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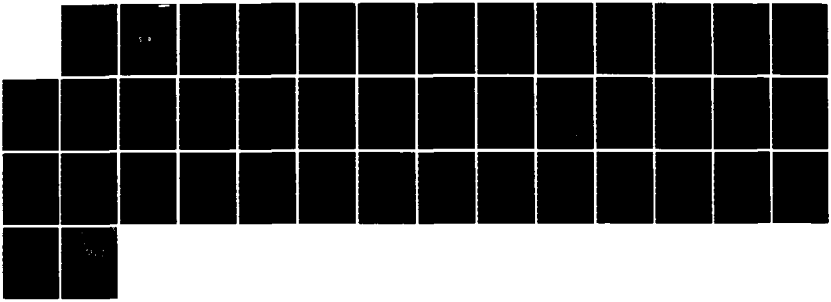

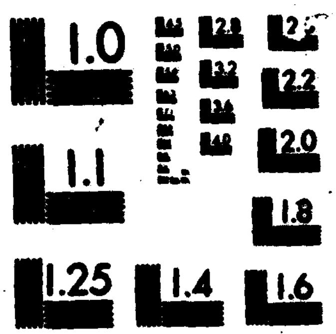

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Proposal for Ocean Engineering Studies for San Nicolas Island Marine Access Improvements

Submitted to the
Pacific Missile Test Center
Pt. Mugu, CA

FPO-1-78(8)

June 1978

Ocean Engineering and Construction

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in November 1977, the Ocean Engineering and Construction Project Office received an inquiry from Public Works Department, Pacific Missile Test Center, (PW/PMTC) Pt. Mugu, California regarding possible support for a survey of submarine hazards to barge landings at San Nicolas Island (SNI). At (Con't)

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Approved by R.A. Erchul (signature)
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Ocean Engineering and Construction Project Office
Chesapeake Division
Naval Facilities Engineering Command
Washington Navy Yard
Washington, D. C. 20374

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1.0 INTRODUCTION

1.1 Background

In November 1977, the Ocean Engineering and Construction Project Office received an inquiry from Public Works Department, Pacific Missile Test Center, (PW/PMTC) Pt. Mugu, California regarding possible support for a survey of submarine hazards to barge landings at San Nicolas Island (SNI), Figure 1. At the present time SNI is accessed by sea using a YFU barge which lands at an area known as NAVFAC Beach. The landing of the barge over suspected underwater rock outcrops poses a potential threat to barge safety. Therefore, it is appropriate to survey the NAVFAC Beach area to qualify and quantify the degree and extent of submarine hazards. Subsequent to the initial inquiry, a meeting was held (19 January 1978) at PW/PMTC regarding the SNI survey work. During this meeting the entire marine access route to SNI was discussed and a broader set of requirements evolved. In addition to a survey of underwater hazards, the entire marine access route and the future development of greatly improved access to SNI due to increased mission requirements were established as requirement areas.

Thus, three major work areas have been developed in this proposal. They are:

- Survey of natural seafloor hazards (NAVFAC Beach)
- Fixes and/or modifications to the present marine access route
- Advanced development of the marine access route to SNI.

1.2 CHESNAVFACENGCOM and PW/PMTC interface

In this proposal, the Ocean Engineering and Construction Project Office (CHESNAVFACENGCOM, Code FPO-1) delineates a number of work areas which are responsive to present and future PMTC requirements. Upon receipt of tasking

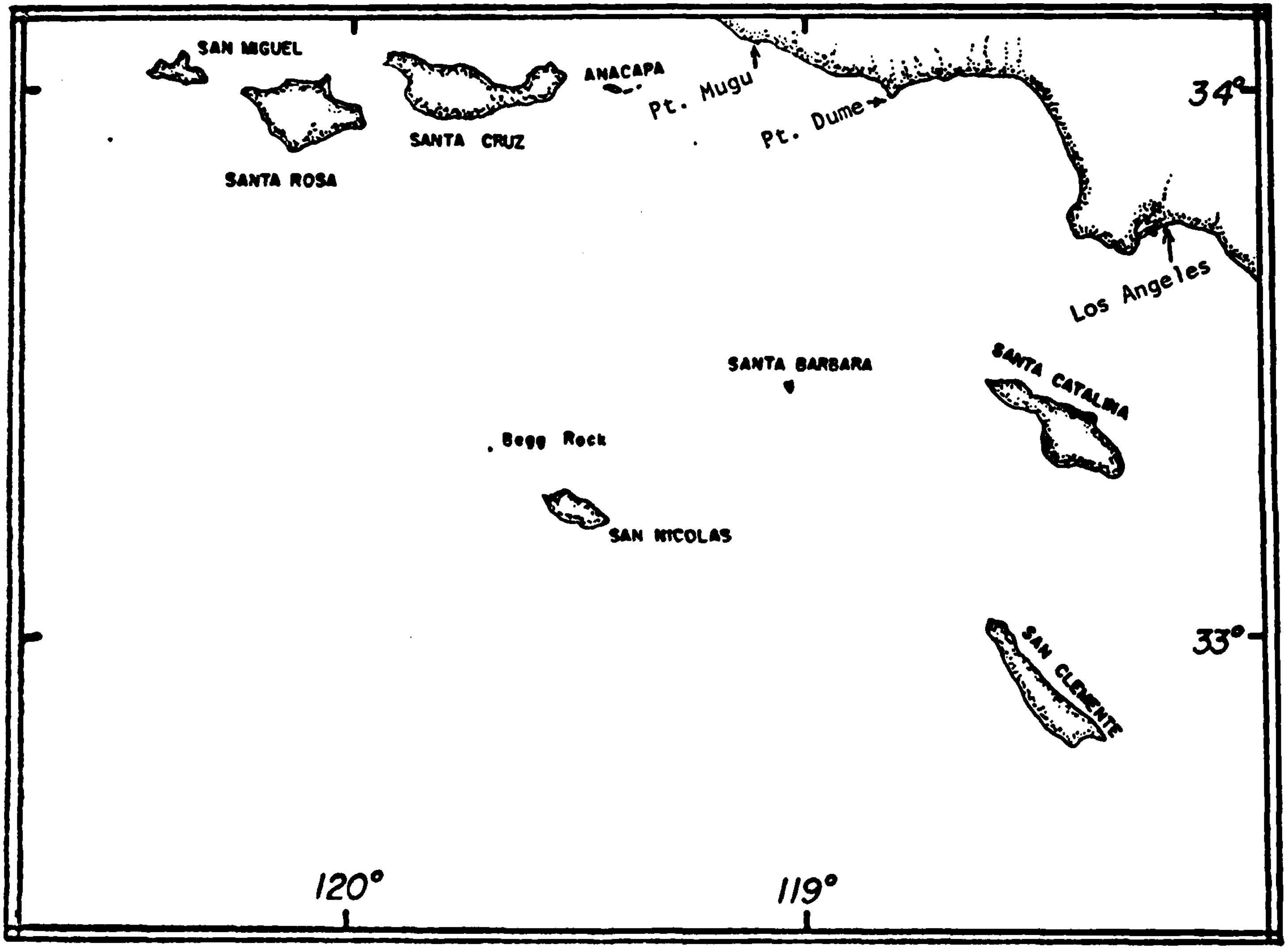

Figure 1 San Nicolas Island relative to the California Coast

from PMTC based on this proposal and subsequent discussions, CHESNAVFACENGCOM will proceed to organize and execute the work designated by PMTC. In the course of work execution CHESNAVFACENGCOM will seek the most cost effective methods drawing upon Navy resources where possible. The capability to operate in this fashion has been demonstrated by the Ocean Engineering and Construction Project Office in the execution of previous PMTC generated tasks (Project Meteor, BSURE Repair, etc.). Other previous CHESNAVFACENGCOM experience which is relevant to SNI waterfront development includes previous surf-zone construction efforts involving structures, cables, pipes, and other fixed ocean facilities.

