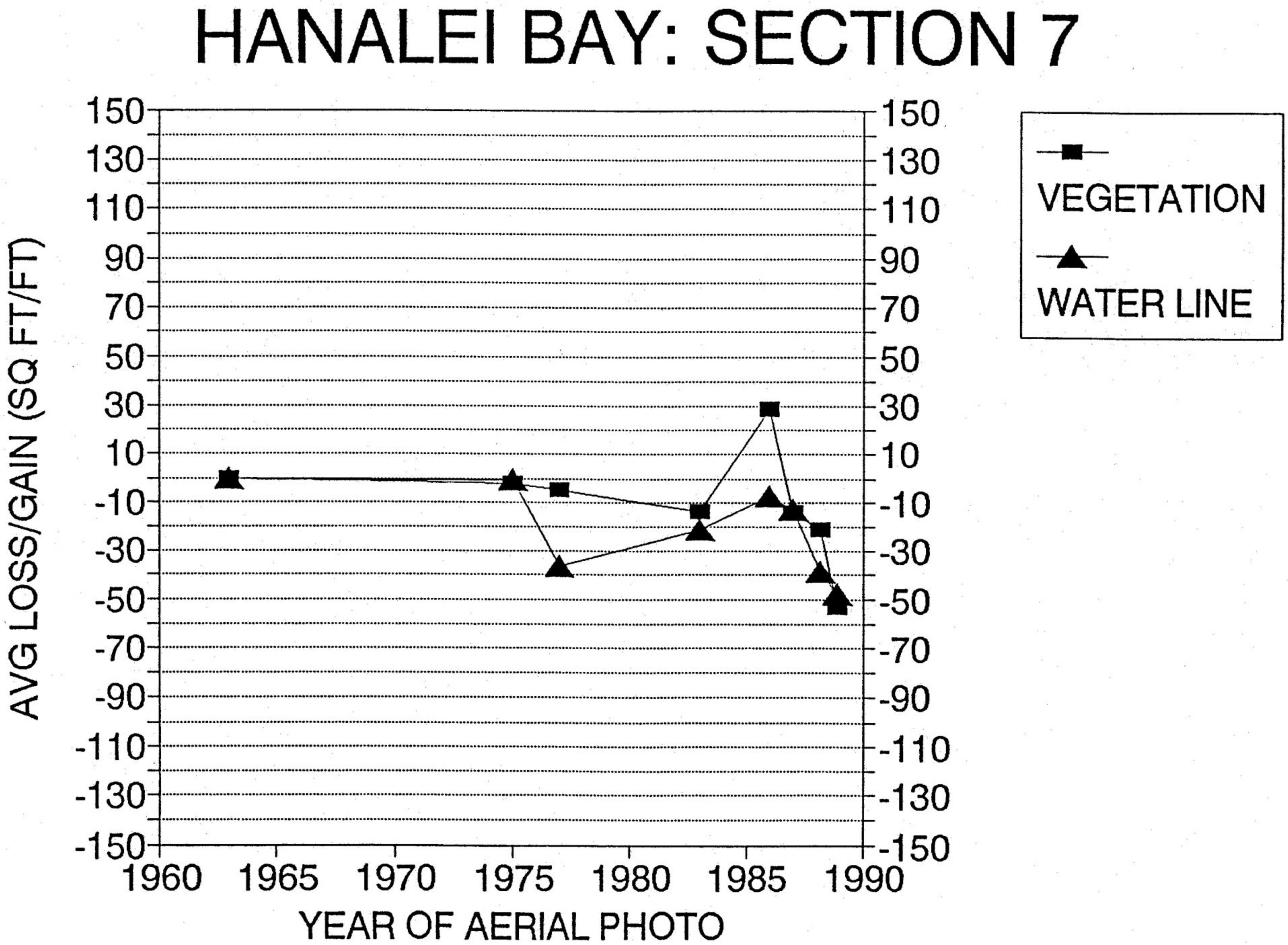


FIGURE I-21


HANALEI BAY: SECTION 7
AVG LOSS/GAIN (SQ FT/FT)
150
130
110
90
70
50
30
10
-10
-30
-50
-70
-90
-110
-130
-150
1960
1965
1970
1975
1980
1985
1990
YEAR OF AERIAL PHOTO
VEGETATION
WATER LINE

APPROPRIATE SHORE PROTECTION MEASURES

Given the erosion trends and current land use practices in the Hanalei Bay study area, improved regulatory measures alone should be adequate to minimize shoreline erosion problems. Any proposed active shore protection measures should conform to the general standard outlined in the 1980 North Shore Development Plan Update, which specifies that "maintenance of the natural beauty, and ecological systems that characterize the North Shore must take priority over any new development."[7] If shore protection measures other than improved regulatory measures are deemed absolutely necessary to prevent the erosion of shorefront property and loss of backshore improvements within the study site, effort must be taken to minimize the deleterious effects on public beaches and adjacent shorelines that result from most shore protection structures.

Beach nourishment is the form of long term active shore protection that generally has the least negative impacts. While the offshore reaches of the bay probably contain adequate volumes of sediment having suitable beach sand characteristics for nourishment, adequate studies need to be conducted to assure that removal of the sediment from the bay will not have a harmful effect on the coastal transport processes. The suitability of beach nourishment for any particular location is a function of cost-effectiveness (source of material, frequency of nourishment, etc.) and environmental considerations. For Hanalei, if the range of cyclic beach changes becomes greater and starts to seriously cause aggravated recession of the vegetation line, then beach nourishment may be considered a viable option to increase the beach width so that the beach storage is sufficient to accommodate the erosion cycle.

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7. North Shore Development Plan Update, December 1980, Wilson Okamoto and Associates, Inc.

If structural measures other than beach nourishment are required in the future, buried rubble revetments placed well inland of the certified shoreline (generally defined as the vegetation line) might be used to protect fastlands from future erosion. Impermeable seawalls will generally aggravate loss of beach sand due to their high reflectivity, and require a suitable hard foundation to prevent differential settlement and failure due to possible scouring at the base of the wall. Where possible revetments should be designed with low angles of repose and covered with sand to encourage subsequent vegetative over-growth. At the present time, erosion is a serious problem near the three stream mouths in Sections 2 and 3 on the western side of Hanalei Bay. Episodic stream discharge events tend to initiate the removal of plugged beach sand through meandering courses which can run parallel to the shoreline for significant distances, causing erosion to fastlands adjacent to the stream mouth. This action could be sufficiently mitigated by using revetments to stabilize the vegetation line near the stream mouths in a manner similar to past construction at the Hanalei River mouth. Such an effort may eventually be needed to prevent erosion of foundation materials and subsequent damage to Route 56 in the northern reach of Section 2. Any stabilization efforts must carefully consider the impacts that fast-shoreland protection structures may have on the dynamic littoral processes which control beach formation in Hanalei Bay.

Detailed analysis may substantiate the feasibility of using offshore structures to stabilize the shoreline within those sections fronted by reef structures. However, care must be taken to insure that the current patterns over the reef area are not altered in a manner that could be detrimental to the beach processes.

Groins are generally not appropriate in high wave energy environments since they may aggravate the offshore transport of sediments from the beach due to localized currents, and may also interrupt longshore movements of sand. However, if future development of the Hanalei River is a desirable future goal, a groin situated at the north end of Section 5 may stabilize the beach area by trapping the northward longshore transport and protecting the beach from the scouring effect of strong river discharge flows. Such a groin would also serve as a jetty to keep the river mouth open and facilitate flushing.

EROSION MANAGEMENT RECOMMENDATIONS

Non-structural approaches which regulate development along the shoreline are generally preferable to structural measures for many reasons, including those that were identified in the 1989 Hawaii Shoreline Erosion Management Study. Construction of man-made erosion barriers tend to be detrimental to the health of beach systems, and interfere with natural littoral processes of accretion and erosion. Structural remedies protect private property, but often at the expense of public beaches and access to those beaches. Often structural remedies don't solve erosion problems, but merely shift them to other areas. Non-structural remedies, on the other hand, are generally more flexible, and don't require an irreversible commitment of resources. Therefore, the erosion management recommendations presented in this section are primarily regulatory in character, and are designed to be both pre-emptive and proactive.

The overall recommendation for this case study area is to classify Hanalei Bay as one large littoral cell, within which are contained smaller sub-cells. The following recommendations could serve as the outline for a littoral cell management plan for the area.

- The entire study area should be designated a Shore District as specified in the Kauai Comprehensive Zoning Ordinance (Sec. 8-13.1), as one specific component of a Shoreline Special Treatment Zone Plan. Lateral boundaries of the district could correspond to the lateral boundaries of the Hanalei littoral cell. Backshore boundaries could be set at the mauka edge of the increased shoreline setbacks. A plan must be formulated and adopted by the Kauai County Planning Commission in order to delineate Shore District Boundaries.

- A 75-foot shoreline setbacks should be established. The 30-year predictions developed in this study show a large variability between different subcells within the overall Hanalei Bay littoral cell. Despite this apparent variability in erosion rates, different setbacks for each subcell are neither necessary nor appropriate because of the obvious interdependence among subcells, and the lack of any distinct definition of each subcell. Instead, the differences in erosion rates among the various subcells provide a rationale to adopt a conservative 75-foot setback for the entire littoral cell. This setback would reflect a compromise between the most extreme 30-year erosion prediction for one area of the study reach and the 30-year erosion predictions for the other subcells. Adopting this conservative, cell-wide, uniform setback also allows for error in the prediction methodology.

- Open zoning of all beachfront parcels on the bay should be maintained as an appropriate method of minimizing development, to preserve the environmental integrity of this scenic area, and to preserve certain areas for possible future public acquisition.

- Shore protection structures should be prohibited, except to protect public infrastructures, ensure public access, or improve public beaches and recreation opportunities. Since the lands in the study site are largely residential or undeveloped, and no structures within the study area are currently threatened, management or regulatory controls should be adequate to maintain this desirable situation. Future developments should be carefully regulated and located far enough landward of the shoreline so that shore protection structures will not be needed to protect them from erosion damage in the future.

- If the erosion climate in Hanalei Bay changes drastically, and becomes accelerated and progressive, then under the context of existing rules and regulations, buried revetments should be the only shoreline protection structure permitted if shore protection is determined to be necessary for individual parcels. Results from this study indicate that Hanalei shorelines and beaches are in a continual state of seasonal flux, but show long-term stability over the 30-year study time-span. Therefore, few structures should be needed, and no structures should be allowed which may disrupt this stability.

## I.3 CASE STUDY SITE #2 - HAENA-WAINIHA

GENERAL DESCRIPTION

The second study site at Haena is also located on the north shore of Kauai, west of Hanalei Bay. Facing northward (northwest-northeast), the study reach extends from Haena County Park to the Wainiha River, a distance of roughly 2 miles. Figure I-22 shows the study reach. Exhibit B (back pocket) provides the base maps for this case study site at a scale of 1 inch = 200 feet. Figure I-23 shows a reduced version of the base map for reference.

The lower elevations of the rugged coastal ridges extending eastward from the Na Pali Coast nearly intersect the coastline at both ends of the study site, but lie several thousand feet inland along the central reach creating a low coastal plain. Excluding the area in the embayment offshore from Haena County Park, nearly the entire reach is characterized by expansive, shallow fringing reef flat with numerous narrow sand-bottom channels. The reef flat extends 1,000-1,500 feet from shore with water depths of mostly 1-5 feet, providing much protection to the shoreline

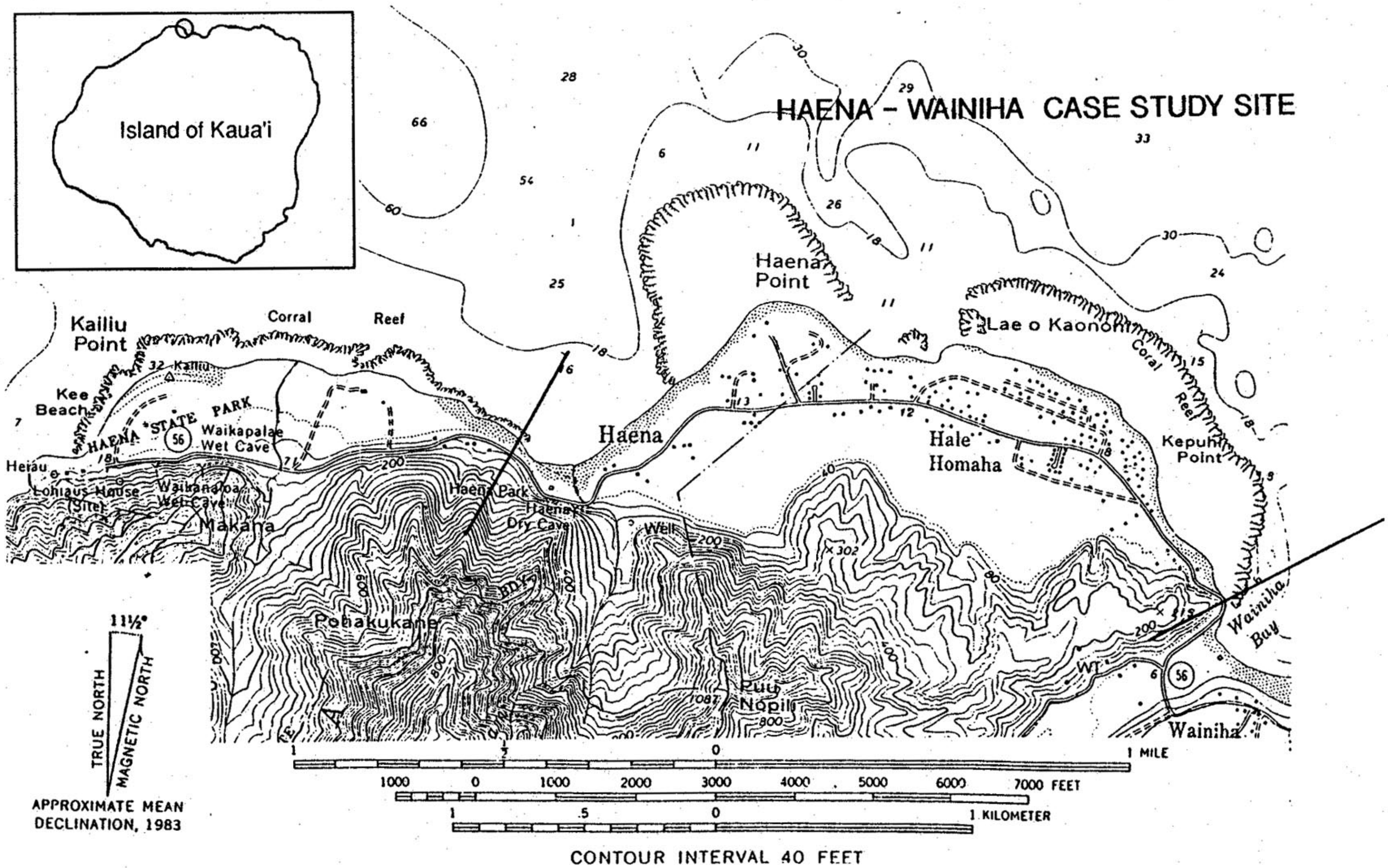


**Figure I-22**
## Ha'ena-Wainiha Case Study Site
**Kaua'i Shoreline Erosion Management Study**

**DHM inc.**
Land Use and Environmental Planning

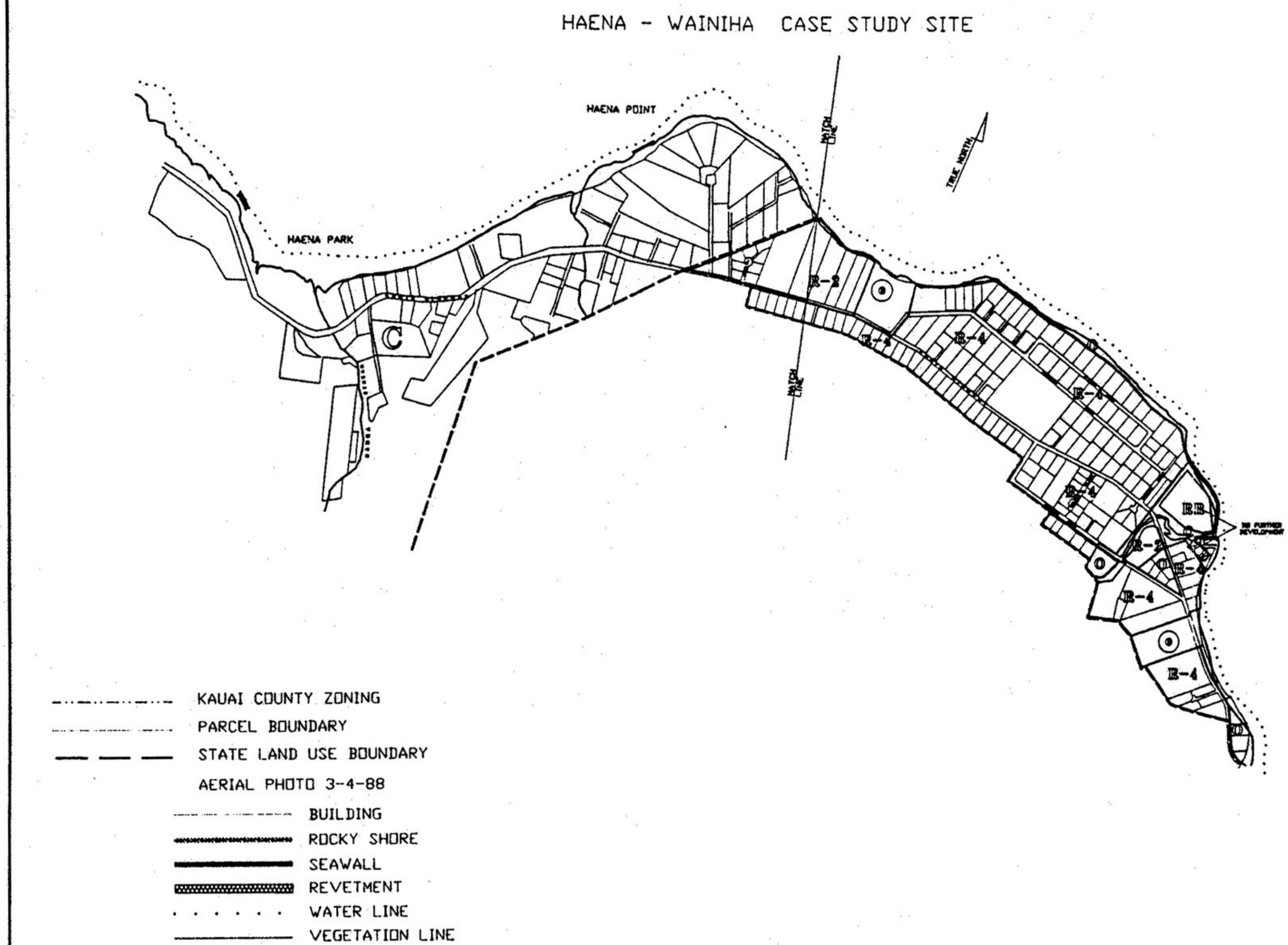


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**Figure I-23**
## Ha'ena-Wainiha Study Site Base Map
**Kaua'i Shoreline Erosion Management Study**

**Edward K. Noda and Associates, Inc.**

during typical tradewind waves. However, breaking wave activity on the reef flat during high winter swell activity can significantly increase water depths, which allows more wave energy to reach the shoreline. This higher wave activity coupled with strong nearshore currents can create serious hazards for swimmers. As a result, the clean, coarse-grained, coral sand beaches of this picturesque coastline are mostly frequented during the calmer wave conditions of the summertime. Wading, snorkeling, scuba diving, and windsurfing are popular activities, particularly between Haena Point and Haena County Park.

The shoreline characteristics throughout the study site may, at first, seem rather similar, comprised mostly of relatively narrow beaches and wide reef flats. However, the coastal processes and beach morphology are variable along the study reach. In general, this is attributed to the varying orientation of the sinuous shoreline with respect to the seasonal wave types that affect the shoreline, and variations in the fringing reef formations.

## LAND USE AND DEVELOPMENT

The Haena case study area is located within the Hanalei District on the north-northwest coast of Kauai. The Hanalei District was the fastest growing area in the state throughout the 1980's, and had a 1989 resident population of 5,700 (DBED estimates, personal Communication); current population figures for Haena will not be available until the results of the 1990 census are released.

The State Land Use designation for the case-study area is almost evenly divided between Urban and Conservation (Limited Use). This division does not correspond to any particular geomorphological boundary. The Land Use District Map for the vicinity is shown in Figure I-24. The Conservation District Subzone Map for the conservation-zoned lands in the area is shown in Figure I-25.

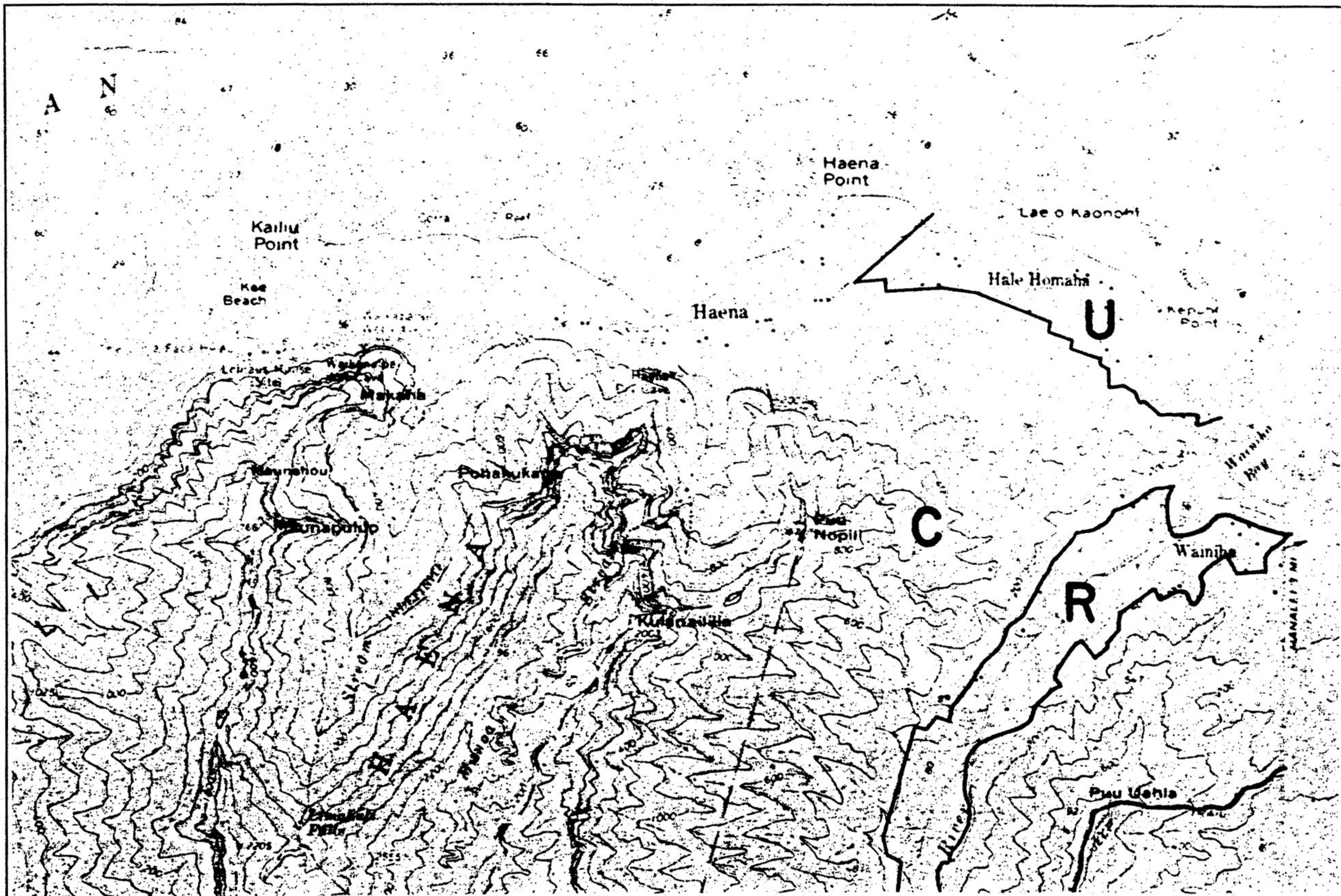


Figure I-24
## Ha'ena-Wainiha State Land Use District Map
**Kaua'i Shoreline Eroison Management Study**

**DHM inc.**
Land Use and
Environmental
Planning

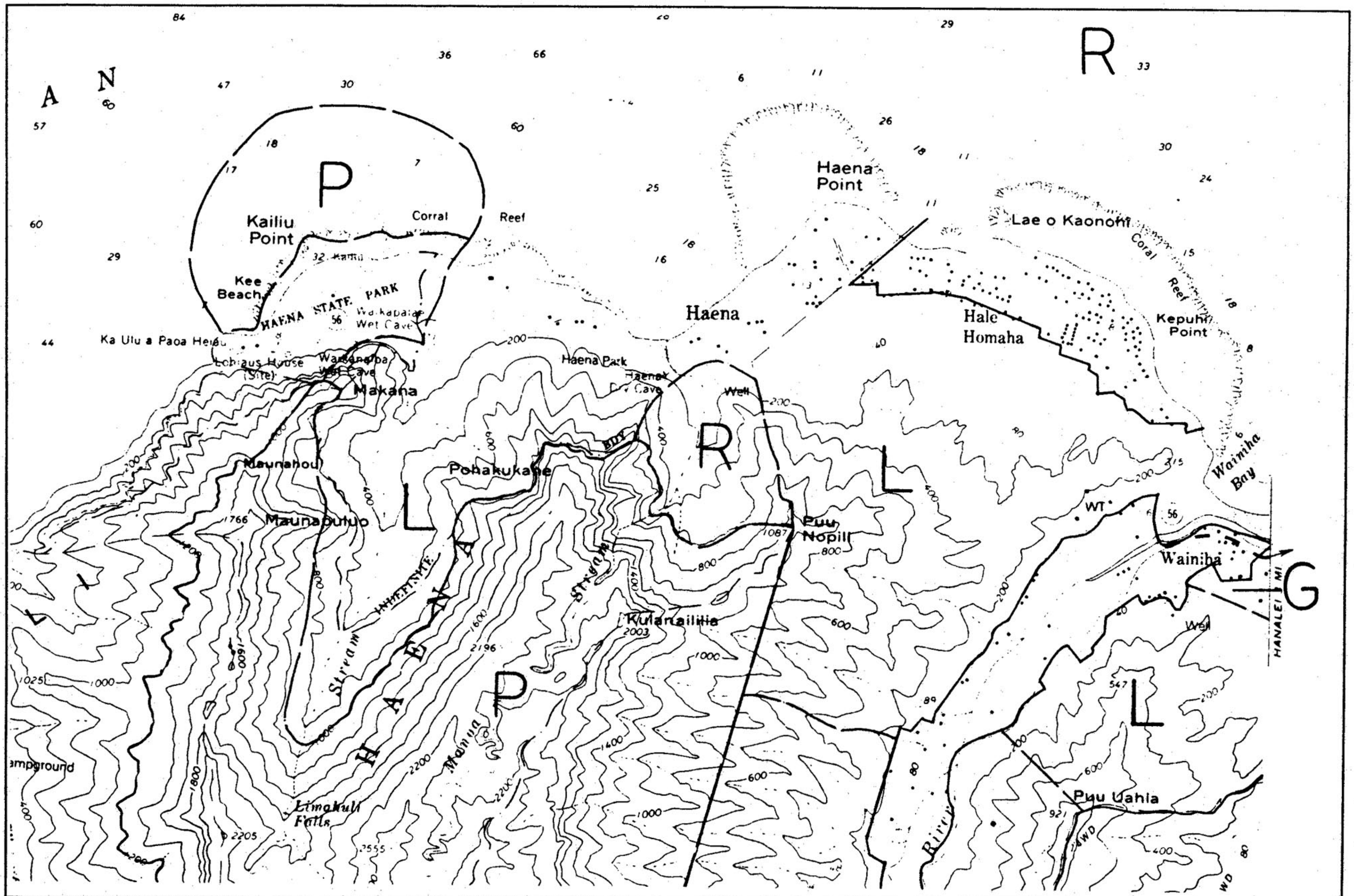


Figure I-25

## Ha'ena-Wainiha State Conservation District Subzone Map

Kaua'i Shoreline Eroison Management Study

**DHM inc.**
Land Use and Environmental Planning

The case study area is located within the North Shore Special Planning Area which includes the District of Hanalei as described in Sec. 4-1 (4) HRS, and portions of other watersheds draining to the ocean between Moloaa Stream and the Na Pali Coast. This area encompasses the entire northern section of the island of Kauai. Haena has been primarily a rural area in the past, and retains a rural character to this day, but faces increasing development pressures. The North Shore Special Planning Area has been identified as an area where, "maintenance of the natural beauty, and ecological systems that characterize the North Shore must take priority over any new development."[8] This entire study area has been identified as a "special value recreation area." The County General Plan Update of 1982 designates the entire portion of the case study area that is in the Urban District as Rural Residential.

The beach areas from the western promontory of Wainiha Bay to the western border of the SLUC Urban District are zoned Open. The lands immediately mauka of these beaches have a variety of different zonings as established by the North Shore Special Plan. The area containing larger lots on the western end of the Urban District has been zoned R-2. An open-zoned area with an existing park separates this R-2 area from the R-4 zoned area that is bounded laterally by Alealea Road and Oneone Road. Two small resort-zoned areas are east of the R-4 area. These resort areas contain Charo's Restaurant and the Hanalei Colony Resort Condominiums. An Open-zoned drainage sump area bisects these two resort areas. No further development is to be allowed in these resort areas. The next section of beachfront properties are within a small area zoned R-4. The final section of the study area beyond this last R-4 zoned section is zoned Open. Figure I-26 depicts the zoning districts for the vicinity.

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8. North Shore Development Plan Update, December 1980, Wilson Okamoto and Associates, Inc.

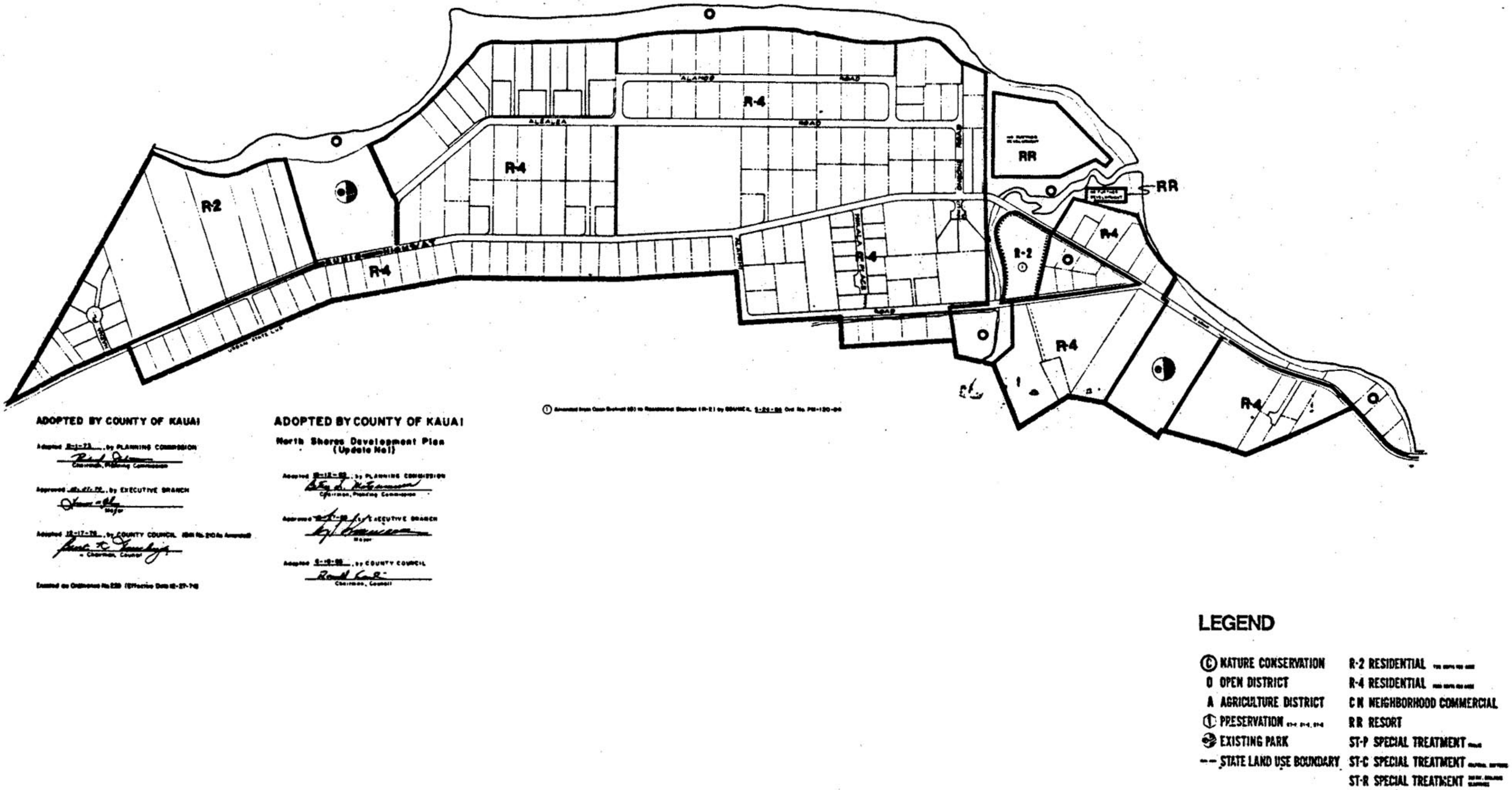



**Figure I-26**

## Ha'ena-Wainiha Zoning Map

**Kaua'i Shoreline Eroison Management Study**

**DHM inc.**
Land Use and
Environmental
Planning

The beach areas fronting the State Conservation District lands have no county zoning designation, nor do the Conservation District lands. All beaches in Hawaii are zoned Conservation by the SLUC, and generally all lands makai of the certified shoreline are considered to be in the Resource Subzone. All of the Conservation lands in this study area that are mauka of the certified shoreline are considered to be in the Limited Subzone.

