BACKGROUND STUDIES FOR THE PROPOSED HILO OUTFALL EXTENSION
HILO, HAWAII

M & E Pacific, Inc.
Consulting Engineers

BACKGROUND STUDIES
FOR THE
PROPOSED HILO OUTFALL EXTENSION
HILO, HAWAII

Submitted in support of permit applications for the
Conservation District Use Permit, the
U.S. Army Corps of Engineers Permit, and the
Coastal Zone Management
Consistency Certification

Applicant:

Department of Public Works
County of Hawaii

Compiled by:

M&E Pacific, Inc.
Engineers and Architects
1001 Bishop Street
Honolulu, Hawaii 96813
September 1986

PREFACE

The Hilo Outfall extension alignment has changed several times prior to selection of the alignment currently proposed in the permit application. The support documents compiled herein may refer to alignments differing from the proposed outfall alignment. Subsequent to the preparation of the earlier documents, additional preliminary engineering studies were completed and the outfall alignment was more clearly defined.

The planning and design of the Hilo outfall extension has involved the following steps:

1. Concept. The Wastewater Facilities Plan for the Hilo District (M&E Pacific, Inc., 1980) projected the wastewater flows over the next 40 years and determined that discharge of that 40-year flow through the existing outfall would be highly stressful on the receiving environment. Preliminary estimates determined that an extension to about the 75- to 130-foot depth would provide adequate dilution. An EIS was prepared to assess the entire wastewater management plan, including the collection, treatment, and disposal alternatives. This volume contains excerpts from the Wastewater Management Plan and the Revised EIS that pertain to the outfall extension.

2. Preliminary Design. A bathymetric survey and reconnaissance dives were conducted in 1983 to 1984 to select alternative alignments. Geophysical studies (Ocean Surveys, 1984, 1986) and an assessment of the Hilo Bay marine biological community (Dollar, 1985) were conducted along these alternative alignments. Based on the findings of the geophysical analyses, a prefinal alignment was selected. This alignment is shown on the drawings attached to the permit application. The 1984 geophysical study is included in this volume, however, the 1986 study is in draft form and the final draft will be submitted at a later date. Initial dilutions were calculated to determine the diffuser

characteristics (diffuser length, number of ports, etc.) that would result in optimal dilution at the selected discharge depth. The initial dilution results for the selected diffuser characteristics are included in this volume to show that adequate dilution will occur at the 40-year design flow, even under worst case conditions (i.e., when the receiving waters are stratified, thus trapping the plume a considerable depth below the water surface). Safe range calculations have been included to determine the blast size limit and corresponding pre-blast survey area. A Draft Supplemental EIS is also included in this volume.

3. Pre-Final Design. Pre-final contract specification documents and plans are being prepared with scheduled completion by January 1987. Comments received in the review of this permit application will be incorporated into the final specifications and plans.

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WASTEWATER FACILITIES PLAN

FOR THE

HILO DISTRICT
(excerpts)

FACILITIES PLAN
FOR THE
HILO DISTRICT, SOUTH HILO, HAWAII

Prepared for:

Sewers and Sanitation
Department of Public Works
County of Hawaii

Prepared by:

M&E Pacific, Inc.
Environmental Engineers
190 South King Street
Honolulu, Hawaii 96813

February 1980

A functional design of the major advanced primary treatment facilities is shown in Table VIII-4.

Data on incorporating the secondary treatment scheme (earlier described) with the advanced primary treatment facilities at some future date is presented to illustrate provisional planning for the upgrading of facilities. Flow sheets for the liquids and solids handling facilities are shown in Figures VIII-6 and VIII-7 and design data is summarized in Table VIII-5.

OCEAN OUTFALL

The existing outfall extends approximately 4,500 feet to a depth of 56 feet. The diffuser section is approximately 210 feet, with 8-inch and 10-inch ports spaced at 15 feet on centers.

It is proposed to extend the outfall into deeper waters (70-90 feet). The proposed diffuser length is 750 feet with port spacing of 12 feet on center. The port size is 3 inches (see Figure VIII-8).

The orientation of the diffusers is positioned in a northwesterly direction. The purpose of this orientation is to provide the adequate dilution during periods of the less south and easterly tide-related currents, and also provide adequate dilution during periods of the predominantly tide-related westerly currents.

Field investigations indicate that the surface portion of the sewage field would be directed in a southerly direction towards the Hilo Harbor-Puhi Bay area about 20 percent of the time from wind stresses. The orientation of the proposed outfall affords a compromise to accommodate the two oceanographic-climatological conditions.

Detailed discussion and calculations on the outfall extension are presented in Appendix K.

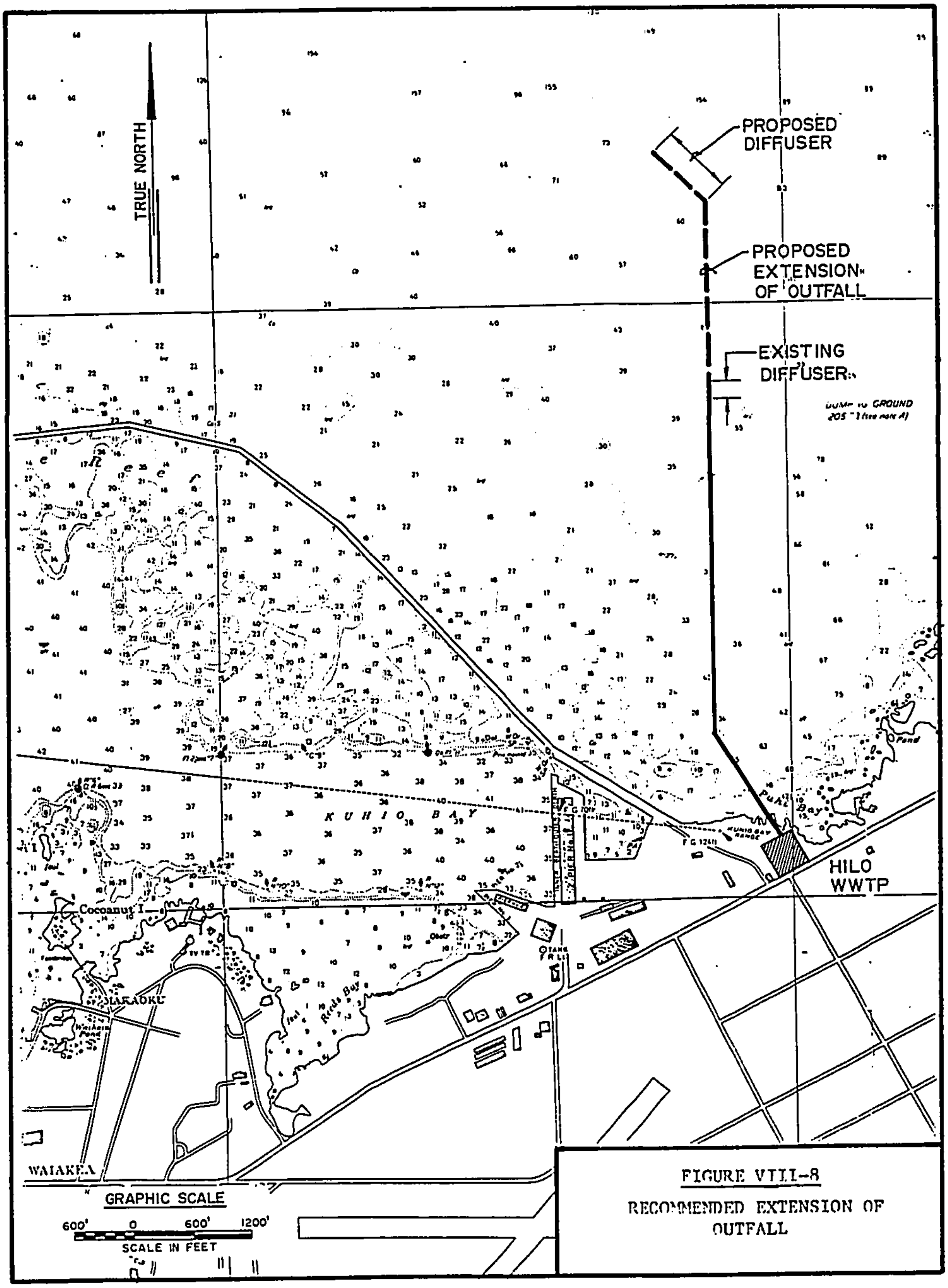

FIGURE VIII-8

RECOMMENDED EXTENSION OF OUTFALL

APPENDIX K

Initial Dilution Calculations
for Preliminary Assessment
for the Extension of the Hilo Outfall

PRELIMINARY ASSESSMENT FOR THE EXTENSION OF THE HILO OUTFALL

EVALUATION OF EXISTING OUTFALL

The existing outfall consists of a 48-inch outfall with a diffuser length of 210 feet. The ports are placed 15 feet on centers. Port sizes vary from 8 to 10 inches.

Initial dilution calculations, utilizing the Brook's Method, indicated that during certain periods, most notably summer and winter, dilutions achieved by the existing outfall at a design flow of 5.0 mgd would be below 50:1. Normally, a minimum initial dilution of 100:1 would be required. This is one of the reasons the outfall should be extended.

TABLE K-1

INITIAL DILUTION AS CALCULATED BY THE PLUME AND BROOKS MODELS FOR THE EXISTING OUTFALL

	L = 225'			L = 500'			L = 1,000'			L = 1,500'		
	3 mgd	6 mgd	10 mgd	3 mgd	6 mgd	10 mgd	3 mgd	6 mgd	10 mgd	3 mgd	6 mgd	10 mgd
Summer 1	59 63	53 40	44 27	114 116	95 78	83 58	136 168	114 116	100 87	152 206	126 142	110 110
Summer 2	91 122	65 94	53 68	194 180	165 121	145 82	229 262	194 180	170 138	254 318	213 221	189 171
Spring	64 114	46 71	38 51	75 117	64 89	58 76	90 152	75 117	66 94	100 175	84 142	73 113
Winter 1	56 67	44 41	39 36	210 180	153 104	124 70	301 312	210 180	165 120	378 430	258 244	200 164
Winter 2	83 73	62 77	50 56	113 116	95 78	125 59	134 167	113 116	99 87	148 205	83 142	110 109
Winter 3	85 104	64 96	54 68	180 168	151 108	128 75	214 240	180 168	158 122	237 297	199 210	175 160

Note: The top number represents initial dilution as calculated by the PLUME model and the bottom number represents initial dilution as calculated by the Brooks model.

L = Diffuser length (225 feet = existing).

REVISED EIS

FOR THE

WASTEWATER FACILITIES PLAN

FOR THE HILO DISTRICT
(excerpts)

REVISED
ENVIRONMENTAL IMPACT STATEMENT
ADMINISTRATIVE ACTION
FOR THE
HILO DISTRICT SEWERAGE SYSTEM
SOUTH HILO, HAWAII

Proposing Agency:

DEPARTMENT OF PUBLIC WORKS
COUNTY OF HAWAII

THIS STATEMENT WAS DEVELOPED IN ACCORDANCE WITH THE ENVIRONMENTAL IMPACT STATEMENT REGULATIONS, STATE OF HAWAII, AND SUBMITTED PURSUANT TO:

Chapter 343
Hawaii Revised Statutes

SEP 17 1980
Date

Edward Harada
EDWARD HARADA, CHIEF ENGINEER

SUMMARY OF THE
ENVIRONMENTAL IMPACT STATEMENT
FOR THE
HILO WASTEWATER MANAGEMENT PLAN

I. Description of the Proposed Action

The proposed action for the Hilo Wastewater Management Plan includes: 1) expanding the existing sewer collection system to include interceptors and pump stations, 2) constructing a new treatment plant to eventually provide either advanced primary or secondary treatment to incoming sewage flows, and 3) extending the existing ocean outfall sewer to discharge beyond nearshore waters.

The project site is located on the northeastern portion of the island of Hawaii and lies on the eastern slopes of Mauna Loa. The study area encompasses an area of approximately 56 square miles in Hilo and also includes Hilo Bay, one of two major deepwater harbors on the island.

Flows from sewered portions of Hilo are presently provided primary treatment at the municipal Hilo Sewage Treatment Plant. Effluent is discharged through a 48-inch outfall extending 4,500 feet offshore into 56 feet of water. The remainder of the populated areas is served by cesspools.

The choice of alternative systems and facilities is based on the cost effectiveness for meeting the following objectives:

a. To eliminate risks to public health and welfare from sewage disposal;

b. To preserve the quality of nearshore waters;

c. To comply with secondary treatment guidelines of EPA and the effluent disposal constraints outlined in the State Public Health Regulations, Chapters 37, 37A, and 38;

d. To minimize damage to facilities and equipment due to tsunamis and flooding; and

e. To control odors due to septic sewage.

The implementation of the recommended system, including construction of interceptor lines and pump stations, will require financial resources as well as time. For these reasons, it was recommended that the existing Hilo treatment facility continue to be utilized until such time that the new treatment facility and associated interceptor lines and pump stations are completed. Since the existing plant will ultimately be abandoned at the time the new treatment facility is operational, it was also recommended that the existing facility not be upgraded to comply with EPA's secondary treatment requirements. Rather, immediate work on expanding the existing sewer collection system to eliminate potential health hazards is recommended.

The proposed treatment facility is to be constructed in increments, with advanced primary treatment to be provided initially (as may be allowed with the granting of a waiver from EPA requirements for secondary treatment), followed by the addition of secondary treatment components at a later date in the event the waiver is denied. This recommendation is based on environmental studies on the impact of effluent discharged into Hilo Bay.

II. Description of Environmental Setting

A. Physical Environment

The physical characteristics of the Hilo study are as follows:

1. Ground elevations range from sea level at Hilo Bay to 600 feet above sea level along the urban fringe at the lower, southeastern slopes of Mauna Loa.

2. Slopes are generally gentle, ranging from six to ten per cent in the upper areas to zero to five percent in the coastal, urbanized areas.

3. Mean annual rainfall varies from 130 inches per year along the shore to as much as 200 inches per year in the mountain sections. Prevalent cloudy skies are responsible for the area receiving only 40 percent of the possible amount of solar radiation.

4. Tradewinds from the northeast are generally more prevalent in the summer than the winter and are stronger in the afternoon than the evening. These tradewinds are responsible for the year round mild temperatures.

5. Wailuku River is the major perennial stream in the study area, with an average discharge of 300 cfs near the coast. The river also represents the physical division of the area's geologic structure. Formations north of Wailuku River are of Mauna Kea volcanic origin, while areas to the south consist of Mauna Loa volcano formations dating back to the Pleistocene Age.

6. The study area rests on highly permeable and well-drained ash and basalt. The water table exhibits a seaward gradient of one to four feet per mile discharging into several freshwater springs off the coast.

7. Surface currents outside Hilo Bay generally exhibit a northwestern direction. During ebb tide, the generalized current pattern within the Hilo breakwater is in a counterclockwise direction.

8. Vegetation in the study area consists mainly of guava, fern, kukui, and hala. High elevation vegetation include hapuu trees, olapa, and ohia.

9. The coastal areas of Hilo are prone to flood damage by high surface runoff rates attributable to a combination of high-intensity rainfall and undefined drainage ways.

10. Hilo Bay is very susceptible to tsunamis generated from the eastern Pacific seismic belt. A breakwater approximately 9,000 feet in length encloses portions of Hilo Bay.

11. Water for the Hilo study area is supplied from both surface and basal water sources. For the year 1973 to 1974, water consumption was 4.1 mgd.

12. Water quality sampling of nearshore waters and an evaluation of coral coverage and biological communities along and flanking the existing Hilo STP outfall indicated no measurably detrimental effects attributable to the present primary effluent discharge.

B. Coastal Water Environment

An inventory of environmental conditions of Hilo Bay and adjacent nearshore waters include:

1. The nearshore waters south of Hilo Bay have been designated as "waters whose quality meets state standards now and will continue to meet them," while nearshore waters north of Hilo Bay are designated as "waters that do not meet state standards but will after best practicable treatment."

2. Existing point discharges in Hilo Bay include (1) thermal discharges from Hilo Electric Company, and ()2 primary treated effluent from the county's municipal treatment plant outfall. Previously, agricultural mill waste was also discharged into Hilo Bay.

3. The following is a summary of past investigations of Hilo Harbor (area shoreward of the breakwater) by Neighbor Island Consultant:

    a. Hilo Harbor is characterized by a two-cell, upper layer circulation pattern.

    b. Low salinity measurements were reported near Wailoa River, attributable to spring flow.

c. Dissolved oxygen levels were generally greater than 4.5 mg/l.

d. Average phosphorus and nitrate concentrations in the eastern portion of Hilo Harbor were 0.06 and 0.132 mg/l respectively.

e. Concentrations of chlorophyll-a in Hilo Bay were generally higher than those reported for Kaneohe Bay and other Pacific atolls.

4. The geological structure of the Hilo study area consists of the Kau volcanic series of Mauna Loa, an extremely permeable basalt.

5. Approximately 600 mgd enters Hilo Bay from the groundwater component. Another 100 mgd enters Hilo Bay from the surface flows.

6. A field investigation near the Hilo outfall was undertaken in conjunction with the proposed project. A summary of the findings is as follows:

   a. The overall current structure in the outfall discharge area is a combination of the north equatorial current, tide-related currents, and wind-driven surface currents. The predominant current is generally westerly, both for surface and subsurface currents.

   b. Based on current and drogue studies, a workable diffuser design is to orient the diffuser toward the northwest.

   c. The impact of the existing primary effluent discharge is not measurably significant, based on chemical analyses of the water column and sediment.

III. The Relationship of the Proposed Action to Land Use Plans, Policies, and Controls

State and county ordinances pertaining to land use control, to some extent, control the magnitude and direction of population growth which in turn exert a direct impact upon the emissions of waste material to the environment. Therefore, the sewerage needs of the Hilo study area are closely related to and are in conformance with present land use policies as delineated in the Hilo Community Development Plan.

IV. Probable Impact of the Proposed Action on the Environment

The probable impacts can be distinguished between those associated with the construction (short-term) and those associated with the operational (long-term) phases of the proposed action.

The physical impacts associated with the construction phase for the interceptor sewers, collection system, and treatment plant include:

1. Minor temporary traffic disruption along roadways.
2. Temporary minor noise and dust disturbances to residents in the proximity of the project sites caused by the construction work.
3. Unpleasant aesthetic appearance due to storage areas requirements and sewerline construction.
4. Construction of sewerlines will generally be limited to existing roadways; also the proposed site for the new treatment plant is located at an abandoned quarry. Therefore, the effect on endangered flora and fauna as well as archaeological and historic sites are expected to be insignificant.
5. Potential accelerated soil erosion caused by high intensity rains which could occur during grading operations.

Long-term impacts of the proposed action will be primarily associated with the operation and maintenance of the proposed treatment plant and pump stations which include the following:

1. An annual expenditure of approximately $450,000 or $300,000 for plant operations for a secondary or advanced primary facility, respectively, based on a flow of 5 mgd.
2. Aesthetic appearance of the facility site involving concrete buildings and tanks surrounded by a chain link fence.
3. Possible effect of noise emanating from the treatment plant and pump stations attributable to pumps and process equipment.
4. Possible odor problems due to the septic nature of the incoming sewage.
5. The proposed plant site is outside of both the 100-year flood area and the estimated inundation limits of a 100-year tsunami and no problems with flooding or erosion is anticipated.

The construction-related impacts associated with the extension of the ocean outfall includes:

1. The problems of noise, traffic and aesthetics due to construction activities and the need of a shoreline staging area to stockpile materials and equipment to accommodate boating/barging operations.
2. Temporary increase in turbidity of water columns in the nearshore waters caused by dredging operations.
3. Possible navigation problems involving the interference of boating and fishing activities in Hilo Bay.

The existing primary sewage discharge from the outfall has no measureable impact on the water quality and marine life in the area. Therefore, the effect of an advanced primary discharge or secondary effluent discharge can be expected to at least remain at present levels because of the large dilutions afforded by ocean outfall.

The secondary impacts as related to population growth are not uncontrolled nor unexpected since the proposed wastewater management plan is in conformance with present land use policies.

V. Adverse Impacts that Cannot be Avoided

The adverse impacts that cannot be avoided are primarily construction related activities, including noise, dust, traffic disruption, aesthetics and erosion. However, these impacts are temporary in nature which can be mitigated through proper construction practices.

VI. Alternatives to the Proposed Action

Three alternative actions were evaluated in lieu of the recommended secondary treatment process which included 1) the discharge of raw sewage, 2) no action with continued use of the present system, and 3) tertiary treatment. The first two alternatives were discarded based on EPA's secondary treatment guidelines. The tertiary treatment alternative was rejected based on the high cost factor. A fourth alternative is still pending in which an application for a modified discharge was submitted to EPA and if granted, an advanced primary treatment system is proposed.

The alternatives on site selection that were considered for the treatment facility included Leleiwi Point and the expansion and upgrading of the existing plant. Both of these alternatives were excluded based primarily on cost-effectiveness. Other factors which precluded the use of the existing site include: 1) there are no assurances of performance dependability when considering the damaging-incurring character of future tsunamis, 2) the maximum insurance coverage for each structure is only $100,000 where many structures exceed this amount, and 3) the proximity to the residential population have been the cause of many odor complaints.

Various alternatives for the treatment processes were evaluated. The criterion for selection of the best alternative was cost-effectiveness dealing with tradeoffs among the resources of land, energy and finance. Alternatives for liquid treatment included pond with filtration units, trickling filter, activated sludge, rotating biological contactor, and physico-chemical treatment. Liquid disposal alternatives included land spreading, injection well and ocean outfall disposal. Solids handling alternatives included anaerobic digestion and incineration while evaluation solids dewatering alternatives consisted of sand beds, vacuum filtration and centrifugation.

VII. Relationship Between Long-Term and Short-Term Use of Man's Environment

The practice of implementing individual sewerage systems is a short-term expedient, but proliferation of these systems can lead to both immediate and long-term problems. Malfunctions in the treatment process would have an immediate impact on the populace in the form of health and nuisance problems with the long-term impact on nearshore water quality impairment.

VIII. Irreversible and Irretrievable Resources Committed by the Proposed Action

Several irreversible and irretrievable resources must be committed to implement the proposed action. These include land, ocean disposal of effluent, financing for design and construction of the facility, and energy. User charge assessments will be required to finance operation and maintenance costs of the system.

IX. Unresolved Issues

The major unresolved issue is whether the proposed treatment facility will provide advance primary or secondary treatment. This issue will remain unresolved pending the approval by the U.S. Environmental Protection Agency of the application for a modified discharge waiving the secondary treatment requirements.

DESCRIPTION OF ENVIRONMENTAL SETTING

B. COASTAL WATER ENVIRONMENT

This section is devoted to describing the coastal water environment for Hilo Bay in terms of its water use classifications, known existing sources of pollutants, circulation characteristics, water quality, and marine biology. Portions of this discussion will be focused upon evaluating the environmental impacts of the existing Hilo STP sewage effluent disposal outfall.

The subject study area is shown on Figure II-12 along with the coastal water uses designated by the State Department of Health for the Hilo Bay area, herein described as the area from Pepeekeo Point to Leleiwi Point. Hilo Harbor, an area within Hilo Bay, is the area shoreward of the breakwater.

According to the state's system of classifying water uses, the nearshore waters flanking Hilo Harbor are designated as Class A. The uses to be protected in these waters are recreational and aesthetic enjoyment. Hilo Harbor waters (Class B) are intended for small boat and aesthetic enjoyment uses and generally refer to those waters of Hilo Bay located within the breakwater. (See Appendix A for a description of the classification system.) Further, in accordance with EPA's National Pollutant Discharge Elimination System (NPDES), the waters south of Hilo from Leleiwi Point have been designated by state authorities as the Puna Eastern Effluent Segment #2; i.e., waters whose quality meets state standards now and will continue to meet them after implementation of the EPA requirement of "best practicable treatment." The nearshore waters immediately north of Hilo Harbor from Paukaa Point to Pepeekeo Point, however, are designated as the Hamakua Effluent Limitation Segment #1; i.e., waters that do not now meet state standards but will after "best practicable treatment" is implemented. Coast waters from Paukaa to Keokea Point are designated as water quality segments; i.e., coastal waters that do not now meet state standards and will not, even with "best practicable treatment."

The outfall for the Hilo Sewage Treatment Plant is located in Puhi Bay on the seaward side of the Hilo breakwater (Figure II-13). The first 2,600-foot portion of the 48-inch diameter reinforced concrete

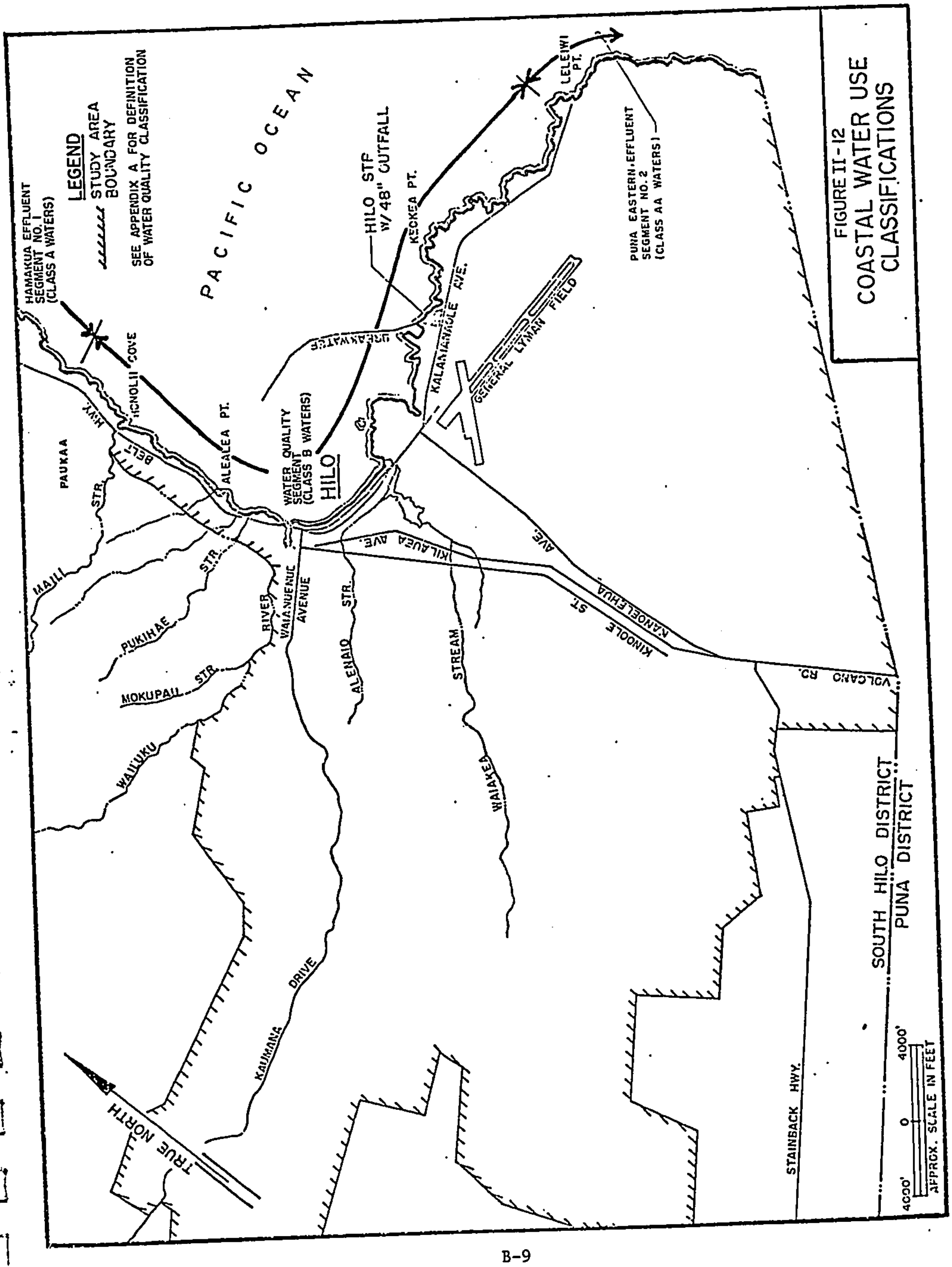

FIGURE II-12
COASTAL WATER USE CLASSIFICATIONS

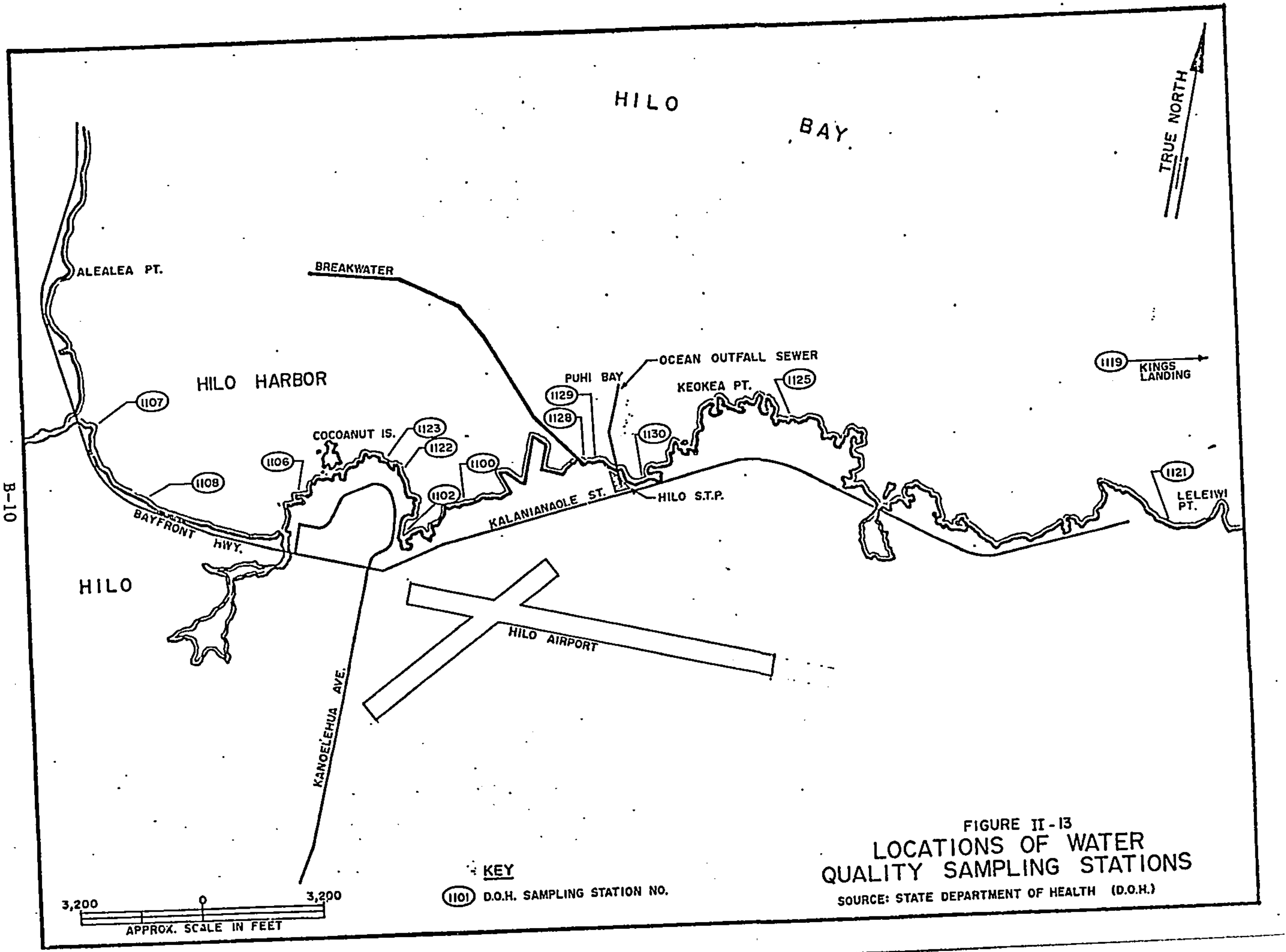

FIGURE II-13
LOCATIONS OF WATER
QUALITY SAMPLING STATIONS
SOURCE: STATE DEPARTMENT OF HEALTH (D.O.H.)

outfall line was placed into operation in 1966 and discharged effluent in about 37 feet of water. A few years later the outfall was extended to about 4,500 feet offshore and discharged effluent at a depth of about 56 feet through a 210-foot diffuser section.

The location of the outfall allows direct exposure to tradewind-generated swells from the north. The area is not directly exposed to southerly swells.

SOURCES OF POLLUTANTS IN HILO BAY

Historically, the coastal water extending from Pepeekeo Point to Leleiwi Point has served as a sink for natural and man-related pollutants from numerous point and nonpoint sources along the coast. Since the turn of the century, these pollutant sources have included wastewater from sugarcane processing operations, a canec plant, surface runoff from agricultural lands, raw sewage discharges, periodic shipboard waste disposal in Hilo Harbor, cesspool overflow and leachate, and the thermal discharges of Hilo Electric Company into Wailoa River.

Over more recent years, efforts have been directed toward curbing these pollutant sources because of apparent adverse effects upon the coastal waters particularly within Hilo Harbor. In fact, the sanitary quality of Hilo Harbor (as indicated by consistently high coliform levels) was so poor prior to 1965 that the State Department of Health prohibited the use of these waters for swimming, recreational boating, and fishing for a number of years. With the cessation of the major raw sewage discharges into the Hilo Harbor area since 1965, however, the sanitary quality of Hilo Harbor waters has improved substantially (Neighbor Island Consultants, 1973, and Chan et al. 1971).

