MINUTE ITEM

This Calendar Item No. 17 was approved as Minute Item No. 17 by the State Lands Commission by a vote of 2 to 0 at its 6/23/83 meeting.

MINUTE ITEM
17

6/23/83
WP 4729
Louie/
Lipphardt

AMENDMENT TO
PUBLIC AGENCY PERMIT

Calendar Item C17 was moved to the regular agenda. During consideration of Item 17, Mr. Norman LeRoy and Mr. Hilman Walker appeared on behalf of Chevron to answer any questions from Commissioners.

Calender Item 17 was approved as presented by a vote of 2-0.

Attachment: Calendar Item C17.

CALENDAR ITEM

C17

6/23/83
WP 4729
Louie/
Lipphardt

AMENDMENT TO
PUBLIC AGENCY PERMIT

APPLICANT: Los Angeles County
Flood Control District
2250 Alcazar Street
Los Angeles, California 90033
Attention: Mr. Eugene Gagne

AREA, TYPE LAND AND LOCATION:
Two parcels totalling 0.33-acres of tide and submerged lands at El Segundo, Los Angeles County.

LAND USE: Storm drain terminus.

TERMS OF ORIGINAL LEASE:
Initial period: 15 years from January 25, 1973.

TERMS OF PROPOSED AMENDMENT:
This amendment modifies the area of Lease PRC 4729.9 to include a storm drain extension.

CONSIDERATION: The public health and safety.

BASIS FOR CONSIDERATION:
Pursuant to Cal. Adm. Code 2003.

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PREREQUISITE TERMS, FEES AND EXPENSES:
Applicant is permittee of upland.

Filing fee and processing costs have been received.

STATUTORY AND OTHER REFERENCES:
A. P.R.C.: Div. 6, Parts 1 and 2; Div. 13.

B. Cal. Adm. Code: Title 2, Div. 3; Title 14, Div. 6.

AB 884: 4/25/84.

OTHER PERTINENT INFORMATION:

1. Chevron, U.S.A., Inc. is proposing to construct a rock groin and place sand fill at their El Segundo Marine Terminal (Lease PRC 5574.1) to provide protection to their beach frontage facilities and submarine pipelines. The beach fill deposition will bury the end of Los Angeles County Flood Control District's existing storm drain (Lease PRC 4729.9). The proposed extension would add approximately 142 feet to the existing storm drain and thereby enable the drain to function properly as designed.

2. A Negative Declaration was prepared by Commission staff, pursuant to CEQA, the State CEQA Guidelines, and the Commission regulations. Commission staff found that project revisions in response to the initial study have mitigated the potential adverse effects to a point where no significant effects occur.

3. The project is situated on lands identified as possessing significant environmental values pursuant to P.R.C. 6370.1, and is classified in a use category "C" which authorizes Multiple Use. The project as proposed will not have a significant effect upon the environmental values.

FURTHER APPROVALS REQUIRED:
California Coastal Commission, United States Army Corps of Engineers.

EXHIBITS:
A. Land Description.
B. Location Map.
C. Negative Declaration.

IT IS RECOMMENDED THAT THE COMMISSION:

1. DETERMINE THAT A NEGATIVE DECLARATION HAS BEEN PREPARED FOR THIS PROJECT BY THE COMMISSION AFTER CONSULTATION WITH RESPONSIBLE AND TRUSTEE AGENCIES.

2. CERTIFY THAT A NEGATIVE DECLARATION, (ND 336), HAS BEEN COMPLETED IN ACCORDANCE WITH CEQA, THE STATE CEQA GUIDELINES, AND THE COMMISSION'S ADMINISTRATIVE REGULATIONS; AND THAT THE COMMISSION HAS REVIEWED AND CONSIDERED THE INFORMATION CONTAINED THEREIN TOGETHER WITH COMMENTS RECEIVED DURING THE REVIEW PROCESS.

3. DETERMINE THAT THE PROJECT WILL NOT HAVE A SIGNIFICANT EFFECT ON THE ENVIRONMENT, AND FIND THAT THE PROJECT IS CONSISTENT WITH ITS USE CLASSIFICATION.

4. AUTHORIZE ISSUANCE TO LOS ANGELES COUNTY FLOOD CONTROL DISTRICT OF AN AMENDMENT WHICH MODIFIES THE LEASE AREA TO PROVIDE FOR AN EXTENSION OF AN EXISTING STORM DRAIN ON THE LAND DESCRIBED ON EXHIBIT "A" ATTACHED AND BY REFERENCE MADE A PART HEREOF; IN CONSIDERATION OF THE PUBLIC HEALTH AND SAFETY.

EXHIBIT "A"

LAND DESCRIPTION WP 4729.9

Those parcels of accreted beach land lying along the Pacific Ocean, in the City of El Segundo, County of Los Angeles, State of California, more particularly described as follows:

PARCEL "A"

A strip of land 14 feet wide, lying 7 feet on each side of the following described line:

COMMENCING at the intersection of the centerline of Vista Del Mar 60 feet wide as shown in the Los Angeles City Engineers Field Book 12401, page 37, on file in the Office of the Engineer of the City of Los Angeles, and the northerly line of Lot 2 Tract No. 1314 as shown on map filed in Book 20, page 161, of Maps, in the Office of the Recorder of the County of Los Angeles; thence S 23° 13' 00" E, 23.99 feet, along said centerline of said Vista Del Mar, to the TRUE POINT OF BEGINNING; thence S 57° 02' 40" W, 63.96 feet to the beginning of a tangent curve to the right, said curve having a radius of 50.71 feet through a central angle of 32° 57' 20", a distance of 29.17 feet; thence West 247.00 feet to the beginning of a tangent curve to the left, said curve having a radius of 95 feet through a central angle of 27° 00' 00", a distance of 44.77 feet; thence S 63° 00' 00" W, tangent to said curve, 53.00 feet to a point designated "A" for purposes of this description, and the end of the herein-described centerline.

PARCEL "B"

A strip of land 44 feet wide, lying 22 feet on each side of the following described line:

BEGINNING at the above-described Point "A"; thence S 63° 00' 00" W, 269.00 feet, and the end of the herein-described line.

EXCEPTING THEREFROM any portion lying landward of the ordinary high water mark of the Pacific Ocean.

END OF DESCRIPTION

REVISED MAY 2, 1983 BY BOUNDARY AND TITLE UNIT, LEROY WEED, SUPERVISOR.


EXHIBIT "B"

WP 4729.9

EXHIBIT "C" WP 4729

STATE OF CALIFORNIA—STATE LANDS COMMISSION EDMUND G. BROWN JR., Governor

STATE LANDS COMMISSION
13TH STREET
SACRAMENTO, CALIFORNIA 95814

/X/ Draft
NEGATIVE DECLARATION
/ / Final

EIR ND 336

File Ref.: WP 5574

SCH#: 83031717

Project Title: Chevron El Segundo Groin and County Outfall Extension

Project Location: Pacific Ocean, El Segundo, Los Angeles County.

Project Description: Construction of a 900-foot long groin to protect against damaging erosion to Chevron's El Segundo Refinery Marine Terminal. Project includes extension of the Los Angeles County Grand Avenue storm drain.

*NOTE: Should additional copies of the Initial Study be required, please contact the designated person below.

This NEGATIVE DECLARATION is prepared pursuant to the requirements of the California Environmental Quality Act (Section 21000 et seq of the Public Resources Code), the State EIR Guidelines (Section 15000 et seq, Title 14, of the California Administrative Code), and the State Lands Commission regulations (Section 2901 et seq, Title 2, of the California Administrative Code).

Based upon the attached Initial Studies, it has been found that:

/ / the project will not have a significant effect on the environment.

/X/ the attached mitigation measures will avoid potentially significant effects.

Contact Person: Ted T. Fukushima
State Lands Commission
1807 - 13th Street
Sacramento, California 95814

Telephone: (916) 322-7813

CALENDAR PAGE 135
MINUTE PAGE 1198

May 23, 1983

WP-5574
SCH No. 83031717

## MITIGATION *

Discussion Items:

1. Continuation of Longshore Transport

   a. Long-term Effects

   b. Short-term Effects

2. Alternative Methods of Protection

   a. Selection Criteria

   b. Alternative Methods Considered

3. Monitoring Program

4. Sediment Compatability

5. Borrow Site

   a. Modification of Wave Energy

   b. Effect on Longshore Transport

6. Turbidity Effects on Plant Operations

7. Abandonment of the Groin

8. Liability and Maintenance

9. Parking and Other Beach Services

10. Benthic Organisms

* Prepared in response to comments on the "Initial Study, El Segundo Marine Terminal (ESMT) Protection Project, El Segundo Refinery, For Chevron U.S.A., Inc.", by Dames and Moore, March 1, 1983.

1. Continuation of Longshore Transport

The question has been raised of the projects long-term and short-term effects on longshore transport or littoral sand supply. Interruption of the longshore transport could result in erosion of downcoast beaches. This question was considered in section 3.3 of the Initial Study and is expanded upon here.

a. Long-term Effects

The proposed protection method has been compared to the Topaz Street groin in Redondo Beach, which has had no adverse impact on surrounding beaches. Dr. Bernard Pipkin has documented this comparison in the letter found in the Appendix to this report.

Dr. Pipkin cites several studies of the Topaz Street groin that demonstrate that sand is passing through and around that groin. He then states that: "The proposed structure at El Segundo is very similar to the Topaz Street groin with the exception of the location of fill placement. The El Segundo structure is 900 feet long compared to 700 feet for Topaz Street; toe depth in both cases is about 20 feet; and design wave height in both cases is very conservative. The difference is that the half-million yards of fill to be placed north of the El Segundo groin will provide an instant stockpile of sand for beaches to the south. Once the fill reaches equilibrium with the dominant wave period and direction, sand should bypass the end of the groin and filter through it to nourish downcoast beaches. There is abundant literature to support this contention and I have taken the liberty to append a bibliography of field and laboratory research on the subject." (see Appendix).

b. Short-term Supply

The short-term erosion concern is in regard to how the groin and beach fill will react under severe winter storm conditions. Storm waves would attack the stable bypassing fill (longshore transport) and deposit a significant amount of material offshore to depths where longshore transport is significantly lower. It has been suggested that down coast erosion will occur until enough material has been impounded from both on-off shore transport and longshore transport to reestablish stable bypassing. The seaward toe of the groin will be at a -20 ft MLLW elevation, and thus very little material will be drawn offshore beyond the impounding capability of the groin. A large portion of material will be deposited within the active littoral transport zone (-3 to -15 ft MLLW) and will overfill the stable bypassing profile. Thus, material will be able to be transported through the permeable portion of the groin immediately after such severe storms. A portion of the beach fill will need to be replaced by natural forces to fill the impound area to the design bypassing profile. This area will probably be located from +6 to -3 ft MLLW. This is the most active zone for longshore transport under normal post storm wave conditions.

The total refilling of the groin is expected to occur over time periods measured in weeks. During this refilling period, sand will continue to be transported through the groin along the overfilled section of the offshore storm-deposited sand repository. Starvation of down coast beaches will be mitigated by the placement of 75,000 cubic yards of beach material directly down coast of the groin. This volume represents nearly 50 percent of the total estimated net annual littoral movement in this area. Thus, total starvation of the down coast beaches would have to occur for a long period of time (6 months) before any significant deficit of littoral material would be experienced.

