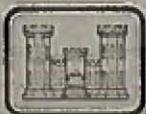


GUAM COMPREHENSIVE STUDY SHORELINE INVENTORY



**United States Army
Corps of Engineers**

*... Serving the Army
... Serving the Nation*

Honolulu District

SEPTEMBER 1980

GUAM SHORELINE INVENTORY

PREPARED FOR:

U. S. Army Engineer District, Honolulu
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Fort Shafter, Hawaii 96858
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TABLE OF CONTENTS

	<u>Page</u>
SECTION 1 - <u>INTRODUCTION</u>	1-1
1.1 Objectives	1-1
1.2 Study Area	1-1
1.3 Methodology	1-2
1.4 Report Format	1-3
SECTION 2 - <u>SHORELINE AND OCEANOGRAPHIC CHARACTERISTICS</u>	2-1
2.1 Reefs	2-2
2.2 Beach Materials	2-2
2.3 Climate	2-2
2.4 Winds	2-2
2.5 Typhoons	2-5
2.6 Tides	2-3
2.7 Waves	2-3
2.8 Currents	2-3
SECTION 3 - <u>TUMON BAY</u>	3-1
SECTION 4 - <u>OCA POINT TO CABRAS ISLAND</u>	4-1
4.1 Agana Bay	4-2
4.2 Asan Bay	4-10
4.3 Piti Bay	4-12
SECTION 5 - <u>APACA POINT TO TAEAYAG BEACH</u>	5-1
5.1 Agat Bay - Apaca Point to Bangi Island	5-1
5.2 Nimitz Beach Area	5-5
SECTION 6 - <u>UMATAC BAY</u>	6-1
SECTION 7 - <u>MERIZO</u>	7-1
SECTION 8 - <u>MANELL CHANNEL TO INARAJAN</u>	8-1
SECTION 9 - <u>TALOFOFO BAY TO YLIG BAY</u>	9-1
SECTION 10 - <u>SUMMARY OF SHORELINE PROBLEM AREAS</u>	10-1
REFERENCES	

LIST OF TABLES

		<u>Page</u>
TABLE 2-1	Annual Percent Frequency of Deep Water Wave Height by Direction	2-4
TABLE 2-2	Annual Percent Frequency of Deep Water Wave Height Versus Wave Period	2-5
TABEL 2-3	Guam, Mariana Islands Deep Water Significant Wave Height Statistics Due to Western North Pacific Tropical Cyclones	2-6
TABLE 10-1	Summary of Shoreline Problem Areas, Guam	10-3

LIST OF FIGURES

<u>Figure No.</u>	<u>Description</u>
1-1	Location of Guam
1-2	Shoreline Inventory Areas
1-3	Legend for Maps of Reaches
3-1	Tumon Bay
3-2	Fafai Beach and North End of Tumon Bay
3-3	North and Middle Tumon Bay
3-4	South Tumon Bay
4-1	Agana Bay
4-2	Asan Bay and Piti Bay
4-3	Oca Point to Duncas Beach, Agana Bay
4-4	Duncas Beach and Trinchera Beach, Agana Bay
4-5	Middle Agana Bay, Paseo de Susana Park, Agana Boat Basin
4-6	Agana Bay West of Paseo de Susana Park
4-7	Adelup Point and Asan Bay
4-8	Asan Bay and Asan Point
4-9	Piti Bay
4-10	Piti Bay to Cabras Island
5-1	Apaca Point to Taelayag Beach
5-2	Apaca Point, Togcha Beach and Salinas Beach
5-3	Salinas Beach to Bangi Island
5-4	Nimitz Beach Park Area
5-5	Anae Island
6-1	Umatac Bay
6-2	Umatac Bay
7-1	Merizo
7-2	Merizo, North End
7-3	Merizo and Piga Beach
7-4	Aba Beach, Jaotan Point and Aang Beach
7-5	Manell Channel
8-1	Manell Channel to Inarajan Bay
8-2	Suyafe River to Asagadao Bay
8-3	Ajayan Bay
8-4	Aga Bay to Dongua Point
8-5	Atao Beach to Agfayan Point
8-6	Agfayan Bay and Inarajan Pools
8-7	Inarajan Bay
9-1	Talofofo Bay to Ulig Bay
9-2	Pago Bay
9-3	Talofofo Bay
9-4	Ypan Point to Mana Bay
9-5	Ypan Beach Park to Togcha Bay
9-6	Togcha Point to Ylig Point
9-7	Ylig Bay
9-8	Tagachan Point to Pago Point
9-9	Pago Bay
9-10	Pago Bay to Iates Point

SECTION 1

INTRODUCTION

1.1 OBJECTIVES

The objective of the Guam Shoreline Inventory is to describe the physical characteristics of the Guam shoreline, with an emphasis on shoreline erosion problems and shore protection needs. The intent of this study is to provide governmental agencies or departments involved in the decision making process with adequate, current information on coastal erosion on Guam, particularly the extent of the erosion and identification of specific areas in need of shore protection.

The scope of work for this shoreline inventory includes:

1. A description of the physical characteristics of the shoreline and immediate backshore area.
2. A qualitative analysis of coastal processes, particularly in eroded areas.
3. A description of the fringing reef characteristics pertinent to shoreline processes.
4. An evaluation of the shoreline condition, including the extent of erosion, if any, and existing or potential problems.

1.2 STUDY AREA

Guam is the largest and southernmost of the Mariana Islands. The Mariana Islands chain, composed of 15 islands, forms a 500-mile long arc in the western Pacific and is part of the imaginary boundary between the Pacific Ocean and the Philippine Sea. There are four major islands in the chain; Saipan, Tinian, Rota and Guam. The location of Guam is shown in Figure 1-1. Guam is approximately 30 miles long, 4 to 8-1/2 miles wide and has an area of 209 square miles.

The islands of Marianas chain are the high points of submarine ridges of volcanic origin. Guam is composed of volcanic material partly covered by coralline limestone. The geologic and topographic features of Guam divide the island into a northern and southern section.

The northern half of Guam is a broad, gently undulating limestone plateau with an elevation of 100 to 600 feet. Three prominent peaks, two of which are volcanic, protrude above the limestone plateau, with a maximum elevation of 860 feet. The plateau is fringed by steep coastal cliffs, with intermittent patches of beach and irregular, narrow coastal plains. The northern limestone plateau is permeable and no permanent streams exist on the plateau.

The southern half of Guam is mountainous with broad, relatively impervious areas of volcanic rock. Several mountain peaks exceed 1,000 feet in height. The volcanic rock of the southern sector has been weathered and eroded by surface water runoff, with numerous deeply incised valleys and streams. Drainage in the area is through rivers and tributaries. There are more than 40 streams in the southern half of Guam. The largest is the Talofofo River and its tributaries which drain a 28-square mile area. There are two prominent limestone masses along the southern coastline, Cabras Island and Orote Peninsula.

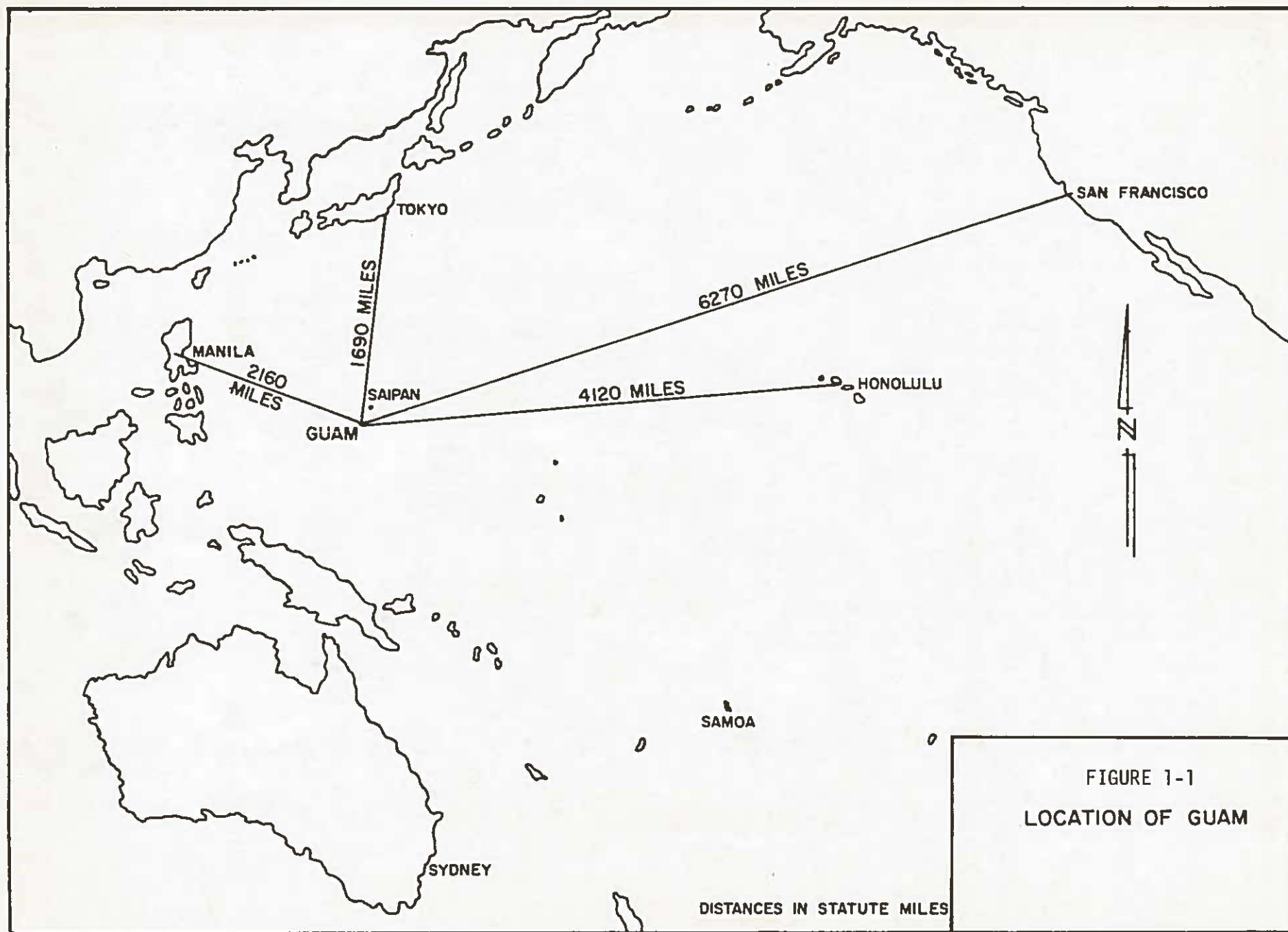


FIGURE 1-1
LOCATION OF GUAM

This shoreline inventory was concerned primarily with the southern half of Guam, where most of the coastal development has occurred. Much of the northern coastline is rimmed by steep limestone cliffs and little or no development has taken place along the generally inaccessible coast. The areas covered during this inventory are shown on Figure 1-2.

1.3 METHODOLOGY

This shoreline inventory included a detailed literature review of available pertinent information and a field investigation to verify and supplement the available information.

A detailed coastal survey was conducted by Randall and Holloman (1974), contracted by the U. S. Army Corps of Engineers and conducted under the auspices of the University of Guam, Marine Laboratory. The study was intended for use as a planning document. The report included an extensive literature review of all previously published information and also included an extensive discussion of the geology and hydrology of Guam.

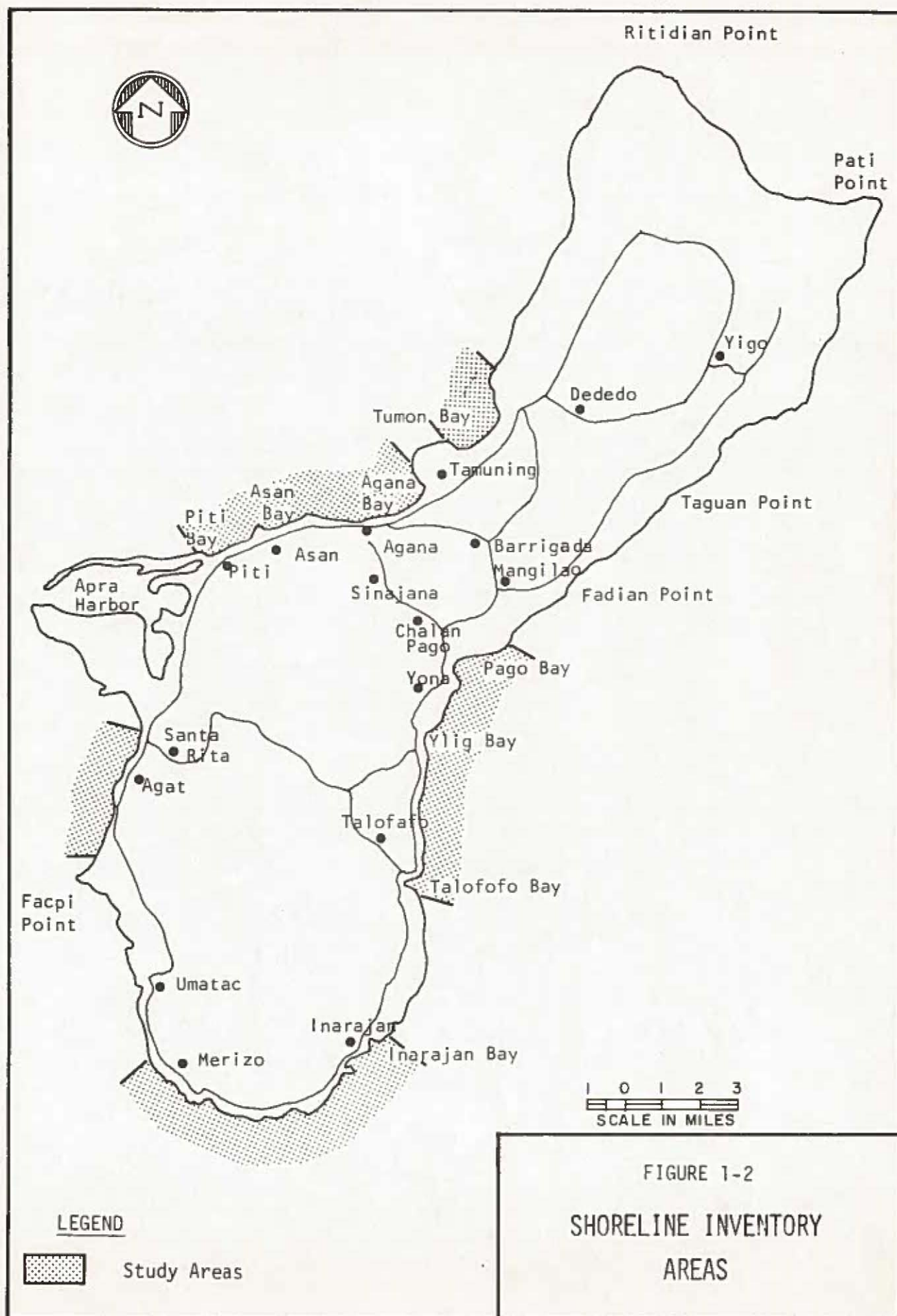
The survey included the entire coastline of Guam, which was divided by the author into twelve sectors, based upon the type and degree of reef development and coastal physiography. For each sector, the authors described the physiography, geology, soils, engineering geology, vegetation zones, hydrology, shoreline and reefs. The emphasis was upon the geological and biological aspects of each sector. There was little discussion of shoreline erosion, specific sites subject to erosion, or nearshore processes affecting the shoreline. The report, however, provided extensive background information and the pertinent material was summarized for inclusion in this report. The material taken from Randall and Holloman (1974) is included in the general introduction to each of the coastal sectors discussed in this report.

A second useful report was the "Atlas of the Reefs and Beaches of Guam" by Randall and Eldredge (1976). This study was strictly a physical inventory of the shoreline and fringing reef flats of Guam. No mention was made of backshore development, coastal erosion or nearshore processes. The information was presented on a series of 95 large scale maps (1" = 400'). The pertinent maps were reduced to fit the 8-1/2" x 11" format of this report, and used for presentation of data obtained during the literature search and field investigations.

The field work for this study was conducted by two engineers in June 1980. A set of orthophotographs (scale 1" = 400') prepared in 1975 and the maps from the above atlas were used for positioning and recording of field observations.

Photographs of the shoreline were taken in each reach, and those representative of the varying shoreline types are included in this report. Fifty-one shoreline profiles were measured, using a hand level and stadia rod. The water level on the reef flat was used as a temporary reference elevation, and then later corrected to mean lower low water datum. Estimated accuracy of the elevations is ± 0.5 feet.

The determination of the chemical composition and size range of the beach sand was by observation. Where possible, the estimates were checked against existing data. The material often varied noticeably even within a given reach, so the observation of the representative characteristics is sufficient for the purposes of this report.



Shoreline erosion was evaluated from observation of the physical condition of the shoreline. The wave climate was mild during the field observations, and in most instances the effects of erosion could be seen, but the erosion was not ongoing due to the small waves. The causative factors were therefore sometimes difficult to determine.

An extensive length of the Guam shoreline was covered in a relatively brief time. As a result, analyses of the coastal processes (sand transport, rip currents, wave exposure, etc.) were based upon very limited observations, during only one wave and tide condition. During a different season or wave condition, the coastal processes might be significantly different than those noted in this report.

In this report, erosion is classified as non-critical, intermediate, or critical. Non-critical erosion is that which, by nature of either the location or extent of the erosion, does not justify protective measures. Critical erosion is defined as severe erosion presenting a threat to existing structure, public facilities, or valuable land area, thereby justifying protective action. Erosion is classified as intermediate if it does not clearly fall within the previous categories. Erosion areas are classified in accordance with their condition as of June 1980. Non-critical areas may well become critical after several years of erosion, or the occurrence of one or two typhoons.

1.4 REPORT FORMAT

A description of the general shoreline and reef characteristics of Guam is included in Section 2, as well as a summary of oceanographic and climatic conditions. This information was obtained from existing data.

The shoreline descriptions are contained in Sections 3 through 9. The general characteristics of each coastal sector are described, followed by a detailed description of each reach. Representative photographs are included with the reach descriptions. The locations of the reaches and the shoreline characteristics are shown on the figures taken from Randall and Eldredge (1976). The legend used for all the figures is shown in Figure 1-3. The location of the cross-section profiles and eroded areas is also shown on the figures. The profile elevations are plotted in Appendix A.

Chapter 10 is a summary of the eroded areas and potential problem areas.

SHORELINE FEATURES

	ROCKY SHORELINE, LIMESTONE
	ROCKY SHORELINE, VOLCANIC
	BEACH DEPOSITS
	INTERMITTENT BEACH DEPOSITS AND ROCKY SHORELINE
	SEA-LEVEL BENCH CUT IN LIMESTONE
	SEA-LEVEL BENCH CUT IN VOLCANIC MATERIAL
	MANGROVE SHORELINE
	MAN-MADE SHORE PROTECTION
	DRAINAGE CULVERT
	BOUNDARIES OF REACHES
	PROFILE LOCATIONS
	SHORELINE EROSION

REEF FLAT FEATURES

	REEF MARGIN
	ALLUVIAL DELTA OFF RIVER MOUTH
	DEPRESSED AREAS OF REEF FLAT
	INNER REEF FLAT
	BOUNDARY OF INNER REEF FLAT MOAT SYSTEM
	OUTER REEF FLAT

FIGURE 1-3
LEGEND FOR MAPS
OF REACHES

SECTION 2

SHORELINE AND OCEANOGRAPHIC CHARACTERISTICS

2.1 REEFS

Guam is completely encircled by fringing reefs except along parts of the limestone cliffs in the northern sector. The fringing reefs vary from narrow cut benches around limestone headlands, thinly veneered by encrusting algae below sea level, to reef flats more than 3,000 feet wide containing a variety of corals and algae. Small bays are common in the southern half of Guam where fresh water outflow from river mouths has prevented or retarded reef development. In two places barrier reefs have developed which fully or partially enclose small lagoons: at Apra Harbor on the west coast and at Cocos Island to the southwest.

For the purposes of coastal description and classification, the reef platform may be divided into several zones suggested by Tracey, et al. (1964). All fringing reefs of Guam do not necessarily have all the zones listed below. This study is concerned only with the reef area between shoreline and the start of the reef margin, so zones seaward of the reef flat are not discussed.

Supratidal Bench Zone

This zone consists of narrow platforms cut into elevated rocky shorelines. The average elevation is slightly higher than mean high tide level. The benches on Guam are generally restricted to coastal regions without a fringing reef platform.

Intertidal Shoreline Zone

This zone is that portion of the shore covered at high tide and exposed at low tide. In exposed areas, where the intertidal zone consists of limestone, wave-cut indentations called "nips" usually develop.

Reef Flat Zones

Limestone reef flats are the most common type and consist of a flat limestone platform which extends from the intertidal shoreline to the wave-washed reef margin. Generally, the outer seaward part of the platform is slightly elevated with respect to the inner shoreward section, and is often exposed at low tide. Because of this, the reef flat can be divided into two subzones--an outer reef flat which is exposed at low tide, and an inner reef flat, covered at low tide. The inner reef flat which retains water at low tide is referred to as the "moat." Unconsolidated sediments veneer the platforms at some locations. These sediments range from a few inches to a foot or more in thickness. The outer reef flats are generally devoid of sediments because wave and surf action tend to keep unconsolidated material swept away. Boulder tracts are a common feature where the outer reef flat grades into the inner reef flat.

A second type of reef flat is the fringing coastal platform composed of volcanic rocks which have been cut down to sea level by marine erosion. In some instances, the inner part of a platform may consist of truncated volcanic rock, while the outer part consists of reef limestone accretion. This type of platform occurs in small isolated stretches along the southwest coast of Guam. The surfaces of these volcanic platforms, like those of limestone platforms, may contain thin patches of unconsolidated sediments.

2.2 BEACH MATERIALS

The following general description of the material forming the beaches of Guam is summarized from a study made by Emery (1962). The beach sands of Guam are of two main types. White or buff sands which consist of calcareous organic remains comprise more than 75 percent of the beaches. Other sands are light brown to black because of the presence of detrital volcanic minerals. Virtually all the beach sands on the northern half of the island are of calcareous origin, due to the lack of stream development on the northern limestone plateau.

A more complex situation exists in the southern half of Guam where surface rocks are of volcanic origin. A network of streams drains this area and transports alluvial and volcanic sediments to the heads of coastal embayments, so the sands contain large percentages of alluvial or volcanic grains. The regions between these embayments have beaches composed of calcareous sands. Apparently, little of the calcareous sand enters the embayments. Likewise, the volcanic sands carried by the streams are contained in the general region of the embayment, with little transport of stream-carried sands to the adjacent beaches.

A third and intermediate type of beach environment exists on the west coast between Umatac and Agat, where volcanic rocks at the coast are subject to wave erosion. In this area, the beach is supplied with sediments from both land and the reef flat, resulting in a mixture of calcareous and volcanic sediments.

2.3 CLIMATE

The Guam climate is typically tropical, with warm and humid conditions throughout the year. The surrounding ocean has a year round temperature of 81 degrees and is largely responsible for the island's tropical climate. There are two distinct seasons, defined by variations in wind and rainfall. A dry season extends from January through May, and a wet season from July through November. December and June are transitional months. Easterly trade winds occur throughout the year, but are dominant during the dry season. From July to October the winds become variable and the occurrence of typhoons increases.

The mean annual rainfall on Guam varies from less than 90 inches on the coastal plains to over 110 inches on the higher mountain areas. The mean annual temperature is 81 degrees. Relative humidity ranges from 65 to 75 percent during the day to 85 to 90 percent at night.

2.4 WINDS

The dominant winds on Guam are the trade winds which approach from the northeast through east-southeast sector. They occur 72 percent of the time throughout the year, but are particularly pronounced during the dry season, January through May, when they occur more than 90 percent of the time. Typical trade wind speeds fall in the 7 to 16 knot range. Wind speeds exceed 17 knots only 3.6 percent of the time.

Wind directions are variable with frequent calms during the main typhoon season from July to December. Trade winds, although they occur less frequently than during the dry season, are still the most common winds during this period.

2.5 TYPHOONS

Typhoons are tropical storms with winds of 65 knots or greater, with associated intense rainfall. Between 1900 and 1946 the frequency of typhoons affecting Guam was approximately 1 per year. Between 1946 and 1976 the frequency decreased to one every two years. From 1946 to 1976 Guam was affected by 14 typhoons. The closest points of approach of the typhoons ranged from 0 to 230 nautical miles. Maximum sustained wind speeds within the typhoons ranged from 70 to 175 knots, while the corresponding winds on Guam ranged from 37 to 150 knots. The most devastating typhoon to hit Guam was typhoon "Pamela" which occurred in May 1976 with sustained winds of 120 knots.

Although severe typhoons occur in the western Pacific throughout the year the period from July to December is the primary typhoon season.

2.6 TIDES

Tides at Guam are semi-diurnal with a mean range of 1.6 feet and a diurnal range of 2.3 feet. Datum for the island (and used as datum for elevations in this report) is mean lower low water (MLLW).

Tidal data for the 19-year period between 1949 and 1967 were taken at Apra Harbor by the National Oceanic and Atmospheric Administration, National Ocean Survey, and are summarized below:

	<u>Feet</u>
Highest Tide (observed)	3.31
Mean Higher High Water, MHHW	2.40
Mean Sea Level, MSL	1.41
Mean Lower Low Water, MLLW	0.00
Lowest Tide (observed)	-1.89

Extreme annual predicted tide range at Guam is 3.5 feet (from 2.6 to -0.9 feet) and occurs during June and December.

2.7 WAVES

Deep water wave data (sea and swell) for the Guam area are available in "Summary of Synoptic Meteorological Observations" (SSMO) prepared by the U. S. Naval Weather Service Command. The data are summarized by height and direction in Table 2-1 and by height versus period in Table 2-2.

The Guam wave climate is dominated by short period wind waves from the sector northeast through southeast, generated by the trade winds. The wind waves are 7 feet or less 84 percent of the time.

Longer period waves influencing the Guam wave climate are generated by storm centers (tropical storms and typhoons) as distant as 1,000 miles. The most severe waves are associated with the typhoons which either strike or closely approach Guam. Hindcasts performed for tropical storms and typhoons in the Western Pacific (1975-1979) indicate that large, long period waves may approach from the west through north sector more frequently than indicated by the SSMO data. Wave heights of greater than 8 feet can be expected to approach from this sector 11 percent of the time in an average year. The hindcast results are summarized in Table 2-3.

TABLE 2-1

ANNUAL PERCENT FREQUENCY OF DEEP WATER
WAVE HEIGHT BY DIRECTION

HEIGHT (ft)	N	NE	E	SE	S	SW	W	NW	TOTAL PCT
< 1	0.6	0.9	2.3	0.5	0.4	0.7	0.5	0.4	6.3
1-2	2.3	4.6	11.3	3.1	1.6	1.1	1.4	0.8	26.2
3-4	2.1	7.4	15.5	2.4	1.5	2.1	0.9	0.5	32.4
5-6	1.5	4.4	10.4	0.7	0.8	0.8	0.5	0.3	19.4
7	0.6	2.6	4.1	0.7	0.6	0.7	0.4	0.1	9.8
8-9	0.3	2.1	1.0	0.1	0.1	0.2	0.1	0	3.9
10-11	0.1	0.5	0.7	0.1	0.1	0.1	0.1	0	1.5
12	0.1	0.2	0.1	0	0	0	0.1	0	0.4
13-16	0.1	0.1	0.2	0	0.1	0.1	0.1	0	0.5
17-19	0	0	0	0	0	0	0	0	0.0
20-22	0	0	0	0	0	0	0	0	0.0
23-25	0	0	0	0	0	0	0	0	0.0
26-32	0	0	0	0	0	0	0	0	0.0
33-40	0	0	0	0	0	0	0	0	0.0
41-48	0	0	0	0	0	0	0	0	0.0
49-60	0	0	0	0	0	0	0	0	0.0
61-70	0	0	0	0	0	0	0	0	0.0
71-86	0	0	0	0	0	0	0	0	0.0
87+	0	0	0	0	0	0	0	0	0.0
TOTAL PCT	7.6	22.8	45.6	7.6	5.1	5.8	3.9	2.1	100.4
TOTAL OBSERVATIONS 2,529									

TABLE 2-2

ANNUAL PERCENT FREQUENCY OF DEEP WATER
WAVE HEIGHT VERSUS WAVE PERIOD

HEIGHT (ft)	Period (seconds)							TOTAL PCT
	<6	6-7	8-9	10-11	12-13	>13	INDET	
<1	1.6	0.1	0	0	0	0	2.4	4.1
1-2	12.0	1.8	0.5	0.1	*	0	0.4	14.9
3-4	17.2	9.6	2.0	0.5	0.1	0	0.6	30.0
5-6	7.0	11.1	4.5	1.1	0.4	0.4	0.4	24.9
7	2.4	5.7	4.9	0.9	0.2	0.1	0.2	14.4
8-9	1.1	2.1	1.7	1.3	0.4	0.1	0.1	6.8
10-11	0.5	0.8	0.9	0.5	0.2	*	0.1	3.1
12	0.2	0.3	0.3	0.3	0.1	0.1	*	1.4
13-16	0.1	0.3	0.2	0.2	0.3	0.1	0.1	1.2
17-19	0	0	0	*	*	0	0	0.1
20-22	0	*	0	0.1	0	0.5	0	0.7
23-25	0	0	0	0	0	*	0	0.1
26-32	0	0	0	0	0	0	0	0.0
33-40	0	0	0	0	0	0	0	0.0
41-48	0	0	0	0	0	0	0	0.0
49-60	0	0	0	0	0	0	0	0.0
61-70	0	0	0	0	0	0	0	0.0
71-86	0	0	0	0	0	0	0	0.0
87+	0	0	0	0	0	0	0	0.0
TOTAL PCT	42.1	31.9	15.0	5.1	1.7	1.4	4.4	101.5
TOTAL OBSERVATIONS 4,589								

TABLE 2-3

GUAM, MARIANA ISLANDS DEEP WATER SIGNIFICANT WAVE HEIGHT
STATISTICS DUE TO WESTERN NORTH PACIFIC TROPICAL CYCLONES

AVERAGE YEARLY CONDITIONS FOR THE PERIOD 1975-1979

Percent of Time Occurrence of Wave Height Versus Wave Direction

WAVE HEIGHT (ft) ($\leq H <$)	Wave Direction Class (From Which Waves Approach)								TOTAL
	N	NE	E	SE	S	SW	W	NW	
0-2	2.7	1.9	.4	.8	.1	.3	6.5	9.4	22.1
2-4	1.5	1.4	.1	.2	.0	.0	3.1	4.1	10.4
4-6	2.1	1.0	.1	.1	0.0	0.0	2.2	3.3	8.8
6-8	1.1	.4	.1	.1	.0	0.0	1.8	2.3	5.8
8-10	.8	0.0	.1	.1	0.0	0.0	1.5	1.7	4.2
10-12	.4	0.0	.1	.1	0.0	0.0	1.8	1.7	4.1
12-14	.5	0.0	.1	.0	.0	0.0	.4	.7	1.8
14-16	0.0	0.0	.1	.1	0.0	0.0	.9	.0	1.1
= >16	0.0	0.0	1.2	1.1	.5	0.0	.3	.3	3.3
TOTAL	9.0	4.7	2.3	2.6	.7	.3	18.4	23.6	

GUAM, MARIANA ISLANDS DEEP WATER SIGNIFICANT WAVE PERIOD
STATISTICS DUE TO WESTERN NORTH PACIFIC TROPICAL CYCLONES

AVERAGE YEARLY CONDITIONS FOR THE PERIOD 1975-1979

Percent of Time Occurrence of Wave Period Versus Wave Direction

WAVE PERIOD (sec) ($\leq T <$)	Wave Direction Class (From Which Waves Approach)								TOTAL
	N	NE	E	SE	S	SW	W	NW	
0-6	6.9	4.8	0.0	.4	0.0	.3	11.4	18.0	41.7
6-8	1.6	.9	.1	.1	0.0	.0	3.1	4.5	10.3
8-10	2.1	.7	.0	.0	0.0	.0	1.8	4.0	8.8
10-12	2.1	1.6	.0	.1	0.0	.0	2.4	3.8	10.1
12-14	1.8	.7	0.0	.1	0.0	.0	4.0	5.2	11.7
14-16	1.4	.6	0.0	.2	0.0	.0	2.4	2.9	7.4
16-18	.8	.2	.8	.0	0.0	0.0	1.1	1.8	4.8
= >18	.8	0.0	.2	.3	0.0	.2	2.4	2.3	6.2
TOTAL	17.6	9.5	1.1	1.3	0.0	.5	28.6	42.4	

2.8 CURRENTS

Inshore current patterns around Guam are poorly known, except at specific locations where project-related studies have been conducted.

The North Equatorial Current caused by the northeast trades generally sets in a westerly direction near Guam, with a speed of 1/2 to 1 knot. According to Emery (1962) the North Equatorial Current diverges off Pati Point on the northeast side of the island. The two separate components then move down the northwest and southeast coasts of Guam, converging in the vicinity of Orote Point.

Current studies by Jones and Randall (1971) at the Agana Outfall and Tanguisson Point indicate a reversing current paralleling the shore driven by the semi-diurnal tide and modified by winds, waves and submarine topography. Little is known of the current structure on the windward, eastern and southern coasts.

Current patterns on the reef flats are dependent on the reef flat topography and the wave-induced mass transport of water over the shallow outer reef flat. Where well developed inner reef flat moats exist, longshore currents are generated which then exit through depressed outer reef flat areas, which in effect act as rip channels. This current pattern is generally the same during both flood and ebb tide, however, velocities may increase during an ebbing tide.

SECTION 3

TUMON BAY

The two-mile long coastline between Ypao Point and Fafai Beach forms a broad concave embayment known as Tumon Bay (Figure 3-1). The bay is bordered at both ends by limestone cliffs. Ypao Point, the south boundary, is a prominent headland more than 200 feet high.

Beaches extend along most of the Tumon Bay shoreline, the principal ones being Fafai, Gogna, Naton and Ypao Beaches. They are among the most heavily used recreational beaches on Guam.

The shoreline is bounded by a wide fringing reef flat, averaging 1,500 feet in width, narrowing to less than 300 feet at the headlands. The outer reef flat consists of reef rock pavement with scattered boulders and is slightly elevated with respect to the inner portion. At low tide, water is retained in the moat while the outer reef flat is exposed. The moat width averages 1,200 feet and extends the length of Tumon Bay. The inner part of the moat has a sand bottom grading into sand, gravel and coral rubble along the outer part. The outer reef flat is uniform except for a small channel through the reef margin off the north end of Naton Beach.

The backshore area is a 1,000- to 2,000-foot wide terrace, which gives way to steeper limestone slopes. There are no streams discharging into the Tumon Bay area, but several storm drain culverts discharge across the shoreline.

Much of Guam's hotel development is concentrated along the Tumon Bay shoreline and backshore terrace, with associated residential and commercial development. The reef flat is a popular region for net fishing, spear fishing, snorkeling, shelling and reef walking. The deeper waters seaward of the reef margin are popular for diving and spear fishing.

The shoreline of Tumon Bay is described in more detail below.