Point Sources

At present, the major point source of pollutants entering Hilo Bay is the county's municipal treatment plant at Puhi Bay. Previously, processing waters from sugar mills were also discharged into the coastal waters. The Hilo Electric Company's thermal discharge (i.e., condenser cooling waters) of about 28 mgd into Wailoa River can also be included with these point sources, although its actual pollutant loads may be relatively small.

The practice of disposing of sugar mill wastes into Hilo Bay has had serious ecological effects over the years (EPA, 1971). However, current regulatory controls aimed at curtailing this practice of ocean disposal of mill processing waste are effectively reducing this source of pollutants in Hilo Bay. Today, only the Pepeekeo sugar mill is in operation along the northern coastline. (This mill is located approximately 8 miles north of the entrance of Hilo Harbor.) The sugar mill is expected to achieve "zero discharge" of its wastes into coastal waters in the near future (State Department of Health, personal communication). Up to 1977, the sugar mill at Papaikou was in operation and discharged its processing waters into the coastal waters.

The implementation of the Hilo municipal sewage treatment plant in 1966 eliminated the major raw sewage discharges and their attendant detrimental effects in Hilo Harbor. This facility has a design capacity of 7.0 mgd. At present, it is discharging approximately 3 mgd of primary-treated chlorinated effluent through a 48-inch, 4,500-foot long ocean outfall (offshore of Puhi Bay) at a depth of 56 feet.

Nonpoint Sources

For Hilo Bay, the two important nonpoint sources of pollutants are surface runoff from agricultural lands and subsurface discharges of pollutants from cesspools entering the bay through large groundwater influxes. It is interesting to note that these two types of sources can also be geographically separated due to the hydrogeological characteristics of the Hilo Bay area (see chapter on Physical Environment).

The primary surface sources are the Wailuku River and other streams to its north that drain agricultural runoff into Hilo Bay. It should be noted that these sources (via Wailuku River) previously received pollutants from household sewage and other types of discharges. In comparison, urban runoff has been found to be relatively insignificant in the area north of the Wailuku River.

In the area south of the Wailuku River, the leachate from subsurface (i.e., cesspool) sewage disposal systems is a significant nonpoint source. The highly permeable geology of this area (south of Wailuku River) appears to allow the transmissibility of pollutants in the groundwater. Recent water quality monitoring results (April and June, 1977) indicate that Class B standards for coliforms, total nitrogen, and total phosphorus are frequently exceeded in the vicinities of some of these subsurface discharges (i.e., Wailoa River, Reeds Bay, and the area adjacent to the commercial port) (unpublished data, U.S. Army Corps of Engineers). In addition, dye tracking studies conducted by the State Department of Health confirm that leachate from cesspools is seeping into the Waikele Stream near Kilauea Street.

EXISTING DATA ON HILO BAY

Water Quality Data

Water quality data, collected by the State Department of Health (DOH) as part of monitoring investigations, are compiled in Appendix B for inspection. (See Figure II-13 for sampling locations.) All sampling stations are limited to the shoreline; therefore, the results generally indicate the influence of terrestrial elements and are not representative of the nearshore water characteristics.

Past Investigation of Hilo Harbor

The most comprehensive environmental investigation of Hilo Bay was conducted by Neighbor Island Consultants in 1973 under the auspices of the Corps of Engineers, Department of the Army. The extent of the study, however, was limited to areas shoreward of the breakwater (referred to hereafter as Hilo Harbor). Although the interest of this report is focused on the waters seaward of the breakwater, the results of the study by Neighbor Island Consultants are included herein to provide insight into the overall condition of the bay and the interactions between the various water segments within the bay.

Currents. Hilo Harbor is characterized by a two-cell upper layer (approximately six feet thick) circulation pattern, with the convergence area being the end of the breakwater and Cocoanut Island. The eastern cell (Blonde Reef-Kuhio Bay) circulates clockwise; the western cell, counterclockwise.

This study also concluded that the net outflow from Hilo Harbor is seaward, with the substantial flows from the Wailuku River and springs along the eastern shoreline of the bay playing an integral part in the circulation system. This is substantiated in the Study of Dispersion in Hilo Bay, Hawaii, by the U.S. Public Health Service (1963) in the observance that "cane trash discharged by the sugar mills just north of Hilo has often been observed to travel in a southerly direction along the coast, yet this material usually does not enter Hilo Bay but is swept seaward before reaching the bay entrance."

Movement of the deep layer in Hilo Harbor indicated a seaward outflow in the western portion of the bay. In the eastern portion, however, only a vacillating movement of drogues was observed.

Physical and Biological Characteristics (see Table II-7).

Salinity. Salinity measurements generally indicated low salinity near the shoreline near Wailoa River and Kuhio Bay, attributable to spring flows. Salinity readings increased to that of seawater as distance from the shoreline increased. It was noted that a "skin" layer of fresh water existed over the majority of the eastern cell.

Dissolved Oxygen. Dissolved oxygen (DO) levels were generally greater than 4.5 mg/l. Dissolved oxygen readings provided further credence to the two-layered structure in Hilo Harbor with high DO readings at the three- to four-meter depth.

Nutrients. Results of a single day's sampling indicated that the average phosphorus concentration within the eastern portion of Hilo Harbor was 0.06 mg/l, with variations from 0.028 mg/l to 0.234 mg/l. The higher readings were noted at sample points near the shoreline. Average nitrate concentrations in eastern Hilo Harbor varied from 0.0003 mg/l to 0.507 mg/l, with an average of 0.132 mg/l.

Nutrient concentrations in western Hilo Harbor were low compared to those found in the eastern portion.

Chlorophyll-a. Concentrations of chlorophyll-a provide an indication of the plant productivity in a water body. Measurements of 4.5 mg/m^3 of chlorophyll-a in eastern Hilo Harbor were recorded. When

TABLE II-7

WATER QUALITY DATA IN HILO HARBOR*

(July to August 1972)

Parameter	Mean	Standard Deviation	Range
1. Salinity (parts per thousand)			
Surface	19.2	4.9	6.8-29.8
Two Meters	29.9	1.9	23.7-33.4
Three Meters	31.6	1.8	28.5-33.7
Five Meters	32.5	2.0	29.0-34.0
2. Temperature (°C): Surface	24.8	1.1	22.0-26.1
3. Dissolved Oxygen (ppm)			
Surface	7.5	1.0	5.9-9.3
Five Meters	7.4	0.5	7.0-8.1
Seven Meters	7.3	0.4	7.0-7.6
Dissolved Oxygen (mg/l)			
Surface	5.0	0.7	3.2-7.9
Bottom	3.9	0.7	2.0-5.6
4. Turbidity (secchi disc) Meters Depth to Disappearance	3.9	0.7	1.5-4.3 (clear to bottom)
5. Total Phosphorus (mg/l)	0.059	0.054	.028-.234
6. Nitrites (mg/l) as N	0.002	0.0007	.001-.003
7. Nitrates (mg/l) as N	0.132	0.15	.0002-.507
8. Chlorophyll-a (mg/m^3)	4.47	1.72	1.66-7.35

* Means of ten stations in Hilo Harbor as calculated by the U.S. Army Corps of Engineers.

Source: Neighbor Island Consultants, "Baseline Environmental Investigation of Hilo Harbor," March 1973.

compared with data from other investigations on isolated Pacific atoll lagoons (chlorophyll-a values range from 0.17 to 0.33 mg/m^3) and relatively productive Kaneohe Bay (0.925 mg/m^3), results indicate an order of magnitude increase over that of Kaneohe Bay and almost two orders of magnitude above those of the atoll lagoons.

CIRCULATION IN HILO BAY

The data available to describe circulation, stratification, and mixing in Hilo Bay are primarily the results of oceanographic studies initiated by the County of Hawaii to evaluate the environmental impact of discharging primary-treated sewage effluent through its sewer outfall offshore off Puhi Bay. These data consist of drogue measurements, salinity-temperature profiles, and dye dispersion data. Supplemental data are also available from investigations conducted within Hilo Harbor (Neighbor Island Consultants, 1973, and unpublished data, U.S. Army Corps of Engineers).

Drogue Measurements

The first drogue study was conducted by the firm of Sunn, Low, Tom & Hara, Inc. (1963) in May 1963, prior to construction of the outfall. This study investigated the current pattern within Puhi Bay. The following summary statement was made in the study report.

> "From these limited studies, it was surmised that there is a continuous flushing of the Puhi Bay waters. At rising tide, a northeasterly surface current flow outward and around Keokea Point is indicated. At ebbing tide, a northwesterly surface current flow outward and around the breakwater is evident. At slack water period, high or low tidal stages, the currents may flow inward toward the shore lines, but at reduced velocities generally less than 10 fpm."

The drogues used in the 1963 study were primarily surface drogues, with a few "deep" drogues at a depth of about 15 feet. The release points at 1,000 and 2,000 feet offshore were well within the embayment, as defined by a line from Keokea Point to the northernmost point of the breakwater. These release points are also shoreward of the present diffuser location. The wind direction varied from the northwest to the northeast during the 1963 study.

The general tide-related current structure just outside of Hilo Bay (as defined by a line from Leleiwi Point to Pepeekeo Point) is indicated by the Hawaii Institute of Geophysics in The Atlas of Hawaii (University of Hawaii Press, 1973) to be toward the northwest under both flood and ebb conditions. A counterclockwise ebb-related current is also shown to occur within Hilo Bay.

In May 1975, a preliminary five-day dilution zone study of the Hilo outfall was conducted as part of the investigation of the Hilo Facilities Plan. Subsequent to the study (over the period September 1976 to June 1977), four week-long field investigations were conducted by Sunn, Low, Tom & Hara, Inc. to supplement the existing data for the Hilo Facilities Plan. The data from these field trips were used to formulate the following discussions.

General Current Patterns. Circulation in Hilo Bay is influenced by the north equatorial and tide-related currents, winds, and freshwater influxes, as well as wave-induced currents near the surf zone.

Surface transport is primarily governed by the effects of winds and the generally seaward-moving freshwater superimposed upon tide-related currents. Naturally, the velocities of these surface currents are variable depending on prevailing wind and seasonal conditions and locality.

The effect of the freshwater lens "floating" on the denser seawater is well exhibited in certain areas. Along the mouth of Hilo Harbor, for instance, the surface layer has been observed to move continuously outward due to the vast amount of freshwater that continuously enters Hilo Harbor from both surface and groundwater sources (Neighbor Island Consultants, 1973, and unpublished data, U.S. Army Corps of Engineers). A similar phenomenon was observed in Puhi Bay, where a large groundwater discharge exists (SLTH, 1963.)

Table II-8 is a statistical summary of drogue speeds measured in the vicinity of the outfall diffuser at various depths. As would be expected, current speeds were observed to decrease with depth. The mean

TABLE II-8

STATISTICAL SUMMARY OF DROGUE SPEEDS IN THE VICINITY OF THE DIFFUSER

Drogue Depth (feet)	Number of Measurements	Median Velocity (knots)	Mean Velocity (knots)	Standard Deviation (knots)	Coefficient of Variation (%)	Range (knots)
Surface	25	0.30	0.33	0.19	58	0.05 - 0.79
10	16	0.12	0.13	0.07	54	0.03 - 0.29
15	14	0.10	0.10	0.06	60	0.03 - 0.24
30	28	0.10	0.09	0.04	44	0.02 - 0.16

speed for surface transport was found to be 0.33 kts and that for the 30-foot depth was 0.09 kts. The mid-depth speeds for 10 and 15 feet were 0.13 and 0.10 kts respectively.

The slower subsurface transport appears to exhibit the combined effects of tide-related currents and bathymetry. While a well-defined, tide-related current pattern is not clearly discernible, the drogue data (see Appendix D) do indicate that the predominant direction of subsurface (10 feet and deeper) transport is from east to west and along Blonde Reef. At times, there also appears to be a reversal in direction. Unfortunately, the drogue results do not yield a better description of this reversal, although indications are that this phenomenon is not strictly tide-related.

The general current pattern in the area of the Hilo STP outfall is indicated on Figure II-14. The wind rose for the nearby airport is given on Figure II-2. Most frequently, the sewage field will move in a westerly direction, both at the surface and subsurface. Less frequently, the subsurface portion of the field will move easterly, while the surface will be reflected toward the northeast, as illustrated by the drogue pattern on May 21, 1975 (see Appendix D).

About 20 percent of the time, wind stress in the area is in a southerly direction and, hence, would deflect the surface portion of the sewage field directly toward the Puhi Bay area. The depth of this surface portion is estimated to be one to two feet, except when the wind is steady for a long duration, in which case the depth may be greater. It should be noted, however, that the large continuous discharge of freshwater from Puhi Bay would serve to retard this shoreward transport to some, as yet unknown, extent.

STRATIFICATION IN HILO BAY

Vertical stratification in Hilo Bay waters is caused by large freshwater influxes (estimated to total over 400 million gallons per day) from surface and subsurface sources along its coast. This phenomenon is an important aspect of circulation since it is intimately related to vertical mixing and horizontal dispersion (hence, mass exchange).

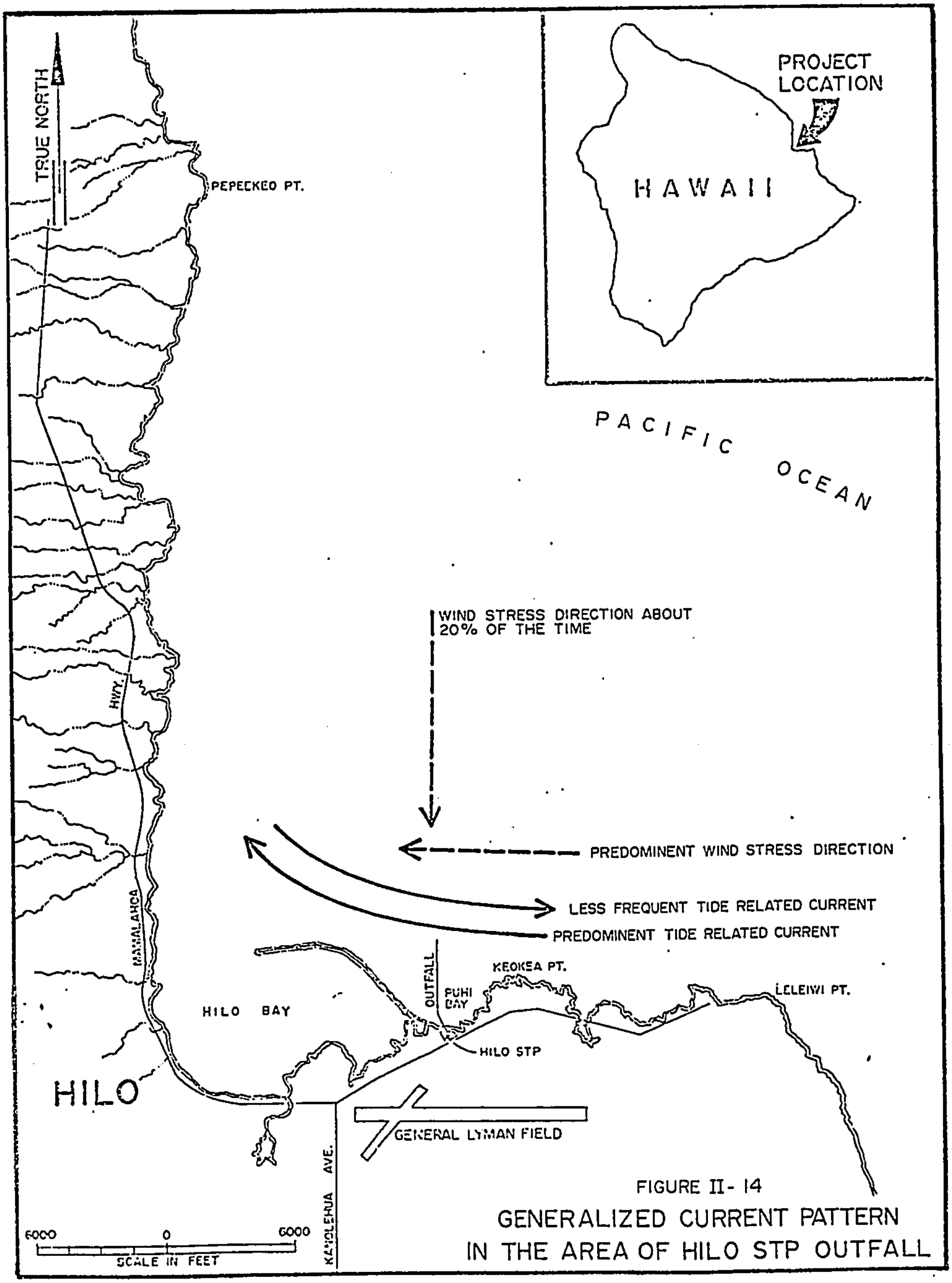

FIGURE II- 14
GENERALIZED CURRENT PATTERN IN THE AREA OF HILO STP OUTFALL

To identify the extent of freshwater influences in Hilo Bay, vertical measurements of salinity and temperature were gathered as part of the field investigations. Salinity-temperature profiles plotted from data collected on three different occasions are presented in Appendix C.

The variable extent of stratification (both temporally and spatially) is clearly illustrated by these profiles. Naturally, the surface layer is most well defined near the major freshwater sources (e.g., along the mouth of Hilo Harbor and at Puhi Bay). Proceeding seaward, the salinity and temperature gradients are observed to diminish as mixing (depending primarily on available wind energy) occurs.

The depth of the freshwater influence in Hilo Bay appears to generally vary with season (wind and freshwater influx). This depth was observed to range from about 10 to 30 feet. At times, it is suspected that strong winds may extend this surface layer to even greater depths. The profiles for April 12, 1977 are representative of typical wet weather conditions in Hilo and indicate the extensiveness of stratification.

Within Hilo Harbor, stratification has been found to be a year-round phenomenon due to its proximity to continuous freshwater discharges (Neighbor Island Consultants, 1973, and unpublished data, U.S. Army Corps of Engineers). Of course, the surface layer is much better defined in the harbor area.

A review of aerial photographs of Hilo Bay has also disclosed that exchange at the surface along the open mouth of the bay is restricted at times. This information and the fact that significant stratification appears to extend out to the bay mouth, at least at times, pose an interesting question; namely, identifying the mechanism responsible for restricting exchange with the open area. While it is suspected that wind and freshwater inputs play major roles in this scheme, the actual mechanics of this observed condition are not presently understood.

WATER QUALITY CHARACTERISTICS OF HILO BAY

The historical water quality data base for Hilo Bay can be described as generally lacking. The existing data are primarily the result of investigations conducted within Hilo Harbor (i.e., within the breakwater) by Neighbor Island Consultants (1973) and Chan et al. (1971). It is therefore not surprising to find that the only data available for assessing ambient water quality conditions outside of Hilo Harbor are the result of field investigations initiated by the County of Hawaii and performed by the firm of Sunn, Low, Tom & Hara, Inc. to evaluate the environmental impact of the effluent discharge from the existing Hilo STP outfall.

The first of these investigations was conducted in May 1975 as a preliminary study. Subsequently (since September 1976), four sets of water quality data have been gathered. These data are contained in Appendix E and were used in formulating the following discussion. The sampling locations established for this area are shown on Figure II-15.

Physical Parameters

The pH levels measured (8.2 to 8.4) were typical of seawater levels found in Hawaiian waters. The slight variations found are within the limits of natural variability and those of instrument precision. The State Water Quality Standards states that the pH should not deviate more than 0.5 units from natural conditions, but not lower than 7.0 nor higher than 8.5 from other than natural causes.

As discussed previously, salinity and temperature measurements revealed the influence of the large freshwater influx into Hilo Bay. At times, the stratification caused by the freshwater was found to extend beyond Station No. 1 (open sea control) and to depths of 20 to 30 feet.

The turbidity and suspended solids (TSS) data are consistent with the observed turbid conditions in Hilo Bay. Turbidity measurements ranged from 0.3 to 1.3 NTU (for all stations) with a mean of 0.6 NTU. Turbidity in open coastal waters around Hawaii is, on the average, about 0.3 NTU (unpublished SLTH data). Diver observations during the first three field trips further disclose that turbid conditions were most evident in a surface layer that ranged from 10 to 20 feet in depth. Below the surface layer, underwater visibility was found to improve.

In contrast, water clarity during June 1977 was found to have improved substantially over what was found during previous trips. These

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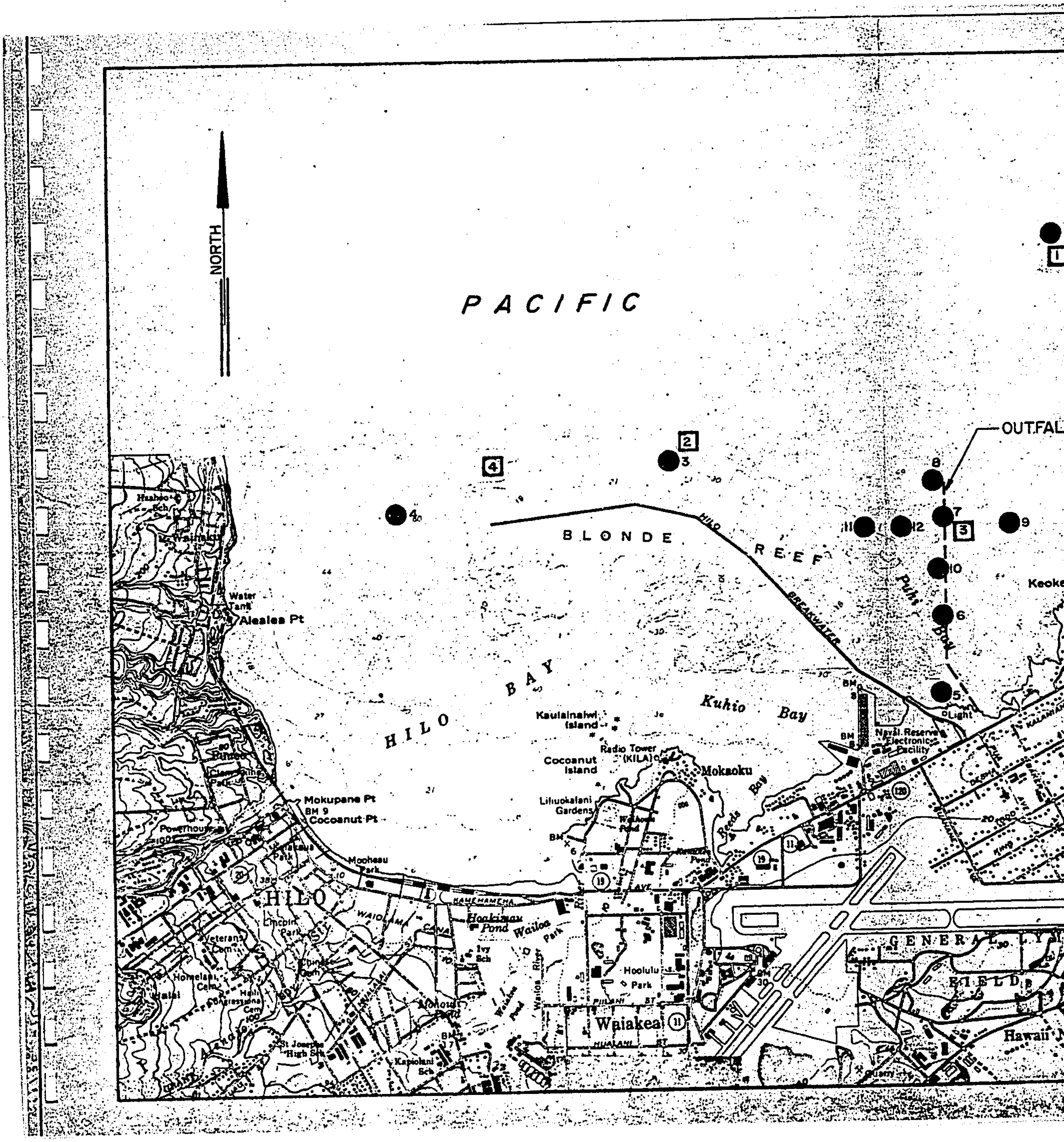

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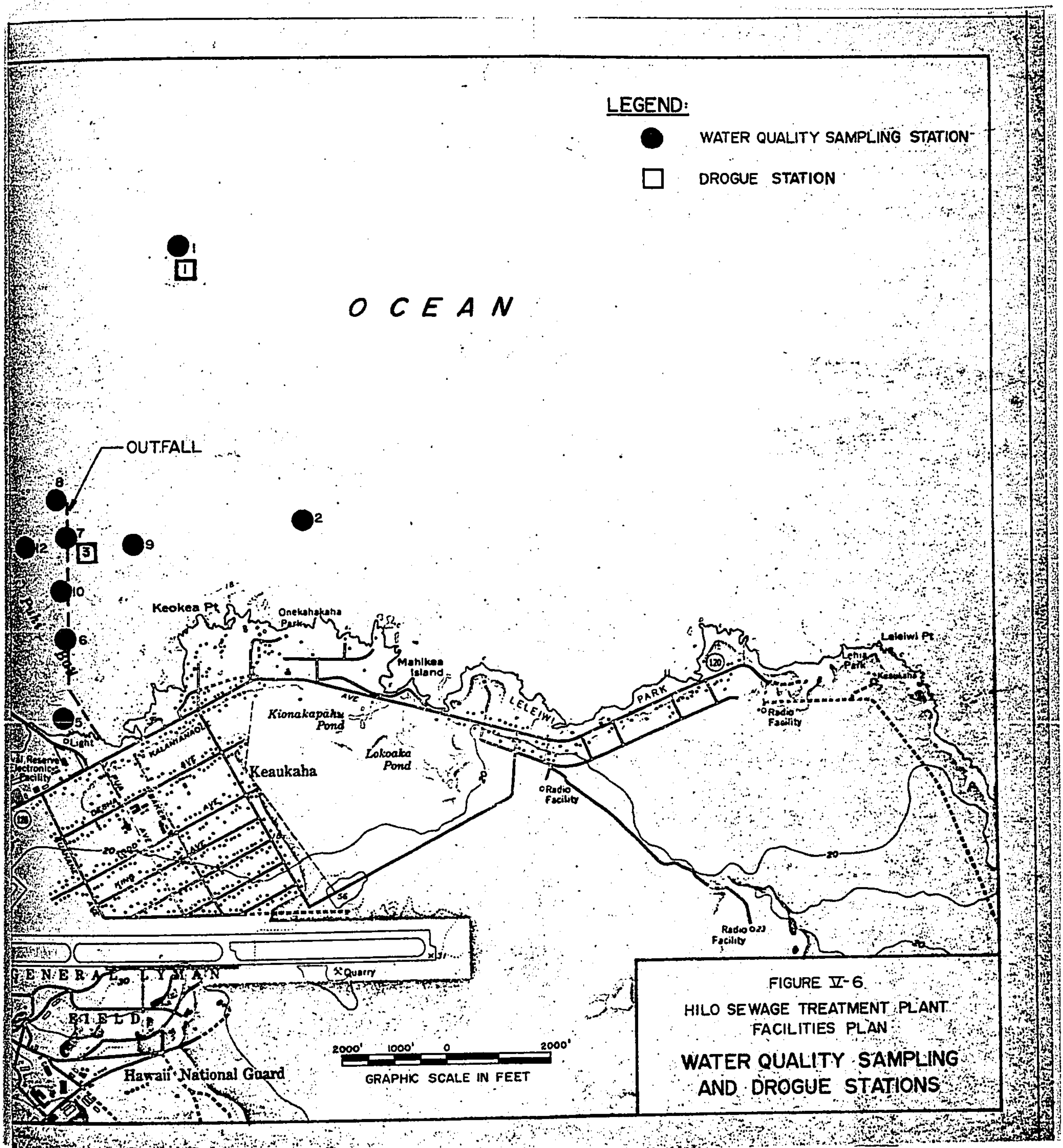

FIGURE V-6

HILO SEWAGE TREATMENT PLANT FACILITIES PLAN

WATER QUALITY SAMPLING AND DROGUE STATIONS observations indicate that turbidity in Hilo Bay may be season-related phenomenon and, possibly, one that reflects the apparent restricted exchange, at times, of bay waters with the open ocean.

Dissolved Oxygen

The dissolved oxygen (DO) measurements have been summarized and are presented in Table II-9. As is evident upon reviewing this table, DO levels in Hilo Bay were found to be very high during daylight hours and often measured at supersaturation levels due to the synthesis of oxygen by photosynthetic plant organisms (i.e., phytoplankton).

Nutrients

Table II-10 is a summary of the nutrient (i.e., total nitrogen and total phosphorus) data gathered. For purposes of discussion, similar values for chlorophyll-a (a measure of the abundance, on standing crop, of phytoplankton) are included in this table.

As shown in Table II-10, the levels of total nitrogen in Hilo Bay were frequently found to be in exceedence of the currently applicable State Department of Health Class A water use standard of 150 ug/l. It is important to note, however, that these relatively high levels were found at all stations. Only slightly higher levels measured at the Hilo STP outfall discharge site (Station No. 7) appear to indicate that the relative impact of this effluent disposal practice upon Hilo Bay is insignificant. These findings thus indicate that the major contributors of nitrogen in Hilo Bay are point and nonpoint sources other than discharge from Hilo STP.

On the average, total nitrogen levels in open coastal waters around Hawaii have been estimated to be about 100 ug/l (unpublished SLTH data). The substantially higher levels found in Hilo Bay appear to be another indication of restricted exchange, at least at times, with pristine ocean waters along the open mouth of the bay.

Total phosphorus levels, unlike those of nitrogen, were found to be within the State Department of Health Class A standard of 25 ug/l. Even the data collected over the outfall discharge site were found to be

TABLE II-9

SUMMARY OF DISSOLVED OXYGEN MEASUREMENTS(1)

Station No.	Station Description	Mean (mg/l)	Range(2) (mg/l)	% DO Saturation Range
1	Control	7.2	6.5-7.0	97-100
2	Control	7.2	6.5-6.9	96-100
3	Breakwater	7.4	6.4-7.6	96-109
4	Mouth of Hilo Harbor	7.7	6.3-8.2	94-119
5	Nearshore	7.1	6.6-7.0	93-101
6	Midway to Shore	7.1	6.2-7.2	93-101
7	Break in Outfall(3)	6.8	5.2-7.7	76-110
8	Diffuser	7.7	7.2-7.5	101-112
9	Zone of Mixing	6.8	6.4-6.8	90-96
10	Zone of Mixing	6.9	6.4-6.9	90-101
11	Zone of Mixing	7.1	6.1-7.4	90-106
12	Zone of Mixing	7.0	5.9-7.4	87-106

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(1) All measurement taken at 5-foot depth.

(2) Range of four measurements.

(3) Repaired in May 1977.

TABLE II-10

SUMMARY OF NUTRIENT AND CHLOROPHYLL-a DATA(1)

	Total Nitrogen (ug/l as N)	Total Phosphorus (ug/l as P)	Chl-a (mg/M^3)
Class A Standards	150	25	-
Station No. (depth, feet)			
1(5)	256	15	1.13
1(30	321	14	1.06
2(5)	270	14	1.47
2(30)	268	18	1.26
3(5)	247	20	1.21
3(30)	283	24	0.96
4(5)	293	21	2.00
4(30)	351	21	1.78
5(5)	319	20	1.74
5(15)	289	14	0.64
6(5)	305	19	2.22
6(30)	188	17	1.09
7(5)	391	24	1.20
7(30)	250	16	1.24
8(5)	217	16	1.73
8(30)	214	18	1.05
9(5)	207	16	1.59
9(30)	201	13	1.09
10(5)	168	16	1.12
10(30)	204	14	0.99
11(5)	168	16	0.78
11(30)	234	20	0.86
12(5)	240	20	1.20
12(30)	196	19	1.16

---

(1) Mean values of four sets of data.

typically within the standard and only slightly higher than background levels.

The chlorophyll-a data parallel the nitrogen levels found. The levels of phytoplankton abundance are substantially higher than those of open coastal areas in Hawaii that are, on the average, about 0.15 mg/M^3 (unpublished SLTH data). They are also comparable to the levels found during the dry season in the south sector of Kaneohe Bay (Oahu) from 1970 to 1973 (SLTH, 1976).

These high levels of chlorophyll-a are also indicative of enriched conditions in Hilo Bay and may be responsible, in part, for the relatively high turbidity found in bay waters.

Sanitary Quality

Bacteriological tests for total and fecal coliforms were performed at each water quality station to monitor the sanitary quality of Hilo Bay waters. Table II-11 is a summary of these data.

While the data gathered exhibited considerable variability, the levels found, particularly in the vicinity of the outfall, were generally low and well within the Class A standards (i.e., a median of 1,000 organisms/100 ml for total coliform and a mean of 200 organisms/100 ml for fecal coliform). There low coliform levels at and around the treated effluent discharge site are an indication of the effective disinfection achieved by chlorination at the Hilo STP.

It should be noted that, although only at low levels, both total and fecal coliforms were also found at control Station No. 2. This finding is an indication that sources other than the Hilo STP outfall are also discharging enteric bacteria into Hilo Bay.

The sanitary quality of Hilo Harbor waters (area shoreward of the breakwater) was also monitored on two different days in April 1977 as part of the Hilo Area Comprehensive Study (unpublished data, U.S. Army Corps of Engineers). The parameters measured were fecal coliform and fecal strep and did not include total coliform. Nevertheless, the data collected at certain stations are presented below (Table II-12) to generally indicate the poorer sanitary quality of the harbor waters compared to the waters outside of the breakwater.

