HAWAII COASTAL EROSION MANAGEMENT PLAN

(COEMAP)

DEPARTMENT OF LAND AND NATURAL RESOURCES

LAND DIVISION

COASTAL LANDS PROGRAM

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

BEACH LOSS IN HAWAII

Beaches Studies conducted at the University of Hawaii[1] show that hardening[2] the shoreline of Oahu where there is chronic coastal erosion causes beach narrowing and beach loss. Researchers have found that on Oahu 10.7 miles of beach has been narrowed by shoreline hardening and 6.4 miles has been lost. This is ~24% of the 71.6 miles of originally sandy shoreline on Oahu.

Beach loss in the state due to hardening of the shoreline is not limited to the island of Oahu[3]. At visits to selected sites and through the review of beach erosion reports[4], beach loss or narrowing leading to recreational impacts have been found equaling 15 miles of actual or imminent losses on the other main Hawaiian Islands. A thorough analysis of all the sandy shoreline in the state would yield much higher numbers of beach loss.

[1] Fletcher, C.H., Mullane, R.A., and Richmond, B.M. (1997) Beach loss along armored shorelines of Oahu, Hawaiian Islands. Journal of Coastal Research, v. 13, p. 209-215.
Coyne, M.A., Fletcher, C.H., and Richmond, B.M. (1999) Mapping coastal erosion hazard areas in Hawaii: observations and errors. Journal of Coastal Research, Special Issue no. 28, p. 45-58.

[2] Shoreline hardening refers to the construction of vertical seawalls or sloping stone revetments along a shoreline to protect coastal lands from marine erosion.

[3] Hwang, D.J., and Fletcher, C.H. (1992) Beach Management Plan with Beach Management Districts. A report prepared for the Coastal Zone Management Program, Office of Planning, 192p.

[4] Makai Ocean Engineering, Inc. and Sea Engineering, Inc. (1991) Aerial photograph analysis of coastal erosion on the Islands of Kauai, Molokai, Lanai, Maui, and Hawaii. A Report to the Office of Planning, Coastal Zone Management Program, Honolulu, HI, 200p.

Beach loss seriously impacts the visitor economy in Hawaii[5] which in 1997 provided 171,900 jobs in the state, accounted for $13 billion in tourism expenditures and supported a payroll of $3.5 billion. Beach narrowing and loss, and shoreline hardening, also severely restrict public access to state conservation lands and natural resources. Public access to beaches and the ocean is a right that is preserved by the State of Hawaii constitution. Beach loss and narrowing, and coastal dune grading that accompanies coastal development causes environmental and ecological damage to natural resources and habitats. Coastal hardening can also produce coastal water quality impacts through increased turbulence and turbidity, and the direct flow of domestic sewage products into coastal waters because of the prevalence of sewage soil filtration (septic and cess pool systems) on shoreline plots. In heavily armored sectors, sand impoundment mauka of walls can lead to general sand volume decreases causing or exacerbating sector-wide erosion trends.

Lands When coastal lands are attacked by erosion it is a natural reaction for shoreowners to protect them. Shorelines are hardened to stop coastal land loss. Segments of the Hawaiian shore are plagued by chronic or episodic erosion that destroys valuable private and public lands and threatens critical infrastructure such as roadways, emergency services, and water treatment plants. To simply let coastal properties erode into the sea, and to allow the heavy financial commitment along our shores come under unmitigated attack by erosion and other coastal hazards would not be a rational management decision.

Hawaii has limited buildable land area and most usable land is at low elevations along coastal plains bounded by the sea on one side, and the mountains on the other. Population centers in Hawaii are typically linked by coastal roadways that are critical to emergency services, utility and power delivery, mainline water and sewage delivery, and the need for commuting by residents.

[5] Travel Industry of America and U.S. Department of Commerce, Office of Tourism Industries (1997) Travel and Tourism Congressional District Economic Impact Study.

Coastal landowners are, on average, citizens paying mortgages and taxes, holding jobs and otherwise gainfully contributing to the economy and society of Hawaii. Many coastal homeowners grew up along the shore and are busy raising their own families. Seeing the loss of their lands by erosion is, for many, a personal and financial disaster. Witnessing the beach loss that frequently accompanies hardening leaves most shoreowners with mixed emotions of sadness, confusion, and bitterness over the seemingly intractable character of their plight.

Ho‘olaulima There is wide agreement that change is needed in our system of coastal land management. Resolving the need to conserve beaches and sustain coastal lands subject to erosion is more than a matter of prohibiting seawalls. Erosion management requires comprehensive and creative land-use tools that are applied in a coordinated fashion with participation by all sectors of the community. However, the direction and specific elements of a new system of coastal lands management are not simple to construct, and may not find universal agreement among all stakeholders.

This document, the Coastal Erosion Management Plan (COEMAP), provides a framework for community discussion and assessment of coastal erosion and beach loss in Hawaii. The objective of COEMAP, and the public dialogue it seeks to foster, is to outline socioeconomic and technical mechanisms for conserving and restoring Hawaii’s beaches in a framework of mitigating erosion impacts and reducing exposure to coastal hazards for future generations.

A series of technical supplements is provided at the back of this document, these include:

1. Technical Supplement, Part A - Summary of Past Erosion Management Efforts in Hawaii.
2. Technical Supplement, Part B - Coastal Erosion and Beach Loss in Hawaii: Facts about beach erosion and the new Coastal Lands Program at DLNR.
3. Technical Supplement, Part C - Causes of Coastal Erosion and Beach Loss in Hawaii.
4. Technical Supplement, Part D – Guidelines for Environmental Assessment of shoreline projects, Office of Environmental Quality Control (OEQC), Department of Health.

Agency efforts to manage erosion, and preserve and restore beaches, must ride on the shoulders of a **strong public outreach and education effort**. The citizens of Hawaii must be made aware of the difficulty of managing the erosion problem, and there must be a heightened public value given to coastal and marine resources in general, and beaches in specific. Successful stewardship will require a flexible policy of **interagency coordination and community participation** built upon trust, leadership and experience. Participants in renovating our coastal management system must come to the table willing to define levels of acceptable change to past practices of coastal use.

Options for managing erosion are expensive, difficult, and will rarely prove completely satisfactory to all stakeholders. Despite this, the problem must be met with optimism, commitment, and a dedication to work together for success or the children of Hawaii will suffer because we were not willing to make the necessary difficult choices.

GOALS AND DIRECTIONS

There is no cookbook for managing erosion, and COEMAP is not a set of instructions. But individuals working on the problem in Hawaii[6] and throughout the nation have identified certain steps that will improve the current erosion management regime in Hawaii. The following goals represent broad targets for improving the erosion management system in Hawaii.

1. The lead agency for coastal erosion management and beach conservation is the Coastal Lands Program (CLP) at DLNR. **The CLP needs to be empowered, and funded** with a specific revenue source with a nexus to coastal lands. One important early

[6] Challacombe, A. (1997) Beach Management in Hawaii: A Public Sector Perspective. Hawaii Planning, v. xviii, no. 6, p. 5, June, Monthly Newsletter of the Hawaii Chapter of the American Planning Association; and, Hwang, D. (1997) Protecting Our Beaches: Balancing Public and Private Interests. Hawaii Planning, v. xviii, no. 6, p. 7, June, Monthly Newsletter of the Hawaii Chapter of the American Planning Association.

step toward empowerment is for the CLP to **issue guidelines for permits** for activities that have the potential to impact beaches and dunes and coastal environments. Office of Environmental Quality Control coastal EA guidelines already exist and could be adopted by the CLP. It is important that such guidelines are adopted by other stakeholder agencies. The CLP should promote adoption of COEMAP and OEQC guidelines throughout state government so that there exists **a consistent and uniform policy of erosion management** at the state level.

2. Encourage state and county decision-makers to **consider erosional trends and processes, and other coastal hazards, at the zoning and subdivision stages** of land development so that structures can be safely and properly located away from hazard areas. This action would prevent burdening landowners and regulatory agencies with foreseeable coastal hazard issues at a later date.

3. Implement **beach and dune restoration with sand nourishment** as a viable management option in Hawaii. **Streamline and coordinate the permitting** necessary to achieve this goal and improve interagency coordination and communication.

4. Implement a **continuous source of scientific data and research products** so that land managers can achieve expert status on the physical processes and geographic patterns of erosion hazards and the technical aspects of its management.

5. Create and maintain a **continuous public education and awareness campaign** so that all citizens can learn to value coastal natural resources and can become participants in the decision-making process for sustaining our coastline.

6. Establish **coastal land acquisition programs** to negotiate purchases from willing sellers of coastal lands that have high public resource value and that constitute erosion management concerns and coastal hazard risks. This program would have among its goals the restoration and revitalization of coastal lands and environments, increasing public access, improving coastal ecological systems and processes, releasing impounded sands, and rejuvenating scenic beauty and amenity.

7. Develop a **Technical Guidance Manual that provides direction for the development, restoration, and redevelopment of the coastline**. The manual[7] would be used on a voluntary basis, but through common usage could become a standard for the safe, economical, and sustainable utilization of the coastline. Creation and development of such a manual will require funding through the various responsible stakeholder agencies, and could take place on a component by component (i.e., chapter by chapter) basis as needs arise. The manual could provide direction during zoning and subdivision stages of development so that coastal lots are created of sufficient dimension and size to maintain a buffer between the shoreline and proposed structures. The manual could provide direction during the zoning of lands so that on large lots, structures are built away from the shoreline on the mauka portion of the lot. There are certain portions of our shoreline where existing development patterns offer a good demonstration of properly located structures with sufficient buffers against erosion hazards. On Oahu, these include portions of Waimanalo, Kailua, and Kahuku where setbacks have been utilized that exceed the present 40ft requirement.

   The manual could also offer guidance and recommendations for implementing actions on already developed shorelines where erosion hazards constitute management concerns.

RECOMMENDATIONS

COEMAP offers the following detailed recommendations to improve erosion

[7] Maui County has already moved in this direction with the creation of a Technical Guidance Manual: "Coastal Protection and Beach Restoration Feasibility Study, for Maui County, Oceanit Laboratories Inc., Nov. 1997, 122p."

management in the state of Hawaii. These recommendations are:

1. **Develop, fund, and empower the Coastal Lands Program at DLNR** as the Lead Agency for coastal erosion management.
2. **Consider erosional trends and processes, and other coastal hazards, at the zoning and subdivision stages** of land development so that structures can be safely and properly located away from hazard areas.
3. Develop a **Technical Guidance Manual that provides direction for the development, restoration, and redevelopment of the coastline**. The manual[8] would be used on a voluntary basis, but through common usage could become a standard for the safe, economical, and sustainable utilization of the coastline.
4. **Enhance Interagency Coordination.** Agencies should improve and standardize permit processing criteria, develop and agree upon acceptable guidelines for constructing Environmental Assessment and permit applications for activities in the shore zone, and build an organized and consistent system of erosion management and resource conservation among CZM, CLP, OEQC/DOH, and the counties and federal COE.
5. **Implement a Pilot Shoreline Hazard Mitigation Project Using Beach and Dune Restoration.** This single tool, though expensive and complex, holds the greatest possibility of replacing the historic system of shoreline hardening in Hawaii. A pilot project, predicated upon identifying technical and socioeconomic factors that would enhance it's success and the longevity of the restored environments, is an extremely important step for Hawaii to achieve.
6. **Establish a continuous datastream, and formalize an enduring data source from the UH-SOEST by creating a branch of the NOAA Coastal Services Center.** The integration of scientific data is sporadic and haphazard, often dependent upon the vagaries of funding, project specific investigations, and the availability and goodwill of individuals. This is fragile footing for an essential component of good coastal management.
7. **Establish a broad, pervasive and enduring public education and awareness-building campaign.** Few government objectives can be realized without the support of the public, and the public cannot support what it does not understand. There are many avenues to build public awareness through the media, the Department of Education, special events and functions, a print campaign, slogans, themes and other techniques
8. **Evaluate the applicability of "willing-user," community-based performance standards and/or planning districts as erosion management tools at erosion hotspots.** A significant challenge to coastal managers is the restoration and redevelopment of densely populated and developed coastal communities where chronic erosion conflicts with beach conservation goals. One equitable approach is to develop "willing-user," community performance standards for guiding changes to land use as future needs arise. Performance standards could be implemented in a framework of management authority that focuses on controlling erosion through resource conservation. Performance standards act as targets for modifying the land use pattern through future redevelopment efforts. Such targets would avoid penalizing current tenants, yet would establish community goals for achieving reduced exposure to coastal hazards and restoring beach and dune environments. Setting performance standards is a form of *minimization* that can be implemented through time on a schedule determined by the landowner through the redevelopment and renovation of existing structures and voluntary changes in land usage.
9. **Fund Coastal Land Acquisition Programs – Ho'opono Kahakai.** Create a coastal land

[8] Maui County has already moved in this direction with the creation of a Technical Guidance Manual: "Coastal Protection and Beach Restoration Feasibility Study, for Maui County, Oceanit Laboratories Inc., Nov. 1997, 122p."

acquisition fund based upon negotiated purchase and willing-seller concepts. This fund will focus on restoring degraded coastlines to a high level of health and sustainability.

10. **Establish a General Permit for Beach and Dune Restoration.** This would be in the best interest of facilitating the use of restoration as a viable option, and reducing the workload of agencies. A General Permit would help to coordinate agency efforts and identify areas of overlapping concern such that the permitting process can be made more efficient without sacrificing the present high level of environmental and ecological safeguards.
11. Restoration is not a Permanent Solution – **Plan for Renourishment and Redevelopment**. Planning for post-restoration realities must proceed on a parallel track, and integrated with, any restoration project.
12. **Adopt, or alter for adoption, the OEQC quidelines for Environmental Assessment of shoreline projects** that were submitted for public commentary in the November 23, 1995 OEQC Environmental Notice. These guidelines are presented in Technical Supplement, Part D (pg. 79).
13. **Focus regulatory efforts and build local expertise** among agency personnel. If we are to improve the erosion management regime in Hawaii, energy and effort must be focused on those localities where there is beach degradation and where active permitting issues arise.
14. Regulators need to **develop littoral sector-specific planning objectives and goals to provide decision-making criteria.** Decision-making authorities and regulators need clear and unambiguous information on littoral processes, sand resources, historical erosion and accretion rates and projected future patterns, development patterns, land ownership histories, land-use trends, structure permitting histories, and other scientific and socioeconomic trends and patterns at areas where erosion management decisions must be made. Regulatory decisions are complex and require evaluation and analysis of numerous and interdependent factors. This is best achieved with pre-established decision-making criteria.
15. Create a system of **Research Products resulting from technical studies** of coastal processes and sand resources. Coastal managers and administrators need improved data on erosion patterns and rates around the state. The scope and characteristics of the erosion problem need to be factually determined at a high resolution, at least to the parcel scale.
16. **Implement a small-scale nourishment General Permit**. The Coastal Lands Program (CLP) at DLNR has proposed to establish a Small-Scale Beach Nourishment Program pursuant to the CDUP process and in collaboration with the COE State Program General Permit (SPGP) for expediting small-scale beach nourishment projects and information gathering. A draft version of this program is contained in Technical Supplement, Part E.
17. Coastal erosion is an active and dynamic agent on our shorelines even during the current period of increasing well-defined and viable management options. Hence, there is an immediate need to **provide a management response to emergency situations** confronting private and commercial landowners. It is important to develop a technical approach to **control interim coastal erosion** on residential lands where a short-term or seasonal wave-related erosion hazard exists, and where long-term erosion trends have created user conflicts.
18. **Implement an "Erosion Control" approach where feasible**. This could include offshore breakwaters, and certain types of attached structures (T-head groins) used in combination with nourishment to stabilize particularly dynamic beach segments where erosion would be controlled effectively without negative impacts to adjoining beaches, or the sediment budget of a littoral cell. The design and specifications of this approach should be conducted by professionals in coastal engineering with an established record of successful use.

Permitting authorities may wish to **adopt the PE Seal (Professional Engineer) as one criteria for accepting permit applications** for erosion control projects.

19. **Analyze Economic Factors**. The economic factors governing the implementation and feasibility of various coastal management alternatives is poorly understood in Hawaii. Economic data designed to identify the necessary funding and benefit/cost rationale of management options will be critical to establishing a framework for implementing a new paradigm of coastal management.
20. **Integrate Hazard Mitigation and Coastal Conservation**. Erosion is only one of several natural hazards that present management challenges along the Hawaiian coast. High winds and associated marine flooding, tsunami flooding, sea-level rise, high waves, stream flooding on coastal plains, landslides, and seismic and volcanic hazards all increase the risk exposure along developed coastal lands.

INITIAL IMPLEMENTING ACTIONS

COEMAP ends with a series of initial implementing steps that emphasize the need for efficiency and direct action for putting into place some of the more expedient tools that regulators can use to improve our erosion management system.

1. **Empower and fund the CLP** so that they can begin to implement specific programmatic and planning tools such as utilizing environmental sequencing, establishing a willing-seller acquisition program, facilitating community-based performance standards, and reviewing and amending the shoreline certification procedure.
2. **Improve interagency collaboration** with frequent MACZMAG Erosion Subcommittee meetings and interagency consultations, with a General Permit for Small-Scale Nourishment, by adopting COEMAP on a state-wide basis, defining standardized coastal EA guidelines, and spearheading an education and awareness effort.
3. **Institutionalize a data stream** to regulators using the UH-SOEST as the home base for a new NOAA Coastal Services Center in Hawaii.
4. **Define and identify statutory and rule changes** necessary to improve erosion management. These could include altering the accreted land law and the offshore mining law, establishing a shoreline monument system for beach monitoring and shoreline certification surveying, and facilitating the creation of General Permits for coastal restoration activities.
5. **Simplify the regulatory system** for conservation and hazard reduction activities requiring permits.
6. Improve decision-making and planing with **site-specific littoral land-use, natural resource, and physical process information**.
7. Establish a **no-tolerance policy toward new encroaching structures**. Enforce the policy using environmental sequencing criteria for avoidance, minimization, or compensatory mitigation of impacts.
8. **Use fines and revocable easements as a system of compensatory mitigation** for existing encroachments.
9. **Build consensus among agencies and communities** for the concepts and tools that will characterize the new erosion management system.
10. **Create a special fund for coastal management at CLP** using resource value land revenues and other funds that offer an alternative to legislative appropriations.
11. **Publicize the new policy of compensatory mitigation** guidelines for encroachments to conservation lands. Consider adopting the same system to county encroachments.
12. **Identify sources of federal funding** for hazard reduction and environmental restoration in Hawaii.
13. **Review management plans and planning goals for county and state beach parks** and confirm that current maintenance activities enhance the natural resources.
14. **Distribute COEMAP** to stakeholder agencies and NGO's for comment.
15. Develop and initiate a **public awareness and education campaign**.

16. Specifically **approach coastal user organizations for input**, including land-owner groups, community organizations, environmental groups, land trusts, development groups and others, with education efforts and seek their input.
17. Develop an **interim erosion mitigation** and lands protection system for owners with legitimate fears of major land losses, define the interim period of use, and work toward establishing a longer-term erosion management system for the sector under erosion stress.
18. **Implement beach and dune nourishment** plans in order to actualize a pilot restoration project.
19. Use the COE-SPGP to **establish a small-scale nourishment program** at DLNR.
20. **Engage in an ongoing evaluation** of the viability of COEMAP concepts to gauge their effectiveness at achieving stated goals.
21. **Plan the creation of a Technical Guidance Manual** for eventual use by all coastal stakeholders including agencies and NGO's to improve our system of erosion and coastal hazard management.

I. OUR RESTLESS SHORE

FOREWORD

Article X of the Hawaii State Constitution mandates the state to conserve and protect Hawaii's natural resources for the benefit of present and future generations. As the trustee of Hawaii's beaches, the Department of Land and Natural Resources (DLNR) has initiated a comprehensive program, the Coastal Lands Program (CLP), to save this precious natural resource for our future. This effort is guided by the doctrine of sustainability promoting the conservation, sustainability and restoration of Hawaii's beaches for future generations.

Windward Oahu. Coastal development, besieged by chronic erosion, has historically relied on shoreline hardening for protection. In many cases this has caused beach narrowing, beach and dune loss, and has restricted public access along miles of the Hawaiian coast. COEMAP provides a framework for decision-making and implementation to better manage the problem of coastal erosion and to improve the conservation of our beaches and dunes.

A. WHY COEMAP?

This document, the Coastal Erosion Management Plan (COEMAP), provides a framework for discussing, assessing, understanding, and ultimately managing the problem of coastal erosion and beach loss in Hawaii. Its foundation is affirmed and strengthened through the participation of coastal landowners, the beach-going public, government agencies and officials, commercial interests, local planning and engineering firms, and other stakeholders. The objective of COEMAP, and the public dialogue it seeks to foster, is to define legal, scientific, socio-economic, and engineering mechanisms for preserving, sustaining and restoring Hawaii's beaches for future generations.

As far as possible, decisions to best achieve improved erosion management should arise from an informed and open exchange among all participants. COEMAP is one source of information for that exchange. COEMAP builds upon past efforts to increase understanding of the problems and issues and to develop mechanisms to improve erosion management in Hawaii. A summary of past erosion management efforts (prior to 1994) is provided in the Technical Supplement, Part A, which is a staff report of the Hawaii Coastal Zone Management Program[9].

Agency efforts to manage erosion, and preserve and restore beaches, should ride on the shoulders of a strong public outreach and education effort. Successful stewardship will require a flexible policy of interagency coordination built upon trust, leadership and experience. These efforts must also be guided by the wisdom and advice of those with knowledge in the legal, scientific, socio-economic, and engineering sectors of coastal lands management.

The complexity of achieving these goals demands a common level of education and familiarity among all participants. COEMAP serves as a source of information and provides a

[9] Technical Supplement, Part A, "The Hawaii Coastal Zone Management Program Beach Management Effort." CZM Staff Report, February (1994), 17p.

discussion of the issues. It offers recommendations for action, and describes alternatives for consideration among concerned parties. Consistent with the goal of improved public awareness, DLNR, in association with the Hawaii Sea Grant College, issued a pamphlet in 1998 titled "Coastal Erosion and Beach Loss in Hawaii: Facts about beach erosion and the new Coastal Lands Program at DLNR." A copy of this pamphlet is reproduced in the Technical Supplement, Part B[10].

A long and unfortunate history of beach loss along the Hawaiian shoreline illustrates the need for a renewed erosion management system. It is useful, therefore, to articulate a statement of the problem arising from coastal erosion in Hawaii such that there is a demonstrated purpose underlying new management strategies. This report documents the loss or narrowing of approximately 24% of the sandy beaches on the island of Oahu over the 20th century and discusses technical aspects of managing erosion. COEMAP ends with a series of policy and technical recommendations for consideration by stakeholder agencies.

B. LOSING OUR BEACHES

A study conducted at the University of Hawaii[11] documents the problem of beach loss due to hardening the shoreline of Oahu (Table 1). Using an analysis of aerial photographs from 1928 or 1949 to 1993, researchers found that armoring a coastline experiencing chronic erosion leads to beach loss, probably through the process of *passive erosion*, as described by Pilkey and Wright[12]. Passive erosion is simply the continued retreat of a beach on an armored shore, such that the beach eventually disappears because it is prevented from further movement when it meets a wall (see diagram). Passive erosion as a cause of beach loss is not unique to Hawaii and has been observed in other studies (Tait and Griggs, 1990; Kraus, 1988[13]; and others). It is probable that sand

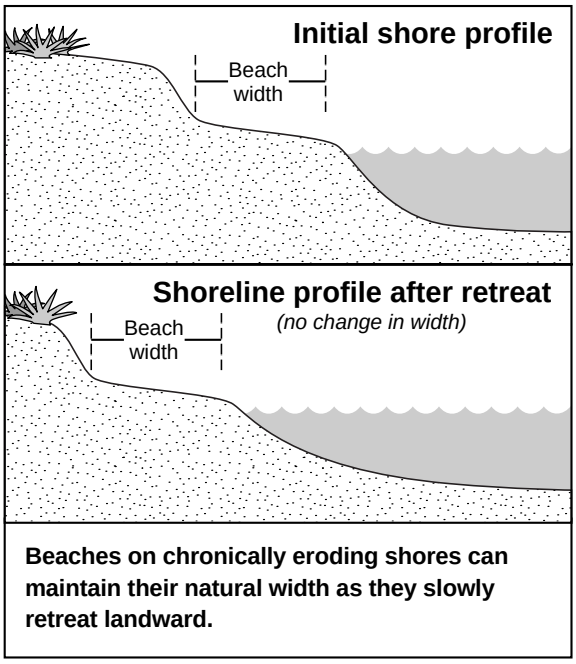
[10] Technical Supplement, Part B, "Coastal Erosion and Beach Loss in Hawaii: Facts about beach erosion and the new Coastal Lands Program at DLNR." DLNR Coastal Lands Program (1998), 2p.

[11] Fletcher, C.H., Mullane, R.A., and Richmond, B.M. (1997) Beach loss along armored shorelines of Oahu, Hawaiian Islands. Journal of Coastal Research, v. 13, p. 209-215.

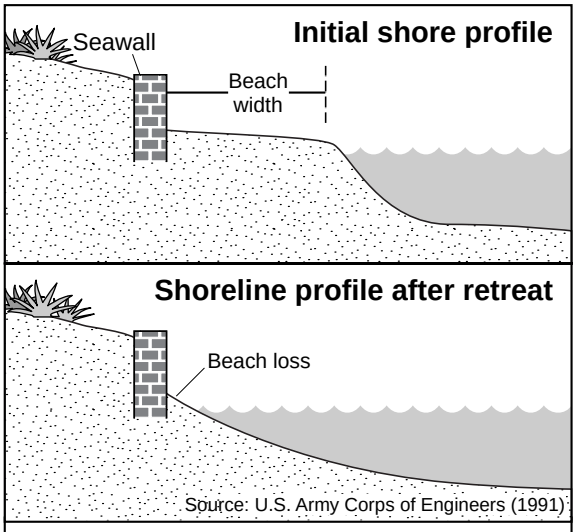
[12] Pilkey, O.H., and Wright, H.L. (1988) Seawalls versus beaches. Journal of Coastal Research, Special Issue, 4, p. 41-64

[13] Tait, J., and Griggs, G. (1990) Beach response to the presence of a seawall. Shore and Beach, v. 58, p. 11-28; Kraus, N.C. (1988) The effects of seawalls on the beach: an extended literature review. Journal of Coastal Research, Special Issue 4, p. 1-28.

Shoreline Hardening and Beach Loss



Beaches on chronically eroding shores can maintain their natural width as they slowly retreat landward.



Beach loss eventually occurs in front of a seawall where there is chronic erosion.

impoundment mauka (landward) of a seawall is a contributing factor to chronic erosion[14]. Fletcher et al., found that on Oahu, 17.3 ±1.5 km (10.7 miles) of beach has been narrowed

[14] Pope, J. (1997) Responding to coastal erosion and flooding damages. Journal of Coastal Research, v. 13, p. 704-710.

TABLE 1

BEACH NARROWING AND LOSS ON OAHU

	Mokuleia	Kaaawa	Kailua-Waimanalo	Maili-Makaha	**Island-wide**
A. Originally sandy (km)	12.2±1.0	7.5±0.6	15.5±1.3	6.0±0.5	**115.6±9.8**
B. Narrowed beach (km)	2.1±0.2	3.2±0.3	0.9±0.1	1.3±0.1	**17.3±1.5**
C. Lost beach (km)	0.2±0	0.8±0.1	1.6±0.1	0.2±0	**10.4±0.9**
D. Degraded beach	18.7%	53.6%	16.3%	24.9%	**23.9%**
E. Short-term, maximum shoreline change rate (m/yr)	-5.1 to 7.7	-5.8 to 14.0	-6.4 to 5.1	-2.2 to 4.0	not calculated
F. Net shoreline change rate (m/yr)	-0.2 to 0.3	-1.7 to 1.8	-0.9 to 0.6	-0.4 to 0.6	not calculated
G. Non-armored mean sandy beach width	26.8 m	13.2 m	22.4 m	43.7 m	not calculated
H. Armored mean sandy beach width	12.8 m	8.9 m	7.1 m	24.5 m	not calculated
I. Mean long-term shoreline change rate for armored sites (m/yr)	-0.2	-0.3	-0.6	-0.5	not calculated
J. Range of shoreline change rates for armored sites (m/yr)	-0.1 to -0.3	0 to -1.7	0.2 to -1.8	-0.2 to -1.0	not calculated

- 97.4 per cent of armored beaches experienced chronic erosion prior to the period of narrowing.
- 92.1 per cent of armored beaches experienced long-term (>12 yr) chronic erosion prior to narrowing.
- Island-wide, all narrowed beaches are on armored shorelines.

by armoring and 10.4 ±0.9 km (6.4 miles) has been lost by this process. This is ~24% of the 115.6 ±9.8 km (71.6 miles) of originally sandy shoreline on Oahu.