Reach A: Fafai Beach (Figure 3-2)

- A popular recreational beach at the north end of Tumon Bay is also known as "Gun Beach."
- The beach is bounded by two prominent limestone bluffs, at the north and south ends.
- Beach length is approximately 1,150 feet, with an average width of 45 feet from the vegetation line to MSL. Fore-shore slope is 1 on 5. (Profile 1)
- Beach material is well sorted, medium to coarse calcareous sand with scattered coral gravel and rubble.
- Fringing reef flat averages 350 feet in width, narrower than along the main part of Tumon Bay. Reef rock pavement extends to shoreline, with small patches of scattered sand on the reef flat. A



Fafai Beach



FIGURE 3-1

TUMON BAY

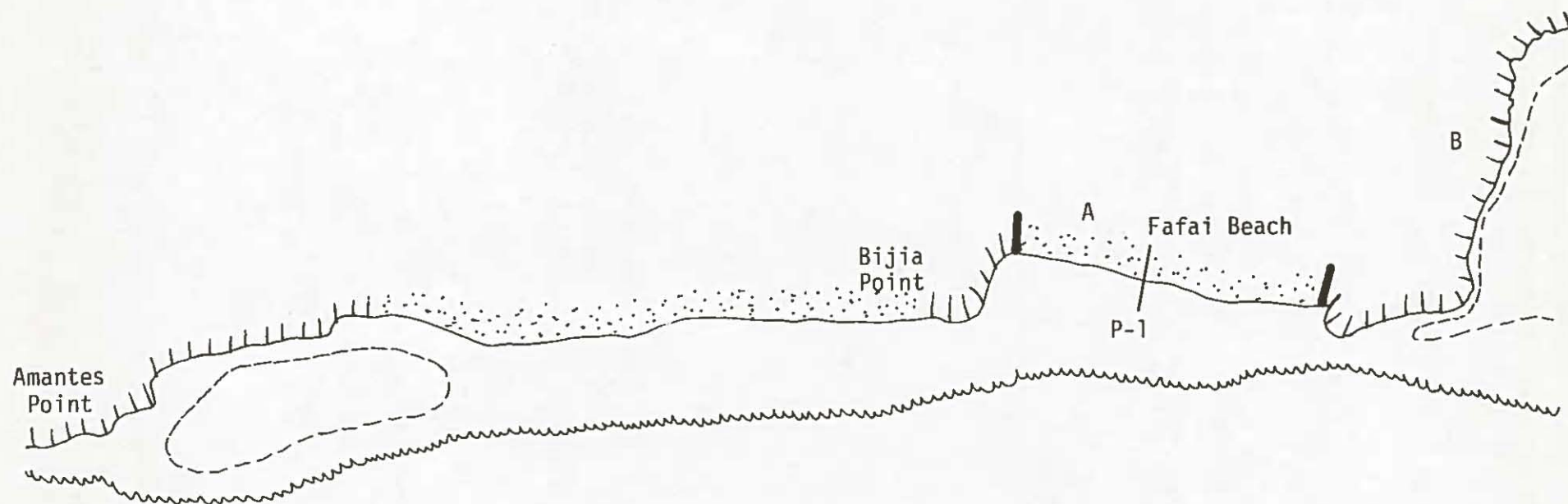


FIGURE 3-2
FAFAI BEACH AND
NORTH END OF TUMON BAY

small channel 6 feet wide and 3 to 4 feet deep extends across the reef flat fronting the parking area. It is apparently man-made, but has no effect on the beach.

- There is a slightly depressed area of reef flat off the central part of the beach. Alongshore transport moves from both north and south toward this area. The depressed reef area may act as a rip channel during large wave conditions. The beach fronting the depressed area is lined with small limestone boulders and rubble at the waterline.
- There is no backshore development, except for the dirt parking area. Public access is easy and the beach is heavily used for recreation, particularly snorkeling and SCUBA diving.
- The beach is stable. There is a noticeably larger volume of sand per unit length on Fafai Beach than on the beaches fronting the main part of Tumon Bay. The sandy foreshore is wider, and the thickness of the sand is apparently greater.

Reach B (Figures 3-2 and 3-3)

- Rocky point of Mariana Limestone separating Tumon Bay from Fafai Beach.
- Reef flat narrows to 100 feet off the point.

Reach C: Gogna Beach (Figure 3-3)

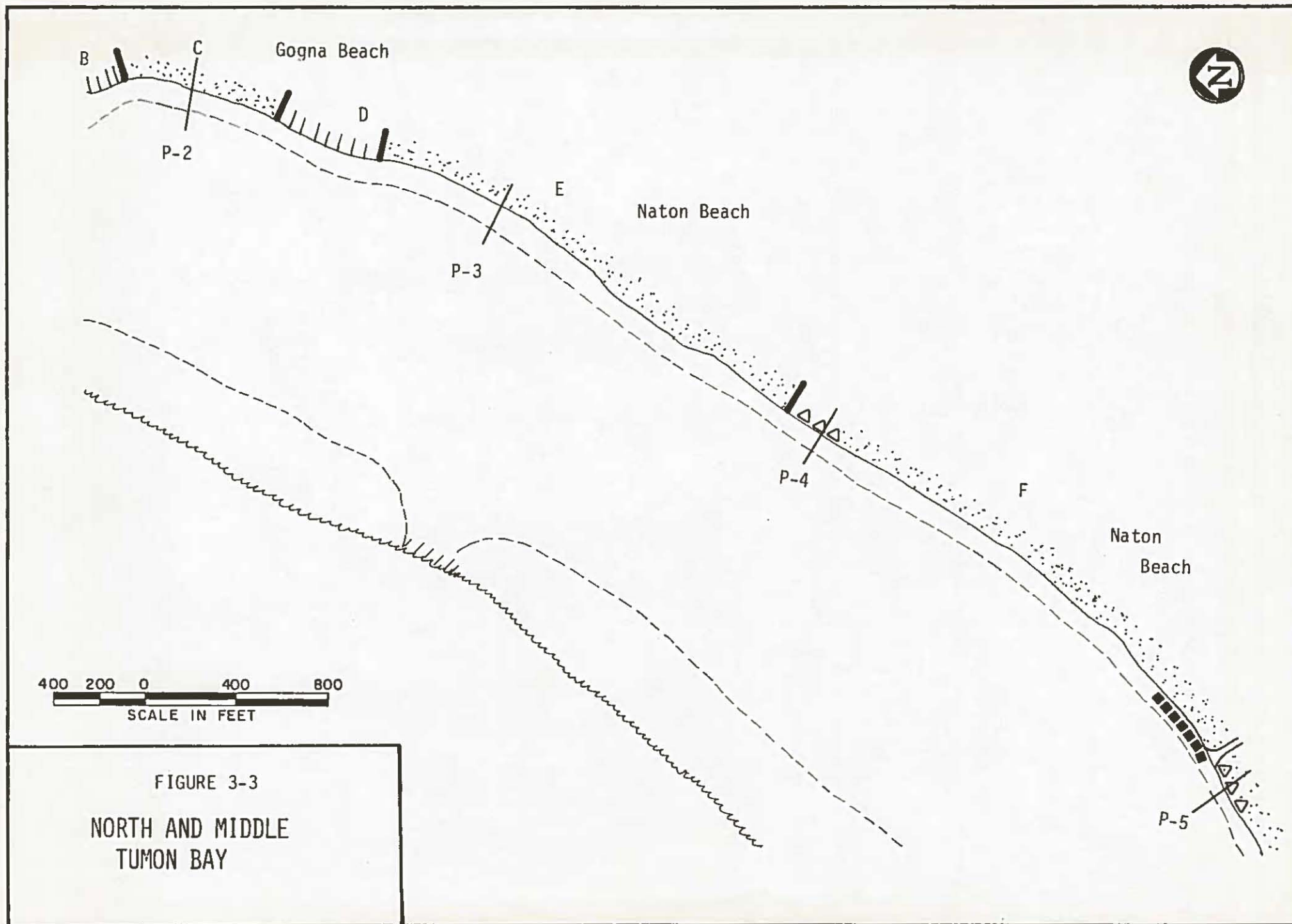
- Small pocket beach between prominent headland to the north and small rocky point to the south.
- Beach length is 700 feet, with a typical width of 50 feet. Foreshore slope is 1:10 (Profile 2).
- Material is medium to fine calcareous sand with scattered coral gravel.
- Fringing reef has a well developed inner reef flat moat, with sandy bottom. Green algae is growing in a 30-foot wide mat near the shoreline.
- The Hotel Okura is located behind the beach. The backshore slopes steadily upward to the hotel at the 30 to 40-foot elevation.
- Access to the beach is primarily limited to hotel guests.
- Stable.



Gogna Beach

Reach D (Figure 3-3)

- Short length of limestone bluff shoreline separating Gogna Beach from Naton Beach.



Reach E: Naton Beach, North End (Figure 3-3)

- Naton Beach extends along the northeast two-thirds of Tumon Bay, a length of 5,500 feet. The length of this reach is 2,000 feet.
- The beach width is typically 50 feet with a foreshore slope of 1 on 10 (Profile 3).
- The beach is medium to fine calcareous sand with scattered coral gravel. The sand is hard packed to the point that a car can be driven the length of the beach at low tide.
- The backshore is undeveloped, except for a 200-foot length at the north end fronting the Reef Hotel, where there are beach facilities for hotel occupants. The rest of Reach E is backed by trees and brush. A network of jeep trails provides public access, and the beach is heavily used by the local population.
- There was no wave action on the reef margin during the survey, and no alongshore transport direction could be discerned. An old hollow tile wall crossing the beach and protruding 6 inches above the sand showed no difference in sand elevation on the north and south sides. Reach E is in the lee of the point at the north end of Tumon Bay during trade winds.
- Stable, no erosion observed.



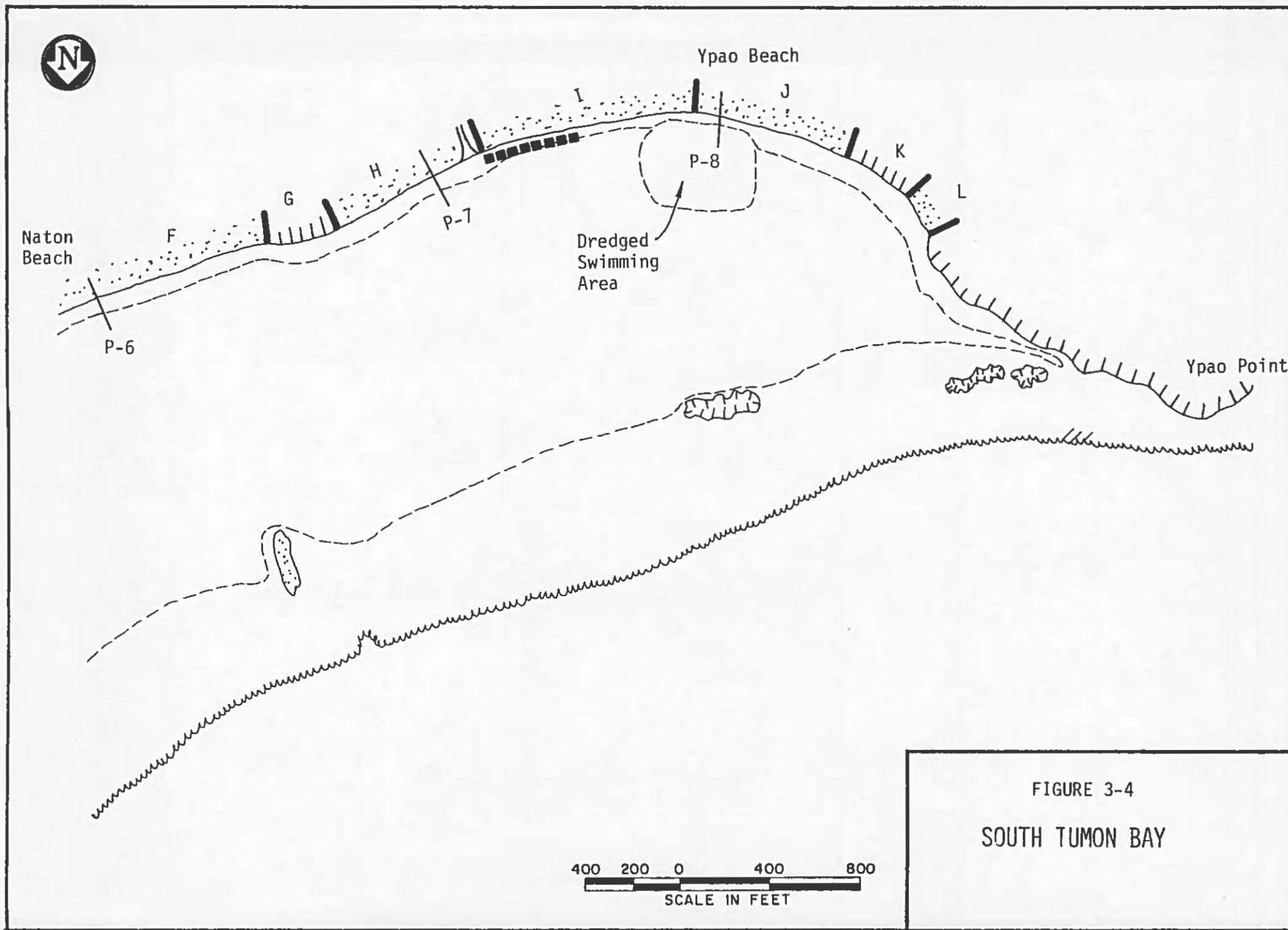
Typical View, Naton Beach

Reach F: Naton Beach, South End (Figures 3-3 and 3-4)

- Reach F is 3,500 feet long. The beach width is slightly narrower than in Reach E, typically 20 to 30 feet with a foreshore slope of 1 on 9.
- The material is well sorted, medium-fine calcareous sand with no coral gravel or rubble. The sand increases slightly in mean diameter at the south end.
- The well developed inner reef flat moat extends along the length of this sector.
- Apparent direction of predominant alongshore transport is to the south during trade wind conditions.
- Over half the backshore area is developed. Three of the several houses along the beach have small retaining walls (Profile 4), the rest are set



Naton Beach, South End



farther back. Three hotels, the Fujita, Da-ichi and Tropicana, have beach frontage. The Da-ichi has a limestone retaining wall where the vegetation line would be located (Profile 5). Profile 6 is typical of the undeveloped area.

- Distribution of sand around a drainage culvert indicates predominant transport to the south.
- Public access to the beach is possible throughout Reach F, but not as conveniently as in Reach E.
- Reach F is apparently stable, with all walls and foundations at or behind the vegetation line. There is a 300-foot long area just north of the Da-ichi and Tropicana Hotels that has three coconut trees with roots exposed and one tree toppled. Very slow erosion may be occurring at this point, but the shoreline has not receded relative to adjacent areas.

Reach G (Figure 3-4)

- Rocky terrace consisting of irregular, solution pitted limestone and large limestone blocks separating Naton and Ypao Beaches.
- A World War II fortification is built into the rocks of the point.

Reach H: Ypao Beach, Northeast End (Figure 3-4)

- Ypao Beach bordering the southwest third of Tumon Bay extends from a small rocky point to the north (Reach G) to Ypao Point. The length of the beach is 1,900 feet. The length of Reach H is 720 feet.
- The beach width averages 45 feet. The foreshore slope is 1 on 8.
- The sand is well sorted, medium-fine calcareous.
- The Continental Hotel is located immediately behind the beach. The seaward boundary of the hotel property is defined by a grouted limestone boulder wall (Profile 7). A drainage culvert discharges at MHW at the south end of the hotel property. A slight difference in sand levels on each side of the culvert indicates a predominant transport to the south. There is no natural vegetation line in Reach H.



Naton Beach, South End



Shore Fortification, Reach G



Ypao Beach, North End

- Stable, no apparent erosion.

Reach I: Central Portion, Ypao Beach (Figure 3-4)

- 700-foot length of beach comprising central part of Ypao Beach.
- Beach consists of medium-fine calcareous sand, and is typically 40 feet wide.
- The intertidal zone between the beach foreshore and reef flat consists of coral rubble, scattered limestone boulders and intermittent protruding beachrock.
- There are a few houses and an apartment building set well behind the vegetation line. The southwest half of Reach I is backed by the parking lot for the Ypao Beach Park.
- A swimming area 400 feet wide by 500 feet long has been dredged into the reef flat at the boundary between Reaches I and J.
- There is some minor erosion occurring in Reach I, with a 2- to 3-foot scarp cut into the foreshore crest. The erosion is above the normal high waterline and apparently occurs during storms.



Ypao Beach, Central Part

Reach J: Ypao Beach, Southwest End (Figure 3-4)

- 600-foot length of beach fronting Ypao Beach Park. Beach is 70 feet wide, with a foreshore slope of 1 on 11. Profile 8 shows a typical section through center of the park and the dredged swimming area.
- Material is medium to fine calcareous sand, with coral rubble and gravel at the waterline.
- This end of Tumon Bay is more exposed to trade winds than the sheltered areas to the north. Trade wind generated chop on the reef flat apparently results in predominant along-shore transport to the southwest.
- The park is a popular recreation area.
- Reach J is stable.



Ypao Beach Park

Reach K (Figure 3-4)

- Low-lying limestone terrace separating Ypao Beach from the Hilton Hotel Beach.

Reach L: Hilton Hotel Beach (Figure 3-4)

- Small man-made beach of calcareous sand about 350 feet long, fronting the Hilton Hotel. The steep, narrow beach is bounded by terraces and the natural limestone outcrops in the area.
- Although accessible via the shoreline from Ypao Beach Park, the hotel beach is used primarily by hotel guests.
- Appears stable.



View Toward Hilton Hotel Beach

SECTION 4

OCA POINT TO CABRAS ISLAND

This sector extends from Oca Point to Cabras Island, a distance of 7 miles (Figures 4-1 and 4-2). It is separated from Tumon Bay by a 1-3/4-mile length of limestone cliffs. There are no beaches between Tumon Bay and Oca Point, and access to the shoreline is difficult.

The sector can be subdivided into three bays, each defined by a headland or prominent peninsula. Agana Bay is a broad embayment between Oca Point and Adelup Point. The Paseo de Susana Park, a man-made peninsula constructed on the reef flat, is located in the center of Agana Bay. Adelup Point, the south boundary, is a small limestone peninsula approximately 40 feet high.

Asan Bay is a shallow embayment bounded by Adelup Point on the north and Asan Point on the south. Asan Point is a protruding limestone ridge with a maximum elevation of 120 feet.

Piti Bay is located between Asan Point and Cabras Island.

Broad reef flats border the entire sector, ranging from a minimum width of 75 feet off Adelup Point to 3,000 feet off Asan Point. The reef is similar to that of Tumon Bay, with a deeper moat area comprising the inner reef flat. The moat has 1 to 3 feet of water during low tide, while the outer reef flat may be exposed. The moat bottom is generally covered with sand and coral rubble. The outer reef flat consists of pavement-like reef limestone. Boulders are common at the intersection of the inner and outer reef flats.

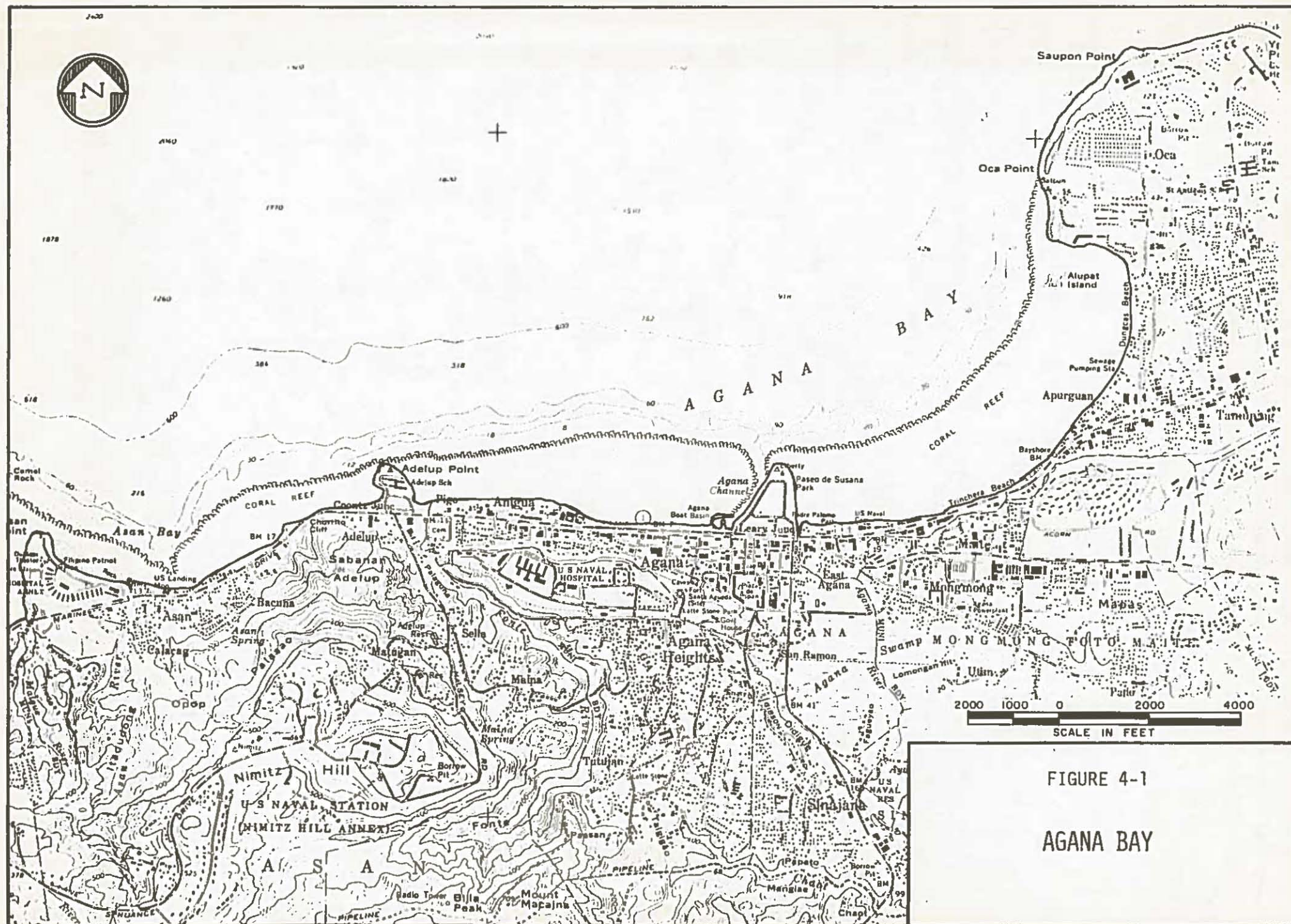
Limestone plateaus and low terraces border the coast from Oca to Adelup Points. Volcanic highlands, with isolated stretches of limestone border the coast from Adelup Point south to Cabras Island. The northern limestone plateau and the volcanic highlands are separated by an area of swamp and marshland.

Six rivers drain the backshore regions. The Agana River, which discharges just north of the Paseo de Susana Park, drains the limestone plateau and marsh area. The Fonte River discharges just north of Adelup Point and the drainage system encompasses both the limestone and volcanic areas. The Asan, Matgue, Taguag and Masso Rivers all drain the volcanic highland region to the south.

The coastline consists of sandy beaches and alluvium, with the exception of the headlands and peninsulas. The beach composition reflects the material source. The beaches from Oca Point to Adelup Point are nearly 100 percent calcium carbonate, of reef origin. The beaches from Adelup Point to Cabras Island contain varying amounts of non-carbonate material. Beach deposits near river mouths which drain the volcanic highlands contain high percentages of inorganic material, with the amount varying inversely with distance from the river. Beaches bordering the alluvial deposits west of Asan Point have a high clay content.

The coastal region is extensively developed, with the city of Agana and the villages of Tamuning, Asan, and Piti occupying the backshore area. Route 1, the main around-the-island artery, parallels the shoreline.

The three embayments are described in more detail below.



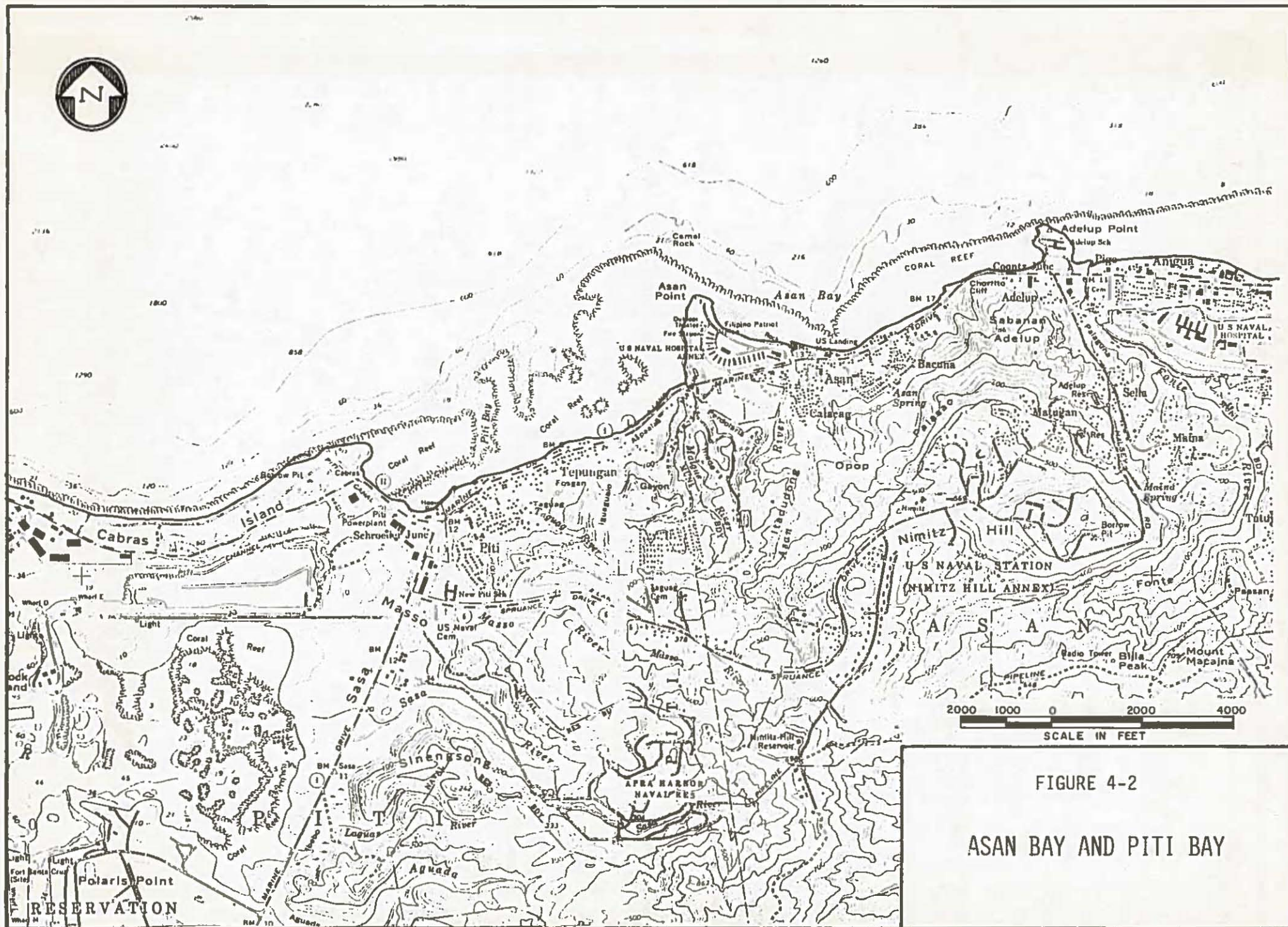


FIGURE 4-2

ASAN BAY AND PITI BAY

4.1 AGANA BAY

The coast of Agana Bay from Oca Point to the Paseo de Susana Park is bordered by a wide fringing reef flat. The reef width varies from 2,000 to 600 feet, increasing slightly from north to south. The reef flat grades into a narrow cut bench platform off Oca Point. There is a well-developed inner reef flat and low tide moat. The bottom of the inner reef flat moat is primarily sand, grading into sand, gravel and coral rubble toward the outer part.

The narrow (approximately 100 feet wide) outer reef flat is of reef rock pavement with widely scattered boulders. Alupat Island, off Dungcas Beach, is located at the boundary of the inner and outer reef flat. The outer reef flat is cut by a shallow channel just west of the island.

The reef flat is interrupted by the Paseo de Susana Park, which extends to within 300 feet of the reef margin. A drainage channel for the Agana River is cut across the reef flat east of the park. Agana Channel, on the west side, provides passage for boats moored in the Agana Boat Basin.

The fringing reef flat is again continuous from the boat basin south to Adelup Point, ranging from 2,100 feet wide at the east end to 900 feet near Adelup Point. A distinct wide inner reef flat is present at the east end, but it is constricted by a wide intertidal shoreline at the west end. The inner reef flat is primarily sand with some mud along the shoreline, grading to sand and coral rubble along the outer part.

The shoreline is described by the reaches below:

Reach A: Oca Point to Dungcas Beach (Figure 4-3)

- Steep limestone slopes and cliffs, with boulders and limestone terraces at the base.

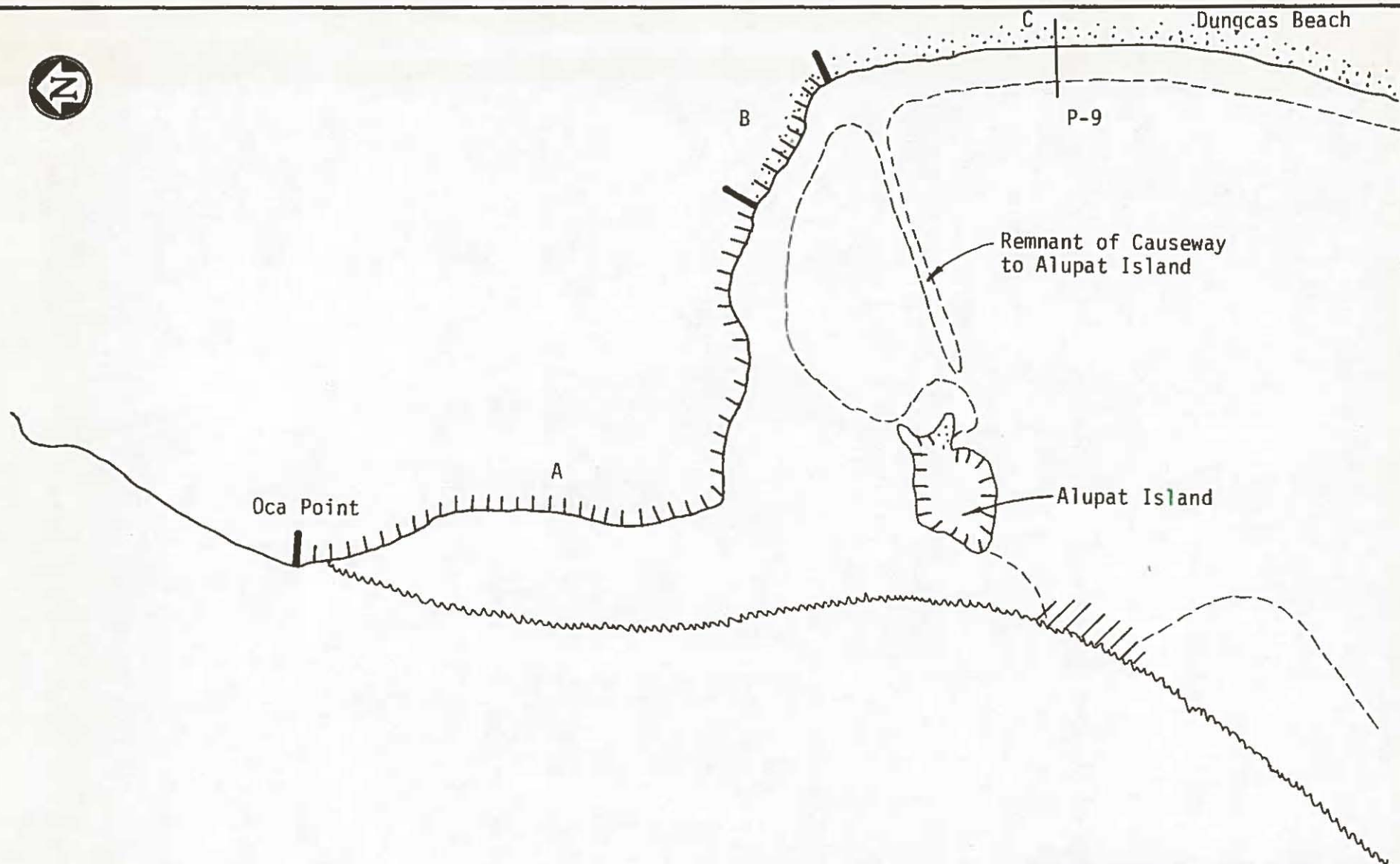
Reach B (Figure 4-3)

- Limestone cliffs gradually give way to Dungcas Beach to the south. Shoreline is intermittent limestone boulders, coral rubble and sand.

Reach C: Dungcas Beach, East End Figures 4-3 and 4-4)

- 2,400-foot long beach bounded by limestone boulders on east and a stream mouth delta at the west end. The beach width is 25 to 35 feet with a foreshore slope of 1 on 9. Profile 9 is typical of Reach C.
- Material is well-sorted, medium calcareous sand, with scattered coral gravel, rubble and small limestone boulders.
- South end of Reach B is marked by a small stream with an intertidal alluvial delta. The reef flat in this area has a thin layer of mud and silt.





400 200 0 400 800
SCALE IN FEET

FIGURE 4-3
OCA POINT TO DUNCAS BEACH
AGANA BAY

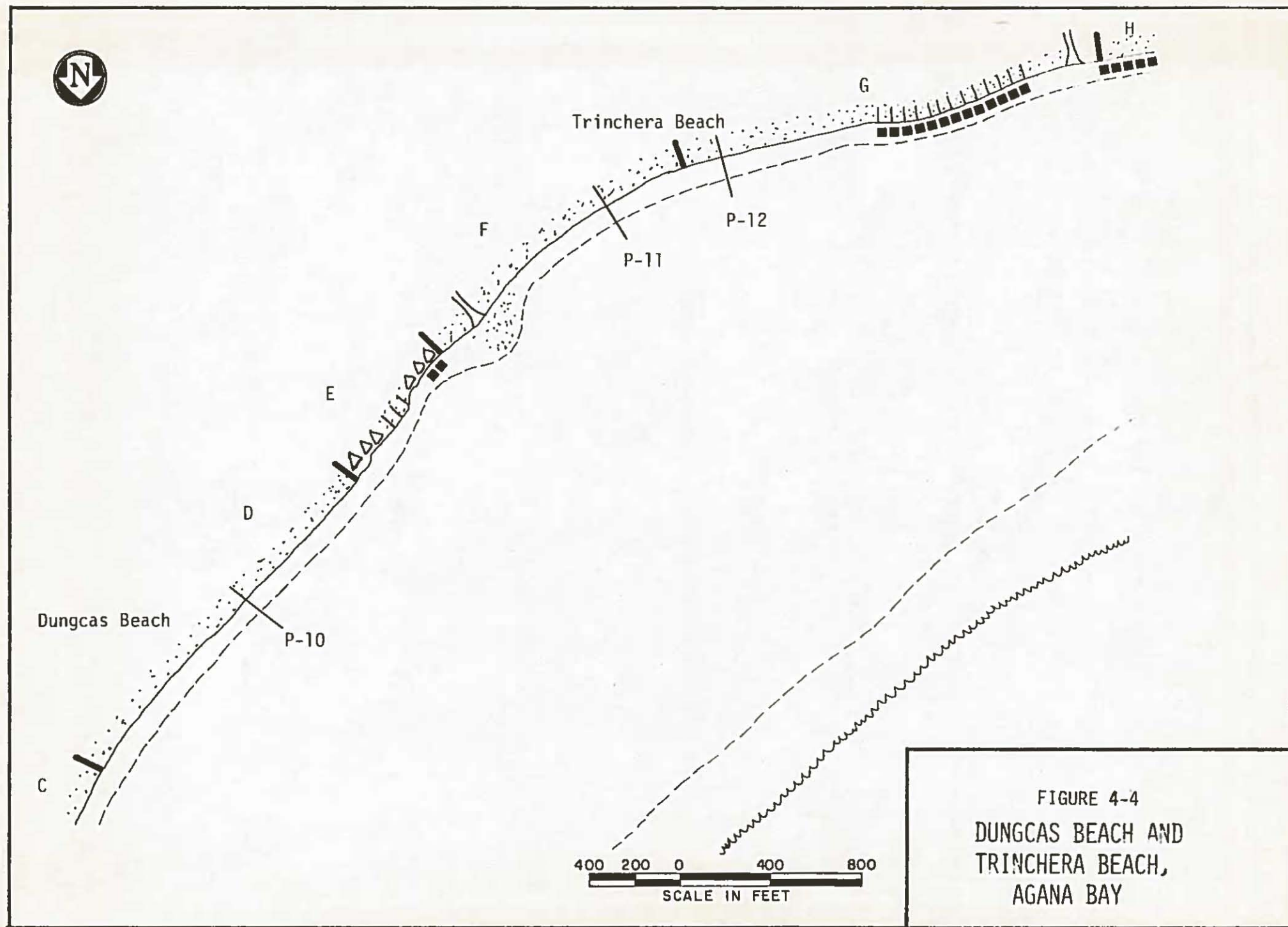


FIGURE 4-4
DUNCAS BEACH AND
TRINCHERA BEACH,
AGANA BAY

- Remnants of an old causeway extending out to Alupat Island are visible at the east end of the beach.
- Beach access is available via a number of dirt jeep trails.
- A scattering of homes can be seen from the beach, with at least 50 percent of the reach either undeveloped or densely vegetated. All homes are set back at least as far as the apartment building shown on Profile 9.
- Stable shoreline.