TABLE II-11

SUMMARY OF TOTAL AND FECAL COLIFORM DATA(1)

Station No.	Station Description	Total Coliform (No./100 ml)	Fecal Coliform (No./100 ml)
1	Control	6	3
2	Control	15	2
3	Breakwater	7	2
4	Mouth of Hilo Harbor	33	2
5	Nearshore	2	2
6	Midway to Shore	24	2
7	Break in Outfall(2)	56	2
8	Diffuser	536	20
9	Zone of Mixing	5	2
10	Zone of Mixing	73	2
11	Zone of Mixing	57	2
12	Zone of Mixing	467	2

---

(1) Mean values for the first three sets of data. The data for June 8, 1977 were not representative of typical conditions due to a malfunctioning chlorinator at Hilo STP. This set of coliform data can be found in Appendix F.

Note: Coliform data taken from surface sample only.

TABLE II-12

SANITARY QUALITY OF HILO HARBOR WATERS

Location	Fecal Coliform (#/100 ml) April 1	Fecal Coliform (#/100 ml) April 5	Fecal Strep (#/100 ml) April 1	Fecal Strep (#/100 ml) April 5
Wailuku River	560	50	8,400	11,600
Wailoa River	10	4	330	670
Ice Pond	300	320	440	3,800
Reeds Bay	206	2	660	2
Commercial Port	24	2	740	2
Hilo Harbor Mouth	10	8	80	50

As illustrated in Table II-12, certain areas in the harbor (viz., Wailuku River, Wailoa River, and Ice Pond) appear to receive enteric bacteria from continuous sources, while others (viz., the commercial port area and Reeds Bay) appear to be affected by periodic discharges (e.g., shipboard wastes). The continuous surface outflow at the harbor mouth appears to be a steady source of these enteric bacteria for outer bay waters.

As part of the field investigations, the T-90 die-off rate for coliform bacteria (i.e., the time it takes for 90 percent of the coliform bacteria to die) in Hilo Bay waters was also determined on two separate occasions. The results of these field tests were 17 and 23 minutes and are comparable to similar data gathered for other Hawaiian coastal areas. For design purposes, it appears reasonable to apply a conservative estimate of 30 minutes for the T-90 coliform die-off rate in Hilo Bay waters.

Toxic Substances

To investigate the presence of toxic substances in Hilo Bay, water and sediment samples were collected and analyzed for heavy metals and pesticides (i.e., chlorinated hydrocarbons). The results of these analyses are shown in Table II-13.

TABLE II-13

HEAVY METAL CONCENTRATIONS IN HILO BAY WATERS

Heavy Metal	Control (Sta. No. 1)	Breakwater (Sta. No. 3)	Outfall Discharge (Sta. No. 7)
Nickel	0.03	0.04	0.07
Copper	0.05	0.04	0.02
Chromium	0.06	0.02	0.02
Zinc	0.13	0.03	0.11
Cadmium	0.002	0.002	0.002
Mercury	0.0002	0.0002	0.0002

Note: All samples were collected at the five-foot depth. All units are expressed in mg/l.

All of the above heavy metal concentrations are near the detectable limits of the analytical procedures used.

As shown in Table II-13, the concentrations of metals found in the samples taken over the outfall discharge are equal to or less than the concentrations of metals found at the "control" station, with the exception of nickel. This is anticipated since the concentration of metals in the effluent from the Hilo facility is also low (see Table II-14).

Metal concentrations in the sediment are reported in Table II-15. While the values of metal concentrations in the sediment near the discharge site are higher than those at the breakwater site, these values are lower than those found in so-called pristine areas (Kahana Bay). Furthermore, published data by the State Department of Health on concentrations of trace metals in sediment from various embayments in the state indicate significantly higher values for Hilo Harbor (shoreward of the breakwater). This can be be primarily attributable to the poor circulation character of the harbor.

TABLE II-14

WASTEWATER CHARACTERISTICS OF HILO TREATMENT PLANT

Parameter	Influent	Effluent
BOD (mg/l)	95	44
Suspended Solids (mg/l)	117	51
pH	7.2	6.6
Ammonia Nitrogen (mg/l)	8.4	9.1
Total Phosphorus (mg/l)	9.2	8.2
Settleable Solids (mg/l)	4.0	1.1
Fecal Coliform (no./100 ml)	4,160	147

Source: Department of Public Works, Bureau of Sewers and Sanitation, County of Hawaii, for period December 1976 to March 1977.

TABLE II-15

HEAVY METAL CONCENTRATIONS IN SEDIMENT

Heavy Metal	Sediment near Discharge Site (Sta. No. 7)	Sediment near Breakwater (Sta. No. 3)	Pristine Area: Kahana Bay*	Hilo Harbor*
Cadmium	0.16	0.09	12.1	5.0
Zinc	12.30	0.23	44.0	161.0
Copper	20.12	9.23	28.4	82.0
Chromium	5.35	0.38	ND	0.43
Mercury	0.10	0.01	ND	0.43
Arsenic	--	--	18.0	156.7

Note: All concentrations are on the dry weight basis. All units are expressed in mg/kg.

* Hawaii State Department of Health, 1976 to 1977.

It should be noted that an extremely high value of arsenic was reported by the State Department of Health. This high value can be attributed to the industrial waste discharge from a cenac processing plant of which arsenic is a byproduct. The waste flow was discharged into Waiakea Pond, which eventually leads into Hilo Harbor. This discharge was terminated in the late 1960s. As indicated from the data of heavy metals concentration in sediment, the high concentrations found in sediment are limited to areas shoreward of the breakwater.

The pesticides results showed that all of the chlorinated hydrocarbons tested were below detectable limits (i.e., less than 1 part per trillion). The chlorinated hydrocarbons investigated included alpha chlorelane, gamma chlordane, aldrin, heptachlor, heptachlor epoxide, DDT, DDE, DDD, and dieldrin.

MARINE BIOLOGY

The following discussion is a summarization of marine biological conditions observed in Hilo Bay since May 1975. The detailed reports submitted for this study by Dr. Ralph Bowers are contained in Appendix F. Figure II-16 is a map of the biological sampling stations established for this study.

Plankton

Plankton samples were collected with a 5-inch plankton net (200-u mesh size) during the four water quality monitoring trips discussed previously, preserved with formalin, and later analyzed by Dr. Bowers using the multiple subsample method.

The four sets of plankton results (Appendix F) exhibit considerable variability and may, in part, reflect seasonal effects upon plankton populations in Hilo Bay. As is common in Hawaiian waters, copepods were found to be the most abundant of the zooplanktons. The data collected also show that their densities varied directly with those of phytoplankton (i.e., short-chain colonial diatoms), their primary food source. The number of zooplankton types found at all stations varied from 9 to 17.

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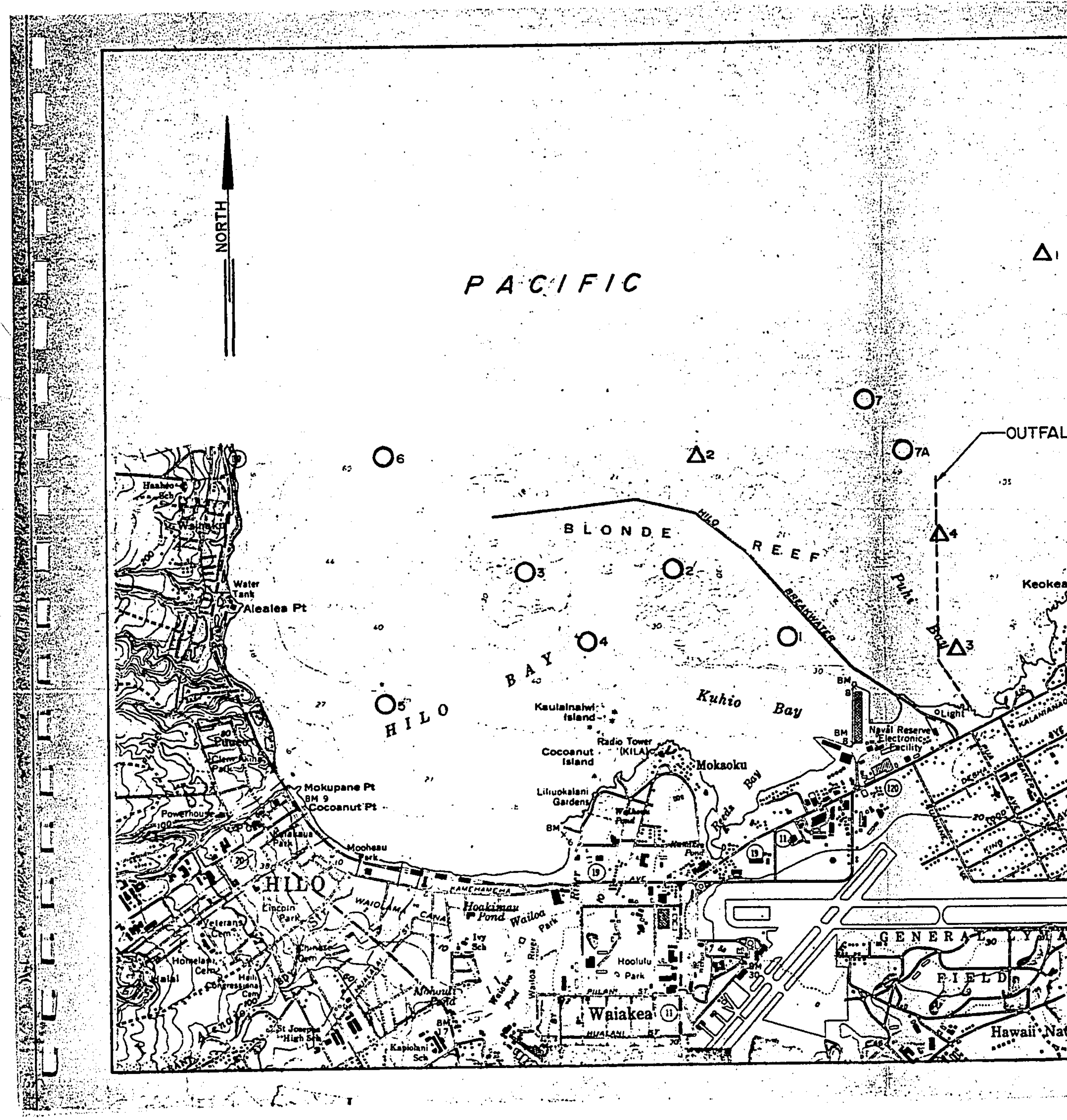

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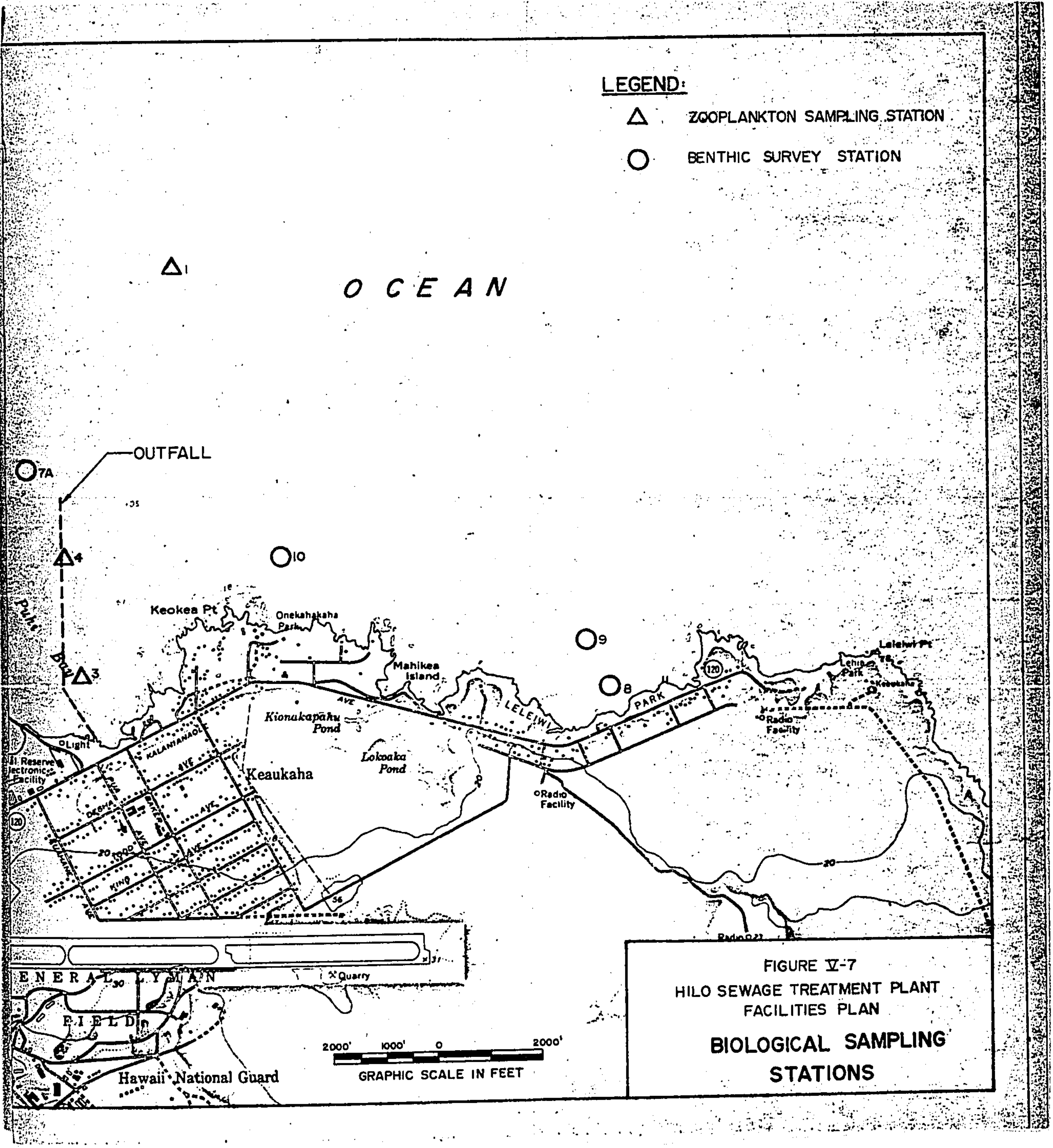

FIGURE V-7
HILO SEWAGE TREATMENT PLANT
FACILITIES PLAN

BIOLOGICAL SAMPLING STATIONS

In terms of copepod densities and number of zooplankton types, the levels found in Hilo Bay are not significantly different from those of other Hawaiian coastal areas. These zooplankton populations are particularly comparable to the area seaward of Hawaii Kai Marina (Oahu), the area seaward of the Honolulu International Airport Reef Runway (Oahu), and Nawiliwili Harbor (Kauai).

The variations in the zooplankton data gathered are most likely the result of "patchy" distributions caused by the influences of current patterns, prevailing winds, and groundwater flows rather than those of the Hilo STP outfall.

Benthic Environment

The data used to describe the benthic environment of Hilo Bay were collected on three separate occasions. In May 1975, a preliminary survey was conducted along the sewer outfall and at two control stations seaward of the breakwater. Subsequently, the stations shown on Figure II-17 were surveyed in January and, again, in June 1977. As shown, several stations were located within Hilo Harbor (i.e., inside of the breakwater) to collect data for comparative purposes. Tabulated estimates of substratum coverage, macroinvertibrate (other than corals) densities, and relative fish abundance are presented in Appendix F.

The topography and substratum found to the east of the breakwater and extending past the Hilo STP are generally characterized by a series of ridges and channels that run at an angle to the alignment of the outfall pipe. These ridges and channels vary in width (approximately 10 to 40 meters) and produce a depth difference of about 10 to 15 feet. The substratum is primarily hard bottom with small patches of sand.

Most of the corals observed in this area are characterized by a low, flat, platelike or encrusting type of growth. The most commonly observed genera include *Porites*, *Montipora*, *Pavona*, and *Leptastrea*, all of which are capable of growth where light levels may be reduced and sediment loads may be relatively high (*Montipora* and *Porites* are common in Kaneohe Bay, where these conditions prevail). It is interesting to note that one of the dominant forms of coral, *Porites lobata*, almost always grows as a flat, encrusting form in the areas observed. This type of coral generally forms massive, pyramid-shaped heads in other areas of the Hawaiian Islands. Only a very few large heads of Porites lobata were observed throughout this area, suggesting that its growth may be slower or possibly controlled by periods of heavy surge that would destroy the larger coral heads.

Very few heads of the finger coral, Pocillopora meandrina, were observed. The paucity of this coral suggests that the area is subject to reduced light levels and possibly reduced salinity levels. Pocillopora is much less tolerant of decreased salinity than either Porites or Montipora. If the reduced salinity is a problem, it is not a result of the outfall but, rather, of groundwater discharge, since most of the Pocillopora coral heads that were observed were located on the concrete reinforcement blocks near the effluent discharge.

Total estimated live coral coverage varies from 36 to 56 percent. A comparison of these coral coverages with those of other areas in the Hawaiian Islands suggests that coral coverage in this portion of Hilo Bay falls within an "expected" range. For example, coral coverage surrounding the island of Lanai, measured by the same methods, averaged 43 percent; at Sandy Beach on Oahu, coverages average 50 percent at the control site; and seaward of the Reef Runway in Honolulu, coverages average 38 percent. These coral coverages were measured at depths between 40 and 55 feet. The area seaward of the Reef Runway has been subjected to prolonged turbid conditions (unpublished SLTH data).

Coralline algae, macroinvertebrates (e.g., sea urchins and sea cucumbers), and demersal (bottom-dwelling) fishes were more abundant near the outfall than at the control sites. Along the outfall, the biostimulatory effect of the effluent upon these benthic marine organisms is evident as the most abundant populations were observed to be in the immediate vicinity of the discharge. In terms of coral coverage, however, the effluent effects are not discernible since the estimates for the outfall area and the control stations show no significant differences.

These biological data and other observations made at stations within the Hilo Harbor area and at control stations offshore of Onekahakaha Park and Richardsons (Leleiwi) Beach Park generally indicate that the marine environment steadily improves eastwardly along the coast. The poorest conditions were found within the harbor and the best conditions were offshore of Richardsons Beach Park.

In relation to this spectrum of marine biological conditions, the Hilo STP outfall discharges into an environment that has been and continues to be exposed to natural and man-related stresses (e.g., large freshwater discharges and high sediment, nutrient and organic loadings). It therefore appears that the existing conditions around the outfall overshadow the negative effects, if any, of this relatively small point discharge.

CHAPTER IV

PROBABLE IMPACT OF THE PROPOSED ACTION ON THE ENVIRONMENT

EFFLUENT DISPOSAL SYSTEM

The present system, which has not been found to have had significant detrimental effects, discharges primary treated effluent within nearshore waters at a depth of 56 feet and at a distance of about 4,500 feet from shore. The proposed system calls for discharging an effluent that has undergone a higher degree of treatment (i.e., advanced primary or secondary treatment) at a deeper depth (about 70 to 90 feet).

Short-Term Impacts

1. Shoreline staging area. A construction staging area will be required along the shoreline to stockpile materials and equipment and to accommodate boating/barging operations. The activities at this yet undesignated site will have attendant noise, traffic, aesthetic, and related impacts during the construction period.
2. Turbidity. Excavation and pipe installation activities will temporarily increase water turbidity at the offshore construction site.
3. Navigation. The presence of the construction barge and boating/barging operations in the waters of Hilo Bay may temporarily interfere with boating and fishing activities in this area.
4. Other short-term impacts. Other temporary adverse effects, sites, such as noise and unsightly aesthetics, normally experienced at construction sites are not anticipated to be significant since construction will start over one-half mile from shore and proceed offshore.

Long-Term Impacts

1. Recreation. The designated area of study for recreational usage in the vicinity of the Hilo outfall extends approximately from Alealea Point on the west to Leleiwi Point on the east. Included in this area are the Bayfront, Coconut Island, Onekahakaha, James Kealoha, and Leleiwi Beach Parks. As indicated on Figure IV-1, shoreline activities are generally those associated with picnicking. Water contact activities at these parks include swimming, diving, surfing, and nearshore fishing.

   In general, most of the water contact activities occur within the nearshore waters, extending offshore to approximately 1,000 feet and to a depth of about 20 feet, for which no limitations on any water contact activity have ever been imposed by the State Department of Health. Also, neither the State Department of Health nor the Department of Fish and Game has placed any limitations on the consumption of fish caught in the vicinity of the outfall diffuser. Data on concentrations of toxic pollutants in fish or shellfish tissue are not available, but the levels of these constituents in the effluent are expected to be low and therefore not be a problem with respect to fish catches.

   Review of available data on water quality parameters of the receiving waters of the existing discharge shows that the quality of the receiving waters is not being significantly altered by the discharge and that all chemical water quality criteria, which may be of consequence relative to water contact activities, are being met after initial dilution of the discharge. Because of these criteria, which are embodied in the State Department of Health Regulations, Chapter 37 and 37-A (Hawaii Revised Statutes, Chapter 242), were established to protect the beneficial uses of the receiving waters, no adverse impacts on recreational activities should result

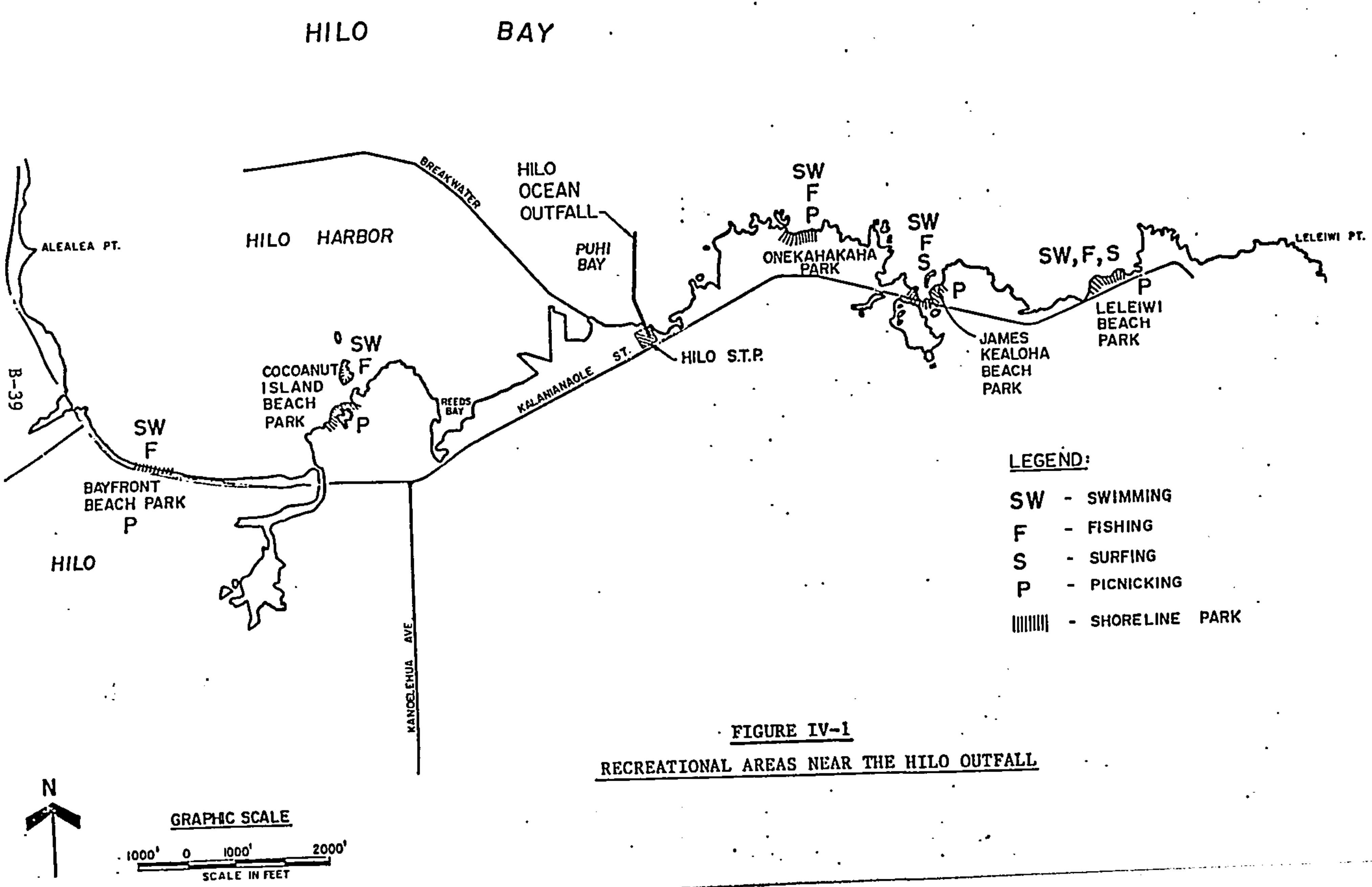

FIGURE IV-1

RECREATIONAL AREAS NEAR THE HILO OUTFALL from the chemical components of the discharge. In addition, the impacts on the microbiological quality of the receiving waters are expected to be minimal due to (1) the initial dilution obtained through the design of the outfall diffuser, (2) dispersion obtained through the ocean currents, and (3) the high coliform die-off rate (T-90).

Effluent Discharge into Ocean Regime

Present Situation: Primary Effluent Discharge. The Hilo sewage outfall dilution zone study (conducted in conjunction with the EPA's Section 201 facilities plan study) indicated that the existing primary sewage discharge from the outfall has no measurable impact on the water quality and marine life in the area when compared to control stations. Coral types and coverages appear to be nearly identical in the vicinity of the sewage discharge and at the "control" stations. Further, both benthic organisms and fishes were found to be more abundant and as diverse near the outfall than elsewhere. This is probably attributable to the biota utilizing the discharged colloidal materials as a food source. It has been suggested in the study that marine life in the area is largely a result of a combination of factors; turbidity, due to wave action and surface runoff, surge, and possibly fresh groundwater discharge. The scarcity of coral growth of the Pocillopora meandrina species and the preponderance of Porites or Montipora suggests that the area is subject to reduced light levels (attributable to turbidity due to wave action and surface runoff) and possibly reduced salinity levels (attributable to the large groundwater discharge). If reduced salinity is a factor, the future outfall discharge is on the order of one-tenth that of an average, combined groundwater and surface water discharge into Puhi Bay. (Overall, Hilo Bay--of which Puhi Bay is a portion--receives greater than 600 mgd over 50 percent of the time.)

The field investigations of the outfall revealed higher concentrations of heavy metals in the sediment in the immediate area of the outfall. It should be noted, however, that no large amounts of sediment were observed in the area, and samples taken were from small patches of sand. Further, metal concentrations in the samples were low when compared to samples measured by the Water Resources Research Center of the University of Hawaii from many other so-called "pristine" locations around the state.

Effect of Advanced Primary Effluent Discharge as Proposed in This Project. The implementation of the advanced primary treatment shall improve plant effluent characteristics, most notably the reduction of floatables and suspended solids. Ambient marine water quality can be expected to remain at present levels due to the large dilution and dispersion afforded by the ocean currents.

While less suspended solids will be removed by the advanced primary process as compared to the secondary treatment process, the problem of sludge deposit is not anticipated. Field investigation in the area of the existing outfall revealed the absence of sludge deposits, even with primary effluent. This absence can be attributed to the large "surge" action in Hilo Bay.

Effect of Secondary Effluent Discharge as Proposed in This Project. With implementation of secondary degree of treatment, plant effluent characteristics can be expected to improve significantly, with reductions in the standard pollutant parameters of suspended solids, settleable solids (turbidity), and BOD (oxygen-demanding materials). Anticipated effluent characteristics resulting from the secondary treatment process and outfall extension have been discussed earlier and are anticipated to meet effluent limitations of the State Water Quality Standards and National Pollutant Discharge Elimination System.

Ambient marine water quality can then be expected to at least remain at present levels because of the large dilutions afforded by ocean disposal. Bacterial concentrations in the water column attributable to this discharge should not differ markedly from that for the existing discharge. Concentrations should remain within the allowable limits of the State Water Quality Standards due to chlorination of effluent prior to discharge and the high rate of bacterial die-off in the seawater environment.

Effects of residual toxic substances (heavy metals, pesticides, etc.) can be minimized with proper considerations in ocean outfall design such that the increase above background is not significant. In practice, these pollutants would be widely dispersed predominantly seaward for effective dispersion.

In summary, the major long-term impact is the establishment of effective water quality control of both groundwater and nearshore waters due to the eventual elimination of cesspool seepage. Risks to public health and welfare attendant with malfunctioning cesspools would be minimized. Effectiveness and economy of scale are the advantages to be gained by upgrading the sewerage system.

CHAPTER VI

ALTERNATIVES TO THE PROPOSED ACTION

Effluent Disposal

The alternatives to ocean outfall disposal of effluent are (1) land spraying, which is a means for reclaiming effluent for irrigational purposes, or (2) ground injection.

The annual rainfall of 100 to 150 inches in the Hilo area minimizes the demand for irrigation. Should this alternative be implemented in any event, standby provisions for effluent disposal during extended rainy periods will also be required. In addition, agricultural land use designations are concentrated in the upper regions and will require either pumping of effluent to a high elevation reservoir or directly to the irrigation field itself.

A further constraint on sewage effluent reclamation is the brackish nature of the effluent due to salt water infiltration into sewers. In summary, costs would be considerable where the need is minimal.

Another alternative for effluent disposal is injection wells. Advantages are low construction costs and flexibility in construction staging. Injection of effluent at 5 mgd would mean a possible build-up of contaminants in the groundwater, with the likelihood of seepage into the nearshore coastal waters through fresh water springs present in Hilo Bay. Water supply development near the coastline, although not now intended by the Department of Water Supply, will be severely constrained in the future if injection wells are used.

Major cost items for the injection well alternative include initial construction of the wells and their replacement over a period of time. On the basis of reliability of performance, the injection well disposal method is not as desirable as the ocean outfall alternative.

APPENDIX G

Comments and Replies to
Environmental Impact Statement

United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
P.O. BOX 50167
HONOLULU, HAWAII 96850

IN REPLY REFER TO:
ES
Room 6307

March 31, 1980

Mr. Edward Harada
Department of Public Works
25 Aupuni Street
Hilo, Hawaii 96720

RE: EIS Preparation Hilo
District Sewerage System,
South Hilo, Hawaii

Dear Sir:

We have reviewed the referenced environmental impact statement (EIS) preparation notice and have the following comments to offer.

In general, the information provided for review appears to cover many of our concerns, assuming that it will be detailed and referenced in the EIS. We are most concerned about the destruction of wetlands and possible degradation of aquatic habitat at the sewage outfall. Therefore, please carefully consider avoidance of critical areas, and delineate any wetlands that may be impacted by the treatment plant or sewage trunk lines.

With reference to the ocean outfall, please provide adequate physical oceanographic data in the EIS to evaluate dilution and transport of sewage effluent. If circulation is inadequate, the project would only accomplish a transfer of major pollution from a dispersed system to a concentrated point source in coastal waters. You might also consider recycling schemes as an alternative to an ocean outfall such as brown water irrigation.

We noticed throughout the briefing document provided for our review that the decision on degree of treatment has not been made. Since this will ultimately change the degree of project impact on the coastal environment, we suggest that this determination be made prior to submitting the EIS for reviews.

The document also suggested that industrial wastes would be also treated within the planned system although the effluent will be predominantly from domestic sources. We suggest that you consider selective treatment for industrial wastewater, because the composition of such effluent is typically different from that of domestic sewage, and treatment of the two types may differ significantly.

These are our concerns for the protection of fish and wildlife resources in the Hilo area. If we can be of any additional assistance, please let us know.

Thank you for the opportunity to comment on this preparation notice.

Sincerely yours,

Maurice H. Taylor

Maurice H. Taylor
Field Supervisor
Division of Ecological Services

M&E Pacific, Inc.

Environmental Engineers

Pacific Trade Center, Suite 600
190 South King Street
Honolulu, Hawaii 96813
(808) 521-3051 Cable: MEPAC

May 12, 1980

Mr. Maurice H. Taylor, Field Supervisor
U.S. Department of Agriculture
Fish and Wildlife Service
Division of Ecological Services
300 Ala Moana Boulevard
P. O. Box 50167
Honolulu, Hawaii 96850

SUBJECT: Environmental Impact Assessment
Hilo District Sewerage System

I would like to thank you for your review and comments on the subject report. The following are in response to your comments dated March 31, 1980.

1. Your concern about the destruction of wetlands will be addressed and a map delineating such areas will be incorporated.

2. An extensive evaluation of the coastal water environment of the Hilo area was done in the preparation of the Section 201 Hilo Facilities Plan and will be incorporated into the EIS. Similarly, an evaluation of the alternatives to the ocean outfall was done and will be addressed.

3. The determination of the degree of treatment is dependent upon the approval by EPA of the Hawaii County's application for a waiver from secondary treatment requirements. Unfortunately, the timetable of which this determination is expected to be made is not in accordance with either the Hilo Facilities Plan nor its EIS. Therefore, the EIA was written to specifically address the impacts of the effluent with the various alternative degrees of treatment (see "EEFLUENT DISCHARGE INTO OCEAN REGIME"). It was determined that the ambient marine water quality can be expected (as a minimum impact) to remain at present levels due to the large dilution and dispersion afforded by the ocean currents. Therefore, it is felt that delaying the approval of the Facilities Plan and the EIS is not strongly justified.

