Prepared in cooperation with the Office of Hawaiian Affairs, State of Hawai‘i

Water Use in Wetland Kalo Cultivation in Hawai‘i

Open-File Report 2007–1157

U.S. Department of the Interior
U.S. Geological Survey

C-108

COVER

Kalo or taro (Colocasia esculenta (L.) Schott) typically in Hawai‘i is grown in wetland patches (lo‘i) directly irrigated with water from rivers or streams. Nearly 300 forms of Hawaiian kalo have been recorded. As a food source it was so important that it was referred to simply as ‘ai, which means food in Hawaiian. Practically the entire plant is edible.

Photo by Chiu W. Yeung, U.S. Geological Survey.

Water Use in Wetland Kalo Cultivation in Hawai‘i

By Stephen B. Gingerich, Chiu W. Yeung, Tracy-Joy N. Ibarra, and John A. Engott

Prepared in cooperation with the
Office of Hawaiian Affairs, State of Hawai‘i

Open-File Report 2007–1157

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
DIRK KEMPTHORNE, Secretary

U.S. Geological Survey
Mark D. Myers, Director

U.S. Geological Survey, Reston, Virginia: 2007

For product and ordering information:
World Wide Web: http://www.usgs.gov/pubprod
Telephone: 1-888-ASK-USGS

For more information on the USGS--the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment:
World Wide Web: http://www.usgs.gov
Telephone: 1-888-ASK-USGS

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Although this report is in the public domain, permission must be secured from the individual copyright owners to reproduce any copyrighted materials contained within this report.

Suggested citation:
Gingerich, S.B., Yeung, C.W., Ibarra, T.N., and Engott, J.A., 2007, Water use in wetland kalo cultivation in Hawai‘i: U.S. Geological Survey Open-File Report 2007-1157, 68 p.

Contents

Abstract 1
Introduction 1
Site Selection 3
Acknowledgments 4
Discharge, Water-Temperature, and Area Data-Collection Methods 4
Discharge Measurements 5
Water-Temperature Measurements 5
Area Measurements 5
Discharge and Water-Temperature Data 6
Kaua‘i 7
O‘ahu 25
Maui 43
Hawai‘i 59
Summary 59
References Cited 59

Figures

1. General movement of irrigation water in a lo‘i kalo 2
2. Location of significant areas of kalo cultivation, State of Hawai‘i 4
3. Flow measured by U.S. Geological Survey staff in lo‘i kalo ‘auwai with (A) an acoustic Doppler velocimeter and (B) the volumetric method 5
4. Thermistor and PVC housing used for collecting temperature measurements 6
5. Wai‘oli lo‘i complex, Island of Kaua‘i 10
6. Water temperature in Wai‘oli lo‘i complex, Island of Kaua‘i 11
7. Daily pattern of water temperature in Wai‘oli lo‘i complex, Island of Kaua‘i 15
8. Hanalei lo‘i complex, Island of Kaua‘i 19
9. Water temperature in Hanalei lo‘i complex, Island of Kaua‘i 20
10. Daily pattern of water temperature in Hanalei lo‘i complex, Island of Kaua‘i 21
11. Makaweli lo‘i complex, Island of Kaua‘i 22
12. Water temperature in Makaweli lo‘i complex, Island of Kaua‘i 23
13. Daily pattern of water temperature in Makaweli lo‘i complex, Island of Kaua‘i 24

14. Waiähole loʻi complexes, Island of Oʻahu....28
15. Water temperature in Waiähole loʻi complexes, Island of Oʻahu....29
16. Daily pattern of water temperature in Waiähole loʻi complexes, Island of Oʻahu....32
17. Waiheʻe loʻi complex, Island of Oʻahu....35
18. Water temperature in Waiheʻe loʻi complexes, Island of Oʻahu....36
18. Continued....37
19. Daily pattern of water temperature in Waiheʻe loʻi complex, Island of Oʻahu....38
20. Haleʻiwa loʻi complex, Island of Oʻahu....40
21. Water temperature in Haleʻiwa loʻi complexes, Island of Oʻahu....41
22. Daily pattern of water temperature in Haleʻiwa loʻi complex, Island of Oʻahu....42
23. Waiheʻe loʻi complexes, Island of Maui....46
24. Water temperature in Waiheʻe loʻi complexes, Island of Maui....47
25. Daily pattern of water temperature in Waiheʻe loʻi complexes, Island of Maui....48
26. Wailua (Lakini) loʻi complex, Island of Maui....49
27. Water temperature in Wailua (Lakini) loʻi complex, Island of Maui....50
28. Daily pattern of water temperature in Wailua (Lakini) loʻi complex, Island of Maui....51
29. Wailua loʻi complex, Island of Maui....52
30. Water temperature in Wailua loʻi complex, Island of Maui....53
31. Daily pattern of water temperature in Wailua loʻi complex, Island of Maui....53
32. Wailua (Waikani) loʻi complex, Island of Maui....54
33. Water temperature in Wailua (Waikani) loʻi complex, Island of Maui....55
34. Daily pattern of water temperature in Wailua (Waikani) loʻi complex, Island of Maui....56
35. Keʻanae loʻi complex, Island of Maui....57
36. Water temperature in Keʻanae loʻi complex, Island of Maui....58
37. Daily pattern of water temperature in Keʻanae loʻi complex, Island of Maui....58
38. Waipiʻo (A) loʻi complex, Island of Hawaiʻi....62
39. Waipiʻo (B) loʻi complex, Island of Hawaiʻi....63
40. Water temperature in Waipiʻo (A) loʻi complex, Island of Hawaiʻi....64
41. Daily pattern of water temperature in Waipiʻo (A) loʻi complex, Island of Hawaiʻi....65
42. Water temperature in Waipiʻo (B) loʻi complex, Island of Hawaiʻi....66
43. Daily pattern of water temperature in Waipiʻo (B) loʻi complex, Island of Hawaiʻi....67

Tables

1. Selected temperature conversions. 6
2. Summary of discharge measurements and areas for selected lo‘i complexes, Island of Kaua‘i 8
3. Water-temperature statistics based on measurements collected at 15-minute intervals for lo‘i complexes on the Island of Kaua‘i 9
4. Summary of discharge measurements and areas for selected lo‘i complexes, Island of O‘ahu 26
5. Water-temperature statistics based on measurements collected at 15-minute intervals for lo‘i complexes on the Island of O‘ahu.....27
6. Summary of discharge measurements and areas for selected lo‘i complexes, Island of Maui.....44
7. Water-temperature statistics based on measurements collected at 15-minute intervals for lo‘i complexes on the Island of Maui. 45
8. Summary of discharge measurements and areas for selected lo‘i complexes, Island of Hawai‘i.....60
9. Water-temperature statistics based on measurements collected at 15-minute intervals for lo‘i complexes on the Island of Hawai‘i. 61
10. Summary of water use calculated for lo‘i and lo‘i complexes by island, State of Hawai‘i.....68

Conversion Factors

Multiply	By	To obtain
	Area	
acre	4,047	square meter (m^2)
	Volume	
million gallons (Mgal)	3,785	cubic meter (m^3)
	Flow rate	
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F=(1.8×°C)+32

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C=(°F-32)/1.8

Vertical coordinate information is referenced to mean sea level.

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Water Use in Wetland Kalo Cultivation in Hawai‘i

By Stephen B. Gingerich, Chiu W. Yeung, Tracy-Joy N. Ibarra, and John A. Engott

Abstract

Ten cultivation areas (8 windward, 2 leeward) were selected for a kalo water-use study, primarily on the basis of the diversity of environmental and agricultural conditions under which wetland kalo is grown and landowner permission and availability. Flow and water-temperature data were collected at the lo‘i complex level and at the individual lo‘i level. To ensure that flow and temperature data collected at different lo‘i reflect similar irrigation conditions (continuous flooding of the mature crop), only lo‘i with crops near the harvesting stage were selected for water-temperature data collection. The water need for kalo cultivation varies depending on the crop stage. In this study, data were collected during the dry season (June - October), when water requirements for cooling kalo approach upper limits. Flow measurements generally were made during the warmest part of the day, and temperature measurements were made every 15 minutes at each site for about a 2-month period.

Flow and temperature data were collected from kalo cultivation areas on four islands—Kaua‘i, O‘ahu, Maui, and Hawai‘i. The average inflow value for the 19 lo‘i complexes measured in this study is 260,000 gallons per acre per day, and the median inflow value is 150,000 gallons per acre per day. The average inflow value for the 17 windward sites is 270,000 gallons per acre per day, and the median inflow value is 150,000 gallons per acre per day. The average inflow value for the two leeward sites is 150,000 gallons per acre per day. The average inflow value measured for six individual lo‘i is 350,000 gallons per acre per day, and the median inflow value is 270,000 gallons per acre per day. The average inflow value for the five windward lo‘i is 370,000 gallons per acre per day, and the median inflow value is 320,000 gallons per acre per day. The inflow value for the one leeward lo‘i is 210,000 gallons per acre per day. These inflow values are consistent with previously reported values for inflow and are significantly higher than values generally estimated for water consumption during kalo cultivation. These measurements of inflow are important for future considerations of water-use requirements for successful kalo cultivation.

Of the 17 lo‘i complexes where water inflow temperature was measured, only 3 had inflow temperatures that rose above 27°C, the threshold temperature above which wetland kalo is more susceptible to fungi and associated rotting diseases. The coldest mean inflow temperature was 20.0°C and the warmest inflow temperature was 24.9°C. All 15 of the sites where outflow temperatures were measured had some temperatures greater than 27°C. Outflow temperatures exceeded 27°C between 2.5 percent and about 40 percent of the time. Mean outflow temperatures ranged from 23.0°C to 26.7°C.

Introduction

Wetland kalo or taro (*Colocasia esculenta* (L.) Schott) is a vital part of the cultural and agricultural traditions of native Hawaiians. In some locations in Hawai‘i, significant competition between instream and offstream uses for limited surface-water resources has led to litigation about rights to water for kalo cultivation and other uses. Appurtenant water rights of kuleana (private land awards to commoners) and kalo lands are preserved under the State Water Code, Hawai‘i Revised Statutes Ch. 174C. Although irrigation flows for kalo cultivation have been measured with varying degrees of scientific accuracy, there is disagreement regarding the amount of water used and needed for successful kalo cultivation, with water temperature recognized as a critical factor. Most studies have focused on the amount of water consumed rather than the amount needed to flow through the irrigation system for successful kalo cultivation. In 2002, the Office of Hawaiian Affairs, State of Hawai‘i, cosponsored the “No Ka Lo‘i Conference” at the Kamakakūokalani Center for Hawaiian Studies, University of Hawai‘i at Mānoa. One of the outcomes of the conference was kalo farmers’ expressed desire to document current water use and to protect and enhance kalo

cultivation. The study documented in this report was pursued to help fulfill the priorities identified during that conference.

Wetland kalo is cultivated throughout Hawai‘i in groups of shallow, watery terraces and pondfields, which native Hawaiians call lo‘i kalo (fig.1). In this report, lo‘i refers to an individual pondfield and lo‘i complex refers to a group of lo‘i. Wetland cultivation is the primary and preferred source for kalo corms (food-bearing underground stem), which are processed into poi, a popular Hawaiian staple food. Wetland kalo requires cool water flowing over its roots to ensure the health and productivity of the crop. Irrigation, therefore, needs to provide more water than just what is consumed in the lo‘i through evaporation from open water, transpiration through the kalo leaves, and percolation through the lo‘i bottom and sides. Irrigation flow must be controlled to provide enough cold water to keep the lo‘i adequately cool throughout the growing cycle. Water-temperature management in individual lo‘i is recognized as a water-management priority. Water temperature is generally considered the most critical physical factor in kalo cultivation water use, but rarely is it systematically measured or analyzed. Various studies suggest that it is best to keep lo‘i water temperatures at about 25°C (77°F) or lower (Reppun v. Board of Water Supply, 1982; Penn, 1997). In general, a higher irrigation rate should dampen water heating and lower irrigation outflow temperature (Penn, 1997).

In cooperation with the Office of Hawaiian Affairs, State of Hawai‘i, the U.S. Geological Survey (USGS) undertook an investigation to evaluate current water use for commercial wetland kalo cultivation in Hawai‘i. The objectives of this 2-year study are (1) to document current water use for selected lo‘i complexes of various sizes on the islands of Kaua‘i, O‘ahu, Maui, and Hawai‘i; and (2) to monitor the variation in inflow and outflow water temperatures of selected lo‘i and lo‘i complexes. Water-use and water-temperature data collected as part of this study provides baseline information on wetland kalo irrigation practices

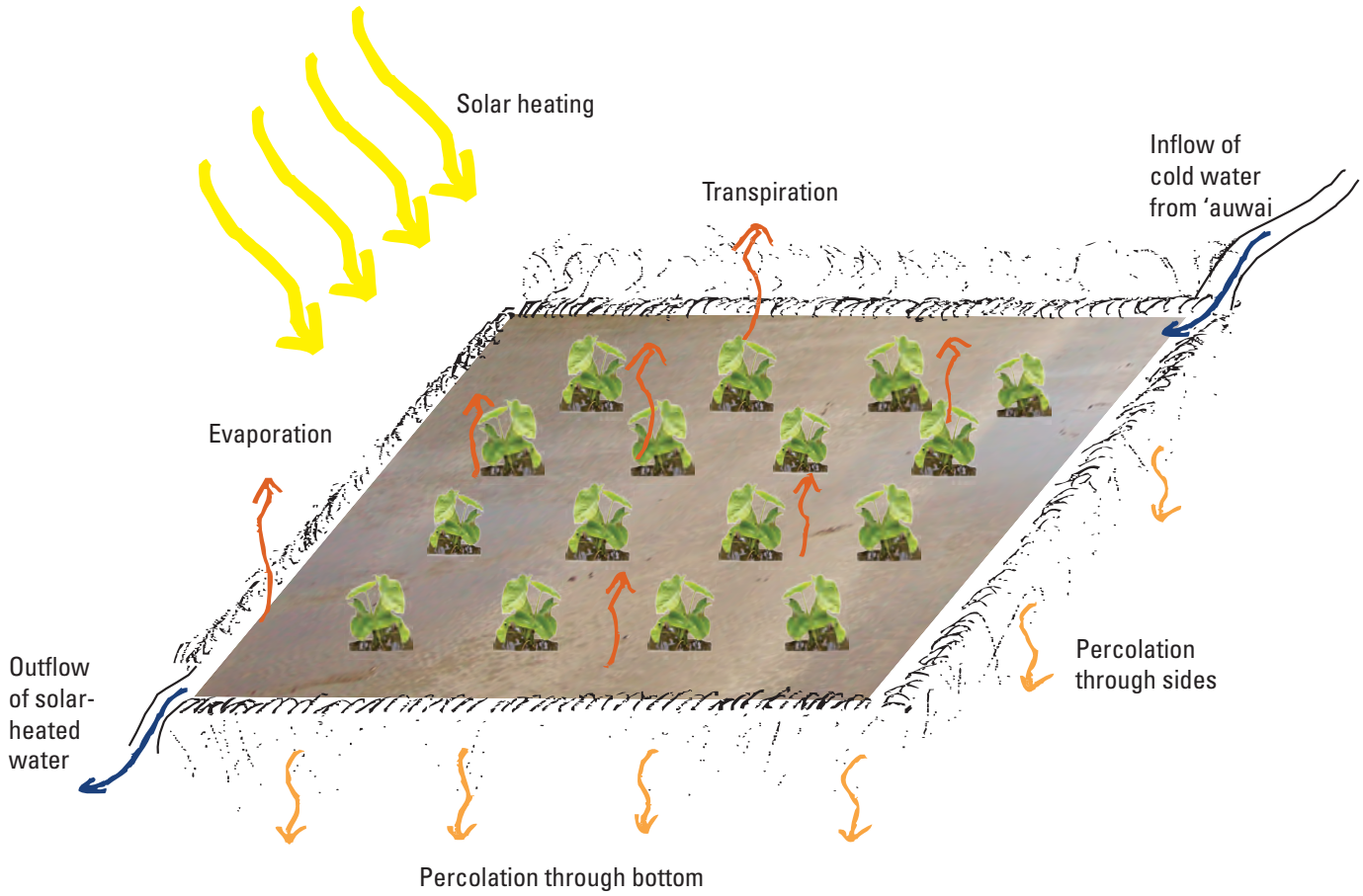


Figure 1. General movement of irrigation water in a lo‘i kalo.

for a variety of geographic settings in the Hawaiian Islands.

The ‘auwai, or irrigation ditch system, constructed at each lo‘i complex transports water from streams to flood each lo‘i. The design of the ‘auwai and lo‘i complexes varies from place to place, and from simple to complicated. An example of a simple lo‘i complex design is where an ‘auwai supplies water to a lo‘i and flow is returned directly back to the stream. An example of a more complicated design exists in Ke‘anae, Maui, where an ‘auwai distributes water to multiple lo‘i staggered along the ‘auwai, and most lo‘i throughflow is returned to the ‘auwai and mixed for reuse in downstream lo‘i irrigation. Flow is ultimately released to the ocean at various locations around the Ke‘anae Peninsula and is too diffuse to accurately measure.

The most rigorous documented measurements of water used for wetland kalo cultivation were made in the 1930s at Hanapēpē, Kaua‘i, by the University of Hawai‘i and McBryde Sugar Company (Miles, 1931). Various water uses were measured including percolation in the lo‘i and ‘auwai, transpiration, and evaporation. The highlighted results of 50,000 to 80,000 gallons per acre per day (gad) represent net loss or consumption (the difference between the amount of water flowing into a lo‘i complex and the amount flowing out) in the lo‘i and the researchers recognized “that a considerably greater amount would have to be diverted in order to successfully grow taro [kalo] with proper circulation of water.” This statement is based on inflow measurements that ranged from 290,000 to 1,100,000 gad (Penn, 1997). The results of this Hanapēpē study were used by the Hawai‘i courts to determine the water rights in connection with the various lands involved in the case. This was the last time that a final court decision was reached on this water rights issue. Some of the most frequently relied on flow-rate measurements were made by Watson (1964) and were presented as evidence in several seminal water-rights cases (Reppun v. Board of Water Supply, 1982; State of Hawai‘i, 2000). Watson reported kalo water requirements of 40,000 gad, a figure also arrived at through a net loss determination. No consideration was given to the amount of throughflow needed to meet the cooling requirements of the lo‘i. Penn (1997) reinterpreted Watson’s findings to suggest that throughflow results for that study would be 100,000 to 250,000 gad. At Hanalei, Kaua‘i, the U.S. Forest Service measured average inflow rates to a lo‘i complex of 87,500 gad and estimated consumptive use for 220 acres in kalo production to be about 23,600 gad (Berg and others, 1997).

Site Selection

Twenty-eight geographic areas with significant kalo cultivation on the islands of Kaua‘i, O‘ahu, Moloka‘i, Maui, and Hawai‘i were initially identified (fig. 2). Each of the islands can be divided into two primary physiographic zones, windward and leeward, which relate to the exposure of these areas to the northeasterly trade winds and orographic rainfall. In general, windward areas receive higher rainfall than leeward areas. Twenty-one of the identified kalo cultivation areas receive rainfall consistent with the windward sides of the islands and seven cultivation areas receive rainfall consistent with the leeward sides of their respective islands. Of these areas, 10 were selected for this study (8 windward, 2 leeward), primarily on the basis of the diversity of environmental and agricultural conditions under which wetland kalo is grown and on the basis of landowner availability. In some areas, more than one complex was studied. Final site selection was made in consultation with the Office of Hawaiian Affairs, State of Hawai‘i, Onipa‘a Nā Hui Kalo, and the State of Hawai‘i Department of Health.

The USGS collected flow and water-temperature data at the lo‘i complex level and at the lo‘i level. Data collection was designed to measure and document the amount of water being used by kalo farmers in a variety of geographic areas. The study was not designed to measure the consumption of water during kalo growth, but rather the throughflow of water used in lo‘i complexes where commercial cultivation generally is viable. For consistency in site selection, lo‘i with crops near harvesting stage were selected for the lo‘i water-temperature data collection. Farmers stagger planting dates to obtain year-round production. Due to differences in water availability and irrigation-system configuration, irrigation practices vary. Farmers generally allocate a greater amount of water to lo‘i with crops at harvesting stage and less water to lo‘i with crops at earlier stages to maximize the use of limited water resources. The selection of lo‘i with crops at harvesting stage ensured that flow and temperature data collected at different lo‘i reflect similar irrigation conditions (continuous flooding of the mature crop). During field visits, farmers were interviewed about their irrigation practices and about their perceptions of their water supply. In general, most farmers believed that their supply of irrigation water was insufficient for proper kalo cultivation.

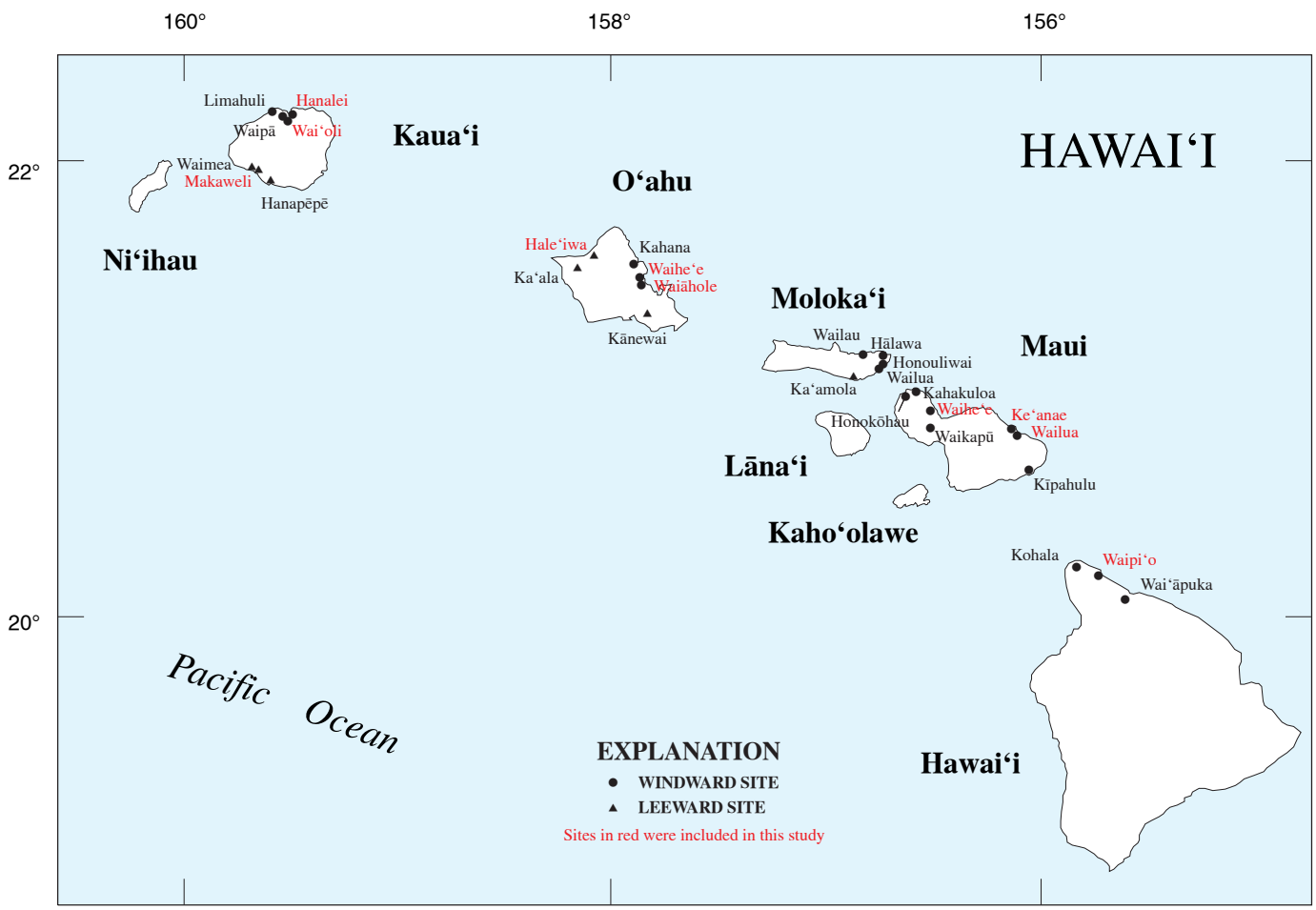


Figure 2. Location of significant areas of kalo cultivation, State of Hawai‘i.

Acknowledgments

The authors wish to thank the stakeholders who helped to initiate and define the scope of this study—Dr. Jonathan Scheuer of the Office of Hawaiian Affairs, State of Hawai‘i, Charlie and Paul Reppun and other members of Onipa‘a Nā Hui Kalo, and David Penn of the State of Hawai‘i Department of Health. We also thank the many kalo farmers who provided lodging (and sometimes food), access to their lo‘i, knowledge of their irrigation systems, descriptions of their farming practices, and aloha during this study. We owe a special debt of gratitude to Charlie and Paul Reppun for providing volunteer help during visits to all of the study areas, for being the liaisons to all the kalo farmers, and for their general insight from more than 30 years of experience in kalo farming. David Reppun also provided volunteer help during the initial visits to Maui and Hawai‘i.

Discharge, Water-Temperature, and Area Data-Collection Methods

Data collection was done during the dry season (June–October) when water requirements for cooling kalo are higher. In general, surface-water temperatures in the Hawaiian Islands begin to rise in April and remain elevated through September, mainly due to increased solar heating (Brasher and others, 2004; Gingerich and Wolff, 2005; Oki and others, 2006). Flow measurements generally were made during the warmest part of the day; temperature measurements were made every 15 minutes at each site for about a two-month period.

Discharge Measurements

Measurements of the amount of water flowing into or out of the lo‘i complexes were made by using current-meter, volumetric-flow, or portable Parshall flume methods. Where channel conditions in the ‘auwai permitted (for example, straight channels, non-turbulent flow, and relatively greater flow volumes), current-meter measurements were made. In the current-meter method, observations of width, depth, and velocity are collected at intervals in a cross section of the channel while the measurer wades in the channel (Rantz and others, 1982). Velocity measurements were made by using an acoustic Doppler velocimeter attached to a top-setting wading rod (fig. 3). Volumetric measurements were made where channel conditions did not permit current-meter measurements, where flow volumes were relatively low, or where volumetric measurements were more convenient than current-meter measurements. Volumetric measurements were made by repeated timed fillings of a calibrated five-gallon bucket and averaging the results (fig. 3). Typically, 10 independent measurements were made by using the calibrated bucket. Although relatively simple, the volumetric measurement is considered the most accurate way to measure low flows (Rantz and others, 1982). Parshall flume measurements were made in selected ‘auwai where flow was too low for current-meter measurements but where the channel was narrow and flow was uniform. At these sites, the Parshall flume was installed and leveled, and repeated measurements were made in the flume stilling well after flow in the flume stabilized. At all sites, regardless of the method of measurement, a reference mark was set and checked at the beginning and ending of each workday to determine if the overall flow conditions changed during the day.

