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FINAL

Environmental Impact Statement

FOR

WINDWARD OAHU REGIONAL WATER SYSTEM IMPROVEMENTS

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

VOLUME I

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OFC. OF ENVIRONMENTAL QUALITY CONTROL

EXECUTIVE CHAMBERS

HONOLULU

JOHN WAIHEE
GOVERNOR

August 4, 1989

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Hayashida:

Based upon the recommendation of the Office of Environmental Quality Control, I am pleased to accept the Final Environmental Impact Statement for the Windward Oahu Regional Water System Improvements, Oahu, Hawaii, as satisfactory fulfillment of the requirements of Chapter 343, Hawaii Revised Statutes. This environmental impact statement will be a useful tool in the process of deciding whether the action described therein should be allowed to proceed. My acceptance of the statement is an affirmation of the adequacy of that statement under the applicable laws and does not constitute an endorsement of the proposed action.

When the decision is made regarding the proposed action itself, I expect the proposing agency to weigh carefully whether the societal benefits justify the environmental impacts which will likely occur. These impacts are adequately described in the statement, and, together with the comments made by reviewers, provide a useful analysis of the proposed action.

With kindest regards,

Sincerely,

JOHN WAIHEE

cc: Marvin T. Miura, Ph.D.

AUG 16 1989

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CITY AND COUNTY OF HONOLULU

BOARD OF WATER SUPPLY

FINAL

ENVIRONMENTAL IMPACT STATEMENT

FOR

WINDWARD OAHU REGIONAL WATER SYSTEM IMPROVEMENTS

This Environmental Document is Submitted Pursuant to Chapter 343, HRS

PROPOSING AGENCY:

Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843

ACCEPTING AUTHORITY:

Governor, State of Hawaii

Kazu Hayashida Date 8/8/88
KAZU HAYASHIDA
Manager and Chief Engineer

BOARD MEMBERS:

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VOLUME I

PREPARED BY:

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1164 Bishop Street, Suite 507
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SUMMARY

This Environmental Impact Statement (EIS) has been prepared to meet the requirements of Chapter 343, HRS, and Title 11 of Chapter 201, Department of Health Administrative Rules. The EIS addresses a proposal by the City and County of Honolulu Board of Water Supply (BWS) to develop water development projects, reservoirs, and transmission mains in an approximately 150 square-mile region extending from Malaekahana through Makapu'u on windward Oahu. The proposed BWS water system improvements will be located on the windward slopes or valleys of the Koolau Range or on the coastal plain between the foot of the Koolaus and the Pacific Ocean. The water development projects will consist of tunnels, inclined wells, conventional ground water wells, and one shaft. The proposed new BWS water sources will either develop dike-impounded ground water, basal ground water, or alluvial ground water.

A total of 46 water development projects, 19 new reservoirs, and 148,540 linear feet of transmission pipeline have been identified by the BWS for evaluation. Some of these proposed projects are budgeted, others planned, and many only conceptual. The BWS will not build all of these projects. Some proposed projects will not be developed because of the high cost or potential adverse impacts. Others will not be developed because exploratory wells show unsatisfactory yields. And others will not be developed because of selection of alternative sites.

With some exceptions, most of the proposed new water sources and reservoirs will be located within or adjoining large tracts of undeveloped open space. The proposed Kaluanui Wells will be within Sacred Falls State Park. The proposed Luluku Wells and Luluku "500" Reservoir will be within a banana field mauka of Likelike Highway. The proposed Kahana Wells and Reservoir will be within Kahana Valley State Park The proposed Kuou Wells II will be within the County's Ho'omaluhia Park. Proposed major water transmission mains will primarily be routed along existing public highways.

Water from potable windward sources not used to service BWS customers in windward Oahu will be pumped around Makapu'u to Hawaii Kai. This will "free" water from leeward sources now used in Hawaii Kai for use elsewhere in Honolulu. Proposed windward water sources which are the

subject of this EIS have a maximum potential yield of about 39 to 43 million gallons per day (mgd) of potable water and about 2 mgd of non-potable water. By comparison, it is projected that the average daily island-wide municipal water demand including all public, residential, commercial, industrial, and agricultural uses supplied by the BWS will increase by about 50.9 mgd between 1980 and the year 2000. It is estimated that about 3.2 mgd of the projected twenty-year increase in average daily municipal demand will be needed in windward Oahu between Laie and Makapu'u.

Median annual rainfall on windward Oahu increases with elevation and ranges from about 39 inches near the coast in Kahuku and Waimanalo to as much as 276 inches near the crest of the Koolau Range inland of Punaluu Valley. At high elevations in windward Oahu, rainfall not lost to evapotranspiration or surface runoff is stored as ground water in the permeable basaltic lava flows between relatively impermeable basaltic dikes. These dikes were formed by molten rock which solidified in the fissures of the volcano. Although the general pattern of ground water movement is toward the ocean, local flow directions are complicated by the shape of dike compartments and by erosion. Generally, water moves gradually by leakage and overflow from dike compartments with higher head to those with lower head. Water from dike reservoirs can also discharge directly into streams which have cut into the water-bearing rocks, indirectly by seeping through permeable alluvium and then into streams, or into man-made development facilities such as water development tunnels.

The primary source of dry-weather base flow of perennial windward Oahu streams is leakage and overflow of dike-impounded ground water. During wet weather, windward streams also receive surface runoff and gain flow from rainfall stored in volcanic ash and/or unconsolidated surface alluvial material overlying relatively impermeable volcanic tuff and/or alluvium. Between Waimanalo and Punaluu, the discharge of perennial windward streams increases with decreasing elevation. However, north of Punaluu, windward streams are intermittent at low elevations because their dry-weather flow naturally percolates into their beds.

About one-half of the proposed BWS projects have the potential to develop ground water which would otherwise enter perennial windward Oahu streams. It is possible that most of the ground water to be developed by these

projects will be at the expense of stream flow. However, all ground water does not become stream flow. Some is lost to transpiration by plants and some seeps to the ocean. Rather than reducing stream flow, ground water development may reduce potable water wasting into the air or ocean. Thus, it is not possible to accurately predict the extent to which stream flow will be reduced by proposed BWS projects. To mitigate adverse impacts, although not required by law, the BWS intends to reduce or cease water production whenever the Department of Land and Natural Resources (DLNR) determines that ground water development has reduced stream flow below instream flow standards adopted by the DLNR.

At low elevations in parts of windward Oahu, basal ground water floats on top of salt water and is partially confined from moving seaward by either dikes or a relatively impermeable wedge of sedimentary caprock. A substantial body of basal ground water, commonly referred to as the Koolauloa Basal Aquifer, is present along 11 miles of coast from Punaluu to Kahuku Point. Smaller bodies of basal ground water are present in Kahana and Kaaawa Valleys and Waimanalo. These basal aquifers are primarily recharged by leakage and overflow of high-level dike-impounded ground water and, to a lesser extent, by direct infiltration of rainfall.

About one-third of the proposed BWS projects would develop ground water from basal aquifers. Development of these projects could cause salt water intrusion into coastal wells located in the same aquifers. The BWS intends to monitor public and private wells for the static head of and salt water intrusion into affected aquifers. Pumpage would be regulated, if necessary, to preserve basal aquifers.

Diversions and/or development of high-level dike-impounded ground water have substantially reduced the dry-weather flow of many perennial windward Oahu streams including Punaluu, Kahana, Hakipuu, Waikane, Waiahole, Waihee, Kahaluu, Heeia, Kamooalii, Maunawili, and Waimanalo Streams and some of their tributaries. Despite these conditions, Kahana, Punaluu, Waikane, and Waiahole Streams are relatively high quality habitats for native stream fauna as compared to other Oahu streams. Koloa and Kaluanui Streams, which are undiverted, are also relatively high quality habitats for native stream fauna.

Native diadromous species live and spawn in streams and estuaries, but their hatchlings must develop in the ocean before returning to fresh or brackish water. Sufficient stream flow is necessary for diadromous stream fauna to have feeding and breeding areas and to permit passage to and from the ocean. Native diadromous stream fauna species which require completely fresh water habitat during part of their life cycle would be adversely affected by reduced stream flow in windward Oahu streams.

Caprock springs fed by confined basal ground water are a major source of wetlands at low elevations in Kahuku and Waimanalo, while other significant natural windward Oahu wetlands depend on stream discharge or overflow of dike-impounded ground water. There are also two man-made wetlands in Ho'omaluhia Park: a 1.5-acre wildlife pond created by impoundment of Ho'oleinaiwa Stream, and a 26-acre flood control reservoir created by the impoundment of Kamooalii Stream.

Windward Oahu wetlands provide habitat for four species of Hawaiian waterbirds listed as endangered by the U.S. Fish and Wildlife Service. Reduced stream flow or springs in these wetlands could adversely affect three waterbird species. Development of basal ground water could reduce the flow and increase salinity of caprock springs in the Punamano Unit of James Campbell National Wildlife Refuge.

Streams and wetlands also provide habitat for a variety of aquatic insects, including two species of damselflies being considered for listing as endangered by the U.S. Fish and Wildlife Service. Depending upon the preferred habitat, certain species of aquatic insects may be beneficially affected by reduced stream flow. Sufficient information is not available to clearly establish the effects of the proposed BWS projects on aquatic insects.

The estuaries of windward Oahu provide habitat for various species of crustaceans and fish. These species live within the area where fresh water discharge from streams and springs and salt water from the ocean mix. Existing information is inadequate to determine whether any species of estuarine fauna might be adversely affected by reduced stream flow or springs.

Diversions for small-scale farms occur on a number of windward Oahu streams. Truck crops, bananas, and taro are the primary agricultural

crops grown with water from these diversions. Stream users diverting water below the static head of the proposed water sources which develop dike-impounded ground water may be adversely affected because of reduced stream flows. However, the BWS intends to manage water development projects as necessary to allow the continuation of existing private agricultural uses of water. As a result, existing private agricultural users should not be adversely affected.

Archaeological reconnaissance surveys were conducted, where possible, at the sites of proposed BWS projects. Archaeological features were observed at several proposed project sites and along several proposed access roads. The BWS intends to conduct supplemental archaeological research as individual projects are programmed and construction plans are prepared. Measures to avoid or mitigate adverse impacts to archaeological resources will be reviewed and approved by the DLNR.

Existing BWS water development charges will not cover all of the cost of proposed windward Oahu water system improvements. Unless BWS water development charges to new water users are increased, construction of the proposed windward Oahu facilities will inevitably require increases in BWS rates for municipal water.

The BWS considered a number of alternatives including no project, alternative well and tunnel sites, regional and island-wide approaches, and proposals of the Oahu Water Plan. Although some alternatives are feasible, many would entail higher costs than the proposed windward Oahu projects. Moreover, some of the alternatives would use water otherwise available for agricultural production.

The proposed water development projects would be consistent with State and County plans pertaining to population growth. However, since the proposed projects could decrease the flow in most windward Oahu streams, they would be in conflict with those portions of State and County plans which relate to preservation of streams. As a mitigation measure, the BWS will implement DLNR instream flow standards by reducing or ceasing water production when so directed by the DLNR.

Depending upon the proposed project, the following regulatory requirements may apply:

- Acceptance of supplemental Environmental Assessment or acceptance of a Supplemental Environmental Impact Statement;

- Approval of a Conservation District Use Application (CDUA) for development in a Conservation District;

- Easement or lease for use of State lands;

- DLNR concurrence with project effects on historic property;

- Department of Health approval for domestic use of water from a new water source;

- Designation of sites for proposed water sources and reservoirs on County Development Plan Public Facilities Maps;

- Special Management Area Use Permit for above-ground development within the County Special Management Area;

- County Grubbing, Grading, and Stockpiling Permits; and

- Building Permits for construction of buildings or structures, and electrical and plumbing improvements.

The unresolved issues related to the proposed BWS windward projects are:

- Plans for reservoirs;
- Plans for access roads;
- Plans for transmission mains;
- Plans for booster pumps;
- Plans for electrical and telephone lines; and
- Plans for projects not budgeted in the Six-Year Capital Improvements Plan (CIP).

The unresolved issues related to potential adverse impacts and mitigation measures are:

- Installation and operation of stream and rainfall gages and creation of models to quantify impacts on stream flow from BWS projects;

- Implementation of instream flow standards when there is no practical way of determining if stream or spring flow were adversely affected by ground water development;

- Adoption of permanent instream flow standards by the State Commission on Water Resource Management;

- Location, number, and funding of additional observation wells to monitor the static head of and salt water intrusion into basal aquifers; and

- Allocation of the remaining undeveloped water in the Koolauloa Basal Aquifer.

The BWS is mandated by law to provide for growing consumer demand on Oahu. An adequate water supply is necessary to meet the areas of concern set forth in the City and County of Honolulu General Plan.

After acceptance of this EIS, the BWS intends to prepare supplemental Environmental Assessments (EAs) as each of the projects are programmed for possible construction. These EAs, including a determination of applicability, will be submitted to the State Office of Environmental Quality Control (OEQC) for publication in the OEQC Bulletin. If appropriate, then the OEQC will require that Supplemental EISs be prepared in accordance with rules adopted by the State Environmental Council. [See Subchapter 10, Section 11-200-26, Administrative Rules, State of Hawaii, Department of Health]

FINAL
ENVIRONMENTAL IMPACT STATEMENT

FOR

WINDWARD OAHU REGIONAL WATER SYSTEM IMPROVEMENTS

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I. DESCRIPTION OF THE PROPOSED PROJECT

A. INTRODUCTION

The Board of Water Supply (BWS) is a semi-autonomous agency responsible for developing and operating a financially self-supporting municipal water system for the City and County of Honolulu. The BWS is governed by a seven-member board. Five members are appointed by the Mayor and confirmed by the City Council and two are ex-officio members: the State Transportation Director and the City Public Works Director. BWS powers include:

1. Raising revenues from the sale of water and related service fees.

2. Issuance of bonds.

3. Expenditure of BWS funds to expand, maintain, and operate the BWS water system.

4. Condemnation of private property.

5. Promulgation and enforcement of rules and regulations to set BWS water rates and service fees, govern dedication of new facilities to the BWS, allocate municipal water among consumers, prevent waste of potable ground water, control disposal of sewage and use of pesticides (to protect potable ground water from contamination), and regulate withdrawal of basal ground water (to prevent salt water intrusion).

In the past, the BWS satisfied the requirements of Chapter 343, HRS, by preparing Negative Declarations or Environmental Impact Statements (EISs) as individual projects were programmed. Previous Negative Declarations and EISs for proposed windward Oahu water system improvements and existing exploratory wells are summarized in Table 1.

This EIS addresses the cumulative impacts and implications of proposed BWS projects in the region extending from Malaekahana through Makapu'u. [Figure 1] Since this region makes up the bulk of windward Oahu, the subject BWS projects will be collectively referred to in

TABLE 1

PREVIOUS NEGATIVE DECLARATIONS AND ENVIRONMENTAL IMPACT STATEMENTS FOR PROPOSED AND EXISTING WINDWARD OAHU REGIONAL WATER SYSTEM IMPROVEMENTS
(As of January 1985)

Type of Assessment	Date of Notice In EQC/OEQC Bulletin	Title	Subject
Negative Declaration	07/23/81	Wailele Exploratory Well	1 exploratory well
Negative Declaration	05/23/81	Laie Exploratory Well	1 exploratory well
Revised EIS	08/13/84	Kaluanui Wells	2 operating wells, water main
Negative Declaration	01/23/81	Punaluu Exploratory Well IV	1 exploratory well
Negative Declaration	02/08/81	Punaluu Exploratory Wells V	7 exploratory wells
Revised EIS	02/08/83	Kahana Valley Water Development Project	4 operating well fields, water mains
Revised EIS	02/23/84	Kahaluu Well	1 operating well
Revised EIS	04/23/82	Pump and Control Building for Haiku Well	1 operating well
Revised EIS	06/23/83	Iolekaa Well	1 operating well
Revised EIS	05/08/84	Kamooalii Watershed Wells	4 operating and 4 standby wells, reservoirs, water mains
Negative Declaration	06/23/83	Waimanalo Well II, Reservoir, Water Main	1 operating well, 1 reservoir, water main
Revised EIS	09/08/83	Kahana "315" Reservoir Project	1 reservoir, water main
Revised EIS	03/23/77	1.5 MG Heeia-Kai Reservoir	1 reservoir, water main
Revised EIS	10/08/80	42" Waterline from Waihee Booster Station to Intersection of Likelike and Kamehameha Highways	water mains
Revised EIS	05/08/80	16" Waterline along Kamehameha Highway from Heeia to Kolokio Streets	water main
Negative Declaration	01/08/85	Luluku "500" Reservoir	1 reservoir, water main

Source: Ref. 36-42, 44-52.

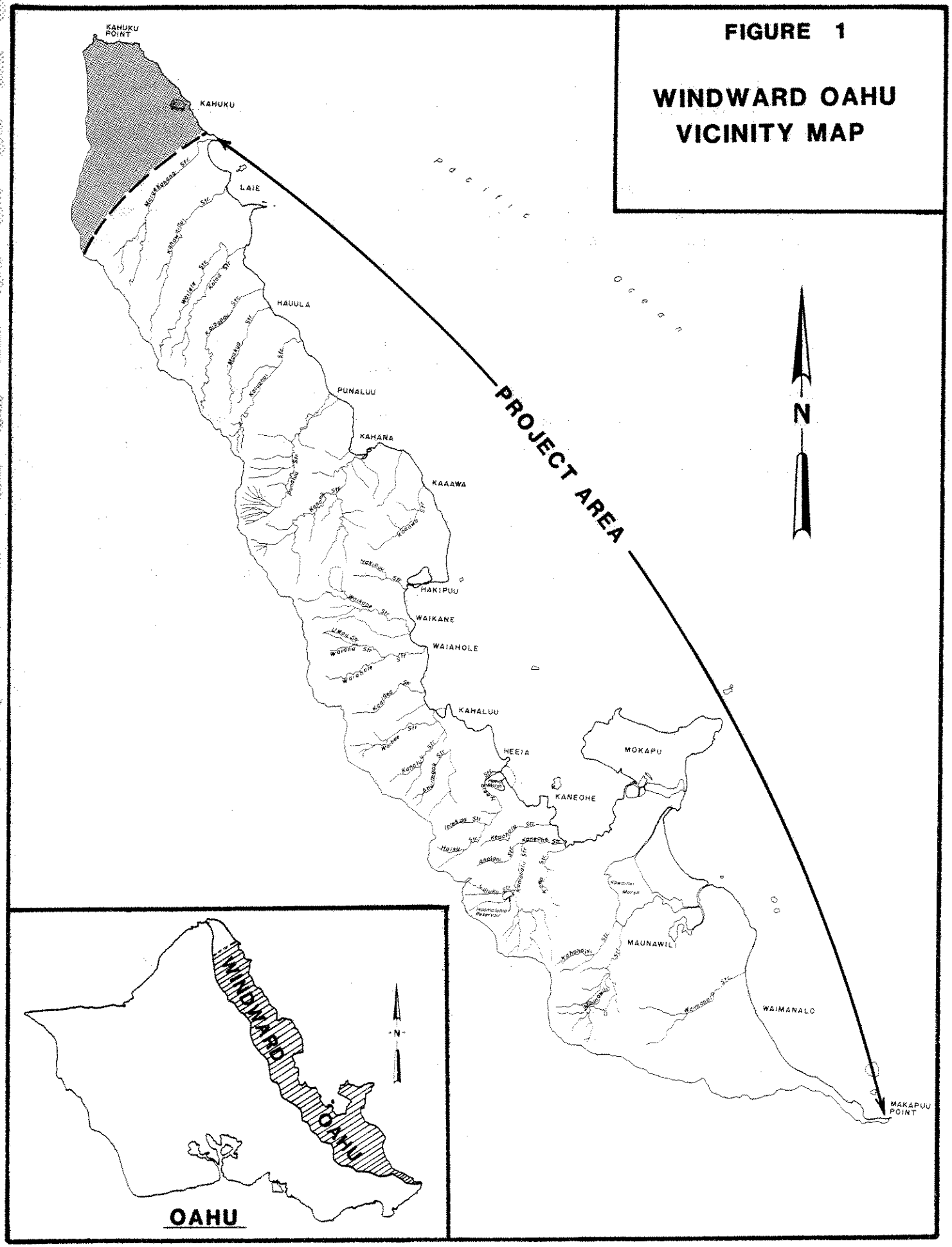


FIGURE 1
WINDWARD OAHU
VICINITY MAP
KAHUKU POINT
KAHUKU
LAIE
HAUULA
PUNALUU
KAHANA
KAAAWA
HAKIPUU
WAIKANE
WAIAHOLE
KAHALUU
HEEIA
KANEOHE
MOKAPU
MAUNAWILI
WAIMANALO
MAKAPUU POINT
PROJECT AREA
N
Pacific
Ocean
WINDWARD
OAHU
N
OAHU

this EIS as windward Oahu water system improvements. However, it should be kept in mind that Kahuku, which is part of windward Oahu, is outside the project area.

Some of the proposed windward Oahu water system improvements are budgeted, others are planned, but many are only conceptual. For this reason, siting has not been resolved for most BWS reservoirs, access roads, transmission mains, electrical lines, and telephone lines discussed in this EIS.

The BWS will not build all of the projects described in this EIS. Some proposed projects will not be developed because of cost or potential adverse impacts. Others, such as Kamooalii Wells I and II, will not be developed because exploratory wells show unsatisfactory yields. And others will not be developed because of selection of alternative sites.

In the future, after acceptance of this EIS, the BWS intends to prepare supplemental Environmental Assessments (EAs) as each of the projects are programmed for possible construction. These EAs, including a determination of applicability, will be submitted to the State Office of Environmental Quality Control (OEQC) for the publication in the OEQC Bulletin. If appropriate, then the OEQC, acting for the Governor, the accepting authority, will require that Supplemental EISs be prepared in accordance with rules adopted by the State Environmental Council.

The BWS also intends to conduct supplemental archaeological research as individual projects are programmed in windward Oahu. Archaeological research reports will be incorporated in supplemental EAs submitted to the OEQC. Measures to mitigate impacts on archaeological resources will be reviewed and approved by the State Department of Land and Natural Resources (DLNR).

Other measures planned by the BWS to mitigate project impacts include water quality and stream flow monitoring. The BWS intends to manage windward water production as necessary to protect ground water quality, maintain existing water uses by other parties, and avoid causing reductions of stream flows to less than standards established by the DLNR.

B. OBJECTIVES

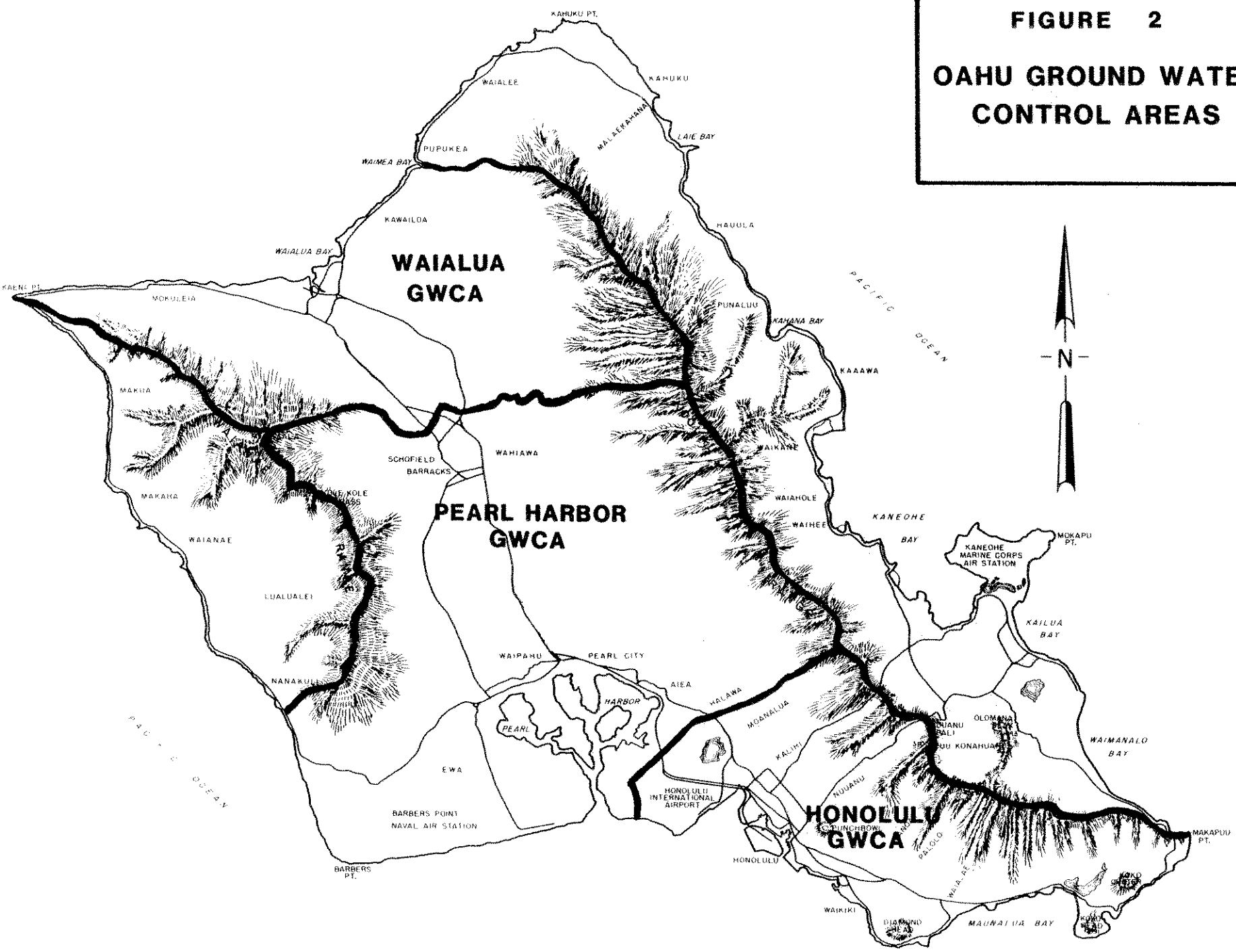
Water from potable windward sources not used to service BWS customers in windward Oahu will be pumped around Makapu'u to Honolulu. This will "free" water from leeward sources now used in Honolulu for use elsewhere on Oahu. Proposed windward water sources which are the subject of this EIS have a maximum potential yield of about 43 million gallons per day (mgd) of potable water and about 2 mgd of non-potable water. By comparison, it is projected that the average daily island-wide municipal water demand including all public, residential, commercial, industrial, and agricultural uses supplied by the BWS will increase by about 50.9 mgd between 1980 and the year 2000. It is estimated that about 3.2 mgd of the projected twenty-year increase in average daily municipal demand will be needed in windward Oahu between Laie and Makapu'u. [See Appendix A] These estimates are based on historic per capita water use and 1978 "II-F" population projections by the State Department of Planning and Economic Development, with assumptions about population and employment distribution provided by the City Department of General Planning. [Ref. 43] Updated BWS projections of municipal water use will not be available until after publication of this Final EIS.

On the average, about 32.78, 70.19, and 2.31 mgd of water supplied by the BWS in 1980 were withdrawn respectively from the Honolulu, Pearl Harbor, and Waialua Ground Water Control Areas (GWCAs) [Figure 2] As of January 1988, to prevent salt water encroachment into fresh water basal aquifers, the Board of Land and Natural Resources (BLNR) has limited BWS withdrawals from the Honolulu, Pearl Harbor, and Waialua GWCAs to an average of 41.66 (1.0 mgd from caprock and 40.66 mgd from the basal aquifer), 92.01, and 2.73 mgd, respectively. In the future, as discussed in Chapter VII, additional BWS water development may be allowed in these GWCAs. [Ref. 87 and Ref. 154]

The BWS plans to develop water from a number of sources including windward wells and tunnels in order to accommodate projected growth. In the event that the BWS is unable to accommodate water demand, then the BWS will be forced to deny hook-ups or to not issue new water meters larger than 5/8" (adequate for a single family home). [Ref. 53, Sec. 1-101(5)] In effect, this would impose a moratorium on most new development until such time as new water sources are developed.

FIGURE 2

OAHU GROUND WATER CONTROL AREAS



C. OVERVIEW OF PROPOSED BWS FACILITIES

Proposed new BWS water sources will either develop dike-impounded ground water, basal ground water, or alluvial ground water. [Figure 3] In some parts of windward Oahu, ground water is confined between relatively impermeable dikes in the permeable basaltic lava flows of the Koolau Range. This is called dike water. Dikes are formed by molten rock solidifying in fissures of volcanoes. In other parts of windward Oahu, basal ground water floats on top of salt water and is sometimes partially confined from moving seaward by either dikes or caprock. Caprock is formed by relatively impermeable coastal deposits of terrestrial and marine sediments. Ground water is also found perched in alluvium or relatively recent lava flows overlying less permeable sedimentary deposits, volcanic ash, or lava flows. Perched ground water is a relatively minor potential water source. The geology and hydrology of windward Oahu are discussed at greater length in Chapter II.

The BWS plans to develop ground water in windward Oahu with tunnels, inclined wells, conventional wells, and one shaft at Kaaawa. Tunnels and inclined wells will be used to tap high-level ground water confined between dikes. Tunnels can be excavated to any length, are usually large enough to allow a man to walk comfortably inside, and can fork or bend. Plate 1 shows a typical tunnel portal. Inclined wells can be drilled up to about 1,000 feet nearly horizontally (although are usually slanted down), have a maximum 3" bore inside their casing, and are relatively straight. Plate 2 shows typical above-ground casings and piping for an inclined well field. Proposed tunnels and inclined wells will be free-flowing and will not be pumped. Unlike inclined wells, tunnels are not cased and frequently cannot be adequately sealed to restore storage. Conventional wells will be used to develop both high-level and low-level dike-confined ground water, basal ground water, and ground water perched in alluvium. Such wells are drilled vertically and cased. While some proposed windward wells may be free-flowing, most will be pumped to maximize their yield. The only proposed windward project involving a shaft is the reactivation of an existing facility from which basal ground water will be pumped.

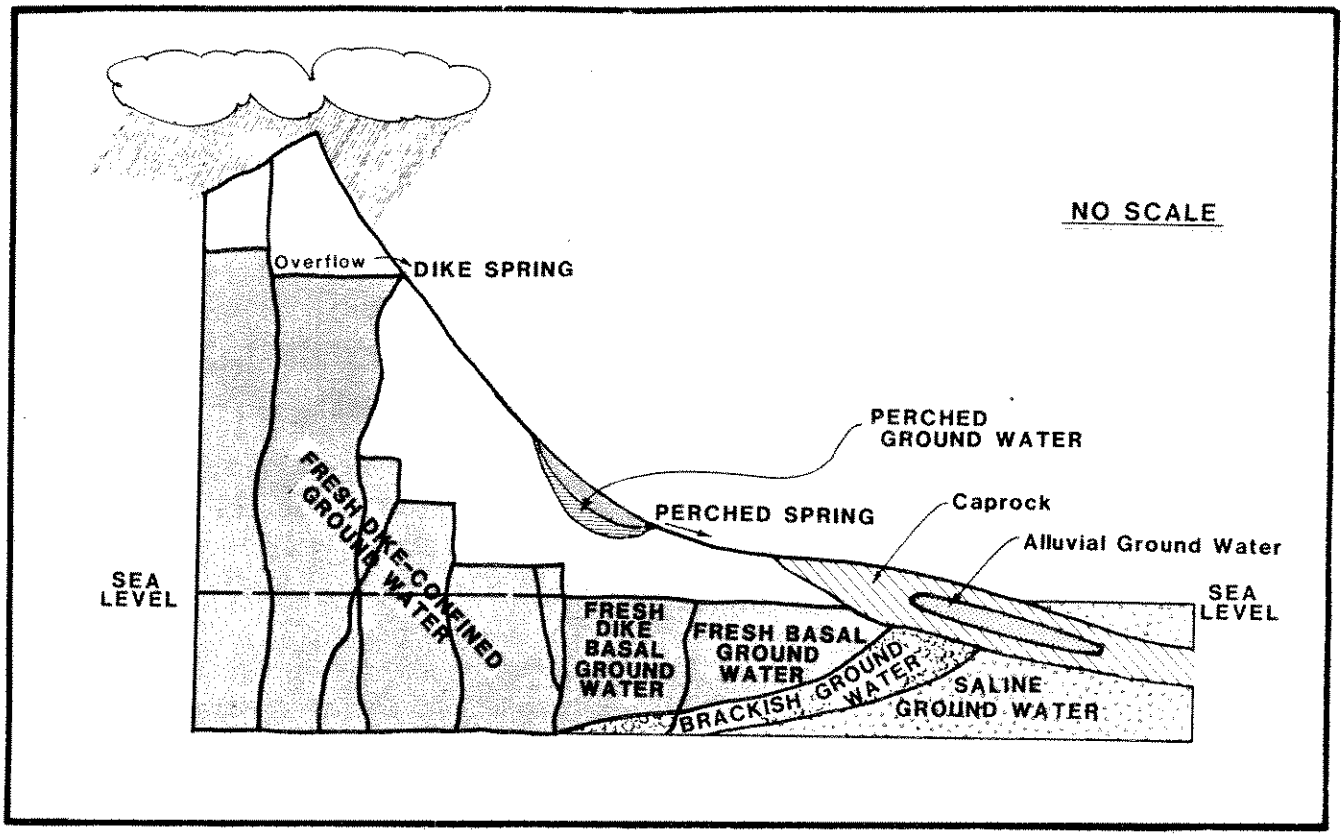


FIGURE 3
TYPES OF GROUND WATER IN WINDWARD OAHU

PLATE 1
WAIHEE TUNNEL PORTAL

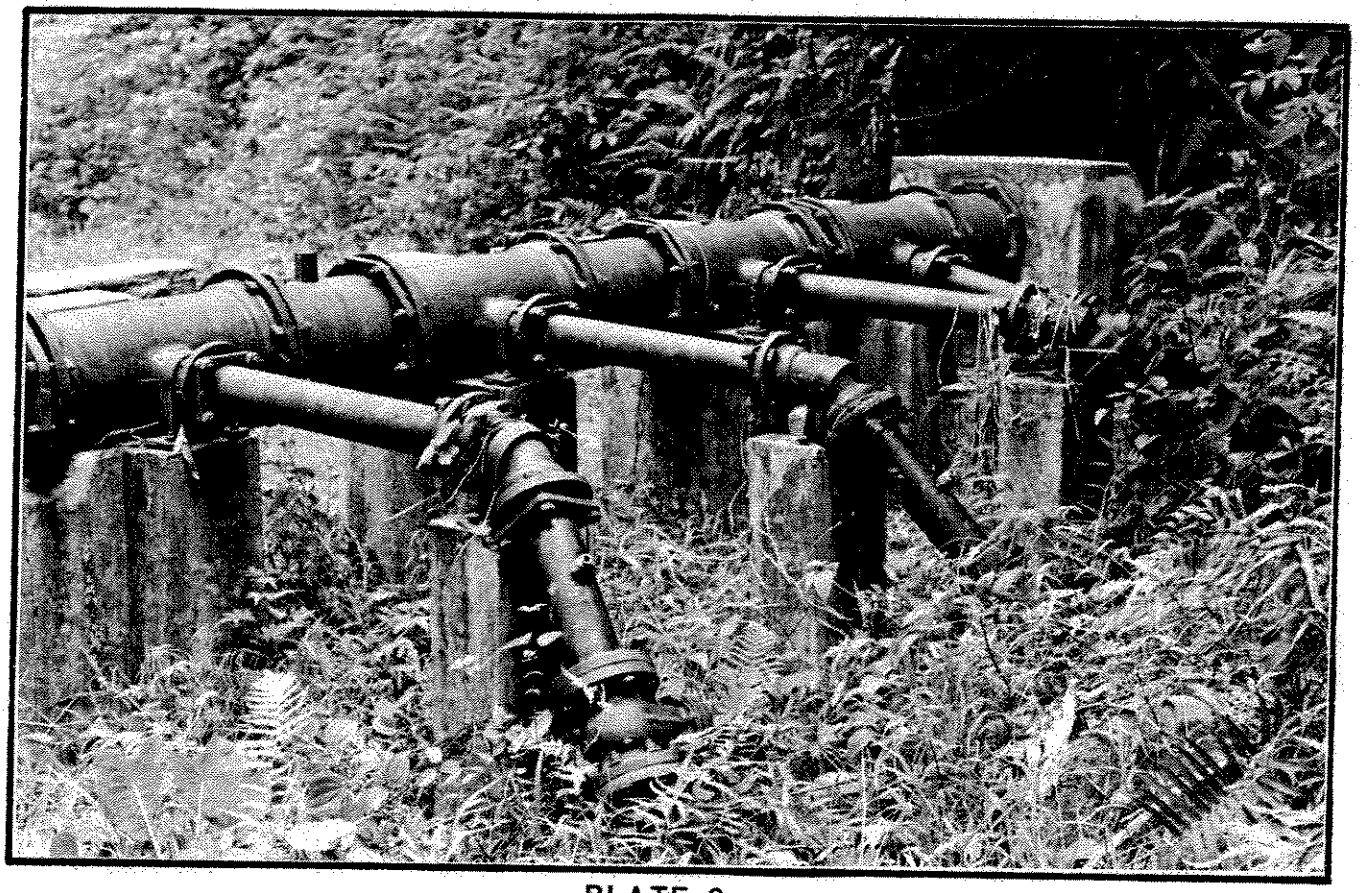


PLATE 2
WAIHEE INCLINED WELLS

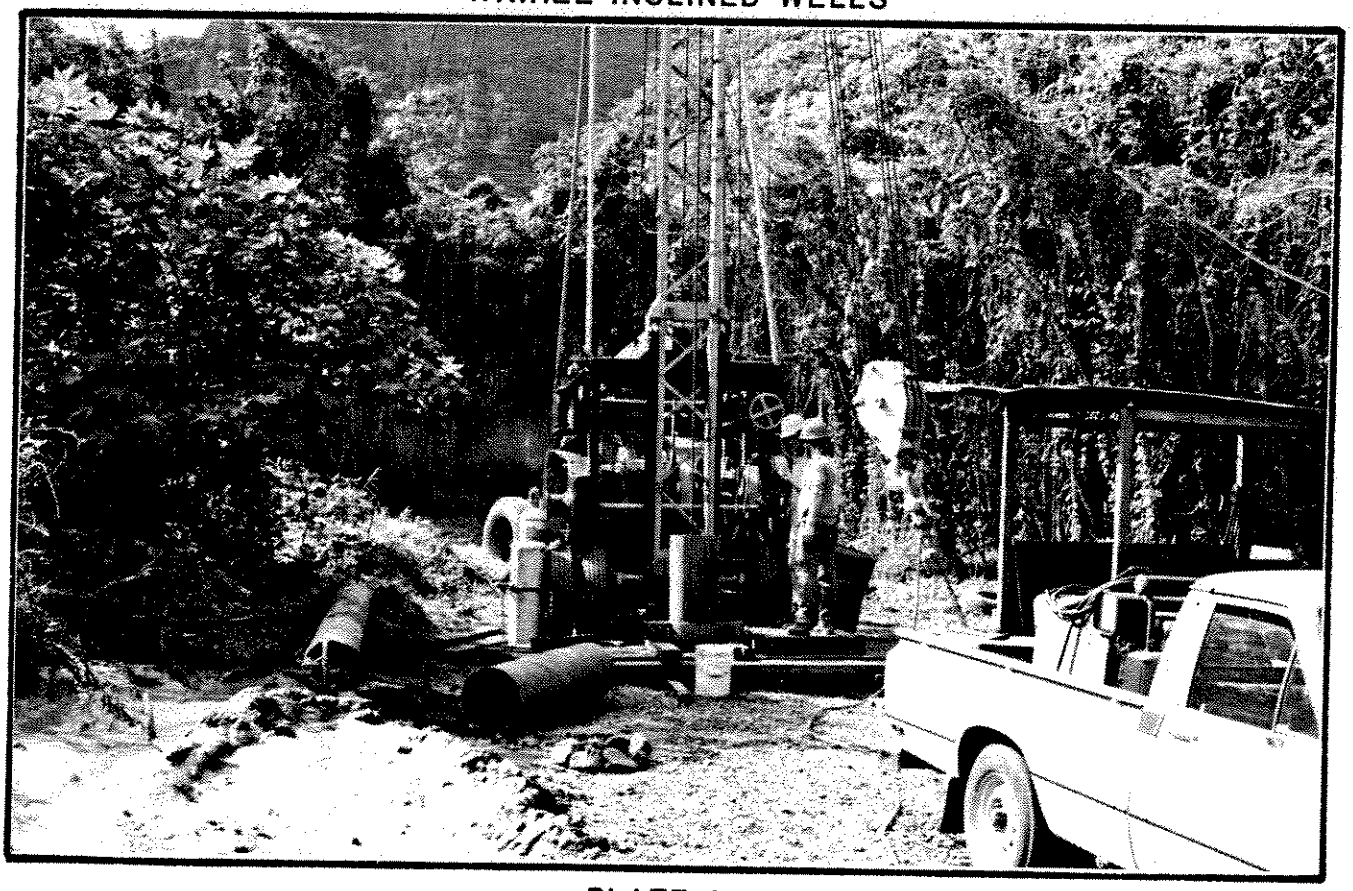


PLATE 3
WELL DRILLING RIG

Development of a new BWS well typically involves two phases: 1) exploratory facilities; and 2) production facilities. It is not unusual for a completed well to be capped for several years before production facilities are installed.

During the exploratory stage, a construction road is needed to allow either a conventional well drilling rig or a tunnel driving jumbo access to the well or tunnel site. Plate 3 shows a typical well drilling rig. By comparison, a dismantled drilling rig for an inclined well can be flown in by helicopter. If a suitable road or jeep trail does not exist, then a minimum access route and work pad are roughly graded. The time needed to drill a well is usually several months, but to excavate a tunnel can take a year or more. Cuttings and other wastes are disposed off-site. After completion, to prevent water from being wasted or contaminated, tunnels are usually bulkheaded and inclined wells are usually capped until they can be put into production.

When a conventional well is completed, a temporary pump is installed to test how much water the well can safely yield. Upon completion of the well pumpage tests, all equipment is removed and a steel plate is welded to the top of the well casing until it can be put into production.

Production facilities for a new BWS water development tunnel or inclined well field will include a water transmission main, standby chlorinator facility (usually off-site, but hooked into the pipeline), all-weather access road (adjacent to the pipeline) for chlorinator and pipeline maintenance, and electrical line to the chlorinator facility. Except for water mains, access roads, and utility lines, production facilities for a new BWS well field (including 1 operating and 1 standby well) will typically be confined within a 10,000 square foot site.

On-site production facilities for a new BWS well field will include pumps, electrical equipment and appurtenances, a one-story control building (including a standby chlorinator facility), piping, landscaping, irrigation system, and fencing. Plate 4 shows typical on-site well field production facilities. In residential areas and public parks, pump mutes or submersible pumps will be used to control

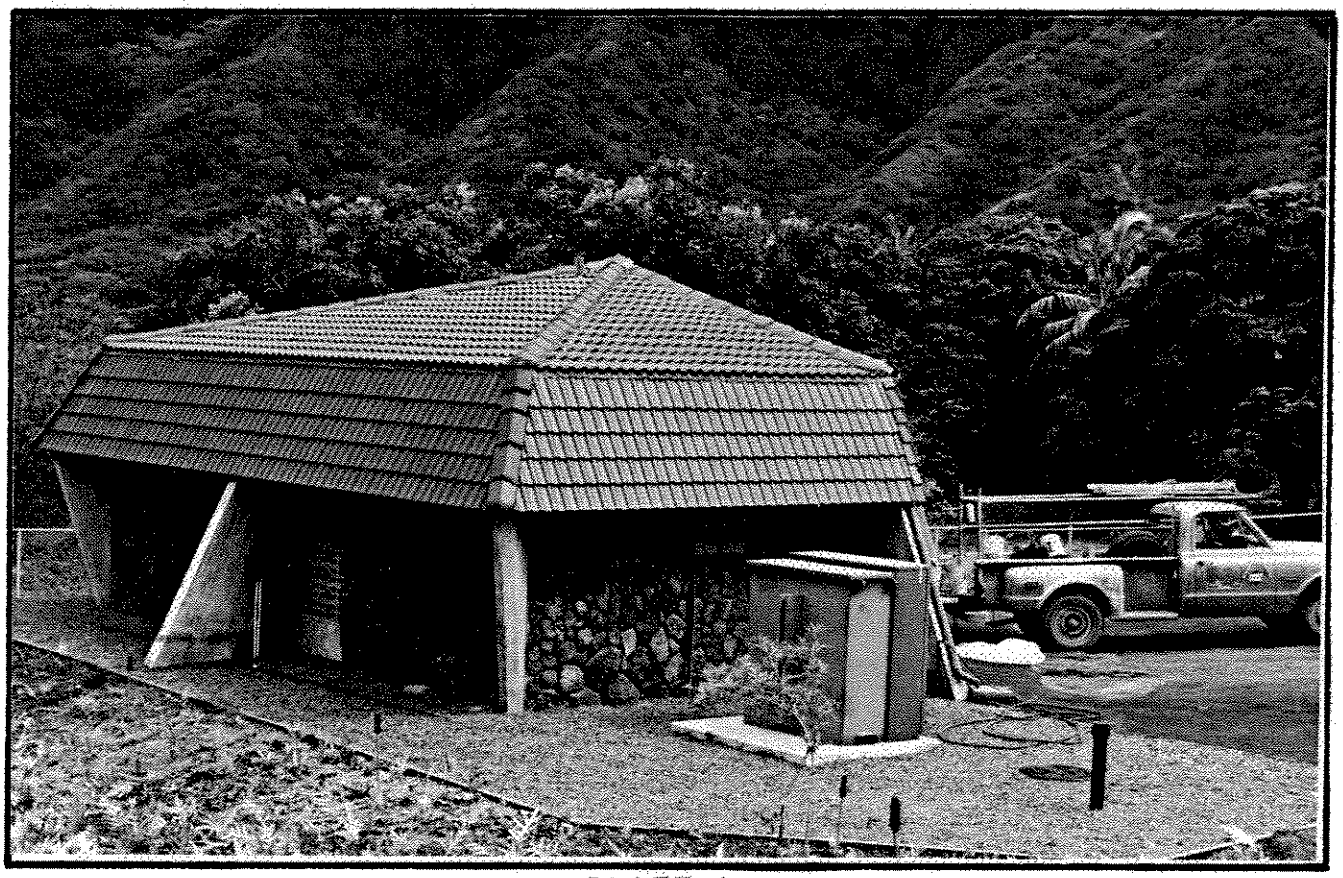


PLATE 4
KAHANA WELLS I CONTROL BUILDING

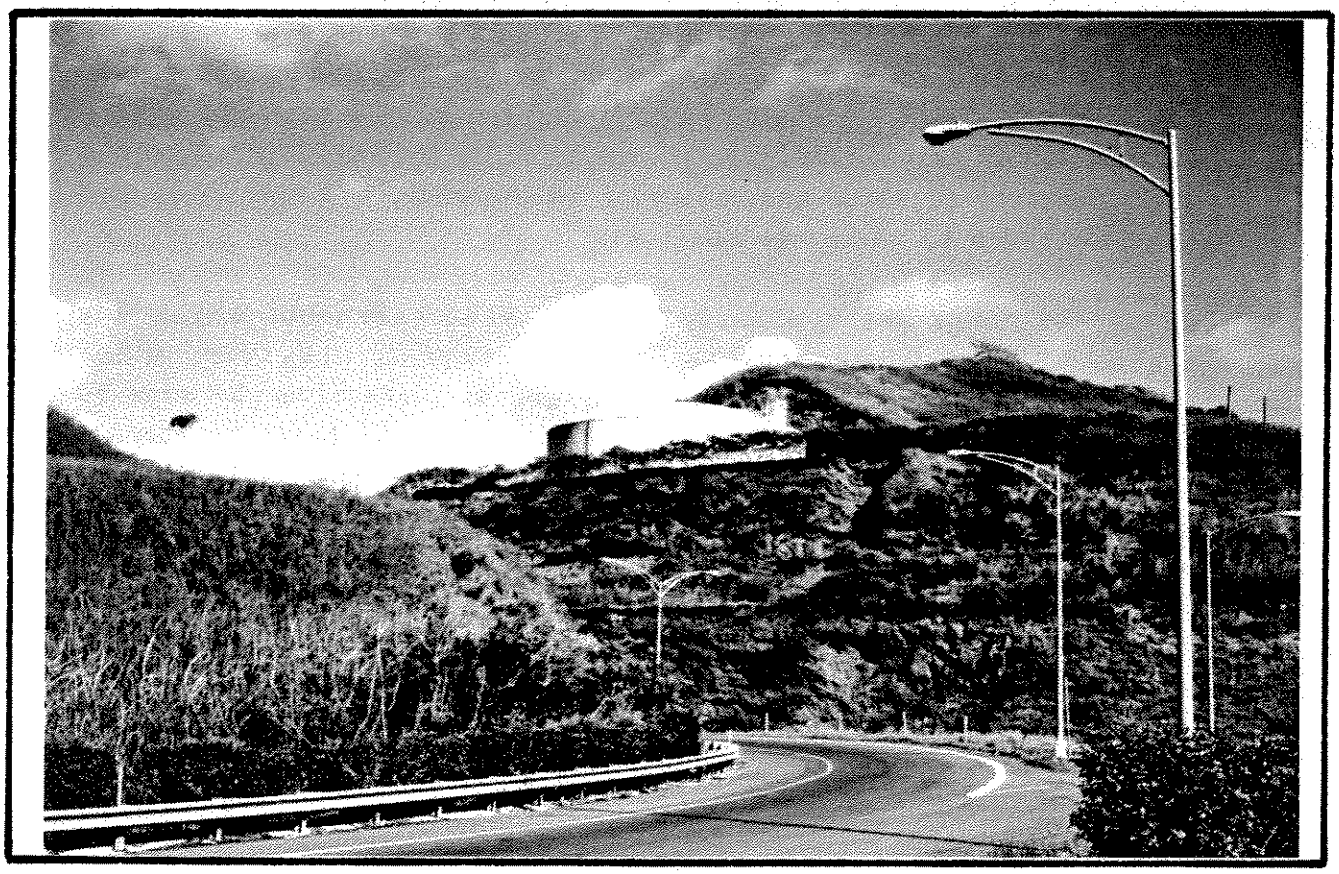


PLATE 5
KAPAA 272 RESERVOIR

pumping noise. Off-site facilities for a new BWS well field will include a water transmission main, all-weather access road for pipeline and control building maintenance, and electrical and telephone lines to the control building.

In order to accommodate normal daily fluctuations in water demand, provide capacity for fire fighting, and stabilize water pressure, it is desirable for the BWS to pump water into one or more reservoirs. Pumpage can be regulated by controls that monitor reservoir water levels. Reservoirs can also be used to reduce water pressure from high elevation water sources, to even out pressure differences between water sources connected to the same water pressure system, to control pressure surges in major water transmission mains which occur when pumps are turned on and off, and to keep transmission mains full of water when pumps are turned off.

Standard reservoir dimensions are listed in Table 2. Plate 5 shows a typical 2 million gallon (MG) reservoir. It is usually necessary to cut a terrace into a hillside to accommodate construction of a reservoir. On steep slopes, installation of a reservoir normally requires a series of terraces for slope stabilization. Reservoir sites are usually fenced and landscaped. Reservoirs are sometimes partially buried, painted earth-tone colors, and obscured with trees to reduce visual impacts. Off-site infrastructure associated with a new reservoir will include water transmission mains, an all-weather access road for pipeline and reservoir maintenance, and electrical and telephone lines to reservoir monitors.

BWS access roads are typically 20 feet wide easements which may include 12 feet wide concrete or A.C. pavement. However, other arrangements such as a crushed coral or gravel surface can be made to accommodate abutting property owners. When the BWS needs to upgrade dirt roads which have other users, improvements are usually limited to patching of potholes, placement of gravel, and installation of culverts to prevent erosion. With very few exceptions, it is BWS policy to ensure road access for maintenance along all new BWS pipelines and utility lines.

TABLE 2
STANDARD RESERVOIR DIMENSIONS

Reservoir Capacity (Million Gallons)	Height (a)	Diameter
0.5 MG	20'	72' (b)
1 MG	22'	96' (b)
2 MG	22'	135' (b)
2 MG	32'	109' (c)
4 MG	22'	186' (c)
4 MG	32'	152' (c)
6 MG	32'	191' (c)

Notes: (a) Includes 2' freeboard
(b) Reinforced concrete
(c) Prestressed concrete

Regardless of size, BWS pipelines are buried to minimize risk of damage. At stream crossings, pipelines are either hung along bridges or buried beneath the stream bed and do not interfere with stream flow. Pipelines from proposed windward sources and reservoirs typically will connect to major transmission mains along windward highways.

Electrical and telephone lines to BWS water sources and reservoirs are usually installed as an overhead system to minimize cost. Underground electrical and telephone lines will be used when required in public parks, within urbanized areas with underground utilities, and for crossing major highways.

D. SUMMARY OF NEW WATER SOURCES

Proposed BWS windward water development projects are described in

Table 3. Because there are alternative well sites, some of the names used for proposed water sources in this EIS may be slightly different than the names finally adopted by the BWS. For example, the Punaluu Inclined Wells are also referred to as Punaluu V-E. In addition, although this EIS refers to a Kaluanui Well I, Well II, and Well II (Alternate), the BWS has actually budgeted one well field of two operating wells in Kaluanui Valley as Kaluanui Wells. This project is identified as Kaluanui Wells in the BWS Six-Year Capital Improvement Plan (CIP). Except for the Halekou Wells, Pali Highway Tunnel Drains, and Waimanalo Wells III and IV, all proposed new sources will develop potable water. Potable water sources can be used either for irrigation or domestic water consumption. To the extent permitted, the BWS intends to maximize the yield from these projects. The sustainable yield and static head (ground water elevation before withdrawal of water) of new water sources can not be reliably determined without exploratory drilling (or excavation). In most cases, the tabulation of maximum potential yield in Table 3 is a liberal estimate of how much ground water can be developed from proposed water sources. However, in a few cases, new windward sources may possibly yield more water than is estimated. Since the Iolekaa Well was put into production in 1985, Table 3 lists its actual design yield. Table 3 also lists the design yields of completed but as yet unused wells.

The status of proposed BWS windward water development projects is described in Table 4. Some of the proposed windward BWS water sources have already been developed but not yet been put into production, others have been budgeted in the BWS Six-Year Capital Improvement Program (CIP), and others are only conceptual. Not all of the planned well sites will yield enough water to justify development of production facilities. For example, due to low yield, Kamooalii Wells I will not be developed. Similarly, due to low yield, Kamooalii Wells II has been sealed. In several cases, there are alternative well sites, not all of which will be developed. In many cases, the yield of an exploratory well will determine whether or not other wells will be drilled in the vicinity.

Conflicting uses may also cause the BWS to forego development of some of the proposed windward water sources. For example, the State of Hawaii, Housing Finance Development Corporation (HFDC) has begun

TABLE 3

DESCRIPTION OF PROPOSED BWS WATER DEVELOPMENT PROJECTS IN WINDWARD OAHU
(As of January 1988)

REGION AND NAME OF WATER SOURCE	DESCRIPTION	TYPE OF WATER SOURCE	MAXIMUM POTENTIAL YIELD	GROUND ELEVATION	STATIC HEAD
MALAEKAHANA-LAIE					
Malaekahana Wells	up to 2 operating and 1 standby well	basal	replaces other wells	about 140'	----
Laie Wells	1 operating and 1 standby well	basal	1.5 mgd	184'	19'
Wailele Wells	1 operating and 1 standby well	basal	1.5 mgd	109'	17'
KAIPAPAU-KALUANUI					
Kaipapau Wells	1 operating and 1 standby well	dike basal	1.5 mgd	about 140'	17'
Kaipapau Wells (Alternate)	1 operating and 1 standby well	dike basal	alternate site	about 120'	17'
Maakua Wells (BWS)	1 operating and 1 standby well	dike basal	1.5 mgd	about 160'	17'
Maakua Wells (BWS Alternate)	1 operating and 1 standby well	dike basal	alternate site	about 110'	17'
Maakua Wells (DOWALD Alternate)	1 operating and 1 standby well	dike basal	alternate site	about 200'	17'
Kaluanui Well I	1 operating well	basal or dike basal	1.5 mgd	134'	21'
Kaluanui Well II	1 operating well	basal or dike basal	1.0 mgd	112'	18'
Kaluanui Well II (Alternate)	1 operating well	basal or dike basal	alternate site	about 140'	21'
PUNALUU					
Punaluu Well IV	1 operating well	alluvial	0.5 mgd	67'	----
Punaluu Well V	1 operating well	basal or dike basal	1.5 mgd	about 60'	----
Punaluu Wells V-A	1 operating and 1 standby well	basal or dike basal	1.5 mgd	165'	20'
Punaluu Wells V-B	1 operating and 1 standby well	dike basal	0.3 mgd	67'	----
Punaluu Wells V-C	1 operating and 1 standby well	dike	1.5 mgd	about 230'	----
Punaluu Wells V-D	1 operating and 1 standby well	dike	1.5 mgd	about 300'	----
Punaluu Tunnel or Inclined Wells	5,000' ± southwest tunnel or up to 4 inclined wells	dike	5 mgd or 2 mgd	about 580'	----
KAHANA					
Kahana Wells II	1 operating and 1 standby well	dike basal	0.5 mgd	about 140'	----
Kahana Wells III	up to 4 operating wells	dike	2.0 mgd	about 280'	----
Kahana Wells IV	up to 4 operating wells	dike	2.0 mgd	about 290'	----
Kahana Wells V	up to 4 operating wells	dike	2.0 mgd	about 300'	----
KAAAWA-HAKIPUU					
Kaaawa Shaft	1 shaft	basal or dike basal	0.3 mgd	20'	20'
Kaaawa Wells I	1 operating and 1 standby well	dike basal	0.5 mgd	about 200'	20'
Kaaawa Wells II	1 operating and 1 standby well	dike basal	0.5 mgd	about 180'	20'
Hakipuu Wells	1 operating and 1 standby well	dike	0.5 mgd	about 160'	----

TABLE 3 [Continued]

REGION AND NAME OF WATER SOURCE	DESCRIPTION	TYPE OF WATER SOURCE	MAXIMUM POTENTIAL YIELD	GROUND ELEVATION	STATIC HEAD
WAIKANE-WAIAHOLE					
Waikane Wells	1 operating and 1 standby well	dike	0.5 mgd	about 250'	----
Waikane Wells (Alternate)	1 operating and 1 standby well	dike	alternate site	about 300'	----
Uwau Wells	1 operating and 1 standby well	dike	0.5 mgd	about 400'	----
Waianu Wells	1 operating and 1 standby well	dike	0.5 mgd	about 300'	----
Waiahole Wells	1 operating and 1 standby well	dike	0.5 mgd	about 540'	----
Waiahole Wells (Alternate)	1 operating and 1 standby well	dike	alternate site	about 460'	----
KAALAEA-WAIHEE					
Kaalaea Wells	1 operating and 1 standby well	dike	0.5 mgd	about 390'	----
Kaalaea Inclined Wells or Tunnel	up to 4 inclined wells or 2,000' ± west-southwest tunnel	dike	1 mgd or 2 mgd	about 800'	----
KAHALUU-AHUIMANU					
Kahaluu Wells I	1 operating and 1 standby well	dike	1.0 mgd	419'	333'
Kahaluu Wells II-A	1 operating well	dike	0.2 mgd	about 40'	----
Kahaluu Wells II-B	1 operating well	dike	0.2 mgd	about 40'	----
Kahaluu Wells II-C	1 operating well	dike	0.2 mgd	about 40'	----
Ahuimanu Inclined Wells or Tunnel	up to 4 inclined wells or 2,500' ± southwest tunnel	dike	1.5 mgd or 2 mgd	about 450'	----
HEEIA					
Iolekaa Well	1 operating well	dike	0.3 mgd	485'	321'
Haiku Well	1 operating well	dike	1.0 mgd	550'	497'
KANEOHE					
Luluku Wells	1 operating and 1 standby well	dike	1.0 mgd	412'	288'
Kuou Wells II	1 operating and 1 standby well	dike	1.0 mgd	342'	258'
Kamooalii Wells I	1 exploratory well	dike	0.0 mgd	467'	156'
Kamooalii Wells I (Alternate)	1 operating and 1 standby well	dike	alternate site	about 410'	----
Kamooalii Wells II	1 exploratory well	dike	0.1 mgd	358'	104'
Kamooalii II (Alternate)	1 operating and 1 standby well	dike	alternate site	about 330'	----
Halekou Wells	2 operating wells (non-potable)	alluvial	0.7 mgd (a)	212'	210'
Pali Highway Tunnel Drains	tunnels (non-potable)	dike	0.3 mgd (a)	about 900'	----
MAUNAWILI					
Maunawili Wells I	1 operating and 1 standby well	dike	0.5 mgd	about 260'	----
Maunawili Wells II	1 operating and 1 standby well	dike	0.5 mgd	about 290'	----
Maunawili Wells III (Alternate A)	1 operating and 1 standby well	dike	0.5 mgd	about 400'	----
Maunawili Wells III (Alternate B)	1 operating and 1 standby well	dike	alternate site	about 330'	----
WAIMANALO					
Waimanalo Well II	1 operating well	dike	1.0 mgd	350'	37'
Waimanalo Well III	1 operating well	alluvial	0.5 mgd (a)	about 80'	----
Waimanalo Well IV	1 operating well	alluvial	0.5 mgd (a)	about 80'	----

NOTES: (a) This source will probably be non-potable and suitable only for irrigation.

TABLE 4

STATUS OF PROPOSED BWS WATER DEVELOPMENT PROJECTS IN WINDWARD OAHU
(As of January 1988)

REGION AND NAME OF WATER SOURCE	DESCRIPTION	EXISTING FACILITIES	DOWALD NO.	FACILITIES IN 6-YEAR BWS CIP
MALAEKAHANA-LAIE				
Malaekahana Wells	up to 2 operating and 1 standby well	none	none	none
Laie Wells	1 operating and 1 standby well	1 exploratory well	3856-08	1 operating and 1 standby well
Wailele Wells	1 operating and 1 standby well	1 exploratory well	3856-09	1 operating and 1 standby well
KAIPAPAU-KALUANUI				
Kaipapau Wells	1 operating and 1 standby well	none	none	1 operating and 1 standby well (a)
Kaipapau Wells (Alternate)	1 operating and 1 standby well	none	none	none
Maakua Wells (BWS)	1 operating and 1 standby well	none	none	1 operating and 1 standby well (a)
Maakua Wells (BWS Alternate)	1 operating and 1 standby well	none	none	none
Maakua Wells (DOWALD Alternate)	1 operating and 1 standby well	none	none	none (a)
Kaluanui Well I	1 operating well	1 exploratory well	3554-04	1 operating well
Kaluanui Well II	1 operating well	1 exploratory well	3554-05	1 operating well
Kaluanui Well II (Alternate)	1 operating well	none	none	1 standby well
PUNALUU				
Punaluu Well IV	1 operating well	1 exploratory well	3453-09	1 operating well
Punaluu Well V	1 operating well	none	none	1 operating well
Punaluu Wells V-A	1 operating and 1 standby well	1 exploratory well	3454-01	1 operating well
Punaluu Wells V-B	1 operating and 1 standby well	1 exploratory well	3453-10	1 operating well
Punaluu Wells V-C	1 operating and 1 standby well	none	none	1 operating well
Punaluu Wells V-D	1 operating and 1 standby well	none	none	1 operating well
Punaluu Tunnel or Inclined Wells	5,000' ± southwest tunnel or up to 4 inclined wells	none	none	4 operating inclined wells
KAHANA				
Kahana Wells II	1 operating and 1 standby well (b)	none	none	none
Kahana Wells III	up to 4 operating wells (b)	none	none	none
Kahana Wells IV	up to 4 operating wells (b)	none	none	none
Kahana Wells V	up to 4 operating wells (b)	none	none	none
KAAAWA-HAKIPUU				
Kaaawa Shaft	1 shaft	1 shaft (c)	3251-02	none
Kaaawa Wells I	1 operating and 1 standby well	none	none	1 operating and 1 standby well
Kaaawa Wells II	1 operating and 1 standby well	none	none	1 operating and 1 standby well
Hakipuu Wells	1 operating and 1 standby well	none	none	1 operating and 1 standby well

Notes: (a) DLNR may possibly develop 1 exploratory well for the BWS at this site.
(b) Contingent upon DLNR plans for Kahana Valley State Park.
(c) New pumps are needed.

TABLE 4 [Continued]

REGION AND NAME OF WATER SOURCE	DESCRIPTION	EXISTING FACILITIES	DOWALD NO.	FACILITIES IN 6-YEAR BWS CIP
WAIKANE-WAIAHOLE				
Waikane Wells	1 operating and 1 standby well	none	none	none
Waikane Wells (Alternate)	1 operating and 1 standby well	none	none	none
Uwau Wells	1 operating and 1 standby well	none	none	none
Waianu Wells	1 operating and 1 standby well	none	none	none
Waiahole Wells	1 operating and 1 standby well	none	none	none
Waiahole Wells (Alternate)	1 operating and 1 standby well	none	none	none
KAALAEA-WAIHEE				
Kaalaea Wells	1 operating and 1 standby well	none	none	none
Kaalaea Inclined Wells or Tunnel	up to 4 inclined wells or 2,000' ± west-southwest tunnel	none	none	none
KAHALUU-AHUIMANU				
Kahaluu Wells I	1 operating and 1 standby well	1 operating well (c)	2651-03	none
Kahaluu Wells II-A	1 operating well	none	none	none
Kahaluu Wells II-B	1 operating well	none	none	none
Kahaluu Wells II-C	1 operating well	none	none	none
Ahuimanu Inclined Wells or Tunnel	up to 4 inclined wells or 2,500' ± southwest tunnel	none	none	none
HEEIA				
Iolekaa Well	1 operating well	1 operating well	2549-01	none
Haiku Well	1 operating well	1 operating well (c)	2450-02	none
KANEOHE				
Luluku Wells	1 operating and 1 standby well	1 operating well (c)	2349-02	none
Kuou Wells II	1 operating and 1 standby well	1 exploratory well	2348-05	1 operating and 1 standby well (a)
Kamooalii Wells I	1 exploratory well	1 exploratory well	2248-01	none
Kamooalii Wells I (Alternate)	1 operating and 1 standby well	none	none	none
Kamooalii Wells II	1 exploratory well	1 exploratory well	2247-01	none
Kamooalii II (Alternate)	1 operating and 1 standby well	none	none	none
Halekou Wells	2 operating wells (non-potable)	2 exploratory wells	none	none
Pali Highway Tunnel Drains	tunnels (non-potable)	tunnels without hookup	none	none
MAUNAWILI				
Maunawili Wells I	1 operating and 1 standby well	none	none	none
Maunawili Wells II	1 operating and 1 standby well	none	none	none
Maunawili Wells III (Alternate A)	1 operating and 1 standby well	none	none	none
Maunawili Wells III (Alternate B)	1 operating and 1 standby well	none	none	none
WAIMANALO				
Waimanalo Well II	1 operating well	1 operating well (c)	1943-01	none (b)
Waimanalo Well III	1 operating well	none	none	none
Waimanalo Well IV	1 operating well	none	none	none

Notes: (a) DLNR developed 1 exploratory well for the BWS at this site.
(b) DLNR funded 1 operating well for the BWS at this site.
(c) This well is not yet in production as of January 1988.

development of an agricultural park in Waiahole Valley. As part of the agricultural park project, a water source, storage, and distribution system will be required. Two exploratory wells were drilled by the DLNR for the HFDC in Waiahole Valley. The HFDC will develop a 1 mgd operating well, a standby well, a reservoir, and transmission mains in 1988. Because of this, the BWS most likely will not develop its proposed wells in Waiahole Valley.

The tax map key, ownership, and zoning of proposed BWS windward water development project sites are listed in Table 5, and site locations are shown in the maps and photographs at the end of this chapter. Appendix B contains schematics showing how proposed windward water sources will be assimilated into the existing BWS water distribution system.

E. SUMMARY OF NEW RESERVOIRS

At this time, BWS plans for windward Oahu reservoirs are mostly unresolved. As many as 19 new reservoirs could be needed in windward Oahu. [Table 6] However, only four proposed reservoirs have a firm site, size, and spillway elevation (i.e. maximum water elevation): the Kahana 315 Reservoir, Ahuimanu 500 Reservoir, Luluku 500 Reservoir, and Waimanalo 364 Reservoir No. 2. (The site described in the EIS for the Heeia Kai 272 Reservoir has turned out to be unsuitable because of unstable soils. An alternate site may be selected or the reservoir capacity decreased to account for the soil conditions.) Preliminary information on proposed BWS windward reservoir sites including tax map key, ownership, and zoning is listed in Table 6, and tentative site locations are shown in the maps at the end of this chapter. Appendix B contains schematics showing how proposed windward reservoirs will be integrated into the existing BWS water distribution system.

Many proposed windward water sources can be put into production without new reservoirs. However, 14 of the 19 reservoirs listed in Table 6 are needed to assimilate proposed new water sources into the BWS system. One of these, the Waimanalo 364 Reservoir No. 2, will be

TABLE 5

LOCATION OF PROPOSED BWS WATER DEVELOPMENT PROJECTS IN WINDWARD OAHU

REGION AND NAME OF WATER SOURCE	DESCRIPTION	TAX MAP KEY	PROPERTY OWNER	PARCEL SIZE (Acres)	STATE LAND USE DISTRICT	COUNTY ZONING
MALAEKAHANA-LAIE						
Malaekahana Wells	up to 2 operating and 1 standby well	5-6-7:1,2	Campbell Estate	118.2, 175.5	Agricultural	AG-2
Laie Wells	1 operating and 1 standby well	5-5-7:1	Zions Securities Corp.	1,934.112	Agricultural	AG-2
Wailele Wells	1 operating and 1 standby well	5-5-6:1	Zions Securities Corp.	240.054	Agricultural	AG-2
KAIPAPAU-KALUANUI						
Kaipapau Wells	1 operating and 1 standby well	5-4-4:4	Plumbers Local 675	158.641	Conservation	P-1
Kaipapau Wells (Alternate)	1 operating and 1 standby well	5-4-4:4	Plumbers Local 675	158.641	Conservation	P-1
Maakua Wells (BWS)	1 operating and 1 standby well	5-4-5:1	State DLNR	151.66	Conservation	P-1
Maakua Wells (BWS Alternate)	1 operating and 1 standby well	5-4-5:3	THC Financial Corp.	4.52	Conservation	P-1
Maakua Wells (DOWALD Alternate)	1 operating and 1 standby well	5-4-5:1	State DLNR	151.66	Conservation	P-1
Kaluanui Well I	1 operating well	5-3-9:2	State DLNR	334.444	Agricultural	P-1
Kaluanui Well II	1 operating well	5-3-9:2	State DLNR	334.444	Agricultural	P-1
Kaluanui Well II (Alternate)	1 operating well	5-3-9:2	State DLNR	334.444	Agricultural	P-1
PUNALUU						
Punaluu Well IV	1 operating well	5-3-7:14	BWS	1.97	Agricultural	AG-2
Punaluu Well V	1 operating well	5-3-3:1	Bishop Estate	710.140	Agricultural	AG-2
Punaluu Wells V-A	1 operating and 1 standby well	5-3-7:23	Bishop Estate	145.222	Agricultural	Ag-2
Punaluu Wells V-B	1 operating and 1 standby well	5-3-3:1	Bishop Estate	710.140	Agricultural	AG-2
Punaluu Wells V-C	1 operating and 1 standby well	5-3-11:1	Bishop Estate	2,947.52	Conservation	P-1
Punaluu Wells V-D	1 operating and 1 standby well	5-3-11:1	Bishop Estate	2,947.52	Conservation	P-1
Punaluu Tunnel or Inclined Wells	5,000' ± southwest tunnel or up to 4 inclined wells	5-3-11.1	Bishop Estate	2,947.52	Conservation	P-1
KAHANA						
Kahana Wells II	1 operating and 1 standby well	5-2-2:1	State DLNR	1,191.394	Conservation	P-1
Kahana Wells III	up to 4 operating wells	5-2-1	State DLNR	3,881.938	Conservation	P-1
Kahana Wells IV	up to 4 operating wells	5-2-1	State DLNR	3,881.938	Conservation	P-1
Kahana Wells V	up to 4 operating wells	5-2-1	State DLNR	3,881.938	Conservation	P-1
KAAAWA-HAKIPUU						
Kaaawa Shaft	1 shaft	5-1-4:3	Kualoa Ranch Ltd.	0.71	Agricultural	AG-2
Kaaawa Wells I	1 operating and 1 standby well	5-1-4:1	Kualoa Ranch Ltd.	497.72	Agricultural	AG-2
Kaaawa Wells II	1 operating and 1 standby well	5-1-4:1	Kualoa Ranch Ltd.	497.72	Agricultural	AG-2
Hakipuu Wells	1 operating and 1 standby well	4-9-2:1	Kualoa Ranch Ltd.	240.04	Agricultural	AG-2

TABLE 5 [Continued]

REGION AND NAME OF WATER SOURCE	DESCRIPTION	TAX MAP KEY	PROPERTY OWNER	PARCEL SIZE (Acres)	STATE LAND USE DISTRICT	COUNTY ZONING
WAIKANE-WAIAHOLE						
Waikane Wells	1 operating and 1 standby well	4-8-6:1	Elizabeth L. Marks	716.462	Agricultural	AG-2
Waikane Wells (Alternate)	1 operating and 1 standby well	4-8-6:1	Elizabeth L. Marks	716.462	Agricultural	AG-2
Uwau Wells	1 operating and 1 standby well	4-8-14:3	Waiahole Water Co. Ltd.	243.18	Conservation	P-1
Waianu Wells	1 operating and 1 standby well	4-8-13:14	Waiahole Water Co. Ltd.	225.0	Conservation	P-1
Waiahole Wells	1 operating and 1 standby well	4-8-13:1	State DLNR	828.73	Conservation	P-1
Waiahole Wells (Alternate)	1 operating and 1 standby well	4-8-13:1	State DLNR	828.73	Conservation	P-1
KAALAEA-WAIHEE						
Kaalaea Wells	1 operating and 1 standby well	4-7-7:9	Mary P. Schnack Trust	54.925	Urban	AG-2
Kaalaea Inclined Wells or Tunnel	up to 4 inclined wells or 2,000' ± west-southwest tunnel	4-7-8:1	Hiram L. Fong & Wife	507.69	Conservation	P-1
KAHALUU-AHUIMANU						
Kahaluu Wells I	1 operating and 1 standby well	4-7-8:2	BWS	1,146.512	Conservation	P-1
Kahaluu Wells II-A	1 operating well	(a)	------	------	Urban	AG-2
Kahaluu Wells II-B	1 operating well	(a)	------	------	Urban	AG-2
Kahaluu Wells II-C	1 operating well	(a)	------	------	Urban	AG-2
Ahuimanu Inclined Wells or Tunnel	up to 4 inclined wells or 2,500' ± southwest tunnel	4-7-51:1	C&C of Honolulu	322.90	Conservation	P-1
HEEIA						
Iolekaa Well	1 operating well	4-6-27:11	BWS	1.767	Urban	R-1
Haiku Well	1 operating well	4-6-15:1	BWS	498.842	Conservation	P-1
KANEOHE						
Luluku Wells	1 operating and 1 standby well	4-5-41:4	Iolani School	421.225	Conservation	P-1
Kuou Wells II	1 operating and 1 standby well	4-5-41:9	C&C of Honolulu	113.431	Conservation	P-1
Kamooalii Wells I	1 exploratory well	4-5-42:1	Iolani School	359.324	Conservation	P-1
Kamooalii Wells I (Alternate)	1 operating and 1 standby well	4-5-42:1	Iolani School	359.324	Conservation	P-1
Kamooalii Wells II	1 exploratory well	4-5-35:1	C&C of Honolulu	215.881	Conservation	P-1
Kamooalii II (Alternate)	1 operating and 1 standby well	4-5-42:1	Iolani School	359.324	Conservation	P-1
Halekou Wells	2 operating wells (non-potable)	H-3 R.O.W.	State DOT	------	Conservation	P-1
Pali Highway Tunnel Drains	tunnels (non-potable)	4-2-10:3	State DOT	11.032	Conservation	P-1
MAUNAWILI						
Maunawili Wells I	1 operating and 1 standby well	4-2-9:1	Y.Y. Valley Inc.	323.0	Agricultural	AG-2
Maunawili Wells II	1 operating and 1 standby well	4-2-63:31	Seventh Day Adventists	108,896 SF	Urban	AG-2
Maunawili Wells III (Alternate A)	1 operating and 1 standby well	4-2-63:32	BWS	21,000 SF	Urban	AG-2
Maunawili Wells III (Alternate B)	1 operating and 1 standby well	4-2-63:38	Seventh Day Adventists	351,152 SF	Urban	AG-2
WAIMANALO						
Waimanalo Well II	1 operating well	4-1-27:15	BWS	0.278	Agricultural	AG-1
Waimanalo Well III	1 operating well (non-potable)	(b)	------	------	Agricultural	AG-1,2
Waimanalo Well IV	1 operating well (non-potable)	4-1-26:23	University of Hawaii	59.325	Agricultural	AG-1

NOTES: (a) Siting is unresolved, but possible sites include portions of TMK: 4-7-5:2,,3,12,13,20,21,45,66,70, or 75.
(b) Siting is unresolved, but possible sites include portions of TMK: 4-1-24:15,16, or 21 or TMK: 4-1-25:10 or 12.

TABLE 6

PROPOSED BWS WATER STORAGE FACILITIES IN WINDWARD OAHU

REGION AND NAME (a) OF WATER STORAGE FACILITY	CAPACITY (MILLION GALLONS)	NEEDED FOR	TAX MAP KEY	PROPERTY OWNER	PARCEL SIZE (Acres)	STATE LAND USE DISTRICT	COUNTY ZONING
MALAEKAHANA-LAIE							
Laie 200 Reservoir	0.3 MG	Laie Wells (b)	5-5-7:1	Zions Securities Corp.	1,934.112	Agricultural	AG-2
Laie 180 Reservoir	0.5 MG	Laie Wells	5-5-7:1	Zions Securities Corp.	1,934.112	Agricultural	AG-2
KAIPAPAU-KALUANUI							
Hauula 180 Reservoir (c)	1.0 MG	System Reliability	5-4-4:4	Plumbers Local 675	158.641	Conservation	P-1
PUNALUU							
Punaluu 315 Reservoir	1.0 MG	Punaluu Tunnel	5-3-11:1	Bishop Estate	2,947.52	Conservation	P-1
KAHANA							
Kahana 315 Reservoir (e)	6.0 MG	System Reliability	5-2-1	State DLNR	3,881.938	Conservation	P-1
WAIKANE-WAIAHOLE							
Uwau 410 Reservoir	0.1 MG	Uwau Wells (b)	4-8-14:3	Waiahole Water Co. Ltd.	243.18	Conservation	P-1
Waianu 315 Reservoir	0.5 MG	Uwau Wells	4-8-12:20	Elizabeth L. Marks	8.35	Agriculture	AG-2
Waiahole 550 Reservoir	0.1 MG	Waiahole Wells (b)	4-8-13:1	State DLNR	828.73	Conservation	P-1
Waiahole 315 Reservoir	0.3 MG	Waiahole Wells	4-8-13:20	State DLNR	29.00	Conservation	P-1
KAALAEA-WAIHEE							
Kaalaea 400 Reservoir	0.3 MG	Kaalaea Wells (b)	4-7-7:9	Mary P. Schnack Trust	54.925	Conservation	P-1
Kaalaea 272 Reservoir	1.0 MG	Kaalaea Wells/Inclined Wells	4-7-7:9	Mary P. Schnack Trust	54.925	Urban	AG-2
KAHALUUU-AHUIMANU							
Ahuimanu 500 Reservoir (e)	0.5 MG	System Reliability	4-7-51:2	Valley of the Temples Corp.	298.638	Conservation	P-1
HEEIA							
Heeia Kai 272 Reservoir (c)	1.5 MG	System Reliability	4-6-14:5	Bishop Estate	207.329	Conservation	P-1
KANEOHE							
Luluku 500 Reservoir (c)	1.0 MG	System Reliability	4-5-41:4	Iolani School	421.225	Conservation	P-1
Kuou 360 Reservoir (c)	0.3 MG	Kuou Wells II (b)	4-5-41:9	C&C of Honolulu	113.431	Conservation	P-1
Kuou 272 Reservoir	0.5 MG	Kuou Wells II	4-5-41:9	C&C of Honolulu	113.431	Conservation	P-1
Kamooalii 500 Reservoir	0.5 MG	Kamooalii Wells I (b)	4-5-42:6	State DLNR	511.739	Conservation	P-1
Pali 500 Irrigation Reservoir	0.3 MG	Pali Drains/Halekou Wells	4-5-42:6	State DLNR	511.739	Conservation	P-1
WAIMANALO							
Waimanalo 364 Reservoir No.2 (d)	1.0 MG	Waimanalo Well II	4-1-27:13	State DLNR	49.0	Agricultural	AG-1

NOTE: (a) Reservoir names include the spillway elevation which is the maximum elevation of water in a reservoir.
(b) These reservoirs are needed to keep transmission mains full of water when well pumps are shut off.
(c) These reservoirs are budgeted in the BWS Six-Year CIP.
(d) This reservoir is completed as of January 1988.
(e) These reservoirs were under construction as of January 1988.

of sufficient size to serve the Waimanalo Agricultural Park. Several proposed wells are higher than the hydraulic head of the BWS system and will require two reservoirs: one higher than the well site (to keep transmission mains full of water when the well pump is shut off) and one below the well site (to reduce the pressure from the well/-reservoir system so that it will be compatible with the existing BWS system).

Five reservoirs listed in Table 6 are needed to reduce pressure fluctuations and improve reliability of the existing BWS system. Two of these, the Ahuimanu 500 and Luluku 500 Reservoirs, will be of sufficient size to serve respectively the Ahuimanu Subdivision Phases II to VI and the Castle Hills Subdivision. The cost of these two reservoirs will be shared by the BWS and private parties.

If water sources described in this EIS are not assimilated into the potable BWS system, then requirements for reservoirs will be different. The Pali Highway Tunnel Drains, Halekou Wells, Waimanalo Well III, and Waimanalo Well IV probably will not be connected to the potable BWS system. It is not possible to determine reservoir and pipeline requirements unless the use of a water source is known.

F. SUMMARY OF NEW ACCESS ROADS

At this time, BWS plans for windward Oahu access roads are mostly unresolved. For purposes of this EIS, it has been assumed that the BWS will minimize the need for new cross-country access roads by improving existing dirt roads and hiking trails. However, in some cases, access road alignments will need to be resolved after detailed topographic surveys. Preliminary information on proposed BWS access road improvements is listed in Table 7 and tentative alignments are shown in the maps at the end of this chapter.

TABLE 7

PROPOSED BWS ACCESS ROAD IMPROVEMENTS IN WINDWARD OAHU

REGION AND NAME OF WATER SOURCE OR WATER STORAGE FACILITY	APPROXIMATE LENGTH OF ACCESS ROAD IMPROVEMENTS	ORIGIN	ROUTE
MALAEKAHANA-LAIE			
Malaekahana Wells	9,000'	Kamehameha Highway	existing dirt roads
Wailele Wells	7,800'	Kamehameha Highway	existing dirt roads
Laie Wells	5,000'	road to Wailele Wells	existing dirt roads
Laie 200 Reservoir	under 500'	Laie Wells	existing dirt road
Laie 180 Reservoir	under 500'	road to Laie Wells	cross-country
KAIPAPAU-KALUANUI			
Kaipapau Wells	3,700'	Kawaipuna Street	abandoned dirt road
Kaipapau Wells (Alternate)	2,200'	Kawaipuna Street	abandoned dirt road
Hauula 180 Reservoir	under 500'	road to Kaipapau Wells	cross-country
Maakua Wells (BWS)	2,600'	Maakua Road	dirt hiking trail
Maakua Wells (BWS Alternate)	900'	Maakua Road	dirt hiking trails
Maakua Wells (DOWALD Alternate)	1,000'	Hauula Homestead Road	existing & abandoned dirt roads
Kaluanui Well I	1,400'	Sacred Falls Road	existing dirt road
Kaluanui Well II	0	road to Kaluanui Well I	----------
Kaluanui Well II (Alternate)	600'	Kaluanui Well I	cross-country
PUNALUU			
Punaluu Well IV	0	Punaluu Wells III	----------
Punaluu Wells V-B	5,200'	Kamehameha Highway	existing dirt roads
Punaluu Well V	1,000'	road to Punaluu Wells V-B	existing dirt road & cross-country
Punaluu Wells V-A	5,200'	road to Punaluu Wells V-B	existing dirt roads
Punaluu Wells V-C	5,200'	road to Punaluu Well V-A	existing & abandoned dirt roads
Punaluu Wells V-D	1,500'	Punaluu Well V-C	mostly dirt hiking trail
Punaluu Tunnel	2,000'	Punaluu Well V-D	cross-country
Punaluu 315 Reservoir	under 500'	road to Punaluu Tunnel	cross-country
KAHANA			
Kahana Wells II	600'	Trout Farm Road	cross-country
Kahana 315 Reservoir	4,800'	Kahana Valley Road	existing & abandoned dirt roads
Kahana Wells III	0	road to Kahana 315 Reservoir	----------
Kahana Wells IV	under 300'	Kahana 315 Reservoir	abandoned dirt road
Kahana Wells V	1,500'	Kahana 315 Reservoir	abandoned dirt road

TABLE 7 [Continued]

REGION AND NAME OF WATER SOURCE OR WATER STORAGE FACILITY	APPROXIMATE LENGTH OF ACCESS ROAD IMPROVEMENTS	ORIGIN	ROUTE
KAAAWA-HAKIPUU			
Kaaawa Shaft	under 100'	unnamed dirt road	existing dirt road
Kaaawa Wells I	6,900'	Kamehameha Highway	existing dirt road & cross-country
Kaaawa Wells II	1,000'	road to Kaaawa Wells I	cross-country
Hakipuu Wells	1,600'	Kamehameha Highway	existing and abandoned dirt roads
WAIKANE-WAIAHOLE			
Waikane Wells	5,500'	Kamehameha Highway	existing dirt roads
Waikane Wells (Alternate)	6,500'	Kamehameha Highway	existing dirt roads
Waiahole Wells	9,700'	South Waiahole Valley Road	existing dirt roads
Waiahole Wells (Alternate)	10,300'	South Waiahole Valley Road	existing dirt roads
Waiahole 550 Reservoir	under 500'	road to Waiahole Wells	cross-country
Waiahole 315 Reservoir	under 500'	road to Waiahole Wells	cross-country
Waianu Wells	3,000'	North Waiahole Valley Road	existing dirt roads
Uwau Wells	2,600'	road to Waianu Wells	existing dirt road
Waianu 315 Reservoir	under 500'	road to Uwau Wells	cross-country
Uwau 410 Reservoir	under 500'	road to Uwau Wells	cross-country
KAALAEA-WAIHEE			
Kaalaea Wells	2,200'	Kamakoi Road	existing dirt road
Kaalaea 400 Reservoir	under 500'	road to Kaalaea Wells	cross-country
Kaalaea 272 Reservoir	under 500'	road to Kaalaea Wells	cross-country
Kaalaea Inclined Wells	5,000'	road to Kaalaea Wells	existing dirt road & cross-country
KAHALUU-AHUIMANU			
Kahaluu Wells I	300'	Kahaluu Tunnel Chlorinator	existing dirt road
Kahaluu Wells II-A	under 300'	Mapele Road or Mapele Place	cross-country
Kahaluu Wells II-B	under 300'	Mapele Road or Mapele Place	cross-country
Kahaluu Wells II-C	under 300'	Mapele Road or Mapele Place	cross-country
Ahuimanu Inclined Wells	2,500'	Hui Kelu Street	dirt hiking trail
Ahuimanu 500 Reservoir	800'	BWS access road	cross-country
HEEIA			
Heeia Kai 272 Reservoir	1,200'	Kahekili Highway	cross-country
Iolekaa Well	0	Haiku 500 Reservoir	----------
Haiku Well	0	BWS access road	----------

TABLE 7 [Continued]

REGION AND NAME OF WATER SOURCE OR WATER STORAGE FACILITY	APPROXIMATE LENGTH OF ACCESS ROAD IMPROVEMENTS	ORIGIN	ROUTE
KANEOHE			
Luluku Wells	0	Likelike Highway	————
Luluku 500 Reservoir	600'	Likelike Highway	existing dirt road & cross-country
Kuou Wells II	400'	Ho'omaluhia Park Road	abandoned dirt road
Kuou 360 Reservoir	under 500'	Kuou Wells II	cross-country
Kuou 272 Reservoir	under 500'	BWS road to Kuou Wells I	cross-country
Kamooalii Wells I	4,500'	Kionaole Road	abandoned dirt roads & cross-country
Kamooalii Wells I (Alternate)	4,500'	Kionaole Road	abandoned dirt roads & cross-country
Kamooalii 500 Reservoir	under 500'	Kamooalii Wells I	cross-country
Kamooalii Wells II	under 100'	Kionaole Road	cross-country
Kamooalii II (Alternate)	under 100'	Kionaole Road	cross-country
Pali Tunnel Drains	0	Pali Highway	————
Halekou Wells	0	Kionaole Road	————
Pali 500 Irrigation Reservoir	under 500'	Kionaole Road	cross-country
MAUNAWILI			
Maunawili Wells I	800'	Maleko Street	existing dirt road & hiking trail
Maunawili Wells II	under 100'	Lopaka Way	cross-country
Maunawili Wells III (Alternate A)	0	Maunawili 500 Reservoir	————
Maunawili Wells III (Alternate B)	under 200'	Lopaka Way	cross-country
WAIMANALO			
Waimanalo Well II	0	Waimanalo 364 Reservoir No. 1	————
Waimanalo 364 Reservoir No. 2	0	Waimanalo 364 Reservoir No. 1	————
Waimanalo Well III	0	Kakaina or Mahailua Street	————
Waimanalo Well IV	0	Ahiki Street	————

G. SUMMARY OF NEW TRANSMISSION MAINS

At this time, BWS plans for windward Oahu transmission mains are mostly unresolved. New BWS pipelines will almost always follow existing roads or proposed access road improvements. Preliminary information on proposed BWS transmission mains is listed in Table 8 and tentative alignments are shown in the maps at the end of this chapter. Sizes of major transmission mains to carry water from Laie to Kaneohe will probably be determined within the next two years (i.e. before exploratory drilling and test pumping of many proposed windward sources). For purposes of this EIS, it has been assumed that new transmission mains along major highways will have sufficient capacity so that additional parallel mains will not be needed during this century.

H. SUMMARY OF NEW BOOSTER PUMPS

At this time, BWS plans for windward Oahu booster pumps are mostly unresolved. A Hauula Booster Pump Station is proposed to pump water from the proposed Hauula 180 Reservoir to the proposed Kahana 315 Reservoir. The new pump station would be located at the Hauula 180 Reservoir site or along the access road to the reservoir. The existing Waihee Line Booster will need to be modified or upgraded. For purposes of this EIS, it has been assumed that the existing Pohakupu Line Booster will also be modified or upgraded.

I. SUMMARY OF NEW ELECTRICAL AND TELEPHONE LINES

At this time, Hawaiian Electric Company and Hawaiian Telephone Company have not resolved their plans for electrical and telephone lines to service most proposed BWS windward water system improvements. For purposes of this EIS, it has been assumed that the utility companies

TABLE 8

PROPOSED BWS TRANSMISSION MAINS IN WINDWARD OAHU

PIPELINE DIAMETER	APPROXIMATE PIPELINE LENGTH	FROM	TO	ROUTE
12"	9,000'	Malaekahana Wells	Kamehameha Highway	new BWS access road
12" & 16"	7,800'	Wailele Wells	Kamehameha Highway	new BWS access road
12"	under 500'	Laie Wells	Laie 200 Reservoir	new BWS access road
12"	see subtotal	Laie 200 Reservoir	Laie 180 Reservoir	new BWS access road
12"	5,000' (subtotal)	Laie 180 Reservoir	pipeline to Wailele Wells	new BWS access road
16" to 48"	89,000'	Wailele Stream, Laie	Waihee Road, Kahaluu	new BWS access road
12" & 16"	5,100'	Kaipapau Wells	Kamehameha Highway	Kamehameha Highway
16"	under 500'	Hauula 180 Reservoir	pipeline to Kaipapau Wells	new BWS access road & Kawaipuna Street
20"	2,700'	Hauula 180 Reservoir	Kamehameha Highway	new BWS access road
12"	4,000'	Maakua Wells (BWS)	Kamehameha Highway	new BWS access roads & Kawaipuna Street
12"	2,600'	Maakua Wells (DOWALD Alt.)	Kamehameha Highway	new BWS access road, Maakua & Hauula Homestead Roads
16"	5,500'	Kaluanui Well II	Kamehameha Highway	new BWS access road, Kukuna & Hauula Homestead Roads
8"	700'	Kaluanui Well I	Kamehameha Highway	new BWS access road, & Sacred Falls Road
12"	under 50'	Punaluu Well IV	pipeline to Kaluanui Well II	new BWS access road
12" & 24"	5,200'	Punaluu Well V-B	pipeline to Punaluu Wells III	----------
12"	1,000'	Punaluu Well V	Kamehameha Highway	new BWS access road
12" & 24"	5,200'	Punaluu Wells V-A	pipeline to Punaluu Wells V-B	new BWS access road
20"	5,200'	Punaluu Wells V-C	pipeline to Punaluu Wells V-B	new BWS access road
20"	1,500'	Punaluu Wells V-D	Pipeline to Punaluu Wells V-A	new BWS access road
16"	see subtotal	Punaluu Tunnel	Pipeline to Punaluu Wells V-C	new BWS access road
16"	2,000' (subtotal)	Punaluu 315 Reservoir	Punaluu 315 Reservoir	new BWS access road
12"	3,300'	Kahana Wells II	pipeline to Punaluu Wells V-D	new BWS access road
42"	11,100'	Kahana 315 Reservoir	Kamehameha Highway	new BWS access road & Trout Farm Road
12"	1,500'	Kahana Wells III	Kamehameha Highway	new BWS access road & Kahana Valley Road
12"	600'	Kahana Wells IV	Kahana 315 Reservoir	new BWS access road
12"	1,500'	Kahana Wells V	Kahana 315 Reservoir	new BWS access road
12"	under 50'	Kaawa Shaft	Kahana 315 Reservoir	new BWS access road
12"	6,900'	Kaaawa Wells I	pipeline to Kaaawa shaft	----------
12"	1,000'	Kaawa Wells II	Kamehameha Highway	new BWS access road
12"	1,600'	Hakipuu Wells	pipeline to Kaaawa Wells I	new BWS access road
12"	5,500'	Waikane Wells	Kamehameha Highway	new BWS access road
12"	under 500'	Waiahole Wells	Kamehameha Highway	new BWS access road
12"	see subtotal	Waiahole 550 Reservoir	Waiahole 550 Reservoir	new BWS access road
12"	13,000' (subtotal)	Waiahole 315 Reservoir	Waiahole 315 Reservoir	new BWS access road
12"	7,700'	Waianu Wells	Kamehameha Highway	new BWS access roads & South Waiahole Valley Road
12"	under 500'	Uwau Wells	pipeline to Waiahole 315 Reservoir	new BWS access road & North Waiahole Valley Road
12"	see subtotal	Uwau 410 Reservoir	Uwau 410 Reservoir	new BWS access roads
12"	2,600' (subtotal)	Waianu 315 Reservoir	Waianu 315 Reservoir	new BWS access roads
			pipeline to Waianu Wells	new BWS access roads

TABLE 8 [Continued]

PIPELINE DIAMETER	APPROXIMATE PIPELINE LENGTH	FROM	TO	ROUTE
12"	under 500'	Kaalaea Wells	Kaalaea 400 Reservoir	new BWS access road
12"	see subtotal	Kaalaea 400 Reservoir	Kaalaea 272 Reservoir	new BWS access roads
12"	4,500' (subtotal)	Kaalaea 272 Reservoir	Pulama Road, Kaalaea	new BWS access road, Kamakoi & Ahilama Roads
12"	5,000'	Kaalaea Inclined Wells	Kaalaea 400 Reservoir	new BWS access roads
42"	see subtotal	Waihee Road, Kahaluu	Lulani Street, Kahaluu	Kamehameha & Kahekili Highways
42"	see subtotal	Lulani Street, Kahaluu	Okana Road, Kahaluu	Ahuimanu Road
42"	see subtotal	Okana Road, Kahaluu	Kulukeoe Street, Kaneohe	Kahekili Highway
42"	see subtotal	Kulukeoe Street, Kaneohe	Anoi Road, Kaneohe	Keneke Street
42"	24,840' (subtotal)	Anoi Road, Kaneohe	Kamehameha Highway, Kaneohe	Likelike Highway
12"	under 50'	Kahaluu Wells I	pipeline to Kahaluu Tunnel	----------
12"	600'	Kahaluu Wells II-A, B, C	Mapele Road, Kahaluu	new BWS access roads, Mapele Place & Mapele Road
12"	2,500'	Ahuimanu Inclined Wells	Ahuimanu 272 Reservoir	new BWS access road
12"	800'	Ahuimanu 500 Reservoir	pipeline on BWS access road	new BWS access road
30"	2,300'	Kahekili Highway, Heeia	Kahaluu Utility Tunnel	cross-country
16"	2,000'	Heeia Kai 272 Reservoir	Kalali Street, Heeia	new BWS access road, Kahekili Highway & cross-country
16"	7,900'	Heeia Street, Heeia	Kolokio Street, Kaneohe	Kamehameha Highway
12"	under 50'	Iolekaa Well	Haiku 500 Reservoir	----------
12"	under 50'	Haiku Well	pipeline to Haiku Tunnel	----------
12"	under 50'	Luluku Wells	pipeline to Luluku Tunnel	----------
12"	under 50'	Luluku 500 Reservoir	pipeline to Luluku Tunnel	----------
16"	4,150'	Luluku 500 Reservoir	Luluku Road	new BWS access road & cross country
12"	under 500'	Kuou Wells II	Kuou 360 Reservoir	new BWS access road
12"	4,500'	Kuou 360 Reservoir	Kuou 272 Reservoir	new BWS access roads & Ho'omaluhia Park Road
16"	under 500'	Kuou 272 Reservoir	pipeline to Kuou Wells I	new BWS access road
12" & 16"	18,000'	Kamooalii Wells II	Castle Hospital Junction	Kionaole Road, Kamehameha & Kalanianaole Highways
12"	under 500'	Kamooalii Wells I	Kamooalii 500 Reservoir	new BWS access road
12"	4,500'	Kamooalii 500 Reservoir	pipeline to Kamooalii Wells II	new BWS access roads
8"	1,500'	Pali Tunnel Drains	Pali 500 Irrigation Reservoir	cross-country
12"	5,400'	Halekou Wells	Pali 500 Irrigation Reservoir	Kionaole Road & new BWS access road
12"	unresolved	pipeline to Irrigation Reservoir	Pali Golf Course & Hawaii Loa College	unresolved
12"	1,300'	Maunawili Wells I	Aloha Oe Drive, Maunawili	new BWS access road & Maleko Road
12"	under 100'	Maunawili Wells II	pipeline to Maunawili 500 Reservoir	new BWS access road
12"	under 50'	Maunawili Wells III (Alt. A)	Maunawili 500 Reservoir	----------
36"	8,800'	Old Kalanianaole Road, Kailua	Olomana Golf Course, Waimanalo	Kalanianaole Highway
12"	under 50'	Waimanalo Well II	Waimanalo 364 Reservoir No. 1	----------
16"	under 100'	Waimanalo 364 Reservoir No. 2	Waimanalo 364 Reservoir No. 1	----------
16"	2,500'	Waimanalo 364 Reservoir No. 1	Waikupanaha Street, Waimanalo	Kaulukanu Street
12"	3,600'	Waimanalo Well III	Kaulukanu Street, Waimanalo	Mahailua & Waikupanaha Streets
12"	2,600'	Waimanalo Well IV	Nonokio Street, Waimanalo	Ahiki & Waikupanaha Streets

will minimize the need for new cross country utility lines by following existing roads or proposed BWS access road improvements. The BWS will need to obtain necessary permits for required utility lines.

J. PHASING AND TIMING

Iolekaa Well began production in 1985. As of January 1988, the Kahaluu Well I, Haiku Well, Luluku Well, and Waimanalo Well II are completed but not yet in production. As shown in Table 4, other new production wells budgeted in the current Six-Year BWS CIP (July 1, 1987 to June 30, 1993) include the Laie, Wailele, Kaipapau, Maakua, Kaluanui I, Kaluanui II, Punaluu IV, Punaluu V-A, Punaluu V-B, Punaluu V-C, Punaluu V-D, Punaluu Inclined, Kaaawa I, Kaaawa II, Hakipuu, and Kuou II wells. [Ref. 116] However, production facilities will not be developed in cases where test pumping of exploratory wells does not show sufficient yield (Kamooalii I, and Kamooalii II) or causes unacceptable adverse impacts.

It is not resolved when, if ever, the BWS will develop new water sources proposed in this EIS which are not budgeted in the Six-Year CIP. Because of limits on the sustainable yield of the affected basal aquifer, the Malaekahana Wells will not be developed except as a replacement for old private wells serving the Kahuku area. Other proposed BWS windward water sources are not thus constrained.

New water sources proposed in this EIS could be developed by private parties or the BWS. As an option, developers can comply with BWS off-site water development charges and obtain commitments for water service by developing and dedicating new water sources to the BWS or by financing development of production facilities at an existing BWS exploratory well. For example, in exchange for a 0.3 mgd water commitment for Waimanalo Agricultural Park, the DLNR gave the BWS $1 million for development of Waimanalo Well II and Waimanalo 364 Reservoir No. 2. [Ref. 36] Conceivably, if reservoirs and infrastructure were developed by the Housing Finance and Development

Corporation in compliance with BWS water system standards, then the State might dedicate its wells in Waiahole Valley to the BWS with the proviso that water be reserved to serve the Waiahole Agricultural Subdivision. Similarly, a private party might finance development of production facilities at Kuou Well II in exchange for a water commitment from the BWS. The same holds true for existing BWS exploratory wells for which production facilities are budgeted but not yet funded in the current Six-Year CIP.

The Waimanalo 364 Reservoir No. 2 is completed and the Kahana 315 and Ahuimanu 500 Reservoirs are under construction. As shown in Table 6, new reservoirs budgeted in the current Six-Year CIP include the Hauula 180, Heeia Kai 272 and Luluku 500 reservoirs. In addition, although not budgeted, the Laie 200 and Kuou 360 reservoirs will need to be built to allow the existing Laie Well and Kuou II Well to be put into production. Timing of other reservoirs is unresolved.

Major new BWS transmission mains proposed along Kamehameha, Kahekili, Likelike, and Kalanianaole Highways will probably all be built before the end of the decade. [See Table 8] Timing of other transmission mains, electrical lines, telephone lines, and access road improvements will be tied to development of BWS production wells and/or reservoirs. By way of illustration, the BWS will develop reservoirs, access roads, transmission mains, and utility lines in Kaalaea Valley only when needed to service BWS production wells.

K. COST OF PROPOSED BWS FACILITIES

Preliminary cost estimates for the proposed facilities were developed from "A Conceptual Study for the Assimilation of the Proposed Windward Sources to the Windward Regional Water System" (see Appendix B), previously completed EISs and the BWS Six-Year Capital Improvements Program, July 1, 1985 to June 30, 1991. The cost estimates included construction of operating and standby wells, installation of pumps and piping, preparation of the site, installation of transmission mains and construction of reservoirs. Costs for 12-foot wide all-weather

access roads were included in the proposed project costs. Estimated costs for projects discussed in previously completed EISs were escalated at 10% per year, not compounded. [See Table 1] A cost summary for the proposed facilities is shown in Table 9.

L. HISTORIC PERSPECTIVE

In 1959, the BWS was merged with the City and County of Honolulu Department of Public Works Suburban Water System. Prior to that time, the Suburban Water System provided water service to the portion of windward Oahu between Hauula and Makapu'u. While municipal water service has subsequently been expanded to include part of Kahuku, the region from Laie to Malaekahana is still served by private water systems operated by Zions Securities Corporation and the Estate of James Campbell.

As of January 1985, the BWS had 15 reservoirs [See Table 10] and developed water from 16 wells, 8 tunnels, and 4 inclined wells in Windward Oahu. [See Table 11] While the BWS originally relied on artesian flow from two wells at Kuou Wells I, in 1975 a pump was installed to increase the yield of the mauka well and the makai well was subsequently capped.

TABLE 9

1987 COST ESTIMATES FOR PROPOSED WINDWARD OAHU REGIONAL WATER SYSTEM IMPROVEMENTS

($000)

Name	Operating Wells	Standby Wells	Total (1)
Malaekahana Wells	$ 3,425	$ 450	$ 3,875
Laie Wells (2)	3,140	450	3,590
Wailele Wells	2,360	450	2,810
Kaipapau Wells (2)	3,948	450	4,398
Maakua Wells	1,990	450	2,440
Kaluanui Wells I and II (3)	-----	---	2,300
Punaluu Well IV	213	---	213
Punaluu Well V	2,331	---	2,331
Punaluu Wells V-A	2.981	450	3,431
Punaluu Wells V-B	1,168	380	1,548
Punaluu Wells V-C	2,967	450	3,417
Punaluu Wells V-D	1,722	450	2,172
Punaluu Tunnel or Inclined Wells (2)	-----	---	6,450
Kahana Wells II, III, IV and V (2) (3)	-----	---	19,950
Kaaawa Shaft	-----	---	250
Kaaawa Wells I	1,155	380	1,535
Kaaawa Wells II	2,678	380	3,058
Hakipuu Wells	1,442	380	1,822
Waikane Wells	2,245	380	2,625
Uwau Wells II (2)	2,023	380	2,403
Waianu Wells (2)	3,142	380	3,522
Waiahole Wells (2)	4,316	380	4,696
Kaalaea Wells (2)	-----	---	3,500
Kaalaea Inclined Wells	-----	---	2,750
Kahaluu Wells I (3)	-----	---	950
Kahaluu Wells II-A; B; C	-----	---	2,450
Ahuimanu Inclined Wells	-----	---	900
Ahuimanu 500 Reservoir	-----	---	300
Iolekaa Well (4)	-----	---	-----
Haiku Well (6)	-----	---	-----
Heeia Kai 272 Reservoir (3)	-----	---	2,500
Luluku Wells (2)	1,751	380	2,131
Kuou Wells II (2) (3)	-----	---	3,450

TABLE 9 (Continued)

Name	Operating Wells	Standby Wells	Total (1)
Kamooalii Wells I and II (2) (3)	-----	---	8,400
Halekou Wells (2)	2,505	---	2,505
Pali Tunnel Drains	-----	---	100
Maunawili Wells I	1,327	380	1,707
Maunawili Wells II	1,075	380	1,455
Maunawili Wells III (Alt A/B)	1,075	380	1,455
Waimanalo Well II (2) (3)	-----	---	2,200
Waimanalo Well III	1,305	---	1,305
Waimanalo Well IV	1,163	---	1,168
Total Transmission Pipeline Cost (5)			$72,983

Notes:

(1) Includes costs of on-site facilities, reservoirs, transmission mains, access roads, and electrical connections, excludes costs for telephone connections, engineering, land acquisition, and other items not directly related to construction. [See Ref. 113]

(2) Includes costs for reservoirs.

(3) Cost data from previously completed EIS.

(4) Well currently in production.

(5) Approximately 148,540 linear feet. [See Tables 7 and 8]

(6) This well was operational but not in production at the time of the Draft EIS

Sources: Ref 36; 42; 48; 49; 50; 51; 113; 116

TABLE 10

EXISTING BWS WATER STORAGE FACILITIES IN WINDWARD OAHU

(As of January 1985)

Region & Name [a] of Water Storage Facility	Capacity (Million Gallons)	Year Built
PUNALUU		
Punaluu 180 Reservoir	0.5 MG	1959
KAALAEA-AHUIMANU		
Waihee 265 Reservoir	1.0 MG	1955
Ahuimanu 272 Reservoir	1.0 MG	1976
HEEIA		
Haiku 500 Reservoir	0.5 MG	1967
KANEOHE		
Kapunahala 272 Reservoir	2.0 MG	1963
Kapaa 272 Reservoir	2.0 MG	1958
MAUNAWILI-LANIKAI		
Maunawili 500 Reservoir	0.3 MG	1965
Pohakupu 272 Reservoir No. 1	1.0 MG	1958
Pohakupu 272 Reservoir No. 2	6.0 MG	1977
Kailua 275 Reservoir	0.3 MG	1941
Kailua Heights 390 Reservoir	0.5 MG	1968
Kailua Heights 230 Reservoir	1.0 MG	1957
Lanikai 230 Reservoir	0.2 MG	1941
WAIMANALO		
Waimanalo 364 Reservoir No. 1	0.1 MG	1956
Waimanalo 230 Reservoir	2.0 MG	1961

NOTE: (a) Reservoir names include the spillway elevation which is the maximum elevation of water in a reservoir.

