COMPREHENSIVE SAND MANAGEMENT PLAN

MAIN REPORT

Prepared for BEACON

July 14, 1989

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1.0 - INTRODUCTION

BEACON was formed by a joint powers authority on July 1, 1986 to foster coordination and cooperation by public and private agencies with respect to protection, maintenance, and enhancement of beaches and coastline along the Santa Barbara and Ventura Counties coastline (BEACON, 1986a). The member agencies of BEACON include the cities of Carpinteria, Oxnard, Port Hueneme, Santa Barbara, and San Buenaventura as well as Santa Barbara and Ventura Counties. A number of ex-officio members also participate in BEACON as non-voting parties. These members include local legislators, Federal and State agencies, and private homeowner groups.

The organization was created as a result of the recognition that beach erosion is a regional phenomenon and individual efforts to deal with specific problems often affects neighboring communities. The general goals of BEACON were formulated by its predecessor association, the South Coast Regional Beach Erosion Control Group. In a comprehensive assessment of beach erosion needs and concerns, it was recommended that five goals be fulfilled. The goals are reproduced below from the initial report (SCRBECG, 1986).

1. Develop an understanding of the processes controlling shoreline changes along the South Coast, and a means to predict future changes as a function of incident wave climate and shoreline development.

2. Develop a regionally-coordinated program to manage existing sand resources in a manner which is both economically and environmentally sound.

3. Identify and develop regionally-coordinated mitigation measures to prevent future damage to coastal resources.

4. Develop viable methods to fund needed studies and economically feasible mitigation measures on an ongoing basis.

In fulfillment of these goals, it is hoped by BEACON that a unified means of protecting and preserving beaches within Santa Barbara and Ventura Counties can be realized (BEACON, 1986b).

1.1 Study Authorization

This report presents the results of a detailed study to formulate a comprehensive shoreline sand management plan for the Santa Barbara and Ventura Counties shoreline. Specifically the study was commissioned to review the historical beach losses and recommend an action strategy to deal with future projections of erosion. The study was authorized by the BEACON Board of Directors on September 3, 1987.

1.2 Study Objectives

The objectives of this study are to fulfill the goals set forth in the State grant application which funded the project. These objectives are reproduced below (BEACON, 1986b):

1. Determine the economic benefit and technical feasibility of nourishing beaches from offshore sand deposits.

2. Identify and prioritize existing sand nourishment resources.

3. Evaluate sand bypassing operations at Santa Barbara, Ventura and Channel Islands Harbors.

4. Formulate optimum sand management techniques and policies for the control of coastal beach erosion.

5. Establish an ongoing coastal sand monitoring program.

With these specific objectives endorsed by the Board of Directors, it was hoped that a long-term goal of increasing beach width over the coastline could be realized. Furthermore it was explicitly stated that in so doing, a decrease in harbor shoaling might be obtained, damages to coastal property due to winter storms decreased or eliminated, and the need for additional seawall construction reduced. Lastly, it was hoped that through BEACON, local programs and policies for the control of beach erosion could be implemented.

In response to these goals and objectives, this study was authorized to form the foundation for understanding of the past, present and future erosion within the study area together with an inventory of available sand resources. These data were to form the basis for the development of a comprehensive sand management plan identifying specific beach erosion control strategies and their technical, economic and environmental feasibilities. Based upon the outcome of the plan it was intended by the Board of Directors that a small demonstration project be identified which could serve as a springboard for implementation of the larger plan.

1.3 Report Organization

This report is divided into several chapters which discuss the different technical elements that were addressed in the recommended formulation. A separately bound document contains several appendices which may be consulted for more detailed technical information and data. The main report volume has been organized to summarize the general shoreline condition, alternative solution strategies, and development of a specific plan of action.

The following report outline was adopted for presentation of the study findings:

- Shoreline Description
- Sediment Budget
- Sand Management Strategies
- Plan Development
- Plan Evaluation
- Plan Implementation
- Conclusions and Recommendations

The reader is referred to the Table of Contents of this report for enumeration of the different appendices contained in the separately bound volume.

Rincon Parkway segment between Carpinteria and the city enaventura (Ventura) serves as the main transportation between the two metropolitan regions. Petroleum prosurfing, and clustered residential development remain as ipal land uses along this strip. The shore segment is ized by thin pocket beach areas backed by a narrow errace, with the coast range mountains acting as the back drop. The pressures of transportation needs and able location has resulted in conditions of narrow or ent setback distances. This close proximity of s and infrastructure to the water's edge exposes the nt to periodic storm damages. For the most part, along the Rincon Parkway are either sparse or non-

Ventura County coastline opens into a broad alluvial tween Ventura and Point Mugu. The shoreline contains the widest sandy beaches within the study region, and it is publicly owned and available for recreation. The nore areas support a variety of land uses including l, residential, petroleum production, recreation, and The Ventura and Santa Clara Rivers empty into this nd are responsible for delivering much of the sand to segment. Three harbors located between Ventura and neme play important roles in regulating the littoral

logic Setting

eologic setting of the Southern California shoreline is plex tectonics whose structure includes plate collision y continental over-riding of a spreading center. The alifornia shoreline has been described as a collision an, 1983) wherein the Pacific Ocean plate subducts on ith the North American plate. From a geologic time e, the process manifests itself in the form of narrow helves cut by submarine canyons, uplifted by coastal and coastal erosion (Inman, 1988).

nning Implication

mmary, it is concluded that the study area may be divided into two segments east and west of the Ventura he basis of their diverse physical characteristics. It follows that shoreline planning strategies may warrant actions in each one. In Chapter 3, it will be shown e planning segments may be further subdivided on the hysical and developmental characteristics.

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2.2 Historical Perspective

In order to obtain a proper frame of reference for the existing shoreline condition of these two segments, it is useful to review the historical shoreline characteristics. Within the BEACON study area, this was accomplished with the aid of vertical and oblique aerial photography dating to the 1920's. Appendix G contains a portion of the referenced photography data. General observations related to beach width and development trends were made which led to several interesting insights. The following synopsis of the shoreline summarizes some of the more pertinent findings noted.

2.2.1 Ellwood to Santa Barbara Harbor

The section of coastline from Ellwood to the Santa Barbara Harbor has changed little over the past 60 years. Numerous oil wells formally occupied the beaches west of Isla Vista, and in the late 1920's very little development existed west of Santa Barbara Harbor. Figure 2-2 shows the beach near Ellwood as it looked at that time, and it can be seen from the photograph that the shoreline was not very different from today's appearance. Beaches were relatively narrow and the coastal bluffs were no doubt exposed to episodic erosion when winter storm waves attacked the bluff toe. With the exception of the former oil and gas development, very little shoreline activity has occurred along this reach.

2.2.2 Santa Barbara to Carpinteria

This coastline segment has been dominated by the construction of the Santa Barbara Harbor facility. The harbor was first constructed between 1927 and 1928 with placement of a detached offshore breakwater to provide a protected navigation facility. Prior to completion of the breakwaters, historical photographs suggest that the City's beaches were narrow or non-existent. The impact of the offshore structure became immediately apparent as large accumulations of sand were collecting inside the harbor, necessitating connection of the offshore breakwater to Point Castillo to prevent shoaling. The additional work was completed by 1930.

As a consequence the harbor became a complete littoral barrier with sand being trapped at a rate of about 800 cubic yards per day (O'Brien, 1936). This translates to an annual accumulation of about 300,000 cubic yards. The beaches downcoast of the harbor began to suffer serious erosional effects. An erosion wave propagated downcoast and was felt as far as south Carpinteria (Herron, 1986). By 1934 a series of groins had been installed from East Beach to Miramar in an effort to stop the

Ellwood, 1929
Photograph courtesy UCLA Department of Geography Spence Collection.

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Figure 2-2

recession. Figure 2-3 shows the shoreline east of East Beach prior to the onset of regular sand bypassing that was authorized in 1935 by the Corps of Engineers. The stone revetment that can be seen in the photograph was constructed by the City of Santa Barbara to protect Cabrillo Boulevard from erosion damage. From 1935 to 1952, the Corps of Engineers dredged the harbor and deposited about 5.4 million cubic yards of sand on East Beach. As a result, Santa Barbara's beach was widened to its approximate present day condition, but the beaches downcoast, which were denuded as a result of the harbor construction, never recovered to their former condition (Herron, 1986). However, a review of historical data suggests that these areas were never very wide originally.

Summerland Beach was also relatively narrow as of 1930. Historical photographs indicate that the area was formerly populated with nearshore oil derricks and piers to extract shallow petroleum deposits.

Padaro Lane and Carpinteria beach areas were relatively thin ribbons of sandy beach as evidenced by early photography. A series of winter storms in the 1930's and 1940's caused extensive damage to the beach cottages west of El Estero and significantly reduced a relatively wide beach at Sandyland (Bailard and Jenkins, 1982.).

2.2.3 The Rincon Parkway

The Rincon Parkway, which extends from Rincon Point to the Ventura River mouth, has always been an area of thin beaches backed by high coastal bluffs. Photography dating back to the late 1800's shows evidence of cobble beaches and a narrow sandy coastline. This section has also experienced the most alteration by man. Through a combination of southern Pacific right-of-way improvements followed by Caltrans construction, the present day rail and highway corridors were developed. Evidence of the narrow beach morphology may be inferred by the historical note that the early stage coach route established at about 1850 was passible only during low tide (Ventura County Historical Museum, 1988). The railroad right-of-way was constructed in 1888, and it wasn't until 1914 that the first series of highway construction encroachments took place. The sequence of U.S. Highway 101 widening since that time has been significant. Major improvements were noted in the 1920's, 1940's, early 1960's and most recently in 1971 when the present right-of-way was finalized.

The most recent construction involved moving the highway about 600 feet seaward between Punta Gorda and Seacliff, as shown in Figure 2-4. As a result of this fill, a significant portion of the active littoral transport area was buried. After

Santa Barbara East Beach, 1936.
Photograph courtesy UCLA Department of Geography Spence Collection.

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Figure 2-3

Highway 101 Encroachment at Seacliff, 1970 and 1971
Photographs courtesy of CALTRANS.

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Figure 2-4

completion of this project, the beach immediately in front of the fill showed accretion while the adjacent downcoast segments to Faria became erosional (Cramer and Pauly, 1979).

As a result of the need to protect the highway and railroad infrastructure, almost the entire stretch of shoreline along the Rincon Parkway was fortified with seawalls and revetments. The small private communities which occupy this reach have also resorted to similar practices to protect their dwellings from winter storm damage. Aerial photographs of Solimar and Faria indicate that residential structures were already close to the water's edge as early as the 1940's.

Near Emma Wood County Park, the shoreline was originally fortified in 1931 to protect the old coast highway route (U.S. Army, 1967). The original seawall was replaced in 1966 by the State and the beaches fronting the park have never been especially abundant.

2.2.4 Ventura River to Mugu Lagoon

From the Ventura River mouth to Point Mugu, the area may be characterized as a wide sandy alluvial plain. Based upon photographic evidence, private development and harbor construction has played a large role in the historical shoreline evolution in this area.

By the late 1920's, Ventura's Pierpont Bay area was parcelled into a shorefront subdivision. Early photographs show the close proximity of the new subdivision and the roadway (Shoreline Drive) to the shoreline, and by 1936, timber groins had been placed to arrest erosion damage, as shown in Figure 2-5. Winter storms in 1937 and 1939 completed the destruction of Shoreline Drive (Ventura-Star Press, 1939). Beaches within the bay were reported to be eroding in the 1950's (Herron,1986), and in response, a series of 7 groins were constructed between 1961 and 1967 to stabilize the area (U.S. Army, 1979). The groins have been effective in reducing erosion within this section of shoreline, and the beaches have been widened as a result of the groin field construction and about 882,000 cubic yards of sand fill placed between them.

Ventura Harbor was completed in 1964. Since that time the harbor has required annual dredging to maintain adequate water depth within its entrance channel. During dredging, sand is bypassed around the harbor and discharged on McGrath State Beach. On occasion, sand has been deposited on South Beach, immediately downcoast of the harbor, and along the lower Pierpont Bay groin field north of the facility.

Pierpont Bay, 1929 and 1936.
Photographs courtesy of UCLA Department of Geography Spence Collection.

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Between what is now McGrath State Beach and Port Hueneme, the beaches have always been wide and abundant. Periodic flood discharges from the once unregulated Santa Clara River provided a constant supply of sediment to nourish the beach. Over time, however, development has caused a gradual encroachment upon the shoreline. Figure 2-6 shows the development which appeared in the late 1920's due to the attractiveness of the beach environment. Because of the close proximity of the houses to the water's edge, this area reportedly experienced several instances of flood damage during the severe winter storm of 1939 (Ventura-Star Press, 1939). These development practices have persisted to this day at Oxnard Shores which saw the emergence of new coastal property seaward of Mandalay Road in 1964.

Channel Islands Harbor was completed in 1960. The inner harbor was excavated to its present day configuration and the material deposited east of Port Hueneme to correct a severe erosion condition caused by the construction of Port Hueneme Harbor. Port Hueneme was built in 1940 to serve military needs. The harbor was placed at the head of the Hueneme submarine canyon and as a result, a complete littoral barrier was created. Hueneme Beach began to erode rapidly, and beaches from Ormond Beach to Laguna Point receded. It wasn't until the Channel Islands fill renourishment and a subsequent program of regular sand bypassing began that Hueneme Beach was restored and downcoast areas improved.

The Point Mugu Naval Base property has had to respond to nearly continual erosion problems over the years. As a result of the Port Hueneme Harbor construction, exposure to storms, and bypassing practice, the Navy has undertaken construction of extensive shore defence works. Three groins were built in 1967 to protect ammunition bunkers west of the runway (Herron, 1986). In addition, a revetment has been established east of Laguna Point to protect shorefront structures. This revetment has required continual maintenance in response to storm attack and a chronic erosion problem east of Laguna Point.

2.2.5 Historical Storms

The shoreline within the Santa Barbara Channel has experienced a series of storms over the years. These events have impacted coastal property and beaches depending upon the severity of the storm, the direction of wave approach and the local shoreline orientation. Based upon a review of data summaries and historical information, several events stand out as notable. Strange compiled a synopsis of coastal storm events since 1900 (U.S. Army, 1988a). His data indicates that the Santa Barbara and Ventura Counties coastal area have experienced perodic damage due to storm wave attack, dating back at least to 1905. From a review of newspaper archives and historical collections, coastal

Oxnard Shores to Port Hueneme, 1929.
Photograph courtesy UCLA Department of Geograph

damage has been especially pronounced since the 1930's. Winter storms of 1937 and 1939 caused widespread erosion damage in Ventura and Hollywood Beaches. Shoreline Drive along Pierpont Bay was destroyed by the 1939 winter storm, and it was also noted that Rincon Beach disappeared and Solimar began to build "barricades" for storm protection purposes. Two storms in 1940 destroyed homes in Sandyland and caused flood damage in Carpinteria.

A series of storms in 1960, 1963, 1965, 1969, and 1971 caused local beach erosion and coastal property damage from Santa Barbara to Oxnard Shores. As a result of the 1970 events the City of Oxnard placed a stone revetment to protect a portion of Mandalay Drive. The destructive sequence of the recent winter storms in 1978 and 1983 caused significant coastal flooding damage throughout the two county area. The most recent storm of record was the January 1988 storm which eroded beach berms and caused localized flood damage in both counties. Table 2-1 summarizes the storm wave characteristics in the central Santa Barbara Channel associated with the more recent westerly events.

In summary, winter storms have caused significant damage since the 1930's and beyond. Coastal damage can also be attributed to development growth. For example, the Pierpont subdivision suffered erosion damage almost immediately after development. Those areas with low lying sandy beaches and structures close to the shoreline appear to have suffered the most damage over the years.

2.3 Present Conditions

The present shoreline condition and character may be inferred by reviewing the variation of the beach profile over the study region. A series of profiles were established and measured in the fall of 1987 and the winter of 1988 as part of this study to determine the present beach characteristics. For a detailed description of the survey, the reader is referred to Appendix D. The coastline was also inventoried from aerial photography flown in 1986. These data were used to document the present baseline condition, and served as the principal reference source with regards to historical comparisons. The beaches within the BEACON area of interest may be described in terms of their existing berm width, back beach characteristics, and land use. Figures 2-7 and 2-8 illustrate the general physical trends which exist from Ellwood to Mugu Beach. The variation in beach width and upland elevation can be seen from these figures. Inspection of the figures indicate the general locations of cliffed backbeach areas west of Carpinteria and the predominate narrow sandy beach conditions west of the Ventura River.

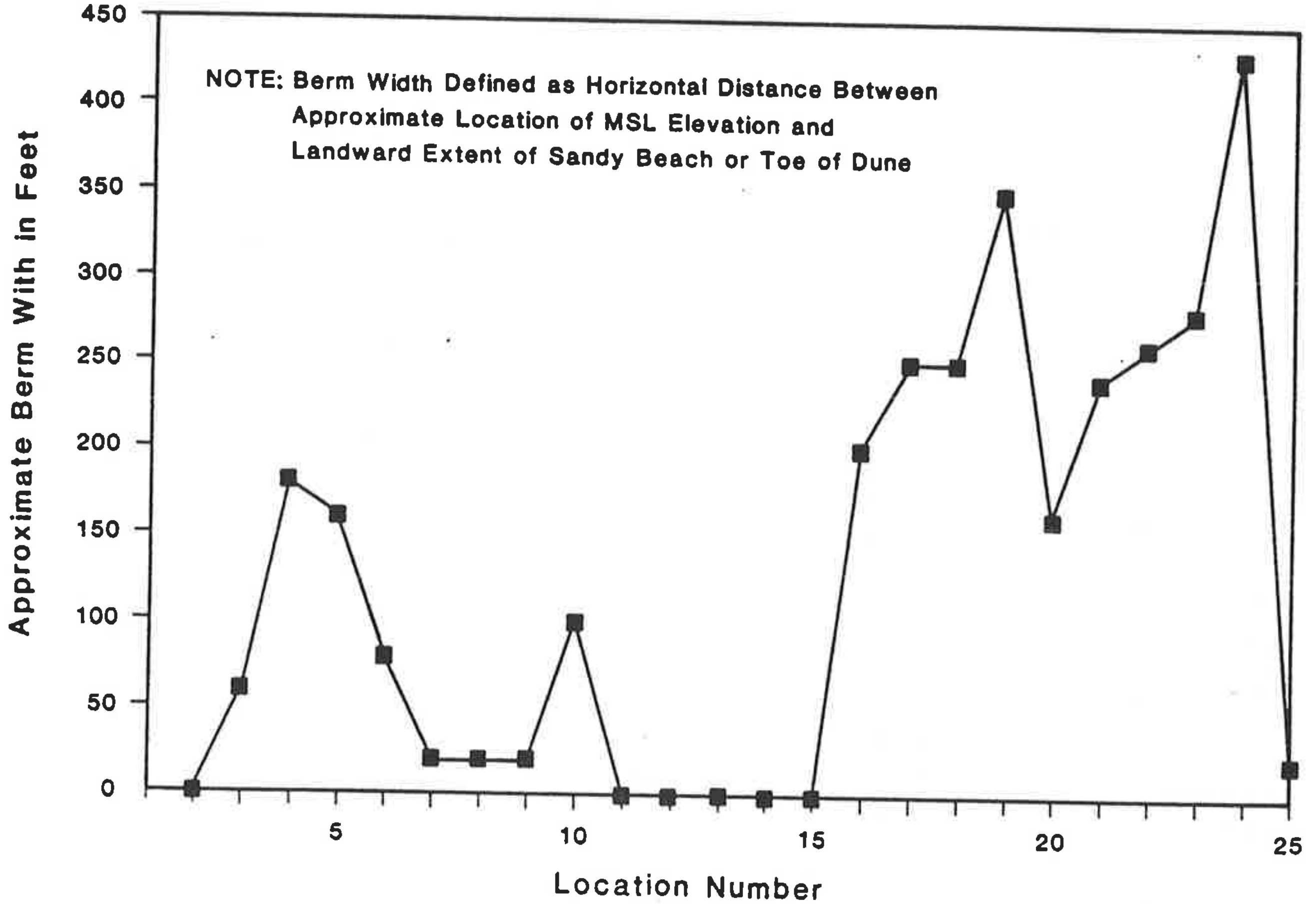
Table 2-1

Westerly Storm Wave Occurrence, 1958-1988
Central Santa Barbara Channel

Date	H_s (ft)	T (sec)	Deepwater Direction (°)	Duration Maximum H_s (hrs)
04/04/58	18.3	18	285	24
02/10/63	17.7	15	270	6
02/06/69	12.8	16	275	6
12/06/69	16.2	21	275	6
12/14/69	12.5	17	285	12
12/18/69	15.3	18	280	6
02/21/77	15.3	18	280	6
01/15/78	13.9	17	280	6
12/31/79	13.2	19	275	12
01/28/81	11.9	18	280	6
12/17/82	13.4	18	270	6
12/27/82	15.8	20	275	12
02/10/83	14.5	22	280	6
02/13/83	12.8	17	270	6
03/02/83	14.0	19	270	12
12/03/85	17.0	17	270	6
01/23/86	13.0	20	280	6
02/01/86	17.9	19	275	6
03/11/86	16.1	17	280	12
03/16/86	13.6	16	285	6
01/17/88	19.1	15	270	6

Hindcast Station is 34.2° N, 119.8° W

Reference: Kent, 1988



LOCATION REFERENCE

1 Ellwood
2 Isla Vista
3 Arroyo Burro
4 Leadbetter Beach
5 East Beach
6 Biltmore
7 Miramar
8 Summerland
9 Padaro Lane
10 Carpinteria
11 La Conchita
12 Hobson
13 Faria
14 Solimar
15 Emma Wood
16 Surfer's Point
17 San Buenaventura State Beach
18 Marina Park
19 McGrath State Beach
20 Oxnard Shores
21 Hollywood Beach
22 Silver Strand
23 Hueneme Beach
24 Ormond Beach
25 Pt. Mugu

EXISTING BEACH BERM WIDTH OVER STUDY AREA

WINTER CONDITION

REFERENCE: BEACON BEACH PROFILE SURVEY, APR 88; AERIAL PHOTOGRAPHY, STATE OF CALIFORNIA, MAR 87

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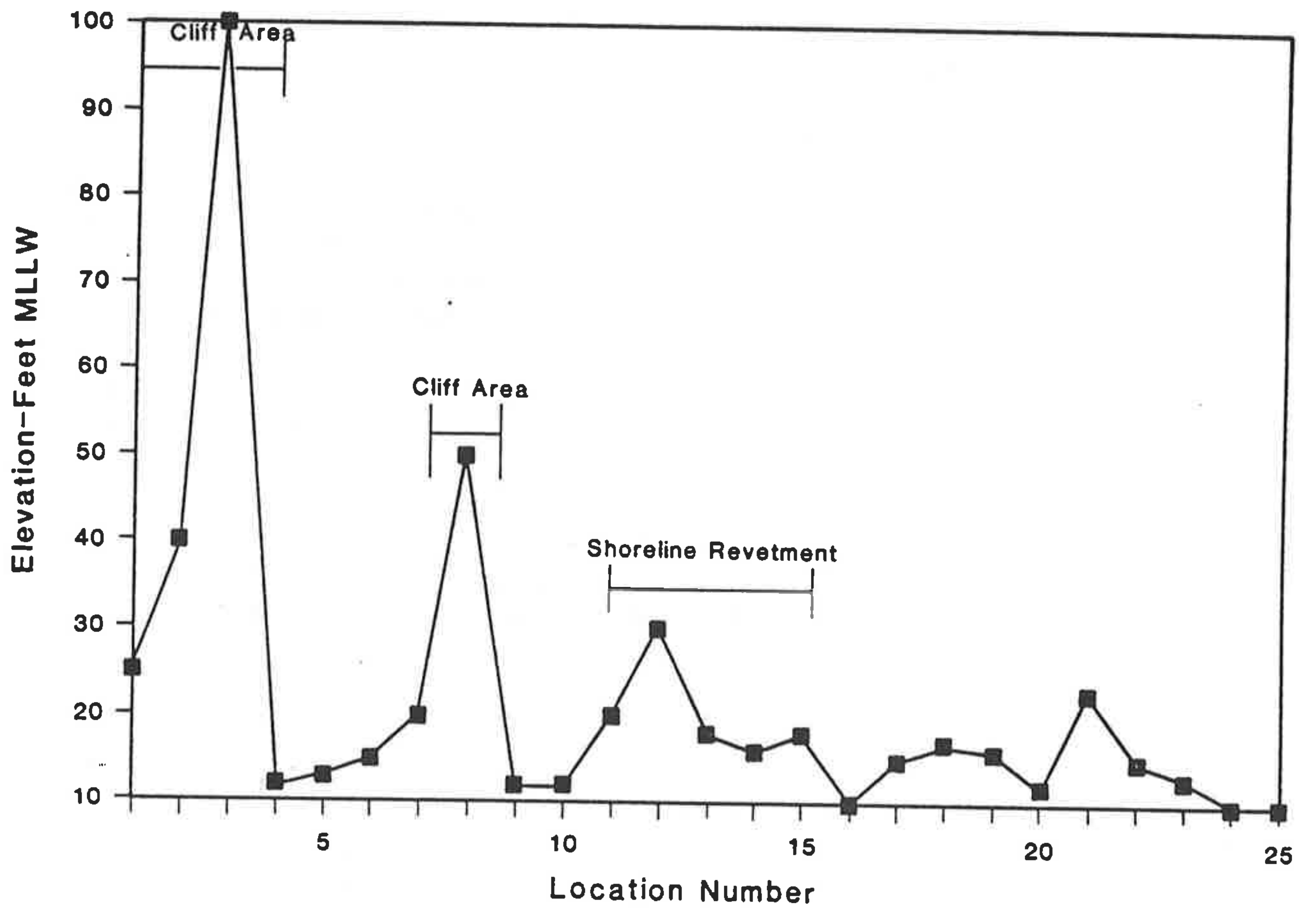
Figure 2-7



LOCATION REFERENCE

1 Ellwood
2 Isla Vista
3 Arroyo Burro
4 Leadbetter Beach
5 East Beach
6 Biltmore
7 Miramar
8 Summerland
9 Padaro Lane
10 Carpinteria
11 La Conchita
12 Hobson
13 Faria
14 Solimar
15 Emma Wood
16 Surfer's Point
17 San Buenaventura State Beach
18 Marina Park
19 McGrath State Beach
20 Oxnard Shores
21 Hollywood
22 Silver Strand
23 Hueneme Beach
24 Ormond Beach
25 Pt. Mugu

EXISTING BACKBEACH ELEVATION OVER STUDY AREA

REFERENCE: BEACON PROFILE SURVEY,
OCT 1987 & APR 1988

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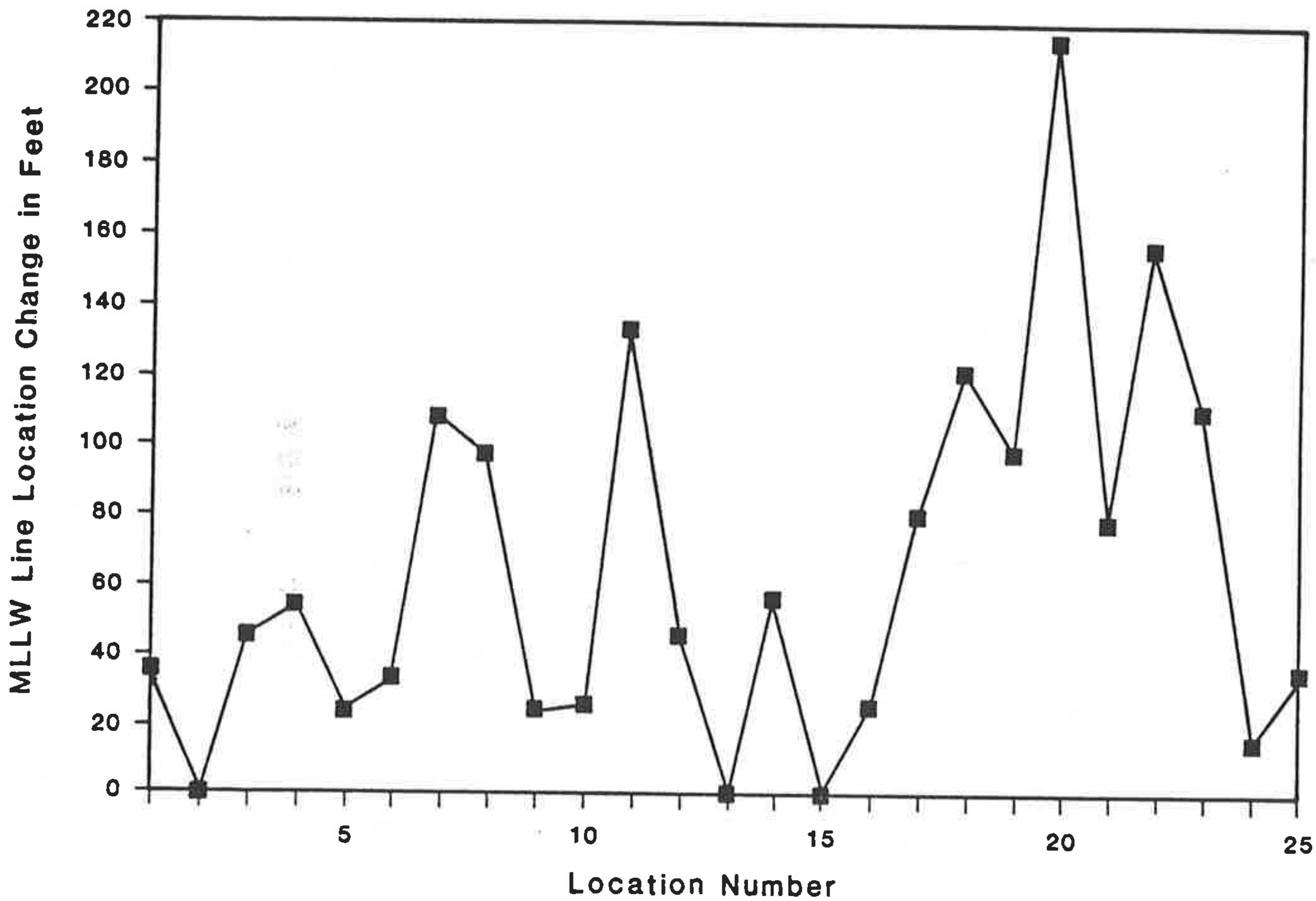
Figure 2-8

The beaches undergo seasonal profile changes in response to the temporal wave climate. The shoreline will retreat in the winter months as the more intense storm waves remove sand from the beach and deposit it in offshore bars. This process may be seen in Figure 2-9 which summarizes the horizontal distance that the Mean Lower Low Water (MLLW) contour moved between the surveys of October 1987 and April 1988.

The present day beach condition may be summarized by the following narrative. In general, the narrow Santa Barbara County beaches are more vulnerable to episodic seasonal reductions in beach width which expose the backbeach bluffs to winter storm wave attack. Local sandy beach areas at Goleta State Beach, Santa Barbara's West and East Beach, and the Sandyland/ Carpinteria area exhibit wider beach berms. However, with the exception of Santa Barbara, these areas are either low lying or show seasonal changes that still leave developed lands vulnerable behind them.

The Rincon Parkway is almost entirely fortified with revetments and seawalls. As such, sandy beach areas are sparse and very narrow. Coastal communities situated seaward of the highway are periodically damaged by winter storm swell and high tides.

The Oxnard Plain region from Ventura to Point Mugu enjoys a seemingly wide beach condition. However on closer inspection, several areas remain exposed to winter storm damage. Ventura's Pierpont Bay has seen increased erosion stress along the southern end. Oxnard Shores development is encroaching seaward and low lying areas along Mandalay Drive require periodic flood and sand migration cleanup. Hollywood Beach, Silver Strand, Hueneme Beach, and Ormond Beach all enjoy relatively wide beaches at this time. Portions of the Naval property within the confines of the Pacific Missile Test Center at Point Mugu remain deficient in beach width and require flood protection.



LOCATION REFERENCE

1 Ellwood
2 Isla Vista
3 Arroyo Burro
4 Leadbetter Beach
5 East Beach
6 Biltmore
7 Miramar
8 Summerland
9 Padaro Lane
10 Carpinteria
11 La Conchita
12 Hobson
13 Faria
14 Solimar
15 Emma Wood
16 Surfer's Point
17 San Buenaventura State Beach
18 Marina Park
19 McGrath State Beach
20 Oxnard Shores
21 Hollywood Beach
22 Silver Strand
23 Hueneme Beach
24 Ormond Beach
25 Pt. Mugu

VARIATION OF MLLW LINE
OCTOBER 1987 TO APRIL 1988

REFERENCE: BEACON BEACH PROFILE
SURVEY, OCT 1987&APR 1988

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Figure 2-9

3.0 - COASTAL SEDIMENT BUDGET

In order to prepare a comprehensive sand management plan, it is necessary to determine the existing patterns of sand movement within the shoreline region of interest. In general the beach is a dynamic sediment environment as the sand grains are continually put in motion by wave and current forces. The littoral material moves as an aggregate in two basic directional patterns: parallel to the shoreline or alongshore and normal to the beach or cross shore. Over time, and depending upon the characteristics of the wave environments, sand will exhibit a net transport behavior with respect to both components. Usually, the sediment will exhibit a net alongshore transport directional preference. Depending upon the frequency and severity of coastal storms and the characteristics of the offshore profile, the sediment may also exhibit a net directional cross shore rate of transport.

Understanding the volumetric and directional patterns of sediment movement within a shoreline section and the interrelationships between adjoining beach segments is necessary in identifying relevant processes, estimating erosion or accretion areas for design treatment, and singling out significant processes that might need special attention. This knowledge is gained best from preparation of a sediment budget.

A sediment budget is a sand transport volume balance which attempts to quantify the movement, erosion, and deposition of material within a section of coastline (U.S. Army, 1984). The analysis is simply a tabulation of sediment sources, losses, and movement within a section of shoreline. The results are then used to assess shoreline effects on the basis that changes in beach width are the direct result of variation in the balance of sand sources, losses, or movement. The budget attempts to balance sand gains against losses and thus allows for projections of future shoreline conditions to be made based upon the net results.

Sources of sediment which can add to the budget include rivers and streams, cliff and shore erosion, net onshore sediment transport, and artificial nourishment by man. Sinks or subtractions of sand from a control volume can include backshore storage by sand dunes, offshore losses, submarine canyon interception, wind blown losses, capture by harbors or other coastal structures, and mechanical removal by man through dredging and mining.

Because of the complexity of the process and the number of physical variables involved, a sediment budget is more accurate where known boundary conditions or measurements of sand flux are available. Within the BEACON study area, the historical dredging records from the existing harbor facilities provide such a measure.

A comprehensive review and analysis of the sediment budget from Ellwood to Point Mugu was prepared as part of this study in order to provide the basic technical foundation for recommending sand management strategy. Appendix A provides a more detailed discussion of the methodology and findings of the budget analysis. The salient points from the analysis are summarized below.

3.1 Methodology for Establishing a Budget

Preparation of a sediment budget followed the general procedural steps listed below:

1. Establish littoral cell and subcell boundaries within the study shoreline;

2. Quantify the alongshore transport boundary conditions where known from historical harbor dredging records;

3. Estimate the relevant sand source and sink quantities within the subcells;

4. Estimate the shoreline erosion rates in terms of net sand gain or loss;

5. Synthesize Items 2, 3 and 4 to conclude the estimated sand transport rates alongshore.

Each item is expanded in the following sections.

3.1.1 Littoral Cell Boundaries

The first step in preparing a sediment budget is to determine the extent of the shoreline that should be studied. This is achieved by determining the appropriate littoral cell boundaries. The concept of a littoral cell was introduced by Inman in 1960 as an independent coastal segment that does not communicate sand between its end points. Consequently, the cell may be analyzed for its sand transport processes and evaluated on future behavior with reasonable confidence that changes within the cell will not impact adjoining units.

The primary study area lies within the Santa Barbara Littoral Cell. This physical unit extends from Point Conception to the Mugu Submarine Canyon as shown in Figure 3-1. It is one of the longest littoral cells in Southern California and includes a variety of coastal types and shoreline orientations as previously discussed. The principal feature of this cell is its predominant net alongshore transport direction. The wave shelter provided by the offshore channel islands results in an almost unilateral movement of sand along the beaches from west to east. Due to the shift in shoreline orientation to a more north-south direction along the Ventura/Oxnard reach and the window of wave exposure to southern hemisphere swell, more upcoast reversal occurs in this area. However, because of the dominant westerly wave energy, the reversed transport volume is estimated to be only a small fraction of the annual total volume.

The Santa Barbara Littoral Cell may be further divided into smaller subcells on the basis of shoreline characteristics and the location of prominent sediment sources and sinks. The reaches that were adopted are listed below and shown in Figure 3-2.

1. Ellwood to Santa Barbara Harbor
2. Santa Barbara Harbor to Carpinteria
3. Carpinteria to Ventura River
4. Ventura River to Ventura Harbor
5. Ventura Harbor to Channel Islands Harbor
6. Channel Islands Harbor to Port Hueneme
7. Port Hueneme to Mugu Submarine Canyon

Subcells 1, 4, 5 and 6 are bounded on the downcoast end by man-made harbor facilities that intercept most, if not all, of the littoral transport. Therefore the respective harbor dredging records provide the best estimate of alongshore transport at those locations. Subcells 2 and 3 were specified on the basis of the differing coastal features, and Subcell 7 is terminated by the aforementioned submarine canyon end point.

3.1.2 Alongshore Transport Boundary Conditions

Alongshore transport is related in part to the magnitude of breaker height which impinges on the shoreline and the angle at which it attacks. In general, wave energy along the shoreline increases as one progresses from Santa Barbara to Ventura. From about Oxnard eastward, energy begins to decrease as the sheltering effects of the Channel Islands becomes dominant. The prevailing westerly waves which propagate down the Santa Barbara Channel generate a strong directional preference for west to east transport over the entire region. However, east of Ventura the beaches are more exposed to southern hemisphere and locally generated storm swell, which creates upcoast reversals in the

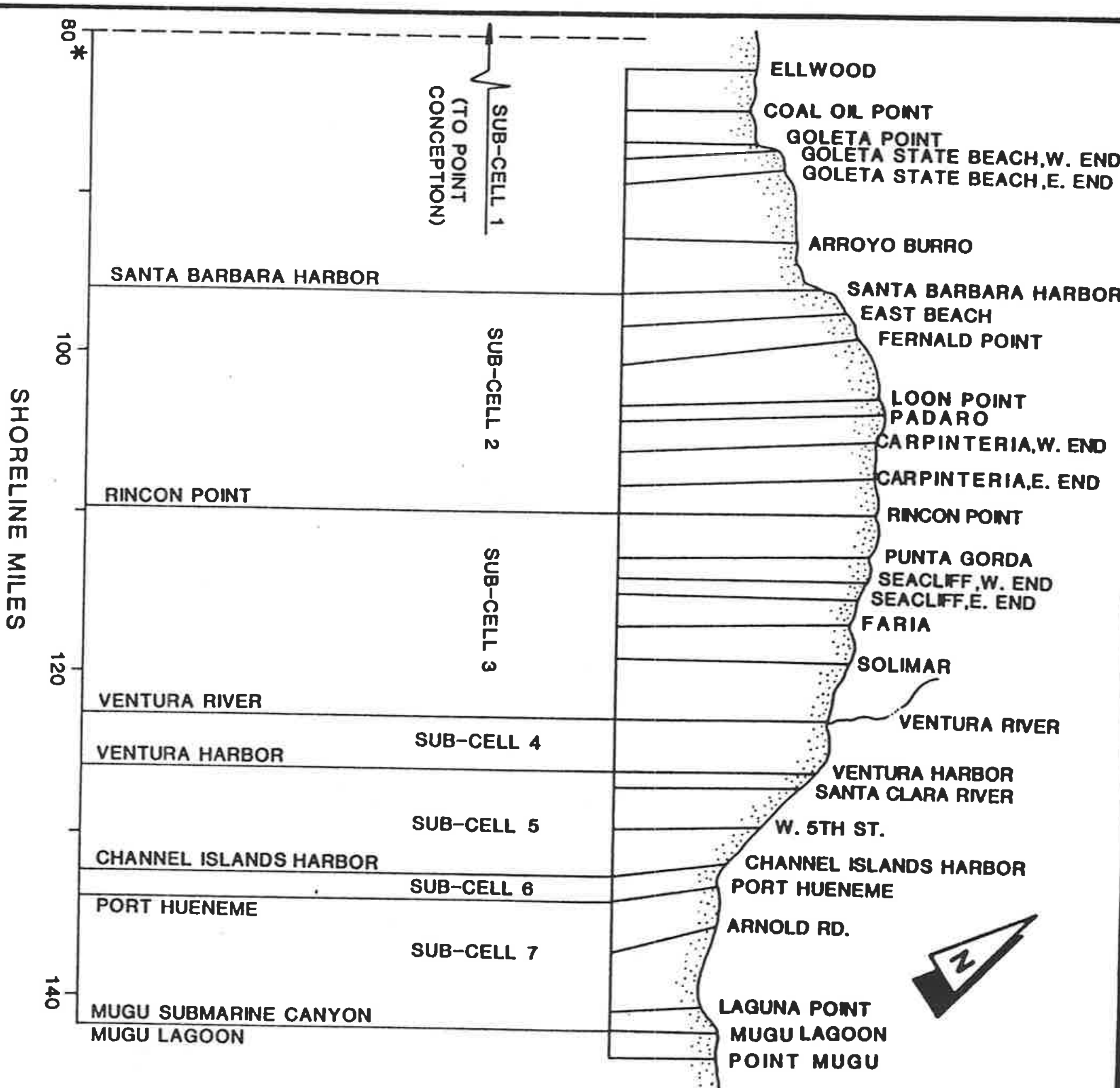
SANTA BARBARA LITTORAL CELL

REFERENCE: U.S. ARMY, 1986

NOBLE CONSULTANTS

Figure 3-1

BEACON LITTORAL SUB-CELLS



*0 = SANTA BARBARA/SAN LUIS OBISPO COUNTY LINE

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spring and fall months. On occasion, beaches west of Ventura will also experience short-term transport reversals caused by pre-frontal storms which generate southeasterly local seas in the channel.

A measure of the variation in the alongshore transport rate may be determined from harbor dredging records. The amount of sediment captured by a harbor can provide a good estimate of the alongshore transport at that location. Moreover, the data may be used in part to estimated the alongshore transport rate elsewhere along the shoreline.

The maintenance dredging records of Santa Barbara, Ventura, and Channel Islands harbors are summarized in Table 3-1. Santa Barbara Harbor has been well documented for its shoaling characteristics. Ventura Harbor was converted to a sand trap in 1970 when its offshore detached breakwater was completed. Channel Islands Harbor was originally constructed as a littoral sand trap in 1960. A review of the dredging records indicates that the three harbors have been dredged in recent times an annual average of 350,000, 640,000, and 1,190,000 cubic yards, respectively. This data was used to calibrate alongshore transport estimates over the study area.

3.1.3 Sand Sources and Sinks

The possible sources and sinks in the BEACON study area have been listed by Bowen and Inman (1966) for littoral sediment. They include:

1. Cliff erosion;
2. Wind transport;
3. River, stream and creek supply;
4. Loss in submarine canyon;
5. Dredging and harbor entrapment;
6. Onshore-offshore transport.

Each of these elements were evaluated as appropriate to formulate an updated estimate of the sediment budget. Cliff erosion and wind transport contributions were evaluated from existing literature summaries. Because of the significance of fluvial sediment sources within the BEACON area, this subject received particular attention.

Estimates of fluvial sediment delivery to the shoreline were made to ascertain the amount of sand delivered to the shoreline. The Ventura and Santa Clara Rivers are the major drainage basins between Ventura and Mugu Canyon. Together they are responsible for all of the fluvial sand delivery along this section of the shoreline. West of Ventura, the Santa Ynez mountain watershed contains numerous small streams and creeks which periodically deliver sediment to the Santa Barbara region.

Table 3-1

Harbor Maintenance Dredging History

Year	Santa Barbara Harbor (1)	Ventura Harbor (2)	Channel Islands Harbor (3)
1933	606,400		
1935	202,000		
1938	584,700		
1940	697,700		
1942	600,100		
1945	717,800		
1947	634,000		
1949	838,200		
1952	1,174,000		
1959	85,100		
1960	522,300		5,335,450[1]
1961	321,200		
1962	269,100		
1963	462,900		2,000,000
1964	396,700	191,000	
1965	311,200	180,000	3,526,668
1966	371,700	143,000	
1967	344,600	239,000	
1968	347,400	257,000	1,620,000
1969	339,600	1,883,000[2]	2,824,133
1970	341,400	245,000	
1971	446,000	1,113,000[1]	2,407,000
1972	400,100	17,000	
1973	365,000	1,301,000	2,500,000
1974	383,300	530,000	
1975	46,600	160,000	1,809,523
1976	395,500		
1977	465,800	911,000	2,370,000
1978	618,400	496,000	
1979	214,800	1,022,000	2,500,000
1980	525,500		
1981	190,000	1,139,000	1,522,699
1982	367,800		
1983	340,000	1,427,000	1,729,000
1984	359,700	1,332,900	
1985	70,000		1,850,000
1986	297,000	910,000	
1987	223,800	363,000	1,993,955

1 = Construction
2 = 1969 Flood Damage
Reference: 3 U.S. Army, 1987
1 ---------, 1988
2 ---------, 1989

Sediment delivery within the study region was computed in two ways. First, the watersheds were analyzed for contribution using an empirical method developed by Flaxman (1973). In general the method evaluates the watershed characteristics such as slope, vegetation cover, and grain size to estimate a sediment yield for the basin. Precipitation and temperature averages are also considered.

Because of the size of the Santa Clara River basin and its historical contribution, an estimate of its sediment delivery was further refined. Using a numerical model developed by Chang (1984), specific flood hydrographs were used in conjunction with measured river cross sections to estimate the sediment delivery to the beach. This method was used to account for any degradation to the river channel due to recent sand mining activity.

The results of the analysis yielded annualized sand delivery volumes to the shoreline from the Santa Ynez Mountain Group watershed and the Ventura and Santa Clara River basins. These volumes were also compared against estimates of historical sediment yield as referenced from the literature to compare the estimate to possible impacts of decreased sediment supply that may have occurred over time due to man's practice.

3.1.4 Shoreline Erosion Rates

Historical changes along the shoreline were evaluated by analysis of beach profiles. Data has been collected by the Corps of Engineers east of Santa Barbara since 1937. The Santa Barbara shoreline was surveyed only twice in 1937 and 1959 (U.S. Army, 1960) while the shoreline east of Ventura has been surveyed more frequently (U.S. Army, 1960, 1969, 1970, 1979). This data was compared to the 1987 BEACON profiles to review net volumetric changes. The BEACON database was referenced to the older Corps baselines using original survey notes and other maps.

The change in sand volume between successive beach profile surveys was computed for the shoreline east of Santa Barbara Harbor where the historical data was available. In comparing the results to the BEACON 1987 profile data, it was assumed that the BEACON transects, spaced at about 2-1/2 mile intervals, were representative of bathymetry between adjacent areas. Thus, by multiplying the computed net beach profile volume change (in cubic yards/foot of beach length) times the distance between adjacent profile locations and dividing the total by the time between survey dates, a measure of annual sand gain or loss was obtained at each shoreline location.

3.1.5 Alongshore Transport Rates

The variation in alongshore transport rate between Santa Barbara Harbor and Mugu Lagoon was estimated using the methodology illustrated in Figure 3-3. The methodology consists of the following steps:

1. Santa Barbara Harbor average dredging data since 1959 was used as the western boundary condition to define the initial littoral transport rate.