Figure 3. Flow measured by U.S. Geological Survey staff in lo‘i kalo ‘auwai with (***A***) an acoustic Doppler velocimeter and (***B***) the volumetric method.

Water-Temperature Measurements

Water temperatures were measured every 15 minutes by using StowAway® Tidbit® thermistors from Onset Computer Corporation that were designed to operate in the -20°C–50°C temperature range. Each thermistor was calibrated in the laboratory following USGS procedures (U.S. Geological Survey, 1997 to present) before installation in the field. Each thermistor was installed inside a 6-in. length of 1.25-in. diameter PVC pipe staked below the lowest expected water level in the ‘auwai or lo‘i being monitored (fig. 4). Monitoring locations were in the shade, where possible, and chosen to avoid potentially stagnant flow. Each thermistor was field checked in place when deployed and again when retrieved by using a laboratory-calibrated field thermistor. Because field checks of the thermistors were within acceptable tolerances, no adjustments to the data were needed. A table showing equivalent temperature values in °C and °F is included (table 1).

Area Measurements

Measurements of the selected lo‘i and lo‘i complex areas were made by walking the perimeter of each lo‘i complex while recording the track with a handheld Global Positioning System (GPS) unit. Each perimeter track was uploaded from the GPS unit to a geographic information system (GIS) program and, where necessary, adjusted to overlay aerial images showing the appropriate lo‘i com-

Figure 4. Thermistor and PVC housing used for collecting temperature measurements.

plexes. The areas, determined from the GIS program, include the cultivated and fallow lo‘i banks, pathways, and ‘auwai inside the perimeter of the track. Removing the area of these non-water-covered parts of the lo‘i complexes from the total area was determined to be too difficult and subjective. The emphasis was, therefore, directed toward treating each lo‘i complex consistently.

Discharge and Water-Temperature Data

As part of this study, 62 flow measurements and 46 sets of temperature data were collected from kalo cultivation areas on four islands—Kaua‘i, O‘ahu, Maui, and Hawai‘i. The flow and temperature measurement data collected as part of this study are available on the World Wide Web. Data from each station listed in the following tables can be retrieved

Table 1. Selected temperature conversions.

Temperature (degrees Celsius)	Temperature (degrees Fahrenheit)
18.0	64.4
18.5	65.3
19.0	66.2
19.5	67.1
20.0	68.0
20.5	68.9
21.0	69.8
21.5	70.7
22.0	71.6
22.5	72.5
23.0	73.4
23.5	74.3
24.0	75.2
24.5	76.1
25.0	77.0
25.5	77.9
26.0	78.8
26.5	79.7
27.0	80.6
27.5	81.5
28.0	82.4
28.5	83.3
29.0	84.2
29.5	85.1
30.0	86.0
30.5	86.9
31.0	87.8
31.5	88.7
32.0	89.6
32.5	90.5
33.0	91.4
33.5	92.3
34.0	93.2
34.5	94.1
35.0	95.0
35.5	95.9
36.0	96.8
36.5	97.7
37.0	98.6
37.5	99.5
38.0	100.4
38.5	101.3
39.0	102.2
39.5	103.1
40.0	104.0

from the *USGS National Water Information System database* (NWIS) by clicking on the linked station name.

The flow and area tables in the following sections, presented by island, provide dates and times of measurements, flow rates in ‘auwai irrigating the lo‘i and lo‘i complexes, the GPS-measured areas of the selected lo‘i and lo‘i complexes, and water use based on the flow and area measurements. The temperature tables summarize (1) the dates of temperature-logger deployment; (2) the mean, maximum, and minimum temperature over the entire period of measurement; (3) the mean of the daily range in temperatures; (4) the range of times the highest temperature in any day occurred; (5) the percentage of measurements greater than 27°C; and (6) the earliest and latest times during the day that the temperatures were greater than 27°C. A temperature of 27°C is cited as the threshold temperature above which wetland kalo is more susceptible to fungi and associated rotting diseases (Ooka, 1994, Penn, 1997).

Two plots are presented for each temperature record collected in the study. One plot shows the entire record of 15-minute temperature data measurements for the length of time each temperature thermistor was deployed. These plots are useful for displaying how the temperature changed over time due to factors such as a period of cloudiness, increased or decreased irrigation caused by rainfall, or ‘auwai problems. The other temperature plots provided show all of the temperature data plotted against the time of day each measurement was recorded. These plots indicate the daily pattern of temperature variation and are also useful for displaying the earliest and latest times of the day when the temperature reached the 27°C threshold.

Kaua‘i

Three areas were measured on Kaua‘i—Wai‘oli and Hanalei (windward sites) and Makaweli (leeward site). Flow measurements were made on August 7-9, 2005, when the temperature loggers were deployed, and on September 21-23, 2005, when the temperature loggers were removed (tables 2 and 3). The Wai‘oli area is supplied through the Wai‘oli ‘Auwai with water diverted from the Wai‘oli River (fig. 4). Of the numerous lo‘i complexes supplied by the Wai‘oli ‘Auwai, four independent lo‘i complexes were studied. Twelve flow measurements were made, and ten temperature loggers were deployed at selected inflow and outflow locations (figs. 5 and 6).

The Hanalei area is supplied through the “China Ditch” with water diverted from the Hanalei River (fig. 7). One lo‘i complex was studied in this area. Four flow measurements were made, and three temperature loggers were deployed in the Hanalei area (figs. 8 and 9).

The Makaweli area is supplied through the Pu‘ulima Ditch with water diverted from the Makaweli River; one lo‘i complex was studied in this area (fig. 10). One flow measurement was made, and three temperature loggers were deployed in the Makaweli area (figs. 11 and 12). A flow measurement was not made during the second visit to the Makaweli area because of damage to the diversion structure.

Table 2. Summary of discharge measurements and areas for selected lo‘i complexes, Island of Kaua‘i.

[Mgal/d, million gallons per day; gad, gallons per acre per day; --, not available; average water use is determined by summing the averages of each lo‘i or lo‘i complex and dividing by the number of lo‘i or lo‘i complexes]

		Complex						Lo‘i					
Geographic designation	Area	Station	Irrigation area (acre)	Date	Measurement time	Discharge (Mgal/d)	Water use (gad)	Station	Irrigation area (acre)	Date	Measurement time	Discharge (Mgal/d)	Water use (gad)
Windward	Wai‘oli	Ka01A-CI	32.39	8/8/2005	0850	4.2	130,000						
				9/21/2005	1147	4.2	130,000						
		Ka01B-CI	2.98	8/8/2005	1000	0.36	120,000	Ka01B-LI	0.21	8/8/2005	1400	0.076	370,000
				9/21/2005	1246	0.55[a]	180,000			9/21/2005	1337	0.047	230,000
		Ka01C-CI	5.46	8/8/2005	1132	0.54	100,000	Ka01C-LI	0.16	8/8/2005	1030	0.028	170,000
				9/22/2005	1211	0.38[b]	70,000			9/22/2005	1255	0.019	120,000
		Ka01D-CI	4.18	8/8/2005	1505	0.15	36,000						
				9/22/2005	1510	0.25	60,000						
Windward	Hanalei	Ka02-CI	53.63	8/7/2005	1708	3.7[c]	69,000	Ka02A-LO	0.51	8/9/2005	0910	0.10	--
				9/21/2005	1604	4.2[d]	78,000			9/21/2005	1722	0.15	--
Leeward	Makaweli	Ka03-CI	0.68	8/9/2005[e]	1241	0.090	260,000						
				9/23/2005[f]	--	--	--						
number			6				6		3				2
minimum			0.68				36,000		0.16				120,000
maximum			53.63				260,000		0.51				370,000
average			16.55				120,000		0.29				220,000

[a]Flow higher than normal due to leakage at field inlet gate.

[b]Flow lower than normal due to damaged upstream diversion dam.

[c]Intake gate was not fully open.

[d]Higher flow because intake gate was fully open.

[e]Two intake pipes (4-inch and 3-inch diameter) are used to divert water from the ‘auwai to the lo‘i. Flow measurement only was made at the the 4-inch-intake pipe on 8/9/2005. Farmer indicated that the 3-inch-pipe will be replaced eventually with a 4-inch-pipe, so two times the 4-inch-pipe measurement would be a reasonable estimate of typical flow to the lo‘i.

[f]Flow was not measured because flow in the ‘auwai was much lower than normal due to damaged upstream diversion dam.

Table 3. Water-temperature statistics based on measurements collected at 15-minute intervals for lo‘i complexes on the Island of Kaua‘i.
[°C, degrees Celsius; na, not applicable]

Geographic designation	Area	Station	Period of record	Temperature (°C)			Range of times daily peak temperatures occurred	Temperature measurements greater than 27°C		
				Mean	Range	Mean daily range		Percent	Earliest time of day	Latest time of day
Windward	Wai‘oli	Ka01A-LI	8/8/05 – 9/22/05	21.4	19.5 – 23.3	1.2	1315 – 1830	0.0	na	na
		Ka01A-LO	8/8/05 – 9/22/05	25.5	19.7 – 34.1	5.5	1200 – 1700	32.6	0930	2045
		Ka01B-CI	8/8/05 – 9/22/05	21.4	19.5 – 23.6	1.2	1315 – 1815	0.0	0000	0000
		Ka01B-LI	8/8/05 – 9/22/05	22.6	19.6 – 28.1	2.8	1130 – 1645	0.8	1415	1700
		Ka01B-LO	8/8/05 – 9/22/05	24.7	20.5 – 30.7	3.5	1330 – 1845	16.8	1215	2045
		Ka01C-LI	8/8/05 – 9/22/05	23.5	19.7 – 30.6	3.1	1145 – 1645	8.1	1045	1800
		Ka01C-LO	8/8/05 – 9/22/05	25.9	20.0 – 33.5	4.3	1145 – 1545	31.3	1000	2100
		Ka01D-CI	8/8/05 – 9/22/05	21.8	19.5 – 24.1	1.5	1130 – 1745	0.0	na	na
		Ka01D-LI	8/8/05 – 9/22/05	23.5	19.2 – 31.8	4.6	1145 – 1630	14.9	1130	1815
		Ka01D-LO	8/8/05 – 9/22/05	26.2	22.1 – 30.8	3.3	1400 – 1730	33.5	1115	2245
Windward	Hanalei	Ka02-CI	8/8/05 – 9/21/05	23.7	21.3 – 26.9	2.2	1445 – 2030	0.0	0000	0000
		Ka02-LI	8/8/05 – 9/21/05	24.2	21.5 – 27.4	2.3	1245 – 1815	0.2	1445	1600
		Ka02-LO	8/8/05 – 9/21/05	26.7	21.9 – 33.5	6.3	1215 – 1700	40.4	1045	2345
Leeward	Makaweli	Ka03-CI	8/9/05 – 9/23/05	24.8	21.5 – 28.3	2.6	1400 – 1815	9.0	1330	2115
		Ka03-LI	8/9/05 – 9/23/05	25.8	21.3 – 36.9	3.8	1030 – 1930	23.8	0830	2330
		Ka03-LO	8/9/05 – 9/23/05	24.5	19.7 – 35.7	3.9	0945 – 2045	10.5	0930	1930

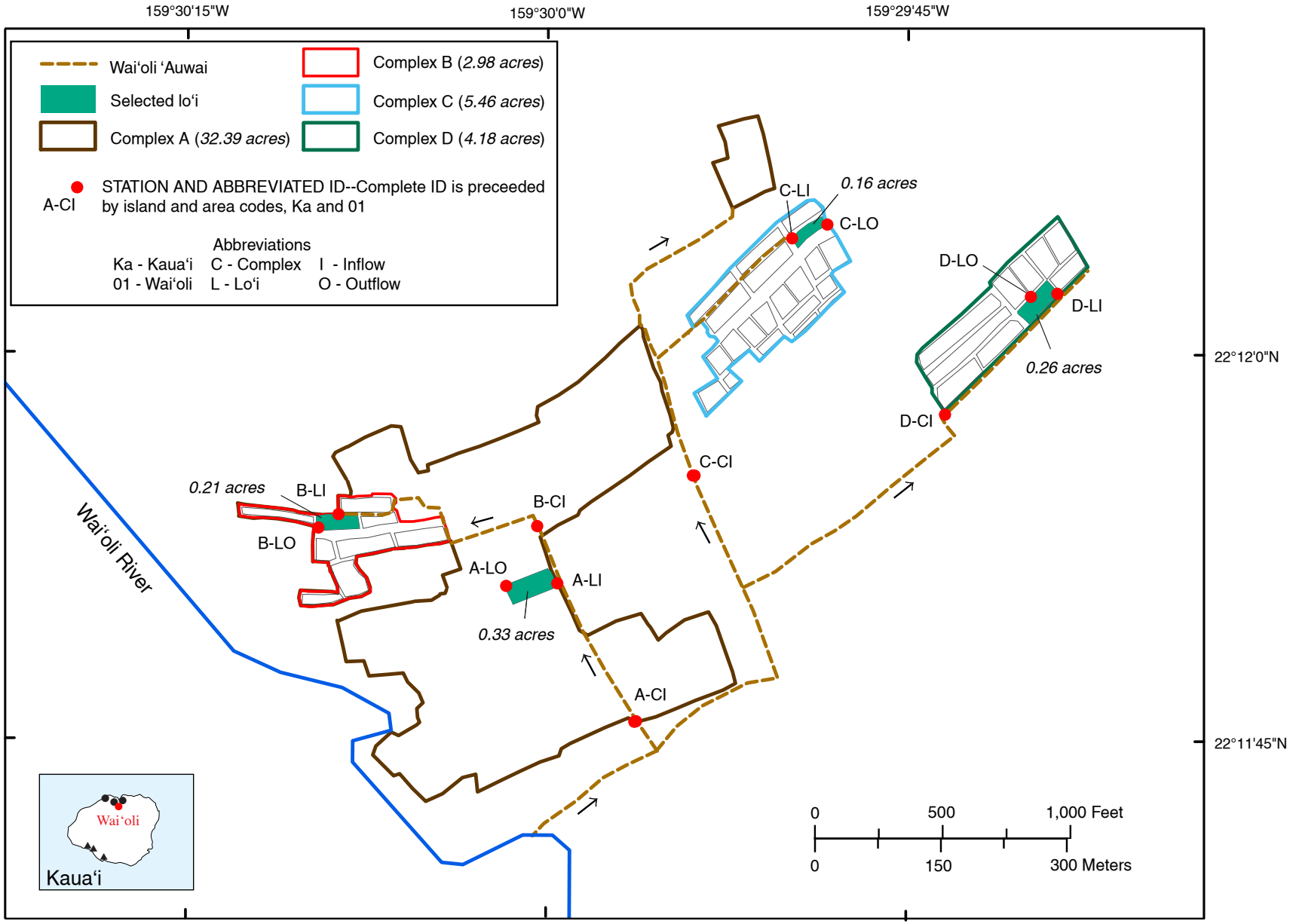
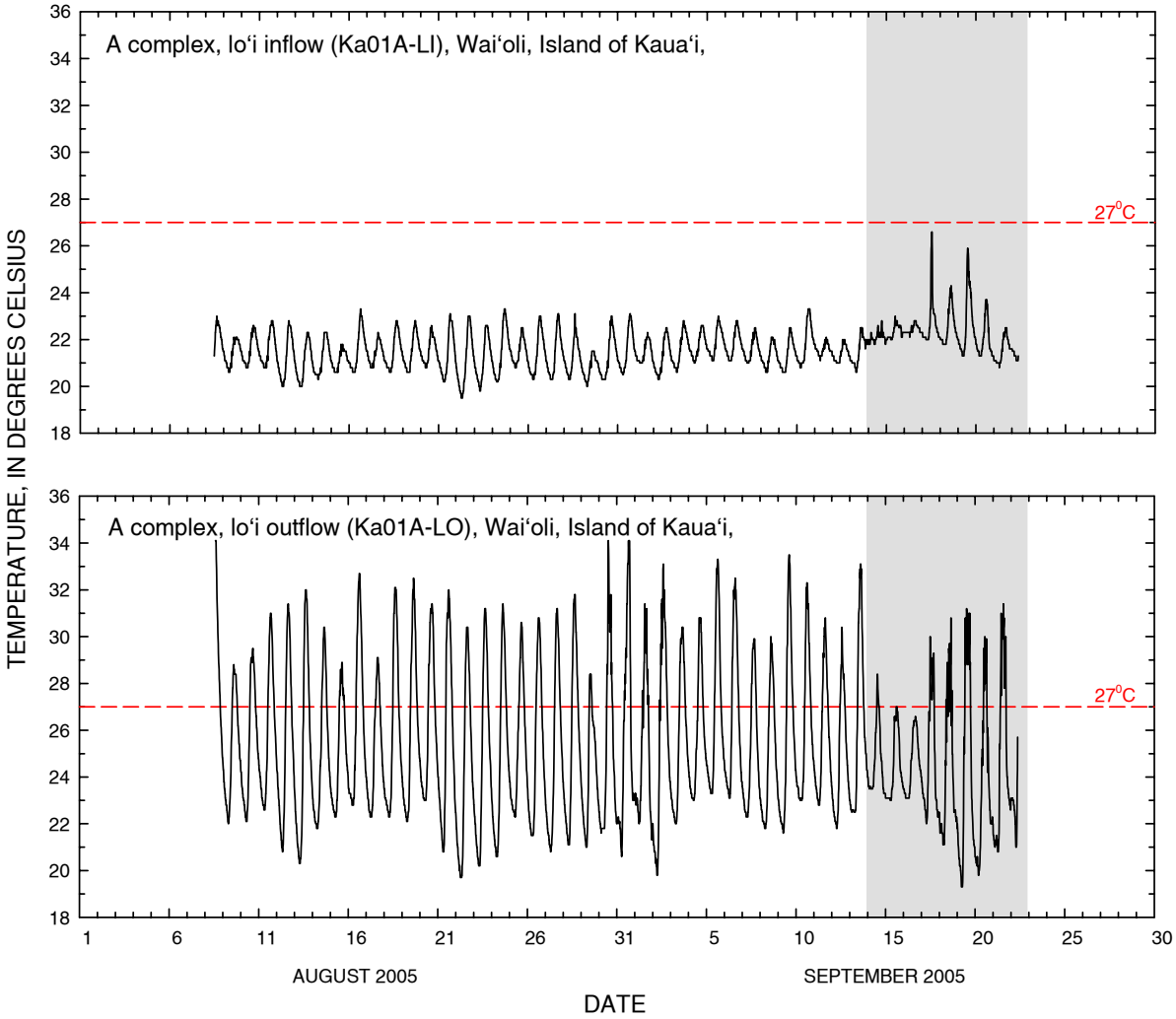
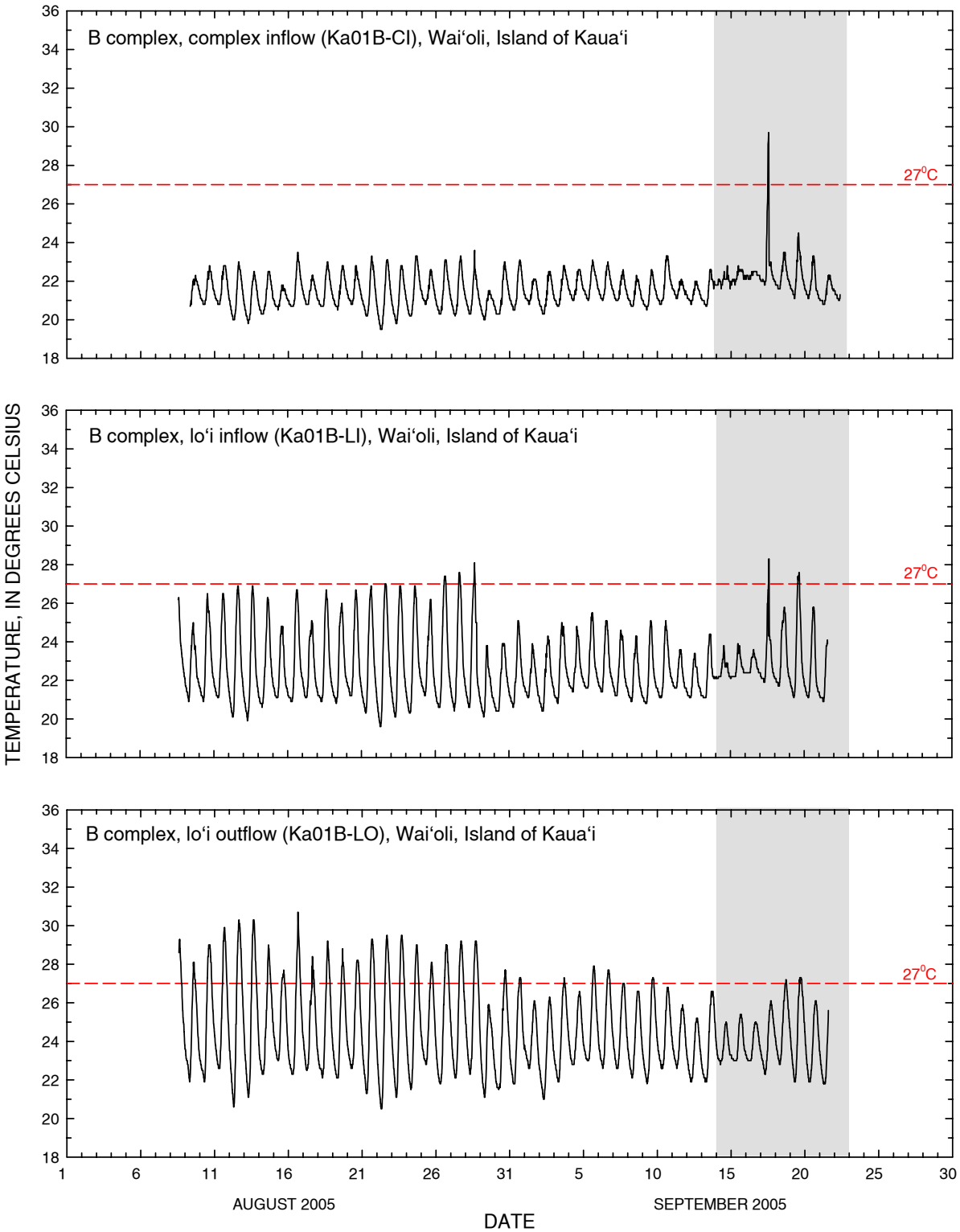


Figure 5. Wai'oli lo'i complex, Island of Kaua'i.



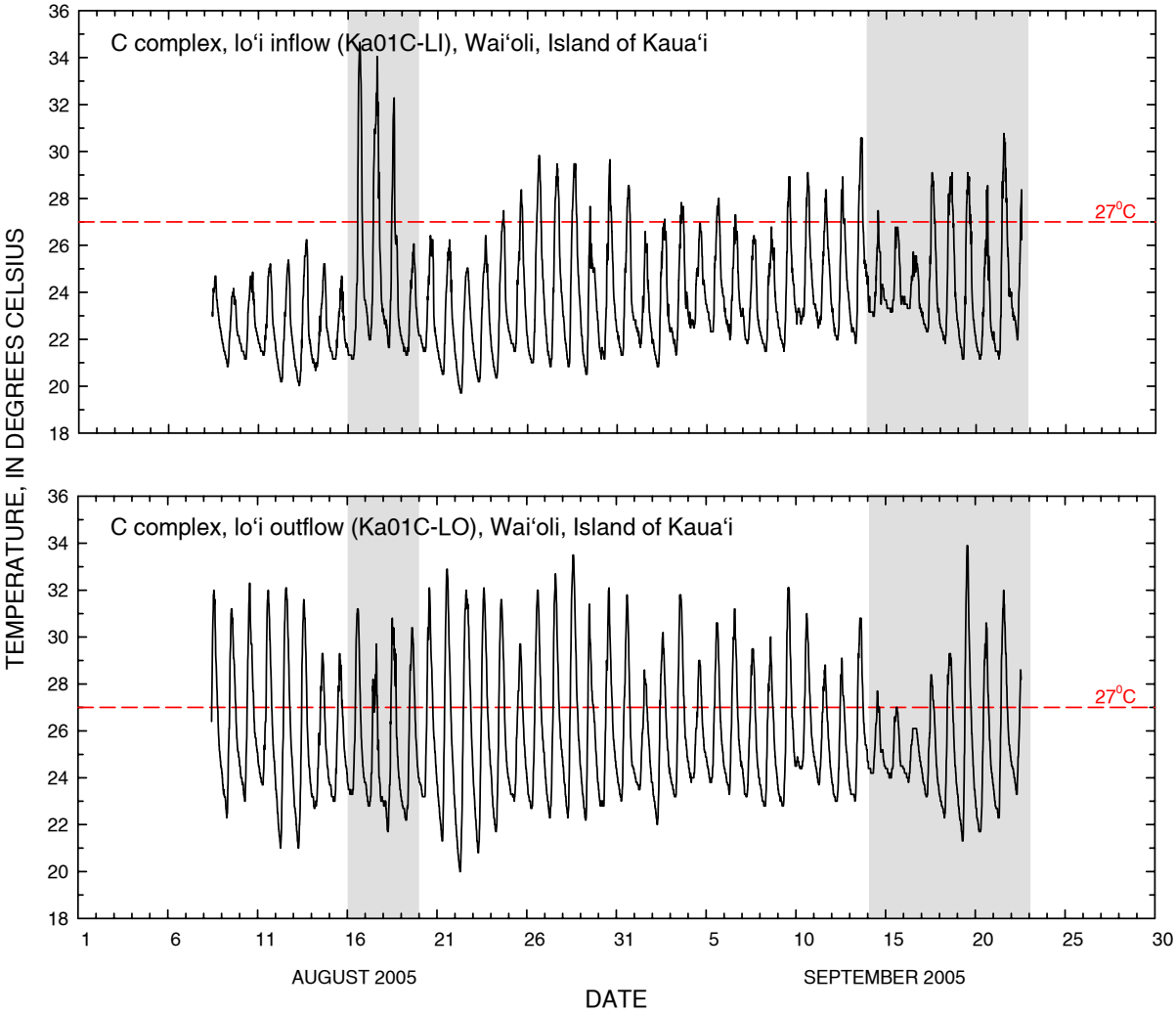
Highlighted periods indicate atypical irrigated conditions. During September 14-15, 2005, a heavy rainstorm flooded the complex and caused damage in the Wai‘oli irrigation system by depositing heavy debris around the diversion dam and ‘auwai. During the following period, the diversion dam and the ‘auwai were being repaired, which significantly altered flow conditions in the irrigation system. During September 18-22, 2005, the farmer indicated that inflow to the selected lo‘i was reduced because the kalo was ready to be harvested.

Figure 6. Water temperature in Wai‘oli lo‘i complex, Island of Kaua‘i.