All work tasked to CHESNAVFACENGCOM will be under the authority of the project manager designated by the Command. The project manager shall be the official focal point for all project decisions. It is highly desirable that PMTC identify a similar focal point to facilitate the project decision-making process.

1.3 Environment versus engineering concerns

In Table 1 a matrix has been developed which shows in a general fashion, some of the sensitivities of engineering work areas to various environmental factors. This is by no means a comprehensive development of the interaction and sensitivities, but it does serve to identify the fact that the engineering complexity will undoubtedly reflect the severity of the island conditions.

ENVIRONMENTAL FACTOR \ WORK AREA	NAVFAC BEACH HAZARD SURVEY	FIXES & IMPROVEMENTS TO THE PRESENT MARINE ACCESS ROUTE	ADVANCED DEVELOPMENT
WIND	-high winds will delay diver & small craft ops.	-wind design criteria must be established for desired scheme -will effect time of utilization	-extreme wind & wind statistics will be req. to establish design criteria for wind load & fatigue
WAVES	-successful diver & small craft ops. possible only in very low sea state	-wave design criteria and character must be established for desired landing scenario -will effect utilization	-design wave criteri will be major cost determining factor for all options.
SUBMARINE ROCK	-objective is to delineate this factor	-hazards must be removed for safety -desired scenario must accomodate general bottom character	-likely to effect foundation design -rotten sedimentary rock fractures easily
SEDIMENT TRANSPORT	-heavy sediment load in water will limit diver visibility.	-improvements must consider large quantity of longshore transport eg. groin formation and filling.	-sediment fill is likely result of const. when long-shore flow is interrupted
BEACH GEOMORPHOLOGY	-good beach area is required for staging ops.	-beach design criteria must be established for desired scenario	-traffic is limited on pure beach, will not support heavy traffic -alteration must consider enironment effect.
TERRESTRIAL FORMATIONS	-good stable site required	-certain terrestrial formations may effect development of desired scenario eg. if costly rock removal is required	-rock formations limit sites -formations may not provide sufficient foundation

TABLE 1 Matrix development of work areas versus environmental factors identifying sensitivities.

2.0 TECHNICAL DISCUSSION OF WORK AREAS

2.1 Survey of natural submarine hazards (NAVFAC Beach)

Submarine rock outcrops can pose a hazard to vessel traffic accessing SNI. Working with the assumption that the present marine access route to SNI for the YFU will continue to be via NAVFAC Beach it is appropriate to qualify and quantify the natural submarine hazards which are likely to pose a damage threat. Once this type of assessment is completed the engineering required for hazard removal can progress.

Some preliminary judgements can be made regarding removal of hazards. It is assumed that much of any required removal can be done using explosives. The actual technical execution of explosive removal may prove to be somewhat difficult. This concern arises because of the highly eroded sedimentary rock which constitutes much of the islands coastal region. Rock of this type tends to be cavernous which provides a sink for explosive energy. Drilling and more specific positioning of explosives may be required in any clearing operation.

Another bottom hazard to engineering for YFU access stems from the possible anchoring difficulty in the rocky bottom. On the one hand anchors or moorings that are to be permanent will require more elaborate engineering and undoubtedly installation will be somewhat more difficult. However, when a non-permanent anchor or mooring is desired, there exists the possibility that anchors may become snagged.

The technical objectives of this survey proposed for the NAVFAC Beach area (Figure 2) include general delineation of bathymetry and identification of those submarine features which protrude from the bottom. In gathering information regarding anomalous features, e.g. rock outcrops, some assessment

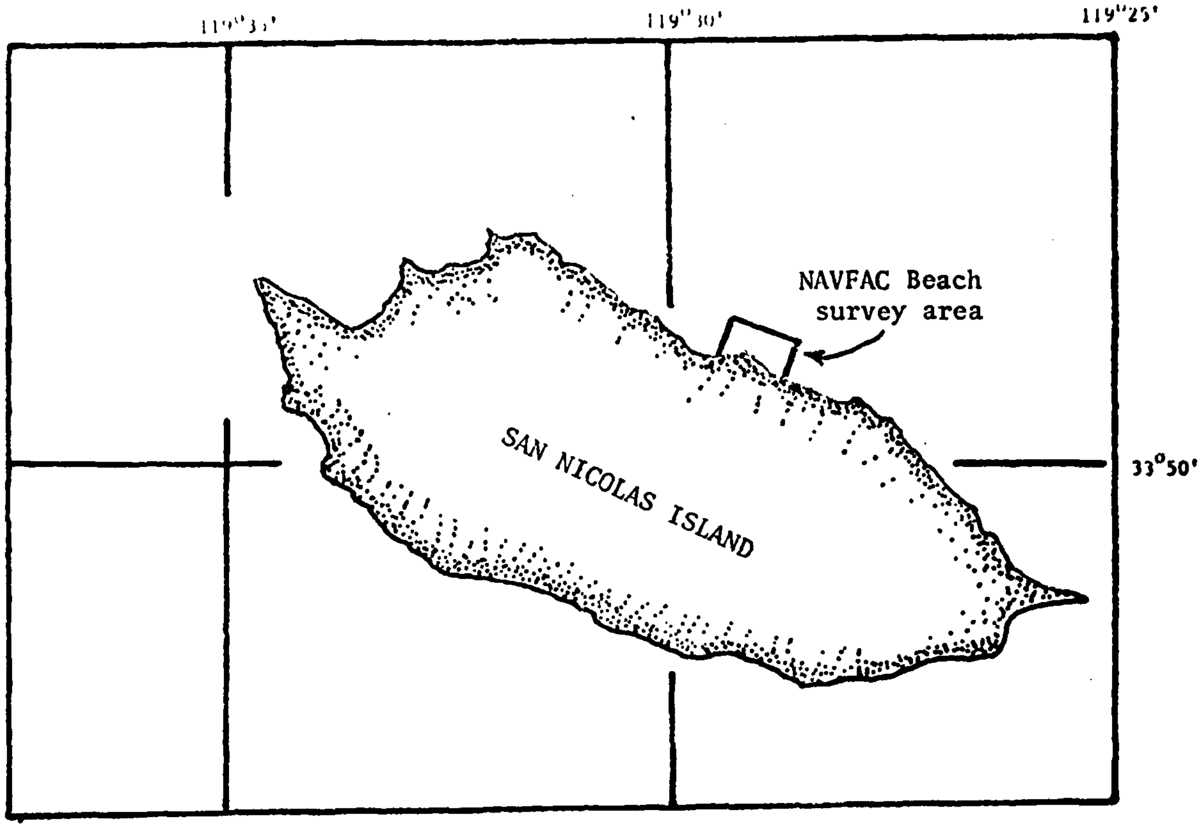

Figure 2 NAVFAC Beach survey area

will be made as to what technique should be used for removal. The area to be surveyed is shown in Figure 3. The survey of NAVFAC Beach will involve the use of divers and remote sensing (echo sounding) from a vessel. The survey will be conducted under the technical control of the Ocean Engineering and Construction Project Office with diver support from Underwater Construction Team Two (UCT-2) (or other Navy diver group).

2.2 Fixes and/or modifications to present marine access route

A vessel broaching risk has been identified for barge landings at NAVFAC Beach. To assess this problem an evaluation of the landing techniques presently used is proposed. Subsequent to the evaluation of the barge landings engineering modifications will be suggested. This may include vessel modifications or the addition of external aids. It is quite possible that no additions and/or modifications will be suggested, but rather some type of device to enhance beach access.

It is assumed that vessel handling and positioning is presently accomplished by using a line astern to an offshore buoy or to a deadman in the beach, and possibly a line ashore to a land-based winch. More precise positioning could be derived through use of multiple dolphins driven into the bottom or extendible jacks, fastened to the YFU. Jacks supporting a ramp to shore also could be employed, Figure 4. References J, K, and L describe similar systems. It is highly unlikely that the aforementioned systems could be acquired within minor development fund boundaries (less than $400K).

