August 17, 1982

Ms. Jacqueline Parnell, Director
Office of Environmental Quality Control
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Dear Ms. Parnell:

Re: Revised Environmental Impact Statement for Makawao-Kula Water Treatment Plants

I have reviewed the Revised Environmental Impact Statement for the Makawao-Kula Water Treatment Plants prepared by the Department of Water Supply.

I hereby accept the Revised Environmental Impact Statement.

Your expeditious review and processing of this document will be appreciated. Should you have any questions, please contact William S. Haines at 244-7816.

Very truly yours,

HANNIBAL TAVARES
Mayor, County of Maui

cc: Dept. of Water Supply
    Environmental Impact Study Corp.
    Norman Saito Engineering Consultants, Inc.
    Roy Takemoto
REVISED ENVIRONMENTAL IMPACT STATEMENT
MAKAWAO-KULA WATER TREATMENT PLANTS
COUNTY OF MAUI
DEPARTMENT OF WATER SUPPLY

REVISED
ENVIRONMENTAL IMPACT STATEMENT
FOR THE
MAKAWAO AND KULA WATER TREATMENT PLANTS
Maui, Hawaii

Submitted By:

[Signature]
William Haines
Director
Department of Water Supply

Prepared By:
Environment Impact Study Corporation
Honolulu and Maui, Hawaii

June, 1982
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AND OFFICIAL CONTACT:
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[Continued on next page]
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ERRATA SHEET

All references to Chapter 49, Public Health Regulations (PHR) are amended to read Chapter 20, Title 11, Administrative Rules which is the current state regulation for potable water systems. Chapter 49, PHR was revised as Chapter 20, Title 11, Administrative Rules on December 26, 1981. In its present form, there is no standard for sodium. The proposed 20 parts per million mcl was reduced to a requirement to monitor for sodium.
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REVISED ENVIRONMENTAL IMPACT STATEMENT

Maui, Hawaii

PROPOSING AGENCY: Department of Water Supply, County of Maui

INITIAL ACCEPTING AUTHORITY: Mayor, County of Maui

FINAL ACCEPTING AUTHORITY: Governor, State of Hawaii
The Department of Water Supply, County of Maui, proposes to construct three water treatment plants to enable the Makawao and Kula water systems to conform with Federal Safe Drinking Water Regulations. Proposed sites for the plants are located near the Kamole Weir (Wailoa Forebay), and Olinda and Piiholo reservoirs. The plant near Kamole Weir will primarily serve the Makawao service area and provide water to the Kula service areas during drought conditions; the plant near Olinda Reservoir will primarily serve the Upper Kula service area. Lower Kula. The proposed water treatment facilities will utilize various types and combinations of treatment units to achieve the desired water quality. The selection of these unit processes depends upon the type and amount of contaminants in the water, as determined by pilot testing.

The primary objective of the proposed project is to furnish consumers with safe and appealing drinking water at a reasonable cost. Present day construction costs for the three plants are estimated at $14.6 million.

Located on the northwest flank of the dormant volcano, Haleakala, the proposed sites are underlain by the Honomanu Volcanic Series and the Kula Volcanic Series.

Soils at the Kamole Weir site are Hamakuapoko silty clay and those at the Piiholo and Olinda reservoir sites are Olinda loam. At all sites, permeability is moderately
rapid, runoff is slow to medium, and the erosion hazard is slight to moderate. The sites are located toward the windward side of Maui and receive rainfall from both winter storms and year-round trade wind showers.

Water sources of the Makawao and Kula water systems are surface waters. Water quality is thus poor after periods of intense rainfall. For the protection of the consumer, the facilities will be designed to provide treatment for the two major contaminants, turbidity and bacteria.

No rare or endangered species of plants or animals were seen or are potentially present on the project site. No significant archaeologic or historic materials or sites were located during the surface reconnaissance of the project site.

Electrical and telephone services are available for all three sites from nearby overhead lines. Disposal of dewatered waste water residue will be required as a routine procedure.

The proposed project will not alter the demand for emergency services in the areas of the three sites.

The state land use designation for the three sites is Agriculture. The Piiholo and Olinda sites are designated General Agriculture by the Makawao-Pukalani-Kula General Plan. The Kamole Weir site is not within the
General Plan boundaries. The proposed project will contribute to attainment of County General Plan policies for long-term development, under the category of Utility and Facility Systems. Maui County Planning Commission Special Use Permits will be required.

The proposed project will generate short-term primary impacts affecting air quality, noise levels and traffic. The adverse construction-related impacts will be mitigated by appropriate measures.

Long-term primary impacts resulting from the project include impacts on air quality and noise levels, and an improvement of the quantity and quality of potable water in the Makawao and Kula areas.

The secondary adverse impacts of the proposed project will be limited to the loss of 3 to 4 acres of land, used for grazing. However, this loss will not adversely affect cattle production.

Several alternatives have been investigated. They include: "no action", alternative sites, alternative water treatment plant design, alternative method of compliance and alternative phasing of the treatment plants.

The construction materials, capital, energy, and labor involved in this project will be irreversibly and irretrievably committed. The water treatment plants are expected to improve the quality of potable water in the area, and meet the requirements mandated by the Federal Safe Drinking Water Act.
Proposed Project

1
SECTION 1
DESCRIPTION OF THE PROPOSED PROJECT

I. INTRODUCTION

The Department of Water Supply, County of Maui, proposes the construction of three water treatment plants for the Makawao and Kula water systems, to meet the requirements mandated by the Federal Safe Drinking Water Act.

The treatment plant sites will be located near the Kamole Weir (Wailoa Forebay), and Olinda and Pihiolo reservoirs (Figures 1-1 through 1-4). The plant near Kamole Weir will primarily serve the Makawao service area and provide water to the Kula service area during drought conditions; the plant near Olinda Reservoir will primarily serve the Upper Kula service area; and the plant near Pihiolo Reservoir will serve the Lower Kula service area. This is discussed in greater detail later in this section.

II. BACKGROUND AND OBJECTIVES

A. Background

The construction of the three water treatment facilities is required to conform to the National Interim Primary Drinking Water Regulations established by PL 93-523 (June 24, 1977) and State Department of Health Regulation, Chapter 49, Potable Water Systems (August 16, 1977). The United States Environmental
Protection Agency (USEPA) has developed primary and secondary drinking water standards to replace the United States Public Health Service Standards. The primary standards are based on dangers to health and are legally enforceable. The requirements for specific maximum contaminant levels (MCL) are found in Appendix A of this report.

B. Objectives

1. General

The primary objective of the water treatment plants is to: first, furnish water safe for human consumption; second, produce water that is appealing to the consumer; and third, produce water using reasonable facilities with respect to capital and operating costs.

2. Specific

The County of Maui has requested the consultants to perform the following:

- Review all laws, ordinances, regulations, standards and other data
- Consult with applicable agencies
- Develop final design criteria for the treatment facilities, including construction cost and operations and maintenance estimates
- Evaluate treatment methods and alternatives
- Evaluate alternative treatment sites
III. GENERAL DESCRIPTION OF THE EXISTING WATER SYSTEM

The Makawao-Kula potable water supply system is a complex, interconnected system located on the northwestern slope of Haleakala. Refer to Figures 1-5 and 1-6. Also refer to Table 1-1 for the storage capacity of the various dams, reservoirs and tanks in the Makawao-Kula system.

The following discusses the individual systems; however each system must be viewed as part of one larger system because of the interconnections.

A. Kula Water System

The Kula water system is the most complex of all the water systems on the island of Maui [1.1]. It serves the Ulupalakua-Kanaio area as well as the communities (i.e., Oïlinda) within the Kula area. This system is divided into two subsystems, the Lower and Upper Kula systems, which are interconnected at several locations.

1. Lower Kula System
   a. Sources

Water for the Lower Kula system is from a series of seven surface intakes located in the upper region of Waikamoi watershed. The intakes are located between the 2,500- and 3,000-feet elevations, in the following
### Table 1-1

**Storage Capacity**

<table>
<thead>
<tr>
<th>TANK NUMBER</th>
<th>DESCRIPTION</th>
<th>LOCATION</th>
<th>CAPACITY</th>
<th>ELEVATION (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>388</td>
<td>Waikamoi Arch Dam</td>
<td>Waikamoi</td>
<td>10.5 MG</td>
<td>4,282</td>
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<tr>
<td>389</td>
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<td>Waikamoi</td>
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<tr>
<td>252</td>
<td>Concrete Reservoir</td>
<td>Olinda</td>
<td>3.0 MG</td>
<td>4,136</td>
</tr>
<tr>
<td>392</td>
<td>Steel Tank</td>
<td>Omaopio</td>
<td>2.1 MG</td>
<td>3,886</td>
</tr>
<tr>
<td>368</td>
<td>R.W. Tank</td>
<td>Kula Heights</td>
<td>20,000 Gal.</td>
<td>3,867 *</td>
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<tr>
<td>367</td>
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<td>Haleakala Acres</td>
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<tr>
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<td>Alae</td>
<td>2.1 MG</td>
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</tr>
<tr>
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<td>Waikohuli</td>
<td>70,000 Gal.</td>
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<td>Keokea</td>
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<tr>
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<td>Kamaole</td>
<td>0.5 MG</td>
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<tr>
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<td>East Kuhulu</td>
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<tr>
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<td>West Kuhulu</td>
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<td>3,040 *</td>
</tr>
<tr>
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<td>Haalo</td>
<td>12,000 Gal.</td>
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<tr>
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<td>Steel Cylinder</td>
<td>Ulupalakua</td>
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<tr>
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<td>Steel Tank</td>
<td>500 Gal.</td>
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<td></td>
</tr>
<tr>
<td>394</td>
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<td>Kuhulu Upper</td>
<td>500 Gal.</td>
<td>2,950 *</td>
</tr>
<tr>
<td>354</td>
<td>Steel Tank</td>
<td>Kuhulu Lower</td>
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<tr>
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<td>Kamaole</td>
<td>500 Gal.</td>
<td>2,900 *</td>
</tr>
<tr>
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<td>Poli Poli</td>
<td>12,000 Gal.</td>
<td>3,245</td>
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<tr>
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<td>Naalae</td>
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<tr>
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<td>Waikoa Farm Lots</td>
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<tr>
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<td>Realahou #1</td>
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<td>R.W. Tank</td>
<td>Realahou #2</td>
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<tr>
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<tr>
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<td>300 Gal.</td>
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<tr>
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<tr>
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<tr>
<td>372</td>
<td>R.W. Tank</td>
<td>Lower Kimo #2</td>
<td>5,000 Gal.</td>
<td>2,900 *</td>
</tr>
<tr>
<td>375</td>
<td>R.W. Tank</td>
<td>Lower Kimo #1</td>
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<td>3,179</td>
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<tr>
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<td>R.W. Tank</td>
<td>Kula Orchard</td>
<td>50,000 Gal.</td>
<td>3,265 *</td>
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<tr>
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<td>Upper Kimo #2</td>
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<td>3,446 *</td>
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<td>Nagamatsu (W)</td>
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<tr>
<td>362</td>
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<td>Nagamatsu (E)</td>
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<td>371</td>
<td>R.W. Tank</td>
<td>Harry Field</td>
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<td>TANK NUMBER</td>
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<td>CAPACITY</td>
<td>ELEVATION (ft)</td>
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<td>-------------</td>
<td>-------------------</td>
<td>---------------</td>
<td>-----------</td>
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</tr>
<tr>
<td>359</td>
<td>Steel</td>
<td>Kamehameha</td>
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<td></td>
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<td>Lateral</td>
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<tr>
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<tr>
<td>398</td>
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<td>Kukahuelo #3</td>
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</tr>
<tr>
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<td>25,000 Gal.</td>
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<td>Concrete Tank</td>
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<td>Unknown</td>
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<tr>
<td>272</td>
<td>Steel Pressure Tank</td>
<td>Olinda</td>
<td>500 Gal.</td>
<td>3,500</td>
</tr>
<tr>
<td>273</td>
<td>Steel Pressure Tank</td>
<td>Olinda</td>
<td>500 Gal.</td>
<td>3,100</td>
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<tr>
<td>271</td>
<td>R.W. Tank</td>
<td></td>
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<td>2,730</td>
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<tr>
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<tr>
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<td></td>
<td>Piholo Reservoir</td>
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<td>50.0 MG</td>
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</tr>
<tr>
<td>254</td>
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<td>2,464</td>
</tr>
<tr>
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<td>5,000 Gal.</td>
<td>Unknown</td>
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<tr>
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<td>R.W. Tank</td>
<td></td>
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<tr>
<td>264</td>
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<td>1.0 MG</td>
<td>1,684</td>
</tr>
<tr>
<td>266</td>
<td>Concrete Tank</td>
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<td>1,673</td>
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<td>257</td>
<td>Steel Tank</td>
<td></td>
<td>25,000 Gal.</td>
<td>1,422</td>
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<td>269</td>
<td>R.W. Tank</td>
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<td>1,580</td>
</tr>
<tr>
<td>255</td>
<td>Steel Tank</td>
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<td>300,000 Gal.</td>
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<tr>
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<td>263</td>
<td>Steel Tank</td>
<td></td>
<td>100,000 Gal.</td>
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<tr>
<td>275</td>
<td>Steel Tank</td>
<td></td>
<td>70,000 Gal.</td>
<td>1,421</td>
</tr>
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<td>262</td>
<td>Steel Tank</td>
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<td>871</td>
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<td>261</td>
<td>R.W. Tank</td>
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<td>705</td>
</tr>
<tr>
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<td>R.W. Tank</td>
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<td>5,000 Gal.</td>
<td>640</td>
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<tr>
<td>259</td>
<td>Steel Tank</td>
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<td>803</td>
</tr>
<tr>
<td>403</td>
<td>Steel Tank</td>
<td>Olinda</td>
<td>12,000 Gal.</td>
<td>1,030</td>
</tr>
</tbody>
</table>

* Unconfirmed
streams: Honomanu, Haipuaena, Puohokamoa (east, west and middle), and Waikamoi (east and west).

The surface intakes are located in a region of higher rainfall (217" to 317" isohyetal lines) than are the water sources of the Upper Kula system.

The surface water from the seven intakes is collected and transmitted through a 24-inch line into the Piholo 50 million gallon (MG) open, concrete-lined storage reservoir. The water is then conveyed through a 24-inch line which reduces to an 18-inch line approximately 3,000 feet west of the reservoir. The 18-inch line conveys water southwesterly to Naalae Road.

b. Capacity

The rated capacity of the 18-inch line is approximately 5.0 million gallons per day (MGD). When required, water can be pumped from Kamole Weir (Makawao system) through a four-stage pump station/force main (18-inch) which connects at the intersection of West Olinda Road.

1-12
c. **Treatment**

Chlorinators are located at Pihiolo Road, Omaopio and Kealahou. Water pumped from Makawao is also chlorinated.

d. **Storage System**

The major storage facility is the 50 million gallon concrete Pihiolo reservoir located in the Makawao Forest Reserve. This reservoir feeds 12 storage tanks ranging in size from 10,000 gallons to 2 million gallons. Please refer to Table 1-1 for additional information.

e. **Treatment Plant Size**

The treatment plant will be designed to handle 2.5 MGD, and ultimately 5 MGD.

2. **Upper Kula System**

a. **Source**

The major water sources for the Upper Kula system are from Haipuaena Stream intake, middle Puohokama Stream and Waikamoi Stream, located at the 4,200-foot elevation. The water is transported via a 24-inch by 12-inch redwood flume and 12-inch tubing into Waikamoi Dam. The water from the dam flows through a 48-inch pipe which conveys water
into two 15.0 MG concrete reservoirs. A
16-inch gravity transmission line then
conveys the water to the booster pump and
a 12-inch line into a 3.0 MG steel storage
tank which overflows into the open, butyl
rubber lined 8.5 MG Olinada Reservoir.

During drought conditions, water from
Kamole Weir (Makawao system) can be pumped
up to the Upper Kula system, as well as
to the Lower Kula system.

Water can also be pumped up from the
Lower Kula system (Omaopio, and Kealahou)
to the Upper. For example, the capacity
of the Omaopio pumps from the lower system
to the upper system is presently 0.9 MGD
and potentially 1.9 MGD.

Additional water is also pumped from
the lower Waikamoi catchment basin (3,100-
foot elevation). This supplements the upper
system.

b. Capacity

The rated capacity of the 12-inch line
from Waikamoi to Olinda is 1.5 MGD. The
capacity increases to 2.5 MGD when the
booster pump is used.
c. Treatment

Chlorinators are located at Olinda Reservoir, Omaopio, Kealahou, Alae, Hapapa and along Upper Kimo Drive.

d. Storage System

The major facilities include: Waikamoi Arch Dam, Waikamoi Dam, two 15 million gallon concrete Waikamoi reservoirs, 3 MG steel Olinda tank, 8.5 MG concrete Olinda Reservoir, 2.1 MG steel Omaopio tank, 2.1 MG Alae tank and 0.5 MG steel Kamole tank reservoir. There are also 31 minor storage facilities ranging in size from 500 gallons to 70,000 gallons.

e. Treatment Plant Size

The treatment plant will be designed to handle 2.5 MGD.

B. Makawao Water System

The Makawao water system serves the communities of Makawao, Pukalani, Halimaile, Kokomo, Kula, Kaupakulua, Haiku, Ulumalu, Pauwela and Peahi.

1. Source

Water for this system during normal conditions is from Awalau and Opana Streams' intakes which is mixed with water from the Lower Kula

1-15
line in Maluhia Tank. Additional water can also be obtained from the Upper Kula transmission system.

During drought conditions, water for Olinda, Makawao, Kokomo, Pukalani, Haliimaile and Haiku is provided by the Kamole Weir located at the Wailoa Ditch and is pumped through a 24-inch force main to the Pookela storage tank. Water is also provided for Kuiaha, Kaupakulua, Ulumalu, Pauwela and Peahi by the Kuiaha Intake located also along Wailoa Ditch. The Lilikoi intake also services Haiku. When the treatment plant is completed, water sources not in compliance will not be used.

An agreement between Alexander and Baldwin, Inc. and the County of Maui allows for the removal of up to 16 MGD of water from the Wailoa Ditch. This agreement allows for the removal of water at Kamole Weir, which is pumped to the Makawao, Lower Kula and Upper Kula systems.

2. **Capacity**

Between Kamole Weir and Pookela Tank, the pumping capacity is 7 MGD at present, with a potential of 12 MGD.
3. **Treatment**

Automatic gas chlorinators provide treatment at the Haliimaile, Maluhia, Haiku, West Kuiaha, Opae Pilau, and Pookela tanks.

4. **Storage System** (Refer to Table 1-1.)

There is a total of 18 storage facilities normally fed by the Awalau and Opana streams' intakes. The 50,000-gallon steel Olinda tank receives water from the Kula system during normal conditions. Peahi, Kuiaha, Kaupakulua, Pauwela and Ulumalu are served by the 12,000-gallon steel Opae Pilau Tank, 10,000-gallon Peahi Tank, 70,000-gallon West Kuiaha Tank and 5,000 Tamayose Tank. Pukalani is served by 0.85 MG concrete tank, 25,000-gallon steel cylindrical tank, 70,000-gallon steel tank, 1.0 MG concrete tank. The rest of Makawao is served by the 50,000-gallon Olinda Tank, 0.5 MG Maluhia Tank, 0.3 MG Pookela Tank, 2 MG Pookela Tank, 70,000-gallon Haiku Tank, 0.1 MG Kokomo Tank, and 47,000-gallon Haliimaile Tank.

5. **Treatment Plant Size**

The treatment plant will be designed to ultimately handle 10.0 MGD.
IV. WATER RESOURCES

(Please refer to Appendix B for additional information.)

A. Kula Water System

The water resources of the Upper and Lower Kula water systems are limited. The minimum amount of water available is based on stream flows which vary during drought conditions from 0.1 to 0.5 MGD. The maximum water available is presently limited by the pipeline capacity and pumps.

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Kula Intake</td>
<td>0.005 MGD</td>
<td>1.5 MGD</td>
</tr>
<tr>
<td>Lower Kula Intake</td>
<td>0.35 MGD</td>
<td>5.0 MGD</td>
</tr>
</tbody>
</table>

B. Makawao System

Maximum withdrawal from the Wailoa Ditch is limited by the water agreement between the County of Maui and East Maui Irrigation Company, which limits withdrawal up to a maximum of 16 MGD.

V. WATER QUALITY

The water quality of the surface water sources of the Kula and Makawao water systems is an important aspect for the design of the treatment facilities. Since the water sources are surface waters, the water quality is poor after periods of intense rainfall. The runoff erodes gulches and stream banks and creates turbidity problems.
Also, the watershed of the Kula system is subject to leaching of humic material and produces the characteristic yellow-brown colored water. The runoff can also carry bacteria into reservoirs and may present potential health problems.

For these reasons, and for the protection of the consumer, it is essential that the water be properly treated to conform to the standards established by Federal and State governments.

The preliminary testing of the water indicates that turbidity and bacteria are the two major areas of concern and the treatment facilities will be designed to provide treatment for the contaminants. Additional information on analysis and test results of the existing surface water quality can be found in Appendix C.

VI. EXISTING WATER CONSUMPTION

A map showing the approximate combined service area of the Kula and Makawao water systems is presented in Figure 1-7. General information on water consumption is presented below. Refer to Appendix D for additional information.

A. Kula Water System

There are approximately 1,902 metered connections, and average daily consumption is estimated at 1.9 MGD. Approximately 50% of the water consumed is used for agricultural purposes.
B. Makawao Water System

There are approximately 3,351 metered connections, and average daily consumption is estimated at 1.36 MGD.

VII. PROPOSED WATER TREATMENT FACILITIES

The proposed water treatment facilities will utilize various types and combinations of treatment units to achieve the desired water quality. The selection of these unit processes depends upon the type and amount of contaminants in the water, as determined by pilot testing. In general, the Upper Kula (Olinda Site) and Lower Kula (Piilolo site) plants will use the processes of rapid mixing (flash mixing), flocculation, sedimentation, filtration, and disinfection; and the Makawao (Kamole Weir) plant will use all of these processes except flocculation and sedimentation. Refer to Appendix B for more details. Based on preliminary test results, disinfection will most likely consist of chlorination.

Generally, the waste water will undergo concentration (thickening) and then dewatering. The method for disposal of the dewatered sludge is delivery to a sanitary landfill.

A. Makawao Water Treatment Plant (Kamole Weir Site)

This plant will basically use the unit processes described above, except that preliminary test results indicate that the sedimentation process will not be
required. Space will be provided for this process in the event that it is desired at a later time. Refer to Figure 1-8.

The Makawao Water Treatment Plant (WTP) will be designed to bring the water into conformance with Federal and State standards and, based on preliminary tests, the contaminants which will have to be addressed include the following: coliform organisms (bacteria), turbidity, corrosivity, cadmium, iron, total trihalomethanes (THM), pH, odor, and sodium. The plant will essentially be designed to treat for the first two of these contaminants, and it is anticipated that corrosivity, cadmium, THM and odor will be reduced and pH adjusted. Sodium will increase because of the treatment process but will not exceed standards. This site will be located on a County-owned parcel of land identified as Tax Map Key (TMK) 2-5-04: portion 39 (Lot A).

B. Lower Kula Water Treatment Plant (Piiholo Site)

This plant will also basically use the unit processes described above. Refer to Figure 1-9. The plant will most likely be located on a parcel of land identified as TMK 2-4-13: portion 62. This parcel is presently privately owned.
LEGEND:
1. STREAM INTAKES
2. 50MG. PIHILO RESERVOIR
3. FLOW CONTROL VALVE
4. ALUMINUM FEED
5. POLYMER FEED
6. pH CONTROL
7. RAPID MIX TANK
8. FLOCCULATION TANK
9. SEDIMENTATION TANK
10. SAND FILTER (DUAL MEDIA)
11. WET WELL & PUMP STATION
12. BACKWASH FEED
13. CHLORINE FEED
14. FILTER BACKWASH STORAGE
15. DEWATERING
16. SUPERNATANT RETURN
17. DEWATERED SLUDGE TO LANDFILL
18. CLEARWELL STORAGE TANK
19. TREATED WATER

LIQUID FLOW
SOLIDS FLOW
CHEMICAL FEED

FIGURE 1-9

PROPOSED LOWER KULA WTP
The Lower Kula WTP will be designed to bring the water into compliance with Federal and State standards and, based on preliminary tests, the contaminants which will have to be addressed include the following: coliforms, turbidity, color, corrosivity, cadmium, lead, THM, iron, manganese, pH, and odor. It is anticipated that the plant will be designed to treat for the first two of these contaminants, and that those remaining will be reduced in the process, and pH adjusted.

C. Upper Kula Water Treatment Plant (Olinda Site)

The Upper Kula WTP will use the unit processes described above, with the addition of pH adjustment after disinfection. Refer to Figure 1-10. The plant will be located near the Olinda Reservoir on a parcel of land identified as TMK 2-3-6: portion 6. The parcel is presently owned by the State of Hawaii.

As with the other two plants, this plant will be designed to meet applicable Federal and State standards. Based on preliminary water quality tests, the contaminants which will have to be addressed include the following: coliform, turbidity, color, corrosivity, cadmium, iron, THM, and pH. It is anticipated that the plant will be designed to treat the
FIGURE 1-10

PROPOSED UPPER KULA WTP
first two of these contaminants, and that most of those remaining will be reduced in the process, and pH adjusted.

VIII. FUNDING

Funding for the design and construction of the proposed projects will come from two sources:

1) State Department of Health Act 243, SLH 78, Item E18, Allotment Advice No. 401 in the sum of $317,000 and Allotment Advice No. 505 in the sum of $222,500 for design.

2) County of Maui, 1980 General Obligation Bond in the sum of $5,500,000 for design and construction.

Efforts are being made to obtain additional funds. Based on EPA cost curves* for the Lower and Upper Kula water treatment plants, the following construction costs are roughly estimated for each of the plants:

1) **Makawao WTP** - Present day construction costs are estimated at $6.5 million. This figure does not include allowance for such items as additional land purchases and access road improvements to the site.

---

*EPA publication #EPA-600/2-79-162a.

1-27
2) **Lower Kula WTP** – Present day construction costs are estimated at least $5.3 million. This figure includes the water treatment plant, 2 MG holding tank, access, power, and drainage.

3) **Upper Kula WTP** – Present day construction costs for this plant are estimated at $2.8 million. In general, this cost includes facilities normally provided in a conventional water treatment plant, including the plant itself, refurbishing the existing 3 MG Olinda tank, and access road.

The current amount of funding available may require that a priority regarding construction of the treatment plants be established and that other methods be evaluated to comply with the Safe Drinking Water Regulations.
REFERENCES TO SECTION 1

[1.1] Part I. Final Report Interim Drinking Water
Existing Environment
SECTION 2
DESCRIPTION OF THE EXISTING ENVIRONMENT

This section provides information on the biophysical and socioeconomic characteristics of the area involved with the proposed project. This information base is used in the evaluation of impacts anticipated from the proposed project, as discussed in Section 4 of this report.

I. PHYSICAL CHARACTERISTICS

A. Geology

The island of Maui consists of two major volcanoes, West Maui and Haleakala. The proposed water treatment plant sites are all located on the northwest flank of Haleakala, which is a dormant volcano. Please refer to Figure 2-1. [2.1]

"The primitive shield of Haleakala volcano is composed of pahoehoe and aa flows of tholeiite, tholeiitic olivine basalt, and oceanite averaging about 15 feet in thickness, with which are associated very minor amounts of pyroclastic materials." This makes up the Honomanu Volcanic Series, which, above sea level, has almost been entirely covered by later flows. This volcanic series was subsequently overlain by the Kula Volcanic Series, which is composed mostly of hawaiite with lesser amounts of alkalic olivine basalt and ankaramite. Aa is predominant but there is some pahoehoe near vents. [2.2]
The Kula eruptions occurred along three well-defined rift zones, the most prominent being the southwestward and the east-northeastward from the summit. Refer to Figure 2-2. The less prominent rift extends north-northwestward from the summit and is marked by a row of cinder cones that extends almost to the coast. [2.3]

B. Soils

Since the three proposed plant sites are located in two different soil associations, soil classifications are presented as follows, by site:

1. Kamole Weir Site

Soils of this proposed site fall within the general classification of the Pauwela-Haiku Association. "This association consists of well-drained, fine-textured soils on low uplands on the north-facing slopes of East Maui. These soils are gently sloping to moderately steep. They developed in material weathered from basic igneous rock. This association makes up about 3 percent of the island." [2.4]

Pauwela soils make up about 45 percent of this association, with Haiku constituting about 40 percent, and Hamakuapoko soils the remainder. [2.5]
HALEAKALA RIFT ZONES.

FIGURE 2-2

Source: (2.1) P. 331

- Kula Volcanic Series
- Hana Volcanic Series
- Molokini Islet is a tuff cone on the southwest rift zone of Haleakala
The particular soils types of this site fall under the category of the Hamakuapoko Series which "consists of well-drained soils on uplands on the island of Maui. These soils developed in material weathered from basic igneous rock. They are gently to strongly sloping." These soils are geographically associated with Haiku, Haliimaile, and Paia soils. [2.6]

Specifically, the soils at this site are as follows: (Refer to Figure 2-3)

Hamakuapoko silty clay, 3 to 7 percent slopes (HIB)

"In a representative profile the surface layer is dark-brown silty clay about 16 inches thick. The subsoil, about 35 inches thick, is dark-brown and very dark grayish-brown silty clay that has subangular blocky structure. The substratum is soft, weathered basic igneous rock. The soil is extremely acid in the surface layer and strongly acid or very strongly acid in the subsoil. Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight." [2.7]

Hamakuapoko silty clay, 7 to 15 percent slopes (HIC)

"On this soil, runoff is medium and the erosion hazard is moderate." [2.8]

2. Pihiolo and Olinda Reservoir Sites

Soils at these sites are part of the general category of the Laumaia-Kaipoioi-Olinda Association which "consists of well-drained, medium-
KAMOLE SITE SOILS

FIGURE 2-3
textured soils on the intermediate and high uplands of East Maui. These soils are gently sloping to very steep. They developed in material weathered from volcanic ash. The association makes up about 5 percent of the island." [2.9]

"Launaia soils make up about 45 percent of the association, Kaipoioi soils about 40 percent, and Olinda soils about 15 percent. Olinda soils have a surface layer of dark reddish-brown, friable loam. The subsoil is dark reddish-brown and yellowish-red, friable silty clay loam. The substratum is soft, weathered basic igneous rock. It occurs at a depth of 40 to 60 inches or more." [2.10]

These proposed plant sites are located within the Olinda Series which "consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash. They are gently sloping to steep. Specifically, the soil type located on these sites is as follows: (Refer to Figures 2-4 and 2-5)

Olinda loam, 12 to 20 percent slopes (OND) [2.11]

"This soil is on smooth, intermediate to high mountain slopes. Included in mapping were small areas of Kaipoioi and Pane soils. In a few places small, eroded spots were included.

2-7
OLINDA SITE SOILS

FIGURE 2-5
In a representative profile the surface layer is dark reddish-brown loam about 6 inches thick. The subsoil, about 5 inches thick, is dark reddish-brown and yellowish-red silty clay loam that has subangular blocky structure. Below this is yellowish-red and reddish-brown silty clay loam and gravelly silty clay loam. This is underlain by slightly weathered basic igneous rock. The soil is slightly acid in the surface layer and subsoil.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate."

C. **Seismic Potential (2.12)**

Earthquakes are densely concentrated in the southern half of the island of Hawaii. Some earthquakes of significant magnitude have occurred off Maui, but it is not as active as Kona or Kau.

Some of the earthquakes of greater magnitude than 4 on the Richter scale which affected Maui include June 14, 1932, January 23, 1938, June 17, 1940, August 7, 1955, August 10, 1957, August 18, 1957. Historically, the most significant earthquakes occurred in 1868, 1871, 1938, and 1951.

The Kau earthquake of April 2, 1868 was the largest historical earthquake. Although seismographs were nonexistent then, the estimated magnitude was 7.5 - 7.75, based on descriptions of the earthquake's effects. The island of Hawaii was naturally the

2-10
hardest hit but some effects were felt on Maui. Vibrations "rattled dishes, swashed water over tops of nearly full cisterns, and made it difficult to stand on slopes of fresh lava of Haleakala."

The February 19, 1871 earthquake was not as large as the 1868 one and it occurred near Honolulu. It caused considerable damage to Honolulu and Oahu; damaged houses, stonewalls, and furniture on Molokai; caused landslides on Lanai; and caused some serious damage to adobe and stone houses in Lahaina. It is estimated that this earthquake had a magnitude of about 7, with the epicenter in the Molokai-Maui area.

On January 23, 1938 an earthquake of magnitude 6.75 occurred 25 miles north of Maui. There was considerable damage on Maui and minor damage on Oahu. Details of this earthquake are not available.

The Kona earthquake occurred on August 21, 1951 off the coast of Kealakekua with a magnitude of 6.9. The epicenter of the quake was along the Kealakekua Fault, approximately 6 miles below sea level. Although it caused extensive damage on the island of Hawaii, it was only weakly felt on the islands of Maui and Oahu.

Maui is located in Seismic Probability Zone 2, "Moderate Damage." Refer to Figure 2-6.
SEISMIC PROBABILITY ZONES
EXISTING BUILDING CODE.

ZONE 0: NO DAMAGE
ZONE 1: MINOR DAMAGE
ZONE 2: MODERATE DAMAGE
ZONE 3: MAJOR DAMAGE

FIGURE 2-6
Source: (2-12)

SEISMIC PROBABILITY ZONES
D. Climate

The majority of Hawaii exhibits only two seasons: the summer, which occurs between May and October when the weather is warmer and drier and the tradewinds are most persistent; and the winter, which is between October and April when the weather is cooler and the tradewinds are more often interrupted by other winds and by intervals of widespread clouds and rain. Hawaii's general climate is reflected by four factors: latitude, the surrounding ocean, Hawaii's location relative to the storm tracts and the Pacific anticyclone, and terrain [2.13].

The latitude of Hawaii puts it well within the tropics, accounting for a relatively uniform day length throughout the year. Consequently, a relatively uniform amount of solar energy is received and, therefore, temperature is relatively uniform. The surrounding ocean supplies moisture to the air, and acts as a thermostat. Because the ocean's temperature varies little compared to large land masses, the temperature varies only 1 to 2 degrees from day to night and only about 6 degrees at the sea's surface on a seasonal basis [2.14].

The Pacific High or anticyclone is a large, subtropical high pressure system which generally
lies northeast of Hawaii. The air, moving outward from this anticyclone, streams past the islands and is the source of the northeasterly tradewinds. Along with its associated storm tracts, this anticyclone follows the seasonal shift in the sun, moving northward in the summer and southward in the winter and tending to be stronger and more persistent in the summer than in the winter. Since the anticyclone weakens and is occasionally absent in the winter, the tradewinds may be interrupted by northerly fronts or by Kona storms; therefore, winter is exhibited by more frequent cloudiness and rain storms and southerly and westerly winds. [2.15]

Terrain has profound effects on weather and climate. Mountains tend to obstruct, deflect, and accelerate air flow. As warm, moist winds rise over windward coasts and slopes, cloudiness and rainfall are more prevalent than over the open sea. Leeward areas, where air descends, tend to be sunny and dry. Terrain can also account for orographic (mountain-caused) rainfall, which is formed when moist tradewind air moves from the sea and is forced up the steep and high terrain of the island. Rainfall distribution, therefore, is usually greatest over the upper slopes and crests and least along the leeward lowlands. [2.16]
1. **Rainfall**

The heaviest rains in Hawaii are usually brought about by winter storms. Lowland lee areas and other dry areas obtain most of their rainfall by winter storms, so the rainfall is strongly seasonal, with summers being arid. The project sites and the Kula watershed, however, are located toward the windward side of the island and receive rainfall from both winter storms and year-round trade wind showers. Refer to Figures 2-7 and 2-8.

Historical rainfall data for the Kula watershed are presented in Table 2-1. The data for each station is graphed in Figures 2-9 through 2-13.

2. **Temperature**

Hawaii's equable temperatures result from the small seasonal variations in energy received from the sun and the tempering effect of the surrounding ocean. Throughout Hawaii the warmest and coolest months differ, on the average, by 9 degrees or less. The daily variation between day and night are greater than the variations between seasons. Windward coasts exposed to tradewind air off the sea have the least variation
### TABLE 2-1

**HISTORICAL RAINFALL DATA**

(Source: Annual Reports, BWS)

<table>
<thead>
<tr>
<th>Date</th>
<th>Olinda/Forest Reserve</th>
<th>Upper Plume Waikamoi</th>
<th>Lower Plume Waikamoi</th>
<th>Puohokamoa1/</th>
</tr>
</thead>
<tbody>
<tr>
<td>1953</td>
<td>20.90</td>
<td>48.95</td>
<td>132.36</td>
<td>115.43</td>
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<tr>
<td>1954</td>
<td>58.27</td>
<td>119.53</td>
<td>200.14</td>
<td>210.57</td>
</tr>
<tr>
<td>1955</td>
<td>49.44</td>
<td>100.91</td>
<td>203.14</td>
<td>217.57</td>
</tr>
<tr>
<td>1956</td>
<td>57.84</td>
<td>123.75</td>
<td>234.12</td>
<td>227.06</td>
</tr>
<tr>
<td>1957</td>
<td>42.94</td>
<td>118.72</td>
<td>259.68</td>
<td>256.83</td>
</tr>
<tr>
<td>1958</td>
<td>40.92</td>
<td>44.89</td>
<td>218.15</td>
<td>241.58</td>
</tr>
<tr>
<td>1959</td>
<td>54.35</td>
<td>115.78</td>
<td>207.55</td>
<td>194.02</td>
</tr>
<tr>
<td>1960</td>
<td>48.13</td>
<td>103.78</td>
<td>217.00</td>
<td>240.00</td>
</tr>
<tr>
<td>1961</td>
<td>38.08</td>
<td>48.79</td>
<td>185.71</td>
<td>205.20</td>
</tr>
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<td>19.27</td>
<td>42.53</td>
<td>102.76</td>
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<td>19.45*</td>
<td>29.87*</td>
<td>59.13*</td>
<td>91.37*</td>
</tr>
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<td>54.15</td>
<td>83.35</td>
<td>160.77</td>
<td>190.43</td>
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<td>1968</td>
<td>67.07</td>
<td>116.58</td>
<td>218.45</td>
<td>240.62</td>
</tr>
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<td>1969</td>
<td>77.12</td>
<td>138.22</td>
<td>275.46</td>
<td>284.71</td>
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<td>1970</td>
<td>50.11</td>
<td>107.86</td>
<td>216.00</td>
<td>252.76</td>
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<td>1971</td>
<td>63.08</td>
<td>151.34</td>
<td>224.05</td>
<td>242.57</td>
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<td>1972</td>
<td>26.27</td>
<td>57.71</td>
<td>127.74</td>
<td>161.54</td>
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<td>1973</td>
<td>32.17</td>
<td>82.48</td>
<td>185.53</td>
<td>236.01</td>
</tr>
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<td>1974</td>
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<td>32.96</td>
<td>68.07</td>
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<td>68.22</td>
<td>128.85</td>
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<tr>
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<td>26.83</td>
<td>57.80</td>
<td>127.15</td>
<td>128.96</td>
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<tr>
<td>1978</td>
<td>28.01</td>
<td>55.38</td>
<td>123.03</td>
<td>133.37</td>
</tr>
<tr>
<td>1979</td>
<td>84.60</td>
<td>125.81</td>
<td>191.97</td>
<td>234.32</td>
</tr>
<tr>
<td>1980</td>
<td>84.35</td>
<td>151.41</td>
<td>206.62</td>
<td>271.47</td>
</tr>
</tbody>
</table>

**Average:** 48.87 95.55 187.16 207.51 196.29

* Data available for six months ended June 30, 1966

**General Location of Stations to Water System:**

1/ Upper Kula System
2/ Lower Kula System
FOREST RESERVE

FIGURE 2-10

RAINFALL (INCHES)

170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0


95.55" AVERAGE

2-20
in temperature between day and night. Farther inland, on leeward coasts and at elevations above about 6,000 feet, the daily range increases. The day's highest temperatures generally occur two hours after noon and are coolest near sunrise. [2.17]

Temperature data for Makawao, Maui, which can be considered representative of what would be expected at the project sites, is shown in Figure 2-14.

3. Wind

The northeasterly tradewind prevails throughout the year in Hawaii, is more persistent in the summer (90%) than in the winter (50%), and tends to be stronger in the afternoon than at night. During the winter months, Hawaii may be under the influence of southerly winds from Kona storms or of southwesterly winds preceding the northeasterly winds that follow cold fronts. [2.18]

In the vicinity of the project sites, northeasterly trade winds blow between 5 and 10 mph during the day. A land wind caused by nighttime temperature variations along the slopes of Haleakala gives the area gentle, down-slope
TEMPERATURE REGIME
MAKAWAO

FIGURE 2-14
evening breezes. Kona winds (from the south) occur primarily in the winter months.