Reach D: Dungcas Beach, West End (Figure 4-4)

- Similar to Reach C, but with more houses and less open space.
- A continuous beach extends along the 1,500-foot long reach. Beach width is 30 to 35 feet, with a 1 on 10 slope. Profile 10 is a typical cross-section.
- The material is well-sorted, 100 percent calcareous sand.
- Public access is difficult since the backshore is all private property.
- Stable shoreline.



Dungcas Beach, West End

Reach E (Figure 4-4)

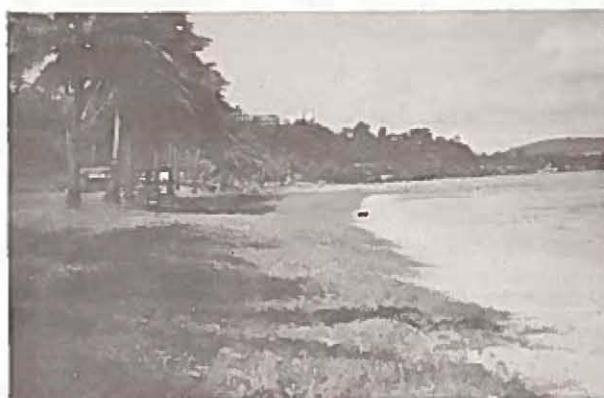
- 700-foot reach of intermittent beach and boulders at the boundary between Dungcas Beach and Trinchera Beach.
- Two abandoned, deteriorating warehouses at the north end are located at the foreshore crest, protected by a vertical seawall up to 8 feet high.
- At the south end there is a small retail building protected by a vertical seawall at the high water line. The parking lot for the building is undercut slightly, apparently from storm waves. The scarp is vine-covered.
- Retail stores and light industrial development along the shoreline make public access difficult.
- Minor erosion along 50 to 100-foot length.



Typical View, Reach E

Reach F: Trinchera Beach, East End (Figure 4-4)

- Narrow, 20-foot wide strip of beach almost awash at high tide. Vegetation line begins at 3.5-foot elevation. Beach slope is 1 on 9. Profile 11 is a typical cross-section.
- Beach material is fine sand with extensive coral gravel and cobbles.
- A flood drain culvert discharges at the north end, and has formed a small sand and alluvial delta.
- Inner reef flat has a covering of fine sand and silt.
- Predominant littoral transport is to the west, apparently due to the trade winds.
- Route 1 parallels the shoreline, separated from the beach by a 60-foot wide grassy park area with a few picnic tables scattered along the reach. Public access is easy and there is room for parking on the highway shoulder. The park is maintained by the Government of Guam.
- Stable beach.



Trinchera Beach, East End

Reach G: Trinchera Beach, Central Part (Figure 4-4)

- 1,900-foot long reach, similar to Reach F.
- Beach material is poorly sorted sand, with a high percent coverage by coral gravel, rubble, and small limestone boulders.
- Inner reef flat is covered with fine sand and silt.
- The park area between Route 1 and the shoreline continues through this reach.
- Minor, intermittent erosion is occurring along Reach G. Profile 12 shows a typical cross-section with a wave-cut scarp. The erosion apparently occurs during high waves or storms, as vines are growing on the face of the scarp, and it is above the normal high water level. There are scattered limestone boulders along the base of the scarp, either dumped to protect against erosion or naturally occurring. They offer minimal protection.



Minor Erosion, Trinchera Beach

Reach H: Trinchera Beach, West End (Figures 4-4 and 4-5)

- A narrow, 1,750-foot long beach, similar in composition to Reaches F and G, but with noticeably more coral rubble.
- A strip development of small stores is squeezed in the narrow area between Route 1 and the shoreline. Many of them were apparently built on filled land. Some of the structures are protected by rudimentary rock revetments or retaining walls. An auto dealership at the west end of the reach is protected by a 480-foot long stable revetment constructed of large limestone boulders.
- Unprotected areas have a wave-cut scarp at the foreshore crest. The scarp is heavily vegetated, indicating that erosion occurs only during high wave conditions.
- There is a potential for storm wave damage to unprotected development areas, since they are close to the shoreline.



Trinchera Beach, West End



Revetment, Trinchera Beach

Reach I (Figure 4-5)

- A natural shoreline, similar to Reaches F and G at the east end of Trinchera Beach, consists of a narrow beach with a vegetated backshore.
- Beach is poorly sorted calcareous sand with coral gravel and rubble.
- The backshore at the east end of Reach I consists of a public park (Padre de Paloma Park) and a U. S. Naval Cemetery. A drainage culvert discharging between the two has formed a small alluvial delta.
- A restaurant at the west end of the reach is protected by a small rubble revetment.



Typical View, Reach I

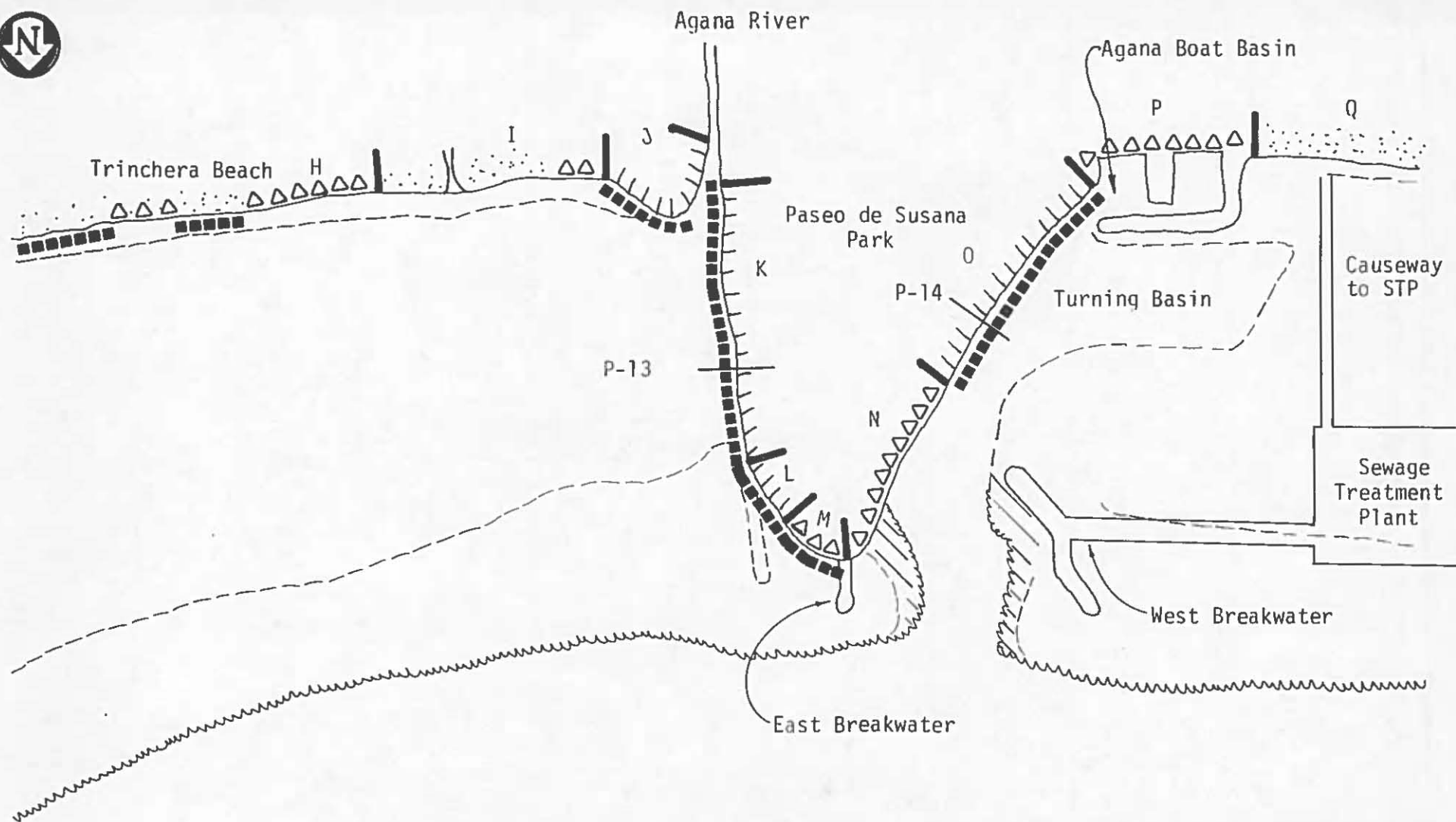


FIGURE 4-5
MIDDLE AGANA BAY,
PASEO DE SUSANA PARK
AGANA BOAT BASIN

Reach J (Figure 4-5)

- Foreshore and intertidal area is covered by limestone boulders with scattered sand and coral rubble in between.
- There is intermittent, minor erosion behind boulders where scarp is exposed to wind driven waves on reef.
- There is no development between the shoreline and Route 1.



Rubble Foreshore, Reach J

Reach K: Paseo de Susana Park (Figure 4-5)

- The 1,000-foot long reach along the east side of the peninsula consists of coral gravel, rubble and scattered boulders. The foreshore width averages 25 feet.
- A scarp 2 to 3 feet high (see Profile 13) is cut into backshore, but is generally vine-covered, indicating the erosion is not chronic.
- A discharge channel for the Agana River parallels the shoreline, with deepwater up to the shore. The channel dead-ends at the seaward tip of the peninsula (see Figure 4-5).
- Minor erosion throughout Reach K.



Paseo de Susana Park, East Side

Reach L: Paseo de Susana Park (Figure 4-5)

- A 240-foot long reach near the seaward tip of the park peninsula is similar to Reach K, but there are more boulders and cobbles.
- Chronic erosion is occurring, ranging from intermediate at south end of reach to severe at the north end, particularly the last 60 feet before the revetment at the seaward tip of the peninsula.



Severe Erosion, Reach L

Reach M: Paseo de Susana Park (Figure 4-5)

- The 400-foot long shoreline at the seaward tip of the peninsula is protected by a large revetment of limestone boulders topped with a layer of grout and a concrete cap. The seaward face of the revetment is almost vertical.
- The revetment is deteriorating and in poor condition, particularly the east end. The grout has cracked due to settlement of the boulders, and 30 feet of the concrete cap has failed at the east end with the backfill being eroded from behind the boulders.



Deteriorating Revetment, Reach M

- Classification - Critical erosion for 30 to 50 feet at east end of Reach M. There is a potential for severe storm wave damage. The tip of the peninsula is within 300 feet of the reef margin and exposed to larger waves than other reaches along Agana Bay.

Reach N: Paseo de Susana Park (Figure 4-5)

- Reaches N, O, P and a section of Q are within the area protected by the two jetties built for protection of the Agana Sewage Treatment Plant and the Agana Boat Basin (see Figure 4-5).
- Reach N, a 600-foot long reach, is protected by a limestone boulder revetment. The outer 350 feet are similar to Reach M, but may be more stable due to protection offered by the new jetties. The inner 250 feet consists of a new revetment section that is stable and in good condition.



Revetment, Reach N

Reach O: Paseo de Susana Park (Figure 4-5)

- Unprotected reach, from the end of the revetment to the Agana Boat Basin.
- The 25-foot wide foreshore (Profile 14) consists of coral gravel, cobbles and scattered limestone boulders.
- A 2 to 3-foot wave-cut scarp has been cut into the backshore, and intermediate to critical erosion is occurring throughout the reach.



Erosion, Reach O

- Incoming waves travel up the boat basin channel and transport material from the unprotected reach toward the boat basin. A few picnic tables and a dirt parking area are threatened by the erosion.

Reach P: Agana Boat Basin (Figure 4-5)

- The boat basin shoreline is stabilized by steel sheetpile bulkheads, capped with concrete or asphalt.
- Stable.

Reach Q (Figures 4-5 and 4-6)

- A 2,800-foot long beach extending west from Agana Boat Basin. The beach is intertidal, with the grass backshore extending to the high water line. Profile 15 shows a typical cross-section of the reach. The beach material is medium-fine calcareous sand.
- The area between the road and the shoreline is a grassy, open park. Two drainage culverts discharge across the beach and each has formed a small alluvium and sand delta.
- The inner reef flat is covered with sand, coral rubble, and a trace of silt.
- Reach Q is stable, with no erosion. It is sheltered from the predominant trade winds by the sewage treatment plant causeway and the wave climate is mild.



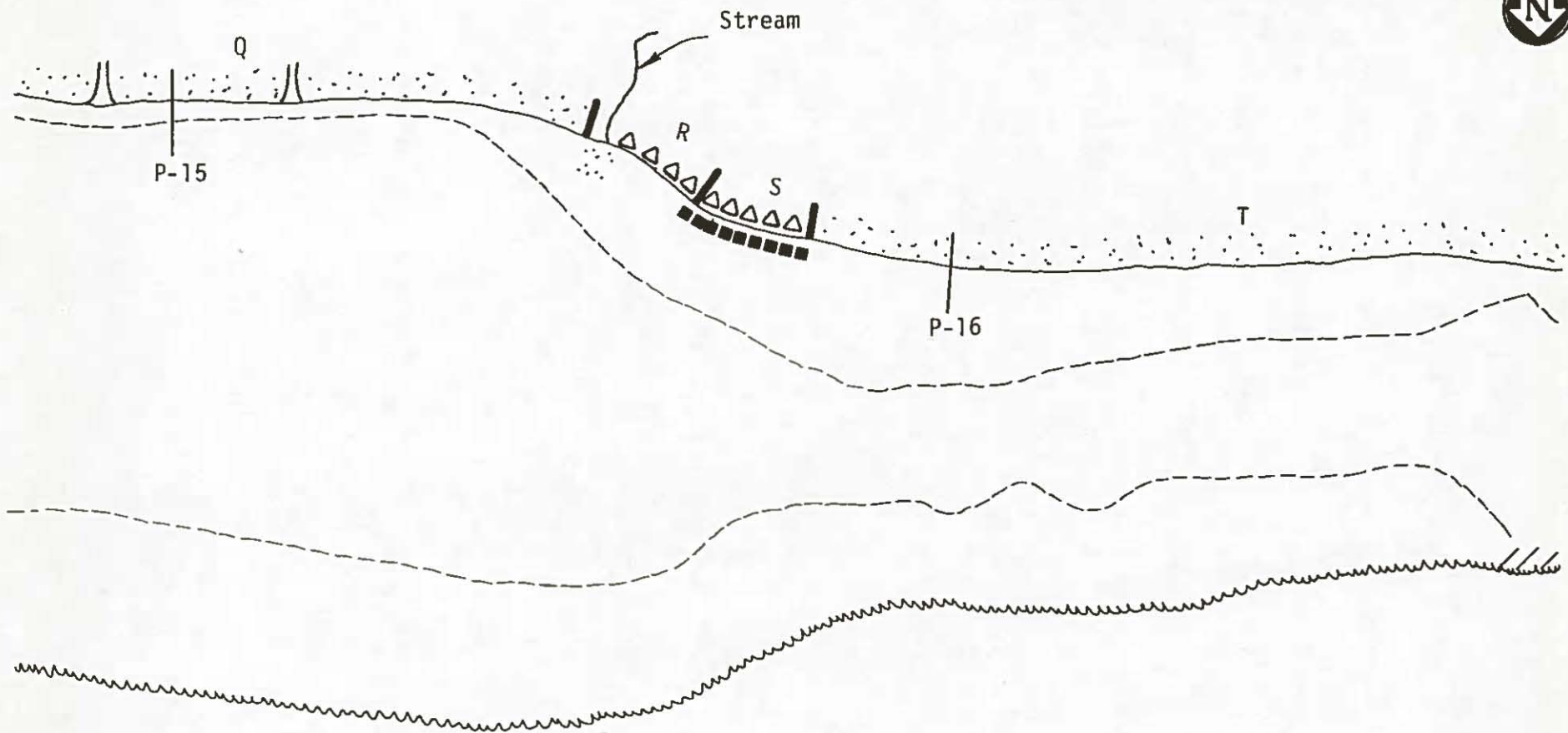
Intertidal Beach, Reach Q

Reach R (Figure 4-6)

- The shoreline consists of beach deposits similar to Reach Q, but intermixed with large limestone boulders dumped to protect artificial fill.
- The area between Route 1 and the shore is developed for commercial and light industrial use.
- A small stream with a calcareous sand delta discharges at the east end of the reach.
- Stable.



Foreshore, Reach R



400 200 0 400 800
SCALE IN FEET

FIGURE 4-6
AGANA BAY WEST OF
PASEO DE SUSANA PARK

Reach S (Figure 4-6)

- The backshore of Reach S, between Route 1 and the shoreline, is a light industrial area built on what appears to be filled land, at least near the seaward edge.
- The shoreline is protected by a rubble and debris revetment in poor condition. The grout is undermined and minor erosion is occurring.
- Minor erosion, susceptible to storm damage.



Typical View, Reach S

Reach T (Figures 4-6 and 4-7)

- A 2,200-foot long beach extending west to the Fonte River. The beach is narrow, typically 20 to 30 feet wide (Profile 16).
- Route 1 parallels shoreline, located from 300 to 500 feet inland. The strip in between is a mixture of light industrial and residential development. Most structures are set well back and the shoreline is in an undisturbed condition.
- Beach material is 100 percent medium to fine calcareous sand with no rubble at the east end. The basalt and alluvium content increases toward the Fonte River, with 100 percent basalt and alluvial material in the immediate vicinity of the river. The river has formed a large intertidal delta of alluvium, basalt and coral rubble.
- Stable, no erosion.



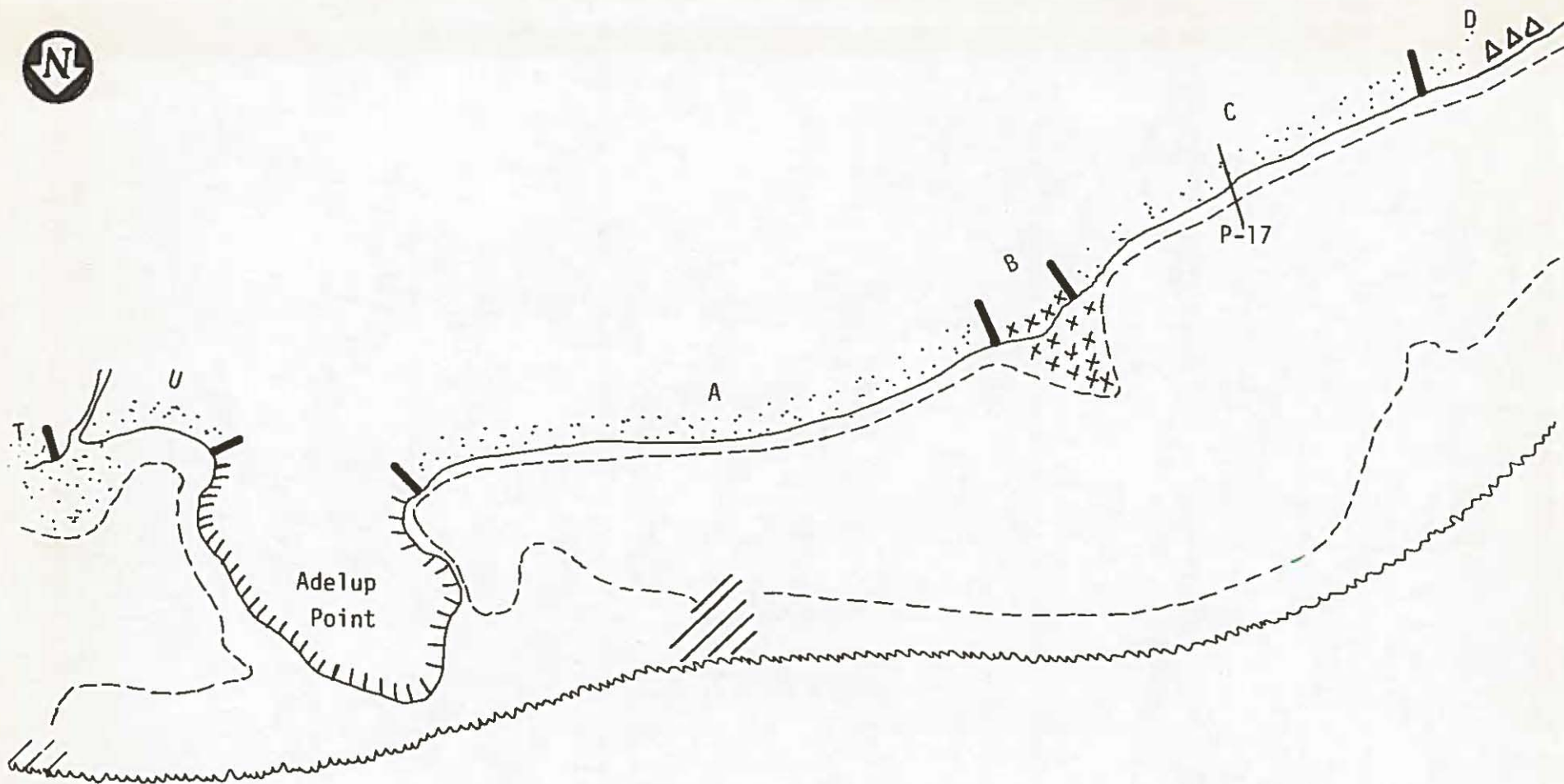
Shoreline, Reach T

Reach U (Figure 4-7)

- Small pocket beach between Fonte River and Adelup Point.
- Beach material is approximately 50 percent basalt and 50 percent calcareous sand. There is little alluvium as compared to Reach T just east of the river.
- A park with shower facilities, barbecue pits and picnic pavilions is located behind the beach.
- Stable.



Park Shoreline, Reach U



400 200 0 400 800
SCALE IN FEET

FIGURE 4-7
ADELUP POINT AND
ASAN BAY

4.2 ASAN BAY

Asan Bay is a shallow embayment with a shoreline length of approximately 1-1/2 miles, bounded by Adelup Point on the east, and Asan Point on the west.

Only the Asan River discharges into Asan Bay. It drains the volcanic highlands shoreward of the bay, and the beaches along the bay contain more non-carbonate material than those in Agana Bay.

The fringing reef flat ranges from 800 to 1,400 feet wide, with a broad channel cut partially across the reef fronting the Asan River. The Asan Bay Channel divides the reef into two sectors. To the east, the reef varies in width from 800 to 1,400 feet. There is a wide, well-developed inner reef flat and low tide moat. The bottom is primarily sand, gravel, and scattered coral rubble. The narrow outer reef flat is composed of reef rock pavement and scattered boulders.

The reef narrows toward Asan Channel. The deepwater of the channel approaches to within 200 feet of shore and there is only an intertidal reef flat.

The reef flat between the Asan Channel and Asan Point is 1,000 feet wide, with an inner reef flat moat and outer reef flat. The inner reef flat consists of sand, gravel, and coral rubble with scattered boulders toward the outer part. The outer reef flat consists of reef rock pavement with scattered boulders. Opposite Asan Point, there is only an intertidal reef flat 450 feet wide.

Asan Bay is described in more detail below.

Reach A (Figure 4-7)

- A beach 2,000 feet long, 20 to 30 feet wide, between Adelup Point and a volcanic headland to the west.
- Composition - Primarily calcareous sand with some volcanic material which becomes more abundant toward the west.
- There is no backshore development.
- Stable.



Typical View, Reach A

Reach B (Figure 4-7)

- High volcanic bluff with steep cliff dropping to water line with numerous limestone boulders scattered around water line.
- Stable.

Reach C (Figure 4-7)

- 1,400-foot long reach, with a very narrow beach almost submerged at high tide (see Profile 17).

- Beach material is fine to coarse calcareous sand with scattered coral gravel and rubble and a few basalt cobbles.
- There is a steep vegetated slope up to Route 1 at the 15-foot elevation. The area is undeveloped and access to the shoreline is difficult.
- Stable, undisturbed shoreline.



Foreshore, Reach C

Reach D (Figures 4-7 and 4-8)

- 1,600-foot long reach with a beach similar to that in Reach C, but slightly wider.
- Beach material is primarily calcareous sand, with an extensive covering of coral gravel and rubble.
- The 100 to 200-foot wide area between the shoreline and Route 1 occupied by homes and small businesses.
- Several of the homes and businesses have retaining walls or seawalls located at approximately the high water mark. The unprotected homes are at a low elevation and may be susceptible to storm wave damage.
- Stable, no evidence of chronic erosion.



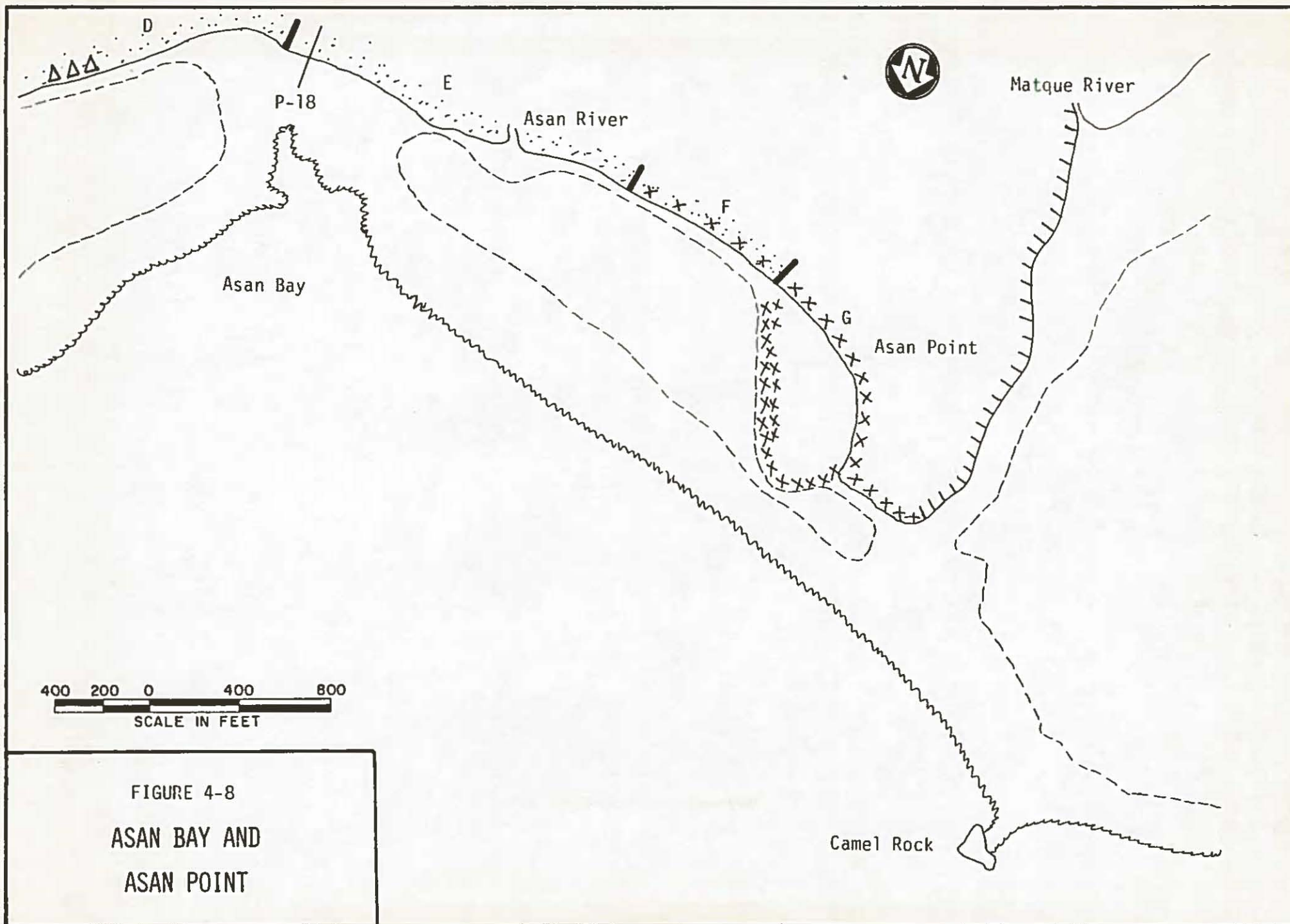
Foreshore, Reach D

Reach E (Figure 4-8)

- 1,550-foot long reach, with a foreshore similar to that of Reach D, but with an abrupt change to a higher basalt content. The Asan River, in the center of the reach, is the source of the basalt.
- The beach is typically 25' wide with a foreshore slope of 1 on 9. (Profile 18)
- The sand is well-sorted, medium fine with 60 percent basalt or alluvium and 40 percent calcareous content. The material becomes larger near the Asan River with poorly sorted coarse sand predominant. The basalt content decreases rapidly with distance from the river on the west side of the river. There is only a trace of basalt at the west end of the reach.



Reach E, West End



- The beach west of the river has a high degree of covering by coral gravel, apparently thrown up by trade wind waves, which approach the shoreline via the Asan Channel.
- The Asan River has formed a delta of basalt and coral gravel and cobbles. There is no silt or alluvial material in the delta.
- Reach E is stable, with no backshore development.

Reach F (Figure 4-8)

- Shoreline grades from sand to rocky material. Basalt boulders and outcrops predominate, with a scattering of calcareous sand and coral rubble.



Rubble Foreshore, Reach F

Reach G (Figure 4-8)

- A swimming area on the reef flat is enclosed by basalt boulders. The shoreline of the swimming area consists of basalt cobbles and small boulders.
- Backshore of Reaches F and G is the site of the former U. S. Naval Hospital Annex. The hospital has been demolished and the area is being developed as a War in the Pacific Park.
- Stable, no erosion.

4.3 PITI BAY

Piti Bay is bounded by Asan Point on the east and Cabras Island on the west. Cabras Island is a narrow limestone island with a maximum elevation of 60 feet. The Piti Power Plant is located on the east end and the commercial port occupies the remainder of the island. The island is connected to the main body of Guam by a man-made causeway.

Three rivers draining the volcanic highlands discharge into Piti Bay; the Matgue, Taguag and Masso Rivers. Narrow beaches of basalt, alluvium and calcareous material rim the shoreline, backed by intermittent residential development.

The fringing reef flat is irregular, ranging from 3,200 feet wide west of Asan Point to 250 feet wide at Tepungan Channel. The reef flat has a prominent intertidal zone alongshore, giving way to an inner reef flat moat. The moat is wide and unusually deep at the east end. The central and western parts are irregular, with a number of deeper pools, and there is no bordering outer reef flat. The reef margin is irregular, cut with several channels. The Tepungan Channel cuts completely across the reef flat. Before the causeway to Cabras Island and the Piti Power Plant were built, Tepungan Channel and Piti Channel connected the east end of Apra Harbor with the open ocean. Camel Rock, a small limestone islet, is located at the reef margin just west of Asan Point.

The irregular reef flat and reef margin of Piti Bay is one of the most popular SCUBA diving areas in Guam.

Reach A (Figure 4-9)

- A 1,400-foot long beach at the east end of Piti Bay. The shoreline is typically 20 feet wide (see Profile 19).
- Beach material ranges from poorly sorted calcareous sand at the east end to medium fine calcareous sand at the west end. Near the Matgue River there is a 50 to 60 percent basalt content. The percentage of basalt decreases with distance from river. There is a small amount of silt on the beach and on the reef.
- A public park is located between Route 1 and the shoreline. Public access is easy and there are picnic tables scattered throughout the area.
- The beach is stable. The north end of Piti Bay is protected from trade winds by Asan Point.



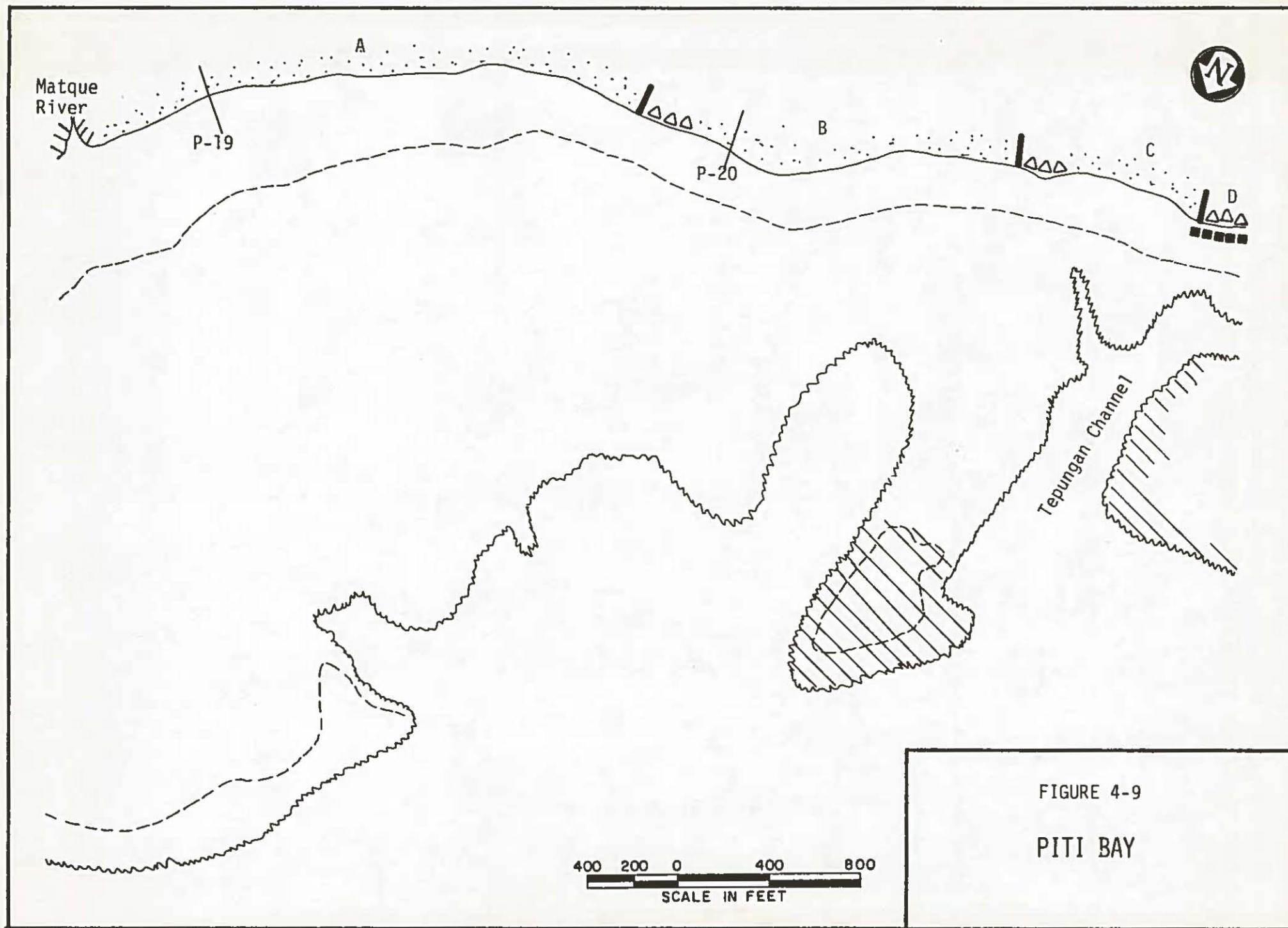
Intertidal Beach, Reach A

Reach B (Figure 4-9)

- 1,800-foot long reach along central part of Piti Bay.
- Shoreline consists of a narrow beach, typically 20 feet wide (see Profile 20).
- Beach sand is a mixture of calcareous and basalt material with little rubble or gravel.
- The area between Route 1 and shoreline has several houses and vacant lots. Houses are as close as 30 feet to the foreshore crest and located at an elevation of 5 feet or less. They appear vulnerable to storm wave damage. One house at the east end has a small rubble seawall; the others are unprotected.
- The beach is narrow, but appears stable during normal conditions, with grass, brush, or vines growing almost to the high water mark.