TABLE 11

DESCRIPTION OF EXISTING BWS WATER SOURCES IN WINDWARD OAHU
(As of January 1985)

REGION AND NAME OF WATER SOURCE	DOWALD NO.	FIRST YEAR IN SERVICE	DESCRIPTION	TYPE OF WATER SOURCE	ESTIMATED SUSTAINABLE YIELD	GROUND ELEVATION	STATIC HEAD
KAIPAPAU-KALUANUI							
Hauula Well	3655-01	1927	1 operating well	basal	0.25 mgd	20'	17'
PUNALUU							
Punaluu Well I	3553-02	1959	1 operating well	basal	see subtotal	7'	18'
Punaluu Wells II	3553-03 to 08	1969	6 operating wells	basal	see subtotal	80'	18'
Punaluu Wells III	3453-06,07	1978	2 operating wells	basal	5.5 mgd (subtotal)	65'	18'
KAHANA							
Kahana Wells I	3353-01,02	1980	2 operating wells	dike basal	0.5 mgd	36' & 94'	20'
KAALAEA-WAIHEE							
Waihee Wells I	2751-02,03	1973	2 operating wells	dike	see subtotal	198'	191'
Waihee Tunnel	2651-02	1955	1,624' southwest tunnel	dike	see subtotal	200'	270' +
Waihee Inclined Wells	2651-01 to 04	1977	4 inclined wells	dike	5-8 mgd (subtotal)	690'	780'
KAHALUU-AHUIMANU							
Kahaluu Tunnel	2651-01	1947	393' southwest tunnel	dike	2.5 mgd	585'	585' +
HEEIA							
Haiku Tunnel	2450-01	1941	1,200' southwest tunnel	dike	2.0 mgd	550'	550' +
KANEOHE							
Luluku Tunnel	2349-01	1945	483' west tunnel	dike	0.8 mgd	530'	530' +
Kuou Wells I	2348-02,03	1955	1 operating and 1 unused well	dike	2.0 mgd	287'	287' +
WAIMANALO							
Waimanalo Tunnels	various	1926	4 southwest tunnels	dike	1.0 mgd	415'-462'	415' +
Waimanalo Well I	2043-02	1956	1 operating well	dike	0.1 mgd	142'	29'

Historically, as shown in Table 12, the average production of existing BWS water sources in windward Oahu has been lower than their estimated sustainable yield. Pumpage of BWS wells in windward Oahu is primarily regulated by controls that monitor water levels in windward reservoirs. When water demand is low and reservoirs are full, then the well pumps are turned off. In general, water pressure within the BWS system affects discharge from BWS tunnels and inclined wells in windward Oahu. For example, December 1984 venturi meter charts for Kahaluu, Haiku, and Luluku Tunnels indicate that their discharge substantially decreases every day at times of high water pressure (i.e. when demand is low). Discharge from Haiku Tunnel was also substantially reduced by installation of a back pressure valve on the transmission main in 1979. Lastly, as required by a ruling of the Hawaii State Supreme Court, the BWS limits water withdrawal from Waihee Valley to preserve a minimum flow of 2.7 mgd in Waihee Stream at an elevation of 170'. This usually prevents pumping the Waihee Wells I and sometimes requires restricting gravity flow from the Waihee Inclined Wells. The BWS also voluntarily regulates water withdrawal from the Waihee Inclined Wells to avoid drying up Waihee Falls.

An intricate network of water transmission mains, valves, and booster pumps connects BWS water sources and reservoirs to BWS customers. In effect, there presently are five different windward pressure systems: the Hauula 180 System, Windward 500 High Service System, Windward Low Service System, Kailua Heights 390 System, and Waimanalo 364 System. Additional reservoirs are needed in some of these systems to reduce problems with fluctuating pressures. Also, existing transmission mains are not adequate to move water from proposed BWS water sources between Kaluanui and Laie to BWS reservoirs in Kailua. A brief description follows of the existing windward pressure systems.

HAUULA 180 SYSTEM

SOURCE: Hauula Well, Punaluu Well I

STORAGE: Punaluu 180 Reservoir

BOOSTER: None

TABLE 12

YIELD OF EXISTING BWS WATER SOURCES IN WINDWARD OAHU

REGION AND NAME OF WATER SOURCE	ESTIMATED SUSTAINABLE YIELD	AVERAGE YIELD IN MGD FOR THE FISCAL YEAR ENDING JUNE 30											
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
KAIPAPAU-KALUANUI													
Hauula Well	0.25 mgd	0.14	0.13	0.12	0.14	0.13	0.15	0.15	0.15	0.12	0.13	0.05	0.22
PUNALUU													
Punaluu Well I	see subtotal	0.26	0.25	0.13	0.34	0.35	0.39	0.36	0.38	0.44	0.39	0.34	0.37
Punaluu Wells II	see subtotal	6.96	6.38	5.56	4.93	6.47	5.05	3.40	2.92	3.15	2.83	2.60	4.17
Punaluu Wells III	5.5 mgd (subtotal)	----	----	----	----	----	0.43	1.25	1.05	1.02	0.22	0.92	0.96
KAHANA													
Kahana Wells I	0.5 mgd	----	----	----	----	----	----	----	0.04	0.51	0.58	0.45	0.47
KAALAEA-WAIHEE													
Waihee Wells I	see subtotal	----	0.56	2.11	1.96	1.89	0.29	----	0.16	----	0.01	----	----
Waihee Tunnel	see subtotal	4.10	3.65	4.10	5.30	3.57	4.47	5.08	5.48	5.39	5.48	5.94	5.68
Waihee Inclined Wells	5-8 mgd (subtotal)	----	----	----	----	0.17	0.70	0.80	0.86	1.15	1.25	1.95	0.56
KAHALUU-AHUIMANU													
Kahaluu Tunnel	2.5 mgd	2.31	2.25	2.52	2.13	2.23	2.13	2.02	2.02	2.58	2.29	2.35	2.25
HEEIA													
Haiku Tunnel	2.0 mgd	1.76	1.51	1.79	1.80	1.69	1.56	1.20	0.90	0.98	0.99	1.21	1.19
KANEOHE													
Luluku Tunnel	0.8 mgd	0.21	0.11	0.17	0.25	0.18	0.45	0.54	0.74	0.78	0.75	0.92	0.65
Kuou Wells I	2.0 mgd	0.79	1.35	1.07	1.53	1.89	1.78	1.89	1.92	1.80	1.56	1.58	2.10
WAIMANALO													
Waimanalo Tunnels	1.0 mgd	0.63	0.61	0.61	0.60	0.55	0.54	0.58	0.61	0.69	0.83	0.86	0.62
Waimanalo Well I	0.1 mgd	0.03	0.12	0.14	0.14	0.06	0.13	0.02	0.01	----	0.01	0.01	0.19
TOTAL	**19.65 to 22.65**	**17.19**	**16.92**	**18.32**	**19.12**	**19.18**	**18.07**	**17.29**	**17.24**	**18.61**	**17.32**	**19.18**	**19.41**

The Hauula 180 System services the area from Hauula to Punaluu. The Punaluu Wells II and III are connected to the system through a closed control valves and could be used to supply water during emergencies. Pressure fluctuations are a problem at the Hauula end of the system.

WINDWARD 500 HIGH SERVICE SYSTEM

SOURCE: Kahaluu Tunnel, Iolekaa Well (beginning in 1985), Haiku Well (beginning in 1987), Haiku Tunnel, Luluku Tunnel

STORAGE: Haiku 500 Reservoir, Maunawili 500 Reservoir, Ahuimanu 500 Reservoir

BOOSTER: Maunawili Booster Pump Station

The Windward 500 High Service System services higher parts of windward Oahu from Kahaluu to Maunawili. The Luluku Tunnel is primarily used to deliver water to the Kapaa 272 Reservoir through a pressure reducing valve. Surplus water from the Windward 500 High Service System flows into the Pohakapu 272 Reservoirs. The Maunawili Booster Pump Station can be used to pump water from the Pohakapu 272 Reservoirs to the Maunawili 500 Reservoir.

WINDWARD LOW SERVICE SYSTEM

SOURCE: Punaluu Wells II, Punaluu Wells III, Kahana Wells I, Waihee Wells I, Waihee Tunnel, Waihee Inclined Wells, Luluku Tunnel, Kuou Wells I

STORAGE: Waihee 265 Reservoir, Ahuimanu 272 Reservoir, Kapunahala 272 Reservoir, Kapaa 272 Reservoir, Pohakapu 272 Reservoir Nos. 1 and 2, Kailua 275 Reservoir, Kailua Heights 230 Reservoir, Lanikai 230 Reservoir, Waimanalo 230 Reservoir

BOOSTER: Waihee Line Booster, Waihee Booster No. 1 (inactive), Kahaluu Line Booster (inactive), Pohakapu Line Booster, Lanikai Line Booster

The Windward Low Service System services lower parts of windward Oahu from Punaluu to Makapu'u. In addition to the sources listed above, surplus water from the Windward 500 High Service System flows into the Pohakupu 272 Reservoirs and surplus water from the Waimanalo 364 System flows through a back pressure valve into the Waimanalo 230 Reservoir. The Pohakupu Line Booster can be used to pump water from the Pohakupu 272 Reservoirs around Makapu'u Point to the Kalama 170 Reservoir in Hawaii Kai.

Because of higher water levels in other nearby BWS reservoirs, the Lanikai 230 Reservoir usually is "locked out" from releasing water into the BWS water distribution system. The Lanikai Line Booster can be used to pump water from the Windward Low Service System to the Lanikai 230 Reservoir.

The Waihee Line Booster was intended to pump water southward along transmission mains in the Windward Low Service System. The booster has four pumps for water from BWS Waihee sources and four pumps for water from BWS Punaluu sources. However, pressure fluctuations prevent use of the Waihee Line Booster when the Punaluu well pumps are engaged.

KAILUA HEIGHTS 390 SYSTEM

SOURCE: None

STORAGE: Kailua Heights 390 Reservoir

BOOSTER: Kailua Heights Booster Pump Station

The Kailua Heights 390 System services higher parts of Kailua. The Kailua Heights Booster Pump Station pumps water from the Kailua Heights 230 Reservoir to the Kailua Heights 390 Reservoir.

WAIMANALO 364 SYSTEM

SOURCE: Waimanalo Tunnels I, II, III, IV, Waimanalo Well I

STORAGE: Waimanalo 364 Reservoir No. 1

BOOSTER: Waimanalo Booster Pump Station

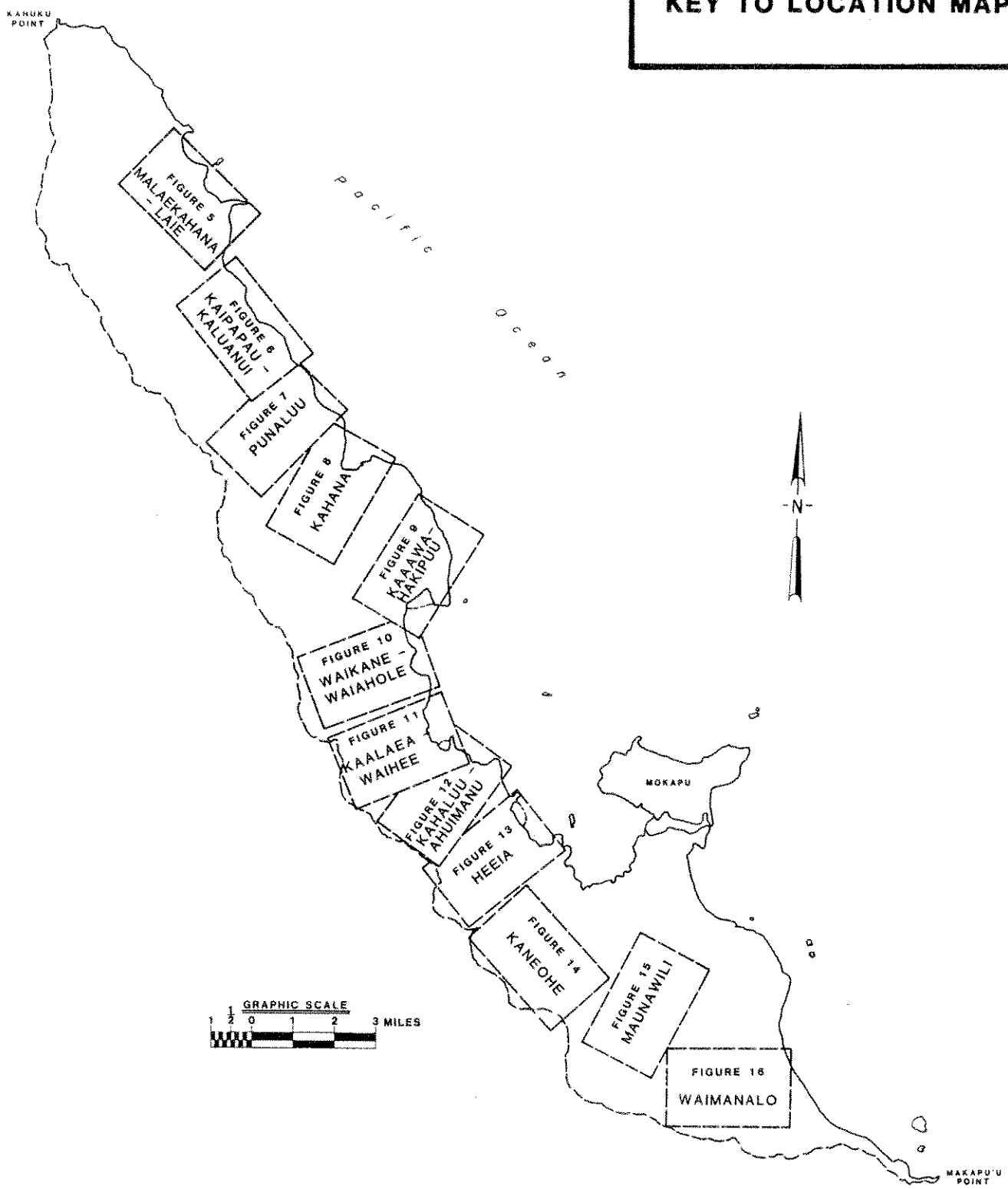
The Waimanalo 364 System services higher parts of Waimanalo. Water for the Waimanalo 364 Reservoir No. 1 comes primarily from the Waimanalo Tunnels and Waimanalo Well I. During periods of high demand, the Waimanalo Booster Pump Station can be used to pump water from the Waimanalo 230 Reservoir to the Waimanalo 364 Reservoir No. 1.

M. LOCATION MAPS

Figure 4 provides a summary of EIS location maps. Figures 5 through 15 are regional location maps showing the approximate locations of proposed BWS water development projects, reservoirs, and transmission mains in windward Oahu at a scale of 1" = 1,000'.

FIGURE 4

KEY TO LOCATION MAPS



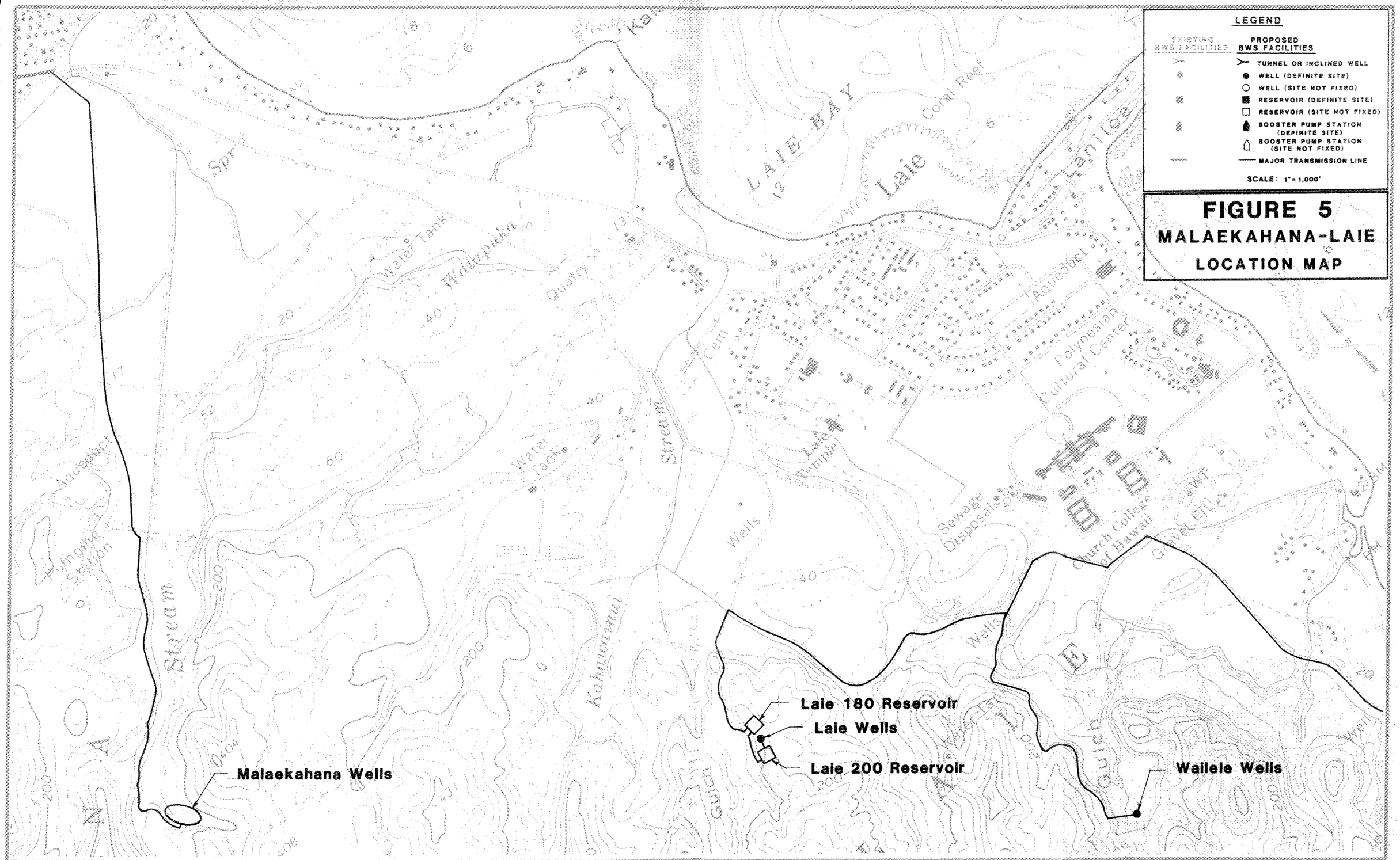


FIGURE 5
MALAEKAHANA-LAIE LOCATION MAP

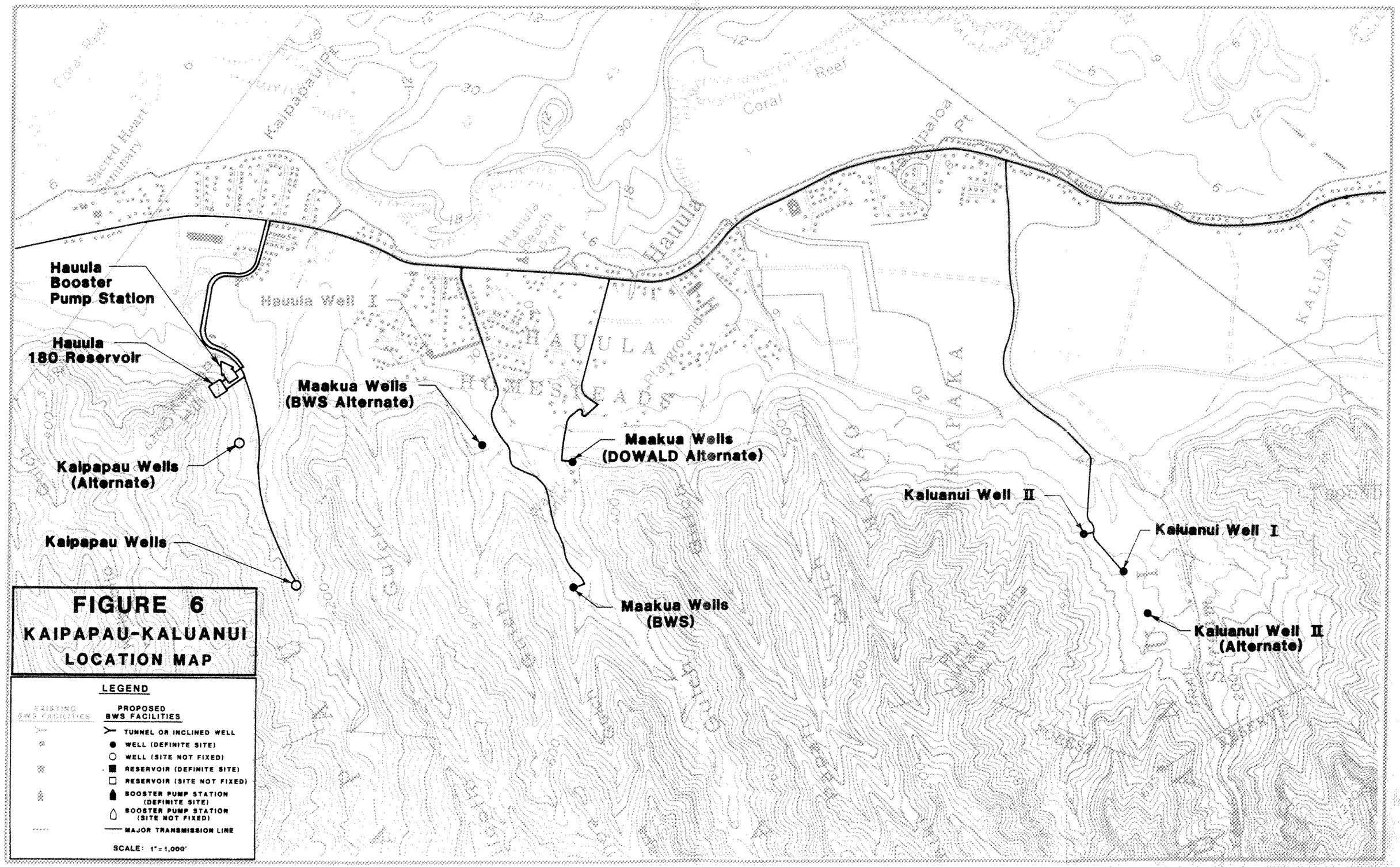


FIGURE 6
KAIPAPAU-KALUANUI LOCATION MAP

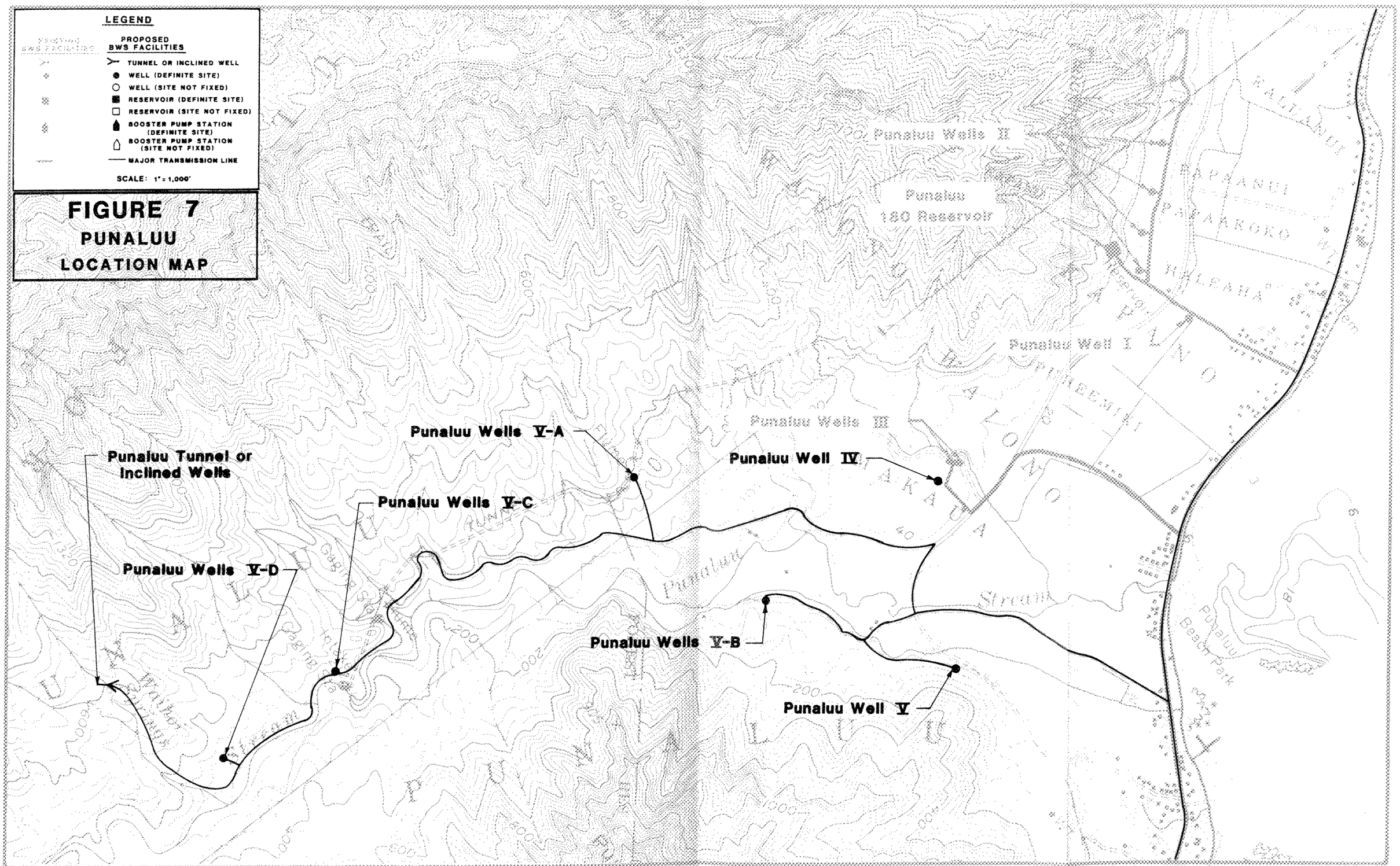


FIGURE 7
PUNALUU
LOCATION MAP

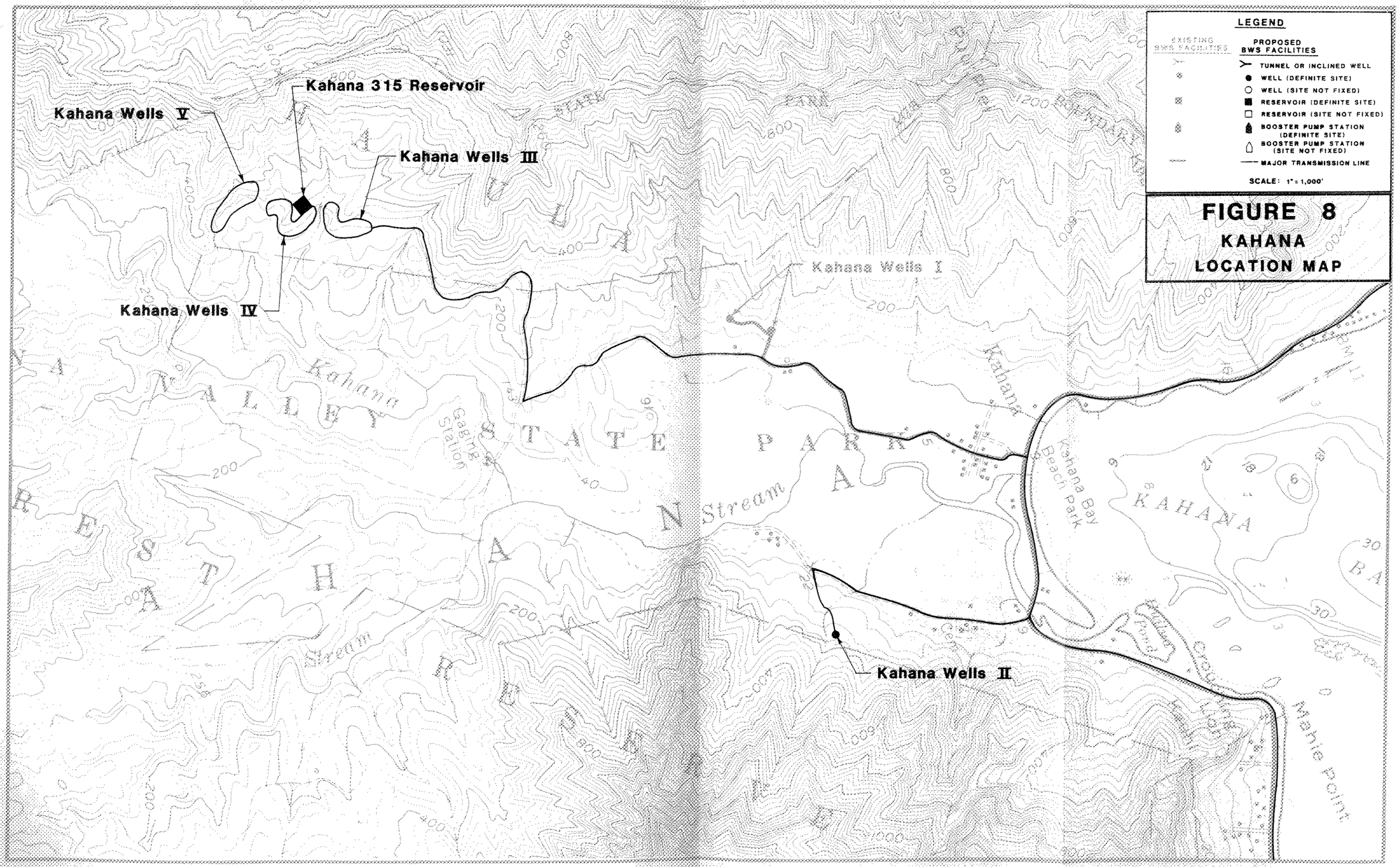


FIGURE 8
KAHANA
LOCATION MAP

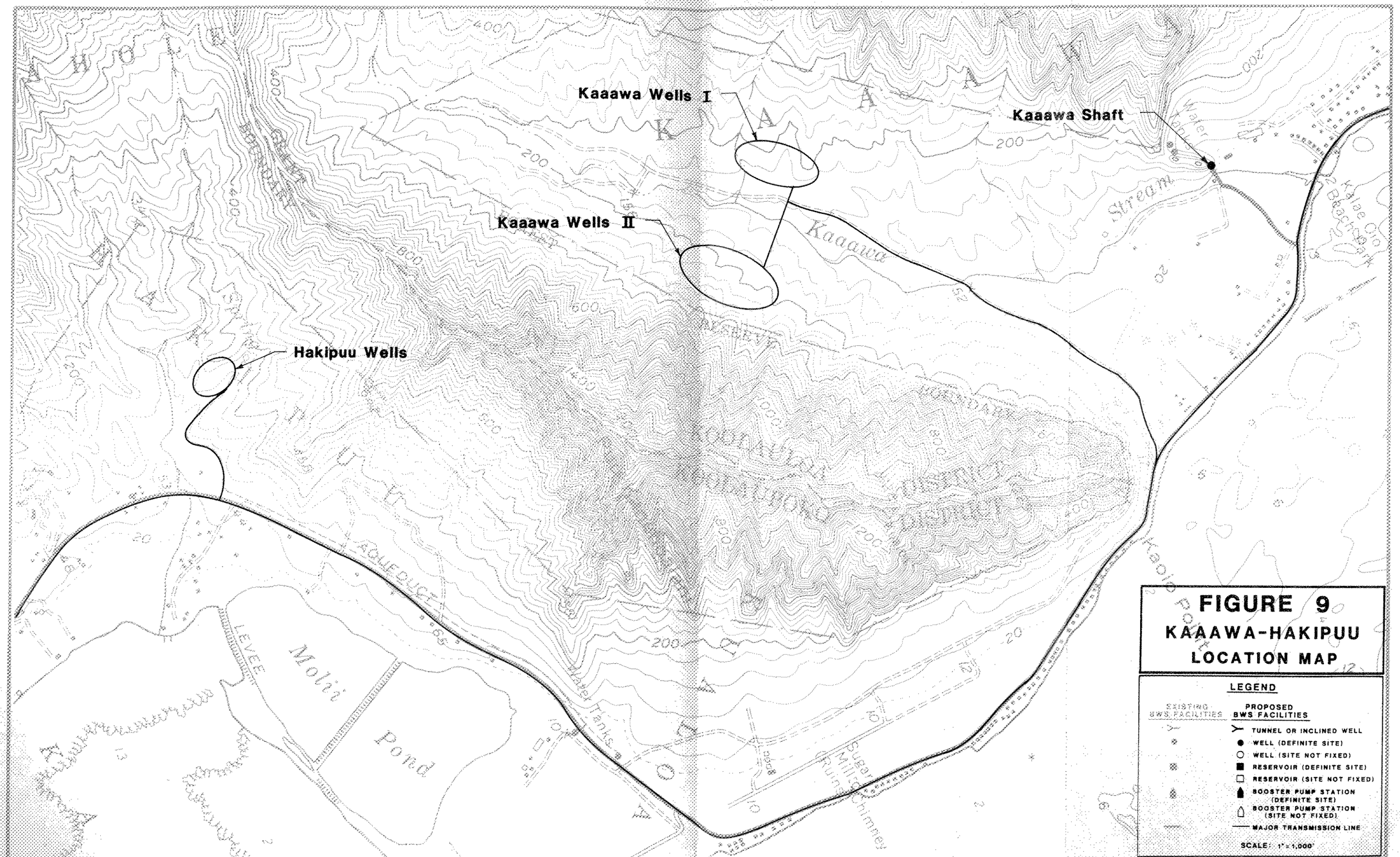


FIGURE 9
KAAAWA-HAKIPUU LOCATION MAP

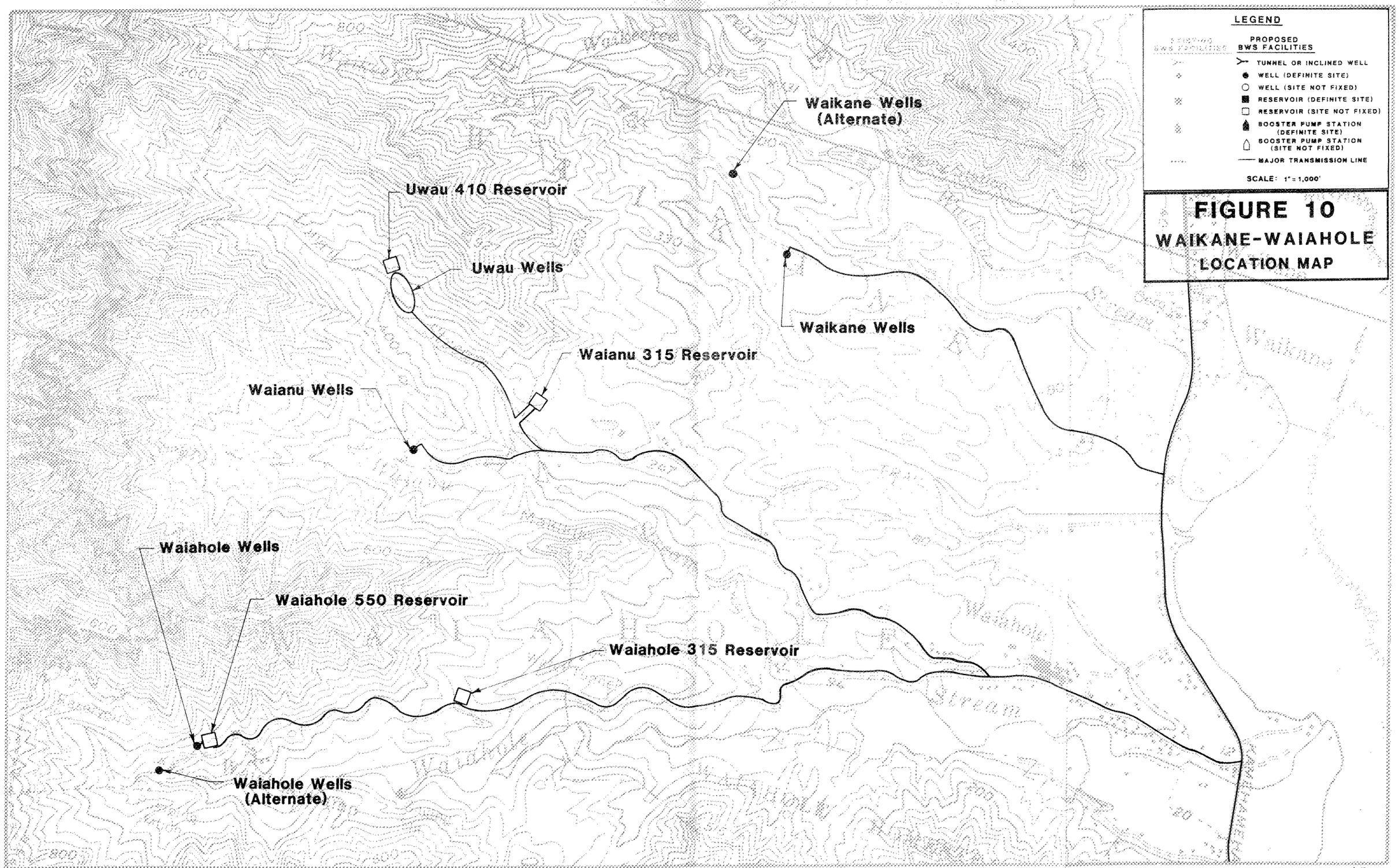


FIGURE 10
WAIKANE-WAIAHOLE LOCATION MAP

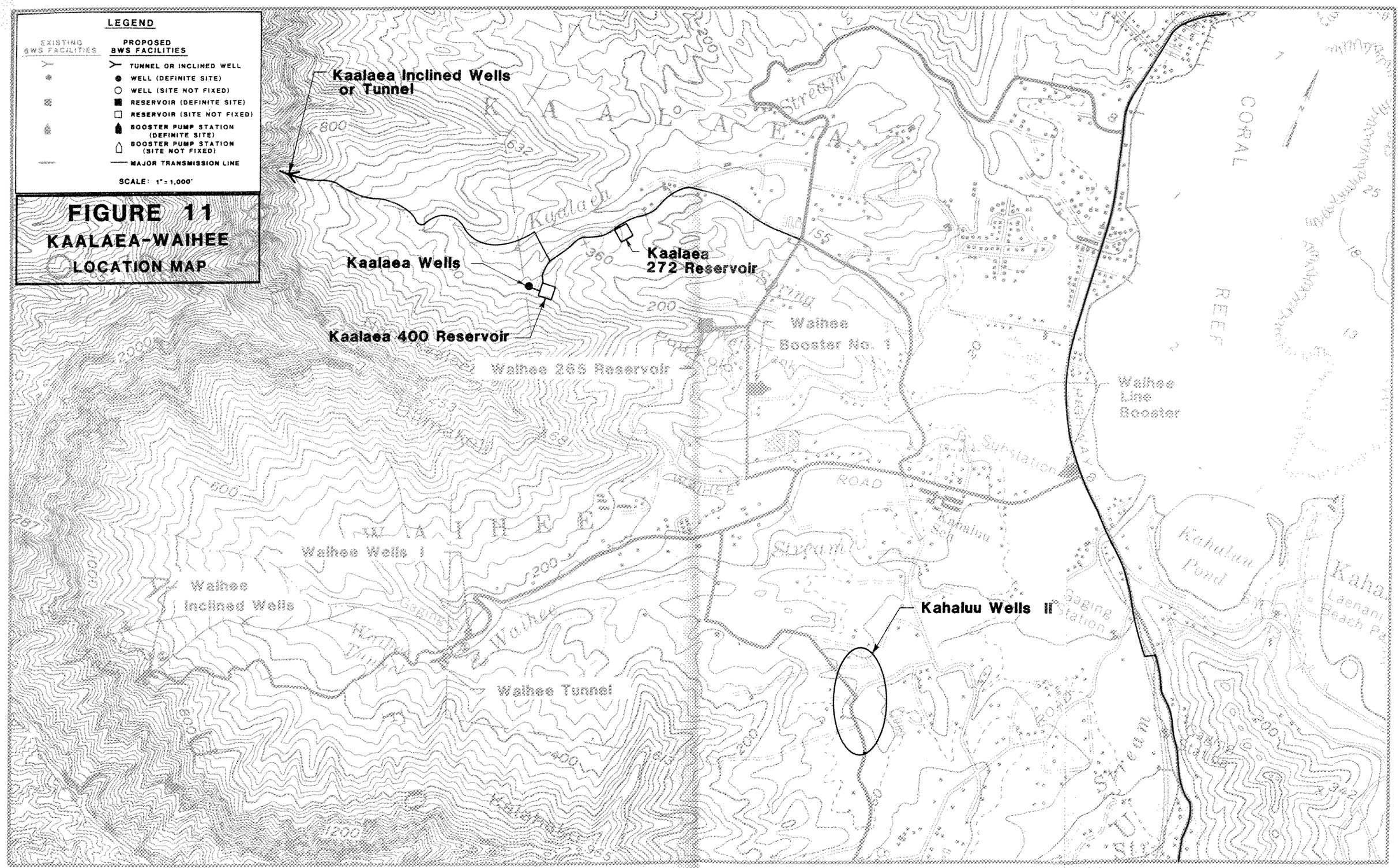


FIGURE 11
KAALAEA-WAIHEE
LOCATION MAP

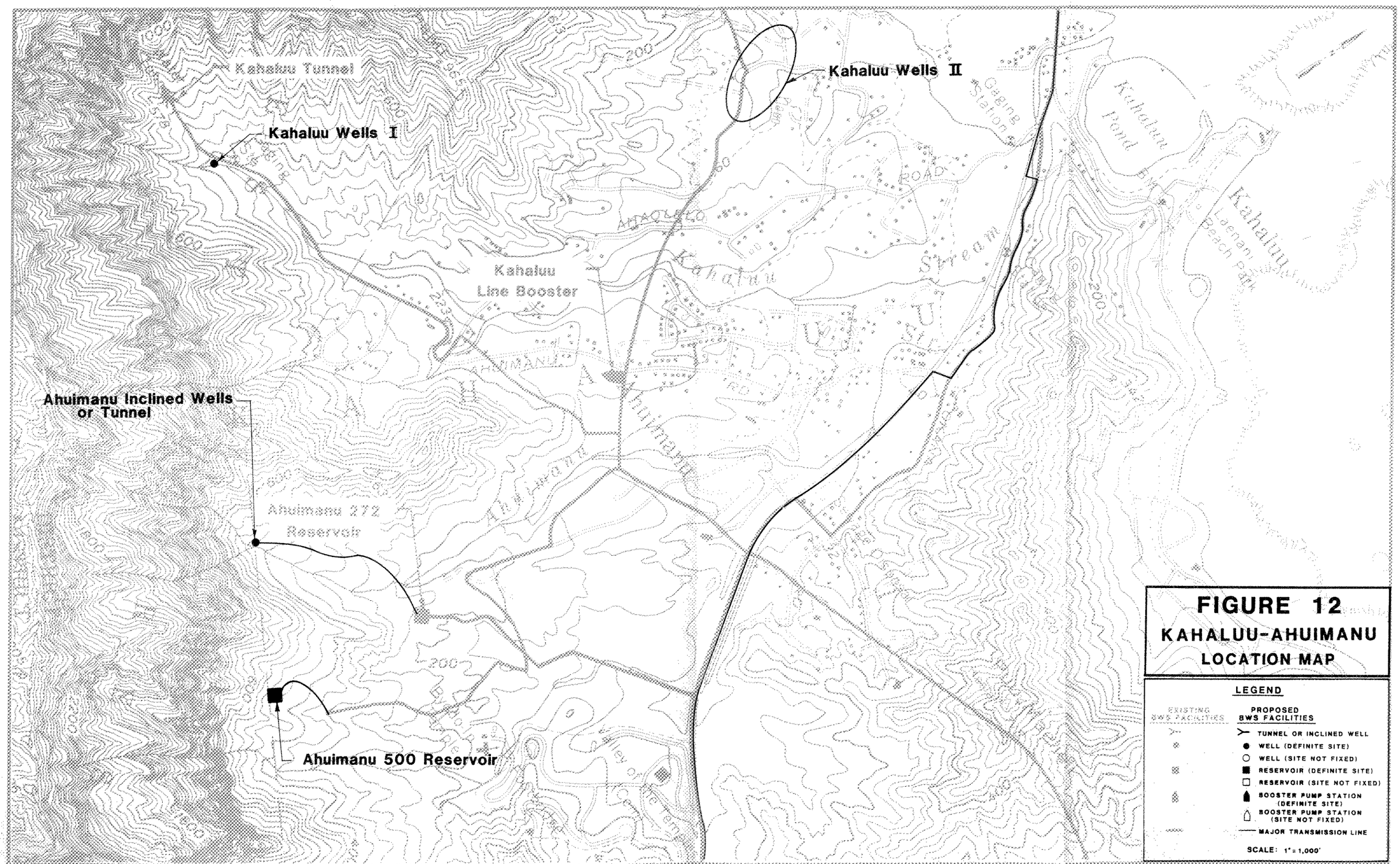


FIGURE 12
KAHALUU-AHUIMANU LOCATION MAP

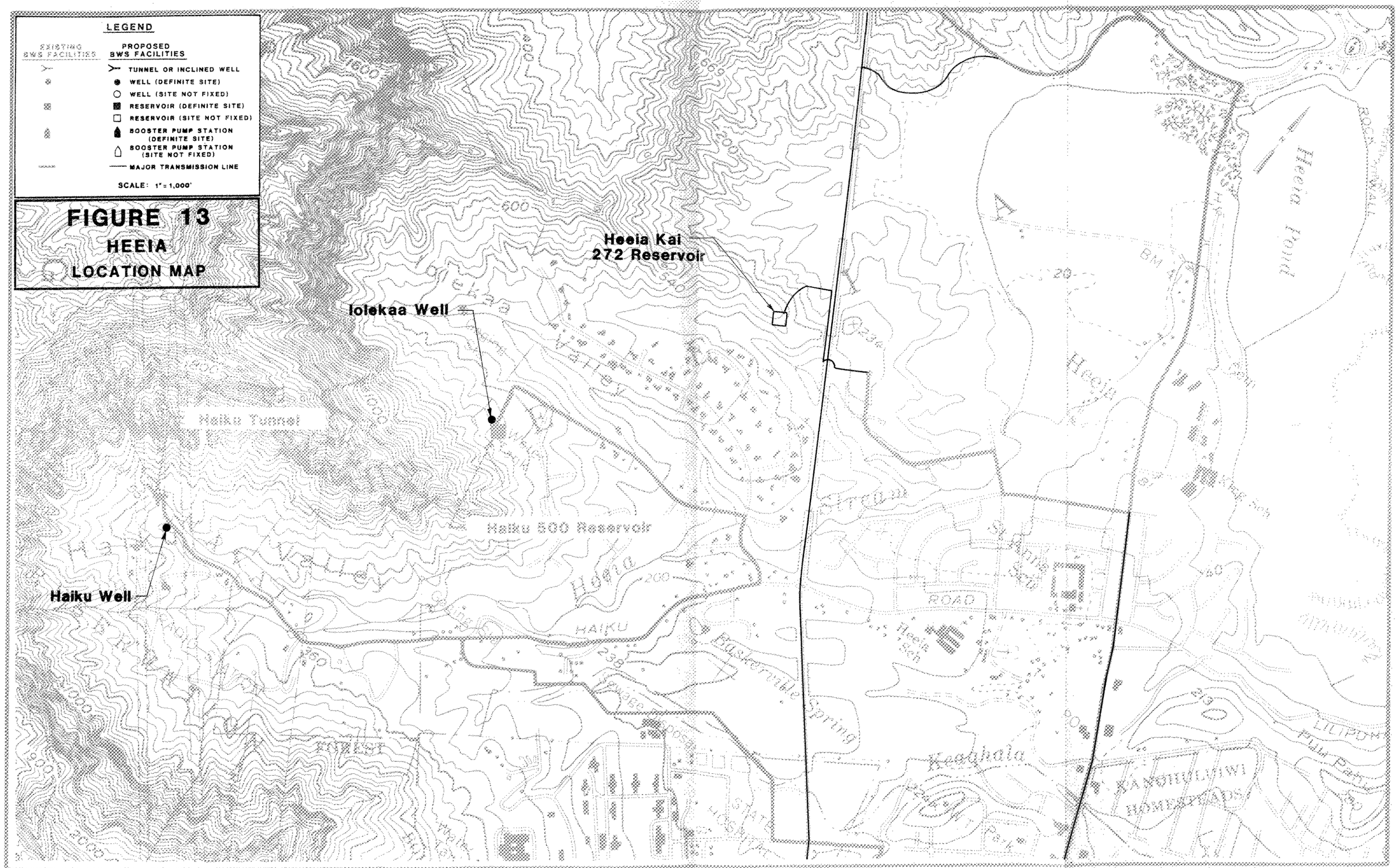


FIGURE 13
HEEIA
LOCATION MAP

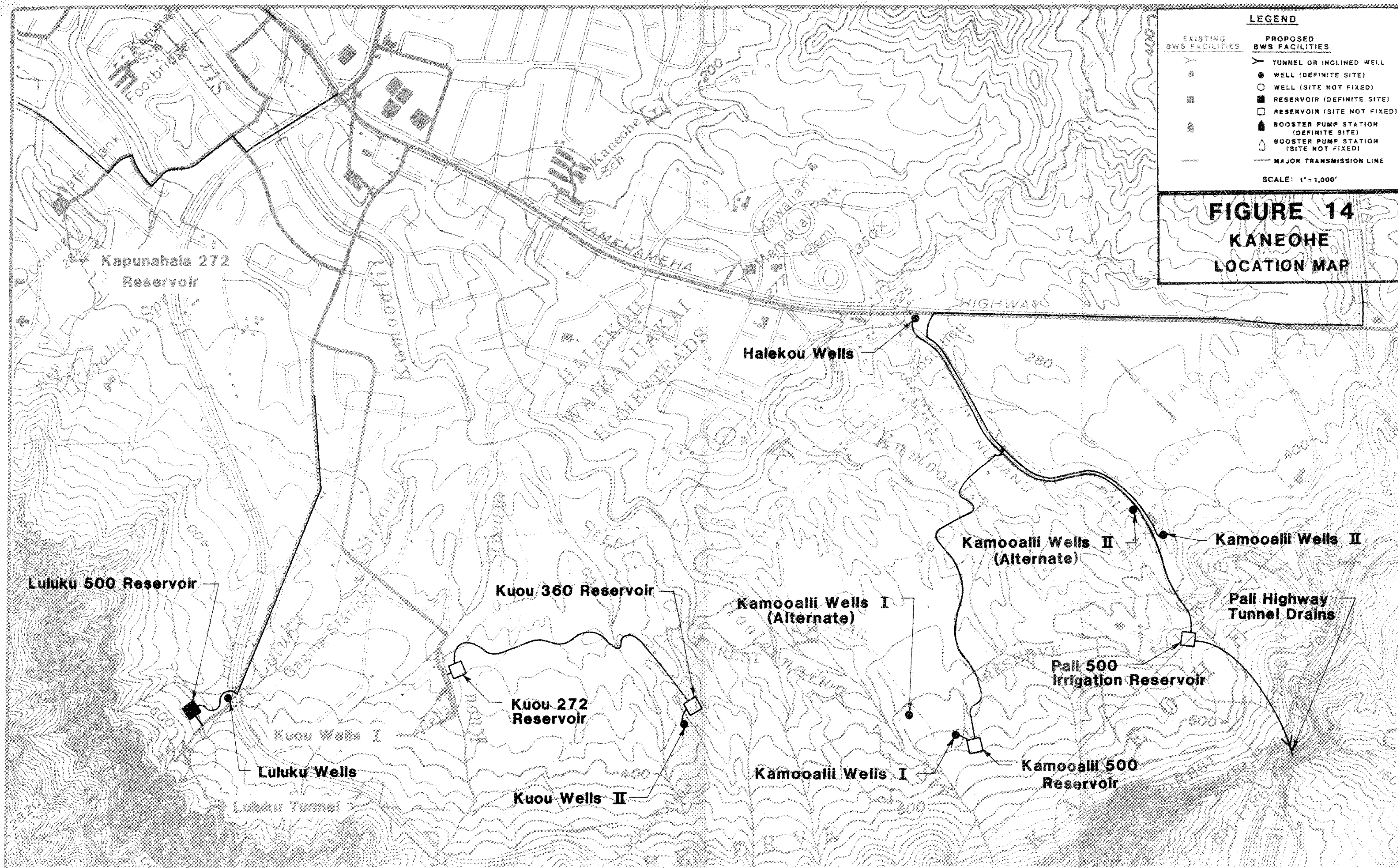


FIGURE 14
KANEOHE
LOCATION MAP

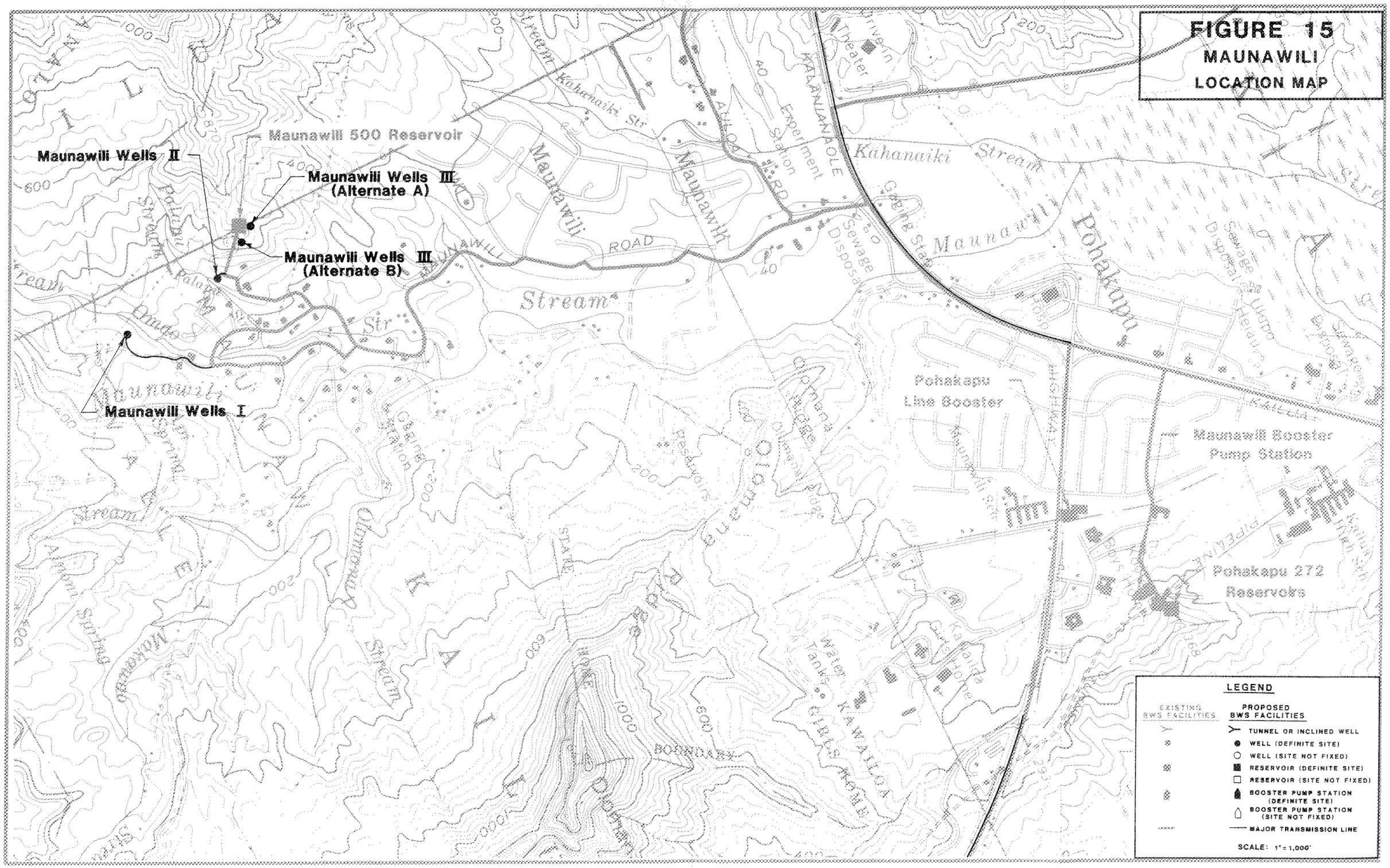


FIGURE 15
MAUNAWILI
LOCATION MAP
Maunawili 500 Reservoir
Maunawili Wells II
Maunawili Wells III (Alternate A)
Maunawili Wells III (Alternate B)
Maunawili Wells I
Maunawili Stream
Kahanaiki Stream
Pohakupu
Pohakapu Line Booster
Maunawili Booster Pump Station
Pohakapu 272 Reservoirs
Kawailoa Girls Home
Water Tanks
Olomana Ridge
Reservoirs
Sewage Disposal
Gaging Station
Experiment Station
Drive-in Theater
Kalanianaole Road
Maunawili Road
Kailua Hwy
Pipeline
Boundary
Olomana
Kawailoa
Olomana Spring
Makapuu
Omao
Palapu
Kahanaiki Str
Maunawili Str
LEGEND
EXISTING BWS FACILITIES
PROPOSED BWS FACILITIES
TUNNEL OR INCLINED WELL
WELL (DEFINITE SITE)
WELL (SITE NOT FIXED)
RESERVOIR (DEFINITE SITE)
RESERVOIR (SITE NOT FIXED)
BOOSTER PUMP STATION (DEFINITE SITE)
BOOSTER PUMP STATION (SITE NOT FIXED)
MAJOR TRANSMISSION LINE
SCALE: 1" = 1,000'

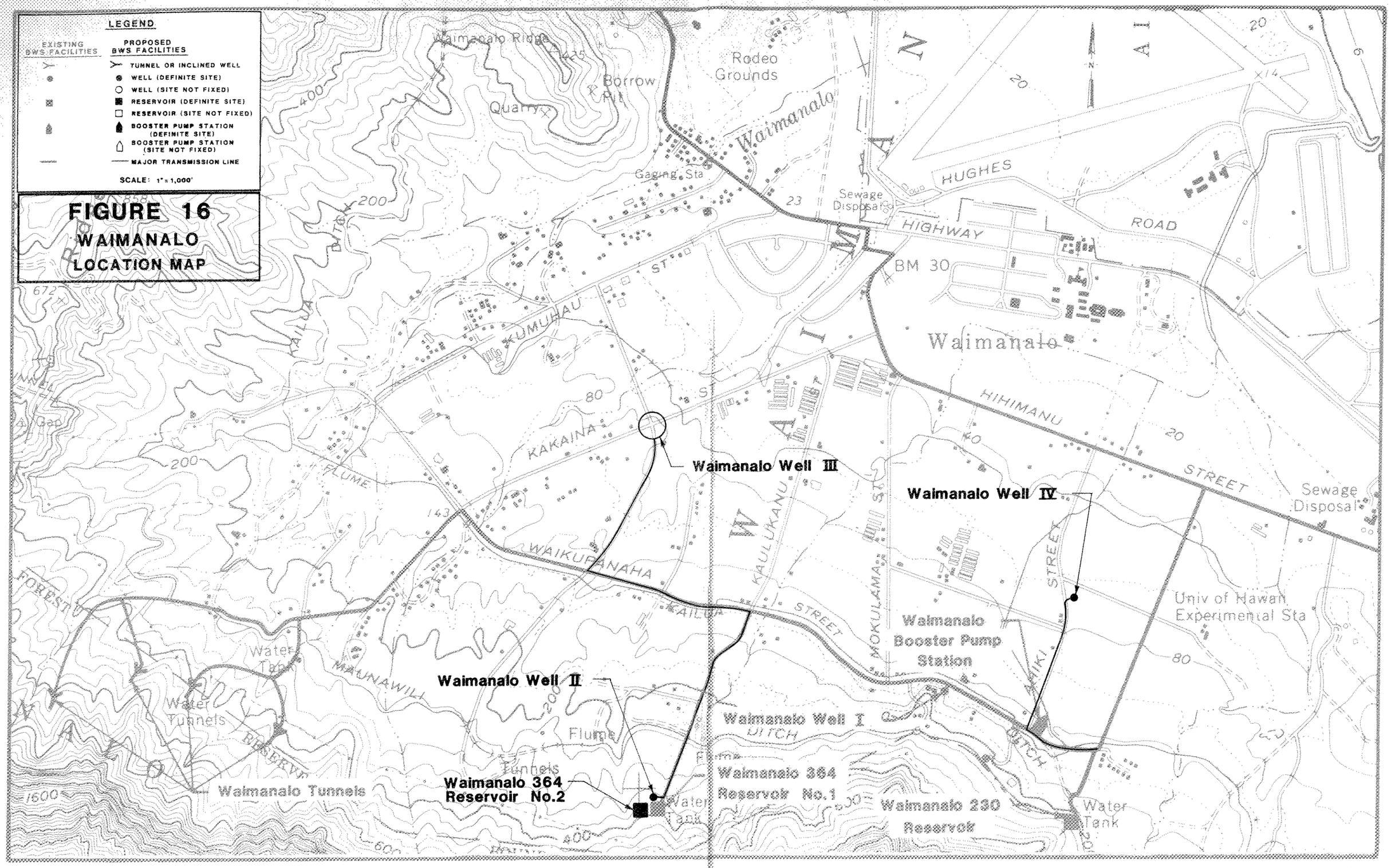


FIGURE 16
WAIMANALO
LOCATION MAP

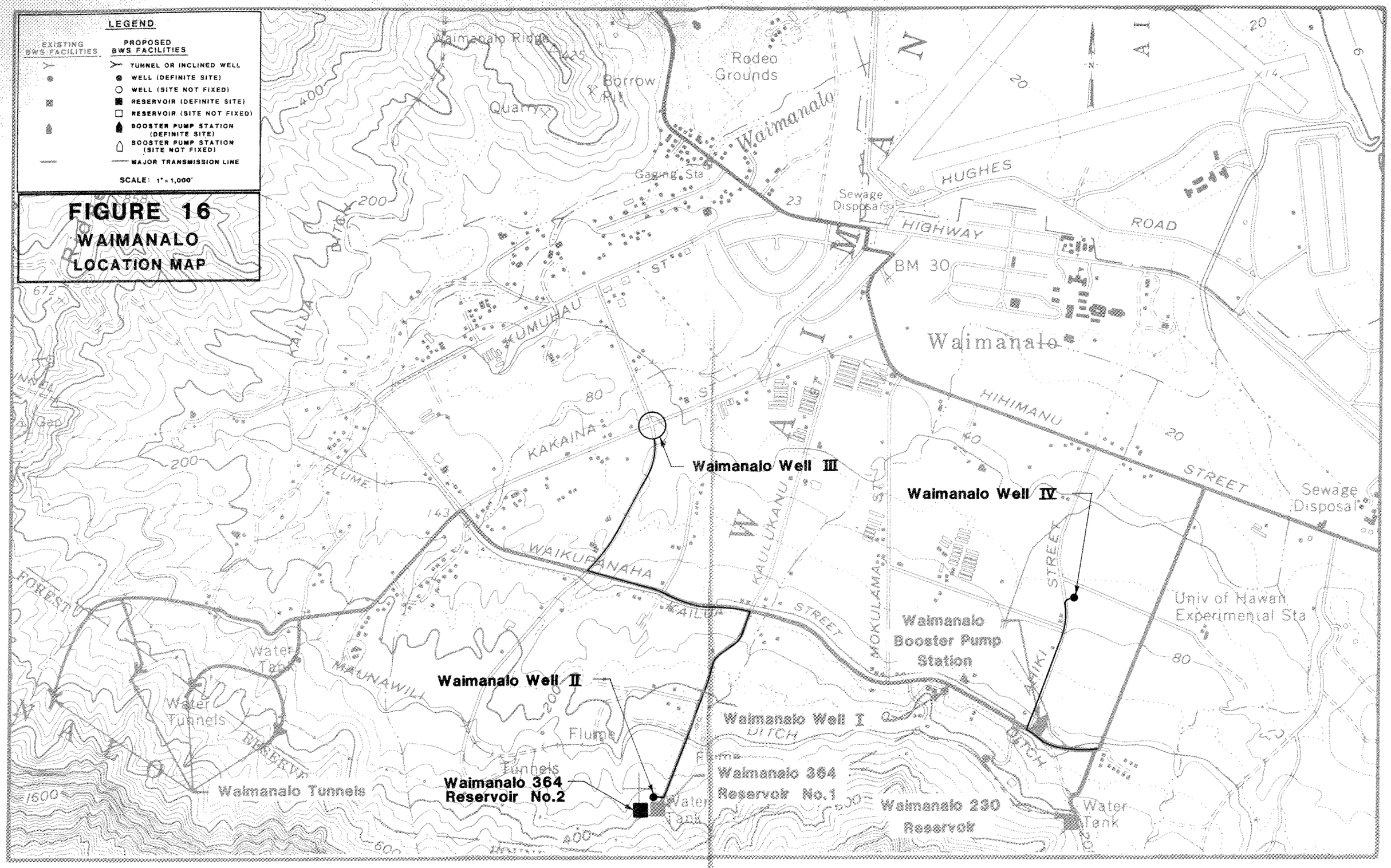


FIGURE 16
WAIMANALO
LOCATION MAP

N. PHOTOGRAPHS OF PROPOSED SITES FOR NEW WATER SOURCES

Plates 6 through 59 show the proposed sites for new BWS water sources in windward Oahu. Pictures were not possible of the proposed Hakipuu Wells because the affected property owner has not authorized the BWS to visit the site. For the same reason, it was necessary to take telephoto pictures of proposed well sites in Kaipapau and Kaaawa Valleys. Because siting is not resolved, a couple of pictures are shown of possible sites for both the Kahaluu Wells II and Waimanalo Well III.

PLATE 6
MALAEKAHANA WELLS SITE

PLATE 7
LAIE WELLS SITE

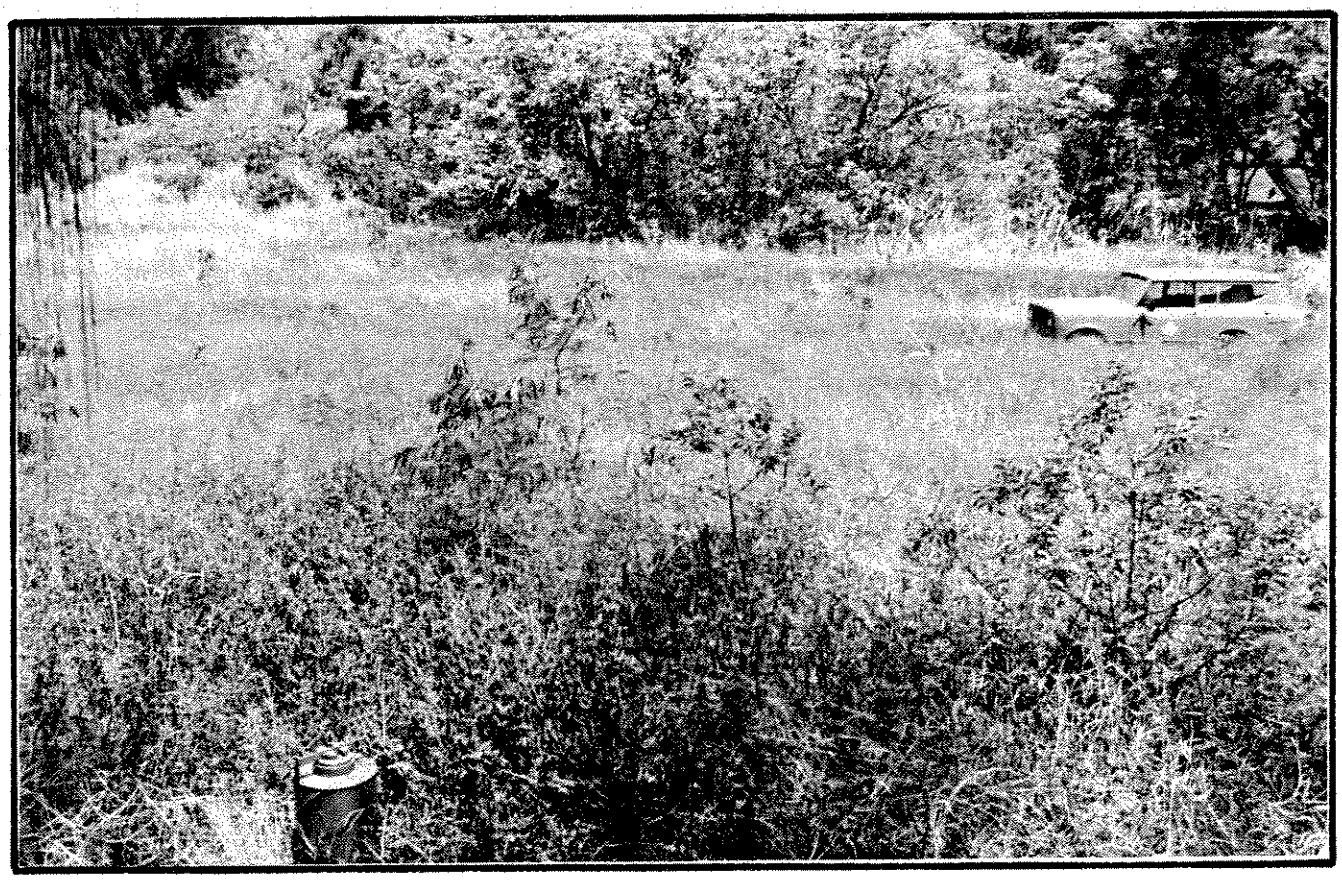


PLATE 8
WAILELE WELLS SITE

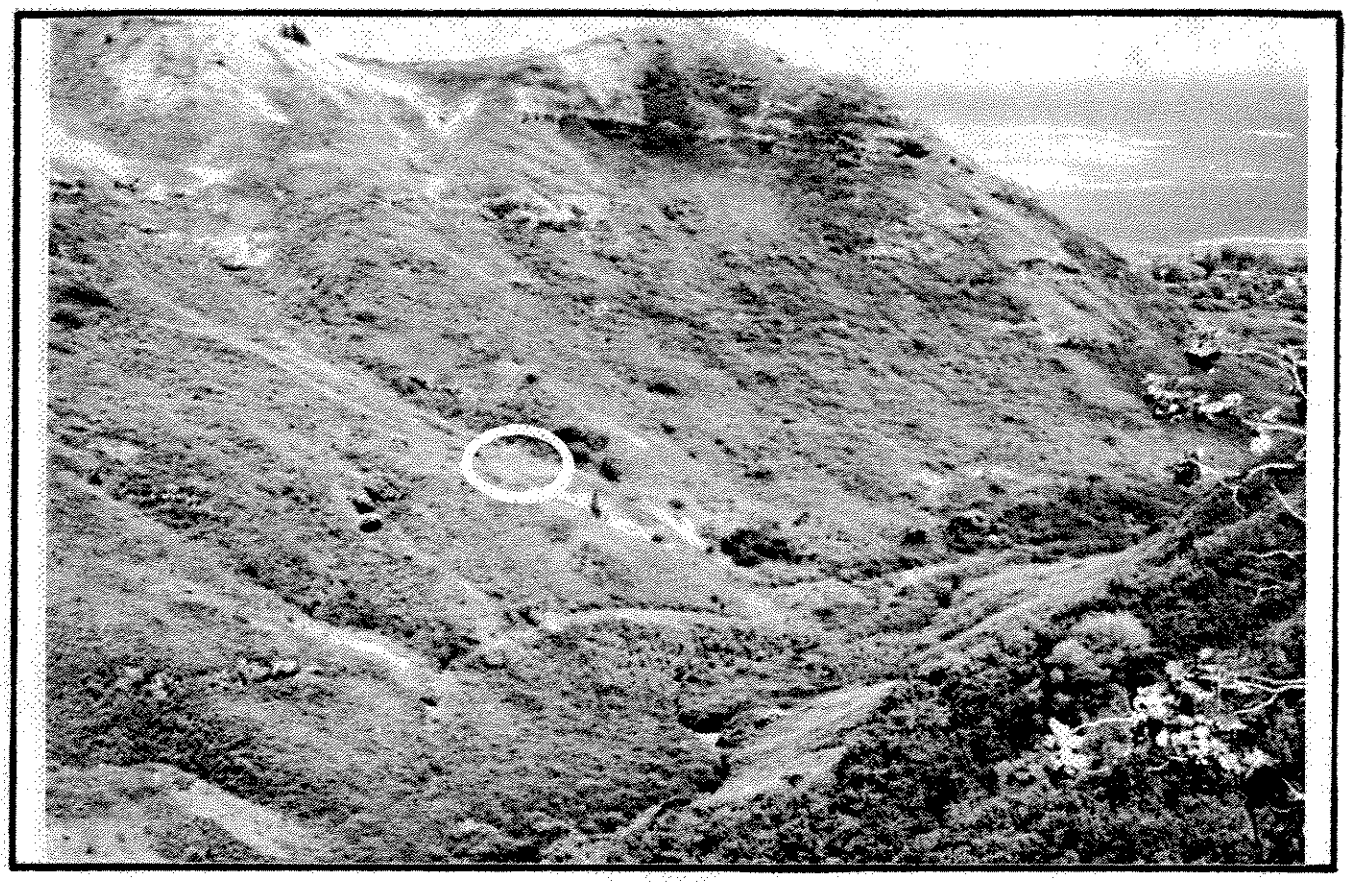


PLATE 9
KAIPAPAU WELLS (ALTERNATE SITE)

PLATE 10
KAIPAPAU WELLS (ALTERNATE SITE)

PLATE 11
MAAKUA WELLS (BWS SITE)

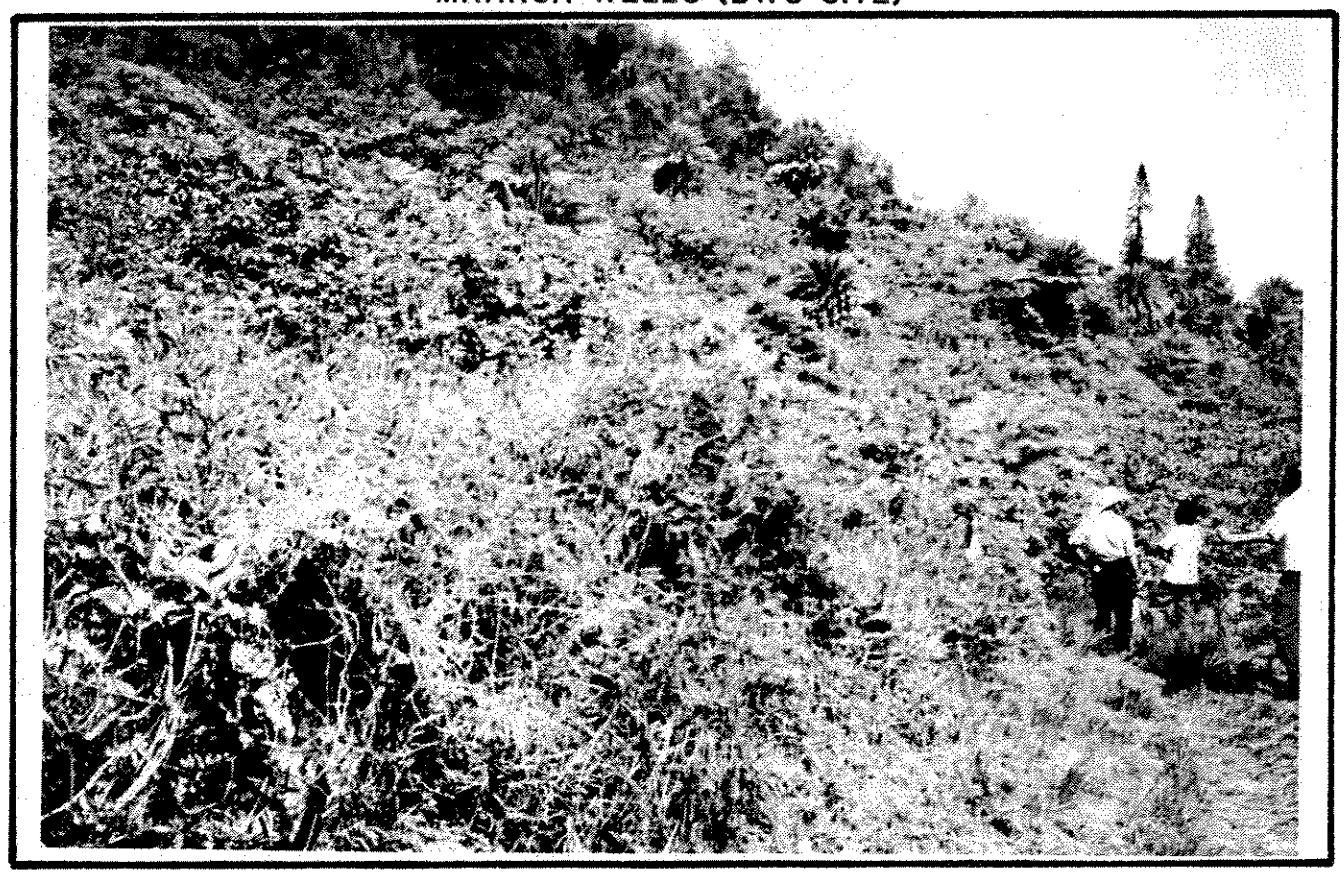


PLATE 12
MAAKUA WELLS (BWS ALTERNATE SITE)

PLATE 13
MAAKUA WELLS (DOWALD ALTERNATE SITE)

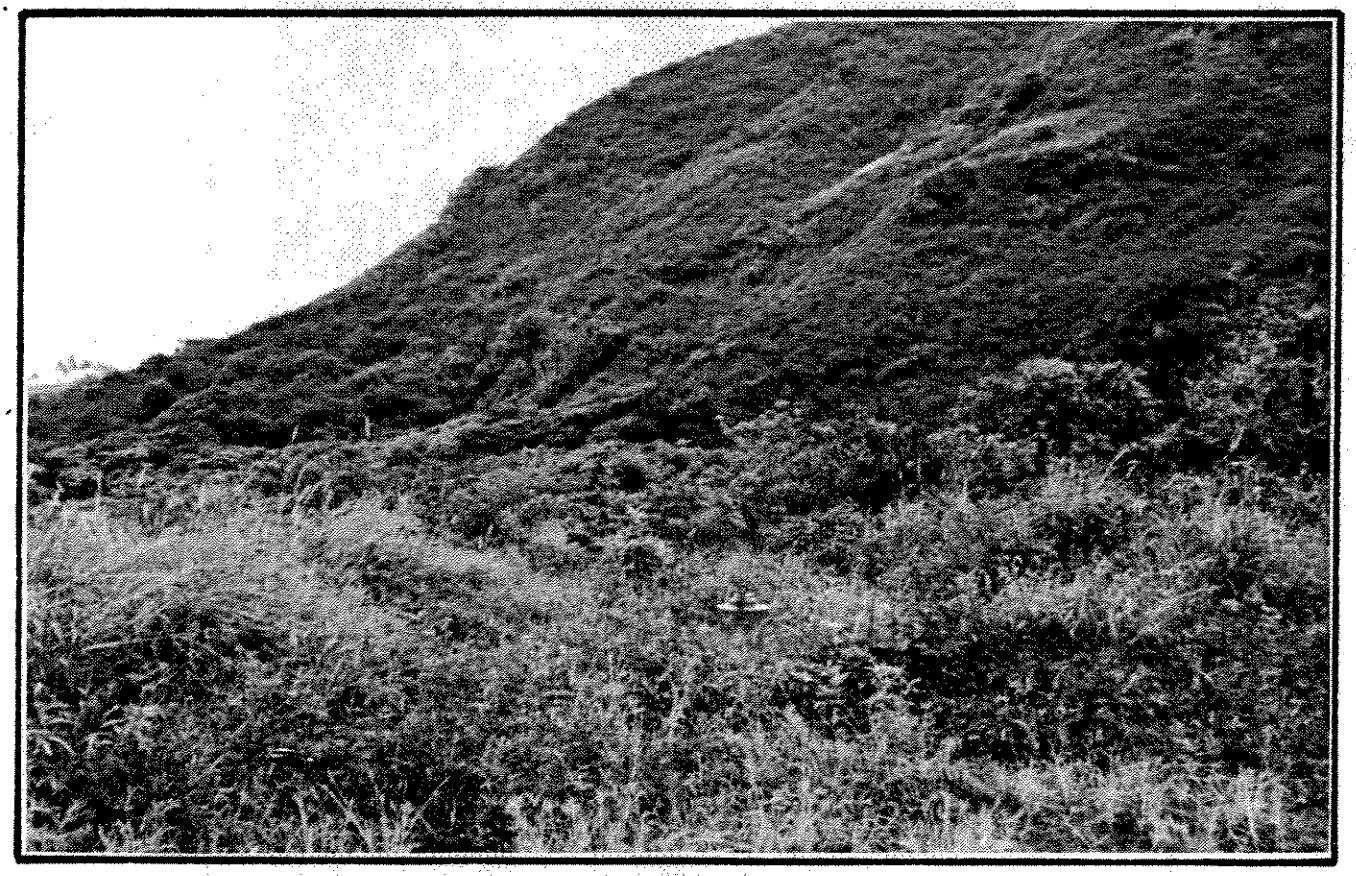
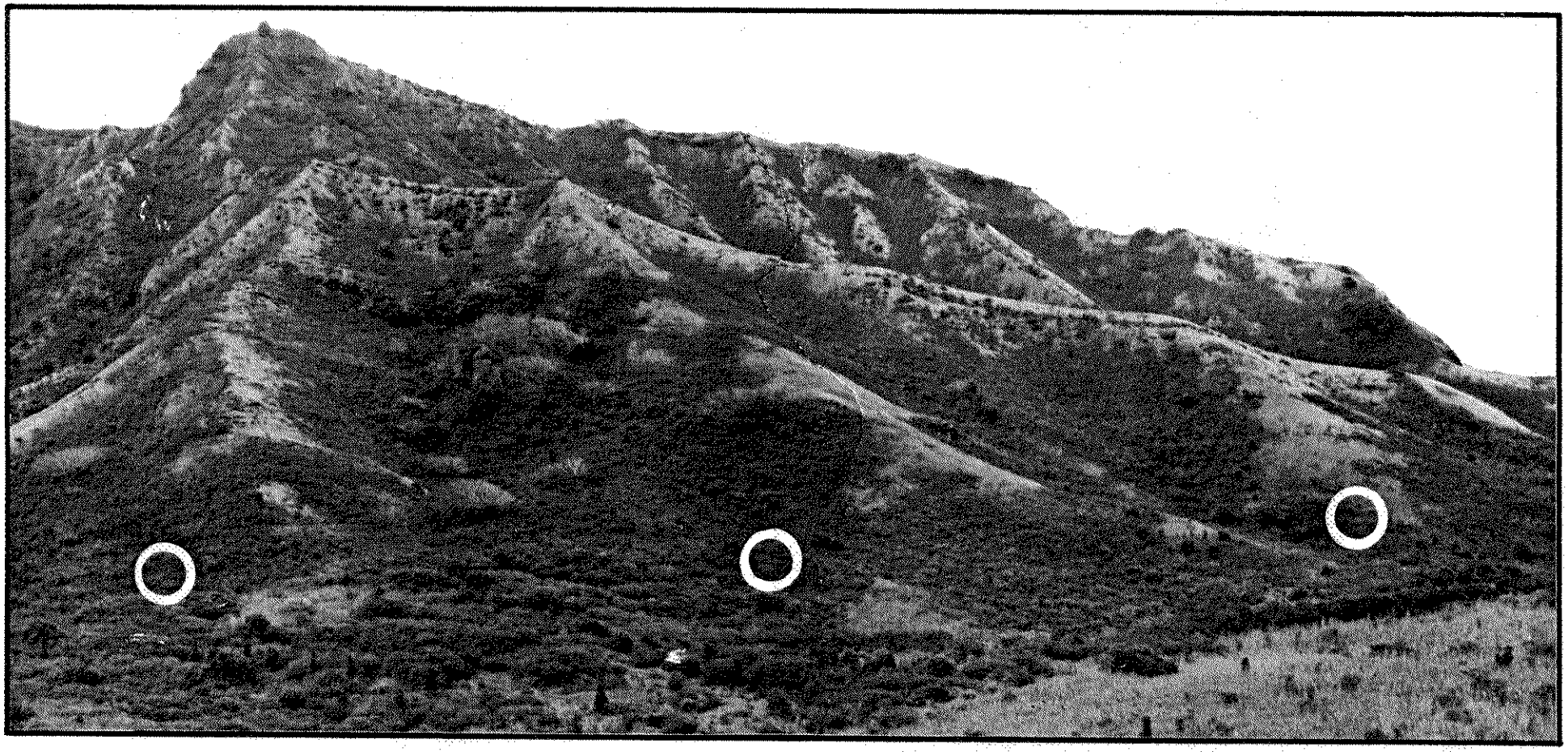


PLATE 14
KALUANUI WELL I SITE

PLATE 15

KALUANUI WELL II SITE AND ALTERNATE



KALUANUI WELL II
(ALTERNATE SITE)

KALUANUI WELL I SITE

KALUANUI WELL II SITE

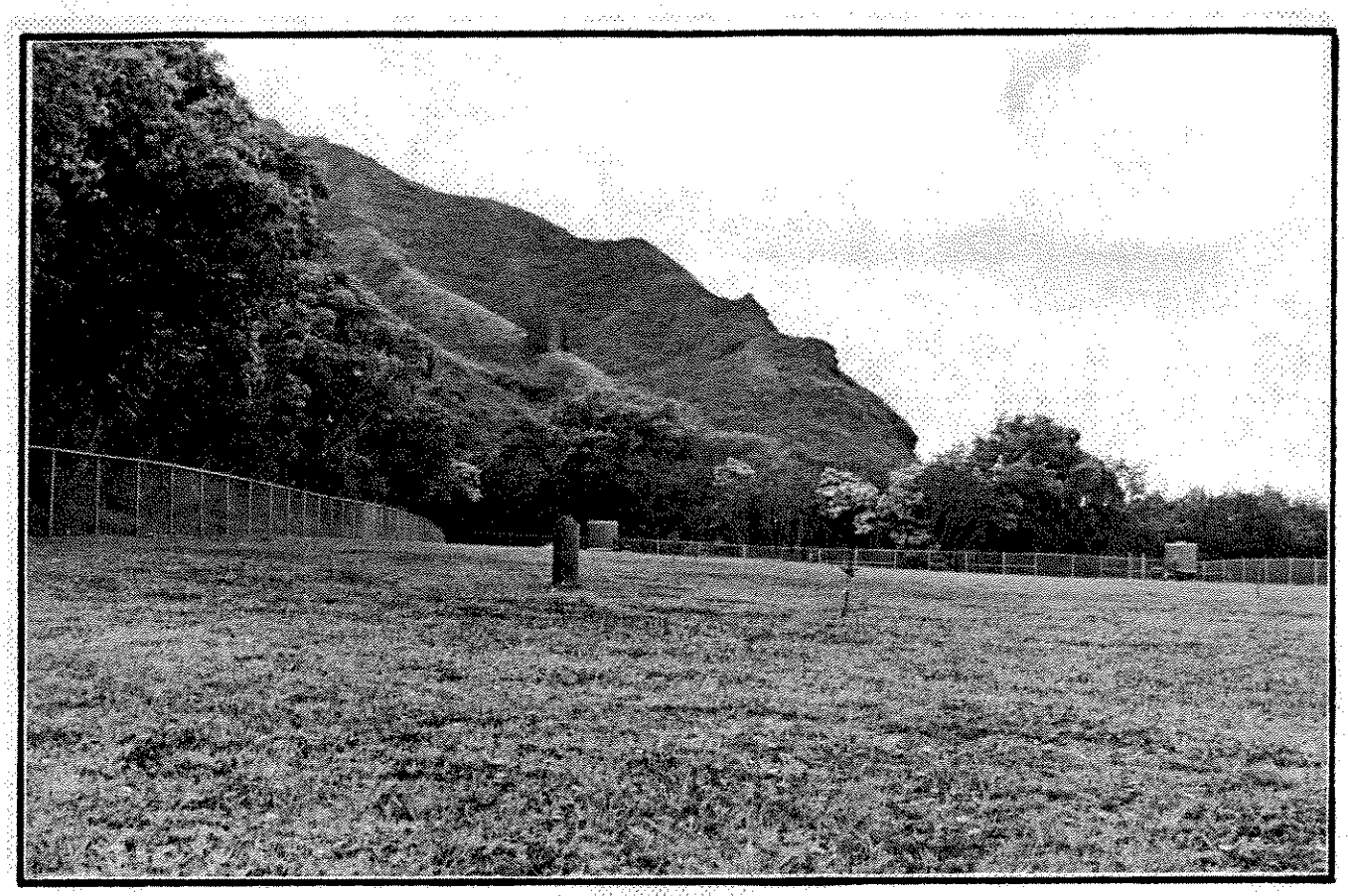


PLATE 16
PUNALUU WELL IV SITE

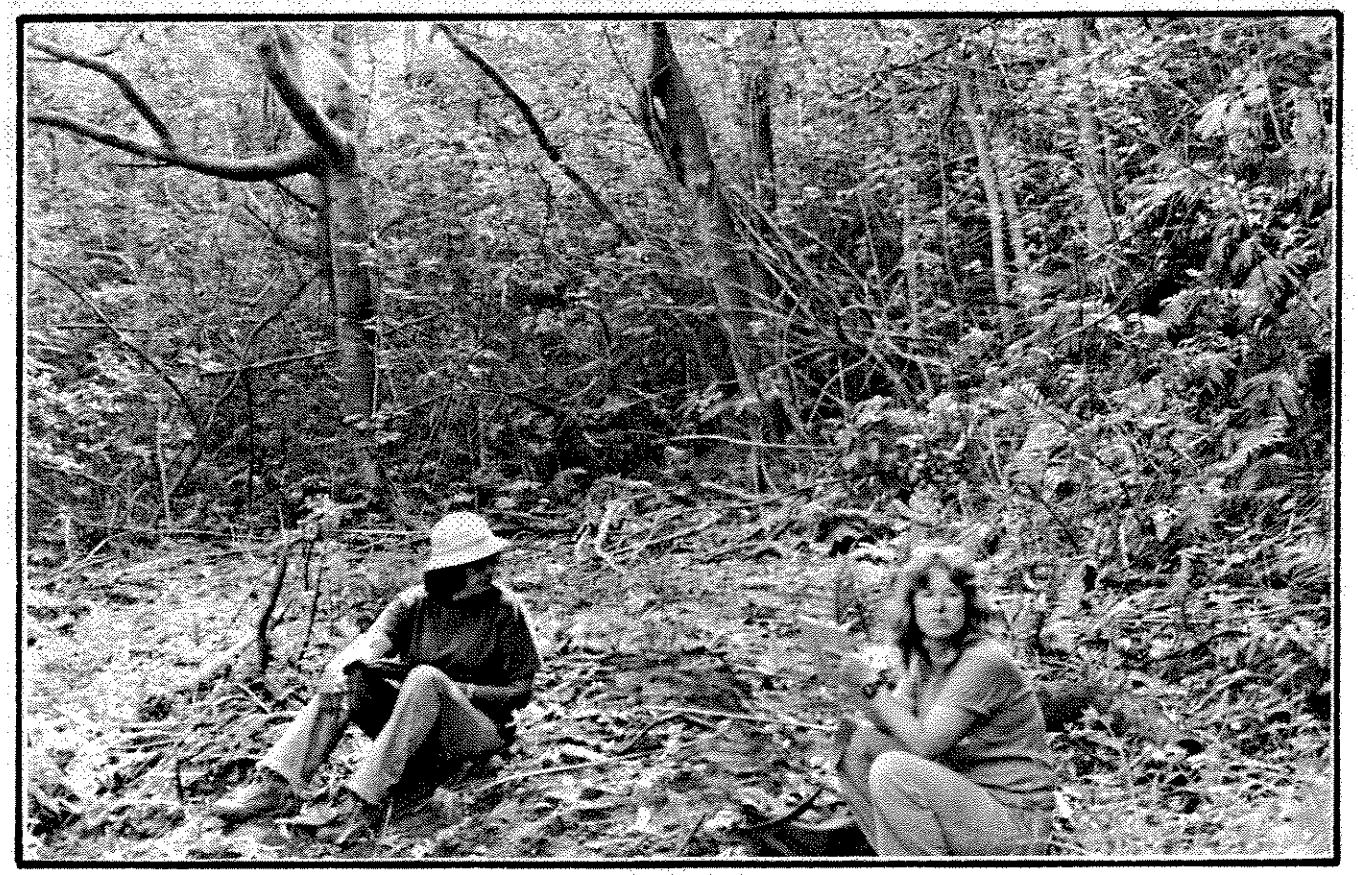


PLATE 17
PUNALUU WELL V SITE

PLATE 18
PUNALUU WELLS V-A SITE

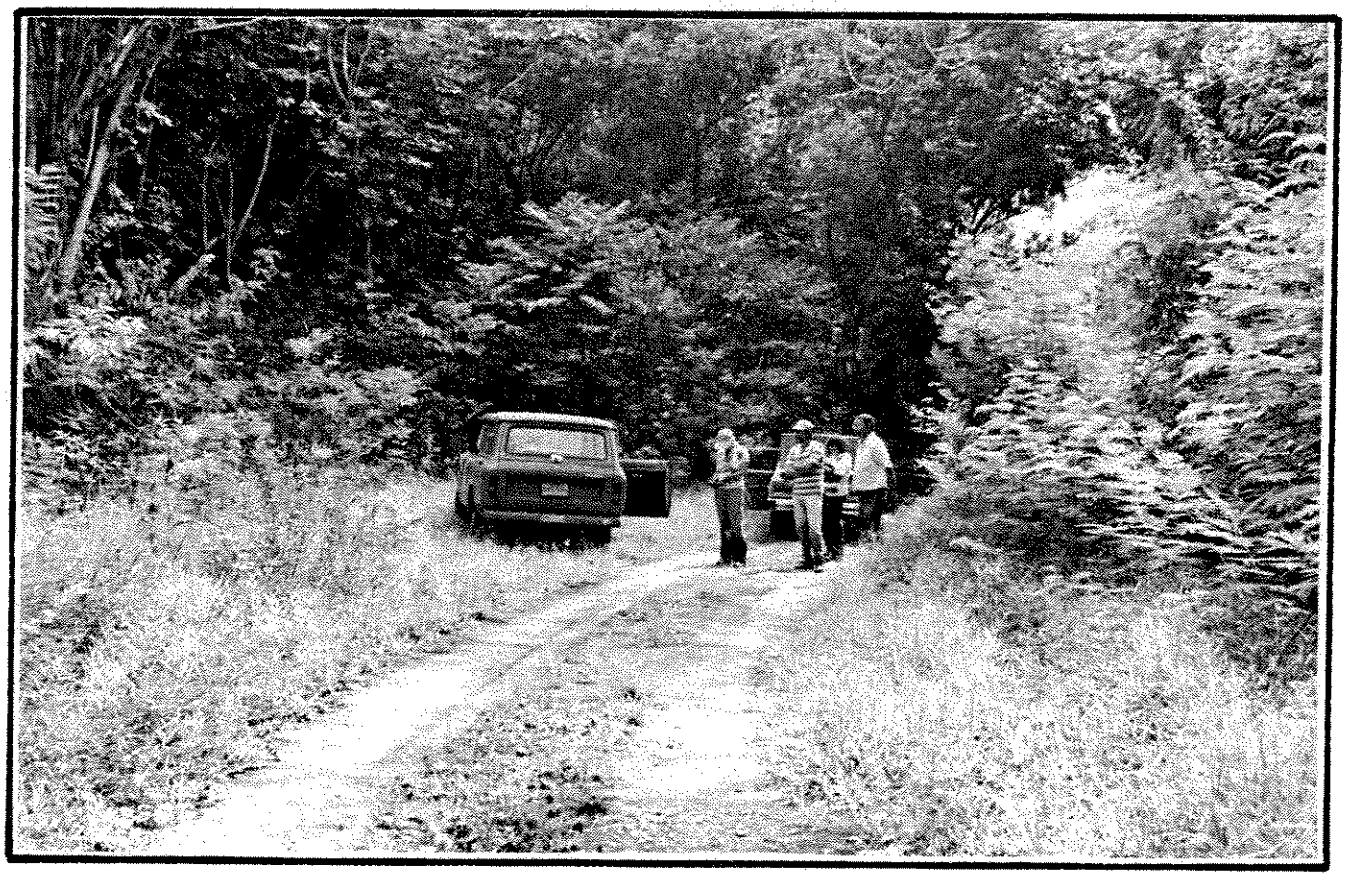


PLATE 19
PUNALUU WELLS V-B SITE

PLATE 20
PUNALUU WELLS V-C SITE

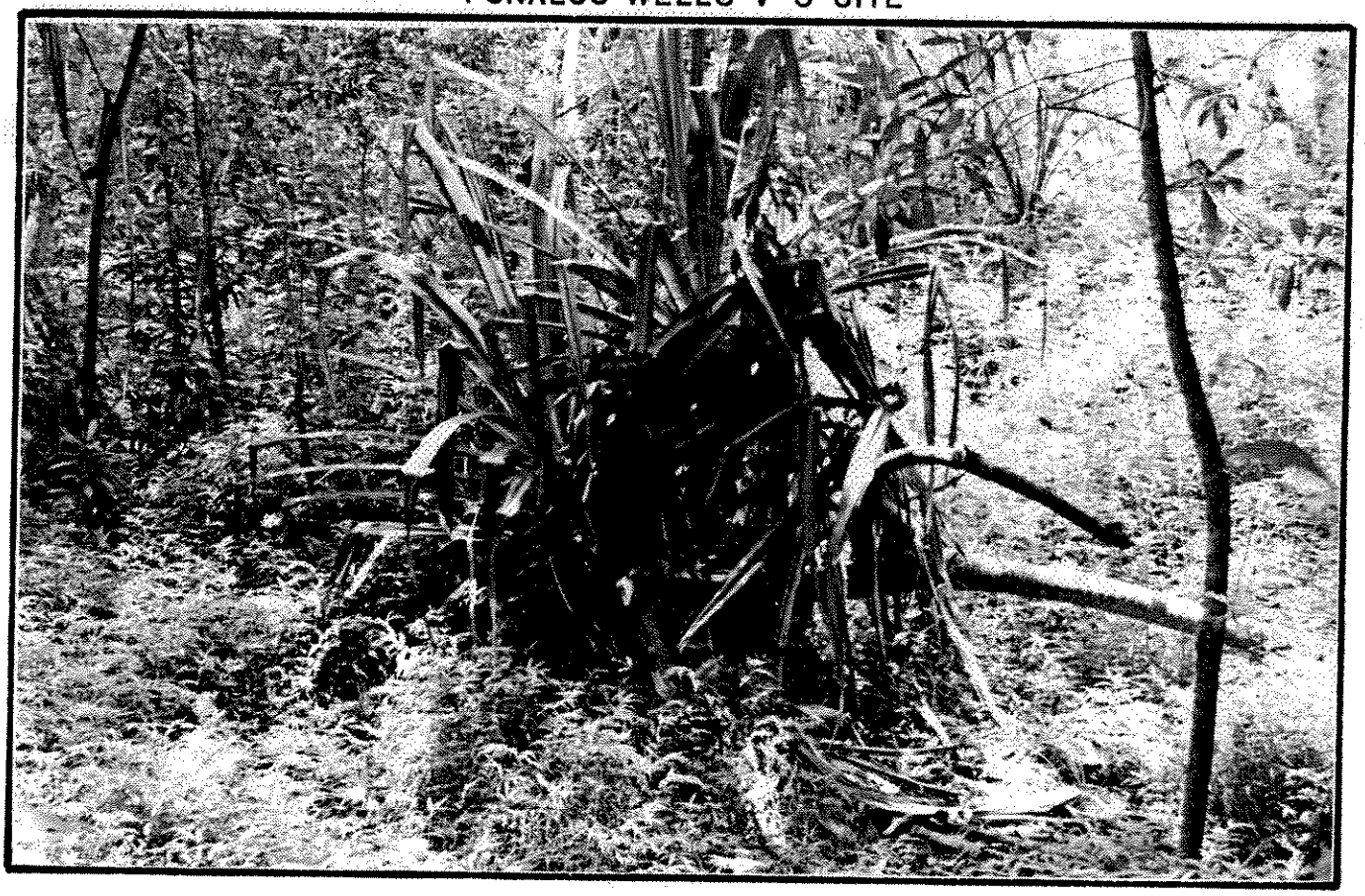


PLATE 21
PUNALUU WELLS V-D SITE

PLATE 22
PUNALUU TUNNEL OR INCLINED WELLS SITE

PLATE 23
KAHANA WELLS II SITE

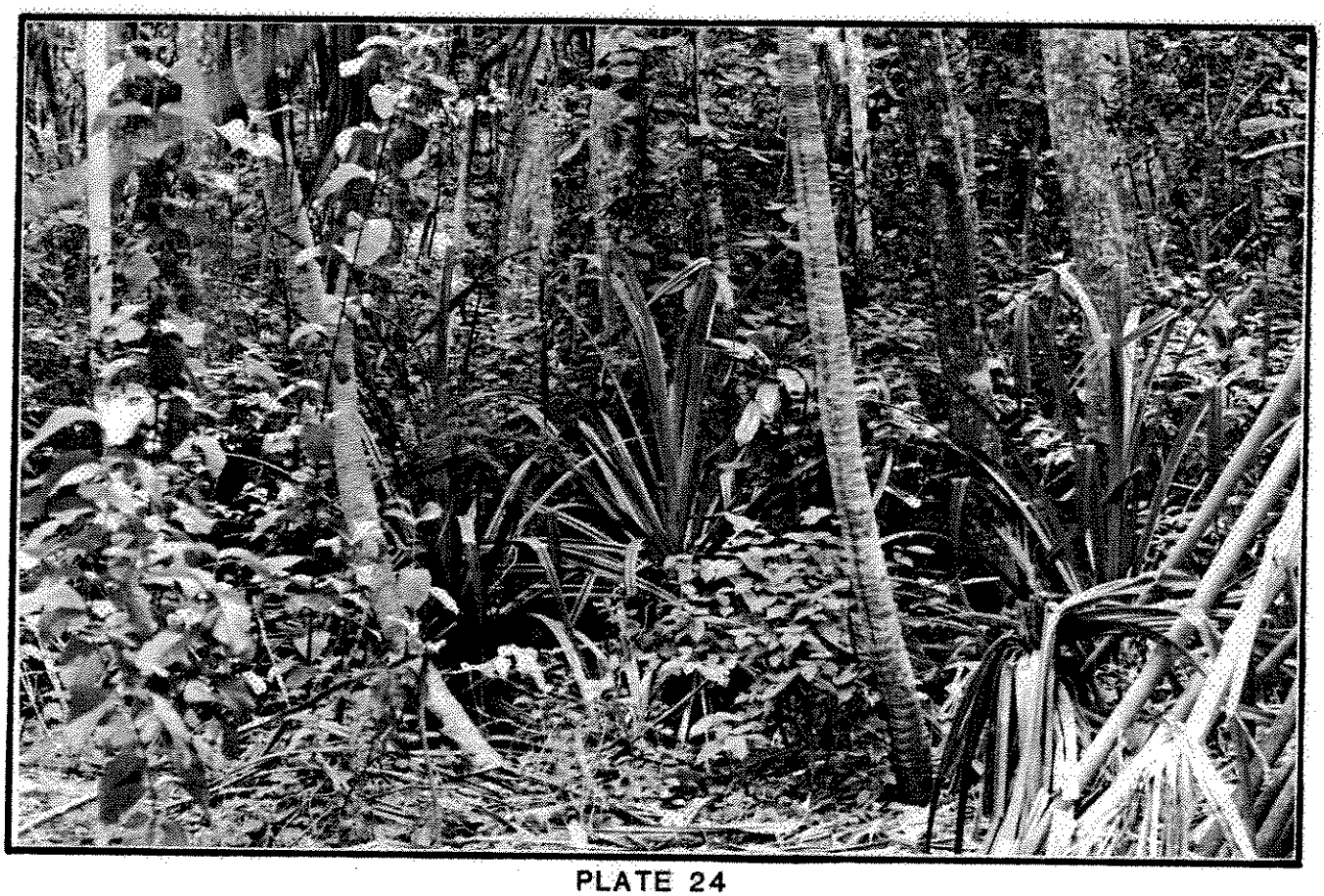


PLATE 24
KAHANA WELLS III SITE

PLATE 25
KAHANA WELLS IV SITE

PLATE 26
KAHANA WELLS V SITE

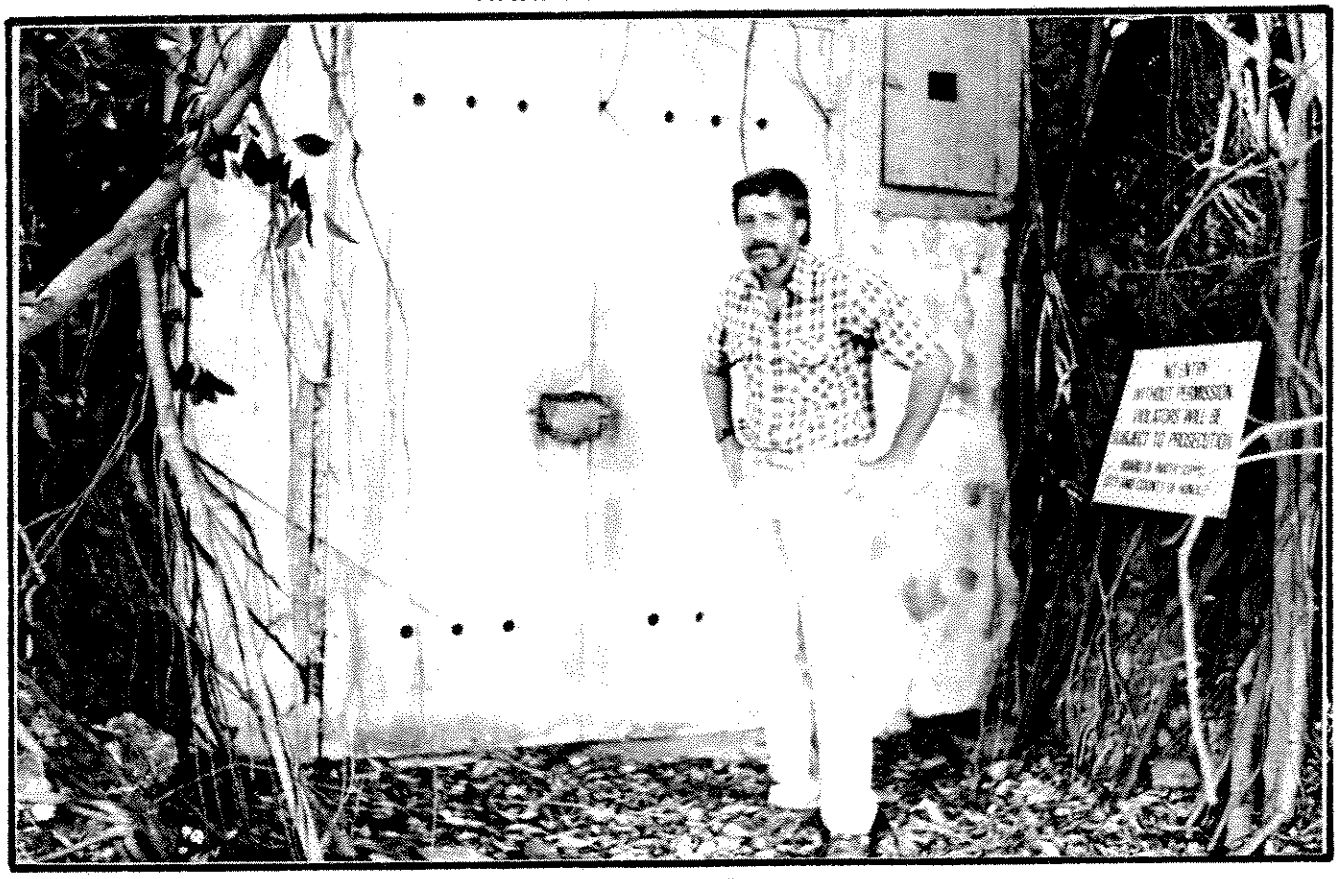


PLATE 27
KAAAWA SHAFT PORTAL

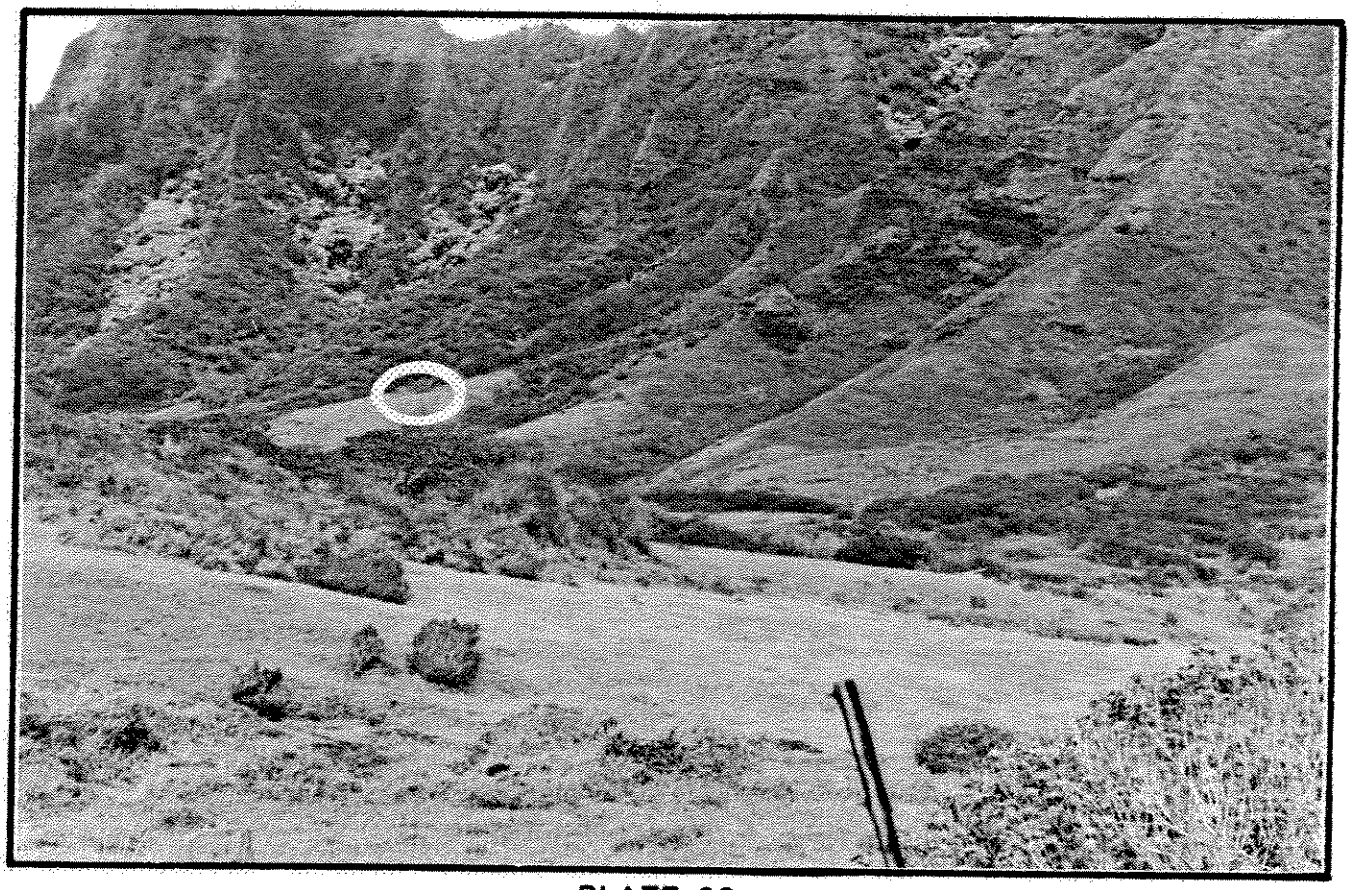


PLATE 28
KAAAWA WELLS I SITE

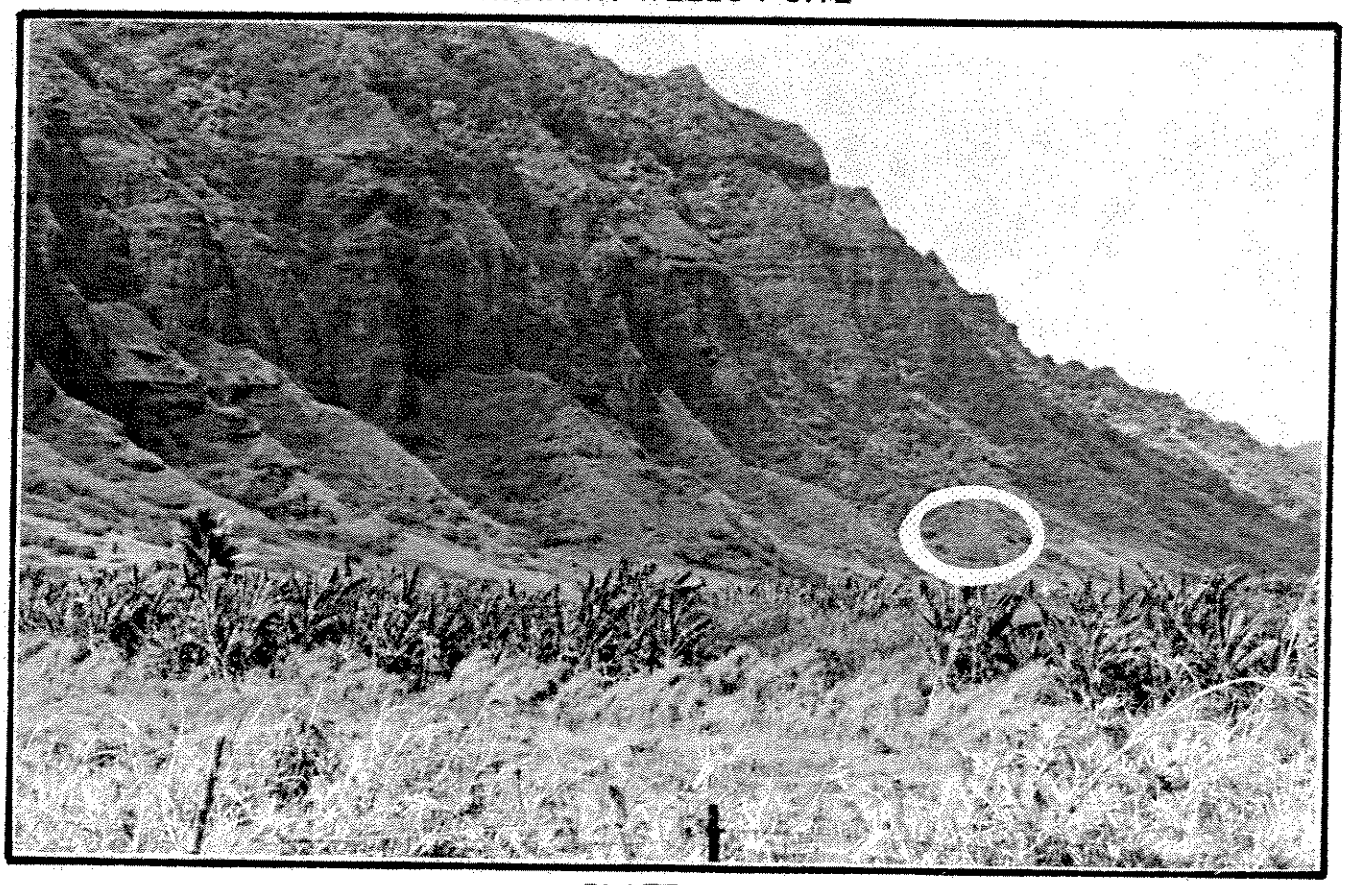


PLATE 29
KAAAWA WELLS II SITE

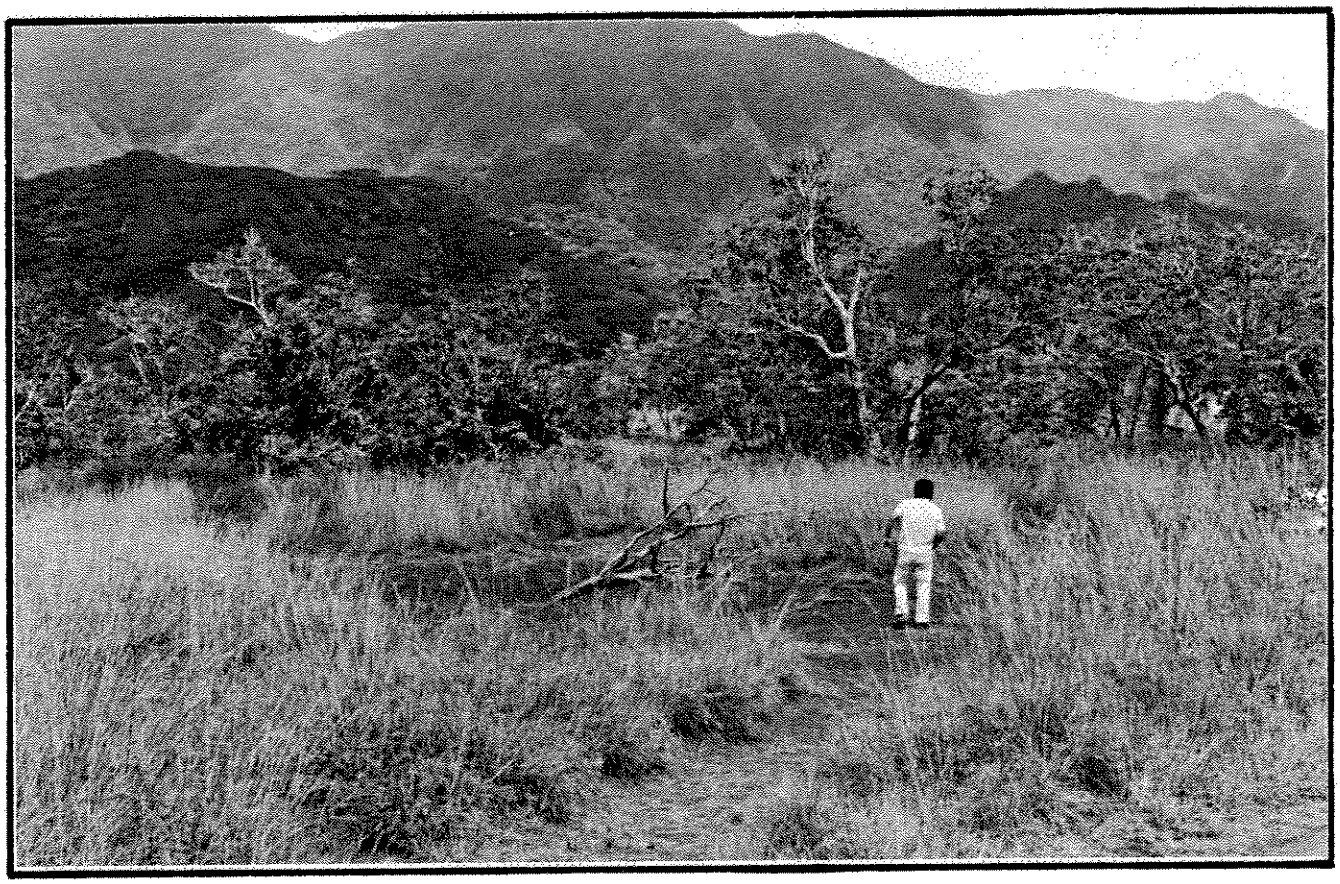


PLATE 30
WAIKANE WELLS SITE

PLATE 31
WAIKANE WELLS (ALTERNATE SITE)