E. **Air Quality**

Ambient air quality in the Kamole Weir vicinity is affected primarily by dust from nearby pineapple fields. Ambient air quality in the vicinity of the other sites does not appear to be impacted by pollutants.

Several locations throughout the State are monitored for air quality, and a summary for 1978 is presented in Table 2-2. For Maui, sampling stations are located at Kahului and at Kihei. The Kahului site is located at the Kahului Shopping Center, in an area which includes Maui Electric Power Plant. The Kihei site is located at the Kihei Wastewater Reclamation Plant in a residential and rural community.

Results from the table show that Kahului and Kihei average the highest for particulate matter of the sites sampled. This may be partly due to the high wind conditions experienced between the West Maui mountains and Haleakala and because much of the area is in sugarcane, portions of which are denuded at any given time. Kahului also exhibits the highest values of sulfur oxides, primarily because of its proximity to Maui Electric Power Plant.
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<th>Department</th>
<th>Barbers Point</th>
<th>Pearl City</th>
<th>Kalani Alii Point</th>
<th>Waimanalo</th>
<th>Kahului</th>
<th>Kihei</th>
<th>Hilo</th>
<th>Kealakekua Bay</th>
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<td>(µg/m³)</td>
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<td>29</td>
<td>74</td>
<td>54</td>
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<td>No. of times AQI* exceeded</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
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SULFUR DIOXIDE

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<th>Number of samples</th>
<th>Range of values (µg/m³)</th>
<th>Average of values (µg/m³)</th>
<th>No. of times AQI* exceeded</th>
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<td>57 57 57 61</td>
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<td>18 C5 15 C5</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

CARBON MONOXIDE

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Period of sampling</th>
<th>Number of samples</th>
<th>Range of values (µg/m³)</th>
<th>Average of values (µg/m³)</th>
<th>No. of times AQI* exceeded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
<td>364</td>
<td>0-20.7</td>
<td>3.125</td>
<td></td>
</tr>
</tbody>
</table>

* Hawaii Air Quality Standards

**Particulates - 100 µg/m³**
**Carbon Monoxide - 10 mg/m³**
**Sulfur Dioxide - 80 µg/m³**
**Nitrogen Dioxide - 150 µg/m³**
**Oxidants - 100 µg/m³**

Source: [1.15]

2-27
F. Ambient Noise Levels

Ambient noise levels were recorded at the sites, using a Brüel and Kjær Sound Level Noise Meter. The existing ambient noise environment is primarily dominated by sounds of wind. Noise levels at the Kamole Weir Site varied from 37-49 dBA, with peak levels of 57-59 dBA near the weir. Noise levels at the other sites varied from 37-40 dBA.

The County of Maui has no specific noise level controls; however, ambient noise levels recorded in the project areas were well below noise standards given in Chapter 44B, Community Noise Control of Oahu, which may be used for comparison only.

II. BIOLOGICAL CHARACTERISTICS

A. Flora

1. Project Sites

A field reconnaissance of the sites was conducted in January, 1981. Flora at the Kamole Weir site include Christmas berry (Schinus terebinthifolius) and roadside weeds. Kikuyugrass (Pennisetum clandestinum) is the predominant grass at the Olinda site and eucalyptus (Eucalyptus robusta) trees surround the area. Kikuyugrass is also found at the Piilolo site, with clumps of gorse (Ulex europaeus) and guava (Psidium guajava).
Refer to Appendix F for a full species list at each of the sites.

2. **Adjacent Areas**

   The Kamole Weir site is located in an area identified as being in Vegetation Zone C₁, (refer to Figure 2-15) [2.20]. The Olinda site is in Vegetation Zone C₂ and the Pi'iholo site lies in Vegetation Zone D₂.

3. **Endangered Plants**

   None of the plants observed on the project sites are listed as endangered species by the Federal Government [2.21].

B. **Fauna**

1. **Project Sites**

   A field reconnaissance was conducted in January, 1981. Avifauna seen on the project sites include upland and forest birds, all primarily introduced. Refer to Appendix F for a complete species list.

   The vegetation suggests the presence of the mongoose, as well as mice and rats. Refer to Appendix F for a complete listing.

2. **Adjacent Areas**

   Avifauna and other animals found in adjacent areas are similar to those found on the project sites.

2-29
<table>
<thead>
<tr>
<th>Zone</th>
<th>General elevations</th>
<th>Mean annual temperature</th>
<th>Annual rainfall, principal origin, and characteristics</th>
<th>Topography and soils</th>
<th>Land use</th>
<th>Vegetation characteristics and principal species</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Sea level to 500 feet on lee sides or low windward lands</td>
<td>75° F, at sea level; max. nem. exceed. 50° F.</td>
<td>Less than 20 inches; southeast origin; torrential and infrequent; run-off and evaporation high; flood lands common</td>
<td>Coastal flats and adjacent sloping lands. Lava common</td>
<td>Irrigated sugar cane, grazing, waste</td>
<td>Ground cover sparse and conditions semi-desert. Alpines, koa hauwai, and kihi grow well where their roots penetrate ground water. Elims and ohia are common shrubs. Annual grasses and herbs are scarce except following rains.</td>
</tr>
<tr>
<td>B</td>
<td>Sea level to 2,000 feet. Lies above A except where it reaches the sea</td>
<td>70° F.</td>
<td>20-40 inches; southeast origin; similar to zone A</td>
<td>Similar to zone A</td>
<td>Irrigated sugar cane below 1,000 feet, pineapple above; grazing, waste</td>
<td>Vegetation similar to zone A but plants more numerous and vigorous due to increased rainfall. Annuals are longer lived. Cactus and Lantana often form dense stands. Both perennial and annual grasses occur. Annual herbs are prominent during and following rainy periods.</td>
</tr>
<tr>
<td>C</td>
<td>Sea level to 2,500 feet. Lies above B except where it reaches the sea</td>
<td>70° F.</td>
<td>40-60 inches; northeast trade-wind origin. Dry periods of more than one month uncommon. Moist spring and dry summer permit maturing of seeds</td>
<td>Gentle and steep slopes dissected by deep gulches; high plateaus. Excellent soil</td>
<td>Irrigated sugar cane and pineapple where topography and soils permit. Grazing restricted to gulches and poorer soils</td>
<td>Both temperate and tropical species adapted, the former seasonal, the latter perennial. Grown is the predominant shrub. Lantana and koa hauwai may form dense stands. Grasses and pasture legumes are responsible and small shrubs are common. Herbaceous forms volunteer good growth on disturbed soils. This zone formerly forested.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Similar to zone C</td>
<td>Steeper mountain gradients and high plateaus. Good soils used for pastures</td>
<td>Too cool for sugar cane or pineapple. Grazing is major use</td>
<td>Like zone C; this was once forested. Now mostly open grassland but remnants of koa and ohia lehua occur. Ailili and puakaewa are dominant shrubs. Grasses, legumes, and other herbs generally form good stands.</td>
</tr>
<tr>
<td>D</td>
<td>Sea level to 1,500 feet on windward side</td>
<td>75° F. at sea level; 1-3° lower than on lee sides at same elevation</td>
<td>60 inches minimum; northeast trade-wind origin</td>
<td>Rough topography. Soils scald, often boggy, have little available plant matter, decreased alga, high organic matter</td>
<td>Non-irrigated sugar cane; limited pineapple. Grazing on non-arable land</td>
<td>Perennial shrubs and grasses most abundant but commonly low in protein, minerals, and total dry matter. Grown, Lantana, and staghorn fern grow profusely in places restricting other vegetative growth.</td>
</tr>
<tr>
<td>D₁</td>
<td>Variable but generally between 1,500 to 4,000 feet on windward sides</td>
<td>60° F.</td>
<td>From more than 60 to 450 inches and more; northeast trade-wind origin</td>
<td>Gentle gradient with small gulches</td>
<td>Forest reserve providing main source of water for islands. Grazing in some cleared portions</td>
<td>Nearly impermeable forest of koa and ohia lehua accompanied by tree ferns and various low growing ferns. Such forests lack diversification of vegetative types and seed producing species.</td>
</tr>
<tr>
<td>D₂</td>
<td>4,000-7,000 feet on windward side. Lies above D₁</td>
<td>50° F.</td>
<td>About 100 to 50 inches; northeast trade-wind origin. Mist frequent</td>
<td>High plateau and gentle mountain slopes. Lava common. Soil thin but good in places</td>
<td>Grazing</td>
<td>Originally forested like zone D₁ but heavy grazing has left only remnants. In cleared portions grasses do well but annuals do not persist because of lack of sunshine and a dry season necessary for seeding. Shrubs are scarce except grazing.</td>
</tr>
<tr>
<td>E₁</td>
<td>7,000-10,000 feet. Lies above D₁; in wetter parts and C₁ in other localities</td>
<td>50° F.</td>
<td>Less than 10 inches; northeast trade-wind origin. Summers are too cool to permit good plant growth</td>
<td>Topography steep. Soils little weathered and make poor substrates for plants. Lava proficient</td>
<td>Grazing</td>
<td>Formerly forested. Much now open grassland. Where grazing not so severe, remnant stands of koa, tramali, and maio persist. Ailili and puakaewa common where trees have disappeared. Herbs are frequent but grazing limits maximum coverage.</td>
</tr>
<tr>
<td>E₂</td>
<td>10,000-14,000 feet</td>
<td>40° F.</td>
<td>Less than 20 inches; northeast trade-wind origin. Snow frequent and may remain in sheltered places all year</td>
<td>Steep but not rugged. Ash zones and lava common. Soil rocky and thin</td>
<td>National Park and Forest Reserve; heavy grazing by native sheep and goats</td>
<td>Vegetation similar to zone E₁ but sparser and more scrubby because of poorer soil and more rigorous climate. Heavy grazing in puea has caused severe denudation of both vegetation and soil.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>National Park and Forest Reserve</td>
<td>Little plant growth except moss and lichen association.</td>
</tr>
</tbody>
</table>

**VEGETATIVE ZONES**

**FIGURE 2-15**
3. **Sensitive Wildlife Habitat**

None of the animals seen or potentially present on the project sites are rare or endangered species. The native forest birds potentially present at the Oliinda and Piilolo sites are considered common.

III. **ARCHAEOLOGICAL/HISTORICAL CHARACTERISTICS**

An archaeological surface reconnaissance was conducted on the project sites in January, 1981. No significant archaeologic or historic materials or sites were located during the reconnaissance. Refer to Appendix G for the archaeologic report.

IV. **SOCIO-ECONOMIC CHARACTERISTICS**

A. **Population**

1. **Existing**

   The resident population of the combined service areas of the Makawao and Kula water systems for the years 1970 and 1980 is given in Table 2-3. The location of the Census Tracts is shown in Figures 2-16 and 2-17. During the 10-year period, Maui County as a whole showed a population increase of 54.8% (from 45,984 to 71,191). Also refer to Appendix D.
<table>
<thead>
<tr>
<th>Census Tract</th>
<th>1970 1/</th>
<th>1980 2/</th>
</tr>
</thead>
<tbody>
<tr>
<td>302 (Haiku-Pauwela)</td>
<td>2,067</td>
<td>3,567</td>
</tr>
<tr>
<td>304 (Makawao)</td>
<td>4,123</td>
<td>10,361</td>
</tr>
<tr>
<td>305 (Paia)</td>
<td>1,665</td>
<td></td>
</tr>
<tr>
<td>303 (Kula)</td>
<td>2,124</td>
<td>5,077</td>
</tr>
<tr>
<td>TOTAL</td>
<td>9,979</td>
<td>19,005</td>
</tr>
</tbody>
</table>


2. **Projected**

The State Department of Planning and Economic Development (DPED) has requested that all agencies use the series II-F population projection, as it is updated, in order to establish a uniform population planning base. The March 1, 1978 revised population projection for Maui County in the year 1980 is 67,400 and in the year 2000 is 124,700 [2.22]. (Also refer to Appendix D.)

B. **Demographic Characteristics**

1. **Ethnicity** [2.23]

   According to the OEO 1975 Census Update Survey for Maui County, the majority of persons living within the Northeast Maui District (Census Tracts 301, 302, 304, 305, and 306) were part-Hawaiian, Caucasian, or Japanese. This was also true for the Kihei-Kula District (Census Tracts 303 and 307). Refer to Table 2-4.

2. **Age-Sex Distribution** [2.24]

   Out of an estimated study population of 10,775, the largest age groups in the Northeast Maui District were 5-9 (10.9%), 10-14 (11.5%), and 15-19 (10.0%). The largest age groups in the Kihei-Kula District were 10-14 (10.3%), 20-24 (7.4%), and 25-29 (8.5%). Refer to Figure 2-18.
<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Total</th>
<th>Northeast Maui</th>
<th>Kihei-Kula</th>
<th>Kahului</th>
<th>Wailuku-Waikupu</th>
<th>Lahaina</th>
<th>Molokai</th>
<th>Lanai</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black, Negro</td>
<td>0.1</td>
<td>0.1</td>
<td>0.6</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Caucasian, Not Portuguese</td>
<td>21.3</td>
<td>19.6</td>
<td>48.9</td>
<td>6.3</td>
<td>12.4</td>
<td>37.4</td>
<td>6.1</td>
<td>6.4</td>
</tr>
<tr>
<td>Portuguese</td>
<td>4.4</td>
<td>9.6</td>
<td>5.0</td>
<td>3.7</td>
<td>4.8</td>
<td>1.2</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Chinese</td>
<td>0.7</td>
<td>0.4</td>
<td>1.6</td>
<td>0.7</td>
<td>1.0</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Filipino</td>
<td>15.3</td>
<td>11.4</td>
<td>3.1</td>
<td>24.7</td>
<td>9.4</td>
<td>11.4</td>
<td>27.5</td>
<td>46.5</td>
</tr>
<tr>
<td>Hawaiian</td>
<td>1.6</td>
<td>1.7</td>
<td>1.0</td>
<td>0.6</td>
<td>1.5</td>
<td>1.6</td>
<td>3.9</td>
<td>3.2</td>
</tr>
<tr>
<td>Part-Hawaiian</td>
<td>21.4</td>
<td>24.4</td>
<td>17.7</td>
<td>11.6</td>
<td>20.3</td>
<td>19.5</td>
<td>46.7</td>
<td>17.5</td>
</tr>
<tr>
<td>Japanese</td>
<td>25.1</td>
<td>17.8</td>
<td>14.1</td>
<td>38.9</td>
<td>40.7</td>
<td>22.1</td>
<td>9.8</td>
<td>16.2</td>
</tr>
<tr>
<td>Korean</td>
<td>0.3</td>
<td>0.4</td>
<td>0.2</td>
<td>0.7</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Puerto Rican</td>
<td>0.4</td>
<td>0.9</td>
<td>0.0</td>
<td>0.7</td>
<td>0.4</td>
<td>0.0</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Samoan</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.0</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Mixed (not Part-Hawaiian)</td>
<td>8.6</td>
<td>12.4</td>
<td>7.0</td>
<td>11.1</td>
<td>8.3</td>
<td>5.6</td>
<td>4.6</td>
<td>7.8</td>
</tr>
<tr>
<td>Other</td>
<td>0.7</td>
<td>0.9</td>
<td>0.5</td>
<td>0.8</td>
<td>0.9</td>
<td>0.9</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>refused/don't know</td>
<td>0.1</td>
<td>0.3</td>
<td>0.0</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Base (est. pop.)</td>
<td>59,661</td>
<td>10,775</td>
<td>9,347</td>
<td>11,186</td>
<td>10,810</td>
<td>9,278</td>
<td>5,815</td>
<td>2,450</td>
</tr>
</tbody>
</table>

Source: [2.23]
AGE-SEX DISTRIBUTIONS

FIGURE 2-18

SOURCE: (2.23)
The sex distribution for the Northeast Maui District was 49.1% males to 50.9% females in 1975. For the Kihei-Kula District the sex distribution was 51.4% males to 48.6% females. Also refer to Figure 2-18.

3. Education [2.25]

Of an estimated study population of 5,438 that contained persons 25 years of age or older, 60% in the Northeast Maui District had received a high school diploma, while 40% had not. These figures compared with 78.3% and 21.7%, respectively, for the Kihei-Kula District (study population of 5,687).

C. Employment and Income

1. Employment

A study conducted by the State Department of Labor and Industrial Relations covered the period from 1964 to 1975 [2.26]. Employment trends for one area within the combined service area of the the water treatment plants is summarized as follows:

Haiku-Pauwela (Census Tracts 302-305)

This area showed Retail and Services being the primary industries, each representing about 28% of the employees in 1975. There were 896 employees, reflecting a decrease of 72.9% of persons employed between
1964 and 1975. This loss was tremendous in the areas of Manufacturing, a loss of 2,007 employees, and in Agriculture, a loss of 638 employees.

The 1975 OEO Census Update Survey determined the industry of the employed population age 16 and older. For the Northeast Maui District the primary industries listed were service (26.2%), agriculture (18.1%), and retail (16.3%), out of a sample population of 4,093. For the Kihei-Kula District (sample population of 4,260) the main industries listed were service (32.3%), construction (21.4%), and retail (16.6%), with 9.1% for agriculture.

Those persons in agriculture could work for the sugar or pineapple plantations, or for vegetable and flower farms in the area between Makawao and Keokea (including Olinda and upper and lower Kula).

"The exact number of farms or farmers (in this area) differs depending on how they are classified. This is partially due to the difficulty of defining part-time farmer from a full-time farmer or by distinguishing between land dedicated to agriculture for tax purposes that is actively farmed versus that minimally farmed to meet the legal tax requirements. It
is further complicated in that the Kula agriculture statistics are reported only as part of Maui/Molokai/Lanai." [2.27]

Despite this, the Makawao-Pukalani-Kula General Plan identified 136 farms in the area, based on the farms identified in the 1972 Land Inventory Report prepared by DPED.

Table 2-5 illustrates overall employment and unemployment trends for the island of Maui from 1970 through 1980. The data shows that there was a relatively high percentage of the work force unemployed from 1971 to 1976. Then 1977 showed a significant decrease in the unemployment rate, which appeared to have been maintained through 1980 [2.28].

2. Income [2.29]

Household incomes in the Northeast Maui District ranged from under $2,000 to $25,000 or more, with half (50.8%) falling between $12,000 and $25,000 or more. Another sizable portion (38.6%) fell rather evenly between $2,000 and $11,999.

Household incomes in the Kihei-Kula District also ranged from under $2,000 to $25,000 or more, with over half (59.1%) falling between
<table>
<thead>
<tr>
<th>YEAR</th>
<th>EMPLOYED</th>
<th>UNEMPLOYED</th>
<th>% UNEMPLOYED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>16,050</td>
<td>1,200</td>
<td>7.0</td>
</tr>
<tr>
<td>1971</td>
<td>16,770</td>
<td>1,450</td>
<td>8.0</td>
</tr>
<tr>
<td>1972</td>
<td>17,600</td>
<td>1,800</td>
<td>9.3</td>
</tr>
<tr>
<td>1973</td>
<td>18,650</td>
<td>1,750</td>
<td>8.7</td>
</tr>
<tr>
<td>1974</td>
<td>19,400</td>
<td>1,850</td>
<td>8.8</td>
</tr>
<tr>
<td>1975</td>
<td>21,100</td>
<td>2,100</td>
<td>9.0</td>
</tr>
<tr>
<td>1976</td>
<td>22,300</td>
<td>2,450</td>
<td>9.9</td>
</tr>
<tr>
<td>1977</td>
<td>24,400</td>
<td>1,850</td>
<td>7.0</td>
</tr>
<tr>
<td>1978</td>
<td>24,750</td>
<td>1,800</td>
<td>6.9</td>
</tr>
<tr>
<td>1979</td>
<td>25,650</td>
<td>1,550</td>
<td>5.7</td>
</tr>
<tr>
<td>1980</td>
<td>26,900</td>
<td>1,500</td>
<td>5.3</td>
</tr>
</tbody>
</table>

Source: [2.28]
$10,000 and $25,000 or more. The mean household income in the Northeast Maui area was $12,260 and the median was $13,300. The mean household income in the Kihei-Kula area was $17,040 and the median was $14,980.

V. INFRASTRUCTURE

A. Electrical and Telephone Services

Existing overhead electrical and telephone lines, which may serve the proposed sites, are located along Baldwin Avenue for the Kamole Weir Site (an existing MECO substation is located at the Kamole Weir Site) and along Olinda and Piilolo roads for the other two sites. Final design will be coordinated with Maui Electric Company and Hawaiian Telephone Company, who will review and approve aspects of the plans prior to government approval of the project plans.

B. Waste Disposal

Disposal of dewatered waste water residue will be required as a routine procedure.

C. Public Facilities

1. Fire

A fire station located at Makawao, which is equipped with 1 large and 1 small fire engine, would service the sites. There are approximately 2-42
4 men to each shift and the response time to the sites is estimated at about 5-15 minutes. The nature of the proposed project involves minimal fire potential and is not expected to require assistance from the Fire Department.

2. **Medical**

The only medical service which would be affected would be emergency care. As previously stated, the nature of the proposed project should require negligible medical service.

Emergency medical service to the proposed project sites would be provided by first phoning 911. There is an ambulance stationed at Makawao, which could be dispatched to either of the sites within 5-15 minutes. The ambulance is always staffed with at least 1 paramedic (MICU - Mobile Intensive Care Technician) who is in constant communication with a physician at Maui Memorial Hospital. If the case can be stabilized in the field, then transport to Maui Memorial Hospital is not necessary. If, however, it is determined that the case should be transported to the hospital, then transit time (excluding field treatment time) is estimated at 20-40 minutes.
3. Police

The central Maui area has 10 beats servicing approximately 342 square miles. One of those beats would service the three proposed project sites, which is part of an area extending approximately from Baldwin Avenue in Paia, to the top of Haleakala, and over to Kanaio. This one beat is comprised of one patrol car manned by one patrol officer. Each of the treatment facilities will be secured by perimeter fencing and locked buildings. Additional police surveillance of the completed facilities should not be required.

4. Schools

Though there are several public schools located within the service area of the treatment facilities, none is within the immediate vicinity of any of the proposed project sites. Makawao Elementary and Intermediate is located near the intersection of Baldwin Avenue and Makawao Avenue, approximately 1.7 miles from the Kamole Weir and over 4 miles from either of the other two sites. Seabury Hall, a private school, is located about 2 miles from the Olinda site, on Olinda Road. Also refer to Table 2-6.
<table>
<thead>
<tr>
<th>AREA</th>
<th>SCHOOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haiku - Pauwela</td>
<td>Haiku School</td>
</tr>
<tr>
<td>Makawao</td>
<td>Makawao School</td>
</tr>
<tr>
<td>Pukalani</td>
<td>Pukalani Elementary School</td>
</tr>
<tr>
<td>Kula</td>
<td>Kula Elementary School</td>
</tr>
</tbody>
</table>

Maui, Hawaii

TABLE 2-6
PUBLIC SCHOOLS
HAiku - MAKAWAO - Kula AREAS

2-45
5. Parks and Recreation

As shown in Table 2-7, there are several parks and recreation facilities in the region surrounding the 3 project sites. The Olinda site is located within 1/2 mile of Waihou Spring Reserve, an 84-acre State-owned parcel which contains picnic areas. The Piilolo site is located within 1/4 mile of Makawao Forest Reserve, a 2,093-acre State-owned forest reserve which allows hunting. The Kamole Weir site is located about 1 mile from Haliimaile Park, a 5.2-acre County-owned neighborhood park.

D. Access and Traffic.

1. Access

To gain access to the proposed Olinda Reservoir or Piilolo project sites from Kahului, one would take Route 36 (Hana Highway) to Route 37 (Haleakala Highway) and then Route 40 (Makawao Avenue). Once on Route 40, one would then take Olinda Road (Route 39) mauka up to Olinda Reservoir. The approximate distance from Kahului is 18 miles. For the Piilolo Site, one would continue a little further along Makawao Avenue and then turn mauka on Piilolo Road for 1.5 miles. At Ehu Road, one would go left and
<table>
<thead>
<tr>
<th>NAME</th>
<th>OWNERSHIP</th>
<th>ACRES</th>
<th>FACILITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makawao School Park</td>
<td>County</td>
<td>3.4</td>
<td>Playfield</td>
</tr>
<tr>
<td>Makawao Park and Mayor Eddie Tam Memorial Center</td>
<td>County</td>
<td>2.9 &amp; 13.7</td>
<td>Baseball, football, horseback riding, social center, gym</td>
</tr>
<tr>
<td>Makawao Rodeo Arena</td>
<td>Private</td>
<td>2.0</td>
<td>Horseback riding, rodeo</td>
</tr>
<tr>
<td>Makawao Forest Reserve</td>
<td>State</td>
<td>2,093</td>
<td>Hunting</td>
</tr>
<tr>
<td>Waihou Spring Reserve</td>
<td>State</td>
<td>84.0</td>
<td>Picnic</td>
</tr>
<tr>
<td>Pukalani Park and Community Center</td>
<td>County</td>
<td>5 acres presently, 25 acres total</td>
<td>Basketball, baseball and social center</td>
</tr>
<tr>
<td>Baldwin Polo Field</td>
<td>Private</td>
<td>N/A</td>
<td>Horseback riding, polo</td>
</tr>
<tr>
<td>Kula Botanical Garden</td>
<td>Private</td>
<td>8.2</td>
<td>Garden - native and introduced plants</td>
</tr>
<tr>
<td>Kula School Park</td>
<td>State</td>
<td>6.9</td>
<td>Playfield, basketball</td>
</tr>
<tr>
<td>Harold P. Rice Park</td>
<td>County</td>
<td>3.8</td>
<td>Picnic</td>
</tr>
<tr>
<td>Keokea Ball Park</td>
<td>County</td>
<td>4.2</td>
<td>Picnic, baseball</td>
</tr>
<tr>
<td>Haleakula Nat'l Park</td>
<td>Federal</td>
<td>20,246</td>
<td>Hiking, picnic, camping</td>
</tr>
<tr>
<td>Kula Game Management Area*</td>
<td>State</td>
<td>5,938</td>
<td>Hunting, hiking</td>
</tr>
<tr>
<td>Kahikinui Game Management Area*</td>
<td>State</td>
<td>13,184</td>
<td>Hunting, hiking</td>
</tr>
<tr>
<td>Polipoli Springs State Rec. Area</td>
<td>State</td>
<td>2.0</td>
<td>Hiking, picnic, camping</td>
</tr>
</tbody>
</table>

* Within Forest Reserve
follow it to the end, about 1.2 miles. The approximate distance of the Piiholo Site from Kahului is about 16 miles. Approximate transit times from Kahului to these sites are 40-50 minutes.

Access to the Kamole Weir site can be gained via two routes from Kahului. One would be to continue on Hana Highway past its junction with Haleakala Highway until Hana Highway meets with Baldwin Avenue (Route 39), and continue mauka along Baldwin Avenue to the project site -- about a 12 mile drive from Kahului. The other, and possibly more desirable route, would be to take Haleakala Highway to Haliimaile Road, then travel along Haliimaile Road to Baldwin Avenue. The approximate mileage from Kahului by this route is 11 miles.

2. Traffic.

Makawao Avenue is a two-lane roadway in good condition. It is a Federal Aid Secondary County (FASC) road. Average daily traffic (ADT) in 1973 along Makawao Avenue was 3,450 - 4,123 vehicles per day.

A recent 24-hour traffic count at the intersection of this roadway with Baldwin Avenue and Olinda road is presented in Table 2-8.
TABLE 2-8

24-HOUR TRAFFIC COUNT
MAKAWAO AVENUE, BALDWIN AVENUE AND
OLINDA ROAD INTERSECTION
APRIL 10-11, 1979

<table>
<thead>
<tr>
<th></th>
<th>Entering Intersection</th>
<th>Leaving Intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makawao Avenue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Leg</td>
<td>1,825</td>
<td>1,946</td>
</tr>
<tr>
<td>West Leg</td>
<td>3,380</td>
<td>3,266</td>
</tr>
<tr>
<td>Baldwin Avenue</td>
<td>2,396</td>
<td>2,310</td>
</tr>
<tr>
<td>Olinda Road</td>
<td>637</td>
<td>716</td>
</tr>
</tbody>
</table>

**Source:** State Department of Transportation, Wailuku, Maui, 1980. Personal communication.
Traffic counts taken by the State Department of Transportation along Makawao Avenue show little, if any, increase between 1976 and 1979 in traffic volume during the afternoon peak hour. [2.30]

Baldwin Avenue, Olinda Road, and Piilolo Road are two-lane roadways in good condition. Ehu Road is a two-lane road in fair condition. ADT counts are not available for these roads. All-weather access roads will be provided to each of the water treatment plants.

E. Shopping Opportunities

The residents of Makawao and Pukalani are served by several stores, concentrated primarily at the new Pukalani Terrace Center in Pukalani. This 15-store shopping complex contains a supermarket, clothing stores, and a hardware store, for example. There are also gas stations nearby. In addition, residents may patronize three shopping malls between Kahului and Wailuku, as well as downtown Wailuku stores.
REFERENCES TO SECTION 2


[2.2] Ibid. Page 326.

[2.3] Ibid. [2.1]. Page 328.


[2.5] Ibid.

[2.6] Ibid. [2.4]. Page 36.

[2.7] Ibid. [2.4].

[2.8] Ibid. [2.4]. Page 37.

[2.9] Ibid. [2.4].

[2.10] Ibid. [2.4]. Pages 10-11.


[2.14] Ibid.

[2.15] Ibid. [2.13].

[2.16] Ibid. [2.13].

2-51
Ibid.

Ibid.


Ibid.

Ibid.


Land Use Plans Policies Controls
SECTION 3

THE RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS, POLICIES AND CONTROLS FOR THE AFFECTED AREA

I. EXISTING LAND USE

A. Project Sites

The proposed location of the Makawao WTP is in the immediate vicinity of the existing Kamole Weir of Wailoa Ditch owned by East Maui Irrigation Co.

The proposed Lower Kula WTP site is presently used as pasture, and is privately owned. The Upper Kula WTP site consists of vacant land adjoining the Olinda Reservoir.

B. Island of Maui

Existing land use on the island of Maui, as of 1972, is shown in Table 3-1.

II. STATE LAND USE DESIGNATIONS

The three proposed sites are within a State Land Use designation of Agriculture [3.1]. One of the alternate sites for the Lower Kula WTP ("Piiholo Site 2") is also within Agriculture, while the other ("Piiholo Site 3") is within a designation of Conservation.

In order to develop Piiholo Site 3, which is within the Makawao Forest reserve, a Conservation District Use Application (CDUA) would have to be filed.
<table>
<thead>
<tr>
<th>Land Use</th>
<th>Acreage</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>17,292</td>
<td>3.53</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>774</td>
<td>0.16</td>
</tr>
<tr>
<td>Manufacturing Services</td>
<td>657</td>
<td>0.13</td>
</tr>
<tr>
<td>and Warehousing 2/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial 3/</td>
<td>233</td>
<td>0.05</td>
</tr>
<tr>
<td>Services 4/</td>
<td>30,986</td>
<td>6.32</td>
</tr>
<tr>
<td>Social and Cultural 5/</td>
<td>1,302</td>
<td>0.26</td>
</tr>
<tr>
<td>Recreation 6/</td>
<td>18,778</td>
<td>3.83</td>
</tr>
<tr>
<td>Agriculture</td>
<td>197,900</td>
<td>40.37</td>
</tr>
<tr>
<td>Transportation 7/</td>
<td>776</td>
<td>0.16</td>
</tr>
<tr>
<td>Unused Open Space Areas 8/</td>
<td>221,534</td>
<td>45.19</td>
</tr>
<tr>
<td>TOTAL</td>
<td>490,234</td>
<td>100.00</td>
</tr>
</tbody>
</table>

1/ Excludes public streets and highways.
2/ Includes warehousing, construction services, and public utilities.
3/ Retail and wholesale trade.
4/ Includes commercial amusement and recreation, hotels, military installations, government offices, parking, cemeteries, personal services, business and repair services, professional services, and finance, insurance and real estate.
5/ Educational, cultural and religious.
6/ Excludes commercial amusement and recreation services.
7/ Includes airports, docks, and land transportation facilities.
8/ Includes vacant land, forest reserve, lakes, steep land, and undedicated streets.

III. MAKAWAO-PUKALANI-KULA GENERAL PLAN

The proposed Piilolo and Olianda sites are located in an area designated as "General Agriculture" by the Makawao-Pukalani-Kula General Plan [3.2]. The Kamole Weir site is not within the general plan boundaries.

IV. COUNTY GENERAL PLAN [3.3]

The General Plan of the County of Maui sets forth the County's broad policies for long-range development. It consists of (1) general objectives expressing the common wishes and aspirations of County residents and (2) policies which will have to be carried out in order to attain each objective.

Under the category of Utility and Facility Systems, the plan presents the objective and policies with regard to water. Refer to Table 3-2. The proposed water treatment plants will assist the County in attaining the first two policies.

V. COUNTY ZONING

For lands outside of the Urban and Rural State Land Use districts, the County of Maui has no specific zoning ordinances. Instead, the State Land Use designations are followed. Thus, the "zoning" for the three sites is Agriculture.
### TABLE 3-2
WATER OBJECTIVE AND POLICIES
MAUI COUNTY GENERAL PLAN

**OBJECTIVE:**

1. To provide an adequate supply of domestic and irrigation water to meet the needs of our people.

**POLICIES:**

1. Support water supply services to those areas which historically experience critical water problems.
2. Meet or exceed Federal quality standards in our potable water.
3. Create systems to provide better fire protection.
4. Limit growth activities to existing water supply and expend the supply of water wisely.
5. Minimize moratoriums on water supply in areas used for resident housing.
6. Support expeditious action on bills providing for replacement of inadequate water transmission systems.
7. Encourage cost sharing programs with private developers in the expansion of our water supply.
8. Seek new sources of water by exploration in conjunction with other government agencies.
9. Maintain the right to manage our transmission and deliverance systems at the County level.
10. Develop sufficient water supply during drought seasons so as to keep agricultural activities viable.
11. Maintain a balance between visitors and residents in the consumption of water.

Source: [3.3]
CORRECTION

THE PRECEDING DOCUMENT(S) HAS BEEN REPHOTOGRAPHED TO ASSURE LEGIBILITY
SEE FRAME(S) IMMEDIATELY FOLLOWING
III. MAKAWAO-PUKALANI-KULA GENERAL PLAN

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10. Develop sufficient water supply during drought seasons so as to keep agricultural activities viable.

11. Maintain a balance between visitors and residents in the consumption of water.

Source: [3.3]
VI. STATE AGRICULTURAL LANDS DESIGNATIONS [3.4]

In 1977 a soil classification system was adopted by the State Board of Agriculture. This classification delineates those lands of the State which are of agricultural importance and categorizes agricultural lands into three classes. The three classes are as follows:

Prime Agricultural Land - Land which has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops economically, when treated and managed according to modern farming methods.

Unique Agricultural Land - Land that has the special combination of soil quality, location, growing season, moisture supply, and is used to produce sustained high quality and high yields of a specific crop when treated and managed according to modern farming methods.

Other Important Agricultural Land - Land other than Prime or Unique Agricultural Land that is also of statewide or local importance for agricultural use.

Soils at the Kamole Weir and Piiholo sites are classified as Prime Agricultural Land. Soils at the Olinda site are classified as Other Important Agricultural Land.

VII. OTHER GOVERNING PLANS AND POLICIES

A. Safe Drinking Water Act, 1974: [3.5; 3.6; 3.7; 3.8]

The Safe Drinking Water Act of 1974 (P.L. 93-523) designates the Federal Government (Environmental Protection Agency or EPA) as having primary responsibility of establishing national standards. The states are
responsible for enforcing the standards and otherwise supervising public water supply systems and sources of drinking water. A public water system is defined as providing piped water for human consumption and that it has at least 15 service connections or regularly serves at least 25 people.

This Act provides for:

- Establishment of primary regulations for the protection of the public health;
- Establishment of secondary regulations relating to the taste, odor, and appearance of drinking water;
- Measures to protect underground drinking water sources;
- Research and studies regarding health, economic, and technological problems of drinking water supplies. Specifically required are studies of viruses in drinking water and contamination by cancer-causing chemicals;
- A survey of the quality and availability of rural water supplies;
- Aid to the States to improve drinking water programs through technical assistance, training of personnel, and grant support;
- Citizen suits against any party believed to be in violation of the Act;
- Record-keeping, inspection, issuance of regulations, and judicial review;
- A 15-member National Drinking Water Advisory Council to advise the EPA Administrator on scientific and other responsibilities under the Act;
A requirement that the Secretary of Health, Education, and Welfare ensure that standards for bottled drinking water conform to the primary regulations established under the Act - or to publish reasons for not doing so; and


Primary standards were designed to provide maximum feasible protection of the public health, utilizing the best treatment methods generally available, with cost as a consideration. The standards are ultimately to include maximum contaminant levels, treatment techniques, and criteria for operation, maintenance, siting, and intake of public water supply systems.

Secondary standards will also be prescribed for taste, odor, and appearance of drinking water, including sodium and total dissolved solids in the water. Secondary standards are to be enforced at the discretion of the individual states.

The proposed water treatment plants are being designed to comply with the Safe Drinking Water Regulations.

B. State Department of Health, Chapter 49, Potable Water Systems [3.9]

These regulations were adopted by virtue of Chapter 340E, Hawaii Revised Statutes, the purpose being to establish drinking water quality standards.
These standards are based on standards and guidelines developed due to enactment of the Safe Drinking Water Act (P.L. 93-523). P.L. 93-523 sets the parameters for inorganic and organic chemicals and for such factors as turbidity and coliforms. Inorganic and organic chemicals and coliforms are monitored by the State Department of Health and turbidity is monitored by the County. Refer to Appendices A and C for additional information on standards and source water quality.

C. State Environmental Policy Act [3.10]

The purpose of the State Environmental Policy Act is to promote efforts which will prevent damage to the environment and stimulate the health and welfare of Hawaii's residents. The Act consists of:
(1) the environmental policy of the State to guide its programs, authorities, and use of resources; and guidelines to be considered by all agencies in the development of their programs. The following is a discussion of relevant policies and guidelines:

Environmental Policy -

(1) "Conserve the natural resources, so that land, water, mineral, visual, air and other natural resources are protected by controlling pollution, by preserving or augmenting natural resources, and by safeguarding the State's unique natural environmental characteristics in a manner which will foster and promote the general welfare, create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of the people of Hawaii."
This project is proposed by the County of Maui in order to meet the requirements mandated by the Federal Safe Drinking Water Act. The existing water supply for the areas to be served by the project, requires treatment.

**Guidelines**

(2)(A) "Encourage management practices which conserve and fully utilize all natural resources."

Implementation of the proposed projects will improve the quality of potable water in the service area.

(10)(B) "Provide for expanding citizen participation in the decision making process so it continually embraces more citizens and more issues."

This EIS was prepared in accordance with Chapter 343, HRS, which provides for two public review periods.
REFERENCES TO SECTION 3


Environmental Impacts 4
SECTION 4

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATIVE MEASURES TO MINIMIZE ADVERSE IMPACTS

I. INTRODUCTION

This section discusses the anticipated environmental impacts from the construction of the water treatment plants. The environmental impacts are discussed under primary and secondary impacts, including short-term and long-term impacts.

Primary impacts result directly from a proposed project, and can be separated into short-term and long-term impacts. Short-term primary impacts are construction-related, lasting no longer than the construction period. Long-term primary impacts last for the entire life of the project and are directly related to the implementation of the project.

Secondary impacts are those which may be indirect results of the proposed project. Anticipated short-term secondary impacts are those which may result during construction and anticipated long-term impacts are those which may indirectly result from implementation of the proposed project.

The anticipated environmental impacts from the construction of the three treatment plants will be discussed together, because, they will use similar processes and will have similar environmental impacts.
II. PRIMARY IMPACTS OF THE PROPOSED PROJECTS

This discussion presents factors which are expected to be affected directly from the proposed projects. Discussion of each parameter will include anticipated short-term and long-term impacts resulting from the proposed projects.

A. Water Quality

1. Short-term Impacts

During construction of the treatment facilities, precautions will be taken to prevent contamination of the existing potable water system. These precautions will include adherence to approved grading plans, which will divert storm water from the denuded areas away from the existing structures. Dust generated during clearing and grading activities will be controlled in the field by appropriate water sprinkling.

A routine refuse program will be maintained at all times during construction to control litter. Completely contained chemical toilets will be provided for the construction workers, and the contractor will dispose the waste according to County and State regulations. Potential contaminants, such as fuel and lubricants, will be stored in areas that would not endanger the water supply should spillage occur.
2. **Long-term Impacts**

The proposed water treatment plants are being constructed to comply with Federal and State water regulations for potable water. As previously stated, the existing water supply for the service area requires treatment, particularly for coliforms and turbidity. Implementation of the treatment plants will have a long-term beneficial impact on the potable water quality of the service area.