2. Progressing eastward from Santa Barbara harbor, additions or subtractions to the assumed initial littoral transport rate were accrued based upon the respective net annual loss or gain in sand volume, as computed from historical beach profile comparisons.

3. Additions to the alongshore rate were made for fluvial delivery or other sand sources or sinks.

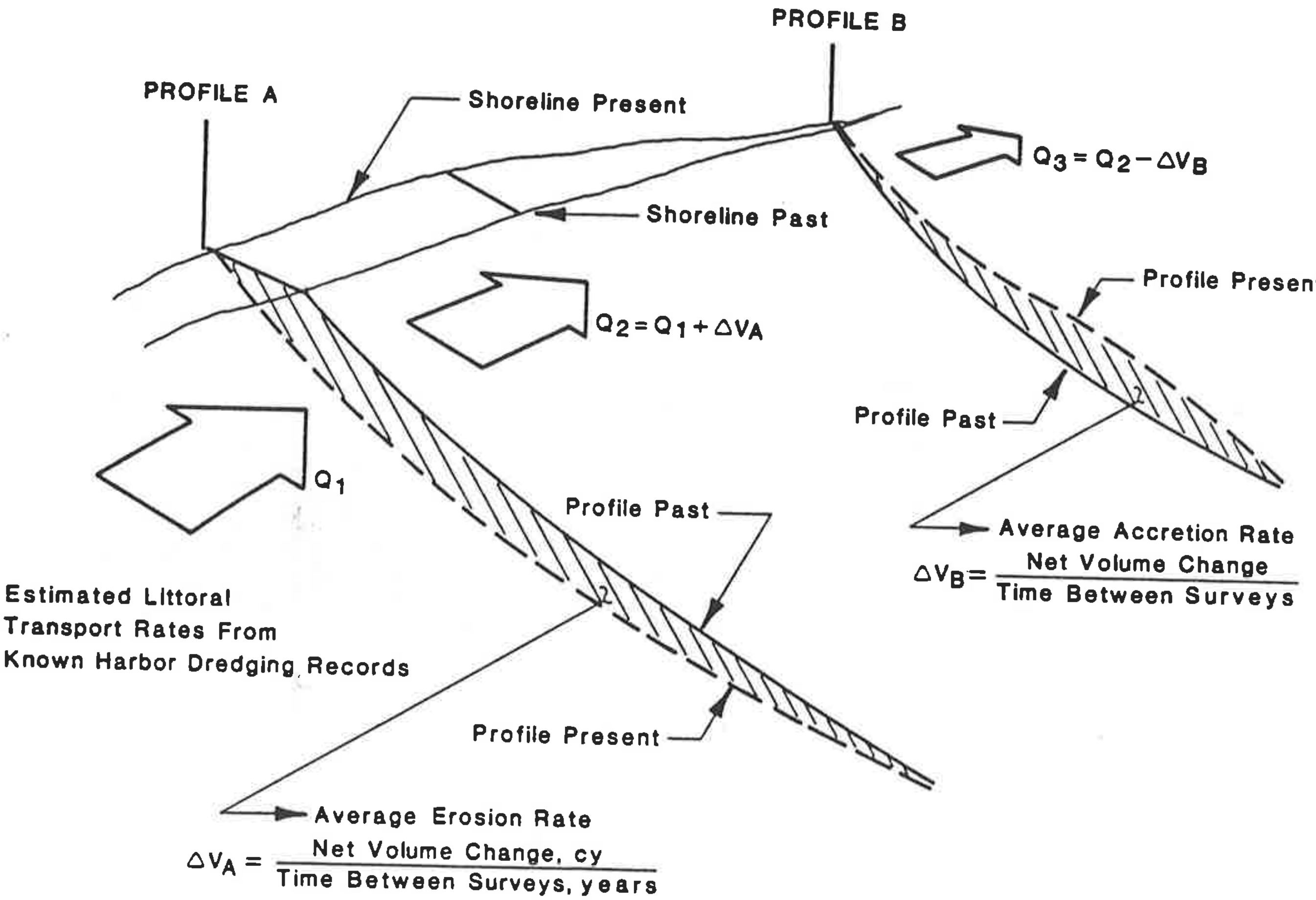
The resultant alongshore transport estimates were then compared to Ventura Harbor and Channel Islands Harbor dredging data to calibrate the analysis at those points. The results of the sediment budget analysis are discussed in the next section.

3.2 Sediment Budget Results

Figure 3-4 presents the estimated spatial variation of alongshore transport rate for the BEACON study region. The figure is composed of a bar graph indicating calculated littoral transport rates at BEACON profile locations east of Ellwood. The figure also shows a suggested linear interpretation superimposed to smooth the data where the individual volume estimates were made. The graph is referenced to the profile numbering sequence adopted for the 1987 BEACON beach profile survey. The reader is referred to Appendix D for a complete description of the individual transect locations. The rationale for the genesis of this figure is discussed in the following sections on a subcell by subcell basis.

3.2.1 Ellwood to Santa Barbara Harbor (Subcell 1)

Pollard (1979) conducted a lengthy study of the shoreline processes west of Santa Barbara Harbor. Using a comparative grain size analysis of native beach sands along the shoreline, he concluded that little or no sediment reaches the southern Santa Barbara coastline from beaches above Point Conception.



PROCEDURE USED TO ESTIMATE LITTORAL TRANSPORT RATE VARIABILITY

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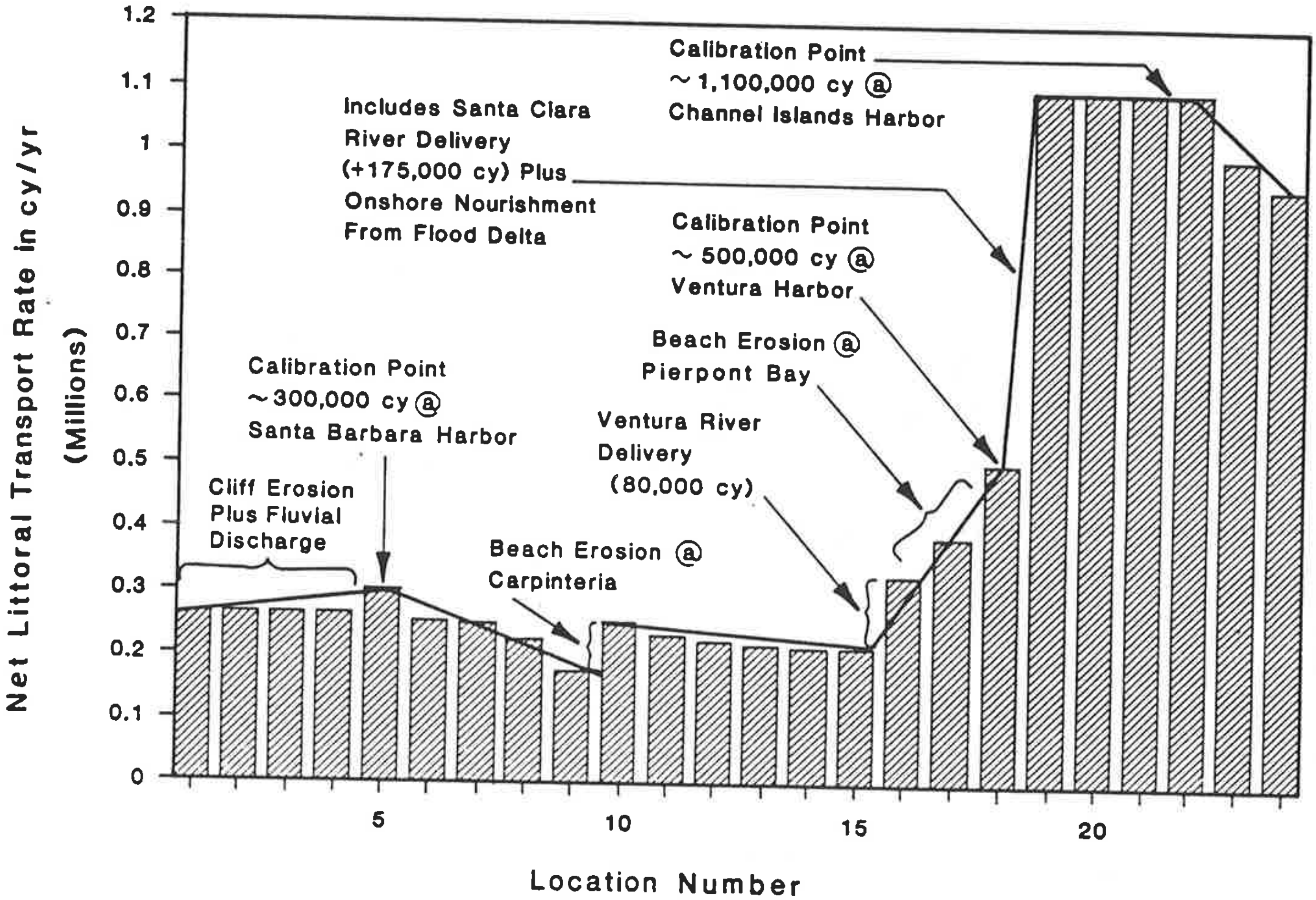
Figure 3-3



LOCATION REFERENCE

1 Ellwood
2 Isla Vista
3 Arroyo Burro
4 Leadbetter Beach
5 East Beach
6 Biltmore
7 Miramar
8 Summerland
9 Padaro Lane
10 Carpinteria
11 La Conchita
12 Hobson
13 Faria
14 Solimar
15 Emma Wood
16 Surfer's Point
17 San Buenaventura State Beach
18 Marina Park
19 McGrath State Beach
20 Oxnard Shores
21 Hollywood Beach
22 Silver Strand
23 Hueneme Beach
24 Ormond Beach

ESTIMATED LITTOROL TRANSPORT RATE OVER STUDY SHORELINE

NOBLE CONSULTANTS

Figure 3-4

Therefore, the principal sources of sediment east of that promontory are limited to cliff erosion, local stream discharge and beach erosion.

No historical beach profiles exist west of Santa Barbara Harbor which enables one to estimate the beach gains or losses. However, a qualitative review of historical photography contained in Appendix G suggests that little variation has occurred possibly due to the ephemeral nature of the beaches themselves. Assuming this to be the case, only cliff erosion and fluvial discharge remain as the principal budget items along this segment.

From Point Conception to Goleta Point, Pollard (1979) estimated that cliff erosion provides a yearly sediment source of about 73,000 cubic yards. If one assumes a uniform bluff retreat of 0.5 to 1 foot per year, an average cliff height of 40 feet above the toe, and 60 percent sand composition, about 21 to 42 percent of the 37-mile-long shoreline segment is estimated to contribute sand each year. Considering the episodic nature of the process as deduced from newspaper files, this estimate appears reasonable. Alternatively, a unit source volume rate may be developed by dividing Pollard's estimated quantity of 73,000 cubic yards by the number of shoreline miles applicable (about 73). This implies that about 2,000 cubic yards of sand per mile of beach may emanate bluff erosion. Using these assumptions, another 10,000 to 15,000 cubic yards of sand per year is estimated to emanate from the cliffs between Goleta Point and Santa Barbara Harbor. Sediment yield along the southern Santa Ynez Mountain group has been estimated to supply about 180,000 cubic yards per year (see Appendix C). These two sources total about 270,000 cubic yards per year.

Historical dredging records from Santa Barbara Harbor indicate that the approximate annual mean sediment transport was 295,000 cubic yards between 1933 and 1987. However, the average annual dredging after 1959 was 350,000 cubic yards. Assuming an amount of 50,000 cubic yards as representative of the yearly reverse transport (Bailard and Jenkins, 1982), the net downdrift transport at Santa Barbara Harbor is concluded to be about 300,000 cubic yards per year. This value is consistent with the above estimated source volume and is considered to be a reasonably accurate value of littoral drift at the location. Therefore, this rate was used as the initial boundary condition for interpolating changes downcoast.

3.2.2 Santa Barbara Harbor to Carpinteria (Subcell 2)

Based upon a comparison of beach profiles surveyed in 1959 and 1987, the shoreline segment from East Beach (Station 5) to Padaro Lane (Station 9) has experienced a net gain of about

125,000 cubic yards per year. Most of this material has accumulated over the submerged portions of the profile. The nearshore sand gain may reflect effects of the beach profiles readjusting to the increased harbor bypassing that has occurred since 1960. This accretion also implies a zone of decreased littoral transport if the net accretion accurately reflects the recent profile behavior. The shoreline from Santa Barbara Harbor to Padaro Lane is sheltered from westerly waves to a degree by the Isla Vista headland and the projection of Santa Barbara Point. A decrease in available alongshore wave energy flux may explain in part the above contention of reduced littoral rate within this wave shadow as deduced from the net beach profile change.

Within the City of Carpinteria area (Station 10), an average net sand loss of 12 cubic yards per year was calculated over the same time period. This is equivalent to a yearly loss of about 75,000 cubic yards at this beach.

If the above beach gain and loss represents a respective subtraction and increase to the littoral transport, a rate of 250,000 cubic yards per year is obtained at Carpinteria. This figure agrees reasonably well with more rigorous calculations performed by Bailard and Jenkins (1982). The preferential loss of sand observed at Carpinteria may be due in part to the effects of coastal storms which eroded the Sand Point protective headland during the 1930's and 1940's. As a consequence, the wave exposure to the area changed and the equilibrium planform of Carpinteria's beach is attempting to conform by rotating clockwise to orient normal to the altered wave climate.

Several small streams discharge along this shore segment, but their specific contributions are not well understood. Based upon a review of debris basin records compiled by Santa Barbara County, it is estimated that the streams historically delivered a small percentage of sand to this shore segment. However, the debris basins are presently intercepting most if not all of this sediment. In addition, about 4 miles of shoreline is cliffed within this subcell. Assuming bluff erosion volume rates of 2,000 cubic yards per year are representative of natural conditions, about 8,000 cubic yards per year may be emanating from bluff erosion. However, this contribution has been gradually reduced by placement of seawalls and revetments to protect railroad right-of-way and private property.

3.2.3 Carpinteria to the Ventura River (Subcell 3)

Between Carpinteria and the Ventura River, a net offshore accumulation of sand is implied by the profile data. The transport rate at Emma Wood County Beach was estimated by subtracting another 35,000 cubic yards per year over the Rincon

Parkway segment to yield an annual rate of about 215,000 cubic yards at that location.

This segment is almost entirely fortified with seawalls and revetments. It is believed that the small streams which discharge along this segment deliver a small volume of sand in response to rainfall intensity. The paucity of historical beach profile data over this section limits the ability to document shoreline changes. However, historical photography and records show that roadway encroachments have been significant along this stretch. Highway construction has encroached over the active zone of littoral transport temporarily reducing downcoast delivery volumes. As a result, the beaches have had to readjust and erosion conditions have and are likely to continue to be problematic. Based upon limited data collected after the last major highway construction near Seacliff (Cramer and Pauly, 1979) it is believed that the immediate offshore areas are still readjusting to the manmade alterations.

3.2.4 Ventura River to Ventura Harbor (Subcell 4)

Sand delivery from the Ventura River and losses from Pierpont Bay beaches have been identified as the main sources of sediment within this subcell. It is estimated that the Ventura River delivers on the average about 80,000 cubic yards of sand per year to the shoreline. As discussed in Appendix C, this total represents about 70 percent of its former natural yield. Therefore, a deficit of at least 35,000 cubic yards per year may be attributed to dam construction and sand mining.

Since 1970, the beaches themselves have eroded at a rate equal to about 210,000 cubic yards per year based on beach profile comparisons. Adding this value to the Ventura River delivery rate implies that the alongshore transport rate within Pierpont Bay is increased from that near Emma Wood beach by about 290,000 cubic yards per year for a total of about 505,000 cubic yards per year.

In the present analysis, it was assumed that all of the alongshore transport is captured by the Ventura Harbor sand trap and entrance channel. As previously discussed, the annual dredging volume at the harbor has averaged about 640,000 cubic yards per year. It is further assumed, as discussed in Appendix A, that this volume includes about 100,000 cubic yards per year which emanates from beaches south of the harbor. This implies a transport rate from upcoast beaches of 540,000 cubic yards per year which agrees reasonable well with the previously referenced rate of 505,000 cubic yards per year. The discrepancy may possibly be explained by the anomalous erosion at Marina Park Beach which has occurred at a rate of about 40,000 cubic yards per year since the 1970's (Noble Consultants, 1988).

3.2.5 Ventura Harbor to Channel Islands Harbor (Subcell 5)

This subcell is influenced by two harbors as the periodic sand bypassing conducted annually at Ventura Harbor and bi-annually at Channel Islands Harbor defines the littoral boundary conditions of the subcell. The Santa Clara River is the dominant sand source within this segment.

Numerical modeling analysis performed as part of this study (see Appendix C) has estimated that the river delivers about 175,000 cubic yards of sand per year to the shoreline. However, when compared to pre-dam and pre-sand mining conditions, this total represents only about one-fourth of the river's former natural delivery rate. Therefore, the subcell is exposed to a potential shortfall of significant magnitude.

It appears that historical flood discharges have helped to nourish the beaches within the subcell. The most recent flood of 1969 deposited about 13,000,000 cubic yards of sand in an offshore delta at the river mouth. It is believed that this event, together with subsequent discharges of lesser magnitude, are responsible for the relatively stable shoreline which has existed between the river mouth and Channel Islands Harbor since 1969. However, calculations summarized in Appendix A suggest that this situation may soon change.

Volumetric shoreline changes between the Santa Clara River and Channel Islands Harbor (Station 19 to Station 21) were computed between 1948 and 1966, 1966 to 1970, and 1970 to 1987. The results indicate that a yearly net loss of approximately 390,000 cubic yards was experienced between 1948 and 1966. However, an annual average net gain of sand of about 1,000,000 cubic yards was experienced between 1966 and 1970. From 1970 to 1987, the average net gain reduced to about 72,000 cubic yards per year. These later periods include the effects of the record flood of 1969. The 1966 to 1970 period was assumed to represent primarily the pre- and post-flood effects of the 1969 flood. The sequence between 1970 and 1987 essentially documents the influence of nourishment from the offshore delta stockpile which accrued as a result of the storm.

The time period from 1948 to 1966 may be interpreted as a pre-harbor sequence representative of natural conditions. The volumetric difference over this period implies that a net natural erosion rate of about 390,000 cubic yards per year occurred between the Santa Clara River mouth and the present day location of Channel Islands Harbor. It is believed that since 1969 this background erosion has been obscured by small episodic deliveries of sand from the Santa Clara River and, to a greater extent, by constant renourishment from the 1969 flood delta deposit. So long as sufficient sand is available from the delta, beaches downcoast will be stable or accrete. However, should sediment supply diminish, the onset of erosion is expected. Analysis at this time indicates that the cumulative effects of the dam construction and sand mining have caused a serious depletion to the area's sediment budget. If this shortfall is not corrected, it is expected that severe beach erosion within the subcell will begin in the mid 1990's.

Sediment losses due to wind borne transport were considered over this segment. As discussed in Appendix A, a minor loss of about 10,000 cubic yards per year is estimated.

3.2.6 Channel Islands Harbor to Port Hueneme (Subcell 6)

Silver Strand Beach, located between Channel Islands Harbor and Port Hueneme, has been relatively stable over the past 50 years. The shoreline forms an equilibrium plan shape, which in theory results in zero net longshore transport rate. However, it is more likely that the beach loses sand to both harbors by natural wave induced transport. The isolation of the subcell from natural renourishment means it is dependent on periodic sand bypassing for maintenance of the beach. Between 1973 and 1987, about 904,000 cubic yards of sand dredged from the Channel Islands Harbor maintenance has been bypassed to the Silver Strand area. This translates to an annual renourishment rate of about 65,000 cubic yards.

3.2.7 Port Hueneme to Point Mugu (Subcell 7)

East of Ormond Beach, Bailard (1985) reported that about 900,000 cubic yards per year is transported downcoast from Port Hueneme to Mugu Canyon. This results in beach erosion at the Naval base. Since approximately 1,190,000 cubic yards per year is bypassed to the Port Hueneme area, it appears that an excess volume of sediment is deposited on Hueneme Beach. This can be validated by the fact that the beach profile immediately downcoast of Port Hueneme (Station 23) shows a net gain of sand between 1970 and 1987 of about 37 cubic yards per foot of beach per year, while Ormond Beach (Station 24) showed a net accretion of about 13 cubic yards per foot per year.

Another measure of the littoral transport rate was estimated by review of historical Corps of Engineers beach profiles between 1938 and 1959. This time sequence includes the post Port Hueneme construction period before beach restoration and sand bypassing was implemented. After consideration of sand bypassing performed between 1953 and 1954, the downcoast beaches eroded between 1948 and 1959 at a rate of about 1.1 million cubic yards per year.

Therefore, it appears that the Channel Islands Harbor bypass program is in agreement with the downcoast beach requirement and amplifies the need for continuation of the current Federal sand bypass program at Channel Islands Harbor.

The pattern of accretion at Hueneme Beach and Ormond Beach and the preferential erosion at Mugu Beach is not immediately clear. It is possible that seasonal reversals in transport may play a part as material is impounded against the Port Hueneme south breakwater. However, the structure is considered too short to block all material from loss to the Hueneme submarine canyon and a portion of bypassed material may be carried back upcoast to the canyon sink. Alternatively, the downcoast erosion may be the result of the upcoast end readjusting from the aftermath of the severe beach erosion which occurred over the subcell between 1940 and 1960. Within the U.S. Navy property, a shortfall of approximately 240,000 cubic yards per year is evident from an annual shoreline recession rate of 7 feet (Bailard, 1985). Rapid erosion was observed upcoast from Laguna Point during the time of Port Hueneme sand interruption. After 1965, erosion has continued downcoast from the runway within the Pacific Missile Test Center.

3.2.8 Summary

Figure 3-5 presents a schematic summary of the estimated sediment budget from Ellwood to Mugu Canyon. The figure represents the littoral transport rate over the shoreline and highlights deficit regions and sources as discussed in the preceding sections.

The results of the sediment budget analysis may be summarized by the following points:

1. In general, the shoreline within the Santa Barbara Littoral Cell has been relatively stable.

2. Bluff erosion is an important source to the budget over the western half of the cell.

3. Localized areas of shoreline erosion were noted at Carpinteria, Pierpont Bay, and Mugu Beach.

4. The Ventura and Santa Clara Rivers have been severely altered by dam construction and sand mining activity. As a consequence, the significant reduction in sand supply to the shoreline will soon result in the onset of serious erosion problems within the Oxnard Plain shoreline.

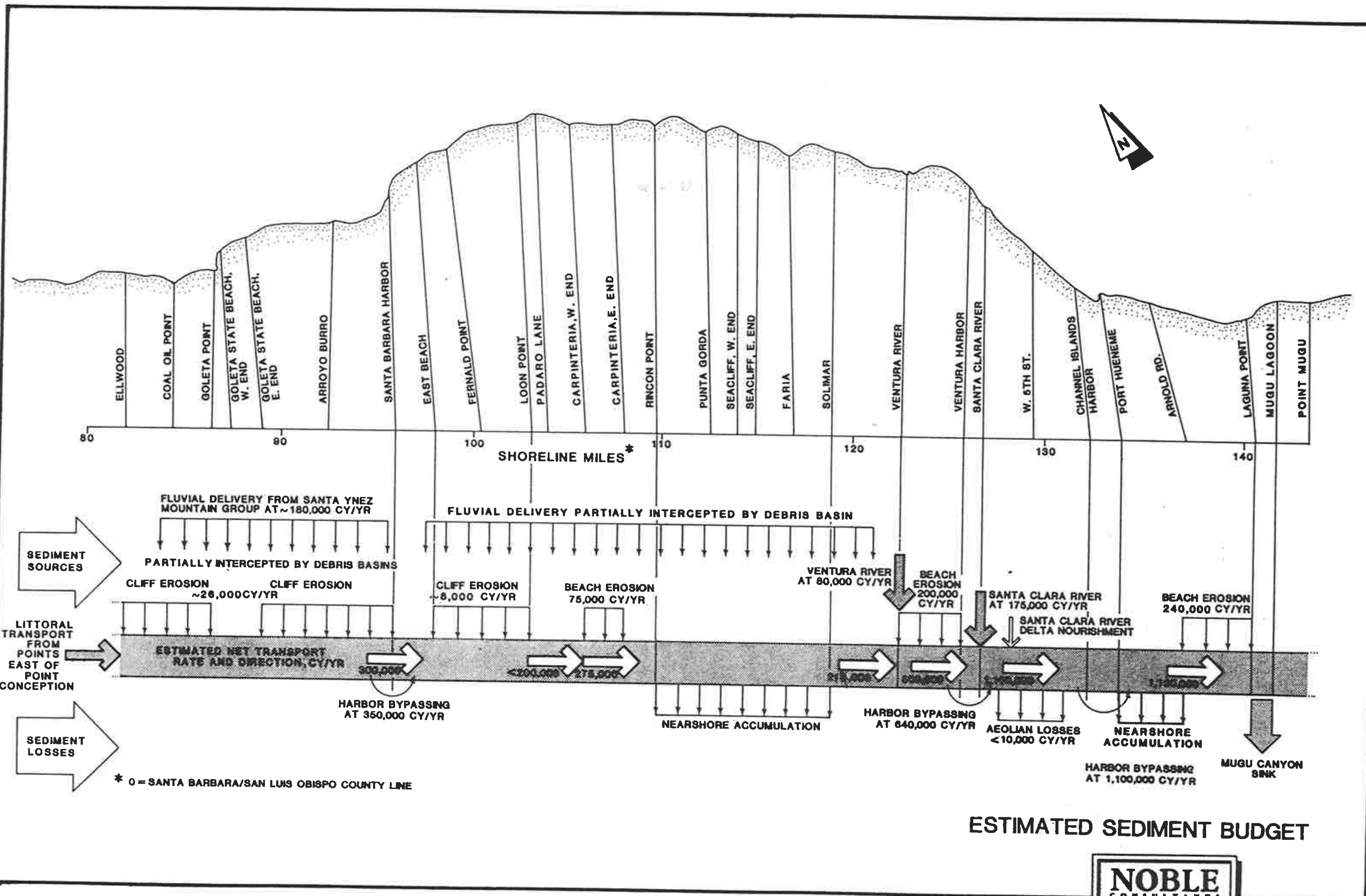


Figure 3-5

Figure 3-5

5. The highway encroachment which has occurred over the years along the Rincon Parkway has been detrimental to the narrow beaches which formerly existed there.

Attention to the last four items will be necessary if the stability of the cell is to be preserved as historically noted by Item 1. As a minimum, attention to the existing sediment budget deficiencies will be required. These deficit areas or erosion "hot spots" are summarized in the following paragraph.

First, Carpinteria is observed to show an anomalous erosion in comparison to neighboring shoreline segments. It is estimated that the deficit accrues at a rate of about 75,000 cubic yards per year. Secondly, the decreased sediment supply to the Oxnard Plain indicates a serious shortfall. It is estimated that about 200,000 cubic yards per year are eroded from Pierpont Bay beaches to make up a deficiency and another 450,000 cubic yards may be lacking from the shoreline east of the Santa Clara River mouth. The latter is a delayed deficit as the aforementioned renourishment from the river flood delta is nearly spent. Calculations summarized in Appendix A project that shoreline erosion arising from the budget debit will commence by the mid-1990's. Data analysis indicates that about 240,000 cubic yards per year may be required east of Ormond Beach to supply the natural littoral transport demand. (Bailard, 1985).

Addressing the sediment budget deficiencies and preservation of sand resources, forms the basis for formulating a comprehensive sand management plan. The next chapter introduces alternative strategies that may be considered to deal with the specific plan objectives.

4.0 - SAND MANAGEMENT STRATEGIES

This chapter presents general concepts of erosion management. A discussion of different strategies is provided together with a no action alternative. The chapter concludes with a recommended course of action for the comprehensive sand management plan that addresses the shoreline needs and fulfills the goals and objectives of BEACON. The plan was developed via the following formulation process:

1. Identify needs and objectives;
2. Consider alternative mitigation strategies;
3. Select an appropriate plan strategy;
4. Formulate the strategy's components;
5. Evaluate the technical, economic, and environmental criteria; and
6. Select the recommended plan.

Items 1, 2, and 3 are discussed in this chapter. The remaining steps are presented in Chapter 5.

4.1 Needs and Objectives

BEACON has declared long-term objectives calling for enhancement of beaches, reduction in storm damage losses, establishment of policy and programs that control beach erosion without the proliferation of shoreline fortification, and reduction of harbor shoaling. These goals are not necessarily compatible. For example, protection of property may be achieved through construction of seawalls and revetments to stop bluff erosion. However, cumulative fortification of the coastline will reduce the natural delivery of sand to the beach to the detriment of downcoast beaches. The challenge is thus to determine the optimum strategy which maximizes the satisfaction each objective and minimizes potential conflicts.

From the standpoint of the sediment budget, specific needs and objectives may be stated which address sand management along the coastline and ways to preserve or increase the littoral supply. The following issues were developed from this perspective:

1. Progressive loss of beach width;
2 Bluff erosion and its sand source contribution;
3. The decline of fluvial sand supply to the shoreline due to stream regulation and sand mining; and
4. Maintenance of harbor bypassing to preserve the littoral transport regime.

These issues may also be addressed within the larger BEACON context of overall beach enhancement and property protection. It is therefore assumed that the strategy which satisfies the sediment budget issues and maximizes the development considerations would best achieve BEACON's major goals and objectives.

In attempting to fulfill this study plan, it is appropriate to review the range of erosion management strategy that may be considered. This is discussed in the next section.

4.2 Alternative Strategies

A wide range of techniques have been implemented at various levels of government, and by individual and private shorefront property owners to combat coastal erosion processes. There are two basic approaches to shore protection. First, there are engineering methods (structural and non-structural), designed to reduce the erosion of shorefront property by controlling or mitigating the natural forces causing the erosion. Second, there are the non-engineering approaches which seek to reduce erosion losses through land management programs, or to lessen the direct social and economic costs and hardships incurred by shorefront property owners where erosion is occurring.

Sorensen and Mitchell (1975) have classified the alternative approaches to coastal erosion into four major categories. They are listed below along with the traditional no action strategy:

1. No action;
2. Control and protection works (engineering alternatives);
3. Land use management;
4. Warning systems; and
5. Public relief, rehabilitation, and insurance means.

These strategies are discussed below in more detail.

4.3 No Action Alternative

The no action strategy is readily recognized as a declaration to do nothing and let nature take its course. This policy is simply as stated. No mitigation of shore erosion or storm protection is adopted. The community accepts the natural course of events, and no attempt is made to control, maintain, or prepare for future scenarios. The strategy has been proposed by Pilkey and others (1985) who argue that no intervention by man is economically acceptable or technically feasible. Aside from actually taking no action to mitigate an erosion condition, the policy can be implemented through institutional measures to limit or control shoreline development, as discussed later in this chapter.

The indication of adopting this strategy was evaluated by forecasting the shoreline evolution from Ellwood to Mugu Canyon under the assumption that no sand management plan is implemented. The forecast was made under the following assumptions:

1. Non-fortified coastal bluffs would recede at a uniform rate of 0.5 to 1 foot per year;

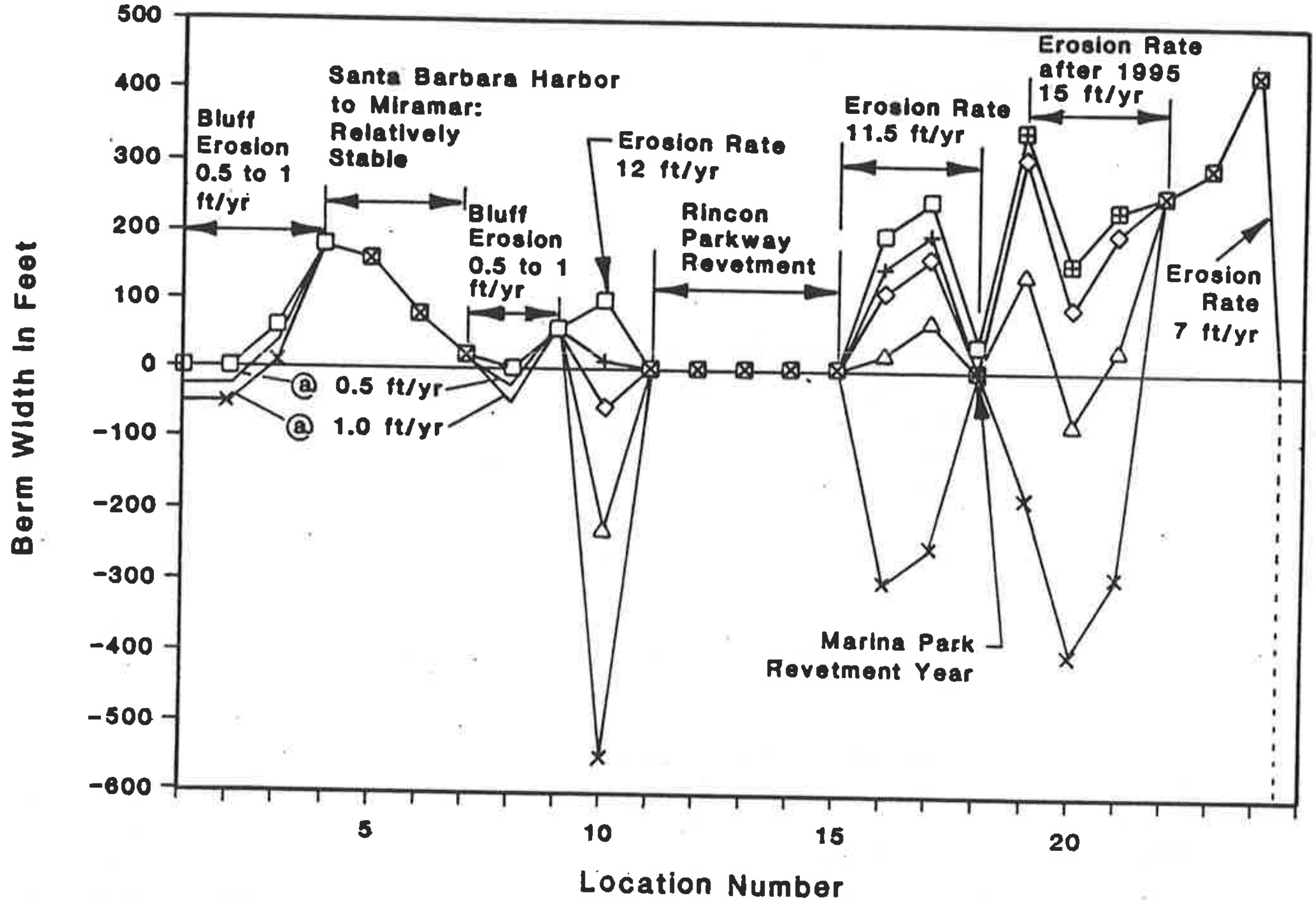
2. Shoreline segments with identified sand budget deficiencies would retreat at a rate equal to the volume debit per lineal foot of beach divided by the estimated depth of closure. (Depth of closure is the water depth at which alongshore and cross shore sand transport ceases to occur to be significant.);

3. Remaining coastal segments which are either fortified with revetments and seawalls and showing no discernible erosion would remain susceptible to winter storm damage in proportion to their beach width.

With the aid of these assumptions, the shoreline evolution diagram shown in Figure 4-1 was prepared. The figure shows the estimated position of the high tide line at various time intervals into the future up to 50 years from present day. Based upon this figure, the following shoreline condition scenarios are estimated for the study area. Predictions are provided for each of the seven littoral subcells previously enumerated.

Subcell 1 - From Ellwood to Santa Barbara Harbor, the beaches shall remain ephemeral and narrow as they presently exist. Bluff erosion is estimated to continue episodically in response to winter storm exposure. For planning purposes it is assumed that the bluff retreat may be annualized to an approximate landward rate of 0.5 to 1 foot per year. From Santa Barbara Harbor to Carpinteria, beaches shall remain at their relative narrow berm widths. Winter conditions will continue to expose back beach property to periodic damage in proportion to storm intensity. High bluff areas shall erode at an irregular rate due to the same storm fatigue.

Subcell 2 - West Beach shall remain healthy and abundant while East Beach is estimated to be relatively constant in condition due to its close proximity to the harbor bypassing discharge point. As storm damage continues and bluff erosion propagates, the demand for individual structural defenses shall increase.



SHORELINE YEAR

- □ 1988
- + 1995
- ◇ 2000
- △ 2013
- × 2038

LOCATION REFERENCE

1 Ellwood
2 Isla Vista
3 Arroyo Burro
4 Leadbetter Beach
5 East Beach
6 Biltmore
7 Miramar
8 Summerland
9 Padaro Lane
10 Carpinteria
11 La Conchita
12 Hobson
13 Faria
14 Solimar
15 Emma Wood
16 Surfer's Point
17 San Buenaventura State Beach
18 Marina Park
19 McGrath State Beach
20 Oxnard Shores
21 Hollywood Beach
22 Silver Strand
23 Hueneme Beach
24 Ormond Beach
24.5 Mugu Lagoon

ESTIMATED SHORELINE EVOLUTION FOR NO ACTION STRATEGY

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Figure 4-1

Carpinteria will continue to erode at an anomalous rate. The central and northern portions of the stretch shall experience the most losses as the shoreline rotates landward to strive for a more stable beach orientation with respect to the wave climate (similar in planform to the shore segments along the Rincon Parkway). Public and private property will require erosion protection structures to avoid monetary losses to capital investments.

Subcell 3 - East of Carpinteria, the Rincon Parkway is estimated to remain much as it looks today. Beaches will be narrow or nonexistent. Periodic maintenance of the extensive seawalls and revetments will be necessary to preserve their integrity. It is likely that the nearshore profile may lower in some areas if sediment deficiencies appear along this segment. This implies increased storm damage resulting from larger wave heights breaking closer to shore.

Subcells 4-7 - East of the Ventura River the situation may be more ominous. The reduced fluvial supply to the reach is likely to manifest itself in the form of continued beach erosion. The Pierpont Bay area is receiving benefit from the existing groin field, however, net erosion is expected to continue in response to the sediment budget imbalance.

East of the Santa Clara River the erosion could be much greater as the diminished sand delivery from that tributary may produce rapid beach losses as early as the 1990's. Beaches east of Port Hueneme will initially be less affected, but over time, the volume of sand bypassed at Channel Islands Harbor will likely decrease due to an upcoast sediment imbalance. Consequently it is anticipated that erosion problems would continue to propagate past Ormond Beach and aggravate the condition at the Point Mugu Naval Base.

It is clear from the above discussion that the no action policy carries with it a continued demand for shoreline fortification. Often this strategy is employed as a least cost expedient to protect structures threatened with impending coastal storm damage. This strategy is essentially in effect along the Rincon Parkway and portions of shoreline elsewhere within the study area.

Under the no-action alternative, bluff erosion from Ellwood to the Santa Barbara Harbor, will continue at an irregular and episodic rate. Toe protection structures can be expected to be effective in mitigating the component of erosion caused by direct wave impingement. However, the amount of bluff loss due to upland irrigation stress is unknown. Studies in the Oceanside littoral cell have documented the erosion which can be attributed to this phenomenon (Kuhn and Shephard, 1980).

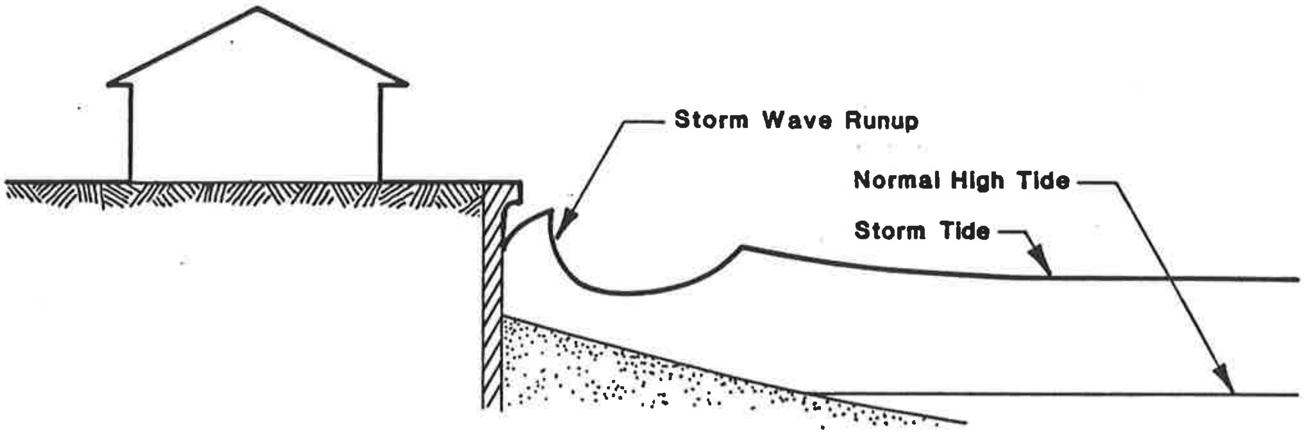
Should erosion continue in the Ventura and Oxnard region as expected, seawalls and revetments will be necessary to protect private property and public road areas. Construction costs for structural protection ranges from $500 to $1,500 per lineal foot. To this capital cost must be added a recurring annual operation and maintenance cost of about 1 to 4 percent of the initial capital expenditure to provide for periodic repair and preservation. Over time, the total estimated cost for future shore protection structures could range as high as $70 million under the no-action alterative.

4.4 Engineering Techniques for Shore Protection

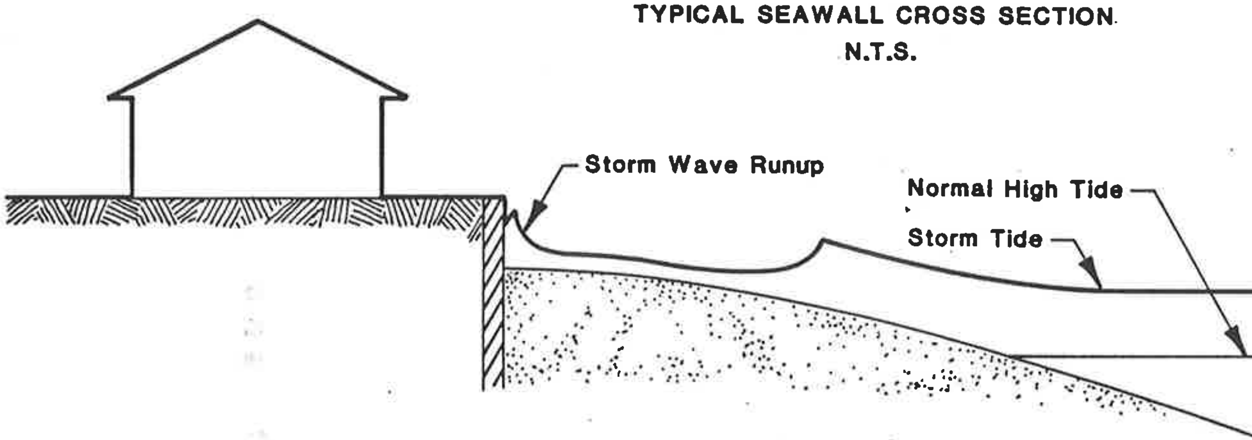
This section discusses engineering techniques for shore protection. These techniques are classified into two major categories - structural methods including breakwaters, seawalls, revetments, groins, and bulkheads; and non-structural methods such as beach nourishment and dune stabilization. The application of any specific engineering technique to mitigate an erosion problem normally requires systematic and thorough study. In particular, the selection of a technique for a given environment and location requires detailed site-specific consideration of needs, cause-effect dynamics, and cost and cost-benefit relationships. Detailed summaries of engineering methods, techniques, and data pertinent to the control of shore erosion problems are included in the Army Corps of Engineers Shore Protection Manual (U.S. Army, 1984), as well as other Corps publications. A detailed bibliographical listing of research related to many of the engineering alternatives referred to here has been published by Sperling and Edge (1978).

4.4.1 Seawalls, Bulkheads, and Revetments

Seawalls, bulkheads, and revetments are structures placed parallel to the shoreline to separate a land area from a water area as shown in Figure 4-2. The distinction among these structures is mainly a matter of purpose. In general, seawalls are built as a last resort and are the most massive because they are intended to resist the full force of the waves. Bulkheads are next in size; their function is to retain fill, and they are generally not designed for direct exposure to severe wave action. On the oceanfront, bulkheads are normally located above the ordinary water level so that they are not brought under direct wave attack except during storms or at times of very high water levels. Revetments are flexible structures designed to protect shorelines against erosion by currents or wave action. The



TYPICAL SEAWALL CROSS SECTION
N.T.S.



TYPICAL BULKHEAD CROSS SECTION
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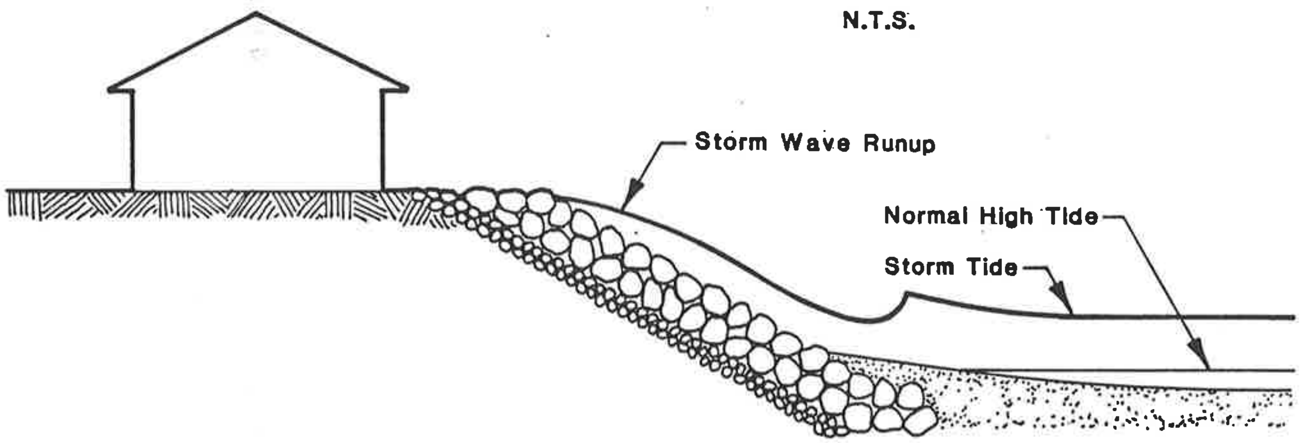

TYPICAL REVETMENT SECTION
N.T.S.

SEAWALL, BULKHEAD & REVETMENT SCHEMATIC SECTIONS

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Figure 4-2

degree of protection afforded depends on the materials used and the method of construction.