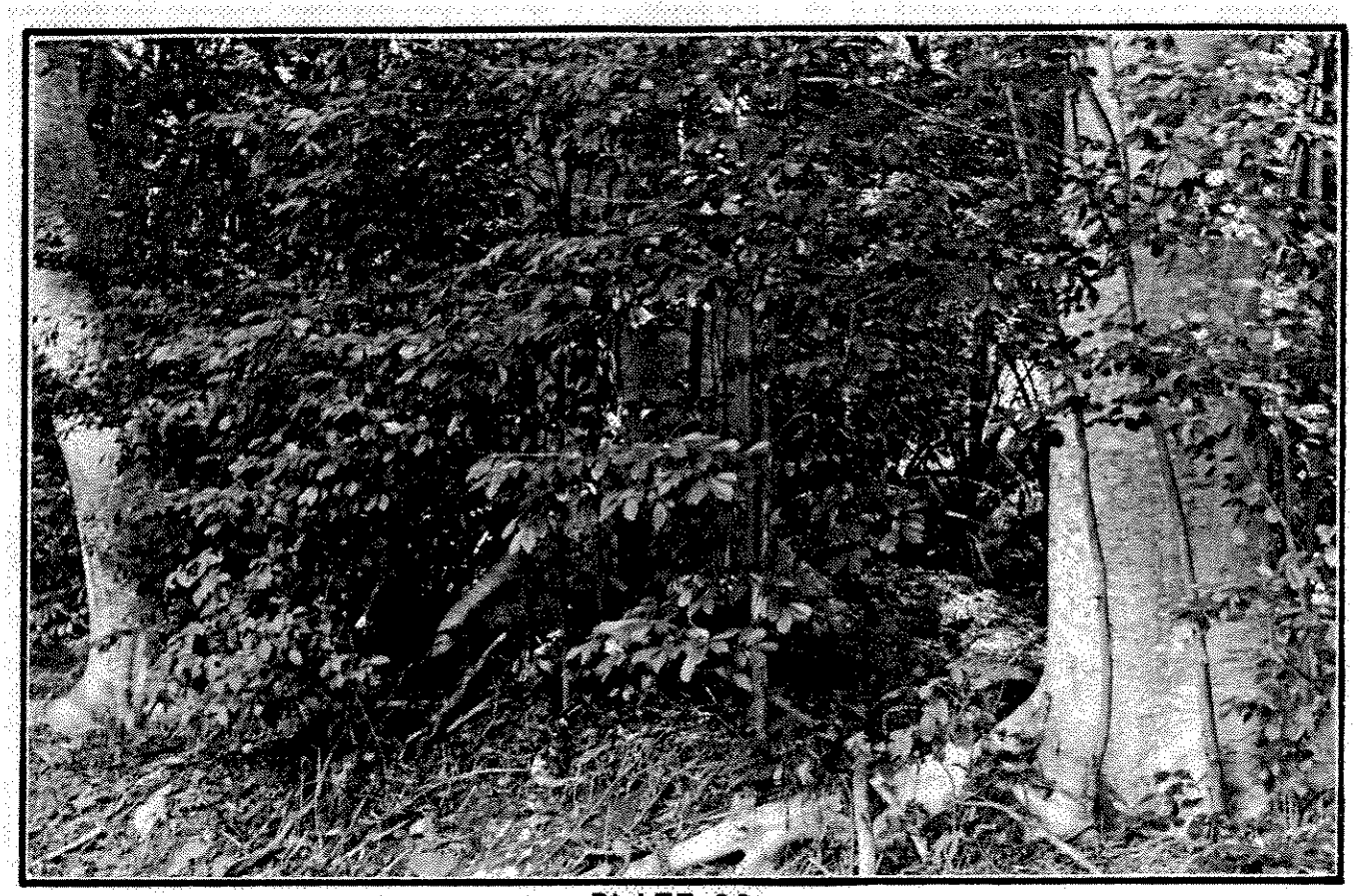


PLATE 32
UWAU WELLS SITE

PLATE 33
WAIANU WELLS SITE

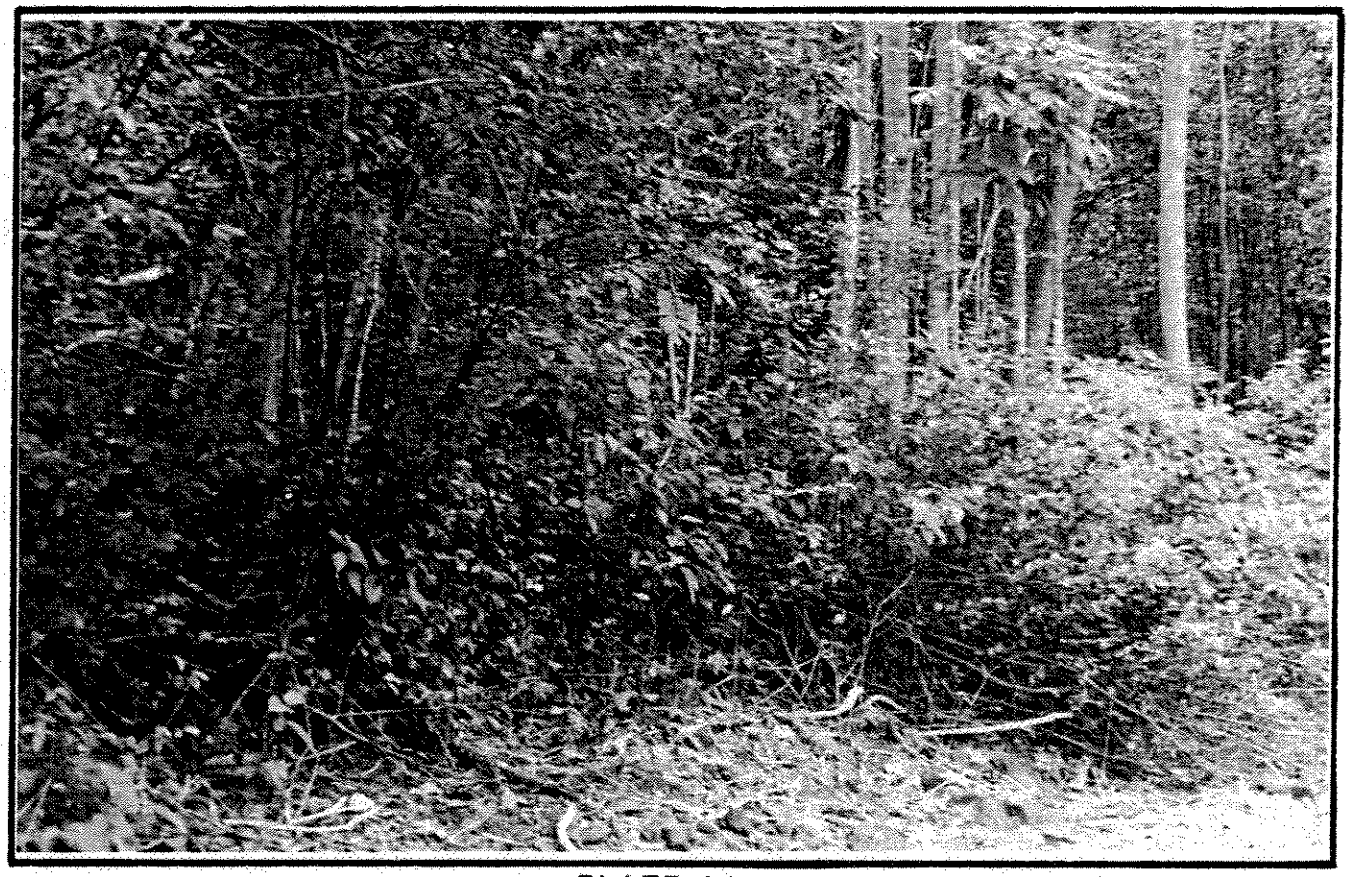


PLATE 34
WAIAHOLE WELLS SITE

PLATE 35
WAIAHOLE WELLS (ALTERNATE SITE)

PLATE 36
KAALAEA WELLS SITE

PLATE 37
KAALAEA INCLINED WELLS OR TUNNEL SITE

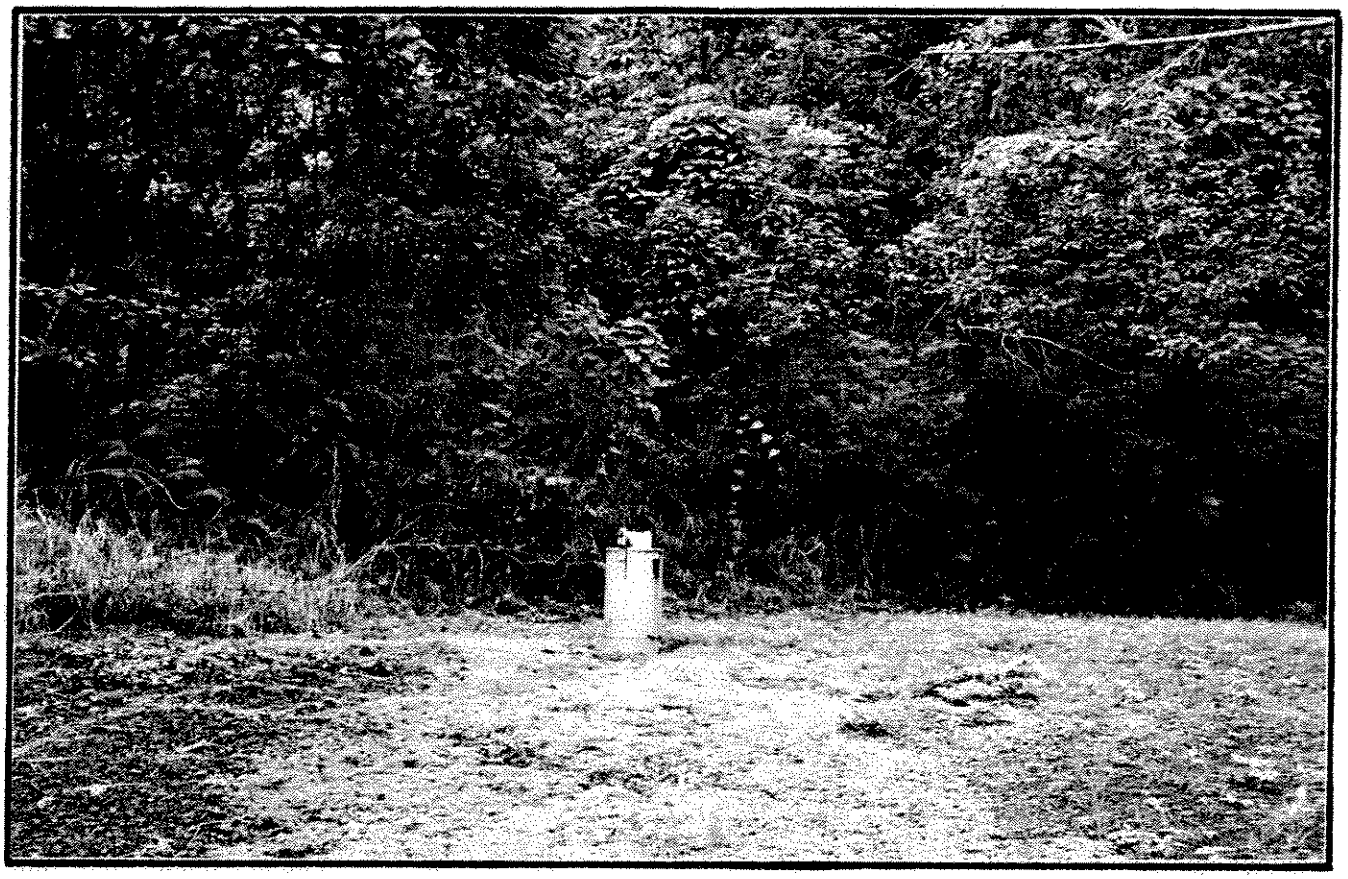


PLATE 38
KAHALUU WELLS I SITE

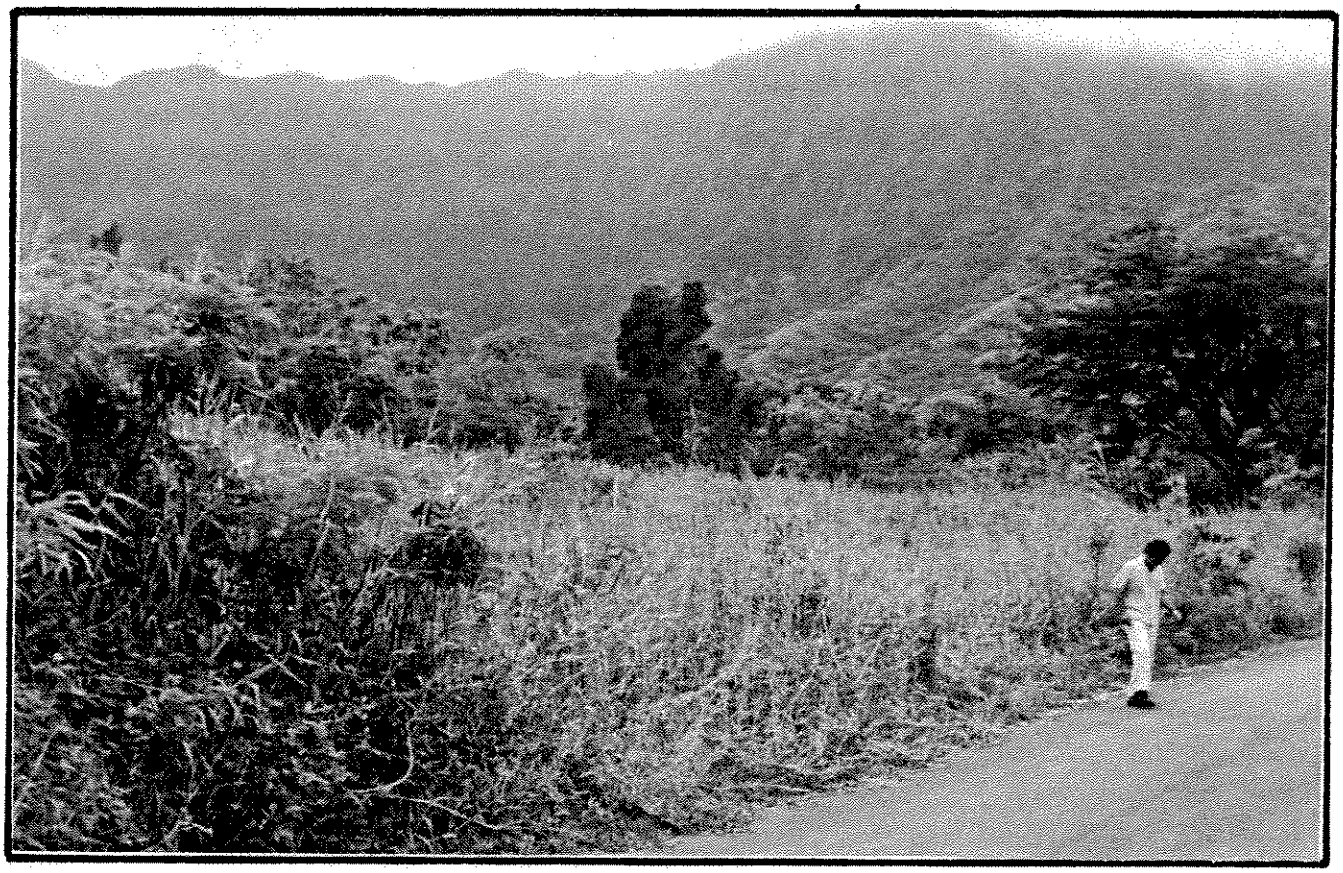


PLATE 39
KAHALUU WELLS II-A, II-B, II-C (ALTERNATE SITE)

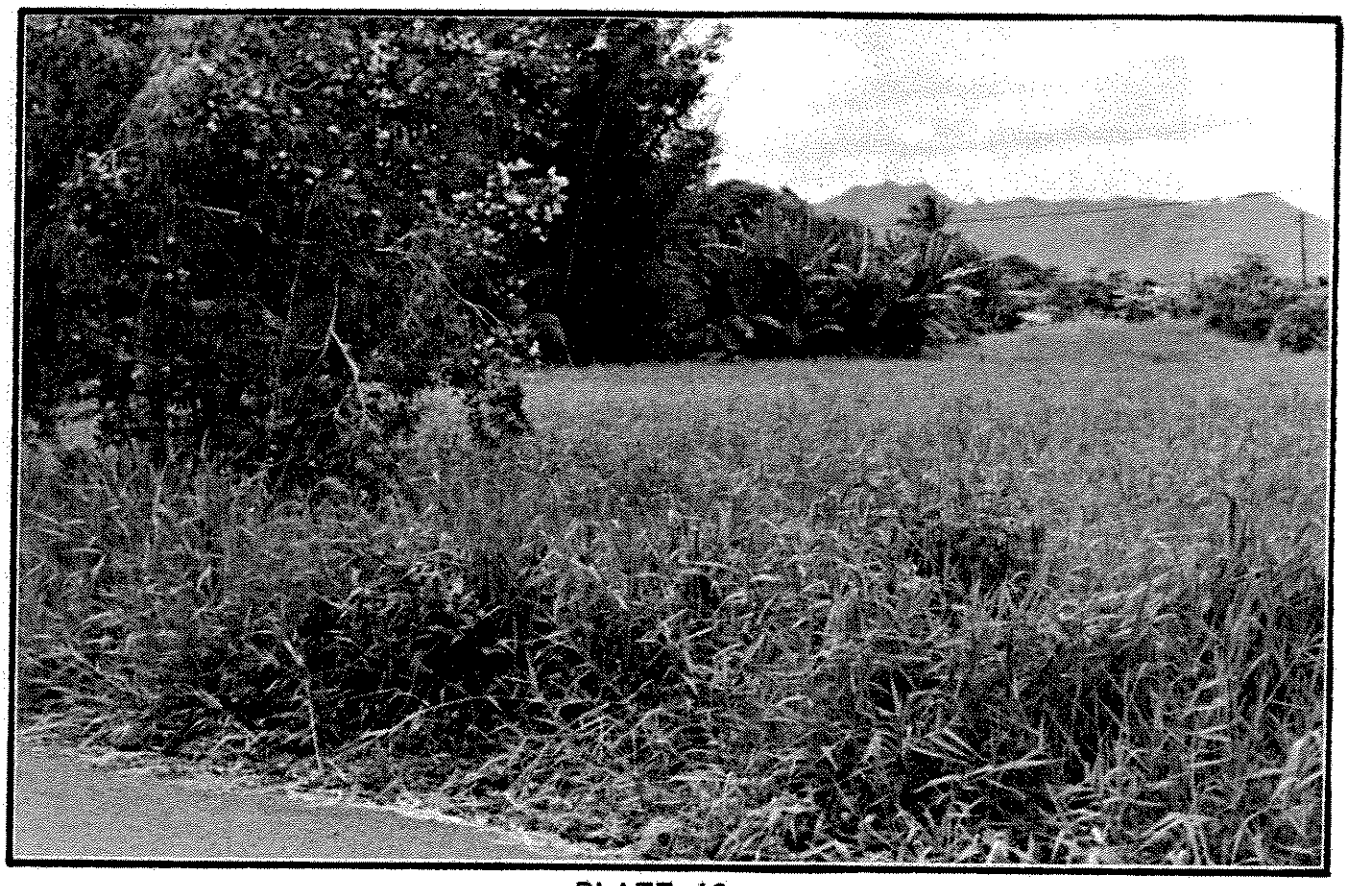


PLATE 40
KAHALUU WELLS II-A, II-B, II-C (ALTERNATE SITE)

PLATE 41
AHUIMANU INCLINED WELLS OR TUNNEL SITE

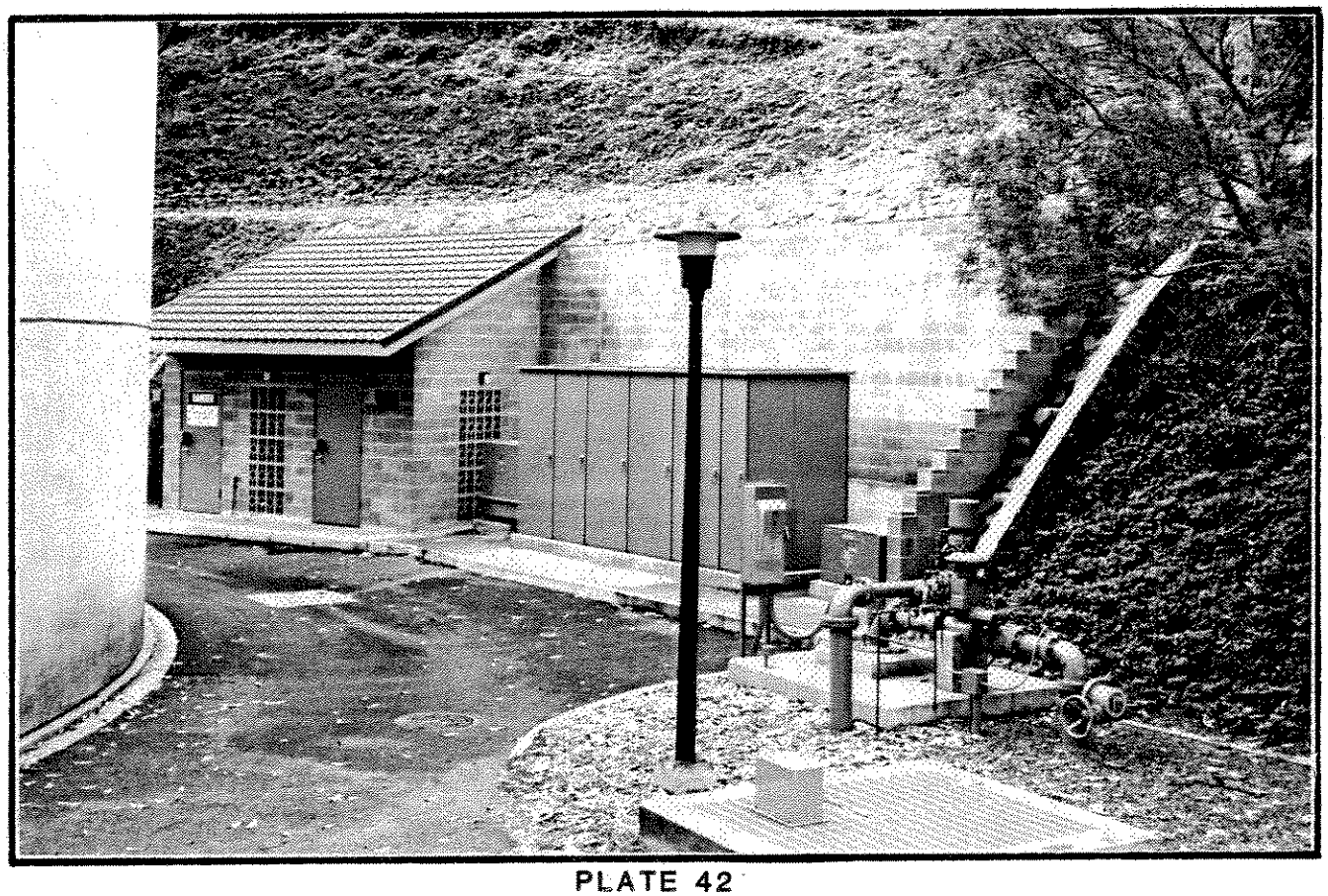


PLATE 42
IOLEKAA WELL SITE

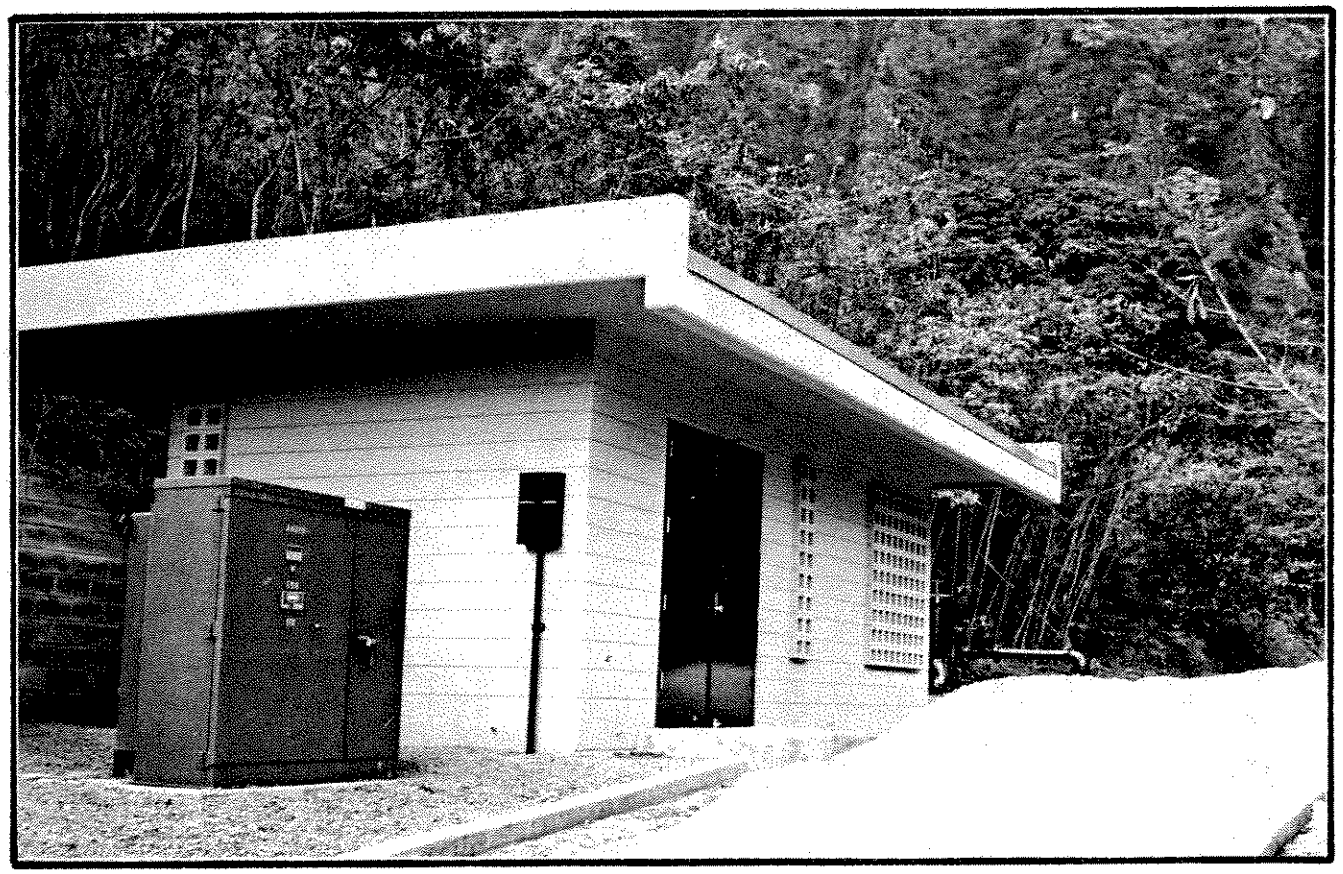


PLATE 43
HAIKU WELL SITE

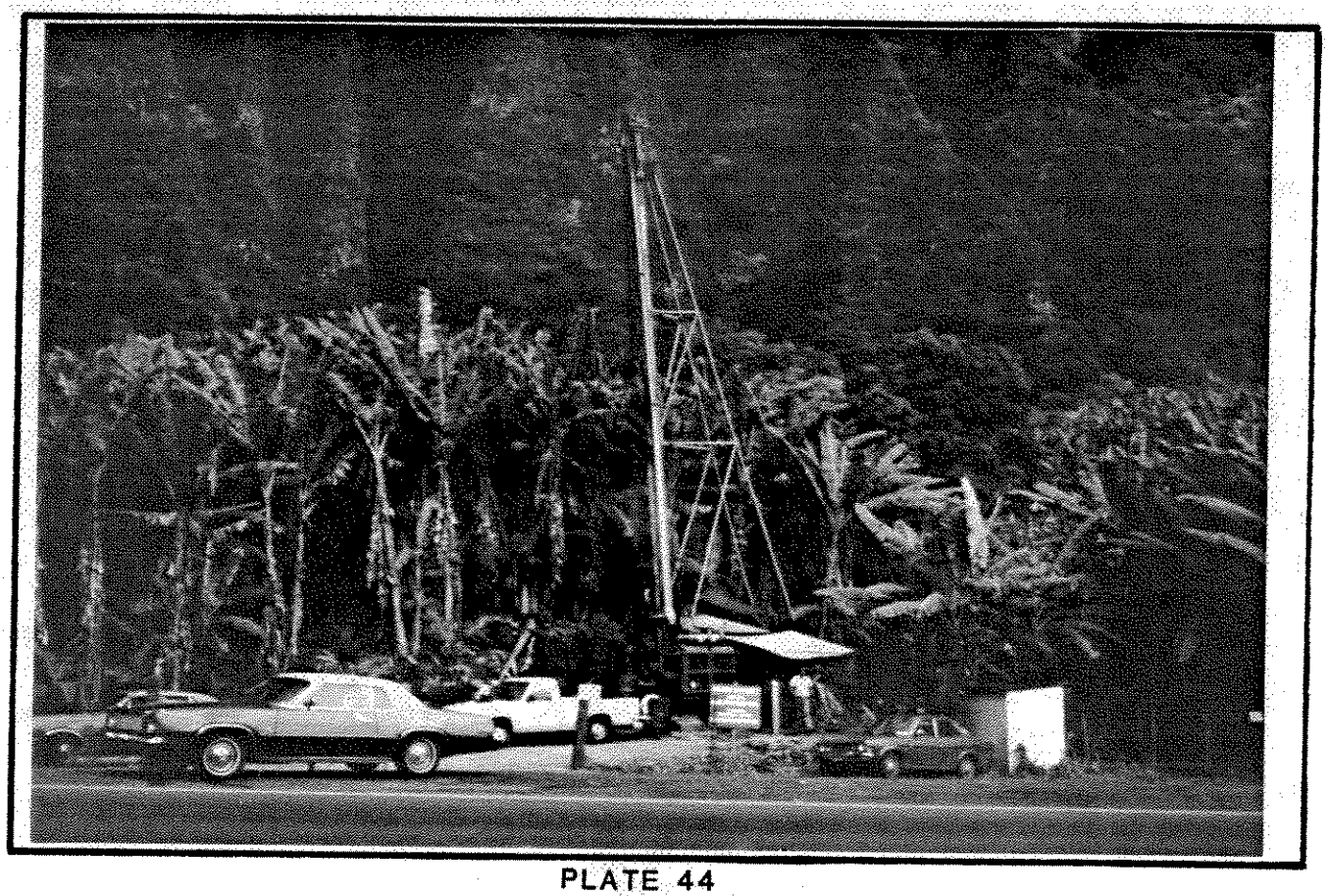


PLATE 44
LULUKU WELLS SITE

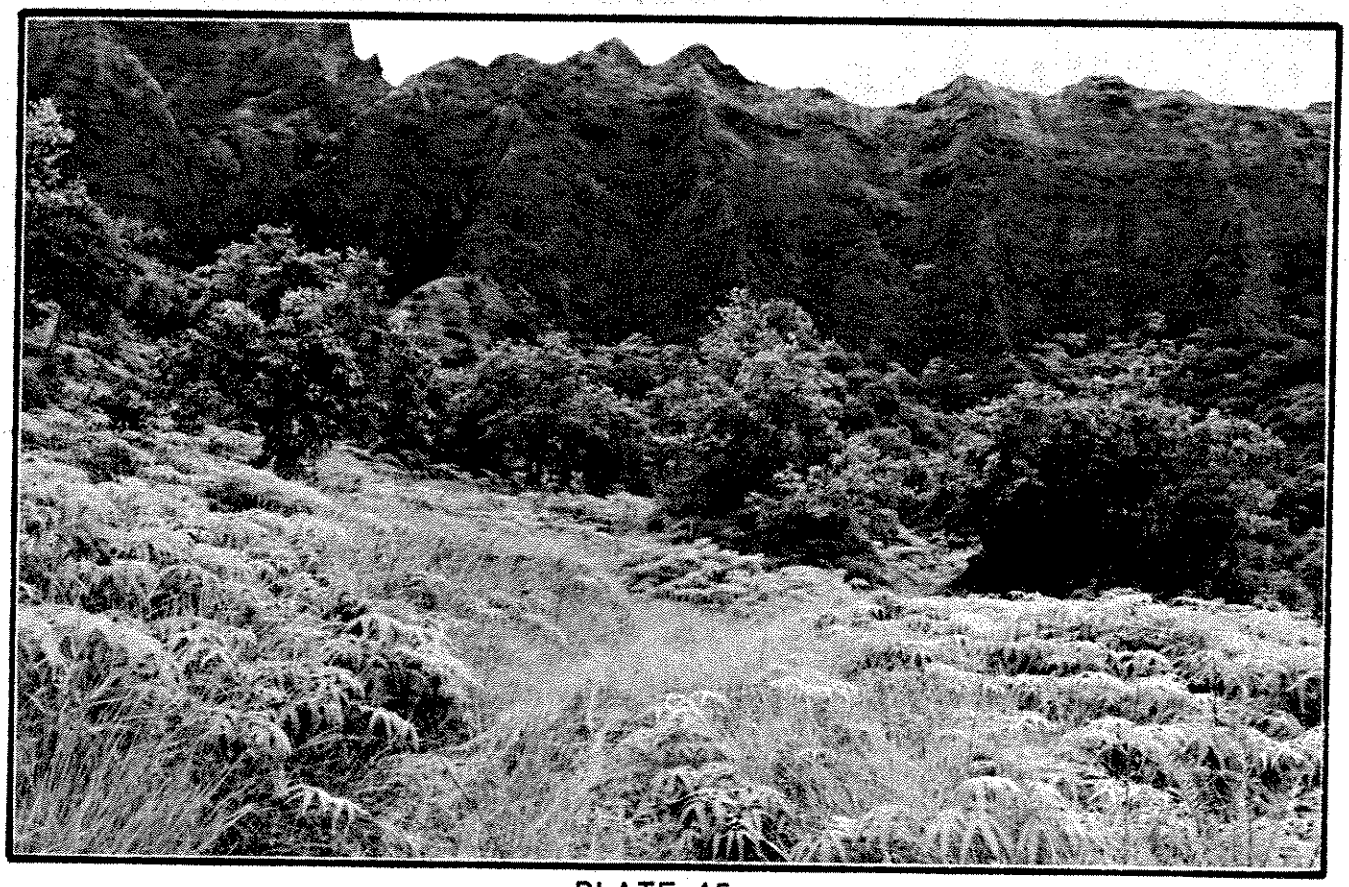


PLATE 45
KUOU WELLS II SITE

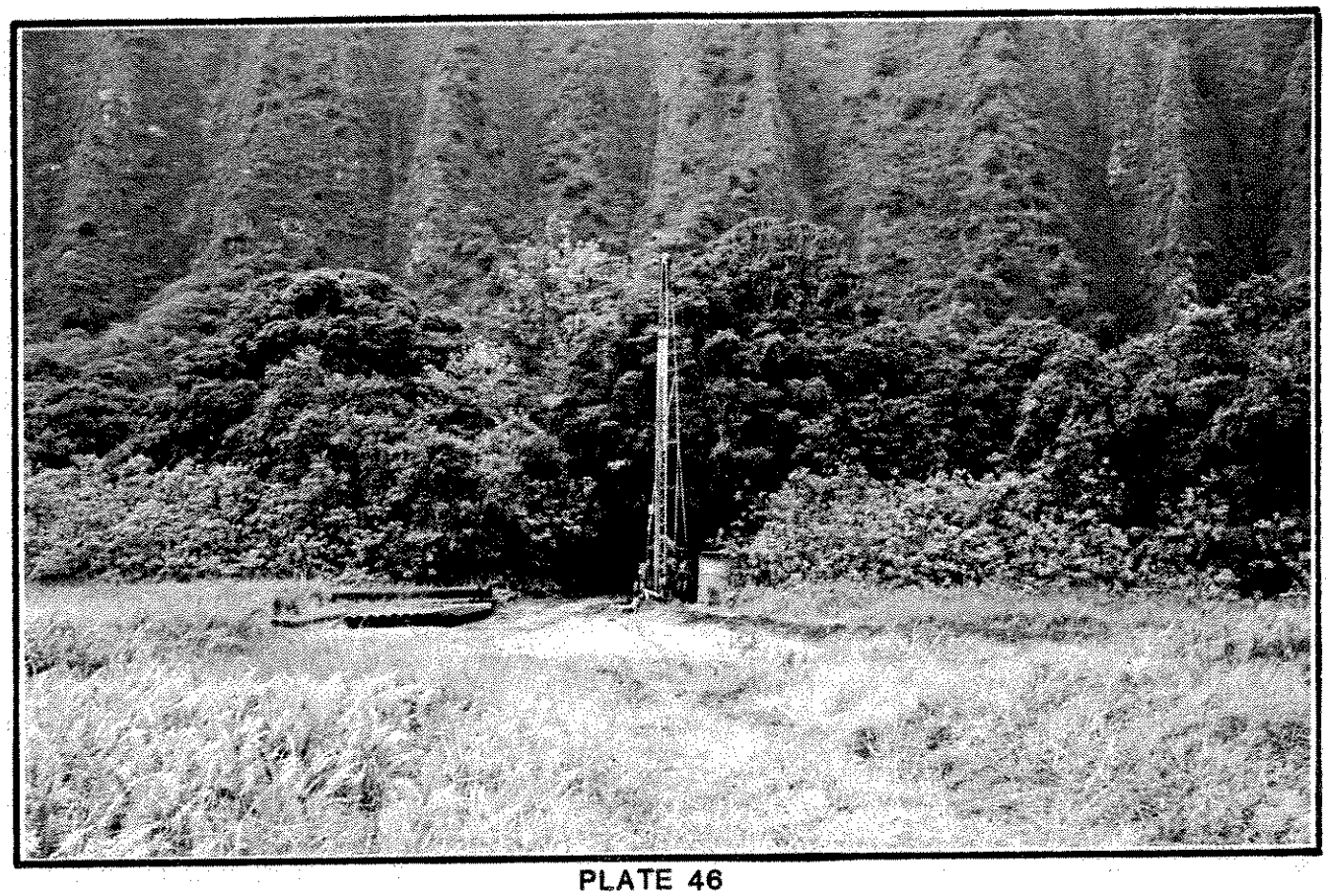


PLATE 46
KAMOOALII WELLS I SITE

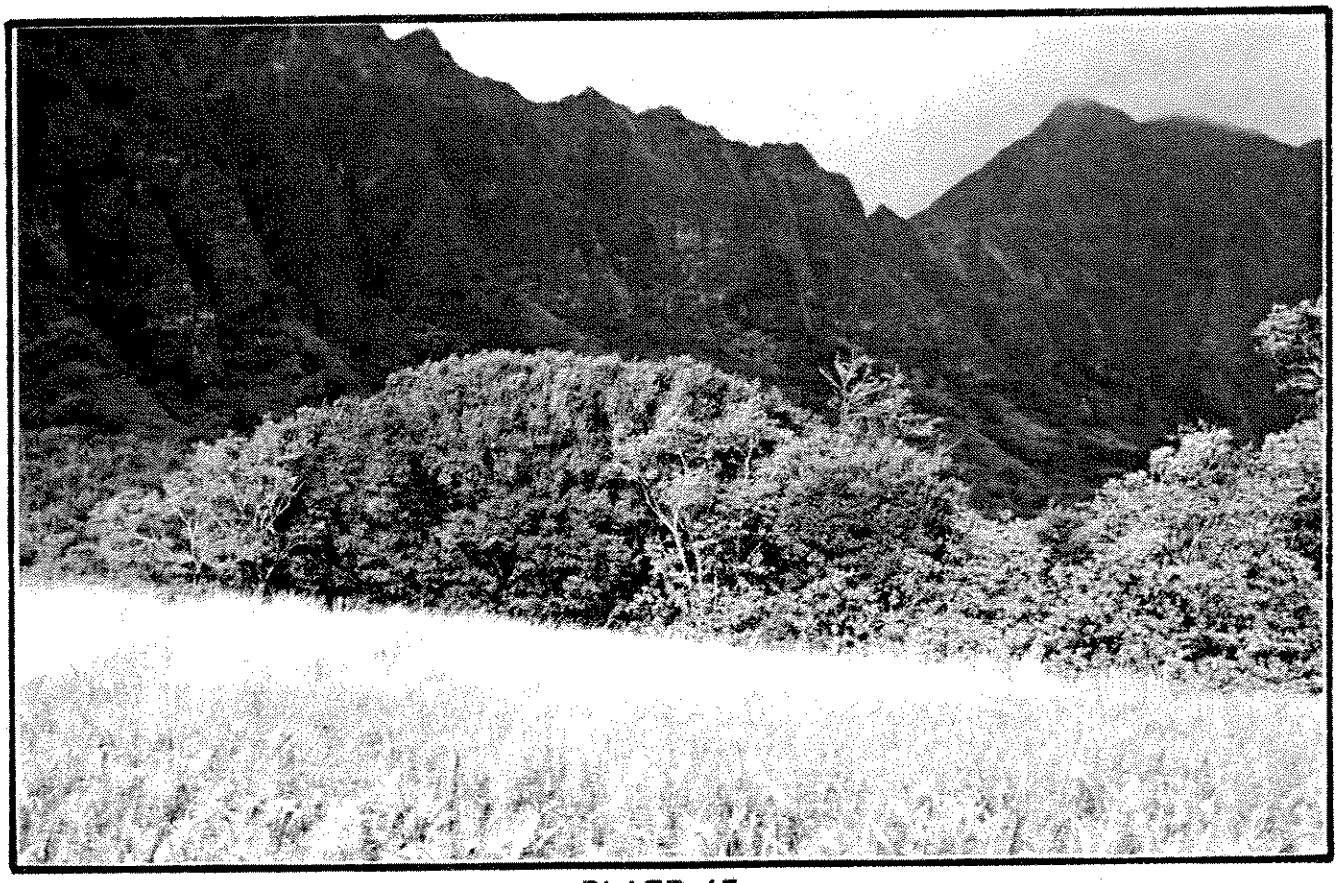


PLATE 47
KAMOOALII WELLS I (ALTERNATE SITE)

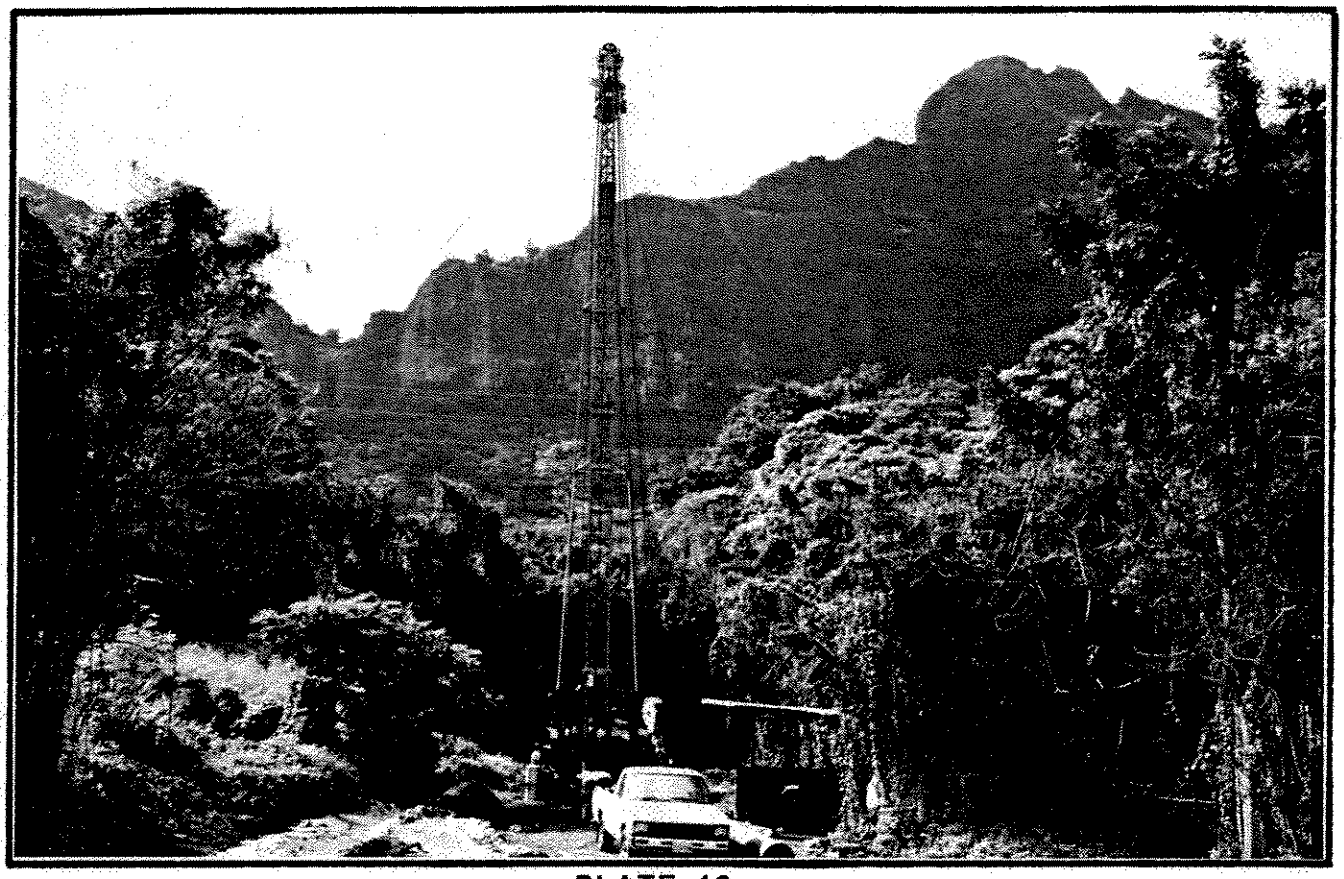


PLATE 48
KAMOOALII WELLS II SITE

PLATE 49
KAMOOALII WELLS II (ALTERNATE SITE)

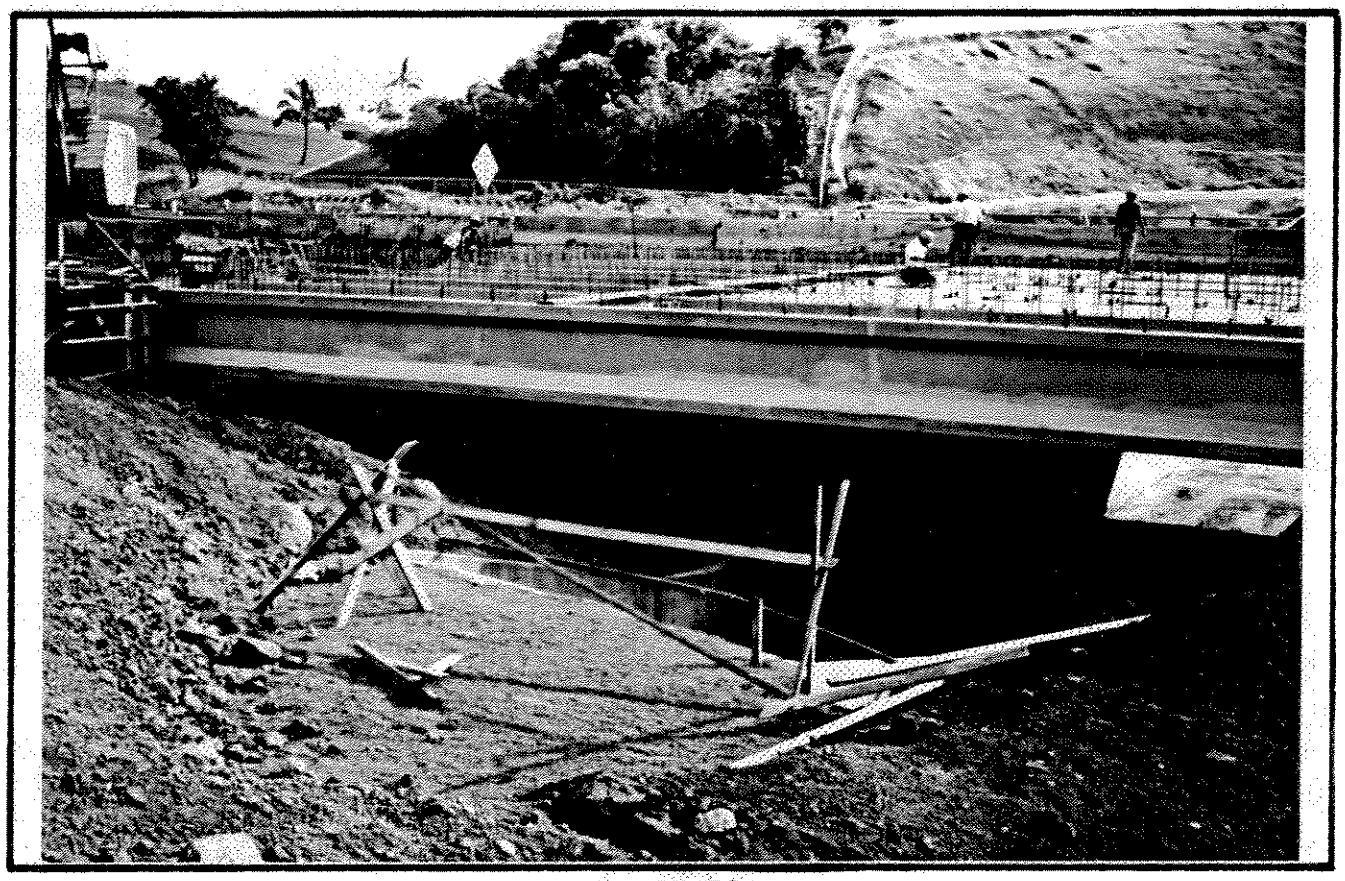


PLATE 50
HALEKOU WELLS SITE

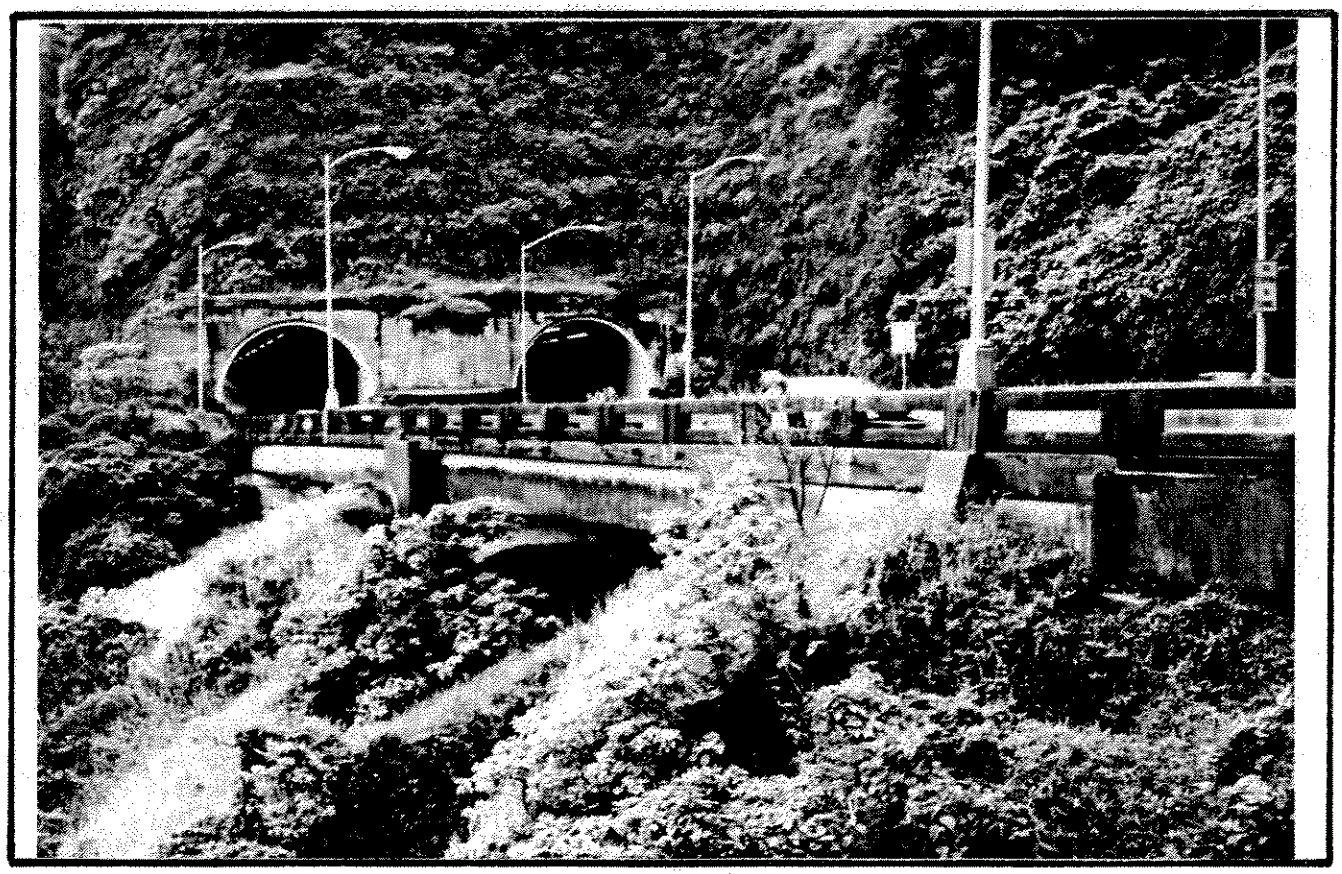


PLATE 51
PALI HIGHWAY TUNNEL DRAINS SITE

PLATE 52
MAUNAWILI WELLS I SITE

PLATE 53
MAUNAWILI WELLS II SITE

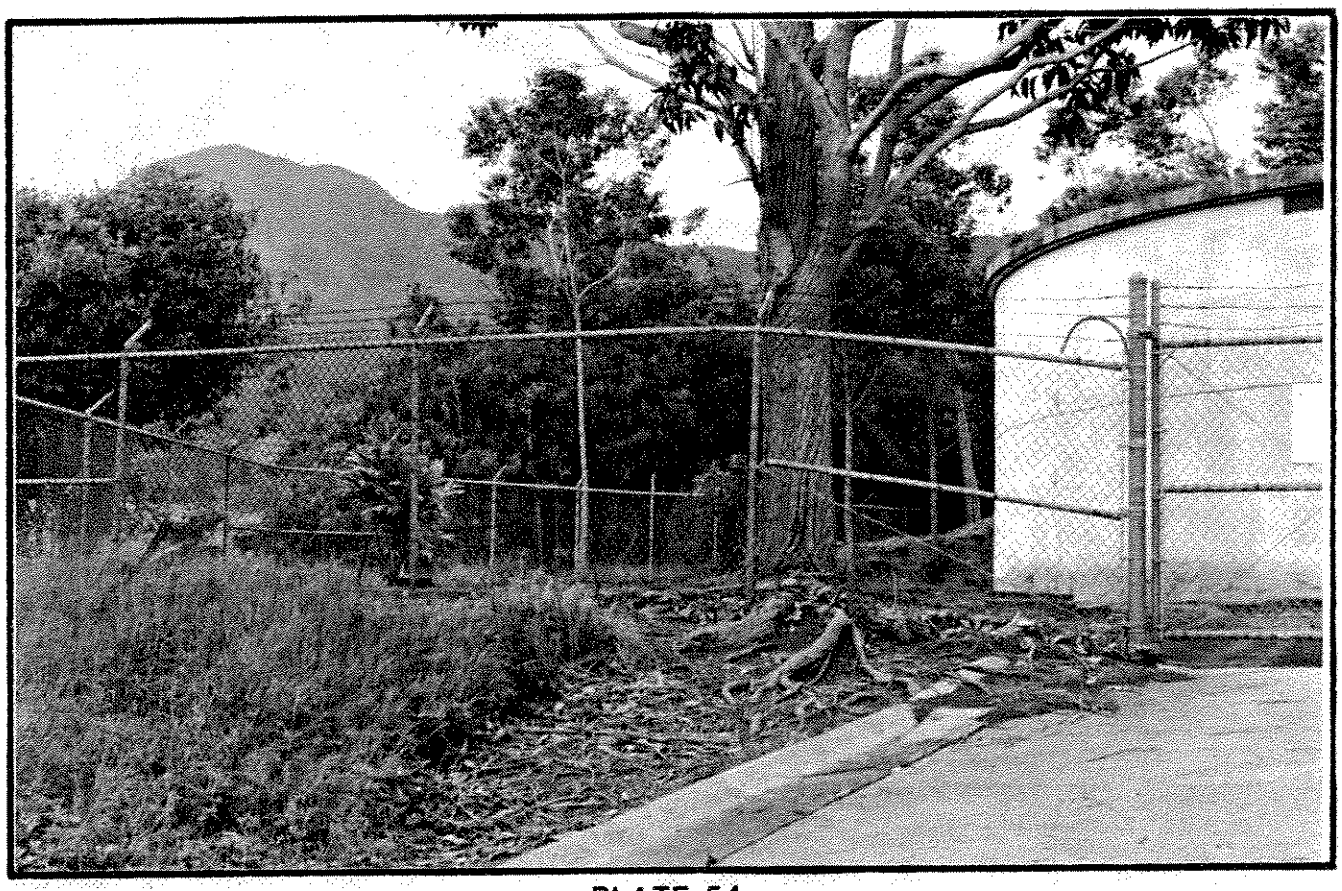


PLATE 54
MAUNAWILI WELLS III (ALTERNATE A SITE)

PLATE 55
MAUNAWILI WELLS III (ALTERNATE B SITE)

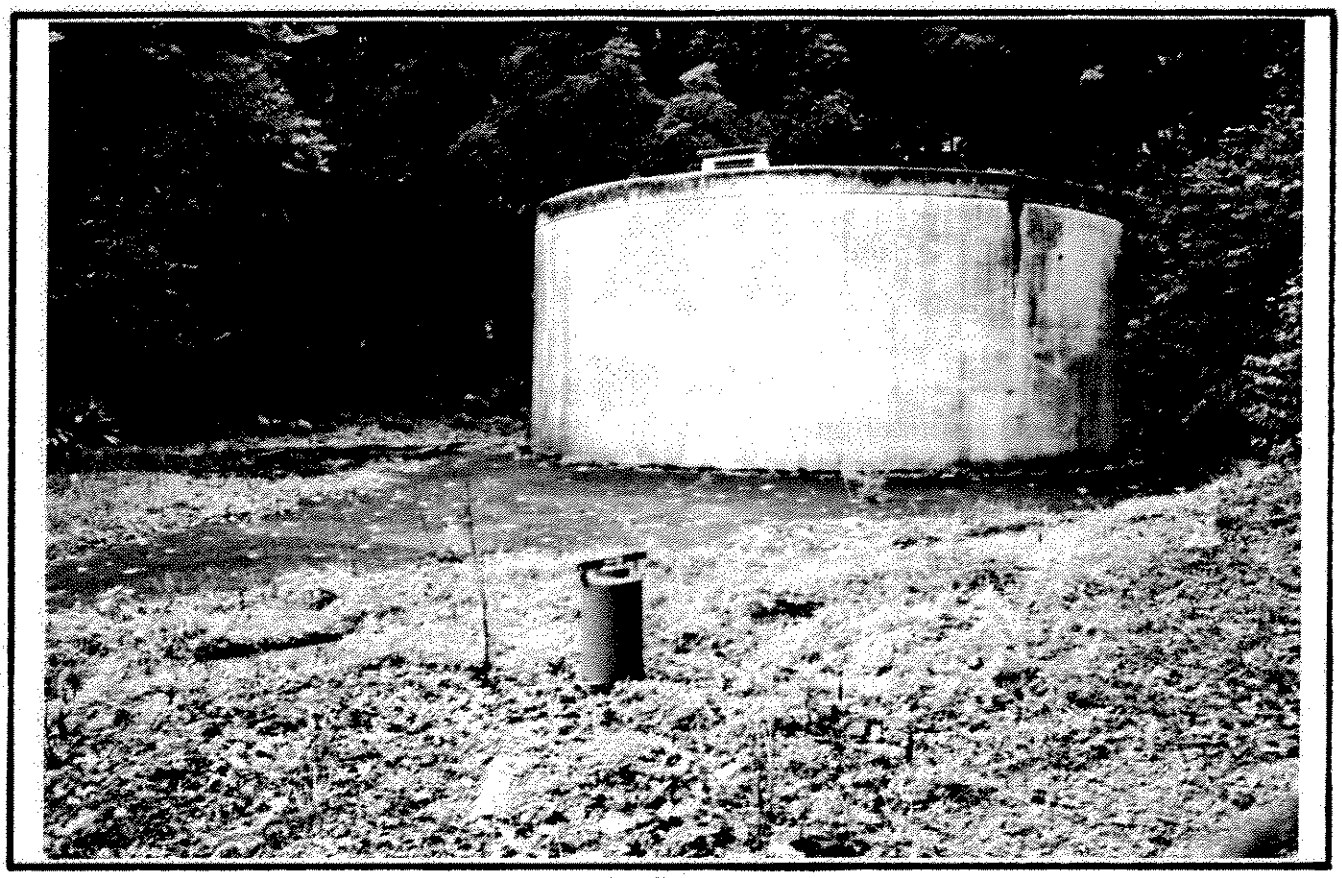


PLATE 56
WAIMANALO WELL II SITE

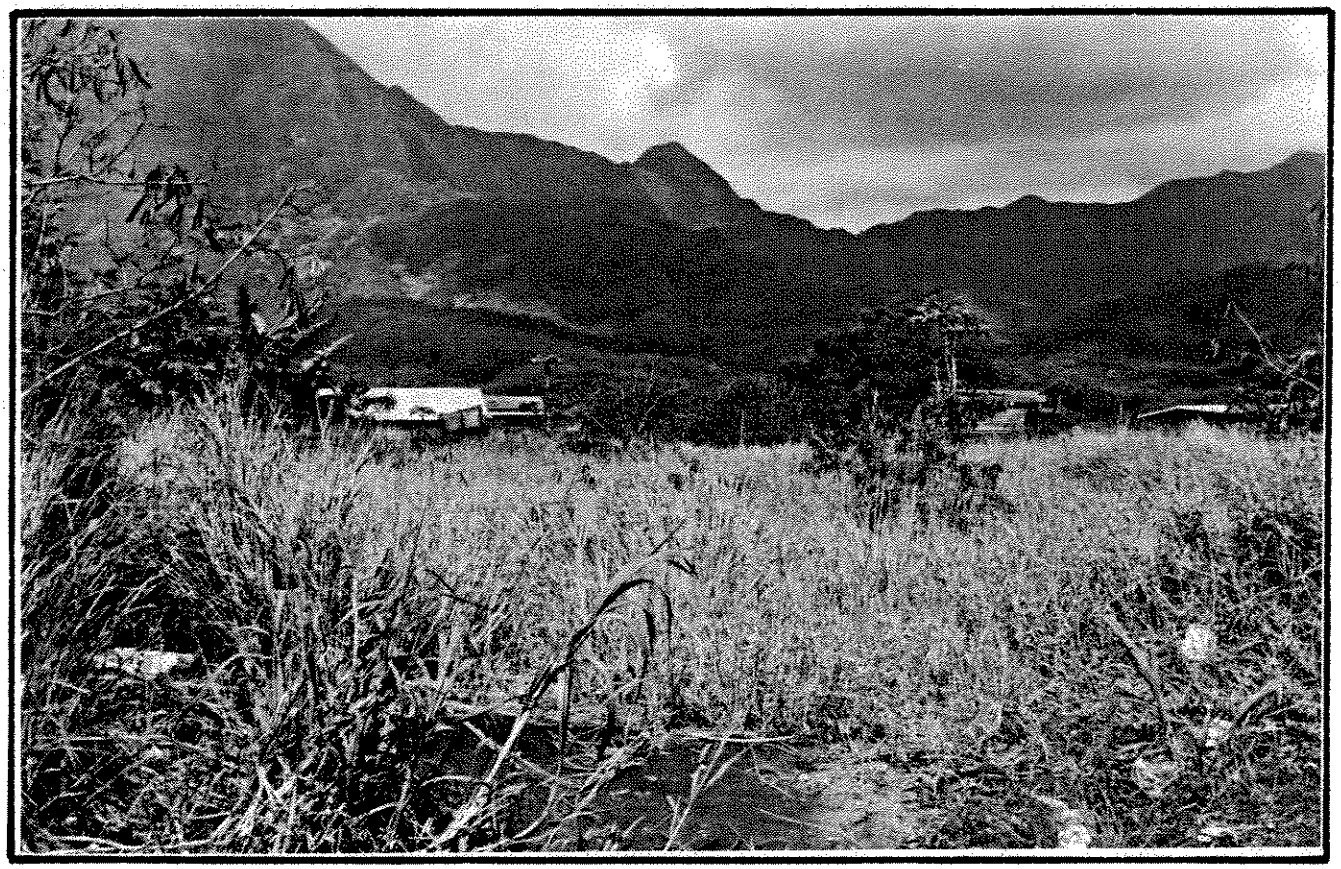


PLATE 57
WAIMANALO WELL III (ALTERNATE SITE)

PLATE 58
WAIMANALO WELL III (ALTERNATE SITE)

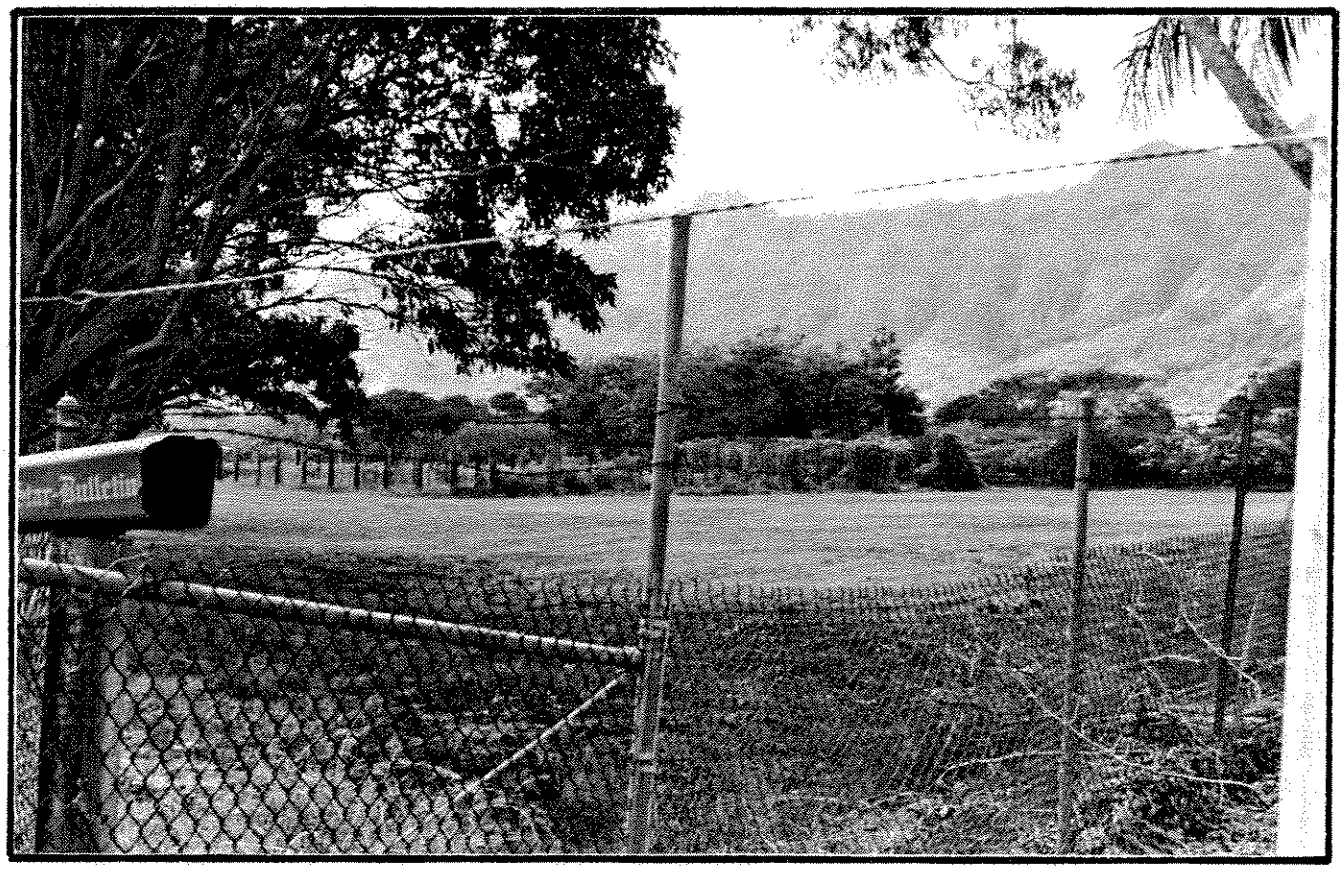


PLATE 59
WAIMANALO WELL IV SITE

II. DESCRIPTION OF THE ENVIRONMENTAL SETTING

This chapter provides an overview of the physical, biological, and human setting of proposed BWS facilities. Emphasis is placed on natural resources and human uses which consulted parties were concerned might be affected by either project construction or water development.

A. TOPOGRAPHY

Oahu is made up of two volcanic mountain ranges, the Waianae and Koolau Ranges, connected by a central plateau. The Koolaus, which are the larger range, are about 37 miles long and reach a maximum height of 3,105 feet. Areas of Oahu northeast of the Koolau ridgeline are usually referred to as windward Oahu because local trade winds are predominantly out of the northeast. Fluvial and marine erosion processes have carved a series of amphitheatre-headed valleys into the windward side of the Koolaus and left a fringing coastal plain. [Ref. 63] Proposed BWS water system improvements will either be located on the windward slopes or valleys of the Koolau Range or on the fringing coastal plain. Sites of proposed new water sources, reservoirs, and transmission mains are shown on topographic maps in Figures 5 through 16, and approximate elevations of proposed water sources and reservoirs are listed in Tables 3 and 6.

B. CLIMATE

Oahu is in the tropics, and the surface temperature of the surrounding ocean ranges from 73° to 80° F. Inland air temperatures are stabilized by wind blowing off the ocean. The warmest months are between May and October, and the coolest months are between about November and April. Near sea level, temperatures in windward Oahu typically range from 60° to 85° F, although temperatures occasionally

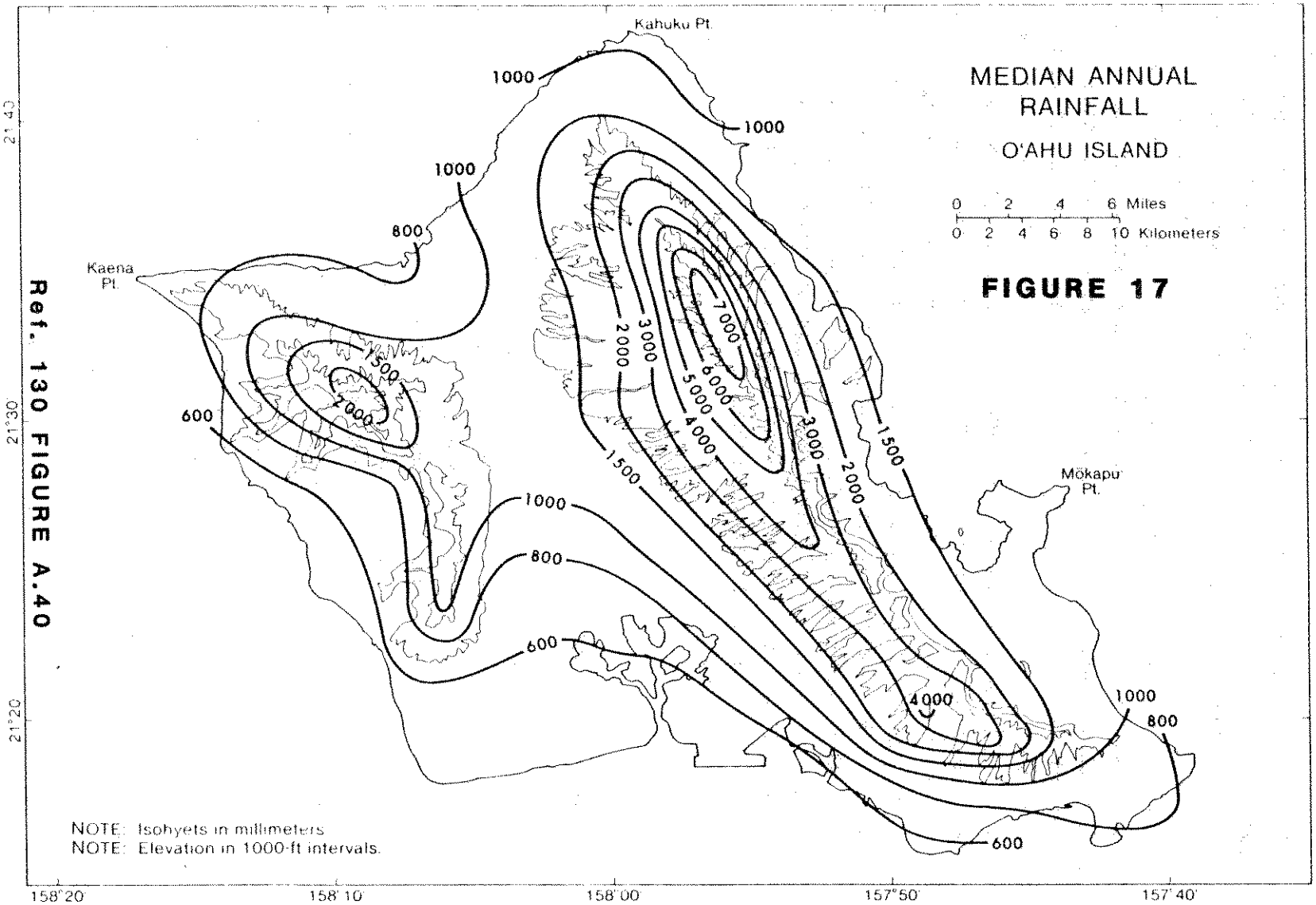
reach the 90°s or drop into the 50°s. Temperatures decrease by about 3° F. per 1,000 feet of elevation. [Ref 28, Ref. 85, Ref. 90]

Between May and October, trade winds predominate with wind mostly from the northeast or east. Wind direction is more variable during the rest of the year. During trade wind conditions, winds blow onshore between Makapu'u and Kahuku. [Ref. 28]

Rainfall over the ocean around Oahu averages between 25 to 30 inches per year and is chiefly from a few intense storms between November and April. In addition to winter storms which bring rain to the entire island, rain in windward Oahu also results from cooling of warm moist air when onshore winds are deflected upward by the Koolau Range. At low elevations in windward Oahu, more than two-thirds of annual rainfall usually occurs between November and April. By comparision, in upper Kahana Valley, as much rain usually falls between November and April as between May and October. Rainfall increases with elevation. Estimated median annual rainfall increases from about 39" near the coast in Malaekahana and Waimanalo to more than 276" near the crest of the Koolau Range inland of Punaluu Valley. [See Figure 17] Rainfall varies greatly from year to year. At high elevations, annual rainfall typically ranges between 2/3 and 4/3 of median annual rainfall. Rainfall at sea level is even more variable. [Ref. 28, Ref. 70, Ref. 85, Ref. 90, Ref. 91] Historically, the first 40 years of this century have been significantly wetter than the following period to date.

At the end of Appendix C, annual rainfall is summarized for two long-term windward Oahu rainfall gages: one in Waiahole Valley at an elevation of 745 feet; and one at the Kaneohe State Hospital at an elevation of 200 feet. [See page C-56] So that it is possible to evaluate which years had more rain than normal, annual rainfall for each of these gages was divided by median rainfall. (Half the years are rainier than the median and half are drier.) Generally, when annual rainfall is higher than the median for Waiahole, the same is usually true for Kaneohe. The converse is usually true for years with low rainfall.

At low elevations in windward Oahu, evaporation from bodies of standing water and transpiration by plants decreases as rainfall



Ref. 130 FIGURE A.40

increases. Evaporation from a pond in windward Oahu is approximately equal to evapotranspiration from a constantly saturated wetland at the same location. When rainfall exceeds evapotranspiration, it is possible for a pond or poorly drained wetland to be full of water much of the year without inflow from surface runoff, streams, or ground water. At Waimanalo and Kahuku, with median annual rainfall of about 39", median annual evapotranspiration from a pond is about 63". At Kawainui Marsh in Kailua, with median annual rainfall of about 49", median annual evapotranspiration is about 59". At the Heeia Meadowlands, with median annual rainfall of about 65", median annual evapotranspiration is about 51". At the Ho'omaluhia Park flood control reservoir and wildlife pond in Kaneohe, with median annual rainfall of about 80", median annual evapotranspiration is about 46". [Ref. 85, Ref. 91] By comparison, over a year's time, 1 mgd of stream flow would amount to 365 million gallons or 13,440 acre-inches of surface water. If impounded, 1 mgd of stream flow would be sufficient to keep over 200 acres permanently flooded during dry weather in any part of windward Oahu.

C. GEOLOGY AND SOILS

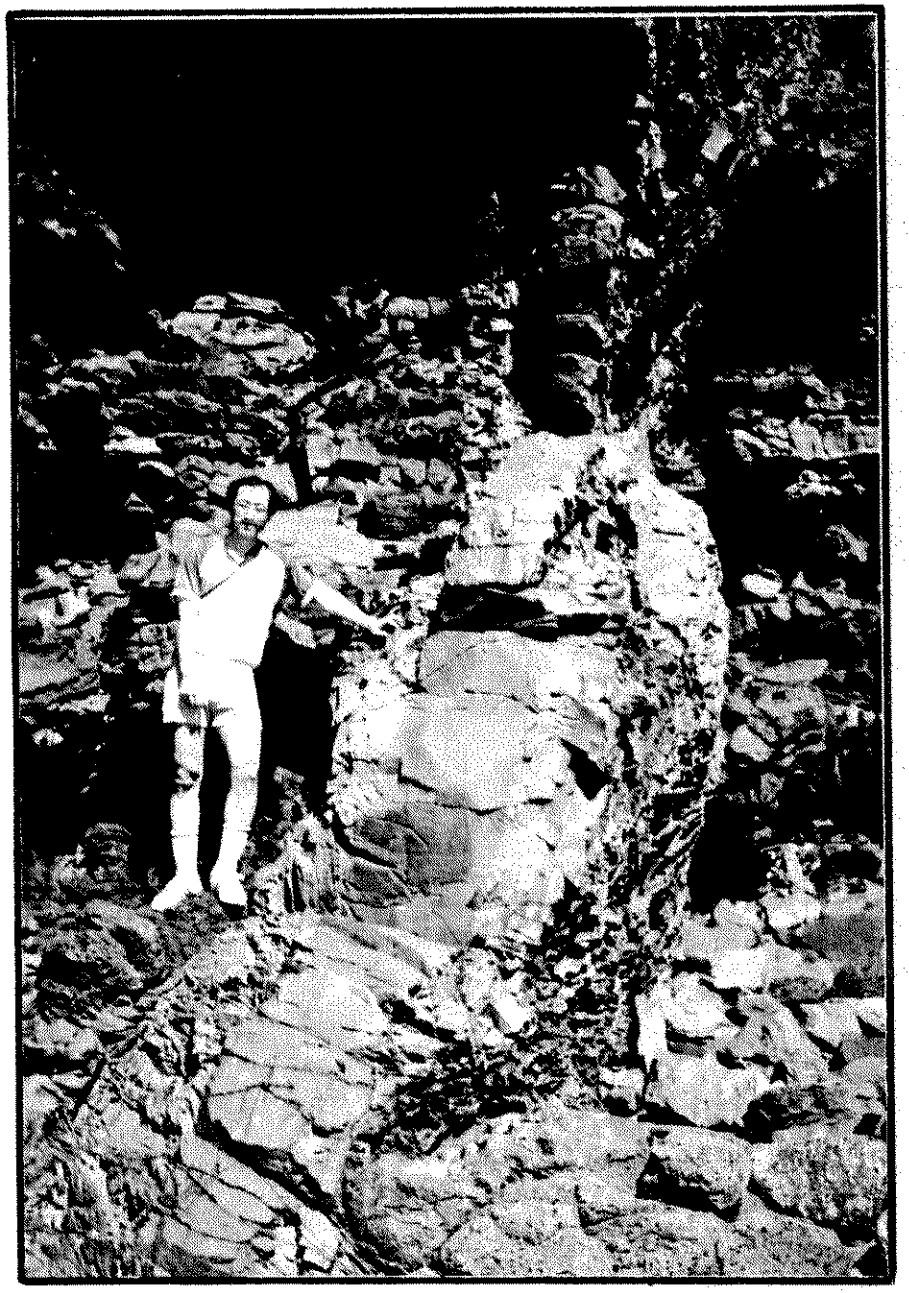
Windward Oahu is the remnant of a deeply eroded basaltic shield volcano. The Koolau volcano was initially broad-shaped, like Mauna Loa on the Island of Hawaii. About 2.5 million years ago, the highest part of the Koolau Range in some places was a few miles east of the existing crest. Subsequently, Oahu underwent a series of submergences and emergences resulting from changes in the ocean level during glacial and interglacial phases. The islandd may have also substantially subsided. Fluvial erosion carved a series of valleys in the Koolau shield and along with wave erosion of cliffs may have reduced its height by as much as 1,000 feet. Alluvium accumulated in valley floors and coral reefs grew over low-lying coastal areas during higher stands of the ocean. Along and makai of parts of the windward Oahu coast, deposits of terrestrial and marine sediments formed a relatively impermeable wedge of sedimentary material known as caprock. The main caldera (collapsed center of eruptions) of the Koolau volcano extended from Waimanalo through Kaneohe. The portion of the Koolau

volcano northeast of this caldera is now completely eroded away. [Ref. 58, Ref. 63]

The Koolau volcano was primarily composed of a series of thin, overlapping, gently-sloping basaltic lava flows. These flows were fed by magma pouring out of fissures in the volcano. When molten rock solidifies in a volcanic fissure under pressure, the structure is rock which is much denser and much less permeable than the confining lava flows. The structure is known as volcanic dike. It is usually nearly vertical, though not always. A dike always cuts across pre-existing lava flows. Dikes are usually less than a yard thick, although they are sometimes as much as 45 feet thick. [See Plate 60] Dikes intrude into the basaltic lava flows underlying most of windward Oahu, except possibly for the coastal plain north of Kaluanui. Numerous dikes are concentrated in dike complexes [Figure 18] which formed in the main rift zone of the Koolau volcano. [Ref. 58, Ref. 82, Ref. 85]

Following a million years of dormancy, the Koolau volcano resumed volcanism on the southeastern end of the Koolau Range. These post-erosion eruptions are collectively known as the Honolulu Volcanic Series because they created such Honolulu landmarks as Diamond Head, Koko Head, Hanauma Bay, Punchbowl, and Salt Lake Crater. The oldest eruptions of the Honolulu Volcanic Series (the Castle flows at the base of the Nuuanu Pali cliffs) occurred about 840,000 to 870,000 years ago while the most recent eruptions (the Kaupo flows beneath Sea Life Park) occurred about 26,000 to 36,000 years ago. [Ref. 8] Because they are relatively recent, Honolulu Series lavas overlie older deeply eroded lava flows and dikes of the Koolau range as well as alluvium, coral reefs, and coral rubble deposited while the Koolau volcano was inactive. In places, erosion and changes in sea level have resulted in interbedding of Honolulu Series lava flows and ash with alluvium and reef deposits. [Ref. 58]

Flows of the Honolulu Volcanic Series only overlie a minor portion of windward Oahu. Patches of Honolulu Series lavas are exposed along Heeia Stream, at Ho'omaluhia Park, makai of the Nuuanu Pali lookout, around the watershed of Kawainui Marsh, at Sea Life Park and other places. The BWS Haiku Well is drilled through shallow flows of the Honolulu Volcanic Series into the underlying older flows of the Koolau volcano. The Kamooalii Well II site also overlies the Honolulu



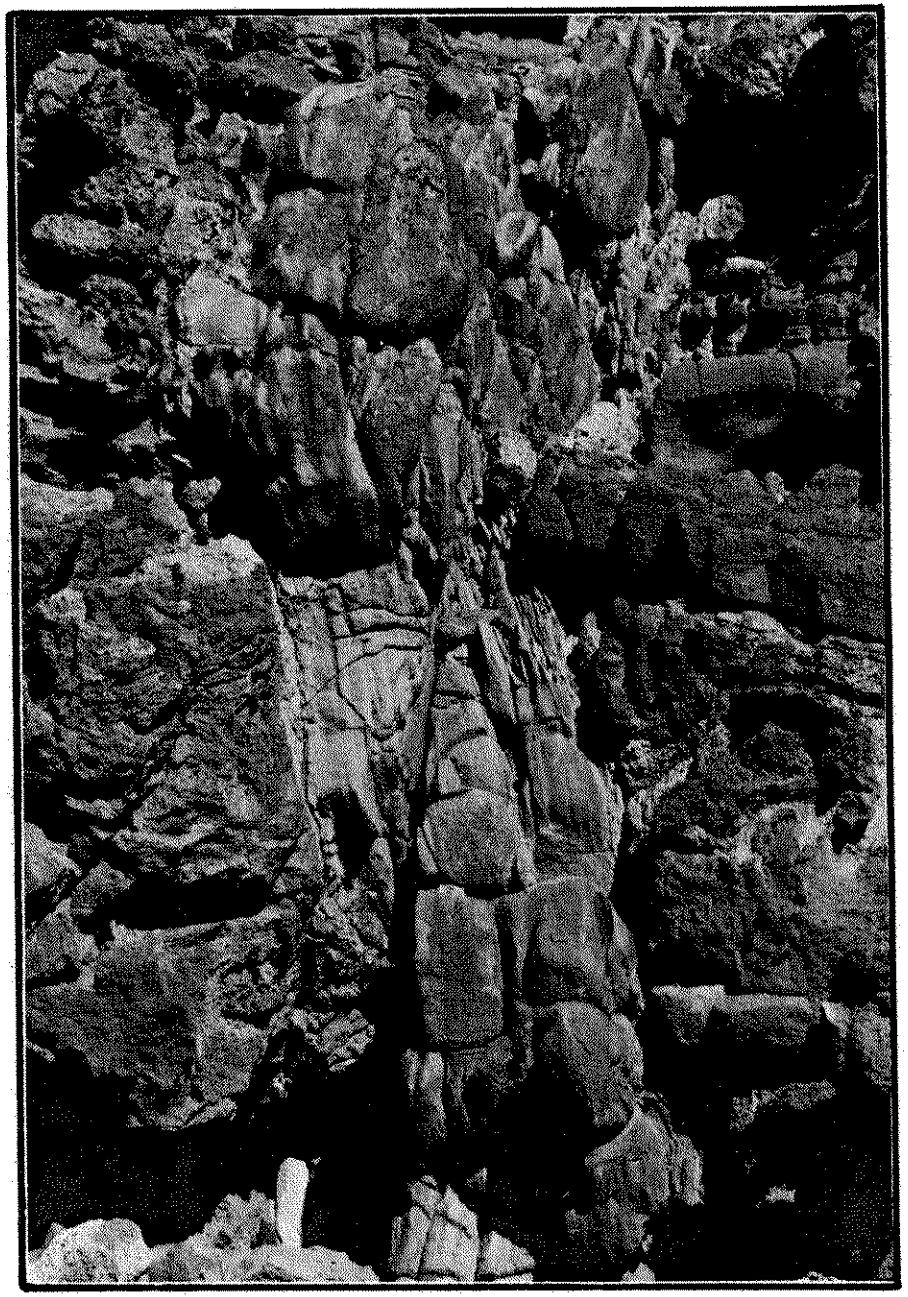
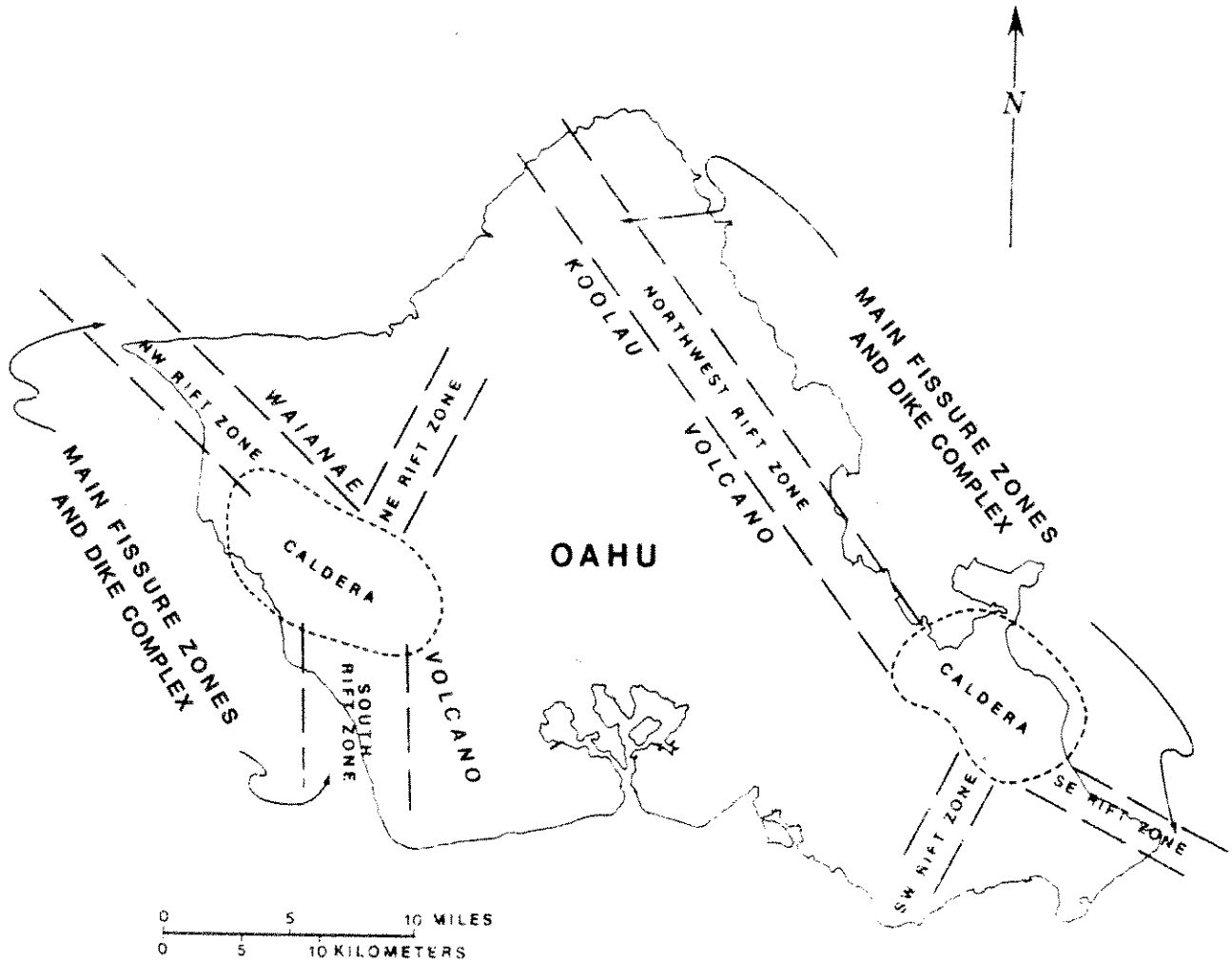


PLATE 60

EXPOSED DIKES ON MAKAPU'U HEAD



RIFT ZONES AND CALDERAS OF KOOLAU AND WAIANAE VOLCANOES

SOURCE: REF. 84

FIGURE 18

RIFT ZONES AND CALDERAS

Volcanic Series. No other proposed windward water source discussed in this EIS will penetrate Honolulu Series lavas. [Ref. 82, Ref. 85]

Most of the project area is covered by clay soils developed from old alluvium and colluvium from the Koolau Range or as residuum on the ridges between streams. [Ref. 63, Ref. 69] Soil stability needs to be thoroughly investigated before proposed reservoirs can be given a firm site. (The site for the Heeia Kai 272 Reservoir shown in this EIS is unsuitable because of unstable soils).

D. HYDROLOGY AND DRAINAGE

Rainfall on windward Oahu which is not lost to evapotranspiration or surface runoff infiltrates into the ground and is stored as ground water. The same is true for water used to irrigate crops in windward Oahu. Ultimately, ground water which is not artificially withdrawn or lost to transpiration by plants discharges into the ocean via streams, coastal springs, or leakage through basaltic rocks and alluvium.

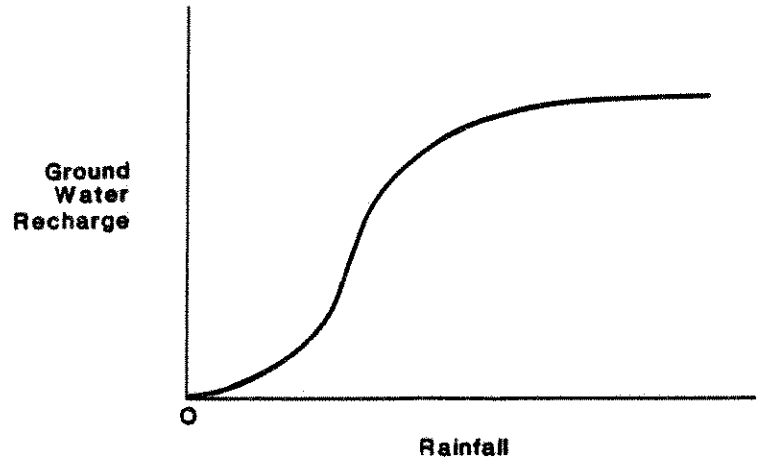
In general, ground water recharge is a function of, but not simply proportional to rainfall. When rainfall is light, most rainfall is lost to evaporation and/or transpiration by plants. As rainfall increases slightly, the additional rainfall mostly infiltrates to become ground water. As rainfall increases further, a greater proportion of rainfall becomes surface runoff. Ultimately, beyond a certain level, increasing amounts of rainfall become surface runoff rather than infiltrating to become ground water. Figure 19 illustrates these concepts.

In parts of windward Oahu, infiltrated rainfall is stored as ground water in the permeable lava flows of the Koolau Range between relatively impermeable dikes. The basaltic Koolau lavas are generally so porous that ground water can saturate between 10 to 30 percent of their volume. Because dikes are frequently oriented at oblique angles to each other, dike compartments are thought to be shaped like irregular prisms. Dike compartments containing the highest ground

FIGURE 19

GROUND WATER RECHARGE VS. RAINFALL

(Not to Scale)



Source: VTN Pacific

water head coincide with the higher rainfall portions of the Koolau crest. Although the general pattern of ground water movement is downhill toward the ocean, local flow directions are complicated by the shape of dike compartments and breaching of compartments by erosion. Although ridges between windward Oahu valleys act as drainage divides for surface runoff, they do not act as hydrologic barriers to movement of high-level dike-impounded ground water. Generally, water moves gradually by leakage and overflow from dike compartments with higher head to compartments with lower head. ("Head" is the elevation to which ground water will rise in a vertical hole relative to mean sea level.) Water from dike reservoirs can also discharge into streams. [Ref. 79]

At low elevations in parts of windward Oahu, within the dike-free porous lava flows of the Koolau Range, basal ground water floats on top of salt water and is confined from moving seaward by either a relatively impermeable wedge of sedimentary caprock or occasional dikes. A substantial body of basal ground water, commonly referred to

as the Koolauloa Basal Aquifer, is present along 11 miles of coast from Punaluu to Kahuku Point. Smaller bodies of basal ground water are present in Kahana and Kaaawa Valleys and Waimanalo. These basal aquifers are primarily recharged by leakage and overflow of high-level dike-impounded ground water and to a lesser extent by infiltration of rainfall and stream flow. [Ref. 82, Ref. 84, Ref. 85]

Ground water is also found perched in alluvium or relatively recent lava flows overlying less permeable sedimentary deposits, volcanic ash, or lava flows. Tuff derived from ash and flows of the Honolulu Volcanic Series is relatively dense and impermeable and can act as a perching member for infiltrated rainfall. [Ref. 85]

Ultimately, all stream flow is a function of rainfall. During wet weather, stream flow is primarily a function of how much rainfall has become surface runoff. During dry weather, stream flow is a function of ground water leakage out of dike compartments. During prolonged dry weather, leakage from dike compartments into windward Oahu streams decreases over time (similar to water draining from a bathtub). After wet weather, some of the dike compartments regain storage from ground water recharge. Because ground water recharge is not simply proportional to rainfall, dry-weather stream flow is not directly proportional to rainfall. Nonetheless, to varying degrees in different parts of windward Oahu, greater rainfall usually shows up later in greater dry-weather stream flow.