B. **Air Quality**

1. **Short-term Impacts**

Dust will be generated during construction and site preparation. Dust will be mitigated in the field using appropriate water sprinkling methods and this will be a condition in the contract document. To also minimize dust and potential erosion, only those areas necessary for the construction will be cleared.

Exhaust from construction equipment are expected to have an insignificant impact on ambient air quality. These emissions will be of short duration, lasting only for the construction period.
2. **Long-term Impacts**

Once the proposed treatment facilities have been completed, the only potential air pollutants would be from the equipment and the chemicals used in the treatment process. These pollutants are expected to have a negligible effect on the ambient air quality.

As a part of each treatment plant, chlorine tanks will be stored within the facility. These tanks will be part of the automated portion of the plant for the chlorination process of the treatment. A chlorine detection system will be provided to detect leaks, and the personnel will be provided with gas masks. The potential for chlorine leakage is anticipated to be low and personnel will receive the necessary training on how to store and change tanks to further minimize the potential for a leak.

C. **Noise**

1. **Short-term Impacts**

   During site preparation and construction of buildings, an increase of ambient noise levels is inevitable. Noise levels generated by construction machinery, which can be expected during construction, are present in Figure 4-1.
### FIGURE 4-1
CONSTRUCTION EQUIPMENT NOISE RANGES

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Noise Level (dBA) at 50 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Compacters (Rollers)</td>
<td></td>
</tr>
<tr>
<td>Front Loaders</td>
<td></td>
</tr>
<tr>
<td>Backhoes</td>
<td></td>
</tr>
<tr>
<td>Tractors</td>
<td></td>
</tr>
<tr>
<td>Scrapers, Graders</td>
<td></td>
</tr>
<tr>
<td>Pavers</td>
<td></td>
</tr>
<tr>
<td>Trucks</td>
<td></td>
</tr>
<tr>
<td>Concretes Mixers</td>
<td></td>
</tr>
<tr>
<td>Concrete Pumps</td>
<td></td>
</tr>
<tr>
<td>Cranes (Movable)</td>
<td></td>
</tr>
<tr>
<td>Cranes (Derrick)</td>
<td></td>
</tr>
<tr>
<td>Pumps</td>
<td></td>
</tr>
<tr>
<td>Generators</td>
<td></td>
</tr>
<tr>
<td>Compressors</td>
<td></td>
</tr>
<tr>
<td>Pneumatic Wrenches</td>
<td></td>
</tr>
<tr>
<td>Jack Hammers and Rock Drills</td>
<td></td>
</tr>
<tr>
<td>Pile Drivers (Peaks)</td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td></td>
</tr>
<tr>
<td>Saws</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Based on Limited Available Data Samples

**Source:** Noise From Construction Equipment and Operations Building Equipment, and Home Appliances, EPA, 1971
All of the proposed plant sites are located sufficiently far enough from residential areas that construction noise impacts, especially in this agriculturally oriented area, are not expected to be a problem. Furthermore, the contractor will take the necessary precautions to mitigate machinery noise levels by ensuring that mufflers on all equipment are in proper operating condition. This increase in ambient noise will be temporary, lasting only for the construction period.

2. **Long-term Impacts**

Once the proposed plants have been completed, equipment expected to generate significant levels of noise are air compressors, backwash and feed pumps. When operating, the noise level adjacent to the equipment will be about 85 dB. Approximately 70-75 feet away the noise level would be about 70-75 dB; however, this level would be for an unobstructed situation. Since the compressors, backwash and feed pumps will be enclosed within a structure, the levels would be considerably less; insulation within the building also can be provided to further minimize noise levels external to the structure.
D. Geology, Soils, and Mineral Resources

1. Short-term Impacts

The proposed treatment plants essentially will be constructed on level grades and grading will be kept to a minimum by terracing. The overall geology, therefore, will be unaffected by construction. Concern regarding geology involves the island of Maui being in Seismic Zone 2. Design and construction of the structures will consider this as appropriate mitigative measures.

The only potential for increased erosion because of the proposed facilities would be during clearing and grading; however, grading will divert run off patterns away from structures and will not be so great to result in significant erosion of existing soils at the site. Once the structures are in place, denuded areas will be revegetated, as necessary, to mitigate potential future erosion.

2. Long-term Impacts

The long-term erosion patterns and soil loss due to the proposed projects are not expected to differ significantly from existing patterns.
The only mineral resource recorded for the Haleakala area is augite. The proposed plants should not affect such deposits, because the nearest deposits of the mineral have been found along the road just below the summit of Haleakala, and just south of the boundary fence of Haleakala National Park near the lower edge of the Park housing area [Macdonald and Abbott, page 411.]

E. Biological Resources

1. Short-term Impacts

The majority of the vegetation found during the biological survey consists of common species of plants found throughout the state; none are considered endangered. Removal of this vegetation will not be significant nor can the site be considered a critical wildlife habitat.

No endangered species of birds or mammals were found on the sites. Native birds and mammals may visit the mauka areas, but the sites do not offer suitable habitats. Also, during construction, fauna in the immediate vicinity of the construction activities will avoid the sites and return upon completion of the construction.
2. **Long-term Impacts**

Completion of the projects should not adversely affect the flora and fauna of the project sites. Long-term adverse environmental impacts to the flora and fauna from the operation of the treatment plants will not be significant.

F. **Archaeological and Historic Resources**

1. **Short-term Impacts**

   The absence of archaeological sites precludes any short-term adverse environmental impacts.

2. **Long-term Impacts**

   The absence of archaeological sites precludes any long-term adverse environmental impacts.

G. **Electrical**

1. **Short-term Impacts**

   Problems with providing electrical service to the proposed plants are not anticipated. Both the design and construction will be closely coordinated with Maui Electric Company to assure that potential conflicts have been considered and resolved.

2. **Long-term Impacts**

   Additional cost to the consumer because of these proposed projects is not expected to be discernable. Electrical costs incurred by
the proposed projects are a necessary aspect of the proposed design to meet Federal and State regulations for potable water.

H. Access and Traffic

1. Short-term Impacts

During construction there will be a brief period of impact to existing traffic patterns, as construction equipment is transported to each site. However, this phase will be completed during off-hours to minimize input. If safety in traffic flow becomes a consideration, then police assistance will be requested.

Once the large equipment is at the site, there will be no alteration of existing traffic patterns and the only routine traffic during construction would be generated by the construction workers themselves. Anticipated impacts resulting from this traffic volume are expected to be negligible.

2. Long-term Impacts

Upon completion, the plants will require daily checking and the occasional delivery of chemicals. The amount of traffic generated by the operation of the treatment plants will be negligible.
None of the sites are currently public areas, nor are they areas through which access must be maintained to reach public areas. Except for the treatment facilities themselves, which will be secured by perimeter fencing, continued access can be gained throughout the area. Therefore, no substantial short-term or long-term impacts to existing access patterns are anticipated.

I. Emergency Services

Fire, medical, or police services should not significantly be affected either for the short-term or the long-term. As stated in Section 2, the Makawao Fire Station, which also houses the ambulance, can respond to the sites within 5-15 minutes. Security for the facilities will be provided both during construction and after completion, so additional police patrols to the site should not be required.

J. Schools

The proposed projects will not have a short- or long-term environmental impact on schools.

K. Parks

The proposed projects will not have a short- or long-term impact on parks.
L. Waste Disposal
   1. Short-term Impacts
      Construction wastes will be disposed of at the County-operated sanitary landfill.
   2. Long-term Impacts
      The operation of the water treatment plants generates sludge during the treatment process. The ultimate disposal of the sludge will be a County-operated sanitary landfill.

M. Economic
   1. Short-term Impacts
      The construction of the treatment plants will undoubtedly be phased due to high capital cost of such an undertaking and it is anticipated that the Makawao Treatment Plant will be started first and the Kula Treatment Plants started as funds become available.

      Based on present costs, the Makawao Treatment Plant will have a stimulatory effect on the local construction industry; the effect will be about $3,445,000 (Phase 1) X 1.7 = $5,856,000. The estimated construction costs for the Lower and Upper Kula Water Treatment Plants are $5.3 million and $2.8 million respectively.
CORRECTION

THE PRECEDING DOCUMENT(S) HAS BEEN REPHOTOGRAPHED TO ASSURE LEGIBILITY.
SEE FRAME(S) IMMEDIATELY FOLLOWING.
None of the sites are currently public areas, nor are they areas through which access must be maintained to reach public areas. Except for the treatment facilities themselves, which will be secured by perimeter fencing, continued access can be gained throughout the area. Therefore, no substantial short-term or long-term impacts to existing access patterns are anticipated.

I. Emergency Services

Fire, medical, or police services should not significantly be affected either for the short-term or the long-term. As stated in Section 2, the Makawao Fire Station, which also houses the ambulance, can respond to the sites within 5-15 minutes. Security for the facilities will be provided both during construction and after completion, so additional police patrols to the site should not be required.

J. Schools

The proposed projects will not have a short- or long-term environmental impact on schools.

K. Parks

The proposed projects will not have a short- or long-term impact on parks.
L. Waste Disposal
   1. Short-term Impacts
      Construction wastes will be disposed of at the County-operated sanitary landfill.
   2. Long-term Impacts
      The operation of the water treatment plants generates sludge during the treatment process. The ultimate disposal of the sludge will be a County-operated sanitary landfill.

M. Economic
   1. Short-term Impacts
      The construction of the treatment plants will undoubtedly be phased due to high capital cost of such an undertaking and it is anticipated that the Makawao Treatment Plant will be started first and the Kula Treatment Plants started as funds become available.

      Based on present costs, the Makawao Treatment Plant will have a stimulatory effect on the local construction industry; the effect will be about $3,445,000 (Phase 1) X 1.7 = $5,856,000. The estimated construction costs for the Lower and Upper Kula Water Treatment Plants are $5.3 million and $2.8 million respectively.
2. **Long-term Impacts**

   The operation of the treatment plants will entail manpower, material and energy costs. The exact costs are presently unknown and can only be determined after the treatment plants have been in operation for a given period of time. However, estimates have been made and discussed under secondary impacts.

III. **SECONDARY IMPACTS**

   A. **Land Use and Water Resources**

   The objective of the construction of the three water treatment plants is to treat existing water supplies to meet current State and Federal drinking water standards. No new water sources will be developed as a result of this project and, therefore, there will not be a stimulus for growth.

   The future land use for the water service area served by the treatment plants is being guided by the County General Plan (1980), Makawao-Pukalani-Kula General Plan (1974), and the proposed Makawao-Pukalani-Kula Community Plan (October, 1981).

   Essentially, the concepts articulated in the 1974 Makawao-Pukalani-Kula General Plan for agriculture are retained in the proposed Makawao-Pukalani-Kula
Community Plan. For example: the enhancement, expansion and protection of present and future agricultural lands have been retained; the plan discourages land speculation and "large estate subdivisions;" and the plan supports the development of an agricultural park.

The future policy regarding water source development, transmission, and competing uses of water will be determined after the Department of Water Supply completes the water master study for the up-country area.

B. Economic

The operation of the water treatment plants requires funds for maintenance, supplies and repair. The estimated operating cost has been developed for the Makawao Treatment Plant, and the costs for the two other treatment plants will be estimated when the engineering reports have been finalized. The Makawao Treatment Plant, being the largest, gives a reasonable estimate of the future costs for treatment.

The following are estimated costs:
<table>
<thead>
<tr>
<th></th>
<th>Annual Costs</th>
<th>Cost Per Million Gallons Treated2/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Cost</td>
<td>$ 84,000</td>
<td>$ 23.01</td>
</tr>
<tr>
<td>Power Cost</td>
<td>761,000 1/</td>
<td>208.49</td>
</tr>
<tr>
<td>Maintenance, Repairs</td>
<td>30,000</td>
<td>8.21</td>
</tr>
<tr>
<td>and Replacement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Misc. Supplies and</td>
<td>6,000</td>
<td>1.64</td>
</tr>
<tr>
<td>Personnel</td>
<td>180,000</td>
<td>49.31</td>
</tr>
<tr>
<td></td>
<td>$1,061,000</td>
<td>$290.66 3/</td>
</tr>
</tbody>
</table>

Using these estimates for the Makawao Treatment Plant as a basis, the operation and maintenance costs for the Upper or Lower Kula Treatment Plants are estimated as:

<table>
<thead>
<tr>
<th>Treatment Plant</th>
<th>Maximum Design Capacity (MGD)</th>
<th>Cost Per MG</th>
<th>Maximum Daily O &amp; M Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makawao</td>
<td>8 to 12</td>
<td>$84.22</td>
<td>$673.76 to $1,010.64</td>
</tr>
<tr>
<td>Upper Kula</td>
<td>2.5</td>
<td>$84.22</td>
<td>$210.55</td>
</tr>
<tr>
<td>Lower Kula</td>
<td>2.5 to 5</td>
<td>$84.22</td>
<td>$210.55 to $421.10</td>
</tr>
</tbody>
</table>

1/ Based on $0.11 per kilowatt hour; however, 99% of the estimated power cost is for the operation of the high service pumps. (Approximately $8,400 is used for the operation of the plant.)

2/ Based on a 10 mgd plant operating 365 days per year.

3/ If all of the cost factors were used as reasonable estimates, with the exception of using a factor of only 1% of the power cost for operation of the treatment plants, then it can be assumed that the cost for treating 1 million gallons would be $84.22.
Another way of looking at the cost for operating the treatment plants is to divide the maximum daily operating cost by the population, with the following results:

Kula: \[
\frac{\$631.65}{3,864 \text{ people}} = \$0.16/\text{person/day}
\]

Makawao: \[
\frac{\$1,010.64}{8,994 \text{ people}} = \$0.12/\text{person/day}
\]

The average is approximately $0.14/person/day for the Makawao-Kula water service area.

IV. REASONS FOR PROCEEDING

The construction of the treatment plants should permit the Department of Water Supply to meet the State and Federal drinking water standards and will, therefore, be a positive beneficial impact. No significant adverse environmental impacts will result from the implementation of the projects.

Alternative means of meeting the objectives are being evaluated, and additional studies on water source development, distribution and uses are being undertaken by the Department of Water Supply to formulate future policies and directions.
Adverse Environmental Effects

5
SECTION 5
PROBABLE ADVERSE ENVIRONMENTAL IMPACTS
WHICH CANNOT BE AVOIDED

This section summarizes adverse impacts presented in the previous section entitled, "Anticipated Environmental Impacts and Mitigative Measures to Minimize Adverse Impacts," and presents mitigative measures to minimize these impacts.

I. PRIMARY IMPACTS OF THE PROPOSED PROJECT

A. Short-term Adverse Impacts

Short-term adverse impacts anticipated because of the proposed projects' construction-related and, therefore, of short duration and should last only for the construction period. Although dust will be generated during site preparation, this should not create significant problems since it can be effectively mitigated in the field through water sprinkling. Exhaust emissions from construction equipment should be quite insignificant and should not adversely affect ambient air quality.

Because of the distance of the sites from nearby streams, erosion and sedimentation into stream waters during construction are not expected.

During construction increased noise would probably be the most prominent compared to other anticipated
impacts. This will be temporary, and the contractor will ensure that mufflers on equipment are in proper operating condition and will limit the hours of construction.

Vegetation which will be cleared and grubbed from the sites is not rare or endangered.

Although native species of birds may visit the Piilolo and Olinda areas, the sites themselves do not provide suitable habitat. Fauna may relocate to adjacent areas during construction but could return upon completion of the projects. Construction activities should not affect existing aquatic biota.

There are no significant archaeological features on the sites.

Solid waste generated during construction should not be a significant problem and will be regularly transported to the nearest landfill. Liquid waste will be disposed in portable chemical toilets so this is not anticipated to be a significant problem.

Transport of construction equipment should be done during hours of lightest traffic to minimize disruption to existing traffic patterns. If necessary, police assistance during this phase may be requested. Construction worker traffic should not adversely affect existing traffic.
B. Long-term Adverse Impacts

1. **Air Quality:**

   Although exhaust emissions may be generated by plant equipment, these emissions are insignificant and should not adversely affect ambient air quality.

   Chlorine tanks will be used on-site and a chlorine detection system will be provided should leakage occur. Mandatory gas masks will also be provided. Potential for leakage is minimal and significant adverse impacts are not expected.

2. **Water Quality:**

   Operations of the proposed water treatment plants will not affect water quality of reservoirs and water sources. Backwash water generated by the plants will be impounded and/or disposed of through acceptable methods. Solids in the backwash water will be primarily silt and clay from the water source and a gelatinous alum floc from the coagulation process. The amount of solids generated will vary seasonally. Since the alum floc is basically inert, adverse impacts are not expected.

3. **Noise:**

   Noise above ambient levels will be generated primarily by the air compressors, backwash and
chemical pumps which will be about 85 dB adjacent to the equipment. Approximately 70-75 feet away, the noise level will be about 70-75 dB. Since sensitive wildlife habitats and rare and endangered species are not expected in the areas, adverse impacts to such species are not anticipated.

4. Biological:

Two of the sites are already being utilized for a purpose similar to that being proposed (Makawao and Olinda) and potential displacement of fauna on the sites is expected to be minimal. The flora species at the sites are primarily common exotic species found throughout the State and do not provide sensitive wildlife habitat.

The proposed projects are not expected to draw more water from the existing water sources.

II. SECONDARY ADVERSE IMPACTS OF THE PROPOSED PROJECT

The proposed projects will preclude other land uses. Since the proposed actions are similar to the existing uses, adverse impacts to and conflicts with the sites and surrounding land uses are not expected for the Makawao and Upper Kula sites. The Lower Kula site will remove approximately 3 to 4 acres of land from pasture. This will not adversely affect cattle production.
III. REASONS FOR PROCEEDING

Adverse impacts anticipated because of the proposed projects have been evaluated and are considered minimal, particularly compared to the benefits which will accrue as a result of the proposed action. These adverse impacts can be mitigated and should not constitute significant adverse impacts.

The proposed treatment plants must be built to comply with the State and Federal safe drinking water regulations.
Alternatives
SECTION 6
ALTERNATIVES

I. NO ACTION

The alternative of no action will result in the continued violation of the State and Federal safe drinking water regulations. The no action alternative is unacceptable, and immediate action is required by the Department of Water Supply to start construction of treatment plants and facilities and to initiate programs to treat the Maoawao-Kula water sources.

II. ALTERNATIVE SITES

The location of a water treatment plant is determined by basic engineering design concepts, and therefore the placement of a plant is limited. Some basic design criteria are a plant must be located near the water source, and no plants should be sited where existing major facilities are not being used to their full potential.

The Makawao and Upper Kula water treatment plants are located between the major water sources and not where any major facilities already exist; they are not located within major urban centers; and it would be difficult to locate the treatment facilities at alternative sites which will meet the criteria established by the basic engineering concepts.
Providing a costly all weather access road to the Lower Kula plant, if it were to be located near the major water storage facility, required that an alternative site be found. Therefore, the only alternative site evaluated was for the Lower Kula water treatment plant mainly due to having existing filters at the other two sites.

III. ALTERNATIVE WATER TREATMENT PLANT DESIGN

The various unit water treatment processes currently available have been described in Appendix E of this report. Please refer to this appendix for a general discussion of water treatment processes.

Presently, engineering consultants have evaluated various treatment processes and have preliminarily recommended specific processes. The final selections will depend on the evaluation by the Department of Water Supply.

Generally, the unit processes may differ, but the overall environmental impacts are similar.

IV. ALTERNATIVE METHOD OF COMPLIANCE

An alternative method of compliance with the safe drinking water regulations is being evaluated for the Kula water system by the Department of Water Supply.
This method proposes building the water treatment plant at Kamole Weir and pumping a greater amount of treated water to the Upper and Lower Kula water systems. This will enable dilution of the more turbid Kula water by the treated Makawao water. The expected results would be in compliance to the existing standards.

This alternative (and other methods) must be evaluated economically and monitored to ensure that there is no potential risk to the health and safety of the consumer. The cost/benefit of the pumping method is currently being studied, and the results are expected within six months. Determination of compliance to standards will require a monitoring program and testing over a period of time. The details have not been worked out and finalized. However, it is expected that this alternative will be worked out within a few months between the Department of Water Supply and the Department of Health.

V. ALTERNATIVE PHASING OF THE TREATMENT PLANTS

The Makawao Water Treatment Plant will be constructed first, and depending on the final results of the alternative methods of compliance, the need for the Kula water treatment plants will be evaluated.
Commitment of Resources
SECTION 7
IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

State and County funds, labor, construction and building materials, and fuel will be committed to the projects. Additional maintenance and operation funds and manpower will be required.

The construction of the treatment plants and/or alternative methods to comply with the drinking water regulations will have a positive long-term impact on the public health of the people in the Makawao-Kula water service area.

Since no significant impacts on biological resources are anticipated, no loss of long-term productivity is expected. However, the water consumer will receive long-term benefits.
Short Term Productivity

Term Uses - Long
SECTION 8

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF HAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The proposed actions have considered the environmental characteristics of the areas and the water requirements of the up-country area. The proposed actions, if implemented, should enable treatment of the existing water to meet Federal and State regulations for potable water, water necessary to meet current requirements for the Makawao-Kula water service area.

The amount of water to be treated from each of the water sources will not be greater than what is presently being drawn.

The proposed actions will not involve trade-offs between short-term losses, foreclose future options, narrow the range of beneficial use of the environment, nor pose long-term risks to health and safety. In fact, the treatment plants will treat existing water from the existing water sources to a level higher than what is presently being distributed to the water service area.
Government Policies to Offset Adverse Effects
SECTION 9

AN INDICATION OF WHAT OTHER INTERESTS AND CONSIDERATIONS
OF GOVERNMENTAL POLICIES ARE THOUGHT TO OFFSET THE
ADVERSE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTION

As indicated in Section 4, Anticipated Environmental
Impacts and Mitigative Measures to Minimize Adverse Impacts,
most of the adverse impacts are short-term and related
to construction activities.

The Department of Water Supply is presently under-
taking additional studies to determine alternative methods
to meet current requirements. Also, studies are under-
way to analyze other water sources, separate distribution
systems for agricultural and domestic uses, and water
needs for the service area.
SECTION 10

LIST OF NECESSARY APPROVALS

State of Hawaii

Department of Health approval by authorities: 1/

- HRS Chapter 340E, Safe Drinking Water Act, Act 84, 1976 Legislature
- Public Health Regulations, Chapter 49, Potable Water Systems

County of Maui

Department of Public Works 1/

1. Building permits through Land Use and Codes Administra-
   tion.

2. Grading permits by authority of the Permanent Ordin-
   nances of the County of Maui, Ordinance No. 639 (Bill

3. Grubbing permits by authority of the Permanent Ordin-
   nances of the County of Maui, Ordinance No. 639 (Bill

4. Sludge Disposal permit.

Maui County Planning Commission

- Land Use Commission Special Use Permits in accordance
to Act 221.

Other

Hawaiian Telephone Company - approval of plans.

Maui Electric Company - approval of plans.

1/ Source: State of Hawaii, Department of Planning and
Economic Development. 1977. Hawaii Coastal Zone Management Program, A Register Of Govern-
ment Permits Required for Development.

10-1
Organizations and Persons Consulted
SECTION 11
ORGANIZATIONS AND PERSONS CONSULTED
NOTICE OF PREPARATION COMMENTS AND RESPONSES

FEDERAL GOVERNMENT

U.S. Department of the Interior, Fish and Wildlife Service 11-3
U.S. Army Engineer District, Honolulu 11-4
U.S. Department of Agriculture, Soil Conservation Service 11-5

STATE GOVERNMENT

Department of Agriculture
Department of Health 11-6
Department of Land and Natural Resources
Department of Planning and Economic Development 11-7, 11-8
Office of Environmental Quality Control, Office of the Governor

COUNTY OF MAUI

Department of Human Concerns 11-9
Planning Department 11-10
County Council
Department of Public Works
Mayor's Office

11-1
OTHER ORGANIZATIONS

Brock and Associates
Alexander and Baldwin, Inc.
Hawaiian Commercial & Sugar Co.
Mr. Douglas Meller
Mr. Gordon E. Stellway
Mr. Arman Ashley
Kula Community Association
Kula Farmers Coop
Kula Farmers Exchange
Kula Kai Community Association
Kula PTA
Makawao Community Association
Maui Economic Opportunity, Inc.
Pukalani Community Association
Haleakala Ranch
Maui Land and Pineapple Co., Ltd.
Ulupalakua Ranch
January 12, 1982

Mr. John L. Ford
Acting Project Leader
Office of Environmental Services
U. S. Department of the Interior
Fish and Wildlife Service
P. O. Box 50167
Honolulu, Hawaii 96822

Dear Mr. Ford:

SUBJECT: Environmental Assessment of the Makawao-Kula Water Treatment Plants

Thank you for your review and comments regarding the preparation notice and the environmental assessment for the above project.

The appendices of the report will be published with the environmental impact statement. The potential yield of the water of the Makawao Water System is up to 16 mgd.

The description of the existing environment by inclusion and identification of aquatic fauna within the affected ditch and stream system is beyond the scope of this environmental impact statement. The major purpose of the proposed water treatment plan is to bring the existing water supply into conformance with the safe drinking water regulations.

Future water requirements and necessary water sources and storage facilities to meet their requirements are a separate issue to be studied at a later time.

Your comments will be incorporated into the environmental impact statement and a copy of the statement will be sent to you for your review.

Sincerely,

William S. Haines, Director

"By Water, All Things Flow Left"
January 13, 1982

Mr. Kivau Cheung, Chief
Engineering Division
Department of the Army
U.S. Army Engineer District,
Honolulu
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Subject: ENVIRONMENTAL ASSESSMENT OF THE HAKAUA-KULA WATER TREATMENT PLANTS

Thank you for reviewing the environmental assessment and preparation notice for the Hakaua-Kula Water Treatment Plants.

Your comment that a Department of the Army permit is not required for the proposed project will be included in the environmental impact statement. Also, the fact that the proposed treatment plant sites are situated in Zone C areas, or areas of minimal flooding, according to the Federal Insurance Administration's Flood Insurance Study for the Island of Maui, will be included in the environmental impact statement.

A copy of the environmental impact statement will be sent to you for your further review.

Sincerely,

William S. Baltes, Director
Department of Water Supply

Mr. William S. Baltes, Director
Department of Water Supply
County of Maui
PO Box 1109
Wailuku, Maui, HI 96793

Dear Mr. Baltes:

Thank you for the opportunity to review the Hakaua-Kula Water Treatment Plant Environmental Assessment, sent to us on 22 October 1981. Based on our review, we provide the following comments:

a. A Department of the Army permit is not required for this project.

b. The three proposed water treatment plant sites for the Maui County Department of Water Supply are situated in Zone C areas, or areas of minimal flooding according to the Federal Insurance Administration's Flood Insurance Study for the Island of Maui. Zone C areas are not considered special flood hazard areas by the study.

The US Army Corps of Engineers will be happy to review the draft Environmental Impact Statement when it becomes available.

Sincerely,

[Signature]
Chief, Engineering Division

"By Water All Things Take Life."
January 13, 1982

Mr. Ernest Robello, Jr.
District Conservationist
Soil Conservation Service
U.S. Department of Agriculture
217 Federal Building
Wailuku, Maui, Hawaii 96793

Dear Mr. Robello:

Subject: ENVIRONMENTAL ASSESSMENT OF THE NAKAWAO-KULA WATER TREATMENT PLANTS

Thank you for reviewing the environmental assessment for the Nakawao-Kula Water Treatment Plants.

Your letter will be included in the environmental impact statement and a copy of the EIS will be sent to you for your review.

Sincerely,

WILLIAM S. HAINES, Director
Department of Water Supply

Mr. William S. Haines, Director
Department of Water Supply
County of Maui
P. O. Box 1100
Wailuku, HI 96793

November 19, 1981

Mr. William S. Haines, Director
Department of Water Supply
County of Maui
P. O. Box 1100
Wailuku, HI 96793

Dear Mr. Haines:

Subject: Nakawao-Kula Water Treatment Plant Environmental Assessment

We have reviewed the above-mentioned environmental impact statement as you requested and have no comments to make at this time.

When the draft environmental impact statement is finished, please send it to me at the following address:

217 Federal Building
Wailuku, HI 96793

Thank you for the opportunity to review this notice.

Sincerely,

WILLIAM S. HAINES, Director
Department of Water Supply

cc: Jack P. Kamatz
State Conservationist
DOA, Honolulu, HI

"By Water, All Things Find Life."
Mr. William S. Holmes, Director  
Department of Water Supply  
County of Maui  
P.O. Box 3378  
Wailuku, Maui 96793

Dear Mr. Holmes:

Subject: Request for Comments on Environmental Assessment for Makawao-Kula Water Treatment Plant

Thank you for allowing us to review and comment on the subject environmental assessment. Please be informed that we do not have any objections to this project.

We realize that the statements are general in nature due to preliminary plant being the sole source of discussion. We, therefore, reserve the right to impose future environmental restrictions on the project at the time final plans are submitted to this office for review.

Sincerely,

[Signature]

WILLIAM K. KOIZUMI  
Deputy Director for Environmental Health

January 13, 1982

Mr. Melvin K. Koizumi  
State of Hawaii  
Department of Health  
P.O. Box 3378  
Honolulu, Hawaii 96801

Dear Mr. Koizumi:

Subject: ENVIRONMENTAL ASSESSMENT OF THE MAKAWAO-KULA WATER TREATMENT PLANTS

Thank you for reviewing the environmental assessment and preparation notice for the Makawao-Kula Water Treatment Plants.

Your letter will be made part of the environmental impact statement and a copy of the EIS will be sent to you for your further review.

Sincerely,

[Signature]

WILLIAM S. HOLMES, Director  
Department of Water Supply

"By Water All Things Flow and Life"
November 25, 1981

Ref. No. 3933

Mr. William S. Haines
Director
Department of Water Supply
County of Maui
P.O. Box 1199
Wailuku, Maui, Hawaii 96793

Dear Mr. Haines:

Subject: Makawao-Kula Water Treatment Plant Environmental Impact Statement Preparation Notice

Thank you for giving us the opportunity to comment on the above subject.

In our judgment, the Environmental Impact Statement should discuss the project’s impacts on the agricultural uses of the sites and the projects’ energy consumption for pumping and treatment. The data provided in the Notice were not sufficient for us to make any specific comments at this time. In this regard, we would appreciate being involved in the review of the Draft EIS.

Sincerely,

[Signature]

Hideto Kono

January 15, 1982

Mr. Hideto Kono, Director
Department of Planning and Economic Development
P. O. Box 2359
Honolulu, Hawaii 96804

Dear Mr. Kono:

SUBJECT: Makawao-Kula Water Treatment Plants

Thank you for your valuable comments on the Preparation Notice.

Your letter will be incorporated into the Environmental Impact Statement, and we offer the following responses to your comments.

The impacts on agricultural uses of the land where the water treatment plants will be constructed will be minimal. The Upper and Lower Kula Treatment Plants will be constructed adjacent to existing storage facilities and will not impact agricultural activities.

The Makawao Treatment Plant will be sited adjacent to the existing treatment and storage facility and will not have a significant impact on the surrounding pineapple fields. The site for the Lower Kula Treatment Plant has been tentatively sited in a pasture and will leave a very minor impact by removal of approximately two acres of pasture land.

The data on the amount of energy required for pumping, and the operation of the Upper and Lower Kula plants will be available when the engineering reports are completed. The estimated annual energy requirements for the Makawao Treatment Plant for treatment plant operations is 67,311 KWH, and 6,530,335 KWH for the high service pump.
Mr. Kudaro Kono, Director  
Department of Planning and Economic Development  
SUBJECT:  Makawao-Rule Water Treatment Plants  
January 20, 1982  
Page 2

The estimated power consumption and cost for the operation of the high service pumps accounts for about 99 percent of the total electrical requirements of the Makawao Treatment Plant.

We look forward to receiving your timely comments on the Draft Environmental Impact Statement.

Sincerely,

[Signature]

William S. Haines  
Director, Department of Water Supply
January 13, 1982

Mr. Edwin T. Okubo
Housing Coordinator
Department of Human Concerns
County of Maui
700 South High Street
Wailuku, Maui, Hawaii 96793

Dear Mr. Okubo:

Subject: ENVIRONMENTAL ASSESSMENT OF THE MAKAWAU-RULA WATER TREATMENT PLANTS

Thank you for reviewing the environmental assessment and preparation notice for the Makawau-Rula Water Treatment Plants.

Your letter will be made part of the environmental impact statement and a copy of the EIS will be sent to you for your further review.

Sincerely,

William S. Haines, Director
Department of Water Supply
Mr. Toosh Ishikawa  
Planning Director  
Planning Department  
County of Maui  
330 South High Street  
Wailuku, Maui, Hawaii 96793  

Dear Mr. Ishikawa:

Subject: ENVIRONMENTAL ASSESSMENT OF THE NAKAMO-KULA WATER TREATMENT PLANTS

Your letter dated October 28, 1981 will be incorporated into the environmental impact statement and a copy of this statement will be sent to you for your review.

Sincerely,

William S. Holmes, Director  
Department of Water Supply

October 28, 1981

Mr. William S. Holmes, Director  
Department of Water Supply  
County of Maui  
Wailuku, Maui, HI 96793  

Dear Mr. Holmes:

Re: Nakamo-Kula Water Treatment Plant Environmental Assessment

This acknowledges receipt of above referenced document.

Please be advised that we will reserve our comments pending a review of the Environmental Impact Statement report.

Please contact my office, should you have any questions.

Very truly yours,

Touche Ishikawa  
Planning Director

cc: Chris Hart

"By Water All Things Find Life."

To:  
Cc:  
Date & Initial:  
PHOENIX  
HOPI  
HEDLEY  
HOLCOMB  
INDY  
FRED  
SUE  
WILD WEST  

200 EBP
January 13, 1982

Ms. Julie R. Abramson, Planner
Brock and Associates
48 Market Street
Wailuku, Maui, Hawaii 96793

Dear Ms. Abramson:

Subject: ENVIRONMENTAL ASSESSMENT OF THE MAKAANO-KULA WATER TREATMENT PLANTS

Thank you for your letter dated October 28, 1981 requesting that Brock and Associates be a consulted party in the preparation of the environmental impact statement.

Your letter will be incorporated into the environmental impact statement and a copy of the EIS will be available at the Wailuku Regional Library for your review.

Sincerely,

William S. Haines, Director
Department of Water Supply

BROCK AND ASSOCIATES

Mr. William S. Haines, Director
Department of Water Supply
County of Maui
P. O. Box 1100
Wailuku, Maui, Hawaii 96793

Re: EIS - Makawao-Kula Water Treatment Plants, as announced in the EGC Bulletin dated October 23, 1981

Dear Mr. Haines:

As an engineering firm whose sphere of work includes water treatment facilities, we are interested in the above-referenced project.

Please list Brock and Associates as a consulted party in the preparation of the environmental impact statement.

Thank you.

Very truly yours,

BRICK AND ASSOCIATES

Mr. William S. Haines

Julie R. Abramson
Planner

"By Water All Things Find Life."
DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 1028
WAILUKU, MAUI, HAWAII 96793

January 13, 1982

Mr. Richard H. Cox
Vice President
Alexander & Baldwin, Inc.
822 Bishop Street
Honolulu, Hawaii 96813

Dear Mr. Cox:

Subject: ENVIRONMENTAL ASSESSMENT OF THE MAKAMAI-ULA HALE TREATMENT PLANTS

Thank you for your letter dated October 30, 1981 requesting that you be a consulted party on the environmental impact statement for the above project.

Your letter will be incorporated into the environmental impact statement and a copy of the environmental impact statement will be sent to you for your review.

Sincerely,

[Signature]

William S. Haines, Director
Department of Water Supply

"By Water All Things Take Life."
DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 1109
WAILUKU, MAUI, HAWAII 96793

January 13, 1982

Mr. Philip F. Conrad
General Manager
Hawaiian Commercial & Sugar Company
Division of Alexander and Baldwin, Inc.
Wailuku, Maui, Hawaii 96793

Dear Mr. Conrad:

Subject: ENVIRONMENTAL ASSESSMENT OF THE MAKAWAO-KULA WATER TREATMENT PLANTS

Thank you for reviewing the Makawao-Kula Water Treatment Plants environmental assessment and preparation notice. When the environmental impact statement is prepared, your letter dated November 4, 1981, will be included as part of the environmental impact statement.

Sincerely,

William S. Haines, Director
Department of Water Supply

HAWAIIAN COMMERCIAL & SUGAR COMPANY
A DIVISION OF ALEXANDER & BALDWIN, INC.
WAILUKU, MAUI, HAWAII 96793

November 4, 1981

Mr. William S. Haines, Director
Department of Water Supply
County of Maui
P.O. Box 1109
Wailuku, Maui, HI 96793

Dear Mr. Haines:

Subject: Makawao-Kula Water Treatment Plant Environmental Assessment

We have reviewed the above document and have no comments to make.

Yours truly,

Philip F. Conrad
General Manager

"By Water All Things Heal"
January 12, 1982

Mr. Douglas Weller
1450 Ala Street, No. 1201
Honolulu, Hawaii 96817

Dear Mr. Weller:

SUBJECT: Environmental Assessment of the Makawao-Kula Water Treatment Plants

Your letter dated November 4, 1981 will be incorporated into the environmental impact statement, and a copy of the environmental impact statement will be sent to you for your review. The major purpose of the proposed water treatment plants is to meet existing requirements mandated by the Federal Safe Drinking Water Act, and the treatment plants have been designed to conform with these requirements.

We thank you for your comments regarding the material to be included in the environmental impact statement. As previously mentioned, this environmental impact statement deals specifically with treatment plants designed to meet current Federal and State requirements.

Future water requirements and necessary water sources and storage facilities to meet their requirements is a separate issue to be studied at a later time.

Sincerely,

William S. Haines, Director

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 3105
WAILUKU, MAUI 96793

Mr. William S. Haines, Director
Department of Water Supply
County of Maui
P.O. Box 3105
Wailuku, Maui, Hawaii 96793

November 4, 1981

Re: Makawao-Kula Water Treatment Plants EIS

Dear Mr. Haines:

I would like to be a consultation party for the forthcoming EIS for the proposed Makawao-Kula Water Treatment Plants. Please send me a copy of the EIS Preparation Notice. Also, I would appreciate being sent a copy of the draft EIS when it becomes available and a copy of the final EIS when it becomes available.

In my opinion, the primary focus of the EIS should be to address the cumulative impact of all planned Maui County projects which directly or indirectly entail removal of water from EMU's top ditch. The EIS also should address the natural variability of water flow in EMU's top ditch and the ability of EMU to manipulate flow in its top ditch by use of reservoirs. As we are both well aware, the future viability of the largest sugar company in Hawaii, i.e., HC & E, is dependent upon an adequate supply of water from EMU's ditches.

Relevant information which needs to be included in the Makawao-Kula Water Treatment Plants EIS is as follows:

1. A table showing the natural probability of different daily levels of flow in EMU's top ditch.
2. A table showing actual monthly flow in EMU's top ditch since the 1920s.
3. A table showing the capacity of reservoirs which can be used to manipulate flow in EMU's top ditch.
4. An estimate of the highest daily flow which could have been sustainable in EMU's top ditch throughout the 1971-1977 drought - assuming that EMU used its reservoirs to the maximum extent possible to "smooth out" natural variability in water supply.
5. A projection of future county population and an estimate of the share of projected population that will need to be serviced with water from EMU's top ditch.
6. A table estimating the cumulative impact of existing and planned Maui County facilities on water supply in EMU's top ditch.
7. An estimate of HC & E sugar cane acreage that has no other source of irrigation water than EMU's top ditch.
8. An estimate of how much water is required from EMU's top ditch to service HC & E mills.

If you have any questions about these points, then please feel free to contact me. Give my regards to the Mayor. I look forward to reading your EIS.

Sincerely,

Douglas Weller
January 13, 1982

Mr. Gordon E. Stellway
Post Office Box 114
Kula, Maui, Hawaii 96790

Dear Mr. Stellway:

Subject: ENVIRONMENTAL ASSESSMENT OF THE
MAKAWAO-KULA WATER TREATMENT PLANTS

Thank you for your letter dated November 7, 1981.

Your letter will be incorporated into the environmental
impact statement for the Makawao-Kula Water Treatment
Plants, and a copy of the environmental impact statement
will be available at the Wailuku Regional Library for
your review.

Sincerely,

[Signature]

WILLIAM A. REISER, Director
Department of Water Supply

"By Water All Things Flow Life"
January 13, 1982

Mr. Arman Ashley
2120 Vineyard Boulevard
Wailuku, Maui, Hawaii 96793

Dear Mr. Ashley:

Subject: ENVIRONMENTAL ASSESSMENT OF THE MARANO-KULA WATER TREATMENT PLANTS

Your note regarding the above project will be incorporated into the environmental impact statement. The environmental assessment will be available for your review at the Wailuku Regional Library.