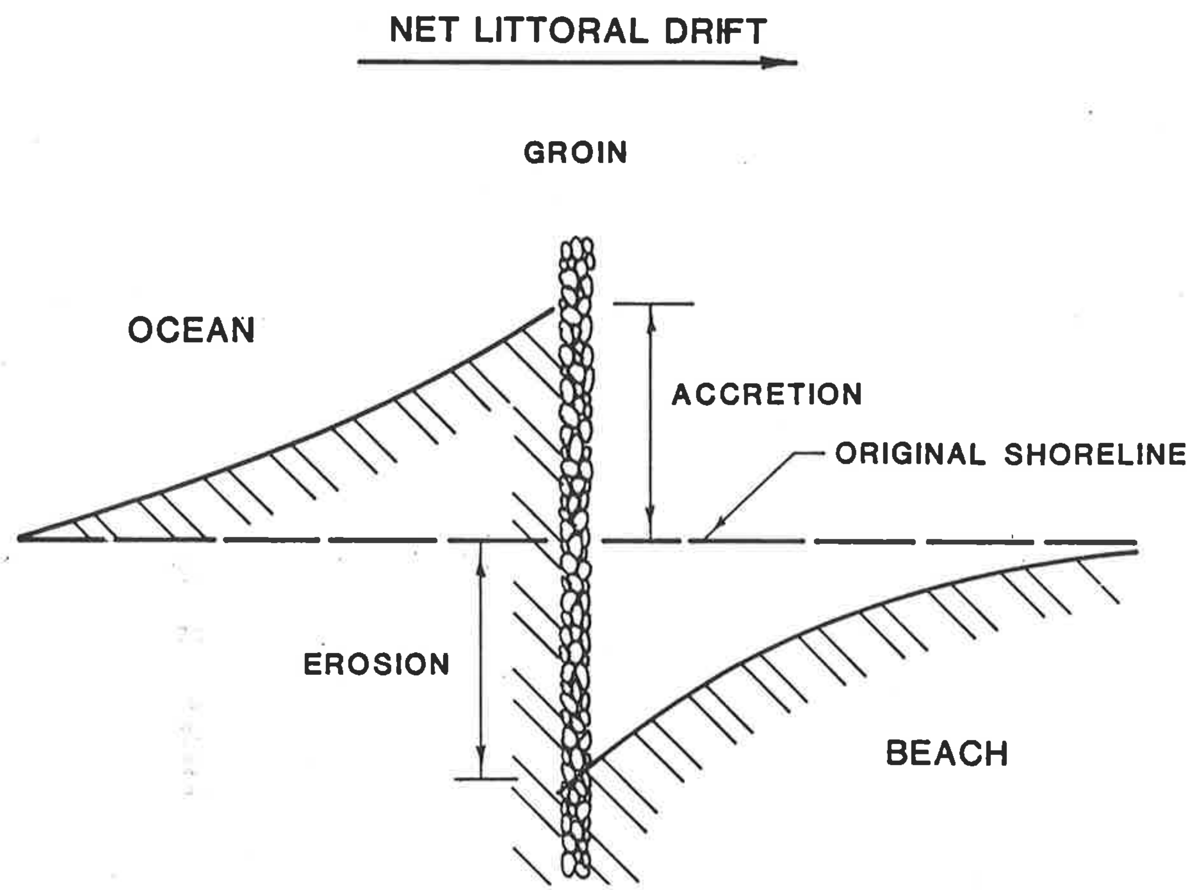
Seawalls, bulkheads, or revetments protect only the land immediately behind them. These structures provide no protection to either upcoast or downcoast areas and have no effect on shoreline erosion updrift. Also, as erosion of the beach proceeds, the magnitude of wave forces acting on these structures during storm events will increase.

Seawalls, bulkheads, and revetments can also have an effect on seaward beach profiles. Scour can be anticipated at the toe of the structure as an initial short-term effect. Scour will form a trough with dimensions governed by the type of structure face, the nature of the wave attack, and resistance of the seabed material. At a rubble-mound seawall, scour may undermine the toe stone, causing it to collapse or sink to a lower stable position. It is safe to assume that these structures would not be effective in reducing loss of the seaward beach.

4.4.2 Groins

Groins are narrow erosion control structures placed perpendicular to the shore to retard erosion of existing or restored beaches. They are designed to extend from a point landward of the predicted recession shoreline to an offshore point sufficient to trap a portion of littoral drift. Since most of the littoral drift moves in a zone landward of the normal breaker depth (about the 6-foot depth contour), extension of groins beyond that depth is generally unnecessary and uneconomical (U.S. Army, 1984).

The groin acts as a partial dam intercepting a portion of the normal longshore transport (Figure 4-3). As material accumulates on the updrift side, supply to the downdrift side is reduced, and the downdrift shore recedes. Accretion on the updrift side continues in accordance with the grain size characteristic of the sand and the height of the groin. At some point accretion stops, and all littoral drift passes the groin. If a groin is high enough to prevent the passage of sediment, then the littoral drift is diverted around the seaward end of the groin. Material in transport around a groin does not move directly shoreward after passing the groin. In fact, groins affect the normal movement of beach sands for some distance downdrift. Thus, a system of groins (or groin fields) too closely spaced will tend to divert sediment offshore rather than create a widened beach. The resulting loss of sediment offshore will worsen erosion problems on downdrift beaches immediately downdrift of the groin.



GROIN INFLUENCED SHORELINE

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Figure 4-3

Groins are usually considered for application in areas where the supply of littoral drift is less than the capacity of the littoral transport forces. In these areas, a shoreline adjustment resulting from the installation of a groin or groin system is unlikely to reduce the actual transport rate. Thus the net effect of the groin will be a reduction of the expected additional losses from beach fills within the groin system. However, for this to occur, the groins must extend to the surf zone. In the case of high profile groins some of the littoral material can be diverted to the offshore zone, resulting in adverse erosion to downdrift beaches.

Where the littoral drift supply satisfies the capacity of the transporting forces, the adjustment in the shore alignment from a groin system may reduce the capacity of longshore transport forces at the groin site. Thus, less material is transported alongshore than prior to the construction of the groins, and a permanent adverse effect to the downdrift shore will occur.

The construction sequence for groin fields, which depends on littoral drift material for filling, is important in minimizing the detrimental effects on downdrift areas. Any natural filling after construction tends to reduce the supply of sediment to downdrift beaches (littoral starvation). The time required for an entire system to fill and for the littoral drift to resume its downdrift movement may be so extensive that downdrift beach areas will be severely damaged. To reduce such effects, construction should begin at the downdrift end of the planned system. Construction of subsequent groins is not recommended until the first groin has filled and sand passing around or over the groin has again stabilized the downdrift beach. As an alternative, the groin field should be artificially filled as they are constructed. Such an operation minimizes the disruption of littoral transport to downdrift beaches. The Pierpont Bay groin field was constructed in this manner (U.S. Army, 1979).

Groins are structurally and functionally different from jetties, which are larger structures with more massive components and are used primarily to confine the tidal flow at an inlet and to prevent littoral drift from shoaling the channel. The jetties and channel stabilization at Ventura Harbor, Channel Islands Harbor and Port Hueneme are directly considered in the planning efforts of this study.

4.4.3 Offshore Breakwaters

Offshore breakwaters are structures designed to protect shore areas from direct wave action. Breakwaters function by dissipating and reflecting incident wave energy. Some wave energy finds its way into the lee or geometric shadow of the breakwater through diffraction around the ends of the breakwater. This wave energy generally represents a small percentage of the incident wave energy. The lack of wave energy which drives the littoral transport system results in a deposition of sediment behind the breakwater as shown schematically in Figure 4-4.

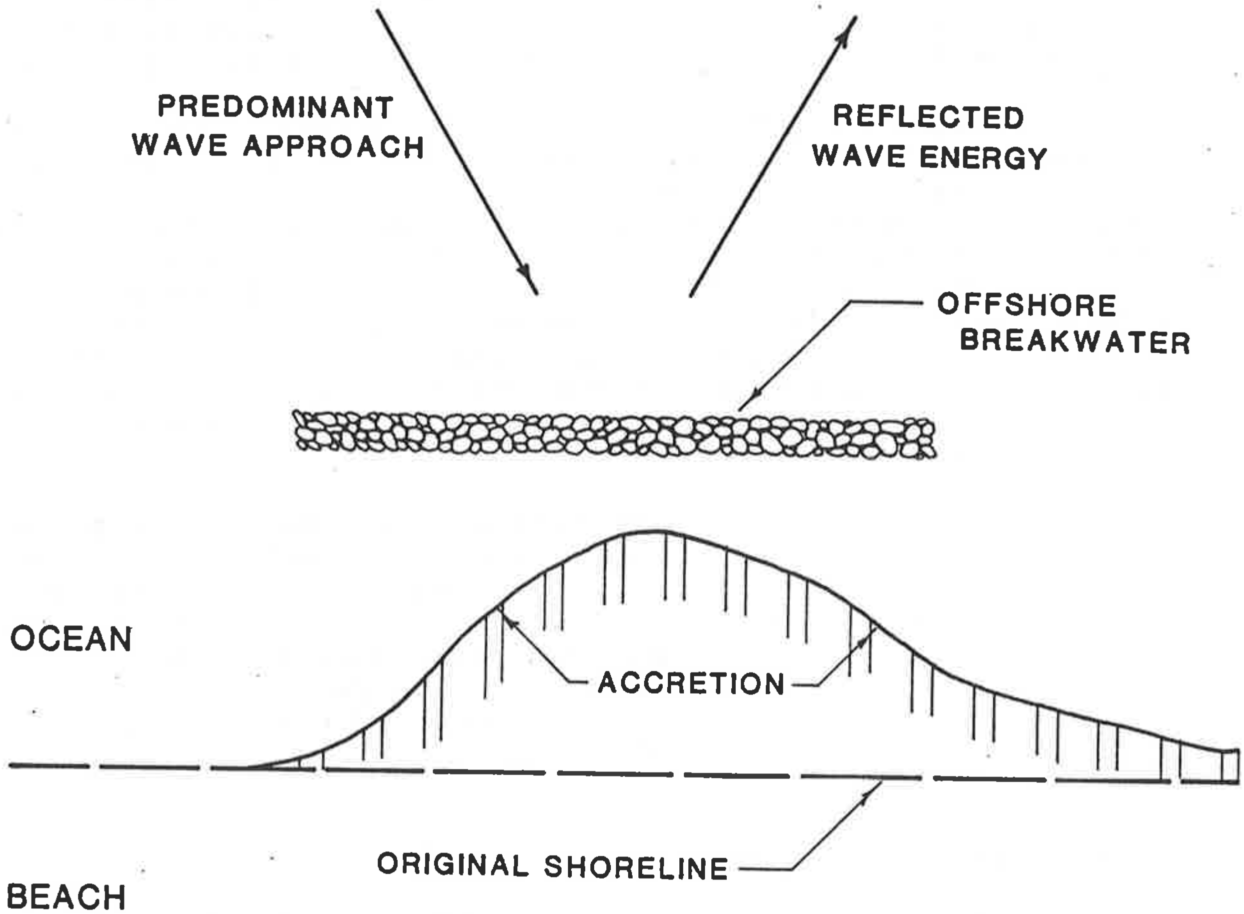
As sand is deposited, a seaward projection of the shore is formed in the still water behind the breakwater. This projecting shore alignment in turn acts as a groin, which causes the updrift shoreline to advance. As the projection enlarges and the zone of longshore transport moves closer to the breakwater, it becomes increasingly more efficient as a littoral barrier. In this situation there generally is accretion updrift of the breakwater and erosion downdrift (U.S. Army, 1984). The original Santa Barbara Harbor construction and the sand traps at Ventura Harbor and Channel Islands Harbor illustrate the use and impacts of offshore breakwaters.

The effectiveness of an offshore breakwater as a sand trap and as a wave shattering structure is dependent on its height in relation to the wave action. To avoid the problems associated with a breakwater which acts as a complete littoral barrier, it may be desirable to design the breakwater so that a degree of wave overtopping is allowed. Such partial barriers need not extend above low water. Adequate markings are required, however, so as not to cause a navigation hazard.

4.4.4 Beach Nourishment

Beach nourishment can range from the periodic replacement of sand lost by erosion to the extensive placement of sand to construct large new beach areas suitable for recreation as schematically illustrated in Figure 4-5. Usually, offshore borrow sites containing compatible sand are dredged and the material pumped ashore via submerged or floating pipeline.

Beach nourishment represents the replacement of a resource, but in and of itself does little to avoid the need for subsequent renourishment. In addition, beach nourishment costs have escalated rapidly in recent years. Continuation of this trend could result in more projects becoming uneconomical, even in high recreational demand areas. Thus, the use of nourishment as an erosion control technique requires a continuous financial commitment. Reconstruction of Santa Barbara's East Beach in the 1940's and 1950's, Hueneme Beach in 1960, and the more recent fills within Pierpont Bay exemplify beach nourishment history in the BEACON area.



OFFSHORE BREAKWATER
INFLUENCED SHORELINE

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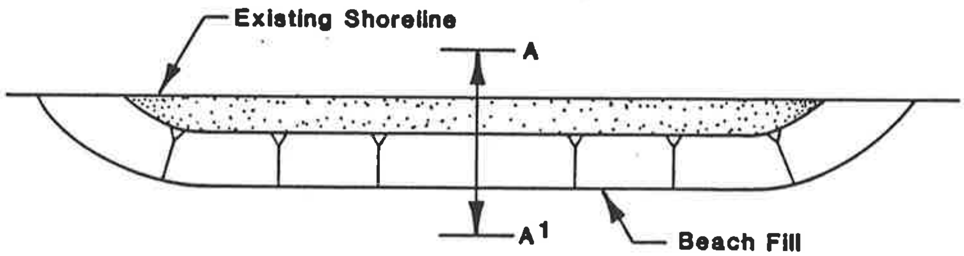
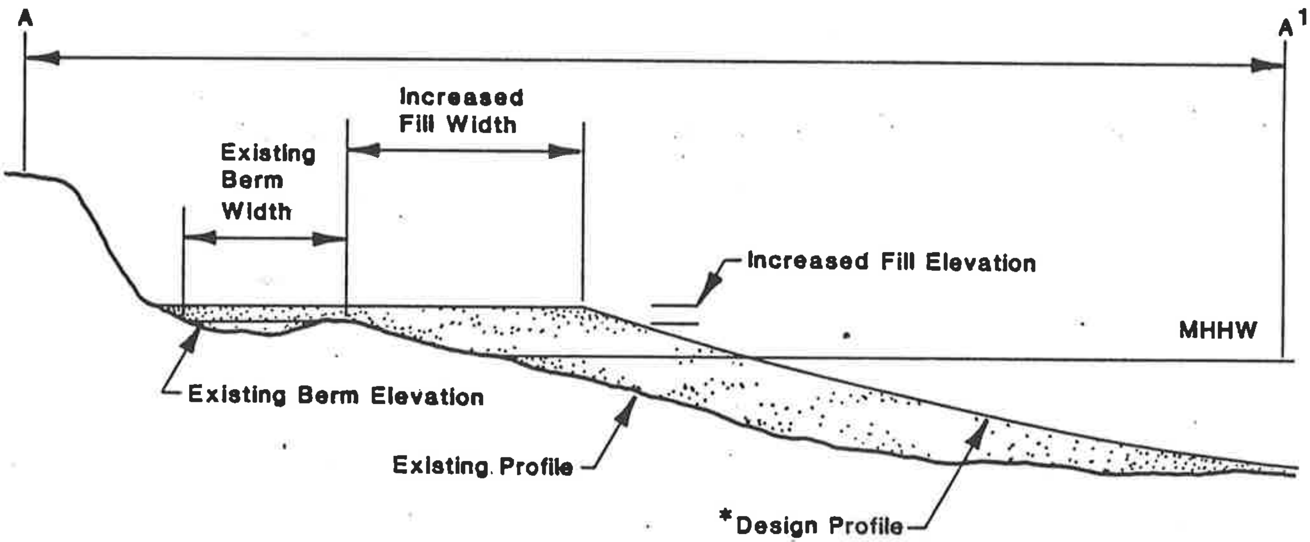
Figure 4-4



TYPICAL PLAN



TYPICAL SECTION A-A1

* Depends on Compatibility of Borrow Sand to Native Sand

BEACH NOURISHMENT
SCHEMATIC FLOW & SECTION

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Figure 4-5

The exploitation of offshore sand resources is not without potential problems, which can include:

1. Increasing the offshore transport of sand during storms and limiting its return as a result of excavations near enough to the shore to upset the beach dynamic equilibrium;

2. Interruption of the supply of sediment to the shore due to the depression left from nearshore dredging which may trap a portion of the dredged material - if a beach is being fed from offshore by currents and wave action; and

3. Changes in offshore bathymetry by excavating sand from protective offshore banks or bars, which can result in changes in the refraction of incident waves and therefore changes in the angle of wave attack (such changes may affect the rate of littoral drift along the shoreline, which can change erosion or accretion pattern).

A detailed study of each proposed dredging operation is required to estimate its actual effect on the beaches and the environment.

4.4.5 Beach Scraping

Beach scraping is the removal of material from the lower part of the beach for deposition on the higher part of the beach or at the dune toe. Beach scraping is usually performed by a scraper pan or front end loader which removes or skims the uppermost layer of the beach. Bulldozers are also used on narrow beaches which do not provide sufficient maneuvering room for a scraper.

Beach scraping is different from artificial nourishment. Artificial nourishment is the replacement of eroded material by new material. Beach scraping is the distribution of the available beach material in a manner which improves the coastal protection capabilities of the overall beach profile without providing any new beach material.

Brunn (1983) examined the advisability of beach scraping and concluded that:

1. Beach scraping by skimming thin surface layers where surplus material is available in the profile is beneficial as protection for eroding dunes;

2. Technically responsible beach scraping does not have an adverse effect on adjacent beaches; and

3. Beach scraping is a method of arranging the available beach material in a more sensible manner on a short-term basis. It is a temporary procedure which does not replace artificial nourishment.

Brunn (1983) also stated that beach scraping should only be done where beach material is available in relative surplus in the profile. This is the area of active fluctuation of the profile where ridges build up by swell activity following a storm or during the spring and summer seasons. Figure 4-6 shows the location of suitable source material in a typical profile. The material which comprises the beach ridge comes from the near shore bottom. The scraped beach material should be used to protect the dune by placing it at the dune toe. A reasonable scraping program will skim no more than about one foot of the upper surface of the beach.

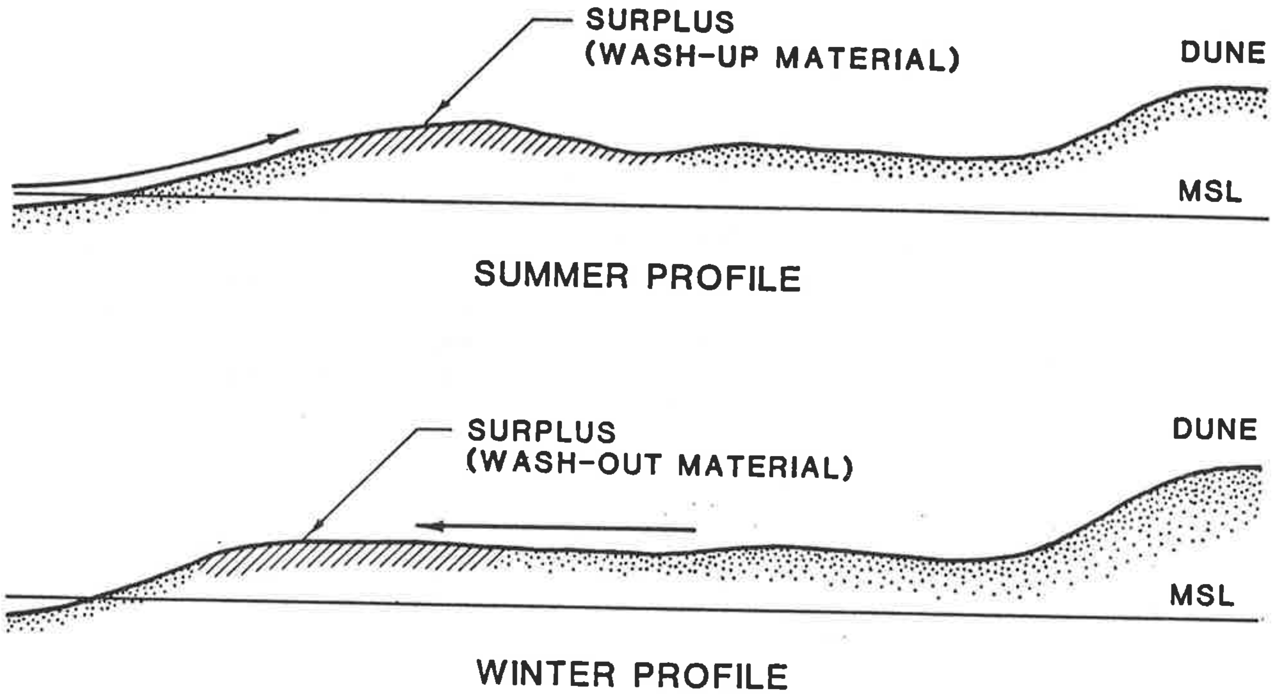
The City of Carpinteria currently uses beach scraping to construct a temporary dune west of Linden Avenue. The dune is built prior to the winter storm season to protect private property from coastal flood damage.

4.4.6 Sand Bypassing

Sand bypassing involves the mechanical transfer of sand around littoral barriers such as jetties and breakwaters. Sand from the accretion area updrift of the barrier is used to nourish the eroded downdrift beaches and maintain the natural littoral transport. In other situations, sand traps are excavated in inlet areas. These traps are periodically dredged to remove the sand which is deposited there by the tidal currents in the inlet. Effective bypassing can be accomplished when the dredged sands are deposited on the downdrift beaches. This has been done on a regular basis at Santa Barbara, Ventura, and Channel Islands harbors.

4.4.7 Dune Stabilization

Dunes that form just behind the beach perform an important role in the littoral processes. The foredunes function as reservoirs of sand to nourish eroding beaches during high water conditions and as levees to prevent wave damage to backshore areas. As such, they are valuable non-rigid, natural shore protection features. Well-established inland dune ridges are a second line of defense against erosion if the foredunes are



SOURCE AREAS FOR BEACH SCRAPING

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Figure 4-6

destroyed by storms. Use of native vegetation helps to trap and hold sand on the dunes and therefore contributes to their growth and repair.

For more rapid accumulation of sand, construction of dunes through use of sand fencing is recommended. Relatively inexpensive, sand fencing is used extensively in artificial dune construction. This method has been used by the Navy along portions of their beach within the Pacific Missile Test Center.

Inman (1981) outlined a dune management program for a beach site north of Oxnard Shores. He recommended grading upwind and downwind sides to 15 to 20 degree slopes and maintenance of dense vegetation cover to inhibit migration. Mechanical transplanting of commercially grown beach grasses or other suitable perennials requires diligent watering and fertilization to establish a healthy ground cover. Woodhouse (1978) presents a detailed summary of dune building and stabilization methods using vegetation.

4.5 Public Policy Measures

In contrast to engineering methods for erosion management, three institutional strategies are available for a less direct approach to the problem. These methods entail controlling development in erosion hazard areas, promotion of public awareness of coastal hazards, and providing economic relief from erosion related losses to property. The different strategies may be classified as land use management alternatives, warning systems, and relief, rehabilitation and insurance techniques. The following sections provide a description of each strategy.

4.5.1 Land Management Use Alternatives

The land management alternative involves the use of a variety of regulatory tools by local, State and the Federal governments for controlling development in erosion hazard areas. Measures that may be implemented generally flow from a government's authority under its police power to promote the public's health, safety and welfare by controlling or regulating the activities of individuals. Specifically, it enables governments to place limits on individual's uses of their own property (i.e., zoning). With regard to erosion processes, it enables governments to control and limit the amount of private and public investment in erosion hazard areas so as to limit or avoid future losses.

Shorefront property is a scarce, and therefore valuable economic resource. Government imposed limitations on the use of this resource requires careful consideration to weigh the consequences and impacts of denying an individual reasonable use of his property or consent to development of hazardous areas. A range of land management techniques and concepts that have been, or could be utilized as shore protection techniques are presented below.

4.5.1.1 Zoning

Zoning involves limiting land use type, intensity, and structural configuration within a clearly defined mapped area such as an erosion or flood hazard area. This limitation on, or prohibition of, development within an area must be designed to protect the public health, safety and welfare (e.g., prevent erosion-related losses), and/or promote the public welfare (preserve beach and dune areas, provide additional open space). Zoning is generally implemented at the local government level. The extent of the regulated area can be tied to an observed erosion rate and its boundary can be periodically readjusted to account for continuing erosion.

An example of zoning would be the establishment of a dune and beach preservation district. This would involve the establishment of a regulatory zone that forbids further development or other specified activities in dune and beach districts. Such a program would recognize the natural protective function of the dunes and beaches in attenuating storm and long-term erosional forces and the preservation for reestablishment of the shore ecosystems.

4.5.1.2 Shifting or Rolling Easement

This alternative involves the maintenance of a public easement (either acquired or prescriptive) at a beach during periods of erosion or accretion. Under erosion, the easement would move inland preceding the advance of the mean higher high water line. Thus, private shorefront property would revert to public use.

4.5.1.3 Building Codes

The promulgation of design standards and materials specifications could be applied to structures located in erosion hazard areas. These regulations are designed to limit the probability of, or amount of, property damage that would accompany continuing erosion or a major storm. Common specifications include: 1) deep foundation standards, 2) minimum floor elevations, and 3) design standards for parts and columns. Uniform design standards for erosion control structures such as seawalls, groins, and revetments can also be incorporated under these provisions.

4.5.1.4 Building Setbacks

Building setbacks entail the establishment of a line seaward of which new construction, excavation and other activities would be regulated or prohibited. Thus, additional construction in erosion hazard areas, or in areas which would preclude the maintenance or reestablishment of the natural beach and dune profile would be prevented. Setback lines have been employed at the state level by Florida, Delaware, and Michigan. The extent of a regulated area can be based on historical erosion rates. In addition, its boundary can also be regularly adjusted to account for continuing erosion or changes in erosion trends.

Santa Barbara County and the City of Santa Barbara have incorporated seacliff setback distance policy as part of their respective coastal plans. The County has adopted a 30-foot setback at Isla Vista and a 50-foot requirement along the Hope Ranch area (Santa Barbara County, 1982). The City has also applied a 50-foot setback assuming an average bluff erosion rate of 8 inches per year for a 75-year life (City of Santa Barbara, 1981). These examples illustrate the setback concept within the BEACON area.

4.5.1.5 Acquisition

Acquisition may be described as the purchase of shorefront areas by State, Federal or local governments through the exercise of the eminent domain power. The acquisition must be for a valid public purpose (e.g., recreation) or promote the public's health, safety and welfare (e.g., prevent future erosion or storm related losses in hazard areas). Purchases may be on a pre-or post-storm basis, and they may be on a fee-simple basis or involve the purchase of easement. An easement involves the purchase, at less than fee-simple, of a portion of the total rights in a shorefront parcel. Provision for continued public access or limitations on future development rights can be obtained in this manner.

Properties may also be obtained through private donation whereby individuals give title to their shorefront properties to a state or local government. This is usually coupled with a provision allowing the donor to receive some kind of benefits, such as a tax deduction.

In addition to fee simple acquisition and easement purchase, mentioned above, the other methods of land acquisition are:

1. Dedication;
2. Eminent domain; and
3. Monetary payments "in lieu" of mandatory dedication.

Dedication can be voluntary with provision of land for public walkways and recreation use being common. The parcels are recorded in the County public records for the perpetual use of the public. Mandatory dedication is used to provide development areas with necessary services or access to individual lots. Utility rights-of-way and street dedications are examples of mandatory dedication. Street dedications can provide beach access as a secondary purpose. Subdivision extraction is another form of mandatory dedication where local governments secure land for public use as a part of a development. Subdivision extraction is used where projects are of a size or location significant enough to justify a public interest in maintaining lands for public use.

An alternative to mandatory dedication is the concept of monetary payments "in-lieu" of dedication. The payments by a developer are used toward the purchase cost of land being developed for public uses such as parks and recreational facilities. Such payments are required when the size or location of a development make actual dedication a problem.

4.5.1.6 Preferential Taxation

This is the application of lower tax rates or assessed values to land which is kept in a natural, or in its existing condition (i.e., less than its best and highest use). Taxes are then based on the value-in-use of the land, and not on its development potential. Lower tax burdens serve as incentives to keep shorefront parcels from being further developed, or as compensation for value reductions caused by other regulatory programs (i.e., zoning).

4.5.1.7 Building Moratoriums

These involve the prohibition of any additional development in erosion hazard areas. Ohio has adopted such a program along the shore of Lake Erie.

4.5.1.8 Transfer of Development Rights

Development rights (land use type, building height, lot coverage, etc.) are defined for shorefront parcels by applicable zoning laws. Shorefront property owners would be permitted to sell some or all of the development rights of their parcels to owners of properties not located in shorefront or erosion hazard areas. This would generate declines in shorefront development intensity and still permit shorefront property owners to capture some of the economic value of their holdings. Transfer of development rights would usually be administered at the municipal and county level.

4.5.1.9 Compensable Regulations

Under this scheme the government would compensate shorefront property owners for the decline in the value of their holdings caused by the imposition of a regulation effecting that property. There is no known use of this method in the United States as yet.

4.5.1.10 Permitting

The permitting alternative involves the establishment of a regulatory framework whereby the undertaking of certain activities in a defined area is contingent upon obtaining a governmental permit by meeting certain terms and conditions. These can include compatibility of the proposed activity in its desired location with established land use, environmental, and socioeconomic policies. In addition, they can also include site-specific design and engineering standards intended to minimize potential adverse economic, social, fiscal, and environmental impacts. These are usually administered through municipal and county building codes. For example, Ventura County contains as part of its coastal zoning plan standards which apply to the construction and maintenance of shoreline protective devices. The standards outline the general allowance criteria and impact analysis requirements which may be required of applicants (County of Ventura, 1987).

Shoreline improvement projects are also generally reviewed by the affected county, municipality, the California Coastal Commission and the U.S. Army Corps of Engineers for technical merit and environmental impacts. In their regulatory procedure, a number of interested State and Federal agencies also participate in the evaluation of any shoreline proposal.

4.5.2 Warning Systems

This group of techniques primarily involves governmental agencies at various levels providing the public with information concerning the projected short-term and long-term risks associated with development in erosion hazard areas. The activities can range from ongoing, year round educational programs to broadcast warnings immediately before major storm events. A range of different programs and activities that serve as warning systems are described below.

4.5.2.1 Public Education

This would encompass a range of programs and activities sponsored by local, State and Federal government agencies. These could include periodic workshops in major shore communities, dissemination of maps and pamphlets detailing erosion hazard areas and erosion probabilities, and speakers programs.

4.5.2.2 Deed Disclosure

This would require the inclusion of a statement on all deeds of properties located in defined erosion hazard areas that such properties are subject to probable, erosion-related impacts. This would warn potential purchasers of shorefront properties of the erosion risk. The definition of the erosion hazard area would likely be done at the state level, and the primary record keeping responsibility would reside at the local or county government level (e.g., county clerk or county recorder's office).

4.5.2.3 Real Estate Disclosure

This is similar to the deed disclosure program above. In this instance, local real estate agents would be required to warn potential buyers of shorefront properties located in erosion hazard areas, that these properties face the probability of future erosion-related losses.

4.5.2.4 Erosion Forecasts

The National Weather Service currently issues estimates of short-term erosion expected to accompany the occurrence of coastal storms. This service usually provides advance notice only for the occurrence of major storms. The erosion forecasts could be supplemented with information on yearly recession rates and how these are being influenced by seasonal weather trends (e.g., prolonged winds). However, long-range beach monitoring is better managed at the BEACON level.

4.5.2.5 Disaster Preparedness

State and local emergency planning officials would develop contingency plans for the evacuation of shorefront areas situated in critical erosion and flood hazard areas. The National Weather Service storm warning would be quickly relayed to local emergency planning officials. State and local officials would inform shorefront residents residing in hazard areas that they face the high probability of severe erosion losses during major storms. Timely evacuation of erosion hazard areas would lessen human suffering associated with short-term erosion accompanying severe storms. This effort could be coordinated with the various public education and civil defense efforts.

This strategy is typically applied along the U.S. Atlantic and Gulf coasts where hurricane storm surges pose serious flood threats. West coast preparedness would be confined mainly to monitoring of the winter spring tide windows when storms can cause the most damage to vulnerable beach areas. The City of Carpinteria presently performs this service through their local lifeguard service.

4.5.3 Relief, Rehabilitation, and Insurance

In contrast to warning systems, this group of techniques deals directly with the locations of structures and public facilities in erosion hazard areas. These measures either offer aid to replace erosion-related losses of property, or create incentives and performance standards for avoiding or minimizing future erosion losses. Some of the important methods are noted below.

4.5.3.1 Insurance

The National Flood Insurance Program (NFIP) is a federally sponsored and operated program which currently provides shorefront property owners subsidized insurance protection against erosion-related losses and undermining caused by waves or currents exceeding specific levels. Thus, it applies only to short-term, erosion-related losses accompanying major storms. Local communities participating in either the emergency or regular programs of the NFIP must adopt minimum building codes and planning programs.

4.5.3.2 Relief and Rehabilitation

Existing rehabilitation and post-disaster assistance is generally not available to cover erosion-related property losses. Aid is generally only available where erosion-related losses have occurred as the result of a major storm. It generally requires a Presidential declaration of a "major disaster" or of an "emergency" for post disaster assistance to be made available. The available aid is generally targeted toward the reconstruction of public facilities, utilities and infrastructure. Low interest loans can be made available to private citizens. Rehabilitation and post-disaster assistance originate at the Federal level through the Federal Emergency Management Agency (FEMA).

4.5.3.3 Relocation Incentive

Economic incentives could be offered by governments to shorefront property owners to relocate out of erosion hazard areas. These could be implemented on a pre-or-post-storm basis. Incentives could include outright grants or low interest loans covering moving or reconstruction expenses. Reconstruction grants or loans could be made contingent upon relocation out of a coastal hazard area. Similarly, tax abatements could be granted on new construction located out of an erosion hazard area. Finally, government(s) could supply assistance in locating and purchasing suitable areas for relocation. These programs would likely be implemented at the State and Federal levels.

4.6 Strategy Selection

The objectives of BEACON and associated sand management issues were listed in Chapter 1.0 and Section 4.1 of this report. Consistent with these obligations and the desire of BEACON for a plan which emphasizes non-structural methodologies, the following general criteria were adopted for plan formulation:

1. The plan should strive for beach enhancement;
2. The plan should be regional in scope; and
3. The plan should avoid structural solutions as much as possible.

Specific evaluation criteria were chosen to identify the contribution of alternative strategies to beach enhancement, sediment supply, harbor maintenance, and storm protection issues. Based upon the discussion presented in Section 4.1, the following criteria were used to evaluate and select appropriate strategy for more detailed development:

1. Will the strategy enhance beaches (main objective)?

2. Does the strategy address bluff erosion mitigation (storm protection and/or sediment budget issue)?

3. Will the strategy address proliferation of shoreline fortification (main objective)?

4. Can the strategy be used to reduce fluvial sand delivery losses (sediment budget issue)?

5. Will the strategy address harbor maintenance dredging (main objective)?

6. Does the strategy help to reduce storm damage to property and infrastructure (main objective)?

The results of this analysis are summarized in Table 4-1. The conclusions suggested by the results are elaborated below.

4.6.1 No Action Alternative

This strategy does not fulfill any of BEACON's goals or objectives. It is therefore not recommended as a satisfactory plan given the fact that other positive alternatives are available for consideration.

4.6.2 Engineering Techniques

Beach nourishment has been identified as an alternative which achieves most of the objectives. Widening the shoreline with suitable sand sources not only enhances the recreational potential, but mitigates shoreline erosion and storm damage and alleviates the concern for proliferation of coastal structure fortification.

Seawalls, bulkheads, revetments, and offshore breakwaters can be used to reduce storm damage and locally reduce storm damages. However, the measures are in conflict with the broader objective of trying to achieve solutions that lessen the need for structural solutions and fortification of the shoreline.

Sand bypassing of existing harbor facilities is identified as a means to achieve regular maintenance of navigation facilities and reduce storm damage by prevention of adverse effects from littoral drift interruption.

Table 4-1
Alternative Strategy Evaluation

Alternative Strategies	BEACON OBJECTIVES AND ISSUES: Enhances Beaches?	Mitigates Bluff Erosion?	Addresses Progressive Shoreline Fortification?	Addresses Fluvial Sand Loss?	Maintains Harbor Dredging?	Reduces Storm Damages?
1. No Action	No	No	No	No	No	No
2. Engineering Techniques:						
Seawalls, Bulkheads, Revetmnts	No	Yes	No	No	No	Yes
Groins	No	No	No	No	No	Yes
Offshore Breakwaters	No	Yes	No	No	No	Yes
Beach Nourishment	Yes	Yes	Yes	No	No	Yes
Sand Scraping	No	No	No	No	No	Yes
Sand Bypassing	No	No	No	No	Yes	Yes
Dune Stabilization	No	No	Yes	No	No	Yes
3. Public Policy Techniques:						
Land Management Zoning	No	No	Yes	No	No	Yes
Shifting Easement	No	No	Yes	No	No	Yes
Building Code	No	No	No	No	No	Yes
Setback	No	No	Yes	No	No	Yes
Acquisition	No	No	Yes	No	No	Yes
Preferential Taxation	No	No	Yes	No	No	Yes
Building Moratorium	No	No	Yes	No	No	No
Transfer of Development Rights	No	No	Yes	No	No	No
Compensable Regulations	No	No	Yes	No	No	No
Permitting	No	No	Yes	Yes	Yes	No
4. Warning Systems:						
Public Eduation	No	No	No	No	No	No
Deed Disclosure	No	No	No	No	No	No
Real Estate Disclosure	No	No	No	No	No	No
Erosion Forecasts	No	No	No	No	No	No
Disaster Preparedness	No	No	No	No	No	No
5. Education, Rehabilitation, and Insurance:						
Insurance	No	No	No	No	No	No
Relief and Rehabilitation	No	No	No	No	No	No
Relocation Incentive	No	No	Yes	No	No	Yes

Beacon Objective	Recommended Strategy
Enhance Beaches	Engineering Techniques
Mitigate Bluff Erosion	Engineering Techniques and/or Public Policy
Address Progressive Shoreline Fortification	Engineering Techniques and/or Public Policy
Address Fluvial Sand Source	Public Policy
Maintain Harbor Dredging	Engineering Techniques and/or Public Policy
Reduce Storm Damages	Engineering Techniques and/or Public policy

Dune stabilization affords a means to provide winter storm protection using a natural defense barrier that would substitute for hard permanent structures. However, its application is limited to relatively wide sandy beach areas with favorable wind conditions.

4.6.3 Public Policy Techniques

Selected use of land management techniques may be appropriate to deal with aspects of the shore protection, fluvial sand source depletion, harbor dredging and storm damage reduction objectives. The first and last objectives may be managed through land development regulation. Updating of building setback criteria exemplifies one strategy plan from this suite of alternatives to deal with receding shorelines and achieve storm damage reduction without the need for additional shore protection structures. Furthermore, the issues of fluvial sand source depletion and continuance of harbor bypassing practice may best be addressed from a policy initiative.

Based upon a review of the public policy techniques previously discussed and summarized in Table 4-1, the following alternatives are appropriate for consideration:

1. Land Management Zoning - Delineation of coastal hazard or sand source zones to prevent future development from erosion damage exposure and/or to preserve bluff erosion and coastal stream sand sources.

2. Building Code - Develop uniform criteria and specifications for erosion protection structures and methods.

3. Setback - Review existing setback policy to protect development and/or preserve bluff erosion sand sources.

4. Permitting - Development regulatory policy to maintain existing harbor sand bypassing operation, protect and enhance sand delivery from rivers and streams, and protect bluff erosion sand sources.

4.6.4 Warning Systems

These strategies do not specifically address the BEACON issues. However, because of their general public informational nature, they represent incidental policy that may be beneficial for incorporation within local jurisdictions.

4.6.5 Relief, Rehabilitation and Insurance

These strategies are also incidental measures that do not specifically mitigate sand management concerns. The economic burden associated with their implementation renders them impractical for local government sponsorship.

4.7 Recommended Sand Management Strategy

Table 4-1 clearly points toward a strategy which utilizes beach renourishment as a principal mechanism to fulfill the majority of BEACON's goals and objectives. In so doing, beaches are enhanced, storm damage may be reduced because of the wider beach berm, and the need for additional shore protection structures is reduced. Furthermore, the problem of bluff erosion is mitigated in a way which compensates for any decrease in natural sediment supply lost by its stabilization.

In addition to beach nourishment, the use of sand bypassing techniques and public policy is suggested to address the issues of harbor maintenance and fluvial sand supply which are not otherwise covered by other means.

The assumptions which were made to arrive at the recommended strategy imply that continued monitoring of the shoreline is advisable to confirm and refine the assumptions, and supplement the limited database which presently exists. Therefore, beach monitoring should be incorporated within any BEACON plan.

Lastly, BEACON has expressed the desire to initiate the regional approach to sand management through implementation of a smaller one time demonstration project (BEACON, 1986b). Such a project would serve as an impetus for the larger program and provide an opportunity to gain valuable technical information for design input to the regional plan.

In summary, the above strategies imply that it is appropriate to recommend short-term and long-term programs. The short-term plan would be aimed at producing information necessary for the specification of the large scale regional program. The specific recommendations are outlined in the following sections.

4.7.1 Short-Term Strategy

The short-term strategy is recommended to consist of the following:

1. Continue monitoring of the BEACON shoreline to confirm technical assumptions and supplement data deficiencies.

2. Define the specific funding program and its practical revenue capability so that the extent of regional improvements can be sized accordingly.

3. Implement a relevant demonstration project to test an element of the regional plan and provide public impetus for completing the long-term plan.

4.7.2 Long-Term Strategy

The long-term strategy is recommended to contain the elements listed below:

1. Develop a beach nourishment program to restore, maintain, and enhance the BEACON shoreline.

2. Institute public policy to ensure that sand bypassing at the four harbors is guaranteed in perpetuity to preserve the natural littoral system.

3. Institute public policy to maximize natural sand delivery to the beaches by rivers and streams and natural cliff erosion.

4. Review and modify, where appropriate, public policy to determine the acceptable balance between beach protection and property protection.

5. Prioritize the phased implementation of the selected sand management plan.

5.0 PLAN DEVELOPMENT

This chapter presents the development of a long-range sand management strategy that incorporates the concepts of beach nourishment, public policy measures and coastal monitoring as its principal elements. In addition, a near-term program of small scale demonstration projects is proposed which will serve to validate critical elements of the long-range program.

From a technical standpoint, beach renourishment depends on the following:

1. Availability of suitable sand borrow sources;

2. Availability of construction equipment to deliver the borrow sand to the beach fill site; and

3. Satisfaction of physical beach fill design criteria that fulfills profile geometry requirements and fill longevity.

These items are discussed below.

5.1 Sand Sources

Beach nourishment can be performed by importing sand from inland or offshore sources. Inland deposits of sand are conventionally delivered to the fill site by truck. Since the standard bulk carrier hauls approximately 18 cubic yards of material, many truck trips are necessary to deliver large volumes of sand to the shoreline. Less conventional methods to transport inland sand in bulk quantity include slurry pipeline and conveyor systems. The latter was performed on a small scale at the excavation of a large foundation in Los Angeles (Los Angeles Times, 1988). The former has not been applied in the United States except in prototype fixed harbor sand bypass plants.

5.1.1 Onshore Sources

Known inland sand sources within the study area include river bed deposits and flood control debris basins. Mining of sand in the Ventura and Santa Clara watershed has been performed for a number of years to supply sand and aggregate for the construction industry. In rare instances small volumes of sand have been delivered to the shoreline in response to local erosion emergencies.

Borrow of sand from debris basins has been proposed by a number of researchers (Bailard and Jenkins, 1982). Figures 5-1 and 5-2 show the location of those retention sites within the immediate Santa Barbara and Ventura Counties area. The control structures are primarily intended to regulate mountain runoff and capture debris and sediment to keep downstream channels free for flood control. Accumulated debris and sediment are periodically removed from the basins, generally following heavy rainfall winters. Usually the material is used for landfill.

In order to use the debris basin sediments for beach nourishment, the accumulated sediment must be graded and sifted to remove undesirable rock and brush. Furthermore, the basins are relatively remote and inaccessible which limits the size of equipment that can operate in the basin. As a result, this resource is better suited to small scale fill operations as the typical volume requirement for beach fill and maintenance is orders of magnitude greater than the quantity of sand available from the debris basins. However, the sediment constitutes a potentially important sand source when viewed from the sediment budget perspective. Therefore, ways to deliver the sand to the beach as a feeder material are desirable. Appendix C provides a discussion of the costs associated with shoreline delivery via trucks.

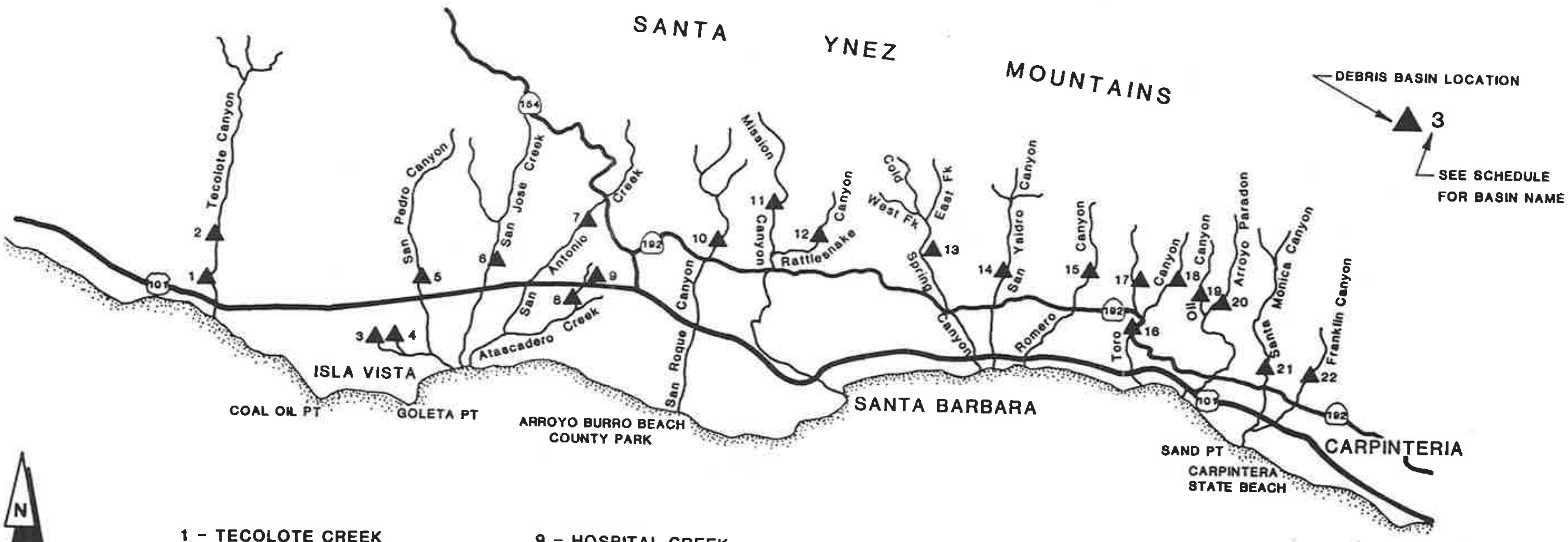
By far the most attractive means to furnish borrow sand in quantity required for beach fill is from offshore deposits. Evaluation of this resource within the BEACON study area was therefore given particular attention.

5.1.2 Offshore Sand Sources

In order to determine the extent of sand potentially available for borrow from offshore areas, the Santa Barbara Channel was studied for suitable source material. Existing literature, previous field surveys, and other data were reviewed to identify candidate deposit locations. Promising sites were then selected for further study to determine their sediment character and volume. This was accomplished via geophysical measurements and vibracore sampling as part of a cruise conducted during August and September 1988. Figure 5-3 shows the general offshore sand deposit areas that were identified in this study. The following paragraphs contain a brief description of each borrow site. Additional details may be found in Appendix B.

5.1.2.1 Offshore Goleta

The Goleta deposit is a narrow east-west trending body that extends eastward from Goleta Point toward the Hope Ranch area.