The primary source of the dry-weather ("base") flow of perennial windward Oahu streams is leakage and overflow of dike-impounded ground water. Luluku Stream is an exception because most of its base flow now stems from leakage from the BWS Luluku Tunnel (which develops dike-impounded ground water). [See Plate 61] Waimanalo Stream is also an exception because it currently gains most of its flow from perched return irrigation water. During and following wet weather, windward streams also receive surface runoff and gain flow from perched ground water. Between Waimanalo and Punaluu, the discharge of most perennial windward streams increases with decreasing elevation. This reflects the impermeability of the dike complex and increased recharge area. However, north of Punaluu, windward streams are intermittent at low elevations because their dry-weather flow percolates into their bed. [Ref. 79, Ref. 83, Ref. 85]

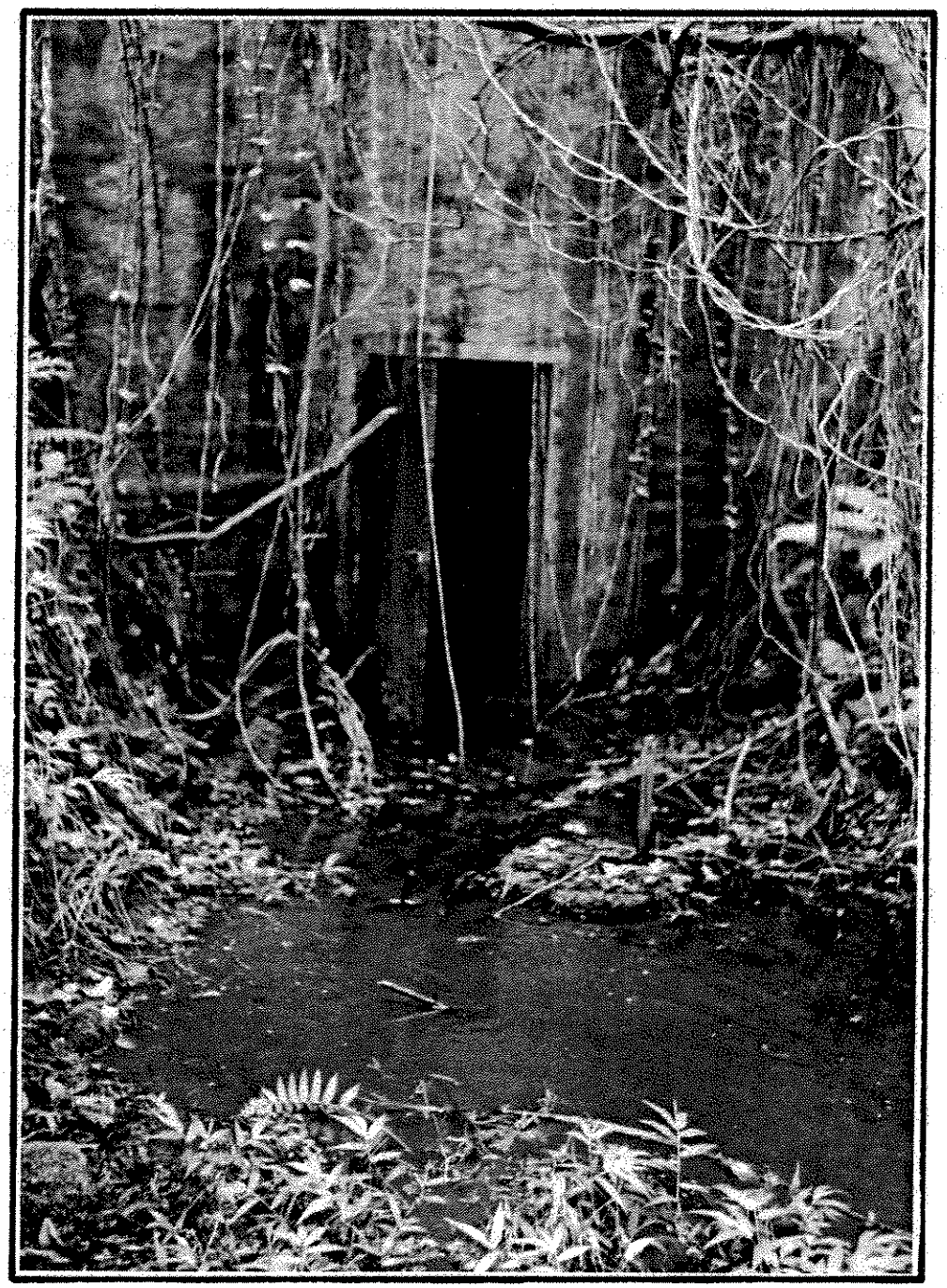


PLATE 61

LEAKAGE FROM LULUKU TUNNEL PORTAL

In general, there are eight ways in which water can reach Oahu streams and wetlands:

1. Rainfall and surface runoff can directly flow into streams and wetlands. [Figure 20] During intense storms, flood flows can be several hundred times greater than dry-weather steam flow.

2. Rainfall (and in a few cases irrigation water) can infiltrate onto a perching member and then leak into a stream or wetland abutting the perching member. [Figure 20] For up to a few weeks after rainfall, perched ground water may be a significant source of stream flow in some windward Oahu streams.

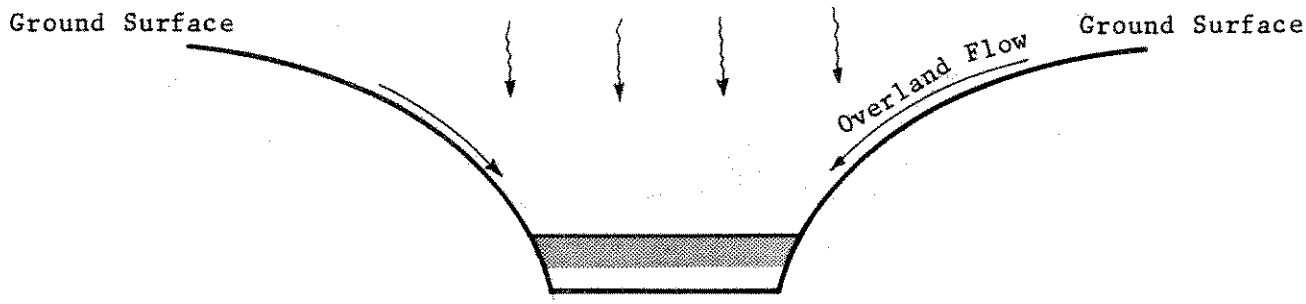
3. High water levels in streams and wetlands can cause bank storage. When water levels fall, bank storage will leak back. [Figures 21 and 22] For up to several days after a period of high water levels, bank storage can be a significant source of stream flow in some windward Oahu streams.

4. At relatively high elevations where Koolau lavas are exposed, dike-impounded ground water can leak into streams which have cut into the permeable water-bearing rock. [Figure 22] Dike-impounded ground water is the primary source of high elevation springs which flow into windward Oahu streams. Because dike reservoirs in adjacent valleys can be hydrologically connected, infiltrated rainfall in one windward Oahu valley can be the source of stream flow in another valley. Erosion of the headwaters of windward streams can increase stream flow in the deeper valleys at the expense of adjacent valleys.

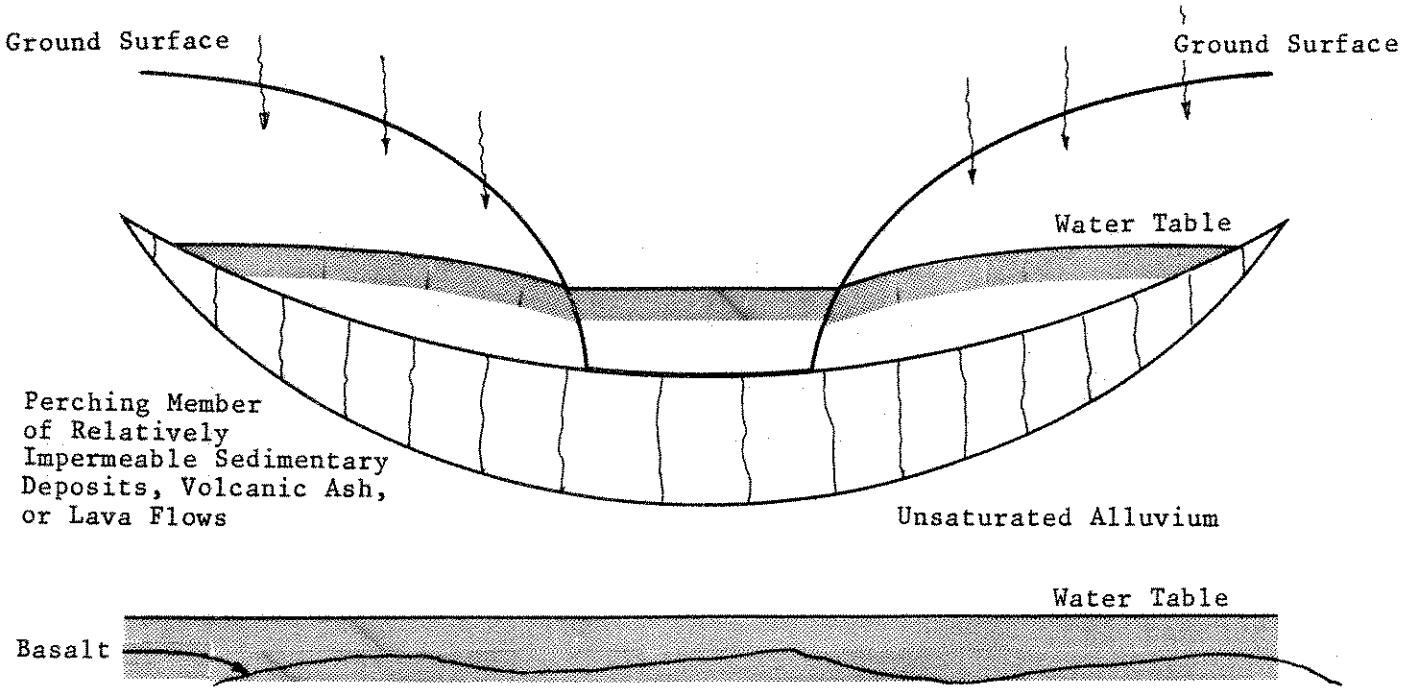
5. At intermediate and low elevations where Koolau lavas are covered with alluvium, dike-impounded ground water can overflow through the overlying alluvium into a stream or wetland. [Figure 23] This is the primary process by which the dry-weather flow of many windward Oahu streams increases with decreasing elevation. This process also contributes water to most fresh water wetlands between Hakipuu and Kailua.

6. In parts of Oahu, ash and lava flows of the Honolulu Volcanic Series overlie more permeable Koolau lavas and alluvium and

WAYS IN WHICH WATER CAN REACH WINDWARD OAHU STREAMS AND WETLANDS



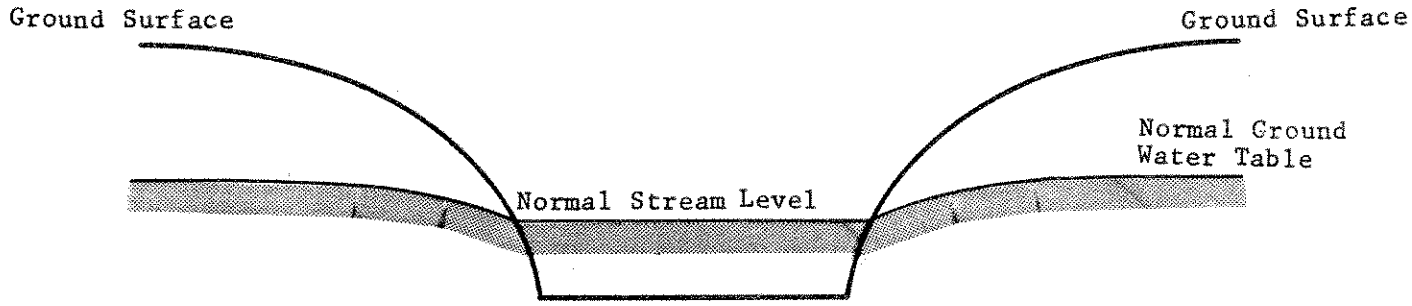
1. Rainfall and Surface Runoff



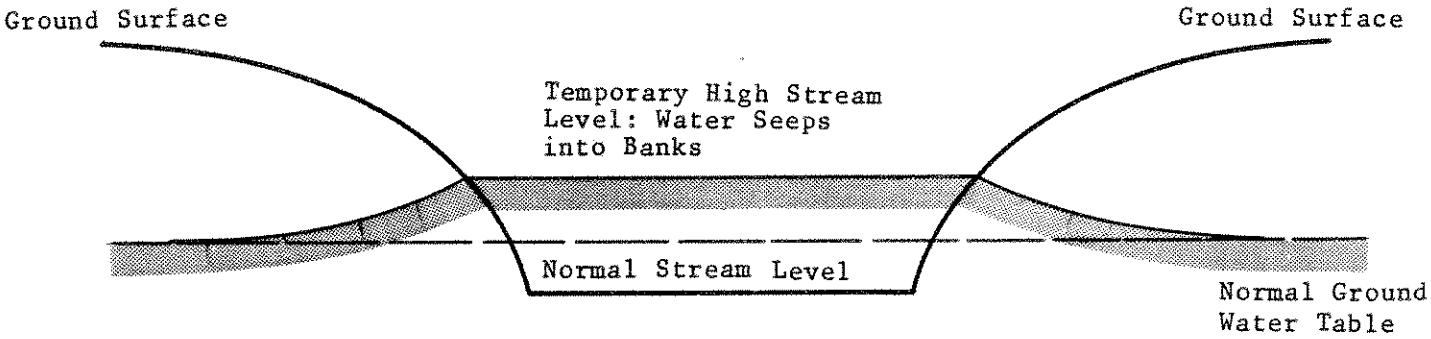
2. Ground Water Infiltrates onto Perching Member and Leaks into Stream or Wetland

FIGURE 20

WAYS IN WHICH WATER CAN REACH WINDWARD OAHU STREAMS AND WETLANDS



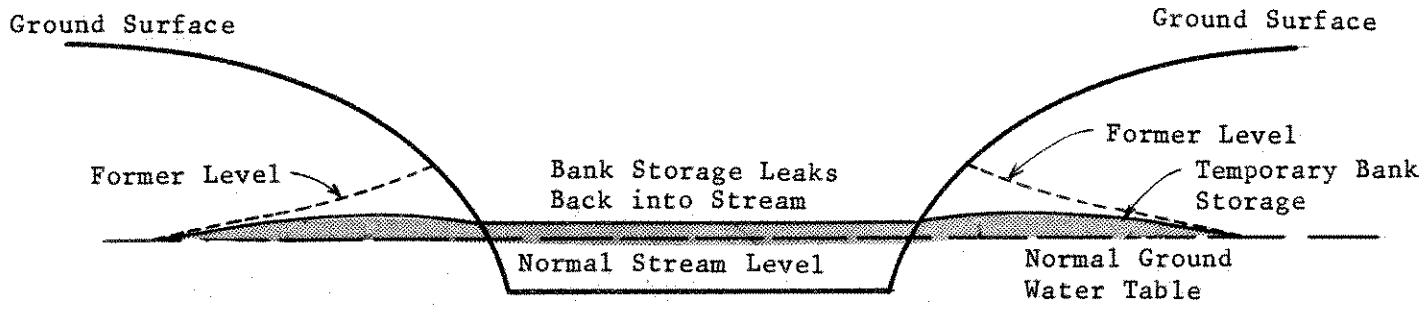
3. Stream Bank Storage



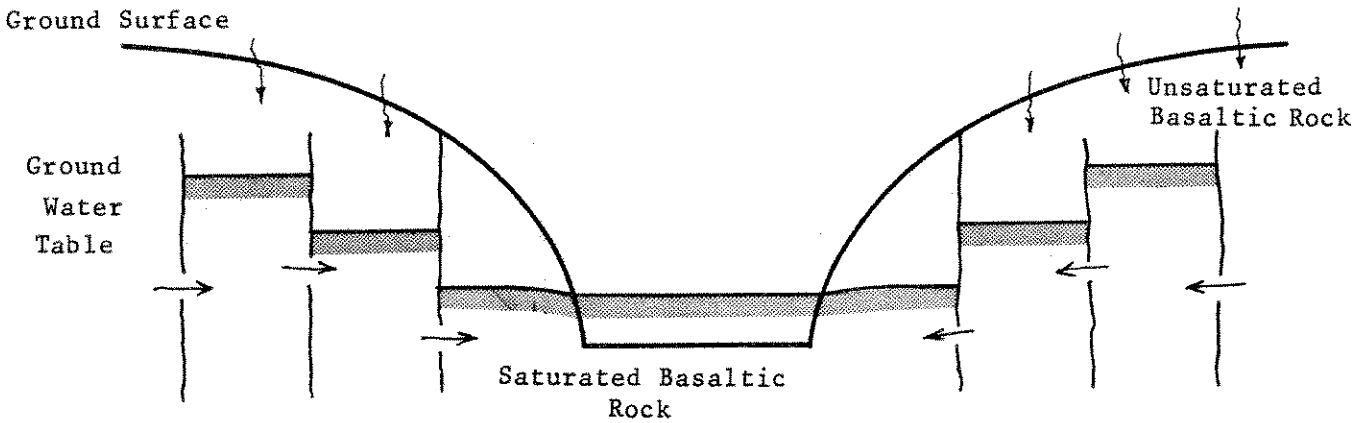
3. Stream Bank Storage

FIGURE 21

WAYS IN WHICH WATER CAN REACH WINDWARD OAHU STREAMS AND WETLANDS



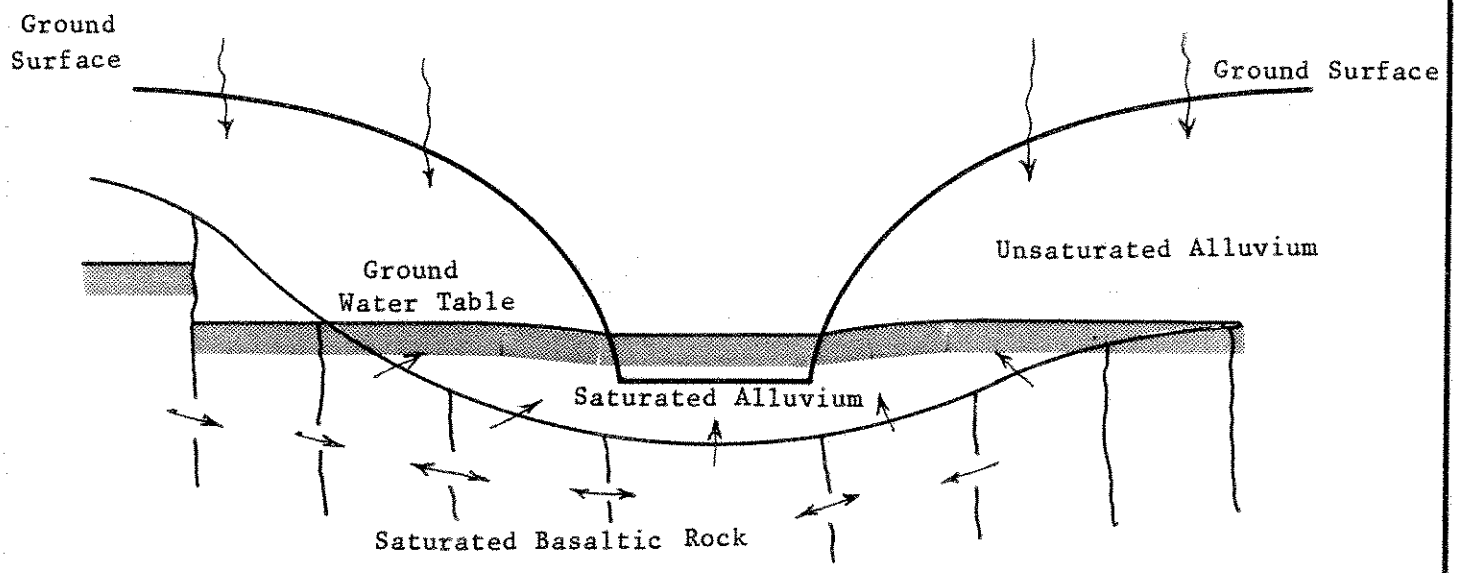
3. Stream Bank Storage



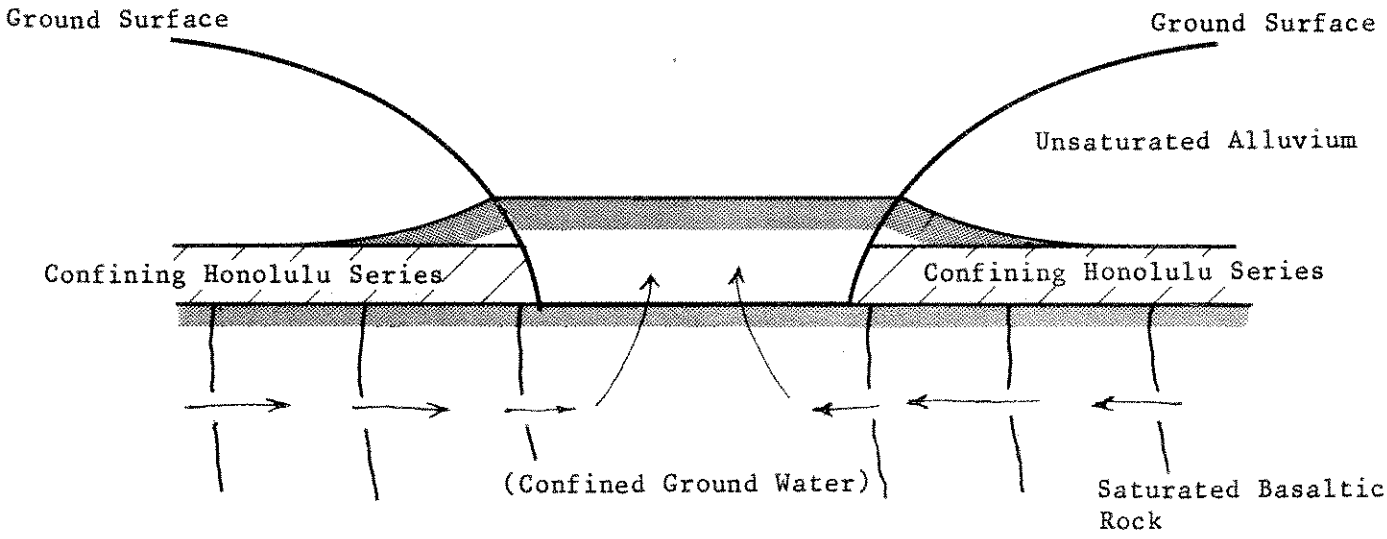
4. Dike Confined Ground Water Directly Leaking or Overflowing into Stream

FIGURE 22

WAYS IN WHICH WATER CAN REACH WINDWARD OAHU STREAMS AND WETLANDS



5. Dike Confined Ground Water Overflowing Through Overlying Alluvium into Stream or Wetland



6. Confined Ground Water Discharge Through Breached Honolulu Volcanic Series

FIGURE 23

prevent dike-impounded ground water from leaking and overflowing to the surface. When Honolulu Series lavas confine dike-impounded ground water, springs occur at the makai edge of Honolulu Series lavas or in places where the Honolulu Series lavas are breached. [Figure 23] Such springs are common in Haiku and Maunawili Valleys and contribute to the flow of Haiku, Keaahala, and Maunawili Streams.

7. At low elevations inland of sedimentary caprock, (such as at Kalauao Springs in Pearl City), basal ground water overflows to the surface in places where ground elevations are lower than the basal water table. [Figure 24] There are no known basal springs in windward Oahu.

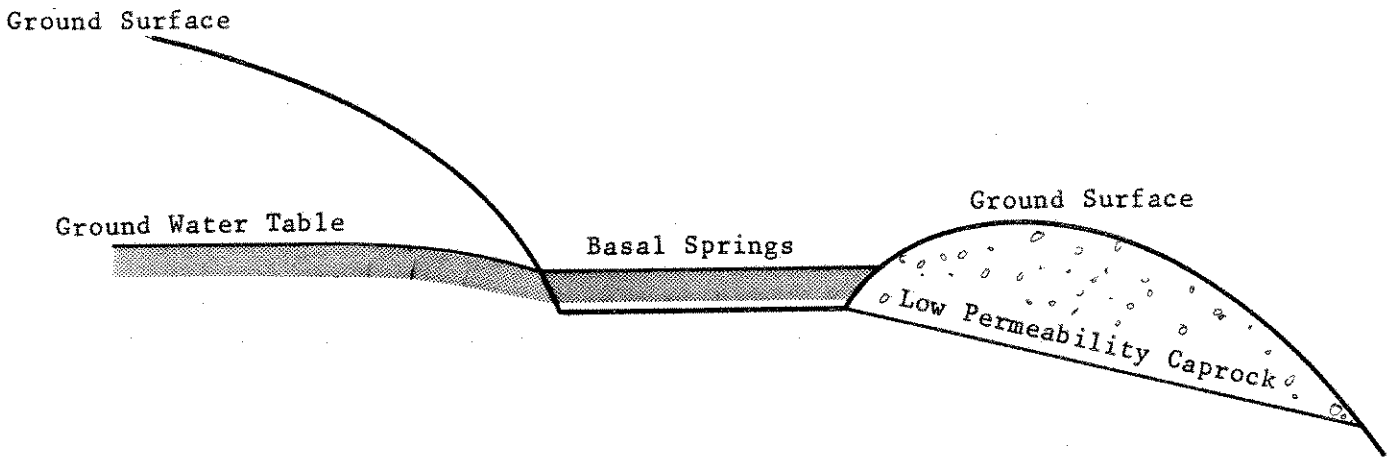
8. At low elevations along parts of Oahu's coast, sedimentary caprock overlies more permeable lavas and prevents basal ground water from overflowing to the surface. When caprock confines basal ground water, springs occur in places where the caprock is breached. [Figure 24] Punaluu, Kahana, Kaaawa, and Waimanalo Streams gain a little flow from brackish caprock springs, and brackish caprock springs contribute water to most coastal wetlands from Punaluu to Kahuku. [Ref. 85]

In general, there are five ways in which water can leave Oahu streams and wetlands:

1. Unless impounded, water will leave streams and wetlands by surface runoff. Man-made drainage improvements such as the Kawainui Canal in Kailua can eliminate natural terrain features which impound water in wetlands.

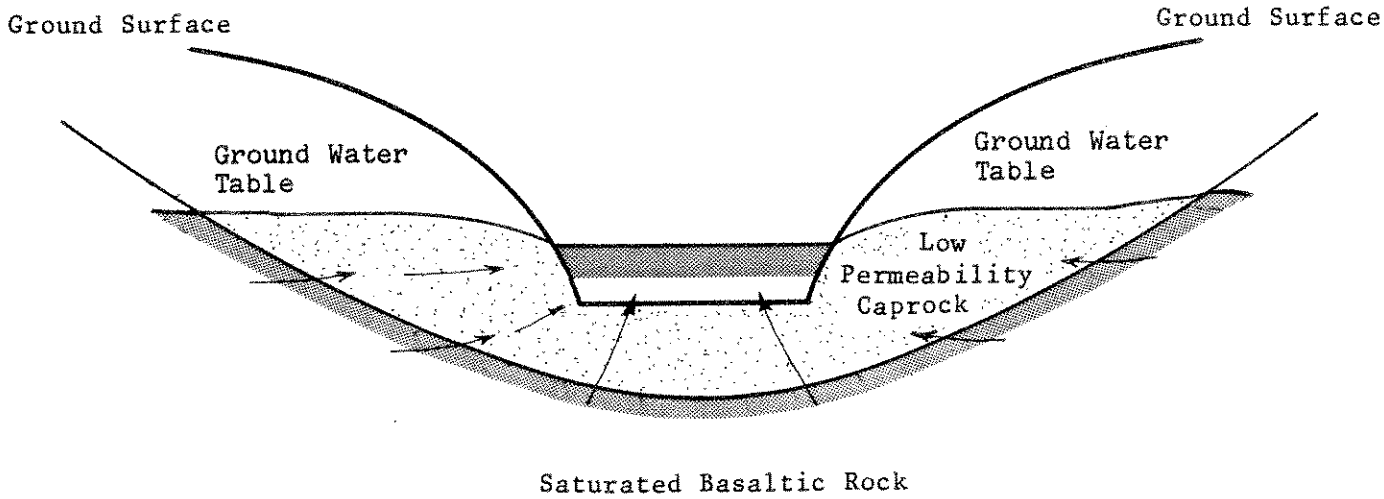
2. When the water table is lower than ground elevation, water can leave streams and wetlands by infiltrating into the ground. In cases where a stream is underlain by a perching member, it is possible for infiltrated stream water to leak back into the stream at lower elevations. Hence streams can sometimes regain part of their underflow. Rapidly flowing streams lose relatively little water to infiltration as the ground below is saturated and becomes relatively impermeable. However, all windward Oahu streams north of Punaluu are intermittent at low elevations because the low

WAYS IN WHICH WATER CAN REACH WINDWARD OAHU STREAMS AND WETLANDS



7. Basal Springs Slightly Inland of Caprock

(Occurs at Pearl Harbor, But Not Known to Occur in Windward Oahu)



8. Basal Ground Water Leaking Through Caprock

(Caprock Springs)

FIGURE 24

gradient allows their dry-weather flow to percolate into their bed.

3. As previously discussed, water can leave streams and wetlands by bank storage.

4. Water can leave wetlands by evaporation. [See Section B of this Chapter.]

5. Water can leave wetlands by transpiration. Transpiration by plants in a constantly saturated wetland is roughly equivalent to pan evaporation. Bank storage can increase transpiration of plants near streams and wetlands. [Ref. 85]

E. STREAMS

During significant rainfall, virtually every gulch in windward Oahu carries surface runoff towards the ocean. But during dry weather, when ground water is the source of stream flow, there are less than twenty places along the windward coast where stream systems discharge into the ocean.

Based on limited data, it appears as if from Kahuku through Kaluanui, the dry-weather flow of all windward Oahu streams infiltrates into the ground below an elevation of roughly 400 feet. Consequently, the natural dry-weather flow of stream systems between Kahuku and Kaluanui is largest above an elevation of 400 feet. Except for Kaluanui and Koloa, streams in this region usually do not discharge into the ocean except when it rains. The general low rainfall and small watershed areas in this region do not sustain large perennial stream flows. Even Kaluanui and Koloa Streams are naturally intermittent at low elevations during prolonged dry weather. [Ref. 82]

In contrast, from Punaluu through Waimanalo, the dry-weather flow of most windward Oahu streams increases with decreasing elevation because ground water discharges into stream beds. Consequently, the natural

dry-weather flow of stream systems between Punaluu and Waimanalo is largest at sea level. [Ref. 85]

Diversions and/or development of high-level dike-impounded ground water have substantially reduced the dry-weather flow of most windward Oahu streams from Punaluu through Waimanalo. By comparison, the small dry-weather flow of streams from Kahuku through Kaluanui is currently not affected by water development projects.

Under existing conditions, Kahana Stream has the largest dry-weather discharge of all windward Oahu streams. [Plate 62] Near its mouth, the discharge of Kahana Stream now exceeds 11 mgd more than 90% of the time (i.e. Q_{90} discharge). [Ref. 85] Prior to the construction of the Waiahole Ditch and Tunnel System, Waiahole Stream probably had a larger dry-weather discharge than Kahana Stream. [See data from USGS Gage No. 2940, Appendix C, page C-27.] However, because of the diversion of high-level dike-impounded ground water by Uwau and Waiahole Tunnels, Waiahole Stream now has less than one-fourth of its former dry-weather stream flow. [Ref. 85]

To evaluate trends in the flow of windward Oahu streams, available historical data from USGS stream gages has been summarized and compiled in Appendix C. USGS stream gage data is frequently presented as "monthly mean discharge", i.e. the average discharge over the period of a calendar month. If stream gage data is available for an entire year, then the USGS calculates "monthly mean discharge" for each of the 12 calendar months in that year. For each year, Appendix C presents both the lowest and median "monthly mean discharge". For any year, the "lowest monthly mean discharge" is a crude approximation of the discharge exceeded 90% of the days of that year, i.e. Q_{90} discharge. If published, the lowest recorded daily discharge for that year is also presented in Appendix C.

By way of illustration, consider USGS Gage No. 3100 on the Middle Branch of Malaekahana Stream at an elevation of 440 feet. The gage is plotted on Map 1, page C-3, and gage data is summarized on page C-4 of Appendix C. For the year ending June 30, 1918, stream flow was measured for 365 days, i.e. 12 months. The median monthly mean discharge for this year was 0.08 mgd. (The median represents the middle value when data is ordered from lowest to highest.) Out of the

PLATE 62
KAHANA STREAM AT GAGING STATION

12 calendar months, the lowest monthly mean discharge was 0. In other words, there was no stream flow for one or more calendar months. Similarly, out of 365 days, the lowest recorded daily discharge was 0.

It should be noted that a stream gage only measures the flow of a stream at the location of the gage. Historical gaged measurements of the discharge of windward streams are usually too short-term to make reliable estimates of dry-weather stream flow. Moreover, stream gages have rarely been situated at the elevation of greatest dry-weather stream flow. For these reasons, estimates of maximum Q_{90} stream discharge summarized in Table 13 have been presented as a range rather than as specific values.

TABLE 13

Estimated 1985 Base Discharge of Windward Oahu Streams

(Estimates are for Water Remaining in Streams After Any Diversion)

Region & Name of Stream	Tributary To	Approximate Q_{90} Discharge at Elevation of Maximum Dry-Weather Discharge (MGD)
MALAEKAHANA-LAIE		
Malaekahana	Ocean	0.1 to 0.2
Kahawainui	Ocean	less than 0.1
Ihiihi	Kahawainui Stream	less than 0.1
Wailele	Ocean	0.1 to 0.2
Koloa	Ocean	0.3 to 0.5
KAIPAPAU-KALUANUI		
Kaipapau	Ocean	0.1 to 0.2
Maakua	Ocean	less than 0.1
Kaluanui	Ocean	0.4 to 0.6
PUNALUU		
Waihoi	Punaluu Stream	1.5 to 3
Punaluu	Ocean	9 to 10
KAHANA		
Kawa	Kahana Stream	1.5 to 2
Kahana	Ocean	12 to 13
KAAWA-HAKIPUU		
Kaaawa	Ocean	0.1 to 0.2
Hakipuu	Ocean	0.3 to 0.5
WAIKANE-WAIAHOLE		
Waikeekee	Waikane Stream	less than 0.1
Waikane	Ocean	1.5 to 2
Uwau	Waianu Stream	less than 0.1
Waianu	Waiahole Stream	0.5 to 1
Waiahole	Ocean	3 to 3.5
KAALAEA-WAIHEE		
Kaalaea	Ocean	0.5 to 1
Haiamoa	Ocean	0.5 to 1
Waihee	Ocean	5 to 6

TABLE 13 [Continued]

Region & Name of Stream	Tributary To	Approximate Q_{90} Discharge at Elevation of Maximum Dry-Weather Discharge (MGD)
KAHALUU-AHUIMANU		
Kahaluu	Ocean	2 to 3
Waiola	Ahuimanu Stream	0.3 to 0.5
Ahuimanu	Kahaluu Stream	0.5 to 1
HEEIA		
Iolekaa	Heeia Stream	0.2 to 0.3
Haiku	Heeia Stream	1.5 to 2
Heeia	Heeia Meadowlands	1.7 to 2.3
KANEOHE		
Keaahala	Ocean	2 to 3
Anolani	Kaneohe Stream	2 to 2.5
Kamooalii	Kaneohe Stream	4 to 4.5
Kaneohe	Ocean	6 to 7
Luluku	Kamooalii Stream	0.4 to 0.6
Kuou	Kamooalii Stream	0.5 to 1
Hooleinaiwa	Kamooalii Stream	0.2 to 0.3
Halekou	Kamooalii Stream	0.5 to 1
Kawa	Ocean	0.1 to 0.2
MAUNAWILI		
Kahanaiki	Kawainui Marsh	0.4 to 0.5
Maunawili	Kawainui Marsh	3 to 3.5
Palapu	Omao Stream	less than 0.1
Omao	Maunawili Stream	less than 0.4
Ainoni	Makawao Stream	less than 0.3
Olomana	Makawao Stream	less than 0.1
Makawao	Maunawili Stream	0.5 to 1
WAIMANALO		
Waimanalo	Ocean	0.5 to 1

Note: Estimates for Q_{90} discharge were made by VTN Pacific. The range is a "best estimate" using available data.

In addition to maintaining stream gages, the USGS has taken a series of instantaneous measurements of dry-weather stream flow on days when ground water is the source of all water in windward Oahu streams. Relevant measurements for streams between Kaluanui and Waimanalo have been summarized in Tables 14 through 23. In most cases, the data illustrate the extent to which windward streams gain water with decreasing elevation. The single data points shown on some of the tables are included to provide the most complete information possible on the stream or streams. Figures 25 to 34 show the locations of the measurements. Except for Waimanalo Stream, gains in dry-weather stream flow below an altitude of about 1,500 feet are mostly due to leakage and overflow of ground water out of dike compartments.

TABLE 14
STREAM DISCHARGE MEASUREMENTS
KALUANUI

Reference: Figure 25

KALUANUI

Station/ (USGS No.)	K-1 ---	252 (3040)	K-2 ---	253 ---	254 (3042)	K-4* ---	K-5* ---	K-6* ---	K-7* ---	K-8* ---
Approximate Elevation	2,100'	1,900'	1,700'	340'	110'	80'	75'	45'	25'	18'
1/26/60	---	.30	---	---	---	.24	---	---	---	---
2/03/61	---	---	---	.25	---	.24	---	---	---	---
9/24/66	0.24	0.32	0.19	0.35	0.28	---	---	---	---	---
6/02/82	---	---	---	---	.29	---	.35	.32	.02	0
6/03/82	---	---	---	---	.28	---	.31	.26	0	0

Note: Measurements in MGD

* USGS Measurements Prior to Pump Test of Kaluanui Well I.

Source: Ref. 82, Plate 1; Ref. 85, Plate 3; Ref 49

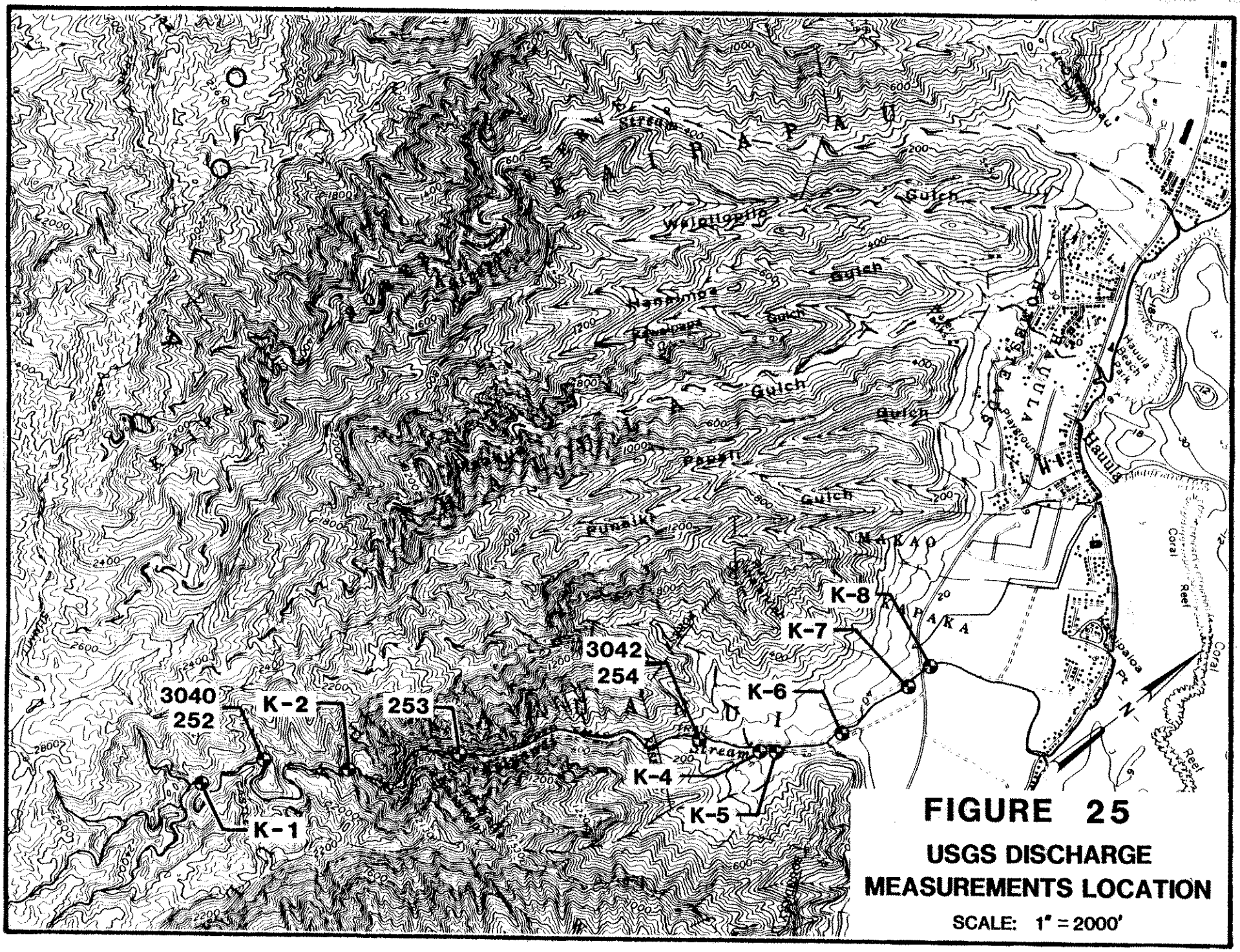


FIGURE 25

USGS DISCHARGE MEASUREMENTS LOCATION

SCALE: 1" = 2000'

TABLE 15
STREAM DISCHARGE MEASUREMENTS
PUNALUU

Reference: Figure 26

PUNALUU

Station/ (USGS No.)	228 ---	229 ---	234 ---	242 ---	243 (3030)	250 ---
Approximate Elevation	700'	620'	380'	270'	212'	15'
6/07/60	---	---	---	---	.67	4.83
2/06/62	.653	1.76	4.23	6.92	5.80	---

PUNALUU DITCH*

Station/ (USGS No.)	244 (3020)
Approximate Elevation	200'
6/07/60	12.7
2/06/62	2.80

WAIHOI TRIBUTARIES

Station/ (USGS No.)	237 ---	238 ---	239 ---	240 ---	241 (3000)
Approximate Elevation	680'	580'	720'	570'	500'
08/26/60	---	.692	1.61	1.55	---
10/17/60	.271	.659	---	---	---
01/31/62	----	---	---	---	1.71

Note: Measurements in MGD

* Punaluu Ditch Diverts Water from Punaluu Stream just above Station 243.

Source: Ref. 85, Plate 3

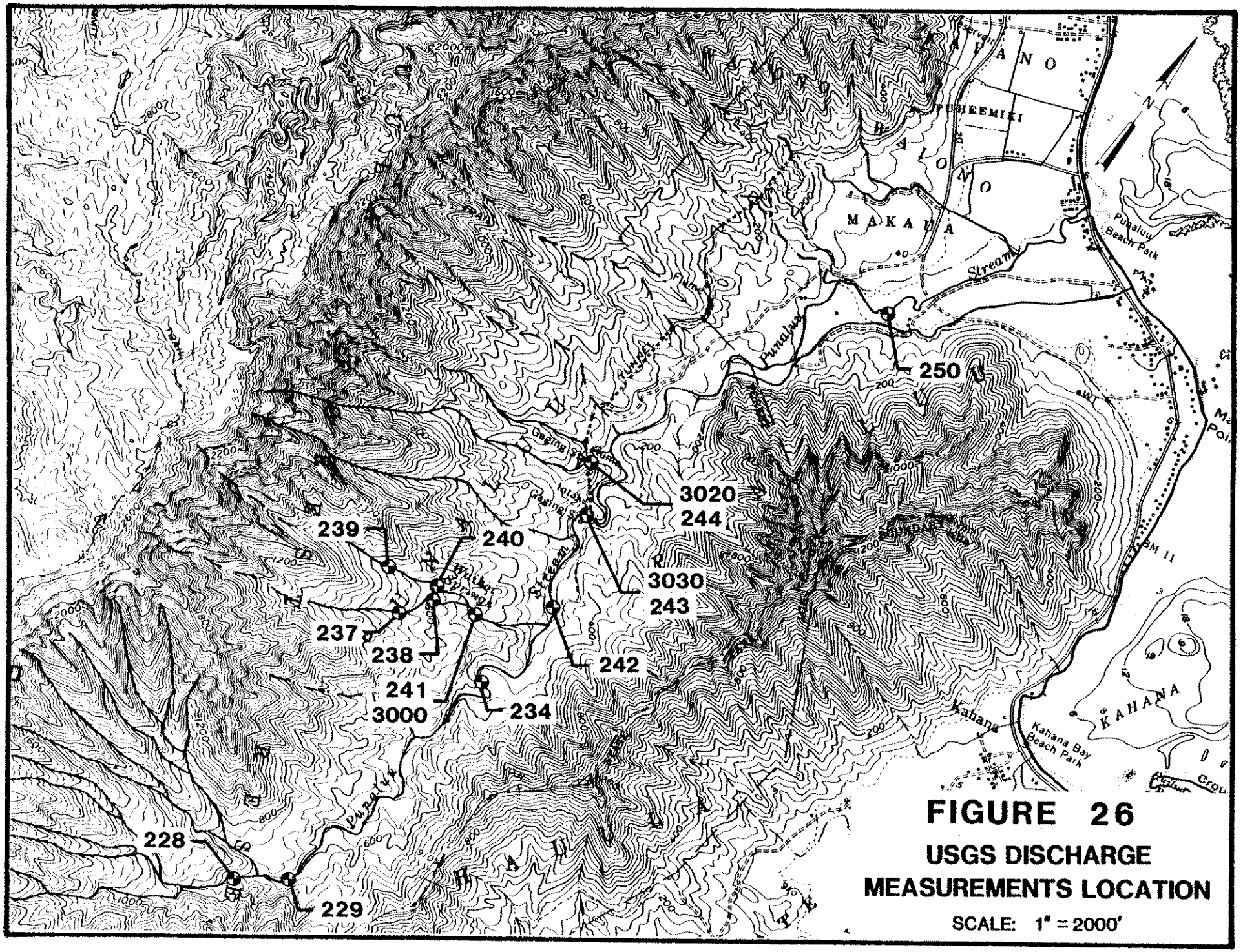


FIGURE 26

USGS DISCHARGE MEASUREMENTS LOCATION

SCALE: 1" = 2000'

TABLE 16
STREAM DISCHARGE MEASUREMENTS
KAHANA

Reference: Figure 27

KAHANA

Station/	216	218	220	225
(USGS No.)	---	---	---	(2965)
Approximate Elevation	280'	250'	230'	30'
8/23/60	---	5.55	---	10.5
9/06/61	2.57	---	---	8.2
2/13/62	1.95	3.55	3.83	10.0

KAHANA TRIBUTARY

Station/	217
(USGS No.)	---
Approximate Elevation	300'
8/23/60	1.95
9/06/61	1.42
2/13/62	.918

KAWA

Station/	226
(USGS No.)	(2970)
Approximate Elevation	30'
10/6/60	1.69
10/4/61	2.75

Note: Measurements in MGD

Source: Ref. 85, Plate 3

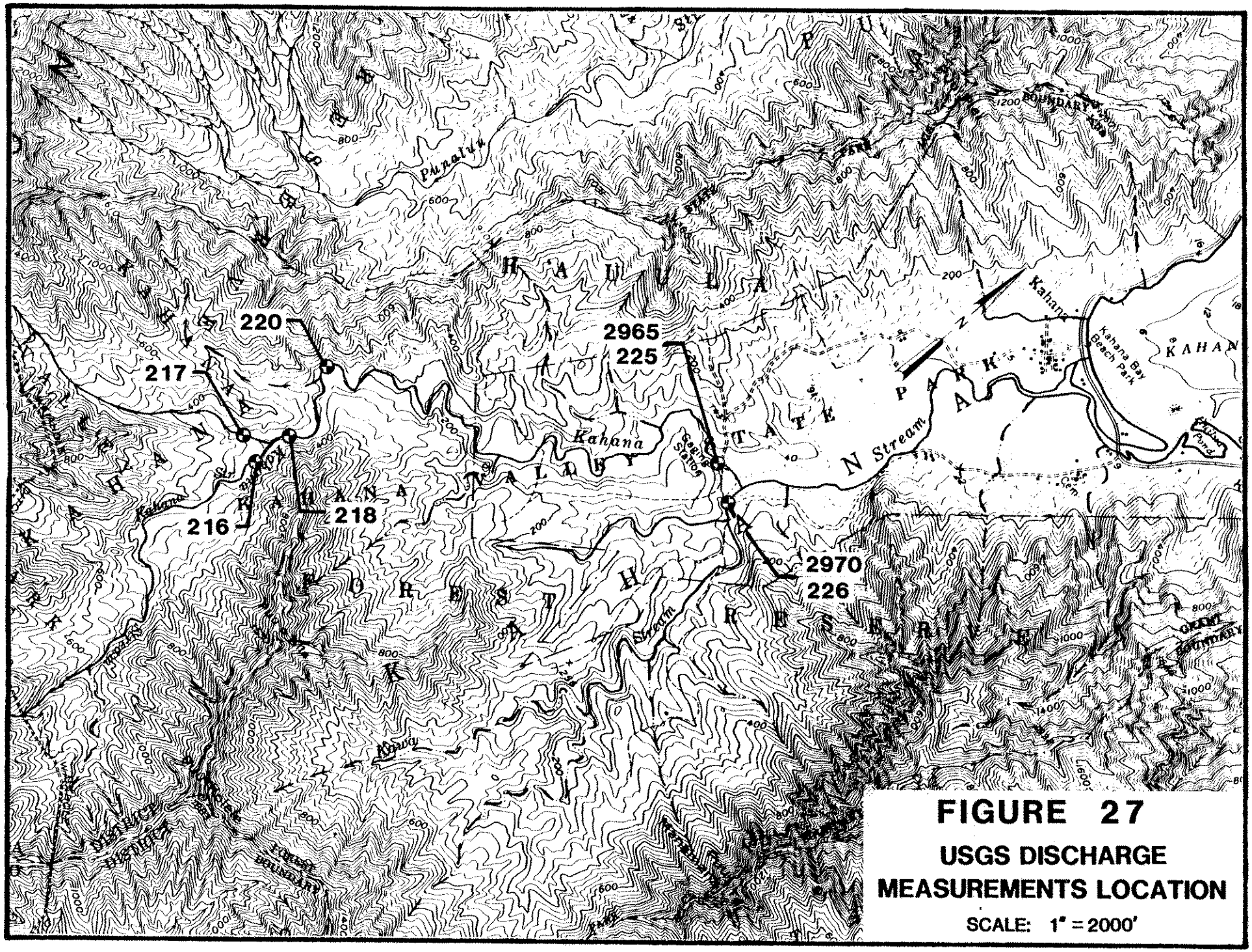


FIGURE 27

USGS DISCHARGE MEASUREMENTS LOCATION

SCALE: 1" = 2000'

TABLE 17
STREAM DISCHARGE MEASUREMENTS
KAAAWA - HAKIPUU

Reference: Figure 28

KAAAWA

Station/ (USGS No.)	206 ---	208 ---	209 ---
Approximate Elevation	220'	50'	15'
3/16/61	.129	.565	---
5/08/61	.039	.144	---
8/15/61	.040	---	.049

HAKIPUU

Station/ (USGS No.)	199 ---	200 ---	202 ---	203 ---	204 ---
Approximate Elevation	220'	70'	60'	50'	30'
7/16/59	.111	.269	.067	.316	.072

Note: Measurements in MGD

Source: Ref. 85, Plate 3

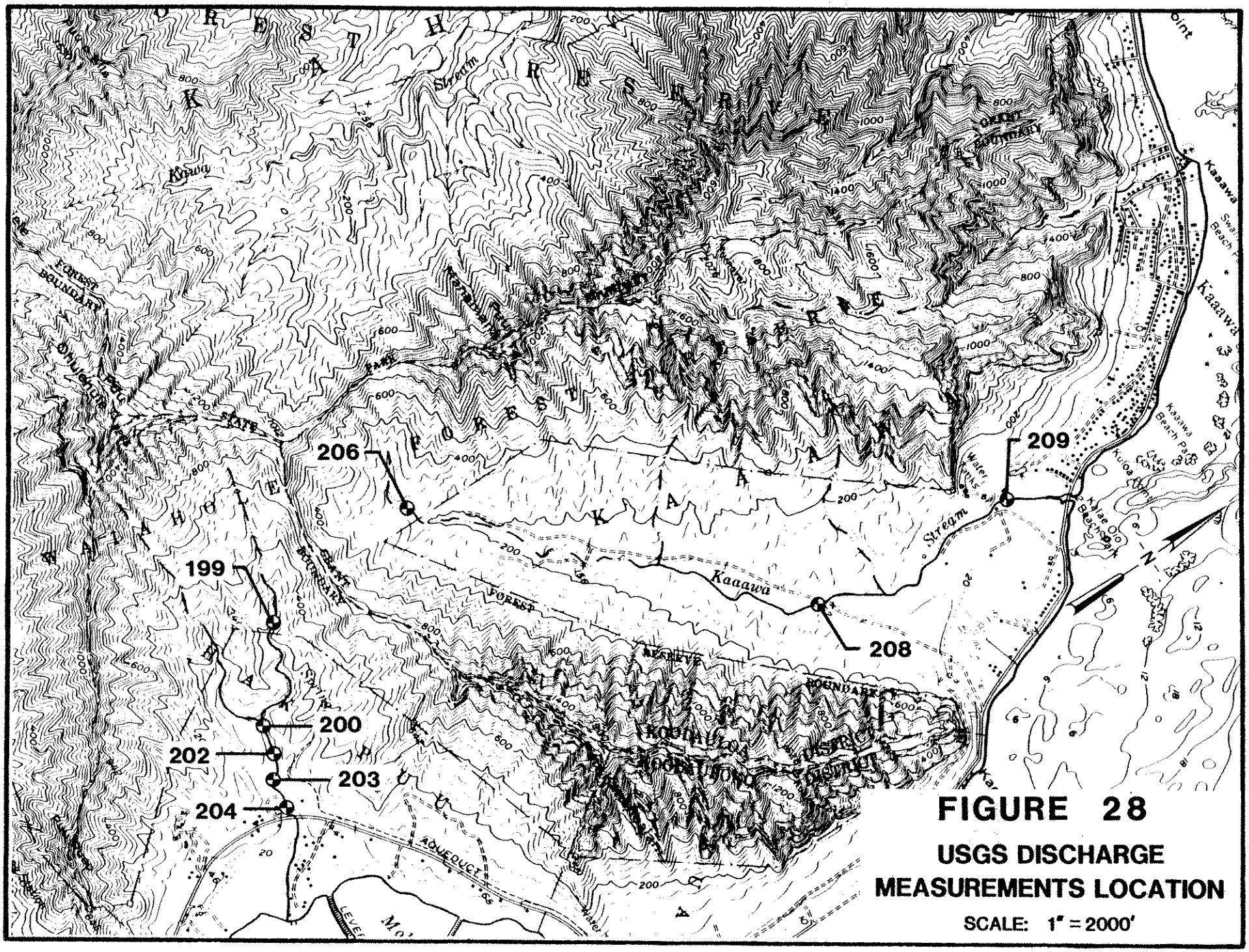


FIGURE 28

USGS DISCHARGE MEASUREMENTS LOCATION

SCALE: 1" = 2000'

TABLE 18
STREAM DISCHARGE MEASUREMENTS
WAIKANE - WAIAHOLE

Reference: Figure 29

WAIKANE

Station/	188	189	190	193	195	198
(USGS No.)	---	---	---	(2949)	---	---
Approximate Elevation	230'	180'	100'	75'	40'	10'
7/15/59	.392	.422	.717	---	1.38	.702

	WAIKEEKEE TRIBUTARY	**UWAU**
Station/	191	183
(USGS No.)	---	---
Approximate Elevation	100'	230'
7/15/59	.058	.083
7/21/59	---	.083
7/19/60	---	.235

WAIANU

Station/	179	180	181	182	184	185
(USGS No.)	---	---	---	---	---	---
Approximate Elevation	530'	420'	330'	240	180'	80'
7/21/59	.224	.026	.200	---	.377	.619
7/19/60	---	---	.231	.505	---	1.06

WAIAHOLE

Station/	176	177	178	186
(USGS No.)	(2900)	(2910)	---	---
Approximate Elevation	420'	250'	100'	80'
7/20/59	.128	2.10	2.34	---
7/21/59	---	2.00	---	2.73
7/19/60	.412	2.85	2.96	3.90

Note: Measurements in MGD
Source: Ref. 85, Plate 3

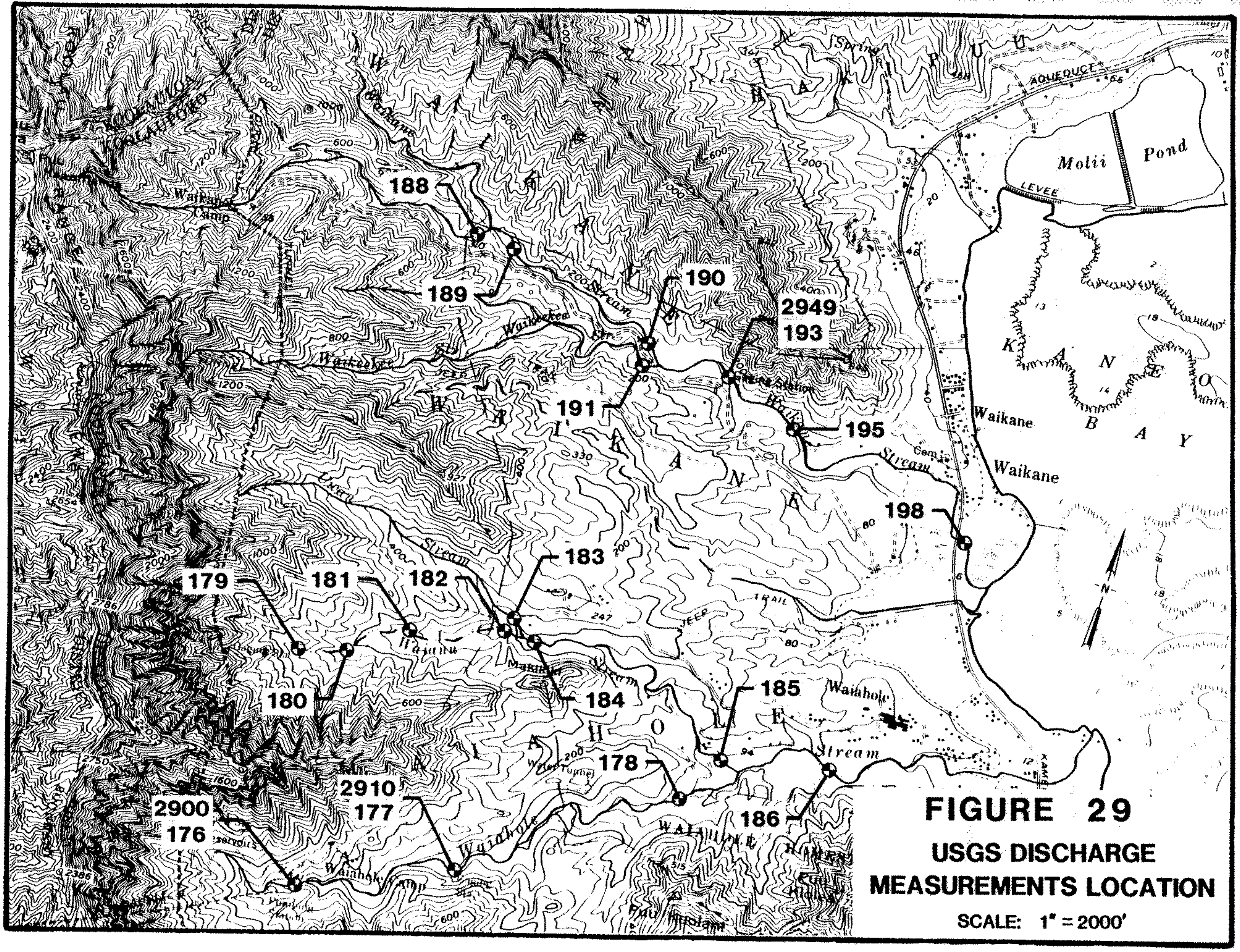


FIGURE 29

USGS DISCHARGE MEASUREMENTS LOCATION

SCALE: 1" = 2000'

TABLE 19 — STREAM DISCHARGE MEASUREMENTS
KAALAEA - WAIHEE - KAHALUU - AHUIMANU

Reference: Figure 30

	KAALAEA			HAIAMOA	
Station/	173	174	175	171	172
(USGS No.)	---	---	---	---	---
Approximate Elevation	300'	240'	150'	15'	10'
7/08/59	---	---	---	.631	.601
7/09/59	.290	.048	.531	---	---

	WAIHEE					TRIBUTARY
Station/	150	156	159	169	170	137
(USGS No.)	(2837)	(2838)	(2840)	---	(2845)	(2836)
Approximate Elevation	639'	259'	194'	20'	10'	616'
7/08/59	---	---	5.42	7.39	---	---
8/10/60	---	---	5.28	---	7.63	---
9/28/61	---	2.29	3.10	---	6.33	---
9/4/62	1.04	1.74	2.26	---	---	.96
9/26/70	1.16	---	2.78	---	5.10	1.10
8/28/81	.588	---	.646	---	---	.330

	KAHALUU							
Station/	125	126	127	128	131	134	135	136
(USGS No.)	---	(2830)	---	---	---	---	---	---
Approximate Elevation	500'	358'	330'	320'	260'	120'	100'	20'
7/07/59	---	.23	---	---	.419	1.25	1.31	.966
2/06/61	---	.13	.039	.141	.579	1.62	---	1.78
8/08/61	.172	.14	---	---	.288	---	---	.879

	WAIOLA	AHUIMANU				
Station/	114	116	119	120	121	122
(USGS No.)	---	---	---	---	---	---
Approximate Elevation	30'	440'	160'	30'	25'	20'
7/07/59	.392	---	---	.403	.850	.790
4/26/60	---	.17	.371	.837	---	---

Note: Measurements in MGD

Source: Ref. 85, Plate 3

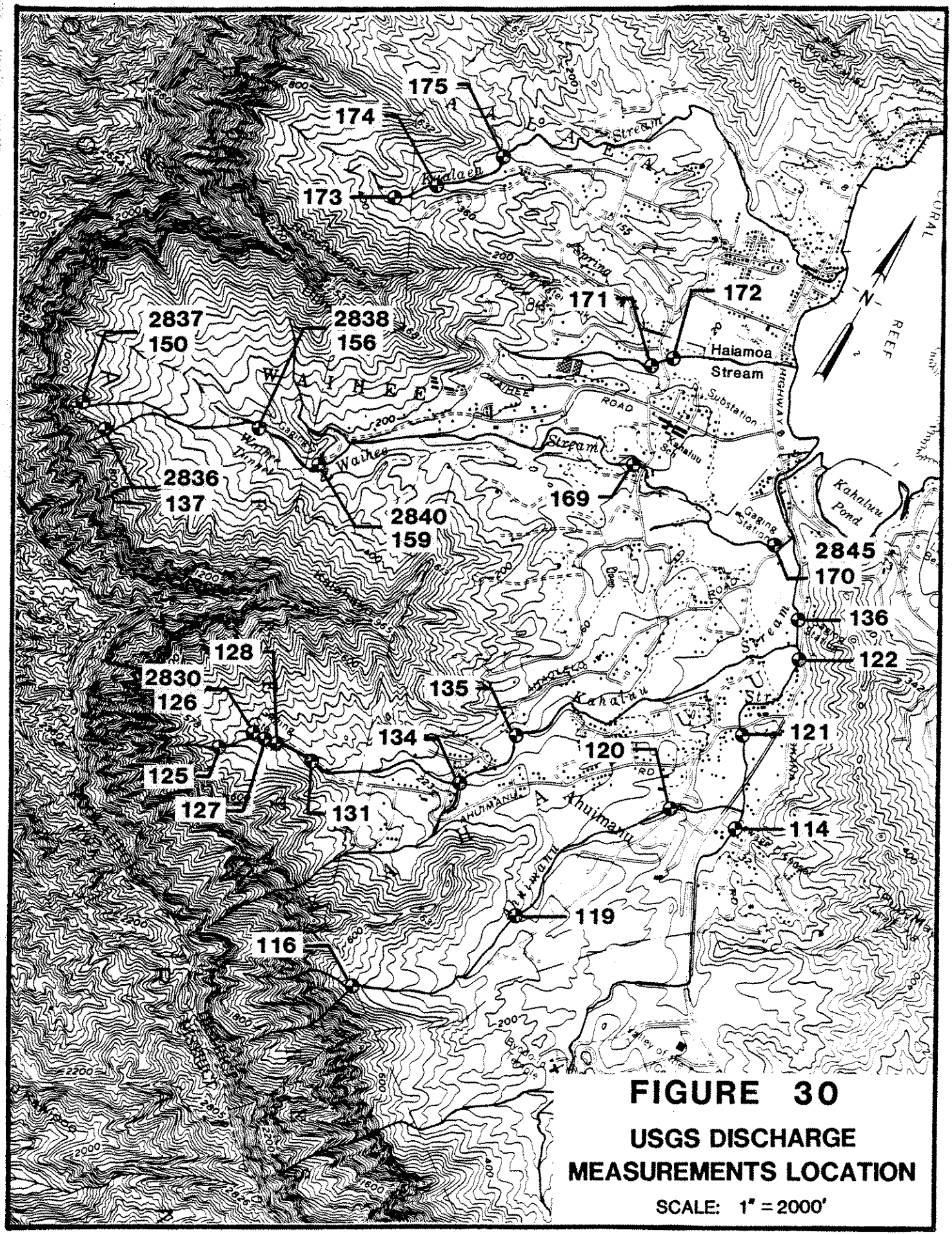


FIGURE 30

USGS DISCHARGE MEASUREMENTS LOCATION

SCALE: 1" = 2000'

TABLE 20
STREAM DISCHARGE MEASUREMENTS
KEAAHALA - HEEIA

Reference: Figure 31

	KEAAHALA			KEAAHALA TRIBUTARY		
Station/	93	98	99	95	96	97
(USGS No.)	--	--	--	--	--	--
Approximate Elevation	120'	80'	30'	180'	150'	130'
6/16/59	---	---	---	.399	2.06	2.37
8/05/60	.427	2.62	3.84	---	---	2.37
10/5/61	.233	2.08	2.29	---	---	2.04

	HAIKU			
Station/	103	104	105	106
(USGS No.)	---	---	(2750)	---
Approximate Elevation	430'	320'	272'	145'
6/17/59	---	---	.43	1.69
8/05/60	---	---	.37	1.59
1/30/61	.670	.90	.88	---
8/11/61	---	.27	.37	1.47
1/24/62	.320	---	.73	---

	IOLEKAA				HEEIA
Station/	107	108	109	110	111
(USGS No.)	---	(2780)	---	---	---
Approximate Elevation	390'	320'	220'	145'	90'
6/17/59	---	.33	---	.35	---
8/05/60	---	.30	.30	.38	2.03
3/08/61	.29	.32	.34	---	---
8/11/61	---	.30	---	.18	1.76
1/24/62	---	.26	---	.34	2.00

Note: Measurements in MGD

Source: Ref. 85, Plate 3

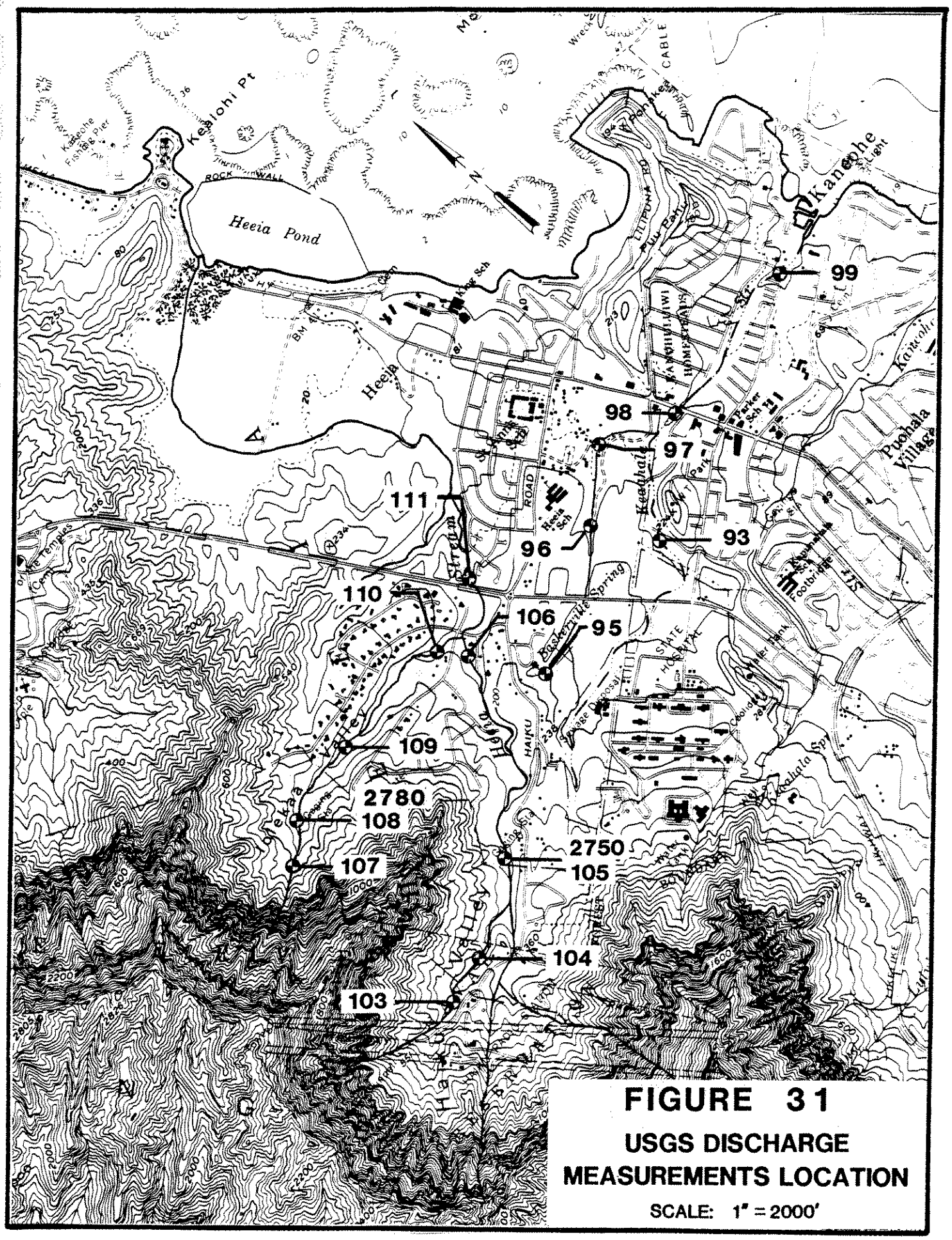


FIGURE 31

USGS DISCHARGE MEASUREMENTS LOCATION

SCALE: 1" = 2000'

TABLE 21 -- STREAM DISCHARGE MEASUREMENTS
KANEOHE

Reference: Figure 32

	ANOLANI	
Station/	89	90
(USGS No.)	---	---
Approximate Elevation	100'	40'
6/12/59	2.13	2.17

	KUOU		LULUKU		
Station/	70	71	76	78	79
(USGS No.)	---	---	---	---	---
Approximate Elevation	220'	150'	520'	220'	150'
6/04/59	.70	1.01	---	---	---
6/10/59	---	---	---	.51	.54
8/03/60	---	---	.45	.44	.48
9/13/61	---	---	.32	.30	---

	KAMOOALII						
Station/	52	54	57	58	63	72	84
(USGS No.)	---	---	---	---	---	---	(2739)
Approximate Elevation	720'	360'	200'	190'	180'	118'	39'
6/03/59	.34	.31	---	1.49	2.69	---	6.00
6/10/59	---	---	---	---	---	4.80	5.60
9/16/59	---	---	0.48	---	1.25	---	5.20
8/01/60	---	---	---	1.77	---	4.47	6.40

	HALEKOU		HOOLEINAIWA	KAWA	
Station/	59	61	64	48	50
(USGS No.)	---	---	---	---	---
Approximate Elevation	200'	190'	180'	140'	100'
6/03/59	.33	.71	.57	---	---
6/04/59	---	---	---	---	---
6/17/59	---	---	---	.019	.147
8/01/60	.44	---	.52	---	---

Note: Measurements in MGD

Source: Ref. 85, Plate 3

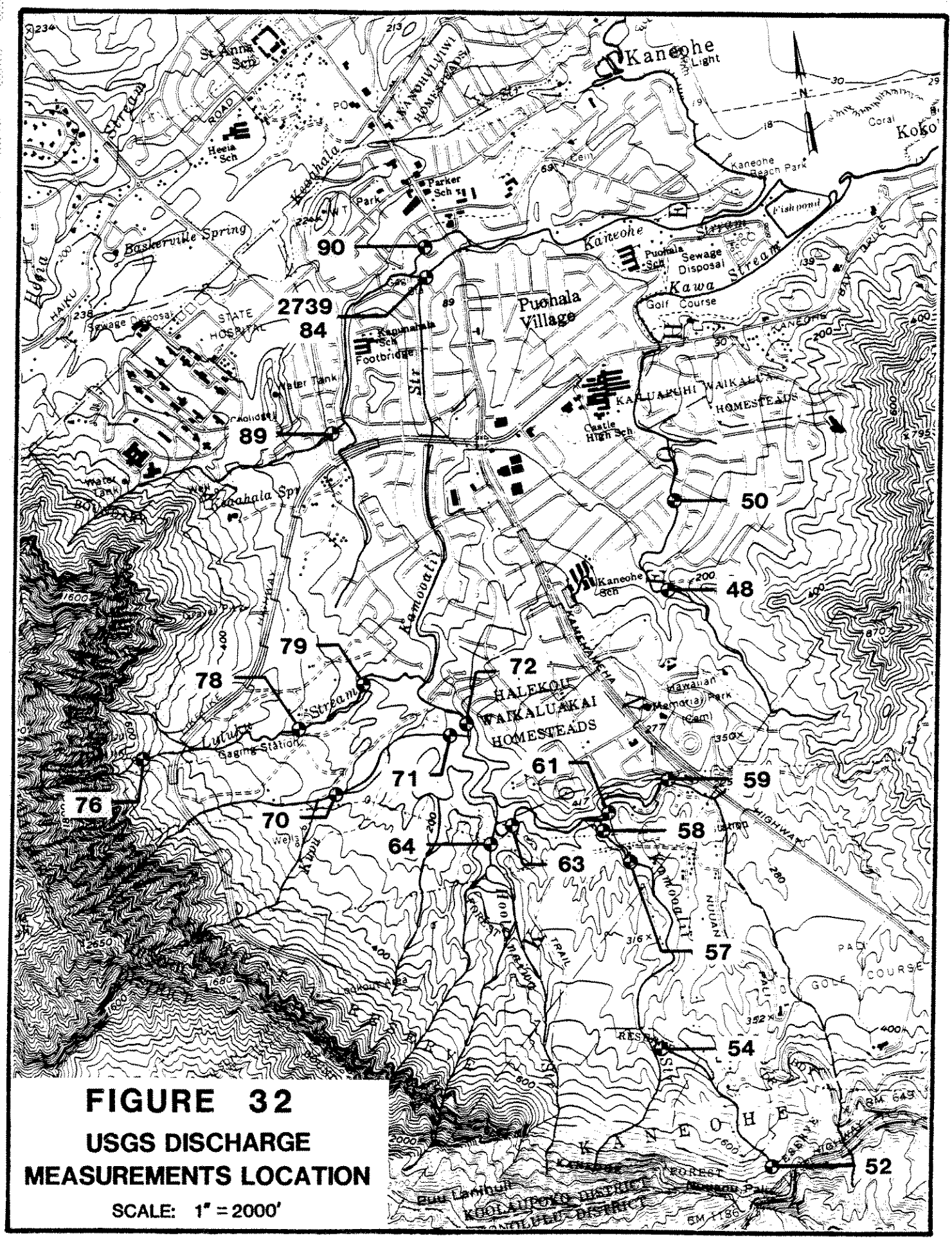


FIGURE 32

USGS DISCHARGE MEASUREMENTS LOCATION

SCALE: 1" = 2000'

TABLE 22
STREAM DISCHARGE MEASUREMENTS
KAHANAIKI - MAUNAWILI

Reference: Figure 33

	KAHANAIKI			KAHANAIKI TRIBUTARY
Station/	44	46	47	42
(USGS No.)	---	---	---	---
Approximate Elevation	500'	70'	20'	450'
7/22/59	.058	.300	.487	.145

	POHAKEA	OMAO		MAUNAWILI	
Station/	40	36	38	35	41
(USGS No.)	(2570)	---	(2560)	(2492)	(2605)
Approximate Elevation	80'	540'	80'	80'	10'
7/23/59	.087	---	.368	.462	---
6/30/60	.188	---	1.22	1.03	3.09
7/29/60	---	.200	2.64	.383	1.94
3/30/61	---	---	.717	.905	---

	PALAPU	OLOMANA		MAKAWAO		
Station/	37	30	31	26	29	32
(USGS No.)	---	---	---	---	---	(2540)
Approximate Elevation	300'	160'	140'	190'	150'	80'
7/22/59	---	.066	.087	.366	---	.72
7/23/59	.040	---	---	---	.765	.72
6/30/60	---	---	---	---	---	---
7/29/60	---	---	---	.416	---	1.10
3/30/61	---	---	---	.640	---	1.57

Note: Measurements in MGD

Source: Ref. 85, Plate 3

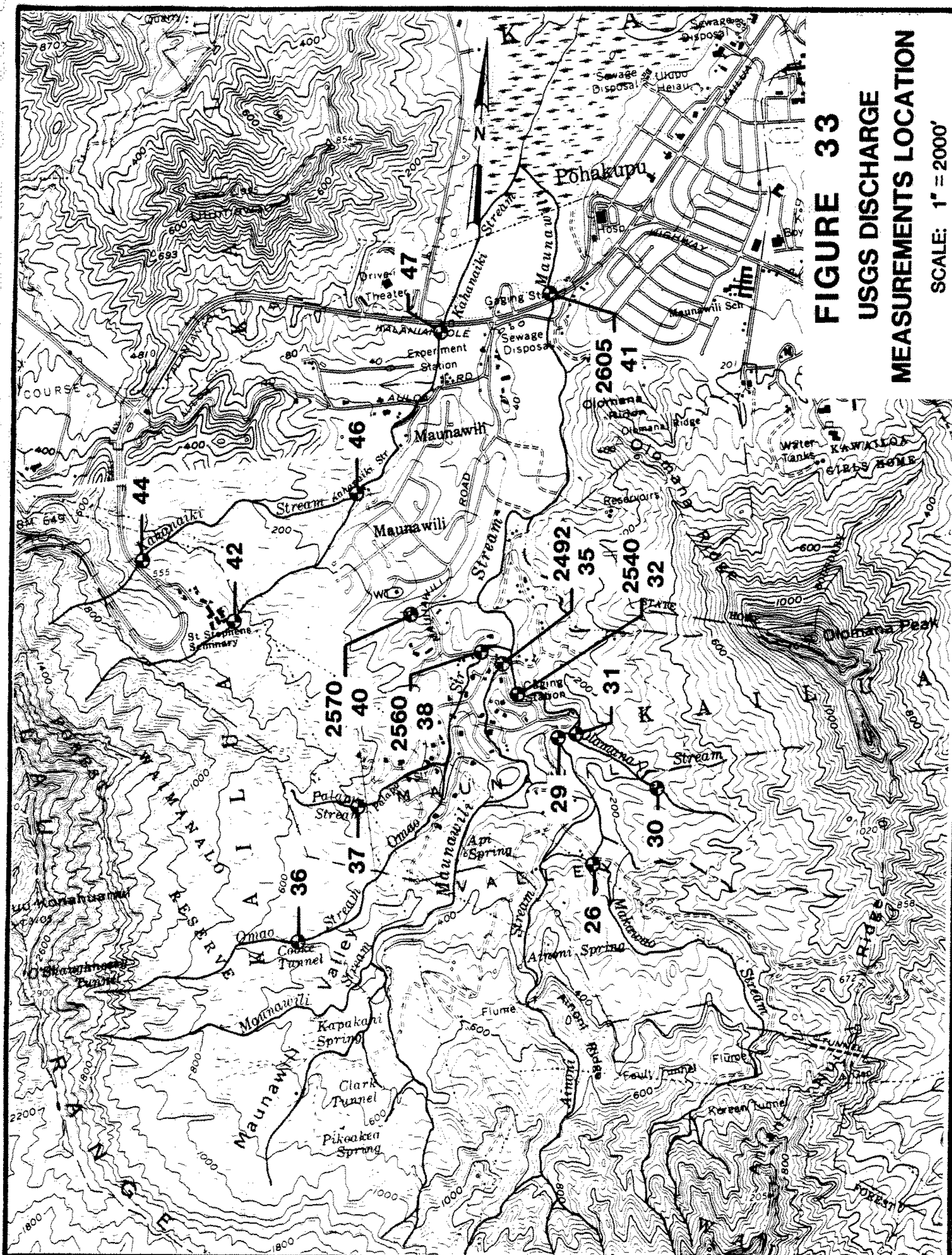


FIGURE 33

USGS DISCHARGE MEASUREMENTS LOCATION

SCALE: 1" = 2000'

TABLE 23
STREAM DISCHARGE MEASUREMENTS
WAIMANALO

Reference: Figure 34

	WAIMANALO		TRIBUTARY
Station/	7	8	1
(USGS No.)	---	(2490)	---
Approximate Elevation	60'	20'	15'
7/31/59	.284	---	.377
6/06/61	---	.350	.325
9/15/61	---	.270	.233

Note: Measurements in MGD

Source: Ref. 85, Plate 3

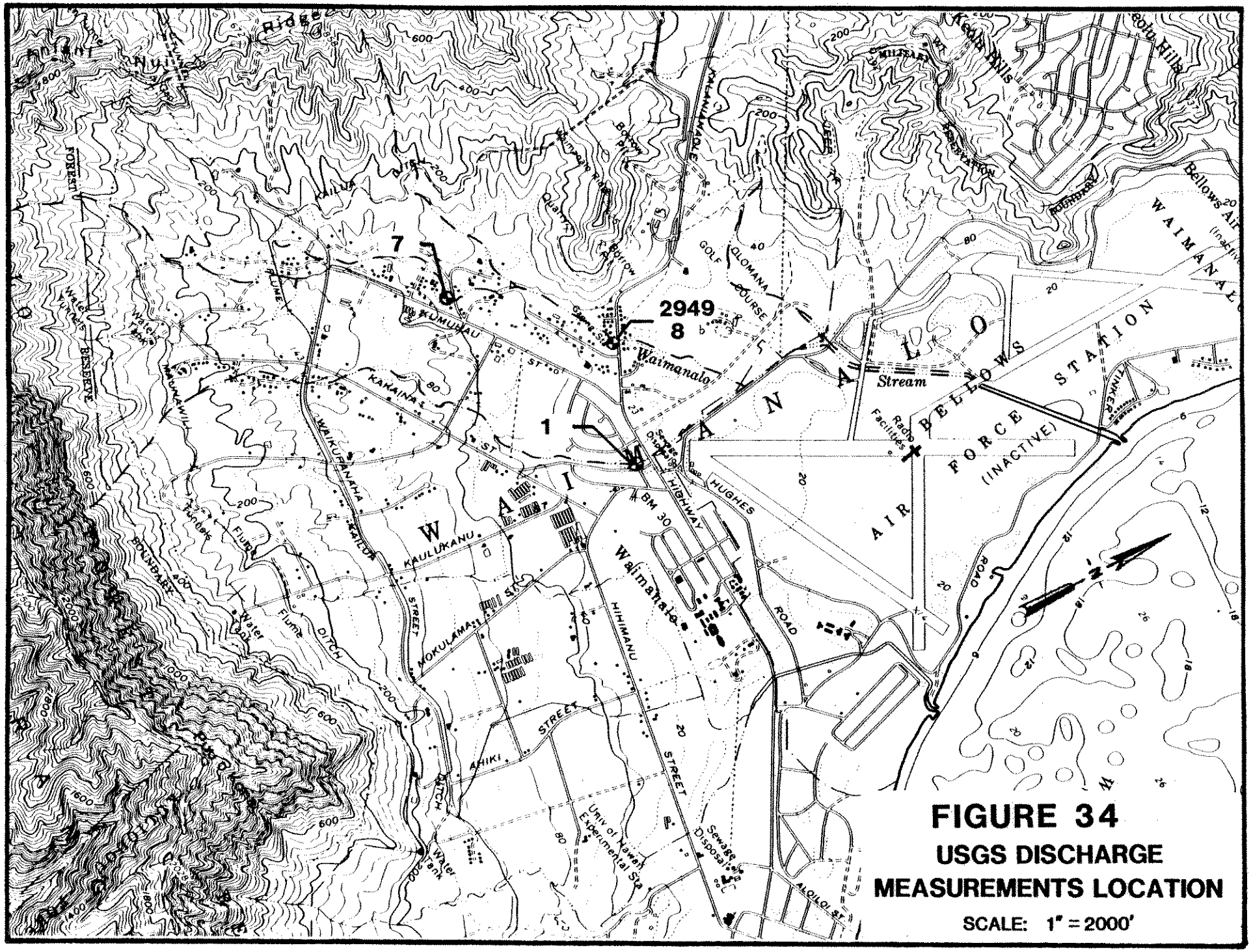


FIGURE 34
USGS DISCHARGE MEASUREMENTS LOCATION
SCALE: 1" = 2000'

F. WATER DEVELOPMENT PROJECTS WHICH HAVE REDUCED STREAM FLOW

There are three types of water development projects which are known to have reduced the flow of windward Oahu streams: 1) direct stream diversions; 2) tunnels which develop dike-impounded ground water; and 3) wells which develop dike-impounded ground water. Available data shows that:

1) Existing stream diversions affect stream flow below but not above the elevation at which water is diverted;

2) Existing tunnels which develop dike-impounded ground water affect stream flow both above and below the altitude of the tunnel portal; and

3) Some existing wells which develop dike-impounded ground water affect stream flow below but not above the static head of the wells.

There is no evidence that existing water development projects affect stream flow except in these three ways. However, in theory, it is possible for a well which develops dike-impounded ground water to reduce stream flow above the static head of the well.

The effect of a diversion on stream flow can be measured by the water flow in the diversion flume or ditch. However, it is difficult to accurately measure the effect on stream flow from a water development tunnel or well. To quantify the effect of a tunnel or well, it is necessary to have a theoretical model capable of predicting stream flow without the tunnel or well. To develop such a model, it would be necessary to know: a) the watershed from which infiltrated rainfall can affect the dry-weather flow of a stream; b) daily rainfall on different parts of that watershed over a period of many years prior to the well or tunnel; and c) daily stream discharge over the same period at the altitude of maximum dry-weather stream flow. Such information is not available for a single windward Oahu stream. It is problematic to even determine the areas from which infiltrated rainfall can affect dry-weather stream flow because: a) not all ground water ends up as stream flow; and b) rainfall at high elevations in one valley can affect dry-weather stream flow in other valleys.

With these cautions kept firmly in mind, an attempt has been made to identify the range of potential impacts from existing water development projects on stream flow in windward Oahu. Tables 24, 25, and 26, respectively, summarize 1) non-BWS water sources which have significantly reduced stream flow; 2) minor non-BWS stream diversions which have slightly reduced stream flow; and 3) BWS water sources which have significantly reduced stream flow.

Identification of major water sources which may significantly reduce stream flow was based on published and unpublished USGS, DLNR, and BWS records. Identification of minor stream diversions was based on interviews with water users. Some minor stream diversions may not have been identified, and others will probably change before BWS proposals discussed in this EIS are implemented.

A number of streams on windward Oahu are being diverted by individual users primarily for agricultural irrigation purposes. Generally, the users divert the steam above their irrigated field and return the "unused" water to the stream. Crops grown with stream water include taro, bananas, papaya, watercress and various truck crops. Flowers are grown with water diverted from various windward streams and various cattle grazing fields irrigated. Ho'omaluhia Reservoir, a portion of a City park, uses water from three windward Oahu streams.

A brief discussion follows of all private and BWS water development projects which have significantly reduced the flow of windward Oahu streams. To the extent practical, water sources are sequentially presented from north to south. The far-reaching impacts of existing water development tunnels and inclined wells is relevant to the potential impacts of proposed BWS tunnels and inclined wells. Similarly, the more confined impacts of existing BWS wells is relevant to the potential impacts of proposed BWS wells which will develop dike-confined ground water.

TABLE 24
Existing Non-BWS Water Sources Which Have Significantly Reduced The Flow of Windward Oahu Streams

Name of Water Source	Owner	Year First In Service	Affected Stream(s)		Tributary To
Punaluu Ditch	Bishop Estate	1920s	Punaluu	(C)	Ocean
Waiahole Ditch and Tunnel System	Waiahole Water Company	1916	Punaluu	(P)	Ocean
			Kahana	(C)	Ocean
			Kawa	(P)	Kahana Stream
			Hakipuu	(P)	Ocean
			Waikane	(P)	Ocean
			Waikeekee	(P)	Waikane Stream
			Uwau	(M)	Waianu Stream
			Waianu	(M)	Waiahole Stream
			Waiahole	(C)	Ocean
			Kaalaea	(P)	Ocean
Kualoa System	Kualoa Ranch	?	Hakipuu	(M)	Ocean
Waiahole Valley Water System	State DLNR, Windward Partners, & Mrs. A.L. Marks	1916	Waianu	(M)	Waiahole Stream
Maunawili Ditch and Tunnel System	State DLNR	1878	Maunawili	(M)	Kawainui Marsh
			Omao	(M)	Maunawili Stream
			Palapu	(P)	Omao Stream
			Makawao	(M)	Maunawili Stream
			Ainoni	(M)	Makawao Stream
			Olomana	(P)	Makawao Stream
			Waimanalo	(M)	Ocean

Notes: (C) Stream gage data in Appendix C appears to show a reduction in dry-weather stream discharge following development of the water source.

(P) No data is available to compare dry-weather stream discharge before and after development of the water source. However, it is possible that the water source causes a reduction in stream discharge.

(M) Miscellaneous USGS measurements suggest a reduction in dry weather stream discharge has occurred after development of the water source.

TABLE 25 — Miscellaneous Existing Minor Non-BWS Stream Diversions Which Have Slightly Reduced The Flow of Windward Oahu Streams

Water User	Acreage	Water Use (1)	Approx. Elevation of Diversion	Affected Stream	Tributary To
G. White	0.5	taro	unknown	Hakipuu	Ocean
P. Lua	unknown	agriculture	unknown	Punaluu Ditch	-----
F. Trotter	unknown	agriculture	unknown	Punaluu Ditch	-----
J. Farias	unknown	agriculture	unknown	Punaluu Ditch	-----
A. Nukumisi	unknown	agriculture	unknown	Punaluu Ditch	-----
G. Okano	unknown	agriculture	unknown	Punaluu Ditch	-----
7-8 Kuleanas	unknown	agriculture	unknown	Punaluu Ditch	-----
G. Fukumitsu	unknown	agriculture	20'	Hakipuu	Ocean
Kualoa Ranch	unknown	agriculture (2)	unknown	Hakipuu	Ocean
H. Roberts	1.3/.75	prawns/flowers	160'	Waikeekee	Waikane Stream
R. Kamaka	12	truck crops	120'	Waikane	Ocean
K. Kamiyama	unknown	agriculture	40'	Waikane	Ocan
A. Kawelo	unknown	truck crops	40'	Waikane	Ocean
N. Marks	unknown	agriculture	30'	Waikane	Ocean
D. Chinen	unknown	agriculture	20'	Waikane	Ocean
S. Serikaku	unknown	truck crops	unknown	Waianu	Waiahole Stream
T. Oshima	unknown	truck crops	unknown	Waianu	Waiahole Stream
C. Reppun	unknown	agriculture	120'-160'	Waiahole	Ocean
F. Lau	unknown	agriculture	80'	Waiahole	Ocean
C. Hoe	unknown	agriculture	unknown	Waiahole	Ocean
M. Murakami	unknown	truck crops	120'	Kaalaea	Ocean
L. Wong	unknown	prawns/taro	80'	Kaalaea	Ocean
S. Nakata	0.5	taro	60'	Waihee	Ocean
R. Hall	unknown	taro	30'	Waihee	Ocean
C. Wong	unknown	taro	30'	Waihee	Ocean
C. & P. Reppun	unknown	taro	unknown	Waihee	Ocean
K. Ryder	4	crops	80'	Kahaluu	Waihee
K. Ginoza	8	bananas/flowers	70'	Kahaluu	Waaihee
M. Tataishi	4	bananas	60'	Kahaluu	Waihee
M. Lau	5	truck crops	60'	Kahaluu	Waihee
Miguel Family	10	bananas	40'	Kahaluu	Waihee
Kokokahi Church	2	agriculture	40'	Anolani	Kaneohe
Ho'omaluhia Res.	26	recreation	200'	Kuou	Kamooalii
Shiroma Farms	unknown	agriculture	unknown	Luluku	Kamooalii
Ho'omaluhia Res.	26	recreation	200'	Kamooalii	Kaneohe
Ho'omaluhia Res.	26	recreation	200'	Halekou	Kamooalii
Ho'omaluhia Res.	26	recreation	200'	Hooleinaiwa	Kamooalii
and Wildlife Pond	1.5				

(1) Up to 5,000 gallons/day are required for adequate irrigation of 1 acre of crops or grass during prolonged dry-weather along the windward Oahu coast. Water needs decline with increasing rainfall.
(2) Two diversions near Coral Kingdom

Source: VTN Pacific, 1985.

TABLE 26
Existing BWS Water Sources
Which Have Reduced the Flow of Windward Oahu Streams

Name of Water Source	First Year In Service	Affected Streams(s)		Tributary To
Waihee Tunnel	1955	Kaalaea	(P)	Ocean
		Haiamoa	(P)	Ocean
		Waihee	(C)	Ocean
		Kahaluu	(C)	Waihee Stream
Waihee Wells I	1973	Waihee	(C)	Ocean
Waihee Inclined Wells	1977	Kaalaea	(P)	Ocean
		Haiamoa	(P)	Ocean
		Waihee	(C)	Ocean
		Kahaluu	(P)	Ocean
Kahaluu Tunnel	1947	Kahaluu	(C)	Ocean
		Ahuimanu	(P)	Kahaluu Stream
Haiku Tunnel	1941	Waihee	(C)	Ocean
		Kahaluu	(C)	Ocean
		Ahuimanu	(P)	Kahaluu Stream
		Waiola	(P)	Ahuimanu Stream
		Iolekaa	(C)	Heeia Stream
		Haiku	(C)	Heeia Stream
		Keaahala	(P)	Ocean
Luluku Tunnel	1945	Luluku	(M)	Kamooalii Stream
Kuou Wells I	1955	Kuou	(M)	Kamooalii Stream
		Kamooalii	(P)	Kaneohe Stream
Waimanalo Tunnels	1926	Waimanalo	(P)	Ocean

Notes: (C) Stream gage data in Appendix C shows a reduction in dry-weather stream discharge following development of the water source. In some cases, this may be due to rainfall instead of ground water withdrawal.

(P) No data is available to compare dry-weather stream discharge before and after development of the water source. However, it is possible that the water source causes a reduction in stream discharge.

(M) Miscellaneous USGS measurements suggest a reduction in dry-weather stream discharge has occurred after development of the water source.

Actual yield of these water sources for FY 1973 through FY 1984 is summarized in Table 12.

Punaluu Ditch

The Punaluu Ditch was built in the 1920s to irrigate sugar cane with water diverted from Punaluu Stream at an altitude of about 210 feet. Ditch maintenance has been poor since the closure of Kahuku Sugar Company in 1970. Median monthly mean discharge of the ditch has fallen from over 6 mgd during the 1960s to less than 2 mgd in the 1980s. There is frequently no flow in the ditch. [See Appendix C, page C-16] Because the end of the ditch is now blocked in Punaluu Valley, ditch water sometimes spills out and reaches Punaluu Stream. Although entirely owned by Bishop Estate, water from the ditch is used by farmers on both kuleana lands and Bishop Estate property in Punaluu Valley.

Waiahole Ditch and Tunnel System

Between 1913 and 1916, the Waiahole Water Company, a subsidiary of Oahu Sugar Company, drove a water transmission tunnel through the Koolau Range between Waiahole Valley and Waiawa. The tunnel transports windward Oahu water for irrigation of sugar cane in leeward Oahu. By 1935, the Waiahole Ditch and Tunnel System had been expanded to include one water development tunnel in Kahana Valley, two in Waikane Valley, one in Uwau Valley, and surface water intakes diverting the headwaters of Kahana, Waikane, Waiahole Streams and tributaries of Waikane and Waiahole Streams. Subsequently, pumps and a pipeline were installed to allow up to 1.7 mgd to be pumped from Waiahole Stream at an altitude of about 500 feet to the main bore of Waiahole Tunnel. (These pumps are currently not in use and their future use needs to be determined by agreement between the Waiahole Water Company and the DLNR.) Yield of the ditch and tunnel system was last increased by the extension of Uwau Tunnel in 1963.

During dry weather, most of the yield of the ditch and tunnel system stems from water development tunnels. USGS data from a gage in Waianu Valley shows a Q_{90} discharge for the system in excess of 23 mgd between 1963 and 1969. [See Appendix C, page C-24] Between this gage and the main bore Waiahole Tunnel, in addition to surface runoff caught by the ditch, water is sometimes pumped from Waiahole Stream into the ditch system or dumped from the ditch system into Waiahole

Stream. There is additional inflow within the main transmission tunnel carrying water to leeward Oahu. The USGS estimates that the dry weather Q_{90} water gain within the main bore Waiahole Tunnel is about 3.7 mgd, of which perhaps half stems from ground water in windward Oahu. [Ref. 85]

Most of the water carried in the Waiahole Ditch and Tunnel System is at the expense of windward Oahu stream flow. However, except for Kahana and Waiahole Streams, there is no data to evaluate the relative extent to which streams have been affected. The lowest monthly mean discharge of Kahana Stream was 14.1 mgd at an altitude of 40 feet over a three-year period (FY 1913-16) prior to construction of the Kahana Tunnel. It is not known whether the period FY 1913-16 was unusually rainy or dry and resulted in atypical measurements of lowest monthly mean disharge. By comparison, after the tunnel was constructed, the lowest monthly mean discharge of Kahana Stream at an altitude of 20 feet was less than 10.7 mgd for 13 of the 25 years in which stream flow was gaged. [See Appendix C, page C-18, 19]

Construction of the main bore Waiahole transmission tunnel did not affect stream flow prior to August 1913. Over an 8 month period ending June 30, 1912, the lowest monthly mean discharge of Waiahole Stream was 14.3 mgd at an altitude of 160 feet, and 17.6 mgd at an altitude of 20 feet. The 3.3 mgd dry-weather gain in Waiahole Stream was partly due to inflow from Waianu Stream and partly due to ground water seeping directly into Waiahole Stream. During the year ending June 30, 1913, the lowest monthly mean discharge of Waiahole Stream was 12.9 mgd at an altitude of 160 feet. Comparable data is not available at 20 feet of elevation. [See Appendix C, page C-27]

During the month following completion of the main bore Waiahole Tunnel, i.e. June 1916, the monthly mean discharge of Waiahole Stream fell to 9 mgd at an altitude of 160 feet. Springs estimated at 5.7 mgd, above the tunnel portal, dried up. After construction of the rest of Waiahole Ditch and Tunnel System, including Uwau Tunnel with a portal elevation of about 800 feet, there were further reductions in the discharge of Waiahole Stream and its tributaries. Between 1955 and 1968, the lowest monthly mean discharge of Waiahole Stream at an altitude of 250 feet was less than 2.2 mgd for 7 of the 13 years in which stream flow was gaged. [See page C-26] On July 20, 1959, in an

unusually dry year, Waiahole Stream had a dry-weather discharge of only 2.00 mgd at an altitude of 250 feet, and 2.73 mgd at an altitude of 80 feet (including 0.62 mgd of inflow from Waianu Stream). [Ref. 85] Stream flow may have been slightly further reduced after 1963 by extension of Uwau Tunnel from 2,275 feet to 2,503 feet. [Ref. 85]

Uwau Tunnel is at the headwaters of Uwau Stream, two valleys away and over one mile from the headwaters of Waiahole Stream. Given the fact that Uwau Tunnel appear to have substantially reduced the dry-weather discharge of Waiahole Stream mauka of inflow from its tributaries, it is possible that other large water development tunnels also have far-reaching impacts on stream flow. Besides affecting Kahana Stream, Kahana Tunnel conceivably may have reduced the dry-weather flow of Punaluu Stream. However, this cannot be evaluated with available data. It is also possible but unprovable that the two Waikane Tunnels reduced the dry-weather flow of Hakipuu Stream, Waikane Stream, and/or Waikeekee tributary of Waikane Stream. Similarly, besides affecting Waiahole Stream, it is possible but unprovable that the main bore Waiahole Tunnel reduced the dry-weather flow of Kaalaea Stream.

Kualoa System

Kualoa Ranch pipes all the water from two springs in the Hakipuu Stream area for irrigation of 15 acres of flowers in Hakipuu and 500 acres of pasture in Kualoa. According to Kualoa Ranch, the combined dry-weather flow of these springs is about 0.7 mgd. Both springs are diverted at an altitude of about 150 feet. Without the diversion, water from the springs would enter Hakipuu Stream.

Waiahole Valley Water System

A pipe diverts 0.4 mgd from the headwaters of Waianu Stream. The water is used by 60 family/farmers in Waiahole Valley, and 3 families in Waikane Valley. In 1916, when first installed, the pipe carried 0.5 mgd. The pipe was installed to guarantee water for tenants in Waiahole and Waikane Valleys as part of an agreement allowing construction of the Waiahole Ditch and Tunnel System. The State acquired water rights for 0.125 mgd from the pipe with State

acquisition of Waiahole Valley. The rest of the water in the pipe is owned (but not used) by Mrs. A. Lester Marks and Windward Partners.

Waihee Tunnel

Construction and operation of the 1,624-foot BWS Waihee Tunnel in 1955 reduced the dry-weather discharge of Waihee Stream and possibly Kahaluu Stream. [See Appendix C, pages C-32, C-35] Yield of the tunnel is controlled with a bulkhead. Conceivably, the Waihee Tunnel may also have reduced the dry-weather flow of Kaalaea and/or Haiamoa Streams. However, this cannot be determined because neither Kaalaea nor Haiamoa Stream has ever been gaged.

Waihee Wells I

Although the BWS Waihee Wells I were first used in FY 1974, because of a lawsuit, practically all pumpage was discontinued beginning in FY 1978. Pumpage from these wells appears to have reduced the dry-weather flow of Waihee Stream at an altitude of 170 feet, i.e. below the static head of the wells, but not at higher elevations. [See Appendix C, pages C-29, C-30, C-34] The effect of pumpage can be demonstrated by comparing the lowest monthly mean discharge of Waihee Stream at altitudes of 193 feet and 170 feet. In FY 1975, when the Waihee Wells I yielded an average of 2.11 mgd, the stream only gained an average of 0.27 mgd between the elevations of 193 feet and 170 feet during the month of lowest stream flow. By comparison, in FY 1982, when the wells yielded an average of only 0.01 mgd, the stream gained an average of 1.95 mgd between these elevations during the month of lowest stream flow. [See pages C-32, C-34]

Waihee Inclined Wells

Construction and operation of the BWS Waihee Inclined Wells in 1977 appears to have reduced the dry-weather discharge of both forks of Waihee Stream. [See Appendix C, pages C-29, C-30] Conceivably, although there is no data in support or to the contrary, the Waihee Inclined Wells may also have reduced the dry-weather flow of Kaalaea

and Haiamoa Streams. Yield from the inclined wells is regulated to sustain Waihee Falls, which are higher than the ground elevation of the inclined wells. The falls dry up when the inclined wells are allowed to flow free.

Kahaluu Tunnel

Construction and operation of the 393-foot BWS Kahaluu Tunnel in 1947 appears to have reduced the dry-weather discharge of Kahaluu Stream, but apparently did not affect Waihee Stream. [See Appendix C, pages C-32, C-35] Springs above the elevation of the tunnel portal were observed to dry up. Conceivably, the Kahaluu Tunnel may also have reduced the dry-weather flow of Ahuimanu Stream. This cannot be determined because Ahuimanu Stream has never been gaged.

Haiku Tunnel

Construction and operation of a 1,200-foot BWS water development tunnel in 1941 in Haiku Valley at an elevation of about 550 feet may have slightly reduced the dry-weather discharge of Waihee Stream about 3.5 miles away at an elevation of 193 feet. Given the distance, this hypothesis will be in question until such time as a model is developed of how rainfall affects Waihee Stream discharge.

For both Waiahole and Kaneohe rainfall gages, calendar year 1941 had about the same level of rainfall as 1940, and calendar year 1942 was substantially rainier than calendar year 1941. [See Appendix C, page C-56] Over the same period, stream gages for Waihee, Kahaluu, Iolekaa, and Haiku Streams all registered a <u>decline</u> in dry-weather stream discharge. [See Appendix C, pages C-33, C-35, C-38-40] The reduction in dry-weather stream discharge may be due to BWS development of Haiku Tunnel and/or the fact that cumulatively, there was more rainfall in the 1930s than in the 1940s.

Conceivably, the Haiku Tunnel may also have reduced the dry-weather flow of Ahuimanu Stream, its tributary Waiola, and/or Keaahala Stream. This cannot be determined because none of these streams has been gaged. Due to a change in the mode of operation, production from

Haiku Tunnel has been substantially reduced since FY 1978, which probably means that effects on stream flow have also been reduced.

Luluku Tunnel

There is inadequate data to determine the effects of the BWS Luluku Tunnel on nearby streams. The tunnel is relatively short (483 feet) and may only have reduced the flow of Luluku Stream and streams to which Luluku is tributary. [Ref. 85] Stream flow is now augmented by leakage from the tunnel when tunnel yield exceeds the demands of the BWS system.

Kuou Wells I

There is inadequate data to determine the effects of the BWS Kuou Wells I. Although their ground elevation was 287 feet, the initial static head of the Kuou Wells was 312 feet. When the two artesian wells were first put into production, springs at an altitude of 310 feet dried up and the flow of Kuou Stream below the springs was visibly reduced. There was additional reduction of stream flow when one of the Kuou Wells was capped and a pump was installed on the other well to increase yield. Presumably, most of the water developed by the remaining production well is at the expense of Kuou Stream, and Kamooalii Stream to which Kuou is tributary.

Maunawili Ditch and Tunnel System

The first section of the Maunawili Ditch was built in 1878 to irrigate sugar cane in Waimanalo with water from streams in Maunawili Valley. By 1926, the ditch had been extended from Omao Stream (at an altitude of 470 feet in Maunawili Valley) to the U.H. College of Tropical Agriculture Waimanalo Research Station (at an altitude of 100 feet in Waimanalo Valley). Between 1900 and 1925, to supplement the flow of the Maunawili Ditch, five water development tunnels were driven in upper Maunawili Valley. Operation of the Maunawili Ditch and Tunnel System became the responsibility of the Hawaii Water Authority in 1953 and subsequently the State DLNR. The system gradually deteriorated

over several decades. Substantial repairs are now in progress to ensure that water entering the system reaches farmers in Waimanalo.

Based on miscellaneous dry-weather measurements, the DLNR estimates that when leaks are repaired, the Q_{90} discharge of the Maunawili Ditch will be roughly 2.4 mgd at the altitude of maximum flow. [Ref. 20] Of this, about 0.3 mgd is from diversion of the headwaters of Waimanalo Stream, 1.1 mgd from water development tunnels in Maunawili Valley, and 1.0 mgd from stream diversions in Maunawili Valley. [Ref. 84] Presumably, most of the flow developed by water development tunnels in Maunawili Valley is at the expense of stream flow in Maunawili Stream and tributaries including Omao, Makawao, Ainoni, and possibly Palapu and Olomana. However, available data is too limited to assess the extent to which different streams have been affected.

Waimanalo Tunnels

There is no data to determine the effects of BWS water development tunnels in Waimanalo on stream flow. Presumably, most of their 0.5 mgd dry-weather flow is at the expense of Waimanalo Stream.