A floating causeway could be installed, if available, as described in references B, E, F, G, H, and I, Figures 5 and 6. Such a system could be installed after winter waves have subsided and removed prior to the next

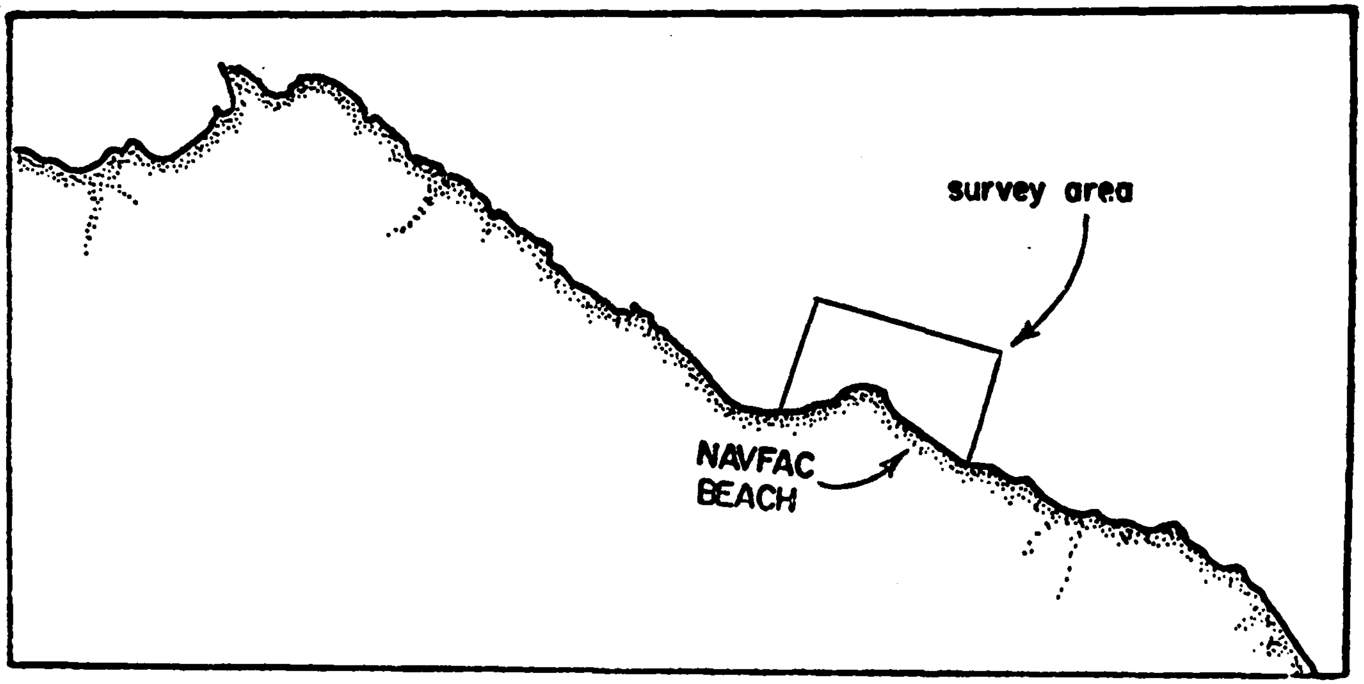

Figure 3 Survey area

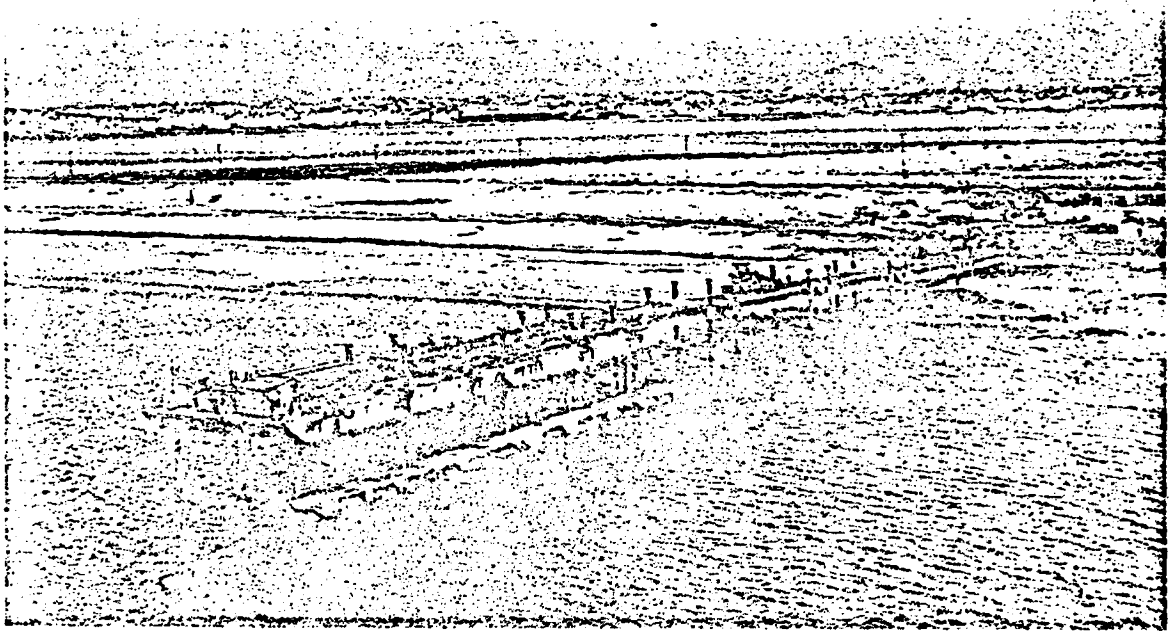

Figure 4 Jack supported pier (COTS System)