Sincerely,

William S. Kalama, Director
Department of Water Supply

"By Water All Things Find Life"
SECTION 12
ORGANIZATIONS AND PERSONS CONSULTED AND/OR
SENT A COPY TO DURING THE EIS REVIEW PROCESS

The following list includes organizations to where the EIS was sent during the review period. Those with an asterisk are those from whom comments were received. The comments and their responses follow this list.

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* Department of Parks and Recreation 12-37

OTHER

Makawao Community Association
Kula PTA
Kula Kai Community Association
Pukalani Community Association
Maui Economic Opportunity, Inc.
Hawaiian Commercial & Sugar Company
Naleakala Ranch
Maui Land and Pineapple Company, Ltd.
* Ulupalakua Ranch
  Alexander & Baldwin, Inc.
  Maui Farmers Exchange
  Maui Vegetables Growers
  Paul Otani
  Masaru Urudomo
  Glen Otani
  George Tanji
  Ron Terry
  Ray Nishiyama
  Maui County Farm Bureau
  Seabury Hall
* Life of the Land
* Douglas Meller 12-41
  American Lung Association 12-45
  Brock & Associates
  Jeanette Foster
  Hamilton Library, Hawaiian Collection
  State Archives
  LB Library
  DPED Library
  Kahului Library
  Lahaina Library
  Makawao Library
  State Main Branch (Library)
  Kaimuki Library
  Kaneohe Library
  Pearl Ridge Regional Library
  Hilo Regional Library
  Wailuku Regional Library
  Lihue Regional Library
  Honolulu Star Bulletin
  Advertiser
  Maui News

12-2
April 21, 1982

Office of Environmental Quality Control
550 Halekoula St., Room 301
Honolulu, HI 96813

Gentlemen:

Subject: Environmental Impact Statement for Makaha-Kula Water Treatment Plants, Makaha and Kula, Maui.

We have no comments to make on the subject environmental impact statement.

Thank you for the opportunity to review this document.

Sincerely,

FRANCIS C. H. LUM
State Conservationist

cc: Mr. William S. Haines, Director
Department of Water Supply
County of Maui
P.O. Box 1109
Wailuku, HI 96793

April 30, 1982

United States Department of Agriculture
Soil Conservation Service
P.O. Box 50004
Honolulu, Hawaii 96850

ATTENTION: Mr. Francis C. H. Lum
Gentlemen:

RE: Draft Environmental Impact Statement for
Makaha-Kula Water Treatment Plants, Makaha
and Kula, Maui.

We acknowledge receipt and hereby wish to thank you for
your response on the subject matter.

Sincerely,

WILLIAM S. HAINES
Director

GO: RCab

cc: Programs Manager

"By Water All Things Flow!"
United States Department of the Interior
FISH AND WILDLIFE SERVICE
360 Ala Moana Boulevard
P.O. Box 50107
Honolulu, Hawaii 96850

Office of Environmental Quality Control
360 Halekauila Street, Room 311
Honolulu, Hawaii 96813

Re: Hanauma-Kula Water Treatment Plants, Hanauma and Kula, Maui

Gentlemen:

We have reviewed the subject Environmental Impact Statement (EIS) and have no additional comments to offer at this time.

Sincerely yours,

Juliette Berman
Acting Project Leader
Office of Environmental Services

cc: INFS - WFO

EPA, San Francisco

April 30, 1982

United States Department of the Interior
Fish and Wildlife Service
360 Ala Moana Blvd.
P.O. Box 50107
Honolulu, Hawaii 96850

ATTENTION: Mr. Lucian Kanner

Gentlemen:

RE: Draft Environmental Impact Statement for Hanauma-Kula Water Treatment Plants, Hanauma and Kula, Maui

We acknowledge receipt and hereby wish to thank you for your response on the subject matter.

Sincerely,

William S. Haines
Director
CO/RC/ab

cc: Program Manager

Save Energy and You Save America!

"In Water All Things Find Life."
United States Department of the Interior
GEOLGICAL SURVEY
Water Resources Division
P.O. Box 50166
Honolulu, Hawaii 96850

April 23, 1982

Office of Environmental Quality Control
550 Kalakaua Street, Room 701
Honolulu, Hawaii 96813

Gentlemen:

We have reviewed the Environmental Impact Statement (EIS) for Makawao-Kula Treatment Plants, and have no significant comments to offer. Generally, we agree with Maui County's plans to provide safe drinking water for the Makawao-Kula area. However, we recommend the treated water be used only for domestic needs. Water for agricultural use does not require the type of treatment outlined in the EIS.

We are returning the EIS for your use.

Sincerely,

[Signature]

[Name] Jones
District Chief

cc: Mr. William S. Haines, Director
Department of Water Supply
County of Maui
P.O. Box 1159
Wailuku, Hawaii 96793

June 9, 1982

Mr. Benjamin L. Jones
District Chief
DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 1159
WAILUKU, MAUI, HAWAI'I

Dear Mr. Jones:


We acknowledge receipt and hereby wish to thank you for your response on the subject matter.

Sincerely,

[Signature]

William S. Haines
Director

GO:KRC:ab
cc: OEQC
EQC
Programs Manager
Environment Impact Study Corp. (Honolulu & Maui)

"By Water All Things Flow"
Dear Mr. Clark:

Thank you for the opportunity to review the Environmental Impact Statement (EIS) for the Mahawu-Kula Water Treatment Plants, sent to us on 3 April 1982.

Since there are no changes in site locations for the proposed water treatment facilities for the three areas, the comments provided in our letter of 4 November 1981 (page 11-4 of the Final EIS) remain valid, and we have no additional comments.

Sincerely,

[Signature]

KESSE CHUNG
Chief, Engineering Division

Cfr.
Mr. William S. Haines, Director
Department of Water Supply
P.O. Box 1109, County of Maui
Wailuku, HI 96793

May 14, 1982

Department of the Army
Corp of Engineers
Pacific Ocean Division
Fort Shafter, Hawaii 96858

ATTENTION: POSED - PV

Gentlemen:


We acknowledge receipt and hereby wish to thank you for your response on the subject matter. Sincerely,

[Signature]

William S. Haines
Director

CO:RC:ab

cc: Programs Manager

"By Water, All Things Find Life."
Environmental Quality Commission
550 Holowalu Street, Room 301
Honolulu, Hawaii 96813

Gentlemen:

Environmental Impact Statement
Makawao and Kula Water Treatment Plants, Maui, Hawaii

The EIS for the Makawao and Kula Water Treatment Plants, Maui has been reviewed and the Navy has no comments to offer. At this command has no further use for the EIS, the EIS is being returned.

Thank you for the opportunity to review the EIS.

Sincerely,

M. M. Dallam
Captain, CEC, U.S. Navy
Facilities Engineer

May 4, 1982

Headquarters
Naval Base Pearl Harbor
Box 110
Pearl Harbor, Hawaii 96860

ATTENTION: M. M. Dallam, Captain, CEC, U.S. Navy
Facilities Engineer by direction of the Commander

Gentlemen:

RE: Draft Environmental Impact Statement for
Makawao-Kula Water Treatment Plants, Makawao
and Kula, Maui.

We acknowledge receipt and hereby wish to thank you for your response on the subject matter.

Sincerely,

William S. Haines
Director

cc: Programs Manager

"By Wm: All Things In Life"
May 3, 1982

Department of the Army
Headquarters United States Army
Support Command, Hawaii
Fort Shafter, Hawaii 96858

ATTENTION: Adolph A. Hight, Col., En
Director of Engineering and Housing

Gentlemen:

RE: Draft Environmental Impact Statement for
Makawao-Kula Water Treatment Plants, Makawao
and Kula, Maui.

We acknowledge receipt and hereby wish to thank you for
your response on the subject matter.

Sincerely,

[Signature]

William S. Haines
Director

cc: Programs Manager

"By Water All Things Flow Life"
Environmental Impact Statement for the Makawao-Kula Water Treatment Plants

Mr. Yamada, 449-1831

Office of Environmental Quality Control
550 Kaliaua Street, Room 301
Honolulu, HI 96813

1. This office has reviewed the subject EIS and has no comment relative to the proposed project.

2. We greatly appreciate your cooperative efforts in keeping the Air Force apprised of your project and thank you for the opportunity to review the document.

Chief, Engrg & Envtl Plg Div
Directorate of Civil Engineering

Cy to: Mr. William S. Haines, Director
Department of Water Supply
County of Maui
P. O. Box 1109
Wailuku, Maui, HI 96793

May 3, 1982

Department of the Air Force
Headquarters 15th Air Base Wing (PACAF)
Hickam Air Force Base, Hawaii 96853

ATTENTION: Mr. William T. Morokoa, Chief

Gentlemen:


We acknowledge receipt and hereby wish to thank you for your response on the subject matter.

Sincerely,

William S. Haines
Director

cc: Program Manager

"By Water All Things Flow, Life"
Office of Environmental Quality
Control
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Gentlemen:

Subject: EIS for Hakawao-Kula Water Treatment Plants
Hakawao and Kula, Maui

We have reviewed the environmental impact statement for the Hakawao-Kula Water Treatment Plants and have no comments to offer.

Very truly yours,

HIDEO MURAKAMI
State Comptroller

May 3, 1982

Department of Accounting and General Services
State of Hawaii
Division of Public Works
P. O. Box 199
Honolulu, Hawaii 96810

ATTENTION: Mr. Hideo Murakami, State Comptroller

Gentlemen:

RE: Draft Environmental Impact Statement for Hakawao-Kula Water Treatment Plants, Hakawao and Kula, Maui

We acknowledge receipt and hereby wish to thank you for your response on the subject matter.

Sincerely,

WILBERT P. HINO
William S. Haines
Director

GO:RC:ab

cc: Program Manager

“By Work All Things And Life”
December 7, 1971

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P. O. BOX 1129
WAILUKU, MAUI, HAWAII 96793

To:  Mr. William H. Holmes, Director
     Department of Water Supply

Subjects: Hana and Kula Water Treatment Plants
          Environmental Assessment

The Department of Agriculture has reviewed the subject assessment and offers the following comments:

We were unable to find a description of the amount of land area involved in the construction of each of the proposed water treatment plants. It also believes that the Environmental Impact Statement should address whether there are any agricultural activities in the immediate vicinity of the proposed projects and any impact the projects might have on those activities.

Thank you for the opportunity to comment.

Jack K. Suva
Chairman, Board of Agriculture

April 8, 1982

Mr. Jack K. Suva, Chairman
Board of Agriculture
Department of Agriculture
State of Hawaii
P. O. Box 22159
Honolulu, Hawaii 96822

Dear Mr. Suva:

SUBJECT: Hana and Kula Water Treatment Plants

Thank you for your comments and we offer the following response.

The exact amount of land required for the construction of the proposed water treatment plants has not been determined. However, we have estimated the following:

Hana, 5 acres; Lower Kula, 6 acres; and Upper Kula, 12 acres.

The existing agricultural land use surrounding the proposed treatment sites are: Pineapple for the Hana site, and pasture for both the Upper and Lower Kula sites.

Sincerely,

William S. Naives
Director

"By Water All Things Find Life."
May 24, 1982

Mr. Jack E. Suna
Chairman, Board of Agriculture
Department of Agriculture
State of Hawaii
P.O. Box 22159
Honolulu, Hawaii 96822

Dear Mr. Suna:

SUBJECT: 
MAKAPOE-KULA WATER TREATMENT PLANT

Thank you for your comments and we offer the following response:

Comments:

"We were unable to find a description of the land area involved in the construction of each of the proposed water treatment plants. We also believe that the Environmental Impact Statement should address whether there are any agricultural activities in the immediate vicinity of the proposed projects and any impacts the projects may have on these activities."

Response:

The exact amount of land required for the construction of the proposed water treatment plant has not been determined. However, we have estimated the following: Makawao—2.5 acres; Lower Kula—4 acres; and Upper Kula—12 acres.

Existing agricultural land used surrounding the proposed treatment sites are: pineapple for the Makawao site, and pasture for both Upper and Lower Kula sites. The proposed water treatment plants will not have significant adverse impact on the existing agricultural activities.

Sincerely,

[Signature]
William S. Heine, Director
Department of Water Supply

"By Water All Things Flow and Live"
May 3, 1982

State of Hawaii
Department of Defense
Office of the Adjutant General
9499 Diamond Head Road
Honolulu, Hawaii 96816

ATTENTION: Mr. Jerry M. Matsuda, Captain

Gentlemen:

RE: Draft Environmental Impact Statement for
Hakuaa-Kula Water Treatment Plants, Hakuaa
and Kula, Maui.

We acknowledge receipt and hereby wish to thank you for your response on the subject matter.

Sincerely,

William S. Haines
Director

cc: Programs Manager

"By Water...All Things Lead"
MEMORANDUM  

To: Office of Environmental Quality Control  
From: Deputy Director for Environmental Health  
Subject: Environmental Impact Statement (EIS) for Nakawao-Kula Water Treatment Plants

Thank you for allowing us to review and comment on the subject EIS. On the basis that the project will comply with all applicable Public Health regulations, please be informed that we do not have any objections to this project.

The Department of Health administers Chapter 20 of Title 11, Administrative Rules pertaining to potable water systems. The basic intent of Chapter 20, Title 11 is to ensure that all public water systems in the State of Hawaii serve water which meets the minimum requirements as primary drinking water standards. The Department is therefore vitally concerned that the proposed treatment plants enable the Kula and Nakawao water systems to meet all the primary drinking water standards. Of particular note is the commitment of the project team to perform all the necessary analyses and studies to ensure compliance with all applicable health and public safety standards.

The information contained in the EIS shows that the Nakawao water system exceeded the maximum contaminant levels (MCLs) for total coliform and turbidity. However, the data indicates a significant reduction in these parameters since the initial testing. All references to Chapter 49, Public Health Regulations (PHR) should be updated to reflect the current regulations and standards for potable water systems. Chapter 49, PHR was revised in December 1981. It should be noted that in the present form, there is no standard for sodium. The proposed 20 parts per million limit was reduced to a requirement to monitor for sodium.

Finally, the Department would like to recommend that if waste disposal is to consist of holding the waste material for transport to a suitable landfill facility, that the holding and transport facilities be in compliance with all applicable regulations.

If you have any questions, please contact the Drinking Water Program at 548-2235.

We realize that the statements are general in nature due to the preliminary nature of the EIS. We therefore reserve the right to impose future environmental restrictions on the project at the time final plans are submitted to this office for review.

[Signature]

Date: May 10, 1983

[Stamp]
DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 3178
KAHULUI, MAUI, HAWAII 96731

May 28, 1982

Mr. Kelvin K. Koizumi
Deputy Director of Health
State of Hawai`i
Department of Health
P.O. Box 3178
Hilo, Hawai`i 96721

Dear Mr. Koizumi:

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT OF HAKAMAO-FULA WATER TREATMENT PLANTS

Thank you for your valuable comments and we offer the following responses:

Comment:

"On the basis that the project will comply with all applicable Public Health Regulations, please be informed that we do not have any objections to this project."

Response:

We concur that the water treatment plants are necessary to meet the public health requirements.

Comment:

The Department of Health administers Chapter 20 of Title 11, Administrative Rules pertaining to potable water systems. The basic intent of Chapter 20, Title 11, is to meet all public water systems in the State of Hawai`i move water which meets the minimum requirements known as primary drinking water standards. The Department is therefore, vitally concerned that all proposed treatment plants enable the Kula and Halawai Water System to meet all of the primary drinking water standards. Of particular note of those contaminants for which the system have in the past exceeded the maximum contaminant levels MCL's those being of microbiological and turbidity contaminants. Of additional concern are any contaminants which the Department of Water Supply has any indications may pose problems in compliance. Specifically, the information contained on page C-6 shows that the Makawao water system exceeded MCL's for both total trihalomethanes and corrosivity in background testing performed by the design engineers.

Response:

We agree that microbiological and turbidity contaminants have been exceeded in the past. The treatment plants have been designed to remove the microbiological and turbidity contaminants. Also, the treatment plant's design will make provisions for the treatment of corrosive water and it is believed that the treatment process will remove the precursor for trihalomethane formation and thereby eliminate the formation of trihalomethane during chlorination process.

Comment:

"All references to Chapter 49, Public Health Regulations (PHR) should be amended to read Chapter 20, Title 11 Administrative Rules which is the current state regulation for potable water systems. Chapter 49, PHR was revised as Chapter 20, Title 11 Administrative Rules during 1981. They were adopted and made effective December 26, 1981. It should be noted that in their present form, there is no standard for sodium. The proposed 20 parts per million MCL was reduced to a requirement to monitor for sodium."

Response:

Please be advised that the environmental impact statement was prepared prior to the effective date of the amendment of Chapter 49, Public Health Regulations. We will amend the revised environmental impact statement to reflect the changes effective December 26, 1981.

Comment:

"Finally, the Department would like to recommend that if waste disposal is to consist of holding the waste material for transport to suitable landfill facilities, that the holding and transport facilities be in compliance with all applicable regulations."

"By water All Things Indo Life."
Mr. Melvin E. Kolisil

Response

The Department of Water Supply will comply with all applicable regulations regarding the waste disposal from the water treatment plants.

Sincerely,

William S. Bailey, Director
Department of Water Supply

KTH/3-13
Office of Environmental Quality Control
550 Middle Street, Room 301
Hilo, Hawaii 96720

Gentlemen:

We appreciate the opportunity to review the Environmental Impact Statement (EIS) for the water treatment plants planned for the Nakawao, Lower Kula, and Upper Kula water systems. We recognize the need for improving the water quality of these three systems.

The Nakawao plant will be on County-owned land located in an Agricultural District. We, therefore, have no comments to offer except to voice our support of this project.

The upper Kula plant will be on State land in an Agricultural District. A formal request should be made to this Department by the County of Maui for use contemplated.

The site for the Lower Kula plant has not yet been fixed. The preferred site is privately owned. It is in an Agricultural District; the first alternative site is also in an Agricultural District. Both sites are easily accessible.

The second alternative site for the Lower Kula plant would be located in a Resource Subzone of the Conservation District. It would be adjacent to the present Pāhulā Reservoir in the Nakawao Forest Reserve. This site was a fission reservoir in 1956 and now is composed of leveled fill material that for several years of heavy use and pressure. The site, however, creates a significant traffic load upon the forestry road within the Nakawao Forest Reserve. The movement of large trucks and equipment over this site might affect the natural surface that would require substantial maintenance at the end of the project. The EIS does not address this problem.

Sincerely,

SUZUKO ODJ, Chairman
Board of Land and Natural Resources

cc: Mr. G. Holmes
Dept. of Water Supply
County of Maui

Mr. G. Holmes, Chairman
Board of Land and Natural Resources
State of Hawaii
P.O. Box 521
Honolulu, Hawaii 96820

May 28, 1982

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P. O. BOX 521
HONOLULU, HAWAII, 96820

Mr. G. Holmes, Chairman
Board of Land and Natural Resources
State of Hawaii
P.O. Box 521
Honolulu, Hawaii 96820

Dear Mr. Ono:

SUBJECT: KANAWAO-KULA WATER TREATMENT PLANTS EIS

Thank you for your comments and we offer the following responses:

Comment:

"We appreciate the opportunity to review the Environmental Impact Statement (EIS) for the water treatment plants planned for the Nakawao, Lower Kula, and Upper Kula water systems. We recognize the need for improving the water quality of these three systems."

Response:

"The Nakawao plant will be on County-owned land located in an Agricultural District. We, therefore, have no comments to offer except to voice our support of this project."

Comment:

"The upper Kula plant will be on State land in an Agricultural District. A formal request should be made to this Department by the County of Maui for use contemplated."

"By Water All Things Flow."
Response:

Please be assured that a formal request for the use of the Agricultural-designated State land in upper Kula will be submitted to your department.

Consent:

"The site for the Lower Kula plant has not yet been fixed. The preferred site is privately owned. It is in an Agricultural District; the first alternative site is also in an Agricultural District. Both sites are easily accessed."

"The second alternative site for the Lower Kula plant would be located in a Resource Subzone of the Conservation District. It would be adjacent to the present Pilnula Reservoir in the Nakawao Forest Reserve. This site was completely cleared and altered during the construction of the 50 million gallon reservoir in 1964, and now is re-grown of leveled fill material that is uniformly sterile. It supports a few species of hardy weeds and grasses. Construction work would not threaten any native ecosystems. It would, however, create a significant traffic load upon the forestry road within Nakawao Forest Reserve. The movement of large trucks and equipment over this at times steep dirt road could cause serious surface wear that would require substantial maintenance at the end of the project. The EIS does not address this problem."

Response:

At this time the sites located in the Agricultural District remain in the preferred alternatives for the Lower Kula Water Treatment Plant. In the event that the site located in the Conservation District is used, an all-weather road will be constructed to provide safe access and to mitigate soil erosion generated by the movement of large trucks over a poorly maintained road.

Sincerely,

William S. Halena, Director
Department of Water Supply

WMLH-10
DEPARTMENT OF PLANNING
AND ECONOMIC DEVELOPMENT

May 6, 1982

Office of Environmental Quality
Central
550 Kalakaua Avenue, Room 301
Honolulu, Hawaii 96813

Attention: Mr. Melvin Kalani

Dear Mr. Kalani:

Subject: Makawao-Kula Water Treatment Plants EIS

Makawao and Kula, Maui

We have reviewed the referenced Environmental Impact Statement and
found that our concerns with the EIS Preparation Notice for the above
subject have been adequately answered in the EIS.

Thank you for the opportunity to comment on the proposed project.

Sincerely,

Hideto Kono

cc: Mr. William S. Haines
Hawaii Department of Water Supply

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. Drawer 209
Wailuku, Maui, Hawaii 96793

June 10, 1982

Mr. Hideto Kono
Department of Planning and
Economic Development
P.O. Box 2359
Honolulu, Hawaii 96804

Dear Mr. Kono:

Re: Draft Environmental Impact Statement for
Makawao-Kula Water Treatment Plants, Makawao
and Kula, Maui

We acknowledge receipt and hereby wish to thank you for
your response on the subject matter.

Sincerely,

William S. Haines
Director

cc: OEQC
OEQC
Programs Manager
Environmental Impact Study Corp. (Honolulu & Maui offices)

"By Water All Things Flow To Life."
MEMORANDUM

TO: Office of Environmental Quality Control

FROM: Director of Transportation

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT
HAKAUMO-KULA WATER TREATMENT PLANTS

EIS. Thank you for the opportunity to comment on the subject.

We have no substantive comments to offer to improve your statement.

May 3, 1982

State of Hawaii
Department of Transportation
860 Punchbowl
Honolulu, Hawaii 96813

ATTENTION: Mr. Ryokichi Higashinuma, Director

Gentlemen:

RE: Draft Environmental Impact Statement for
Hakawao-Kula Water Treatment Plants, Hakawao and Kula, Maui.

We acknowledge receipt and hereby wish to thank you for your response on the subject matter.

Sincerely,

William S. Haines
Director

CO: RO: ab
cc: Programs Manager

"By Water All Things Flow"
May 6, 1982

William Haines, Director
Department of Water Supply
County of Maui
P.O. Box 1109
Wailuku, Maui, Hawaii 96793

SUBJECT: Environmental Impact Statement for Makawao-Kula Water Treatment Plants

Dear Mr. Haines:

We have reviewed the subject statement and offer the following comments for your consideration:

1. A summary sheet should be included pursuant to EIS Regulation 1:47-4.

2. Page 2-33
   The EIS indicates that no rare or endangered species have been seen or are potentially present. The statement should be documented.

3. Section 3 of the EIS should discuss the State Environmental Policy Act, Chapter 344, Hawaii Revised Statutes and how it relates to the proposed project.

4. Page 4-6
   The EIS states that each treatment plant will have chlorine tanks. The size of the tanks and how much chlorine gas stored should be discussed. In addition, there should be discussion regarding the potential impact of chlorine gas leaking and how it may affect the surrounding area and population, if any.

5. The EIS is unclear whether additional water will be pumped for usage. Because water pumping is part of the entire action as page 5-1 states, "Source treatment and distribution are the main components of a water system," the entire system and any future increase in water usage should be discussed. More importantly, such discussion is required in EIS Regulation 1:32 which states,

   A group of action shall be treated as a single action when: (1) the component actions are phases or increments of a larger total undertaking; (2) an individual project has a necessary precedent for a larger project; (3) an individual project represents a commitment to a larger project; or (4) the actions in question are essentially the same and a single Statement will adequately address the impacts of any single action.

Therefore, we recommend that any plans of increased pumping or developing new sources should be identified in the EIS and discussed.

6. The EIS should also discuss the impacts of pumping during drought conditions.

7. It is important to recognize the value of the consultation process in developing an acceptable EIS. We refer you to Doug Holler's comment in the consultation section which remains unanswered and should require an adequate response.

8. The issue of the potential increase of pumping and its effect on the aquatic fauna should be discussed.

9. The archaeologist conducting the survey should be identified.

We trust that these comments will be helpful to you in preparing the revised statement. An attached sheet lists the commenting parties. We thank you for the opportunity to comment on the document. We look forward to the revised statement.

Sincerely,

[Signature]

Attachments
DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 1109
WAILUKU, MAUI
HAWAII 96793

May 28, 1982

Mr. Charles G. Clark
Director
Office of Environmental Quality Control
State of Hawaii
550 Haeusela Street, Room 301
Honolulu, Hawaii 96813

Dear Mr. Clark:

SUBJECT: MAAKAI-KULA WATER TREATMENT PLANTS ENVIRONMENTAL IMPACT STATEMENT

Thank you for reviewing the environmental impact statement and we offer the following responses to your comments:

Comment:

"A summary sheet should be included pursuant to EIS Regulations 1462a."

Response:

A summary sheet will be included in the revised EIS.

Comment:

Page 2-31, "EIS indicates that no rare or endangered species have been seen or are potentially present. This statement should be documented."

Response:

A documentation may be found in Appendix F of the EIS statement.

Comment:

"Section 3 of the EIS should discuss the State Environmental Policy Act, Chapter 344, Hawaii Revised Statutes and how it relates to the proposed project."

Response:

Section 3 will discuss the State Environmental Policy Act, Chapter 344, HRS.

Comment:

Page 4-4

"The EIS states the each treatment plant will have chlorine tanks. The size of the tanks and how much chlorine gas storage should be discussed. In addition, there should be discussion regarding the potential impact of chlorine gas leaking and how it may affect the surrounding area and population, if any."

Response:

The size of the chlorine tanks and amount of chlorine gas to be stored has not been exactly determined at this time. The final construction plans for the water treatment plants will evaluate the amount and size of the chlorine gas cylinders. Preliminary design considerations being evaluated include one ton chlorine gas cylinders to be used at the treatment plants.

The potential of a major chlorine gas leak is remote. At a cautionary measure, all treatment plants will have a chlorine detection system and an alarm system will be activated in the event of minor chlorine leaks. We presently use chlorine gas as a disinfectant and have not had a major chlorine leak. In the remote and highly improbable situation where there should be a major chlorine leak, there would be no residences and/or urban centers which will be impacted by a major chlorine gas leak.

Comment:

"The EIS is unclear whether additional water will be pumped for usage. Because water pumping is part of the entire system as page 8-I states, "source treatment and distribution are the main components of our water system." the entire system and any future increase in water usage should be discussed. More importantly, such discussion is required in EIS Regulations 1117 which states:

"By Water All Things Take Life."
A group of actions shall be treated as a single action when:

1. Component actions are phases or increments of a larger total undertaking; (2) an individual project is a necessary precedent for a larger project; (3) an individual project represents a commitment to a larger project; or (4) the actions in question are essentially the same and a single statement will adequately address the impacts of any single action.

Therefore, we recommend that any plans of increased pumping or developing new sources should be identified in the EIS and discussed.

Response:
The Makawao-Kula Water Treatment Plant EIS specifically deals with the construction of water treatment plants to treat the existing Makawao-Kula water system. The water treatment plant is being proposed to meet current state and federal potable drinking water requirements. The treatment plants are specific actions to be taken within an existing water system, and will not entail the drawing of additional water.

Page E-1 of Appendix E was a general introductory statement to set up a framework for the discussion of water treatment plant design. Furthermore, Appendix E serves as a general discussion on water treatment plants for the public.

We believe that we are in conformance with EIS Regulations 15:12 in that the proposed three water treatment plants have been discussed in a single EIS document; there are no necessary precedents for a larger project; that the individual water treatment projects do not represent a commitment to a larger project; the three water treatment plants proposed are not phases or increments of a larger total undertaking; and, the three water treatment plants are essentially the same and that a single statement will adequately address the impacts of any single action.

Comment:

"The EIS should also discuss the impacts of pumping during drought conditions."

Response:

The EIS did discuss the interrelated Makawao-Kula water system and the pumping required to meet the water requirements during drought conditions. Additional information can be found in Appendix D of the EIS.

Comment:

"It is important to recognize the value of the consultation process in developing an acceptable EIS. We refer you to Doug Heller's comment in the consultation section which remains unanswered and should require an adequate response.

Response:

Our response to Mr. Hiler and to you is that the major purpose of the proposed water treatment plants is to meet existing requirements mandated by the Federal Safe Drinking Water Act and the treatment plants have been designed to conform with these requirements. This environmental impact study deals specifically with treatment plants designed to meet current state and federal requirements. Future water requirements and necessary water sources and storage facilities to meet their requirements is a separate issue to be studied at a later time. Once again, we want stress the fact that the treatment plants are designed to meet existing water needs. The amount of water which can be taken from Waioa Ditch has been fixed at 16 mgd: the amount of water which will be obtained for the upper and lower water treatment plants has been determined by safe yield of the existing water sources.

Comment:

"The issue of the potential increase of pumping and its affect on the aquatic fauna should be discussed."

Response:

Again, we reiterate the fact that the amount of water to be taken from the Waioa Ditch is fixed at 16 mgd. The county will not exceed this amount. There are no flowing streams adjacent to the treatment plants which will be impacted by the water treatment plants. Please remember that the water source for the treatment plants has been in existence for numerous years and we do not plan to increase the present draw.
Mr. Charles G. Clark

May 28, 1982

Comment:
The archaeologists conducting the survey should be identified.

Response:
The archaeologist conducting the survey was Richard Borden.
Sincerely,

William S. Eanes, Director
Department of Water Supply

MT: Utah
Office of Environmental Quality Control
350 Naikaua Street, Room 301
Honolulu, Hawaii 96813

Gentlemen:

Subject: Environmental Impact Statement
Hakauo-Kula Water Treatment Plants

We have reviewed the subject EIS and have no comments to offer at this time. We do, however, concur with the purpose for the water treatment plants.

Thank you for the opportunity to review the documents.

Sincerely,

Lloyd K. Mizuta
Donnis H. Thompson
Superintendent of Education

May 3, 1982

State of Hawaii
Department of Education
P. O. Box 21568
Honolulu, Hawaii 96804

ATTENTION: Mr. Donnis H. Thompson, Superintendent

Gentlemen:


We acknowledge receipt and hereby wish to thank you for your response on the subject matter.

Sincerely,

William S. Haines
Director

Cc: Program Manager

"By Water All Things Flow Life"
DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 1060
WAILUKU, MAUI, HAWAII 96793

July 8, 1982

State Energy Division
250 S. King Street
Honolulu, Hawaii 96813

Gentlemen:

Re: DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR HAKAUAHO-KULA WATER TREATMENT PLANTS, HAKAUAHO AND KULA, MAUI.

Your response of "no comments" was inadvertently sent to the Honolulu Board of Water Supply and was returned to us by the Office of Environmental Quality Control on June 22, 1982.

Thank you for your participation and response.

Sincerely,

William S. Haines, Director
Department of Water Supply

cc: Environmental Quality Commission
Office Environmental Quality Control
Program Manager, Bennington Engineering Consultants, Inc.
Environmental Impact Study Corporation (Honolulu/Haleiwa)
Subject: EIS for the Makena and Kula Water Treatment Plants, Makena, Hawaii, March 1982, County of Maui

We have reviewed the subject EIS and offer the following comment. As in sewage treatment plants, water treatment plants (WTP) need properly trained and certified operating personnel. Herefore WTP operators have not been needed here; therefore, qualified personnel may be lacking locally. Also, legislative and institutional regulations may be needed to require properly qualified and registered operating personnel.

Thank you for the opportunity to comment. This material was reviewed by WRC personnel.

Sincerely,

Edwin T. Murabayashi
EIS Coordinator

cc: H. Cox

Y.S. Fok

U.W., Maui County

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.0. BOX 1109
MAKANA, MAUI, HAWAII 96729

May 26, 1982

Mr. Edwin T. Murabayashi
EIS Coordinator
Water Resources Research Center
University of Hawaii at Manoa
Holmes Hall 281
2540 Dole Street
Honolulu, Hawaii 96822

Dear Mr. Murabayashi:

SUBJECT: MAKANA-KULA WATER TREATMENT PLANTS

Thank you for your comments and we offer the following response:

Comment:

"We have reviewed the subject EIS and offer the following comment. As in sewage treatment plants, water treatment plants (WTP), need properly trained and certified operating personnel. Herefore WTP operators have not been needed here; therefore, qualified personnel may be lacking locally. Also, legislative and institutional regulations may be needed to require properly qualified and registered operating personnel."

Response:

The Department of Water Supply is presently in the process of establishing positions through the civil service class for water treatment plant operators. The department has budgeted for the water treatment plant operators and for the training of the treatment plant operators. The treatment plants will be staffed by qualified operators.

Sincerely,

William S. Kalama, Director
Department of Water Supply

MTT/1ab

"By Water All Things Fad Life"
Proper evaluation of potential impacts to possibly threatened endangered aquatic life cannot be made without a comprehensive study of all major fauna in the area.

Another concern to be addressed in this discussion of the existing environment is whether a minimum streamflow has been established at any of the project areas in the interest of preserving life forms dependent on the aquatic regime.

Because the fauna checklists of Appendix F include the category of species that are "likely present, or which possibly visit the site," the following two birds are recommended for inclusion in the table prepared for the Olinda site and given on page F-17:

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dendroica</td>
<td>Poliostotus</td>
<td>Maui Creeper</td>
</tr>
<tr>
<td></td>
<td>Maculata Newtoni</td>
<td>Maui Creeper</td>
</tr>
<tr>
<td></td>
<td>Vestiaria Cocinae</td>
<td>&quot;Piwi&quot;</td>
</tr>
</tbody>
</table>

Flora

Pages 2-28 and 2-29 include itemizations of existing plant forms and the vegetation zones in which the treatment plants are located. However, descriptions of the general vegetative characteristics of each area and given vegetation zones is also needed.

The endangered Clidemia hirta is reported to grazing in Pilihaa Sites 1 and 2 (page F-6). Since C. hirta is rare & pests, and since efforts are being made to prevent its establishment on Maui, we recommend that any plants discovered during the project be reported to the Maui office of the Division of Forestry and Wildlife, State Department of Land and Natural Resources. Furthermore, efforts should be made to avoid spreading C. hirta to other areas during construction. Perhaps the most viable means of avoiding difficulty is to eliminate the species from the site before starting work.

Treatment Plant Operations

The treatment of surface water for domestic consumption represents a virtually novel activity for the Hawaiian Islands. Because several public water systems on Maui are supplied by surface sources, there is a strong possibility that areas other than Kula-Makawao will ultimately be required to construct treatment facilities. Accordingly, the need for qualified people to operate the treatment plants will also have to be addressed. With respect to this concern we raise the following questions:

1. Are "certified" or "Skill" operators of water treatment plants currently required by Hawaii law and/or regulations, and
2. Are certification courses currently offered in the State of Hawaii?
May 7, 1982

Mr. Melvin Kuzumaki

If such certification courses are considered necessary, has the use of the Maui Community College technical training program been considered? Such questions will ultimately need to be addressed by the Drinking Water Division of the Hawaii Department of Health, and should be considered during these initial phases of the proposed Makawao-Kula treatment programs.

Yours truly,

[Signature]

Dr. D. Cox
Director

cc: Dept. of Water Supply
Sheila Constant
R. Alan Holt
Charles Lamoureux
Water Resources Research Center
Jacquelin Miller
David Peterson

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P. O. BOX 11017
WAILUKU, MAUI, HAWAII 96793

May 20, 1982

Dr. D. Cox
Director
University of Hawaii at Manoa
Environmental Center
Crawford 317
2550 Campus Road
Honolulu, Hawaii 96822

Dear Dr. Cox:

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT FOR MAKAWAO-KULA WATER TREATMENT PLANTS

Thank you for your comments and we offer the following responses:

Comment:

Fauna

The discussion of existing fauna at each of the treatment plant sites in Chapter 2 (page 2-19) and Appendix F is somewhat abbreviated. We recommend that further explanation be provided of the field reconnaissance methods used to assess the fauna of the area. In particular, it would be useful to give information as to when the field study was made (i.e., time of day), for what durations and on how many occasions.

Responses:

For all of the three treatment sites approximately four hours were spent at the treatment site to conduct the fauna surveys and the surveys were conducted during mid-morning. These surveys were conducted in January 1981 and periodic checks were made at the treatment plant site over a three or four month period as additional work was done examining the water quality or evaluating the site.

“By Water All Things Flow Left”
Comment:

"The assessment given to adjacent areas (page 2-10) infers that avifauna and other animals in regions bordering the projects are similar to those found in the treatment plant sites themselves. Once again, however, no mention is made of the methods used to arrive at such a conclusion. If a field reconnaissance was performed in adjacent regions, the techniques and methodologies of these surveys should be included in the EIS."

Response:

The fauna survey was conducted for the following areas: Makawao, 2.5 acres; Lower Kula, 4 acres; and Upper Kula, 12 acres and approximately 500 feet surrounding the project site. The project areas have already been altered and the following conditions exist: Makawao, the site is located within an existing pineapple field; the Upper Kula site, contains a large reservoir and a filter unit within the 12 acres on site and the Lower Kula treatment site will be located within an existing pasture.

Comment:

The U.S. Fish and Wildlife Service (FWS) has in recent years done extensive surveys of avifauna of this and other regions of Maui. Although not published, the information developed is available for investigative projects of this nature. For that reason, we suggest that FWS survey data be used in the preparation of the revised EIS and properly referenced.

Response:

We will check with the U.S. Fish and Wildlife Service and if the information is applicable we will include it in the revised EIS.

Comment:

"We concur with Mr. John Ford's implication (letter from FWS to Maui Department of Water Supply, page 11-1) that the description of the existing environment would be enhanced through a survey of aquatic fauna near the proposed treatment plant sites.

Response:

"Proper evaluation of potential impacts to possible threatened or endangered aquatic life cannot be made without a comprehensive study of all major fauna in the area."

Comment:

The water source for the three treatment plants has been in existence for a very long time and there are no flowing streams located adjacent to the treatment plants. Furthermore, the description of existing environment by inclusion and identification of aquatic fauna within the effective ditch for Makawao system and stream system is beyond the scope of this environmental impact statement. The major purpose of the proposed water treatment plants is to bring existing water supply into conformance with a safe drinking water regulations.

Response:

Another concern to be addressed in this discussion of existing environment is whether existing stream flow has been established at any of the project areas in the interest of preserving life forms dependent on the aquatic regime.

Response:

The establishment of minimum stream flow at any of the project areas and the interest of preserving life forms dependent on aquatic regime is beyond the scope of the department's jurisdiction, and as we have previously mentioned, there are no flowing streams adjacent to the treatment plant sites.

Comment:

"Because of the fauna checklist of Appendix F include the category of species that are 'likely present, or which would possibly visit the site,' the following two birds are recommended for inclusion in the table prepared for the Olinda site and given on page F-7."
Doak C. Cox  -4- May 28, 1982

Response:
The department will include the two birds mentioned and include it into page 2-17.

Comment:
Flora

"The niozus weed Cldesia hirta is reported as growing in Pinaola Sites I and II (page 2-6). Since Cldesia is such a pest, and since efforts are being made to prevent its establishment on Kauai, we recommend that any plants discovered during this project be reported to the Maui Office of the Division of Forestry and Wildlife, State Department of Land and Natural Resources. Furthermore, efforts should be made to avoid spreading Cldesia to other areas during construction. Perhaps the most viable means of avoiding difficulty is to eliminate the species from the sites before starting construction."

Response:
The department will consult with the Department of Land and Natural Resources, Maui Division of Forestry and Wildlife.

Comment:
Treatment Plant Operations

"The treatment of surface water for domestic consumption represents a virtually new activity for the Hawaiian Islands. Because several public water systems on Maui are supplied by surface sources, there is a strong possibility that areas other than Kula-Hanakaa will ultimately be required to construct treatment facilities. Accordingly, the need for qualified people to operate the treatment plants will also have to be addressed. With respect to this concern we raise the following questions."

---

Response:

1. Are certified or licensed operators of water treatment plants currently required by Hawaii law and/or regulations, and

2. Are certification courses currently offered in the State of Hawaii

If such certification courses are considered necessary, has the use of the Maui Community College technical training program been considered? Such questions will ultimately need to be addressed by the Drinking Water Division of the Hawaii Department of Health, and should be considered during these initial phases of the proposed Kualaa-Puka treatment program.