Along certain coasts it is known why erosion occurs. Many times, however, the causes of erosion are hidden and even after close study scientists and engineers are not able to definitively, and quantitatively pinpoint all original causes. Nonetheless, it is important that erosion mitigation and management plans are predicated upon some effort to understand the causes of erosion. This can be achieved through examination of past land use patterns including sand mining, circumstances of reef degradation, analysis of historical aerial photos and beach profiles, the history of storms and wave events, and the recollections of long-time shorefront users. By integrating these sources of information with an understanding of coastal sedimentary processes, it is often possible to characterize the most likely causes of erosion at a particular shoreline.

In broad terms, it is thought that the erosion of coastal lands is caused either singly or in combination by sea-level rise, wave and current action, or sediment deficiencies. These each are discussed with regard to Hawaii in the Technical Supplement, Part C[15].

1. Coastal Erosion vs. Beach Erosion

Coastal erosion and beach erosion are not the same, though they are related. Coastal lands may

[15] Technical Supplement (Part C) "Causes of Coastal Erosion and Beach Loss in Hawaii." 6p.

experience long-term, chronic erosion under some conditions. Coastal lands are typically composed of sand in Hawaii, so that as they erode and shift their position landward, they release a supply of sand to the adjoining beach. The beach then, remains wide and healthy even as it moves with the eroding coastline. If sand is not available to a beach on a chronically eroding coast, then beach erosion will ensue, leading to beach narrowing and eventually beach loss.

Beach narrowing and loss occurs where sand supplies are diminished, or discontinued. Where chronic erosion of coastal lands leads to shoreline armoring (the construction of seawalls and revetments, also known as shoreline hardening), usually on shorelines experiencing long-term retreat, sand supplies are typically interrupted and nearby beaches experience a decrease in sand volume. The original causes of chronic coastal erosion are typically a combination of wave and current action, sea-level rise, and/or sediment deficiencies caused by human activities[16]. In addition to Oahu, significant beach losses have occurred on all Hawaiian Islands, especially the island of Maui, and to a lesser degree, on Kauai and Hawaii.

Beach loss incurs costs to all aspects of Hawaiian life. The local populace of Hawaii throngs to the beaches for the enjoyment of ocean access, socializing, exercise, being alone and being together. The beaches are among the principle reasons many Hawaiians call these islands home. On sunny weekends and holidays, literally tens of thousands of residents can be found playing and communing along our sandy shorelines. As beaches disappear, the fabric of life in Hawaii will change and the daily miracle of living among these islands will lose its luster.

The ecology of shorelines is destroyed when beaches disappear. Further damage occurs with the frequently unrecognized demise of coastal dunes which are often leveled and graded (covered) with topsoil when shorelines are developed. Continued beach loss will undoubtedly impact our visitor industry, the principal engine driving the economy. Tourism in the state is closely tied to the quality of Hawaiian beaches. As visitors find access difficult to shorelines lined by seawalls and crowded with development, they will come to realize that our beaches are degraded, that coastal vistas are no longer pristine, and that fulfilling opportunities to experience the Hawaiian shore depicted by the visitor industry are rare. Beaches are a critical component of the tourism infrastructure, like all infrastructure, they must be maintained. Conserving beaches is an economic as well as environmental responsibility of our system of land management. Resolving beach loss should be the business of every Hawaiian citizen, the day may come when continued beach loss will make a mark in everyone's life.

Beach loss, however, does not occur in a vacuum nor without rationale. In nearly all cases the same seawalls and revetments that are damaging beaches are simultaneously protecting valuable coastal property. Along residential shorelines, the ownership of property, as in any neighborhood around the nation, is the focus of the day-to-day activities of families and hard-working individuals from all walks of life. Coastal lands, like all lands, are owned by a cross-section of Hawaiian society. From absentee owners who may rent their lands, to long-time kamaaina families that trace their roots on our shoreline through the centuries, it is difficult to watch one's land wash into the waves without taking action. Coastal lands are all the more valuable in light of the limited buildable land area and restricted resources of our island home. Not only residences, but roadways, sewage lines and treatment plants, harbors, airports, commercial facilities and all manner of public infrastructure may be found along our shores. To simply let our coastal investments and human efforts wash into the sea would not be a rational management decision.

C. COASTAL HAZARDS

Erosion is not the only hazard impacting coastal development. Tsunami's, hurricanes, periods of large waves that occur seasonally, kona (southerly) storms, high wind events, stream flooding at the coast, undercutting and slumping of steep shores, and long-term sea-level rise are

[16] Mullane, R. and Suzuki, D. (1997) Beach Management Plan for Maui. Prepared by University of Hawaii Sea Grant Extension Service and County of Maui Planning Department, 41p.

all natural processes that are of concern to land managers and coastal land owners[17].

Bay and Bay[18] describe the situation from the government's perspective. Government has an inherent stake and an expressed obligation to protect the lives and property of its citizens. Mitigating damage from coastal hazards reduces the heavy burden placed on limited public fiscal resources.

Hurricane Iniki, for example, caused $1.6 billion in losses to residential property, visitor accommodations, public utilities, public buildings and agriculture[19]. Recovery from these losses required state public assistance of over $17 million, federal assistance of $621 million, and private assistance exceeding $38 million. Iniki caused over $67 million in damage to state and county property, and 2 years later Kauai County remained in an economic recession with tourism down by 20 percent, auto sales down by 45 percent, jobs down by almost 8 percent, and an unemployment rate over 20 percent. Kauai County lost an estimated $14 million in property tax revenue during 1993 and 1994.

All these losses strain government assistance programs and result in tax losses at all levels. For these reasons, and to enhance beach conservation in an era of migrating shorelines and dynamic weather patterns, it is in government's interest to discourage inappropriate shoreline development in known hazard areas, including erosion hazard zones.

Coastal hazard reduction can be achieved if structures are set back a rational distance from the shoreline, elevated above expected flood or water levels, and built according to appropriate construction specifications. These actions, with additional land use guidelines detailed in this plan, are compatible with beach conservation and preservation measures. Hence it is in the best interest of regulatory authorities to pursue the compatible goals of beach conservation and hazard reduction using an integrated framework.

D. HO'OLAULIMA

(many hands working together)

Solutions to the apparent conflict of landowner expectations on retreating coastlines subject to coastal hazards, are not easy, they are not cheap, and they will require that all parties come to the table willing to define levels of acceptable change to past practices of coastal use. Parties with aspirations to conflict, to place blame, and guided by distrust, will achieve only dissension, discord, and ultimately failure. The result will be continued beach loss. Parties with the intention to compromise, to reach understanding, and to work in the spirit of achievement and accomplishment will promote the ability of this generation to pass on a healthy and viable coastal environment to our children and grandchildren. Options for managing the erosion problem are expensive, difficult, and will rarely prove completely satisfactory to all stakeholders. Despite this, the problem must be met with optimism, commitment and resolve or the children of Hawaii will suffer because we were not willing to make the necessary difficult choices.

The Board of Land and Natural Resources circulated COEMAP for comment in 1997 as an element of departmental policy to promote the sustainable use of coastal resources, including beaches. All aspects of COEMAP were exposed to public scrutiny through a year-long process of public presentations and discussion groups. This public awareness effort is ongoing and will be continuously sustained. Outreach and awareness building is the first level of implementation of COEMAP recommendations. Importantly, the ideas in COEMAP provide a conduit for feedback and conflict resolution that is a critical part of the envisioned management framework. Indeed, COEMAP is an organic document,

[17] Fletcher, C.H., and others (1994, and new edition *in press*) Atlas of Natural Hazards in the Hawaiian Coastal Zone. State of Hawaii, Coastal Zone Management Program, Honolulu, and U.S. Geological Survey, Menlo Park, 400p.

[18] Bay, J. and Bay, M. (1996) Reducing hazards in shoreline areas: policy and legal options. A report from the Coastal Acquisition Project, Phase II, Hawaii Coastal Zone Management Program, 15 p.

[19] Hamnett, M., Davidson Oh, K.G., and Bryant, K. (1996) Hawaii Coastal Hazard Mitigation Planning Project, Phase II: Findings and Recommendations. Hawaii CZM Program, Honolulu, 27p.

meaning that it is ever-evolving, and it's purpose is to incorporate new information and learned lessons to improve the erosion management system in Hawaii.

COEMAP should be read by all coastal stakeholders, including: State and County authorities, the commercial and residential development industry, land-use managers and planners, coastal consultants, coastal residents, public-interest groups, and the general public.

II. MANAGING COASTAL EROSION

A. HAWAII'S CURRENT MANAGEMENT REGIME

The coastal management structure that has evolved in Hawaii consists of three layers of jurisdiction, with varying degrees of overlap and prescribed coordination. Oceanit, Inc. and Sullivan[20] and Lacayo Planning, Inc. and Sea Engineering, Inc.[21] present an overview of the erosion management framework in Hawaii.

1. Federal Authority

Federal authority applies to the navigable waters of the United States, which extend from the mean high water mark seaward to the 200 mile limit of the Exclusive Economic Zone. The federal government administers these waters through the U.S. Army Corps of Engineers (COE) and their Department of Army Permit (DA). The DA permit must be obtained for virtually any construction fill and dredge or discharge activities. Private ownership of the land beside, or below, or near the site of permitting does not change the need for a DA permit. The regulatory authorities and responsibilities of the COE are prescribed in the following laws:

1. Section 10, Rivers and Harbors Act of 1899 (33 USC 403) – prohibits the obstruction or alteration of navigable waters of the United States without a COE permit;
2. Section 404, Clean Water Act (33 USC 1344) – prohibits the discharge of dredged or fill material into waters of the United States without a COE permit; and
3. Section 103, Marine Protection, Research and Sanctuaries Act of 1972, as amended (33 USC 1413) – authorizes the COE to issue permits for the transportation of dredged material for the purpose of dumping it into ocean waters[22].

The COE will not approve any projects until all other applicable state and county permit requirements have been satisfied.

In addition to navigable waters authority, federal jurisdiction is triggered for projects needing a federal permit, if significant federal funding is involved, or if any major federal action significantly affecting the environment is required. In all of these cases the National Environmental Policy Act of 1969 (NEPA) requires the preparation of a federal Environmental Impact Statement (EIS) or Environmental Assessment (EA). For many actions that trigger the need for a federal EIS, state law will also require a state-level EIS. The two EIS documents can be combined, and many of the content requirements are the same or similar.

2. State Authority

The National Coastal Zone Management Act (CZMA) of 1972 was enacted to assist states in

[20] Oceanit, Inc. and Sullivan, J.N. (1990) Erosion Management Program Recommendations for Hawaii. A report to the Coastal Zone Management Program, Office of Planning, State of Hawaii, Honolulu, 95p.

[21] Lacayo Planning, Inc and Sea Engineering, Inc. (1993) Beach Nourishment Viability study, Regulatory Analysis Component. A report to the Coastal Zone Management Program, Office of Planning, State of Hawaii, Honolulu, 32p., plus attachments.

[22] Id.

developing management policies for their own coastal resources. Coastal erosion is specifically mentioned in CZMA as an area of concern to be addressed by state policy. The CZMA requires that state programs include a planning process for assessing the effects of shoreline erosion, evaluating ways to lessen the impact, and restoring areas adversely affected by erosion[23]. The national CZM program is administered by the Office of Ocean and Coastal Resource Management (OCRM), an office in the National Oceanic and Atmospheric Administration (NOAA), in the U.S. Department of Commerce.

Hawaii's CZM law (Chapter 205A, HRS) was enacted in 1977. Hawaii's coastal zone includes all lands, and all waters from the shoreline to the seaward limit of the state's jurisdiction[24]. In addition, although federal lands are administratively excluded from the CZM area, federal activities on these lands are subject to federal consistency requirements. As lead agency for CZM in Hawaii, the Office of Planning (OP), in the State Department of Business and Economic Development and Tourism (DBEDT) is responsible for reviewing and deciding the consistency of federal activities with the State's CZM program.

Hawaii's Coastal Zone Management Program (CZMP) establishes broad objectives and policies to guide all actions affecting the coastal zone and is administered by the OP through a network of state agencies and the county planning departments. The erosion planning and management activities fall primarily under the jurisdiction of the counties, through the administration of the Special Management Area (SMA) and shoreline setback provisions of Chapter 205A, HRS, and the Department of Land and Natural Resources (DLNR), Conservation District Regulations.

All submerged lands seaward of the shoreline, to the limit of state territorial waters, are included in the Conservation District, one of four land-use classifications in the state. Pursuant to Chapter 183, HRS, the Board of Land and Natural Resources (BLNR), staffed by the DLNR, is responsible for establishing the procedures and certifying where the shoreline is located, and for promulgating and administering the Conservation District use regulations. All activities proposed within the Conservation District require a Use Permit (CDUP), for which there is an application, and review process. BLNR can approve, deny, or approve with conditions, proposed uses of the Conservation District.

The Department of Health, Office of Environmental Quality Control (OEQC) administers the Hawaii EIS law (Chapter 343, HRS) and provides public notice of EA's (Environmental Assessments) accompanying CDUP's, Shoreline Certification Applications, and other shoreline use projects, falling under various lead agencies. For instance, associated with the Shoreline Certification process is the requirement for two public notices in the OEQC Bulletin (OEQCB: HAR, Sect. 13-222-12). The first is to notify the public that a Shoreline Certification Application has been received, and requests comments within 14 days of publication, and the second is to notify the acceptance or rejection of said application.

3. County Authority

Under Chapter 205A, HRS, the four counties are required to establish a "shoreline area" with setbacks no less than 20 ft and no more than 40 ft inland from the shoreline wherein no development is allowed. The law also allows counties to establish ordinances creating setbacks greater than 40 ft, and to extend jurisdiction over the shoreline area seaward to the mean sea level. Maui and Honolulu counties have defined instances where the setback is

[23] Id.

[24] The shoreline is defined 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" (Chapter 205A-1, HRS). In 1990, the Hawaii State Legislature ammended the definition of state marine waters to "the water column and water surface, extending from the upper reaches of the wash of the waves onshore, seaward to the limit of the state's police power and management authority, including the United States territorial sea, notwithstanding any law to the contrary." (Chapter 190D-3, HRS). In a 1988 proclamation, President Reagan extended the territorial sea of the U.S. from three to twelve miles (Id).

greater than 40 ft, but to date, no county has moved its jurisdiction seaward to mean sea level. The statute is intended to control development on the shoreline, maintain open space, and preserve public access, however, variances for prohibited activities may be issued following review by county authorities.

Chapter 205A, HRS, provides authority to the counties to establish SMA boundaries and an SMA permit process. Permits for activities on SMA lands are classified as either major or minor depending on the potential environmental impact and the value of the proposed development.

Any proposed activities requiring a CDUP or SMA permit must undergo an application procedure requiring a description of the proposed activity, and known alternatives, the environmental setting and potential impacts, and proposed mitigative actions to lessen the impacts. In certain cases (identified in Chapter 343, HRS) an Environmental Assessment (EA) must be additionally submitted to the state Department of Health, Office of Environmental Quality Control (OEQC), which administers the Hawaii Environmental Impact Statement Law (Chapter 343, HRS). That office is responsible for advertising to the public that a period of review is underway for the EA and for soliciting document review by all interested parties and agencies. If the OEQC makes a finding of significant impact (FOSI), a full EIS must be developed under their guidance. The OEQC has proposed standards and guidelines governing the preparation of EA's for shoreline construction projects, including projects that may result in environmental impacts to the beaches and dunes of Hawaii (see Technical Supplement, Part D[25]).

4. Critique

As discussed above, Hawaii appears to have a well-developed and comprehensive administrative system in place to effectively respond to coastal erosion and beach loss. This system was codified in the early 1970's with the adoption of shoreline setback requirements by county governments, and in the late 1970's with the establishment of the state's Coastal Zone Management Program. Why then, as pointed to in Chapter 1, has beach loss occurred in such great proportions?

On one hand the problem lies in our failure to recognize the problem in the first place, and our propensity to discount the economic, cultural, and intrinsic importance of beaches. On the other hand, the problem is essentially a planning issue rooted deeply in our failing system of coastal zone management and regulation.

Hawaii's Coastal Zone Management Program was primarily developed as an adjunct to Hawaii's uniform land use and zoning laws, which fail to recognize the primacy of shoreline dynamics in their implementing rules[26]. Coastal areas are dynamic zones that are undergoing constant change in response to a multitude of factors including sea-level rise, wave and current patterns, hurricanes, and human influences. Traditional zoning tools have promoted erosion control through shoreline hardening rather than accommodation and enhancement. As Hwang[27] notes in retrospect, "Almost all of the current shoreline problems could have been avoided if shoreline instability were planned for at the zoning stage, before parcels of land are subdivided."

Another related problem is that the linkages between the CZM program and other federal, state, and county agencies responsible for the administration, management or regulation of coastal areas have traditionally been weak. Unlike other states that have well-integrated beach conservation programs in place or are in the process of developing these programs, like Texas, Hawaii has failed to move in this direction. The problem can be characterized as a weak federal presence with respect to servicing local agencies with the latest scientific and

[25] Technical Supplement (Part D) "Draft Shoreline Hardening Policy," Office of Environmental Quality Control (OEQC), Department of Health, 6p.

[26] Challacombe, A. (1997) Beach Management in Hawaii: A Public Sector Perspective. Hawaii Planning, v. xviii, no. 6, p. 5, June, Monthly Newsletter of the Hawaii Chapter of the American Planning Association.

[27] Hwang, D. (1997) Protecting Our Beaches: Balancing Public and Private Interests. Hawaii Planning, v. xviii, no. 6, p. 7, June, Monthly Newsletter of the Hawaii Chapter of the American Planning Association.

technical solutions to deal with beach loss, and equally weak linkages between state and county agencies responsible for beach and shore conservation. Hawaii, in effect, has no widely accepted program, or plan related to beach conservation at this time. It is time that Hawaii reinvents its shoreline management regime with new tools, techniques, and programs.

B. NEW TOOLS FOR EROSION MANAGEMENT

Reducing the threat of coastal erosion and processes such as hurricane storm surge, coastal stream flooding, tsunami inundation and high wave and high wind impacts requires full consideration of policy and legal options designed to reduce exposure to these hazards.

1. State and County Tools

Across the nation, state coastal managers use many different management techniques. Regulatory measures such as permits, zoning ordinances and building codes are the primary elements of state programs to protect coastal resources. States also make wide use of incentives, voluntary programs, land acquisition, planning, public education and intergovernmental coordination.

Section 307 of the Coastal Zone Management Act, which requires federal agencies to conduct their activities consistent with state coastal management programs, is also a key management technique. However, resource management priorities, management techniques, and organizational structure differ from state to state. Various management techniques include[28]:

1. Research and Assessment
    a) Resource Assessments
    b) Inventory and Mapping
    c) Geographic Information Systems
    d) Habitat Restoration Research
    e) Sea-Level Rise Research
    f) Beach Profile Development
    g) Remote Sensing
2. Land and Water Management
    a) Land Acquisition
    b) Conservation Easements
    c) Public Access Development
    d) Restoration/Enhancement
    e) Public Investment Restrictions
    f) Coastal Property Disclosure
3. Planning
    a) Local Land-use Plans
    b) Special Area Management Plans
    c) Regional Plans
    d) Public Access Management Plans
    e) Disaster Preparedness Plans
4. Regulation
    a) Setbacks/Buffers
    b) Special Use Permits
    c) Shoreline Stabilization Restrictions
    d) Local Zoning Ordinances
    e) Compensatory Wetland Mitigation
    f) Mitigation Banking
    g) Wetland Permits
    h) Development Permits
5. Education
    a) Technical Assistance to
    b) Landowners and Government
    c) Publications, Video and Other
    d) Media
    e) Workshops and Conferences
6. Intergovernmental Coordination
    a) Federal Consistency Procedures
    b) Operating Agreements

Many of these tools, and others, are presently used in Hawaii by various state and county land and resource management agencies. The following sections of this chapter describe certain of these techniques in more detail in the expectation that they can be used more effectively or their scope broadened in managing the problem of beach loss and coastal erosion. The description is not exhaustive, and the authors of COEMAP encourage the continued development of creative coastal management policies.

[28] National Oceanic and Atmospheric Administration (NOAA). 1998 (on-line). "Reducing the Impacts of Coastal Hazards" by Sandy Ward and Catherine Main. NOAA's State of the Coast Report. Silver Spring, MD: NOAA

2. Criteria to Guide Decision Making

Any administrative approach to managing the erosion hazards in Hawaii will need to incorporate the considerations of a broad spectrum of concerned stakeholders with a diversity of interests and goals.

County, state and federal administrations share responsibility for governing the parcel by parcel usages and management decisions that will determine the future state of our coastline. Together, they are responsible for the implementation of recommendations in this or any other document and for the law as it is written in Chapter 205A. These levels together will primarily be responsible for implementing strategies for all types of both developed and undeveloped lands. Although beach conservation is primarily a state issue because beaches lie seaward of the certified shoreline and fall under state Conservation District authority and management by the CDUP (Conservation District Use Permit), it is the coastal land losses, chronic erosion, and private development rights that precipitate impacts and necessitate hazard mitigation on a day in and day out basis. These issues are the engine driving our management of sandy shores, and it is these that lie under shared jurisdiction.

State agencies and county planning and permitting departments attempt to coordinate and facilitate their respective missions, but in the end, a common vision governing the exercise of day to day administration of the shore on both sides of the certified shoreline must be achieved. If agencies of the state and counties seek to improve the management of erosion, it will be crucial that both administrations establish mutually acceptable criteria for conservation and mitigation. These criteria must be articulated, reviewed and modified, and finally accepted as policy with governing rules for dealing with erosion. One example of such criteria are found in the 1991 Oahu Shoreline Management Plan[29] which are used by the City and County of Honolulu Department of Planning and Permitting to make consistent management decisions along their shore.

The fundamental and preeminent challenge facing erosion managers is to create an effective marriage of agency goals and methodologies for the betterment of their constituency and our environment along the shore.

This fact is recognized in the structure and function of the Coastal Zone Management Program of the Office of Planning. Among other efforts, the CZMP provides counties with a framework, with funding, with information, and with guidance in managing the coastline of Hawaii. Indeed, the counties are the functional arms of a larger system of coastal management that includes all levels of government. Since the CZMP exists as a consistency and oversight body with a mandate to enhance coastal management, and the Coastal Lands Program (CLP) at DLNR is the permitting authority governing activities on Hawaiian beaches, it is appropriate that both agencies work together to facilitate the development of site-specific criteria for decision making and permitting in the SMA (Special Management Area). This must be achieved in collaboration with and under the guidance and agreement of the various counties.

3. Regulatory Tools

Although the CZMP does issue determinations to ensure that coastal activities are consistent with state CZM objectives and policies, except for certain community development districts, it is not a regulatory body, and it does not possess the power to exercise the implementation of state laws and to actively manage state lands. The DLNR, the DOH, the counties, and the COE share the majority of responsibility for implementing new programs, issuing permits and affecting true changes to coastal erosion management in Hawaii.

a. Hawaii's Permitting Puzzle On both a national and local level there has been much discussion on the applicability of using sand nourishment for beach and dune restoration as an erosion management tool. If Hawaii is to pursue beach and dune restoration using marine sand sources as a policy of erosion management, it will require conducting activities seaward of

[29] Sea Engineering, Inc. and Moon, B.A. (1991) Oahu Shoreline Management Plan. A report prepared for the City and County of Honolulu Department of Land Utilization, 57p.

the mean high water mark, an area that is regulated by the U.S. Army Corps of Engineers (COE). If a significant impact to the environment is identified, such as with a large-scale restoration project, then a federal Environmental Impact Statement (EIS) must be submitted in accordance with the National Environmental Policy Act (NEPA) of 1969 in order to acquire the necessary Department of Army (DA) permit.

The Hawaii Environmental Impact Statement Law (Chapter 343, HRS) also requires that a Hawaii EIS be submitted for any activities involving eight types of conditions. Among these eight are the use of state or county funds or lands, use of Conservation District lands, or use of the Shoreline Setback Area.

The Hawaii EIS law is modeled after NEPA, and since large-scale beach nourishment will trigger both federal and state EIS requirements it will be necessary to prepare a single EIS document that addresses both federal and state issues. The two levels of requirements are closely matched, however, and the burden of conducting the EIS study is not made significantly more difficult with the joint use. The submission of the joint EIS is coordinated by the DOH Office of Environmental Quality Control (OEQC) and its final acceptance at the state level is granted by the governor or mayor for public projects, and by the permit lead agency for private projects.

Under the federal Clean Water Act (Section 401), an applicant requiring a federal license or permit to conduct work in state waters must also obtain a Water Quality Certification (WQC) from DOH. Additionally, any beach restoration activity that utilizes the discharge of a sand slurry, or the placement of dredged sand in coastal waters will require a National Pollution Discharge Elimination System (NPDES) permit. This permit application will be reviewed by the federal Environmental Protection Agency (EPA) and issued by DOH.

As the lead agency for the CZMP of Hawaii, the Office of Planning is responsible for reviewing and deciding the consistency of all federal activities with state goals in CZM areas (coastal lands and waters). A consistency determination is required from OP/CZMP for federally-funded activities and activities requiring federal permits and licenses. The state's consistency determination can include conditions to mitigate or offset potential impacts of the activity or use proposed in the permit application.

The State DLNR under the legal authority of Chapter 183, HRS will require a CDUP for large-scale restoration activities because beaches and lands seaward of the certified shoreline will be impacted by sand dredging and filling. The Land Division of DLNR will also have to issue a separate Right of Entry for sand mining or fill based on a submitted Environmental Assessment (EA) describing the proposed activities and possible impacts.

In order to obtain a CDUP, a shoreline certification must be granted by the State Surveyor under Chapter 205A, HRS. This requires a separate application to the Land Division of the Department of Land and Natural Resources which requests a review by the State Surveyor in the Department of Accounting and General Services (DAGS). A period of public comment is announced in the OEQC Bulletin (14 days), after which a recommendation is forwarded from the Surveyor's office to the Chairperson's Office of DLNR, where it is approved or rejected.

Under county jurisdiction, sand mining or moving and depositing by mechanical means for public uses within a shoreline area may be authorized by a Shoreline Setback Variance (SSV), provided that "moving of sand will not adversely affect beach processes, will not diminish the size of a public beach, and be necessary to stabilize an eroding shoreline" (Chapter 205A-46, HRS). The setback requirements are administered and enforced by the permitting departments of the counties and they will be the issuing authorities of the SSV for nourishment actions.

Because restoration will involve activities in the "Special Management Area" (SMA) that extends no less than 100 yards inland from the shoreline, and the power to regulate these lands is delegated to the counties under Chapter 205A, HRS, a "major" SMA Permit must be obtained if the total valuation of the project exceeds $125,000 or if it may have a significant adverse environmental or ecological effect. Otherwise, a SMA Minor Permit may be issued by the

county. This is conditioned upon documentation that there will be no adverse environmental or ecological impacts resulting from the action, and that public access is maintained or enhanced as a result of the project.