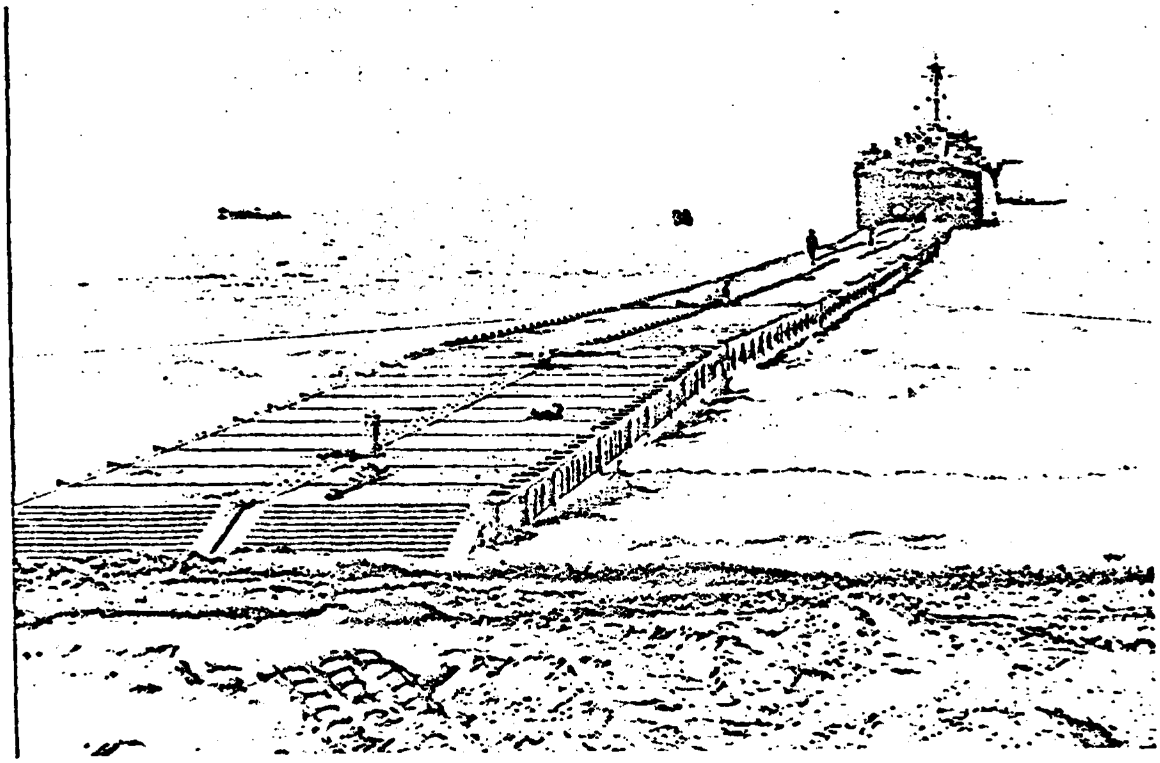

Figure 5 Floating causeway

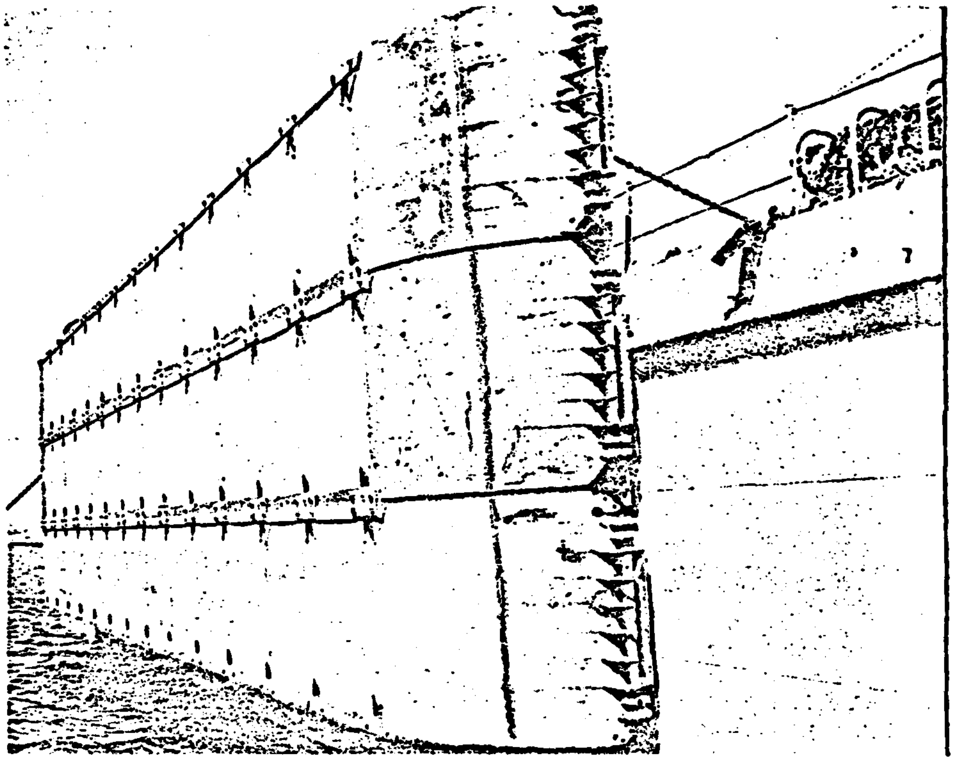

Figure 6 Floating Causeway section

severe weather season. An extensive anchoring system would be needed, as well as landing mat or pavement ashore. The landing mat designed by PW/PMTC may be adequate for this purpose. The problems of navigating the YFU to the head of the floating causeway and securing it in place are presented in the reference documents. Again, implementation of this system could only be accomplished within the $400K limitation if the equipment were already available within the Navy system.

The problem of precise positioning could possibly be minimized if the YFU could carry its own floating causeway or hard surface ramp which could be unfolded from the bow of the ship and extended across intervening shallow water and cross the soft beach sand. Such a system was developed at the Civil Engineering Laboratory (CEL) in 1959 and successfully tested. It is described in reference B. This system, called the "Rush Roll" consists of a 6 ft. diameter steel cylinder which can be unfolded by hand to form a pontoon bridge 13-½ ft. wide and 17½ ft. long, Figures 7 to 10. Each will support the heaviest vehicular traffic which could be considered over water, mud, or loose sand. Three such units could be stowed on the ramp of the YFU without infringing on the normal deck space. They could be unfolded from the lowered ramp to form a bridge 51½ ft. long. Additional units could extend the causeway as long as is needed, but would infringe on deck space.

A number of these units were manufactured in 1959 at a cost of $3,200 each. Even with 19 year's cost escalation it would seem that they could be considered for this application (well within the $400K). It seems highly improbable that any of the original units are still available at CEL or elsewhere, but this is not known. This appears to be a promising candidate, whether the units are left in place for the season after assembly