Response:
The Department of Water Supply is presently in the process of the establishment of positions through the civil service class for water treatment plant operators. The department has budgeted for these positions and for the training of the water treatment plant operators. All of the treatment plants proposed will be staffed by qualified operators.

Sincerely,

William N. Baines, Director
Department of Water Supply

M. K. Ishii
May 6, 1982

Mr. William S. Haines, Director
Department of Water Supply
County of Maui
P.O. Box 1109
Wailuku, HI 96793

Dear Mr. Haines:

The enclosed letter from a member of our faculty, Professor Matthew Spriggs, is in response to the Environmental Impact Statement that was sent by your office to our Department for comment.

Sincerely,

Richard W. Lieban
Chairman

Attachment

May 6, 1982

Office of Environmental Quality Control
550 Nalakuli Street, Room 301
Honolulu, HI 96813

Dear Sir/Madam:

Re: Hanaunua-Kea Water Treatment Plants,
Environmental Impact Statement

I have examined this EIS, in particular the Archaeological Reconnaissance appended as Appendix C. While the reconnaissance revealed no features of archaeological interest, I feel that a historical document search in relation to the project areas should be undertaken to establish former land use at these sites—Kahoe property or whatever. Such information helps greatly in evaluating the likelihood of prehistoric remains having existed on the sites and subsequent impacts to them. I would hope that future Department of Water Supply EIS include such information.

Yours,

Matthew Spriggs
Assistant Professor
May 24, 1982

Dr. Richard M. Lieban
Chairman
Department of Anthropology
University of Hawaii at Manoa
Pohaku Hall 346
2440 Heeia St.
Honolulu, Hawaii 96822

Dear Dr. Lieban:

SUBJECT: PROFESSOR MATTHEW SPEIGGS'S LETTER REGARDING THE HANAKOA-EKA WATER TREATMENT PLANTS EIS

Thank you for your comments and we offer the following response:

Comment:

"I have examined this EIS, and particularly the Archaeological Reconnaissance Appended as Appendix G. While the reconnaissance revealed no features of archaeological interest, I feel that historical document research in relation to the project area should have been undertaken to establish former land uses at these sites - Kalaia awards or whatever. Since information helps greatly in evaluating the likelihood of prehistoric remains having existed on the sites and subsequent impacts to them. I would hope that future Department of Water Supply EIS include such information."

Response:

Historical document research in relation to the proposed area was not undertaken based on the archaeological reconnaissance conducted for the project sites. The probability of prehistoric use of the proposed water treatment sites was believed to be non-existent based on available information. We believe that such effort was not needed and the cost not justified to the tax payer.

"In Water, All Men Are Free."
Office of Environmental Quality Control
County of Maui
200 High Street
Wailuku, Hawaii 96793

Gentlemen:

Re: EIS Hikuwao-Kula Water Treatment Plants

Our review of your draft regarding the above referenced project does not appear to present a fire potential and subsequently, do not anticipate any adverse impact caused by the project.

Respectfully submitted,

Gerald K. Tavares
Fire Chief

May 3, 1982

Department of Fire Control
County of Maui
Wailuku, Hawaii 96793

ATTENTION: Mr. Gerald K. Tavares, Fire Chief

Gentlemen:


We acknowledge receipt and hereby wish to thank you for your response on the subject matter.

Sincerely,

William S. Haines
Director

cc: Programs Manager

"By Water All Things Find Life"
April 22, 1982

Office of Environmental Quality Control
555 Ilikaiwa Street
Honolulu, Hawaii 96823

Dear Sir:

Subject: Nakawua-Kula Water Treatment Plants

We have reviewed the draft Environmental Impact Statement for the Nakawua-Kula Water Treatment Plants project, and have determined that the proposed project will not have any adverse effects on our planning projects and programs. Therefore, we have no objection to the proposed project.

Very truly yours,

Velma M. Dayos
Director of Human Concerns

cc: Department of Water Supply, County of Maui
Housing Coordinator

April 30, 1982

Department of Human Concerns
County of Maui
Maui, Hawaii 96793

ATTENTION: Ms. Velma M. Santos, Director
Gentlemen:

We acknowledge receipt and hereby wish to thank you for your response on the subject matter.
Sincerely,

William S. Haines
Director

cc: Programs Manager

"By Water All Things True Life."
April 21, 1982

Mr. William S. Haines, Director
Department of Water Supply
County of Maui
Wailuku, Maui, Hawaii 96793

Dear Mr. Haines:

Subject: Environmental Impact Statement
Nakawau-Kula Water Treatment Plants

Thank you for the opportunity to review the subject statement. We have no comments to offer.

Very truly yours,

RALPH HAYASHI
Director of Public Works

April 30, 1982

Department of Public Works
County of Maui
Wailuku, Maui 96793

ATTENTION: Mr. Ralph Hayashi, Director

Gentlemen:


We acknowledge receipt and hereby wish to thank you for your response on the subject matter.

Sincerely,

William S. Haines
Director

cc: Programs Manager

"By Water All Things Flow Life"
DEPARTMENT OF PARKS AND RECREATION  
COUNTY OF MAUI  

May 28, 1982

Mr. Nolle B. Smith, Jr.,  
Director  
Department of Parks and Recreation  
County of Maui  
Wailuku, Maui, Hawaii, 96793

Dear Mr. Smith,

SUBJECT: MAAHALO-FULA WATER TREATMENT PLANTS EIS

Thank you for your comments and we offer the following responses:

Comment:

"The Department of Parks and Recreation expresses support for a water quality program and system that will serve these areas for many years to come."

Response:

We appreciate your support for the proposed water treatment plants.

Comment:

"Development of a facility of this type at the proposed sites should include serious consideration for:

a. Ongoing operation and long-range maintenance as a part of initial construction.

b. Noise, dust and visual pollution.

c. Buffer zone use."

Thank you for this opportunity to comment. We are returning the EIS which is enclosed.

Sincerely yours,

Sulle B. Smith, Jr.  
Director of Parks & Recreation

cc: Mr. William S. Haines, Director  
Department of Water Supply

"By Water All Things Ind Light."
Response:

The EIS did discuss the long-term primary and secondary impacts of the operation and maintenance of the proposed water quality treatment plants. In addition, it should be noted that the Department of Water Supply is presently in the process of establishing positions through the civil service class for water treatment operators. The department has budgeted for these positions and for the training of the water treatment plant operators. All of the treatment plants proposed will be staffed by qualified operators.

The anticipated impacts to ambient noise levels and air quality and mitigative measures proposed to minimize any adverse effects to same were also discussed in the EIS. The visual intrusion of the proposed water treatment plants in their respective areas is anticipated to be minimal. The existing land use of the project sites can be described as open space with at least a 1/4 mile buffer zone between a site and the nearest parks and recreation facility.

Comment:

"While archeological and cultural disturbance is not considered a factor at the proposed sites, all of the areas are important recreationally, and any changes to current use should incorporate careful detail and providing alternatives and be initiated with communication and sensitivity to neighboring communities and to current user needs."

Response:

We concur that communication and sensitivity to neighboring communities is necessary to maintain recreational values of surrounding areas.

Sincerely,

William E. Haines, Director
Department of Water Supply
MTWitah
April 19, 1982

Mr. William S. Haines
Department of Water Supply
County of Maui
P.O. Box 1109
Wailuku, Maui

Dear Mr. Haines:

Re: Draft Environmental Impact Statement, Hāna-Kula Water Treatment Plants

I have briefly reviewed the Draft Environmental Impact Statement and find that certain questions are left unanswered. The report indicates that approximately 50% of the water to be treated will be used for agricultural purposes and therefore would not require treatment. However, the report does not make any estimate as to the proportion of the remaining 50% that is used for drinking water as opposed to general domestic use. I think that this figure is necessary before the true cost of the system can be determined.

The proposed plan contemplates the expenditure of $16.6 million to construct treatment plants to treat 15 MGD most of which does not need to be treated. I feel that alternatives should be weighed closely before the commitment of funding of this magnitude towards such a dubious project.

As a matter of interest, we operate in a portion of San Joaquin County, California where the drinking water standards are met by supplying bottled water to residences of agricultural workers. Until clear and present danger can be shown by the use of the water supplied in the present system, I feel that the cost is probably too high to justify the expenditure and alternatives should be sought to comply with the drinking water requirement that would avoid treating all of the water in the system.

Sincerely,

C. Pardee Erdman

May 24, 1982

C. Pardee Erdman
Ulupalakua Ranch, Inc.
Maui, Hawaii

Dear Mr. Erdman:

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT FOR HĀNA-KULA WATER TREATMENT PLANTS

Your comments are appreciated and the following responses are provided.

Complaint:

"I have briefly reviewed the Draft Environmental Impact Statement and find that certain questions are left unanswered. The report indicates that approximately 50% of the water to be treated will be used for agricultural purposes and therefore would not require treatment. However, the report does not make any estimate as to the proportion of the remaining 50% that is used for drinking water as opposed to general domestic use. I think that this figure is necessary before the true cost of the system can be determined."

Response:

The estimate of 50% of the water use for agricultural purposes is correct; however, the environmental impact statement did not state that the water used for agricultural purposes did not require treatment.

We agree that water used solely for agricultural purposes need not be treated. However, the existing water distribution system precludes separation of water used for domestic and agricultural purposes. We are currently evaluating the feasibility of a separate water source and distribution system for agricultural use. This evaluation will take approximately two years, and a decision made at that time.

"By Water All Things Feed Life"
A percentage estimate for the service area of domestic water used for drinking versus general domestic use is unavailable. The amount of water used by individuals not only varies daily, but from individual to individual, and also with different intended uses. Therefore, it is a commonly accepted practice for water suppliers to provide only potable water to each household, and the allocation of the water remains with that household.

The construction of dual lines supplying treated water for drinking and untreated water for general domestic use and irrigation is costly. There is also the potential health problem should individuals drink the untreated water.

**Comment:**

"The proposed plan contemplates the expenditure of $14.6 million to construct treatment plants to treat 15 MGD most of which does not need to be treated. I feel that alternatives should be weighted closely before the commitment of funding of this magnitude towards such a dubious project."

**Response:**

Federal and State laws and regulations require compliance with water quality standards. These minimum standards have been promulgated for the protection of the individual water user. The construction of water treatment plants is the most reliable means of providing safe drinking water, even though costly.

**Comment:**

"As a matter of interest, we operate in a portion of San Joaquin County, California where the drinking water standards are met by supplying bottled water to residences of agricultural workers."

**Response:**

The use of bottled water for drinking is only acceptable on a small scale and when there is assurance that the health of the individual will not be jeopardized. This is not the case in the Waihee-Waiehu area. The population of the service area is large and there is no assurance that people will use only the bottled water for drinking.

**Comment:**

"Until a clear and present danger can be shown by the use of the water supplied in the present system, I feel that the cost is probably too high to justify the expenditure and alternatives should be sought to comply with the drinking water requirements that would avoid treating all of the water in the system."

**Response:**

The County of Maui is, and will continue to be, in violation of existing State and Federal drinking water standards until the treatment plants are in operation and/or alternative treatment methods are implemented.

Sincerely,

[Signature]

Willis S. Haines, Director
Department of Water Supply
Office of Environmental Quality Control
550 Katekawa Street, Room 301
Honolulu, Hawaii 96814

Mr. William S. Holmes, Director
Department of Water Supply
City of Hawaii
P.O. Box 1109
Waikiki, Hawaii 96823

Subject: EIS for Makawai-Kula Water Treatment Plants

May 4, 1982

Dear Mr. Holley,

On page 11-15 of the draft EIS you will note that there is a letter from Mr. Douglas Neller requesting to be a consultant party. Mr. Neller also requested to be sent a copy of the EIS Preparation Notice and a copy of the draft EIS. Mr. Neller also asked that the EIS address the cumulative impact of all planned Maui County projects which directly or indirectly entail removal of water from East Maui Irrigation Company (EMI)'s top ditch.

Mr. Neller has informed us that (1) he is not a consultant party on pages 11-15 of the draft EIS, (2) he is not listed as a consultant party on pages 11-15 of the draft EIS, and (4) none of his questions have been addressed in the draft EIS. For that reason, Mr. Neller has asked that Life of the Land act in his behalf and take whatever administrative and legal action is necessary to ensure that his questions are answered. In our judgement, since Mr. Neller is both a member of Life of the Land and a corporate officer, and since Mr. Neller has been empowered to act as a representative of Life of the Land in matters relating to Maui Stream, we consider his letter of November 4, 1981 to be an action taken on behalf of Life of the Land. Hence, this letter of May 4, 1982 should be treated as a letter from a consultant party representing persons including but not limited to Douglas Neller.

The point of Mr. Neller's November 4, 1981 letter is very simple. As noted on page 10 of the draft EIS, the County of Maui can withdraw up to 16 mgd from EMI's top ditch (the Waikoloa Ditch) to supply water to upstream Maui. However, EMI officials have testified in public hearings that the low flow of the Waikoloa Ditch is 16 mgd. The same officials also have testified that the two sugar mills of HC & S, which is the largest sugar company in Hawaii, are totally dependent on water from the Waikoloa Ditch. Hence, removal of water from the Waikoloa Ditch has the potential for severe impacts on HC & S viability during droughts. Because of EMI concerns about water supply during droughts, EMI applied for a TCA permit from the Haua Planning Commission to remove most of the water from the last big undiversified steam on Maui - Hana Stream. Mr. Neller successfully represented Life of the Land in a contested case hearing concerning EMI's application to divert Hana Stream. EMI withdrew its permit application after the hearing officer found that there was no evidence on the record that the County of Maui planned or needed to take the allowable 16 mgd from the Waikoloa Ditch. Mr. Neller has remarked to us that the Haua Department of Water Supply stuck its head in the sand and refused to testify in public concerning the amount of water it needed to remove from the Waikoloa Ditch. Consequently, Mr. Neller relied on the population projections used in the December 1980 County of Maui "900 Water Quality Plan."

After EMI withdrew its application to divert Hana Stream, Mr. Neller reread the hearing transcript and was surprised to find that EMI had enormous reservoirs. If these reservoirs had been connected to the Waikoloa Ditch, then EMI would have been able to meet the needs of its mills and still supply 16 mgd to the County during the worst droughts in recorded history. Unfortunately, the hearing transcript did not indicate the elevation of EMI reservoirs. However, it is clear that the recorded low flow of 16 mgd in the Waikoloa Ditch may be an artifact of poor management of EMI reservoirs rather than an unavoidable eventuality during droughts.

Given these facts, Mr. Neller's questions were a reasonable attempt to determine the risks involved in increasing water removal from the Waikoloa Ditch. We would like to see his questions answered in the Revised EIS, and we are prepared to use whatever administrative and legal remedies are necessary to this end.

Two quotations from the Environmental Quality Commission EIS Regulations are in order at this point. As specified in Section 1142 CONTENT REQUIREMENTS:

"... specific reference to related projects, public and private, existent or planned in the region shall be included for purposes of evaluating the possible overall cumulative impacts of such actions. (Sec. 1142[c])"

"... The interrelationships and cumulative environmental impacts of the proposed action and other related projects shall be discussed in the EIS. (Sec. 1142[c])"

The Revised EIS for Makawai-Kula Water Treatment Plants will not be in compliance with these provisions of EQC EIS Regulations concerning content requirements unless the cumulative impacts of

250 S Hotel St, 8th, Honolulu, Hawaii 96813. Tel 521-1200
May 4, 1982
DEGC and Department of Water Supply
page 5

Water removal from the Waiola Ditch are addressed. Treating development of new pumps and pipes to remove water from the Waiola Ditch as an action unconnected from development of new pumped domestic use of water from the Waiola Ditch is an outright violation of the spirit and letter of EIS Regulations. Yet this is what is done in the draft EIS.

Sincerely,

Arthur Mori
President

June 3, 1982

Arthur Mori, President
Life of the Land
250 S. Hotel St., Mw. 211
Honolulu, Hawaii 96813

Douglas Miller
1450 Anable St., No. 1201
Honolulu, Hawaii 96813

Dear Messrs. Mori and Miller,

SUBJECT: KAHULU-KULA WATER TREATMENT PLANTS

Your comments are appreciated and the following responses are provided.

Comment:

"On page 11-15 of the draft EIS you will note that there is a letter from Mr. Douglas Miller requesting to be a consulted party. Mr. Miller also requested to be sent a copy of the EIS Preparation Notice and a copy of the draft EIS. Mr. Miller also asked that the EIS address the cumulative impact of all planned Maui County projects which directly or indirectly entail removal of water from East Maui Irrigation Company (EMI)'s top ditch."

"Mr. Miller has informed us that (1) he was not sent a copy of the EIS Preparation Notice, (2) he was not sent a copy of the draft EIS, (3) he is not listed as a consulted party on pages 12-1 or 12-2 of the draft EIS, and (4) none of his questions have been addressed in the draft EIS. For that reason, Mr. Miller has asked that Life of the Land act in his behalf and take whatever administrative and legal action is necessary to ensure that his questions are answered. In our judgement, since Mr. Miller is both a member of Life of the Land and a corporate officer, and since Mr. Miller has been empowered to act as a representative of Life of the Land in matters relating to Hanawa Stream, we consider his letter of November 4, 1981 to be an action taken on behalf of Life of the Land. Hence, this letter of May 4, 1982 should be treated as a letter from a consulted party representing persons including but not limited to Douglas Miller."

"By Water, All Things Flow"
Arthur Morl  
Douglas Meller  
June 3, 1982

Response:
The number of copies of the preparation notice were limited and we were unable to send copies to all people requesting copies. However, copies of the EIS are available at the public libraries on Oahu and Maui. A copy of the EIS was sent to the State of Hawaii on April 2, 1981 and since Mr. Meller is a member of the planning commission and has been involved in the planning process, the EIS is available to him. Furthermore, we have a copy of the EIS available to Mr. Meller and have listed Mr. Meller and me as consultants.   

Comment:
"The point of Mr. Meller's November 21, 1981 letter is very simple. As noted in the December 1980 County of Maui 1980 Water Quality Plan, the County of Maui can divert all the water from the Hanawa Ditch to supply water to upcountry residents. However, EMI officials have testified in public hearings that the low flow of the Hanawa Ditch is 16 mgd. The same officials also testified that the two sugar mills in Maui are completely dependent on water from the Hanawa Ditch. Hence, removal of water from the Hanawa Ditch has the potential for severe impacts on BC & S viability during droughts. Because of EMI concerns about water supply during droughts, EMI applied for a permit from the Maui Planning Commission to divert a portion of the Hanawa Ditch. Mr. Meller successfully represented the County of Maui at a public hearing concerning EMI's application to divert Hanawa Ditch. EMI withdrew its permit application after the hearing officer found that the evidence on record was insufficient to show that the Hanawa Ditch would be available during droughts. The hearing officer also found that the County of Maui had not planned or needed to take the allowable 16 mgd from the Hanawa Ditch. Mr. Meller has noted that the Maui Department of Water Supply has not planned to take water from the Hanawa Ditch. Consequently, Mr. Meller is concerned about the population projections used in the December 1980 County of Maui 1980 Water Quality Plan."

Arthur Morl  
Douglas Meller  
June 3, 1982

Response:
Our original response to Mr. Meller's comment during the Notice of Preparation period was, and is, that the EIS is available to him and available to the public. The EIS is available to the public and has been designed to provide water to meet existing State and Federal Drinking Water Standards.   

Comment:
"After EMI withdraws its application to divert Hanawa Ditch, Mr. Meller re-read the hearing transcripts and was surprised to find that EMI had enormous reservoirs. If these reservoirs had been connected to the Hanawa Ditch, the EMI would have been able to meet the needs of its mills and still have 16 mgd to the County during the worst droughts. Unfortunately, the hearing transcripts did not indicate the elevation of EMI reservoirs. However, it is clear that the record shows that EMI had reservoirs rather than an unavoidable drought.

Response:
We cannot comment on the management of EMI reservoirs or their use during droughts. However, we are prepared to use whatever administrative and legal remedies are necessary to ensure protection of public health and safety.

Comment:
"Given the above information, Mr. Meller's questions were reasonable attempts to determine the risk involved in increasing water removal from the Hanawa Ditch. We would like to see his questions answered in the revised EIS. We are prepared to use whatever administrative and legal remedies are necessary to ensure the protection of public health and safety.

Two questions from the Environmental Quality Commission EIS Regulations are in order at this point. As specified in Section 1142 Content Requirements,
... specific reference to related projects, public and private, existing or planned in the region shall be included for purposes of examining the possible overall cumulative impacts of such actions. (Sec. 1:42[c])

... the interrelationships and cumulative environmental impacts of the proposed action and other related projects shall be discussed in the EIS. (Sec. 1:42[e])

The revised EIS for Nakaoa-Kula Water Treatment Plants will not be in compliance with these provisions of EDC EIS Regulations concerning content requirements unless the cumulative impacts of water removal from the Waianoa Ditch are addressed. Treating development of new pumps and pipes to remove water from the Waianoa Ditch as an action unconnected from development of overseas water treatment plants to permit expanded domestic use of water from the Waianoa Ditch is an outright violation of the spirit and letter of EDC Regulations. Yet this is what is done in the draft EIS.

Response:
We have previously stated that the County of Maui is allocated up to 16 mgd from the Waianoa Ditch. The water treatment plant (Nakaoa) is required to treat the water to conform to existing state and federal standards. The County will not exceed the 16 mgd allocation and the treatment plant has been designed in phases, but will not exceed 16 mgd. We again stress, that the proposed Nakaoa Water Treatment Plant is only one component of the existing water system.

Sincerely,

William S. Holmes, Director
Department of Water Supply

Makaha

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 30
MAKAWA, MAUI, HAWAII 96768

May 13, 1982

Mr. Douglas Miller
1620 Asa Street, No. 1201
Honolulu, Hawaii 96817

Dear Mr. Miller:

SUBJECT: Draft Environmental Impact Statement

We are transmitting herewith, for your review and comments, the Draft Environmental Impact Statement for the Nakaoa-Kula Water Treatment Plants, Nakaoa and Kula, Maui.

Your comments will be appreciated by May 28, 1982. We request that all comments be directed to the Office of Environmental Quality Control with a copy to our office.

Please feel free to contact me if you have any questions regarding this EIS.

Sincerely,

William S. Holmes
Director

cc: OEGC/EQC
Program Management
Encl.

"By Water All Things Flow Lfe"
1550 Aina Street  
Mr. William S. Haines  
Office of Environmental Quality  
Department of Water Supply  
County of Maui  
P.O. Box 1109  
Wailuku, Maui 96793  

May 25, 1982

To Mr. Douglas Heller  
1550 Aina Street  
Suite 1201  
Honolulu, Hawaii 96817

Subject: Draft EIS for Makawao-Kula Water Treatment Plants

Gentlemen:

The Final EIS will be legally deficient unless it addresses the questions I raised in my letter of November 4, 1981. You should also bear in mind that the Governor rather than the Department of Water Supply is responsible to accept the Final EIS.

Lastly, I should point out that the EIS Appendix G (Water Consumption) fails to relate projections for Makawao and Kula to OPEC population projections for the island of Maui. To be specific, OPEC projects that between 1980 and the year 2000, Maui’s population will increase by 50,000 people. By comparison, based on the EIS Table 0-6, the OPEC growth rate for Makawao water consumption used in Table 0-13 apparently makes the assumption that agricultural zoned lands in Makawao will absorb 50,000 new people between 1980 and the year 2000. If this were true, I would get another consultant to fix these population and water projections for upcountry Maui.

Sincerely,

Douglas Heller

June 15, 1982

Mr. Douglas Heller  
1550 Aina Street  
Suite 1201  
Honolulu, Hawaii 96817

Subject: Makawao-Kula Water Treatment Plants  

Letter dated May 25, 1982

Our response to your questions raised on November 4, 1981 remains the same. Please refer to our correspondence (January 13, 1982 and June 3, 1982).

We agree that a line agency cannot accept its own EIS; the Mayor and Governor will be the initial and final accepting authorities for the revised EIS.

The data presented in Tables D-8 and D-13 are projections for informational use only and not intended to be viewed as the Department's developmental policy. There is no assumption that the agricultural designated lands in Makawao will absorb the entire future population.

Sincerely,

William S. Haines  
Director  

cc: OGC  
QGC  
Program Manager  
Environmental Impact Study Corp. (Honolulu/Hana)

"By Water All Things Are Life"
Unresolved Issues
SECTION 13
UNRESOLVED ISSUES

This section briefly describes the unresolved issues.

The unresolved issues are primarily concerned with costs and the use of public funds to meet the requirements imposed by the safe drinking water regulations.

COSTS

The costs for the simultaneous construction of three water treatment plants is estimated at 14.208 million dollars. This cost greatly exceeds the funds presently available ($5.8 million). In the interim, a decision has been made to phase the construction of the treatment plants, the first plant to be constructed will be the Makawao Water Treatment plant at a cost of $3.5 million. (Please refer to Table 13-1.) The decision to construct this plant first is based on:

1. The water supply is the most reliable of the three water sources.
2. During drought conditions, water is, and can be, pumped up from the Makawao system to the Upper and Lower Kula systems.
3. There is the possibility that alternative, less costly means could bring the Upper and Lower Kula water systems into compliance with existing standards.
<table>
<thead>
<tr>
<th>Treatment Plant</th>
<th>Phase</th>
<th>MGD</th>
<th>Capital Cost $ Million</th>
<th>Operation and Maintenance Cost ($ Million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Kula</td>
<td>1</td>
<td>1.7</td>
<td>5.500</td>
<td>.838</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2.5</td>
<td>5.830 to 7.19</td>
<td>1.108</td>
</tr>
<tr>
<td>Lower Kula</td>
<td>1</td>
<td>2.5</td>
<td>5.110</td>
<td>.466</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5.0</td>
<td>5.460</td>
<td>.782</td>
</tr>
<tr>
<td>Makawao</td>
<td>1</td>
<td>8.0</td>
<td>3.518</td>
<td>.383</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>12.0</td>
<td>4.574 to 5.745</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>12.0</td>
<td>1.079</td>
<td>?</td>
</tr>
</tbody>
</table>
4. An alternative distribution system separating agricultural water from domestic water is being explored. The results of this study could have a significant bearing on the size of the treatment plants and directly affect the cost for the construction of the treatment plants.

5. Turbidity levels of the Makawao water source are high during rains, requiring treatment.

WATER QUALITY

The other major unresolved issue is concerned with whether or not the water, after being treated, will comply with the standards established by the safe drinking water regulations at the consumer's tap. The regulations are explicit in the location of where the water is to be tested with the exception of turbidity which is tested at the treatment plant; all other testing is conducted at the consumer's tap.

There is no doubt that the water leaving the treatment plant will conform to all applicable standards. However, after the water leaves the treatment plant, the water passes through water distribution lines of varying length and age; and is also stored in tanks composed of redwood. The joints of the old waterline were sealed with jute and lead, and the jute joints provide an ideal
habitat for the cultivation of microrganisms. The redwood tanks also provide an ideal substratum for the cultivation of microrganisms which can and is being controlled by disinfection.

The high turbidity of existing water can also cause silt build up within the distribution and storage systems which can affect turbidity levels.

There is the possibility that the treated water could become contaminated within the distribution and storage systems. This fact will not be known until the treatment plant(s) are in operation and treated water pumped through the system and tests conducted at the consumer's tap.

In the event that contamination of the treated water occurs within the distribution and storage systems, numerous mitigative measures are available. One of the first steps to be taken is the immediate flushing of the distribution lines and storage systems with the treated water. The second and more costly step will be the replacement of the water distribution lines (only the older segments) and some of the storage tanks.

**ALTERNATIVE TREATMENT PROCESS**

Turbidity has been one of the parameters which has caused considerable problems within the water service area. The existing standard for turbidity is 1 TU, and
on numerous occasions, the turbidity levels have been exceeded. As specified in Section 11-20-5 "Maximum contaminant levels - turbidity" (Chapter 20 of Title 11, Administrative Rules, Potable Water Systems, Department of Health, State of Hawaii) the Department of Water Supply is investigating the feasibility of a 5 NTU standard. Whether this will be acceptable to the enforcement agency is an unresolved issue.

WATER RATES

The cost of construction and operation and maintenance of the water treatment plants will be ultimately borne by the consumer. The exact amount of the increase in water rates is not known at this time.

WATER BUDGET

No attempt has been made in this document to address the water budget for the water service area. Information has been provided on consumption and projections made on future water consumption. The water source budget is a separate issue which will be studied in the near future by the Department of Water Supply.

13-5
Appendices
APPENDIX A

WATER QUALITY STANDARDS
APPENDIX A
WATER QUALITY STANDARDS

I. INTRODUCTION
The high quality of most drinking water in Hawaii is recognized. However, mounting concerns over the spread of potential environmental pollution and the development of sensitive methods of detecting pollutants have led to new Federal and State legislation that will ensure that the quality of drinking water poses no threat to public health.

II. ESTABLISHING STANDARDS
The hazard of ingesting chemical pollutants in drinking water can be assessed in two general ways: (1) epidemiological studies and (2) laboratory studies of toxicity. The use of either method, or both, provides baseline information used in the development of the standards. However, research will continue to determine the effects of low dose-rate and potential long-term health effects of toxic agents. As new findings emerge, the standards will change in the future.

III. STANDARDS
The current standards are found in Table A-1. In all instances the State and Federal Primary Standards
### TABLE A-1

**INORGANIC CHEMICALS (mg/l)**

<table>
<thead>
<tr>
<th>CONSTITUENT</th>
<th>EPA STANDARDS</th>
<th>STATE STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary</td>
<td>Secondary</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Aluminum</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.05</td>
<td>-</td>
</tr>
<tr>
<td>Barium</td>
<td>1.0</td>
<td>-</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.01</td>
<td>-</td>
</tr>
<tr>
<td>Calcium</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chloride</td>
<td>-</td>
<td>250.0</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>0.05</td>
<td>-</td>
</tr>
<tr>
<td>Chromium (VI)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Copper</td>
<td>-</td>
<td>1.0</td>
</tr>
<tr>
<td>Fluoride</td>
<td>1.4-2.4</td>
<td>-</td>
</tr>
<tr>
<td>Hardness</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Iron</td>
<td>0</td>
<td>0.3</td>
</tr>
<tr>
<td>Lead</td>
<td>0.05</td>
<td>-</td>
</tr>
<tr>
<td>Magnesium</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Manganese</td>
<td>-</td>
<td>0.05</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.002</td>
<td>-</td>
</tr>
<tr>
<td>Nitrate (as N)</td>
<td>10.0</td>
<td>-</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.01</td>
<td>-</td>
</tr>
<tr>
<td>Silver</td>
<td>0.05</td>
<td>-</td>
</tr>
<tr>
<td>Sodium</td>
<td>-</td>
<td>20.0</td>
</tr>
<tr>
<td>Sulfate</td>
<td>-</td>
<td>250.0</td>
</tr>
<tr>
<td>Zinc</td>
<td>-</td>
<td>5.0</td>
</tr>
<tr>
<td>CONSTITUENT</td>
<td>Maximum Contaminant Levels</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>----------------------------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td>EPA Standards</td>
<td>Primary</td>
</tr>
<tr>
<td>Carbon (alcohol extract)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon (chloroform extract)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foaming agents (MBAS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aldrin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DDT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dieldrin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endrin</td>
<td></td>
<td>0.0002</td>
</tr>
<tr>
<td>Lindane</td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>Methoxychlor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organophosphates &amp; Carbonates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxaphene</td>
<td></td>
<td>0.005</td>
</tr>
<tr>
<td>2,4-D</td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td>2,4-5-TP (Silvex)</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Total herbicide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloroform</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phenols</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mineral Oil</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A-2b
### TABLE A-1

**PHYSICAL, RADIOLOGICAL, AND MICROBIOLOGICAL PARAMETERS**

<table>
<thead>
<tr>
<th>CONSTITUENT</th>
<th>MAXIMUM CONTAMINANT LEVELS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EPA STANDARDS</td>
</tr>
<tr>
<td></td>
<td>Primary</td>
</tr>
<tr>
<td><strong>Physical</strong></td>
<td></td>
</tr>
<tr>
<td>Color - ACU</td>
<td>15 color units</td>
</tr>
<tr>
<td>Corrosivity</td>
<td>Noncorrosive</td>
</tr>
<tr>
<td>Odor - TON</td>
<td>3 threshold odor number</td>
</tr>
<tr>
<td>pH</td>
<td></td>
</tr>
<tr>
<td>Suspended solids - mg/l</td>
<td></td>
</tr>
<tr>
<td>Taste</td>
<td></td>
</tr>
<tr>
<td>Turbidity - TU</td>
<td>1</td>
</tr>
<tr>
<td>Foaming agents</td>
<td></td>
</tr>
<tr>
<td>Total dissolved solids (TDS)</td>
<td>0.5mg/l</td>
</tr>
<tr>
<td><strong>Radiological</strong></td>
<td></td>
</tr>
<tr>
<td>Gross Alpha - pCi*</td>
<td>15</td>
</tr>
<tr>
<td>Gross Beta - pCi</td>
<td></td>
</tr>
<tr>
<td>Radium 226 &amp; 228 - pCi</td>
<td></td>
</tr>
<tr>
<td>Strontium 90 - pCi/</td>
<td></td>
</tr>
<tr>
<td>Tritium</td>
<td>2,000</td>
</tr>
<tr>
<td><strong>Microbiological</strong></td>
<td></td>
</tr>
<tr>
<td>Coliform - organisms/100ml</td>
<td>1</td>
</tr>
</tbody>
</table>

*Picocurie (pCi) - that quantity of radioactive material producing 2.22 nuclear transformations per minute.*
are identical. The secondary standards are presently being evaluated by the State and in all probability will follow the recommended Federal Standards.

IV. HEALTH RISKS

The potential health risks for various pollutants are listed in Tables A-2 through A-4.

V. IMPLICATION ON PROJECT

The water quality of the service area (Makawao - Kula) has been tested. The results of all tests conducted to date can be found in Appendix C of this report.
<table>
<thead>
<tr>
<th>SUBSTANCE</th>
<th>FORMS IN AQUEOUS ENVIRONMENT</th>
<th>POTENTIAL HEALTH EFFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic (As)</td>
<td>( \text{HAsO}_4^- ), ( \text{H}_2\text{AsO}_4^- ), ( \text{HAsO}_2 ), ( \text{(CH}_3\text{)}_2\text{AsO(OH)}_2 ), ( \text{(CH}_3\text{)}\text{AsO(OH)}_2 )</td>
<td>linked with skin cancer and black foot disease; recognized carcinogen</td>
</tr>
<tr>
<td>Barium (Ba)</td>
<td>( \text{Ba}^{++} ), ( \text{BaSO}_4^{+} ), ( \text{BaCO}_3^{+} )</td>
<td>muscle stimulant, toxic to heart, blood vessels and nervous system</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>( \text{Cd}^{++} ), humic acid complex, ( \text{CdCO}_3^{+} )</td>
<td>causes nausea and vomiting, concentrated in liver and kidney; carcinogenic</td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>( \text{Cl}^- )</td>
<td>imparts salty taste at concentrations above 400mg/l, no documented serious health effects</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>( \text{HCrO}_4^- ), ( \text{HCr}_2\text{O}_7^- ), ( \text{Cr}^{+++} )</td>
<td>trivalent form harmless; nausea and ulcers after long-term exposure</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>( \text{Cu}^+ ), ( \text{Cu}^{++} ), ( \text{Cu(OH)}^{+} ), ( \text{Cu(NH}_3\text{)}_2^{++} )</td>
<td>above 1mg/l causes disagreeable taste and ingestion is unlikely</td>
</tr>
<tr>
<td>Fluoride (F)</td>
<td>( \text{F}^- )</td>
<td>concentrations above 1.0mg/l reduces tooth decay; above 4.0mg/l causes mottled teeth; greater than 15.2mg/l may cause fluorosis</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>( \text{Fe}^{++} ), ( \text{Fe(OH)}^{+} )</td>
<td>high levels impart an unattractive appearance and taste</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>( \text{Pb}^{++} ), ( \text{Pb(OH)}^{+} ), ( \text{(CH}_3\text{)}_4\text{Pb} )</td>
<td>causes constipation, loss of appetite, anemia, abdominal pains, paralysis and accumulates in bones</td>
</tr>
</tbody>
</table>
### TABLE A-2

**INORGANIC PARAMETERS**

<table>
<thead>
<tr>
<th>Substance</th>
<th>Forms in Aqueous Environment</th>
<th>Potential Health Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese (Mn)</td>
<td>Mn&lt;sup&gt;++&lt;/sup&gt;, MnO&lt;sub&gt;2&lt;/sub&gt;−, MnO&lt;sub&gt;4&lt;/sub&gt;−, MnO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>not considered health hazard; unpleasant taste; discolors laundry</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>HgCl&lt;sub&gt;2&lt;/sub&gt;+, CH&lt;sub&gt;3&lt;/sub&gt;Hg+, Hg(NH&lt;sub&gt;3&lt;/sub&gt;)&lt;sub&gt;x&lt;/sub&gt;++</td>
<td>highly toxic to man; gingivitis, stomatitis, tremors, chest pains, coughing</td>
</tr>
<tr>
<td>Nitrate (NO&lt;sub&gt;3&lt;/sub&gt;)</td>
<td>NO&lt;sub&gt;3&lt;/sub&gt;−</td>
<td>high levels have been associated with methemoglobinemia and diarrhea; note: above 100mg/l interferes with coliform test</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>HSeO&lt;sub&gt;3&lt;/sub&gt;−, SeO&lt;sub&gt;4&lt;/sub&gt;−, (CH&lt;sub&gt;3&lt;/sub&gt;)&lt;sub&gt;2&lt;/sub&gt;Se, (CH&lt;sub&gt;3&lt;/sub&gt;)&lt;sub&gt;2&lt;/sub&gt;Se&lt;sub&gt;2&lt;/sub&gt;</td>
<td>associated with increased dental cavities; believed to cause symptoms similar to arsenic poisoning</td>
</tr>
<tr>
<td>Silver (Ag)</td>
<td>AgCl&lt;sup&gt;−&lt;/sup&gt;</td>
<td>low concentrations cause darkening of skin; fatal at very high concentrations</td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>Na&lt;sup&gt;+&lt;/sup&gt;</td>
<td>excessive sodium intake contributes to an age-related increase in blood pressure that culminates in hypertension in genetically susceptible people</td>
</tr>
<tr>
<td>Sulfate (SO&lt;sub&gt;4&lt;/sub&gt;)</td>
<td>SO&lt;sub&gt;4&lt;/sub&gt;−</td>
<td>high concentrations cause a laxative effect</td>
</tr>
<tr>
<td>Total dissolved solids (TDS)</td>
<td>minerals</td>
<td>very high concentrations have cathartic reaction and does not quench thirst</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>Zn&lt;sup&gt;++&lt;/sup&gt;, Zn(OH)&lt;sup&gt;+&lt;/sup&gt;, Zn(Cl)&lt;sub&gt;x&lt;/sub&gt;&lt;sup&gt;y&lt;/sup&gt;</td>
<td>astringent taste above 5mg/l; high concentrations give milky appearance and form a greasy film upon boiling; very high concentrations associated with nausea and fainting</td>
</tr>
<tr>
<td>SUBSTANCE</td>
<td>EFFECTS</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Carbon - alcohol extract</td>
<td>may produce taste and odor; generally provides gross indication of exposure to organics</td>
<td></td>
</tr>
<tr>
<td>Carbon - chloroform extract</td>
<td>may produce taste and odor problems; provides gross indication of exposure to organics</td>
<td></td>
</tr>
<tr>
<td>Foaming agent (MBAS)</td>
<td>causes foaming</td>
<td></td>
</tr>
<tr>
<td>Aldrin (C₁₂H₆Cl₆)</td>
<td>neurotoxin; suspected carcinogen</td>
<td></td>
</tr>
<tr>
<td>DDT (C₁₄H₉Cl₉)</td>
<td>neurotoxin; causes unsteadiness, dizziness, paraesthesia, vomiting, convulsions</td>
<td></td>
</tr>
<tr>
<td>Dieldrin (C₁₂H₄OCl₆)</td>
<td>neurotoxin; suspected carcinogen</td>
<td></td>
</tr>
<tr>
<td>Endrin (C₁₂H₈Cl₆)</td>
<td>neurotoxin; suspected carcinogen</td>
<td></td>
</tr>
<tr>
<td>Lindane (C₉H₆Cl₆)</td>
<td>suspected carcinogen</td>
<td></td>
</tr>
<tr>
<td>Methoxychlor (C₁₆H₁₅Cl₃O₂)</td>
<td>fatal at high doses</td>
<td></td>
</tr>
<tr>
<td>Organophosphates</td>
<td>parasympathetic stimulation, convulsions, respiratory failure, death</td>
<td></td>
</tr>
<tr>
<td>Carbonates</td>
<td>causes achromation, salivation, myosis, convulsions and death</td>
<td></td>
</tr>
<tr>
<td>Toxaphene (C₁₅H₁₀Cl₈)</td>
<td>neurotoxin</td>
<td></td>
</tr>
<tr>
<td>Herbicide: 2,4-D (C₉H₉Cl₂O₃)</td>
<td>nonpoisonous; may produce unpleasant taste in water</td>
<td></td>
</tr>
<tr>
<td>Silvex (C₉H₇O₃Cl₃)</td>
<td>can produce unpleasant oily taste in exposed fish</td>
<td></td>
</tr>
</tbody>
</table>
## TABLE A-4
### OTHER PARAMETERS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>POTENTIAL EFFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td>aesthetically displeasing; may dull clothes, stain food and fixtures; colored compounds may be precursors to organohalides</td>
</tr>
<tr>
<td>Odor</td>
<td>undesirable for drinking; may add odor to fish or shell fish; some odor-causing compounds may be precursors to organohalides</td>
</tr>
<tr>
<td>Turbidity</td>
<td>aesthetically displeasing; may interfere with disinfection and maintenance of chlorine residual</td>
</tr>
<tr>
<td>Specific conductance</td>
<td>related to TDS; very high levels have cathartic reaction and does not quench thirst</td>
</tr>
<tr>
<td><strong>Biological Parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Coliform bacteria</td>
<td>serves as an indicator organisms to determine the adequacy of disinfection; most bacteria are nonpathogenic but may be pathogenic</td>
</tr>
<tr>
<td><strong>Radionuclides</strong></td>
<td></td>
</tr>
<tr>
<td>Gross beta</td>
<td>somatic and genetic damage</td>
</tr>
<tr>
<td>Radium-226</td>
<td>somatic and genetic damage</td>
</tr>
<tr>
<td>Strontium-90</td>
<td>somatic and genetic damage</td>
</tr>
<tr>
<td>Gross alpha</td>
<td>somatic and genetic damage</td>
</tr>
</tbody>
</table>
REFERENCES


APPENDIX B

EXISTING WATER RESOURCES
APPENDIX B
EXISTING WATER RESOURCES

I. INTRODUCTION [B.1]

A review of the water consumption and source and transmission developments for the service area indicates that water shortages occur even though improvements have been made to the water systems over the years.