Large-scale beach restoration will require a total of 13 permits or actions to obtain the agreement of federal, state, and county agencies, these are[30]:

1. National Council of Environmental Quality, **Federal EIS**, based on
   a) NEPA of 1969 (Public Law 91-190)
2. U.S. Army Corps of Engineers, **Department of Army Permit**, based on
   a) Section 10, Rivers and Harbors Act of 1899 (33 USC 403)
   b) Section 404, Clean Water Act (33 USC 1344)
   c) Section 103, Marine Protection, Research and Sanctuaries Act of 1972, as amended (33 USC 1413)
3. **Federal Consistency Determination**, Hawaii Coastal Zone Management Program, Office of Planning, DBEDT, under
   a) CZM Act of 1972, Chapter 205A, HRS
4. **Water Quality Certification**, Hawaii Department of Health, Clean Water Branch under authority of
   a) Section 401 of the Clean Water Act, Federal Water Pollution Control Act of 1972, Public Law 92-500, Chapter 342D, HRS
5. **Hawaii EIS**, for the DOH, Office of Environmental Quality Control, can be same document as 1. above, addressing both federal and state guidelines, defined by
   a) Chapter 343, HRS
6. **National Pollutant Discharge Elimination System Permit**, from the DOH Environmental Management Division, under authority of
   a) Chapter 342D, HRS and Title 11, Chapter 55, HAR
7. **Shoreline Certification**, Department of Accounting and General Services
   a) Chapter 205A, HRS
8. DLNR, Land Division**, Conservation District Use Permit** granted by the Board of Land and Natural Resources under
   a) Chapter 205, HRS, Title 13, Chapter 2
9. DLNR **Right-of-Entry-Authorization** under
   a) Chapter 171, HRS
10. A major **Special Management Area Use Permit** administered by the counties under authority of
    a) Chapter 205A, HRS and county governing ordinances
11. Counties will also issue a **Shoreline Setback Variance** for any activities within the designated setback zone under
    a) Chapter 205A, HRS and county governing ordinances
12. A **Permit for Grading and/or Grubbing** will need to be issued for sand fill activities based upon
    a) County Ordinances
13. A **Flood Hazard Certification** must be awarded by county agencies to certify that the permitted activity will not alter the elevation of base flood conditions (100 yr flood) of the NFIP
    a) County Ordinances

b. General Permit It is clear from this review that a high level of analysis and understanding must accompany any large-scale beach restoration project in Hawaii. It would be in the best interest of facilitating the use of restoration as a viable option, and reducing the workload of agencies, to coordinate and identify areas of overlapping effort such that the permitting process can be made more efficient without

[30] Lacayo Planning, Inc and Sea Engineering, Inc. (1993) Beach Nourishment Viability study, Regulatory Analysis Component. A report Prepared for the Hawaii Coastal Zone Management Program, 32p. plus attachments.

sacrificing the present high level of environmental and ecological safeguards.

One approach to realize this goal is to define a single "General Permit" such as the Department of the Army State Program General Permit (SPGP, administered by the Corps of Engineers) that defines guidelines for activities seaward of the certified shoreline, identifying state or federal jurisdiction. Such activities could include integrated conservation and hazard mitigation projects, such as small-scale beach restoration.

One General Permit applicable under state or federal jurisdiction, administered by a single lead agency, that defines guidelines for Best Management Practices to achieve integrated conservation and hazard mitigation along the shoreline, would provide efficiency and economy to the effort to restore lost beaches. That lead agency should be the Coastal Lands Program at DLNR. This would, in fact, move directly toward the environmental restoration and erosion mitigation identified in management alternatives 2. (Beach Restoration), and 3. (Erosion Control) articulated in Pope (1997) and described ahead in section II.B.5.

c. Rights of Ownership An accompanying issue that must be addressed prior to filling and accreting coastal lands is the rights of ownership and use for private lands that have eroded and whose property boundaries (metes and bounds) lie across the area of restoration.

It would be a mistake, and in fact would violate stated FEMA goals, if beach restoration resulted in increased development in coastal hazard areas. It is highly likely that sand nourishment and the resulting accretion of the shoreline, would shift the highest reach of the waves seaward of their pre-nourishment location. Future certifications at such sites by owners with overlapping metes and bounds would result in a seaward shift in the setback zone and the encroachment of development into high hazard areas.

Property owners who have hardened their coastal lands, and thereby "fixed" the position of the certified shoreline may be rewarded for their actions with larger areas of private property and buildable land compared to owners who have not hardened their property and who allowed the position of the shoreline to migrate inland over time.

A discussion of this issue by the CZMP, Marine and Coastal Management Advisory Group (MACZAG), Subcommittee on Coastal Erosion concluded that representatives of DAGS Survey Office should consult with the Office of the Attorney General and others with legal expertise to further explore these issues. One approach would be to file a unilateral agreement among property owners in a project area with the Bureau of Conveyances. It is also expected that amended legislation will be necessary to resolve the issue.

d. Environmental Sequencing Hwang[31] describes the "environmental sequencing approach" to erosion hazard reduction. Environmental sequencing helps regulators to focus on the most efficient and acceptable means of shoreline protection while reducing the burdens on the regulated community. Sequencing is an environmental decision-making framework based on the concepts of avoidance, minimization, and compensatory mitigation.

1. **Avoidance** Avoidance relies on historical shoreline data and erosion analysis to determine a safe location for structures. This is the most effective way to prevent shoreline erosion problems. Avoidance requires that erosion hazards are recognized prior to zoning at the county level, and that erosion projections are incorporated in plans for subdividing coastal lots. Hence, avoidance leads to the safe siting of structures away from coastal hazards.
2. **Minimization** If structures are improperly located and coastal hazards cannot be avoided, the environmental and economic impacts need to be minimized. Minimization employs an array of planning and engineering tools to take the place of the traditional, and harmful, seawall or revetment. These include seabags, dune enhancement, sand replenishment,

[31] Hwang, D.J. (1998) An environmental sequencing approach to shoreline management. First Regional Conference on Coastal Erosion Management in Hawaii and other Pacific Islands. Abstracts with programs, University of Hawaii Sea Grant College Program.

offshore structures, and other erosion control and beach restoration technologies.

3. **Compensatory Mitigation** If environmental impacts cannot be minimized, the concept of compensatory mitigation can be employed where the landowner contributes to the state or county an amount related to the costs to develop or replenish similar beach resources elsewhere.

Environmental sequencing for reducing erosion hazards can be integrated with efforts to reduce exposure to other coastal hazards, including hurricanes.

e. Integrating Hazard Mitigation In October of 1996, the University of Hawaii Social Science Research Institute (SSRI) provided 20 recommendations as the result of their CZM funded Hawaii Coastal Hazard Mitigation Planning Project[32]. When combined, these initiatives represent an integrated approach to coastal hazard mitigation. They recommended:

1. Hawaii government should enforce existing floodplain regulations and shoreline setback requirements;
2. Designate coastal high hazard areas on all county planning, zoning, and land-use maps, and establish a hazard mitigation review process;
3. Review Flood Insurance Rate Maps and evaluate their adequacy in coastal high hazard designations;
4. Establish variable shoreline setbacks;
5. Adopt the latest version of the Uniform Building Code;
6. Assess the capacity of county building departments to adequately enforce the provisions of the 1991 Uniform Building Code;
7. Encourage development of a federal tax credit for hazard mitigation;
8. Monitor the availability of Federal Emergency Management Agency grant funds for hazard mitigation and make the establishment of a hazard mitigation homeowner grant program a priority;
9. Encourage private groups to take a leadership role in improving design and construction standards to reduce the risk of future hurricane damage;
10. Develop a hazard mitigation incentive program through the Hawaii Hurricane Relief Fund;
11. Establish a Hurricane Mitigation Advisory Board;
12. Establish a beach monitoring program;
13. Develop a coastal retreat strategy for high hazard areas;
14. Fund training programs on the provisions of the 1991 Uniform Building code for county building department officials and building contractors;
15. Establish a wind hazard assessment program;
16. Fund the development and distribution of public information materials on the risk of future hurricane damage and steps individuals and businesses can take;
17. Develop a hurricane hazard mitigation program for state buildings;
18. Develop a hurricane recovery and hazard mitigation plan;
19. Create state income tax credits for hazard mitigation;
20. Provide low interest loans for hurricane hazard mitigation.

These recommendations focus principally on reducing hazards to coastal development, but certain actions would also promote avoidance and minimization of erosion threats, hence leading to enhanced beach conservation.

f. Setback Programs Various states have dealt with the mitigation of coastal hazards, including chronic erosion, through the use of construction setbacks (see Table 3).

1. North Carolina North Carolina's coastal development regulations require property owners to set their buildings back from eroding shorelines and protective beaches and dunes. These natural features and the design and size of the proposed development determine the construction setback required. The setback is measured from the first line along which aerial photos show stable natural vegetation or from the point at which a ground survey shows stable vegetation.

[32] Hamnett, M., Davidson Oh, K.G., and Bryant, K. (1996) Hawaii Coastal Hazard Mitigation Planning Project, Phase II: Findings and Recommendations. Hawaii CZM Program, Honolulu, 27p.

New, smaller structures must be set back farthest landward of (1) a distance equal to 30 times the long-term annual erosion rate, (2) the crest of the primary dune, (3) the landward toe of the frontal dune, or (4) 60 feet landward of the vegetation line. Larger structures must be set back a distance 60 times the average annual erosion rate or 120 feet landward of the vegetation line. Where erosion rates exceed 3.5 feet per year, the setback line for larger structures is 30 times the erosion rate plus 105 feet. The law allows single-family residences on preexisting lots not deep enough to meet the erosion setback requirements as long as they are set back at least 60 feet[33].

2. Florida The State of Florida has implemented two effective tools for mitigating coastal hazards, land use and building code requirements, through its Coastal Construction Control Line (CCCL) regulation.

During the 1980s, Florida's Department of Environmental Protection established the CCCL to upgrade the standards that guide land use and building construction in high-hazard coastal areas. The CCCL defines the zone along the coastline subject to flooding, erosion, and other impacts during a "100-year storm" (a severe storm that has a 1% chance of occurring each year). Properties located seaward of the CCCL setback are subject to state-enforced elevation and construction requirements that are more stringent than National Flood Insurance Program (NFIP) coastal (V-Zone) requirements. Likewise, the wind-load requirements seaward of the CCCL are more stringent than those of the standard building codes[34].

The test of the CCCL requirements came on October 4, 1995, when Hurricane Opal struck a portion of the Florida coastline as a category 3 hurricane with 111 to 115 mile per hour winds (Table 2).

Coastal flood forces, consisting of storm surge, wind-generated waves, flood-induced erosion and flood-borne debris, appeared to cause most of the resultant structural damage during Opal. Of the 576 major habitable structures located seaward of the CCCL and permitted by the state under the current standard, none sustained substantial damage. In contrast, 768 of the 1,366 pre-existing structures seaward of the CCCL sustained substantial damage.

Table 2. Damaged Structures seaward of the CCCL due to Hurricane Opal

	Structures built to CCCL standards (576 total)	Structures NOT built to CCCL standards (1366 total)
Structures not substantially damaged	576	598
Structures substantially damaged	0	768
Percentage of structures substantially damaged	0%	56%

More structures were damaged or destroyed by wave erosion associated with Hurricane Opal than in all other coastal storms that have occurred in Florida over the past 20 years combined. The fact that CCCL-permitted structures sustained no damage in Hurricane Opal is a result of the use of hazard-resistant construction and siting requirements.

3. Hawaii Bay and Bay[35] report on the minimum construction setbacks of 40 ft established in Hawaii which are required under Chapter 205A, Hawaii Revised Statutes. With the granting of a variance from the governing county, a structure can be sited within 20 ft of the shoreline, or less in the County of Hawaii. Variances are awarded in cases of emergency or because the 40 ft condition would render the lot unbuildable otherwise. The County of Hawaii Planning Commission Rules allow the granting

[33] National Oceanic and Atmospheric Administration (NOAA). 1998 (on-line). "Reducing the Impacts of Coastal Hazards" by Sandy Ward and Catherine Main. NOAA's State of the Coast Report. Silver Spring, MD: NOAA.
[34] Id.

[35] Bay, J. and Bay, M. (1996) Reducing hazards in shoreline areas: policy and legal options. A report from the Coastal Aquisition Project, Phase II, Hawaii Coastal Zone Management Program, 15 p.

of a Shoreline Setback Variance for lesser setbacks if certain criteria can be met. The lesser setback is applicable to lots which were created prior to adoption of the Planning Department's Rule 11 (January 19, 1997) when one of the following exists: 1) when the average lot depth of a parcel is one hundred feet or less; or 2) when the buildable area of a parcel is reduced to less than fifty percent of the parcel after applying the forty-foot shoreline setback line and all state and county requirements of the parcel.

Many nonconforming structures have been grand-fathered under the current setback law such that the typical residential developed coast in Hawaii has a range of permitted, nonconforming, and non-permitted structures at various distances from the shoreline. Under the law the counties have the ability to increase the setback. The City and County of Honolulu has increased it's setback for new construction from 40 ft to 60 ft. Maui County has a setback up to 150 ft depending on lot size and other aspects, and Kauai and Hawaii Co's have maintained the minimum 40 ft, except where county rules permit a lesser setback.

4. Georgia Beach Nourishment Project Sea Island, Georgia is a small resort island with beaches that attract numerous vacationers and new residents. Since the late 1980s, beach erosion has been chronic, primarily as a result of coastal storms and northeasters. The erosion persisted until it was difficult to walk on the beach at high tide. The owners of the resort island concluded that the best way to preserve the primary attraction of the resort, the beach, was with a beach nourishment project along the shore. Although the project was expensive and the resort owners funded it themselves, they considered it an economic necessity for the future of the entire community.

In 1990, the beach on Sea Island was nourished, and two groins were constructed to alleviate the chronic erosion problem. Since then, the resort has continued the beach nourishment project by moving sand from time to time, planting vegetation and using snow fences to hold the sand in place during windy periods.

The project has thus far proved successful in maintaining a beachfront for residents and vacationers, and in preventing the erosion that was threatening beachfront homes on the island. After eight years, sand dunes and vegetation are thriving on the beach, and the threat of coastal hazards impacting the beachfront homes has greatly diminished.

5. Certified Shoreline[36] The setback in Hawaii, as mentioned earlier, is measured from the Certified Shoreline. It is defined in the Coastal Zone Management Act (HRS-205 A) 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 creates some problems, as described by Fletcher and Hwang (1994). Chief among them is the fact that coastal land owners and managers (typically homeowners, and commercial interests) frequently landscape their beachfront property to push the vegetation line seaward and thereby gain valuable building space. This constitutes a slow but inexorable encroachment of development upon the hazardous and fragile beaches of Hawaii. Also, wave run-up does not provide the surveying profession, responsible for identifying the certified shoreline, with a fixed natural monument or datum with measurable characteristics. Hence, the defined shoreline is based upon an inherently ephemeral and unobservable phenomenon that is identified by interpretation and judgement, leading to problems of inconsistency and disagreement. The State Surveyor, who "certifies" the position of the shoreline, processes approximately 200 applications per year and it is impossible to conduct an on-site visit to confirm the proper application of the law at each one. Currently, the Office of the Attorney General handles about 5 to 6 contested case hearings a year that deal with certification. The majority of these involve a dispute over the interpretation of physical evidence of the *upper reaches of the wash of the waves.*

[36] Fletcher, C.H., and Hwang, D. J. (1994) Shoreline Certification Review and Recommendations. A Report to the Coastal Zone Management Program of Hawaii, 76p.

6. Other States For comparison, some states use the Mean High Water tidal datum measured from benchmarks, or other datums that can be easily surveyed by civil engineers or surveyors (Table 3).

Table 3. States with fixed and rate-variable setbacks.

States with Fixed Setback	**Setback**	**Basis for Setback**	**Reference Point**
Maine	75 feet	Setback is part of the state zoning law and not specifically for erosion control	Seasonal Mean High Water
Delaware (changing to erosion rates)	100 feet, no development seaward of line	Based on U.S. Army Corps of Engineers study	Ocean beaches 10 foot contour; Bay beaches 7 foot contour, NGVD
Florida (see below)	Setback distance varies w/ stricter building standards seaward of line	Erosional trends, shoreline fluctuations 100 year storm surge, and associated waves	Mean High Water
Alabama	Setback ranges from 120 to 450 feet, no development seaward of line	Ranking of 4 factors: 1) impact of storms; 2) alignment of existing structures; 3) buildable property; 4) maintain structures at higher elevations	Mean High Water
States with Variable Setbacks	**Setback**	**Reference Point**	**Shoreline Change Methodology**
New York	25 ft in low erosion areas (<1 ft/yr); 40 yr setback +25 ft in high erosion areas (>1 ft/yr)	Dune – Landward toe of 1st dune Bluff – Landward receeding edge	Aerial photographs (40 to 50 yr time span)
Rhode Island	50 feet in low erosion areas (<1 ft/yr) 30 yr setback in high erosion areas (>2 ft/yr)	Dunes – Primary dune crest Bluffs – Landward edge Wetland – Veg. transition line Beach – Scarp or deposition change	Aerial photographs with Zoom Transfer Scope (1970-‘80’s technology)
New Jersey	50 year setback	Mean High Water, locally determined	Aerial photographs (‘52, ‘71, ‘88, recent)
North Carolina	1. Development <5000 sq. ft. furthest of a. 30 year setback b. behind crest of primary dune c. behind land toe of frontal dune d. 60 feet landward of veg. line 2. Development >5000 sq. ft. a. 60 year setback in areas with annual erosion rate >3.5 ft/yr b. 30 year setback + 105 ft in areas with erosion rate <3.5 ft/yr	1. a. Vegetation line b. primary dune = to 100 year storm level +6 feet elevation c. primary dune with sufficient height, vegetation, continuity and configuration to offer protective value d. vegetation line 2.a. & b. vegetation line	Aerial photographs (22 to 50 years) orthogonal grid matrix system

4. Non-Regulatory Tools

a. Federal Emergency Management Agency

1. Floodplain Policies In 1994, the Federal Emergency Management Agency (FEMA) identified coastal hazard mitigation as a new management initiative. Presently (1998), they

are in the last phase of a multi-year analysis of the national exposure to coastal erosion, and will submit a future report to the U.S. Congress with recommendations on the agency role in both erosion planning and response activities.

Current FEMA efforts seek to limit economic exposure to coastal flooding hazards. The agency uses the historical frequency and magnitude of coastal floodplain inundation (including stream floods, storm surge and tsunami inundation, and high wave hazards) as the basis for modeling the elevation and inland limit of the "100 year flood" (1 per cent annual recurrence probability). Results are published as construction and building siting guidelines in a series of maps called Flood Insurance Rate Maps (or FIRM's). These maps show the inland limit of predicted coastal flooding and high wave velocity hazards (V zones), and set minimum elevations (the Base Flood Elevation, or BFE) for building construction. FIRM's have been adopted nationally for insurance rating and floodplain management.

Communities in flood hazard areas as mapped on the FIRM's are able to get affordable flood insurance, through the National Flood Insurance Programs (NFIP) administered by FEMA. Commercial insurance carriers act as agents for the NFIP to offer flood insurance to homeowners at reasonable rates through the NFIP in what otherwise would be uninsurable locations.

However, although Hawaii has the highest per capita NFIP participation rate in the nation, numerous structures here are not insured since they are not subject to federally backed or insured mortgages[37]. Additionally, many insured structures in Hawaii do not meet the mandated NFIP building codes because the stricter requirements only apply to new or substantially rebuilt homes. Hence, the NFIP is not fully resolving the problem of hazard exposure and in the event of a serious disaster, insurance will not fully alleviate the resulting socioeconomic burdens.

As pointed out by Hamnett[38] the direct hit of a hurricane on a densely populated area of Hawaii has the potential to cause financial losses exceeding the total annual state budget. Accordingly, in order to reduce the financial exposure to catastrophic losses, FEMA offers programs providing incentives for reducing hazard exposure by lowering insurance costs if certain performance standards are achieved.

The FEMA Community Rating System (CRS) provides incentives and guidelines for establishing planning performance standards in coastal communities of homeowners. The CRS offers reduced premium rates for communities that implement adequate land use and loss control measures, facilitate accurate risk ranking, promote flood insurance awareness, and encourage measures for the management of natural and beneficial floodplain functions and erosion hazards. In Hawaii, these activities and measures would typically be enacted at the county level. Communities may receive additional credit for implementing eligible mitigation activities. This could include changes in the shoreline setback, or development of mitigation plans that place stricter development and building guidelines on structures in the coastal V zone.

The CRS has established a ranking system, from 1 to 9, where a 5 per cent decrease in flood insurance premiums is offered for each lower ranking achieved with specified mitigation efforts, up to a maximum of 45 per cent reduction. Currently, Maui County is the only community in the state participating in the CRS. They have a Class 8 rating which earns a 10 per cent discount on their insurance premiums.

FEMA also offers the Flood Mitigation Assistance (FMA) program, which provides mitigation assistance grants and mitigation insurance coverage to eligible states and communities. One-time planning grants for mitigation development are available to states ($75,000) and to communities ($25,000).

[37] Bay, J. and Bay, M. (1996) Reducing hazards in shoreline areas: policy and legal options. A report from the Coastal Acquisition Project, Phase II, Hawaii Coastal Zone Management Program, 15 p.

[38] Hamnett, M.P. (1993) Findings and Recommendations. Coastal Hazard Mitigation Planning Project: Findings, Recommendations and Technical Documents. Honolulu: Social Science Research Institute, University of Hawaii for the Hawaii Coastal Zone Management Program, 239p.

Mitigation activities could include planning the acquisition of property for land banking, aggregate mitigation activities, and technical assistance. The amount is capped at $5,000,000 to any state or community over a 2-year period. Amounts are subject to 75/25 matching funds.

2. Applicability of NFIP to Erosion In Hawaii, the exposure to marine flooding is not equal along all shorelines, and delineating historical flood limits as the sole criteria guiding coastal hazard mitigation neglects the ongoing erosion hazard and, alone, may not be adequate as a beach conservation measure. Nonetheless, many activities that reduce flood hazard exposure are consistent with erosion mitigation and beach conservation.

In the case of undeveloped shorelines, a level of *avoidance* of flooding and erosion hazards can be achieved with the use of an increased construction setback from the shoreline. It is possible to determine a setback based upon the historical rate of coastal erosion and thus define future erosion hazard areas (i.e., 30 times the annual erosion rate defines a distance landward of the current shoreline that is vulnerable to the erosion hazard over the next 30 years). This approach recognizes coastal erosion as the principal hazard guiding mitigation policy, and establishes avoidance as the primary goal.

To achieve integration of flood and erosion hazard reduction, a variable setback calculated with erosion rates used to delineate projected future erosion hazards that also sets minimum BFE's, would provide a high level of hazard avoidance along the Hawaiian coast. Additional building criteria implementing bearing wall orientation, load-path construction techniques, and post and pier construction would further reduce hazard exposure. Development guidelines based on criteria defined by BFE's and erosion hazard zonation would achieve insurance premium reductions, dune and beach conservation goals, and lower damage expenses carried on government budgets in the event of storm surge, high winds, large waves, chronic erosion, coastal stream flooding, tsunami inundation, and accelerated sea-level rise. Hence, erosion mapping and flood inundation mapping should be undertaken with coordination and common standards by management agencies.

3. FEMA Erosion Vulnerability The FEMA is updating its Coastal Construction Manual (FEMA-55) in an effort to improve the quality and durability of residential construction in coastal areas and thereby reduce the amount of damage caused by natural hazard events in coastal areas. The agency is currently considering, and circulating for comment, draft guidelines for erosion hazard analysis. If adopted in the new manual, these would include a series of checklists, flowcharts and figures to guide an erosion hazard vulnerability analysis of shoreline properties targeted for development, or redevelopment.

They propose that erosion hazards be defined as part of the evaluation criteria made by commercial and governmental professionals in selecting, designating, and designing development projects along the coast. To define an erosion hazard it is necessary to estimate the "Maximum Shoreline Erosion," based on the long-term erosion rate, a storm erosion distance (eroded profile), and a stable bluff/dune face slope distance. To make these determinations, a number of variables must be considered by an erosion analyst.

1. General Information
    a) property location and dimensions
    b) land use at site and adjacent properties
    c) history of damaging flood and erosion events at site and nearby
2. Physical and Natural Processes
    a) soils, geology and vegetation – site and region
    b) site drainage – potential for erosion from surface water or groundwater
    c) coastal morphology and coastal processes
    d) presence and influence of nearby tidal inlets and coastal structures
    e) littoral sediment supply and sediment budget
    f) topography of nearshore, beach, dune, bluff, uplands
    g) relative sea-level change – land subsidence or uplift
3. Historic Shoreline Changes – Magnitudes and Causes

a) shoreline change maps and historic aerial photographs
b) published erosion rates – long-term and short-term
c) spatial variability in erosion rates
d) temporal variability in erosion rates – seasonal, annual, and long-term
e) erosion/accretion cycles – magnitude and periodicity
f) inlet- or structure-induced erosion

4. Observed and Predicted Coastal Flood Conditions

a) flood elevations due to tides, storm surge, tsunami or seiche
b) wave conditions at shoreline (height, period, direction)
c) wave runup, overtopping and flooding
d) erosion of beach, dune and/or bluff
e) sediment overwash
f) breaching or inlet formation

5. Other Sediment/Erosion Considerations

a) erosion by wind
b) burial by storm overwash or wind-blown sand
c) erosion by channeling of flow between buildings or obstructions
d) local scour potential and presence of terminating strata

6. Navigation and Erosion Control Projects – Type, Location, Age and Performance

a) navigation projects (jetties, dredged channels, flood channels) affecting site
b) shore protection structures, on property or nearby
c) dune/bluff stabilization projects, on property or nearby
d) beach/dune nourishment projects – completed or planned

b. Community Performance Standards

Along developed shorelines where existing setbacks have proven historically inadequate and shoreline hardening has been used to stop chronic erosion, it will not be possible to establish a new setback policy without forcing much of the existing land usage to become "nonconforming." This may have undesirable financial implications for present tenants. Past efforts in Hawaii to overlay "after-the-fact" enhanced setbacks on developed residential shores have been stopped by residents with fears of land devaluation.

However, this does not mean that efforts to alter land use patterns on developed shorelines should be abandoned. Indeed, it on such developed residential coastlines that the community can become the primary workforce. Public education and awareness of the value of beaches and dunes, and the logical and rational steps that can be made toward their conservation and the simultaneous mitigation of coastal hazards can, in time, lead to improved land usage. No more powerful force can be applied to our shorelines than the will of a community dedicated to conservation and mitigation goals.

A first step is to raise public awareness of coastal hazards, and awareness of what are, and are not, appropriate shoreline development practices and alternatives. Heightened public awareness can lead to enhancing current land use practices that are beneficial, reducing practices that are harmful or increase hazard exposure, and can encourage and help achieve future goals of hazard avoidance and beach conservation. To reach these goals a shoreline community may establish voluntary, willing user *performance standards*. Such standards could be designed to conform to CRS rankings and the community would be thus rewarded with reduced insurance premiums.

Performance standards provide and define targets for future redevelopment and land usage. Such targets should avoid penalizing current tenants, yet would establish community goals for achieving reduced exposure to coastal hazards. Setting performance standards is a form of *minimization* on developed coastal lands that can be implemented through time on a schedule determined by the landowner through the redevelopment and renovation of existing structures and voluntary changes in land usage.

Applicable performance standards include:

1. defining nonregulatory, "willing user" variable setbacks and BFE's as targets to guide the redevelopment and renovation of existing structures;

2. setting construction standards promoting wind and flood reinforcement and avoidance;
3. following landscaping standards promoting dune preservation, sand conservation and beach enhancement;
4. promoting enhanced coastal access and parking;
5. creating and paying into a community beach and dune restoration fund.

These performance standards should be nonregulatory targets setting a future vision for the community that would ultimately enhance land values, increase community pride, and restore damaged beach environments. A simple descriptive pamphlet containing site-specific maps and guidelines could be the first step in implementing this goal. It would also be necessary to identify a community representative or point person to assist in awareness-building and to facilitate communication between the neighborhood users and the lead agency.

In the spirit of the incentives offered by the NFIP/CRS, the state and counties of Hawaii should provide incentives to communities of homeowners located in erosion hazard areas that seek to define and achieve performance standard goals for hazard exposure reduction and dune and beach conservation. This could include efforts along the lines of the CRS and/or FMA and/or alternative incentives to reduce exposure and promote beach conservation. Additionally this action would move toward achieving recommendations 10, 16, 19, and 20 of the Hamnett et al[39] report.

c. Coastal Lands Acquisition

Many state coastal programs outside Hawaii have established the regulation and management of coastal development activities and land use as a major component of their efforts. Some states (Maine, North Carolina, South Carolina) characterize these activities as a "strategic retreat" from the shoreline[40].