## NEARSHORE WAVE CLIMATE

Located just a few miles west of Hanalei Bay within a similarly northward-facing coastal reach, the deepwater wave climate affecting the Haena-Wainiha study reach is similar to Hanalei Bay in terms of seasonal wave approach directions, periods and wave heights. The site is exposed to winter North Pacific Swell and predominant tradewind-generated waves during the summer months. A more detailed discussion of these wave types is presented in the previous section of this report on the Hanalei case study site.

Although the deepwater wave climate is similar for both case study sites, the nearshore wave conditions are quite different. The configuration of the shoreline along this Haena-Wainiha reach is predominantly convex-shaped, while the Hanalei reach is concave-shaped. Therefore, the easterly portion of the Haena-Wainiha study site (from Haena Point to the Wainiha River) is more directly exposed to the predominant east-northeasterly tradewind-generated waves than the interior shoreline reach within Hanalei Bay. In fact, surfers are known to frequent the breaks at the seaward reef margin off Haena Point during the summertime when conditions elsewhere along the north shore are too small and unrideable.

The west end of this study site within Haena Bay is sheltered from the predominant tradewind-generated waves by the expansive reef flat offshore Haena Point, but is directly exposed to the winter North Pacific swell. Similar to Hanalei Bay, the North

Pacific swell undergoes considerable refraction effects prior to reaching the interior portions of the shoreline within the embayment.

The varying characteristic of the nearshore wave climate affecting certain reaches along this study site plays an important role in the seasonal transport of beach sediment along the shoreline.

## COASTAL CHARACTERISTICS

Because of the convex shape of the shoreline reach within this study site and the variable reef flat configuration fronting this shoreline reach, the coastal processes affecting certain segments of the shoreline vary. Thus, for the purposes of discussion and analysis, the Haena-Wainiha study site was divided into four coastal reaches along morphologic boundaries in a manner similar to Hanalei Bay. The boundary locations for the four segments are depicted in Figure I-27. A brief description of the characteristics within each shoreline segment is provided below. The typical beach widths indicated for each segment were taken from the January 1983 color photograph to provide a relative comparison between the different shoreline reaches. However, the numbers are not necessarily representative of the changes over time for the respective segments.

### Section 1

Section 1 is a roughly 1,600-foot reach at the eastern end of the study site, between Kepuhi Point and the rocky promontory at the western end of Wainiha Bay. Wainiha Bay is a reef-less, relatively deep water embayment at the mouth of the Wainiha River which contributes a significant volume of land-derived sediment onto the beach and within the bay itself. However, the apparent dominance of calcareous grain composition in the beach sands along the Section 1 study reach, and the barrier formed by the rocky promontory at the eastern boundary of this segment, suggest that there may be little exchange of beach sediment between Wainiha Bay and the study reach.

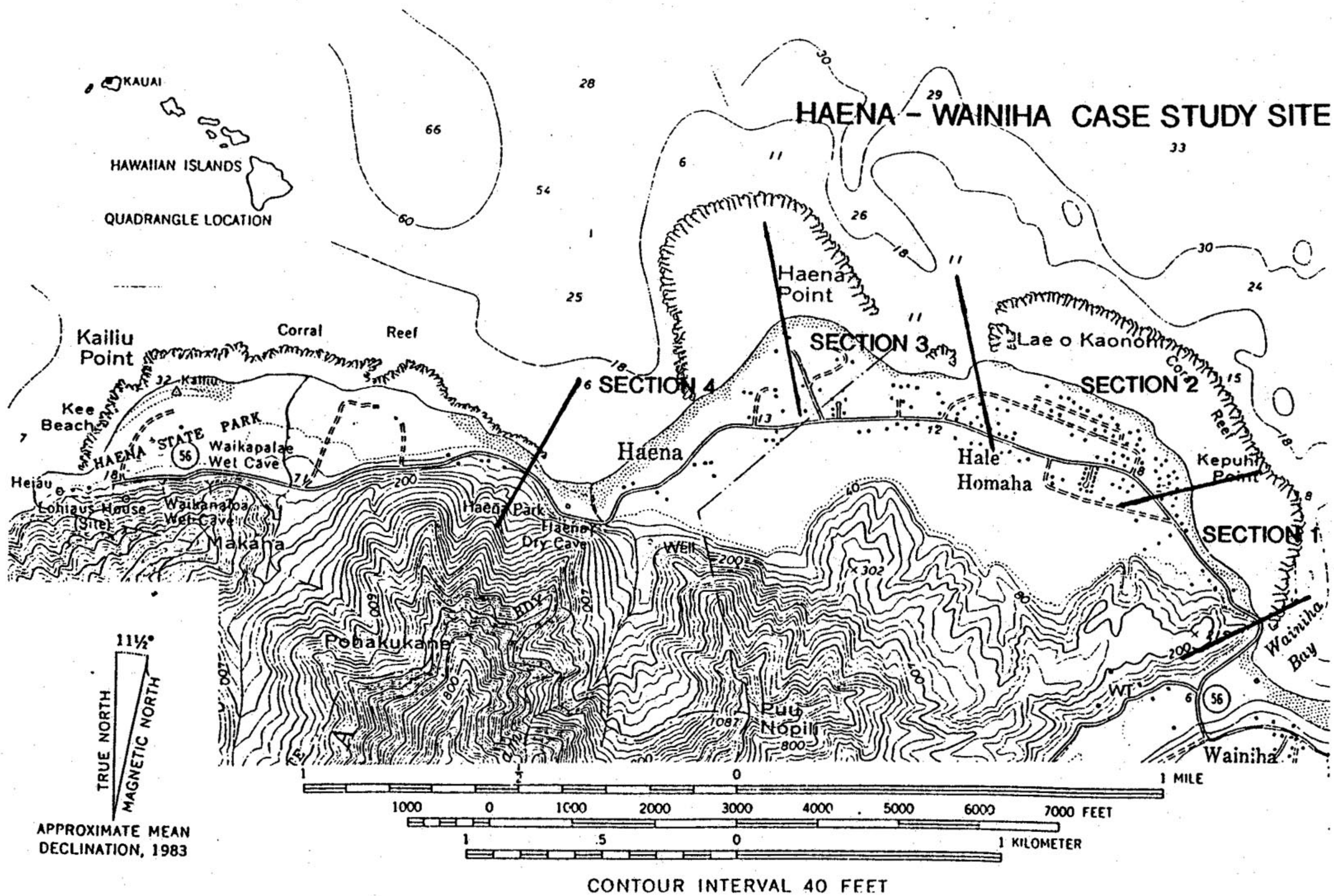



**Figure I-27**
## Coastal Segments of Ha'ena-Wainiha Case Study Site
**Kaua'i Shoreline Erosion Management Study**

**Edward K. Noda and Associates, Inc.**

The nearshore reef is deeper and more variable along this segment than the fringing reefs fronting other segments of the study site. A large sand pocket occupies an extensive area on the central part of the reef, with sand channels extending to the beach at both the ends and in the middle of Section 1. It is estimated from wave breaking characteristics and color aerial photographs that the nearshore reef depths in Section 1 are mostly characterized by intermediate depths of 5-15 feet. The gently curved arcuate shoreline along Section 1 faces east-northeast directly into the tradewinds. The western end of this segment transitions into the convex shaped shoreline of Section 2. Typical beach width in Section 1 is 30 feet, and there are no shore protection structures located along this reach.

**Section 2**

Beyond Section 1, the first 1,000 feet of Section 2 is of similar character to Section 1, but with a narrow width of shallow reef fronting the beach. A sand channel separates this 1,000-foot reach from the remaining 1,800-foot reach within this Section 1. The unique feature in this 1,000 foot reach is a loosely-placed, non-consolidated rock/rubble revetment. From the drainage channel at the eastern end of Section 2, this shore protection structure extends for roughly 500 feet towards the northwest. Comprised of the same materials stabilizing the drainage channel mouth, the line of boulders becomes more exposed away from the drainage outlet, with a predominant alignment about midway between the vegetation line and the water line.

West of the line of boulders, the longer extent of Section 2 faces north-northeast and consists of a more homogenous shoreline with a relatively straight beach and wide shallow reef flat. Throughout the approximately 1,800 foot length of beach in this part of Section 2, the shallow reef extends roughly 600 feet offshore with less than 5 foot depths. Plunging breakers nearly always form along the seaward margin of this broad reef flat, with greatest heights due to the winter North Pacific swell.

Beachrock is exposed at the waterline along more than 75% of this shoreline reach within Section 2. There are no shore protection structures other than the scattered boulder revetment on the eastern end of Section 2 (fronting Charo's restaurant). Typical beach width in Section 2 is 60 feet.

<u>Section 3</u>

Section 3 runs for approximately 2,200 feet between the west boundary of Section 2 and Haena Point. This arcuate segment of the shoreline recedes landward from the rounded corners at either end of the Section as the nearshore reef flat deepens and becomes more variable. Similar to Section 1, several small sand channels bisect the reef along this shoreline reach, extending offshore from the beach to form a major sand channel off the eastern edge of Haena Point's broad reef flat. Small protective patches of shallow reef at the beach toe between the sand channels result in a cuspate characteristic in the alignment of the beach. The central portion of this Section 3 faces nearly due north. There are no shore protection structures in Section 3, and the typical beach width is 75 feet.

<u>Section 4</u>

Section 4 extends roughly 4,000 feet from Haena Point westward to just beyond Haena County Park, where backshore dunes become more pronounced. This shoreline reach faces predominantly northwestward. Haena County Park, at the west end of the study site, is at the center of the broad "V"-shaped shoreline embayment facing due north, known as Haena Bay. This section is characterized by dramatic bathymetry changes in the nearshore region. The broad shallow reef flat encompassing Haena Point extends about 1500 from shore, from the eastern boundary of Section 4 to the central portion of this reach. A deep channel cuts through this reef parallel to shore on the west side of the point. Plunging breakers line the seaward edge of the reef flat offshore Haena Point on almost all days of the year. The interior portion of the bay is sheltered from the predominant tradewind waves and remains calm in the summertime. However, this shoreline section is directly exposed to the winter North Pacific swell.

Towards the western half of this section, a narrow shallow reef margin extends from the waterline offshore to about 300 feet from the beach, being slightly deeper westward. Immediately beyond this reef margin, the water depth drops to greater than 50 feet to the expansive sand-bottomed interior of the embayment. The near-vertical wall face of the shoreline reef margin throughout the extent of Section 4 is etched with arches and caves, presumably created by the percolation of groundwater. This feature of the area has lent itself to the local naming of the beach as "Tunnels".

There are only two regions of discontinuity in the shallow reef margin lining the shore in Section 4. One is located at the western end of this reach near the mouth of Manoa Stream. The other is located near Haena Point at the eastern end of this reach, at the head of a deep sand channel running westward, parallel to shore. This sand channel may play a significant role in the sediment transport dynamics near Haena Point. Figure I-28 shows a sketch of this channel feature and the coastal processes affecting the shoreline in this area.

There is one prominent shore protection structure in Section 4, located at the eastern end of this shoreline reach (see Base Map). A revetment, consisting of large boulders placed on the steep wave-cut embankment at the vegetation line, fronts the length of a property on the western side of Haena Point. This structure is in a critical area of the beach near the origin of the large sand channel which cuts through the reef flat parallel to the shore, as discussed above.

Typical beach width in Section 4 varies from as much as 200 feet at Haena County Park to approximately 50 feet near the recently placed rock revetment structure at Haena Point.

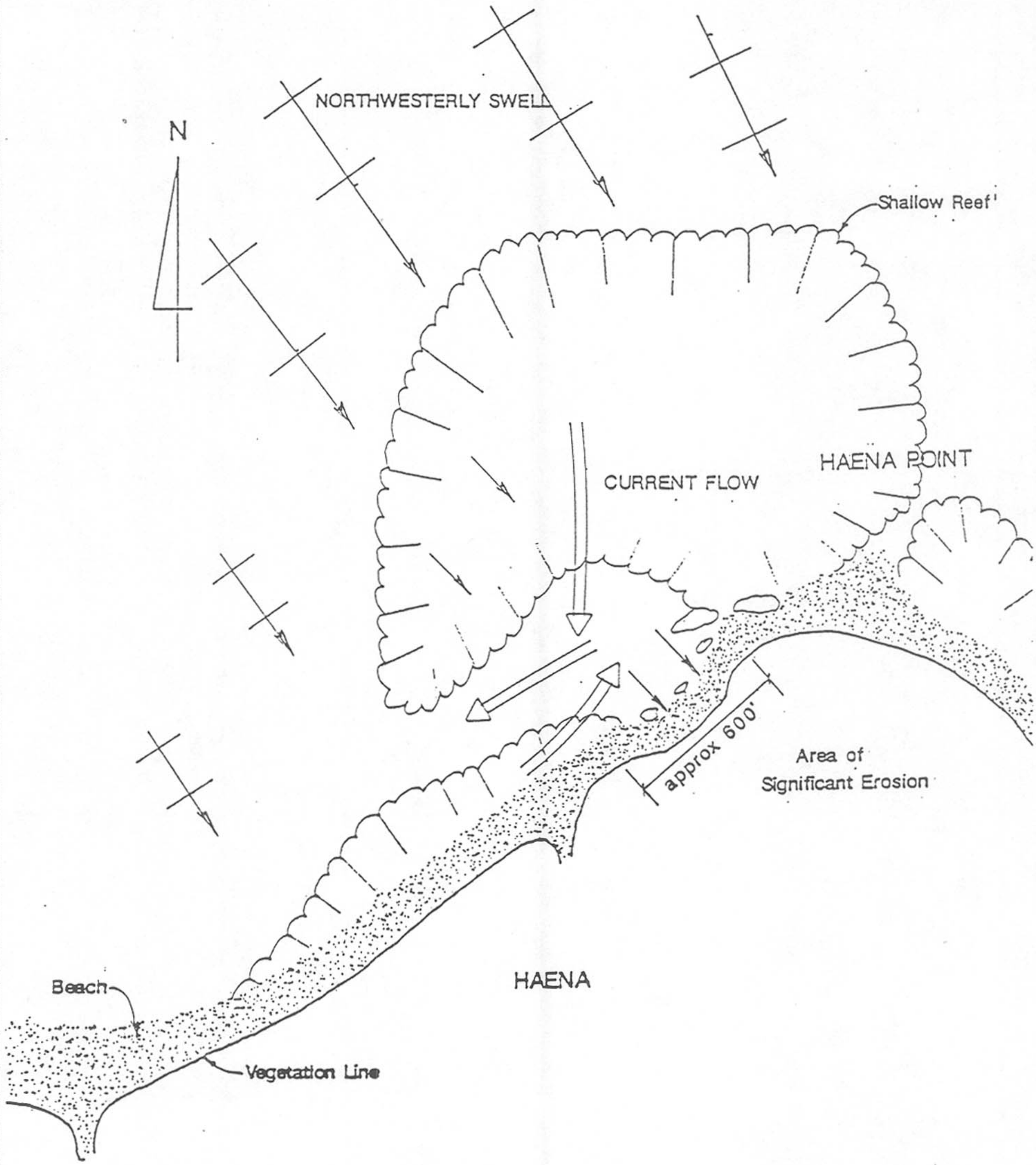



Figure I-28
## Ha'ena Point Channel Features
Kaua'i Shoreline Erosion Management Study

Edward K. Noda and Associates, Inc.

## COASTAL PROCESSES

The patterns of erosion and accretion along the shoreline at the Haena-Wainiha study site are functions of both the angle of incidence between the incoming seasonal wave types and the different shoreline segments, as well as the relative positions of protective reef areas and deeper channels along the shoreline reaches. Generally, if wave crests approach parallel with the shoreline, there will be little induced longshore transport. Sediment transport will tend to be directed in onshore/offshore movements perpendicular to the shoreline, with large, steep, shorter period waves eroding beach sediments and smaller, rolling, longer period waves redepositing the same sediments back onto the beach. However, as soon as incoming wave crests approach at an angle to the shoreline, breakers at the beach toe induce longshore sediment transport in the direction of wave breaking.

Because of the convex shape of the overall study reach, with shoreline segments facing northwestward through northeastward, the wave types affecting this site can result in seasonal changes in the littoral transport characteristics. Summertime tradewind-generated waves propagate towards the coastline from the east to northeast direction and winter swells propagate in from the northwest to northerly direction. Even without the presence of the diversely-shaped, abrupt reef formations along this study reach, it is clear that the angle of incidence of incoming wave energy may have opposite components of longshore propagation during different wave seasons.

The diversity of the nearshore reef system and variable bathymetry in the nearshore region results in complex wave and current patterns along shore, creating the highly variable shoreline configuration along this study reach. The Haena-Wainiha study site was divided into four segments in order to be able to describe the variability of the coastal processes.

The bathymetry contours seaward of the shallow reef flats cause waves to refract as they approach from deep water. If the offshore slopes are gentle, wave crests will align themselves nearly parallel with the bottom contours. Convex-shaped contours will cause wave energy to converge (increasing the energy per unit length of wave crest), while concave-shaped contours will cause wave energy to diverge (decreasing the energy per unit length of wave crest). For shoreline segments that are fronted by shallow reef flats, wave-breaking occurs near the seaward margin where water depths rapidly shoal up to the reef flat. Secondary waves formed on the reef flat will continue to propagate towards shore generally along the alignment of wave breaking, although irregular depths over the reef flat will cause continued refraction of the secondary waves as they propagate over the reef. Therefore, the shape of the reefs and the variability of water depths over the reefs contribute to create complex patterns of wave approach at the shoreline.

The maximum wave energy that can reach the shoreline is directly related to the water depth. Therefore, deeper depths within the sand channels bisecting the reef can permit relatively greater wave energy to reach the shoreline than adjacent shoreline reaches fronted by shallow reefs. The arcuate-shaped shorelines in the central portions of Section 1 and Section 3 are probably the result of such differential wave energy acting on the shoreline over time. During heavy winter swell, shoreline areas not protected by the shallow reefs can experience heavy surging and extensive runup on the foreslope of the beach, resulting in substantial turbulence and sediment suspension. These suspended sediments can be carried offshore through the channels by the shoreline currents, which is why most of the channels contain sand deposits. During the summer season, wave energy reaching the shoreline through the channels is sufficiently mild so that neither significant runup nor sediment suspension at the beach toe occur. Milder wave energy can also transport sediments back towards shore if there is no extreme discontinuity between the channel depths and the beach toe.

In addition to influencing the wave characteristics at the shoreline, the reef and channel systems can result in nearshore current patterns that may seem contrary to wave-induced longshore currents. These currents result from hydraulic gradients set up on the reef areas due to the breaking wave activity, and can have a significant effect on sediment transport characteristics along the shoreline. Large waves breaking on the reef flat cause a super-elevation of the mean water level known as "wave set-up". Wave set-up can vary from a few inches during large tradewind-wave conditions to a couple feet during high winter swell. In other words, when a large northwest winter swell is running, the mean water level over the reef inside of the breaker line is higher than the mean water level in adjacent deeper areas. This hydraulic gradient induces current flow through the deeper channels in the reef, where the water seeks to flow through paths of least frictional resistance back towards the ocean. Such conduits become major arteries for the transport of beach sediment that is suspended by breaking wave energy at the shoreline. This process probably occurs in Section 2 at the east end fronting Charo's restaurant, where wave set-up on the broad central reef flat may induce current flow easterly through a shore-parallel depression in the reef, which drains offshore through a break in the shallow fringing reef. Thus, high wave activity may cause erosion of this beach area if suspended beach sediments are carried offshore by the hydraulic flows. Such flows can also occur during an ebbing tide, as water drains from the expansive reef area during falling tide level. The easterly-flowing currents through this reef channel can run counter to the approaching easterly tradewinds and waves.

The above-described process may also occur in Section 4 at the east end near Haena Point. Wave set-up generated over the broad reef flat surrounding Haena Point drains through a very large and deep channel cut into the western side of the reef, parallel to shore. Extreme high wave activity can cause erosion to the shoreline near the head of the channel, as wave-suspended sediments are carried offshore and deposited in the deep interior portion of the bay.

Super-elevation of the mean water level on the reef flat due to wave set-up can also allow more wave energy to reach the shore during high wave activity. Deeper water depths result in less dissipation of the secondary wave energy over the reef, allowing more of the energy to attack the shoreline. Also, the higher mean water level permits these waves to attack at higher elevations on the beach foreslope, causing greater runup on the beach and shoreline than would otherwise occur. Where erosion has resulted in an escarpment at the vegetation line, the higher runup on the beach can cause aggravated scouring at the base of the embankment, and accelerated erosion due to collapse of the undercut embankment sections. This occurred along the eastern end of Section 4, during a past winter season of particularly large waves. A revetment was recently constructed on one of the properties in this area to prevent further loss of fastlands (which may actually have been accreted lands), and to facilitate development nearer the shoreline.

LONG-TERM SHORELINE CHANGES

Historical aerial photos were analyzed to determine the long-term fluctuations of the vegetation line and waterline, using the technique described in the previous section of this chapter on case study sites. It was possible to obtain seven vertical aerial photographs spanning a nearly 40-year time period from 1950 through 1988. The dates of the historical aerial photos used in this analysis are:

November 1950
(Unknown) 1960
October 1963
April 1975
January 1983
July 1987
March 1988

The paucity of available photos cannot reveal seasonal variability in the shoreline changes. Most of the photos were taken during the winter season, when high wave conditions have maximum influence on the littoral transport processes. Thus, the historical long-term trends revealed by this analysis lends conservation in estimating future long-term trends. Overlays of the historic shorelines digitized from the aerial photos are contained in Appendix C for each of the four shoreline sections within the Haena-Wainiha study site.

Figures I-29 through I-31 graphically depict the cumulative average erosion (-) or accretion (+) changes for each of the four sections. By establishing the earliest photo as the zero baseline, the cumulative plots of shoreline loss or gain are indicative of the horizontal position of the shoreline relative to the earliest photo position. On each figure, simultaneous displays of the four sections show changes to the vegetation line (Figure I-29), waterline (Figure I-30), and beach width (Figure I-31).

Table I-2 summarizes pertinent parameters which are helpful to interpret the data displayed in Figures I-29 through I-31. Peak to peak values indicate the maximum cyclic fluctuations. The long-term trend is indicated by the average rate of change using linear regression techniques to obtain the best fit line to the data. The General Classification indicates the future tendencies towards erosion or accretion based on the long-term historical characteristics as revealed by the data.

Except for Section 1, the vegetation line generally shows a long-term trend towards accretion, with relatively small recessionary fluctuations. Section 3 shows the greatest accretion over the period of record, with a gain of over 35 feet in the average position of the vegetation line from the base year, and a long-term average rate of +0.9 feet per year. Section 1 shows a relatively stable long-term trend in the position of the vegetation line.

FIGURE I-29

# HAENA: SECTIONS 1-4

## CUMULATIVE CHANGE IN VEGETATION LINE

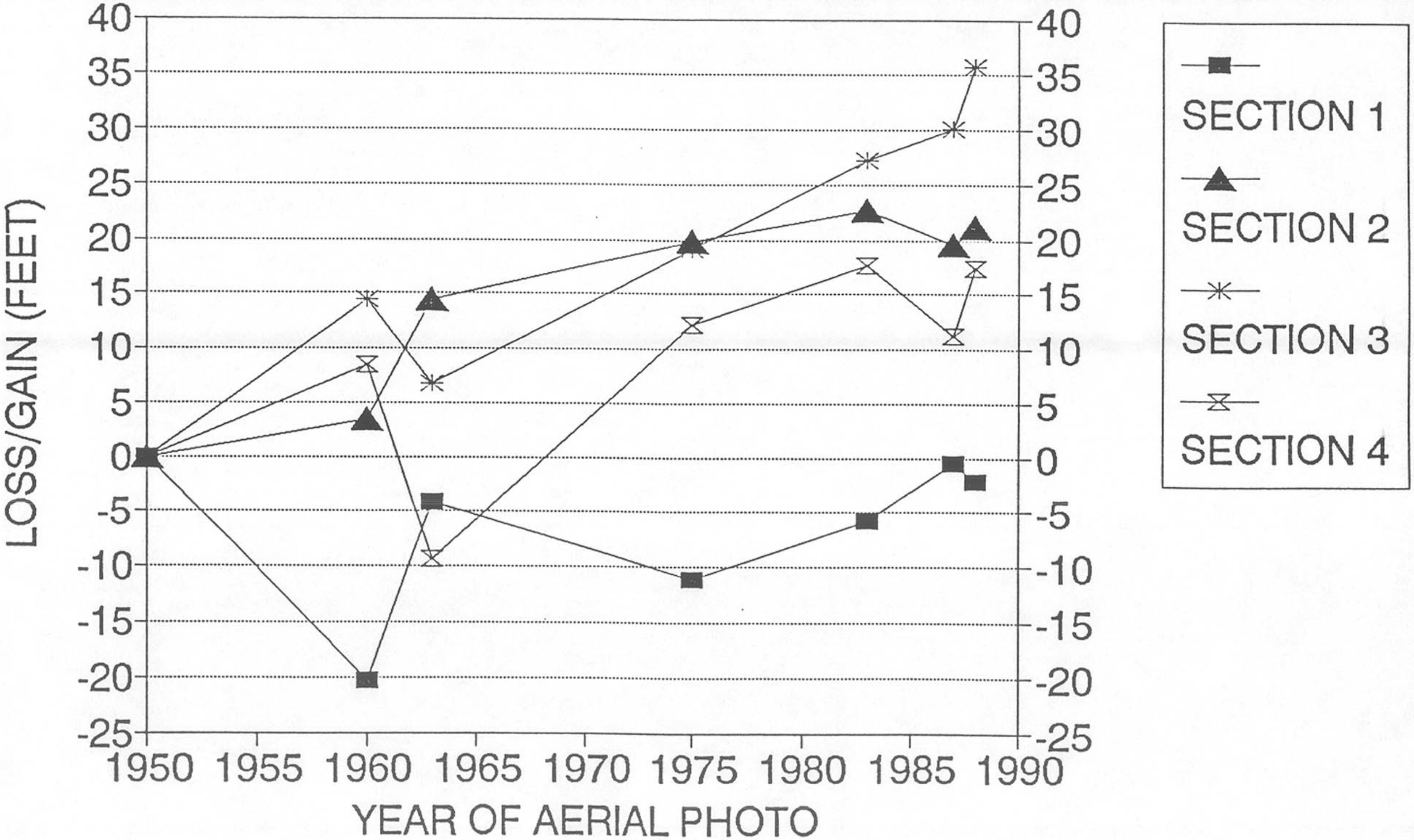


FIGURE I-30

# HAENA: SECTIONS 1-4

## CUMULATIVE CHANGE IN WATER LINE

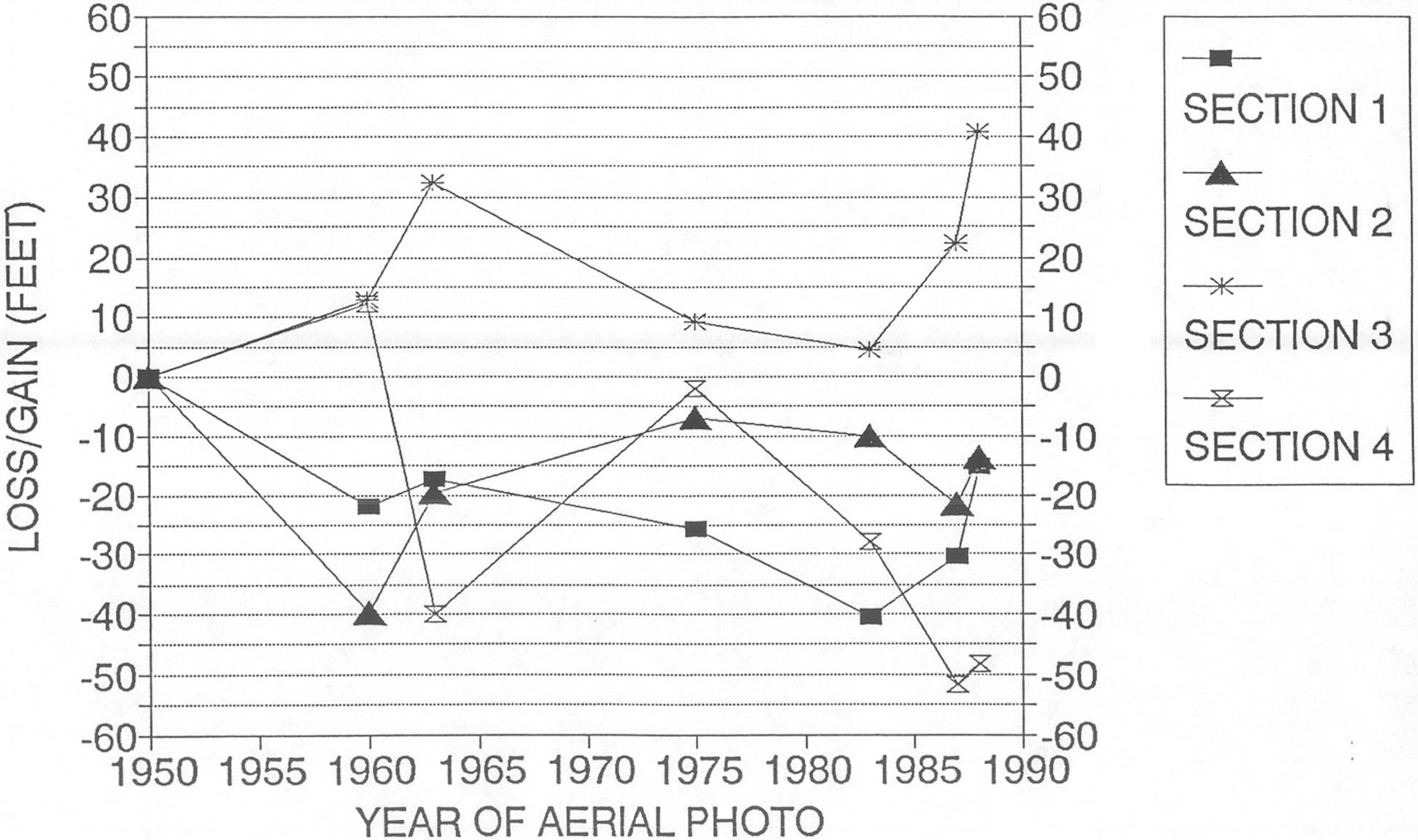
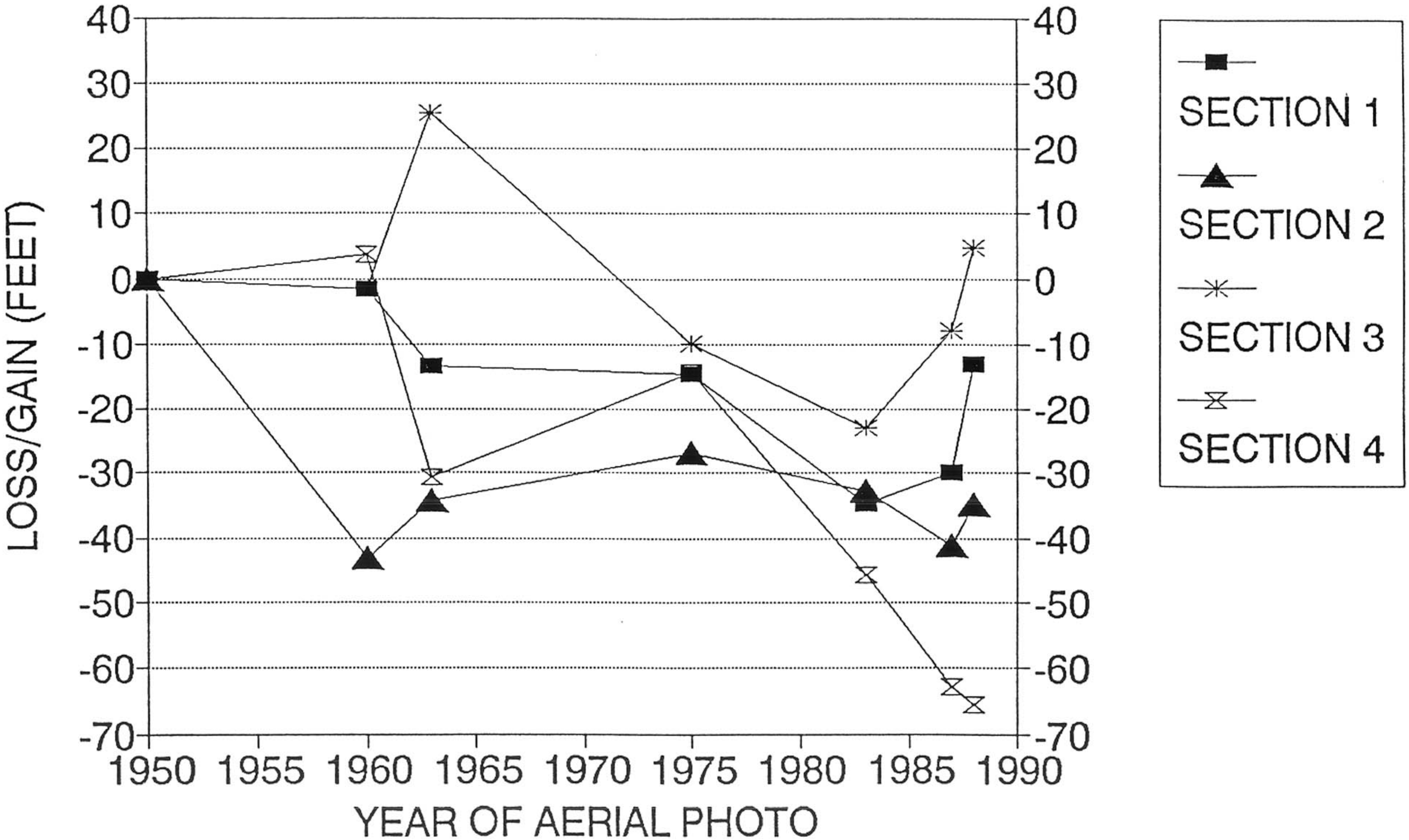


FIGURE I-31

# HAENA: SECTIONS 1-4

## CUMULATIVE CHANGE IN BEACH WIDTH



# TABLE I-2

| | HAENA CASE STUDY SITE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SECTION 1 | | | SECTION 2 | | | SECTION 3 | | | SECTION 4 | | |
| | VEG | WATER | BEACH | VEG | WATER | BEACH | VEG | WATER | BEACH | VEG | WATER | BEACH |
| **Max Cycle:** | | | | | | | | | | | | |
| Peak To Peak Values (Ft) | -1/-20 | -40/-15 | -35/-2 | +4/+23 | 0/-40 | 0/-43 | +7/+36 | +4/+41 | +25/-23 | -9/+18 | +12/-40 | -15/-66 |
| Max Change (Ft) | 19 | 25 | 33 | 19 | 40 | 43 | 29 | 37 | 48 | 27 | 52 | 51 |
| | | | | | | | | | | | | |
| **Overall Trend:** | | | | | | | | | | | | |
| Average Rate (Ft/Year)[1] | +0.1 | -0.6 | -0.7 | +0.6 | +0.1 | -0.6 | +0.9 | +0.5 | -0.4 | +0.6 | -1.2 | -1.7 |
| 30-Year Change (Ft)[2] | +3 | -18 | -21 | +18 | +3 | -18 | +27 | +15 | -12 | +18 | -36 | -51 |
| | | | | | | | | | | | | |
| **General Classification:** | | | | | | | | | | | | |
| S = Stable | X | | | | | | | | | | | |
| E = Erosion Tendency | | X | X | | | X | | | | | X | X |
| A = Accretion Tendency | | | | X | | | X | X | | X | | |
| A/E = Cyclical | | | | | X | | | | X | | | |

---

[1]Using linear regression techniques to obtain best fit line. Slope of line yields average rate: (-)=erosion, (+)=accretion.

