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'94 SEP 13

September 12, 1994

Mr. Brian J. J. Choy, Director
Office of Environmental Quality Control
220 South King Street
Central Pacific Plaza, Suite 400
Honolulu, Hawaii 96813

Dear Mr. Choy:

SUBJECT: FRONT STREET IMPROVEMENT PROJECT, LAHAINA, MAUI, HAWAII; FINAL ENVIRONMENTAL ASSESSMENT

The Maui County Department of Public Works and Waste Management has determined that the proposed Front Street Improvement Project will not have significant environmental effects and has issued a negative declaration. No comments were received during the 30-day public comment period which began on July 23, 1994. Please publish this notice in the September 23, 1994 OEQC Bulletin.

Transmitted herewith are four (4) copies of the Final Environmental Assessment prepared for the Front Street Improvement Project and a completed OEQC Bulletin Publication form.

We thank you for your assistance in handling this matter. Please contact Mr. Rory Frampton of Chris Hart & Partners at 242-1955 if you have any questions.

Sincerely,

GEORGE N. KAYA
Director of Public Works
and Waste Management

cc: Ann Cua, Maui Planning Department
Chris Hart

1994-09-23-MA-FEA-Front Street Improvement

Final Environmental Assessment

Front Street Improvement Project
Lahaina, Maui, Hawaii

Department of Public Works and
Waste Management

County of Maui

CHRIS HART & PARTNERS

September, 1994

Final Environmental Assessment

Front Street Improvement Project
Lahaina, Maui, Hawaii

Department of Public Works and
Waste Management

County of Maui

CHRIS HART & PARTNERS

Prepared for:

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September, 1994

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I. PROJECT OVERVIEW

A. PROJECT AREA

1. Description of the Improvement Area

The Lahaina Front Street improvement area includes the portion of Front Street situated between Baker Street on the north and Shaw Street on the south, a linear distance of 4,800 feet or approximately nine-tenths of a mile. See Figures 1 through 3. The northern and southern portions of this area act as transition zones between the residential communities on either side and the urban core of Lahaina Town.

The section of Front Street between Papalaua Street and Dickenson Street comprises the primary commercial district of Lahaina. This area is characterized by it's historic style of architecture. Lahaina's 700 foot long seawall is found in this portion of the improvement area.

Between Dickenson Street and Canal Street can be found the historic center of Lahaina Town. There is commercial development on the mauka side of the Street. The Lahaina Library, the Pioneer Inn and the Banyan Tree park are located makai of Front Street in this area. Banyan Tree park includes the historic Courthouse and remnants of the waterfront Fort.

The southernmost portion of Front Street improvement area, between Canal St. and Shaw St., contains an assortment of contemporary land uses, including Kamehameha III elementary school, a church, public park, shopping area, hotel and residential lots along the makai side. On the mauka side of Front St. land uses include a gas station, restaurant, public parking, and the Malu'ulu o Lele Park.[1]

2. General Front Street Information

Front Street is the heart of the Lahaina Town Core, the regional center of the Lahaina coast. Lahaina Town contains regional commercial services, major civic facilities and spaces, and residential neighborhoods. The

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[1] County of Maui, Planning Department. Design Study for Front Street Improvement Plan: Lahaina Historic District–Past and Present (Document C). Prepared by Belt Collins & Associates et. al. December 1992

town's significant features – it's historic character, compact small-town scale, and it's vitality – are embodied in the Front Street environs. These are qualities the community wishes to emphasize and enhance.[2]

Lahaina's rich history is preserved in the character of the town, and lends a sense of place to Lahaina which is unique in the islands. As noted in the Design Study for Front Street Improvement Plan, "Lahaina's uniqueness lies not so much in its interesting history, as it does in the fact that history has been preserved. Lahaina is today a blend of cultural themes and economic influences that have each left a physical remnant of their presence, and it is that mosaic of remnants that gives Lahaina its unique character." The overall character of Lahaina as a human-scale pedestrian orientated town with one and two-story turn-of the-century buildings remains intact.[3] It is this character which draws visitors to Lahaina, making it a busy commercial and retail center.

Lahaina's historic status is recognized locally and nationally. Lahaina Town is registered in the National and State Registers of Historic Places and is designated by the County as Maui County Historic Districts No. 1 and 2. Further regulatory protection is offered by Lahaina Town's location in the Special Management Area.

B. PROJECT NEED

Lahaina's popularity as a visitor destination points to the need for both infrastructure and street design improvements. Aging and inadequate infrastructure is in need of improvement. Inadequate drainage structures result in periodic flooding within Lahaina. The water system needs to be upgraded to meet projected demand. Overhead telephone and electrical lines are unsightly and impede pedestrian flow, and street lighting is generally inadequate.

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[2]County of Maui,. Lahaina Community Plan. December 1983.
[3]County of Maui, Planning Department. Design Study for Front Street Improvement Plan: Lahaina Historic District-Past and Present (Document C). Prepared by Belt Collins & Associates et. al. December 1992

Existing roadway and sidewalk design presently results in pedestrian and vehicular congestion. Narrow sidewalks lead to crowding and pedestrian spill over onto roadways. Sidewalks are not wheelchair accessible, resulting in difficult or impossible mobility for the physically challenged and those with strollers. Inadequate roadway design and insufficient parking often results in traffic moving at a crawl.

A number of studies have been conducted in recent years to identify needed improvements in design and infrastructure and how to accomplish these while preserving the character of Lahaina. The most recent of these studies, which largely provide the guidelines and data for the proposed improvements, are. the **Lahaina Town Development Plan** (1987 and 1988)[4]; and the **Design Study for Front Street Improvement Plan** (1992).[5]

1. Infrastructure Needs

a. Water

Capacity of the water system is dictated by the maximum daily demand plus fire flow requirements. Based on flow calculations and pipeline analyses conducted for the county of Maui,[6] the existing water networks will have to be upgraded to meet increasing water needs brought about by the development of land uses established by the Lahaina Community Plan.

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[4] County of Maui, Office of the Mayor, Lahaina Town Development Plan: Phase I Infrastructure Study. Prepared by R.T. Tanaka Engineers, Inc., 1987
County of Maui, Office of the Mayor. Lahaina Town Development Plan: Infrastructure Master Plan (Phase II), 1988.
[5] County of Maui, Planning Department. Design Study for Front Street Improvement Plan: Design Guidelines for Front Street Improvements (Document A). December 1992.
County of Maui, Planning Department. Design Study for Front Street Improvement Plan: Front Street Building inventory (Document B), December 1992.
County of Maui, Planning Department. Design Study for Front Street Improvement Plan: Lahaina Historic District: Past and Present (Document C). December 1992.
[6] County of Maui, Office of the Mayor. Lahaina Town Development Plan: Infrastructure Master Plan (Phase II), 1988.

b. Drainage System

According to the Lahaina Town Development Plan Infrastructure Study[7], scattered drainage systems exist within the immediate areas of Lahaina Town. Some of these systems were built in connection with recent developments. Others, however, are over 40 years old, undersized, and in a state of disrepair. Essentially, an internal drainage system within Lahaina Town is almost non-existent. Localized flooding occurs along Front Street during periods of heavy rainfall, especially in those areas where there are no curbs or gutters and where sidewalks are at grade with the street pavement. Significant flooding has occurred in the area of Wainee and Prison Streets where houses have been inundated by food waters up to three feet deep. To mitigate any major flooding, the development of an internal drainage system for providing adequate storm drainage facilities needs to be undertaken.

c. Electrical and Telephone

The basic electrical and telephone lines are all overhead and situated within the roadway system. Some minor telephone and electrical services serving newly developed properties are located underground. Most of the power poles tend to obstruct motorist sight distance and pedestrian flow along the sidewalks. Street lighting is generally inadequate along Front Street within the project area. [8]

d. Sewer

The entire Front Street area is serviced by sewer lines, with all sewage pumped to the waste water treatment plant in Honokowai. The system is generally adequate, but is 40 -50 years old and may be burdened by major developments. The sewer laterals which serve individual buildings are in poor condition and in need of replacement.

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[7]County of Maui, Office of the Mayor, Lahaina Town Development Plan: Phase I Infrastructure Study. Prepared by R.T. Tanaka Engineers, Inc., 1987
[8]County of Maui, Planning Department. Design Study for Front Street Improvement Plan: Design Guidelines for Front Street Improvements (Document A). December 1992.

These laterals and connections are believed to contribute to intrusion and infiltration problems.

2. Roadway Conditions

Lahaina draws large numbers of visitors, resulting in both pedestrian and vehicular congestion. As identified in the Design Study for Front Street Improvement Plan:[9]

> The existing design of Lahaina's roadway network contributes to periodic traffic congestion. Identified problems include narrow streets, lack of sidewalks or shoulder areas for pedestrians, poor sight distances at intersections, on-street parking, and lack of off-street parking. As a result of these conditions, vehicles must sometimes slow to pedestrian walking speed, creep into intersections in order to merge into traffic, impede traffic flow by maneuvering to parallel park, or repeatedly circle the area looking for parking. The sum effect of these conditions is frequent vehicular congestion caused by a single vehicle rather than an excessive volume of traffic.

3. Pedestrian Circulation

Narrow sidewalks create congestion between oncoming pedestrian. The crowding of people on the walkway in close proximity to the shops is part of the experience of Lahaina and lends to it's ambiance. There are, however, a number of barriers and obstacles to pedestrian flow. These include obstructions of walkways by telephone poles, traffic signs, bollards, fire hydrants and other street furniture. Low overhanging planters, utility covers, and the use of inappropriate pavement types also impedes pedestrian circulation. Pedestrian safety is compromised by broken and uneven pavement, lack of adequate tree grates of street trees, uneven transition between public and private walkways, and no sidewalk at the seawall between Baker and Papalaua Streets.

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[9]County of Maui, Planning Department. Design Study for Front Street Improvement Plan: Lahaina Historic District–Past and Present (Document C). Prepared by Belt Collins & Associates et. al. December 1992

C. PROPOSED IMPROVEMENTS

1. Infrastructure Improvements

a. Water

Proposed improvements to the water system consist of installing a 12 inch waterline in Front Street between Baker Street and Lahainaluna Road. This 12 inch waterline will connect with the existing 12 inch waterline between Lahainaluna Road and Shaw Street. The existing 8 inch waterline between Baker Street and Lahainaluna Road will be abandoned after the 12 inch line becomes operational. All existing water services (laterals, etc.) will be reconnected to the 12 inch waterline.

b. Drainage System

Proposed improvements to the drainage system include the installation of new drain lines, drainage outlets, culverts, concrete drop inlets, and gutters. Drainage system facilities were determined on the basis of full development of land uses as defined in the Lahaina Community Plan, adopted in December, 1983. One new drainage outlet to the ocean, Drainline "B", is proposed to be located opposite Lahaina Center. Drainline "B" will only consist of a inlet and outfall to collect stormwater in the immediate vicinity and will have a design flow of 1 cubic feet per second (CFS). Three other existing ocean outlets will be replaced and enlarged. These are designated as Drainlines "C," "D" and "F." The most significant of these increases is the expansion of Drainline "F". The locations of the proposed outlets are shown in Figure 4, design plans are shown in Figures 12 and 13.

Drainlines "C" and "D" have design flow capacities of 52 and 103 CFS, respectively. These drainlines collect flows primarily from Front Street, as well as Papalaua Street and Lahainaluna Road.

The proposed improvements to Drainline "F" consist of removing all existing structures and the installation of two 4 x 8 feet box culverts, opening to a 14 feet wide concrete channel. The drainage will exit over a rough boulder concrete apron designed to spread and retard the flow as it meets the shore. The design flow capacity is 632 CFS (100-year storm.) In addition to runoff from the immediate vicinity, Drainline "F" will convey runoff from those areas mauka of Honoapiilani Highway which are south of Lahainaluna Road and makai of the proposed Soil Conservation Service's (SCS's) diversion channel to Kauaula Stream.

c. Electrical and Telephone

Proposed improvements to the electrical and telephone system include relocating most of the utilities underground. Primary electrical service will remain overhead, while all secondary electrical services, telephone and cable services will be relocated underground. Additional street lighting will also be installed.

d. Sewer

All existing sewer laterals within the project area will be replaced with PVC sewer laterals. Sewer laterals will be provided with reinforced concrete jackets if they are within 18 inches of the existing or new waterline and drainline.

2. Roadway Improvements

The Front Street asphalt pavement will be reconstructed and resurfaced. Curbs and gutters will be installed as needed, smooth transitions to existing roadways and driveways will be provided. While the total number of parallel parking stalls will be decreased, loading zone areas will be increased. The revised parking plan was formulated with active involvement of the Front Street merchants during the development of the "Design Guidelines for Front Street Improvements." The roadway will be restriped, and additional directional and informational signs will be provided.

3. Improvements to the Pedestrian Environment

Improvements to the pedestrian environment include the installation of wheelchair ramps, new sidewalk construction, and widening existing sidewalks. See Figures 5 thorugh 9 for the proposed location of these improvements and Figures 10 and 11 for typical details. Some of the widened sidewalk areas will be landscaped and provided with benches. Trash and recycling receptacles will be placed at appropriate intervals. New crosswalks will be installed and existing sidewalks repainted or relocated. Some of the obstacles and barriers to pedestrian circulation will be removed, including the bollards along the seawall between Lahainaluna and Dickenson Roads. Pavement surfaces will be made contiguous and even, and street lighting will be improved.

II. DESCRIPTION OF THE EXISTING ENVIRONMENT

A. PHYSICAL SETTING

1. Land Use Characteristics

Because the proposed improvements traverse the entire length of the Lahaina Urban core, the existing land uses are highly varied. Commercial retail is the predominant land use within the improvement area. The predominant commercial uses include eating and drinking establishments, art galleries, and visitor oriented retail shops. Public uses include the Kamehameha III Elementary School the Banyan Tree Park and the Brick Palace Park. See Figure 3.

Both the north end (Baker Street to Papalaua Street) and the south end (Canal Street to Shaw Street) of the proposed improvement area are residential transition areas. In the northern transition subzone are found residences, the Lahaina Methodist Church, and Lahaina Center. Along Front Street between Canal and Shaw Streets on the south end of the improvement area can be found Kamehameha III Elementary School, residences, Malu'ulu o Lele Park, Holy Innocents Episcopal Church, and 505 Front Street.

The central portion of the proposed improvement area is dominated by commercial uses between Papalaua Street and Dickenson Street. Lahaina Shopping Center and Lahaina Marketplace are located in this section as are a number of small retail shops, art galleries, and restaurants. The seawall along Front Street defines the makai border of Front Street between Lahainaluna Road and Dickenson Street. The land uses along Front Street between Dickenson Street and Canal Street are public, historical, hotel and commercial. Commercial uses include The Wharf shopping center, the Banyan Inn Market Place and Burger King restaurant, all along the mauka side. Also on the mauka side is the historic Baldwin House. The Pioneer Inn Hotel is located on the makai side as is the Lahaina State Library. The two parks located in this subzone are Banyan Park and Campbell Park.

2. Climate

The climate in the Lahaina region is influenced by the persistent north-north easterly trade winds. Lahaina Town is located in the dry leeward portion of West Maui. Average annual temperature in Lahaina Town is about 75°F. Average monthly temperatures vary by about nine degrees between the coolest and warmest months. Rainfall at the project site averages approximately 15 inches per year.

3. Topography and Soil Characteristics

The topography in the Lahaina vicinity is generally flat near the coastline and rises gently to Honoapiilani Highway and the foothills of the West Maui mountains behind the town. The slope rises steeply beyond to the peaks of the West Maui Mountains.

The soil type in the project area is Pulehu silt loam 0 to 3 percent slopes (PpA) of the Pulehu series. This series consists of well drained soils on alluvial fans and stream terraces and in basins. They developed in alluvium washed from basic igneous rock. The Pulehu series are part of the Pulehu-Ewa-Jaucas association, which are deep, nearly level to moderately sloping, well-drained and excessively drained soils.[10]

At present, the coastline south of Lahaina Harbor, in the vicinity of Drainline "F", is severely eroded. Review of historical aerial photographs show that the beach is normally 30 to 50 feet in width, and that beach erosion has occurred in the past. Local beach users indicated that this eroded state has been in effect since the passage of Hurricane Iniki in 1992. From observations at the site of wave reflection and severe water agitation in front of the seawalls, it is tempting to blame them for the eroded state of the beach. However, the seawalls can be seen in photographs as far back as 1954, and while they probably slow the beach building process, it is apparent that there are beach erosion and accretion cycles that are independent of their presence. (See Appendix A) Also, based on the aerial photographs, the presence of the outlet structures (wing walls) of Drainline "F" on the beach has had minimal impact, contributing neither to beach erosion nor accretion. This is likely due to the overwelming influence of the Lahaina Harbor jetty to the north.

4. Terrestrial Flora and Fauna

The proposed improvement area falls within the Kiawe and lowland shrub vegetation zone. Characteristic plants of this zone include kiawe, koa haole, finger grass and pili grass.[11] The Lahaina area has been extensively landscaped with plants commonly used for landscaping, including, coconut palm trees, plumeria, Bermuda grass, and hibiscus. There are also a number of large specimen trees in the area which provide shade and ambiance. These include banyan and monkeypod trees. All of these trees are introduced species.

The improvement area is situated within a primarily commercial area. Terrestrial fauna on the site is reflective of this setting. Avifauna likely found in the area includes the common myna, several species of dove,

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[10] U.S. Department of Agriculture, Soil Conservation Service in cooperation with the University of Hawaii Agricultural Experiment Station. Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii, 1972.

[11] Armstrong, R. Warwick, (ed.) Atlas of Hawaii, University of Hawaii Press, 1991.

cardinal, house finch and house sparrow. Mammals common to the area include cats, dogs, rodents, and mongoose.

No known endangered species of plants or animals are in the project area.

5. Marine Environment

A coastal and marine environmental investigation was conducted for the project by Sea Engineering and AECOS (see Appendix A). The report included an evaluation of the general oceanographic conditions in the vicinity of Drainline "F".

The project site is protected from waves and wind from the northwest through northeast, however, it is exposed to southern winds and waves from Kona storms, hurricanes, and southern swell. Regional coastal currents are predominately driven by the tides. The currents parallel the coast and reverse with ebb and flood conditions. Currents tend to be northerly with ebb tides and southerly with flood tides, although current reversals do no always occur, and the northerly flow appears to be dominant.

Drogue studies at the project site indicated northerly currents during both ebb and flood conditions for the shallow nearshore zone within the fringing offshore reef. Current directions at the site are hypothesized to be heavily influenced by the local bathymetry and wave conditions. The bathymetry for the site shows a pass in the fringing reef off Drainline "F" where the circulation tends to flow.

Water quality measurements made in June 1994 from nearshore and offshore waters between Mala Wharf and Puamana show that for most parameters, conditions during the summer (dry) season are fairly typical of dry open coastal waters around the Hawaiian Islands, with minimal influences from land drainage on the nearshore waters. Comparisons with samples collected just south of Lahaina in 1976, in 1982-83, in 1988, and recently off Kaanapali suggest that baseline water quality in this area has not changed substantially in over 15 years.

The marine environment off Drainline "F" is a shallow reef flat extending seaward to a shoaling reef margin about 500 feet off Lahaina Beach. Much of the reef flat is under 1 meter deep, has a bottom type of mixed sand and rubble , and supports mostly a moderately dense growth of algae dominated by *Lyngbya* and *Acanthophora*. Fishes are sparse because of lack of suitable cover. The seaward margin of the reef is a shoaling mound of coral rubble deposited by waves.

Just landward of the rubble mound is an area of large coral heads, mostly *Porites lobata*. Coral cover is high, exceeding 80% in localized areas. This environment, designated in Appendix A as Biotope "C" or the coral moat biotope, supports a diverse and abundant fish fauna and provides a unique snorkeling opportunity that is under utilized by visitors.

Seaward of the reef margin is a reef front which slopes gently into deeper water. This slope is limestone cut by grooves and supporting a coral community of increasing cover from minimal occurrence of corals along the shallow margin to 90% cover beyond about 200 feet seaward.

6. Archaeological/Historic Resources

Front Street is an integral component of the historical character of Lahaina Town. Many of the buildings along Front Street are considered historically significant, and Lahaina's historic status is recognized locally and nationally. Lahaina Town is registered in the National and State Registers of Historic Places and is designated by the County as Maui County Historic Districts No. 1 and 2.

Lahaina was a significant place in the Hawaiian Kingdom, serving as its capital during the first half of the nineteenth century. The Palace Complex Site of Kamehameha III was located in the southern portion of the project area makai of the present Malu'ulu o Lele Park. The current site of Kamehameha III School was the site of royal residences, including that of Nahienaena. The archaeological study listed in this report as Appendix B, presents a more detailed description of the history of project area. While most of the surface remains associated with these and other important sites near the existing Kamehameha III School have been destroyed, there exists the possibility of subsurface remains in areas which have been previously undisturbed.[12]

7. Air Quality

Air quality in the Lahaina area is considered good. Both point sources and non-point sources of emissions in the area are not high enough to generate high concentrations of pollutants. In addition to relatively low emissions, persistent exposure to the north easterly trade winds serves to disperse emissions.

8. Noise Characteristics

Surrounding noise levels in the vicinity of the project site are considered relatively low. Background noise levels are attributed to natural (e.g. wind) conditions, and traffic along Front Street. Some noise is also associated with night time entertainment along Front Street.

9. Visual Resources

As noted previously, Lahaina's rich history is preserved in the character of the town. It's many historic buildings and streetscapes are important visual resources. The visual experiences provided from Front Street include makai views of the ocean, mauka views of the Pioneer Mill smokestack and West Maui Mountains, and views of landscaped open space areas. The seawalls along Front Street visually emphasize Lahaina's relationship with the sea.[13]

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[12] Klieger, Paul, phd. Moku'ula: The Last Resort (preliminary report). Prepared by Bishop Museum for the Lahaina Restoration Foundation. March, 1993.
[13] County of Maui, Planning Department. Design Study for Front Street Improvement Plan: Lahaina Historic District–Past and Present (Document C). Prepared by Belt Collins & Associates et. al. December 1992

B. SOCIO-ECONOMIC ENVIRONMENT

1. Population

The population of the County of Maui has exhibited relatively strong growth over the past decade with a 1990 population of 100,374, a 41.7% increase over the 1980 population of 70,847. The population of Maui Island has exhibited even stronger growth with a 1990 population of 91,361, a 45.4% increase over the 1980 population of 62,823. The 1990 population of Lahaina District was 14,574, a 41.7 increase over Lahaina Districts 1980 population of 10,284.[14]

2. Economy

The Lahaina economy is based primarily upon the visitor industry. Visitor accommodations are located near the shoreline along with necessary support facilities and residential communities. Kapalua and Kaanapali have developed into important visitor destination anchors while the old Lahaina Town with its historic character and charm has developed into the region's visitor, service, commercial and residential center. Agriculture is also an important part of Lahaina's economy. Sugar cane and pineapple fields are found in the Lahaina district, and the historic Pioneer Mill on Lahainaluna Road continues to process cane.

C. PUBLIC SERVICES

1. Police and Fire Protection

The Lahaina District Station of the Maui County Police Department has provided police protection for the Lahaina District since 1974. The station, located behind the Lahaina Civic Center in Wahikuli, employs 48 officers. Police protection in the Front Street improvement area is supplemented by the Front Street "Koban" (substation) which is the base for Lahaina's three police bicycle patrol officers.[15]

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[14] State of Hawaii, Department of Business Economic Development and Tourism (DBEDT). State of Hawaii Data Book 1992: A Statistical Abstract. March 1993

[15] Personal Communication with Officer Tengan of the Maui County Police Department, Lahaina District. July 5, 1994.

Fire protection in the Lahaina District is provided by the Maui County Fire Department's Lahaina Station. The Lahaina Fire Station, built in 1972, is staffed by 30 firefighters. There are three shifts with ten men on each shift. The station has two fire trucks.[16]

2. Solid Wastes

Only two landfills are currently operating on Maui, the Central Maui Landfill in Puunene, and the Hana landfill. Single family residential solid waste collection is provided by the County and taken to the Central Maui Landfill, which also accepts waste from private refuse collection companies. A convenience station is located in Olowalu to service West Maui residents. Solid wastes are transported from this convenience station to the Central Maui Landfill. Solid waste collection for commercial establishments is provided by private companies.

3. Schools

The Lahaina District is serviced by both private and public schools which provide education for preschool through high school age children. Public schools in the Lahaina District include the King Kamehameha III Elementary School for children from kindergarten through fifth grade, which lies in the Front Street Improvement area, the Lahaina Intermediate School for grades six through eight, and Lahainaluna High School for grades nine through twelve. Private schools in the Lahaina District include Sacred Hearts School for grades kindergarten through twelve and several preschools.

4. Recreational Resources

Lahaina has a wide reputation as a recreational destination, particularly for ocean related activities. Ocean sports and recreation available in the Lahaina District include swimming, fishing, surfing, scuba diving, snorkeling, sailing, and para-sailing. State and County beach parks in the Lahaina District include the Honolua-Mokuleia Marine Life Conservation

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[16]Personal Communication with Mr. Kobo of the Maui County Fire Department, Lahaina Station. July 5, 1994.

District, the D.T Fleming Park, Honokowai Beach Park, Wahikuli State Wayside, Malu'ulu o Lele Park (located in the Front Street improvement area), Puamana Beach Park, Launiupoko St. Wayside, Ukumehama Beach Park, and Papalaua State Wayside.

The beach and offshore area to the south of Lahaina Harbor, in the vicinity of Drainline "F", is used for recreational activities, predominately for beginner level surfing, ocean kayaking and snorkeling.

D. INFRASTRUCTURE

1. Roadways

As in the rest of Maui, the automobile is the primary source of transportation in Lahaina. An extensive roadway system exists in the Lahaina area. Right-of-way widths vary with each roadway. Some roads are paved with curbing and sidewalks while others are comprised of asphaltic concrete pavement with limited curbing.

The average right-of-way width along Front Street is 35 feet, with pavement width varying from 28 feet to 30 feet. The majority of Front Street has curb and gutter and sidewalk, however, the condition of these facilities vary greatly. In some cases curbs and gutters are non-existent and sidewalks are at grade with the existing street. There is no curb, gutter or sidewalk on the makai side of Front Street between Baker Street and Papalaua Street.

2. Sewer

The entire Front Street improvement area is serviced by sewer lines. Sewage from the area is transported to the pump station at Mala Wharf and pumped to the wastewater treatment plant at Honokowai. The existing system consists of 8", 10", 12", and 18" lines from Shaw to Baker Streets, a pump station at Malu'ulu o Lele Park and a 12" force main from the pump station to midblock between Dickenson Street and Lahainaluna

Road. The lines which enter onto Front Street from the intersecting roads are 8" lines.[17]

3. Water

The Lahaina Town's water sources are Kanaha Stream and a water well near Lahainaluna School. This system is also reinforced by the Alaeloa Source with a 16" transmission line along Lower Honoapiilani Road and Honoapiilani to Lahaina Town. The existing water system is basically located within the road right of ways, and consists of a network of waterlines ranging from 4" to 12"[18].

4. Drainage

Lahaina Town is located within three major drainage basins. Fortunately, the potential for major flooding of low areas has been lessened due to interceptor ditches constructed by Pioneer Mill Company within the sugar cane fields mauka of the town. These ditches divert runoff and thereby reduce flooding in Lahaina Town. Rainfall within Lahaina Town does cause flooding within low lying areas and streets. Major flooding could occur due to a long duration storm.

The majority of drainage systems within Lahaina Town were implemented due to various recent developments within the area. These include the Baker Street drainage (36" pipe), the Papalaua Street drainage (24" and 30" pipes), Dickenson Street drainage (24" and 30" pipes), Prison Street drainage (24" pipe), and Malu'ulu o Lele Park drainage (a system of open channels and pipelines). There are also a number of older systems built over 40 years ago. [19]

The existing drainage systems discharge into the ocean. In the project area there are approximately fifteen (15) outlets to the ocean.

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[17]County of Maui, Planning Department. Design Study for Front Street Improvement Plan: Lahaina Historic District-Past and Present (Document C). Prepared by Belt Collins & Associates et. al. December 1992
[18]County of Maui, Office of the Mayor, Lahaina Town Development Plan: Phase I Infrastructure Study. Prepared by R.T. Tanaka Engineers, Inc., 1987
[19]County of Maui, Office of the Mayor, Lahaina Town Development Plan: Phase I Infrastructure Study. Prepared by R.T. Tanaka Engineers, Inc., 1987

The Drainline "F" outlet is located about 200 feet southwest of the Lahaina Harbor breakwater. The existing drainage ditch and culverts are located south and adjacent to Kamehameha School. At present the drainage ditch is partially filled with sediment, and the outlet is in a state of disrepair. Properties on both sides of the drainline are protected at the shoreline by vertical seawalls. The outlet of the drainline consists of a concrete apron with wing-walls, extending approximately 15 feet from the seawalls onto the beach. The northern wall is built on top of a partially destroyed sewer line that extends past the wall and into the ocean.

5. Electrical and Telephone

Basic electrical and telephone lines are all overhead and situated within the roadway system. Minor electrical and telephone which service new developments are located underground.

III. POTENTIAL IMPACTS AND MITIGATION MEASURES

A. PHYSICAL ENVIRONMENT

1. Surrounding Land Uses

During the construction phase there is a potential for disruption to existing business establishments and residences. The County of Maui and their consultant team have established an ongoing dialogue with residents and merchants of the area in order to develop a construction management plan which will seek to minimize impacts on day to day activities. The first Public workshop was held on July 7, 1994, at Kamehameha III School. Initial measures which have been identified and will be further refined and incorporated into the construction management plan include the following:

- Development of a phasing or timing plan in order to avoid major impacts to Front Street activities during peak tourism periods and other important events such as Halloween.
- Conducting the majority of work, including subsurface utility work, during night time hours in order to maintain traffic flow during the

heavy day time shopping hours. This will involve utilizing temporary patching or metal plates to ensure that traffic flows are unimpeded.

- Maintenance of pedestrian access to all stores during sidewalk and roadway construction via temporary pedestrian bridges and/or walkways.
- Full completion of roadway and sidewalk improvements in segments so that construction activity in a given area is started and completed in the shortest time frame possible.
- Development of a traffic mitigation plan to identify the most efficient and practical methods for diverting traffic through Lahaina Town during those periods when portions of Front Street will need to be closed.
- Hiring of a project manager to work as a liaison between community members and the construction contractors. The project manager will ensure that the merchants are kept apprised of the progress and issues as they arise.

These and other measures that are developed will be incorporated into the construction bidding documents to ensure that they will indeed be implemented.

The proposed project is not anticipated to have long term adverse effects on surrounding land uses. By improving pedestrian and vehicular flow, and pedestrian safety, the proposed improvements will preserve and complement existing land uses. Accessibility will be enhanced, and congestion reduced.

2. Topography/Landform

The proposed project will require excavation for installing underground utilities, waterlines, sewer laterals, and drainlines below Front Street. Short term environmental impacts to topography and landform will be limited to those associated with roadwork and excavation of the roadway.

As the site has been previously graded and because Front Street will be restored to it's original grade, there are no significant long-term impacts anticipated to topography or landform.

Reconstruction of the outlet for Drainline "F" will result in the removal of the existing outfall or wing walls perpendicular to the coast which extend into the beach area. This should serve to improve lateral shoreline access. The proposed outfall design calls for an apron to spread and retard flows. (See Figure 12) Some scouring of the beach is likely to occur in front of the apron, but this will likely be a temporary condition that will be naturally repaired with the end of storm conditions and consequent redistribution of beach sediment. The proposed outfall structure will be located inland of the shoreline, in line with the existing vertical seawalls, and should have no impact on longshore sediment transport or lateral beach access.

The outfalls for drainlines "B", "C" and "D", are located along Front Street as shown in Figure 4. The proposed locations occur along the Front Street seawalls. These shoreline areas are considered "hardened" by the rock revetments and concrete masonry structures necessary for the protection of the Front Street foundation. All three of these proposed improvements will terminate at approximately 4 ft. above Mean Sea Level (M.S.L.). (See Figure 13) In consideration of the character of the existing shoreline conditions and the height of the structures above M.S.L., the outfalls should have no impact to nearshore littoral drift processes or lateral beach access.

3. Terrestrial Flora and Fauna

There are no anticipated significant long-term or short term impacts from the proposed action to the terrestrial flora and fauna. The proposed project will not require permanent removal of existing vegetation from the area. There will, however, be some damage to landscape planting during new irrigation work and connection of the new sewer laterals. This damage will be repaired and new landscaping installed. New coconut palms (Cocos nucifera) and ground cover (Zoysia Japonicus) will be introduced in the Front Street improvement area as part of the landscape plan. This proposed landscape planting is consistent with the existing character of Lahaina.

4. Offshore Environment

The buoyant discharge models for Drainline "F" (see Appendix A) show that the high velocities of the projected flow for both the 5-year and 100-year storms dilutes the plume through entrainment and mixing with surrounding waters. The discharge plume is narrow near the shore, and carries the effluent rapidly offshore to deeper water where it can be more easily diluted by stronger coastal currents.

Water quality impacts on the marine environment can result from salinity depression as fresh water is discharged from a storm drain, from sediments carried with the discharge, and from a variety f pollutants associated with terrestrial runoff. Construction related impacts are expected to be minor as the site will be isolated from the marine environments during construction at the shore. The results of modeling of the discharge plume indicate that damage from salinity depression will be limited to the shallow reef flat directly off the mouth of Drainline "F". Even severe conditions from a 100-year flood event will not produce salinity depression harmful to corals in the high coral coverage, reef front environment.

Sediment impacts can occur to sensitive marine ecosystems in the Lahaina area and require that adequate controls exist (or are implemented on a project basis) in the watershed to minimize erosion during infrequent storms. Mitigation of pollutant impacts can be achieved by street sweeping and maintenance of drainage systems. Prevailing currents on the reef flat off Drainline "F" are anticipated to provide significant protection to coral reef resources in this area.

Development of Drainline "F" must proceed with care to minimize the volume of flows, and in particular, the transport of fine sediments and urban pollutants into the marine environment. However, the location of Drainline "F" is preferable as an outlet for locally generated storm runoff compared with locations between Lahaina Harbor and the south end of the Lahaina Beach reef. The existing outlet is close to an opening in the shallow reef margin adjacent to the Lahaina Harbor breakwater, minimizing opportunity for discharges to impact sensitive outer reef flat ecosystems.

5. Archaeological/Historic Resources

Much of Lahaina's rich history is preserved in the character of the town, and lends a sense of place to Lahaina which is unique in the islands. The overall character of Lahaina as a human-scale pedestrian oriented town with one and two-story turn of the century buildings remains intact. In recognition of the importance of preserving Lahaina's historic character the Maui County Cultural Resources Commission has adopted the "Design Guidelines for Front Street Improvements". These guidelines were used extensively in the formulation of the proposed improvements. A primary goal of this project is to improve the functional and aesthetic aspects of Front Street, in order to preserve and enhance its unique sense of place.

As discussed earlier, Lahaina was an important center of human activity well before European contact and although there is little evidence of pre-contact artifacts above ground today, there is a potential for encountering significant sub-surface remains. The entire project site within the Front Street right of way, however, has been previously disturbed during installation of existing water, sewer and drainline facilities. The possibility of encountering undisturbed cultural deposits within Front Street is considered remote. However, the expansion of Drainline "F" just south of Kamehameha III School could involve subsurface trench work in areas that may be relatively undisturbed. This is dependent on the amount of excavation which was done to install the two existing drainlines and the drainage ditch.

In a 1993 study by Dr. Paul Klieger of the Bishop Museum on the various aspects of the island of Moku'ula and the Loko Mokuhinia, it was noted that further analysis of soils and sediments found in future excavations will provide clues to the origin of Loko Mokuhinia and thus its possible cultural function. Although the proposed Drainline "F" is not in the immediate vicinity of these areas, it is possible that if undisturbed soil profiles exist, they could provide valuable historic data.

In light of these considerations, archaeological tests were performed in the makai section of the proposed Drainline "F" easement. Two exploratory trenches were dug to examine soil profiles and buried materials. The results of the testing is presented in Appendix B. Both trench profiles seem to represent exclusively filled deposits. Nothing indicative of early post-Contact (A.D. 1778-1850) of pre-Contact human habitation was evident in the test units.

There is a strong probability that soil along the drainage throughout the easement area is similarly disturbed as an artifact of drainage construction. However, as substantial portions of the easement area were not available for investigation due to limited access, it is recommended that archaeological monitoring of future construction along the drainage be performed. Despite the fact that a modern school, church, utility easements and other improvements have been built on the present project area since the days of *ali'i* residence, it cannot be stated with certainty that the soils in this area are completely disturbed and/or devoid of archaeological data. The archaeological report concludes that monitoring of excavations in this vicinity is highly recommended due to the potential of retrieving archaeological data (National Register Criterion D).

An adequate monitoring plan for Drainline "F" and the Front Street right of way will be developed in conjunction with the State Historic Preservation Office.

6. Air Quality

Anticipated short term air quality impacts are related to construction activities. These include fugitive dust and on-site emissions from construction equipment as well as short term indirect impacts from slow moving construction equipment traveling to and from the project work area, and from traffic delays associated with Front Street roadwork.

Mitigation measures will include a frequent watering program for fugitive dust control and moving heavy equipment during periods of low traffic volume to mitigate the potential traffic impact of slow moving equipment. Front Street excavation work will be also be scheduled to coincide with periods of low traffic volume. The majority of excavation work involving heavy equipment will be performed at night when the potential for human exposure is dramatically reduced.

On a long term basis, the project will not generate adverse air quality conditions.

7. Noise

Ambient noise conditions will be affected over the short-term by construction activities. Construction equipment, such as bulldozers, front end loaders and materials-carrying trucks, would be dominant source of noise during the construction period. Other construction-related noise sources include impact tools such as jack hammers and hand-held pneumatic tools.

Construction in the vicinity of residences is anticipated to be limited to daylight hours where possible and will be minimized through proper adherence to Department of Health requirements. Compressors, generators and all other internal combustion engine equipment will be equipped with improved mufflers. Intake silencers will be installed on equipment where applicable. To the extent possible, hydraulic impact tools will be used instead of pneumatic impact tools. All nighttime work in the vicinity of residences will be conducted in compliance with DOH Nighttime Allowable Noise Limits.

There are no anticipated adverse long-term noise impacts as a result of the proposed action.

8. Visual Resources

Short term impacts to visual resources are associated with construction activities. The presence of construction equipment will be evident along Front Street, and may influence the historic ambiance of the town for the duration of construction. This will be minimized by conducting work during nighttime hours. Materials and equipment needed for nighttime work will not be stored in the Front Street area.

Long term impacts to the visual environment are anticipated to be beneficial. By placing most utilities underground, increasing street lighting, improving pedestrian the pedestrian environment, Lahaina will be visually enhanced by the proposed action.

B. SOCIO-ECONOMIC ENVIRONMENT

1. Population and Local Economy

Front Street is the center of commercial activity for the tourism industry in West Maui. Any significant disruptions to Front Street businesses from construction related activities could have major economic impacts. It is also important to maintain adequate levels of comfort for Maui visitors. The County of Maui is committed to the development of a construction management plan which will minimize potential disruptions to Front Street businesses. The primary components of the construction management plan have been identified in Section III.A.1.

On a short term basis, the project will support construction and construction-related employment.

On a long term basis, there are no anticipated direct impacts to population or the local economy. However, long term indirect benefits to the local economy may be realized as a result of enhancing the pedestrian experience of Lahaina.

2. Housing

There are no anticipated short-term or long-term housing impacts anticipated as a result of the proposed action.

C. INFRASTRUCTURE

1. Roadways

Because some of the improvements will be below ground, Front Street will be impacted by the proposed improvements. Traffic along Front Street and intersecting streets in the area will be adversely impacted during the construction phase of the proposed action. Mitigative measures will include:

- Conducting major excavation and heavy equipment work during night time hours when traffic levels are lowest.
- Development of a traffic mitigation plan which will be a part of and relate to the construction management plan.

There are no anticipated adverse long-term impacts to Front Street as a result of the proposed action. The impacts to roadways are instead anticipated to be beneficial. The proposed improvements are intended to improve vehicular traffic flow through Lahaina Town.

2. Water

Water service will be maintained throughout the construction of the new 12-inch line. Once the new line is in place, service will be temporarily cut off for a few hours while the new line is connected to the system.

No adverse long-term impacts are expected as a result of the proposed action. By installing a larger waterline in Front Street, water system capacity will be increased in the region.