Typical View, Reach B



Reach C (Figure 4-9)

- Narrow beach, similar to that in Reaches A and B. Beach composition is the same, except that there is less sand and a scattering of limestone boulders.
- The only development between the beach and Route 1 is one house at the east end, which is protected by a 5 to 6-foot high grouted limestone seawall.
- Stable.



Typical View, Reach C

Reach D (Figures 4-9 and 4-10)

- 500-foot long reach.
- A group of houses are located in the 200-foot wide strip between Route 1 and the shoreline.
- All houses are protected by rudimentary seawalls located at approximately mean sea level. The seawalls consist of only one or two rows of boulders, and range from 2 to 3 feet high. There is no beach.
- Houses are close to the water and at an elevation of less than 5 feet; there is a potential for storm wave damage.
- Chronic minor erosion throughout the reach.



Typical View, Reach D

Reach E (Figure 4-10)

- Reach E consists of Santos Park which extends east from the Masso River a distance of 230 feet.
- The shoreline is a narrow strip of beach, approximately 20 feet wide with a slope of 1 on 9.
- Beach is a poorly sorted mixture of basalt, alluvium, and calcareous material.
- The inner reef has a covering of alluvial material and silt.



Santos Park Shoreline

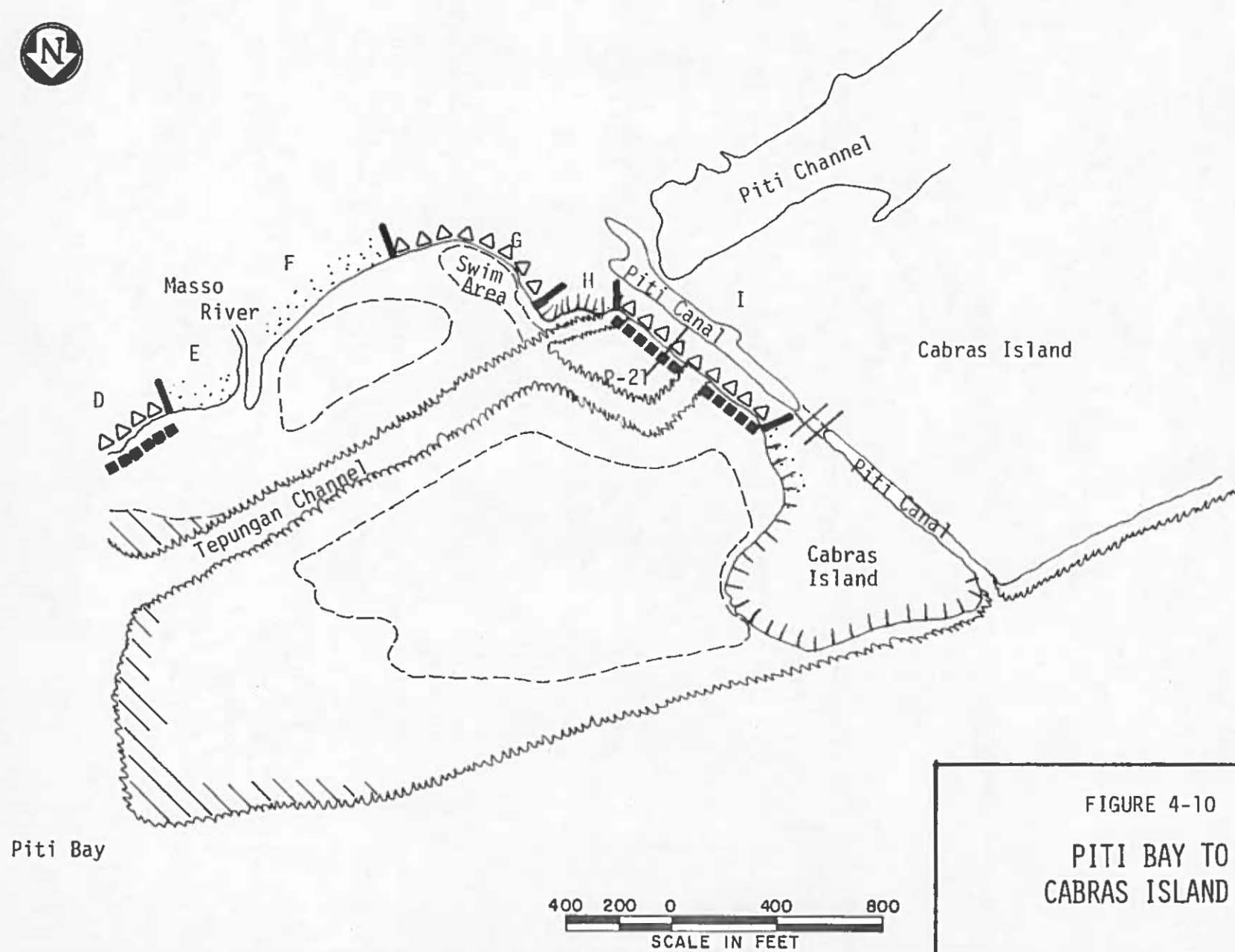


FIGURE 4-10
PITI BAY TO
CABRAS ISLAND

- Park area is undeveloped except for a basketball court.
- Stable.

Reach F (Figure 4-10)

- Small crescent beach 450 feet long located just west of the Masso River.
- Beach material is calcareous sand.
- An undeveloped, open field extends back 300 feet to Route 1.
- A rock and rubble spit extends seaward at the mouth of the Masso River and marks the east end of Reach F.
- Stable.



Beach West of Masso River

Reach G (Figure 4-10)

- Reach G consists of the USO Beach Park. A swimming area has been dredged in front of the west half of the reach (see Figure 4-10). The shoreline is protected by a combination of concrete gravity retaining wall, steel sheet-pile wall, and a grouted limestone boulder revetment. The walls reach a height of approximately 8 feet above MLW. The walls are stable, but there is no longer a beach in front. A combination of reflection off the walls and deposition in the swimming area is probably responsible for the erosion. The intertidal area along the western third of the reach is a remnant of the sand beach. The other two-thirds is coral rubble.
- Stable shoreline.



USO Beach Park

Reach H (Figure 4-10)

- Rock and rubble point separating the USO Beach Park from the shore protection lining the causeway to Cabras Island.

Reach I (Figure 4-10)

- Shoreline consists of a limestone boulder revetment protecting the causeway to Cabras Island. The revetment consists of 1 to 6-foot diameter limestone boulders, randomly dumped. There is no filter layer or bedding material and earth is being eroded from behind the boulders. (Profile 21)
- A culvert for cooling water intake crosses under the road and comprises 150 feet of the 700-foot reach. The culvert is formed of concrete with protective return walls on each side, and is stable.
- The erosion is minor and the road is not threatened at present, but there is a potential for storm wave damage and undercutting of road.



Revetment, Reach I

SECTION 5

APACA POINT TO TAYLAYAG BEACH

The three-mile coastline from Apaca Point to Nimitz Beach is irregular, with projecting headlands and river embayments (Figure 5-1). The shoreline is fringed by reef flats ranging in width from 100 to 2,600 feet. Channels cut completely or partially through the fringing reef at the mouths of some of the larger rivers.

The coast is protected from direct trade wind wave approach by Orote Point to the north and Cocos Barrier Reef to the south. The wave climate is typically mild except during periods of west swell or winds, or the approach of tropical storms.

The sector contains numerous small beaches, generally composed of calcareous material and/or alluvium.

The coastline is backed by a low coastal plain, which extends from Apaca Point to Taylayag Beach, the southern boundary of the sector. The coastal plain is extensively developed. The residential and commercial development is centered around the village of Agat. Route 2 borders the coastline from Apaca Point to Taylayag Beach, then swings inland south of that point.

5.1 AGAT BAY - APACA POINT TO BANGI ISLAND

This coastal subsector comprises the southern half of Agat Bay. There are two major beaches, Togcha Beach and Salinas Beach, in the sector. There is also a third, unnamed beach extending from Gaan Point to Bangi Island.

Five streams discharge into the area; the Namo River, Togcha River, Finile Creek, Gaan River and Auau Creek.

The width of the reef flat varies from 850 feet at Apaca Point to 1,000 feet at Gaan Point, then increases to 2,600 feet off Bangi Point. The reef is indented by partial channels off Togcha Beach and just south of Gaan Point.

There are small islets located on the reef flat at the north and south ends of the sector. Pelagi Islets, two small limestone islands, are located on the seaward edge of the reef flat off Apaca Point.

The shoreline of this sector is described in detail below.

Reach A: Apaca Point (Figure 5-2)

- Rocky point consisting of low limestone cliffs and steep slopes.
- There is a picnic area developed on plateau behind the point.

Reach B (Figure 5-2)

- Small pocket beach 400 feet long between Apaca Point and the jetties at the mouth of the Namo River.

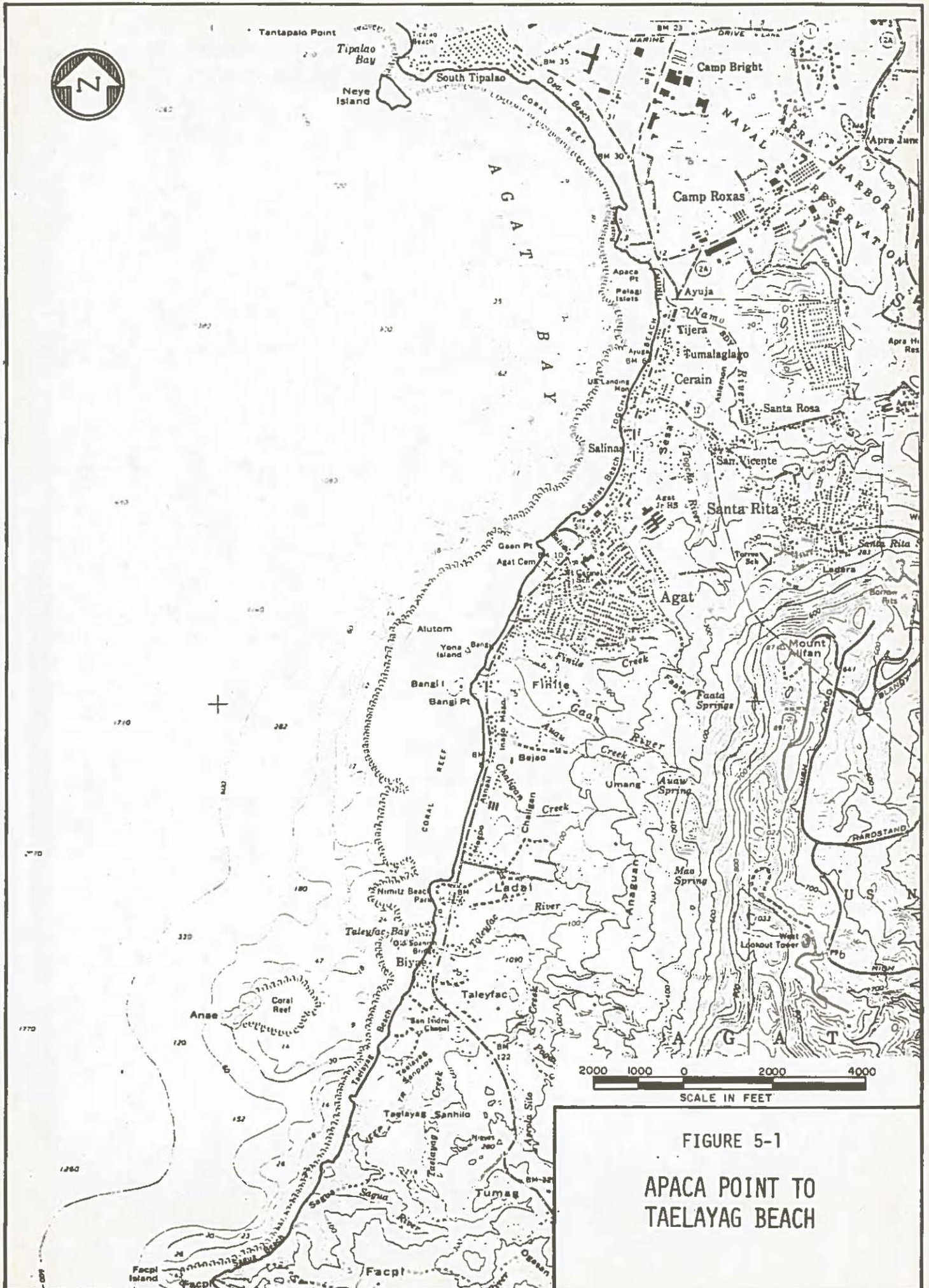
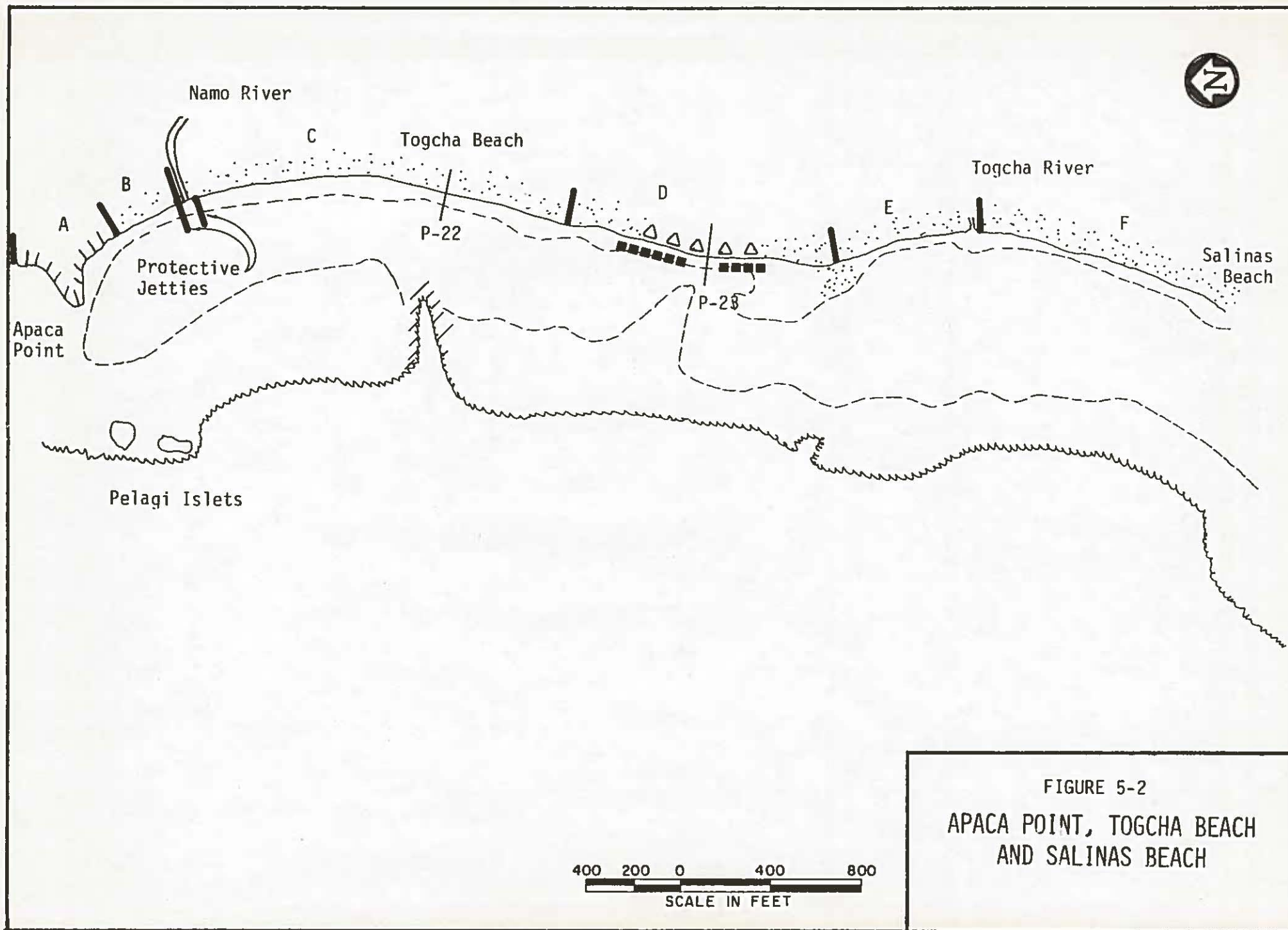


FIGURE 5-1
APACA POINT TO
TAELEYAG BEACH



- Beach foreshore is 35 feet wide.
- Beach material is poorly sorted calcareous sand with extensive coral gravel and rubble.
- Backshore is undeveloped.
- Inner reef is covered with silt and mud.
- Stable.

Reach C: Togcha Beach, North End
(Figure 5-2)

- 1,600-foot long reach extending south from the Namo River.
- Shoreline is a stable beach, typically 30 feet wide (see Profile 22).
- Beach material is primarily poorly sorted calcareous sand, mixed with 35 percent volcanic material and some silt. Coral gravel, rubble and boulders are scattered on top.
- Backshore along north half of Togcha Beach is generally undeveloped and is heavily vegetated. There are a few scattered houses, most set well back from the beach.
- Stable beach.

Reach D: Togcha Beach, Central Part (Figure 5-2)

- 1,200-foot long reach along central part of Togcha Beach.
- The foreshore is narrow and consists of poorly sorted calcareous sand with some alluvial material intermixed.
- The inner reef is covered with a layer of mud and silt.
- A small stream marks the south end of Reach D. A large subtidal delta of calcareous sand, rubble and alluvium has been formed.
- Several houses between the shoreline and Route 2 are built close to the beach and most are protected by seawalls, most commonly hollow tile walls (see Profile 23 for a typical cross-section).



Beach South of Apaca Point



Togcha Beach, Central Part



Togcha Beach, North End

- There is intermittent erosion along the unprotected areas of the reach. Of the 1,200-foot long reach, approximately 600 feet is protected by seawalls, 350 feet is eroding, and 250 feet is stable. The unprotected houses may be susceptible to storm wave damage. The reef is relatively narrow (800 feet) off this reach.

Reach E: Togcha Beach, South End (Figure 5-2)

- 650-foot long reach, bounded by Togcha River at the south end. Foreshore is 25-35 feet wide and consists primarily of calcareous sand mixed with alluvial and volcanic material.
- There are a few houses between Route 2 and the shoreline, but they are set well back from the water.
- Stable beach.

Reach F: Salinas Beach (Figures 5-2 and 5-3)

- 2,300-foot long beach bounded by Togcha River on the north and a small point protected by a rock revetment on the south.
- Beach width averages 30 feet and is composed of medium-fine well-sorted calcareous sand with scattered gravel.
- Route 2, located 200 to 300 feet inland, parallels the shoreline. The backshore area has scattered houses, except for a small park at the south end of the reach with 200 feet of beach frontage. The houses are at a low elevation and may be subject to storm wave damage.
- The Agat Community Center marks the south end of the reach and Profile 24 was measured at the site.
- Stable beach, no erosion.



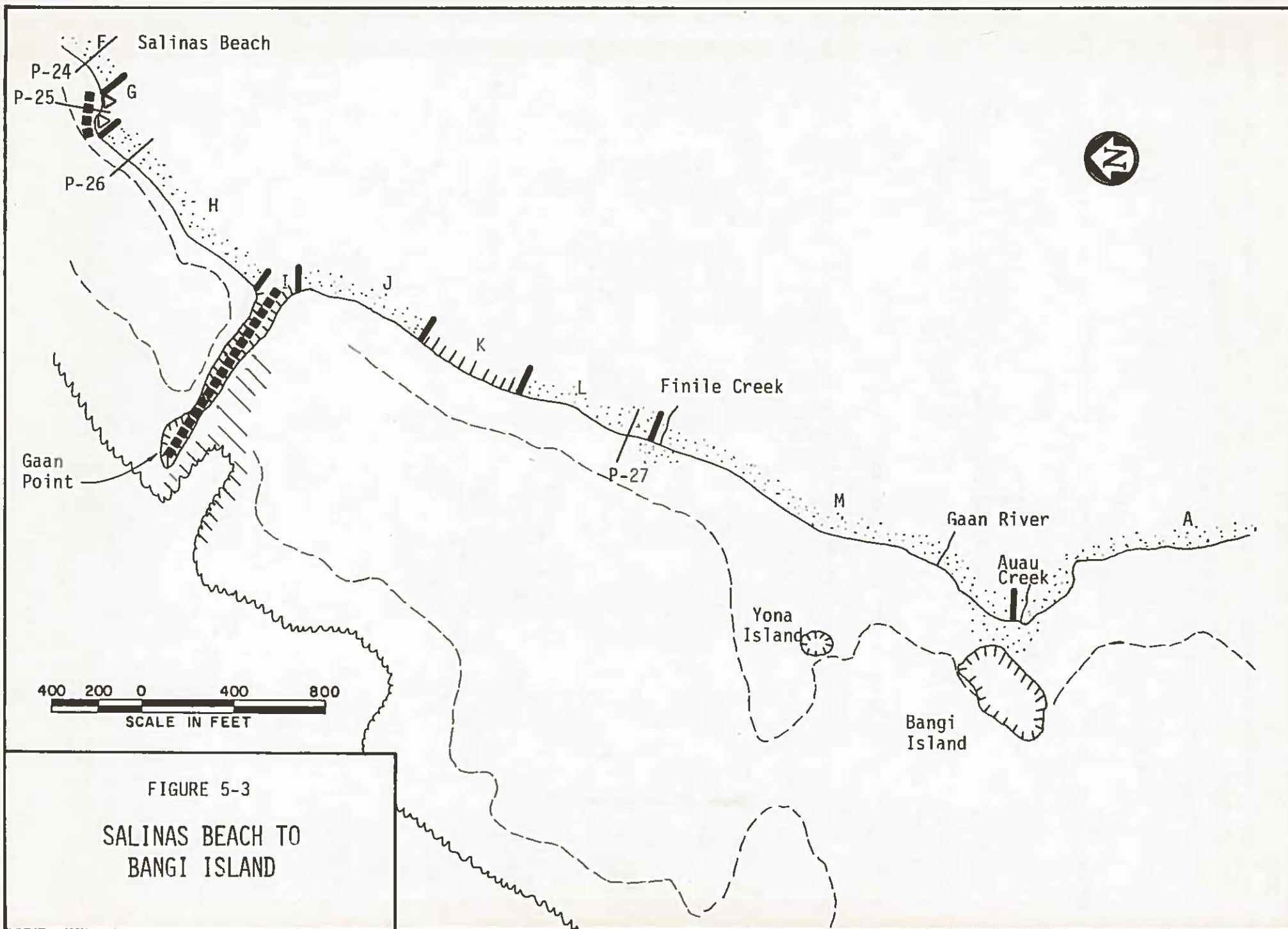
Typical View, Salinas Beach

Reach G (Figure 5-3)

- North side of War Memorial Park, which is protected by a 350-foot long limestone boulder seawall.
- Profile 25 shows a typical cross-section across the seawall. The boulders range from 2 to 5 feet in diameter. The intertidal shoreline in front is coral rubble and scattered sand.
- Minor erosion of the backfill from behind the boulders is occurring and should be monitored.



Revetment, War Memorial Park



Reach H: War Memorial to Gaan Point
(Figure 5-3)

- 800-foot length of beach fronting the War Memorial Park and a small sewage treatment plant.
- The beach is 35 feet wide and consists of poorly sorted calcareous sand with scattered gravel. (Profile 26)
- Stable, no erosion.



Beach Fronting War Memorial Park

Reach I: Gaan Point (Figure 5-3)

- Gaan Point is a man-made peninsula, approximately 80 feet wide that extends 900 feet seaward across the reef flat. An old sewer outfall runs along the peninsula and used to discharge at the reef margin. The peninsula was apparently built to support and protect the outfall pipe.
- The shoreline of the peninsula is randomly dumped boulders and rubble. The south side is eroding and a 3-foot scarp has been cut in the backfill in some places. The peninsula has been breached at the shoreward end and is now actively eroding, particularly at high tide.
- The peninsula is probably subject to severe erosion during storms.



Gaan Point, Looking Shoreward



Eroded Area at Base of Gaan Point

Reach J (Figure 5-3)

- 500-foot long pocket beach just south of Gaan Point.
- Sand is poorly sorted calcareous material, with no basalt.
- Foreshore is 35 feet wide, with a 1 on 12 slope.
- A small cemetery is located between the beach and Route 2.
- The beach vegetation line is undisturbed and the beach is stable.



Pocket Beach South of Gaan Point

Reach K (Figure 5-3)

- A rocky point, 600 feet long, separating two beaches.
- The shoreline consists of scattered limestone boulders.
- Backshore is undeveloped.

Reach L (Figure 5-3)

- 600-foot long beach, bounded on the south by Finile Creek.
- Beach is 35 feet wide, (Profile 27) and the material is poorly sorted calcareous sand with a low basalt content and no alluvial material. Finile Creek has formed an intertidal delta of alluvial material and basalt cobbles.
- There are a few houses on the backshore area between the shoreline and Route 2. Houses are at a low elevation and may be subject to storm wave damage.
- Beach is stable.



Typical View, Reach L

Reach M (Figure 5-3)

- 1,650-foot long beach between Finile Creek and Bangi Point.
- The Gaan River discharges near the south end of the reach and the Auau Creek discharges at Bangi Point.
- The beach width averages 20 feet, and the material is medium fine calcareous sand with some basalt. The percentage basalt is 50-60 percent at the north end near Finile Creek, decreasing to almost zero at Bangi Point.
- The backshore is generally undeveloped with only a few houses located at Bangi Point.
- The beach is stable.



Beach North of Bangi Point

5.2 NIMITZ BEACH AREA

This coastal sector extends from Bangi Point to Taelayag Creek, a distance of 1-1/2 miles. Nimitz Beach Park, in the center of the sector, divides the sectors into two shoreline regimes. The beaches to the north are primarily calcareous, except for intermittent areas where alluvial material is introduced into the near-shore zone by streams or flood drain culverts. South of the park, the beaches are primarily alluvial material and basalt, and the content is reflected by the brown

color of the beaches. The inner reef flat in this area is covered by a layer of mud and silt, ranging up to several inches thick.

The fringing reef flat decreases in width from 2,200 feet off Bangi Point to 1,850 feet just north of Nimitz Beach Park. There is a well developed inner reef flat moat. The inner reef flat has a thin veneer of sand, gravel, and coral rubble, with scattered boulders and exposed reef rock. The outer reef flat is reef rock pavement with scattered boulders.

Two major channels cut through the reef flat, located at Nimitz Beach Park and off the Taleyfac River. The two channels are separated by an 800-foot length of reef flat.

South of the Taleyfac River, the reef flat is narrow, 250 to 550 feet wide. The reef is mainly intertidal reef flat consisting of reef rock pavement. Anae Island is located seaward of the fringing reef margin.

The backshore is undeveloped, except for a few houses in the area from Nimitz Beach Park to the Taelayag Creek. Route 2 parallels the shoreline along the north half of the sector, then swings inland south of the beach park.

Access to the shoreline is easy north of Nimitz Beach Park and difficult south of the park. The beach park is heavily used for recreation, particularly on weekends. The Nimitz Channel is used for small boat access to the open ocean, and by snorkelers and divers.

Reach A (Figures 5-3 and 5-4)

- 1,300-foot long beach, extending from Bangi Point to the Chaligan River. Profile 28 shows a typical cross-section.
- Material is 100 percent medium-fine calcareous sand, well sorted with a scattering of coral gravel on top.
- Inner reef flat is covered by a thick layer of clean calcareous sand.
- Backshore is undeveloped, with the road set back approximately 100 to 150 feet from the shoreline.
- Reach A is stable, no erosion.



Beach South of Bangi Point

Reach B (Figure 5-4)

- Reaches B, C and D are all part of a long, narrow beach extending from the Chaligan River to the north side of Nimitz Beach Park.
- The narrow intertidal shoreline consists of 50 to 70 percent calcareous material, with the remainder alluvial. The source of the alluvial material is the Chaligan River, which has formed an alluvial delta,



Eroding Shoreline Near Chaligan River

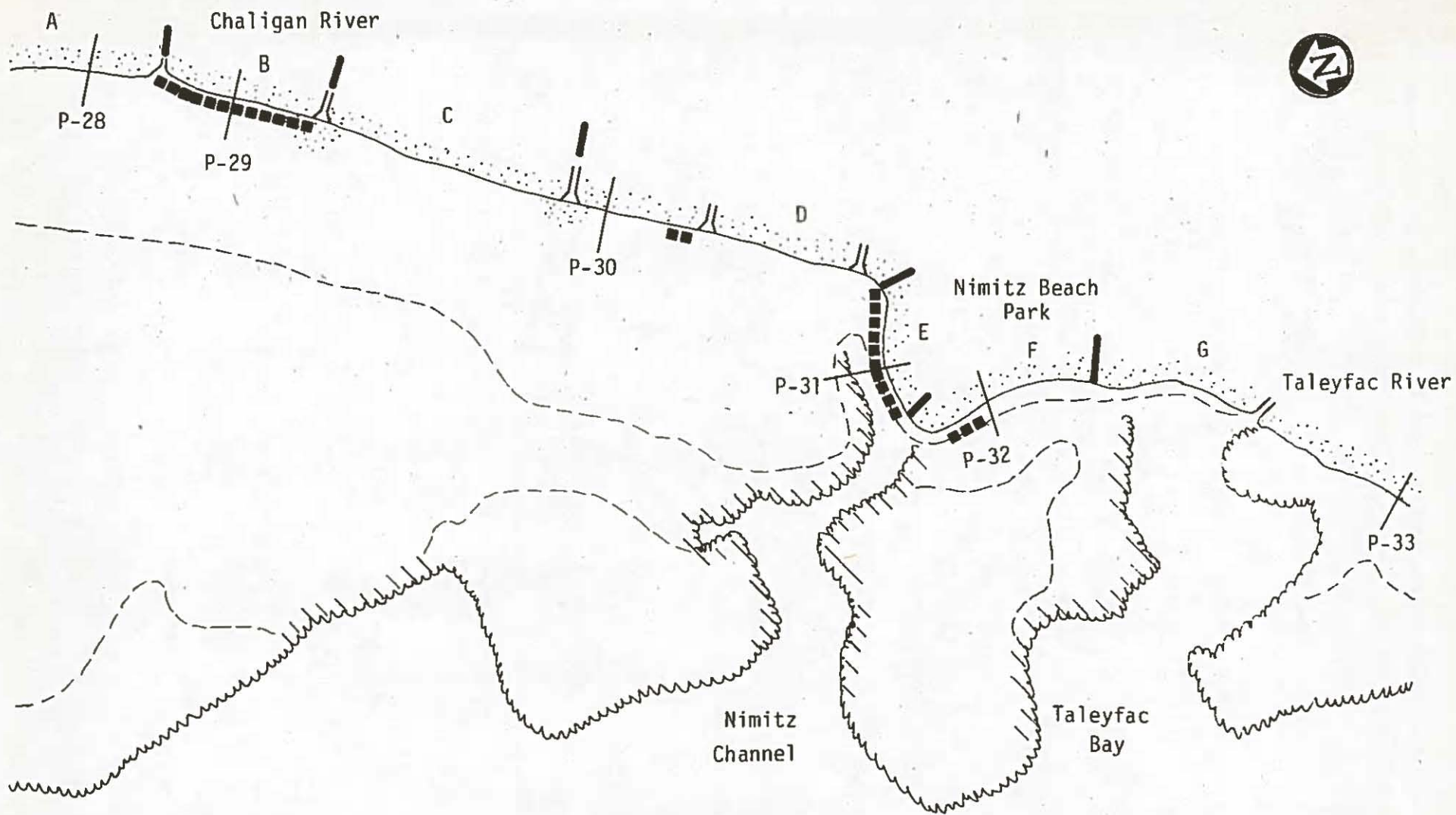


FIGURE 5-4

NIMITZ BEACH PARK AREA

and from erosion of the backshore material. The distinct change in beach material from Reach A to Reach B is indicative of predominant littoral transport to the south.

- The backshore along 400 feet of the reach south of the Chaligan River is eroding. Bare earth is exposed and the maximum height of the scarp is 6 feet. Profile 29 shows a typical cross section. At the point of most severe erosion, the scarp is within 32 feet of the highway.
- Classification - Intermediate erosion.

Reach C (Figure 5-4)

- 10- to 15-foot wide intertidal beach, with the vegetation line at the high water mark. Beach material is poorly sorted sand, primarily calcareous.
- Intertidal reef flat is primarily coral rubble and outcrops of intermittent reef rock pavement.
- Route 2 parallels the shoreline, approximately 70 feet back from the beach. The area is grassy open space.
- Stable.



Typical View, Reach C

Reach D (Figure 5-4)

- Narrow (10 to 15 feet) strip of beach consists of poorly sorted calcareous sand with a scattering of basalt.
- Road parallels the beach, separated by a grassed backshore berm, typically 50 feet wide (Profile 30).
- A small intertidal delta has formed at each of the three culvert discharges in Reach D. The delta material is mud, silt and basalt and coral cobbles. The nearshore reef flat has a thin cover of alluvial mud and silt.
- Some erosion is occurring immediately north of the middle culvert in Reach D, extending a distance of 200 feet. A 3-foot scarp has formed and some coconut trees are undercut.
- Classification - Intermediate erosion.



Beach North of Nimitz Beach Park

Reach E (Figure 5-4)

- The narrow foreshore (approximately 10 feet wide) consists of coral rubble with intermixed sand. The sand is a mixture of basalt and calcareous material.
- The north side of Nimitz Beach Park is eroding, apparently under the influence of locally generated trade wind waves on the reef flat north of the site.
- The erosion has resulted in a 4-foot to 5-foot wave-cut scarp along most of Reach E. Coconut trees are undercut in places and the scarp is within 5 feet of some of the picnic tables. Profile 31 shows a typical scarp cross-section.
- Classification - Intermediate erosion.



Erosion, North Side of Nimitz Beach Park



Erosion, North Side of Nimitz Beach Park

Reach F (Figure 5-4)

- Reach F forms the west boundary of Nimitz Beach Park. The beach width is typically 30 feet with a slope of 1 on 8 (Profile 32).
- The material is 60 percent basalt, 40 percent calcareous.
- A 200-foot length just south of the point is eroding. The backshore terminates in a 1-foot to 3-foot scarp. The erosion ranges from minor to intermediate.
- The point at the boundary between Reaches E and F appears to be accreting.
- The reef flat off Reach F is approximately 1,600 feet wide. The reef flat is bounded by the Nimitz Channel on the north and Taleyfac Bay to the south. There is some silt apparent on the inner reef flat.



Reach F, Nimitz Beach Park

Reach G (Figures 5-4 and 5-5)

- Reach G consists of a continuous series of gentle crescent beaches, extending from the south boundary of Nimitz Beach Park to a rocky point at the mouth of Taleyfac Creek, a distance of 3,100 feet. The Taleyfac River discharges across the center of Reach G.
- A marked change in beach material occurs at the beach cusp at the boundary between Reaches F and G. The sand is brown, reflecting the high terrestrial content, probably from the Taleyfac River. The sand is poorly sorted, primarily basalt and alluvial with a 30 to 40 percent calcareous content. The material south of the Taleyfac River is coarser than that to the north. North of the river, the material is well sorted, fine, brown alluvial sand.
- The rocky point is a volcanic outcropping, the northern most boundary of the volcanic rock shoreline typical of the area to the south.
- The reef flat is approximately 600 feet wide off the southern part of Reach G. Taleyfac Bay a deep, wide channel extending almost to the shoreline, bounds the northern part of Reach G.
- A shallow alluvial delta of mud and silt has formed off the mouth of the Taleyfac River. The inner reef flat south of the river is also mud and silt. The silt on the reef decreases north of the river.
- The narrow beach gently slopes up to a vegetated backshore. Vegetation consists of vines, grass and trees overhanging the beach. Profile 33 is typical of Reach G.
- The backshore area has a few houses visible from the beach. They are set well back and the shoreline is undisturbed.
- Reach G is stable, no erosion.