2. Alternative Methods of Protection

Additional information has been requested to determine the environmental and feasibility aspects of alternative methods of protecting Chevron's beach frontage and pipelines. Also, the proposed location of the 900 foot (ft) groin is being questioned.

Chevron studied numerous alternative means of dealing with the continued erosion at El Segundo for approximately two years prior to preparation of the "Initial Study". No designs or maintenance schemes were considered which were expected to adversely effect local sand supply. The beach fill aspect of the proposed 900 ft groin, as well as its semi-permeable design, substantiated initial consideration of this ultimate choice.

a. Selection Criteria:

As mentioned above, no solutions were considered which might adversely affect local sand supply. Therefore, one must look to other environmental and feasibility criteria in making the selection of the best method for dealing with this ongoing erosion problem.

The following feasibility criteria were used by Chevron in deciding on the best solution:

- long-term protection of the El Segundo Marine Terminal (ESMT) and submarine pipelines,
- proven engineering design,
- availability of an ongoing sand supply,
- cost of the solution,
- obtaining government permits for the project in all its phases.

In addition, the following environmental selection criteria are offered as the primary considerations in this matter:

- impact on local aesthetics,
- impact on local recreational resources,
- impact on benthic organisms.

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b. Alternative Methods Considered:

Table 1 (attached) is an amended version of Table 1 of the Initial Study. It summarizes the nine alternative methods considered by Chevron to address protection of its beach frontage. Four general types of solutions were considered:

- o construction of one or more rock groins, some of which would be accompanied by a long-term sand nourishment program (Alternatives No. 1, 3, 4 & 5 of Table 1),
- o implementation of a long-term sand nourishment program (Alternative No. 2 of Table 1),
- o construction of a surfing or underwater reef (Alternative No. 6 and 7 of Table 1),
- o construction of seawalls accompanied by various means of also protecting the submarine pipelines (Alternative No. 8 and 9 of Table 1).

Following is a discussion of each of the specific alternatives considered within each of the above general classes, and how they were evaluated with respect to the feasibility and environmental criteria.

(1) Rock Groins:

o <u>Alternative 1 - 900 ft rock groin with 500,000 cubic yards beach fill:</u> The chosen protection method satifies all of the feasibility criteria mentioned previously. It provides a long-term solution to Chevron's problem of protecting both its onshore facilities and its submarine pipelines. It is a proven engineering design (see Dr. Pipkin's report, Appendix). It does not depend on the availability of a long-term source of compatible sand re-nourishment. It will cost $5,600,000, which is the least costly ($5,600,000) of the nine alternatives. Finally, it required obtaining government permits only once, and not every four years, as in some of the cases which follow.

Regarding the chosen alternative's environmental impact, it will have some aesthetic impact since the rock groin will be visible to people using the beach and near shore areas for recreation (see section 3.17.2, Page 79 of "Initial Study"). It will contribute to local recreation resources by expanding the sandy beach area available for sun bathers. It also will protect the bike path (if re-built), and may improve surfing conditions. Finally, it will have some impact on benthic organisms, but it will be only a one-time impact. This is because the beach fill material will only have to be dredged once, with no ongoing sand nourishment requirements. It should be noted, however, that Dr. Pipkin states that a minimal sand nourishment program may be required on a ten year cycle. (see Appendix).

o Alternative 3 - Two 750 ft groins with 350,000 cubic yards beach fill: This alternative was considered less feasible than the 900 ft groin with beach fill because it did not offer a permanent solution. This was because the 750 ft groins would terminate shoreward of the seaward boundary of the littoral drift zone. Thus, sand would continue to be removed from the filled beach by the longshore transport phenomenon, thereby requiring periodic sand nourishment to keep pipelines adequately protected.

As discussed in the sediment compatibility study done by Dames and Moore and submitted to the U.S.Army Corps of Engineers as part of their permit application, there appears to be a limited supply offshore El Segundo of compatible sand borrow material. As shown in Figure 1, twenty-three (23) vibracores were taken to gather the data for this study. These vibracores were taken from two general areas offshore Chevron's beach frontage. One of the two areas (vibracore #5 - 11) contained sand that preliminary analysis indicated was unacceptable as beach fill. The other site is the proposed borrow site for the 900 ft. groin beachfill. If the borrow material had to be imported from a distant source, it would greatly increase the cost.

The cost of this solution was originally understated in the Initial Study at $4,900,000, as there was an error in the groin constructin cost. Also, it does not include the cost of locating and dredging sandfill on a regular basis. The frequency of required dredging is difficult to predict, but may be as often as every four years, which would add approximately $2,500,000 to the cost. In particularly stormy winters, it could be every year for a few years. This would mean the application for and acquisition of necessary government permits for the dredging operation on a frequent basis.

Including the cost for periodic re-nourishment, the total cost for this option is estimated at $6,500,000..

Regarding this alternatives environmental impact, two 750 ft groins would present a greater aesthetic impact than a single 900 ft groin. It would involve 600 linear feet of additional rock structure (750 ft + 750 ft less 900 ft = 600 ft additional). Like the 900 ft groin, it would provide a wider beach and protect the bike path (if rebuilt). Unlike the 900 ft groin, it would involve a continued impact on marine benthic organisms due to the frequent dredge and fill operation.

o Alternative 4 - One - 750 ft groin with beachfill and periodic nourishment: This alternative was considered less feasible than the 900 ft groin because it also did not offer a permanent solution. This is because, as with the two 750 ft groins, the toe of the groin would be inside the littoral drift zone. Thus, sand would continue to be removed from the filled beach by the longshore transport system, requiring periodic sand re-nourishment to keep the pipelines covered. Since a nearby sand borrow source is not known for the large volumes of sand that would be needed every few years, this alternative is unreliable. Also, government permits would have to be acquired on a frequent basis for the dredging and fill operations.

The total present worth cost for this option is estimated at $5,100,000.

This alternative's environmental impact is approximately the same as that of the 900 ft groin; it would have a slightly diminished aesthetic impact, since it would be 150 feet shorter. It would provide a wider beach than presently exists, and protect the bikepath (if rebuilt). Unlike the 900 ft. groin, it would continue to disturb marine benthic organisms during each dredge and fill operation.

o <u>Alternative 5 - One - 750 ft groin with beach fill and lowering of No. 3 Submarine Berth lines:</u> This alternative was considered less feasible than the 900 ft groin because it also did not offer a permanent solution. As with the other two solutions involving 750 ft groins, the toe of the groin would be inside the littoral drift zone. Thus, sand would continue to be removed from the filled beach by the longshore transport system. This would necessitate a program of periodic nourishment to keep the mid-beach lines protected and covered. The Initial Study did not consider this additional cost of $3,200,000.

Including the cost for periodic re-nourishment, the total present worth cost for this option is estimated at $7,900.000.

This alternative's environmental impact is approximately the same as that of the 900 ft groin with only a slightly diminished aesthetic impact since it would be 150 ft shorter.

2) Sand Nourishment Program:

Shown as alternative No. 2 of Table 1, this alternative was again considered less feasible than the 900 ft groin because it does not offer a permanent solution to Chevron's erosion problem. It would require dredging and beach fill on a frequency that is impossible to predict, since it depends on the vagaries of the weather. Chevron has estimated that about every four years nourishment with 150,000 cubic yards of fill would be required. However, this could be increased to every one or two years due to severe winter storms similar to those experienced in January through March, 1983. Since the source of sand for such frequent beach fill efforts is unpredictable (see Appendix), and since government permits would be required for each such effort, this solution was also felt to be unreliable. The total present worth cost for this option is $6,000,000.

The environmental impact of a regular nourishment program would include the visual aesthetic impact of frequent dredging operations. It would contribute to local recreational resources by widening the beach and protecting the bikepath (if rebuilt). Finally, it would disturb the marine benthic organisms more than under the 900 ft groin alternative, due to the impact of the frequent dredge and fill operation.

(3) Surfing or Underwater Reefs:

Shown as alternatives No. 6 and 7 of Table 1, these two alternatives were considered infeasible since they represent solutions that are not proven engineering design in the water depths required for this project. In addition, they were considerably more expensive than thee 900 ft groin. They would cost $8,200,000 and $8,500,000, respectively. Also, they would restrict access to Chevron's submarine pipelines since the underwater reefs would be located on top of selected lines.

The environmental impacts of these alternatives were not examined closely, since it was an unproven engineering design.

(4) Seawalls:

Shown as alternatives No. 8 and 9 of Table 1, these two alternatives were considered infeasible since they do not solve the erosion problem as it affects Chevron's pipelines. Option No 8, involving the use of concrete filled bags to protect the submarine lines, is only a short term (20 year) solution to the problem of exposure of these lines. In addition, Chevron's recent experience in protecting their pipelines from the March 1983 storms has led them to question the physical feasibility of placing these bags around their lines. Option No. 9, involving lowering of the four berths' pipelines would cost $13,000,000 in present worth dollars.

As mentioned previously, the question was also raised as to the possible location of the 900 ft groin at the southern perimeter of the beach frontage owned by Southern California Edison. Chevron has had several conversations over the last several years with Edison representatives regarding their mutual shorefront problems. At this point in time, Edison does not want to participate with Chevron on the proposed project. Edison has constructed a rock seawall that they believe will provide adequate protection to their facilities. Chevron's shore protection problems are different from Edison's. In addition to protecting shore facilities, Chevron must protect pipelines that extend from the beach to four offshore berths. The 900 ft. groin provides the means of controlling or maintaining [illegible] sand cover over the pipelines. Edison's problem involves protection [illegible] f their onshore facilities.

A coordinated project with Edison considering a single groin and beach fill would have significant cost and aesthetic impacts. In order to provide the required seaward coverage of Chevron's pipelines, the groin would need to be lengthened to a total length of approximately 1,400 ft, if placed at the southern boundary of Edison's property. Additional dredge borrow source material would need to be defined and the total volume required for beach fill could easily more than double the present estimate of 500,000 to 750,000 cubic yards. Thus, as much as 1,500,000 cubic yards of compatible fill material would have to be located, dredged and placed on approximately 3/4 mile of shorefront. Such a structure, even if desired by Edison, would be placed closer to a high density beach use area (Manhattan Beach).

3. Monitoring Program

Chevron's primary design criteria has always been to avoid erosion on down coast beaches. Design alternatives which ignored this consideration were disregarded. Chevron's analysis of the design and sand pre-fill characteristics has been substantiated by third party experts in the field: Mr. John Hale, the designer of the proposed project, and Dr. Bernard Pipkin (See Appendix).

Los Angeles County survey data documents the gradual erosion of all South Bay beaches at differing rates depending on wave patterns and artificial replenishment projects. All experts can agree that beach erosion will continue independent of the proposed groin project. However, it is important that the groin design does not cause incremental erosion. Regardless of the groin construction, beach erosion will continue on the South Bay beaches.