3. Drainage

Short-term drainage impacts would be associated with rainfall during construction of Front Street improvements. A construction drainage plan will be engineered and in place to mitigate potential drainage impacts. This plan will ensure drainage capability equivalent to or better than that provided by the existing drainage system. Drainage swales, temporary culverts and/or pumping will be utilized as required to mitigate drainage impacts per the engineered temporary drainage plan.

Long-term drainage impacts are anticipated to be beneficial. The Front Street drainage improvements will provide an internal drainage system with adequate storm drainage facilities. This system is intended to reduce localized flooding which presently occurs along Front Street during periods of heavy rainfall. The proposed expansion of Drainline "F" will be a major step towards alleviating severe flooding that occurs in the area of Wainee and Prision Streets.

IV. RELATIONSHIP TO GOVERNMENT PLANS, POLICIES AND CONTROLS

A. STATE LAND USE DISTRICT

The Hawaii Land Use Law, Chapter 205, Hawaii Revised Statures, establishes four major land use districts in which all lands in the State are placed. These districts are designated "Urban," "Rural," Agriculture," and "Conservation." The subject property is located within the "Urban" district. The proposed improvements are compatible with this designation.

B. GENERAL PLAN OF THE COUNTY OF MAUI

The General Plan of the County of Maui (1990) update provides long term goals, objectives and policies directed toward the betterment of living conditions in the county. Addressed are social, environmental, and economic issues which influence future growth in Maui County. The following General Plan objectives are addressed by the proposed project:

Objective: To preserve for present and future generations the opportunity to know and experience the arts, culture and history of Maui County.

Policy: Encourage the rehabilitation and adaptive use and reuse of historic districts, site and buildings in order to perpetuate traditional community character and values.

Objective: To encourage exceptional and continuing quality in the development of visitor industry facilities.

Objective: To control the development of visitor facilities so that it does not infringe upon the traditional social, economic and environmental values of our community.

Objective: To see that all developments are well designed and are in harmony with there surroundings.

Objective: To provide an adequate supply of potable and irrigation water to meet the needs of Maui County's residents.

Policy: Develop improved systems to provide better fire protection.

Objective: To improve the quality and availability of public facilities throughout Maui County.

Policy: Encourage the development of public facilities which will be architecturally and ecologically compatible with their surroundings and foster community development.

The proposed action is in accordance with the above objectives and policies of the Maui County General Plan.

C. LAHAINA COMMUNITY PLAN

Nine (9) community plan regions have been established in Maui County. Each Region's growth and development is guided by a Community Plan which contains objectives and policies in accordance with the County General Plan. The purpose of the Community Plan is to outline a relatively detailed agenda for carrying these out.

The proposed project is located within the Lahaina Community Plan region. The proposed project facilitates implementation of the Lahaina Community Plan by serving the following recommendations:

Physical Aspects (2) Land Use (j) Use Honoapiilani Highway and Front Street to define the Lahaina Town Core... to emphasize the importance of Lahaina Town as the regional resident and visitor attraction and service center. (1) Emphasize visitor amenities, regional commercial activities, and facilities which convey community identity along Front Street between Baker and Prison Streets. **(3) Urban Design** (a) Circulation and Parking (4) The pedestrian walkway along the makai edge of Front Street should be enhanced and enlarged wherever feasible with landscaping, streetscape furniture, and rest/overlook areas.

Support Systems: Utilities and Facilities: (1) Transportation (b) Establish Front Street as a local road within Lahaina Town with an emphasis on enhancing pedestrian and bicycle amenities through (1) Reduction or elimination of on-street parking. **(2) Improvements to pedestrian circulation** through widened sidewalks and promenades along the makai side. (4) **Drainage** (a) Establish a comprehensive program of improvement to the storm drain system...

D. MAUI COUNTY HISTORIC DISTRICTS

The proposed action is within areas covered by the Maui County Historic District Ordinance which seeks to preserve the history and culture of the county. The Ordinance created Historic Districts in which a ten member Cultural Resources Commission (CRC) reviews building permits for construction within the district and establishes regulations on buildings and uses. The Maui County Historic Districts includes Lahaina Historic District #1, established in 1962, and Lahaina Historic District #2, established in 1967. Lahaina Historic Districts #1 and #2 together comprise an area of approximately 47 acres and includes the majority of the Front Street improvement area, extending north from Shaw Street to the northern end of the Lahaina Center property.

The CRC has adopted the "Design Guidelines for Front Street Improvements". Many of the proposed improvements came directly from these guidelines. The project has been reviewed by the CRC to ensure consistency with the guidelines and the overall historic character of Lahaina Town. On September 1, 1994, the CRC voted to grant Historic District Approval for the project.

E. SPECIAL MANAGEMENT AREA OBJECTIVES AND POLICIES

The project involves work within the County's Special Management Area (SMA) and Shoreline Setback and as such will require a SMA permit and Shoreline Setback Variance from the Maui Planning Commission. Pursuant to Chapter 205A, Hawaii Revised Statutes, and the Rules and Regulations of the Planning Commission of the County of Maui, projects located within the SMA are evaluated with respect to SMA objectives, policies and guidelines. This section addresses the project's relationship to applicable coastal zone management considerations, as set forth in Chapter 205A and the Rules and Regulations of the Planning Commission.

A. RECREATIONAL RESOURCES

Objective: Provide coastal recreational resources accessible to the public.

Policies:

1. Improve coordination and funding of coastal recreation planning and management; and

2. Provide adequate, accessible and diverse recreational opportunities in the coastal zone management area by:

    a. Protecting coastal resources uniquely suited for recreation activities that cannot be provided in other areas;

    b. Requiring replacement of coastal resources having significant recreational value, including, but not limited to, surfing sites and sandy beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;

    c. Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;

    d. Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;

    e. Encouraging expanding public recreational use of county, state, and federally owned or controlled shoreline lands and waters having recreational value;

    f. Adopting water quality standards and regulating point and non-point sources of pollution to protect and, where feasible, restore the recreational value of coastal waters; and

g. Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits, and crediting such dedication against the requirements of Section 46-6 of the Hawaii Revised Statutes.

Response:

The beach and offshore area to the south of Lahaina Harbor, in the vicinity of Drainline "F", are used for recreational activities, predominately for beginner level surfing, ocean kayaking and snorkeling. Reconstruction of the outlet for Drainline "F" will result in the removal of the existing outfall or wing walls perpendicular to the coast which extend into the beach area. This should serve to improve lateral shoreline access along the beach.

The location of Drainline "F" is preferable as an outlet for locally generated storm runoff compared with locations between Lahaina Harbor and the south end of the Lahaina Beach reef. The existing outlet is close to an opening in the shallow reef margin adjacent to the Lahaina Harbor breakwater, minimizing opportunity for discharges to impact sensitive outer reef flat ecosystems. Sediment impacts can occur to sensitive marine ecosystems in the Lahaina area and require that adequate controls exist (or are implemented on a project basis) in the watershed to minimize erosion during infrequent storms. Mitigation of pollutant impacts can be achieved by street sweeping and maintenance of drainage systems. Prevailing currents on the reef flat off Drainline "F" are anticipated to provide significant protection to coral reef resources in this area.

B. HISTORICAL/CULTURAL RESOURCES

Objective: Protect, preserve and, where desirable, restore those natural and man-made historic and prehistoric resources in the coastal zone management areas that are significant in Hawaiian and American history and culture.

Policies:

1. Identify and analyze significant archaeological resources;

2. Maximize information retention through preservation of remains and artifacts or salvage operations; and

3. Support state goals for protection, restoration, interpretation and display of historic resources.

Response:

The possibility of encountering undisturbed cultural deposits within the Front Street Right-of-Way is considered remote. However, the expansion of Drainline "F" just south of Kamehameha III School could involve subsurface trench work in areas that may be relatively undisturbed. As such, an archaeological report and testing was conducted to ascertain the nature of soil profiles and potential cultural materials in this area. The report is included in this assessment as Appendix B. Briefly, the testing did not discover non-disturbed soils, the excavated areas appear to have been artificially filled fairly recently. However, based on the historical significance of the area, archaeological monitoring during future excavation activities is recommended.

An adequate monitoring plan for Drainline "F" excavations as well as the remainder of the Front Street right of way will be developed in conjunction with the State Historic Preservation Office.

C. SCENIC AND OPEN SPACE RESOURCES

Objective: Protect, preserve and, where desirable, restore or improve the quality of coastal scenic and open space resources.

Policies:

1. Identify valued scenic resources in the coastal zone management area;

2. Insure that new developments are compatible with their visual environment by designing and locating such

developments to minimize the alteration of natural land forms and existing public views to and along the shoreline;

3. Preserve, maintain and, where desirable, improve and restore shoreline open space and scenic resources; and

4. Encourage those developments which are not coastal dependent to locate in inland areas.

Response:

The proposed project will not adversely impact scenic or open space resources. Short term impacts to visual resources may be associated with construction activities. The presence of construction equipment will be evident along Front Street, and may influence the historic ambiance of the town for the duration of construction. This will be minimized by conducting work during nighttime hours. Materials and equipment needed for nighttime work will not be stored in the Front Street area.

Long term impacts to the visual environment are anticipated to be beneficial. By placing most utilities underground, increasing street lighting, improving pedestrian the pedestrian environment, Lahaina will be visually enhanced by the proposed action. The proposed improvements will not involve significant alteration to the existing topographic character of the site and will not affect public views to the shoreline.

D. COASTAL ECOSYSTEMS

Objective:

Protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems.

Policies:

1. Improve the technical basis for natural resource management;

2. Preserve valuable coastal ecosystems of significant biological or economic importance;

3. Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs; and

4. Promote water quantity and quality planning and management practices which reflect the tolerance of fresh water and marine ecosystems and prohibit land and water uses which violate state water quality standards.

<u>Response:</u>
As discussed above and in Appendix A, sediment impacts can occur to sensitive marine ecosystems in the Lahaina area and require that adequate controls exist (or are implemented on a programmatic basis) in the watershed to minimize erosion during infrequent storms. Mitigation of pollutant impacts can be achieved by street sweeping and maintenance of drainage systems.

Prevailing currents on the reef flat off Drainline "F" are anticipated to provide significant protection to coral reef resources in this area. The location of Drainline "F" is preferable as an outlet for locally generated storm runoff compared with locations between Lahaina Harbor and the south end of the Lahaina Beach reef. The existing outlet is close to an opening in the shallow reef margin adjacent to the Lahaina Harbor breakwater, minimizing opportunity for discharges to impact sensitive outer reef flat ecosystems. Appropriate soil erosion mitigation measures will be implemented during the construction of the project to protect downstream properties.

E. <u>ECONOMIC USES</u>

<u>Objective:</u> Provide public or private facilities and improvements important to the State's economy in suitable locations.

<u>Policies:</u>
1. Concentrate in appropriate areas the location of coastal dependent development necessary to the state's economy;

2. Insure that coastal dependent development such as harbors and ports, visitor facilities, and energy-generating facilities are located, designed, and constructed to minimize adverse social, visual and environmental impacts in the coastal zone management area; and

3. Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:

   a. Utilization of presently designated locations is not feasible,

   b. Adverse environmental effects are minimized, and

   c. Important to the state's economy.

<u>Response:</u>

Front Street is the center of commercial activity for the tourism industry in West Maui. Indirect benefits to the local economy may be realized as a result of enhancing the pedestrian experience in Lahaina. Any significant disruptions to Front Street businesses from construction related activities, however, could have major economic impacts. It is also important to maintain adequate levels of comfort for Maui visitors during construction. The County of Maui is committed to the development of a construction management plan which will minimize potential disruptions to Front Street businesses. The primary components of the construction management plan have been identified in Section III.A.1.

Also, on a short term basis, the project will support construction and construction-related employment.

F. <u>COASTAL HAZARDS</u>

<u>Objectives:</u> Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion and subsidence.

Policies:

1. Develop and communicate adequate information on storm wave, tsunami, flood, erosion and subsidence hazard;

2. Control development in areas subject to storm wave, tsunami, flood, erosion and subsidence hazard;

3. Ensure that developments comply with requirements of the Federal Flood Insurance Program; and

4. Prevent coastal flooding from inland projects.

Response:

A major goal of this project is to provide storm water collection system improvements which will alleviate existing flooding problems in the Lahaina area. There are existing problem areas along Front Street and in the area of Wainee and Prison Streets. The implementation of the proposed improvements should reduce existing hazards to property from flooding.

G. MANAGING DEVELOPMENT

Objective: Improve the development review process, communication, and public participation in the management of coastal resources and hazard.

Policies:

1. Effectively utilize and implement existing law to the maximum extent possible in managing present and future coastal zone development;

2. Facilitate timely processing of application for development permits and resolve overlapping of conflicting permit requirements; and

3. Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life-cycle and in terms understandable to the general public to facilitate public participation in the planning and review process.

Response:
The County of Maui and their consultant team have established an ongoing dialogue with residents and merchants of the area in order to develop a construction management plan which will seek to minimize impacts on day to day activities. The first Public workshop was held on July 7, 1994, at Kamehameha III School. Additional opportunity for review of the proposed action is provided through the County's Special Management Area (SMA), Shoreline Setback Variance (SSV) and Historic District permitting processes. The development review process has also been streamlined by consolidating the SMA, SSV and Historic District review process.

F. LIST OF CONSULTED AGENCIES

The following agencies have been consulted during the preparation and processing of this environmental assessment:

County of Maui

- o Planning Department
- o Department of Public Works and Waste Management
- o Department of Water Supply

State of Hawaii

- o Department of Health
- o Department of Land and Natural Resources
  Historic Preservation Office
  Office of Conservation and Environmental Affairs
  Land Management

Federal Government

- o Department of the Army
  Corps of Engineers

V. PUBLIC COMMENT

No comments on the Draft Environmental assessment were received. The 30-day review period ended August 22, 1994.

FIGURES

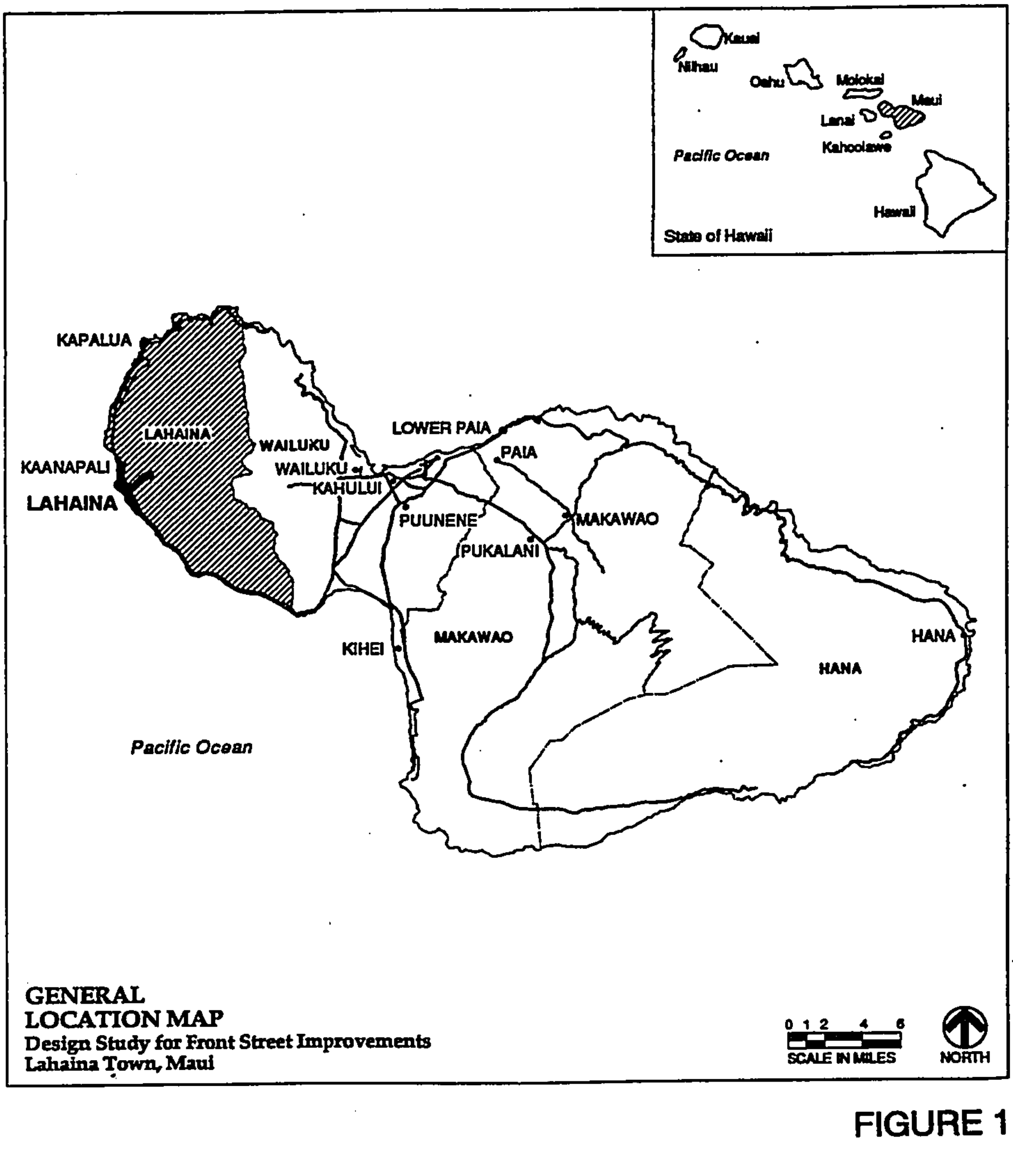

Kauai
Nihau
Oahu
Molokai
Maui
Lanai
Kahoolawe
Pacific Ocean
Hawaii
State of Hawaii
KAPALUA
LAHAINA
WAILUKU
KAANAPALI
WAILUKU
KAHULUI
LAHAINA
LOWER PAIA
PAIA
MAKAWAO
PUUNENE
PUKALANI
KIHEI
MAKAWAO
HANA
HANA
Pacific Ocean
GENERAL
LOCATION MAP
Design Study for Front Street Improvements
Lahaina Town, Maui
0 1 2 4 6
SCALE IN MILES
NORTH

FIGURE 1

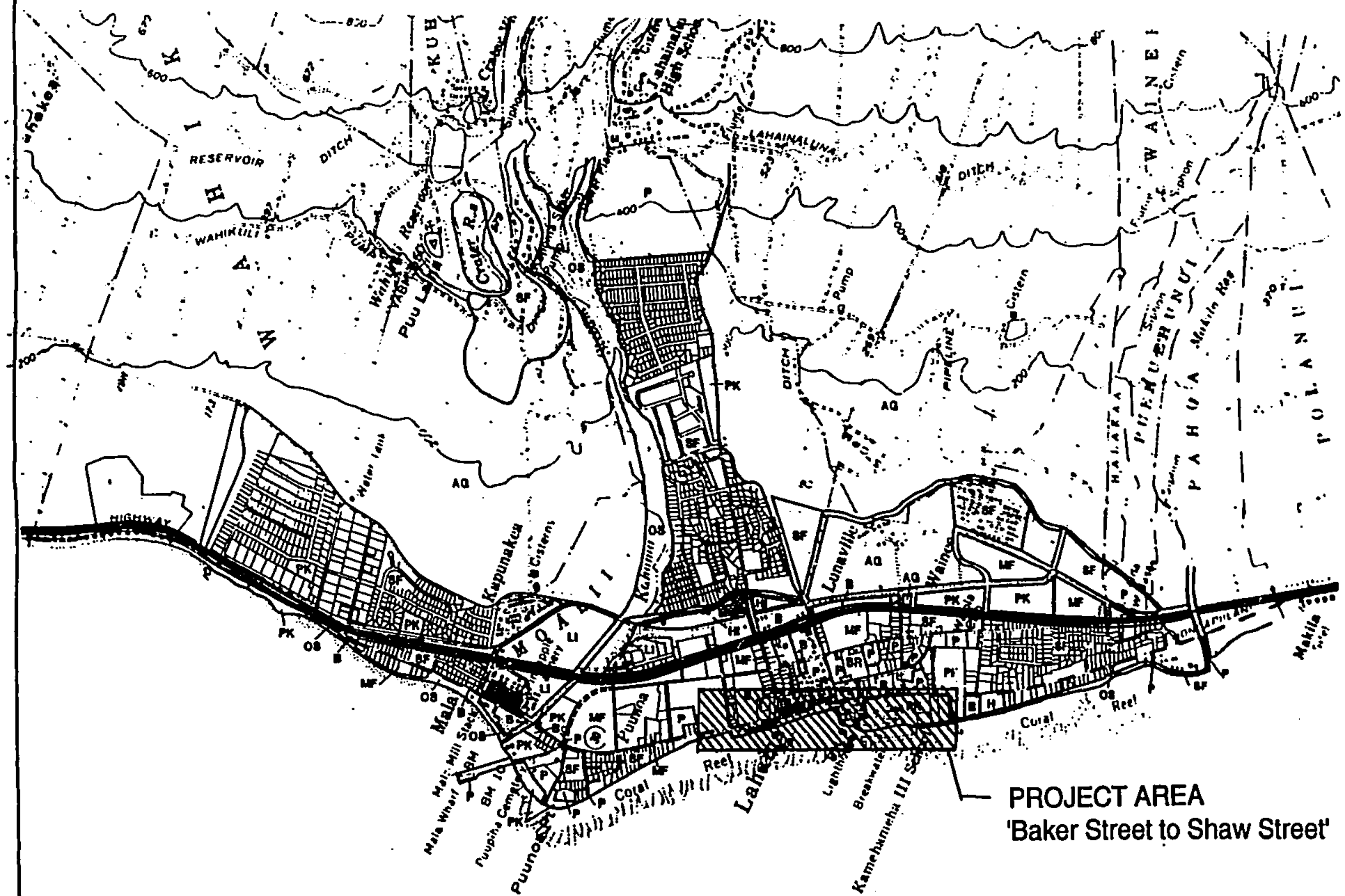
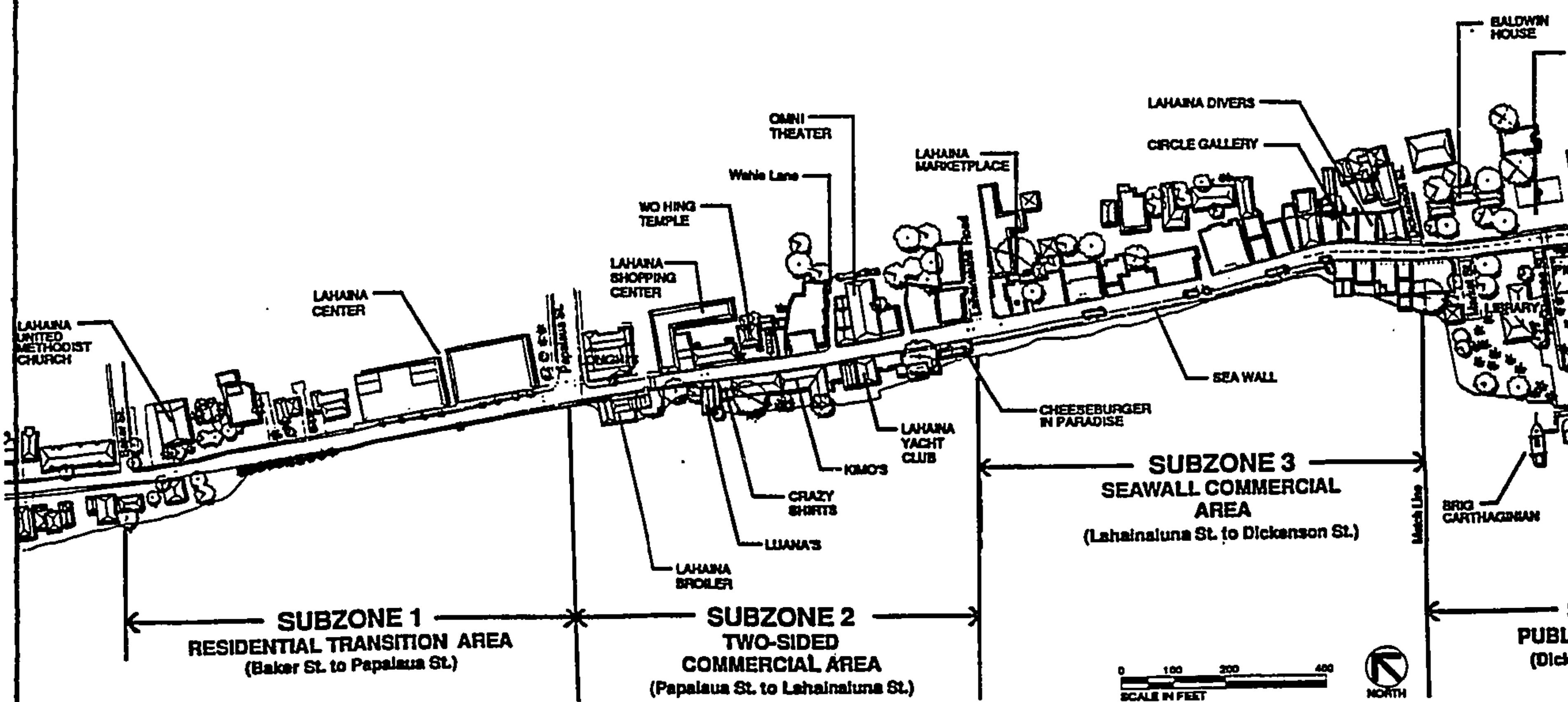
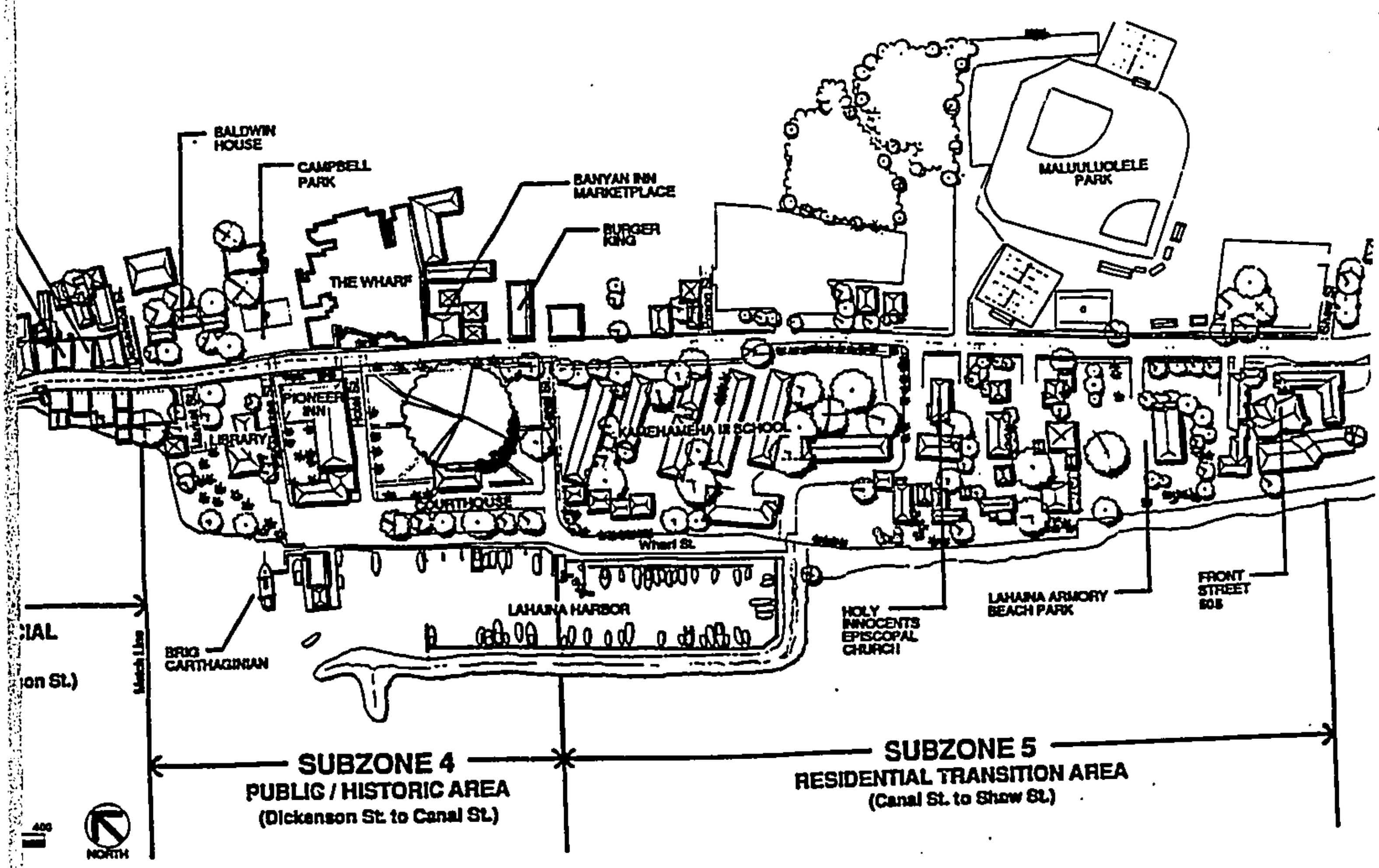

PROJECT AREA
'Baker Street to Shaw Street'
RESERVOIR
DITCH
LAHAINALUNA
PIPELINE
Pump
Cistern
Crater Rd
Puu Laina
Kapunakea
Lunaville
Wainee
Puunoa
Mala Wharf
Coral
Reef
Breakwater
Lighthouse
Kamehameha III School
Makila
HIGHWAY

FIGURE 2

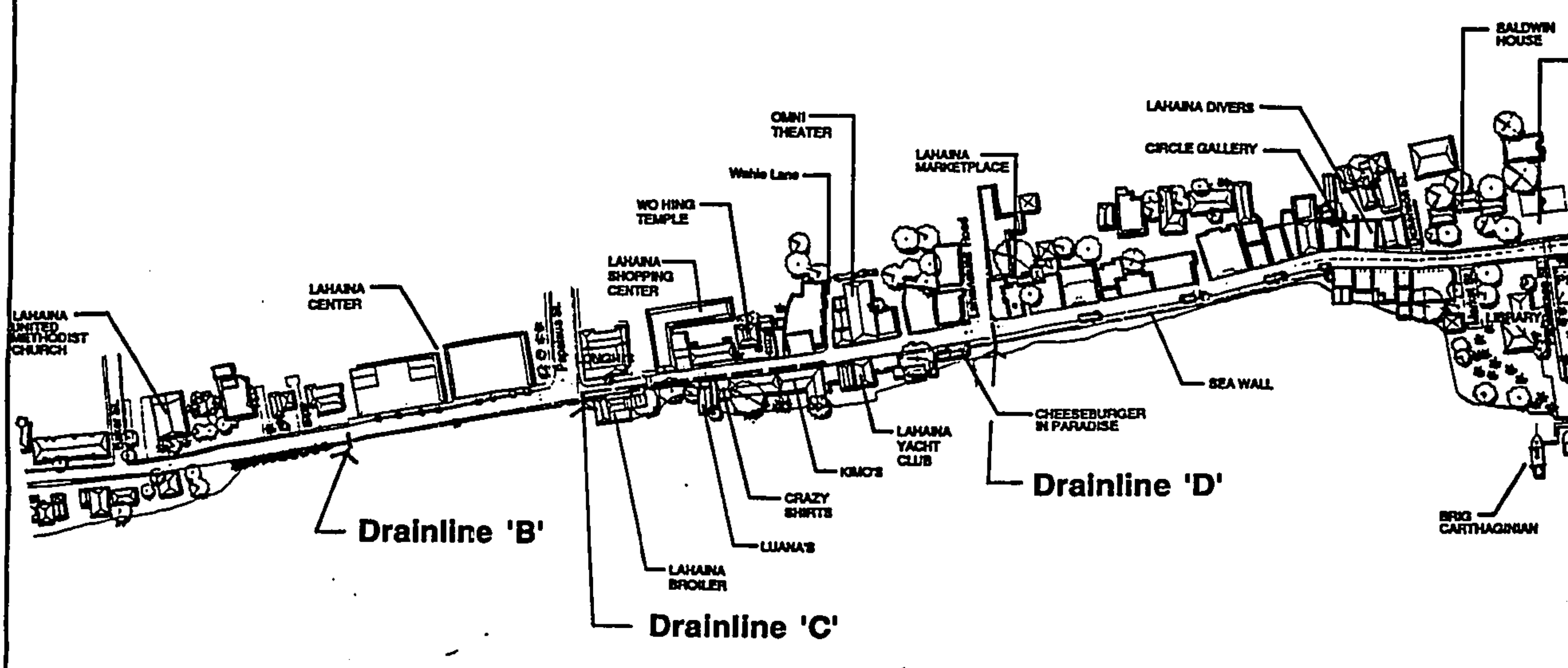

BALDWIN HOUSE
LAHAINA DIVERS
CIRCLE GALLERY
OMNI THEATER
Wahie Lane
LAHAINA MARKETPLACE
WO HING TEMPLE
LAHAINA SHOPPING CENTER
LAHAINA CENTER
LAHAINA UNITED METHODIST CHURCH
LIBRARY
SEA WALL
CHEESEBURGER IN PARADISE
LAHAINA YACHT CLUB
KIMO'S
CRAZY SHIRTS
LUANA'S
LAHAINA BROILER
BRIG CARTHAGINIAN
SUBZONE 1
RESIDENTIAL TRANSITION AREA
(Baker St. to Papalaua St.)
SUBZONE 2
TWO-SIDED COMMERCIAL AREA
(Papalaua St. to Lahainaluna St.)
SUBZONE 3
SEAWALL COMMERCIAL AREA
(Lahainaluna St. to Dickenson St.)
Match Line
0
100
200
400
SCALE IN FEET
NORTH

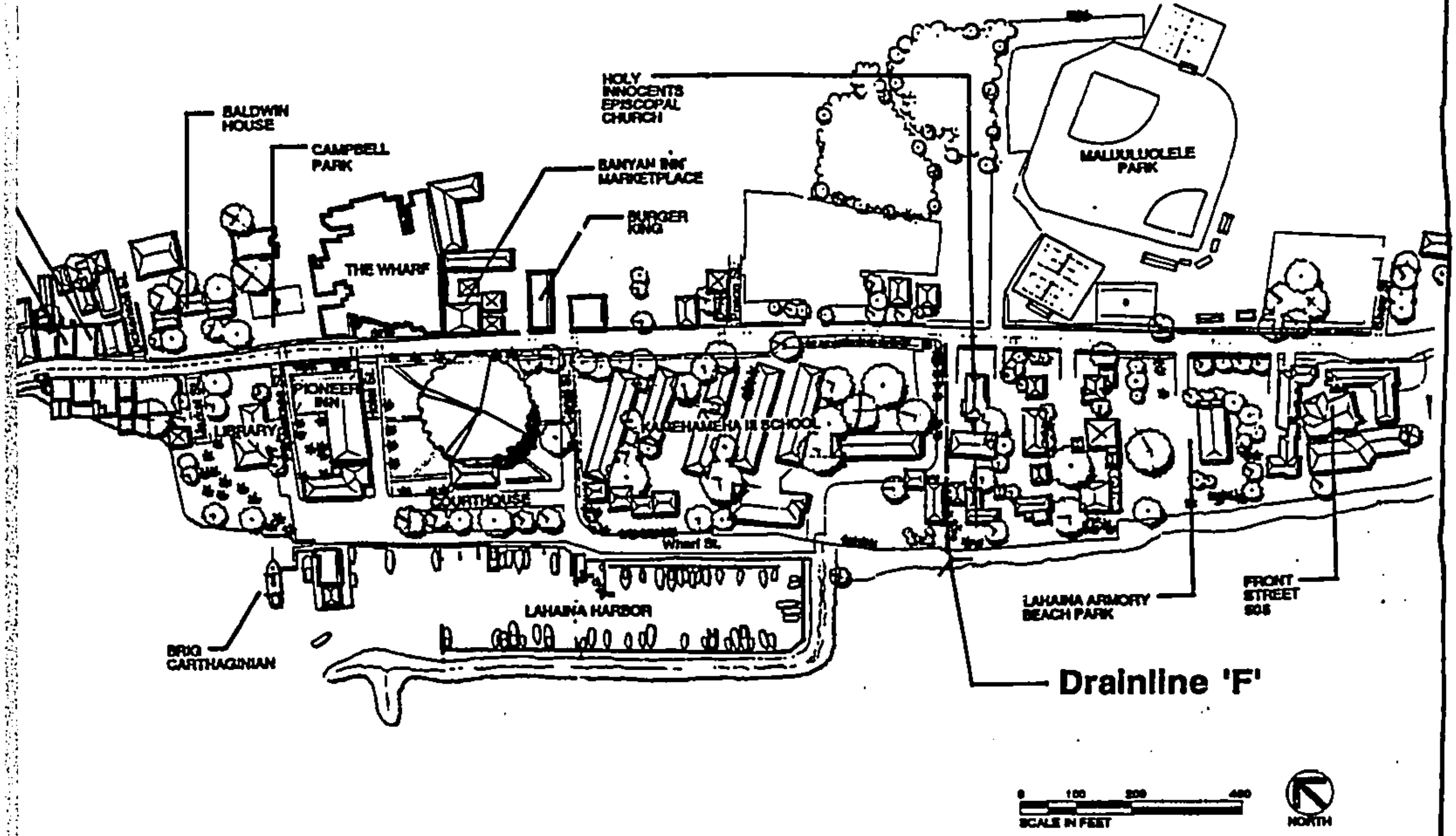


PROJECT AREA

ILLUSTRATIVE PLAN BY: BELT COLLINS & ASSOCIATES

FIGURE 3

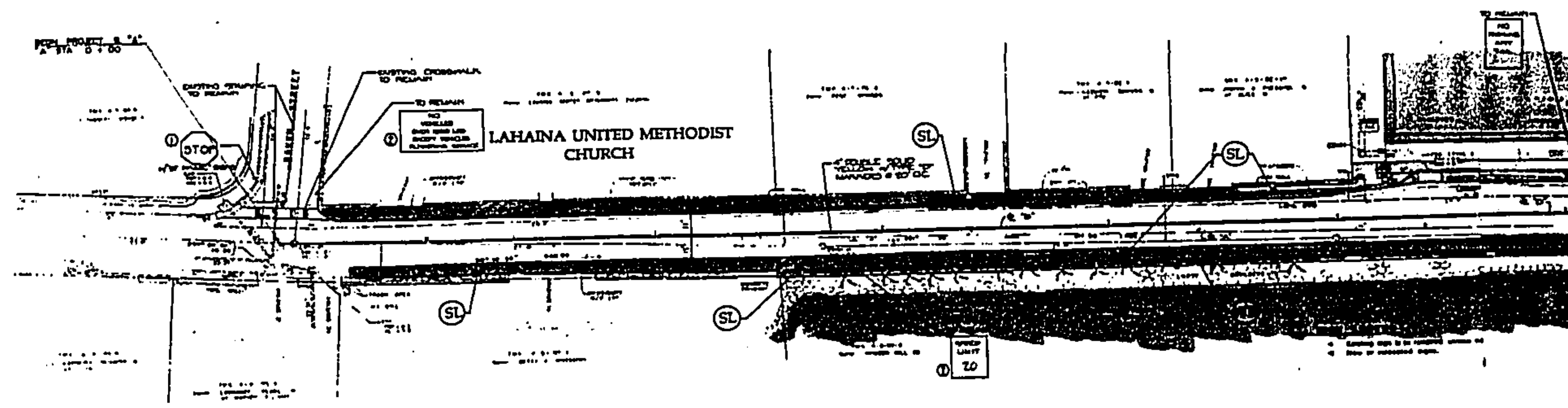

LAHAINA UNITED METHODIST CHURCH
LAHAINA CENTER
LAHAINA SHOPPING CENTER
WO HING TEMPLE
Wahie Lane
OMNI THEATER
LAHAINA MARKETPLACE
LAHAINA DIVERS
CIRCLE GALLERY
BALDWIN HOUSE
LIBRARY
SEA WALL
CHEESEBURGER IN PARADISE
LAHAINA YACHT CLUB
KIMO'S
CRAZY SHIRTS
LUANA'S
LAHAINA BROILER
BRIG CARTHAGINIAN
Drainline 'B'
Drainline 'C'
Drainline 'D'