Mouth of Taleyfac River

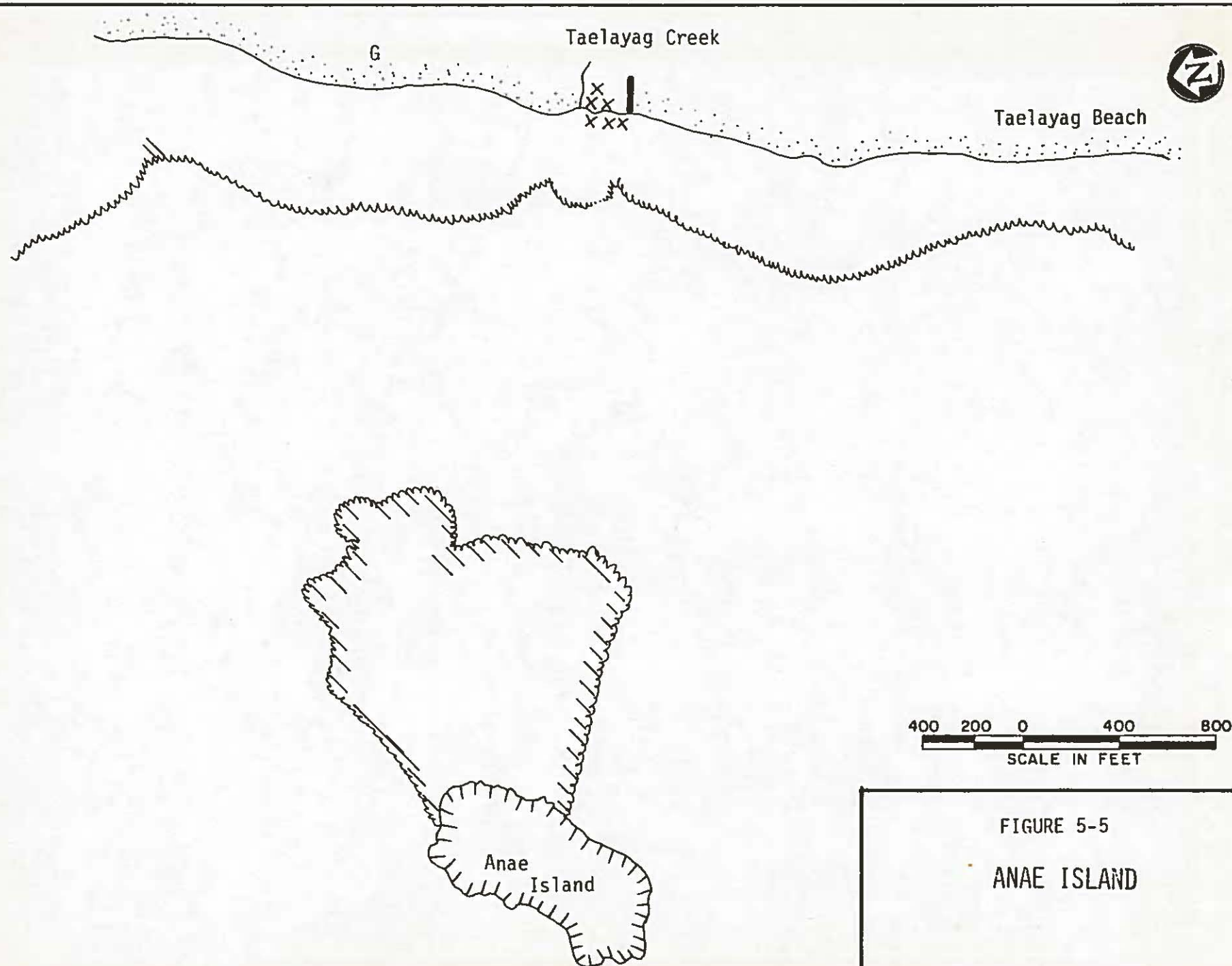


FIGURE 5-5

ANAE ISLAND

SECTION 6

UMATAC BAY

The shoreline from Taelayag Beach to the start of the Cocos Barrier Reef, which includes Umatac Bay, consists of rocky volcanic headlands, steep volcanic shorelines, and small beaches at the heads of bays. The coastline forms several prominent embayments; Sella Bay, Cetti Bay, Fouha Bay and Umatac Bay (Figure 6-1).

Lowlying narrow terraces of limestone border much of the shoreline. The terraces are solution pitted with irregular surfaces, and generally less than three feet above the level of the bordering reef platform. Most beaches are small pocket beaches, located at the head of the embayments. Beach material is a mixture of basalt, red clay derived from volcanic rock and calcareous sand.

The bordering reef flat is narrow intertidal reef. The inner parts of the fringing reefs are often composed of basalt which has been eroded to mean sea level. The outer parts of the basalt platforms are veneered by recent deposits of reef limestone.

The backshore area is the steep, mountainous volcanic land of southern Guam, and is drained by many rivers. The rivers are short and steep with no well defined estuaries. Channels cut completely through the fringing reef at the mouths of the larger rivers.

Route 2 is located inland, at elevation of 100 to 750 feet, except at Umatac where it parallels the shoreline. The only development is at the village of Umatac. Umatac is the only part of this coastal sector where the shoreline is easily accessible.

Several historical sites are located in the vicinity of Umatac Bay. Fort San Jose (Ruins), Fort Santo Angel (Ruins) are on the bluff north of Umatac Bay; Megellan Monument is at the head of the bay; Fort Soledad (Ruins) is located on the bluff south of Umatac Bay.

This coastal sector is in the lee of the predominant trade winds and the wave climate is generally mild, except during the approach of tropical storms or hurricanes.

The shoreline of Umatac Bay is described in more detail below.

Reach A (Figure 6-2)

- Reach A consists of steep volcanic rock shoreline alternating with low-lying pitted limestone terrace.
- Narrow intertidal reef flat consists of eroded volcanic rock terrace off the volcanic shoreline and reef rock pavement off the limestone shoreline.
- The ruins of Fort Santo Angel and Fort San Jose are located on the bluff behind the shoreline.
- Stable, no backshore development.

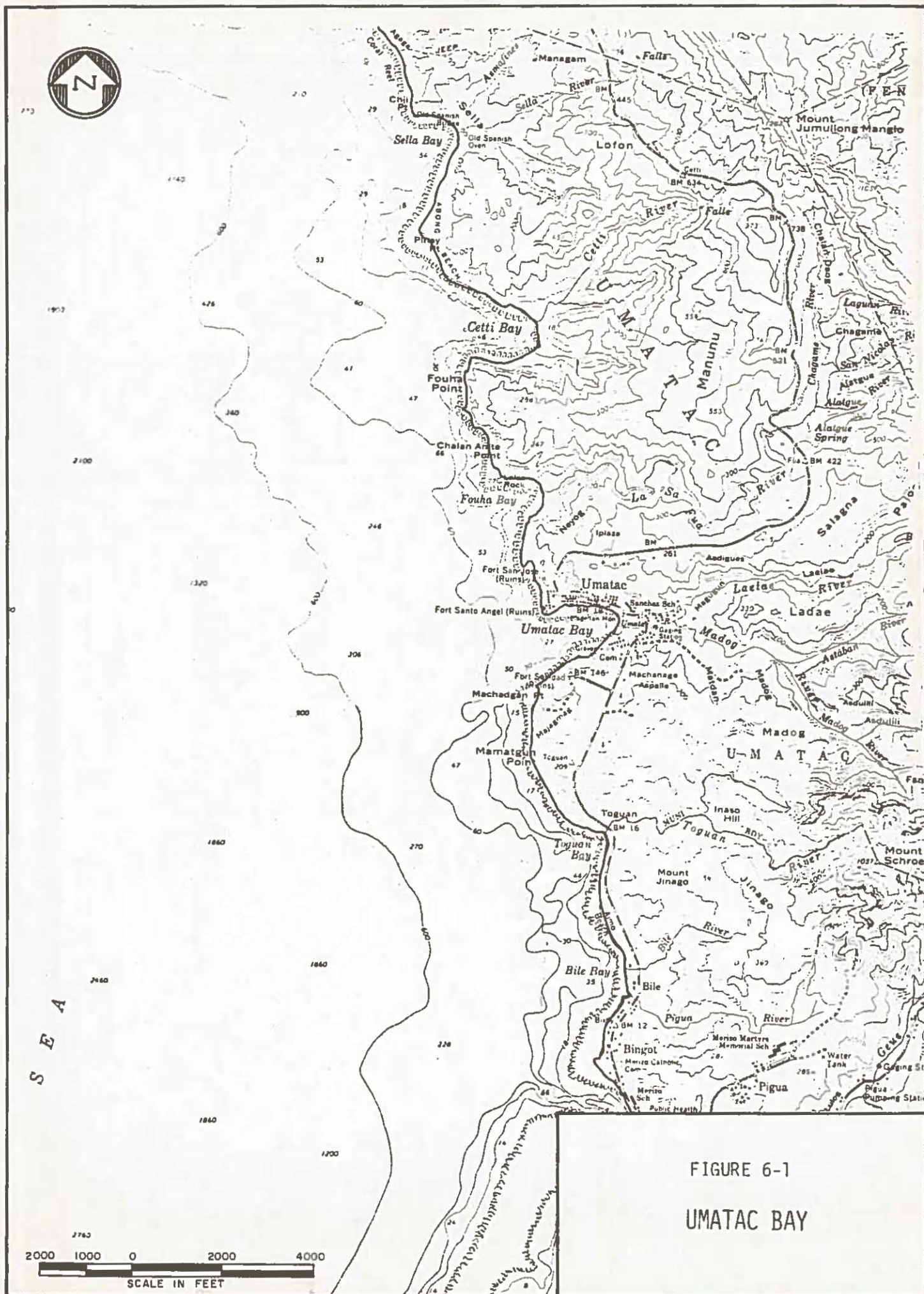


FIGURE 6-1

UMATAC BAY

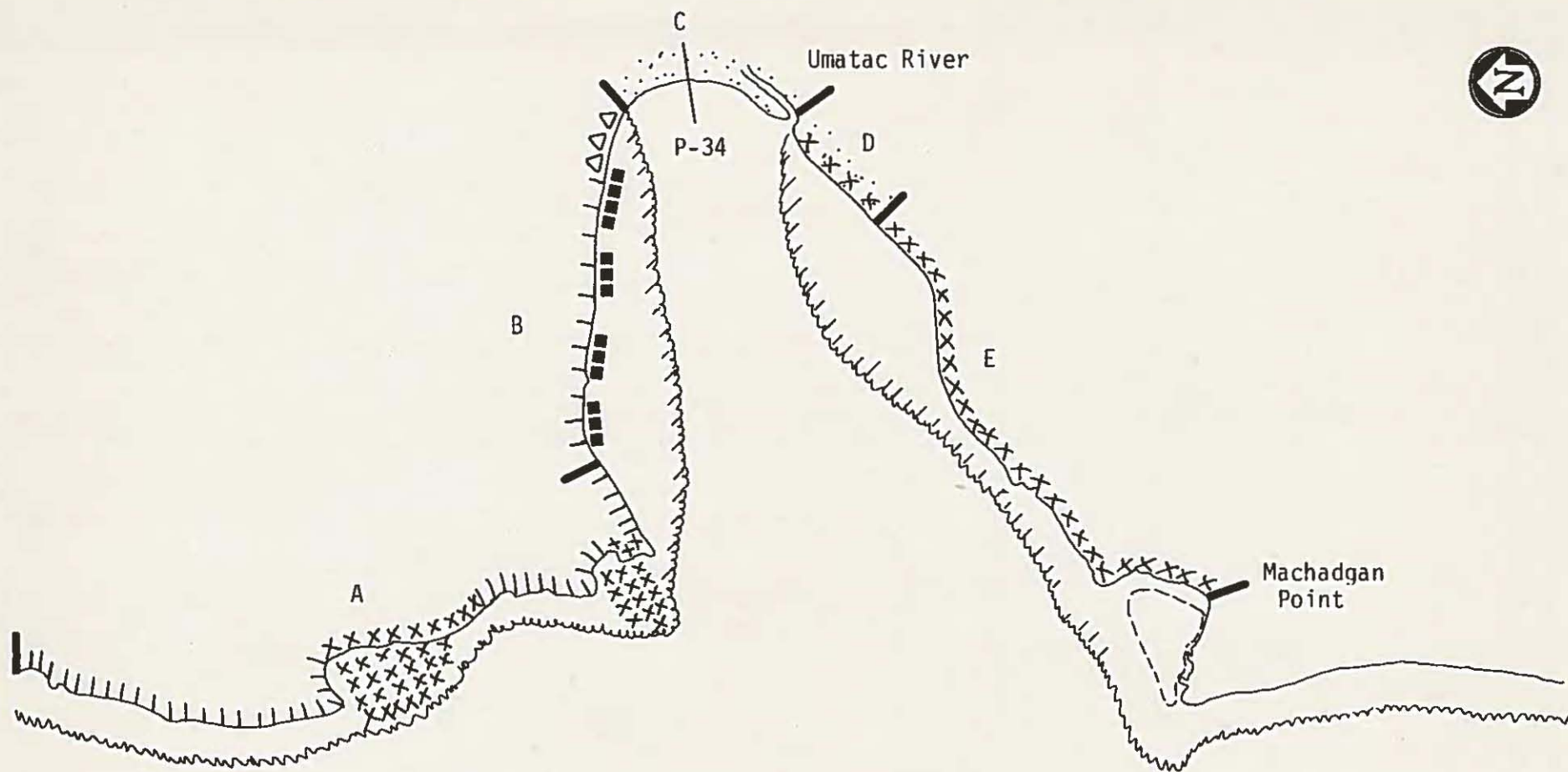


FIGURE 6-2

UMATAC BAY

400 200 0 400 800
SCALE IN FEET

Reach B (Figure 6-2)

- 1,000-foot long reach extending along the north side of Umatac Bay.
- The main part of the village of Umatac is located on the backshore of Reach B. The strip of land between Route 2 and the shoreline is lined with houses. Most are at an elevation of 10 to 15 feet, on top of what appears to be filled land. A few of the homes built close to the water are protected by hollow tile seawalls.



Umatac Bay, North Side

- The backshore berm slopes steeply down to the intertidal shoreline, which consists of an intermittent protruding limestone bench, boulders, and scattered patches of sand. The sand is a poorly sorted mixture of calcareous and basalt material. The percent of calcareous material increases with distance from the river mouth at the head of the bay.
- Intermittent, minor erosion is occurring throughout Reach B. Although the fill material of the steep bank can be eroded by big waves, the underlying limestone bench stabilizes the shoreline at mean sea level.

Reach C (Figure 6-2)

- 750-foot long crescent beach at the head of Umatac Bay. The beach width varies, up to 75 feet wide.
- The beach material is 91 percent basalt, primarily sand and cobbles, with the remaining 9 percent calcareous. The Umatac River discharges on the south side of the beach and is the source of the volcanic material.



Head of Umatac Bay

- There is no fringing reef fronting the beach. A deep channel extends to the shoreline.
- Route 2 is located slightly inland around the head of Umatac Bay, and the backshore area is a public park. Park facilities include picnic tables, a shower, basketball court, and water fountain. A grouted limestone retaining wall separates the park area from the beach (Profile 34).
- Stable, no erosion.

Reach D (Figure 6-2)

- A 400-foot length of shoreline south of the Umatac River consisting of a narrow strip of basalt sand and rubble. The vegetated backshore rises steeply to a row of houses at the lot to 15-foot elevation.
- Stable.



Umatac Bay, South Side

Reach E (Figure 6-2)

- Volcanic rock shoreline, with steep slopes and cliffs.
- The narrow reef is reef rock pavement.
- The ruins of Fort Soledad are located on the bluff above Machadgan Point.
- Stable.

SECTION 7

MERIZO

The Merizo area includes the coastal region between the mouth of Mamaon and Manell Channels (Figure 7-1). The predominant feature is Cocos Lagoon, enclosed by Cocos Island and the Cocos Barrier Reefs. Cocos Lagoon, including the barrier reefs, has an area of 3.9 square miles. The depth within the lagoon ranges from 10 to 45 feet. Two deep channels connect the lagoon waters with the open sea; Mamaon Channel and Manell Channel.

The landward margin of the lagoon is bordered by a low, narrow alluvial coastal plain backed by steep volcanic mountainous land. The Geus River forms a broad alluvial valley at the head of the Mamaon Channel. The village of Merizo is located in this valley. Several small rivers form alluvial valleys and a broad coastal plain at the head of Manell Channel.

The shoreline along Cocos Lagoon is bordered primarily by alluvium. Near the mouth of the Geus River and at Achang Bay, the shores are mud flats and mangrove swamps. A nearshore shelf extends seaward from the alluvial plain. The width varies from less than 100 feet to 1,300 feet, gently sloping to a depth of 5 feet at the seaward margin. The shelf then gives way to the deeper lagoon or channel waters.

The Mamaon Channel is fairly straight and about one mile long. The depth is 100 feet where it passes through the barrier reef. The current in the channel flows strongly outward at ebb tide, and is weak and variable during flood tide. The deep water Manell Channel provides access to the ocean, but a broad reef prevents passage into Cocos Lagoon except for small boats at high tide.

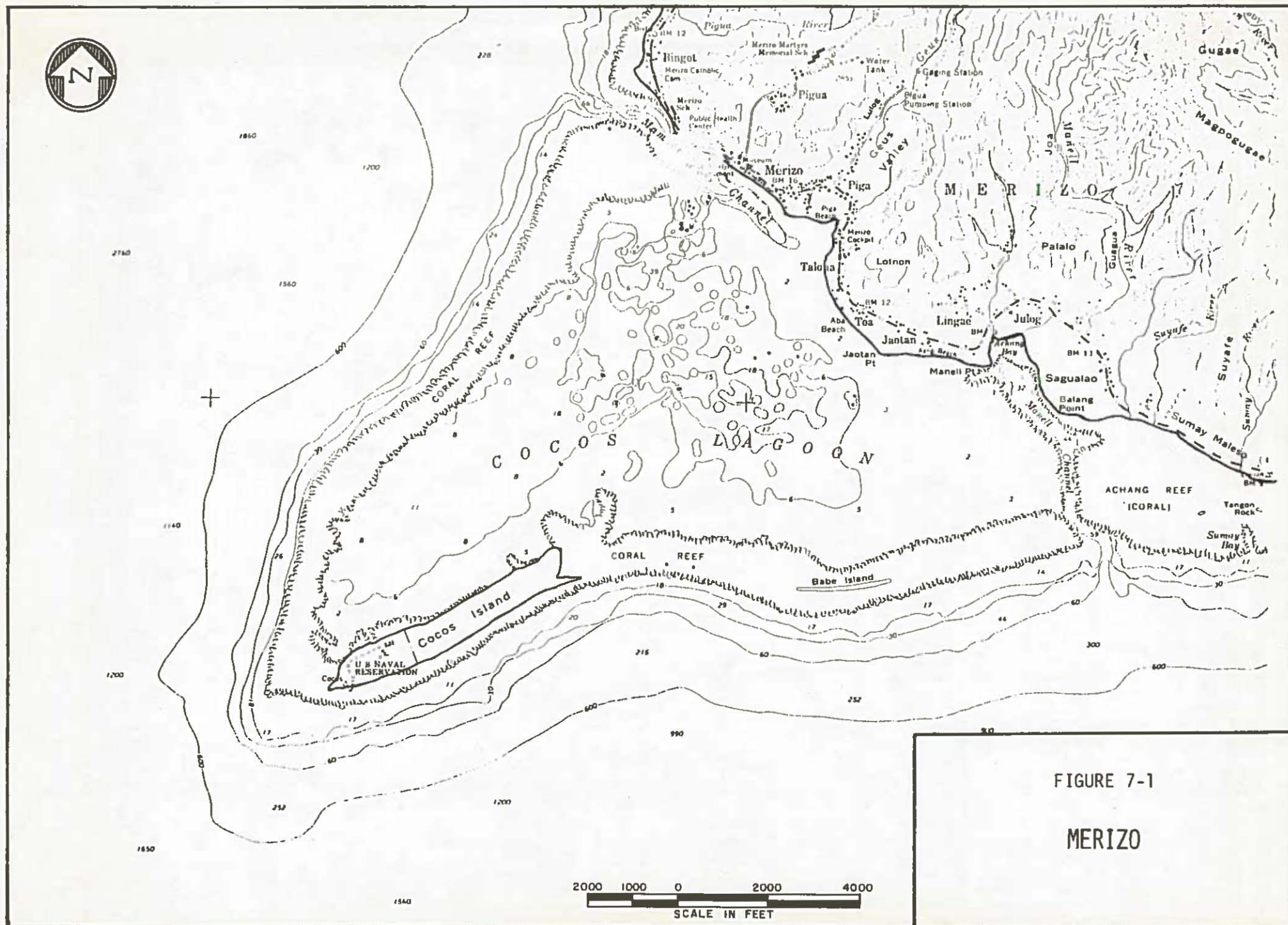
The shoreline is extensively developed and altered from its natural condition. The village of Merizo occupies most of the shoreline, with residential and commercial development concentrated along the coastline bordered by Mamaon Channel. Several marinas and piers are located along the narrow fringing reef shelf between the shoreline and Mamaon Channel.

The density of development diminishes from the Geus River to Achang Bay. Route 4 is located slightly inland, and mangroves fringe much of the shoreline. There is little development along the shoreline of Achang Bay and Route 4 remains inland. There are extensive mangroves along Achang Bay extending to the Suyafe River.

The protected waters of Cocos Lagoon are widely used for recreation, including boating, sailing, glass bottom boat tours, water skiing, snorkeling, diving and shell collecting.

Reach A (Figure 7-2)

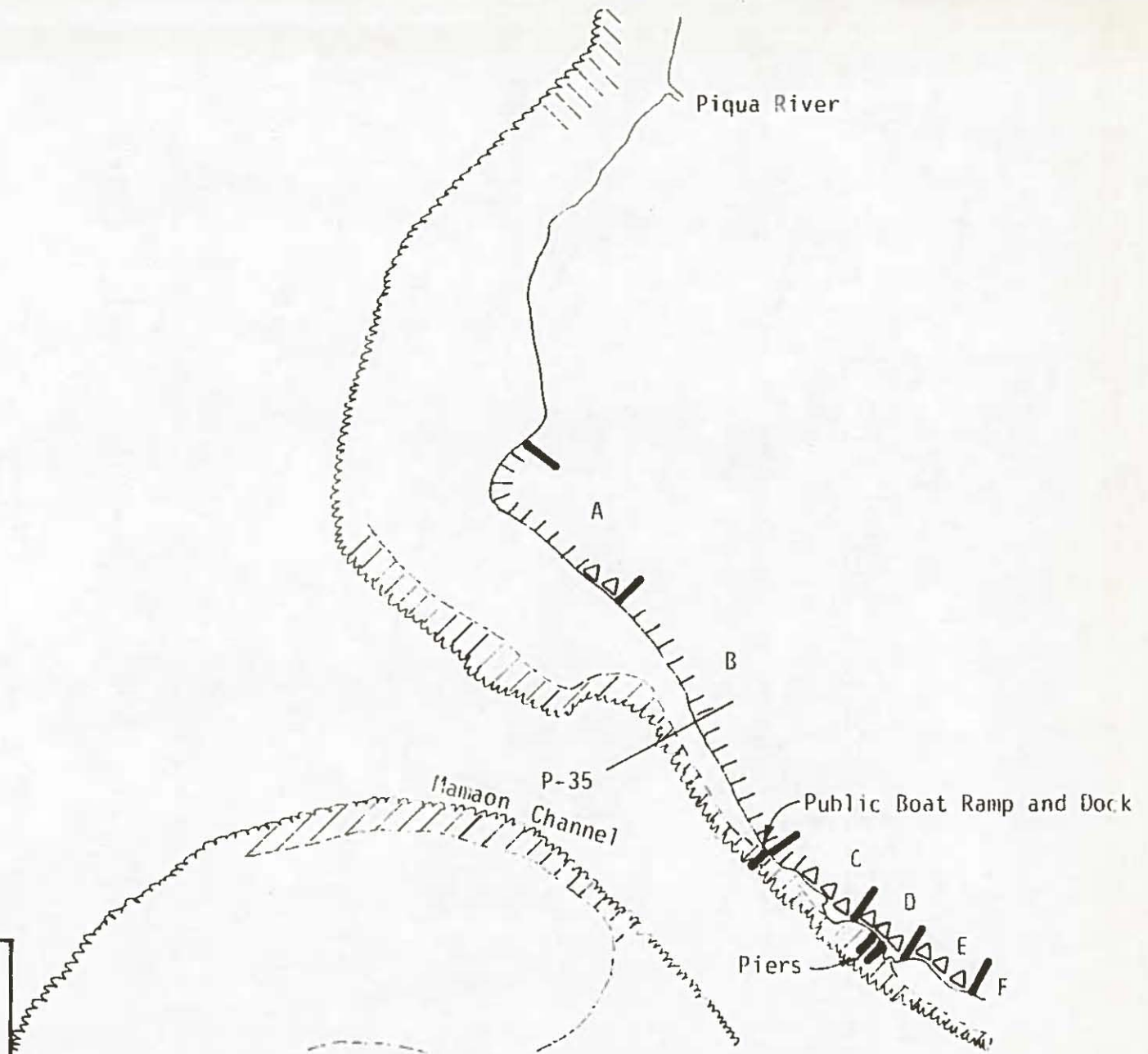
- Rocky shoreline consists of low-lying limestone terrace.
- Route 4 is located inland, except at the south end of Reach A, where it closely parallels the shoreline.





400 200 0 400 800
SCALE IN FEET

FIGURE 7-2
MERIZO, NORTH END



- There is no development except for a combined gas station/house at the south end, squeezed between the highway and shoreline. The structure is protected by a vertical retaining wall 12 to 15 feet high located at mean lower water.
- Intertidal reef flat is 350 feet wide.
- Stable, no erosion.

Reach B (Figure 7-2)

- 600-foot long reach consisting of a park with a public boat launching ramp and loading dock at the south end.
- Profile 35 shows a typical cross-section of the park. The backshore, at the 10 to 15-foot elevation slopes steeply to the shoreline. The steep bank is densely vegetated with vines, brush and small trees. The narrow intertidal shoreline is medium to coarse sand mixed with limestone boulders and an intermittent limestone bench.
- The intertidal reef flat narrows to 100 feet and consists of reef rock pavement veneered with silt sand, gravel and coral rubble.
- Stable.

Reach C (Figure 7-2)

- 300-foot long sector with houses built along the shoreline.
- Shoreline is a mixture of coral rubble, boulders, and calcareous sand. One or two of the houses are protected by a vertical concrete seawall.
- Stable.



Seawall, Reach A



Park Shoreline, Reach B



Typical View, Reach C

Reach D (Figure 7-2)

- Private marina with two docks, a fuel pier, marine railway, and boat launching ramp.
- Marina is a base for boats carrying tourists to Cocos Island and a charter fishing boat. Boats have access to open ocean through Mamaon Channel.



Marina, Reach D

Reach E (Figure 7-2)

- 300-foot long reach bounded by marina on the north and a small private boat ramp in the south.
- The shoreline is intermittent rubble, debris, and small boulder seawalls. Vines and brush extend to the shoreline.
- The houses are set back from the shoreline.
- Stable, no apparent erosion.



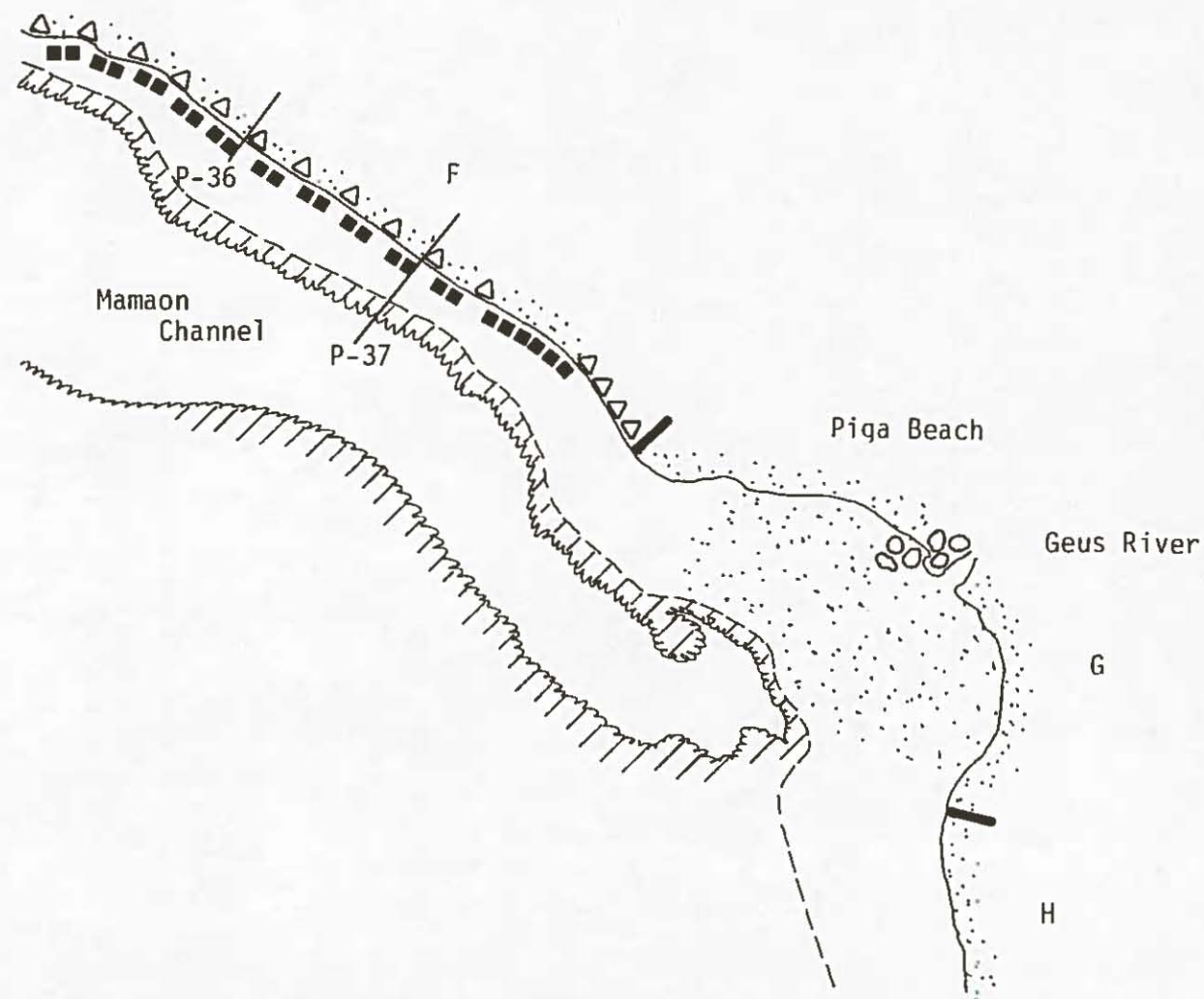
Foreshore, Reach E

Reach F (Figure 7-3)

- 2,200-foot long reach fronting the main developed area of Merizo. A narrow coastal strip between the shoreline and Route 4 is developed with houses and small businesses.
- The intertidal shoreline consists of coral gravel, rubble, alluvial material and debris. There is no beach. The percentage of alluvial material increases to the south.
- The houses are typically at elevations of 6-10 feet, although some are lower. Most are protected by rudimentary seawalls, ranging from single rows of limestone boulders to steel reinforced hollow tile walls. The condition of the walls ranges from excellent to very poor. Profiles 36 and 37 show two typical cross-sections. The distance from the road to the shoreline in Profile 36 is typical of this reach. On unprotected lots, the vegetation line extends to mean high water. Unprotected areas have a wave-cut scarp of 2 to 3 feet.



Rubble Seawall, Reach F



400 200 0 400 800
SCALE IN FEET

FIGURE 7-3
MERIZO AND PIGA BEACH



Grouted Seawall, Reach F



Unprotected Shoreline, Reach F

- The reef flat is 200 to 300 feet wide, and covered with a layer of mud, especially at the south end of the reach. The nearshore water is turbid. Numerous small boats are moored on the inner reef flat.
- Two small streams discharge into Reach F and both have formed small alluvial deltas on the reef flat.
- Several houses are built within 20 feet of the water, one right at the mean low waterline. During onshore winds, the houses may be subject to wave damage.
- A small park is located at the north end of the reach. The site is protected by a grouted limestone wall which is deteriorating. Other than at the park, there is no public access to the shoreline.
- Intermediate erosion is occurring throughout the reach.

Reach G: Piga Beach (Figure 7-3)

- The shoreline forms a small, shallow embayment at the mouth of the Geus River. The Mamaon Channel dead-ends on the reef flat off the river, and a large mud flat has formed between the river mouth and the channel.
- Route 4 swings inland at the Geus River and a few houses are located between the highway and the shoreline. Most of the area is undeveloped and the coastal land is covered by dense brush and vegetation. Mangroves border the shoreline on both sides of the river.



Piga Beach at Low Tide



Piga Beach, East End

- The vegetation extends to the mean high waterline and grades directly into the mud covered reef flat. The amount of mud on the reef decreases near the south end of the reach.
- A 120-foot length of shoreline near the north end of the reach is protected by a row of small limestone boulders. There is some minor erosion around the tree roots behind the boulders. The rest of the reach is stable.

Reach H: Aba Beach (Figure 7-4)

- Reach H is similar to Reach G except that there is less mud on the inner reef and there are four houses built close to the shoreline. The house at the east end is protected by a well built hollow tile wall built at mean sea level. The adjacent house has a small private boat ramp protected with a rubble jetty. A small channel has been dredged parallel to the jetty to provide small boat access to the deeper lagoon waters. There is minor erosion between the jetty and the tile wall. The remaining shoreline has vegetation to the mean high water line.
- The four houses are at a low elevation (less than 10 feet) but the lagoon and barrier reef offer protection from southerly storm waves.
- The reef flat gradually gives way to the deeper lagoon waters.



Typical View, Reach H

Reach I (Figures 7-4 and 7-5)

- Extensive length of shoreline bordered by mangroves extending to the Suyafe River, the east boundary of the Merizo coastal sector.
- The mangroves are backed by dense brush and vegetation. The highway is 800 to 1,400 feet inland and only a few houses are on the seaward side of the road. The shoreline is not easily accessible through this reach. Much of the back-shore is a swampy alluvial plain.
- The Manell River discharges at the head of Achang Bay, a small embayment in the center of the reach. The Manell Channel begins off the mouth of the river but the channel does not cut completely through the fringing reef flat. A small boat channel has been dredged on the west side of Achang Bay in order to provide access to the deep water of the Manell Channel. The channel is bounded by man-made jetties on each side. The jetties are constructed of fill protected by randomly dumped limestone boulders. They are in poor condition and eroding, but mangrove sprouts are growing along the jetty waterline and should stabilize the banks. There is a small mooring basin at the head of the channel. Facilities are rundown and consist of only a shed and a wooden dock in poor condition. The basin is limited to small boats, but there is no launching ramp.