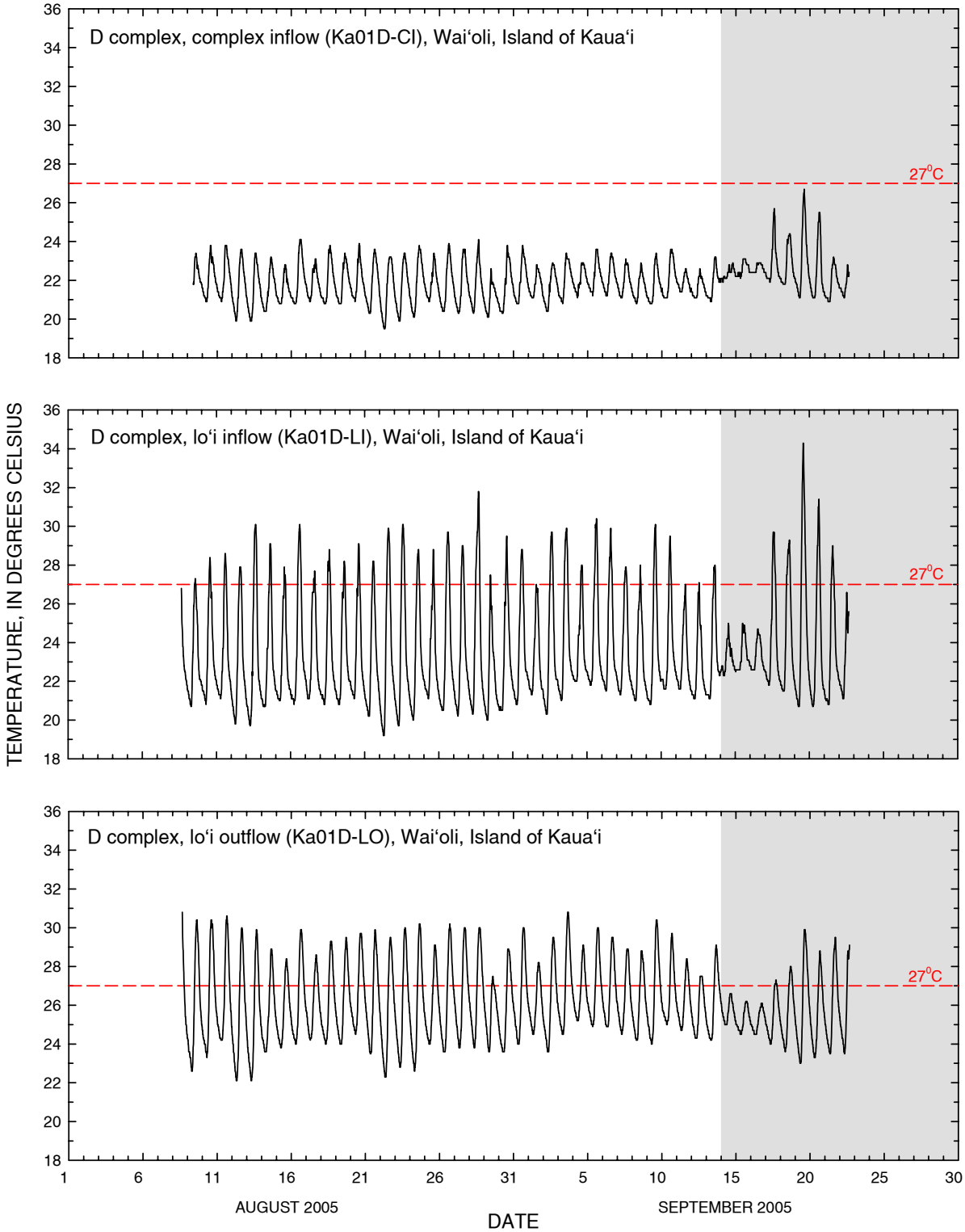
Highlighted periods indicate atypical irrigated conditions. During September 14-15, a heavy rainstorm flooded the complex and caused damages in the Waiʻoli irrigation system by depositing heavy debris around the diversion dam and ʻauwai. Afterward, the diversion dam and the ʻauwai were being repaired, which significantly altered flow conditions in the irrigation system.

Figure 6. *Continued.*



Highlighted periods indicate atypical irrigated conditions. During August 16-19, lo‘i was dried out. During September 14-15, a heavy rainstorm flooded the complex and caused damages in the Wai‘oli irrigation system by depositing heavy debris around the diversion dam and ‘auwai. During the following period, the diversion dam and the ‘auwai were being repaired which significantly altered flow conditions in the irrigation system.

Figure 6. *Continued.*



Highlighted periods indicate atypical irrigated conditions. During September 14-15, a heavy rainstorm flooded the complex and caused damages in the Waiʻoli irrigation system by depositing heavy debris around the diversion dam and ʻauwai. During the following period, the diversion dam and the ʻauwai were being repaired which significantly altered flow conditions in the irrigation system.

Figure 6. *Continued.*

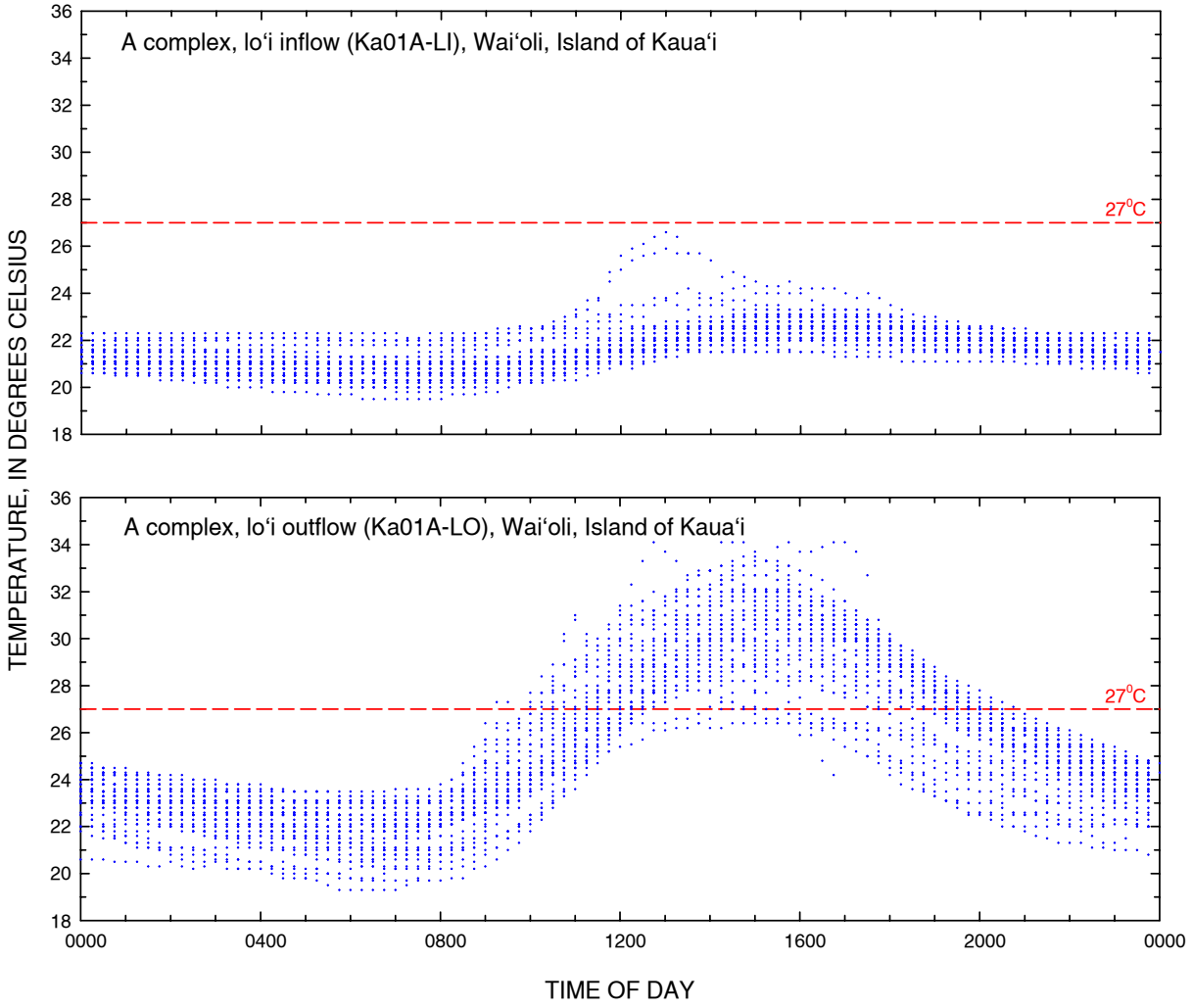


Figure 7. Daily pattern of water temperature in Wai‘oli lo‘i complex, Island of Kaua‘i. Plot shows all temperature data plotted against the time of day that each measurement was recorded.

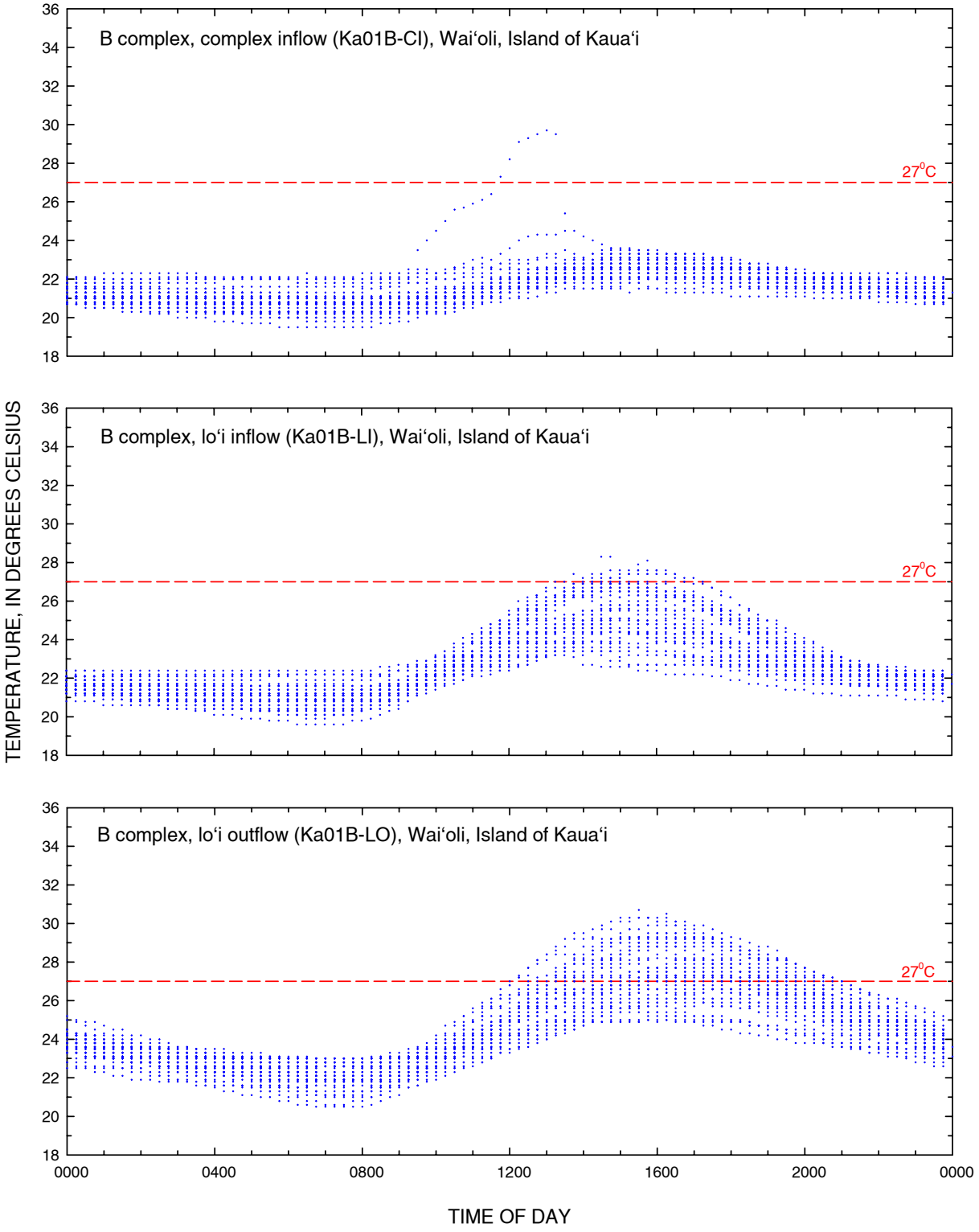


Figure 7. *Continued.*

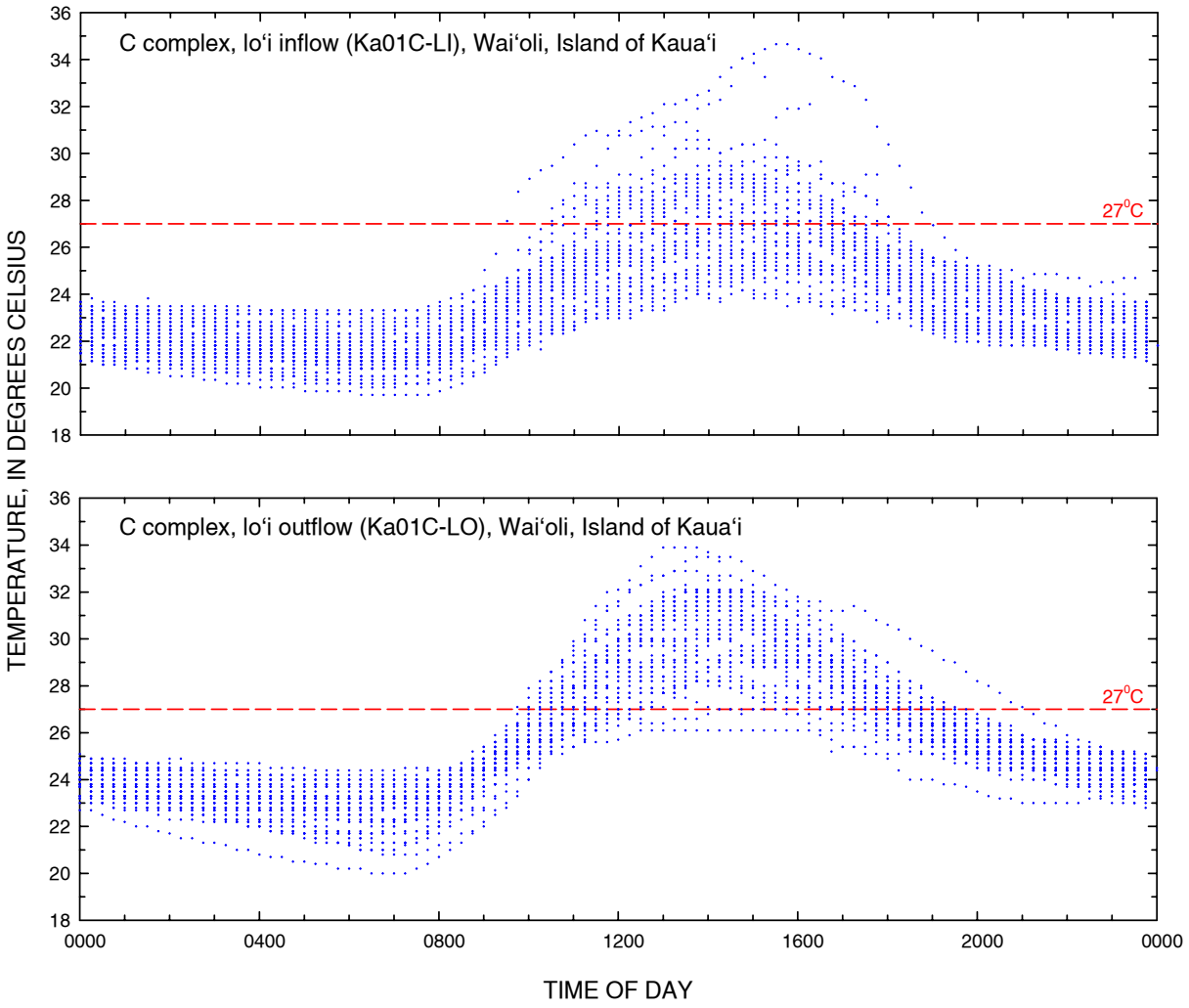


Figure 7. *Continued.*

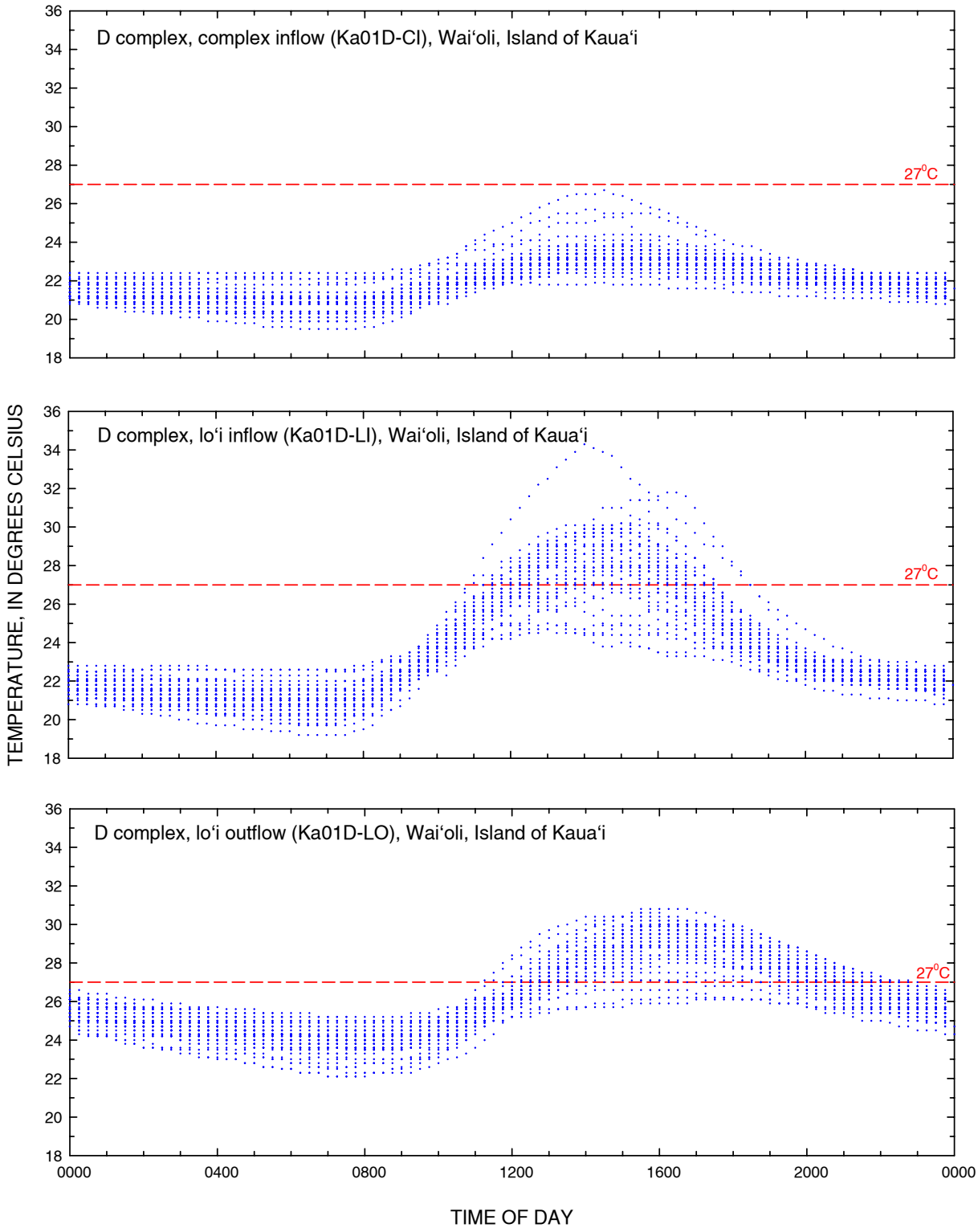


Figure 7. *Continued.*

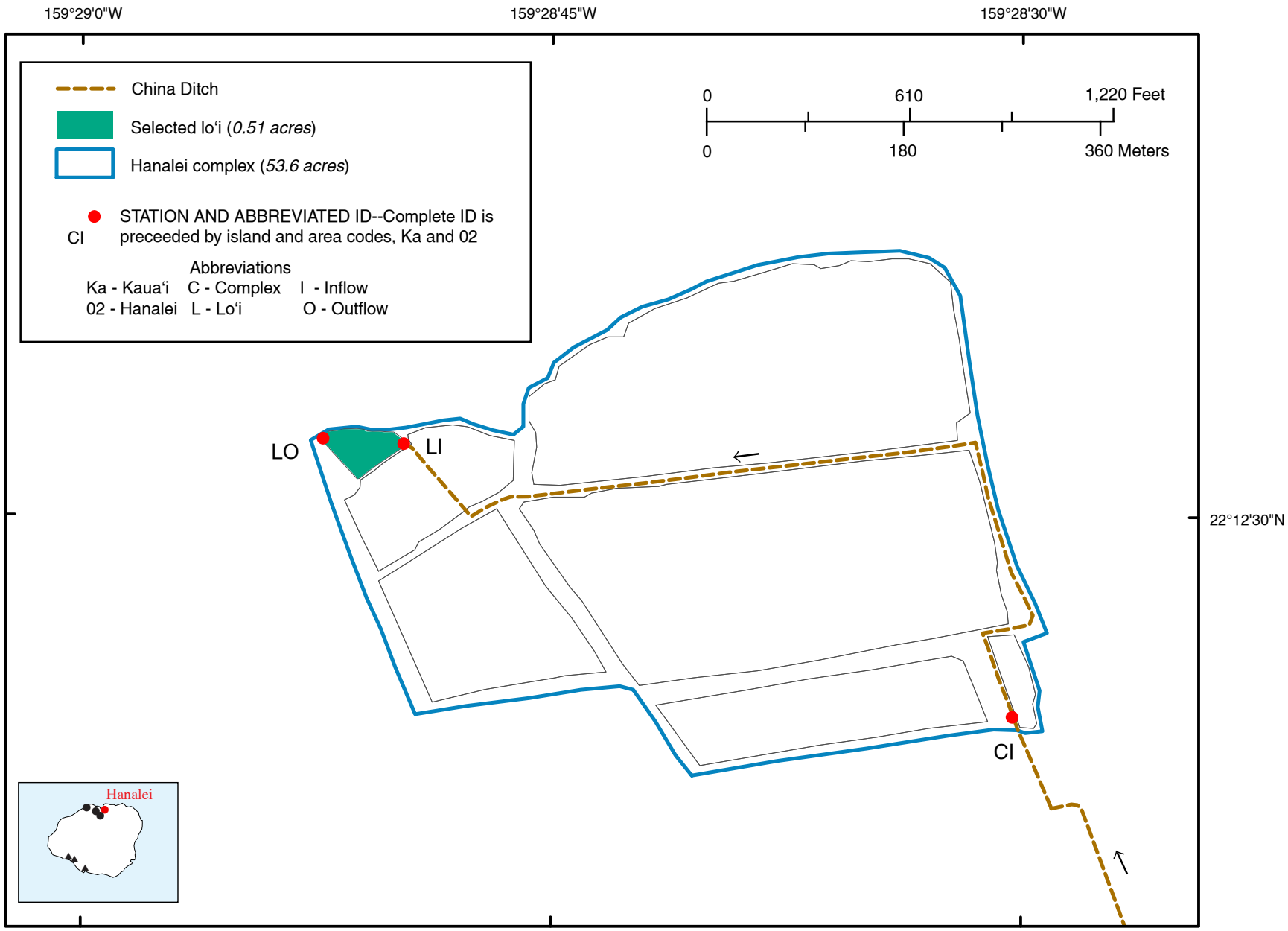
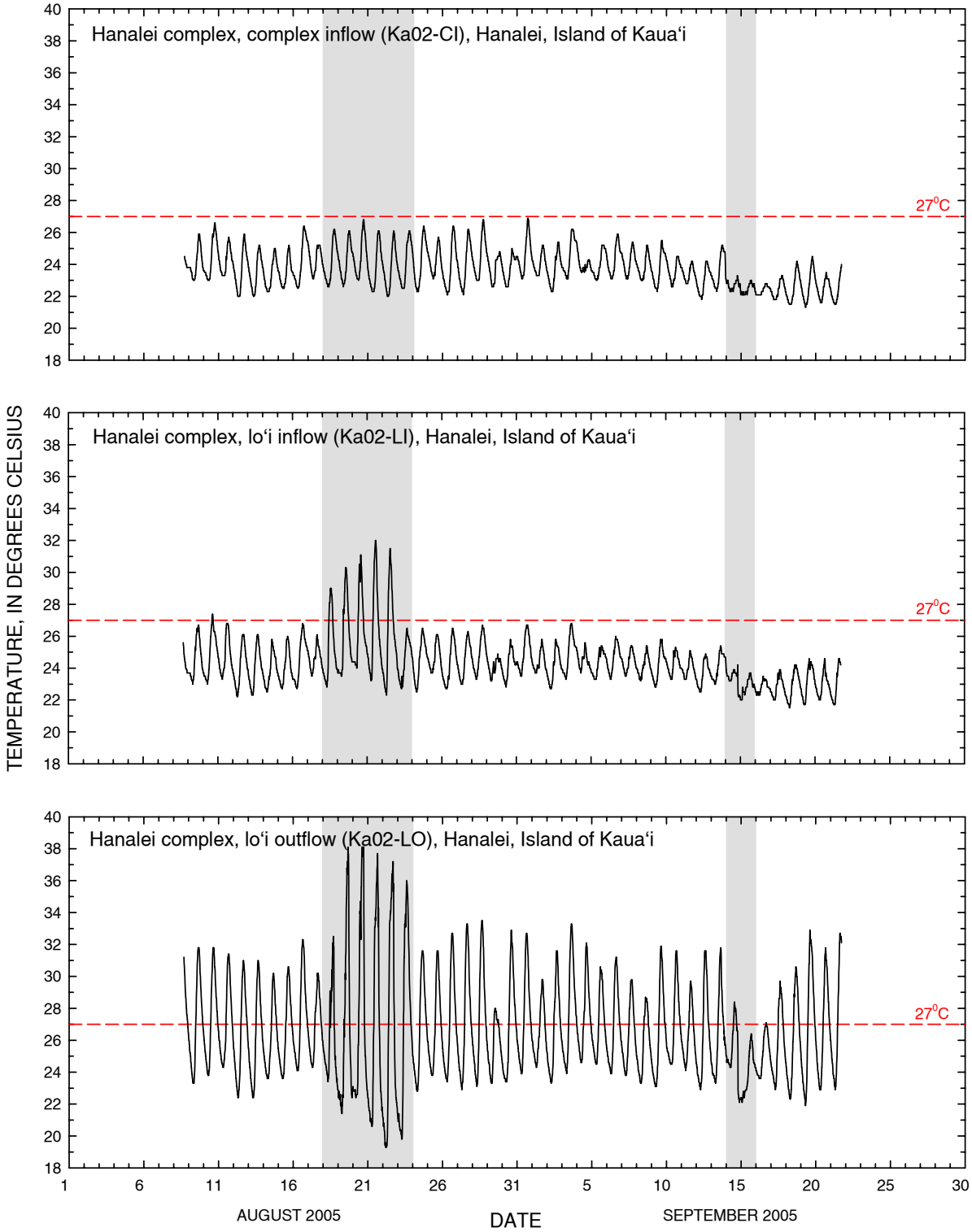


Figure 8. Hanalei lo‘i complex, Island of Kaua‘i.