4. In order to identify, assess and document possible dischargers of heavy metals and organic toxicants, a survey of commercial/industrial establishments was conducted in conjunction with the secondary treatment waiver application. In that survey, four establishments were identified which include:

   a. Hilo Dental Associates, Inc.
   b. Hilo Medical Lab, Inc.
   c. State Department of Health, Waikea Health Center
   d. Hilo Quality Cleaners, Ltd.

   It was found that the heavy metal and toxicant concentration in the wastewater sampled at the existing treatment facility are similar to the background levels in domestic wastewater. Therefore, selective treatment for industrial wastewater would not be a practical recommendation. More importantly, it should be noted that the existing commercial/industrial discharges after dilution and dispersion through the outfall system would not impose any severe impact upon the marine environment. Attached for your information are the results of the heavy metal and toxicant concentrations of the Hilo wastewater as reported in the supporting documents for the secondary treatment waiver application. These tables and a similar discussion in relation to industrial discharges as described above will be addressed in the revised EIS.

We trust that these replies meet with your satisfaction. Should you have any questions, please call Ken Ishizaki at 521-3051.

JAMES S. KUMAGAI, Ph.D.
Vice President

BM/ep

Attach.

TABLE 1

ORGANIC TOXICANT CONCENTRATIONS IN THE EFFLUENT OF THE HILO WWTP*

Organic Toxicant	Concentration in ug/l
Bromodichloromethane**	<10
Bromoform	<10
Carbon Tetrachloride	<10
Chloroform	<10
Dichloromethane	<10
Dimethyldisulfide**	<10
1-1-1 Trichloroethane**	<10
1-1-2-2 Tetrachlorothene	<10
Toluene	<10
Trichloroethylene	<10
2-Propynol**	<10

* All organic toxicants listed in Table 1, Federal Register, Volume 44, Number 117, Friday, June 15, 1979, page 34831, were analyzed. Only those toxicants identified in the analyses are noted in this table.

** Compounds are not listed in Table 1, Federal Register, Volume 44, Number 117, Friday, June 15, 1979, page 34831.

TABLE 2

ESTIMATED HEAVY METALS CONCENTRATION AFTER INITIAL DILUTION FOR THE HILO DISCHARGE

Constituent	Water Quality Criteria* (ug/l) Average Over 24-Hr Period	Water Quality Criteria* (ug/l) Maximum Allowable	Concentration (ug/l) Wastewater	Concentration (ug/l) After Initial Dilution
Antimony	**		<100	< 2.0
Arsenic	29	67	< 5	< 0.1
Beryllium	**		< 5	< 0.1
Cadmium	1	16	< 5	< 0.1
Chromium	**		10	0.20
Copper	0.79	18	40	0.78
Cyanide	**		< 10	< 0.20
Lead	**		14	0.27
Mercury	**		<1.0	< 0.02
Nickel	**		< 50	< 1.0
Selenium	4.4	10	<0.5	< 0.01
Silver	0.26	0.58	< 20	< 0.4
Thallium	**		<100	<2.00
Zinc	**		110	2.20
Asbestos				

* Unless otherwise noted, water quality criteria are based on the proposed criteria developed by the EPA as set forth in the Federal Register, Volume 44, No. 52, Thursday, March 15, 1979, and Volume 44, No. 144, Wednesday, July 25, 1979. The criteria listed reflect the allowable concentration to protect the salt water aquatic life.

** The proposed criteria are not available or none have been established for the protection of the salt water aquatic life.

TABLE 3

CONCENTRATION OF TOXIC POLLUTANTS IN DOMESTIC WASTEWATER

Constituent	Concentration (mg/l)
Arsenic	0.014
Cadmium	0.005
Chromium	0.020
Copper	0.119
Cyanide	0.029
Lead	0.051
Mercury	0.0005
Nickel	0.031
Zinc	0.490

Source: Eason, J.E., Kremer, J.G., Dryden, "Industrial Waste Control in Los Angeles County," JWPCF, Vol. 50, April 1978.

TABLE 4

CONCENTRATIONS OF HEAVY METALS IN WASTEWATER AT THE HILO FACILITY

Metal	Concentration in mg/l Influent	 Effluent[a]	Limits of Detection*
Manganese	0.015	0.015	0.002
Chromium	0.004	0.04	0.002
Copper	0.020	0.020	0.001
Nickel	0.007	0.007	0.002
Silver	0.004	0.004	0.002
Zinc	0.052	0.052	0.001
Mercury	0.00006	0.00004	0.00001
Arsenic	0.05	0.05	0.05
Selenium	0.01	0.01	0.01
Lead	0.06	0.05	0.01
Cyanide	0.07	0.06	—

* Test performed in 1978 by C. Brewer Laboratory, Honolulu, Hawaii.

[a] Supernatant of settled sample

HILO DENTAL ASSOCIATES, INC.
475 KINOOLE STREET
HILO, HAWAII 96720

TELEPHONE: 935-1149

September 5, 1978

Department of Public Works
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720
ATTN: Edward Harada
Chief Engineer

Dear Sir,

In response to your letter of August 25, 1978 the following information is submitted:

Hilo Dental Associates, Inc. has installed in its facility a catchment system to retrieve the heavy metals, i.e. mercury and silver, that is used in our business. This is done so that these metals can be refined and reused by our Corporation.

We discharge a sterilization solution, Benzeconium Chloride, and some solutions used in developing X-rays, but we cannot identify them from the list that was sent to us.

Sincerly,

Walt L R Serrao
WALTER L R SERRAO
Business Manager

HILO MEDICAL LAB, INC.

Ponahawai Professional Center, Suite 104
275 Ponahawai Street • Hilo, Hawaii 96720
Phone: 935-4814

E. W. BEST, M.D., F.C.A.P.
A. S. WOO, JR., M.D., F.C.A.P.

M. S. PARK, M.D., F.C.A.P.

September 1, 1978

Mr. Harold Sugiyama
Bureau of Sewers and Sanitation
Department of Public Works
25 Aupuni Street
Hilo, Hawaii 96720

SUBJECT: Listing of Toxic Pollutants & Quantity

The only pollutants that we use in our laboratory are:

1. Aqueous solution of 0.05% potassium cyanide. Approximately 500 ml of this solution is flushed into the drain weekly with lots of water.
2. Aqueous solution of 0.025% potassium cyanide. Approximately 400 ml of this solution is being discharged weekly into the drain.

If there is any question, please call Juan Macanas at 935 4814.

Juan Macanas
Chief Technologist
Hilo Medical Lab, Inc.

EORGE R. ARIYOSHI
GOVERNOR

GEORGE A. L. YUEN
DIRECTOR OF HEALTH

AUDREY W. MERTZ, M.D., M.P.H.
DEPUTY DIRECTOR OF HEALTH

HENRY N. THOMPSON, M.A.
DEPUTY DIRECTOR OF HEALTH

JAMES S. KUMAGAI, PH.D., P.E.
DEPUTY DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 916
HILO, HAWAII 96720

September 15, 1978

Chief Engineer
County of Hawaii
Department of Public Works
Hilo, HI 96720

LISTING OF TOXIC POLLUTANTS DISCHARGED TO THE SEWER SYSTEM

The Department of Health, Waiakea Health Center, located at 191 Kuawa Street, discharges the following pollutants:

Potassium Cyanide
Approximately 60 g/year is used for the detection of isoniazid (INH) metabolites. Due to the chemical reaction during the testing procedure, very little is discharged into the sewer system.

Phenol
Approximately 200 g/year is used in carbofuchsin stains.

3 gallons/year of Lysol is used as a disinfectant.

Silver
An estimated 1,200 feet of 70 mm film and 3,000 x-ray films, 14 x 17 inches, are processed during the year. The silver is currently not extracted before discharging into the sewer system.

Marie M. Shimizu
(Mrs.) MARIE M. SHIMIZU
Laboratory Administrator, Hawaii

js

cc: District Health Officer, Hawaii
Chief Sanitarian, Hawaii

Hilo Quality Cleaners, Ltd.

CLEANING · LAUNDERING · RENTAL SERVICE · LINENS · UNIFORMS · MOPS

September 19, 1978

Mr. Harold Sugiyama
Bureau of Sewers and Sanitation
Dept. of Public Works, County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

In Re: Letter dated August 28, 1978

Dear Mr. Sugiyama:

We are enclosing a copy of the letter received from our supplier regarding laundry washroom supplies.

In the dry cleaning department, I have gone through the list of chemicals concerned and feel that there is a very minimal discharge into the sewer system since we have a filtration system which filters the solvent constantly while the dry cleaning machines are in operation. Also, we distill the solvent once every other week for the purpose of recycling it and not discharge or waste it.

If there are any questions, please contact me.

Sincerely yours,

Masao Ochi

Masao Ochi, President and
General Manager

MO:mot

Encl. 1

INOVA CO
NCORPORATED

982 TERMINAL WAY • SAN CARLOS • CALIFORNIA 94070
AREA CODE 415 • 591-9645

September 14, 1978

Mr. Masao Ochi
Hilo Quality Laundry
865 Kinoale Street
Hilo, Hawaii 96720

Dear Mr. Ochi:

Warren Lampshire contacted me regarding the possibilty of the presence of Arsnic in your laundry soap. In turn, I contacted the soap manufacturers and was assured that there is no arsnic in the soap. The soap is composed of caustic soda and rendered tallow fat only.

In addition, please be advised that all the laundry chemicals you purchase through Lampco are bio-degradable and contain no arsnic.

It's time again for me to make my service visit to you. I'llbe in Hilo--Monday and Tuesday, October 2nd. and 3rd., to work in your plant for two days to check out the washroom. At that time, we can further discuss the sewage situation.

See you in October.....

Sincerely,

Matt

Matt Musante

MM:jb

c.c. Warren Lampshire
Lampco

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858

PODED-PV

28 May 1980

Mr. Edward Harada, Chief Engineer
Department of Public Works
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Harada:

We have reviewed your Environmental Impact Statement for the Hilo District Sewerage System, South Hilo, Hawaii, dated 28 April 1980. The extension of the outfall and the stream crossing in the Wailuku and Wailoa Rivers will require a Department of the Army (DA) permit. To avoid bioassay and bio-accumulation testing requirements under Section 404 of the Clean Water Act, we suggest that the fill used to anchor, cover, or cushion the sewer lines meet the following criteria:

a. The material be composed predominantly of sand, gravel, or any other naturally occurring sedimentary material with particle size larger than silt, characteristic of, and generally found in areas of high current or wave energy such as streams with large bed loads or coastal areas with shifting bars and channels; or

b. Material be substantially the same as the substrate at the construction site, its source sufficiently removed from sources of pollution to provide reasonable assurance that such material has not been contaminated by pollution and adequate terms and conditions be imposed to provide reasonable assurance that the material will not be moved by currents or other means that would be damaging to the environment outside the construction site.

When submitting the DA permit application, we suggest that you identify the fill material and provide data to substantiate that the fill meets the exclusion criteria provided. The environmental impact statement should address potential impacts, if any, on recreational activities, particularly surfing, resulting from extension of the sewer line. If the environmental statement is being prepared to satisfy the U.S. Environmental Protection Agency (EPA) or to obtain an EPA grant, we suggest that you provide us a letter from EPA accepting or adopting the environmental statement, when submitting the DA permit application. More details on how you intend to construct the sewer outfall extension and stream crossing are needed when applying for the DA permit.

Sincerely,

B. R. SCHLAPAK
Colonel, Corps of Engineers
District Engineer

[illegible]
[illegible]
Deputy District Engineer

HILO HAWAII OCEAN OUTFALL

GEOPHYSICAL INVESTIGATION

FINAL REPORT

HILO HAWAII OCEAN OUTFALL GEOPHYSICAL INVESTIGATION

REPORT NO. 84019-84-0403

April 3, 1984

Presented to: Walter Lum Associates, Inc.
98-722 Kuakao Place
Pearl City, HI 96782

Prepared By: Ocean Surveys, Inc.
91 Sheffield Street
Old Saybrook, CT 06475

HILO HAWAII OCEAN OUTFALL
GEOPHYSICAL INVESTIGATION

1.0 INTRODUCTION

As one portion of the engineering study for an ocean outfall at Hilo, Hawaii, Ocean Surveys, Inc. (OSI) conducted a geophysical investigation along the proposed primary and an alternate ocean outfall alignment. This program was designed to yield data addressing specific geotechnical conditions along each of the two proposed outfall alignments.

The geophysical survey included acquisition of precision depth data and subbottom profiling investigations along more than five (5) miles of survey trackline. Geophysical data acquisition was conducted during the period March 2-3, 1984.

The study site location together with a plan view presentation of the bathymetric data and a geological cross-section along the proposed primary and alternate ocean outfall alignments is shown on OSI drawing No. 84019-A which accompanies this report.

2.0 FIELD DATA ACQUISITION

The following sections of this report present a discussion of the systems and methodology employed for the acquisition of project navigation, bathymetric and geophysical data. Field operations conducted employing a 35-foot Bruno and Stillman as a survey vessel.

2.1 Survey Control and Positioning

Quite possibly the most important and almost certainly the most underestimated consideration in marine survey work involves project horizontal and vertical control. More specifically, if uncertainties exist in the position of the survey vessel during data acquisition, the validity and usefulness of the collected data immediately arise.

Survey vessel position during all geophysical data acquisition was provided employing a Cubic DM 40A "Autotape" electronic navigation system which provides range accuracies of 0.5 meters plus 1:100,000 of the measured range distance (e.g., at 10 km, the range accuracy is 0.6 meters.)

Simply stated, the "Autotape" is the most accurate dynamic positioning system currently available. In common with other range-range electronic positions systems, the "Autotape" employs two or more shore-based responder units located at known stations. The shore-based responders are interrogated at a nominal one-second interval by the master unit (interrogator) located on board the survey vessel to yield precise measurements of the distance between the interrogator antenna and each of the responders. Trilateration calculations employing the measured ranges and the known locations of the two responders then yields the instantaneous survey vessel position.

2.2 Survey Vessel Control[1]

Survey vessel control as differentiated from vessel positioning, addresses the mechanism and/or procedures employed to obtain tracklines where they are desired. Positioning, on the other hand, documents where the vessel actually went. Vessel control for these survey operations was accompanied by on-board plotting employing a Hewlett-Packard Model 41-CV programmable calculator. Specifically, range-range position data from the "Autotape" together with the coordinates of each shore responder

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[1] Survey vessel positioning and trackline control services were accomplished by Sea Engineering, Makapuu Point, Honolulu, Hawaii.

station were input to the HP 41CX at nominal 15-second intervals allowing computation and plotting of the exact position of the survey vessel. These data were plotted on-board providing both documentation of actual survey tracklines and a mechanism allowing the survey vessel to be "conned" along the desired preplotted survey lines.

2.3 Bathymetric Measurements

To complement the geophysical measurements, precision measurement of water depths was obtained employing a Raytheon DE 719B survey grade "fathometer". The DE 719B incorporates both tide, draft and speed of sound correction to adjust for local water mass characteristics.

To insure maximum data accuracy, the DE 719B was calibrated for local water mass sound speed by performing a "bar check." The bar check procedure consists of lowering an acoustic target, the "bar," on a calibrated sounding line to the specified project depth and adjusting of the "fathometer" speed of sound control such that the target reflection is printed precisely at the calibration depth. The target is then raised to successively higher elevations and calibration readings (i.e., the variations) at these other depths are recorded. Bar checks were performed prior to commencement of survey operations each day and at intervals during the day to verify consistent water mass sound speed and retention of "fathometer" sound speed calibration.

Variations which exist in the indicated depth at calibration points are incorporated in the bathymetric data analysis to yield maximum accuracy in the resulting depth measurements. The resulting accuracy of measured depth values following adjustment for sound speed vs. depth and tidal height reference is six (6) inches or better. Technical details and a specification sheet for the Raytheon DE 719B are included in Appendix A.

2.4 Subbottom Profiling System

In order to provide the highest quality seismic reflection data, an OSI Model 300 high resolution Boomer/Sparker system was employed for all subbottom profiling operations. Basically, the OSI Boomer system consists of a high voltage power supply, an electro-mechanical transducer used to create an intense acoustic pulse in the water and an extremely sensitive receiving system comprised of a multi-element array of hydrophones.

In operation, the system generates a high energy acoustic pulse which propagates downward to the seafloor where it is partially reflected; the balance of the signal continuing into the subbottom. As a similar partial reflection/transmission occurs at each subsequent interface between materials of differing physical properties, the return signals which are presented in the form of a continous graphic record, detail the sediment layering and the bedrock depths along each survey trackline.

The OSI system has the ability to employ either the high resolution Boomer transducer or an alternate multi-electrode sparker for generation of the outgoing acoustic pulse. The sparker, if employed, generates a higher energy, lower frequency signal than the Boomer allowing subbottom penetration in areas where the Boomer signals may have difficulty penetrating. It should be noted, however, use of the sparker to achieve deeper subbottom penetration/information will result in an attendant

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"Fathometer" is a registered trademark of Raytheon, Co., Lexington, Massachusetts.

reduction of the resolution of the subbottom profiling records as the sparker generates a lower frequency signal which lacks the resolution of the higher frequency Boomer signal. Use of the sparker source is, thus, generally restricted to situations where the Boomer system fails to yield the desired depth of subbottom profilng information. During these investigations, as subbottom information of 20 to 30 feet below the seabed in coralline areas and up to 150-200 feet in areas of unconsolidated sediments were routinely obtained, use of the sparker system was not deemed warranted.

During the field period, the Boomer system was operated at a 300 joule power level. The Boomer transducer (acoustic signal source) was mounted in a catamaran tow vehicle which was towed immediately astern and to one side of the survey boat. Reflected signals from the seafloor and subbottom reflectors were received employing an OSI multi-element hydrophone streamer. The received signals were amplified, filtered, and displayed on a 19-inch Gifft Model 4000T precision seismic recorder to yield a continuous graphic profile of the water depths and subbottom reflectors along each trackline. Specification sheets for the OSI Model 300 Boomer and the Gifft recorder are presented in Appendix A.

In addition to use of the high resolution Boomer system, to generate optimum subbottom profiling records, OSI also provided specialized signal processing equipment consisting of a TSS swell filter. As the Boomer source is conventionally mounted on a surface following tow vehicle (a catamaran), variation is surface to seafloor distances caused by swell tend to degrade the quality of the acquired subbottom profile records. The swell filter functions by electronically determining and removing these variations allowing generation of high quality seismic data under less than optimum operating conditions.

By the way of discussion, what is "seen" by the Boomer or other subbottom profiling systems are the interfaces between sediments have different "acoustic impedance"; a quality defined as the product of bulk density times compressional wave velocity. The interfaces seen on the graphic records, thus, are where changes occur in either or both the bulk density and/or the sound speed of the material through which the acoustic signal is propagating.

As can be appreciated, many of the physical variations which result in changes in bulk density also effect similar changes in compressional wave propagation velocity. For example, a more compact sediment such as a coarse sand will have both a higher bulk density and a higher compressional wave velocity than either silts or clays. It must, however, also be realized that there are other sediment properties (e.g., voids, cemented or partially cemented materials, variations in gas content, etc.) which can influence one or the other of these two parameters without markedly effecting the remaining one.

3.0 DATA REDUCTION, ANALYSIS AND PRESENTATION

The following sections of this report detail the methodology employed for the reduction and analysis of the geophysical data acquired in support of the Hilo Ocean Outfall project.

3.1 Survey Vessel Trackline

As real-time on-board trackline plotting and control were employed during data acquisition, final survey trackline generation required only replotting of the field sheets to provide working drawings for plotting the results of bathymetric and subbottom profile analysis.

The trackline map generation and subsequent seismic data presention on OSI Drawing No. 84019-A has been constructed at a scale of 1 inch equal 80 feet corresponding with both the bathymetric contour drawing and the trackline preplot sheets furnished by the ocean outfall design engineer, Metcalf and Eddy, Honolulu, Hawaii.

3.2 Bathymetric Data Reduction

Analysis to yield corrected depth data consisted of integrating the field recorded depth values with tidal height data computed from the NOAA water level predictions for the project site. As the primary purpose of acquiring sounding data was to support analysis of the subbottom profiler records, no attempt has been made to incorporate the additional sounding data with the previous survey data obtained by Metcalf and Eddy. The contours presented in the upper panel of OSI Drawing No. 84019-A are thus based solely upon the more extensive prior survey.

It should be noted that the sounding data obtained along the geophysical survey lines depicted local depth variation of up to ten (10) feet from the prior survey contour depths at various locations along and/or adjacent to the proposed ocean outfall alignments. It is felt these above depth differences result from the high degree of small scale depth variability in seafloor elevations which must be expected in areas of coral. Some of these variations also result from the fact survey lines during the geophysical investigation traversed areas between the previous sounding survey tracklines and thus traversed seaflooor features not previously mapped.

3.3 Subbottom Profiling Data

The geologic cross-section (profiles) presented on OSI Drawing No. 84019-A were constructed by interpreting the data derived from the bathymetric and subbottom profile records. As noted above, the water depth profile along the outfall alignment has been obtained from the contour drawing developed from a prior sounding survey.

The graphic records obtained along the survey tracklines have been analyzed to determine the sequence and thickness of subsurface materials existing along the proposed primary and alternate ocean outfall alignments. Subbottom profiling data reduction and analysis procedures include several aspects which require discussion in order to allow a more comprehensive understanding of the geological cross section presented on OSI Drawing No. 84019-A.

During the data acquisition phase, event marks are placed upon the subbottom profiler records corresponding to each navigation fix obtained to document the survey vessel position as it traverses each trackline. Additionally, as the Boomer system source is towed behind the survey vessel, position of the seismic data is computed employing the measured distance (layback) between the electronic navigation system antenna and the Boomer source/ receiver pair.

Interpretation of the seismic reflection profiles is accomplished by tracing the seafloor and subbottom reflectors on mylar "overlays" of the the graphic records. The depth below the seafloor to each reflector is then measured and plotted on a cross section containing the seafloor profile derived from the bathymetric (or contour) data along the proposed outfall alignment centerline. Data from each of the offset subbottom profile lines were also analyzed and plotted in analagous fashion. Data from each of the survey lines were examined and compared to the interpretted centerline profiles prior to profile finalization.

It is important to realize that the records generated by the Boomer or other subbottom profiling system displays data as a function of time rather than depth, per se. In exactly the same fashion as depth sounder data, a transformation from time to distance (depth) must be made. With sounding data, this is accomplished employing the bar-check procedure. For subbottom profilng records, establishing a sound speed value to use for computation generally employs one of the following methods:

1. If no other data is available, use the pre set value (4800 ft/sec.) of the seismic recorder.

2. If cores or borings are available, an estimate of the sound speed in each layer/zone of unconsolidated and consolidated material may either be estimated based upon previous data for similar material or the speed of sound in these materials may be measured.

3. Remote sensing techniques may be employed (e.g., wide angle relection or refraction methods) to measure the in situ compressional wave speed.

4. The type of material is inferred from the subbottom profiler records and any availabe supporting data. A sound speed is selected which is appropriate for the type of material that are thought to be present.

The range of sound speeds encountered in unconsolidated marine sediment varies from nominally 5 or 10 percent below to more than 50 percent above the sound speed in sea water. In areas where cemented, and/or consolidated materials are encountered, the sound speed of the latter materials may exceed twice the speed of sound in sea water. As these variations in the speed of sound translate directly to variations in the computed thickness for the material, the importance of establishing an accurate velocity value for subbottom materials is apparent. Equally important, use of an incorrect value will lead to a corresponding distortion in the interpretation.

As no physical samples allowing definitive assessment seafloor and subbottom material type were available, the interpretation would have to be based upon either an "average" velocity for inferred material types or upon the preset sound speed (4800 ft/sec.) of the seismic recorded. The latter option was elected as the more prudent and conservative approach until samples or additional data regarding the seafloor and subsurface materials are obtained. As both diver reports and the "character" of the reflections detailed on the subbottom profiler records indicate seafloor and subsurface materials appear to consist principally of coral exhibiting various densitites, these materials can be expected to have substantially higher sound speeds; potentially up to 8-9000 ft/sec. The computed material thickness presented on Drawing No. 84019-A, thus, are considered to represent minimum thickness values.

4.0 RESULTS

Subbottom profile records obtained along the both alignments of the proposed extension of the Hilo Ocean Outfall indicate that the majority of the seafloor is composed of coral of varying densities with only extremely localized patches of sand and/or interlayered coral and sand. Computation of layer thickness using sound speed of 4800 ft/sec., yield estimated thickness values averaging 10 to 20 feet.

As discussed in the previous section, it is believed a compressional wave sound speed value of 4800 ft/sec. for the coral is probably significantly lower than exists within these materials if they are in fact, consolidated coral. The uncertainty arises in attempting to estimate an appropriate sound speed as this value will vary with the degree of consolidation and consistency exhibited by the coral. More specifically, the actual sound speed for these materials will vary with the percentage of unconsolidated sand existing either in pockets and/or in layers within the coral, volume of voids, recementation between coral masses, and numerous other factors all which will effect the bulk density. The net effect of the increased sound speed expected to exist in the coralline layer is that the "true" layer thickness are probably 50 to 80 percent greater (thicker) than the thicknesses depicted on the cross-section.

From the standpoint of outfall construction, it is suggested that if the observed lateral variations in material strength characteristics will impact on the installation of the proposed outfall extension, samples of the various indicated materials should be obtained.

As a final observation, both the seafloor and the near subbottom materials exhibit an extremely high degree of lateral variability-in depth, thickness and composition. Within the context of this project, it must be cautioned that even minor variations in the route of the proposed alignment from the surveyed alignments, must be expected to encounter the same range and lateral variability in material types but at substantially different locations along other routes.

Basically, the geophysical investigations have corroborated the previous reports of seafloor conditions along the proposed alignments. The geophysical data, however, additionally shows that the composition and/or density of the coral layer varies significantly along each of the alignments. Although it is an admittedly subjective evaluation, based upon the "character" of the seismic reflection data from the materials labeled "hard coral" an increase in bulk density/material hardness of 30 to 50 percent is expected relative to the composition of the materials which exist along other portions of the alignments.

INITIAL DILUTION CALCULATIONS

(selected alignment)

80-FOOT DEPTH DIFFUSER

Season	Length (ft)	Ports (no.)	Flow[1] (cfs)	Centerline[2] Dilution	Trapping[3] Level (ft)	Flux-Avg[4] Dilution x 1.77
Summer	252	21	16.24	105	28.6	186
			22.40	99	29.1	174
			36.80	91	33.0	161
	300	25	16.24	109	28.8	193
			22.40	102	28.7	180
			36.80	94	30.8	166
April	252	21	36.80	119	19.9	210
	300	25	36.80	121	19.8	214
Summer	252	11	16.24	94	30.8	166
			22.40	89	35.5	158
			36.80	88	46.4	156

[1] 16.24 cfs = 20-year max
22.40 cfs = 40-year max
36.80 cfs = 40-year peak

[2] Centerline dilution: dilution at the centerline of the plume

[3] Trapping level: depth (measured from the water surface) where the plume has been trapped under density stratified conditions of the ambient waters

[4] Flux-average dilution: derived from an assumed distribution of concentrations weighted by a distribution of velocity; this is the dilution used to assess conformance with water quality standards

BLASTING SAFE RANGE

calculations

SAFE RANGE CALCULATIONS TO DETERMINE BLAST SIZE LIMIT AND THE PRE-BLAST SURVEY AREA FOR THE PROTECTION OF HUMPBACK WHALES

HILO OUTFALL EXTENSION
HILO, HAWAII

JANUARY 1984

SAFE BLAST RANGE

The estimated safe range for sea mammals during blasting for the Hilo Outfall Extension has been based on a Canadian Department of Fisheries and Oceans study on the effects of high explosives on marine life.[1] "Safe range" is defined in that report as the "range distance from an explosion at which there should be no explosion-related injuries to test organisms."

The safe range is related to charge weight, detonation depth, and target (sea mammal) depth. As a conservative measure, the deepest end of the outfall extension was chosen as the detonation depth for both of the proposed alignments. The mammals were assumed to be resting on the seabed, the maximum target depth possible. For a particular given weight of TNT detonated, a mammal could be within the corresponding isohyets illustrated on the accompanying figures and actually be unharmed if they were anywhere above the bottom. As a further safeguard, shape charges will be used for blasting. Shape charges are highly directional, thus can be placed to direct a maximum of energy downward and propagate a minimum of energy through the surrounding waters.

Results from the test blast conducted for the Waianae Outfall Extension project indicated that a 1,000-pound blast did not produce significant adverse effects and that the predictive methodology used herein was fairly accurate.

The substrate along the proposed alignment for the Hilo extension is as hard or harder than at Waianae; thus, a blast size limit comparable to Waianae would be necessary. Based on the Waianae experience, it is proposed that the blast size restriction for the Hilo outfall extension be as follows:

1. No blasting - December to March
2. Blast size limit - 1,000 pounds
3. Pre-blast survey - prior to each blast; 2,000-yard radius

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[1] D.G. Wright, "A Discussion Paper on the Effects of Explosives on Fish and Marine Mammals in the Waters of the Northwest Territories," Canadian Technical Report of Fisheries & Aquatic Sciences, No. 1052, February 1982.

SAFE BLAST RANGE FOR MAMMALS

(50 to 80 Feet)

Charge Weight (lbs/kg)		Target Depth (ft/m)		I^1_{sc} bar-msec / kg1/3	A^2	R^3_{sc}	R^4_s	
(lb)	(kg)	(ft)	(M)				(m)	(ft)
15	6.8	50	15.2	0.1795	97	300	568	1,865
		75	22.9	0.1795	146	320	606	1,990
		100	30.5	0.1795	194	350	663	2,170
		125	38.1	0.1795	243	380	720	2,360
		150	45.7	0.1795	291	400	758	2,490
20	9.1	50	15.2	0.1629	80	300	626	2,060
		75	22.9	0.1629	120	350	731	2,400
		100	30.5	0.1629	160	370	772	2,530
		125	38.1	0.1629	200	400	835	2,740
		150	45.7	0.1629	240	420	877	2,880
25	11.4	50	15.2	0.1511	69	300	675	2,220
		75	22.9	0.1511	103	350	788	2,580
		100	30.5	0.1511	138	380	855	2,810
		125	38.1	0.1511	172	400	900	2,950
		150	45.7	0.1511	206	430	968	3,180
30	13.6	50	15.2	0.1424	61	300	716	2,350
		75	22.9	0.1424	92	350	835	2,740
		100	30.5	0.1424	122	380	907	2,980
		125	38.1	0.1424	153	400	955	3,130
		150	45.7	0.1424	183	430	1,026	3,370
40	18.2	50	15.2	0.1293	50	300	789	2,590
		75	22.9	0.1293	76	350	921	3,020
		100	30.5	0.1293	101	390	1,026	3,370
		125	38.1	0.1293	126	410	1,078	3,540
		150	45.7	0.1293	151	440	1,157	3,800
70	31.9	25	7.6	0.1072	17	210	666	2,190
		50	15.2	0.1072	35	280	888	2,910
		75	22.9	0.1072	52	320	1,015	3,330
		100	30.5	0.1072	69	370	1,173	3,850
		125	38.1	0.1072	87	400	1,269	4,160
		150	45.7	0.1072	104	420	1,332	4,370
		175	53.2	0.1072	121	450	1,427	4,680
100	45.5	25	7.6	0.0952	14	210	750	2,450
		50	15.2	0.0952	27	280	1,000	3,270
		75	22.9	0.0952	41	330	1,178	3,860
		100	30.5	0.0952	55	370	1,321	4,330
		125	38.1	0.0952	68	400	1,428	4,680
		150	45.7	0.0952	82	420	1,499	4,910
		175	53.2	0.0952	95	45	1,607	5,270

SAFE BLAST RANGE FOR MAMMALS, CONT.