Mangrove Shoreline, Reach I

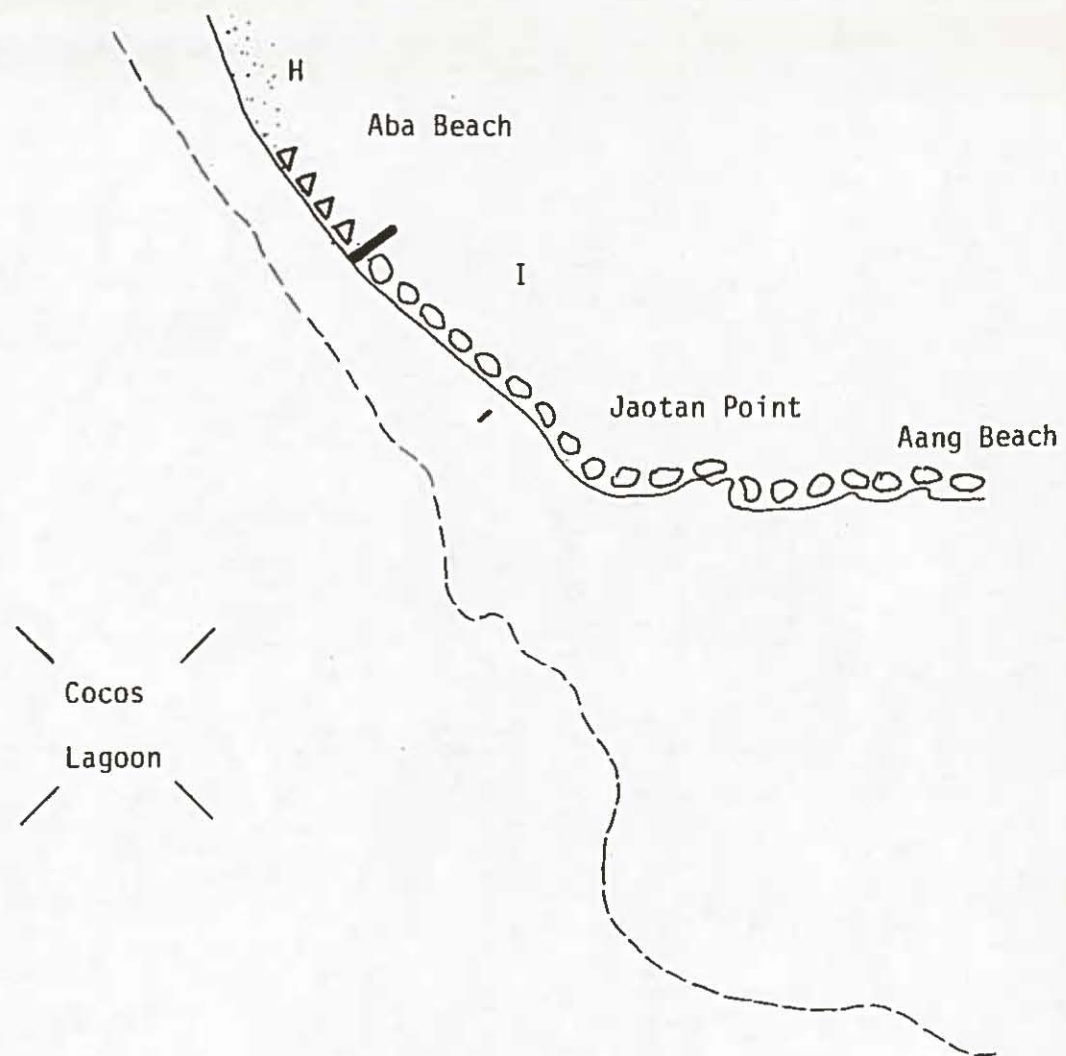
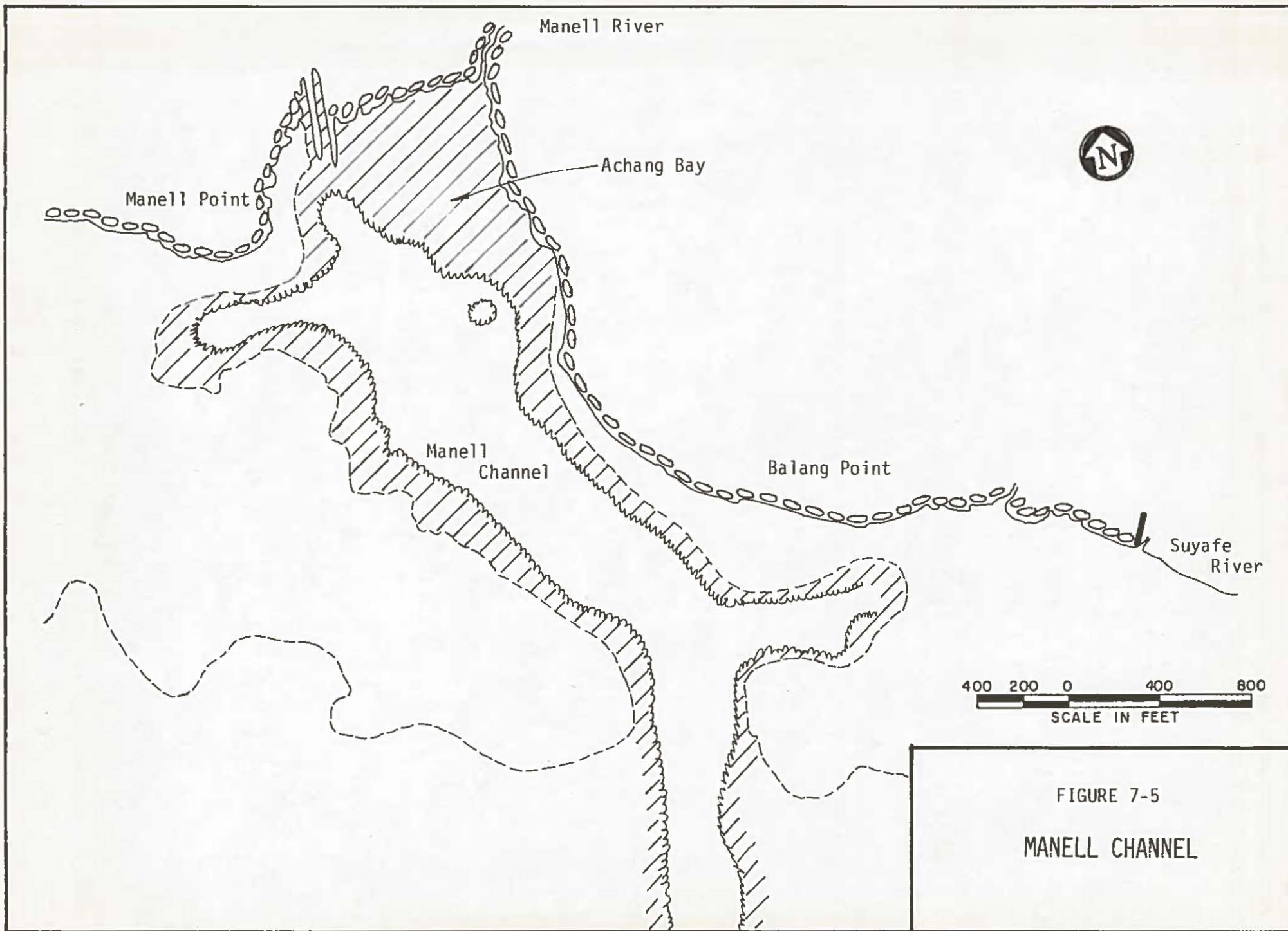


FIGURE 7-4
ABA BEACH, JAOTAN POINT,
AND AANG BEACH



- The fringing reef flat is very wide between Aba Beach and the head of Manell Channel. The reef is veneered with sand, gravel, coral rubble, and some mud along the mangrove shoreline.

SECTION 8

MANELL CHANNEL TO INARAJAN

This sector extends 6 miles along the southeast coast of Guam. The shoreline consists of sand and alluvial beach deposits, with intermittent areas of irregular limestone terraces. The shoreline is backed by intermittent limestone terraces, low alluvial plains, and volcanic mountain slopes.

Much of the southeast coast is bordered by wide fringing reef flats. Broad reef flats and prominent algal margins extend from Agfayan Point to the Manell Channel. Narrow reefs and cut benches at the 6-foot elevation predominate at headlands and from Agfayan Bay to Inarajan Bay. Unconsolidated beach sediments are more extensive along sections of the coast bordered by wide reef platforms. The part of the coast bordered by a narrow fringing reef generally has intermittent patches of beach deposits separated by rocky shorelines.

Twelve rivers and streams drain the backshore area. River channels cut completely through the reef flat at Ajayan, Agfayan and Inarajan Bays. Partial channels indent the reef flat at Sumay Bay, Asgadao Bay and Malillog Point.

Beaches have formed at the heads of all bays in the sector except at Inarajan Bay. Beach deposits form a wide coastal terrace extending from Balang Point to Agfayan Point. Basalt content of the beaches ranges from 0 to 90 percent. The basalt content is highest near the mouths of the rivers.

Route 4 parallels the shoreline along the entire sector and provides easy access to the coast. Residences and small farms are widely scattered from the Manell Channel to Agfayan Bay. Inarajan is the only village in the sector. This section of the coast is utilized by fishermen, snorkelers, divers and picnickers.

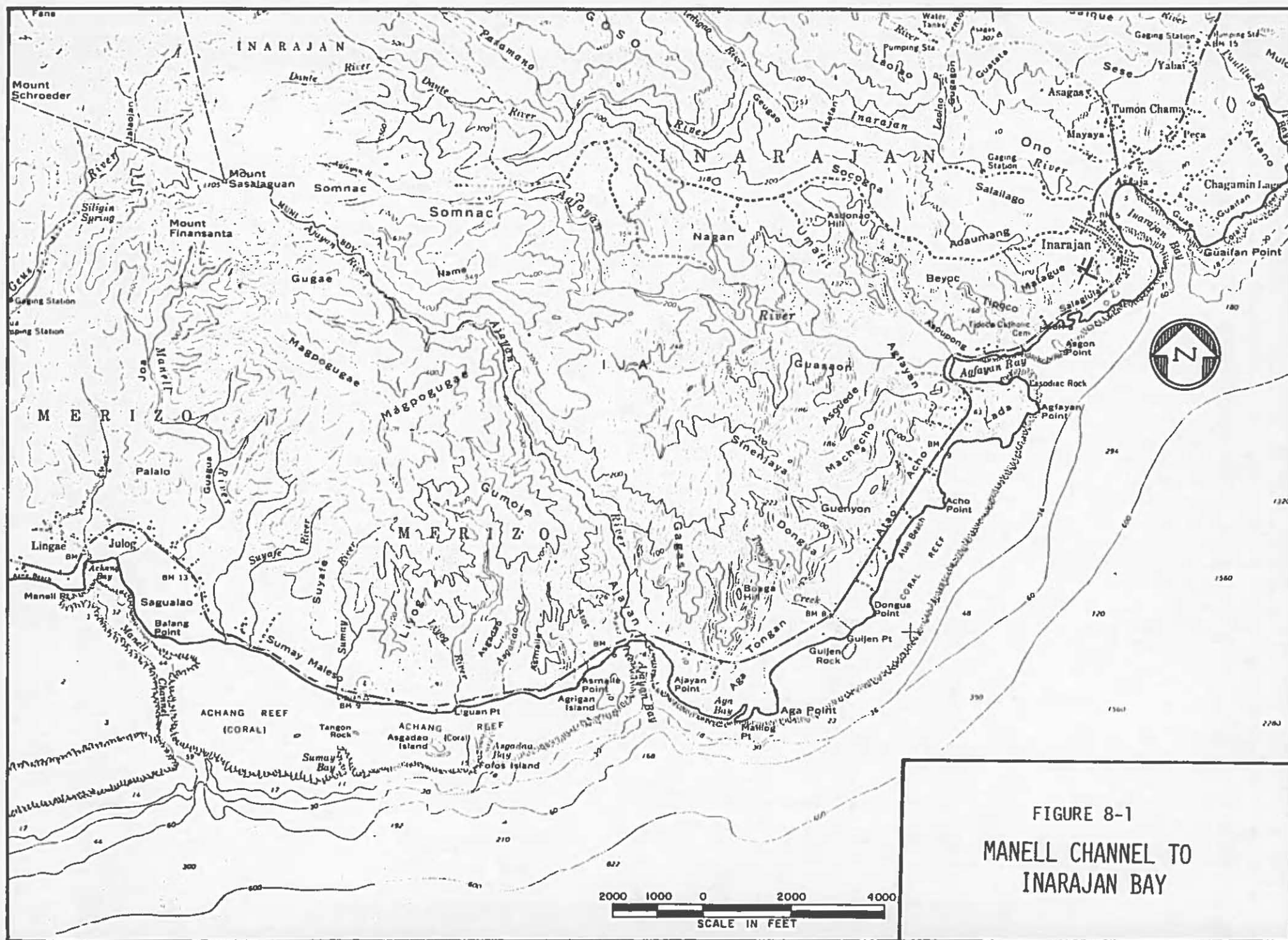
The sector is described in more detail below.

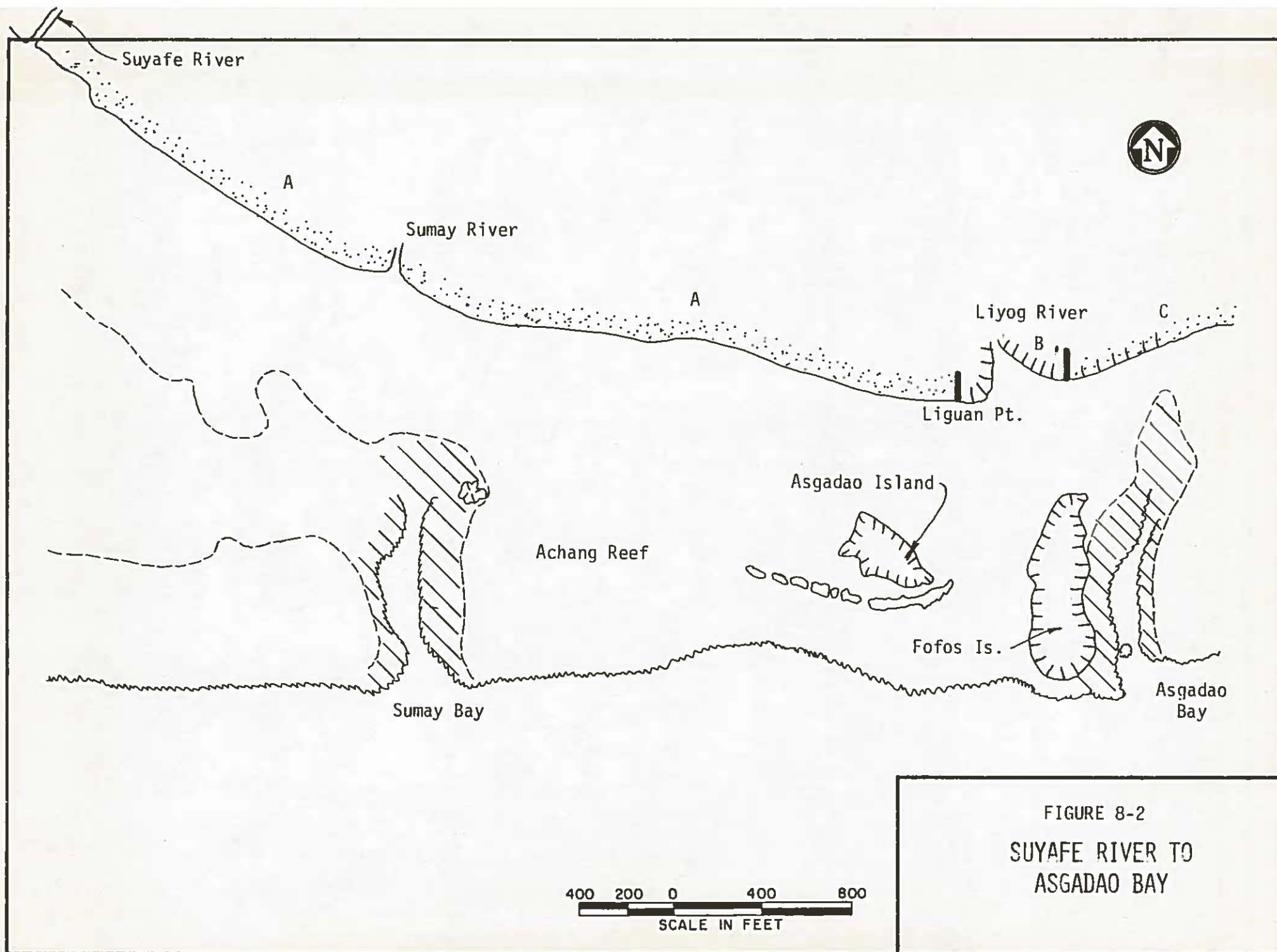
Reach A: Suyafe River to Liguana Point (Figure 8-2)

- The shoreline of this 5,200-foot long reach consists of a narrow sandy beach. The beach width varies from 10 to 30 feet. Along most of the reach, the water level at high tide reaches the vegetation line and no beach is visible.
- The sand is primarily calcareous, mixed with volcanic material which becomes more abundant near the river mouths. The volcanic content is 42 percent at the west end of the reach and 14 percent at the east end (Emery, 1962).
- The Sumay River discharges at the center of the reach. A small alluvial delta of silt, sand and gravel has deposited on the reef platform off the mouth of the river.



Intertidal Beach, Reach A





- A wide fringing reef borders the shoreline. The reef is 2,700 feet wide at the west end and narrows to 1,200 feet at the east end. A partial channel cuts halfway across the reef flat at Sumay Bay, corresponding to the Sumay River mouth. West of Sumay Bay, there is a defined inner reef flat moat system.
- East of Sumay Bay, the reef consists of an intertidal reef flat with minor holes and depressions. The inner part is veneered with sand, gravel, and coral rubble; the outer part is reef rock pavement.
- Route 4 parallels the shoreline, located 50 to 200 feet inland. Most of the area in between is undeveloped and covered with brush, trees and grass, but there are a few scattered houses seaward of the road. The backshore terrace is formed of old unconsolidated beach sediments. Access to the shoreline is easy all through the reach.
- Stable, no erosion.

Reach B: Liyog River (Figure 8-2)

- Rocky shoreline around the river mouth is a narrow band of pitted limestone.
- Liyog River has formed an alluvial delta on the reef flat.
- A partial channel cuts across the reef flat at Asgadao Bay, opposite the mouth of the river.
- Two limestone islets are located on the reef flat just east of Asgadao Bay.



Liyog River Delta, Reach B

Reach C: Liyog River to Ajayan Bay (Figures 8-2 and 8-3)

- Shoreline consists of small, narrow beaches alternating with rocky points. Beach lengths range from 400 feet to 700 feet; widths are typically 25 feet. Profile 38 is a representative cross-section.
- The rocky areas, shown on Figures 8-2 and 8-3 are either lowlying pitted limestone benches or steep volcanic rock outcroppings. The limestone benches are backed by grassy terraces with calcareous sand thrown up behind the benches.



Typical View, Reach C

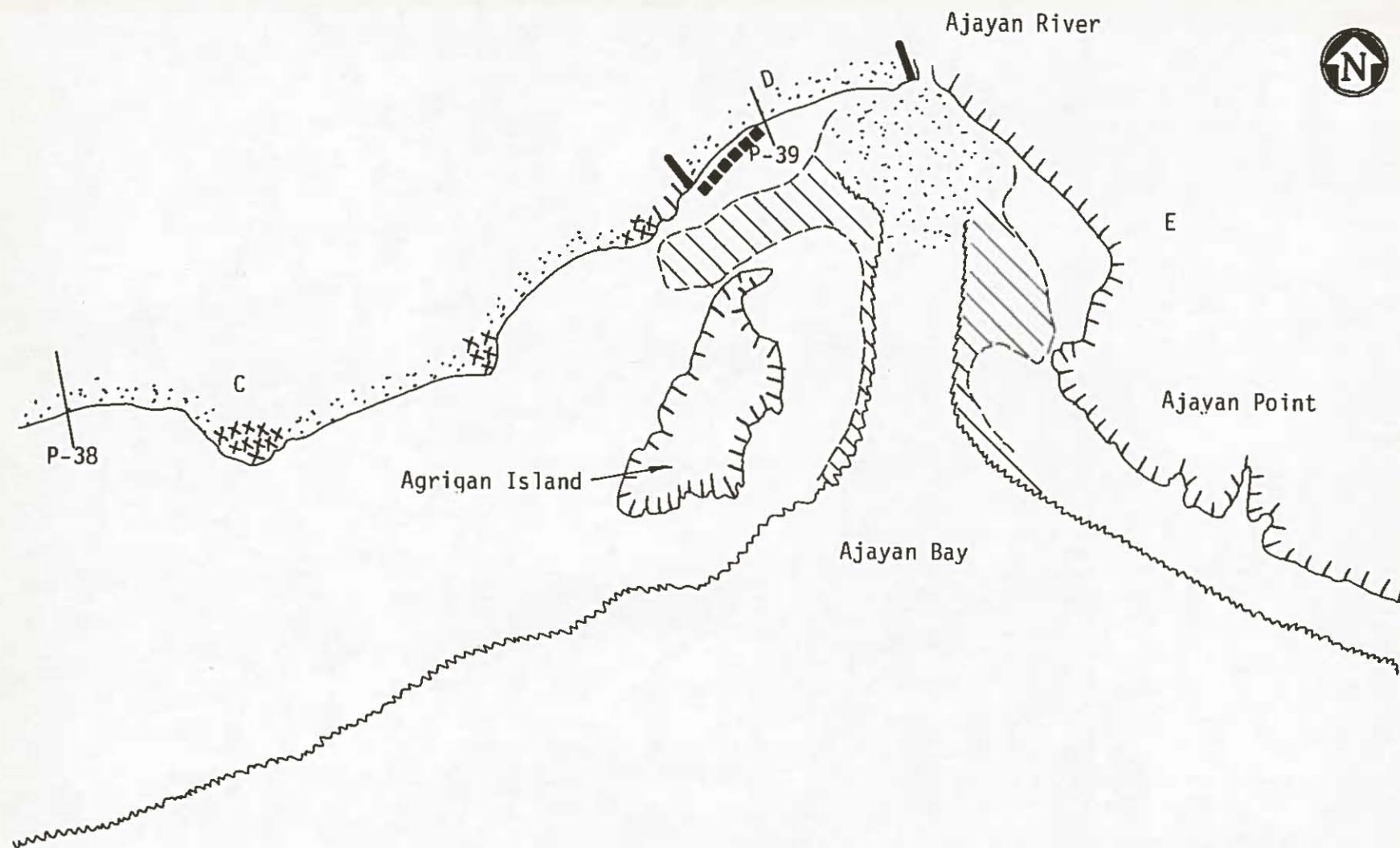


FIGURE 8-3

AJAYAN BAY

400 200 0 400 800
SCALE IN FEET

- The beach material is calcareous sand mixed with up to 30 percent basalt. Scattered coral gravel and rubble are present on the foreshores.
- The intertidal reef flat decreases in width from 1,400 feet at the west end of the reach to 1,000 feet at the east end. The reef substrate is reef rock with scattered sand, gravel and coral rubble. Agrigan Island is a low limestone islet on the reef flat just east of Ajayan Bay.
- Route 4 parallels the coast, located 25 to 300 feet inland. The backshore area is undeveloped - there are no houses or public structures. The area is vegetated with grass, trees and brush. There is easy access to the shoreline throughout the reach.
- Stable, no erosion.

Reach D: Ajayan Bay (Figure 8-3)

- 950-foot long beach at the head of Ajayan Bay. Beach width is 20 to 35 feet with a gently sloping foreshore (Profile 39).
- The east half of the beach is primarily basalt and calcareous sand. Along the west half, the beach narrows and an intermittent limestone ledge protrudes at the waterline. The silt content also increases at this end of the beach.



Minor Erosion, Ajayan Bay

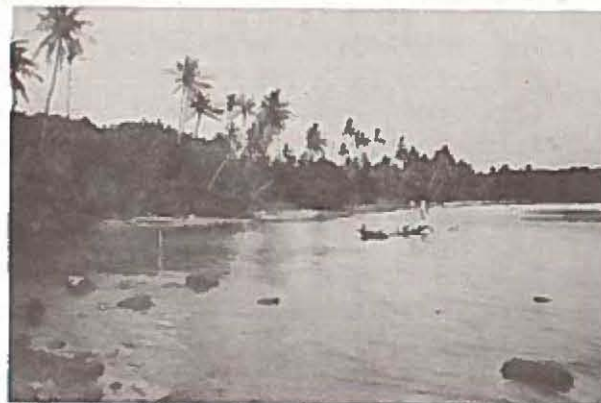


Ajayan Bay, East End

- There is no reef at the head of Ajayan Bay; the deep channel cuts completely through the reef. There is an intertidal reef flat off the west end of the beach (Figure 8-3). An alluvial delta has formed off the river mouth.
- Route 4 parallels the shoreline located approximately 100 feet inland. The strip of land behind the beach is heavily overgrown with coconut trees and brush. Access to the beach is easy but it is not well suited for recreation.
- Minor erosion is occurring along the west half of the beach and coconut trees are being undercut.

Reach E: Ajayan Bay to Aga Bay (Figures 8-3 and 8-4)

- Rocky shoreline consisting of low pitted limestone terrace. Scattered sand is present on and behind the terrace at the east end of the reach along the shoreline of Ajayan Bay.
- Access is difficult, as Route 4 is inland and the area between coastline and road is densely vegetated. There are a few scattered houses along the road.
- Intertidal reef flat is narrow, averaging 150 feet, and the substrate is reef rock pavement with scattered boulders.
- Stable.



Limestone Terrace Shoreline, Reach E

Reach F: Aga Bay (Figure 8-4)

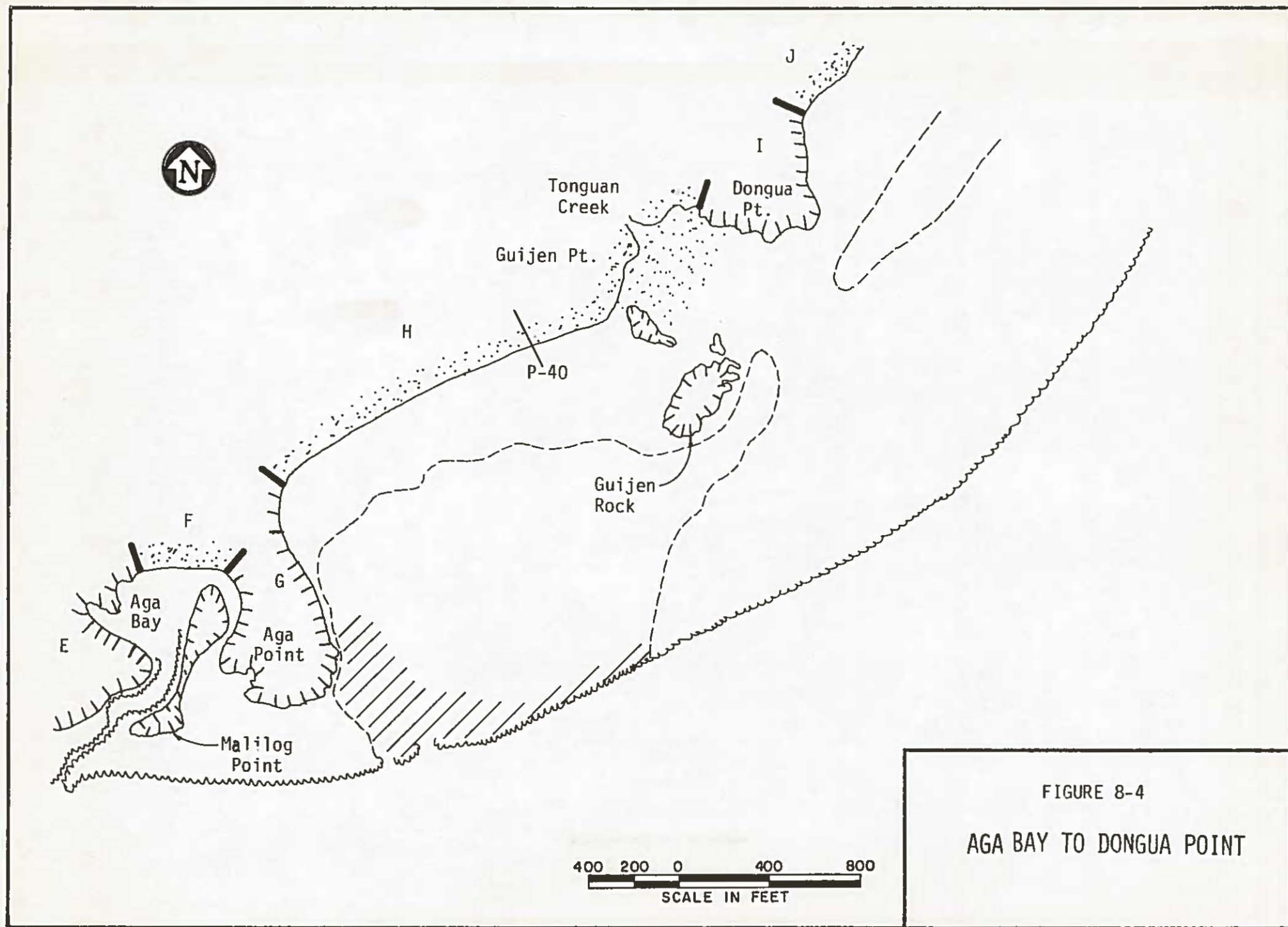
- Small pocket beach at the head of Aga Bay, approximately 400 feet long. The beach is narrow, almost submerged at high tide.
- Beach material is medium to fine, well sorted calcareous sand with a low base salt content and no rubble. There is some silt in the sand and on the reef flat.
- Aga Bay is very well protected by the rocky points on each side and Malilog Point, a small limestone islet that almost completely blocks off the bay.
- The reef flat inside the islet is covered with sand. A narrow channel crosses the reef just west of Malilog Point.
- The backshore is undeveloped and the beach is not easily accessible. Mangroves are taking root at the head of the bay.
- Stable.



Pocket Beach, Aga Bay

Reach G: Aga Point (Figure 8-4)

- Rocky point of low pitted limestone.
- Narrow intertidal reef flat with reef rock substrate.



Reach H: Aga Point to Dongua Point (Figure 8-4)

- Crescent beach bounded by two rocky points. Beach length is 2,200 feet, average width is 50 feet (Profile 40).
- The beach is medium calcareous sand with scattered coral gravel and rubble.
- Fringing reef flat is approximately 1,300 feet wide. A wide inner reef flat, low tide moat and depressed outer reef flat have developed between Aga Point and Guijen Rock. The substrate is reef rock with sand and coral veneer on the inner reef flat. There are numerous small islets at the east end of the reach. There is a large calcareous sand delta off Tonguan Creek, in the lee of the islets.
- Predominant alongshore transport is to the west due to the influence of the trade winds.
- Route 4 parallels the shoreline approximately 250 feet inland. There are a few houses located along the highway, otherwise the backshore area is undeveloped. Public access is available at a number of points.
- Stable, no erosion.



Typical View, Reach H

Reach I: Dongua Point (Figure 8-4)

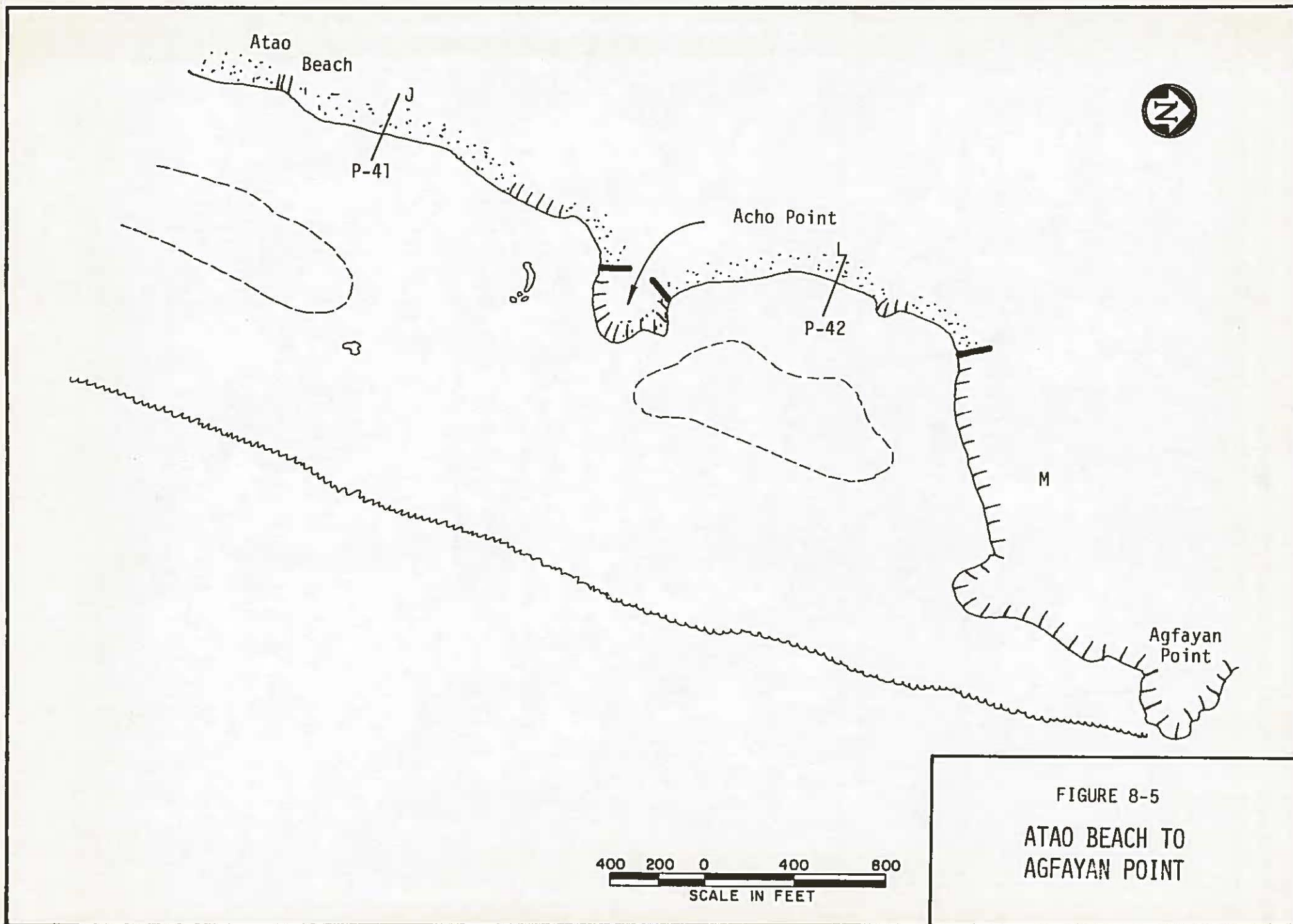
- Rocky point of low pitted limestone.
- Wide (1,300 feet) intertidal reef flat consists of reef rock pavement.
- Stable.

Reach J: Atao Beach (Figures 8-4 and 8-5)

- A 2,400-foot long beach extending from Dongua Point to Acho Point. Typical beach width is 30 to 50 feet (see Profile 41). Beach is interrupted in places by patches of limestone terrace.
- Material is medium-fine calcareous sand with only 1 percent basalt. Extensive coral rubble and gravel is scattered on the beach surface.
- The reef flat is approximately 1,300 feet wide. The reef is predominantly intertidal but there is a minor inner reef flat and moat development in the



Atao Beach, Reach J



center of the reach. The substrate of the inner reef is reef rock pavement veneered with sand, gravel and coral rubble. The outer reef is scoured clean.

- Observed littoral transport was to the west due to influence of the trade winds.
- Route 4 parallels the coast, 300 feet inland. The backshore has a few houses located along the road, but the rest is vegetated.
- The beach appears stable.

Reach K: Acho Point (Figure 8-5)

- Low pitted limestone shoreline with scattered beach deposits on landward side.
- Intertidal reef flat off the point is 1,000 feet wide. The substrate is reef rock.
- The point is undeveloped.
- Stable shoreline.

Reach L (Figure 8-5)

- A 1,400-foot long crescent beach bounded by two limestone headlands. Beach width varies, up to 60 feet. Profile 42 shows a typical cross-section. The beach is divided into two sectors by a short length of limestone terrace.
- Sand ranges from fine to coarse with scattered coral gravel.
- Reef flat is predominantly intertidal with minor inner reef flat and moat development. Substrate is reef rock with sand, gravel and coral rubble veneer inshore.



Reach L

- Backshore is undeveloped. Jeep trails provide access to shoreline.
- Stable.

Reach M: Agfayan Point (Figures 8-5 and 8-6)

- Low pitted and pinnacled limestone shoreline with intermittent beach deposits on landward side. There is a cut bench at Agfayan Point.
- Reef flat width decreases in this reach, down to zero at the point. The reef flat is predominantly intertidal. Substrate is reef rock pavement veneered with sand, gravel and coral rubble along inner part. Reef width remains narrow along south side of Agfayan Bay.