1 - TECOLOTE CREEK
2 - TECOLOTE CREEK
3 - TECOLOTITO CREEK
4 - CARNEROS CREEK
5 - SAN PEDRO CREEK
6 - SAN JOSE CREEK
7 - SAN ANTONIO CREEK
8 - HOSPITAL CREEK
9 - HOSPITAL CREEK
10 - SAN ROQUE CREEK
11 - MISSION CREEK
12 - RATTLESNAKE CANYON
13 - COLD SPRINGS/MONTECITO CREEK
14 - SAN YSIDRO CREEK
15 - ROMERO CREEK
16 - TORO CANYON CREEK (LOWER WEST)
17 - TORO CANYON CREEK (UPPER WEST)
18 - TORO CANYON CREEK (EAST)
19 - OIL CANYON NO 5
20 - ARROYO PARADON
21 - SANTA MONICA CREEK
22 - FRANKLIN CREEK

DEBRIS BASINS
SANTA BARBARA COUNTY

REFERENCE : SANTA BARBARA COUNTY FLOOD CONTROL DISTRICT

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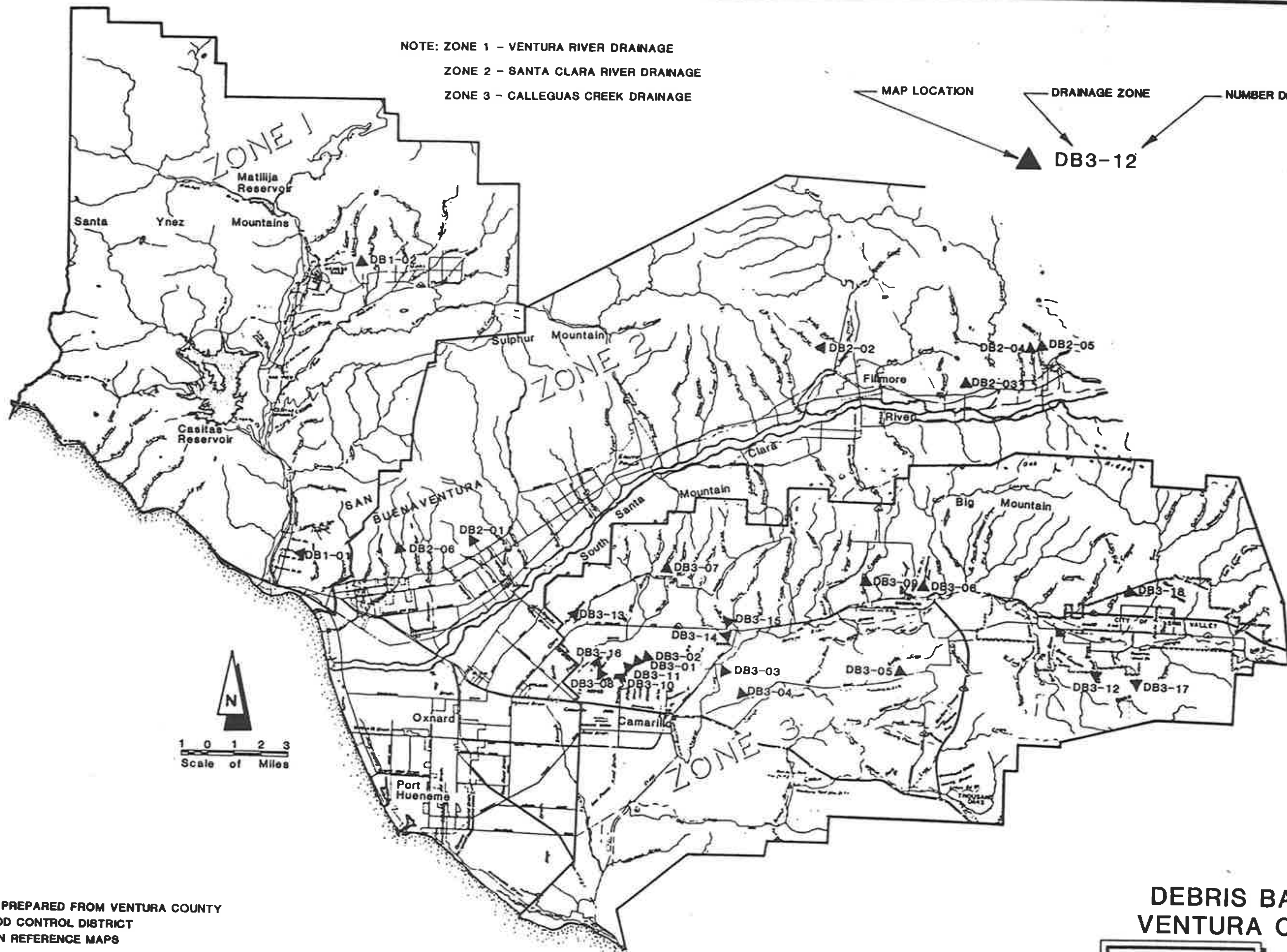
Figure 5-1



REFERENCE: MAP PREPARED FROM VENTURA COUNTY
FLOOD CONTROL DISTRICT
BASIN REFERENCE MAPS

DEBRIS BASINS
VENTURA COUNTY

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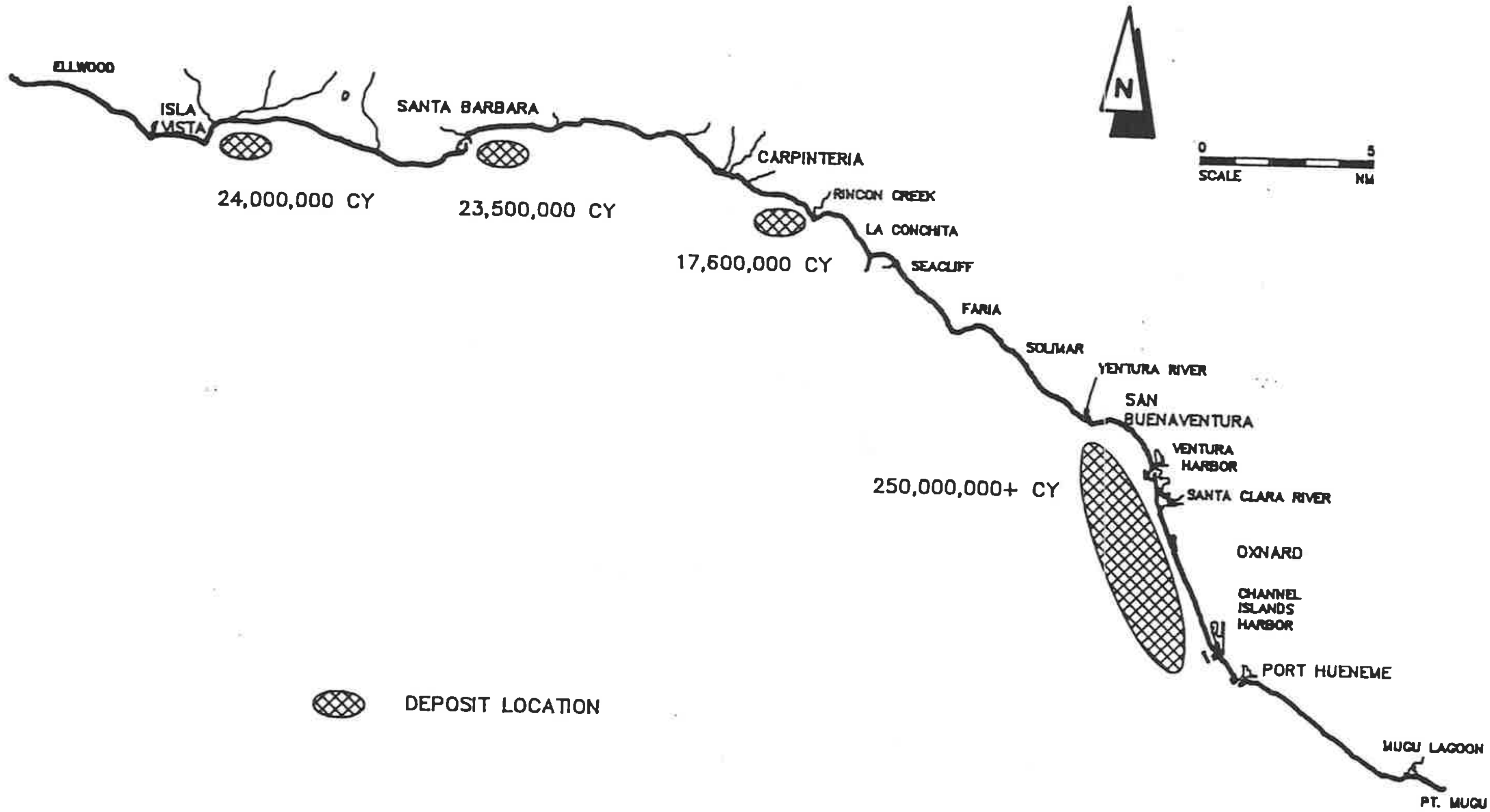
Figure 5-2



OFFSHORE SAND DEPOSITS

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Figure 5-3

Figure 5-3

At its west end it lies approximately one mile south of Goleta State Beach and Goleta Slough. The overall sediment deposit is approximately 3.5 miles long, but is generally less than 0.5 miles wide in the north-south dimension.

The surveyed area of the deposit occurs in a water depth range of 30 feet to over 120 feet, and it appears from the geophysical data that as much as 50 percent of the total volume of sediment may be beyond the economic dredging limit. Approximately 24,000,000 cubic yards of sand was calculated to be available for dredging. The mean grain size of the sediments averaged about 0.14 mm.

5.1.2.2 Offshore Santa Barbara

The Santa Barbara deposit consists of three potential borrow areas based on mapping and analysis of the geophysical data. The division between the western area and the two eastern areas is based primarily on the existence of man-made structures including the harbor entrance channel, Stearn's Wharf, and the sewer outfall. The two eastern deposits are separated by the axes of a pair of an echelon anticlinal folds over which the sediment apparently thins to less than 20 feet.

The western area lies immediately offshore of the harbor breakwater in water depths of 30 to 45 feet. The dredgible thickness of the deposit is estimated to range from 25 to 45 feet and contains an estimated volume of about 9 million cubic yards. However, sediment cores show grain size to be predominantly very fine sand with silt to silty clay below a depth of 3 feet. Due to the relatively fine-grained sediment and the lack of definition of the base of the deposit it is considered the least favorable of the three potential borrow areas in the Santa Barbara area.

The eastern offshore borrow area trends east-west for about 8,000 feet and lies in water depths of 55 to 70 feet. It is about 4,000 feet directly south of East Beach and Santa Barbara Cemetery beach. The thickness of the deposit varies from 25 to over 50 feet with the thicker portion lying in the deeper water portion of the area. It contains an estimated dredgible volume of at least 13 million cubic yards. Additional sediment could be dredged in deeper waters. Grain size analysis found that the sediment generally consisted of fine to very fine sand, with an indication of some medium sand at depth.

The eastern nearshore borrow area also trends east-west. It is centered approximately 2,000 feet offshore the eastern end of East Beach in water depths of 25 to 50 feet. Dredgible thickness varies from 25 to 40 feet and it contains an estimated dredgible volume of 10.5 million cubic yards. The grain size data indicates near surface material of fine to very fine sand overlying medium sand at relatively shallow depths.

The two eastern deposits offshore of Santa Barbara appear to be acceptable borrow areas from the standpoint of location relative to beaches requiring replenishment, water depth range, volume of sediment, and grain size distribution. The nearshore deposit has the added advantage of being in relatively shallow water.

5.1.2.3 Offshore Carpinteria

The deposit of interest is naturally broken into two parts by the bedrock outcrop area that extends west from Sand Point; these are referred to as Carpinteria north and south. The northern deposit is relatively small with an average thickness of about 20 feet. An estimated dredgible volume of 4.5 million cubic yards was calculated, and core data showed primarily very fine sand.

The southern deposit is much larger and may be fault bounded on the north side. The dredgible volume is restricted by water depths which range from 50 to over 80 feet. However, the major limitation to dredging may be the two Chevron pipelines which cross the area and divide it into two sub areas. Estimated dredgible volumes are in the range of 5.5 million cubic yards for the northern segment and 7.6 million cubic yards for the southern segment. Core samples showed only marginal to unsuitable material.

The deposits offshore Carpinteria appear to be of limited potential use as borrow areas even though they are well situated with respect to target beaches. Water depth limitations and man-made obstructions can probably be mitigated (at a cost), however there are no strong indications of material with a suitable grain size.

5.1.2.4 Santa Clara River

The area offshore of the Santa Clara River and Ventura River mouths contains a large volume of sediment, but the material also consists of a high percentage of fine grained sand. It is believed that the majority of the fine to medium sand may be restricted to the nearshore zone (water depths less than 30 feet) which is considered too shallow for dredging on the open shelf. Furthermore, the thick blanket of relatively fined grained late Pleistocene and Holocene sediment has buried older and possibly coarser grained channel deposits at too great a depth to be economically dredgible. Pockets of medium grained sediment may exist but the deposit boundaries or sediment facies changes are too gradual to definitively map with existing geophysical data.

Dahlen (1988) used recent seismic data collected by the University of Southern California and core data collected by both the U.S. Army and this investigation to refine the limits of the borrow area which lies in the water depth ranges of 30 feet to approximately 50 feet. The volume of the deposit was estimated to be about 250 million cubic yards assuming a relatively uniform blanket of Holocene sediment approximately 25 feet thick.

Grain-size data for the cores collected in this investigation generally indicate a marginally suitable material with no definite pattern of location or depth for the fine-grained material versus the very fine-grained sediment.

5.1.2.5 Summary

Table 5-1 summarizes the general characteristics of the four sand reserve areas. Review of the table shows that the Santa Clara delta region contains the largest volume of sediment. The Santa Barbara deposit was determined to contain the coarsest sand which makes it the most attractive for beach nourishment purposes. The data indicates that large quantities of sand are available within the shoreline areas that could potentially use it. Delivery of the borrow material to candidate beach sites is most efficiently performed by floating dredge equipment as discussed in the next section.

5.2 Sand Recovery and Transport

5.2.1 Dredge Equipment

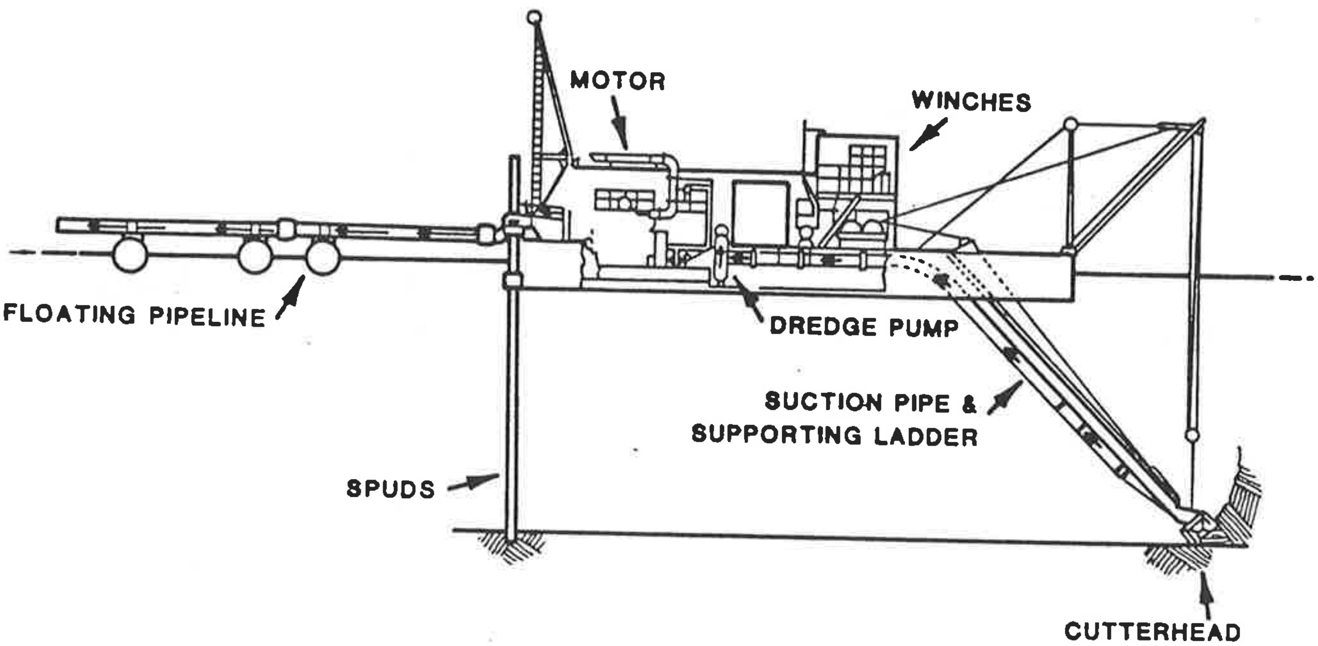
Beach renourishment from offshore borrow areas can be achieved with two types of dredges: hydraulic pipeline and hopper. Hydraulic pipeline dredges are essentially floating barges with onboard pumping equipment which are capable of excavating wide bottom cuts. The suction pipe is often fitted with a rotating cutterhead which loosens the material to be excavated for easier withdrawal. Hence, these dredges are commonly referred to as cutter suction equipment. Pipeline dredges are generally thought of as fixed plant since the dredge is connected to a flexible pipeline that carries the dredge spoil onshore. The dredge can progress through a deposit by adjusting anchors and pile spuds to "walk" forward. Sections of pipeline are added as necessary to accommodate the dredge's propagation through a deposit. Figure 5-4 shows a typical pipeline dredge plant.

Table 5-1

Offshore Sand Deposit Characteristics

Borrow Area		Estimated volume cy	Estimated range in sediment size d_{50}, mm
Goleta			
	Western	17,000,000	0.14 to 0.20
	Eastern	7,000,000	0.14 to 0.20
		24,000,000	
Santa Barbara			
	Nearshore	10,500,000	0.12 to 0.38
	Offshore	13,000,000	0.11 to 0.38
		23,500,000	
Carpinteria			
	Northern	4,500,000	0.11 to 0.22
	Southern	13,100,000	0.11 to 0.15
		17,600,000	
Santa Clara River Delta			
		250,000,000	0.08 to 0.13

Reference: Data from shallow vibracores collected in August-September, 1988.



This dredge is generally equipped with two stern spuds. These spuds are used to advance the dredge into the cut or excavating area. A well-designed 30 inch dredge (size is given by the diameter of the discharge pipe) with 5,000 to 8,000 hp on the pump and 2,000 hp on the cutter will pump 2,000 to 4,500 cubic yards per hour in soft material, and 200 to 2,000 cubic yards per hour in soft to medium hard rock through pipeline lengths up to 15,000 ft.

TYPICAL CUTTER SUCTION PIPELINE DREDGE

REFERENCE: HERBICH, 1975

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Figure 5-4

A hopper dredge is a self propelled vessel with onboard pumping equipment and storage bins to hold excavated material. The principal advantage of a hopper is its ability to freely maneuver through a deposit area and transport the material to distant discharge locations. Figure 5-5 shows a typical hopper dredge.

Table 5-2 summarizes the characteristics of typical dredges in the United States that would be available to the BEACON area. Fixed pipeline dredges are capable of higher daily production rates whereas hopper dredges are reduced in efficiency because of the time required to fill, discharge and transport material and their limited dredge spoil storage capacity. However, their mobility in locations such as the BEACON area where fill sites are irregularly spaced between borrow sites makes their use more feasible.

Pipeline dredges are limited to the length of pipeline attached to the dredge. Furthermore they become operationally hampered in rough seas and consequently can be more expensive to operate because of downtime accumulation. Both dredge types are presently limited to excavation depths of about 90 feet below the water surface. As a minimum economic criteria, it is preferable that at least 15 feet of bottom material (bank) be available for dredging within a water depth of 30 to 60 feet.

For planning purposes, beach nourishment costs were estimated assuming use of hopper dredge equipment. This decision was made on the basis of the location of the offshore borrow areas with respect to potential nourishment sites and the greater flexibility in delivering sand to more distant areas.

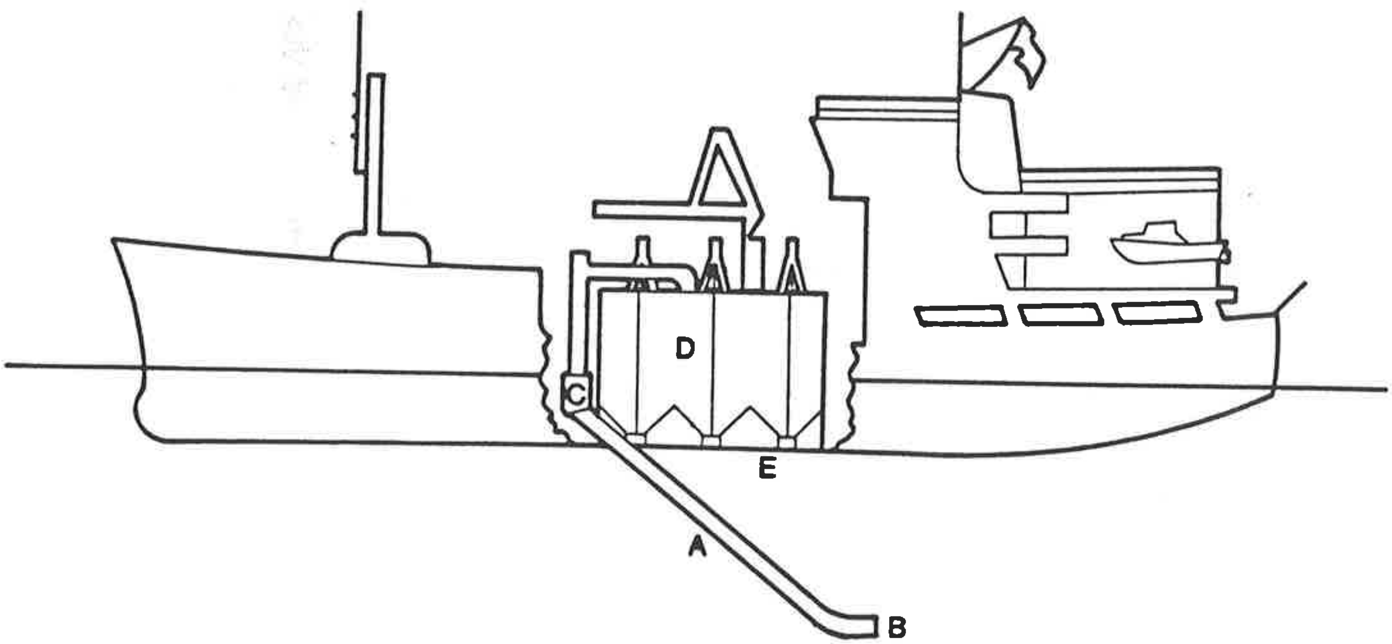
5.2.2 Nourishment Costs

Figures 5-6 through 5-9 show the distance in nautical miles from each borrow source area to points along the shoreline. The cost of delivering sand from these borrow areas to any point is directly proportional to the transport distance. Time to fill and empty the hopper dredge's storage bins is generally constant. Considerable cost savings can be realized if the sand can be bottom dumped from the dredge instead of pumped out of the bins. In the first operation, the dredge merely opens bottom compartment doors and the bin storage is dumped directly on the bottom while the hopper is still underway.

The direct pump out method requires that the hopper moor to a specially adapted buoy which in turn is connected to a pipeline that is laid to the beach. The dredge tethers to the buoy and uses her pumps to empty the storage bins. Sand is then delivered directly to the beach via the pipeline much like the fixed dredge

Hopper dredges are seagoing vessels designed to dredge and transport dredged material to open-water disposal areas. The working of a hopper dredge is similar to that of a home vacuum cleaner.

Dragarms (A) with dragheads (B) extend from each side of the ship's hull. The dragheads are lowered to the channel bottom and slowly pulled over the area to be dredged. Pumps (C) create suction in the dragarm and the silt or sand is drawn up through the arms and deposited in hopper bins (D) in the vessel's midsection. When the bins are full, the dredge sails to the designated disposal area and empties the dredged material through large hopper doors (E) in the bottom of the hull.



TYPICAL TRAILING HOPPER DREDGE

REFERENCE: U.S. ARMY

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Figure 5-5

Table 5-2

Typical Dredges for Beach Nourishment Available to the BEACON Area

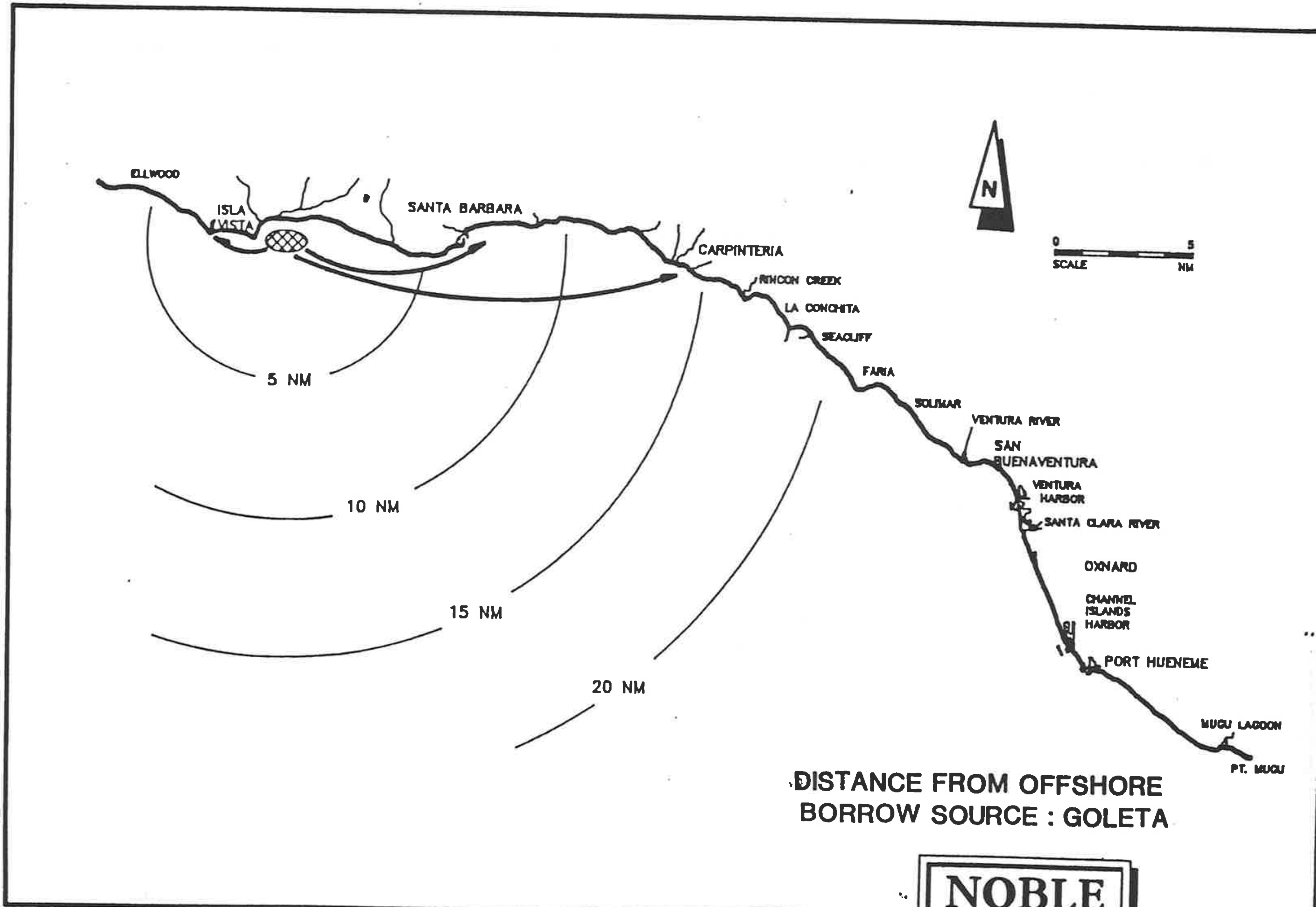
Owner	Dredge Name	Dredge Type	Discharge Pipe Size	Pump Size	Hopper Bin Capacity
			inches	horsepower	cubic yards
1	"Florida"	CS[1]	36	15,000	-
	"Illinois"	CS	30	9,700	-
	"Louisiana"	CS	25	3,425	-
2	"H.D. McCurdy"	CS	30	6,000	-
	"Ollie Riedel"	CS	27	6,000	-
3	"Long Island"	TH[2]	-	na	16,000
4	"Padre Island"	TH	-	7,615	3,600
5	"Newport"	TH	-	6,000	4,000
	"Westport"	TH	-	2,600	1,500
6	"Eagle I"	TH	-	11,685	6,400
7	"Atchafalaya"	TH	-	2,880	1,300
	"Ouachita"	TH	-	8,000	4,000
8	"Essayons"	TH	-	7,200	6,000
	"Yaquina"	TH	-	2,250	825

<u>Owner:</u>

1 - Great Lakes Dredge & Dock Co., Oak Brook, ILL
2 - Western-Pacific Dredging Co., Portland, OR
3 - Henry Dubois Sons Co., Oak Brook, ILL
4 - North American Trailing Co., Oak Brook, ILL
5 - Manson Construction Co., Seattle, WA
6 - Bean Dredging Corp., New Orleans, LA
7 - Gulf Coast Trailing Co., Kenner, LA
8 - U.S. Army Corps of Engineers, Portland District

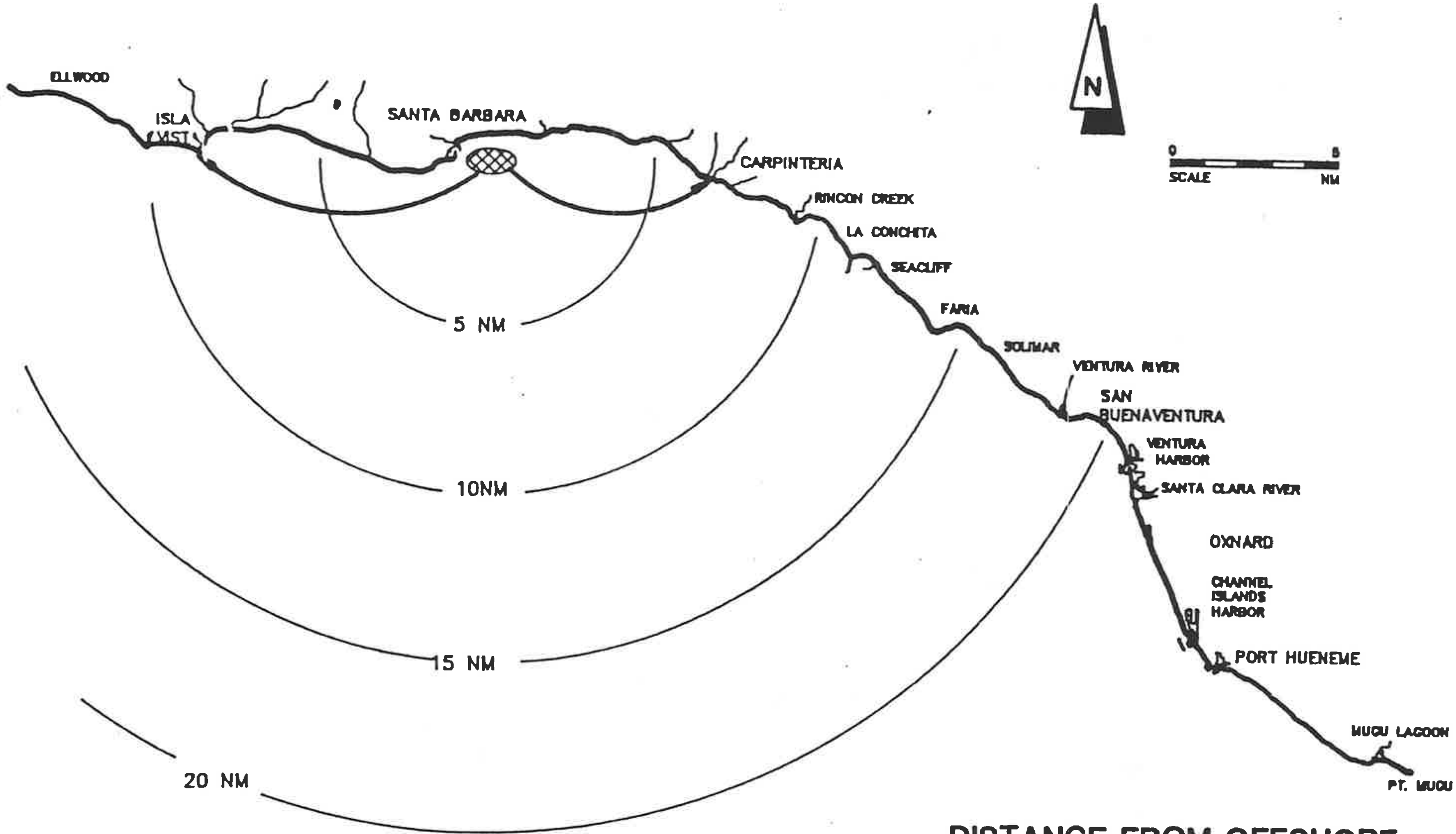
[1] CS = Cutter Suction Dredge
[2] TH = Trailing Suction Hopper Dredge

Reference: World Dredging Mining & Construction, 1989



DISTANCE FROM OFFSHORE BORROW SOURCE : GOLETA

Figure 5-6



DISTANCE FROM OFFSHORE BORROW SOURCE: SANTA BARBARA

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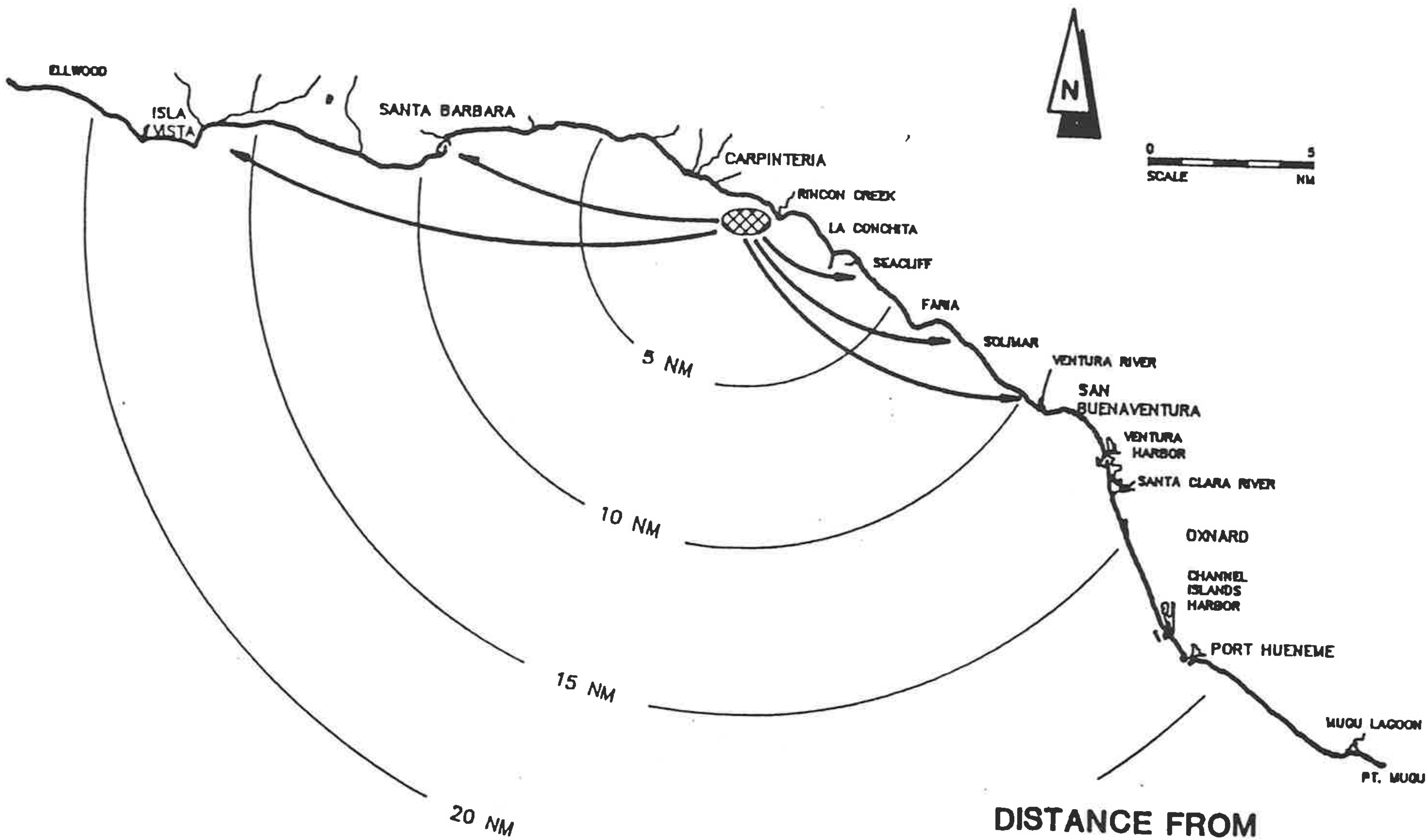
Figure 5-7

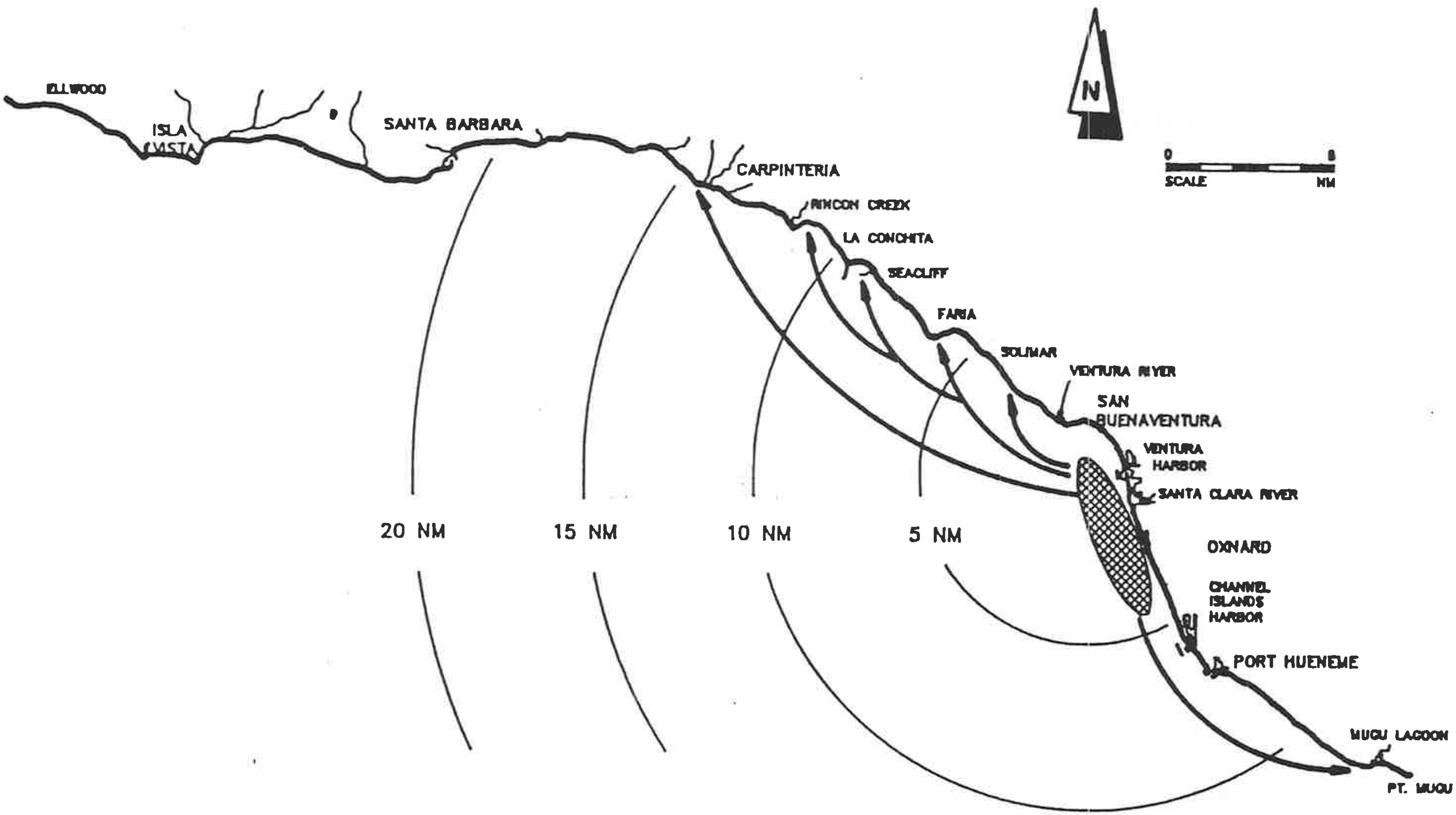
Figure 5-7



DISTANCE FROM OFFSHORE BORROW SOURCE: CARPINTERIA

NOBLE CONSULTANTS

Figure 5-8



DISTANCE FROM OFFSHORE
BORROW SOURCE: SANTA CLARA DELTA

NOBLE CONSULTANTS

Figure 5-9

Figure 5-9

operation. This method of discharge is more expensive because of the capital expense tied up in the buoy and pipe material as well as the time required by the hopper dredge to empty the bins.

Hopper dredges within the U.S. fleet may be further classified as ship or barge type. The first class are those which are fully self propelled, sea going vessels. The latter class are barges which are assisted by push tug. As a result they are slower moving and require more sail time between borrow area and discharge destination.

The different classes of hoppers were estimated for unit cost on the basis of an assumed daily rental rate and the different cycle times involved. This information is summarized in Table 5-3. For purposes of this study, unit price estimates for beach nourishment associated with the hopper barge type equipment were used to assess project costs since they constitute a higher unit price.

5.3 Beach Fill Design Criteria

The beach renourishment concept was formulated by consideration of several pertinent technical design criteria. These criteria include minimum dry beach width, minimum beach elevation, borrow source compatibility, and fill life. The adopted criteria are discussed below.

5.3.1 Dry Beach Width

Minimum berm width was specified based upon seasonal variation. Beach profiles recorded during the BEACON study and observations suggest that the beaches generally recede about 50 feet during the winter months. The calmer summer seas usually restore the berms to their prior condition. It is during the depleted winter profile condition when storm waves occur. Consequently, a minimum buffer width of beach is desirable to absorb storm energy for property protection. This study assumed that a berm width of 50 feet in the winter is a minimal requirement. This translates to a minimum summer berm width of 100 feet. These widths were used to specify beach fill widths for property protection.

5.3.2 Berm Elevation

In conjunction with the berm width, the beach must be high enough in elevation to absorb wave runup and thus prevent sea water from inundating backshore land. A simplified wave runup analysis was performed using procedures outlined by the U.S. Army (1984). Runup was computed by estimating the transformation of

Table 5-3

Beach Nourishment Unit Costs
Using Hopper Dredge Equipment

Distance From Borrow Source in Nautical Miles	Unit Price $/cy Dredge Volume-cy 1,000,000	2,000,000	3,000,000	6,000,000
Equipment: Hopper Dredge; Fill Method: Direct Pump Out				
5	$7.10	$5.00	$4.30	$3.60
10	$7.60	$5.50	$4.80	$4.10
15	$8.00	$6.00	$5.30	$4.60
20	$8.50	$6.50	$5.80	$5.00
25	$9.00	$7.00	$6.20	$5.50
Equipment: Hopper Dredge; Fill Method: Bottom Dump				
5	$1.40	$1.40	$1.40	$1.40
10	$1.90	$1.90	$1.90	$1.90
15	$2.40	$2.40	$2.40	$2.40
20	$2.90	$2.90	$2.90	$2.90
25	$3.20	$3.20	$3.20	$3.20
Equipment: Hopper Dredge; Fill Method: Direct Pump Out				
5	$7.60	$5.50	$4.80	$4.10
10	$8.50	$6.50	$5.80	$5.00
15	$9.50	$7.40	$6.70	$6.00
20	$10.40	$8.40	$7.70	$7.00
25	$11.40	$9.40	$8.60	$7.90
Equipment: Hopper Dredge; Fill Method: Bottom Dump				
5	$1.90	$1.90	$1.90	$1.90
10	$2.80	$2.80	$2.80	$2.80
15	$3.60	$3.60	$3.60	$3.60
20	$4.90	$4.90	$4.90	$4.90
25	$5.50	$5.50	$5.50	$5.50

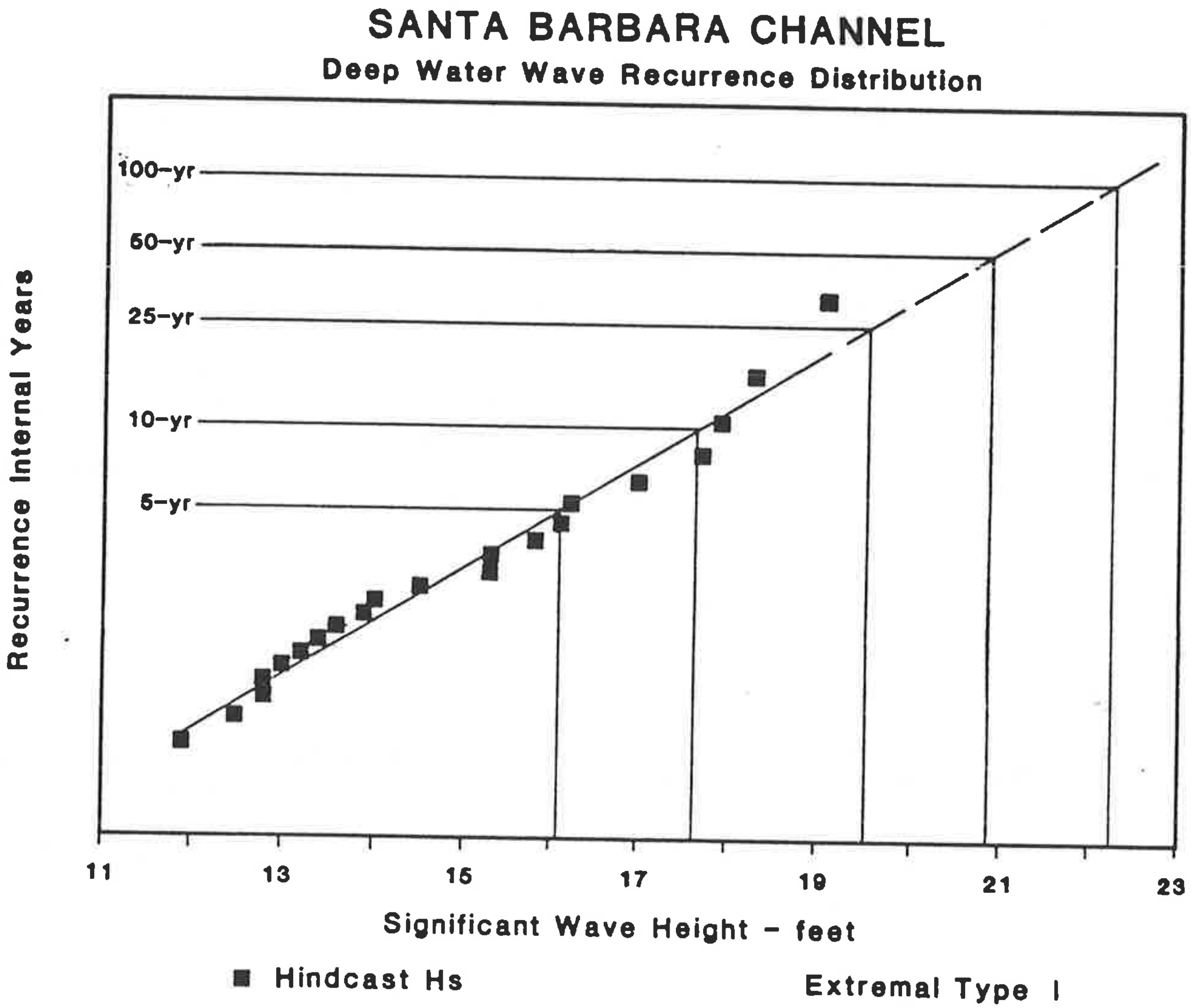
Note: See Appendix I for detailed cost backup data deep water storm waves in the Santa Barbara Channel to different shoreline points. Figure 5-10 summarizes the wave data that was used to describe the deep water storm climate. For purposes of this study a storm wave with a 50 year return probability was selected to assess runup requirements. Table 5-4 tabulates the results.