Chevron has developed a monitoring program which addresses down coast erosion and will detect any increase caused by the Chevron groin. The program is based on a survey of twelve (12) beach profiles from Playa Del Rey to Hermosa Beach (See Figure 2). These surveys will be taken semi-annually the years before and after construction and annually in August thereafter. This data will be analyzed by a third party consultant and a report prepared annually for at least five years. The analysis will consist of a determination of sand volume changes from year to year at depths from 0'MLLW to -25' MLLW. Changes will be compared between above groin profiles and below groin profiles. In the unlikely event that the consultant determines that a direct cause-effect relationship does exist between the presence of Chevron's groin and downcoast erosion, Chevron will take remedial action. Such action would have to be determined at the time, but could include beach nourishment, breach of a portion of the groin, a sand bypass system or repair of erosion-damaged property. The percentage of erosion attributed to the groin would establish the percent financed by Chevron. Chevron believes the design is sound, and that the annual analysis will substantiate this.

4. Sediment Compatibility

The question was raised of the compatibility of the borrow source material for the beachfill site. As mentioned previously, Dames and Moore made a sand compatibility study based on a program of 24 offshore core samples in December 1982 and January 1983. This report was submitted to the U.S. Army Corps of Engineers (COE) in March 1983. Following is a summary of the results of this report.

The results of grain size analyses indicate dominant constituents of offshore sediments were fine to medium sands. Coarser gravel material and shell fragments were noted in several core sections. These coarser materials were usually present in a matrix of medium to fine sands. Silts and clays averaged only a few percent in most samples analyzed. Two samples contained silts and clays in excess of 20 percent. These samples accounted for less than one 1 foot (ft) from a total of approximately 140 ft of recovered core length. Surface sediments were usually darker in color and finer than subsurface sediments.

Figure 1 presents a drawing of an outline of the proposed borrow area with north-south and east-west cross-sections. This outlined surface area represents approximately 234,000 square yards. Sixteen vibracores between 3½ and 11 ft in length were obtained from this area. This number is in excess of the 11 vibracores required by the following formula presented in the COE guidelines:

$$N = \frac{\sqrt{A}}{50}$$

(where N is the required maximum number of vibracores and A is the surface area of proposed dredging in square yards.)

Based on results of grain size analyses from samples collected along beach profiles 1 and 2, grain size envelopes were developed (Figures 3 and 4). Results of the grain size analyses performed on channel samples removed from vibracores VC-1 through VC-4 and VC-12 through VC-23 were used to develop a composite grain size curve. Each sample interval from cores VC-1 through VC-4 and VC-12 through VC-23 was weighted according to its length in relation to the total length of recovered core. For each size class, the composite was calculated by the summation of percent by weight multiplied by the footage of each interval divided by the total footage sampled for all locations. Figure 5 shows the composite grain size curve for vibracores VC-1 through VC-4 and VC-12 through VC-23.

Figures 6 and 7 show this composite grain size curve in relation to the grain size envelopes developed for beach profiles 1 and 2. Although these figures show that some of the material within the proposed borrow area is coars than that found along the receiving beach, this is not in violation of COE guidelines. The coarser componenets of sediments in the proposed borrow area are less than 60 millimeters in diameter and re not expected to present any adverse aesthetic impacts along the receiving beach. Figures 6 and 7 clearly suggest that sediment contained within the proposed borrow area is compatible with sediments on the receiving beach according to COE guidelines.

5. <u>Borrow Site</u>

a. Modification of Wave Energy:

The questions have been raised as to what modification to wave energy will be caused by the resulting dredge depression and what will the resulting wave height be (on average) in comparison to pre-project wave height. The total incident wave energy within the project area will remain unchanged compared to pre-construction conditions. However, as discussed in Section 3.4 of the Initial Study and shown schematically on Figure 19 of the Initial Study, there will be a redistribution of wave energy within the project area. Some areas will experience an increase in incident wave height and other areas will experience a decrease in incident wave height. These locations will change depending on direction and period of incident waves. A typical wave condition for this area (based on Table 6 in the Initial Study) would have a height of 1-3 ft and a wave period of 12-16 seconds. The dominant approach direction is from the west. Refraction effects over the dredge borrow depression could potentially result in local wave height increases under these specific conditions of less than 25 percent (increase average wave height range from 1-3 ft to 1.25-3.75 ft). It should be noted that Figure 19 is a schematic representation only and ultimate refraction effects are dependent on final dredge depression bottom contours. However, the effects will be local (length scale on order of 500 ft) and are expected to result in changes (increases and decreases) of less than 25 percent for typical conditions.

b. Effect on Longshore Transport:

Concern has been expressed that the dredge borrow site is located too close to shore and will fill in with material drawn offshore from the beach fill. This would cause a deficit in sand carried in the longshore transport system, which would potentially result in increased down coast erosion. In support of this concern Los Angeles County Engineer - Facilities Department prepared several profiles depicting the Redondo-Malaga Cove dredge depression, the proposed El Segundo dredge depression and pre and post 1983 storm profiles near Venice beach (see Figure 8). In preparing the Figure, the County states that the Initial Study presents conflicting data on the inshore limit of the proposed dredge source. Since this data was used to formulate their conclusions, the following paragraph is presented to clarify the data.

The County's report refers to Page 64 of the Initial Study which indicates -25 ft MLLW at 1250 feet, while Figure 19 (from Initial Study) indicates -30 MLLW. The inshore limit of the proposed dredge cut is defined as -25 ft. MLLW. The length of the beach parallel dredge cut (north to south) is approximately 1,250 ft. This is not the distance from the shoreline (which presently is approximately 1,500 ft from the shoreline to the inshore limit of the dredge cut). The County selected Figure 19 from the Initial Study, to base their profiles of the proposed El Segundo dredge cut. Since this is a schematic drawing, scaling data from this figure is inappropriate. Chevron has have revised the County's Figure II (see Figure 8 of this report) to reflect a correct representation of the proposed dredge cut profile.

As shown on Figure II, a considerable amount of material has been drawn offshore Venice beach as a result of the 1982/1983 winter storms. The seaward limit of this storm includes offshore movement of material is shown in Figure 8 to be approximately -22 ft MLLW and only a small fraction (5 percent) of the total volume is seaward of -30 ft MLLW. Since the dredge cut will be seaward of -25 ft MLLW, there is little chance that any significant offshore transport of material will be drawn into the dredge depression by storm events and not returned to the active littoral zone. The profiles presented by the County for Venice beach are typical of profiles we have examined in Santa Monica Bay that all indicate the seaward limit of active on-offshore littoral movement is in the range of -17 to -22 ft MLLW. The shoreward limit of dredge cut was selected after examination of historical beach profiles, wave data and operational limits of available dredging equipment.

Calculations using recently developed analytical techniques have been made to determine the seaward limit of significant sand transport. Using the methods presented in Hallermeier (1983*), Chevron calculates an annual depth limit to significant sand transport of 20.1 ft. Hallermeier (1983) presents an estimate of 19.0 ft. for this same annual limit for Venice and Santa Monica. These results also support selection of -25 ft. MLLW for the shoreward unit of dredge cut to be in deep enough water to preclude significant volumes of sand being "trapped" in the dredge depression.

The Redondo to Malaga Cove dredge and sand nourishment project was examined in order to provide an indication of the behavior of a dredge depression with similar characteristics of sand grain sizes, wave exposure and depth of nearshore limit of dredge cut. We understand the uncertainties in making a direct comparison between such projects and therefore included a detailed examination of profiles to establish a historical limit of on-offshore transport within Santa Monica Bay. Both approaches have provided confirmation of the selection of -25 ft MLLW as an acceptable shoreward limit for dredging.

6. Turbidity Effects on Power Plant Operations

The issue has been raised regarding increased turbidity in local coastal waters caused by dredging and beach fill operations. Similar levels of turbidity are created by severe storm activity in local coastal waters. Such storm activity does not normally cause problems for the cooling water systems of these two facilities. This temporary degradation of water quality may effect the operation of the two power stations adjacent to Chevron: Southern California Edison's El Segundo Generating Station and Los Angeles Department of Water and Power's Scattergood Station. Chevron advised both of these facilities regarding this possible impact, and they responded that they anticipated no adverse effects on their respective cooling water intake systems.

7. Abandonment of the Groin

Further clarification of Section 3.18 of the Initial Study was requested with respect to abandonment of the groin after its useful life. Although Chevron cannot anticipate a time when they would not need the proposed beach protection project, if unforeseeable events should occur, the groin would have to be abandoned. It would be modified at that time so as to permit uninterrupted longshore transport and also to minimize the "attractive hazard" aspect of the remaining rock structure. Such measures might include removal of some of the shoreward portions of the groin. If necessary, the entire structure could be totally removed, but this seems unlikely to be required to accomplish the joint goals of continuation of the littoral process and diminution of the groin as an "attractive hazard".

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* Hallermeier, R. J., 1983, Sand Transport Limits In Coastal Structure Designs, Proceedings of Coastal Structures 1983, American Society of Civil Engineers.

8. Liability and Maintenance

It was pointed out that the groin will constitute an "attractive hazard" if there is access to the structure by the public, and that maintenance and liability responsibilities should be clearly specified. Chevron is constructing a privately-owned structure specifically to protect their own private property being threatened by ocean erosion. As such, it is in Chevron's interest and is their intent to maintain the groin so that it continues to performs its intended function. To minimize the "attractive hazard" aspects of the structure, a 6-foot high chain link fence will be constructed approximately mid-way in the length of the groin to minimize the possibility of access to parts of the groin adjacent to and in contact with the sea. In addition, a guard rail and chain will be located at the shoreward end of the groin to prevent bicyclists from gaining easy access to the top of the groin. These two security structures are shown in attached Figures 9 and 10. Chevron will assume liability for construction and maintenance of the groin, and will provide the County and/or State with documentation releasing them from any such liability.

9. Parking and Other Beach Services

It was suggested that the State Land Commission's assessment of "no effect" on selected beach services was inaccurate. Although it may be somewhat understated, a significant impact on maintenance and lifeguard services seems unlikely. El Segundo Beach is not a particularly important recreational resource to either regional or local areas. The beach is located next to an industrialized area, and adjacent to more desirable beaches on the north and south (Dockweiler and Manhattan Beach State Parks). For these reasons, attendance at this beach is relatively low. Nevertheless, the benefits to the public that will result from a slightly-enlarged beach would appear to warrant whatever small increase in beach services may be required as a result. As mentioned in No. 8, above, regarding liability and maintenance of the groin, Chevron is proposing this project to protect its own private property. Any positive impact on local recreational resources (with possible consequent increased need for recreational services) is a side-benefit only. (Chevron has acknowledged their error on page 56 of the Initial Study regarding the presence of 130 spaces, not 30 spaces, in the one public parking lot at the north edge of the beach.)