[2]Average rate * 30 Years = extrapolated rate over next thirty years.

The position of the waterline for all four sections showed a pattern of cyclic fluctuation over the period of record, as would be expected for beaches exposed to this type of high wave energy environment. Section 3 showed the only positive long-term trend towards accretion of the waterline, although a recessionary cycle of almost 30 feet occurred between 1963 and 1983. (During this same time period, the vegetation line accreted about 20 feet, resulting in a dramatic narrowing of the beach width by almost 50 feet.) Over the long-term, the average beach width in Section 3 showed a slight tendency towards narrowing because the vegetation line accreted at a faster rate than did the waterline. Section 4 showed the greatest long-term trend towards recession of the waterline, with a maximum recessionary cycle of over 50 feet and long-term average rate of -1.2 feet per year.

With the relative consistency of the vegetation line and the cyclic fluctuations of the waterline, it is not surprising that the beach width changes fluctuate over the long-term, since the beach width change is a measure of the relative change between the vegetation line and waterline positions. What is interesting to note is that the beach width changes generally indicate a long-term trend towards narrowing of beach width for all sections. Section 4 suffered the greatest long-term loss in beach width over the period of record, with maximum change of over 50 feet between 1975 and 1988 and long-term average rate of narrowing of -1.7 feet per year. The average rate of narrowing of the beach width in Section 4 is greater than the rate of waterline recession since the vegetation line has been accreting at an average long-term rate of +0.6 feet per year.

Following is a discussion of the specific long-term shoreline changes for the four sections within the Haena-Wainiha study site.

Section 1

Field observations indicate that the first 1000 feet into the eastern part of Section 2 is more dynamically similar to Section 1 than the remainder of the reach within Section 2. Thus, the long term shoreline changes for Section 1 should also pertain to this eastern end of Section 2.

The reef areas fronting Section 1 are relatively deeper, and more variable than the shallow reef flats fronting other segments of the study site. Numerous sand channels extend to shore from a large sand pocket lying about 500 feet from shore. With an east-northeasterly facing shoreline, breaking wave heights during large winter swell from the northerly directions are not as large as experienced in other parts of the study area due to refraction effects and the protection afforded by the wide shallow reef flat fronting Section 2. It is anticipated that large winter swell can induce longshore transport of sediments from "upstream" beach and reef flat areas in Section 2 down towards Section 1. However, the channel feature at the eastern end of Section 2 may prevent any significant longshore transport of sediment from Section 2 into Section 1. Although some sediment loss to Wainiha Bay from Section 1 during winter swell activity may occur, the rock promontory at the eastern border of Section 1 should act effectively as a groin in trapping beach sediment within Section 1.

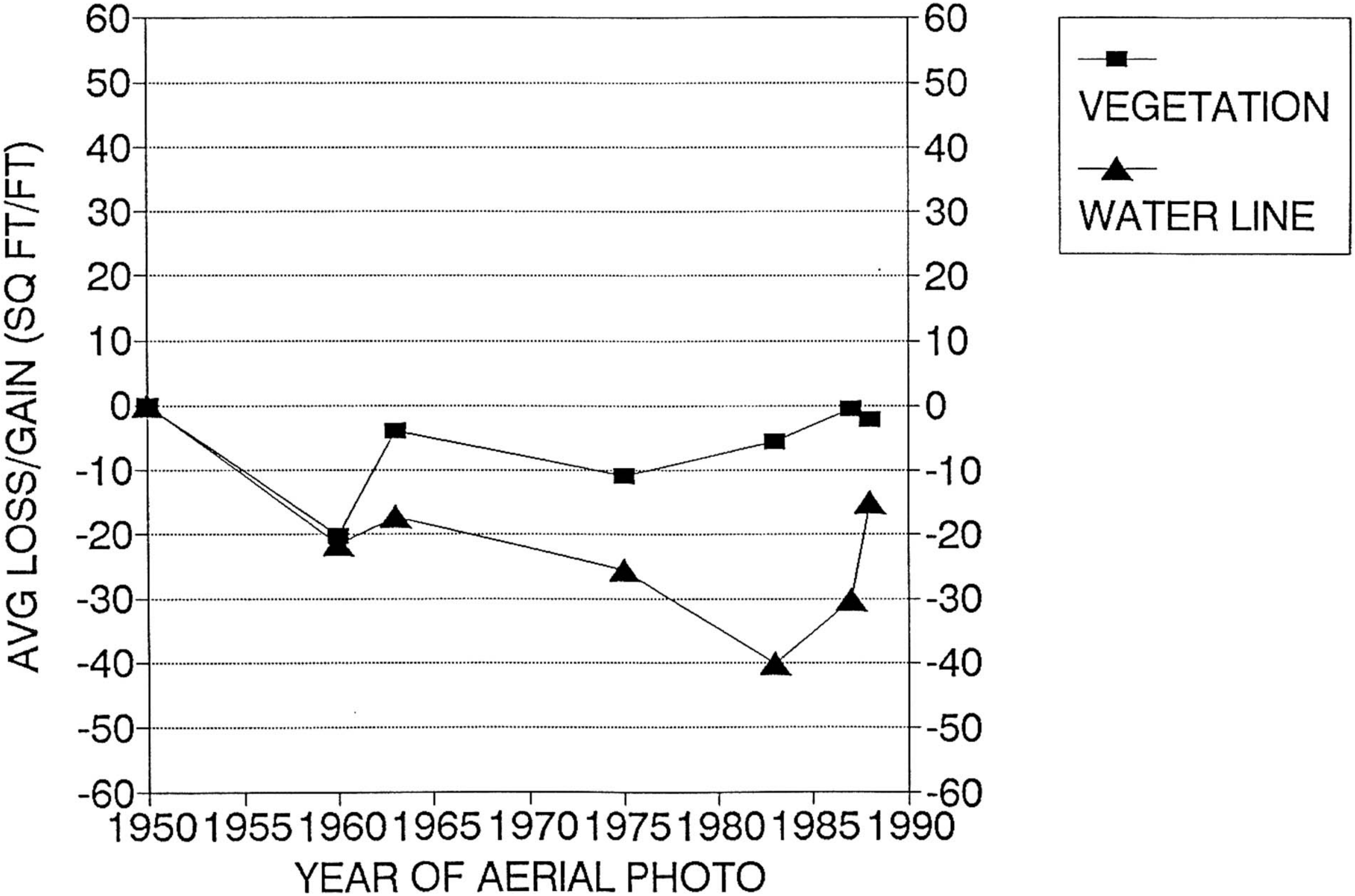
Section 1 faces directly towards the tradewind waves, with little if any component of longshore transport. Thus, sediment transport during the summer tradewind conditions is predominantly in the onshore-offshore direction.

The sand channels probably play an active role in the long-term characteristics of this shoreline reach. During high wave activity, offshore transport of sediments would be expected through the channels. During moderately low wave activity, onshore transport of sediments from the reserves stored in the sand channel would be expected. Onshore-offshore transport could occur throughout the year depending on the specific wave characteristics. Small winter swell with relatively long wave periods may refract sufficiently to induce onshore transport, while large swell may attack the shoreline with sufficient turbulence to induce offshore transport. Large tradewind waves during the summer season may also induce offshore transport, while the typically smaller waves may act to replenish the beach. It was observed during the field investigation that the interface between the vegetation line and the beach backshore transitioned quickly from sharp, undercut, vertical banks with obvious exposure and loss of greenery to continuous, rounded profiles with scatterings of vine growth extending towards the water line. Changes in the character of the vegetation line were generally indicative of the relative positions of the sand channels and the shallow protective portions of the reef flats.

Figure I-32 shows the cumulative change of the vegetation line and waterline positions over the period of record for Section 1. As indicated in Table I-2, the average position of the vegetation line over the long term has been relatively stable, with a maximum recessionary cycle of only 19 feet. However, isolated areas within Section 1 have experienced larger changes (i.e. up to 50 feet of change between the most accreted and eroded position of the vegetation line near the eastern boundary). The waterline position has fluctuated with a maximum cycle of 25 feet and average long-term rate of -0.6 feet per year. Extrapolation of the average rate of waterline recession over the next 30 years yields an estimate of -18 feet. However, between 1950 and 1983, the average waterline position receded up to 40 feet prior to reversing to an accretionary cycle. The potential tendency towards future long-term erosion of the waterline, together with the cyclical fluctuations in the waterline position, supports a conservative estimate of future long-term shoreline change for the entire reach within Section 1 of 30 feet over a thirty year period.

FIGURE I-32

# HAENA: SECTION 1



Section 2

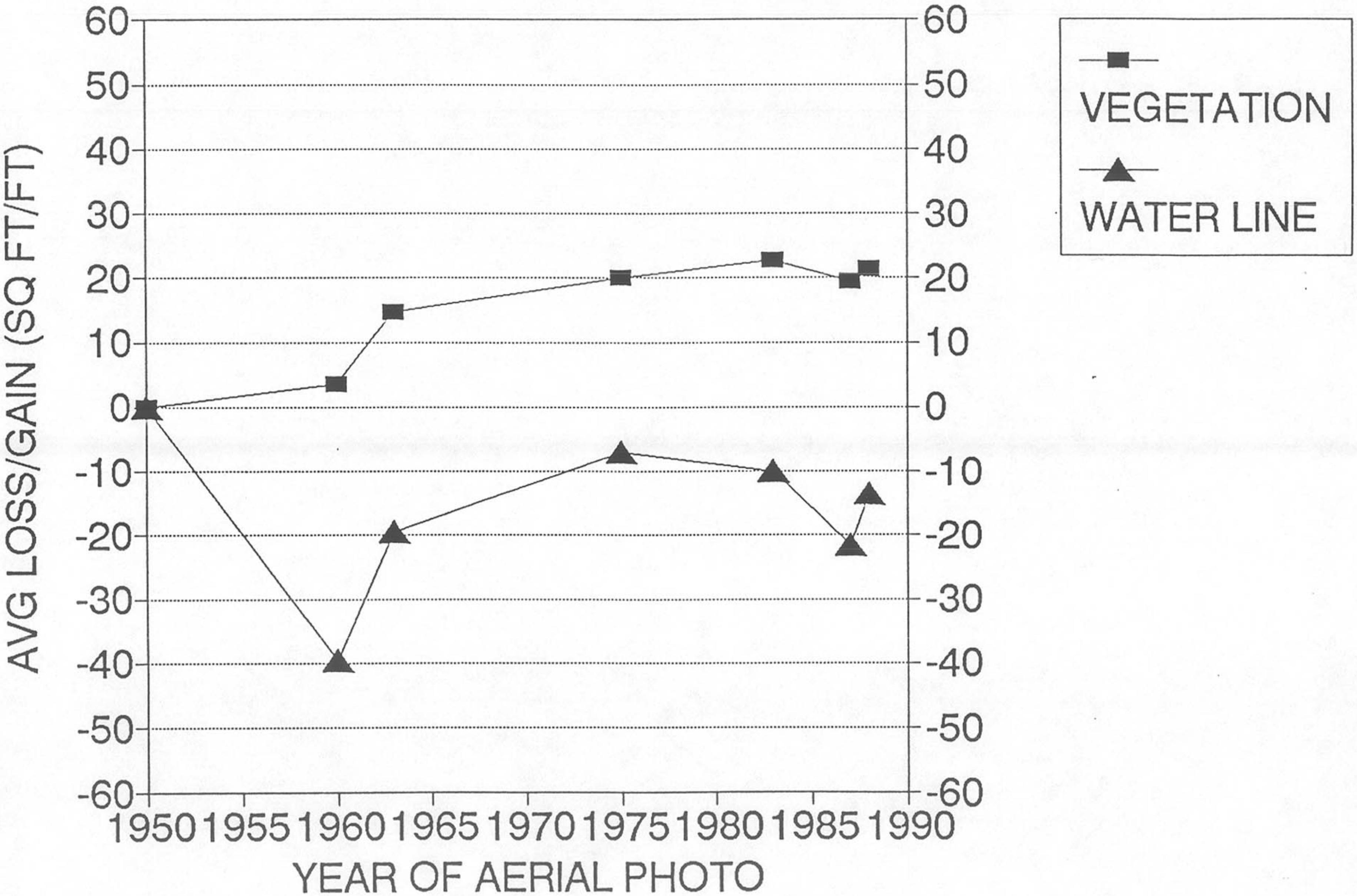
The wide shallow reef flat extending eastward from the border of Section 3 throughout most of the length of Section 2 makes up one of the more homogenous features along any of the reaches within this study site. It is not surprising that the nature of the beach in this area is similarly more uniform than in the other Sections. Figure I-33 shows the cumulative change of the vegetation line and waterline positions over the period of record for Section 2.

This reach is slightly convex-shaped facing north-northeast, and the seaward margin of the reef flat typically carries lines of plunging breakers throughout the year. With the shallow uniform depths over the reef flat providing substantial protection from direct wave attack, the shoreline is expected to be relatively stable. In fact, Table I-2 indicates a long-term accreting trend for the vegetation line of +0.6 feet per year, yielding an extrapolated 30-year rate of +18 feet. This accretionary trend is highly linear. It was observed during the field investigation that the transition between the vegetation line and the beach backshore is gently-sloped without evidence of undercutting due to erosion.

The average long-term trend for the waterline shows relative stability. However, the changes in the waterline position have been highly cyclical, with maximum recessionary cycle of 40 feet. With this north-northeasterly exposure, both onshore-offshore and longshore movement of beach sediment is expected throughout the year. Depending on the wave characteristics, both transport mechanisms can occur simultaneously. Winter swell activity can induce longshore transport from Section 3 towards Section 2, and from Section 2 towards through Section 1. Easterly tradewind waves would induce a longshore transport in the opposite direction. Northeasterly tradewind waves would have a more direct onshore component.

FIGURE I-33

# HAENA: SECTION 2



The beach width is relatively narrow, being wider towards the center than near the ends. Given the fluctuating characteristics of the waterline position and small unit beach volume, there may be a susceptibility towards long-term erosion of the shoreline even though the historical record shows a consistent moderate accretion trend. This vulnerability supports a conservative estimate of future long-term shoreline change of 20 feet over a thirty year period, being biased towards the mean value in the fluctuation of the water line position over the historical record.

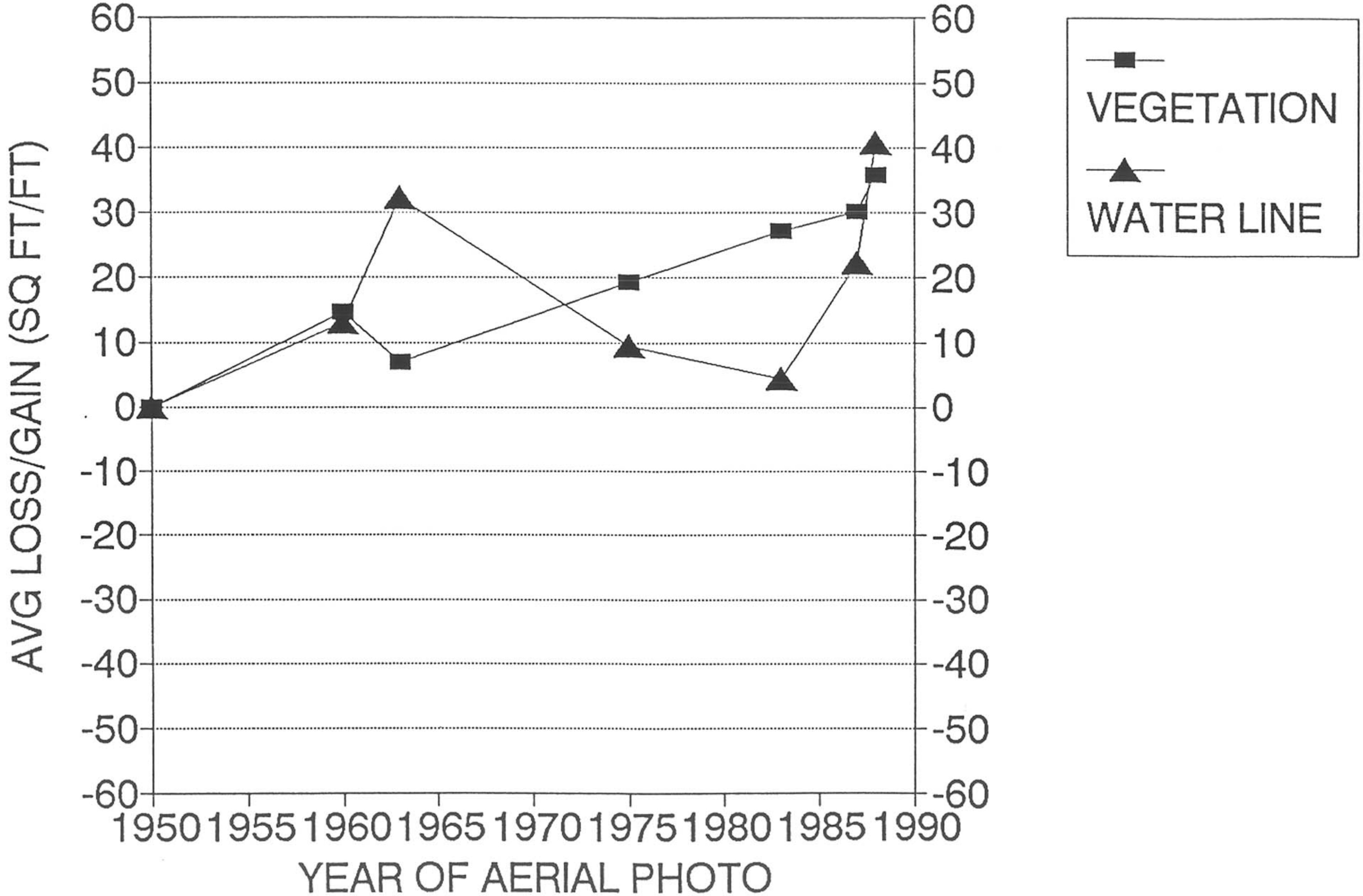
__Section 3__

Table I-2 indicates that the shoreline condition at Section 3 is the healthiest within the study reach. Figure I-34 shows the cumulative change of the vegetation line and waterline positions over the period of record for Section 3. Average vegetation line positions followed a strongly linear, positive trend, accreting over 35 feet during the study period. The water line position fluctuated more, but only seaward of the 1950 base year position, while also maintaining a long-term positive trend. The field investigation also verified the continuous, non-erosive condition of the transition between vegetative cover and beach backslope.

Such conditions at Section 3 are not unexpected given the relative sheltering of this north-facing reach with respect to incoming wave energy. The area is relatively protected from the dominant northwest winter swell by the expansive reef flat off Haena Point and from the steepest of the summer tradewind waves by the long reef flat offshore Section 2. The less frequent winter swell from due north may largely refract into the reef margins at the borders of Sections 2 and 4, considerably reducing wave energy in the central portion of Section 3. The remaining north swell wave energy would approach the beach front with little longshore component of wave energy. Such long-period swell waves could also induce onshore transport of sand through the sand channels. There is not only sand storage within the channels, but also on the shallow fringing reef on the east side

FIGURE I-34

# HAENA: SECTION 3



of Haena Point, as can be seen in the color aerial photo. While there is little evidence for transport out of the cell, it may be that there is a net gain in sediment at Section 3 from longshore transport out of Section 4.

Given the above, and assuming that the long-term history of accreting conditions may easily change to simply stable conditions, a conservative estimate of future long-term shoreline change for Section 3 is 0 feet for a thirty year period.

<u>Section 4</u>

West of Haena Point, Section 4 faces predominantly northwest. Nearly the entire reach is lined with a narrow reef margin that drops off dramatically to depths of 50 feet and greater within the interior portion of the embayment. Beach sediment transported off the reef margin is probably lost from the active littoral system. This large sand reservoir contained within the interior reaches of the bay is a potential source for sand mining and replenishment of the beaches.

This reach is sheltered from the predominant tradewind waves by the broad shallow fringing reef encompassing Haena Point. However, this reach is directly exposed to the winter northwesterly swell. These waves may undergo significant refraction effects as they approach the embayment, resulting in reduced energy along the western half of Section 4 situated towards the central portion of embayment. The beach width near Haena County Park situated at the apex of the "V"-shaped shoreline, is significantly wider than anywhere else along this reach.

Table I-2 indicates that, over the historical record, both the water line and beach width in Section 4 suffered the most severe erosion of all areas at the study site. Long-term average recession of the waterline was -1.2 feet per year, with maximum cyclic recession of over 50 feet. Figure I-35 shows the cumulative change of the vegetation line and waterline positions over the period of record for Section 4.

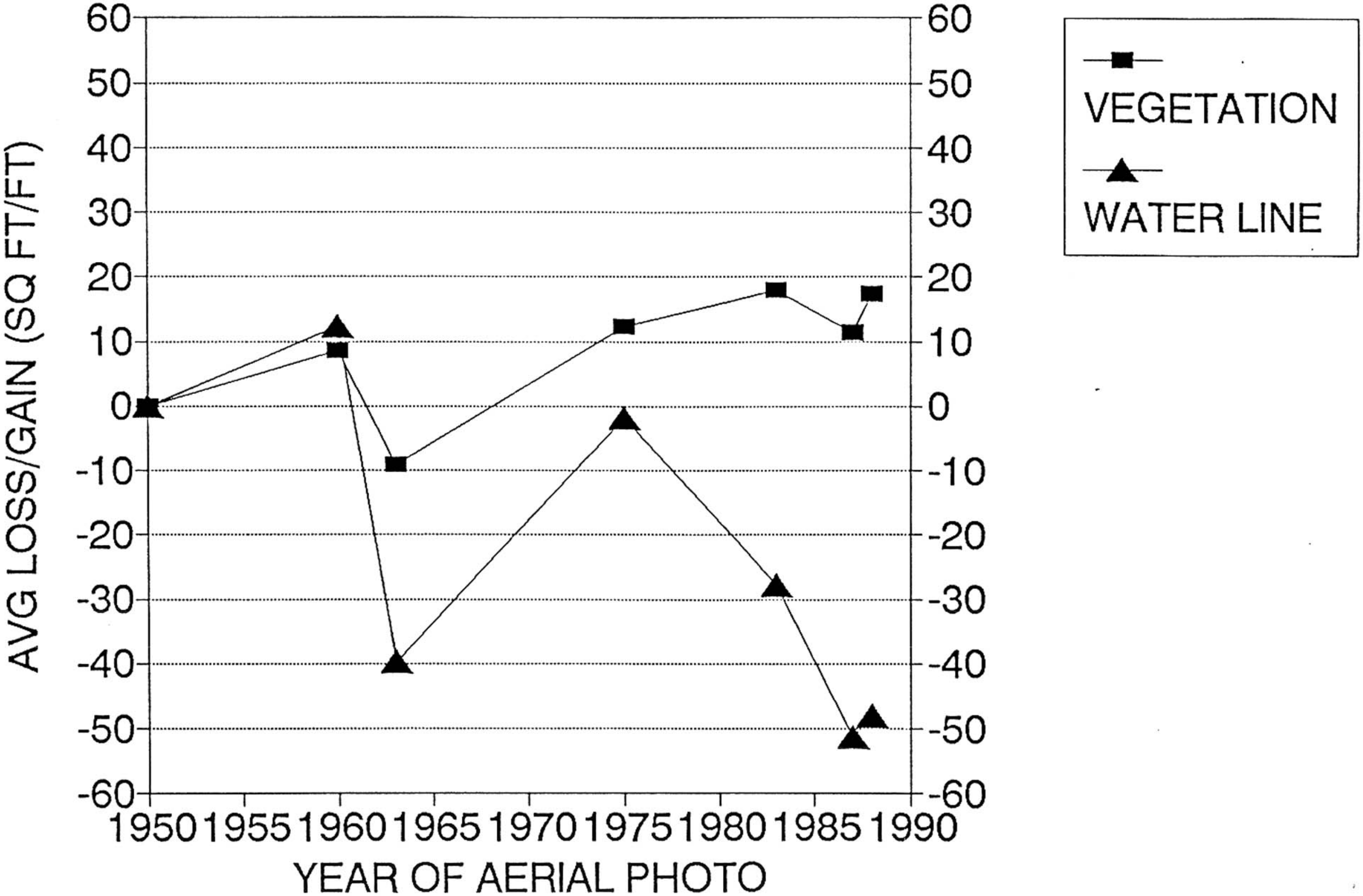
Although the long-term data indicate that the vegetation line has been accreting over much of the study period, the field reconnaissance revealed severe undercutting of many large trees at the vegetation line over much of the easterly reach. At some point in the recent past, the accreted position of the vegetation line along the eastern end has undergone erosion. It may be that the long-term recession of the waterline together with the accretion of the vegetation line had reduced beach volume to a point where it could not provide adequate protection to the fastlands.

Close to Haena Point, several large trees are surviving isolated on the back slope of the beach with their complete root systems exposed. Also, a few large tree trunks lay near the waterline, their color already turned to the grey of driftwood. It is in this same area that a recent revetment has been placed on a property lot. This part of the beach in Section 4 is at the head of the large channel through the western flank of the reef at Haena Point. As discussed earlier, this channel may serve as a conduit to drain the super-elevated water levels experienced on top of the reef flat during large winter swell conditions. The pronounced narrowing of the beach in this area just west of Haena Point may be the result of aggravated scour caused by the waves breaking at higher elevations on the beach and the offshore transport of the suspended sediments by the strong current within the channel.

Given the long-term recessionary trend of -1.2 feet per year for the waterline (which extrapolates to a future change of 36 feet over 30 years), the narrowing trend for the beach width of -1.7 feet per year (which extrapolates to a future change of 51 feet over 30 years), and visible evidence of severe erosion to apparently stable fastlands, a conservative estimate of long-term

FIGURE I-35

# HAENA: SECTION 4



future shoreline change is 60 feet for a thirty year period. It should be noted that this area is the most heavily frequented by beach-goers within the Haena-Wainiha study site.

Summary

In summary, estimates of future long-term shoreline change for the four Sections along the Haena-Wainiha study reach for a thirty year period are as follows:

**Section 1:** Since localized aggravated erosion has occurred in mini-cells within this reach which also contains stable areas, a conservative estimate exceeds the average conditions of change in the historical record:

```
Max cycle of vegetation line accretion/erosion
     =  -1 feet  to  -20 feet    =  19 feet
     Trend-derived 30-Year Change =  +3 feet
Max cycle of water line accretion/erosion
     = -40 feet  to  -15 feet    =  25 feet
     Trend-derived 30-Year Change = -18 feet
Max cycle of beach width accretion/erosion
     = -35 feet  to   -2 feet    =  33 feet
     Trend-derived 30-Year Change = -21 feet
```

USE: Max 30 feet for 30-year period

**Section 2:** The narrow beach and small sand volume favor a conservative estimate weighting waterline and beach width characteristics even though the vegetation line has historically accreted:

```
Max cycle of vegetation line accretion/erosion
     =  +4 feet  to  +23 feet    =  19 feet
     Trend-derived 30-Year Change = +18 feet
Max cycle of water line accretion/erosion
     =   0 feet  to  -40 feet    =  40 feet
     Trend-derived 30-Year Change =  +3 feet
Max cycle of beach width accretion/erosion
     =   0 feet  to  -43 feet    =  43 feet
     Trend-derived 30-Year Change = -18 feet
```

USE: Max 20 feet for 30-year period

**Section 3:** A conservative estimate from the historical record which indicates conditions of accretion assumes only stable conditions:

Max cycle of vegetation line accretion/erosion
= +7 feet to +36 feet = 29 feet
Trend-derived 30-Year Change = +27 feet
Max cycle of water line accretion/erosion
= +4 feet to +41 feet = 37 feet
Trend-derived 30-Year Change = +15 feet
Max cycle of beach width accretion/erosion
= +25 feet to -23 feet = 48 feet
Trend-derived 30-Year Change = -12 feet

USE: <u>0 feet for 30-year period</u>

**Section 4:** Visible evidence of massive undercutting at the vegetation line, long-term recession of the water line, narrowing of beach width especially in the last 15 years, and the recent construction of a shore protection structure on this recreation-oriented coastal reach, warrant extreme conservatism:

Max cycle of vegetation line accretion/erosion
= -9 feet to +18 feet = 27 feet
Trend-derived 30-Year Change = +18 feet
Max cycle of water line accretion/erosion
= +12 feet to -40 feet = 52 feet
Trend-derived 30-Year Change = -36 feet
Max cycle of beach width accretion/erosion
= -15 feet to -66 feet = 51 feet
Trend-derived 30-Year Change = -51 feet

USE: <u>60 feet for 30-year period</u>

APPROPRIATE SHORE PROTECTION STRUCTURES

Given the erosion trends and current land use practices in the Haena study area, improved regulatory measures alone should be adequate to minimize shoreline erosion problems. Any proposed active shore protection measures should conform to the general standard outlined in the 1980 North Shore Development Plan Update, which specifies that "maintenance of the natural beauty, and ecological systems that characterize the North Shore must take priority over any new development." Beach preservation should be the priority in the Haena area, which has been identified as having a "high statewide significance."[9] If shore protection measures other than improved regulatory measures are deemed absolutely necessary to prevent the erosion of shorefront property and loss of backshore improvements, effort must be taken to minimize negative impacts on the complex littoral processes which result from poorly designed shore protection structures. Beach nourishment is the form of active shore protection that generally has the least negative impacts, and may be economically feasible for this study site. Potential deposits are located within Haena Bay and within the larger sand channel areas such as east of Haena Point. Three key features which need to be evaluated to determine the appropriateness of the submarine sand source for beach nourishment are: (1) adequate volumes of sediment for dredging, (2) compatibility of the sediment type with the beach sand characteristics at the nourishment sites, and (3) assurance that removal of sediment from the submarine source will not have a harmful effect on the biological and physical coastal processes. The deep embayment offshore from the vertical reef margins encompassing Haena County Park appears most promising. It should be recognized that beach nourishment typically requires periodic re-nourishment to maintain a beach system that is susceptible to erosion trends.