A powerful tool for resource protection can be the acquisition of lands that are subject to coastal hazards, that are environmentally sensitive, and that have a high public resource value. Acquisition and protection programs of various types are being carried out in Hawaii by numerous agencies, each with its own mission, jurisdiction, and authority[41]. At this writing, the City and County of Honolulu is considering the purchase of Pua'ena Point on the north shore to protect it from development. Maui County budgeted $15 million for coastal land purchases in FY'98 and the City and County of Honolulu had $12.5 million available for the same purpose. The State of Hawaii is in the process of acquiring the Ka Iwi shoreline on the south coast of Oahu for approx. $10 million to protect it from commercial development.

Placing lands into permanent protection status provides greater guarantees of future preservation than the use of zoning tools such as variable setbacks. Land acquisition may be a useful approach along developed shorelines where owners are willing to voluntarily sell lands (termed "negotiated purchase") to the state or county for the purpose of preservation. Bay and Bay[42] describe the acquisition of lands in high coastal hazard areas as the most direct way to mitigate impacts.

The government can purchase an interest in land either through condemnation, known as eminent domain, or through a negotiated purchase with a willing seller.

1. Eminent Domain Powers[43] The exercise of eminent domain by government authorities is the

[39] Hamnett, M.P. (1993) Findings and Recommendations. Coastal Hazard Mitigation Planning Project: Findings, Recommendations and Technical Documents. Honolulu: Social Science Research Institute, University of Hawaii for the Hawaii Coastal Zone Management Program, 239p.

[40] Beatley, T., Brower, D.J., and Schwab, A.K. (1994) Coastal Zone Management. Island Press, Washington, D.C., 210p.

[41] Bay, J.H. (1994) Methods and Strategies for Acquiring Coastal Lands. Prepared for Hawaii Coastal Zone Management Program, 82p. plus appendices.

[42] Bay, J. and Bay, M. (1996) Reducing hazards in shoreline areas: policy and legal options. A report from the Coastal Aquisition Project, Phase II, Hawaii Coastal Zone Management Program, 15p.

[43] Bay, J.H. (1994) Methods and Strategies for Acquiring Coastal Lands. Prepared for Hawaii

least desirable approach to land acquisition. It is the most expensive acquisition alternative, and usually the least socially popular. The power to condemn lands for public purposes resides with the government, providing the landowner receives just compensation. To condemn land, the government must follow a specific set of legal procedures that effectively raise the cost of the transaction above the simple market value of the land. In Florida, the exercise of eminent domain is calculated to increase acquisition costs an average of 150% of their fair market value. Condemnations tend to be politically unpopular because they are viewed by a wary public as harsh and unfair treatment of landowners by big government. Condemnations are generally the method of last resort in any land acquisition scheme. Any program attempting to achieve conservation goals through a process of community dialogue and public decision-making should seek cooperative methods, not eminent domain, to acquire coastal lands in order to avoid creating antagonistic relationships with landowners and generating public distrust.

2. Negotiated Purchase[44] The most direct and most common method of land acquisition is to negotiate a purchase with a willing seller. As described below, the nations leading acquisition programs in California and Florida, are predicated upon a "willing seller" philosophy. Negotiated purchases offer increased flexibility for all parties, and are easily modified or tailored to support the needs of the landowner. For example, an owner can realize tax advantages by dedicating part of their land and selling the rest to government for conservation. Further, if they are willing to sell the total parcel provided they are allowed to live on the land for the rest of their life, such a deal can be easily negotiated.

In a negotiated purchase, lands can be acquired in *fee-simple* by the state or county, although this is nearly always an expensive proposition. However, the fee-simple purchase gives government total and permanent control of the land.

In the fiscally restrictive climate of the 1998/99 Hawaiian economy, a *less-than-fee-simple* acquisition, with its reduced costs (and reduced guarantees of preservation), may be a more realistic approach to acquisition in some situations. For instance, *conservation easements* can be purchased by government, or donated by a landowner, as a less-than-fee-simple status. This transaction incurs a land control status whereby a parcel will be used for conservation purposes and the owner agrees not to put the property to any incompatible use. Future owners are also subject to the terms of such an easement.

Landowners can be persuaded to donate conservation easements, or sell them at less than market value, because of the favorable tax consequences involved, including a decrease in the valuation of their property for tax purposes.

Another less-than-fee-simple property interest is *transferred development rights* (TDR). This method separates the development potential of land from the land itself and treats that potential as a marketable commodity[45].

In a TDR program, a regulatory agency restricts further development of a parcel, but allows the owners to take their right to development and apply it to another piece of land. Depending on the terms, the owners may even be able to sell that right to a third party.

Public purchase of an owner's right to develop their property has been used to prevent the destruction, or substantial transformation, of a parcel and to prevent the development of large open lands. Development rights may be purchased outright by a public entity and banked in a charitable conservation trust. Alternatively, they may be purchased by a private developer and used to increase the density in a designated section of an urban area where, typically, the right to develop at greater than normal densities is extremely valuable to private developers[46].

Other land acquisition schemes include:

Coastal Zone Management Program, 82p. plus appendices.

[44] Id.

[45] Id.

[46] Beatley, T., Brower, D.J., and Schwab, A.K. (1994) Coastal Zone Management. Island Press, Washington, D.C., 210p.

1. building *private-public partnerships* with not-for-profit conservation groups to purchase lands, or various land-use options;
2. conducting negotiated purchases of *parcel blocks* on damaged shorelines and selling them for redevelopment under a new, site-specific zoning regime;
3. using certain *permit conditions* to offset development impacts, or as a form of compensatory mitigation where funds or actions are applied by the permitee for conservation purposes with some nexus (relationship) to the original impacts;
4. *impact fees* assessment on new development to recover or offset a proportionate share of public capital required to accommodate the development, such fees might be applied to environmental conservation activities with a clear nexus to the nature of the development.

3. Florida Florida is one of the nation's leaders in acquiring conservation and recreation lands. Their effort consists of a number of related programs in land banking that collectively amount to an effort greater than that of the entire federal government. The primary approach to land acquisition that has evolved in Florida is the dedication of small, continuous revenue sources, such as tax increments, that are used to support the debt service payments on large bond issues.

The largest of these acquisition programs, CARL (Conservation and Recreation Lands) has acquired 435,400 acres of land and expended $807 million since it's inception in 1979. In 1990, the Florida State legislature authorized the Preservation 2000 bond program enacting the issuance of $3 billion in bonds over a 10 year period for land acquisition[47].

CARL projects must meet at least one of the following 6 public purposes:

1. To conserve and protect environmentally unique and irreplaceable lands that contain native, relatively unaltered fauna and flora representing a natural area unique to, or scarce within a region of Florida or a larger geographic area.
2. To conserve and protect lands within designated areas of critical state concern, if the proposed acquisition is related to the natural resource protection purposes of the designation.
3. To conserve and protect native species habitats or endangered or threatened species.
4. To conserve, protect, manage, or restore important ecosystems, landscapes, and forests, if the protection and conservation of such lands are necessary to enhance or protect significant surface water, ground water, coastal, recreational, timber, or fish or wildlife resources which cannot otherwise be accomplished through local and state regulatory programs.
5. To provide areas, including recreational trails, for natural resource-based recreation.
6. To preserve significant archaeological or historic sites.

By statute, 20 per cent of the Preservation 2000 funds must be spent on acquisition of coastal lands. In addition, CARL receives recurring revenues from a 5.84% increment of the real property documentary tax, from an excise tax on phosphate ore mining, and from some additional sources.

1. In the planning phase for coastal parcels, 3 additional criteria are considered:
2. The value of acquiring coastal high-hazard parcels, consistent with hazard mitigation and post-disaster redevelopment policies, in order to minimize the risk of life and property and to reduce the need for further disaster assistance;
3. The value of acquiring beachfront parcels, irrespective of size, to provide public access and recreational opportunities in highly developed urban areas;
4. The value of acquiring identified parcels the development of which would adversely affect coastal resources.

CARL is a "willing seller," negotiated purchase program. The program has the power to condemn property, however the statutory prerequisites are rigorous and experience has indicated that purchase through condemnation

[47] Bay, J.H. (1994) Methods and Strategies for Acquiring Coastal Lands. Prepared for Hawaii Coastal Zone Management Program, 82p. plus appendices.

typically costs 150% of the fair market value. Instead, CARL uses leases, conservation easements, and other less-than-fee-simple methods to achieve its objectives[48]. This has been a source of criticism by some involved with the effort who cite the high cost (80 to 85 per cent of fair-market value) of typical less-than-fee purchases. In the end, less-than-fee acquisition does not provide the enduring guarantees of conservation that come with a fee-simple purchase. It is felt by some critics that full fee-simple purchases would be more cost-effective. Other critics state that CARL needs strengthening in the areas of planning and resource management, and that many CARL targets were not the product of careful planning and goal setting, but rather were targets of opportunity not backed up by careful consideration.

CARL nonetheless demonstrates the significance of political support. If the political support is there, the money and programs will follow[49].

4. California Another state-level program that focuses on acquisition is the California State Coastal Conservancy created in 1976 to allow the state to use acquisition, as well as regulation, for coastal protection, restoration, and management[50].

The Coastal Conservancy is separate from the California Coastal Commission. The Commission is a state grantee agency under the federal Coastal Zone Management Act and has regulatory powers including permitting. The Conservancy has no permitting or regulatory powers and its primary mission is to act as a facilitator and problem-solver.

The Conservancy is characterized by the following features[51].

1. It cannot exercise power of eminent domain without legislative approval.
2. Its projects, including land acquisition, are not subject to individual legislative approval, hence it has increased flexibility.
3. It has the authority to make grants and enter into partnerships with private nonprofit organizations.
4. It can acquire and hold fee simple and less-than-fee interests in lands without going through the State Land commission and other normal bureaucratic procedures for lands acquisition.
5. It has been funded primarily by general obligation (GO) bonds until bond issues failed at the polls in 1994 and 1998. Those involved with the program, however, are optimistic that the statewide recession of the last decade has ended and that funding for the Conservancy will regain it's former strong footing.
6. The Conservancy provides technical assistance to plan and design projects, it holds community meetings and workshops to resolve conflicts, it provides grants and matching funds for projects, it undertakes demonstration projects, it works closely with nonprofit groups to achieve conservation goals, and it leverages funding with multi-stakeholder consortiums.
7. Through it's powers and philosophy it has the flexibility to take risks, act quickly, innovate, and otherwise act to implement state coastal policies.

The Coastal Conservancy has been especially effective in its use of innovative acquisition techniques, including less-than-fee interests, lot consolidation, area-planning programs, partnerships with nonprofit land trusts, and TDR and the transfer of development credits (TDC).

Because its primary mission has been to accommodate the competing demands of development, public use, and resource protection in creative ways, it's philosophy has always been to utilize an approach of mediation and compromise. It is not a program whose primary mission is to acquire land, or issue permits or denials. However, critics state that an approach of compromise does not well-serve the long-term interests of resource protection and that sensitive, mediated development has little to do with conservation.

d. Education and Outreach

[48] Id.
[49] Id.
[50] Id.
[51] Id.

A 1998 review of the Ocean Resources Management Plan[52] highlights the value of a mobilized and educated public as a means of achieving change in government management of natural resources. The Review identifies the general "lack of recognition of ecological and economic importance of ocean and coastal resources for Hawaii." In general, coastal and ocean resources do not carry the same political weight as higher profile political issues such as the economy and education. This should not be the case. Our economy, and our lifestyle and quality of life in Hawaii are all dependent to a great degree upon the preservation and perpetuation of a viable, thriving, and healthy coastal and ocean ecology and resource base. The fact that the management of these resources is not accorded high political value in the public arena of social discourse is a sign of disorganization among the management leadership. It signifies a lack of vision for the future of our ocean resources.

Once a vision is identified, and a plan of action is defined, there can be the clear articulation of a new coastal future communicated to the people of Hawaii. A rational plan for resource conservation must ride upon the political will of the constituency. However, the constituency (the people) can only give such a plan high value if they are educated and possess a high degree of awareness of the issues. The most effective strategy for altering the policies and procedures of our coastal management system are doomed to failure if we do not build a high level of awareness and education among the citizens of Hawaii, and the users of our beaches and shorelands. The power to change flows up from the people once the people are educated on the issues and the possible directions for improvement.

e. Funding Research

Coastal resource managers lack sufficient scientific data and analysis to make informed decisions regarding the occurrence, magnitude, continued threat, causes, and mitigation of coastal erosion and other coastal hazards. This prevents them from establishing planning goals for coastal sectors[53]. This also places the planning process on a reactionary footing that is poorly equipped to protect coastal resources. Often the first awareness that regulators have of an erosion problem area is a phone call from a homeowner in an emergency situation and in need of immediate protection. This causes a chain of reactionary events, on an accelerated schedule, driven by a mixture of chaos, panic, emotion, and legal regulation. The time for planning and proaction are long past. At this point, the chain of reactionary events is oriented to the immediate mitigation of the threat to the landowner. Resource conservation is lowered to secondary status. This would not necessarily be a bad system of management if it were limited to a few dozen homes, or even a few hundred. The resource impacts might be relatively benign and the valuation of costs to benefits might be in favor of such a system of management. But there are thousands of coastal properties in Hawaii that have been channeled through this system of reaction management. The combined impact of this lack of planning, applied over the years to miles of coastline, has now placed significant portions of the shoreline on the brink of loss.

Managers are hampered by the lack of a continuous datastream providing information on past, current and potential future problem areas. Without objective, high-quality descriptive data in a useable format, it will be impossible for managers to implement a system of environmental sequencing. Without high resolution data on erosion patterns and trends, regulators are consigned to reactionary permit processing…this is not planning.

The State of Florida, through its university system, maintains a multi-level research program that provides scientific products to managers. The managers themselves are

[52] Lowry, K., Hamnett, M., Anderson, C.L., and LeMaitre, M. (1998) Review of the Ocean Resources Management Plan (draft). A Report to the Hawaii Office of Planning, Coastal Zone Management Program, 30p.

[53] Challacombe, A. (1997) Beach Management in Hawaii: A Public Sector Perspective. Hawaii Planning, v. xviii, no. 6, p. 5, June, Monthly Newsletter of the Hawaii Chapter of the American Planning Association.

involved in deciding where to focus research efforts, and what data is needed to assist in planning. Beach profile monitoring, storm surge modeling, sand resource investigations, annual tracking of erosion and accretion patterns throughout the state, and new technology development and application to coastal resource management are hall marks of the Florida system. The availability of high-quality research products has made the regulators and planners of Florida agencies acknowledged experts on coastal processes. They are able to develop community plans in the expectation of future hazard patterns, and they are able to engage a process of informed decision-making, and goal-setting based upon the best available scientific data and analysis.

5. Five Alternatives for Erosion Management

"Today's coastline is of economical, social, cultural, and environmental value to communities and to nations. However, shorelines are dynamic and ephemeral places where erosion trends tend to dominate. Development along the shore places the desires of man (to have a safe and stable home) in direct opposition to the natural trends of nature (to erode, transport, and deposit coastal lands)."

So wrote Joan Pope, a coastal geologist with the U.S. Army Corps of Engineers, in a research article published in the Journal of Coastal Research in 1997[54]. She goes on to advise that coastal erosion management should be the rational consideration of a range of options including: abandonment, beach restoration, erosion control, adaptation, or hardening the shoreline.

This succinct and clear statement of the options is worth a closer look because it provides a useful common language for discussion, and sets out a framework for decision-making.

a. Abandonment - "do nothing"

The abandonment solution involves taking no action to protect human developments along an eroding shore. The beach is allowed to behave as it will regardless of the causes of erosion or the impacts that shoreline retreat may have upon the upland region. This is the appropriate response in areas where erosion or flooding problems are so severe that hazard mitigation is not economically viable, that is, where the cost of protection would exceed the value of the investment. This may also be the preferred approach in areas where the natural appearance of the shoreline, and the natural patterns of shoreline change, are important to the character and attractiveness of the system and deemed of highest priority in the socioeconomic valuation of management options.

Decision-making for this approach is based primarily upon socioeconomic considerations and must involve a high level of public participation and community dialogue. At Shell Island, North Carolina, a 9-story condominium is being allowed to fall into the sea as the state forbids the construction of seawalls or bulkheads because they often aggravate nearby erosion. In Oregon, a row of newly-built townhouses perched on the lip of an eroding coastal bluff are being undermined by erosion, and the state has stopped attempts to protect them. Both New York and Massachusetts have allowed, at times, beachfront buildings to collapse rather than permit their protection by shoreline hardening.

Abandonment has not been considered in Hawaii as an erosion management alternative. What criteria would Hawaiian regulators use to define a situation where a home would be lost rather than protected from erosion? Alternatively, what will regulators do when the very first seawall application on an otherwise pristine beach arrives on their doorstep?

b. Beach restoration - "fill the beach with sand"

Beach restoration involves the placement of sand on an eroding shoreline to resupply deficiencies in natural sand volume due to waves and currents or human activities, or to counteract shoreline retreat caused by sea-level rise. Sand placed on the beach to offset these losses may partially mitigate chronic erosion or provide a buffer to protect the back beach and upland against future storm or seasonal wave-induced erosion or flooding. A healthy beach may also

[54] Pope, J. (1997) Responding to coastal erosion and flooding damages. Journal of Coastal Research, v. 13, p. 704-710.

provide recreational benefits that contribute to the economic vitality of a community. This is the only management alternative that actually adds sand back into the littoral system and restores the beach to some previous configuration that is an improvement to its eroded state.

The restoration of a dune system with endemic coastal vegetation may be a major component of the effort as the dune further enhances the sand storage capacity of the shoreline and provides additional mitigation against the effects of storm or seasonal wave erosion.

The Coastal Zone Management Program funded a study and review of the state of knowledge of offshore sand resources[55]. The results indicate that sand resources exist in marine environments sufficient to promote the use of beach restoration using offshore materials. Further discussions of beach restoration in various committees and public forums, as well as additional research[56], have identified environmental, commercial, and technical aspects of the procedure that should be further investigated before the technique can be widely employed in Hawaii. These include dredging impacts to offshore ecosystems, availability of suitable sand recovery and delivery technologies, sand grade and color inadequacies, and financing and administrative issues including permitting and cost sharing.

Typical beach restoration involves placing sand on the upper portion of the beach profile so that it is visible and leads to an immediate improvement in beach width and scenic amenity. Sand may also be placed lower on the profile such that it is below the water level yet still acts as a feeder to the beach. Any sand that is placed within reach of the waves will immediately, and continuously thereafter adjust to assume a dynamic equilibrium profile. This condition is achieved by the natural migration of sand across the entire profile. That is, the dry beach width will decrease because sand moves offshore to feed the lower portion of the profile that is below sea level. The degree to which this sand remains in the system and continues to provide benefits to the dry beach varies from site to site and should be the focus of research designed to improve our understanding of equilibrium profile fluctuations.

Challenges to beach restoration[57] include finding a source of sand with adequate grain characteristics that will constitute a stable beach under the expected range of wave energies. There must also be a careful determination of the necessary fill volume to not only restore the beach and dune system lost to historical erosion and development practices, but to also fulfill the uneroded potential sand volume that was denied by the presence of shoreline armoring. That is, along many shorelines actual erosion has been stopped because of walls and revetments, it may be that any sand placed on such shores will immediately erode to fulfill some undefined "erosion potential" demanded by the system but unavailable because of armoring[58]. It is important, therefore, to fully understand the sand budget of Hawaiian beach systems to address this question and to make realistic economic projections of sand (fill) characteristics and volume[59]. Beach restoration also requires data on historical shoreline changes and projections of future patterns of change, as well as studies of waves and currents and sediment transport processes to assess the economic life and design components of the project.

Potential environmental (benthic and pelagic faunal communities and dependents) disruptions

[55] Sea Engineering, Inc. (1993) Beach nourishment viability study. A report prepared for the Coastal Zone Management Program, Honolulu, 300p.

[56] Hampton, M.A., Torresan, M.E., Wong, F.L., Fletcher, C.H., Bailey-Brock, J.H., and Cruickshank, M.J. (1997) Reef-front sediment deposit in Kailua Bay Hawaii: A possible sand resource? First Regional Conference on Coastal Erosion Management in Hawaii and other Pacific Islands. Abstracts with programs, University of Hawaii Sea Grant College Program.

[57] Bodge, K.R. (1998) Beach management and restoration. First Regional Conference on Coastal Erosion Management in Hawaii and other Pacific Islands. Abstracts with programs, University of Hawaii Sea Grant College Program.

[58] Id.

[59] Fletcher, C.H., and Norcross, Z. (1998) Knowing large-scale coastal behavior. First Regional Conference on Coastal Erosion Management in Hawaii and other Pacific Islands. Abstracts with programs, University of Hawaii Sea Grant College Program.

at the sand source to be mined[60] must be fully assessed and mitigated to an acceptable level among all stakeholders. It does not make sense to destroy one environment in order to restore another. Lastly, as recommended by the National Research Council[61], all restoration efforts must be fully monitored so that lessons learned from analysis of fill performance, and source site recovery, can lead to improved future restoration efforts.

Beach restoration is being seriously considered in Hawaii. Several small-scale projects are in progress on Maui and Oahu. The Department of Land and Natural Resources is proposing a bill in the 1999 Legislature to fund beach restoration projects, and together the CZM program and DLNR are conducting a site assessment survey to identify a viable large-scale restoration project.

c. Erosion control - "slow down the erosion rate"

Coastal erosion control techniques use structures that are designed to reduce sediment losses and thus slow the rate of erosion. The intent is to protect the backshore by trapping and holding sand and thus stabilize the beach. The trapping characteristic of this approach could mean adverse impacts to adjacent beaches if sand held in the project area would normally migrate through or accrete on neighboring beaches. Because of this, erosion control projects should include the use of additional sand to fill the profile to an equilibrium level relative to the structures plus any additional sediment the structures may cause to be diverted offshore and lost to the littoral system.

The purpose of a beach erosion control project should be to slow the loss of the placed sand, not to trap sand from the ambient littoral system.

Structures include groins, T-head groins, detached breakwaters, artificial headlands, perched beaches, reef/sill systems, dune fencing, beach dewatering, and a number of devices on the market (i.e., surge breakers at Kualoa Beach Park, Oahu). As with all aspects of coastal behavior, there are no guarantees that the desired effect will be achieved with the system of choice. Nevertheless, certain structures, such as T-head groins and detached breakwaters, are solidly based in both theory and practice and can produce results with a high level of predictability under appropriate conditions when their use is designed by an experienced professional[62].

A properly designed beach erosion control project is one of the greatest challenges of coastal engineering. The complex interaction of these structures with the littoral system requires a good understanding of local beach dynamics, coastal processes, historical shoreline patterns, and acceptable performance tolerances. In evaluating the performance of a particular structure, it is important to avoid the classic mistake of misinterpreting natural profile recovery and accretion as the work of the structure.

The beach erosion control approach is more appropriate for areas where the problem is chronic erosion due to diminished sediment supply. These structures can be very useful in areas where it is too expensive to maintain a beach by continuing to bring in large quantities of sand from an outside source. Groins, breakwaters and headlands work best in areas where longshore transport is much more dominant than cross-shore transport in moving sediment out of the project area. Structures alone do not protect the back beach from wave-induced flooding and erosion. They provide their benefit to the shore by trapping and or holding sand in the desired location and allowing sufficient elevation of the beach profile to be maintained. It is the beach held by the structures that provides protection to the coastal upland and related human developments.

d. Adaptation - "live with it"

[60] Bailey-Brock, J.H., and Giles, H. (1998) Benthic communities resident to the Kailua, Oahu sand cell. First Regional Conference on Coastal Erosion Management in Hawaii and other Pacific Islands. Abstracts with programs, University of Hawaii Sea Grant College Program.

[61] National Research Council (1995) Beach Nourishment and Protection. National Academy Press, Washington, D.C., 334p.

[62] Bodge, K.R. (1998) Beach management and restoration. First Regional Conference on Coastal Erosion Management in Hawaii and other Pacific Islands. Abstracts with programs, University of Hawaii Sea Grant College Program.

Adaptation requires that development patterns change in order to allow natural erosion/accretion cycles to continue without interference.

This protects natural shoreline attributes from the impact of human alterations to coastal processes, but requires modification of human occupancy and use of the coastal zone. This is a management, rather than engineering, approach that utilizes tools such as zoning restrictions, building standards, community facilities districts, new subdivision requirements, and/or new rules governing permit restrictions and allowable actions in an erosion hazard area.

Decision-making for this approach is based upon socioeconomic considerations and must involve a high level of public participation and dialogue. Examples include:

1. changing set-back requirements for new construction,
2. setting new limitations on development and landscaping,
3. relocating structures threatened by erosion,
4. flood-proofing buildings,
5. new building standards for high winds, wave impacts and erosion threats,
6. land banking,
7. implementing a "coastal retreat" policy.

The basic assumption behind this approach is that it is easier and cheaper to retreat than to stay and eternally wage war with coastal hazards[63]. Developing an adaptation methodology requires an economic analysis that includes a valuation of the scenic and recreational amenity of natural shorelines.

Adaptation includes identification of "hazard zones" where human activities and future patterns of shoreline change may overlap. It is within these hazard zones that the land-use tools are applied to implement adaptation. It is important, therefore, to involve the local community and the larger population of beach users in an open discussion of options and consequences, as well as uncertainties.

e. Hardening - "build walls"

Pope reviews coastal armoring as an erosion response. Coastal armoring includes the use of seawalls, revetments, bulkheads, levees and dikes in an attempt to harden the shoreline.

This is usually the approach of last resort, and is most appropriate where the primary problem is one of storm-induced damages rather than chronic erosion. In Hawaii, to the contrary, armoring has been the typical response to intermittent as well as chronic erosion hazards and is often the first choice among landowners.

In her article, Pope states that if armoring is placed along a chronically eroding coast, the beach in front of the structure is likely to eventually disappear. This is not due to an active aggravation of the erosion process, but rather because the back beach reference has been stabilized while the shoreline has not. This process is called *passive erosion* because of the tendency for a shoreline to passively retreat up to a wall, losing the beach in the process. Many studies by coastal scientists and engineers alike support this finding[64].

Other challenges accompany shoreline hardening, these include the following.

1. *Groin-effects* occur when a portion of a wall protrudes across the shoreline and blocks

[63] Bay, J. and Bay, M. (1996) Reducing hazards in shoreline areas: policy and legal options. A report from the Coastal Aquisition Project, Phase II, Hawaii Coastal Zone Management Program, 15 p.

[64] U.S. Army Corps of Engineers (1991) Beach response to the presence of a seawall: Comparison of field observations. U.S. Army Corps of Engineers, Coastal Engineering Research Center, *Technical Report CERC-91-1*, 63p.; McDonald, H.V. and Patterson, D.C. (1984) Beach response to coastal works, Gold Coast, Australia. Coastal Engineering '84 (New York, American Society of Coastal Engineers), p. 1522-1538; Kraus, N.C. (1988) The effects of seawalls on the beach, an extended literature review. Journal of Coastal Research, Special Issue 4, p. 1-24; Pilkey, O.H., and Wright, H.L. (1988) Seawalls versus beaches. Journal of Coastal Research, Special Issue, 4, p. 41-64; Tait, J.F., and Griggs, G.B. (1990) Beach response to the presence of a seawall. Shore and Beach, v. 58, p. 11-28; Hall, M.J., and Pilkey, O. H. (1991) Effects of hard stabilization on dry beach width for New Jersey. Journal of Coastal Research, v. 7, no. 3, p. 771-785; Fletcher, C.H., Mullane, R.A., and Richmond, B.M., 1997, Beach loss along armored shorelines on Oahu, Hawaiian Islands. Journal of Coastal Research, v. 13, no. 1, p. 209-215.

longshore sand movement causing down-drift erosion.