10. Benthic Organisms

The question has been raised of the impact of the proposed proojeet on the benthic (bottom-dwelling) marine organisms due to the foot-print of the groin, the dredging of sand, and the placement of the dredged sand. As mentioned in the "Initial Study", Chevron retained Marine Biological Consultants (MBC) to conduct a field survey in Fall 1982 to examine this issue. MBC obtained sand samples from the prject site at El Segundo beach and also from a "reference" beach where a similar groin and beachfill were installed in 1970. The reference beach was the Redondo Beach area near the 700 ft long Topaz Street groin. Samples were taken at both beaches between elevations of +10 ft and -20 ft MLLW. These sand samples were analyzed in MBC's laboratory for the presence of benthic org[illegible] MBC concluded that their comparison of the two beaches indicated no likely impact by the proposed project on benthic organisms, as the following excerpt from their report indicates:

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"Infaunal density, species richness, and biomass will probably increase per unit area in both the intertidal and subtidal portions of the project area. These increases are not expected to be statistically significant because of the high variability of the present community. The unit area increases will partially offset the effect of soft bottom habitat loss. The net productivity loss will represent a very small incremental reduction in that of sandy nearshore bottoms in Santa Monica Bay. On a Bay-wide basis the reduction will be indistinguishable from normal year to year variation, which is two orders of magnitude greater. Short-term effects related to passage of storms will have a greater impact on the community throughout the nearshore zone than will the project. The effects of swell from a hurricane off Baja California, were observed during the study. Its impact on even the least exposed portion of the project area (15 to 20 ft below mean lower low water) was greater than is projected for beach replenishment.

The Pismo clam does not currently have an adult population of any size off the El Segundo site. Juveniles recruited during the last three to four years exist in the breaker zone. These will probably be smothered by burial during beach replenishment, but the new beach should prove equally acceptable as a settlement site for new recruits of future year classes.

In the short term, declines will occur throughout the nearshore vertical range affected by groin construction. The long-term effect, based on comparison with a stabilized 12-year old groin, is expected to be increased density, richness, and standing crop of the benthos on a unit area basis." (MBC, Dec. 9, 1982*)

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* "Reassessment of Groin of Groin Emplacement and Beach Replenishment Impact on the Marine Biota near the Chevron U.S.A. Refinery, El Segundo, California, Based on Site-Specific Data", prepared by MBC for Chevron U.S.A., El Segundo, California, December 9, 1982.

ATTACHMENTS TO "MITIGATION"

TABLE 1 - ESMT Protection Project: Design Alternatives

FIGURE 1 - Field Sampling Program Vibracore Locations

FIGURE 2 - Beach Profile Monitoring Points

FIGURE 3 - Beach Profile 1 Grain Size Envelope

FIGURE 4 - Beach Profile 2 Grain Size Envelope

FIGURE 5 - Composite Cumulative Grain Size Curve for Vibracores VC 1-4 and VC 12-23

FIGURE 6 - Beach Profile 1 Grain Size Envelope and Composite Cumulative Curve

FIGURE 7 - Beach Profile 2 Grain Size Envelope and Composite Cumulative Curve

FIGURE 8 - Estimated Ocean Bottom Depths: A Comparison

FIGURE 9 - Chain-Line Fence to be Located Approximately 50 ft. Offshore of North Side of Groin.

FIGURE 10 - Location of Chain-link Fence and Guard Rails

APPENDIX - Letter of February 10, 1983 from Dr. Bernard W. Pipkin, Ph.D., to Mr. Charles I Rauw, Dames and Moore, regarding the performance of the Topaz Street Groin, Redondo Beach, as a prototype for the proposed Chevron Groin, El Segundo, California.

TABLE 1

ESMT PROTECTION PROJECT DESIGN ALTERNATIVES

(From "Initial Study"; amended May 23, 1983)

| Alternative | Constant[1] Dollars | Present Worth[2] Dollars | Pros | Cons |
|---|---|---|---|---|
| 1. • One - 900 ft groin<br>• 500,000 $yd^3$ beach fill | 2,400 M<br>3,200 M<br>$ 5,600 M | $ 5,600 M | 30+ plus maintenance-free life. Gives total protection for marine terminal and submarine pipe-lines. Proven engineering design. Project economics desirable over alternative #2 past 20th year. Will protect bike path (if reconstructed) and widen beach. | |
| 2. Sand Nourishment Program:<br>• 500,000 $yd^3$ beach fill in year zero<br>• 150,000 $yd^3$ beach fill every 4 yrs. | 3,400 M<br>6,800 M<br>$ 10,200 M | 3,400 M<br>2,600 M<br>$ 6,000 M | Project economically attractive over alternative 1 up to 20th year. Will protect bike path (if reconstructed) and widen beach. | Erosion problem is not solved. Commits to sand nourishment to protect pipelines. Destroys benthos population everytime beach is nourished. Potential long term sand supply problem. |
| 3. • Two - 750 ft groins<br>• 350,000 $yd^3$ beach fill<br>• Additional Beach fill in ensuing yrs | 3,200 M[4]<br>2,300 M<br>2,500 M<br>$ 8,000 M | 3,200 M<br>2,300 M<br>1,000 M<br>$ 6,500 M | Will protect bike path (if reconstructed) and widen beach. | Toe of groin inside littoral drift zone. Lines will start exposure in four years. Commits to sand nourishment to protect pipelines. Destroys benthic population every time beach is nourished. Potential long term sand supply problem. |
| 4. • One - 750 ft groin<br>• 350,000 $yd^3$ beach fill<br>• Additional beach fill in ensuing yrs | 1,500 M<br>2,300 M<br>3,200 M<br>$ 7,000 M | 1,500 M<br>2,300 M<br>1,3[illegible]0 M<br>$ 5,100 M | Economically attractive over alternative #1 in "present worth dollars". Will protect bike path (if reconstructed) and widen beach. | Toe of groin inside littoral drift zone. Commits to sand nourishment program to protect pipelines. Destroys benthic population every time beach is nourished. Potential long-term sand supply problem. |
| 5. • One - 750 ft groin<br>• 350,000 $yd^3$ beach fill<br>• lower 3 berth lines<br>• Additional beach fill in ensuing yrs[3] | 1,500 M<br>2,300 M<br>2,800 M<br>3,200 M<br>$ 9,800 M[3] | 1,500 M<br>2,300 M<br>2,800 M<br>1,300 M<br>$ 7,900 M | Will protect bike path (if reconstructed) and widen beach. | Toe of groin inside littoral drift zone. Marine terminal operation interference during lowering of lines. Commits to sand nourishment to protect pipelines. Destroys benthic population every time beach is nourished. Potential long term sand supply problem. |

1. All cost figures are first quarter 1983.
2. Present worth based on 8 percent inflation and 15 percent interest rate. Present worth estimates provided to allow comparison [illegible]natives with periodic future nourishment costs with alternatives representing single construction periods.
3. [illegible] estimate. Table 1 in "Initial Study" did not include cost of beach fill in ensuing years.
4. Err[illegible] [illegible]tial Study". Correct estimated cost is $3,200 M.

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## TABLE 1

### RSMT PROTECTION PROJECT: DESIGN ALTERNATIVES

(From "Initial Study"; amended May 23, 1983)

| Alternative | Constant Dollars | Present Worth Dollars | Pros | Cons |
|---|---|---|---|---|
| 6. • Surfing Reef:<br>• One reef - 500' by 250'<br>• 1,000,000 $yd^3$ beach fill | 3,200 M<br>5,000 M<br>$ 8,200 M | $ 8,200 M | 30+ year maintenance-free life. Gives total protection for marine terminal and sub-lines. Will benefit surfing, protect bike path (if reconstructed) and widen beach. | Not a proven engineering design. |
| 7. Underwater Reef Station:<br>• 2 reefs - 750 ft and 500 ft long, ea.<br>• 1,000,000 $yd^3$ beach fill | 3,500 M<br>5,000 M<br>$ 8,500 M | $ 8,500 M | 30+ year maintenance-free life. Gives total protection for marine terminal and sub-lines. Will benefit surfing, protect bike path (if reconstructed) and widen beach. | Not a proven engineering design. Restricts access to pipelines for future repairs/modifications. |
| 8. • Reef, Seawall - 1,980 ft<br>• Nylon concrete filled bags | 3,000 M<br>2,600 M<br>$ 5,600 M | $ 5,600 M | Will protect bike path (if reconstructed) and totally protect marine terminal. | Erosion problem is not solved, resulting in narrower beach and potentially no beach. 20 year maintenance free life. Repair costs to bring project life to 30 years are not included. Installation of nylon bags may be infeasible. |
| 9. • Rock Seawall - 1,980 ft<br>• Lower marine terminal lines 15 feet - total ten | 2,000 M<br>11,000 M<br>$ 13,000 M | $13 000 M | Will protect bike path (if reconstructed) and totally protect marine terminal. | Erosion problem is not solved, resulting in narrower beach and potentially no beach. 20 year maintenance free life. Pipeline repair costs to bring project life to 30 years are not included. Loss of marine terminal operations during constructin period. |
| 10. No Action | | | | Erosion problem is not solved, resulting in narrower beach and potentially no beach. Projected damange to bike path and marine terminal facilities. Environmental hazard to unprotected pipelines. Public and agency reaction to exposed sub-lines. High risk. |