The table provides an approximate estimate of shallow water storm wave height for the listed areas and the approximate wave runup that would occur on the beach. Breaker heights were estimated based on assumptions of average beach slopes, and the resultant runups were computed. In general, the results suggest that minimum dry beach elevations should be +11.0 to +12.0 feet above Mean Lower Low Water datum (MLLW) in the Santa Barbara County area while Ventura County beaches east of the Rincon Parkway should be filled to at least elevation +13.0 feet MLLW. These elevations were used to specify the volume of dry beach fill required for beach widening at candidate fill sites. Inspection of beach profiles measured in October 1987 and summarized in Appendix D indicate that the calculated berm elevations compare well to natural conditions.

5.3.3 Borrow Material Compatibility

The initial volume of sand required for beach fills depends upon the similarity in grain size distribution when compared to the native sand that exists at the beach proposed for nourishment. Essentially , the finer the borrow, the greater is the volume required, whereas coarse borrow sand allows for reduced fill volumes. This condition may be explained by the fact that finer sands are stable at flatter slopes, whereas coarse grain material lies on a steeper slopes and therefore not as much sand is needed to restore the profile.

Using an equilibrium profile theory presented by Dean (1988a), the percentage of borrow material required for candidate beach areas was estimated. Table 5-5 summarizes the results. The table compares the average native and borrow grain sizes for representative shoreline sections and different offshore deposits in terms of an overfill ratio. The overfill ratio is defined as the number of cubic yards of fill material required to widen a beach divided by the comparable number of cubic yards required to achieve the same width if sand identical to the existing beach material were used. Comparisons are also made to an older empirical method considered too conservative for this study.



SANTA BARBARA CHANNEL
STORM WAVE HEIGHT RECURRENCE

REFERENCE: DATA FROM KENT, 1988

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Figure 5-10

Table 5-4

Beach Berm Elevation Calculations
(Wave Runup Analysis)

	Approximate Shallow water wave height* H'o ft	Wave Period sec	Runup ft	Runup elevation ft, MLLW
Isla Vista	9.6	16.0	5.1	11.1
Carpinteria	11.6	16.0	5.8	11.8
Pierpont Bay	15.4	16.0	6.6	12.6
Oxnard	13.5	16.0	6.3	12.3

*Assumes deep water wave height of 20.8 feet (50-year return probability), stillwater level of +6.0 feet MLLW.

Reference: Table prepared using simplified wave runup calculation procedures summarized in the Shore Protection Manual, U.S. Army, 1984.

Table 5-5

Offshore Sand Source Overfill Ratios

Borrow Site	Fill Site: Isla Vista	Goleta	Santa Barbara	Carpinteria	Emma Wood
Goleta	2.4 (3.5)	2.8 (6.0)	1.7 (1.75)		
Santa Barbara	1.8 (1.6)	2.3 (3.0)	1.0 (1.2)	2.4 (1.8)	
Carpinteria				3.2 (9.0)	3.1 (*)
Santa Clara River Delta					3.7 (*)

Note: Overfill ratio is defined as the ratio of borrow sand volume to sand volume identical to native material required to fill a given beach.

() : SPM method by Hobson, 1977
 : Equilibrium profile method by Dean, 1988
* : Unstable per SPM methodology

5.3.4 Fill Longevity

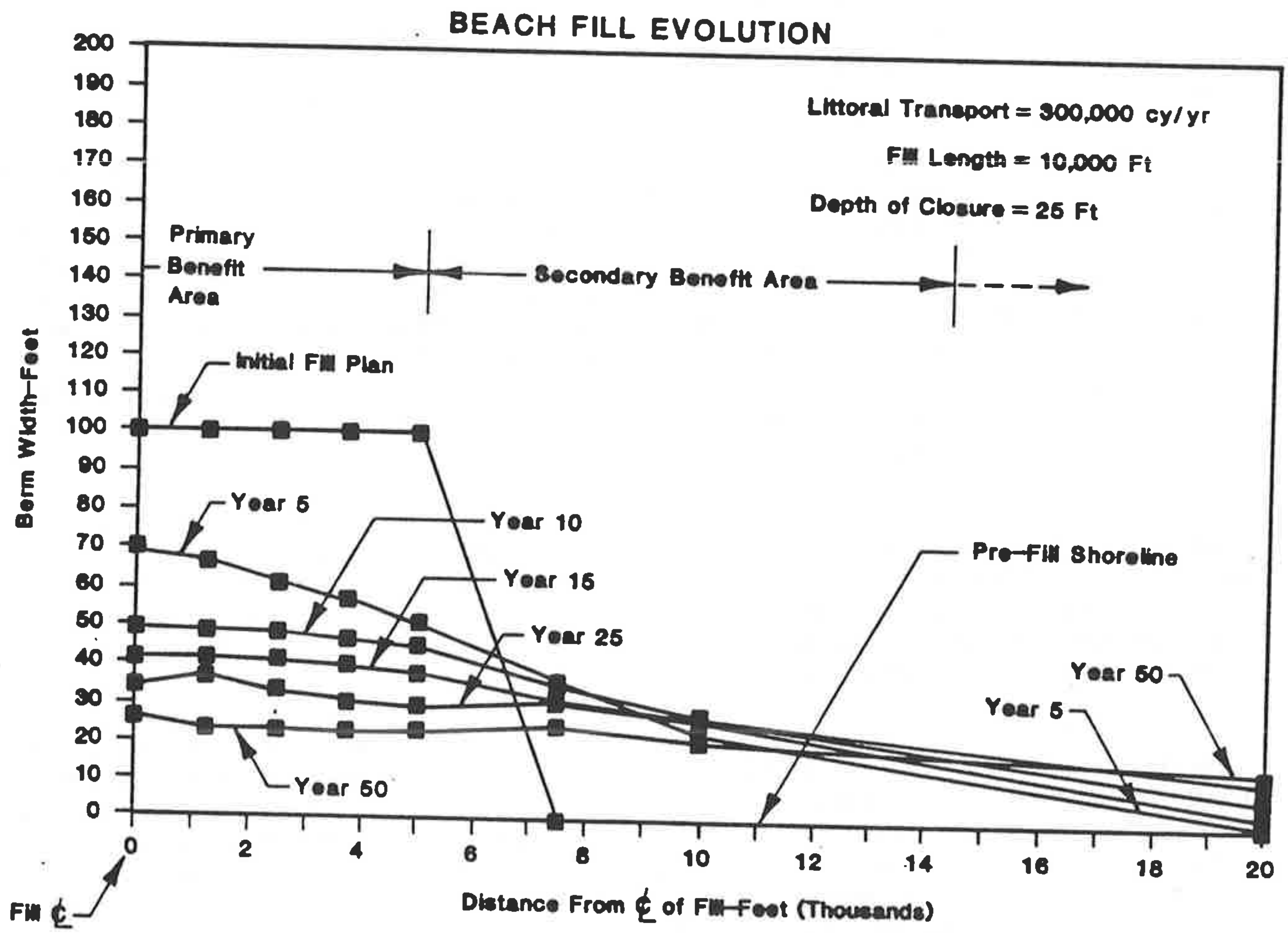
The remaining design criteria for beach renourishment projects is the estimated life. Beach fills spread laterally alongshore in an upcoast and downcoast direction as waves rework the artificial deposit. The theory has been described by many including Dean (1988a) and Larsen et al (1987). In general artificial fills rapidly diffuse at first and as a consequence lose a portion of their width to lateral spreading. The process slows with time and subsequent width reductions occur more slowly. Finer grained material will also tend to be transported more rapidly than coarse size sands (Dean, 1988a).

This diffusion process means that an upcoast fill, aside from contributing sand to the overall sediment budget, will result in some beach widening beyond the endpoints of the fill boundary. This characteristic may be utilized to obtain secondary recreation and storm protection benefits. For a fill length of 10,000 feet, for example, the beach within about another 10,000 feet of the project limits may accrete by about 20 to 30 feet over a 5 to 50 year period. This principal is schematically illustrated in Figure 5-11 and was used to address private shore segments.

Periodic injection of sand can serve to maintain a desirable width, but the technique is further complicated by the wave energy available to move the sediment. Simply stated, if a large volume of sand is deposited at a beach whose profile has historically been sediment limited, the potential for increased alongshore transport exists.

The beaches of Santa Barbara County are thought to be source limited in that the sandy portion is a relatively thin veneer overlying a rocky substrate. (Inman, 1988). This implies that during winter conditions when beach profiles are diminished, not enough sand is available for transport even though the available wave energy is present. Therefore it is believed that the existing alongshore transport from Ellwood to the Ventura River may be characterized by this condition. Exceptions along the way may include the more sandy beach segments such as Goleta, East Beach, and Carpinteria. The implication of this phenomenon is that artificial fills may dissipate more rapidly due to greater littoral transport rate resulting from the extra sand present.

Based upon sediment budget studies it is estimated that the lower and upper bound of alongshore transport from Ellwood to Point Mugu is on the order of 300,000 cubic yards per year to about 1,000,000 cubic yards per year. Discounting variations in wave energy over the study shoreline, it may be conservatively assumed that the upper limit of alongshore transport may be representative of artificial beach conditions within the Santa Barbara area. This criteria is accommodated by specifying



DIFFUSION OF BEACH FILL

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Figure 5-11

additional fill width to compensate for an accelerated diffusion and advection rate. Therefore, beaches which are assumed to be governed by this availability factor require more sand to compensate for the anticipated transport. This factor may also be reconciled by scheduling larger volumes of periodic renourishment to maintain the minimum specified beach width. Table 5-6 summarizes fill widths and maintenance volumes estimated to achieve the minimum 50 foot winter berm width criteria.

5.4 Beach Renourishment Site Selection

Candidate sites for beach nourishment were reviewed by the following criteria:

1. Renourish areas with sediment budget deficits;
2. Restore non-existent or narrow beaches;
3. Enhance areas with high recreation potential and access; and
4. Provide storm protection buffer for backbeach property and infrastructure.

Figure 5-12 summarizes an appraisal of the study area shoreline in terms of the above criteria. The figure indicates the general shoreline segments where each criteria may be considered applicable. The main conclusion that may be drawn from the figure is that beach nourishment is appropriate over most of the study shoreline for different reasons.

5.5 Sand Recycling

The shoreline east of the Ventura River poses another strategy option. The area has been identified as having adequate present day beach width, but a strong potential for rapid erosion in the near future. The future erosion potential is associated with the sharply reduced fluvial sand production rates caused by dam construction and sand mining on the Ventura and Santa Clara Rivers. Furthermore, it is recognized that the Mugu Submarine Canyon is the ultimate sink for most if not all littoral sand within the regional cell. Therefore, measures which could be developed to capture this sand and recycle it upcoast would realize a conservation of existing beach resources and reduce the need to supplement the local budget deficit. In other words, mechanical backpassing of sand upcoast would defray the necessity for beach reconstruction in the future and lesson the need for periodic beach renourishment from offshore sources by simply maintaining the present adequate widths which currently exist.

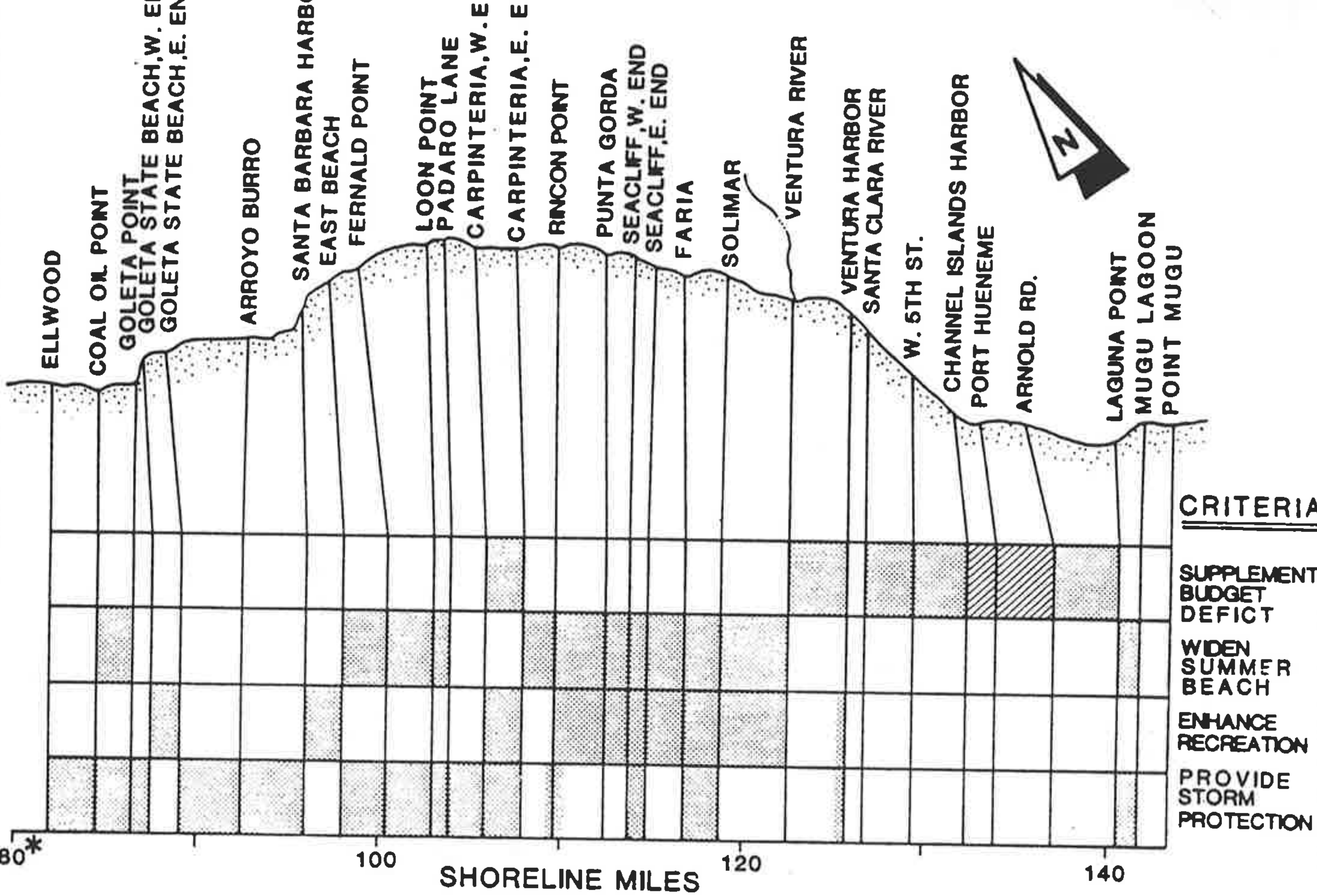
Table 5-6

Estimated Fill Widths and Renourishment Volumes

Location	Estimated longshore rate (existing) cy/yr	Construction fill width ft	Assumed transport rate (after fill) cy[1]
Isla Vista	263,000	110	526,000
Goleta	263,000	100	526,000
Santa Barbara	300,000	100	512,000
Carpinteria	250,000	100	1,380,000
Emma Wood	215,000	150	1,610,000

Note: A 5 degree breaking wave angle is assumed.

[1] Includes factor of safety as per Dean, 1988.



CRITERIA DEFINITION:

BUDGET DEFICIT – SEDIMENT LOSSES EXCEED SOURCES

WIDEN SUMMER BEACH – EXISTING SUMMER BEACH WIDTH IS NON-EXISTENT OR VERY NARROW

ENHANCE RECREATION – GOOD ACCESS AREA MAY ACCOMMODATE BEACH WIDENING TO INCREASE USE

STORM PROTECTION – BACKBEACH EXPOSED TO RECURRING WINTER STORM DAMAGE

LEGEND

SHORELINE SEGMENT APPROPRIATE FOR BEACH NOURISHMENT TO SATISFY CRITERIA

RELATED BY HARBOR BYPASSING

*0 = SANTA BARBARA/SAN LUIS OBISPO COUNTY LINE

BEACH NOURISHMENT SITE SELECTION EVALUATION

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Figure 5-12

The sand recycling method has been considered one of the highest priority techniques that should be considered to restore littoral sand supply (State of California, 1975).

The sand recycling concept may be implemented via fixed bypass plants or floating hopper dredges or a combination of the two. Presently the Federal government is committed to annual maintenance at Ventura Harbor and a biannually dredging program at Channel Islands Harbor. The equivalent of about 640,000 and 1,190,000 cubic yards of sand is bypassed around these facilities annually. The bypassed material then continues downcoast to the Mugu Canyon sink.

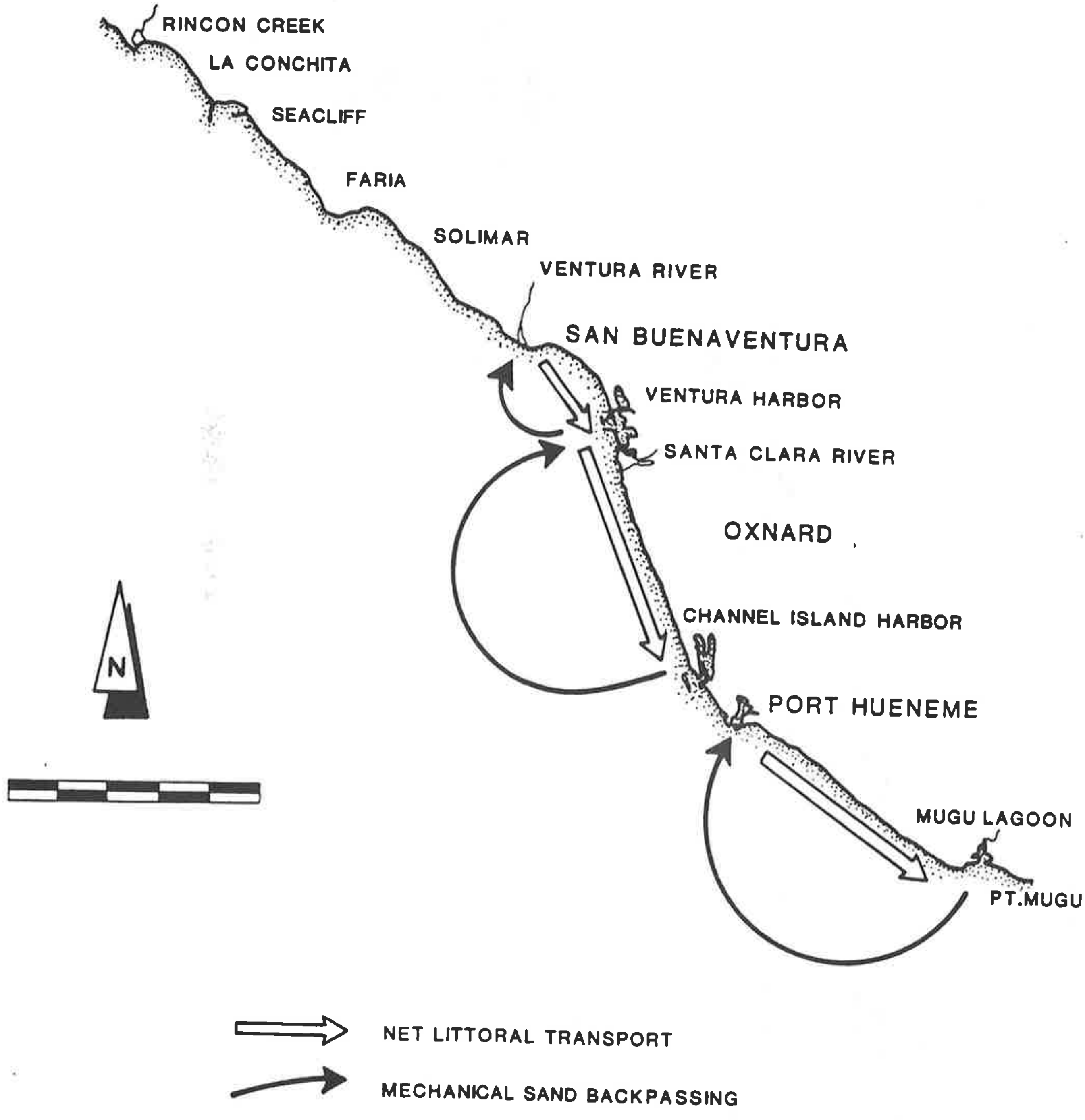
The sand recycling strategy is illustrated in Figure 5-13. Littoral sand over the shore segment between Pierpont Bay and Mugu Canyon could be intercepted and returned upcoast within three compartments. Sand could be reclaimed at Laguna Point, Channel Islands Harbor, and Ventura Harbor and returned upcoast to Hueneme Beach, McGrath State Beach, and Upper Pierpont Bay respectively. Hopper dredges could be used to transport the sand, or alternatively fixed eductor jet pumps could be utilized. The latter method has been successfully employed in Australia to bypass comparable sand volumes as required by any of the proposed three backpass stations shown in Figure 5-13. With careful planning, the methodology would prove more flexible and less costly than conventional dredging methods. A fixed plant also provides the opportunity to transport and deliver sand daily to multiple discharge points if desired.

Comparative cost analysis indicates that the fixed plant strategy would yield a cheaper annualized cost in comparison to hopper dredge methods transporting a volume of approximately 2.7 million cubic yards (Hydro Sands, Inc., 1989). The technology is still developing and requires more design study prior to its incorporation within the BEACON area.

5.6 Levels of Action

The sand nourishment strategy may be implemented at different levels of action depending on need and funding limitations. Figure 5-12 indicates that based upon the adopted criteria, the entire study shoreline is appropriate for shoreline recovery and enhancement. This plan, therefore, constitutes an upper bound level of action, and subsequent alternatives may be formulated based upon reduced scopes of renourishment.

Figure 5-14 summarizes four levels of action that were formulated. Plan 1 represents the maximum regional recovery program of area wide renourishment as recommended from Figure 5-12. Plans 2 through 4 represent successive reductions in renourishment coverage.



SAND RECYCLING CONCEPT

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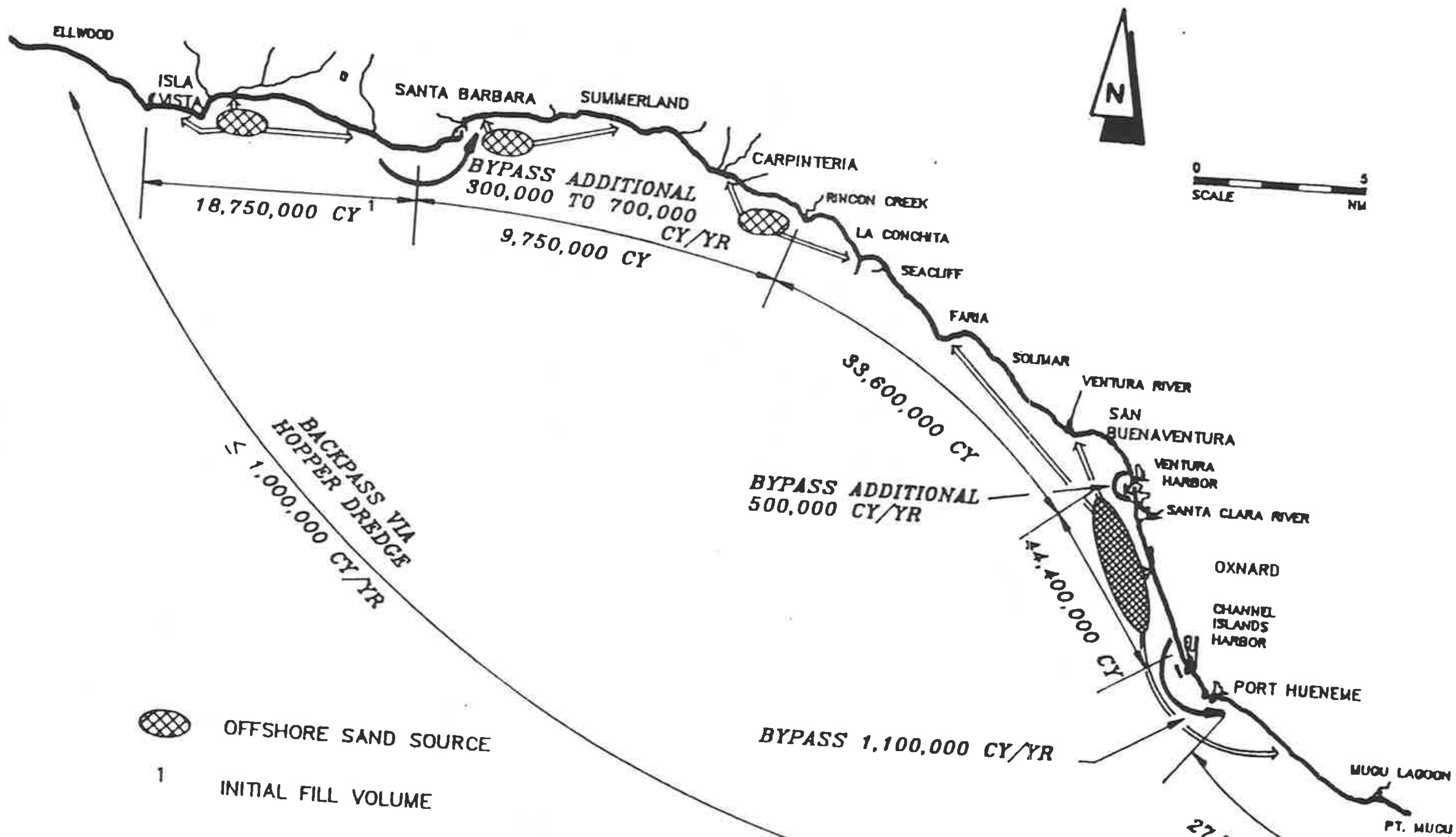
Figure 5-13



PLAN 1

REGIONAL RECOVERY AND MAINTENENCE

ISLA VISTA - PT. MUGU

NOBLE

Table 5-7

Regional Recovery and Maintenance: Plan 1

Details:

56 miles of beach fill from offshore dredge operation between Isla Vista and Laguna Point.

Preliminary Cost Estimate:

Location	Action	Expense Item	Amount cy	Unit Price $/cy	Cost		25-Year Project Cost
1. Goleta to Santa Barbara	Beach Fill	Mob/Demob			$500,000		
		Sand Volume	18,750,000 cy	$3.10	$58,100,000		
						Subtotal:	$58,600,000
2. Santa Barbara to Carpinteria	Beach Fill	Mob/Demob			$1,000,000		
		Sand Volume	9,750,000 cy	$3.10	$30,200,000		
						Subtotal:	$31,200,000
3. Carpinteria to San Buenaventura	Beach Fill	Mob/Demob			$1,000,000		
		Sand Volume	33,600,000 cy	$3.50	$117,600,000		
						Subtotal:	$117,600,000
4. San Buenaventura to Channel Islands Harbor	Beach Fill	Mob/Demob			$500,000		
		Sand Volume	44,400,000 cy	$3.10	$137,600,000		
						Subtotal:	$138,100,000
5. Port Hueneme to Laguna Point	Beach Fill	Mob/Demob			$500,000		
		Sand Volume	27,750,000 cy	$3.50	$97,100,000		
						Subtotal:	$97,600,000
6. Santa Barbara	Additonal Harbor Maintenance	Dredging	700,000 cy	$2.00	$1,400,000/yr		
			Subtotal:	$35,000,000			
7. Ventura Harbor	Additional Harbor Maintenance	Dredging	500,000 cy	$2.00	$1,000,000/yr		
		Subtotal:	$25,000,000				
8. Laguna Point Sand to Ellwood		Mob/Demob			$250,000		
	Backpassing	Dredging	1,000,000 cy	$5.50	$ 4,600,000/yr		
	Subtotal:	$138,300,000					

SUM:	$642,400,000
Contingencies (10%)	$64,200,000
Engineering & Design (4.5%)	$28,900,000
Supervision & Admin (4.5%)	$28,900,000
TOTAL:	$764,400,000

After the completion of the initial fill, annual maintenance of about 1,000,000 cubic yards per year would be required to recycle sand from the Mugu Canyon area upcoast to Ellwood. The volume, to be transported by hopper dredge, is assumed to be necessary, to maintain the post fill alongshore transport rate west of the Ventura River.

5.6.2 Reduced Regional Recovery and Maintenance (Plan 2)

This plan is illustrated in Figures 5-16 through 5-20 and the components are summarized in Table 5-8. The plan is intended to fulfill the following objectives:

1. Reconstruct and maintain a public beach at Isla Vista with secondary bluff erosion mitigation benefit.

2. Enhance Goleta State Beach to increase recreation and provide a secondary downcoast benefit of beach widening to reduce bluff erosion problems.

3. Maintain sand bypassing at Santa Barbara Harbor.

4. Enhance Santa Barbara's East Beach and restore beaches downcoast to Miramar for recreation and property protection objectives; provide a secondary benefit downcoast to Summerland as a result of the fill transport to that area.

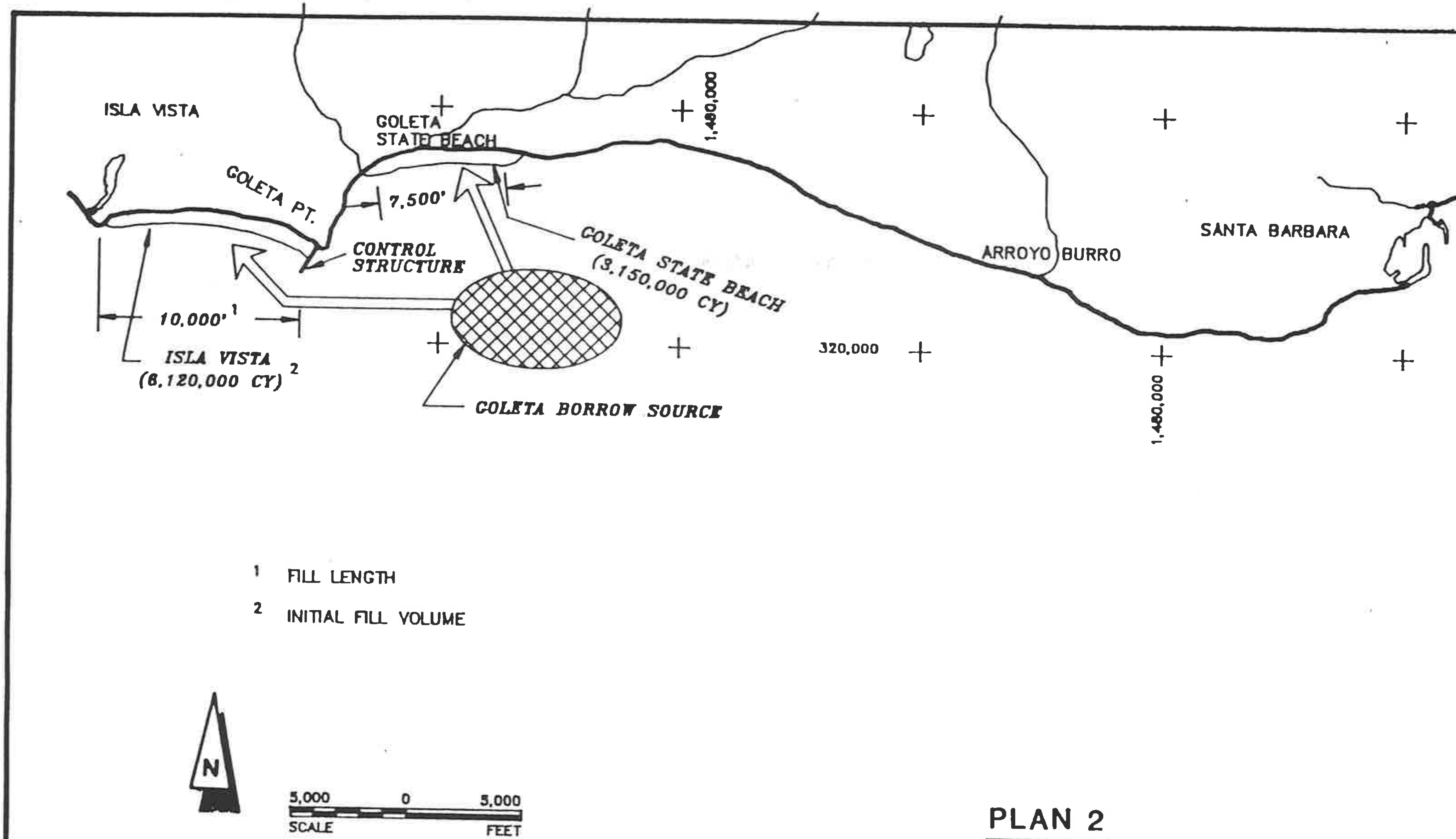
5. Restore and enhance beaches from Padaro Lane through Carpinteria for recreation and property protection purposes.

6. Provide for small, periodic sand inputs along the Rincon Parkway to stimulate pocket beach growth and provide some measure of enhancement and structure protection to the structurally fortified segment.

7. Reconstruct a sandy beach from Solimar through Emma Wood County Park for recreation enhancement.

8. Construct a fixed sand backpass/bypass transfer system at Ventura Harbor, Channel Islands Harbor, and Laguna Point to recycle littoral sand from Pierpont Bay to Mugu Canyon.

9. Optional construction of groin fields east of McGrath State Beach to reduce alongshore transport over the populated coastal sections and reduce the need for sand supplementation.



PLAN 2

REDUCED REGIONAL RECOVERY AND MAINTENANCE
ISLA VISTA -SANTA BARBARA

NOTES :

1. COORDINATES ARE CALIFORNIA STATE GRID ZONE 5.

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Figure 5-16

Figure 5-16

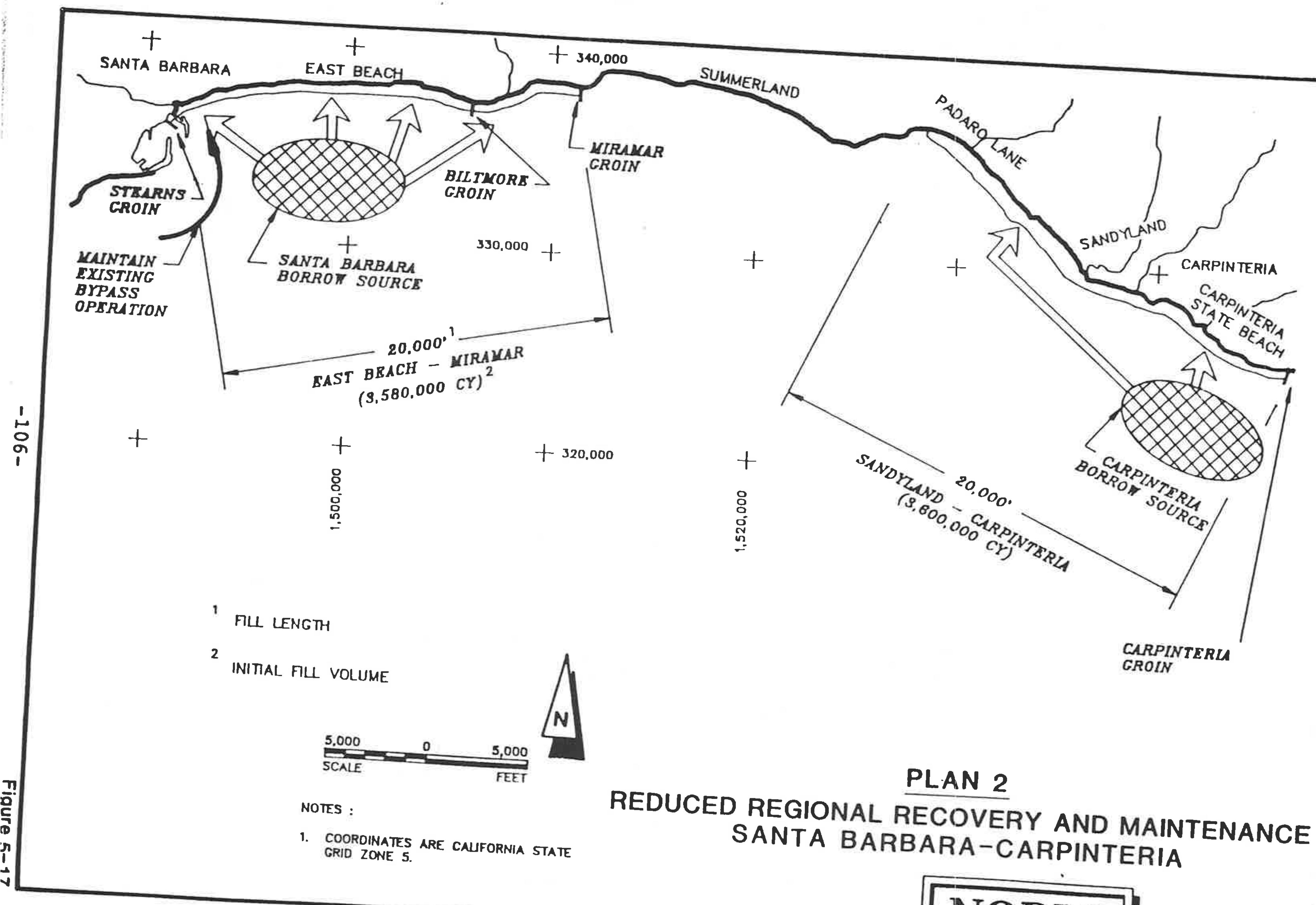
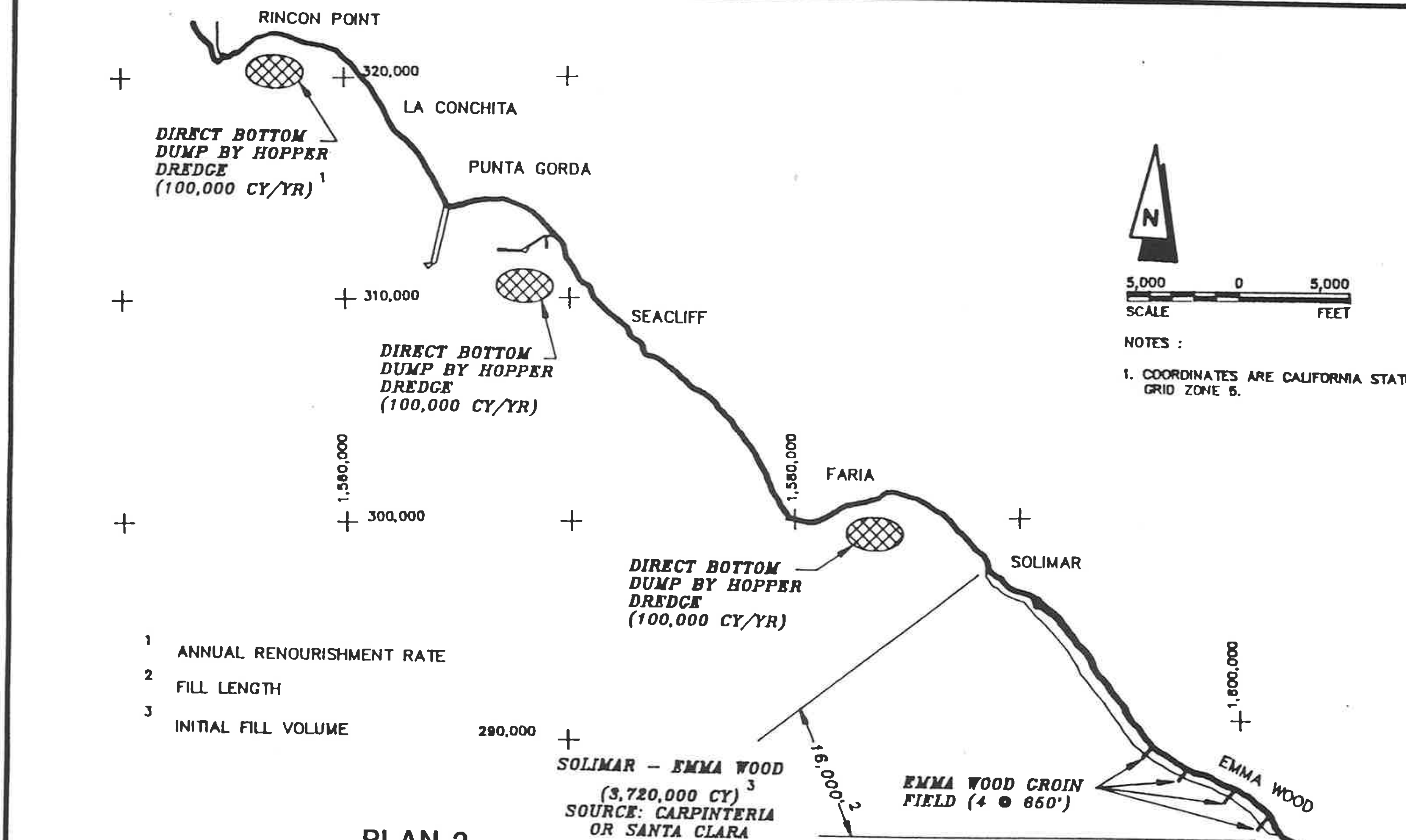

SANTA BARBARA
EAST BEACH
340,000
SUMMERLAND
PADARO LANE
MIRAMAR GROIN
BILTMORE GROIN
STEARNS GROIN
MAINTAIN EXISTING BYPASS OPERATION
SANTA BARBARA BORROW SOURCE
330,000
SANDYLAND
CARPINTERIA
CARPINTERIA STATE BEACH
20,000'[1]
EAST BEACH - MIRAMAR
(3,580,000 CY)[2]
320,000
1,500,000
1,520,000
20,000'
SANDYLAND - CARPINTERIA
(3,600,000 CY)
CARPINTERIA BORROW SOURCE
CARPINTERIA GROIN
1 FILL LENGTH
2 INITIAL FILL VOLUME
N
5,000 0 5,000
SCALE FEET
NOTES :
1. COORDINATES ARE CALIFORNIA STATE GRID ZONE 5.
PLAN 2
REDUCED REGIONAL RECOVERY AND MAINTENANCE
SANTA BARBARA-CARPINTERIA
NOBLE

Figure 5-17



PLAN 2

REDUCED REGIONAL RECOVERY AND MAINTENANCE CARPENTERIA–EMMA WOOD

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Figure 5-18

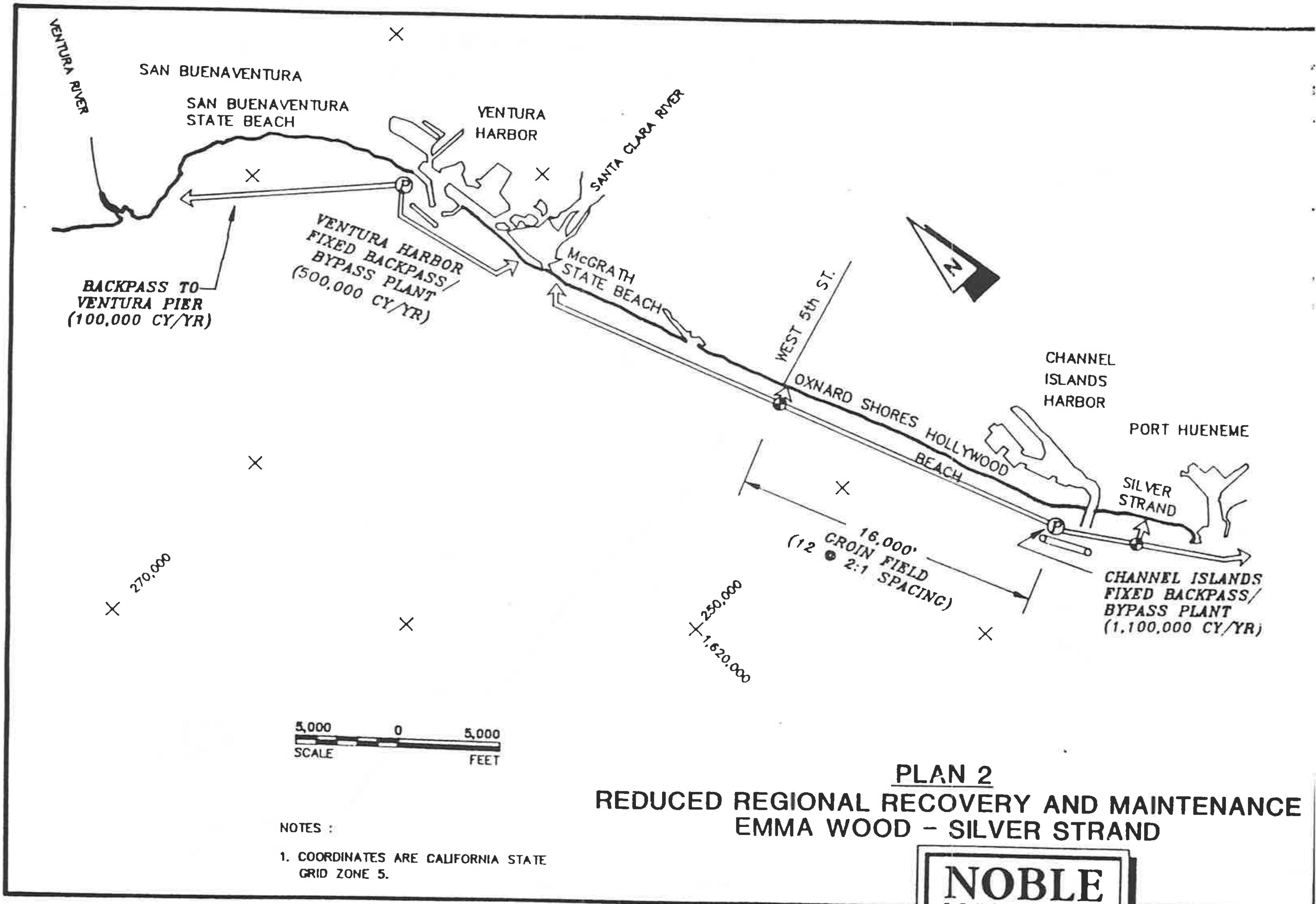
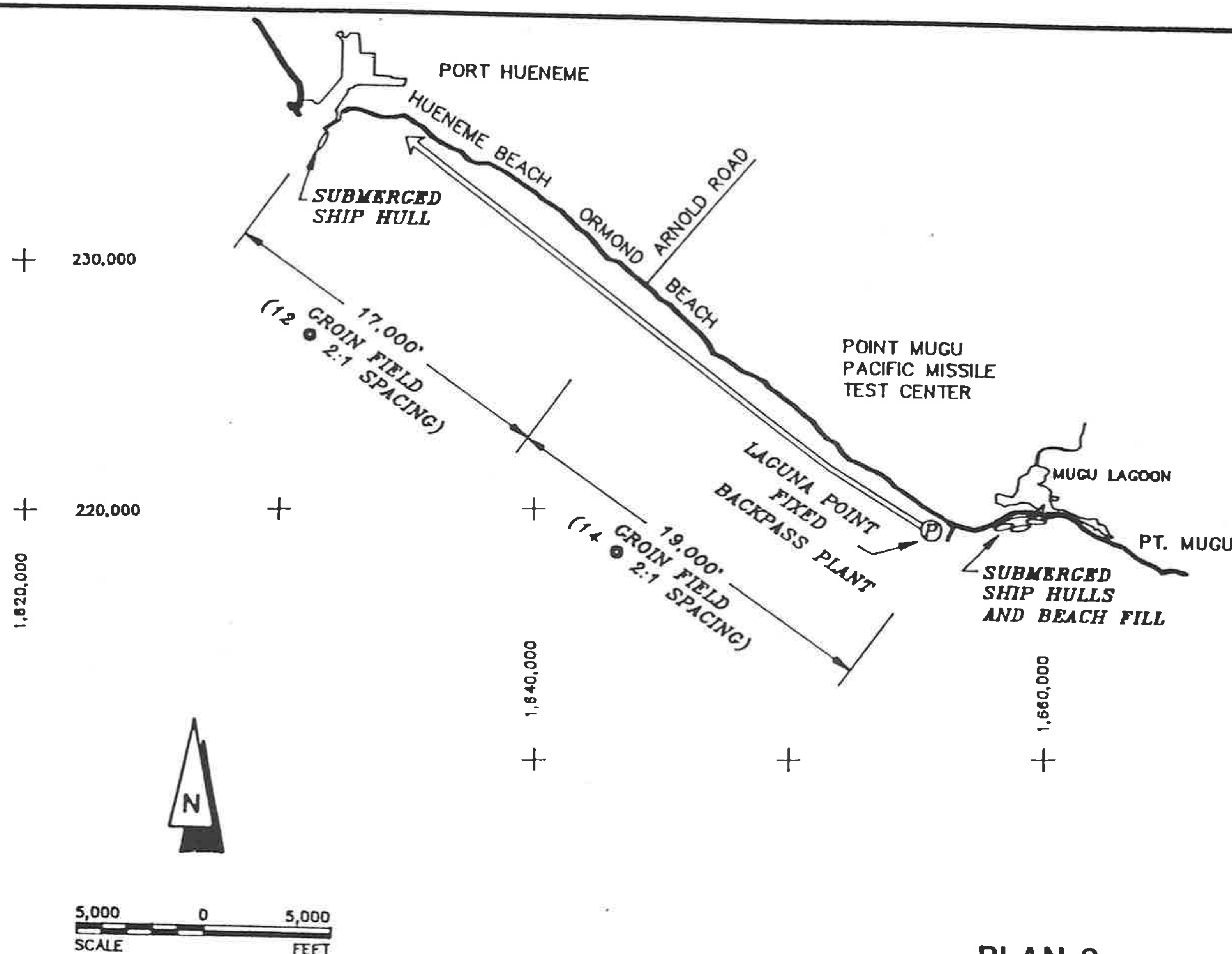

VENTURA RIVER
SAN BUENAVENTURA
SAN BUENAVENTURA STATE BEACH
VENTURA HARBOR
SANTA CLARA RIVER
BACKPASS TO VENTURA PIER (100,000 CY/YR)
VENTURA HARBOR FIXED BACKPASS/ BYPASS PLANT (500,000 CY/YR)
McGRATH STATE BEACH
WEST 5th ST.
OXNARD SHORES HOLLYWOOD BEACH
CHANNEL ISLANDS HARBOR
PORT HUENEME
SILVER STRAND
16,000' GROIN FIELD (12 @ 2:1 SPACING)
CHANNEL ISLANDS FIXED BACKPASS/ BYPASS PLANT (1,100,000 CY/YR)
N
270,000
250,000
1,620,000
5,000
0
5,000
SCALE
FEET
PLAN 2
REDUCED REGIONAL RECOVERY AND MAINTENANCE
EMMA WOOD - SILVER STRAND
NOTES :
1. COORDINATES ARE CALIFORNIA STATE GRID ZONE 5.
NOBLE
CONSULTANTS

Figure 5-19



NOTES:

1. COORDINATES ARE CALIFORNIA STATE GRID ZONE 5.

PLAN 2
REDUCED REGIONAL RECOVERY AND MAINTENANCE SILVER STRAND – PT. MUGU

NOBLE CONSULTANTS

Figure 5-20

Table 5-8

Reduced Regional Recovery and Maintenance: Plan 2

1. Isla Vista	10,000 ft. of beach fill from offshore dredge operation and construction of one control groin.
2. Goleta	7,500 ft. of beach fill at Goleta State Beach from offshore dredge operation.
3. Santa Barbara	20,000 ft. of beach fill from West Beach east past Miramar Beach from offshore dredge operation and construction of three control groins at West Beach, Biltmore and Miramar.
4. Carpinteria	20,000 ft. of beach fill from offshore dredge operation and construction of one control groin.
5. Rincon Point	Sand injection at Rincon Point by hopper bottom dump from offshore dredge operation.
6. Punta Gorda	Sand injection at Punta Gorda by hopper bottom dump from offshore dredge operation.
7. Faria	Sand injection at Faria by hopper bottom dump from offshore dredge operation.
8. Emma Wood	16,000 ft. of sand fill from offshore dredge operation and construction of four groins.
9. Ventura	Beach nourishment along San Buenaventura State Beach from fixed backpass/bypass plant at Ventura Harbor.
10. Oxnard Shores	Beach nourishment along McGrath, Oxnard Shores, and Hollywood Beaches from fixed backpass/bypass plant at Channel Islands Harbor. Plus optinal construction of 12 control groins along Oxnard Shores and Hollywood Beaches.
11. Silver Strand	Beach nourishment through fixed backpass/bypass plant at Channel Islands Harbor.
12. Ormond Beach	Beach nourishment along Ormond Beach and Hueneme Beach from fixed backpass plant at Laguna Point. Plus construction of 12 optional control groins along Ormand Beach and 14 optional control groins along Hueneme Beach. Extension of Port Hueneme South breakwater.
13. Mugu Lagoon	Beach fill from offshore dredge operation plus construction of a submerged breakwater donated by the U.S. Navy.