Water source improvements and storage facilities at the Lower and Upper Waikamoi areas and transmission improvements from Waikamoi to Kanaio (Upper Kula system) and the construction of the Lower Kula transmission system from Lower Waikamoi to Alae have enabled continued water service during drought conditions.

Financing of distribution system improvements has been difficult to obtain, causing construction to lag behind the demand for additional water. Also, the exhaustability of the source limits further expansion of the gravity distribution system. This fact has led to the design of the existing system, which provides for pumpage of water from the lower source to the higher systems as necessary.

A series of pumps are used to transport water from the lower to the upper systems. The Upper Kula pump system receives water from the Lower Kula line, which in turn
utilizes the Makawao-Olinda pumping system to supplement
the existing water with water from the Makawao System.
The series of water transmission systems and pumping sys-
tems interconnect the Makawao and Kula water systems.
Discussions of the Upper and Lower Kula water systems
and the Makawao water system follow.

II. KULA WATER SYSTEM

The Kula water system serves the Olinda-Kula-Kanaio
areas. This area is located between approximately the
2,000 and 4,000-foot contours on Haleakala, with Olinda
to the north and Kanaio to the south. The Kula system
is divided into the Upper and Lower systems.

A. Upper Kula System

This system serves the area above the 2,800-foot
elevation to the 4,000-foot elevation. The maximum
capacity of the water line is 2.5 mgd and the storage
facility is 41 MG [B.2]. The safe yield of the source
is 1.0 mgd and of the system is 0.9 mgd. Refer to
Table B-1.

Also, the Lower Waikamoi pumps at the 3,100-foot
elevation are used to supplement the Upper System from
the East and West Waikamoi Streams. The maximum capa-
city of this system is 0.8 mgd.

The Upper system can be supplemented by the
water of the Lower system by use of the Upper Kula

B-2
### TABLE B-1

**EXISTING SAFE YIELD OF SOURCE AND SYSTEM**  
**KULA WATER SYSTEM**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>PUMP OR LINE CAPACITY</th>
<th>STORAGE CAPACITY</th>
<th>SAFE YIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(INCH)</td>
<td>MGD</td>
<td>MG</td>
</tr>
<tr>
<td><strong>UPPER SYSTEM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake &amp; Flume</td>
<td>8</td>
<td>0.8</td>
<td>41.0</td>
</tr>
<tr>
<td>Lower Pump</td>
<td>16, 12</td>
<td>2.7</td>
<td>11.5</td>
</tr>
<tr>
<td>Transmission</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walkambi-Olinda</td>
<td>12</td>
<td>2.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Distribution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olinda-Omao</td>
<td>12</td>
<td>2.3</td>
<td>5.2</td>
</tr>
<tr>
<td>Omao-Naale</td>
<td>8</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Naale-Kamaole</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplement</td>
<td>Upper Kula Pumps</td>
<td>12</td>
<td>1.0(1)</td>
</tr>
<tr>
<td><strong>LOWER SYSTEM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake Pipeline</td>
<td>12, 24</td>
<td>6.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Transmission &amp; Distribution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilholo-Kula Kai</td>
<td>18</td>
<td>3.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Supplement</td>
<td>Olinda Pumps</td>
<td>18</td>
<td>1.5(2)</td>
</tr>
<tr>
<td><strong>COMBINE - EXISTING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL (MGD)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Supply pumped from Lower System to Upper System.  
(2) Supply from Olinda pumps into Lower System.  
(3) Safe yield available to the Upper System.  
(4) Safe yield available to the Lower System.  

Source: [B-6]
pumping system. The capacity is 0.9 mgd with potential of 1.9 mgd with improvements to the system.

Please refer to Table B-1 for the safe yield estimates.

B. Lower Kula System

The Lower System serves the area below the 2,800 foot elevation and above the 2,000-foot elevation.

This system has a maximum capacity of 6.5 mgd [B.3]. The water source is at the 3,000-foot elevation, and consists of a series of intakes at the East and West Waikamoi, East, Middle and West Puohokamo, Haipuaena and Honomanu Streams.

Three pump stations located at Olinda obtain water from the Makawao water system, and the Kamole Pumping Station. The Olinda system has a capacity of 1.5 MGD, or 5.5 MGD with further improvements to the system [B.4].

The safe yield of the Lower System is 3.0 mgd and of the source is 3.4 mgd.

Please refer to Table B-1 for safe yield estimates.

C. Combined Systems - Upper and Lower Kula Systems

The safe yield of the water system can be expressed as the maximum daily quantity of water that
can be safely drawn from a system at all times without depletion of the water supply and storage of the system. Expressed on a quantity basis, the safe yield of the source includes the availability of the source supply and the capacity of the source facilities available to meet the demand. The safe yield of a system, however, considers the transmission, storage, and distribution ability of the system and the effect on it by losses through leakage and/or breakages. For these calculations, a 13% allowance for losses is deducted from the safe yield of the source to obtain the safe yield of the system.

Table B-1 shows the safe yield of the existing water source and systems. It reflects the ability of the available water yield of the source (4.3 mgd) to meet the safe yield demand of the system (3.8 mgd) [B.5].

III. MAKAWAO WATER SYSTEM

The Makawao water system serves the communities of Makawao, Pukalani, Hailiimaile, Kokomo, Kuiaha, Kaupakulua, Haiku, Ulumalu, Pauwela and Peahi.

Water for this system, during normal conditions, is from the Awalau and Opana Stream Intakes, which are mixed with water from the lower Kula line in Maluhia Tank. Additional water can also be obtained from the Upper Kula transmission system.
During drought conditions, water for Olinda, Makawao, Kokomo, Pukalani, Ha’iLiimaile, and Haiku is provided by the Kamole Weir, located at the Wailoa Ditch, and flows through an 8-inch and 12-inch gravity main to the Kokomo Storage Tank. Water is also provided for Kuiaha, Kaupakulua, Ulumalu, Pauwela and Peahi by the Kuiaha Intake, also located along Wailoa Ditch. The Lilikoi Intake also serves Haiku. When the treatment plant is completed, the water sources not in compliance will not be used.

An agreement between Alexander and Baldwin, Inc. and the County of Maui allows for the removal of up to 16 mgd of water from the Wailoa Ditch. This agreement allows for the removal at Kamole Weir of water which is then pumped to the Makawao, Lower Kula and Upper Kula systems.

IV. FUTURE WATER SUPPLY
A. Kula Water System

The future implementation of the pumping system and storage facilities, which can transport water from the Lower system to the Upper system, will enable the safe yield of the system to be increased from 3.8 mgd to 7.4 mgd. Refer to Table B-2 for additional information [B.6].

B. Makawao Water System

The Wailoa Ditch water source provides and will continue to provide water for the Makawao and Kula water systems. The County of Maui will be allowed to
### TABLE B-2

**EXISTING SAFE YIELD OF SOURCE AND SYSTEM**

**MAKA'AWO WATER SYSTEM**

<table>
<thead>
<tr>
<th>Description</th>
<th>Line Size (Inches)</th>
<th>Pump or Line Capacity</th>
<th>Storage Capacity (Gallons)</th>
<th>Tank Number</th>
<th>SOURCE (MGD)</th>
<th>SYSTEM (MGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peahi</td>
<td>1, 5, 2, 3, 4, 6</td>
<td>70,000</td>
<td>5,000</td>
<td>67</td>
<td>68</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10,000</td>
<td></td>
<td>69</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12,000</td>
<td></td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Kuiaha Intake</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haiku</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lilikoi Intake</td>
<td>6, 8, 12</td>
<td>1-100 HP</td>
<td>100,000</td>
<td>64</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-50 HP</td>
<td>70,000</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>70,000</td>
<td>66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haliiimaile</td>
<td>8</td>
<td>1-150 HP</td>
<td></td>
<td>60</td>
<td></td>
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<tr>
<td>Kamole Weir to Makawao and Olinda</td>
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<td>Kamole Weir to Pukalani</td>
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<td>25,000</td>
<td>59</td>
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</table>
remove up to 16 mgd, and current use is below this figure. The safe yield of this source will be limited by the pumping cost, distribution line capacities, and storage facilities.
FOOTNOTES TO APPENDIX B


APPENDIX C

WATER QUALITY TEST RESULTS
APPENDIX C
WATER QUALITY TEST RESULTS

The water quality of the Makawao and Kula water systems is periodically tested by the State Department of Health. Months in which there was at least one violation for bacteria and/or turbidity are presented in Table C-1.

The engineering firms involved in the design phase of the three water treatment plants are also collecting data on water quality. Preliminary results are presented following Table C-1. Results from Austin, Tsutsumi and Associates are for Makawao WTP. Results for the Upper Kula WTP are from Kennedy/Jenks Engineers, and results from R. M. Towill Corporation are for Lower Kula WTP.
<table>
<thead>
<tr>
<th>MONTH/YEAR</th>
<th>MAKAWAO Bacteria (1/100ml)</th>
<th>MAKAWAO Turbidity (1TU)</th>
<th>KULA Bacteria (1/100ml)</th>
<th>KULA Turbidity (1TU)</th>
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<tr>
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<td>X</td>
<td>X</td>
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<tr>
<td>December</td>
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</tbody>
</table>

C-2a
### TABLE C-1, Continued

**MAKAWAO-KULA WATER SYSTEM**

**Bacteriological and Turbidity Violations**

**CODE:** \( X = \text{Violation} \)

<table>
<thead>
<tr>
<th>MONTH/YEAR</th>
<th>MAKAWAO</th>
<th>KULA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bacteria (1/100ml)</td>
<td>Turbidity (1 TU)</td>
</tr>
<tr>
<td>January, 1980</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>February</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>X</td>
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<td>X</td>
<td>X</td>
</tr>
<tr>
<td>December</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Department of Health Water Violations.

C-2b
LABORATORY ANALYSIS REPORT

TO: Austin, Tsutsui & Associates, Inc.  ATTN: Mr. William Bonnet
ADDRESS: Suite 900, 745 Fort Street Mall  PHONE: 
SAMPLES OF: Water from Kahului Water System, Kamole Heir, Maui

SAMPLED BY: Client  SAMPLING DATE: 11-11-80  TIME: 1:00 PM
RECEIPT DATE: 11-13-80  SAMPLING DATE: 11-11-80  TIME: 1:00 PM

DATE SAMPLE ANALYZED: 11/14-12/08  TIME: 9:15 PM

SAMPLE DESCRIPTION: GRAB  SAMPLE TYPE: UNITS: 

Apparent Color: 0.00  TRUE COLOR: 0

Foaming Agents (MBAS): < 0.025  Called: 12-23-80

Sulfides: 0.45  mg/L

Iron: 1.53  mg/L

Manganese: 0.32  mg/L

Odor: TO. N

Sulfates: 1.29  mg/L

Zinc: 0.03  mg/L

pH: 6.18

Corrosivity: 4.23  (Bennet Index)

(Laboratory Remarks: Samples analyzed according to “Methods for Chemical Analysis of Water and Wastes”, U.S. Environmental Protection Agency, March, 1979.)
LABORATORY ANALYSIS REPORT

TO: Austin, Tutsuani & Associates
ATTN: Mr. William Bonnet
ADDRESS: Suite 900, 745 Fort Street Mall
SAMPLE OF: Water from Makawao Water System, Kamole Heir, Maui

RECEIPT DATE: 11-26-80
TIME: 3:45 PM

DATE SAMPLE ANALYZED: 11/26-12/16
TIME SAMPLE ANALYZED: Grab

<table>
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<tr>
<th>SAMPLE DESCRIPTION</th>
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<tr>
<td>True Color</td>
<td>C.U.  6</td>
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<tr>
<td>Foaming Agents (MBAS)</td>
<td>mg/L &lt; 0.025</td>
</tr>
<tr>
<td>Sulfides</td>
<td>mg/L &lt; 0.1</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/L &lt; 0.03</td>
</tr>
<tr>
<td>Manganese</td>
<td>mg/L 0.018</td>
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<tr>
<td>Odor</td>
<td>T.O.N. 8</td>
</tr>
<tr>
<td>Sulfates</td>
<td>mg/L 0.33</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg/L 0.024</td>
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<tr>
<td>pH</td>
<td>6.75</td>
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<tr>
<td>Corrosivity</td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td>NTU 0.6</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/L &lt; 0.02</td>
</tr>
</tbody>
</table>

## Laboratory Analysis Report

**Date:** 11/9/81  
**Page:** 1 of 1

**To:** Austin,Butler and Assoc.  
**Attn.:** Mr. Bill Berman

**Address:**  
**Phone:**

**Samples of:** Kitchen well water

**Sampled By:** Client  
**Sampling Date:** 12/6/80  
**Receipt Date:** 12/1/80  
**Time:**

<table>
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<tr>
<th>Date Sample Analyzed</th>
<th>12/6-12/31</th>
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</thead>
<tbody>
<tr>
<td>Time Sample Analyzed</td>
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**Sample Type:** Grab

**Sample Description:**

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<th>Units</th>
<th>Value</th>
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<td>7.10</td>
</tr>
<tr>
<td>Total Alkalinity</td>
<td>meq/l</td>
<td>17.5</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>mg/L</td>
<td>44.8</td>
</tr>
<tr>
<td>Chlorine</td>
<td>mg/L</td>
<td>8.0</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>meq/l</td>
<td>5.93</td>
</tr>
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<td>Sulfate</td>
<td>mg/L</td>
<td>&lt;0.1</td>
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<tr>
<td>Sulfide</td>
<td>mg/L</td>
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<tr>
<td>MBAS</td>
<td>mg/L</td>
<td>5.39</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>&lt;0.03</td>
</tr>
<tr>
<td>Copper</td>
<td></td>
<td>&lt;0.03</td>
</tr>
<tr>
<td>Iron</td>
<td></td>
<td>&lt;0.03</td>
</tr>
<tr>
<td>Manganese</td>
<td></td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Zinc</td>
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<tr>
<td>Sodium</td>
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<td>Nitrate-N</td>
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</tr>
<tr>
<td>Color</td>
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**Laboratory Remarks:** Samples analyzed according to "Methods for Chemical Analysis of Water and Wastes", U. S. Environmental Protection Agency, March, 1979.

T.O.N. = Threshold Odor is units.
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<tr>
<th>Substance</th>
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<th>Max</th>
<th>Actual</th>
<th>Max</th>
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<td>0.009</td>
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<td>Manganese</td>
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* Exceeds MCL

System
MONTHLY AVERAGES
RANGE 0.9 - 18.1
MEAN 5.6 (32 months)

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Highest Single reading
6/24/78  76

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LOWER KULA WTP

CONTAMINANTS AND CONTAMINANT LEVELS
(PRELIMINARY)

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<td>2. Bacteriological Data</td>
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R. M. TOWNER CORPORATION
677 Ala Moana Blvd., #1016
Honolulu, Hawaii  96813
## SECTION I

### TURBIDITY DATA

**Location:** Piilolo, Lower Kula

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Minimum 0.8  
Maximum 6.9
### SECTION 2

**Bacteriological Data**

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**Median**

< 1

**Mean**

Approx. 2.2
### SECTION 3

**PRIMARY INORGANIC PARAMETERS**

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<th>Cadmium (mg/l)</th>
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<td>-</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>RMT #9/10-28-80 (Piiholo Reservoir)</td>
<td>-</td>
<td>-</td>
<td>&lt; 0.005</td>
<td>-</td>
<td>&lt; 0.05</td>
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<tr>
<td>RMT #10/10-28-80 (Piiholo Reservoir)</td>
<td>-</td>
<td>-</td>
<td>0.014</td>
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<td>&lt; 0.05</td>
</tr>
<tr>
<td>S&amp;S Report/4-22-74 (Kula, Maui)</td>
<td>0.005</td>
<td>0.10</td>
<td>0.001</td>
<td>0.005</td>
<td>0.001</td>
</tr>
<tr>
<td>S&amp;S Report/4-29-75 (Kula, Maui)</td>
<td>0.005</td>
<td>0.10</td>
<td>0.001</td>
<td>0.005</td>
<td>0.01</td>
</tr>
<tr>
<td>DNS/7-5-80 (Piiholo Trans. Line)</td>
<td>&lt; 0.002</td>
<td>&lt; 0.10</td>
<td>0.007</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
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<tr>
<td>DNS/7-23-80 (Kula, Maui)</td>
<td>&lt; 0.002</td>
<td>&lt; 0.8</td>
<td>&lt; 0.005</td>
<td>&lt; 0.02</td>
<td>&lt; 0.02</td>
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<tr>
<td>RMT #1/11-25-80 (Piiholo Reservoir)</td>
<td>&lt; 0.002</td>
<td>&lt; 0.1</td>
<td>&lt; 0.005</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
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<tr>
<td>RMT #2/11-25-80 (Piiholo Reservoir)</td>
<td>&lt; 0.002</td>
<td>&lt; 0.1</td>
<td>&lt; 0.005</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
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### PRIMARY INORGANIC PARAMETERS (cont'd)

<table>
<thead>
<tr>
<th>Sample/Date (Location)</th>
<th>Mercury (µg/l)</th>
<th>Nitrate -N (mg/l)</th>
<th>Selenium (mg/l)</th>
<th>Silver (mg/l)</th>
<th>Fluoride (mg/l)</th>
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<tr>
<td>DWS/5-12-80 (Piiholo Trans. Line)</td>
<td>0.01</td>
<td>0.61</td>
<td>&lt;0.002</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
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<td>RRTC #1/7-7-80 (Piiholo Reservoir)</td>
<td>0.08</td>
<td>4.49</td>
<td>&lt;0.002</td>
<td>&lt;0.01</td>
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<tr>
<td>RRTC #2/7-7-80 (Piiholo Reservoir)</td>
<td>0.05</td>
<td>3.82</td>
<td>&lt;0.002</td>
<td>&lt;0.01</td>
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<td>RRTC #3/7-8-80 (Piiholo Reservoir)</td>
<td>0.02</td>
<td>3.81</td>
<td>&lt;0.002</td>
<td>&lt;0.01</td>
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<td>RRTC #4/7-8-80 (Piiholo Reservoir)</td>
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<td>3.58</td>
<td>&lt;0.002</td>
<td>&lt;0.01</td>
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</tr>
<tr>
<td>RRTC #5/7-8-80 (Piiholo Reservoir)</td>
<td>-</td>
<td>0.37</td>
<td>-</td>
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<tr>
<td>RRTC #6/10-28-80 (Piiholo Reservoir)</td>
<td>-</td>
<td>0.37</td>
<td>-</td>
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</tr>
<tr>
<td>RRTC #7/10-28-80 (Piiholo Reservoir)</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RRTC #8/10-28-80 (Piiholo Reservoir)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>RRTC #9/10-28-80 (Piiholo Reservoir)</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>RRTC #10/10-28-80 (Piiholo Reservoir)</td>
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<td>-</td>
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<tr>
<td>S&amp;S Report/4-22-74 (Kula, Maui)</td>
<td>-</td>
<td>0.09</td>
<td>0.001</td>
<td>0.01</td>
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<tr>
<td>S&amp;S Report/4-29-75 (Kula, Maui)</td>
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<td>0.01</td>
<td>0.001</td>
<td>0.01</td>
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<tr>
<td>DWS/7-1-80 (Piiholo Trans. Line)</td>
<td>0.12</td>
<td>2.39</td>
<td>&lt;0.002</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>DWS/7-23-80 (Kula, Maui)</td>
<td>&lt;0.5</td>
<td>0.06</td>
<td>&lt;0.01</td>
<td>&lt;0.03</td>
<td>&lt;0.20</td>
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<tr>
<td>RRTC #1/11-5-80 (Piiholo Reservoir)</td>
<td>0.04</td>
<td>0.46</td>
<td>&lt;0.002</td>
<td>&lt;0.01</td>
<td>0.05</td>
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<tr>
<td>RRTC #12/11-25-80 (Piiholo Reservoir)</td>
<td>0.04</td>
<td>0.40</td>
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<td>&lt;0.01</td>
<td>0.05</td>
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C-13
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Std.</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Arsenic (mg/l)</td>
<td>0.05</td>
<td>&lt; 0.002</td>
<td>&lt; 0.02</td>
<td>0.0039</td>
<td>&lt; 0.002</td>
</tr>
<tr>
<td>2. Barium (mg/l)</td>
<td>1.0</td>
<td>&lt; 0.1</td>
<td>&lt; 0.8</td>
<td>0.21</td>
<td>&lt; 0.1</td>
</tr>
<tr>
<td>3. Cadmium (mg/l)</td>
<td>0.01</td>
<td>0.001</td>
<td>0.033</td>
<td>0.0093</td>
<td>&lt; 0.005</td>
</tr>
<tr>
<td>4. Chromium (mg/l)</td>
<td>0.05</td>
<td>0.005</td>
<td>&lt; 0.05</td>
<td>0.038</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>5. Lead (mg/l)</td>
<td>0.05</td>
<td>0.001</td>
<td>0.17</td>
<td>0.051</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>6. Mercury (ug/l)</td>
<td>2.0</td>
<td>0.01</td>
<td>0.5</td>
<td>0.13</td>
<td>0.06</td>
</tr>
<tr>
<td>7. Nitrate -N (mg/l)</td>
<td>10.0</td>
<td>0.01</td>
<td>4.49</td>
<td>1.66</td>
<td>0.46</td>
</tr>
<tr>
<td>8. Selenium (mg/l)</td>
<td>0.01</td>
<td>0.001</td>
<td>&lt; 0.01</td>
<td>0.0031</td>
<td>&lt; 0.002</td>
</tr>
<tr>
<td>9. Silver (mg/l)</td>
<td>0.05</td>
<td>&lt; 0.01</td>
<td>&lt; 0.03</td>
<td>0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>10. Fluoride (mg/l)</td>
<td>---</td>
<td>&lt; 0.01</td>
<td>&lt; 0.20</td>
<td>0.087</td>
<td>0.05</td>
</tr>
</tbody>
</table>
**SECTION 4**

**PRIMARY ORGANIC PARAMETERS**

<table>
<thead>
<tr>
<th>Sample/Date (Location)</th>
<th>Chlorinated Hydrocarbons (mg/l)</th>
<th>Chlorophenoxyx (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMT C #1/7-7-80 (Piiholo Reservoir)</td>
<td>Neg.</td>
<td>Neg.</td>
</tr>
<tr>
<td>RMT C #2/7-7-80 (Piiholo Reservoir)</td>
<td>Neg.</td>
<td>Neg.</td>
</tr>
<tr>
<td>RMT C #3/7-8-80 (Piiholo Reservoir)</td>
<td>Neg.</td>
<td>Neg.</td>
</tr>
<tr>
<td>RMT C #4/7-8-80 (Piiholo Reservoir)</td>
<td>Neg.</td>
<td>Neg.</td>
</tr>
<tr>
<td>RMT C #5/7-8-80 (Piiholo Reservoir)</td>
<td>Neg.</td>
<td>Neg.</td>
</tr>
<tr>
<td>DNS/7-8-80 (Piiholo Trans. Line)</td>
<td>Neg.</td>
<td>Neg.</td>
</tr>
<tr>
<td>RMT C #11/11-25-80 (Piiholo Reservoir)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMT C #12/11-25-80 (Piiholo Reservoir)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. (mg/l)</td>
<td>0.1092 (total)</td>
<td>0.11 (total)</td>
</tr>
</tbody>
</table>
CORRECTION

THE PRECEDING DOCUMENT(S) HAS BEEN REPHOTOGRAPHED TO ASSURE LEGIBILITY
SEE FRAME(S) IMMEDIATELY FOLLOWING
**PRIMARY INORGANIC PARAMETERS**

**SUMMARY**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Std.</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Arsenic (mg/l)</td>
<td>0.05</td>
<td>&lt; 0.002</td>
<td>&lt; 0.02</td>
<td>0.0039</td>
<td>&lt; 0.002</td>
</tr>
<tr>
<td>2. Barium (mg/l)</td>
<td>1.0</td>
<td>&lt; 0.1</td>
<td>&lt; 0.8</td>
<td>0.21</td>
<td>&lt; 0.1</td>
</tr>
<tr>
<td>3. Cadmium (mg/l)</td>
<td>0.01</td>
<td>0.001</td>
<td>0.033</td>
<td>0.0093</td>
<td>&lt; 0.005</td>
</tr>
<tr>
<td>4. Chromium (mg/l)</td>
<td>0.05</td>
<td>0.005</td>
<td>&lt; 0.05</td>
<td>0.038</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>5. Lead (mg/l)</td>
<td>0.05</td>
<td>0.001</td>
<td>0.17</td>
<td>0.061</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>6. Mercury (ug/l)</td>
<td>2.0</td>
<td>0.01</td>
<td>0.5</td>
<td>0.13</td>
<td>0.06</td>
</tr>
<tr>
<td>7. Nitrate -N (mg/l)</td>
<td>10.0</td>
<td>0.01</td>
<td>4.49</td>
<td>1.66</td>
<td>0.46</td>
</tr>
<tr>
<td>8. Selenium (mg/l)</td>
<td>0.01</td>
<td>0.001</td>
<td>&lt; 0.01</td>
<td>0.0031</td>
<td>&lt; 0.002</td>
</tr>
<tr>
<td>9. Silver (mg/l)</td>
<td>0.05</td>
<td>&lt; 0.01</td>
<td>&lt; 0.03</td>
<td>0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>10. Fluoride (mg/l)</td>
<td>-</td>
<td>&lt; 0.01</td>
<td>&lt; 0.20</td>
<td>0.087</td>
<td>0.05</td>
</tr>
</tbody>
</table>
### SECTION 4

**PRIMARY ORGANIC PARAMETERS**

<table>
<thead>
<tr>
<th>Sample/Date (Location)</th>
<th>Chlorinated Hydrocarbons (mg/l)</th>
<th>Chlorophenoxyx (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMTC #1/7-7-80 (Piiholo Reservoir)</td>
<td>Neg.</td>
<td>Neg.</td>
</tr>
<tr>
<td>RMTC #2/7-7-80 (Piiholo Reservoir)</td>
<td>Neg.</td>
<td>Neg.</td>
</tr>
<tr>
<td>RMTC #3/7-8-80 (Piiholo Reservoir)</td>
<td>Neg.</td>
<td>Neg.</td>
</tr>
<tr>
<td>RMTC #4/7-8-80 (Piiholo Reservoir)</td>
<td>Neg.</td>
<td>Neg.</td>
</tr>
<tr>
<td>RMTC #5/7-8-80 (Piiholo Reservoir)</td>
<td>Neg.</td>
<td>Neg.</td>
</tr>
<tr>
<td>DNS/7-8-80 (Piiholo Trans. Line)</td>
<td>Neg.</td>
<td>Neg.</td>
</tr>
<tr>
<td>RMTC #11/11-25-80 (Piiholo Reservoir)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMTC #12/11-25-80 (Piiholo Reservoir)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. (mg/l)</td>
<td>0.1092 (total)</td>
<td>0.11 (total)</td>
</tr>
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## SECTION 5

### PARAMETERS AMENDED TO PRIMARY *

<table>
<thead>
<tr>
<th>Sample/Date (Location)</th>
<th>Corrosivity</th>
<th>TDS (mg/l)</th>
<th>Chlorides (mg/l)</th>
<th>Sodium (mg/l)</th>
<th>Trihalo-Methane (ug/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMTC #1/7-7-80 (Piiholo Reservoir)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>RMTC #6/10-28-80 (Piiholo Reservoir)</td>
<td>-3.79</td>
<td>118</td>
<td>Neg.</td>
<td>4.23</td>
<td>-</td>
</tr>
<tr>
<td>RMTC #7/10-28-80 (Piiholo Reservoir)</td>
<td>-3.31</td>
<td>116</td>
<td>Neg.</td>
<td>3.38</td>
<td>68</td>
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<tr>
<td>RMTC #8/10-28-80 (Piiholo Reservoir)</td>
<td>-3.96</td>
<td>92</td>
<td>Neg.</td>
<td>2.67</td>
<td>51</td>
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<tr>
<td>RMTC #9/10-28-80 (Piiholo Reservoir)</td>
<td>-3.88</td>
<td>103</td>
<td>Neg.</td>
<td>2.32</td>
<td>-</td>
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<tr>
<td>RMTC #10/10-28-80 (Piiholo Reservoir)</td>
<td>-3.88</td>
<td>91</td>
<td>Neg.</td>
<td>2.32</td>
<td>-</td>
</tr>
<tr>
<td>S&amp;S Report/4-29-75 (Kula, Maui)</td>
<td>-</td>
<td>70</td>
<td>1.5</td>
<td>2.76</td>
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<tr>
<td>DWS/7-8-80 (Piiholo Trans. Line)</td>
<td>-</td>
<td>66.2</td>
<td>5.0</td>
<td>12.1</td>
<td>-</td>
</tr>
<tr>
<td>DWS/7-23-80 (Kula, Maui)</td>
<td>-</td>
<td>28</td>
<td>4.2</td>
<td>1.6</td>
<td>-</td>
</tr>
<tr>
<td>RMTC #11/11-25-80 (Piiholo Reservoir)</td>
<td>-3.9</td>
<td>29</td>
<td>1.2</td>
<td>8.7</td>
<td>-</td>
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<tr>
<td>RMTC #12/11-25-80 (Piiholo Reservoir)</td>
<td>-3.8</td>
<td>32</td>
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<td>-</td>
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<tr>
<td>DWS/9-3-80 (Maui Elec. Substa. Kula)</td>
<td>-</td>
<td>22</td>
<td>5.4</td>
<td>1.5</td>
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*Proposed parameters to be amended to primary.*
### Parameters Amended to Primary *Summary*

<table>
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<tr>
<th>Parameters</th>
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<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Corrosivity</td>
<td>Non-corrosive</td>
<td>-3.31</td>
<td>-3.96</td>
<td>-3.79</td>
<td>-3.88</td>
</tr>
<tr>
<td>2. TDS (mg/l)</td>
<td>500</td>
<td>22</td>
<td>118</td>
<td>69.7</td>
<td>70.0</td>
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<tr>
<td>3. Chlorides (mg/l)</td>
<td>250</td>
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<td>1.2</td>
</tr>
<tr>
<td>4. Sodium (mg/l)</td>
<td>20 (^1)</td>
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<td>12.1</td>
<td>4.53</td>
<td>2.76</td>
</tr>
<tr>
<td>5. Trihalomethane (ug/l)</td>
<td>100</td>
<td>50</td>
<td>68</td>
<td>56.3</td>
<td>51</td>
</tr>
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1. Proposed std.
## SECTION 6
### SECONDARY PARAMETERS

<table>
<thead>
<tr>
<th>Sample/Date (Location)</th>
<th>Color (mg/l)</th>
<th>Copper (mg/l)</th>
<th>Foaming Agent (mg/l)</th>
<th>Hydrogen Sulfide (mg/l)</th>
<th>Iron (mg/l)</th>
<th>Manganese (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMTC #1/7-7-80 (Pitholo Reservoir)</td>
<td>-</td>
<td>&lt; 0.02</td>
<td>-</td>
<td>-</td>
<td>0.33</td>
<td>-</td>
</tr>
<tr>
<td>RMTC #2/7-7-80 (Pitholo Reservoir)</td>
<td>-</td>
<td>&lt; 0.02</td>
<td>-</td>
<td>-</td>
<td>0.30</td>
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<tr>
<td>RMTC #3/7-8-80 (Pitholo Reservoir)</td>
<td>-</td>
<td>&lt; 0.02</td>
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<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>RMTC #4/7-8-80 (Pitholo Reservoir)</td>
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<td>&lt; 0.02</td>
<td>-</td>
<td>-</td>
<td>0.23</td>
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</tr>
<tr>
<td>RMTC #5/7-8-80 (Pitholo Reservoir)</td>
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<td>&lt; 0.02</td>
<td>-</td>
<td>-</td>
<td>0.24</td>
<td>-</td>
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<td>RMTC #6/10-28-80 (Pitholo Reservoir)</td>
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<tr>
<td>RMTC #7/10-28-80 (Pitholo Reservoir)</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>RMTC #8/10-28-80 (Pitholo Reservoir)</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.36</td>
<td>-</td>
</tr>
<tr>
<td>RMTC #9/10-28-80 (Pitholo Reservoir)</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.38</td>
<td>-</td>
</tr>
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C-18
## SECONDARY PARAMETERS (cont'd)

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<th>Sample/Date (Location)</th>
<th>Odor (TON)</th>
<th>Sulfate (mg/l)</th>
<th>Zinc (mg/l)</th>
<th>pH</th>
<th>Total Alkalinity (mg/l)</th>
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<td>RMTG #1/7-7-80 (Piiholo Reservoir)</td>
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<td>RMTG #4/7-8-80 (Piiholo Reservoir)</td>
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<td>DWS/7-9-80 (Piiholo Trans. Line)</td>
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C-19
## SECONDARY PARAMETERS

### SUMMARY

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<th>Max.</th>
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<th>Median</th>
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<td>1. Color (units)</td>
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<td>47</td>
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<td>2. Copper (mg/l)</td>
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<td>&lt; 0.02</td>
<td>&lt; 0.02</td>
<td>&lt; 0.02</td>
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<tr>
<td>3. Foaming Agent (mg/l)</td>
<td>0.5</td>
<td>&lt; 0.01</td>
<td>&lt; 0.02</td>
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<td>4. Hydrogen Sulfide (mg/l)</td>
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<td>0.166</td>
<td>0.197</td>
<td>0.182</td>
<td>0.166</td>
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<tr>
<td>5. Iron (mg/l)</td>
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<td>0.07</td>
<td>0.60</td>
<td>0.30</td>
<td>0.30</td>
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<tr>
<td>6. Manganese (mg/l)</td>
<td>0.05</td>
<td>0.07</td>
<td>0.40</td>
<td>0.27</td>
<td>0.35</td>
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<tr>
<td>7. Odor (TON)</td>
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<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>8. Sulfate (mg/l)</td>
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<td>11.3</td>
<td>9.7</td>
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<tr>
<td>9. Zinc (mg/l)</td>
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<td>0.03</td>
<td>0.03</td>
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<td>10. pH</td>
<td>6.5-8.5</td>
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<td>11. Total Alkalinity (mg/l)</td>
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## SECTION 7

### WATER QUALITY DATA SUMMARY

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<tr>
<td>1. Turbidity (NTU)</td>
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<td>2. Coliform (/100 ml)</td>
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<td>TNDC</td>
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<td>3. Primary Inorganic Parameters</td>
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<td>Arsenic (mg/l)</td>
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<td>&lt; 0.002</td>
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<td>Barium (mg/l)</td>
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<td>0.005</td>
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<td>0.038</td>
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<td>0.13</td>
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<tr>
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<td>&lt; 0.02</td>
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<tr>
<td>Foaming Agent (mg/l)</td>
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<td>&lt; 0.01</td>
<td>&lt; 0.02</td>
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<td>&lt; 0.01</td>
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<td>Hydrogen Sulfide (mg/l)</td>
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<td>0.182</td>
<td>0.166</td>
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APPENDIX D

WATER CONSUMPTION
APPENDIX D
LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE NO.</th>
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<tbody>
<tr>
<td>D-1</td>
<td>Summary of Water Services and Consumption—Makawao District, 1952-1980</td>
</tr>
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<td>D-2</td>
<td>Historical Water Consumption by Subarea, 1952-1980</td>
</tr>
<tr>
<td>D-3</td>
<td>Average Daily Consumption by Subarea, 1957-1980</td>
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<td>D-4</td>
<td>Population — Makawao District</td>
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<td>D-5</td>
<td>Census Division Data for Makawao District (Uncorrected)</td>
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<tr>
<td>D-6</td>
<td>Census Division Data Corrected for Makawao District Water Service Area</td>
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<td>D-7</td>
<td>Kula Population Projection</td>
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<td>Makawao Population Projection</td>
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<td>D-9</td>
<td>Kula Water System—Subarea Consumption</td>
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<td>Kula Area Water Consumption by Service Area, 1980</td>
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<td>D-11A</td>
<td>Kula Water Use Estimates for 1980</td>
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<td>D-11B</td>
<td>Total Water Use for Kula</td>
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<td>D-11C</td>
<td>Upper Kula Water Estimates and Projections</td>
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<td>D-11D</td>
<td>Lower Kula Water Estimates and Projections</td>
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<td>D-11E</td>
<td>Total Kula Wet and Dry Year Projections</td>
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<td>Makawao Water System — Subarea Service</td>
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<td>D-12B</td>
<td>Makawao Water System — Subarea Consumption</td>
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<td>Makawao Subarea—Total Water Consumption and Projections</td>
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<td>Projected Water Requirements—Makawao Water District</td>
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D-1
# APPENDIX D

## LIST OF FIGURES

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<td>Makawao District Consumers and Water Consumption</td>
</tr>
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<td>D-3A</td>
<td>Average Daily Consumption - Kokomo-Kaupakulua</td>
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<td>D-3B</td>
<td>Average Daily Consumption - Kuiaha</td>
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<td>D-3C</td>
<td>Average Daily Consumption - Haiku-Pauwela</td>
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<td>D-3D</td>
<td>Average Daily Consumption - Makawao-Pukalani</td>
</tr>
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<td>D-3E</td>
<td>Average Daily Consumption - Haliimaile-Paia-Hamakuapoko</td>
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<td>D-3F</td>
<td>Average Daily Consumption - Kula</td>
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<td>D-4</td>
<td>Projected Population for Kula</td>
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<td>D-5</td>
<td>Projected Population for Makawao</td>
</tr>
<tr>
<td>D-6A</td>
<td>Upper Kula Water Estimates and Projections</td>
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<td>D-6B</td>
<td>Lower Kula Water Estimates and Projections</td>
</tr>
<tr>
<td>D-7A1</td>
<td>Kula Dry Year Projections (4%, 5%, 6%)</td>
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<td>D-7A2</td>
<td>Kula Dry Year Projections (7%, 8%, 10%)</td>
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<td>D-7A3</td>
<td>Kula Wet Year Projections (4%, 5%, 6%)</td>
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<td>D-8</td>
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APPENDIX D
WATER CONSUMPTION
Makawao-Kula

I. WATER SERVICE AND CONSUMPTION

The Makawao water system was developed approximately 72 years ago (1908). Most of the residents collected rain water and stored the water in tanks. The system consisted of a 2.5-inch pipeline from the Maluhea Reservoir (150,000 gal. capacity) which served the needs of 22 consumers.

The advent of World War II, followed by the increased development of farms in the Kula area, necessitated by the nineteen-fifties the enlargement of the water system.

In 1952 the "First Report of the Maui County Water Works Board" was issued, covering the period of July 1, 1949 through December 31, 1952. According to this report, the total number of consumers in 1952 was 2,044, and the annual consumption was 468,278,000 gallons. The system has expanded over the last twenty-eight years.