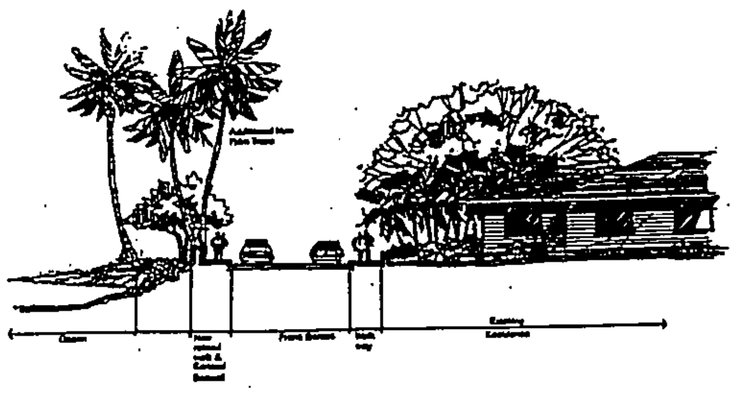


PROPOSED DRAINAGE OUTLETS

ILLUSTRATIVE PLAN BY: BELT COLLINS & ASSOCIATES

FIGURE 4



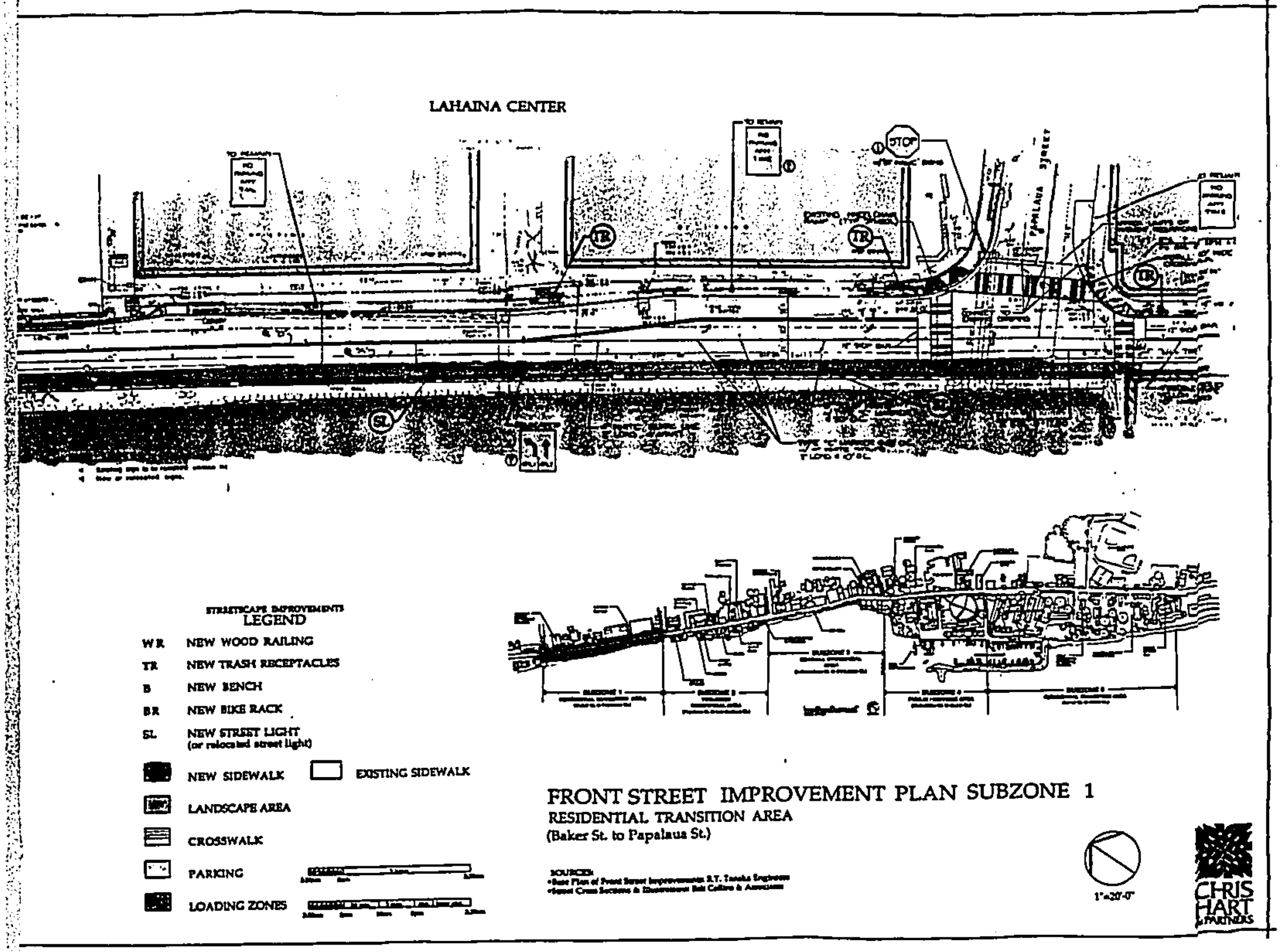


SECTION A-A

not to scale

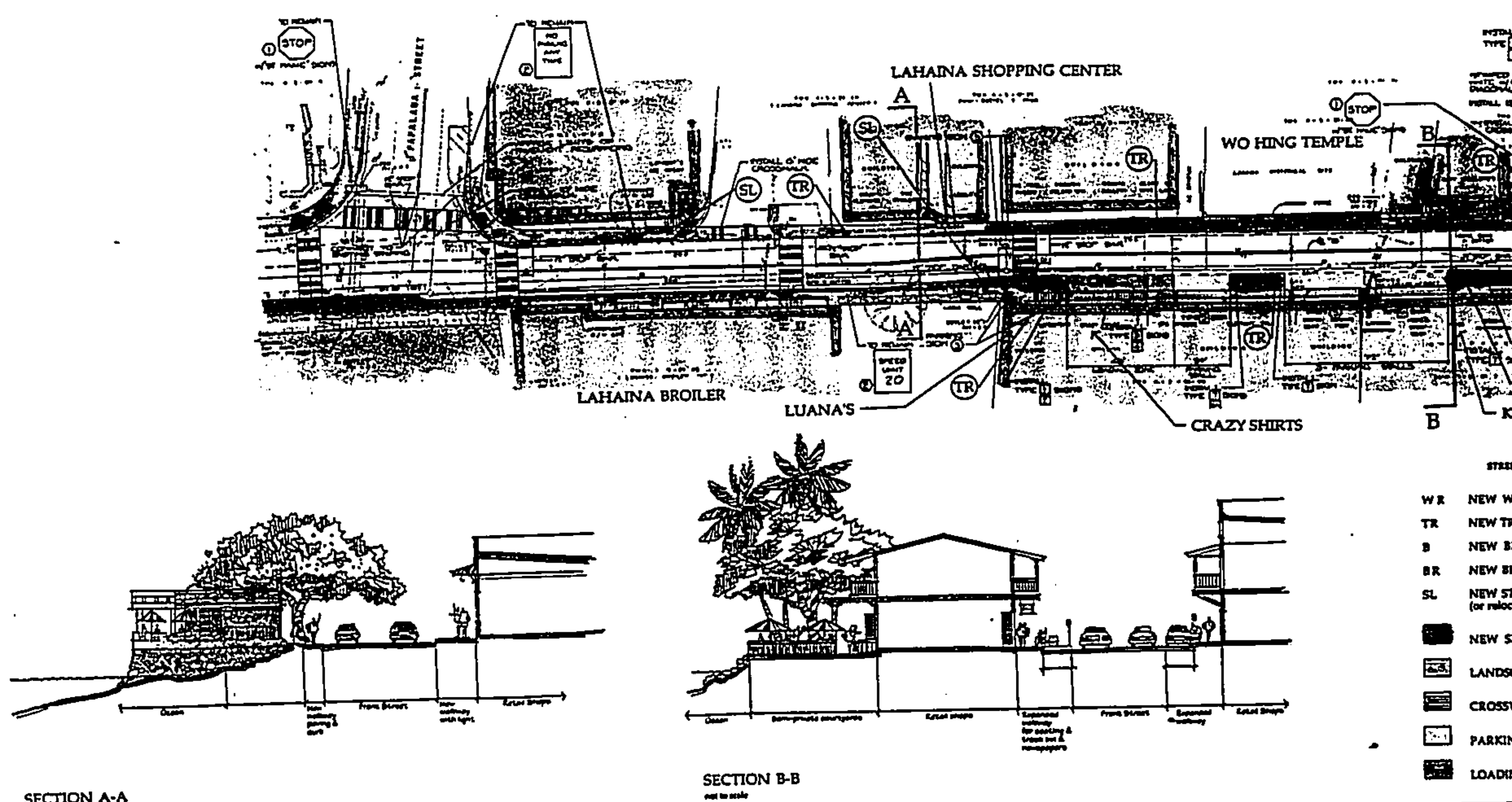
STREETSCAPE IMPROV
LEGEND

- WR NEW WOOD RAILIN
- TR NEW TRASH RECEPTA
- B NEW BENCH
- BR NEW BIKE RACK
- SL NEW STREET LIGHT (or relocated street ligh
- NEW SIDEWALK
- LANDSCAPE AREA
- CROSSWALK
- PARKING
- LOADING ZONES



LAHAINA CENTER
STOP
PAPALAUA STREET
STREETSCAPE IMPROVEMENTS
LEGEND
WR NEW WOOD RAILING
TR NEW TRASH RECEPTACLES
B NEW BENCH
BR NEW BIKE RACK
SL NEW STREET LIGHT (or relocated street light)
NEW SIDEWALK
EXISTING SIDEWALK
LANDSCAPE AREA
CROSSWALK
PARKING
LOADING ZONES
FRONT STREET IMPROVEMENT PLAN SUBZONE 1
RESIDENTIAL TRANSITION AREA
(Baker St. to Papalaua St.)
SOURCES
1"=20'-0"
CHRIS HART & PARTNERS

FIGURE 5


LAHAINA SHOPPING CENTER
WO HING TEMPLE
LAHAINA BROILER
LUANA'S
CRAZY SHIRTS
STOP
SPEED LIMIT 20
SECTION A-A
SECTION B-B

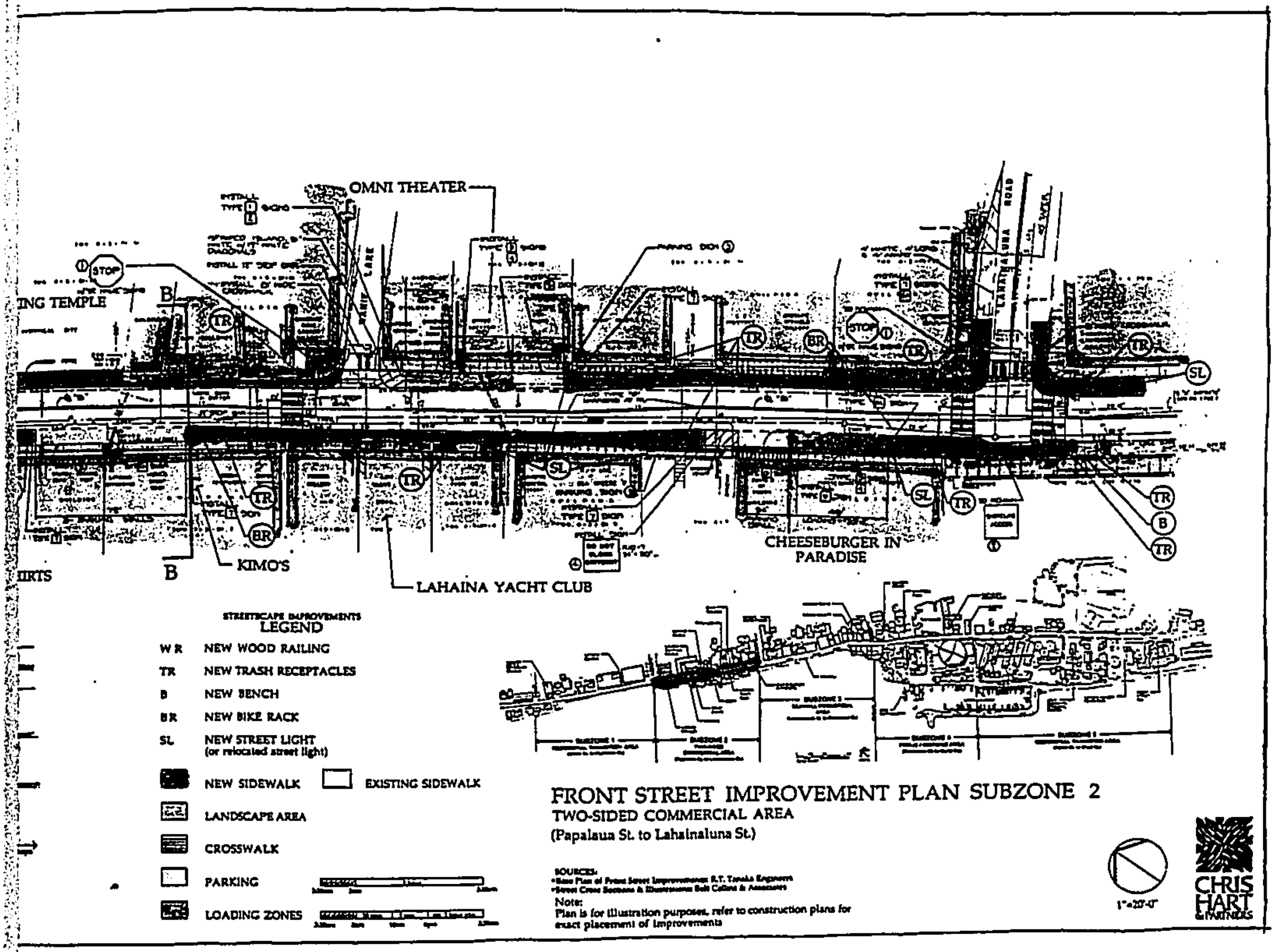
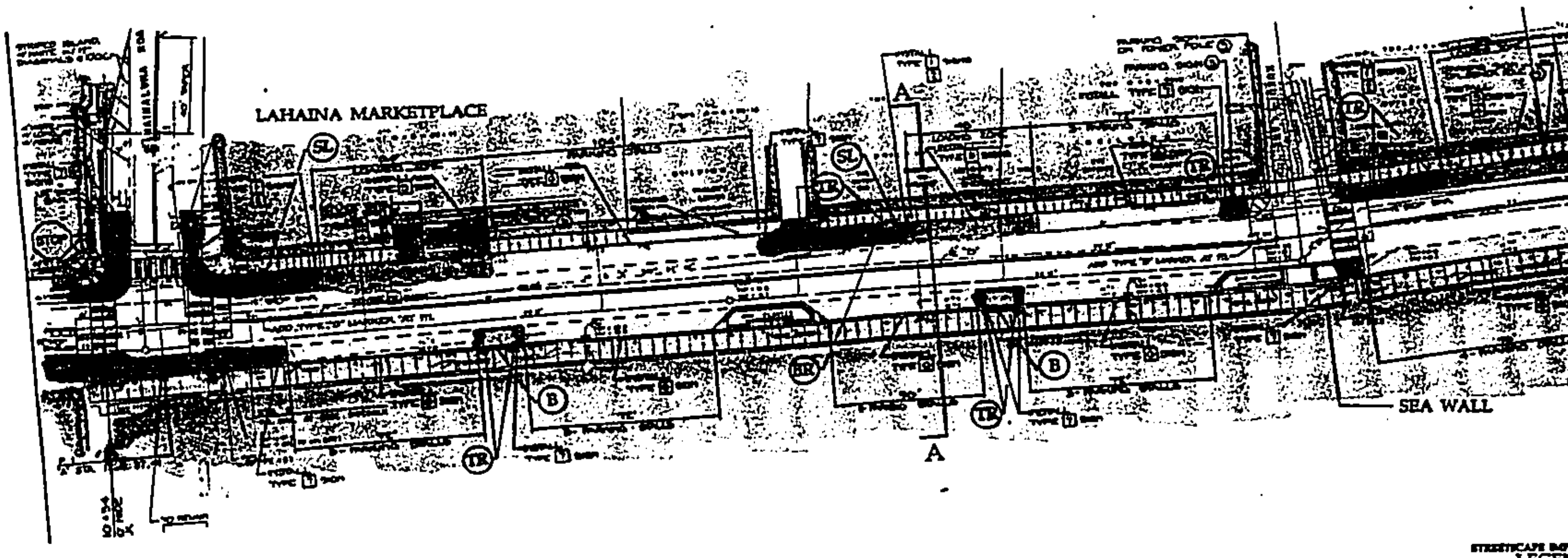
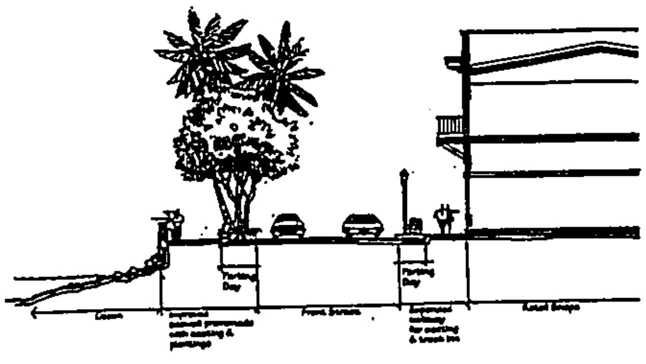

OMNI THEATER
LAHAINA YACHT CLUB
KIMO'S
CHEESEBURGER IN PARADISE
STREETSCAPE IMPROVEMENTS LEGEND
WR NEW WOOD RAILING
TR NEW TRASH RECEPTACLES
B NEW BENCH
BR NEW BIKE RACK
SL NEW STREET LIGHT (or relocated street light)
NEW SIDEWALK
EXISTING SIDEWALK
LANDSCAPE AREA
CROSSWALK
PARKING
LOADING ZONES
FRONT STREET IMPROVEMENT PLAN SUBZONE 2
TWO-SIDED COMMERCIAL AREA
(Papalaua St. to Lahainaluna St.)
Note:
Plan is for illustration purposes, refer to construction plans for exact placement of improvements
CHRIS HART & PARTNERS

FIGURE 6

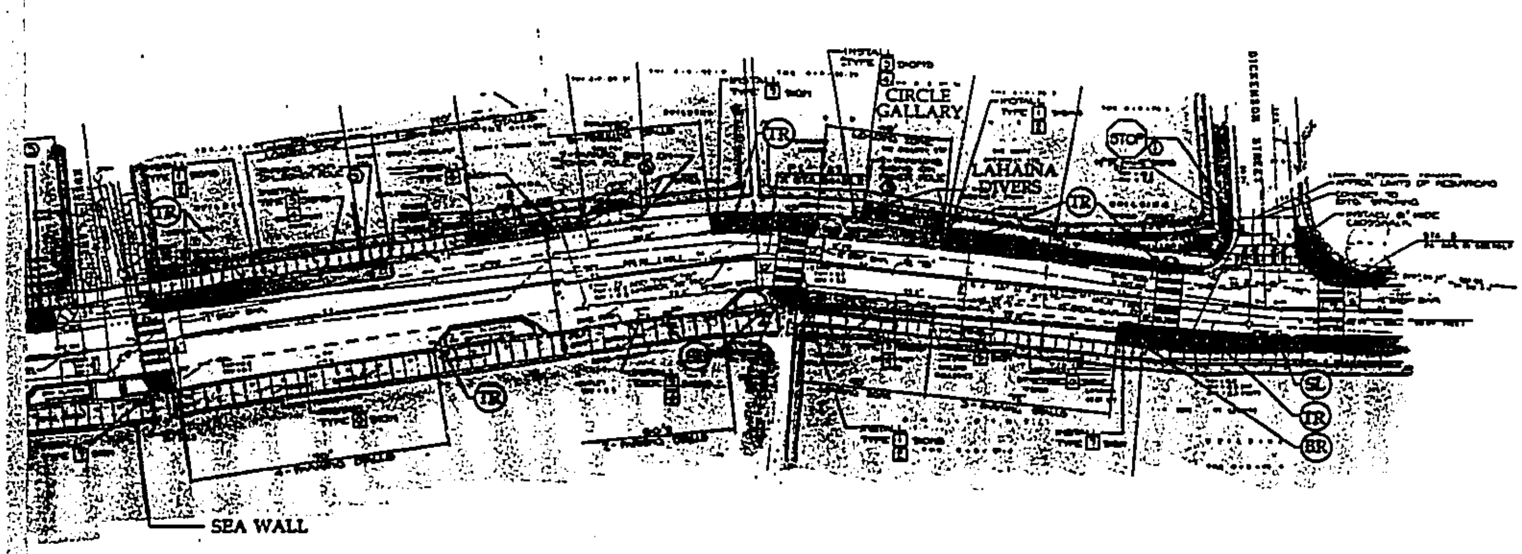




SECTION A-A
not to scale

STREETSCAPE IM...
LEGEN...

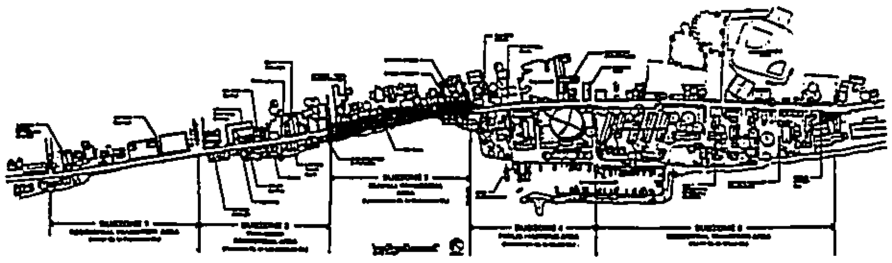
WR	NEW WOOD RAI...
TR	NEW TRASH REC...
B	NEW BENCH
BR	NEW BIKE RACK
SL	NEW STREET LIG... (or relocated street l...)
	NEW SIDEWALK
	LANDSCAPE ARE...
	CROSSWALK
	PARKING
	LOADING ZONES



STREETSCAPE IMPROVEMENTS
LEGEND

WR NEW WOOD RAILING
TR NEW TRASH RECEPTACLES
B NEW BENCH
BR NEW BIKE RACK
SL NEW STREET LIGHT (or relocated street light)

NEW SIDEWALK
EXISTING SIDEWALK
LANDSCAPE AREA
CROSSWALK
PARKING
LOADING ZONES



Location Map

FRONT STREET IMPROVEMENT PLAN SUBZONE 3
SEAWALL COMMERCIAL AREA
(Lahainaluna St. to Dickenson St.)

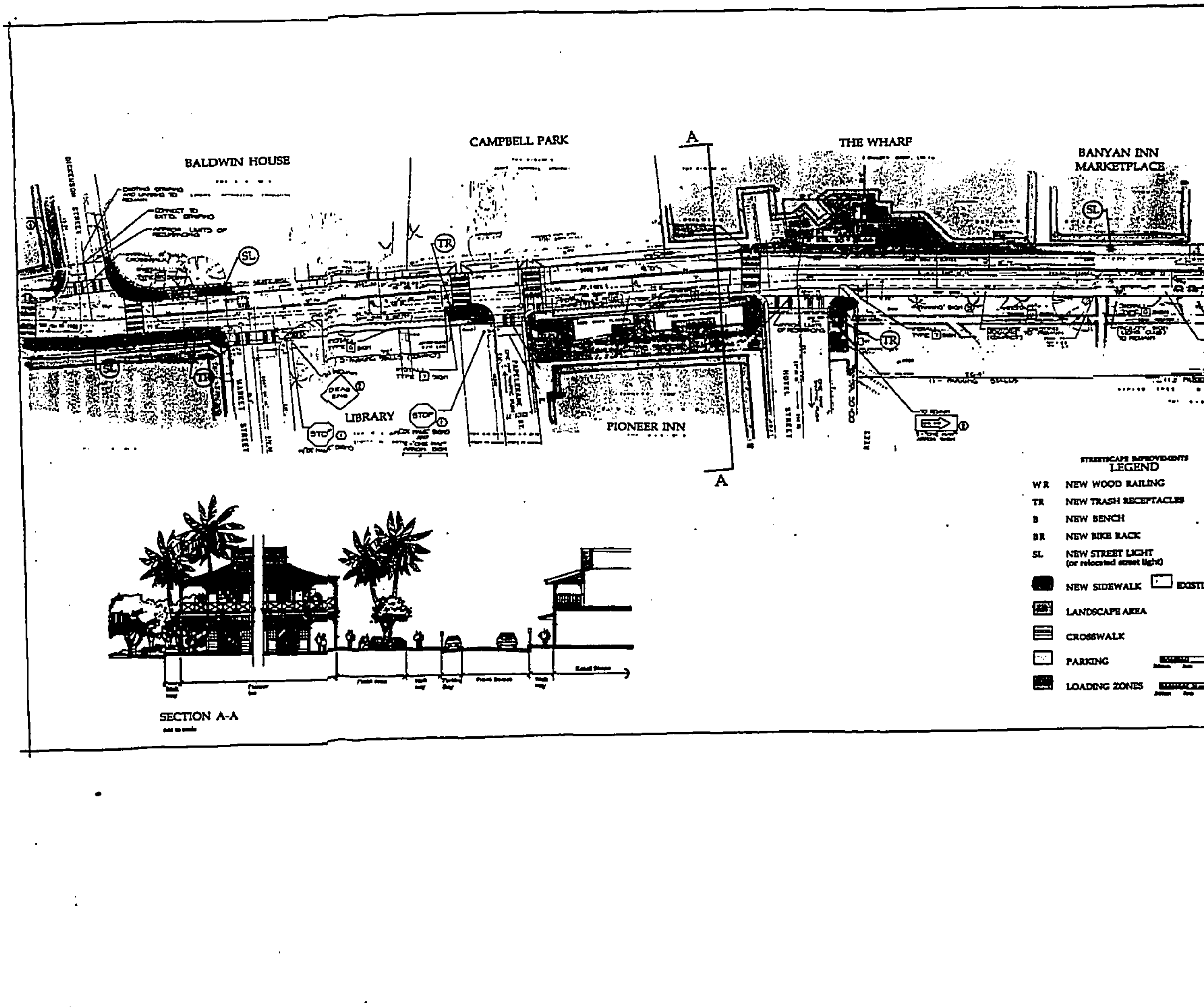
SOURCES:
•Base Plan of Front Street Improvements R.T. Tanaka Engineers
•Street Cross Sections & Illustrations Belt Collins & Associates

Note:
Plan is for illustration purposes, refer to construction plans for exact placement of improvements

1"=20'-0"

CHRIS HART & PARTNERS

FIGURE 7


BALDWIN HOUSE
CAMPBELL PARK
THE WHARF
BANYAN INN MARKETPLACE
LIBRARY
PIONEER INN
A
A
SECTION A-A
STREETSCAPE IMPROVEMENTS LEGEND
WR NEW WOOD RAILING
TR NEW TRASH RECEPTACLES
B NEW BENCH
BR NEW BIKE RACK
SL NEW STREET LIGHT (or relocated street light)
NEW SIDEWALK
LANDSCAPE AREA
CROSSWALK
PARKING
LOADING ZONES

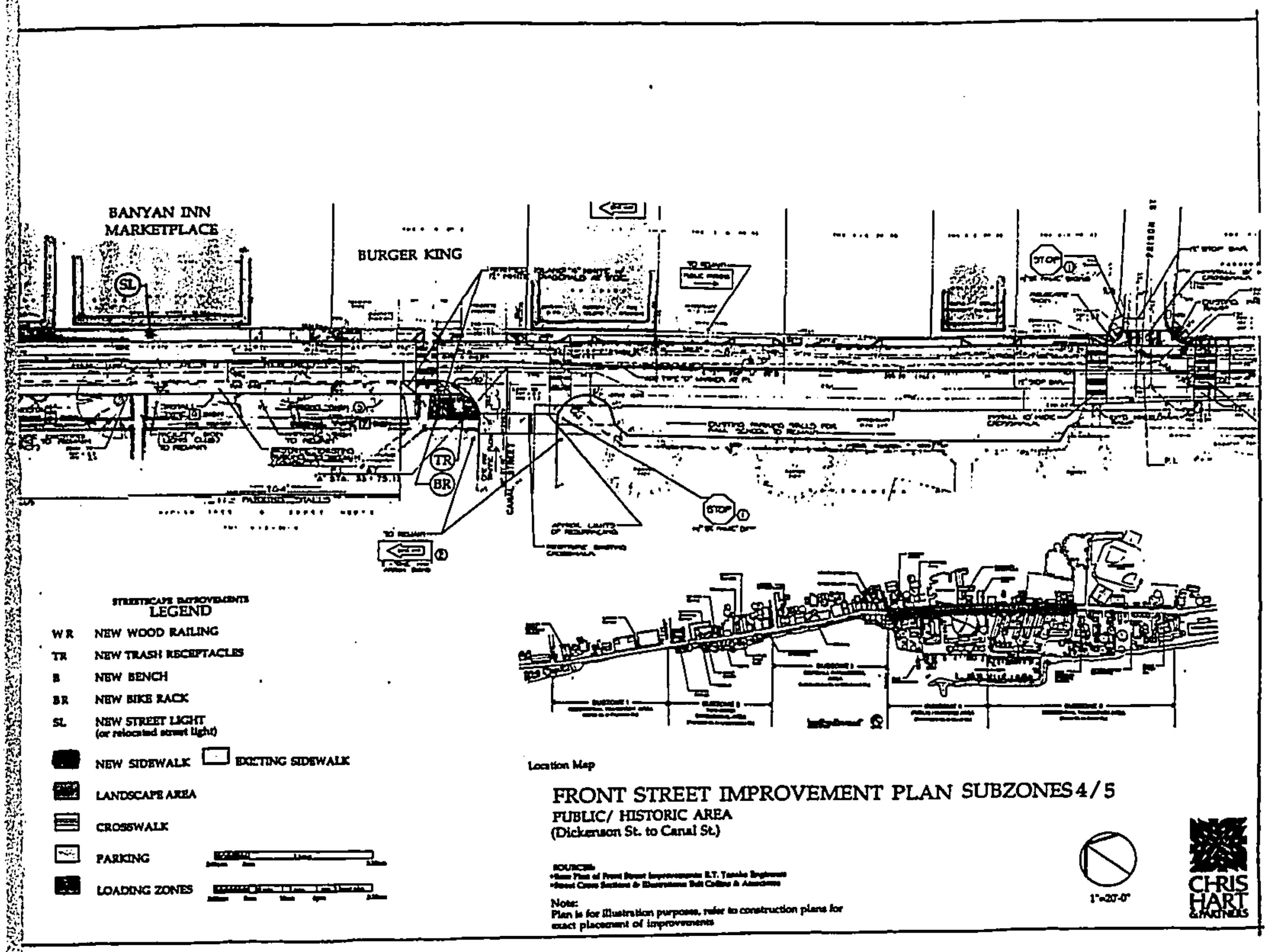
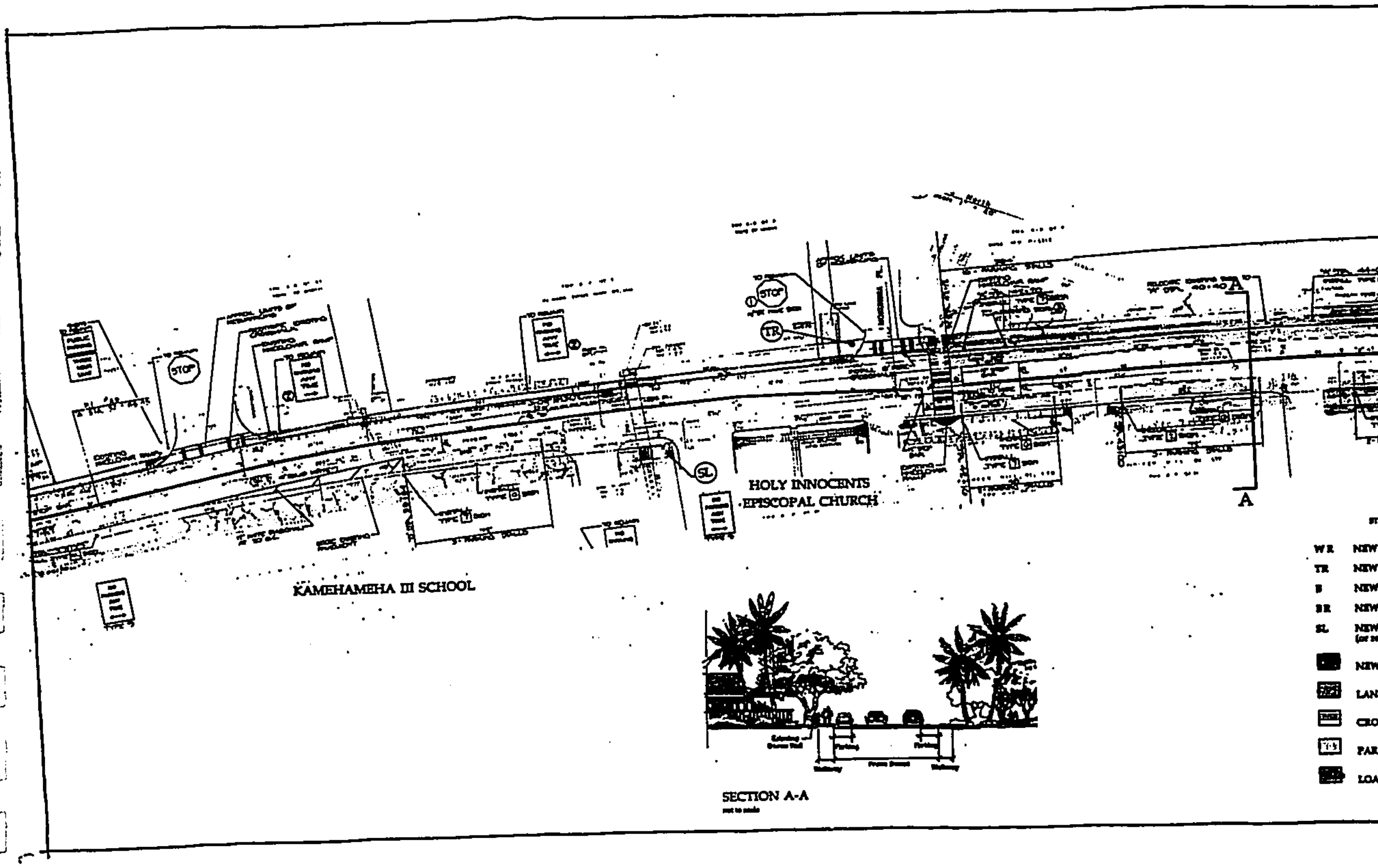

BANYAN INN MARKETPLACE
BURGER KING
SL
TR
BR
STOP
LEGEND
WR NEW WOOD RAILING
TR NEW TRASH RECEPTACLES
B NEW BENCH
BR NEW BIKE RACK
SL NEW STREET LIGHT (or relocated street light)
NEW SIDEWALK
EXISTING SIDEWALK
LANDSCAPE AREA
CROSSWALK
PARKING
LOADING ZONES
Location Map
FRONT STREET IMPROVEMENT PLAN SUBZONES 4/5
PUBLIC/ HISTORIC AREA
(Dickenson St. to Canal St.)
Note:
Plan is for illustration purposes, refer to construction plans for exact placement of improvements
1"=20'-0"
CHRIS HART & PARTNERS

FIGURE 8



HOLY INNOCENTS
EPISCOPAL CHURCH
KAMEHAMEHA III SCHOOL
STOP
TR
SL
A
SECTION A-A

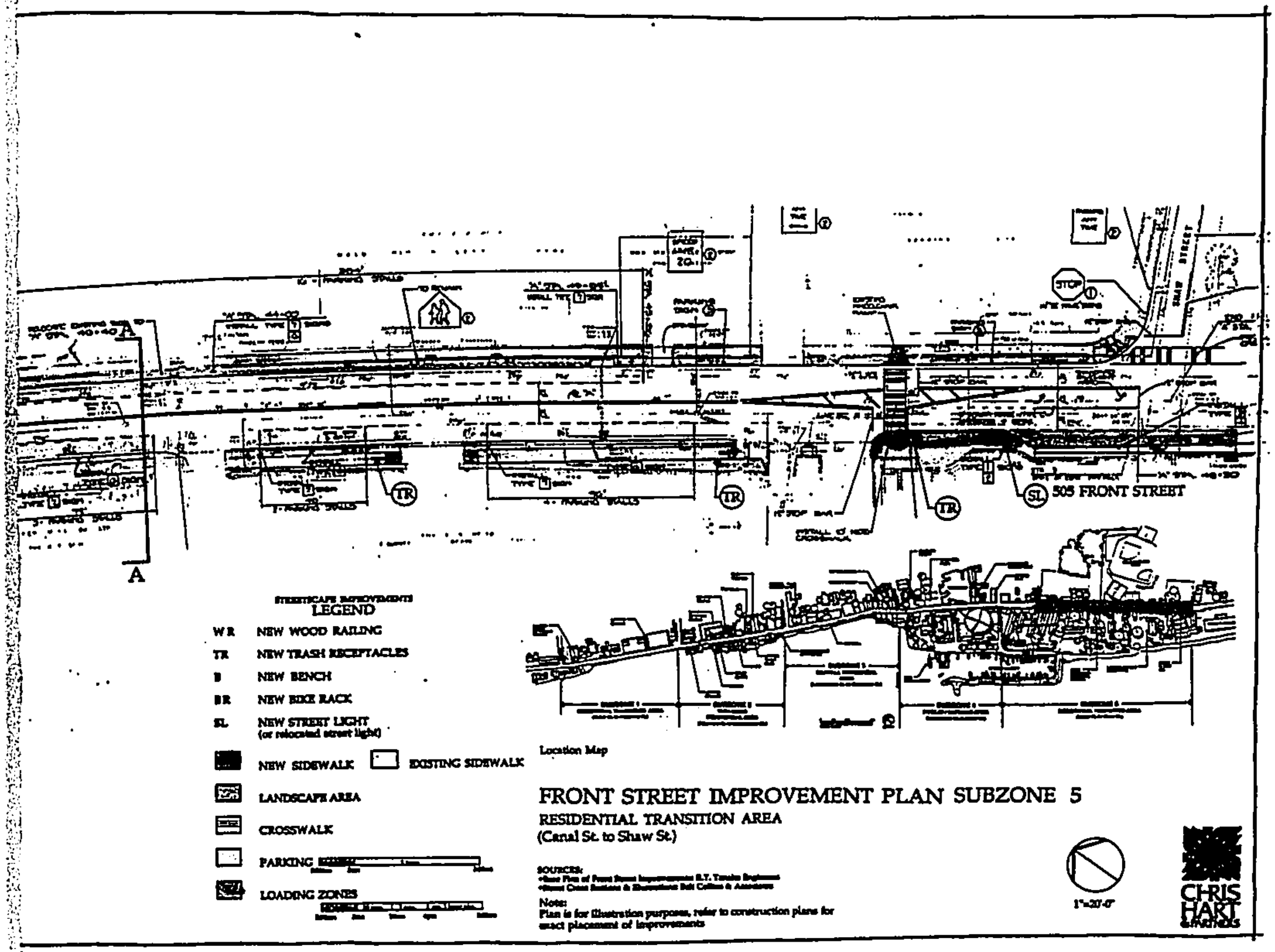
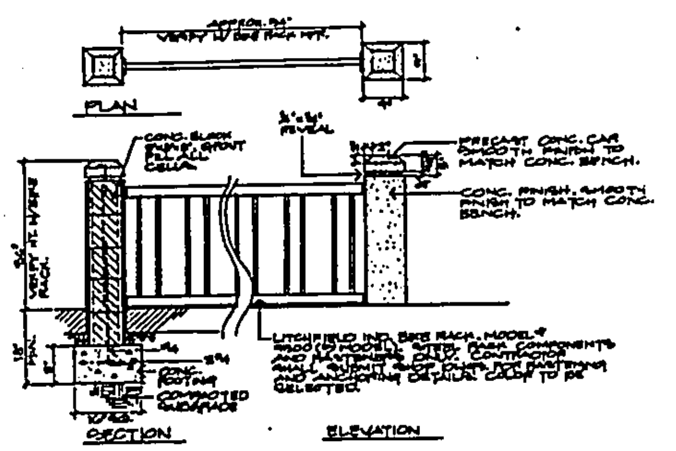
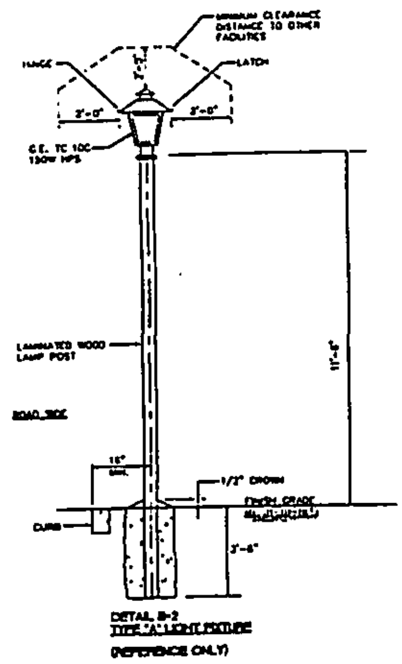