10. Extend the Port Hueneme south breakwater to prevent sand loss to Hueneme Canyon.

11. Fill Mugu Lagoon beach and stabilize it with offshore ship hulk submerged breakwaters.

The cost breakdown of the plan is summarized in Table 5-9. The essential design criteria are outlined below.

The fill projects west of the Ventura River were specified to provide a resultant minimum winter berm width of 50 feet over a project life of 25 years. This is accomplished by pumping a total of almost 20,000,000 cubic yards of sand onshore to satisfy overfill requirements. A five-year renourishment maintenance program was specified to maintain this minimum fill width over the project life to reduce mobilization and demobilization costs. The estimated total project cost over a 25 year period is about $445 million.

The renourishment liability may be reduced by the use of control groins to regulate the loss of sand at the downcoast end of the fills. The control groin would be a low profile shore perpendicular structure located at the downcoast end of the fill site. Its purpose would be to regulate the littoral transport to pre-fill rates so that fill life is extended as much as possible. Furthermore, the structure would serve to maintain the widened planform of the fill. The concept is similar to the terminal groin at Santa Barbara's East Beach which has helped to preserve the width of the upcoast fill that was restored there about 40 years ago. The specific technical merits of control groins at other recommended locations requires more careful study and, ideally, is best preceded by a prototype test.

Approximately 2.4 million cubic yards of renourishment is estimated every 5 years for the sediment limited beaches west of the Ventura River. Assuming control structures could reduce this liability by as little as 10 percent, a savings of over $1,600,000 every 5 years would be realized. Thus, their contribution to the overall plan economics increases with their effectiveness.

Sand recycling is specified for the Ventura to Mugu Canyon segment to take advantage of the existing beach conditions there and maintain present widths. Sand capture prior to loss to Mugu Canyon is a critical element of the plan. At this time, construction and maintenance of a fixed bypass plant system appears to offer the potential for least cost.

The individual plants would consist of a shore stationed pump house that would drive a series of eductor suction jet pumps buried within the active nearshore littoral zone. Each eductor would be capable of excavating a cone shaped depression up to 20

Table 5-9

Preliminary Cost Estimate
Reduced Regional Recovery and Maintenance: Plan 2

Location	Project List	Expense Item	Amount cy or ft	Unit Price $/cy or $/ft	Cost	Remarks	25[illegible] Proj[illegible]
1. Isla Vista	Initial Fill	Mob/Demob			$250,000		
		Sand Volume	6,120,000 cy	$4.10	$25,100,000		$25,4
	Control Groin	Mob/Demob			$200,000		
		Groin Length	600 ft	$1,500	$900,000		$1
	Maintenance Fill	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	384,000 cy	$5,90	$2,300,000	Per 5 yrs	$10,4
						Subtotal	$36
2. Goleta	Initial Fill	Mob/Demob			$250,000		
		Sand Volume	3,150,000 cy	$4.80	$15,100,000		$15,4
	Maintenance Fill	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	448,000 cy	$4.60	$2,100,000	Per 5 yrs	$9
						Subtotal:	$25,0
3. Santa Barbara	Initial Fill	Mob/Demob			$250,000		
		Sand Volume	3,580,000 cy	$4.80	$17,200,000		
		Mob/Demob			$40,000		
		West Bh. Borrow	500,000 cy	$2.00	$1,000,000		$18
West Beach	Control Groin	Mob/Demob			$75,000		
		Groin Length	600 ft	$1,850	$1,110,000		$1,
Biltmore	Control Groin	Mob/Demob			$75,000		
		Groin Length	650 ft	$1,500	$975,000		$1,1
Miramar	Control Groin	Mob/Demob			$75,000		
		Groin Length	650 ft	$1,500	$975,000		$1,
	Maintenance Fill	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	204,000 cy	$5.90	$1,204,000	Per 5 yrs	$5,8
						Subtotal:	$27,
4. Carpinteria	Initial Fill	Mob/Demob			$250,000		
		Sand Volume	3,600,000 cy	$5.80	$20,900,000		$21,
	Control Groin	Mob/Demob			$75,000		
		Groin Length	600 ft	$1,500	$900,000		$1,
	Maintenance Fill	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	900,000 cy	$4.00	$3,600,000	Per 5 yrs	$15,
						Subtotal:	$48,
5. Rincon Point	Sand Injection	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	500,000 cy	$4.60	$2,300,000	Per 5 yrs	$10,
6. Punta Gorda	Sand Injection	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	500,000 cy	$5.50	$2,800,000	Per 5 yrs	$12,2
7. Faria	Sand Injection	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	500,000 cy	$5.50	$2,800,000	Per 5 yrs	$12,
						Subtotal:	$34,
8. Emma Wood	Initial Fill	Mob/Demob			$250,000		
		Sand Volume	3,720,000 cy	$5.40	$20,100,000		$20,
	Control Groins	Mob/Demob			$100,000		
		Groin Length	2600 ft	$1,500	$3,900,000	4 Groins	$4,000
	Maintenance Fill	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	496,000 cy	$5.50	$2,700,000		$11,
						Subtotal:	$36,200

Table 5-9 (Continued)

Location	Project List	Expense Item	Amount cy or ft	Unit Price $/cy or $/ft	Cost	Remarks	25-Year Project Cost
9. Ventura Harbor	Backpass Plant	Sand Volume	500,000 cy	$2.00	$1,300,000	Per yr	$25,000,000
10. Oxnard Shores	Optional Groin Field Construction	Mob/Demob			$150,000		
		Groin Length	7,200 ft	$1,500	$10,800,000	12 Groins	$11,000,000
10./ 11. Channel Islands Harbor	Backpass Plant	Sand Volume	1,100,000 cy	$2.00	$2,200,000	Per yr	$55,000,000
12. Ormond Beach	Optional Groin Field Construction	Mob/Demob			$75,000		
		Groin Length	7,800 ft	$1,500	$11,700,000	12 Groins	$11,800,000
12. Laguna Point	Backpass Plant	Sand Volume	1,100,000 cy	$2.00	$2,200,000	Per yr	$52,800,000
	Optional Groin Field Construction	Mob/demob			$75,000		
		Groin Length	9,100 ft	$1,500	$13,700,000	14 Groins	$13,800,000
13. Mugu Point	Mob/Demob				$250,000		
	Beach Fill	Sand Volume	700,000 cy	$8.50	$6,000,000		$6,300,000
	Submerged Breakwater		(Donated by Navy)				

SUM:	$373,700,000
Contingencies (10%)	$37,400,000
Engineering & Design (4.5%)	$16,800,000
Supervision & Admin (4.5%)	$16,800,000
TOTAL:	$444,700,000

feet deep. By placing a sufficient number of eductor parallel or perpendicular to the shoreline, a continuous, relatively low volume, pumping rate could be realized to move the sand slurry upcoast or downcoast as needed. A buried pipeline lined with rubber or high density polyethylene with selected discharge points would be installed over the segment to provide the maximum flexibility in sand management (Hydro Sands, Inc. 1989).

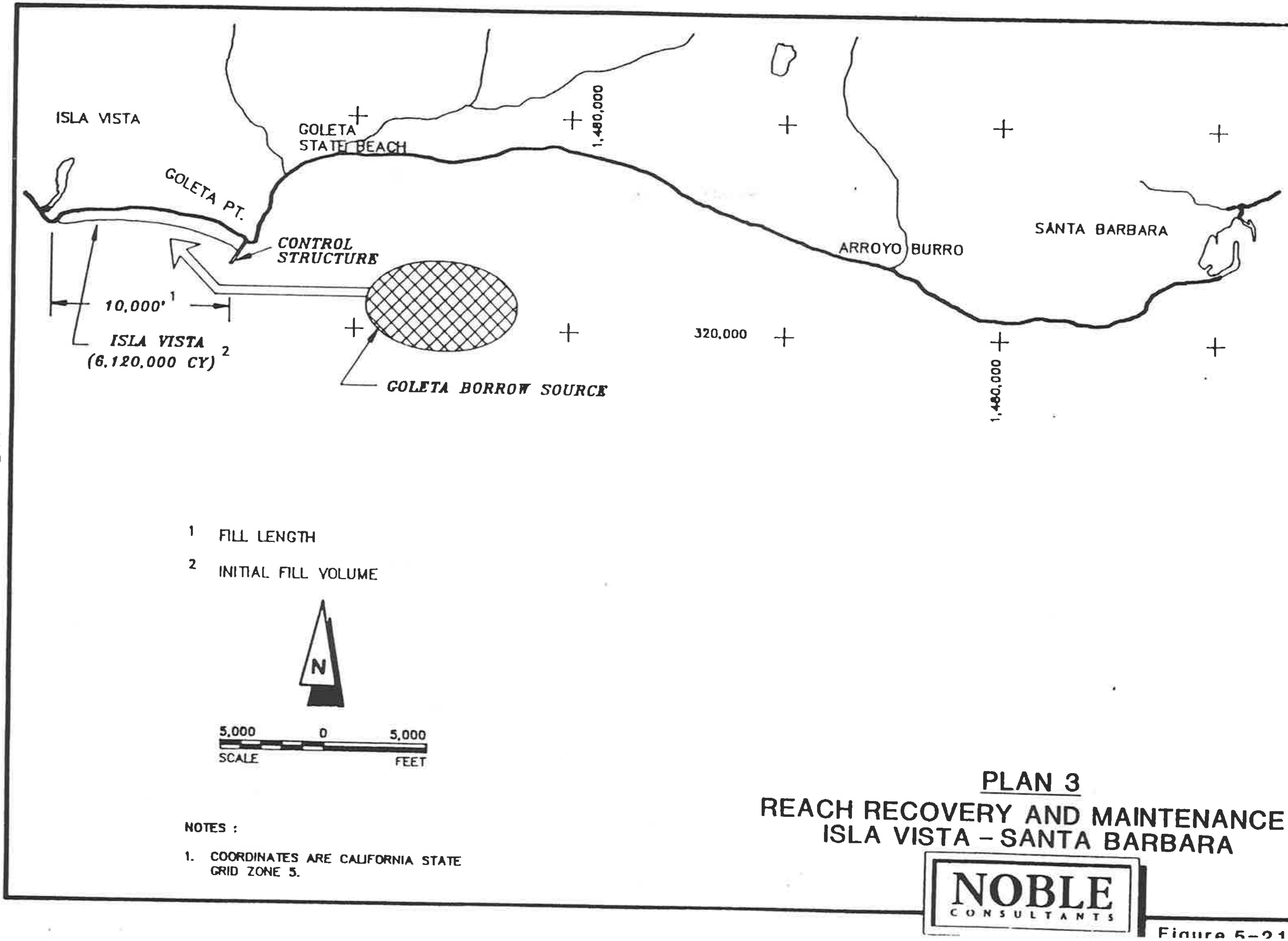
The technology has been perfected in Australia and successfully implemented in a channel bypassing operation. However, the technology is still in its infancy and has yet to be applied with success on the West Coast. Use of hopper dredges to effect this transfer will necessitate construction of expensive breakwaters to impound sand at the Mugu Canyon and is not considered cost effective.

Construction of a local beach fill stabilized by submerged ship hulk breakwaters is recommended for the Navy property at Mugu Lagoon to compensate for the proposed sand capture at Laguna Point. Extension of the Port Hueneme breakwater by similar means is suggested to reduce a suspected sand loss down Hueneme Canyon that is believed to occur during times of upcoast littoral transport reversal.

5.6.3 Reach Recovery and Maintenance (Plan 3)

Figures 5-21 through 5-24 show the details of the third level of effort. The plan is intended to fulfill the following objectives:

1. Reconstruct and maintain a public beach at Isla Vista with secondary bluff erosion mitigation benefit.
2. Maintain the existing Santa Barbara Harbor sand bypassing program to preserve the littoral sand supply downcoast.
3. Enhance the narrow beaches between Biltmore downcoast to Miramar for recreation and property protection objectives; provide a reduced secondary benefit.
4. Restore and enhance the beach at Carpinteria for recreation and property protection purposes.
5. Provide for small, periodic sand inputs along the Rincon Parkway to stimulate pocket beach growth and provide some measure of enhancement and structure protection to the structurally fortified segment.



ISLA VISTA
GOLETA STATE BEACH
GOLETA PT.
CONTROL STRUCTURE
1,480,000
10,000' 1
ISLA VISTA (6,120,000 CY) 2
GOLETA BORROW SOURCE
320,000
ARROYO BURRO
SANTA BARBARA
1,480,000
1 FILL LENGTH
2 INITIAL FILL VOLUME
N
5,000 0 5,000
SCALE FEET
NOTES :
1. COORDINATES ARE CALIFORNIA STATE GRID ZONE 5.
PLAN 3
REACH RECOVERY AND MAINTENANCE
ISLA VISTA - SANTA BARBARA
NOBLE
CONSULTANTS

Figure 5-21

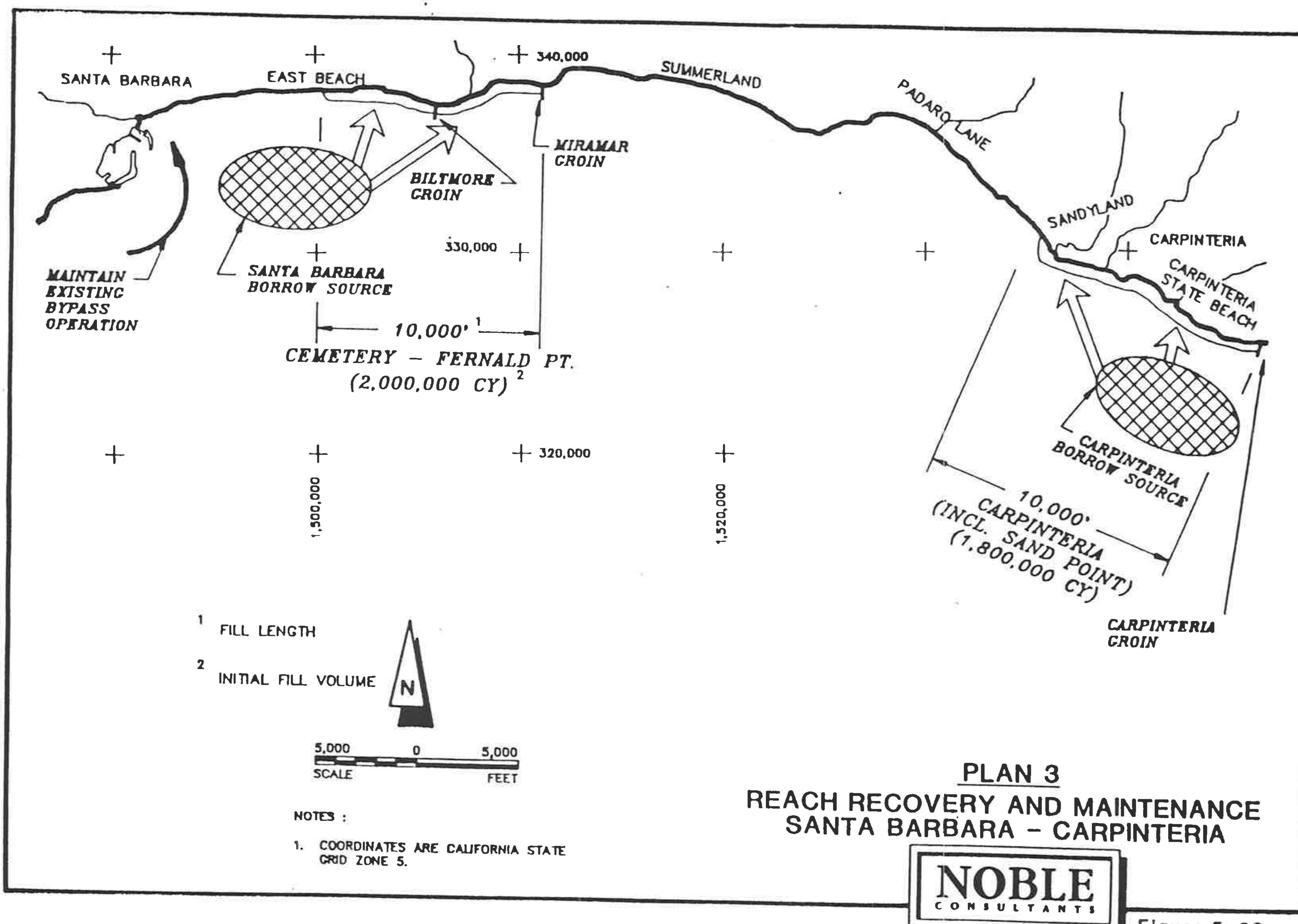
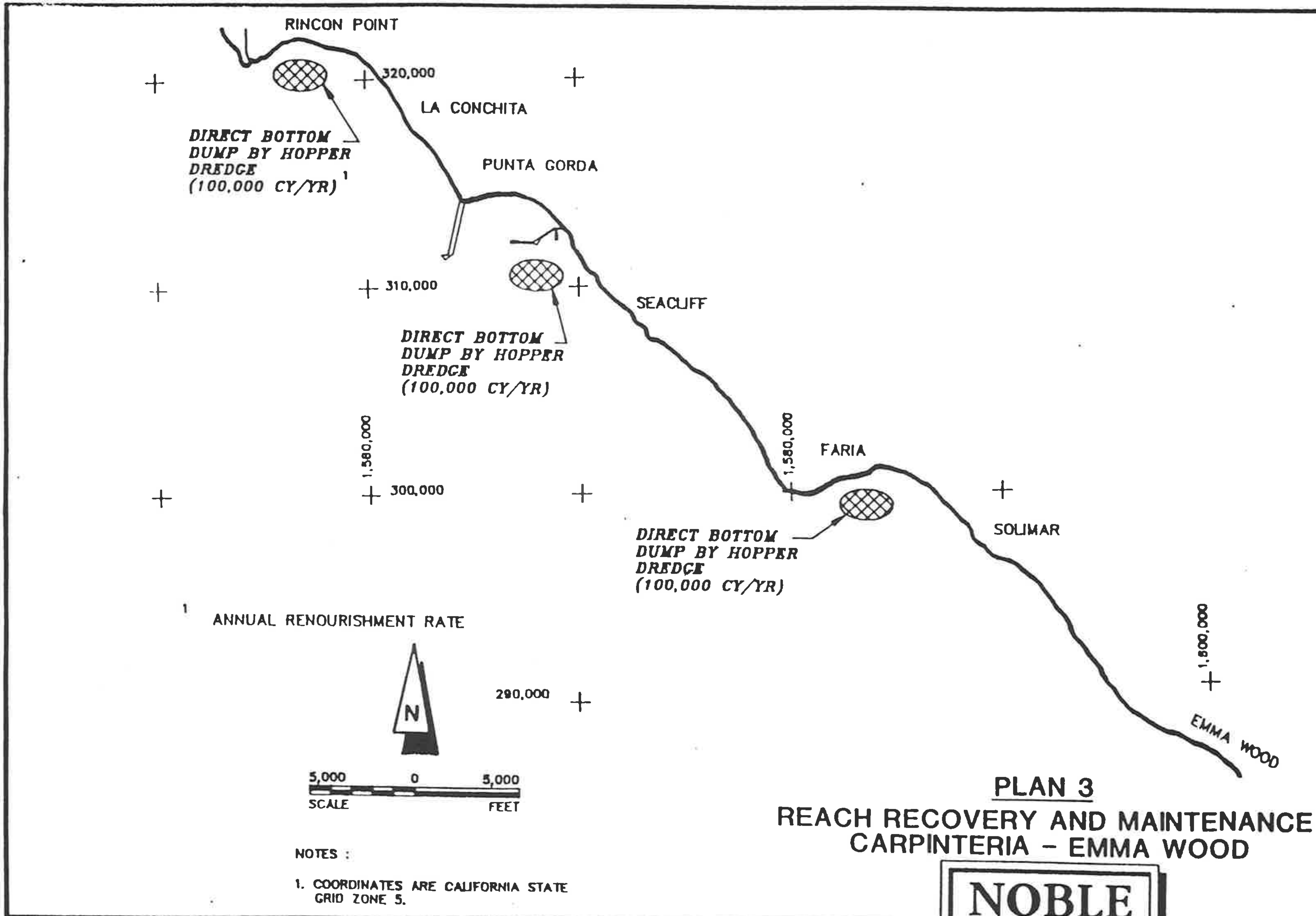

SANTA BARBARA
EAST BEACH
340,000
SUMMERLAND
PADARO LANE
MIRAMAR GROIN
BILTMORE GROIN
SANDYLAND
CARPINTERIA
CARPINTERIA STATE BEACH
330,000
SANTA BARBARA BORROW SOURCE
MAINTAIN EXISTING BYPASS OPERATION
10,000' 1
CEMETERY - FERNALD PT.
(2,000,000 CY) 2
320,000
1,500,000
1,520,000
CARPINTERIA BORROW SOURCE
10,000'
CARPINTERIA
(INCL. SAND POINT)
(1,800,000 CY)
CARPINTERIA GROIN
1 FILL LENGTH
2 INITIAL FILL VOLUME
N
5,000 0 5,000
SCALE FEET
NOTES :
1. COORDINATES ARE CALIFORNIA STATE GRID ZONE 5.
PLAN 3
REACH RECOVERY AND MAINTENANCE
SANTA BARBARA - CARPINTERIA
NOBLE CONSULTANTS

Figure 5-2



PLAN 3
REACH RECOVERY AND MAINTENANCE
CARPINTERIA - EMMA WOOD

Figure 5-23

Figure 5-23

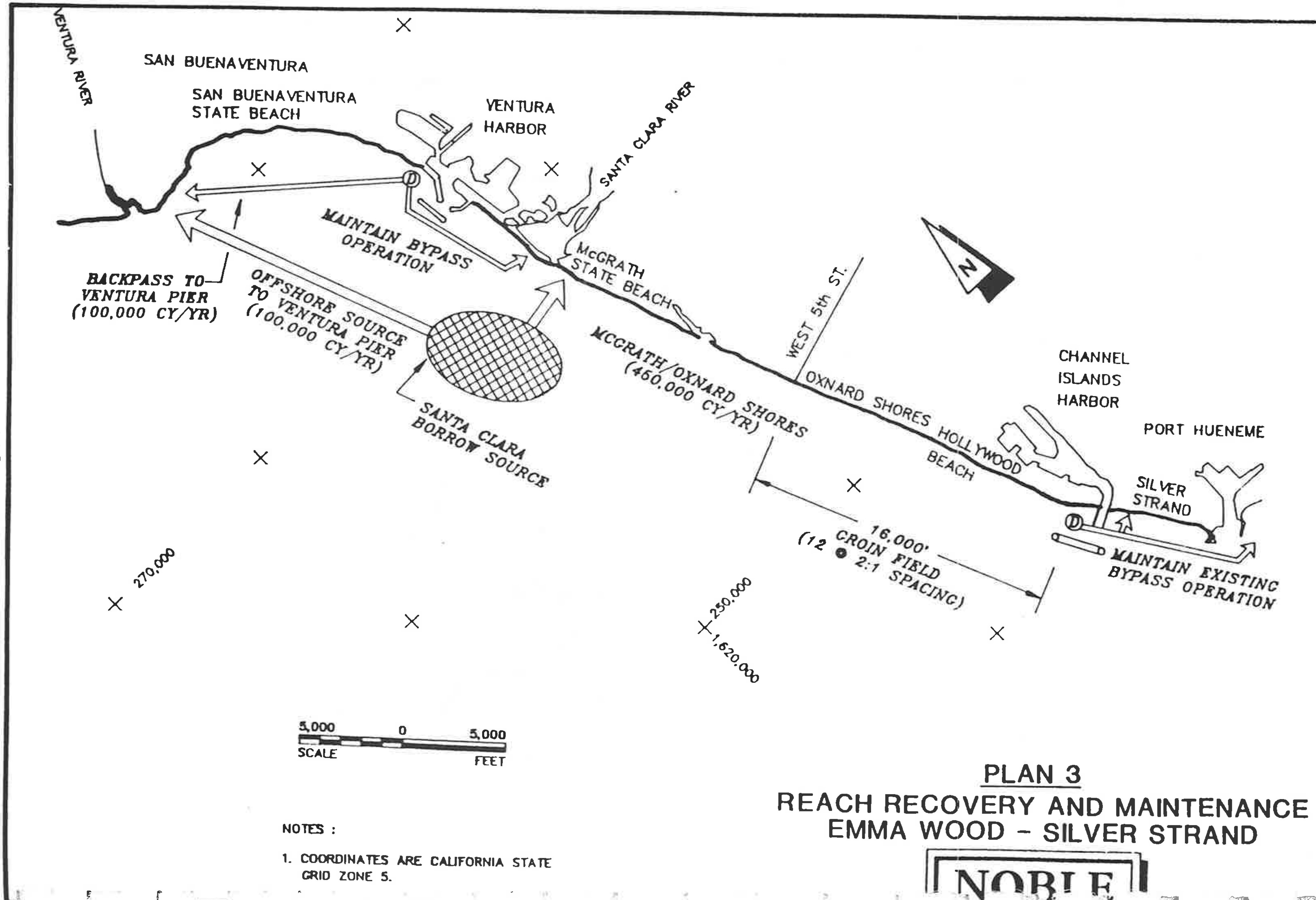

VENTURA RIVER
SAN BUENAVENTURA
SAN BUENAVENTURA STATE BEACH
VENTURA HARBOR
SANTA CLARA RIVER
MAINTAIN BYPASS OPERATION
BACKPASS TO VENTURA PIER (100,000 CY/YR)
OFFSHORE SOURCE TO VENTURA PIER (100,000 CY/YR)
SANTA CLARA BORROW SOURCE
McGRATH STATE BEACH
McGRATH/OXNARD SHORES (460,000 CY/YR)
WEST 5th ST.
N
OXNARD SHORES
HOLLYWOOD BEACH
CHANNEL ISLANDS HARBOR
PORT HUENEME
SILVER STRAND
16,000' CROIN FIELD (12 @ 2:1 SPACING)
MAINTAIN EXISTING BYPASS OPERATION
270,000
250,000
1,620,000
5,000 0 5,000
SCALE FEET
NOTES :
1. COORDINATES ARE CALIFORNIA STATE GRID ZONE 5.
PLAN 3
REACH RECOVERY AND MAINTENANCE
EMMA WOOD - SILVER STRAND
NOBLE

Figure 5-24

6. Supplement the Pierpont Bay sediment budget through a combination of sand backpassing from conventional maintenance dredging at Ventura Harbor and sand injection from nearby offshore borrow areas to maintain existing conditions.

7. Supplement the sediment budget deficit east of the Santa Clara River with periodic sand injection from offshore borrow sources to preserve existing conditions. Optional construction of 12 groins between Oxnard Shores and Channel Islands Harbor to reduce the rate of erosion and the periodic renourishment liability.

Plan 3 differs from Plan 2 in the following areas by reducing the scope of recovery.

1. The Goleta fill project is deleted.

2. The East Beach portion of the Santa Barbara fill is deleted.

3. Only Carpinteria beach is restored.

4. The Ventura County sand backpass plants are deleted and a 5-year cycle of sand supplementation from offshore sources is inaugurated to make up for projected erosion deficits.

Tables 5-10 and 5-11 summarize the design components and the projected gross initial and 25 year maintenance costs. The estimated total project cost is about $231 million.

5.6.4 Feeder Beach Injection (Plan 4)

This plan is depicted in Figure 5-25. The objectives of this plan are as follows:

1. Address the four identified erosion "hot spots" with periodic sand injection to prevent further shoreline erosion.

2. Provide minimal supplementation to sediment budget deficit areas to preserve status quo conditions.

Plan 4 is considered to be the minimum level of response necessary to maintain a current level of shoreline condition. The plan calls for a 5-year cycle of periodic sand injection at selected beach areas. Four areas have been specified based upon the results of the sediment budget analysis as concluded in Section 3.2.8 of this report.

Table 5-10

Reach Recovery and Maintenance: Plan 3

1. Isla Vista	10,000 ft. of beach fill from offshore dredge operation and contruction of one control groin.
2. Santa Barbara	10,000 ft. of beach fill from southern end of East Beach to Miramar beach from offshore dredge operation and construction of two control groins at Biltmore and Miramar.
3. Carpinteria	10,000 ft. of beach fill from offshore dredge operation and construction of one control groin.
4. Rincon Point	Sand injection at Rincon Point by hopper bottom dump from offshore dredge operation.
5. Punta Gorda	Sand injection at Punta Gorda by hopper bottom dump from offshore dredge operation.
6. Faria	Sand injection at Faria by hopper bottom dump from offshore dredge operation.
7. Ventura	Beach nourishment along San Buenaventura State Beach from existing dredge material at Ventura Harbor and offshore supplementation.
8. Oxnard Shores	Beach fill along McGrath, Oxnard Shores, and Hollywood Beaches from offshore dredge operation plus optional construction of 12 control groins along Oxnard Shores and Hollywood Beaches.

Table 5-11

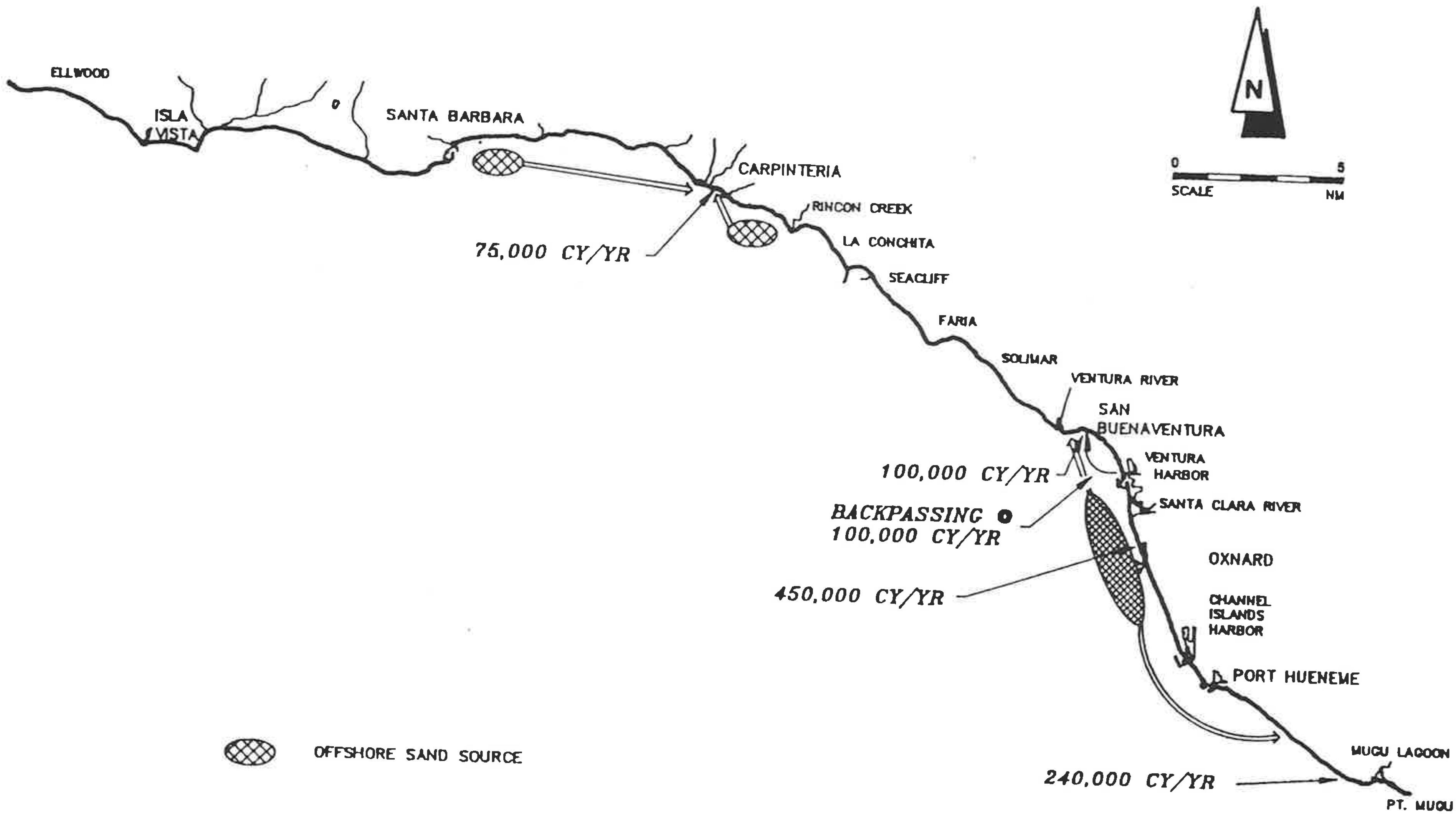
Preliminary Cost Estimate
Reach Recovery and Maintenance: Plan 3

Location	Project List	Expense Item	Amount cy or ft	Unit Price $/cy or $/ft	Cost	Remarks	25-Year Project Cost
1. Isla Vista	Initial Fill	Mob/Demob			$250,000		
		Sand Volume	6,120,000 cy	$4.10	$25,100,000		$25,400,000
	Control Groin	Mob/Demob			$150,000		
		Groin Length	600 ft	$1,500	$900,000		$1,100,000
	Maintenance Fill	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	384,000 cy	$5.90	$2,300,000	Per 5 yrs	$10,400,000
						Subtotal:	$36,900,000
2. Santa Barbara	Initial Fill	Mob/Demob			$250,000		
		Sand Volume	1,504,000 cy	$6.50	$9,800,000		
		Mob/Demob			$40,000		
		West Bh. Borrow	500,000 cy	$2.00	$1,000,000		$11,100,000
Biltmore	Control Groin	Mob/Demob			$75,000		
		Groin Length	650 ft	$1,500	$975,000		$1,100,000
Miramar	Control Groin	Mob/Demob			$75,000		
		Groin Length	650 ft	$1,500	$975,000		$1,100,000
	Maintenance Fill	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	204,000 cy	$5.90	$1,200,000	Per 5 yrs	$5,800,000
						Subtotal:	$19,100,000
3. Carpinteria	Initial Fill	Mob/Demob			$250,000		
		Sand Volume	1,800,000 cy	$6.50	$11,700,000		$12,000,000
	Control Groin	Mob/Demob			$75,000		
		Groin Length	600 ft	$1,500	$900,000		$1,000,000
	Maintenance Fill	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	900,000 cy	$4.00	$3,600,000	Per 5 yrs	$15,400,000
						Subtotal:	$28,400,000
4. Rincon Point	Sand Injection	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	500,000 cy	$4.60	$2,300,000	Per 5 yrs	$10,200,000
5. Punta Gorda	Sand Injection	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	500,000 cy	$5.50	$2,800,000	Per 5 yrs	$12,200,000
6. Faria	Sand Injection	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	500,000 cy	$5.50	$2,800,000	Per 5 yrs	$12,200,000
						Subtotal:	$34,600,000
7. Ventura Harbor	Backpass via Existing Dredge	Mob/Demob			$50,000		
		Sand Volume	100,000 cy	$3.00	$300,000	Per yr	$8,400,000
	Offshore Borrow	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	500,000 cy	$4.60	$2,300,000	Per 5 yrs	$12,800,000
						Subtotal:	$21,200,000

Table 5-11 (Continued)

Location	Project List	Expense Item	Amount cy or ft	Unit Price $/cy or $/ft	Cost	Remarks	25-Year Project Co
8. Oxnard Shores	Offshore Borrow	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	2,250,000 cy	$3.70	$8,300,000	Per 5 yrs	$42,800,000
	Optional Groin Field Construction	Mob/Demob			$150,000		
		Groin Length	7,200 ft	$1,500	$10,800,000	12 Groins	$11,000,0
						Subtotal	$53,800,000

SUM:	$194,000,00
Contingencies (10%)	$19,400,000
Engineering & Design (4.5%)	$8,700,00
Supervision & Admin (4.5%)	$8,700,00
TOTAL:	$230,800,00



PLAN 4
FEEDER BEACH INJECTION
ISLA VISTA – PT. MUGU

NOBLE CONSULTANTS

Figure 5-25

Tables 5-12 and 5-13 list the target feed points and pro-jects a gross cost over a 25 year period of about $101 million. This cost may be reduced by about 2/3 if it can be shown tha sand can be deposited in the nearshore area instead of directl discharged on the beach. Considerable cost savings in dredgi costs may be realized if the vessel can simply bottom dump th sand for natural onshore migration by wave action. A prototyp experiment to test this concept was attempted at Santa Barbara' East Beach in 1933 with no apparent success (Dunham, 1986). However, the possibility of the method in areas of higher wav energy and near the lee shore of coastal headlands should b investigated. The potential savings may mean the difference in the economic feasibility and local funding independence of th plan.

5.6.5 Public Policy

All four plan levels of action identified above require public policy component which addresses the need to:

- Continue harbor dredging;
- Eliminate fluvial sand mining;
- Bypass debris basin sediment;
- Mitigate loss of bluff erosion as a sand source; and
- Mitigate dam impacts.

Based upon a review of the public policy techniques previously discussed and summarized in Table 4-1, the following alternatives are considered appropriate:

1. Land Management Zoning - Delineation of coastal hazard or sand source zones to prevent future development from erosion damage exposure and/or to preserve bluff erosion and coastal stream sand sources.

2. Building Code - Develop uniform criteria and specifications for erosion protection structures and methods.

3. Setback - Review existing setback policies to protect development and/or preserve bluff erosion sand sources.

4. Permitting - Develop regulatory policy to maintain existing harbor sand bypassing operations, protect and enhance sand delivery from rivers and streams and protect bluff erosion sand sources.

Table 5-12

Feeder Beach Injection: Plan 4

1.	Carpinteria	Sand injection at Carpinteria Beach by hopper pump out from offshore dredge operation.
2.	Pierpont Bay	Sand injection at Pierpont Bay Beach (San Buenaventura State Beach) by hopper pump out from offshore dredge operation and beach nourishment from existing dredge material at Ventura Harbor.
3.	Oxnard Shores	Sand injection at Oxnard Shores Beach by hopper bottom dump from offshore dredge operation.
4.	Ormond Beach	Sand injection at Hueneme Beach by hopper bottom dump from offshore dredge operation.

Table 5-13

Preliminary Cost Estimate
Feeder Beach Injection: Plan 4

Location	Project List	Expense Item	Amount cy or ft	Unit Price $/cy or $/ft	Cost	Remarks	25-Y Projec
1. Carpinteria Beach	Sand Injection	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	375,000 cy	$5.90	$2,200,000	Per 5 yrs	
						Subtotal	$9,8(
2. Pierpont Bay	Sand Injection	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	500,000 cy	$4.60	$2,300,000	Per 5 yrs	$10,20
	Ventura Harbor Backpassing	Mob/Demob			$50,000	Per 2 yrs	
		Sand Volume	200,000 cy	$3.00	$600,000	Per 2 yrs	$7,800
						Subtotal	$18,00(
3. Oxnard Shores Beach	Sand Injection	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	2,250,000 cy	$3.70	$8,300,000	Per 5 yrs	
						Subtotal	$33,20(
4. Ormond Beach	Sand Injection	Mob/Demob			$250,000	Per 5 yrs	
		Sand Volume	1,200,000 cy	$4.90	$5,900,000	Per 5 yrs	
						Subtotal	$23,600,0
				SUM:			$84,600,
				Contingencies (10%)			$8,500,0
				Engineering & Design (4.5%)			$3,800
				Supervision & Admin (4.5%)			$3,800
				TOTAL:			$100,700,

5.6.6 Demonstration Projects

In the short-term, BEACON may elect to implement one or more smaller scale pilot projects which includes features of the regional plan. Such projects may demonstrate particular aspects of the above plans or serve as prototype experiments to determine the potential benefits that might be realized from concepts that are unproven. Five demonstration projects are proposed as a means to tangibly test or implement elements called for by the different plans. The projects are discussed below.

5.6.6.1 Hopper Dredge Bottom Dump Test

The potential cost savings to be gained from hopper dredges supplying sand to the shoreline without resorting to direct pump out methods is substantial. However, the ability for the sand to naturally migrate onshore is uncertain. It has been proposed that direct dumping of sand in the lee area of headlands may stimulate a natural onshore migration. Figure 5-26 suggests several test sites from Isla Vista to Pierpont Bay. It is proposed that the hopper deposit about 250,000 cubic yards of sand in the nearshore zone followed by monitoring to trace the fate of the deposit.

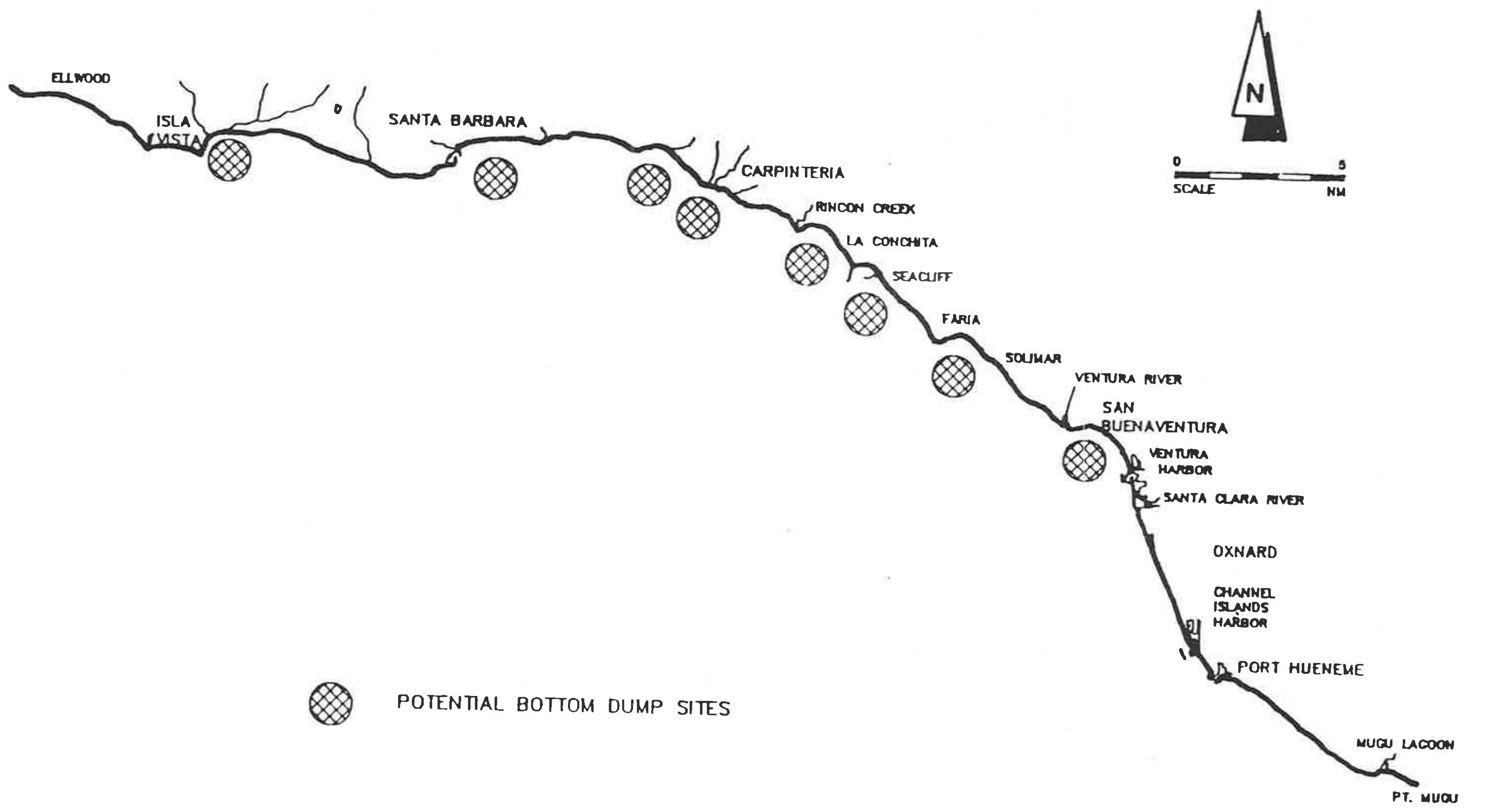
The potential pay off from a successful experiment has been discussed. The drawback to the proposal lies in its underwater obscurity which prevents a visible demonstration for public viewing. Should the experiment fail, a considerable sum of money could be labeled as wasted effort.