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9. Statewide Recreation Resources Inventory Principal Swimming Areas, John Clark and Wayne Souza, DLNR, Honolulu, 1987.

Given the apparent stability of the shoreline in the study area, other structural measures should only be considered after demonstration of continual, progressive erosion of the shoreline over a long time (30 years) period. If structural measures are justified and required, buried revetments placed landward of the certified shoreline (the vegetation line in most cases) are the only appropriate measure to directly protect fastlands from future erosion. Any stabilization efforts must carefully consider the impacts that fast-shoreland protection structures may have on the dynamic littoral processes which control beach formation in Haena. Impermeable seawalls will aggravate loss of beach sand due to their high reflectivity, and groins are not appropriate in high wave energy environments since they may aggravate the offshore transport of sediments from the beach due to localized currents. Revetments should be designed with low angles of repose to encourage infilling of sand particles within the voids between the stones and subsequent vegetative over-growth during accretionary cycles. However, buried revetments are preferable for aesthetic reasons and improved beach access.

Detailed analysis may substantiate the feasibility of using offshore structures to stabilize the shoreline. However, care must be taken to insure that the complex current patterns over the reef area are not altered in a manner that could be detrimental to the beach processes. Their construction would require a community approach to the sharing of both costs and benefits, and their effect on the aesthetic and recreational quality of the shoreline would have to be assessed.

EROSION MANAGEMENT RECOMMENDATIONS

For the Haena study area, just as for the Hanalei area, non-structural approaches to erosion control have been determined to be most appropriate. The rural character and scenic beauty of the area would be better preserved by improved regulatory activity to control the detrimental effects of erosion, than by structural protection measures. Large lot sizes, low density zoning, and relatively limited development allow regulators the flexibility necessary to realistically and successfully implement shore protection regulations.

The overall recommendation for this case study area is to classify the entire area from the western promontory of Wainiha Bay to the western boundary of Haena County Park as one large littoral cell, within which are contained smaller sub-cells.[10] The following recommendations may serve as an outline for the littoral cell management plan for the area.

- The entire study area should be designated a Shore District as specified in the Kauai CZO (Sec. 8-13.1), as one specific component of a Shoreline Special Treatment Zone Plan.

- A 60-foot shoreline setback should be established. The 60-foot setback reflects the most extreme 30-year future erosion estimates for one section of the study area. This conservative, uniform setback reflects the possible interdependence of all subcells within the Haena littoral cell, and the need to reduce the demand for shore protection structures which might interfere with sand exchanges within the cell.

- Shore protection structures should be prohibited, except to protect public infrastructure, to ensure public access, or to improve public beaches and recreational opportunities. Since the majority of lands within the study site are residential or undeveloped, with average lot depth of more than 220 feet, management or regulatory controls should provide adequate means to deal with shoreline erosion.

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10. Further study may reveal that the area beyond the western park boundary to Kee Beach should also be included in this littoral cell. However, this area which includes the Haena State Park was outside the study area, so no recommendations can be made at this time.

- For those few Resort-zoned parcels on which intensive improvements exist, buried revetments should be the preferable shoreline protection structure permitted if shore protection is continued as a policy option and determined to be absolutely necessary for these individual parcels. If revetments are allowed in this area, they should be located entirely within the private property boundary, and provisions should be made for removal of the revetments if adjacent properties are negatively affected.

- Those Open-zoned beachfront properties between the western promontory of Wainiha Bay and the Hanalei Colony Resort should remain in Open zoning in order to minimize development, preserve shoreline aesthetics, and preclude any demand for future shore protection structures. At the same time, these properties should be actively considered for acquisition by either the State or the County, because their dimensions are too small to accommodate adequate setbacks, and could realistically be termed "undevelopable." The remainder of the County zoned shorefront properties in the study area from the western border of Charo's to Haena County Park should be considered for rezoning to Open, or to R1, to preclude any intensive future development of these properties, and to minimize all development in this hazard-prone zone. Those conservation lands on the western end of the study site should be treated as Open zoned lands. More protection should be offered them.

- Detailed analysis should be required before offshore structures can be considered appropriate for shoreline protection. Littoral processes in the Haena area are extremely complex, and only after considerable, detailed study could the implications of offshore structures be adequately determined. This type of oceanographic study was beyond the scope of this investigation. Possible negative impacts of such structures might outweigh the potential desired erosion control benefits.

- Beach nourishment should be considered the preferred option for stabilization of the beach and shoreline area with Section 4. Submarine sand investigations should be undertaken to establish the feasibility of mining sand from the deepwater interior of Haena Bay.

# Chapter II

## CHAPTER II. IMPACT ANALYSIS OF THE RECOMMENDED REGULATORY CHANGES

The beach and shoreline erosion management recommendations contained in this report are primarily regulatory in character. They reflect the realization that erosion is a natural process that can be cyclical, continuous, discriminate, or a combination of these processes. Healthy beaches tend to have homeostatic rebuilding capability to restore their natural equilibria, even after particularly destructive storm events. The natural, cyclic migration typically observed in Hawaiian beach systems[11] is not generally a problem until the shoreline becomes developed and beach and shoreline recession threatens non-migratory structures and politically- platted property. Most natural long-term changes in beach structure are relatively small. "This natural equilibrium cannot be maintained, however, when man takes possession of the beaches. His concept of real estate requires that land be considered an unalterable entity. A patch of sand that can be washed away, together with the structures on it, is not a salable commodity."[12]

Structural solutions to shoreline erosion generally don't stop the erosion process, but rather delay or displace it to adjacent areas, interfere with nature's reconstructive cycle and impede the stabilizing flows of sand in and out of a beach area. Some shoreline structures which are designed to directly prevent shoreline fluctuation have been shown to cause beach loss or degradation.[13] It has also been observed that most shore

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11. Ralph Moberly and Theodore Chamberlain, Hawaiian Beach Systems, 1968 Hawaii Institute of Geophysics, University of Hawaii at Manoa.

12. Joseph M. Heikoff, Politics of Shore Erosion: Westhampton Beach. Ann Arbor: Ann Arbor Science Press, 1976.

13. David Chapman, "Coastal Erosion Control", in Coastal Zone 85, Magoon et al. editors, NYSCE, 1985.

stabilization structures are not designed to prevent beach loss, but rather to protect private property, usually at the expense of public beaches.[14] Often, measures designed specifically for beach stabilization and nourishment may provide the indirect benefit of preventing erosion of the fast shorelines. In the absence of sand nourishment, however, eroded property from the fast shoreline may supply the replenishment material necessary for beach preservation and maintenance of a littoral sand budget balance. Although the complexities of shoreline and beach erosion are not completely understood, past experience has clearly shown that poorly designed shore stabilization structures contribute to beach loss, and also create access problems for beach users.

Section 8-13.3 (h) of the Kauai County Comprehensive Zoning Ordinance (CZO) states that in order "to prevent beach loss, shoreline protective structures shall be used only where protection of the back-shore is of greater importance than beach preservation, or where less disruptive methods have failed." Given this mandate, structural solutions to beach and shoreline erosion should only be considered in special circumstances, such as to protect harbor entrances, unique coastal ecosystems, critical public infrastructure, or heavily urbanized regions, to prevent massive flooding, or to save lives. Property owners need to be made aware of the ephemeral nature of certain beach property, and the unacceptability of shoreline structures which would threaten the public beaches, and create problems for other property owners and public beach users.

Implicit in these recommendations is an acceptance of the standard that shorefront development should be located as far back from the shoreline as possible, and that pre-emptive solutions to erosion problems are generally more satisfying and effective than reactive solutions. They are designed to allow

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14. Ralph Hayashi, "Erosion Control Measures for Shoreline Property", in Coastal Zone 85, Magoon, et al. editors, American Society of Civil Engineers, New York, 1985.

for "development that is compatible with the Island's scenic beauty and environment and to preclude inadequate, harmful or disruptive conditions that may prove detrimental to the social and economic well-being of the residents of Kauai."[15] The management recommendations contained in this report acknowledge the need for preservation of Kauai's limited beach resources. These recommendations also recognize that various shorelines face varying degrees of risk from erosion, and that shoreline setbacks should reflect these different conditions. However, in certain cases, nonstructural remedies for coastal erosion may be neither feasible nor effective. Increasing setbacks will not reverse the loss of shoreland due to erosion, even if such action will lessen the likelihood of property damage, loss of life, loss of beach access, and loss of beaches. Certain valuable coastal areas, especially those areas that have been intensively developed, may need to be actively maintained and preserved. Therefore, in this section, an attempt is made to analyze not only the impacts of regulatory options, which are designed primarily to allow natural littoral processes to proceed unimpeded and protect beach integrity (but not necessarily backshore property), but also the impacts associated with commonly used structural stabilization measures, which are designed to inhibit natural littoral processes. While some structural measures are primarily concerned with the protection of the fast shoreline (often at the expense of beaches), others are designed specifically to enhance beach areas. Shoreline protection structures and methods which protect the beach as well as the fast shoreline are preferred.

The recommendations for the Poipu area were based on the findings presented in the 1989 Hawaii Shoreline Erosion Management Study. In the study, an examination of aerial photographs over a 30-year period indicated that the Sheraton Beach area (Figure II-1) had experienced continuously progressive erosion since the early 1970's. After determining the average rate of this past erosion,

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15. Kauai County Comprehensive Zoning Ordinance, 1987, Chapter 8 Introduction.

eliminate, the possibility of a property owner to develop. A property owner's tort liability would not change unless public use of the property was required. If private property owners were required to allow public access across their property without a reasonable relation to providing public access to the beach, the county would probably assume tort liability, and the action may be interpreted as an uncompensated "taking."

The Federal Constitution prohibits ex post facto legislation, so existing development would not be subject to the requirements outlined in Sec. 8-13.

Economic Impacts: The County Planning Commission would have to develop a Shoreline Special Treatment Zone Plan, which would require considerable staff time, or the use of a private planning consultant, with attendant costs. Continuing costs of administration of the plan would result from added planning staff position(s). Benefits would be added protection for the threatened shorefront, and greater flexibility for the Planning Director to respond to different erosion conditions with appropriate setback requirements. For private landowners, any proposed construction activity in the Shore District would be subject to special permitting requirements, including the preparation of an "Information Report," by a qualified expert. Such reports and permits may be prohibitively expensive to attain, and preclude certain development in the Shore District. More direct costs may accrue to the private landowners, if they are denied a shore protection structure because it is not "of greater importance than beach preservation." This cost could be considerable since beachfront land is worth from $40-100 per square foot in the Poipu area. Denial of full use of their property could also have considerable economic costs.

Social Impacts: Designation of the invaluable shoreline areas and beaches of Kauai as Shore Districts would ensure that proposed development of those areas would not negatively affect the public beaches, or public access to the beaches. Continued and a long-term erosion rate of 3 feet per year was projected. For the Poipu Beach Park area, the beach has shown a cyclic erosion/accretion trend from the early 1960's to the present. Therefore, maximum shoreline fluctuations were used to estimate the future long-term erosion trend of 40 feet for a 30-year period.

## II.1 POIPU

The Poipu study area has an areal extent of approximately 30 acres and has a shoreline of approximately 7,000 lineal ft. It is located within the Koloa District[16] on the southern shore of Kauai. The Koloa District had a 1980 resident population of 8,734, and Poipu had a resident population of 685.[17] The resident population in the Koloa district had climbed to 11,900 by 1989,(personal communication DBED Statistics Branch) and the estimated tourist population on any given day for this district is 8,000.

Located within an area that has a state land use designation of urban, and within a resort area as designated by the Kauai General Plan, the entire study area lies within a rapidly growing area of Kauai that has been referred to as "Kauai's Gold Coast." The area is experiencing continual development pressures, as major landowners abandon agricultural endeavors for more lucrative resort and residential building projects. These extensive development projects will add large numbers of both residents and tourists to a part of Kauai that is already approaching the limits of its natural resource base. Accessible beach areas suitable for recreation are one resource that is already in short supply on the south shore of Kauai. The two beaches in the study area are intensively used, and particularly

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16. The Koloa District consists of a major portion of the southern Kauai shore mauka to the mountains.

17. Poipu is the only coastal community within the case study site with population data.

popular. Survey conducted by the County of Kauai Parks and Recreation Department indicate that over 900 people utilize the Poipu Beach County Park every day.[18] The Sheraton Beach may be even more intensively used, perhaps having to service as many as 1,900 persons per day.[19] The intensity of use indicates that continued access to these beach areas by both residents and visitors is likely to be a strong priority.

This shoreline, though not exposed to large winter swell generated by North Pacific storms, has been periodically exposed to severe erosion events in the form of hurricanes and Kona storms. The most memorable in recent times was Hurricane Iwa, in November, 1982. This storm caused extensive damage to most oceanfront structures in the Poipu area, and caused storm-surge flooding to homes as far as 450 feet inland.[20] Islandwide damages were estimated to be in excess of $234 million dollars, much of which was due to storm wave destruction in the Poipu area.[21] No redevelopment plan existed for the area, and relocation of damaged buildings further inland was never considered. Instead, property owners were encouraged to redevelop the shoreline and given blanket approvals for most reconstruction activities. Many of the shoreline protection structures in the Poipu area were constructed during this time. Although shore protection structures are prevalent along the

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18. Personal Communication, Department of Public Works, County of Kauai.

19. This number was derived by using numbers of rooms in the Sheraton Kauai, Poipu Beach Hotel, Waiohai, and Kiahuna Resort, multiplying by 2 (double occupancy), compensating for an average occupancy rate of 70%, and assuming that 89% of the visitors will use the beach and ocean. Room numbers from: Visitor Plant Inventory, Hawaii Visitors Bureau Market Research Division, 1989. Occupancy rates and visitor activity survey numbers from Margy Parker, Poipu Beach Resort Association.

20. Hurricane Iwa, Hawaii, November 23, 1982, by Chiu, Arthur N.L.
et al., Committee on National Disasters, National Research Council, Washington D.C. 1983.

21. Ibid.

entire study reach, only one building permit for such structures is recorded in the County Building Division records. While these problems are understandable in the aftermath of Hurricane Iwa, policies need to be established for the treatment of non-conforming structures in this area.

Current total valuation of these beachfront properties exceeds $45 million. This valuation from the Kauai County Property Tax Office translates to an average value of $40 per square foot for the beachfront properties in Poipu. In all likelihood, market values are considerably higher, and may exceed $70 per square foot. Built improvements on these same properties are valued in excess of $50 million. Since the land is worth as much, if not more, than the built improvements, owners will try to maximize use of that property, and will resist any measures that do not allow for prevention of loss of property to erosion, or which require a renunciation of property development rights in favor of an erosion management plan.

In the context outlined above, the legal, social, and economic impacts which may result from each of the proposed management recommendations for the Poipu Beach study area was assessed. The core recommendations that were developed in the 1989 Hawaii Shoreline Erosion Management Study are highlighted. They have been modified and expanded in this study.

MANAGEMENT MEASURES

Recommendation #1. Designation of the entire Poipu study area from the Sheraton Poipu to Brennecke Beach as one large littoral cell, within which are contained a number of smaller subcells. A more definitive littoral cell study should be undertaken in conjunction with the development of a littoral cell management plan for the area. This study would include a thorough examination of the geophysical, oceanographic, and littoral processes at work in the area, and allow for more accurate prediction of future erosion trends. It would also examine the possible negative or positive impacts that existing shore stabilization structures have on the littoral processes and beaches in the area. The high value of improvements in this area combined with an apparently continual erosion problem for certain parts of this littoral cell necessitate this more expensive and reliable analysis, which could be used to support management recommendations against legal challenges. The littoral cell management plan would outline the options available to decisionmakers at the appropriate cell-wide scale. A cell-wide plan would ensure that if structural stabilization measures are deemed necessary, they will be designed to benefit the entire cell, not just a small portion of the shoreline at the expense of the adjacent beaches.

Legal Impacts: There will be no legal costs directly attributable to this recommendation. Littoral cell designation and formation of a management plan would invariably have legal impacts, but until such plans and designations are completed, those impacts are impossible to assess. A major legal benefit would be to provide a management unit on which to base shoreline land use decisions that is rationally based on geophysical processes.

Economic Impacts: The economic costs associated with a detailed littoral cell study and management plan would be limited to the parties responsible for the study and plan. Those costs would vary depending on the detail and scope of the study, private-public agency involvement, and degree of confidence required in the results. At a minimum, such a study would include beach profile surveys, bathymetric surveys, sand character and transport determinations, and nearshore littoral current and wave measurements. Costs could be borne by the public, through government expenditure of funds, or by private landowners in the district who desire permits for shore protection structures. Economic benefits would accrue to all parties who have an interest in beach protection, because protection measures based on littoral cell management would be more effective, efficient, and equitable than those based primarily on private property protection.

Social Impacts: Management decisions based on the overall protection of an entire littoral cell will necessarily be more equitable than those based on protection of private property. The social benefit to be gained by preservation of healthy beach systems through littoral cell management outweighs the costs which may accrue due to loss of private property rights.

Recommendation #2. **A Shore District should be established** which includes the Sheraton, Poipu Beach Park, and Brennecke beaches and their associated backshore properties to the mauka edge of the increased shoreline setbacks. The lateral boundaries for this particular Shore District reflect the possibility that these beaches are all contained within the same littoral cell. To serve as a useful management unit, the Shore District designation must include not only the appropriate littoral cell, but also the associated backshore properties.

Legal Impacts: At the County level, a Shoreline Special Treatment Zone Plan would have to be prepared and adopted by the Planning Commission, as outlined in Sec. 8-13.2, Kauai County CZO. Adoption of such a plan would place new requirements for development of any property within the Shore District. At the discretion of the Planning Director, the inland boundary of Shore Districts can be set considerably farther from the shoreline than the 40 feet specified in HRS 205A and in the Kauai County Shoreline Setback Rules and Regulations (impacts of increased shoreline setbacks are discussed below). The Shore District zoning was originally designed to serve as an overlay zone, "to protect and maintain physical, biological, and scenic resources of particular value to the public." Current underlying zoning designations would not change, nor would any legal principles relating to regulation or "taking" be violated. The courts have consistently held that regulations may restrict, but not eliminate, the possibility of a property owner to develop. A property owner's tort liability would not change unless public use of the property was required. If private property owners were required to allow public access across their property without a reasonable relation to providing public access to the beach, the county would probably assume tort liability, and the action may be interpreted as an uncompensated "taking."

The Federal Constitution prohibits ex post facto legislation, so existing development would not be subject to the requirements outlined in Sec. 8-13.

Economic Impacts: The County Planning Commission would have to develop a Shoreline Special Treatment Zone Plan, which would require considerable staff time, or the use of a private planning consultant, with attendant costs. Continuing costs of administration of the plan would result from added planning staff position(s). Benefits would be added protection for the threatened shorefront, and greater flexibility for the Planning Director to respond to different erosion conditions with appropriate setback requirements. For private landowners, any proposed construction activity in the Shore District would be subject to special permitting requirements, including the preparation of an "Information Report," by a qualified expert. Such reports and permits may be prohibitively expensive to attain, and preclude certain development in the Shore District. More direct costs may accrue to the private landowners, if they are denied a shore protection structure because it is not "of greater importance than beach preservation." This cost could be considerable since beachfront land is worth from $40-100 per square foot in the Poipu area. Denial of full use of their property could also have considerable economic costs.

Social Impacts: Designation of the invaluable shoreline areas and beaches of Kauai as Shore Districts would ensure that proposed development of those areas would not negatively affect the public beaches, or public access to the beaches. Continued access to and maintenance of healthy beaches would become the priority over protection of private property. Recreational opportunities are essential to the maintenance of the health and welfare of the resident population, as well as the continued survival of the tourist industry. Results from surveys conducted by the Poipu Beach Resort Association indicate that nearly 90% of all tourists intended to use the beaches and ocean for recreation. Policies or management alternatives which result in restricted access to beaches, or degradation of public beaches, will continue the accelerating disenfranchisement of Hawaii residents from their land. This will exacerbate attendant social problems, which will have a negative impact on both the local community and the tourist industry as well. Adoption of Shore District zoning will provide a flexible method to protect against further disenfranchisement.

Recommendation #3: **A 180-foot shoreline setback should be established for the Sheraton Beach area (3 feet/year average erosion rate x 30 years x 2).**

Legal Impacts: Courts have consistently upheld the government's right to regulate. Both the State of Hawaii and Kauai County have clearly enunciated their interests in protecting the beaches and shorelines, and the public's access to beaches. Moreover, expanded setbacks merely restrict, but do not eliminate the ability of a property owner to develop shorefront property. As long as a property owner is not denied all use of all his property, and the setback is not "beyond the reasonable expectation of the parties," setback regulations will not constitute a "taking."

Any proposed expansions of the shoreline setback areas need to include provisions for variances. New rules and regulations are needed outlining the conditions under which variances may be granted to allow shore protection structures and other structures within the shoreline setback. These new rules should reflect the standard that all development should be located as far back from the shoreline as possible. They should also include a revised definition of hardship to clarify that a structure must be necessary for safety or protection from erosion or wave damage to public shoreline access and public beach areas, rather than individual property. Incorporation of the BLNR's position which specifically excludes economic arguments as a basis for hardship determination is recommended.

Such a substantial enlargement of the setback area for the Sheraton Beach sub-cell would create a large number of nonconforming structures. The Federal Constitution forbids ex post facto legislation, and non-conforming structures, or structures permitted under current law, must be allowed to remain, or will be considered a taking. The Hawaii courts have yet to address whether it would be a taking if a regulation prohibits a landowner from reconstructing a structure that was destroyed by a natural cause (i.e. hurricane). Such a regulation would probably be legally defensible if the property owner was not denied all use of all of the property. If used in conjunction with retirement schedules for non-conforming structures, such regulations may prove to be an effective method to eventually eliminate encroachments into the setback areas.

Finally, any increase in setbacks which mandated access rights not directly related to beach access would probably be considered an uncompensated taking. (See Appendix A.)

Economic Impacts: All of the backshore properties in the Sheraton Beach sub-cell are zoned R-20 or RR-20, and have been intensively developed with tourist-oriented dwelling and recreation facilities. Buildings and other structures that are integral parts of the Sheraton Kauai, the Kiahuna Resort, and the Poipu Beach Hotel would become non-conforming structures if such an expanded setback area were adopted. More than 200 dwelling units would be affected, as well as restaurants, shops, and swimming pools. If the land were not already developed, the setback would restrict development on the majority of the

Sheraton beachfront property, and more than half of the Poipu Beach Hotel property. A smaller percentage of the Kiahuna property would be affected, because of its large size. Altogether, adoption of a 180-foot setback would restrict development on more than 8 acres of prime oceanfront real estate, which is currently valued in excess of $20,000,000. Since this area is already developed, the mere creation of an extended setback would not have much economic impact, unless it were accompanied by a mandated retirement of the non-conforming structures. If the non-conforming structures could neither be replaced, nor upgraded, economic costs to the resort owners would be substantial. The loss of room rents alone would exceed $6,000,000 per year (based on the 1990 room rate). Foregone tax revenues and loss of jobs would increase this cost. Another possible cost might be a loss of hotel guests who want to stay in a room close to the shoreline. It is relatively obvious that substantial economic costs would be involved if a new 180-foot setback were adopted, and accompanied by retirement schedules and restrictions on replacement of non-conforming structures.

Less obvious and harder to quantify would be the economic benefits to be gained by adoption of this substantial setback. Most of the major benefits would be related to the maintenance of healthy beach systems, and would only be realized if shoreline setbacks were one component of an overall beach preservation program. Beaches are one of nature's most effective shoreline protection devices, and serve as buffers to protect the fast shoreline and shoreline developments from damage.[22] Shoreline setbacks that restrict development in the dynamic shoreline area will help maintain these protective beaches, by lessening the demand for shoreline protection structures which often exacerbate beach loss. Not only do setbacks help maintain protective beaches, they serve to locate structures away from hazardous areas. Millions of dollars of damage caused by waves from Hurricane Iwa could have been avoided had structures been located farther from the shoreline. Temporary dislocation costs, community disruption costs, and increased insurance costs associated with such cataclysmic events could also be lessened.

The other major economic benefit of extended shoreline setbacks would be increased beach-related recreational opportunities for both visitor and resident alike. While no exact figures exist to calculate the direct economic benefit of beaches to Hawaii, the ocean recreation industry generates in excess of $400 million per year. No attempt was made to separate the beaches component of this figure, but many ocean recreation activities are dependent on healthy, attractive, accessible beaches. In addition, the vast majority of visitors to Poipu intend to utilize the beaches and ocean for recreational purposes.[23] Increased shoreline setbacks could contribute to an overall improvement of the attractiveness of Kauai as an exclusive destination, with the creation of garden areas between the hotel rooms and the shoreline. All of the above benefits are predicated on the assumption that shoreline setbacks reduce demand for shore protection structures, thereby allowing natural erosion and accretion cycles of the shoreline to proceed, and for beach equilibrium to be maintained.

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22. "Shoreline Response to Hurricane Gilbert: Lessons for Coastal Management," by E.R. Theiler et.al., in Coastal Zone 89, Magoon et. al. eds., ASCE New York, 1989.

23. Poipu Beach Resort Association Survey.

Social Impacts: Social costs would be primarily associated with the loss of private property rights that would accompany such extensive setbacks. Property owners are likely to feel persecuted by the government regulatory bodies and increase resentment towards government. Certain de facto access privileges may be replaced by de juris restrictions on access. Social benefits would include improved coastal view planes, improved beach recreation opportunities, and preservation of natural ecosystems.

Recommendation #4: **The Poipu Beach Park area should have an established 80-foot shoreline setback and the Open District zoning should be maintained. This setback (2 x maximum erosion/accretion cycle over 30 years) is determined by the need for open space in the area,** the relative stability of the Poipu Beach Park beach, and the need for government to take the lead in demonstrating the effectiveness of non-structural erosion control measures.

Legal Impacts: Legal impacts would be similar to the impacts outlined for the Sheraton Beach. Since much of the land in the Poipu Beach sub-cell is already owned by the County, the taking issue would be a less crucial consideration. A more important legal benefit may be the demonstration value of adopting shoreline management techniques as a means of erosion control. Government entities have traditionally favored structural solutions to deal with shoreline erosion. Although the courts have generally refused to hold government entities liable for property damages due to shoreline construction activities that aid navigation or protect public resources, the cost of potential damages and possible mitigation of those damages should be an integral part of project evaluation.[24] If government agencies were willing to demonstrate the effectiveness of non-structural erosion control measures, and use structural solutions only as a

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24. D. Chapman and R. Hildreth, "Coastal Erosion Management in Australia and the U. S., in Coastal Zone 85, Magoon, et al., editors, ASCE, New York, 1985.

last resort, other property owners may be more willing to adopt such strategies. It is essential that management strategies be coordinated for an entire littoral cell, or the presence of ill-conceived erosion control structures may disrupt the natural littoral processes so as to render any non-structural management measures ineffective.

Economic Impacts: Economic impacts will be similar to those outlined for the Sheraton Beach sub-cell, but costs will be less severe, and benefits will be more easily realized. The Waiohai property is the only property in this sub-cell which is zoned Resort, and which has been intensively developed with tourist facilities. An 80-foot setback would affect a relatively small portion of the overall property and improvements. A few dwelling units would encroach into the setback area, including a restaurant and wading pool. Relocation of these improvements would be relatively inexpensive.

The remainder of the private properties in the Poipu Beach sub-cell are zoned Open, and only two of these properties have been improved with single-family dwellings. All of these houses would encroach into an extended setback area, but relocation of these houses to conform to a new setback would be possible given the size of the parcels. Proposed new construction should be able to meet the 80-foot requirement without undue hardship.

Improvements to Poipu Beach Park are restricted to showers, comfort stations, a pavilion, a gazebo, a playground, and lifeguard stands. Only the showers and the lifeguard stand would encroach upon an extended setback area. Relocation of the showers further inland would be inexpensive, and the lifeguard stand is relatively portable. No major improvements are planned for Poipu Beach County Park, so no opportunity costs would be associated with adoption of this setback.

Economic benefit to be gained by adoption of an increased setback would relate primarily to the gains outlined above which would accrue to all parties who have an interest in maintaining healthy beaches. A secondary benefit would be the amelioration of damage costs that occur as a result of violent storm events. Structures located farther landward of the shoreline will not be so exposed to storm wave damage.

Social Impacts: Social impacts would be directly related to gain or loss of open space and recreational opportunities. Preservation of open space and beach recreational opportunities in the Poipu area is particularly critical because of the limited land available for public use. Ocean-related recreational opportunities are a traditional part of the cultural heritage in Hawaii, and loss or denial of such opportunities will create social dislocation and antipathy.

STRUCTURAL MEASURES

Recommendation #1: **Offshore structures are recommended for the Sheraton Beach.** Offshore artificial reefs, or breakwaters, may be appropriate, but only as possible cell-wide improvements. Further study is needed to ensure that such structures would stabilize the target beaches and not adversely affect neighboring beaches or shorelines.

Legal Impacts: Permission to construct in the littoral zone must be obtained from Federal and State agencies. The U.S. Army Corps of Engineers (USCOE) is responsible for the planning, construction, operation, and maintenance of civil works projects for flood control, navigation, and shore protection. Many of their activities, such as the construction of seawalls, breakwaters, jetties, and harbor improvements are directly related to erosion control. Federal law provides for the protection of the shoreline against erosion. Although the USCOE may undertake investigations of erosion problems under specific authorization from Congress and can provide assistance for protection of public shores, they have no authority to construct erosion control projects aimed solely to protect private property. However, the USCOE is involved in the regulation of shoreline activities. Until 1968, the primary thrust of the USCOE's regulatory activities was the protection of navigation, but since then, the program has evolved to one involving the consideration of the full public interest.[25] The USCOE coastal jurisdiction extends from the mean high water mark seaward to the 3-mile limit.

At least four State agencies would be directly involved in the regulation of offshore construction activities. The Department of Transportation has jurisdiction over any navigable waters in the State. The Department of Land and Natural Resources has control over developments in the Conservation Districts, which include the areas from the certified shoreline to the 3-mile limit. The Department of Health would have to certify that any proposed project would not contribute to significant water quality deterioration. The Coastal Zone Management Program in the Office of State Planning would have to certify that any development was in conformity to the policies and objectives of the Hawaii CZMA.

Ownership, maintenance, and tort liability would need to be determined by participating agencies, and probably redetermined in court. Any potential development in the coastal zone is subject to civil action that may be initiated under provisions of Sec. 205A, HRS, if such development is contrary to the policies or objectives of the CZMA. Although the courts have traditionally upheld the rights of government agencies to build shore protection structures to protect navigation and public property, such rights may not extend to structures which are designed to solely protect private property. If such structures created new erosion problems at nearby beaches and properties, the government may be liable for damages.

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25. Federal Register, 11/13/86, p. 41220. (See Appendix A)

Economic Impacts: The percentage of wave attenuation required to provide the necessary degree of shore protection is primarily a function of the crest height of the breakwater. Since the cost of a breakwater increases rapidly with the height of the crest, low-crested structures below mean sea level would be considerably cheaper than traditional emergent breakwaters that are infrequently overtopped by breaking waves.[26] Rough estimates indicate that costs for construction of an 850-foot segmented breakwater offshore of Sheraton Beach would exceed $1.7 million. These costs may be considerably lessened if the breakwater was constructed as an artificial undersea reef, as opposed to a traditional emergent breakwater. However, the wave attenuation capabilities of an underwater structure would be less than that of an emergent structure.

In addition to construction costs, the costs of planning and design, permit procedures, and the environmental impact statement that would be required for such a project. Long-term maintenance and liability costs also have to be considered. If these costs were distributed among shoreline property owners and beach users, the costs for any one party would probably not be prohibitive. Moreover, the system-wide benefits accruing to these owners would help to make collective approaches to financing more feasible. Opportunity costs associated with loss of nearby beaches as a result of negative impacts from the offshore structure need to be considered.

Economic benefits may include all those benefits associated with healthy, attractive beaches, if the offshore structures mitigate erosion. Shorefront property could be more fully utilized, and the need for increased setbacks may be obviated. Recurring sand replenishment costs may be eliminated, as would the need for other stabilization structures.

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26. E. Fulford, "Reef Type Breakwaters for Shoreline Stabilization," in Coastal Zone 85, Magoon et al. editors, ASCE, New York, 1985.

Social Impacts: Social costs may be those which would accrue as a result of losses of use of the Poipu Beach Park as a result of negative impacts caused by the offshore structures. An artificial reef may pose an unseen navigation hazard. An emergent breakwater would be aesthetically unpleasant, and negatively affect the viewplane from the shoreline seaward.