Highlighted periods indicate atypical irrigation conditions. During August 18-23, the selected lo‘i was dried out for fertilization. During September 14-15, entire complex was flooded by heavy rainstorm.

Figure 9. Water temperature in Hanalei lo‘i complex, Island of Kaua‘i.

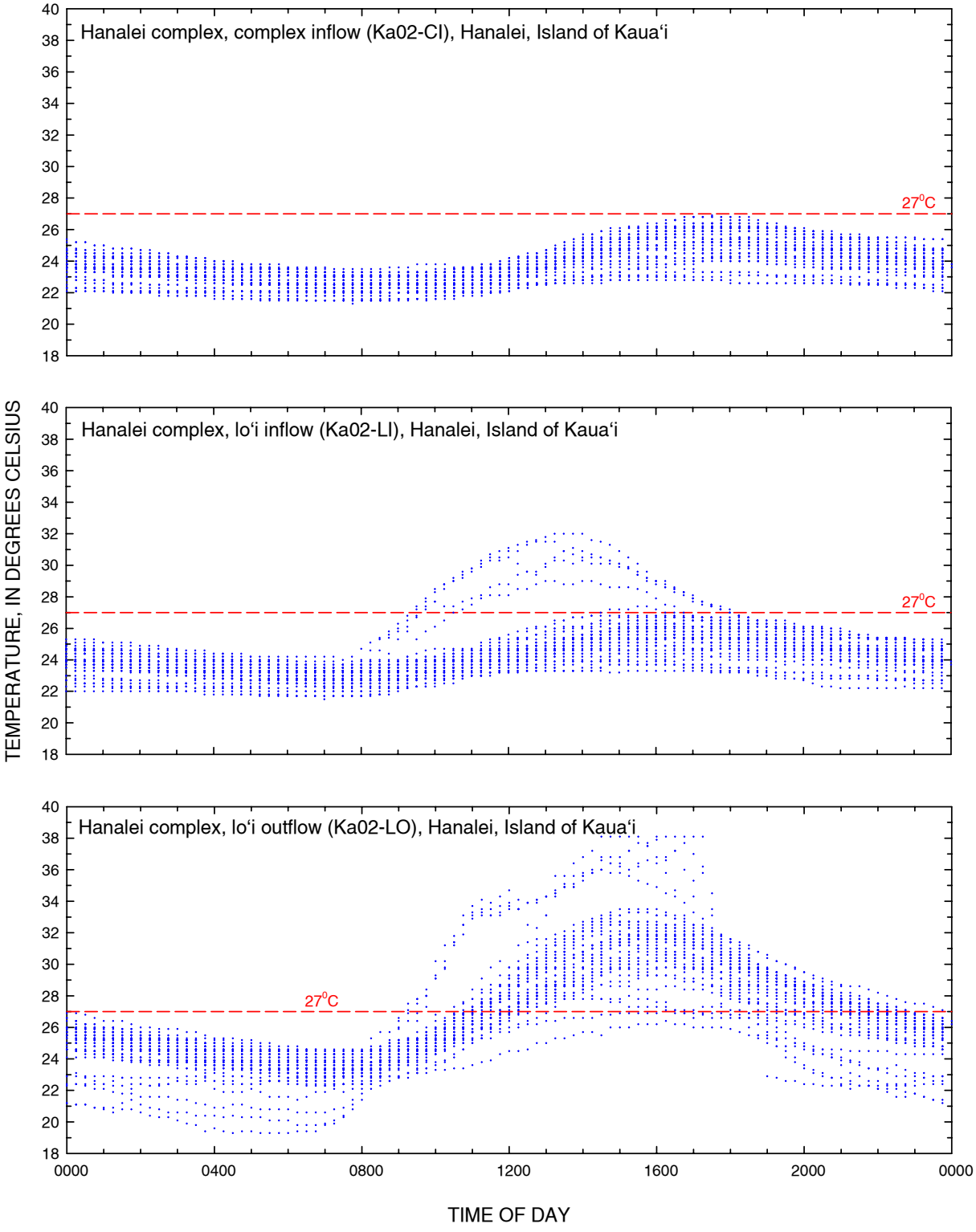


Figure 10. Daily pattern of water temperature in Hanalei Io‘i complex, Island of Kaua‘i. Plot shows all temperature data plotted against the time of day that each measurement was recorded.

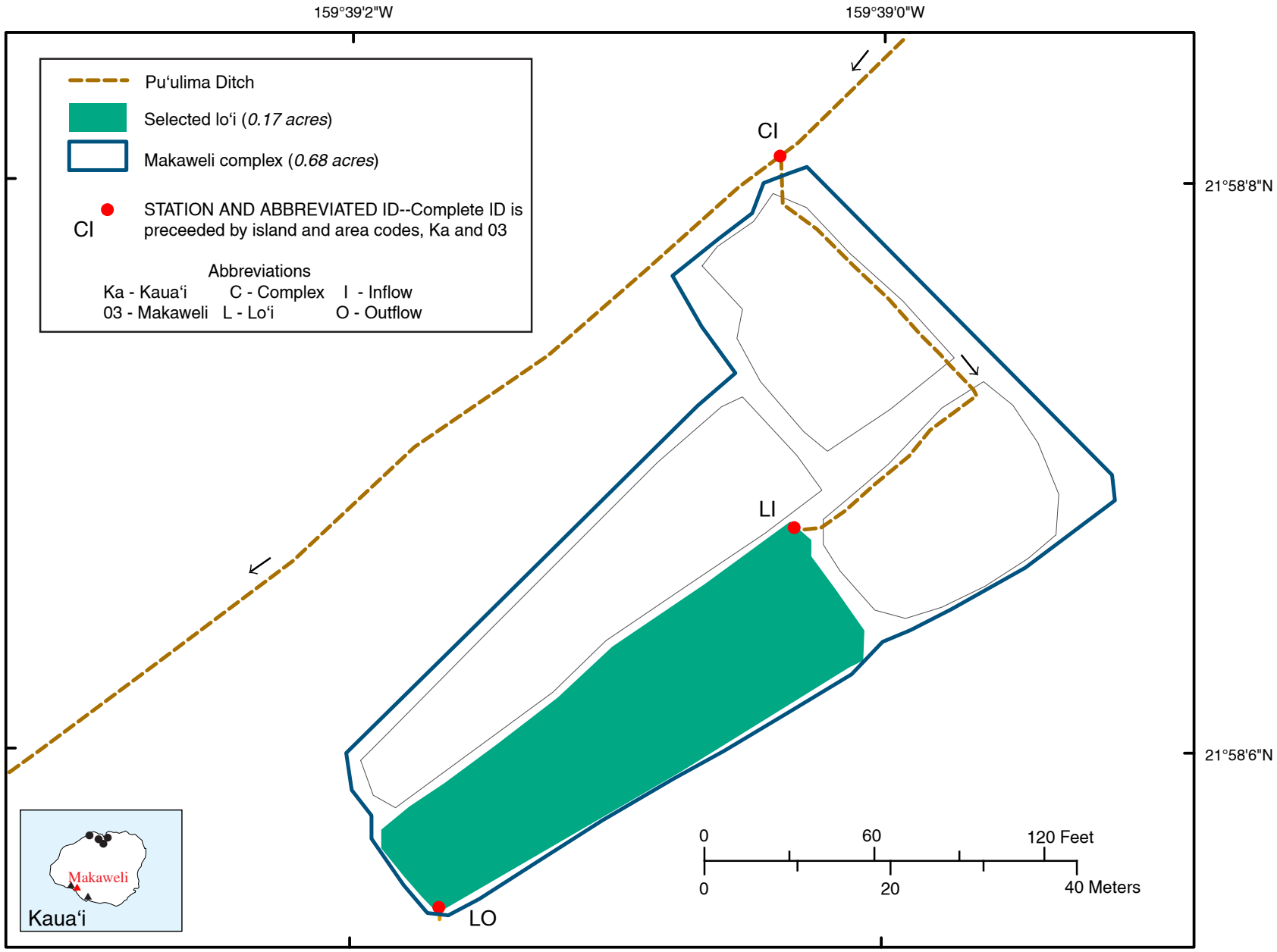
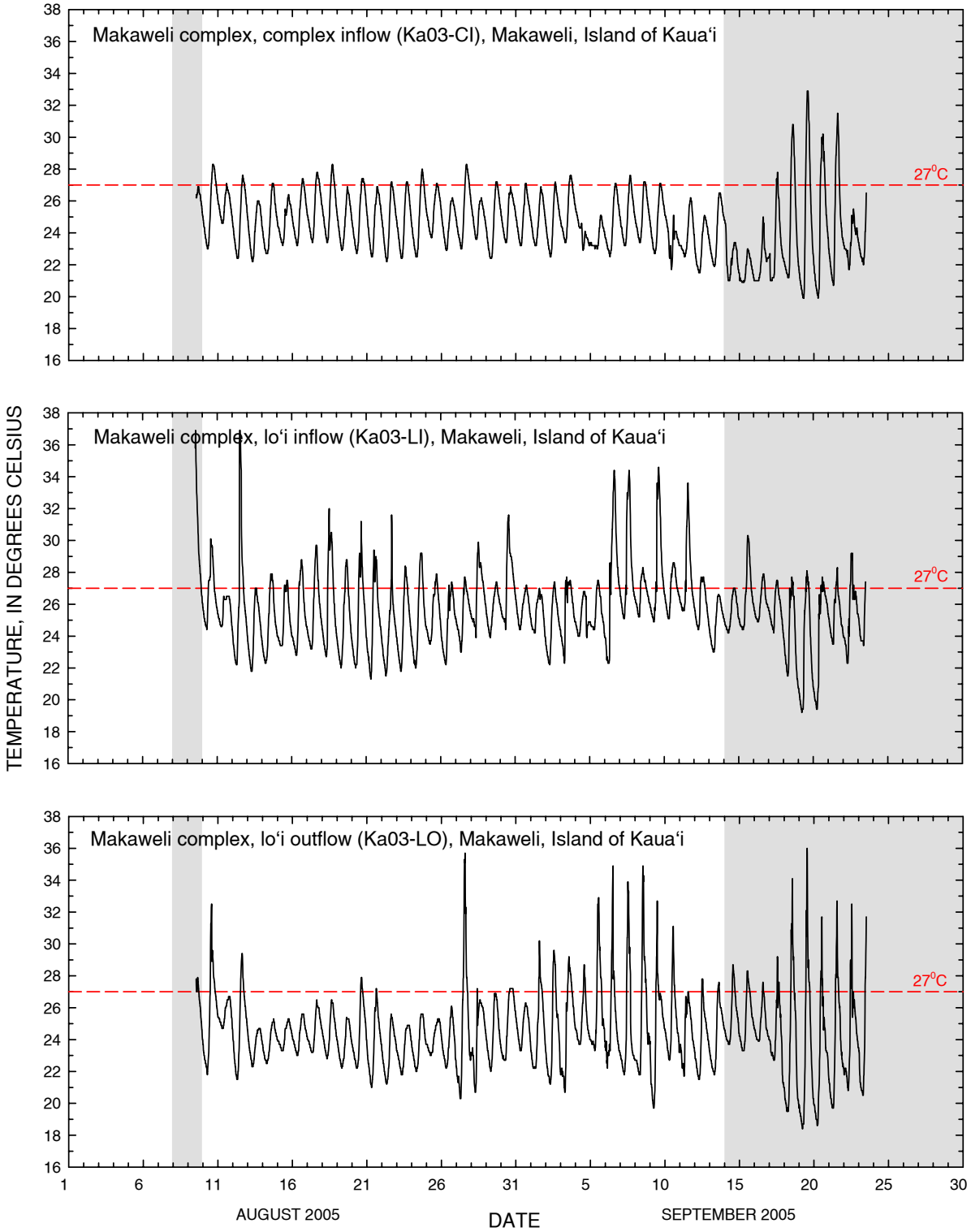


Figure 11. Makaweli lo'i complex, Island of Kaua'i.



Highlighted periods indicate atypical irrigated conditions. On August 9, at the time of first visit, no flow was going into the selected lo‘i. During September 14-15, a rainstorm deposited heavy debris upstream of the main diversion dam which significantly reduced flow in the ‘auwai for the following period.

Figure 12. Water temperature in Makaweli lo‘i complex, Island of Kaua‘i.

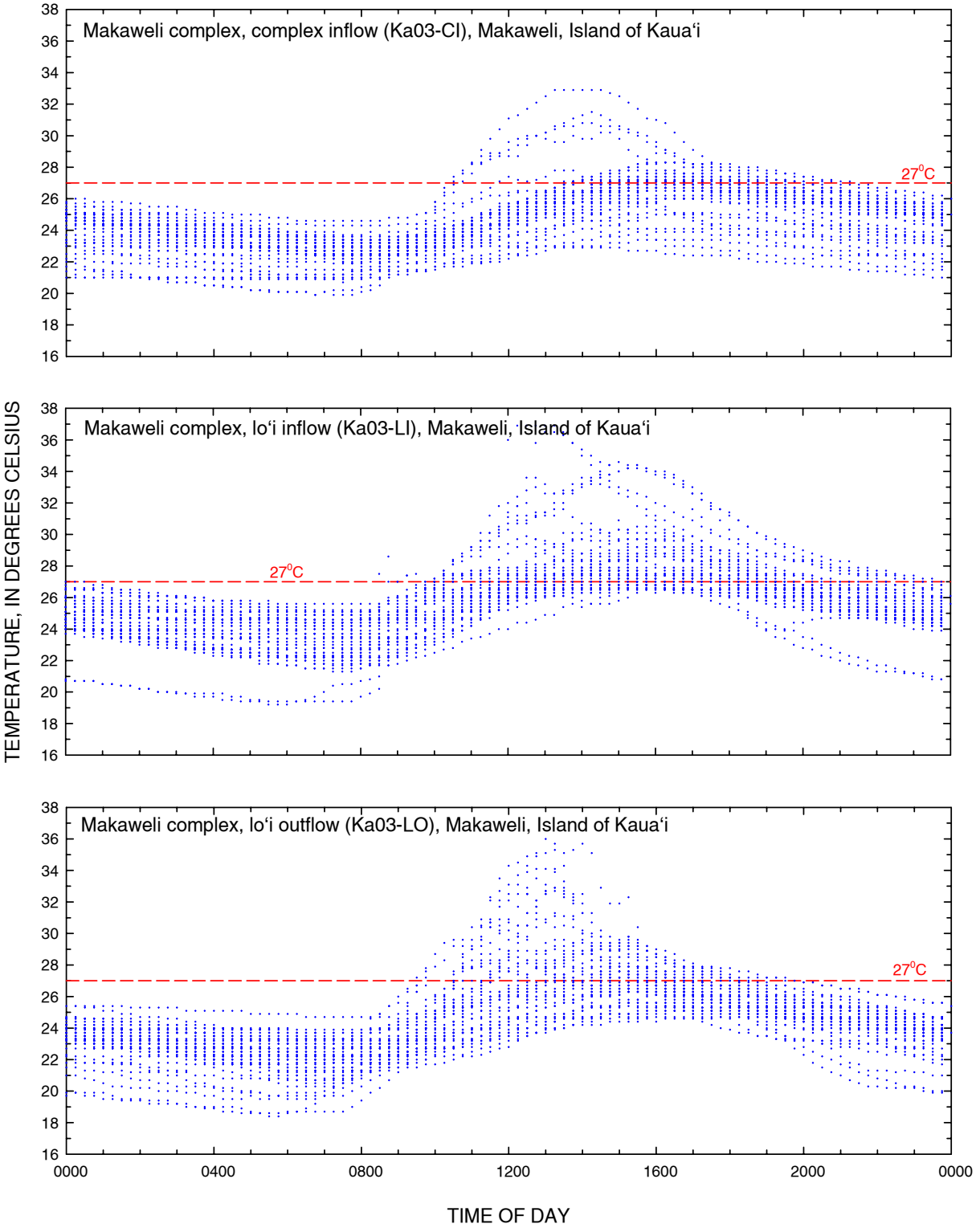


Figure 13. Daily pattern of water temperature in Makaweli lo‘i complex, Island of Kaua‘i. Plot shows all temperature data plotted against the time of day that each measurement was recorded.

O‘ahu

Three areas were measured on O‘ahu—Waiāhole and Waihe‘e (windward sites) and Hale‘iwa (leeward site). Flow measurements were made in Waiāhole on August 15, 2005, when the temperature loggers were deployed, and on October 17, 2005, when the temperature loggers were removed (tables 4 and 5). The Waiāhole area is supplied through an unnamed ‘auwai with water diverted from Waianu Stream (fig. 13). Two independent complexes were studied. Ten flow measurements were made, and seven temperature loggers were deployed at selected inflow and outflow locations (figs. 14 and 15).

Flow measurements were made in Waihe‘e on August 23, 2005, when the temperature loggers were deployed, and on October 18, 2005, when the temperature loggers were removed (tables 4 and 5). The Waihe‘e area is supplied through the Waihe‘e Ditch with water diverted far upstream from Waihe‘e Stream (fig. 16). Two lo‘i complexes were available for study in this area. Eight flow measurements were made, and four temperature loggers were deployed in the Waihe‘e area (figs. 17 and 18).

The Hale‘iwa area is supplied by ground water pumped from nearby springs and was considered to be one lo‘i complex for this study (fig. 19). No flow measurements were made because of difficulty finding places to make measurements, but the kalo farmer estimated the flow to be 1.08 Mgal/d (table 4). Three temperature loggers were deployed in the Hale‘iwa area from August 10, 2006, to September 26, 2006 (table 5; figs. 20 and 21).

Table 4. Summary of discharge measurements and areas for selected lo‘i complexes, Island of O‘ahu.

[Mgal/d, million gallons per day; gad, gallons per acre per day; na, not applicable, average water use is determined by summing the averages of each complex or lo‘i and dividing by the number of complexes or lo‘i]

		Complex						Lo‘i					
Geographic designation	Area	Station	Irrigation area (acre)	Date	Measurement time	Discharge (Mgal/d)	Water use (gad)	Station	Irrigation area (acre)	Date	Measurement time	Discharge (Mgal/d)	Water use (gad)
Windward	Waiāhole	Oa04A-CI	1.00	8/15/2005	1019	0.35	350,000	Oa04A-LI	0.12	8/15/2005	1045	0.080	660,000
				10/17/2005a	0932	0.25	250,000			10/17/2005	1009	0.033	270,000
		Oa04B-CI	0.71	8/15/2005	1325	0.42	590,000	Oa04B-LI	0.12	8/15/2005	1420	0.045	390,000
				10/17/2005b	1252	0.72	1,000,000			10/17/2005	1327	0.080	690,000
								Oa04B-LO		8/15/2005	1516	0.012	na
										10/17/2005	1345	0.060	na
Windward	Waihe‘e	Oa05A-CI	1.94	8/23/2005	1340	0.59	300,000	Oa05B-LI	0.21	8/23/2005	1258	0.11	520,000
				10/18/2005	1439	0.52	270,000			10/18/2005	1047	0.047	230,000
		Oa05B-CI	1.02	8/23/2005	1318	0.15	150,000	Oa05B-LO		8/23/2005	1204	0.047	na
				10/18/2005	1021	0.12	120,000			10/18/2005	1604	0.030	na
Leeward	Hale‘iwa	Oa06-CI	25.14	na	na	1.08c	44,000	Oa06-LI	0.70	9/26/2006	1023	0.15	210,000
number			5				5		4				4
minimum			0.71				44,000		0.12				210,000
maximum			25.14				1,000,000		0.70				690,000
average			1.17				310,000		0.29				400,000

[a]‘auwai overflow upstream of measurement site resulting from backwater conditions caused by debris in the ‘auwai; reason for lower flow.

[b]‘auwai had just been cleaned; reason for higher flow.

[c]Estimated pumping rate of 750 gal/min (by farmer) from nearby spring to irrigate lo‘i complexes

Table 5. Water-temperature statistics based on measurements collected at 15-minute intervals for lo‘i complexes on the Island of O‘ahu.

[˚C, degrees Celsius; na, not applicable]

Geographic designation	Area	Station	Period of record	Temperature (˚C)			Range of times daily peak temperatures occurred	Temperature measurements greater than 27˚C		
				Mean	Range	Mean daily range		Percent	Earliest time of day	Latest time of day
Windward	Waiãhole	Oa04A-CI	8/15/2005 – 10/17/2005	21.4	20.5 – 23.3	1.4	1030 – 2345	0.0	na	na
		Oa04A-LI	8/15/2005 – 10/17/2005	21.5	20.4 – 23.4	1.5	0945 – 2345	0.0	0000	0000
		Oa04A-LO	8/15/2005 – 10/17/2005	24.6	20.8 – 35.7	8.5	1100 – 1730	21.6	1030	1845
		Oa04B-CI	8/15/2005 – 10/17/2005	21.7	20.5 – 24.2	1.5	1100 – 2345	0.0	0000	0000
		Oa04B-LI	8/15/2005 – 10/17/2005	21.9	20.5 – 24.5	1.7	1100 – 1730	0.0	na	na
		Oa04B-LO	8/15/2005 – 10/17/2005	24.5	20.5 – 35.3	7.6	1015 – 1530	21.4	0915	1915
			8/15/2005 – 10/17/2005	23.0	20.5 – 29.7	4.1	1045 – 1600	2.5	1130	1645
Windward	Waihe‘e	Oa05A-CI	8/23/2005 – 10/18/2005	21.6	20.7 – 22.7	0.7	1045 – 2345	0.0	0000	0000
		Oa05B-CI	8/23/2005 – 10/18/2005	21.8	20.7 – 23.9	1.2	1030 – 1545	0.0	0000	0000
		Oa05B-LI	8/23/2005 – 10/18/2005	22.0	20.7 – 24.9	1.5	1030 – 1500	0.0	0000	0000
		Oa05B-LO	8/23/2005 – 10/18/2005	25.0	21.4 – 35.3	4.9	1030 – 1700	22.3	0900	2200
Leeward	Hale‘iwa	Oa06-CI	8/10/2006 – 9/26/2006	23.2	22.6 – 24.2	0.7	0700 – 1800	0.0	na	na
		Oa06-LI	8/10/2006 – 9/26/2006	25.2	21.7 – 31.0	4.1	0930 – 1830	23.2	1100	2145
		Oa06-L	8/10/2006 – 9/26/2006	26.3	21.9 – 35.1	5.4	1315 – 1730	34.5	1000	2215