5.6.6.2 Beach Nourishment Pilot Project

The feasibility of the large scale beach renourishment projects recommended in the plan may be visibly demonstrated on a much reduced scale. Four beaches have been proposed based upon need and their primary public use designation. The project calls for using a hopper dredge to borrow sand from an offshore deposit and directly discharging the sand on the beach. The amount of fill is limited to about 250,000 cubic yards for budget purposes. This translates to a fill project only about 1/2 mile long. As such the fill is subject to rapid diffusion. For this reason, it would be better to incorporate a test control groin into this project in order to evaluate the merits of stabilization.

5.6.6.3 Control Groin Demonstration

This alternative could be tested at one of several beaches identified west of the Ventura River. A low profile groin would



HOPPER DREDGE BOTTOM DUMP
DEMONSTRATION TEST SITES

NOBLE
CONSULTANTS

Figure 5-26

Figure 5-26

be constructed to determine its ability to stabilize and reduce losses to the immediate upcoast beach. The test is ideally combined with a test fill so that the groin compartment may be fully filled. It is suggested that the structure be temporary and constructed from flexible material such as geotextile tubes so that removal could be easily accomplished if necessary.

This alternative may be most economically conducted using the West Beach borrow site at Santa Barbara. Existing harbor dredge equipment could be used at modest cost to remove up to 500,000 cubic yards of sand from West Beach and to fill a groin cell within the Biltmore shoreline area.

5.6.6.4 Dune Stabilization

This demonstration project which might be considered applies to beaches east of the Ventura River. The shore segment experiences prevailing westerly winds and high tides which on occasion result in wind borne and overwash sediment movement. The problem is particularly chronic at Oxnard Shores where the City of Oxnard periodically cleans Mandalay Drive. Construction of sand fence and vegetative stabilization could be tested at designated shore segments along this stretch to determine the feasibility of natural dune growth. Capture of aeolian sand into dunes would provide an attractive natural defense from the more rare occurrences of severe storm wave and tide which have flooded the area.

This was attempted in the early 1970's at Oxnard Shores in an effort to inhibit sand from inshore migration (City of Oxnard, 1980). Sand fences were installed, but the combined effects of vandals and citizen pressure resulted in their removal. However, the problem remains, and a low cost solution would alleviate a local nuisance and at the same time encourage enhancement and preservation of similar dune zones elsewhere.

5.6.6.5 Debris Basin Recapture

This alternative would demonstrate the feasibility of reducing the impact of natural sediment depletion of food control debris basins by direct or indirect means. The first test would consist of delivering sand to the beach by truck while the latter method would explore the success of bypassing material immediately downstream of the dam for subsequent natural delivery.

Direct delivery of debris basin sediment entails prior removal of incompatible material such as brush, boulders and the like. This may be accomplished through mechanical sifting and reworking of the sediment using conventional earth moving equipment. The "screened" sediment may then be hauled by truck to the beach for deposition. Alternatively, the material may l placed downstream of the debris basin dam for natural delivery t the shoreline during the next significant rainfall and stream discharge. This method would reduce transport costs and probab not require as much material screening.

This demonstration project would evaluate the sedimen characteristics of the more productive basins, identify the mos economical method to clean the sediment of the more undesirable detritus and cobble, and evaluate direct shoreline versus natura stream bed delivery methods.

5.6.6.6 Demonstration Project Costs

Table 5-14 summarizes the estimated costs associated with each of the above five pilot projects. Of the five plans, th debris basin alternative would be the least expensive.

5.7 Coastal Monitoring

A coastal monitoring program should be included as part c each plan alternative. The recommended BEACON sand monitorir program should be designed to do the following:

1. Track erosion/accretion trends;
2. Track sediment delivery into the littoral system;
3. Anticipate changes in shoreline condition; and
4. Provide guidance to make adjustments to th comprehensive sand management plan.

The monitoring plan can incorporate a regular schedule o field data collection for comparison with preceding data sets When plotted the data would represent a time history of shoreline position and the implied trend for future behavior. In addition monitoring of the principal coastal processes will allow fo analysis of related factors to shoreline response so that forecasting of beach conditions may be performed ahead of actual beach profile measurements. Therefore, the monitoring program i recommended to minimally consist of direct measurements of beach elevations followed by monitoring of the related oceanographic and meteorologic factors responsible for the induced shorelin changes.

The recommended monitoring program consists of beach profile measurements, rainfall and stream flow monitoring, and aerial photography review. These individual elements are discussed in detail in Chapter 7.0.

Table 5-14

Demonstration Project Costs

1. Hopper Dredge Bottom Dump Test

Mob/Demob Hopper Dredge		150,000
Sand volume 250,000 cy @ $1.40		350,000
		$ 500,000
Contingencies (10%)		50,000
Engineering & Design (4.5%)		23,000
Supervision & Adminstration (4.5%)		23,000
		$ 565,250
Monitoring	8 surveys @ $20,000	160,000
Evaluation		24,000
TOTAL		$ 784,000

Candidate Sites:

Goleta State Beach
Carpinteria
Rincon Parkway
San Buenaventura State Beach

2. Beach Nourishment Pilot Project

Mob/Demob Hopper Dredge		250,000
Sand volume 300,000 cy @ $6.80		2,040,000
		$2,290,000
Contingencies (10%)		229,000
Engineering & Design (4.5%)		103,000
Supervision & Adminstration (4.5%)		103,000
		$2,717,960
Monitoring	8 surveys @ $10,000	80,000
Evaluation		24,000
TOTAL		$2,829,000

Candidate Sites:

Goleta State Beach
Santa Barbara East Beach
Carpinteria State Beach
Emma Wood County Beach

Table 5-14

(Continued)

3. Control Groin Demonstration

Mob/Demob			100,000
Control groin	650' @ $1,500		975,000
Sand fill	60,000 cy @ $2 (Biltmore)[1]		120,000
	@ $16 (elsewhere)[2]		960,000
		$1,195,000 -	$2,035,000
Contingencies (10%)		120,000 -	203,000
Engineering & Design (4.5%)		54,000 -	92,000
Supervision & adminstration (4.5%)		54,000 -	92,000
		$1,428,000[1] -	$2,422,000[2]
Monitoring	surveys @ $10,000	80,000	
Evaluation		24,000	
TOTAL		$1,530,000 -	$2530,000

Candidate Sites: Biltmore[1]
Summerland[2]
Carpinteria State Beach[2]
Emma Wood County Beach[2]

1 = Borrow Site West Beach, Dredge Pump
2 = Borrow Site, Land Source, Truck Delivery

4. Dune Stabilization

Mob/Demob		5,000
Erect snow fence	- 2000 LF x 3 @ $10/LF	60,000
Vegetate	- 200,000 SF @ $1/SF	200,000
		$ 265,000
Contingencies (10%)		27,000
Engineering & Design (4.5%)		12,000
Supervision & Adminstration (4.5%)		12,000
		$316,000
Evaluation		12,000
TOTAL		$ 330,000

Candidate Sites: Oxnard Shores
Hollywood Beach

Table 5-14

(Continued)

5. Debris Basin Sand Delivery

a) Beach delivery		
Mob/demob		2,000
Test accumulated sediment to choose sand source basin:		8,000
Screen sediment	10,000 cy @ $2/cy	20,000
Deliver sand	10,000 cy @ $12/cy	120,000
Dress Beach	10,000 cy @ $1/cy	10,000
		$ 160,000
Contingencies (10%)		16,000
Engineering & Design (4.5%)		6,400
Supervision & Adminstration (4.5%)		6,400
		$ 189,000
Evaluation		12,000
TOTAL		$ 201,000

Candidate Sites: Goleta State Beach
Carpinteria State Beach
San Buenaventura State Beach

b) Debris Basin Bypass		
Mob/demob		2,000
Test accumulated sediment to choose sand source basin:		8,000
Remove debris	10,000 cy @ $1/cy	10,000
Haul sediment to downstream area	10,000 cy @ $6/cy	60,000
		$ 80,000
Contingencies (10%)		8,000
Engineering & Design (4.5%)		3,600
Supervision & Adminstration (4.5%)		3,600
		$95,000
Evaluation		12,000
TOTAL		$ 107,000

6.0 - PLAN EVALUATION

The four plans were evaluated on the basis of technical economic and environmental criteria. The results of this analysis are presented below.

6.1 Technical Evaluation

6.1.1 Anticipated Effects

The logistics and scale of the Regional Recovery and Maintenance Plan (Plan 1) are enormous. Assuming an average hopper dredge production rate of 10,000 cubic yards per day about 37 years would be required for a single dredge to complete the project. At least seven dredges would be necessary to achieve a satisfactory completion time of about five years. More importantly, this plan would severely deplete the estimated offshore resources identified in this study. About 58 million cubic yards of sand are estimated to be available from the Goleta, Santa Barbara, and Carpinteria deposits. It is estimated that at least 75 percent of these deposits would be needed to renourish the shoreline between Ellwood and Faria.

The extent of renourishment is also estimated to increase maintenance dredging volumes at Santa Barbara and Ventura harbors because of the increased width of the active beach profile. For planning purposes, the respective increases are anticipated to total up to 700,000 cubic yards per year at Santa Barbara Harbor and 500,000 cubic yards per year at Ventura. These projected increases in harbor maintenance are in conflict with BEACON's goals and objectives related to harbor facilities.

The Reduced Recovery and Maintenance Plan (Plan 2) would add about 21,000,000 cubic yards of sand into the littoral system west of the Ventura River. The target fills at Isla Vista, Goleta State Beach, Santa Barbara, Carpinteria, and Emma Wood are designed to provide beach enhancement at the primary location, and secondary renourishment to adjacent beaches by diffusion and advection. The natural depletion of the initial fill is decreased as the length of the renourishment project is increased. Thus, the longer fills at Santa Barbara and Carpinteria are more desirable.

Through periodic maintenance renourishment of the shoreline west of the Ventura River, about 800,000 cubic yards of sand per year would be added to the littoral system to maintain minimum project berm widths. This periodic sand injection is also anticipated to provide a measure of beach restoration for adjacent non-fill sections, and ultimately help to offset potential sediment budget deficits east of the Ventura and Santa Clara rivers.

The proposed sand backpassing scheme is intended to lessen the need for future beach reconstruction between Pierpont Bay and Mugu Canyon. The annual littoral transport over the subcell would be continually recycled upcoast to maintain the present beach width.

Plan 3 is anticipated to yield the same results as Plan 2, but at a reduced scale. This implies that less storm damage reduction benefits will be obtained from its implementation. The equivalent of about 600,000 cubic yards per year would still be added to the study shoreline via maintenance fill operations every five years, but the extent of beach reconstruction and enhancement is reduced. Sand backpassing from Mugu Submarine Canyon is replaced by supplementation of anticipated budget debits at Oxnard Shores and east of Pierpont Bay by pumping 2.75 million cubic yards of sand ashore every five years from the Santa Clara offshore deposit to maintain existing beach widths.

Plan 4 is considered to be the minimum level of action necessary to preserve status quo conditions and prevent further shoreline degradation. Periodic injection of 965,000 cubic yards per year between Carpinteria and Mugu Beach is intended to mitigate erosion "hot spot" areas and prevent future recession at those beaches.

6.1.2 Unresolved Issues

The sand management plan contains several elements which require further technical resolution to determine technical risks. The issues are:

1. Fill longevity;
2. Sand backpassing feasibility;
3. Maintenance method; and
4. Coastal processes uncertainty.

The first issue deals with the uncertainty of littoral transport west of the Ventura River after placement of large sand fills. The shoreline has traditionally been sediment limited, and the diffusion of sand within such environments should be verified. The validity and merit of downcoast control groins to offset tendencies for rapid fill loss also requires confirmation.

The proposed fixed sand backpassing/bypassing plants between Ventura Harbor and Mugu Beach also requires further development. The technology has been demonstrated in Australia with success, however, the methodology needs to be expanded to address the scale and flexibility specified in the plan.

The method of periodic maintenance should be reviewed to explore the feasibility of direct bottom dump discharge methods which will effect sand delivery to the beaches. Contrary to renourishment by direct pipeline transfer, the method suggests that natural wave processes might achieve the desired end result at considerably less expense. This issue has significant impacts on the economic feasibility.

Finally, the identified sediment budget deficit areas should be confirmed, particularly for areas east of the Santa Clara River. The consequences of the present uncertainty in the potential sediment debit for beaches east of Oxnard Shores greatly affects the need for and extent of action called for by the sand management plan and the timing for implementation.

6.1.3 Demonstration Projects

The demonstration projects may be used to resolve some of the identified technical uncertainties noted above. Selection of one or more of the small projects should consider its pertinence to the overall sand management plan, associated risks, the potential for rewards if proven successful and cost. Table 6-1 presents a simplified evaluation of the five proposed projects based on these criteria.

The first three alternatives entail pilot projects that can be used to test elements of the overall plan. Of the three projects, the potential cost savings to be gained from hopper dredges supplying sand to the shoreline without resorting to direct pump out methods is substantial. However, the ability for the sand to naturally migrate onshore is uncertain. It has been proposed that direct dumping of sand in the lee area of headlands may stimulate a natural onshore migration.

The last alternative provides a means to demonstrate the feasibility and importance of maintaining natural fluvial sand delivery to the shoreline. It is also one of the least expensive programs that may be implemented.

6.2 Economic Evaluation

The traditional method of evaluating flood control and other public projects of a similar nature is through a benefit/cost analysis - a comparison of the public and private costs and

Table 6-1

Demonstration Project Evaluation

Alternative	Applicability to Sand Management	Risk	Benefit Potential	Cost
1. Hopper Dredge Bottom Dump Test	Regional	High	High	$780,000
2. Offshore Sand Renourishment	Regional	Moderate	Moderate	$2,800,000
3. Control Groin w/ Fill	Regional	Moderate	Moderte	$1,500,000 to $2,500,000
4. Dune Stabilization	Local	Low	Low	$330,000
5. Debris Basin Recapture	Regional	Low	Low	$100,000 to $200,000

benefits of the proposed project. This section describes the methodology for determining the relative benefit/cost ratios for alternative projects and includes a simplified benefit/cost comparison of selected alternative projects.

The estimated project costs for the four beach nourishment plans was summarized in Chapter 5.0. Initial costs and on-going maintenance costs were presented. This section summarizes the benefits which were considered to be realized from each plan so that data for alternative comparison would be available.

6.2.1 Benefit Categories

There are several key benefits from the proposed projects. These include the enhancement or continuation of recreational usage of the beaches, the reduction of property loss resulting from beach and cliff erosion, and the reduction of valuable land lost to erosion. A discussion of these benefit categories are provided below.

6.2.1.1 Recreation

Recreational benefit days are generally given a value of $2 to $4 per user. Several studies of beach erosion control efforts in New Jersey and Florida have used the lower number, while a recent U.S. Army Corps of Engineers (COE) Reconnaissance Study for Santa Barbara County valued recreational benefits at $3.30 to $3.95 per user day, depending on the level of amenities and facilities at the specific beach. As an example, East Beach in Santa Barbara was assigned a recreational value of $3.95 per user day by the COE with its more developed recreation and nearby commercial activities, while Carpinteria City Beach was assigned a value of $3.30.

It is difficult to forecast future recreation use of enhanced beaches without a detailed survey of accessibility and parking availability. In lieu of such analysis, it was assumed that 80% of current beach usage benefits would be lost in proportion to the proportion of current beach that would be lost without a stabilization and nourishment program. Usage of the beach parks that have revetments and seawalls and little or no sand in western Ventura County (such as Emma Wood) is primarily limited to camping and fishing, and is very limited compared to the sand beaches. The beaches that are likely to lose the most usage are Carpinteria, and Ventura through Hollywood beaches which are projected to disappear within 25-35 years in the absence of an enhancement project.

Because annual beach usage is very high, ranging from approximately 200,000 user days at McGrath State Beach to 814,000 at Carpinteria State Beach to 2.1 million at San Buenaventura State Beach in 1987, potential recreational benefits of sand replenishment are very large even at the $2 per day benefit level. As an example, the loss of 80% of Carpinteria beach usage would result in an annual loss of $1.3 million in recreational benefit. The loss of 80% of Ventura State Beach usage would mean an annual recreational loss of $3.36 million. The COE evaluation of benefit/cost ratios limits allowable recreational benefits to 49% of all benefits (i.e., COE funded projects cannot be primarily of recreational benefit). For use in evaluating the true community value of beach visitors, using full recreational benefits but limiting the benefit to $2 per person day is a good compromise.

For plans that would enhance and expand the size of an available beach, a 4% annual growth factor was included where parking space would allow it (e.g., San Buenaventura State Beach), assuming that better beaches would increase annual use by that factor. Plan 4, which stabilizes but does not increase beach size, was assumed to result in current levels of beach use. For beaches along the Oxnard plain, the current beach widths are very large, and beach capacity from McGrath State Beach south is limited by parking availability, not beach size. Thus, one could lose 50 feet of beach width without any adverse impact on usage.

6.2.1.2 Damage Reduction

Potential damage control is another critical benefit of the proposed projects. This includes both public and private damage, which has been substantial in the past and will become a much greater problem if the beach widths decline and go negative as estimated in Chapter 4.0. As examples, damage from storms in winter 1977-78 was estimated at approximately $300,000 in Santa Barbara County, mostly private, and $1.8 million in Ventura County, of which 80% was public improvements.

The January 1983 storms, considered to have a 15 year frequency, resulted in approximately $1.4 million in public shoreline damage in Santa Barbara and $850,000 in Ventura County. This only includes damage that would be prevented by wider beaches, and excludes damage to piers and harbors that would not be affected by sand nourishment activities. Ventura County spent over $1 million in 1984 and 1985 to rehabilitate Emma Wood and Hobson-Faria County beach parks after damage in 1983. Winter 1988 storms did approximately $750,000 damage in the City of San Buenaventura, to mostly public facilities. These figures do not represent a consistent jurisdiction-by-jurisdiction total, but provide examples of some of the more dramatic incidents.

Public agencies are constantly spending money on beach maintenance, protection, and damage repair activities. As an example, Carpinteria builds a dune each year to prevent erosion on the City beach, and the U.S. Navy built a revetment and other erosion control improvements to protect waterfront structures at the Point Mugu Pacific Missile Test Center. It is difficult to project how much is spent, but it is estimated to be at least $1 million annually that could be eliminated if a major sand renourishment plan was implemented.

Private costs are also difficult to assess, as they occur on an irregular basis. Revetments and seawalls installed to protect houses on the northern coast of Ventura County and southern Santa Barbara County cost $500 to $1,500 a foot or $20,000 to $75,000 a lot for typical 40 to 50 foot lots. There are probably 300 homes between Sandyland and Solimar that have added or will need to add protection assuming status quo conditions. This implies that a minimum cost of $6-23 million will be incurred there by the private sector.

There is not sufficient time or budget to evaluate each property threatened by coastal erosion, but one can project the ultimate impact of beach erosion if no action is taken as described in Chapter 4.0. Based on this forecast of beaches and property underlying homes totally eroding in 50 years or less without some action, one can project the total loss of the homes in the area to be eroded. This could occur at any point after the beach is assumed to erode, so the value of structures and contents is assumed lost at an average of $250,000 per home ($125/sq. ft. ($80 structural plus $45 contents) and 2000 sq. ft. average). This is a very simplistic model, but since the probability of a destructive storm approaches 100% over 50 years, a reasonable projection at the aggregate level can be obtained from this analysis. There are approximately 950 homes within the study area that may be impacted by erosion damages. This implies that the maximum damage potential could reach as high as $238 million.

6.2.1.3 Land Erosion Control

Prevention of land erosion is another critical element in determining the benefits of sand nourishment activities. While not critical until erosion reaches property lines, erosion that takes property takes not only improvements, but the value of the underlying site as well. With waterfront lots approaching $200 a square foot in the beach areas (a recent transaction of $500,000 for a 34 by 75 foot lot at Silver Strand) and approximately $100 a square foot in Faria, people value waterfront lots very highly and a great deal of property value would be lost if erosion was allowed to take houses.

Bluff land values are also high, but somewhat lower than beachfront because they do not have direct beach access and the typical lot sizes in the Santa Barbara Hope Ranch/Isla Vista area containing the bluffs are much larger. If one assumes a very conservative estimate of $100 a square foot for private beachfront property and $10 a square foot for bluff-top property, the average value of land that could be lost to erosion over the study area is on the order of $11 million per foot of recession. Public oceanfront is not assumed to have erosion value because it is valued for recreational benefits, and it should not be valued twice.

6.2.2 Methodology

A summary of the benefit/cost ratios for several possible BEACON projects at sites where beach erosion is considered most critical and potential losses are highest was performed. Three benefit categories of recreation, land erosion, and structure damage were estimated based upon the predicted shoreline recession rate summarized in Figure 4-1. Site specific assumptions were made to reflect a probable time history of losses as the beach segment in question continues to recede.

Detailed analysis was performed for the following shoreline segments:

1. Isla Vista;
2. Goleta State Beach;
3. Santa Barbara East Beach to Miramar;
4. Padaro Lane to Carpinteria;
5. Emma Wood Beach;
6. Pierpont Bay;
7. McGrath State Beach to Hollywood Beach.

Appendix I contains the calculation worksheets that were prepared to review the annual schedule of benefits and costs over an assumed 25-year time period. Each table summarizes the recreational, structure damage prevention, and land erosion benefits associated with mitigating beach erosion and/or winter storm exposure. An approximate estimate of the benefit cost ratio was developed by comparing the total discounted benefits against the corresponding project costs for the corresponding level of action.

Structure damage benefits were computed based upon the number of dwellings that would be impacted in absence of a project. For example, within Pierpont Bay approximately 50 homes north of Ventura Harbor would be threatened if no action is taken, and their loss was assumed.

It was noted by the analysis that the prime benefit was found to be recreational. If the beach usage numbers are correct the value of beach user days at $2 each is much greater than structural or erosion property value losses.

Due to time and budget constraints, benefits for the remaining shoreline segments, not analyzed in detail, were determined by extrapolating totals from similar segments. Thus benefits at Hope Range, Summerland, the Rincon Parkway and beaches east of Port Hueneme were obtained. Secondary benefits for shoreline segments immediately adjacent to fill areas in Plans 2 and 3 were estimated by assuming them to be 10 percent of their Plan 1 value.

The four plans were evaluated economically by comparing the aggregate shoreline benefits computed for each plan level to the estimated schedule of initial construction and maintenance costs as summarized from data in Chapter 5.0. In this manner, an indication of the relative merits of each plan may be reviewed.

As described above, recreational benefits were valued at $2 a day and 80% were considered proportional to beach size. Thus, if a beach that has one million annual visitors is reduced to one half its size, annual visitors will be reduced to 600,000 and $800,000 of recreational usage will be lost - $800,000 of recreational benefit from a sand renourishment project. Property damage was divided by the number of years from the first potential loss, and private land values were similarly treated.

A net present value was calculated using a 7.5% discount rate, and the primary benefit/cost ratio illustrated for a 25 year time frame. The discounted benefit/cost ratio will usually be lower than a straight undiscounted analysis because costs tend to be high in the first year and benefits occur during the whole period or are clustered in the latter years; thus, benefits are discounted more than costs.

6.2.3 Summary of Findings

The results of the benefit/cost analysis are summarized in Tables 6-2, 6-3, and 6-4. Table 6-2 summarizes the approximate benefits over the study shoreline for the different levels of action. Table 6-3 shows the assumed schedule of project costs which was used to obtain the total discounted value. Lastly, Table 6-4 provides a preliminary summary which compares total plan benefits against total plan costs.

Given the sensitivity of the analysis used and the level of detailed, the results indicate that Plan 3 or 4 will prove to be the most favorable levels of effort from an economic standpoint.

Table 6-2
Preliminary Estimated Project Benefits (25-Year)

Beach Segment	Recreational	Structure Protection	Land Erosion	Total Benefits
Plan 1:				
Isla Vista	$2,700,000	$800,000	$600,000	$4,100,000
Goleta	$7,100,000	$100,000	$300,000	$7,500,000
Hope Ranch	$8,100,000	$2,400,000	$1,800,000	$12,300,000
Santa Barbara	$3,900,000	$2,800,000	$6,500,000	$13,200,000
Summerland	$1,400,000	$800,000	$900,000	$3,100,000
Carpinteria	$16,000,000	$2,100,000	$13,700,000	$31,800,000
Rincon Parkway	$2,400,000	$2,200,000	$0	$4,600,000
Emma Wood	$800,000	$3,300,000	$0	$4,100,000
Pierpont Bay	$20,600,000	$500,000	$900,000	$22,000,000
McGrath-Hollywd	$8,200,000	$300,000	$2,000,000	$10,500,000
Hueneme-Mugu Bch	$6,100,000	$500,000	$10,600,000	$17,200,000
	$77,000,000	$16,000,000	$37,000,000	$130,000,000
Plan 2:				
Isla Vista	$2,700,000	$800,000	$600,000	$4,100,000
Goleta	$7,100,000	$100,000	$300,000	$7,500,000
Hope Ranch	$800,000	$200,000	$200,000	$1,200,000
Santa Barbara	$3,900,000	$2,800,000	$6,500,000	$13,200,000
Summerland	$100,000	$100,000	$100,000	$300,000
Carpinteria	$16,000,000	$2,100,000	$13,700,000	$31,800,000
Rincon Parkway	$200,000	$200,000	$0	$400,000
Emma Wood	$800,000	$3,300,000	$0	$4,100,000
Pierpont Bay	$20,600,000	$500,000	$900,000	$22,000,000
McGrath-Hollywd	$8,200,000	$300,000	$2,000,000	$10,500,000
Hueneme-Mugu Bch	$6,100,000	$500,000	$10,600,000	$17,200,000
	$67,000,000	$11,000,000	$35,000,000	$112,000,000
Plan 3:				
Isla Vista	$2,700,000	$800,000	$600,000	$4,100,000
Goleta	$300,000	$100,000	$100,000	$500,000
Santa Barbara	$2,300,000	$2,000,000	$6,500,000	$10,800,000
Summerland	$10,000	$10,000	$10,000	$30,000
Carpinteria	$13,300,000	$1,900,000	$10,600,000	$25,800,000
Emma Wood	$800,000	$3,300,000	$0	$4,100,000
Pierpont Bay	$20,600,000	$500,000	$900,000	$22,000,000
McGrath-Hollywd	$8,200,000	$300,000	$2,000,000	$10,500,000
Hueneme-Mugu Bch	$6,100,000	$500,000	$10,600,000	$17,200,000
	$54,000,000	$9,000,000	$31,000,000	$95,000,000
Plan 4:				
Carpinteria	$13,300,000	$1,900,000	$10,600,000	$25,800,000
Pierpont Bay	$20,600,000	$500,000	$900,000	$22,000,000
McGrath-Hollywd	$8,200,000	$300,000	$2,000,000	$10,500,000
Ormond Beach	$3,100,000	$300,000	$5,300,000	$8,600,000
	$45,000,000	$3,000,000	$19,000,000	$67,000,000

Table 6-3
Estimated Project Cost Schedule

Year	Plan 1	Plan 2	Plan 3	Plan 4
1	$105,700,000	$91,200,000	$38,000,000	$20,100,000
2	$105,700,000	$91,200,000	$38,000,000	$0
3	$105,700,000	$6,900,000	$0	$0
4	$105,700,000	$6,900,000	$0	$0
5	$105,700,000	$6,900,000	$0	$0
6	$11,800,000	$32,900,000	$38,800,000	$20,100,000
7	$11,800,000	$6,900,000	$0	$0
8	$11,800,000	$6,900,000	$0	$0
9	$11,800,000	$6,900,000	$0	$0
10	$11,800,000	$6,900,000	$0	$0
11	$11,800,000	$32,900,000	$38,800,000	$20,100,000
12	$11,800,000	$6,900,000	$0	$0
13	$11,800,000	$6,900,000	$0	$0
14	$11,800,000	$6,900,000	$0	$0
15	$11,800,000	$6,900,000	$0	$0
16	$11,800,000	$32,900,000	$38,800,000	$20,100,000
17	$11,800,000	$6,900,000	$0	$0
18	$11,800,000	$6,900,000	$0	$0
19	$11,800,000	$6,900,000	$0	$0
20	$11,800,000	$6,900,000	$0	$0
21	$11,800,000	$32,900,000	$38,800,000	$20,100,000
22	$11,800,000	$6,900,000	$0	$0
23	$11,800,000	$6,900,000	$0	$0
24	$11,800,000	$6,900,000	$0	$0
25	$11,800,000	$6,900,000	$0	$0
Total project cost	$764,000,000	$445,000,000	$231,000,000	$101,000,000
Discount cost @ 7.5%	$511,000,000	$271,000,000	$132,000,000	$52,000,000

Table 6-4
Preliminary Benefit/Cost Analysis Results

Plan	Estimated Benefits (discounted)	Estimated Project Costs (discounted)	Benefits - Costs
	Beach Maintenance by Direct Pump-Out Hopper Dredge Method		
1	$130,000,000	$511,000,000	($381,000,000)
2	$112,000,000	$271,000,000	($159,000,000)
3	$95,000,000	$132,000,000	($37,000,000)
4	$67,000,000	$52,000,000	$15,000,000
	Beach Maintenance by Bottom Dump Hopper Dredge Method		
1	$130,000,000	$489,000,000	($359,000,000)
2	$112,000,000	$243,000,000	($131,000,000)
3	$95,000,000	$91,000,000	$4,000,000
4	$67,000,000	$19,000,000	$48,000,000

Based upon the above analysis, the following general conclusions were made:

1. The best projects from a benefit/cost standpoint are those with high rates of beach erosion and considerable recreational use.

2. While erosion and structural loss can be significant, they are small compared to public recreational benefits.

3. From a discounted benefit/cost analysis, projects that spread costs out consistently will appear better than projects with high up-front expenses.

6.2.4 Sensitivity

A significant item which affects the preceding analysis is the beach fill maintenance cost. Should direct bottom dump methods prove to be technically possible, the total project life costs for the beach enhancement sites will be reduced by as much as two-thirds the conventional direct pump-out method. This will result in Plan 3 and Plan 4 being more favorable.

The analysis is much less sensitive to assumed land values because of the overall bias toward recreational benefits. For this study average data was consulted. However, given the volatile nature of oceanfront property in Southern California, it is recommended that land valuation be periodically updated.

6.3 Environmental Evaluation

Analysis of the environmental aspects of beach erosion control requires very specific information on the location, schedule and construction methods planned for each project. Analysis at a more general level is attempted in this report since the projects in question are at a proposal stage and information at a specific level is not yet available.

The environmental analysis outlines the issues involved in the proposed beach erosion control plans and reviews the Local Coastal Plans of each member government of BEACON. A ranking of both generic engineering methods and a selection of individual projects is provided.

Appendix E and F supports this section and includes a compilation of relevant coastal zone policies of BEACON member governments and the occurrence of biological resources of the BEACON coastline which are currently under special protection.

This analysis serves a dual purpose. First, policies which control the adverse effects of industrial activities on resources in the coastal zone of the member governments of BEACON are identified. These policies are part of and consistent with Federal and State coastal management programs. In addition, this analysis may serve as the basis for a CEQA "initial study." The purpose of an initial study is to determine if significant effects on the environment are a likely result of a proposed project, and if so, to initiate the EIR process (Remy, et al. 1989).

Local governments recognize the beneficial effects of the control of beach erosion and coastal flooding. Provisions for shoreline installations which alter natural processes are identified at every level of coastal planning. These measures are permitted when required to protect coastal property and uses, and when no other less environmentally damaging alternative is available.

6.3.1 Environmental Issues

The coastline of the Santa Barbara Channel is an environmentally sensitive area. The coincidence of the Santa Barbara oil spill in 1969 with passage of the federal National Environmental Policy Act (NEPA) brought national attention to the conflicts between industrial activities and the resources of the area. The incident highlighted the need for the incorporation of substantive (rather than merely procedural) provisions of law in the California Environmental Quality Act enacted in 1970.

Because of their importance to the area four prominent resource values are included in this analysis: visual resources, including scenic views and esthetics; recreation, including access; biological resources, including sensitive habitats; and water quality, including all waterborne pollutants.

6.3.1.1 Visual Resources

The scenic beauty of the study area is world renowned. The preservation of visual beauty is recognized by most local planning and zoning authorities as of major importance to the well-being of the area. Construction activities of any kind on the shoreline, and especially in the littoral zone, detract from visual resources and the preservation of broad unobstructed views.

6.3.1.2 Recreation and Access

Recreational opportunities are highly sought after in the study area. With public and private ownership contiguous on beach front properties, local governments must fulfill the often conflicting functions of protecting both private property and public access. Structural methods of controlling beach erosion can interrupt some forms of recreation and public access to recreational areas.

6.3.1.3 Biological Resources

Industrial activities such as the movement of large amounts of sand or construction of shoreline structures disrupts normal environmental conditions. Changes in physical substrate result in losses of biological productivity which may be permanent.

Biological resources of national significance exist in the study area (see Appendix F). Highly visible species such as Harbor seals, the beach spawning grunion and the endangered California Least tern occur in the area. Habitats which are protected by specific policies include sand dunes, wetlands, rocky points and tidepools, subtidal reefs, kelp beds, seabird nesting and roosting sites, native plant communities and offshore fishing grounds.

6.3.1.4 Water Quality

Water quality is an essential component to the integrity of the visual, biological and recreational resources of the study area. Any degradation of water quality as a result of an industrial operation is readily detectable in areas of high recreational use. Turbidity as a result of the movement of sand and silts, toxic outfall from waterborne machinery, and shoreline construction debris are examples of water quality degradation associated with construction activities.

6.3.2 Local Control of Coastal Land Use

The California State Planning and Zoning Law provides for the regulation of land use in the coastal zone by local governments.

The Federal Coastal Zone Management Act of 1972 (FCMA) mandated long-range planning for the conservation and management of coastal resources and conferred authority to the States for this task, so long as each state prepared a coastal plan which is in compliance with federal requirements. The State of California implemented the California Coastal Act (CCA) in 1977 including the formation of a Coastal Commission. One important function of the Commission is to assist local governments in exercising their planning and regulatory powers.

Local governments which choose to exercise their planning and zoning powers in this new context prepare local coastal programs (LCPs) which are in turn reviewed by the Commission for consistency with the CCA. LCPs consist of land use plans, zoning ordinances and maps, policies and special actions warranted for sensitive resources. All members of BEACON have prepared LCPs acceptable to the Commission.

As state policy and planning often follow enabling federal legislation in method and intent, so local government planning often follows the approach taken by enabling state legislation. Relevant provisions of the CCA are therefore important to include in this review. In addition, the State Coastal Commission continues to exercise permit jurisdiction over development in the tidelands.

6.3.3 Beach Erosion Policy

The California Coastal Act of 1976 contains three major provisions regarding beach erosion (all CCA sections and BEACON LCP policies cited here are included in Appendix E). Section 30235 permits structures that alter natural shoreline processes so long as coastal sand supply is protected. Diking, filling and dredging are permitted so long as adverse environmental effects are mitigated (30233, 30706). Most importantly, the CCA requires that new development shall not require the construction of protective devices (30253(2)). Member governments of BEACON provide for the control of beach erosion in somewhat more specific terms as summarized below:

> Santa Barbara County states a preference for non-structural solutions to beach erosion, prohibits above-ground structures on dry sandy beach areas, requires continued supply of sand to the shoreline, protects access, and requires bluff-top setbacks. (Policies 3-1 through 3-4).
>
> Ventura County limits beach erosion control to protection of existing developments. Protection of the sand supply and an evaluation for environmental soundness of the project is required (Policy 1-7).
>
> The City of Santa Barbara provides a set of policies which prohibit the use of seawalls, revetments and bulkheads unless they are the only solution to the protection of existing principal structures, and so long as access and esthetics are protected. All future development on the dry sandy beach is prohibited (Policies 6.3-6.7).

The Cities of Oxnard and Carpinteria take a similar approach with strong accentuation on minimization of adverse impacts (Carpinteria Policy 3-1 through 3-4, Oxnard Policies 12, 13, Ventura Policy for beach erosion p.63).

Structural methods for controlling beach erosion are often large and expensive to construct. Adverse environmental effects can arise from diverse causes. Misplaced groins or borrow sites, for example, can divert sand offshore, resulting in a more serious erosion problem than the problem the installation was designed to solve.

6.3.4 Environmental Policy Consistency

The California Coastal Act protects the integrity of all four resources included in this review. Visual resources (Sec. 30251), recreation and access (Sec. 30210, 30211, 30220, 30221 30234), biological resources (Sec. 30230, 30231, 30240), and water quality (Sec. 30231) are all protected with variable degrees of specificity. The LCPs prepared by member governments of BEACON also protect these resources.

The resource policies of each member of the BEACON association are reviewed as they specifically relate to the major engineering techniques proposed for control of beach erosion. The techniques are: 1) dredging beach quality sand from offshore sources, 2) constructing permanent installations on the shoreline which modify sand transport processes and wave action in the littoral zone, 3) non-structural methods such as depositing sand on eroded beaches (beach nourishment), dune stabilization and revegetation, and 4) an open category of "Special Methods" required to protect environmentally sensitive habitats and species. All policies referred to below are included in Appendix E.

In Figure 6-1, a matrix interrelates the four resource areas discussed above and these four engineering techniques. The expected level of significance of environmental impacts are identified in each cell. References also appear in each cell of BEACON member policies which are particularly relevant to the issue. The level of impact of "special methods" on resource values is considered slight since it is assumed that these methods will provide effective protection.

6.3.4.1 Visual Resources

Santa Barbara County has designated all areas in the County where views exist from Highway 101 to the oceans as a "View Corridor" subject to protection of visual resources. Policy 4-9 requires the preservation of unobstructed broad views of the ocean from Highway #101.

ENVIRONMENTAL ISSUES	IMPACTS OF BEACH EROSION CONTROL			
	Offshore Dredging	Shoreline Structures	Non-Structural Methods	Special Methods Areas
Visual Resources				STBC View Corridors 17 Intertidal ESAs Kelp Beds VC Rocky Tidepools Endangered Species Habitats Mugu Lagoon STB Andree Clark Bird Refuge CPT Offshore Reefs OXN Ormond Beach V Ventura River and Santa Clara River Estuaries and Associated Ponds and Lagoons Bikeways
Recreation (Access)				
Biological Resources				
Water Quality				

LEGEND

ENGINEERING TECHNIQUE

Offshore Dredging
- Removal of Sand from Offshore Site and Delivery Onshore

Shoreline Structure
- Breakwaters
- Groins
- Revetments
- Bulkheads
- Sea Walls

Non-Sturctural Methods
- Sand Bypassing
- Beach Nourishment
- Dune Stabilization
- Intertidal Vegetation
- Debris Basin Bypassing

Special Method Areas
- Special Engineering Methods needed to Protect Sensitive Resources

STATE & BEACON GOVERNING AUTHORITY

CCA - California Coastal Act
STBC - Santa Barbara County
VC - Ventura County
STB - City of Santa Barbara
V - City of San Buenaventura
CPT - City of Carpinteria
PTH - City of Port Hueneme
OXN - City of Oxnard

LEVEL OF SIGNIFICANCE

Slight

Moderate

Potentially Significant (CEQA Guideline 15065, 21083)

ENVIRONMENTAL SIGNIFICANCE OF METHODS FOR THE CONTROL OF BEACH EROSION

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Figure 6-1

The City of Santa Barbara protects all scenic views of the coastal zone (Policy 9.1).

Carpinteria requires their Architectural Review Board to review all projects (other than single family residences) for visual resource considerations (Ordinance 201). In addition, Policy 4-1 protects unobstructed views to the ocean.

Oxnard Policy 16 (P 40) specifies that all new construction in the coastal zone minimize impacts on visual resources.

These policies indicate a reluctance to place structures which are permanent and visible on the beach or in shoreside waters. If such structures are considered essential, then considerable control of design and construction must be expected, as well as considerable public opposition. The level of impact of permanent shoreline structures on visual resources is therefore considered potentially significant. For offshore dredging and non-structural methods the expected impacts are slight.

6.3.4.2 Recreation and Access

The Santa Barbara County Coastal Plan takes the approach of securing access to and along the coastline as an important means for implementing the goal of the CCA of providing maximum opportunities for recreation. Policies 7-1, 2 and 3 ensure assess in very specific terms. Policies 7-8 through 7-26 specify numerous land, easement and facility acquisition designed to increase access and recreation opportunities.

Ventura County states categorically that for all new development both vertical access to the mean high tide line and lateral access along the shoreline is mandatory.

The City of Santa Barbara takes specific action in the LCP zoning publicly owned coastal lands for recreation and open space (Policy 3.1).

Carpinteria grants priority use to recreation activities in the coastal zone as far as 250 feet inland and lateral access is also mandatory (Policy 7-13, 15).

Port Hueneme (Table 1 p.23) identifies recreation and access as primary LCP issues for specific beach areas and identifies actions for these areas.

Oxnard requires access to and along the shoreline for all new developments, with certain minor exceptions (Policy 50).

The City of Ventura protects access along revetments (p.63). This city uses bikeways to provide for access and recreation opportunities along the coastline.

Clearly, recreational use dominates most beaches in the study area. Public access is protected by all BEACON members. Permanent shoreline structures inevitably impact recreational use and mitigation measures for lost recreational opportunities are probably essential. The level of significance is considered severe for shoreline structures on recreational use, and slight for offshore dredging and nonstructural methods.

6.3.4.3 Biological Resources

The LCPs of all members of BEACON provide protection for biological resources. This protection is provided primarily through protection of environmentally sensitive habitats or ESAs.

Santa Barbara County requires all projects taking place in an ESA to conform to the applicable habitat protection policies. For example, sand dunes at Mussel Rock, Surf, Devereux and Channel Islands are protected by policies that prohibit industrial use except when no alternative location is feasible and then only under strict controls. Policies 9-2 through 9-5 protect dune vegetation and critical bird habitat during breeding and nesting season, and prohibit unauthorized vehicles, and foot traffic except on designated paths. Equally complete policies govern activities in wetland, rocky point and intertidal, subtidal reef and kelp bed habitats.

In addition Santa Barbara County regulates development adjacent to ESAs which is regulated through the use of setbacks, buffer zones, erosion control and other restrictions (Policy 2-11).

Ventura County provides protection for tide pools, creek corridors, coastal dunes, wetlands and recognition of the importance of Mugu Lagoon as the last estuary in Southern California to remain near its natural state. Policies for shoreline installations protect habitat values, sensitive species and coastal waters from contamination (Policies 3 p.27, 4 p.83, 3 p.132).

The city members of BEACON each provide similar protection of biological resources, with the addition of specific areas of importance under their jurisdiction as ESAs. For example, Santa Barbara identifies the offshore kelp beds, the commercial fisheries and a highly productive area offshore from Arroyo Burro Creek as particularly important and provides for protection of marine resources and endangered species (Policies p.3-72,75). Ventura identifies the Ventura and Santa Clara River mouth areas and associated ponds and lagoons as particularity sensitive habitat areas. Carpinteria takes an approach similar to Santa Barbara County in which policies are developed for each habitat type (wetlands, seal rookeries, subtidal reefs, tide pools and kelp beds) and requires that these policies be met (Policy 9-2).

Oxnard identifies a wetland area at Ormond Beach and five dune areas which provide nesting habitat for the endangered Least tern. In addition a resource protection ordinance is created for ESAs specifying uses, buffer zones and requiring development planning.

Finally, Port Hueneme identifies habitat protection policies for specific shoreline areas, such as the Bubbling Spring Waterway.

From these policies it is clear that protection of biological resources is a high priority for BEACON members. In most instances protection of biological resources takes precedence over recreational use. The precise location of industrial activity and its duration are particularity important and may require modification to accommodate species and habitat protection. Offshore sand mining obviously destroys the associated biological systems. Its rate of recovery may depend upon the mining methods used. Sand habitats are usually not particularity productive biologically. However, kelp beds, mariculture sites, and commercial fishing grounds for halibut, shellfish and trawl species must be avoided.

The level of significance of offshore dredging is, therefore, considered potentially significant (Figure 6-1) when associated with biologically productive species.

The littoral zone is sprinkled with tidepools, surf grass habitats, foraging and nesting habitats for endangered species such as the California Least tern, spawning habitat for the renowned Grunion and even a seal haulout. Careful timing and choice of location of projects can avoid these sensitive areas. The significance of potential impacts of shoreline structures on biological resources is therefore considered severe. The significance of non-structural methods is once again slight.

An inventory of the occurrence of environmentally sensitive habitats and species for the BEACON area is included in Appendix F.

6.3.4.4 Water Quality

Santa Barbara County prohibits the discharge of pollutants, or degradation of water quality in any form resulting from development (Policy 3-19).

Ventura County protects water quality by use of an all-purpose policy (Policy 5) protecting beach areas from adverse impacts.

The City of Santa Barbara includes by referral the policies of the Regional Water Quality Control Board (Policy 6.9).

Carpinteria protects coastal wetlands, steams and ground-water basins from pollutants (Policy 3-19).

Oxnard provides for extensive control of the quality of coastal waters including removal of all toxic substances (Policy 10).

The quality of coastal water is protected under CCA Sec 30231 but certainly with less rigor than potable water sources such as groundwater, watersheds, lakes and streams. Sources of degradation of water quality include turbidity resulting from use of silt-laden sand, discharge of pollutants from construction machinery and construction debris. A moderate level of impact is therefore indicated for both offshore dredging and shoreline structures.

6.3.5 Project Ranking

A preliminary ranking of the level of significance of the environmental impact of individual projects proposed by BEACON results from relating the resource values, the relevant BEACON member policies and the installations proposed. This ranking is strictly preliminary. The precise areal extent of each project, its schedule and the construction methods proposed must be known before a more comprehensive ranking can be made.

The array of projects included in Table 6-5 varies primarily in the presence of sensitive biological resources and in the use of permanent shoreline structures for erosion control. For example, the use of sand fill in Carpinteria Plan 4 and Goleta Plan 2 is preferable from an environmental perspective over plans proposing the use of groins. Both offshore and onshore reefs occur in the Carpinteria area. These features and the associated habitats are subject to disruption by shoreline construction activities and require protection, and mitigation of any habitat losses which might occur (Swigert, 1989).