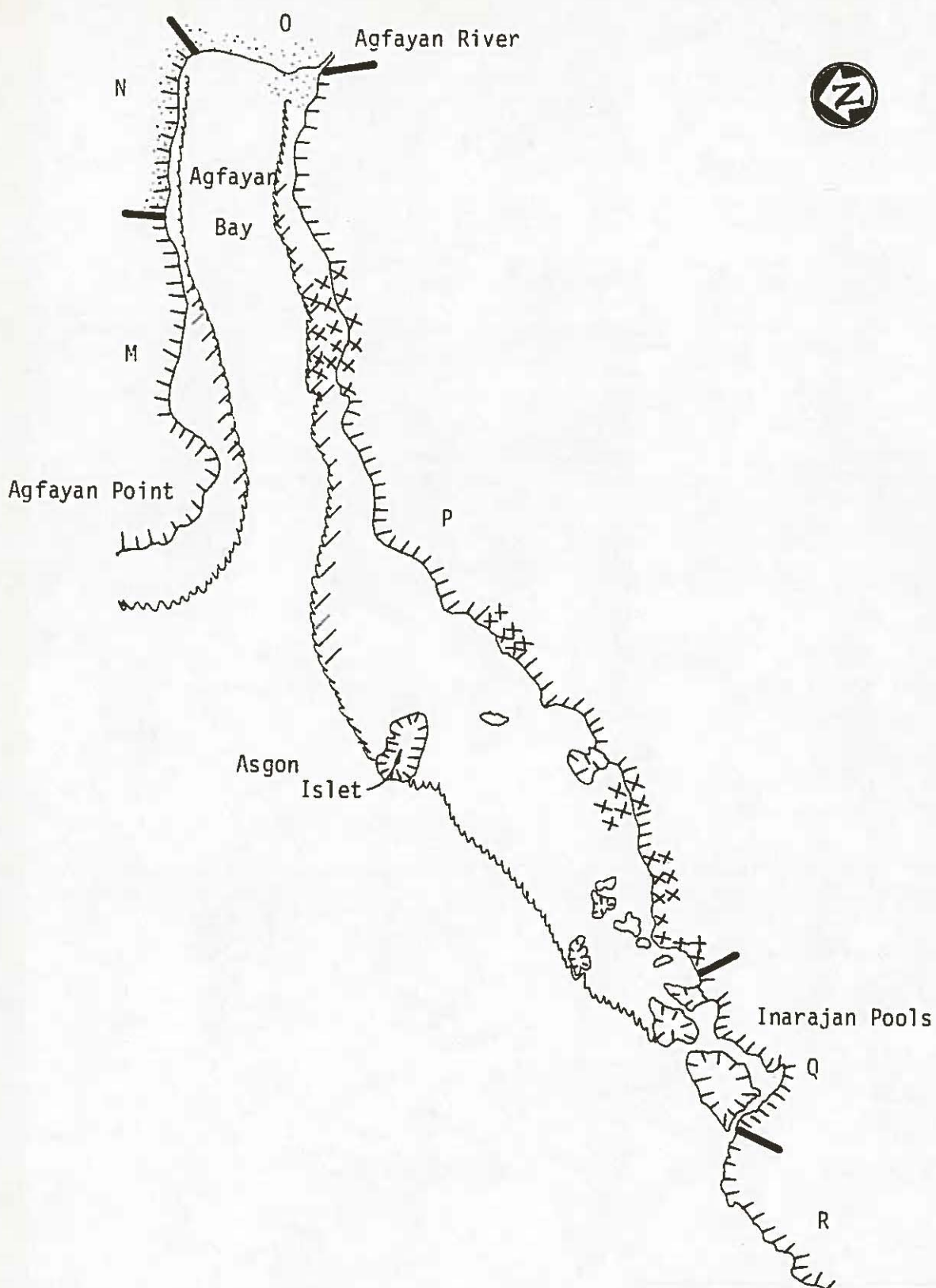


FIGURE 8-6

AGFAYAN BAY AND
INARAJAN POOLS

Reach N: Agfayan Bay (Figures 8-6)

- Agfayan Bay is a long narrow embayment well protected from most wave approach, due to the narrow opening in the fringing reef.
- Shoreline in Reach N consists of limestone boulders with scattered calcareous sand.
- Backshore is undeveloped with vines growing down to high tide level.
- Stable.

Reach O: Agfayan Bay (Figure 8-6)

- Narrow beach at the head of the bay is 400 feet long, with a width of 10 to 200 feet. Agfayan River discharges across the north side of the beach.
- Beach sand varies from coarse calcareous sand at the south end to medium size at the river with 60 to 70 percent basalt content.
- Route 4 circles the head of the bay 150 feet inland; backshore area is vegetated with grass, vines and coconut trees.
- Stable, no erosion.



Agfayan Bay, Reach O

Reach P: Agfayan Bay to Inarajan Pools (Figure 8-6)

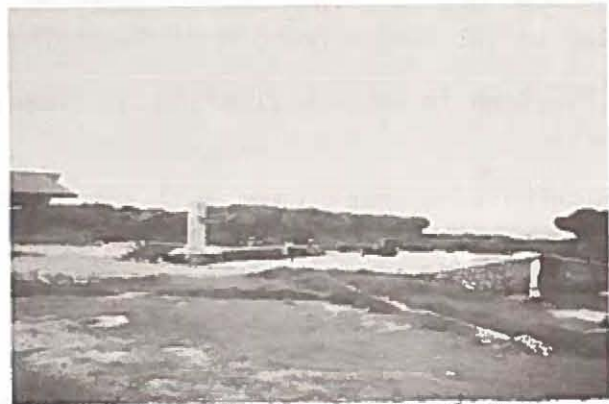
- Shoreline consists of low-lying pitted limestone terraces with intermittent volcanic rock outcroppings.
- The intertidal reef flat is approximately 400 feet wide.
- Route 4 parallels the shoreline, located 50 to 200 feet inland at approximately the 5-foot elevation. The area between the road and the shoreline consists of rock and rubble, with grass on top. There are a few scattered houses on the landward side of the road. There is no development on the seaward side.
- The shoreline is stable. The road, however, may be subject to wave damage when southerly waves approach during tropical storms and hurricanes.



Limestone & Basalt Terraces, Reach P

Reach Q: Inarajan Pools (Figure 8-6)

- A public park and swimming area has been constructed in Reach Q by modifying the existing limestone terrace shoreline and dredging a small swimming area between a series of small islets and the shoreline. Facilities include the swimming area, high dive, main meeting pavilion, picnic pavilions, barbecue pits and lookout point on top of one of the islets.
- The shoreline is stable and protected from wave attack by the offshore islets.



Inarajan Pools, Reach Q

Reach R: Inarajan Pools to Inarajan Bay (Figure 8-6)

- Shoreline is higher limestone terraces and cliffs.
- There is no reef flat, only a wave-cut bench on the south half of Reach R; there is a 100-foot wide intertidal reef flat paralleling the shore inside the entrance to Inarajan Bay.
- Stable.

Reach S: Inarajan Bay (Figure 8-7)

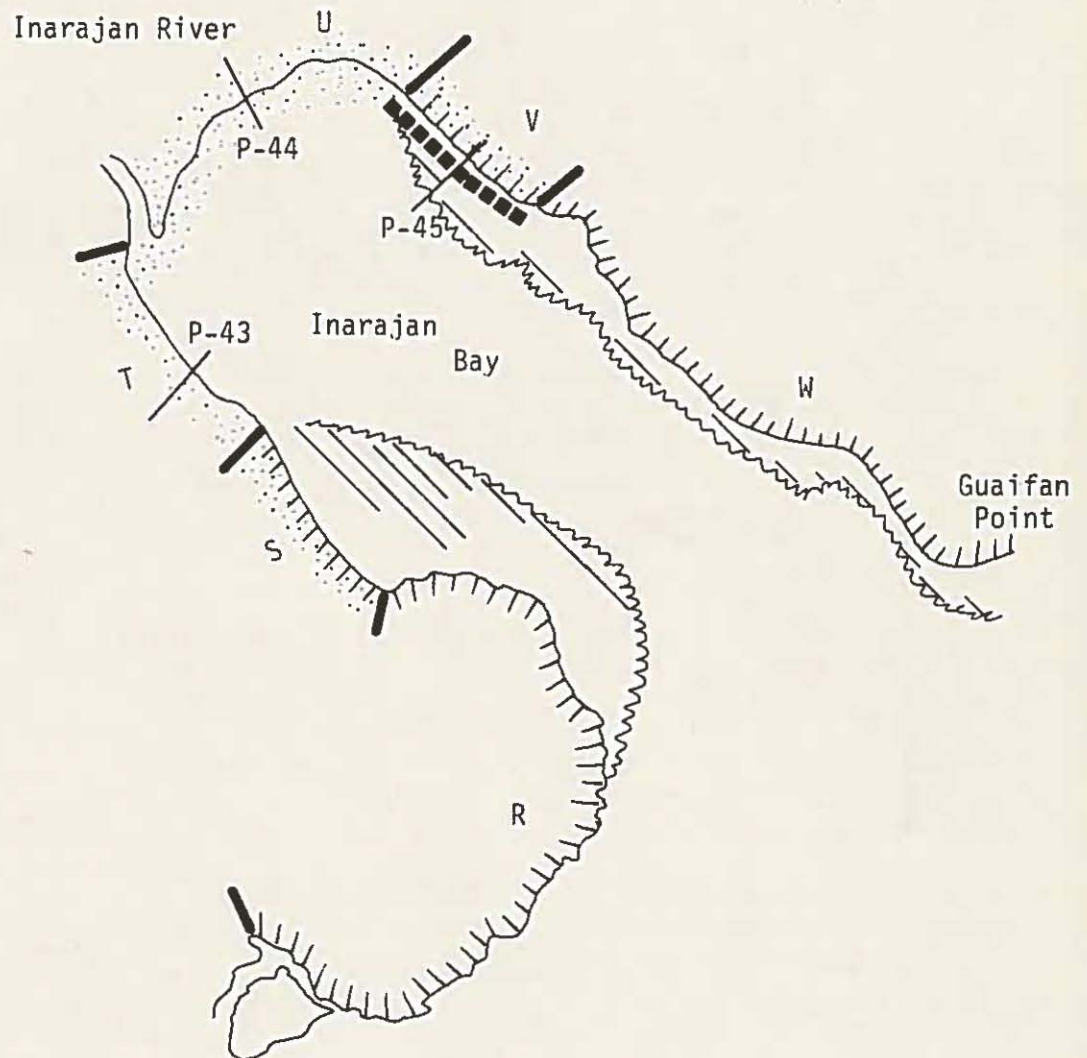
- The main part of the village of Inarajan lies on the south side of Inarajan Bay, behind Reaches S and T.
- The shoreline consists of limestone boulders, concrete debris, and intermittent limestone bench with some scattered calcareous and alluvial material.
- Route 4 is located from 120 to 200 feet inland. There is only one house seaward of the road. The backshore is vegetated with grass, vines and scattered trees.
- There is no apparent erosion in Reach S, but the backshore berm may be subject to erosion during storm wave conditions.



Rubble Shoreline, Reach S

Reach T: Inarajan Bay (Figure 8-7)

- Reach T is a 500-foot long beach just south of the Inarajan River. The beach is only 20 feet wide and the high tide level is at the vegetation line (see Profile 43). Beach width decreases to the south and grades into the rubble of Reach S. The pilings of an old dock are located between Reaches S and T.



400 200 0 400 800
SCALE IN FEET

FIGURE 8-7
INARAJAN BAY

- The beach material is 80 to 90 percent alluvial material and volcanic sand, with the remainder calcareous.
- There is a 160- to 200-foot wide grassy area between the beach and the highway. Two houses are located on the backshore berm, both set back 100 feet from the shoreline.
- Stable, no erosion.



Inarajan Bay, Reach T

Reach U: Inarajan Bay (Figure 8-7)

- A 2,200-foot long crescent-shaped beach at the head of Inarajan Bay. The beach width varies up to 60 feet (Profile 44).
- The beach material is fine alluvial and basalt sand with 10 percent medium to coarse calcareous sand intermixed.
- Route 4 circles the head of the bay, located 200 feet inland. The area in between is overgrown with thick brush and trees.
- Stable, no erosion.



Beach at Head of Inarajan Bay

Reach V: Inarajan Bay (Figure 8-7)

- Shoreline is an intermittent limestone terrace with small boulders and calcareous sand thrown up behind.
- A secondary road parallels the shoreline (Profile 45). The road is subject to some undercutting and there is a 1- to 2-foot scarp along the edge of the road. There are a few houses on the landward side of the road, set back at least 100 feet.
- Minor erosion along the 600-foot long reach.



Rubble Shoreline, Reach V

Reach W: Inarajan Bay to Guaifan Point (Figure 8-7)

- Low pitted limestone terraces, except for Guaifan Point, where higher terraces form limestone cliffs.
- Stable, no backshore development.



Limestone Terraces, Reach W

SECTION 9

TALOFOFO BAY TO PAGO BAY

This sector extends 7 miles along the east coast of Guam (Figures 9-1 and 9-2). Beach deposits have accumulated at the heads of all the bays along this sector and form a wide coastal terrace from Ylig to Asanite Points. The beach deposits alternate with solution-pitted limestone terraces. The elevation of the terraces varies from less than 3 feet to 40 feet above sea level. In general, beach deposits accumulate more extensively along sections of the coast bordered by wide reef flat platforms, while the coast bordered by narrow reefs have alternating patches of beach and limestone terraces.

Prominent rocky headlands are found north of Ylig Bay, the south side of Ylig Bay, the north and south sides of Talofoyo Bay and north of Pago Bay.

Fringing reef flat platforms border most of the shoreline. Narrow cut benches have developed at some headlands where fringing reef flats are absent.

A limestone plateau borders this coastal sector. The region consists of steep slopes and clifted headlands which are set back from the shoreline in places by the lower limestone terraces of various widths.

Only four rivers have cut through the limestone plateau land from Talofoyo Bay to Pago Bay; the Talofoyo, Togcha, and Ylig and Pago Rivers. River channels cut completely through the reef flat at Talofoyo Bay, Ylig Bay and Pago Bay. A narrow, partial channel is cut through the reef flat at Togcha Bay.

Route 4 parallels the shoreline along this sector. There is little development with only scattered houses. The main village of Talofoyo is located approximately one mile inland.

The sector is directly exposed to the predominant trade winds and the trade wind generated waves. The offshore waters are rough most of the year.

Reach A: Matala Point (Figure 9-3)

- Several levels of limestone terraces forming low cliffs and rocky headlands.
- Intertidal reef flat varies from approximately 300 feet south of Matala Point to a few feet on the east side. Substrate is reef rock pavement with scattered boulders and coral rubble.

Reach B: Paicpouc Cove (Figure 9-3)

- Paicpouc Cove forms a small secondary bay within the boundaries of Talofoyo Bay. There is a small beach at the head of the cove.
- Beach material is mostly volcanic with some calcareous sand and rubble.
- Access to the cove is difficult.

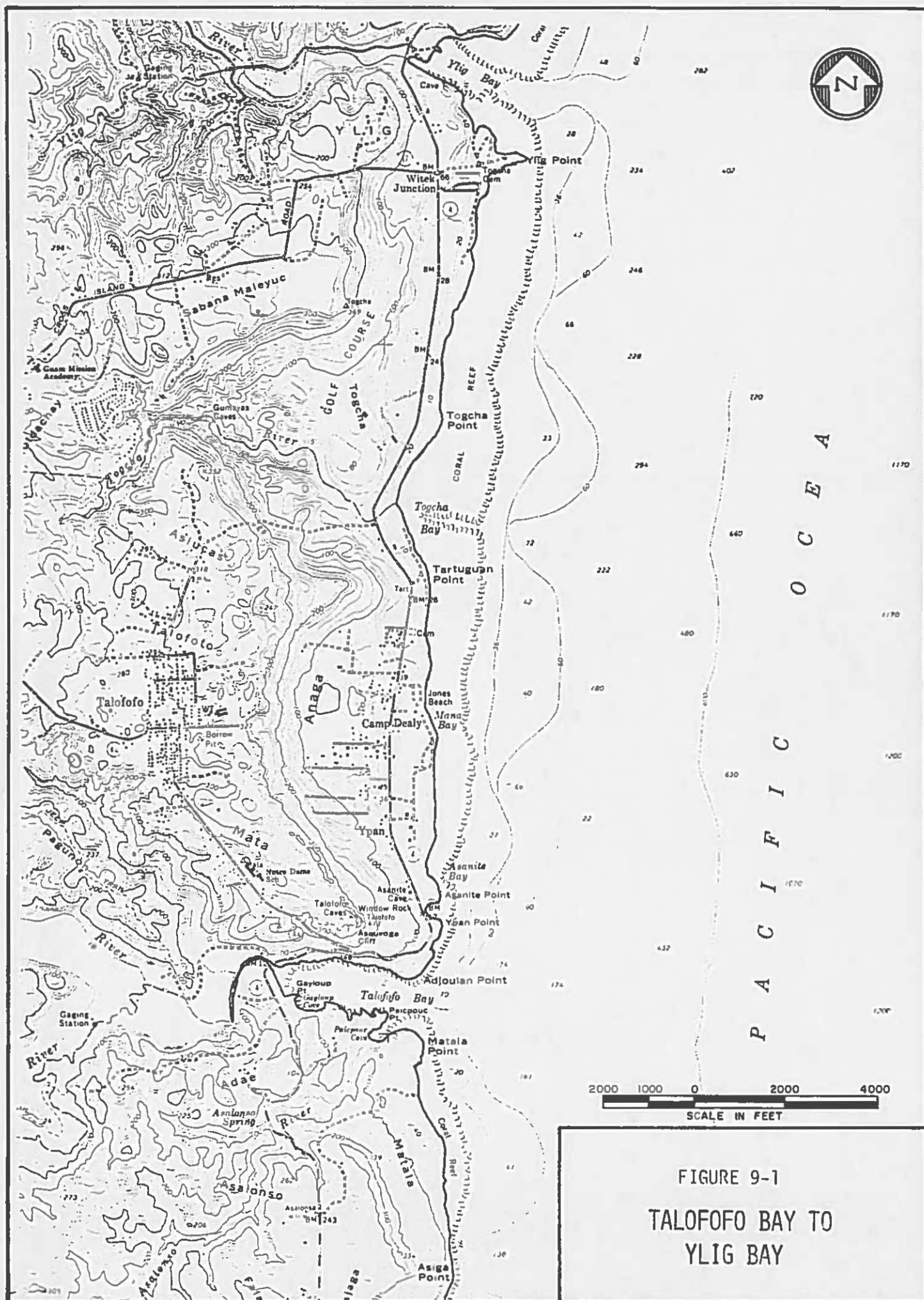
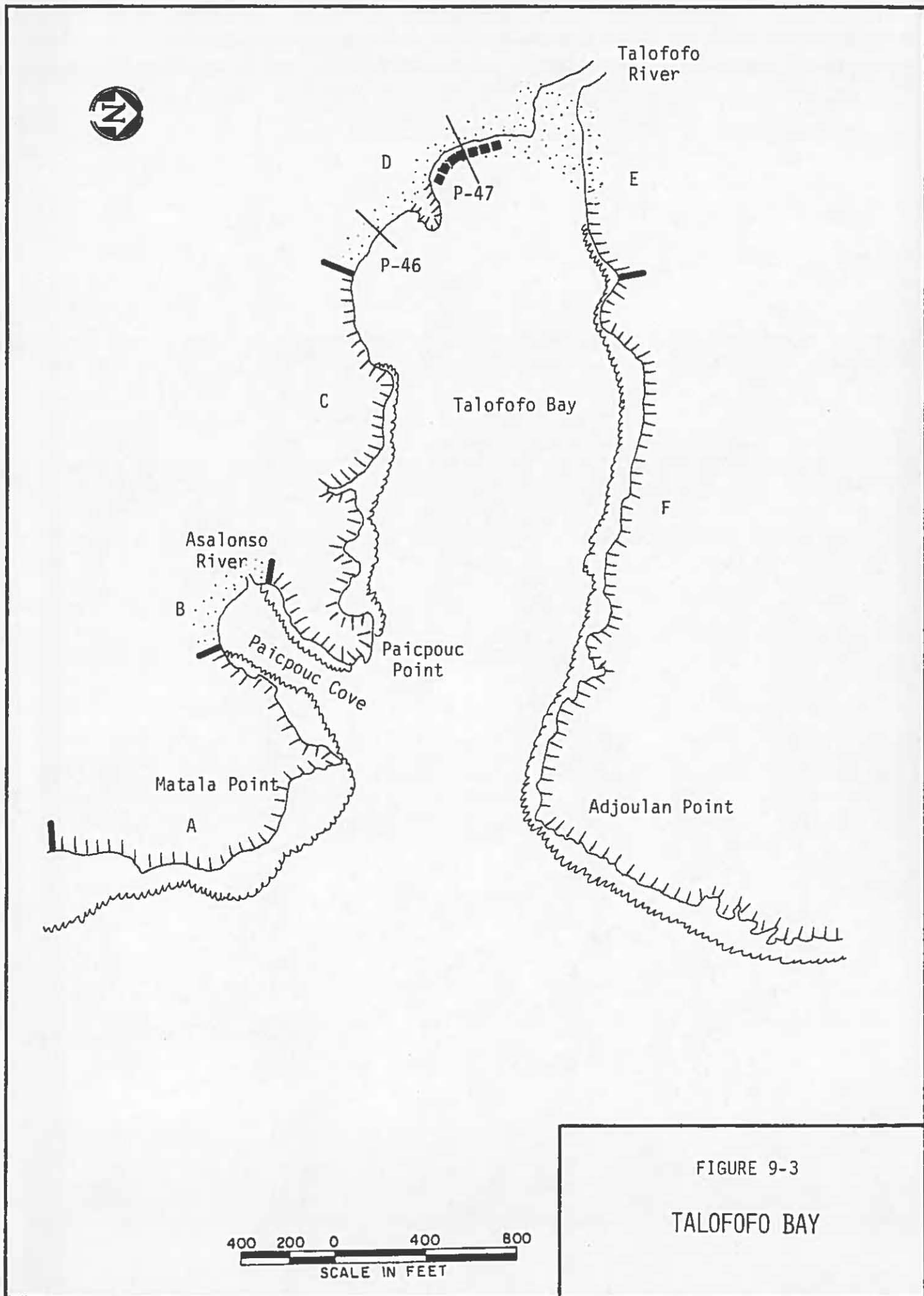




FIGURE 9-2

PAGO BAY



Reach C: Paicpouc Point (Figure 9-3)

- Rocky shoreline, similar to Reach A.
- Inertidal reef flat is only a few feet wide.

Reach D: Talofoyo Bay (Figure 9-3)

- A 1,100-foot long beach at the head of Talofoyo Bay. The beach is divided into two sectors by a small rocky peninsula protruding into the bay. The small pocket beach on the south side of the peninsula is stable, protected by the peninsula and the rocky point to the south. Profile 46 is a representative cross-section of this beach sector.
- North of the peninsula, the 700-foot long beach has completely eroded for a distance of approximately 400 feet. The backshore berm terminates in a wave-cut scarp which is actively eroding (see Profile 47). The beach is still intact along the remaining 300 feet, increasing to a width of 100 feet at the mouth of the Talofoyo River.
- The beach material is fine volcanic and alluvial sand, with approximately 10 percent calcareous sand intermixed. Near the river mouth, there are alternating layers of brown alluvial and black volcanic sand.
- Talofoyo Bay is oriented such that trade wind waves enter the bay and form surfable waves in the shoal area off the beach. The waves also result in long-shore transport of the beach material. The apparent transport is from south to north, i.e., from the peninsula toward the river mouth. This predominant transport may result in continued erosion of the beach area to the north. The beach is exposed to a considerable amount of wave action, as evidenced by the extensive driftwood accumulation at the foreshore crest.
- A public park is located at the south end of the reach, behind the stable portion of the beach. Facilities include a parking area and picnic pavilions.



Park Area, Talofoyo Bay



Eroding Beach, Talofoyo Bay



Talofoyo Beach, North End

- The remaining backshore area is undeveloped and is vegetated with grass, vines and trees. Profile 47 was taken at the closest approach of Route 4 to the shoreline, a distance of 90 feet.
- Talofoto Bay is a popular surf site. However, the water is highly turbid whenever there is wave action due to the fine sand and silt deposited in the river mouth delta and the inner reaches of the bay.
- The erosion can be classified as intermediate to severe. The eroded beach is a loss of recreational potential, but there are no structures or facilities presently threatened. Construction of a revetment has been considered by the Corps of Engineers to stabilize the shoreline. Except for surfing, the recreational potential is limited due to the predominantly turbid water.

Reach E: Talofoto Bay (Figure 9-3)

- Limestone terraces, boulders, and scattered sand, grading into higher bluffs at the north end.
- The backshore slopes steeply up to Route 4 at the 50-foot elevation.
- Stable.

Reach F: Adjoulan Point (Figures 9-3 and 9-4)

- Limestone terraces, forming low cliffs and rocky headlands.
- Narrow intertidal reef flat.
- Backshore slopes steeply up to Route 4, which rounds the point at the 50- to 150-foot elevation.

Reach G: Ypan Point to Asanite Point (Figure 9-4)

- A 330-foot long beach between two limestone points. The beach consists of coral rubble and boulders at the south end grading into a sandy foreshore at the north end. Beachrock outcrops at the waterline along most of the reach.
- The south end is eroding over approximately a 150-foot length. Profile 48 is representative of the eroding area. A 2- to 3-foot scarp is located only 10 feet from the edge of Route 4, but the scarp is at the 10-foot elevation and fronted by a rubble foreshore.
- The intertidal reef flat is 500 feet wide, with intermittent moat development as shown by Profile 48.
- Classification - Intermediate erosion at south end. The beach is stable during normal conditions, but storm waves could result in erosion and potential undercutting of the highway.



Eroding Scarp, Reach G

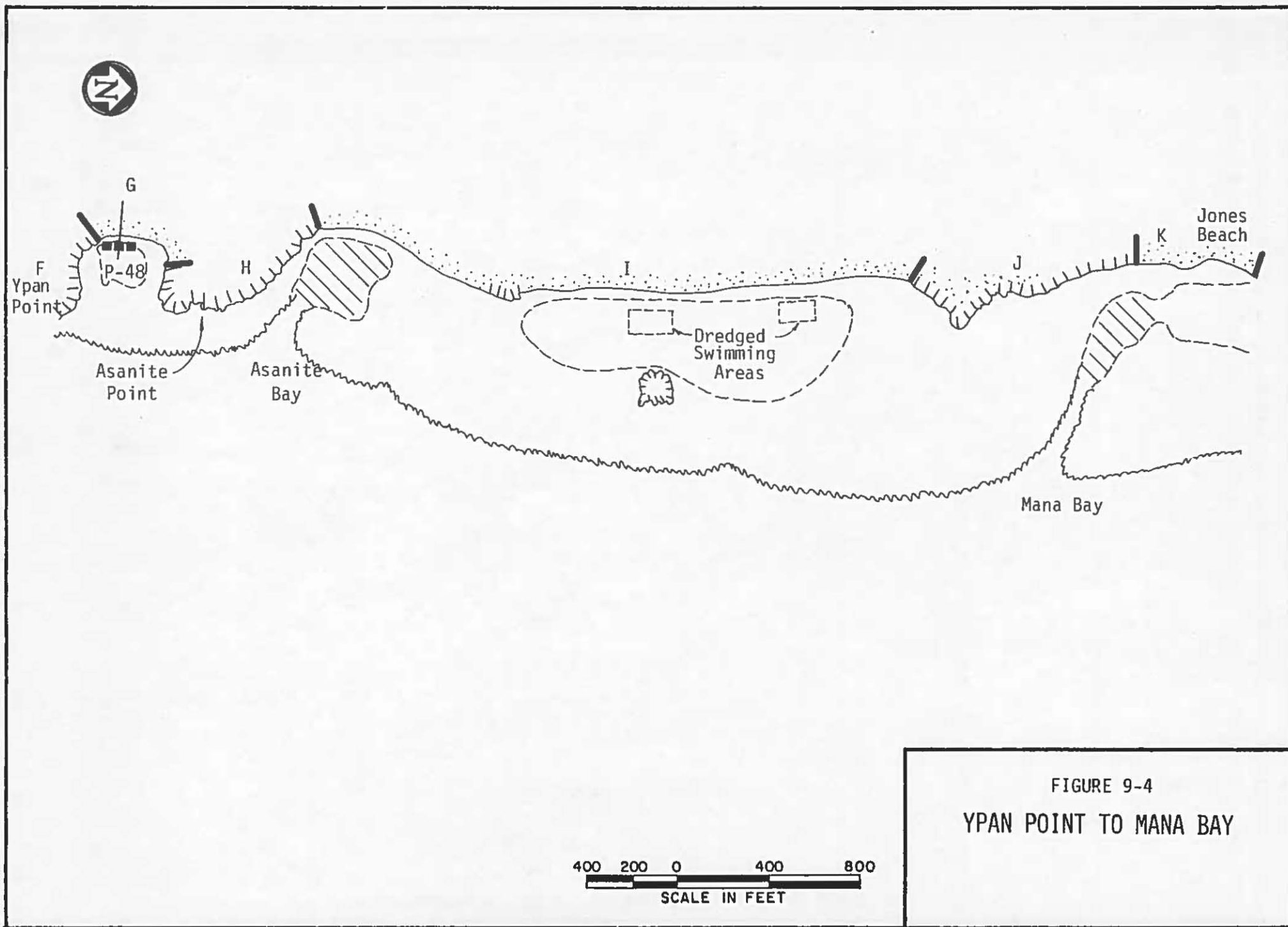


FIGURE 9-4
YPAN POINT TO MANA BAY

Reach H: Asanite Point (Figure 9-4)

- Rocky shoreline with low pitted limestone terraces.
- Narrow intertidal fringing reef flat.

Reach I: Asanite Point to Mana Bay (Figure 9-4)

- A 2,700-foot long beach between two limestone points. Beach width averages between 60 to 100 feet. Foreshore slope is 1 on 8.
- Beach material is 100 percent calcareous, consisting of poorly sorted sand and coral rubble. Beachrock protrudes at the waterline along most of the reach.
- The fringing reef flat increases from 750 feet at the south end to 1,000 feet at the north end. The reef is predominantly intertidal with a minor moat development off the center of the reach. There are three small dredged swimming areas on the inner reef flat.
- Route 4 is located 1,000 feet inland. There are a few houses on the backshore, but all are at least 200 feet inland. The beach is posted with keep out signs and there is no public access.
- Stable.



Typical View, Reach I

Reach J

- Rocky shoreline consisting of low limestone terraces located just south of Mana Bay. Sand is thrown up behind the terraces in places.
- Intertidal reef flat is 1,000 feet wide and the substrate is reef rock pavement. The reef flat is bounded on the north by Mana Bay, a natural channel cut partially through the reef flat.

Reach K: Jones Beach (Figure 9-4)

- Jones Beach is a 450-foot long beach, the south end of a 2,000-foot long beach extending north to Tartugan Point.
- The beach width averages 65 feet. The material is poorly sorted calcareous sand, with scattered coral gravel and rubble. The foreshore slope is 1 on 10.
- Jones Beach is private and posted with keep out signs. Public access is blocked from Route 4.



Jones Beach, Reach K

- The beach is backed up a series of retaining walls up to 7 feet high. The back-shore area is undeveloped except for an abandoned bath house.

- Stable.

Reach L: Ypan Beach Park (Figure 9-5)

- Calcareous sand beach, 1,550 feet long, separated from Jones Beach by a sandy cusp. The sand is poorly sorted, with scattered coral gravel and rubble. Beach width is 60 to 70 feet (see Profile 49) becoming narrower at the north end. The beach gives way to a limestone terrace at the north boundary of the reach.
- The reef flat is 800 to 1,000 feet wide with a minor moat development on the inner reef flat.
- The backshore of the south end of the Reach L is undeveloped. Park facilities, including a parking lot, bath house, and picnic facilities have been constructed along the north half. The park is a popular swimming and picnic area, even on weekdays.
- Stable, no erosion.



Ypan Beach Park

Reach M: Tartugan Point to Togcha Bay (Figure 9-5)

- The rocky shoreline of Reach M consists of a low-lying limestone terrace. Calcareous sand and rubble is scattered on and behind the terrace in places.
- The reef flat width varies from 1,000 feet off Tartugan Point to 2,000 feet off the Togcha River. The reef flat is predominantly intertidal reef rock pavement. Togcha Bay, at the north end, is a narrow partial channel cut across the reef flat. The channel is a popular snorkeling and diving spot. There are four small limestone islets on the reef flat.
- Route 4 parallels the shore, 400 to 600 feet inland. The area in between is undeveloped. Access to the shoreline is difficult.
- Stable.



Limestone Terraces, Reach M

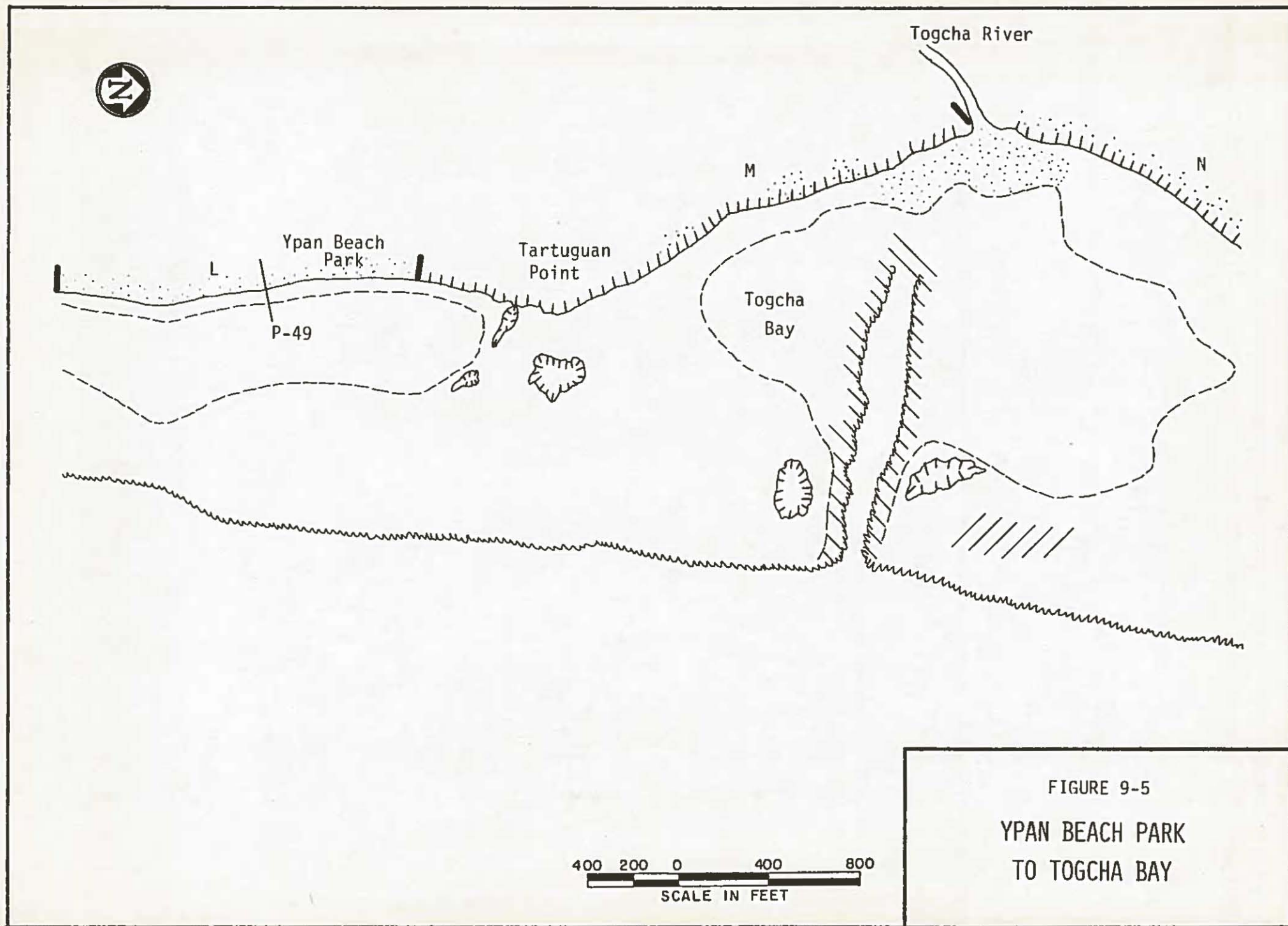


FIGURE 9-5

YPAN BEACH PARK
TO TOGCHA BAY

Reach N: Togcha River to Ylig Point (Figures 9-5, 9-6 and 9-7)

- Shoreline consists of intermittent low-lying pitted limestone terrace, with scattered beach deposits of poorly sorted calcareous sand and rubble.
- The reef flat ranges in width from 900 to 1,350 feet. The reef is intertidal with a reef rock substrate. Sand, gravel, and coral rubble is scattered along the shoreline and in reef depressions.
- The backshore area is a low-lying coastal terrace consisting of unconsolidated beach deposits, overgrown with trees and brush. Route 4 is located 200 to 800 feet inland. A network of jeep trails along the shoreline provides easy access. The backshore area is undeveloped.
- Stable, no erosion.