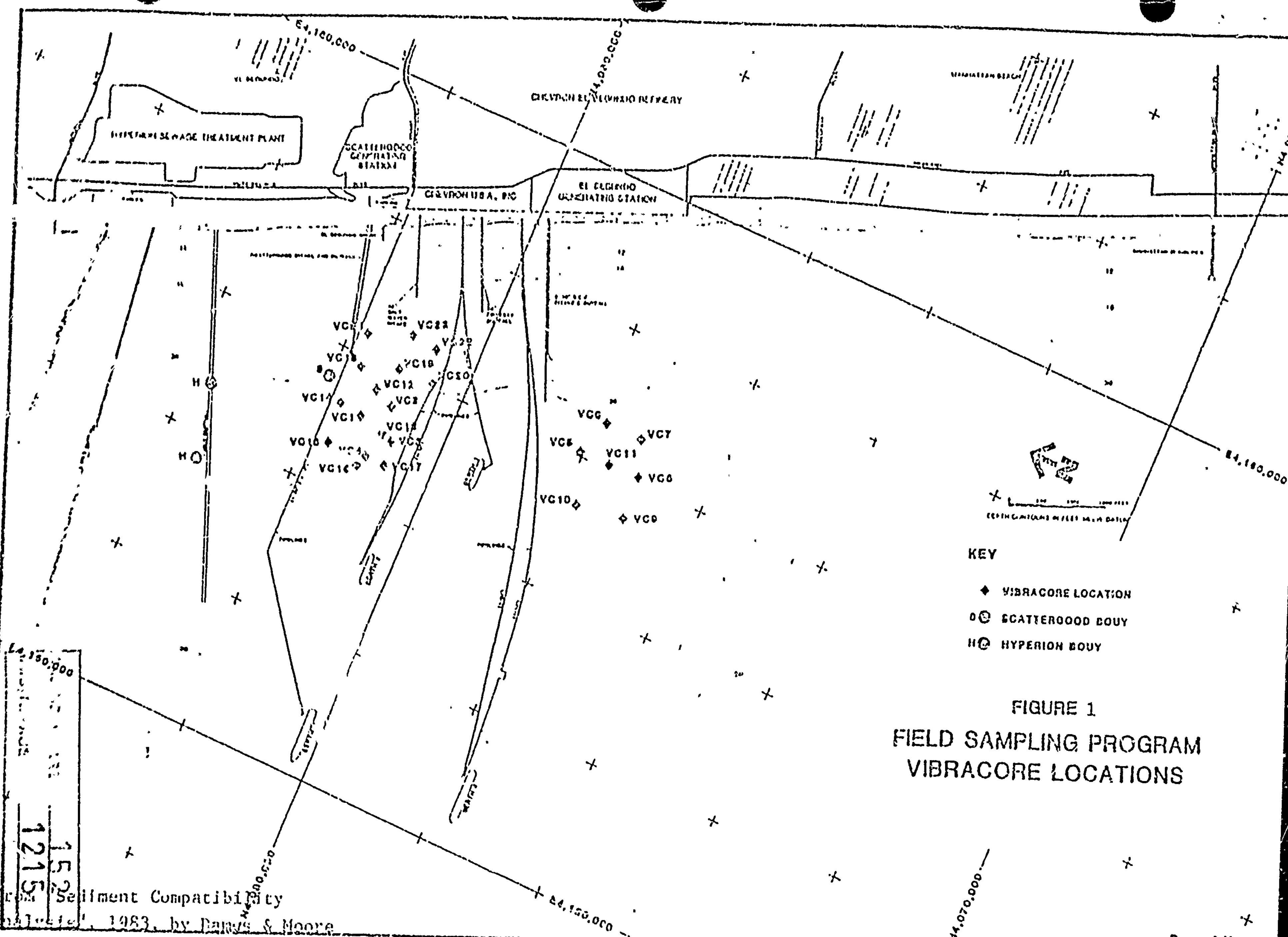


FIGURE 1
FIELD SAMPLING PROGRAM
VIBRACORE LOCATIONS

From "Sediment Compatibility Analysis", 1983, by Dames & Moore

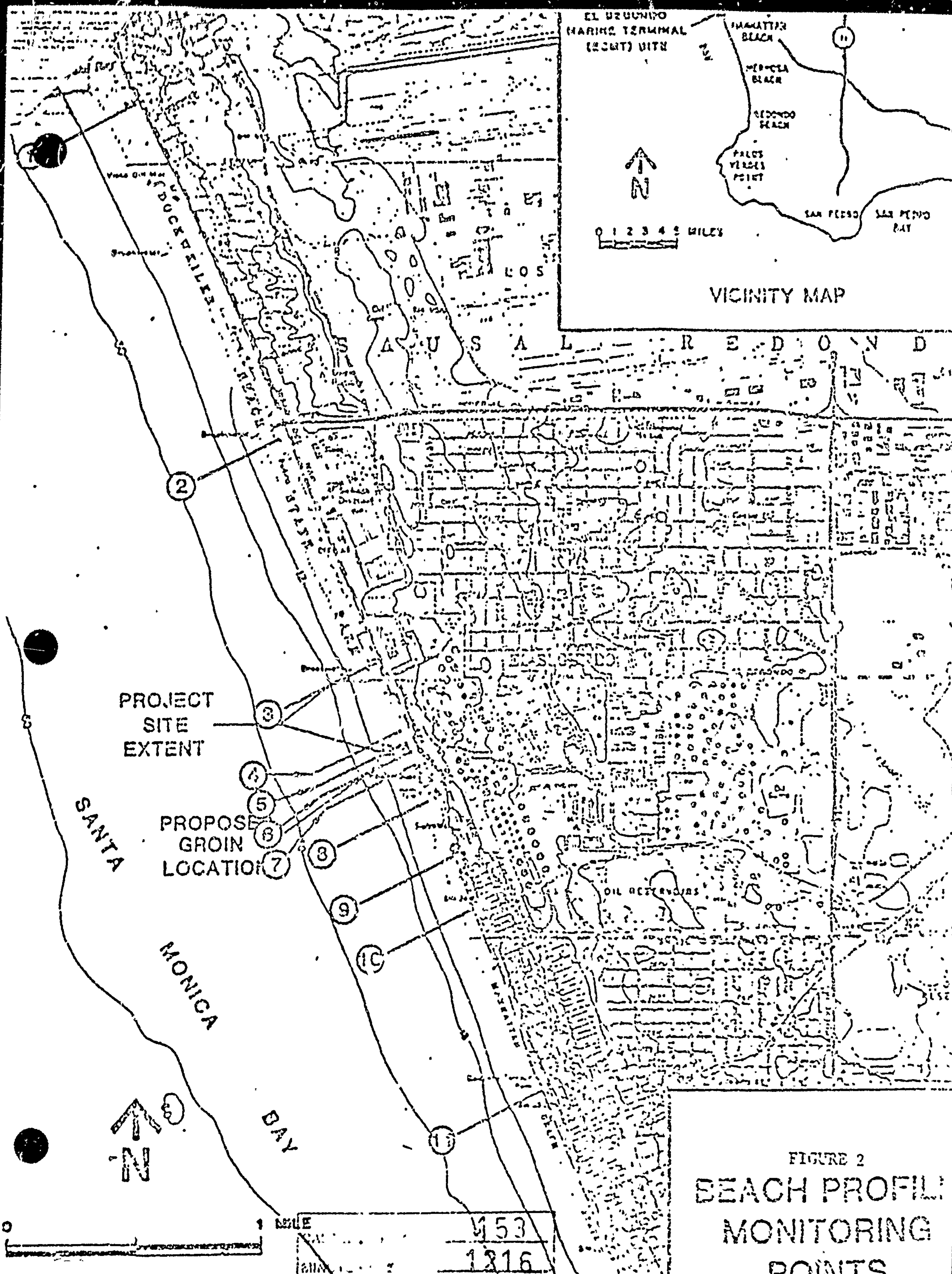


FIGURE 2
BEACH PROFILE
MONITORING
POINTS

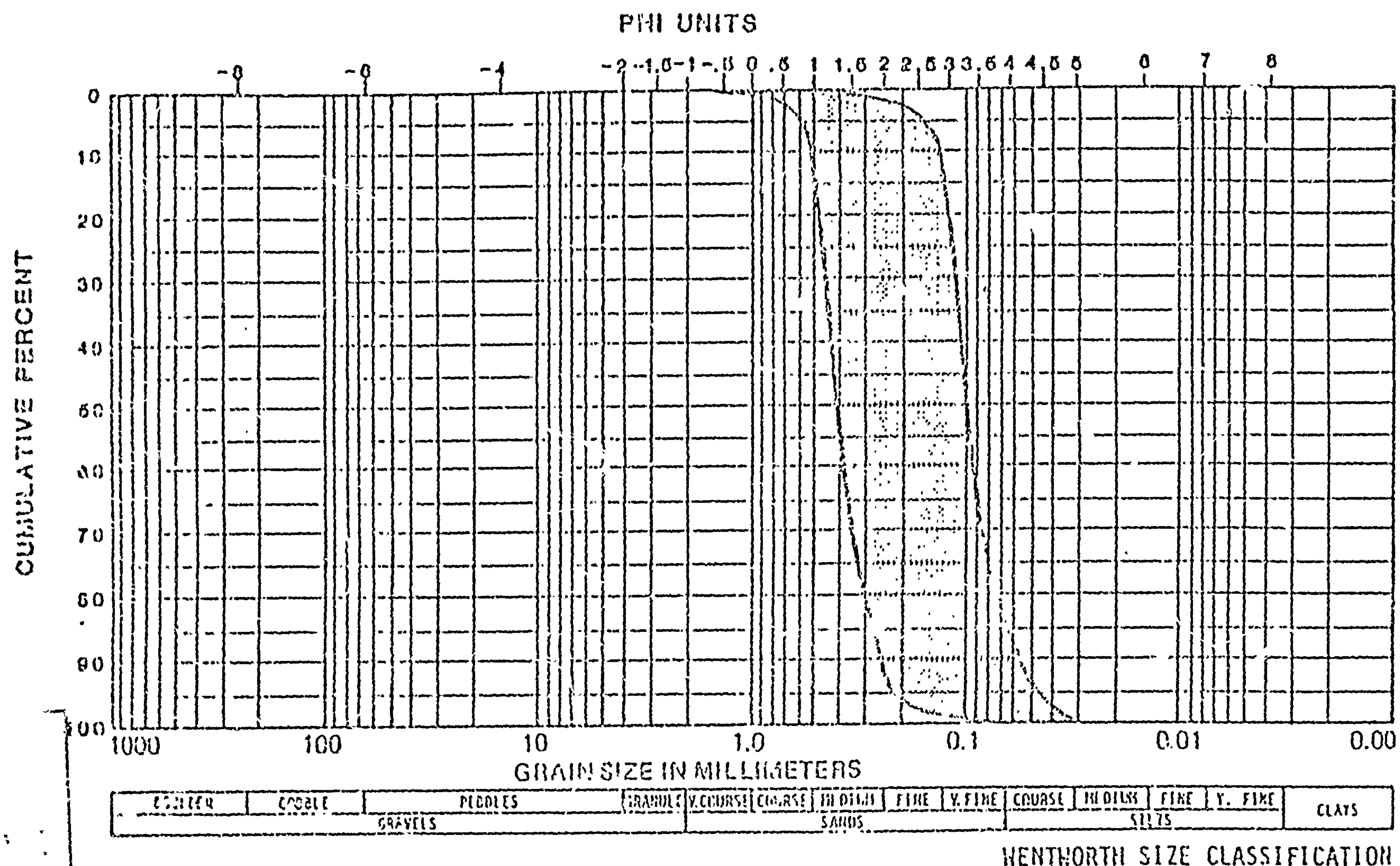


FIGURE 3

# BEACH PROFILE 1 GRAIN SIZE ENVELOPE

From "Sediment Compatibility Analysis"

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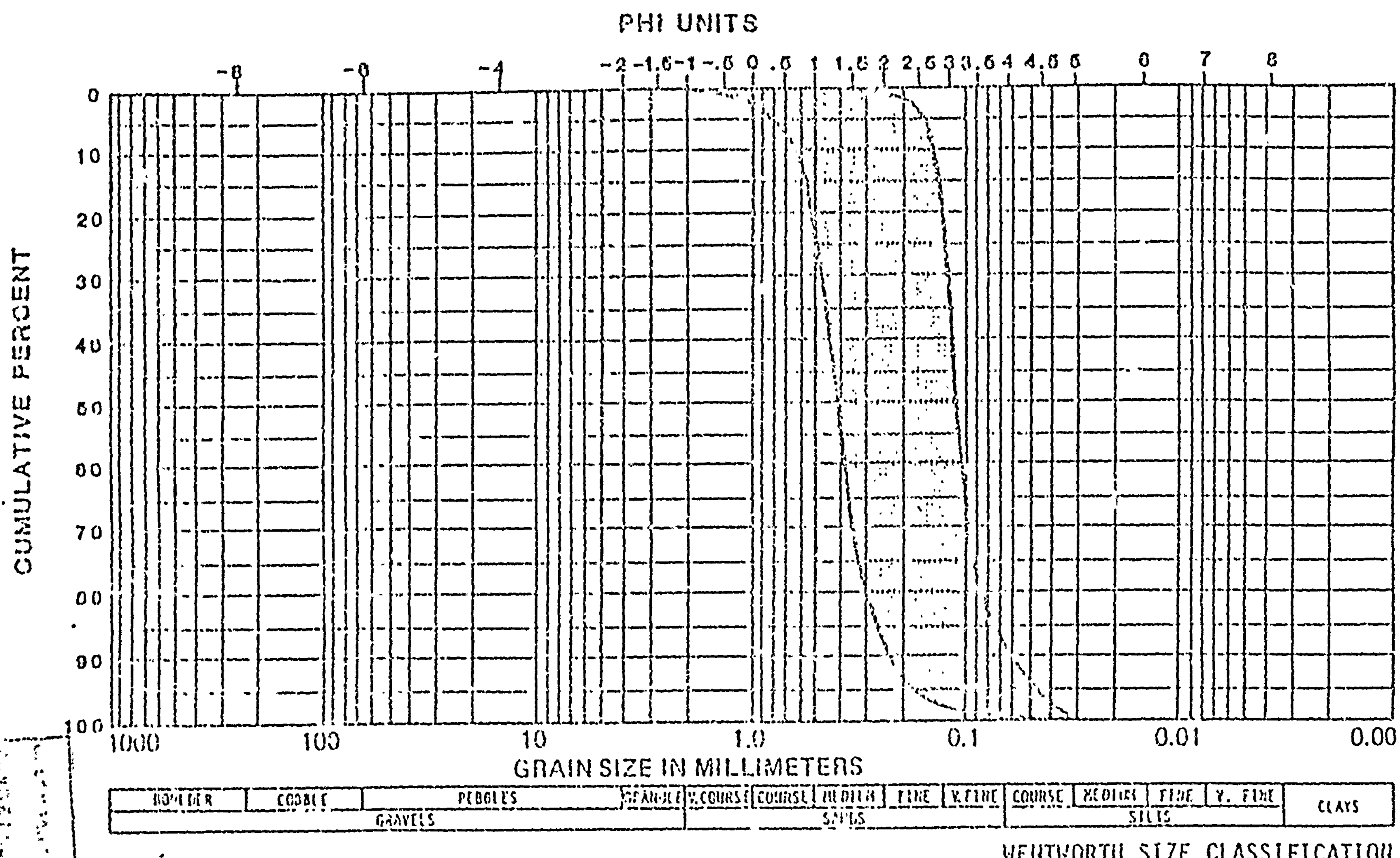