G. PROPOSED WATER DEVELOPMENT

Non-BWS water development projects are proposed in three areas of windward Oahu; in Punaluu Valley, Waiahole Valley and in Kahaluu Valley. In Punaluu Valley, Fred Trotter, a Bishop Estate leasee, has proposed that the Punaluu Ditch intake be restored and three former Kahuku Sugar Company stream intakes be re-established on Punaluu Stream. The Punaluu Ditch originally diverted a maximum of up to 8-10 mgd, with an average of about 4-5 mgd. Currently, it diverts about 1-2 mgd. [Ref. 127]

In addition, the original Kahuku Sugar Company diversions would be re-cut to divert water from Punaluu Stream and prevent flooding in Punaluu Valley. A total of 5-5.5 mgd of ditch and stream water would

be used to irrigate up to 550 acres in Punaluu Valley. [Ref. 127] To date, the projects have not been granted all necessary regulatory permits.

As of the date of this Final EIS, one State water development project has been proposed in Waiahole Valley. The Department of Agriculture and Department of Business and Economic Development Housing and Finance Development Corporation (HFDC, formerly Hawaii Housing Authority) are jointly developing an agricultural park in Waiahole Valley. The HFDC has been granted necessary permits by the BLNR to develop two wells to serve the proposed agricultural subdivision. Two exploratory wells have been drilled by the DLNR for the agricultural park, about 1,800 feet west of the site of the proposed BWS Waiahole Wells. HFDC will develop a 1 mgd operating well, a standby well, a reservoir, and transmission mains in 1988. Because of this, the BWS most likely will not develop its proposed wells in Waiahole Valley. Proposed State water development facilities in Waiahole Valley will not be designed to BWS standards. Since the BWS will not manage such facilities, the DLNR will probably assume full responsibility for maintenance and establishment of rates and charges for water use. [Ref. 146]

The two DLNR exploratory wells in Waiahole Valley probably develop ground water which would otherwise seep into Waiahole Stream below their static (non-pumping) head. Well No. 2853-04 is located at an elevation of 493 feet and has a static head of 485 feet. Well No. 2853-05 is located at an elevation of 490 feet and has a static head of 488 feet. A 72-hour pump test for each well yielded about 1.71 mgd. The test was not adequate to determine maximum sustainable yield because water levels continued to fall during the pump test. Impacts of the pump test on stream flow were not monitored by the DLNR.

To mitigate the impacts of proposed State wells on the flow of Waiahole Stream, the DLNR is in the process of "withdrawing" water currently available from a State lease to Oahu Sugar Company, Ltd. The Waiahole Irrigation Company, a susidiary of Oahu Sugar Company, formerly pumped up to 1.7 mgd from Waiahole Stream at an altitude of about 500 feet to the Waiahole Tunnel portal for transmission to leeward Oahu. Although the Waiahole pumping station had been discontinued for many yers, as recently as 1984, Oahu Sugar Company

was considering rebuilding and operating the pumping station. The effect of proposed State water license amendments will be to permanently discontinue the Waiahole pumping station. [Ref. 128, Ref. 146, Ref. 152]

Waianu Stream is tributary to Waiahole Stream. Waianu Stream water (currently 0.4 mgd) goes into a pipe at high elevation to service 60 families/farmers in Waiahole Valley, and three tenants of Mrs. Marks in Waikane Valley. When the HFDC completes its new water system for Waiahole Valley, the HFDC will divert 125,000 gallons per day from the pipe into Waianu Stream. The rest of the water in the pipe is owned by Mrs. A. Lester Marks and Windward Partners. Since the pipe is antiquated and has little use in Waikane Valley, most of the piped water will probably overflow into Waianu Stream when Waiahole tenants stop using it. (The State bought 1/4 of the water rights to the pipe when buying Waiahole Valley. The pipe is supposed to take 0.5 mgd.) [Ref. 146]

The U.S. Department of Agriculture Soil Conservation Service has taken the lead in developing a concrete flood control channel on Kahaluu Stream. The project involves construction of a 3,900-foot long concrete channel, from an elevation of about 88 feet to the man-made Kahaluu Lagoon, and a concrete debris basin. In order to allow continued agricultural use of water from Kahaluu Stream, an irrigation by-pass channel will be constructed to carry stream water from an elevation of about 75 feet to existing stream users. In times of normal stream flow, the irrigation by-pass channel is designed to accommodate 3.2 mgd. Unused water from the by-pass channel will re-enter Kahaluu Flood Control Channel at an elevation of 17.5 feet, just mauka of inflow from Ahuimanu Flood Control Channel. The total project has received all necessary permits and construction will be completed in 1988. [Ref. 144]

H. BASAL GROUND WATER

By definition, an aquifer is a permeable, porous geologic formation saturated with water. By definition, a basal aquifer is saturated

with both fresh water and ocean water, with fresh water floating on and displacing the ocean water. The fresh water saturating a basal aquifer is commonly referred to as basal ground water.

If a cylindrical plastic bag (wider than it is deep) were filled with fresh water and placed in the ocean, then the bag would float in the ocean with 40 inches of fresh water submerged for every 1 inch of fresh water exposed above sea level. It is possible for fresh water to float in the ocean because salty ocean water weighs 2.5% more than fresh water. This principle generally applies to water saturating a basal aquifer, but the situation is much more complicated because 1) basal ground water continuously leaks into the ocean; 2) there is a brackish "transition" zone at the interface between fresh water and salt water (where fresh water and salt water have mixed); and 3) sedimentary material with low permeability (i.e. caprock) may confine basal ground water.

There are two kinds of basal aquifers in Hawaii, unconfined and confined. An unconfined basal aquifer is one in which the water table (i.e. upper surface of water saturating the aquifer) is free to change as the amount of water in the aquifer changes. A confined basal aquifer is one in which water saturating the aquifer is confined from moving upward by sedimentary caprock overlying the aquifer. The water is also restrained from moving in a horizontal seaward direction by the caprock. Hence, ground water in a confined basal aquifer is under pressure. Figure 35 illustrates these concepts.

The water table of an unconfined basal aquifer typically has very little slope. Unless there is a hydrologic barrier to the seaward movement of basal ground water, the water table of an unconfined basal aquifer on Oahu will range from near sea level at the shoreline to a few feet above sea level a mile inland from the ocean.

In some parts of Oahu, basal ground water is inhibited from moving seaward by dikes and/or sedimentary caprock. The frictional resistance to water movement through less permeable caprock and/or dikes causes basal ground water to "pile up" on their inland side until there is sufficient hydraulic head (i.e. water pressure) to push water past them. Hence, inland of caprock or dikes, the water table of an unconfined basal aquifer may be more than twenty feet above sea

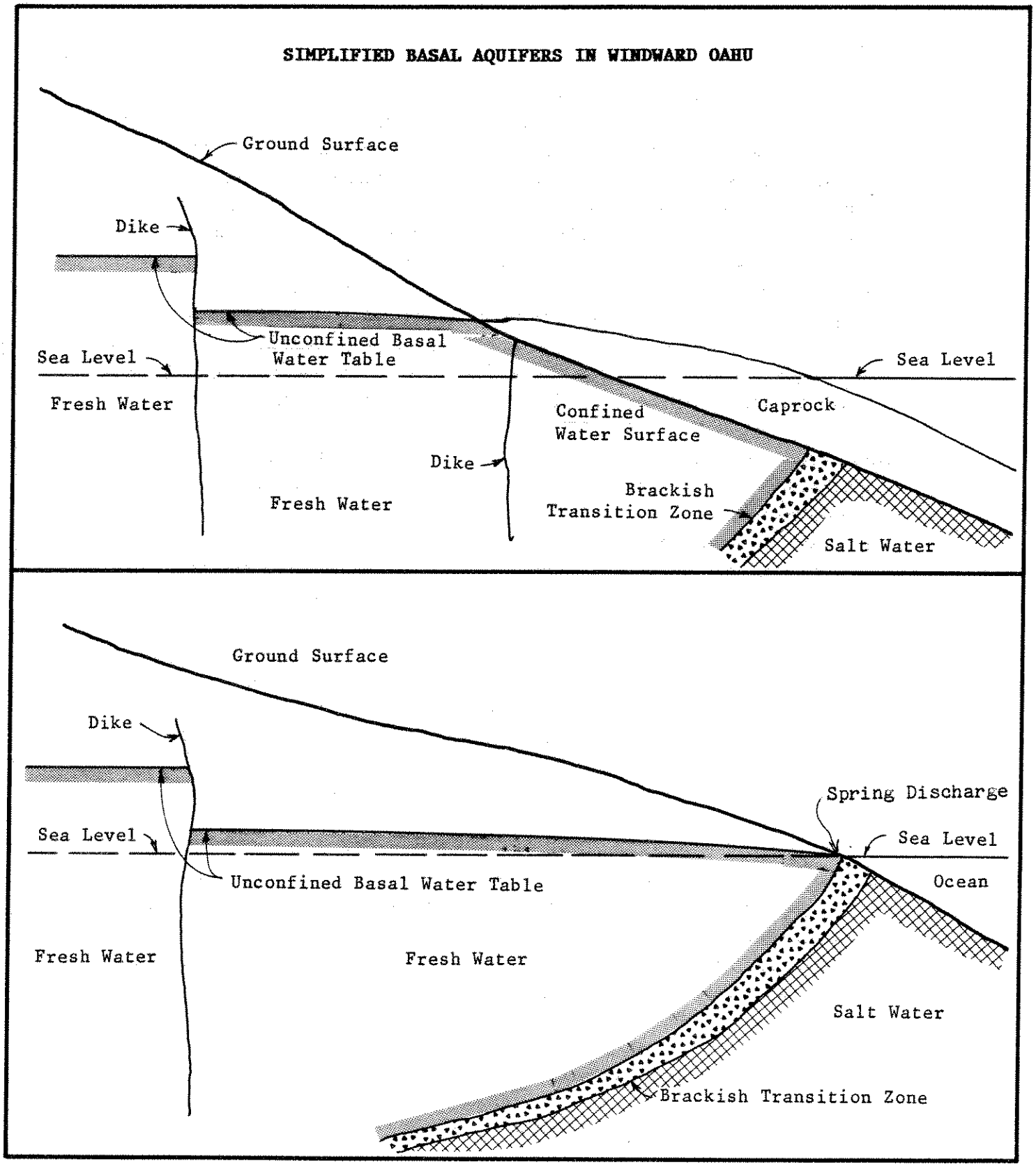

SIMPLIFIED BASAL AQUIFERS IN WINDWARD OAHU
Ground Surface
Dike
Unconfined Basal Water Table
Sea Level
Sea Level
Fresh Water
Confined Water Surface
Caprock
Dike
Brackish Transition Zone
Fresh Water
Salt Water
Ground Surface
Dike
Spring Discharge
Sea Level
Sea Level
Unconfined Basal Water Table
Ocean
Fresh Water
Fresh Water
Salt Water
Brackish Transition Zone

FIGURE 35

level.

Unconfined basal aquifers in windward Oahu are primarily recharged by leakage and overflow of high-level dike-impounded ground water and to a lesser extent by direct infiltration of rainfall, stream flow, and sometimes irrigation water. Confined basal aquifers in windward Oahu are recharged by the seaward movement of unconfined basal ground water and dike-impounded ground water. Caprock prevents direct infiltration of surface water into confined basal aquifers. Ground water leaves confined basal aquifers in windward Oahu by slowly seeping around or through caprock and any dikes beneath the caprock. Springs can occur at low elevations in places where there are holes in the caprock confining basal ground water under pressure. Such caprock springs are present in Kahuku, Punaluu, Kahana, Kaaawa, and Waimanalo.

When aquifer recharge exceeds aquifer water losses, ground water accumulates and water pressure (hydraulic head) increases. When aquifer recharge is less than aquifer water losses, water pressure decreases. Seepage of ground water out of a basal aquifer is proportional to water pressure in the aquifer. Over the long term, under natural conditions, average recharge of a basal aquifer will always equal average ground water losses from the aquifer.

As summarized in Table 3 and Figures 5-9 of Chapter I, the BWS is proposing to develop basal ground water in windward Oahu with a series of wells between Malaekahana and Kaaawa. The BWS is also proposing to develop high-level dike-impounded ground water in Punaluu and Kahana Valleys which to some extent currently recharges basal aquifers in these valleys.

In the parts of windward Oahu where the BWS is proposing to develop basal ground water, the static head (non-pumping water level) of existing BWS wells is generally more than 17 feet above sea level. [See Tables 3 and 11] The water table (or hydraulic potential) is high in this region because caprock and dikes substantially retard the discharge of basal ground water from basal aquifers. Caprock in windward Oahu starts from a ground elevation of about 30 feet and extends up to several miles beyond the shoreline.

It is not known to what extent a hydraulic connection exists between

basal aquifers in windward Oahu. Current thinking is that because of dikes and poorly permeable alluvial fill material in stream valleys, there is only limited movement of basal ground water along the coast between Kaaawa and Punaluu. [Ref. 85] There is no data to prove or disprove this theory. In contrast, because the static heads of coastal wells gradually decline in a northwesterly direction from about 22 feet at Punaluu to about 10 feet at Kahuku, one hypothesis is that beginning north of Punaluu Stream, most basal ground water moves northward beneath the coastal plain and discharges into marshes and springs between Kahuku Town and Kahuku Point. [Ref. 59] Under this hypothesis, there is a single basal aquifer extending from Punaluu Valley to Kahuku Point known as the Koolauloa Basal Aquifer. If this hypothesis is correct, then ground water in the Koolauloa Basal Aquifer flows in all directions from areas of high hydraulic potential to areas of low potential. Assuming hydraulic integrity, long term excessive pumping of wells in any part of the aquifer could adversely affect the static head and yield of wells in other parts of the aquifer. Another implication of this hypothesis is that basal ground water between Kaluanui and Laie can be developed by wells in Kahuku and/or Punaluu.

Other than differentials in the static heads of coastal wells, which could be accounted for by reduced rainfall towards Kahuku, there is no evidence that the Koolauloa Basal Aquifer is completely hydrologically continuous between Punaluu and Kahuku. Another hypothesis is that most basal ground water in Koolauloa slowly leaks through coastal caprock rather than flowing to Kahuku through and beneath sedimentary fill material in Kaluanui, Kaipapau, Malaekahana, and numerous smaller stream valleys. Even if caprock is only poorly permeable substantial quantities of ground water still could seep into the 30 square miles of caprock between Punaluu and Kahuku. [Ref. 57] As evidence that basal water may seep into caprock, an exploratory BWS alluvial well (Punaluu Well IV) shows developable yields of 0.5 mgd. If this hypothesis is correct, then basal ground water between Punaluu and Kahuku would behave more as if it were compartmentalized between stream valleys (as is the case in leeward Oahu) than as if it were part of a continuous aquifer. Another implication of this hypothesis is that it is not possible to develop basal ground water between Kaluanui and Laie with wells in either Punaluu or Kahuku.

There is insufficient data at this time to resolve the extent to which valley fill caprock limits movement of fresh basal ground water across Kaluanui, Kaipapau, and other stream valleys. However, there is some evidence for a continuous Koolauloa Basal Aquifer. In 1961, a 4-day pump test of Kahuku Plantation Well 398 (DOWALD No. 3354-02) near the mouth of Kaluanui Valley at a rate of 4.3 mgd produced a slight drawdown in the static head of Plantation Well 401 (DOWALD No. 3654-04) which is 1,000 feet to the east, and observation Well 396 (DOWALD No. 3654-02) which is 2,500 feet to the north. [Ref. 85] Similarly, after a brief shutdown, the BWS Punaluu wells were pumped at rates of 483 to 888 gpm for about 4 hours in June 1983, and produced a slight drawdown in Well 401 (DOWALD No. 3654-04) which is about a mile to the northwest, but not in the exploratory Kaluanui Well I. [Ref. 49] A possible explanation for this effect is that intervening caprock or dikes inhibit basal ground water flow between Well 401 (DOWALD No. 3654-04) and Kaluanui Well I.

Before the Kahuku Sugar Plantation closed in 1970, records were kept on the yield, static head, and chloride content of numerous plantation wells. Based on hydrological budgeting and the operational experience of wells in the region, the BWS conservatively estimates that between 31 to 36 mgd of basal ground water can be withdrawn by appropriately sited wells in the Koolauloa Basal Aquifer without adversely affecting the basal water table or causing salt water intrusion into public and private wells which are currently in use. By comparison, as of the date of the Draft EIS, the BWS estimated that existing wells normally withdraw about 20.3 mgd of basal ground water between Kahuku and Punaluu (of which about 10 mgd is withdrawn by wells north of Laie, and 6 mgd is withdrawn by wells south of Kaluanui). [Ref. 49] Subsequently, when Amorient Aquaculture International, Inc. reduced withdrawal of basal ground water in Kahuku, the BWS authorized the U.S. Fish and Wildlife Service to drill two new wells in Kahuku and withdraw the same quantity of basal ground water formerly used by Amorient. [Ref. 159]

Based on the "worst case" assumption that there is only minimal movement of basal ground water along the coast from Punaluu to Kahuku, most proposed BWS basal wells are sited in those parts of the Koolauloa Basal Aquifer where there currently is relatively little development of basal ground water. Based on the same assumption,

after completion of a 1 mgd DOWALD well to service Kahuku Agricultural Park, the BWS is restricting all additional public or private development of basal ground water between Malaekana and Kahuku. The BWS will not develop new wells in Malaekahana except to replace existing wells which are now in use and do not meet BWS standards.

I. WETLANDS

A wetland might be defined as a seasonally or permanently flooded inland area. Some wetlands are brackish and subject to tidal influence. In wetlands, plant species are found which require and/or can survive saturated soil conditions. Plant species which cannot survive saturated soil conditions may be partially or completely excluded. Predominant flora in low elevation Oahu freshwater wetlands include California grass, water hyacinth, honohono grass, various bulrushes and sedges, hau, cattail, Job's tears, and ape. Predominant flora in brackish Oahu wetlands include mangrove, sourbush, saltgrass, pickle weed, and various sedges. Except at high elevations, most plant species present in Oahu wetlands either have been introduced to Hawaii or occur naturally outside of Hawaii. No rare or endangered native plants are present in low elevation Oahu wetlands except for a water fern, Marsilea vilosa, which is only found in small areas of leeward Oahu. [Ref. 6, Ref. 160]

Except for the man-made Ho'omaluhia Park Wildlife Pond and Flood Control Reservoir, extensive windward Oahu wetlands are all at low elevations on the coastal plain. Significant natural coastal wetlands in windward Oahu include those at Kahuku, Kahana, Waikane, Waiahole, Haiamoa, Kahaluu, Heeia, Kawainui, and Waimanalo. Kawainui Marsh at 800+ acres is several times larger than any other natural windward Oahu wetland. Kaelepulu Pond in Kailua was formerly a large shallow brackish wetland, but it has been dredged and coverted into a marine lake within a housing development (Enchanted Lake). The Nuupia Fishponds, originally constructed by the Hawaiians, have become a wetland which is sometimes saltier than the ocean. In effect, man-made aquaculture and mariculture ponds at Kahuku and Hakipuu are also

wetlands.

Although not all wetlands are useful to man, some wetlands may serve a number of valuable functions in Hawaii. They can trap silt from storm runoff and reduce deposits of sediment on beaches, bays, and coral reefs. They can act as flood control basins for storm runoff and reduce flooding of coastal areas. They can remove nutrients from storm runoff and wastewater discharges and help to protect coastal water quality. They can be used for aquaculture or for wetland agriculture. Open waters in wetlands can provide habitat for shorebirds, waterbirds, fish, and invertebrates.

The fresh water in a wetland or estuary can come from either rainfall, surface runoff, streams, or ground water springs. Fresh water can leave wetlands by either surface runoff, infiltration, evaporation, or transpiration. A more detailed discussion is contained in Sections B and D of this Chapter. Although it is not possible to directly measure ground water infiltration into wetlands, ground water is often as important as streams in maintaining fresh water in wetlands. For example, as much water may seep underground into Kawainui Marsh as surface water which visibly flows into the Marsh. (One estimate is that of the 26.2 mgd average annual rainfall on the Kawainui Marsh watershed, mauka of Kalanianaole Highway, an average of 2.4 mgd is carried away to Waimanalo by the Maunawili Ditch and Tunnel System, 10.4 mgd is lost to evapotranspiration, 6.7 mgd becomes stream flow into the Marsh, and 6.7 mgd is stored as ground water in the Marsh watershed and eventually seeps into the Marsh.) [Ref. 20, Appendix B]

Nutrients (nitrogen and phosphorus) contribute to growth of plants in wetlands and the productivity of estuaries and marine waters. It is generally acknowledged that additional nutrients may be beneficial to marine food-chains in Hawaii. However, excessive nutrient loading of wetlands, estuaries, embayments, and other bodies of water with poor circulation can result in smothering plant growth and/or loss of habitat for water-dependent animals.

Ground water on Oahu generaly does not carry much nutrients (except where it has been polluted by surface land uses or cesspools). On the other hand, streams and surface runoff can carry a lot of nutrients. Under dry-weather conditions, the majority of the nutrients entering

Kawainui Marsh and its tributary Maunawili Stream stem from the discharge of City wastewater treatment plants (WTP). [Ref. 161] These wastewater discharges will be phased out before the end of the decade and sewerage diverted to Kailua WTP. Apart from the direct discharge of treated sewage, urbanization and agricultural operations usually increase total nitrogen and phosphorus in surface water runoff. [Ref. 131]

The concentration of dissolved nutrients in perennial windward Oahu streams is fairly constant even during storms. For relatively brief periods, storm flows exponentially increase the concentration of particulate nutrients (from sedient). Over the long term, dissolved nitrogen and phosphorus compose the bulk of the nutrients carried by perennial windward Oahu streams. [Ref. 131] Hence, over the long term, the total quantity of nutrients carried by any perennial windward Oahu stream to wetlands, estuaries, and/or marine waters is roughly proportional to total stream flow over the same period.

J. ESTUARIES

An estuary might be defined as a coastal body of brackish water formed by mixing of fresh water and sea water. Most estuaries in Hawaii are either stream mouths subject to tidal influence or embayments. Coastal wetlands in windward Oahu are commonly estuarine at low elevations near the shoreline. But not all brackish windward Oahu wetlands are estuaries. For example, caprock springs along the coast in Kaaawa and Kahuku are the natural source of brackish wetlands which do not come in contact with sea water during high tide.

Estuaries provide habitat for a wide variety of aquatic biota. In the continental United States, a majority of fisheries involve species which at some point in their life cycle are estuarine-dependent. The same is not true in Hawaii, probably because Hawaiian estuaries are geologically recent and relatively small. By mainland standards, in terms of size, Pearl Harbor is the only significant estuary anywhere in Hawaii. [Ref. 132]

Windward Oahu estuaries include Kahana estuary, parts of Kaneohe Bay (especially the south Bay), the Kahaluu Flood Control Basin, the makai portion of Heeia Marsh, the makai portion of Kawainui Marsh, Kawainui Canal, Kaelepulu Channel, and the mouths of virtually every windward Oahu stream. During dry weather, because of good circulation, most of Kaneohe Bay is marine rather than estuarine. [Ref. 119] Prior to the construction of the Kawainui Canal and various flood control levees in the 1960s, Kawainui Marsh used to drain into Kaelepulu Pond (now dredged and converted to Enchanted Lake). At that time, none of Kawainui Marsh was estuarine and Kaelepulu Pond was estuarine rather than marine.

K. TERRESTRIAL VEGETATION AND WILDLIFE

The Hawaiian Islands were formed by volcanoes which emerged from the ocean devoid of plant and animal life. Because the islands are only a few million years old, all vegetation and wildlife unique to Hawaii have evolved over eons from ancestral species of plants and animals which arrived in Hawaii as the result of natural processes.

Counting subspecies, varieties, and forms, there are more than 2,500 kinds of higher plants found only in Hawaii. These endemic plants are believed to have evolved from about 275 immigrant species of plants native to other parts of the world. [Ref. 28] As a result of human actions, especially clearing of land and introduction of plants and plant-eating animals from outside of Hawaii, introduced plant species have almost completely replaced native plant cover on the main Hawaiian islands below an elevation of about 450 meters. [Ref. 28] Hundreds of Hawaii's endemic plant species are unofficially considered either threatened or endangered. [Ref. 2] However, only a few species of endemic plants have received formal recognition and protection as endangered species from either the U.S. Fish and Wildlife Service [Ref. 72] or the State Department of Land and Natural Resources [Ref. 101].

Since the Nature Conservancy of Hawaii is preparing an atlas of

reported sitings of potentially threatened or endangered Hawaiian plants, the location maps contained in Chapter I of this EIS were compared with Nature Conservancy maps and file reports in February 1985. [Ref. 60] The most "recent" Nature Conservancy records of rare endemic plants in the project area are limited to the following:

- Lepidium o-waihiense C. & S. ('anaunau) was observed in Malaekahana at an unknown site in 1919. (The proposed BWS Malaekahana Wells are located in Malaekahana Valley.) It should be noted that although rare on the main Hawaiian Islands, 'anaunau is common in the Northwestern Hawaiian Islands (a national wildlife refuge) and has been dropped from consideration as a candidate endangered species. [Ref. 102]

- Viola oahuensis was observed in the "Punaluu mountains" at an unknown site in 1916. (The proposed BWS Punaluu Tuunnel is located on the slopes of Punaluu Valley.)

- Lobelia hypoleuca H. ('opelu) was observed on the Kahana Bay Trail at an unknown site south of Kahana Stream in 1932. (The proposed BWS Kahana Wells, III, IV, and V and Kahana 315 Reservoir are located along an abandoned jeep road north of Kahana Stream.)

Field trips were made to all of the proposed sites for new BWS water sources in windward Oahu except for well sites at Kaipapau, Kaaawa, and Hakipuu Valleys. [See Plates 6 to 57 at the end of Chapter I.] Aggressive introduced plants were found to have displaced almost all native vegetation along proposed access routes to and at sites of proposed water sources. Most native plants observed are common in other parts of windward Oahu. Introduced plants predominate along streams and, in many places, provide shade for flora near streams and fauna in the streams.

Because there is a possibility of encountering rare endemic plants at high elevations on Oahu, formal botanical surveys were conducted for this EIS at the sites of the proposed Punaluu Tunnel, Kaalaea Inclined Wells, and Ahuimanu Inclined Wells. The botanical surveys included the proposed access road routes described in this EIS for the Punaluu Tunnel and Ahuimanu Inclined Wells. In general, most of the plants observed were common introduced species. No rare, threatened, or

endangered native plants were found. [See Appendix E.]

There are only two species of land-based mammals unique to Hawaii: the hoary bat (Lasiurus cinereus) and the Hawaiian monk seal (Monachus schauinslandi). The project area does not provide habitat for either of these endangered endemic species. [Ref. 28]

Prior to human contact, there were more than 110 species and subspecies of birds unique to Hawaii. Fossils have been found of at least 40 kinds of endemic birds for which there are no recorded sitings. Most, if not all, of these "unrecorded" species became extinct after Hawaii was settled by the Polynesians. Another 24 kinds of endemic birds have become extinct within the last two centuries. Of the 46 types of endemic birds still remaining, 30 (including 4 kinds of waterbirds) are listed by the U.S. Fish and Wildlife Service as endangered species. [Ref. 11] Factors now adversely affecting endemic bird populations include introduced predatory animals, introduced bird diseases and parasites, habitat alteration, and in some cases competition with introduced birds. [Ref. 3, Ref. 11, Ref. 29, Ref. 74]

Apart from waterbirds, most endemic birds on Oahu are limited to native forests. The predominately introduced vegetation in the immediate vicinity of proposed BWS facilities does not provide suitable habitat for rare or endangered endemic terrestrial birds. [Ref. 3, Ref. 11]

There are more than 10,000 kinds of insects found only in Hawaii. These endemic insects are believed to have evolved from as few as 150 immigrant ancestral species. [Ref. 28, Ref. 86] As a result of habitat alteration and introduction of predators, parasites, and competitors, hundreds of species of native Hawaiian insects have become either rare or extinct. [Ref. 28, Ref. 73] To date, two species of Hawaiian insects have been proposed for listing in Federal endangered species regulations. [Ref. 73, Ref. 101]

Although no survey was done for the various project sites, the project area probably does not provide suitable habitat for rare endemic terrestrial insects. Vegetation in the immediate vicinity of proposed BWS facilities is predominantly introduced, and the elevation of the

project area is within the range of most introduced insect species. Displacement of endemic host plants and introduction of insects from outside of Hawaii have resulted in the disappearance of almost all endemic insects from lowland areas on the main Hawaiian Islands. [Ref. 28]

Prior to human contact, there were more than 1,000 species of land snails unique to Hawaii. As a result of habitat alteration, introduced predators, and in some cases introduced parasites, hundreds of species of endemic mollusks are now either rare or extinct. An entire genus of Hawaiian tree snails, Achatinella, has been listed as endangered by the U.S. Fish and Wildlife Service. [Ref. 28]

Achatinellid snails have been occasionally observed on introduced vegetation such as guava. However, there are no records indicating that any species of Achatinella has been seen in the project area in the last fifty years. During the twentieth century, achatinellids have rarely been found on Oahu below an elevation of about 1,000 feet. [Ref. 95, Ref. 96, Ref. 97]

L. STREAM FAUNA

Native Hawaiian stream fauna are summarized in Table 27. In addition to the native aquafauna, as a result of human actions, at least thirty introduced species of fish, two introduced species of crustaceans, and one introduced species of mollusk are commonly found in Hawaiian streams. [Ref. 27, Ref. 98] None of these species are formally listed as threatened or endangered by either State or Federal regulations. [Ref. 72, Ref. 101] Howevever, one of the native fishes, Lentipes concolor, has been listed for consideration for possible addition to the Federal List of Endangered and Threatened Wildlife. The species is shown as Category 1 which means the U.S. Fish and Wildlife Service has substantial information on hand to support the biological appropriateness of the proposed listing. This species is thought to be extinct on Oahu. In addition, two species, Awaous stamineus and Sicyopterus stimpsoni, have been listed as "of

TABLE 27

NATIVE HAWAIIAN STREAM FAUNA

Species	Local Name	Status	Usual Habitat	Range
MOLLUSKS				
Neretina granosa	hihiwai	endemic	fresh water(a)	statewide
Melanoides sp.	pond snail	indigenous	fresh water	statewide
Pseuidisidora rubella	lymnaeid snail	endemic	fresh water	Kauai, Oahu, Molokai, Maui
Erinna newcombi	lymnaeid snail	endemic	fresh water	Kauai
Erinna aulacospira	lymnaeid snail	endemic	fresh water	Kauai, Molokai, Maui, Hawaii
Pseuidisidora reticulata	lymnaeid snail	endemic	fresh water	Niihau, Kauai, Oahu
Ferissia sharpi	ancylid mollusk	endemic	fresh water	statewide
CRUSTACEANS				
Atyoida bisulcata	o'pae kala'ole	endemic	fresh water(a)	statewide
Macrobrachium grandimanus	o'pae o'eha'a	endemic	brackish water(a)	statewide
FISHES				
Awaous stamineus	o'opu nakea	endemic	fresh water(a)	statewide
Stenogobius genivattatus	o'opu naniha	indigenous	brackish water(a)	statewide
Lentipes concolor	o'opu alamo'o	endemic	fresh water(a)	Kauai, Molokai, Maui, Hawaii
Sicyopterus stimpsoni	o'opu nopili	endemic	fresh water(a)	statewide
Eleotris sandwicensis	o'opu okuhe	endemic	brackish water(a)	statewide
Kuhlia sandvicensis	aholehole	endemic	brackish or salt water(a)	statewide

Note: (a) Hatchlings from eggs of these species must develop in the ocean.

Source: Ref. 27, Ref. 56, Ref. 67, Ref. 76, Ref. 94, Ref. 98, Ref. 99, Ref. 100.

special concern". Populations of stream animals unique to Hawaii have been eliminated or substantially diminished in many streams by artificial reduction of habitat and by competition and predation from introduced species. Reduction of stream flow (by water development projects) and man-made alterations of stream channels can eliminate stream habitat and create barriers to upstream migration of diadromous native species (which spend part of their life cycle in the ocean). Reduction of stream flow and channelization can also create conditions such as crowding and warmer water which favor introduced species of stream fauna. [Ref. 27, Ref. 56]

Many perennial streams in windward Oahu have been channelized to prevent flooding of urbanized areas. [Plate 63, Plate 64] Concrete channels have been installed in sections of Kaalaea, Kahaluu, Ahuimanu, Waiola, Heeia, Keaahala, Kaneohe, Anolani, Kamooalii, Luluku, Kawa, Maunawili, Palapu, Omao, and Waimanalo Streams. [Ref. 19, Ref. 27] The DLNR has also given a permit for additional channelization of Kahaluu Stream for the last stage of a multi-phase Soil Conservation Service flood control project. [Ref. 21]

The entire flow of Kamooalii Stream and its tributaries Kuou, Piho, Hooleinaiwa, and Halekou is impounded within a 26 acre reservoir by the Ho'omaluhia Park flood control dam. The vertical outlet tower by which water exists from the Ho'omaluhia reservoir is a total barrier to upstream migration of juvenile Awaous stamineus and Macrobrachium lar and will eventually lead to the complete absence of these species mauka of the flood control dam. [Ref. 50] About 1,500 channel catfish (Ictalurus punctatus) were introduced in the Ho'omaluhia reservoir in 1981 and are thriving in the warm water. [Ref. 113]

Because of Hawaii's volcanic origin, there initially were no plants or animals in Hawaiian streams. With the exception of the introduced Tahitian prawn (Macrobrachium lar), which is diadromous, all species of fish, crustaceans, and mollusks introduced by human action to Hawaiian streams complete their life cycle in fresh water. In contrast, all six species of fish, both species of crustaceans, and one species of mollusk (hihiwai) naturally occurring in Hawaiian streams have evolved from marine species, but not to the extent that they are independent of the ocean. While these native species live in fresh or brackish water, hatchlings from their eggs must spend a

PLATE 63
KAHALUU AND AHUIMANU STREAM FLOOD CONTROL CHANNELS

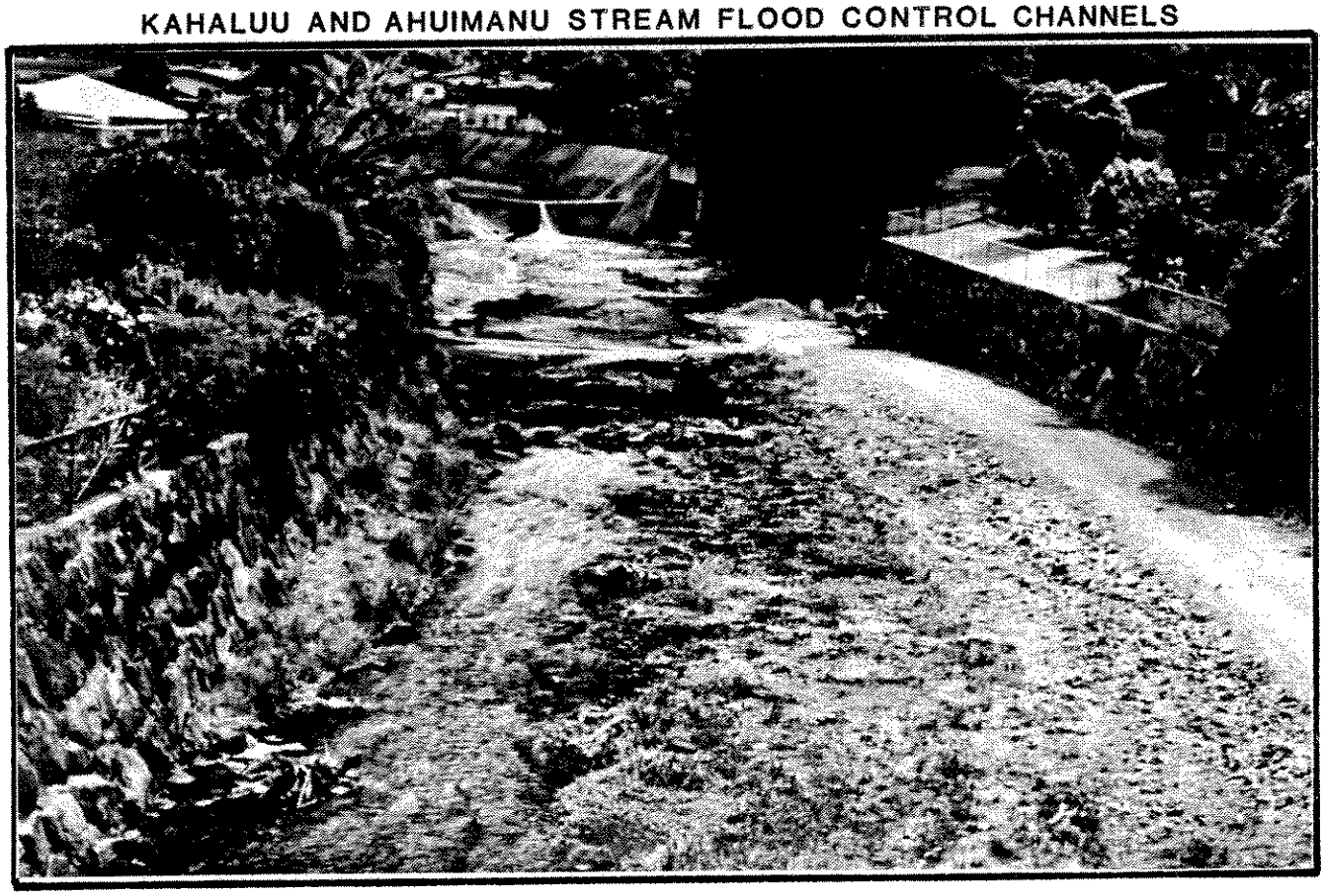


PLATE 64
KANEOHE STREAM FLOOD CONTROL CHANNEL

period of development in the ocean and then migrate upstream. There is no evidence that any of the diadromous animals in Hawaiian streams are capable of "homing" on their natal stream, like salmon, after undergoing development in the ocean. Instead to varying degrees, populations of diadromous animals in any Hawaiian stream are dependent on hatchlings from diadromous animals in other streams. [Ref. 27, Ref. 56, Ref. 67, Ref. 94, Ref. 98, Ref. 99, Ref. 100]

Several of the diadromous species found in Hawaiian streams are capable of climbing waterfalls. Atyoida bisulcata, Lentipes concolor, and Neretina granosa maintain abundant populations above some of the highest waterfalls on the Neighbor Islands. Sicyopterus stimpsoni is almost capable as a climber. Awaous stamineus, and the introduced M. lar are often found above 20 to 30-foot high waterfalls and at high elevations within watersheds. [Ref. 56]

Like their immigrant ancestors, six species of tiny mollusks native to Hawaiian streams and wetlands complete their life cycle in fresh water. Because of their small size, not much research has been done about the range or requirements of endemic lymnaeid snails. The two species known to occur on Oahu (Pseuidisidora rubella and Pseuidisidora reticulata) have been found in small intermittent streams and on damp rocks and leaves as well as in perennial windward Oahu streams. [Ref. 99] The same is true for the tiny endemic ancylid mollusk (F. sharpi). [Ref. 100] The indigenous pond snail (Melanoides sp.) is common in both small and large perennial Oahu streams. [See Appendix D.]

In terms of diadromous endemic stream fauna, Koloa, Kaluanui, Punaluu, Kahana, Waikane and Waiahole Streams are of significantly higher environmental quality than other windward Oahu streams. However, many Neighbor Island streams provide much better habitat for endemic stream fauna. [See Appendix D.] Punaluu, Kahana, and Waiahole Streams are among the few Oahu streams sizable enough to provide extensive habitat for large o'opu nakea (Awaous stamineus).

Two common native crustacean and three native fish species maintain populations in the lower reaches of Waikane Stream. While the rarest endemic species of goby (Lentipes concolor) is functionally extinct on Oahu, one specimen was collected in 1979 in Kaluanui Stream. As of

1986, Kaluanui and Koloa Streams are the only Oahu streams which still contain hihiwai (N eritina granosa) and Kaluanui, Koloa, and Kahana Streams are the only Oahu streams which still contain o'opu nopili (Sicyopterus stimpsoni). [Ref. 1, Ref. 139] Populations of these species on Oahu are dependent on hatchlings from relatively abundant populations on Kauai, Molokai, and Maui. [Ref. 100]

M. AQUATIC INSECTS

The total number of native insects recorded in Hawaii now exceeds 10,000 species. However, entomologists believe many other species have yet to be described or collected. Among native insects, many require fresh water habitat during a portion of their life cycle. With few exceptions, as discussed below, most species of aquatic insects are not considered endangered or threatened.

The members of the order odonata and two suborders, the anisoptera or dragonflies, and the zygoptera or damselflies, are the most important of Hawaii's aquatic insects. The odonata, consists of about 40 forms in 30 distinct species, the other 10 being geographical species. Five of these species are dragonflies and the remainder damselflies. Two of the dragonflies and all of the damselflies are found nowhere else in the world. [Ref. 124] Two of the damselflies of the coenagrionidae family, blackline megalagrion, Megalagrion nigrolineatum; and oceanic megalarion, Megalagrion oceanicum, are listed by the U.S. Fish and Wildlife Service as a Category 2 candidate endangered species. (Category 2 means listing a species as endangered or threatened is appropriate, but for which conclusive data on biological vulnerability and threat(s) are not currently available to support proposed rules at this time.) [Ref. 73] These two species are found only on Oahu. A third species of damselfly, in the same family, pacific megalagrion, Megalarion pacificum, is thought to be extinct on Oahu, but not on other Hawaiian islands. [Ref. 125] This damselfly is also considered endangered. [Ref. 73]

The blackline megalagrion have been observed along streams from near

sea-level to 2,400 feet or more. Nymphs of the blackline magalagrion have been found under stones and in algae in running or quiet waters. The oceanic megalarion can be found in a variety of conditions ranging from shallow running water, to several feet up a rock bank alongside swiftly running water. [Ref. 124]

Reliable information on aquatic insect populations in individual streams is not available. Reliable information on life cycle and biological requirements is also unavailable for virtually all species of endemic aquatic insects.

N. WATERBIRDS

Waterbirds are defined as species of birds dependent upon wetland habitat for a major portion of their ecological requirements. Four species are considered endemic (unique) to Hawaii: Hawaiian or Koloa Duck (Anas wyvilliana); Hawaiian Stilt (Himantopus mexicanus knudseni); Hawaiian Gallinule (Gallinula chloropus sandvicencis); and Hawaiian Coot (Fulica americana alai). The black-crowned night heron (Nycticorax nycticorax hoactli) is considered indigenous to Hawaii and the cattle egret (Bubulcus ibis) an introduced species. [Ref. 115]

All four endemic species are listed as endangered by the U.S. Fish and Wildlife Service. [Ref. 72] Although relatively uncommon in Hawaii, the black-crowned night heron is not listed or considered a candidate of endangered or threatened species, due to its wide distribution in North and South America. The cattle egret, a waterbird introduced to Hawaii in 1959, is also found in North and South America. [Ref. 115]

Koloa are found primarily on Kauai and, to a limited extent, in some areas of Oahu; gallinules primarily on Kauai and Oahu; coots primarily on Oahu, Maui, and Kauai; and stilts primarily on Oahu, Maui and Kauai. Koloa use a variety of fresh water habitat including marshlands, flooded grasslands, ponds, streams, and mountain pools. Gallinule habitat primarily consists of thickly vegetated marsh

interspersed with fresh water ponds, taro patches, and reedy margins of streams and ditches. Coots use the same kinds of habitat as gallinules, but prefer more open water. Coots also often use brackish wetlands. Stilts use a variety of shallow wetland habitat ranging from fresh to salt water. Stilts wade, rather than swim, unlike other Hawaiian waterbirds. Stilts will use irrigation reservoirs, flooded grasslands, marshes, taro patches, fishponds, and tidal mudflats. [Ref. 3, Ref. 114]

In general, the U.S. Fish and Wildlife Service has found that very brackish wetlands are much less suitable for Hawaiian waterbird habitat than fresh water or slightly brackish wetlands. Native ducks and gallinules are excluded, and abundance of native stilts and coots is diminished by increasing salinity. Only stilts will utilize tidal mudflats for feeding. In natural Hawaiian wetlands and estuaries, low level salinity (up to 10 parts of chlorides per thousand parts of water) increases the population of invertebrates. However, higher salinity causes a major reduction in both the diversity and numbers of invertebrates on which Hawaiian waterbirds feed. Higher salinity also excludes many plant species and results in a monoculture unattractive to native ducks, gallinules, and coots. [Ref. 139, Ref. 140]

By way of illustration, in July 1986, Amorient Aquaculture International, Inc. converted most of their fresh water prawn ponds to a mixture of 20% fresh and 80% ocean water in order to culture marine shrimp. Hawaiian ducks and gallinules no longer frequent Amorient's shrimp mariculture ponds, and use by other native waterbirds has substantially diminished. [Ref. 140]

Amorient ponds used to drain via the Kii Ditch into the Kii Unit of James Campbell National Wildlife Refuge in Kahuku. This portion of the refuge was also partially dependent on caprock springs. When Amorient reduced withdrawal of basal ground water in Kahuku, the BWS authorized the U.S. Fish and Wildlife Service to drill two new wells in Kahuku and withdraw fresh basal ground water for use in the Kii Unit of the Refuge. After completion of these artesian wells, Kii Ditch water has been diverted from the Refuge. Open water in the Punamano Unit of the Refuge continues to be completely dependent on brackish caprock springs. [Ref. 140, Ref. 159]

Both wet-weather and dry-weather wetland habitat are of importance to survival of Hawaiian waterbirds. Following rains, all species will take advantage of intermittent wetlands to feed and sometimes to nest. During dry weather, endemic waterbirds are concentrated at permanent areas of open water in natural and man-made wetlands. Reproduction tends to be most successful at such permanent areas of open water.

Hawaiian waterbirds cannot survive without open water in wetlands. Neither open water without vegetation (such as Enchanted Lake) nor vegetation without open water (such as much of Kawainui Marsh) meet the complete habitat requirements of these species. Agriculture and land development have replaced large areas of Oahu's wetlands or made them unsuitable for use by native waterbirds. Over time, because they trap silt, many remaining wetlands will naturally lose their open water areas. Inland erosion from human activities and rapid growth of introduced species of vegetation have greatly accelerated the process. Under present conditions, without human intervention, fresh open water in wetlands such as Kawainui Marsh and the Heeia Meadowlands will inevitably dwindle to the point where native waterbirds will be excluded during dry weather.

Man-made drainage improvements probably have significantly reduced the amount of open water in fresh water Oahu wetlands. For example, during dry weather, the base flow of ground water and streams entering Kawainui Marsh can easily pass unnoticed out of the artificial Kawainui Canal which drains the Marsh. Installation of inlet controls (such as berms) to restrict dry-weather flow into drainage improvements would be an effective way to restore open water to such wetlands. "Otherwise, the situation appears to be like trying to keep water in a bathtub by trickling in a few drops of water, but leaving the drain wide open." [Ref. 20, Appendix B]

Although there are many reasons for the decline in the four endemic waterbird species, the primary cause is loss of wetland habitat suitable for reproduction. Sugarcane fields have replaced taro fields, and housing developments, hotels, shopping centers, and a variety of other urban uses have displaced many wetland areas formerly used as waterbird habitat. Encroachment of introduced plants, such as California grass, water hyacinth, and mangrove have also degraded waterbird habitat by eliminating open water and allowing access by

waterbird habitat by eliminating open water and allowing access by predators. Predators, including dogs, feral cats, mongooses, and other mammals have reduced waterbirds populations on all Hawaiian islands, and made many wetlands unsuitable for reproduction by waterbirds. Cattle egrets and black-crowned night herons are also predators of nestling waterbirds. [Ref. 114]

Man-made and artificially improved wetlands can provide important habitat for Hawaiian waterbirds. Coots nest at the U.H. Mariculture Research and Training Center ponds in Hakipuu and formerly made heavy use of Amorient Aquaculture International Inc.'s prawn ponds in Kahuku. [Ref. 117, Ref. 140] Windward Oahu wetlands, which have been deliberately improved for waterbird habitat include the James Campbell National Wildlife Refuge in Kahuku, the Ho'omaluhia Park Wildlife Pond in Kaneohe [Plates 65 and 66], and the Nuupia Ponds complex in Kaneohe Marine Corps Air Station. All four species of Hawaiian waterbirds nest at the James Campbell National Wildlife Refuge, Koloa nest at Ho'omaluhia Park, and stilts nest at the Nuupia Ponds. In April 1982, 38 Koloa were released at the Ho'omaluhia Park Wildlife Pond, of which about a dozen have taken up permanent residence at either the pond, Ho'omaluhia Flood Control Reservoir, or Kamooalii Stream. [Ref. 50, Ref. 139, Ref. 140]

O. ESTUARINE FAUNA

The estuarine environment can provide the nutrient base, protection, depth and salinity for a wide variety of biota to exist. Studies of Hawaiian estuarine areas have found the following fauna: seven species of shrimp, including the o'pae o'eha'a (Macrobrachium grandimanus), the Malaysian prawn (Macrobrachium rosenbergii), the Tahitian prawn (Macrobrachium lar), and the grass shrimp (Palaemon debilis); four species of crab, including the thukuhar (Metopograpsus messor), the haole crab (Portunus sanguinolentus), the hapa crab (Thalamita crenata), and the Samoan crab (Scylla serrata); twenty-seven species of fish, including the nehu

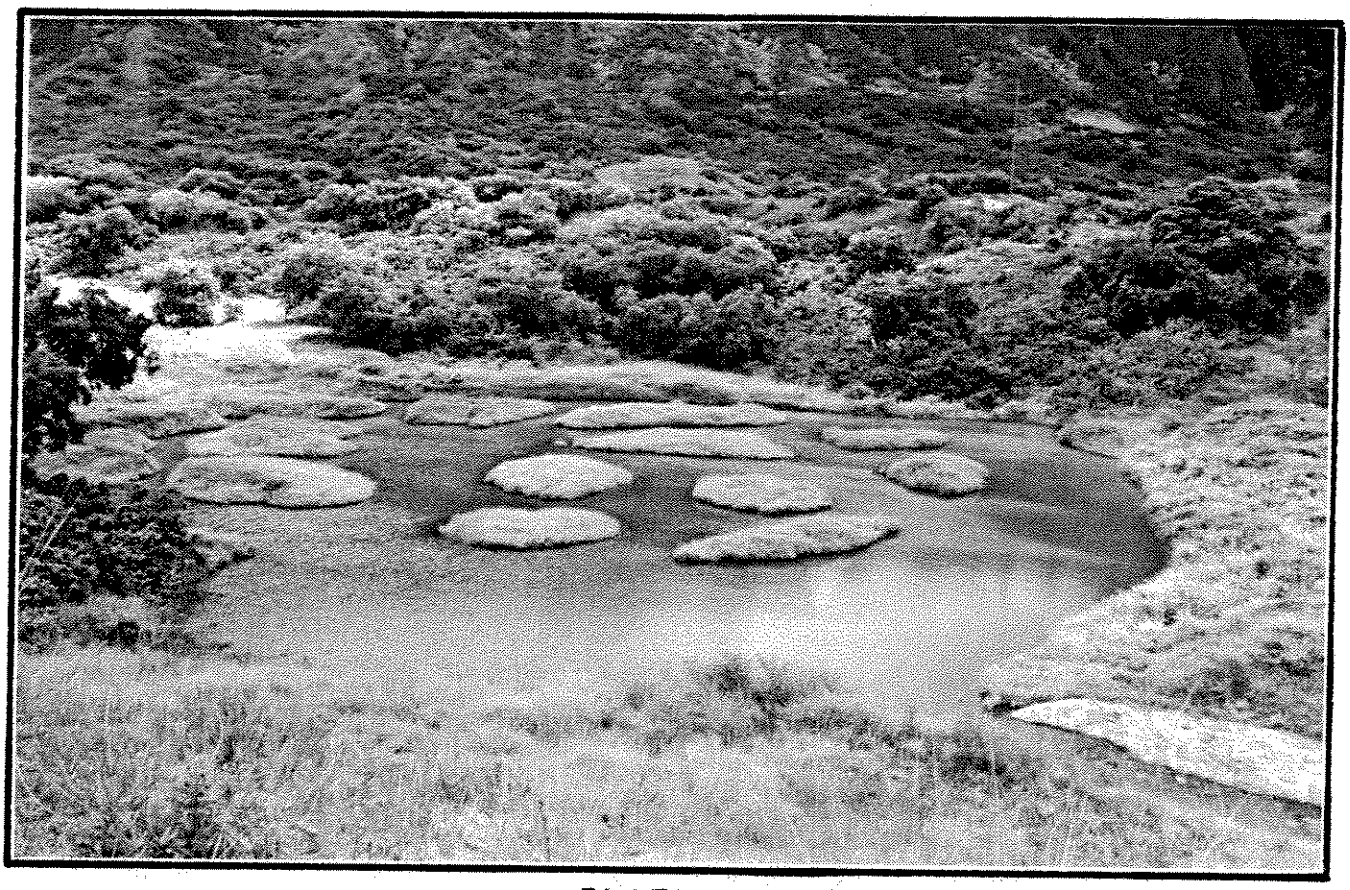


PLATE 65
HO'OMALUHIA WILDLIFE POND

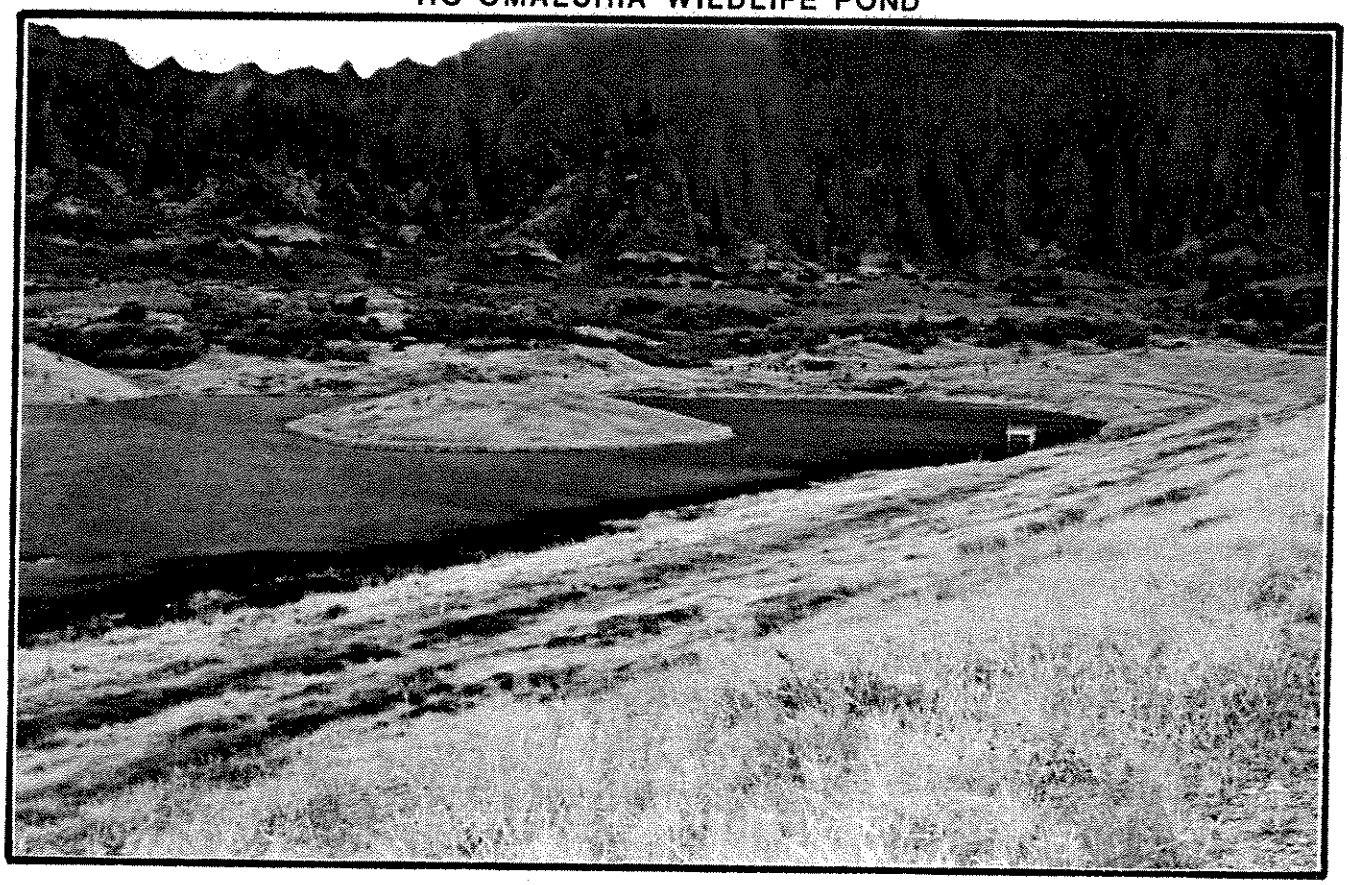


PLATE 66
HO'OMALUHIA DAM AND RESERVOIR

(Encrisolina purpurea), o'opu naniha (Stenogobius genivattatus), o'opu okuhe (Eleotris sandwicensis), aholehole (Kuhlia sandvicensis), paoo kaulaloa (Oxyurichthys brichotus), goby (Bathygobius fuscus), uouoa (Neomyxus chaptalii), ulae (Saurida gracilis), paku (Bothus pantherinus), and o'opu kawa (Diodon holocathus). [Ref. 121 and Ref. 122] Importantly, estuaries are also nursery areas for several species of fish: mullet (Mugil cephalus), milkfish (Chanos chanos), barracuda (Sphyraena barracuda), and aholehole. Also present in the estuarine environment are 62 species of marine algae. Most of the estuarine species in Hawaii are euryhaline, i.e., adapted to wide variations in salinity or salt content of the water, and are derived from marine rather than freshwater ancestors. [Ref. 123]

Since commercial Hawaiian fisheries predominantly involve marine species, relatively little research has been done about the life cycle of fish and invertebrates found in Hawaiian estuaries. Apart from insects, most or all native species of estuarine biota must spend or can tolerate a larval stage in marine waters. However, eggs from some species like nehu may have a higher mortality rate outside of estuaries. [Ref. 132] Juveniles of some native species like o'opu okuhe and o'pae o'eha'a must return from marine waters to estuaries because they cannot complete their life cycle in undiluted ocean water (35 parts of chlorides per thousand parts of water). On the mainland, many estuarine-dependent species live in the ocean as adults, but must return to estuaries to reproduce. Native species with similar requirements may exist, but have not yet been conclusively identified in Hawaii. Juveniles of many native marine species seek out estuaries to find food or avoid predators. Some of these species could have reduced populations without estuaries. [Ref. 135, Ref. 136]

P. ARCHAEOLOGICAL FEATURES

Except as noted below, a literature search and preliminary archaeological reconnaissance survey have been conducted for all of the proposed water sources discussed in this EIS. Findings are reported in Appendix F. Only a literature search was conducted for

the proposed Kaipapau Well, Kaaawa Wells, and Hakipuu Wells because access was not allowed by affected property owners. Kaaawa Shaft, Iolekaa Well, Haiku Well, Kuou Wells II, Kamooalii Wells I, and Waimanalo Well II were omitted from archaeological studies because there is no possibility of adversely affecting archaeological resources. No further land disturbing actions are needed to bring Kaaawa Shaft, Iolekaa Well, and Haiku Well into production. Waimanalo Well II is located on a terrace cut for Waimanalo 364 Reservoir No. 1. Pineapple was formally cultivated at the sites of both Kuou Wells II and Kamooalii Wells I. [Ref. 104]

Archaeological featues have been observed at the proposed sites or in the immediate vicinity of Kaluanui Well I, Kaluanui Well II (Alternate), Kahaluu Wells II, Ahuimanu Inclined Wells, Maunawili Wells I, and along proposed access road routes to Maakua Wells (BWS), Kahana Wells III, Kaalaea Inclined Wells, and Ahuimanu Inclined Wells. Literature search also indicates that archaeological features are probably present in the vicinity of proposed sites for Kaipapau Wells (Alternate), Kaaawa Wells II, Punaluu Well V, Punaluu Wells V-A, Kahana Wells II, Kaaawa Wells II, Hakipuu Wells, Uwau Wells, Waianu Wells, Kahaluu Wells II, and Ahuimanu Inclined Wells.

Previous BWS reconnaissance surveys did not find archaeological features at proposed sites for the Kahana 315, Luluku 500, and Waimanalo 364 Reservoirs. [Ref. 36, Ref. 38, Ref. 47] Reconnaissance surveys have been postponed for other proposed reservoirs until siting is resolved.

At the time of the Draft EIS, it was thought that a proposed cross-country BWS pipeline from the Luluku 500 Reservoir to Luluku Road might cross archaeological features makai of Likelike Highway. Subsequently, based on a detailed study of the area by Bishop Museum archeologists, a pipeline route has been selected along a former Ho'omaluhia Park construction road which avoids all archaeological features. [Ref. 151]

Q. LAND USE

Most proposed BWS water sources, reservoirs, access roads, and utility lines will be located within or next to large tracts of undeveloped open space. Significant land uses in the immediate project areas are discussed in this section.

The following BWS wells and reservoirs, along with their access roads, utility lines, and transmission mains, will be located within public parks. The proposed Kaluanui Wells will be within Sacred Falls State Park. The proposed Kahana Wells II, III, IV, and V and Kahana 315 Reservoir will be within Kahana Valley State Park. The proposed Kuou Wells II, Kuou 360 Reservoir, and Kuou 272 Reservoir will be within the County's Ho'omaluhia Park.

The following major BWS facilities will be located next to existing public hiking trails: Maakua Wells (BWS or BWS Alternate), Punaluu Wells V-D, Kahana Wells III, Kahana Wells IV, Kahana Wells V, Kahana 315 Reservoir, Ahuimanu Inclined Wells, and Maunawili Wells I. New BWS access roads (and utility lines) proposed along hiking trails to these facilities are summarized in Table 7 of Chapter I. (It should be noted that the "hiking trail" to Kahana Wells III, IV, and V and the Kahana 315 Reservoir is actually an abandoned jeep road.)

A few major BWS facilities will be located in areas now used for cultivation of crops. The proposed Luluku Wells and Luluku 500 Reservoir will be located within a banana field. Depending on how siting is resolved, the proposed Kahaluu Wells II, Kuou 272 Reservoir, and Waimanalo Well III may also be located within areas now used for intensive agriculture. Within the larger area from which sites will be selected for the Kahaluu Wells II, several parcels are used for cultivation of bananas, taro, or truck crops. There is a banana field in the general vicinity of possible sites for the Kuou 272 Reservoir. Out of several alternative locations for Waimanalo Well III, one possible site is used for cultivating roses and another is used for an outdoor nursery.

Proposed BWS reservoirs will not be located next to residential areas. However, the following BWS wells will be located in the general vicinity of existing residences: Kahaluu Wells I, Kahaluu Wells II,

Iolekaa Well, Maunawili Wells II, Maunawili Wells III, and Waimanalo Well III. The proposed BWS access road to the Kaipapau Wells and Hauula 180 Reservoir will cross a parcel containing a private residence at the mauka end of Kawaipuna Street. The proposed BWS access road to the Maunawili Wells I will cross a parcel containing a private residence at the mauka end of Maleko Street.

BWS access road improvements (along with utility lines and transmission mains) are proposed along the routes of many existing and abandoned dirt roads. [See Table 7 in Chapter I.] Proposed BWS transmission mains will also be located along several residential streets and along the shoulders of most of the major highways which serve windward Oahu. [See Table 8 and Figures 5 to 16 in Chapter I.]

R. AESTHETICS

Proposed wells and reservoirs will mostly be at undeveloped vegetated sites. Proposed well sites are shown in the plates at the end of Chapter I. The following major BWS facilities may be visible from residential areas or from windward Oahu highways: Hauula 180 Reservoir, Kahaluu Wells II, Heeia Kai 272 Reservoir, Luluku Wells, Kuou 360 Reservoir, Kuou Wells II, Luluku 500 Reservoir, Halekou Wells, and Waimanalo Well III.

Proposed BWS access road improvements and overhead utility lines will be in open space areas where there are no paved roads and no overhead utility lines.

S. AIR QUALITY AND NOISE

Apart from traffic on windward highways, there are no significant sources of noxious fumes or noise in the project area. The proposed

Luluku Wells will be adjacent to Likelike Highway, and the proposed Halekou Wells will be adjacent to Kamehameha Highway. If the proposed H-3 Freeway is built mauka of Ho'omaluhia Park, then the H-3 will be adjacent to the proposed Kuou 360 Reservoir, Kuou Wells II, and Halekou Wells.

T. NATURAL HAZARDS

County Flood Insurance Rate maps identify most proposed well and reservoir sites as "Zone C": areas of minimal flooding, or as "Zone D": areas of undetermined, but possible, flood hazard. Part of the larger area within which the Kahaluu Wells II will be sited is identified as "Zone B": areas subject to 100-year flooding with average depths less than one foot, or where the contributing drainage areas is less than one square mile. Proposed BWS transmission mains in part will be located in areas subject to periodic flooding or occasional tsunami inundation. [Ref. 71]

Because of unstable soils, the Heeia Kai 272 Reservoir can not be built at the site shown in this EIS. Soil engineering studies will be needed for all proposed BWS reservoirs which do not yet have a firm site.

III. ENVIRONMENTAL IMPACTS OF PROJECT CONSTRUCTION

A. DRAINAGE AND EROSION

Proposed BWS facilities will not significantly alter existing drainage patterns and will not impound surface water either within or outside of natural channels. The amount of development in any watershed will not be sufficient to significantly increase storm runoff.

Erosion will be controlled by limiting grading and by landscaping cut areas in accordance with the County grading ordinance. No unusual erosion control measures are considered necessary. Improvements on existing dirt roads will probably help to reduce total soil runoff from the project area.

B. TERRESTRIAL VEGETATION AND WILDLIFE

Development of proposed BWS facilities will require removal of existing vegetation along the routes of access roads and pipelines and at the sites of new water production facilities and reservoirs. No rare or endangered plants will be affected, and most of the plants which will be removed are common, widespread introduced species. Although it is very unlikely that rare endemic plants will be encountered, as required by a County Special Management Area Use Permit, a botanical survey has been conducted along the alignment of proposed pipeline and access road improvements between Kamehameha Highway and the Kahana 315 Reservoir.

Development of proposed BWS facilities will not affect the habitat of rare or endangered terrestrial mammals, birds, insects, or snails. Introduced animals found in the project area are common and widespread. Since relatively little vegetation will be removed at any one place, impacts to wildlife will not be significant.

C. ARCHAEOLOGICAL FEATURES

Supplemental research will be conducted to identify archaeological resources which might be affected by BWS facilities. As projects are programmed for development, archaeological reports will be incorporated in supplemental EAs submitted to the OEQC (for determination as to whether a Supplemental EIS will be required). Notice will be published in the OEQC Bulletin.

For those facilities which have been determined in this EIS to be close to surface archaeological resources, more detailed surveys will be conducted and surface features mapped. BWS construction plans will be shown on archaeological survey maps. For those facilities for which siting was not resolved in this EIS, if there has been no reconnaissance for the presence of surface archaeological features, then the BWS will commission archaeological reconnaissance surveys. More detailed surveys and mapping will be conducted if necessary. In areas where there is a high probability of encountering subsurface archaeological features, before undertaking any development, the BWS will commission test pit surveys or archaeological excavations. In situations where there is a possibility of encountering subsurface archaeological features, as determined by the DLNR, the BWS will either commission test pit surveys before construction or archaeological monitoring during construction of BWS facilities. If any cultural materials are encountered during construction, then construction will stop and the BWS will notify the DLNR Historic Sites Section. The BWS will also notify DLNR archaeologists prior to conducting any trenching in State parks so that they may examine new trenches for any cultural remains.

Whenever practical, proposed BWS facilities will be located to avoid archaeological features. However, it will be difficult to avoid damage to significant archaeological resources with the proposed site, access road, and pipeline for the Hakipuu Wells; the proposed Kahaluu Wells II; and the proposed site, access road, and pipeline for the Ahuimanu Inclined Wells. Appropriate impact mitigation measures will need to be worked out between the BWS and the State Historic Preservation Officer. Pursuant to Sec. 6E-8, HRS, the BWS needs written approval from the State DLNR to undertake any project which adversely affects historic property.

D. LAND USE

Apart from limited areas used for intensive agriculture and a few hiking trails, proposed BWS facilities will not displace existing land uses. Dirt roads improved by the BWS will continue to be available for use by abutting property owners.

Some private property may be acquired by eminent domain prior to development of proposed BWS facilities. Persons with a property interest will be compensated for their losses as required by law. In addition to BWS payments for land acquisition, any affected farmers will be compensated for improvements and crops on property which the BWS acquires.

E. AESTHETICS AND RECREATION

Structures, fences, access roads, and overhead utility lines will be placed in areas that presently are undeveloped open space. Several proposed BWS reservoirs including the Hauula 180 Reservoir and Heeia Kai 272 Reservoir may be located on conspicuous sites. Landscaping and unobtrusive designs will be used to mitigate visual impacts of new BWS facilities. Underground utility lines will be used for crossing major highways, within urbanized areas with underground utilities, and when required to protect the aesthetics of public parks.

Proposed BWS facilities may be such a significant visual intrusion as to discourage recreational use of an abandoned jeep road to the Kahana Wells III, IV, V and Kahana 315 Reservoir, and a hiking trail to the Ahuimanu Inclined Wells. The BWS is responsible for constructing a new hiking trail in Kahana State Park at a location to be determined by the DLNR Division of State Parks, Outdoor Recreation and Historic Sites. Otherwise potential visual impacts to hiking trails and public parks will be relatively minor.

F. AIR QUALITY AND NOISE

A certain amount of dust, noise, and fumes will be unavoidable during construction of proposed BWS facilities. Dust will be controlled by sprinkling as required. Contractors will be responsible for compliance with Department of Health rules governing noise and exhaust emissions.

G. TRAFFIC

Construction of proposed BWS transmission mains along major windward Oahu highways will probably require closing a highway lane and directing traffic with flagmen. To minimize traffic congestion, all highway lanes will have to be open during peak traffic hours. Nonetheless, there is only one two-lane highway between Kahuku and Kaneohe. Incrementally opening and closing sections of one highway lane between Laie and Kaneohe, so that new BWS transmission mains can be installed, will inevitably cause several years of public inconvenience.

IV. ENVIRONMENTAL IMPACTS OF WATER DEVELOPMENT

A. STREAM FLOW

Proposed BWS projects will not affect rainfall and will not significantly alter topography. Hence, they will not adversely affect the amount of surface runoff reaching windward Oahu streams.

With one exception, it is unlikely that proposed BWS projects will increase the quantity of ground water seeping into windward Oahu streams. Some of the irrigation water to be provided to Waimanalo Agricultural Park from Waimanalo Well II will probably be perched in a sedimentary aquifer and infiltrate into Waimanalo Stream below an elevation of about 100 feet.

Over two dozen proposed BWS projects have the potential to take ground water which would otherwise end up in perennial windward Oahu streams. It is likely that most of the ground water to be developed by these projects will be at the expense of stream flow. However, it is not possible to accurately predict the extent to which stream flow will be reduced because not all ground water becomes stream flow. Some ground water is lost to transpiration by plants and some just seeps into the ocean. Unlike transpiration from continental land masses, which can significantly contribute to rainfall, transpiration by plants in windward Oahu contributes very little to Oahu rainfall. Because of rapid nearshore and offshore circulation, seepage of windward Oahu ground water into the ocean does not contribute to estuaries outside of parts of Kaneohe Bay. Hence, rather than reducing stream flow, it is possible for windward Oahu ground water development to reduce potable water wasting into the air or ocean.

Reductions in stream flow due to BWS projects will be proportionally minor during and following wet weather when surface runoff, perched water, and stream bank storage are the major sources of water in streams. However, reductions in stream flow due to BWS projects could be proportionally significant during dry weather when the primary source of stream flow is leakage and overflow of dike-impounded ground water. For example, during a storm when stream discharge exceeds 100 mgd, a 1 mgd reduction in stream flow would be relatively unimportant. But, during dry weather, if base stream discharge were only 2 mgd, a 1

mgd reduction in stream flow would be a major impact.

Measuring the extent to which future BWS projects actually reduce stream flow is likely to be problematic and expensive. Suppose, for example that pumping of a well did not noticeably affect stream flow for six months, and then stream flow declined one half mile downstream from the well. Without a model of how rainfall affected stream flow before the well was pumped, there would be no way to reliably quantify the extent to which such a reduction in stream flow was due to low rainfall (non-well-interference effects) or to ground water development. The only way to produce such a model would be to gage rainfall (throughout the region in which rainfall contributed to dry-weather stream flow) and to gage stream flow (at a low enough altitude to measure the total effect of ground water development on stream flow). Moreover, even if stream flow records can be adjusted to compensate for effects not attributable to well interference, it may be months after well interference with the flow of a stream is detected before the interference effect reaches a maximum.

As of the date of this Final EIS, unless directed to do so by the DLNR, the BWS does not plan to pay for installation and operation of stream and rainfall gages and computer modeling necessary to quantify the impacts of proposed BWS projects on stream flow. Operational rain gages may not be adequate for modeling how rainfall affects dry-weather stream flow anywhere in windward Oahu. If appropriate long-term rainfall data were collected, then operational USGS gages are capable of adequately measuring the total extent, but not the highest elevation at which proposed BWS projects reduce the dry-weather discharge of Kaluanui, Kahana, Waikane, and Kamooalii Streams. However, other streams which may be adversely affected are currently not gaged at an altitude which would ensure that all potential impacts on stream flow are measured. Apart from the Punaluu Ditch, the same is true for agricultural diversions of surface water which may be adversely affected by proposed BWS projects.

In order to mitigate impacts on stream flow, whenever directed to do so by the DLNR, the BWS will reduce water production from the proposed sources described in this EIS. Similarly, in order to maintain existing surface water uses by private parties, whenever directed to do so by the DLNR, the BWS will reduce water production from the

proposed sources described in this EIS. As discussed more fully in Chapter VIII, the BLNR has adopted interim instream flow standards for windward Oahu streams. In time, the BLNR's standards will be superseded by either interim or final instream flow standards adopted by the State Commission on Water Resource Management. Current interim instream flow standards "grandfather" existing stream diversions, require preservation of median stream flow at all elevations for "gaged" streams, and prohibit new diversions of "ungaged" streams. [Ref. 155, Ref. 156]

Sometime in 1988, the DLNR plans to determine which streams are "gaged" and to estimate the median flow at various elevations of such streams. Sometime in 1989, pursuant to rules which will be adopted by the State Commission on Water Resorce Management, the DLNR plans to estimate and formally certify the amount of water used by "grandfathered" stream diversions. [Ref. 143] DLNR estimates of median stream flow and existing stream diversions theoretically can be used by the DLNR to regulate water production from proposed BWS windward Oahu water sources. For example, even if it is not resolved that a BWS well is causing a reduction in the flow of a "gaged" stream, the DLNR can order the BWS to reduce or stop pumpage whenever stream flow is at or below the median. However, on "gaged" streams, the DLNR will not have any practical way of determining when stream flow at any "ungaged" elevation is less than estimated median flow. Because most windward streams gain water with decreasing elevation, a BWS water source could reduce a stream's discharge to less than median flow at some "ungaged" elevations while that stream still had more than median flow at "gaged" elevations. Similarly, the DLNR will not have any practical way of determining whether a BWS water source has reduced the flow of any "ungaged" stream.

The BWS does not plan to install additional stream gages unless directed to do so by the DLNR. The BWS also does not intend to unilaterally assume the DLNR's responsibilities for determining compliance wth interim or final instream flow standards.

Apart from any interim or final instream flow standards which may be adopted by the BLNR or State Commission on Water Resource Management, the City (including the BWS) is contracturally obligated to preserve sufficient flow in Hooleinaiwa Stream to maintain the Ho'omaluhia Park

Wildlife Pond. Minimum discharge of Waihee Stream will be preserved as required by court order, unless the State Commission on Water Resource Management changes the requirements which the BWS must meet.

Most of the proposed BWS projects which have the potential to reduce windward Oahu stream flow are wells, tunnels, or inclined wells which would develop dike-impounded ground water. Wells will only penetrate one or two dike compartments and will need to be pumped to remove dike-impounded ground water. In contrast, tunnels and inclined wells will penetrate at least several and possibly any number of dike compartments and will rely on gravity flow of ground water out of dike compartments.

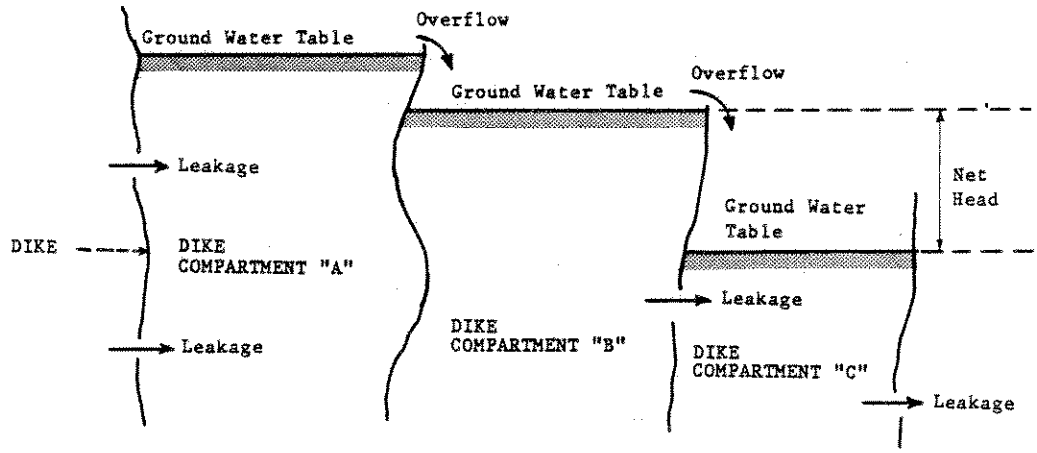
Pumping of a well in a dike compartment will lower the ground water table in that compartment. In turn, this will reduce movement of ground water out of that dike compartment and may possibly increase movement of ground water into that dike compartment. [See Figure 36] All of these effects on ground water can be eliminated by simply ceasing to pump, although it may take up to a few months for natural conditions to be completely restored.

If a water development tunnel is allowed to discharge water without restrictions, then the ground water table within every dike compartment penetrated by the tunnel will be lowered to the invert elevation of the tunnel terminus. This is analogous to the effect which would be produced by knocking a hole in the side of a bathtub filled with water. Once stored ground water has moved out of the dike compartment, the amount of water leaving the compartment will be equal to the natural inflow. Also, there may possibly be increased movement of water into dike compartments in which the ground water table has been lowered because increased head differential causes greater water flow across leaky dikes. [See Figure 36] All of these effects are irreversible unless it proves feasible to "patch" the dikes penetrated by the tunnel. With one exception, past attempts to restore dike-storage by bulkheading water development tunnels have rarely been successful. The exception has been the successful bulkheading of the Waihee Tunnel.

The effects of allowing an inclined well field to discharge dike-impounded ground water without restrictions are identical to those

FIGURE 36

Simplified Hydraulics of Dike-Impounded Ground Water



HYDRAULIC PRINCIPLES:

1) Water transfer of dike-impounded ground water can occur in three ways: (1) leakage; (2) overflow; (3) leakage and/or overflow. Under natural conditions, inflow of ground water into a dike compartment equals overflow plus leakage out of the dike compartment.

2) Leakage of ground water between two hydraulically connected dike compartments is proportional to the difference in ground water head (i.e. unconfined water table elevations) of the two dike compartments.

3) If enough ground water were removed from Dike Compartment "C" with a well or tunnel to cause the water table in "C" to drop, then leakage out of "B" into "C" would be increased because of the increase in net head between "B" and "C". An increase in leakage out of "B" would be accompanied by a decrease in overflow out of "B" because of principle (1).

4) Some of the dike compartments are so impermeable that water transfer occurs by overflow, not leakage. For example, removing ground water from Dike Compartment "B" with a well or tunnel would not affect ground water in or overflow out of Dike Compartment "A". However, if enough ground water were removed to cause the water table to drop in Dike Compartment "B", then overflow out of "B" would be eliminated. Also, leakage out of "B" into "C" would be reduced because of the reduction in net head between "B" and "C".

produced by a water development tunnel. However, unlike tunnels, inclined wells can be capped, or have their yield restricted and use storage. As with conventional vertical wells, elimination of water withdrawal from inclined wells will allow natural ground water conditions to be restored.

There are a number of ways in which removal of ground water from a dike compartment could theoretically reduce stream flow:

1) If ground water in a dike compartment directly overflows or leaks into a stream, then artificial lowering of the water table within that dike compartment would cause an immediate reduction in overflow or leakage into the stream. [Figure 22] A reduction in stream flow would start at the static head (i.e. natural water table before water removal) of the water development project which removed dike-impounded ground water.

2) A dike compartment might not directly overflow or leak into a stream, but it might contribute ground water to other dike compartments which overflow or leak into a stream. [Figure 22] Removal of ground water from that first dike compartment might capture ground water which would otherwise show up downstream as stream flow. Such a reduction in stream flow would be at a lower elevation than the static head of the water development project which removed dike-impounded ground water. It might take months of water removal before a reduction in stream flow can be detectable.

3) A dike compartment might not directly overflow or leak into a stream, but it might overflow into alluvium, colluvium, and/or volcanic ash which at some lower point discharge into a stream. [Figure 23] As with 2), removal of ground water would intercept stream gain which would otherwise show up at a lower elevation than the static head of the water development project. Also, as with 2), adverse impacts to stream flow might not show up until after several months of ground water removal.

4) In places where the ground water table is in contact with a porous stream bed and ground water infiltrates into a stream, artificial lowering of the water table by ground water development can allow

stream flow to infiltrate into the ground. Such effects would be confined to slow moving streams at a lower elevation than the static head of the water development project.

5) As explained in Figure 36, it is possible for ground water removal from one dike compartment to increase leakage and reduce overflow from an "upstream" dike compartment. If the "upstream" dike compartment directly or indirectly overflowed into a stream, then stream flow would be reduced above the static head of the water development project.

Development of dike-impounded ground water can be but is not always at the expense of stream flow. Over the long term, any reduction in stream flow will be less than water development. As previously discussed in Chapter II, available data suggests that existing wells which develop dike-impounded ground water affect ground water movement and stream flow below, but not significantly above their static head. In contrast, water development tunnels and inclined wells probably increase ground water leakage out of adjacent and "upstream" dike compartments into many dike compartments penetrated by a tunnel or inclined well. This hydrologic "domino-effect" may be the mechanism which accounts for the possibly far-reaching effects of existing tunnels and inclined wells on stream flow in relatively distant valleys.

Based on past experience with existing BWS water development projects, Table 28 and Figures 37 through 58 summarize the parts of windward Oahu streams which might possibly undergo a reduction in dry-weather flow as a result of proposed BWS projects. In order to make such an analysis, it has been necessary to make assumptions about the static head of proposed but unbuilt vertical wells which will develop dike-impounded ground water. It also has been assumed that such proposed wells will take ground water which is the source of gains in stream flow below, but not above, their static head. It has also been assumed that any proposed water development tunnel or inclined well may possibly take ground water which seeps into the headwaters and middle reaches of streams in both the immediate project vicinity and abutting valleys. While these assumptions may turn out to overestimate impacts, they allow a reasonable worst-case overview of the risks that each proposed water development project may pose to

perennial streams in windward Oahu.

Three of the proposed BWS water development projects listed in Table 28 are sufficiently unusual as to warrant a special explanation of how they will affect stream flow. These three projects are the Halekou Wells, Pali Highway Tunnel Drains, and Luluku 500 Reservoir.

The Halekou Wells are shallow alluvial wells installed by the State DOT to remove ground water from the site of the H-3 Halekou Interchange. In the vicinity of the wells, ground water is locally recharged into thick alluvium and volcanic ash. The Halekou Wells will intercept about 0.7 mgd of ground water, most of which probably now seeps from the alluvium into Halekou Stream.

The Pali Highway Tunnel Drains were installed by the State DOT during construction of the Pali Highway to keep ground water from flooding the highway. Basically, they are existing free-flowing tunnels which develop dike-impounded ground water. The proposed BWS diversion of water now flowing from the drains (about 0.3 mgd) would take the headwaters of Kamooalii Stream and sometimes eliminate all dry-weather flow in Kamooalii Stream mauka of Ho'omaluhia Park.

The proposed Luluku 500 Reservoir will accommodate water from the existing BWS Luluku Tunnel. Like the Pali Drains, the Luluku Tunnel develops high-level dike-impounded ground water. Tunnel water drains into a transmission main. The bulkhead in the Luluku Tunnel is leaky. Whenever BWS water usage is low, the excess water leaks past the tunnel bulkhead into Luluku Stream. Over the past decade as water usage from Luluku Tunnel has increased, there has been a substantial decrease in leakage from the tunnel into Luluku Stream and consequently in stream flow. During December 1984, USGS stream flow measurements showed that stream flow below the tunnel increased by 0.01 mgd during times of the day when water usage from Luluku Tunnel was at its lowest. After installation of the Luluku 500 Reservoir, reductions in stream flow will become permanent.

TABLE 28

Proposed BWS Water Development Projects Which May Reduce the Flow of Windward Oahu Streams

Name of Water Source	Maximum Potential Yield	Assumed Static Head	Potentially Affected Stream(s)		Tributary To
Punaluu Wells V-C	1.5 mgd	180'	Punaluu	(Fig. 37)	Ocean
Punaluu Wells V-D	1.5 mgd	240'	Punaluu	(Fig. 38)	Ocean
Punaluu Tunnel	5.0 mgd	580'+	Kaluanui	(Fig. 39)	Ocean
			Waihoi	(Fig. 40)	Punaluu Stream
			Punaluu	(Fig. 40)	Ocean
Punaluu Inclined Wells (Alt. to Punaluu Tunnel)	2.0 mgd	580'+	Kaluanui	(Fig. 39)	Ocean
			Waihoi	(Fig. 40)	Punaluu Stream
			Punaluu	(Fig. 40)	Ocean
Kahana Wells III	2.0 mgd	140'	Kahana	(Fig. 41)	Ocean
Kahana Wells IV	2.0 mgd	140'	Kahana	(Fig. 41)	Ocean
Kahana Wells V	2.0 mgd	140'	Kahana	(Fig. 41)	Ocean
Hakipuu Wells	0.5 mgd	180'	Hakipuu	(Fig. 42)	Ocean
Waikane Wells or Alt.	0.5 mgd	140'	Waikane	(Fig. 43)	Ocean
Uwau Wells	0.5 mgd	280'	Waianu	(Fig. 44)	Waiahole Stream
Waianu Wells	0.5 mgd	280'	Waianu	(Fig. 44)	Waiahole Stream
Waiahole Wells or Alt.	0.5 mgd	480'	Waiahole	(Fig. 45)	Ocean
Kaalaea Wells	0.5 mgd	300'	Kaalaea	(Fig. 46)	Ocean
			Haiamoa		Ocean
Kaalaea Inclined Wells	1.0 mgd	800'+	Kaalaea	(Fig. 47)	Ocean
			Haiamoa		Ocean
			Waihee		Ocean

TABLE 28 [Continued]

Name of Water Source	Maximum Potential Yield	Assumed Static Head	Potentially Affected Stream(s)	Tributary To
Kaalaea Tunnel (Alt. to Kaalaea Incl. Wells)	2.0 mgd	800'+	Kaalaea (Fig. 47) Haiamoa Waihee	Ocean Ocean Ocean
Kahaluu Wells I	1.0 mgd	333'	Kahaluu (Fig. 48)	Ocean
Kahaluu Wells II	0.6 mgd	40'	Unamed Ditch (Fig. 49)	Waihee Stream
Ahuimanu Inclined Wells	1.5 mgd	450'+	Kahaluu (Fig. 50) Ahuimanu Waiola	Ocean Kahaluu Stream Ahuimanu Stream
Ahuimanu Tunnel (Alt. to Ahuimanu Incl.Wells)	2.0 mgd	450'+	Kahaluu (Fig. 50) Ahuimanu Waiola	Ocean Kahaluu Stream Ahuimanu Stream
Haiku Well	1.0 mgd	497'	Haiku (Fig. 51) Keaahala	Heeia Stream Ocean
Luluku 500 Reservoir (Hookup to Luluku Tunnel)	0.2 mgd	530'+	Luluku (Fig. 52)	Kamooalii Stream
Kuou Wells II	1.0 mgd	260'	Kamooalii(Fig. 53) Hooleinaiwa	Kaneohe Stream Kamooalii Stream
Halekou Wells	0.7 mgd	210'	Halekou (Fig. 54)	Kamooalii Stream
Pali Highway Tunnel Drains	0.3 mgd	900'+	Kamooalii(Fig. 55)	Kaneohe Stream
Maunawili Wells I	0.5 mgd	220'	Omao (Fig. 56 Maunawili and 58)	Maunawili Stream Kawainui Marsh
Maunawili Wells II	0.5 mgd	280'	Palapu (Fig. 57 Omao and 58)	Omao Stream Maunawili Stream
Maunawili Wells III	0.5 mgd	280'	Palapu (Fig. 57 Omao and 58)	Omao Stream Maunawili Stream

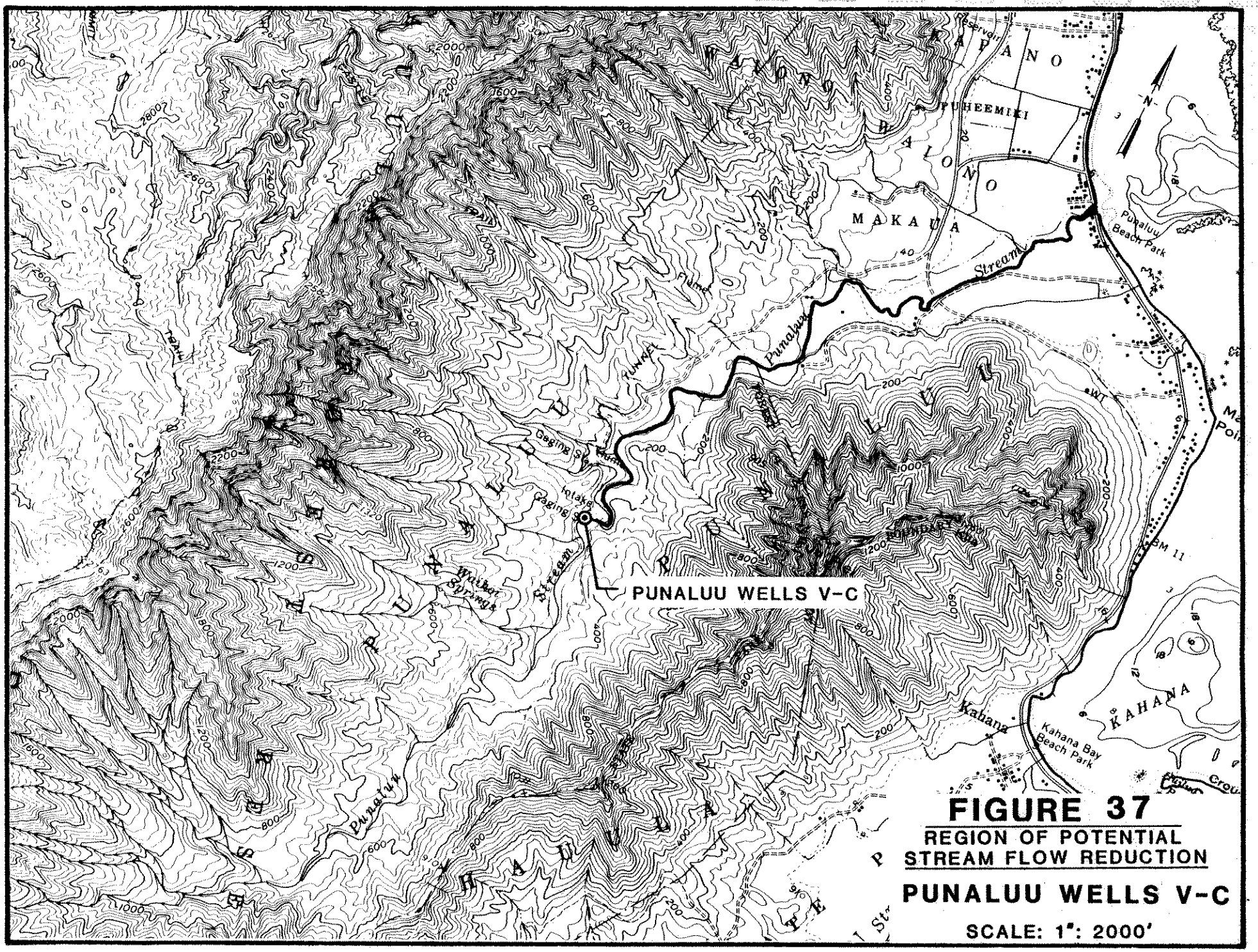


FIGURE 37

REGION OF POTENTIAL STREAM FLOW REDUCTION

PUNALUU WELLS V-C

SCALE: 1": 2000'

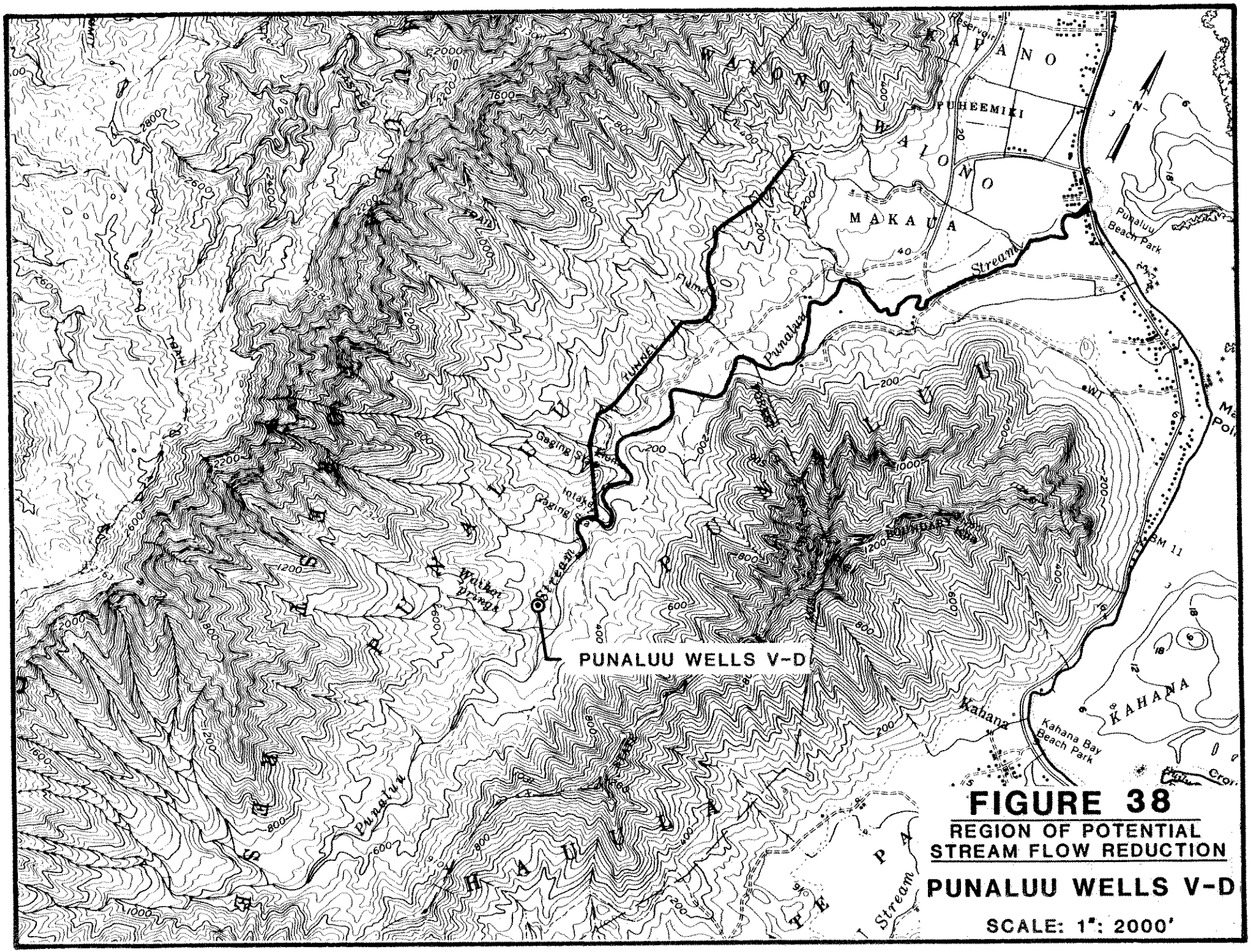


FIGURE 38

REGION OF POTENTIAL STREAM FLOW REDUCTION

PUNALUU WELLS V-D

SCALE: 1": 2000'

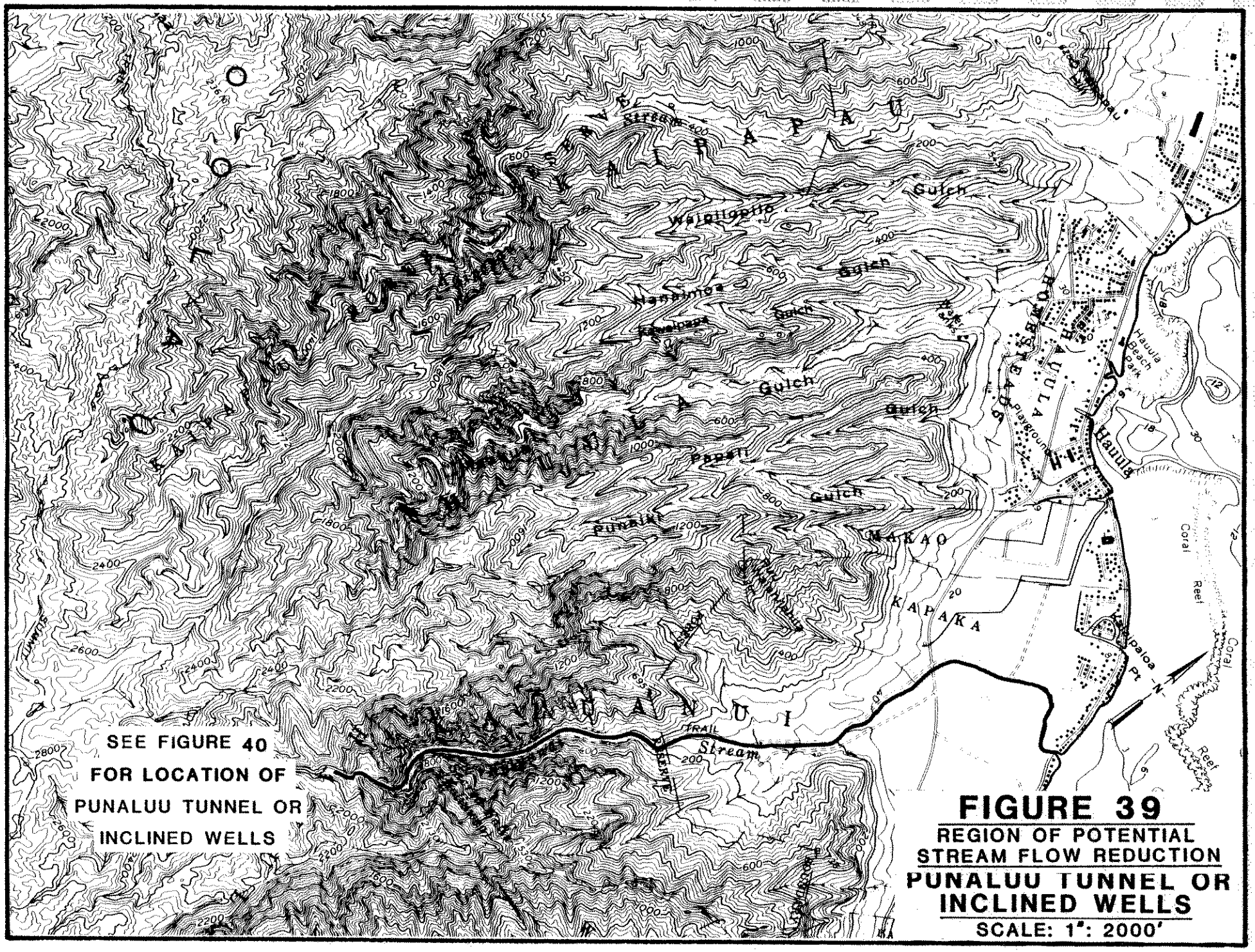


FIGURE 39

REGION OF POTENTIAL STREAM FLOW REDUCTION

PUNALUU TUNNEL OR INCLINED WELLS

SCALE: 1": 2000'

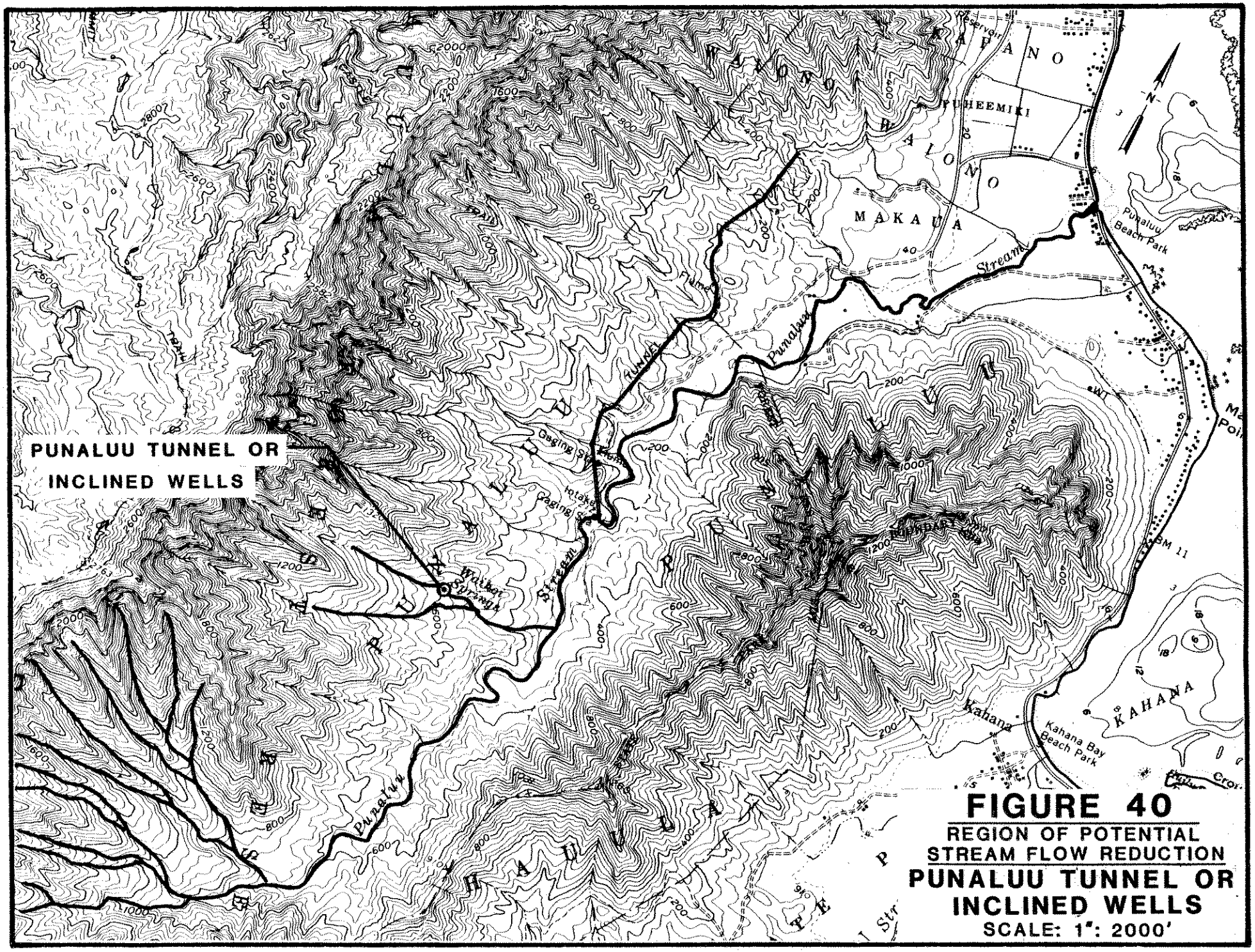


FIGURE 40

REGION OF POTENTIAL STREAM FLOW REDUCTION

PUNALUU TUNNEL OR INCLINED WELLS

SCALE: 1": 2000'

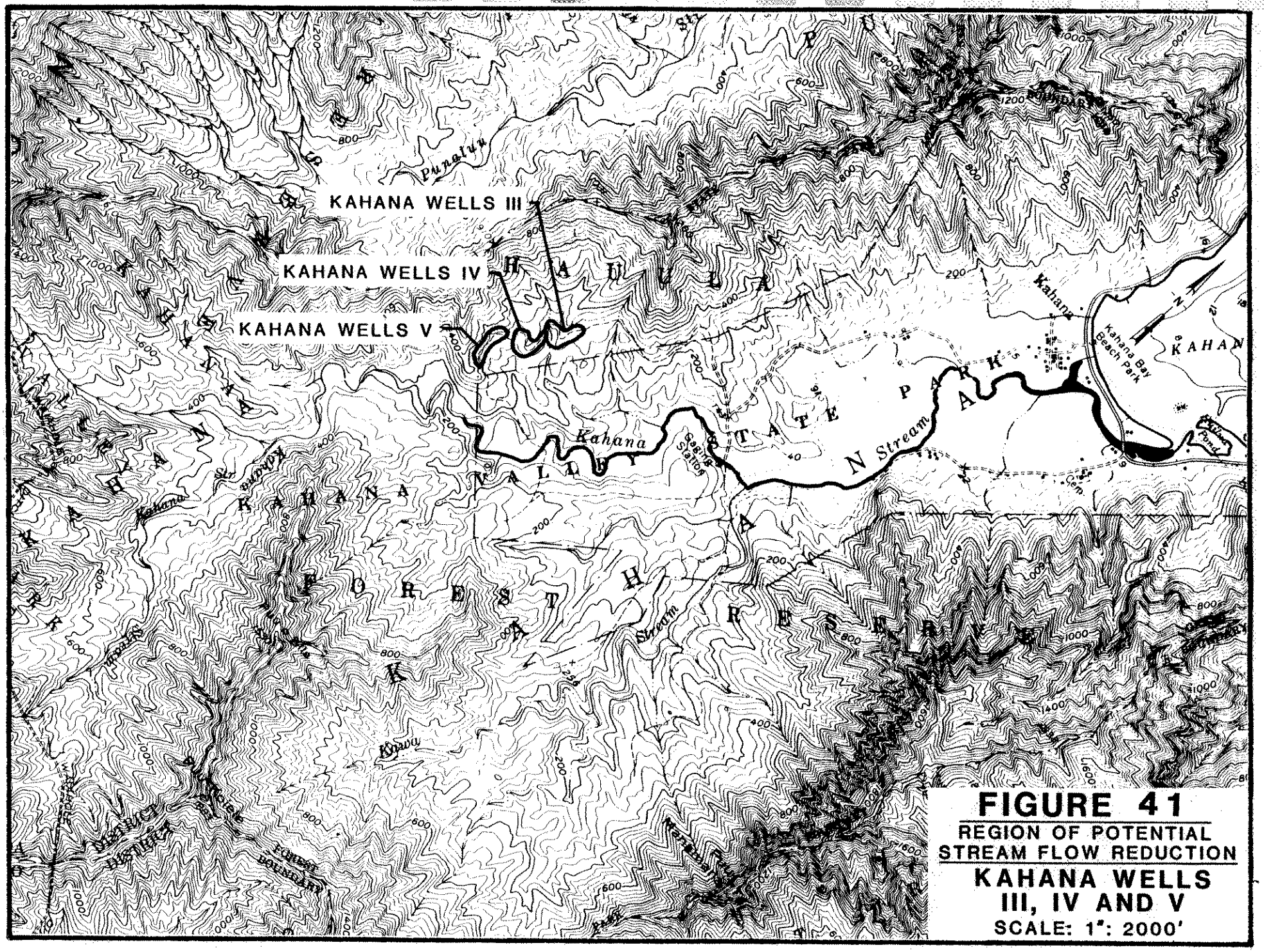


FIGURE 41

REGION OF POTENTIAL STREAM FLOW REDUCTION

KAHANA WELLS III, IV AND V

SCALE: 1": 2000'