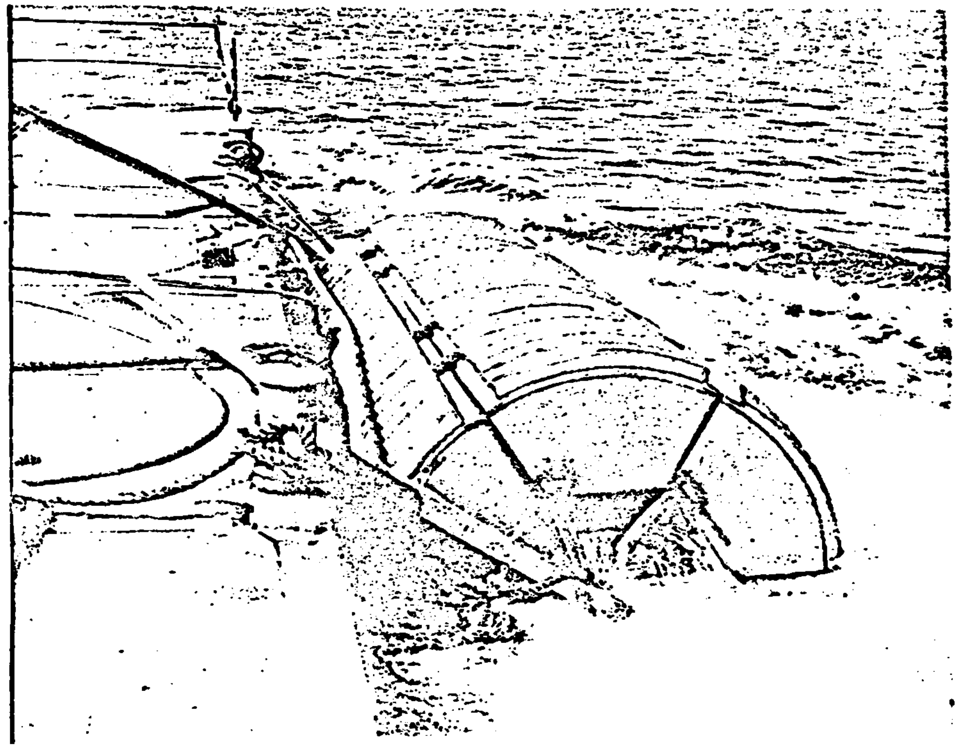

Figure 7 Rush Roll in water

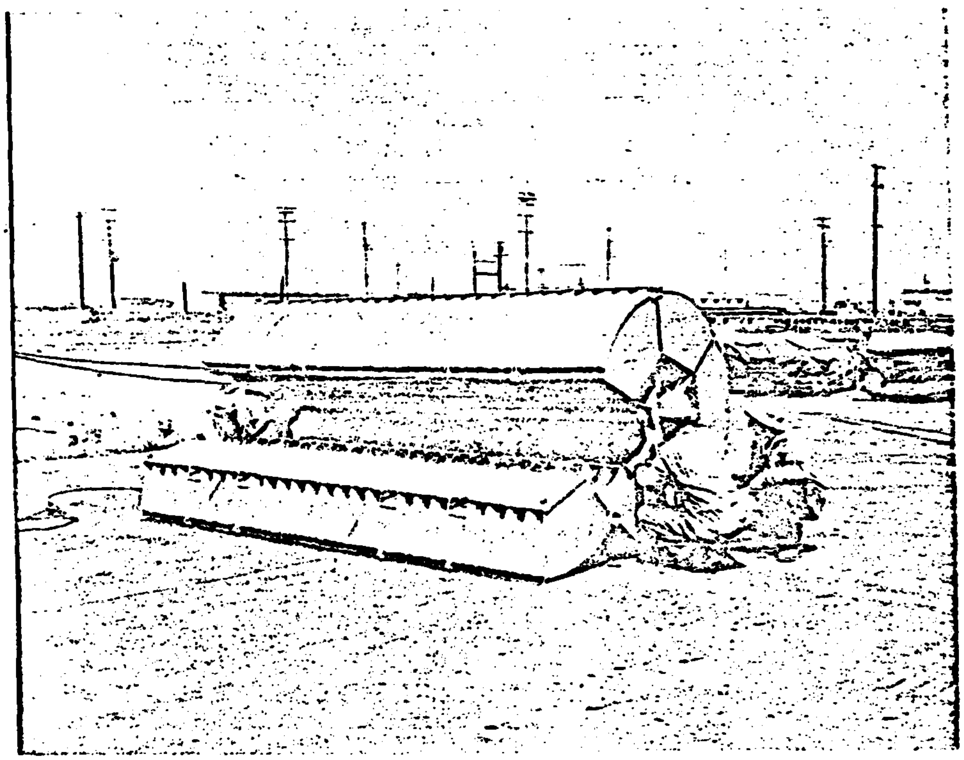

Figure 8 Rush Roll opening

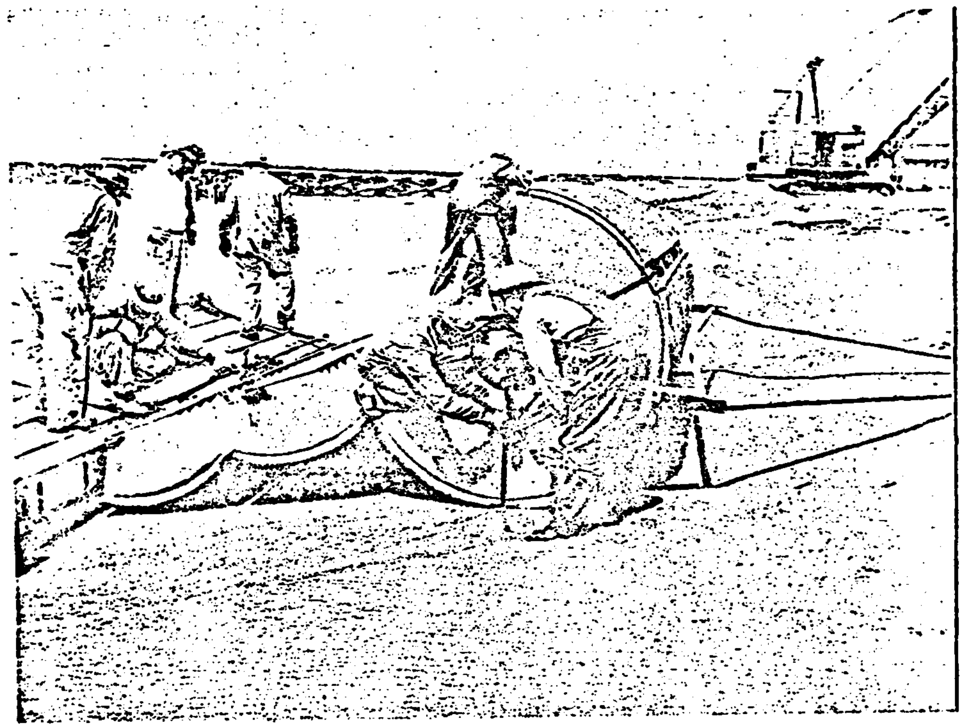

Figure 9 Rush Roll on vessel ramp

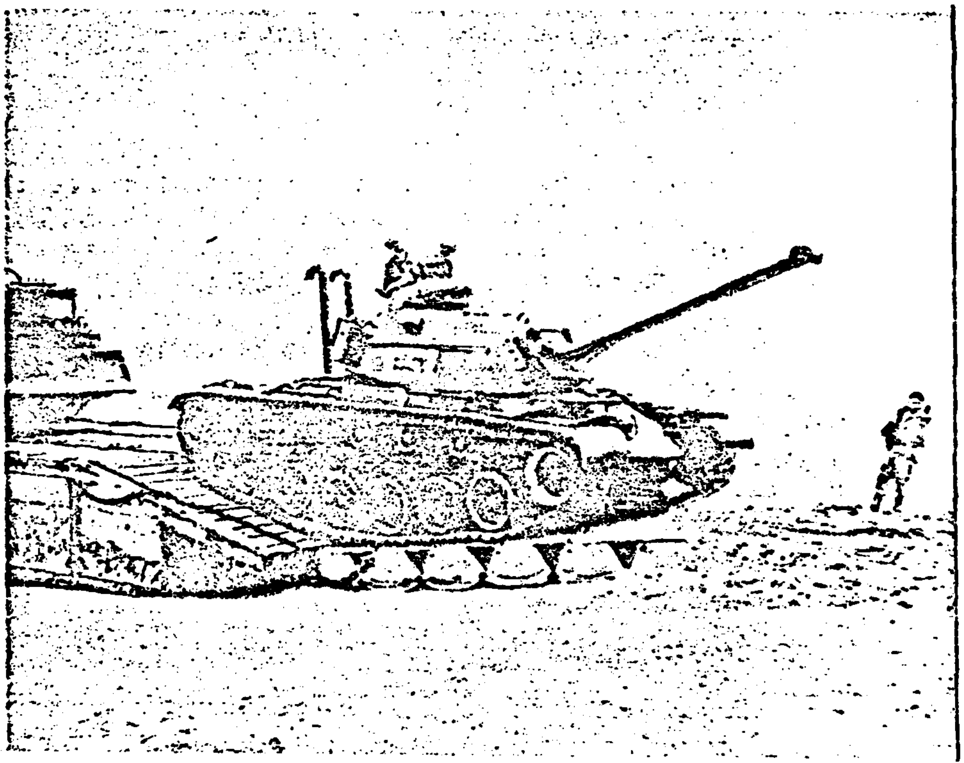

Figure 10 Rush Roll being used on sand beach

or whether they are disassembled and rolled up into the YFU ramp for each trip.

It is recognized that PW/PMTC has completed the design and partial fabrication of a landing ramp (for NAVFAC Beach). Final installation of the ramp will require the driving of sheet pile. If the ramp is to be completed (pile driving) it may be an ideal time to install dolphins to aid vessel positioning. The determination of a landing scheme using the PW/PMTC ramp (possibly with other aids) will be a part of the proposed work. This approach, will be more permanent than the Rush Roll and it should save unloading time. The initial cost of the more permanent facilities will undoubtedly be greater than vessel modifications; but life cycle total cost could be less.

2.3 Advanced development of the marine access route to SNI

The general purpose of the work proposed is to develop ocean environmental design criteria for the feasible and reasonable options which may be considered for a future formal waterfront at SNI. The lack of any natural harbor site on SNI presents a major obstacle to the development of a waterfront facility. A pier will either be subject to the full brunt of the ocean waves, or it must be protected by a large and costly breakwater. Wave heights of 69 feet have been recorded near SNI. This fact must be reflected in the design of any in-water facility exposed to the ocean at SNI.

For a pier without breakwater protection an acceptable-failure survival concept is likely to be utilized in design. An acceptable-failure survival concept would be one where designated elements on the structure will fail, but the primary structure will survive. As a result, repair is designed to be simple, with spare parts on hand. Alternatives to this approach do exist, such as the jack-up pier island, and they shall be considered.

For the unprotected pier, the incident wave heights present an operating constraint. Previous studies have indicated that cargo transfer from a ship subject to wave action is not practical in Sea states over State 3. These conditions, Sea states in excess of 3, exist off of SNI more than one third of the time throughout the year.