FIGURE 4

# BEACH PROFILE 2 GRAIN SIZE ENVELOPE

From "Sediment Compatibility Analysis",
by D... & M..., 19..

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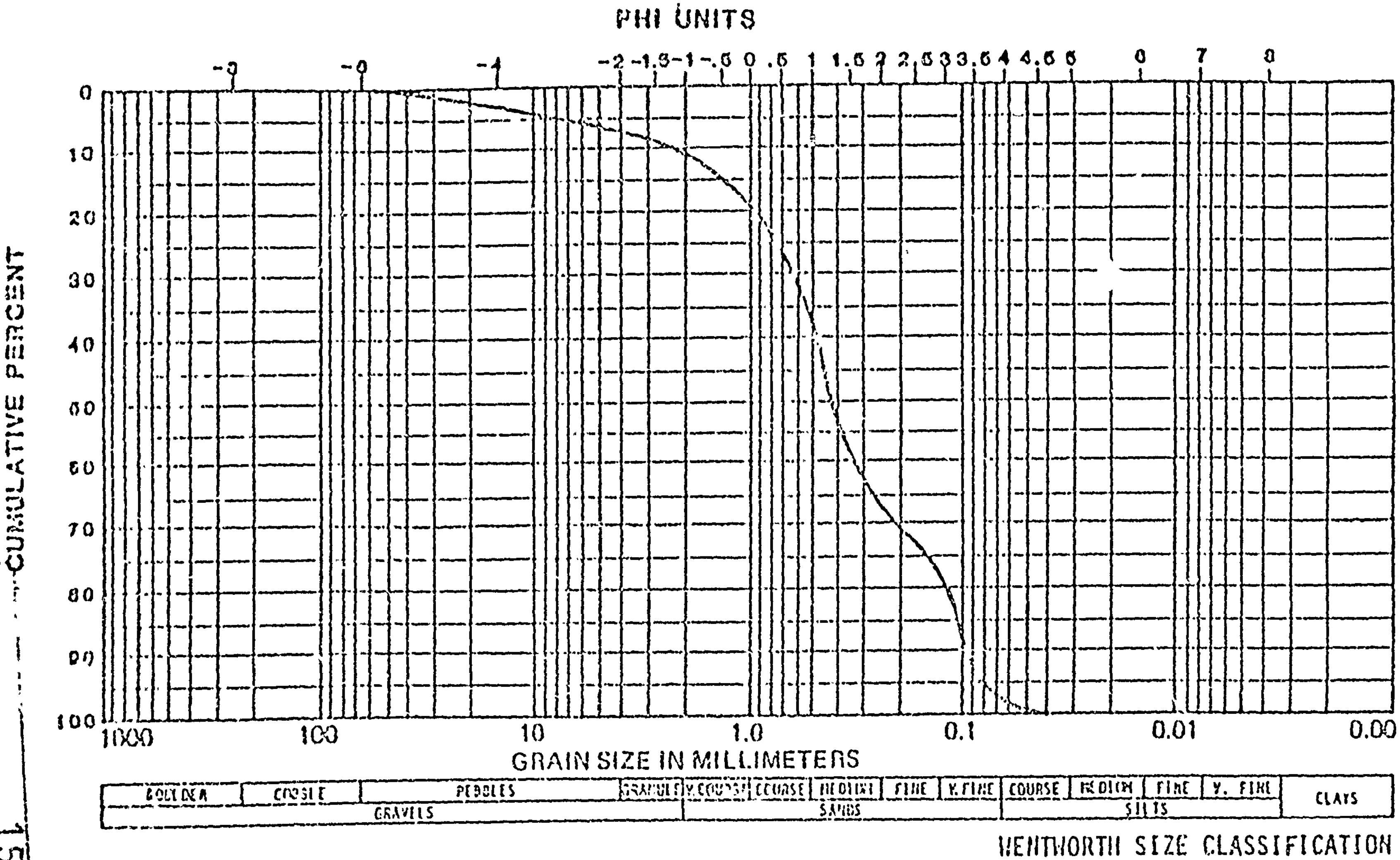


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om "Sediment Compatibility
nlysis", by Danes &
ore, 1983

FIGURE 5

COMPOSITE CUMULATIVE GRAIN SIZE CURVE

FOR VIBRACORES VC 1-4 AND VC 12-23

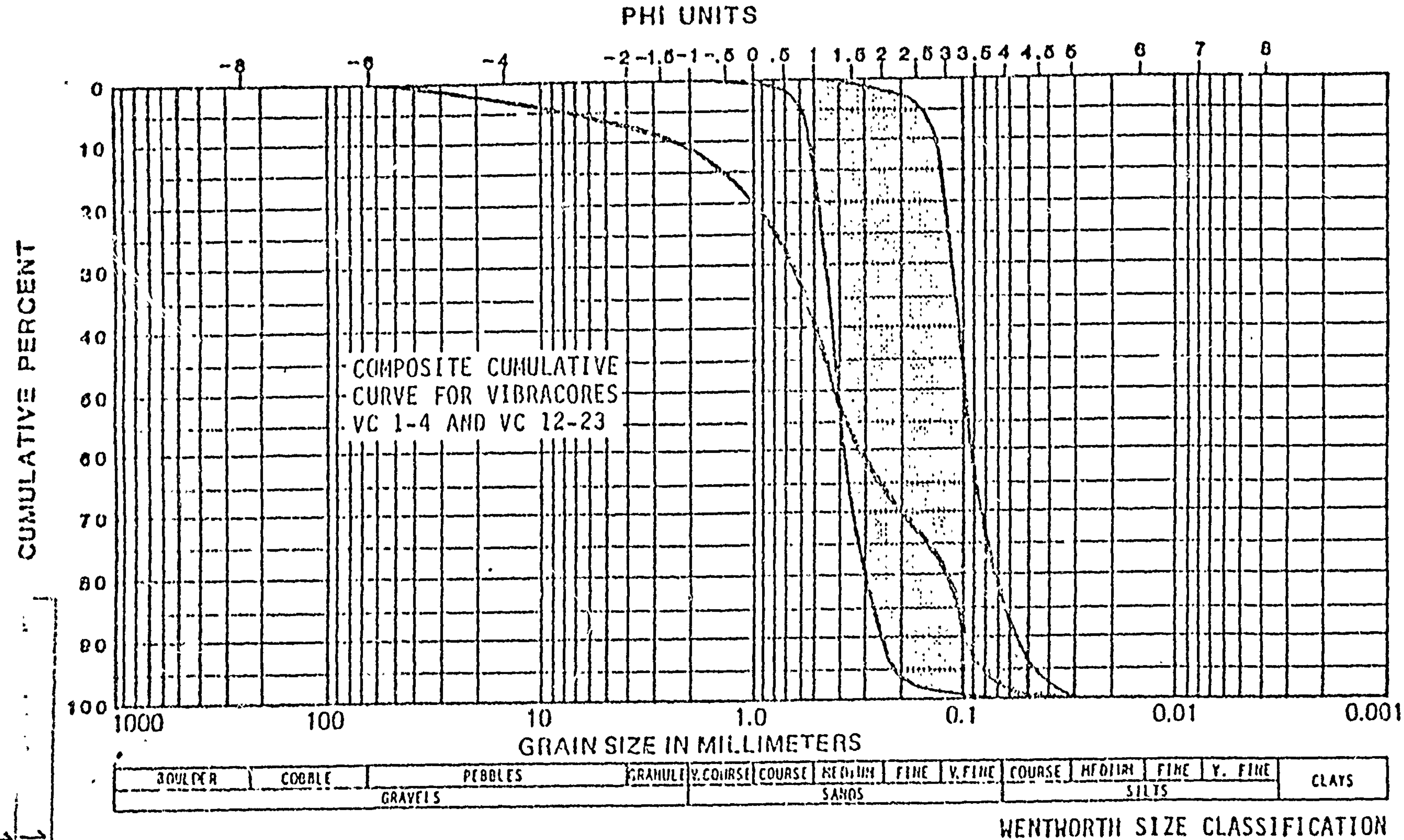




FIGURE 6

# BEACH PROFILE 1 GRAIN SIZE ENVELOPE AND COMPOSITE CUMULATIVE CURVE

...om "Sediment Compatibility ...alysis", by Dames & Moore, ...83.