2. *Sediment impoundment* is the trapping of sand behind a wall, this leads to sand volume deficiencies because erosion of the land can be an important source of sand to beaches. Sediment impoundment may create an increased demand for sand within a littoral cell causing accelerated erosion along unprotected sections of shoreline. Only beach monitoring efforts can provide the data to fully investigate this problem, and studies have not undertaken this task to date.
3. *Cross-shore reflection* occurs as waves bounce off walls and cause scour and the deflection of sediment offshore. However, some studies[65] question the veracity of cross-shore reflection as a negative impact because actual sand deficiencies may not be caused. Nonetheless, cross-shore reflection has been implicated in Lanikai as a negative influence on beach stability[66].
4. *End effects* are typically a localized scour effect at the ends of a wall.
5. *Differential erosion* in some circumstances may be a perceived, rather than real occurrence. Differential erosion is identified when an unprotected shore continues to retreat adjacent to a protected shore, thereby giving the appearance of having been caused by the wall. Historical shoreline change data can be effectively used to define the occurrence (and magnitude) of this phenomenon as a factor in the erosion of the beach.

6. Design Considerations

In the majority of cases where erosion threatens human habitation and infrastructure on the Hawaiian coastline, the challenge to managers and engineers is to mitigate the erosion hazard while at the same time fully preserving, even restoring, the beaches along the shoreline. However, it is foreseeable that on some shorelines the cost of beach preservation and restoration may be prohibitive and the rational alternative may not be beach conservation. It is equally foreseeable that the cost of protecting upland development and property is prohibitive and that abandonment is the rational alternative. These are socioeconomic decisions that are not likely to be easy or obvious. But it is critically important that the valuation criteria and public dialogue for making these decisions be engaged and openly defined rather than hidden from public view. In the end, it will be the case that combinations of various approaches are used to differing degrees to resolve erosion hazards along the Hawaiian shore.

The technical considerations necessary to fully design and successfully implement these approaches to erosion management include the following[67].

1. Hydrodynamic Site Characteristics
    a) understanding the wave climate,
    b) wave transformation,
    c) current patterns,
    d) fairweather vs storm conditions and frequency,
    e) bathymetry,
    f) water level conditions;
2. Geologic Site Characteristics
    a) present sediment supply rates and transport dominance,
    b) historical shoreline trends and patterns,
    c) inherited geologic features,
    d) foundation conditions,
    e) profile variability,
    f) sediment characteristics,
    g) availability and quality of construction materials (sand fill);
3. Project Economics
    a) benefit-cost ratio,
    b) performance requirements,

[65] Kraus, N.C., and McDougal, W.C. (1996) The effects of seawalls on the beach: Part I, An updated literature review. Journal of Coastal Research, v. 12, no. 3, p. 691-701.

[66] Lipp, D.G. (1995) Changes in beach profiles due to wave reflections off seawalls at Lanikai, Hawaii (thesis). University of Hawaii, Department of Ocean Engineering, 94p.

[67] Pope, J. (1997) Responding to coastal erosion and flooding damages. Journal of Coastal Research, v. 13, p. 704-710.

c) future land-use and partner funding expectations,
d) constructability,
e) ability to perform future maintenance,
f) acceptable levels of risk;

4. Environmental Considerations

a) land use,
b) biological community requirements,
c) environmental policy,
d) potential for physical and environmental impacts,
e) endangered species,
f) cultural resources;

5. Socio-Political Guidelines

a) customer and partner expectations,
b) future development trends,
c) user community requirements,
d) public safety and accessibility,
e) local legal and zoning restrictions,
f) national and state regulatory and funding policies.

7. Project Performance Monitoring

No solution for addressing coastal erosion is ever final and no coastal project is ever complete. There are no absolutes along the coast, only compromise and adaptation. It is good to remember that no one type of erosion management is best for all locations. What works well in one place will not necessarily work well somewhere else. It is also the case that no erosion management approach will work equally well in all conditions. Every approach is designed for a certain range of conditions. If those conditions are exceeded or not realized, the project may fail to function as intended. There is no such thing as "low cost" erosion management. There are no bargains in the effort to preserve our beaches and protect our lands.

It is important, therefore, to monitor project performance, especially in the case of beach restoration, in order to improve technical understanding of all aspects of erosion management. In fact, this was a major recommendation of the National Research Council, Committee on Beach Nourishment and Protection[68]. Erosion hazard reduction and beach preservation projects need continual re-evaluation, maintenance, and modification.

A monitoring program will require establishing a base-line condition, and ideally should start before any construction is undertaken, and continue over several years during and well after a project. This includes monitoring biological, geological, engineering, and socioeconomic aspects of the effort, as well as monitoring the sand borrow site if the potential for residual impacts from dredging exists.

a. Physical Monitoring

Monitoring is essentially the collection of a time series of data that describes the need for, evaluates the performance of, and otherwise builds a scientific framework for erosion management decision-making.

Monitoring the physical processes associated with a beach restoration project, for example, should be oriented toward establishing a sediment budget[69]. This includes identifying and quantifying all sand sources and sinks, and rates of exchange. Gains and losses in the sand budget are balanced against the changes in sand volume in the area. Monitoring data is collected to quantify the physical processes that comprise the sources, sinks, and sand volume changes in a project area. These can include the previous history of the coastal site, beach profiles, local anthropogenic impacts, history of storms, waves and currents, historical shoreline changes, water levels, structures, sediment characteristics, rates and volumes of transport, bathymetry, and photographic documentation.

b. Biological Monitoring

Biological monitoring should be oriented toward determining the existing biological resources that may be altered by a project and providing recommendations that will avoid long-term negative impacts to those resources. This can be achieved by characterizing the pre-project temporal and spatial variability in biological resources present within and near a management

[68] National Research Council (1995) Beach Nourishment and Protection. National Academy Press, Washington, D.C., 334p.
[69] Id.

area, and evaluating the post-project recovery of biological resources that may be impacted by the project[70].

c. Economic Monitoring

According to the National Research Council[71], economic monitoring should attempt to answer the following questions:

1. How large are the economic benefits, and do they approximate those predicted for the project?
2. What are the effects of the project on property values and to what extent are these effects linked to coastal hazard reduction, enhanced aesthetics, and recreational amenities?
3. What were the construction and other related costs, and were they well approximated by the cost estimates?
4. Are there other significant but perhaps unanticipated costs and/or benefits accruing from the project?
5. From the locality's standpoint, did the project stimulate growth, and, if so, what desirable or undesirable effects did the growth have on the community?
6. Did the project encourage construction that places more property at risk from coastal hazards?
7. What was the actual distribution of the costs and benefits of the project - that is, who benefited and who paid?

[70] Id.
[71] Id.

III. RECOMMENDATIONS

A. OWNING-UP TO THE PAST

The people of Hawaii strive to live in harmony with their dynamic shoreline. No resident actively seeks to damage the beaches and dunes that are so much a part of the daily beauty that surrounds us all. Awareness, education, and foresight can build public conviction for an enhanced coastal future. The menu of options and tools for coastal land stewardship can be increased. Funding, statute changes, and rule amendments to implement new coastal policies for Hawaii are only as far away as the political resolve to ask. A strong unified voice will be heard by our leaders. Government can respond to the complex issues of erosion management in a manner that enhances the interests of all stakeholders. But it will take time, work, a willingness to forgive and accept, vision on the part of our leaders, and a broad public awareness effort.

This final section of COEMAP outlines actions and makes recommendations to reduce coastal hazard exposure, and increase beach and dune conservation and restoration. These recommendations are intended to be used as tools to authorize agencies seeking changes and to empower citizens searching for answers.

Simplistic and non-comprehensive management practices cannot be effectively applied to our dynamic shoreline. But a comprehensive plan for managing erosion can offer powerful guidance for developing policy, framing the discussion of issues and stakeholder needs, and directing the actions of agencies.

Several well-documented realities about the management of coastal lands in Hawaii are now evident:

1. we have managed our beaches and dunes poorly in the past;
2. coastal hardening as a solution to *chronic* erosion is environmentally destructive;
3. historical patterns of erosion management have been too frequently inadequate and have too often ignored resulting impacts;
4. the existing regulatory framework for coastal conservation and hazard mitigation is not sufficiently comprehensive, it can be improved and its effectiveness can be increased; and
5. the improvement of these failings will not be easy, rapid, inexpensive, or simple.

B. STRATEGIC RECOMMENDATIONS

Improved management guidelines and policies can emerge from a more detailed understanding of coastal environmental processes, from the successful coordination of multiple levels of government, and from the participation of communities of coastal users. The following recommendations individually and collectively will move Hawaii toward the attainment of these goals.

1. **Develop, fund, and empower the Coastal Lands Program at DLNR as the Lead Agency for coastal erosion management.** The mission of the CLP is to manage growth along the state's shoreline in order to achieve a balance of resource conservation and reduced hazard exposure. This is best achieved through participation and partnerships with all stakeholder agencies and coastal communities. The Coastal Lands Program will oversee and assist in the implementation of technical and policy recommendations embodied in COEMAP and derivative efforts to promote the establishment of sustainable coastal use policies and programs. The CLP should be staffed by experts in coastal management and planning, and coastal science and engineering who will work cooperatively with other federal, state and county agencies and workers to devise additional

management strategies to mitigate shoreline degradation.

a) Funding for the CLP can originate from many sources, including:
   i) federal monies for coastal management,
   ii) donations,
   iii) legislative appropriations,
   iv) bonds with debt service repaid by small revenue streams with a nexus to coastal lands,
   v) federal grants,
   vi) fines and penalties,
   vii) fees, and other revenues generated by public resource-value lands, and others.

b) At this writing the state of Hawaii is experiencing a fiscal crisis that is manifested in a declining annual budget, a reduction in the size and scope of government, and a restriction in the flexibility of existing programs. The CLP was created in the midst of this crisis and despite the widely recognized importance of its mission, it is not likely to enjoy significant levels of funding in the immediate future. In fact, the CLP was created without an increase in DLNR staff or expenditures.

c) A rational source of funding for the CLP is the utilization of state resource lands to generate revenues. This could include fees, tenantships, and fines generated by users of state lands with nonpermitted shoreline structures such as piers, docks, walls and other structures crossing state lands. These could be a source of funds for exercising compensatory mitigation under the CLP. A special fund should be created to house these monies so they are not lost from the coastal zone so they can be applied to restoration and mitigation activities of the CLP and sister agencies. Grants (such as available from the EPA for environmental restoration) are another source of funds for conducting restoration and mitigation activities in fulfillment of the CLP mission.

d) Activities within the purview of the CLP may include:
   i) administering the CDUA process,
   ii) planning new state regulatory functions and programs on the shoreline in a framework of multiagency coordination and community participation;
   iii) providing public education;
   iv) sponsoring and conducting research and monitoring efforts;
   v) conducting enforcement activities;
   vi) planning and facilitating agency coordination on permitting and planning within coastal hot spots;
   vii) creating and providing GIS layers of shoreline data;
   viii) acquiring and maintaining a coastal database with standardized format, accuracy and precision;
   ix) developing programs for beach nourishment, offshore sand recovery, and alternatives to shoreline hardening;
   x) creating opportunities for compensatory mitigation and bringing into conformance existing nonpermitted structures, activities and usages;
   xi) conducting land acquisition planning and implementation;
   xii) setting planning goals oriented toward sustainable development for specific littoral cells to promote resource protection and restoration.

e) The CLP may also provide grants-in-aid to the counties, citizen groups, and individuals (homeowners) who wish to conduct activities that are consistent with the CLP mission.

f) The CLP should enhance the counties' ability to control and regulate

development activities along their shorelines.

g) The CLP should facilitate working agreements with the counties, the federal government, and other state agencies to simplify the complex permitting process for projects such as beach and dune restoration and renourishment, and offshore sand mining.

h) The CLP should promote and support county programs designed to facilitate coastal restoration and hazard mitigation.

i) The CLP should review and recommend amendments to the shoreline certification process for the purpose of environmental restoration, conservation, and hazard mitigation.

2. Encourage state and county decision-makers to **consider erosional trends and processes, and other coastal hazards, at the zoning and subdivision stages** of land development so that structures can be safely and properly located away from hazard areas. This action would prevent burdening landowners and regulatory agencies with foreseeable coastal hazard issues at a later date.

3. Develop a **Technical Guidance Manual that provides direction for the development, restoration, and redevelopment of the coastline**. The manual[72] would be used on a voluntary basis, but through common usage could become a standard for the safe, economical, and sustainable utilization of the coastline. Creation and development of such a manual will require funding through the various responsible stakeholder agencies, and could take place on a component by component (i.e., chapter by chapter) basis as needs arise. The manual could provide direction during zoning and subdivision stages of development so that coastal lots are created of sufficient dimension and size to maintain a buffer between the shoreline and proposed structures. The manual could provide direction during the zoning of lands so that on large lots, structures are built away from the shoreline on the mauka portion of the lot. There are certain portions of our shoreline where existing development patterns offer a good demonstration of properly located structures with sufficient buffers against erosion hazards. On Oahu, these include portions of Waimanalo, Kailua, and Kahuku where construction setbacks have been utilized that exceed the present 40ft requirement.

   The manual could also offer guidance and recommendations for implementing actions on already developed shorelines where erosion hazards constitute management concerns.

4. **Enhance Interagency Coordination.** Agencies should improve and standardize permit processing criteria, develop and agree upon acceptable guidelines for constructing Environmental Assessment and permit applications for activities in the shore zone, and build an organized and consistent system of erosion management and resource conservation among CZM, CLP, OEQC/DOH, and the counties and federal COE. This coordinated system should incorporate the best aspects of ideas embodied in COEMAP and other applicable sources. A strong starting point would be to:

   a) guarantee a continuous datastream to coastal managers,

   b) build a prevalent, consistent, and continuous public education and awareness campaign,

   c) implement beach and dune restoration as a viable management tool,

   d) establish community redevelopment procedures and guidelines to recover and restore beaches and dunes where they have been lost by shoreline hardening,

   e) institute environmental sequencing as the basis for coastal planning,

[72] Maui County has already moved in this direction with the creation of a Technical Guidance Manual: "Coastal Protection and Beach Restoration Feasibility Study, for Maui County, Oceanit Laboratories Inc., Nov. 1997, 122p."

f) establish a coordinated approach where federal expectations of CZM activities, state resource conservation goals, and county development plans are all integrated and defined in a mutually acceptable framework without exclusion of the goals at any government level.

5. **Implement a Pilot Shoreline Hazard Mitigation Project Using Beach and Dune Restoration.** Using federal Section 309 monies, the State Coastal Zone Management Program has funded the Coastal Lands Program at the DLNR to conduct a site selection analysis for the development of a pilot beach restoration project in Hawaii. DLNR, in turn, has subcontracted for coastal engineering expertise to evaluate candidate sites on Oahu and Maui shorelines that present the strongest mix of socioeconomic, geologic, and engineering factors promoting successful implementation of beach and dune restoration as a management option.

   a) This is a critical and important first step to implement sand nourishment for the integrated purposes of beach and dune restoration and hazard reduction. Nourishment is the use of sand mined from either offshore[73] or onshore to augment the littoral sediment budget of a beach experiencing chronic erosion. Nourishment and restoration reduce the exposure of coastal development to natural hazards by increasing beach width, dune elevation, and profile recovery.

   b) This project should lead to a report identifying the best candidates for coastal restoration from the perspective of both engineering and socio-economic criteria. The report should be used as a tool at the state legislature to request funds for a full engineering study and analysis of the lead site. The expected cost may reach over $500,000 and the analysis may take 3 years or more to complete. Planners, regulators, and legislators should expect to fund the actual restoration effort within a few years of that appropriation at an expected additional cost of several million dollars to engage the final restoration of the dune and beach environment.

   c) This entire effort will fail if the community does not support it. Education, awareness, outreach, and public dialogue are fully as important as the engineering and economics in completing this effort.

   d) Restoration must be established as a viable coastal management tool in Hawaii. This is best achieved with a carefully conceived pilot project that will have a high degree of success. Although there have been a number of small-scale restoration efforts, there has not been a large-scale nourishment project in Hawaii aimed at revitalizing an entire littoral cell.

   e) An important, and often undiscussed component of this effort should be the evaluation of upland development patterns in the area of the restoration project. A **planning analysis** should examine the potential for increased development, increased density, and increased economic commitment in the area that has been historically an erosion hazard zone, but has with restoration achieved a temporarily reduced hazard exposure. It has been the experience of many mainland restoration efforts that sand nourishment leads to *temporary* decreases in hazard exposure. Hence, stakeholders should engage in long-term planning for upland development patterns under a range of scenarios, including a future return to increased hazard exposure.

6. **Establish a continuous datastream, and formalize an enduring data source from the UH-SOEST by creating a branch of the NOAA Coastal Services Center.** The coordination of agency functions within and between layers of government is formalized, in various ways, through law and

[73] Dollar, S.J., 1979. Sand mining in Hawaii: Research, restrictions, and choices for the future. Sea Grant Technical Paper, UNIHI-SEAGRANT-TP-79-01, 106p

administrative rule. However, the integration of scientific data is sporadic and haphazard, often dependent upon the vagaries of funding, project specific investigations, and the availability and goodwill of individuals. This is fragile footing for an essential component of good coastal management.

a) The role of research and science in the erosion management effort should be solidified by establishing a consistent, reliable, and continuous datastream from researchers at the UH School of Ocean and Earth Science and Technology (SOEST). This would provide access to the highly applicable work presently being conducted there on beach dynamics, sand resources, coastal processes, sea level movements, erosion patterns, and littoral cell budgets. This would additionally provide a forum for managers to request specific studies and data products in response to current needs, and in expectation of near-term planning issues.

b) One mechanism for this would be to create a "regional node" of the NOAA Coastal Services Center located in Charleston, S.C. Another mechanism would be to establish a more autonomous entity that is not a direct federal effort, but which benefits from federal funding. Various avenues for establishing a research service provider for the state and counties should be explored in light of funding realities and management needs.

c) A first step in this process is the confirmation of regulatory authorities that there is a NEED for a responsive, high quality, and nationally respected coastal data research provider in Hawaii. Administrators may choose to submit legislation to create and fund such a provider, and a resolution establishing its need. As mentioned throughout earlier recommendations, managers at all levels have a need for improved data on coastal stability, patterns of coastal change, and characteristics and viability of sand for responding to chronic shortages.

   i) During 1998 MACZMAG meetings, the City and County of Honolulu has called repeatedly for improved data collection and dissemination on erosion patterns.

   ii) The 1997 and 1998 report of the nongovernmental members of MACZMAG identified the need for an improved database, and even suggested that a government office dedicated to that purpose be created.

   iii) Maui County and the UH Sea Grant College, at the 1998 Erosion Management Conference, identified the recent availability and involvement of scientific expertise at UH for assisting decision-making, as a turning point in the ability of the County Planning Department to effectively manage their coast.

   iv) Kauai County relies upon assistance from UH-SOEST to develop permit guidelines, to testify in contested cases, and to assist in the decision-making process.

   v) USGS, FEMA, DLNR, DOH, and CZM rely on UH-SOEST as a sounding board and feedback source, as well as a point of origin for technical assistance, advice, and public awareness building.

d) These and other activities point to the already established role of erosion research at UH-SOEST as an effective component in the erosion management system of Hawaii. However, that role is undefined and unformalized and rests solely upon the willingness of scientists to become involved. This is a fragile footing and could at any time leave a gapping void in the information network if individuals shifted priorities or places of work. The importance of a continuous source of data and objective expertise is such that it must be institutionalized and codified, and that a solid framework of high quality data collection and dissemination not be dependent upon the vagaries of specific project funding.

7. **Establish a broad, pervasive and enduring public education and awareness-building campaign in coordination with the Ocean Resources Management Plan and other resource management efforts such as MHI-MRI (DLNR) and the Polluted Run-off Program (DOH).** Few government objectives can be realized without the support of the public, and the public cannot support what it does not understand. There are many avenues to build public awareness through the media, the Department of Education, special events and functions, a print campaign, slogans, themes and other techniques.

   a) Institutionalize a regularly occurring **coastal forum** to give voice to all stakeholders and as a component of public awareness building. Coastal managers, scientists and engineers possess the expertise and knowledge to predict, at a preliminary level, the resulting physical and socioeconomic impacts of management decisions. To access this body of knowledge, it is important to enhance communication among coastal stakeholders. Communities face the issue of erosion on a daily basis and can provide the perspective of "workability" and feasibility for various socioeconomic management options. The fact that successful erosion management rests upon the participation of managers, scientists, engineers, and communities increases the need for an open and frequent forum designed to achieve mutually advantageous and acceptable solutions.

      i) One excellent example of this was the 1998 First Regional Conference on Coastal Erosion Management in Hawaii and Other Pacific Islands. This conference was jointly sponsored by the Sea Grant College at UH Manoa, the County of Maui Planning Department, and the US Geological Survey. it was attended by a wide range of stakeholders, including homeowners, hotel managers, scientists, engineers, and agency authorities.

      ii) Another example of a public forum that improves communication among a range of stakeholders is the Marine and Coastal Zone Management Advisory Group (MACZMAG) and the Subcommittee on Coastal Erosion. MACZMAG meets every other month to discuss the broad issues related to effective and sustainable coastal zone management in Hawaii. The public is invited to attend and contribute to the dialogue and a diverse cross-section of concerns and opinions are regularly presented.

      iii) The Erosion Subcommittee of MACZMAG meets on an irregular though frequent basis to address specific erosion management issues. This is also an open and broad-ranging forum that has achieved a great deal of consensus and open communication among members of the public, the research and private sector, and government regulators and planners.

      iv) Another example of an effective public forum is the series of colloquia and seminars that are held by the UH-Manoa. For example, in the fall semester of 1998, the UH Water Resources Research Center sponsored a speaker series on coastal erosion highlighting local and national planners, scientists, and engineers.

   b) Integrate management and public expectations. Coastal managers must communicate with local community-based resident and user groups, and private property owners for their opinions on coastal management options. Where communities are not responsive to management alternatives, there is a reduced chance of successful implementation and shared funding for

innovative conservation practices. Where communities and managers are able to communicate on a common level of understanding and education about alternatives and impacts, and where common goals can be defined and articulated, there exists an enhanced opportunity for achieving success.

i) Most importantly, where projects incorporating beach and dune restoration are proposed, the public must be educated regarding the **specific criteria for project success or failure**. If they observe a wide sandy beach initially resulting from a restoration project that soon begins to narrow as it experiences profile adjustment, they may conclude the decrease in dry beach width is a sign of project failure. Whereas the planners had fully expected the reduction as part of the profile equilibration process. More than any engineering criteria, the court of public opinion will judge the success or failure of implementing new management programs.

8. **Evaluate the applicability of "willing-user," community-based performance standards and/or planning districts as erosion management tools at erosion hotspots.** A significant challenge to coastal managers is the restoration and redevelopment of densely populated and developed coastal communities where chronic erosion conflicts with beach conservation goals. One equitable approach is to develop "willing-user," community performance standards for guiding changes to land use as future needs arise. Performance standards could be implemented in a framework of management authority that focuses on controlling erosion through resource conservation. Performance standards act as targets for modifying the land use pattern through future redevelopment efforts. Such targets would avoid penalizing current tenants, yet would establish community goals for achieving reduced exposure to coastal hazards and restoring beach and dune environments. Setting performance standards is a form of *minimization* that can be implemented through time on a schedule determined by the landowner through the redevelopment and renovation of existing structures and voluntary changes in land usage.

a) Creating a new setback regime in a location experiencing chronic erosion would relegate existing land tenancy to "nonconforming" status and levy significant economic penalties to landowners. A more equitable approach is to develop community-based performance standards for guiding subsequent changes to land use as future needs arise. Performance standards could be implemented in a framework of management authority that focuses on controlling erosion through resource conservation. This would be ideal for implementing the concepts of environmental sequencing, and for using redevelopment tools and coastal restoration to recover lost resources and protect existing ones.

b) Performance standards act as targets for modifying the land use pattern through future redevelopment efforts. Such targets would avoid penalizing current tenants, yet would establish community goals for achieving reduced exposure to coastal hazards and restoring beach and dune environments. Setting performance standards is a form of *minimization* that can be implemented through time on a schedule determined by the landowner through the redevelopment and renovation of existing structures and voluntary changes in land usage.

c) Applicable performance standards include:

i) defining nonregulatory, "willing user" variable setbacks as targets to guide the redevelopment and renovation of existing structures;

ii) setting regulatory construction standards promoting wind and flood reinforcement and avoidance;

iii) following landscaping standards that promote dune preservation, sand conservation and beach enhancement;

iv) and promoting enhanced coastal access and parking.

d) These performance standards could be established as a mixture of **nonregulatory and regulatory targets** setting a future vision for the community that would ultimately enhance land values, increase community pride, and restore damaged beach environments. A simple descriptive community pamphlet containing site-specific maps and guidelines could be the first step in implementing this goal.

e) In the spirit of the incentives offered by the NFIP/CRS, the state and counties of Hawaii may wish to consider providing incentives to communities of homeowners located in erosion hazard areas. This could include efforts along the lines of the CRS and/or FMA and/or alternative incentives to reduce hazard exposure and promote beach and dune restoration and conservation.

9. **Establish a Fund for Land Acquisition – Ho'opono Kahakai**. Create a coastal land acquisition fund based upon negotiated purchase and willing-seller concepts. This fund will focus on restoring degraded coastlines to a high level of health and sustainability, hence the fund can be called "**Ho'opono Kahakai**" (literally, to make right the beaches). One aspect of this fund can be a focus on redevelopment as a tool for implementing strategic improvements at erosion hotspots in the following manner.

   a) The CLP would use revolving funds of **Ho'opono Kahakai** to negotiate a willing-seller purchase of private developed lands in an erosion hotspot, and then resell them to the development sector under a new management regime.

   b) The new beach management regime would require that all residential development is sited landward of a 30 year erosion hazard setback as measured from the mauka toe of the primary dune. It would also define a relocation buffer zone located landward of the 60 yr hazard boundary which would be preserved for structure relocation in the event of future shoreline retreat. These setback guidelines would have to be defined following an analysis of historical shoreline fluctuations.

   c) Construction guidelines and landscaping recommendations would need to be specified such that exposure to losses due to coastal hazards are reduced and beach and dune restoration and conservation is enhanced.

   d) Lands in **Ho'opono Kahakai** would be resold or auctioned to the private development sector for redevelopment under the new guidelines. Revenues from the resale would infuse the Coastal Lands Program to purchase additional lands either adjacent to the resold properties or in other coastal hotspots under the same strategy.

   e) Pre-arrange for participation of the commercial development market. Ideally **Ho'opono Kahakai** would function as a partnership program under state and county agreement.

   f) **Ho'opono Kahakai** may have other characteristics to promote conservation and hazard mitigation goals. Regulators may wish to fund the program with bond issuances. Also, negotiated purchases may result in the state simply holding acquired lands without resale, perhaps used to increase shoreline access. The program may also wish to utilize "less-than-fee-simple" title to parcels in order to achieve erosion management objectives.

10. **General Permit for Restoration.** It would be in the best interest of facilitating the use of restoration as a viable option, and reducing the workload of agencies, to coordinate and identify areas of overlapping effort such that the permitting process can be made more efficient without sacrificing

the present high level of environmental and ecological safeguards.

a) One approach to realize this goal is to define a single "General Permit" such as the Department of the Army State Program General Permit (SPGP, administered by the Corps of Engineers) that defines guidelines for activities seaward of the certified shoreline, identifying state or federal jurisdiction. Such activities could include integrated conservation and hazard mitigation projects, such as small-scale beach restoration.

b) One General Permit applicable under state or federal jurisdiction, administered by a single lead agency, that defines guidelines for Best Management Practices to achieve integrated conservation and hazard mitigation along the shoreline, would provide efficiency and economy to the effort to restore lost beaches. That lead agency should be the Coastal Lands Program at DLNR.

11. **Restoration is not a Permanent Solution – Plan for Renourishment and Redevelopment.** Planning for post-restoration realities must proceed on a parallel track, and integrated with, any restoration project. If the source and cause of erosion is not rectified, then any restoration effort will experience erosion. There will be shorelines where erosion causes are not well understood, and where sea-level rise may be an important driving force behind shoreline retreat. Whether the restoration offers hazard mitigation for 1 year or 20 years, it will eventually need *renourishment*. How long can renourishment continue? Regulators, planners, and communities of users must honestly and openly explore future socio-economic scenarios. These may consist of continued erosion, accelerated sea-level rise, expanded development and population growth, exhausted sand supplies, and storms that damage the restoration project. The process of planning must not stop when the last yard of sand is placed on a restored shoreline. Restoration is not a permanent solution, but it does buy time to plan for the future, and the wise among us will use that time effectively to plan for the future of all coastal dependents.