The littoral transport presents an environmental difficulty. The former pier at San Nicolas Island has become an inland groin due to the complete deposition of sand and silt on both sides of the structure. Fortunately, littoral transport is not a detriment; it can be accommodated by building a structure which does not significantly impede the existing water currents or wave action, or a structure which totally impedes the water current and wave action. The former approach is that of a piled foundation using large bent spacings, the latter, that of a mole breakwater with littoral drift diverted to deep water (thus denuding the downstream beaches and changing the shape of the sand spit at the eastern end of the island), or with littoral drift bypassing around the mole (which incurs added construction costs.)

The coastal geology of San Nicolas Island is that of multiple thin sandstone and siltstone strate (thicknesses from an inch to a foot) that are severely weathered and deformed. Unconfined compressive strengths of samples from the various strate vary from 600 to 16,000 psi. These conditions create uncertainties in pile driving and foundation behavior. Therefore, exploratory borings and perhaps seismic surveys are required to establish soil properties and to locate discontinuities or anomalies.

This data provides the basis for structural design and determination of construction methods.

Environmental impact of a suitably designed facility is not seen as deleterious to any natural land or water habitats. The existence of seal rookeries on parts of the San Nicolas coast will not interfere with potential site selection. Elimination of some kelp beds could possibly be a minor impact. In any case, an environmental impact assessment (EIA) will be required, and probably an environmental impact statement (EIS) will be necessary.

In the course of the study, the offshore ocean engineering technology will be assessed for materials and techniques of construction which are economical, and particularly suitable to survival in hostile environments. For structures subject to the full wave action, particular attention must be given to both structural fatigue and corrosion protection. In the case of a mole, the design of the armoring layer presents difficulties due to high internal pressures arising from the overriding waves.

The lack of industrial facilities at San Nicolas bears on other technical issues relative to the waterfront development. Noteworthy is the absence of any shelter for construction equipment. Consequently, consideration must be given to distant fabrication and a rapid on site installation scenario. If a complete mole surround is contemplated, then the actual progress of construction must be strictly scheduled to avoid filling in of the prospective harbor area by the very rapid (high volume) littoral transport. Otherwise, the new harbor must be dredged before use; a needless expense.

The proposed design criteria study options are 1) a small pier, unprotected; 2) a large pier, unprotected; and 3) a protected harbor of modest size. If the ultimate port consideration is for unitized cargo and single high value items of 100 tons weight, and ships to 400 foot length and 35 foot draft, the first major option, the small unprotected pier, is not a valid option.

The basic port fuctions are invariant with the size of the waterfront facility. However, the manner in which they are implemented affects the engineering design and construction, and consequently the cost. Hence the following basic port functions will be considered for each major engineering option (small pier or large pier, unprotected, and protected harbor) to determine the range of that function which can be accommodated under each major option:

- o transportation service: at sea: the types of ships, size, draft, frequency of port call, passenger service, etc.; on shore: inland carrier.

- o transportation system: dry bulk, POL, breakbulk including high value items, pallet, container, trailer, LASH barge;

- o traffic management: multiple ship service, contingency service, safe haven, navigation, fueling, commodity breakdown, storage and ultimate destination, etc.

- o waterfront facilities: cargo handling (cranes, trucks, tractors, conveyors, pipes and pumps) marshalling storage, maintenance, ship's service.

- o environmental impact

Much of the data to be considered regarding the port functions can be derived from the results of the WESTNAVFACENGCOM planning study.

Two engineering concepts will be discussed for the projected facility. The first concept is that of a jack-up platform used as a pier island which is connected to shore by a trestle. As presently used in the offshore oil industry, the pier island is a large steel barge with self-elevating legs. The barge hull permits distant yard fabrication and can be towed to site fully equipped. The size of the pier island is selectable, possibly rectangular. On board equipment could include 100 ton cranes, special equipment for unitized and odd size cargo, POL lines, storage for cargo, shops, and shelter for personnel. Since the platform is self-elevating, it can be adjusted to the optimum height for the vessel, and should sea conditions become extreme, can be raised to a height clear of the wave crests. (Design wave height for this location is likely to be high).

The connection to shore, a trestle, could be designed to carry loads up to 100 tons with the provision of multiple point loading. Both the trestle and the pier island could be designed to minimally impede littoral drift. The trestle, fixed in height above the water, would incorporate an acceptable failure mode concept in deck design. Failure would occur in a predetermined manner such that repair/replacement time and costs are minimized. The trestle height and structural design would insure survival for all the normally encountered sea conditions throughout the year (wave heights less than 20 feet 99.8% of the time).

The second engineering concept to be discussed focuses on a completely enclosed harbor thus eliminating the sea state limitation. A protected harbor at an open sea site is a costly venture owing to the large number of lineal feet of breakwater required. The earth and rock filled mole with precast concrete forms for armor (tetrapods, hexapods, tribars, Dolosses, Akmons, and numerous others) is the most economical form of breakwater for this site. This assumes that a rock and fill material source is available on shore.

Tentatively, two configurations for the mole appear feasible. The first is conventional, two roughly circular section arms from shore overlapping at the most seaward point to form an entrance channel leeward of the primary wave direction. The design will be such that the sand from the source side of the littoral transport will be diverted seaward thus preventing fill of the harbor entrance, Figure 11A. Dredging maintenance at this particular site is to be avoided owing to the inconvenience of retaining equipment within the limited harbor area.

The second shape for the mole represents a novel approach, used successfully at Skagen in Denmark. This is the addition of a wing mole on the source side of the littoral transport. The hydrodynamics of the littoral drift around the wing mole is such as to by-pass the material beyond the leeward side of the breakwater and return it to its natural drain (that being the sand spit at the eastern end of San Nicolas Island). Figure 11B. The validity of either of these concepts must be established with models (mathematical and physical movable-bed models).

Generally, there will be more than adequate space inside the mole for conventional pier construction. The minimum mole size will be fixed by the maneuvering room required by the largest ship when bending about the pier head. A maximum size may be derived by estimating the turning basin required for the largest ship to be serviced and the multiple ship berthing requirement.