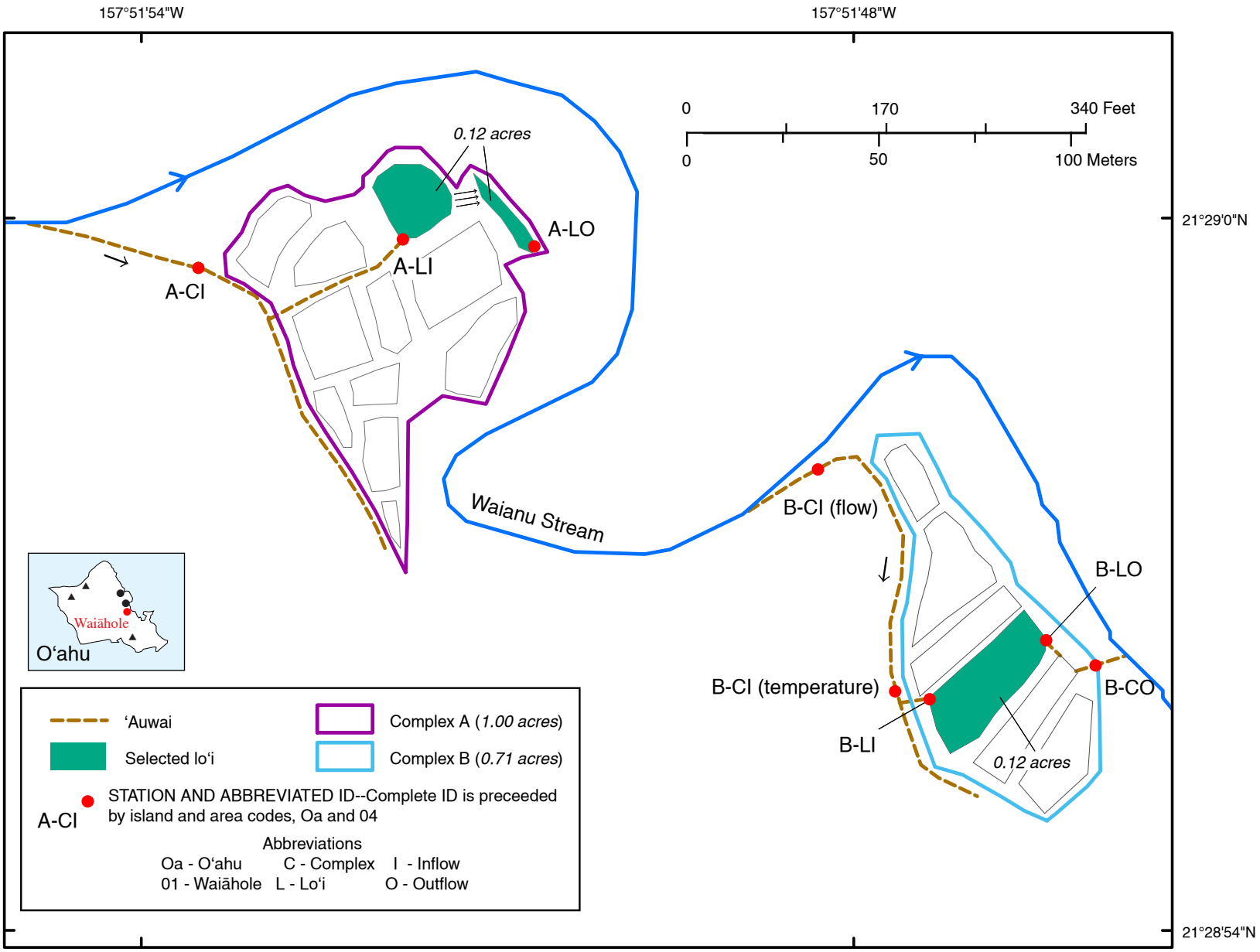
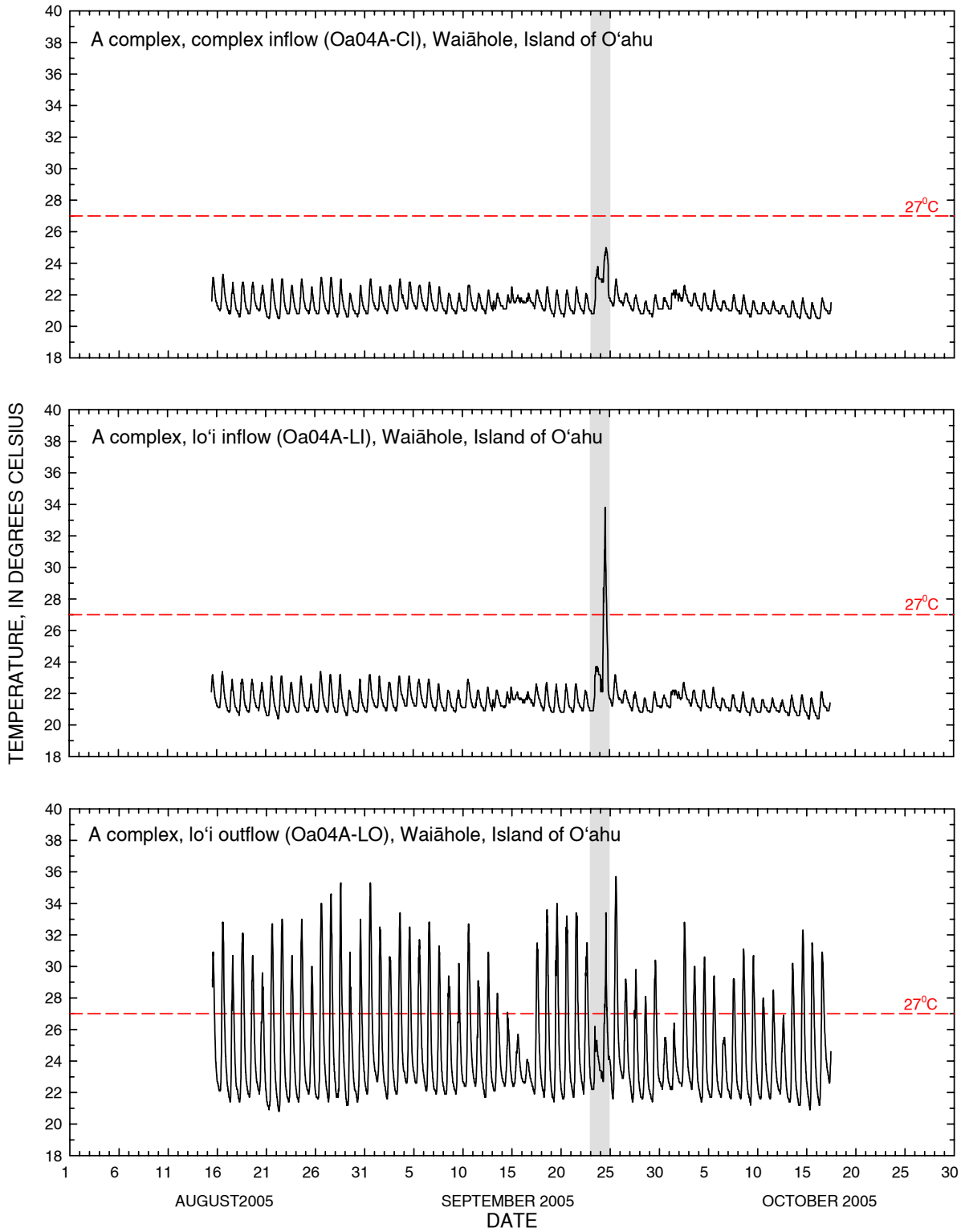
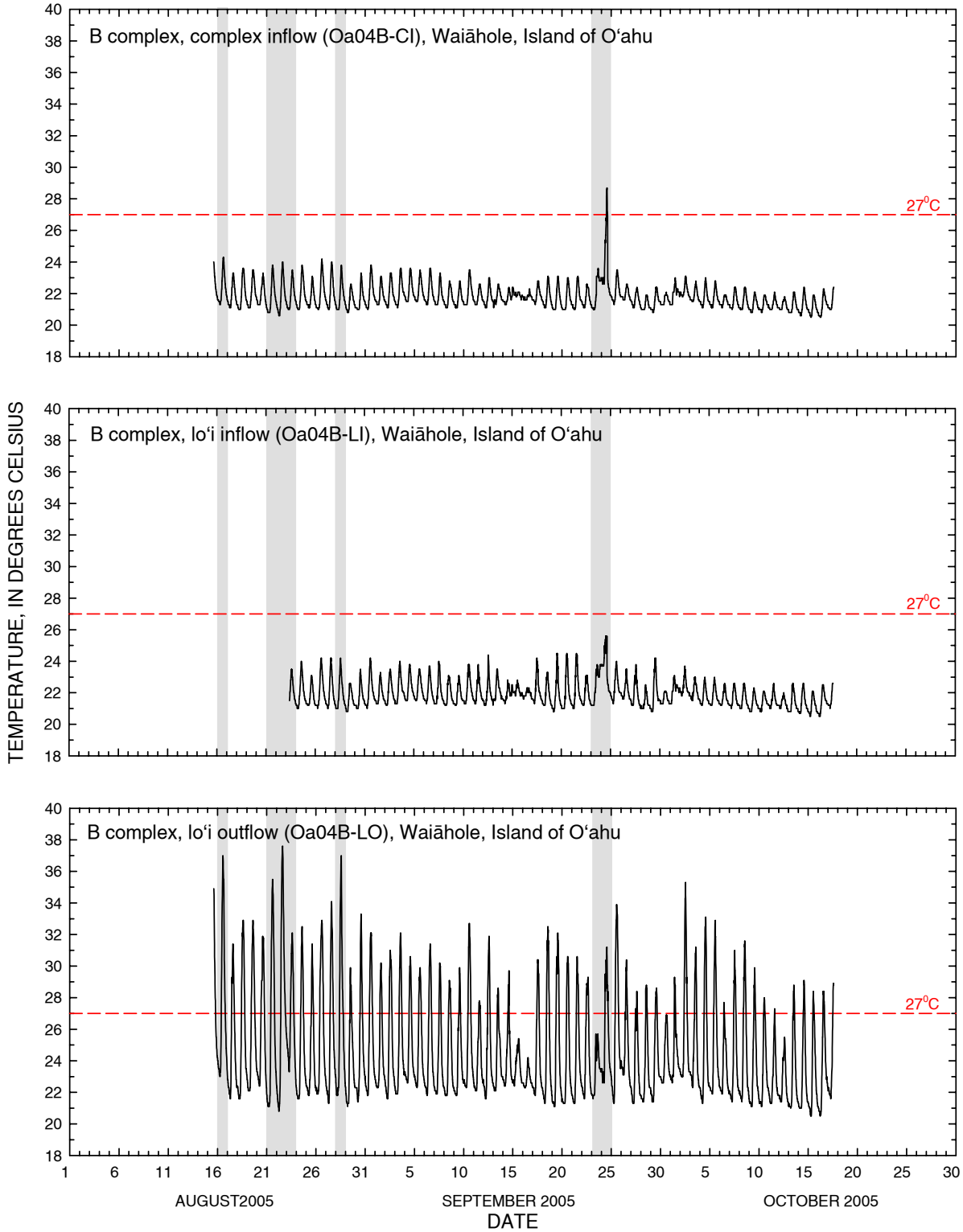


Figure 14. Waiāhole lo'i complexes, Island of O'ahu.



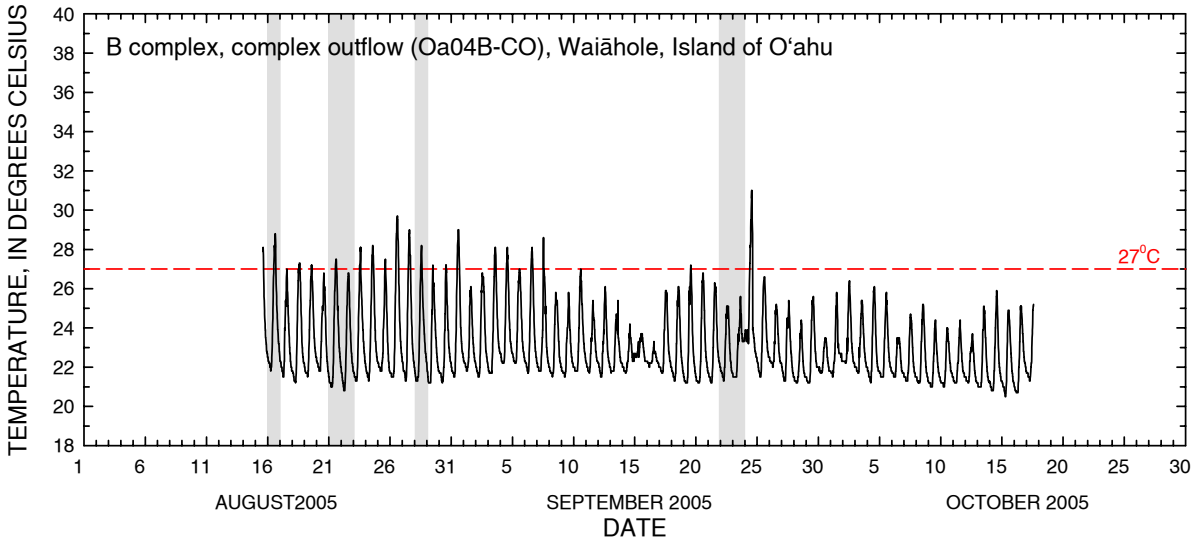
Highlighted periods indicate atypical irrigated conditions. On September 23, a heavy rainstorm flooded the complex and deposited debris around diversion dam and ‘auwai which significantly reduced inflow on the following day and caused the water temperature to rise.

Figure 15. Water temperature in Waiāhole lo‘i complexes, Island of O‘ahu.



Highlighted periods indicate atypical irrigated conditions. On August 16, 21-23, farmer noted that intake pipe to the selected lo‘i was shut off for weeding. On August 28, field inflow was lower than normal. On September 23, heavy rainstorm flooded the complex and deposited debris around diversion dam and ‘auwai which significantly reduced inflow on the following day and caused water temperature to rise.

Figure 15. *Continued.*



Highlighted periods indicate atypical irrigated conditions. On August 16, 21-23, farmer noted that intake pipe to the selected lo‘i was shut off for weeding. On August 28, field inflow was lower than normal. On September 23, heavy rainstorm flooded the complex and deposited debris around diversion dam and ‘auwai which significantly reduced inflow on the following day and caused water temperature to rise.

Figure 15. *Continued.*

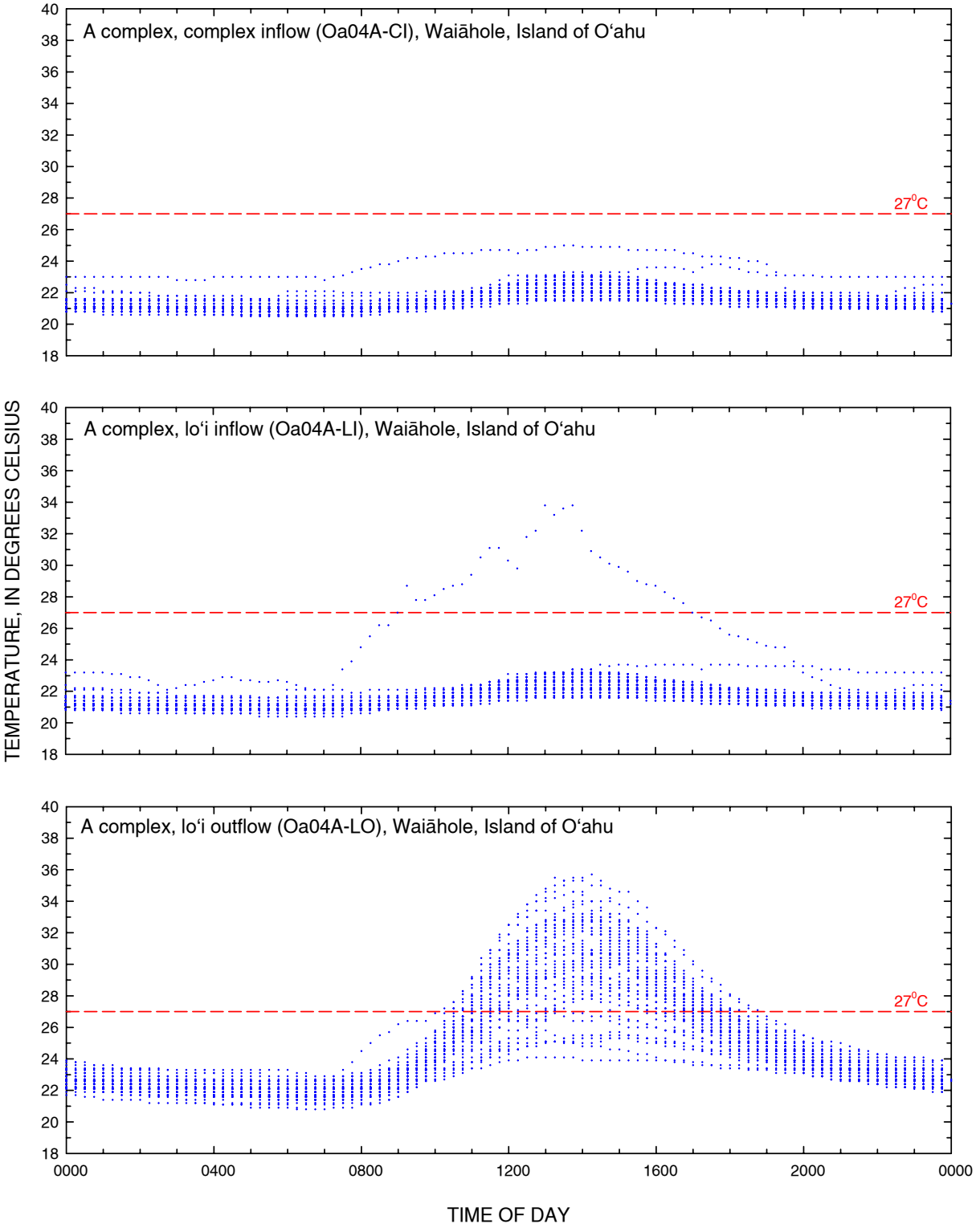


Figure 16. Daily pattern of water temperature in Waiāhole lo‘i complexes, Island of O‘ahu.

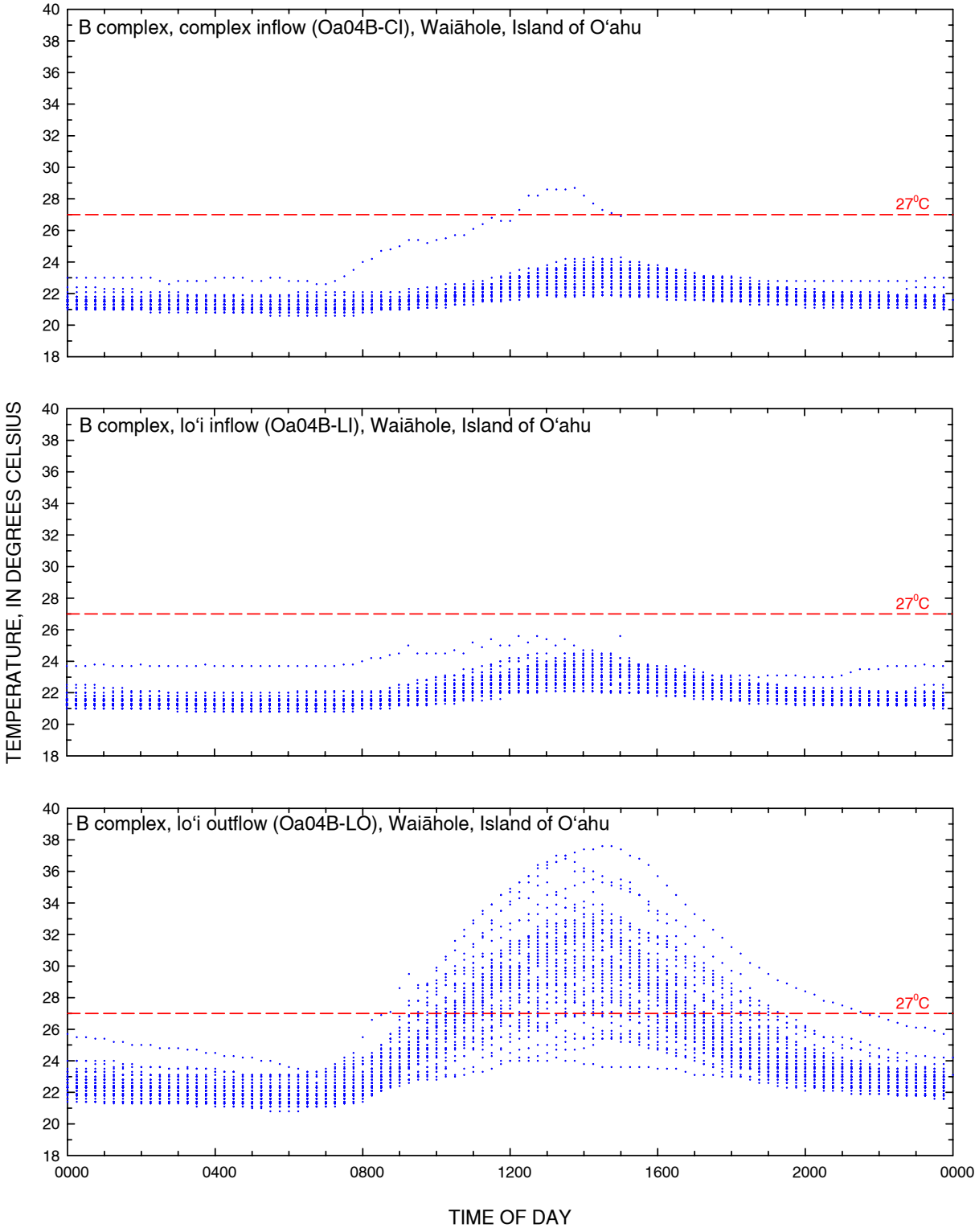


Figure 16. *Continued.*

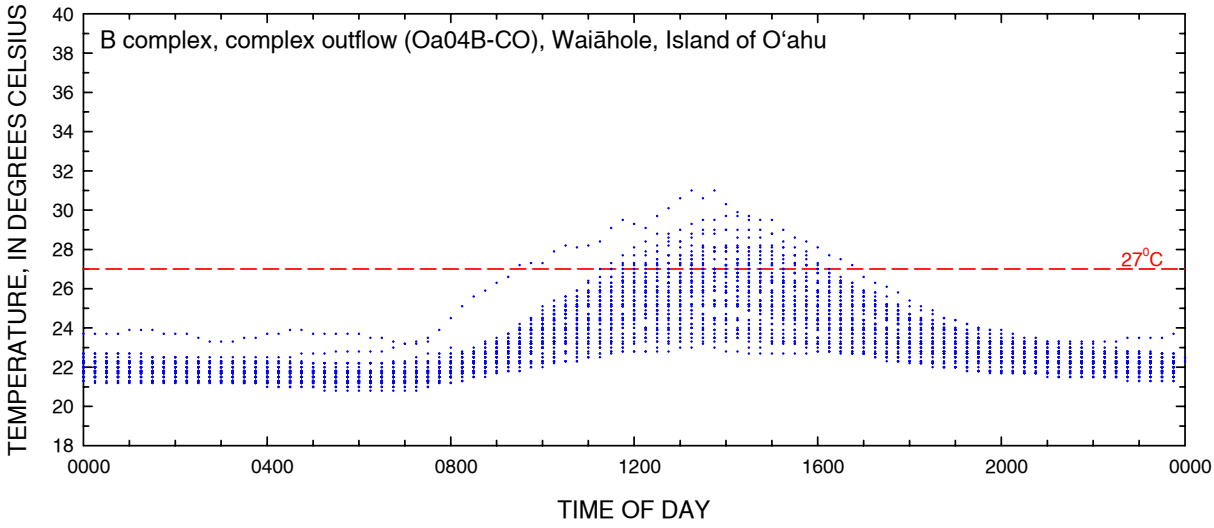


Figure 16. *Continued.*

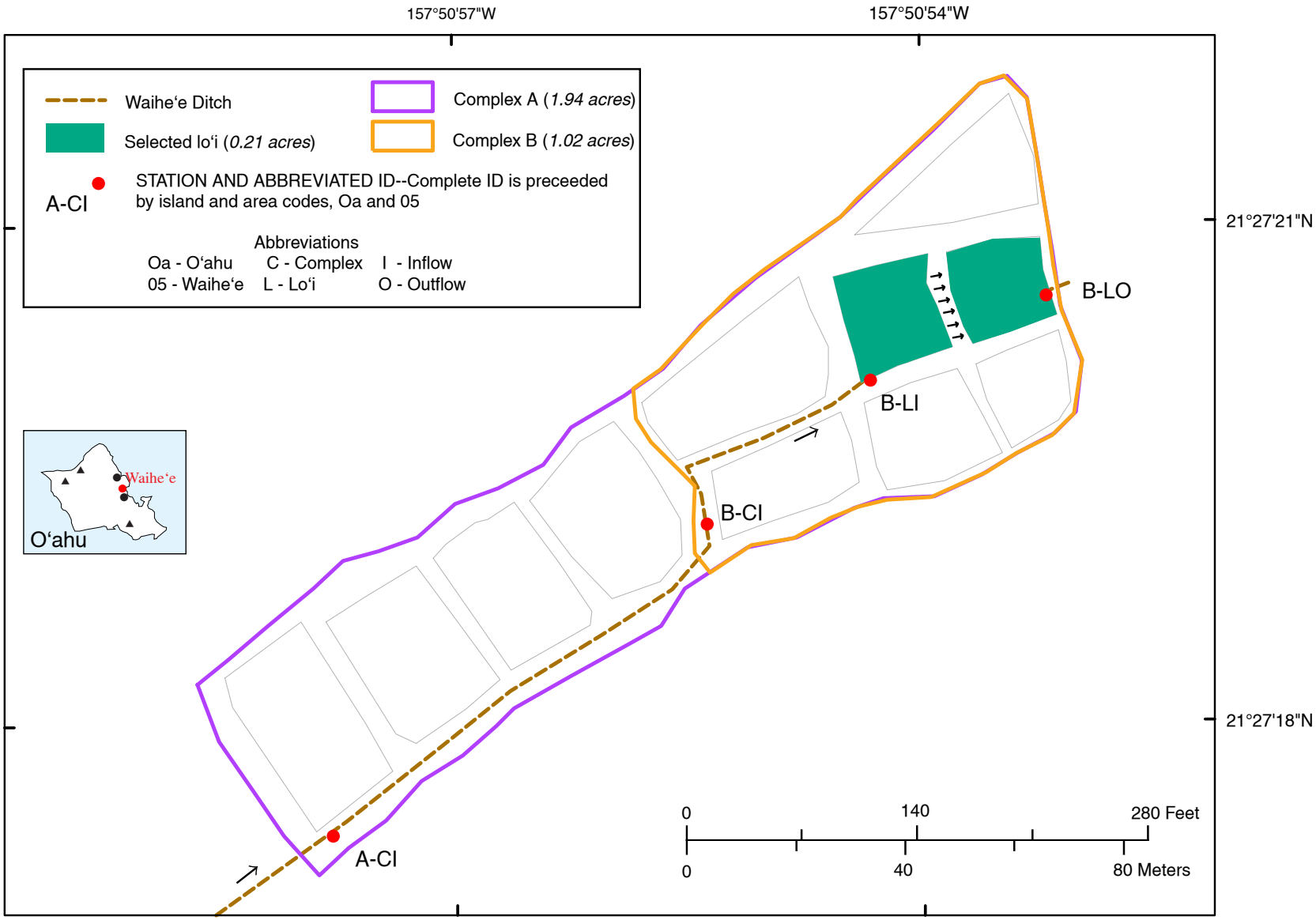
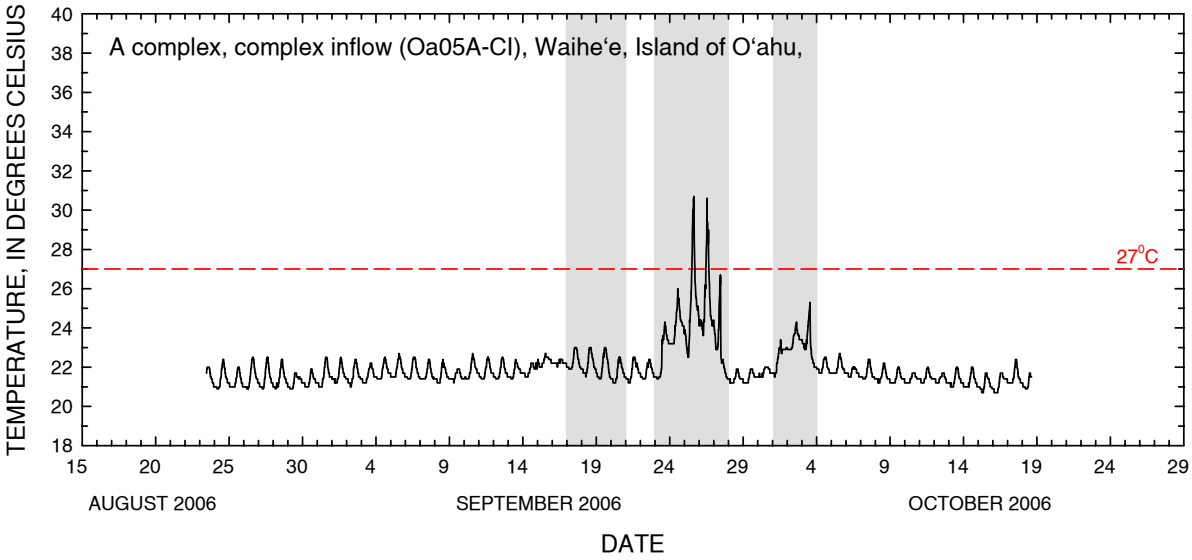
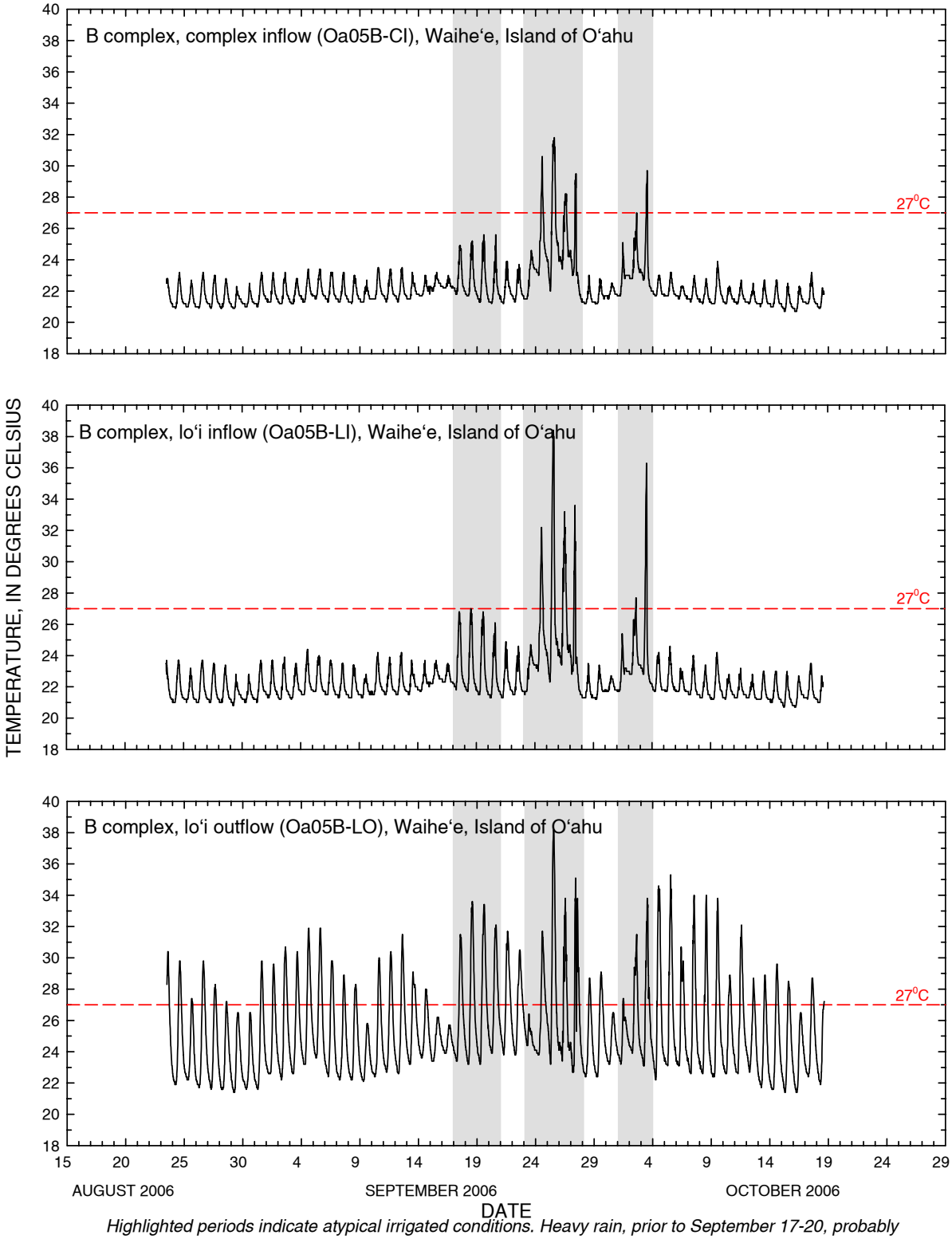


Figure 17. Waihe'e lo'i complex, Island of O'ahu.