Charge Weight (lbs/kg)		Target Depth (ft/m)		I^{1}_{sc} $\frac{\text{bar-msec}}{\text{kg1/3}}$	A^{2}	R^{3}_{sc}		R^{4}_{s}
(lb)	(kg)	(ft)	(M)				(m)	(ft)
150	68.2	25	7.6	0.0832	10	190	776	2,540
		50	15.2	0.0832	21	260	1,062	3,480
		75	22.9	0.0832	31	305	1,246	4,080
		100	30.5	0.0832	42	350	1,430	4,690
		125	38.1	0.0832	52	370	1,512	4,950
		150	45.7	0.0832	63	400	1,634	5,360
		175	53.2	0.0832	73	450	1,839	6,030
200	90.9	25	7.6	0.0756	9	190	854	2,800
		50	15.2	0.0756	17	255	1,147	3,760
		75	22.9	0.0756	26	300	1,349	4,420
		100	30.5	0.0756	34	340	1,529	5,010
		125	38.1	0.0756	43	380	1,709	5,600
		150	45.7	0.0756	52	400	1,799	5,900
		175	53.2	0.0756	60	430	1,933	6,340
300	136.4	25	7.6	0.0661	7	180	927	3,030
		50	15.2	0.0661	13	240	1,235	4,050
		75	22.9	0.0661	20	290	1,493	4,890
		100	30.5	0.0661	26	320	1,647	5,400
		125	38.1	0.0661	33	350	1,802	5,910
		150	45.7	0.0661	39	380	1,956	6,410
		175	53.2	0.0661	46	410	2,111	6,920
400	181.8	25	7.6	0.0600	5	170	963	3,150
		50	15.2	0.0600	11	230	1,303	4,270
		75	22.9	0.0600	16	270	1,530	5,010
		100	30.5	0.0600	22	320	1,813	5,940
		125	38.1	0.0600	27	350	1.983	6,500
		150	45.7	0.0600	33	375	2,124	6,960
		175	53.2	0.0600	38	400	2,266	7,430

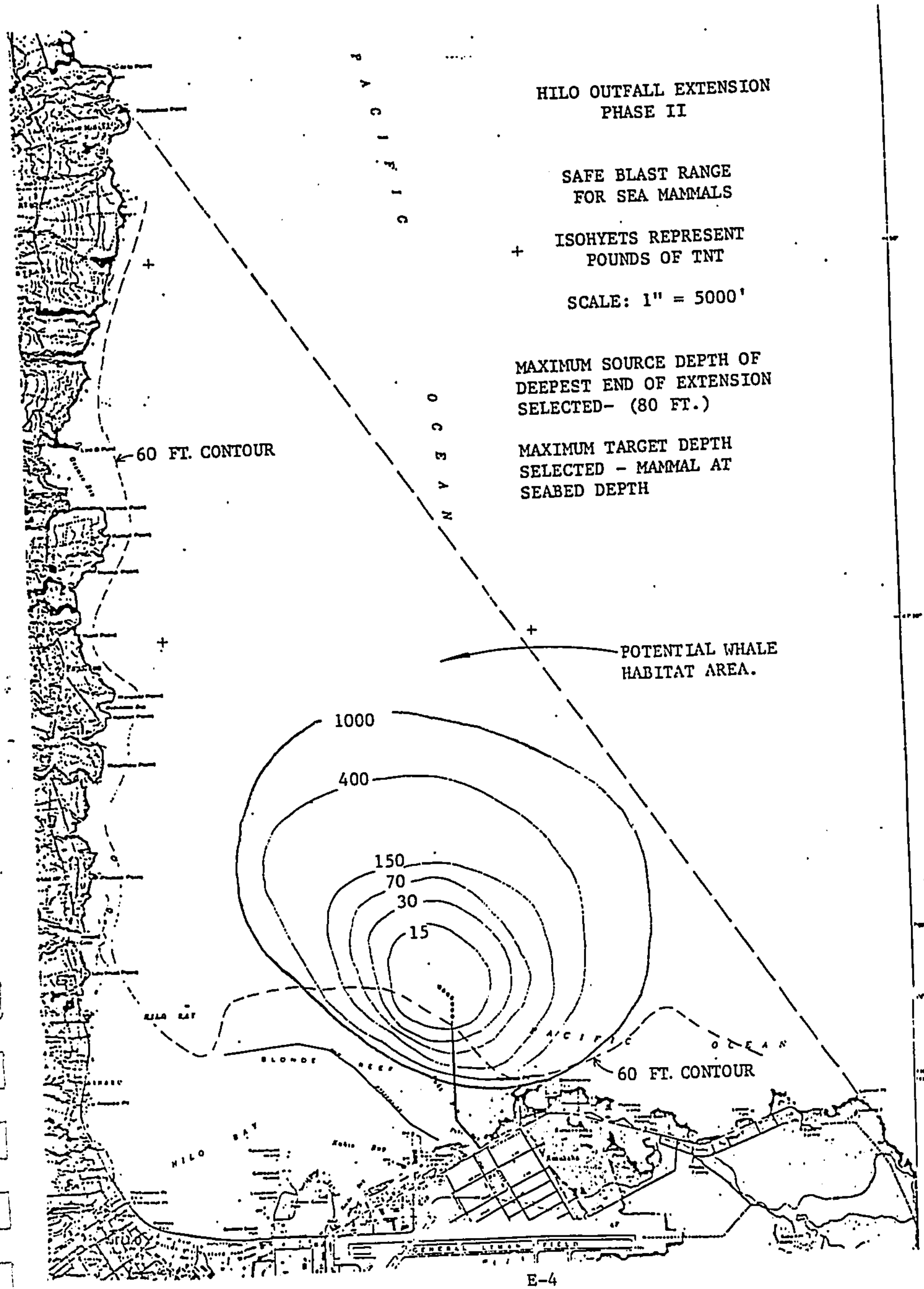
[1] I_{sc} (scaled impulse) was calculated by dividing the safe impulse level that a mammal can withstand (assumed to be 0.34 bar msec, see Table 1) by the cube root of the charge weight: $I_{sc} = I/wt^{1/3}$

[2] Parameter 'A' was derived from the depth of the target mammal, depth of the detonation (blast depth of 80 feet was selected), and charge weight such that:

$$A = \frac{\text{target depth x detonation depth}}{(\text{charge weight})^{2/3}}$$

[3] R_{sc} (scaled range) was determined by using the best-fit curve in Figure 1 corresponding to the calculated value of 'A' and the scaled impulse (I_{sc}).

[4] R_s (safe range) was calculated by multiplying the scaled range (R_{sc}) by cubc root of the charge weight: $R_s = R_{sc}$ x charge weight$^{1/2}$



HILO OUTFALL EXTENSION
PHASE II

SAFE BLAST RANGE
FOR SEA MAMMALS

ISOHYETS REPRESENT
POUNDS OF TNT

SCALE: 1" = 5000'

MAXIMUM SOURCE DEPTH OF
DEEPEST END OF EXTENSION
SELECTED- (80 FT.)

MAXIMUM TARGET DEPTH
SELECTED - MAMMAL AT
SEABED DEPTH

TABLE 1

EFFECTS OF DIFFERENT IMPULSES ON MAMMALS DIVING BENEATH THE WATER SURFACE

(from Yelverton et al. 1973)

Impulse		Effects
bar.msec	(psi.msec)	
2.76	(40)	No mortality. High incidence of moderately severe blast injuries, including eardrum rupture. Animals should recover on their own.
1.38	(20)	High incidence of slight blast injuries, including eardrum rupture. Animals should recover on their own.
0.69	(10)	Low incidence of trivial blast injuries. No eardrum ruptures.
0.34	(5)	Safe level. No injuries

Source: Wright, 1982.

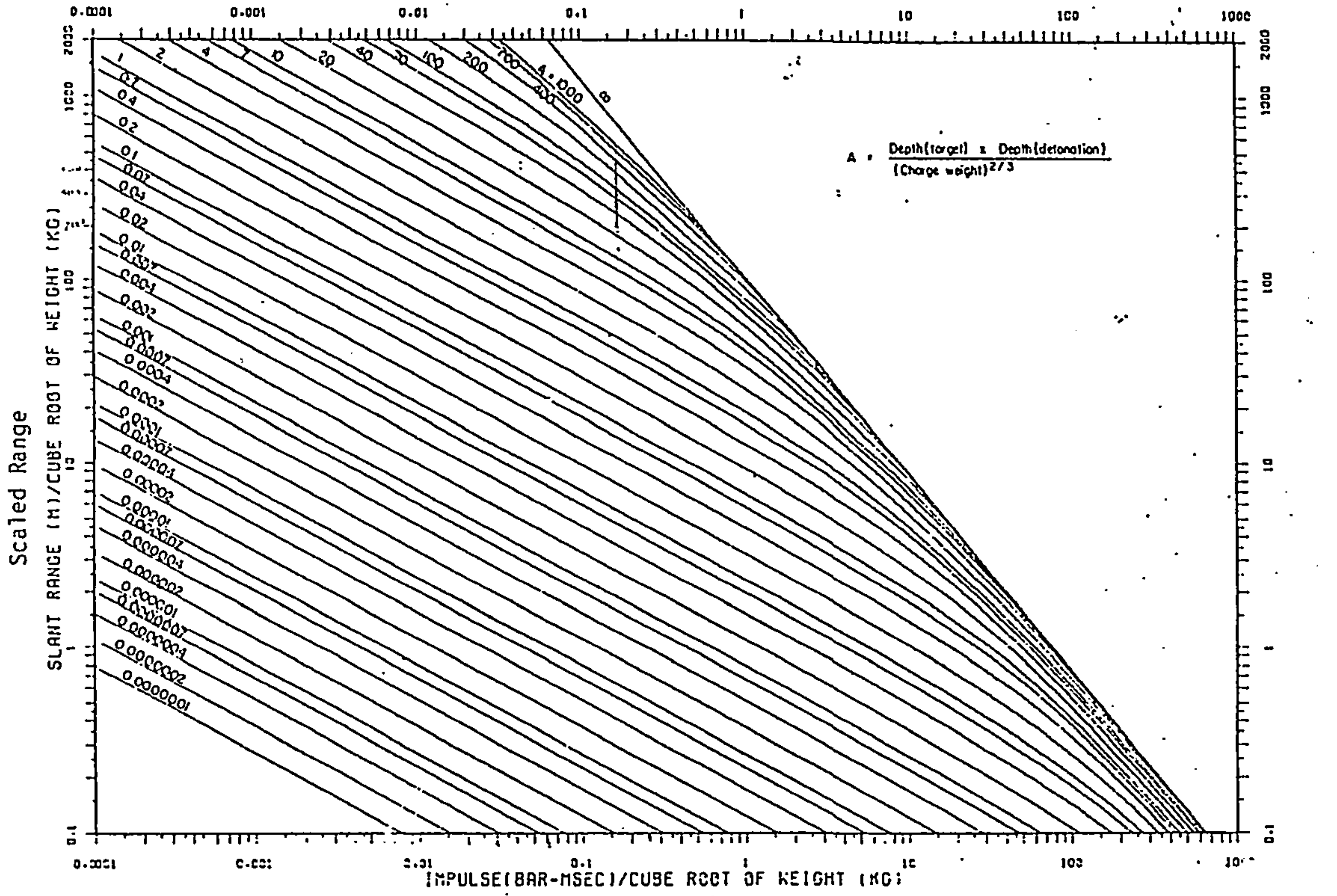


Figure 2. Curves for calculating lethal range from impulse (Hill 1978; after Yelverton et al. 1975).

ENVIRONMENTAL ASSESSMENT OF HILO BAY:

MARINE BIOLOGICAL COMMUNITY STRUCTURE

IN THE VICINITY OF THE PROPOSED

HILO SEWAGE OUTFALL EXTENSION

ENVIRONMENTAL ASSESSMENT OF HILO BAY:

MARINE BIOLOGICAL COMMUNITY STRUCTURE IN THE VICINITY OF THE PROPOSED HILO SEWAGE OUTFALL EXTENSION

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FEBRUARY 20, 1985

INTRODUCTION

Plans are currently being developed for extending the Hilo sewage outfall diffuser from the present depth of approximately 50 feet to a water depth of 80 feet. Several alignments have been proposed to facilitate the extension, all of which extend in a northerly direction from the terminus of the present outfall in Hilo Bay. Since the areas traversed by these alignments have been shown to be the habitat for living coral communities it was deemed prudent to conduct a detailed marine environmental assessment of the outfall alignments and adjacent areas in Hilo Bay. The purpose of this report is provide a clear and comprehensive picture of the biological communities (particularly stony corals and reef fish) that occupy the potential outfall extension alignments in Hilo Bay. In addition, a secondary purpose was to gain a general impression of the physical and chemical characteristics of the environment. These physical and chemical parameters combine to constitute the ecological processes that function to shape or define a particular biotic community structure. Since any effects that may occur to the community as a result of future activity will likely be manifested as alterations in natural physical and chemical processes, an accurate description of these processes is a most practical way of estimating and comparing potential environmental alteration at various locales.

METHODS

All field surveys were conducted on February 1-3, 1985. All underwater work was conducted from a 35 foot motor vessel and employed scuba gear.

Prior to the field work six quantitative transect sites were selected on the three potential outfall alignments (see Figure 1). In the field these stations were located as precisely as possible by shooting sextant angles to three landmarks on shore. At each of these sites quantitative photo-quadrat transects were conducted in order to accurately assess the benthic community structure and bottom composition and topography. A nylon surveying tape 150 feet long was stretched between two points on a specified compass bearing (320 degrees). The tape was marked at ten random points. A rectangular aluminum quadrat frame 1 meter by 2/3 meter was sequentially placed over the transect tape so that the tape bisected the long axis of the frame and the random mark was in the center of the frame. At each quadrat location a color photograph recorded the segment of reef area enclosed by the quadrat frame (see plates 1, 3 and 4). In addition, a diver with knowledge of the taxonomy of resident species visually estimated the percent cover and occurrence of organisms and substrata types within the quadrat frame. Following the period of field work, quadrat photographs were projected onto a grid enabling units of bottom cover for each species and bottom type to be calculated. This information was combined with the in-situ cover estimates and the combined assessment provided the data base for the benthic community structure analysis.

Quantitative assessment of reef fish abundance was conducted in conjunction with the benthic surveys. As the transect tape was being laid out along the bottom fishes within a band approximately two meters wide along the transect path were identified to species and enumerated. Care was taken to conduct the fish survey in such a manner that the minimum disturbance by divers was created to ensure the least possible dispersal of fish populations. However, it should be noted that the limited water visibility due to very turbid conditions, and the tendency for larger non-territorial fishes to aggregate and avoid divers contributed to a high variability in transect results.

In addition to the quantitative transect methods, qualitative reconnaissance swims were conducted by the investigators. The purpose of these swims was to observe as much of the bottom topography and biotic community structure as possible within the limits of the short time allowed underwater at the proposed outfall extension depths. These swims functioned very well in allowing the transition between various zones to be observed. Without numerous transects that would have been impossible within the time-frame of the present study, such transitional schemes would likely have been missed. Representative areas of each bottom zone were recorded photographically on each of the reconnaissance swims. The procedure followed for conducting these swims was to begin at the approximate seaward boundary of each of the proposed alignments and follow a compass heading toward shore for approximately 30 minutes. In this manner approximately 1/3 mile of bottom was covered per swim.

RESULTS & DISCUSSION

Figure 1 shows the locations of all transects and reconnaissance swims in relation to the proposed outfall alignments. Transect sites A and B-C were located on the central alignment, sites D and E on the southern alignment, and site F was located on the northernmost alignment, which was also the greatest distance from shore. Sites B and C were combined into a single transect since they were close enough together to be indistinguishable by the navigational methods employed, and also since reconnaissance of the entire B and C sites showed virtual homogeneity of the area. The more seaward transect at each alignment (B-C, E, and F) was located in the region where the diffuser would occur at depths of 70-80 feet, while the more landward transects (A and D) were located in the approximate center of the prospective outfall alignment extension at depths of 60-70 feet.

Table 1 lists the mean bottom cover of each species of coral and non-coral bottom cover encountered on each of the five transects, as well as total coral cover and indices of Shannon-Weaver coral species diversity. The latter statistic is a measure of the degree of evenness of distribution of bottom cover among a given number of coral species. Figure 2 graphically represents this data and shows the total coral cover at each site as well as how living cover is distributed among genera and species. Interpretation of Figure 2, as well as qualitative observations made during the course of the survey indicate several major trends with regard to benthic community structure of Hilo Bay. First, and probably most significant is the relatively high coral cover encountered at every transect location. Bottom topography throughout the entire study area of the Bay consists of a relatively flat reef platform intersected by shallow rubble filled surge channels (see plate 3). The platform areas between the channels are characterized by very high levels of coral cover sometimes approaching 100% coral cover (see plates 1 and 2). Mean transect total cover estimates, which integrate cover from both the channels and platforms, ranged from 56 to 75 percent. Such values are considered extremely high for Hawaiian reefs, especially when the poor water quality (high turbidity) that is reportedly the normal condition for Hilo Bay is considered. Other areas of optimal coral cover encountered in Hawaii within the depth range of 60-80 feet, such as off the Kona coast, generally occur in areas of extremely clear water. Since the large majority of reef corals require light for growth, it is generally assumed that highly turbid water would serve as a negative influence for highly developed reef structures dominated by living cover. Clearly, such is not the case for Hilo Bay.

The second major trend indicated by the composite species composition of the coral community shown in Figure 2 is the dominance of genera and species that normally are rather minor components of reef assemblages, while the normally dominant forms are relatively scarce throughout most of the transect regions. In particular, two species of the genus Montipora (M. verrucosa and M. patula) comprise very significant proportions of the coral cover. Both of these species occur predominantly in large overlapping plate-like growth forms which result in a three dimensional aspect to the reef surface (see plates 1 and 2). Also occurring with relatively high frequency is the flat encrusting species Leptastrea purpurea. Generally this species is encountered as small encrustations of several inches diameter; however, at the Hilo Bay sites very large expanses of the coral were commonly encountered.

Conspicuous by their absence, or very low occurrence levels on the mean transect composites were several species of the genus Porites (P. lobata and P. compressa) and Pocillopora meandrina. These three species generally comprise the vast majority of coral cover on Hawaiian reefs. Site A, which was the shallowest transect (60 feet) and was located closest to shore, was the only transect that contained a significant percentage of Porites spp. cover (31 percent) (see plate 4). The relatively high species diversity index (1.60) at Site A reflects the high proportion of Porites which coexists with high Montipora cover. Pocillopora meandrina was not encountered on any of the transect quadrats and was only occasionally observed during the entire dive series.

Observations made during the three reconnaissance swims, however, indicate that the community assemblages described above are not typical for the whole of Hilo Bay, but just for the depth range of 60-80 feet, which encompassed all transect sites. The major observation derived from the swims indicates that the

Montipora-Leptastrea communities thrive to the point of complete community domination at depths below 70 feet. At progressively shallower depths Montipora and Leptastrea become correspondingly less abundant while both Porites lobata and P. compressa gradually increase. Figure 3 shows the percent cover of total coral as well as that of Montipora-Leptastrea and Porites at approximate 10 foot depth intervals estimated from photographs taken during reconnaissance swim 2. Since these coverage estimates were made from single photographs taken at points on the reef where coral cover appeared maximal they indicate higher coral cover than the averaged estimates from the transect-quadrat technique. The trends of the lines in Figure 3 illustrate the coral community zonal transition as a function of depth in Hilo Bay. While the total coral cover increases only slightly with increasing depth between 40 and 80 ft. the difference in cover between the two species groups is large. Porites dominates almost completely at the shallow depths, and decreases to less than 5% of total cover at 80 feet, while the pattern for Montipora-Leptastrea is almost exactly reversed. At a depth of 60 feet the two groups coexist in roughly equal proportions (see plate 4).

While it is nearly impossible to unequivocally determine the environmental factors that lead to such a zonation pattern, it is possible to speculate on these processes, based on theoretical schemes that have been developed in the past regarding causal factors for coral community structure in Hawaii. Two physical parameters appear to be largely responsible for the observed pattern within Hilo Bay: conclusive force from wave stress which can break and abrade coral colonies, and high particulate loads in the water column which can restrict light penetration and prevent growth by burial. It appears that in the outer regions of Hilo Bay, in the depth range of 40-80 feet shoreline orientation and wave refractive processess are such that wave stress is minimal, even from relatively rare incidences of very large storm waves. At most transect sites evidence of physical destruction due to wave damage was not apparent. Site F, however, did show some signs of relatively recent storm stress in the form of large overturned coral colonies that had been broken from the reef surface, as well as accumulations of rubble fragments in low pockets on the reef surface (see plate 5). On the other hand the entire water column in the outer Bay is frequently very turbid with high concentrations of suspended particulate material, apparently of terrestrial origin. These high concentrations are potentially damaging to corals that do not have the ability to rapidly remove settling particulates from the living surfaces of the coral colonies. Such high turbidity also results in very restricted light levels at the reef surface which could slow the growth of corals adapted to high light levels characteristic of clear water. It appears that with the stability inherent to low wave stress, high particulate loads and low light levels combine to create habitats suited to the plating or encrusting forms of <u>Montipora</u> and <u>Leptastrea</u>. The delicate plates observed to be the dominant growth form at the deep sites would be unable to sustain the physical force of storm waves without extensive breakage. However, this growth form is ideal to maximize utilization of the small quanta of light that reaches the reef surface since maximum surface area is available for incoming light utilization. In addition, the polyps (individual coral animals that comprise a coral colony) of the several species of Montipora are relatively large and the calices (cup-like skeletal structure secreted by the polyps) are raised so that settling sediment fills the inter-calyx space. All of these structural characteristics appear to be adaptations to optimal growth in a stable, but turbid environment. On the other hand, Porites species have small, flat calices that would appear to be much more sensitive to sedimenting particles. While Porites lobata does occur commonly in flat plating forms between 40 and 60 feet, the lack of this coral at the transect sites indicates that perhaps light limitation and high sediment loads restrict the habitat to the shallower zones. Porites is generally considered to be the dominant coral capable of outcompeting other genera in areas of suitable environmental conditions on Hawaiian reefs. The lack of these suitable conditions, presumably due to the turbidity described above leads to the lack of competitive superiority by Porites and instead Montipora and Leptastrea are competitively superior and able to exploit most of the available space available on the deeper reef.

However, as can be seen in Figure 3 at depths shallower than 60feet Porites spp. does comprise the majority of coral cover. The species cover is divided between stands of the delicate finger coral P. compressa and thin, flat plating forms of P. lobata (see plate 4). Both of these growth forms are rather fragile and would not be expected to be found in areas where conclusive force from breaking waves is a regular characteristic of the environment. While the substrata is qualitatively similar to the deeper areas it appears that the major environmental difference between the Montipora and Porites dominated zones is the degree of light penetration and turbidity. Water clarity appeared to be greater moving toward shore due to both less suspended material and decreasing depth.

Since it was beyond the scope of this report to survey areas closer to shore and shallower than 30 feet it is not possible to report on the location and composition of the third major zone. This area would be within the range of predictable force from waves of a magnitude sufficient to damage or destroy all but the sturdiest growth forms of reef corals. Within this zone species composition would likely be dominated by encrusting or hemispherical colonies of P. lobata and Pocillopora meandrina. Coral cover in this zone would likely be much lower in the two outer zones and the majority of substrata would be bared carbonate reef rock.

Another surprising observation made during the course of the survey was the almost complete lack of macrobenthic species other than corals. Only one individual each of the sea urchins Tripnestes gratilla and Heterocentrotus mammillatus were encountered during the entire field period. No observations of sea cucumbers, sea stars or other motile macroinvertebrates were recorded. In addition, no macrothalloid benthic algae were observed.

Quantitative assessments of reef fish abundance were conducted in conjunction with the benthic surveys. Results of the fish surveys are presented in Table 2 and Figure 4. It should be noted that the limited visibility due to high turbidity and the tendency for larger non-territorial fishes to aggregate and avoid divers contributed to the high variability in transect results. In particular, larger herbivores such as Acanthurus mata and Scarus sordidus, were seen at several sites but were not included in the transect results because they were not within the specified transect survey zone.

At intermediate depths (50-60 feet), the benthic cover, as described above, is dominated by coral-covered platforms bisected with surge channels filled with sand and rubble. Fishes noted on more than one occasion in this area were the herbivores Scarus sordidus, Ctenochaetus strigosus, Acanthurus mata, A. triostegus, A. olivaceus, Zebrasoma flavescens, Naso lituratus, and Stegastes fasciolatus; the butterfly fishes Chaetodon unimaculatus, C. multicinctus, C. quadrimaculatus, C. trifasciatus and Forcipiger flavissimus; the angelfish Centropyge potteri; the goatfish Parupaneus multifasciatus; the wrasses Thallosoma duperreyi, T. ballieui, and Gomphosus varius; the snapper Lutjanus kasmira; the filefish Pervagor spilosoma; and the triggerfish Rhinecanthus rectangulus.

At the deeper sites (particularly transects E and F) fewer fishes were noted. The predominant species were Ctenochaetus strigosus, Chaetodon unimaculatus, Chaetodon multicinctus, Thallosoma duperreyi, Parupaneus multifasciatus, and Pervagor spilosoma. At the top of the steep slope located at the seaward boundary of the transect area (approximately 85 feet in depth), large groups of the planktivorous damselfish Chromis agilis were observed. At site E several specimens of the two introduced species of snapper Lutjanus kasmira and grouper Cephalopholis argus were seen in coral near the edge of the slope. A small school of the large parrotfish Scarus perspicillatus, and a large kahala Seriola dumerilii were also observed near the slope.

In general, at all transect stations and on all reconnaissance swims it was evident that there was a distinct lack of all fish fauna that are generally regarded as of commercial or recreational value as "food fish". In the total of approximately ten hours underwater only six individuals of commercially valuable food fish and one small lobster were observed. The apparent lack of carangids (jacks, ulua) squirrelfish (menpachi, aweoweo), and large goatfish (kumu) is surprising particularly considering the high coral cover and consequently structural complexity of the reef structure. Generally fish abundance and diversity is positively correlated with substratum complexity, apparently due to the increased shelter to small individuals created by dense three dimensional coral structures.

CONCLUSIONS

The results of the survey presented in this report clearly indicate that the marine environment of Hilo Bay in the vicinity of the proposed sewage outfall diffuser extension is characterized by very high levels of reef coral bottom cover.

Such community structure is rather surprising in view of the generally perceived relationships between environmental variables (in particular turbidiity) and coral reef development. As such, the findings of this survey represent a relatively unique case that fits into the theoretical scheme that has been developed over the past several years regarding the cause and effect of Hawaiian coral reef community structure. However, while the benthic communities of Hilo Bay may be considered rather interesting from a theoretical ecological standpoint due to the unique combination of environmental factors, the area does not appear to represent any type of rare or endangered marine community, or a system that might be expected to be particularly susceptible to temporary environmental alteration. The living coral assemblages are not limited to a small restricted zone. Virtually all of the bottom surveyed during the course of the field work for this report was consistently covered with living colonies according to the distributions described in the previous section. At a minimum this area encompassed several square miles, and if time and resources had allowed it is highly probable that community structure would have been observed to be similar over a much larger area of Hilo Bay. In addition, while the distribution of the species assemblages is rather unusual in terms of dominance none of the corals or other fauna observed represented rare or unique species. All were relatively common on most well-developed Hawaiian reefs, but in very different relative proportions than found in Hilo Bay. In fact, one of the more unexpected results was the lack of common reef fauna usually associated with coral reef communities.

With respect to extension of the Hilo sewage outfall, it appears inevitable that reef areas with high percentages of living coral will be traversed. However, it appears that such a situation will not represent any manner of significant detrimental activity. The corridor of the reef cleared for the location of the outfall extension will probably recover in terms of coral cover within several years. Indeed, the outfall structure itself will undoubtedly serve as a settling surface for coral, leading to an eventual increase in cover over the present. This is the case with the existing outfall and diffuser structure which was observed to be almost totally covered with living coral colonies (see plate 6).

With respect to susceptibility of marine organisms to temporary alterations of water quality characteristics, Hilo Bay communities may be significantly more resilient than communities occurring in waters that are generally free of high levels of particulate material. The most likely alteration to environmental conditions that might be associated with construction activities would be a temporary increase in water column turbidity. However, natural conditions of turbidity in Hilo Bay are presently so severe that the incremental increase due to the construction of the outfall extension would most likely be indistinguishable.

Results of this survey indicate that the area is <u>sub-optimal</u> with respect to reef fish, both in terms of species number and total individuals. In particular, fish of commercial or recreational value are absent or very scarce, either as a result

not great Barrier Reef?

of undesirable habitat or excessive fishing pressure. In either event, the slight temporary environmental alterations that could accompany outfall construction would not appear to cause any changes in fish populations. In a similar manner, the area does not represent any sort of recreational resource for skin or scuba diving due to the usually low visibility in the water column. Thus, there does not appear to be potential for any type of negative environmental resource-related consequences related to the proposed outfall extension.

Table 1. MEAN TRANSECT PERCENT COVER OF CORAL SPECIES AND NON-CORAL SUBSTRATA IN HILO BAY.

TRANSECT LOCATION	A	B-C	D	E	F
CORAL SPECIES					
Montipora verrucosa	25.0	30.3	30.1	37.3	12.8
Montipora patula	4.5	19.7	8.5	6.7	12.6
Porites lobata	17.0	0.2	2.1	1.4	0
Porites compressa	14.3	0	0	0.2	0.4
Leptastrea purpurea	9.0	4.1	18.4	10.5	6.8
Pavona varians	2.9	2.0	1.9	3.7	0
Pavona duerdeni	0.2	0	0.2	0	23.4
Pavona (Pseudocolumnastrea) pollicata	0	0	0	0	1.8
Fungia scutaria	0.2	0	0.1	0	0
Palythoa tuberculosa	0	0	0	0.2	0
NON-CORAL SUBSTRATA					
LIMESTONE	25.6	30.1	38.7	26.2	15.6
RUBBLE	0	8.1	0	13.1	27.2
MEAN TRANSECT TOTAL CORAL COVER	74.5	56.3	61.3	60.0	57.1
SPECIES-COVER DIVERSITY	1.60	0.965	1.24	1.14	1.43

Table 2. HILO BAY QUANTITATIVE FISH ASSESSMENT

Species	Transect Site				
	A	B	D	E	F
MULLIDAE - Goatfishes					
Parupaneus multifasciatus	1	2	3	4	1
CHAETODONTIDAE - Butterflyfishes					
Chaetodon unimaculatus	6	8	6	2	
Chaetodon quadrimaculatus			2		
Chaetodon kleinii				1	
Chaetodon multicintus	2	2	6		2
Chaetodon trifasciatus	2	1			
Forcipiger flavissimus	1				1
POMACANTHIDAE - Angelfishes					
Centropyge potteri			2		
POMACENTRIDAE - Damselfishes					
Stegastes fasciolatus			2		
LABRIDAE - Wrasses					
Thalassoma duperreyi	4		4	7	1
Thalassoma ballieui		1	1	1	
Bodianus bilunulatus	1				
Labroides phthirophagus	1				
SCARIDAE - Parrotfishes					
Scarus sordidus		8			2
juvenile Scarus	5	6			
ACANTHURIDAE - Surgeonfishes					
Ctenochaetus strigosus	22	26	11	7	28
Acanthurus olivaceus	6				
Zebrasoma flavescens		2			2
MONOCANTHIDAE - Filefishes					
Pevagor spilosoma			3	3	
Total Number Individuals	51	56	40	25	37
Total Number Species	11	9	10	7	7

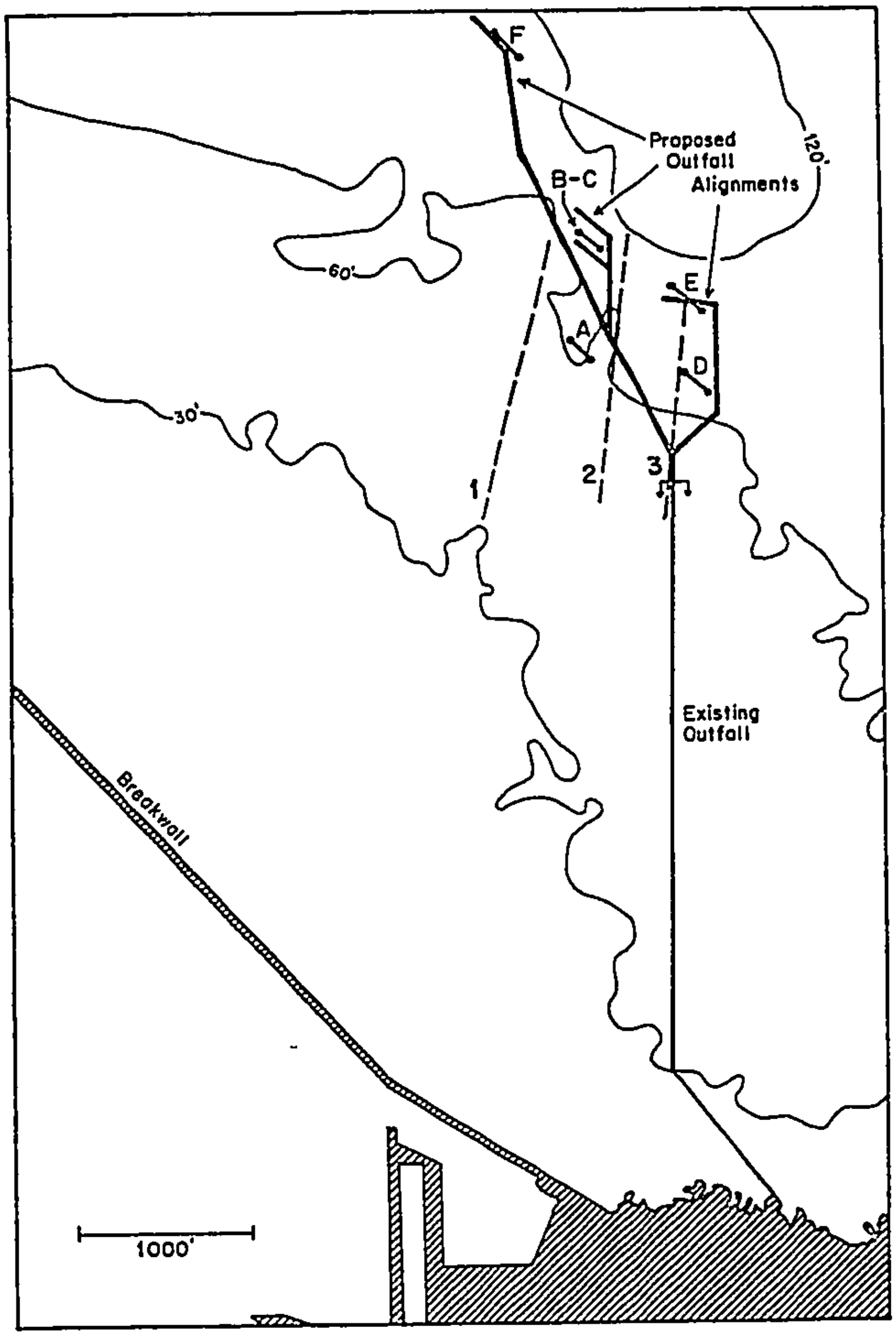


Figure 1. Map of Hilo Bay showing location of existing outfall structure and diffuser, as well as the three proposed outfall diffuser extension alignments. Paths of reconnaissance swims are shown as dashed lines and numbered 1-3. Transect locations are shown as solid lines and site designation is indicated by letters A-F.