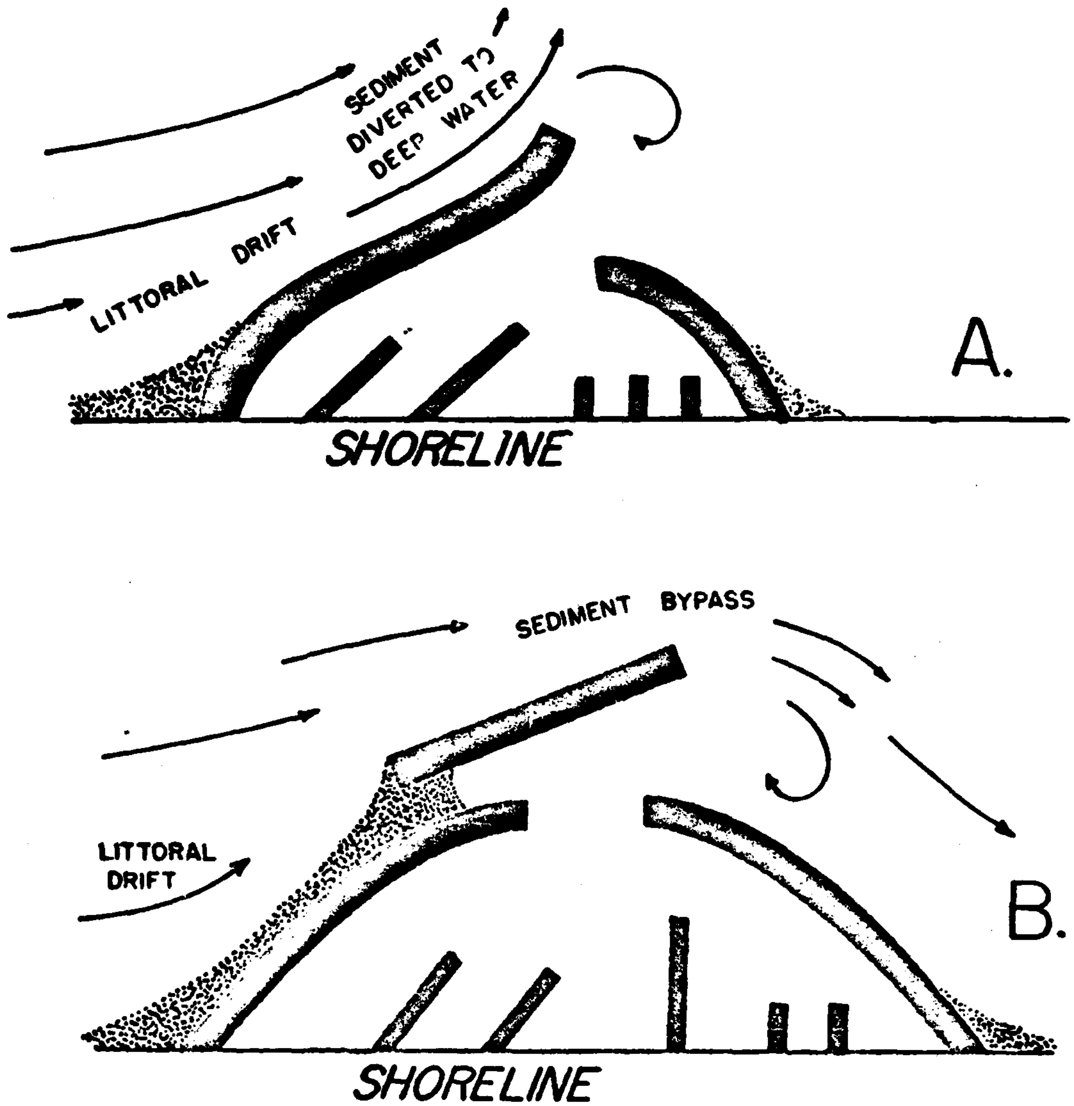

Figure 11 A. Enclosed harbor with littoral drift diverted

B. Enclosed harbor with littoral drift by-pass

The actual benefit and the cost of all these alternatives will be part of the proposed study.

This study will not address design criteria for the shore facilities, for which ample room must be provided. These requirements do not involve ocean engineering and are standard NAVFAC considerations in waterfront planning.

3.0 DELINEATION OF PROPOSED WORK

3.1 Survey at NAVFAC Beach

3.1.1 Scope of Work

Depth sounding runs will be made perpendicular to the known bathymetric contours at very close spacing. The perpendicular tracks will be tied together with additional track lines running parallel to the contours. The results of the depth sounding will be used to quantify bottom slope variation and to identify outcrops of rocks (or coral), ledges or other obstacles which require visual diver inspection.

The position of the vessel performing the depth sounding runs will be determined by a mini-ranger navigation system throughout the operation. A back-up plotting system utilizing theodolites and X-Y plotting procedures will be available to compliment the mini-ranger. Other major equipment for the survey will include: a LARC 5, LARC 15 (provided by UCT-2), underwater cameras, Raytheon DE 719 Fathometer and marker floats. Communication for the operation will use a handie-talkie network.

Prior to the survey the mini-ranger and fathometer will be rigged on board the LARC 15 and operationally tested. On the day of the survey the LARC 15 will begin by placing four BNU-1 marker buoys at the corners of the survey area. The buoys will then be used by the LARC 15 crew as a visual guide. The planned survey pattern will be a grid of 10 yard spacing. This pattern will be followed to within the limits of the navigational capabilities of the survey vessel. The primary navigation unit, the mini-ranger, has an associated point mode output incorporated in the master unit. This unit will be placed on board the survey vessel. A continuous plot will be maintained so that deviations from the planned grid can be quickly identified.

Should the theodolite navigation system be required the following procedures will be followed:

(1) The survey chief on board the survey vessel will call for fixes at 30 second intervals. The number of each fix will be radioed to the transit operators who will record the angle position of the vessel, the fix number, and time.

(2) Concurrent with the radio signal for the fix number, a flag system will also be used. A flag will be hoisted on the vessel where it is visible to the theodolite operators to indicate a request for a fix will be forthcoming (ready sign). The flag will be quickly lowered at the same moment the "mark" is relayed by radio. Different color flags will be used so that positions on grid can be reconstructed in the event of radio failure.

(3) On board the vessel, the fathometer will depress the event marker to identify the position on the chart at each fix signal, and also record the fix number, flag color, and time.

In addition to the bathymetric survey a diver survey of anomalous features (potential vessel hazards) will be undertaken. The divers and equipment for the diver survey will be provided by UCT-2. All diving will be done in accordance with the U.S. Navy Diving Manual. Diving will be under the supervision and direction of the UCT-2 diving officer, with the survey chief providing technical direction. The dive boat will proceed to the various underwater obstruction sites as determined by the plotting plan derived from the depth survey. Each position will be accurately located by using the *mini-ranger*. A BNU-1 marker buoy shall be dropped at an obstacle site for divers convenience. Divers will descend and survey the obstruction or hazard. Divers will observe the features of the obstruction and provide an illustration for further investigation. During the progress of the survey, tide and current will be monitored and logged. All depth recordings will be corrected to reflect mean low water. Underwater photographs of the obstruction/hazard situation shall be taken by the divers.

3.1.2 Materials and equipment for survey

Item	Source
Theodolites and Tripods	UCT-2
Mini-ranger and 3 Transponders	CHESDIV
Batteries (Mini-ranger) (4)	UCT-2
Battery Charger	CHESDIV
Power Leads (battery)	CHESDIV
Measuring Tape (100')	CHESDIV
Raytheon Depth Recorder	CHESDIV
Charts Drafting-Plotting Equipment	CHESDIV
Handie Talkie (4)	CHESDIV
BNU-1 Buoys (6)	CHESDIV
Camera	CHESDIV
LARC 15	UCT-2
LARC 5	UCT-2

3.1.3 Schedule

A tentative schedule has been established in order to assure diver support.

August 13, 1978	CHESDIV personnel depart Washington, DC
August 15, 1978	UCT-2/CHESDIV depart Port Hueneme
August 16-21, 1978	Conduct survey at San Nicolas
August 22, 1978	UCT-2/CHESDIV depart San Nicolas
August 23, 1978	CHESDIV personnel depart Port Hueneme
September 30, 1978	Complete Survey Report

3.1.4 Cost Estimate

Labor	
Planning (6 man days)	$ 960.00
Operations (25 man days)	4,000.00
Data Reduction & Reporting (17 man days)	2,880.00
Management & Oversight (6 man days)	960.00
UCT-2 Diving	NC
Direct Charges	
Travel (3 trips D.C. to CA & return)	$ 2,800.00
UCT-2 deployment	1,400.00
Refurbishment of equipment	1,700.00
Report figures, duplication & prep.	500.00
TOTAL =	$15,200.00

3.2 Fixes and/or modifications to present access route

3.2.1 Scope of Work

A review of the presently utilized YFU landing and beach access technique is proposed. This will involve on-site observation and documentation of operations. Hardware that is employed in the landings will be surveyed and assessed as to its condition and appropriateness. All data will be analyzed and a determination will be made regarding the possible engineering improvements that can be made to enhance the present access scheme. One improvement will be the ramp designated by PW/PMTC (which is partially fabricated). Other minor additions to facilitate use of the ramp may be required and will undoubtedly result from the engineering problem analysis.

When improvements are recommended a design concept will be developed to the extent necessary to generate a cost estimate and implementation schedule. Priority will be given to utilization of existing equipment and facilities. This is particularly important because of the recent expenditure to remove and repair the engines of the YFU presently being used. It is possible that a larger vessel could be considered, but this will depend on, and must reflect, upcoming requirements.

The survey of NAVFAC Beach is a prerequisite to this work.