Highlighted periods indicate atypical irrigated conditions. Heavy rain, prior to September 17-20, probably clogged intake and reduced flow to complex which caused the rise in water temperatures. On September 23, heavy rainstorm flooded the complex and deposited debris to upstream diversion dam and ʻauwai which significantly reduced inflow to complex and caused water temperatures to rise. During October 1-4, upstream diversion dam was being repaired which probably caused the reduction in flow and rise in water temperatures.

Figure 18. Water temperature in Waiheʻe loʻi complexes, Island of Oʻahu.



Highlighted periods indicate atypical irrigated conditions. Heavy rain, prior to September 17-20, probably clogged intake and reduced flow to complex which caused the rise in water temperatures. On September 23, heavy rainstorm flooded the complex and deposited debris to upstream diversion dam and ʻauwai which significantly reduced inflow to complex and caused water temperatures to rise. During October 1-4, upstream diversion dam was being repaired which probably caused the reduction in flow and rise in water temperatures.

Figure 18. *Continued.*

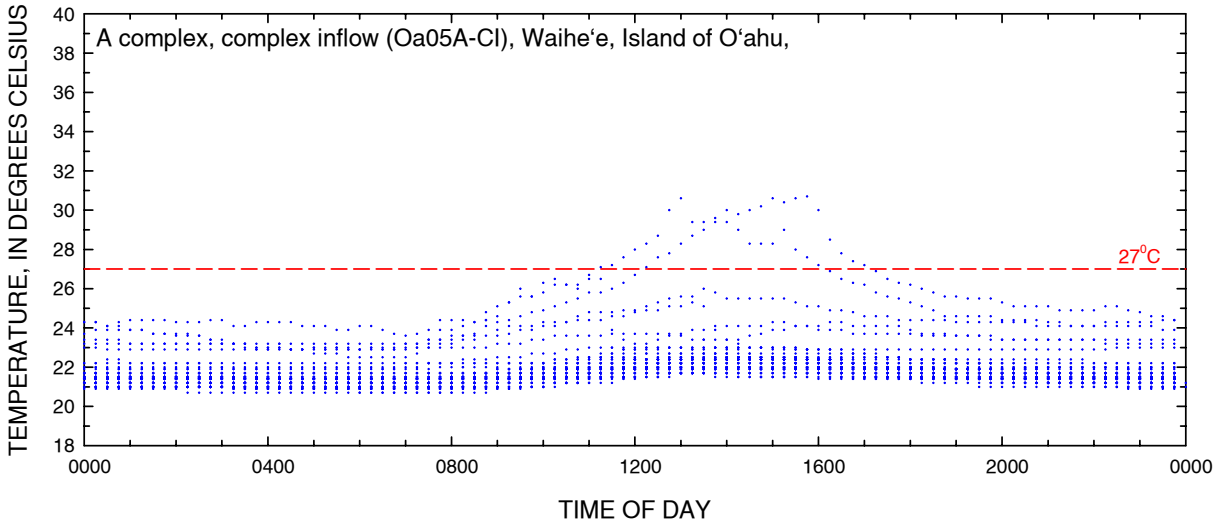


Figure 19. Daily pattern of water temperature in Waiheʻe Loʻi complex, Island of Oʻahu. Plot shows all temperature data plotted against the time of day that each measurement was recorded.

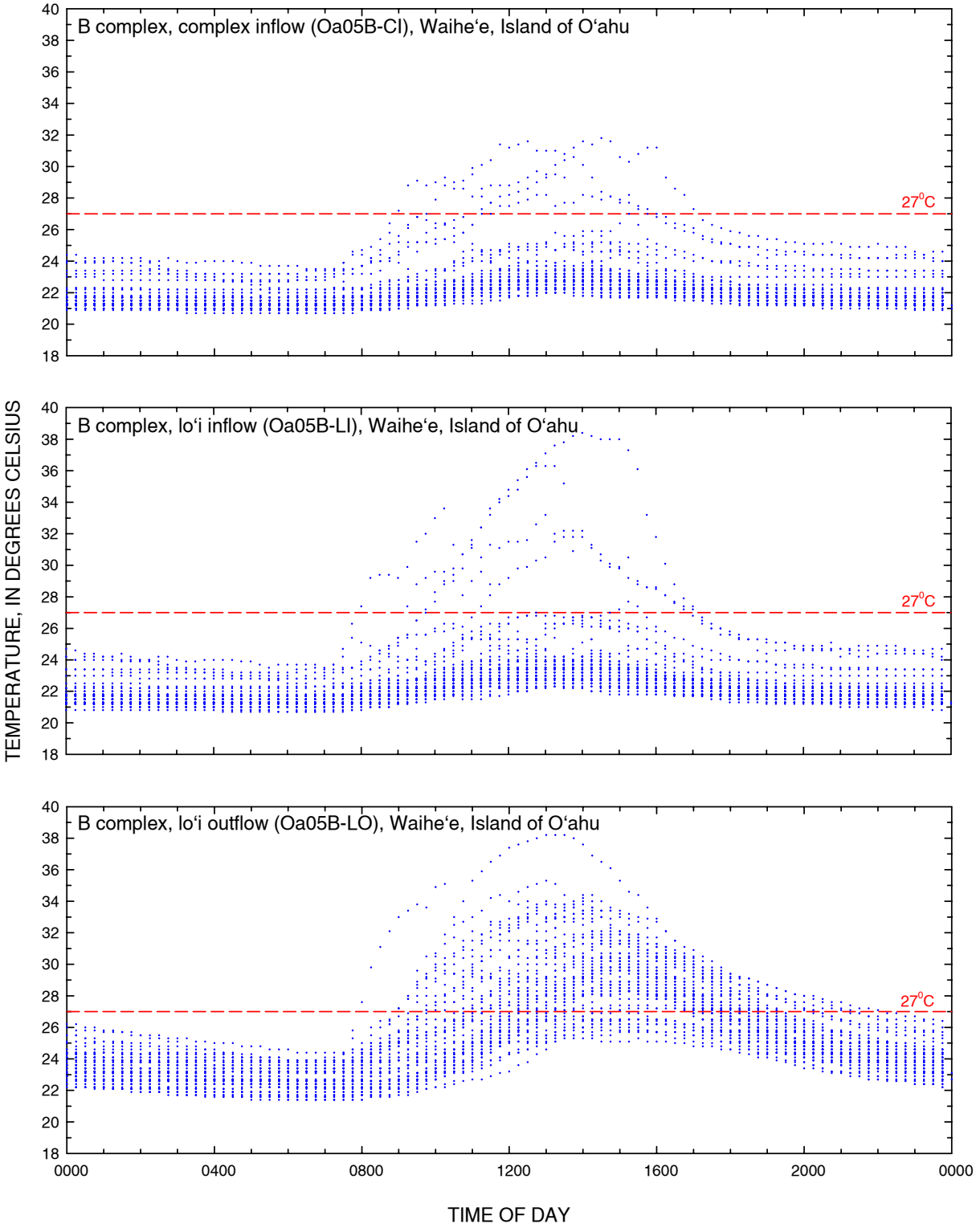


Figure 19. *Continued.*

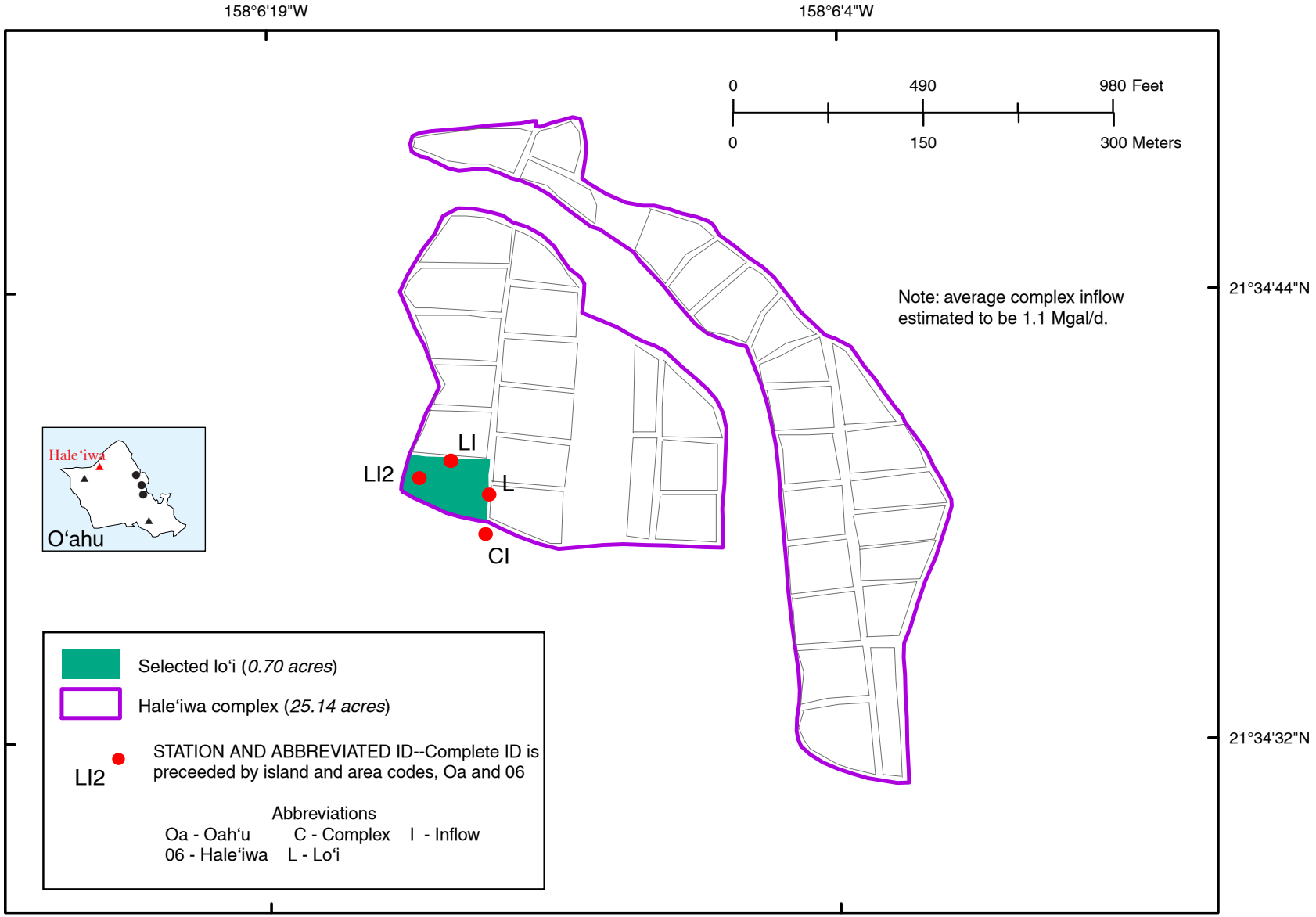


Figure 20. Hale‘iwa lo‘i complex, Island of O‘ahu.

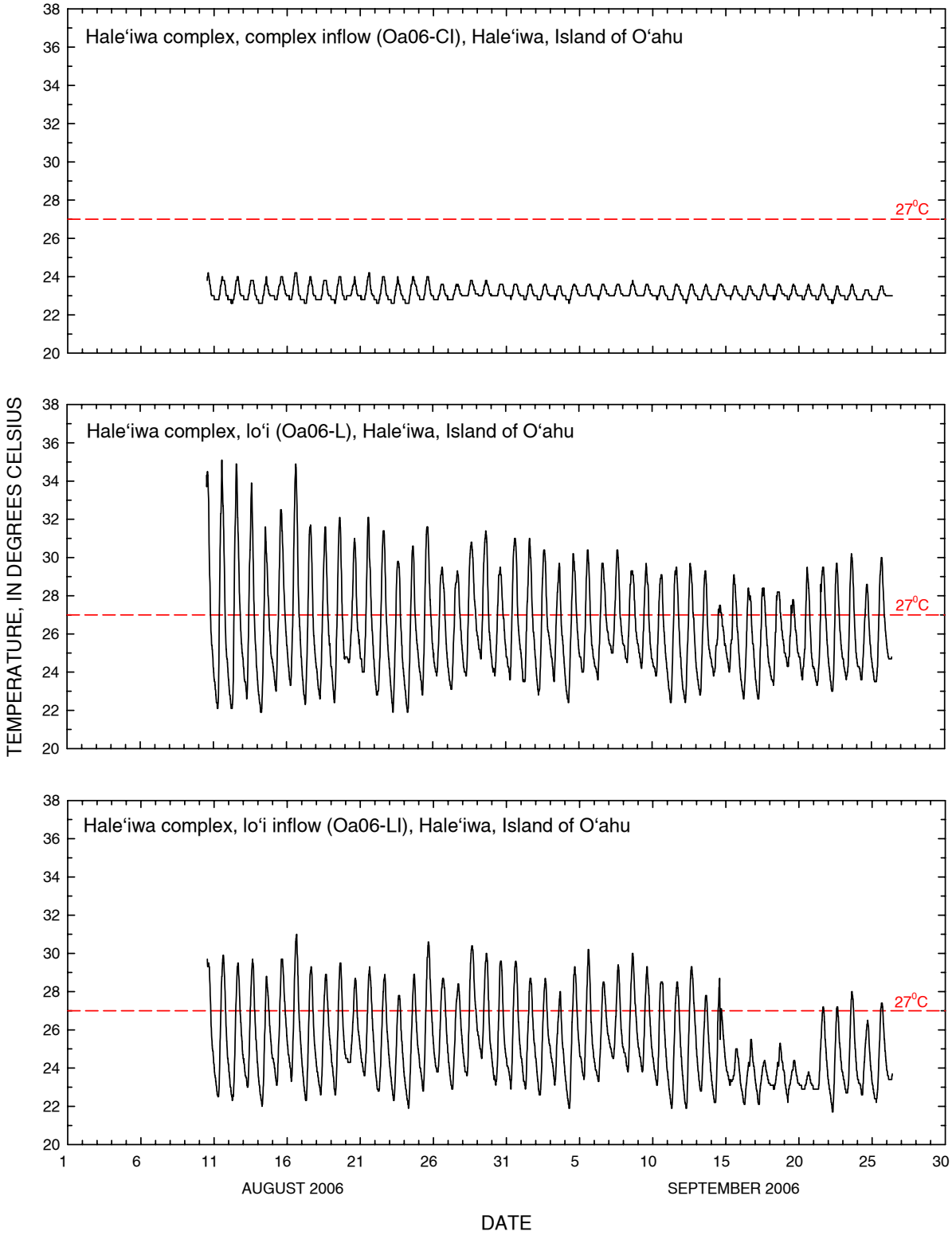


Figure 21. Water temperature in Hale‘iwa lo‘i complexes, Island of O‘ahu.

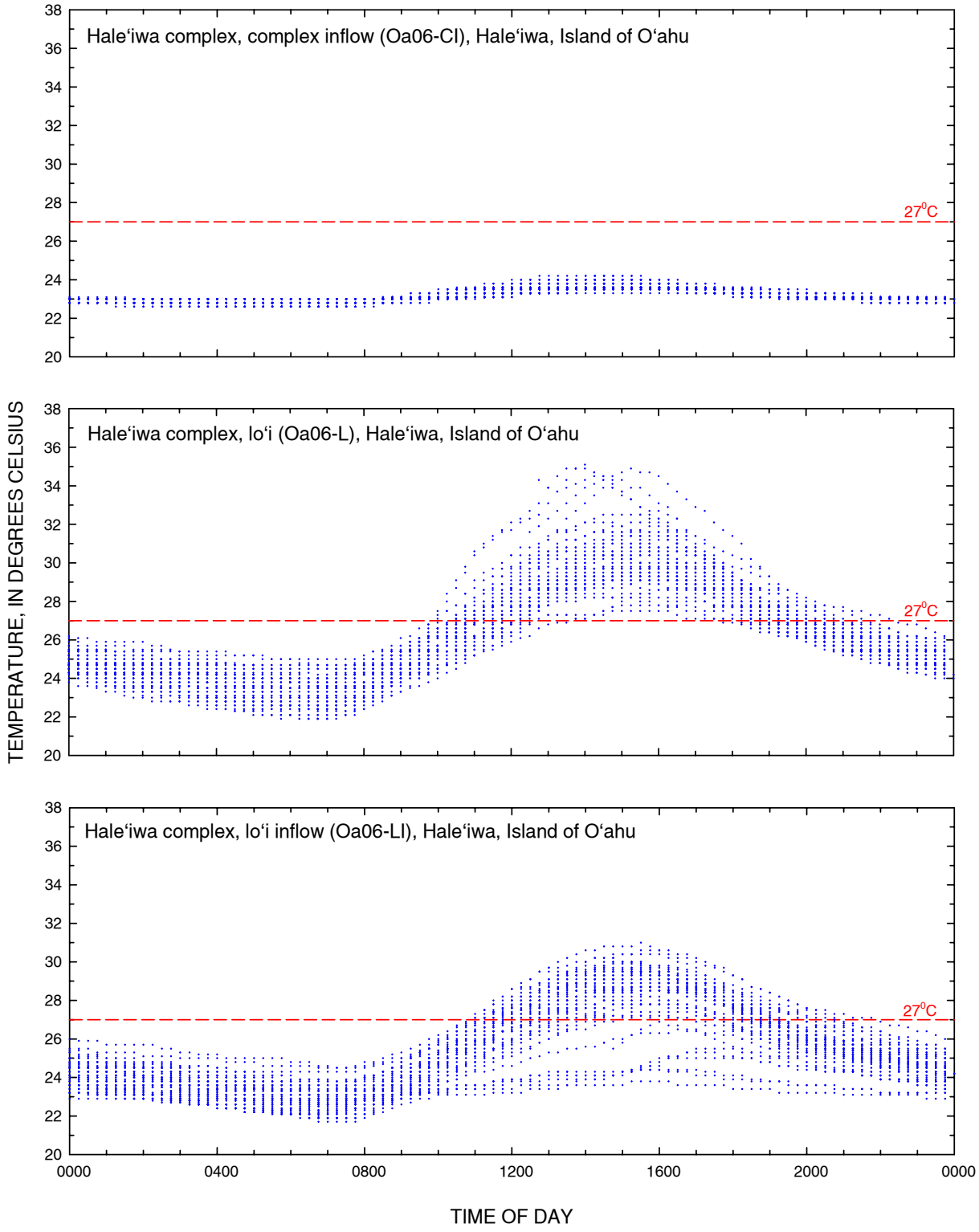


Figure 22. Daily pattern of water temperature in Hale‘iwa Io‘i complex, Island of O‘ahu. Plot shows all temperature data plotted against the time of day that each measurement was recorded.

Maui

Three areas were measured on Maui—Waiheʻe, Wailua, and Keʻanae, all windward sites. Flow measurements were made July 29-31, 2006, when the temperature loggers were deployed, and September 21-22, 2006, when the temperature loggers were removed (tables 6 and 7). The Waiheʻe area gets water through an ʻauwai supplied by Spreckel's Ditch with water diverted from the Waiheʻe River (fig. 22). The Waiheʻe area was considered to be two loʻi complexes (an upper and a lower complex), both of which were studied. Eight flow measurements were made, and three temperature loggers were deployed at selected inflow and outflow locations (figs. 23 and 24).

The Wailua area contains numerous loʻi complexes, three of which were available for study—Lakini, Wailua, and Waikani. The Lakini loʻi complex is supplied through an ʻauwai with water diverted from Hamau Stream. Hamau Stream receives diverted water from Waiokomilo Stream further upstream (fig. 25). The Lakini area was considered to be one loʻi complex in this study. Eight flow measurements were made, and two temperature loggers were deployed in the Lakini area (figs. 26 and 27). In addition to the five flow measurements made to determine flow directly into the complex, two measurements were made in the ʻauwai upstream of all loʻi complexes to determine the amount of flow available for all downstream loʻi complexes (July 30, 2006, 2.31 Mgal/d and September 21, 2006, 1.37 Mgal/d), and one measurement was made in Hamau Stream (*NWIS link*) downstream of the ʻauwai diversion to determine how much water remained in the stream (July 30, 2006, 0.54 Mgal/d).

The loʻi complex named Wailua in this study is supplied through an ʻauwai with water diverted from Waiokomilo Stream (fig. 28). Two flow measurements were made, and one temperature logger was deployed in the Wailua area (figs. 29 and 30).

The Waikani area is supplied through an ʻauwai with water diverted from Wailuanui Stream (fig. 31). Two flow measurements were made, and two temperature loggers were deployed in the Waikani area (figs. 32 and 33).

The Keʻanae area has numerous loʻi and all active loʻi were treated as one loʻi complex supplied by the Keʻanae Flume, which diverts water from Pālauhulu Stream (fig. 34). Two flow measurements were made, and two temperature loggers were deployed in the Keʻanae area (figs. 35 and 36) but the loʻi complex outlet temperature logger (Ma12-CO) failed to collect data during the deployment. Flow measurements were made near the flume intake at the site of a former USGS streamflow gaging station (Taro patch feeder ditch at Keʻanae, Maui, station *16522000*) where the median flow from 1934 to 1968 was 2.2 Mgal/d.

Table 6. Summary of discharge measurements and areas for selected lo‘i complexes, Island of Maui.

[Mgal/d, million gallons per day; gad, gallons per acre per day; na, not applicable; average water use is determined by summing the averages of each complex or lo‘i and dividing by the number of complexes or lo‘i]

Geographic designation	Area	Complex						
		Station	Irrigation area (acre)	Date	Measurement time	Discharge (Mgal/d)	Water use (gad)	Remarks
Windward	Waihe‘e	Ma08A-CI	2.30	7/29/2006	1501	0.34	150,000	total flow for upper and lower complexes
				9/22/2006	1158	0.30	130,000	total flow for upper and lower complexes
		Ma08B-CIR	na	7/29/2006	1500	0.025		
		Ma08B-CIL	na			0.060		
			0.76		na	0.085	110,000	combined right and left complex inflows
		Ma08B-CIR	na	9/22/2006	1150	0.058		
		Ma08B-CIL	na		1055	0.067		
			0.76		na	0.13	160,000	combined right and left complex inflows
Windward	Wailua (Lakini)	Ma09-CIR	na	7/30/2006	1004	0.26		
		Ma09-CIL	na		0947	0.30		
			0.74		na	0.56	750,000	combined right and left complex inflows
		Ma09-CIR	na	9/21/2006	1015	0.16		
		Ma09-CIL	na		1049	0.058		
		Ma09-CIM	na		1206	0.19		
			0.74		na	0.41	550,000	combined right, left, and middle complex inflows
Windward	Wailua	Ma10-CI	3.32	7/30/2006	1136	0.59	180,000	
				9/21/2006	0845	0.46	140,000	
Windward	Wailua (Waikani)	Ma11-CI	2.80	7/30/2006	1236	0.54	190,000	
				9/21/2006	1608	0.26	93,000	
Windward	Ke‘anae	Ma12-CI	10.53	7/31/2006	0836	1.9	180,000	former U.S. Geological Survey streamflow-gaging station
				9/21/2006	1415	1.6	150,000	
number			6				6	
minimum			0.74				93,000	
maximum			10.53				750,000	
average			3.41				230,000	

Table 7. Water-temperature statistics based on measurements collected at 15-minute intervals for lo‘i complexes on the Island of Maui.