12. **Adopt, or alter for adoption, the environmental assessment guidelines of the DOH-OEQC** that were submitted for public commentary in the November 23, 1995 OEQC Environmental Notice. The guidelines were also aired in the form of a major news story such that they gained significant public exposure. Modifications may be appropriate based on an analysis of responses and reconsideration of issues. These guidelines are presented in Technical Supplement, Part D (pg. 79).

    a) It is appropriate for additional state agencies, specifically the DLNR and the DBEDT to adopt these guidelines in their application review process so that there become established, clear and consistent standards for decision-making along the shoreline. County authorities should be involved in the adoption of the final guidelines so that there is consistency, ownership, and application to the guidelines and the review of shoreline projects.

13. **Focus Regulatory Efforts, build local awareness among agency personnel.** If we are to improve the erosion management regime in Hawaii, energy and effort must be focused on those localities where there is beach degradation and where active permitting issues arise.

    a) Beaches that remain viable for the purposes of recreation, ocean access, hazard mitigation, scenic beauty, and function as a healthy ecosystem are not an immediate management concern—even if the adjacent back-beach area is heavily armored. Armoring, in and of itself, is not a concern unless it compromises or poses a threat to one of the above mentioned parameters.

    b) All beaches should be monitored to establish their continued health and viability, but initial concerns should focus on restoration, hazard mitigation, and interagency coordination.

c) As a rule, coasts undergoing long-term retreat and chronic erosion constitute the greatest management concern. Hence, it is important to have scientific data on historical patterns of coastal change.

d) Political realities in Hawaii dictate that the State Legislature will be more likely to fund and legislatively implement a new erosion management regime if it has the support and backing of the counties. A review of other states experiences in wrestling with the similar need to revamp their erosion management program strongly indicates the need for a "grassroots" movement that convinces the legislative body that the need for change is immediate and the desire for change is strong.

14. **Decision-making Criteria.** Decision-making authorities and regulators need clear and unambiguous information on littoral processes, sand resources, historical erosion and accretion rates and projected future patterns, development patterns, land ownership histories, land-use trends, structure permitting histories, and other scientific and socio-economic trends and patterns at areas where erosion management decisions must be made. Regulatory decisions are complex and require evaluation and analysis of numerous and interdependent factors in order to carry out the letter of the law.

    a) To achieve the goal of providing an informed framework for decision-making, it is important to conduct regional analyses of physical environmental and socio-economic patterns at the scale of the littoral cell. These analyses should provide regulators with recommendations in the form of general developmental, sociological, infrastructural, and environmental targets that establish a decision-framework for permitting, zoning, and otherwise guiding land-use.

15. **Create a system of Research Products resulting from technical studies of coastal processes and sand resources.** Coastal managers and administrators need improved data on erosion patterns and rates around the state. The scope and characteristics of the erosion problem need to be factually determined at a high resolution, at least to the parcel scale.

    a) A series of **erosion risk maps** at 1:2000 scale using color aerial photography should be created showing detailed rates of shoreline change, including rates of volume change, on every coastal parcel or every 20 m along the coast. These data will improve understanding of sediment budgets, and shoreline changes. The ERM series should be distributed throughout the state to agencies and government offices with coastal decision-making authority. ERMs must also be updated on a regular basis. Users will need the data available in GIS format, on CD ROM, as mapped products, and on-line.

    b) **Define Statewide Erosion Hazard Zones and map BFE's.** Managers and decision-makers need to have detailed information on the pattern and history of erosion along our coastline. This information can be integrated with the FEMA Flood Insurance Rate Maps that set Base Flood Elevations for housing construction in coastal flood zones. This data can be established in a variety of media including digital layers on various GIS systems, CD ROMS for desk-top viewing in PC or Mac formats, downloaded or viewed interactively from on-line sites, and as hard-copy map products. This recommendation can be combined with recommendation a) (above) to improve the scientific framework for regulatory and planning decision-making.

        i) Large-scale aerial photographs (1:2000) enlarged to poster size offer a mapping surface on which this information can be provided in the context of existing land-use trends. Aerial photo-maps can display the present erosion rate, projections of the future 30 year erosion hazard zone, FEMA BFE's, the contemporaneous vegetation

line, and the upper debris line all clearly superimposed upon the photographic background showing development, land use, and geologic features of the shoreline. A series of these reference photomaps will greatly enhance the ability of managers to assess the potential impacts of actions in a physical setting and with knowledge of shoreline change patterns. These data can be established as a map-series showing the statewide erosion hazard zones. Managers may also wish to include the 60 year, and 90 year erosion hazard zones, although the current database of past shoreline positions does not support significant projection accuracy beyond the 60 year level (1912 NOAA "T-sheets" are the earliest accurate shoreline position available for Hawaii). The database for this process needs to be created and periodically updated using a combination of high-resolution aerial photogrammetry and a network of beach profiles.

ii) Erosion rates and BFE's should be delineated at a high density along the coastline. Current research at the UH indicates a spacing of approximately 20 m alongshore is sufficient to determine the erosion rate pattern on nearly all developed parcels and to determine the large-scale coastal behavior (i.e., dynamic shoreline meanders through time) that control patterns of change[74]. Managers may wish to consult technical sources to determine the favored statistical technique for establishing erosion rates. Along much of the Hawaiian shoreline there are approximately 5 to 8 aerial photographs available over the time period 1949 to 1996. There is also a 1912 mean high water line, mapped by federal surveyors, that can be compared to the photographic evidence for a total of 86 years of shoreline history. One may use a number of techniques to determine a rate of shoreline change through time: end-point analysis, linear regression of shoreline positions, least median of squares regression, jackknifing, average of rates, and minimum description length criterion are all published statistical methodologies for determining rates of shoreline change each with their own attributes and limitations.

iii) These data can be used to identify areas of management concern and potential community-based performance standards for hazard mitigation and resource restoration. A rate-based setback system can also be established using such data for undeveloped regions where avoidance is the primary management target to mitigate future hazards.

iv) Lands falling within a particular erosion hazard area would be subject to specific construction and land-use guidelines. FEMA has already proposed the framework for such a system, and it can be easily modified and adopted by the state and county administrations to meet local needs.

v) Erosion rate data are necessary for: evaluating and enhancing the setback regime; identifying management decision criteria on shoreline stability; defining community performance standards; guiding the planning and application of negotiated purchase (willing seller) coastal land acquisition programs; identifying areas of present and future management concern where resources and efforts will need to be concentrated; assisting the real estate and

[74] Coyne, M.A., Fletcher, C.H., and Richmond, B.M., (in press) Mapping erosion hazard areas in Hawaii: Observations and Errors. Journal of Coastal Research.

development sectors; and otherwise providing a scientific framework for developing improved management tools and options on a site-specific basis.

c) Use aerial photography, ground-based surveys, and other survey techniques to **monitor beaches**. This will improve understanding of short and long-term changes in the shape and position of beaches in response to sea-level rise, wave and current processes, and sediment deficiencies.

   i) The most common of these, and the easiest to implement, is a ground-based monitoring effort using traditional survey techniques that provide a time-series of measured beach cross-sections, known as "beach profiling."

   ii) A beach monitoring system will provide valuable information for determining the potential impacts of coastal developmental uses, storms, sea-level rise, tsunami, and various environmental influences. Beaches also need to be monitored to distinguish short-term changes from long-term trends. Monitoring programs can identify human impacts causing sediment deficiencies, and provide a technical framework for improving coastal management practices that damage beaches. Florida, South Carolina, Texas, and other states have monitoring programs in place.

   iii) The University of Hawaii has maintained a network of ~80 beach profile monitoring stations on Kauai, Maui, and Oahu since 1994. This time series should be extended and supported and the data provided to agencies with erosion management authority.

   iv) Beach profile monitoring should be implemented as a permit condition for activities that have the potential to cause sand deficiencies, or alterations to the morphology of beaches such that their ability to respond to seasonal wave and current events, and sea-level rise, may be reduced. Agencies, then, should become familiar with technical aspects of monitoring so that proper permit conditions can be provided, and that monitoring results can be interpreted by agency personnel.

d) Land management and disaster mitigation agencies should support development of numerical **wave run-up and storm-surge models** (and their field verification) to predict and improve understanding of wave impacts, flooding patterns, coastal processes, and to augment the shoreline certification process.

   i) Numerical modeling can be a valuable source of information for formulating guidelines for the safe siting of coastal development, defining BFE's for building codes, and for improving the evaluation of the certified shoreline and the appropriateness of the existing setback regime in Hawaii. Surge and run-up models can be used to improve understanding of adequate Base Flood Elevations for currently unmapped regions of the coast in Hawaii where the FEMA does not offer guidance on site elevations for buildings. Models should address run-up characteristics (magnitude, recurrence interval, elevation) of tsunami, storm surge, swell, and locally generated wind waves.

   ii) Run-up models also have the potential to improve the identification of the certified shoreline in Hawaii so that it can be less subject to equivocal interpretation of sparse natural evidence.

e) Scientific understanding of the occurrence and magnitude of **hurricanes and tsunami** in Hawaiian waters, and their coastal inundation

patterns can be improved and should be the subject of enhanced research supported by agencies with coastal jurisdiction. High wind storms of less than hurricane strength, and the waves they generate are also of concern to coastal land managers and owners. Tsunami generated by the sudden movement of the sea floor pose a continuous threat to the Hawaiian Islands.

i) It is vitally important that research continue to improve understanding of these and other meteorological and geophysical hazards along the coastline so that enhanced mitigation can be achieved in a framework of environmental sustainability.

ii) Public education and awareness should be a high-level goal in these research efforts so that the populace of Hawaii can react accordingly when a hurricane or tsunami threatens our shore.

f) Wave and current patterns and other **littoral characteristics**, and sediment transport in coastal waters are poorly understood, yet they are a critical force in the seasonal and inter-annual cycle of beach fluctuations. They also influence the management of sustainable coastal water quality. With improved knowledge of littoral characteristics on a sector by sector basis will come the ability to establish viable and realistic planning goals on behalf of regulatory agencies.

i) The number and quality of circulation studies and sediment transport analyses should be increased and funding encouraged from federal sources and research-oriented state sources.

ii) County and state authorities need information on the stability and seasonal dynamics of particular littoral cells. Those that are identified as unstable, and where erosion hotspots are delineated, can be the focus of restoration and mitigation efforts and enhanced management tools. Stable cells can be the focus of conservation, monitoring, avoidance, and proactive management practices.

g) Research indicates the presence of **offshore reserves of sand** that may support restoration as a regular management option. The existing practice of mining sand from *active* dunes and dune fields should be viewed as a limited resource that has attendant environmental and cultural impacts that are negative. **On-land sand resources** other than active dune fields should be explored as potential resources. It is important to closely examine the water quality and ecological impacts that may result from the use of sands with high fine sediment content for beach restoration.

i) The Mana Plain on Kauai consists of regions composed of unlithified, or lightly lithified carbonate sand that may provide a sand resource option for coastal restoration. Many states have utilized “borrow pits” for sand and gravel resources. The Mana Plain should be assessed and mapped as a potential sand resource for coastal restoration. A mapping exploration effort should be directed at the Mana Plain to identify levels of dune activity, cementation and lithification history, thickness and lateral extent, statistical sedimentological characteristics, and an assessment of potential use for coastal restoration should be determined. Other cuspate forelands, of similar origin and geologic history, should also be assessed for this purpose.

ii) As the mining of active dune fields faces future restrictions and depletion, and offshore or alternative onshore carbonate sand mining comes on-line, it will be important for agencies to develop

accessible stockpiles of beach-grade sand that can be utilized by permittees seeking erosion mitigation under the Small-Scale Nourishment Program of the DLNR (see Recommendation 11, below)

iii) **Sand nourishment** is the strongest technical option presently available to both protect eroding coastal lands and sustain and restore public dunes and beaches. The Hawaiian coast has many features that promote successful nourishment, including widespread fringing reefs that dissipate wave energy, short and embayed beaches with prominent headlands that stabilize and isolate the sediment budget of a littoral cell, and a predictable seasonal wave field. A study released by the National Research Council offers guidance on this issue.

h) There are, nonetheless, significant problems associated with beach and dune restoration that need further research and delineation.

(1) Do offshore sand resources exist in sufficient quantity and appropriate quality to support restoration?

(2) What are the attendant environmental impacts to marine dredging and sand mining and are they acceptable given the goals of coastal land conservation?

(3) Where will the money come from to pay for beach and dune restoration, and how will the costs be shared?

(4) What are acceptable benefit/cost ratios to restoration, and is it a sustainable management alternative in a future of increased population growth, greater development pressure and predicted higher sea levels?

(5) How long will sand mining offer a solution for erosion management? Dade County, Florida is reportedly facing depleted offshore sand resources after 20 years of mining for restoration.

(6) Is offshore sand silt-free, and does it have the proper grain size and grain color for beach restoration?

(7) Do marine sand fields and sand-filled channels contain faunal communities that can be impacted by mining without causing impacts to related communities?

(8) Will offshore mining lead to turbidity problems in the water column?

i) All **nourishment projects should be monitored** by a state coastal surveying team in order to establish a database to augment and improve beach fill design strategies. It is already apparent that beaches in Hawaii are being nourished with sand by local owner groups, and the resulting morphological changes and sand flux patterns are not monitored with a standardized methodology. Neither do many of these existing efforts restore the role of dunes as storehouses of sand for profile recovery from wave impacts, rather they focus on beach restoration alone. These are lost opportunities for learning. Additionally, conflicts are arising in the area of permitting and open communication between multiple user groups regarding the success and legality of these efforts.

i) All restoration projects must have clearly identified performance criteria so that public understanding of the technique can be based upon realistic expectations. For instance, there are no criteria for evaluating fill sand from the standpoint of resulting turbidity. Schedules for renourishment should be identified and modified as experience dictates,

and cost ratios shared among stakeholders should be shifted to match sustainable and socially responsible sources of funding. Public expectations of long-term dry beach width must be evaluated and engineering realities must be made public.

j) Despite its great promise, nourishment is expensive and there is a significant lack of knowledge pertaining to offshore sand quality and quantity, appropriate beach design, renourishment schedules, extraction and delivery techniques, impacts on water quality and sand field faunal communities, and the sustainability of the sand resources in Hawaii.

k) The existence of these potential barriers to beach nourishment make it imperative that a successful pilot project be conceived and implemented in the immediate future in order to evaluate the full and long-term potential of nourishment as a viable management alternative. As part of the pilot project, a GIS database of sand reserves and sedimentary characteristics should be constructed using all available information and improved with a directed sand reserve research program.

l) Create and fund a **sand reserve research program** to delve into relevant aspects and issues pertaining to offshore sands, as well as selected onshore sand resources. A sand research program is necessary in order to establish the viability of marine sand extraction and beach restoration as a realistic alternative for coastal management. This would be best framed within a pilot restoration effort (see Recommendation 3, above) directed at a well understood littoral cell. A funding structure should be established emphasizing cost-sharing among federal, state, county, and landowner stakeholders.

   i) Sand reserve research should include assessments of the environmental impacts of mining, turbidity effects, ecological/faunal impacts, sand suitability, and the sustainability of offshore sand flats. Sea Engineering, Inc., the UH Coastal Geology Group, the Marine Minerals Technology Center, and the US Geological Survey are four research organizations with the expertise and interest to support the development of this recommendation.

   ii) An onshore component of this effort should focus on coastal plain sand resources, such as those located on cuspate forelands and other geological accretion plains, that exhibit high potential as sand reserves. Environmental, social, ecological, riparian and groundwater hydrological impacts must be carefully assessed.

16. **Small-scale Nourishment Projects.** The Coastal Lands Program (CLP) at DLNR has proposed to establish a Small-Scale Beach Nourishment Program pursuant to the CDUP process and in collaboration with the COE State Program General Permit (SPGP) for expediting small-scale beach nourishment projects and information gathering.

   a) This program, which is still under development, tentatively proposes a permit ceiling of 25,000 yd^3 as the maximum allowable fill size for restoration under the SPGP. This number represents a reasonable limit based on studies of beach and dune sand volume along windward Oahu. Four years of beach profile monitoring by the Coastal Geology Group at UH offers guidance on nourishment volumes. At Kailua Beach, for example, possessing an apparently healthy and viable sand volume budget, for every 100 ft alongshore distance, there exists an average beach profile volume of 7,220 yd^3 (72.2 $\pm$57.4 yd^3/ft) of sand between the vegetation line and the offshore depth of closure (the marine limit of beach sand). When measured from the

mauka toe of the frontal dune to the depth of closure, the average volume increases to 10,800 yd^3 (108 ±66.0 yd^3/ft). Notice the significant variance around the average, indicating that the beach sand volume has a wide range of values even for this one littoral system. Hence, two large housing lots with a combined ~200 ft frontage length, and perhaps as many as three or four medium-size lots, could accommodate a healthy beach and dune restoration project to mitigate the erosion hazard[75] under this program. Because most permit applications are from single homeowners, or small groups of 2 or 3 homeowners, 25,000 yd^3 provides a reasonable and flexible estimate of "small-scale nourishment."

b) This effort is important and should be encouraged, continued, and extended. However, there is an immediate need to conduct supporting research to better identify the Best Management Practices guiding this program. This research could be funded through the CLP or the CZM program. For instance,

   i) Past research in Hawaii[76] has recommended that sand used for beach restoration should have a typical grain-size distribution of 2 – 0.15 mm with <10 per cent finer than 0.15 mm. There is a need to substantiate or redefine these criteria for **fill sand acceptability** including a review of existing federal and state experiences, determinations of sand/mud thresholds and resulting turbidity, definition of ambient turbidity in coastal waters, and evaluations of grain size, abrasion resistance, color, and sorting thresholds for sand fill and beach stability.

   ii) There is a need to define **fill placement construction practices** including siltation control, permitting for fill placement, and beach design.

   iii) There is a need to define **conditions of success or failure** of small-scale projects, and the permitted schedule of renourishment. For instance, landowners will not utilize fill for mitigation if placed sand is rapidly eroded and there is no condition for renourishing or otherwise protecting threatened land.

   iv) There is a need to define a **methodology of Hawaiian beach design** that is based on parameters developed with field data from the Hawaiian shoreline. This effort could conduct sensitivity analyses of mainland design practices using Hawaiian field scenarios to establish the viability of concepts and methodologies.

c) The program description highlights monitoring all fill activities as a critical need, this is consistent with federal practices. As this program achieves success and becomes viewed by consultants as a viable alternative for their clientele, there will develop an increased demand for sand resources. Hence, it will become increasingly important to monitor performance in order to determine the suitability of various sand resources for this program, including: dune sand, coastal plain sand, offshore sand, sand from boat basins, harbor mouths and dredged channels.

17. **Interim Controls.** Coastal erosion is an active and dynamic agent on our shorelines even during the current period of increasing well-defined and viable management options. Hence, there is an immediate need to provide a management response to emergency situations confronting private

[75] Beach volume measurements vary from 14.8 to 129.8 yd^3 per ft (alongshore) when measured from the vegetation line, and 26.3 to 184.7 yd^3 per ft when measured from the mauka toe of the frontal dune.

[76] Hampton, M.A. (1998) Offshore Sand Research. Comments made during a briefing of current research on the marine sand resources of Hawaii. DLNR Board Room, members of MACZMAG Subcommittee on Coastal Erosion, August 28, 1998, Honolulu.

and commercial landowners. It is important to develop a technical approach to control interim coastal erosion on residential lands where a short-term or seasonal wave-related erosion hazard exists, and where long-term erosion trends have created user conflicts.

a) Both Conservation District Rules and the County Special Management Area Rules provide for emergency permits. A consistent and uniform set of technical options, with components that can be tailored to the personality of the target shoreline, should be developed to fulfill the need for emergency protection. The term "emergency" should guide the selection of applicable and appropriate technology. In the past, in both Maui County and the City and County of Honolulu, rock seawalls and/or revetments have been constructed under emergency permits. A rock revetment or seawall is not an emergency solution – it is a permanent solution, and on a chronically eroding shoreline it is an environmentally damaging solution. An interim erosion control technology should be effective, removable (temporary), and "tunable." That is, it should be easily reconfigured to accommodate changing conditions and lessons learned. It also needs to have characteristics that will permit it to be integrated into future management options that come online at a later date.

b) If a permanent solution is requested, it should be evaluated with full consideration given to all long-term solutions (i.e., Pope's articulation, sect. II.B.5), and should not be applied for under the auspices of "emergency" permitting.

c) Two technical approaches have potential to fulfill emergency needs: large, protective sand bags, and small-scale sand nourishment (see Recommendation 11, above). Large 1 ton sand-filled "sea bags" are being used successfully to protect property on Oahu, Maui, Molokai, and Kauai. These projects utilize seabag revetments constructed at a low slope, ideally attended by small-scale sand nourishment. In certain settings a small groin or the use of detached breakwaters may be desirable to stabilize the fill. Landowners should be prepared to renourish the fronting beach as long as the sea bags remain. Maintaining public access, and the ecological characteristics of the beach, should be given high priority.

d) Seabag revetments present advantages over the traditional use of placed armor stone in that they are more easily reconfigured to accommodate changing conditions and they are easily removed when a more permanent solution is implemented. They are also less hazardous for public usage, and enjoy increased public acceptance because they are clearly an "interim" rather than permanent installation. Disadvantages include reports of high expense, and high wave reflectivity. Seabags differ little from armor stone in terms of coastal hardening, but their presence is a reminder that the job of mitigation and conservation is not finished and stakeholders must continue to work toward longer-term solutions.

18. **Implement an "Erosion Control" approach where feasible**. This could include offshore breakwaters, and certain types of attached structures (T-head groins) used in combination with nourishment to stabilize particularly dynamic beach segments where erosion would be controlled effectively without negative impacts to adjoining beaches, or the sediment budget of a littoral cell. Managers must keep in mind that the purpose of the structures is to control the erosion of placed sand fill, and that good erosion control projects use sand and structures together as a system, not alone. The design and specifications of this approach should be conducted by professionals in coastal engineering with an established record of successful use. Permitting authorities may wish to adopt the PE Seal (Professional Engineer) as one criteria for accepting permit applications for erosion control projects.

19. **Analysis of Economic Factors**. The economic factors governing the implementation and feasibility of various coastal management alternatives is poorly understood in Hawaii. Economic data designed to identify the necessary funding and benefit/cost rationale of management options will be critical to establishing a framework for implementing a new paradigm of coastal management in Hawaii.

    a) Economic arguments for and against certain management options should be combined with considerations of environmental sustainability when deciding upon a course of action. Presently, there is little economic information available to guide decision-making. In the end, economic data may be the most compelling factor when conceiving and implementing a program of management on the coast of Hawaii. Utilize GIS tools to implement this recommendation.

    b) Beach user surveys, neighborhood surveys, willing payer surveys, assembled valuation criteria from a diverse population of beach users and stakeholders can all be used to define the economy of various management options. If beach and dune restoration is planned, it must rest upon a solid cost/benefit rationale.

    c) The cost of exploration, recovery, delivery and construction of beach restoration efforts is at a low level of understanding. All financial aspects of restoration should be quantified for proper planning and feasibility analysis.

    d) The economy of land acquisition should be investigated such that random and potentially wasteful acquisition procedures do not come to characterize this potentially valuable approach to conservation and hazard mitigation. How should a land acquisition program be funded, managed, and planned?

20. **Integrate Hazard Mitigation and Coastal Conservation**. Erosion is only one of several natural hazards that present management challenges along the Hawaiian coast. High winds and associated marine flooding, tsunami flooding, sea-level rise, seasonal high waves, stream flooding on coastal plains, landslides, and seismic and volcanic hazards all increase the risk exposure along developed coastal lands.

    a) Agency efforts to manage coastal erosion must include a scientific basis for integrating the multiple hazards of the coastal zone in order to reduce risks to coastal populations. Beach preservation and land loss should not be isolated as the only land management issues on our shorelines. However, because coastal erosion management and beach preservation are high profile issues, and they are chronic and widespread, they do provide a framework for establishing broader risk-reduction practices in the coastal zone.

    b) Likewise, Hawaiian beaches are not isolated environments. They are intimately connected to adjoining marine and terrestrial ecosystems that constitute a seamless system of natural environments along the coast. These include reefs that are the sand factories, the dunes that are sand repositories, the coastal streams and wetlands that offer aquatic refugia and are a source of nutrients, and the coastal marine water column and its vertical ecological strata. Our beaches are dependent upon the health and viability of these neighboring geologic, aquatic, and oceanographic systems. Agency efforts to establish a system of beach preservation and coastal management must recognize the interdependent ecologies of the coastal zone and practices must be defined that will enhance the sustainability of the entire environmental system of the coastal zone.

C. INITIAL IMPLEMENTING ACTIONS

1. **Establish, empower, and fund the Coastal Lands Program** and the creation of new erosion management, beach conservation, and hazard mitigation programs, such as,

a) a small-scale nourishment program,

b) a large-scale coastal restoration program,

c) a system of management based on avoidance, minimization, and compensatory mitigation,

d) a willing-seller land acquisition program with a component emphasizing strategic redevelopment and resource restoration (**Ho'opono Kahakai**),

e) a community-based performance standards program emphasizing hazard mitigation and resource restoration (**Ho'olaulima**),

f) provide assistance to enhance county efforts to integrate historical erosion trends and coastal hazard vulnerability at the zoning and subdivision stages of development,

g) formulate and implement a public awareness and education campaign,

h) review and amend the Shoreline Certification process.

2. **Enhance interagency collaboration**, build an organized and consistent system of erosion management among CZM, CLP, OEQC/DOH, and the counties and federal COE;

   a) CZM and/or CLP should continue the dialogue and issue discussion of the MACZMAG Erosion Subcommittee as it promotes a common level of understanding of the issues and awareness of concerns among the public, commercial, and agency sectors; adopt OEQC permit guidelines, and work to improve the level of technical analysis in EA's for coastal projects including site-specific descriptions identifying coastal stability, littoral cell characteristics, erosion patterns, and sand resources.

3. **Institutionalize a source of high-quality data** and research products at the UH-SOEST that would be available to all public and private entities (government sector and commercial sector) for improving understanding of coastal processes and reducing the costs associated with data acquisition.

4. **Introduce legislation to fund and support the necessary statutory and rule changes** and program operations that will implement the concepts and approach embodied in COEMAP, and consistent with aspects of Chapter 205-A and derivative efforts. Workers should consider the following:

   a) Repealing or modifying the accreted land law,

   b) Establish a monument program for the Shoreline Certification process and redefine the shoreline to a cadastral datum, that is, an elevation, such that it continuously incorporates erosion history. The elevation could be based upon numerically modeled seasonal high wave run-up characteristics (which differ on every shore), or upon the height of the frontal dune, or other measurable feature with unequivocal characteristics,

   c) Clarify and strengthen enforcement efforts and programs,

   d) Identify coastal lots where the 20 foot (or less) setback accommodation may lead to future erosion hazards and potentially impact the beach environment.

   e) Identify minimum buildable area criteria for coastal lots in areas with histories of chronic or episodic erosion such that development may lead to future erosion hazards and potentially impact the beach environment.

   f) Prohibit seaward shifts in the certified shoreline,

   g) Identify littoral cells without current armoring and establish a prohibition against any future armoring, establish an abandonment policy in these areas, perhaps with a temporary protection clause (~1 yr) and a relocation assistance program, to mitigate the erosion hazard and to conserve beaches,

h) Implement a "Master CDUP" concept for large scale restoration programs,

i) Amend Chapter 183 HRS and Title 13 Chapter 2 HAR to create a new subzone in the Conservation District for all submerged lands and beaches, include a distinct set of objectives and policies for conservation and work with federal and county agencies to establish consistency through the CZMP,

j) Improve education with videos, pamphlets, and 90 sec. Radio and TV spots,

k) Investigate sand resources for restoration including developing a definitive understanding of the biological impacts of dredging and the viability of marine sand fields and channels, and the development of a "borrow pit" system for coastal plain sands.

5. **Simplify and streamline the regulatory and permitting system** of the coastal zone.