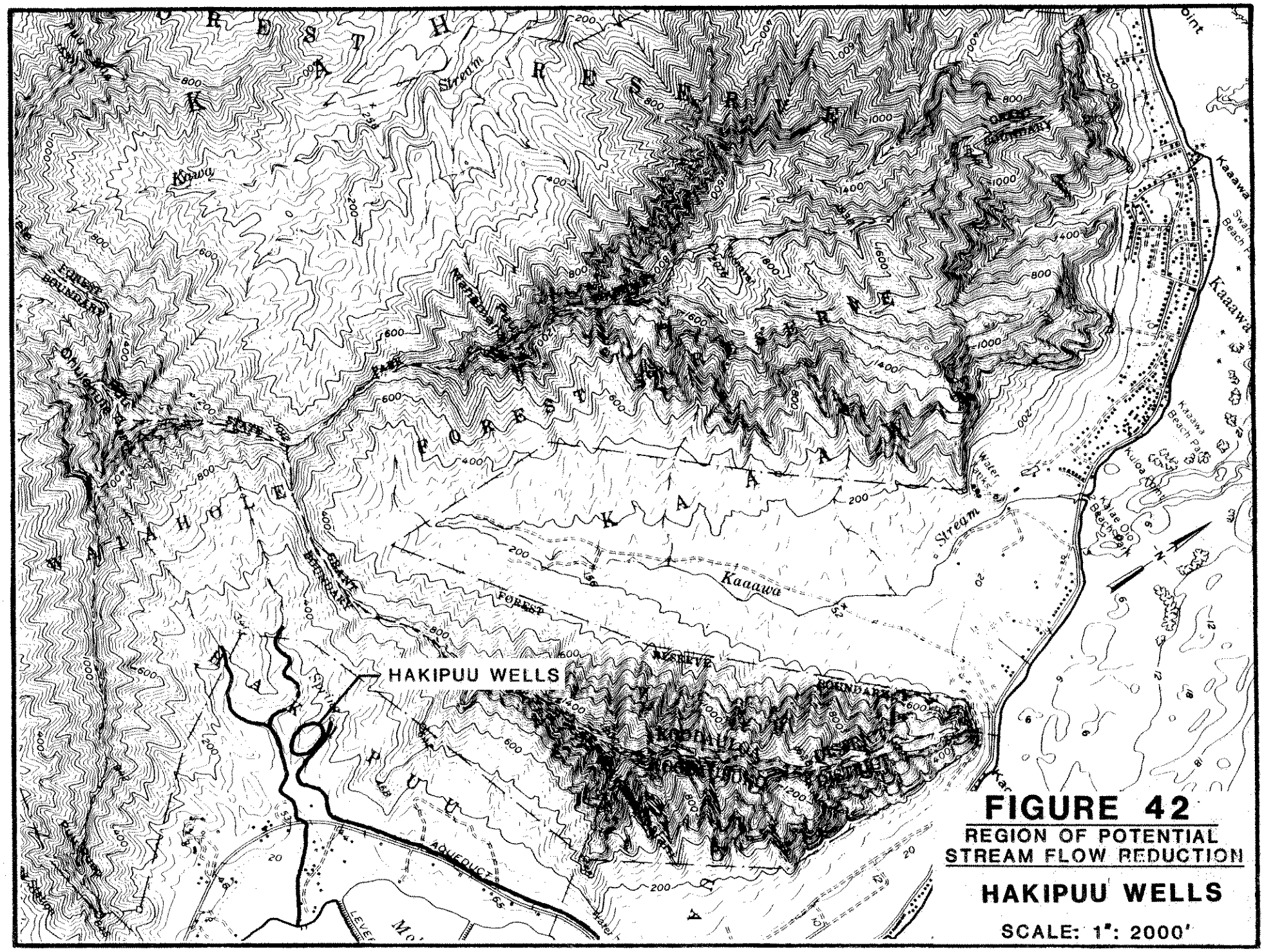


FIGURE 42

REGION OF POTENTIAL STREAM FLOW REDUCTION

HAKIPUU WELLS

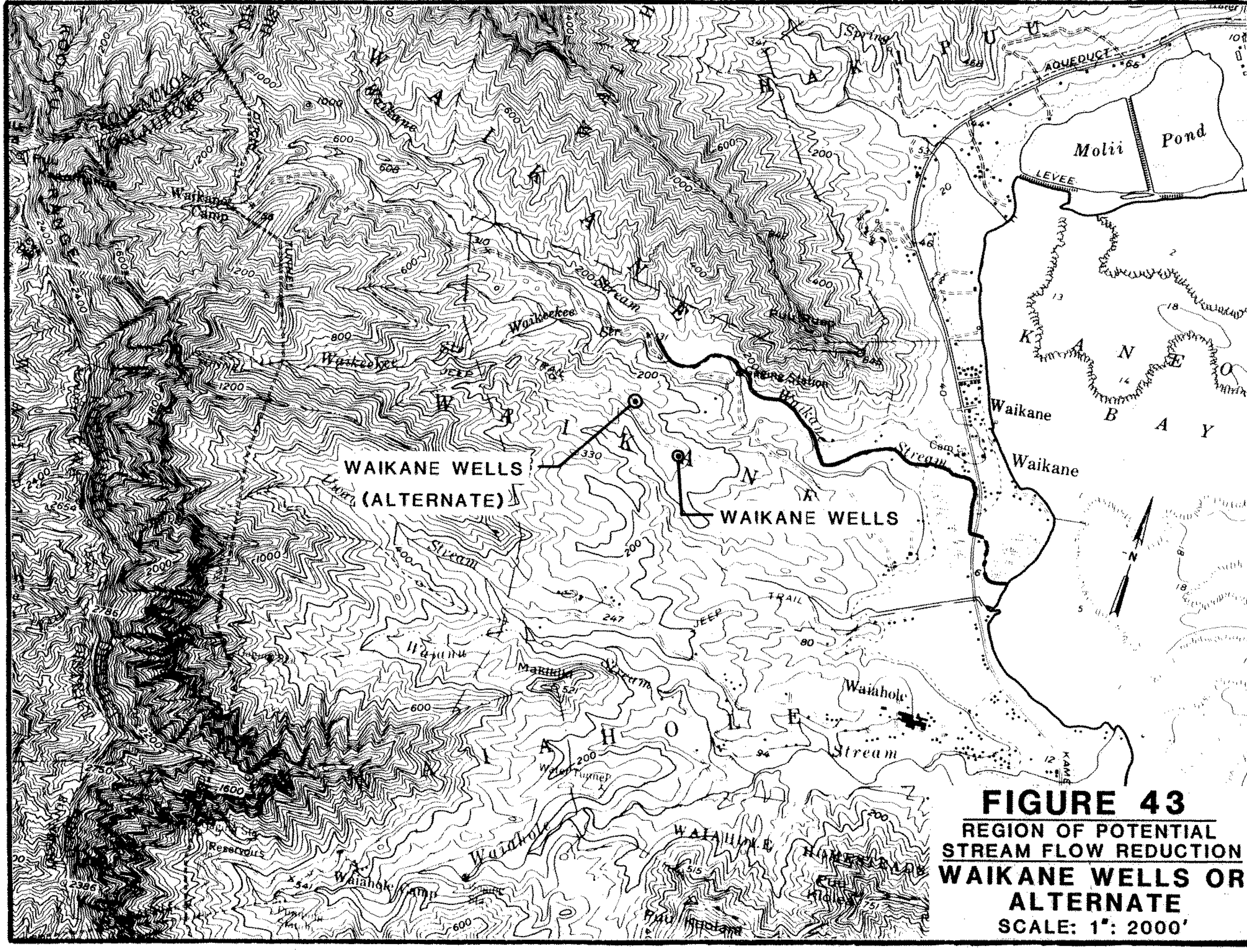


FIGURE 43

REGION OF POTENTIAL STREAM FLOW REDUCTION

WAIKANE WELLS OR ALTERNATE

SCALE: 1": 2000'

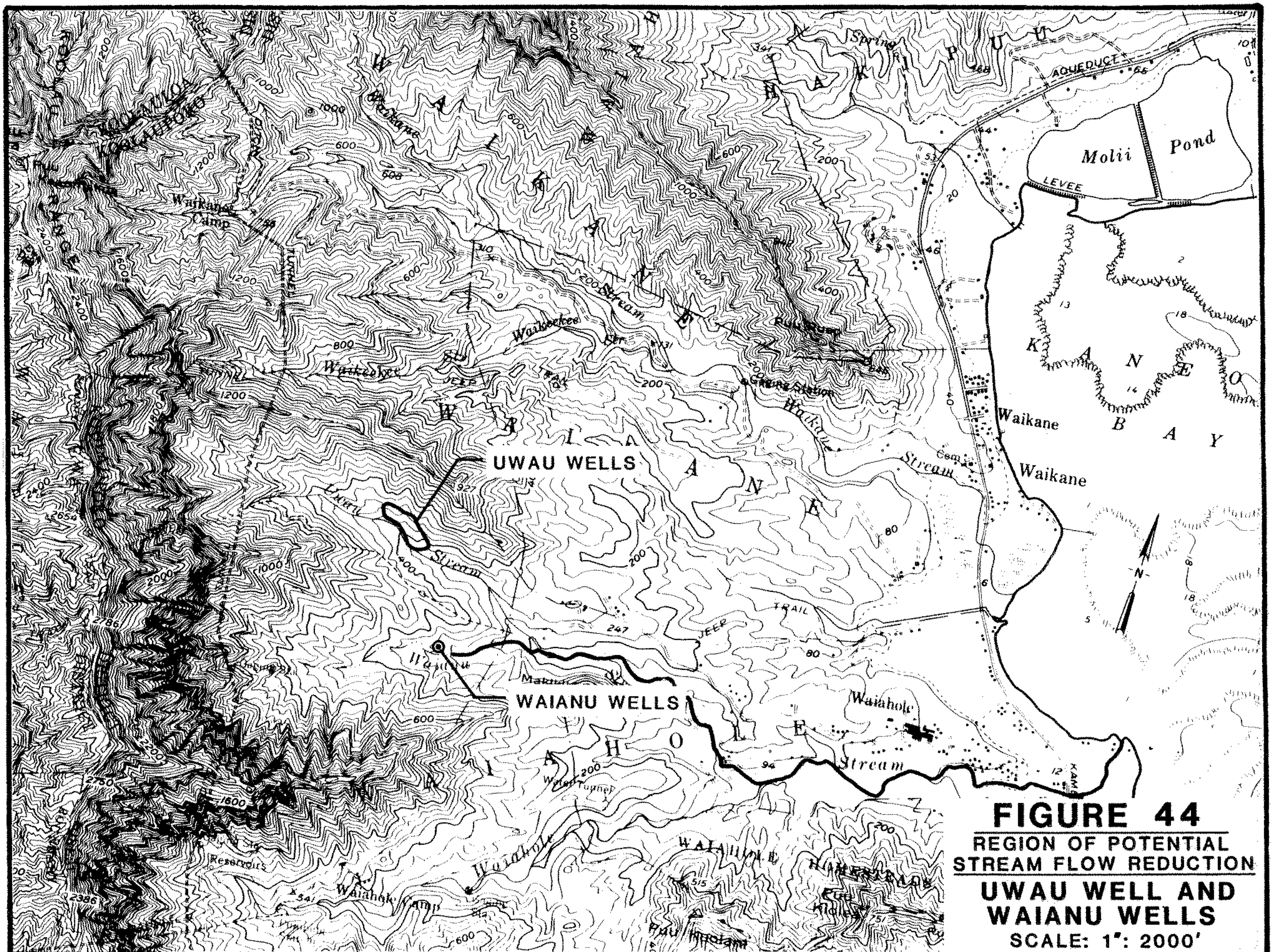


FIGURE 44

REGION OF POTENTIAL STREAM FLOW REDUCTION

UWAU WELL AND WAIANU WELLS

SCALE: 1": 2000'

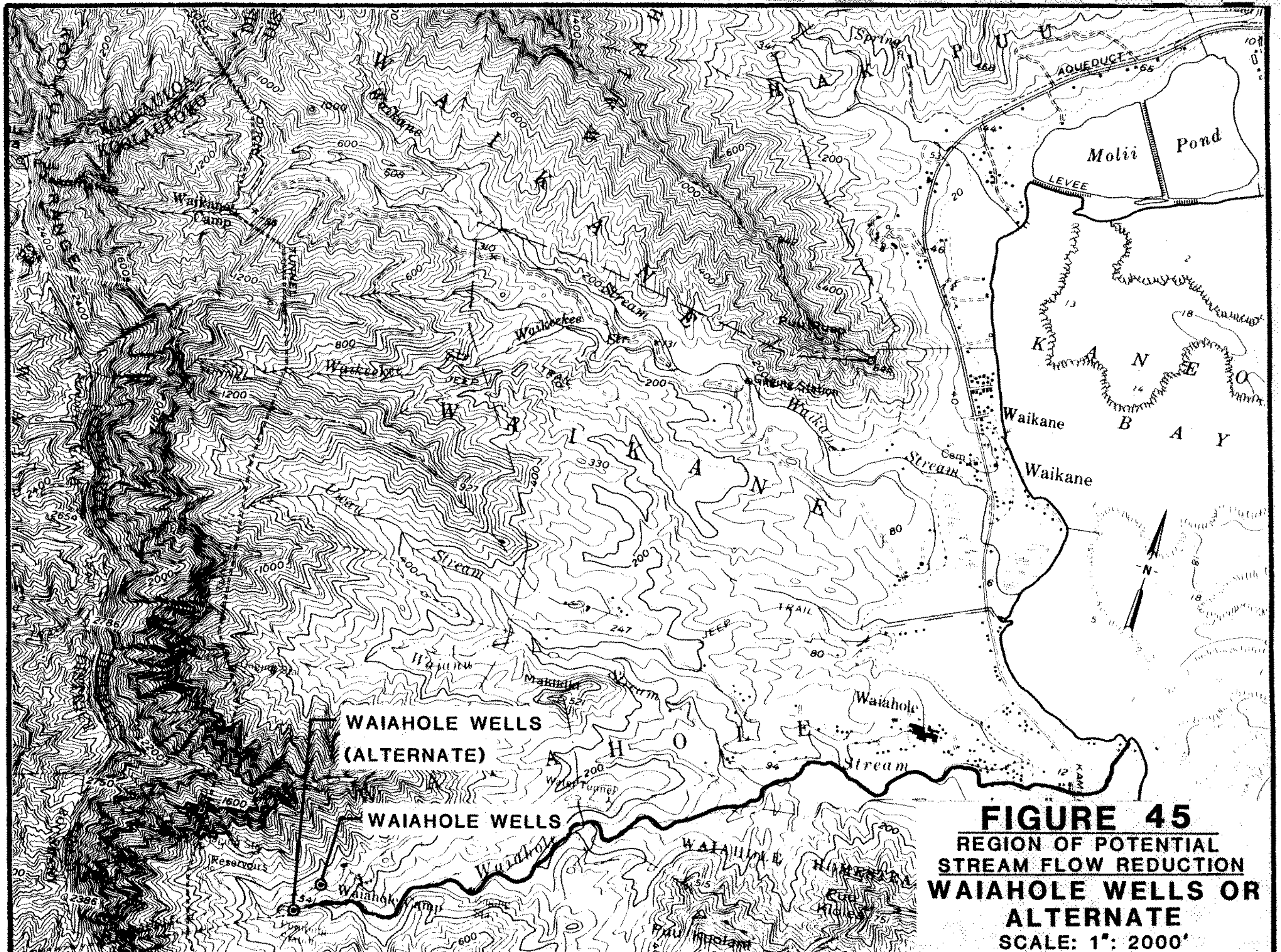


FIGURE 45
REGION OF POTENTIAL STREAM FLOW REDUCTION
WAIAHOLE WELLS OR ALTERNATE
SCALE: 1": 2000'

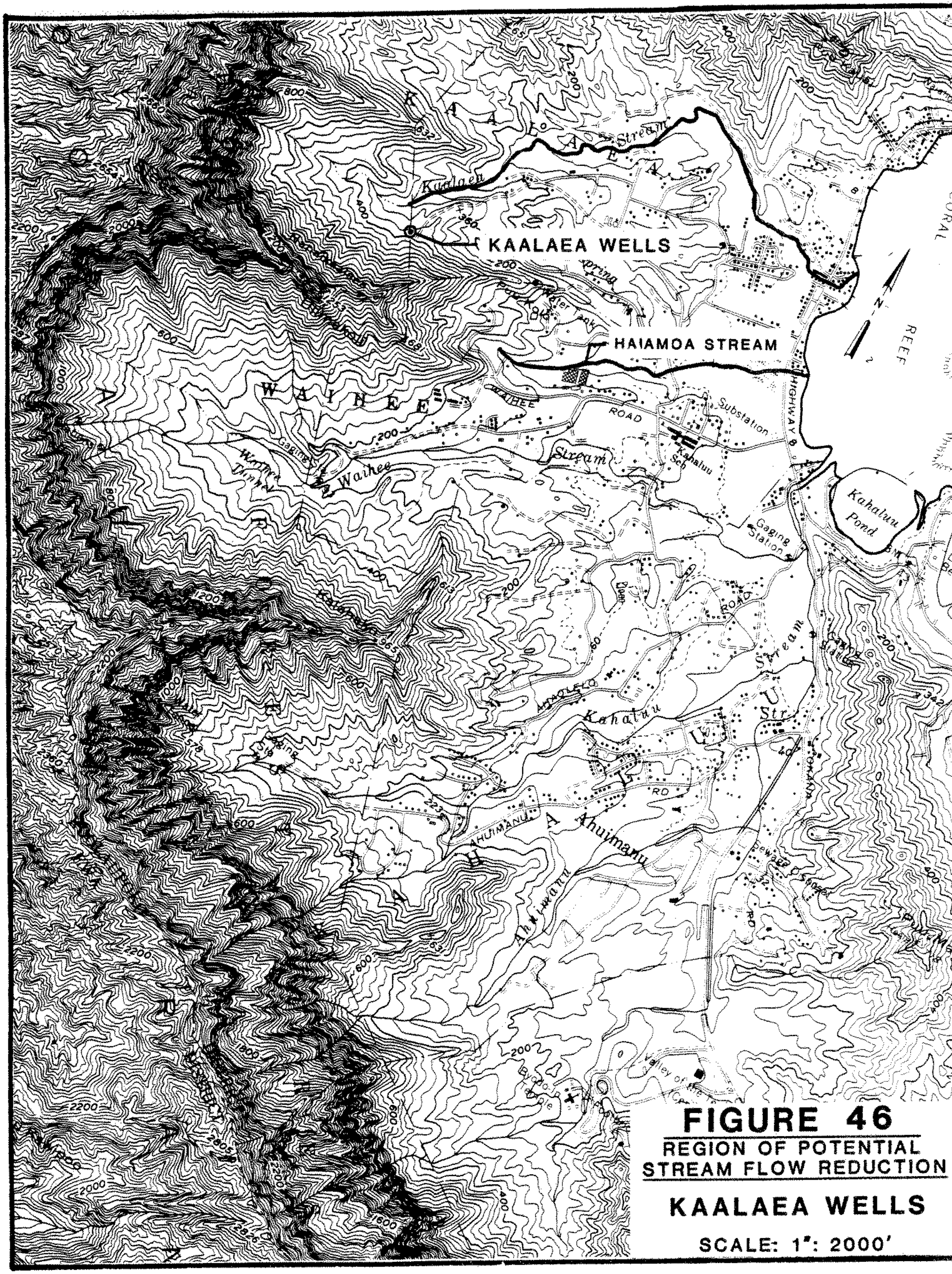


FIGURE 46

REGION OF POTENTIAL STREAM FLOW REDUCTION

KAALAEA WELLS

SCALE: 1": 2000'

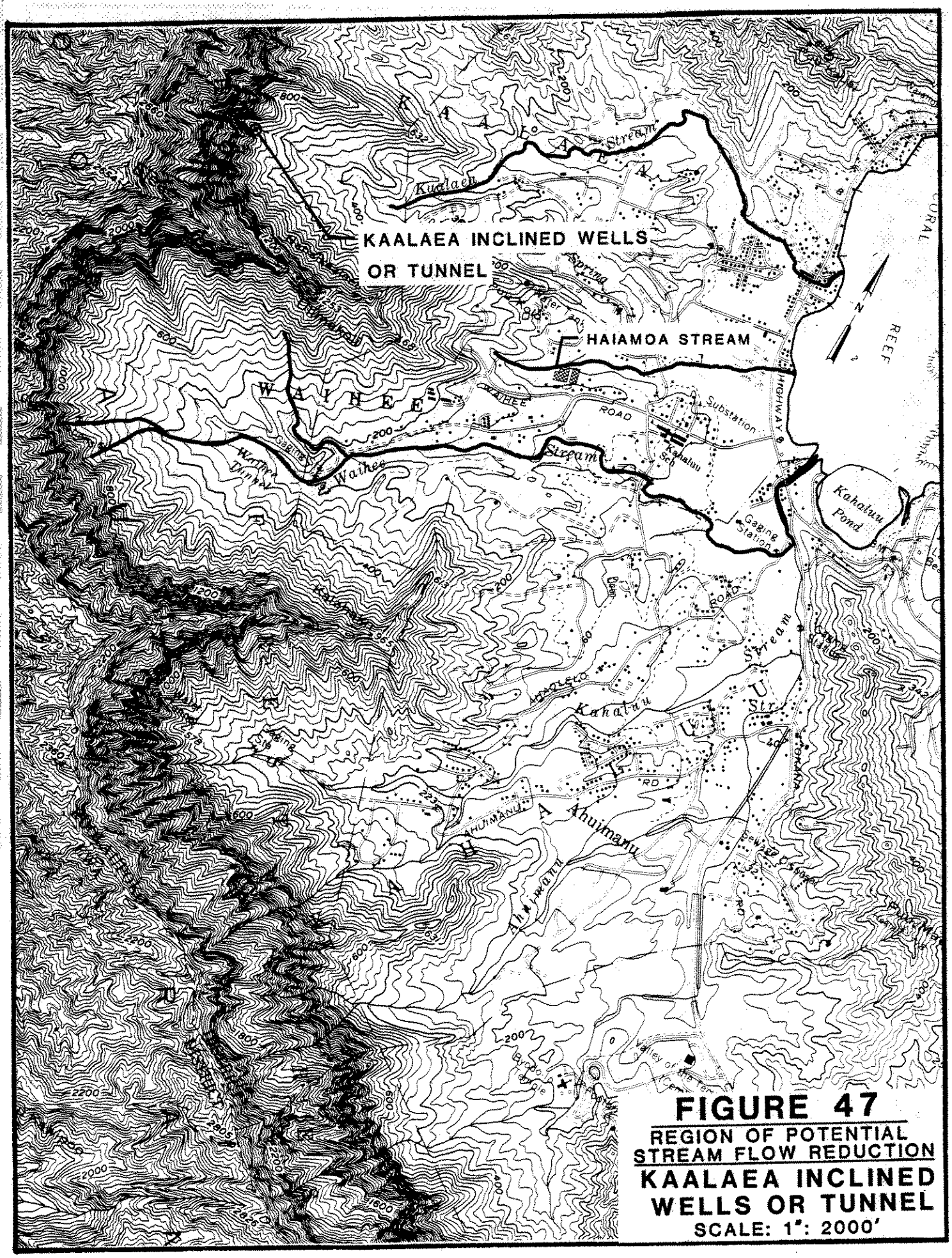


FIGURE 47

REGION OF POTENTIAL STREAM FLOW REDUCTION

KAALAEA INCLINED WELLS OR TUNNEL

SCALE: 1": 2000'

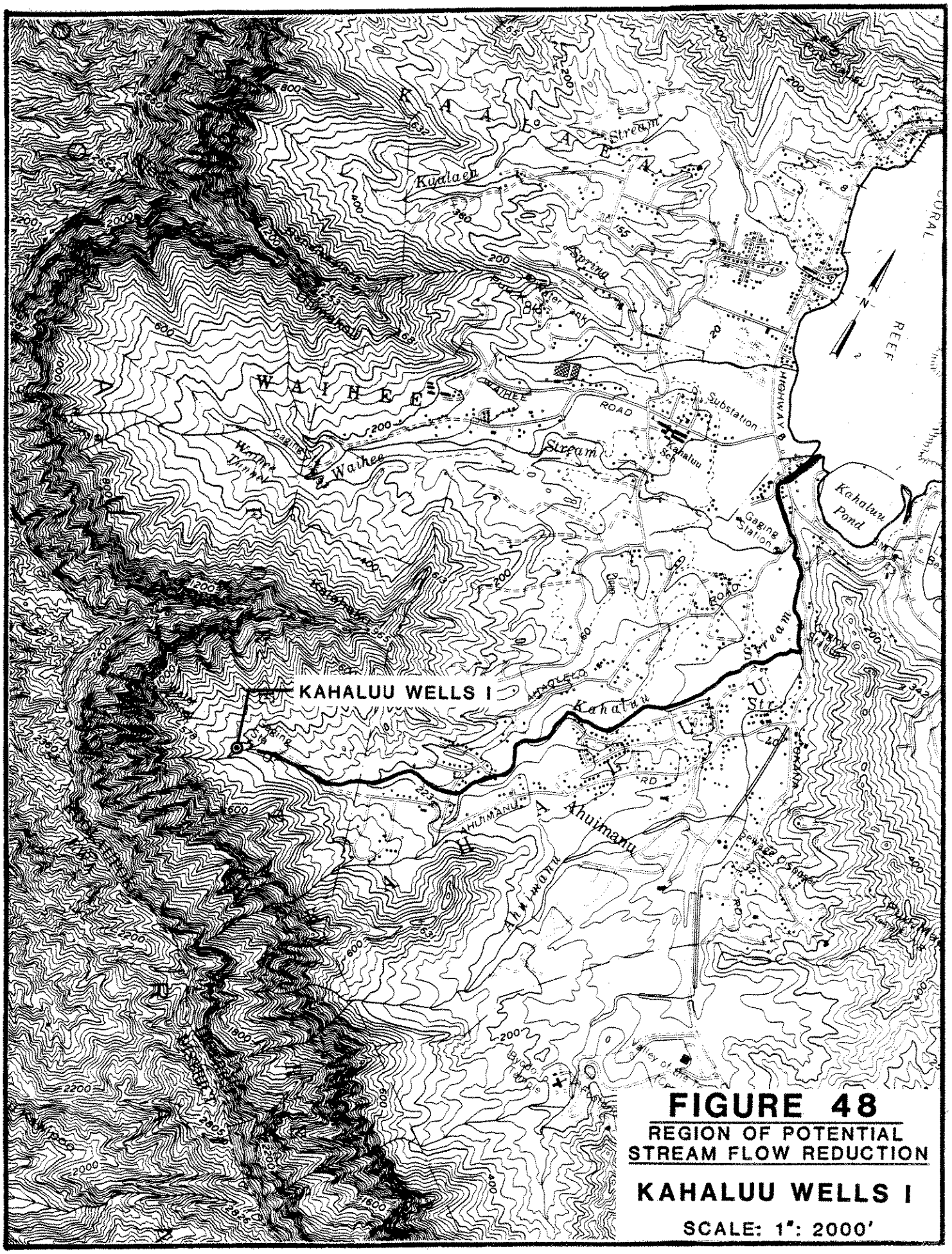


FIGURE 48

REGION OF POTENTIAL STREAM FLOW REDUCTION

KAHALUU WELLS I

SCALE: 1": 2000'

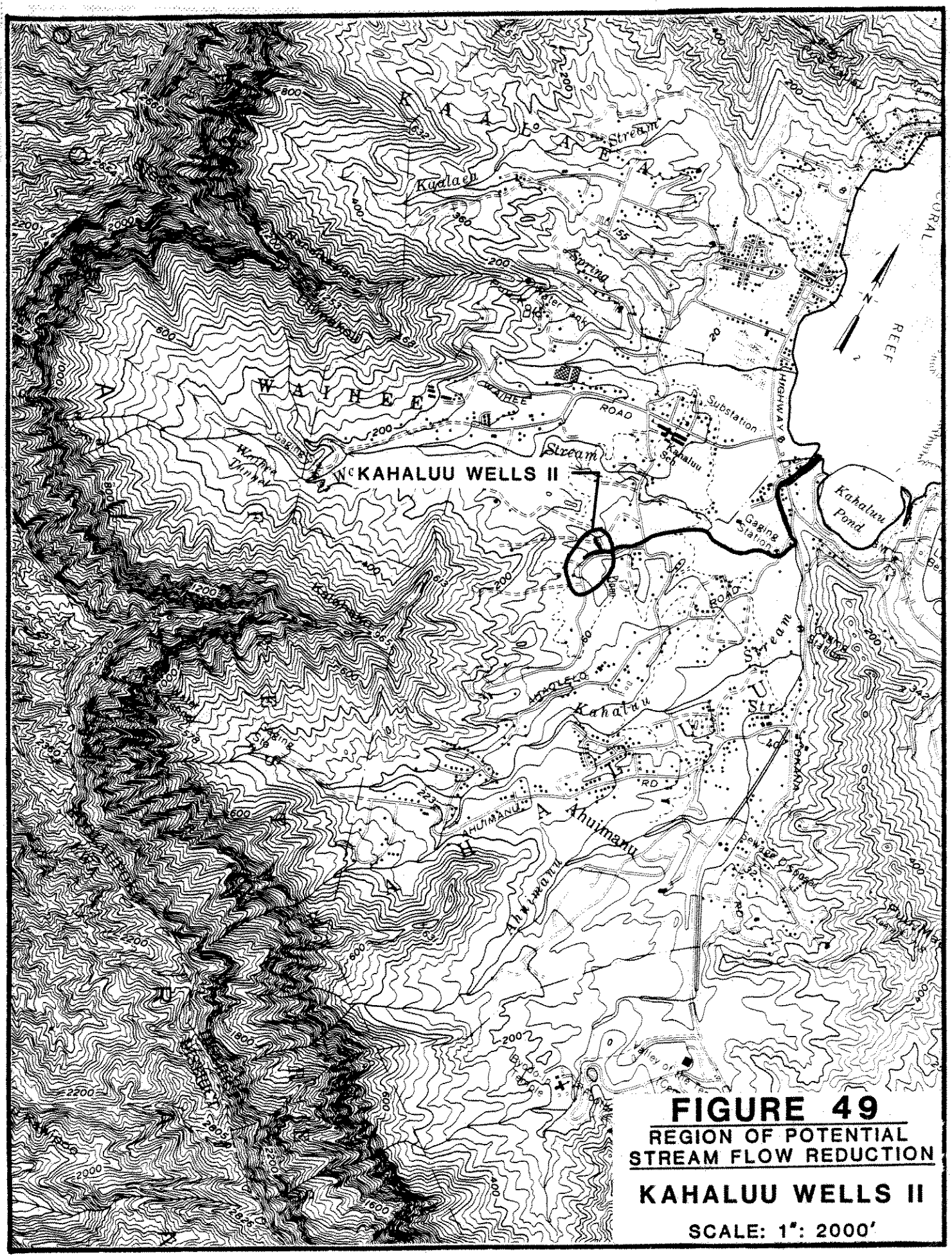


FIGURE 49

REGION OF POTENTIAL STREAM FLOW REDUCTION

KAHALUU WELLS II

SCALE: 1": 2000'

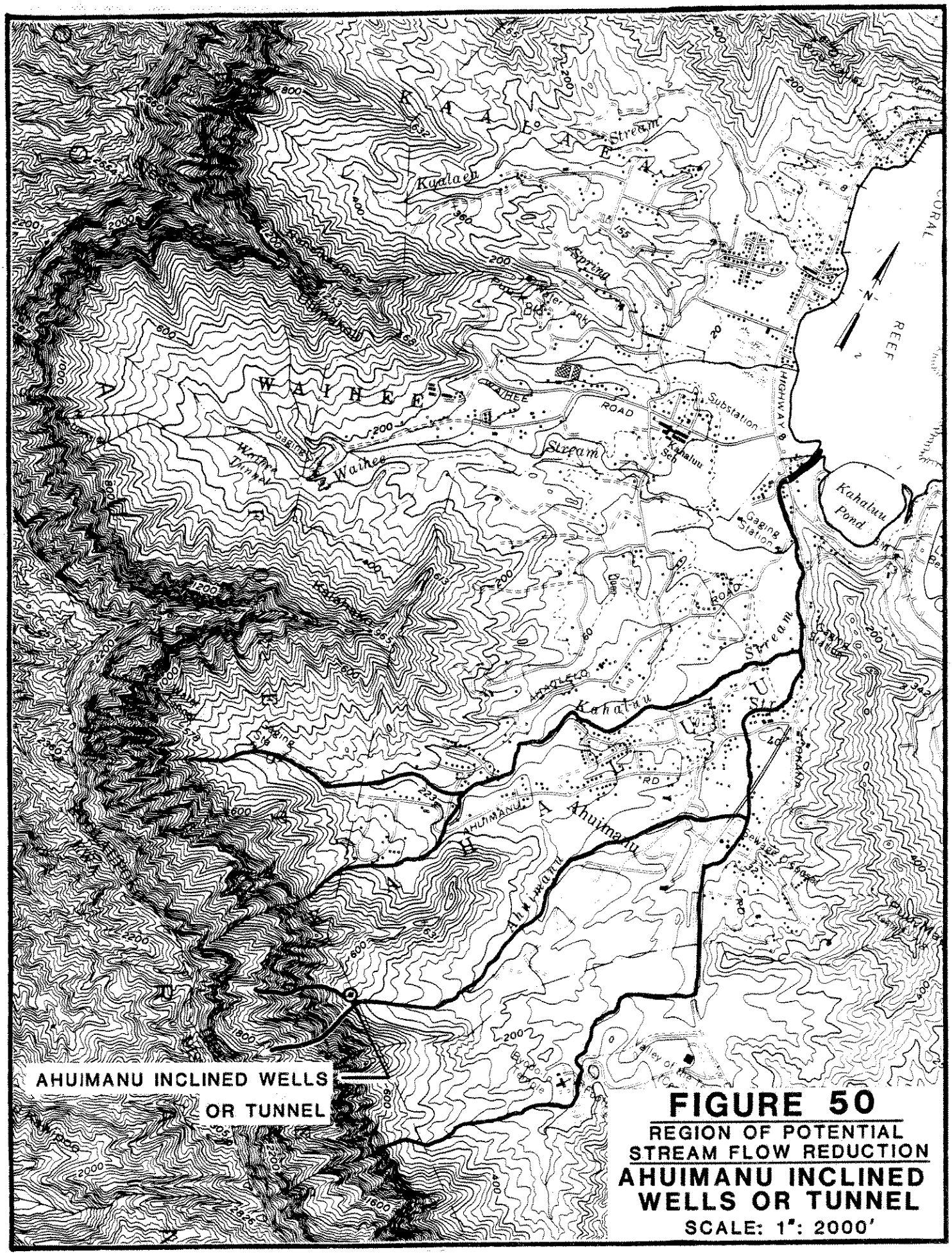


FIGURE 50

REGION OF POTENTIAL STREAM FLOW REDUCTION

AHUIMANU INCLINED WELLS OR TUNNEL

SCALE: 1": 2000'

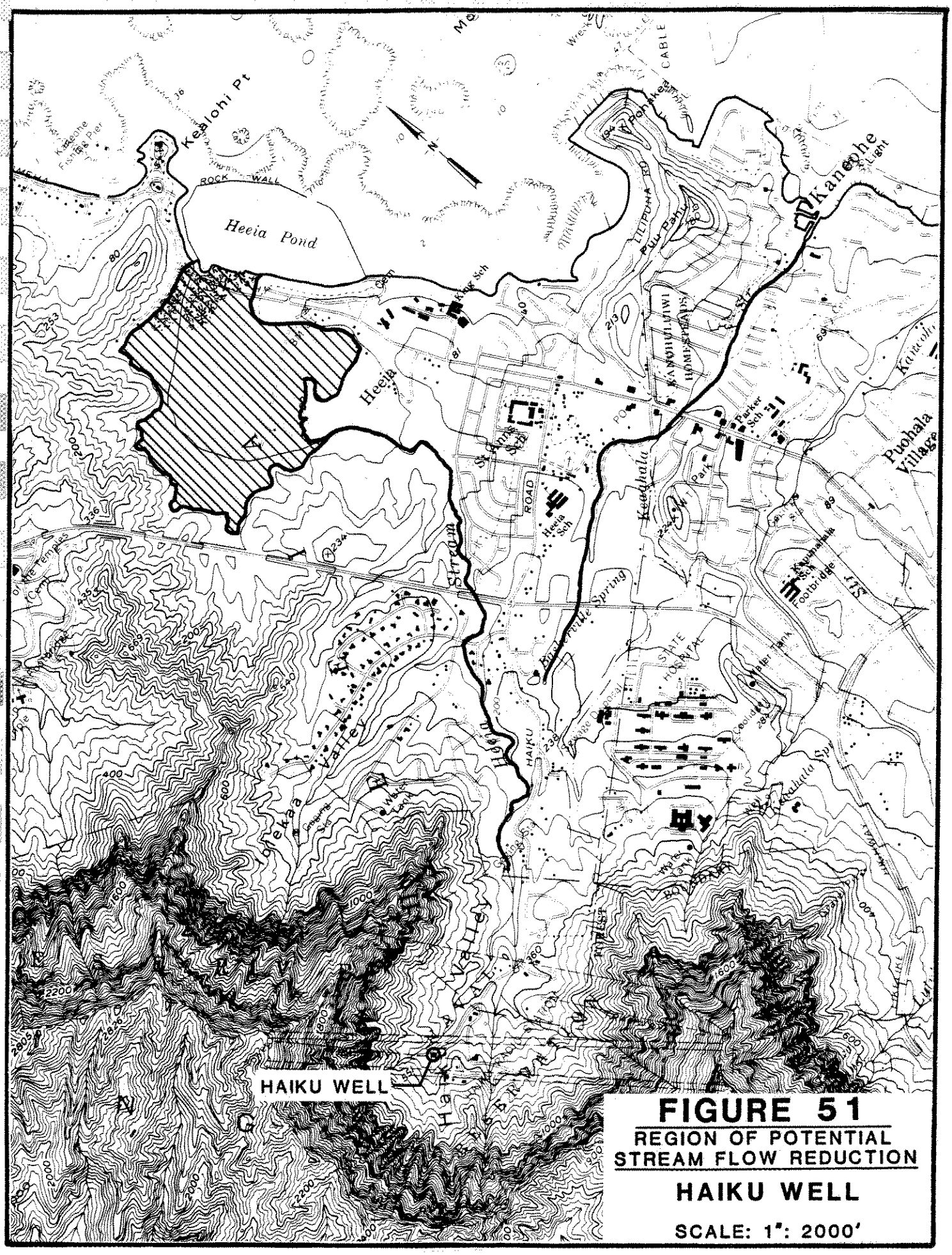


FIGURE 51

REGION OF POTENTIAL STREAM FLOW REDUCTION

HAIKU WELL

SCALE: 1": 2000'

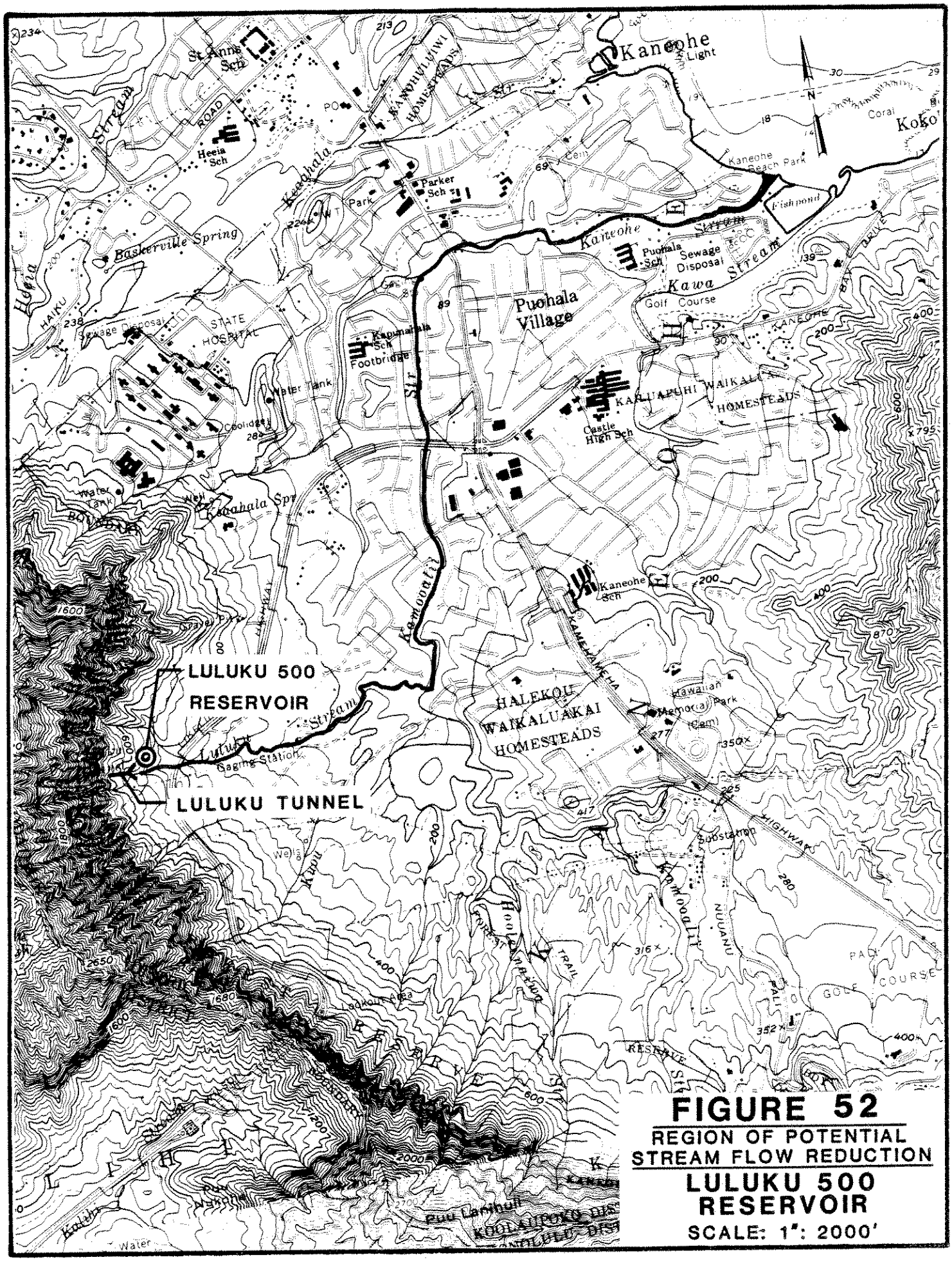


FIGURE 52

REGION OF POTENTIAL STREAM FLOW REDUCTION

LULUKU 500 RESERVOIR

SCALE: 1": 2000'

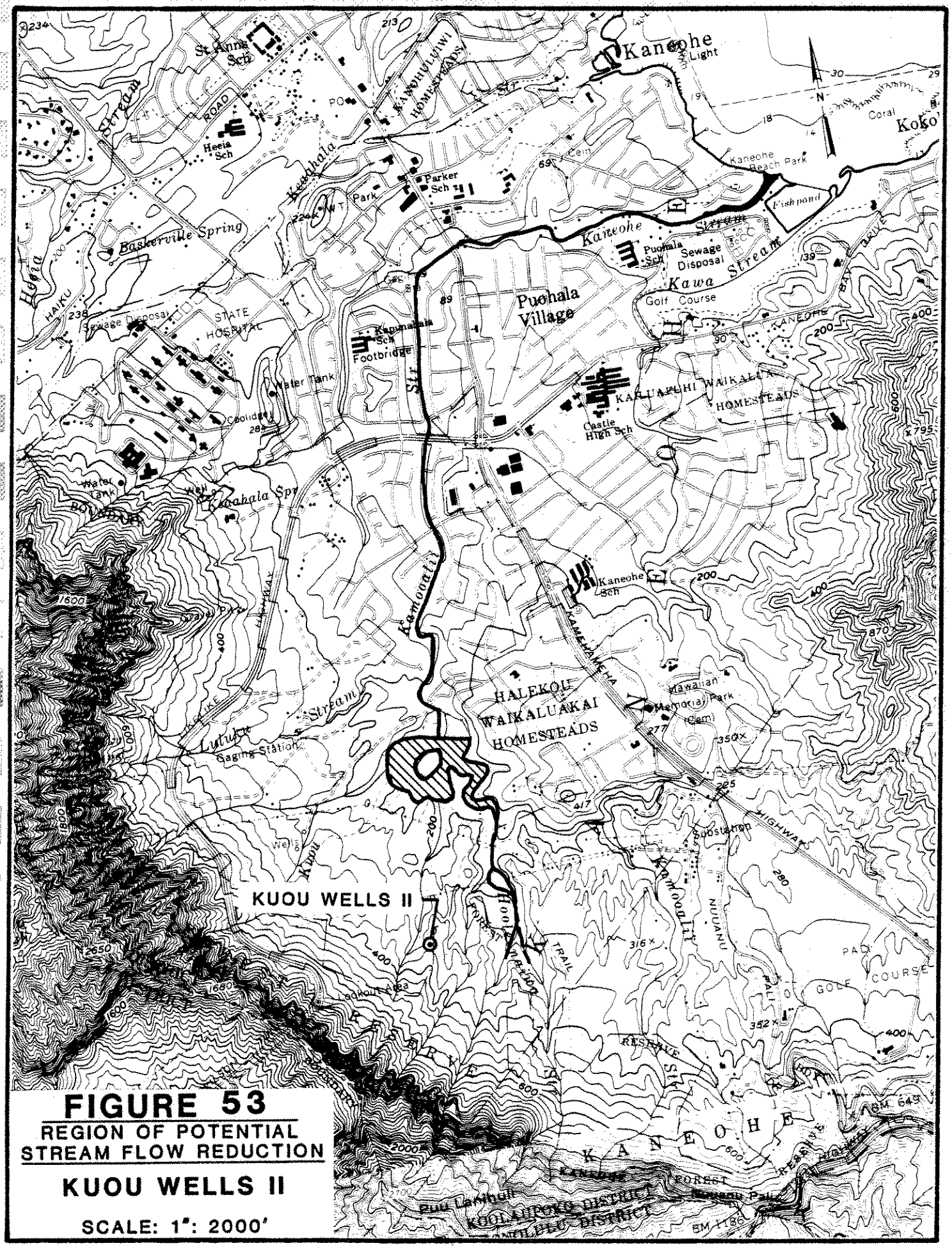


FIGURE 53

REGION OF POTENTIAL STREAM FLOW REDUCTION

KUOU WELLS II

SCALE: 1": 2000'

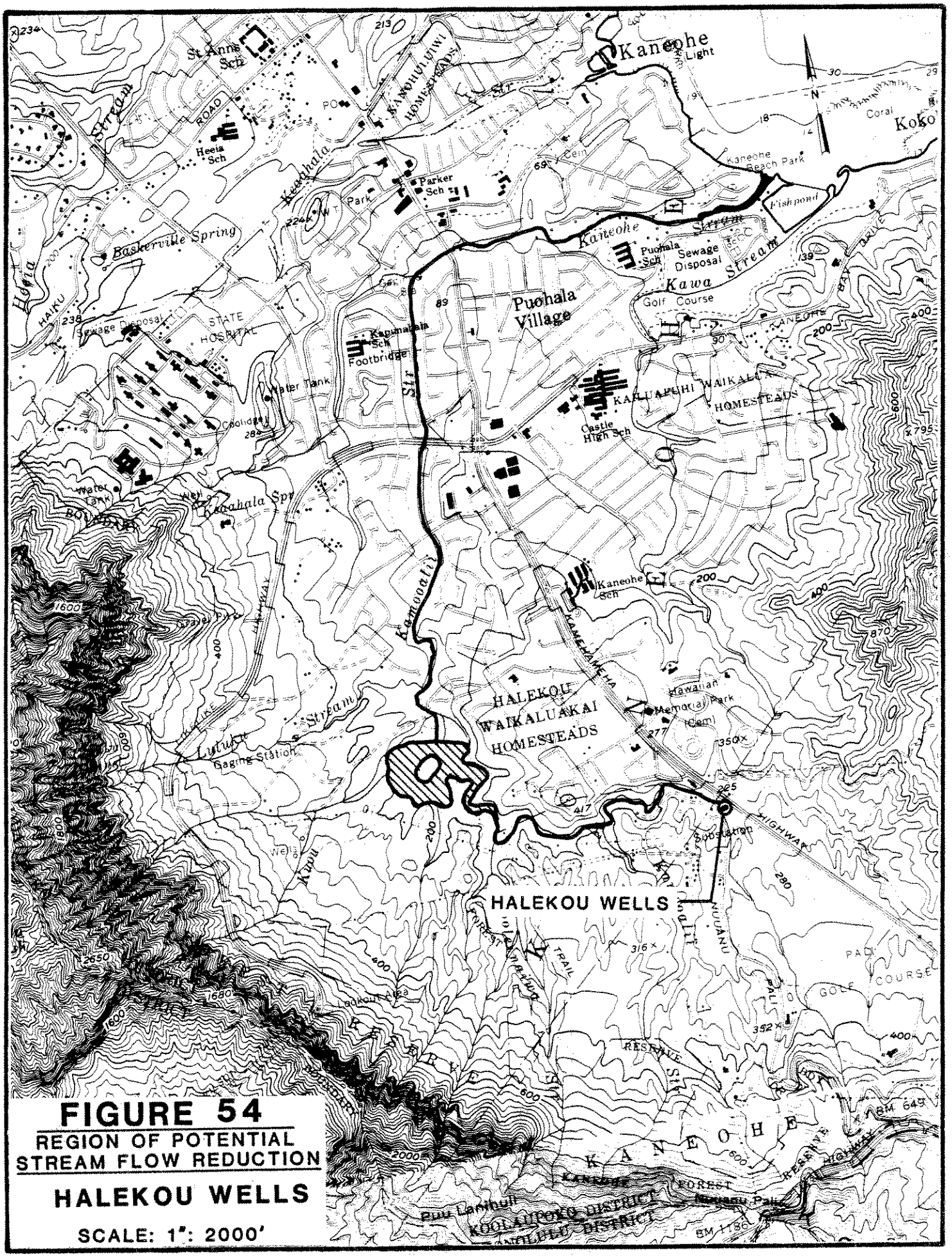


FIGURE 54

REGION OF POTENTIAL STREAM FLOW REDUCTION

HALEKOU WELLS

SCALE: 1": 2000'

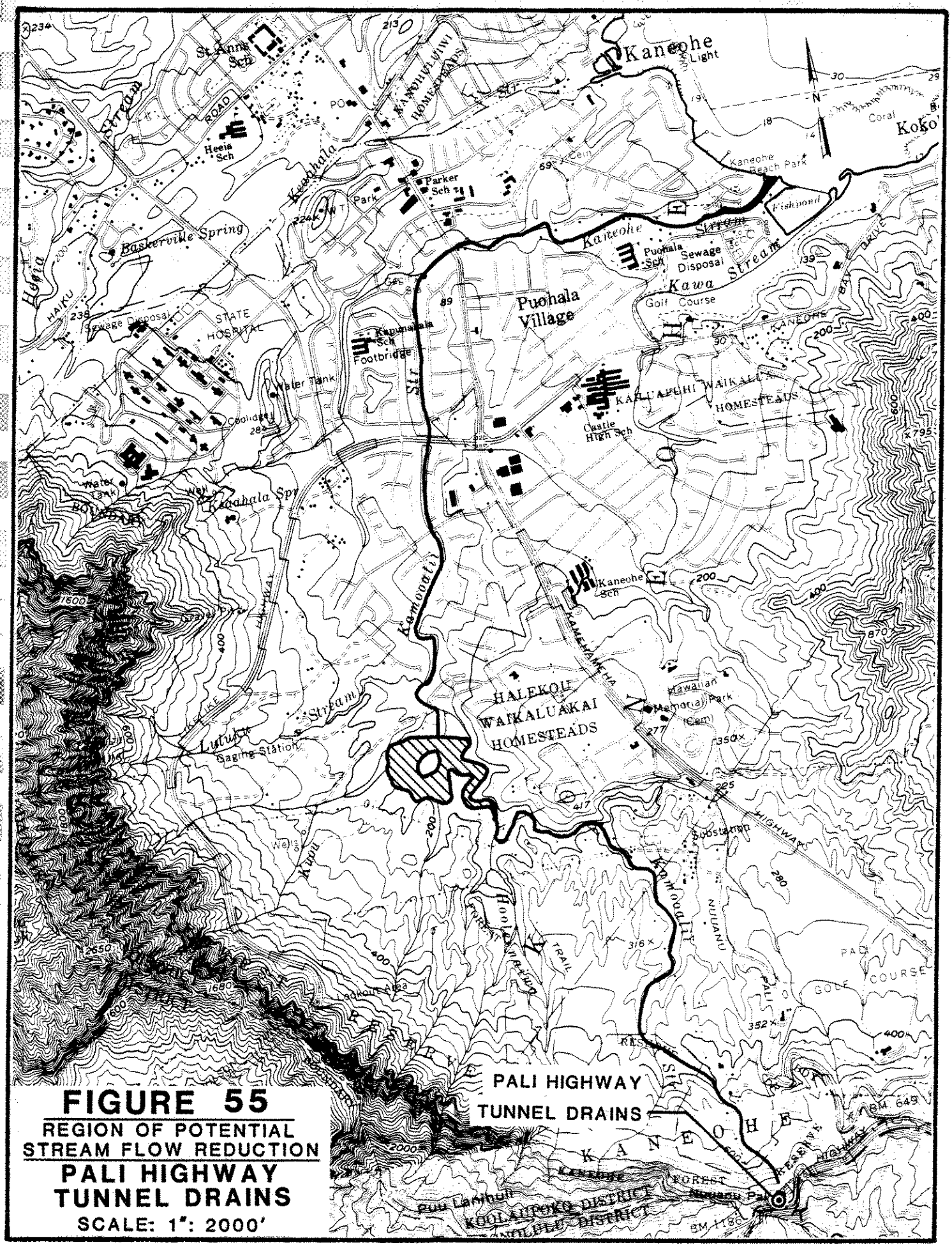


FIGURE 55

REGION OF POTENTIAL STREAM FLOW REDUCTION

PALI HIGHWAY TUNNEL DRAINS

SCALE: 1": 2000'

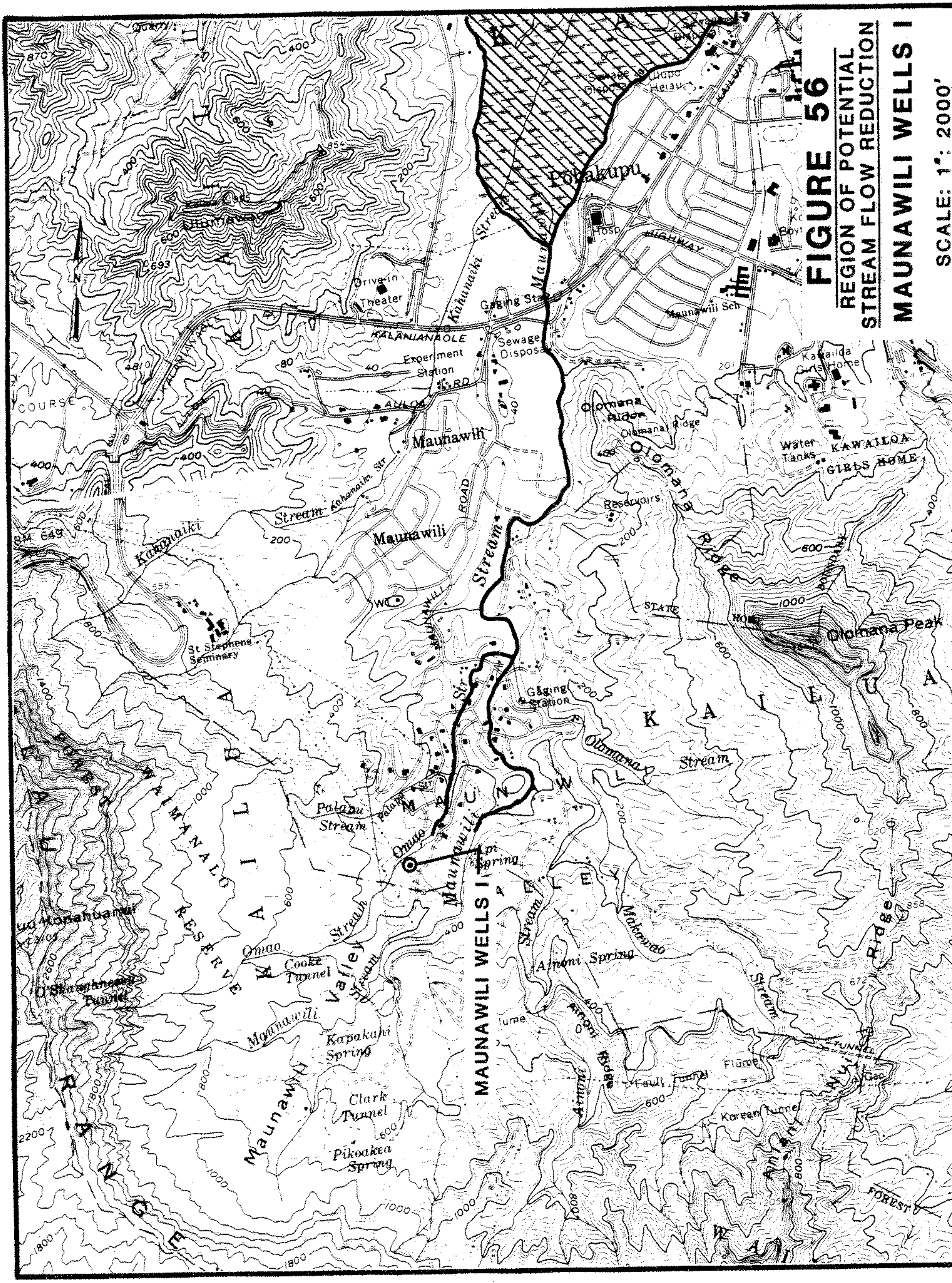


FIGURE 56
REGION OF POTENTIAL
STREAM FLOW REDUCTION
MAUNAWILI WELLS I
SCALE: 1": 2000'
MAUNAWILI WELLS I
Pohakupu
Olomana Peak
Olomana Ridge
Maunawili
St Stephens Seminary
Kahanaiki Stream
Maunawili Stream
Olomana Stream
Palapu Stream
Omao Stream
Makawao Stream
Maunawili Valley
Cooke Tunnel
O'Shaughnessy Tunnel
Kapakahi Spring
Clark Tunnel
Pikoakea Spring
Ainoni Spring
Fault Tunnel
Korean Tunnel
Gaging Station
Experiment Station
Sewage Disposal
Drive-in Theater
Reservoirs
Water Tanks
KAWAILOA GIRLS HOME
KALANIANAOLE
HIGHWAY
WAIMANALO FOREST RESERVE
KAILUA

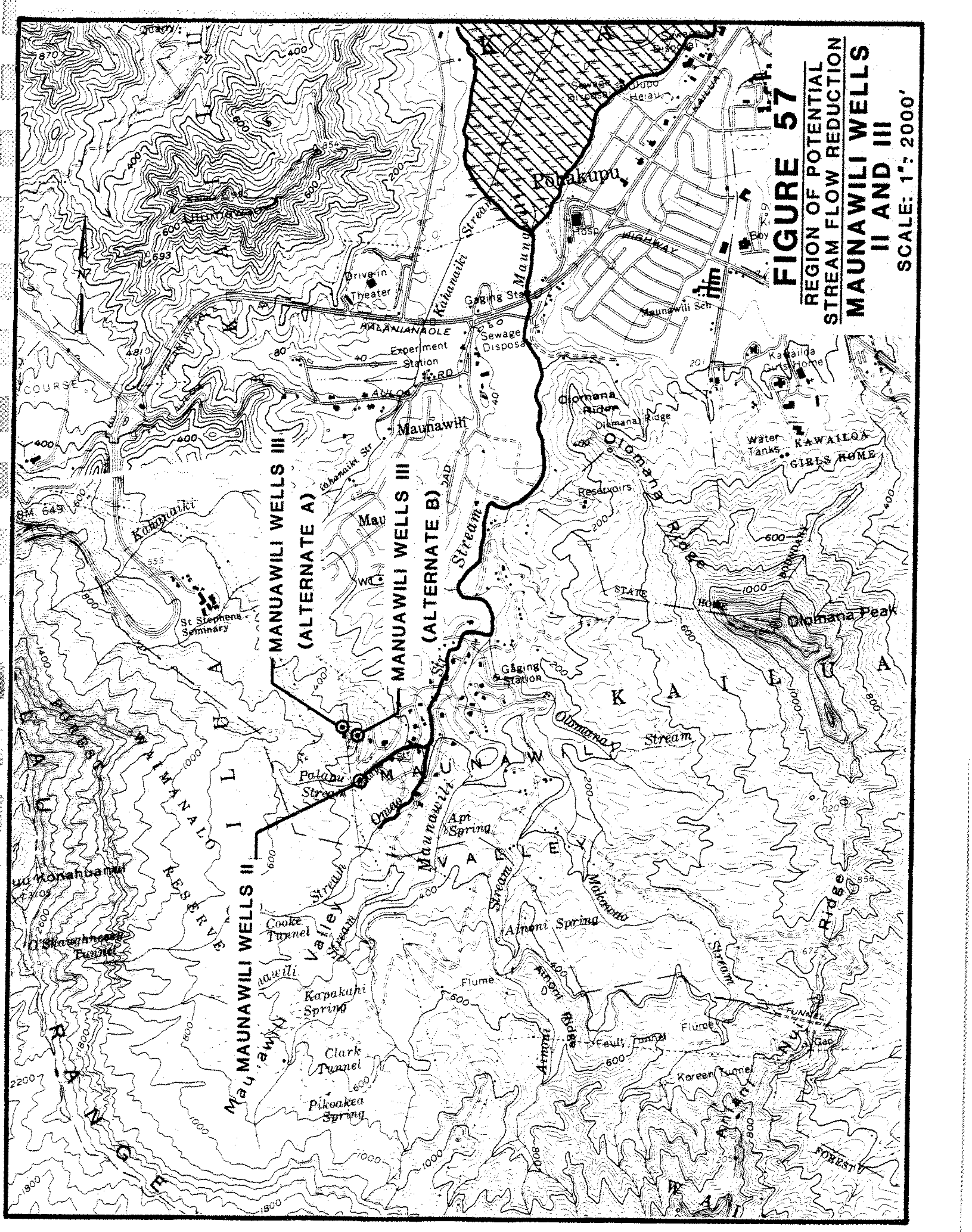


FIGURE 57
REGION OF POTENTIAL STREAM FLOW REDUCTION
MAUNAWILI WELLS II AND III
SCALE: 1": 2000'

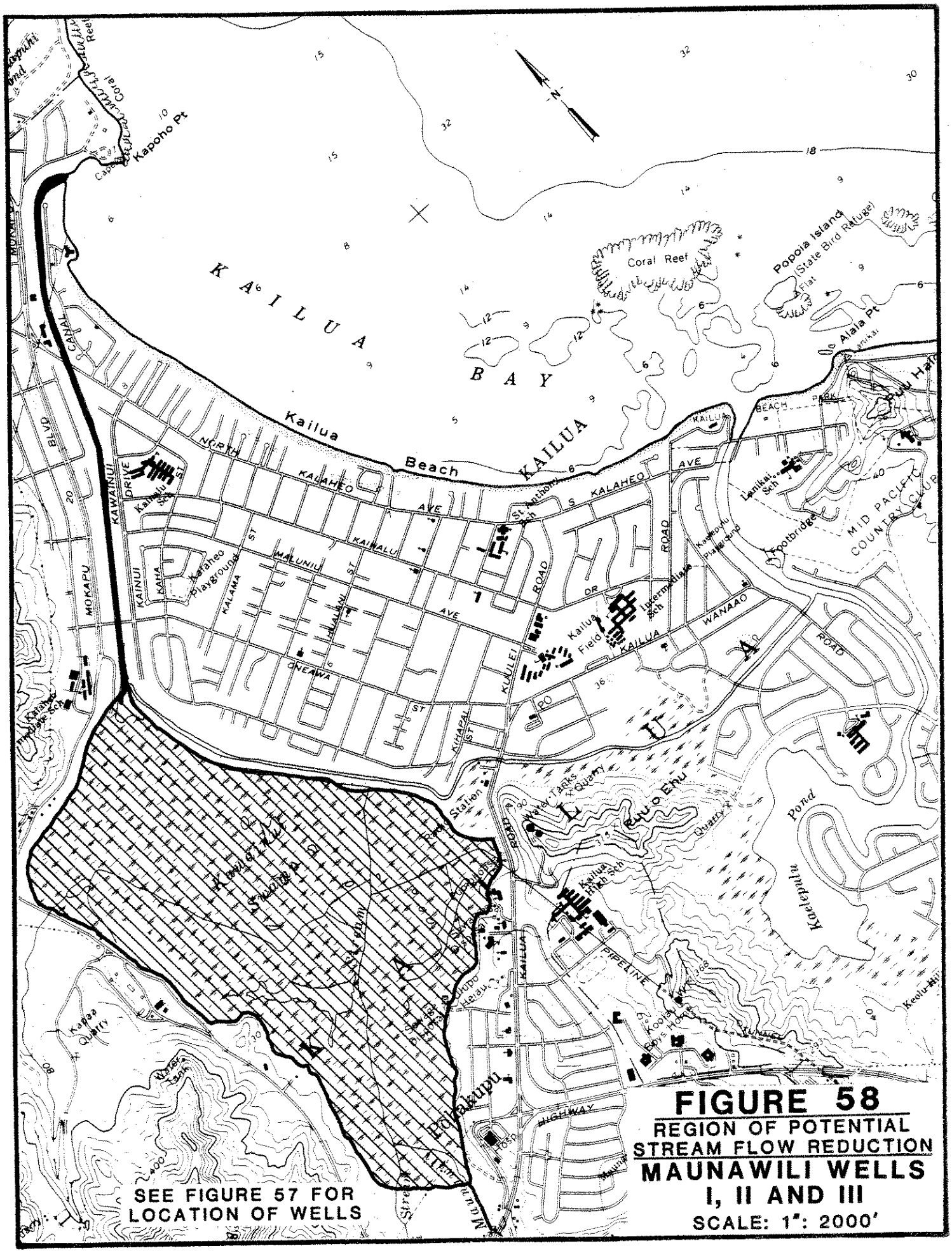


FIGURE 58

REGION OF POTENTIAL STREAM FLOW REDUCTION

MAUNAWILI WELLS I, II AND III

SCALE: 1": 2000'

Three proposed BWS wells (Iolekaa, Luluku, and Waimanalo II) which develop dike-impounded ground water are unlikely to significantly affect the dry-weather flow of the nearest windward Oahu streams. Iolekaa Stream gains most of its dry-weather flow above athe static head of Iolekaa Well; Luluku Stream gains most of its dry-weather flow above the static head of Luluku Well; and Waimanalo Stream gains most of its dry-weather flow above the static head of Waimanalo Well II. [See Tables 3, 20, 21 and 23] Hence, during dry weather, ground water developed by these wells would not otherwise seep into adjacent streams below the well static head. As with other wells which develop dike-impounded ground water, it is theoretically possible but unlikely that these wells will significantly reduce stream flow above their static head by increasing leakage out of "upstream" dike compartments.

Parties commenting on the Draft EIS requested analysis of whether proposed basal wells could affect stream flow. Because there is no direct hydraulic connection beteen the basal water table and windward Oahu streams, lowering of the basal water table by ground water development will not cause streams to infiltrate into the ground. Conversely, a high basal water table will not directly seep into stream beds and dramatically increase stream flow. Possible indirect effects are probably also not significant.

As discussed in Chapter II, basal aquifers are partially recharged by the seaward leakage of dike-impounded ground water. Leakage from a dike compartment hydraulically connected to a basal aquifer is proportional to the difference in their ground water head. Development of basal ground water will lower the basal ground water head. Hence, theoretically, it is possible for development of basal ground water to increase leakage out of inland dike compartments which would otherwise contribute ground water to stream flow.

Given the distance between basal aquifers and dike compartments which contribute ground water to stream flow, and given the relatively great differential in their ground water head, it seems unlikely that there is sufficient hydraulic connection for a slight lowering of the coastal basal water table to significantly reduce overflow and leakage of inland dike-impounded ground water into streams. There is no evidence that this phenomenon has ever occurred.

As discussed in Chapter II, springs [Figure 24] occur along the windward Oahu coast in places where there are holes in the caprock overlying and confining a basal aquifer. These caprock springs are fed by artesian pressure from a basal aquifer. Because development of basal ground water will reduce the artesian head of the ground water, it will reduce the quantity of water flowing from caprock springs. Caprock springs contribute to but are not a significant component of low-elevation dry-weather stream flow in windward Oahu. [Ref. 85]

B. BASAL GROUND WATER

As discused in Chapter II, loss of ground water from a basal aquifer is proportional to the net head in the aquifer. Over the long term, under natural conditions, average recharge of a basal aquifer will always equal average ground water losses from the aquifer. Over the short term, whenever aquifer recharge is less than aquifer water losses, the quantity and head of fresh water in a basal aquifer declines. Equilibrium is reached when water pressure has fallen to the point where losses from the aquifer equals aquifer recharge. Conversely, whenever aquifer recharge exceeds aquifer water losses, the quantity and head of fresh water in a basal aquifer increases until seepage out of the aquifer equals aquifer recharge.

From a broad hydrologic standpoint, artificial withdrawal of basal ground water can be treated as if it were a reduction in recharge or an increase in discharge. As shown in Figure 59, withdrawal of basal ground water with a well can potentially cause four effects on a basal aquifer:

1) The water table (head) of an unconfined aquifer will drop.

2) The artesian head (i.e. height to which water rises in a borehole) of a confined aquifer will drop.

3) For a confined aquifer, the transition zone between fresh water and salt water will move inland and upward. For an

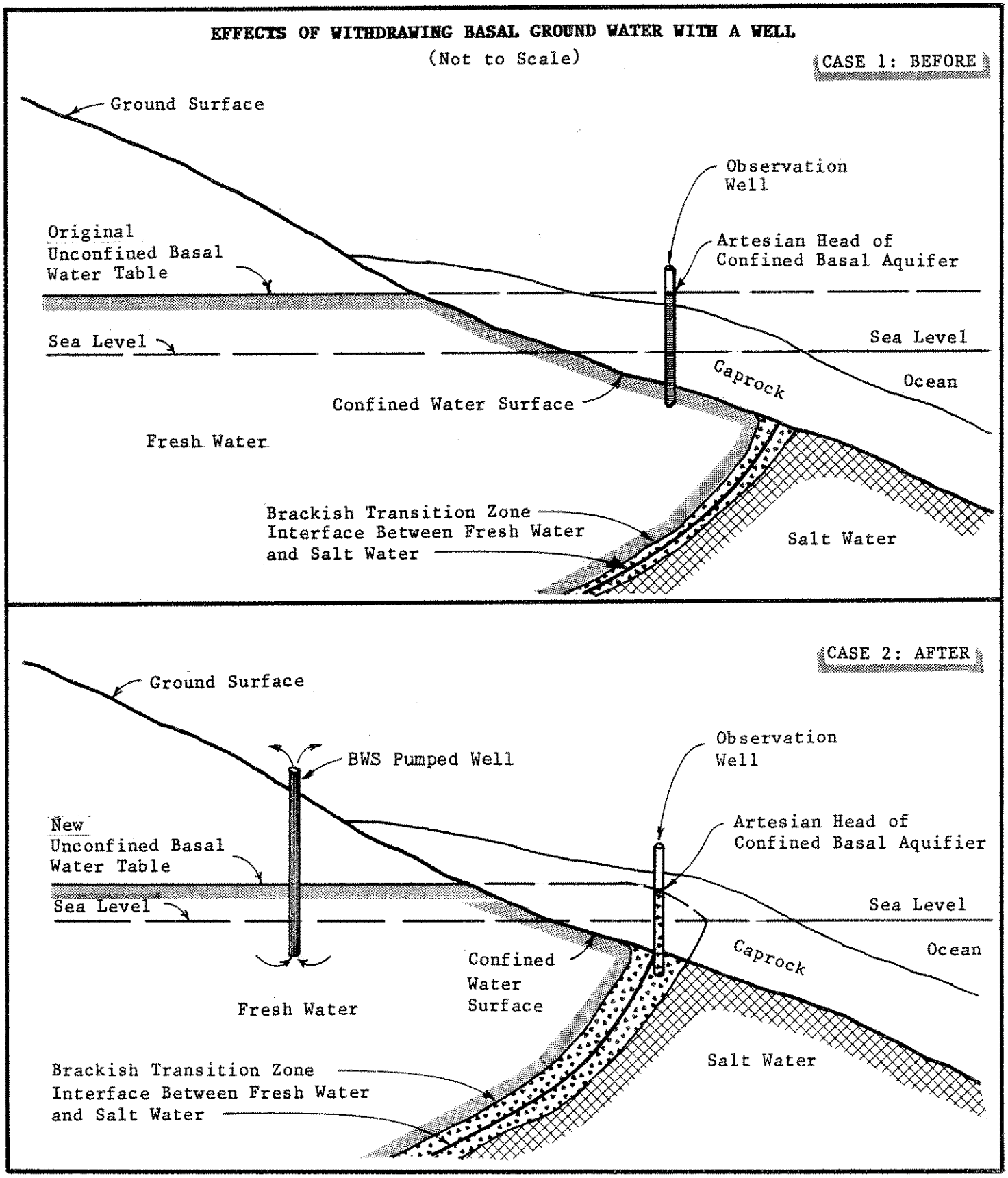

EFFECTS OF WITHDRAWING BASAL GROUND WATER WITH A WELL
(Not to Scale)
CASE 1: BEFORE
Ground Surface
Observation Well
Original Unconfined Basal Water Table
Artesian Head of Confined Basal Aquifer
Sea Level
Sea Level
Caprock
Ocean
Confined Water Surface
Fresh Water
Brackish Transition Zone
Interface Between Fresh Water and Salt Water
Salt Water
CASE 2: AFTER
Ground Surface
BWS Pumped Well
Observation Well
New Unconfined Basal Water Table
Artesian Head of Confined Basal Aquifier
Sea Level
Sea Level
Caprock
Ocean
Confined Water Surface
Fresh Water
Salt Water
Brackish Transition Zone
Interface Between Fresh Water and Salt Water

FIGURE 59

unconfined aquifer, the transition zone will primarily move upward.

4) The brackish transition zone will thicken for both the confined and unconfined aquifer.

Figure 59 also illustrates one of the potential risks of developing basal ground water; salt water intrusion into coastal wells. Because of such risks, it is normal BWS practice to regularly monitor the static head and salinity of both production wells and observation wells throughout a basal aquifer. This allows water development to be decreased when necessary to prevent salt water intrusion into production wells.

Additional observation wells will be needed in windward Oahu if all the basal wells proposed in this EIS are put into production. Siting of future observation wells is not resolved at this time. However, if the BWS does not install observation wells, then the DLNR will. [Ref. 143]

Regardless of whether or not the Koolauloa Basal Aquifer is hydrologically continuous between Punaluu and Kahuku or is compartmentalized between sedimentary fill material in valleys, adequate ground water is available to allow proposed BWS water development projects without adverse effect on the yield or salinity of existing wells in the basal aquifer. However, this may not be the case if there is any increase in private water development in Koolauloa [Ref. 49]

Allocation of the remaining undeveloped ground water in the Koolauloa Basal Aquifer is an unresolved issue. Unless water development is restricted by the State Commission on Water Resource Management, it seems likely that competing demands for limited ground water resources will be resolved on a first-come first-served basis. BWS Rules and Regulations only authorize the BWS to prohibit new wells and restrict pumpage from existing wells when necessary to prevent overdraft of or salt water intrusion into an aquifer. The State Water Commission is granted similar powers pursuant to Act 45, SLH 1987. However, the Commission theoretically also has the power to "reserve" water for particular future uses. [See Chapter VIII.C]

In the event that the Koolauloa Basal Aquifer is substantially or completely hydrologically continuous, BWS development of the sustainable yield of the aquifer is likely to reduce the discharge and increase the salinity of coastal caprock springs seeping into the James Campbell National Wildlife Refuge at Kahuku. These caprock springs are fed by artesian pressure from a confined basal aquifer. If BWS development of basal ground water between Laie and Punaluu reduces the artesian head of basal ground water in Kahuku, then the quantity of ground water seeping from caprock springs at Kahuku will also be reduced. If BWS development of basal ground water between Laie and Punaluu causes the brackish transition zone between fresh and salt water to move inland at Kahuku, then the ground water feeding the caprock springs will become saltier. [See Figure 59] On the other hand, if basal ground water movement across stream valleys in the northern windward coast is restricted by caprock, and basal ground water primarily leaks into the caprock rather than moving north to Kahuku, then such effects will not occur. At this time, it is not possible to determine whether BWS ground water development between Laie and Punaluu can affect caprock springs in Kahuku.

Unlike the Koolauloa Basal Aquifer, the sustainable yields of basal aquifers between Punaluu and Kaaawa have not been proven by years of pumpage. Recharge and yields of basal aquifers in Punaluu and Kahana Valleys will probably be reduced by BWS development of dike-impounded ground water in these valleys. Consequently, pumpage from proposed BWS basal wells south of Kaluanui may need to be carefully regulated to prevent salt water intrusion.

C. WATER QUALITY

There are two areas of water quality concerns pertaining to proposed BWS water development projects; salt water intrusion into basal aquifers, and contamination of ground water sources by either pesticides, sewerage, or return irrigation water. Salt water intrusion into a basal aquifer occurs when ground water pumping and natural losses exceed recharge of the aquifer. Under these

conditions, the brackish transition zone at the interface between the fresh water and salt water would move toward coastal wells. If this were to occur, the rate of pumping would have to be decreased until the pumping rate plus natural losses are equal to the recharge of the basal aquifer. [See Figure 59] Long-term sustainable withdrawal of basal ground water, without salt water intrusion into wells, can be maximized by proper spacing and siting of wells parallel to the coast.

The BWS will monitor salinity and static heads of basal wells to prevent salt water intrusion into basal aquifers. If there is a risk of salt water intrusion into a basal aquifer, the BWS will decrease pumpage from wells. Additional monitoring of wells are needed on windward Oahu to measure salt water intrusion. However, at this time, the location of such wells is not resolved.

Pesticide contamination of ground water sources could occur in areas where BWS wells are located in the same watershed as the application of pesticides. In parts of windward Oahu, banana production requires subsurface application of nematicides to control the banana root borer. Currently, the banana root borer has infested bananas in Waimanalo, but not other areas. [Ref. 50] The proposed Waimanalo Wells III and Waimanalo Wells IV both could be at risk from pesticide contamination.

The Kahaluu Wells II, Kuou Wells II, and Luluku Wells have banana production in their watersheds. Bananas raised in these watersheds currently do not need subsurface application of pesticides because the banana root borer is not yet present. Thus, there is currently minimal risk of pesticide contamination of ground water. However, this might not be true in the future.

Contamination of ground water sources by return irrigation water is most commonly due to use of brackish irrigation water or use of more fertilizer than plants can assimilate. No proposed BWS water source is believed to be at risk from either practice.

Contamination of a ground water source by sewerage can occur when wastewater is discharged onto or into the ground within the recharge area of the water source. The proposed Waimanalo Wells III and IV could both be at risk from contamination by cesspools within their

watershed. Consequently, these alluvial wells will probably be limited to non-potable uses. Contamination from a relatively distant municipal sewerage injection well is also possible but much less likely.

The BWS will monitor potable ground water sources for contamination by either pesticides, fertilizer, or sewerage. If such contamination is detected, the BWS will cease pumping until appropriate impact mitigation measures can be determined.

D. WETLANDS

The fresh water in windward Oahu wetlands comes from either rainfall, surface runoff, streams, or ground water springs. Proposed BWS water development projects could potentially affect windward wetlands by reducing stream flow and/or ground water springs. Effects would probably be insignificant during and following wet weather. During prolonged dry weather, proposed ground water development potentially could reduce the area and depth of fresh open water within some wetlands and increase tidal ocean intrusion into some wetlands. Wetland vegetation which could not tolerate increased salinity would be excluded from parts of wetlands which became more brackish.

Major windward Oahu wetlands which potentially could have fresh water inflow reduced by proposed BWS water development projects include those at Kahuku, Kahana, Waikane, Waiahole, Haiamoa, Kahaluu, Heeia, Ho'omaluhia, and Kawainui. [Table 29] During dry weather, open water within the Punamano Unit of James Campbell National Wildlife Refuge in Kahuku is entirely dependent on ground water springs. (Springs in Kahuku are fed by leakage of confined basal ground water through overlying caprock.) During dry weather, fresh water reaching Kahana Marsh is primarily due to Kahana Stream flow. During dry weather, fresh water reaching other listed windward Oahu wetlands is due to some combination of stream flow and ground water springs. (Springs in wetlands between Hakipuu and Kailua are fed by overflow of dike-impounded ground water through overlying alluvium.)

TABLE 29

PROPOSED BWS WATER DEVELOPMENT PROJECTS WHICH MAY REDUCE STREAM FLOW INTO OR GROUND WATER SPRINGS IN MAJOR WINDWARD OAHU WETLANDS

Name of Water Source	Location of Potentially Affected Wetland	Potentially Affected Tributary Stream
Laie Wells	Kahaku	not applicable (a)
Wailele Wells	Kahaku	not applicable (a)
Kaipapau Wells	Kahaku	not applicable (a)
Maakua Wells	Kahaku	not applicable (a)
Kaluanui Well I	Kahaku	not applicable (a)
Kaluanui Well II	Kahaku	not applicable (a)
Punaluu Wells V-A	Kahaku	not applicable (a)
Kahana Wells III	Kahana	Kahana
Kahana Wells IV	Kahana	Kahana
Kahana Wells V	Kahana	Kahana
Waikane Wells	Waikane	Waikane (b)
Uwau Wells	Waiahole	Waihole (b)
Waianu Wells	Waiahole	Waihole (b)
Waiahole Wells	Waiahole	Waihole (b)
Kaalaea Wells	Haiamoa	Haiamoa (b)
Kaalaea Inclined Wells or Tunnel	Haiamoa	Haiamoa (b)
Kahaluu Wells II	Kahaluu	not applicable (c)
Haiku Well	Heeia	Heeia (b)
Iolekaa Well	Heeia	not applicable (c)
Kuou Wells II	Ho'omaluhia Wildlife Pond and Reservoir	Hooleinaiwa and Kamooalii (b)
Halekou Wells	Ho'omaluhia Reservoir	Kamooalii (b)
Pali Highway Tunnel Drains	Ho'omaluhia Reservoir	Kamooalii
Maunawili Wells I	Kawainui	Maunawili (b)
Maunawili Wells II	Kawainui	Maunawili (b)
Maunawili Wells III	Kawainui	Maunawili (b)

Notes: (a) Proposed water source may reduce discharge and increase salinity of caprock springs in James Campbell National Wildlife Refuge in Kahuku.

(b) Proposed water source may reduce either stream flow into or ground water springs in affected wetland.

(c) Proposed water source will not affect stream flow tributary to the affected wetland but may reduce ground water springs in the wetland.

Because natural wetlands in Kahuku are dependent on caprock springs, they are naturally brackish. However, the U.S. Fish and Wildlife Service uses fresh basal ground water from wells to control salinity in the Kii Unit of James Campbell National Wildlife Refuge. Kahana, Heeia, and Kawainui Marshes are partially brackish because they are subject to tidal ocean intrusion.

At this time, it is not possible to determine the extent of basal ground water movement along the northern windward coast across alluvial fill in stream valleys. In the event that the Koolauloa Basal Aquifer is substantially or completely hydrologically continuous, BWS basal wells at Laie, Wailele, Kaipapau , Maakua, Kaluanui and northern Punaluu are likely to have the cumulative impact of reducing the discharge and increasing the salinity of caprock springs in Kahuku wetlands. However, this effect will not occur if basal ground water north of Punaluu primarily leaks into coastal caprock rather than moving north to Kahuku.

BWS development of dike-impounded ground water is likely to reduce the dry-weather discharge of Kahana Stream, which flows into Kahana Marsh, and streams and/or ground water springs which flow into wetlands at Waikane, Waiahole, Haiamoa, Kahaluu, Heeia, Ho'omaluhia, and Kawainui. [See Table 29] Available information is not adequate to evaluate to what extent a reduction in stream flow or ground water springs within any natural windward Oahu wetland will reduce the area or depth of fresh open water. Inflow from ground water springs has not been measured in any windward Oahu wetland. Available information is also not adequate to evaluate to what extent a reduction in stream flow or ground water springs will increase tidal ocean intrusion into Kahana, Heeia, or Kawainui Marshes.

Current interim instream flow standards, which require preservation of at least median stream flow, are probably sufficient to prevent significant dry-weather impacts to stream-fed windward wetlands. Apart from instream flow standrds, the City (including the BWS) is required by a contract with the Corps of Engineers to preserve sufficient flow in Hooleinaiwa Stream to maintain constant water levels in Ho'omaluhia Park Wildlife Pond. Conceivable, final instream flow standards may allow adverse impacts to other stream-fed windward Oahu wetlands listed in Table 29. It should be kept in mind that

instream flow standards do not regulate effects from BWS projects on ground water springs within wetlands.

E. ESTUARIES

The fresh water in an Oahu estuary can come from either rainfall, surface runoff, streams, or ground water springs. Proposed BWS water development projects could potentially affect windward estuaries by reducing stream flow and/or ground water springs. Effects would probably be insignificant during and following wet weather. Depending on what final instream flow standards are adopted by the State Commission on Water Resource Management, cumulative effects in some cases could be proportionally significant during prolonged dry weather. Existing information only permits qualitative assessment of potential impacts rather than evaluation of their magnitude.

Reduction of fresh water reaching Kaneohe Bay would reduce the size and increase the salinity of estuaries within the Bay. Probably most of the water which would be developed by the proposed Hakipuu Wells, Waikane Wells, Uwau Wells, Waianu Wells, Waiahole Wells, Kaalaea Wells, Kaalaea Inclined Wells or Tunnel, Kahaluu Wells I, Kahaluu Wells II, Ahuimanu Inclined Wells or Tunnel, Iolekaa Well, Haiku Well, Luluku Wells, Kuou Wells II, Halekou Wells, and Pali Highway Tunnel Drains would be at the expanse of fresh water now reaching Kaneohe Bay. If not developed, some of the yield of these proposed water sources would otherwise be lost to evaporation and transpiration, rather than entering the Bay.

Reduction of fresh water reaching the Kahaluu Flood Control Basin and Kawainui Canal would increase the salinity of these man-made estuaries. Some of the ground water which would be developed by the proposed Kahaluu Wells I, Kahaluu Wells II, Ahuimanu Inclined Wells or Tunnel, and possibly the Kaalaea Inclined Wells or Tunnel would otherwise enter the Kahaluu Flood Control Basin as stream flow. Similarly, some of the ground water which would be developed by the proposed Maunawili Wells I, II, and III would otherwise enter the

Kawainui Canal.

Reduction of stream flow and/or ground water springs within some coastal windward Oahu wetlands would allow greater intrusion of ocean water during high tides. Estuarine parts of wetlands such as Kahana, Heeia, and Kawainui Marshes would become saltier, and possibly there would also be a small increase in the size of these estuaries. The proposed Kahana Wells III, IV, and V would reduce fresh water reaching Kahana Marsh; Haiku and possibly Iolekaa Well would reduce fresh water reaching Heeia Marsh; and Maunawili Wells I, II, and III would reduce fresh water reaching Kawainui Marsh.

When an estuary is a relatively narrow, low-gradient unblocked stream mouth, high stream flow can rapidly dilute and/or wash away tidal ocean inflow. In such streams, the effect of reduced stream flow is to increase the distance a salt-water wedge moves inland during high tides. In other words, the brackish estuarine area increases because of reduced stream flow. To varying degrees this effect might occur if proposed BWS projects reduced stream flow in Kaluanui, Punaluu, Hakipuu, Waikane, Waiahole, Kaalaea and Haiamoa streams.

F. STREAM FAUNA

As summarized in Table 28 and Figures 37 through 58, BWS water sources which develop dike-impounded ground water are likely to reduce the flow of most perennial windward Oahu Streams. Reductions in stream flow can reduce populations of endemic diadromous stream fauna (which must spend part of their life cycle in the ocean). In parts of streams with reduced flow, there will be loss of habitat and increased crowding, predation, and siltation. If reductions in flow result in sand bars blocking stream mouths most of the year, then there will be less recruitment of juvenile stream animals from the ocean into streams.

With the exception of Koloa Stream, there is a risk of reduced flow in all windward Oahu streams which provide either high or moderate

quality habitat for endemic stream animals. Stream animals which prefer fresh water habitat will be most affected. One of the two windward Oahu streams in which hihiwai are found and two of the three windward streams in which o'opu nopili are found would have reduced flow if the proposed Punaluu Tunnel or Inclined Wells and the proposed Kahana Wells III, IV and V are developed. Oahu populations of these species are not viable by themselves. Instead they are recruited from hatchlings on the Neighbor Islands.

Most of the windward Oahu streams in which o'opu nakea and o'opae kala'ole are found are also at risk from proposed water development projects. In the event that there are significant reductions in populations of o'opu nakea in streams with reduced flow, then there is a possibility of cumulative effects. Fewer o'opu nakea will produce less eggs, which in turn may mean fewer juveniles returning to all Oahu streams from the ocean. Cumulative effects are less likely with o'pae kala'ole than with o'opu nakea because the former is more widespread, abundant, and tolerant of fluctuations in stream flow.

Additional research needs to be conducted on a stream by stream basis to determine how much stream flow can be reduced without adversely affecting endemic stream animals which prefer fresh water. Many windward Oahu streams used to have much larger flows in their current channels, and some stream animals may require more than just existing median flows to complete their life cycle.

Native stream animals which prefer brackish stream mouths may be unaffected by current interim instream flow standrds. The brackish area within stream mouths will not become much shallower as a result of reduced stream flows. Also, species which seek out brackish stream mouths generally tolerate wide variations in salinity without ill effects.

G. AQUATIC INSECTS

Only limited information is available about the distribution or life cycle of aquatic insects in windward Oahu streams. The lack of data precludes the ability to make reliable conclusions about impacts to aquatic insects. The primary adverse impact would be loss of habitat as a result of diminished stream flow. Species favoring fast moving water as a habitat during part of their life cycle would be adversely affected. Conversely, reduced stream flow would be beneficial to species which favor slower moving or still waters, including mosquitoes.

Available habitat is not the only factor affecting the presence of endemic aquatic insects. The presence of predators, especially insectivorous fish such as mosquito fish, also impacts aquatic insects. In habitats where endemic aquatic insects and mosquito fish are both present, the fish have often exterminated the insects. [Ref. 125]

Changes in stream flow, reduction in areas of wetlands, and the introduction of predators may all have contributed to the decline of endangered native species of damselflies. Further research needs to be conducted to permit definitive conclusions as to the relative importance of these factors.

H. WATERBIRDS

BWS water development projects in windward Oahu pose a risk of cumulative adverse impacts to three species of endangered endemic waterbirds. Reduction of suitable dry-weather habitat will result in a reduction of waterbird populations. Hawaiian Gallinules and Koloa Ducks need fresh open water in wetlands. Brackish wetlands support fewer Hawaiian Coots than comparable fresh water wetlands. BWS basal ground water development between Punaluu and Laie poses a risk of reducing fresh open water and increasing salinity in the Punamano Unit of James Campbell National Wildlife Refuge. However, depending on

hydrology, it is possible that such impacts will not occur. BWS development of dike-impounded ground water poses a risk of reducing fresh open water in wetlands at Kahana, Waikane, Waiahole, Haiamoa, Kahaluu, Heeia, Ho'omaluhia Reservoir, and Kawainui and a risk of increasing tidal ocean intrusion into wetlands at Kahana, Heeia, and Kawainui. [See Table 29] Such impacts will probably be avoided by BWS compliance with current interim instream flow standards. Sufficient information is not available to reliably determine how much stream flow must be maintained to avoid adverse impacts to stream-fed windard Oahu waterbird habitats. Conceivably, final instream flow standards may allow adverse impacts.

I. ESTUARINE AND MARINE FAUNA

Most native species found in Hawaiian estuaries are derived from marine rather than fresh water ancestors. As such, most native estuarine species are not adversely affected by relatively short-term increases in estuarine salinity. Salinity tolerance analyses for selected species have found that o'pae o'eha'a, grass shrimp, Samoan crab, hapa crab, and several native species of fish found in Hawaiian estuaries can survive a few days of immersion in full-strength ocean water. In contrast, the introduced Tahitian prawn cannot tolerate marine salinity. [Ref. 121, Ref. 122]

Interim instream flow standards for windward Oahu (with which the BWS will comply) prohibit water removal whenever dry-weather stream flow is at or less than existing median flow. Such standrds are probably adequate to prevent proposed BWS ground water development from adversely affecting windward Oahu estuaries and estuarine biota.

Conceivably, in the future, permanent instream flow standrds may allow more water to be removed from windward Oahu streams. During dry weather, this may allow reduction in the size and/or increase in the salinity of some windward Oahu estuaries. On the other hand, some windward estuaries would become larger.

Not enough is known to reliably determine the effects on estuarine biota if there were a reduction in the size and/or increase in the salinity of a windward Oahu estuary. Smaller estuaries and/or increased dry-weather estuary salinity possibly may result in smaller populations of estuarine-dependent species (which spawn in estuaries or which cannot permanently survive in a marine environment). Since the Northwestern Hawaiian Islands and Johnson Atoll have no estuaries, their nearshore waters exclude all estuarine-dependent species. Specifically, a few species of fish such as nehu (Encrisolina purpurea), o'opu okuhe (Eleotris sandwicensis), and o'opu naniha (Stenogobius genivattatus), and several species of shrimp including o'pae oeha'a (Macrobrachium grandimanus), Tahitian and Malaysian prawns (Macrobrachium sp.), and the grass shrimp (Palaemon debilis) are found in Hawaiian estuaries but not the Northwestern Hawaiian Islands and Johnston Atoll. [Ref. 132, Ref. 136, Ref. 138] Except for the Tahitian and Malaysian prawns, these species at least temporarily tolerate full-strength sea water as adults. [Ref. 121, Ref. 122] However, they apparently cannot adapt to a permanent unsheltered marine environment. The same is also true for various species of worms and other invertebrates. [Ref. 140]

Many species of fresh-water-tolerant marine fish, including aholehole (Kuhlia sandvicensis), papio (Carangoides sp. and Caranx sp.), omaka (Caranx mate), barracuda (Sphyraena barracuda), mullet (four native species, the most common of which is Mugil cephalus), and milkfish (Chanos chanos), seek out Hawaiian estuaries and/or shallow sheltered bays. [Ref. 137] Possibly this is to find food or avoid predators. Research by the Oceanic Institute has found that both mullet and milkfish spawn in the ocean rather than estuaries and that their eggs need full-strength ocean water to hatch. These species can be cultured in a totally marine environment at all stages of their life cycle. [Ref.134] Although litle research has been conducted on other marine fishes which seek out estuaries as juveniles but are found in the ocean as juveniles and adults, there is no reason to assume that they cannot adapt to full-strength ocean water at all stages of their life cycle. With the possible exception of omaka, these species are found in the totally marine environment of the Northwestern Hawaiian Islands and/or Johnston Atoll. [Ref. 133, Ref. 136, Ref. 137, Ref. 138] Marine biologists caution that presence of these species at the Northwestern Hawaiian Islands and/or Johnston Atoll conceivably could

be due to as yet undetected genetic differences from Hawaiian populations or due to recruitment from hatchlings in Hawaii. [Ref. 135, Ref. 136]

There is no definitive answer whether smaller estuaries and/or increased estuary salinity could reduce populations of marine fish which seek out Hawaii estuaries. The high nutrient loading of stream-fed estuaries induces growth of plants eaten by mullet and milkfish and invertebrates eaten by other fish. Reduced stream flow would proportionally reduce nutrients reaching windward Oahu estuaries. A major reduction in dry-weather stream flow could reduce the dry-weather productivity of estuaries which in turn could possibly reduce populations of some marine fish which seek out estuaries. Complete elimination of estuaries might not adversely affect other species which use estuaries. Some marine biologists in Hawaii suspect but are not sure that increases of the dry-weather salinity of windward Oahu estuaries will not adversely affect Oahu population of aholehole, papio, omaka, barracuda, mullet, and milkfish. However, they note that lower salinity conceivably could enhance populations of some of these species by excluding predators and/or competitors. [Ref. 132, Ref. 136]

J. EXISTING WATER USES

The BWS intends to manage operation of its proposed water development projects as necessary to allow other parties to continue their existing use of water from tunnels, wells, stream diversions, and springs. In a few cases, if BWS projects interfere excessively with other water users, and if acceptable to such users, the BWS may opt to directly supply them with low cost or free municipal water. Complaints by affected water users can be brought straight to the BWS. Complaints can also be made to the State Commission on Water Resource Management, which is now charged by State law with certifying existing water uses and resolving disputes over water use.

Proposed BWS water development projects which develop dike-impounded ground water may potentially reduce the flow in a number of windward Oahu streams and tributary springs. Stream and spring diversions located below the static head of the proposed BWS projects could be adversely affected. The extent of adverse effect would depend on the amount of reduced flow at the point of diversion. The dynamics of ground water movement in windward Oahu watersheds are not well enough understood to predict the amount of spring and stream flow reduction for most BWS water development projects.

Most existing windward Oahu stream users could be adversely affected by BWS projects. Stream users would be affected in the following streams: Punaluu; Hakipuu; Waikane; Waianu; Waiahole; Kaalaea; Waihee; Kahaluu; Luluku; Kamooalii; Halekou; and Hooleinaiwa. [See Tables 25 and 28] Based on available information, three existing stream users are not expected to be adversely affected. The existing users on Waikane Stream produce prawns/flowers (H. Roberts) and truck crops (R. Kamaka). These two users are located at elevations above the point where Waikane Stream may be affected by reduced flows. Two Kualoa Ranch diversions of springs mauka of Coral Kingdom in Hakipuu are not expected to be adversely affected. [See Table 25]

In 1982, Kualoa Ranch was granted a modification permit for Well No. 3251-01 located about 2,000 feet from Kaaawa Shaft. The permit specified a limit of 0.2 mgd for irrigation of corn. This basal well and the proposed Kaaawa Shaft are expected to have mutual interference effects.

K. PROPOSED WATER DEVELOPMENT

BWS water development projects in Punaluu could adversely affect proposed private water development for agricultural uses in this valley. Punaluu Wells V-C, Punaluu Wells V-D, and the Punaluu Tunnel or Inclined Wells could decrease stream flow in Punaluu Stream. Reduced stream flow would result in proposed improvements to the Punaluu Ditch intake and proposed new diversions of Punaluu Stream

capturing less surface water. Such impacts would be contingent upon the State Commission on Water Resource Management adopting instream flow standards which allowed additional private removal of water from Punaluu Stream to be economically feasible. (Assuming that Punaluu Stream flow in excess of instream flow standards were not entirely captured by BWS water development, current interim instream flow standards prohibit all additional surface water development for at least half of the year. Agriculture may not be profitable if there is no way to irrigate crops for the driest half of the year.)

Because of State water development plans for Waiahole Agricultural Park, the BWS most likely will not develop its proposed wells in Waiahole Valley. Any BWS water development in Waiahole Valley would be managed to avoid adverse affects on the yield of wells proposed to serve the agricultural park.

In 1988, an irrigation by-pass channel will be completed to remove water from Kahaluu Stream for use by farmers whose stream diversions will be eliminated by Kahaluu Flood Control Channel. Kahaluu Wells I and the Ahuimanu Inclined Wells or Tunnel could reduce stream flow in Kahaluu Stream and the proposed irrigation by-pass channel. This in turn could limit agricultural uses of water from the irrigation by-pass channel.

L. AGRICULTURE

Proposed BWS water sources which develop dike-confined ground water may reduce seepage of ground water into cultivated areas and increase the need for private irrigation of orchards and crops. Unfortunately, it is not possible to evaluate either the importance of such seepage or the extent to which it might be reduced. Areas of concern are probably limited to the following. The proposed Hakipuu Wells may possibly reduce ground water seeps into taro patches and other cultivated areas makai of Kamehameha Highway. The proposed Kahaluu Wells II may possibly reduce ground water seeps into banana groves and truck crops in the immediate vicinity of the well sites. And, the

proposed Luluku and Kuou II Wells may possibly reduce ground water seeps into banana groves around Ho'omaluhia Park (makai of Likelike Highway).

In general, the BWS intends to manage windward water development as necessary to allow the continuation of existing private agricultural use of water from tunnels, wells, stream diversions, and springs. In a few cases, when agreeable to farmers, it may prove desirable for the BWS to replace existing agricultural water sources with low cost or free municipal water service. This will need to be resolved at a later date.

New BWS water sources will be taking water which otherwise could have been privately developed for agricultural use. As discussed more fully in Chapter VIII, if proposed in a water allocation plan adopted by County ordinance, the State Commission on Water Resource Management theoretically can restrict BWS water development and reserve some windward Oahu water for agricultural use. Otherwise, competing demands for limited water resources will probably be resolved on a first-come first-served basis. If the BWS implements all of the projects proposed in this EIS, if existing non-municipal water uses continue at present levels, and if the State Commission on Water Resource Management adopts stringent permanent instream flow standards, then there will be relatively little opportunity for additional low-cost water development in windward Oahu.

Under the Honolulu City Charter, the BWS is only responsible to develop highly reliable, relatively expensive potable municipal water systems for domestic use rather than non-potable and/or cost-effective agricultural water systems. In general, the BWS will not develop new water sources when this would interfere with proposed State agricultural water development projects. Formerly, the State DLNR Division of Water and Land Development (DOWALD) was responsible to develop and operate agricultural water systems. However, Act 306, SLH 1987, transferred responsibility for development and operation of State agricultural water systems to the State Department of Agriculture. At this time, it seems likely that DOWALD will assume responsibility for operating a State domestic and agricultural water system to service the HFDC subdivision in Waiahole Valley.

Windward Oahu farmers who wish to use water developed by new BWS water sources will be allowed to do so in competition with other parties on a first-come first-served basis. BWS rates and charges for water provided to farmers are lower than for other users. [See Table 30] By fall 1987, the BWS had approved 540 applications for Oahu farms to obtain water at agricultural water rates. Typical farms using municipal water range from 1 to 6 acres, although a few are as large as 10 acres. The BWS has a 0.3 mgd water commitment to sell water for use on five-acre lots in Waimanalo Agricultural Park.

BWS water system development charges (a one-time fee to new users for off-site water development, storage, and pipelines) are substantially lower for farmers than for other users. Maximum BWS water development charges for a farmer installing a new 1.5" meter (with a meter capacity of 144,000 gallons/day) are only $5,000. By comparison, a commercial user, industrial user, park, or school would pay a maximum BWS water development charge of $22,800 for a new 1.5" meter. Maximum BWS water development charges for dwelling and lodging units range from $1,000/unit for a single-family residence to $544/unit for a multi-family high-rise or resort. (A new 400-unit high-rise apartment or hotel using an average of 100,000 gallons/day would pay a maximum water development charge of $217,600.)

As of May 1988, monthly BWS rates for water provided to farmers are $0.98 per thousand gallons for the first 13,000 gallons and $0.69 per thousand gallons for any additional water used. (By comparison, all other users pay a flat $0.98 per thousand gallons.) During dry weather, average daily water use for agriculture needs are estimated to be about 3,000 gallons/acre for flowers, foliage, and potted plants raised in shade houses; 4,100 gallons/acre for truck crops and orchards; 5,400 gallons/acre for bananas; and 21,600 gallons/acre for prawns. [Ref. 89] Along the windward coast, assuming 300 days of irrigation per year at existing BWS rates, it would cost in excess of $850/year for a farmer to irrigate one acre with 4,100 gallons/day.

Based on published estimates of potential net profits per acre for various agricultural commodities, current BWS agricultural water rates are probably affordable for cultivation of truck crops, bananas, potted foliage, and orchids. However, at current rates it is probably not economically feasible to purchase BWS water for cultivation of

TABLE 30

SELECTED BWS RATES AND CHARGES

Monthly Rates Per 1,000 Gallons	Aug 22 1985	Dec 1 1987	July 1 1988	July 1 1989	July 1 1990	July 1 1991
General Rate	$0.84	$0.98	$1.11	$1.22	$1.33	$1.38
Agricultural Rate for First 13,000 Gallons	$0.84	$0.98	$1.11	$1.22	$1.33	$1.38
Agricultural Rate for Water in Excess of 13,000 Gallons	$0.69	$0.69	$0.75	$0.88	$1.01	$1.13
One-Time Water System Development Charges (for off-site Water Development, Storage, and Pipelines)						
New Single Family 5/8" Meter	$ 1,000		$ 1,500	$ 1,800	$ 2,100	
New Multi-Family Low-Rise Meter (Per Unit)	$ 748		$ 1,200	$ 1,400	$ 1,600	
New Multi-Family High-Rise Meter (Per Unit)	$ 544		$ 800	$ 900	$ 1,100	
New Agricultural 5/8" Meter	$ 1,000		$ 1,500	$ 1,800	$ 2,100	
New Agricultural 1.5" Meter	$ 5,000		$ 7,700	$ 9,000	$10,300	
New Business or Public 5/8" Meter	$ 4,560		$ 7,900	$ 9,600	$11,300	
New Business or Public 1.5" Meter	$22,800		$39,600	$47,900	$56,300	

alfalfa, other kinds of cattle feed, sweet corn, watermelon, guava, prawns, taro, and watercress; and possibly not feasible for papaya. [Ref. 5, Ref. 105]

As shown in Table 30, the BWS has recently adopted incremental increases in monthly rates which by July 1991 will boost the general rate to $1.38 per thousand gallons and the agricultural rate (in excess of 13,000 gallons) to $1.13 per thousand gallons. At 1991 agricultural rates, assuming 300 days of irrigation per yer, it would cost in excess of $1,390/year for a farmer to irrigate one acre with 4,100 gallons/day. 1991 BWS agricultural water rates will still be affordable for full-time irrigation of flowers, foliage, and potted plants and intermittent irrigation of truck crops and orchards. However, the economic feasibility of full-time irrigation of truck crops and orchards will probably be contingent upon higher prices for agricultural commodities in 1991.

M. GROWTH AND LAND USE

Availability of water is a prerequisite for population growth, new development, and expansion of agriculture. Counting all municipal water uses, gross average per capita water consumption ranges from 144 gallons/day in the BWS Wahiawa Water District to 303 gallons/day in the BWS Ewa Water District. Average per capita residential water usage ranges from 104 to 168 gallons/day for single family residences and from 90 to 97 gallons/day for multi-family residences. [See Appendix A] Availability of water will not directly cause people to have more children or create more employment opportunities.

While first priority for use of water from new windward BWS sources will be to service BWS customers in windward Oahu, any excess water will be exported to Honolulu. (Such exports are reversible if future conditions warrant.) Water from the Pearl Harbor aquifer not needed in Honolulu could then be used in other parts of leeward Oahu. Hence, the cumulative impact of proposed windward Oahu regional water system improvements will be to allow population growth in windward Oahu, the

Honolulu Ground Water Control Area, the Pearl Harbor Ground Water Control Area, and the Waianae Coast. [See Figure 2] Where and how much growth occurs is controlled by County Development Plans and zoning.

N. BWS WATER PRICES

In general, environmental constraints and growth in island population have led the BWS to pursue water development projects which are increasingly expensive. Adopted BWS water system development charges will only cover about half of the cost of planned Oahu water system improvements through 1990. Unless BWS water development charges are increased, construction of proposed BWS facilities will inevitably require increases in BWS rates for municipal water.

O. AIR QUALITY AND NOISE

Electrical pumps used on BWS facilities are relatively quiet and do not generate fumes. Pump mutes or submersible pumps will be used so that pumping noise will be inaudible in public parks and residential areas.

P. NATURAL HAZARDS

Most proposed BWS water sources will be pumped. Natural hazards (and system failures) are likely to occasionally cause power outages on Oahu. Despite BWS use of reservoirs, if a power outage lasts longer than one day, then BWS water service will only be available from

tunnels, inclined wells, and wells equipped with standby generators.

Storm flow of windward Oahu streams can be in excess of 100 times their dry-weather flow. Reduction of the dry-weather flow of an unchannelized perennial stream is likely to allow vegetation to grow in the stream bed. Growth of vegetation in a stream bed will reduce the capacity of the stream channel to carry storm runoff and in some cases may result in storm flows overtopping the stream banks.

It is not possible to reliably assess the extent to which potential reductions in stream flow, due to proposed BWS water sources, might result in sufficient vegetation growth in streams as to increase the risk of flooding during storms. Punaluu, Kahana, Hakipuu, Waikane, Waiahole, and Kaalaea Streams are largely unchannelized perennial windward Oahu streams with a history of flooding. [Ref. 71] If allowed by permanent instream flow standards, BWS water development projects potentially might cause significant reduction of the base flow of these streams.