505 FRONT STREET
SHAW STREET
STOP
TR
SL
A
LEGEND
WR NEW WOOD RAILING
TR NEW TRASH RECEPTACLES
B NEW BENCH
BR NEW BIKE RACK
SL NEW STREET LIGHT (or relocated street light)
NEW SIDEWALK
EXISTING SIDEWALK
LANDSCAPE AREA
CROSSWALK
PARKING
LOADING ZONES
Location Map
FRONT STREET IMPROVEMENT PLAN SUBZONE 5
RESIDENTIAL TRANSITION AREA
(Canal St. to Shaw St.)
SOURCES:
Note:
Plan is for illustration purposes, refer to construction plans for exact placement of improvements
CHRIS HART

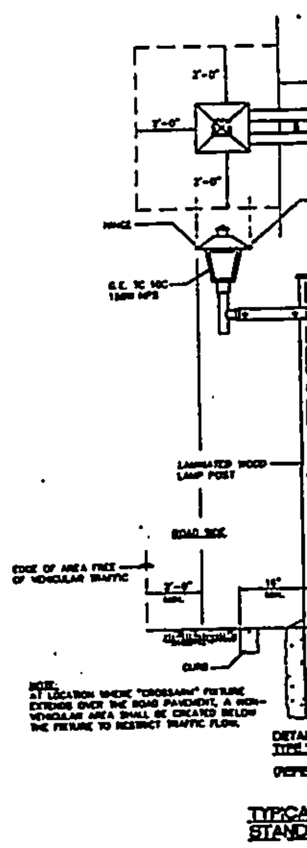
FIGURE 9



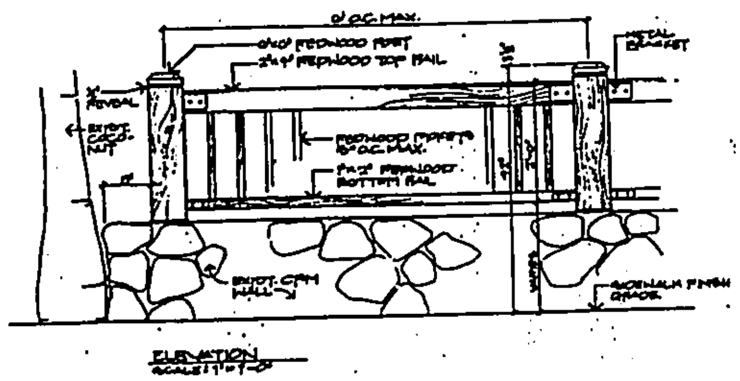
BIKE RACK



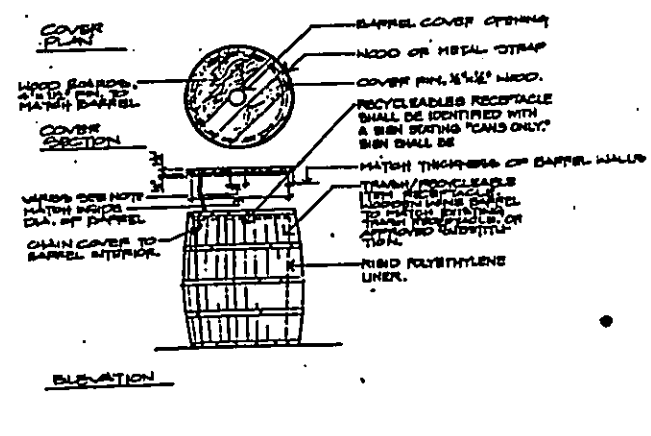
TYPICAL "STRAIGHT" STANDARD INSTALLATION



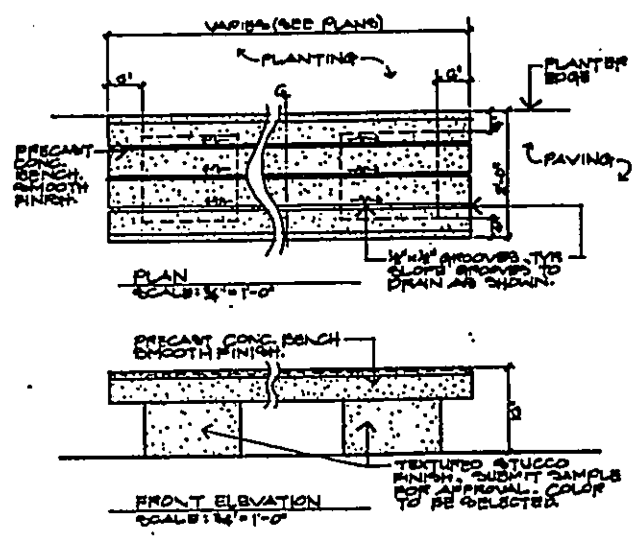
STREET LIGHT



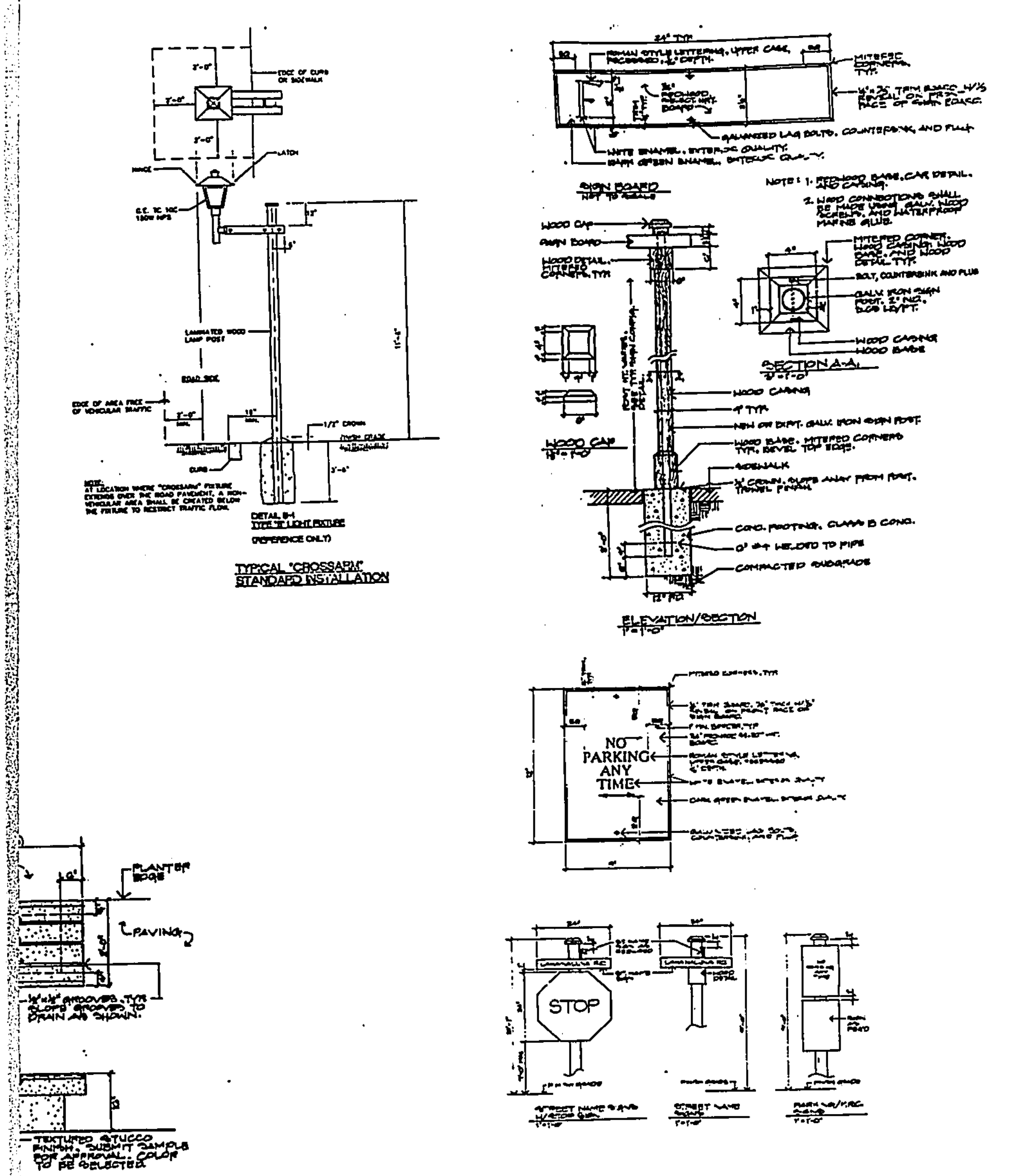
WOOD RAILING



TRASH RECEPTACLE



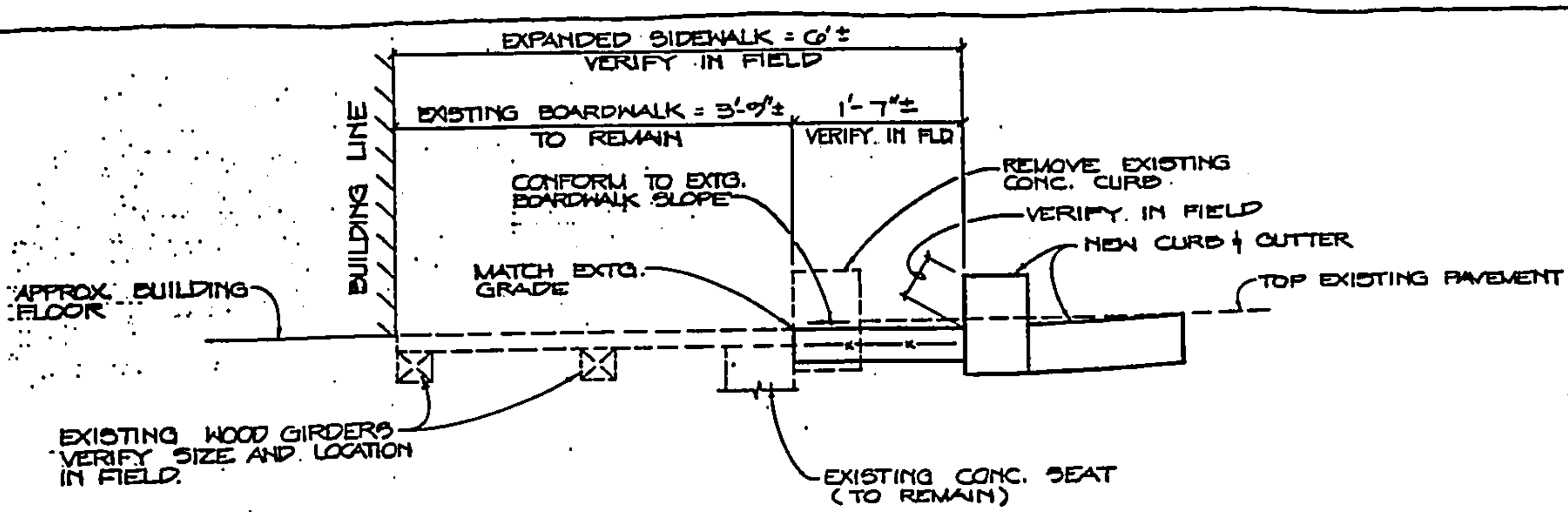
BENCH



SIGNAGE

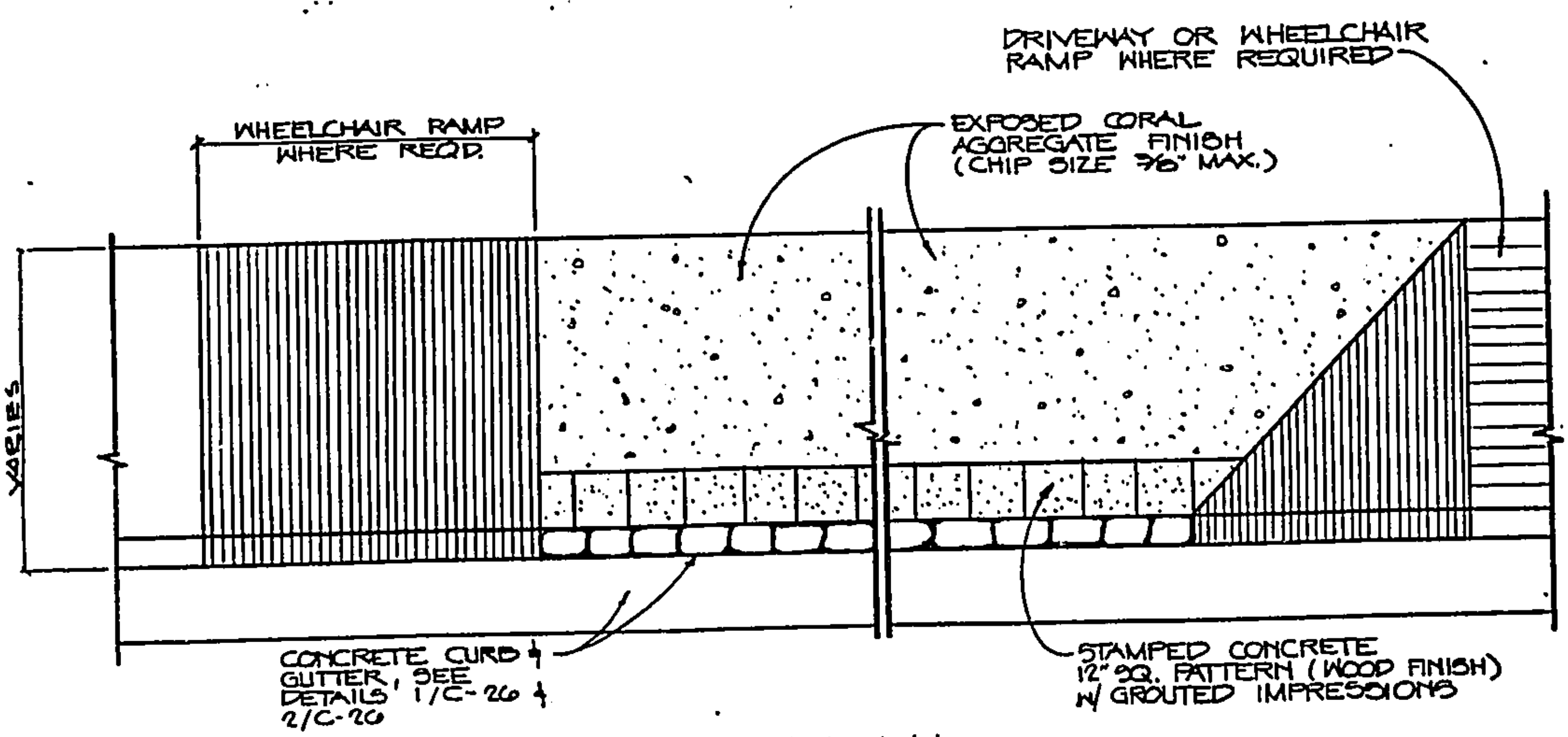
FIGURE 10

CONSTRUCTION DETAILS BY: BELT COLLINS & ASSOCIATES



SECTION

DETAIL - BOARDWALK EXPANSION

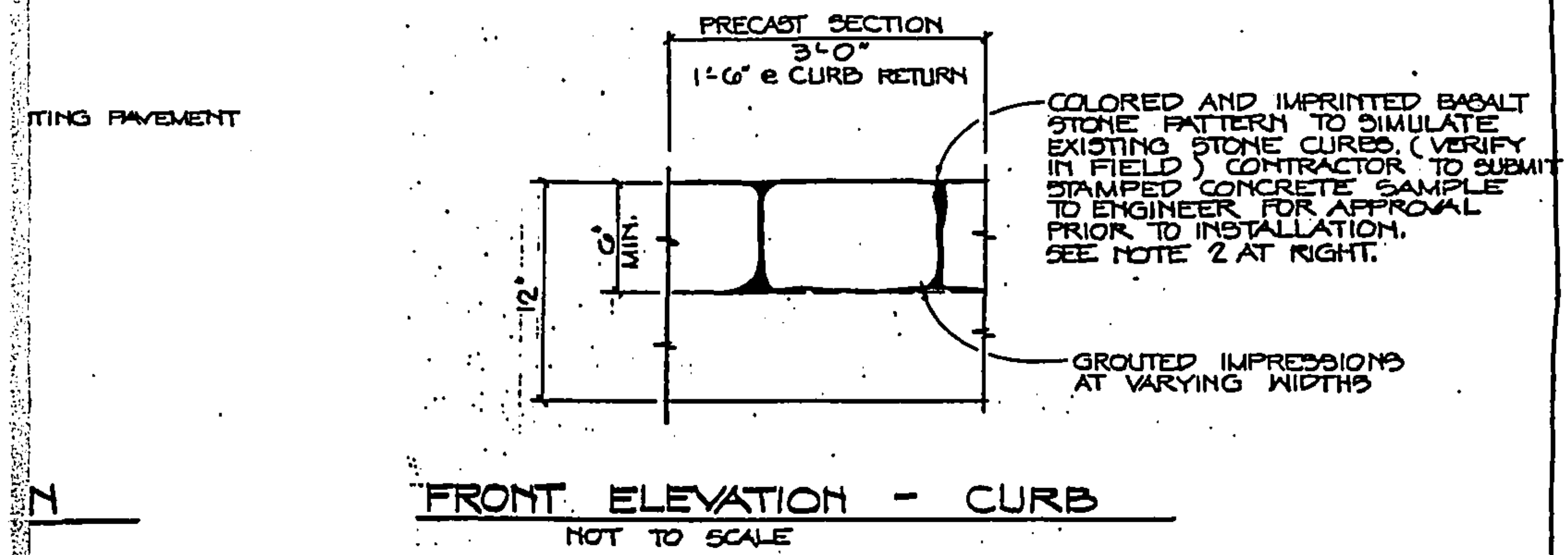


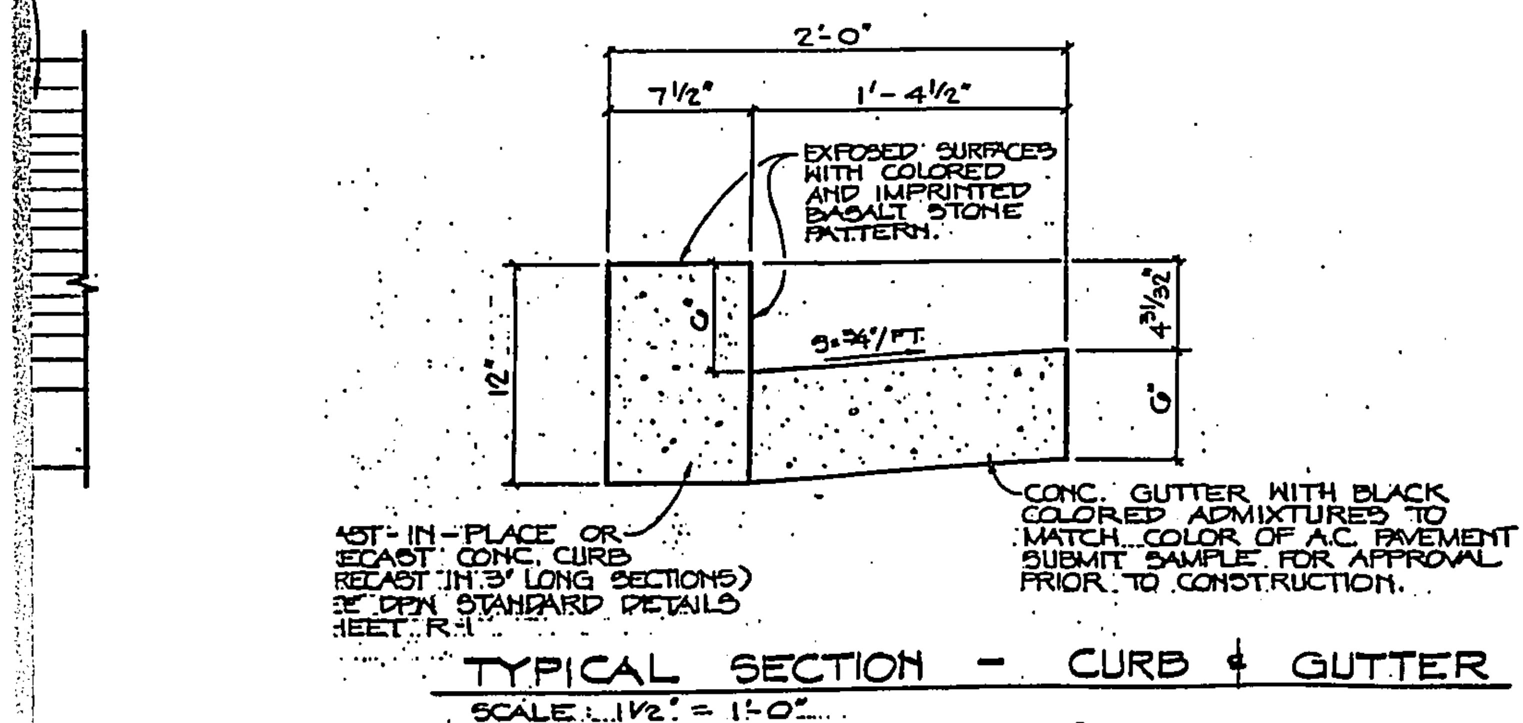
PLAN

DETAIL - TYPE "A" SIDEWALK

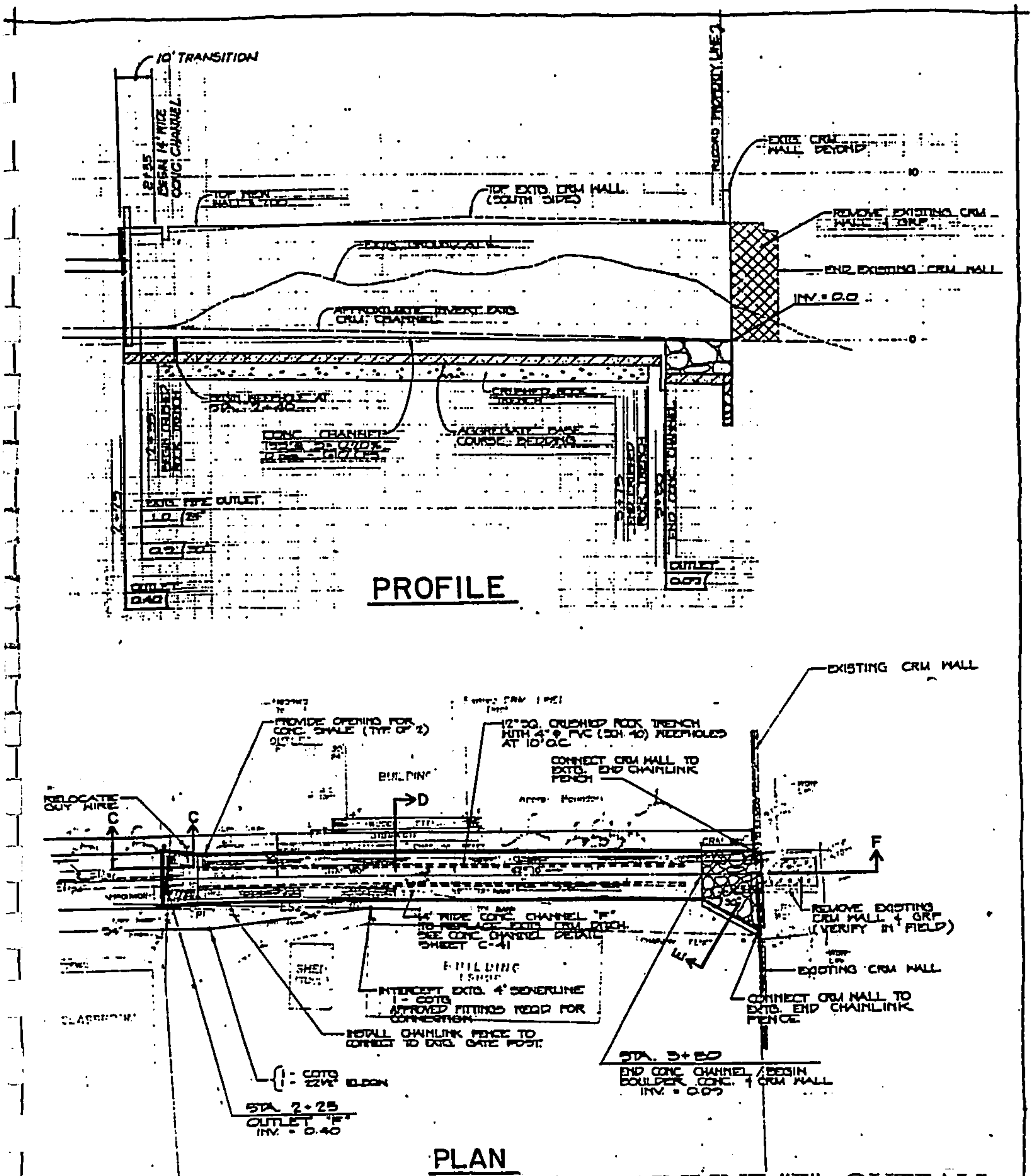
SCALE: 3/8" = 1'-0"

Details by: R. T. Tanka Engineers Inc.



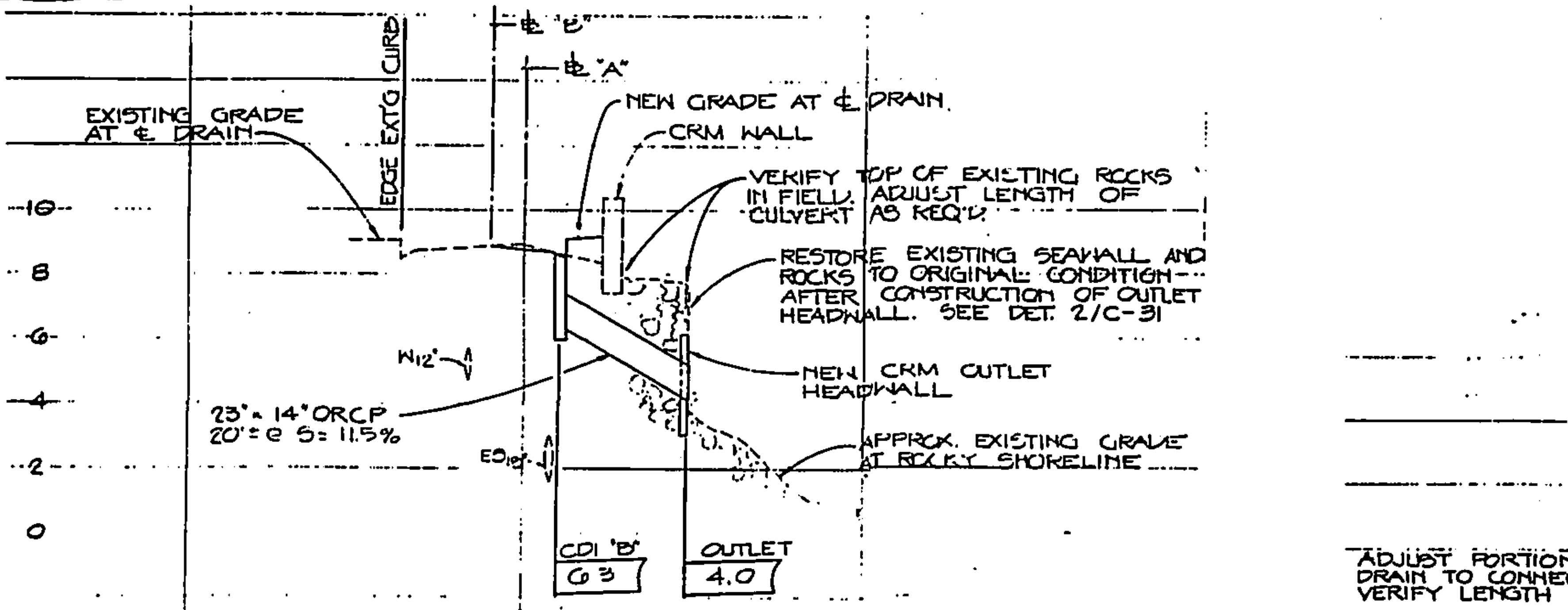


CONSTRUCTION DETAILS FIGURE 11



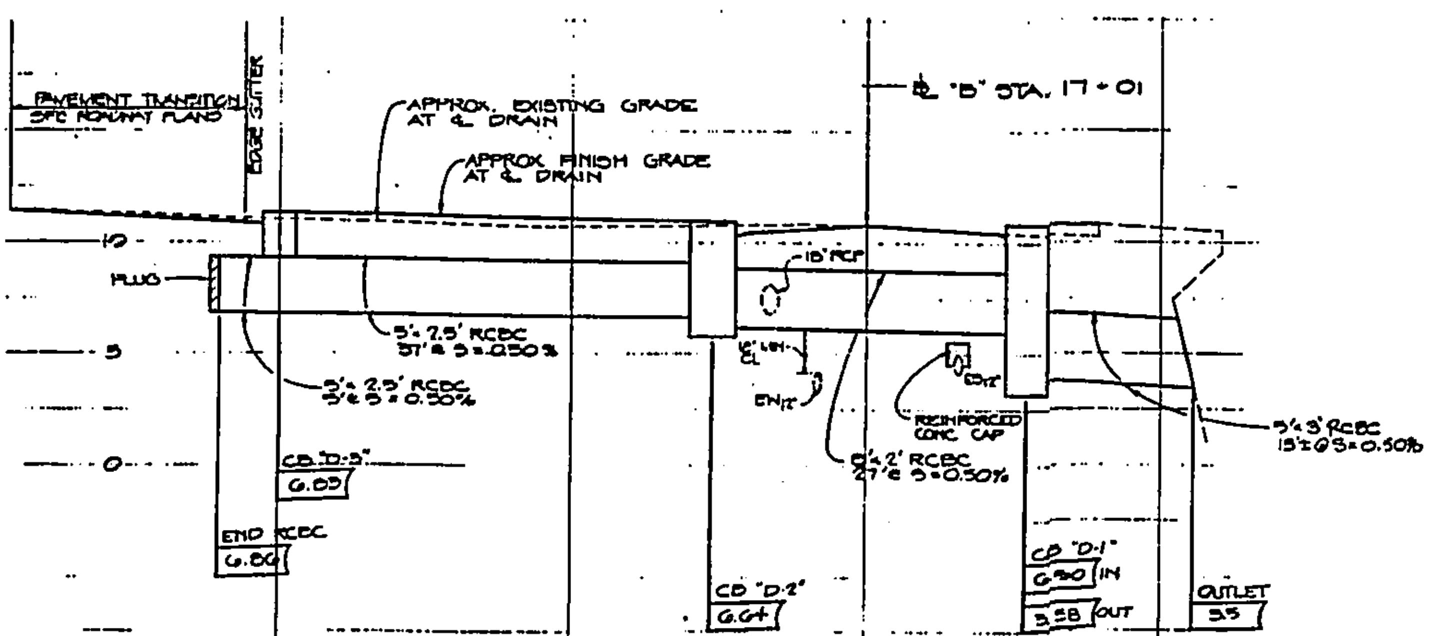
DRAINLINE "F"- OUTFALL
FIGURE 12

Details by: R. T. Tanka Engineers Inc.



PROFILE - DRAINLINE "B" CROSSING

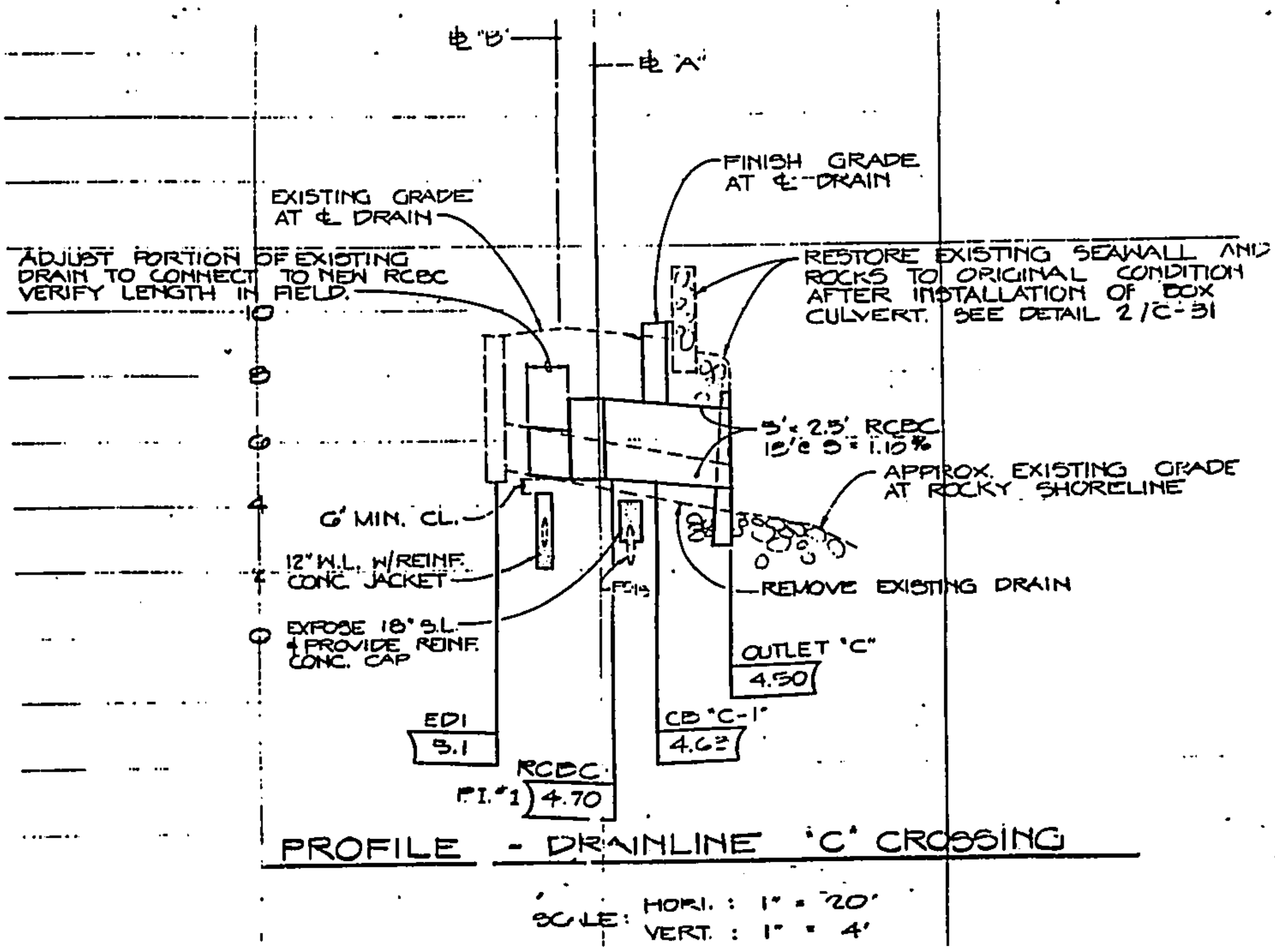
SCALE : HORI : 1" = 20'
VERT : 1" = 4'



PROFILE - DRAINLINE "D"

SCALE: HORI. 1" = 10'
VERT. 1" = 5'

Details by: R. T. Tanka Engineers Inc.



DRAINLINES "B", "C", & "D"- OUTFALLS

FIGURE 13

APPENDIX A

COASTAL AND MARINE ENVIRONMENTAL INVESTIGATION REPORT

COASTAL ENGINEERING AND MARINE ENVIRONMENT INVESTIGATIONS FOR DRAINLINE "F" IMPROVEMENTS, LAHAINA, MAUI

Prepared For:

Chris Hart & Partners
1955 Main Street, Suite 200
Wailuku, Maui

Prepared By:

Sea Engineering, Inc.
Makai Research Pier
Waimanalo, Hawaii

and

AECOS, Inc.
970 N. Kalaheo Avenue, Ste. C-311
Kailua, HI 96734

July 1994

#94-47

EXECUTIVE SUMMARY

As part of the Front Street Improvement Project, Drainline "F" will be renovated and expanded to accommodate the projected runoff from a 100-year storm. The general oceanographic conditions for the project site have been evaluated from a review of previous literature, analysis of historical aerial photographs, a surface drogue study, a bathymetric survey, and observation of the existing condition of the nearshore zone. A buoyant discharge model has also been completed that characterizes the plume transport and dispersion for projected 5-year and 100-year storm events. Water quality samples were taken in the Lahaina region and at the project site, analyzed, and compared with previous similar studies. Classification of bottom types and biotope mapping was accomplished by review of aerial photographs and a reconnaissance survey at the project site.

The project site is protected from waves and wind from the northwest through northeast, however, it is exposed to southern winds and waves from Kona storms, hurricanes, and southern swell. Regional coastal currents are predominately driven by the tides. The currents parallel the coast and reverse with ebb and flood conditions. Currents tend to be northerly with ebb tides and southerly with flood tides, although current reversals do not always occur, and the northerly flow appears to be dominant.

Drogue studies at the project site indicated northerly currents during both ebb and flood conditions for the shallow nearshore zone within the fringing offshore reef. Current directions at the site are hypothesized to be heavily influenced by the local bathymetry and wave conditions. The bathymetry for the site shows a pass in the fringing reef off the drainline where the circulation tends to flow.

The buoyant discharge models show that the high velocities of the projected flow for both the 5-year and 100-year storms dilutes the plume through entrainment and mixing with surrounding waters. The discharge plume is narrow near the shore, and carries the effluent rapidly offshore to deeper water where it can be more easily diluted by stronger coastal currents.

At present the coastline is severely eroded. Review of historical aerial photographs show that the beach is normally 30 to 50 feet in width, and that beach erosion has occurred in the past. Based on the aerial photographs, the presence of outlet structures of Drainline "F" on the beach has had minimal impact, contributing neither to beach erosion nor accretion.

The plans for the renovated outlet for Drainline "F" call for an apron to spread and retard the flow. Some scouring of the beach is likely to occur in front of the apron, but this will likely be a temporary condition that will be naturally repaired with the end of storm conditions and consequent redistribution of beach sediment. The proposed storm drain improvements should have no significant impact on longshore sediment transport.

Sand that has accumulated in the drainage culvert behind the shoreline can be removed and placed on the beach north of Drainline "F". This will both nourish the beach and keep the sand from returning to the drainline area during construction.

Water quality measurements made in June 1994 from nearshore and offshore waters between Mala and Puamana show that for most parameters, conditions during the summer (dry) season are fairly typical of dry open coastal waters around the Hawaiian Islands, with minimal influences from land drainage on the nearshore waters. Comparisons with samples collected south of Lahaina in 1976, in 1982-83, in 1988, and recently off Ka'anapali suggest that baseline water quality in this area has not changed substantially in over 15 years.

Measurements made in and off of Kaua'ula Stream in relation to a storm in December 1982 (Grigg, 1983) demonstrated that storm runoff from the Lahaina Watershed contributes to elevated nutrients (nitrates and orthophosphates) and suspended solids in the nearshore waters. Measurements made two weeks after the storm showed most parameters had returned to pre-discharge values.

The marine environment off Drainline "F" is a shallow reef flat extending seaward to a shoaling reef margin about 500 feet off Lahaina Beach. Much of the reef flat is under 1 meter, deep, has a bottom type of mixed sand and rubble, and supports mostly a moderately dense growth of algae dominated by *Lyngbya* and *Acanthophora*. Fishes are sparse because of a lack of suitable cover. The seaward margin of the reef is a shoaling mound of coral rubble deposited by waves.

Just landward of the rubble mound is an area of large coral heads, mostly *Porites lobata*. Coral cover is high, exceeding 80% in localized areas. This environment, designated Biotope "C" or the coral moat biotope, supports a diverse and abundant fish fauna and provides a unique snorkeling opportunity that is under utilized by visitors.

Seaward of the reef margin is a reef front which slopes gently into deeper water. This slope is limestone cut by grooves and supporting a coral community of increasing cover from minimal occurrence of corals along the shallow margin 90% cover beyond about 200 feet seaward.

Water quality impacts on the marine environment can result from salinity depression as fresh water is discharged from a storm drain, from sediments carried with the discharge, and from a variety of pollutants associated with terrestrial runoff. Construction related impacts are expected to be minor if the site is adequately isolated from the marine environment during construction at the shore. The results of modeling of the discharge plume indicate that damage from salinity depression will be limited to the shallow reef flat directly off the mouth of Drainline "F". Even severe conditions from a 100-year flood event will not produce salinity depression harmful to corals in the high coral coverage, reef front environment.