[˚C, degrees Celsius; na, not applicable]

Geographic designation	Area	Station	Period of record	Temperature (˚C)			Range of times daily peak temperatures occurred	Temperature measurements greater than 27˚C		
				Mean	Range	Mean daily range		Percent	Earliest time of day	Latest time of day
Windward	Waihe‘e	Ma08A-CI	7/29/2006 – 9/22/2006	21.6	19.9 – 24.0	2.0	1015 – 1845	0.0	na	na
		Ma08B-CIL	7/29/2006 – 9/22/2006	24.9	20.3 – 34.0	7.6	1130 – 1615	25.4	0930	1915
		Ma08B-CO	7/29/2006 – 9/22/2006	25.5	20.0 – 35.5	5.7	1115 – 1645	27.0	0945	2115
Windward	Wailua (Lakini)	Ma09-CIT	7/30/2006 – 9/21/2006	20.7	18.5 – 23.4	2.3	1300 – 1815	0.0	na	na
		Ma09-CO	7/30/2006 – 9/21/2006	23.2	18.4 – 31.7	7.4	1130 – 1645	16.9	1015	1800
Windward	Wailua	Ma10-CI	7/30/2006 – 9/21/2006	22.5	20.5 – 25.9	1.9	1200 – 1900	0.0	na	na
Windward	Wailua (Waikani)	Ma11-CI	7/30/2006 – 9/21/2006	22.2	21.0 – 24.0	0.7	0700 – 2345	0.0	na	na
		Ma11-CO	7/30/2006 – 9/21/2006	26.1	22.1 – 31.8	3.3	1400 – 2045	29.1	0000	2345
Windward	Ke‘anae	Ma12-CI	7/31/2006 – 9/21/2006	20.0	19.0 – 21.9	1.0	1345 – 2330	0.0	na	na
		Ma12-CO	equipment malfunction	na	na	na	na	na	na	na

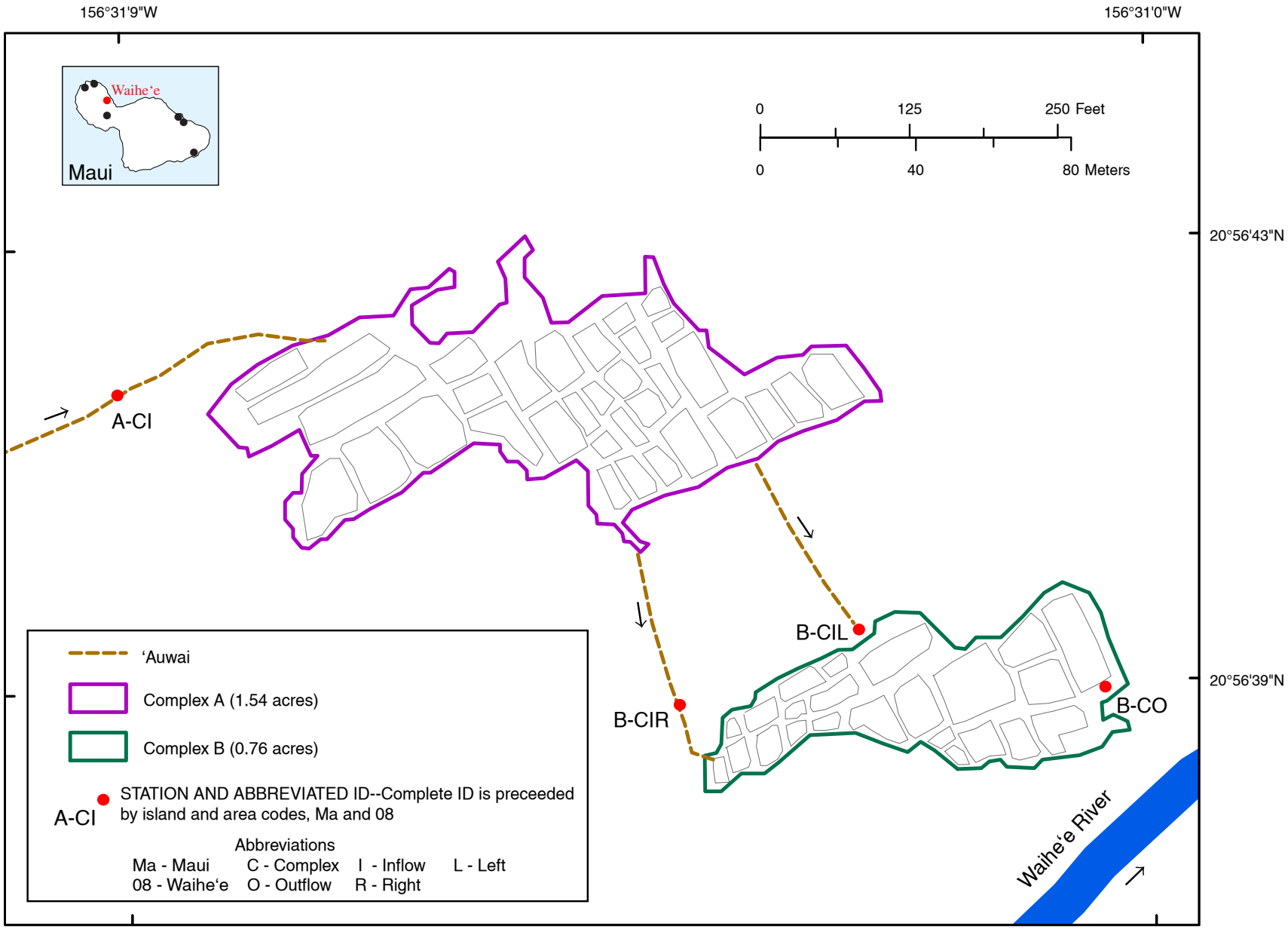


Figure 23. Waiheʻe loʻi complexes, Island of Maui.

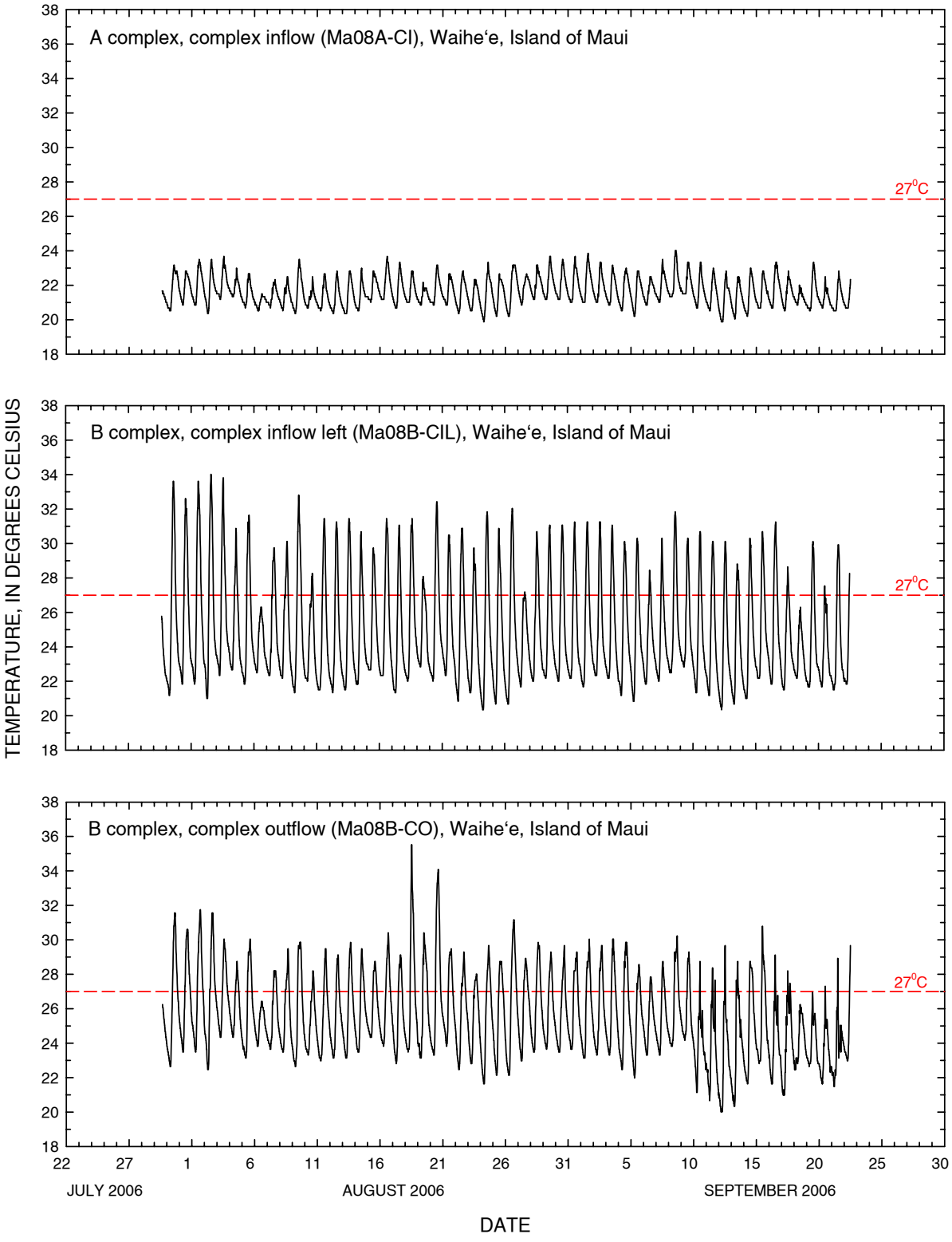


Figure 24. Water temperature in Waiheʻe loʻi complexes, Island of Maui.

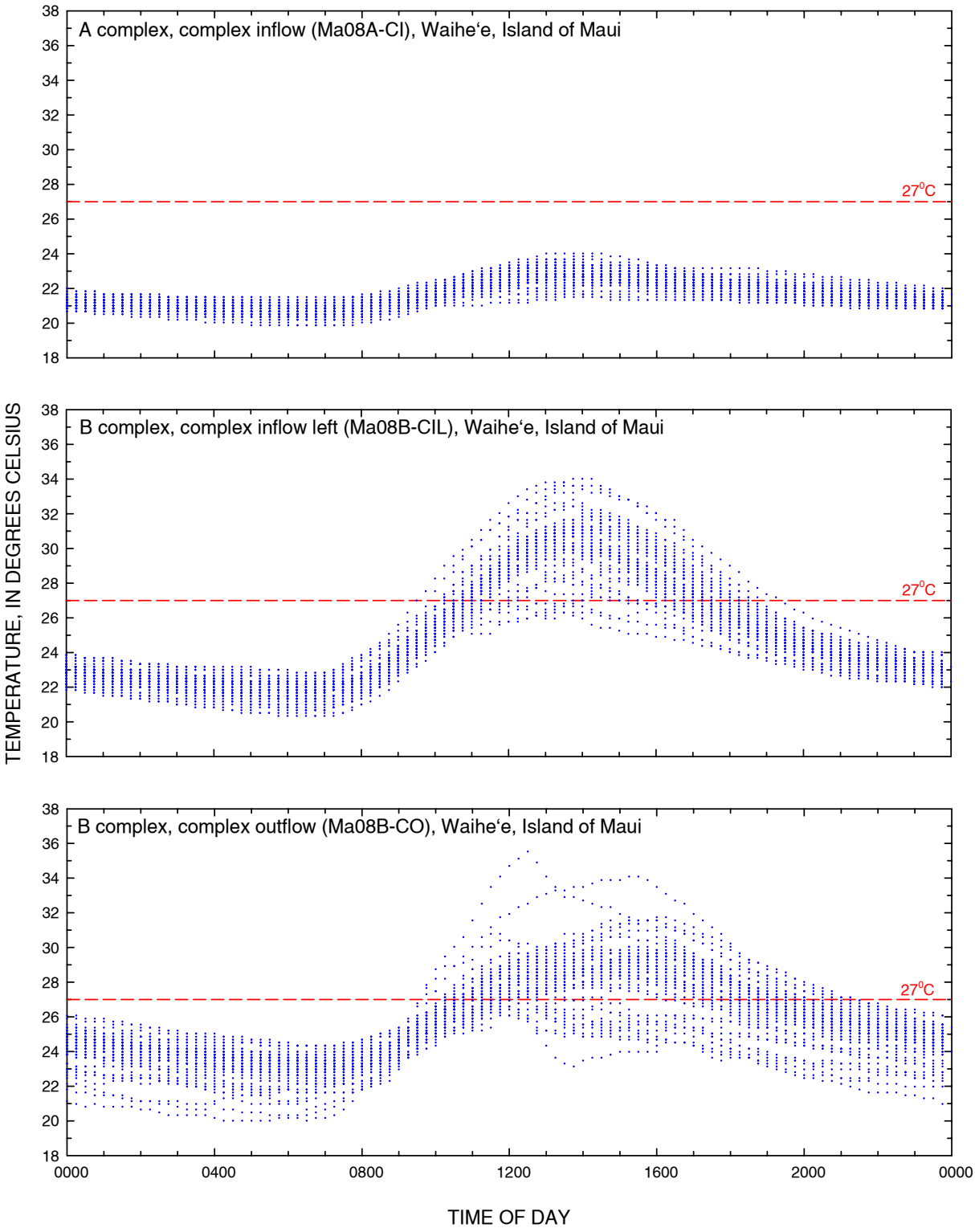


Figure 25. Daily pattern of water temperature in Waiheʻe loʻi complexes, Island of Maui. Plot shows all temperature data plotted against the time of day that each measurement was recorded.

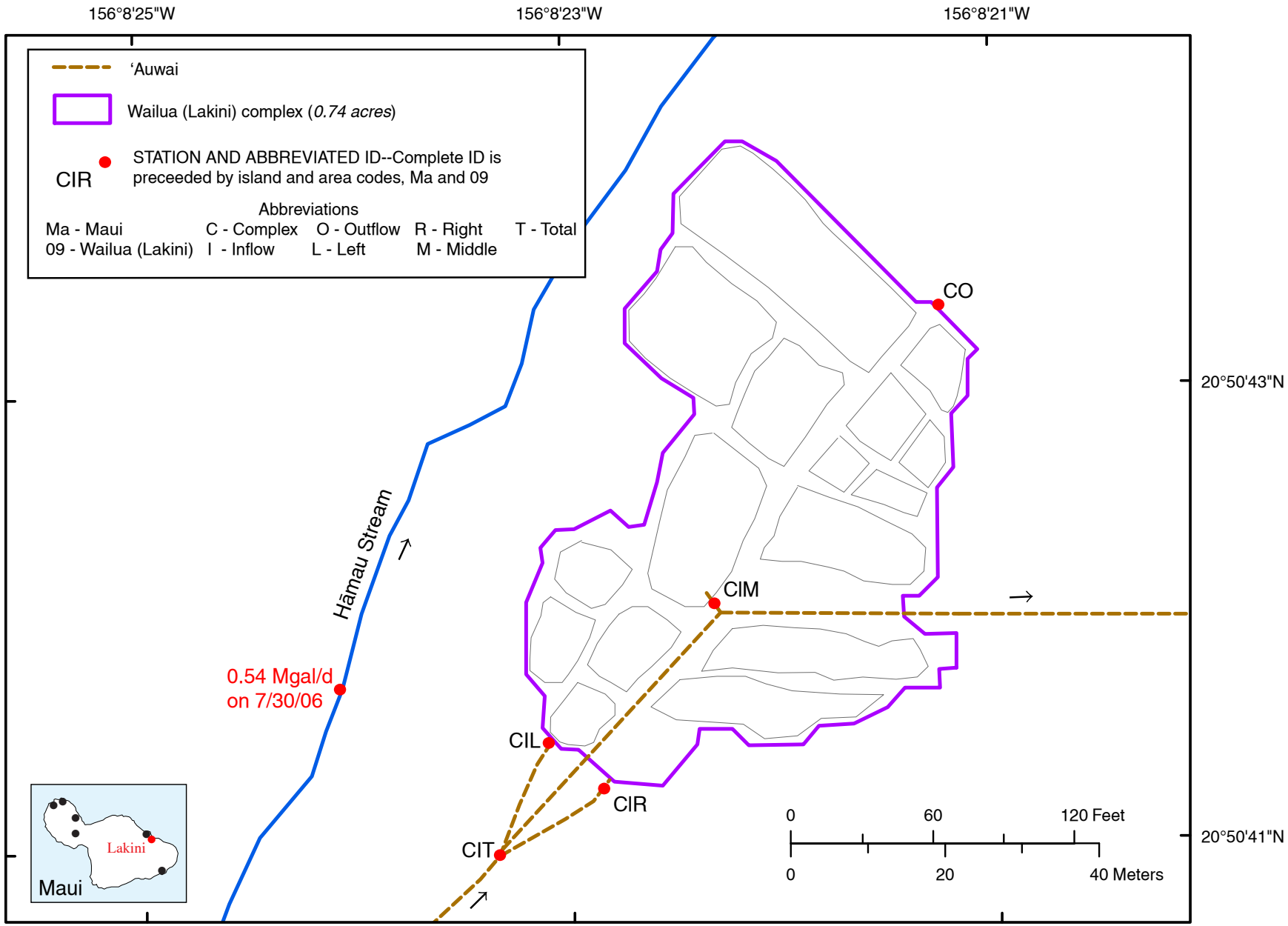


Figure 26. Wailua (Lakini) lo'i complex, Island of Maui.

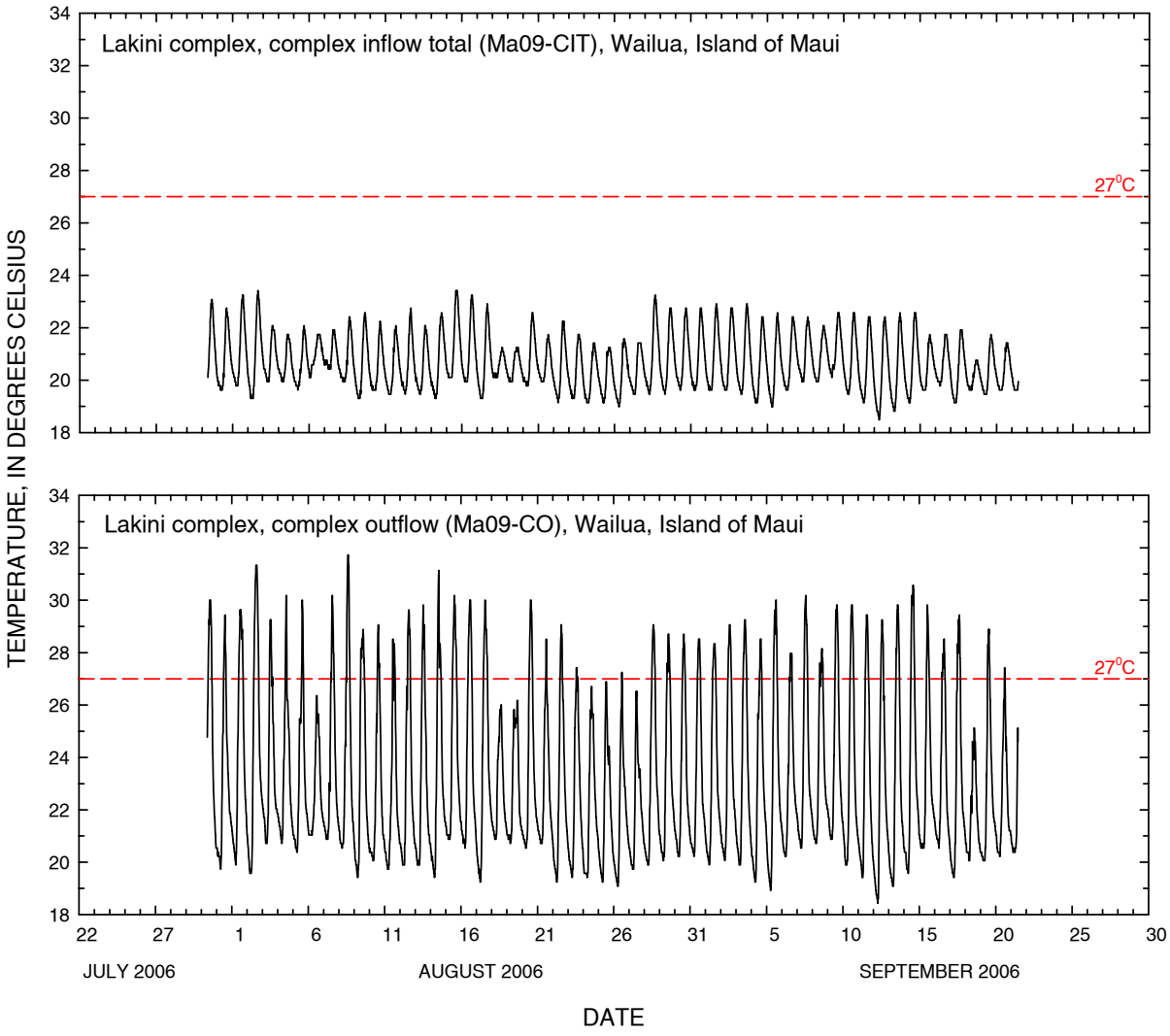


Figure 27. Water temperature in Wailua (Lakini) Io‘i complex, Island of Maui.

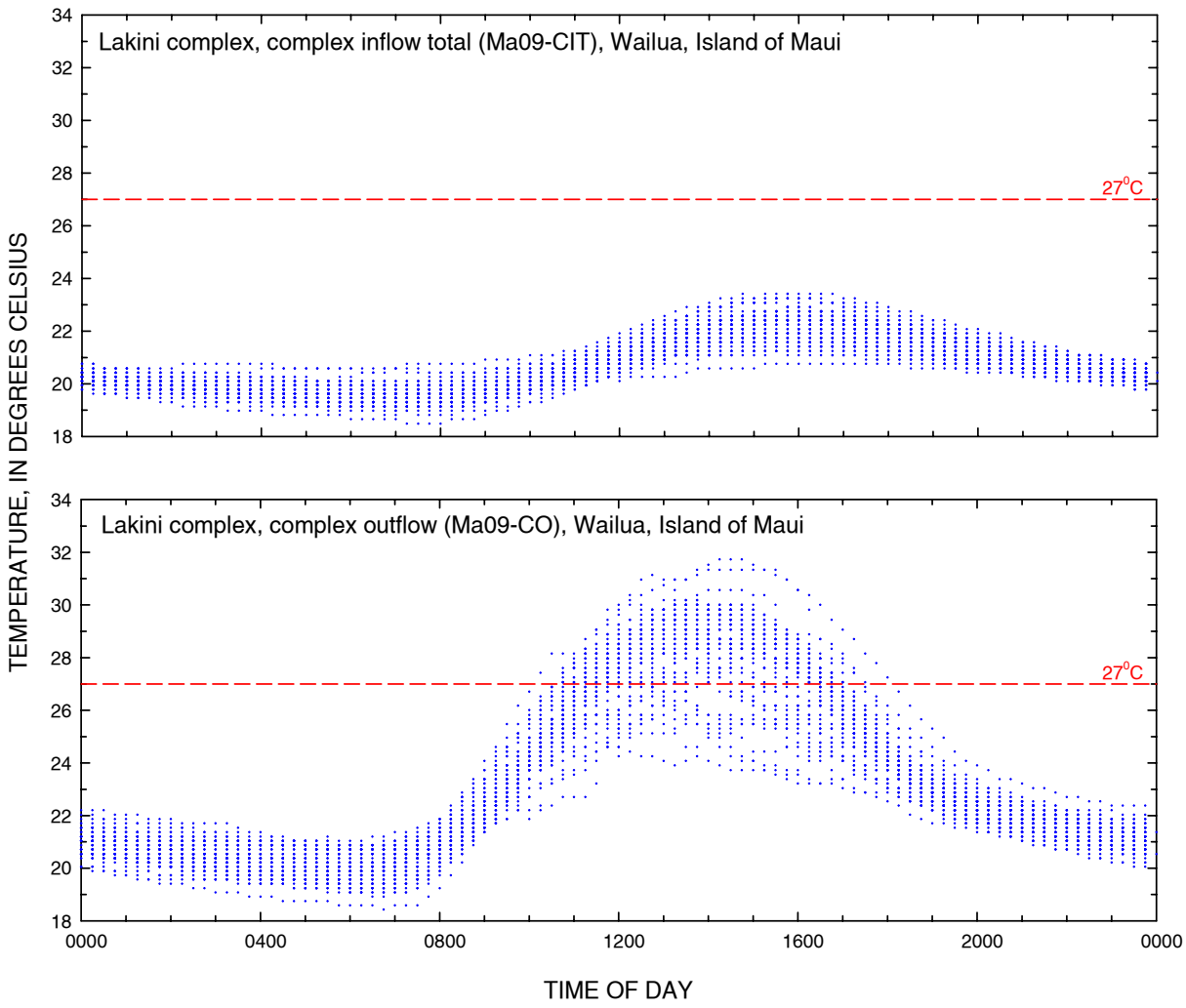


Figure 28. Daily pattern of water temperature in Wailua (Lakini) lo‘i complex, Island of Maui. Plot shows all temperature data plotted against the time of day that each measurement was recorded.

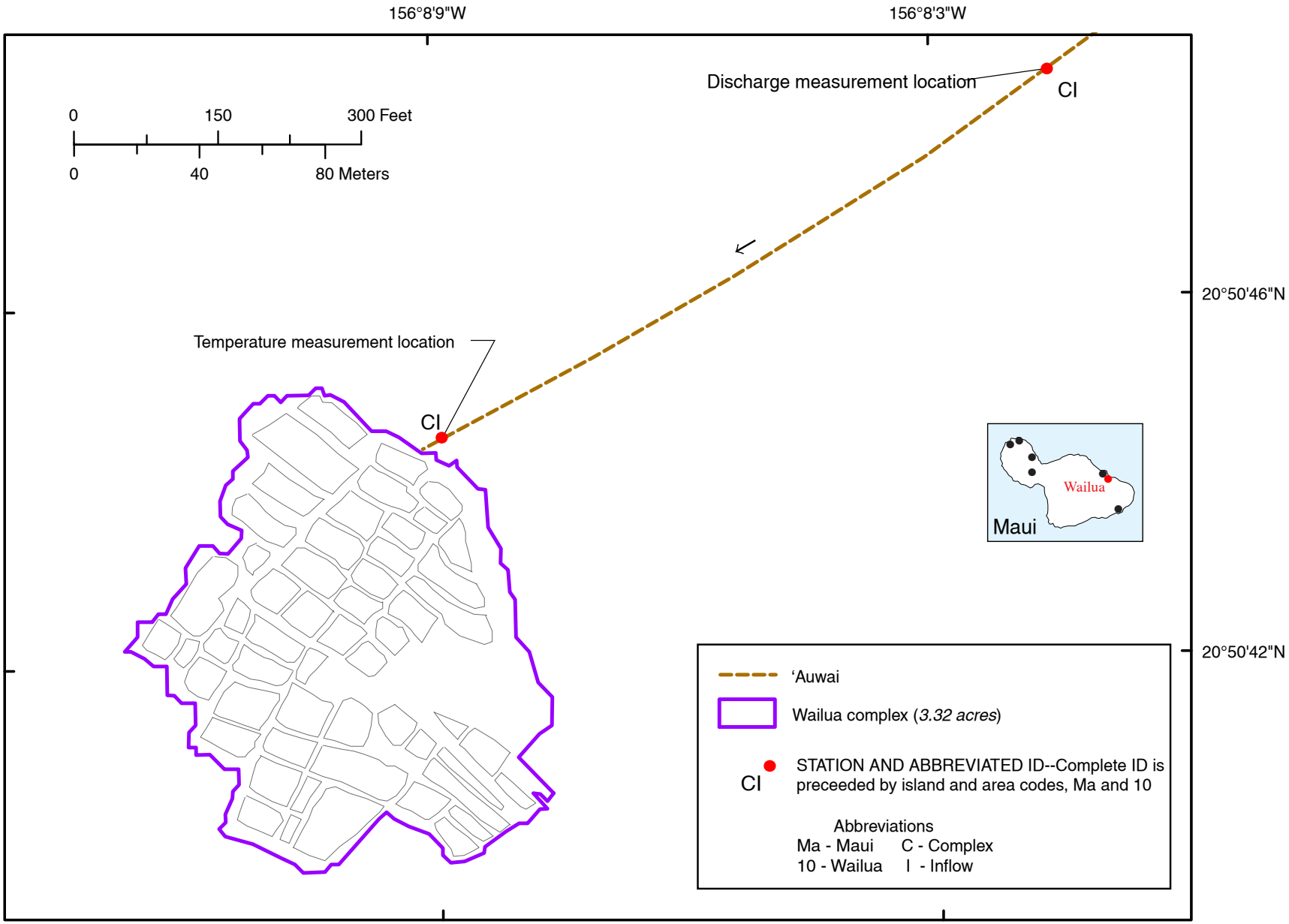


Figure 29. Wailua lo'i complex, Island of Maui.