3.2.2 Schedule

It is estimated that work proposed in this area will take three (3) calendar months to complete.

3.2.3 Cost Estimate

Labor	
Planning (5 man days)	$ 800.00
Review SNI facilities & observe YFU techniques (10 man days)	1,600.00
Analysis (20 man days)	3,200.00
Concept development (20 man days)	3,200.00
Reporting (15 man days)	2,400.00
Management & Oversite (10 man days)	1,600.00
Direct Charges	
Travel (1 trip D.C. to CA & return)	900.00
Report, figures, duplication, etc.	500.00
TOTAL =	$14,200.00

3.3 Advanced development of the marine access route to SNI

Execution of the proposed scope of work will involve the assignment of selected specialists in the areas of site selection, oceanography, foundation engineering, marine soils engineering, structural design, etc. as needed, to the individual tasks that comprise the study. The individual tasks will be initiated after specialists acquire thorough understanding of the PMTC requirements. Execution of the scope of work will also require that the Ocean Engineering and Construction Project Office maintain close coordination and liaison with WESTNAVFACENGCOM and appropriate groups at NAVFACENGCOM.

The proposed work will utilize results from previous studies, surveys and programs. Sources such as the Project Meteor environmental survey and engineering study, the NAVFAC Beach survey and subsequent report, previous Corps of Engineers reports and other available sources will be considered for study input. The facility functional requirements, cost range and schedule constraints will be provided by PMTC or others as study inputs. The study itself will identify ocean facility structural concepts which are viable for meeting functional requirements and environmental design criteria using feasible ocean construction methods and equipment. Great emphasis will be placed on limiting concept development to cost and schedule constraints.

3.3.1 Scope of Work (Figure 12)

Task 1 - Integrate and assess requirements

Input regarding SNI future marine access requirements will be organized and assessed in order to size the needed ocean facilities. During this task interaction with WESTNAVFACENGCOM, PMTC, NAVFACENGCOM and CHESNAV-FACENGCOM (FPO-1) will be necessary.

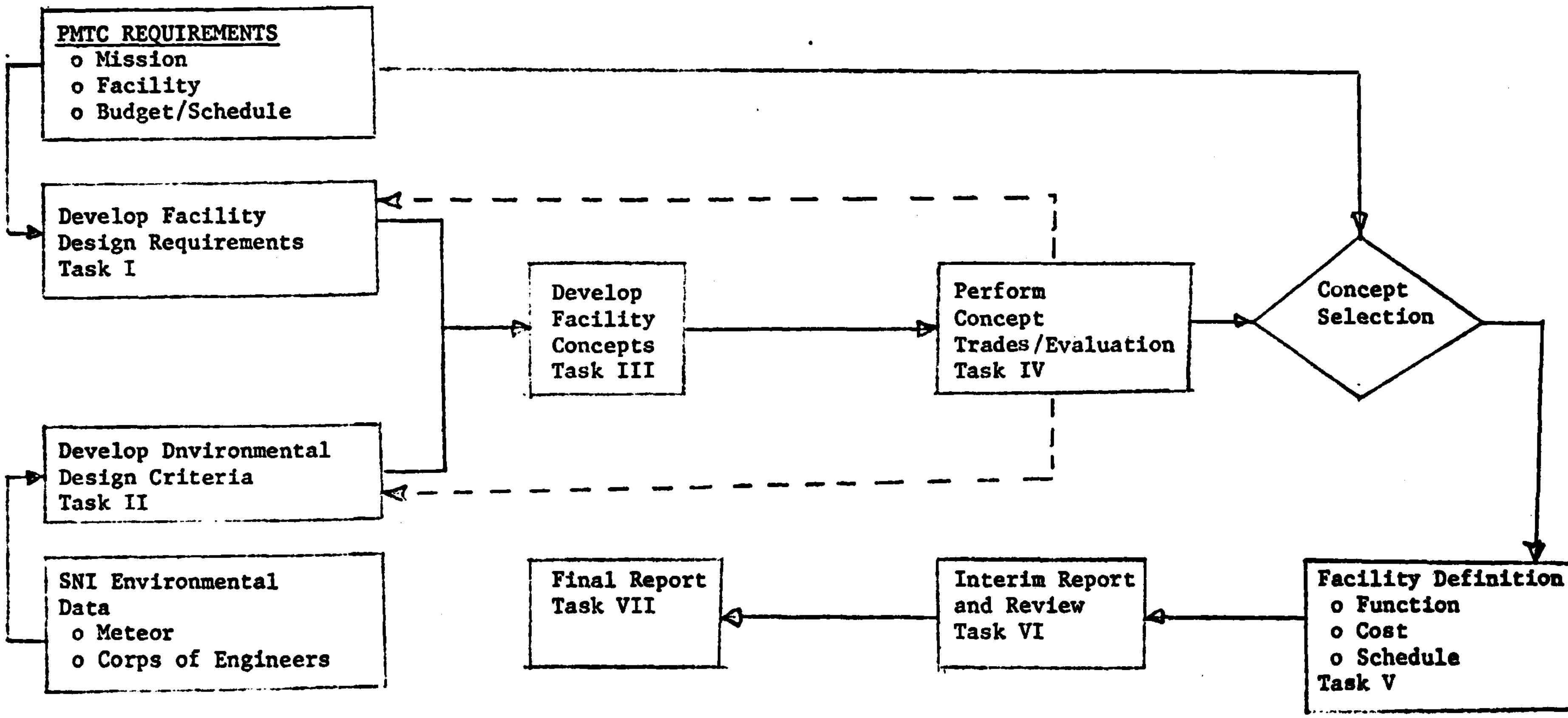

Figure 12 ADVANCED DEVELOPMENT, OCEAN ENGINEERING STUDY (FLOW CHART)

Task II - Establish design criteria

Environmental data inputs from a variety of sources will be organized and abstracted into design criteria. In addition, data voids and deficiencies will be identified so that they may be considered in cost and schedule estimating.

Task III - Ocean facility design concept development

Using task I and II inputs viable ocean facility concepts will be identified and defined. Primary emphasis will be placed on design criteria, available technology and construction contstraints.

Task IV - Concept confirmation

The viable facility concepts will be examined and the best candidate (or candidates) will be identified. During this task numerous inputs and interfaces will be considered. Things such as mission requirements, justifiable cost and schedule requirements will be considered in determining the best concept.

Task V - Cost and schedule development

For the selected concept a cost estimate will be developed and a schedule for implementation will be determined.

Task VI - Interim report

An interim report will be prepared which addresses:

- ocean facility description
- operational environmental constraints
- cost estimate
- schedule
- delineation of design criteria

Task VII - Final report

A final report will be prepared after presentation of the interim report to PMTC and others. Feedback from sponsor will be included or addressed as necessary.

3.3.2 Schedule

It is estimated that work proposed in this area will take 12 calendar months to complete.

3.3.3 Cost estimate

<u>Labor</u>

Task I -	Integrate and assess requirements 25 man days	$ 4,000.00
Task II -	Establish design criteria 75 man days	12,000.00
Task III -	Ocean facility design concept 50 man days	8,000.00
Task IV -	Concept confirmation 15 man days	2,400.00
Task V -	Cost and schedule development 50 man days	8,000.00
Task VI -	Interim report 50 man days	8,000.00
Task VII -	Final report	4,800.00
	TOTAL LABOR	$47,200.00

Direct Charges

Travel

Task I 2 trips D.C. to CA and return	$ 1,600.00
Task II 1 trip D.C. to CA and return	800.00
Task IV 1 trip D.C. to CA & return	800.00
Task VI 2 trips D.C. to CA & return	1,600.00
Task V 2 trips D.C. to CA & return	1,600.00
Computer	1,000.00
Report preparation, drawings, figures, etc.	5,000.00
TOTAL DIRECT	$12,400.00

SUMMARY

Labor	$47,200.00
Direct	$12,400.00
	$59,600.00
10% Contingency	6,000.00
GRAND TOTAL	$65,600.00

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