Sediment impacts can occur to sensitive marine ecosystems in the Lahaina area and require that adequate controls exist (or are implemented on a project basis) on the watershed to minimize erosion during infrequent storms. Most urban pollutants are associated with the fine sediment fraction carried into the ocean by storm runoff. Mitigation of pollutant impacts can be achieved by street sweeping and maintenance of drainage systems. Prevailing currents on the reef flat off Drainline "F" are anticipated to provide significant protection to coral reef resources in this area.

The coral moat environment (Biotope "C") of the Lahaina Beach reef flat harbors a marine community that would be sensitive to impacts from land runoff. Development of the reef community in shallow, protected waters is due to a unique set of circumstances. The shallow reef margin supports an extensive deposit of loose rubble which provides protection to the moat from the abrasive action of waves, but enhances the exchange of water as waves break across the mound. The inward flow of water from translated waves and the along shore flow northward on the reef flat isolates the coral moat community from land influences.

Development of Drainline "F" must proceed with care to minimize the volume of flows and, in particular, the transport of fine sediments and urban polllutants into the marine environment. However, the location of Drainline "F" is preferable as an outlet for locally generated storm runoff compared with locations between Lahaina Harbor and the south end of the Lahaina Beach reef. The existing outlet is close to an opening in the shallow reef margin adjacent to the Lahaina Harbor breakwater, minimizing opportunity for discharges to impact on the sensitive outer reef flat ecosystems.

I. INTRODUCTION

PROJECT LOCATION AND GENERAL DESCRIPTION

The Drainline "F" coastal storm water drainage outlet is located about 200 feet southwest of the Lahaina Harbor breakwater, in Lahaina Town on the west shore of Maui (Figure I-1). The drainline trends perpendicular to the shoreline and passes south and adjacent to Kamehameha III school. The drainage ditch is partially filled with sediment, and the outlet is in a state of disrepair. Properties on both sides of the drainline are protected at the shoreline by vertical seawalls. The outlet of the drainline consists of a concrete apron with wing-walls, extending approximately 15 feet from the seawalls onto the beach. The northern wall is built on top of a partially destroyed sewer line that extends past the wall and into the ocean. Photographs of the existing shoreline in the vicinity of Drainline "F" are shown in Figure I-2.

Drainage system improvements, as part of the Front Street Improvement Project, include plans that expand the flow capacity of Drainline "F" to levels predicted for a 100-year storm. Drainage system facilities were determined on the basis of full development of land use categories as defined in the "Lahaina Community Plan" of December, 1983. The improvements call for the removal of all existing structures. The new drainage system will consist of twp 4 x 8-foot box culverts opening to a 14 feet wide concrete channel. The drainage will exit over a rough boulder concrete apron designed to spread and retard the flow as it meets the shore. Two alternate designs for this apron have been proposed. In the first, the apron will extend past the shoreline (as defined by the seawalls) out onto the beach, over the footprint of the existing structures. The second alternative calls for the apron to end at the shoreline, even with the seawalls.

Although historically the project site has a sandy shoreline, typically 30 feet to 50 feet in width, at this time (June 1994) only a narrow strip of beach lies in front of the sea wall at mean sea level, with increased width next to the Lahaina Harbor breakwater. Even with the reduced beach width, however, the area is used for recreational activities, predominately for beginner level surfing, ocean kayaking, and snorkeling. The beach width increases significantly about 200 feet south of the drainline, where the sea wall ends.

The southern arm of the Lahaina Harbor breakwater extends perpendicular from shore approximately 200 feet before turning north. Most of the surfing activities take place about 150 feet seaward from the breakwater corner.

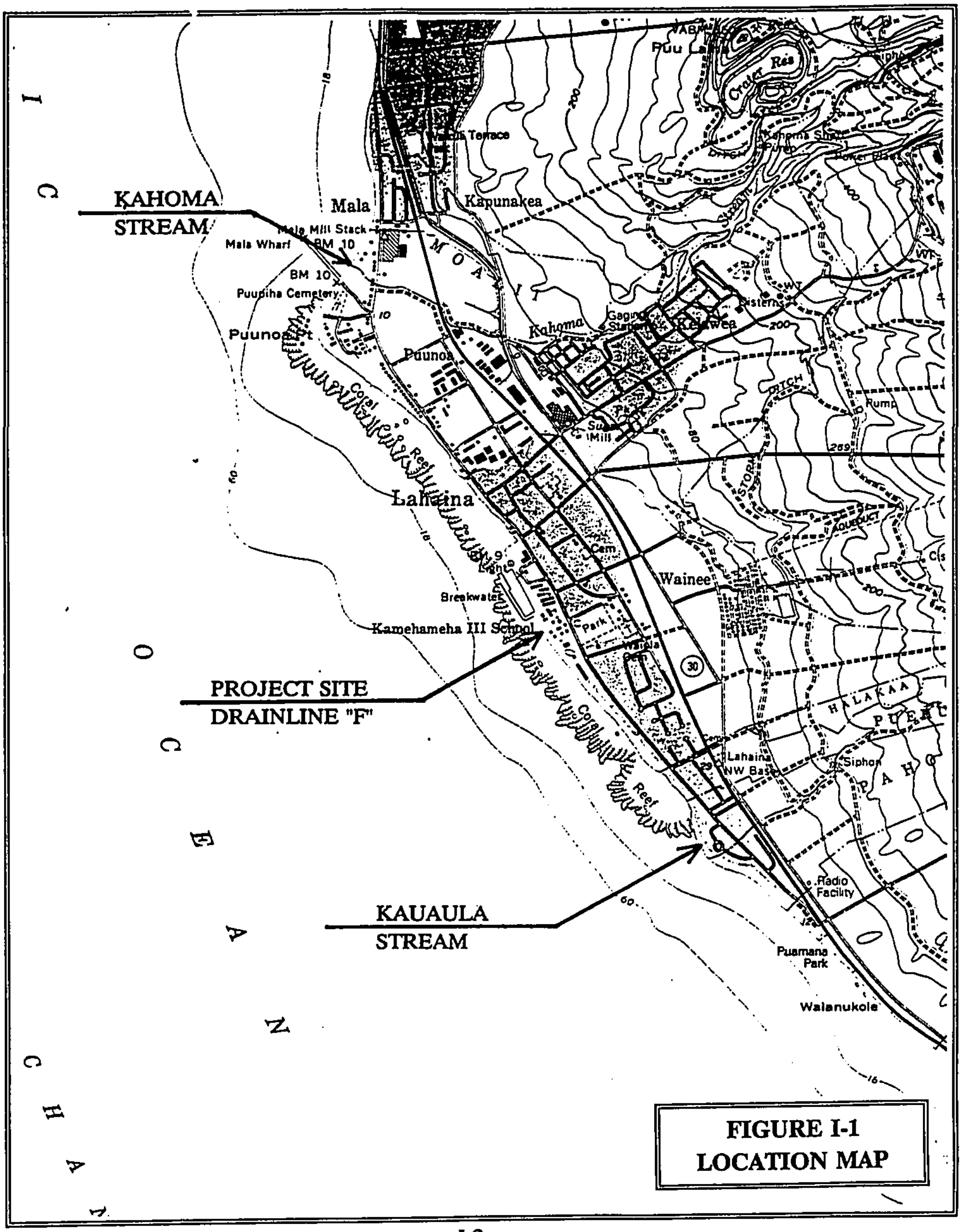


FIGURE I-1
LOCATION MAP

A. LAHAINA SHORELINE IN THE VICINITY OF DRAINLINE "F".

B. LOOKING SOUTH FROM THE JUNCTION OF THE SHORE AND LAHAINA HARBOR BREAKWATER

FIGURE I-2

PURPOSE AND SCOPE OF STUDY

The purpose of this study is to provide information for the project environmental assessment and permitting process by evaluating the existing oceanographic conditions at the project site and assessing the impacts of the project on the physical and biological environment. Characterization of the general oceanographic conditions for the project site include descriptions of the waves, winds, both regional and site specific circulation, and stormwater discharge transport and dilution. The marine biological environment and ambient water quality will also be investigated.

Work tasks include:

- Review of existing reports and aerial photographs containing information about the waves, winds, currents, and circulation in the Lahaina coastal region.
- Field investigation of nearshore currents by use of surface current drogues.
- Evaluation of the condition, characteristics, and general coastal processes in the vicinity of Drainline "F", with specific application to the improvement apron design and its possible impact on the shore.
- Completion of a buoyant discharge model to characterize plume transport and dispersion at the discharge location. The model will include information gathered from the literature search and the field experiments, and be applied to design conditions (100-year flood), as well as less extreme conditions of 50-year and 5-year events.
- Qualitative biotope mapping of the shore, reef, and offshore area in the vicinity of Drainline "F" by review of aerial photographs.
- Field survey to assess the biological assemblages in the vicinity of drainline "F" potentially subject to adverse impacts from drainage.
- Collect and analyze water quality samples at locations representing the nearshore and offshore waters in the vicinity of Drainline "F" and nearshore Lahaina waters.

II. COASTAL ENVIRONMENTAL SETTING

WINDS

The wind climate in the Hawaiian islands can be divided into two distinct seasons based upon the annual variation in persistence of the northeast tradewinds. The tradewinds predominate in the summer months of May through September, blowing 80 to 90 percent of the time with typical speeds from 10 to 25 mph. The tradewinds weaken in persistence during the winter months of November through March, and during this time southerly or westerly winds may blow intermittently. These are also known as Kona winds, and accompany the passage of storm fronts associated with low pressure systems travelling across the North Pacific ocean.

The project site is located on the west coast of Maui, and is sheltered from direct exposure to the northeast tradewinds by the West Maui mountains. The island topography and convective winds create considerable local variation along the coast. Parts of the coast are subject to strong, gusty tradewinds funneled through narrow gorges in the West Maui mountains. However, light and variable winds often predominate in the Lahaina region, and will follow a diurnal cycle associated with thermal gradients. Therefore, on-shore sea breezes will commonly blow at mid-day during typical tradewind conditions.

The Lahaina region is directly exposed to Kona winds blowing from the south-southwest to west. Periods of Kona winds are generally of short duration (1 to 3 days), and damaging Kona winds are not common. These do occur, however, and a severe Kona storm in January, 1980 had sustained wind speeds of about 30 knots or greater for a period of several days.

WAVES

There are four primary wave types that describe the wave climate of the Hawaiian Islands. These are northeast tradewind waves, southern swell, Kona storm waves, and North Pacific swell.

The project site is almost completely protected from both northeast tradewind waves and North Pacific swell by the islands of Maui and Molokai. In addition, the islands of Lanai and Kahoolawe offer partial shelter to the project area from southern swell and Kona storm waves.

Southern swell is generated from mid-latitude winter storms over the Tasman Sea and the Southern Pacific Ocean. These waves must travel long distances in order reach the Hawaiian Islands, and are therefore characteristically long and low, with deep water wave heights of 1 to 6 feet, and periods of 12 to 20 seconds. Their approach can vary from southeast through southwest. They are most common during the summer months of April through October, but may occur at any time.

Kona storm waves are locally generated by the southerly winds of Kona storms. They may have wave heights over 10 feet, with periods of 8 to 10 seconds. Kona storm waves approach from the south to the west, with the largest waves usually coming from the southwest. Deepwater wave heights during the severe Kona storm of January 1980 were about 17 feet with a period of 9 seconds.

As deepwater waves enter shallower depths, they can be significantly affected by the contours of the bottom. The process of wave refraction can focus the waves and increase the wave heights, or it can spread the waves and cause wave height decrease. A refraction diagram for the Lahaina Harbor area, using southern swell with a period of 12 seconds, was constructed as part of the environmental assessment for the Mala Wharf boat launching ramp and showed no appreciable regional increase or decrease in wave height due to refraction at the project site (Oceanic Institute, 1975).

STORMS

There are two distinct types of storms that typically affect the Hawaiian Islands, these are Kona storms and tropical cyclonic storms. Kona storms occur when the winter low pressure systems that travel across the North Pacific ocean dip south and approach the islands. Southerly winds generated by these storms not only cause Kona storm waves, but bring considerable precipitation to the normally dry leeward coasts. Hurricanes, the worst-case tropical cyclonic storms, are caused by intense low pressure vortices that are usually spawned in the eastern tropical Pacific ocean and travel westward. While they typically pass south of the Hawaiian Islands, their paths are unpredictable and they will occasionally pass near or over the Hawaiian Islands. In recent years hurricane Iwa (1982) and hurricane Iniki (1992) directly hit the island of Kauai. Damage from these hurricanes was extensive, not only on Kauai which was subject to both high wind and waves, but also along coastal areas on other islands exposed to large hurricane storm waves.

Wave heights up to 12 feet were reported at Lahaina during hurricane Iwa (Grigg, 1983). High waves during hurricane Iniki damaged or destroyed numerous boats moored in the

Lahaina Roadstead, and resulted in considerable erosion of the west facing Lahaina and Kaanapali shoreline.

TIDES

The tides in the Hawaiian Islands are semi-diurnal in nature, with high and low water occurring twice daily. Based on National Oceanic and Atmospheric Administration (NOAA) survey records the tides at Lahaina are:

Mean Higher High Water	2.2 feet
Mean High Water	1.7 feet
Mean Tide Level	1.0 feet
Mean Low Water	0.3 feet
Mean Lower Low Water	0.0 feet

CURRENTS AND CIRCULATION

In the large scale of global oceanic circulation, the Hawaiian Islands are located within the stream of the North Equatorial Current. However, local currents are generally tidally driven. In general, currents in the Lahaina region are semi-diurnal reversing tidal currents. Environmental Consultants (1976), Grigg (1983), and Sea Engineering, Inc. (1989) all show data that correlate current reversals with tide reversals. The coastal currents set parallel to the coast, northerly during ebb tide and southerly during flood tide. Current meter and drogue data off West Maui indicate a lack of vertical shear, that is, the currents are approximately equal throughout the water column. There is, however, a horizontal shear, meaning that currents are stronger away from the shoreline in deeper water.

Ebb currents, in the northerly direction, are usually stronger than the southerly flood currents, indicating a net transport to the north. A net northerly flow does not always prevail, however. Sea Engineering, Inc. (1989) took current measurements at Launiuopoko, two miles south of Drainline "F" in January 1988 that, while showing reversing tidal currents in agreement with previous work, also show a net transport to the south. A Department of Health employee who observes plume propagation after high runoff events notes that while the large plumes generated by the Kahoma and Kaua'ula streams usually move to the north, occasionally they move south (Wiltse, 1994, pers. comm.). It is likely that the net transport is to the north a large percentage of the time, but that net southerly transport occasionally occurs.

Drogue studies off Lahaina show current speeds up to 3.28 ft/sec (2 knots) (Aki 1975, in Environmental Consultants, 1976). Measurements in the Launiuopoko area, in shallower water (30 feet) show current speeds up to 0.98 ft/sec (30 cm/sec) (Environmental Consultants, 1976). Grigg (1983) measured currents offshore of Drainline "F", and showed a maximum speed of approximately 0.8 ft/sec in a southerly direction.

It is likely that currents near shore are greatly affected by reef configurations and water transport over the reef by breaking waves (known as wave set-up). Sunn, Low, Tom, and Hara (1974) found southerly currents inside the reef at Lahaina Town (north of the project site), while currents outside the reef were northerly.

Current drogue measurements were taken at the project site on June 20, 1994. Figure II-1 shows drogue paths and current speeds for flood tide while Figure II-2 shows drogue paths and current speeds during ebb tide. Five stations were chosen, three directly in front of Drainline "F" at 100 feet intervals (stations D1, D2, D3), and two on the sides, one 150 feet to the north and 100 feet offshore (station D4), and one 150 feet to the south and 100 feet offshore (D5). Station locations were measured and buoyed off, and positions of the drogues were estimated from buoy locations and markers placed on the beach.

Typical summer conditions prevailed during the day of the measurements, with moderate regional tradewinds giving local onshore sea breezes at the site of 10 to 12 knots for the flood measurements, and 6 to 8 knots for the ebb measurements. Surf was small (1 to 2 feet), but breaking waves occurred over the fringing reef and off the southwest corner of the Lahaina Harbor breakwater, as well as at the shoreline. About 10 to 15 persons were surfing in the area during the flood tide measurements. The surf increased somewhat during the day, and about 20 persons were surfing during the ebb tide measurements.

Both ebb and flood currents were strongly to the north, with stronger currents at ebb tide. Average currents for stations D1, D2, and D3 in front of the Drainline are 0.27 ft/sec for flood tide and 0.48 ft/sec at ebb. The highest speeds were 0.52 ft/sec measured from stations D2 and D3 during ebb tide.

Drogue trajectories showed a stronger onshore component during the flood measurements. These measurements were made at mid-day and the onshore flow may have been caused in part by the stronger onshore winds. The water in the northern corner of the site, bounded by the Lahaina Harbor breakwater and shoreline seawall, became visibly turbid

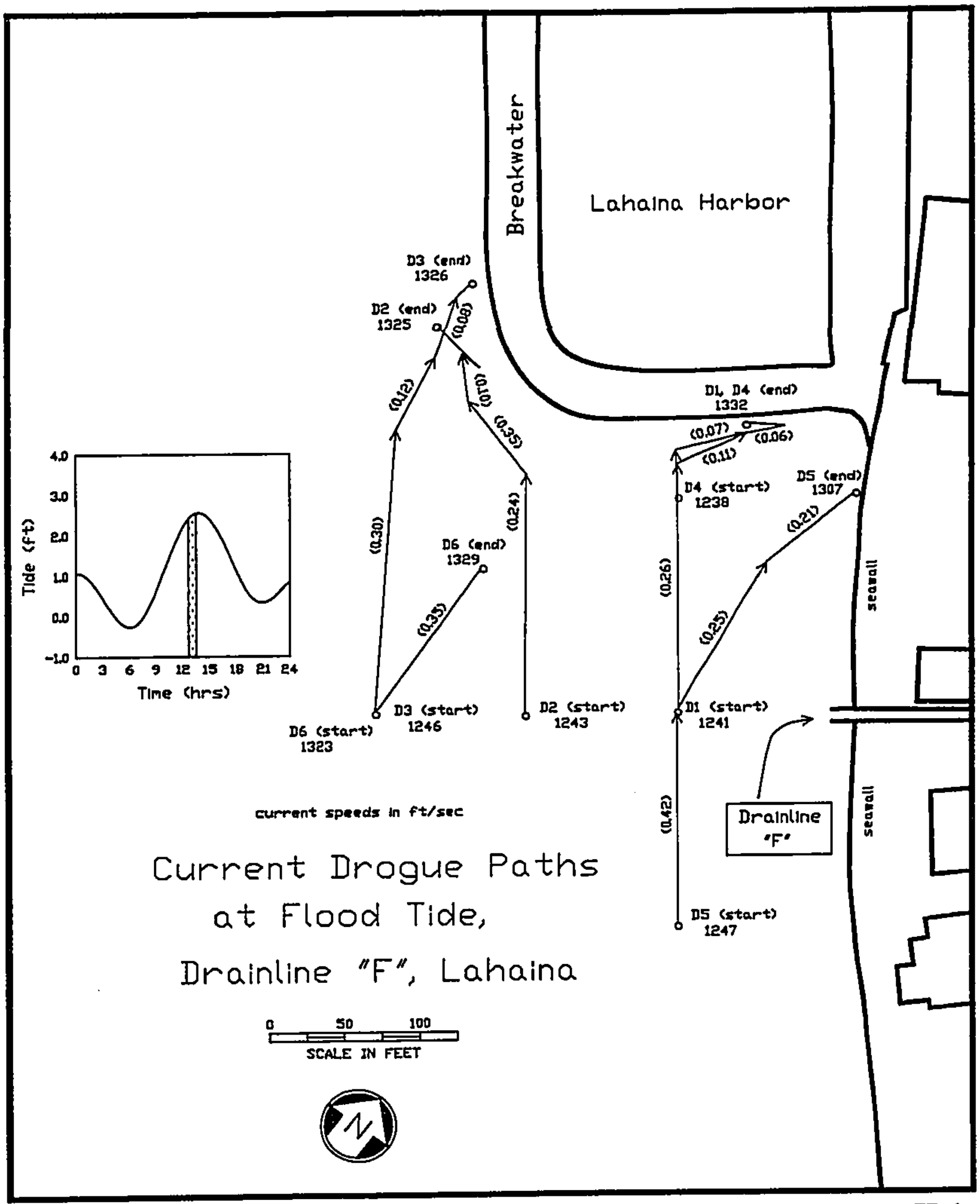

Breakwater
Lahaina Harbor
D3 (end)
1326
D2 (end)
1325
D1, D4 (end)
1332
D4 (start)
1238
D5 (end)
1307
D6 (end)
1329
D6 (start)
1323
D3 (start)
1246
D2 (start)
1243
D1 (start)
1241
D5 (start)
1247
Drainline "F"
seawall
seawall
Tide (ft)
Time (hrs)
current speeds in ft/sec
Current Drogue Paths
at Flood Tide,
Drainline "F", Lahaina
SCALE IN FEET

FIGURE II-1

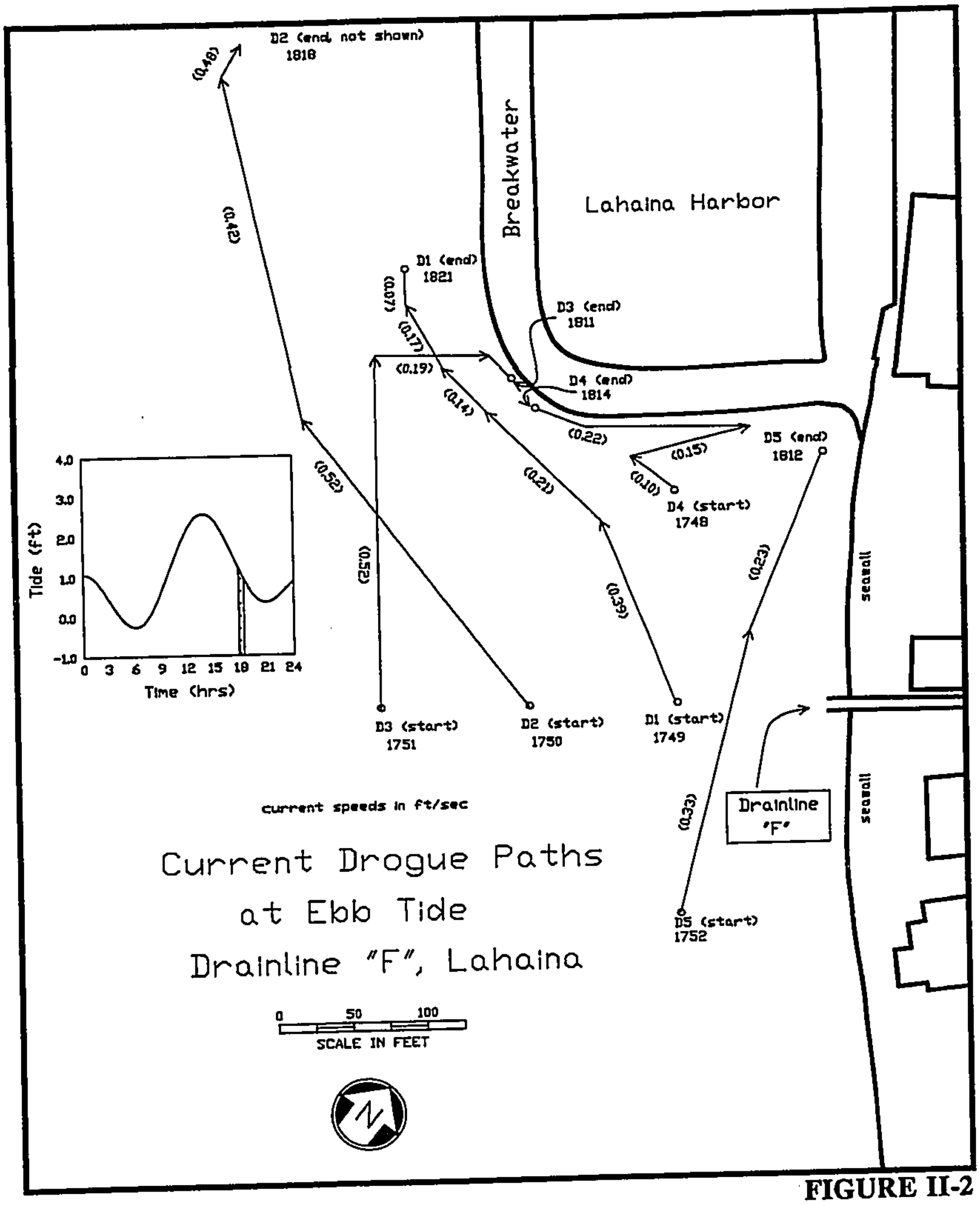

D2 (end, not shown)
1818
(0.48)
(0.42)
Breakwater
Lahaina Harbor
D1 (end)
1821
(0.07)
(0.17)
D3 (end)
1811
(0.19)
D4 (end)
1814
(0.14)
(0.22)
(0.15)
D5 (end)
1812
(0.10)
D4 (start)
1748
(0.52)
(0.21)
(0.52)
(0.39)
(0.23)
seawall
4.0
3.0
2.0
1.0
0.0
-1.0
Tide (ft)
0 3 6 9 12 15 18 21 24
Time (hrs)
D3 (start)
1751
D2 (start)
1750
D1 (start)
1749
current speeds in ft/sec
Drainline
"F"
(0.33)
seawall
Current Drogue Paths
at Ebb Tide
Drainline "F", Lahaina
D5 (start)
1752
0 50 100
SCALE IN FEET
N

FIGURE II-2

during the course of the flood measurements, and the drogues in this vicinity became stationary. However, a turbid plume was observed adjacent to the breakwater, flowing offshore. It is likely that onshore flow of surface water is compensated by an offshore underflow.

Spring tide conditions existed on the day of the survey, and high water was slightly higher than mean higher high water. Wave reflection off the seawalls was vigorous, giving agitated conditions at the shoreline. This accounted for the turbidity of the water near the shore.

Currents were stronger, and the offshore flow more pronounced for the ebb tide current measurements. There was no collection of turbid water as observed during the flood tide measurements. While a weak onshore flow was apparent (drogues D4 and D5, Figure II-2), there was also a strong boundary flow along the breakwater.

The trajectories of drogues D2 and D1 in the ebb tide measurements show what is probably the prevailing flow for the site: a northerly flow that heads offshore at the breakwater. What looks like an anomalous trajectory for drogue D3 is probably the result of an onshore push due to wave action. There are also indications of a small eddy at the tip of the breakwater in both the ebb and flood measurements. A schematic of the estimated typical current and circulation pattern in the vicinity of Drainline "F" is shown in Figure II-3.

It is likely that currents in front of Drainline "F" are strongly influenced by the fringing reef configurations and transport of water across the reef due to breaking waves. The shallow fringing reef in front of Drainline "F" extends to the south for over 2000 feet without a break, while a gap exist just to the north in front of the Lahaina Harbor breakwater. It is therefore considered unlikely for currents inside the reef at the site to ever flow to the south.

BATHYMETRY

General bathymetry and bottom contours were mapped during the field investigations, and are shown on Figure II-4. The project site is within a fringing coral reef system, which shoals to a depth of 1.5 feet approximately 500 feet offshore. The bathymetry deepens toward shore and becomes generally broad and flat with a depth of 2.5 feet before rising over a narrow ridge (depth 1.5 feet) and dropping to a trough (depth 3.0 feet) just off Drainline "F". The fringing reef ends just north of the drainline, such that there is a 250 feet gap of deeper water (greater than 2 feet) between the breakwater and the shallow reef. A small patch reef is situated about 150 to 200 feet west of the Lahaina Harbor breakwater. Although this patch reef is deeper than the shallow fringing reef, local refraction effects enhance wave heights here, and this is where most of the surfing activity takes place. The breaking waves here are readily apparent on aerial photographs.

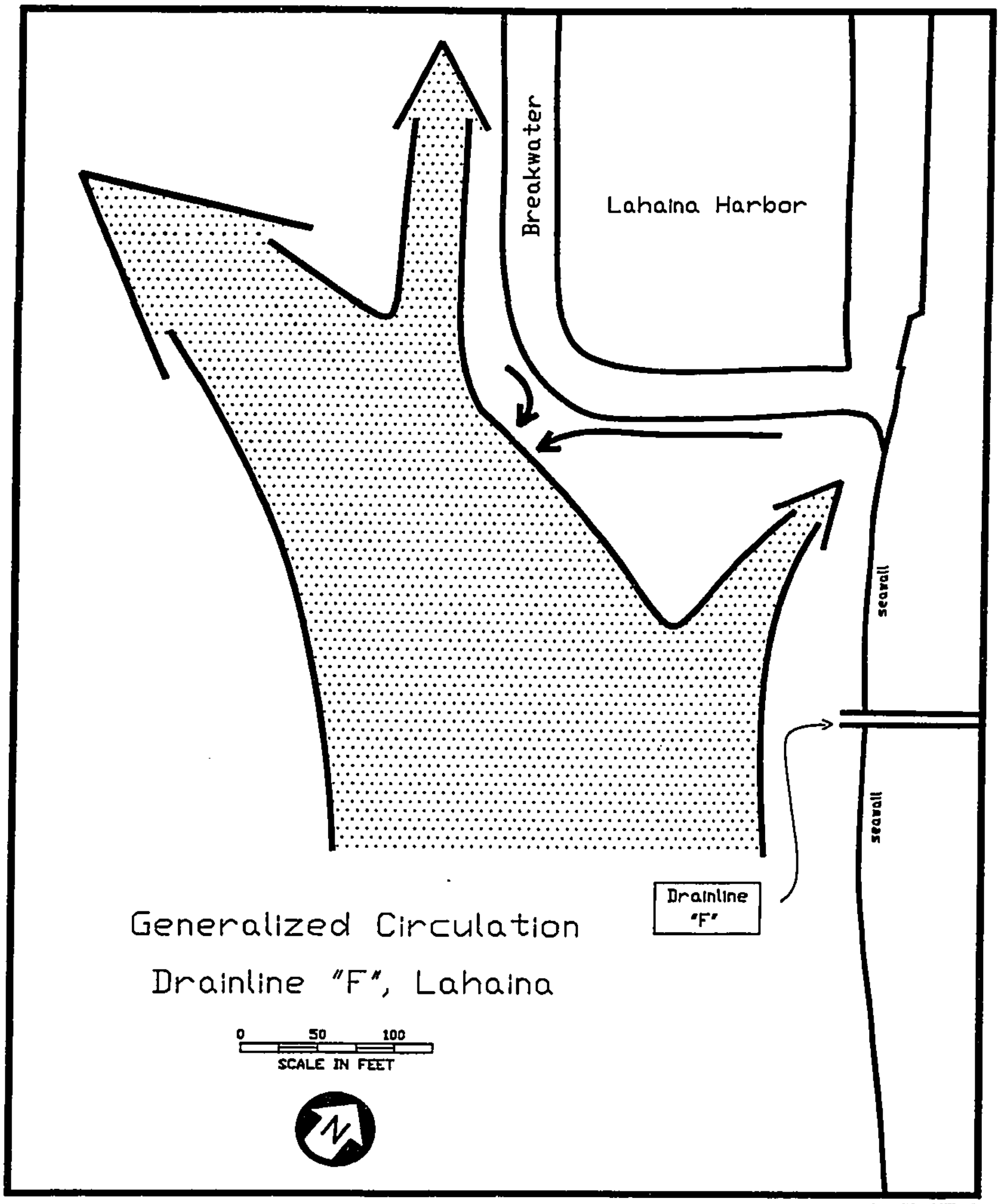

Breakwater
Lahaina Harbor
seawall
seawall
Drainline "F"
Generalized Circulation
Drainline "F", Lahaina
0 50 100
SCALE IN FEET
N

FIGURE II-3

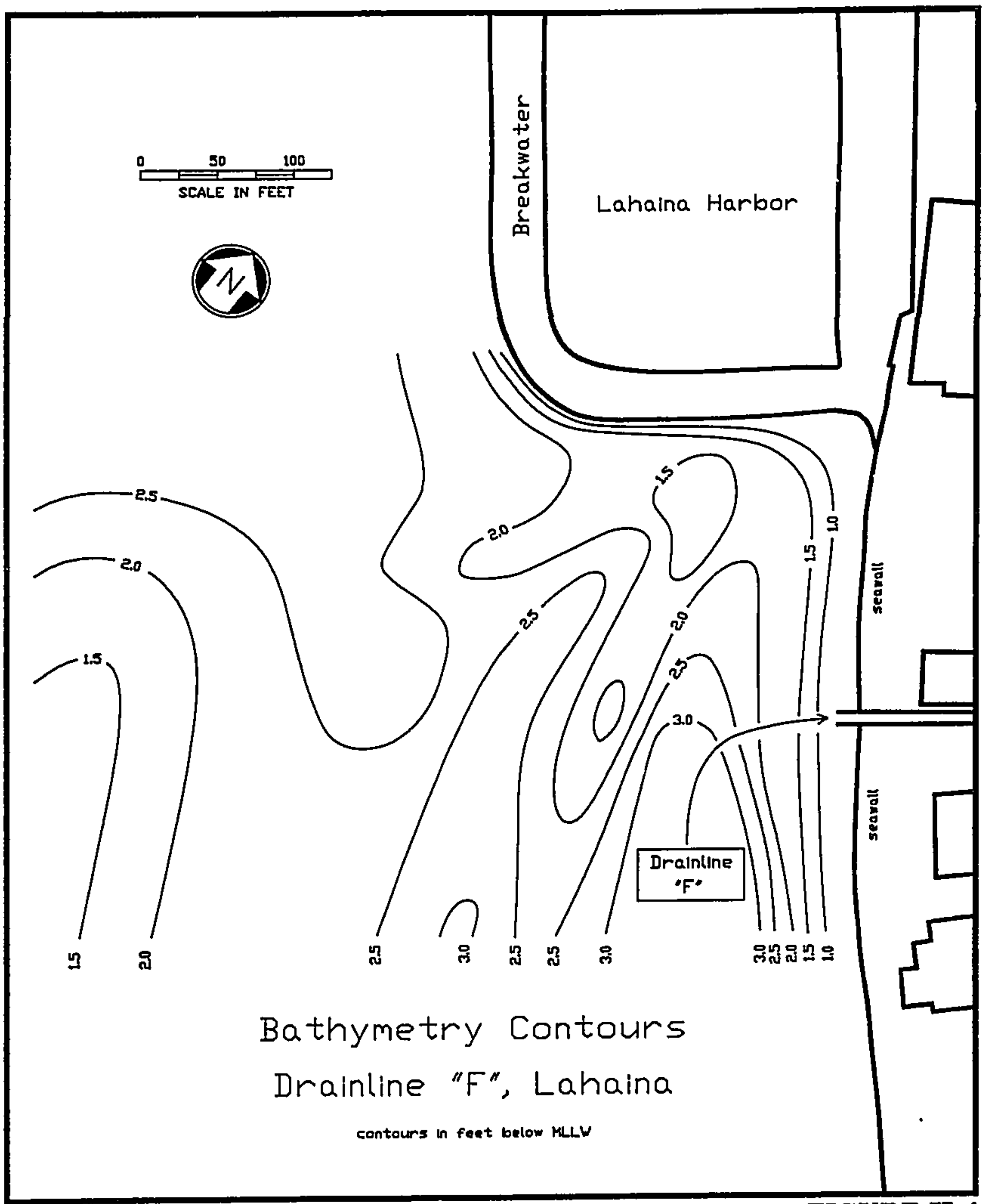

0
50
100
SCALE IN FEET
N
Breakwater
Lahaina Harbor
seawall
seawall
Drainline "F"
1.5
2.0
2.5
3.0
1.0
Bathymetry Contours
Drainline "F", Lahaina
contours in feet below MLLW

FIGURE II-4

COASTAL PROCESSES

Wave breaking occurs on the shallow fringing reef about 500 feet offshore of drainline "F". Waves generally meet the reef at a shallow angle, breaking from south to north. This would tend to drive a northerly longshore current, in agreement with measurements discussed above. Waves can also be seen in aerial photographs refracting around the northern end of the fringing reef, providing further evidence of relatively deep water in this vicinity. In some photographs the water in this gap area appears roiled, which is consistent with appearance of current flow against waves. Aerial photographs also show focusing of waves over the patch reef off the breakwater.

Aerial photographs show that the waves travelling over the fringing reef generate secondary wave crests behind them. These were observed at the site, particularly at higher water levels. The secondary waves eventually break on the shoreline, causing increased agitation and suspension of sediment.

The beach at the project site was severely eroded at the time of the site visit. A very narrow strip of beach north of Drainline "F" became exposed at approximately mean sea level, but at higher water levels the beach disappeared, and there was vigorous reflection of waves off the sea wall. However, a small beach was exposed even at high water levels in the corner where the Lahaina Harbor breakwater and the seawall meet. This area served as a launching area for surfers and other beach users. Except for minor accretion right at the drainline, there was no beach south of Drainline "F" for approximately 200 feet, even at low water levels. Local beach users indicated that this eroded state has been in effect since the passage of Hurricane Iniki in 1992. The sandy beach south of drainline "F" (seaward of the 505 Front Street complex), is heavily used for sunbathing and other beach activities. The rounded shape of the northern part of this beach indicates that it is probably slowly building to the north. The drainage culvert behind the drainline outlet is partially filled with sandy sediment, apparently transported there during storms or other high wave events.

The beach sediment is bimodal, with well rounded, coral cobbles generally overlying estimated medium to coarse grained sand. The sand is dark, and composed of approximately 80% terrigenous material. The terrigenous composition reflects the close proximity and high relief of the West Maui mountains.

Examinations of aerial photographs show that historically the beach is typically on the order of 30 to 50 feet in width. From observations at the site of wave reflection and severe water agitation in front of the seawalls, it is tempting to blame them for the eroded state of the beach. However, the sea walls can be seen in photographs as far back as 1954, and while they probably slow the beach building process, it is apparent that there are beach erosion and accretion cycles that are independent of their presence.

The presence of the wing wall structures on the beach, the outlet for Drainline "F", has only minimal effects on shoreline processes. The Lahaina Harbor breakwater is a virtually impassable barrier for normal littoral drift and dwarfs any impacts from the drainline structures. In most of the aerial photographs examined, the beach width at the site is independent of the presence of the drainline. In its present eroded state, however, the wing walls of the drainline act somewhat as groins, and there is some accumulation of sediment on the southern (updrift) side of the drainline.

REGIONAL DRAINAGE

The project site is situated within the Lahaina subwatershed, which is between the subwatersheds of two major streams, the Kahoma stream to the north, and the Kaua'ula stream to the south (Figure I-1). The floodplain of the Kahoma stream has been developed, so that homes and businesses were occasionally threatened by high run-off storm events. The recent construction of the Kahoma Stream Flood Control Project has mitigated this threat. The U.S. Department of Agriculture, Soil Conservation Service, continues to study regional drainage and flood control needs for the Lahaina area.

The West Maui Soil and Water Conservation district, assisted by the Soil Conservation Service, is proposing a Lahaina Watershed project for flood prevention and the adverse impacts of land erosion and sedimentation. The primary element is a floodwater diversion channel that starts at Lahainaluna Road, extends across the Lahaina subwatershed, and discharges at two ocean outlets (Kaua'ula Stream and a second outlet 3,600 feet to the south). Completion of this project will significantly reduce drainage through Lahaina Town.

Drainline "F" is designed to accommodate a 100-year flood level, with flow rate of 632 CFS. This estimate is based upon complete implementation of the "Lahaina Community Plan" of December 1983, which includes development of lands which are now agricultural and re-development of under-utilized lands to highest uses and maximum density, with consequent runoff increase. The estimated flow rate at Drainline "F" for a 2-year flood is 75 CFS and that for a 5-year flood is 145 CFS. The lesser flood levels give flow figures for events that can be expected to occur reasonably often.

III. WATER QUALITY

PREVIOUS STUDIES

A number of studies have measured water quality in the Lahaina area over the years. Recent interest in seeking the cause(s) for algal blooms, particularly by *Cladophora sericea* and *Hypnea musciformis* in offshore benthic areas, has resulted in funding for both offshore and watershed monitoring programs, although data from these studies are just becoming available or are still being collected. A study by Environmental Consultants, Inc. (ECI, 1976) provides data from the vicinity of Makila Point to Launiupoko and Awalua collected over 15 years ago. A total of six locations were sampled on five occasions in March (three consecutive days) and April (two consecutive days) of 1976. Measured were light penetration, turbidity, nutrients (phosphate, ammonia, nitrate, and nitrite), chlorophyll, and dissolved oxygen. Of direct interest to the present undertaking are the surveys by Grigg (1983) which looked at water quality off the Drainline "F" culvert and off Kaua'ula Stream (Makila Point) to the southeast in relation to storm conditions that generated terrestrial runoff. Each of these previous studies is discussed below following presentation of the June 1994 sampling results.