Table 6-5

Environmental Ranking and Rationale for Proposed Beach Erosion Projects

RANKING	PROJECT LOCATION [1]	INSTALLATION (PLAN) [1]	BENEFITS	IMPACTS
3	Carpinteria	Groin, Fill (2,3)		• Visual and Recreation Nuisance • Potential Loss of Water Quality • Habor Seal Disturbance • Borrow Site Conflict with Fishe • Distruction of Intertidal Reef ar Offshore Rock Habitats
1	Carpinteria	Fill (4)	• No Visual, Recreational Biological or Water Quality Impacts	• Borrow Site Conflicts with Fisheries • High Maintenance of Erosion Control
1	Ventura Harbor	Backpass Plant (2)	• Avoids Ventura & Santa Clara River estuaries • Avoids Maintenance Dredging • Provides Sand Downcoast	• Construction Disturbance
2	Ventura Harbor	Backpass using Existing Dredge (3)	• Avoids Construction Disturbance	• Dredge Spoil Deposition • Potential Loss of Water Quality
3	Isla Vista	Groin, Fill (2,3)		• Grunion Beach Disturbed • Borrow Site Conflicts with Offshore Fisheries • Littoral Zone Used by Endange[illegible] Bird Species • Visual Nuisance • Potential Loss of Water Quality
1	Goleta	Fill (2)	• Avoids Visual, Recreation, Biological and Water Quality Impacts • Avoids Construction Disturbance	• Borrow Site Conflicts with Fisheries • High Maintenance of Erosion C
4	Santa Barbara	Groin Field, Fill (2,3)	• Avoids Sand Point Recruitment Area for Birds	• Visual and Recreation Nuisance • Potential Loss of Water Quality • Construction Impacts
4	Emma Wood	Groin Field, Fill (2)		• Visual and Recreation Nuisance • Potential Loss of Water Quality • Borrow Site Conflicts with Offshore Fisheries • Construction Disturbance
4	Oxnard Shores & Channel Island Harbor	12 Groins, Bypass Plant (2)		• Visual and Recreational Nuisanc • Potential Loss of Water Quality • Construction Impacts • Threat to Ormond Beach Habitat

Installation of sand bypass plants at Ventura and Channel Islands harbors are considered environmentally preferable to continued maintenance dredging. Also, bypassing enhances the supply of sand to beaches downcoast.

Carpinteria Plans 2 and 3 and Isla Vista are ranked third because of the use of single groins in areas of high recreation use. Sensitive habitats also occur in these areas.

The Santa Barbara, Emma Wood and Oxnard Shores beach nourishment projects include the use of groin fields in high use recreation areas and are therefore ranked lowest. These projects are large and the potential for impacts during construction is high.

6.4 Preferred Plan

The sand management plan is recommended to consist of the following elements:

1. Beach nourishment
2. Public policy
3. Short-term demonstration project
4. Long-term coastal monitoring.

Based upon review of the technical, economic and environmental issues, the preferred plan is selected as discussed below.

6.4.1 Beach Nourishment

Plans 1, 2, and 3 are nourishment and sand management plans which specifically address BEACON's goals and objectives. They differ in their extent of shoreline coverage and maintenance methods. Plan 4 maintains only status quo conditions, and it contains no provisions for beach enhancement. Therefore, from a technical viewpoint, Plans 1, 2, and 3 are preferred.

Based on economics, the costs associated with Plans 1 and 2 are substantially greater than estimated benefits, whereas Plans 3 and 4 have more balanced benefit/cost ratios especially if long-term maintenance can be achieved using hopper dredge bottom dump technologies. Hence, Plans 3 and 4 are preferred based on economics.

From an environmental perspective, Plan 4 is favored because of its limited scope and non-use of coastal structures. The remaining plans are less favorable because of the use of control groins and the greater potential for impacting biological resources.

In summary, Plan 3 is selected as the preferred beach nourishment element because it provides the optimum balance of satisfying technical objectives, has a more favorable benefit/cost ratio, and is associated with more reasonable potential environmental impacts.

6.4.2 Public Policy

The plan should include public policy elements to address sand management issues, sand source preservation, and acceptable property protection/beach protection practice. The preferred plan should therefore incorporate land zoning and permitting to:

1. Continue harbor dredging;
2. Eliminate fluvial sand mining;
3. Bypass debris basin sediments;
4. Mitigate loss of bluff erosion as a sand source; and
5. Mitigate dam impacts.

6.4.3 Short-Term Demonstration Project

Three of the five demonstration projects have been developed specifically to address technical aspects of the long-term plan. The hopper dredge bottom dump test stands to yield the greatest economic payoff for its high risk experiment to verify natural, onshore migration of sand. The control groin project is intended to test a key element of the beach nourishment program called for in the long-term plan. Lastly, the offshore sand renourishment alternative is the most visible and direct means to evaluate large scale fill design criteria. These three demonstration projects are preferred because of their technical importance and potential cost savings implications.

6.4.4 Long-Term Coastal Monitoring

The sand management plan recognizes that the database within the Santa Barbara Littoral Cell is limited and should be improved. Regular collection of beach profile data, wave information, and hydrologic measurements is recommended to improve the technical understanding of the shoreline, confirm critical design assumptions, and allow for plan refinement.

7.0 - PLAN IMPLEMENTATION

Implementation of the preferred comprehensive sand management plan is recommended to progress according to the ordered tasks listed below:

1. Develop funding program;
2. Verify the preferred plan;
3. Construct and monitor one or more demonstration projects;
4. Perform necessary design and permitting tasks;
5. Authorize construction;
6. Implement long-term monitoring; and
7. Implement public policy measures.

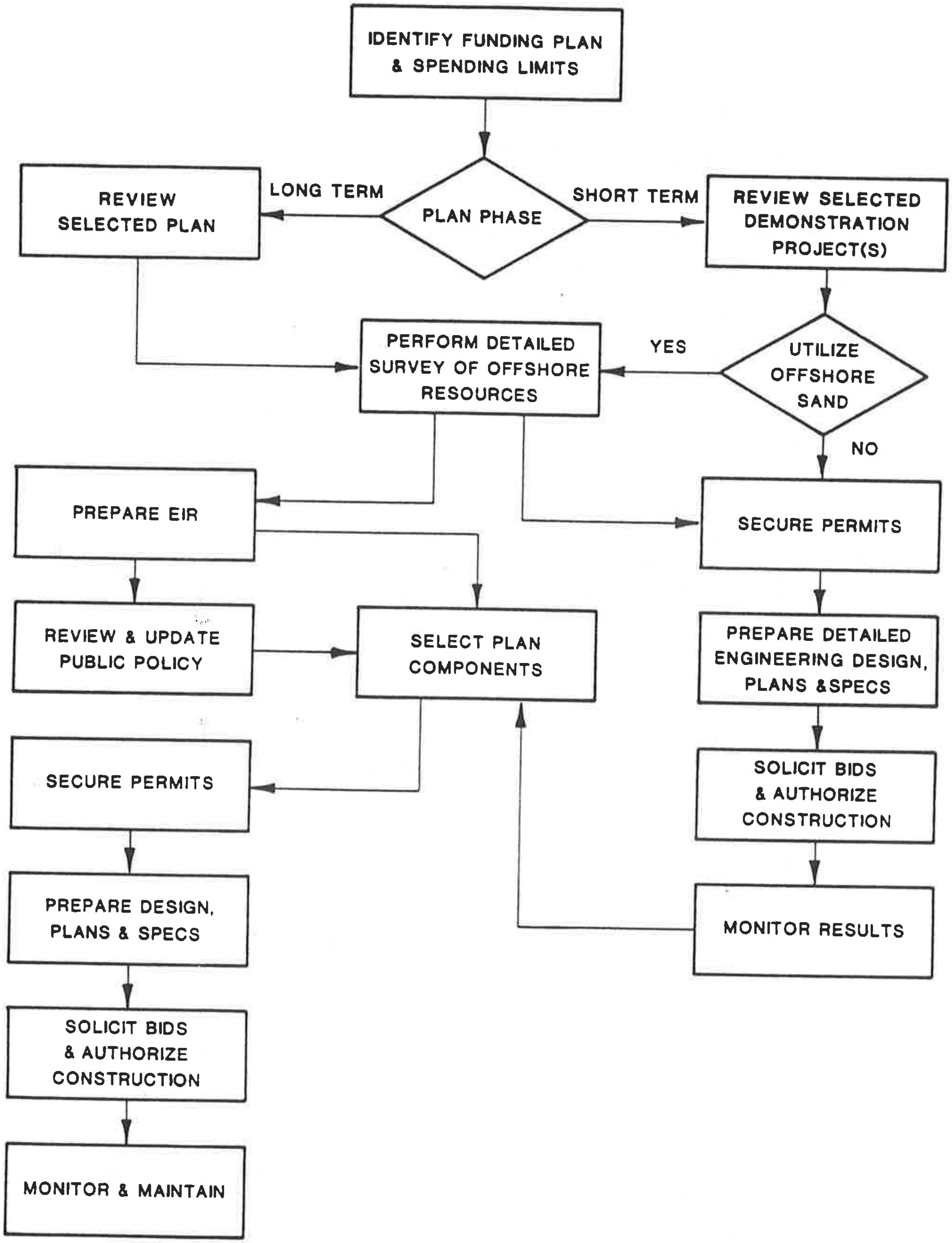
A flow chart of the above process is shown on Figure 7-1. The figure indicates a suggested sequence of action to implement a short-term demonstration project and the ultimate long-range plan.

The first order of business deals with development of an appropriate funding plan to underwrite the initial construction, maintenance, and administrative aspects of the program. Because of its importance to plan implementation, funding strategy is discussed in more detail in the next section.

7.1 Funding Options

The considerable costs associated with the candidate sand management plans imply that funding may be a major obstacle toward implementation of a preferred level of action. Consequently the mechanism to financially support the plan will need to be developed in detail. Furthermore, it is very likely that the size and scope of the preferred plan will be limited by the extent of monies that can be raised to pay for it. This section provides a discussion of possible funding mechanisms and strategies that BEACON may pursue in the implementation process.

There are a variety of different magnitude improvement projects that have been identified for possible BEACON implementation to reduce the beach damage and sand loss that have been the recent pattern in Santa Barbara and Ventura Counties. These range in cost from a regional sand management plan costing $764 million to demonstration projects at several specific



PLAN IMPLEMENTATION FLOW CHART

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Figure 7-1

beaches that could be implemented for a nominal cost. In addition to one-time costs, there are annual maintenance and renourishment costs as well. Fixed items, such as groins or sand bypass plants, have somewhat higher fixed costs and lower annual costs than dredging and pumping sand, which would need to be repeated on a one- to five-year cycle.

A formula for funding the improvements should consider both benefits and costs that would be avoided as a result of sand renourishment. Examples of avoided costs would include much of the annual or biannual dredging costs at Ventura and Channel Islands harbors that could be saved if permanent bypass plants were installed ($2.2 million net savings). Additional savings include the costs of annual and occasional beach and shoreline maintenance activities by shoreline property owners. By rough calculation, there are approximately 950 individual structures (mostly homes), three large hotels or motels, and one major condominium project that have direct beach or bluff access.

This analysis does not represent a recommendation for funding techniques, but a discussion of alternative local funding concepts (with the exception of avoided costs) for public consideration. Any large demonstration or overall improvement project will require State and/or Federal grant funds, but a local share will be required, particularly to meet ongoing costs.

7.1.1 Benefits Associated with Beach Nourishment

In developing a funding plan for beach nourishment activities, it is important to allocate benefits to beneficiaries, and thus determine a funding plan that is appropriate. Selecting additional local revenue sources required to fund erosion control efforts must include both tests of equity (fairness) and ease of collection (efficiency).

There are several levels of benefit for increased beach size, ranging as follows:

- The individuals and governmental agencies that own waterfront land and will benefit from reduced damage and reduction of erosion;

- The population of the coastal communities who will enjoy a more pleasant community from beach recreation usage and a better economy as a result of increased tourism;

- The business owners who will benefit from increased business; and

- The beach users from within the counties and throughout the state and county.

It should be clear that the largest beneficiaries will be the first group, whose property is either currently threatened or will be by beach erosion within the 50 year time frame of the BEACON study. Past general erosion either general or storm specific has resulted in tangible and quantifiable damage to structures, roads, campgrounds,and other public and private property along with intangible losses of value as a result in reduction of property size from erosion. Waterfront lots are typically worth $100-200 per square foot, or $300-500,000 for a small parcel. In the past, private property owners have invested as much as $500 to $1,500 per front foot - or $25-75,000 for a typical 50 foot frontage coastal lot - for protective devices such as revetments and seawalls that will protect property from erosion and large wave damage for 30-50 years.

7.1.2 Revenue Sources

7.1.2.1 Assessments

Owners have funded coastal protection measures both individually and through assessment districts. Such erosion and damage control activities have reduced property damage, but have done little for recreation enhancement, and in fact may have diminished recreational usage. Using an estimate of 950 homes plus several hotels and condominiums as the equivalent of 1,200 coastal units, improvement costs of $1,000 per unit would yield $1.2 million. Improvements costing $25,000 per unit would generate $30 million and result in an average per unit monthly assessment of $175 (deductible from federal tax as a local tax) assuming 30 year financing at 7.5% tax-free public interest. While this is a high assessment, the property is extremely valuable and will decline in size (estimated by up to one foot per year) in the absence of shore protection activity.

A smaller benefit assessment could be levied on properties nearby but not adjacent to the beach. They will not receive the direct property protection benefits, but they will receive a higher benefit of better beaches than the community at large. The principle of tiered levels of benefit has been used in relation to other public projects, such as plans for benefit assessment districts around the Los Angeles Metro Rail Stations. In the absence of specific property protection benefits, it will be more difficult to get voter support for the creation of an assessment district.

There are a variety of provisions in state law for raisi special assessments, ranging from the Municipal Improvement Ac of 1911, 1913, and 1915, to County Service Areas, the Mello-Roo Community Facilities Act of 1982, and provisions of sta redevelopment district law. The Mello-Roos provisions a probably the most flexible in terms of using the available fund for both capital and maintenance expenses.

Public agencies that own waterfront land include special districts, cities, the counties, state parks and transportati departments, and the federal Department of the Navy. They wi benefit from a reduction of emergency repair and re-constructio activities, and from increased usage of their facilitie Although public agencies do not receive any benefit themselve the residents of the jurisdictions receive the benefits in ter of reduced maintenance costs.

There does not appear to be any per-mile factor in terms public damage costs, but particular storm events have resulted in large public clean-up costs. Costs have been as high as $100-50 per lineal foot for repairs to Ventura County beaches after 1983 series of storms that was considered to represent a 15 year storm. Costs to the City of Santa Barbara were approximately $ million during the same storm periods. The City of Carpinteri has estimated an annual cost for beach erosion control for the City beach of around $105,000, not including occasional highe costs associated with larger storm events. The Navy is estimate to spend $500,000 annually to protect structures at Point Mug from wave damage. The expenditures incurred by Caltrans and State Parks for annual erosion control is not known, but it i conservatively estimated to be about $100,000.

It is estimated that local government public shor protection costs between Isla Vista and Point Mugu average in th $1-2 million dollars range annually, not including exceptional events. There are some years in which a minimum is spent, an others in which several million are spent to repair storm damage Local costs are funded through a variety of sources, ranging from General Fund revenue to Transient Occupancy Taxes to Tideland Oil revenues. The State Parks Department uses State genera funds for normal maintenance activity. Approximately three-quarters of State Beach costs are met through user fees that are set on a statewide basis, with the remainder coming from genera tax revenues.

Beach users will benefit from better facilities, businesse will benefit from greater tourism-related business, and the local population will benefit from increased employment opportunities, as well as increased tourism. These benefits are much smalle per individual than the specific benefit to owners of waterfront property, but the group is much larger.

Thus, in terms of equity, the owners of waterfront property should pay the most per individual, and other beneficiaries should pay a substantially lesser amount per individual.

Efficiency of collection is also an issue that must be considered. There are a limited number of forms of tax or user fee collection, and initiative actions have limited the ability of governmental jurisdictions to use certain forms of revenue collection, such as the property tax. Benefit assessment districts can be created for specific and defined improvements, but not for general application throughout a city. User fees are difficult to assess on beach users where there is no fee now, since many public beaches have open access and free parking. The collection costs would be extremely high and net revenues minimal. Public agency general funds are large, but currently have many existing demands and cannot be anticipated to fund BEACON projects.

An increase in hotel or transient occupancy tax is another option that has merit in targeting a population base that benefits from improved beaches. Much of the visitor traffic for the Santa Barbara and Ventura coastal communities is attracted by the beautiful coast and beaches, and it is reasonable that they contribute to beach maintenance and improvements. Santa Barbara and Ventura currently have 10% transient occupancy tax rates, while Oxnard has 9% and Carpinteria has 8%. An increase of 1% in each community devoted to a beach enhancement fund could yield $1.2 million annually, conservatively assuming 60% occupancy of hotels and motels and an average bill of $75/night. Tax on short-term apartment or house rentals, and increases in number of rooms and usage, would make this a relatively productive and increasing source.

7.1.2.2 Mitigation Fees

Another aspect to consider is the degree to which any governmental or private actions interfere with the natural renourishment of beaches, and the degree to which it can be identified. If such actions occur, it is appropriate to consider a mitigation fee. Examples of such actions germane to disturbance of natural beach renourishment include the construction of harbors, which interfere with the natural movement of sand up or down a coast, the damming of rivers for flood control or water supply purposes, and river bed sand mining.

Concepts of mitigation fees could include assessments on harbor users, such as a small fee per foot for berth space or a fee per boat based on length and draft. There are four harbors that affect the BEACON study area. They are Santa Barbara, Ventura, Channel Islands, and Port Hueneme Harbors. The estimated number of berths is 5-6,000, and the average boat size is approximately 30 to 40 feet. Average boat size is much larger at the military and commercial harbor at Port Hueneme. At a 5% increase in berthing cost (currently estimated to run $200-250 per month), approximately $800,000 would be raised annually. Given a 10% fee increase, or about $22 a month, approximately $1.6 million would be raised annually from a group that specifically gains from the presence of boat harbors.

A sand retention mitigation fee on water supply and flood control dams is another potential revenue source that could be used to fund the sand nourishment activity required because of their existence. The major rivers in Ventura and Santa Barbara Counties (Santa Clara, Ventura, and Santa Ynez) are all dammed for water supply purposes. There are at least 350,000 water service accounts in the two counties, although some may receive their supply strictly from wells rather than reservoirs.

It is estimated that dams on the Santa Ynez, Ventura, and Santa Clara Rivers prevent about 650,000 cubic yards of sand per year from reaching the shoreline. Assuming a replacement cost of $6 per cubic yard represents the annual expense that would be required to supplement this deficit from offshore sources, a water user mitigation fee of about $10 per household is calculated.

The $10 fee, still less than $1/month per household or business, would yield almost $4 million, a potentially substantial local funding source. It is an appropriate source in terms of mitigation, and also a good funding source for small countywide benefits per household and per business. However, there are many water districts, and it might be politically difficult to accomplish a countywide water mitigation fee. Furthermore, the rivers north of Point Conception are believed to not contribute substantially to the sediment budget inside the Santa Barbara Channel. Thus, the revenue source from associated water districts north of the Santa Ynez Mountains would not be appropriate. Nevertheless, a county-imposed utility users tax on water usage might be a possible implementation procedure for this funding source.

There is no readily available data source on the amount or dollar value of sand mining currently under way in the two counties, so it is not possible to determine what would be an equitable mitigation fee on sand mining. However, considering the extent of the impact of sand mining to the sediment budget, a tax to replace the lost sand commensurate with the replacement cost would be appropriate. An excessive fee would make the existing sand mining operations non-competitive with operations outside the two counties.

7.1.2.3 Summary

Table 7-1 summarizes the above discussion in terms of potential locally based revenues that could be used to assist in funding beach preservation and renourishment activities. Certain Federal sources are considered from a cost avoidance perspective, but the remaining sources are local ones that could be used as a local match for State or Federal grants. While the discussion has considered the local benefits in terms of damage reduction and recreation enhancement, there is as much basis for Federal and State support as for any property that is used as State or Federal park land. While the 60 mile study area represents only about 5% of the California coast, it may represent 10-20% of the California coast that is accessible to the public and near major population centers.

Although totals are shown as a relative amount, it is clearly infeasible to develop all of the above revenue sources to support a sand management and renourishment plan. In addition, capitalizing the annual revenues to fund a revenue bond would leave insufficient local funds to support ongoing maintenance activity. However, the above table does illustrate some potential funding sources that could be used to match State or Federal grants and also contribute to ongoing maintenance.

7.1.3 Reach by Reach Funding Potential

The majority of fund sources obviously come from specific areas, and short of a regional recovery and maintenance program, there will be a preference that certain funding sources be spent on specific improvements. As an example, funding from the Corps of Engineers would have to come in lieu of their expenditures for harbor dredging. The numbers cited in Table 7-1 represent the potential savings of dredge costs for Channel Islands and Ventura harbors, that could be spent on the backpass/bypass plants, and their structures and pipeline that would replace the Corps of Engineers dredging activity. Likewise, the largest amount of transient occupancy tax comes from the City of Santa Barbara, so any funds from that source may be preferred for public beaches in the Santa Barbara area. Thus, the revenue sources identified in Table 7-1 may be diluted by their geographical origination. Consequently, the comprehensive funding plan must factor this issue into account, and strive to emphasize the regional nature and overall benefit to be gained by pooling revenue.

7.1.4 Potential State Bond Issue Funding

Recent elections have included several bond issues to purchase and improve public parks and provide clean water (e.g., Propositions 70 and 83). State government has also provided

Table 7-1

Potential Funding Sources
for
BEACON Sand Management Activities

Funding Source Revenue*	Annualized Revenue	Capitalized
Avoidable Cost		
Corps of Engineers	$2,200,000	$25,800,000
U.S. Navy Pt. Mugu	500,000	5,800,000
Caltrans/State Parks	100,000	1,200,000
Local Government	1-2,000,000	11-23,500,000
Benefit Assessment & User Fees		
Private Structures	2,500,000	30,000,000
Transient Occupancy Tax	1,200,000	14,100,000
Mitigation Fees		
Harbor Berthing Fees	800,000-1,600,000	9.4-18,800,000
Water User Fee	4,000,000	25.5-47,000,000
Sand Mining Fee	?	?
TOTALS	$ 12.3-14,100,000	$123-166,300,000

*Assuming Public Tax Exempt bond financing at 7.5% and 30 years assistance for beach maintenance programs in isolated cases. Because of the importance of State and local beaches for recreational purposes, beach renourishment activities should have as much priority for State bond financing assistance as the purchase of additional park or beach lands for public usage. In additional, although beach renourishment projects can be relatively expensive, they are not as costly as purchase and infrastructure development of new public beaches.

Other State recreation assistance bond issues have included local match requirements ranging from a minimum of 25% to a maximum of 50%. Projects generally are one-time rather than ongoing, as sand renourishment activities tend to be. Thus, use of grant funds for an ongoing project would either require that a particular bond issue and grant not be closed out, or that a series of bond issues be used for ongoing project activity. There is some risk in the latter strategy, since an initiated project may have funding difficulties if a latter bond issue fails. Given the magnitude of the levels of action described in Chapter 5.0, it is likely that obtaining State funding assistance will be mandatory to successfully implement a program. This strategy should therefore receive high priority within BEACON's funding development.

7.2 Project Development

Once the funding mechanism has been established, the implementation process is recommended to follow two parallel paths of selecting and constructing short-term and long-range projects. The short-term or demonstration pilot project should include features of the regional plan. Such a project may demonstrate a particular aspect of the plan or serve as a prototype experiment to determine the potential benefit that might be realized from a concept that is unproven. Three preferred demonstration projects are proposed as a means to tangibly test or implement elements called for by the plan. The projects were listed in Chapter 5.0.

7.2.1 Long-Range Plan

As schematically shown in Figure 7-1, development of the long-range plan should proceed by quantifying the construction limits of the identified offshore sand sources through deep vibracore drilling, permitting, and detailed design phases.

The permitting process will require additional consideration of environmental quality as required under CEQA guidelines. The lead agency for the CEQA process will normally be a single county. The lead agency prepares an initial study at its own expense to determine if the project is likely to have a significant effect on the quality of the environment. If the study indicates that significant consequences are likely, then a Notice of Preparation of an Environmental Impact Report (EIR) is issued, which formally initiates the CEQA process. If the study indicates that significant effects on the quality of the environment are not likely, a Negative Declaration is prepared. After a public review period, the Negative Declaration is reviewed and approved by an interagency decision making body and the project proceeds (Remy et al, 1989).

7.2.2 Public Policy

The preferred public policy items listed in Chapter 6.0 should be reviewed and incorporated into the appropriate local codes, ordinances and guidelines. Where appropriate, BEACON should solicit policy concurrence and adoption by State and Federal agencies for overall consistency.

7.3 Long-Term Monitoring

The comprehensive sand management plan should be reviewed periodically to examine needs and priorities in response to improvements in the database. A critical question in the formulation of the plan rests in the validity of the shoreline recession predicted for the beaches east of the Santa Clara River. It has been postulated by Dean (1988b) that the segment could be benefiting from onshore renourishment over a much broader nearshore self segment than is assumed in this study.

A regular program of beach profile monitoring is recommended as a prudent course of action to confirm projections of shoreline evolution prior to commitments of substantial monies. In addition to beach profile surveys, a range of monitoring tasks can be implemented. This section presents a summary of beach monitoring options for consideration within the BEACON jurisdiction. The purpose of the monitoring program is to collect relevant field measurements which are the key indicators of the region's coastal processes.

Coastal processes are temporal phenomenon which vary daily, seasonally,and yearly in their behavior. Usually key indicators such as wave conditions or alongshore transport are averaged over time. The shoreline within Santa Barbara and Ventura Counties are effected by the following:

1. Wave climate;
2. Fluvial sediment delivery; and
3. Activity by man.

The ultimate purpose of a monitoring program is to track the amount of sediment delivered to the coast, its movement alongshore, and associated volume changes on the beach. Interpretation of the data on a regular basis would enable one to anticipate trends in shoreline response and take appropriate action and/or adjustment to sand management activity. It is also possible that a numerical shoreline response model could be developed and integrated with real time field data input to serve as an indicator of immediate beach erosion activity and a forecast tool to flag potential trouble spots.

The most comprehensive study program to date in California is the Coast of California Storm and Tidal Wave Study (CCSTWS). This technical program being conducted by the Corps of Engineers consists of three aspects: field data collection, review of existing data, and development of shoreline numerical models to simulate the dominant processes. The field program includes wave/wind data collection, aerial photography analysis, beach and nearshore bathymetry measurements, sediment sampling, fluvial discharge measurements, and geologic and littoral transport analysis. The purpose of the CCSTWS is to eventually refine the understanding of shoreline response. The Corps' current schedule calls for beginning study activity within the Santa Barbara-Ventura area in about five years.

The monitoring plan described in this section is one that is intended to be implemented by a number of participating agencies and organizations. Data is proposed for collection on a regular basis for interpretive analysis. Conclusions would be directed toward refinement of understanding of the littoral sand budget and forecasting trends of shoreline response.

7.3.1 Plan Components

The essential ingredients of the monitoring plan are:

1. Wave data collection;

2. Fluvial discharge and hydrologic measurements;

3. Beach profile surveys;

4. Aerial photography review; and

5. Dredging records review.

The monitoring plan is intended to be a relatively simple program consisting of direct shoreline response measurements and correlation against wave energy, rainfall, and man activity. It is also intended that the cumulative results of the program could be directly utilized by more comprehensive CCTSW technical study should Federal funding be extended to the BEACON study area.

7.3.1.1 Beach Profile Measurements

Twenty-five beach profile stations have been established as part of the BEACON sand management study. The alongshore spacing of transects is about one every 2-1/2 miles. This spacing constitutes a minimal density for determination of volumetric fluctuations. Descriptions of the profile stations and the specifications for measurement are given in Appendix D. Figure 7-2 shows the profile station locations.

Profiles should be initially measured at least once per year during the first two weeks of October. This will provide data to track annual net changes of shoreline position and sand volume. Additional measurements are desirable during March and after the occurrence of significant coastal storms. The decision to survey additional data may be made based upon less expensive and more frequent pier surveys such as the ongoing monthly program at San Buenaventura State Pier. Differences in successive months data from such reference stations totaling more than 60 cy/ft would initiate steps to survey the entire nearshore network to determine sand volume status. Figure 7-3 shows how the monthly data from San Buenaventura State Pier may be used in this regard.

The frequency of surveys could be determined by appraisal of a three year initial profile monitoring effort. Thereafter, subsequent profile measurements would be keyed into less extensive dry land surveys and fixed pier monthly data.

The advantages of using existing piers as survey platforms is the significant cost reduction which can be realized and the relative ease of taking measurements. Their accuracy limitations may be offset by a principal reliance on the more extensive full profile surveys that would be scheduled from review of the reference data results.

7.3.1.2 Wave Data Collection

Directional and non-directional wave gages are recommended for installation and maintenance over the BEACON shoreline area. A minimum of five pier-mounted stations are specified from Goleta to Hueneme Beach. The proposed network is shown in Figure 7-2. One deep water directional wave gage is also suggested in the east central portion of Santa Barbara Channel on the platform "Grace" oil structure. The non-directional stations are recommended for economy and to simplify data reduction.

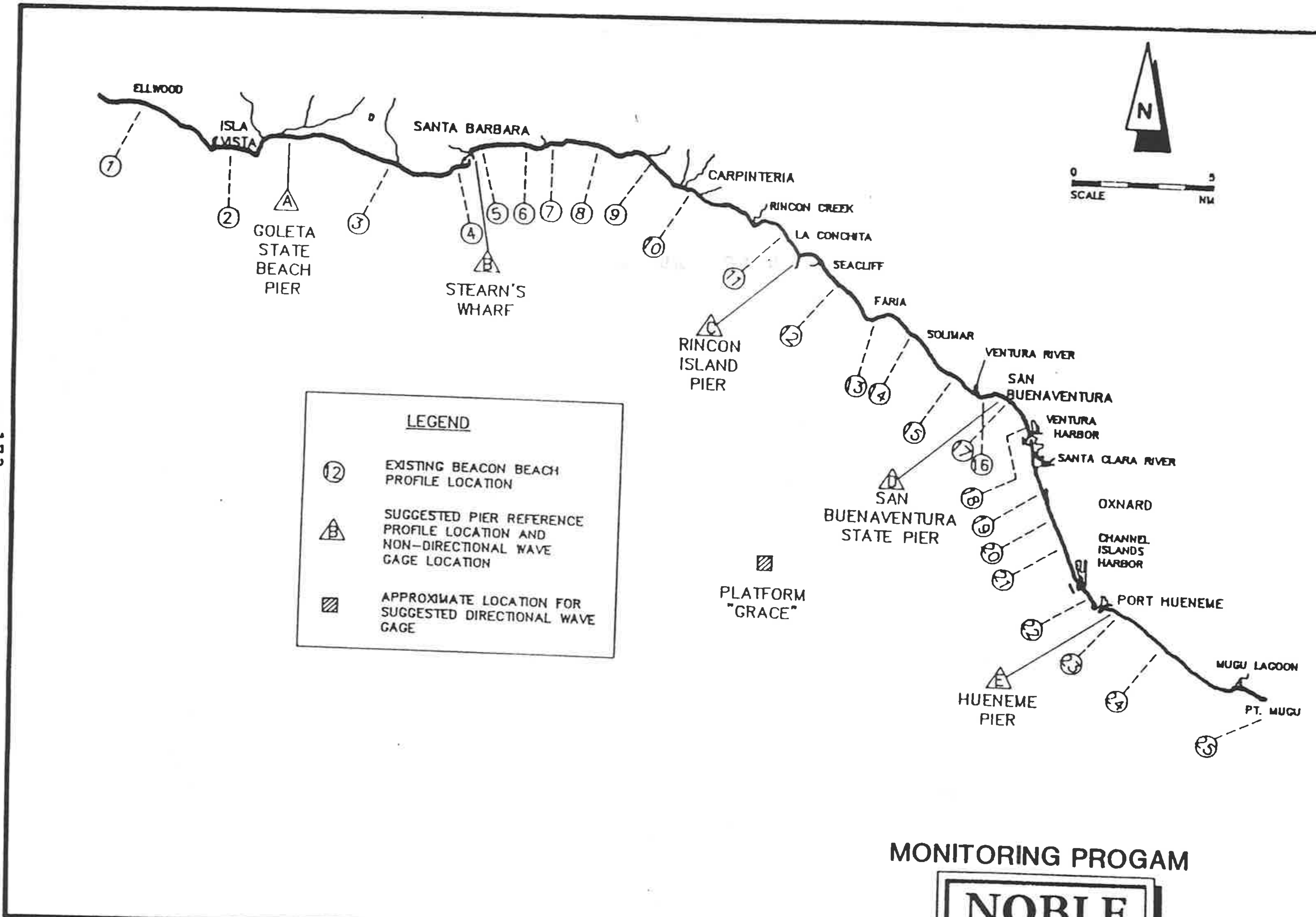
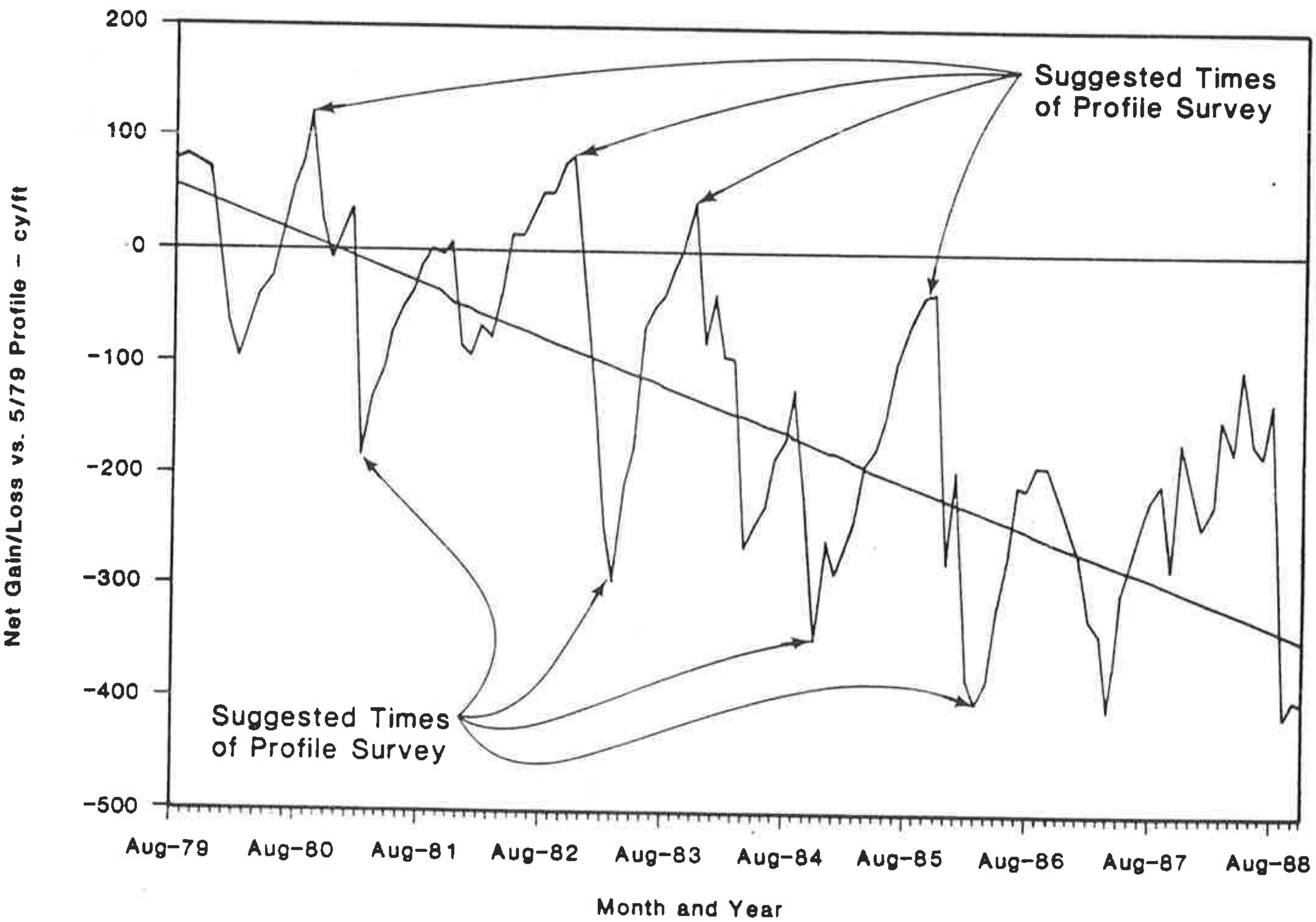

ELLWOOD
ISLA VISTA
GOLETA STATE BEACH PIER
SANTA BARBARA
STEARN'S WHARF
CARPINTERIA
RINCON CREEK
LA CONCHITA
SEACLIFF
RINCON ISLAND PIER
FARIA
SOLIMAR
VENTURA RIVER
SAN BUENAVENTURA
VENTURA HARBOR
SANTA CLARA RIVER
SAN BUENAVENTURA STATE PIER
OXNARD
CHANNEL ISLANDS HARBOR
PORT HUENEME
PLATFORM "GRACE"
HUENEME PIER
MUGU LAGOON
PT. MUGU
N
0 5
SCALE NM
LEGEND
EXISTING BEACON BEACH PROFILE LOCATION
SUGGESTED PIER REFERENCE PROFILE LOCATION AND NON-DIRECTIONAL WAVE GAGE LOCATION
APPROXIMATE LOCATION FOR SUGGESTED DIRECTIONAL WAVE GAGE
MONITORING PROGAM
NOBLE
CONSULTANTS

Figure 7-2



SAN BUENAVENTURA STATE PIER SURVEY DATA AS REFERENCE STATION

MAY 1979 TO NOVEMBER 1988

NOBLE CONSULTANTS

Figure 7-3

Wave measurements should be recorded for continuous two minute duration periods at 3 hour intervals. Data should be reduced for significant wave height, peak energy period, and total energy over the spectrum. It is recommended that BEACON encourage the Corps of Engineers, California Department of Boating and Waterways and the Scripps Institute of Oceanography's Ocean Engineering Research Group, who operate and maintain the California wave measuring network, to install gages in the Santa Barbara Channel nearshore zones as suggested. Installation of a wave gage array costs on the order of $50,000 per station not including maintenance.

7.3.1.3 Hydrologic Measurements

Santa Barbara County and Ventura County flood control districts maintain rainfall gages within the coastal watershed areas. Stream gage measurements are maintained by the U.S. Geological Survey (USGS) for the Ventura and Santa Clara River systems while data is compiled at the flood control district offices. These hydrologic data sets may be used to infer the volume of coarse sediment delivered to the open coast. The BEACON monitoring program recommends that this data be collated for comparison to the shoreline response measurements.

The USGS is also responsible for direct measurement of suspended and bed load discharge from the Ventura and Santa Clara rivers. The logistics of dispatching field technicians during peak periods of river flow and the complexity of accurate and representative sampling renders sediment data collection difficult at best. It is, therefore, recommended that sediment discharge be calibrated to river stage.

7.3.1.4 Aerial Photography

Aerial photographs are best analyzed by controlled digitization of stereo images. Precision instrumentation calibrated to known vertical monuments and ground control elevations eliminate distortion and bias introduced by hand techniques. The U.S. Army Corps of Engineers, Los Angeles District maintains analog stereo plotter instruments. Aerial overflights of the coast are also routinely scheduled by the Corps on an annual basis. Negatives are generally recorded at a scale of 1:1200 or 1:4000 at 60 percent overlap specification.

The data set constitutes an excellent record for observing general shoreline position at the time of overflight. It is recommended that the Corps be encouraged to analyze shoreline changes via aerial photography at five year intervals. Data should be used from similar seasonal time periods for consistency. Photography should be reduced to the MHHW contour location. This horizontal line can be converted to approximate volumetric changes over the profile using depth of zero transport relationships as determined from actual beach profile measurements.

7.3.2 Data Management

All data should be collected at the designated BEACON repository(s). Measured parameters may be plotted over a time scale abscissa with a tiered ordinate consisting of profile sand volume change, total wave energy over the measurement interval, and rainfall and stream flow hydrographs. Linear regression analysis or other appropriate statistical data reduction is suggested to provide trend indication within the anticipated envelope of data oscillation.

Data requirements, collected data summaries, and monitoring adjustments are recommended topics for review on an annual basis by the BEACON Administrative Coordinating Committee in consultation with BEACON's Technical Advisor.

7.3.3 Program Cost

Table 7-2 summarizes the estimated cost for the different data collection elements. The cost of each element may be borne by the sponsor agency or funded in whole or part by BEACON. The cost for monitoring the shoreline is a relatively inexpensive commitment given the potential return in investment. Anticipation of erosion trouble spots in advance of serious deterioration provides an opportunity to avoid costly emergency action during times of storm duress. The ability to update and fine tune the sand management plan also will permit BEACON and its member constituents the chance to better plan for the future and specify a time table of long-range plan implementation with greater certainty.

Table 7-2

Estimated Monitoring Program Costs

		INITIAL COST	RECURRING COST
1.	Beach Profiles:		
	Survey 4 reference piers monthly and reduce data @ $1000/survey	——	$ 4,000/ survey
	Survey 25 Beacon transects and reduce data @ $1,000/profile	——	$ 25,000/ survey
2.	Wave Data Collection:		
	Install 4 pier mounted non-directional shallow water wave gages @ $50,000 ea.	$200,000	
	Install 1 platform mounted directional deep water wage gage	$ 60,000	
	Monitor data	——	([1])
		$260,000	
3.	Digitize aerial photography every 5 years		
	Set up elevation benchmarks (1-time)	$ 20,000	
	Digitize shoreline		([2])
4.	Compile fluvial discharge and hydrolic measurement data		([3])
5.	Review data annually		$ 6,000
	TOTAL INITIAL COST	$280,000	
	TOTAL MINIMUM ANNUAL COST		$54,000*

* Plus cost of BEACON profile survey when conducted.

[1] by Scripps Institute of Oceanography
[2] by Corps of Engineers
[3] by County Flood Control Districts

8.0 - CONCLUSIONS AND RECOMMENDATIONS

8.1 Findings and Conclusions

The following findings and conclusions were reached as a result of the comprehensive sand management study:

8.1.1 Shoreline Conditions

From Ellwood in Santa Barbara County to the Ventura River in Ventura County -

- o The shoreline is sediment source limited, resulting in narrow but relatively stable beaches fronting a slowly eroding coastal bluff.
- o Local streams are a principle source of sediment for this area, accounting for approximately 70 percent of the littoral sand budget.
- o Bluff erosion averages between 0.5 and 1.0 feet per year for this area and accounts for the remaining 30 percent of the littoral sand budget.
- o Coastal storm damage is principally the result of development encroachment towards the shoreline.
- o The Sandyland/Carpinteria beach area has been preferentially eroded during recent times.
- o The primary need for beach enhancement and storm protection throughout this region is related to the existing narrow beach widths.
- o Beaches downcoast of Santa Barbara Harbor are closely dependent on the continued dredging of the harbor.

East of the Ventura River to the Mugu Submarine Canyon -

- o The Ventura and Santa Clara Rivers are the primary sources of sand for this area. The historically abundant supply of sand from these rivers resulted in broad beaches backed by extensive sand dunes.
- o The construction of dams and continued sand mining activities on the Ventura and Santa Clara Rivers have dramatically reduced the rate of fluvial sand supply to the coast.

- The resulting imbalance in the littoral sand budget implies that serious beach erosion will occur beginning in the mid-1990's.

- The beaches in this area are further dependent on continued dredging at Ventura and Channel Islands Harbors.

8.1.2 Sand Management Strategy

- A beach management strategy combining a comprehensive beach nourishment program with public policy measures was found to best accomplish BEACON's stated objectives.

- Large deposits of beach quality sand exist just offshore of Goleta, Santa Barbara, Carpinteria and Oxnard for use in renourishing adjacent beaches.

- Existing dredging technology is capable of recovering the offshore sand and transporting it to the beach. Hydraulic dredges have been used in similar projects to pump sand ashore.

- Significant cost savings may be possible if hopper dredges can be used to dump the sand in shallow water, allowing natural wave action to bring the sand ashore.

- Four levels of beach nourishment action were formulated and are listed below in decreasing order of cost and benefits:

  - Plan 1: Regional Recovery
  - Plan 2: Reduced Regional Recovery
  - Plan 3: Reach Recovery
  - Plan 4: Feeder Beach Injection

- Total plan costs range from a high of $764 million for Plan 1 to a low of $101 million for Plan 4.

- From a strict benefit/cost standpoint, Plan 4 is the best plan; however, Plan 3 provides a significantly wider range of benefits with only a small reduction in the overall benefit/cost ratio.

- Five potential demonstration projects were defined as a means of evaluating different aspects of the proposed sand management program. Listed below, in order of decreasing cost, these projects include:

- Beach Nourishment Pilot Project
- Hopper Dredge Bottom Dump Test
- Control Groin Demonstration
- Dune Stabilization
- Debris Basin Recapture

o Continued coastal monitoring is needed to better define existing and future erosion rates. This is particularly true in the Ventura/Oxnard area. The monitoring program should include:

  - Tracking of erosion/accretion trends
  - Tracking of littoral sediment delivery
  - Anticipation of future shoreline changes
  - Periodic input for updating the comprehensive sand management plan

o Public policy can be used to enhance natural sediment supply, insure that harbor bypassing practice is maintained and mitigate shoreline development.

8.2 Recommendations

The following recommendations are provided based on the findings and conclusions of the comprehensive sand management study:

8.2.1 Long-Term Plan

o A regional beach nourishment program should be implemented to combat ongoing and future beach erosion.

o Plan 3, Reach Recovery, is the recommended level of action as it represents the best balance between total benefits and costs.

o Public policy is recommended to address the following items:

  - Mitigation of decreased sediment supply to compensate for future bluff erosion protection

  - Strict management of the Ventura and Santa Clara River sediment supply to maximize natural sediment delivery

  - Management of debris basin desilting to maximize natural sediment delivery

- Requirement for perpetual commitment to harbor sand bypassing
- Refined environmental criteria relating to practical beach nourishment techniques
- Development of regionally-consistent setback criteria and building code provisions for shore protection structures

o The present coastal beach profile monitoring program should be continued and expanded to include:

- Wave data collection
- Fluvial sand discharge
- Aerial shoreline photography
- Dredging records review

8.2.2 Short-Term Demonstration Project

In order to demonstrate overall project feasibility and validate critical program assumptions, one or more demonstration projects should be implemented as a first step.

o The hopper dredge bottom dump project is recommended as the highest priority project by virtue of its potentially high payoff. This high risk project, if proven successful, would reduce long-term program costs by as much as two-thirds.

o If funding is available, BEACON should also implement the control groin and offshore sand renourishment demonstration projects.

8.2.3 Implementation

The recommended sand management program should be implemented in the following manner:

1. Develop and implement a regional funding program.
2. Select, design, and construct one or more demonstration projects.
3. Review the selected long-term sand management plan for consistency with the identified level of available funding.

4. Perform a detailed survey of relevant offshore sand borrow sites to quantify construction sand volumes.

5. Design and construct the recommended long-term plan.

6. Continue and expand the recommended comprehensive coastal monitoring program.

In conclusion, the implementation of the comprehensive sand management plan will require political negotiation to develop a workable program. The principal areas of political effort concern selection and prioritization of community action and funding commitment. Koppelman and Davies (1978) have found that it is the political aspect of erosion control that is the deciding factor in the implementation of a program. Implementation does not occur solely on the basis of technical rationality. When viewed from the standpoint that mediation and compromise are part of such a process, erosion control plans can be successfully enacted.

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