On the Mainland, in instances where water withdrawal has exceeded the sustainable yield of sedimentary aquifers, dewatering of sediments has occasionally resulted in compaction and subsidence. Water withdrawal does not cause subsidence in Oahu's basaltic aquifers and has not been shown to cause subsidence in Oahu's alluvial aquifers. Regardless, proposed BWS water sources will not be used to "mine" ground water in excess of sustainable yield.

V. SUMMARY OF PROPOSED IMPACT MITIGATION MEASURES

A. SUPPLEMENTAL ARCHAEOLOGICAL RESEARCH

Surface archaeological reconnaissance surveys and literature research for this EIS have indicated that a number of proposed BWS facilities may be in the vicinity of archaeological resources. [See Appendix F] Recommended supplemental archaeological research is summarized in Table 31. Additional surface reconnaissance surveys are needed at sites where access was not possible. Test pits are needed at sites where archaeologists believe there is a possibility of finding subsurface remains. Archaeological excavation is needed at a few sites where there is high probability of uncovering artifacts.

As BWS projects are programmed for development, archaeological reports will be prepared and incorporated in supplemental EAs submitted to the OEQC (for determination as to whether a Supplemental EIS is needed). BWS construction plans will be shown on archaeological survey maps as part of such reports. When necessary, depending on engineering feasibility, cost, and the requirements of the DLNR, BWS projects may be relocated to avoid adverse impacts to cultural resources or the BWS may commission salvage archaeology.

Section 6E-8, HRS, requires that before any State or County agency commences any project which may affect historic property, the agency shall advise the DLNR. The proposed project may not be commenced unless the DLNR has given its written concurrence.

B. SUPPLEMENTAL ENVIRONMENTAL ASSESSMENTS

In the future, after acceptance of this EIS, the BWS intends to prepare supplemental Environmental Assessments (EAs) as individual projects are programmed in windward Oahu. These EAs will be submitted for review by the State Office of Environmental Quality Control (OEQC). If appropriate, then the OEQC will require that Supplemental EISs be prepared in accordance with rules adopted by the State Environmental Council.

TABLE 31

Recommended Supplemental Archaeological Research

Mitigation Measure	Proposed Water Sources
Archaeological Excavation Before Construction at Well Site and Pipeline	Kahaluu Wells II-A, II-B, II-C Ahuimanu Inclined Wells or or Tunnel Maunawili Wells I
Test Pit of Well Site	Uwau Wells Waianu Wells Waiahole Wells Kaalaea Inclined Wells or Tunnel Maunawili Wells II
Site Inspection *	Kaipapau Wells and Pipeline Kaipapau Wells (Alternative) and Pipeline Kaaawa Wells I, II and Pipeline Hakipuu Wells and Pipeline
Test Pit Along Pipeline/Access Road	Malaekahana Wells Laie Wells Wailele Wells Maakua Wells (BWS) Maakua Wells (BWS Alternate) Maakua Wells(DOWALD Alternate) Punaluu Wells IV, V, V-A, V-B, V-C, V-D, Tunnel or Inclined Wells Kahana Wells II Waikane Wells Waikane Wells (Alternate) Uwau Wells Waianu Wells Kaalaea Inclined Wells or Tunnel

* Also includes all proposed reservoir sites and pipelines to reservoirs, except for Kahana 315; Ahuimanu 500; Luluku 500; and Waimanalo 364 No. 2 Reservoirs

Supplemental EAs will not be prepared for the proposed Kaluanui, Kahana, Kahaluu I, Haiku, Iolekaa, Luluku, Kuou II, Kamooalii I, Kamooalii II, and Waimanalo II Wells; and the proposed Kahana 315, Luluku 500, and Waimanalo 364 No. 2 Reservoirs. There has already been compliance with Chapter 343, HRS, concerning these projects. Supplemental EAs also will not be prepared for proposed transmission mains along windward Oahu highways. Potential impacts from these mains have been adequately described in this Final EIS.

C. COMPENSATION FOR PROPERTY AQUISITION

When private property is acquired by eminent domain, persons with a property interest will be compensated for their losses as required by law. In addition to BWS payments for land acquisition, any affected farmers will be compensated for improvements and crops on property which the BWS acquires.

D. CONSTRUCTION MITIGATION MEASURES

Erosion will be controlled by limiting grading and by landscaping cut areas in accordance with the County grading ordinance. Dust will be controlled by sprinkling as required. Contractors will be responsible for compliance with Department of Health regulations governing noise and exhaust emissions. When construction takes place along major windward Oahu highways, flagmen will be used to direct traffic at times when a highway lane is closed. All highway lanes will be kept open during peak traffic hours.

E. SUBMERSIBLE PUMPS, UNDERGROUND UTILITY LINES, AND LANDSCAPING

In residential areas and public parks, pump mutes or submersible pumps will be used to control pumping noise. To mitigate visual impacts, underground electrical and telephone lines will be used when required in public parks, within urbanized areas with underground utilities, and for crossing major highways. Landscaping will be used to mitigate the visual impact of new control buildings and reservoirs.

F. STREAM FLOW MONITORING

When and where directed by the DLNR, the BWS will contract for installation and operation of stream flow gages. Without some form of gages, there is no practical way to determine whether stream flow has dropped below instream flow standards adopted by the DLNR. However, stream gages, per se, are incapable of determining to what extent a reduction in stream flow is due to low rainfall or to BWS ground water development.

G. INSTREAM FLOW STANDARDS

A stated purpose of instream flow standards adopted by the DLNR is to protect stream, wetland, and estuarine biota. Although instream flow standards do not regulate ground water development, the BWS will voluntarily comply. Specifically, the BWS will reduce or cease water production from proposed water sources whenever the DLNR determines that ground water development has reduced stream flow below instream flow standards. The BWS does not intend to unilaterally assume the DLNR's responsibilities for determining compliance with instream flow standards.

H. WATER QUALITY MONITORING

The BWS will monitor the quality of the proposed water development projects to ensure that the withdrawn water is potable and meets applicable regulations. The BWS will also measure salinity in basal wells for salt water intrusion into the basal aquifer. If there is a risk of salt water intrusion into the basal aquifer, the BWS will decrease pumpage from wells. Additional monitoring wells are needed on windward Oahu to measure salt water intrusion. At this time, siting of such wells is not resolved.

The BWS will also monitor potable water sources for pesticide contamination. Wells most at risk are Kahaluu Wells II, Kuou Wells II, and Luluku Wells.

I. REGULATION OF BASAL WELLS

If all proposed public and private basal water development projects in windward Oahu were implemented, they would exceed the sustainable yield of the Koolauloa Basal Aquifer. Hence, BWS or DLNR regulation of wells will be necessary to protect the aquifer. BWS Rules and Regulations authorize the BWS to prohibit new wells and restrict pumpage from existing wells when necessary to prevent overdraft of, or saltwater intrusion into an aquifer. The State DLNR Commission on Water Resource Management is granted similar powers pursuant to Act 45, SLH 1987.

VI. SUMMARY OF UNAVOIDABLE ADVERSE IMPACTS

A. UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts from proposed BWS projects would occur during construction of facilities and during long-term use of proposed wells, tunnels, and inclined wells. Unavoidable adverse impacts associated with construction of the projects include:

- Removing vegetation and disturbing surface features to construct proposed water system improvements;
- Siting of facilities in otherwise undisturbed areas; and
- Traffic congestion on the coastal highway between Laie and Kaneohe.

Unavoidable adverse impacts associated with long-term use of proposed water sources include:

- Reducing the potential for ground water development by parties other than the BWS;
- Reducing dry-weather seepage of ground water into most windward Oahu streams, wetlands, and estuaries;
- Reducing base flow for most perennial streams from Kaluanui to Maunawili; and
- Reducing dry-weather stream flow into most windward Oahu wetlands and estuaries.

B. COMMITMENT OF RESOURCES, FUTURE OPTIONS, AND LONG-TERM PRODUCTIVITY

Implementation of proposed windward Oahu water development projects will commit non-renewable resources, including materials and labor for construction of required facilities. Land, the other non-renewable resource, will also be committed. Commitment of these resources will preclude their use for other purposes. Thus, future options for the use of these resources will be foreclosed. None of the projects poses long-term risks to the health or safety of the residents of Oahu.

Generally, once wells or inclined wells are put into production, they continue in production. During this period, resources will be irreversibly committed. However, depending upon future circumstances, production theoretically could be stopped, and conditions would return to "normal" or pre-production status.

The case is different with tunnels driven into dike compartments. Once a tunnel is excavated, it is difficult or impossible to seal the tunnel to achieve "pre-tunnel" conditions. Driving a tunnel can be considered an irreversible commitment of resources.

Proposed windward Oahu water development projects will increase long-term urban productivity on Oahu, but reduce the potential for expansion of those forms of agriculture which are not economically feasible without low-cost water. The projects will provide water to supply projected population growth on Oahu. Unless sufficient water is available from BWS sources to meet demand, the BWS will be forced to curtail service to new users. In effect, this would impose a moratorium on most new development until new water sources can be implemented. The short-term productivity of Oahu would be adversely affected by a moratorium on development.

C. GOVERNMENTAL POLICIES OFFSETTING ADVERSE IMPACTS

The BWS is required by law to provide for consumer demand on Oahu. The BWS has established water use planning objectives to achieve its mandate. Relevant planning objectives include:

- Investigate, prepare for, and develop timely additional potable ground water sources and alternative sources requiring treatment, to provide for anticipated consumer demands.

- Attempt to insure that growth in consumer demand will be compatible with available water supply. [Ref. 43]

An adequate water supply is fundamental to the nine areas of concern addressed by the City and County of Honolulu General Plan: 1) population; 2) economic activity; 3) the natural environment 4) housing; 5) transportation; 6) physical development and urban design; 7) public safety; 8) health and education; and 9) culture and recreation. [Ref. 43]

Population forecasts developed by the Department of Planning and Economic Development (DPED) indicate an increase in the number of residents on Oahu. County land use plans and zoning direct projected growth in residents to the leeward and central areas of Oahu. Both of these areas have limited potential for additional water development. Implementation of some windward Oahu water development projects will be required for the BWS to meet its mandate.

VII. ALTERNATIVES TO THE PROPOSED PROJECT

A. NO PROJECT

Over the next several decades, total Oahu water demand is projected to increase to the point where the BWS will have to seriously explore all feasible options. At some future date, the BWS will probably have to utilize relatively expensive approaches, such as demineralization of brackish water. For this reason, the BWS has rejected the "no project" alternative in favor of projects which will provide additional water and incorporate adequate mitigation measures.

The BWS will not develop all of the projects described in this EIS. Some proposed projects will not be developed because of cost or potential adverse impacts. Others will not be developed because exploratory wells show unsatisfactory yields. Most proposed reservoirs, access roads, transmission mains, and utility lines are contingent upon development of proposed water sources.

B. ALTERNATIVE WELL AND TUNNEL SITES

Except in cases where there already are existing BWS facilities, it would be feasible to slightly shift the locations of proposed windward water sources. This might affect the environmental impacts of project construction, but not the environmental impacts of water development.

To the extent practicable, this EIS has attempted to pin down siting of proposed water sources rather than leaving siting to be resolved later. The advantage of this approach is that site specific impacts can be evaluated and affected interest groups can be identified. If justified, then the BWS will consider relocating proposed windward water sources.

A feasible alternative with less significant environmental impact than some proposed windward water sources would be for the BWS to develop potable ground water with wells in other parts of Oahu. As mentioned

in Chapter I, the BLNR regulates pumpage from three Ground Water Control Areas (GWCAs) on Oahu to protect basal aquifers from salt water intrusion. [See Figure 2 in Chapter I] As of January 1988, the BLNR has authorized ground water withdrawals totaling 49.378 mgd from the Honolulu GWCA, 219.535 mgd from the Pearl Harbor GWCA, and 67.325 mgd from the Waialua GWCA. Under current BLNR policies, the BLNR may authorize additional ground water withdrawals totaling 10.622 mgd from the Honolulu GWCA (7.612 mgd from the Moanalua-Kaimuki sub-area and 3.010 mgd from the Waialae-Hawaii Kai sub-area), 5.465 mgd from the Pearl Harbor GWCA (Waianae sub-area), and 22.675 mgd from the Waialua GWCA (12.247 mgd from the Mokuleia sub-area, 6.388 mgd from the Waialua sub-area, and 4.04 mgd from the Kawailoa sub-area). [Ref. 87 and Ref. 154] Prior to December 1984, when the BLNR re-evaluated ground water withdrawals by Oahu Sugar Company, the BLNR would not authorize additional withdrawals from the Pearl Harbor GWCA. Consequently, the BWS has not developed comprehensive long-range plans for new municipal water sources in this GWCA. Since use of basal springs and free-flowing wells within the Pearl Harbor GWCA is not regulated by the BLNR, the BWS is studying the possibility of developing about 5 mgd of potable water from HECO's Waiau Shaft.

The BWS has completed a regional EIS for the Honolulu GWCA and is currently preparing a regional EIS to evaluate proposed and possible water sources in the region between Kahuku and Kaena Point (Waialua GWCA).

The basal aquifer between Malaekahana and Kahuku will be close to its sustainable yield after the State proceeds with development of the Kahuku Agricultural Park. No new BWS wells are planned in this area.

Along the Waianae Coast, proposed BWS wells in Waianae Valley have an estimated yield of 2 mgd and proposed BWS wells in Makaha Valley have an estimated yield of up to 4 mgd.

It may be impractical or prohibitively expensive to increase municipal use of ground water from designated GWCAs to the limits established by BLNR policies. It also would be necessary to relocate some existing private wells to allow maximum BWS pumpage from the Pearl Harbor GWCA. The wells recently phased out by Oahu Sugar Company within the Pearl Harbor GWCA withdrew brackish water primarily for irrigation.

Replacing coastal wells which withdraw non-potable water with inland wells which would withdraw potable water from the same basal aquifer could cause salt water intrusion into remaining coastal wells. Oahu Sugar Company is the major user of water from the Pearl Harbor GWCA. They would be unlikely to agree to utilize new inland wells within the Pearl Harbor GWCA unless the BWS absorbed all construction costs and any additional pumping costs.

It would be necessary to install a lengthy transmission main before the BWS could use water from the Waialua GWCA to meet leeward Oahu water demand. Projected municipal water demand in the BWS Waialua-Kahuku Water Use District (which lies within the Waialua GWCA) [Appendix A] is far less than the water supply potentially available for development.

DLNR rules require that the BLNR issue a Well Drilling Permit before a new well is drilled in GWCAs. A Use Permit is required before a new well can be pumped or pumpage increased from an existing source in a designated GWCA. The BWS will not necessarily be the only applicant requesting use of surplus water in GWCAs. Use of undeveloped ground water in a GWCA is on a first-come first-served basis, but there must be a beneficial use before any new water withdrawals will be permitted. [Ref. 17] BWS rules enforce similar provisions outside of GWCAs. [Ref. 53]

C. REGIONAL AND ISLAND-WIDE APPROACHES

This section addresses "unconventional" ways to meet the growing Oahu demand for water other than developing potable ground water with wells and tunnels. Possible approaches vary widely in cost, impacts, and social acceptability.

1. Conservation, Bulkheading of Tunnels, Controlling Leaks. A very efficient approach to meeting future water demand is to conserve water and avoid unnecessary losses. Major possibilities

include installing water saving devices, constructing or relocating bulkheads on water collection tunnels, and repairing leaky water mains.

Ordinance No. 79-27 amended the Oahu Plumbing Code to require installation of low-volume flush toilets (3.5 gallons or less per flush) and cooling water recirculating systems in new developments after November 9, 1979. Water savings could be expanded by installing water conservation devices in toilets and on shower heads, faucets, or other water-using appliances in existence prior to November 1979. While the BWS currently is not authorized by statute or ordinance to subsidize "retrofitting" old fixtures with water saving devices, there could be merit in such a program. However, at present, there is no reliable data on the water savings that could be expected, or the actual cost of a retrofitting program. From March through December 1982, the BWS gave away 130,000 shower flow restrictors for installation by Oahu homeowners. Conceivably, this program could be restarted and expanded.

Voluntary "retrofitting" is not always successful. For example, during an intense drought in 1977, the City of Oxnard, California distributed 3,200 water conservation kits free of charge within a single geographic area. These kits contained a toilet tank dam to reduce the quantity of water flushed by the toilet, a plastic shower head flow restrictor, and dye tablets to detect leaks from toilet storage tanks. The distribution was followed a month later by a survey of 637 households receiving the water conservation kits. It was found that 6% of those surveyed had installed the devices. Follow-up studies showed that those consumers who installed the devices used 3% less water. Presumably, percentage water savings would be less after the drought when these households resumed watering their yards. [Ref. 43, p. 79-80]

Parties reviewing the Draft EIS requested further analysis of the potential constraints, benefits, and costs of replacing existing toilets with lower-volume flush toilets. The City wastewater collection and treatment system is not a constraint. In fact, the City would realize a small but undetermined savings because of reduced pumping costs. [Ref. 147, Ref. 148] There would be no

risk of sewage sticking in sanitary piping if flushes were reduced to 3.5 gallons. However, existing plumbing within a building could limit further reduction in toilet water usage. Sewage from extra-low-volume "air-assisted" flush toilets might stick in the sanitary piping if the pipes made an abrupt bend and slopes were insufficient before inflow from other building wastewater fixtures. [Ref. 149] Hence, it would be much less problematic to amend the Plumbing Code to require "air-assisted" flush toilets in new construction rather than to use them to "retrofit" existing buildings.

Toilets installed on Oahu prior to 1979 probably use 5 to 7.5 gallons per flush. Flushes could be reduced to 3.5 gallons by toilet tank inserts at relatively low cost. Alternatively, at greater but unknown cost, compatible toilets could be "retrofitted" with "dual flush" devices which enable users to select from two or more flush volumes based on flushing requirements. Water usage can be reduced to between 2.5 and 4.3 gallons per event by "dual flush" devices. Simply replacing older toilets with conventional modern toilets (like those installed in new construction on Oahu) could reduce water consumption to between 3.0 to 3.5 gallons per flush. In buildings with compatible plumbing, installation of toilets with air-pressurized tanks to increase water pressure could reduce water consumption to between 2.0 to 2.5 gallons per flush, and installation of toilets which use compressed air to directly flush sewage could reduce water consumption to 0.5 gallons per flush. "Air-assisted" toilets tend to be quieter but require more cleaning and maintenance than conventional flush toilets. [Ref. 153, Table 5-2]

Based on several studies in which residential toilet usage ranged from 2.3 to 4.1 flushes per capita per day, the EPA estimates an average of 3.5 residential toilet flushes per capita per day. [Ref. 153] Assuming one residential toilet for every two people, a typical toilet in an Oahu house or apartment is flushed 7 times per day. Assuming the "retrofitting" an older residential toilet on Oahu could save 2.5 gallons per flush, "retrofitting" potentially could save 17.5 gallons/day per toilet. Assuming 300,000 older residential toilets on Oahu could be "retrofitted", average municipal water consumption could be reduced by 5.25 mgd.

At this time, it would not be cost-effective for the BWS to replace older private residential toilets with modern toilets that use 3.5 gallons per flush. It now costs the BWS as much as $2,000,000 to $4,000,000 to develop and bring a new 1 mgd water source into production. This amounts to spending between $2 and $4 for a new 1 gallon/day souce. Hence, if "retrofitting" would reduce average municipal water consumption by 17.5 gallons/day per toilet, it would only be cost effective to spend between $35 and $70 of public funds per toilet to "retrofit" existing private residential toilets. Because of material and labor costs, "retrofitting" is probably several times more expensive.

Part of Oahu's water supply comes from high level tunnels driven into the Koolau and Waianae mountains. Water trapped in the permeable basalt by impermeable lava dikes is developed by these tunnels. By bulkheading at the dikes (installing an impermeable seal in the tunnel), a tunnel would be able to store water for use during periods of high demand. Without a bulkhead, a buildup of storage is not possible and the tunnel would produce only base flow year round. However, out of four BWS tunnels with bulkheads, the procedure has been effective only at Waihee. Other attempts were unsuccessful in restoring the hydraulic integrity of the dikes which formerly controlled storage.

Normally, approximately 12% of the water input into the overall BWS system is unaccounted for. This includes meter errors, non-metered uses (fire, line flushing, etc.) and an unknown amount of leakage. A survey of the Ewa-Waianae District water distribution system in 1977-78 found that only 1% of the water carried in 50 miles of pipe was lost to leakage. The rest of the unaccounted-for water was due to meter errors and non-metered uses. Another leakage survey recently covered Sand Island. Apart from a few minor leaks, the BWS found that one "misplaced" service was the cause of the high percentage of unaccounted-for water.

2. Demineralization of Brackish Water. Large quantities of brackish ground water could be made available for domestic use if excess salt were removed. Although probably more expensive than normal ground water development, demineralization techniques are

available which are considerably less costly than desalting ocean water. In 1982, construction of an 8 mgd reverse osmosis demineralization plant to treat brackish water from the Pearl Harbor region was estimated to cost approximately $11.4 million. [Ref. 43] In simple terms, reverse osmosis involves pumping brackish water against a semi-permeable membrane. Potable water emerges from the membrane while impurities are left on the high-pressure side of the membrane. Recent advances in membrane technology may substantially reduce pumping cost for reverse osmosis. [Ref. 61] In order to accurately assess the operational costs of reverse osmosis, the DLNR, BWS, DOH, and U.H. Water Resources Research Center are collaborating on a 1 mgd demonstration plant to be built in leeward Oahu. Operating costs will be studied for a five-year period. Funds for design and construction of the demonstration plant have been appropriated by the Legislature. Construction costs are estimated at about $4.5 million. The demonstration plant is currently under design, and construction will begin in 1989. [Ref. 143] Economies of scale will be possible if the demonstration plant is expanded.

3. **Exchanging Water with Agriculture.** While no cost estimate is available, treated sewage effluent or brackish water could be exchanged for well water or Waiahole Ditch water used to irrigate sugar cane on leeward Oahu. Oahu Sugar Company would need to agree to such an exchange, and the BWS would need to develop a new source of irrigation water for use by Oahu Sugar Company. In addition, the BLNR would need to approve any increase in BWS pumpage of potable water from the Pearl Harbor GWCA made possible by a permanent decrease in pumpage from Oahu Sugar Company wells in the Pearl Harbor GWCA.

Without dilution or demineralization, only 7 mgd of well water now used by Oahu Sugar Company could meet the Federal requirement that the chloride concentration in drinking water be less than 250 ppm. [Ref. 106] However, the Waiahole Ditch supplies Oahu Sugar Company with an average of 32 mgd of potentially high quality water from water development tunnels, stream diversions, and pumpage from streams high in the Koolau Range. [Ref. 81, p. 279] The Kahana, Waikane 1, Waikane 2, Uwau, and main transmission

tunnels supply an average of about 26 mgd of water to the Waiahole Ditch. [Ref. 108] This tunnel water would be suitable for domestic use if carried in pipes instead of an open ditch.

Exchange of brackish water or treated sewage effluent for high quality irrigation water poses several risks. First, ground water could possibly be contaminated or rendered unpotable if minerals, dissolved solids, chemical compounds (e.g. nitrates), or infectious agents are not adequately neutralized or filtered out as the water percolates through soil. Second, cane productivity could suffer. Third, the soil could become caked with salts and become less permeable, requiring more water to leach salts out of the soil. Fourth, treated sewage effluent might clog the drip irrigation tubes used in cane fields by encouraging growth of algae or bacteria or by having a high suspended solids content.

At this time, the most feasible option would be to exchange brackish water for high quality water used to irrigate sugar cane growing above relatively impermeable marine and sedimentary deposits (caprock) on the Ewa Plain. However, this is the region where sugar cane will be phased out and replaced with a "Second City" under current City and State plans. Except in caprock areas, it is not possible to prevent return irrigation water from degrading basal water relative to chlorides and total dissolved salts. Unless percolation is restricted by caprock, it would be counterproductive to use brackish irrigation water above parts of the basal lens which are a source of drinking water.

Full scale field studies (sponsored by the U.H. Water Resources Research Center. Hawaii Sugar Planters Association, Oahu Sugar Company, City Department of Public Works, and BWS) using diluted secondry treated sewage effluent from Mililani Wastewater Treatment Plant (WTP) for irrigation indicate that problems with cane productivity and soil retention of salts can be resolved. For a time, Oahu Sugar Company was using Mililani WTP effluent to irrigate fields in furrow irrigation. However, Oahu Sugar made a decision a few years ago to terminate use of secondary treated sewage for irrigation.

Resumption of use of diluted secondary treated sewage by Oahu Sugar Company would be much more difficult under present conditions. Except for a small portion of their acreage retained in furrow irrigation to accommodate mill waste water, the rest of Oahu Sugar's fields have been converted to drip irrigation. Since the Mililani WTP has been phased out, it would be necessary to upgrade the City's Honouliuli WTP to provide secondary treatment plus screening of suspended solids before sizable amounts of wastewater would be available for exchange with high quality water used for drip irrigation. Because of cost, the City only plans to provide advanced primary treatment at the Honouliuli WTP. An application for waiver of secondary treatment requirements has been submitted to the U.S. EPA under Section 301(h) of the Clean Water Act. [Ref. 107]

4. Using Non-Potable Water for Landscaping. Instead of potable water, brackish water could potentially be used to irrigate landscaping and parks located above caprock. For example, the BWS will soon be developing 5 mgd of brackish spring water draining from the Sumida watercress farm at Kalauao Springs. A major use of this water will be for irrigation along highways by the State Department of Transportation in place of existing potable irrigation water. The BWS is also exploring the feasibility of developing an extensive non-potable water system to service urban development on the Ewa Plain.

5. Trapping Storm Runoff. The economics of trapping storm runoff are probably unattractive but have not been thoroughly investigated. [Ref. 57] At some time in the future, as a means of preserving coastal water quality, there may possibly be joint public and private programs to install dams to slow storm runoff out of natural drainage basins such as Waikele Stream. Besides reducing siltation of near shore waters, such measures could result in increased recharge to Oahu's basal water supply.

The environmental benefits of land-based disposal of storm water need to be balanced against the debits. First, storm water ponding basins require large areas. While some forms of

agriculture can be located in a ponding basin, most land uses are precluded. Second, ponding basins can create breeding grounds for mosquitoes. Third, ponding basins will continually require maintenance because of silt build-up from flood flows.

6. Tapping Stream Water and Springs. Surface water on Oahu could theoretically be treated and used for human consumption. However, treatment of surface water resources is probably more costly than to install wells and pump the ground water which is the source of the dry-weather flow of streams and springs.

Although additional development of surface water for irrigation is technically feasible in windward Oahu, new stream diversions are subject to relatively stringent regulation by the BLNR. In leeward Oahu, there are several small springs and streams mauka of and within urbanized areas. [Ref. 57] Basal springs around Pearl Harbor offer the largest potential source of surface water for irrigation.

7. Taking Agricultural Water. On the average, when water is not pumped from Waiahole Stream, the State of Hawaii owns about 6.4 mgd of the water developed by the Waiahole Ditch. [Ref. 108] In 1984, which is the driest year on record, when an average of 4.82 mgd of State owned water was developed by the Waiahole Ditch, the State owned share of the dry-weather ditch flow probably fell as low as 3 mgd. [Ref. 112] Under the current lease, the State can withdraw State owned water conveyed by the Waiahole Ditch for either domestic use or irrigation of crops and can withdraw privately owned water conveyed by the Waiahole Ditch for domestic use. [Ref. 109, p. 4]

The BLNR has indicated that it will not authorize the BWS to simply take State owned water from the Waiahole Ditch. A more reasonable approach would be to require that if sugar cane fields are phased out, then other parties be allowed to use water formerly developed for irrigation. For example, Oahu Sugar Company uses an average of about 5.6 mgd of water per 1,000 acres for drip irrigation of sugar cane on the Ewa Plain. [Ref. 111]

In December 1984, because of reductions in cultivated acreage and irrigation requirements, the BLNR recertified allowable Oahu Sugar Company pumpage within the Pearl Harbor GWCA from 115 mgd to 92.5 mgd. [Ref. 87] Apparently, the BLNR has not acknowledged that reduction of cultivated acreage inland of caprock can reduce the recharge and sustainable yield of the Pearl Harbor aquifer.

8. Increasing Water Prices. The rate for water assessed by the BWS is set so as to cover costs, including development of new sources, but not to make a profit. For the first 13,000 gallons of water used in a month all users are charged the same basic rate. In 1970, this rate was $0.34 per 1,000 gallons. Currently the basic rate is $0.98 per 1,000 gallons, representing an increase of around 6% per year. Above 13,000 gallons per month. agricultural users are currently given a reduced rate of $0.69 per 1,000 gallons. Prior to July 1980, industrial users were also given a reduced rate. To encourage conservation, they are now charged the basic rate for all water used. Residential users continue to be charged the basic rate for all water used.

Increased water prices could lead to more efficient use of water and discourage waste. One recent study estimates that if other variables remained constant. a 10% increase in water prices would result in a 0.29% decrease in water consumption by single-family residences. [Ref. 110] Another study by the Hawaii Institute for Management and Analysis in Government (HIMAG), recommended imposition of peak-load (i.e. higher summer) prices for municipal water users. [Ref. 13] The logic of the HIMAG recommendation is based on the assumption that the low cost of municipal water discourages the application of available water-saving technology especially by large water users. If this assumption is correct, then peak load pricing could delay the time when the BWS will be forced to turn to more expensive water sources. Peak load pricing has not yet been adopted, but as previously noted, the discounted rate formerly given to large industrial users has been eliminated in order to encourage water conservation.

D. PROPOSALS OF THE OAHU WATER PLAN

The 1982 Oahu Water Plan evaluated all of the alternatives described in this Chapter as well as the feasibility of blending brackish and potable water to increase supply. At the time the Plan was prepared, the BLNR would not authorize additional ground water withdrawals from the Pearl Harbor GWCA. The Plan recommended that a total of 36.65 mgd of additional potable water be developed with wells to accommodate projected municipal water demand. Of this total. about 20.8 mgd was proposed to be developed by the following windward water wells. [Ref. 43, p. 55]

Proposed Windward Sources	Oahu Water Plan Estimate of Sustainable Capacity
Laie Wells	1.0 mgd
Wailele Wells	1.0 mgd
Kaipapau Wells	1.0 mgd
Maakua Well	0.5 mgd
Kaluanui Wells	2.0 mgd
Punaluu Wells V Series	5.0 mgd
Kahana Wells II	0.5 mgd
Kahana Wells III	2.0 mgd
Kaaawa Well I	0.5 mgd
Kaaawa Well II	0.5 mgd
Hakipuu Well	0.5 mgd
Waiahole-Waikane Wells	0.5 mgd
Kahaluu Well	1.0 mgd
Iolekaa Well	0.3 mgd
Haiku Well	1.0 mgd
Luluku Wells	1.0 mgd
Kuou Wells II	0.5 mgd
Kamooalii Wells I	0.5 mgd
Kamooalii Wells II	0.5 mgd
Waimanalo Well II	1.0 mgd
TOTAL	20.8 mgd

CHAPTER VIII. RELATIONSHIP OF THE PROPOSED PROJECT TO LAND USE PLANS, POLICIES AND CONTROLS

The following paragraphs summarize major State and County land use plans, policies, and controls which are relevant to proposed windward Oahu water system improvements.

A. STATE PLAN AND LAND USE CONTROLS

The Hawaii State Plan, enacted by Act 100, SLH 1978, indicates legislative intent to:

> Ensure that adequate support services and facilities are provided to accommodate the desired distribution of future growth throughout the State. (Sec. 226-5(b)(3), HRS)
>
> Encourage the protection of rare or endangered plant and animal species and habitats native to Hawaii. (Sec. 226-11(b)(6), HRS)
>
> Promote the preservation and restoration of significant natural and historic resources. (Sec. 226-12(b)(1), HRS)
>
> Support water supply services to areas experiencing critical water shortages. (Sec. 226-16(b)(5), HRS)
>
> Facilitate the use of available urban lands to accommodate the housing needs in various communities. (Sec. 226-19(b)(6), HRS)
>
> Direct future urban development away from critical environmental areas or impose mitigating measures so that negative impacts on the environment would be minimal. (Sec. 226-104(c)(4), HRS)
>
> Identify critical environmental areas in Hawaii to include but not be limited to the following: watershed and recharge areas; wildlife habitats (on land and in the ocean); areas with endangered species of plants and wildlife; natural streams and water bodies; scenic and recreational shoreline resources; open space and natural areas; historic and cultural sites; areas particularly sensitive to reduction in water and air quality; and scenic resources. (Sec. 226-104(c)(5), HRS)

State land use controls to implement the State Plan are designated in Sec. 226-52, HRS. These are district boundary classification by the State Land Use Commission and review of Conservation District Use Applications (CDUA) by the State Board of Land and Natural Resources (BLNR). Pursuant to Chapter 205, HRS, the Land Use Commission is responsible to classify all lands in the State into one of four land use districts: Urban, Rural, Conservation, or Agriculture. As provided in Sec. 205-5 and 183-41, HRS, the BLNR regulates use of the Conservation District. BLNR rules allow public water development facilities anywhere in the Conservation District provided that environmental impacts are mitigated to the satisfaction of the BLNR. [Ref. 16]

With respect to State Plan policies, proposed windward Oahu water system improvements will provide a portion of the water needed to accommodate projected Oahu population growth. Appropriate mitigation measures will be used so that construction of proposed BWS facilities will not cause significant adverse effects on rare or endangered species, natural or historic resources, wildlife habitats, perennial streams, or scenic resources. However, additional development of high-level dike-confined ground water in windward Oahu may reduce the dry weather flow of several perennial streams. The potential for new BWS facilities to adversely affect stream flow, habitat of native stream fauna, and habitat of endangered native waterbirds is evaluated in Chapter IV of this EIS.

B. STATE COASTAL ZONE MANAGEMENT PROGRAM

The State Coastal Zone Management (CZM) Law (Sec. 205A-2(c)(4) and 205A-5, HRS), requires all public agencies to protect coastal ecosystems, i.e., the habitat of waterbirds and diadromous stream fauna. As discussed in Chapter IV, additional development of high-level dike-impounded ground water in windward Oahu has the potential to adversely impact the habitat of native stream fauna and waterbirds. The 1978 State CZM Program document proposed that the State Department of Health (DOH) adopt statewide minimum stream flow regulations to

protect coastal ecosystems. [Ref. 88, p. 210-211] However, the DOH has not adopted minimum flow regulations. Act 185, SLH 1982 (Chapter 176D, HRS), assigned responsibility to the State BLNR to adopt interim and final in-stream flow standards for windward Oahu streams and regulate alteration of windward Oahu stream channels. Act 45, SLH 1987 (the State Water Code) repeals Chapter 176D as of July 1, 1989. Nonetheless, on July 30, 1987, the BLNR adoped the following interim instream flow standards for windward Oahu streams:

(a) With respect to gaged streams, the standard shall be 100% of the median flow computed after existing diversions have been deducted.

(b) With respect to ungaged streams, no further diversion shall be allowed.

(c) These flow standards can be modified on a case-by-case, stream-by-stream basis by individual application, when additional amd more specific data becomes available for each such individual stream. [Ref. 156]

According to the State Attorney General, the BLNR is only authorized by Chapter 176D and not Act 45 to adopt interim instream flow standards. [Ref. 155] This probably means that interim instream flow standards adopted by the BLNR will not be in effect after July 1, 1989 (the date on which Act 45 repeals Chapter 176D). If, as has been argued, adoption of interim instream flow standards is a form of rule making [Ref. 157], then the BLNR's decision not to follow the procedural requirements for rule making established by the State Administrative Procedures Act (Chapter 91, HRS) might mean that the BLNR's interim instream flow standards are not yet legally in effect.

Chapter 176D does not authorize the BLNR to directly regulate ground water development in order to implement interim instream flow standards. However, pursuant to Chapter 183, HRS, the BLNR may impose conditions when approving a CDUA for ground water development in the Conservation District. For example, the CDUAs for the BWS Haiku and Kahaluu Wells were approved with the condition that ground water development be managed so as not to violate interim instream flow standards (which had not been set at that time). Regardless of

whether conditions are imposed on approval of CDUA, the BWS intends to reduce or cease water production from proposed new souces when the DLNR indicates that this is necessary to comply with the BLNR's interim instream flow standards. This will be the method by which the BWS complies with the Hawaii CZM Program.

The BLNR's interim instream flow standards clearly "grandfather" stream diversions in existence on July 30, 1987. If a windward Oahu stream has never been gaged, then "no further diversion" is allowed. However, by installation of a stream gage for some as yet undetermined minimum period, an interested party could modify an interim instream flow standard for the gaged stream from "no further diversion" to "median flow computed after existing diversions have been deducted". For any stream which formerly had or presently has a gage for this undetermined minimum period, the standard is "median flow computed after existing diversions have been deducted".

Sometime in 1988, DLNR staff plan to decide the minimum stream gage period for an interim instream flow standard to be set at existing median flow. Later this year, for streams which have been gaged for this minimum period, DLNR staff plan to estimate median stream flow at all elevations. Such DLNR estimates will probably use a combination of stream gage records, instantaneous stream flow measurements above and below gages, rainfall gage records, correlations, and best judgement. Estimates of median stream flow prepared by DLNR staff for gaged windward Oahu streams can be modified based on new data submitted in applications by interested parties. [Ref. 143]

If groundwater development were managed in accordance with the BLNR's interim instream flow standards as if ground water development were a kind of stream diversion, then:

(a) Windward Oahu groundwater sources in use on June 30, 1987 would be "grandfathered".

(b) New ground water development after June 30, 1987 would be managed so as not to cause any reduction in the flow of ungaged streams.

(c) New ground water development after June 30, 1987 would be managed so as not to cause any reduction in the flow of gaged streams below DLNR estimates of median flow.

Management of new ground water development in accordance with the BLNR's interim instream flow standards will be relatively unproblematic at sites where there are existing stream gages. If a new water source may reduce stream flow at a gage, and if requested by the DLNR. then the BWS will stop water development from that source whenever the gage records stream flow equal to or less than DLNR estimates of median flow. If the DLNR does not request that ground water development be stopped, then water development will continue. Hence, the DLNR will have the burden of determining that a new BWS ground water source in fact reduces stream flow at the gage. For example, as shown in Table 28, pumpage from Kahaluu Well I could possibly reduce the flow of Kahaluu Stream. In 1983, the USGS installed gage 2832 at an elevation of 150 feet on Kahaluu Stream. [Ref. 158] Sometime in 1988, DLNR staff will calculate median flow at the gage and the BWS will bring Kahaluu Well I into production. Afterwards, if requested by the DLNR, the BWS will stop pumping Kahaluu Well I whenever gage 2832 records stream flows equal to or less than DLNR estimates of median flow. If DLNR does not so request, then pumpage from Kahaluu Well I will not be regulated on the basis of stream flow at gage 2832. In the event the BWS develops a computer model which shows that only rainfall, and not pumpage of Kahaluu Well I, affects stream flow, then pumpage will not be regulated on the basis of stream flow at gage 2832.

Management of new groundwater development in accordance with the BLNR's interim instream flow standards will be problematic for gaged streams at elevations where there are no gages. Sometime in 1988, DLNR staff will estimate median stream flow at various elevations on such streams. However, except at gages, it is not resolved how the BWS or DLNR will monitor whether stream flow is equal to or less than estimated median flow. For example, as shown in Table 28, pumpage from Haiku Well could possibly reduce the flow of Haiku Stream. Haiku Stream is now only gaged at an elevation of 272 feet. [Ref. 158] However, Haiku Stream gains most of its dry-weather flow below this elevation (see Table 20), and pumpage from Haiku Well potentially may reduce stream flow gains below the existing gage. Or for example, as

shown in Table 28 and Figure 40, the proposed Punaluu Inclined Wells potentially may reduce the flow of Punaluu Stream's headwaters. Punaluu Stream is currently only gaged at an elevation of 212 feet. [Ref. 158] However, gravity flow from the Punaluu Inclined Wells is likely to reduce stream flow above the existing gage.

The BWS plans to take somewhat the same approach in compliance with interim instream flow standards for ungaged sections of streams as for gaged sections of streams. If a new water source may reduce stream flow at ungaged sections, and if requested by the DLNR, then the BWS will stop water development from that source. If the DLNR does not request that ground water development be stopped, then water development wll continue. Hence, the DLNR will have the burden of determining that (a) a new BWS ground water source in fact reduces stream flow; and (b) stream flow at any affected ungaged section of stream is equal to or less than DLNR estimates of median flow.

Management of new ground water development in accordance with the BLNR's interim instream flow standards will be highly problematic for ungaged streams. For example, as shown in Table 28, pumpage from the proposed Kaalaea Wells could possibly reduce the flow of Kaalaea and/or Haiamoa Stream. However, these streams have never been gaged. Once the Kaalaea Wells are put into production, there will be no reliable way for either the BWS or DLNR to conclusively determine that the flows of Kaalaea and Haiamoa Streams are unaffected.

The BWS approach to compliance with interim instream flow standards for ungaged streams will be the same as for ungaged sections of streams. If a new water source may reduce the flow of an ungaged stream, and if requested by the DLNR, then the BWS will not develop water from that source. otherwise, the BWS may develop that water source. Hence, the DLNR will have the burden of determining that a proposed groundwater source will reduce the flow of an ungaged stream.

The BWS does not intend to install additional stream gages unless directed to do so by the DLNR. Although the BWS is waiting for direction from the DLNR on how to proceed, the BWS is not delaying its plans to bring existing and proposed wells into production. The BWS does not intend to unilaterally assume the DLNR's responsibilities to determine when groundwater development must be restricted to comply

with the BLNR's interim instream flow standards.

Part II of Chapter 205A, HRS, requires the Honolulu City Council to establish a Special Management Area (SMA) around the perimeter of Oahu and regulate above-ground development within the SMA to implement CZM policies including protection of coastal ecosystems. Kahana Wells II, which will not affect stream flow, is the only proposed new BWS windward water source within the existing County SMA. [Ref. 32] Construction of this well will require a Special Management Area Use Permit (SMP). Proposed BWS infrastructure for many windward wells will also require a SMP.

C. STATE WATER CODE

Act 45, SLH 1987 (the State Water Code), creates a new State agency named the Commission of Water Resource Management (Water Commission) to head the DLNR. "... on matters relating to the State Water Code". On other matters, the BLNR continues to head the DLNR. BLNR authority to adopt interim and final instream flow standards for windward Oahu streams and regulate stream channel alterations in windward Oahu, is repealed effective July 1, 1989. Similarly, BLNR authority to designate and regulate water usage in Ground Water Control Areas (GWCAs) on any island is repealed effective July 1, 1989. Also, BLNR authority to set minimum standards and require records for new wells is repealed effective July 1, 1989.

Act 45 directs the Water Commission, after adoption of necessary rules, to adopt interim and final instream flow standards and regulate alterations of stream channels throughout the State. Such rules may not be adopted until after completion of this Final EIS. Unlike Chapter 176D, HRS, Act 45 provides several clear legal mechanisms for regulation ofground water development which may affect stream flow. Section 2, Part VI of Act 45 provides that

> The Commission shall implement its instream flow standards when disposing of water from State watersheds, including that

removed by wells or tunnels where they may affect stream flow, and when regulating use of lands and waters within the State conservation district, including water development.

Section 2, Part IV of Act 45 also authorizes the Commission to designate Water Management Areas in which all surface and ground water uses require a permit. Section 2, Part III of Act 45 in part requires that

> The Commission shall condition permits under Part IV of this chapter in such a manner as to protect instream flows ....

In effect, Act 45 restricts State and county agencies from using their regulatory powers to prohibit stream diversions allowed by the Commission's instream flow standards. Section 2, Part I of Act 45 provides that

> No State or county government agency may enforce any statute, rule, or order affecting the waters of the State controlled under the provisions of this chapter, whether enacted or promulgated before or after the effective date of this chapter, inconsistent with the provisions of this chapter.

Hence, if the Water Commission adopts interim instream standards for windward Oahu streams before July 1, 1989, then the Commission's standards will supersede the BLNR's standards.

Other things enacted by the State Water Code include but are not limited to the following:

- Within one year of Water Commission rules being adopted, all persons using either surface or ground water in Hawaii must report the amount, source, and purpose of use. Subsequent changes must also be reported. After verifying such reports, the Commission then issues certificates to the water users. These certificates are to be used by the Commission in resolving claims to water rights and existing "grandfathered" uses.

- Appurtenant water rights of kuleana and taro lands cannot be diminished or extinguished.

- The Commission is responsible to hear and decide all disputes concerning water use and/or water rights anywhere in the State. Appeals to the courts can only be based on the record used by the Commission.

- The Commission is responsible to designate and regulate all water use in Water Management Areas in order to protect water quality, water rights, and existing water uses; settle disputes; or to achieve optimum development of basal ground water. Ground Water Control Areas which the BLNR formerly regulated on Oahu are automatically continued as Water Management Areas.

- Permits are required for both existing and proposed ground water and surface water development facilities. The Commission must set standards for these permits to prevent ground water contamination and water wastage.

- A Hawaii Water Plan is created initially consisting of four parts. The Commission must prepare a water resource protection plan (and inventory). State agencies responsible for water development must prepare a plan for their projects. The Department of Health (DOH) must prepare a water quality plan. Each county by ordinance must adopt and periodically update a plan allocating water to land use. (County plans must be consistent with State land use district boundaries, the Commission's plan, and the DOH plan.) Subsequently, the Commission must prepare and update an integrated Water Resource Protection and Quality Plan on which Commission actions are to be based. (This Plan is supposed to facilitate implementation of county land use plans, while achieving other objectives of the Water Code.)

- The Commission has emergency regulatory powers during water shortages.

- Public condemnation of property canot be used to acquire water rights without the Commission's permission.

- The Commission is authorized to administratively impose $1,000 per day civil fines or to seek injunctions against violations of its rules or decisions.

One potential effect of the State Water Code will be to clarify whether water development from a new BWS ground water source has adversely impacted an existing surface water diversion. Under the Water Code, the burden of proof is on existing stream users to measure how much water they take during different times of the year. After a "grandfathered" stream use is verified and certified by the Water Commission, there will be a factual basis for determining whether ground water development has adversely affected this use. Although procedures have not yet been formalized by adoption of Commission rules, it is likely that the Commission will respond to complaints by stream users about impacts of BWS ground water development. If a stream user is found to be unable to take his certified use, then the Commission may order the BWS to cease ground water development or provide ground water in lieu of surface water. [Ref. 143]

Since the Commission has not adopted instream flow standards, it is not resolved how the BWS will comply with such standrds. At a minimum, the BWS will reduce or cease water production from proposed new sources when the DLNR indicates that this is necesssary to comply with the Commission's instream flow standards.

Theoretically, the Water Code may allow changes in the existing first-come first-served process of water development. If a county plan (allocating water to land use) "reserves" undeveloped water for a particular future use (such as agriculture), at a particular location, within a defined and reasonable time frame, then the Commission is likely to "reserve" this water with its Water Resource Protection and Quality Plan. Otherwise, the Commission will probably not restrict new water development which has reasonable uses, complies with instream flow standards, and has no adverse impacts on water quality. [Ref. 143] As of January 1988, the Department of General Planning is beginning the preparation of a plan allocating water to Oahu land use. At this time, it is not resolved whether the county plan will "reserve" undeveloped groundwater for particular future uses. [Ref. 145]

D. COUNTY GENERAL PLAN AND ZONING

The City and County of Honolulu has two kinds of land use plans; a General Plan which is adopted by resolution, and Development Plans (DPs) which are enacted by ordinance. The County General Plan provides an overall framework including long-range objectives and implementing policies. County DPs interpret the General Plan, provide urban design standards, and incorporate maps showing the approximate locations proposed for future land uses and public facilities. Significant BWS facilities such as production wells and reservoirs can not be built unless shown on DP Public Facility Maps.

Relevant policies of the 1982 Oahu General Plan are as follows:

> Facilitate the full development of the primary urban center. [Ref. 34, Population Objective C Policy 1]
>
> Encourage the gradual development of a secondary urban center in the West Beach-Makakilo area to relieve development pressures in the urban-fringe and rural areas. [Ref. 34, Population Objective C Policy 2]
>
> Manage physical growth and development in the urban-fringe and rural areas so that ... their proportion of the island-wide resident population remains unchanged. [Ref. 34. Population Objective C Policy 3]
>
> Retain the Island's streams as scenic, aquatic, and recreation resources. [Ref. 34, Natural Environment Objective A Policy 3]
>
> Protect plants, birds, and other animals that are unique to the State of Hawaii and the Island of Oahu. [Ref. 34, Natural Environment Objective A Policy 8]
>
> Protect Oahu's scenic views, especially those seen from highly developed and heavily traveled areas. [Ref. 34, Natural Environment Objective B Policy 2]

Develop and maintain an adequate supply of water for both residents and visitors. [Ref. 34, Transportation and Utilities Objective B Policy 1]

Develop and maintain an adequate supply of water for agricultural and industrial needs. [Ref. 34, Transportation and Utilities Objective B Policy 2]

New BWS windward water sources will develop water to accommodate growth and development proposed in the 1982 Oahu General Plan. However, additional development of high-level dike-confined ground water has the potential to adversely affect the habitat of native stream fauna and waterbirds. The "project" will not in itself guide where population growth takes place on Oahu. Implementation of County land use plans is primarily achieved with zoning rather than with water supply because the BWS has no legal mandate to use water supply as a tool to direct growth. In the absence of any law, ordinance, or rule authorizing the BWS to refuse service when water is available, the BWS is committed to meeting all future demand on a first-come first-served basis.

Pursuant to Sec. 205-5, HRS, County zoning regulates use of lands which the State Land Use Commission has classified in either the Urban or Agricultural District. As provided by Sec. 46-4, HRS, zoning is established as a means of implementing County land use plans. All proposed BWS windward Oahu water system improvements are permitted uses in all zoning districts established by the current County Land Use Ordinance. [Ref. 31] County zoning does not address the potential impacts of ground water development on stream flow or coastal ecosystems.

CHAPTER IX. LIST OF NECESSARY APPROVALS

A wide variety of Federal, State, and County permits have been established to mitigate the environmental impacts of development. Depending on where new BWS water sources, reservoirs, access roads, transmission mains, booster pumps, and utility lines are proposed in windward Oahu, one or more of the following agency approvals will be required. Except at crossings, perennial stream channels will not be altered, and no other development is proposed in wetlands. Permits marked with an asterisk (*) will be necessary for crossing stream beds with buried transmission mains and may be needed for new bridge abutments on stream banks.

FEDERAL APPROVALS

- Department of the Army permit* for any temporary or permanent access roads, stream crossings, or for placement of fill material in wetlands, pursuant to 33 USC Sec. 1344, from the U.S. Army Corps of Engineers.

STATE APPROVALS

- Approval of a supplemental Environmental Assessment for each BWS project, pursuant to State Environmental Council rules, by the State Office of Environmental Quality Control or approval of a Supplemental Environmental Impact Statement by the Governor. [Ref. 24]

- Determination of Federal consistency with the Hawaii Coastal Zone Management Program* for a Department of the Army Permit, pursuant to 16 USC Sec. 1456(c) and Sec. 205A-3(3), HRS, by the State Department of Planning and Economic Development (DPED). [Ref. 22]

- Stream channel alteration permit*, prior to July 1, 1989, pursuant to Chapter 176D, HRS. by the State Board of Land and Natural Resources (BLNR). [Ref. 18] The State Commission on Water Resource Management will establish a similar permit, pursuant to Act 45. SLH 1987.

- Approval of a Conservation District Use Application (CDUA) for development in the Conservation District, pursuant to Sec. 183-41 and 205-5, HRS, by the BLNR. [Ref. 16]

- Easement or lease for use of State lands, pursuant to Chapter 171. HRS, by the State BLNR.

- Concurrence with project effects on historic property, pursuant to Sec. 6E-8, HRS, by the State Department of Land and Natural Resources (DLNR).

- Approval for domestic use of water from a new water source, pursuant to Chapter 340E, HRS, by the State Department of Health. [Ref. 14]

COUNTY APPROVALS

- Designation of sites for water sources and reservoirs on Development Plan Public Facilities Maps, pursuant to Sec. 5-412(3), Revised charter of the City and County of Honolulu by the Honolulu City Council.

- Special Management Permit for above-ground development within the County Special Management Area, pursuant to Part II of Chapter 205A, HRS. from the Honolulu City Council. [Ref. 32]

- Preparation of Flood Hazard District Declaration* for development in a Flood Hazard District, pursuant to Article 11 of Chapter 21, Revised Ordinances of Honolulu, by the County Department of Land Utilization. [Ref. 31]

- Grubbing, Grading, and Stockpiling Permits for grading, grubbing, or stockpiling, pursuant to Chapter 180C, HRS, and Chapter 23, Revised Ordinances of Honolulu, from the County Department of Public Works.

- Building Permit for construction of buildings or structures and electrical and plumbing improvements, pursuant to Chapters 16, 17, 18, 19, and 25, Revised Ordinances of Honolulu, from the County Building Department.

As of Janury 1988, the Laie, Wailele, Kaluanui, Punaluu IV, Punaluu V-A, Punaluu V-B, Kaaawa I, Kaaawa II, Hakipuu, Kahaluu I, Kahaluu II, Iolekaa, Haiku, Luluku, Kuou II, and Waimanalo II wells had received all "discretionary" approvals then required for completion, i.e., designation on County Development Plan Public Facilities Maps and approval of a CDUA, if applicable. Conceivably, additional approvals may be required by the State Commission on Water Resource Management once the Commission adopts rules.

The Waiamanalo 364 Reservoir No. 2 is completed at this time. The Kahana 315 and Ahuimanu 500 Reservoirs have received all necessary permits and are under construction. The CDUA for the Luluku 500 Reservoir has been approved and construction will begin in 1988.

The Koolauloa Development Plan Public Facilities Map (City and County of Honolulu, Ordinance 87-49, May 14, 1987) shows the following BWS water development or storage projects: Laie Wells; Wailele Wells; Hauula 180 Reservoir; Kaipapau Wells (Alternate); Maakua Wells (DOWALD Alternative); Kaluanui Wells; Punaluu Well IV; Punaluu Wells V-A; Punaluu Wells V-B; Punaluu Wells V-C; Punaluu Wells V-D; Punaluu Inclined Wells; Kahana Wells II; Kahana Wells III; Kahana 315 Reservoir; Kaaawa Wells I; and Kaaawa Wells II. The Koolaupoko Development Plan Public Facilities Map (City and County of Honolulu, Ordinance 87-67, May 29, 1987) shows the following BWS water development or storage projects: Hakipuu Wells; Kahaluu Wells I; Kahaluu Wells II; Ahuimanu 500 Reservoir; Heeia Kai 272 Reservoir; Luluku Wells; Luluku 500 Reservoir; Kuou Wells II; Kamooalii Wells I; Kamooalii Wells II; Waimanalo Well II; and Waimanalo 364 Reservoir No. 2.

X. SUMMARY OF UNRESOLVED ISSUES

There are certain unresolved issues indentified in this EIS, some pertain to the proposed projects and others to potential impacts and mitigation measures. Unresolved issues about the proposed projects are:

- Plans for windward Oahu reservoirs. Up to nineteen new reservoirs could be needed. However, only four proposed reservoirs have firm sites, sizes, and spillway elevations.

- Plans for windward Oahu access roads. It has been assumed that the BWS will minimize the need for new cross-country access roads. Access road alignments will need to be resolved after detailed topographic surveys and in some cases after archaeological surveys and test pits.

- Plans for windward Oahu transmission mains. New BWS pipelines will almost always follow existing roads or proposed access road improvements. Sizes of major transmission mains to carry water from Laie to Kaneohe will probably be determined within the next year.

- Plans for windward Oahu booster pumps. A new booster pump station is proposed for the Hauula 180 Reservoir. Existing pump stations may need to be modified or upgraded.

- Plans for electrical and telephone lines. The utility companies have not determined their plans for the proposed improvements.

- Plans for projects not budgeted in the BWS Six-Year CIP. The status of unbudgeted projects will depend upon yields of exploratory wells, competing uses, environmental impacts, sustainable yields of aquifers, and a number of other factors.

Unresolved issues related to potential adverse impacts and mitigation measures are:

- Installation and operation of stream and rainfall gages and creation of models to quantify impacts on stream flow from BWS projects. The BWS does not plan to install such gages unless

directed to do so by the DLNR. If appropriate rainfall data were collected, then operational USGS gages are capable of adequately measuring the total extent, but not the elevation at which proposed BWS projects reduce the dry-weather discharge of Kaluanui, Kahana, Waikane, and Kamooalii Streams. However, other streams which may be adversely affected are currently not gaged at an altitude which would ensure that all potential impacts on stream flow are measured.

- Implementation of instream flow standards. In order to mitigate impacts on stream flow and comply with interim and final instream flow standards, the BWS will reduce or cease water production from proposed windward sources whenever directed to do so by the DLNR. However, the DLNR will not have any practical way of determining when stream flow at any ungaged elevation is less than required by instream flow standards, or whether BWS water sources have reduced stream flow at any elevation.

- Adoption of permanent instream flow standards by the State Commission on Water Resource Management. Although interim instream flow standards have been established, it has not been determined when permanent standards will be adopted, or what they will be. It also is unresolved how much flow must be preserved in streams to avoid adverse impacts to stream fauna, waterbirds, and estuarine fauna.

- Location, number, and funding of additional observation wells to monitor the static head of and salt water intrusion into basal aquifers. Observation wells are used to monitor the static head and salinity throughout a basal aquifer. The location and number of additional observation wells has not been determined. If the BWS does not develop such wells, then the DLNR will do so.

- Allocation of the remaining undeveloped water in the Koolauloa Basal Aquifer. Competing demands for limited water resources most likely will be resolved on a first-come first-served basis unless the Water Commission "reserves" water for future uses in its Water Resource Protection and Quality Plan.

XI. ORGANIZATIONS AND PERSONS CONSULTED

[Comments and Responses are Reproduced in Appendices G and H]

		Pages
	A. FEDERAL GOVERNMENT	
	U.S. Department of Agriculture Soil Conservation Service	G-3, H-3
#	U.S. Army Corps of Engineers, Honolulu District Engineer	G-3
	U.S. Department of the Interior	
	Fish and Wildlife Service	G-4, H-64
	Geological Survey	G-6, H-3
*	U.S. Department of the Navy, Naval Base Pearl Harbor	H-4
	B. STATE OF HAWAII	
*	Department of Accounting and General Services	H-4
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	Department of Business and Economic Development	G-14,H-5
	Housing Finance and Development Corporation	G-15,H-7
#*	State Energy Office	
*	Department of Defense	H-8
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#	Office of Environmental Quality Control	G-17
#	Department of Land and Natural Resources	G-11
#	Kahana Valley Advisory Board	G-13
#*	State Historic Preservation Officer	
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#	Water Resources Research Center	G-20
	C. CITY AND COUNTY OF HONOLULU	
	Department of General Planning	G-22,H-13
	Department of Housing and Community Development	G-23,H-14
	Department of Land Utilization	G-24,H-14
#	Department of Parks and Recreation	G-25
	Department of Public Works	G-26,H-16
#	Department of Transportation Services	G-27
*	Building Department	H-17
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*	Kailua Neighborhood Board	H-20
*	Kaneohe Neighborhood Board	H-23
#	Koolauloa Neighborhood Board	G-32
#*	Waimanalo Neighborhood Board	

* No Response to the EIS Preparation Notice
\# No Response to the Draft EIS

D. PRIVATE ORGANIZATIONS

#	Alu Like	G-33
#	Bishop Museum Botany Department	G-34
	Conservation Council for Hawaii	G-35,H-29
*	East Oahu County Farm Bureau	H-30
#	Hakipuu Community Association	G-36
	Hawaiian Electric Company, Inc.	G-37,H-31
#	Hawaiian Telephone Company	G-38
#	Hawaii Audubon Society	G-39
	Hawaii's Thousand Friends	G-40,H-32
	Hui Malama Aina O Ko'olau	G-47,H-38
*	David Kahanu	H-40
#	Kaaawa Community Association	G-50
	Kawai Nui Heritage Foundation	G-51,H-42
#	Kokokahi Hunger Mission Model	G-55
#*	Koolauloa Community Council	
*	The League of Women Voters of Hawaii	H-48
	Life of the Land	G-59,H-51
#	Luluku Banana Growers Association	G-60
*	Maunawili Community Association	H-52
	Native Hawaiian Legal Corporation	G-62,H-54
	Pohakupu Community Association	G-63,H-56
#	Punaluu Community Association	G-64
	Sierra Club, Hawaii Chapter	G-65,H-57
#	The Outdoor Circle	G-68
#	Waiahole Waikane Community Association	G-70

E. PRIVATE PROPERTY OWNERS

	The Estate of James Campbell	G-71,H-61
#*	Estate of Harold K.L. Castle	
#*	Elaine L. Chang Trust	
#*	Hiram L. Fong	
#*	Iolani School	
#*	Kamehameha Schools/Bernice Pauahi Bishop Estate	
	Kualoa Ranch	G-72
	Elizabeth L. Marks	G-73
#*	Robert Nakata	
#	Pacific Union Association of Seventh Day Adventists	G-75
#*	Plumbers & Fitters Local 675	
#*	Mary P. Schnack, Trust	
#*	THC Financial Corporation / Cooper Ranch Association	
#*	Valley of the Temples Corporation	
	Waiahole Irrigation Company / Oahu Sugar Company Ltd.	G-76,H-62
	Zions Securities Corporation	G-77,H-63

* No Response to the EIS Preparation Notice
\# No Response to the Draft EIS

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UNITED STATES
DEPARTMENT OF
AGRICULTURE

SOIL
CONSERVATION
SERVICE

P. O. BOX 50004
HONOLULU, HAWAII
96850

September 30, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, HI 96813

Dear Dr. Miura:

Subject: Draft Environmental Impact Statement (EIS) for Windward Oahu Regional Water System Improvements

We have no comments to offer at this time, but appreciate the opportunity to review the draft EIS on this project.

Sincerely,

ACTING

RICHARD N. DUNCAN
State Conservationist

cc:
Mr. Lawrence Whang, Board of Water Supply, City and County of Honolulu, 630 South Beretania Street, Honolulu, HI 96843

H-3

United States Department of the Interior

GEOLOGICAL SURVEY

WATER RESOURCES DIVISION
P.O. Box 50166
Honolulu, Hawaii 96850

October 29, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: Environmental Impact Statement - Windward Oahu Regional Water System Improvements

Thank you for letting us review the draft Environmental Impact Statement (EIS) for Windward Oahu Regional Water System Improvements. We have no additional comments.

We will keep our copy of the EIS to use as a reference to review the proposed supplemental EIS.

Sincerely,

Dan A. Davis
Acting District Chief

cc: Mr. Lawrence Whang, Board of Water Supply, Honolulu, Hawaii

DEPARTMENT OF THE NAVY
COMMANDER
NAVAL BASE PEARL HARBOR
BOX 110
PEARL HARBOR, HAWAII 96860-5020

IN REPLY REFER TO:
5090
Ser N5B/2104
16 SEP 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, HI 96813

Dear Dr. Miura:

DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)
WINDWARD OAHU REGIONAL WATER SYSTEM IMPROVEMENTS

The Draft EIS for the Windward Oahu Regional Water System Improvements has been reviewed and we have no comments. Since we have no further use for the EIS, it is being returned to your office.

Thank you for the opportunity to review the Draft.

Sincerely,

T. L. FERRIER
Captain, U.S. Navy
Chief of Staff

Enclosure

Copy to:
Mr. Lawrence Whang
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, HI 96843

Received: 9/17/87

(P)1763.7

SEP 15 1987

Dr. Marvin T. Miura, Director
Office of Environmental
Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: Windward Oahu Regional
Water System Improvements

We have reviewed the subject document and have no comments to offer.

Very truly yours,

TEUANE TOMINAGA
State Public Works Engineer

MY:jk
cc: Mr. Lawrence Whang

JOHN WAIHEE
GOVERNOR

SUZANNE D. PETERSON
CHAIRPERSON, BOARD OF AGRICULTURE

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October 2, 1987

Oct 7 2 34 PM '87

MEMORANDUM

To: Dr. Marvin T. Miura, Interim Director
Office of Environmental Quality Control

Subject: Draft Environmental Impact Statement (EIS) for Windward Oahu Regional Water System Improvements Board of Water Supply (BWS), City and County of Honolulu
TMK: Zones 4 and 5

The Department of Agriculture has reviewed the subject Draft EIS and has the following comments to offer.

We previously reviewed the EIS Preparation Notice and expressed our concerns in our memorandum to Mr. Kazu Hayashida, Manager and Chief Engineer, BWS (page G-8 of the Draft EIS). The Draft EIS adequately addresses our concerns concerning proposed development of groundwater sources and the impacts this may have on irrigation water users, affected farmers, and the agricultural areas within the scope of the EIS.

Thank you for the opportunity to comment.

Suzanne D Peterson

SUZANNE D. PETERSON
Chairperson, Board of Agriculture

cc: Mr. Lawrence Whang, BWS
DLNR-DOWALD

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

JOHN WAIHEE
GOVERNOR
ROGER A. ULVELING
DIRECTOR
MURRAY E. TOWILL
DEPUTY DIRECTOR
BARBARA KIM STANTON
DEPUTY DIRECTOR

KAMAMALU BUILDING, 250 SOUTH KING ST., HONOLULU, HAWAII
MAILING ADDRESS: P.O. BOX 2359, HONOLULU, HAWAII 96804 TELEX: 7430250 HIDPED

Ref. No. P-7543

October 30, 1987

MEMORANDUM

TO: Dr. Marvin Miura, Director
Office of Environmental Quality Control

FROM: Roger A. Ulveling

SUBJECT: Draft Environmental Impact Statement (DEIS) for Windward Oahu Regional Water Systems Improvements

We have reviewed the subject document and offer the following comments.

The DEIS attempts to address the cumulative impacts and implications of the Board of Water Supply's proposed projects in the Windward Oahu region, extending from Malaekahana through Makapuu. It identifies 56 well sites, including alternative sites, and 19 reservoir storage facilities for possible development on both publicly- and privately-owned lands. Each project is identified by general location pending subsequent site assessments for groundwater sources and environmental impacts.

We find it difficult to assess the regional land use impacts likely to result from these projects as the projected demand data found in Appendix A are outdated. A more accurate picture of the future based on recent data will help clarify needs and justify proposed projects based on possible land uses. As noted in the appendix, projections of municipal water consumption will need to be revised to reflect the State's population and economic projections developed since the 1978 source of the DEIS's projections. Also, the County's revised land use planning guides including its Development Plans need to be considered.

We also note the proposal for water from potable Windward Oahu sources to be pumped around Makapuu to Honolulu. This transfer of water may result in socio-economic impacts affecting future growth potential in the Windward area. These impacts should be identified and discussed in the final EIS.

Finally, with regard to the Coastal Zone Management Program's objectives and policies, we find that the document's information on coastal ecosystems, historic resources, and scenic and open spaces is adequate from the regional, "broad brush" perspective. However, the individual projects

should be assessed for compliance with the Chapter 205A, HRS, objectives and policies on a case-by-case basis as specific sites are identified and more detailed information becomes available. This is of particular importance regarding the impacts on coastal ecosystems and CZM policies relative to minimizing stream diversions and regulating instream uses.

Thank you for the opportunity to comment on this Draft Environmental Impact Statement.

Murray E. Towill
for Director

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

November 27, 1987

Mr. Murray E. Towill
Deputy Director
Department of Business and
Economic Development
State of Hawaii
P. O. Box 2359
Honolulu, Hawaii 96804

Dear Mr. Towill:

Subject: Your Letter of October 30, 1987 to the Office of Environmental Quality Control on the Draft Environmental Impact Statement for Windward Oahu Regional Water System Improvements

Thank you for commenting on the environmental document for our proposed water system projects.

We offer the following in response to your comments:

1. The projected municipal water demand in Appendix A is within the range of the revised projections and indicates that additional water supplies must be developed to meet the demands from an increasing resident population.

2. Only excess water not needed in the Windward area will be pumped to Honolulu. We believe that the island's water needs should be met first by groundwater developments before pursuing the development of costly alternative sources.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

Mr. Murray E. Towill
Page 2

November 27, 1987

3. Supplemental environmental documents will be prepared for each individual project as they are scheduled into our capital improvements program.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Office of Environmental Quality Control
VTN Pacific, Inc.

H-7

P-772/87

JOHN WAIHEE
GOVERNOR

RUSSELL N. FUKUMOTO
Acting Executive Director

STATE OF HAWAII
Department of Business and Economic Development
Housing Finance and Development Corporation
P. O. BOX 17907
HONOLULU, HAWAII 96817

IN REPLY REFER TO:
87:PLNG/4142JT

September 23, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Re: Draft Environmental Impact Statement (EIS)
Windward Oahu Regional Water System Improvements

Dear Mr. Miura:

Thank you for the opportunity to review the subject draft EIS.

The Housing Finance and Development Corporation, formerly a part of the Hawaii Housing Authority, has no comments to offer.

Sincerely,

RUSSELL N. FUKUMOTO
Acting Executive Director

cc: Mr. Lawrence Whang
Board of Water Supply

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE ADJUTANT GENERAL
3949 DIAMOND HEAD ROAD, HONOLULU, HAWAII 96816-4495

September 16, 1987

Engineering Office

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Windward Oahu Regional Water System Improvements

Thank you for providing us the opportunity to review the above subject project.

We have no comments to offer at this time regarding this project.

Yours truly,

Signed

Jerry M. Matsuda
Major, Hawaii Air
National Guard
Contr & Engr Officer

Enclosure

cc: Mr. Lawrence Whang, Board of Water Supply, C&C of Honolulu

SEP 21 1 10 PM '87

H-8

P-757/

OCT 7 2 35 PM '87

September 29, 1987

MEMORANDUM

To: Dr. Marvin T. Miura, Director
Office of Environmental Quality Control

From: Director of Health

Subject: Draft Environmental Impact Statement for Windward Oahu Regional Water System Improvements, Malaekahana to Makapuu, Oahu

Thank you for allowing us to review and comment on the DEIS. We provide the following comments on noise for your consideration.

1. Noise from stationary equipment, such as pumps and emergency generators, must be attenuated to meet the allowable noise levels as specified in Title 11, Administrative Rules, Chapter 43, Community Noise Control for Oahu.

2. Construction activities must also comply with the provisions of Title 11, Chapter 43, Community Noise Control for Oahu.

   a. A noise permit must be obtained if the noise levels from the construction activities are expected to exceed the allowable levels of the rules.

   b. Construction equipment and onsite vehicles requiring an exhaust of gas or air must be equipped with mufflers.

   c. The contractor must comply with the conditional use of the permit as specified in the rules and conditions issued with the permit.

3. Since construction noise can have a disruptive effect on classroom activity, noisy construction work near schools should be scheduled during nonschool hours.

4. Heavy vehicles travelling to and from the project sites must be minimized near existing residential areas and schools, and must comply with the provisions of Title 11, Administrative Rules, Chapter 42, Vehicular Noise Control for Oahu.

5. Should there be a baseyard or stockpile located adjacent to residences or schools, mitigative measures, such as barriers or berms, must be constructed to reduce the noise from such areas. Contingency plans must be developed in the event that complaints are received regarding noise emanating from these areas.

Calvin T. Masaki
for JOHN C. LEWIN, M.D.

cc: Lawrence Whang

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

October 14, 1987

Dr. John C. Lewin, Director
Department of Health
State of Hawaii
P. O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Lewin:

Subject: Your Letter of September 29, 1987 to OEQC on the Windward Oahu Regional Water System Improvements Draft EIS

Thank you for commenting on the environmental document for our proposed water system projects.

All construction activities will be required to comply with Chapter 42 of Title II, Vehicular Noise Control for Oahu and Chapter 43 of Title II, Community Noise Control for Oahu.

Should a baseyard or stockpile be located adjacent to residences or schools, the contractors shall be required to take mitigative measures to minimize noise emanating from those areas.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: OEQC
VTN Pacific, Inc.

H-9

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9268

STP 8.2440

October 29, 1987

Dr. Marvin Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 115
Honolulu, Hawaii 96813

Dear Dr. Miura:

Draft Environmental Impact Statement
Windward Oahu Regional Water System Improvements
Halaekahana to Makapuu, Oahu

We have no further comments beyond those provided earlier during the review of the EIS Preparation Notice.

Thank you for this opportunity to provide comments.

Very truly yours,

Edward Y. Hirata
Director of Transportation

DT:ko

cc: HWY, STP(dt)
Mr. Lawrence Whang, Board of Water Supply

F-809/87 cc

University of Hawaii at Manoa

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

October 30, 1987

NOV 2 1 4 5 PM '87

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Draft Environmental Impact Statement (EIS)
Windward Oahu Regional Water System Improvements
Windward, Oahu

The above cited document proposes the improvement and construction of numerous water development projects in the Windward Regional Water District. The improvements would include new wells, reservoirs, transmission lines, and support facilities. This review was prepared with the assistance of Paul Ekern, Agronomy and Soils; Michael Graves, Anthropology; Edwin Murabayashi, Henry Gee and Yu-Si Fok, Water Resources Research Center; and Steven Armann, Environmental Center.

H-10

General Comments

The Windward Regional Water System Improvements Draft EIS describes the proposed systems but does not identify or evaluate the potential environmental impacts of the actions. In this regard the document more closely resembles a planning information document. Substantive amendments and revisions are needed to assure that the content requirements of an EIS are met. Acceptance of the EIS should be deferred until these revisions have taken place. Examples of topics requiring additional attention include but are not limited to the following:

M. Location Maps

The proposed Waimanalo Well IV (Fig. 16, P.54) is sited about 4000 feet from the existing Waimanalo Sewage Treatment Plant, which disposes of its effluent by ground injection on-site. The draft EIS does not address what effect this will have on the water quality of the new well. Dr. Michael Chun, Director and Chief Engineer, Department of Public Works, City and County of Honolulu, called attention to this issue at the EIS Preparation stage (p. G-26).

Archaeology

Much of the proposed work will involve the excavation of wells and the laying of pipelines. Yet, there has been no subsurface testing of any of the proposed well areas, even in the localities where surface features occur. It is suggested in the draft EIS that this work will be carried out as part of the mitigative phase of archaeological fieldwork. However, the purpose of the EIS is to identify all potentially significant resources prior to approval and prior to initiating construction activities so that approving agencies can be fully informed as to the environmental consequences of a project This document proposes to identify these resources after the establishment of the construction plans. This procedure will not fulfill the statutory and regulatory requirements of an Environmental Impact Statement. The process should be reversed.

A map showing the areas surveyed for archaeological remains must be provided in the EIS. Except for the well site locations, it is unclear what areas were surveyed. Access roads and utility lines will be an essential part of the proposed project. It is not always clear if the routes for these installations will always follow existing roads or if new routes will be required. The document indicates that some parcels of land were not surveyed because permission had not been received from the land owners. These access problems must be resolved and the parcels field inspected for archaeological sites if they will be part of this project.

The identification of archaeological sites within project boundaries should be accompanied by an assessment of the significance of each site according to standards established by the Historic Sites Section of the Department of Land and Natural Resources, State of Hawaii. Such an assessment is required if reviewers are to assess the impact of the project relative to the resources that will be affected. None of the sites which may be affected has been provided with such an assessment. There are no plan maps of the sites, no description of associated cultural materials, or developed inferences concerning the status or role of these sites within the matrix of a larger, now extinct cultural system. These are issues which should be addressed in the Archaeological Assessment provided in a Draft Environmental Impact Statement.

Specific Comments

Listed below are comments and reference information that may be useful in the preparation of the EIS:

Page 85. We believe that the map shown on this page was withdrawn from circulation. It would be better to cite Giambelluca, T. W.; Nullet, M.A.; and Schroeder, T.A.; 1986, Rainfall Atlas of Hawaii. Department of Land and Natural Resources, Report No. R-76. This suggestion also applies to the appendix data C-56,57,and 58.

Page 85. See Giambelluca, T.W. et al.; 1984. Rainfall frequency study for Oahu. DLNR Report R-73 for additional information on Oahu rainfall data.

Page 86. Statewide, long term, evaporation rates are presented in the report by Ekern, P.C. and Chang, Jen-hu, 1985 - Pan Evaporation: State of Hawaii 1894-1983, Department of Land and Natural Resources Reprint R-74. Related discussions are provided by Nullet, Dennis, 1987 in his report on Energy sources for evaporation on Tropical Islands. Physical Geography 8(1): 36-45, and Ekern, Paul. 1983, Measured Evaporation in High Rainfall Areas, Water Resources Research Center, University of Hawaii, Tech. Report 156.

Pages 87, 160. Should interpret soils in the context of the last 1000 years of Hawaiian slash and burn agriculture, valley fill, and paddy agriculture. See: Riley, T.J. 1973 - Wet and Dry in a Hawaiian Valley: the archaeology of an agricultural system. PhD dissertation in Anthropology, University of Hawaii, May 1973.

Page 95. The role of the 10,000 year B.P. (Before Present) low sea stand terraces, and 5000 year B.P. sea level rise to current sea level, on subsurface seepage patterns of streams could be included in the discussion and figures. Ruhe, R.V., et al., 1965. Nature of Soil Parent Materials, in the Ewa-Waipahu area, Oahu, Hawaii. Soil Science Society of America Proceedings 29(3): 282-287.

Page 202. The EIS notes that the Board of Water Supply will monitor ground water sources for pesticide contamination. It should be recognized that nutrients from fertilizers may also contribute to ground water alteration through return irrigation waters.

The need for water system improvements is recognized and the data presented in the two volumes of this Draft EIS provide much of the descriptive basis on which potential environmental impacts of the proposed improvements could be evaluated. Unfortunately, the Draft EIS is significantly inadequate in the use of this information in terms of assessing potential environmental impacts. The document needs major revision to meet the content requirements of an EIS.

Thank you for the opportunity to comment on this document. We hope our comments will be helpful in preparing the final document.

Yours truly,

Jacquelin N. Miller

Jacquelin N. Miller
Assoc. Environmental Coordinator

cc: L. Stephen Lau
Paul Ekern
Yu-Si Fok
Henry Gee
Michael Graves
Ed Murabayashi
Steven Armann

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

November 13, 1987

Ms. Jacquelin N. Miller
Assoc. Environmental Coordinator
Environmental Center
2550 Campus Road, Crawford 317
Honolulu, Hawaii 96822

Dear Ms. Miller:

Subject: Your Letter of October 30, 1987 to the Office of Environmental Quality Control on the Draft EIS for the Windward Oahu Regional Water System Improvements

Thank you for commenting on the environmental document for our proposed water system projects.

The environmental document will be revised to reflect the following:

1. A discussion on the potential impact that ground injection of effluent from the Waimanalo Sewage Treatment Plant will have on new water sources will be included in the revised EIS.

2. Archaeological fieldwork will be performed before any construction occurs. Preliminary design work must be done to determine the feasibility of siting a particular facility such as a well, control building, or pipeline at a specific location. After the site has been tentatively selected, then a detailed archaeological survey will be made which may or may not affect the final design.

   Many of our proposed projects are only conceptually sited, and only a rough reconnaissance survey was made. As each proposed project is programmed for construction and a specific site or pipeline alignment is selected, supplemental environmental documents will be prepared addressing archaeological sites in more detail, as applicable, in compliance with Chapter 343, HRS, requirements.

3. The median annual rainfall map on page 85 will be replaced with the map shown in the Rainfall Atlas of Hawaii (Giambelluca, Nullet, and Schroeder).

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

4. Applicable data from Pan Evaporation: State of Hawaii 1894-1983 (Ekern and Chang) and Measured Evaporation in High Rainfall Areas (Ekern) will be noted in the Revised EIS.

5. Information in Wet and Dry in a Hawaiian Valley: The Archaeology of an Agricultural System (Riley) and Nature of Soil Parent Materials (Ruhe et al.) may be included in the revised document.

6. Our routine monitoring of water quality is able to detect contamination from return irrigation waters. However, because of the geology and hydrology of the areas where most agricultural activities are located, we do not anticipate any adverse impact to water quality from these types of activities.

7. As mentioned in the Draft EIS, supplemental environmental documents will be prepared for most of the projects before construction begins in compliance with the requirements of Chapter 343, HRS.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
For Manager and Chief Engineer

cc: Office of Environmental Quality Control
PTN Pacific, Inc.

DEPARTMENT OF GENERAL PLANNING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

DONALD A. CLEGG
CHIEF PLANNING OFFICER

GENE CONNELL
DEPUTY CHIEF PLANNING OFFICER

WM/DGP 9/87-3045

October 14, 1987

Honorable Marvin T. Miura, Director
Office of Environmental Quality Control
State of Hawaii
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Draft Environmental Impact Statement (DEIS)
and Technical Appendices for Windward Oahu
Regional Water System Improvements,
Board of Water Supply, City and County of Honolulu

The Department of General Planning has reviewed the subject Draft Environmental Impact Statement (DEIS) and offers the following comments:

1. The DEIS appears to be complete and factual. While instream stream flow standards have since been approved, the DEIS adequately addresses the issue of potential stream flow impacts.

2. The Board of Water Supply is aware of the requirement that future major water resource development and transmission projects must conform to the requirements of the Development Plans for Koolauloa and Koolaupoko and that these projects must be indicated on the Development Plan Public Facilities Maps for these areas.

3. The continued development of new water sources is needed to adequately service the growing population of the City and County of Honolulu.

Thank you for the opportunity to review this Draft Environmental Impact Statement.

Sincerely,

DONALD A. CLEGG
Chief Planning Officer

cc: Lawrence Whang, Board of Water Supply

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813
PHONE 523-4181

FRANK F. FASI
MAYOR

RECEIVED
BD OF WATER SUPPLY
Oct 1 3 04 PM '87

MIKE MOON
DIRECTOR
ROBERT MIYASATO
DEPUTY DIRECTOR

September 30, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: Environmental Impact Statement
Windward Oahu Regional Water System Improvements

We have no objection to the proposed Windward Oahu water system improvement proposal.

The proposed regional water system improvements are intended to meet the projected water demands of the Windward Oahu population on which the City and County of Honolulu Development Plan is based. Thus, the proposed improvement project will be consistent with the growth objective of the City's plans. All water needs of the Windward district will be met before exportation of water to other water use districts will be considered.

Sincerely,

for MIKE MOON
Director

cc: Board of Water Supply
(Lawrence Whang)

H-14

DEPARTMENT OF LAND UTILIZATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813 • (808) 523-4432

FRANK F. FASI
MAYOR

RECEIVED
BD OF WATER SUPPLY
Oct 29 3 35 PM '87

JOHN P. WHALEN
DIRECTOR

LU9/87-4729(AC)

October 29, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
State of Hawaii
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Mr. Miura:

Draft Environmental Impact Statement (EIS) for
Windward Oahu Regional Water System Improvements

The Department of Land Utilization has reviewed the Draft EIS and offers the following comments:

1. Special Management Area (SMA):

   We note that Kahana Wells II is the only new proposed new windward water development project requiring a SMA permit. The Draft EIS, however, describes support facilities such as transmission mains, access roads and utility lines as unresolved issues. Also unresolved are the locations of up to sixteen new reservoirs. Any development of these facili- ties within the SMA is subject to review and approval under Chapter 33, ROH.

2. Wildlife:

   a. Stream Fauna: Six streams (Waiahole, Waikane, Kahana, Punaluu, Kaluanui and Koloa) are identified as having important ecological significance for native aquatic fauna. The EIS states that the proposed projects will not have significant adverse effects on these streams;

however, it is not clear as to how this conclusion has been reached. The final EIS should provide specific documentation that water withdrawals adjacent to these streams will not produce adverse impacts on the stream wildlife.

b. Wetlands and Estuaries: The Draft EIS states that reduction of stream flow could adversely impact Kahana, Heeia, and Kawainui Marshes. What specific impacts could occur to these wetlands as a direct result of implementation of the windward water development projects?

3. Native Vegetation

The botanical surveys prepared and incorporated into the Draft EIS contain information on a limited number of projects. Will additional studies be prepared for the supplemental EISs on a project-by-project basis?

We hope these comments will be helpful to you in the final preparation of the EIS. If you have any questions, please contact Art Challacombe of our staff at 523-4648.

Very truly yours,

JOHN P. WHALEN
Director of Land Utilization

JPW:sl
1415B

cc: BWS

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

November 13, 1987

TO: JOHN P. WHALEN, DIRECTOR
DEPARTMENT OF LAND UTILIZATION

FROM: KAZU HAYASHIDA
MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

SUBJECT: YOUR LETTER OF OCTOBER 29, 1987 TO THE OFFICE OF ENVIRONMENTAL QUALITY CONTROL ON THE DRAFT EIS FOR THE WINDWARD OAHU REGIONAL WATER SYSTEM IMPROVEMENTS

Thank you for commenting on the environmental document for our proposed water system projects.

We offer the following in response to your comments:

1. Special Management Area (SMA): All projects that are within the SMA will be submitted for your review and approval under Chapter 33, ROH.

2. Stream Fauna/Streamflow: We shall include a discussion in the final EIS on why particular streams will not be affected by well projects located adjacent to the streams. Water development in a separate dike compartment and well development projects downstream of springs would not, in most instances, affect stream flows. A comprehensive discussion on the relationship, if any, between the two will also be included in more detail in the supplemental EIS's which may be prepared for individual projects.

3. Wetlands and Estuaries: Two potential impacts that could occur from a significant reduction in streamflow are a decrease in the size of the marshes and wetlands and degradation of their ecological environment.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

John P. Whalen, Director
Page 2

November 13, 1987

4. Native Vegetation: Supplemental environmental documents will be prepared, including additional botanical surveys, as projects are programmed into our construction program.

If you have any questions, please contact Lawrence Whang at 527-6138.

cc: Office of Environmental Quality Control
WTN Pacific, Inc.

H-16

ENV 87-153

SEP 8 4 11 PM '87

September 4, 1987

Mr. Marvin T. Miura, Ph.D.
Director
Office of Environmental Quality Control
State of Hawaii
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: EIS For Windward Oahu Regional Water System Improvements, Malaekahana to Makapuu, Oahu

We have reviewed the subject EIS and have the following comments:

1. As we have stated earlier, there may be potential conflicts between proposed water transmission mains and existing and proposed sewer mains and storm drains. Hence, we request that construction plans be coordinated with the Divisions of Engineering and Wastewater Management.

2. Based on preliminary planning, it appears that there will be no conflict between the Kahawainui Stream Flood Control Projects and the proposed Laie wells and reservoirs.

3. The proposed Maunawili Wells I is located downstream of the Maunawili Estate WWTP which discharges its effluent into the stream. The treatment plant will be abandoned in the near foreseeable future.

Very truly yours,

Sam Callejo

for ALFRED J. THIEDE
Director and Chief Engineer

cc: Lawrence Whang,
Board of Water Supply

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

September 15, 1987

TO: ALFRED J. THIEDE, DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

FROM: KAZU HAYASHIDA, MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

SUBJECT: YOUR LETTER OF SEPTEMBER 4, 1987 ON THE DRAFT EIS FOR THE WINDWARD OAHU REGIONAL WATER SYSTEM IMPROVEMENTS, MALAEKAHANA TO MAKAPUU

Thank you for your comments on the environmental document for our proposed water system improvement projects.

We will coordinate our construction plans with the Divisions of Engineering and Wastewater Management.

Your other comments will be incorporated into the Revised EIS, as applicable.

Should you have any questions, please contact Lawrence Whang at 527-6138.

KAZU HAYASHIDA

cc: OEQC
YTN Pacific Inc.

H-17

RECEIVED SEP 15 11 30 AM '87

PB 87-928

September 14, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: Draft EIS for Windward Oahu Regional Water System Improvements

We have reviewed the subject draft EIS and have no comments.

Thank you for the opportunity to review the document.

Very truly yours,

HERBERT K. MURAOKA
Director and Building Superintendent

TH:ly
cc: J. Harada
Board of Water Supply

P-EIS/87 cc

HONOLULU FIRE DEPARTMENT
1455 S. Beretania Street, Room 305
Honolulu, Hawaii 96814

October 29, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

SUBJECT: Windward Oahu Regional Water System Improvements: EIS Comments

We have reviewed the subject EIS and are generally in favor of improving the water system for this area.

We foresee beneficial results from an improved water delivery system from a fire protection standpoint. We are concerned, however, about traffic control during construction on the two-lane highway between Kaneohe and Kahuku. We request ample notification prior to construction and installation, where lane closures may delay fire apparatus emergency response. This request also applies to any other streets which may be affected by construction activities.

Thank you for the opportunity to comment on this project. Should you have any questions, please contact Battalion Chief Kenneth Word of our Administrative Services Bureau at 943-3838.

Under separate cover, we are returning the EIS to you.

Sincerely,

Frank K. Kahoohanohano

FRANK K. KAHOOHANOHANO
Fire Chief

FKK/KAW:sb

cc: Mr. Lawrence Whang
Board of Water Supply

Nov 2 1 1987

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

November 6, 1987

TO: FRANK K. KAHOOHANOHANO
FIRE CHIEF
FIRE DEPARTMENT

FROM: KAZU HAYASHIDA
MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

SUBJECT: YOUR LETTER OF OCTOBER 29, 1987 TO THE OFFICE OF ENVIRONMENTAL QUALITY CONTROL ON THE DRAFT EIS FOR THE WINDWARD OAHU REGIONAL WATER SYSTEM IMPROVEMENTS

Thank you for commenting on the environmental document for our proposed water system projects.

We will give you adequate notice of our pending construction activities that involves closure of one or more lanes of traffic.

If you have any questions, please contact Lawrence Whang at 527-6138.

cc: OEQC
VTN Pacific Inc. with letter

POLICE DEPARTMENT

CITY AND COUNTY OF HONOLULU

1455 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96814 · AREA CODE (808) 943-3111

FRANK F. FASI
MAYOR

DOUGLAS G. GIBB
CHIEF

WARREN FERREIRA
DEPUTY CHIEF

OUR REFERENCE SS-LK

September 24, 1987

SEP 25 3 00 PM '87

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: Windward Oahu Regional Water System
Improvements, Malaekahana to Makapuu, Oahu

We have reviewed the draft Environmental Impact Statement (EIS) and have no objections to the above proposal.

The improvements will, however, involve intensive construction which may affect our windward Oahu highways. We recommend that adequate safety measures be implemented to expedite traffic flow and to insure the safety of motorists.

Sincerely,

Warren Ferreira
for DOUGLAS G. GIBB
Chief of Police

cc: Mr. Lawrence Whang

H-19

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

September 30, 1987

TO: DOUGLAS G. GIBB, CHIEF OF POLICE
POLICE DEPARTMENT

FROM: KAZU HAYASHIDA, MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

SUBJECT: YOUR LETTER OF SEPTEMBER 24, 1987 TO THE OFFICE OF ENVIRONMENTAL QUALITY CONTROL ON THE WINDWARD OAHU REGIONAL WATER SYSTEM IMPROVEMENTS, MALAEKAHANA TO MAKAPUU

Thank you for commenting on the Draft EIS for our proposed water system projects.

Adequate safety measures in accordance with Federal, State, and City regulations will be implemented to expedite traffic flow and insure the safety of roadway users.

If you have any questions, please contact Lawrence Whang at 527-6138.

Kazu Hayashida
KAZU HAYASHIDA

cc: OEQC
YTN Pacific, Inc.

November 18, 1987

Mr. Lawrence Whang
Board of Water Supply
C & C of Honolulu
630 S. Beretania St.
Honolulu, Hi 96843

Dear Mr. Whang:

re: Draft EIS for Windward Oahu Regional Water Systems Improvements

The Environment Committee of the Kailua Neighborhood Board thank you for this opportunity to be a part of the BWS Windward Water Systems Improvements process.

First note that we are responding only to Volume I at this time, but our comments on Vol. II and North Shore EIS will be forthcoming. We feel it would prove inadequate to respond just to the Windward EIS since most of Oahu's water is transported out of its originating area, whether naturally or mechanically.

Throughout this EIS we find statements such as "Thus, it is not possible to accurately predict the extent to which stream flow will be reduced by proposed BWS projects" p.iii. "Native stream fauna would be adversely affected by reduced stream flow in Windward Oahu streams." p. iv. "Reduced stream flow could affect some wetlands on Windward Oahu" p.10. "Despite their importance, extensive research in estuarine fauna has not been conducted on Oahu." pg. 147. "Thus, much of the information on the fauna within Windword Oahu estuaries is unknown" p. 147. "Although there are many reasons for the decline in these 4 endemic waterbird species, the primary cause is loss of wetland habitat suitable for reproduction (protected from predators) pg. 157. "It is likely that most of the ground water to be developed by these projects will be at the expense of stream flow" p. 168. "Reduction of stream flow could adversely impact Kahana, Heeia and Kawainui Marshes" p. 203. "Maunawili Wells I, Maunawili Wells II and Maunawili Wells III could adversely affect Omao, Palapu and Maunawili streams and eventually Kawainui Marsh" p. 203. "Two potential adverse impacts could occur from reduction of stream flow, a decrease in the surface area of the marsh, and an increase in the salinity of the marsh" p.203" "Important waterbird habitats on Windward Oahu which could be affected by BWS water development projects include Kahana Marsh, Heeia Marsh, Kawainui Marsh and Ho'omaluhia Reservoirs and Wildlife Pond" p. 207., etc.

With all of the above statements acknowledged in this EIS, we didn't know how the BWS could expect the public to concur with the BWS implementation of projects as proposed. As stated over and over, Hawaiian waterbirds, flora and insects are dependent on a suitable habitat and to propose that this EIS be accepted with full knowledge that we are again contributing to the degradation and demise of our native flora and fauna underestimates the public intelligence. It appears that the only safe and humane method of evaluating implementation of BWS projects is by an EIS per stream Valley, and its effect in the watershed, stream, marsh, water users and natural habitat. Hawaii has the dubious distinction of losing (eliminating) its native flora and fauna at the highest rate in the nation. "At least count, 72% of all the extinctions recorded in the United States were of species once found only on these island. And scientists predict that more than 50% of Hawaii's remaining native ecosystems -- along with the thousands of native species they support -- could disappear within the next 20 years or sooner unless we move quickly to save them." (The Nature Conservancy of Hawaii, October 1987) We don't believe that a City agency as important and vital as the BWS should be one of the contributors to "Hawaii, the endangered species capital of the world"(Hon.Advertiser, Nov. 17, 1987 p.A-5).

On p. 165 it is stated "Apart from limited areas used for intensive agriculture and a few hiking trails, proposed BWS facilities will not displace existing land uses." First, what is the definition of "a few hiking trails?" You may not be aware of the steady decline in public accessible hiking trails and the mere mention of displacing hiking trails concerns us greatly.

We are also worried about the following statement on p. 201 "Unless existing water law is changed by State legislature of City Council, it seems likely that competing demands for limited ground water resources will be resolved on a first-come first-serve basis." Water developed on this basis is dangerous in that it allows for development of water resources by a private party and thus possibly eliminating another public potable water source. We are also worried that water development done independently would affect present stream users as well as stream flora and fauna. Since this appears to be a governmental law that needs to be changed, what can the public do?

Pages 213-14 address the agricultural water question, but we don't feel the problem has been answered adequately. We question the statement "in a few cases, it may prove desirable for the BWS to replace existing ag. water sources with subsidized municipal water service." Who and what would determine the "few cases" and what would constitute "prove desirable" and at what cost would the "subsidized municipal water service" be provided? We are also concerned with the statement "Windward Oahu farmers who wish to use water development by new BWS water sources will be allowed to do so in competition with other parties on a first come first serve basis." This procedure seems unfair and a definite disadvantage to the small farmer. P. 214 states the costs differences, but doesn't state the profit margins. It is logical that a commercial industrial or residential (resort, multi-family) profit margin higher than a typical farmer 1-6 acres so the initial water development costs is not prohibitions. so to

place farmers in competition with others for their water seems unfair. Also p. 214 states "it is probably not economically feasible to purchase BWS water for cultivation of alfalfa, other kinds of cattle feed, sweet corn, watermelon, guava, prawns, taro & watercress: & possibly not feasible for papaya." Our question then is where do these farmers get their water since the BWS or independent developer will develop and divert potential farm water? Does Hawaii no longer raise the above-mentioned crops and become even more mainland dependent?

We quote from p. 217 "In the future, after acceptance of this EIS the BWS intends to prepare supplemental Environmental Assessments (EAs) as individual property are programmed in Windward Oahu." But the next paragraph (p. 219) says "Supplemental (EAs will not be prepared for the proposed Kaluanui, Kahana, Kahaluu I, Haiku, Iolekaa, Luluku, Kuou II, Kamooalii I, Kamooalii II and Waimanalo II Wells; the proposed Kahana 315, Luluku 500 and Waimanalo 364 No. 2 Reservoirs; and proposed transmission mains along Windward Oahu highways. There has already been adequate compliance with Chapter 343, HRS, concerning these projects." Does this mean that the public will have no input into these projects? Also in the future could the same thing happen to other Windward BWS projects?

We applaud the statement "The BWS intends to regulate ground water production as necessary to implement the instream flow standards adopted by the BLNR" (p. 220) But we are concerned by the statement "The purpose of Chapter 167 was to establish a program to protect beneficial stream uses in Windward Oahu where practicable." We feel an explanation and rational for the words beneficial and practicable is necessary.

Water Development Projects which have reduced stream flow is explained on p. 3 and we understand what is being said but the difficulty would be to "accurately measure the effect of stream flow, etc., but were surprised by the sentence "Such information is not available for a single Windward Oahu Stream (p. 127). We feel that this type of information is important even though difficult to implement and follow through, it would prove to everyone's benefit in the long run. We are also dismayed with the statements (p. 129) "No data is available to compare dry-weather stream discharge before and after development of the water source," etc. and (Miscellaneous USGS measurements suggest a reduction in dry weather stream discharge has occurred after the development of the water source." How can new water sources be developed when there is no accurate data on the impacts they will have? We also found it interesting and confusing that the stream Discharge Measurements that were referenced were from 1959-1982 with most data from the early 60's. Wouldn't this be outdated information considering the development that has taken place over the last 20 years?

In closing we address (p. 234) "Increased water prices could lead to more efficient use of water and discourage waste." Efficiency is not necessarily a result of higher prices; we feel that educating the public about Hawaii's water supply and with water-saving technology, the BWS can take the lead in encouraging water and environment conservation.

Annetta Kinnicutt
Chair. Environmental Committee

Donna Wong
Committee Member

H-21

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

December 18, 1987

Ms. Annetta Kinnicutt
Ms. Donna Wong
Kailua Neighborhood Board
c/o Kailua Satellite City Hall
302 Kuulei Road
Kailua, Hawaii 96734

Dear Ms. Kinnicutt and Ms. Wong:

Subject: Your Letter of November 18, 1987 on the Draft EIS for the Windward Oahu Regional Water System Improvements

Thank you for your comments on the Draft EIS.

The Windward Regional Draft EIS is an assessment of our long-range water plans which include source, storage, and transmission facilities. Many of the projects are still in the conceptual stage. Since all the projects have a common objective, we felt that a regional EIS with its subsequent supplemental EIS's would give the public a comprehensive overview of the Board's future plans instead of EIS's for individual projects.

Supplemental EIS's will address concerns associated with each particular project. You will be given the opportunity to review and comment on them. Where we find obvious environmental problems associated with certain projects, those projects will be dropped from our long-range plans.

The State Water Code and Instream Standards should ensure the preservation of streamflows and wetland environments. All of our projects must be in compliance with the requirements that may be imposed under those regulations.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

December 18, 1987

We also offer the following responses to your comments as they relate to the regional EIS:

1. As we do not have exclusive claim to any of the sources in the EIS, other governmental agencies or the public, such as those engaged in farming, can themselves proceed to develop those sources in our EIS provided they do not adversely affect existing water sources.

2. If we find that hiking trails will be affected by our projects, we will work with the State Parks Division to realign hiking trails, if necessary. We are currently working with them on the replacement of a hiking trail in Kahana Valley where we are constructing a reservoir.

3. Our "first-come, first-serve" policy gives everyone, including farmers an equal opportunity to obtain water from our system. The farmers, themselves, should decide if it is economically feasible to obtain water from the Board or to develop alternative sources. The new State Water Code requires that the Counties prepare a comprehensive water use plan. The plan will take into account the water requirement of all present and potential users, including the plantations and farmers. Development of new water sources, both by BWS and the public must be in conformance with the plan.

4. EIS's have already been prepared and accepted in accordance with Chapter 343, HRS, for those projects listed on page 219 of the Regional Draft EIS with the exception of the transmission mains. Supplemental environmental documents are still required for major portions of the transmission main projects. The Final EIS will be revised to reflect this inaccuracy.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

December 18, 1987

5. The terms "beneficial" and "practical" as used in Chapter 167 of Title 13 is left to the interpretation of the Board of Land and Natural Resources.

6. Stream discharge measurements summarized in Tables 14 through 23 are the latest measurements we have on dry-weather stream flows.

7. We have an on-going educational program aimed primarily at elementary school aged children. This program excourages children to conserve water with the hope that these children will carry the water conservation ethic into adulthood.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Office of Environmental Quality Control
WTN, Pacific, Inc.

KANEOHE NEIGHBORHOOD BOARD NO. 30
c/o KANEOHE SATELLITE CITY HALL
46-024 KAM HIGHWAY
KANEOHE, HAWAII 96744

Rec'd 11/9/87

October 26, 1987

Mr. Marvin Miura
Office of Environmental
Quality Control
465 S. King St., Room 104
Honolulu, Hawaii 96813

Dear Mr. Miura:

Subject: Comments on the Draft Environmental Impact Statement concerning extraction of water from Windward Oahu

The Kaneohe Neighborhood Board recommends that the Board of Water Supply DEIS for extraction of water from Windward Oahu not be accepted in its present form. The document is deficient in accordance with Hawaii Revised Statute Chapter 343 for the reasons set forth below.

The DEIS does not disclose impacts on stream flows from the proposed level of extraction nor does it consider the interim standards or development of permanent stream flow standards as required by the Water Code. The DEIS does not relate with necessary specificity the impacts from stream flow modification on flooding and erosion damage to the region, nor of the consequences of water extraction on salinity, estuaries, fauna, and flora from reduced ground water tables, stream flow and fresh water infiltration. The attached summary lists specific concerns.

The Board of Water Supply proposal has the potential to profoundly modify the character and environment of Windward Oahu, possibly imposing significant social, economic and ecological damage. As such, the document fails as a disclosure statement to provide sufficient information to allow a reasoned decision concerning costs, benefits and considerations of alternative actions or mitigation, nor to assess the proposed action in terms of the state and county general plans, development plans and functional plans.

We strongly recommend that sufficient studies be conducted to properly assess impacts before further action is taken.

Sincerely yours,

Nancy Clingan

Nancy Clingan, Chair

John Goody, Committee Chair

cc: Lawrence Whang, BWS

Summary of the Windward Oahu water system improvements environment impact statement.

Over two dozen proposed BSW projects have the potential to take ground water which would otherwise end up in perennial windward Oahu streams. It is likely that most of the ground water to be developed by these projects will be at the expense of stream flow (168).

Kaneohe Bay is the largest estuary in the State (146). Development of BWS projects could adversely affect the esturarine environment in streams and wetlands. The reduction of water flow has the potential to alter salinity and circulation patterns in the estuary (205). A number of potentially adverse impacts could occur from reduction of stream flow - a decrease in surface of the marsh and increase in the salinity of the marsh (203). As a consequence, open water habitat of four (endangered) native waterbirds will decline (207).

Both estuaries and wetlands are ecologically important in that they each support a distinct class of aquatic ecosystem, with wetlands also providing essential habitat for birds (146).

Reduction of stream flow and man made alterations of stream channels, can eliminate stream habitat and create barriers to upstream migration of diadromous native species (151). Despite their important, extensive research on estuarine fauna has not been conducted on Oahu. Thus, much of the information on the fauna within windward Oahu estuaries is unknown (147).

Finally, reduction of the dry weather flow of an unchannelized perennial stream will allow vegetation to grow in the stream bed. Growth of vegetation in a stream channel to carry storm runoff and in some cases may result in storm flows overtopping the stream banks (216).

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

December 17, 1987

Ms. Nancy Clingan, Chair
Kaneohe Neighborhood Board No. 30
c/o Kaneohe Satellite City Hall
46-024 Kamehameha Highway
Kaneohe, Hawaii 96744

Dear Ms. Clingan:

Subject: Your Letter of October 26, 1987 to the Office of Environmental Quality Control on the Draft Environmental Impact Statement (EIS) for the Windward Oahu Regional Water System Improvements

Thank you for your comments on our EIS.

The Windward Regional Draft EIS is an assessment of our long-range water plans which include source, storage, and transmission facilities. Many of the proposed projects are still in the conceptual stage. Since all the projects have common objectives, we felt that a regional EIS followed by supplemental EIS's should give the public a comprehensive overview of the Board's future plans instead of EIS's for individual projects.

Supplemental EIS's will address the environmental concerns that are associated with an individual project, and you will be given the opportunity to review and comment on them. Where we find obvious environmental problems with certain projects, the projects will be dropped from our long-range plans.

The State Water Code and Instream Flow Standards should ensure that streamflows and wetlands are preserved. All of our projects must comply with requirements that may be imposed under those regulations.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

Alternative solutions such as desalting seawater and demineralization of brackish water to increase our water supply are already being pursued. The State is in the design stage for a proposed pilot desalting plant which will be constructed in Ewa.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Office of Environmental Quality Control
WTN Pacific, Inc.

KAHALU'U NEIGHBORHOOD BOARD NO. 29
c/o KAHALU'U COMMUNITY CENTER
47-232 WAIHE'E ROAD
KANE'OHE P.O., HAWAI'I 96744
(He'ela Kea/'Ahuimanu, Kahalu'u, Waihe'e, Ka'alaea, Waiahole, Waikane, Hakipu'u, Kualoa)

"Let us not ever have an unhappy minority rather, let us build a community consensus"

October 31, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

SUBJECT: Environmental Impact Statement
Windward Oahu Regional Water System Improvements

Thankyou for the opportunity to respond to the EIS. The Kahalu'u Neighborhood Board joins many other Windward and island-wide community organizations in questioning the quality and acceptability of this document as a valid assessment of the environmental impact(s) for the proposed development of Windward water.

In our comments addressing the preparation notice, dated 10/26/84 (see attached copy), we stated the following:

> "We found the Preparation Notice enlightening and frightening at the same time. We are encouraged by the disclosure of the water planning on the Windward side. Thus for the first time we are able to examine the total efforts of the Board in water development. We are also frightened by the magnitude of development that is being proposed. To this end, we fully expect that the EIS will fully address the specific impacts as well as the cumulative impacts that may result from the development of water on the Windward area."

Three years have passed since that statement was made - three years of time for the BWS to develope base-line data on "specific impact", "cumulative impact", and discussion that would truly "enlighten" the Windward and island community as to the necessity of and/or the alternatives to a proposal of such "magnitude". The EIS, as it stands, is woefully inadequate, fraught with contradictory statements, gross genaralizations and assumptions. As a planning document for water use, development, and allocation, it offers an insensitive and bleak outlook on Windward Oahu's future. As a result of this EIS we are more "frightened" than "enlightened", and more steadfast in our determination to expose the BWS as just another "water developer" trying to pass itself off as representative of whole-county interests. The BWS has interpreted the City Charter mandate - "to provide adequate water supply and storage facilities for domestic use" - in the narrowest possible way and at the expense of the Windward Oahu interests that the Bws does not represent, namely recreational and agricultural uses and environmental protection..

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AVAILABILITY OF WATER/STREAMFLOW AND DIVERSION

One need not read much beyond the seven-page SUMMARY before gaining a sense of the inadequacy and misguided nature of this document. The BWS seems itself to be consumed by its own narrow reading of the legal mandate "to provide for growing consumer demand on Oahu to the extent of available sources" (p.vii). How is "available" defined in this context? Is Windward water truly "available" for major diversion to points outside of any given watershed when surveys of truck farmers, nursery and aquaculture operations within those watersheds up and down the Windward coast have revealed a need for more water in order to develope or expand existing operations? Is Windward water "available" for further tapping when even this EIS admits to a fact that Windward residents and farmers have been painfully aware of for too long:

> "Diversions and/or development of high-level dike-impounded ground water have substantially reduced the dry-weather flow of many perennial windward Oahu streams including Punaluu, Kahana, Waikane, Waiahole, Waihee, Kahaluu, Heeia, Kamooalii, Maunawili and Waimanalo streams and some of their tributaries." (p.iii)

The paragraph quoted above then goes on to make the audacious understatement that "despite these conditions", meaning substantial existing diversion and development, the Punaluu, Waiahole, Kahana and Waikane streams are "relatively high quality habitats for native stream fauna as compared to other Oahu streams"! We ask: "Relative to what?" Something always looks like a lot when compared to nothing. Most of Oahu's streams have already been reduced to a sad trickle. The "high quality" streams are merely the ones left with a streamflow to talk about. Does this EIS point out just how substantial the historical diversion of water from Windward to Leeward for such uses as sugar and pineapple production was? Waiahole stream, for example, once had a regular flow in the neighborhood of 30+ mgd and now has only a fraction of that.