This point is especially critical. Attorney Dennis Hwang has written,

"Nowhere is the need for increased coordination more important than in dealing with the layers of regulations along the coast. For a landowner to obtain permission for a seawall, only one or two permits may be required. However, for a less environmentally harmful alternative, such as sand replenishment and a containing structure such as a groin, the applicant may need a Shoreline Certification, Shoreline Setback Variance, Shoreline Management Area permit, Conservation Direct Use Application, Clean Water Act dredge and fill permit, NPDES permit, Water Quality Certification, Coastal Zone Management consistency certification, Right-of-Entry Authorization, and an Environmental Assessment or Environmental Impact Statement at the state and federal level. The regulatory scheme designed to protect the environment creates an incentive for landowners to select options that are less environmentally friendly."

6. **Implement an improved technical basis for decision-making** as outlined in earlier recommendations. This should be the goal of all agencies concerned with coastal management in Hawaii.

   a) establish and enhance scientific and engineering research for the purpose of gathering data on shoreline change and related processes, including monitoring beaches;

   b) identify sand resources and extraction technologies for beach nourishment;

   c) define nourishment characteristics and criteria;

   d) create GIS layers of existing and new data;

   e) instigate economic analysis to develop economic policies;

   f) identify and rank erosion hotspots where there are critical management concerns, and delineate the appropriate technical approach to their improved management;

7. **No-Tolerance Policy.** The DLNR should announce a policy of no tolerance toward new encroaching coastal construction of all types. The policy of no tolerance means that all structures that encroach on Conservation District beaches that are illegally built or illegally repaired following the announcement date will be torn down or a form of compensatory mitigation will be applied.

8. **Fines and Revocable Easements.** DLNR should establish a system of fines and the provision for short-term, revocable easements at illegal encroachments. DLNR Land Division staff should build a list of encroachments, and a GIS layer, that will be targeted for fines, fees, and revocable easements in the immediate future. Parties in violation of the Conservation District Rules will be given the option of paying the levied fine, and a schedule of fees and accepting a short-term revocable easement, or having the offending structure (or portion)

removed. One avenue for developing a fine and fee schedule can be the use of estimates of avoided cost on the part of the landowner.

9. **Build Consensus.** Collected fines should be used to fund the implementation of CLP programs by paying costs related to bringing together officials, and parties from all levels of Hawaii with overlapping concerns in the coastal zone, to reach consensus on a future administrative direction within the general framework of the CLP. Parties that participate in this process should expect to assist in the creation of a legislative package establishing an erosion management system as outlined in COEMAP. At a minimum, the CLP should be staffed with three planners with overlapping responsibility for permit processing, but who collectively possess expertise in law, in science/engineering, and in land management. Existing staffing levels in the Land Management Division of DLNR are overburdened and should be augmented with additional positions for CLP efforts.

10. **Special Fund for CLP Programs.** Create a Special Fund for revenues so that they may be used to implement COEMAP recommendations and CLP plans and objectives.

11. **Publicize the New Policy.** The policy of no tolerance, the policy of fines and revocable easements, the distribution of this report, and the solicitation of federal, county and community group involvement in the planning process and the creation of a legislative package, should occur simultaneously in the form of a press release and press conference.

12. **Identify Federal Funding Sources.** Identify sources of Federal money that can be utilized to improve beach and dune conservation and restoration, and hazard reduction in Hawaii. Specifically, monies that can be applied to beach nourishment and/or coastal land acquisition.

13. **Review Management Plans.** Review all state and county beach parks and assess management plans at those sites.

14. **Distribution of Report.** Circulate this document to county and other state authorities for comment.

15. **Public Awareness Campaign.** Develop and initiate a public awareness campaign, including—a poster for display at libraries and schools; a teaching module for elementary and high school science classes; seminars to legislative committees and the general legislative membership; a short video (5-15 minutes) for use by neighborhood boards and citizens groups; media field trips.

16. **Community Input.** Specifically approach land owner groups, community groups, coastal user groups, and the commercial development sector with education materials, and a request for input/assistance in developing solutions.

17. **Interim Coastal Lands Protection System.** In order to meet the needs of landowners with legitimate fears of erosional losses, a temporary protection system must be established with an assessment of the level and immediacy of need, an evaluation of the costs associated with no action, an analysis of the comparative benefits of preserving the public resource against the benefits of the landowner. These judgements should be framed within the OEQC EA criteria. If it is determined that erosion mitigation is the preferred alternative, then a system of temporary components, accompanied by dune and beach restoration using sand nourishment, will be developed. Sand nourishment is for the purpose of enhancing or protecting and preserving public access, marine ecology, and view planes of the coast, as well as countering the incidence of short-term, event-related erosion. Landowners will need to design the interim protection using site-specific factors and professional assistance, as well as submit an EA or CDUA (perhaps following emergency rules if necessary). OEQC guidelines EA content should be adopted. Fill for the system should be sand with native characteristics with a low percentage of fines. Preferably, administrative conditions for offshore, or coastal plain sand mining

can be implemented for these purposes in response to emergency requests.

18. **Implementing Beach Nourishment. Plans.** Conditions, directions, and plans should be made for moving forward with a pilot beach nourishment project that has a high probability of success. Beach nourishment projects should be accompanied by planning studies that identify future alternatives for continued hazard reduction and beach and dune preservation under realistic scenarios of erosion trends, sea level rise and upland development.

19. **Small-Scale Nourishment.** Implement a small-scale beach and dune restoration program under CDUA authority and through the COE – SPGP.

20. **Evaluate Viability of Concepts.** A planning analysis should be conducted at an erosion hotspot to evaluate the viability of concepts described in this report as a means of erosion management on the Hawaiian coast. The analysis should focus on TMK-GIS applications of the **Ho'opono Kahakai** concept and creating community-based performance standards (**Ho'olaulima**). The analysis should specifically assess technical and policy applications of these concepts.

21. **Plan the creation of a Technical Guidance Manual** for eventual use by all coastal stakeholders including agencies and NGO's to improve our system of erosion and coastal hazard management.

Technical Supplement, Part A

THE HAWAII COASTAL ZONE MANAGEMENT PROGRAM

BEACH MANAGEMENT EFFORT

THE HAWAII COASTAL ZONE MANAGEMENT PROGRAM

BEACH MANAGEMENT EFFORT

February, 1994

INTRODUCTION

Beaches are one of Hawaii's most important resources. They are precious natural features that provide recreational opportunities and scenic beauty. Hawaii's beaches are critical for tourism, the primary industry of the State, and are culturally important to the residents of Hawaii. Furthermore, beaches, dunes, and offshore sandbars help minimize risks from coastal hazards by dissipating wave energy which may otherwise damage inland property. Beaches are also important as habitats for seabirds, turtles, seals, and other animals and plants.

One of the themes heard most often at coastal zone management public meetings is a concern about the "loss of beaches". Clearly, "loss of beaches" means different things to different individuals and communities. Some are talking about the literal loss of beaches by means of erosion that in many cases has already reduced recreational areas and threatened property. In this context, erosion, and legal and illegal erosion control structures, such as seawalls, are a concern. Others are referring to a continuing loss of coastal open space that they associate with particular beaches or the construction of homes and hotels that block views along the shorelines. Loss of beaches also connotes reduced access to popular beaches because of new construction, leasehold conversion, reduced parking or other impediments. It also means increased competition among residents and visitors for limited beach space and competition among different types of recreational activities.

Some of these problems are addressed by the shoreline setback and special management area provisions of the Coastal Zone Management (CZM) Program. However, to increase our understanding of the problems and issues and to develop mechanisms to improve beach management, a number of beach management studies have been conducted.

HAWAII CZM PROGRAM BEACH MANAGEMENT PROJECTS

Beach Changes on Oahu as Revealed By Aerial Photographs, prepared by Dennis Hwang for the Department of Planning and Economic Development and the Hawaii Institute of Geophysics, University of Hawaii, 1981.

This report analyzes aerial photographs of the beaches of Oahu taken over a period of up to 50 years. To determine whether accretion or erosion had taken place, changes in the beach vegetation line at designated transects are recorded. Transects are conducted at approximately 1,000-foot intervals. The vegetation lines of sequential photographs are then compared to determine the net movement of sand.

To characterize the sandy shore of Oahu, the report develops 5 classifications: hazard area, chronic erosion area, unstable beach area, stable beach area, and accreting beach areas. It notes that areas classified as hazard, chronic erosion, and unstable should be areas of greatest concern to coastal managers. Also, the report indicates there are too many hard control structures on Oahu, and many buildings have been placed in areas extremely vulnerable to large wave inundation.

Recommendations

Hazard areas

1. Establish a minimum 80-foot setback from the vegetation line for all new construction.
2. Prohibit new houses within the new 80-foot zone.
3. Carefully analyze reconstruction after destruction of previous structures and buildings.
4. Discourage the reduction of dunes or berms for vista creation because of their role in protecting backshore areas from large waves.

Chronic erosion areas

1. To determine rate of retreat, conduct periodic field or aerial surveys.

2. Prohibit new subdivisions in these areas.
3. Determine the extent of setback using local erosion rates and the life expectancy of proposed structure.

Unstable beach areas

1. Avoid development in accretion areas to avoid destruction during the erosional phase of the cycle characteristic of these areas.
2. Obtain appropriate setback for unstable beach areas by adding the historic range of the vegetation line position and a buffer of 40 ft.

Accreting beach areas

1. Generally, in accreting beach areas, there are no major problems. However, ownership of accreted land may be a concern.

Stable beach areas

1. No major problems exist in these areas, except for tsunami and storm damage possibilities.

<u>Hawaii Erosion Management Study,</u> prepared by Edward K. Noda and Associates, Inc., and DHM Inc., for Hawaii Coastal Zone Management Program, 1989.

The study provides a comprehensive overview of erosion and erosion management in Hawaii as an initial step towards the development of a uniform method or regulatory process for the implementation of non-structural and structural measures.

Numerous factors affecting shoreline erosion control are discussed, including coastal processes, probable long-term erosion trends, methods for estimating long-term shoreline change, shoreline protection/stabilization, and erosion management and regulation. Specific case study sites apply these factors. In addition, reviews of states with more advanced erosion management systems (i.e. Florida and North Carolina) are included.

Alternative shoreline stabilization mechanisms, fitting of shoreline stabilization alternatives to various geological, land use and development scenarios, and benefit/cost analyses are discussed. A proposed system to improve erosion management in Hawaii is developed.

Recommendations

1. Develop a statewide approach to funding, planning, and designing appropriate shoreline erosion counter-measures in Hawaii. (CZM Office - preliminary role)
2. Coordinate the counties in the development of a on-going system for beach erosion monitoring. This includes routine data collection, aerial photography, computer mapping, and erosion rate projections. (CZM Office – lead role)
3. Monitor and enforce erosion management regulations. (Counties lead role)
4. Classify littoral cells as stable or unstable through a program of data collection and analysis and then determine appropriate shoreline setbacks, considering land use and erosion rates.
5. First, develop long-term erosion plans for critical, unstable, and erosion-prone areas involving combinations of structural and non-structural remedies. Second, develop site-specific management plans for these areas.
6. Littoral cell erosion management plans should include policies and programs for alternative management and financing of physical structures that benefit private property owners.
7. Streamline the permit process and clarify erosion policy objectives in federal, state, and local permits.
8. Develop in-house expertise and knowledge of coastal processes and engineering principles in government agencies with management and regulatory responsibilities.

<u>Oahu Shoreline Study, Part I. Data on Beach Changes</u> (1988) prepared by Sea Engineering, Inc., for the City and County of Honolulu.

The study produced two products. The first is a collection of 1988 aerial shoreline photographs and computer-generated images from these photographs which depict recent shoreline changes. The second product is an update of Dennis Hwang's previous study, Beach Changes on Oahu as Revealed by Aerial photographs (1981). The 1988 changes are measured and summarized in tables that include the results the of 1981 report.

Oahu Shoreline Study, Part 2. Management Strategies, prepared by Sea Engineering, Inc., for the City and County of Honolulu, 1989.

Shoreline setback and management recommendations are provided for each beach sector studied on Oahu. The management strategies are developed by integrating the beach change data with existing land use data, the extent and conditions of existing shore protection, existing beach conditions, and qualitative and quantitative knowledge of continuing beach processes.

Beach-specific setback recommendations

1. Extend shoreline setbacks to comply with recommendations of this report (primary recommendation).
2. Review zoning along Oahu's shoreline within the context of existing and recommended setback provisions.
3. Investigate the establishment of "beach improvement districts."
4. Review the provisions of the Shoreline Setback Rules.
5. Focus shoreline setback provisions prohibiting development in the shoreline sectors on habitable, protective, and other structures that might impede natural shoreline processes.
6. Monitor the shoreline more closely for illegal shoreline construction. Amend the Shoreline Setback Rules to establish fines for setback violations. Institute a program for monitoring setback violations by conducting shoreline aerial photography every two to four years.
7. Implement the shoreline setback provisions with close coordination between the DLU and the State Department of Land and Natural Resource (DLNR).

Beach-specific management policies

1. Set examples of shoreline preservation with City and County beach parks.
2. Establish public rights-of-way to all beaches to ensure public access.
3. Update the data in this report every eight to ten years.

Erosion Management Program Recommendations for Hawaii, prepared by Oceanit Laboratories, Inc., for Hawaii Coastal Zone Management Program, 1990.

The report proposes the development of a comprehensive database on erosion, based on the analysis of aerial photography using computerized methods for calculating historic rates of beach recession. Guidelines for evaluating and recommending solutions to erosion problems are also proposed. A list of information requirements and a set of questions that should to be raised in dealing with site-specific erosion problems is included. Other recommendations are to develop a comprehensive erosion plan and create an Office of Beaches. In addition, a proposed mission statement, guidelines, goals, and objectives for the erosion management program are discussed.

Recommendations

Informational Recommendations

1. Establish a database for the coastal zone of Hawaii, including oceanographic, topographic, land and water uses.
2. Use aerial surveys and a computer-aided digitizing method for monitoring the total coastline of Hawaii, supplemented with shoreline surveys at selected high-risk locations.

3. Coordinate federal, state, and county erosion management funding to develop a comprehensive database for coastal areas.

Planning Recommendations

1. Define the certified shoreline and tie it into survey monuments. Revise the line continuously to account for erosion.
2. Simplify the permit process and inform coastal land users of permit requirements in their areas.
3. Create a master plan for state erosion management addressing the nature and cause of erosion problems, problem assessment, and immediate, medium, and long-term mitigative activities.
4. Develop a comprehensive State coastal erosion plan as part of a shoreline plan.
5. Consolidate jurisdiction and regulatory powers of the shoreline area into one agency. Establish a separate division within an existing agency responsible for handling these matters. The division would be responsible for:
   a) periodic updates of coastal database;
   b) regulating shoreline uses in accordance with the coastal erosion plan;
   c) conducting enforcement matters relative to illegal uses or structures; and
   d) implementing beach renourishment or shore protection measures when necessary.

Resource Management Recommendations

1. Clarify and strengthen enforcement power over the actions and results of coastal area construction.
2. Delineate areas susceptible to erosion damage from storm waves, surge and' inundation.
3. Create maps of the hazard areas and inform public of restrictions on protecting properties in these areas.

<u>Kauai Shoreline</u> <u>Erosion Management Study,</u> prepared by DHM Inc., Edward K. Noda & Associates, Inc., and Moon, O 'Connor, Tam & Yuen for Hawaii Coastal Zone Management Program, 1990.

The study develops appropriate management recommendations for Kauai shoreline areas, analyzes the impacts of these recommendations, and develops specific shoreline erosion management plans for selected areas of Kauai. Aerial photographs were used to evaluate historic shoreline movements. Beach vegetation lines, waterlines, and selected features in Hanalei Bay and the Haena-Wainiha area were digitized into a computer- aided drafting (CAD) system. The long-term shoreline change data are used to develop shoreline management recommendations.

Legal, social, and economic impacts of both the recommended regulatory changes to shoreline setbacks and the adoption of Shore Districts as an erosion management tool are discussed. Shore Districts allow the Kauai County Planning Department discretion in establishing shoreline setbacks in these areas. Possible implementation mechanisms for the recommendations are included.

Recommendations

1. Give non-structural remedies preference over structural remedies for shoreline management on Kauai.
2. Remove illegal shoreline structures.
3. Enforce more strictly all regulations affecting coastal development and beach preservation.
4. Establish setbacks of no less than 60 feet for Haena area and 75 feet for Hanalei Bay.
5. Develop and update a shoreline structure inventory.
6. Create overlay Shoreline Special Districts as specified in the Kauai Comprehensive Zoning Ordinance for the Hanalei, Haena-Wainiha, and Poipu areas.
7. Develop a Shoreline Special Treatment Zone Plan for adoption by the
8. Establish a 80-foot shoreline setback for the Poipu Beach Park area.

Aerial Photograph Analysis of Coastal Erosion on the Islands of Kauai, Molokai, Lanai, Maui and Hawaii, prepared by Makai Ocean Engineering, Inc., and Sea Engineering, Inc., for the State of Hawaii Office of State Planning Coastal Zone Management Program, 1991.

Approximately 66.2 miles of sandy shoreline are included in the study. Aerial photographs from different years are analyzed for each area selected to determine historical changes in shoreline positioning. To determine erosion and accretion rates, photographs were digitized, corrected, and compared. This report is in atlas form with a description of the coastal characteristics, beach history, backshore development, shoreline processes, and beach usage; graphs depicting erosion and accretion rates between photographic dates; and a diagram of each shoreline area. The diagram of each shoreline area includes shoreline protection structures, 1988 water and vegetation lines, roads and buildings, and the transect lines used for the analysis.

Recommendations

1. For future monitoring efforts, focus on areas that are not already committed to shoreline protection structures.
2. Develop and implement a program to select beaches needing more frequent and/or detailed monitoring.
3. For the monitoring program, select beaches that are eroding, slated for future development, or already have shoreline protection that might affect the beach.
4. For every monitored beach, take a complete set of overlapping vertical and low-level oblique color aerial photographs every five years. The low-level oblique photographs will help interpret the vertical photographs and document further beach dynamics.
5. Add new data on shoreline change to the existing digital database.

1991 Oahu Shoreline Management Plan, prepared by Sea Engineering, Inc., and Barbara Moon for The City and County of Honolulu Department of Land Utilization, 1991.

The report focuses on 31 miles of sandy beaches on Oahu that 1) are being developed primarily for residential *use,* 2) are high-quality recreational beaches that should be preserved for public use, and 3) were recommended in Part 2 of the Oahu Shoreline Study for increased shoreline setbacks. The study

1) identifies natural beach sectors that are high-quality public recreational resources;

2) develops alternative strategies to preserve beaches;

3) examines potential impacts of alternative strategies on existing residences and other private land abutting the shoreline; and

4) recommends government regulations and other actions to implement a plan encompassing the most promising strategies.

Digitized maps showing all major features were created for the 13 miles of residential shoreline properties were created. This study predicts future shoreline positions and provides information on the statistical variability of the prediction.

Recommendations

Short-term, cost-effective, low impact strategies

1. Eliminate the 20-foot shoreline setback permitted under certain conditions.
2. Require a minimum area of 3,000 square feet buildable lot area for residential beachfront properties.
3. Prohibit shoreline setback credit for property owners who acquire, through land court and/or consolidation and resubdivision, accreted shorefront land.
4. Require a minimum setback of 60 feet for new developments on vacant land, or redevelopments resulting in a higher unit count.

5. Create a mechanism to grandfather illegal shoreline protection structures that meet criteria established by technical engineering and design standards.
6. Prohibit the use of vertical seawall structures in areas where this form of protection is not wide-spread and where future seawall requests are likely. Require buried revetments or similar form of private property protection, if necessary, without complex permitting requirements.
7. Strengthen criteria for granting shoreline setback variances by stricter standards for proving "hardship"
8. Apply established administrative enforcement procedures to violations within the shoreline setback area.

Long Term Strategies

1. Amend the City and County of Honolulu Land Use Ordinance (Article7) or the Special Management Ordinance to create a Beach Preservation District to manage beach sectors subject to chronic long- term erosion or episodic and severe erosion.
2. Establish objectives for each District sector and develop specific regulatory requirements for problems specific to the sector.
3. Adapt the existing Improvement District approach to vulnerable beach sectors necessitating public/private cost-sharing.
4. Establish and fund a recruitment and training program for professional monitoring and enforcement staff.

The Hawaii Ocean Resources Management Plan, Hawaii Ocean and Marine Resources Council, January 1991.

The Office of State Planning, as a member of the Hawaii Ocean and Marine Resources Council, was involved in the development of the Hawaii Ocean Resources Management Plan. This Plan addresses broad ocean management issues as well as specific ocean management sectors, including beaches and coastal erosion. The stated objective for beaches and coastal erosion is to develop an integrated State erosion management system that ensures: 1) the preservation of sandy beaches and public access to and along the shoreline; and 2) the protection of private and public property from flood hazards and wave damage. Policies and implementing actions are also included. The policies are listed below:

1. Establish and maintain a comprehensive coastal shoreline survey, database, and other research.
2. Coordinate County, State and Federal erosion and beach-management efforts.
3. Exercise greater enforcement of laws and regulations,
4. Ensure the continued natural production of sand and assess the potential for using beach replenishment.
5. Promote an erosion-control structure limitation strategy.
6. Develop an active public participation and education program to preserve and protect beaches.
7. Maintain and develop access to beaches and along the shoreline.
8. Assure adequate funding resources and personnel.
9. Plan for climate change, sea-level rise, and emerging issues.

Beach Management Plan with Beach Management Districts, prepared by Dennis Hwang and Charles Fletcher for Hawaii's Coastal Zone Management Program, 1992.

The purposes of the study were to develop a comprehensive and coordinated management plan to preserve pristine beaches while allowing for "intelligent and safe" development along the shore and to address the erosion problems of currently-developed sections of the coast. The report found that, since 1928, approximately 8 to 9 miles (or close to 15%) of the sandy shorelines studied on Oahu have disappeared or been negatively impacted by shoreline stabilization structures. The loss of beaches is also occurring on Hawaii's other islands. Beach loss has accelerated due to a combination of factors such as sea-level rise and hardening of the shoreline. The report notes that beach loss is likely to

accelerate unless there is a fundamental change in beach resource management.

Beach Management Districts (BMDs) are recommended as an alternative to hard control structures. The three general forms of BMDs finance the study and implementation of possible erosion control alternatives. Other states, such as Florida and Maryland, have successfully implemented BMDs.

Recommendations:

1. Establish an agency responsible for the administration and management of beaches.
2. Establish improvement and overlay districts to help in the management of Hawaii's beaches.
3. Promote erosion control devices other than traditional hard control structures through Beach Management Districts.
4. Distribute the cost of preventive erosion measures between the State, counties, and coastal landowners.
5. Develop an education program to convey the problems of beach loss, erosion, and sea-level rise to the public.
6. Enable the modification of shoreline setback regulations through new legislation.
7. Concentrate further research on the monitorisng of beaches with aerial photographs and beach profile surveys to facilitate proper beach management decisions.
8. Investigate the prospect of using offshore sand deposits as a cheap source for renourishment projects.

<u>Beach Nourishment Viability Study</u>, conducted by Sea Engineering, Inc. and Lacayo Planning for the Hawaii Coastal Zone Management Program, 1993.

This study explores the viability of beach nourishment from offshore sand sources. Hawaii's, and other states', procedures, permits, and environmental assessment requirements associated with offshore sand mining and beach nourishment are reviewed. Options are presented to adjust Hawaii's management framework to facilitate rather than discourage beach nourishment by casting regulatory requirements in a more supporting role. In addition, the report reviews previous investigations of Oahu's offshore sand resources, synthesizes and presents the useful data, describes an unsuccessful effort to profile an offshore sand deposit, and outlines a future work plan for sub-bottom profiling

Recommendations:

1. Establish an office of beaches within the Division of Boating and Ocean Recreation, DLNR.
2. Establish a Department of Environmental Protection to facilitate more effective administration of water quality regulations relative to beach nourishment projects.
3. Repeal the section of Chapter 205A, HRS, that enables the counties to prepare beach management plans and extend their jurisdiction makai to the high water line, providing instead that the new state office of beaches be the lead agency for beach management.
4. Amend Chapter 183, HRS, and Title 13, Chapter 2, HAR, to create a new subzone in the Conservation District for all submerged lands and beaches. Include a distinct set of objectives for the conservation of ocean and beach resources, and regulations to facilitate non-structural approaches to shoreline protection.
5. Implement the "master CDUA" concept for beach nourishment activities. Also, delegate the BLNR's decision-making authority to DLNR's Office of Conservation and Environmental Affairs.
6. Continue the research in shoreline erosion and beach management issues through the CZM Program, but transfer the lead role for research to the proposed office of beaches.
7. Request the State Legislature to establish a dedicated fund for shoreline research and beach management activities, into which revenues from fines, licenses, damage awards, and permit application fees for

shoreline-related activities shall be deposited.

8. Charge the proposed office on beaches with responsibility for preparing beach management plans.
9. Charge counties with responsibility for establishing and administering assessment districts for private shoreline properties that benefit from shore protection projects.

RECENT DEVELOPMENTS AND PLANNED PROJECTS

Legislative Proposals

In 1990, a review and assessment of the CZM Program was conducted. Through extensive public and agency participation, the CZM Program developed the Recommendations for Improving the Hawaii Coastal Zone Management Program (1991). This report was sent to the Governor and the Legislature. Although an administrative bill was introduced to the Legislature in 1991, no action was taken. A revised version of this earlier bill was considered by the 1993 Legislature. The resulting legislation amended the enforceable CZM objectives and policies to include the following objective and policies for beach protection.

*Objective:*Protect public beaches for public use and recreation.

Policies

(A) Locate new structures inland from the shoreline setback to conserve open space and to minimize loss of improvements due to erosion;

(B) Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreation and waterline activities; and

(C) Minimize the construction of public erosion-protection structures seaward of the shoreline.

The legislation also made other revisions to Chapter 205A, Hawaii Revised Statutes, that will help resolve beach management issues in Hawaii. Bills being considered in 1994 may make revisions persuant to recommendations in a number of the consultant reports. The fate of the proposed legislation will not be known until June 1994.

Section 309 Strategy

The Hawaii CZM Program's Strategy for the Section 309 Enhancement Grants Program includes a multi-year effort specific to coastal hazards, including erosion. The proposed program change is the amendment of Chapter 205A, Hawaii revised Statutes, to incorporate changes to the objectives and policies related to beach management, and shoreline setback provisions that were proposed in the Recommendations for Improving the Hawaii Coastal Zone Management Program. Work on this multi-year effort was initiated in FY '92. The program change is scheduled for completion in FY '94.

Another proposed program change focused on public access will also benefit beach management efforts. The program change will be a new acquisition program that will improve Hawaii's ability to acquire coastal lands, including those areas which should not be developed due to risks from coastal hazards, including erosion. This project will be initiated in FY '93 and will be completed in FY '95.

Shoreline Certification Issues

Legal research on the requirements for shoreline delineation in Hawaii for construction setback purposes and to demarcate the boundaries between private and public property is currently underway. The effects of natural erosion and accretion, natural and human-induced vegetative growth, and other human-induced changes on the legal shoreline is also being studied. The study will conclude with recommendations for amending existing State statutes, and county regulations if necessary, to alleviate the existing confusion and frustration that occurs during the shoreline certification process.

FUTURE DIRECTIONS

The CZM Program studies have investigated erosion trends, coastal processes, regulatory options and jurisdictional improvements. A number of recommendations have been developed to improve the management of Hawaii's beaches. Further, the Hawaii Ocean Resources Management Plan objective, policies and implementing actions for beaches and coastal erosion provide a structure for future beach management efforts.

Hawaii's agencies involved in beach management need to review and digest the results and recommendations of the previous beach responsibilities. Such work has already been initiated. Through the Coastal and Ocean Management Policy Advisory Group (COMPAG), the CZM Program is leading an effort to coordinate and prioritize the State's beach management efforts. Both State and County agencies are involved in this effort. For effective beach management, a single agency should be assigned as lead with statutory responsibility. This will prevent erosion management from stalling at the policy level with no implementation. Also, a strategy for management needs to be worked out with goals, approaches, and time frames.

Until this coordination, prioritization, responsibility assignment, and strategy formulation effort is complete, we do not anticipate further beach management projects. However, in the interim, the CZM Program expects to continue monitoring beach changes on a periodic basis through aerial photography and perhaps beach profiling. In addition, the CZM program will continue to monitor and push for enforcement of and compliance with existing laws and rules relating to beach management.