JUNE 1994 SAMPLING

Water quality samples were collected along and off the shoreline at Lahaina for the purpose of providing a characterization of these waters relative to similar data collected earlier and the State of Hawaii, marine water quality criteria for coastal waters. Samples were collected during the morning hours of June 14, 1994 at a total of ten locations between the mouth of Kaua'ula Stream at Puamana south of Lahaina and the mouth of Kahoma Stream at Mala. Six samples were collected from immediately off the shore; four samples were from offshore areas paired with four of the shoreline stations (Figure III-1). The following descriptions apply to this set of samples:

Station 1 - 1A directly off mouth of drainage channel for Kaua'ula Stream at Puamana. Station 1B in line with drainage channel, approximately 800 feet seaward.
Station 2 - Along shoreline opposite the north side of the Lahaina Shores Hotel.
Station 3 - 3A located directly opposite drainage channel south of Lahaina Harbor. Station 3B located some 1200 feet offshore, in line with drainage ditch
Station 4 - 4A directly off "Cheeseburger in Paradise" restaurant at shore. Station 4B, approximately 800 feet offshore of restaurant.
Station 5 - Along shoreline in front of (overgrown) drainage channel near Pu'unoa Pount.
Station 6 - 6A directly off channel mouth of Kahoma Stream at Mala. Station 6B off end of Mala wharf in line up with mouth of drainage channel for Kahoma Stream.

The results of the June 1994 water quality sampling are presented in Table III-1.

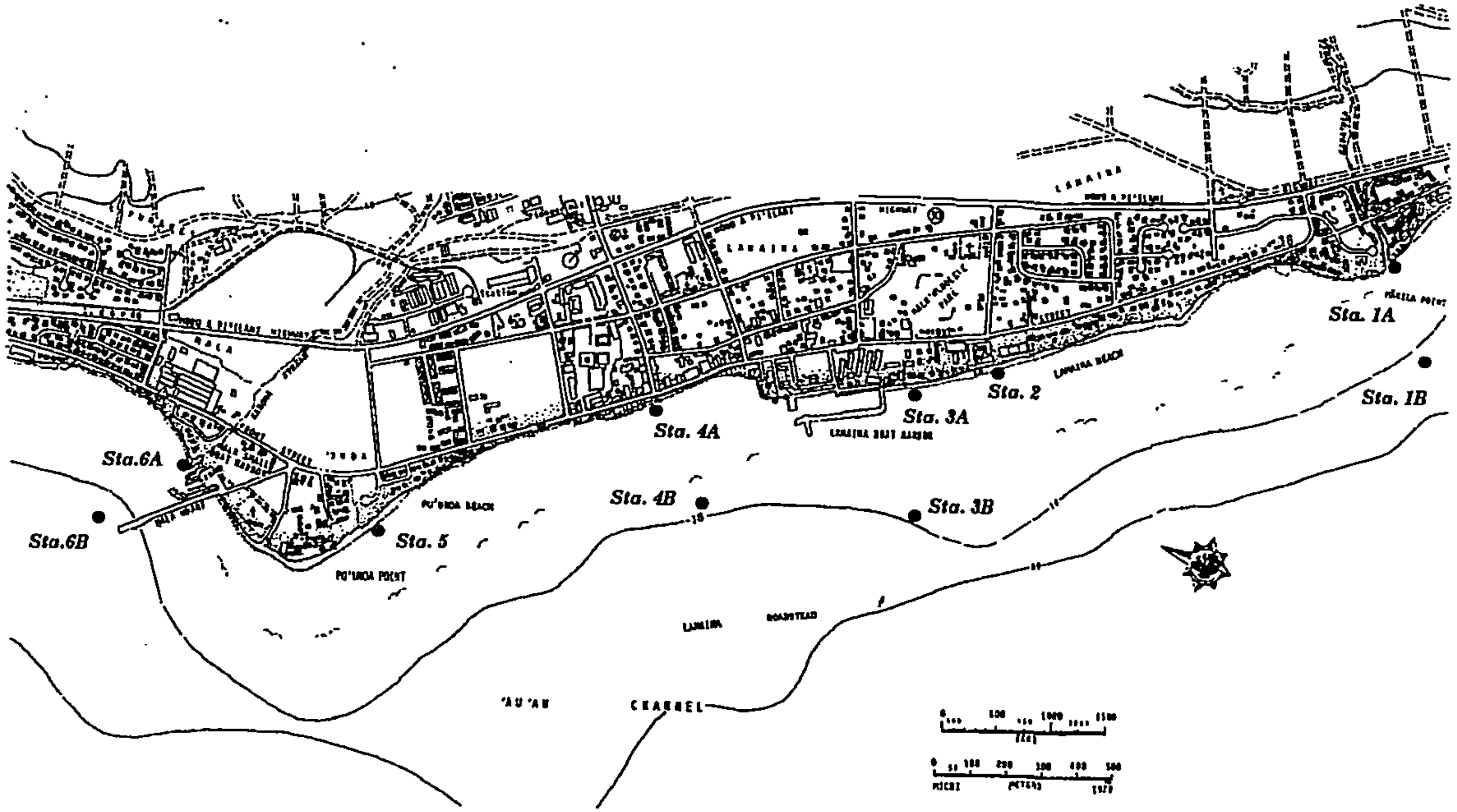


FIGURE III-1. WATER QUALITY SAMPLING STATIONS OFF LAHAINA, MAUI, JUNE 1994.

TABLE III-1. RESULTS OF WATER QUALITY SAMPLING IN THE MARINE ENVIRONMENT BETWEEN MALA AND PUAMANA IN THE LAHAINA AREA OF WEST MAUI.

STA. No.	DATE	TIME	DEPTH (m)	TEMP. (°C)	SALINITY (ppt)	D.O. (mg/l)	pH	TURB. (ntu)	TSS (mg/l)	NO_3+NO_2 (µg N/l)	NH_3 (µg N/l)	TOTAL N (µg N/l)	TOTAL P (µg P/l)	CHL α (µg/l)
LAHAINA, MAUI - Shoreline stations														
1A	6/14/94	1020	*0.1*	26.0	33.52	7.1	8.23	1.74	5.7	5	1	143	16	0.68
2	6/14/94	1005	*0.1*	26.0	34.39	6.9	8.22	0.92	2.3	2	8	130	19	0.20
3A	6/14/94	0955	*0.1*	26.0	34.48	7.1	8.22	2.57	4.6	2	1	130	19	0.15
4A	6/14/94	0915	*0.1*	25.5	34.43	6.7	8.20	8.68	12.6	3	1	156	19	0.69
5	6/14/94	0905	*0.1*	26.0	34.66	6.1	8.17	0.50	2.1	3	2	136	7	0.21
6A	6/14/94	0855	*0.1*	26.0	34.61	6.7	8.26	1.06	3.6	1	1	136	25	0.29
LAHAINA, MAUI - Offshore stations														
1B	6/14/94	0815	*0.2*	26.0	34.62	6.5	8.25	0.35	1.8	1	1	108	12	0.07
2B	6/14/94	0820	*0.2*	26.0	34.63	6.5	8.26	0.32	1.4	2	1	115	12	0.09
3B	6/14/94	0825	*0.2*	26.0	34.64	6.4	8.24	0.51	1.5	2	1	117	20	0.14
4B	6/14/94	0835	*0.2*	26.0	34.64	6.3	8.25	0.36	1.8	3	1	124	11	0.09

TEMPERATURE AND SALINITY

Temperature and salinity showed very small variation from place to place in June 1994 indicating that conditions were probably fairly typical for summer (dry) season, with minimal influences of land drainage on the nearshore waters. Nearshore locations varied somewhat more (33.52 to 34.66 ppt) than offshore locations (34.62 to 34.64 ppt) as might be expected, and interestingly salinity along the shore increased from south (off Kaua'ula Stream) to north (off Mala and the mouth of Kahoma Stream). The differences between locations are certainly quite subtle and the observed gradient may be coincidental. The low value of 33.52 ppt off Kaua'ula Stream is indicative of a slight fresh water influence from the drainage channel.

Grigg (1983) reported salinities off drainline "F" at 35.0 to 35.5 ppt in September and 33.0 ppt on January 2 after a December 24, 1982 storm. Salinities off Kaua'ula Stream varied between 34.0 and 35.0 in September, and 0.0 (fresh water) and 32.5 in January. Temperatures also were depressed after the storm, averaging 27.5 °C (n=5) in September and 25.3 °C (n=5) in January off Drainline "F" (very similar means were recorded off Kaua'ula Stream), presumably reflecting normal seasonal trends. Salinities off the old Ka'anapali Airport in April 1994 ranged from 34.55 to 34.88 (n=26; Bob Bourke, pers. communication).

Temperatures reported in Table III-1 are for the surface waters in June 1994. Divers conducting the biological reconnaissance on June 30 noted a distinctly cooler layer below about 2 meters depth seaward of the Lahaina Harbor breakwater. Such sensible differences in temperature may not be as great as perceived. Development of a diurnal thermocline was noted in the waters south of Lahaina during the investigation conducted by ECI (1976). Surface and bottom waters were seldom more than 0.5 C° apart, however.

DISSOLVED OXYGEN

Oxygen is produced in the marine environment by algae as a by-product of photosynthesis. The atmosphere is the other source of oxygen found in the water, although solubility (less than 7 ppm in sea water) limits the concentration achievable by diffusive processes. Dissolved oxygen (DO) values measured in June 1994 were all very normal for sea water in the range of 91 to 106 percent saturation (percent present as a function of oxygen solubility at the given temperature and salinity). Only the nearshore areas had values slightly above saturation, indicating production of oxygen by benthic algae.

The ECI (1976) study included many DO measurements at progressive depths in the water column at each of six stations on four different dates in March and April 1976. Nearly 150 separate measurements were taken, and the DO was always in the range of 6.1 to 6.8 mg/l (temperatures and salinities prevailing at the time were about the same as measured in our June 1994 survey). Oxygen tended to increase with depth, indicating "...a significant input of oxygen to the water column due to benthic productivity" (ECI, 1976, p. 58). The influence of benthic algae on DO was tested in shallow waters by samples collected over shallow reef areas with a wide range of benthic algal cover. These consistently produced values above saturation.

pH

Sea water is relatively well buffered with respect to pH, which means that changes in pH are seldom very great. Elevated daytime pH in shallow reef waters may signal high productivity as algae remove CO_2 from the water (a high DO should also be observed at such times). pH values measured in June 1994 are very ordinary for sea water samples, with very little variation (range 8.17 to 8.26) and no discernable distribution patterns.

TURBIDITY AND SUSPENDED SOLIDS

Turbidity and suspended solids are related to the concentrations of fine particulates suspended in the water. These may be silts and clays generated from land drainage or reef processes, and/or phytoplankton or other organic mater in the water. Turbidity is a measure of the light reflecting off these small particles; suspended solids is the dry weight of the suspended material. Both turbidity and total suspended solids (TSS or NFR) tended to show greater variability than any of the other parameters measured in June 1994. The variability would no doubt be even greater were samples collected over a long period of time. Runoff and wave action can significantly elevate turbidities and suspended solids in nearshore waters. Turbidities ranged from 0.32 to 8.68 ntu, with low values (typically 0.3 ntu) at most offshore locations. Suspended solids varied from 1.4 to 12.6 mg/l and correlate with the turbidity values (r=0.975). Offshore values averaged only 1.6 mg/l (n=4).

Measurements of settleable and suspended solids were made by Grigg (1983) in relation to a storm on December 24, 1982 in the Lahaina area. "During" samples were collected in Kaua'ula Stream and at three points seaward from the mouth giving settleable solids in the range of <0.02 to 0.10 ml/l and suspended solids (TSS) between 93 and 108 mg/l in the stream and <0.02 ml/l settleable solids and 38 to 89 mg/l TSS in the nearshore directly off the stream mouth. While settleable solids from nearshore samples collected off Drainline "F" and Kaua'ula Stream were everywhere not detectable (<0.02 ml/l), suspended solids ranged between 74 and 128 mg/l on January 2, 1983. These values are greater than the numbers purported to represent the suspended load in the stream at a peak flow of 1240 cfs on December 24. No explanation for the discrepancies is given.

Turbidity and suspended solids measured at a single station located 1500 feet offshore and midway between Puamana Park and Launiupoko Park on January 20, 1988 gave values of <0.1 ntu and 2.1 mg/l, respectively (*AECOS*, 1988).

NUTRIENTS

Nutrients are measured because of these chemicals influence growth rates and abundance of phytoplankton and benthic algae. Nutrient values in June 1994 also show little variation from place to place. With the exception of a few scattered, very slightly "elevated" numbers, ranges are on the order of only a few micrograms for inorganic nitrogen compounds (nitrate and ammonia), 20 to 25 micrograms nitrogen for total N, and 20 micrograms phosphorus for total P. Nitrate, which can be an indicator of terrestrial runoff or ground water influences was highest at Station 1B (5 μg N/l or ppb as compared with 1 to 3 ppb at all other locations). One ammonia value (at Station 6) appeared elevated (8 μg N/l or ppb as compared with a range of 1 to 2 ppb at all other stations). A discharge of (?fresh) water from an 8" PVC pipe was observed flowing across the beach in this area.

Total nitrogen (total N) and total phosphorus (total P) measure the amount of each element in inorganic species, organic species, and particulates in the water. Total nitrogen was higher on average (138 μg N/l or ppb, n=6) nearshore than offshore (116 ppb, n=4). Total P distribution is similarly patterned (16 ppb, n=6 nearshore; 13 ppb, n=4 offshore).

Historical values for inorganic nutrients come from ECI (1976), for stations in the Laniupoko area. Ammonia values were on the order of 5 μg ppb in March and 1 to 2 ppb in April, 1976. Mean nitrates in this study ranged from 0.7 to 2.8 ppb. Mean nitrites (measured separately from nitrates) were consistently around 0.1 to 0.2 ppb. Orthophosphate means varied between 5.9 and 6.5 ppb. Ammonia values in 1976 were similar or slightly elevated relative to the 1994 values. The small differences may be analytical. The nitrate values are generally quite comparable. A single sample from this area on January 20, 1988 yielded an ammonia of <1 ppm and a nitrate + nitrite of 6 ppm (*AECOS*, 1988). This sample was collected from a point 1500 feet offshore between Puamana and Launiupoko Parks. Total N was not measured in the 1976 study, but the single sample collected in January 1988 from this area had a total N of 148 ppb.

Total P was not measured in 1976 and orthophosphate was not measured in the 1994 samples. These values cannot be directly compared because the porportion of total P that is dissolved, inorganic phosphorus is variable. Usually, however, orthophosphates are on the order of 30 to 80% of the total P. At the single station in this area revisited in January 1988, orthophosphate and total phosphate were both 8 ppb (i.e., essentially all of the phosphate present was as inorganic orthophosphate).

Grigg (1983) measured inorganic nutrients (orthophosphate, nitrate + nitrite, silicate) before, during, and after storms in and seaward of Kaua'ula Stream. Measurements were also made on the "before" and "after" dates at four locations off Drainline "F"; however, the "after" samples were collected more than two weeks following the storm event. Nitrate + nitrite values ranged from 0.4 to 0.8 ppb on September 21, 1982 ("before") and 1.5 to 3.1 ppb on January 2, 1983 ("after"). These values are comparable to or less than the values reported in the most recent sampling in this area (Table 1, Sta. 1A and 1B). The values are certainly low in comparison with stream and nearshore samples (about 630 and 35 ppb, respectively) collected during the storm of December 24, 1982. Samples from off Kaua'ula Stream in September 1982 gave nitrate + nitrate values similar to those collected off Drainline "F" at the same time; samples from off the stream on January 2 were between 5.3 and 11.9 ppb. Three samples were collected in the marine environment from just off a drain north of Launiupoko Park in January 1988. The mean of three samples showed evidence of elevated nitrate + nitrite (195 ppb). Some individual values for ammonia (11 ppb) and orthophosphate (32 ppb) might be considered slightly elevated relative to typical offshore values. Although no discharge was occurring from the outlet, salinity was depressed (24 ppt), showing that seepage from the ground was occurring (*AECOS*, 1988).

Measurements of orthophosphates off Drainline "F" in September 1982 gave values at or below about 1 ppb. In January 1983, values at these same locations ranged between 3.4 and 6.8 ppb. Values for orthophosphate off Kaua'ula Stream were similar to those off Drainline "F" in September 1982, but were elevated during and after the December 24 storm (13.6 to 37.5 ppb during and 4.0 to 8.7 ppb after). These measurements demonstrate that fresh water runoff is a source of nitrogen and phosphorus to the nearshore environment in the Lahaina area.

Although the study is currently underway and results must be treated as preliminary, water quality data from a series of stations off the old Lahaina/Ka'anapali Airport were reviewed courtesy of Bob Bourke (Oceanit Laboratories, Inc.) These values, from surface waters north of Lahaina collected in April 1994 showed nitrates ranging from 1 to 5 µg NO_3+NO_2-N/l, total N ranging from 90 to 100 µg N/l, orthophosphates from 6 to 12 µg PO_4-P/l, and total P from 11 to 20 µg P/l. Values are all very similar to those measured off Lahaina in June 1994, although total N concentrations were higher off Lahaina (129 µg N/l, n=10 compared with 85 µg N/l, n=10).

CHLOROPHYLL

The measurement of chlorophyll in water samples provides an estimate of the relative abundance of phytoplankton. Chlorophyll α values measured in June 1994 (Table IIII-1) were generally low and decreased offshore (0.31 µg/l, n=6, nearshore; 0.09 µg/l, n=4, offshore). Values obtained in March-April 1976 ranged from means of 0.04 µg/l (n=24) in April to a high mean of 0.42 µg/l (n=24) on March 18, 1976 (ECI, 1976). A single sample of offshore waters from this same area south of Puamana gave a chlorophyll α value of 0.19 µg/l for January 1988 (*AECOS*, 1988).

BACTERIA

Terrestrial runoff can be a significant source of bacteria to nearshore waters (Harrigan, 1991), whether from agricultural lands (particularly pasturelands) or urban storm drains. Coliform bacteria, particularly fecal coliforms, are widely used as indicators of sewage pollution. In recent years, the enterococcus bacteria have replaced fecal coliforms as the standard for assessing the potential for the presence of pathogenic organisms from fecal contamination in marine recreational waters (DOH, 1992). The State of Hawaii, Department of Health currently collects microbiological data (fecal coliforms and enterococcus) at Mala Wharf and Lahaina Small Boat Harbor.

IV. BIOLOGY

LAHAINA MARINE ENVIRONMENTS

A series of fringing reef segments occur along the coastline of West Maui between Honokowai Point (Ka'anapali) and Hekili Point (Olowalu). These reefs tend to occur off the broad points of land that project into the 'Au'au Channel. The reefs are characterized by shallow flats extending one to several hundred meters off the shoreline and an outer reef margin that may expose on low tides. Between these reefs the bottom tends to drop away gradually but steadily from shore. Live coral growth is mostly found on the front part of the reef called the frontal slope. The "between reef" segments may also harbor considerable coral growth, and this may occur where the bottom rises above the general trend of the submarine slope. However, these areas are not reefs in the strict sense, because the outer margin is well below mean sea level and a shallow reef flat is not present.

A fringing reef wraps around Pu'unoa Point from Mala Wharf to the middle of Lahaina Town, and another extends from the vicinity of the harbor south to Makila Point (the mouth of Kaua'ula Stream). The small "between reef" segment bounded by these two fringing reefs forms the old landing at Lahaina, and is the location of the present-day Lahaina Small Boat Harbor (the harbor was also built onto the fringing reef on the south side).

The following description of reef environments at Lahaina is taken from MICRI (*AECOS*, 1980), but pertains mostly to the reef north of Lahaina Boat Harbor. Nonetheless, from the description, this area is in many ways similar to the reef area off Drainline "F". References to "MICRI-42T1" and "MICRI-42T2" are to notes made by a towed diver in *AECOS* (1980) made off the front of the reef between Pu'unoa Point and Puamana.

FRINGING REEF OFF PU'UNOA

Coral cover ranges from 30 to 90 % on the reef margin and slope off Pu'unoa [Bowers, 1974; ACOE, 1976; MICRI-42T1]. Cover is greatly reduced fronting Bakers and Papalana Streets (4 to 12 % on the margin; 10 to 19 % on the reef slope). Total cover is 11% on the reef margin off the harbor. Cover ranges from 23 to 48 % on the reef slope here [Bowers, 1974].

Few corals inhabit the reef flat, but algae are fairly abundant. *Acanthophora spicifera* is most common off Pu'uona Point. *Sargassum* sp. is abundant along the slope off Baker Street, and *Lyngbya* sp. is common on the reef flat. *Ulva* sp. and *Gracilaria* sp. are most common on the inner reef flat off Papalana Street. *Halimeda*, *Trichogloea*, and *Corallina* are common on the outer reef flat here. *Lyngbya* is common off the center of Lahaina Town. *Halimeda* and *Lyngbya* are common southeast of the harbor [Bowers, 1974].

Porites compressa and *P. lobata* dominate on the reef slope [Bowers, 1974; MICRI-42T1]. *Porites* sp. and *Pocillopora* sp. are most common on the reef flat [Bowers, 1974]. Fishes are sparse on the reef flat and generally not abundant even in deeper water [Bowers, 1974; MICRI42T1]. Fishes are more numerous over the outer reef and slopes off Pu'unoa than toward Lahaina Harbor [Bowers, 1974]. *Melichthys niger* is most common. *Melichthys vidua*, *Zebrasoma flavescens*, *Canthigaster jactator*, *Chaetodon quadrimaculatus*, and *Thalassoma duperreyi* are also common [MICRI-42T1].

OFF LAHAINA HARBOR

Live corals are sparse on the reef slope outside Lahaina Harbor, with cover averaging 2%. Dead coral, broken by anchors and anchor chains, is much more abundant in the area where boats are moored. *Porites compressa*, *P. lobata*, and *Pocillopora meandrina* are the principal species. The sea urchin, *Tripneustes gratilla*, is common. Algal cover is less than 1%, consisting of patchy *Dictyopteris* sp. [MICRI-42T2]. Few fishes are present on the shallow reef flat. Abundance increases slightly in deeper water over the reef slope [Bowers, 1974]. *Melichthys niger* is most conspicuous [MICRI-42T2]. Algae and sea urchins are more abundant on the outer reef than the inner reef flat [Bowers, 1974; ACOE, 1976]. Coral cover ranges from 9 to 85 % on the reef edge and from 4 to 57 % on the reef flat. Corals and fishes decrease near the entrance of Lahaina Harbor [Sunn, Low, Tom and Hara, 1974].

The deep water coral, *Pocillopora molokensis*, is reported from a depth of 165 feet (50 m) off Lahaina [Maragos, 1977].

THE LAHAINA BEACH REEF

The focus of a biological reconnaissance survey made on June 30, 1994 was the northern portion of the reef that lies between Lahaina Small Boat Harbor and Makila Point (Figure I-1). The reef extends as a shallow flat off Lahaina Beach. The following descriptions combine the results of the recent qualitative reconnaissance survey off Drainline "F" and the observations in this area of Dr. Richard Grigg (1983). A list of marine species observed on June 30, 1994 is given in Appendix Table 1.

Figure IV-1 depicts the marine environment in the general vicinity of Drainline "F" and Lahaina Small Boat Harbor. The marine bottom types are based upon a 1978 aerial photograph, modified by the observations made on June 30, 1994. Heavy stippling is used to designate sand and/or mostly soft bottom substratum. A coarse dotted line separates the sand of Lahaina Beach from the submerged base of the beach. Elsewhere, heavy stippling indicates sand or silty-sand bottom, as in the harbor entrance channel. Lighter stippling represents bottom of mixed sand and limestone rubble. The rubble mound at the reef edge is cross-stippled. Substratum that is predominantly consolidated limestone is shown as white (unmarked). Dashed lines separate biotope areas and/or boundares of significant change in bottom type.

SHORELINE

The beach southward from Lahaina Boat Harbor is known as Lahaina Beach (Clark, 1980). This beach forms a more or less continuous sand shore from the vicinity of the harbor to the vicinity

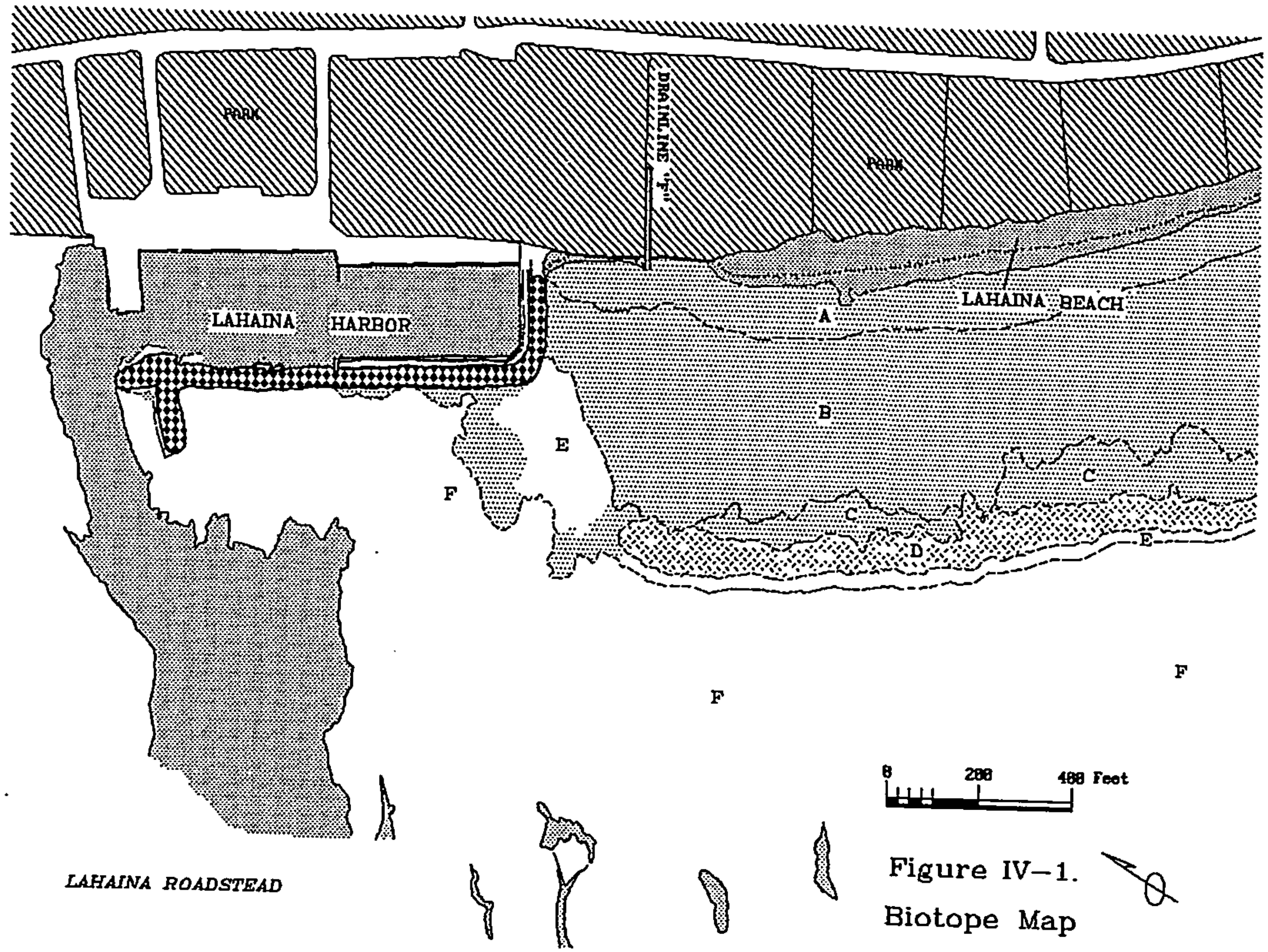


Figure IV–1.
Biotope Map

of Makila Point and may sometimes extend around the point to Puamana Beach south of the mouth of Kaua'ula Stream. The beach appears to be extremely variable in width from place to place and time to time. A review of the several aerial photographs collected for this study shows the following past conditions. In May 1954 a beach approximately 50 feet in width was present between the harbor breakwater and Drainline "F" outlet, but no beach was present off the seawall extending south of the outlet — the sand shore beginning in the vicinity of the County beach park and extending south to a small point 1800 feet north of Makila Point (around which, the beach is comprised of cobble). The beach near the harbor and off Drainline "F" was about 50-feet wide in December 1978, December 1982, November 1981, and August 1988 and appeared to be continuous southward (as far as the photographs on hand reveal) on all of these dates except August 1988. On this date, very little sand shore was present south of the beach park. In June 1994, only a very narrow beach (10 to 15 feet wide) was present between the breakwater and Drainline "F" and no beach was present south of Drainline "F" for some 100 feet or more towards the beach park (as shown in Figures I-2 and IV-1).

The basalt boulder revetment of the Lahaina Boat Harbor provides an intertidal environment of basalt substratum which supports mostly the alga, *Hincksia breviarticulata*, and several typical, littoral invertebrates: the shore crab, *Grapsis tenuicrustatus*, the false limpet, *Siphonaria normalis*, the opihi, *Cellana exarata*, and the periwinkle, *Littorina pintado*. These species were also found on the retaining wall forming the shore south of Drainline "F". The shingle urchin, *Colobocentrotus atratus*, is present on the seaward face of the harbor breakwater.

NEARSHORE REEF FLAT

The reef flat presents an environment which is shallow (under 1 meter at low water) with a bottom of mixed sand and limestone rubble. The sand is dark near shore, consisting of fine terrigenous material (basalt grains) in addition to limestone grains. From the aerial view, the rubble and sand can be seen to be arranged in tracks across the reef, indicating occasional deposition and/or reworking of loose material by large waves. Seaward from the base of the beach, the rubble bottom is dominated by dark tufts of the blue-green alga, *Lyngbya majuscula*, comprising Biotope "A". The innermost part of this biotope is subject to burial under sand at times when the beach expands.

Off Drainline "F" and towards the wall of the harbor, the algae, *Padina japonica* and *Dictyota acutiloba,* are abundant in Biotope A. Further south, these species are present but less conspicuous. Also present in Biotope A are small stones of the calcareous alga, *Hydrolithon reinboldi*. Fishes and macroinvertebrates are generally rare. The swimming crab, *Thalamita* sp., was observed.

Acanthophora spicifera dominates the middle part of the reef flat (Biotope "B"). *Lyngbya* is generally abundant in this biotope as well. Other common species of algae include *Spyridia filamentosa, Padina japonica, Microdictyon setchellianum,* and *Hypnea cervicornis*. Seaward of

Drainline "F" in the vicinity of the harbor wall, *Dictyota acutiloba*, *Stypopodium hawaiiensis*, *Sargassum* spp., and *Liagora* sp. are all common on the middle part of the reef flat. This latter area tends to merge into Biotope "E" because of the lack of a rubble shoal along the part of the reef edge closest to the harbor (see below and Figure IV-1). The mound-forming polychaete, *Mesochaetopterus*, is abundant on this part of the reef flat.

Small heads of the coral, *Porites lobata*, are encountered. Fishes are not conspicuous in this area, although juvenile manini (*Acanthurus triostegus*), mamo (*Abudefduf abdominalis*), and wrasses occur around isolated boulders and occasional larger coral heads. The sea cucumber, *Holothuria atra*, is common, as is the small sacoglossan, *Plakobranchus ocellatus*. The urchin, *Echinometra mathaei*, is associated with scattered, larger boulders.

OUTER REEF FLAT

Directly west or offshore of Drainline "F" in the direction of the outer corner of the harbor revetment, Biotope B transitions to Biotope E (described below) without the reef margin and rubble shoal that is present from about directly off the drainline southeastward. Within the transition area, algal abundance and diversity are high, with a mixture of species seen in biotopes A, B, and E co-mingled. Particularly abundant are *Dictyota acutiloba*, *Sargassum* spp., *Acanthophora spicifera*, *Padina japonica*, *Hypnea cervicornis*, *Lyngbya majuscula*, and *Stypopodium hawaiiensis*. *Sargassum polyphyllum* is very abundant within the surface zone at the outer edge of the reef.

The reef flat off Lahaina Beach is marked by occasional large heads of living or partly living coral, mostly *Porites lobata*. These rise from the featureless sand and rubble bottom to near the low water surface. The generally isolated heads increase in abundance and size offshore to form a distinct biotope behind the rubble mound of the reef margin. This area, which resembles a coral moat environment, is labeled "Biotope C" in Figure IV-1. Here, the water depth is closer to 1.5 meters, and massive coral heads 1 to 2 meters across rise above a sand and rubble bottom. Although most of the larger heads are *Porites lobata*, *Porites compressa* and *Montipora capitata* are common corals here. Also present are *Montipora flabellata*, *Leptastrea purpurea*, and *Pocillopora meandrina*. *Porites lobata* heads are heavily infested with the trematode, *Plagioporus* sp. Cover approaches 80% in localized areas. The mushroom coral, *Fungia scutaria*, may occur, but only non-living heads were seen on June 30, 1994. Grigg (1983) laid a transect across this reef flat from Drainline "F" to the reef margin in September 1982 (and repeated in January 1983). His report is confusing as to the number of 1 m^2 quadrats used to quantify the results (shown as two in his Figure 2A, but results are reported from five quadrats in his Table VII). The results show coral cover increasing from inside to 30 or 40% at the outermost point.

Algae are generally not as conspicuous in Biotope C as inshore. In some areas dark green tufts of the blue-green, *Lyngbya majuscula*, cover the bottom. In other areas, bright yellow-green tufts (*Nostoc* sp.?) are abundant. Coral rubble is covered with an algal turf composed of mostly minute species. Growing on the coral blocks are heads of the calcareous alga, *Porolithon gardineri*, although many of these appeared to be no longer alive in June 1994. Other commonly encountered algal species include *Liagora* sp., *Neomeris annulata, Galaxaura* spp., *Halimeda discoidea*, and *Turbinaria ornata.*

Fishes are numerous, although variable in abundance from place to place. Most common are Pacific gregory (*Stegastes fasciolatus*), moano (*Parupeneus multifasciatus*), weke'a (*Mulloidichthys flavolineatus*), needlefish (*Platybelone argalus*), young 'omaka (*Stethojulis balteata*), kole (*Ctenochaetus strigiosus*), manini (*Acanthurus triostegus*) and mamo (*Abudefduf abdominalis*).

Common macroinvertebrates in this biotope are the collector urchin, *Tripneustes gratilla*, and sea cucumber, *Holothuria atra*. Also observed were wana urchin (*Echinothrix diadema*), rock-boring urchin (*Echinometra mathaei)*, and the spaghetti worm, *Loimia medusa.*

RUBBLE MOUND

The rubble "mound" (Biotope "D" in Figure IV-1) is a shallow deposit all along the reef edge varying in width between over 100 feet to 30 or 40 feet across. Portions uncover at low tide. On the landward side, the edge of the mound is steep and over 1 meter high. The entire structure appears to be the result of waves depositing coarse material on the reef and the mound appears to be building inward. In a few places, tongues of loose material extend shoreward. Deposited rubble can be seen to be filling in the coral moat area (Biotope C). The upper surface was difficult to inspect because of breaking waves and the shallowness, which precluded swimming above the surface. The material is loose and appears to be reworked with some frequency. Macroalgae are sparse, either because the substratum is unstable or because the surface is exposed at low tide. However, *Porolithon onkodes* covers many of the limestone fragments. Abundant under stones is the brittlestar, *Ophiocoma erinaceus.*

REEF FRONT

In front of the rubble mound, the bottom drops away slowly (Biotope "E"), and loose material is replaced by consolidated limestone. Scattered boulders are found. In the shallows fronting the mound, where the bottom is covered with *Microdictyon setchellianum*. Patches of large *Liagora* sp. and limu kohu, *Asparagopsis taxiformis*, are conspicuous at depths under 1.5 meter. *Neomeris annulata* is extremely abundant in this area.

With increasing depth in the seaward direction, bottom relief also increases. The limestone bottom is cut by narrow grooves which run downslope and gradually increase in width and depth. Corals and fishes increase steadily in numbers and diversity to seaward and the shallow reef front transitions to a deeper biotope (Biotope "F") where *Porites lobata* dominates, but *Pocillopora* *meandrina* is common. Macroalgae are much less consicuous than in Biotope E. Coral cover at a depth of around 2 meters (6 feet) is on the order of 15 to 20% of the bottom, but cover was observed to steadily increase with depth, although the June 1994 survey did not extend beyond about the 3 meter depth contour.

Grigg (1983) presents results of three transects run seaward from the reef margin. Along each transect, quadrats of one square meter area were photographed at 50-foot intervals for a total of five photo-quadrats per transect line. Depths are not provided in the body of the report, but would seem to be under 3 m (10 feet) at 200 feet off the reef margin. The area was visited twice (in September 1982 and January 1983), although no representation is given that the exact quadrat locations were revisited. Coral cover was determined from the photographic slides to the nearest 5% of area. Average coral cover was computed at 50% of the bottom, but a clear gradient of from about 25% cover in the shallowest quadrats to 90% cover in the deepest quadrats is evident in the tabulated results. Results from September 1982 and January 1983 showed no significant differences.

Grigg (1983) reported totals of 12 and 13 species of algae, 10 and 9 species of coral, and 38 and 32 species of fishes respectively for the October and January transects off the Drainline "F" site. It is unclear, but presumed that the totals include both the offshore (seaward of the reef margin) transects and a single transect run from the culvert to the reef margin. Not stated is whether these numbers represent total species observed along or near the transects, or total species observed in the quadrats[1]. The numbers appear high for the latter to be the case. Our June 1994 observations on the reef flat and upper reef front suggest that although 9 or 10 species may be present here, these would not be found in 15 randomly selected m^2. Obviously a repeat quantitative survey would best settle the question, but an initial explanation is that some of the less common coral species present in 1982-83 have since disappeared or become much rarer in occurrance.

The fish fauna of the reef front is clearly distinct from that of the reef flat. Particularly common are Pacific gregory (*Stegastes fasciolatus*), durgons (*Melicthys niger)*, umauma-lei (*Naso lituratus*), kala (*Naso unicornis*), kole (*Ctenochaetus strigosus*). pualu (*Acanthurus xanthopterus*), 'omaka (*Stethojulis balteata*), moana (*Parupeneus multifasciatus*), and the triggerfish, humuhumunukunukuapua'a (*Rhinecanthus rectangulus*). While not numerous, a wide variety of butterflyfishes are present. Many more species of fishes could probably be listed from this biotope were more time devoted and greater depths cobvered than was the case on June 30, when Biotope C received the most attention.

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1 Grigg (1986) states that "[a]ll species of algae, coral and fish were counted within quadrats laid every 50 feet along the transects" for a follow-up survey conducted further south off Puamana. Counts of fishes are not given, only presence somewhere in one of the quadrats. However, given the small total area of the quadrats, it is difficult to understand how comparative species counts could be obtained by this method.

V. ASSESSMENT OF PROJECT IMPACTS

STORMWATER MIXING AND TRANSPORT

The effluent from Drainline "F" will be freshwater runoff and will discharge into saline coastal waters. A buoyant surface discharge model, "CORMIX 3" (Jones and Jirka, 1991), developed in cooperation with the U.S. Environmental Protection Agency (EPA), was therefore used to calculate the characteristics of the effluent plume for two cases, a 5-year storm and a 100-year storm. The 100-year storm is the design condition for the drainline improvements, while the 5-year storm represents an extreme event with a relatively high degree of probability that illustrates high runoff conditions.

Input parameters for the plume model are shown in Table V-1. The water depth, current speed, and water quality were determined from on-site measurements. The discharge parameters were given by the drainline plans and design conditions. Water salinity concentrations were used to trace the mixing and dispersion of the plume. The results for the 5-year storm are shown in Table V-2, and are plotted in Figure V-1. The results for the 100-year storm are shown in Table V-3, and plotted in Figure V-2.

The results for the 5-year storm show considerable mixing and dilution of the effluent when it is approximately 500 feet from the shoreline (Table V-2). This is the approximate distance to the shallowest part of the coralline-algal fringing reef in front of the drainline. Dilution of the plume centerline near the 500 feet offshore mark for the 100-year event is approximately 60% of that of the 5-year event.

Both the 5-year and 100-year discharge volumes are such that the flow velocities from the drainline outlet overwhelm the ambient current flow measured at the site. The high relative velocities of the discharges cause rapid entrainment and mixing, accounting for significant dilution of the plumes at the 500 feet offshore mark.