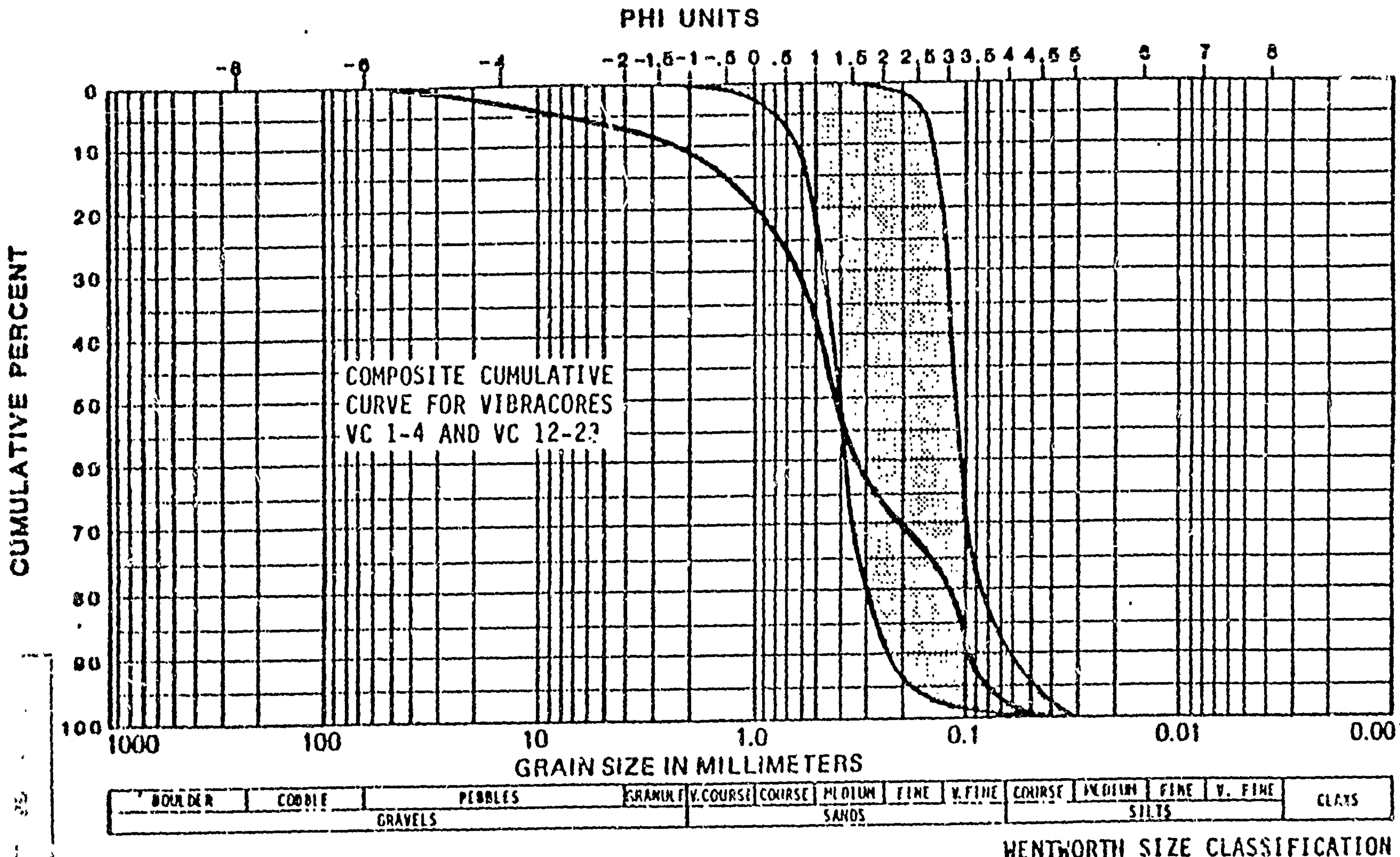


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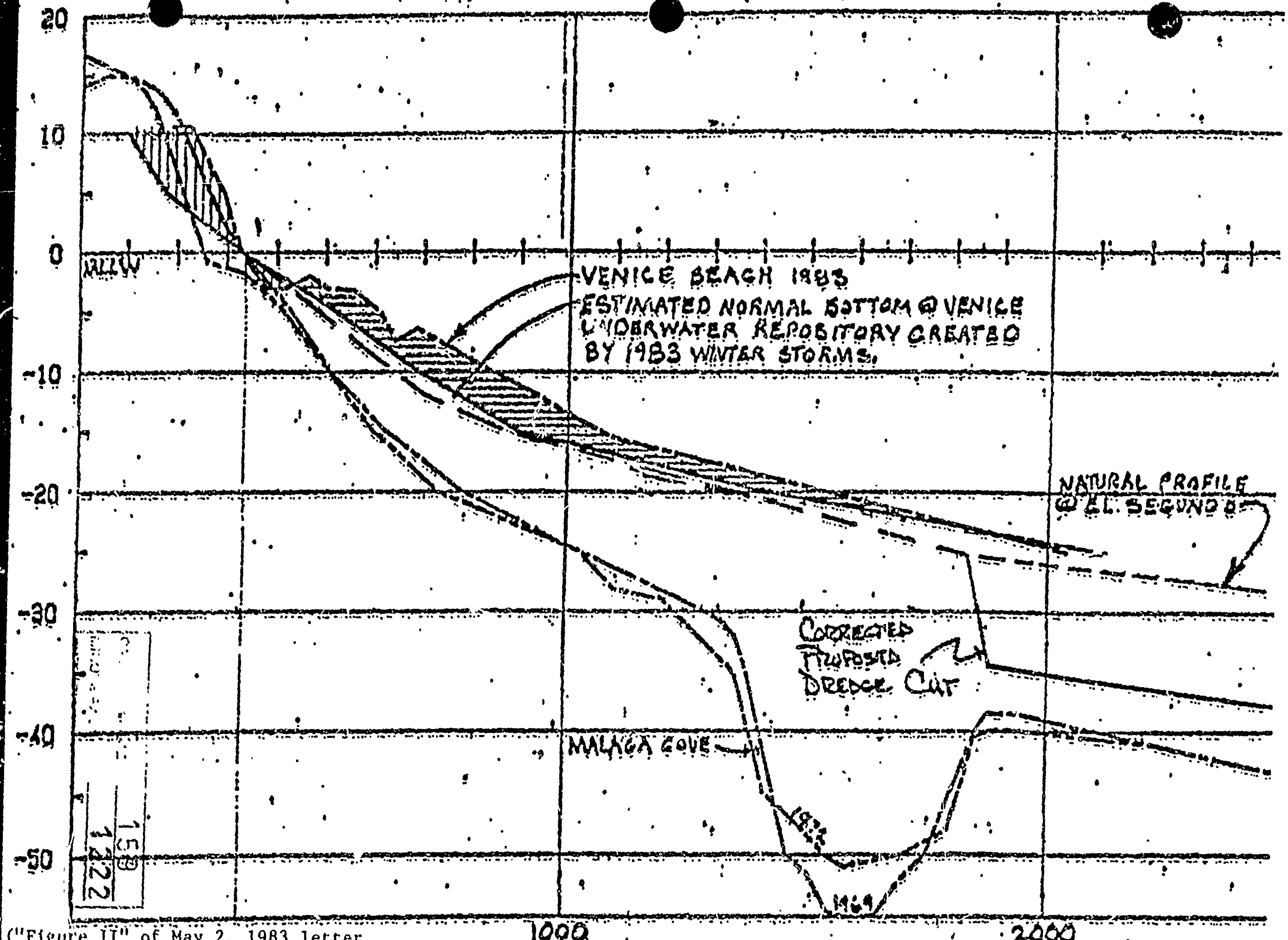
FIGURE 7

# BEACH PROFILE 2 GRAIN SIZE ENVELOPE AND COMPOSITE CUMULATIVE CURVE

From "Sediment Compatibility Analysis",




("Figure II" of May 2, 1983 letter from L. A. County Dept. of Engineer-Facilities)