This EIS assures us, adding to our historical loss of this precious resource, that "Based on available information, with few exceptions, all of the existing windward Oahu stream users could be adversely affected by BWS projects"(p.210). The list of affected streams that then follows is but an echo of the list of already substantially tapped streams mentioned above. Where does this end? Even DLNR-DOWALD has admitted that it does not even begin to have the data necessary to developing "Permanent Instream Flow Standards". - a prerequisite for any water development considerations.

These enlightening facts become even more frightening when juxtaposed with other EIS statements like: "...any excess water can be exported to Honolulu."(p.215), and the possibility (a nice word for "probabability") "...that most

of the ground water to be developed by these projects will be at the expense of stream flow (p.iii).

AGRICULTURE

A brief comment is in order regarding the future of Windward Oahu's now booming agrarian economy - and it is best said with sarcasm. On page 215 we are told that "...first priority for use of water from new windward BWS sources will be to service BWS customers in windward Oahu...". For the lucky farmer who has either lost his free stream water or had it severely curtailed, or the farmer who intends to expand one of the many thriving nursery operations that are rapidly becoming the backbone of the windward agrarian economy, this may appear to be "good news". The "not-so-good news" is found on page 213 wherein it is mentioned that "Windward Oahu farmers who wish to use water developed by new BWS water sources will be allowed to do so in competition with other parties on a first-come first served basis." What then, according to this EIS - and BWS policy, is meant by "first priority" on page 215? The final statement in the section entitled AGRICULTURE (pp.213,214) leaves us no doubt as to the "bad news". There some windward farmers, unless they have already seen the writing on the wall-with recent hikes in Ag rates, discover that those BWS agricultural rates are only "...probably affordable for cultivation of truck crops, bananas, potted foliage, and orchids.". The worst news of all then follows:

> "However, it is probably not economically feasible to purchase BWS water for cultivation of ...sweet corn, watermelon, guava, prawns, taro, and watercress; and possibly not feasible for papaya."(p214)

The attitude of the BWS towards agriculture in our rural community is made obvious on page 211 wherein the cumulative contribution of small farms is completely ignored and the individual farmer's input is wrongfully maligned:

> "Based on known information, none of the existing stream users appears to contribute a significant share of any single agricultural crop grown on these streams."

It should be obvious that Windward agriculture consists primarily of smaller, family farms. They must be assessed by their cumulative socio-economic contribution and not as large-scale agribusinesses.

BWS MANDATE vs GROWTH AND LAND USE CONCERNS

The Kahaluu Neighborhood Board has a long standing concern for the protection of its rural, agrarian character and the resources necessary for development of that lifestyle. The contribution of that combination of open space and productive agricultural land to the scenic, aesthetic, and cultural wealth of our island and state is obvious. In fact it is precisely that wealth and character

that is at the heart of our islands' biggest industry, Tourism.

The BWS believes that the "...proposed windward Oahu water development projects are necessary..."(p.vii) to their meeting the requirements of their mandate. Where in this EIS is the limited, municipal nature of that mandate described? If, as they state on page 215,"... availability of water is a prerequisite for...expansion of agriculture", as well as those municipal uses for which the Board feels responsible, does it not follow that the same water sources may well be considered "necessary" for windward agricultural expansion that is at the heart of the rural, agrarian character that our community has attempted to preserve? Where in this EIS is this conflict thoroughly identified and discussed? Where is the necessary discussion of county zoning and the whereabouts and quantity of as yet undeveloped, Ag-zoned land that must rely on the availability of the very same resources? Is this Regional EIS not a poorly disguised attempt to claim as "necessary" what in fact should be described as "coveted" or "desired"? After a decade of seemingly endless work on the Development Plans - and the relative stability of zoning (especially for Ag and Preservation lands in our area) that occurred, this attempt at massive diversion of Windward water comes as an insult.

SOME FINAL QUESTIONS

- re: NATURAL HAZARDS. Paragraph 2, p.215 states that reduction of stream flow of unchannelized perrenial streams could "conceivably" bring on overgrowth of stream vegetation - likely to contribute to flood hazard. Yet in the paragragh that immediately follows a denial of the ability to assess the potential for this hazard contradicts the former statement. There is ample evidence in Windward streams of this obvious hazard!

- re: WETLANDS/ESTUARIES. Where is the official USACOE Survey of Wetlands mentioned? Are mere generalizations sufficient in assessing the impact on these vital environmental resources? What studies have been consulted or conducted as to the socio-economic and environmental value of wetlands and the importance of ground or surface water to their continued survival? The studies that are cited are limited in scope and the EIS is lacking in original research. What socio-economic studies exist that identify the potential cost of loss of these environments?

- re: ALTERNATIVES. The wrongful assumption that windward water is "available" -especially when considering the lack of baseline data on stream flows and instream use requirements- undercuts discussion of the alternatives to this proposal. What cost analysis has been done as to the potential for retrofitting fixtures, water catchment systems, desalinization plants (at developers' expense), legislative action or a combination thereof as steps to be taken towards water conservation? Where is the necessary discussion and cost analysis of alternatives should BWS be

told that the desired water sources are simply not available?

At our regular N.B.#29 meeting of August 12, 1987 Mr. Kazu Hayashida agreed that desalinization of water is an inevitability even if windward water is further developed. He agreed that the general public has not been well apprised of this fact. Is this EIS not the appropriate place for such notice and discussion of ramifications or will the general public be treated to this surprise after the developers of Hawaii Kai and the Leeward plain/second city have already counted their profits? Will the taxpayer then be looked to to foot this "inevitable" bill?

Finally, is it the BWS' mandate to provide for all consumer demands forever or is there a concern for providing only for affordable housing that will directly benefit those in need of a "first" home?

We apologize for the length of our response. We feel, however, that the magnitude of this proposal, its potential negative impact, and our future as a viable windward community warrant the criticism. We ask, once again, that the entire project be put on hold at this time, if not forever.

John Reppun
for Kahalu'u Neighborhood Board #29

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

December 16, 1987

Mr. John Reppun
Kahaluu Neighborhood Board No. 29
c/o Kahaluu Community Center
47-232 Waihee Road
Kaneohe, Hawaii 96744

Dear Mr. Reppun:

Subject: Your Letter of October 31, 1987 to the Office of Environmental Quality Control on the Draft EIS for the Windward Oahu Regional Water System Improvements

Thank you for your comments on the Draft EIS.

The Windward Regional Draft EIS is an assessment of our long-range water plans which include source, storage, and transmission facilities. Many of the projects are still in the conceptual stage. Since all of the projects have common objectives, we felt that a regional EIS with subsequent preparation of supplemental EIS's should give the public a comprehensive overview of the Board's objectives instead of EIS's prepared for individual projects.

Supplemental EIS's will address your concerns and will give you another opportunity to comment on the various projects. Should we find obvious environmental problems associated with certain projects, those projects will be dropped from our long-range plans.

The recent adoption of the State Water Code and implementation of the Instream Standards should ensure that streamflows and wetlands are preserved. Your concerns on streamflow and streamflow diversions will be addressed in the applicable supplemental EIS's.

COPY

December 16, 1987

Furthermore, we have gone on record saying that we will work closely with farmers who are using streamflows or ground water to assure them that their water sources will be preserved.

We also offer the following responses to your comments as they relate to the regional EIS:

1. Should long-term data be required to determine median streamflow, we will, if necessary, contract with the U.S. Geological Survey to install new stream gages where new wells are to be installed. Streamflow data will be coordinated with the State.

2. Other agencies or the public, such as those engaged in farming, can develop any of the potential sources mentioned in the regional EIS. We do not have exclusive claim to any of the sources.

3. Agricultural and rural land uses in the Windward area are guided by the State land use controls. Water is made available to developments, including agricultural developments, on a "first come" basis.

4. Alternative solutions, such as rate restructuring and retrofitting, will enhance water conservation, but will not provide enough water to meet projected water demands.

   The State is in the design stage of constructing a pilot desalting plant in Ewa. Construction may be initiated within a year or two with completion of the project estimated two years later.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

December 16, 1987

5. The cost for operating and maintaining the municipal water system is borne by every consumer and is based on the amount of water used. Only agricultural users qualify for a slightly reduced rate.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Office of Environmental Quality Control
VTN Pacific, Inc.

CONSERVATION COUNCIL for HAWAII

STATE BOARD AND OAHU CHAPTER • P.O. BOX 2923 • HONOLULU, HI 96802 • (808) 941-4974

October 30, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear ~~Dr. Miura~~ Marvin:

Subject: Environmental Impact Statement for Windward Oahu Regional Water System Improvements

We intended to do a full review of this important EIS but after reading a few sections, it became quite apparent that the document is over two years old and there was no effort, aside from the March 13, 1987 memo, to revise the document before it was circulated for public review. Because of this, many of the statements made in the EIS are not accurate today. Any one who has worked on the Water Code knows that major revisions should have been reflected in this document. A cover memo stating the BWS will comply with the Water Code and rules adopted thereto is not sufficient.

We bring up another example, where recent actions taken by the BWS may have a significant bearing on the future development of water on this island. That action is the new water rate hikes, which is barely mentioned as an alternative on page 234. A major alternative such as using different pricing strategies to encourage water conservation should receive in-depth analysis by the BWS, not just a passing remark.

We do not want to belabor the point, but we must stress that this statement, even with numerous reviewer comments and BWS reponses will still wind up falling far short of what an acceptable EIS should be.

We recommend that the EIS be redrafted with current information being the basis of considering the environmental impacts of the proposed project.

Thank you for allowing us to make comments on this statement.

Yours truly,

Rick Scudder

Rick Scudder,
Chairman

cc: BWS

State affiliate of the National Wildlife Federation. C.C.H. is a private non-profit corporation. Founded in 1950 for island resource conservation, environmental health and education.

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BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

November 9, 1987

Mr. Rick Scudder, Chairman
Conservation Council for Hawaii
P. O. Box 2923
Honolulu, Hawaii 96802

Dear Mr. Scudder:

Subject: Your Letter of October 30, 1987 to the Office of Environmental Quality Control on the Draft EIS for the Windward Oahu Regional Water System Improvements

Thank you for commenting on the environmental document for our proposed water system projects.

Although some of the data presented in the Draft EIS is dated, the data does not affect the discussions on potential impacts.

The Water Code was passed after the Draft EIS was completed and will be noted in the section on land use plans, policies, and controls.

The recently adopted water rate hikes are not an alternative solution to the proposed projects. The water rate hikes are needed to meet the fiscal responsibilities of the department and for no other reason. Costs to improve, maintain, and operate our system do not rely on the tax dollars but on revenues from water billings and water facilities charges.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

For KAZU HAYASHIDA
Manager and Chief Engineer

cc: Office of Environmental Quality Control
YTN Pacific, Inc.

HFBF Since 1948
HAWAII FARM BUREAU FEDERATION · STATE OF HAWAII

EAST OAHU COUNTY FARM BUREAU
45-260 WAIKALUA ROAD • KANEOHE, HAWAII 96744

RECEIVED BD OF WATER SUPPLY Nov 2 9 27 AM '87 MOR DEP

October 30, 1987

Mr. Kazu Hayashida
Manager & Chief Engineer
Board of Water Supply
630 South Beretania
City & County of Honolulu
Honolulu, HI 96843

Dear Mr. Hayashida:

Thank you for the opportunity to comment on your Environmental Impact Statement for Windward Oahu Regional Water System Improvements.

The East Oahu County Farm Bureau has several comment in regards to areas of serious concern.

Our concern centers along increasing agricultural activities in Windward Oahu. Your intent is to eventually remove all available waters from Windward Oahu to other parts of the island. The next effect upon agricultural activity will be to eliminate any substantial growth and probably reduce overall ag activities.

No statistics are currently available on total ag water usage in Windward Oahu.

Prior to removing any waters from Windward Oahu a complete statistical ag water usage evaluation should be made. In addition, potential ag water usage and potential economic ag growth should also be evaluated.

We also feel that if additional waters are diverted from Windward Oahu, reduced stream flows will occur. We have observed increased vegetation in streams due to lower water levels. Impacts to life and property from flooding due to overgrown stream channels needs to be addressed in further detail.

We would also like you to consider the possibility of putting up excess water from agricultural water systems turned over to you by Department of Land & Natural Resources for use by other agricultural users (i.e. at state rates).

Thank you once again for giving us this opportunity to comment on Environmental Impact Statement for Windward Oahu Regional Water System Improvements.

Sincerely,

Grant Hamachi

Grant Hamachi, President
East Oahu County Farm Bureau

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

November 12, 1987

Mr. Grant Hamachi, President
East Oahu County Farm Bureau
45-260 Waikalua Road
Kaneohe, Hawaii 96744

Dear Mr. Hamachi:

Subject: Your Letter of October 30, 1987 on the Draft EIS for Windward Oahu Regional Water System Improvements

Thank you for commenting on the environmental document for our proposed water system projects.

It is our intent to first meet Windward water needs. Any water excess to Windward needs will then be pumped to other areas. We believe that the State Department of Agriculture is the appropriate agency to conduct a complete agricultural water requirement study and to develop the water resources to accommodate the various agricultural activities.

Although we list a number of water development projects that may have the potential to affect stream flows, the impact of individual projects will be evaluated in detail in the supplemental EIS's to ensure compliance with the State's instream standards. This, in turn, should ensure that existing streamflows are maintained.

Increased vegetation in stream channels are primarily due to decreased rainfall and are not attributable to our existing sources. The maintenance of streams is the responsibility of other agencies.

Whenever excess water is turned over to us by the State, we leave it up to the State to indicate to us as to how the water should be allocated. However, the consumers are required to pay our prevailing water rates to cover the operation and maintenance of the system.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: WTN Pacific, Inc.

P- 744/87

ENV 2-1
JA/G

Brenner Munger, Ph.D., P.E.
Manager
Environmental Department
(808) 548-6880

October 2, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: Draft Environmental Impact Statement (EIS) for Windward Oahu Regional Water System Improvements

We have reviewed the subject EIS and have the following comments:

1. The statement in Volume I, Chapter I, Section H (i.e., page 27) regarding HECO's plans to serve the booster pumps is adequate for the purpose of the subject EIS. In addition, a sentence should be added in this Section which mentions that "these plans will require HECO overhead line construction through State Conservation Areas".

2. A number of proposed Board of Water Supply (BWS) facilities presented in Volume I, Chapter I, Section N (i.e., Figures 13-15, pages 51-53) cross or are in close proximity to existing HECO 138 KV transmission lines. Since these overhead lines will remain energized during construction, we recommend that the following notes be included as part of the final construction plans.

   * The Contractor is to exercise extreme caution when the excavation and construction crosses or is in close proximity of HECO lines and is to maintain 13'-0" clearance for his equipment while working close to and/or under the overhead facilities.

   * The Contractor is to comply with the directions of the State of Hawaii Occupational Safety and Health Law (DOSH).

   * When excavation is adjacent to or under existing structures or facilities, the Contractor is responsible for properly sheeting and bracing the excavation and stabilizing the existing ground to render it safe and secure from possible slides, cave-ins and settlement, and for properly supporting existing structures and facilities with beams, struts or underpinning to fully protect it from damage.

   * Should it become necessary, any work required to relocate HECO facilities shall be done by HECO. The Contractor shall be responsible for all costs and coordination.

   * The Contractor shall be liable for any damages to HECO's facilities.

   * The Contractor shall report any damages to HECO's facilities to the HECO Trouble Dispatch at phone 548-7961.

   * A minimum of 30'-0" shall be maintained between HECO overhead conductors and the final land grade after the installation of the proposed facilities.

   * Service roads and/or trails leading to and from HECO's facilities shall remain accessible for HECO's use at all times.

3. The HECO Koolau substation and its associated 138 KV lines shown on Figure 14, page 52 of Volume I, may be affected by these water system improvements.

Sincerely,

Brenner Munger

cc: Mr. Lawrence Whang,
Board of Water Supply

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

October 9, 1987

Dr. Brenner Munger
Manager, Environmental Department
Hawaiian Electric Company, Inc.
P. O. Box 2750
Honolulu, Hawaii 96840

Dear Mr. Munger:

Subject: Your Letter of October 2, 1987 to the Office of Environmental Quality Control on the Draft Environmental Impact Statement (EIS) for the Windward Oahu Regional Water System Improvements

Thank you for commenting on the environmental document for our proposed water system facilities projects.

We will note in the Final EIS that overhead HECO lines will be required to serve facilities within conservation-zoned areas.

Your construction notes will be included as part of the final construction plans for projects near HECO's 138 KV transmission lines.

Work in the vicinity of HECO's Koolau substation and its associated 138 KV lines will be coordinated with HECO

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Office of Environmental Quality Control
VTN Pacific, Inc.

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HAWAII'S THOUSAND FRIENDS

Ke aloha o ko kākou 'āina, 'O ia ka mana kū pa'a. Pānoanoa ka 'āina, Mānoanoa ka po'o.
The Love of our land, is the power for us to stand fast. Rare is the land, many are the people.

October 30, 1987

Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
630 South Beretania St.
Honolulu, Hawai'i 96843

RE: Environmental Impact Statement for Windward Oahu Regional Water System Improvements

Dear Mr. Hayashida,

Hawaii's Thousand Friends is a non-profit citizen's organization dedicated to intelligent land use planning. We are, therefore, pleased to be a consulted party in the above-referenced matter. Our comments, questions and suggestions are the result of HTF research, which includes information obtained from knowledgeable members and experts, and by Judy S. Givens, an attorney specializing in water law.

Hawaii's Thousand Friends (HTF) is ambivalent concerning the idea of a regional EIS for this project. Such experts as the acting district chief of the U. S. Geological Survey have flatly stated, "A single EIS for all windward projects is too broad in scope. Because future circumstances may be different as compared to the present, we may be approving items that we may not be aware of" (Vol. II, G-6). However, while windward residents may examine the proposed project's enormous scope, this draft leaves too much unanswered.

The environmental impact statement rules, section 11-200-2, define an EIS as an informational document ... which discloses the environmental effects of a proposed action, effects of a proposed action on the economic and social welfare of the community and state ... measures proposed to minimize adverse effects and alternatives to the action and their environmental effect" (emphasis added).

Section 11-200-16, which appears to apply to both draft and final EIS's states, "The environmental impact statement shall contain an explanation of the environmental consequences of the proposed action. The contents shall fully declare the environmental implications of the proposed action and shall discuss all relevant and feasible consequences of the action."

941 River Street Suite 202 Honolulu, Hawai'i 96817 (808) 538-1296

Section 11-200-17(i) provides that "The draft EIS shall contain a statement of the probable impact of the proposed action on the environment."

The Board of Water Supply (BWS) has **not** supplied enough information to comply with the requirements of the rules or to allow decision makers to reach a sound decision. No one could adequately evaluate the environmental risks based upon the information contained in the draft EIS. The document points up the need for further study, especially of the effect of water development on stream flow, which will determine the extent of most of the other impacts. **Until the BWS can say, with a fair degree of accuracy, what the impact on stream flow will be, it should not proceed with the proposed projects.**

Other significant omissions include a discussion of the effects of the proposed actions on recreational and aesthetic enjoyment of windward O'ahu; a response to Department of Land and Natural Resources comments concerning impacts on Punaho'olapa; a response to the Doak Cox (Vol. II, G-19) comment "that, because of storage effects, reduction in draft from a well will not result in rapid restoration of seepage to streams from the aquifers tapped directly or indirectly by a well" (Vol. II, G-19). The fact that there can be a significant lag time between reduction of withdrawals and increased stream flow supports the need for accurate models prior to **any** development. BWS must be able to mitigate any serious negative impacts in a timely manner. At this point, it does not appear that it has the information necessary to do so.

No mention is made of whether a lower ground water table will result in greater demand for irrigation water in the agricultural areas of windward valleys. The BWS and farmers should not be in costly new contention over these inter-dependent area resources.

The DEIS doesn't address the alternative of designating one or more streams as high quality streams, to be protected from any further flow reductions, despite the consultant's comments that "Of the 36 Windward O'ahu streams evaluated, data indicate that six ... are of significantly higher quality than the others in terms of native aquatic fauna and the environmental conditions conducive to their survival ... In the face of the growing water needs of the entire island, concentrating efforts on effectively protecting Waiahole, Waikane, Kahana, Punaluu, Kaluanui and Koloa Streams may provide the most reasonable method of maintaining optimal use of this resource by the community" (Vol. II, 14). We believe these streams and others to also be critical to the productivity of estuarine waters in Kawai Nui, Kailua Bay, Kane'ohe Bay, Kahana Bay, Mamalu Bay and other Windward sea areas, a subject of much interest to subsistence, sport, and commercial fishermen, and to other residents and visitors. It cannot be assumed, as stated in the DEIS Summary (iv) that fauna will "not be significantly adversely affected" without providing adequate supporting data.

The draft EIS should fully assess the effects of rate restructuring. A progressive rate structure was recently suggested by a BWS consultant, along with abolishing the subsidized agricultural rate. The latter met with a great deal of opposition, but the former is a legitimate way of encouraging water conservation. Domestic and industrial water users would be much more careful about wasting water if they had to pay dearly for doing so. This alternative to more water development on the windward side deserves serious consideration, but got short shrift in the draft EIS. The discussion of "retrofitting" old fixtures with water saving devices is unsatisfactory: were the results worthwhile when 130,000 shower flow restrictors were given to O'ahu residents? The negative small sample from Oxnard, California is surely not the only case study which could be reviewed.

Following are comments addressed to particular, identified portions of the DEIS:

Summary, p. iii: "It is possible that most of the ground water to be developed by these projects will be at the expense of stream flow." Until the effects of further water developments can be predicted with a fair degree of certainty it is not appropriate to proceed.

Summary, p. iii: What is BWS's position concerning the interim instream flow standards: are they bound, and do they recognize that even their ground water withdrawals must be restricted as necessary to comply with the interim instream flow standards?

Summary, p. iii: "Pumpage would be regulated, if necessary, to preserve basal aquifers" - preserve at status quo, or something less? If less, what?

Summary, p. iv: "sufficient information is not available to clearly establish the effects of the proposed BWS projects on aquatic insects." EIS Rules, Section 11-200-17(i) state that the DEIS **shall** contain a statement of the probable impact of the proposed action on the environment. It is not acceptable to simply state that information is not available. Since botanical, limited biological, and archaeological studies were deemed appropriate to the development of the DEIS, why were studies not initiated for water-dependent insects?

Summary, p. iv: Does BWS intend to leave any water for **new** agricultural uses? Especially given the proposed increase in rates for agricultural users, if no water is left for such users, there may be no expansion of agricultural uses on the windward side, which runs contrary to the policy of the state to "foster attitudes and activities conducive to maintaining agriculture as a major sector of Hawaii's economy" [Hawaii State Planning Act. H.R.S. Section 226-7(b)(1)].

Summary, p. v: How were the costs of various alternatives determined? Were the benefits of reduced environmental impacts

factored in? Whether reviewers endorse or challenge BWS positions can depend on the validity of the rationale.

Summary, p. v: "BWS will implement any instream flow standards adopted by BLNR." The statements in the document are contradictory: please clarify exactly what BWS's position is vis-a-vis the interim standards.

Summary, p. vii: Refers to BWS mandate to provide for growing consumer demand to the extent of available water resources. At the informational meeting in Kane'ohe, Mr. Hayashida indicated that it was the BWS belief that this mandate is specified in the City Charter, Section7-105: "The board of water supply shall: ... (j) Prescribe and enforce rules and regulations having the force and effect of law to carry out the provisions of this article of the charter, including (1) the regulation of water systems and necessary appurtenances for subdivisions and other properties and requirements for adequate water supply and storage facilities for domestic use and fire protection, ..." Our review of the Charter doesn't reveal any such mandate as that claimed, even in the section cited. Further, we must all face the fact that eventually we will run out of water to supply growth. This is an appropriate time to examine the costs and benefits of additional growth, especially as they apply to the Windward side. Unfortunately, the DEIS fails to give any clear indication of what the environmental and social costs of further water development will be.

Page 30: "Other proposed BWS windward water sources are not thus constrained." Does that mean that there are no limits on the sustainable yields of other basal aquifers? Please explain.

Page 136: "Hypothesis will be in question until such time as a model is developed of how rainfall affects Waihee Stream discharge." When will such a model be developed?

Page 145: "BWS conservatively estimates that between 31 to 36 mgd of basal ground water can be withdrawn ... <u>without adversely affecting the basal water table</u> ..." How does BWS define "adversely affecting?"

Page 165: Archaeological features are not the sum of cultural concerns, and it is more than artifactual remnants for which BWS has a responsibility in these ancient valleys. The DEIS is inadequate in that time spent in the field and the methodology followed for archaeological evaluations are not given. Further, Hawaiian cultural evaluation of sites, districts and features are not included. Where an archaeologist may believe that archaeological excavation is "mitigation," Hawaiians may be aware that this is simply another method of destruction, serving neither the culture nor site in a sensitive manner. We are especially appalled by your consultant's cavalier statement, used frequently, that "If evidence of significant historic or prehistoric remains is found to be present at any of these locations, <u>it is highly unlikely that it will be of such significance that it would have to be preserved, and</u>

<u>archaeological salvage excavations will undoubtedly be a proper mitigative measure</u> (emphasis mine). We believe this to be both unprofessional and arrogant. Materials presented for Maunawili and Kahana are incomplete, as major studies have been done in both valleys, to my knowledge, by Jane Allen (Bishop Museum for Royal Hawaiian Golf Course) and Patricia Beggerly (Ph.D. dissertation), respectively. Similarly, archaeological studies effected for the proposed H-3 segment impacting the Luluku Archaeological District indicate a need for much more extensive exploration than was apparently given by your consultant. No mention is made that the receiving waters for the Maunawili streams to be affected are in the Kawai Nui Archaeological, Cultural and Historic District. Therefore, the flow of water is itself critical to the management of this coastal zone resource, intended to be managed as a unique cultural and natural marsh park. Further, it is unthinkable that BWS did not invite comments from the Society for Hawaiian Archaeology for the expertise they could bring to evaluating cumulative impacts to artifactual resources; nor the Office of Hawaiian Affairs, whose cultural experts might be able to bring more than a merely technical examination to the cultural resources to be impacted. Hawaiian religion, Hawaiian wealth, Hawaiian lifestyle, Hawaiian economics, Hawaiian law and rights were water based, in whole or in part. The DEIS is wholly inadequate here.

Page 168: Further development should not proceed until BWS has determined the extent to which stream flow will be reduced. The rules require that there be a list of unresolved issues and either a discussion of how such issues will be resolved prior to commencement of the action, or what overriding reasons there are for proceeding without resolving the problems. You have included, at page 244 et seq., a list of unresolved issues which allude to your basic lack of information concerning the effect of further water development on stream flows, but no commitment to resolve the issues or justification for proceeding without making such determinations. Stream flow will play the most important role in determining what other impacts result from water development. The fact that determining impacts on stream flow will be expensive does not justify failing to do so. The fact that it will be problematic is, of course, relevant. However, if it is impossible to determine the extent of the effects that further water development will have on stream flows, we as a society are faced with two choices: develop regardless, or maintain the status quo. We believe that a vast majority of Honolulu's citizens, if given that choice, would choose a moratorium on water development rather than endanger their Island home itself.

Page 169: Someone must gage streams and develop a model to predict impact of water development before BWS proceeds. We need to know not only what the possible effects are but how likely the various possibilities are before anyone can rationally determine whether they are acceptable.

Page 169, 170: Again, BWS fails to clearly state its policy concerning the interim instream flow standards: will it "manage

ground water development ... to implement instream flow standards" or "whenever practicable ... monitor stream flow and reduce ground water development as necessary to maintain stream flow as proposed by BLNR instream flow rules"?

Page 173: On page 127 you state that it is theoretically possible for a well which develops dike-impounded ground water to reduce stream flow above the static head of the well. On page 173 you assume that vertical wells which develop dike-impounded ground water will take ground water which is the source of gains in stream flow below, but not above, their static head. You claim that the above assumption, inter alia, allows for a worst-case overview of the risks that each proposed water development may pose to perennial streams. We believe a worst-case scenario would assume effects both above and below the static head of the well and all other theoretically possible negative effects.

Page 172, 173: The list of ways in which removal of ground water could reduce stream flow is incomplete: lowering of the ground water table can cause surface water to seep into the ground, rather than just removing water which would otherwise add to a stream.

Page 202: By constructing wells and tunnels into more than one dike, won't you promote transfer of water pollutants from one dike to another at a much more rapid page?

Page 204: Please explain how flood control maintenance will minimize effect on stream fauna access to the ocean.

Page 205: Please explain why O'ahu residents should be satisfied to know that five native species of stream fauna and snails will exist on other islands and in other environments, but not in the O'ahu windward streams to be affected by these projects?

Page 208: If stream flows are reduced, ground water tables may also be reduced, so marshes will be affected one way or another. As an active participant of the Technical and Policy Advisory Committee which framed the three-year study leading to the Kawai Nui Marsh Management Plan, soon to be implemented, I am curious to know the source of the theory that "ground water seeping into these marshes is a more important source of surface water than dry-weather stream flow."

Page 209: If you need information, **survey**. The BWS should not assume no impact in the face of no information.

Page 210: When will further research be done concerning the impact of reduced stream flow on populations of aquatic or water-dependent insects?

Page 210: Doesn't the lack of information on the dynamics of ground water movement in Windward O'ahu watersheds warrant an extremely conservative approach?

Page 213: BWS should not dry up taro lands - those are **protected** water rights, even if they are not currently exercised. BWS should not adversely affect any agricultural lands, given the State's policy to protect, promote, and enhance agriculture.

Page 213: Please clarify "subsidized municipal water service" - does that mean the rates quoted on page 214, which are admittedly too high to allow cultivation of alfalfa, other kinds of cattle feed, sweet corn, watermelon, guava, prawns, taro, and watercress; and possibly papaya? That's unacceptable. We should be promoting local diversified agriculture, not rendering it economically infeasible.

Page 220: (F. STREAM FLOW MONITORING) Reads fine, except for "otherwise" in the last sentence. Please omit.

Page 221: Another example of the ambiguity contained in the document at various points: will BWS comply with the stream flow rules or not?

Page 224: If Windward O'ahu water resources are removed, rendering many valleys useless for existing or potential agricultural and rural purposes, won't they then be vulnerable to the same development pressures that have generated this proposal?

Page 225: We disagree that BWS is mandated by law to provide for consumer demand to the extent of available resources. We need to step back and decide how much more water is available. Is it all water that is economically recoverable and presently legally available? Or do we leave some water untouched to protect the environment?

Page 230: Says funds for design and construction of desalinization demonstration plant were requested of '85 legislature. Please update as to current status.

Page 233: No account seems to have been taken of the amount of water which would be available if sugar were to phase out entirely, which some say is a likelihood in the short term.

Page 234: Please explain why reductions in cultivated acreage can reduce the sustainable yield of the Pearl Harbor aquifer.

In conclusion, Hawaii's Thousand Friends believes this is a perfect time to step back and take a hard look at where we're going. How much more growth can our water supply accommodate? How will further water development on Windward O'ahu affect our environment? We realize that this is the question that the DEIS was intended to answer, but we do not feel that it has done so adequately. Once the environmental impacts are clearly defined, we need to ask whether they are a price we're willing to pay for future development. Thank you for the opportunity to have a longer period of time in which to review this DEIS.

Sincerely,

Muriel B. Seto

Muriel B. Seto, Executive Director

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

December 9, 1987

Ms. Muriel B. Seto
Executive Director
Hawaii's Thousand Friends
941 River Street, Suite 202
Honolulu, Hawaii 96817

Dear Ms. Seto:

Subject: Your Letter of October 30, 1987 on the Draft EIS for Windward Oahu Regional Water System Improvements

Thank you for your comments on our EIS.

The Windward Regional Draft EIS is an assessment of our long-range water plans which include source, transmission and storage facilities. Many of the projects are still in the conceptual stage. The projects all have common objectives; therefore, we felt that a regional EIS with the subsequent preparation of supplemental EIS's should give the public a more comprehensive overview of the Board's objectives instead of EIS's prepared for individual projects.

The supplemental EIS's will address in detail all of the environmental concerns and problems that are associated with the projects. You will be given the opportunity to review and comment on them. The supplemental EIS's will have to meet the requirements of Section 11-200-11 before we will be allowed to proceed with the projects covered in the EIS's. Furthermore, other agencies and the public, such as those engaged in farming, can proceed to develop any of the potential sources mentioned in the regional EIS; we do not have exclusive claim to any of the sources. Where we find that there are obvious environmental problems associated with certain projects, those projects will be dropped from our long-range plans.

The State Water Code and Interim Instream Standards should ensure that streamflows and wetlands are preserved. All of our projects will be required to be in compliance with the requirements. Your concerns, such as monitoring and maintaining streamflows, need for mitigative measures, designation of particular streams, existing and future pumpages and any other related matter will be addressed before we proceed with any project to ensure compliance with the Water Code and Interim Instream Standards.

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Furthermore, we have gone on record that we will work closely with farmers that are using streamflows or ground water to ensure that their sources of water are preserved.

We also offer the following responses to your comments as they relate to the regional EIS:

1. Alternative solutions, such as rate restructuring and retrofitting, will enhance water conservation but will not totally provide enough water to meet projected water demands.

2. Archaeological reconnaissance surveys were performed for those projects that are only conceptually sited. More detailed archaeological surveys, including test pit excavations, will be made as required for projects which we plan to undertake.

3. The term "subsidized municipal water service" refers to the agricultural rates available to farmers from our system. Substituting municipal water for small private systems must be evaluated on a case by case basis.

4. We will omit the word "Otherwise" on page 220.

5. Water developed in Windward Oahu will be used in Windward Oahu. Any water excess to the present needs of the Windward district will be transported to Honolulu. When the needs of the Windward district increase, the same water being transported to Honolulu will remain in the Windward district and additional supplies will be developed for the Honolulu district. Agricultural and rural uses in the Windward areas are guided by land use controls. Water can be made available to areas of need provided an adequate supply of water exists.

6. The State is still in the design stages of constructing a pilot desalting plant in Ewa. Construction may be initiated in a year or two with completion of the project estimated at two years.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

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7. When sugar is phased out, the amount of water that would become available will be dependent upon the water quality of the sources given up by the sugar companies and the revised water budget for a particular area. Combined average draft by the sugar companies in the Pearl Harbor and Waialua areas is about 170 mgd. Much of the water used for sugar irrigation is brackish and would either require desalting, or used in dual water systems where the brackish water is used primarily for irrigation of golf courses and highway landscapings.

8. Water demand projections show that groundwater supplies, assuming the sugar companies remain in operation, would be able to meet the islandwide demand until the year 2000.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Frank F. Fasi, Mayor
VTN Pacific, Inc.

MHS/LHYW/HHM:do
cc: K. Hayashida
L. Whang

87-2396

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MGR
DEP
P/E

Oct. 29, 1987

Kazu Hayashida, Manager and Chief Engineer
The Board of Water Supply
630 S. Beretania St.
Honolulu, Hawaii 96843

Subject: Comments on Draft EIS for Windward Oahu Regional Water System Improvements

Dear Mr. Hayashida,

While The Board of Water Supply is mandated to provide water for consumer demand, it is not mandated to provide the cheapest water. In light of the water code with its minimum stream flow requirements, is Windward water "available"? It is wrong to start with that assumption. A regional EIS should present comparative data and analysis on all alternatives. The bias of this EIS in favor of taking Windward water is reflected in the choice of language used in the analysis of the negative impacts of water development. Every impact is downplayed.

Stream Flow (p. 168)

"...water wasting into the air or ocean."(p. 168) Who determined that that water is wasted? Where is the evidence either pro or con?

"reductions in stream flow due to BWS projects could be proportionately significant..."(p. 168) "...windward Oahu streams which might possibly undergo a reduction in dry-weather flow as a result of proposed BWS projects." (p.173) These terms are very misleading given the evidence in this EIS and in other studies (which should be referred to--the Waihee water case for example). "Will probably" would be closer to the truth. The EIS says the BWS intends to mitigate the adverse impacts of water development on stream flow "whenever practicable," but nowhere does it go into detail about how it will do this, or what it will do if it cannot mitigate the effects.

Stream Fauna (p. 204)

Since the fish do not necessarily go back to the same stream after going to the ocean, what will the cumulative effect be of drastically reducing the number of streams they can go back to? Saving a few streams may be as good as saving none. Who is to guarantee that the City and County will "provide flood control maintenance at stream mouths" in a timely fashion--one that coincides with the life-cycle of the fish? It is a misunderstanding of and insult to environmental goals and laws to dismiss effects on stream flow fauna by saying, "These species are found on other islands and in a variety of other environments." (p. 205)

Estuarine and Marine Fauna (p. 205)

The study of effects on estuaries is totally inadequate. No original research was done. The studies cited were very limited in scope. What about the value

of estuaries as nurseries and feeding grounds for salt water organisms? Isn't there an economic and social cost of losing estuaries?

Waterbirds (p. 207)

"It is possible, but not proven that groundwater seeping into these marshes is a more important source of surface water than dry-weather stream flow." There is no evidence given to support this statement. Why wouldn't BWS developments affect the groundwater source?

Existing Users (p. 210) **Agriculture** (p. 213)

Besides the individual effects on existing users who do not "contribute a significant share of any single agricultural crop grown on these streams" (!), what about the cumulative effect on all the existing users? How much agriculture is there on the Windward side? Do existing users want or need more water? "However, in a few cases, it may prove desireable for the BWS to replace existing agricultural water sources with subsidized municipal water service." (p. 213) Take water which agriculture has developed and then make them pay to get it back? Is there potential for agriculture on the Windward side? How much land is zoned for agriculture? What will the economic and social loss be if these lands can't be farmed because of lack of water? In order to provide low cost food, while competing with cheap mainland and foreign labor, agriculture needs low cost water. Given the new ag rates, the last paragraph on p. 214 stating that "water rates are probably affordable for cultivation..." should be rewritten.

Growth and Land Use (p. 215)

"First priority" for use of water for BWS customers in Windward Oahu is in conflict with the "first come, first served basis" stated on p. 213 and on p. 240.

Natural Hazards (p.216)

Paragraphs 2 and 3 are contradictory. Far more attention needs to be paid to increased flooding due to vegetation encroachment in reduced flow streams.

Conclusion

By assuming that Windward water is both available and relatively cheap, BWS downplays the potential contribution of alternatives. None of the alternatives to Windward water are quantified in any way. Why is there "no reliable data on the water savings" from retrofitting old fixtures if "there could be merit in such a program." (p. 229) It seems that demineralization of brackish water is "probably more expensive than normal ground water development." How does this cost compare to the economic and social costs, including transportation costs, of developing Windward water? The need to develop water is based on projected demand, but what measures is the BWS taking to meet the second of its planning objectives stated on p. 225, "Attempt to insure that growth in consumer demand will be compatible with available supply." Is the BWS planning on supplying water only for affordable housing?

"The Windward Oahu water development projects will increase long-term productivity on Oahu." (p. 224) What kind of productivity? What about the long-term productivity of Windward agriculture? How will the loss of streams' cultural, recreational, and natural values affect "long-term" productivity?

As a regional EIS, this document is badly deficient and unacceptable.

Charles F. Reppun

Charles F. Reppun, president
Hui Malama Aina O Koolau

-3-

H-39

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

November 18, 1987

Mr. Charles F. Reppun
President
Hui Malama Aina O Koolau
47-410 Lulani Street
Kaneohe, Hawaii 96744

Dear Mr. Reppun:

Subject: Your Letter of October 29, 1987 on the Draft EIS for Windward Oahu Regional Water System Improvements

Thank you for commenting on the environmental document for our proposed water system projects.

We offer the following response to your comments:

1. Streamflow: We shall comply with the State Instream Flow Standards and Water Code.

2. Stream Fauna: We shall be coordinating the preservation of habitats for all stream fauna with the State Fish and Game Agency.

3. Estuarine and Marine Fauna: We do not anticipate any adverse impacts to marine fauna in estuaries. The document mentions that opae oehaa, the greso shrimp, Samoan crab, the hapa crab, the oopu okuhe, and aholehole were all able to tolerate increases in salinity; only the Tahitian prawn would be adversely affected.

4. Waterbirds: Supporting evidence that "groundwater seeping into these marshes is a more important source of surface water than dry-weather streamflow" will be included in the revised EIS.

5. Existing Agricultural Uses: Streamflows will be maintained to meet the existing water uses for farmers along the various streams.

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CITY AND COUNTY OF HONOLULU

COPY

Mr. Charles F. Reppun
Page 2

November 18, 1987

6. Growth and Land Use: Water service is given on a "first-come, first-served" basis. Water developed in the Windward area will be used to meet the Windward water demands first, then, if there is any excess, the excess water will be pumped to Honolulu until the excess is required for the Windward area.

7. Natural Hazards: Maintenance of streams is the responsibility of other agencies. The State instream standards are the appropriate documents to address this problem if the problem is significant due to reduced streamflows.

8. Alternatives: Water conservation is an ongoing program of the department which will help to stretch the available supply, but it will not be enough to meet the projected demands.

   We find that groundwater development is the most feasible means to meet future water requirements. Development of alternative sources is costly and should be deferred until we reach the limit of groundwater development. We are required to provide water meeting the Federal and State's Safe Drinking Water Act requirements. When we reach the limit of groundwater development, desalting of brackish water will have to be undertaken to meet the additional water demands.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: VTN Pacific, Inc.

H-40

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CITY COUNCIL
CITY AND COUNTY OF HONOLULU
HONOLULU, HAWAII 96813 / TELEPHONE 523-4000

DAVID W. KAHANU
COUNCILMEMBER

September 29, 1987

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
Honolulu, Hawaii

Dear Mr. Hayashida:

SUBJECT: Windward Oahu Regional Environmental Impact Statement

In offering the following comments on the above study conducted by VTN Pacific for the Honolulu Board of Water Supply, I commend the agency for presenting us with this general overview of proposed water development in Windward Oahu.

As I understand it, this regional impact statement serves as a preliminary evaluation of potential impacts water development might have on the Windward area of the island; more specific, localized impact statements will be prepared by the Board of Water Supply as the development program proceeds.

Recognizing that the responsibility of the Board of Water Supply is to continually seek ways to extend its water supply to meet domestic needs on the island, permit me to note the following concerns:

1) Maintenance of stream waters for agricultural users--a number of Windward Oahu farmers presently use stream water for irrigation. What assurance do we have that farmers presently will continue to have use of this water if wells which are drilled near streams affect the output of water in the streams?

2) Maintenance of water levels/ecosystems in Windward Oahu streams--how will the Board of Water Supply address new controls on minimum stream flow?

3) Protection of Windward Oahu watershed areas--in what ways will the Board of Water Supply assure the protection of watershed areas which permit recharge of Windward water resources, in light of continuing pressures for urban development in upslope areas?

9

Mr. Hayashida
September 29, 1987
Page 2

Thank you for this opportunity to comment on the above environmental impact statement.

Sincerely,

DAVID W. KAHANU
Councilman
Windward Oahu - District II

DWK:dsf

cc: Kahaluu Neighborhood Board
Koolauloa Neighborhood
Kaneohe Neighborhood Board
Kailua Neighborhood Board
Hawaii Farm Bureau Federation

H-41

1114

October 14, 1987

The Honorable David W. Kahanu
Councilmember, City Council
City and County of Honolulu
Honolulu, Hawaii 96813

Dear Councilmember Kahanu:

Subject: Your Letter of September 29, 1987 on the Draft EIS for the Windward Oahu Regional Water System Improvements

Thank you for attending the informational meetings at Kaaawa Elementary School and Castle High School, and for your comments on the environmental document.

In response to your concerns, we offer the following:

1. "Maintenance of stream waters for agricultural users--a number of Windward Oahu farmers presently use stream water for irrigation. What assurance do we have that farmers presently will continue to have use of this water if wells which are drilled near streams affect the output of water in the streams?"

   We are required by the State Board of Land and Natural Resources to comply with their interim instream regulations which require that existing flows be maintained.

2. "Maintenance of water levels/ecosystems in Windward Oahu streams--how will the Board of Water Supply address new controls on minimum stream flow?"

   We will maintain flows in the streams in accordance with the requirements of the State instream standards. If projects will adversely affect stream flows, we may not proceed with the projects.

3. "Protection of Windward Oahu watershed areas--in what ways will the Board of Water Supply assure the protection of watershed areas which permit recharge of Windward water resources, in light of continuing pressures for urban development in unslope areas?"

   Although the redistributing of lands is a State function, we have recommended against the urbanization of lands when they are considered to be prime recharge areas.

If you have any questions, please contact me at 527-6180.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

FORWARDED:

/s/ Jeremy Harris
JEREMY HARRIS
Managing Director

bcc: Jeremy Harris

MHS/LHYW/GH/HHM:do
cc: K. Hayashida, G. Hiu, L. Whang

87-2175

P. 1031 cc

31 October 1987

Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawai'i 96813

Re: Response to draft Environmental Impact Statement for Windward Oahu Regional Water System Improvements

Dear Mr. Miura:

We appreciate the opportunity to comment on the subject dEIS. Before making specific comments, we feel some general observations are in order.

First, the development of the dEIS at this time indicates the inverted nature of our county planning processes. This dEIS reveals (although incompletely in our view) the potential impacts of the water development thought necessary to permit implementation of the County's General plan provision for a future secondary urban center in 'Ewa. This information should have been available to the City Council when they were making General Plan decisions in 1981-82. Now the General Plan is being used to justify taking as much as 37.8 million gallons per day (mgd) of windward water for other than windward use. What does windward O'ahu get out of this? "Reducing base flow of most perennial streams from Punaluu to Maunawili." (p. 223)

The regional development scheme is also being justified by using outdated population projections. In our response to the EISPN for this development, we asked whether 1978 "IIF" or 1984 "M" DPED population projections were being used. BWS' 11/29/84 letter said that "IIF" projections were being used because the City & County's Department of General Planning had not adopted the "M" projection. Now, three years later, we have been advised by DGP that they adopted the "M" projections in 1984. However, the dEIS states "estimates based on 1978 'IIF' population projections" (p. 5) are the basis for the year 2000 water consumption figures; these are referenced to the "Oahu Water Plan" published in 1982!.

What is the currency of the information used in the document? The cover letter from Chief Engineer Kazu Hayashida is

Na Kia'i Pono 'O Kawai Nui

KAWAI NUI HERITAGE FOUNDATION
P.O. BOX 1101 KAILUA, HAWAI'I 96734

dated March 13, 1987; the 343 certification page at the front of the document is dated 4/6/87; the reviewer transmittal attached is dated September 2, 1987. Between March and September 1987, two events occurred which have potential to impact this development scheme and the dEIS: passage of the State Water Plan; and approval by the Board of Land & Natural Resources of interim instream flow standards for all windward O'ahu streams. Yet the dEIS is written as if neither of these events had happened: e.g., "Although instream standards may be established in early 1987" (p. 170). In addition, numerous references are made to the "Oahu Water Plan" which, as noted above, was published five years ago; was the information used from that updated? Not if the population projections are any sample.

Comments on specific statements in the dEIS follow:

p. v, paragraph 3: "BWS prices for sale of municipal water." It has been our understanding heretofore (in discussions in the Water Code Roundtable, for example) that BWS was not "selling" water but was recouping, in its charges, the cost of developing and transmitting water. If it is selling a commodity, what are the tax implications?

p. 4, paragraphs 2 & 3: We had questioned in our response to the EISPN the validity of doing one EIS for the regional development. Statements such as these paragraphs reinforce our conclusion that we did not think the single EIS valid. Although the following paragraph promises to prepare supplemental Environmental Assessments (EAs) for specific projects as programmed, we question the adequacy of this procedure on two grounds. One is the historical tendency for applicants, whether governmental or private, to assume that acceptance of the initial EIS means the project shall go forward regardless of the degree of impact revealed by a supplemental EA. Secondly, this dEIS is available to the public for comment through notification in the OEQC "Bulletin". EAs, however, are almost always only made known to the public when the negative declaration or EISPN is noticed in the "Bulletin". In the case of the former, the only recourse left to a concerned public is legal action, which is time-consuming and expensive.

IF this EIS is approved, we urge the BWS to follow the lead of recent actions by the City & County Department of Public Works and supply copies of the specific EAs to community organizations and associations concerned with the project site areas. Otherwise, this dEIS may be the last opportunity concerned citizens have to make their views known -- a scary prospect since the regional development is dealing with a scenario to the year 2000.

p. 21: Is the ownership of TMK 4-2-9:1 (Maunawili Wells I) accurate? We believe this is part of the property acquired by "Y. Y. Valley, Inc." for golf courses and amenities.

p. 23, last paragraph: We assume "improving...hiking trails" for access to facilities means making them into roads. Will they still be available as hiking trails?

p. 84, second paragraph: "Historically, the first 40 years of this century have been significantly wetter than the following period to date." If this statement is accurate, then inclusion of the first 40 years rainfall in any calculations of stream flows over time would make those stream flows appear greater than they are currently or, presumably, can be expected to be in the project period (to year 2000).

p. 86, top paragraph: "Ref. 85" -- this is an 1894 document, apparently reprinted in 1969. Are the figures accurate for current situations?

p. 91, last sentence: "These basal aquifers are primarily recharged by leakage and overflow of high-level dike-impounded ground water and to a lesser extent by infiltration of rainfall and stream flow." Similiar statements are made elsewhere in the document. Will not tunnels and incline wells tapping the high-level dike-impounded water lead to a reduction in basal aquifer size?

p. 148, second paragraph: "As a result of human actions, especially clearing of land and introduction of plants and plant-eating animals from outside of Hawaii, introduced

plant species have almost completely replaced native plant cover on the main Hawaiian islands below an elevation of about 450 meters." Similiar statements, with different elevation parameters, could be made about avian and aquatic fauna. Yet througnout this and other sections on the topic, the emphasis is on rare or endangered species. We would argue that native flora and fauna are in small enough distributions that any disturbance of them, whether or not they are "common" in other parts of this or other Hawaiian islands, should not be written off, as seems to be the tenor of the flora and fauna sections of the dEIS.

p. 150, last paragraph: "However, there are no records indicating that any species of Achatinella has been seen in the project area in the last fifty years." Did anybody look for them more recently than 1958? No information is not the same as no impact!

p. 155, second paragraph: This appears to completely ignore the likelihood that diadromous endemic stream fauna in Maunawili Stream and its tributaties will improve as implementation of the State's "Resource Management Plan for Kawainui Marsh" removes encroaching marsh vegetation, permitting freer passage way from the streams to the ocean.

p. 156, second through last paragraphs: all four endangered waterbirds are found in Kawainui and its tributary marshes (along Hamakua Drive and Kaelepulu Pond). Again, implementation of the "Resource Management Plan for Kawainui Marsh" will provide 50-300 ft. buffers around the Marsh, protecting breeding and nesting areas for the waterbirds.

p. 160-161: We are disturbed by the tenor of the entire section on archaeology and are aware that the preparer of the technical report is not held in high regard by many in the field of Hawaiian archaeology. Specifically (last paragraph, p. 160) how thorough were the surveys done for the Kahana 315, Luluku 500, and Waimanalo 364 reserviors? Did they rely on obvious visual evidence without exploration of brush-covered areas? This is what happened in the

original study of the Luluku makai area, which is now known to cover some 40 acres and include terrace walls larger than any previously found. Also, last sentence, first paragraph, p. 161: Was not the subject report made available to the Office of Hawaiian Affairs? If so, why can the Board of Water Supply not see it? Lastly, an extensive reconnaisance of Maunawili Valley has just been completed by Jane Allen of the Bishop Museum. The report is supposed to be available by the end of this year; we urge BWS to see what it may have that is relevant to the Maunawili wells I, II, and III and their accesses.

p. 162, last paragraph: the location of the Luluku 500 reservior certainly looks as though it would be visible from Likelike and Kamehemeha Highways, Ho'omaluhia Park, and parts of Kane'ohe town.

p. 164, first paragraph: "Proposed BWS facilities will not alter existing drainage patterns" -- what about road construction and "improvement" of existing hiking trails? Would these not provide additional impermeable surfaces, resulting in increased sheetflow?

p. 165: In line with our previous comments on the archaeology analysis, we urge the BWS to contract qualified archaeologists for additional work. Also, based on what we know of the archaeology in Maunawili Valley, the Valley should probably be added to the list in the second paragraph of areas where archaeological features will be hard to avoid.

p. 168, third paragraph: We object to the statement "reduce potable water wasting into the air or the ocean." Without this "waste", neither cloud moisture (a substantial portion of rainfall source in the higher Ko'olau) or estuaries would exist. This viewpoint is objectionably anthropocentric, assuming water has value only if it is serving human needs.

p. 172, top line: "Overflow situations are unaffected." Note 3 under Figure 36 appears to contradict this statement.

p. 198, second paragraph: "would take the headwaters of Kamooalii Stream" implies that Kamo'oali'i Stream would not exist except for the presence of the Pali Highway tunnel Drains. The characterization of the stream in Hawaiian legend as a "raging dog" indicates it must have existed much prior to the Pali Tunnels.

p. 208, second paragraph: "Kawainui Marsh one species (coots);" This statement is not accurate. Both the "Hawaiian Waterbirds Recovery Plan" (1985) and the "Resource Management Plan for Kawainui Marsh" (p. 19, 1983) point out that the Marsh provides habitat for the four endangered species of native Hawaiian waterbirds.

pp. 213,214: Are the sections on water pricing current?

pp. 220,221 "Instream flow standards": As noted above, this section is not up-to-date.

p. 224, last paragraph: "The windward Oahu water development projects will increase long-term productivity on Oahu." Long-term productivity of what? Houses?

"Unless sufficient water is available from windward Oahu sources to meet demand, the BWS will be forced to curtail service to new users." Nothing in this dEIS has indicated that windward is the only source of water. In addition to other physical sources, we believe the BWS has not taken anywhere near a strong enough stance on conservation, even though on p. 228 the dEIS states that "a very efficient approach to meeting future water demand is to conserve water".

p. 225, last paragraph: We have already noted above our concern with the lack of currency of the population figures used.

"leeward and central areas of Oahu. Both of these areas have limited potential for additional water development." Is this statement supported by other water-knowledgeable agencies, such as the United States Geological Survey? We

note with amazement the absence of comments from USGS. We urge OEQC to determine whether USGS was furnished a copy of the dEIS.

p. 229, first paragraph: How has Ordinance No. 79-27 been enforced? Is there any information on the degree of compliance?

Second paragraph: We question the statement "For obvious reasons, 'retrofitting' can not be forced on anyone against their wishes." If the citizenry, the City Council, and the BWS found that enforced retrofitting would substantitally reduce the need for water development and concomitant costs, it seems probable that retrofitting might be legally required and paid for by public funds.

p. 230, last paragraph: "Funds for design and construction of the demonstration plant have been requested from the 1985 Legislature." We believe these funds have been provided in the budget (?and some released).

p. 244 "Summary of unresolved issues": The number of unresolved issues makes us believe that the dEIS cannot be considered adequate to address the total and cumulative impact of this proposed water development scheme. We therefore urge OEQC to require more complete and up-to-date information and a more complete development of the alternatives for water conservation to meet the presumed needs.

Me ke aloha pumehana,

Susan E. Miller

Susan E. Miller
Vice President, Public Affairs

cc: Lawrence Whang, Board of Water Supply
Governor John Waihee
Mayor Frank Fasi
Councilmember Dennis O'Connor
Councilmember David Kahanu
Kailua Neighborhood Board No. 31, c/o Annetta Kinnicutt
Senator Clayton Hee
Senator Jimmy Wong
Representative Whitney Anderson
Representative Rep Bellinger
Representative Cam Cavasso
Representative Marshall Ige
Representative John Medeiros
Representative Terrance Tom
Commissioner Robert Nakata, State Water Resources Commission

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KAWAI NUI HERITAGE FOUNDATION
P.O. BOX 1101 KAILUA, HAWAI'I 96734

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

December 24, 1987

Ms. Susan E. Miller
Kawai Nui Heritage Foundation
P. O. Box 1101
Kailua, Hawaii 96734

Dear Ms. Miller:

Subject: Your Letter of October 31, 1987 to the Office of Environmental Quality Control on the Draft Environmental Impact Statement (EIS) for the Windward Oahu Regional Water System Improvements

Thank you for your comments on the Draft EIS.

The Windward Regional Draft EIS is an assessment of our long-range water plans which include source, storage and transmission facilities. Many of the projects are in the conceptual stage. Since all the projects have common objectives, we felt that a regional EIS with subsequent supplemental EIS's would give the public a comprehensive overview of the Board's future plans instead of EIS's prepared for individual projects.

The supplemental EIS's will address the environmental concerns that are associated with the specific project. You will be given the opportunity to review and comment on them.

All of our proposed water development projects will be required to be in compliance with the State Water Code and the In-stream Flow Standards.

We also offer the following responses to your comments as they relate to the regional EIS:

1. The currency of data presented in the document varies according to the availability of the data at the time the Draft EIS was being prepared. Overall, revised data on population projections or streamflow will not significantly affect the discussions in the EIS.

2. The phrase "for sale" appearing on page V, paragraph 3, will be deleted. (Ref. p. V, paragraph 3.)

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3. The EIS will be revised to indicate the ownership of TMK: 4-2-9: 1 was acquired by Y. Y. Valley, Inc., for golf courses use. (Ref. p. 21.)

4. Hiking trails that may be affected by any of our projects may be rerouted around the project site or reestablished after the construction work is completed. (Ref. p. 23.)

5. "Reference 85" was printed in 1969. The "1894" is the number of the USGS document: "Paper 1894."

6. Dike impounded water does not contribute to recharge of the basal aquifer. Dike water and basal water are two separate sources of ground water.

7. We will be coordinating our supplemental environmental documents with the U. S. Army Corps of Engineers who is responsible for activities that may affect wetlands including waterbird habitats.

8. Only reconnaissance surveys were made for most of the conceptual sites including a literature search. Qualified archaeologists performed the survey done for the Kahana 315 and the Luluku 500 Reservoirs.

9. The sentence "Overflow situations are unaffected" will be deleted on page 172. This statement only applies in situations where there are no leaking dike compartments.

10. The EIS will be corrected to indicate that Kawainui Marsh supports all four endangered species of Hawaiian waterbirds. (Ref. p. 208.)

11. The water pricing on pages 213 and 214 were current at the time the Draft EIS was published. The new rates went into effect on December 1, 1987, and will be reflected in the revised EIS.

12. The section on "In-stream Flow Standards" will be updated.

13. The verb "will" will be changed to "may." You are correct in that future water service is not totally dependent upon development of Windward Oahu water sources. (Ref. p. 224.)

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14. Alternative solutions, such as rate restructuring and retrofitting, will enhance water conservation, but will not provide enough water to meet projected water demands. (Ref. pp. 228 and 229.)

15. Water development in Leeward and Central Oahu have limited potential as can be attested to by the State's designation of Central Oahu as the "Pearl Harbor Ground Water Control Area."

16. The USGS was a consulted party on this EIS. Their comments are attached.

17. Since 1979, the Plumbing Code required flow limiting devices for faucets and flush valves and required the recirculation of cooling water. To our knowledge, there should be full compliance on the initial plumbing work.

18. Funds have been released for the construction of a pilot desalting plant in Ewa. The project is still in the design stage and construction may begin within two years with completion estimated at another two years. (Ref. p. 230.)

19. The unresolved issues will hopefully be resolved by the time the supplemental EIS's are prepared.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

Attachment

cc: Office of Environmental Quality Control
~~VTN~~ Pacific, Inc.

United States Department of the Interior

GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
P. O. Box 50166
Honolulu, Hawaii 96850

October 4, 1984

RECEIVED
OCT 18 1984
VIN PACIFIC

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
630 South Beretania Street
Honolulu, Hawaii 96843

The Environmental Impact Statement (EIS) Preparation Notice for Windward Oahu Regional Water System Improvements project have been reviewed and have the following comments:

General comments:

1. A single EIS for all windward projects is too broad in scope. Because future circumstances may be different as compared to the present, we may be approving items that we may not be aware of.

2. There is little or no discussion on water-quality problems.

Itemized comments: (see attached comments from Kiyoshi)

Thank you for giving us the opportunity to review the EIS Preparation Notice for your Windward Oahu Regional Water Improvements.

Very truly yours,

Dan Davis
Acting District Chief

EIS - WINDWARD OAHU

by Kiyoshi Takasaki

Page	Paragraph	Line	Remarks
4	1	3	The phase "and will not be pumped" should be deleted. Our failure or refusal to "mine" stored dike-impounded water is not a wise policy. Water in storage should be mined during periods of low recharge and should be restored during periods of high discharge. This manipulation of storage for optimal development can be accomplished by either the use of bulkheads (restore and mine by free flow) or by pumping (mine). Water is restored during non-pumping periods.
4	3	9	After "bulkheaded" add the following "for the purpose of restoring storage".
5	2	2	Delete remainder of paragraph following Table 2.
6	Table	Heading	Replace "MAXIMUM POTENTIAL YIELD" with "PLANNED DEVELOPMENT". Also replace given maximum with a more realistic range in yields estimated for development.
7	Table	Heading	Same as page 6.
28	1	5	Replace "maximum potential yield of about 66 to 51 mgd" with a more realistic "planned development potential of about to mgd. The figures being the new sums of the ranges in the tables on pages 6 and 7.
37	Table		Streams in Lake and Hawaii are gaining streams at high altitudes and losing streams at low altitudes.

G-7

H-48

The League of Women Voters of Hawaii

STATE & ED FUND
49 S. HOTEL #314
HONOLULU, HAWAII 96813
PHONE: (808) 531-7448

October 30, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Subject: Draft Environmental Impact Statement for Windward Oahu Regional Water System Improvements Vol. I

Dear Dr. Miura:

We would like to thank you for the opportunity to comment on the Draft EIS for Windward Oahu Regional Water System Improvements, Vol. I.

1. The League is concerned that the Board of Water Supply appears to be confusing a "water development plan" and an EIS. Preparing a single EIS for a whole set of projects is sometimes defensible because such an EIS informs the citizens about "cumulative" impacts. However, in this particular instance (a total of 46 water development projects, 19 new reservoirs, and 148,540 linear feet of transmission pipelines), it falls short of such an objective, since the Waialua-Kahuku Regional EIS and an EIS for Honolulu have been prepared separately.

As a result, the Draft EIS fails in achieving either of the intended objectives, i.e., (1) providing indepth impact analyses and (2) providing information about cumulative impacts for the citizens and policy makers for making intelligent decisions.

The BWS should prepare an updated comprehensive water development plan for all of Oahu, including both the currently planned and projected projects, but dropping such clearly unfeasible projects as those identified in this EIS. Such a water resource development plan is called for by the Water Code. It must include clear estimates of population increase projections (beyond a simple statement that the DPED projects a population growth -- p. 2, statement by Kazu Hayashida) and the plans of the City and County of Honolulu to meet such population increase figures (the county "General Plan", "Development Plans" and County Zoning) in order to explain the need for the proposed project(s).

In addition, the BWS should prepare more detailed EIS's for a single or a smaller number of projects which examine an exact amount of water to be drawn, the exact use of water, and more site specific socio-economic, cultural and environmental impact analyses.

Membership in the League is open to all citizens, men and women, 18 years and over

2. This Draft EIS does not adequately account for the volume of surface and ground water currently withdrawn by non-BWS users, and the volume of groundwater and surface water required to maintain the necessary stream flow levels to sustain the existing agricultural and cultural activities, and the ecosystem.

First, non-BWS users and the volume of surface and ground water they draw must be identified. (The Water Code instructs the DLNR to collect such information and issue a certificate of use to recognize the reporting of such users and the volume of water drawn. This action has not yet taken place.)

Second, the minimum instream flow standards should be determined. (If necessary using tentative standards -- either for each stream, or a single standard for a group of streams according to season)

Third, the volume of water identified above should be added to the volume of water currently drawn by the BWS in the evaluation of any additional currently planned or future water development projects by the BWS and other parties.

3. The overall picture this Draft EIS and the Waialua-Kahuku Regional EIS provide readers amounts to a **large-scale "inter-basin" water transfer.**

While interstate and interbasin transfers are not new or unusual, such projects can have irreversable adverse impacts. Construction costs of large-scale water transfers are high, and economic losses and environmental costs in the basin of origin may also be high.

We are particularly concerned with the socio-economic and cultural impacts of such large-scale transfer. Will Windward Oahu able to maintain its lush tropical greens? Will it diminish aquifer recharge and reduce stream flows? (Will there be enough surface water to maintain the native flora and animals in the streams and swamps?) Will there be enough water left for the future Windward expansion, including increased agricultural activities? Will it in any way affect the lifestyles of the Windward Oahu? Will lowered water tables affect ground water quality and cause land subsidence?

Who will pay for the cost of development and transportation of water? The new users including the land and housing developers? Or the BWS water users in general including those in Windward Oahu (the case if the water rate is increased uniformly to cover the future capital improvement costs)?

The League believes the evaluation of new proposed interbasin water transfers should include:

- ample and effective opportunities for informed public participation in the formulation and analysis of proposed projects;
- examination of all short- and long-term economic costs including, but not limited to, construction, delivery, operation, maintenance and market interest rate;
- participation and review by all affected governments.

Furthermore, we must examine the social cost to the basin of origin; in this case, the Windward Oahu communities which may find gradual alteration of their natural environment, and accordingly changes in lifestyle and economic activities. Will the Windward Oahu residents be compensated for the social cost they may pay as a result of this water transfer?

This Draft EIS, for the reasons explained earlier, does not answer many questions which must be answered before conceiving such ambitious undertakings.

4. <u>In Conclusion</u>, the League believes that the preparation of this Draft EIS is premature and that the OEQC should not accept this EIS. We suggest that the BWS make further efforts to:

- prepare an updated, clearly written and reasonable water development plan
- encourage public dialogue about the development plan, and
- prepare an indepth EIS for a single project, or a group of smaller number of projects as appropriate.

An EIS must adequately account for the volume of surface and ground water currently withdrawn by non-BWS users, and the volume of groundwater and surface water to maintain the necessary stream flow levels to sustain the uses such as the existing agricultural and cultural activities, and the ecosystem.

While the development plan does not necessarily require such information, it must establish clear linkages to the population projections of different areas of Oahu, the County's land use plans, and the exising water use and the proposed water development projects.

Yours Sincerely,

Kiyoko K. Nitz

Dr. Kiyoko K. Nitz
Natural Resources Chair
League of Women Voters of Hawaii

cc: Board of Water Supply
Honolulu LWV

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

December 18, 1987

Dr. Kiyoko K. Nitz
League of Women Voters of Hawaii
49 South Hotel Street, #314
Honolulu, Hawaii 96813

Dear Dr. Nitz:

Subject: Your Letter of October 30, 1987 on the Draft Environmental Impact Statement (EIS) for Windward Oahu Regional Water System Improvements

Thank you for your comments on our EIS.

The Windward Regional Draft EIS is an assessment of our long-range plans which include source, storage, and transmission facilities. Many of the projects are still in the conceptual stage. Since all the projects have common objectives, we felt that a regional EIS followed with supplemental EIS's should give the public a comprehensive overview of the Board's future plans instead of EIS's for individual projects.

Supplemental EIS's will address environmental concerns associated with the projects. You will be given the opportunity to review and comment on them. When we find obvious environmental problems associated with projects that cannot be satisfactorily mitigated, those projects will be dropped from our long-range plans.

The State Water Code and Instream Flow Standards should ensure that streamflows and wetlands are preserved. All of our projects must comply with any requirements that may be imposed under these regulations.

We also offer the following responses to your comments as they relate to the regional EIS:

1. As required by the State Water Code, the City and County of Honolulu will be preparing a comprehensive water use plan. The plan will incorporate our and other users' water requirement. The plan will be used as a guide for future water development.

2. A table showing population projections and water demand will be included in the Final EIS.

3. The supplemental EIS's for new well projects will take into account all water users in the watersheds and basins where the wells will be located.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

4. Water developed for interbasin transfer will be within the sustainable yield of the basins and the requirements of the Interim Instream Flow Standards. Interbasin transfer of water is necessary to accommodate the development plans of the City and County. The City of Honolulu, which imports half of its total water requirement from the Pearl Harbor basin, could not have been developed unless water was imported from other basins. "New" water will be allocated on a "first come, first served" basis. Everyone is given an equal opportunity to obtain water from our system. Furthermore, farmers may develop any of the sources in the EIS as we do not have exclusive rights to any of the sources.

5. We do not anticipate adverse impacts to the rural-agrarian lifestyles along the Windward coast from our proposed projects. Changes are primarily guided by zoning and land use controls.

6. There is no evidence that ground water withdrawals on Oahu has caused any land subsidence.

7. The cost of developing new water facilities will generally be borne by developers and applicants for new water services. The cost of operating and maintaining the municipal water system, including transportation costs, are shared by all consumers.

8. Our Oahu Water Plan is based on the State's population projections and the City's Development Plans.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Office of Environmental Quality Control
~~VTN~~ Pacific, Inc.

LIFE OF THE LAND

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MGR
DEP
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October 30, 1987

Re: Draft EIS for Windward Oahu Regional Water System Improvements

Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Hayashida:

The Draft EIS indicates that without a model of how rainfall affected stream flow before the BWS developed dike-impounded ground water with a new water source, "... there would be no way to reliably quantify the extent to which ... a reduction in stream flow was due to low rainfall ... or to ground water development." When is the BWS going to pay for installation of stream and rainfall gages and computer modeling necessary to quantify the impacts of proposed BWS water sources on stream flow? We believe this issue should be explicitly addressed in the Final EIS for Windward Oahu Regional Water System Improvements.

As a matter of policy, Life of the Land opposes BWS development of the proposed Punaluu Wells V-C, Punaluu Wells V-D, Punaluu Tunnel or Inclined Wells, Kahana Wells III, Kahana Wells IV, Kahana Wells V, Hakipuu Wells, Waikane Wells, Uwau Wells, Waianu Wells, Waiahole Wells, Kaalaea Wells, Kaalaea Inclined Wells or Tunnel, Ahuimanu Inclined Wells or Tunnel, Maunawili Wells I, Maunawili Wells II, and Maunawili Wells III. We believe that public funds should not be invested in water sources with the potential to be unusable because of adverse impacts on stream flow. We will fight any attempt to amend State Instream Flow Standards on the basis that the BWS will not be able to put exploratory water sources into production.

We have no problems with BWS development of basal ground water in windward Oahu. Provided that the water table in the Ho'omaluhia Reservoir and Wildlife Pond remain stable, we also have no problems with ground water development from streams tributary to Kaneohe Stream. There is not much environmental or social value in water flowing down concrete channels or wasting into the ocean without ever becoming a stream or wetland.

Sincerely,

A.S. for

Arthur Mori
President

cc: OEQC
William Paty

19 Niolopa Place, Honolulu, Hawaii 96817. Tel. 595-3903

H-51

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

November 6, 1987

Mr. Arthur Mori, President
Life of the Land
19 Niolopa Place
Honolulu, Hawaii 96817

Dear Mr. Mori:

Subject: Your Letter of October 30, 1987 on the Draft EIS for the Windward Oahu Regional Water Systems Improvements

Thank you for commenting on the environmental document for our proposed water system projects.

We share your concern in the protection of streamflow. To avoid any adverse impacts to streams, we will be contracting with the U. S. Geological Survey to install stream gaging stations to monitor the impacts, if any, on streamflow from our proposed projects. We also have no intent to change any Instream Flow Standards that may be implemented and will either reduce or terminate pumpage as necessary to comply with the standards.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: ~~WTN~~ Pacific with letter

MAUNAWILI COMMUNITY ASSOCIATION
P. O. Box 943 *Kailua, Hawaii*

November 17, 1987

Mr. Lawrence Whang
Board of Water Supply
City and County of Honolulu
630 South Beretania St.
Honolulu, Hi 96843

Dear Mr. Whang:

The Maunawili Community Association is pleased to have the opportunity to comment on the Board of Water Supply EIS for Windward O'ahu Regional Water System Improvements.

We are pleased to see that the Board of Water Supply intends to protect the ground water quality (which we feel is important, not only to potable water users as a first use, but also as it runs off and affects Kawai Nui Marsh in our area); maintain existing water use by other parties (we believe that small farmers should be especially protected where they already exist or even where they might be encouraged to exist in the future); and attempt to avoid reduction of stream flows to less than standards...established by DLNR (the interim standards for Maunawili Streams call for no diversions and it seems likely that permanent standards will also protect the biota of Maunawili Valley Streams and Kawai Nui Marsh). These are very important issues to us as well. These measures should be a partial help to keep our agricultural aspect to the Windward side.

As a philosophical principle, Maunawili Community Association is willing to have an island-wide sharing of water resources, but with the specification that the sharing by all does not deprive the streams of their well-being (with respect both to quality and quantity of water) and that the small-area farmers are not forced to give up their agricultural production either because of lack of sufficient quantity of water or because of the costs of the water they need.

We have several concerns about the three (or 4) proposed wells in Maunawili that can be addressed before any further implementation of these wells is developed since these (3 or 4) Maunawili wells are not included in the six-year BWS CIP plan, and there are presently no existing facilities. The next few years should provide time to update the data concerning the fifteen gauge sites in Maunawili Valley.

The stream flow data for the nine gauge stations in Maunawili is old enough to be historically interesting, but not practically useful, except in conjunction with more recent gauge readings. In vol. 1 your Maunawili data is from 1959 & '61 and in vol. 2 your technical appendices for the following streams your data shows: Kahanaiki from 1916 only (p.C50), from Pohakea 1914, for Kamakalepo 1916, for Maunawili 1916 (with the note that the headwaters have been diverted above the station by Maunawili Ditch system since 1878, Makawao 1984 (from 1913 to 1916 and 1958 to 1965 taken yearly in June, from 1966 to 1984 it was measured only in September. For Maunawili Stream # 2580 1922 and 1923, for Maunawili Stream #2600 1913 through 1916, for Maunawili # 2605 from Sept. 1967 thru Sept 1971, and at Maunawili Ditch June 1954 through June 1965. (Vol. II, Pages C49-C54.) For many of the gauge stations there is no median monthly water flow rate. We can certainly come up with such data for the next few years during both wet and dry seasons? I don't know if there is still a gauge station at Pohakea, but there is still certainly a spring there.

There should be readings also for Omao Stream, Palapa Stream, Ainoni Stream, and Olomana Stream and the unnamed stream(?) in Makalii Valley (beyond the sewage treatment plant and to the right after the little bridge over Maunawili Stream) and the other unnamed branch(?) that leads into the Kahanaiki Stream. It would also be helpful to note when there is water in the three intermittent streams (on the side of Mt. Olomana), and to note how much flow there is. Would it be possible to train persons who live near any of these streams to take monthly readings? We would try to find such persons for you if this were a practical suggestion.

We understand that the well recently sunk on the Yasuo Yasuda's Royal Hawaiian Golf property (formerly Castle lands) is now pumping 25 gals/hour. At that rate we have been told the golf course owners will have to sink 12 wells for their 2 golf courses. Is this a reasonable estimate to reach 1/2 million g/d? If it is, and these private owners have 12 wells and B.W.S. has three wells each supposed to have a maximum yield of .5 mgd, and half (?) of our stream waters is already being diverted by the Maunawili Ditch System to Waimanalo, will there be any water left for the Marsh? for any taro or flower farming, much less to then give more to the people of Hawaii?

On p. 101 you say that "Diversions and/or development of high-level dike-impounded ground water have substantially reduced the dry-weather flow of most windward O'ahu streams..." All three of our Maunawili wells would be dike impounded water source and we can't afford a more reduced flow in these streams. We need guarantees that the Maunawili streams are not going to be affected.

Our community association would like to state for the record that our priorities are: 1) Windward streams, and especially for

us Maunawili streams, remain streams with sufficient water to promote a healthy stream and riparian biota and to protect whatever native species are still present both upstream and downstream in the marsh, 2) water for agricultural uses to promote and maintain some food independence from sources beyond the sea, 3) Potable water for residents and tourists simultaneously with 4) development of other water sources (reservoirs, desalinated ocean water, reuse of water depending on primary use for second and third uses, etc.), trapping rain water and continued conservation education.

With these priorities in mind we would like to suggest the following conditions:

1. No wells should be developed if they can not comply with the present no water diversion from any of Maunawili Valley Streams.
2. More data should be retrieved in the next few years for all Maunawili Valley streams and for the Kahanaiki streams flowing into the marsh.
3. If data cannot show that there will be stream diversion, and if diversions do occur after the well is developed there will be provisions that the well(s) will be capped/or closed/or shut down, except for periods when streams are at a sufficient level to support a positive healthy environment for stream and marsh biota, and not merely a minimal essential quantity.
4. The tremendous number of archaeological sites in Maunawili are becoming apparent with the present Bishop Museum work, and so we could expect that on land not recently disturbed by construction, it would be fairly likely to find something present. We suggest that a local resident, Dr. Paul Brennan, who is well-versed now in Maunawili archeology, is included in the on-site inspection at some point before development proceeds.

We would also like to encourage BWS's participation in regular monitoring and controlling the quality of the water in the upland streams and as the main streams feed into the marsh.

Sincerely,

Victoria S. Creed
President

cc: Sen. Clayton Hee, Rep. Whitney Anderson, City Councilmember Dennis O'Connor, State Commission on Water Resources Management Bob Nakata, MECA, OCA, PCA and KNB

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

December 9, 1987

Ms. Victoria S. Creed, President
Maunawili Community Association
P. O. Box 943
Kailua, Hawaii 96734

Dear Ms. Creed:

Subject: Your Letter of November 17, 1987 on the Draft Environmental Impact Statement (EIS) for Windward Oahu Regional Water System Improvements

Thank you for commenting on the environmental document for our proposed water system projects.

All of our well drilling projects shall be in compliance with the State Water Code and Instream Standards. Therefore, if required, we shall work with the State in evaluating existing stream gage data and in formulating a monitoring program if additional long-term data are required to establish more valid data on streamflows. We have an ongoing stream gaging program with the U.S. Geological Survey and we will, if necessary, contract with them on the installation of new stream gages where we have installed new wells.

Furthermore, we will be preparing supplemental EIS's, when required, for our proposed projects. The EIS's shall address in more detail the environmental feasibility of the projects and shall address the conditions for development of new wells which are stated in your letter. Your association shall be given the opportunity to review and comment on any supplemental EIS's that are prepared for projects in your area.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: WTN Pacific, Inc.

F- 821/87 cc

Native Hawaiian Legal Corporation

1164 BISHOP STREET, SUITE 900, HONOLULU, HAWAII 96813 TELEPHONE (808) 521-2302

October 31, 1987

Mr. Lawrence Whang
Board of Water Supply
City and County of Honolulu
630 South Beretania St.
Honolulu, Hawaii

RE: Comments on Draft Environmental Impact Statement for Windward Oahu Regional Water System Improvements

Dear Mr. Whang:

On behalf of George Fukumitsu, Waianae Land Use Concerns Committee, and Eric Enos, I am writing to provide you comments on the above-referenced document.

My clients continue to be concerned that the scope of planned development of the Windward Oahu Regional Water System will potentially cause immensely complex hydrological consequences that have not been adequately disclosed in your draft EIS. With the passage of the State Water Code, the Board should engage in a comprehensive study of the fresh water ecological systems in the Windward Oahu streams before attempting to withdraw groundwater sources upon which these streams might be dependent.

Instream Flow Standards. In addition, it should study and recognize its legal obligations under the BLNR instream flow standards before proceeding on any course of action which could interfere with these standards. The Code recognizes the dynamics between groundwater and surface water. The legislature intended to reflect this recognition in implementing the instream flow standards.

The Board must comply with these standards, not just when it is "practicable" to do so, as it mistakenly assumes on p. 170. The EIS suggests that Chapter 167, DLNR administrative Rules, does not apply to groundwater developments in Windward Oahu. p. 221. This interpretation would defeat the intent of the legislature in imposing an instream protection program through the Water Code.

On July 31, 1987, the BLNR adopted interim instream flow standards for Windward Oahu. It fixed the standard at 100% of the median flow for streams that have guage records. For unguaged streams, there can be no further diversions unless the BLNR or the Water Commission finds otherwise. Hence, the failure to resolve the issues related to the costs of stream flow modelling and the means to mitigate adverse effects cannot be left unresolved without posing a serious legal obstacle to proceeding with any aspect of water development in Windward Oahu.

Agriculture. Furthermore, the Board has not revealed in its EIS what the impact of its proposed development will be on small farmers who traditionally depend on surface waters which will probably be affected by the tunnels, wells, and shafts it plans to install. For example, the EIS does offer a qualitative prediction that:

> [t]he proposed Hakipuu wells may possibly reduce ground water seeps into taro patches and other cultivated areas makai of Kamehameha Highway. p. 213.

However the EIS does not quantitatively estimate any reduction of this seepage. Will this effect be negligible or significant?

On p. 169, the Board concedes it has not resolved whether it will finance the costs of modelling to determine such impacts. It also concedes it has not resolved what it will do to mitigate any projected effects on streamflow. However, the Board cannot simply dismiss its obligation to abide by state-imposed streamflow standards by asserting that they do not directly apply to groundwater withdrawal.

The EIS offers to allow Windward Oahu farmers to use BWS water on a first-come, first-serve basis in competition with all other users. Also, it has become widely known that the Board is moving to eliminate the current pricing differential between domestic and other urban water consumers, as the most recent increases in water rates demonstrate. However, the economic impact on diversified agriculture of the proposed improvements is not discussed. Similarly, the impact on changing the whole mix of economic uses of water is not revealed if the costs of the proposed improvements are born by water consumers.

1. How will the costs of the proposed $50 million in average annual expenditures for 1985-1990 (p. 30) be financed among water users?

2. Why is this capital cost not being assessed primarily to the recent developments which are causing the strain on the current water supply in the first place?

3. Wouldn't this alternative pricing strategy, i.e., marginal cost pricing, be the most economically efficient way of covering the costs of the proposed improvements?

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4. By charging current water customers more for the costs of making improvements to the existing water supply system (six-year CIP), isn't the Board causing those newer developments to be subsidized by those customers?

Secondary Impacts. The secondary and socioeconomic impacts of these proposed developments is thus profound and should be discussed, pursuant to the EIS rules. The master plan contemplates moving huge quantities of water from Windward Oahu to Honolulu to accommodate urban developments on that side of the island. Those effects should be disclosed. In addition, Honolulu's current sources of urban water would then be freed up to supply Leeward Oahu urban expansion. These effects should also be revealed. The EIS should incorporate in its discussion an analysis of the incremental costs being imposed by all the projected demand for water and discuss how those costs should be allocated to realize greatest economic efficiency and environmental protection.

Thank you for allowing me this opportunity to comment.

Sincerely,

ALAN T. MURAKAMI
Attorney-at-law

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

December 23, 1987

Mr. Alan T. Murakami
Native Hawaiian Legal Corporation
1164 Bishop Street, Suite 900
Honolulu, Hawaii 96814

Dear Mr. Murakami:

Subject: Your Letter of October 31, 1987 on the Draft Environmental Impact Statement for Windward Oahu Regional Water System Improvements

Thank you for your comments on the EIS.

The Windward Regional Draft EIS is an assessment of our long-range water plans which include source, storage, and transmission facilities. Many of our projects are still in the conceptual stage. Since all the projects have common objectives, we felt that a regional EIS with subsequent supplemental EIS's should give the public a comprehensive overview of the Board's future plans instead of EIS's prepared for individual projects.

Supplemental EIS's will address the environmental concerns that are associated with each project. You will be given the opportunity to review and comment on them. Where we find obvious environmental problems associated with certain projects, those projects will be dropped from our long-range plans.

The State Water Code and Instream Flow Standards should ensure that streamflows and wetlands are preserved. Our projects must comply with any requirements that may be imposed under these regulations.

We also offer the following responses to your comments as they relate to the regional EIS:

1. We have gone on record that we will work closely with farmers that are using streamflows or ground water to ensure that their sources of water are preserved.

ARD OF WATER SUPPLY
AND COUNTY OF HONOLULU

COPY

Mr. Alan T. Murakami
Page 2

December 23, 1987

2. Our annual budget is based upon projected revenues from water service fees and water facilities charges. Our water facilities charges reflect the pro-rata share of capital costs for new facilities and are assessed to applicants for new water service. Existing consumers subsidize new water system improvements only to the extent that the improvements provide a betterment for the existing systems.

3. Peak load pricing will encourage conservation but will penalize large water users. Our existing rate structure spreads the cost to operate, maintain, and improve the water system to all of our consumers according to the amount of water used.

4. Secondary impacts primarily applies to population growth and its associated demand for more housing and jobs. With a maximum potential yield of 40 mgd, approximately 230,000 additional people can be accommodated by the water system. However, most of the sources are likely to produce less than estimated, which decreases the number people that can be served.

We hope to have a fully integrated water system whereby water can be delivered from a water abundant area to any area of need on the island.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: VTN Pacific, Inc.

H-56

Pohakupu Community Association

Y - 810/87
cc

October 27, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 So. King Street, Room 104
Honolulu, HI 96813

Re: Windward Oahu Regional Water System Improvements EIS

Dear Dr. Miura:

Our comments regarding the newest EIS on the windward regional water system have not changed much from those we submitted to Mr. Hayashida in December of '84. As long as the BWS works closely with the state on setting policy and managing water, priority is given to the needs of the existing population rather than to the dreams of extravagant entrepeneurs, a cautious rather than rash approach is taken when operating in the realm of guesswork, and a long-term, protective outlook is maintained realizing that water is our most valuable resource then we feel the best needs of windward residents will be served. The extent to which the EIS reflects these views is the extent to which we support it.

Sincerely,

Robin Dwight
President

Vicki A. Owens
Planning Committee

cc: L. Whang, BWS
Kailua Neighborhood Board

P.O. BOX 1475, KAILUA, HAWAII 96734

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

November 6, 1987

Ms. Robin Dwight, President
Pohakupu Community Association
P. O. Box 1475
Kailua, Hawaii 96734

Dear Ms. Dwight:

Subject: Your Letter of October 27, 1987 to the Office of Environmental Quality Control on the Windward Oahu Regional Water System Improvements

Thank you for commenting on the environmental document for our proposed water system projects.

We will be working closely with applicable State agencies to protect, prevent degradation, and avoid depletion of Oahu's potable groundwater resources.

If you have any questions, please contact Lawrence Whang at 527-5221.

Very truly yours,

For KAZU HAYASHIDA
Manager and Chief Engineer

cc: OEQC
WTN Pacific, Inc. with letter

H-57

SIERRA CLUB, HAWAI'I CHAPTER
HONOLULU GROUP
P.O. BOX 11070, HONOLULU, HAWAI'I 96828
(808) 946-8494

October 30, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Re: Windward Oahu Regional Water System Improvements
Malaekahana to Makapuu, Oahu
Environment Impact Statement

We have studied this EIS and find that we cannot approve of this plan for supplying water for the future needs of Oahu for the following reasons:

I. There is a basic conflict in that the Board of Water Supply agrees to abide by the terms of the Water Code and by Minimum Stream Flow Standards and yet throughout the document there are statements which makes it clear that digging proposed wells will affect the streams and there is not sufficient data to guarantee a minimum stream flow that will ensure maintenance of stream life, aesthetic and recreational values and agricultural uses of the streams through dry periods. The document repeats many times that stream flow will be affected, but that amounts have not or cannot be easily determined. Cumulative effects are not sufficiently discussed. It is clearly pointed out that there may be affects on streams in other areas, or that it is possible for the effect to be slow in appearing. The difficulty of obtaining the data is gone into in some detail, as well as the complexity of the natural water systems.

Other pertinent statements are made on page 168: "reductions in stream flow due to BWS projects could be (should say, will be) proportionally significant during dry weather when the primary source of stream flow is leakage and overflow of dike-impounded ground water---- It is this effect during dry periods that we are concerned about. Farmers in Kahaluu are now experiencing this problem.

SIERRA CLUB, HAWAI'I CHAPTER
HONOLULU GROUP
P.O. BOX 11070, HONOLULU, HAWAI'I 96828
(808) 946-8494

Again, "Measuring the extent to which future BWS projects actually reduce stream flow is likely to be problematic and expensive----" Since there are less than twenty places where the streams regularly reach the ocean, we feel that these places, along with the estuaries, are extremely important in maintaining ecological balance for a productive eco-system for a variety of biota. The amount of water in the streams is also important in keeping the streams clear in times of great storms for flood control. This is only briefly discussed in the EIS. Because of former diversions, the EIS states that Waiahole streams probably now have less than one fourth of its former dry weather flow. It must be recognized that there are already many such diversions of Windward streams that have seriously diminished the natural flow of the streams.
Again on page 168, the BWS claims that their projects will not adversely affect the amount of surface runoff reaching Windward Oahu streams. We have viewed the present BWS project in Kahana State Park and cannot agree with this claim. The proof will come after the first major, prolonged rainfall. Most certainly, sediment content from so much earth-moving and vegetation clearing will reach the streams and the ocean.

II. We do not agree with the narrow interpretation by the BWS of its mandate by law. Nowhere does the mandate say that Oahu's highest quality water, directly from its originating source, must be provided at the cheapest cost for municipal purposes only, a larger part of which is used to flush toilets, wash cars, boats, driveways, etc. Cheaply produced water has been traditional, but many other traditional practices have fallen by the wayside in the rush for so-called progress. If we insist upon growth, then the BWS must find other than traditional methods for providing the water, and cost undoubtedly will be greater. This plan aims to develop all of the Island's remaining water, regardless of cost in actual and long time environmental costs, in this century.

SIERRA CLUB, HAWAI'I CHAPTER
HONOLULU GROUP
P.O. BOX 11070, HONOLULU, HAWAI'I 96828
(808) 946-8494

This will leave an exhausted resource and no choices for those who follow us. Planning cannot be done as if there is no tomorrow. Political planning is limited from election to election, therefore, it is up to those with the knowledge to provide more information and leadership. This document is proof that the knowledge is there in regards to the complexities of water systems, but only an engineering expertise is applied. A philosophy which speaks to the resource--maintaining, managing and perpetuating for future generations--is sadly lacking in this document. In the past, we remember a manager who worried about maintaining the watershed. Shouldn't this also be a part of the mandate?

Alternatives are mentioned, but are not seriously discussed and compared. There is no cost/benefit ratio analysis done on any project or its alternative. If, as predicted by the BWS, Oahu will eventually go to water de-salination of some sort, why shouldn't this alternative be vigorously persued now, rather than after the streams have dried up? Why can't large developers be required to supply their own water from outside the aquifer? With modern technology, there are many solutions that should be more thoroughly explored, including more vigorous conservation.

III. From the discussion on aesthetic and recreational impacts, one gets the impression that the only aesthetics that count are those which can be seen from the main highway. From the EIS, if the impcct occurs in an area of undeveloped open-space, there need be no concern about aesthetic destruction. The project in Kahana State Park, again, is an excellent example of that mind-set. The result will be difficult if not impossible to mitigate and is very upsetting to a hiker, or to anyone who wishes to get off the main highway to enjoy a natural setting.

The discussion on recreational impacts is entirely unsatisfactory, Seemingly, from the BWS point of view, a public park was designated for the primary purpose of water development. Any disruption to the recreational value of the park is not worth consideration. A deep

SIERRA CLUB, HAWAI'I CHAPTER
HONOLULU GROUP
P.O. BOX 11070, HONOLULU, HAWAI'I 96828
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disregard is shown for the value of hiking trails. One wonders if we have nothing but golfers among State and City officials. There is apparently a lack of awareness that any loss of trails on Oahu is serious---so serious that there has been formed a Trail Access Task Force, supported by the Trail and Mountain Club, Sierra Club, Oahu Pig Hunters Association, the University Women's Club, the Audubon Society, the Botanical Society and Council persons Bornhorst and Gill. Hikers do not seek every opportunity to get into areas of undeveloped open-space to view extensive destruction to the flora and fauna. We are well aware of the decline of native biota, but we do energetically work to preserve even the small amount of that which is left, and we do value, obviously much more than the BWS, even a single bush or tree or snail that has survived man's extensive destruction.

IV. The Hawaii Chapter of the Sierra Club has long had a policy of support for diversified agriculture and especially the small farmer. The Windward Water Development Plan has the potential for being completely destructive to what has been a fast-growing activity. Even though the Water Code grandfathers in the present farmers, 80% of those in Windward Oahu are dependent upon stream water. If the streams are depleted, this will be of no value. Again, the EIS states that the streams will be depleted. The Waihee Court Water Case is an example. Future expansion for small farmers is not taken into consideration, thus precluding options for future generations. It is clearly stated that some of the development will be irreversible. According to some farmers, water seepage is very important to their survival in dry weather, and they are presently suffering from water development already in place. The farmers do not agree with the BWS proposal that existing agricultural water sources may be replaced with subsidized municipal water service.

SIERRA CLUB, HAWAI'I CHAPTER
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Statements such as, "Apart from limited areas used for intensive agriculture and a few hiking trails, proposed BWS facilities will not displace existing land uses---" strike us as being misleading and even chauvanistic. BWS policies and development affect everything in the long run. Those "few" may not seem important to some but are vital to those affected. (page 165).

We also disagree with the intimation that agricultural production in Windward Oahu is of little importance. The statement refers to the single production of any one farm, but does not discuss the cumulative benefits to the community and to the Island as a whole. Farming is a productive activity, while so many of Hawaii's employment opportunities are service-oriented.

In conclusion, we do not want to see this plan go forward, only later to hear, "We didn't really mean to dry up the streams or to chase the farmers from their livelihood. We simply didn't have sufficient and valid data!" While we are fully aware of the life-necessity of pure water, we greatly value the other benefits of a natural water system. The State as a whole will suffer greatly if we allow these to fall by the wayside. We think that it is possible to have both with modern technology and with far-sighted and intelligent decisions. We suggest that the Board of Water Supply should go back to "the drawing board".

Mahalo for permitting us to comment. Aloha

Lola N. Mench
Conservation Committee
Honolulu Group, Hawaii Sierra Cl

OARD OF WATER SUPPLY
TY AND COUNTY OF HONOLULU

COPY

November 13, 1987

Ms. Lola N. Mench
Honolulu Group, Hawaii
Sierra Club
P. O. Box 11070
Honolulu, Hawaii 96828

Dear Ms. Mench:

Subject: Your Letter of October 30, 1987 to the Office of Environmental Quality Control on the Draft EIS for the Windward Oahu Regional Water System Improvements

Thank you for commenting on the environmental document for our proposed water system projects.

In response to your comments, we offer the following:

1. For projects that may have the potential to affect streamflows, we will be contracting with the U.S. Geological Survey to install gages to monitor those streams for compliance with the State's Instream Flow Standards. Because of the geological makeup of the Windward area, extensive monitoring of streamflows are required to determine their effects by specific well projects.

2. We find that groundwater development is the most feasible means to meet future water requirements. Development of alternative sources is costly and should be deferred until we reach the limit of groundwater development. We are required to provide water which meets the Federal and State's Safe Drinking Water Act requirements.

3. Aesthetic and recreational water uses within designated park and recreational areas will be preserved. We will comply with all environmental requirements that are imposed on our projects.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

4. We will be complying with the requirements of the State's Instream Standards which require that we maintain existing streamflows and the State Water Code.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

for KAZU HAYASHIDA
Manager and Chief Engineer

cc: Office of Environmental Quality Control
VTN Pacific, Inc.

THE ESTATE OF JAMES CAMPBELL

87-2361 cc

October 26, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Windward Oahu Regional Water System Improvements

This is in reference to the subject Environmental Impact Statement (EIS) draft dated April 6, 1987.

The EIS states that three wells are proposed for development in the Koolauloa aquifer (which extends from Punaluu to Kahuku), that will replace other wells. Other than the one well located mauka of Kahuku Hospital, there are no other Board of Water Supply (BWS) wells in the area unless the wells to be replaced are private wells.

The EIS also states that water will be taken from Kahuku to service windward and southern Oahu, excluding Malaekahana and Kahuku. We are concerned that drawing water from the Koolauloa aquifer in the area of Punaluu, which comes from the same aquifer, could have a serious impact on the water supply for Kahuku.

The Estate's Kahuku Water Management Plan, a copy of which was sent to BWS on July 25, 1984, sets forth our plans to develop the water resources on land owned by the Estate from the Laie-Malaekahana boundary on the east to the Waialee-Paumalu boundary on the west. We are following that plan very closely. We are concerned as to what the BWS plans will have on our potable water needs and our agriculture and aquaculture users.

It is our intent to be in contact with Lawrence Whang to review the impact of the BWS plans on our Kahuku Water Management Plan.

In the meanwhile, should you have any questions, please call Sam Keala of our office.

Very truly yours,

O. K. Stender
Chief Executive Officer

OKS:sak
cc: Kazu Hayashida
Lawrence Whang

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813-4380 (808) 536-1961

H-61

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

November 18, 1987

Mr. O. K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813-4380

Dear Mr. Stender:

Subject: Your Letter of October 26, 1987 on the Draft EIS for the Windward Oahu Water System Improvements

Thank you for commenting on the environmental document for our proposed water system projects.

We have no plans for replacing any existing wells in the Koolauloa aquifer. Your reference to replacement wells may have been misinterpreted from page 138 where we mentioned that Mr. Fred Trotter, a Bishop Estate lessee, proposes to re-establish three Kahuku Sugar Company intakes along Punaluu Stream.

Water level and water quality monitoring are being performed and will continue to be performed to insure that withdrawals in the Koolauloa aquifer are within the estimated sustainable yield. This will help to alleviate any adverse impacts to existing sources and guide the development of future sources.

Before we implement any future source development project, a supplemental environmental document will be prepared and will address a number of factors including streamflow regulations, aquifer integrity, and the impact on your "Kahuku Water Management Plan."

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: OEQC
VTN Pacific

OAHU SUGAR
P.O. Box "0"
Waipahu, Hawaii 96797
(808) 677-3577

P-797/c7 cc

Amfac

October 23, 1987

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 So. King Street, Room 104
Honolulu, HI 96813

Subject: Windward Oahu Regional Water System Improvements

Dear Dr. Miura:

We have reviewed the draft Environmental Impact Statement for Windward Oahu Regional Water System Improvements which the Board of Water Supply recently submitted. In this regard, we would like to make the following comments:

- The Waiahole Irrigation Company, Limited operates a water development and transmission system which extends from Kahana Valley to Waiahole Valley and then trans-Koolau to the Leeward side of Oahu. This water system is essential and vital to Oahu Sugar Company and must be carefully protected. We must be assured that each separate project contained in your draft EIS does not impact our system to any extent; hence, we must be consulted as each separate project between Kahana and Waiahole (including the Kaalaea inclined well or tunnel) is developed.

- The proposed Uwau wells and the Waianu wells appear to be located on property owned by the Waiahole Irrigation Company, Limited. In the event that these wells are developed, we would require compensation from the BWS for these sites.

Thank you for this opportunity to comment on this project.

Very truly yours,

W. D. Balfour, Jr.

W. D. Balfour, Jr.
President and Manager

cc: M. Burke
B. DeMent
Lawrence Whang, BWS

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

November 5, 1987

Mr. W. D. Balfour, Jr.
President and Manager
Oahu Sugar Company
P. O. Box "0"
Waipahu, Hawaii 96797

Dear Mr. Balfour:

Subject: Your Letter of October 23, 1987 to the Office of Environmental Quality Control on the Windward Oahu Regional Water System Improvements

Thank you for commenting on the environmental document for our proposed water system projects.

We will inform you as each separate water development project between Kahana and Waiahole (including the Kaalaea inclined well) is scheduled into our Capital Improvements Program.

Should we decide to develop the proposed Uwau and Waianu wells, compensation for these sites will be made.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

For KAZU HAYASHIDA
Manager and Chief Engineer

cc: Office of Environmental Quality Control
~~VPN~~ Pacific, Inc.

RECEIVED
BD OF WATER SUPPLY
OCT 2 12 07 PM '87

Zions Securities Corp.

55510 KAM HIGHWAY • LAIE, HAWAII 96762 • 293-9201

September 29, 1987

Board of Water Supply
City & County of Honolulu
630 South Beretania St
Honolulu, Hi 96843

Gentlemen:

We are in receipt of the Windward Oahu Regional Water System's Improvement plan, received in our office September 25, 1987.

My concern is the Laie and Wailele wells as proposed within your system. Both of these test wells are mauka of Laie water system's existing wells.

Your report indicated that about one-third of the prosed BWS Projects could develop ground water from basal aquifers. Development of these projects could cause saltwater infusion into coastal wells located in the same aquifers. Our concern, therefore, is that drawing water from the Laie and Wailele BWS wells will have a negative impact on existing wells within our water system.

We are also concerned about the unresolved issues related to the proposed BWS windward projects insofar as plans for reservoirs, access roads, transmission mains, booster pumps, electrical and telephone lines are not fully explained or outlined within your plans.

Your review and consideration of our concerns and comments would be greatly appreciated.

Very truly yours,

ZIONS SECURITIES CORPORATION

Marvin H. Stone, MANAGER

MHS:vrm

H-63

October 13, 1987

Mr. Marvin H. Stone, Manager
Zion Securities Corp.
55-510 Kamehameha Highway
Laie, Hawaii 96762

Dear Mr. Stone:

Subject: Your Letter of September 29, 1987 on the Draft Environmental Impact Statement (DEIS) for the Windward Oahu Regional Water System Improvements, Malaekahana to Makapuu

Thank you for commenting on the environmental document for our proposed facilities in Windward Oahu.

Regarding your concern on salt water intrusion, we anticipate no impact to your existing wells in Laie. The proposed draft from the Laie and Wailele Wells in addition to the existing draft from your wells are within the estimated sustainable yield for the area.

Supplemental environmental documents will be prepared and submitted to the Office of Environmental Quality Control for publication in their OEQC Bulletin for all projects whose environmental impacts are not fully addressed in the present document. Projects in the DEIS which meet Chapter 343, HRS requirements are the Kamooalii Wells I and II, Kuou Well II, Luluku Well, Kahana Wells II to V, Kahana Reservoir, and Kaluanui Wells. These projects were addressed in previous EIS's.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Office of Environmental Quality Control

MHS/HHM:jj
cc: K. Hayashida, L. Whang
87-2199

United States Department of the Interior

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

ES
Room 6307

15 MAR 1988

Mr. Kazu Hayashida
Manager and Chief Engineer
Honolulu Board of Water Supply
630 South Beretania Street
Honolulu, Hawaii 96843

RECEIVED
BD OF WATER SUPPLY
MAR 16 10 09 AM '88

Re: Draft Environmental Impact Statement for Windward Oahu Regional Water System Improvements, City and County of Honolulu

Dear Mr. Hayashida:

We have reviewed the referenced Draft Environmental Impact Statement (EIS) and offer the following comments for your consideration.

General Comments

Our primary concern with the proposed development of groundwater resources in Windward Oahu is the protection of instream flows to maintain stream habitats for native aquatic species and wetland habitats for endangered waterbirds. Despite the historic reduction of the streamflows from surface diversions and groundwater withdrawal and the degradation of aquatic habitats by channel modification, certain streams on Oahu still provide habitat for native fishes and invertebrates. Important species include the o'opu nakea, o'opu nopili, 'opae, and hihiwai. In addition, several streams along Windward Oahu feed wetlands that support endangered waterbirds and migratory waterfowl. We are pleased that the Board of Water Supply has stated its intent to comply with the instream flow standards established by the Board of Land and Natural Resources for Windward Oahu and regulations set by the Commission on Water Resource Management.

Specific Comments

a. The Draft EIS lists 27 water development projects that have the potential to deplete instream flows and affect wetlands by withdrawal of groundwater. To assist in your planning efforts, we have modified Table 28 of the Draft EIS to list the proposed projects that may affect wetlands and high quality streams (as designated in Appendix D of the Technical Appendices) (Enclosure 1).

We recommend that development of groundwater resources be avoided at sites where the reduction of surface flows may degrade stream or wetland habitat values for fish and wildlife. If the Board of Water Supply decides to develop some or all of the groundwater resources listed in the modified Table 28, we recommend that these sites receive priority for the development of permanent streamflow and rainfall monitoring stations and mitigation measures.

For your information, the Service recently installed artesian freshwater wells at the Kii Unit of James Campbell National Wildlife Refuge. This portion of the refuge is no longer dependent on surface flow from the Kii Ditch or from caprock springs. However, the Punamano Unit is still fed by caprock springs; therefore, an increase in salinity from the withdrawal of groundwater in the Koolauloa Basal Aquifer may have an adverse effect on endangered waterbird resources at the Punamano Unit.

Summary Comments

On July 30, 1987, the Board of Land and Natural Resources established interim instream flow standards for windward Oahu streams. The standards are as follows:

a. For gaged streams, the standard shall be 100% of the median flow computed after existing diversions have been subtracted.

b. For ungaged streams, no further diversions shall be allowed.

c. The interim standards can be modified on a stream-by-stream basis when additional and more specific data become available.

However, Chapter 167, Title 13, "Protection of In-stream Uses of Water, Windward Oahu," does not cover withdrawal of groundwater. As stated in the cover memorandum in the Draft EIS, we are pleased that the Board of Water Supply has voluntarily agreed to comply with the interim instream flow standards for Windward Oahu as applied to the development of groundwater. If the development of groundwater resources that may affect high and medium quality streams or wetlands cannot be avoided, we offer our assistance to the Board of Water Supply in the development of mitigation measures and monitoring programs.

We appreciate this opportunity to comment.

Sincerely,

for Willie R. Evans

Ernest Kosaka, Field Supervisor
Environmental Services
Pacific Islands Office

cc: DLNR

Enclosure

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Table 28. High and moderate quality streams and wetlands that may be affected by Honolulu Board of Water Supply water development projects. H = high quality and M = moderate quality streams as designated in Appendix D of the Technical Appendices.

Project	Stream	Wetland
Punaluu Wells V-C	Punaluu (H)	no wetlands present
Punaluu Wells V-D	Punaluu (H)	no wetlands present
Punaluu Tunnel	Punaluu (H)	no wetlands present
Punaluu Inclined Wells	Punaluu (H)	no wetlands present
Kahana Wells III	Kahana (H)	Kahana wetlands
Kahana Wells IV	Kahana (H)	Kahana wetlands
Kahana Wells V	Kahana (H)	Kahana wetlands
Hakipuu Wells	Hakipuu (M)	Moili Pond
Waikane Wells	Waikane (H)	Waikane wetlands
Uwau Wells	Waiahole (H)	wetlands present
Waianu Wells	Waiahole (H)	wetlands present
Waiahole Wells	Waiahole (H)	wetlands present
Kaalaea Wells, Tunnel, Inclined Wells	Kaalaea (M) Haiamoa (M) Waihee (M)	Kahaluu wetlands
Kahaluu Wells II	Waihee (M)	Kahaluu wetlands
Ahuimanu Inclined Wells and Tunnel	Ahuimanu (M)	no wetlands present
Haiku Well	low quality stream	Heeia wetlands
Luluku Reservoir	Kamooalii (M)	no wetlands present
Kuou Wells II	Kamooalii (M)	Hoomaluhia wetlands
Balekou Wells	Kamooalii (M)	Hoomaluhia wetlands
Pali Highway Drains	Kamooalii (M)	Hoomaluhia wetlands
Maunawili Wells I, II, and III	Maunawili (M)	Kawainui marsh

March 29, 1988

Mr. Ernest Kosaka
Field Supervisor
Environmental Services
Pacific Islands Office
Fish and Wildlife Service
United States Department of the Interior
P. O. Box 50167
Honolulu, Hawaii 96850

Dear Mr. Kosaka:

Subject: Your Letter Dated March 15, 1988 Commenting on the Draft Environmental Impact Statement (EIS) for the Windward Oahu Regional Water System Improvements

Thank you for reviewing and commenting on the Draft EIS.

Your letter will be included in the Final EIS. We also have the following response to your comments:

1. We reiterate our commitment to observe instream flow standards as established by the Commission on Water Resource Management.

2. Table 29, rather than Table 28, will be revised in accordance with your letter. We will include Kahaluu Wells II as possibly affecting wetlands although we are not aware of any open water other than irrigated taro patches in the vicinity. Most of the groundwater, which these wells will develop, surfaces near Ahilama Road and is carried in a drainage ditch to Waihee Stream.

3. We have arranged for the United States Geological Survey to monitor streams for us where applicable in the past and will continue to utilize their services in the future.

4. The department will operate newly developed water sources in conformance with the requirements of the State Department of Land and Natural Resources' instream flow standards.

5. We appreciate your offer of assistance in the development of mitigation measures and monitoring programs.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: VTN Pacific