Social benefits include increased public recreational opportunities associated with healthy beaches. A carefully designed underwater reef may provide habitat for sea life, and new recreational opportunities for divers and even surfers. A major benefit may be avoidance of more disruptive shore protection measures.

Recommendation #2: Sand replenishment is recommended as a short-term measure if necessary and if sand is available.

Legal Impacts: No particular legal impacts are associated with this measure, unless sand is taken from within the shoreline area. Commercial sand mining within the shoreline setback area is prohibited in the County of Kauai, unless authorized by variance.

Economic Impacts: Economic costs of sand replenishment can be considerable, and there is currently a sand shortage on Kauai. A particular problem associated with beach sand replenishment is the necessity to find sand which is compatible both physically and aesthetically with existing beach sand. A one-time beach nourishment cost for the Sheraton Beach would approximate $1.3 million, and would require 15,000 cubic yards of sand. This nourishment may last up to ten years if the erosion trends do not accelerate.

Economic benefits are restoration of a healthy beach, increased protection for shoreline properties and improvements. Over the long term, it may be sufficient to balance the littoral sand budget that appears to be in a deficit condition at present. Beach nourishment does not disrupt the natural littoral cycles, and can provide for expanded recreational opportunities.

Recommendation #3: **If immediate direct shore protection is necessary, it should be limited to buried revetments** located landward of the certified shoreline of the subject property, and in no case should be allowed to encroach onto the public beach area.

Legal Impacts: Revetments located within the shoreline setback area currently require building permits, shoreline setback variances, and Special Management Area Use Permits (if valued under $65,000) from the County of Kauai. Shoreline setback variances may only be granted if conditions are imposed which guarantee lateral access, and minimize adverse impacts on beach processes. If the revetment encroaches onto state beach land, Conservation District Use approval must be granted by the BLNR. Recent changes in Section 205A-44, HRS, state that variances may be granted for structures which artificially fix the shoreline if erosion is likely to cause hardship. No variances shall be granted unless conditions are imposed to guarantee lateral access to the beach, and to minimize adverse impacts on beach processes. Recent changes to BLNR policy indicate that shoreline structures will be permitted on public beaches only if necessary to preserve public shoreline access and public beach areas.

Both public agencies and private parties may commence civil action against any agency that does not comply with the objectives, policies, and guidelines set out in HRS 205A. Owners of shoreline protection structures may be liable for erosion damage to adjacent properties, if such damage is related to the structure. Post-performance bonds should be considered as a method to guard against such damages, if private erosion control structures continue to be built.

Economic Impacts. A 1,350-foot buried revetment would be necessary to protect the entire length of the Sheraton Beach. Estimated costs of a boulder revetment of this size exceed $500,000 for the revetment alone. Sand nourishment would be an essential ingredient of this solution, if beach protection was the desired outcome. The revetment alone would only protect the backshore property, and may interfere with sand transport and accretion. Including beach sand nourishment to the cost would add another $1.3 million to the total direct economic costs of this solution. Indirect costs would depend on the design of the revetment, and would be related to the value of beach recreation opportunities. A poorly designed revetment would limit beach access and reduce usable beach area.

Economic benefits of such a solution would accrue primarily to the property owners whose properties are protected from erosion by the revetment. The Sheraton Kauai, the Kiahuna Resort, and the Poipu Beach Hotel have intensively developed the immediate backshore area. Protection of the fast shoreline may protect these developments from future erosion hazards, but will not enable more intensive development of those properties. In fact, a revetment which may cause restricted beach access and exacerbate beach loss would cause a loss of tourist business.

Social Impacts. Most revetments restrict beach access and do nothing to protect the beach, so social impacts of revetments are primarily negative. A revetment that was buried, and constructed in conjunction with beach nourishment, would not impede access and would provide for greater beach recreational opportunities.

II.2 HANALEI BAY

Recommendation #1. **The entire study area should be designated a Shore District as specified in the Kauai CZO (8.13.1), as one specific component of a Shoreline Special Treatment Zone Plan.**

Legal Impacts. The Shore District zoning classification was established to "regulate development or alterations to shore and water areas...of particular value to the public."[27] This entire study area has been identified as a "special value recreation area."[28] Adoption of Shore District overlay zoning for the entire Hanalei littoral cell would allow the Planning Department more discretion to establish shoreline setbacks farther inland than the 40 feet setbacks outlined in the Kauai County Shoreline Setback Rules and Regulations. The County Council adoption is needed to delineate Shore District boundaries. The legal issues concerning the right to regulate land use, and the question of uncompensated "taking" were discussed above in the Poipu section.

Economic Impacts. Administrative costs would may be substantial, as a Shoreline Special Treatment Zone Plan would need to be prepared, and new regulations would have to be enforced. Costs to private property owners would only materialize if the owner wanted to locate a development in the shoreline setback area. The costs of the necessary permits may serve as a deterrent to development in this shoreline area. The primary economic benefit would be added protection for the limited shoreline areas in an area of Kauai that is famous for its magnificent beaches.

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27. Kauai County CZO 1987.

28. North Shore Development Plan Update, December 1980.

Social Impacts. Adoption of Shore District zoning would ensure that beach protection is given priority over protection of private property. Preservation of beaches and access to beaches provides for the improved welfare of both residents and visitors alike.

Recommendation #2. **A 75-foot shoreline setback should be established.**

Legal Impacts. The right to regulate land use has been previously discussed. As long as a property owner is not denied all use of his entire property, even extensive setback restrictions will probably be upheld in court. Throughout the study area, the average private lot depth, as measured from the shoreline to the mauka boundary of the parcels, exceeds 300 feet. A 75-foot shoreline setback would cause no extreme hardship to an owner of these parcels.

Another consideration is the creation of non-conforming structures as a result of new setbacks. Throughout the Hanalei study area, homes are located well landward of the shoreline, and very few would encroach onto the extended setback areas. Retirement schedules could be adopted for relocation of those non-conforming structures.

A uniform extended setback for the entire Hanalei littoral cell is more easily administered and more legally defensible than setbacks which are based upon questionably defined subcell erosion rates.

Economic Impacts. Economic impacts of an extended setback would be relatively minor. The entire study area is zoned Open or Conservation, except the landward area of Sections 6 and 7, which are zoned Resort. Potential development of Sections 6 and 7 may be impeded by an extended setback, but costs of restricting development in an extended shoreline area would be offset by the increased natural attractiveness. Throughout the study area, the average private lot depth, as measured from the shoreline to the mauka boundary of the parcels, exceeds 300 feet. The shortest private lot in the study area has an average depth of over 175 feet. One section of the Waioli County Park has a depth of 178 feet. Therefore, a 75-foot shoreline setback would cause no extreme hardship to any owner of these parcels, even if hardship were defined by economic criteria.

An extension of the shoreline setback is needed to provide an adequate buffer zone that can be used to accommodate the natural cyclical erosion that is evident in Hanalei. For such a dynamic, pristine, and culturally sensitive beach area such as Hanalei Bay, the economic benefit of providing the margin of safety necessary to preserve this natural resource is difficult to quantify. The economic costs that may be associated with a loss of the beaches in Hanalei is equally difficult to estimate. Extended setbacks also mitigate damage due to violent storm events, and preclude the need for expensive shore protection structures.

Social Impact. The Hanalei area exemplifies the ideal that many people have about Hawaii. It is a popular destination for tourists and residents who seek to experience a Hawaii that has in many places disappeared. It is difficult to assess the social value of such a place, and the importance of maintaining it. Many of the present-day shoreline property owners have shown a certain wisdom by locating their houses far inland from the shoreline. Through their actions, they have recognized the dynamic nature of the beaches in Hanalei Bay and the periodic erosion after exposure to large winter waves. Adoption of extended setbacks will ensure that new property owners will abide by these locational customs, and preclude the need for any shore protection structures which would protect poorly-placed improvements at the expense of public beaches and access.

Recommendation #3. **Open zoning of all beachfront parcels on the bay should be maintained as an appropriate method of minimizing development.**

Impacts. The majority of lands in the study area are already zoned open, so legal impacts would be negligible. Open zoning is one of the most restrictive zoning classifications outlined in the Kauai CZO. Continuation of Open zoning will maintain the low-density nature of development in this area. Although an unfortunate side effect of Open zoning of beachfront properties is to create very exclusive, extremely expensive properties, these properties would be even more expensive if commercial development were allowed. Future public acquisitions would be even more unlikely than at present. The benefit of low-density development in a flood-prone, tsunami zone such as Hanalei is self-evident. Adequate public beach access currently exists in the Hanalei area, but public park facilities are often inadequate for the huge numbers of tourists and residents that utilize them. Open-zoning ensures that the entire beach area is maintained in a relatively pristine state, and beach users can spread out along the entire length of Hanalei Bay. Future park land acquisitions may be facilitated by maintaining this zoning.

Recommendation #4. **Shore protection structures should be prohibited, except to ensure public access, protect public infrastructure, or to improve public beaches and recreation opportunities.**

Impacts. Recent changes to the Coastal Zone Management Act, Chapter 205A, HRS, indicate that the permitting agencies responsible for coastal zone management are under no obligation to permit shoreline stabilization structures. The law also mandates stringent conditions to be attached to any shoreline setback variance. These conditions are designed to guarantee shoreline access and beach integrity. It is inherently more efficient to practice prevention than remediation. If property owners are made aware of the prohibitions against shore protection structures, they will locate their improvements far away from the potential erosion risk. Property owners who proceed to build in the erosion-prone areas will do so at their own risk.

Given the long-term stability of the Hanalei littoral cell, and the large size of the majority of lots in this area, prohibiting shore protection structures should have no major economic impacts, other than to encourage property owners to locate their improvements farther inland. If the erosion climate changes, and becomes so progressive that major portions of fast shoreland were being permanently lost, economic implications would be considerable. Current market valuation of the shorefront real property in Hanalei town alone exceeds $100 million. Loss of this property to erosion would cause private losses as well as losses to the County Property Tax Department.

However, the short-term loss of even high-value property should not be sufficient justification to permit shoreline stabilization structures which may cause even greater losses to the public beaches. Adoption of a prohibition on shoreline stabilization structures would guarantee continued beach access and preservation of high quality beaches Hanalei.

<u>Recommendation #5</u>. **If the erosion climate in Hanalei Bay changes drastically, and becomes accelerated and progressive, then under the context of existing rules and regulations, buried revetments should be the only shoreline protection structure permitted if shore protection is determined to be necessary for individual parcels.**

<u>Impacts</u>. The impacts of revetments were discussed thoroughly in the Poipu section. There are a few major differences. In Hanalei, erosion is not progressive and continuous over the long term, but rather seasonal and cyclical. Also, no major improvements are located so near the shoreline that they are in immediate danger from erosion damage. Finally, there is no hard

substrate in the Hanalei area which could serve as a foundation for shoreline stabilization structures, so their effectiveness at even protecting the shoreline would be questionable. However, if continual, progressive erosion can be definitively demonstrated over a long (30 year) time period, they may be the least objectionable protection alternative. If revetments are allowed, they should have to be located well landward of the certified shoreline, and buried to minimize their visual impacts on this scenic area.

# Chapter III

## CHAPTER III. BEACH MANAGEMENT PLANS POIPU BEACH COUNTY PARK

The Poipu County Park study area is 5.44 acres in areal extent, and has a shoreline of approximately 600 ft. It is located within the Koloa District[29] on the southern shore of Kauai. The Koloa District had a 1980 resident population of 8,734, and Poipu had a resident population of 685.[30] The population in the Koloa district had climbed to 11,900 by 1989, and the estimated tourist population on any given day for this district is 8,000.

Located within an area that has a state land use designation of urban, and within a resort area as designated by the Kauai General Plan, the park and its immediate surroundings have all been designated Open in the Kauai Comprehensive Zoning Ordinance. This Open District zoning within an area designated Resort in the General Plan reflects the public use nature of the park area, and "a judgment that such lands are not now needed for the uses indicated in the general plan." This Open zoning may also facilitate future park acquisitions by limiting adjacent development.

Much of the neighboring shoreline in the area is rocky and irregular, but the Beach Park has an extensive beach area composed primarily of calcareous sands of biological origin. The offshore bottom contour has a slope of about 1V:20H, flattening to a nearshore slope of 1V:50H. The ocean bottom is predominantly rocky/reef substrate, with sand pockets and channels.

The coastline is relatively sheltered from predominant northeast tradewind-generated waves and the North Pacific swells. However the park is exposed to south swells during the summer months and

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29. The Koloa District consists of a major portion of the southern Kauai shore mauka to the mountains.

30. Poipu is the only coastal community within the case study site with population data.

to less frequent hurricane generated and Kona storm waves that approach from a southerly direction. Incoming wave energy from the south undergoes little refraction effects, since the bathymetry contours are nearly parallel with the approaching wave fronts. Typical deep wave heights are 1-4 feet, with surf heights of 6-8 feet not uncommon because of the long wave period.

The park is fronted by a shallow rocky reef outcrop named Nukumoi Point. This point is a natural tombolo, wherein the beach has accreted to the point where it is connected with the offshore rocky outcrop, which functions as a natural breakwater. There is also a rocky headland on the eastern seaward edge of the park that may define the boundary of the park littoral cell. A man-made breakwater was built as an attempt to further stabilize the beach fronting Poipu Beach Park by augmenting the the rocky headland, but recent modifications to this breakwater may have created new erosion trends. A seawall of approximately 200 feet in length solidifies the shoreline immediately in front of the main pavilion. Very little beach remains seaward of this structure, but other areas of the park have more extensive beaches.

The park is in a moderately improved condition, with a over 20-year old pavilion and gazebo set on the landward side of the beach and other minor improvements, such as comfort stations, showers, lifeguard stands, and picnic tables. This park is the only beach park that is improved and owned by the County of Kauai in this entire south shore resort area. It is used extensively by both the resident and tourist populations, not only because it offers the amenities of a pavilion, picnic tables, public showers and restrooms, but also because it has a protected swimming area with relatively calm and shallow waters, an aesthetically pleasing beach, and lifeguard services.

The 1989 Hawaii Shoreline Erosion Management Study has estimated that the rate of shoreline erosion at the Poipu Beach Park may approach 40' landward loss over a 30 year period in the worst case (i.e. an uninterrupted erosion cycle). Over that same time period, resident population in the Koloa district is projected to increase to more than 20,000, with more than 10,000 visitors on any given day. Counts taken in 1989 by the County of Kauai Department of Parks and Recreation indicate that Poipu Beach Park averages over 1,900 users a day, and over 300,000 users per year. These estimates indicate that measures need to be taken to ensure that existing beach parks are maintained, expanded when feasible, and that new beach parks should be established without undue delay. At the same time, it is incumbent upon the county and state to take the lead in demonstrating that beaches can be preserved in their natural conditions, and that development of beachfront property must be carefully managed to avoid the necessity of artificial beach stabilization structures.

Any good management plan must be based on relevant and current information, to be complemented by timely and peremptory enforcement. The priority management task for the Poipu Beach park would be the establishment of a beach erosion data base which includes beach topographic profiles, transects, and aerial photographs with which to determine actual long-term and seasonal erosion rates for the area. A more thorough and precise definition of the littoral cells operating in the area should also be attempted. These data should be collected on a seasonal basis in order to ensure that seasonal variations are not misconstrued, and on a 3 to 5 year cycle so that long-term trends can be ascertained, and management and regulatory actions can be designed which are consistent and effective. Given the limited resources of county government, these continuous various data collections should be funded through the state and federal(CZM) programs that provide monies for such management purposes. Local manpower and public works engineering crews could be responsible for ground topographical surveys, while the Office of State Planning (OSP) should coordinate the gathering and dissemination of aerial data, and in a joint program that would involve the University of Hawaii, provide both analytical skills and training programs to ensure continuous local presence and expertise.

While this data base for the Poipu County Park and other areas is being established, a number of interim management options exist.

1) Do nothing. As long as beach and shoreline erosion do not threaten expensive shoreline improvements, public recreational opportunities or beach access, no action may be necessary. This would allow the natural littoral processes to continue to shape the shoreline. The do nothing alternative must be one part of an overall management strategy, and it will only work if the erosion in this area does not continue to progress. Shore protection structures currently in place on this shoreline may have already irreversibly affected littoral processes, and created a sand deficit for the entire cell. If a sand deficit does exist, it may be artificially supplemented by beach nourishment.

2) Regulate development in the threatened area to prevent or minimize property losses. This option would involve planning for shoreline uses that would be compatible with the recognized erosion risk. The current open-space nature of the Poipu Beach Park allows for this option to be considered. Setbacks from the shoreline for any damageable structure shall be increased to reflect predicted erosion trends and viable life of any proposed facility. Within the setback area, only expendable or easily relocated structures would be permitted. This alternative does not prevent erosion, nor necessarily improve recreational opportunities. It does recognize the importance of allowing the natural littoral processes to proceed unimpeded, and that certain existing facilities may be lost unless relocated inland. This option may seem to be a capitulation, and that valuable beach property will be irretrievably lost if this policy is adopted. However, the advantages to such a policy include low cost, flexibility, political acceptability, environmental sensibility, and maintenance of open space in the park. It is essential to the credibility of management

alternatives that county and state governments set the example of preserving coastlines in as natural a state as feasible. If this option is pursued, elimination of illegal shore protection structures on neighboring properties may have to be an integral part of this management policy. Shore protection structures located both in the park and on adjacent properties may exacerbate, or even be the principle cause of continued beach erosion.

3) Enhance natural shoreline defenses. This option would include beach nourishment as well as vegetative plantings at the interface between the beach and park backshore. Beach nourishment can be effective depending on the source of beach sand and the required frequency of nourishment. A major problem on Kauai is an island-wide shortage of sand, making this option both technically difficult and expensive. In-place cost for sand may approach $100/cubic yard. If an acceptable grade of sand can be found in economically exploitable offshore deposits, this would be an attractive option. However, no sand should be removed from one active littoral cell to be placed in another, because this would merely be shifting the sand deficit from one area to another. Redistribution of sand within a littoral cell may be possible, for example, where sand that is moved offshore from the beach by natural processes is mechanically recycled and placed back on the beach. Salt-tolerant vegetative plantings can be an effective method of stabilizing dune and backshore areas. The roots and stems bind the sand and soil to form an erosion resistant layer. The naupaka hedges lining the backshore of the Sheraton Beach is an example of this method. Vegetation does not protect against storm wave erosion, and severe erosion events would necessitate periodic replantings. Labor costs to clean up the eroded vegetation from the beach and to establish new plantings may be considerable. Artificial seaweed placed in nearshore waters has been used in some cases to stabilize beach areas subject to erosion. The artificial seaweed fronds are

intended to reduce wave energy and trap sand, but reports of the effectiveness of this technique have been conflicting. The feasibility of using artificial seaweed for the Poipu area is questionable given the occasional high energy waves that attack the shoreline and the nearshore bathymetry characteristics.

4) Construct hazard modification devices, structures which diminish or nullify the natural processes. Structural options for the park may include revetments or offshore structures such as breakwaters or artificial reefs. Structural options are quite costly, and their effectiveness in preserving the beach area is questionable. Costs and potential impacts of proposed structures need to be carefully considered. An offshore segmented breakwater may cost in excess of $2,000/lineal foot. A buried revetment would be somewhat cheaper, possibly in the range of $400-$500/lineal foot. Buried, sloping boulder revetments can serve as the "last line of defense" in preventing erosion of fastlands during beach erosion cycles or episodic storm events. During periods of beach accretion, the revetment would be buried beneath the beach. However, a buried revetment will not help to preserve or maintain the fronting beach. Offshore structures, on the other hand, will help to protect and stabilize the beach. Offshore structures are more technically challenging to design and are substantially more expensive than shoreline revetments. Offshore structures can be either submerged or emergent, and they function as shore protection structures by dissipating the incoming wave energy responsible for erosion. Offshore structures may interfere with recreational opportunities in nearshore waters (such as existing surf sites), or they may enhance recreational opportunities (such as fishing, diving, or creation of new surf sites). The existing shore-connected "breakwater" at the east end of the beach is questionable in its efficiency at stabilizing this portion of the beach. Some observers in the Poipu area have claimed that improvements to the

breakwater resulted in exacerbated erosion in the park. Comparison of pre- and post-construction topographic surveys would confirm the shoreline changes subsequent to work on the breakwater. This structure does provide a very sheltered beach area for children to play in the water.

**Recommended Option.** At Poipu Beach Park, the rate of erosion is considered to be relatively slow, as determined by the prediction technique adopted in the 1989 Hawaii Shoreline Management Study. The beach fronting the Park and to the west (although presently in an eroded state), has been relatively stable in the long term. One factor contributing to this is the stabilizing influence of the protective offshore rock outcrop west of the park. Known as Nukumoi Point, this rock outcrop is a natural offshore breakwater which has formed a "tombolo", or a sand spit that connects the rock outcrop to the shoreline. This natural tombolo not only helps to stabilize the park shoreline, but also provides a substantially increased beach area per lineal foot of shoreline. The shore-connected "breakwater" structure built at the east end of the park may also serve to stabilize the beach. Since few building structures exist in the park at present, and since no new structures are currently planned, then the regulation option would be preferable from both the economic and environmental perspectives. Existing erosion control structures within the park should be evaluated and may warrant improvement or modification. The seawall in the center of the park should be modified to present a less reflective face to the incoming waves, or preferably removed and rebuilt as a revetment landward of the beach. The shore-connected breakwater should be evaluated to determine whether it is functioning effectively of whether it should be modified.

Minor improvements to the existing erosion control structures may mitigate any potential for exacerbated erosion, however, the general erosional processes that may be occurring will continue to result in potential recession of the park shoreline and loss of valuable park lands. Given the current market price of beachfront property in the Poipu area ($70/sq. ft.), and the inflationary character of land prices throughout Hawaii, it may seem more cost effective for the county to maintain and protect the park shoreline than to retreat from the shore and acquire more land to replace the property lost to erosion. If the desire is to maintain or improve the beach, thereby protecting the park shoreline, then beach nourishment with vegetative plantings should be considered. At the east end of the beach in the lee of the shore-connected breakwater, sand from the beach may be accumulated in the water just off the beach toe. Sand eroded from the beach during high wave activity is trapped behind the structure, and typical wave energy that would normally move the sand back to the beach is completely blocked by the structure. Therefore, this sand should be mechanically moved back to the beach periodically. Studies should also be undertaken to identify potential offshore sand deposits for beach restoration work.

If the maintenance efforts related to plantings and beach nourishment become too burdensome or costly, then additional erosion control structures may be warranted. Offshore structures would be preferable since they would help to stabilize the beach as well, rather than shoreline revetments which protect the backshore but do not mitigate erosion of the beach. However, detailed studies need to be accomplished in order to properly design an appropriate offshore structure. Coastal engineering studies should include data gathering to define the coastal processes, analytical studies to design and numerically model the characteristics of the structure, and possibly physical model studies to verify the performance of the structure.

# Chapter IV

# CHAPTER IV. IMPLEMENTATION OF THE EROSION MANAGEMENT RECOMMENDATIONS

Although this study concentrated on specific geographic areas, the regulatory changes and management recommendations proposed in this report span a number of political and administrative jurisdictions, and can be applied islandwide. Many of the deficiencies that can be found in an examination of the beach erosion management program on Kauai are related to inadequate implementation rather than inadequate policy. A prime example can be found in the Kauai County Comprehensive Zoning Ordinance. As early as 1972, the Kauai County Council recognized the need for special protection of unique shoreline areas. Ordinance No. 164 was adopted to enable this protection by creating overlay Shore District zoning. These protective Shore Districts have yet to be implemented. Such deficiencies are perhaps due to a lack of concern on the part of responsible officials and the general public. Public concern may materialize when a popular beach is noticably threatened by erosion, or by an inappropriate shoreline protection structure. As a result of both the episodic nature of some erosion events and the reactive nature of the public and property owners, there has been inadequate support and funding for long-term erosion study and control.

Public education regarding erosion control and beach preservation is needed. A renewed commitment by the regulatory agencies to protect public beaches as well as private property will be essential. Administrative or legislative actions must be accompanied by adequately-funded and professionally-staffed monitoring and enforcement programs at all levels of government. The two main front-line agencies in particular need of increased funding and manpower to monitor and enforce shoreline regulations are the Kauai County Planning Department and the State Office of Conservation and Environmental Affairs.

In this section a categorization of potential management solutions to the shoreline erosion problem provided by outlining implementation responsibilities, and suggests funding sources and mechanisms to aid in that implementation. The recommendations have been divided into five major categories:

1) those that can be implemented through administrative action of the planning director/commission;

2) those that can be implemented through ordinances passed by the county council;

3) those that can be implemented by the Office of State Planning, Coastal Zone Management Program, or by other state agencies;

4) those that can be implemented through enactment of state legislation;

5) those that can only be implemented through a collaborative effort of county and state agencies.

## IV.1 RECOMMENDATIONS REQUIRING ACTION BY THE PLANNING COMMISSION/DIRECTOR

a) Establishment and adoption of a Shoreline Special Treatment Zone Plan, and concomitant establishment of Shore District Boundaries. Where feasible, the lateral boundaries of the Shore Districts should coincide with the boundaries of distinct littoral cells. The fore-shore boundary would be the mean sea level line. The back-shore boundary would coincide with the mauka boundary of the newly established shoreline setback. The Planning Director and Planning Commission should pursue additional sources of funding from the State and Federal government.

b) Formation of shoreline erosion management plans, which would include the establishment of new shoreline setbacks based on the littoral cell concept, as determined by erosion prediction studies. The setbacks would reflect predicted erosion rates, zoning, permitted development density, and service life of projected property improvements. These plans would also specify those conditions under which cell-wide shoreline stabilization measures may be justified, and the conditions which must be met to ensure that such structures do not negatively affect neighboring shoreline areas or the public interest. This type of comprehensive shoreline management would be preferred over small-scale or individual projects. This would primarily be a County responsibility, with assistance from the State CZM Program. This could also be funded through developer exactions, whenever shoreline property development is proposed.

c) Prohibition of shoreline protection structures, or at least adoption of a moratorium on the permitting and construction of all beach and shoreline protection structures, until a comprehensive erosion management plan is established by the County for the particular littoral cell within which the prospective structures would be contained. Developers or landowners wishing to construct shore protection structures before such a plan has been formulated by the County would be responsible for one's own plan and costs.

d) Expansion of the county jurisdiction over the shoreline area to include the lands between the vegetation line and the mean sea level, as called for in recent revisions to HRS 205A-45 (b). This measure requires no particular financing, but is essential to efficiently adjudicate shoreline claims, especially where illegal structures are involved.

e) Removal of illegal, unpermitted shoreline structures. Property owners should be entirely responsible for removal costs. Enforcement costs would be the responsibility of the County, with assistance from the State CZM Program.

f) Adoption of new rules and regulations outlining the conditions under which variances may be granted to allow shore protection structures and other structures within the shoreline setback. These new rules should reflect the standard that all development should be located as far back from the shoreline as possible and should include a clear definition of hardship to mean more than merely economic inconvenience. Costs of developing and implementing these rules would be the responsibility of the County, with assistance from the State CZM Program. Incentives for encouraging placement of improvements farther inland need to be further explored.

g) Preservation of public shorelands in as natural a state as feasible, so that normal beach processes can proceed unimpeded, and so that access and recreational opportunities are not disrupted. Any improvements to such public properties should be located sufficiently landward, or be of a transitory/inexpensive nature, so as not to require shore protection structures if threatened by erosion. Exceptions would be those improvements that would enhance public recreational opportunities, beach access, and usable beach area. Long-term savings to the County should result from this measure. If expensive intervention is required to protect beach resources, park user fees may need to be established. Impact fees on new developments in the area, which will add to the user burden on the park, should be more fully utilized.

h) Establishment of a shoreline structure inventory. This will enable stronger enforcement of shoreline regulations.

## IV.2 RECOMMENDATIONS REQUIRING ACTION BY THE COUNTY COUNCIL

a) Maintenance of Open-zoning for beachfront properties, reevaluation of other current zoning designations within the Shoreline Special Treatment Zone, and rezoning of those parcels that cannot accommodate the appropriate setbacks. Zoning which allows high-density usage of unstable beachfront property may be inappropriate, because the high value of improvements on such property may preclude any shoreline management options other than stabilization structures which may infringe on public access or threaten the stability of adjacent shorelines and public beaches. Financing of this measure would be primarily a County responsibility, but could be done in conjunction with an overall CZO update to minimize costs.

b) Establishment of variable shoreline setbacks, based on erosion rates, zoning, permitted development density, and service life of projected improvements. Although the Planning Director could adopt extended setbacks if Shore Districts are established, the County Council would have to amend the Shoreline Rules and Regulations if setbacks are to be extended in any areas not designated as Shore Districts. Costs for the studies necessary to make the islandwide assessments of erosion rates would be borne by the County, the State CZM, and by developer exactions.

c) Priority acquisition of shorefront property which may be undevelopable without erosion protection structures. County funds, State grants-in-aid, and developer exactions would be used to finance these acquisitions. Condemnation proceedings may need to be employed in some cases.

## IV.3 RECOMMENDATIONS TO BE IMPLEMENTED BY STATE CZMP

a) Adoption of an erosion prediction methodology that is consistent with current accepted theory regarding coastal geomorphological processes, is widely applicable, and can be refined as more information becomes available. Financing of this program will rely on a new State commitment to coastal preservation, as well as matching Federal funds.

b) Commencement of a program which identifies those offshore areas of the State which may be potential sources of sand for beach nourishment. These studies would include an analysis of economic and environmental impacts of exploitation of these resources. State funding should be sought for this program.

c) Further exploration of the feasibility of utilizing the States' Geographic Information System (GIS) to store and manage data on coastal erosion.

## IV.4 RECOMMENDATIONS THAT REQUIRE ACTION BY THE STATE LEGISLATURE

a) Reevaluation of policies which allow for replacement and repair of non-conforming or illegal structures. Non-conforming/illegal structures should be allowed to be repaired or replaced only if they do not infringe upon public beach access and clearly do not affect the integrity of public beaches. Retirement schedules for any such structures that do compromise public access or beaches should be established to eventually eliminate the offending structures. Changes to Chapter 205A, HRS would be necessary to implement this recommendation. The DLNR and County Planning Agencies would be responsible for enforcement and would require adequate commitment of State funds for personnel and program costs.

b) Adoption of substantial fines and penalties (such as license revocation) to be assessed upon those contractors who proceed with construction of any shoreline stabilization structures or other structures within the shoreline setback area before having all necessary permits. Adoption of minimum as well as maximum per diem fines for all violators, including property owners. Again, changes to Chapter 205A, HRS would be required. Fines would be used as a revolving fund to pay for enforcement programs, and shorefront property acquisition.

c) Establishment of Community Facilities Districts. These districts would be subject to special assessment taxation in order to pay for the monitoring, enforcement and analyses necessary to coordinate any planned shoreline stabilization measures, and to capitalize those projects which are deemed essential to both the public and private good. Property owners within these districts can be assessed according to beach frontage, total area of property within the district, or real property assessed value, as long as the assessment formula is reasonable. Such financing by assessment was proposed in the aborted 1990 Senate Bill #3292. (See Appendix C). This would be the primary mechanism to be used to pay for the studies that are needed to determine the most appropriate methods of erosion control for a particular littoral cell. Funds generated by these assessments would also be used for construction of shoreline stabilization structures, if such structures are deemed appropriate and essential. Individual, private shoreline structures would not be permitted, unless they are part of a comprehensive management effort. This would ensure that the integrity of littoral cells would be maintained, that both private property and the public good would be protected, and that beaches and beach access will be preserved. The adoption of this measure may be the key to the long-term viability of many of the above recommendations. Kauai County can barely afford current programs, much less the expanded type of shore protection programs that have been suggested above. Individual property owners would also be unwilling and unable to fund such programs and studies. The creation of Community Facilities Districts would allow for assessments to be made which reflect not only the value of the property in the district, but also the location of improvements to that property. Assessments would be based on ability to pay, intensity of shorefront development, and risk of erosion to properties, as well as benefit to be gained from shoreline protection.

d) The State legislature may wish to dedicate a portion of the hotel room tax to beach preservation, considering the extremely high percentage of tourists who use the beach resources.

## IV.5 RECOMMENDATIONS WHICH REQUIRE COLLABORATIVE STATE AND COUNTY EFFORT TO IMPLEMENT

a) Establishment of a comprehensive beach and shoreline erosion monitoring program in conjunction with the state CZM program, to be updated and reviewed periodically (every 5 years). At a minimum, this program should include historical and contemporary aerial photographs which can be digitally entered into a computer mapping system for use in the prediction of past and current erosion trends. The States' GIS may be the logical place to store and manage these data. An interactive data base which can be easily accessed and updated to contain ground surveys, beach profiles, and legal shoreline determinations is also necessary. Costs of such a program would be shared by the State and County, with the County primarily responsible for the in-kind services of surveyors and planners.

b) Geographic delineation of littoral cells, to be followed by designation of the beaches and shorelines within the littoral cells as stable or unstable, accreting or eroding, seasonal or permanent. This task would also be a joint program, with the County Planning Department supplying the local expertise, and the State CZM Program providing funding and oceanographic expertise.

c) Establishment of a computer information system to record shoreline development permit applications and violations of shoreline restrictions. This information system would allow for real-time sharing of information amongst the various agencies in the county and the state that are responsible for controlling shoreline development. The Counties would have to provide the information, the State CZM Program would supply the funding for the computer system, and for communication and maintenance costs.

d) Dedication of adequate funding and establishment of at least one full-time position within the County Planning Department to process shoreline setback variances and CZMA permits, and to monitor and enforce setback regulations. This position should be staffed by an individual with the necessary qualifications to critically review applications for shoreline protection structures. The County would supply the manpower, the State would supply the funding for the necessary positions.