In 1980 the system had 5,253 connections and used approximately 1,200,879,000 gallons of water - a growth of about 159% in connections and 164% consumption. (Please
refer to Table D-1 and Figure D-1A). Additional information is provided for the water subareas served within the Makawao District in Table D-2.

Average daily consumption of the subareas within the Makawao District is presented in Table D-3 and Figures D-3A through D-3F. The data and figures show a dramatic rise in connections and water consumption over the last two decades, especially for the Kula and Makawao areas.

II. FUTURE WATER REQUIREMENT

A. Introduction

Projections of future water requirements for the Makawao District cannot be done with accuracy. The growth trend, especially in the Kula area with its different water use and requirements, presents problems in projecting future requirements. The vast potential for urbanization and continued need for water for agriculture are evident. The water needs can be tremendous, greater than presently available.

Previous projections for the other subareas, especially the Makawao-Pukalani subarea, have been overestimated, demonstrating that water projections are influenced by numerous variables and, at best, can only indicate trends in future water requirements.
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<th>NUMBER OF CONSUMERS</th>
<th>GALLONS (1,000 Gallons)</th>
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<td>468,278</td>
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<td>2,068</td>
<td>509,488</td>
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<tr>
<td>1954</td>
<td>2,089</td>
<td>456,700</td>
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<td>1955</td>
<td>2,099</td>
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<td>1956</td>
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<td>401,625</td>
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<td>1957</td>
<td>2,157</td>
<td>481,956</td>
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<td>1958</td>
<td>2,175</td>
<td>495,548</td>
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<td>523,129</td>
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<td>2,263</td>
<td>444,397</td>
</tr>
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<td>449,491</td>
</tr>
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2/ Total includes halona prior to 1-1-76.
3/ Total includes halona prior to 1-1-76.
4/ Total for Upper/Lower Kula, Milihahana and Kalanai.
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<td>60,465</td>
<td>68,353</td>
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<td>87,654</td>
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<td>570,315</td>
<td>76,401</td>
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<td>1,244,556</td>
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<td>96,969</td>
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<td>1,255,720</td>
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<td>62,071</td>
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<td>118,205</td>
<td>1,073,924</td>
<td>99,024</td>
<td>1,279,916</td>
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<td>61,603</td>
<td>109,882</td>
<td>1,196,849</td>
<td>89,449</td>
<td>1,292,930</td>
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<td>1980</td>
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<td>68,479</td>
<td>116,810</td>
<td>1,320,346</td>
<td>97,684</td>
<td>1,308,910</td>
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</tr>
</tbody>
</table>

*Please refer to Figures D-3A to D-7P. Daily Consumption Graphs.

1/ Pokotani was included with Makena prior to 1978.
2/ This was the Vale-Raro area prior to 1964.
3/ Combined totals for lower and upper Rula, Uguagalaba & Rano.
KULA DAILY CONSUMPTION

- COMBINED LOWER & UPPER KULA
- UPPER KULA
- LOWER KULA

FIGURE D3-F

1000 GALLONS


D-12
Nonetheless, water projections are necessary for planning purposes and are required to evaluate the optimum size for the water treatment plants. The following discussion and projections are presented with this in mind.

B. Makawao District Water Service Area

Projections of the future water needs for the Makawao District require analysis of the historical consumption pattern. Also, other parameters may be used for water projection; these include population trends, general plans, and other indirect measures of growth such as telephone connections. However, future water projections will only use previous water consumption as a base for projections. The other parameters were evaluated and found not to be useful for projections.

1. Population - 1980

The population of the Makawao Service District is found in Tables D-4, D-5 and D-6. The 1980 Census was used and altered to estimate the population for the water service district. The population for the Makawao Service District is estimated at 16,410 people for 1980.

2. Population Projections

The population estimates for Kula and Makawao are found in Tables D-7 and D-8 and D-13.
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kula</td>
<td>Wailea²</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1,111</td>
<td>-</td>
<td>-</td>
<td>1,348</td>
</tr>
<tr>
<td></td>
<td>Keokea</td>
<td>454</td>
<td>698</td>
<td>436</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waikoa</td>
<td>695</td>
<td>517</td>
<td>416</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Makawao-</td>
<td>Halimaile</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>638</td>
<td>743</td>
<td>16.5</td>
<td>150</td>
</tr>
<tr>
<td>Paia</td>
<td>Lower Paia³</td>
<td>1,235</td>
<td>1,137</td>
<td>925</td>
<td>1,105</td>
<td>1,516</td>
<td>37.2</td>
<td>626</td>
</tr>
<tr>
<td></td>
<td>Makawao</td>
<td>903</td>
<td>1,098</td>
<td>977</td>
<td>1,066</td>
<td>2,912</td>
<td>173.2</td>
<td>1,111</td>
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<tr>
<td></td>
<td>Paia³</td>
<td>4,272</td>
<td>3,195</td>
<td>2,144</td>
<td>541</td>
<td>193</td>
<td>-64.3</td>
<td>630</td>
</tr>
<tr>
<td></td>
<td>Pukalani</td>
<td>-</td>
<td>-</td>
<td>1,629</td>
<td>3,963</td>
<td>143.3</td>
<td>1,478</td>
<td></td>
</tr>
<tr>
<td>Haiku-</td>
<td>Haiku</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>464</td>
<td>616</td>
<td>32.7</td>
<td>194</td>
</tr>
<tr>
<td>Pauwela</td>
<td>Pauwela</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>355</td>
<td>463</td>
<td>30.4</td>
<td>234</td>
</tr>
</tbody>
</table>


2. Wailea is outside of the Makawao District water service area. Therefore, if the Census Designated Place (CDP) is subtracted out of the Kula Division, this would be indicative of the population of the Kula area (4,975 - 1,111 = 3,864).

3. CDP's Lower Paia and Paia are outside of the Makawao District water service area; therefore, they must be subtracted out of the Makawao - Paia Census Division (10,703 - 1,709 = 8,994).
TABLE D-5

CENSUS DIVISION DATA FOR MAKAWAO DISTRICT
UNCORRECTED

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kula</td>
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<td>2,786</td>
<td>2,124</td>
<td>4,975</td>
<td>134.2</td>
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<tr>
<td>Makawao - Paia</td>
<td>NA</td>
<td>5,680</td>
<td>5,788</td>
<td>10,703</td>
<td>84.9</td>
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<td>Haiku - Pauwela</td>
<td>NA</td>
<td>1,943</td>
<td>2,067</td>
<td>3,552</td>
<td>71.8</td>
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<tr>
<td>TOTAL</td>
<td>10,409</td>
<td>9,979</td>
<td>19,230</td>
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</table>

D-15
TABLE D-6

CENSUS DIVISION DATA CORRECTED FOR MAKAWAO DISTRICT
WATER SERVICE AREA

<table>
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<tr>
<th>Census Division</th>
<th>1940</th>
<th>1950</th>
<th>1960</th>
<th>1970</th>
<th>1980</th>
<th>% Change 1970-80</th>
<th>% Change/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kula</td>
<td>1,149</td>
<td>1,215</td>
<td>2,786</td>
<td>2,124</td>
<td>3,864</td>
<td>81</td>
<td>8.1</td>
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<td>903</td>
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<td>2,611</td>
<td>4,142</td>
<td>8,994</td>
<td>117</td>
<td>11.17</td>
</tr>
<tr>
<td>Haiku - Pauwela</td>
<td>NA</td>
<td>-</td>
<td>-</td>
<td>2,067</td>
<td>3,552</td>
<td>72</td>
<td>7</td>
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<tr>
<td>TOTAL</td>
<td>2,052</td>
<td>2,313</td>
<td>5,397</td>
<td>8,333</td>
<td>16,410</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1  CDP Total - Table D-4
2  Kula Census Division - Table D-5
3  Makawao-Paia Census Division less Paia and Lower Paia CDP’s - Tables D-4 and D-5
4  Kula Census Division total less Wailea CDP - Table D-4
### TABLE D-7

**KULA POPULATION PROJECTION**

KULA POPULATION CHANGE 1970-1980-81%; Average Change/Year-8.1%

Base Year 1980 - Population = 3,864

<table>
<thead>
<tr>
<th>Year</th>
<th>4%</th>
<th>5%</th>
<th>6%</th>
<th>7%</th>
<th>8%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>5,779</td>
<td>6,294</td>
<td>6,919</td>
<td>7,601</td>
<td>8,341</td>
<td>10,022</td>
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<td>2000</td>
<td>8,466</td>
<td>10,252</td>
<td>12,392</td>
<td>14,952</td>
<td>18,010</td>
<td>25,995</td>
</tr>
<tr>
<td>Year</td>
<td>4%</td>
<td>5%</td>
<td>6%</td>
<td>7%</td>
<td>8%</td>
<td>10%</td>
</tr>
<tr>
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<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>1990</td>
<td>18,570</td>
<td>20,436</td>
<td>22,467</td>
<td>24,680</td>
<td>27,085</td>
<td>32,544</td>
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<td>33,288</td>
<td>39,960</td>
<td>48,549</td>
<td>58,476</td>
<td>84,339</td>
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</tbody>
</table>

*NOTE: Hāiku and Pauwela combined into Makawao - Paia data.*
Graphed in Figures D-4 and D-5. The population will be used to project future water demands for the Makawao District.

3. **Number of People Per Connection**

   **Objective:** Determine the number of people per water connection

   **Assumptions:**
   

   b. Assume a total of 5,253 water connections in 1980.

   **Calculations:**

   \[
   \frac{16,410}{5,253} = 3.12 \text{ people/ connection}
   \]

4. **Average Daily Consumption Per Connection for the Makawao District**

   **Objective:** Determine average daily consumption per connection for Makawao District

   **Calculation:**

   \[
   \frac{2,992,814}{5,253} = 569.73 \text{ gpd/ connection}
   \]

5. **Average Daily Consumption Per Capita Per Day**

   **Objective:** Determine average consumption per capita per day for Makawao District for 1980
FIGURE D-5
PROJECTED POPULATION FOR MAKAWAO
Assumptions:

a. 3.12 people/connection
b. 569.73 gpd/connection

Calculation:

\[
\frac{569.73 \text{ gpd/connection}}{3.12 \text{ people/connection}} = 182.60 \text{ gallons/capita/day}
\]

6. **Determine Population of Makawao District Using Water Consumption**

Objective: Determine population of Makawao District using gallons/capita/day

Assumptions:

a. Average daily consumption of Makawao District 2,992,814 gpd
b. 182.60 gpcd

Calculations:

\[
\frac{2,992,814 \text{ gpd}}{182.60 \text{ gpcd}} = 16,390 \text{ people}
\]

Analysis:

The calculated population of 16,390 people is a close fit of the 1980 Census of 16,410. However, since agricultural water consumption within the Kula area, especially the lower Kula system, there is a built-in error in the calculations.
The Maui County design criteria* for water use indicate an optimal water use rate of 140 gpcd for "Residential" and "Apartment" areas. (No design criteria are listed for agricultural areas.) The calculated average consumption of 182.6 gpcd for Makawao District thus appears to be rather high. This is due to the fact that there is a great deal of agricultural water consumption within the Kula subarea. Therefore, the actual consumption per capita per day for the District, excluding agricultural use, is probably considerably lower than calculated above.

For example, in 1977 the County of Maui, Department of Water Supply calculated that in the Upper Kula system, 82% of the meters were domestic and used 45% of the water. The agricultural meters totaled 18% and used 55% of the water. In the Lower Kula water system, 75% of the meters were domestic and used 22% of the water. The agricultural meters totaled 23% and used 98% of the water.

The other subareas served by the Makawao District have very little agricultural water use and are primarily domestic. Additional calculations using the percentage breakdowns for the Kula area are provided below.

C. Kula Service Area

The historical water consumption for the Kula subarea from 1967 through 1980 is found in Table D-9. Figure D-3F graphs the daily consumption from 1957 through 1980. The table and figure show a continual increase in the consumption of water, with dips representing drought conditions.

Table D-10 presents the 1980 data for connections and consumption by the Kula subareas. The data from this table is used to estimate the agriculture and domestic consumption by the Upper and Lower Kula systems. The estimates found in Tables D-11A and D-11B. The projections are presented in Tables D-11C, D-11D, and D-11E. Graphed in Figures D-6A, D-6B, D-7A1, D-7A2, and D-7A3 are estimates and projections for the Upper and Lower Kula water systems.

D. Makawao Service Area

The historical water consumption for the Makawao subarea from 1967 through 1980 is found in Tables D-12A and D-12B. Projections from 1980 to the year
<table>
<thead>
<tr>
<th>YEAR</th>
<th>Number of Meters</th>
<th>% Change</th>
<th>Consumption (000 Gal)</th>
<th>% Change/Consumption</th>
<th>Average Day (000)</th>
<th>% Change</th>
<th>Rainfall Day / 0.1</th>
<th>% Change</th>
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<tbody>
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<td></td>
<td></td>
<td></td>
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<td>Change</td>
<td>Annual</td>
<td>Change</td>
<td>Annual</td>
<td>Change</td>
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<tr>
<td>1</td>
<td>1957</td>
<td>344</td>
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<td>.92</td>
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<tr>
<td>2</td>
<td>1958</td>
<td>576</td>
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<td>(1.06)</td>
<td>(7.8)</td>
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<td>1959</td>
<td>1,047</td>
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<td>1.0</td>
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<td>31.15</td>
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<td>1,005</td>
<td>452,727</td>
<td>82,019</td>
<td>22.36</td>
<td>1.22</td>
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<td>5</td>
<td>1971</td>
<td>1,044</td>
<td>409,559</td>
<td>(40,781)</td>
<td>(9.95)</td>
<td>(1.22)</td>
<td>(1.22)</td>
<td>(22.0)</td>
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<td>(195,341)</td>
<td>(20.97)</td>
<td>(1.35)</td>
<td>(1.28)</td>
<td>(20.79)</td>
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<td>1975</td>
<td>1,424</td>
<td>596,500</td>
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<td>1.63</td>
<td>.28</td>
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<td>.20</td>
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<tr>
<td>13</td>
<td>1979</td>
<td>1,822</td>
<td>653,110</td>
<td>(20,416)</td>
<td>(31.24)</td>
<td>(1.89)</td>
<td>(1.39)</td>
<td>(20.63)</td>
</tr>
<tr>
<td>14</td>
<td>1980</td>
<td>1,952</td>
<td>704,133</td>
<td>11,015</td>
<td>1.50</td>
<td>1.92</td>
<td>.03</td>
<td>1.58</td>
</tr>
</tbody>
</table>

1/ Combined Upper and Lower Rula Systems, Ulupalakua-Kealakua. 2/ Rula Water Meter Issued. 3/ Average Day x 1.5 = Rainstorm day. ( ) = Decrease
<table>
<thead>
<tr>
<th>SUB-AREA</th>
<th>UPPER KULA</th>
<th>ULUPALAKUA*</th>
<th>LOWER KULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connections</td>
<td>Consumption</td>
<td>Connections</td>
<td>Consumption</td>
</tr>
<tr>
<td>1,211</td>
<td>295,053</td>
<td>58</td>
<td>30,226</td>
</tr>
</tbody>
</table>

**NOTE:**

Upper System (Upper Kula + Ulupalakua):

Total Services: 1,269  
Consumption: 325,279,000 gal.

Lower System:

Total Services: 633  
Consumption: 378,860,000 gal.

**TOTALS:**

Total Services: 1,902  
Consumption: 704,133,000 gal.
<table>
<thead>
<tr>
<th>YEAR</th>
<th>TOTALS</th>
<th>DOMESTIC</th>
<th>AGRICULTURE</th>
<th>LOWER KULA SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CONNECTION</td>
<td>METERs</td>
<td>METERs</td>
<td>METERs</td>
</tr>
<tr>
<td>19771</td>
<td>1,039</td>
<td>770.406</td>
<td>962</td>
<td>197.64</td>
</tr>
<tr>
<td>AD</td>
<td>.542</td>
<td>.420</td>
<td>.295</td>
<td>.704</td>
</tr>
<tr>
<td>MD</td>
<td>.013</td>
<td>1.005</td>
<td>.292</td>
<td>1.06</td>
</tr>
<tr>
<td>19782</td>
<td>1,738</td>
<td>835.754</td>
<td>961.86</td>
<td>170.192</td>
</tr>
<tr>
<td>AD</td>
<td>.466</td>
<td>.569</td>
<td>.543</td>
<td>1.39</td>
</tr>
<tr>
<td>MD</td>
<td>.095</td>
<td>.854</td>
<td>.394</td>
<td>1.39</td>
</tr>
<tr>
<td>19792</td>
<td>1,822</td>
<td>693.118</td>
<td>1,006</td>
<td>141.051</td>
</tr>
<tr>
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<td>.386</td>
<td>.672</td>
<td>.526</td>
<td>.811</td>
</tr>
<tr>
<td>MD</td>
<td>.179</td>
<td>.208</td>
<td>.343</td>
<td>1.21</td>
</tr>
<tr>
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<td>1,802</td>
<td>704.133</td>
<td>1,040</td>
<td>146.733</td>
</tr>
<tr>
<td>AD</td>
<td>.401</td>
<td>.490</td>
<td>.328</td>
<td>.809</td>
</tr>
<tr>
<td>MD</td>
<td>.201</td>
<td>.235</td>
<td>.342</td>
<td>1.214</td>
</tr>
</tbody>
</table>

**CODE:**

AD = Average Day  
MD = Maximum Day


2 Data from Table D-2

3 Percentages used were based on 1977 Dept. of Water Supply.
### TABLE D-11B

**TOTAL WATER USE FOR KULA**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>AG</th>
<th>AVERAGE DAY</th>
<th>MAX. DAY</th>
<th>DOMESTIC</th>
<th>AVERAGE DAY</th>
<th>MAX.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>501.443</td>
<td>1.374</td>
<td>2.06</td>
<td>268.96</td>
<td>.737</td>
<td>1.22</td>
</tr>
<tr>
<td>1978</td>
<td>546.518</td>
<td>1.502</td>
<td>2.24</td>
<td>266.23</td>
<td>.729</td>
<td>1.09</td>
</tr>
<tr>
<td>1979</td>
<td>468.538</td>
<td>1.283</td>
<td>1.91</td>
<td>224.57</td>
<td>.614</td>
<td>.922</td>
</tr>
<tr>
<td></td>
<td>(451.671)</td>
<td>(1.237)</td>
<td>(1.85)</td>
<td>(242.08)</td>
<td>(.663)</td>
<td>(.994)</td>
</tr>
<tr>
<td></td>
<td>(474.411)</td>
<td>1.299</td>
<td>1.94</td>
<td>229.72</td>
<td>.629</td>
<td>.943</td>
</tr>
<tr>
<td></td>
<td>(425.452)</td>
<td>(1.165)</td>
<td>(1.74)</td>
<td>(232.20)</td>
<td>(.636)</td>
<td>(.954)</td>
</tr>
<tr>
<td></td>
<td>1979¹</td>
<td>451.967</td>
<td>1.238</td>
<td>1.85</td>
<td>242.256</td>
<td>.663</td>
</tr>
<tr>
<td></td>
<td>1980¹</td>
<td>430.023</td>
<td>1.178</td>
<td>1.76</td>
<td>236.584</td>
<td>.648</td>
</tr>
</tbody>
</table>

¹ Data for Kula Total Ending October 1979 and October 1980 - Dept. of Water Supply

**ERROR PERCENTAGES:**

- **1979:**
  - Ag: -3.6%
  - Domestic: +7.8%

- **1980:**
  - Ag: -10.32%
  - Domestic: +2.98%

The error percentages are used to correct the figures in Table D-11B and are represented in parentheses (¹).
### TABLE D-11C

**UPPER KULA WATER ESTIMATES AND PROJECTIONS**

<table>
<thead>
<tr>
<th>Year</th>
<th>Agriculture (MG)</th>
<th>Domestic (MG)</th>
<th>Total (MG)</th>
<th>Source</th>
<th>Safe Yield 5 (MG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>.670</td>
<td>1.005</td>
<td>.542</td>
<td>.813</td>
<td>1.818</td>
</tr>
<tr>
<td>1978</td>
<td>.569</td>
<td>.854</td>
<td>.569</td>
<td>.853</td>
<td>1.70</td>
</tr>
<tr>
<td>1979</td>
<td>.472</td>
<td>.708</td>
<td>.597</td>
<td>.896</td>
<td>1.61</td>
</tr>
<tr>
<td>1980</td>
<td>.490</td>
<td>.735</td>
<td>.627</td>
<td>.941</td>
<td>1.68</td>
</tr>
<tr>
<td>1981</td>
<td>.670</td>
<td>1.005</td>
<td>.658</td>
<td>.988</td>
<td>2.01</td>
</tr>
<tr>
<td>1982</td>
<td>.670</td>
<td>1.005</td>
<td>.691</td>
<td>1.037</td>
<td>2.05</td>
</tr>
<tr>
<td>1983</td>
<td>.670</td>
<td>1.005</td>
<td>.726</td>
<td>1.089</td>
<td>2.10</td>
</tr>
<tr>
<td>1984</td>
<td>.670</td>
<td>1.005</td>
<td>.762</td>
<td>1.143</td>
<td>2.15</td>
</tr>
<tr>
<td>1985</td>
<td>.670</td>
<td>1.015</td>
<td>.800</td>
<td>1.2</td>
<td>2.21</td>
</tr>
<tr>
<td>1990</td>
<td>.704</td>
<td>1.056</td>
<td>1.021</td>
<td>1.532</td>
<td>2.58</td>
</tr>
<tr>
<td>2000</td>
<td>.817</td>
<td>1.226</td>
<td>1.664</td>
<td>2.497</td>
<td>3.723</td>
</tr>
</tbody>
</table>

Note: This data is presented in Figure D-6A

1. Estimates obtained from Table D-11A
2. Assumes no agriculture meters to be issued for next three years, and water consumption could be as high as 1977
3. Assumes 1% compound growth in agricultural consumption of water
4. Assumes 5% compound growth in domestic consumption of water using base year 1977 of 0.542 MG
5. Department of Water Supply, County of Maui
## TABLE D-11D

### LOWER KULA WATER ESTIMATES AND PROJECTIONS

<table>
<thead>
<tr>
<th>YEAR</th>
<th>AGRICULTURE</th>
<th>DOMESTIC</th>
<th>TOTAL</th>
<th>SOURCE</th>
<th>SAFE YIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg.</td>
<td>Max.</td>
<td>Day</td>
<td>Avg.</td>
<td>Max.</td>
</tr>
<tr>
<td>1977</td>
<td>.704</td>
<td>1.06</td>
<td>.195</td>
<td>.292</td>
<td>1.352</td>
</tr>
<tr>
<td>1978</td>
<td>.933</td>
<td>1.39</td>
<td>.263</td>
<td>.394</td>
<td>1.784</td>
</tr>
<tr>
<td>1979</td>
<td>.811</td>
<td>1.21</td>
<td>.228</td>
<td>.343</td>
<td>1.553</td>
</tr>
<tr>
<td>1980</td>
<td>.809</td>
<td>1.21</td>
<td>.228</td>
<td>.342</td>
<td>1.55</td>
</tr>
<tr>
<td>1981</td>
<td>.850</td>
<td>1.275</td>
<td>.239</td>
<td>.359</td>
<td>1.634</td>
</tr>
<tr>
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<td>.871</td>
<td>1.306</td>
<td>.251</td>
<td>.377</td>
<td>1.683</td>
</tr>
<tr>
<td>1983</td>
<td>.936</td>
<td>1.404</td>
<td>.263</td>
<td>.395</td>
<td>1.799</td>
</tr>
<tr>
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<td>.983</td>
<td>1.475</td>
<td>.277</td>
<td>.415</td>
<td>1.89</td>
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<tr>
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<td>1.032</td>
<td>1.548</td>
<td>.367</td>
<td>.55</td>
<td>2.098</td>
</tr>
<tr>
<td>1990</td>
<td>1.317</td>
<td>1.976</td>
<td>.371</td>
<td>.55</td>
<td>2.526</td>
</tr>
<tr>
<td>1995</td>
<td>1.681</td>
<td>2.522</td>
<td>.474</td>
<td>.71</td>
<td>3.232</td>
</tr>
<tr>
<td>2000</td>
<td>2.146</td>
<td>3.2</td>
<td>.604</td>
<td>.906</td>
<td>4.106</td>
</tr>
</tbody>
</table>

1. Estimates from Table D-11A
2. Assume growth of 5% (compound) in domestic consumption using 1980 as base year
3. Assume 5% growth (compound) in Ag consumption using 1980 as base year
<table>
<thead>
<tr>
<th>YEAR</th>
<th>4%</th>
<th>5%</th>
<th>6%</th>
<th>7%</th>
<th>8%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>Dry</td>
<td>2.19</td>
<td>3.2</td>
<td>2.33</td>
<td>3.35</td>
<td>2.57</td>
</tr>
<tr>
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<td>Dry</td>
<td>2.28</td>
<td>3.42</td>
<td>3.22</td>
<td>3.1</td>
<td>3.7</td>
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<tr>
<td>1980</td>
<td>Dry</td>
<td>2.37</td>
<td>3.55</td>
<td>2.42</td>
<td>3.63</td>
<td>2.53</td>
</tr>
<tr>
<td>1981</td>
<td>Dry</td>
<td>2.42</td>
<td>3.63</td>
<td>2.56</td>
<td>3.47</td>
<td>2.64</td>
</tr>
<tr>
<td>Wet</td>
<td>1.99</td>
<td>3.0</td>
<td>2.98</td>
<td>3.07</td>
<td>2.03</td>
<td>3.05</td>
</tr>
<tr>
<td>1982</td>
<td>Dry</td>
<td>2.56</td>
<td>3.75</td>
<td>2.69</td>
<td>3.49</td>
<td>2.82</td>
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<tr>
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<td>3.11</td>
<td>2.16</td>
<td>3.46</td>
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</tr>
<tr>
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<td>4.24</td>
<td>2.93</td>
</tr>
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<td>2.39</td>
<td>3.86</td>
<td>2.26</td>
<td>3.33</td>
</tr>
<tr>
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<td>2.96</td>
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</tr>
<tr>
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<td>3.63</td>
</tr>
<tr>
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<td>Dry</td>
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<td>3.11</td>
<td>4.78</td>
<td>3.62</td>
</tr>
<tr>
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<td>3.52</td>
<td>2.46</td>
<td>5.6</td>
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</tr>
<tr>
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<td>Dry</td>
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<td>5.29</td>
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<td>5.96</td>
<td>4.57</td>
</tr>
<tr>
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<td>4.71</td>
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<td>4.75</td>
</tr>
<tr>
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<td>5.18</td>
<td>3.91</td>
<td>5.95</td>
<td>4.64</td>
<td>6.92</td>
</tr>
</tbody>
</table>

Per centages are compound.

1. Dry year 1973, base 2.11 KG
2. Wet year 1980, base 1.92 KG

"AD" - Average Day
"ND" - Max. Day (AD x 1.5)

**Note:** The figures are based on water sales and do not reflect 10% loss within the system. Therefore, the max. day could be 10% higher.
UPPER KULA WATER SYSTEM
ESTIMATES & PROJECTIONS

FIGURE D-6A

MILLION GALLONS

SYSTEM 1.7
SAFE YIELD 1.5

SOURCE 0.9
SAFE YIELD 0.5


TOTAL SYSTEM REQUIREMENT
TOTAL MAXIMUM DAY
DOMESTIC MAXIMUM DAY
DOMESTIC AVERAGE DAY
AGRICULTURE MAXIMUM DAY
AGRICULTURE AVERAGE DAY

D-32
<table>
<thead>
<tr>
<th>YEAR</th>
<th>TULLE Lenkau</th>
<th>Kedama</th>
<th>Gayaba</th>
<th>Buli-Paowea</th>
<th>Nahompo</th>
<th>Pokolai</th>
<th>Milinga</th>
<th>Pala</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967</td>
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<td>247</td>
<td>111</td>
<td>2,274</td>
<td>263</td>
<td>2,274</td>
<td>808</td>
<td>146</td>
</tr>
<tr>
<td>1968</td>
<td>1,447</td>
<td>252</td>
<td>113</td>
<td>2,281</td>
<td>263</td>
<td>2,281</td>
<td>856</td>
<td>150</td>
</tr>
<tr>
<td>1969</td>
<td>1,447</td>
<td>256</td>
<td>114</td>
<td>2,284</td>
<td>268</td>
<td>2,284</td>
<td>924</td>
<td>160</td>
</tr>
<tr>
<td>1970</td>
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<td>257</td>
<td>119</td>
<td>2,315</td>
<td>265</td>
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<td>991</td>
<td>164</td>
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<td>193</td>
<td>2,338</td>
<td>277</td>
<td>2,338</td>
<td>1,097</td>
<td>170</td>
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<td>1972</td>
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<td>277</td>
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<td>1973</td>
<td>1,447</td>
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<td>2,400</td>
<td>1,260</td>
<td>176</td>
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<td>278</td>
<td>2,400</td>
<td>1,259</td>
<td>176</td>
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<td>278</td>
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</tr>
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<td>1977</td>
<td>1,447</td>
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<td>310</td>
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<td>2,400</td>
<td>278</td>
<td>2,400</td>
<td>1,259</td>
<td>176</td>
</tr>
<tr>
<td>Year</td>
<td>No. of Meters</td>
<td>Change in Change</td>
<td>Consumption (MG)</td>
<td>% Annual Change</td>
<td>% Average Day (MGD)</td>
<td>% Max. Day (MGD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>--------------</td>
<td>------------------</td>
<td>------------------</td>
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<td>--------------------</td>
<td>-----------------</td>
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<tr>
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<td>(5.0)</td>
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<td>(0.04)</td>
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<td>(1.23)</td>
<td>(1.19)</td>
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<td>47.05</td>
<td>0.13</td>
<td>0.19</td>
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</table>

1: Subareas combined
( ) Decrease

D-38
2000 are found in Table D-12C and are graphed in Figure D-8.

E. **Summary**

The projected water requirements for the Makawao District Water Service Area (Kula and Makawao service areas) from 1981 to the year 2000 are presented in Table D-13. The projections have been broken into wet and dry conditions and include a 10% factor for water loss within the system.
### TABLE D-12C

MARAWAO SUB-AREA
TOTAL WATER CONSUMPTION AND PROJECTIONS
(IN MILLION GALLONS)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>AD</th>
<th>MD</th>
<th>+10% ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>19801</td>
<td>1.361</td>
<td>2.04</td>
<td>2.244</td>
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<tr>
<td>1981</td>
<td>1.469</td>
<td>2.204</td>
<td>2.424</td>
</tr>
<tr>
<td>1982</td>
<td>1.587</td>
<td>2.381</td>
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<td>1983</td>
<td>1.714</td>
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<tr>
<td>1984</td>
<td>1.851</td>
<td>2.777</td>
<td>3.055</td>
</tr>
<tr>
<td>1985</td>
<td>1.999</td>
<td>2.998</td>
<td>3.297</td>
</tr>
<tr>
<td>1990</td>
<td>2.938</td>
<td>4.407</td>
<td>4.847</td>
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</tbody>
</table>

1 Base Year 1980 used 1.36 MG
2 10% added to max. day for water loss

AD – Average Day
MD – Max. Day (AD x 1.5)
Assume 8% compound growth

**NOTE:** AD and MD consumption data from 1967-1980 from Table D-12B
MAKAWAO SYSTEM $\%$ PROJECTIONS

FIGURE D-8

D-41
### Table D-13: Projected Water Requirements - Makawao Water District

<table>
<thead>
<tr>
<th>YEAR</th>
<th>RULA % PROJECTION</th>
<th>MAXAWAO % PROJECTION</th>
<th>TOTAL REQUIRED YIELD</th>
<th>SOURCE</th>
<th>WATER REMAINING</th>
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<tbody>
<tr>
<td>Net</td>
<td>2,016</td>
<td>3,024</td>
<td>5,039</td>
<td>2,204</td>
<td>2,424</td>
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<tr>
<td>Dry</td>
<td>2,564</td>
<td>2,647</td>
<td>5,211</td>
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<td>Net</td>
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<td>5,310</td>
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<td>2,619</td>
</tr>
<tr>
<td>Dry</td>
<td>2,692</td>
<td>4,039</td>
<td>6,641</td>
<td>2,800</td>
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<tr>
<td>Net</td>
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<td>2,571</td>
<td>2,872</td>
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<tr>
<td>Dry</td>
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<td>4,641</td>
<td>6,668</td>
<td>2,949</td>
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<td>Net</td>
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<td>3,500</td>
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<td>Dry</td>
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<tr>
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<td>7,616</td>
<td>12,693</td>
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<tr>
<td>2000</td>
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<td>7,677</td>
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<tr>
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<td>6,480</td>
<td>9,721</td>
<td>16,201</td>
<td>6,480</td>
<td>9,721</td>
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1 Combined Upper and Lower Rula 4.3 MGD source safe yield during wet conditions. Combined Upper and Lower Rula 6.4 MGD source safe yield during dry conditions. Assume source from Wailoa Ditch to be 16 MGD; however, the ditch flows may vary during dry conditions. The 16 MGD is added to the Rula system source safe yield for dry and wet conditions.

2 Projected amount of water remaining under wet and dry conditions.

3 Projected amount of water required to be pumped from Makawao system to meet Rula demand during dry conditions. Assume source flows of about .6 MGD for the Rula area during dry conditions.
APPENDIX E

WATER TREATMENT PLANT DESIGN
APPENDIX E
WATER TREATMENT PLANT DESIGN

I. GENERAL

Source, treatment and distribution facilities are the main components of a water system. The treatment plant's major function is to improve water quality. The source and distribution facilities are also important and must be evaluated as factors affecting overall water quality.

The standards established for water quality have been previously discussed in Appendix C. The design of a treatment plant must consider the quality of the water source and the processes required to bring the water into conformance with established water quality standards.

A. Water Source Supply Quality

The type of treatment will depend on the quality of the water source and existing water quality standards. Generally, the quality of the water source will not change dramatically, except for the normal seasonal changes, if the surrounding watershed and/or basin is not altered by man. The two general categories of water sources are: ground water sources (wells, shafts) and surface water sources (rivers, streams, dams). The latter is the case for this report. Each water source has its peculiarities and characteristics; for example, ground water sources generally are uniform in quality, contain higher
concentrations of dissolved substances and are free of turbidity and color. On the other hand, surface water sources generally are variable in quality, contain lower concentrations of minerals, are highly colored and turbid, and contain odor and taste substances.

B. Selection of Treatment Process

Various types and combinations of treatment units are generally required to achieve the desired water quality. The selection of a particular type and/or combination of treatment units requires laboratory and pilot testing. Operation and maintenance costs must also be considered in the final selection of the unit process. The various unit processes available are briefly discussed in the following section. The material presented has been extracted from "State of the Art of Small Water Treatment System," USEPA (August, 1977) and "Water Treatment Plant Design," ASCE-AWWA-CSSE (1969). The processes described may not remain those of choice; the state of art changes and new methods are being developed.

II. UNIT PROCESSES

A. Aeration

1. General

Aeration is a process by which water and air are brought into contact with each other to
transfer volatile substances to and from water. Volatile substances include, but are not limited to, oxygen, carbon dioxide, nitrogen, hydrogen sulfide, methane, and unidentified organic substances responsible for odor and taste problems.

Aeration may be used to reduce the concentration of taste- and odor-producing substances, such as hydrogen sulfide and certain volatile organic compounds, by adding oxygen to water for the oxidation of these compounds.

The decision to use aeration depends on the water source quality and economic considerations.

a. **Surface Water**

Surface waters usually exhibit low concentrations of carbon dioxide, high oxygen concentration and no hydrogen sulfide; aeration is not required for the removal or addition of these gases. Also, surface waters in many cases contain volatile organic substances causing odor and taste problems which can be reduced by adding oxygen by aeration. In many instances the aeration process has not been effective because of the low volatility of the taste and odor compounds.
b. **Ground Water**

Ground water may contain high concentrations of carbon dioxide, methane, hydrogen sulfide, iron and manganese. Aeration has been found effective in removal of methane, hydrogen sulfide (concentrations of 1.0 – 2.0 mg/l) and carbon dioxide removal. The addition of oxygen by aeration is also desirable for iron and manganese removal.

2. **Aeration Methods**

Three methods of aeration used in small water systems are gravity, mechanical draft, and diffused aeration.

a. **Gravity Aeration or Water Fall Aerators**

Various types are available, including water fall aerators, spray nozzles, cascades and multiple tray. Common to all types is that aeration is accomplished by causing the water to break into drops or the formation of a thin film, thereby increasing the area of water exposed per unit volume.

b. **Mechanical Aerators**

Mechanical aerators use motor-driven impellers, alone or in combination with
air injection devices, to add oxygen to the water. For small treatment plants, a tower through which water droplets fall and air ascends in countercurrent flow can be used. The tower can be made of a series of trays with wire mesh, slats, or perforated bottoms over which water is distributed. Coke, stone or ceramic balls 5 to 15 cm (2 to 6 inches) in diameter are placed on the trays to increase efficiency by increasing the surface area. The use of coarse material has been effective in removal of iron and manganese, the coarse media functioning as a catalyst for the precipitation of the oxides of iron and manganese.

c. Diffused Aerators

Diffusion aerators are similar to mechanical aerators, as both produce bubbles of air in the water by air injection devices. Generally the aeration units are rectangular basins with diffuser equipment located near the bottom. The diffuser equipment consists of orifices or nozzles in air piping, with diffuser plates or tubes through which compressed air is forced into the water. Basins are 9 to 15 feet (2.7 to
4.6 m) deep and 10 to 30 feet (3.1 to 9.2 m) wide, with ratios of width to depth not to exceed 2:1 for proper mixing. The length of the rectangular basin is determined by the desired retention period, generally 10 to 30 minutes. The amount of air required depends on the purpose of aeration and ranges from 0.01 to 0.15 ft³ (0.075 to 1.12 m³) of air per gallon of water treated.

B. Oxidation

Oxidation is used in water treatment to remove and/or destroy undesirable tastes and odors, to aid in the removal of iron and manganese, and to improve clarification and color removal. The most frequently used oxidizing agents are chlorine, oxygen and potassium permanganate.

1. Oxygen

Aeration adds oxygen to water for the oxidation of iron and manganese. Precipitation of 1 mg/l of iron requires 0.14 mg/l of oxygen, and 0.24 mg/l of oxygen is required for the precipitation of 1 mg/l of manganese.

2. Chemical Agents

Commonly used oxidizing chemicals are chlorine, chlorine dioxide, ozone and potassium permanganate. Chlorine and potassium permanganate
are frequently used because of cost and availability, while ozone and chlorine dioxide must be generated on-site and are relatively expensive.

Chemical agents are stronger oxidizing agents than air and are, therefore, more effective. The choice of oxidizing agent depends on availability, cost considerations, and benefits.

Chlorine, chlorine dioxide, and potassium permanganate destroy taste- and odor-producing compounds and oxidize soluble iron and manganese to insoluble oxides which can be removed by coagulation, sedimentation, and filtration. However, the efficiency of an oxidizing agent depends on the concentration, pH, and other factors.

a. Chlorine

Chlorine is effective for iron oxidation but requires longer contact time for the oxidation of manganese, when compared to potassium permanganate at levels greater than 0.2 mg/l. Theoretical amounts of chlorine required for the oxidation of iron and manganese are 0.6 mg/l per 1.0 mg/l of iron and 1.3 mg/l per 1.0 mg/l of manganese.
b. **Potassium Permanganate**

This oxidizing agent's reaction is faster and not as pH-dependent as chlorine. Theoretical amounts of potassium permanganate required to oxidize 1.0 mg/l of iron and manganese are 0.94 mg/l and 1.92 mg/l, respectively.

C. **Adsorption**

Adsorption is the attraction and accumulation of one substance on the surface of another. This process is used for the removal of fluoride, arsenic, and organic pollutants. Two adsorptive media commonly used are activated alumina and activated carbon.

1. **Activated Alumina**

This compound is a highly porous and granular form of aluminum oxide, and is used for the removal of arsenic and fluoride. The removal of these two compounds is by a combination of adsorption and ion exchange. Since the removal of arsenic and fluoride is not a problem, no further discussion is warranted.

2. **Activated Carbon**

Activated carbon has been used in water treatment plants for numerous years and is effective as an adsorbing agent because of the large surface area-to-mass ratio. It has been
used for the removal of hydrocarbons, odor and color, and for control of taste. Two types of activated carbon are used in water treatment, powdered and granular. The former is used for taste and odor control and the latter for removal of organics (including mercury).

D. Clarification

The individual processes which make up clarification are coagulation, rapid mixing, flocculation and sedimentation. Substances creating color and turbidity in water can be removed by clarification. Raw water, especially surface water, often contains suspended substances, creating turbidity problems.