Technical Supplement, Part B

Coastal Erosion and Beach Loss in Hawaii: Facts about beach erosion and the new Coastal Lands Program at DLNR

Technical Supplement, Part C

Causes of Coastal Erosion and Beach Loss in Hawaii

INTRODUCTION

In broad terms, it is thought that the erosion of coastal lands is caused either singly or in combination by sea-level rise, wave and current action, or sediment deficiencies. These each are discussed below with regard to Hawaii.

A. SEA-LEVEL RISE

1. Global Sea-Level Rise In recent years many studies using data from satellites and tide gauges around the world have examined the questions "Is global sea level changing and why? At what rate is it changing?" The answer to these questions is of significant interest to all coastal communities. In the ensuing scientific discussion over this issue a few widely accepted opinions are emerging:

a. *Global sea level is rising*[77]. This trend may or may not be seen at a particular coast because the land on most shorelines is itself either rising or sinking due to geophysical and tectonic processes. This has the effect of increasing or reducing the sea-level trend on specific shorelines, a process known as "relative" sea-level change.

b. *Global sea level is rising in the range 1.8 to 2.4 mm/yr* (nearly 1 inch per decade)[78]. This global trend is influenced by many factors, including the El Nino phenomenon, human water-use patterns on a global scale, global climate change, thermal expansion due to warming of the upper ocean, and the growth or decay of glaciers around the world.

2. Sea-Level in Hawaii Hawaii has a system of tide gauges located on the islands of Kauai, Oahu, Maui, and Hawaii that record fluctuations in sea-level. The tide gauge system is maintained and operated by the UH Sea Level Center. Analysis of these records, provide rates of sea-level rise around the state over the last several decades. A fascinating result is that each island has its own rate of rising sea level.

The Big Island, because it is young and still growing, has not achieved an equilibrium balance with the underlying layers of Earth that support it. Hence, it is slowly sinking in a process known as lithospheric flexure. The resulting relative sea-level rise there is quite rapid, ~1.5 in/decade (3.8 - 4.0 mm/yr on the Hilo Harbor tide gauge).

Maui, because it lies near the Big Island, and due also to the youthful age of Haleakala, is probably also experiencing flexure. Relative sea level there is rising ~1.2 in/decade (~2.4 mm/yr at Kahului Harbor).

Oahu and Kauai lie outside the area of subsidence and have lesser rates of rise, ~0.6 in/decade (1.5 - 1.8 mm/yr at Honolulu Harbor, Kaneohe Bay, and Nawiliwili Harbor). Of interest, Oahu is actually slightly rising, although not fast enough to outpace global sea-level rise. Oahu is rising because it is passing over a flexural bulge in the crust that surrounds the subsiding area around Maui and the Big Island[79].

3. Global Warming & Future Sea Level Sea-level rise, considered alone, is not presently a cause for concern in Hawaii. Worries regarding accelerations in the future rate of rise resulting from an enhanced global greenhouse effect (that is, global warming) have been expressed by scientists, planners, and policymakers throughout the decades of the 1980's and 1990's. Scientific consensus has been revised several times over this period regarding how high sea-level may rise during the next century. The most up-to-date projection[80] of future sea level indicates a *50 cm (20 in) rise higher than today by the year 2100*, with a range of uncertainty of 20-86 cm. This estimate assumes that most of the rise will be due to the thermal expansion of sea water resulting from radiative forcing

[77] Nerem, R.S., Haines, B.J., Hendricks, J., Minister, J.F., Mitchum, G.T., and White, W.B. (1997) Improved determination of global mean sea level variations using TOPEX/POSEIDON altimeter data: Geophysical Research Letters, v. 24, p. 1331-1334.
[78] Id.

[79] Muhs, D.R. and Szabo, B.J. (1994) New uranium-series ages of the Waimanalo Limestone, Oahu, Hawaii: Implications for sea level during the last interglacial period. Marine Geology, v. 118, p. 315-326.
[80] Warrick, R.A., Provost, C. Le, Meier, M.F., Oerlemans, J., and Woodworth, P.L. (1996) Changes in Sea Level. Chapter 7, in Climate Change 1995, The Science of Climate Change: Published for the Intergovernmental Panel on Climate Change, Cambridge University Press, p. 359 - 405.

(atmospheric warming), followed by increased melting of glaciers and ice caps. The authors of the same study go on to suggest that much of the rise in sea level over the next century, especially the first half of next century, has been set in motion by the dumping of pollutants in our atmosphere by industrial activities that have already occurred.

4. Impact on Beaches Despite the uncertainties of predicting future sea levels, it is felt by some researchers that the present rate of rise is sufficiently rapid to cause coastal retreat at significant rates[81]. One engineering study[82] suggests from 53% to 88% of the total erosion (1.7 to 5.5 m/yr) experienced on some continental shores can be attributed to sea-level rise, and the remainder to net sand losses from the site.

However, along many coastlines other factors exert more of a control on erosion and accretion patterns than sea level alone. Beaches are subject to continuing processes that tend to remove material, if these processes are not matched or exceeded by supply processes, erosion is inevitable regardless of sea-level change. Hence, sea-level rise is just one of many factors impacting beach behavior and, as an isolated process, its relative importance on beaches can be difficult to ascertain because of dramatic near-term fluctuations caused by other physical forces[83].

Using the local tide gauge trends, the commonly used "Bruun Rule[84]" (relating beach retreat to sea-level rise) predicts a retreat of ~0.12 to 0.15 m/yr (~0.4 to 0.5 ft/yr) on Oahu and Kauai[85]. This perhaps, may be taken as one estimate of the background erosion rate due to sea-level rise when additional processes of coastal sediment transport are not influencing shoreline fluctuations. This general rate of retreat is found along many coasts of Oahu[86] using aerial photographic measurements that show coastal erosion occurring in the range of ~0.1 to 0.2 m/yr along much of the shoreline. Examples include Sunset Beach (mean erosion rate = 0.22 m/yr), central Ewa Beach (mean erosion rate = 0.11 m/yr) and the Oneula shoreline (mean erosion rate = 0.12 m/yr). However, a nearly equal length of shoreline on Oahu shows accretion. Indeed the entire coastline of Kailua Beach has a history of long-term accretion interrupted only by erosion events of limited duration.

At present, coastal researchers are not able to isolate the effects of long-term sea-level rise on the stability and dynamics of the Hawaiian shoreline. It does appear that the rather moderate rates of coastal erosion observed on large portions of the Oahu shoreline are consistent with the influence of recorded sea level as predicted by the Bruun Rule.

In their historical shoreline analysis of long-term trends on Oahu, Coyne et al.[87] compiled statistics for 20 km (13 miles) of beach length showing net erosion or accretion over ~45 yr period ending in 1996. Measurements at 873 sites, spaced 20 m apart along beaches on all shores of Oahu, reveal a mean rate of change of 0 m/yr, a mode (most frequent rate) of -0.1 m/yr (erosion), and a standard deviation of 0.4 m/yr. Approximately 47.5 percent of the shoreline is eroding at a mean rate of 0.27 m/yr and 52.4 percent is accreting at a mean rate of 0.23 m/yr. Although the study only examined the beaches at Lanikai, Kailua, Sunset, Oneula, Ewa, and Iroquois Point, the number of eroding and accreting sites was nearly normally distributed. Hence, these data indicate that although sea level is rising around Oahu, either it is not eliciting a uniform response in the sandy beaches, and/or there are other processes that are dominant in determining the spatial distribution

[81] National Research Council (1995) Beach Nourishment and Protection. National Academy Press, Washington, D.C., 334p.
[82] Everts, C.H. (1985) Sea level rise effects on shoreline position. Journal of Waterway, Port, Coastal and Ocean Engineering, v. 111.6, p. 985-999.
[83] Id.
[84] Bruun, P. (1962) Sea-level rise as a cause of shore erosion. Journal of Waterays and Harbors division, American Society of Civil Engineers, v. 88, p. 117-130.
[85] Hwang, D.J., and Fletcher, C.H. (1992) Beach management plan with beach management districts. Report for the Hawaii Coastal Zone Management Program, Honolulu, 192p.
[86] Coyne, M.A., Fletcher, C.H., and Richmond, B.M. (in press) Mapping coastal erosion hazard areas in Hawaii: Observations and errors. Journal of Coastal Research.
[87] Id.

of eroding and accreting sites. These other process most likely include, wave and current action and/or sediment deficiencies.

B. WAVE AND CURRENT ACTION

Beaches change their shape in response to wave and current forces, and to sand availability. To improve understanding of beach dynamics, scientists and engineers track these changes by measuring the profile, or cross-section, of the beach[88].

1. Seasonal Profile Changes Beaches get sand from both the ocean and the land. Ocean currents can move sand along the coast to build beaches. Dunes and other landward sand deposits give sand to a beach in response to the forces of wind and waves. High waves will cause a beach to change its shape, or profile, by redistributing sands across the shoreline (see diagram). To absorb high wave energy, beaches and dunes give up sand to the waves which carry it seaward and drop it on the bottom. This raises the seafloor and flattens the overall profile of the beach. Waves then shoal and break further offshore, minimizing their erosive impact. This typically happens in response to seasonal shifts in wave energy. Beaches recover from these natural changes when smaller waves move the sand back onto the beach[89] and winds blow it into the dunes to be captured by coastal vegetation.

2. Chronic Erosion Erosion caused by repeated episodes of high wave attack is typically focused on the upland immediately behind the beach, constantly drawing upon sand stores there to feed the profile changes occurring. Along most Hawaiian shores, sands stored in dunes and fossil shorelines are moved onto the beach by this process. Beaches benefit from this source of sand so that they remain wide and healthy even as the land behind them erodes. Chronic erosion, then, causes land loss but not beach loss. Studies are underway at the University of Hawaii to more exactly quantify the source and variation of beach sands[90]. Nonetheless, it is apparent that the process of land loss by erosion can be an important source of sand to many beaches.

Armoring, to stop chronic coastal land loss, refocuses wave forces onto the beach in front of a wall or revetment. Beach erosion ensues, leading to a volumetric loss of sand that produces beach narrowing, and eventually beach loss.

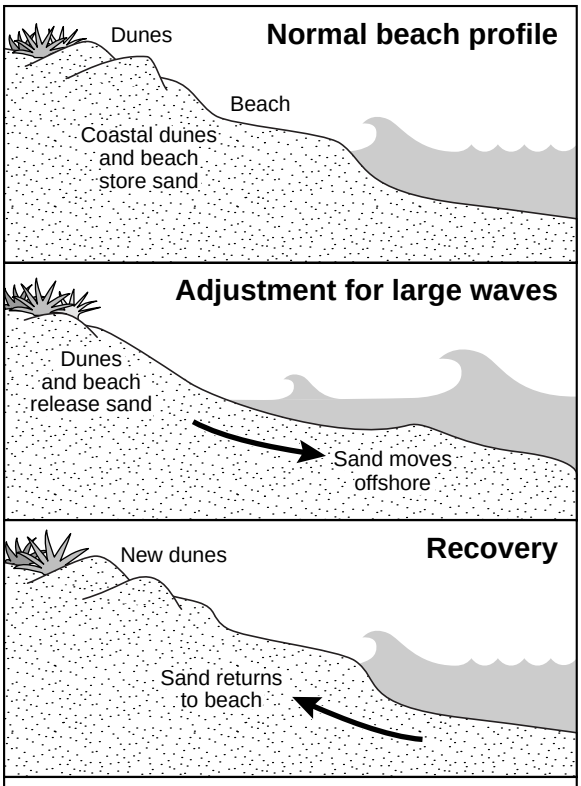
3. Local Variability Waves are the key players in the process of coastal retreat

[88] U.S. Army Corps of Engineers, Coastal Engineering Technical Notes II-2, II-8, II-13, II-16, II-20, II-26, II-30, II-31, II-38, II-39, II-40. Coastal and Hydraulics Laboratory, Vicksburg.

[89] Dail, H.J., Merrifield, M.A., and Bevis, M. (manuscript) Steep beach morphology changes due to energetic wave forcing: Waimea Bay, Oahu, UH Department of Oceanography, 31p.

[90] Harney, J.N., and Fletcher, C.H. (1998) Composition, and distribution of sediments in Kailua Bay, Oahu, Hawaii. First Regional Conference on Coastal Erosion Management in Hawaii and other Pacific Islands. Abstracts with Programs, University of Hawaii Sea Grant College Program.

Seasonal beach profile adjustments



Large waves, which tend to occur seasonally in Hawaii, cause a beach to temporarily change its profile.

because they are able to reach high onto the beach and into the dunes during certain seasons of the year when they are at their maximum height.

On the north shores of the islands, waves are highest in the winter because they are generated by distant storms in the Northern Pacific. On the south shores they are highest in the summer because they are generated by storms in the Southern Hemisphere. On the windward shores, high waves are generated by strong tradewinds and by a mix of tradewinds and large north or south waves that wrap around the coastline. The leeward shores are typically hidden from tradewinds, but can experience the wrap around of both south and north waves in their respective seasons.

Many local features combine to determine the pattern and process of wave action on our shores: the presence of reefs and offshore channels, the orientation of the coast to the prevailing winds and the approach of distant waves, the offshore depth variability, and short-term weather systems that drive wave-generating winds in unusual ways. Waves that approach our shores from an angle are capable of causing currents that flow along the coast, known as "longshore currents." These can move sand from one end of a beach to another.

Sometimes it is local winds that generate waves which in turn drive longshore currents. For instance, in Kailua Bay, the passage of cold fronts in the winter can drive strong winds from the north that cause sand accretion along the southern end of Kailua Beach. The beaches of south Maui are influenced by tradewind-driven flow so that sand typically moves to the south. But when intense "Kona storms" from the south and west occur there, sands are driven to the north in large quantities. Alternatively, the beaches of the Waianae coast on Oahu experience longshore currents to the southeast driven by waves, not winds, approaching from the north in the winter, and reversing currents to the north, driven by southerly waves in the summer.

4. Improved Understanding Studies of these highly variable local patterns of wind and wave dynamics[91] can be important keys to dispelling misunderstandings of beach processes, and unlocking effective management tools for coastal land conservation and beach preservation. In the myriad coastal settings of Hawaii, any knowledge that increases our insight to sand movement caused by wave and current action along the shoreline can also play a significant role in consensus building for community decision-making. Analysis of littoral cell sediment processes and budgets is also critical to implementing a sustainable program of dune and beach restoration and nourishment[92].

[91] *for example*, Noda, E.K. (1989) Hawaii Erosion Management Study, for Coastal Zone Management Program, 1989; Noda, E.K., Moon, O 'Connor, Tam & Yuen (1990) Kauai Shoreline Erosion Management Study, for Coastal Zone Management Program.

[92] National Research Council (1995) Beach Nourishment and Protection. National Academy Press, Washington, D.C., 334p.

C. SEDIMENT DEFICIENCIES

There are situations that call for human interference with patterns of sand flow and accumulation. These include clearing storm drainage channel mouths, dredging harbors and boat basins, widening harbors or extending breakwaters, crossing the shoreline with outfall pipes, or cutting new channels. These and other activities that are common on the Hawaiian shoreline have the potential to cause sediment deficiencies along adjacent beaches. It is important to conduct a careful assessment of dynamics and patterns on the shoreline in question in order to minimize impacts to coastal resources. Moderate erosion trends can be exacerbated, and accreting coastlines caused to erode, by poorly conceived civil works projects on the coast that trap sand or alter it's movement.

1. Past Sand Mining In the past, Hawaii's beaches have been subjected to sand mining for lime processing. The calcareous sand ($CaCO^3$) is baked to release carbon dioxide and produce simple lime (CaO) for use as a building material. Past mining sites include Baldwin Beach Park and Sugar Cove on Maui, and Kahuku beach and Waimea Bay on Oahu. Old photographs of the beach at Waimea Bay show the popular "jump rock" completely surrounded by sand where today it is offshore of the beach in moderately shallow water. Sand mining that ended there in 1965 is in large part responsible for the retreat of both the vegetation line and the beach foreshore over recent decades. With the end of sand mining, the beach is now stable, although it does experience dramatic seasonal and shorter term profile fluctuations in response to large winter waves[93].

Sand mining will result in obvious negative impacts to beaches by decreasing sand volumes, steepening the morphology of the shoreline, and reducing the ability of profiles to respond to seasonal wave stresses. Although presently outlawed in Hawaii, there are occasional requests to mine remote beaches that are perceived as being of low socioeconomic value and high sand volume.

2. Sand Behind Walls Sediment impoundment accompanies coastal armoring[94]. Sands that would normally be released into coastal waters during high wave events and with seasonal profile fluctuations are trapped behind walls and revetments and prevented from adding to the beach sediment budget. One wall may have minimal impact, but along many Hawaiian coastlines a myriad of armoring types combine to reduce sand availability to nearly zero. Natural coastal erosion does not damage beaches that have access to a robust sediment budget. Beaches on chronically eroding coasts that are not armored remain healthy even during shoreline retreat because sands are released from eroding coastal lands that nourish the adjoining beach. Armoring traps those sands and a sediment deficiency develops such that the beach does not withstand seasonal wave stresses and begins to narrow with time. Chronic beach erosion and beach loss eventually results. Many beaches disappear simply because they are starved of sand.

3. Dune Grading Studies show Hawaiian beach sands are composed of fossil material[95], and have been stored in coastal sediment reservoirs for a period of time prior to moving onto the active beachface.

One of the most important storage sites for sand is the frontal dune system that lines many shores. As already mentioned, armoring traps these sands. Additionally, the leveling and grading with topsoil that accompanies housing construction on beachfront lots is one of the most destructive practices taking place along the Hawaiian coast. Our dune ecologies have been

[93] Dail, H.J., Merrifield, M.A., and Bevis, M. (manuscript) Steep beach morphology changes due to energetic wave forcing: Waimea Bay, Oahu, UH Department of Oceanography, 31p.

[94] Pope, J. (1997) Responding to coastal erosion and flooding damages. Journal of Coastal Research, v. 13, p. 704-710.

[95] Grossman, E.E., and Fletcher, C.H. (1998) Sea level 3500 years ago on the Northern Main Hawaiian Islands. Geology, April, v. 26, no. 4, p. 363-366; and Harney, J.N., and Fletcher, C.H. (1998) Composition, and distribution of sediments in Kailua Bay, Oahu, Hawaii. First Regional Conference on Coastal Erosion Management in Hawaii and other Pacific Islands. Abstracts with Programs, University of Hawaii Sea Grant College Program.

decimated by common landscaping practices[96] that do not seek enhancement of the endemic environment, do not recognize the value of salt tolerant vegetation as a tool for beach and dune preservation, and do not establish dune conservation as a goal of the landscaping effort.

Soil filling to support short-grass lawns is a source of siltation to coastal waters during erosion events, and acts to compact and trap dune sands such that the adjacent beach experiences "deflation," or a lowering of elevation due to sand removal by waves without replacement by dune sand. Deflated beaches fronting filled dunes provide poor erosion buffering capabilities and are themselves a degraded environment with little to offer the normal coastal ecosystem and its host of organisms with beach-dependent lifestages (turtles, various marine larvae, certain reef fishes).

4. Channelization Many streams that flow intermittently from our mountains to the coast are subject to flash-flooding during heavy rainfall events. To prevent coastal zone flooding, the most hazardous of these streams have been channelized into concrete canals or gutters so that flooding is contained.

Where these open onto the coastal zone, the channel mouths tend to trap sand that is moving along the shoreline. The buildup of sand within the channel mouths increases the upstream flood hazard and creates a sand deficiency on the adjacent beach.

Public works departments often clear these accumulations and dispose of the sand in various ways, including trucking it off-site to be used elsewhere (i.e., golf courses). Unless these sands are returned to the immediate beach area, the long-term dredging and clearing is nothing less than a sand-mining effort, and it will have a similar impact on the adjacent beach. This has the potential to reduce available sand volumes and create chronic erosion where none previously existed.

In placing cleared sands onto adjacent beaches it is important to be aware of prevailing sediment transport patterns so that returned sand can function in a manner that will provide nourishment. To ensure this, it will be necessary to conduct a review of the ambient littoral processes and develop schedules of transport direction around each channel mouth, with guidelines on the placement of returned sand.

D. HUMAN INFLUENCE

Perhaps more than any other cause, it is human interference with natural sand transport processes that underlies much of the chronic erosion plaguing portions of the Hawaiian shoreline.

Localized reef degradation, water quality deterioration that impacts sand generating ecosystems, sand impoundment, mining, and dune grading are all activities that are still prevalent in our coastal zone although their true impacts are often not recognized.

It is critically important that all individuals and agencies that use or manage the coast conduct an audit and assessment of their assumptions, rules, and protocols so that potential impacts of which they are not aware can be brought to light, and better management practices defined and brought on line.

The beaches of Hawaii are vital economic, environmental, and cultural resources. The beach environment provides habitat for marine and terrestrial organisms with beach-dependent life-stages and is home to species of indigenous, endemic Hawaiian plants. A sandy beach provides protection from the effects of storm surge, tsunami flooding, and large wave impacts. Beaches are the focus of traditional and modern religious, cultural, and recreational activities. Beaches also are the basis for an essential visitor industry that exceeds, by a factor of three, all other industries combined when providing direct income to the State. Tourism supports over one third of all jobs in the state. In Hawaii, the environment is the basis for a healthy economy. As characterized in one national media report, "...beaches are Hawaii's bread and butter..." (CNN, June 21, 1996).

[96] Fletcher, C.H. (1997) The Science and Management of Coastal Erosion. Hawaii Planning, v. 18, no. 6, June, 1997, p. 3-10; Fletcher, C.H. (1997) Landscaping to Preserve Beaches. Hawaii Landscaping, v. 1, no. 4.

Where there is coastal armoring causing beach loss, there is also reduced public access to the ocean. Walls on narrowed beaches have the effect of privatizing the otherwise publicly accessible shoreline. Under the public trust doctrine the state holds beach resources and access in trust for the public and is constitutionally bound to defend, preserve, protect, maintain, and perpetuate that resource.

Because the state owns the beaches, and is the trustee of that resource, it is the state that has the fiducial responsibility to take the lead in beach management. Hence, it is critical to outline the available options to be used as tools in managing coastal erosion.

Waimanalo, Oahu. Sand impoundment behind this revetment at Bellows Airfield creates a local sand deficiency. As a result, it is responsible for ~1000 ft of beach loss and dune destruction, and chronic erosion characterizes the coast to either side of this structure.

Technical Supplement, Part D

Office of Environmental Quality Control (OEQC), Department of Health –

Guidelines for Environmental Assessment prepared in conjunction with an application for shoreline alteration and hardening

COEMAP makes the following recommendation - It is appropriate for state agencies, specifically the DLNR and the DBEDT to adopt the following guidelines in their application review process so that there become established, clear and consistent standards for decision-making along the shoreline. County authorities should also evaluate these guidelines and consider their adoption so that there is consistency between state and local agencies in the evaluation criteria for shoreline projects.

ENVIRONMENTAL ASSESSMENT GUIDELINES.

Following are amended (Fall, 1998) EA evaluation guidelines.

Guidelines for Environmental Assessment prepared in conjunction with an application for shoreline alteration and hardening.

It is the policy of the State of Hawaii under HRS Chapter 205A to discourage all shoreline hardening that may affect access to, or the configuration of, our island beaches.

Any Environmental Assessment prepared in conjunction with an application to construct a seawall, revetment or similar structure, or an activity that will alter in any way littoral processes affecting the shoreline, should be accompanied by appropriate justification and detailed studies including, but not limited to, the following:

1. Historical shoreline analysis of coastal erosion and accretion rates This should include a description of all movements of the neighboring shoreline over at least the past 30 years. This analysis should be based, at least in part, on aerial photographs available through government agencies and private vendors (Air Surveys Hawaii, Inc.; Towill, R.M., Corp.; City and County of Honolulu, Coastal Lands Program, Department of Planning and Permitting; DBEDT, Office of Planning; and the various planning and permitting departments in each county). The analysis should provide a detailed history of erosion and accretion patterns using all available evidence. This analysis should include descriptions of shoreline erosion rates, a map (with scale, north arrow, and title) showing past positions of the shoreline in the project area, and an analysis of the causes of erosion. It is especially important to describe how the project will mitigate the cause(s) of erosion, and avoid exacerbating erosion on the adjacent shoreline.

2. Shoreline type A description of the nature of the affected shoreline, whether sandy, rocky, mud flats or any other configuration. The history and characteristics of adjoining sand dunes, streams and channels, and reefs should be included.

3. Site maps Submit maps with title, north arrow and scale, and photographs that clearly show the current certified shoreline, previous certified shorelines, the private property line and the location of the proposed structure. Any nearby public access right-of-way should also be depicted. Applicants should also include a color copy of a color vertical aerial photograph (usually can be purchased at reasonable price from Air Surveys Hawaii, Inc.) that shows the project area and the adjacent offshore region. The applicant may wish to identify important components of the project on the color photo. Color aerial photos exist for most of the shoreline area of Hawaii and often clearly show important geologic and geographic features that are critical to fully evaluating the environmental context, and even the likelyhood of success, of a proposed project. Evaluation of an aerial photo of a project site can be an important tool yielding significant information relevant to the applicants planning efforts.

4. Beach profiles Submit beach profiles that extend offshore at appropriate intervals along the beach indicating the width and slope of both the submerged and dry portions of the beach and showing major features of the beach. Profiles should extend from the mauka toe of the primary dune to the offshore depth of closure of profile fluctuations (refer to U.S. Army Corps of Engineers Coastal Engineering Technical Notices II-31 (11/93), II-40, 3/98, and other relevant documents for guidance).

5. Existing walls Submit an analysis of any existing nearby walls or revetments and their cumulative impacts on the shoreline.

6. Description of improvements A description of structures and improvements (such as homes or swimming pools) on the subject property, their distance from the property line and shoreline, how they may be affected by the construction of the proposed hardening project, and the specific feasibility of relocating them as a hazard mitigation activity.

7. Coastal hazard history A coastal hazard analysis for the area in question. This should include any relevant coastal processes such as hazardous currents and seasonal wave patterns, including a description of the recent incidence of damaging high waves, high winds or water levels from storms, vulnerability to tsunami, and the best estimate of Base Flood Elevations and flood zone designation as mapped by the FEMA Flood Insurance Rate Maps.

8. Waves and currents A description of the wave and current regime acting along the shoreline in question, including, a wave refraction analysis (one simple form of this analysis is to describe wave crest patterns as shown in an aerial photograph), a description of littoral currents and their seasonal patterns and the impact of the proposed activity on these patterns.

9. Sediment movement If the proposed activity involves any action that may interfere with the normal pattern of sediment transport along the coast, or alter in any way the morphology of the shoreline or the resident sand volume, applicants must submit a description of these alterations and their impact on shoreline processes including an estimate of the annual volume of sediment in transport and seasonal patterns of transport, and whether these impacts may have any deleterious effects on neighboring shoreline segments.

10. 30 year erosion hazard An analysis that uses annual erosion rate data to project the location of the 30 yr erosion hazard zone as measured from the certified shoreline or vegetation line in the absence of any shoreline stabilization structures. This information should be provided in the form of a mapped line or zone, and accompany text descriptions. The analysis may be combined with items 1 or 3, or submitted independently.

11. Photographs Eye-level (taken by an individual standing on the ground) photos of the site that illustrate past and present conditions and locate the proposed structure.

12. Alternatives All alternatives to shoreline hardening should be thoroughly researched and analyzed. These alternatives should include beach and/or dune restoration using sand replenishment, retreat from the shoreline by moving existing structures inland, and a no action alternative.

13. P.E. Seal The seal of a Professional Engineer (P.E.) with experience in the area of coastal engineering should be included with any technical plans for a shoreline hardening structure that accompany the application.

The inclusion of this information will help make an Environmental Assessment complete and meet the requirements of Chapter 343, HRS. Only after thorough study and analysis should any permit for shoreline hardening be considered.

Technical Supplement, Part E

Resolution on COEMAP – Maui County Council

Resolution on COEMAP – City and County of Honolulu Council

Resolution on COEMAP – Office of Planning, Marine and Coastal Zone Management Advisory Group