# Appendix A

# SHORELINE SETBACK ANALYSIS FOR THE ISLAND OF KAUA'I

MOON, O'CONNOR, TAM & YUEN,
ATTORNEYS AT LAW, A LAW CORPORATION

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# SHORELINE SETBACK ANALYSIS FOR THE ISLAND OF KAUA'I

## INTRODUCTION

This study analyzes possible legal and practical consequences arising from a regulation proposed by the County of Kaua'i which would increase the shoreline setback boundaries on the island of Kaua'i from the present width of twenty (20) to forty (40) feet to a width of up to one-hundred eighty (180) feet. Any county regulation proposing to expand a shoreline setback area should also include: (1) a clear definition of hardship and (2) provisions for disposition of non-conforming structures. The analysis is separated into three parts: Part I is a discussion of the current regulatory and permitting framework. Part II provides a legal analysis of the shoreline regulation and recent judicial decisions. Part III is a discussion of the current policies followed by the governing agencies regarding regulation of shoreline setbacks.

## I. REGULATORY FRAMEWORK

A. Overview. In general, shoreline setback areas are subject to two (2) regulatory programs which determine permissable land and water uses within the coastal zone. Pursuant to Section 205-2 of the Hawaii Revised Statutes ("HRS"), The State of Hawaii Land Use Commission ("LUC") classifies all land and water bodies of the State into four major land use districts: urban, agriculture, conservation and rural. HRS §205-2 empowers the LUC to set standards for determining the boundaries of each district, giving consideration to the master plan or general plan of each county. The State of Hawaii Board of Land and Natural Resources ("BLNR") pursuant to HRS §183-41 promulgates regulations for the use of for certain coastal lands classified by the LUC in the conservation district.

Coastal lands are also regulated under Hawaii's Coastal Zone Management Program ("HCZM"), HRS §205A et seq. The coastal lands classified under HRS §205A are comprised of

> "the waters from the shoreline to the seaward limit of the State's jurisdiction and all land areas excluding those lands designated as state forest reserves."

HRS §205A-3 designates the Office of State Planning ("OSP") as the lead agency with the authority to oversee the management of the HCZM. At the county level, under the HCZM, each county has concurrent authority to designate special management areas ("SMA") within the coastal zone management area of the individual county and to regulate those designated SMAs to comply with the objectives, policies and guidelines under the HCZM. The planning commissions of the county of Kaua'i, Mau'i and Hawaii are the primary regulatory authorities for each respective county. The City Council of the City and County of Honolulu is the governing authority for the island of O'ahu.

HRS §205A-43 defines the shoreline setback area as "not less than twenty feet and not more than forty feet inland from the shoreline," and authorizes each county to extend the shoreline setback area by county ordinance. HRS §205A-44. Uses within a shoreline setback area not only require approval from the authorities under the HCZM, but also from the BLNR if the area is within an area in the conservation district, pursuant to HRS §183-41.

B. State Shoreline Setback Regulations. HRS §205A-42 designates the BLNR as the governing authority empowered to adopt rules prescribing procedures for determining a shoreline and appeals of such determinations. HRS §205A-43 authorizes the counties to enforce the shoreline determination and promulgate rules of procedure including the following:

(1) to adopt rules for determining the location of the shoreline setback; and

(2) to review all applications for any structure, activity, or facility that would be prohibited without a variance, and require the applications to include accurate data and maps showing natural conditions and topography relating to all existing and proposed structures and activities.

HRS §205A-43.5 requires the county authorities to hold public hearings for variance applications and to act on each such variance application.

HRS §205A-44(a) prohibits the mining or taking of sand, dead coral, coral rubble, rocks, soil, or other beach or marine deposits from the shoreline with the following exceptions:

(1) the taking from the shoreline area of material not in excess of one gallon per person per day, for reasonable, personal, noncommercial provided that the counties may establish stricter provisions;

(2) mining or taking authorized by variance;

(3) clearing of materials from existing drainage pipes, canals, and mouths of streams, provided that the sand removed shall be placed in adjacent areas without increasing turbidity; or

(4) cleaning the shoreline area for state or county maintenance without increasing turbidity.

A variance in accordance with this statute is required for all other proposed structures or activities otherwise prohibited. A variance is not required for any structure in the shoreline area if the presiding county authority finds in writing based on the record presented that the proposed structure or activity is necessary for or ancillary to:

(1) cultivation of crops;

(2) aquaculture;

(3) landscaping; provided that the proposed structure or activity will not adversely affect beach processes and will not artificially fix the shoreline;

(4) drainage;

(5) boating, maritime, or water sports recreational facilities;

(6) public agencies or utilities' facilities or improvements for public utility services;

(7) private facilities or improvements that are clearly in the public interest;

(8) private facilities or improvements which will neither adversely affect beach processes nor artificially fix the shoreline; provided that the authority also finds that hardship will result to the applicant if the facilities or improvements are not allowed within the shoreline area;

(9) private facilities or improvements that may artificially fix the shoreline; provided that the authority also finds that shoreline erosion is likely to cause hardship to the applicant if such construction are not allowed within the shoreline area; provided further that the authority imposes conditions to prohibit any structure seaward of the existing shoreline unless it is clearly in the public interest; or

(10) moving sand from one location seaward of the shoreline to another similar location; provided that the moving will not adversely affect beach processes,

diminish the size of a public beach, and will be necessary to stabilize an eroding shoreline.

HRS §205A-46(b) authorizes the counties to define "hardship" provided that hardship is not determined as a result of county zoning changes, planned development permits, cluster permits, or subdivision approvals after June 16, 1989. HRS §205A-46 further requires that the variance must contain appropriate conditions to maintain safe lateral access to and along the shoreline, minimize risk of adverse impact on beach processes and risk of structures failing and becoming loose rocks or rubbish on public property and adverse impacts on public views to, from and along the shoreline. Although the state statute may provide for such exceptions through the variance process, HRS §205A-48 requires that "in case of conflict between the requirements of any other state law or county ordinance regarding shoreline setback lines, the more restrictive requirements shall apply in furthering the purposes of this part."

C. Shoreline Setback Regulation for the County of Kaua'i. Regulations of Kaua'i's shoreline setback area are contained in Chapter 8 of the Kaua'i County Code section entitled "The Shoreline Setback Rules and Regulations of the County of Kaua'i" ("Kaua'i Shoreline Setback Regulation"). Section 1 of the Kaua'i Shoreline Setback Regulations appoints the Kaua'i Planning Commission and the Director of the County Planning Department ("Kaua'i Planning Director") as the regulatory authorities.

Section 2 of the Kaua'i Shoreline Setback Regulations defines the shoreline setback area for Kaua'i as follows:

> ". . . forty (40) feet inland from the upper reaches of the wash of waves other than storm and tidal waves, except that such shoreline setback lines shall be twenty (20) feet inland on any land parcel of record when any one or more of the following exist:
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> a. Where the average depth of the parcel, as measured from the shoreline or the seaward boundary of the parcel, whichever is the lesser, is less than one hundred (100) feet. The average depth of the parcel shall be determined by standard geometrics of a rectilinear lot or by a combination of a series of rectilinear divisions of the total lot. The [Kaua'i Planning Director's] findings relating to the determination of the average depth shall be final.

The applicant submits a form with a written statement to substantiate that the development is in the public interest or required under hardship. The Kaua'i Planning Commission forwards a copy to the Department of Public Works and the Department of Water, and may solicit comments from other governmental agencies, and submits his recommendations in writing to the Kaua'i Planning Commission. Within sixty (60) days after the application filing, the director shall prepare a report for public review. Within sixty (60) days from the receipt of the director's report, the Kaua'i Planning Commission then must schedule at least one (1) public hearing upon at least twenty (20) days prior notice of the scheduled hearing. If the Kaua'i Planning Department fails to either issue or deny the application within the sixty (60) day time period the variance will be deemed approved.

## II. LEGAL ANALYSIS

A. Overview. An amendment to the Kaua'i Shoreline Setback Regulations to expand the shoreline setback area from a width between twenty (20) feet and forty (40) feet to a width of up to one-hundred eighty feet raises three major legal issues. First, since the setback area is measured from the shoreline, judicial definitions of how the shoreline is located will impact upon the location of the setback areas. Second, there have been many judicial decisions regarding whether regulation of land use constitutes a governmental "taking" for which compensation must be paid to the affected property owner. Third, any amendment to the Kaua'i Shoreline Setback Rules which would require public access to private property may impose tort liability on the County of Kaua'i for personal injuries suffered by persons while using the setback areas for recreational purposes.

B. Shoreline Defined. HRS §205A-41 defines 'shoreline' as the upper reaches of the wash of the waves, other than storm and seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth, or the upper limit of debris left by the wash of the waves." This definition is a codification of Hawaii Supreme Court case law which has developed concerning the location of boundaries which run along the high water mark.

The Hawaii Supreme Court in McCandless v. Du Roi, 23 Haw. 51 (1915) ("McCandless") held that distances and azimuths in a Land Court decree are not conclusive in locating a boundary line on a body of water where the line is also described in general terms as running along the body of water. In a later case, the Hawaii Supreme Court interpreted the location of the high water where the property is described as running "ma ke kai" (along the sea), its seaward boundary is the upper reaches of the wash of the waves, as evidenced by the edge of vegetation or the line of debris left by the waves, and not by the horizontal plane of mean high water. In Re Application of Ashford, 50 Haw. 314 (1968). Likewise, the Hawaii Supreme Court held in County of Hawaii v. Sotomura, 55 Haw. 176, 182 (1973) ("Sotomura") that where the wash of the waves may be marked both by the line of debris left by the waves and by the vegetation line further inland of the line of debris, the location of the high water mark is the vegetation line.

The Hawaii Supreme Court in Sotomura further held that the location of the shoreline boundary of beach front property may move due to erosion, even when the property at issue has been registered with the Land Court. Id., 55 Haw. at 180. Therefore, even if a seaward boundary is conclusively set by Land Court decree to be located along the high water mark, "the precise location of the high water mark on the ground is subject to change and may always be altered by erosion." Id. See also, In re Application of Castle, 54 Haw. 276, 506 P.2d 1 (1973). In fact, in a later case, the Hawaii Supreme Court upheld Sotomura by holding that the designation of the seaward boundary of beach front property as running to the high water mark takes precedence over a description of the property by distances and azimuths, even for property which is registered in the Land Court. In Re Sanborn, 57 Haw. 585 (1977).

Plaintiffs in Sanborn owned shoreline property which was registered in the Land Court in 1951. The Land Court decree described the seaward boundary of the property by distances and azimuths and as running along the high water mark. Subsequently, in order to obtain approval from the County to subdivide their property, Plaintiffs were required to obtain certification of a map of the property by the State Surveyor. Plaintiffs prepared a map showing the seaward boundary of their property according to the distances and azimuths in the Land Court decree, forty (40) feet makai from the vegetation line. The State Surveyor would not approve this map because he disagreed with Plaintiffs' location of the seaward boundary. The State appealed from the Land Court order to the State Surveyor to certify the map. In finding that the location of the highwater mark could be subject to change, the Supreme Court noted in dictum, that:

> "with reference to land courted property, that land below high water mark is held in public trust by the State, whose ownership may not be relinquished, except where relinquishment is consistent with certain public

> purposes. Under this analysis, any purported registration below the upper reaches of the wash of waves in favor of the appellees was ineffective."

Id., 57 Haw. at 594-594.

C. Regulation and Taking Issues.

1. Judicial Rulings.

a. United States Supreme Court. In a recent landmark decision, First English Evangelical Lutheran Church of Glendale v. Los Angeles County, 482 U.S. 304 (1987), the United States Supreme Court held that a land use regulation can be a taking when the regulation denies the property owner any use of its property. This holding departs from prior Supreme Court decisions in which the Court deferred in large part to state and local decisions regarding the regulation of land. The Court also held that even if the regulation results only in a temporary denial of the use of property, "the Just Compensation Clause of the Fifth Amendment requires that the government pay the landowner for the value of the use of the land during this period." Id. at 319. Furthermore, where the regulation does not preclude the use of property but instead requires that the landowner cannot exclude the public from the property, the regulation is a taking. For example, Kaiser Aetna v. United States, 444 U.S. 164 (1979)("Kaiser") concerned the Kuapa Pond in Hawaii Kai, which Kaiser Aetna and its predecessors developed into a marina which opened up into Maunalua Bay. The United States government contended that Hawaii Kai Marina became navigable waters of the United States from which Kaiser could not exclude members of the public. However, the U.S. Supreme Court held that:

> "the 'right to exclude' [the public], so universally held to be a fundamental element of the property right, falls within this category of interests that the Government cannot take without compensation."

Id. at 179-180.

On the other hand, a regulation which limits an owner's right to make profitable use of only some segments of his property will not constitute a taking under most circumstances. Keystone Bituminous Coal Ass'n v. DeBenedictis, 480 U.S. 470, 497-498 (1987). An important distinction of this exception is that the regulation must be rationally related to a legitimate governmental purpose to provide access to the beach. For example, in Nollan v. California Coastal Commission, 483 U.S. 825 (1987), the U.S. Supreme Court held that a condition requiring the Nollans to allow lateral public access across their property was invalid because it was not rationally related to the purpose of allowing public access to the beach, the regulation was invalid.

The Nollans owned beach front property which included a sea wall which ran along the beach and separated the beach from the rest of their property. They sought a permit to demolish a dilapidated cottage and build a new house on the property. The California Coastal Commission (the "California Commission") agreed to issue the permit on the condition that the Nollans grant an easement to allow the public to pass through the area between the sea wall and the high water mark.

The Nollans filed a writ of administrative mandamus to invalidate the condition claiming that the condition could not be imposed absent evidence that their proposed development would have a direct adverse impact on public access to the beach. The Ventura County Superior Court remanded the case for a full evidentiary hearing. On remand, the California Commission argued that since the structure would block a view of the ocean thus preventing the public "psychologically from realizing a stretch of coastline exists nearby . . ." the condition offset the impact upon the public by requiring the Nollans to provide additional lateral access to the beach. The California Commission agreed and upheld the condition. On appeal, the Nollans argued that the California Commission was authorized to impose public access conditions only where the proposed development would have an adverse impact on public access to the sea. The California Commission argued that the restrictions were rationally related to furthering the governmental interests of protecting public access to and preventing congestion on public beaches and further argued that the California Commission could have denied the Nollans' permit outright if it concluded that the Nollans' building would have violated these public interests. However, the U.S. Supreme Court found that an easement running along the beach (as opposed to running from the roadways to the beach) was not rationally related to furthering governmental interests of protecting public access as the structure did not affect public access to the beach. The U.S. Supreme Court explained:

> It is quite impossible to understand how a requirement that people already on the public beaches be able to walk across the Nollans' property reduces any obstacles to viewing the beach created by the new house. It is also impossible to understand how it lowers any 'psychological barrier' to using the public beaches, or how it helps to remedy any additional congestion on them caused by construction of the Nollans' new house.

The Nollan case must be carefully considered before any changes are made to the regulations which may require public access to the setback areas. If the County of Kaua'i intends to amend its regulations to expand the shoreline setback area to distances of up to one hundred sixty (160) feet, and/or require property owners to allow public access to shoreline setback areas without a rational relationship to furthering governmental interest of protecting public access, it is likely that the regulation will be invalid and constitute a governmental taking.

b. Hawaii Supreme Court. The Hawaii Supreme Court has also addressed the issue of when land use regulation may constitute a governmental taking in County of Kaua'i v. Pacific Standard Life Insurance Co., 65 Haw. 318 (1982)(hereinafter "Pacific Standard"). In this case, the Hawaii Supreme Court held that the property owner could not establish a taking "simply by showing that they have been denied the ability to exploit a property interest that they heretofore had believed was available for development." Id. at 338, quoting Penn Central Transportation Co. v. New York City, 438 U.S. 104, 130 (1978). The developer challenged the validity of an initiative vote which repealed an ordinance changing the zoning of certain shoreline property from a classification which called for open space and agricultural use to a classification which allowed resort development. The repeal of the zoning change thwarted the shoreline property owner's planned resort development. The Hawaii Supreme Court held that to determine whether a land use regulation constitutes a taking, the court must look at the circumstances of each case to determine "whether 'regulation has interfered with distinct investment-backed expectations' sufficient to require compensation therefor." Id., at 338, quoting Penn Central Transportation, at 124. The repeal was compatible with the requirements of due process, it was a legitimate exercise of the police power, and it did not deny the property owner economically viable use of its land. The court also found that the owner's expectations regarding resort development were speculative. The court reasoned that the property owner's right to construct a resort development did not vest because the developer had yet to obtain necessary governmental approval permitting such construction. Thus, the repeal of the zoning ordinance did not constitute a taking for which the owner was entitled to compensation.

The Hawaii Supreme Court has also held that there is no taking when a Land Court boundary changes due to a change in the location of the shoreline. The Hawaii Supreme Court in Sanborn, supra held that locating the seaward boundary of the property at the vegetation line was not a "taking" of the forty

(40) feet of private property between the vegetation line and the original Land Court location. The location of the seaward boundary at the vegetation line was not "beyond the reasonable expectations of the parties" at the time the property was registered, because the McCandless decision, which was rendered long before the property was registered, provided that the high water mark took precedence over a description by distance and azimuth. It was also not unexpected that the high water mark would also change since the high water mark along the property changed from season to season depending upon the slope of the beach. Since it was not beyond the reasonable expectations of the parties, the change of the seaward boundary from the distances in the Land Court decree to the vegetation line was not a taking of the Sanborns' property. Sanborn supra, 57 Haw. at 596-597.

2. Judicial Guidelines for Regulations. These judicial decisions above-cited suggest the following guidelines provided that there is reasonable use of the property and a rational relationship between the regulation and the provision of public access to the beaches. If the Kaua'i Shoreline Setback Rules are amended to expand the area covered by the regulations, it is unlikely that the Courts will find a taking of private property without compensation provided that there is reasonable use of the property and a rational relationship between the regulation and the governmental interest to provide public access to the beach. The Legislature already has enunciated the state interests in protecting the shoreline and preserving the public's access to the beaches. Moreover, the Kaua'i Shoreline Setback Rules restrict, but do not eliminate, the ability of a property owner to develop shore front property. The permit/variance mechanism allows a property owner to develop his property under certain conditions and prevents the restrictions on use of the setback areas from constituting a governmental taking.

a. Expansion of Shoreline Setback Area. The U.S. Supreme Court decisions discussed above indicate that even if shoreline setback regulations restrict a property owner's ability to develop a portion of his property in some manner, such shoreline setback regulations will not constitute a taking so long as there is a rational relationship between the regulation and the provisions of public access to the beach. However, if the setback regulations are amended to require property owners to allow public access across their property without a reasonable relation to providing public access to the beach, the regulations may constitute a taking for which the government will be required to pay compensation. Finally, a change of the boundary of the shoreline setback areas will not constitute a governmental taking as long as the change is not "beyond the reasonable expectations of the parties."

b. Methodology. Accepting any single method of determining a shoreline setback area is an issue yet to be brought before the courts. The cases cited above involved sand beaches, and therefore, to the extent possible, it is arguable that the methods used in those cases are appropriate for sand beaches. It is important to remember that it nevertheless appears that such boundaries, in the Hawaii court's view, are incapable of absolute certainty. Any methodology used to determine shoreline setback areas, regardless of the degree of scientific accuracy, would be subject to the legal definition of the highwater mark as established by the Hawaii Supreme Court. As discussed previously, the Hawaii Supreme Court has defined the high water mark as "the upper reaches of the vegetation line." By definition, the precise location of the high water mark is therefore subject to change and may always be altered by erosion. Regardless of how precise the methodology is purported to be, it is "the body of water whose margin is meandered is the true boundary". McCandless, supra at 56 (1951).

c. Disposition of Non-Conforming Structures. The Federal Constitution forbids ex post facto legislation, and therefore, any non-conforming structure existing at the time of shoreline certification must be allowed to remain or will be legislatively taken. HRS §205A-44(b)(1) states that "structures in the shoreline area shall not require a variance if they were completed prior to June 22, 1970 . . ." The Hawaii courts have not addressed the question of whether a regulation prohibiting a landowner from reconstructing a non-conforming structure that was destroyed by a natural cause (i.e. hurricane) would constitute a taking. It is arguable that the regulation would not constitute a taking if the reconstruction of the non-conforming structure would prevent public access to the beach and the landowner was nevertheless allowed reasonable use of the property without the necessity of reconstructing the non-conforming structure.

D. Liability for Personal Injury. The Kaua'i Shoreline Setback Rules which are based on a public policy designed to preserve access to beaches do not require property owners to open their beach front property to the public. If the setback area is increased in size, the restrictions on development would leave more beach front area physically open, but it would not legally open these areas to the public.

If proposed amendments to the Kaua'i Setback Rules do not require a property owner to open the setback area of his property to the public, the owner will not be subject to any change in his tort liability to someone who is injured on his property. Under general tort principles, a landowner who induces or invites people to use the beach areas adjoining his property is required to exercise reasonable care for those people's safety. Kaczmarczyk v. City and County of Honolulu, 65 Haw. 612 (1982). The standard of reasonable care dictates that the landowner take precautions against and warn of known hidden dangers. Geremia v. State, 58 Haw. 502, 506 (1977).

In an attempt to define and limit a property owner's liability for personal injuries to persons he allows to use his property for recreational purposes, Chapter 520, HRS. Under this statute, a property owner is not liable for injuries to anyone entering or using his property for recreational purposes, unless he invites or permits public use of the property. HRS §520-3. Even when the property owner allows public use of his property for recreational purposes, his tort liability is greatly limited by HRS §520-4. HRS §520-4 provides that a property owner who opens his property for recreational use does not: (1) assure that the premises are safe; (2) owe the users a duty of care to take precautions against and to warn of known dangers on the property; or (3) assume responsibility for any injuries caused by the acts of people who come on his property. HRS §520-5 provides for an exception to these limits on liability if: (1) the owner wilfully or maliciously fails to guard or warn against a dangerous condition which the owner creates or against a dangerous activity which the owner knowingly pursues; (2) the owner charges for recreational use of his property, unless the charge is in the form of lease rent from the State or other governmental body; or (3) the injured person is a houseguest of the owner.

If the shoreline setback regulations are amended to require property owners to allow public access to the setback portions of their property regardless of whether or not the regulation was reasonably related to providing public access to the beach, the regulations should be deemed to be a taking by the government. Nollan, supra. In that event, the state,and not the beach front property owner, would be the owner of the setback area. Under these circumstances, it would be unlikely that the property owner would be liable for personal injuries occurring on the property subject to the easement. Jones v. Halekulani Hotel, Inc., 557 F.2d 1308 (9th Cir. 1977) [property owner not liable for injuries on easement created by prescription]. The state, as owner of the setback area, would owe a duty of care to those people whom it invites or permits to be on the property. Moreover, HRS §520-2(1) exempts land owned by the government from the property to which Chapter 520 applies. Thus, the government would not be protected against tort liability for injuries resulting from recreational use of the the setback area.

## III. REGULATORY AUTHORITIES' POLICIES REGARDING EXTENDING SHORELINE SETBACK AREAS

A. Certification of a Shoreline Setback Areas. Certification of a shoreline is made by the State surveyor. The resolution of any dispute over the location of a certified shoreline is the joint responsibility of the State Surveyor and the BLNR. The State Land Use Commission District Regulations, Reg. 4-1 provides that:

> The regulations . . . are intended to reasonably expedite the eventual elimination of existing uses or structures that are not in conformity with the provisions of this part because their continued existence violates basic concepts of health, safety and welfare as well as principles of good land use. However, in applying the aforesaid regulations, no elimination of non-conforming uses or structures shall be effected so as to cause unreasonable interference with established property rights."

Read in conjunction with HRS §205A-44(b), these "structures" which are in non-conformance include those in existence prior to the enactment of HRS §205A but do not include certain minor structures which "do not affect beach processes or artificially fix the shoreline and do not interfere with public access or public views to and along the shoreline". However, the permitted structures are not to be enlarged within the shoreline area without a variance.

It appears that the regulatory authorities agree that the BLNR will defer certification of a shoreline to the state surveyor. The Kaua'i Planning Department issued a specific response to a petition filed with the LUC requesting clarification of matters pertaining to certification of shorelines and conservation district boundaries. The petitioner requested clarification of, among other issues, whether or not the conservation district boundaries can extend farther than the certified shorelines where the shorelines were subsequently inundated by storm waves caused by Hurricane Iwa in November 1982. The Kaua'i Planning Department submitted its position that storm waves, tsunami or hurricane surges should be excluded when determining a shoreline, and that shoreline certification rests with the State Surveyor and the BLNR. See Declaratory Order, In re Petition of Douglas Meller; Docket No. DR83-9. The LUC issued a declaratory order[2/] stating, in

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2/ The LUC's jurisdiction to entertain Petitioner's request was questionable as Petitioner was not a landowner of the subject area nor was there an actual controversy regarding certification presently existing. The LUC rendered its opinion and declaratory order "in an attempt to render some assistance in matters that are seldom simple and uncomplicated . . .and hoping to remove uncertainty as provided under Rule 8-12".

pertinent part, that a conservation district boundary described as running along the shoreline could not be extended farther inland than the physical local shoreline. In the event a re-certification of a shoreline required an extension farther inland than a conservation district boundary, a conservation district boundary could then be extended. In any event, the re-certification of the shoreline rests with the state surveyor and the BLNR. The LUC explained that the Hawaii courts have consistently interpreted a shoreline as the highwater mark or upper annual reaches of the waves, specifically excluding storm and tidal waves. Likewise, the maximum inland line of a conservation district boundary line incorporates normal, seasonal fluctuations and not "extraordinary occurrences such as storm-generated or tidal waves."

B. Variances.

1. Defining "Hardship." The BLNR issued a policy statement on October 27, 1989, concerning the adoption of objectives, criteria and guidelines for resolving shoreline encroachments on state-owned lands. The BLNR explained that

> ". . . the focal point of resolving shoreline encroachments should be on how the resolution of an encroachment will impact public shoreline access and public beach areas and not how it will impact the abutting private property owner. If the encroachment serves to protect, preserve and enhance public shoreline access and public beach areas, it may be allowed to remain with appropriate land disposition from this Department. If not, then the encroachment should be removed."

Moreover, "economic arguments, such as the amount of money invested in a sea wall and/or the cost of the removal, should not be used in determining when to dispose of public lands and when to remove the encroachment."

2. Disposition of Non-Conforming Structures. The BLNR also suggested in its policy statement that all shoreline encroachments must be physically removed prior to any shoreline certification except for the following encroachments, which shall be held non-exclusive and open to the public:

1. To allow for existing footings and repair work on State-owned land for existing sea walls built within the private fee properties.

2. If the sea walls and revetments completely straddles the property line between private and State land, with no section of the sea wall/revetment built entirely on State land. The exact distance makai of the property line to be decided on a case-by-case basis (i.e. revetment) and to take into consideration the impact of erosion upon the beach.

3. Encroachments that do not prohibit public shoreline access and do not take public beach areas.

Reg. 4-5 of the State Land Use Commission District Regulations provides that the existence of the non-conforming use is considered a question of fact and shall be decided by the presiding county planning department after public notice and hearing. To the extent allowed by HRS §205A-44(b), which excepts non-conforming structures existing prior to the passing of the statute, so long as: (i) the regulation is reasonably related to the purpose of allowing public access to the beach, and (ii) landowner is not prevented from reasonable development of its property, the BLNR's position may not be considered a taking.

C. Amending Shore District Subdivision Lot Size. Section 8-22.4 of the Kaua'i County Code provides for amendments to the zoning requirements provided that "the change will further the public necessity and convenience and the general welfare". Amending the Shore District requirements to include minimum lot sizes would be within the powers of the Planning Commission granted under the ordinances, provided that proper notice and public hearings are followed under Article 22 of the Kaua'i County Code.

## IV. RECOMMENDATIONS

A. Overview. It is clear from case law and state statutes described above that the County of Kaua'i may expand a shoreline setback area. The methodology used to determine the location of the boundaries is at the county authorities' discretion subject to the guidelines established by the Hawaii Supreme Court.

We recommend that any proposed county regulation to expand a shoreline setback area to distances of up to 180 feet should be rationally related to allowing public access to the beach and also include (1) a clear definition of the term "hardship" and (2) provisions for disposition of non-conforming structures.

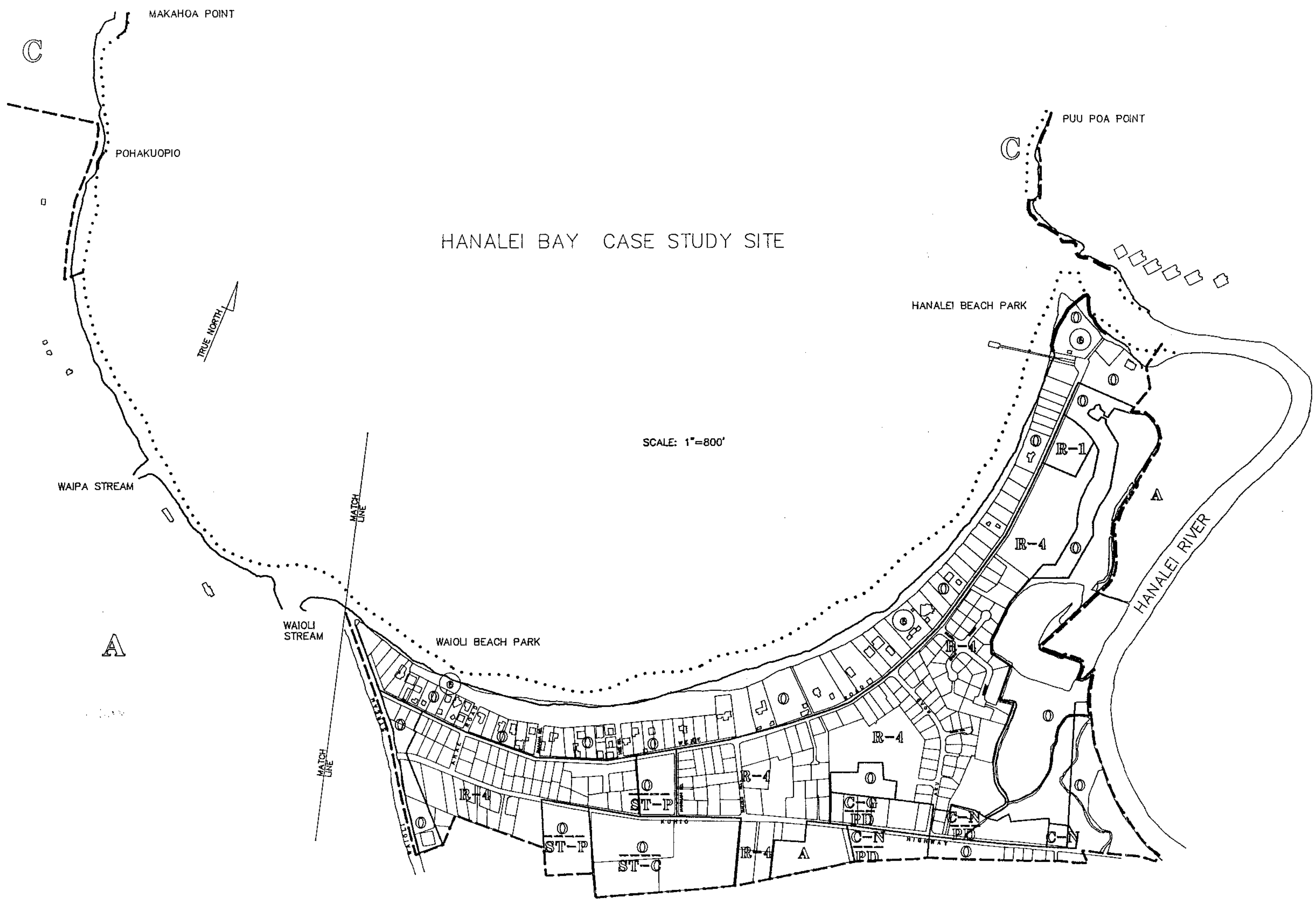
B. Definition of Hardship. Section 7 of the Kaua'i Shoreline Setback Rules allows variances upon a showing of hardship, provided that the non-conforming structure is "necessary for safety or protection from erosion or wave damage" upon approval by the Kaua'i Planning Commission and the County Engineer of the Department of Public Works, County of Kaua'i. This provision appears to be consistent with BLNR's position that the non-conforming structure must be determined based upon its impact on public shoreline access and public beach areas. We recommend that the definition of the term "hardship" be amended to clarify that the structure must be necessary for safety or protection from erosion or wave damage to public shoreline access and public beach areas and to incorporate the BLNR's position to specifically exclude economic arguments as a basis for determining hardship.