The suspended substances include mineral and organic matter and microorganisms ranging in size from 0.001 to one micrometer (the size of colloidal particles). The larger particles (sand, silt, etc.) readily settle out of water during the sedimentation process and do not require the use of chemical coagulation. The size of the particle, particularly the ratio of particle surface-area-to-mass, is an important characteristic. Large particles have a low surface-area-to-mass ratio and, therefore, sedimentation by gravity occurs. Particles in the colloidal range have a large surface-area-to-mass ratio and are influenced by the surface electrical charge, thus
gravity sedimentation will not remove these particles. Both coagulation and flocculation unit processes are needed to remove small particles. The objective of coagulation and flocculation is to form an envelopment of suspended particles within the floc particles, which then can be removed by sedimentation and/or filtration. Coagulation is the precursor of flocculation. The individual unit processes are discussed below.

1. Coagulation

In coagulation, colloidal particles are driven together by chemical forces. This process is rapid and occurs within seconds of the application of the coagulating chemical to the water. The process by which coagulation occurs is a reduction in the force of surface electrical charges which keep suspended colloidal particles apart. The reduction of the repulsive forces allows the colloidal particles to join together to form larger particles. These larger particles are able to form a floc, which can then be settled out.

Coagulation is influenced by physical and chemical forces, including electrical charge on particles, exchange capacity, particle size and concentration, pH, water temperature, and electrolyte concentrations.
The addition of salts of trivalent aluminum, iron or a synthetic polyelectrolyte coagulant to water containing colloidal particles, causes a series of reactions resulting in the reduction of the electrical charges on the particle, with the formation of flocs. The coagulation reaction is influenced by the physical and chemical factors of the raw water, as previously discussed, and these factors must be evaluated prior to the selection of the specific coagulation and/or unit process.

The most frequently used coagulant is aluminum sulfate \([\text{Al}_2(\text{SO}_4)_3 \cdot 14.3\text{H}_2\text{O}]\), averaging about 17% \(\text{Al}_2\text{O}_3\). Other coagulating compounds used are potash, alum and sodium aluminate. Iron salts (ferric sulfate, ferrous sulfate, chlorinated ferrous sulfate, and ferric chloride) are also used as coagulants. In some cases, coagulation can be improved by the use of activated silica, bentonite clays, and polyelectrolytes. Also, pH of 6.0 to 7.8 is optimum for coagulation using aluminum salts, or a slightly broader pH for iron salts.

2. **Rapid Mix**

Rapid mix is a unit process important to induce coagulation and flocculation; this process
rapidly mixes the chemicals and water and uniformly distributes the chemicals throughout the water. Since the reaction of the chemicals with the particles occurs quickly, propellers or impellers are used to create turbulence within the water column, thereby causing uniform mixing.

Design parameters for the rapid mix chamber require 20 seconds to 2 minutes contact time, and mixing units need 0.3 to 0.6 W per m³/day (1 to 2 hp ft³/second). A useful parameter is the power input into the water (measured by velocity gradient G). G values of 500 sec⁻¹ to 1,000 sec⁻¹ and detention times of about 2 minutes have been successful.

3. Flocculation

After the coagulant has been introduced and diffused, the minute particles are brought into contact with each other, resulting in greater density and an increase in size. The primary force of attraction is the Vander Waals force. The likelihood of collisions between particles is enhanced by slow mechanical mixing or agitation of the water.

The completeness of the process depends on the character of the water and the value of GT. The value of the velocity gradient G is useful
in estimating the effectiveness of mechanical agitation in the flocculation basins. The optimal range in values is between approximately 20 sec⁻¹ and 70 sec⁻¹. When the velocity gradient (G) is multiplied by the detention time in seconds, another parameter GT is obtained. The range of GT is approximately 30,000 – 150,000. Retention time for best flocculation is between 20 to 60 minutes. Laboratory and plant trials are required to established G and T values.

4. Sedimentation

After coagulation and flocculation, the water must pass through a relatively large basin at a low velocity to allow the floc particles to settle out. This process is commonly called "sedimentation" or "clarification." Sedimentation is one of the most widely used processes in water treatment, next to chlorination. The efficiency of sedimentation depends on numerous factors and variables which have not yet been satisfactorily formulated mathematically to be useful for design.

Sedimentation generally is used in two ways, plain sedimentation and sedimentation following coagulation and flocculation. Plain sedimentation is used to remove settleable solids occurring
naturally in surface water, which are settled without treatment. This is a useful preliminary process for water containing heavy sediment loads.

Sedimentation following chemical coagulation and flocculation is used to remove the settleable solids.

The effectiveness of the sedimentation tank depends on the settling characteristics of the suspended solids and on the hydraulic characteristics of the settling tank.

The hydraulic characteristics of the settling tank depend on both the geometry and the flow through the tank. The most commonly used tank(s) for sedimentation are the horizontal-flow type, either rectangular or circular in shape.

In either shape, the design objective is to obtain the condition of ideal flow through the basin. The ideal flow for a rectangular basin requires that all of the water entering at one end of the basin should flow in parallel paths of equal velocity to the effluent end of the basin. In reality, this condition cannot be achieved because of differential friction drag and irregular tank currents.
The ideal flow for a circular basin occurs when the centrally fed water moves in radial paths of equal velocity to the outlet channel of the basin. In reality, this condition cannot be achieved because the flow from the center is not perfectly radial, but has definite vertical velocity components, downward at the distribution well and changing upward near the periphery.

The choice of type, rectangular or circular, is usually based on personal preference. However, laboratory testing is required prior to establishing the design criteria, and experience over the years has demonstrated that a minimum of two sedimentation basins is preferred.

General design criteria for rectangular basins vary in width from 5 to 24 feet (1.5 to 7.3 m) with an approximate width-to-length ratio of 1:4. The basin depths range from 7 to 16 feet (2.1 to 4.9 m). The basins should be sized to provide an average detention time of 2 to 6 hours, or 8 to 12 hours for treatment of highly turbid waters.

An important parameter in sizing the basins is the "overflow rate", the flow rate divided by the surface area of the basin and expressed
in terms of gpd/ft² or m³/m² day. The
theory is that if the settling velocity of a
particle is greater than the overflow rate of
the basin, the particle will settle out of the
water before the water leaves the basin. Labor-
atory testing is required to determine the para-
eters and variations which affect settling
and is used to determine the size and overflow
rate of the basins.

E. Filtration

Filtration of water is a physical and chemical
process for separating suspended and colloidal par-
ticles from water by passage through a porous medium,
generally a bed of sand or other granular material
such as coal. As the water passes through the medium,
the suspended and colloidal particles are deposited
in the interstices between the grains of the medium
or the medium itself.

A number of mechanisms are involved in particle
removal by filtration. Some of these mechanisms are
physical and others are chemical. The effects of both
actions must be considered together to fully explain
the overall action of filtration. These actions in-
clude adsorption, flocculation, sedimentation and
straining. Adsorption of the particles to the surface
of the filter grains is dependent upon the physical characteristics of the suspended filter which are functions of the filter grain size, the floc size, the adhesive characteristics of the floc, and the shearing strength of the floc. Adsorption is also affected by the chemical characteristics of the suspended particles, the aqueous suspension medium, and the filter medium. Two important chemical characteristics are the electro-chemical and Vander Waals forces.

Effective filtration requires the pretreatment of water to remove the floc particles that are small enough to penetrate the filter bed. The suspended particles removed during filtration range in diameter from about 0.001 to 50 micrometers and larger.

1. Types of Filters

Water filters are classified in various ways. Hydraulically, they may be classified as slow or rapid, depending upon the rate of flow per unit of surface area. Slow filters operate at rates of 1 to 10 mgd per acre, and rapid filters operate at rates of 1 to 8 gpm per square foot.

Filters are also classified according to the type of filter media used, such as sand,
coal (or anthracite), coal-sand, multi-layered, mixed bed, or diatomaceous earth. They may be described according to the direction of flow through the bed, downflow, upflow, biflow, fine-to-coarse or coarse-to-fine. Another distinction is between pressure and gravity (or free surface) filters.

Since the water industry has made considerable progress in filter design and filtration procedures, the filters may be divided into conventional and recent developments. Conventional types include slow sand, rapid gravity and pressure filters (sand or anthracite media). Recent developments include rapid gravity and pressure units with coal-sand, multi-layer or mixed-bed media.

The following is a brief description of the types of filters and media currently used:

a. Gravity Filters

This type of filter is a free surface filter using gravity flow conditions for filtering the water. This type of filter is characterized by downflow operation followed by an upflow washing of the filter media to remove the filtered particles collected on the media.
The vast majority of present day water treatment plants use the gravity rapid sand filter. It is the standard of the water industry. The conventional gravity rapid sand filter is normally a single-media, downflow, fine-to-coarse filter. However, new plants will utilize gravity rapid filters with coarse-to-fine media and utilize mix media beds.

b. Pressure Filters

Pressure filters are similar in filter bed construction to a typical gravity filter. However, in a pressure filter, the entire filter apparatus, including the media layer, gravel bed and underdrains, is enclosed in a steel shell. The advantage of the pressure filter is that pressure in the water lines leading to the filter is not lost and can be used to maintain pressure within the distribution system.

The disadvantages include potential loss or disruption of the media during backwash operations which cannot be visually observed. The inability to see the filter media and the possibility of media bed
disruption have, in the past, limited the municipal application of pressure filters to treatment of relatively unpolluted waters and many State health departments have restricted use of pressure filters to the treatment of well waters for the removal of hardness, iron or manganese.

c. Diatomite Filters

Under certain conditions, diatomite filters may be used for municipal purposes. Generally, for small cities where the overriding consideration is low capital cost and where relatively good raw-water conditions permit successful operations.

This type of filter, usually operated under pressure, consists of a layer of diatomaceous earth supported by a septum or filter element. The layer of diatomaceous (1/8-in. or 3.2 mm thick) must be maintained during the filtration process by a constant feed of the diatomite filter medium to the influent unfiltered water. At the conclusion of the filter run, the layer of diatomaceous earth will have increased in thickness from 1/8-inch (3.2

E-20
mm) to about 1/2-inch (13 mm). The primary difficulty in using this filter is in maintaining the diatomaceous earth film of uniform permeability and filtering capability.

2. Media
   a. Single Media

Single media filters employ only one type of filtering medium as opposed to dual and mixed media filters. The types of single media filters include rapid sand, slow sand and anthracite.

(1) Rapid Sand Filters

The rate of operation is approximately 2 to 4 gpm/ft² (120 to 240 m³/m²/day). Generally, for surface waters, the standard is 2 gpm/ft² (120 m³/m²/day). Higher rates require that pretreatment processes (coagulation, flocculation, and sedimentation) are functioning properly.

The filter medium, silica sand, is supported on a gravel bed located over an underdrain collection system. The silica sand is usually 25 to 30 inches (64 to 76 cm) thick and the
gravel bed 12 to 18 inches (30 to 46 cm). The head loss is about 1 ft. (0.3 m) and backwashed when head loss reaches 8 ft. (2.4 m).

The selection of the sand and gravel size will depend on design of the filtering units.

(2) Slow Sand Filters

Slow sand filters have a similar configuration to rapid sand filters, with a bed of sand supported by a layer of gravel. The filtration rate ranges from 0.05 to 0.10 gpm/ft² (2.9 to 5.9 m³/m²/day). The low filtration rate requires large structures and land area, and for this reason slow sand filters are not currently used.

(3) Anthracite Filters

Anthracite coal is used in single media filters. The coal has a lower specific gravity than sand and has greater bed porosity for a given effective size.

(4) Activated Carbon Filters

Granular activated carbon can be placed over the filter medium for
removal of taste- and odor-causing organisms.

b. Dual Media

This type of filter uses two types of filtering media, usually arranged in a coarse-to-fine configuration, the former on the top. The most common type of dual media combination is the anthracite-coal-sand. Typically, the profile consists of a coarse layer of coal 18 inches (46 cm) deep, followed by a fine layer of sand 8 inches (20 cm) deep. Flow rates are about 4 gpm/ft² (240 m³/m²/day), which is higher than a single media rapid sand filter (2 to 4 gpm/ft²).

c. Mixed Media

Mixed media filters employ more than two types of filtering media, arranged in a coarse-to-fine configuration. Typically, the mixed media bed consists of three layers: coal (SG 1.4) on top, followed by sand (SG 2.65) in the middle, and garnet (SG 4.2) on the bottom. The volumes used are coal (60%), sand (30%), and garnet (10%). The vast surface area of the filtering
media increases the length of filter runs and, since the total surface area of the grain is greater than single or dual media beds, the mixed media bed is more resistant to breakthrough and more tolerant to surges in flow rate.

2. **Backwashing Facilities**

Filter backwashing is essential for the removal of the material filtered from the water. Backwash water from a clean source is applied to the underside of the filterbed through the underdrains and designed to provide a uniform application of water through the filter media. The backwash water containing the filtered particles is then carried away in wash water troughs located above the surface of the filter medium. Also, in addition to the backwash facilities, filters can be equipped with surface wash facilities which are turned on one minute before and after backwashing. The surface wash facilities can be either rotary washers or fixed jets.

3. **Filtration Aids**

The addition of a filtering aid, such as a polyelectrolyte, to the settled water prior
to its passage through the filter improves the filtrability of the water and permits a higher filtration rate. The use of a polyelectrolyte is usually warranted only for a coarse-to-fine filter (dual or mixed media filters) and not for conventional fine-to-coarse rapid sand filters which can be clogged by the addition of polyelectrolytes.

E. Disinfection

Disinfection is a unit process which involves the destruction or deactivation of objectionable organisms. These organisms may be objectionable from the standpoint of either health or aesthetics. These organisms consist of certain classes of bacteria, viruses, protozoa, and small invertebrates.

Disinfection can be accomplished in several ways. Excluding water treatment processes such as sedimentation, coagulation and filtration, that result in the partial removal of organisms, the specific water disinfection processes include the use of one or a combination of the following: (1) physical treatment such as storage or the application of heat or other physical agents; (2) ultraviolet irradiation; (3) metal ions, Cu and Ag; and (4) oxidants, halogens, ozone and other inorganic or organic materials.
Except for chlorine and some of its compounds, most of the above-mentioned have one or more serious limitations that preclude their general acceptance in the United States for municipal potable water treatment operations. Chlorination, including the use of chlorine dioxide and ozonation, is the most frequently used method of disinfection for potable water treatment.

Chlorine is applied to water in one of three forms: as elemental chlorine, as hypochlorite salts, or as chlorine dioxide. The efficiency of chlorine for disinfection is affected by the following:
- kind and concentration of disinfectant
- contact time provided
- chemical character and temperature of the water
- kind and concentration of organisms to be destroyed

The application of chlorine or its compound to a particular water must be tailored to the circumstances that exist at any given time. For example, hypochlorite chlorine is used for small treatment plants, elemental chlorine is commonly used in municipal plants, and chlorine dioxide by facilities concerned with the reduction of manganese or for the control of very difficult taste and odor problems.

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Other factors being constant, the effectiveness of chlorine is proportional to the concentration (chlorine becomes more dilute as it is used up) and reaction time (becomes lower with lessened contact time). Thus, the concentration and reaction time are inter-dependent; with a longer contact time, less chlorine is required; with less contact time, a higher chlorine dose required.

Also, the reaction of chlorine in water must be considered in evaluating this disinfectant. When elemental chlorine is added to water, it forms hypochlorous acid (HOCl) and hydrochloric acid (HCl).

\[ \text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HOCl} + \text{H}^+ + \text{Cl}^- \]

The reaction generally displaces to the right and very little Cl\(_2\) remains in solution; the hypochlorous acid (HOCl) dissociates into hydrogen and hypochlorite ions.

\[ \text{HOCl} \rightarrow \text{H}^+ + \text{OCl}^- \]

The degree of ionization is dependent on the pH of the water. At pH 6.5, approximately 90% of the hypochlorous acid is not dissociated. At pH 8.5 about 90% of the hypochlorous acid dissociates to hydrogen and hypochlorite ions. Between pH 6.5 and 8.5 chlorine will exist as hypochlorous acid and
hypochlorite ions. These two forms existing in water as termed "free available chlorine." Free available HOCl and OCl⁻ forms of chlorine are not equally germicidal, HOCl being superior because of its strong and oxidizing power, and its small molecular size and electrical neutrality which allow it to penetrate cells readily. The increase of H⁺ with the addition of chlorine may cause pH adjustment to be required.

Since chlorine is an oxidant, organic matter and other oxidizable material in water deplete the amount of chlorine and lessen its effectiveness as a disinfectant. It is, therefore, important to remove these substances to increase the disinfective effectiveness of elemental chlorine.

Chlorine reacts with ammonia in water. The hypochlorous acid (HOCl) reacts with nitrogen to form various inorganic chloramines - principally monochloramine (NH₂Cl), dichloramine (NHCl₂) and under certain conditions trichloramine (NHCl₃). The relative amounts of the different chloramines formed are dependent on pH, time, temperature and the quantity of chlorine and ammonia initially present. The formation of chloramines greatly reduces the reactivity of the chlorine and requires longer detention time. Most organic chloramines have little or no germicidal capacity.
Chlorine also reacts with other substances; typical inorganic reducing agents such as hydrogen sulfide, ferrous iron and divalent manganese are rapidly oxidized. The oxidation of nitrates to nitrates by chlorine as well as oxidation, substitution and addition of organic substances, can result in the formation of numerous chloro-organic compounds. Some of these such as chlorophenol cause objectionable taste when present in trace amounts. Also, the formation of trihalomethanes is possible.

For these reasons, it is recommended that chlorine be added only after processes which will reduce the organic concentrations of the water and thereby decrease the probability of trihalomethane formation.

F. Stabilization

Water leaving the treatment plant and entering the distribution system should be stable — neither scale-forming nor aggressive for the temperature experienced in the distribution system. Two ways of stabilizing water are adjustments to pH and addition of polyphosphate or silicates.

1. pH Adjustment

Water is considered to be stable when it is at the point of calcium carbonate saturation equilibrium. At this point, calcium carbonate
is neither dissolved nor deposited. Raising pH causes deposition of calcium carbonate and lowering pH causes the water to become aggressive (cause leaching of cadmium, iron, lead and other substances from the pipes). There must be enough calcium ions present in solution for calcium carbonate to form, and if there are not, lime (CaO) should be added to raise the pH. In hard waters, where sufficient calcium ions are present, sodium hydroxide (NaOH) or soda ash should be added to raise the pH.

2. Polyphosphate

The addition of polyphosphate is effective for scale and corrosion control, causing a reaction with iron and other minerals in water so that positive-charged particles are formed. These particles migrate to the cathode area of the corrosion and deposit as a thin film which reduces the corrosion of the metal. Bi-metallic (zinc) polyphosphate or zinc orthophosphate is usually more effective for corrosion control than sodium polyphosphate.

3. Silicate

Sodium silicate is sometimes used for corrosion control.
G. **Taste and Odor Control**

The occasional appearance of offensive tastes and odors, especially from surface water sources, presents problems in the treatment process from the point of view of cost. Some of the treatment processes include chlorination, use of chlorine dioxide, potassium permanganate and activated carbon. Activated carbon is probably the best known and oldest treatment used for taste and odor control. The cost of treating the water must be carefully evaluated.
APPENDIX F

FLORA/FAUNA CHECKLISTS
APPENDIX P

PLORA/FAUNA CHECKLISTS

For each species, the following information is provided:

1. Family
2. Scientific name
3. Vernacular name
3. Status of the species. The following symbols are employed.
   E endemic to the Hawaiian Islands, i.e., occurring naturally nowhere else in the world.
   I indigenous, i.e., native to the Hawaiian Islands, but also occurring naturally (without the aid of man) elsewhere.
   X exotic, i.e., species of accidental or deliberate introduction after the western discovery of the islands.
   P Polynesian introduction; includes those species brought by the Polynesian immigrants previous to Captain Cook's discovery of the islands.
APPENDIX F, cont'd.

FLORA/FAUNA CHECKLISTS

Flora References


Fauna References


State of Hawaii, Department of Land and Natural Resources, Division of Fish and Game, Wildlife Branch. Annotated Checklists of the Birds and Mammals of Hawaii.
# CHECK LIST OF PLANTS
Kamole Weir Site, Maui, Hawaii.

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
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<tr>
<td><strong>MONOCOTYLEDONAE</strong></td>
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<tr>
<td>BROMELIACEAE</td>
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<tr>
<td>Ananas comosus <em>(Stickm.) Merr.</em></td>
<td>Pineapple</td>
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<td><strong>GRAMINEAE</strong></td>
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<tr>
<td>Chloris barbata Swart.</td>
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<td>Coix lacryma jobi</td>
<td>Job's tears</td>
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<td>Panicum maximum Jacq.</td>
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<td>Panicum purpurascens Ruddi</td>
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<td>Pennisetum purpurem Schumach</td>
<td>Elephant grass</td>
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<td>Rhynchospermum repens *(Wildd.) C. E. Hubbard</td>
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<td><strong>LILIACEAE</strong></td>
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<td>Ti, ki</td>
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<td><strong>DICOTYLEDONAE</strong></td>
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<td>AMARANTHACEAE</td>
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<td>Amaranthus spinosus L.</td>
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<td>Schinus terebinthifolius Ruddi</td>
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<td>Emilia sonchifolia *(L.) DC.</td>
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<td>Verbesina encelioides *(cav.) B. &amp; Wex Gray</td>
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F-3
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<td>Ricinus communis L.</td>
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<td>Indigtera suffructicosa Mill.</td>
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<td>Leucaena leucocephala (Lam.) de Wit</td>
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<td>Ulex europaeus L.</td>
<td>Gorse</td>
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<td>Abutilon mollis Sweet</td>
<td>Hairy abutilon</td>
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<td>Malvastrum coromandelianum (L.) Garde</td>
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<td>Sida fallax Walp.</td>
<td>Ilima</td>
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<td>Strachytrapheta cayennensis (L.) C. Rich</td>
<td>Cayenne vervain</td>
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</table>
GENERAL OBSERVATIONS

The predominant overstory is Christmas berry trees with common roadside weeds along the access road.

CONCLUSION

No species of flora observed during the reconnaissance are considered rare or endangered. The site has been disturbed and is surrounded by pineapple fields presently under cultivation.
CHECK LIST OF PLANTS
Piilolo Sites 1 and 2, Maui, Hawaii (TMK 2-4-13; por. 62)

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<td>Pennisetum clandestinum Hochst. ex Chiov.</td>
<td>Kikuyu grass</td>
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<td>Rattail</td>
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<td><strong>LILIACEAE</strong></td>
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<td>Acacia koa</td>
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F-6
CHECK LIST OF PLANTS, Continued
Piiholo Sites 1 and 2, Maui, Hawaii (TMK 2-4-13: por. 62)

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<td>Psidium guajava</td>
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<td>L.f. guajava</td>
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<td>ROSACEAE</td>
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<tr>
<td>Rubus rosaeolius</td>
<td>Thimbleberry</td>
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GENERAL OBSERVATIONS

This parcel includes the chosen site and one of the alternate sites. The parcel contains an overstory of ohia trees and understory of kikuyugrass and rattail grass. Throughout the pasture gorse and guava can also be found. The gulch separating the two sites contains ferns and other endemic plants, such as halapepe (Dracena aurea).

CONCLUSION

Halapepe is a fairly rare plant. A few trees are found in the pasture; however, many more are found in the gulch, which is located outside of the proposed project area. Therefore, no significant impacts are anticipated.
### CHECK LIST OF PLANTS

*Piiholo Site 3, Maui, Hawaii (Piiholo Reservoir)*

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<tr>
<td><strong>GRAMINEAE</strong></td>
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<td></td>
</tr>
<tr>
<td>Heteropogon contortus (L.) Beav.</td>
<td>Pili grass</td>
<td>X</td>
</tr>
<tr>
<td>Rhynchelytrum repens (Willd.) C. E. Hubb</td>
<td>Natal redtop</td>
<td>X</td>
</tr>
<tr>
<td><strong>LILIACEAE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cordyline terminalis (L.) Kunth</td>
<td>Ti, ki</td>
<td>P</td>
</tr>
<tr>
<td><strong>DICOTYLEDONAE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMPOSITAE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bidens pilosa L. var. pilosa</td>
<td>Spanish needle; koko-kahiki</td>
<td>X</td>
</tr>
<tr>
<td><strong>LEGUMINOSAE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leucaena leucocephala (Lam.) de Wit</td>
<td>Koa-haole</td>
<td>X</td>
</tr>
<tr>
<td>Ulex europaeus L.</td>
<td>Gorse</td>
<td>X</td>
</tr>
</tbody>
</table>

**GENERAL OBSERVATIONS**

The site has been disturbed and attempts have been made to replant the area with a eucalyptus species and pine trees. However, the trees are stunted due to poor soil conditions.

**CONCLUSION**

No species of flora observed during the reconnaissance are considered rare or endangered. The site has been disturbed.
# Check List of Plants

**Olinda Site, Maui, Hawaii**

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gymnospermae</strong></td>
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<tr>
<td><strong>Toxodaceae</strong></td>
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<tr>
<td>Cryptomeria japonica (L.F.) D. Bon</td>
<td>Japanese cedar</td>
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<tr>
<td><strong>Monocotyledonae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gramineae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pennisetum clandestinum Hochst. ex Chiov.</td>
<td>Kikuyugrass</td>
<td>X</td>
</tr>
<tr>
<td>Rhynchospora repens (Willd.) C. B. Hubb</td>
<td>Natal redtop</td>
<td>X</td>
</tr>
<tr>
<td>Sporobolus africanus (Poin) Robyns &amp; Tourney</td>
<td>Rattail</td>
<td>X</td>
</tr>
<tr>
<td>Iridaceae</td>
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<td></td>
</tr>
<tr>
<td>Gladiolus sp.</td>
<td>Gladiolus; 'ukihaole</td>
<td>X</td>
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<tr>
<td>Zingiberaceae</td>
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<td></td>
</tr>
<tr>
<td>Hedychium coronarium</td>
<td>Ginger</td>
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<tr>
<td><strong>Dicotyledonae</strong></td>
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<tr>
<td><strong>Lauraceae</strong></td>
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<tr>
<td>Persea americana Mill.</td>
<td>Avacado</td>
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<tr>
<td><strong>Leguminosae</strong></td>
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<tr>
<td>Acacia decurrens Willd.</td>
<td>Black wattle</td>
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<tr>
<td>Ulex europaeus</td>
<td>Gorse</td>
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<tr>
<td><strong>Moraceae</strong></td>
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<td>Ficus carica</td>
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<td><strong>Myrtaceae</strong></td>
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<tr>
<td>Eucalyptus sp.</td>
<td>Swamp mahogany</td>
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<tr>
<td>Eucalyptus robusta</td>
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<tr>
<td>Psidium guajava L.F. guajava</td>
<td>Guava</td>
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*F-9*
CHECK LIST OF PLANTS, Continued
Olinda Site, Maui, Hawaii

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<tr>
<td>Prunus persica (L.)</td>
<td>Peach; piki</td>
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</tr>
<tr>
<td>Rubus penetrans Bailey</td>
<td>Blackberry</td>
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</tr>
<tr>
<td>Rubus rosaeolius</td>
<td>Thimbleberry</td>
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</tbody>
</table>

GENERAL OBSERVATIONS

The site is surrounded by eucalyptus trees and the open area surrounding the reservoir is covered with kikuyu-grass and gorse.

CONCLUSIONS

No species of flora observed during the reconnaissance are considered rare or endangered. The site has been disturbed and previously used for pasture.
CHECK LIST OF FAUNA  
Kamole Weir Site, Maui, Hawaii

[Fauna observed, likely present, or which would possibly visit the site]

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
<th>STATUS</th>
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<tr>
<td>Coturnix coturnix japonica</td>
<td>Japanese quail</td>
<td>X</td>
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<tr>
<td>Phasianus colchicus torquatus</td>
<td>Ring-necked pheasant</td>
<td>X</td>
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<tr>
<td><strong>CHARADRIIDAE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pluvialis dominica fulva</td>
<td>Pacific golden plover</td>
<td>I</td>
</tr>
<tr>
<td><strong>COLUMBIDAE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streptopelia chinensis</td>
<td>Lace-necked dove</td>
<td>X</td>
</tr>
<tr>
<td>Geopelia striata</td>
<td>Barred dove</td>
<td>X</td>
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<tr>
<td><strong>ALAUDIDAE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alauda arvensis arvensis</td>
<td>European skylark</td>
<td>X</td>
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<tr>
<td><strong>MIMIDAE</strong></td>
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<tr>
<td>Mimus polyglottos</td>
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<td>X</td>
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<td><strong>STURNIDAE</strong></td>
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<td>Acridotheres tristis</td>
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<tr>
<td>Zosterops japonica</td>
<td>Japanese white-eye</td>
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<td><strong>PLOCEIDAE</strong></td>
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<tr>
<td>Estrildininae</td>
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<td></td>
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<tr>
<td>Lonchura punctulata</td>
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<td>Passerinae</td>
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<td><strong>FRINGILLIDAE</strong></td>
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<td></td>
</tr>
<tr>
<td>Carduelininae</td>
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<tr>
<td>Carpodacus mexicanus</td>
<td>House finch; linnet</td>
<td>X</td>
</tr>
<tr>
<td><strong>RICHDONENINAE</strong></td>
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</tr>
<tr>
<td>Richmondena cardinalis</td>
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CHECK LIST OF FAUNA - Continued
Kamole Weir Site, Maui, Hawaii

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<tr>
<td>Rattus norvegicus</td>
<td>Norway rat</td>
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<tr>
<td>Rattus exulans</td>
<td>Polynesian rat</td>
<td>P</td>
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<tr>
<td>Mus musculus</td>
<td>House mouse</td>
<td>X</td>
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<tr>
<td>VIVERRIDAE</td>
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<td>Herpestes auropunctatus</td>
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<tr>
<td>Rana rugosa</td>
<td>Wrinkled frog</td>
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</tbody>
</table>

*Observed during field reconnaissance: January, 1981.*
CHECK LIST OF FAUNA

Piilolo Sites 1 & 2, Maui, Hawaii (TMK 2-4-13:por. 62)

[Fauna observed, likely present, or which would possibly visit the site]

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<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
<th>STATUS</th>
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<tbody>
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<td>STRIGIDAE</td>
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<tr>
<td>* Asio flammeus sandwichensis</td>
<td>Short-eared owl: pueo</td>
<td>E</td>
</tr>
<tr>
<td>PHASIANIDAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Coturnix coturnix japonica</td>
<td>Japanese quail</td>
<td>X</td>
</tr>
<tr>
<td>* Phasianus colchicus torquatus</td>
<td>Ring-necked pheasant</td>
<td>X</td>
</tr>
<tr>
<td>CHARADRIIDAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Pluvialis dominica fulva</td>
<td>Pacific golden plover</td>
<td>I</td>
</tr>
<tr>
<td>COLUMBIDAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Streptopelia chinensis</td>
<td>Lace-necked dove</td>
<td>X</td>
</tr>
<tr>
<td>* Geopelia striata</td>
<td>Barred dove</td>
<td>X</td>
</tr>
<tr>
<td>ALAUDIDAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Alauda arvensis arvensis</td>
<td>European skylark</td>
<td>X</td>
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<tr>
<td>MIMIDAE</td>
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<tr>
<td>* Mimus polyglottos</td>
<td>Mockingbird</td>
<td>X</td>
</tr>
<tr>
<td>STURNIDAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Acridotheres tristis</td>
<td>Mynah</td>
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<td></td>
</tr>
<tr>
<td>PSITTIROSTRINAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Loxops virens wilsoni</td>
<td>Maui 'amakihi</td>
<td>E</td>
</tr>
<tr>
<td>DREBANIDINAE</td>
<td></td>
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<tr>
<td>Himatoma sanguinea</td>
<td>'Apapane</td>
<td>E</td>
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<tr>
<td>ZOSTEROPIDAE</td>
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<td></td>
</tr>
<tr>
<td>* Zosterops japonica</td>
<td>Japanese white-eye</td>
<td>X</td>
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<tr>
<td>PLOCEIDAE</td>
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<td></td>
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<tr>
<td>ESTRILDINAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Lonchura punctulata</td>
<td>Spotted munia; ricebird</td>
<td>X</td>
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<tr>
<td>PASSERINAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Passer domesticus</td>
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F-13
CHECK LIST OF FAUNA - Continued
Piilolo Sites 1 & 2, Maui, Hawaii (TMK 2-4-13;por. 62)

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<tr>
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</tr>
<tr>
<td>CARDUELINAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Carpodacus mexicanus</td>
<td></td>
<td>House finch; linnet</td>
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<tr>
<td>RICHMONDENINAE</td>
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<tr>
<td>Richmondena cardinalis</td>
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<td>Cardinal</td>
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<td><strong>CLASS MAMMALIA</strong></td>
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<td></td>
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<tr>
<td>MURIDAE</td>
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<td></td>
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<tr>
<td>Rattus norvegicus</td>
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<td>Norway rat</td>
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<tr>
<td>Rattus exulans</td>
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<td>Polynesian rat</td>
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<tr>
<td>Mus musculus</td>
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<td>Dog</td>
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<td>Felis catus</td>
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<td>Cat</td>
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<td>BOVIDAE</td>
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<tr>
<td>Bos taurus</td>
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<td>Cattle</td>
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</table>

*Observed during field reconnaissance: January, 1981.
CHECK LIST OF FAUNA
Piilolo Site 3, Maui, Hawaii (Piilolo Reservoir)
[Fauna observed, likely present, or which would possibly visit the site]

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<tr>
<td>sandwichensis</td>
<td>pueo</td>
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<td>Ring-necked pheasant</td>
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<tr>
<td>CHARADRIIDAE</td>
<td>Pacific golden plover</td>
<td>I</td>
</tr>
<tr>
<td><em>Pluvialis dominica fulva</em></td>
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<td></td>
</tr>
<tr>
<td>COLUMBIDAE</td>
<td>Lace-necked dove</td>
<td>X</td>
</tr>
<tr>
<td><strong>Streptopelia chinensis</strong></td>
<td>Barred dove</td>
<td>X</td>
</tr>
<tr>
<td><strong>Geopelia striata</strong></td>
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</tr>
<tr>
<td>ALAUDIDAE</td>
<td>European skylark</td>
<td>X</td>
</tr>
<tr>
<td><em>Alauda arvensis arvensis</em></td>
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</tr>
<tr>
<td>MIMIDAE</td>
<td>Mockingbird</td>
<td>X</td>
</tr>
<tr>
<td><em>Minus polyglottos</em></td>
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<td></td>
</tr>
<tr>
<td>DREPANIDIDAE</td>
<td>Maui 'amakihi</td>
<td>E</td>
</tr>
<tr>
<td>PSITTIROSTRINAE</td>
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<tr>
<td><em>Lorops virens wilsoni</em></td>
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<td>DREPANIDINAE</td>
<td>'Apapane</td>
<td>E</td>
</tr>
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<td><em>Himatione sanguinea</em></td>
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<tr>
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<td>Japanese white-eye</td>
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<tr>
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<td>X</td>
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<td>ESTRILDINAE</td>
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<tr>
<td><em>Lonchura punctulata</em></td>
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<td>PASSERINAE</td>
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<td>X</td>
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<tr>
<td><em>Passer domesticus</em></td>
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F-15
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<td><em>Carpodacus mexicanus</em></td>
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<td><strong>MURIDAE</strong></td>
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<td><em>Rattus norvegicus</em></td>
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<td><em>Rattus exulans</em></td>
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<td><em>Mus musculus</em></td>
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<tr>
<td><em>Herpestes auropunctatus</em></td>
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* Observed during field reconnaissance: January, 1981.
CHECK LIST OF FAUNA
Olinda Site, Maui, Hawaii

[Fauna observed, likely present, or which would possibly visit the site]

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
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<tr>
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<tr>
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</tr>
<tr>
<td>* Asio flammeus</td>
<td>Short-eared owl:</td>
<td>E</td>
</tr>
<tr>
<td>sandwichensis</td>
<td>pueo</td>
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</tr>
<tr>
<td>PHASIANIDAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Coturnix coturnix japonica</td>
<td>Japanese quail</td>
<td>X</td>
</tr>
<tr>
<td>Lophortyx californicus</td>
<td>California quail</td>
<td>X</td>
</tr>
<tr>
<td>* Phasianus colchicus torquatus</td>
<td>Ring-necked pheasant</td>
<td>X</td>
</tr>
<tr>
<td>CHARADRIIDAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Pluvialis dominica fulva</td>
<td>Pacific golden plover</td>
<td>I</td>
</tr>
<tr>
<td>COLUMBIDAE</td>
<td></td>
<td></td>
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<tr>
<td>Streptopelia chinensis</td>
<td>Lace-necked dove</td>
<td>X</td>
</tr>
<tr>
<td>Geopelia striata</td>
<td>Barred dove</td>
<td>X</td>
</tr>
<tr>
<td>ALAUDIDAE</td>
<td></td>
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</tr>
<tr>
<td>* Alauda arvensis arvensis</td>
<td>European skylark</td>
<td>X</td>
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<tr>
<td>MIMIDAE</td>
<td></td>
<td></td>
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<tr>
<td>Mimus polyglottos</td>
<td>Mockingbird</td>
<td>X</td>
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<tr>
<td>STURNIDAE</td>
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<tr>
<td>Acridotheres tristis</td>
<td>Mynah</td>
<td>X</td>
</tr>
<tr>
<td>DREPANIDIDAE</td>
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<td></td>
</tr>
<tr>
<td>PSITTIROSTRINAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Loxops virens wilsoni</td>
<td>Maui 'amakihi</td>
<td>E</td>
</tr>
<tr>
<td>Maculata newtoni</td>
<td>Maui Creeper</td>
<td>E</td>
</tr>
<tr>
<td>DREPANIDINAE</td>
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<tr>
<td>Himatione sanguinea</td>
<td>'Apapane</td>
<td>E</td>
</tr>
<tr>
<td>Vestiaria coccinea</td>
<td>'I'iwi</td>
<td>E</td>
</tr>
<tr>
<td>ZOSTEROPIDAE</td>
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</tr>
<tr>
<td>* Zosterops japonica</td>
<td>Japanese white-eye</td>
<td>X</td>
</tr>
<tr>
<td>PLOCEIDAE</td>
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<td></td>
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<tr>
<td>ESTRILLINAE</td>
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<tr>
<td>Lonchura punctulata</td>
<td>Spotted munia; ricebird</td>
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</table>

F-17
CHECK LIST OF FAUNA - Continued
Olinda Site, Maui, Hawaii

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
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<tbody>
<tr>
<td><strong>PASSEIRNAE</strong></td>
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<tr>
<td>*Passer domesticus</td>
<td>House sparrow</td>
<td>X</td>
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<tr>
<td><strong>PRINGILLIDAE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Carpodacus mexicanus</td>
<td>House finch; linnet</td>
<td>X</td>
</tr>
<tr>
<td><strong>RICHMONDENIDAE</strong></td>
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</tr>
<tr>
<td>*Richmondena cardinalis</td>
<td>Cardinal</td>
<td>X</td>
</tr>
</tbody>
</table>

| **CLASS MAMMALIA**                |                     |        |
| Rattus norvegicus                 | Norway rat          | X      |
| Rattus exulans                    | Polynesian rat       | P      |
| Mus musculus                      | House mouse         | X      |
| Herpestes auropunctatus           | Mongoose             | X      |

* Observed during field reconnaissance: January, 1981.

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APPENDIX G

ARCHAEOLOGICAL RECONNAISSANCE

Richard Bordner
APPENDIX G

ARCHAEOLOGICAL RECONNAISSANCE

On January 16-17, 1981 an archaeological reconnaissance was conducted of three proposed water treatment facility sites for the Maui County Department of Water Supply.

Kamole Weir Site

This proposed project site is located in what is presently modified pineapple fields and fill. The central area consists of two man-made hillocks, surrounded by pineapple fields. The entire area has been extensively modified, and there are no surface indications of other cultural material. It is the judgment of the present writer that, due to the lack of significant archaeological and historical materials located during this reconnaissance, this proposed project site will need no further archaeological work.

Olinda Site

This proposed project site is located above Olinda, in an area that presently contains the Olinda Reservoir and associated structures. The land surface, while heavily modified, is, in some sections, apparently undisturbed. The only feature of interest located within the study area was a frame house of shake construction, apparently
constructed in about the 1920-40 period. It is not certain whether this house pre-dates the reservoir or if it is an auxiliary to it, but is is presently abandoned and in disrepair. As the house does not appear architecturally significant, nor is it of sufficient age to warrant further historical or archaeological research, no further archaeological work is recommended for this proposed project site.

**Piiholo Sites 1 and 2**

The proposed project site and alternate site are located in apparently unmodified pasture land. No cultural material was located within the study area. On the basis of this reconnaissance, no further archaeological work is recommended for these proposed sites.

**Piiholo Site 3**

This alternate site is located in an area consisting of fill from the Piiholo Reservoir. Therefore, no materials of archaeological or historical interest were encountered there. On the basis of this reconnaissance, no further archaeological work is recommended for this site.

**CONCLUSION**

No cultural materials of significance were located within any of the potential sites. No further archaeological work is recommended for these sites.

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