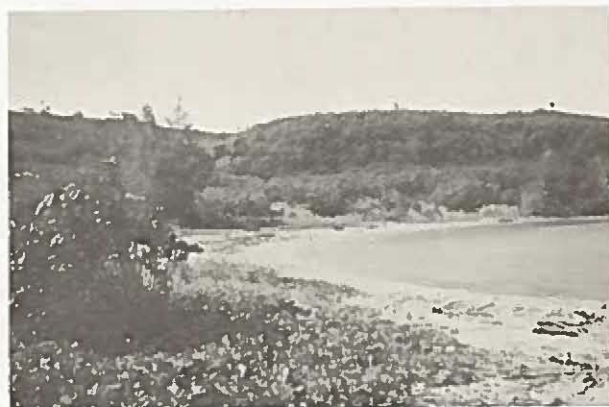
Typical View, Reach N

Reach O: Ylig Point (Figure 9-7)

- Rocky shoreline, with limestone terrace grading into steep limestone cliffs at the entrance to Ylig Bay.
- The width of the intertidal reef flat decreases with distance into the bay, terminating at the mouth of the Ylig River.
- Togcha Cemetery is located on a sandy terrace at the south end of Reach O.
- Stable.

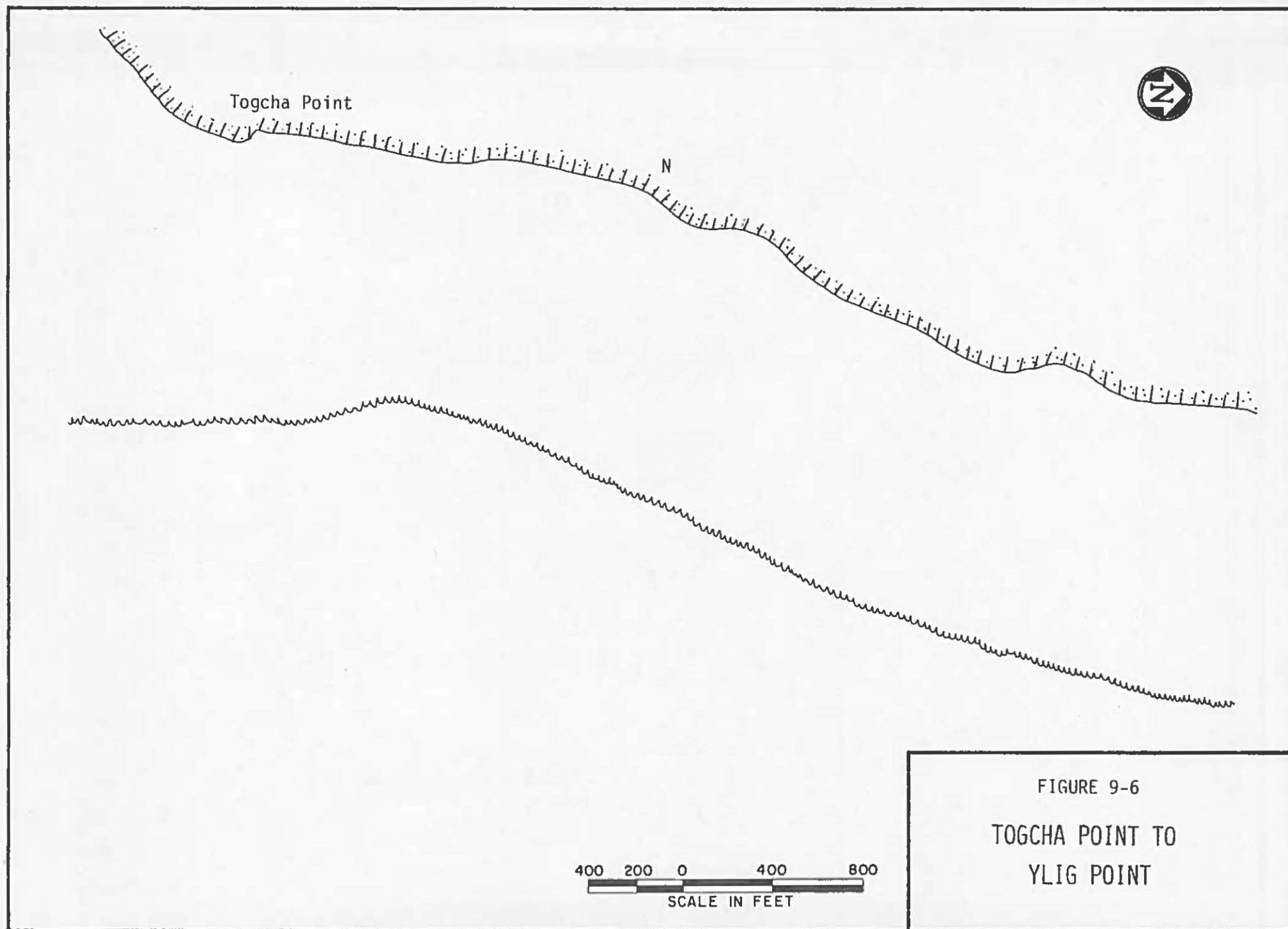
Reach P: Ylig Bay (Figure 9-7)

- The beach at the head of Ylig Bay is bounded by Ylig River and rocky cliffs on the north. The beach consists of two small pocket beaches, each 300 to 400 feet long, separated by a small peninsula of limestone boulders jutting into the bay. The beaches are 70 feet wide with a foreshore slope of 1 on 7. (Profile 50)



Ylig Bay, Reach P

- The beach material is medium to fine sand, approximately 60 percent calcareous and 40 percent volcanic and alluvial. Coral gravel, cobbles, and a large amount of driftwood are scattered on the beach face.
- The predominant trade winds are directly onshore and the bay is exposed to trade wind waves. There is no fringing reef off the beaches, but the long narrow channel attenuates the incoming waves.



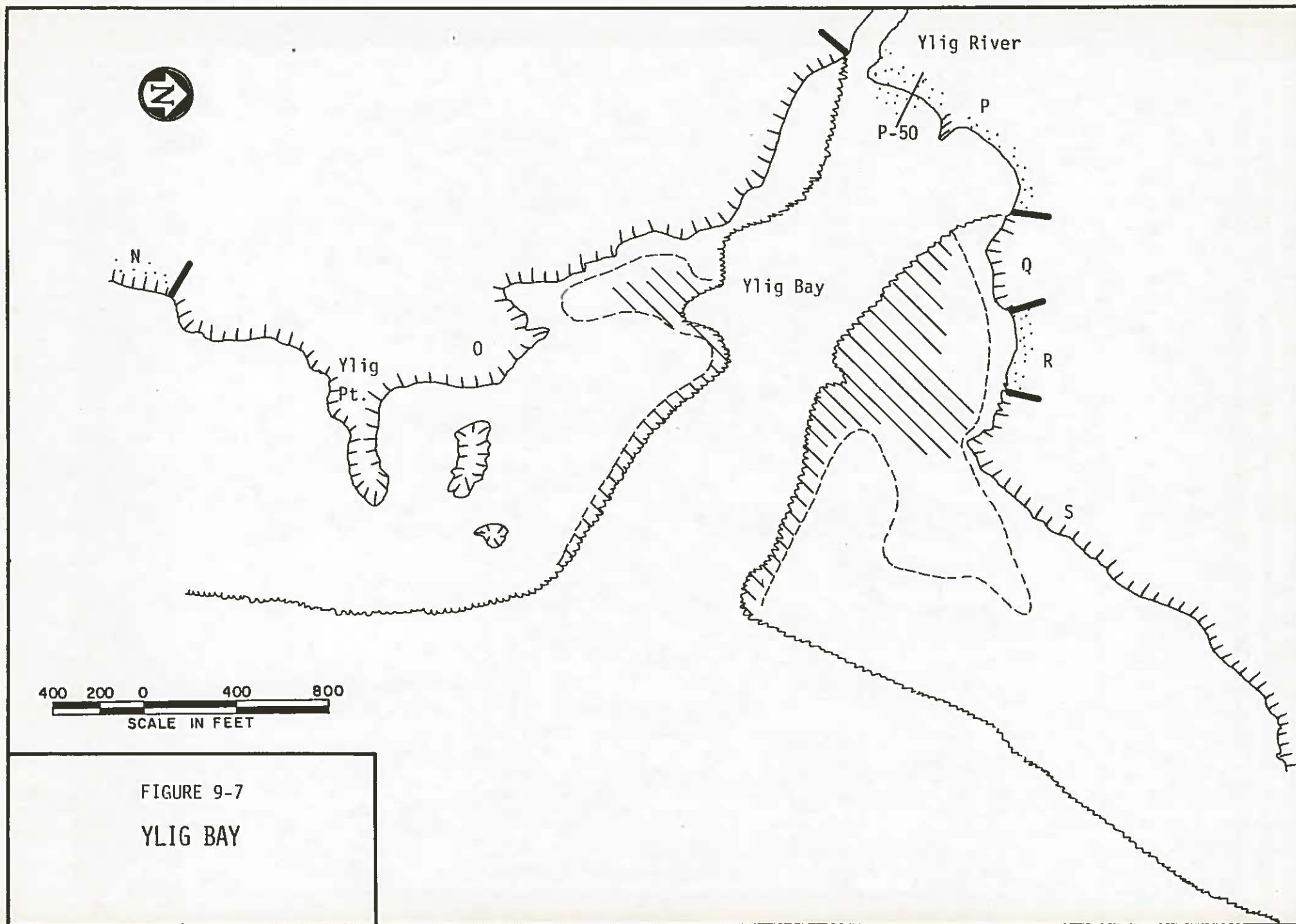


FIGURE 9-7

YLIG BAY

- There is no backshore development. Route 4 is located 500 feet inland. The area in between is densely vegetated.
- Stable, no erosion.

Reach Q: Ylig Bay (Figure 9-7)

- Minor headland consisting of steep limestone cliffs.
- The intertidal reef flat begins again off Reach Q.
- Stable.

Reach R: Ylig Bay (Figure 9-7)

- Small 350-foot long pocket beach on the north side of Ylig Bay. The width is 40 to 50 feet with a foreshore slope of 1 on 11.
- The beach material is medium calcareous sand with a trace of volcanic material and scattered gravel and rubble.
- The beach is protected from wave approach by the 600-foot wide intertidal reef flat.
- A narrow winding road leads to the beach from Route 4, which is at the 50- to 100-foot elevation.
- Stable.



Pocket Beach, Reach R

Reach S: (Figure 9-7)

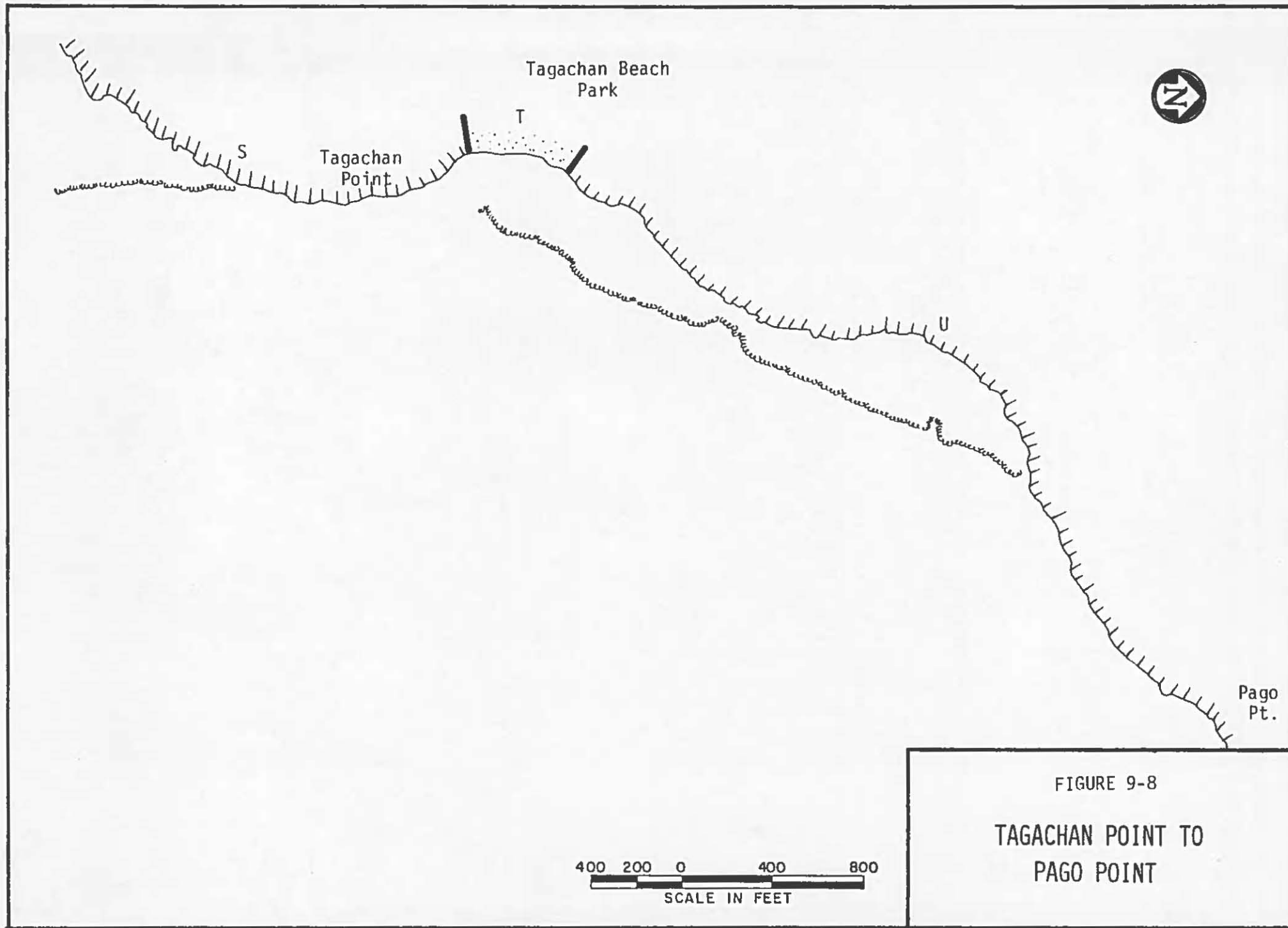
- Steep limestone terraces and cliffs at the north headland of Ylig Bay, extending to Tagachan Point.
- The fringing reef flat width decreases from Ylig Bay to Tagachan Point, and there is no defined reef flat off the point.
- Stable.

Reach T: Tagachan Beach Park (Figure 9-8)

- Small scenic park with a 400-foot long pocket beach. The beach width varies, up to 90 feet.
- The beach material is poorly sorted calcareous sand and rubble. Limestone boulders or beachrock line the shore.
- The park area has picnic pavilions and a bath house. The park is reached by a paved access road from Route 4.
- Stable.



Tagachan Beach Park



Reach U: Tagachan Beach Park to Pago Bay (Figures 9-8 and 9-9)

- Rocky shoreline consisting of steep limestone slopes and cliffs with boulders and blocks at the base.
- Intertidal fringing reef decreases from 100 feet at the beach park to zero about halfway to the point. Substrate is reef rock pavement with scattered sand and coral rubble. There is a sea level bench cut in the limestone shoreline from the termination of the reef to Pago Point.
- Shoreline along the south side of Pago Bay is undisturbed.
- Fringing reef begins off Pago Point and extends to the head of Pago Bay. Average width is 1,000 feet. Inner reef flat is a poorly developed low tide moat.

Reach V: Pago Bay (Figure 9-9)

- A 1,400-foot long beach at the head of Pago Bay, south of the Pago River mouth.
- Typical width is 20 to 25 feet with a foreshore slope of 1 on 10.
- Beach material is 50 percent calcareous, 50 percent basalt well-sorted medium sand.
- The narrow beach is backed by a wide coastal terrace of grass and vines. There is no backshore development. Access to the beach is by dirt jeep trails.
- The intertidal reef flat is 1,200 feet wide at the out end of the reach, and grades into an alluvial river delta at the inner end. The Pago Bay channel cuts completely through the reef flat.



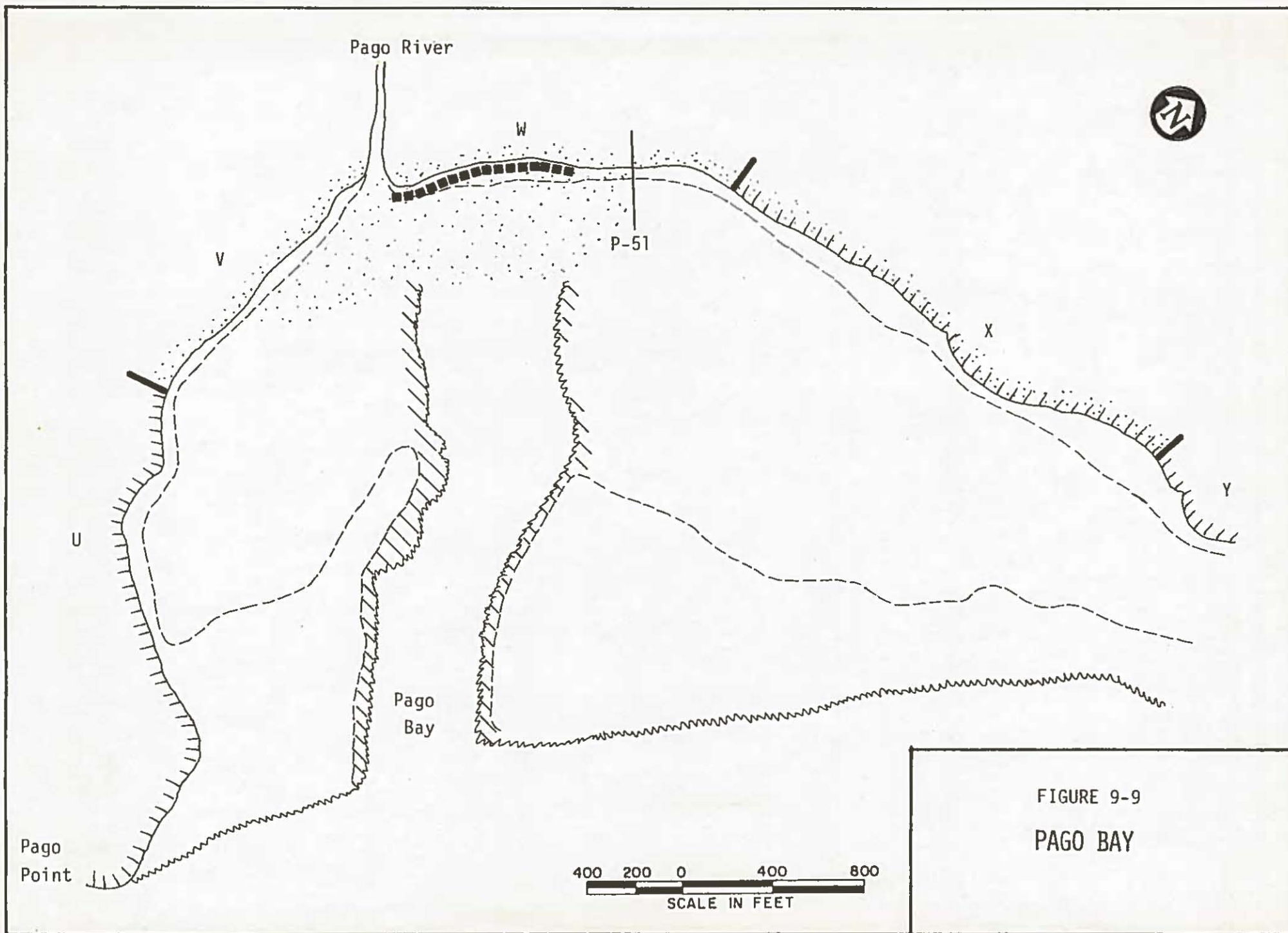
Pago Bay, Reach V

Reach W: Pago Bay (Figure 9-9)

- A 1,400-foot length of beach north of the Pago River, similar in form to that in Reach V, but with 90 percent calcareous sand and only 10 percent basalt. The calcareous sand is poorly sorted, with intermixed gravel and rubble.
- The beach width is 20 to 25 feet with a foreshore slope of 1 on 9 (Profile 51).
- The sand composition in Reaches V and W is indicative of predominant transport to the south, probably in response to the prevailing trade winds.



Typical View, Reach W



- The alluvial river delta fronts the south half of the beach, grading into the reef flat to the north. The reef flat off the north side of the beach is up to 2,500 feet wide.
- The 850-foot length of beach immediately north of the Pago River is subject to minor, ongoing erosion. A two-foot scarp has been cut into the backshore along this area. A remaining coconut tree on the beach foreshore indicates a beach recession of at least 25 feet in the recent past.



Eroding Area, Reach W

- There is no backshore development.

Reach X: Pago Bay (Figure 9-9)

- A 2,100-foot reach that is a transition zone between the beaches at the head of Pago Bay and the limestone cliffs to the north. The foreshore is narrow, similar in form to Reaches V and W, but the material consists entirely of coral rubble and limestone terraces.
- A housing development on the backshore is on top of a 30 to 50-foot high bluff. Access to the shoreline is by a jeep trail only.



Rubble Shoreline, Reach X

- Stable beach.

Reach Y (Figures 9-9 and 9-10)

- Rocky shoreline consisting of steep limestone slopes and cliffs with boulders at the base.
- The fringing reef decreases to a width of 800 feet off this reach.
- Stable.

Reach Z (Figure 9-10)

- Beach at north end of Pago Bay is 1,300 feet long, width varies up to 30 feet.
- Beach material is calcareous sand and gravel.
- Fringing reef flat consists of outer reef flat with inner reef low tide moat. There is a small channel opposite the beach.
- Access to the beach is difficult. The backshore is a steep undeveloped limestone slope.
- Stable.

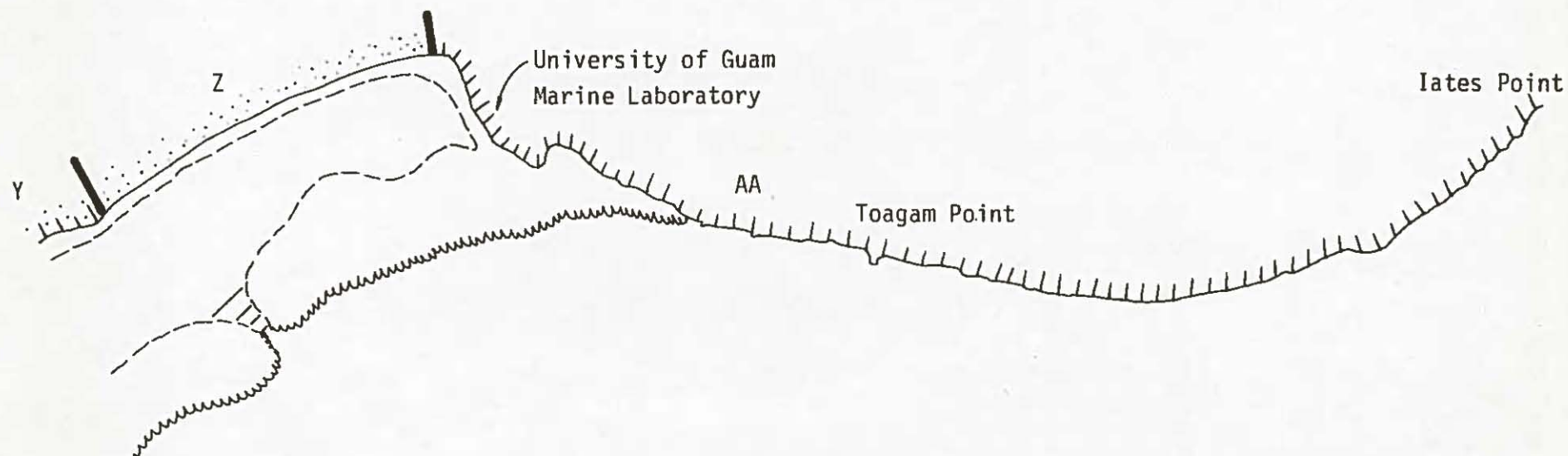


FIGURE 9-10
PAGO BAY TO
IATES POINT

400 200 0 400 800
SCALE IN FEET

Reach AA (Figure 9-10)

- Rocky shoreline, extending from beach to Iateas Point. Shoreline consists of steep limestone slopes and cliffs. Most of the sector bordered by a wave cut bench.
- Intertidal reef at south end of reach is crossed by a University of Guam Marine Laboratory seawater intake channel.
- A sewer outfall is located between Taogam Point and Iates Point.
- University of Guam Marine Laboratory is located at the north end of Pago Bay.
- Shoreline access is difficult.
- Stable.

SECTION 10

SUMMARY OF SHORELINE PROBLEM AREAS

The Guam Shoreline Inventory identified 33 existing or potential shoreline problem areas, summarized in Table 10-1. Of the 33 sites, 18 are undergoing minor erosion and 6 are areas of potential damage to low-lying houses or roads during tropical storms or typhoons.

Only 9 of the sites are subject to intermediate or severe erosion, a total of approximately 3,700 feet of shoreline. Three of the nine sites are at the Paseo de Susana Park. Erosion is occurring along the entire unprotected east side of the park which faces the incoming trade wind waves, and is most severe along the 240 feet of shoreline adjoining the revetment. The 400-foot length of old revetment on the seaward tip of the peninsula is deteriorating and in poor condition. Alternatives for repair of the revetment should be investigated before the occurrence of storm or typhoon waves results in collapse of the breakwater. The west side of the peninsula is unprotected along a 900-foot length and is undergoing chronic erosion. This site is within the protective jetties for the Agana Boat Basin entrance channel, so the wave climate is mild. The transport, however, is always toward the boat basin, resulting in erosion of the shore, particularly where the revetted shoreline ends. Because of the protection offered by the jetties, this site could probably be stabilized with a minimum of expense.

Three other sites rated as having intermittent to severe erosion are in the vicinity of Nimitz Beach Park. The worst of the three is the north facing side of Nimitz Beach Park, where there is a wave-cut scarp and loss of park land is occurring.

Intermediate erosion is occurring at intermittent sites along the main developed shoreline of Merizo, a distance of 2,000 feet. Numerous houses are built close to the water on what appears to be filled land. Several property owners have built seawalls, ranging from rudimentary to substantial. The unprotected lots are subject to erosion. The site could be stabilized with relatively small structures, as Cocos Lagoon and Barrier Reef offers protection from storm and typhoon waves.

Much of the beach at Talofofu Bay has been eroded back to the vegetation line, and the erosion is continuing along the north half of the beach. The length fronting the public park is stabilized by a small rocky peninsula which prevents transport of sand toward the river. The U. S. Army Corps of Engineers in 1974 prepared a Detailed Project Report on the site, recommending construction of a revetment along the eroding reach. No action has been taken to date. The highway (Route 4) is not presently threatened by the erosion, but it might eventually be necessary to stabilize the shoreline to prevent undercutting of the road.

Intermediate erosion has also occurred just north of Talofofu Bay, at Ypan Point. A wave-cut scarp is only 10 feet from Route 4. It appears from the slope and composition of the beach and the elevation of the base of the scarp that erosion takes place only during storms or typhoons.

Table 10-1 contains a column of recommended action for each problem site. The recommendations range from "no action" to "shore protection required." Investigation of shore protection alternatives is recommended for only 8 sites, as discussed above.

In summary, shoreline erosion does not appear to be a major problem on Guam, in spite of the considerable coastal development that has taken place. This is probably due to the wide fringing reefs, which offer protection from waves and also supply calcareous material to the beach systems.

TABLE 10-1

SUMMARY OF SHORELINE PROBLEM AREAS, GUAM

<u>Location</u>	<u>Reference Map</u>	<u>Problem</u>	<u>Classification</u>	<u>Affected Length (ft)</u>	<u>Recommended Action</u>
Naton Beach, Tumon Bay	Reach F, Figure 3-3	Possible Slow Reces- sion at Shoreline	Minor Erosion	300 Feet	Monitor
Ypao Beach, Tumon Bay	Reach I, Figure 3-4	2 to 3-Foot Scarp Cut into the Fore- shore Crest	Minor Erosion	400 Feet	Monitor
Dungcas Beach, Agana Bay	Reach E, Figure 4-4	Slight Undercutting of Private Parking Lot	Minor Erosion	100 Feet	None
Trinchera Beach, Agana Bay	Reach G, Figure 4-4	Intermittent Erosion of the Backshore Dur- ing Storms	Minor Erosion	700 Feet	Monitor
Trinchera Beach, Agana Bay	Reach H, Figure 4-4	Erosion of Filled Land During Storms. Also Potential for Storm Wave Damage	Minor Erosion	750 Feet	Monitor
Agana River, Agana Bay	Reach J, Figure 4-4	Erosion of Backfill From Between Boulders	Minor Erosion	300 Feet	None
Paseo de Susana Park, Agana Bay	Reach K, Figure 4-5	2 to 3-Foot Scarp Cut into Backshore	Minor Erosion	1,000 Feet	Monitor
Paseo de Susana Park, Agana Bay	Reach L, Figure 4-5	Chronic Erosion of Backfill Near the Sea- ward Tip of the Park	Intermediate to Severe Erosion	240 Feet	Shore Protection Needed
Paseo de Susana Park, Agana Bay	Reach M, Figure 4-5	Deteriorating Revetment Subject to Storm Wave Damage. Backfill Being Eroded in Places	Potential Failure of Revetment. Severe Erosion of Backfill Along 30- Foot Length	400 Feet	Investigate Alter- natives for Repair of Revetment

<u>Location</u>	<u>Reference Map</u>	<u>Problem</u>	<u>Classification</u>	<u>Affected Length (ft)</u>	<u>Recommended Action</u>
Paseo de Susana Park, Agana Bay	Reach O, Figure 4-5	Chronic Erosion of Unprotected Backfill Material	Intermediate to Severe Erosion	900 Feet	Investigate Shore Protection Alternatives
Agana Bay West of Paseo de Susana Park	Reach S, Figure 4-6	Backfill Eroding From Behind Small Rubble Revetment in Poor Condition	Minor Erosion	450 Feet	None
Asan Bay	Reach D, Figures 4-7 and 4-8	Unprotected Houses Near Shore may be Subject to Storm Wave Damage	Potential Storm Wave Damage	600 Feet	None
Piti Bay	Reach B, Figure 4-9	Unprotected Houses at Low Elevation Subject to Storm Wave Damage	Potential Storm Wave Damage	400 Feet	None
Piti Bay	Reach D, Figures 4-9 and 4-10	Unprotected Houses at Low Elevation Subject to Storm Wave Damage. Also Chronic Minor Erosion Through Reach D	Potential Storm Wave Damage. Minor Erosion.	500 Feet	Monitor
Piti Bay	Reach I, Figure 4-10	Deteriorating Revetment Protecting Road; Subject to Storm Wave Damage. Minor Erosion of Backfill Occurring	Potential Damage to Revetment During Storm Waves. Minor Erosion	550 Feet	Investigate Alternatives for Repair of Revetment
Togcha Beach, Agat Bay	Reach D, Figure 5-2	Intermittent Erosion Along Unprotected Areas of Reach D. Houses may be Susceptible to Storm Wave Damage	Minor Erosion. Potential Storm Wave Damage	400 Feet	None

<u>Location</u>	<u>Reference Map</u>	<u>Problem</u>	<u>Classification</u>	<u>Affected Length (ft)</u>	<u>Recommended Action</u>
Salinas Beach, Agat Bay	Reach F, Figures 5-2 and 5-3	Houses at Low Elevation may be Subject to Storm Wave Damage	Potential Storm Wave Damage	600 Feet	None
War Memorial Park, Agat Bay	Reach G, Figure 5-3	Erosion of Backfill From Behind Limestone Boulder Seawall	Minor Erosion	350 Feet	Monitor
Gaan Point, Agat Bay	Reach I, Figure 5-3	Shoreline of Man-Made Peninsula is Eroding. Peninsula is Breached at the Base.	Minor Erosion	900 Feet	None
Finile Creek, Agat Bay	Reach L, Figure 5-3	A Few Houses at Low Elevation may be Subject to Storm Wave Damage	Potential Storm Wave Damage	300 Feet	None
Chaligan River, Nimitz Beach Area	Reach B, Figure 5-4	Eroding Alluvial Shoreline. Scarp is within 32 Feet of the Highway	Intermediate to Severe	400 Feet	Monitor
Beach North of Nimitz Beach, Nimitz Beach Area	Reach D, Figure 5-4	Erosion Around Culvert Headwall. Wave-Cut Scarp has Formed	Intermediate	200 Feet	Monitor
North Side of Nimitz Beach Park	Reach E, Figure 5-4	Chronic Erosion of Backshore. Park Area Being Lost	Intermediate Erosion	500 Feet	Investigate Shore Protection Alternatives
Nimitz Beach Park	Reach F, Figure 5-4	Intermittent Erosion of Backshore	Minor Erosion	200 Feet	None
Umatac Bay	Reach B, Figure 6-2	Intermittent Erosion of Backshore Fill Material	Minor Erosion	Intermittent Along 1,000 Feet	None
Merizo	Reach F, Figure 7-3	Intermittent Erosion of Unprotected House Lots Throughout Reach F	Intermediate	Intermittent Along 2,000 Feet	Investigate Shore Protection Alternatives

<u>Location</u>	<u>Reference Map</u>	<u>Problem</u>	<u>Classification</u>	<u>Affected Length (ft)</u>	<u>Recommended Action</u>
Ajayan Bay	Reach D, Figure 8-3	Erosion Occurring Along West Half of the Beach at the Head of Ajayan Bay	Minor	400 Feet	Monitor
Agfayan Bay to Inarajan	Reach P, Figure 8-6	No Erosion as Shoreline is Limestone and Basalt Terraces. However, Road is at the 5-Foot Elevation and may be Overtopped by Storm Waves	Potential Storm Wave Overtopping	4,000 Feet Length of Road	Design Road for Overtopping Conditions
Inarajan Bay	Reach S, Figure 8-7	Potential Erosion of Backshore Material During Storm Waves	Potential Erosion During Storms	600 Feet	Monitor
Inarajan Bay	Reach V, Figure 8-7	One to Two Foot Wave-Cut Scarp Along Shoreline at Edge of Secondary Road	Minor Erosion	600 Feet	Monitor
Talofofo Bay	Reach D, Figure 9-3	Beach has Completely Eroded Along a 400-Foot Length of Shoreline. Erosion is Chronic and Ongoing. No Structures are Threatened	Intermediate to Severe	400 Feet	Investigate Shore Protection Alternatives
Ypan Point	Reach G, Figure 9-4	Beach Just North of Point is Eroding at South End. A 2 to 3 Foot Scarp is 10 Feet From the Edge of Route 4, Storm Waves Could Undercut Highway	Intermediate	150 Feet	Investigate Shore Protection Alternatives

<u>Location</u>	<u>Reference Map</u>	<u>Problem</u>	<u>Classification</u>	<u>Affected Length (ft)</u>	<u>Recommended Action</u>
Pago Bay	Reach W, Figure 9-9	Beach Section Just North of Pago River is Eroding, With a 2-Foot Scarp Cut into Backshore. There are Indications that the Beach Recession may be Steady and Ongoing	Minor	850 Feet	Monitor

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APPENDIX A
BEACH PROFILES