FIGURE 8: ESTIMATED OCEAN BOTTOM DEPTHS, A COMPARISON

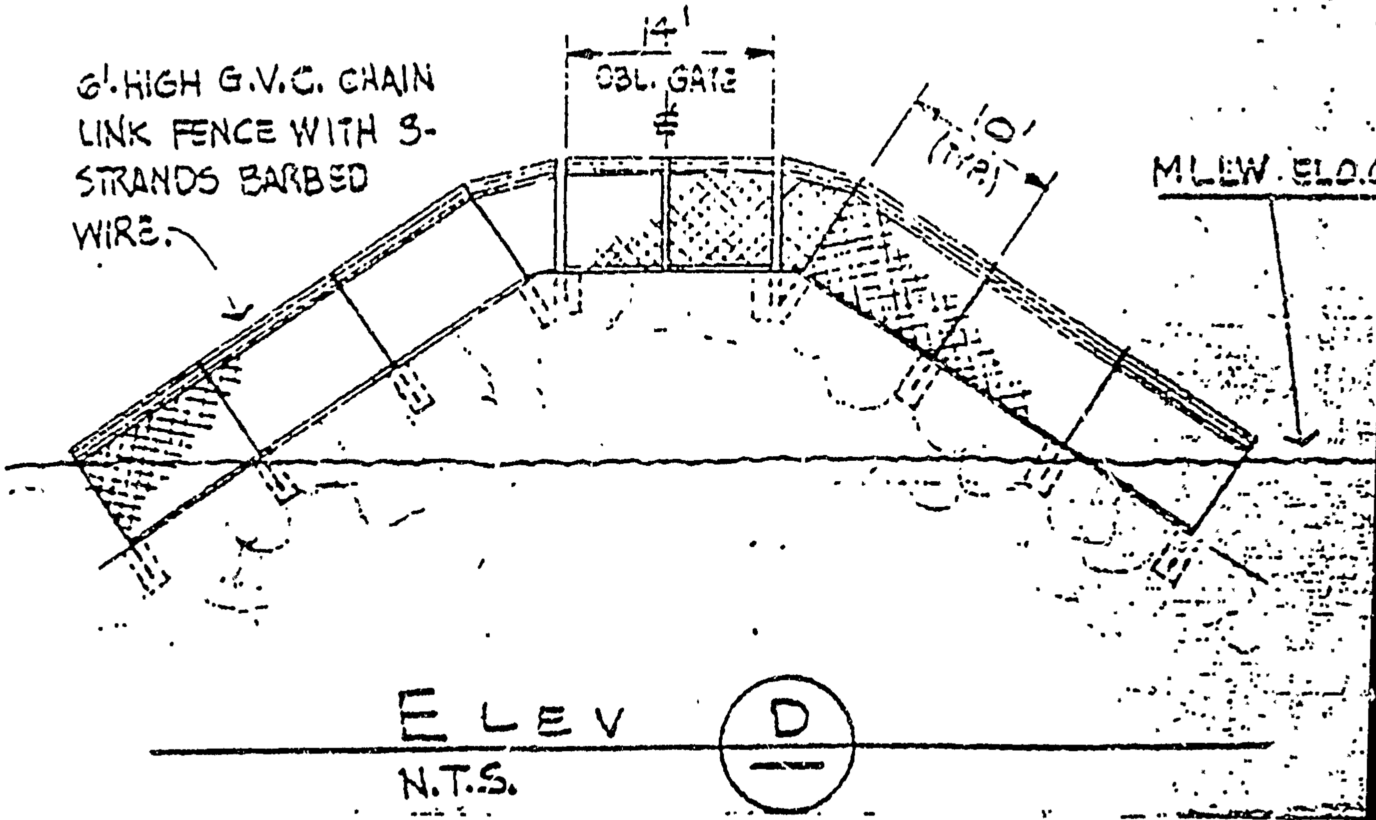



FIGURE 9

CHAIN-LINK FENCE TO BE LOCATED APPROX. 50 FT. OFFSHORE OF NORTH SIDE OF ROCK GROIN

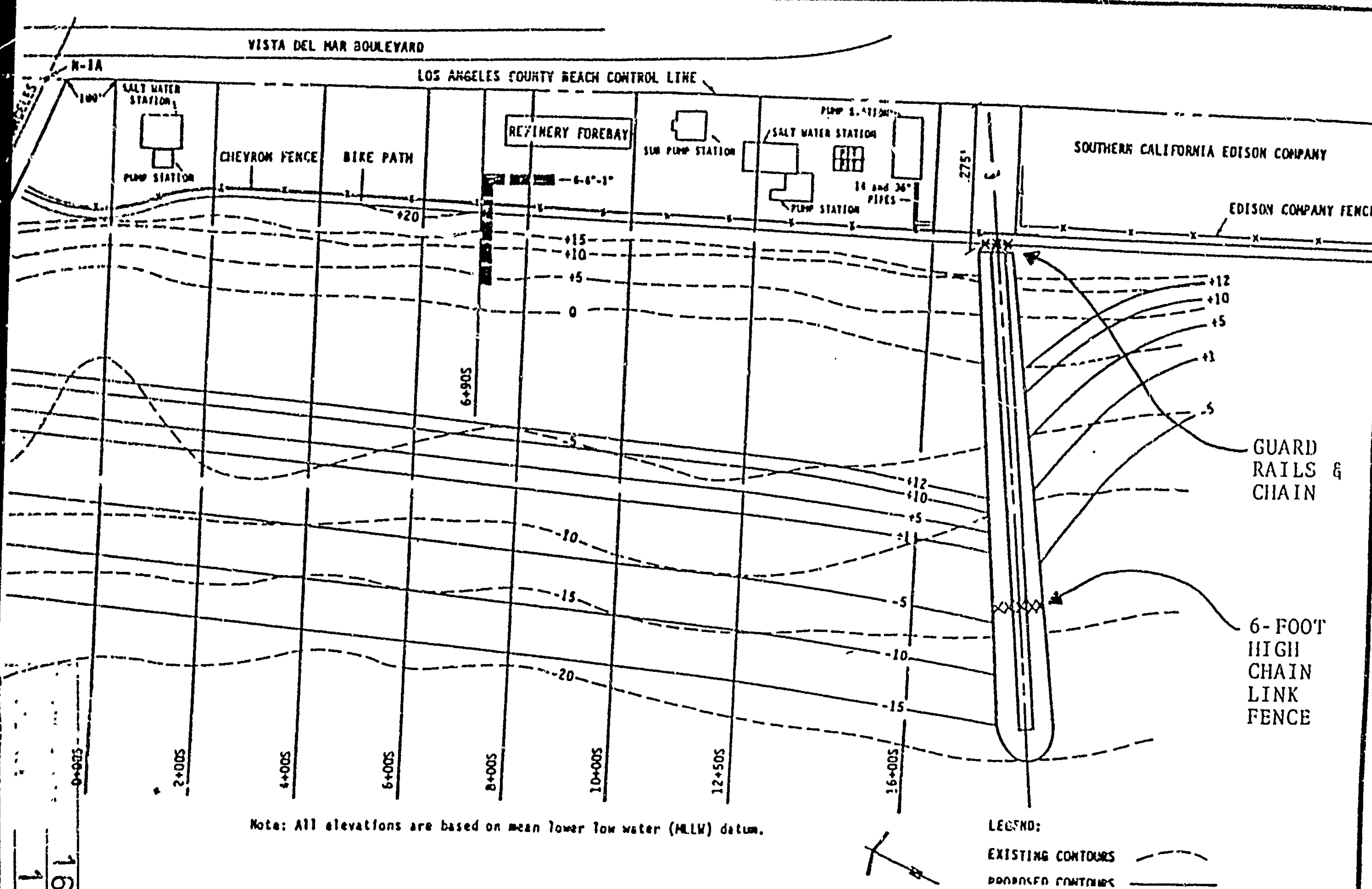



FIGURE 10

LOCATION OF CHAIN-LINK FENCE & GUARD RAILS

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APPENDIX TO "MITIGATION"


BERNARD W. PIPKIN, PH.D.
1828 Granvia Altamira
Palos Verdes Estates, Ca. 90274

Consulting Geologist
Engineering and Mining Geologist

Phone · Bus. 378-369[illegible]
Res. 378-79[illegible]


February 10, 1983

Mr. Charles I. Rauw
Senior Coastal Engineer
Dames and Moore
1100 Glendon Avenue, Suite 1000
Los Angeles, CA 90024

Re: Performance of the Topaz Street Groin, Redondo Beach, as a prototype for the proposed Chevron groin, El Segundo California

Dear Mr. Rauw,

At the request of Dames and Moore I am submitting evidence and opinion on the efficacy of the Topaz Street groin in Redondo Beach relative to the proposed groin construction at El Segundo. I am a professor of Geological Sciences at the University of Southern California, a licensed engineering geologist in the State of California, and much of my professional and academic experience lies in the realm of coastal engineering. I followed the Redondo Beach restoration project from its inception and was involved in beach-erosion research for the State of California, Department of Water Resources, at the time beach fill was placed and the groin was constructed (Pipkin, 1967). In addition, I have had several students perform independent research projects under my direction at this location, the results of which I will submit as evidence of groin efficiency.

In 1954 the congress passed Public Law 780 authorizing placement of fill along an 8,000 foot stretch of beach from the Redondo Beach pier to Malaga Cove. The project was funded in 1967 and placement of 1.4 million cubic yards of dredge beach material was completed in October, 1968. This part of Redondo Beach has long been regarded as a "node" at the end of the Santa Monica littoral cell, that is, on the long term littoral drift simply oscillates within this 1-mile stretch of beach. It soon became apparent after fill placement that northward drift from southerly swell was carrying beach material toward the Redondo Beach pier and the Redondo Submarine Canyon where it would be lost forever from the system. The Corps of Engineers decided to place a groin at the north end of this stretch of beach to stop littoral drift before it reached the "wave shadow" of King Harbor and the pier. The groin was built in 1970 and specification provided for a length of about 700 feet, a top elevation of +12' M.L.L.W., and a top width of 8-12 feet. Side slope of the trunk is 1.5:1 and the slope at the head of the structure is 2:1. The toe depth of the filter blanket is 22 feet, and the core stone is at 20 feet M.L.L.W.

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The filter blanket and core stone were dumped and a double layer of armor stone ranging from 22 tons to 6 tons was placed by a crane on the core wedge of sand accumulated on the south side of the groin clearly indicating a blockage of sand movement toward the north. Repeated survey by the Corps of Engineers, Los Angeles District, indicated that sand no longer moved into the wave shadow of the King Harbor Breakwater and pier area.

It was of interest whether the structure would block the south moving littoral current and thus cause accretion on the north side of the groin and scour of the beach on the south side, especially during winter swell conditions. In addition, it was of interest to know if the groin was permeable and whether sand actually passed through the structure.

In late 1978, 200 pounds of fluorescene-dyed sand was injected on the south side of the Topaz Street groin and two sampling transects were established north of the groin (Sutton, 1979). The sand was taken from Doheny Beach and the fluorescene dye was fixed to it with epoxy resin, in a method described by Ingle (1966). Sampling was done with 3" x 5" greased cards pressed on to the sand surface at predetermined intervals. Injection was on November 5, 1978, and sampling was performed on November 12th, 26th, and December 3, 1978. A large number of dyed grains appeared on the north side of the groin on the first sampling indicating a rather rapid movement of sand toward the north. In addition, dyed grains were depleted on the south side but reappeared again December 3rd indicating a rather rapid reversal of flow. It is the opinion of the undersigned that once sand builds up to an equilibrium profile around the groin it tends to flow rather easily through the interstices of the larger rock or around the head in deeper water.

Another study (Vaughan, 1976) used grain parameters and statistical measures to contrast the beach material north and south of the groin. According to Vaughan "...the Topaz street groin has served to: (1) dissipate wave energy at the shore, (2) intercept the longshore transport of sand, and (3) keep recently added sand in place to the south of the structure." On a personal note, the undersigned has kept a desultory watch on the project because of an interest in beach cycles. About 20 acres of new recreational land was created by the fill and it has been maintained over the past decade by the influence of the Topaz Street groin.

The proposed structure at El Segundo is very similar to the Topaz Street groin with the exception of the lcoation of fill placement. The El Segundo structure is 900 feet long compared to 700 feet for Topaz Street; toe depth in both cases is about 20 feet; and design wave height in both cases is very conservative. The difference is that the half-million yards of fill to be placed north of the El Segundo groin will provide an instant stockpile of sand for beaches to the south. Once the fill reaches equilibrium with the dominant wave period and direction, sand should bypass the end of the groin and filter through it to nourish downcoast beaches. There is abundant literature to support this contention and I have taken the liberty to append a bibliography of field and laboratory research on the subject.

It is the opinion of the undersigned that the proposed structure in combination with beach fill will provide the necessary shoreline protection for the proposed engineering works and will not deprive downdrift beaches of sand nourishment. The structure should perform very much like the Topaz Street groin at Redondo beach that has been one of the more successful attached structures built by the Corps of Engineers (Clancy, U.S.C.E., personal communication). It is also the opinion of the undersigned that periodic replacement of fill will be required, probably at about 10-year intervals (based upon a drift rate of 50,000 cubic yards/year). Should you have any questions please call upon me.

Very truly yours

Bernard W Pipkin

Bernard W. Pipkin
Engineering Geologist 159
State of California

BWP/ndl

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1227

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Pipkin, B.W., and others, 1967, Progress report on study of beach nourishment along the southern California coastline; State Calif., Dept. Water Resources, Southern District, 59 p.

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Vaughan, Jesse, 1976, Analysis of swash zone sands from Topaz street groin area, Redondo Beach, California; The Compass, v. 54, p. 4-8.

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Balsillie, J.H., and Bruno, R.O., 1972, Groins: An annotated bibliography; U.S. Corps Engineers, C.E.R.C., M.P. 1-72. A well indexed and comprehensive coverage of laboratory and field investigations on groins world wide.

Berg, Dennis W., and Watts, G.M., 1967, Variations in groin design; Proceedings Amer. Soc. Civil Engineers, v. 93, p. 79-100. A compendium of groin types that have been constructed on U.S. Shorelines and waterways.

Price, W.A., and Tomlinson, K.W., 1968, The effect of groynes on stable beaches beaches; Proc. 11th Conf. on Coastal Engineering, A.S.C.E., v. 1, p. 518-525. Wave basin tests showed that permeable groins had little effect inshore or offshore whereas impermeable groins produced buildup of sand offshore from groin.

Sollitt, C.K. and Cross, R.H., 1976, Wave reflection and transmission at permeable breakwaters; Coastal Engin. Research Center Tech. Paper 76-8, 172 p. Main point is that much long (storm) period wave energy is passed through permeable rock structures, that is, as much as 30% of storm wave energy passes through rock breakwaters (and deeper parts of rock groins).


SANTA MONICA
LOS ANGELES
MONTEBELLO
PICO RIVERA
WHITTIER
INGLEWOOD
HUNTINGTON PARK
LENNOX
SOUTH GATE
DOWNEY
SANTA FE SPRINGS
EL SEGUNDO
SITE
LYNWOOD
WILLOWBROOK
HAWTHORNE
LAWNDALE
COMPTON
PARAMOUNT
NORWALK
MANHATTAN BEACH
HERMOSA BEACH
TORRANCE
REDONDO BEACH
LAKEWOOD
CYPRESS
CARSON
LOMITA
PALOS VERDES ESTATES
ROLLING HILLS ESTATES
ROLLING HILLS
WILMINGTON
LONG BEACH
SAN PEDRO
SEAL BEACH
HUNTINGTON BEACH
EXHIBIT "B"
WP 5574