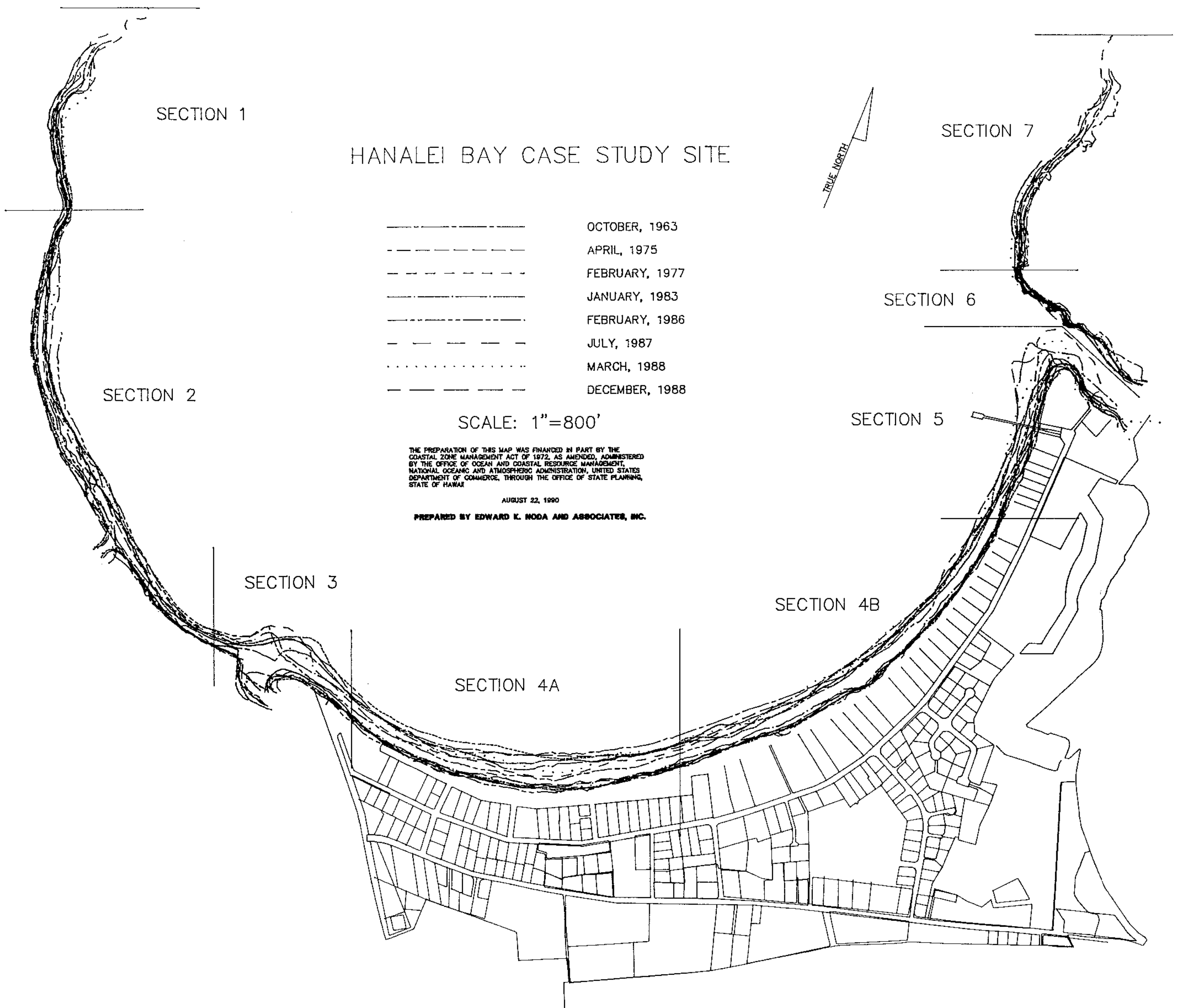
C. Disposition of Non-Conforming Structures. The present Kaua'i Shoreline Setback Rules allow non-conforming structures existing prior to the promulgation of HRS§205 to remain but fails to address the issue of applications requesting approval for reconstruction of non-conforming structures that have since been destroyed. It appears that the county authorities may be able to prohibit the reconstruction of such non-conforming structures within certain parameters. We recommend that any prohibition of reconstruction of a pre-existing non-conforming structure include the following:

a. the prohibition must be rationally related to providing public access to the beach; and

b. the landowner must not be prevented from other reasonable use of the property.

# Appendix B


MAKAHOA POINT
C
POHAKUOPIO
HANALEI BAY CASE STUDY SITE
PUU POA POINT
C
HANALEI BEACH PARK
TRUE NORTH
SCALE: 1"=800'
WAIPA STREAM
MATCH LINE
WAIOLI STREAM
A
WAIOLI BEACH PARK
HANALEI RIVER
A
O
R-1
R-4
ST-P
ST-C
C-G
PD
C-N
MATCH LINE
KUHIO
HIGHWAY


HANALEI BAY CASE STUDY SITE
SECTION 1
SECTION 2
SECTION 3
SECTION 4A
SECTION 4B
SECTION 5
SECTION 6
SECTION 7
TRUE NORTH
OCTOBER, 1963
APRIL, 1975
FEBRUARY, 1977
JANUARY, 1983
FEBRUARY, 1986
JULY, 1987
MARCH, 1988
DECEMBER, 1988
SCALE: 1"=800'
THE PREPARATION OF THIS MAP WAS FINANCED IN PART BY THE COASTAL ZONE MANAGEMENT ACT OF 1972, AS AMENDED, ADMINISTERED BY THE OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, UNITED STATES DEPARTMENT OF COMMERCE, THROUGH THE OFFICE OF STATE PLANNING, STATE OF HAWAII
AUGUST 22, 1990
PREPARED BY EDWARD K. NODA AND ASSOCIATES, INC.

# SECTION 1

## HANALEI BAY CASE STUDY SITE

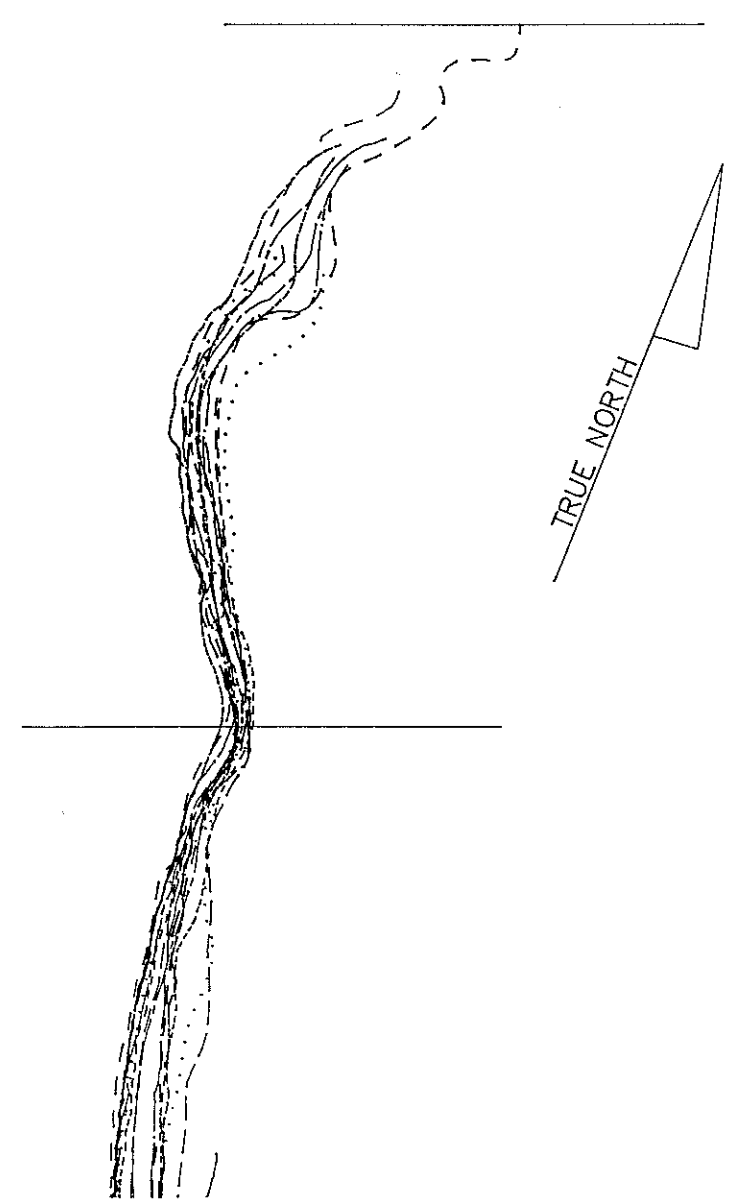
- OCTOBER, 1963
- APRIL, 1975
- FEBRUARY, 1977
- JANUARY, 1983
- FEBRUARY, 1986
- JULY, 1987
- MARCH, 1988
- DECEMBER, 1988

SCALE: 1"=400'

THE PREPARATION OF THIS MAP WAS FINANCED IN PART BY THE COASTAL ZONE MANAGEMENT ACT OF 1972, AS AMENDED, ADMINISTERED BY THE OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, UNITED STATES DEPARTMENT OF COMMERCE, THROUGH THE OFFICE OF STATE PLANNING, STATE OF HAWAII

AUGUST 22, 1990

**PREPARED BY EDWARD K. NODA AND ASSOCIATES, INC.**

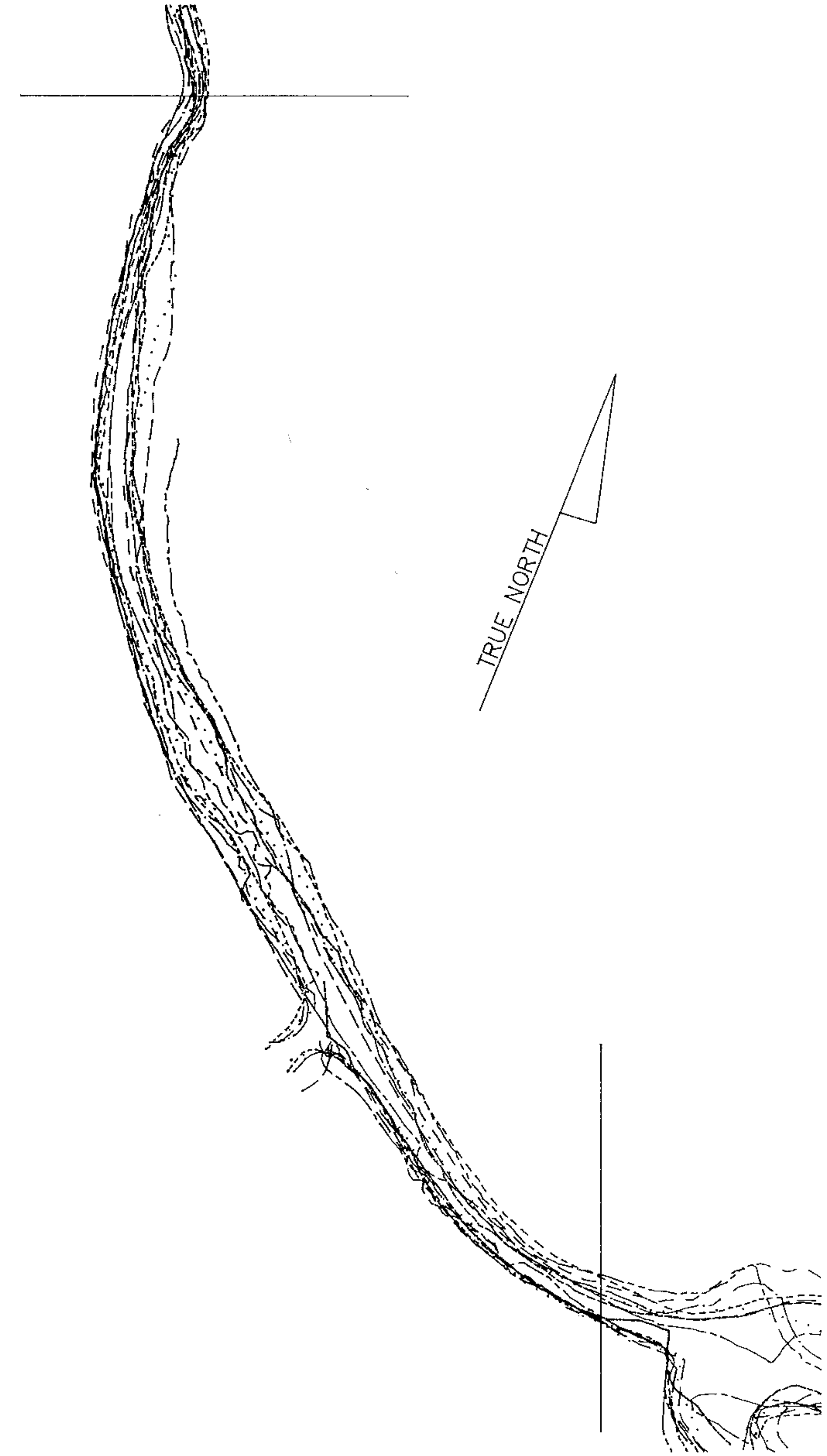


# SECTION 2

## HANALEI BAY CASE STUDY SITE

OCTOBER, 1963
APRIL, 1975
FEBRUARY, 1977
JANUARY, 1983
FEBRUARY, 1986
JULY, 1987
MARCH, 1988
DECEMBER, 1988

SCALE: 1"=400'

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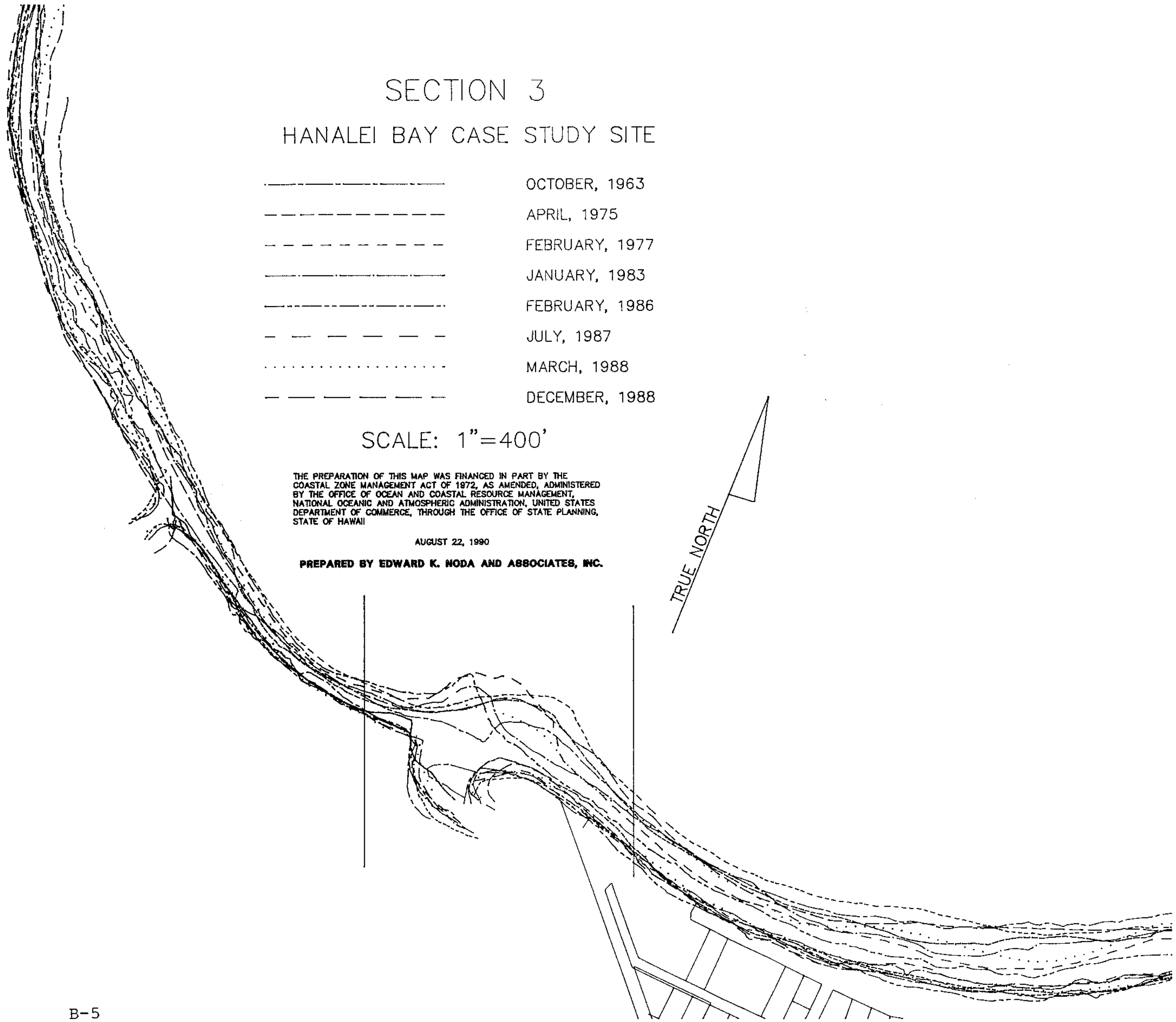
AUGUST 22, 1990

**PREPARED BY EDWARD K. NODA AND ASSOCIATES, INC.**

# SECTION 3

## HANALEI BAY CASE STUDY SITE

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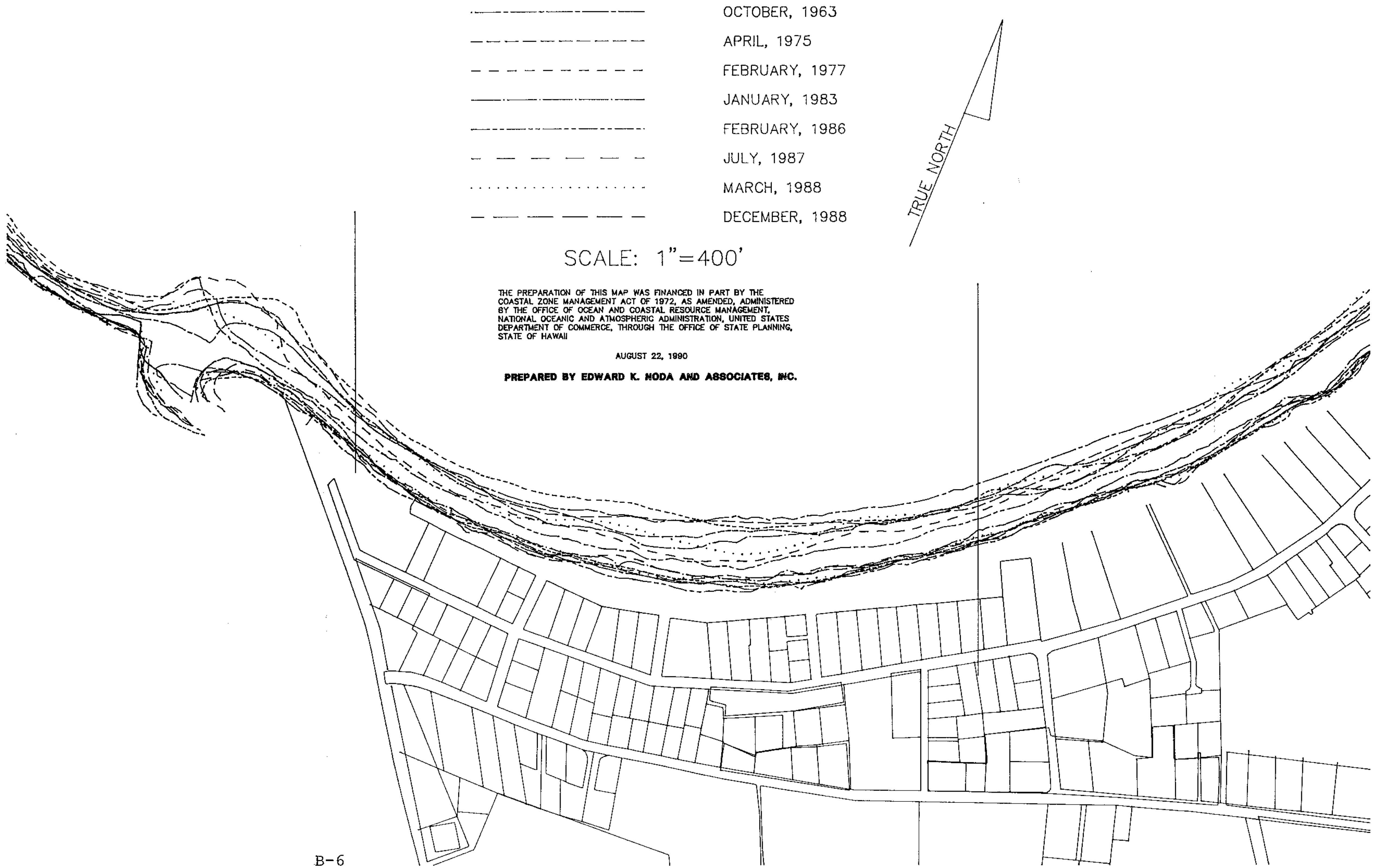
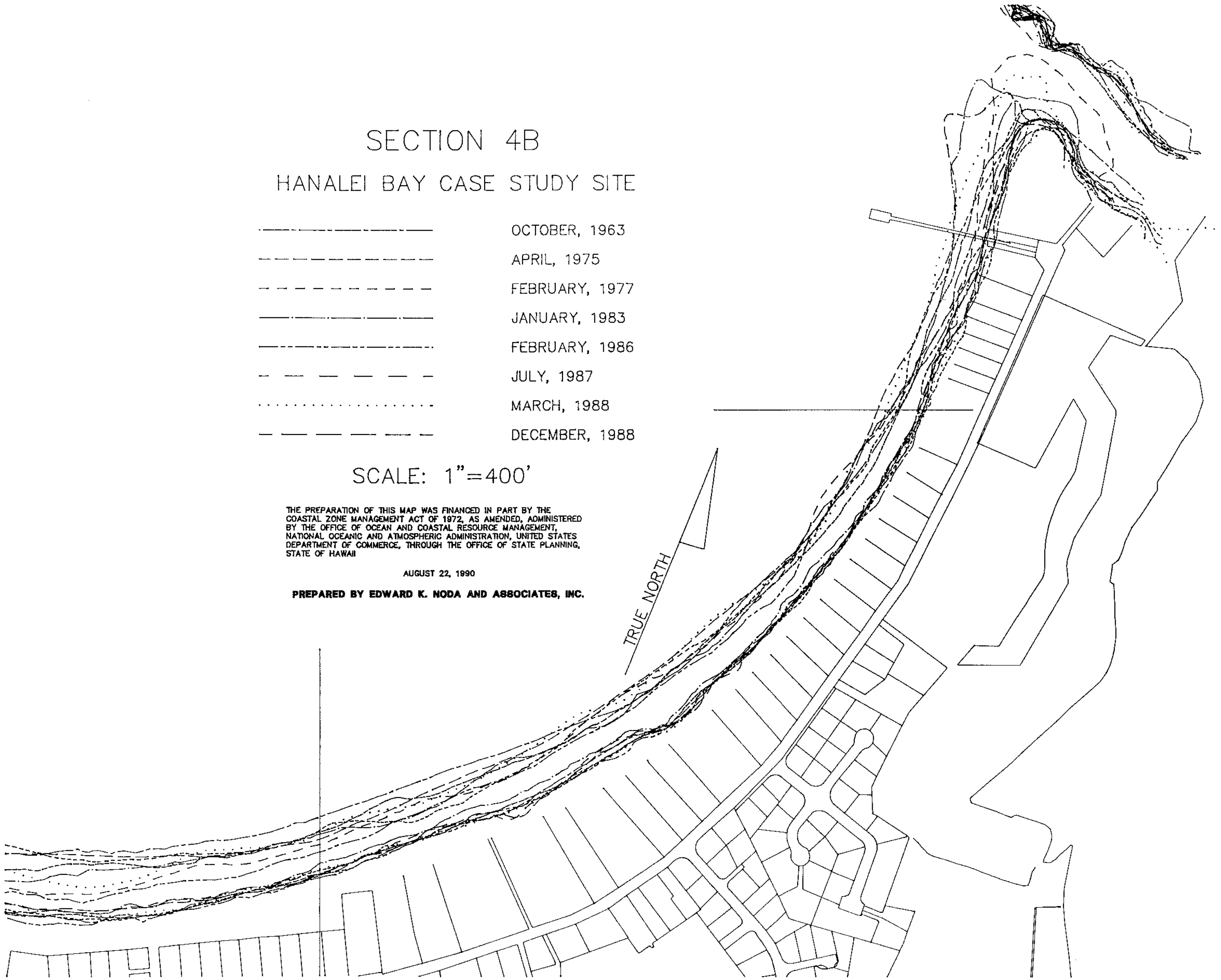
AUGUST 22, 1990

**PREPARED BY EDWARD K. NODA AND ASSOCIATES, INC.**

# SECTION 4A

## HANALEI BAY CASE STUDY SITE




SECTION 4B
HANALEI BAY CASE STUDY SITE
OCTOBER, 1963
APRIL, 1975
FEBRUARY, 1977
JANUARY, 1983
FEBRUARY, 1986
JULY, 1987
MARCH, 1988
DECEMBER, 1988
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AUGUST 22, 1990
PREPARED BY EDWARD K. NODA AND ASSOCIATES, INC.
TRUE NORTH

# SECTIONS 5,6,7

## HANALEI BAY CASE STUDY SITE

OCTOBER, 1963
APRIL, 1975
FEBRUARY, 1977
JANUARY, 1983
FEBRUARY, 1986
JULY, 1987
MARCH, 1988
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AUGUST 22, 1990

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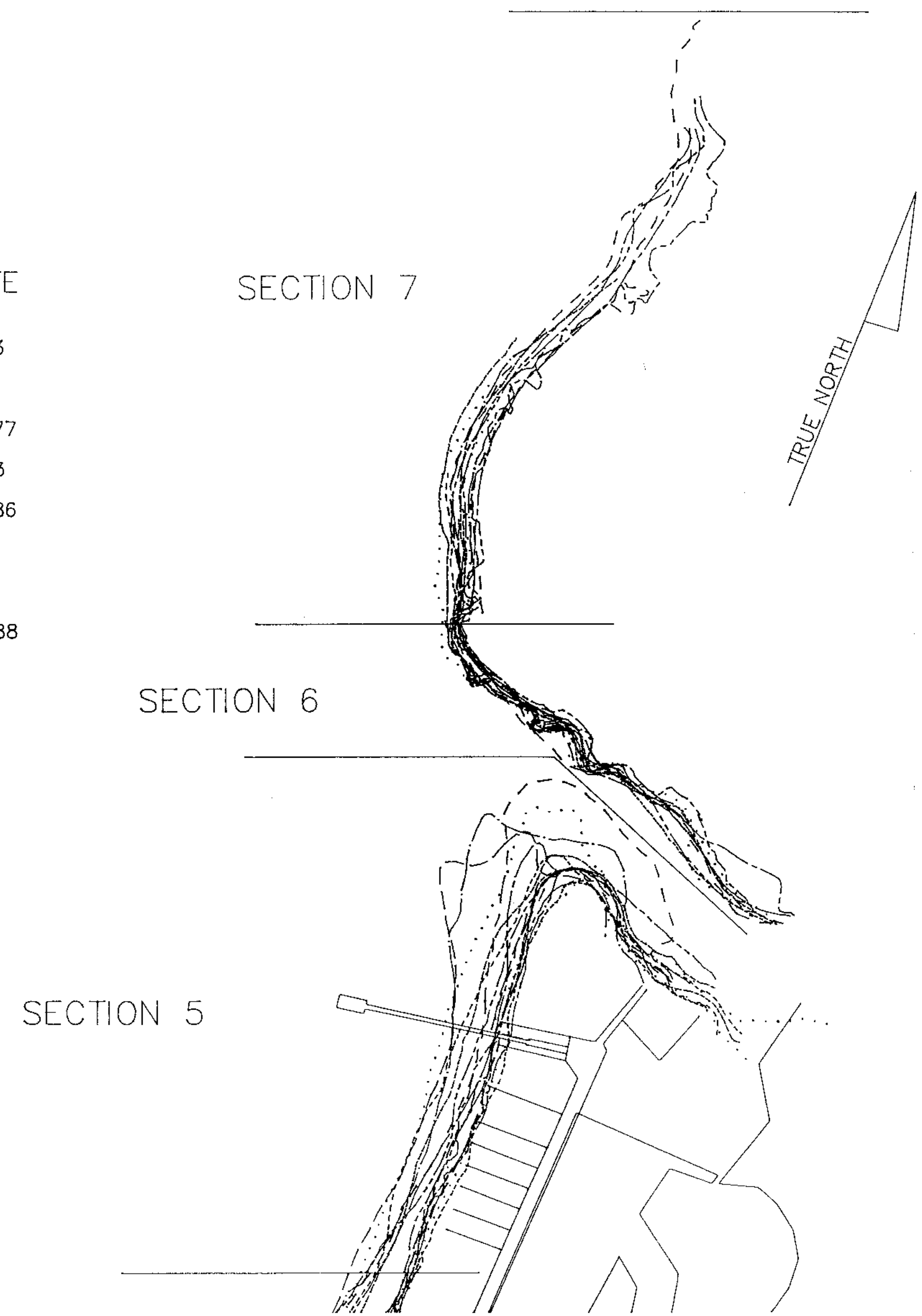
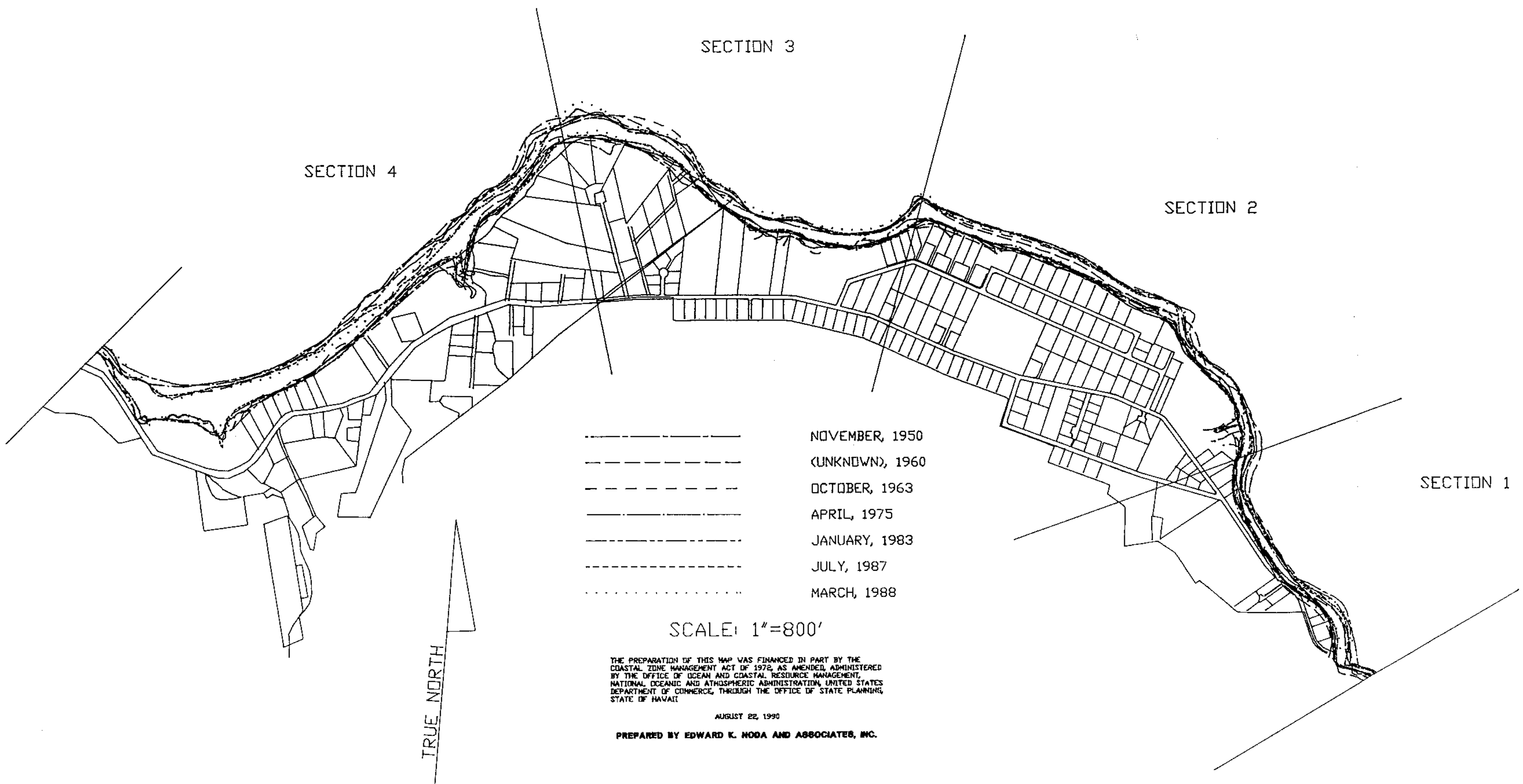
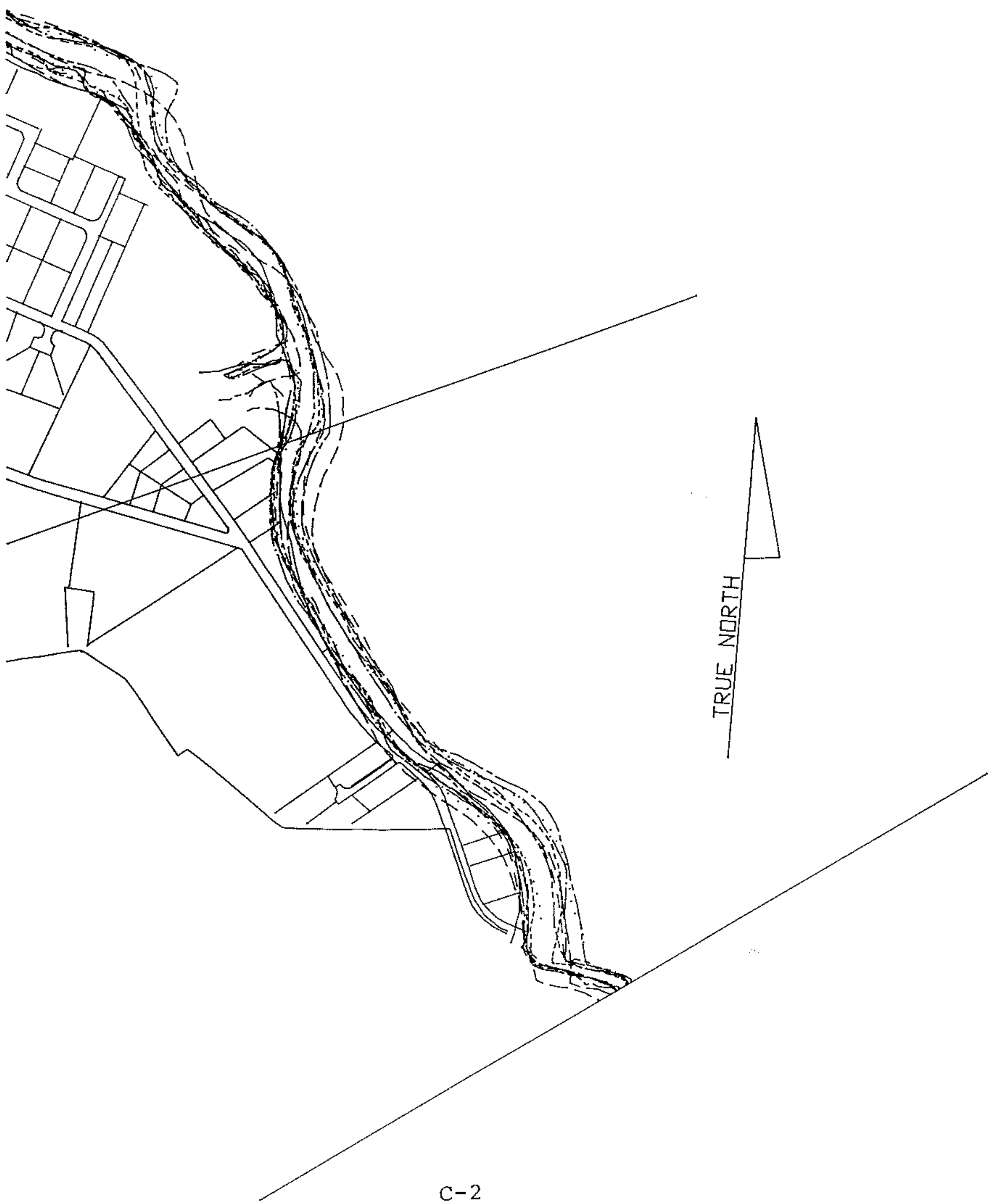