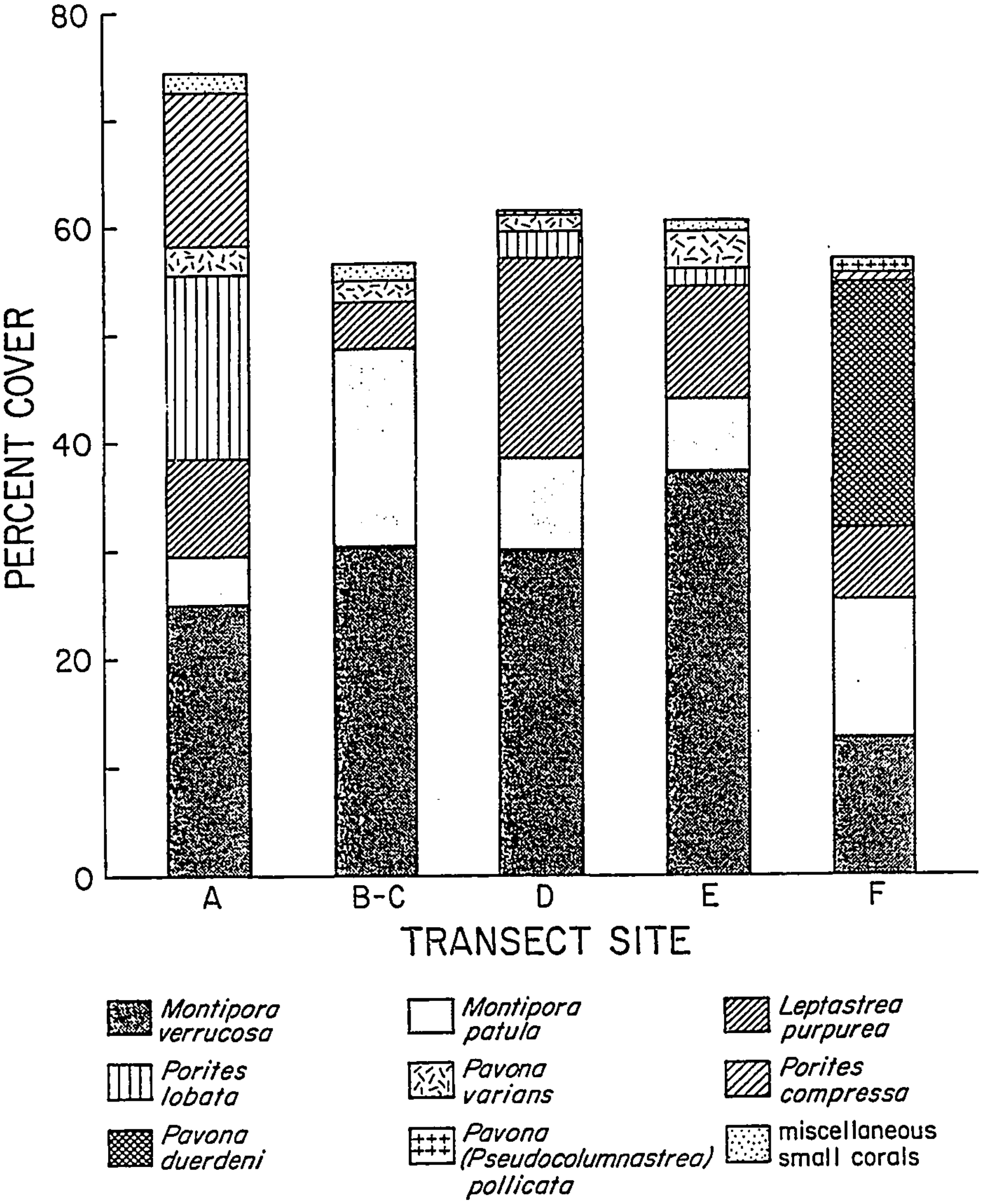


Figure 2. Bar graph showing percent cover of major coral species and total coral cover at each transect site. Cover estimates are calculated as the mean cover for ten random quadrats selected on a 150 foot transect line.

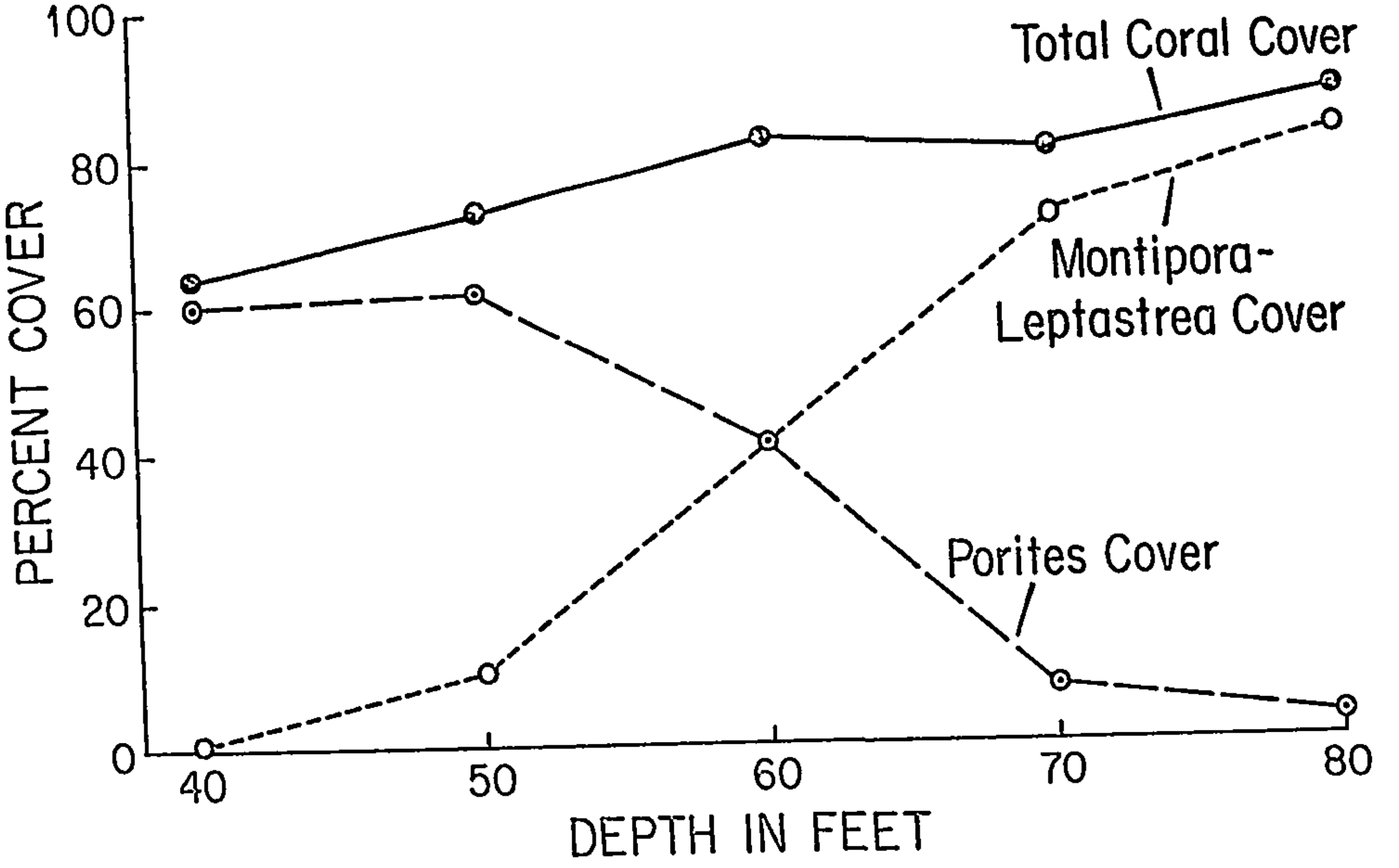


Figure 3. Graph showing relationship of zonation of major coral groups to depth in Hilo Bay. Porites cover dominates community assemblages at 40-50 foot range, while Montipora and Leptastrea comprise the majority of coral at the 70-80 foot zone. At the 60 foot depth the two species co-exist in roughly equal proportions. Data taken from random photographs taken during reconnaissance swim #2.

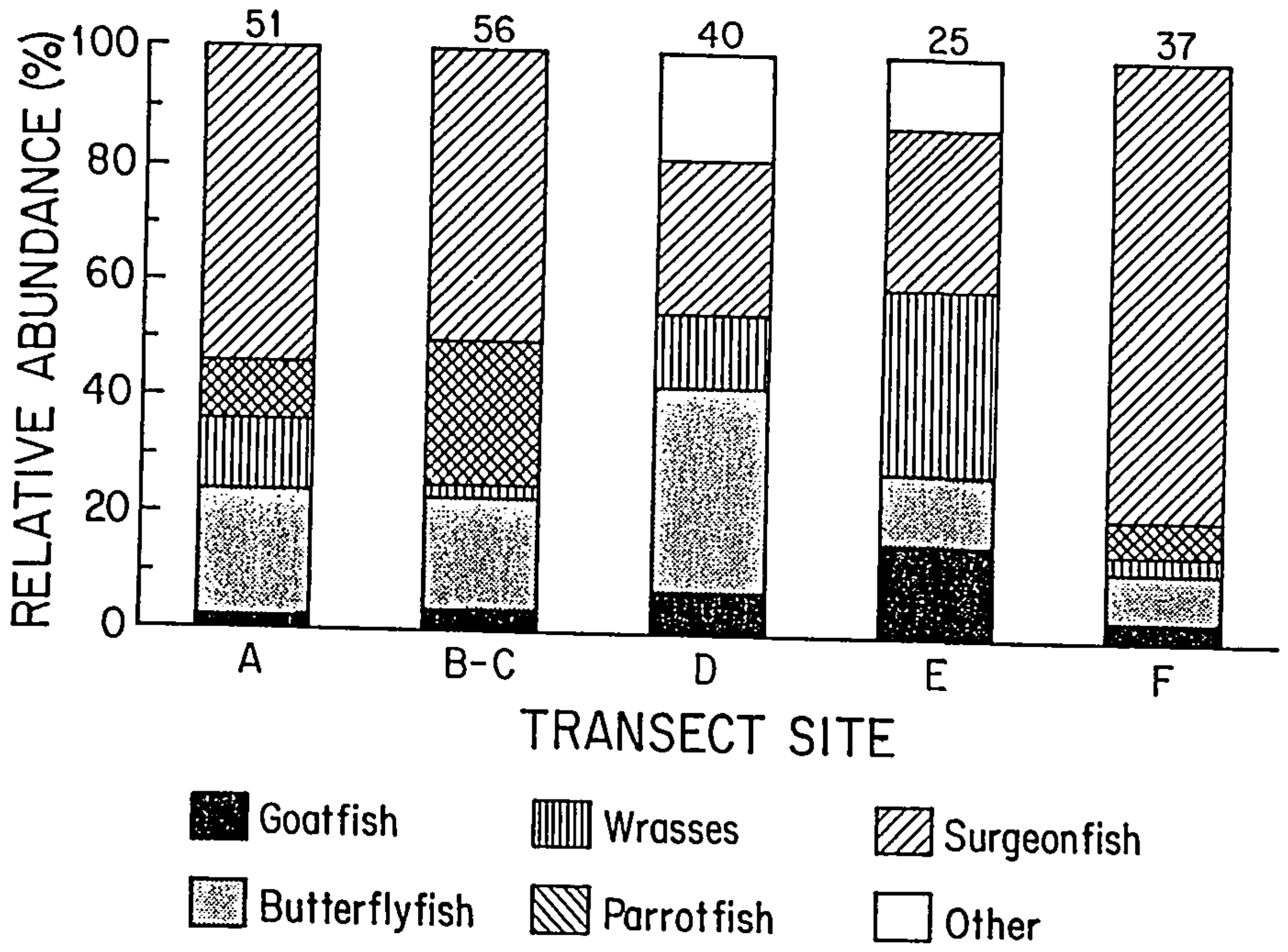
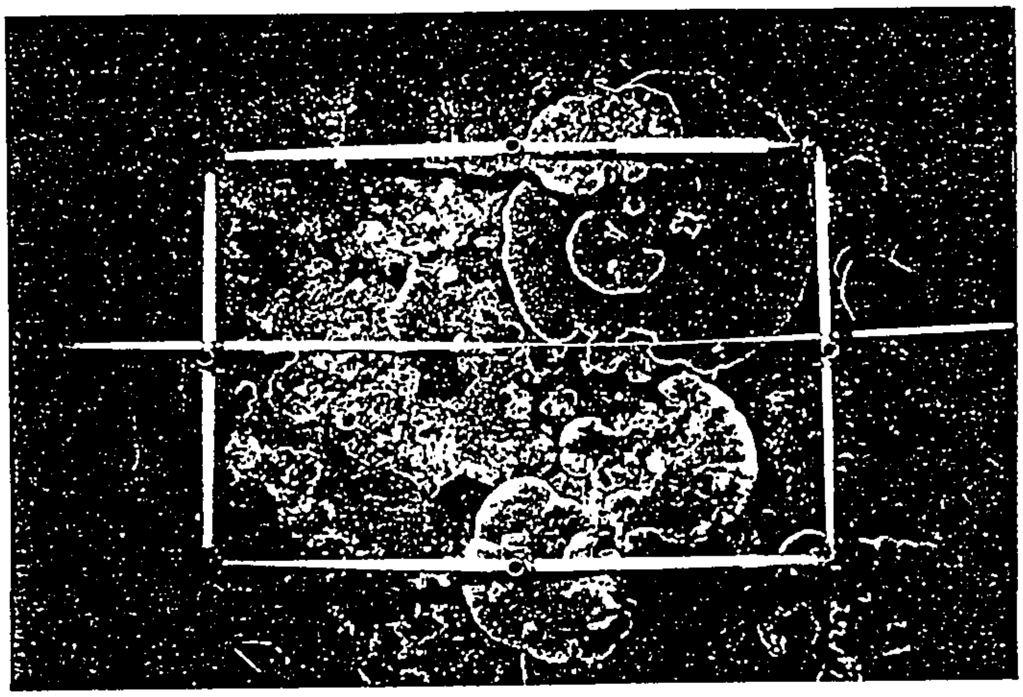


Figure 4. Bar graph showing abundance and distribution of reef fish on transects in Hilo Bay. Numbers at the top of each transect bar are total number of individuals counted on each transect survey.



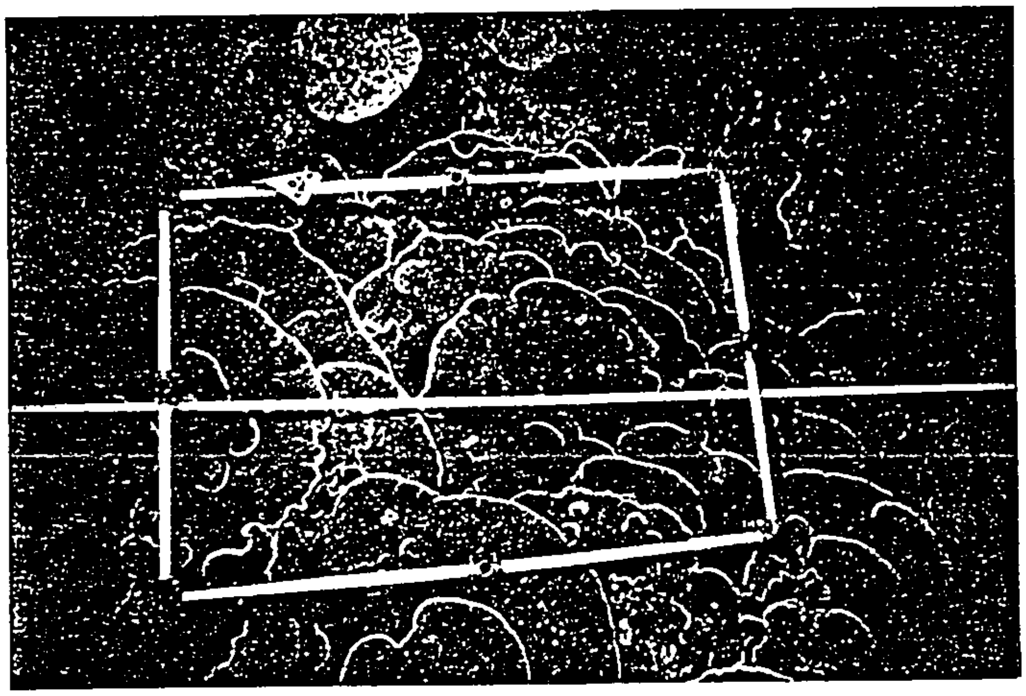


PLATE 1. Typical transect quadrat photographs at Site A (top) and Site E (bottom). Large circular overlapping coral colonies are Montipora verrucosa and Montipora patula.

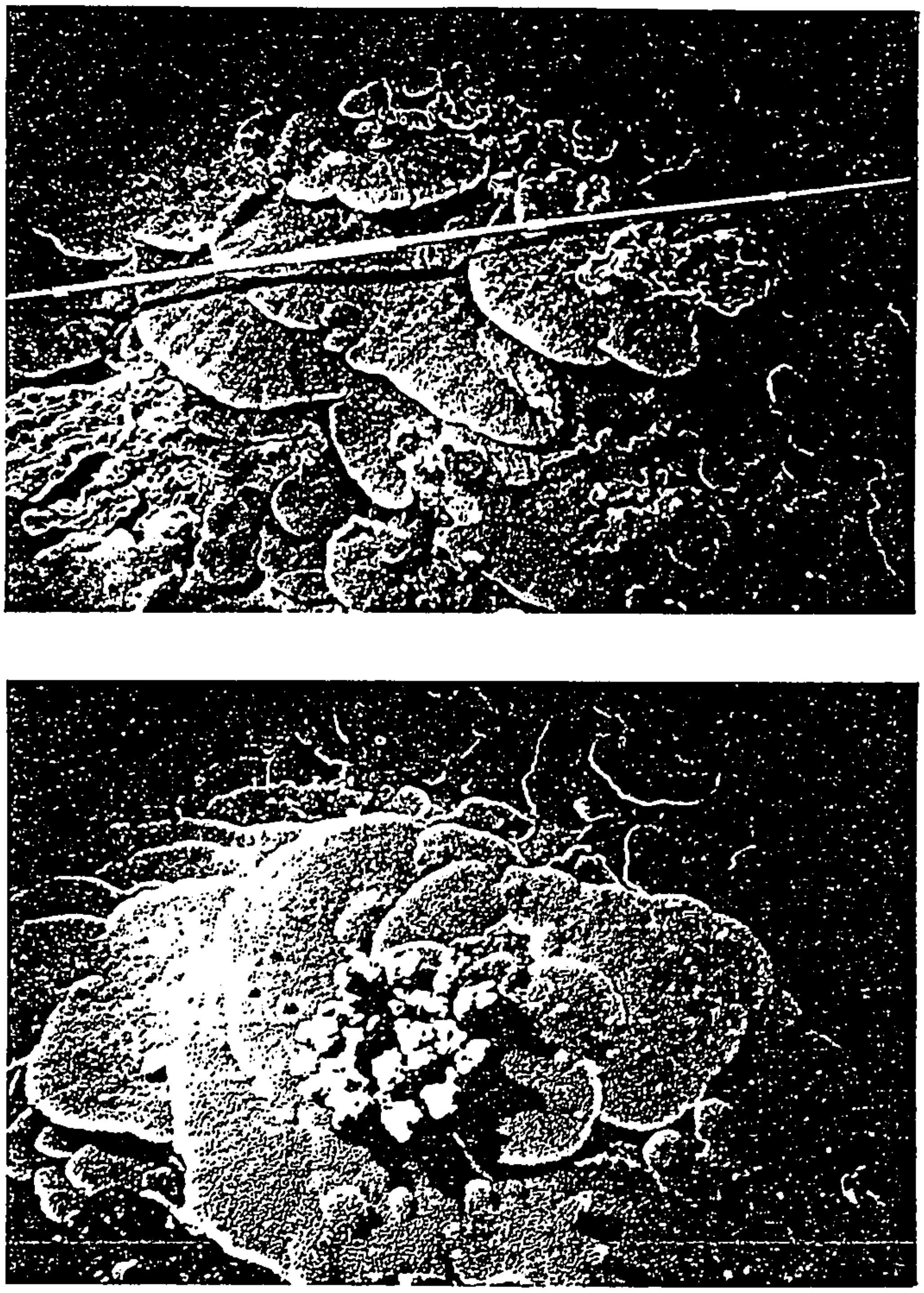
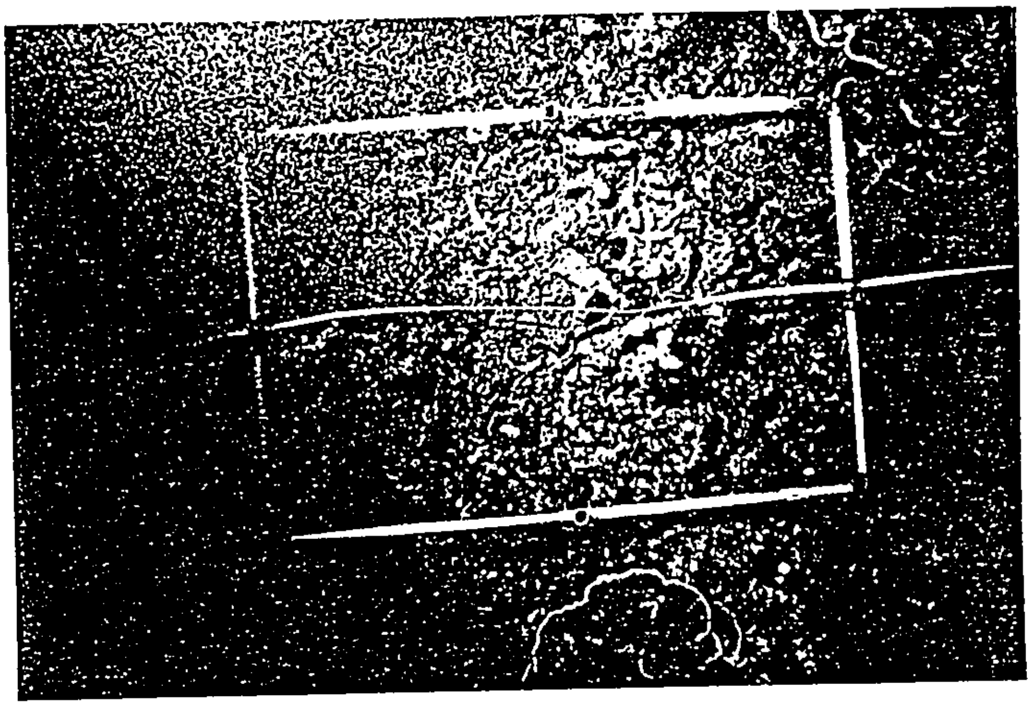


PLATE 2. Close-up photograph of typical colonial structure of Montipora verrucosa found throughout the reef platform in the proposed diffuser extension site in Hilo Bay. The overlapping plate-like growth form increases the substratum complexity by creating habitat space between the plates. In the bottom photograph a colony of Porites compressa, commonly called "finger coral" can be seen growing on the center of a Montipora plate.



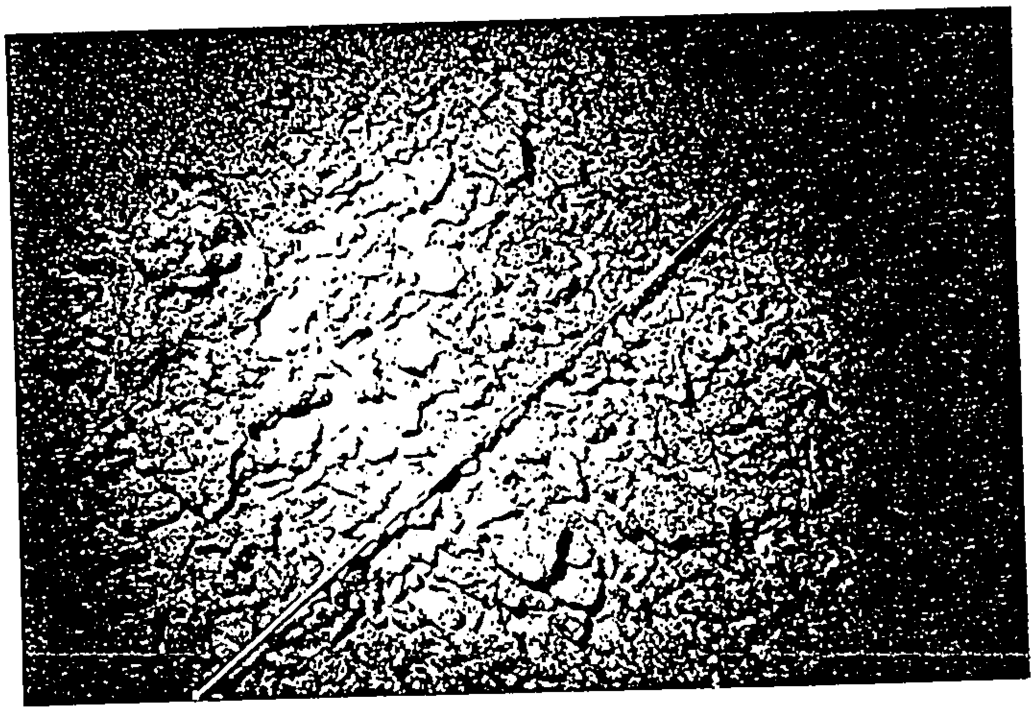
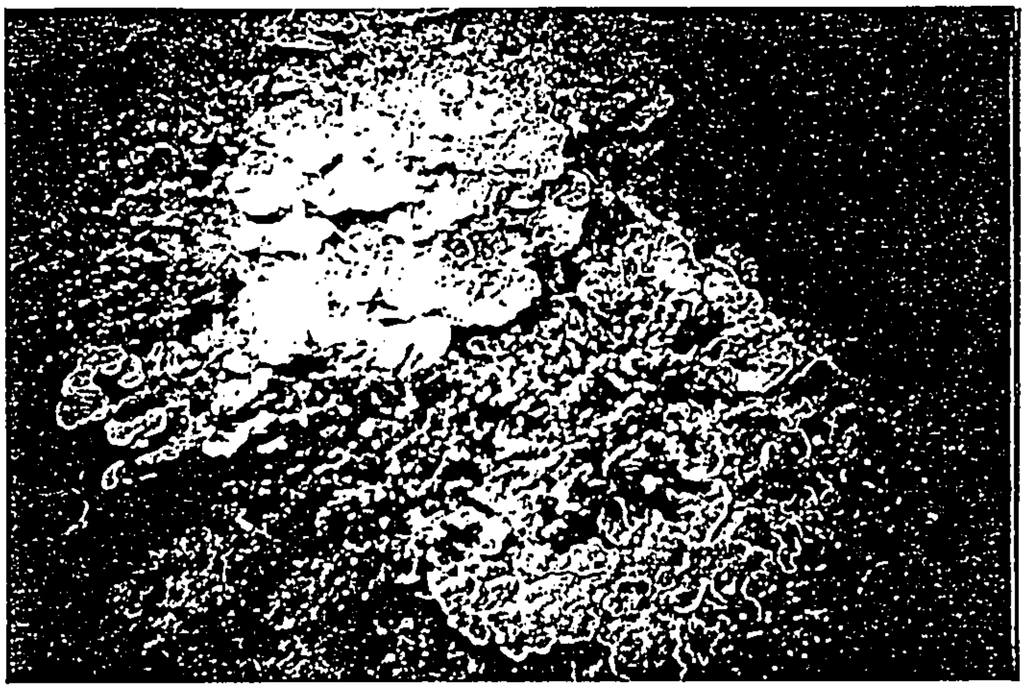


PLATE 3. Typical areas defined as rubble-filled surge channels. Top photograph is at a depth of 50 ft. taken on reconnaissance swim 2. Bottom photograph is located on Transect F. Rubble fragments are apparently broken from the reef surface by storm waves or bio-eroding activity and subsequently collect in low surge channels.



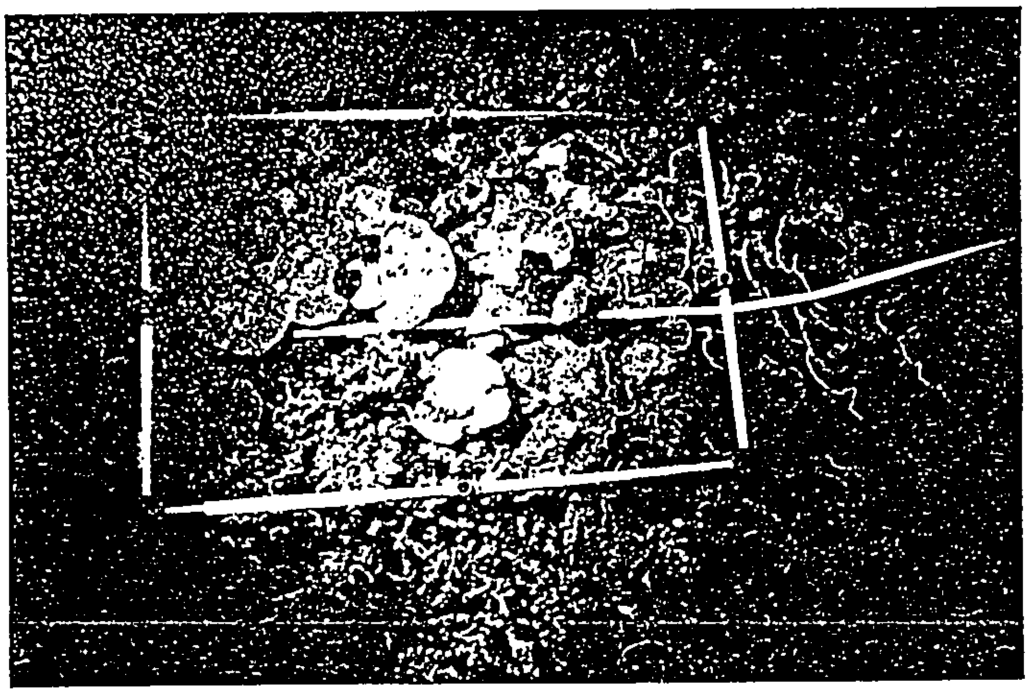


PLATE 4. Porites zone in the shallower (30-60 ft.) regions of Hilo Bay. Top photograph shows a typical area of high coral cover divided between finger-like *Porites compressa* and flat plates of green *Porites lobata* taken at a depth of 40 ft. on reconnaissance swim 2. Bottom photograph shows a typical quadrat on Transect A at a depth of 60 ft. where the coral cover is a combination of species of *Porites* and *Montipora*.

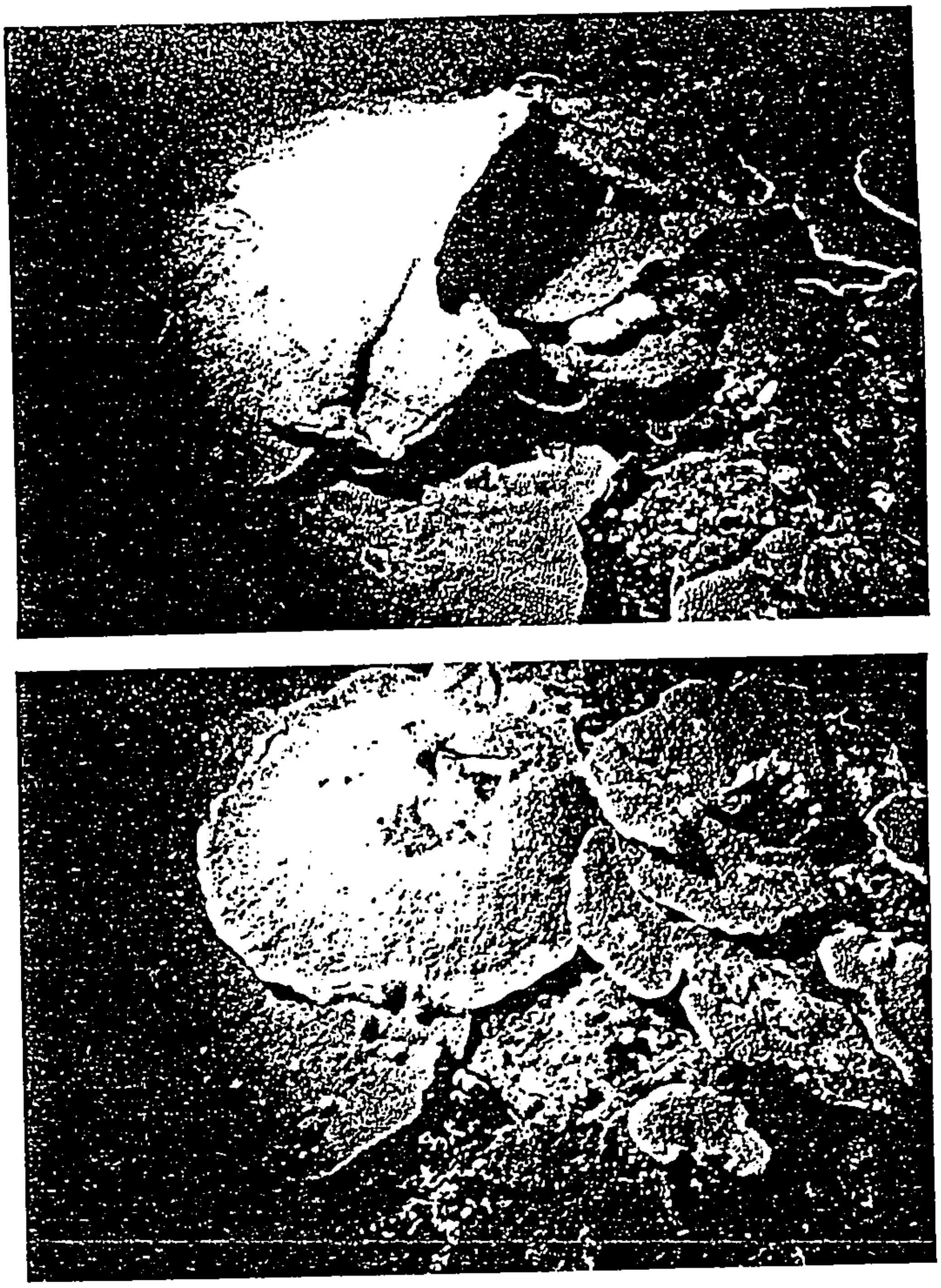


PLATE 5. Effects of storm damage to Montipora colonies is shown in these two photographs. Top photo shows a large conical shaped M. verrucosa colony that has recently been broken from the reef platform and overturned. Living coral tissues can be seen at the edges of the overturned colony. Bottom photo shows a similar conical colony of M. patula that also appears to have been broken from the reef and overturned some years ago. Living tissue on this colony has spread upward over what was once the bottom of the structure leaving only a small circular area of the skeleton which has yet to be covered over by new growth. Both photographs were taken at a depth of 80 ft. near the site of transect F.