In general, the modelling shows that the rapid velocities of the discharge effluent during extreme storm events carry the effluent into deeper offshore waters, where the bathymetry deepens and the coastal current speeds increase. Increased water flux here will further dilute the effluent plume. The water quality offshore during storms is likely to be greatly influenced by the discharges of the Kaua'ula stream to the south and the Kahoma stream to the north, as well as discharge from other drainlines in the Lahaina subwatershed.

TABLE V-1. CASE STUDY INPUT PARAMETERS USED FOR A PLUME MODEL OF THE DRAINAGE DISCHARGE IN LAHAINA

Environment Parameters		
Average water depth (ft MSL)	3.5	
Current speed (ft/s)	0.33	
Current direction	NW	
Manning's n friction coefficient	0.030	
Wind speed (knots)	10	
Ambient water specific density	1.023	
Discharge Parameters		
	5-Year Storm	100-Year Storm
Discharge configuration	Surface discharge	Surface discharge
Rectangular channel geometry:		
Width (ft)	20	20
Water depth (ft)	1.0	2.5
Discharge rate (ft^3/s)	145	632
Effluent water specific density	0.997	0.997
Tracer Concentrations		
Tracer	In Effluent Water	In Ambient Water
Salinity (ppt)	0.0	34.48

TABLE V-2. RESULTS OF A PLUME CASE STUDY FOR THE 5-YEAR STORM DRAINAGE WATER DISCHARGE IN LAHAINA

Plume Centerline Distance (ft)		Plume Width (ft)	Centerline Dilution	Concentration
Alongshore (North Drift)	Offshore			Salinity (ppt)
3	15	20	1.0	0.0
18	68	36	2.2	18.5
35	121	78	2.9	22.5
53	174	102	3.4	24.5
73	227	125	3.9	25.7
93	280	147	4.4	26.6
114	334	168	4.7	27.2
136	387	188	5.1	27.7
159	440	208	5.4	28.2
183	493	230	5.8	28.5
207	546	248	6.1	28.8

Notes:
(1) A CORMIX plume model for a surface discharge is used for the calculations.
(2) The plume width is defined as a Gaussian 1/e (37%) width.

TABLE V-3. RESULTS OF A PLUME CASE STUDY FOR THE 100-YEAR STORM DRAINAGE WATER DISCHARGE IN LAHAINA

Plume Centerline Distance (ft)		Plume Width (ft)	Centerline Dilution	Concentration
Alongshore	Offshore			Salinity (ppt)
5	25	21	1.0	0.0
106	418	154	3.2	23.8
223	810	278	4.5	26.8
350	1200	398	5.4	28.1
487	1590	518	6.2	29.0
630	1990	636	6.9	29.5

Notes:
(1) A CORMIX plume model for a surface discharge is used for the calculations.
(2) The plume width is defined as a Gaussian 1/e (37%) width.

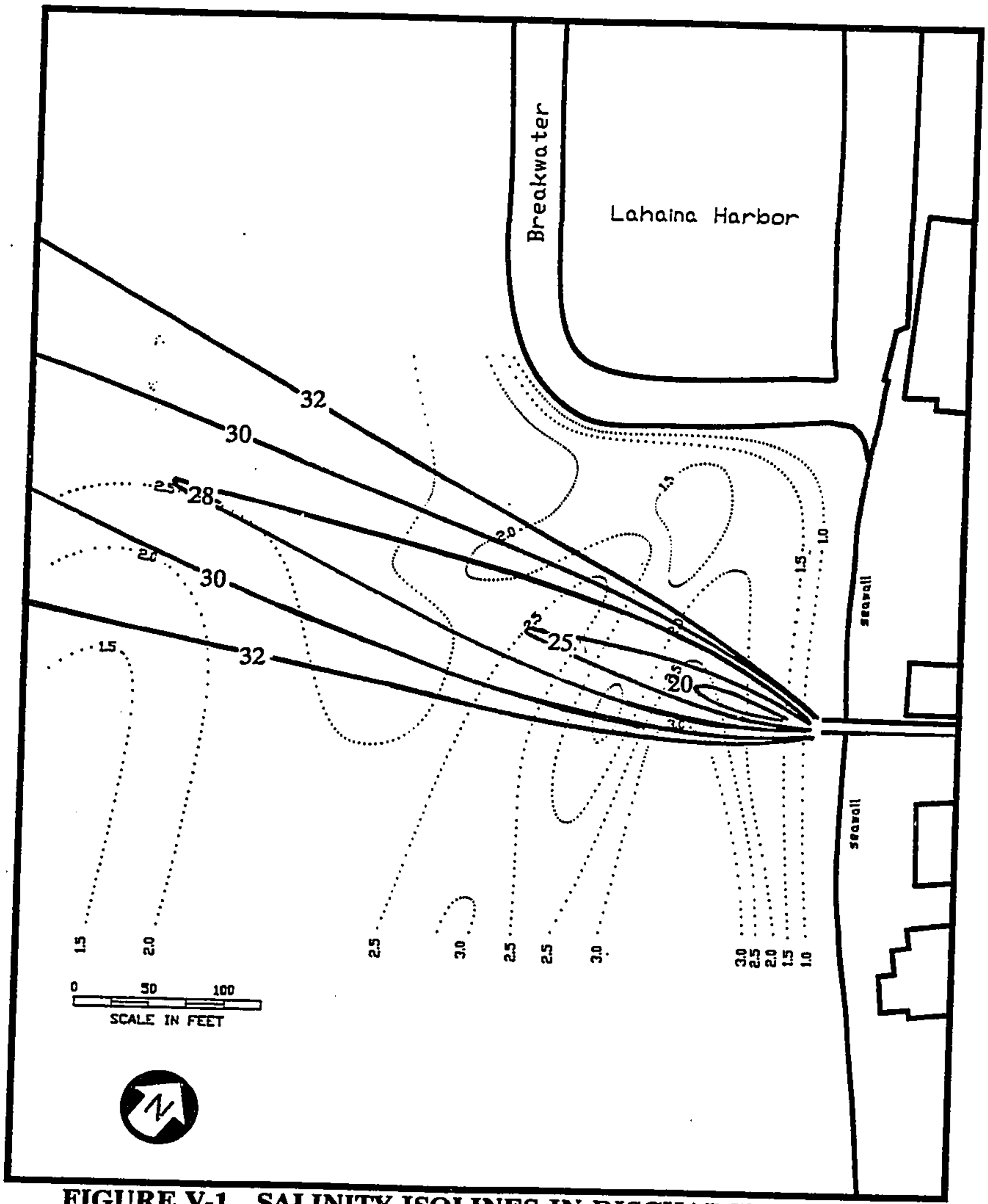

**FIGURE V-1. SALINITY ISOLINES IN DISCHARGE PLUME
5-YEAR STORM**

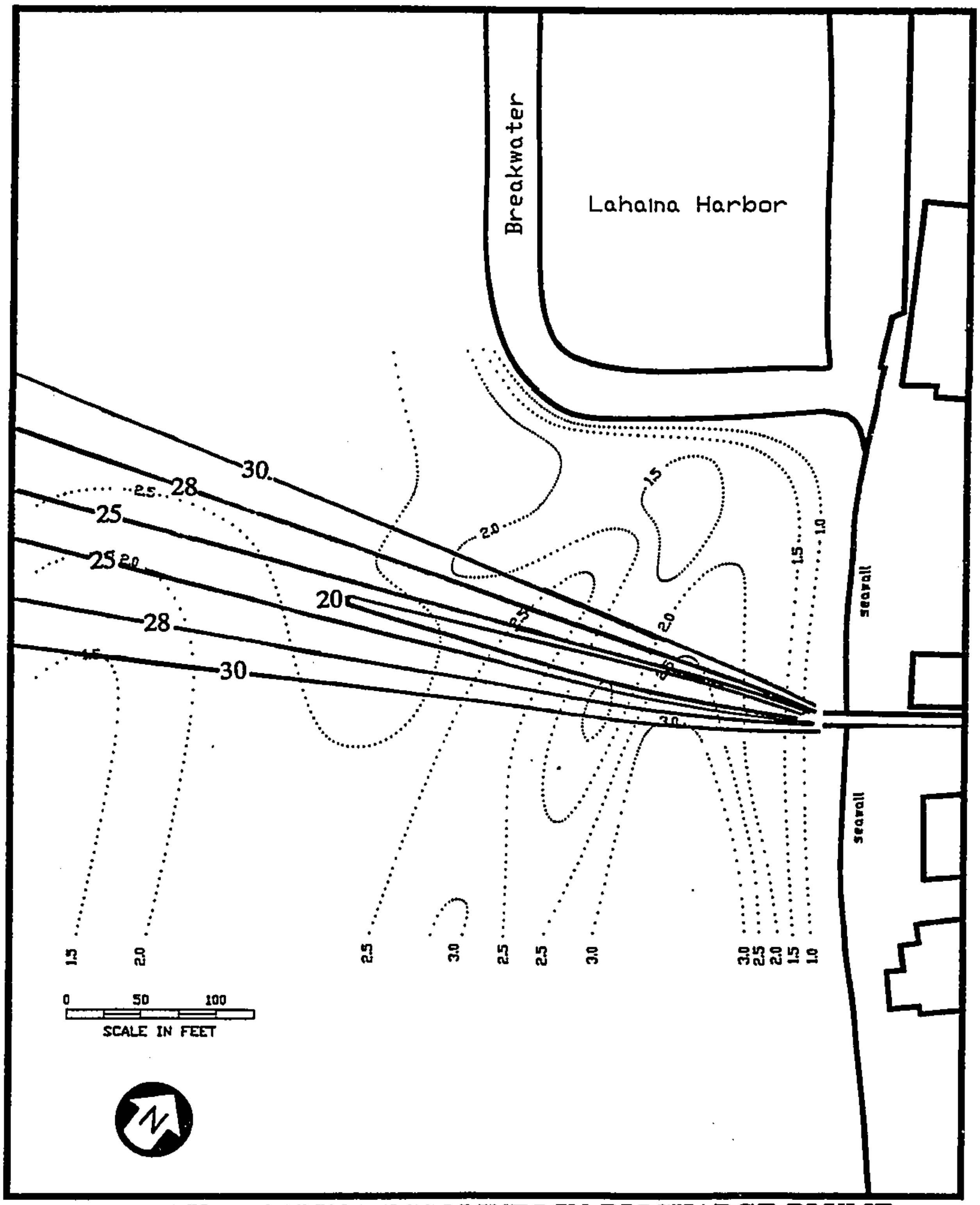

FIGURE V-2. SALINITY ISOLINES IN DISCHARGE PLUME
100-YEAR STORM

Grigg (1983) was able to measure water quality characteristics near Drainline "F" before and after the 5-year storm of December 23-24, 1982. He observed that low salinity waters of the discharge plume remained in the upper 3 feet of water. After one week, salinity values were observed to be nearly back to normal. He also saw no significant impacts of the storm on the nearshore reef ecosystems. It should be noted that a 5-year storm is a regional event, and the high discharge from Kahoma and Kaua'ula streams would affect the Lahaina coast both north and south of the project site with considerably more impact than the estimated flow from an improved Drainline "F."

SHORELINE IMPACTS

The project plans call for the complete removal of existing structures, including the old sewer line and the wing walls of the drainline outlet. An apron roughened with protruding cobbles and boulders will spread and retard the flow as it exits onto the beach. Two alternate designs for this apron are under consideration. In the first the apron will extend from the seawalls approximately 15 feet, similar to the projection of the existing wing walls. In the second, the apron will end at the beach, even with the seawalls on either side.

Review of aerial photographs has shown that the impacts on the beach by the existing drainline outlet structures have been minimal. Neither beach erosion nor accretion appears to be significantly affected by the presence of the drainline, although in the present eroded state of the beach there is a very small amount of beach accretion observable on the southern side of the drainline. Removal of the existing structures will therefore have no significant impact.

Neither of the two alternatives being considered for the drainline outlet will impede longshore sediment transport. Of the two plans, only the proposed extended apron alternative imposes any structure on the beach. However, the mean sea level elevation of the top of the apron will permit longshore transport of sand past the structure during high tides. During periods of high runoff, scour of the beach in front of the drainline down to the level of the apron will occur, but this effect should be temporary if the rest of the beach is not seriously eroded. The presence of the apron will in fact limit scour and damage to the beach during high discharge conditions. This alternative may slightly inhibit shoreline access and represent a small hazard to beach users due to slippery rocks on the apron projection.

The second alternative, ending the apron at the seawall, will have no direct impact on beach users, but may cause erosion of the beach directly in front of the drainline due to scour from discharge water. In this case, most of the eroded sediment will be deposited on the reef in front of the drainline. This is likely to be a temporary condition that will be mitigated with the end of discharge and redistribution of beach sediment.

The present accumulation of sand in the drainage culvert behind the seawalls will have to be removed prior to drainline improvements. Depositing this sand north of the drainline will nourish the beach in this area, and, as the littoral drift is to the north, prevent it from returning to the drainline area during construction.

WATER QUALITY IMPACTS

Long term impacts on the marine realm can occur as a consequence of the focused discharge of runoff into the nearshore waters. Several different aspects of the physical and chemical nature of this discharge may have an influence on biological resources at and off the shore. These impacts will tend to be episodic and quite variable in extent as a function of discharge volume. Little known, but quite possibly important, will be the potential for pollutants from the watershed to be introduced into the marine environment.

In the early 1980's the Soil Conservation Service (SCS, 1980) prepared a plan to alleviate damage to urban and agricultural lands caused by floods in the Lahaina area. Studies were conducted (Grigg, 1983) to assess several alternative proposals, with emphasis on evaluating these in terms of the impacts on nearshore coral reef and associated ecosystems. Two potential discharge sites were compared in the Grigg study: one 250 feet south of Lahaina Harbor[2] and the other the mouth of Kaua'ula Stream. Implementation of the plan has progressed through preparation of an Environmental Assessment (SCS, 1992). The significance of the watershed management plan as it relates to the drain line improvements proposed by the County of Maui for Lahaina Town, is the diversion of flows from the Lahaina subwatershed to the Kaua'ula Stream outlet and 3600 feet further south to a second ocean outlet at Waianukole (between Puamana and Launiupoko). That is, lands mauka of about the 60-foot elevation from Lahainaluna Road to mauka of Wainee Village would drain southward, rather than into Lahaina Town. This action will essentially isolate Drainline "F" from upland flows, reducing both the sediment load discharged onto the reef and the potential contribution of agricultural chemicals (fertilizers and pesticides) to the reef flat.

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[2] Grigg (1983) states that the location of the alternate discharge site he studied was "...150 yards east of Lahaina Harbor.."; however the distance may be in error.

The primary impact of a drainage system project on the marine environment is that produced by the storm-water discharge. A (usually) temporary change in water quality occurs where the effluent mixes with the receiving water. Water quality impacts must consider both the substances carried dissolved or suspended in the effluent as well as the water itself which, by virtue of its low salt content can cause damage to marine ecosystems. Construction of the outlet structure may require mitigation by way of isolation of the construction site from the reef flat environment. However, the drainage outlets for Lahaina are all shoreline structures opening onto generally shallow, inner reef flat environments, supporting biological assemblages adapted to periods of high turbidity and rapid recovery following disturbance. No sensitive marine resources are located in these areas.

Many drainage improvement projects involve mechanical alterations to *existing drainage* systems with the result that storm runoff is delivered more rapidly to the discharge point along the shore than was previously the case. As is true for Drainline "F", these systems typically handle storm water and contribute little or no flow between storms. Alterations may entail enlarging the collection area or otherwise increasing the catchment efficiency (e.g., creation of impermeable surfaces such as buildings and paved areas), thereby producing a greater volume of discharge for a given size storm. The proposed drainage alterations at Lahaina mostly involve improvements to the delivery systems of existing drainage basins. Systems will handle similar flows more efficiently. Drainline "F" entails an increase in drainage basin area. All of the proposed alterations follow older drainage channels. While drainage areas will not be changed, a substantial increase in collection efficiency is planned. Further, the nature of the drainage basin is anticipated to change from mostly residential or vacant land (with some agriculture) to urban use. For practical purposes, the proposed channel must be viewed as a new effluent source with respect to the nearshore environment.

URBAN STORM DRAIN WATER QUALITY

A number of studies have been undertaken to characterize storm water runoff from urban areas (early reviews appear in FWPCA, 1969 and AVCO, 1970). Material from street runoff alone has been shown to contain a variety of pollutants, although the primary constituent of street surface contaminants is inorganic material, similar to silt and sand (Sartor and Boyd, 1972). The nature of the pollutants dissolved in the runoff water or associated with the solids will depend upon the kinds and extent of various activities that occur on or adjacent to the street. Pollutants associated with the operation of automobiles (petroleum hydrocarbons, certain heavy metals such as lead, nickel, and zinc) are typical. Observed concentrations of pollutants of all kinds in urban runoff vary widely. In general, contaminant concentrations will be greatest when a long interval has transpired since the last flow-generating rainfall or street cleaning effort (Sartor and Boyd, 1972). For some, but not all, constituents the concentration reaches a maximum early after precipitation starts, then decreases with continuing runoff.

Studies have been conducted in Hawaii designed to characterize the quality of runoff from many different types of watersheds (see Ching, 1972; Fujiwara, 1973, Matsushita, 1973; Yim and Dugan, 1975; DOH, 1980; Yamane & Lum, 1985). The study by Fujiwara (1973) sampled storm drain systems in central Honolulu. Included were urban-residential and industrial areas (Iwilei). The study by Yamane and Lum (1985) is perhaps the most detailed urban watershed study conducted in Hawaii to date. Two watersheds were monitored in Mililani Town in central Oahu and analyses of over 300 samples of storm water runoff were made between 1980 and 1984. This area is mostly residential and suburban in character. The DOH (1980) study looked at runoff from different types of areas ranging from conservation to commercial and distributed from upper Manoa valley to the H-1 Freeway at the mouth of the valley. Only a few samples were collected to represent the storm runoff.

Summarizing the results of the Hawaii and/or the U.S. mainland studies is difficult because of the substantial range over which the concentration of each constituent can vary. Even the study in Mililani Town produced significant differences between adjacent drainage basins in water quality characteristics for all constituents measured except fecal coliforms, pH, and total Kjeldahl nitrogen (Yamane and Lum, 1985). Furthermore, considerable variation is expressed for many constituents from storm to storm, or from time to time during a single storm. Table V-4 provides selected results of constituent concentrations from three of the studies cited. This table is adapted from *AECOS* (1990), and may represent somewhat more industrial or urbanized watersheds than would generally be true for the Lahaina town watershed.

All three of the studies represented in Table V-4 made comparisons with similar U.S. mainland results and some aspect of the State of Hawaii Water Quality Standards and/or EPA water quality criteria. The DOH (1980) study noted that nutrient concentrations and NFR (total suspended solids) in the Manoa storm-drain runoff were substantially higher than reported from many mainland urban areas. In fact, while total N values were relatively high at three of the sites sampled by DOH (those listed in our Table 1), total P values were about the same as or less than levels reported by most mainland cities (data in DOH, 1980; see also Fujiwara, 1973). With respect to suspended solids, the DOH values are high relative to the Iwilei storm drain results, but well within the range of values reported by Yamane and Lum (1985) for Mililani drainages. The relationships between sediment transport and stream flow during flood events have been extensively studied in Hawaii as elsewhere (see Jones, Nakahara, and Chinn, 1971). The subject is complex, but suffice it to say that sediment loads would be lowest from developed watersheds (as at Iwilei) and greatest from watersheds with broad areas of exposed soils (agricultural areas, construction areas).

TABLE V-4. SUMMARY OF WATER QUALITY CHARACTERISTICS FROM STORM DRAIN STUDIES ON OAHU (after *AECOS*, 1990).

	Iwilei[1]	Manoa[2]			Mililani[3]	
		A	B	C	A	B
Discharge (ft^3/sec)					30	12
pH	6.5 - 6.7				7.2	7.0
Total solids (mg/l)	220 - 263				251	131
TSS (mg/l)	6 - 16	110	452	168	204	96
Turbidity (ntu)					35	20
DO (mg/l)	5.7 - 7.6					
Conductance (µS/cm)					79	52
Chloride (mg/l)	23 - 35					
Total hardness (mg/l CaCO3)	64 - 73					
COD (mg/l)	16.5 - 82.4	120	84	43	60	34
BOD (mg/l)	3.6 - 14.1	>16	>16	6.4		
Grease (mg/l)	0.3 - 2.1					
NUTRIENTS: (µg/l)						
ammonia		200	180	160		
NO_2+NO_3	1000 - 1310	2710	2140	30	210	100
TKN	80 - 6970	4010	3280	1920	1200	1400
TN		6720	5420	1950		
ortho P	500 - 1880					
Total P	1560 - 2760	120	120	160	340	170
METALS: (ug/L)						
arsenic		ND	ND	ND		
cadmium		ND	ND	ND		
chromium	8 - 17	ND	ND	ND		
copper	12 - 28	74	15	40		
iron	26 - 88					
lead	129 - 4560	110	ND	630	20	10
mercury		3	ND	2	0.2	0.1
nickel		79	51	68		
zinc	315 - 1070	371	20	203		
BACTERIA	(MPN)				(no./100 ml)	
Total coliform	9700 - 14800					
Fecal coliform	287 - 835				26000	26000
Enterococcus	5100 - 11800					

1 - Fujiwara (1973); range of flow weighted averages or flow proportioned composite values from three separate storm samplings in Iwilei district of Honolulu (industrial).

2 - DOH (1980); results of single samples representing runoff from A = H1-freeway, B = University commercial area, and C = Manoa mixed residential/commercial area.

3 - Yamane & Lum (1985); Median values from two watersheds (A & B) in Mililani Town over four years. Number of samples varied from 9 to 208.

Fujiwara (1973) noted that the residential and commercial areas in Honolulu contributed organic matter, as measured by the COD, at higher levels than reported elsewhere. He attributed this difference to the greater coverage by vegetation and continuous growing season in Hawaii, factors which might also produce higher nutrient values in some drainage systems (Sartor and Boyd, 1972).

FRESH WATER IMPACTS

Potentially most severe of the acute impacts will be the depression of salinity within the effluent plume extending offshore during events associated with major floods. Salinity depression has been modeled above for two different flood events: 5-year and 100-year storms. Taking 20 to 25 ppt (59 to 74% of ambient salinity) as representing reasonable limits above which potential harm to benthic marine organisms would not occur, the five-year storm model shows the zone of potential harm to extend no more than 200 feet offshore and limited to a narrow zone across Biotopes A and B. The 100-year storm contours show the zone of salinity depression to 20 ppt still confined to the area of Biotopes A and B, but the 25 ppt contour extends beyond the reef edge (potentially having some adverse effect of biotopes C, D, and E. Highly mobile organisms, such as fishes, can avoid a brackish water plume (and withstand somewhat greater salinity depression for a short period of time). Attached benthic organisms, such as corals, are at greatest

risk. Although somewhat dependent upon the temperature differential between the plume and the receiving water and the concentration of suspended material, brackish water will be more buoyant than the receiving water, the lowest salinities reached during discharge will be at the surface. Thus, the depth of the plume relative to the bottom is an important consideration. At this location, Biotope F would, by virtue of the depth of water over the reef front, be reasonably safe from salinity depression impacts; shallow reef flat areas would not be.

SEDIMENT IMPACTS

The discharge plume will carry suspended solids into the marine environment. An immediate impact will be the turbid water associated with the plume. The high turbidity potentially associated with the discharge plume will have several effects on the marine environment. Most notable will be an aesthetic one which will interfere with other uses of the area (for example, diving) for some period of time. As fine material settles out of the plume, this material may cover the bottom, potentially altering the nature of the bottom with resulting deaths of benthic organisms. Corals can be killed or damaged by excessive siltation. Given the relatively low energy of the offshore environment, siltation effects are potentially a problem if care is not exercised on the watershed. The most significant sources of suspended material of potential harm to the marine environment (mauka lands including but not limited to agricultural lands) have been diverted from the local Lahaina drainages. The zone of potential damage from coarse sediment carried as bed load is most probably less than that ascribed above for salinity depression effects.

Dependent upon ocean currents prevailing during the period of discharge, most of the very fine material discharged will be carried considerable distance from the outlet before settling out of the water column. The prevailing currents will move the discharge plume from Drainline "F" northwest and off the reef flat through a low part of the reef margin adjacent to the harbor breakwater (see page II-7). Here, wave action will tend to sweep settled particulates into deeper water. Thus, direct smothering of benthic life is unlikely. In some coastal areas, silt derived from construction activities in the nearshore environment has remained for a considerable period of time (years), becoming resuspended by storm waves and shifted about the area by currents. A potential and subtle impact can result from the decrease in light energy received at the bottom due to turbid water, harming the growth of coral and algae. This effect is not likely to be serious unless turbid water is generated continuously over a long period of time either because material carried out of the ditch remains in the nearshore environment and is constantly resuspended by waves or the outflow of turbid water is continuous (i.e., the drainage acts as a perennial stream).

URBAN POLLUTANT IMPACTS

The values in Table V-4 cannot easily be applied to runoff from Drainline "F". The purpose of the table is to demonstrate both the kinds of pollutants found in urban runoff and the considerable variability in concentrations that occurs from place to place, and quite probably from time to time at the same location. The chronic impacts on marine reef environments of the many substances contributed by urban runoff are not at all understood. Certainly a variety of potentially harmful pollutants may find their way into the new channel as the watershed becomes urbanized. The long-term effects of these chemicals on extant marine resources cannot be predicted in any rational way. An observed decline in resources following urbanization in other parts of the islands may as easily be attributed to other factors (increased fishing pressure and human activities generally) as to a general rise in stream-borne and storm water runoff pollutants. Assessing impacts of storm water contaminants is complicated by the manner in which constituents are delivered to the receiving water. The discharge of water from a storm drainage system is an intermittent occurrence. In many parts of Hawaii the relatively frequent, short-duration, and high intensity rain storms reduce the accumulation of contaminants on streets and other impermeable surfaces (DOH, 1980). Under these conditions, the concentrations of contaminants in the discharge, particularly any constituents which show a pattern of decreasing concentration with increasing storm duration, should be relatively low.

Of course, pollutant loadings (that is, the total amount of a substance delivered into the receiving waters over a period of time) may not be related to rainfall frequency, only the amount that is delivered with each storm. Fujiwara (1973) has suggested that the actual intermittent impact upon receiving waters is far more critical than the total loading. Certainly, for many of the potentially toxic substances that could be found in storm-water runoff, the peaks in concentration may be more significant for a receiving water such as the coastal environment off Lahaina because the potential for accumulation in the nearshore environment is not great. Studies have shown that the more toxic compounds associated with urban street runoff are associated with the fine solids fraction (Sartor and Boyd, 1972), which will enjoy greater dilution and dispersion upon discharge from the channel.

The Lahaina area is typified by infrequent rains; therefore significant time periods for accumulation of contaminants on impermeable surfaces will occur. Potentially significant mitigation of pollution impacts can be achieved by careful attention to recommendations given in Sartor and Boyd (1972; also Sartor, Boyd and Agardy, 1974) with respect to street cleaning and maintenance. Primary, would be a regular program of street sweeping.

Recognizing that runoff from certain urban and industrial areas can produce significant pollutant loadings into the nation's aquatic environments has prompted the Environmental Protection Agency to promulgate regulations governing storm water discharges under the NPDES program (55 FR 47990 et seq; 56 FR 12098 et seq). The channel may eventually come under the program for municipal storm sewers, requiring the filing of a permit application and development of a variety of programs to control the discharge of pollutants into the channel by the operator of the storm drainage system. Implementation of the storm water regulations is expected to begin the process of bringing under control discharges into streams or the ocean from drainage systems that are typically intermittent and represent nonpoint sources of pollution. Application of the State of Hawaii water quality standards (which are based on averaged values over unspecified time periods) has been difficult in such cases because of the intermittent nature of the discharge.

SENSITIVE BIOLOGICAL COMMUNITIES

Development of the coral community in the shallow, protected waters behind the reef margin of the Lahaina Beach reef is due to a unique set of circumstances. This area is deeper than either the reef flat inshore or the reef margin immediately seaward (see Figure II-4), providing sufficient depth for upward coral growth with considerable relief. This vertical relief resulting from the growth of massive *Porites lobata* and more delicate but complex *Porites compressa*, provides a physical environment attractive to a variety of marine plants and animals. The relief and complex mix of substrata gives cover and support for the food resources attractive to a variety of fishes: 46 species of fishes were identified from this biotope on June 30, out of 64 recorded for the entire reef flat and upper reef slope (down to 3 meters depth). The shallow margin to seaward supports a somewhat unusual deposit of loose rubble, in places over 1 meter thick, which provides protection to the moat from the abrasive action of waves, but enhances the exchange of water into the biotope. As waves break across the mound, an inward flow of water is established over and through the mound. This constant replenishment of ocean water in an otherwise fairly protected situation provides the unique conditions conducive to rich coral growth. Similar conditions may be found in deeper water on the reef front, but the attenuation of light at the greater depths slows coral development. The moat is separated from the shore by several hundred feet of shallow reef flat, but perhaps equally important is the mostly one-way flow of water from translated waves pushing water inward, then flow developing northward as water piled onto the reef flat seeks outlet at the only large break or opening in the rubble mound near the harbor sea wall.

There is no doubt that the marine assemblage of Biotope C would be particularly sensitive to damage from excessive terrestrial runoff. Large amounts of fresh or brackish water forming a surface layer to as little as 0.5 meter (1 to 1.5 feet) depth would quickly kill the tops of the coral blocks. Excessive siltation could accumulate between the coral blocks and alter the reef substratum characteristics. Accumulated fine material constantly stirred into the water column by fishes or waves, could reduce light penetration affecting coral survival and otherwise reduce coral recruitment. However, the circumstances described above as conducive to the development of the assemblage are protective of the community. Development of Drainline "F" must proceed with care to minimize volume of flows and particularly transport of fine sediments and urban pollutants. However, the location of Drainline "F" is preferable to minimize adverse impacts on the reef from runoff than any other location between Lahaina Harbor and the south end of the Lahaina Beach reef because of the existing outlet provided by the fact that the shoal terminates short of the harbor revetments.

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APPENDIX TABLE 1.
SPECIES LISTING FOR THE LAHAINA BEACH REEF, MAUI

Species	Common name	Status	Biotope*
MARINE ALGAE			
CYANOPHYTA			
Lyngbya majuscula			A, B, c
Nostoc sp.			C
uniden.			c
CHLOROPHYTA			
Dictyosphaeria cavernosa			b
Halimeda discoidea			B, C
Halimeda opuntia			B
Microdictyon setchellianum			c, E
Neomeris annulata			B, C, E, F
Ulva fasciata	*palahalaha*		e
PHAEOPHYTA			
Dictyota acutiloba	*alani*		A, B, E
Dictyota bartayresii	*alani*		A, B
Dictyota sandvicensis	*alani*		A, B
Hincksia breviarticulata	*hu'ilio*		intertidal
Mesopora pangoensis			B
Padina australis			E, F
Padina japonica			A, B, C, E
Sargassum echinocarpum	*kala*		E
Sargassum polyphyllum			E, F
Stypopodium hawaiiensis			B, E
Turbinaria ornata			B, C, E, F
RHODOPHYTA			
Acanthophora spicifera			B, E
Asparagopsis taxiformis	*kohu*		E, F
Galaxaura fastigiata			C
Galaxaura rugosa			C, E
Gracilaria bursapastoris			a
Gelidiella machrisiana			c
Halymenia formosa	*lepe'ahina*		F
Hydrolithon reinboldii			A, B
Hypnea cervicornis			B, C, E
Laurencia sp.			B
Liagora sp.			B, C, E
Porolithon gardineri			C
Porolithon onkodes			c, D, E
Spyridia filamentosa			B, C
Trichogloea requienii			E

Species	Common name	Status	Abundance
CNIDARIA			
ACROPORIDAE			
Montipora flabellata Studer		ind.	C, F
M. capitata (Dana)	(= *M. verrucosa* Lam.)	ind.	C, F
M. patula Verrill		ind.	C, F
FAVIIDAE			
Leptastrea purpurea (Dana)		ind.	b, c, f
POCILLOPORIDAE			
Pocillopora damicornis (L.)		ind.	c
P. meandrina Dana		ind.	C, E, F
PORITIDAE			
Porites compressa Dana	finger coral	ind.	C
P. lobata Dana		ind.	B, C, F
PLATYHELMINTHES, TREMATODA			
ALLOCREADIIDAE			
Plagioporus sp.	metacercariae	ind.	C
ANNELIDA, POLYCHAETA			
CHAETOPTERIDAE			
Mesochaetopterus sagittarius (Claparède)		ind.	B
SERPULIDAE			
Spirobranchus giganteus corniculatus (Grube)	Christmastree worm	ind.	c
TEREBELLIDAE			
Loimia medusa (Savigny)	spaghetti worm	ind.	B, C
MOLLUSCA, GASTROPODA			
PATELLIDAE			
Cellana exarata (Reeve)	*opihi*	end.	intertidal
LITTORINIDAE			
Littorina pintado Wood	*pupu kolea*, periwinkle	ind.	intertidal
CONIDAE			
Conus spp.	cone shell		C, e, f
PLAKOBRANCHIDAE			
Plakobranchus ocellatus van Hasselt		ind.	B
SIPHONARIIDAE			
Siphonaria normalis Gould	false limpet	ind.	intertidal
ARTHROPODA, CRUSTACEA			
STENOPIDEA			
Stenopus hispidus (Olivier)	bandana prawn		b

Species	Common name	Status	Biotope*
ARTHROPODA, CRUSTACEA (Continued)			
CALLIANASSIDAE			
Callianassa sp.	mud shrimp		b
PALINURIDAE			
Panulirus penicillatus (molt only)	Pacific spiny lobster		b
PAGURIDAE	Hermit crabs		
Calcinus latens Randall			C
C. elegans (Milne Edwards)			C
PORTUNIDAE			
Thalamita sp.	swimming crab		a
ECHINODERMATA			
OPHIUROIDEA - OPHIOCOMIDAE	Brittlestars		
Ophiocoma erinaceus Müller & Troschel		ind.	B, C, D
O. brevipes Peters		ind.	B
ECHINOIDEA - DIADEMATIDAE	*Wana*		
Diadema paucispinum A. Agassiz		ind.	c
Echinothrix diadema (L.)		ind.	C
E. calamaris (Pallas)		ind.	C
ECHINOIDEA - TOXOPNEUSTIDAE			
Tripneustes gratilla (L.)	collector urchin, *hawa'e*	ind.	C, E, F
ECHINOIDEA - ECHINOMETRIDAE			
Colobocentrotus atratus (L.)	shingle urchin, *ha'uke'uke*	ind.	intertidal
Echinometra mathaei (Blainville)	rock boring urchin, *ina*	ind.	B, C, E
Heterocentrotus mammillatus (L.)	slate pencil urchin	ind.	C, D
ECHINOIDEA - HOLOTHURIDAE	Sea cucumbers, *loli*		
Actinopyga mauritiana (Quoy & Gaimard)		ind.	c, f
Holothuria atra Jaeger		ind.	B, C, E
VERTEBRATES, FISHES			
SYNODONTIDAE	Lizardfish		
Synodus variagatus (Lacepède)	*'ulae*	ind.	f
MURAENIDAE	Eels		
Echidna nebulosa (Ahl)	*puhi kapa*, snowflake	ind.	f
Gymnothorax meleagris (Shaw & Nodder)	*puhi-'oni'o*, moray	ind.	c
Gymnomuraena zebra (Shaw)	*puhi*, zebra moray	ind.	c
BELORIIDAE	Needlefish		
Platybelone argalus (Bennett)	*'aha*	ind.	C
FISTULARIDAE			
Fistularia commersonii Rüppell	*nunu*, cornetfish	ind.	c, f
AULOSTOMIDAE			
Aulostomus chinensis (L.)	*nunu*, trumpetfish	ind.	b, c

Species	Common name	Status	Biotope*
VERTEBRATES, FISHES (Continued)			
HOLOCENTRIDAE			
Sargocentron spp.	squirrelfish		C
SERRANIDAE			
Cephalopholis argus Bloch & Schneider	*roi*	ind.	f
APOGORIDAE	Cardinalfishes		
Apogon kallopterus Bleeker	*'upapalu*	ind.	b
MULLIDAE	Goatfishes		
Mulloides flavolineatus (Lacepède)	*weke'a*	ind.	C, F
M. vanicolensis (Valenciennes)	*weke-'ula*	ind.	C
Parupeneus cyclostomus (Lacepède)	*moana ukali-ulua*	ind.	C
P. bifasciatus (Lacepède)	*munu*	ind.	C
P. multifasciatus (Quoy & Gaimard)	*moano*	ind.	C, B
P. porphyreus (Jenkins)	*kumu*	end.	c
Upeneus taeniopterus Cuvier	*weke pueo*	ind.	c
CHAETODONTIDAE	Butterflyfishes		
Chaetodon auriga Forsskål	threadfin	ind.	c
C. lunula (Lacepède)	*kikakapu* (racoon)	ind.	C, F
C. miliaris Quoy & Gaimard	*wiliwili* (milletseed)	end.	A, B, C
C. fremblii Bennett	*kikakapu* (bluestripe)	end.	a
C. ornatissumus Cuvier	*kikakapu* (ornate)	ind.	C, F
C. unimaculatus Bloch	*kikakapu* (teardrop)	ind.	f
C. quadrimaculatus Gray	*lau hau* (four spot)	ind.	f
Forcipiger flavissimus Jordan & McGregor	*lau wiliwili nukunuku oi'oi*	ind.	f
CIRRHITIDAE	Hawkfishes		
Cirrhitops fasciatus (Bennett)	*pili-ko'a*	ind.	C
Cirrhitus pinnulatus (Bloch & Schneider)	*po'o-pa'a*	ind.	C, E
Paracirrhites forsteri (Bloch & Schneider)	*hilu pili-ko'a*	ind.	C
POMACENTRIDAE	Damselfishes		
Abudefduf sordidus (Forsskål)	*kupipi*	ind.	C, E
A. abdominalis (Quoy & Gaimard)	*mamo*	end.	B (juv), F
Chromis ovalis (Steindachner)	oval chromis	end.	f
C. vanderbilti (Fowler)	blackfin chromis	ind.	b (juv), C
Plectroglyphidodon imparipennis	bright-eye damselfish	ind.	C
P. johnstonianus Fowler & Ball	blue-eye damselfish	ind.	C
Stegastes fasciolatus (Ogilby)	Pacific gregory	ind.	C, E, F
LABRIDAE	Wrasses		
Gomphosus varius Lacepède	*hinalea 'aki-lolo*	ind.	B, C, F
Macropharyngodon geoffroy (Quoy & Gaimard)	shortnose wrasse	end.	F
Thalassoma duperrey (Quoy & Gaimard)	*hinalea lau-wili*	end.	F
T. ballieui (Vaillant & Sauvage)	*hinalea luahina*	end.	C
T. trilobatum (Lacepède)	*'awela*	ind.	C, E, f

APPENDIX B

ARCHAEOLOGICAL REPORT

BISHOP MUSEUM

CELEBRATING A
CENTURY OF DISCOVERY

Kamehameha III School Drainage Archaeological Testing Project

prepared for Chris Hart and Partners
1955 Main Street, Suite 200
Wailuku, *Maui*, *Hawai`i 96793*

by Paul Christiaan Klieger, Ph.D.
Principal Investigator
and
Laura Prishmont, B.A.
Research Assistant

6 September 1994

Anthropology Department
Bishop Museum

DRAFT

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Introduction

Under contract to Chris Hart and Partners, Bishop Museum archaeologists investigated a drainage easement area in Lahaina, Maui, as part of the County of Maui mandated Lahaina Front Street Improvement Project. Since the existing drainage will be widened in the future, this project was developed out of a concern for undisturbed archaeological subsurface features and cultural soils possibly present in the immediate area, an area of known historic importance. The following is a report on our findings.

Setting

The area investigated is a drainage easement located on the property of Kamehameha III School in downtown Lahaina, Maui, Hawai'i, identified by Tax Map Key 2nd Division, 4-6-02:Par 13 (Figure 1). The area investigated is approximately 100 m long, extending from Front Street to the east to the ocean. The easement is approximately 3 to 4 m wide.

Historical Background

Beach front acreage of Pākalā 'Ili in the *ahupua'a* of Puakō, Lahaina, was a choice neighborhood, inhabited by the Royal court and *kaukau ali'i* (lesser chiefs) in the early days of the nineteenth century. It is located just north of Moku'ula, Hale Piula, and Loko o Mokuhinia, the royal residence of King Kamehameha III from 1837 to 1845. The core of the *ali'i* settlement was near the beach of Pākalā, a favorite ancient surfing area known as'Uo. Here were the houselots of the *kapu* women and powerful chiefs of the Maui and Hawai'i dynasties once again united and amplified through the marriage of Keōpūolani and Kamehameha, and the homes of the influential *hapa haole* Young family. The present drainage extends across this land.