# Appendix C

# HAENA-WAINIHA CASE STUDY SITE






# SECTION 1

## HAENA-WAINIHA CASE STUDY SITE

| | |
|---|---|
| —·—·—·—·— | NOVEMBER, 1950 |
| — — — — — | (UNKNOWN), 1960 |
| - - - - - - - | OCTOBER, 1963 |
| ——·——·—— | APRIL, 1975 |
| -—-—-—-— | JANUARY, 1983 |
| –  —  —  —  — | JULY, 1987 |
| ·················· | MARCH, 1988 |

SCALE: 1″=400′

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AUGUST 22, 1990

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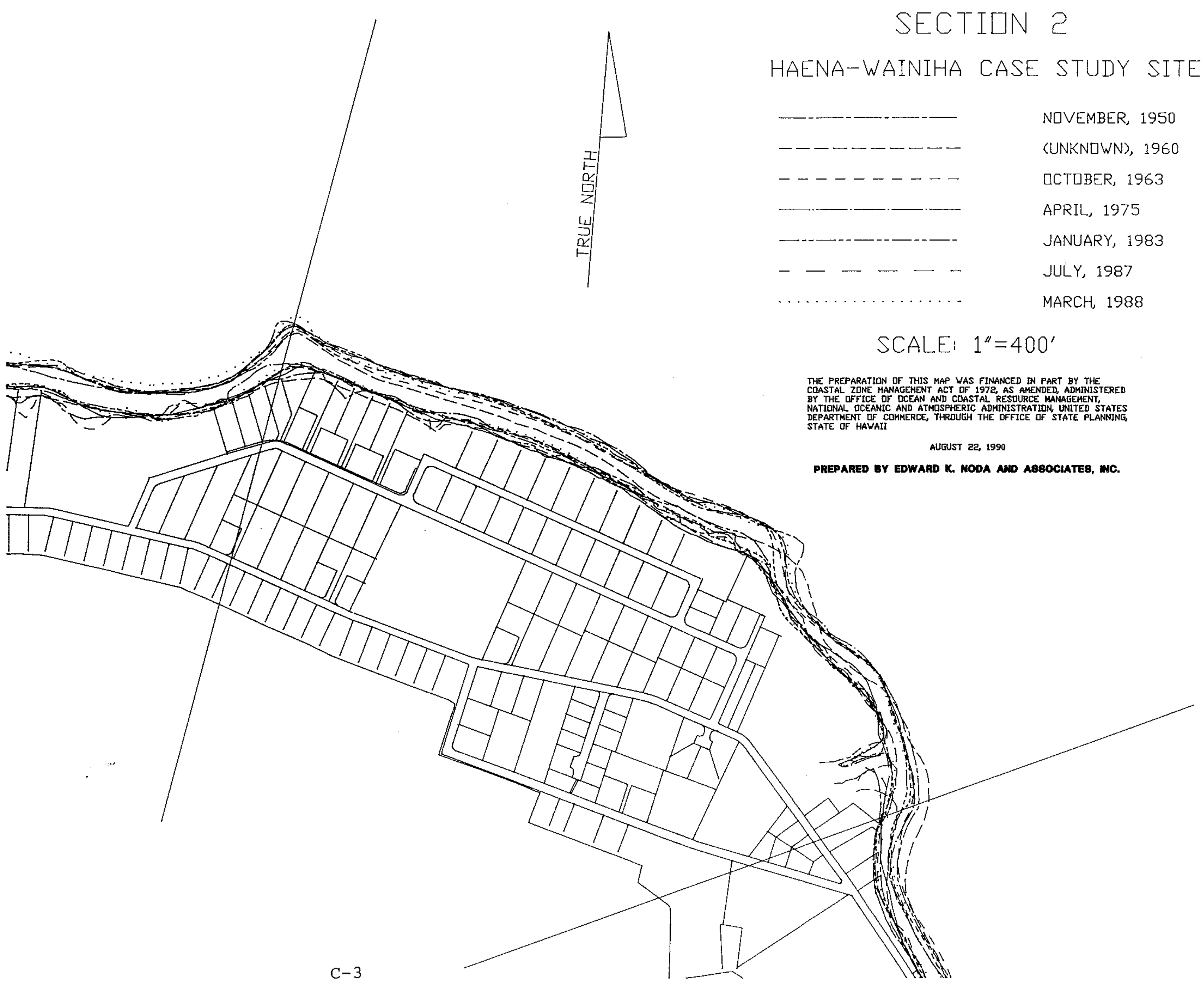
SECTION 2
HAENA-WAINIHA CASE STUDY SITE
TRUE NORTH
NOVEMBER, 1950
(UNKNOWN), 1960
OCTOBER, 1963
APRIL, 1975
JANUARY, 1983
JULY, 1987
MARCH, 1988
SCALE: 1"=400'
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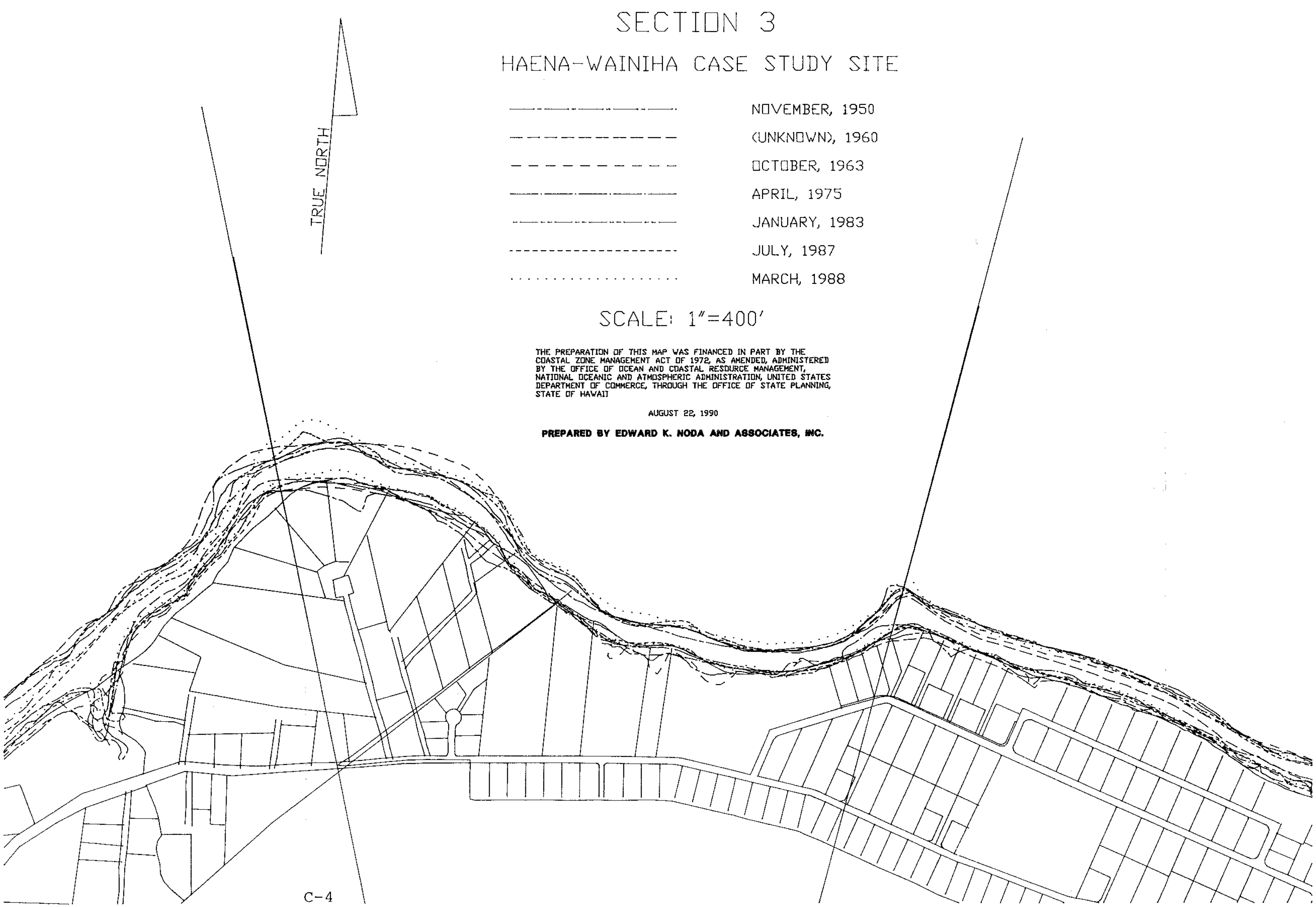
SECTION 3
HAENA-WAINIHA CASE STUDY SITE
NOVEMBER, 1950
(UNKNOWN), 1960
OCTOBER, 1963
APRIL, 1975
JANUARY, 1983
JULY, 1987
MARCH, 1988
TRUE NORTH
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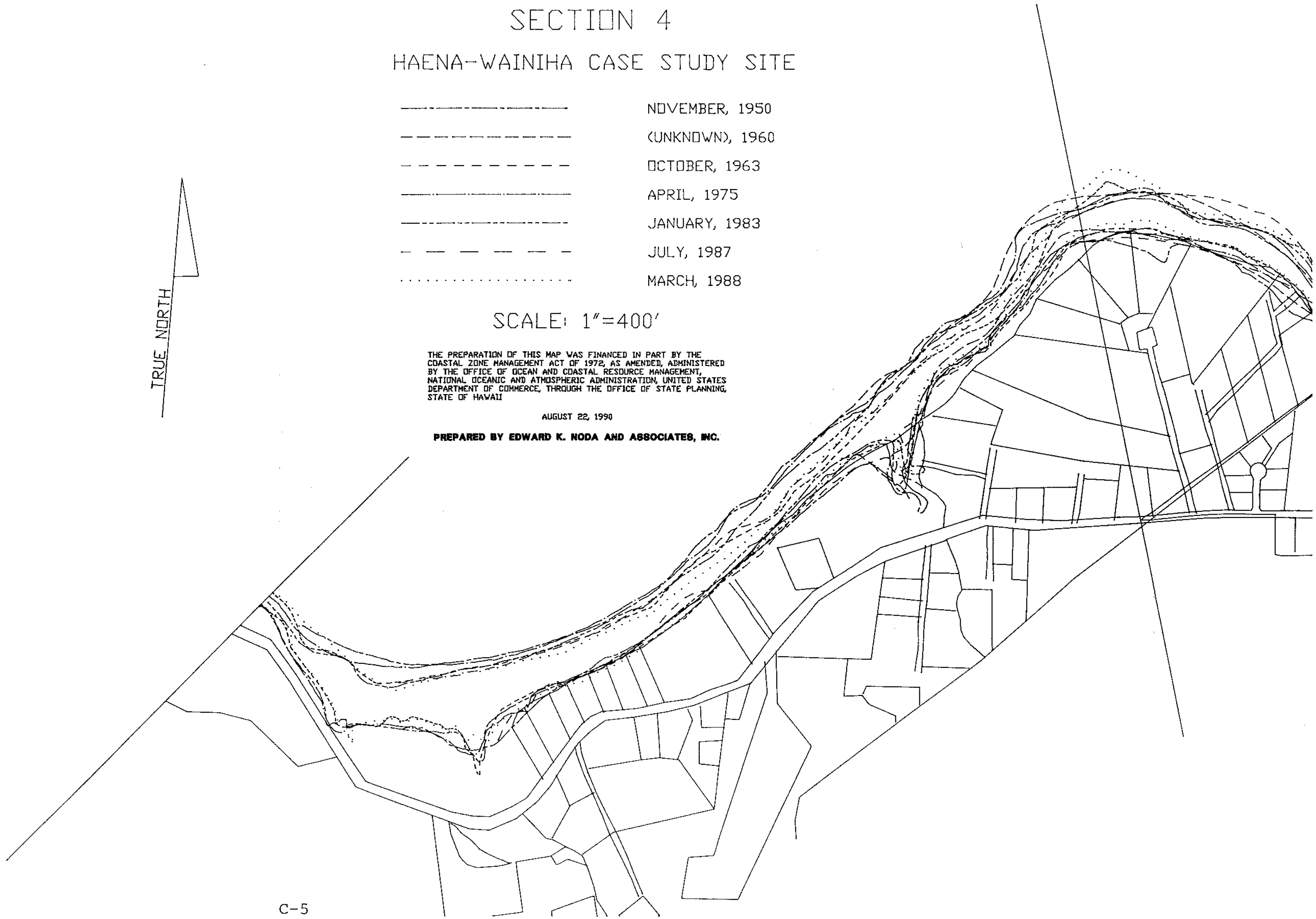
SECTION 4
HAENA-WAINIHA CASE STUDY SITE
NOVEMBER, 1950
(UNKNOWN), 1960
OCTOBER, 1963
APRIL, 1975
JANUARY, 1983
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AUGUST 22, 1990
PREPARED BY EDWARD K. NODA AND ASSOCIATES, INC.
TRUE NORTH

# Appendix D

APPENDIX D

STAND. COM. REP. NO. 1150-90

Honolulu, Hawaii
April 6, 1990

RE: S.B. No. 3292
S.D. 2
H.D. 1

Honorable Daniel J. Kihano
Speaker, House of Representatives
Fifteenth State Legislature
Regular Session of 1990
State of Hawaii

Sir:

Your Committee on Finance, to which was referred S.B. No. 3292, S.D. 2, entitled:

"A BILL FOR AN ACT RELATING TO COMMUNITY FACILITIES,"

begs leave to report as follows:

The purpose of this bill is to grant general powers to the counties to provide, by ordinance, for the establishment of community facilities and special tax districts within each county.

As a result, this bill would provide the counties maximum flexibility in financing necessary special improvements, maintenance, and services.

Your Committee finds that this infrastructure financing alternative is crucial to the quality of life of Hawaii's people and to the long-term success of Hawaii's economy. This measure would present the counties with a creative and flexible means of financing improvements for both infrastructure and community facilities in a timely, responsive manner.

Testimony in support of this measure was submitted by the Department of Finance of the County of Hawaii, the Hawaii Island Economic Development Board, the Chamber of Commerce of Hawaii, and the Land Use Research Foundation of Hawaii.

Technical, nonsubstantive amendments have been made for the purposes of style and clarity.

Your Committee on Finance is in accord with the intent and purpose of S.B. No. 3292, S.D. 2, as amended herein, and recommends that it pass Third Reading in the form attached hereto as S.B. No. 3292, S.D. 2, H.D. 1.

Respectfully submitted,

JOSEPH M. SOUKI, Chairman

CAROL FUKUNAGA, Vice Chairman

ROSALYN BAKER, Member

JERRY CHANG, Member

JULIE DULDULAO, Member

KAREN K. HORITA, Member

MARSHALL K. IGE, Member

LES IHARA, JR., Member

VIRGINIA ISBELL, Member

EZRA R. KANOHO, Member

BERTHA C. KAWAKAMI, Member

JOSEPH P. LEONG, Member

CALVIN K.Y. SAY, Member

HARVEY S. TAJIRI, Member

NOBORU YONAMINE, Member

MICHAEL LIU, Member

BARBARA MARUMOTO, Member

THE SENATE
FIFTEENTH LEGISLATURE, 1990
STATE OF HAWAII

S.B. NO. 3292 S.D. 2 H.D. 1

# A BILL FOR AN ACT

RELATING TO COMMUNITY FACILITIES.

**BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:**

SECTION 1. The purpose of this Act is to grant general powers to the counties to provide, by ordinance, for the establishment of community facilities and special tax districts within each county. It is the legislature's intent to allow the counties maximum flexibility in financing necessary special improvements, maintenance, and services through the establishment of community facilities districts and special tax districts.

SECTION 2. Chapter 46, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"§46- **Community facilities districts.** (a) Any county having a charter may enact an ordinance, and may amend the same from time to time, providing for the creation of community facilities districts to finance special improvements and maintenance or to provide services in the county. The improvements, maintenance, and services may be provided and financed under the ordinance. The county shall have the power to levy a special tax on property located in a district to finance the improvements, maintenance, or services, and to pay the debt service on any bonds issued to finance the improvements. The county may issue and sell bonds to provide funds for the improvements. Bonds issued to provide funds for the improvements may be either bonds when the only security therefor is the properties included in the district or the special taxes thereon, or bonds payable from general taxes or secured by the general taxing power of the county. If the bonds are secured only by the properties included in the district or the special taxes thereon, the bonds shall be issued according and subject to the provisions of the ordinance. If the bonds are payable from general taxes or secured by the taxing power, the bonds shall be issued according and subject to chapter 47.

(b) A tax imposed by ordinance pursuant to this section is a special tax and not a special assessment, and there is no requirement that the tax be fixed in an amount or apportioned on the basis of benefit to any property or that the improvement or service convey a special benefit on any property in the district. The improvement or service may also benefit property outside the district. There shall be a lien for taxes levied pursuant to this section. The lien shall have priority over all other liens except the lien of assessments and general property taxes. The lien of special taxes levied pursuant to this section shall be on a parity with the lien of assessments and general property taxes.

(c) The ordinance may provide procedures for: creating districts (and subdistricts of zones therein); the types of improvements to be made and financed; the types of services and maintenance to be performed and financed; the method of levying and apportioning special taxes on property within the district to finance; the method of maintaining the improvements or services; and the method of paying the costs incurred from the administration and collection of special taxes or from the administration of any bonds.

The ordinance shall provide for the procedures for: providing notice to and opportunity to be heard by affected property owners; fixing the special taxes against the properties within the district; levying, collecting, and enforcing the special taxes (including penalties for delinquent special taxes and sale for default); making changes therein or in the improvements, maintenance, or services to be provided or financed; the acquisition or construction of improvements or the provision of maintenance or services; the issuance of bonds to pay all or part of the cost of improvements (including cost of issuance, reserves, capitalized interest, and any other related expenses); refunding bonds previously issued; and other matters as the council shall determine to be necessary or proper.

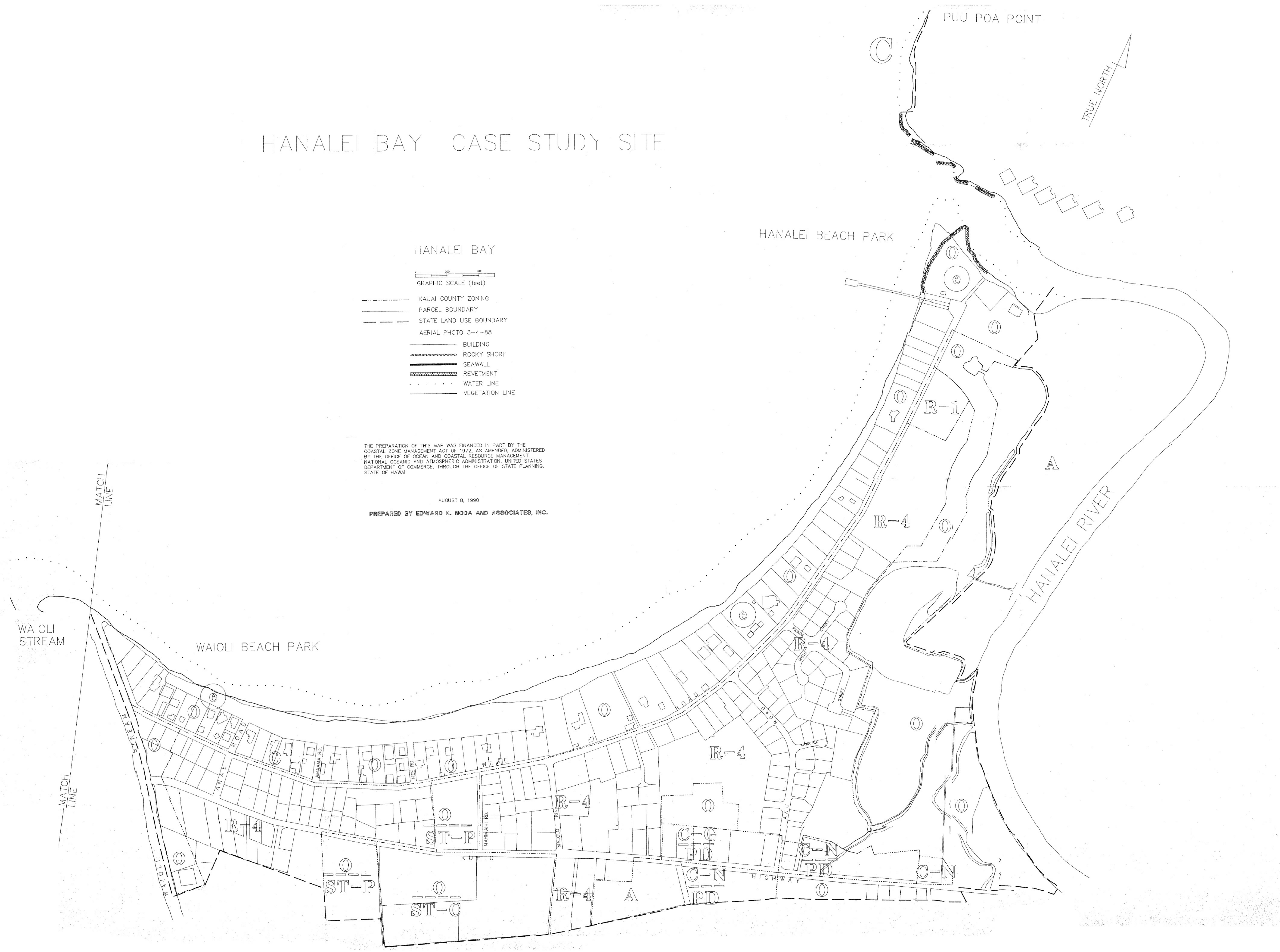
(d) Each issue of bonds shall be authorized by ordinance, separate from the foregoing procedural ordinance, and shall be in such amounts, denominations, forms, executed in such manner, payable at such place or places, at such time or times, at such interest rate or rates (either fixed or variable), with such maturity date or dates and terms of redemption, security (including pledge of special taxes and liens therefor), credit enhancement, administration, investment of proceeds and special tax receipts, default, remedy, or other terms and conditions as the council deems necessary or convenient. The bonds shall be sold in the manner and at the price or prices determined by the council.

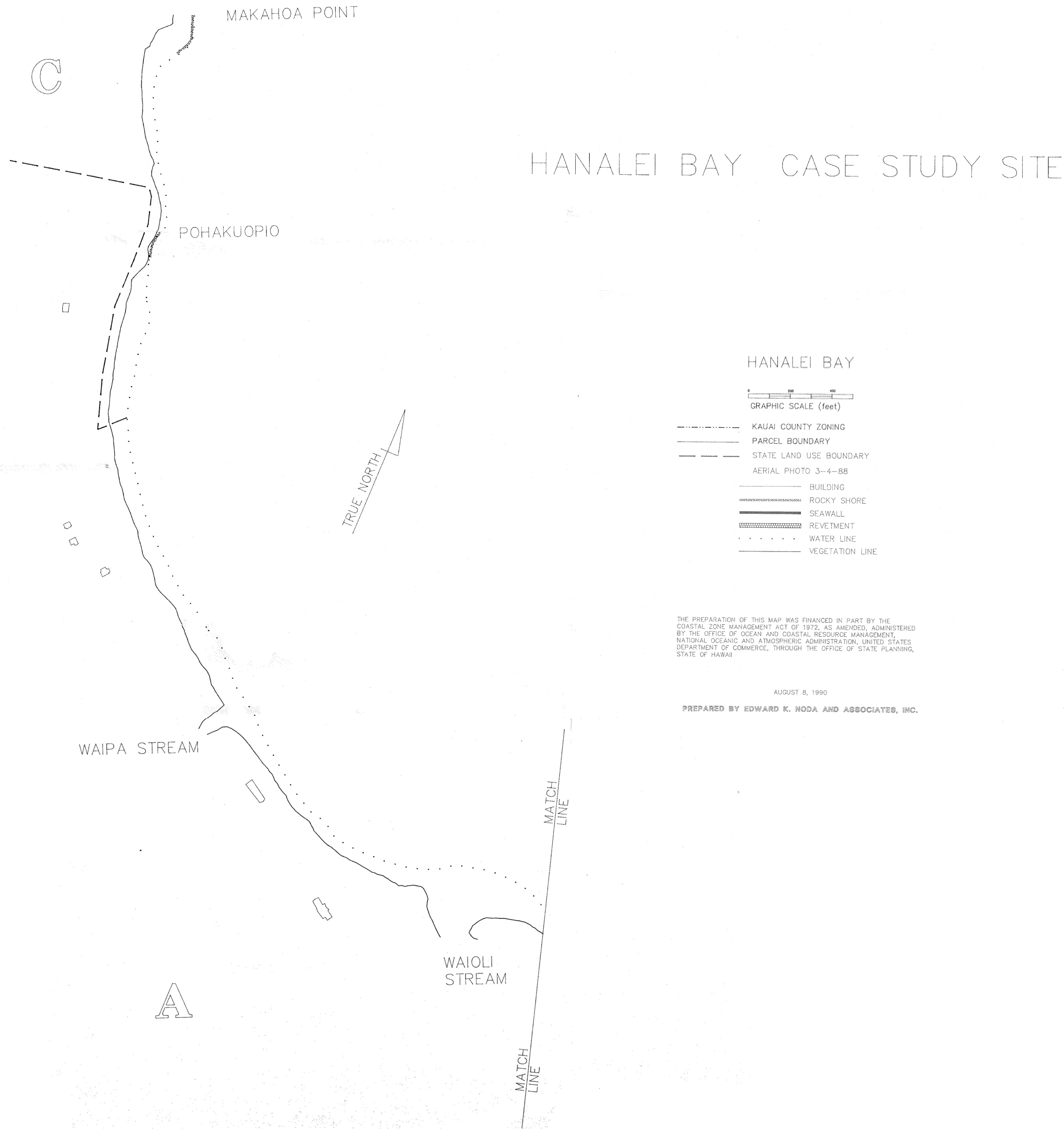
(e) This section provides a complete additional and alternative method of doing the things authorized hereby, and the creation of districts, levying and collection of special taxes, issuance of bonds and other matters covered by this section, or by the procedural or bond ordinances authorized by this section, need not comply with any other law applicable to these matters.

(f) No action or proceeding to question the validity of or enjoining any ordinance, action, or proceeding undertaken pursuant thereto (including the determination of the amount of any special tax levied with respect to any property or the levy thereof), or any bonds issued or to be issued pursuant thereto under this section, shall be maintained unless begun within thirty days of the adoption of the ordinance, determination, levy, or other act, as the case may be, or, in the case of bonds, within thirty days after adoption of the ordinance authorizing the issuance of those bonds."

SECTION 3. New statutory material is underscored.

SECTION 4. This Act shall take effect on July 1, 1990.


HANALEI BAY CASE STUDY SITE
PUU POA POINT
TRUE NORTH
HANALEI BEACH PARK
HANALEI BAY
0 200 400
GRAPHIC SCALE (feet)
KAUAI COUNTY ZONING
PARCEL BOUNDARY
STATE LAND USE BOUNDARY
AERIAL PHOTO 3-4-88
BUILDING
ROCKY SHORE
SEAWALL
REVETMENT
WATER LINE
VEGETATION LINE
THE PREPARATION OF THIS MAP WAS FINANCED IN PART BY THE COASTAL ZONE MANAGEMENT ACT OF 1972, AS AMENDED, ADMINISTERED BY THE OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, UNITED STATES DEPARTMENT OF COMMERCE, THROUGH THE OFFICE OF STATE PLANNING, STATE OF HAWAII
AUGUST 8, 1990
PREPARED BY EDWARD K. NODA AND ASSOCIATES, INC.
MATCH LINE
WAIOLI STREAM
WAIOLI BEACH PARK
HANALEI RIVER
WEKE ROAD
ANAE ROAD
KUHIO HIGHWAY
R-1
R-4
A
O
C-G PD
C-N PD
C-N
ST-P
ST-C


HANALEI BAY CASE STUDY SITE
MAKAHOA POINT
C
POHAKUOPIO
TRUE NORTH
WAIPA STREAM
MATCH LINE
WAIOLI STREAM
A
MATCH LINE
HANALEI BAY
0
200
400
GRAPHIC SCALE (feet)
KAUAI COUNTY ZONING
PARCEL BOUNDARY
STATE LAND USE BOUNDARY
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AUGUST 8, 1990
PREPARED BY EDWARD K. NODA AND ASSOCIATES, INC.

# HAENA - WAINIHA CASE STUDY SITE


GRAPHIC SCALE (feet)

KAUAI COUNTY ZONING
PARCEL BOUNDARY
STATE LAND USE BOUNDARY
AERIAL PHOTO 3-4-88
BUILDING
ROCKY SHORE
SEAWALL
REVETMENT
WATER LINE
VEGETATION LINE

THE PREPARATION OF THIS MAP WAS FINANCED IN PART BY THE COASTAL ZONE MANAGEMENT ACT OF 1972, AS AMENDED, ADMINISTERED BY THE OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, UNITED STATES DEPARTMENT OF COMMERCE, THROUGH THE OFFICE OF STATE PLANNING, STATE OF HAWAII

AUGUST 8, 1990

**PREPARED BY EDWARD K. NODA AND ASSOCIATES, INC.**

# HAENA - WAINIHA CASE STUDY SITE