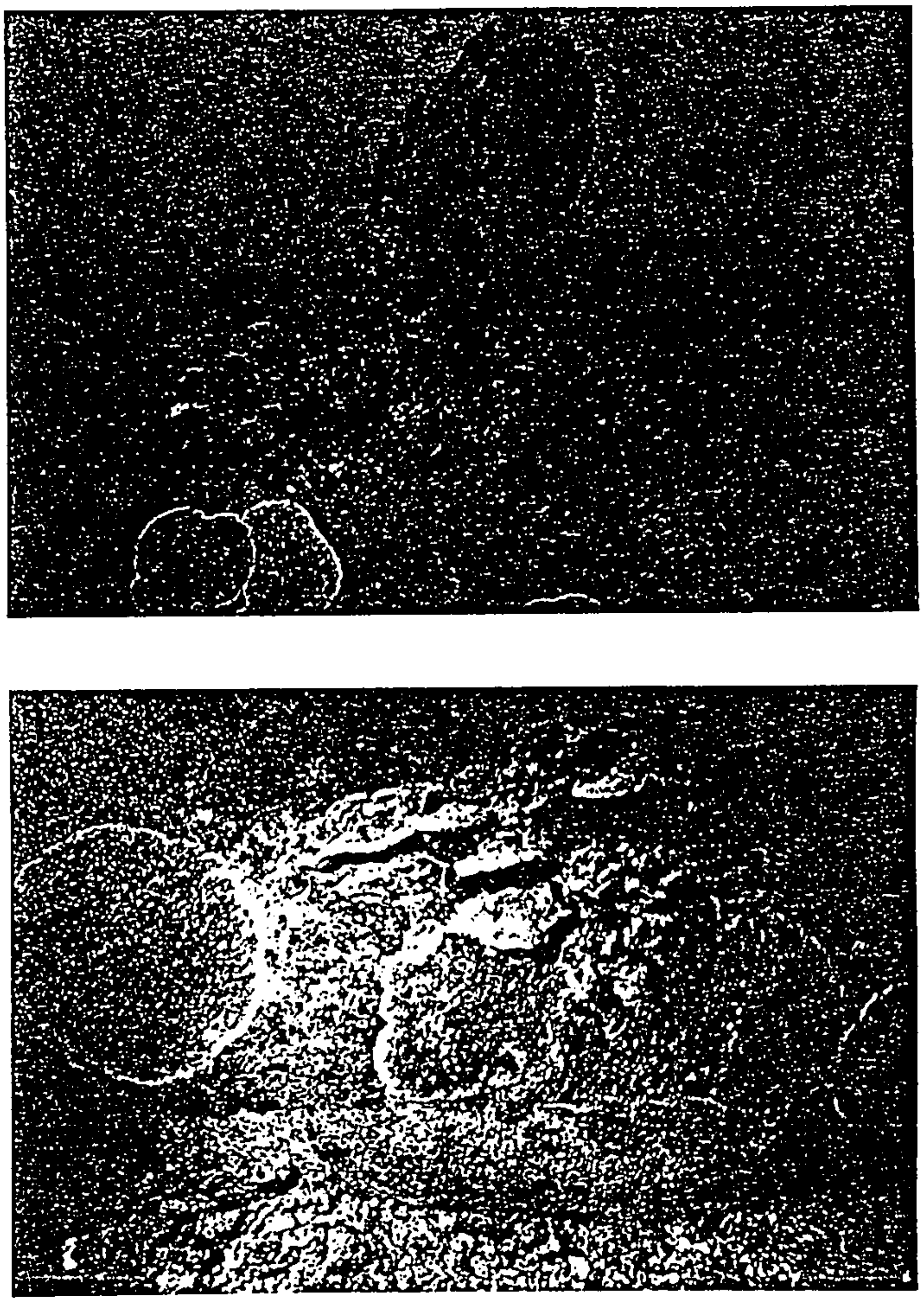


PLATE 6. The existing Hilo Bay outfall pipe and diffuser at a depth of 50 ft. Top photograph shows one of the diffuser ports and the bottom photograph a section of the diffuser pipe. Both structures are covered to a large extent by living colonies of corals of the same species as found on the transect surveys. Round encrusting forms with white borders are species of *Montipora* while the thicker lumpy forms are *Porites lobata*.

DRAFT

SUPPLEMENTAL

ENVIRONMENTAL IMPACT STATEMENT

FOR THE PROPOSED

HILO BAY OUTFALL SEWER EXTENSION

DRAFT
SUPPLEMENTAL
ENVIRONMENTAL IMPACT STATEMENT
FOR THE
PROPOSED HILO BAY OUTFALL SEWER EXTENSION
HILO, HAWAII

Proposing Agency:

Department of Public Works
County of Hawaii

THIS STATEMENT WAS DEVELOPED IN ACCORDANCE WITH THE ENVIRONMENTAL IMPACT STATEMENT REGULATIONS, STATE OF HAWAII, AND SUBMITTED PURSUANT TO:

CHAPTER 343
HAWAII REVISED STATUTES

SEPTEMBER 1986
DATE

HUGH Y. ONO
CHIEF ENGINEER

CHAPTER I
PROJECT DESCRIPTION

LOCATION

The project is located on the northeastern shore of the Island of Hawaii, often called the Big Island. The outfall for the Hilo Sewage Treatment Plant extends into the Puhi Bay on the seaward side of the Hilo breakwater (Figure I-1). The area in the vicinity of the outfall is largely industrial. Hilo Harbor, which provides boat access to coastal waters, is a significant ocean landmark adjacent to the project site.

OBJECTIVES

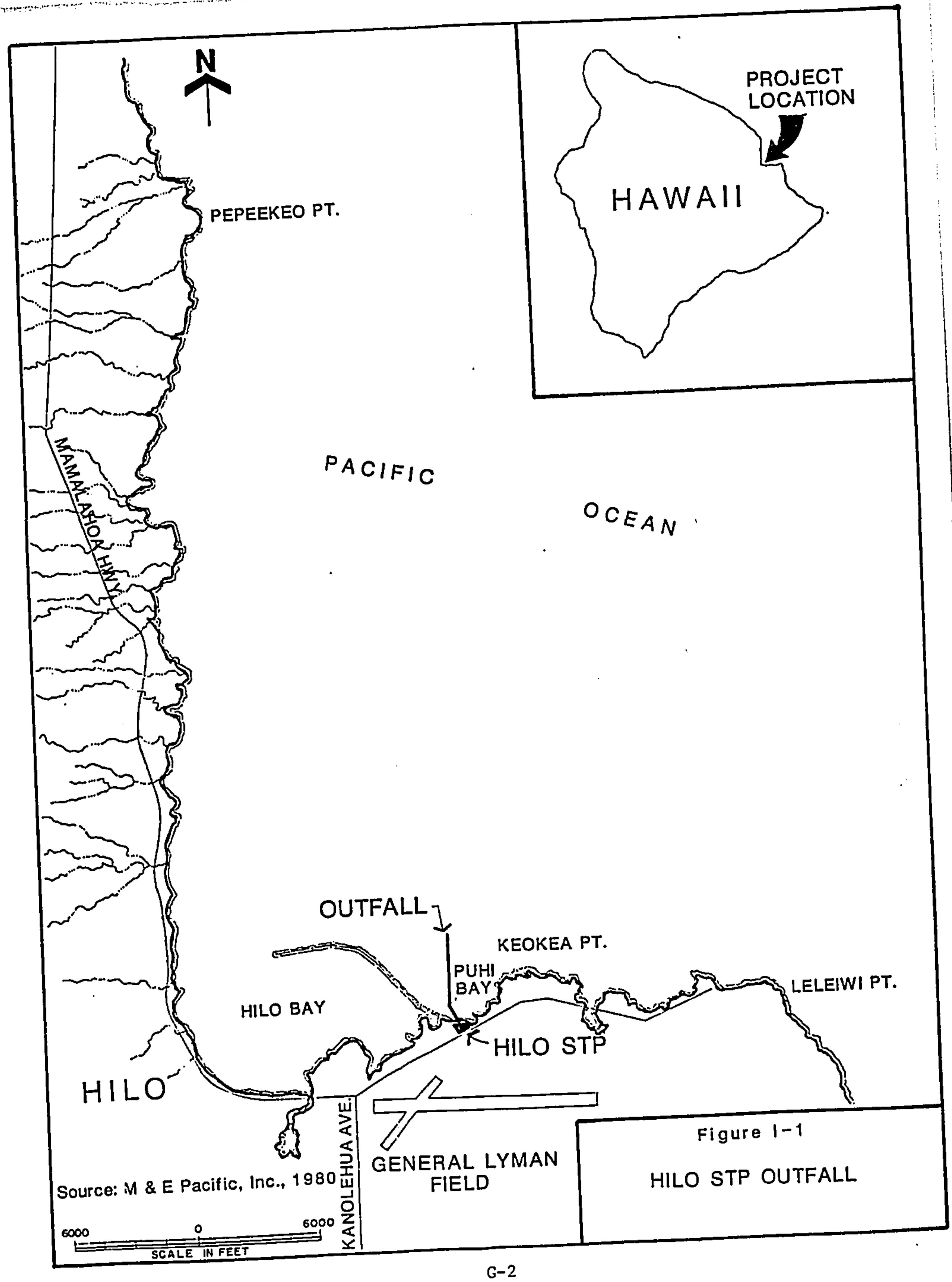
The objectives of the project are as follows:

1. To increase effluent dilution to lessen the potential for adverse environmental impacts;
2. To protect against shoreward transport of effluent bacteria.

DESCRIPTION

The proposed project will modify and extend the existing outfall such that the effluent is discharged 5,680 feet offshore at a depth of 80 feet (Figure I-2). The extension includes a 1,180-foot section of 48-inch reinforced concrete pipe and a 260-foot diffuser with 3-inch ports spaced 12 feet on centers. Five mgd of primary effluent from the Hilo Sewage Treatment Plant will be discharged through the outfall.

The orientation of the diffusers will be in a northwesterly direction. The purpose of this orientation is to provide adequate dilution during periods of south and easterly currents, and also provide adequate dilution during periods of the predominantly tide-related westerly currents.



Source: M & E Pacific, Inc., 1980

Figure I-1

HILO STP OUTFALL

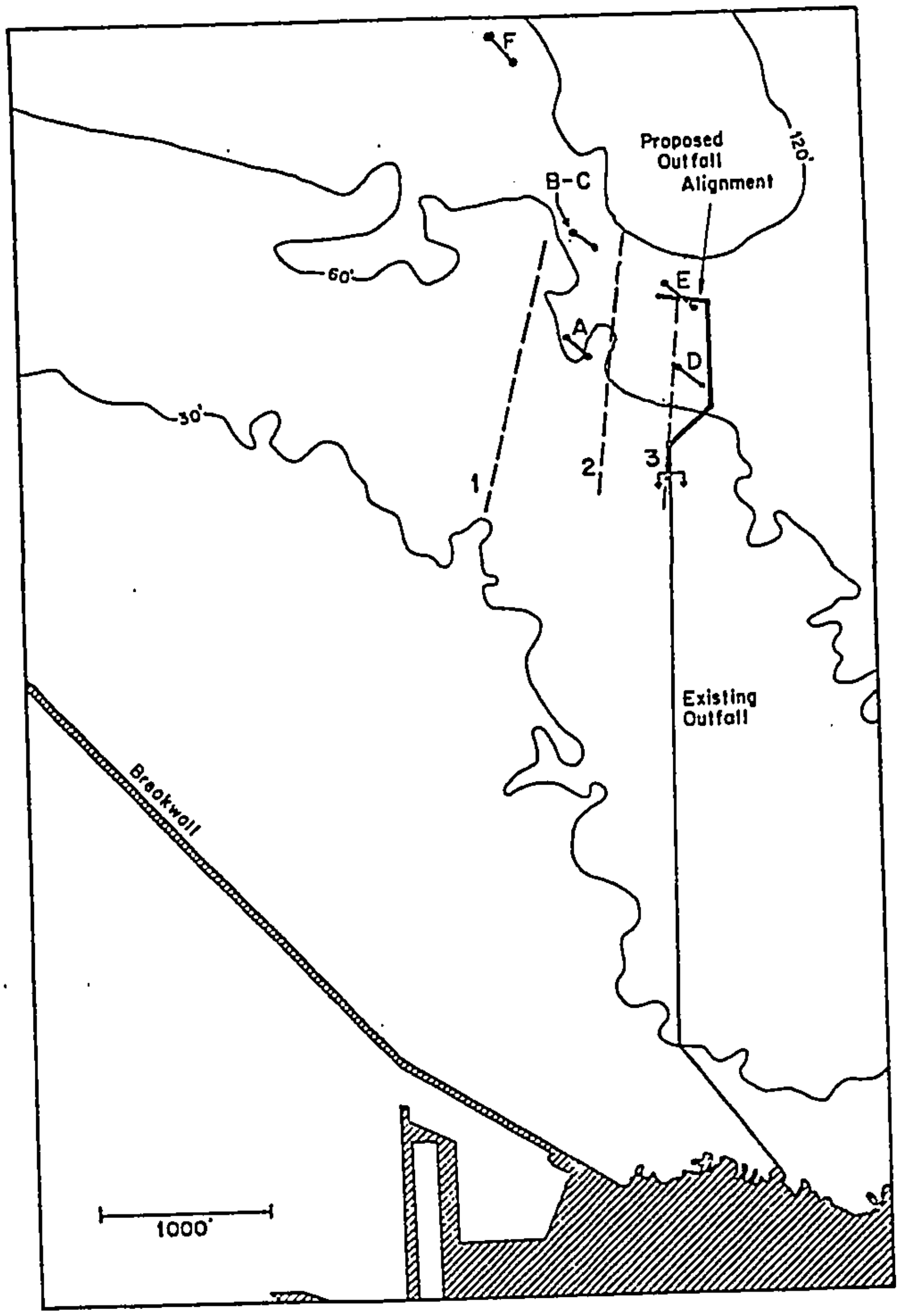


Figure I-2 Map of Hilo Bay showing location of existing outfall structure and diffuser, as well as the proposed outfall diffuser extension alignment. Paths of reconnaissance swims are shown as dashed lines and numbered 1-3. Transect locations are shown as solid lines and site designation is indicated by letters A-F.

Source: Steven Dollar, 1985.

Field investigations indicate that the surface portion of the sewage field would be directed in a southerly direction towards the Hilo Harbor-Puhi Bay area about 20 percent of the time from wind stresses. The orientation of the proposed outfall affords a compromise to accommodate the two oceanographic-climatological conditions.

COSTS AND FUNDING

The approximate budgeting costs for modification and extension of the outfall, reflecting present levels in construction costs, is $2,000,000 (M&E Pacific, Inc., 1980).

Funding for the project is based on the following proportions:

75%	Federal
10%	State
15%	County

SCHEDULE OF CONSTRUCTION

As the final phase of the Hilo Wastewater Management Plan, modification and extension of the Hilo outfall is tentatively scheduled to begin in 1988. The schedule is subject to revision, depending on funding from both federal (EPA) and local (State and CIP) sources.

HISTORY OF OUTFALL

In 1966, the first 2,600-foot portion of the 48-inch reinforced concrete outfall was put into operation, discharging effluent in 37 feet of water. A few years later the outfall was extended to 4,500 feet offshore discharging effluent through a 210-foot diffuser in 56 feet of water. Eight-inch and ten-inch diffuser ports, spaced 15 feet on centers, were located on the diffuser section.

CHAPTER II

RELATIONSHIP TO APPLICABLE STATUTES AND REGULATIONS

The following permits and consistency certification are applicable to the Hilo outfall extension and modification:

1. Department of Health,
   National Pollutant Discharge Elimination System,
   Section 301(h) Permit
2. U.S. Army Corps of Engineers, Refuse Act Permit
3. Department of Land and Natural Resources,
   Conservation District Use Application
4. Department of Transportation, Shorewater Work Permit
5. U.S. Coast Guard, Aids to Navigation Permit
6. Department of Planning and Economic Development,
   Hawaii Coastal Zone Management Program
   Federal Consistency Certification

Section 301(h) of the Clean Water Act provides publicly owned wastewater treatment works an opportunity to apply for variances from secondary treatment requirements for discharges to marine waters. The main criteria of concern for Hilo outfall is Subsection 301(h)(2) which states that a variance will not interfere with the attainment or maintenance of that water quality which ensures protection of water supplies and protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife, and allows recreational activities on and in the water. Compliance with Subsection 301(h)(2) requires monitoring as stated in Subsection 301(h)(3). Water quality monitoring through sampling and testing, and comparison to waters of similar character which are unaffected by effluent discharges, would be required.

The Refuse Act essentially states that it is unlawful to discharge from floating craft or shore, any refuse other than that flowing from streets and sewers in liquid state, into any navigable water. Filing for the Refuse Act Permit, under Sections 10 and 13 of the 1899 River and Harbor Act, assumes compliance with other applicable federal agencies and acts such as the NMFS 1972 Marine Protection, Research and Sanctuaries Act (MPRSA). Authorization of marine discharge is the purpose of this permit.

The state Conservation District Use Application (CDUA) regulates the uses within the conservation districts to protect open space, wildlife habitat, watersheds, and recreational, aesthetic, historic, and cultural values. Of particular concern for Hilo outfall construction is the disturbance of marine communities, including coral, reef fish, and larger mammals such as humpback whales, known to frequent the area. The minimization of adverse impacts to marine biota and the maintenance of water quality would be necessary for permit approval.

The Shorewater Work Permit is established to regulate construction activities in shorewaters of the state for protection of navigation and shoreline resources. The permit applies to all projects with temporary or permanent construction in the shorewaters of Hawaii.

The Coast Guard Aids to Navigation permit applies to offshore construction. The offshore structures are recorded on maps to minimize navigational hazards.

The HCZMP is a network of authorities incorporated into the program as a means of carrying out the CZM objectives and policies in accordance with the implementation and compliance sections of the State's CZM law, Chapter 205A, HRS. The federal consistency review process is a mechanism to ensure continued coordination of state and federal interests, allowing early consultation of activities to minimize and resolve conflicts. The HCZMP objectives and policies relevant to extension of Hilo outfall fall under the following categories:

Recreational Resources

Coastal Ecosystems

Economic Uses

Coastal Hazards

Managing Development

CHAPTER III
ENVIRONMENTAL SETTING

The coastal water environment and biological environment of Hilo Bay in the vicinity of the outfall expansion will be discussed in this chapter.

COASTAL WATER ENVIRONMENT

The coastal water environment of Hilo Bay, in terms of its water quality and wave stress as reported by Steven Dollar, Marine Research Consultant, is summarized below (Dollar, 1985).

Water Quality

The entire water column in the outer bay is frequently very turbid with high concentrations of suspended particulate material, apparently of terrestrial origin. These high concentrations are potentially damaging to coral colonies that do not have the ability to rapidly remove settling particulates from their living surfaces. These water quality conditions have resulted in the development of an indigenous assemblage of coral suited to these naturally turbid conditions. High turbidity also results in restricted light levels at the reef surface which could slow the growth of corals adapted to the high light levels characteristic of clear water.

Wave Stress

In the outer regions of Hilo Bay, in the depth range of 40 to 80 feet, shoreline orientation and wave refractive processes are such that wave stress is minimal, even from relatively rare incidences of very large storm waves. At most transect sites evidence of physical destruction due to wave damage was not apparent (Figure I-2). Site F, however, did show some signs of relatively recent storm stress in the form of large overturned coral colonies that had been broken from the reef surface, and accumulations of rubble fragments in low pockets on the reef surface.

BIOLOGICAL ENVIRONMENT

This section includes descriptions of the biological environment in Hilo Bay in the vicinity of the outfall expansion.

Benthic organisms and nekton were surveyed at six transect sites (Figure I-2). The more seaward transects (B-C, E, and F) were located in the region where depths of 70 to 80 feet existed, while the more landward transects (A and D) were located at depths of 60 to 70 feet. Three reconnaissance swims were also conducted by the investigators to observe bottom topography, biotic community structure, and transition between zones.

The following discussion is a summary of marine biological conditions observed in Hilo Bay in February 1985, submitted for this study by Steven Dollar, Marine Research Consultant (Dollar, 1985).

Benthic Organisms

Table III-1 lists the mean bottom cover of each species of coral and non-coral encountered on each of the five transects, the total coral cover, and the Shannon-Weaver coral species diversity index. The latter statistic is a measure of the degree of evenness of distribution of bottom cover among a given number of coral species. Figure III-1 graphically represents this data and shows the total coral cover at each site as well as how living cover is distributed among genera and species. Interpretation of Figure III-1, and qualitative observations made during the course of the survey indicate several major trends with regard to benthic community structure of Hilo Bay.

First, and probably most significant, is the relatively high coral cover encountered at every transect location. Bottom topography throughout the entire study area of Hilo Bay consists of a relatively flat reef platform intersected by shallow rubble filled surge channels. The platform areas between the channels are characterized by very high levels of coral cover sometimes approaching 100 percent. Mean transect total cover estimates, which integrate cover from both the channels and platforms, ranged from

TABLE III-1

MEAN TRANSECT PERCENT COVER OF CORAL SPECIES AND NONCORAL SUBSTRATA IN HILO BAY

Transect Location	A	B-C	D	E	F
CORAL SPECIES					
Montipora verrucosa	25.0	30.3	30.1	37.3	12.8
Montipora patula	4.5	19.7	8.5	6.7	12.6
Porites lobata	17.0	0.2	2.1	1.4	0.0
Porites compressa	14.3	0.0	0.0	0.2	0.4
Leptastrea purpurea	9.0	4.1	18.4	10.5	6.8
Pavona varians	2.9	2.0	1.9	3.7	0.0
Pavona duerdeni	0.2	0.0	0.2	0.0	23.4
Pavona (Pseudocolumnastrea pollicata)	0.0	0.0	0.0	0.0	1.8
Fungia scutaria	0.2	0.0	0.1	0.0	0.0
Palythoa tuberculosa	0.0	0.0	0.0	0.2	0.0
NONCORAL SUBSTRATA					
Limestone	25.6	30.1	38.7	26.2	15.6
Rubble	0.0	8.1	0.0	13.1	27.2
MEAN TRANSECT TOTAL CORAL COVER	74.5	56.3	61.3	60.0	57.1
SPECIES-COVER DIVERSITY	1.60	0.965	1.24	1.14	1.43

Source: Steven Dollar, 1985.

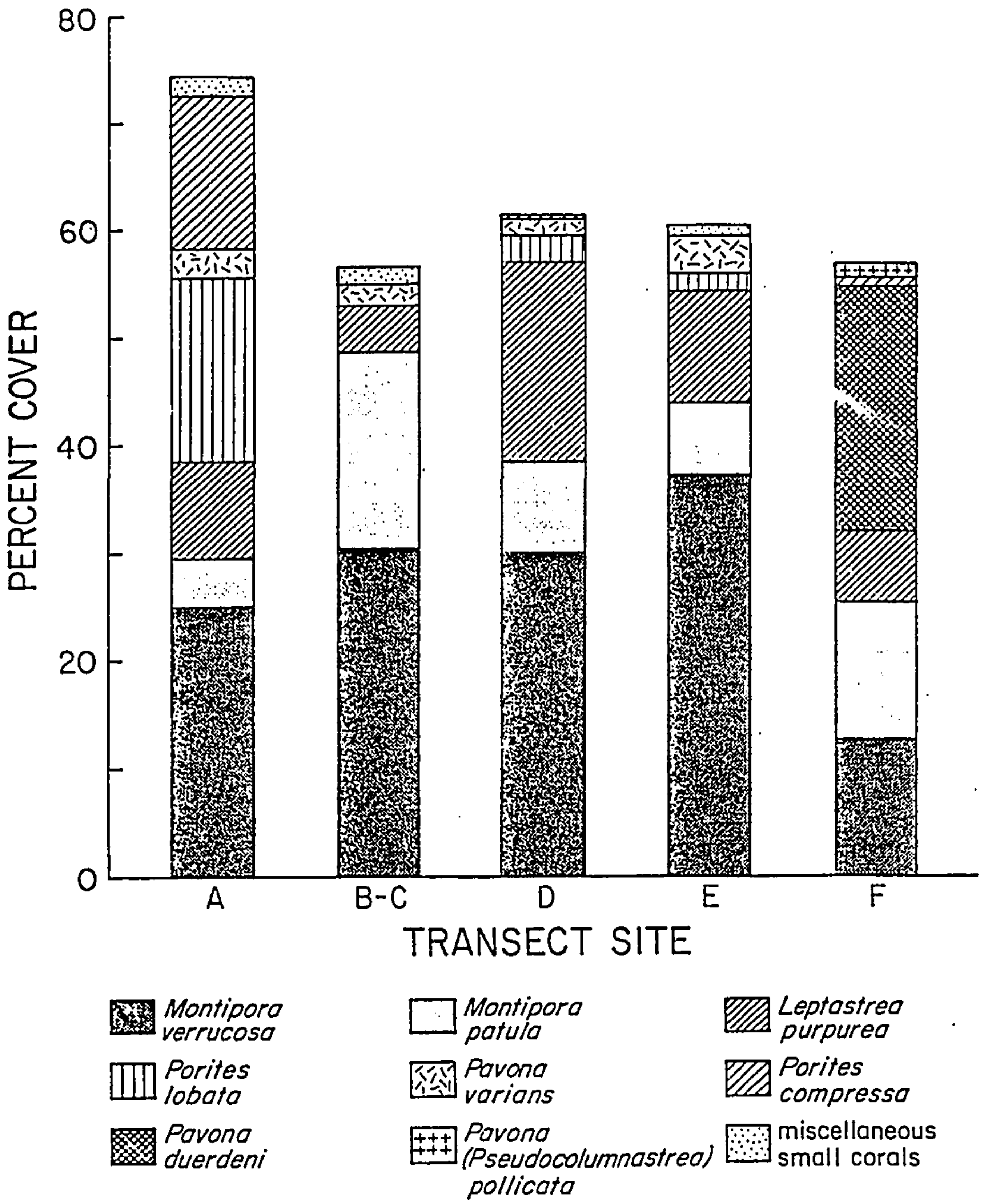


Figure III-1 Bar graph showing percent cover of major coral species and total coral cover at each transect site. Cover estimates are calculated as the mean cover for ten random quadrats selected on a 150 foot transect line.

Source: Steven Dollar, 1985.

56 to 75 percent. Such values are considered extremely high for Hawaiian reefs, especially when the poor water quality (high turbidity) that is reportedly the normal condition for Hilo Bay is considered. Other areas of optimal coral cover encountered in Hawaii within the depth range of 60 to 80 feet, such as off the Kona coast, generally occur in areas of extremely clear water. Since the large majority of reef corals require light for growth, it is generally assumed that highly turbid water would serve as a negative influence for highly developed reef structures dominated by living cover. Clearly, such is not the case for Hilo Bay.

The second major trend indicated by the composite species composition of the coral community shown on Figure III-1 is the dominance of genera and species that are normally rather minor components of reef assemblages, while the normally dominant forms are relatively scarce throughout most of the transect regions. In particular, two species of the genus *Montipora* (*M. verrucosa* and *M. patula*) comprise very significant proportions of the coral cover. Both of these species occur predominantly in large overlapping plate-like growth forms that result in a three dimensional aspect to the reef surface. Also occurring with relatively high frequency is the flat encrusting species *Leptastrea purpurea*. Generally, this species is encountered as small encrustations of several inches in diameter; however, at the Hilo Bay sites, very large expanses of the coral were commonly encountered.

Conspicuous by their absence, or very low occurrence levels, on the mean transect composites were several species of the genus *Porites* (*P. lobata* and *P. compressa*) and *Pocillopora meandrina*. These three species generally comprise the vast majority of coral cover on Hawaiian reefs. Site A, which was the shallowest transect (60 feet) and was located closest to shore, was the only transect that contained a significant percentage of *Porites spp*. cover (31 percent). The relatively high species diversity index (1.60 at Site A reflects the high proportion of *Porites* that coexist with high *Montipora* cover. *Pocillopora meandrina* was not encountered on any of the transect quadrats and was only occasionally observed during the entire dive series.

Observations made during the three reconnaissance swims, however, indicate that the community assemblages described above are not typical for the whole of Hilo Bay but just for the depth range of 60 to 80 feet, which encompasses all transect sites. The major observation derived from the swims indicates that the Montipora-Leptastrea communities thrive to the point of complete community domination at depths below 70 feet. At progressively shallow depths, Montipora and Leptastrea became correspondingly less abundant, while both Porites lobata and P. compressa gradually increase. Figure III-2 shows the percent cover of total coral as well as that of Montipora-Leptastrea and Porites at approximate 10-foot depth intervals estimated from photographs taken during reconnaissance swim 2. Since these coverage estimates were made from single photographs taken at points on the reef where coral cover appeared maximal, they indicate higher coral cover than the averaged estimates from the transect-quadrat technique. The trends of the lines on Figure III-2 illustrate the coral community zonal transition as a function of depth in Hilo Bay. While the total coral cover increases only slightly with increasing depth between 40 and 80 feet, the difference in cover between the two species groups is large. Porites dominates almost completely at the shallow depths and decreases to less than 5 percent of total cover at 80 feet, while the pattern for Montipora-Leptastrea is almost exactly reversed. At a depth of 60 feet, the two groups coexist in roughly equal proportions.

While it is nearly impossible to unequivocally determine the environmental factors that lead to the observed zonation pattern, it is possible to speculate on these processes, based on theoretical schemes that have been developed in the past regarding causal factors for coral community structure in Hawaii. Two physical parameters appear to be largely responsible for the observed pattern within Hilo Bay: concussive force from wave stress that can break and abrade coral colonies and high particulate loads in the water column that can restrict light penetration and prevent growth by burial.