The nucleus of the neighborhood, which may have been synonymous with the name "Kalua'ehu," was part of Kamehameha I's encampment of *ali'i* of 1802-1803 which may have extended from the "Brick Palace" (near the present Library) and Keawe-iki southward to Moku'ula, the Kalua o Kiha (Figure 2). Prior to the Māhele of 1848, O'ahu Governor Kekūanaō'a was in charge of Pākalā, a duty which he relinquished just prior to the Māhele in 1848 (Māhele Book 1848:29).

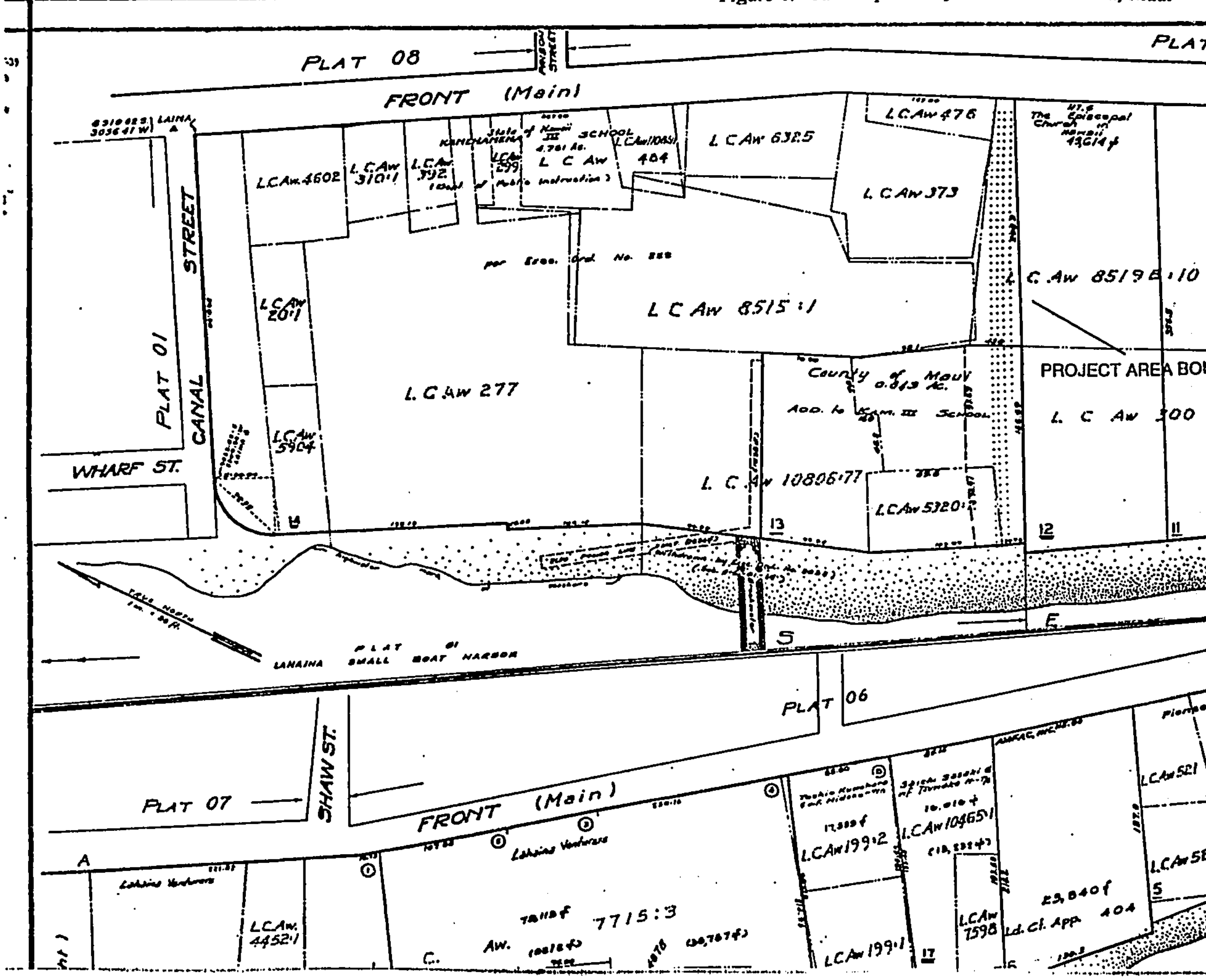
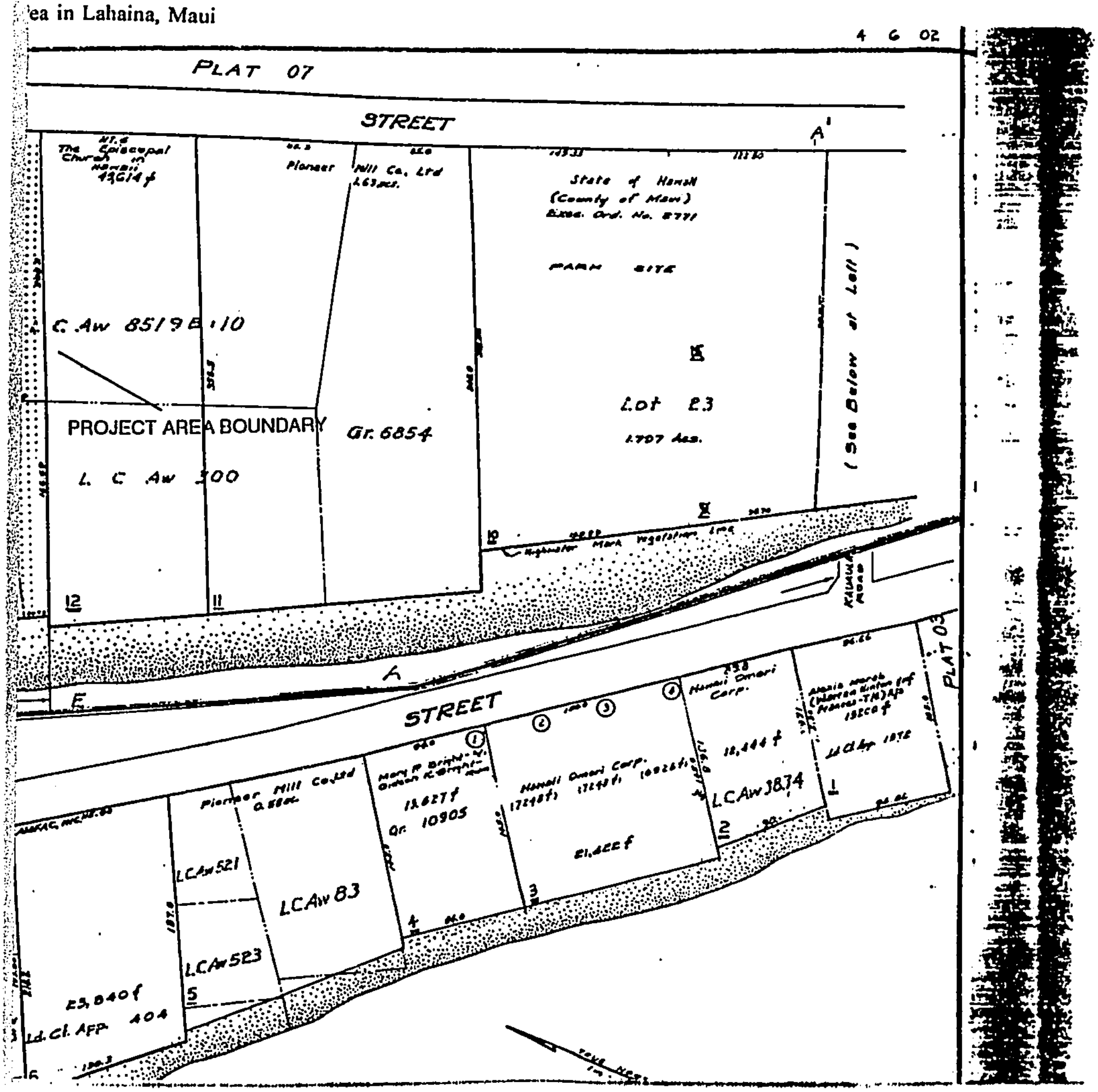


Figure 1. Tax Map of Project Area in Lahaina, Maui

ea in Lahaina, Maui



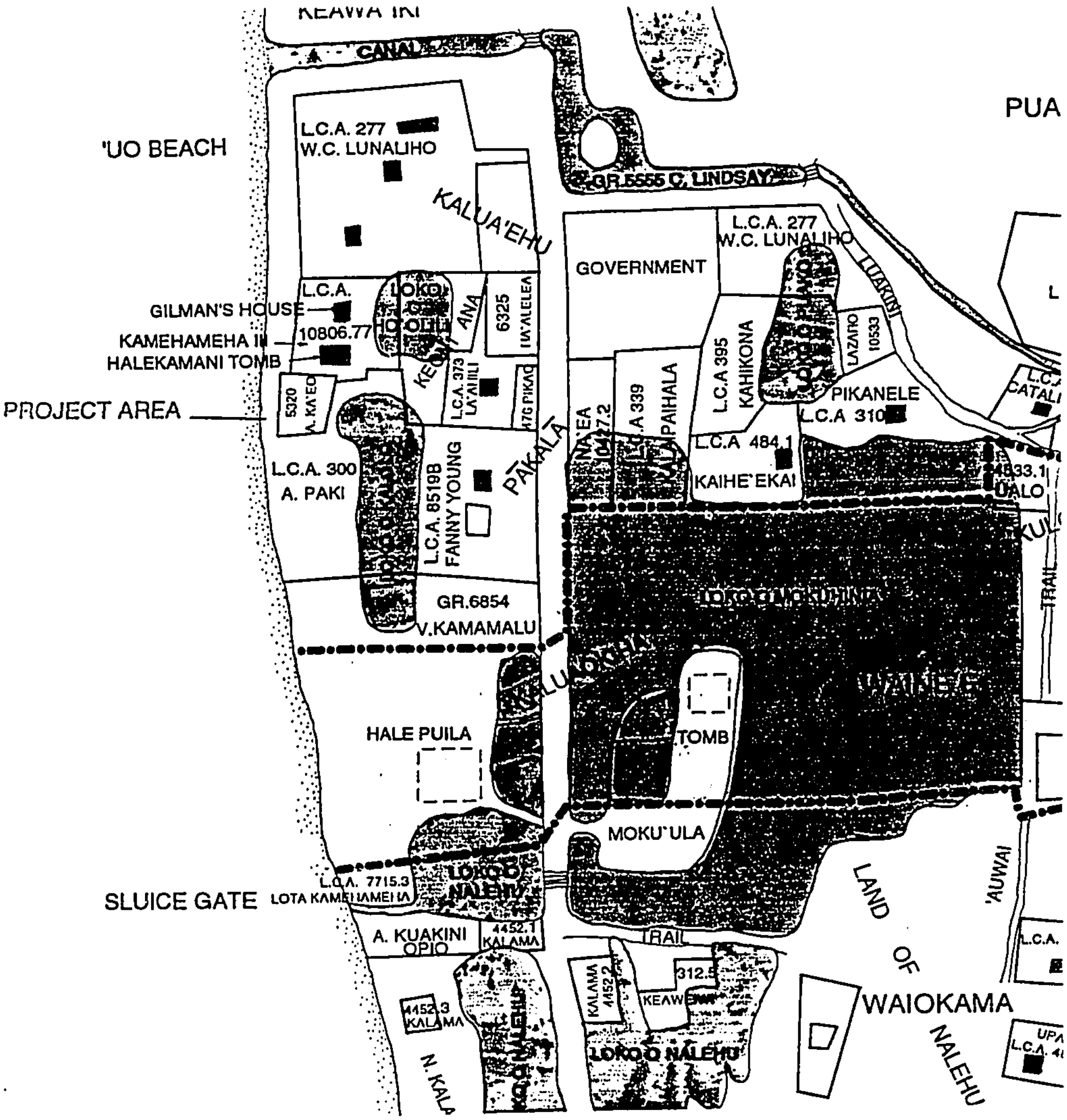


Figure 2. Reconstruction of southern Lahaina based on 1848 Māhele documents an Bishop's survey of 1884. Project area is in the upper left. (from Klieger 1993)

A large section of this beach frontage was occupied by Abner Pākī, father of Princess Bernice Pauahi Bishop (LCA 300--BCQLT 10:585), grandson of Maui king Kamehamehanui (Kame'eleihiwa 1992:267), and *hānai* father of the kingdom's last monarch, Queen Lili'uokalani. Pākī received this housesite in 1837, named "Panaewa" from Ka'aimalolo, mother of Asa Ka'eo, who in-turn had received her land from Kahekili Ke'eaumoku "before 1820" (NT 3:569; BCQLT 10:585). The present project area includes the northern part of LCA 300.

Occupying about half of Pākī's parcel was a large section of the Loko o Ka'alolo (probably from Ka'aimalolo; also called the Loko o Kekūanaō'a after the O'ahu governor who had been in control of Pākalā). The *loko* was most likely a sand-banked pond (*loko pu'uone*) characteristic of Loko o Mokuhinia and surrounding ponds. Present excavations were most likely located at or near the site of this fishpond. A small lot for Asa Ka'eo, brother/cousin to Pākī through Ka'eo's mother Ka'aimalolo, was located just to the north along the beach (LCA 5320). Ka'eo received this lot from his mother in 1844 (BCQLT 10:542). Ka'eo's southern boundary lies within the present drainage.

Next to A. Ka'eo's small parcel was houselot LCA 10806.77, the houselot of Pā Halekamani, former home of Kauikeaouli, King Kamehameha III's sacred sister Nāhi'ena'ena. This enclosure also housed the first western-style tomb for *ali'i*, initially built for the internment of Keōpūolani, the mother of Nāhi'ena'ena, Kauikeaouli, and Liholiho (King Kamehameha II). The royal remains were removed to a new tomb at Moku'ula in 1837, and the building was remolded for residence by the U.S. Consulate (Klieger 1993). The adjacent cottage of Nāhi'ena'ena was assumed by the merchant G. Gilman.

North of Gilman's "Seaside Cottage," as he named Nāhi'ena'ena's *hale pili*, were lands extending to Canal Street--another parcel of the original Royal compound. At the time of the Māhele of 1848, the LCA 277 was awarded to William Charles Lunalilo, the future king. Gilman describes the house of William Charles Lunalilo and his parents Charles Kana'ina and *kuhina nui* Auhea Kekāuluohi:

> Among the most pretentious [of chiefly houses at this location] was that of the ex-queen of Kamehameha II, Auhea, most familiarly known as the big-mouthed queen. This was a fine building of colored stone plaster with a wide veranda

and every convenience suitable for those who occupied it. (Gilman 1906:170)

A grove of *kou* trees shaded this house and the adjacent home formerly of Princess Nāhi'ena'ena leased by Gilman. The property was bounded to the east by a bank in the Loko o Ho'olili, and Premier Keoni Ana claimed the east half of the fishpond and its adjacent land under LCA 8515.1 for a residence. The present drainage probably extends across the southern border of Keoni Ana's *kuleana*. The Lunalilo beach front property to the north, of 1.67 acres, is referred to by the name Kalua'ehu in LCA 277 (BCQLT 9:692)

Directly to the south of Keoni Ana, east of the property of Pākī and his wife Konia, and across the tiny Loko o Ka'alolo, the premier's sister Fanny Young had a houselot (LCA 8519B.1-- BCQLT 10:301). Across the government road to the east was a houselot of her husband, George Na'ea (LCA 10427.2), who received his lands from Pikau in 1846. Fanny inherited land called Haleu *ahupua'a* from her father, John Young, Sr. in his will of 1835 which was accepted as testimony during the Māhele proceedings of 1848 (see Privy Council 3A:98-99 and NR:708). The Pākalā parcel appears to have been divided, with the upper half being awarded to her brother, Keoni Ana. Much of the Young family holdings would eventually pass through Fanny's daughter, Dowager Queen Emma, becoming the Queen Emma Trust (Queen's Hospital). Through the patronage of Queen Emma, a portion of Fanny's lands at LCA 8519B:10 in Pākalā were eventually granted to the Episcopal Church, becoming the Church of the Holy Innocents. The eastern portion of the drainage easement was once part of LCA 8519B.10 awarded to Fanny Young.

The remaining beach front of Pākalā, just south of Chief Pākī, is noted in Pākī's Native Testimony as belonging to Victoria Kamāmalu, daughter of M. Kekūanaō'a, governor of O'ahu and Kīna'u, the late *kuhina nui* and daughter of Kamehameha I. During the Māhele, the Princess Victoria became the largest landholder in the kingdom after the king himself. Much of her land eventually formed the nucleus of the Bishop Estate (Klieger 1992). Victoria possibly had a claim to this land from her father Kekūanaō'a's former control of Pākalā, but it is not known by which mechanism it became hers. It was not a Land Commission Award. By Land Patent 6854, this particular Bishop Estate property was exchanged for Pa'ala'akai, Waialua, O'ahu in 1917, as the Territory of Hawaii claimed it needed the lands in Pākalā for a public school (Kamehameha III School). The "remnant" land was apparently not required, however, and it was sold to Pioneer Mill.

This particular area of Lahaina, despite its early nineteenth century significance, became less so after the Royal Hawaiian court left in 1845. Eventually most of the lands to the immediate north on the present project area were turned over to the government, and made available for public education through Executive Order 222 and the subsequent establishment of Kamehameha III School.

Archaeological Results

On 18 August 1994, two stratigraphic trenches were excavated by backhoe perpendicular to the drainage channel (Figure 3). Much of the drainage channel was inaccessible, however. The drainage on the eastern half of the project area was subsurface and covered with an asphalt parking lot. We did not test this area.

The western portion of the easement was tested. It consists of an open drainage. The drainage consists of two large, rounded basalt cobble and mortar walls, 1.30 meters in height and 0.80 meters in width. The parallel walls, 1.70 apart. extend 56 meters to the ocean. The top of the walls are level with the surface of the surrounding grounds. The wall continue to the ocean (Figure 4).

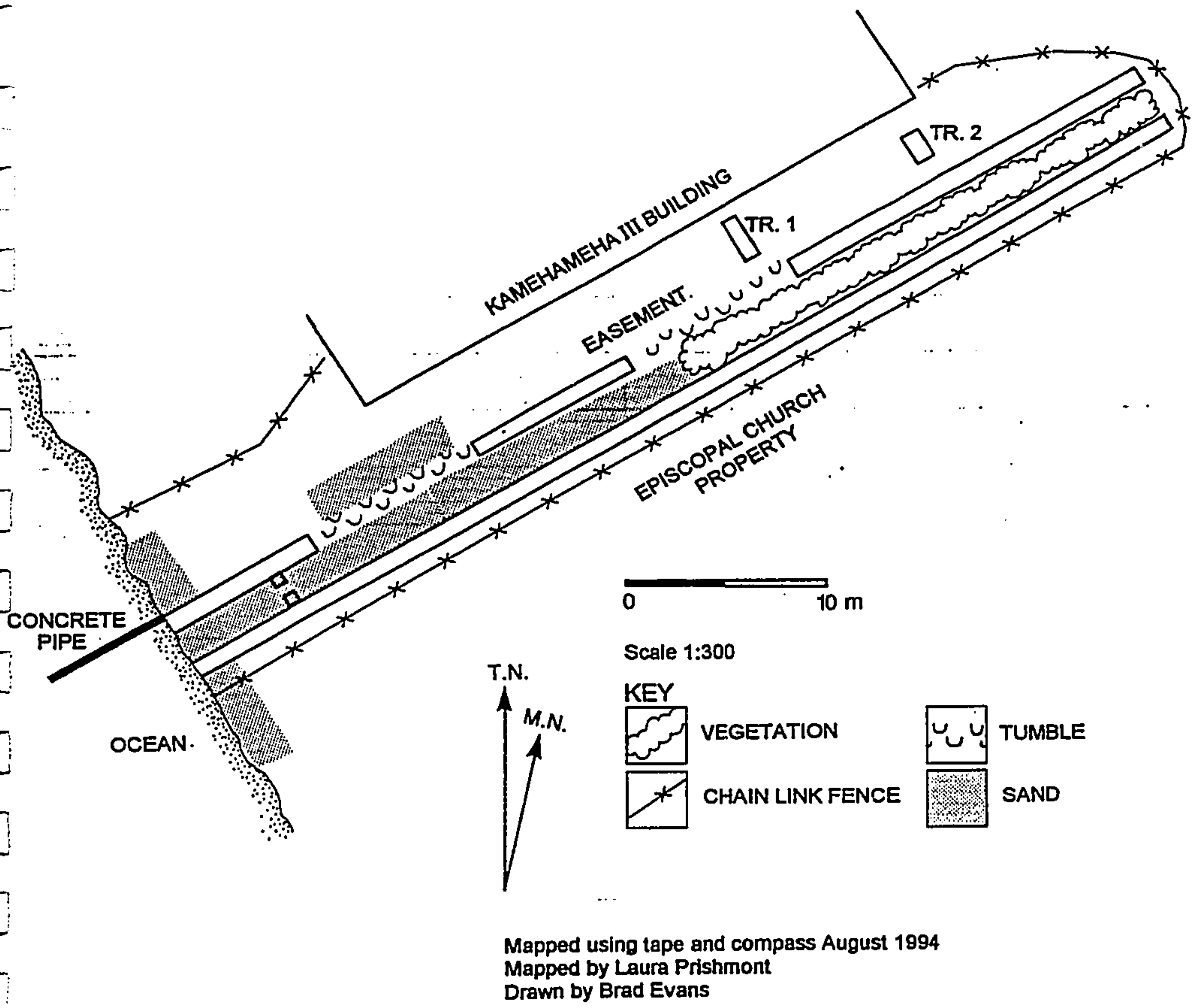
The easement is completely fenced in by a tall chain link fence. On the south side of the easement, the fence is located one meter from the tope of the drainage wall, and the surface is concrete. The Church of the Holy Innocents is located on the other side of the fence. Permission was not requested to excavate on church property.

On the north side of the drain, the wall is tumbled in some areas. A building of Kamehameha III School is located from four to five meters from the drainage wall. This distance made the operations of the backhoe difficult.

Trench 1

Trench 1, 2.00 long by 0.80 wide by 1.40 m in depth, was located on the north side of the drainage at 21.60 meters west of the end of the subsurface portion of the drain. This was the furthest extent of possible backhoe excavation.

Trench 1 stratigraphy (Figure 5) shows a series of fill events, extending down to the water table. Fill materials include glass and metal inclusions which appear to be recent. A large earthenware or concrete pipe measuring 73 cm in diameter was found at the base of this



KAMEHAMEHA III BUILDING
TR. 2
TR. 1
EASEMENT.
EPISCOPAL CHURCH PROPERTY
CONCRETE PIPE
OCEAN
0
10 m
Scale 1:300
T.N.
M.N.
KEY
VEGETATION
TUMBLE
CHAIN LINK FENCE
SAND
Mapped using tape and compass August 1994
Mapped by Laura Prishmont
Drawn by Brad Evans

Figure 3.

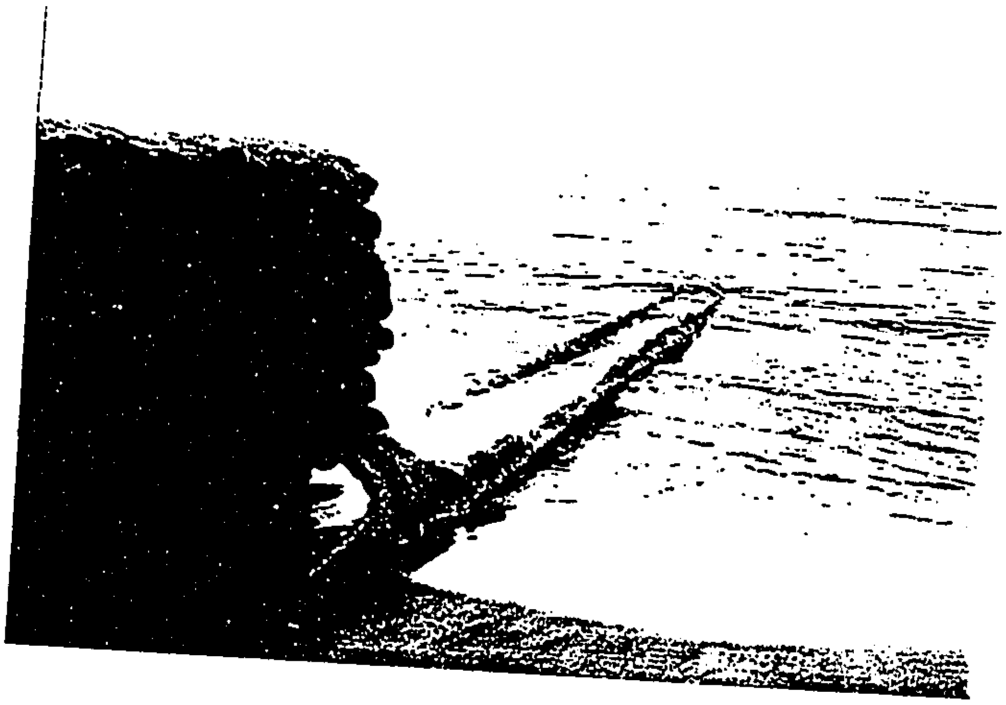


Figure 4. Drainage to the West.

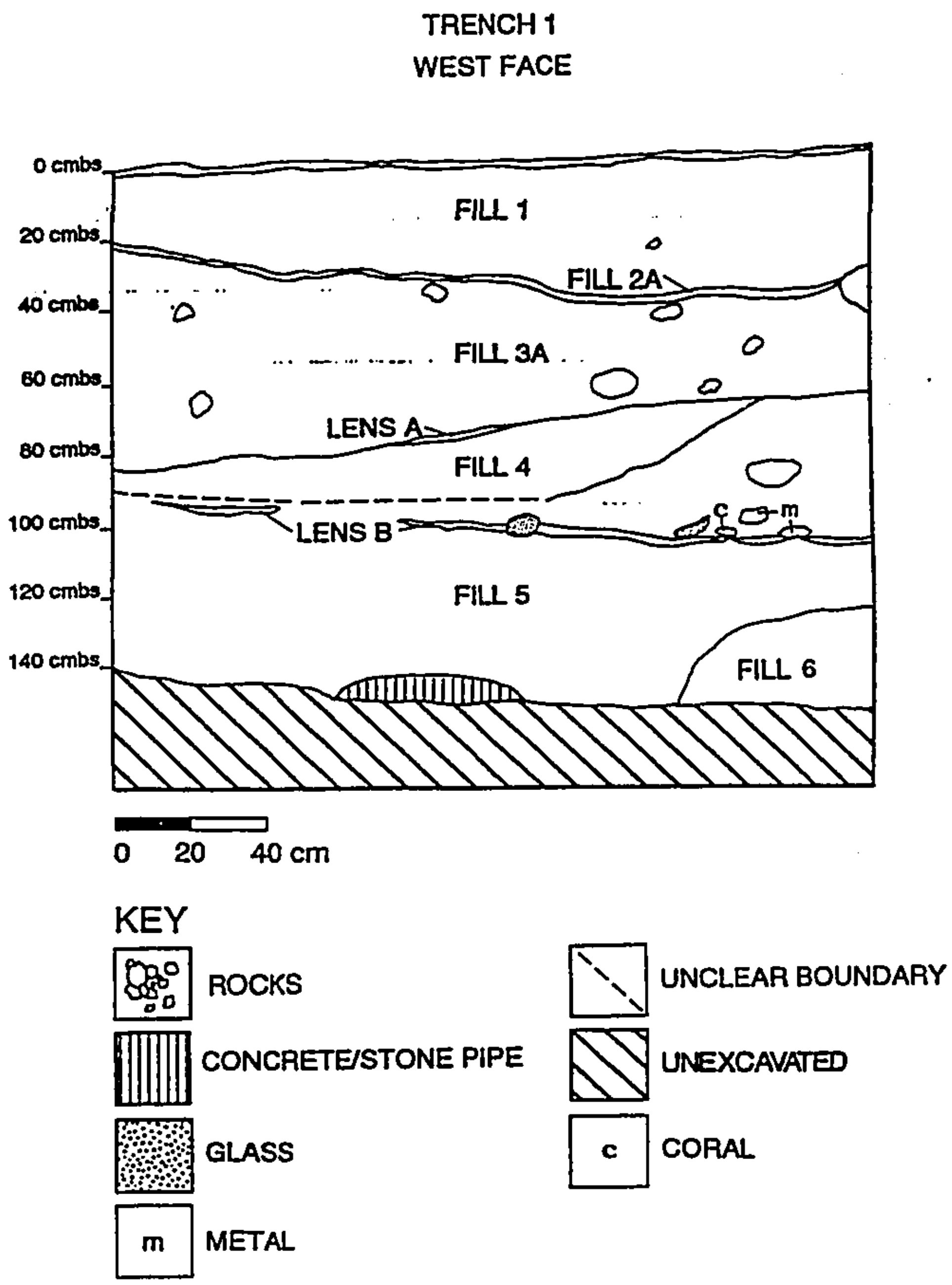

TRENCH 1
WEST FACE
0 cmbs
20 cmbs
40 cmbs
60 cmbs
80 cmbs
100 cmbs
120 cmbs
140 cmbs
FILL 1
FILL 2A
FILL 3A
LENS A
FILL 4
LENS B
c
m
FILL 5
FILL 6
0 20 40 cm
KEY
ROCKS
CONCRETE/STONE PIPE
GLASS
m
METAL
UNCLEAR BOUNDARY
UNEXCAVATED
c
CORAL

Figure 5.

trench. This probably signifies that the immediate area was disturbed when the pipe was first laid.

Fill 1--This recently deposited fill is present in Trench 1 as well as Trench 2. The fill ranges from 10 to 40 cm in thickness. It is a reddish brown (5yr 4/3) silty clay containing approximately 10% by volume angular gravel. The consistence is compact; slightly sticky and slightly plastic. Fill 1 directly overlies Fill 2 with an abrupt, smooth boundary.

Fill 2a--This recent fill is present in Trench 1 with lenses of similar deposits occurring throughout this trench and Trench 2. It is 2 to 4 cm in thickness. It is a black (7.5yr 2/0) silk; nonsticky and nonplastic. Charcoal is apparently associated with Fill 2a. Fill 2 directly overlies Fill 3 with an abrupt smooth boundary.

Fill 3a--This recently deposited fill occurs only in Trench 1, and ranges in thickness from 30 to 60 cm. It is a dark brown (7.5yr 3/2) gravelly pebbly loamy sand. It contains sub-rounded to rounded pebbles to small cobbles and common fine roots. Fill 3 directly overlies Fills 4 and 5, and Lens A, with abrupt, smooth boundaries.

Lens A--This is a deposit similar to Fill 2. It is 1 to 2 cm thick. It is a black (7.5 yr 2/0) silt; nonsticky and nonplastic. The lens directly overlies Fill 4 with an abrupt, smooth boundary.

Fill 4--This fill occurs in Trench 1 only and ranges in thickness from 2 cm to 10 cm. It is a dark brown (7.5 yr 3/2) loam with fine sand and few angular coral fragments. There are few medium roots and the consistence is slightly sticky and slightly plastic. Fill 4 directly overlies Fill 5 with an abrupt to clear boundary.

Fill 5--This fill occurs in both Trench 1 and Trench 2. It ranges here in thickness from 45 to 70 cm. It is a mottled grey to very dark brown (10yr 5/1 to 3/2) sandy loam. There are occasional angular coral fragments and subrounded pebbles to small cobbles with fine to medium calcareous and volcanic sand. The consistence is very slightly sticky and nonplastic. Lens B occurs discontinuously within this layer. Glass and metal fragments were found in this layer, some samples of which were collected. Also, a large (50 cm diameter) earthenware or concrete pipe was discovered at the base of the trênch, at the water table, ca. 150 cm below surface. The northern section of the trench overlies a Fill 6 with an abrupt, irregular boundary. This was the bottom of the excavation in the southern section of the unit.

Lens B--This lens is similar to Fill 2 and Lens A. It is 2 cm in thickness and extends into Fill 5. It is black (7.5yr 2/0) silt; nonsticky and nonplastic and contains some charcoal. The boundary with Fill 5 is discontinuous, abrupt, and smooth.

Fill 6--This layer occurs only in Trench 1. It ranges in thickness from 7 to 14 cm+. It is a mixed very dark grey brown to very pale brown (10yr 3/2 to 8/3) loam. Fine to medium calcareous and volcanic sands are present in the matrix. The consistence is very slightly sticky and very slightly plastic. Metal fragments were found within this layer. Excavation stopped here due to the presence of the water table.

Trench 2

Trench 2, 1.5 m long by 0.80 m wide by 1.65 m in depth, was located on the north side of the drainage at 11.70 meters from the end of the subsurface portion of the drainage on the west. Trench 2 stratigraphy (Figure 6) showed a series of fill events extending to the water table, and contained inclusions of metal and glass. The large pipe found in Trench 1 was also found here.

Fill 1--This is a recently deposited fill found in both trenches. It ranges in thickness from 1.00 to 1.07 m. The deposit contains three lenses (C, D, and E). Glass fragments were found within this layer. Fill 1 directly overlies Fill A with an abrupt, wavy boundary.

Lens C--This lens occurs within Fill 1 and is 1 to 10 cm thick. It is a reddish brown, yellowish red (5 yr 4/5) silty clay. The consistence is sticky and slightly plastic. One charcoal fragment was noted in the lens. The boundary is abrupt.

Lens D--This lens occurs within Fill 1 and is very similar to Fill 2, Lens A, and Lens B of Trench 1. Lens D is 2 cm think and is a black (7.5yr 2/0) silt, The consistence is nonsticky and nonplastic. Charcoal, metal, and glass inclusions were noted in this lens. The boundary is abrupt.

Lens e--This lens occurs within Fill 1 and ranges in thickness from 10 to 30 cm. It is a mottled light brownish grey and greyish brown (10yr 6/2 to 5/2) silty clay loam. The consistence is slightly sticky, slightly plastic. It contains sparse charcoal. The boundary is clear.

Fill 2b--This fill is found only in Trench 2. It ranges in thickness from 10 cm to 15 cm. It is a mottled greyish brown and which (10yr 5/2 to 8/2) sandy loam. The fill contains

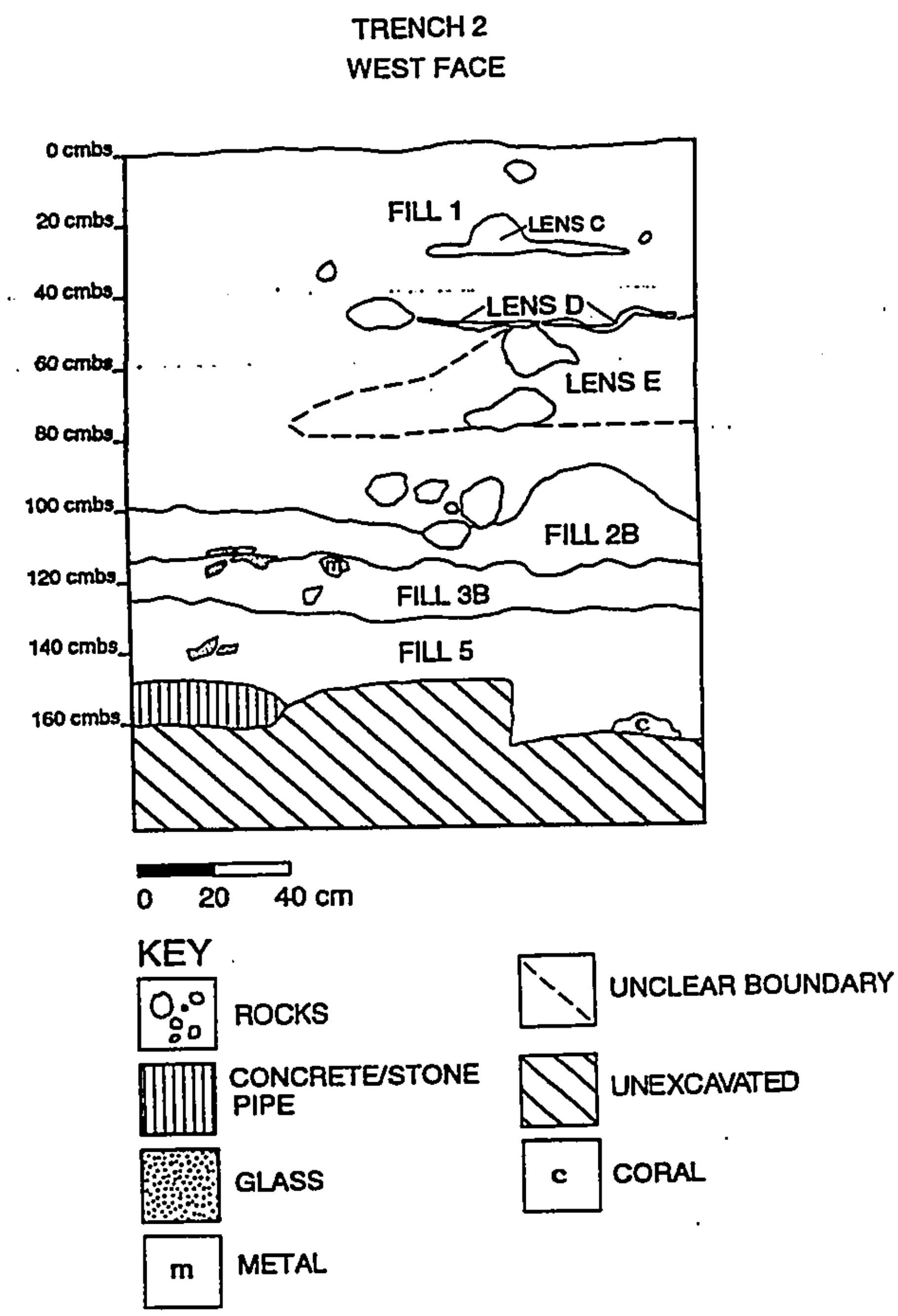

TRENCH 2
WEST FACE
0 cmbs
20 cmbs
40 cmbs
60 cmbs
80 cmbs
100 cmbs
120 cmbs
140 cmbs
160 cmbs
FILL 1
LENS C
LENS D
LENS E
FILL 2B
FILL 3B
FILL 5
c
0 20 40 cm
KEY
ROCKS
CONCRETE/STONE PIPE
GLASS
m
METAL
UNCLEAR BOUNDARY
UNEXCAVATED
c
CORAL

Figure 6.

occasional rounded to subrounded gravel and pebble inclusions as well as subangular coral fragments. The consistence is slightly sticky and slightly plastic. Historical glass fragments were found within this layer. Fill 2b directly overlies Fill 3b with an abrupt, wavy boundary.

Fill 3b--This fill is found only in Trench 2. It is 11 to 16 cm thick. It is a mottled black and yellowish red (5yr 2.5/1 and 5/6) silt, which predominantly consists of decomposing metal flake fragments. Glass and occasional coral pieces were associated with this fill. It directly overlies Fill 5 with an abrupt, smooth boundary.

Fill 5--This fill deposit is found in both trenches. A large coral cobble was found at the base as well as a piece of ceramic vessel. Fill 5 directly overlies the pipe previously described in the south end of the trench. The water table was reached a few centimeters below the top of the pipe on the north end of the trench. Excavations were terminated at this point.

Interpretations and Recommendations

The ceramic shard found in TR 2, Fill 5 is possibly of nineteenth century origin. Other materials appear to be of more recent origin, with older materials being mixed with newer ones.

Both trench profiles seem to represent exclusively filled deposits in the immediate area. Certainly nothing indicative of early post-Contact (A.D. 1778-1850) or pre-Contact human habitation is evident in these units.

There is a strong probability that soil along the drainage throughout the easement area is similarly disturbed as an artifact of drainage construction. However, as substantial portions of the easement area were not available for investigation due to limited access, it is recommended that archaeological monitoring of future construction along the drainage be preformed. Despite the fact that a modern school, church, utility easements and other improvements have been built on the present project area since the days of *ali'i* residence, we cannot state with certainty that the soils in this section of Pākalā are completely disturbed and/or devoid of archaeological data. It was discovered at Moku'ula (Klieger 1994), for example, that many architectural features of King Kamehameha III's palace complex are still extant under the coral and soil fill of Malu'ulu o Lele Park. Considering the placement of the present drainage with a few meters of the site of the old tomb at Halekamani, and the closeness of *ali'i* residences, monitoring of any excavations in the vicinity is highly recommended due to the potential of retrieving archaeological data (National Register Criterion D).

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