The stability inherent to low wave stress, high particulate loads, and low light levels combine to create habitats suited to the plating or encrusting forms of Montipora and Leptastrea. The delicate plates observed to be the dominant growth form at the deep sites would be unable to sustain the

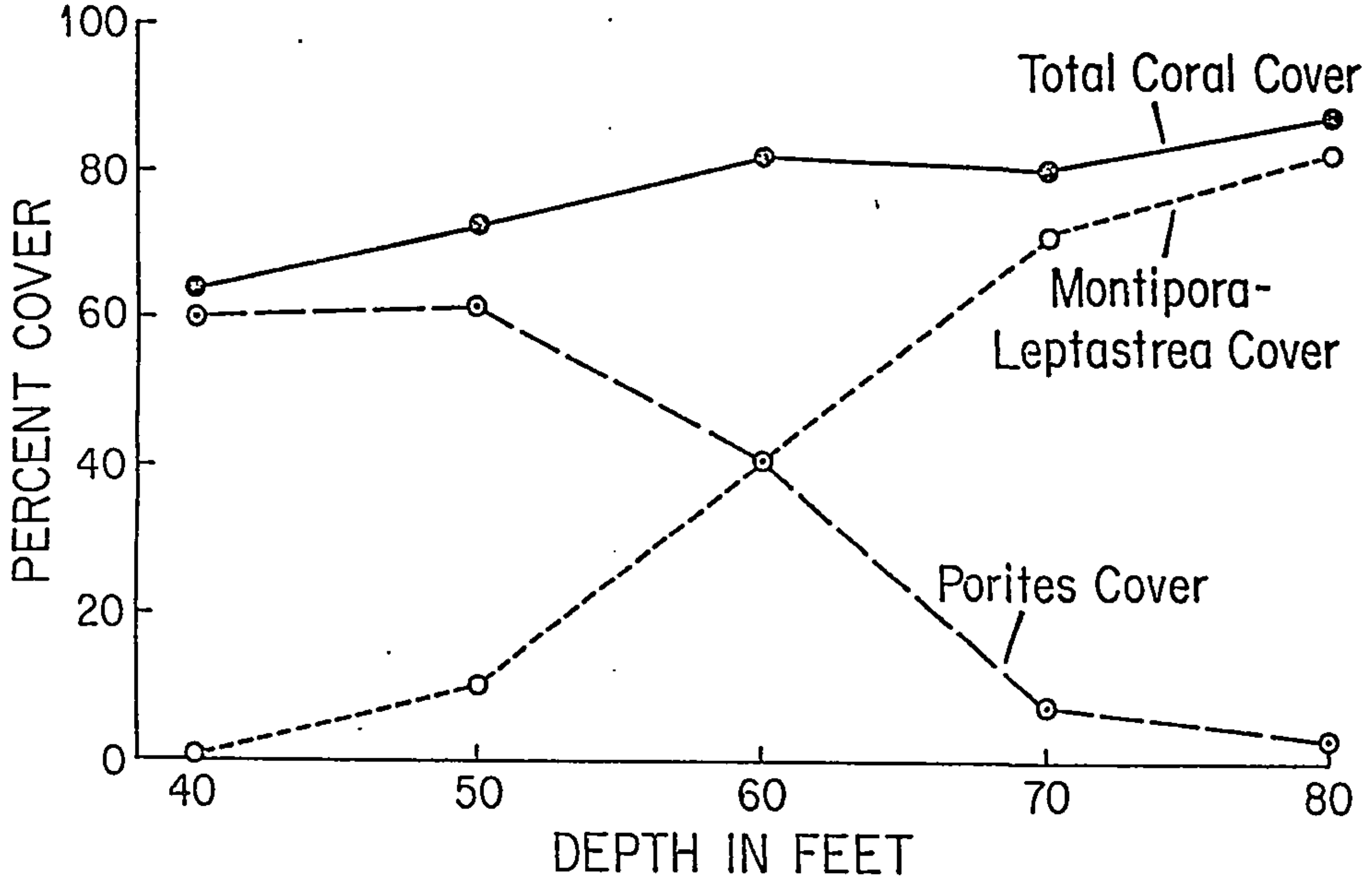


Figure III-2 Graph showing relationship of zonation of major coral groups to depth in Hilo Bay. Porites cover dominates community assemblages at 40-50 foot range, while Montipora and Leptastrea comprise the majority of coral at the 70-80 foot zone. At the 60 foot depth the two species co-exist in roughly equal proportions. Data taken from random photographs taken during reconnaissance swim #2.

Source: Steven Dollar, 1985.

physical force of storm waves without extensive breakage. However, this growth form is ideal to maximize utilization of the small quanta of light that reaches the reef surface since maximum surface area is available for incoming light utilization. In addition, the polyps (individual coral animals that comprise a coral colony) of the several species of Montipora are relatively large and the calices (cup-like skeletal structure secreted by the polyps) are raised so that settling sediment fills the inter-calyx space. All of these structural characteristics appear to be adaptations to optimal growth in a stable but turbid environment.

The Porites species have small, flat calices that appear to be much more sensitive to sedimenting particles. While Porites lobata does occur commonly in flat plating forms between 40 and 60 feet, the lack of this coral at the transect sites indicates that perhaps light limitation and high sediment loads restrict the habitat to the shallower zones. Porites is generally considered to be the dominant coral capable of outcompeting other genera in areas of suitable environmental conditions on Hawaiian reefs. The lack of these suitable conditions, presumably due to the turbidity described above, leads to the lack of competitive superiority by Porites and instead Montipora and Leptastrea are competitively superior and able to exploit most of the space available on the deeper reef.

However, as can be seen on Figure III-2, at depths shallower than 60 feet Porites spp. comprises the majority of coral cover. The species cover is divided between stands of the delicate finger coral P. compressa and thin, flat plating forms of P. lobata. Both of these growth forms are rather fragile and would not be expected to be found in areas where conclusive force from breaking waves is a regular characteristic of the environment. While the substrata is qualitatively similar to the deeper areas, it appears that the major environmental difference between the Montipora and Porites dominated zones is the degree of light penetration and turbidity.

It was beyond the scope of this report to survey areas closer to shore and shallower than 30 feet. However, this area would be within the range of predictable force from waves of a magnitude sufficient to damage or destroy all but the sturdiest growth forms of reef corals. Within this zone species composition would likely to dominated by encrusting or hemispherical colonies of P. lobata and Pocillopora meandrina. Coral cover in this zone would likely be much lower in the two outer zones and the majority of substrata would be bared carbonate reef rock.

Investigators observed the almost complete lack of macrobenthic species other than corals. Only one individual each of the sea urchins Tripnestes gratilla and Heterocentrotus mammillatus were encountered during the entire field period. No observations of sea cucumbers, sea stars, or other motile macroinvertebrates were recorded. In addition, no macrothalloid benthic algae were observed.

Nekton

Quantitative assessments of reef fish were conducted by divers in conjunction with the benthic survey. Care was taken to minimize disturbance and dispersal of fish populations. However, limited visibility due to high turbidity and the tendency for larger nonterritorial fishes to aggregate and avoid divers contributed to a high variability of results.

Results of the fish surveys are presented in Table III-2 and on Figure III-3.

Fishes noted on more than one occasion at intermediate depths (50 to 60 feet) were the herbivores Scarus sordidus, Ctenochaetus strigosus, Acanthurus mata, A. triostegus, A. olivaceus, Zebrasoma flavescens, Naso lituratus, and Stegastes fasciolatus; the butterfly fishes Chaetodon unimaculatus, C. multicinctus, C. quadrimaculatus, C. trifasciatus, and Forcipiger flavissimus; the angelfish Centropyge potteri; the goatfish Parupaneus multifasciatus; the wrasses Thallosoma duperreyi, T. ballieui, and Gomphosus varius; the snapper Lutjanus kasmira; the filefish Pervagor spilosoma; and the triggerfish Rhinecanthus rectangulus.

At the deeper sites (particularly transects E and F) fewer fishes were noted. The predominant species were Ctenochaetus strigosus, Chaetodon unimaculatus, Chaetodon multicinctus, Thallosoma duperreyi, Parupaneus

TABLE III-2

HILO BAY QUANTITATIVE FISH ASSESSMENT

			Transect Site		
Species	A	B	D	E	F
Mullidae - Goatfishes					
Parupaneus multifasciatus	1	2	3	4	1
Chaetodontidae - Butterflyfishes					
Chaetodon unimaculatus	6	8	6	2	-
Chaetodon quadrimaculatus	-	-	2	-	-
Chaetodon kleinii	-	-	-	1	-
Chaetodon multicintus	2	2	6	-	2
Chaetodon trifasciatus	2	1	-	-	-
Forcipiger flavissimus	1	-	-	-	1
Pomacanthidae - Angelfishes					
Centropyge potteri	-	-	2	-	-
Pomacentridae - Damselfishes					
Stegastes fasciolatus	-	-	2	-	-
Labridae - Wrasses					
Thalassoma duperreyi	4	-	4	7	1
Thalassoma ballieui	-	1	1	1	-
Bodianus bilunulatus	1	-	-	-	-
Labroides phthirophagus	1	-	-	-	-
Scaridae - Parrotfishes					
Scarus sordidus	-	8	-	-	2
Juvenile Scarus	5	6	-	-	-
Acanthuridae - Surgeonfishes					
Ctenochaetus strigosus	22	26	11	7	28
Acanthurus olivaceus	6	-	-	-	-
Zebrasoma flavescens	-	2	-	-	2
Monocanthidae - Filefishes					
Pevagor spilosoma	-	-	3	3	-
Total Number of Individuals	51	56	40	25	37
Total Number of Species	11	9	10	7	7

Source: Steven Dollar, 1985.

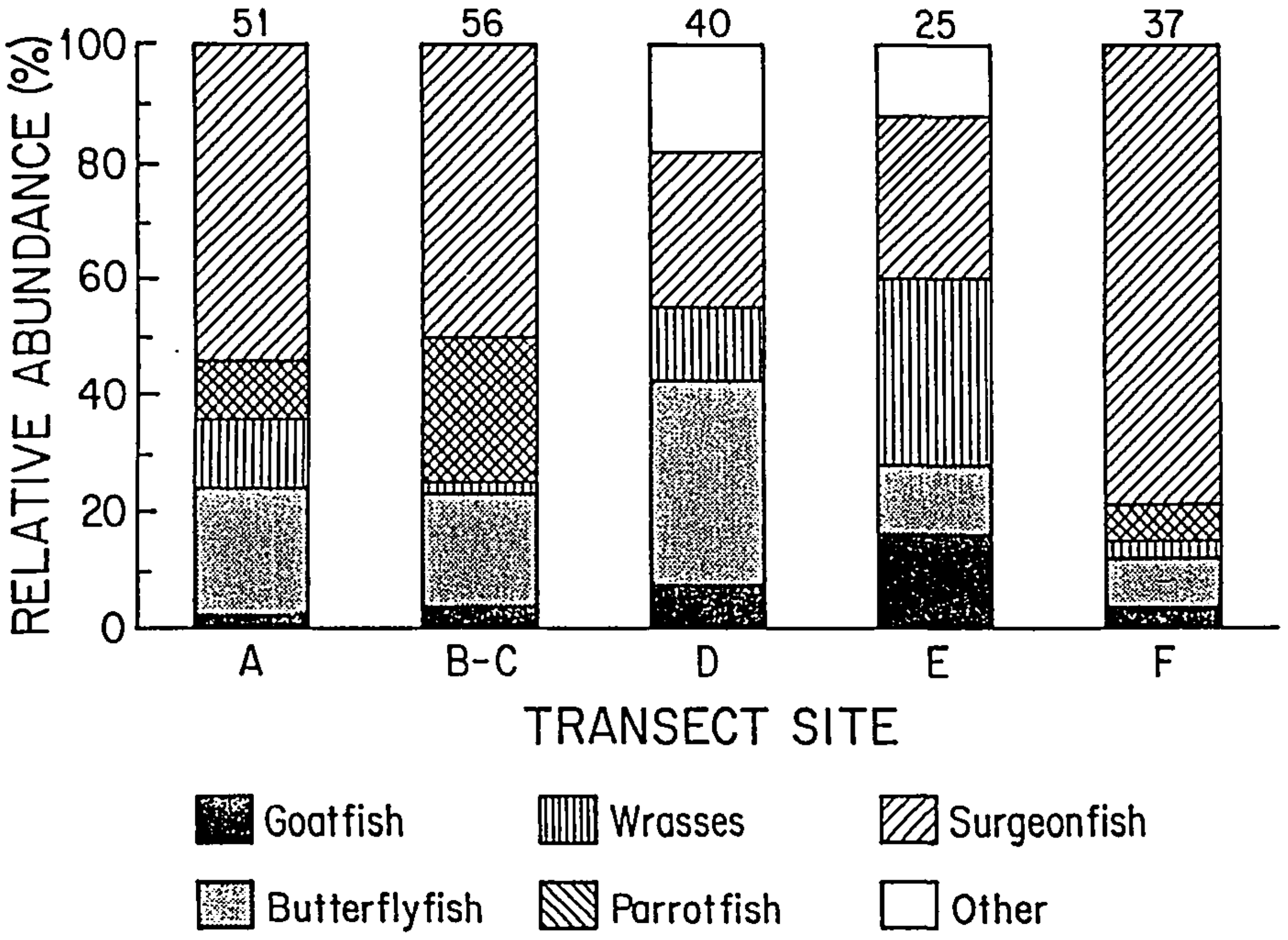


Figure III-3 Bar graph showing abundance and distribution of reef fish on transects in Hilo Bay. Numbers at the top of each transect bar are total number of individuals counted on each transect survey.

Source: Steven Dollar, 1985.

multifasciatus, and Pervagor spilosoma. At the top of the steep slope located at the seaward boundary of the transect area (approximately 85 feet in depth), large groups of the planktivorous damselfish Chromis agilis were observed. At Site E several specimens of the two introduced species of snapper Lutjanus kasmira and grouper Cephalopholis argus were seen in coral near the edge of the slope. A small school of the large parrotfish Scarus perspicillatus and a large kahala Seriola dumerilii were also observed near the slope.

In general, there was a distinct lack of all fish fauna that are generally regarded for commercial or recreational value as "food fish." In the total of approximately ten hours underwater, only six individuals of commercially valuable food fish and one small lobster were observed. The apparent lack of carangids (jacks, ulua), squirrelfish (menpachi, aweoweo), and large goatfish (kumu) is surprising, particularly considering the high coral cover and structural complexity of the reef. Generally, fish abundance and diversity are positively correlated with substratum complexity due to the increased shelter to small individuals created by dense three dimensional coral structures.

The National Marine Fisheries Service (NMFS) has stated that endangered humpback whales inhabit Hilo Bay. A typical population in Hilo Bay at any time is five to six humpbacks. During the mating season (December to May), males "sing" at mid-depth or near the ocean floor. When calving, the humpbacks are near the surface and near shore. Whales begin to congregate off the Big Island during November. The bulk of the population then migrate along the archipelago and are near Kauai from April to May (NMFS et al, 1984).

Green sea turtles are also an endangered species that may be found in the area. However, the NMFS reports that the turtles are distributed throughout the archipelago, with most of the population near the leeward isles (NMFS et al, 1984).

CHAPTER IV
PROBABLE IMPACT AND MITIGATION MEASURES OF THE PROPOSED ACTION

This chapter presents the probable impacts, mitigation measures, and negative effects that cannot be mitigated for Hilo outfall modification and extension that were not mentioned in previous reports (M&E Pacific, Inc., 1980).

PROBABLE IMPACTS

Probable impacts discussed in this section are direct impacts (short-term and long-term) and indirect impacts.

Direct Impacts

Short-term direct impacts are those temporary impacts resulting from and occurring during the construction of the outfall extension. Long-term direct impacts are potentially significant effects that may occur over time as a direct result of the proposed outfall expansion.

Modification and extension of Hilo outfall requires blasting of the ocean floor to excavate a trench for the new pipeline and diffusers. Blasting is expected to have a dramatic effect on the marine environment. Ignition of explosive charges will disturb nekton and damage coral and other benthic organisms in the blast path. A temporary increase in turbidity at the site would also result from blasting. Similarly, increased siltation on coral formations and disturbance of fish habitat would result.

Another major short-term impact of the outfall expansion is stockpiling of the excavated coral and rock resulting from trench construction. Onsite stockpiling near the trench excavation would damage nearby coral communities and increase turbidity. An alternative to stockpiling at the site is transporting the excavated material offsite to a location on shore. This alternative would require expensive equipment and could increase turbidity during transport to shore.

Long-term direct impacts of the outfall modification are expected to have a positive effect on the human and marine environments. Environmental quality would be improved over the existing situation as a result of the following:

1. Improved water quality;
2. Increased diffuser depth would provide better initial dilution of outfall effluent and lessen the potential for sediment accumulation of discharged solids on the sea bed even further;
3. Outfall pipeline would provide a good surface for new coral growth; and
4. Colloidal material in the effluent would attract feeding fish to the area.

Indirect Impacts

Indirect impacts associated with the project are:

1. Less chance of recreational contact with effluent due to increased distance to the new diffuser from shore.
2. Increased population of demersal fish and cryptofauna due to high relief habitat resulting from increased coral growth.

MITIGATION MEASURES

The following mitigation measures would reduce the direct, indirect, or cumulative impacts resulting from the outfall expansion.

Blasting

A safe blast range analysis involving selection of the most conservative parameters for source and target depth would be used. The use of highly directional shape charges would minimize the percent of energy propagated through the water. The National Marine Fisheries Service (NMFS) recommends restricting blasting from December to March to protect humpback whales that migrate to Hilo Bay during the mating season. The NMFS also recommends restricting the explosive weight based on the contractor's needs after examination of substratum analysis. Careful analysis of test blast results would help to prevent unnecessary damage to the benthic community. Finally, adequate warning signals and a pre-blast survey of 2000-yard radius around the blast zone prior to each ignition would alert and disperse boats, people, whales, and green sea turtles from the area.

Stockpiling

Mitigation of adverse impacts would be minimized by use of surge channels *parallel to the proposed outfall for stockpiling.* Stockpiling in the existing rubble-filled surge channels would minimize damage to living coral communities. Stockpiling in surge channels would also eliminate the need for equipment to stockpile on shore and avoid spilling of material during transport to shore. A temporary increase in turbidity within the surge channels during the construction period is expected. Turbidity from stockpiling of material is not anticipated to migrate beyond the immediate environs of the construction area because of the depressed elevation of the surge channels.

NEGATIVE EFFECTS THAT CANNOT BE MITIGATED

Coral damage, disturbance of marine life, and temporary increase in turbidity are impacts that cannot be mitigated. However, the effect of these impacts is not permanent.

With respect to extension of the Hilo sewage outfall, it appears inevitable that reef areas with high percentages of living coral will be traversed. However, it appears that such a situation will not represent any manner of significant detrimental activity. The corridor of the reef cleared for the location of the outfall extension will probably recover in terms of coral cover within several years. Indeed, the outfall structure itself will undoubtedly serve as a settling surface for coral, leading to an eventual increase in cover over the present. This is the case with the existing outfall and diffuser structure, which was observed to be almost totally covered with living coral colonies.

With respect to susceptibility of marine organisms to temporary alterations of water quality characteristics, Hilo Bay communities may be significantly more resilient than communities occurring in waters that are generally free of high levels of particulate material. The most likely alteration to environmental conditions that might be associated with construction activities would be a temporary increase in water column turbidity. However, natural conditions of turbidity in Hilo Bay are presently so severe that the incremental increase due to the construction of the outfall extension would most likely be indistinguishable.

Results of the marine research consultant's survey indicate that the area is suboptimal with respect to reef fish, both in terms of species number and total individuals. In particular, fish of commercial or recreational value are absent or very scarce, either as a result of undesirable habitat or excessive fishing. In either event, the slight temporary environmental alterations that could accompany outfall construction would not appear to cause any changes in fish populations. In a similar manner, the area does not represent any sort of recreational resource for skin or scuba diving due to the unusually low visibility in the water column. Thus, there does not appear to be potential for any type of negative environmental resource-related consequences related to the proposed outfall extension.

CHAPTER V
ALTERNATIVES TO THE PROPOSED ACTION

Two alternatives to the proposed outfall extension are described in this section.

DIFFERENT ALIGNMENT

Altering the proposed outfall alignment would not have a significant effect on the overall marine environment. The marine research consultant has stated in his report that the living coral assemblages are not limited to a small restricted zone. Virtually all of the bottom surveyed during the course of the field work was consistently covered with living colonies according to the distributions described previously. At a minimum, the area of coral cover encompassed several square miles. Therefore, altering the alignment would not decrease the short-term impact of construction on the overall benthic community.

NO ACTION

The no-action alternative would preserve the existing Hilo outfall as is. The advantage to this alternative is the avoidance of short-term direct impacts resulting from construction. Disadvantages to this alternative are less initial effluent dilution and poorer water quality.

CHAPTER VI

CONSULTED PARTIES AND PARTICIPANTS IN THE PREPARATION PROCESS

The following agencies were consulted during the preparation of the Draft Supplemental EIS:

A. County of Hawaii

   1. Planning Department

B. State of Hawaii

   1. Department of Planning and Economic Development

   2. Department of Land and Natural Resources

C. Federal Government

   1. Department of Interior, Fish and Wildlife Service

   2. Department of Commerce, National Marine Fisheries Service

   3. Army Corps of Engineers

CHAPTER VII

COMMENTS AND RESPONSES RECEIVED DURING PREPARATION

The Environmental Impact Statement Preparation Notice for the proposed Hilo Bay Outfall Sewer Extension was published in the OEQC Bulletin on July 23, 1986. The thirty-day review period, announced in the OEQC Bulletin, ended on August 22, 1986. There were no letters received in response to the EIS Preparation Notice. Three agencies responded by telephone and requested to be included in the distribution of the Draft Supplemental EIS. The agencies are:

1. Department of Interior, Fish & Wildlife Service
2. Department of Commerce, National Marine Fisheries Service
3. Department of Planning and Economic Development

In response to the requests from the agencies listed above, preliminary copies of the Draft Supplemental EIS were sent to each party. Each agency was also informed that the Draft Supplemental EIS would be available after August 22, 1986.

REFERENCES

1. Dollar, Steven. 1985. Environmental Assessment of Hilo Bay: Marine Biological Community Structure in the Vicinity of the Proposed Hilo Sewage Outfall Extension.

2. State of Hawaii, Department of Land and Natural Resources. Conservation District Use Permit.

3. M&E Pacific, Inc. 1980. Facilities Plan for the Hilo District, South Hilo, Hawaii.

4. M&E Pacific, Inc. 1980. Revised EIS for the Hilo Wastewater Management Plan of the Hilo District, South Hilo, Hawaii.

5. U.S. Army, Corps of Engineers. 1971. Permits for Work and Structures in, and for Discharges or Deposits into Navigable Waters.

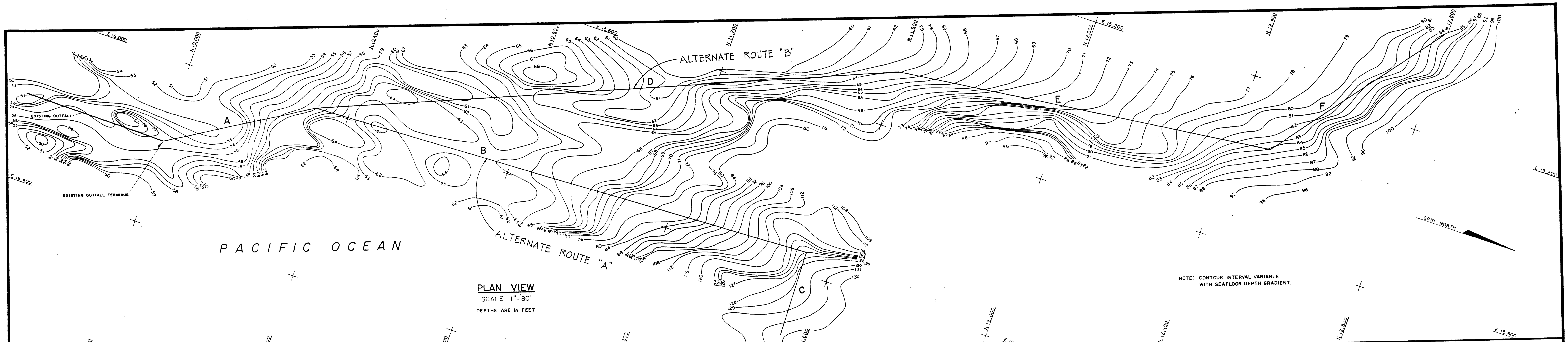
6. U.S. Environmental Protection Agency. 1982. Revised Section 301(h) Technical Support Document.

Other Sources

1. Hawaiian Dredging & Construction Co. and M&E Pacific, Inc. 1984. Letter from Harry H. Isobe of Hawaiian Dredging to Norman Ikei.

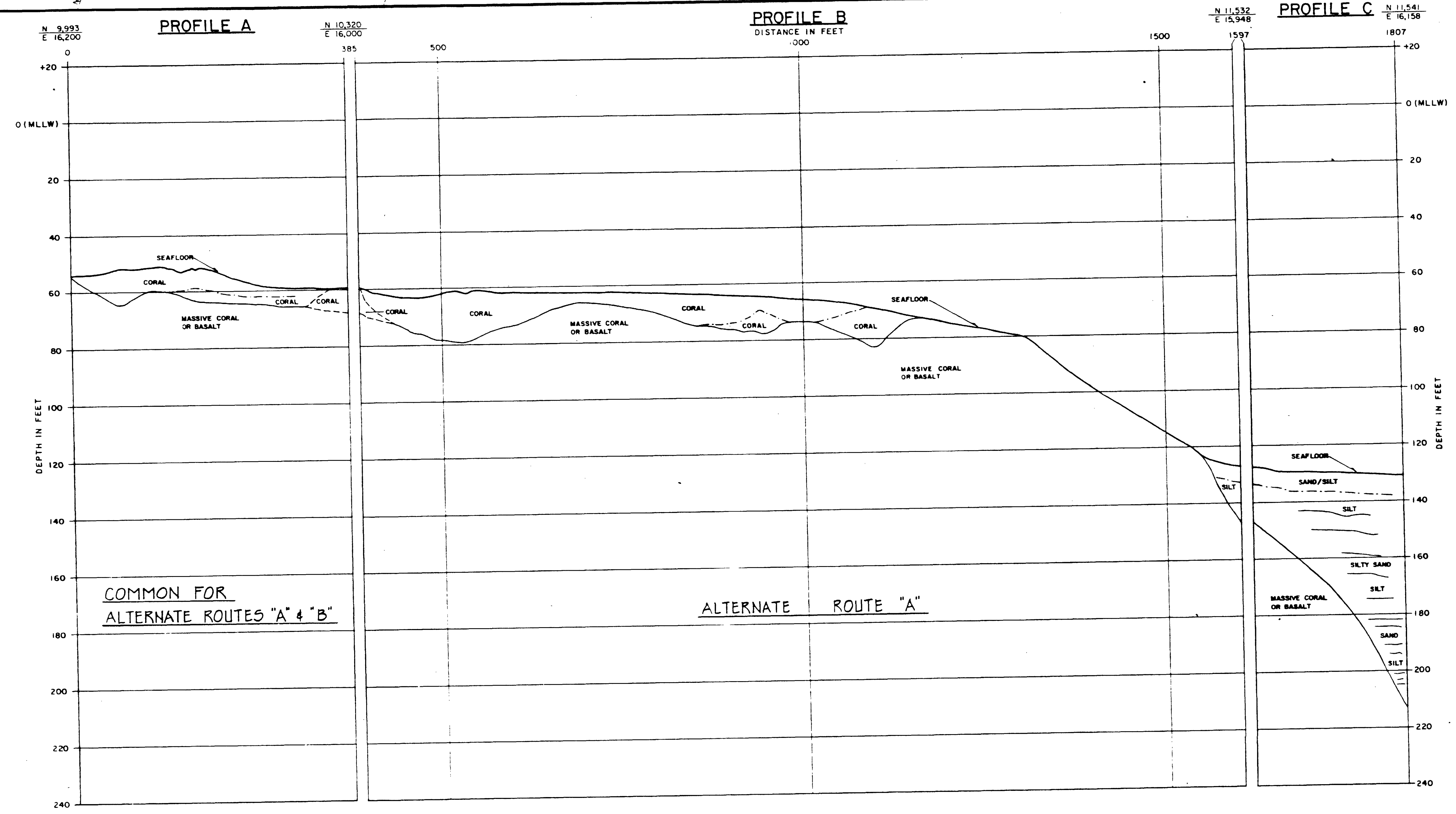
2. National Marine Fisheries Service, Department of Land and Natural Resources, and M&E Pacific, Inc. Meeting on January 11, 1984.

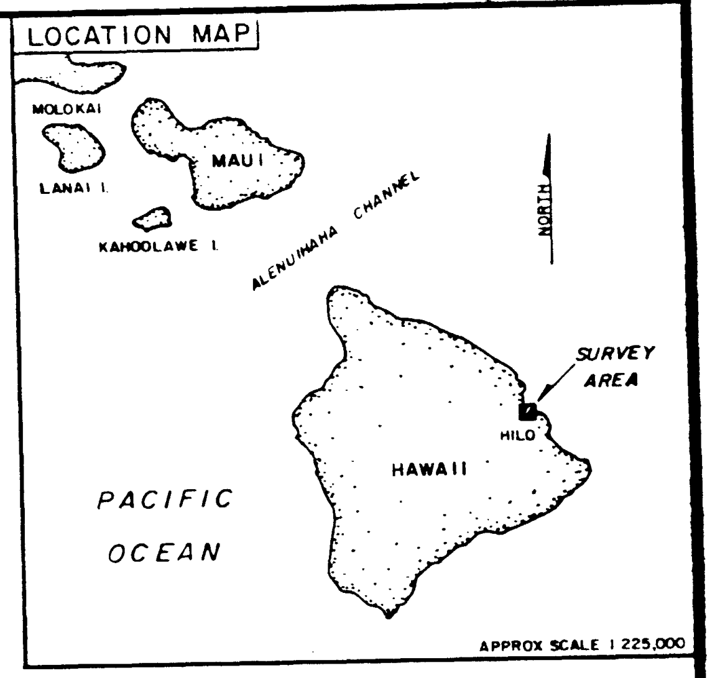
3. National Marine Fisheries Service, Department of Land and Natural Resources, Department of Health, and M&E Pacific, Inc. Meeting on December 17, 1984.

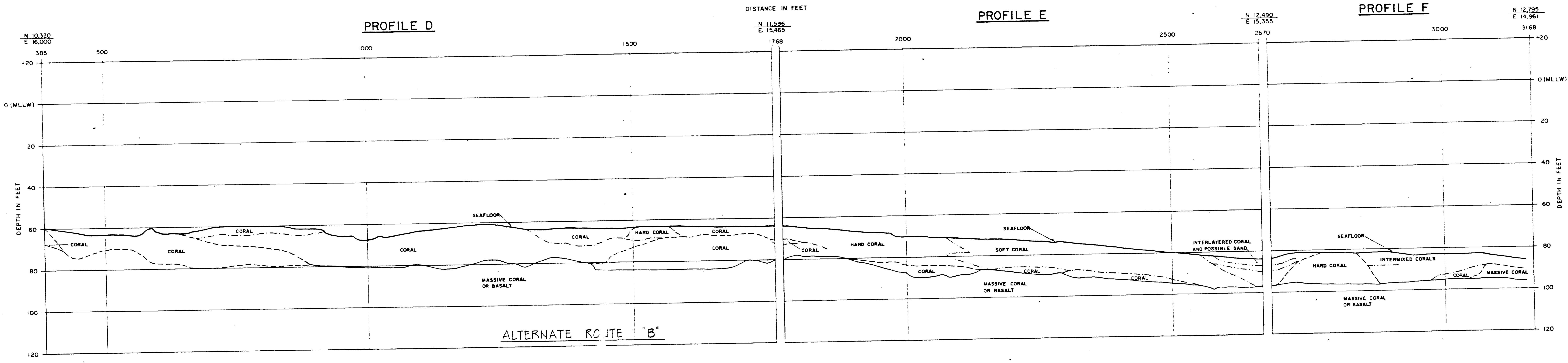


PLAN VIEW
SCALE 1"=80'
DEPTHS ARE IN FEET

NOTE: CONTOUR INTERVAL VARIABLE WITH SEAFLOOR DEPTH GRADIENT.







LEGEND

———	SEAFLOOR
———	INTERFACE BETWEEN CORALLINE REEF MATERIAL AND MASSIVE LIMESTONE OR BASALT.
— — — —	INTERFACE BETWEEN LOWER DENSITY CORAL OR CORAL/CARBONATE SANDS SEQUENCES AND DENSER/MORE MASSIVE CORALS.
—·—·—	INTERFACE BETWEEN LOWER DENSITY CORAL OR BETWEEN CORAL/SAND SEQUENCES.
—··—··—	WEAK INTERFACES BETWEEN LOWER DENSITY CORAL OR CORAL/SAND SEQUENCES.
☰	INTERFACES BETWEEN UNCONSOLIDATED DEPOSITS, E.G., SAND/SILT OR SILT/SILT ALONG PRIMARY (ABC) ALIGNMENT - ZONE 1550 TO 1807.

NOTES

1. PROJECT GRID BASED UPON TRIANGULATION POINT "HALIA" - DISTANCES ARE IN FEET FROM THE TERMINUS OF THE EXISTING OUTFALL.
2. VERTICAL DATUM IS MEAN LOWER LOW WATER (MLLW).
3. SEA FLOOR CONTOURS IN UPPER PANEL ARE AFTER METCALF AND EDDY HAWAII SOUNDING SURVEY CHART FOR THE PROPOSED HILO OCEAN OUTFALL EXTENSION (1983) - UNNUMBERED.
4. THE INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY CONDUCTED BY OCEAN SURVEYS, INC. ON MARCH 1-3 1984.
5. INTERPRETATION OF SEAFLOOR COMPOSITION AND SUB SURFACE GEOLOGY IS BASED UPON DATA FROM DIVER INVESTIGATIONS AND UPON THE MORPHOLOGY AND CHARACTER OF THE SEISMIC REFLECTION DATA DISPLAYED ON THE SUBBOTTOM PROFILER RECORDS. NO PHYSICAL SAMPLING DATA FOR INPUT TO OR CONFIRMATION OF THE SEISMIC INTERPRETATION WAS AVAILABLE.
6. COMPUTATION OF SUBBOTTOM THICKNESSES/DEPTH TO REFLECTORS IS BASED ON A VELOCITY VALUE OF 4800 FT/SEC. (SEE DISCUSSION IN ACCOMPANYING PROJECT REPORT).

20 0 20 40 60
VERTICAL SCALE IN FEET
SCALE 1"=20'

80 0 80 160 240
HORIZONTAL SCALE IN FEET
SCALE 1"=80'

· CHECK GRAPHIC SCALES BEFORE USING

OCEAN SURVEYS, INC. OSI
OLD SAYBROOK. CONNECTICUT

PREPARED FOR WALTER LUM ASSOCIATES, INC.

PLAN AND PROFILE
HILO OUTFALL PROJECT
HILO, HAWAII

PROJ. MGR D.L. BELL	SURVEY DATE 1-3 MAR 1984	SCALE VERT. 1"=20' HORIZ 1"=80'
DRAFTED BY V KASK	DATE 4 APRIL 1984	DWG NO 84019-A

87-001