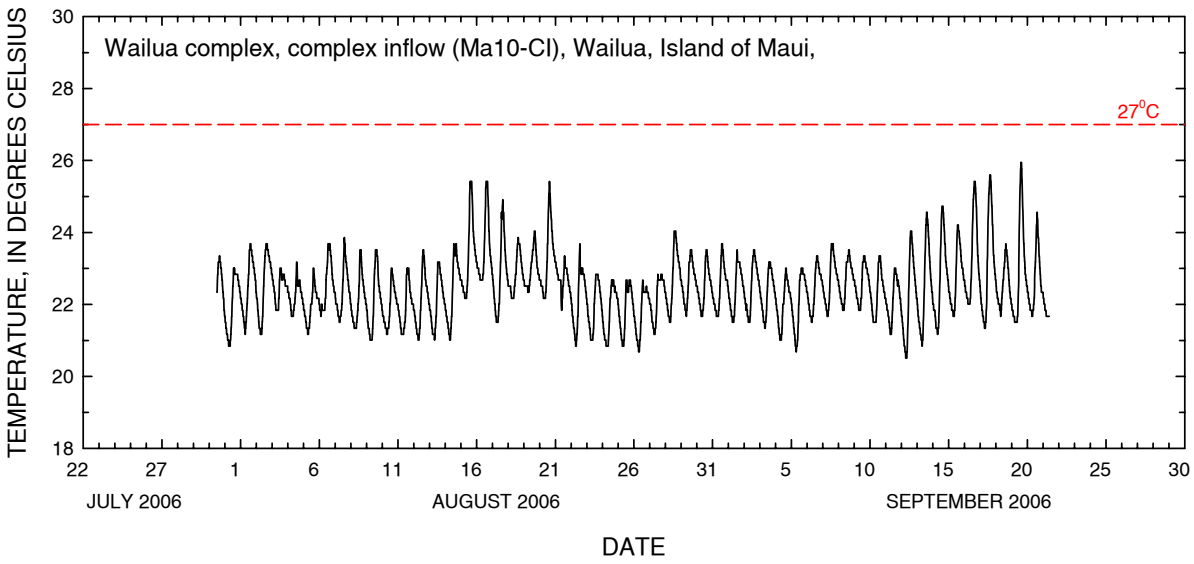


Figure 30. Water temperature in Wailua lo‘i complex, Island of Maui.

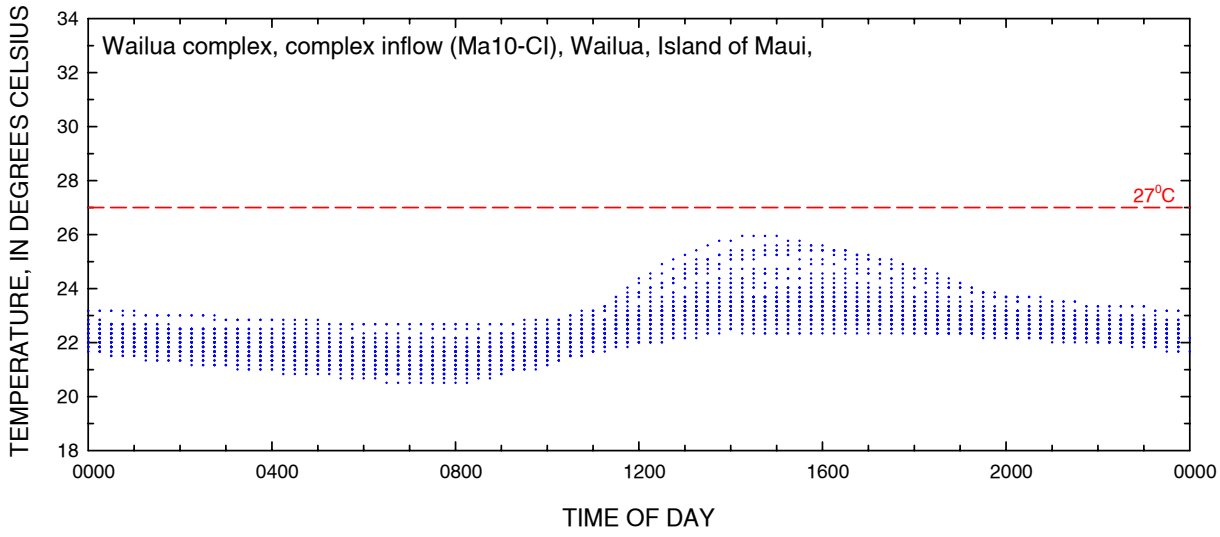


Figure 31. Daily pattern of water temperature in Wailua lo‘i complex, Island of Maui. Plot shows all temperature data plotted against the time of day that each measurement was recorded.

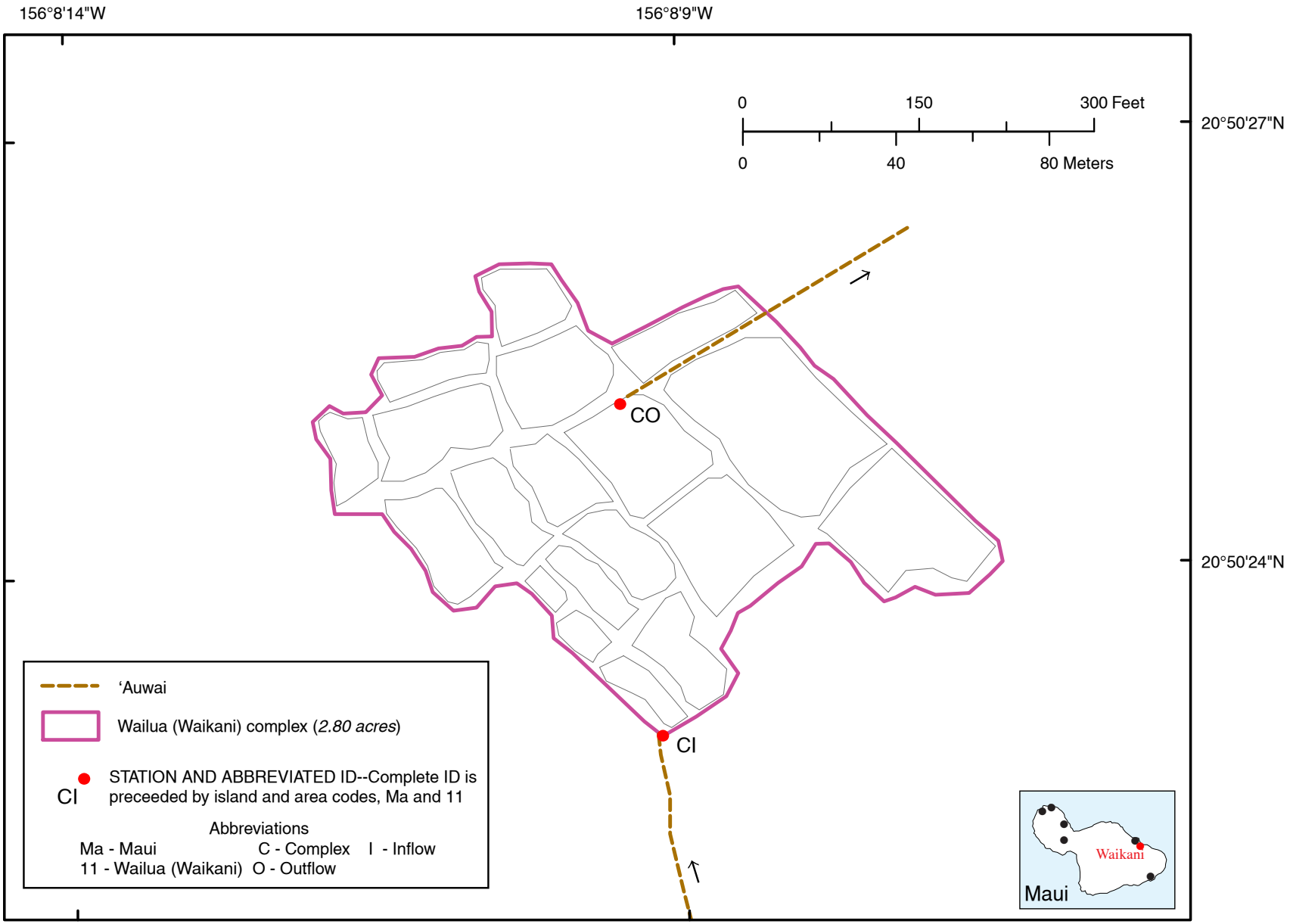


Figure 32. Wailua (Waikani) lo'i complex, Island of Maui.

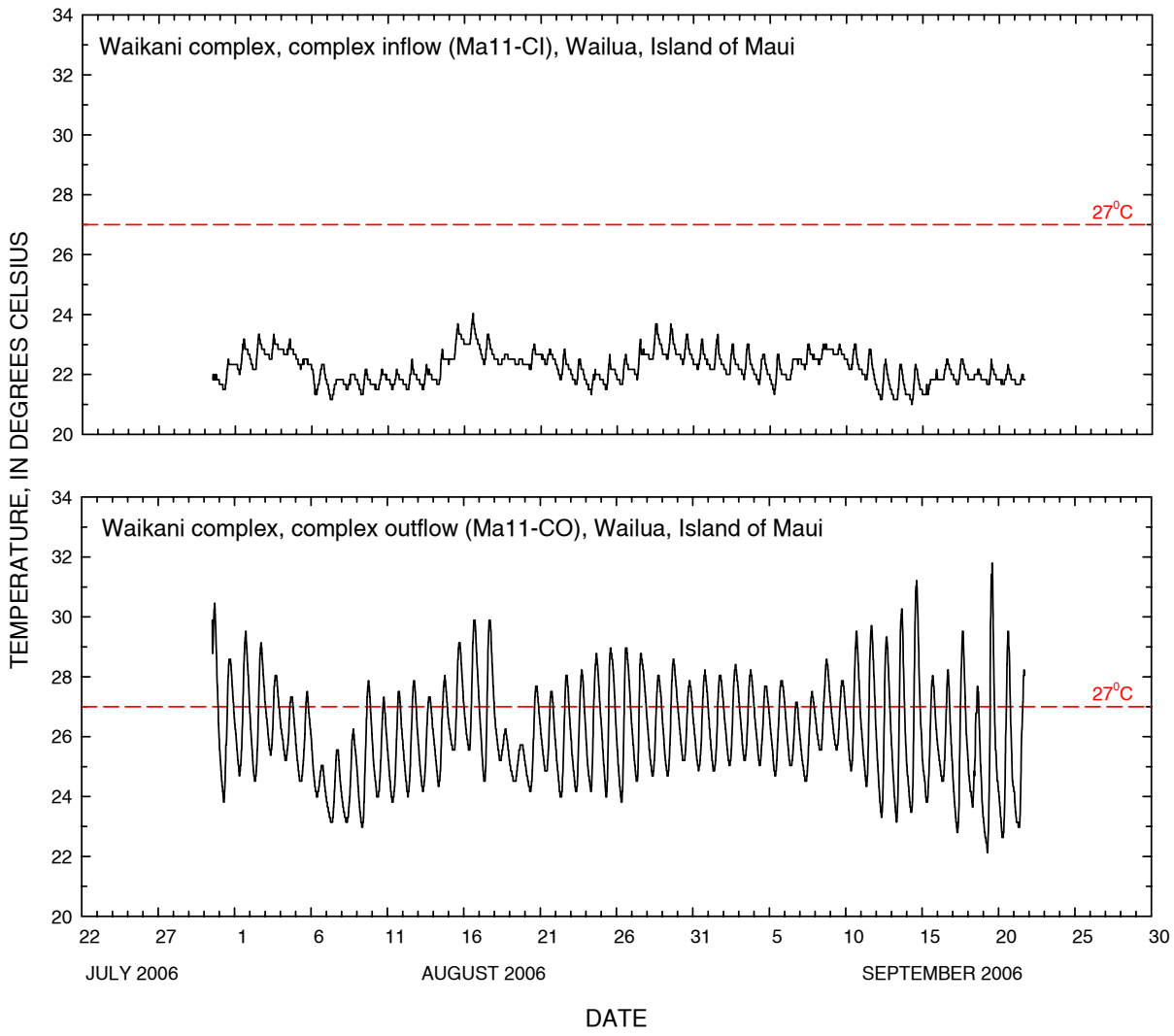


Figure 33. Water temperature in Wailua (Waikani) lo‘i complex, Island of Maui. Plot shows all temperature data plotted against the time of day that each measurement was recorded.

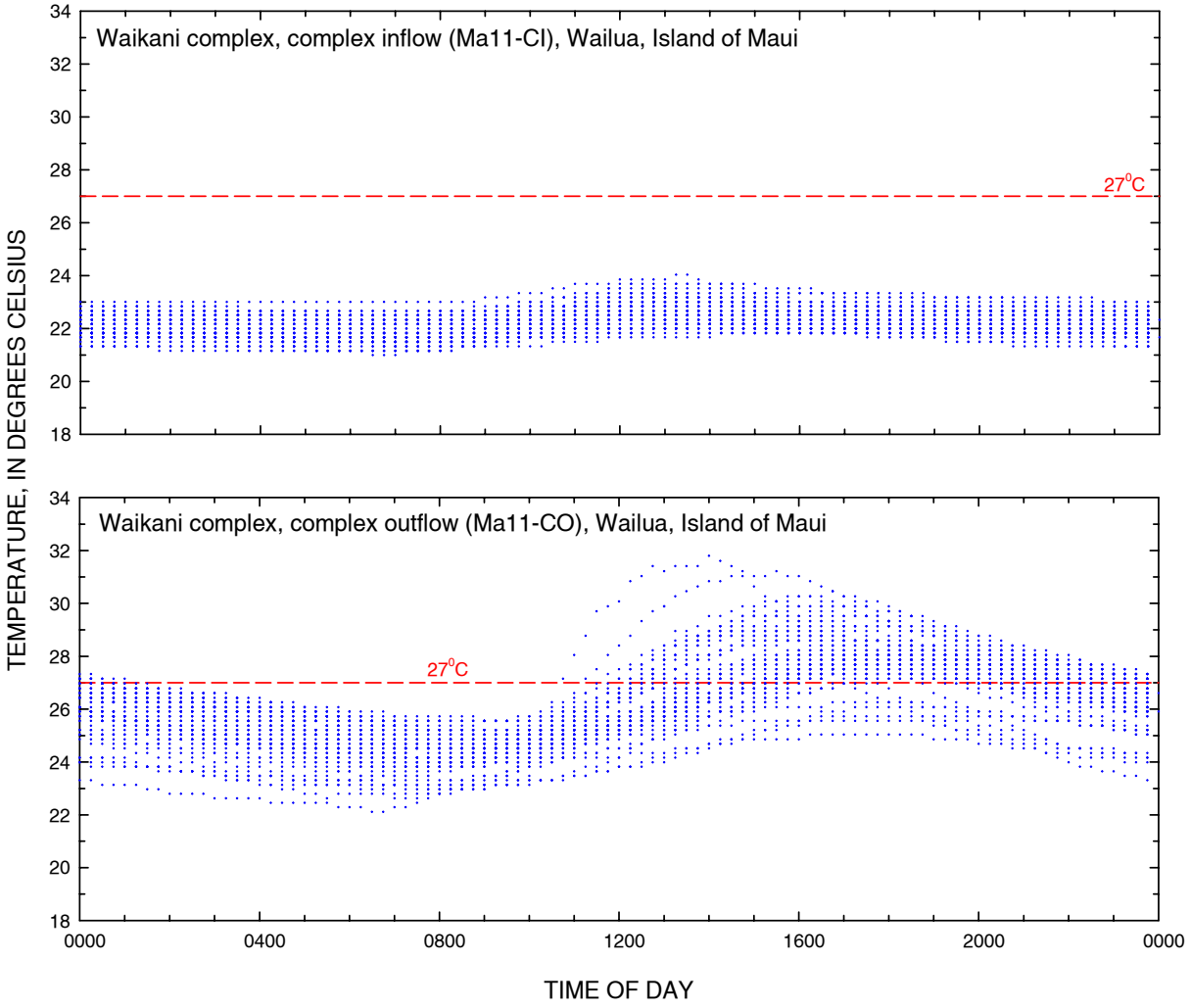


Figure 34. Daily pattern of water temperature in Wailua (Waikani) lo‘i complex, Island of Maui.

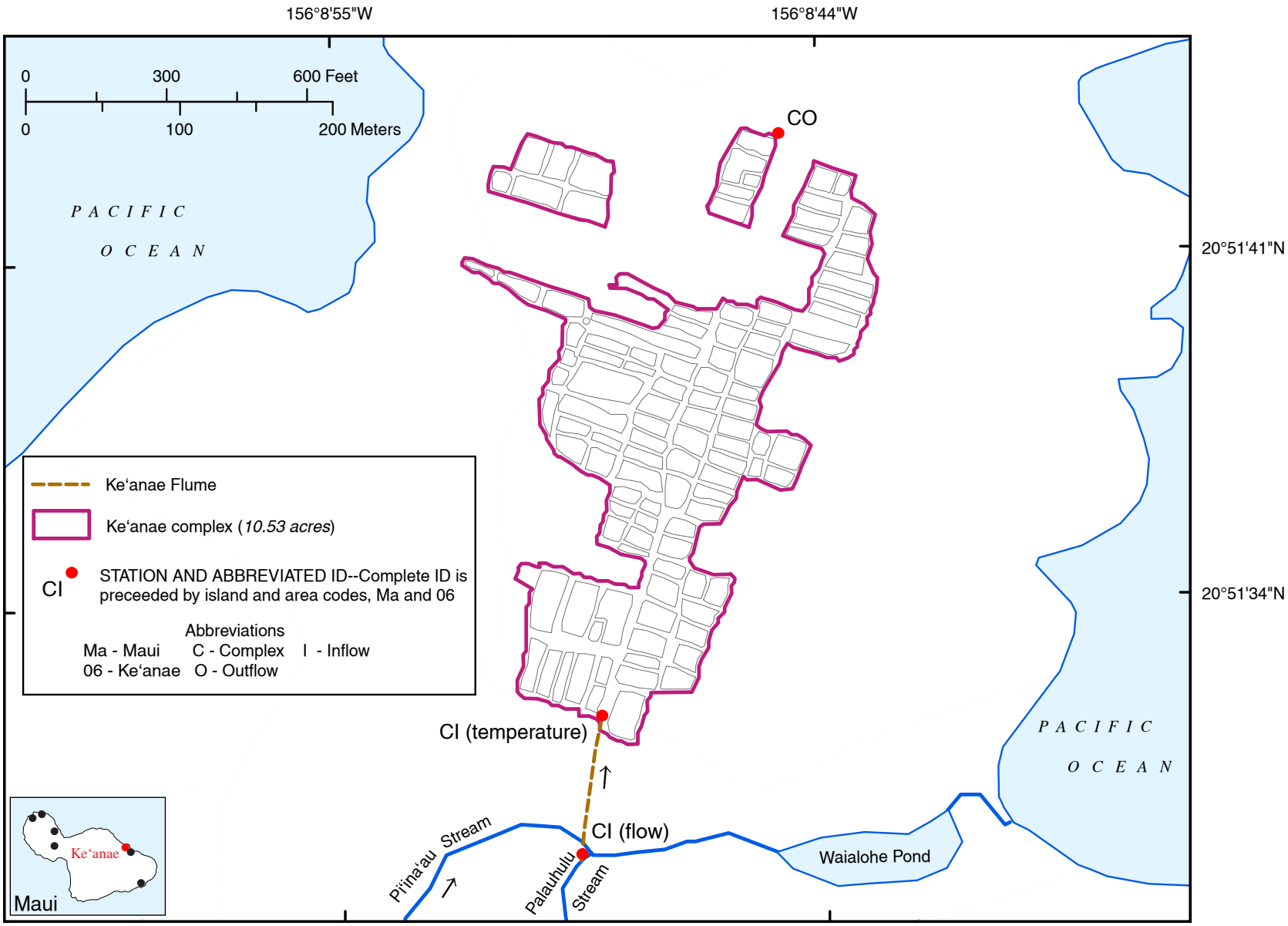


Figure 35. Ke'anae lo'i complex, Island of Maui.

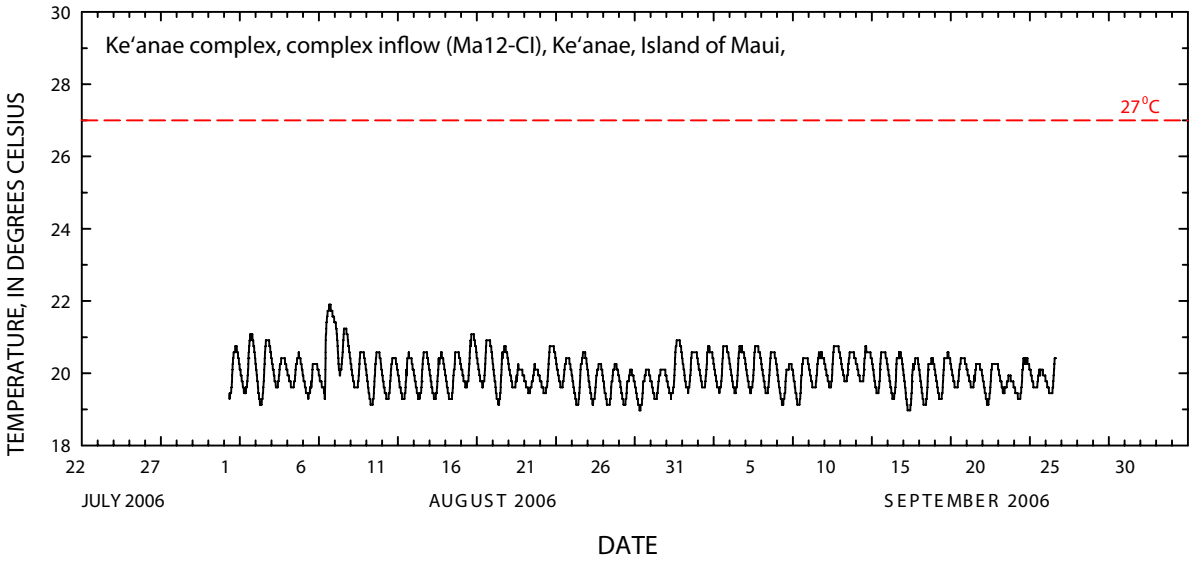


Figure 36. Water temperature in Ke'anae lo'i complex, Island of Maui.

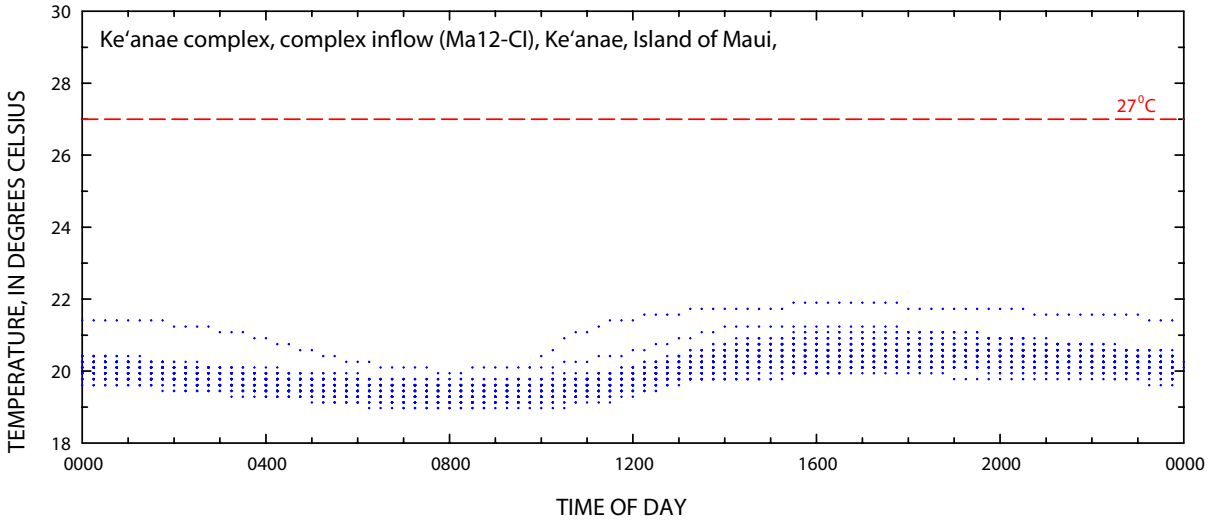


Figure 37. Daily pattern of water temperature in Ke'anae lo'i complex, Island of Maui. Plot shows all temperature data plotted against the time of day that each measurement was recorded.

Hawai‘i

On the Island of Hawai‘i, the windward site of Waipi‘o had two complexes available for study. Flow measurements were made on June 11, 2006, when the temperature loggers were deployed, and on August 8, 2006, when the temperature loggers were removed (tables 8 and 9). The Waipi‘o area is supplied through several ‘auwai with water diverted from Wailoa Stream (figs. 37 and 38). Five flow measurements were made, and six temperature loggers were deployed at selected inflow and outflow locations (figs. 39–42).

Summary

Ten kalo cultivation areas (out of an initial count of 28 areas) were selected for study (8 windward areas, 2 leeward areas), mainly on the basis of the diversity of environmental and agricultural conditions under which wetland kalo is grown and on the basis of landowner permission and availability. Flow and water-temperature data were collected at the lo‘i and lo‘i complex level. For consistency in site selection, lo‘i with crops near harvesting stage were selected for the lo‘i water-temperature data collection to ensure that flow and temperature data collected at different lo‘i reflect similar irrigation conditions (continuous flooding of the mature crop). Data collection was done during the dry season (June–October), when water requirements for cooling kalo are higher. Flow measurements generally were made during the warmest part of the day, and temperature measurements were made every 15 minutes at each site for about a 2-month period.

As part of this study, 62 flow measurements and 46 sets of temperature data were collected from kalo cultivation areas on four islands—Kaua‘i, O‘ahu, Maui, and Hawai‘i. (the data summarized in this report are available on the World Wide Web at *http://waterdata.usgs.gov/hi/nwis/sw*. The average inflow for the 19 lo‘i complexes measured in this study is 260,000 gad, and the median inflow is 150,000 gad (table 10). The average inflow for the 17 windward sites is 270,000 gad, and the median inflow is 150,000 gad. The average inflow for the two leeward sites is 150,000 gad. The average inflow measured for 6 lo‘i is 350,000 gad, and the median inflow is 270,000 gad. The average inflow for the 5 windward lo‘i is 370,000 gad, and the median inflow is 320,000 gad. The inflow value for the 1 leeward lo‘i is 210,000 gad. These values are consistent with previously reported values for inflow and are significantly higher than values generally estimated for consumption during kalo cultivation. These measurements of inflow are important for future considerations of water-use requirements for successful kalo cultivation.

Of the 17 lo‘i complexes where water inflow temperature was measured, only 3 lo‘i complexes had inflow temperature values greater than 27°C. These sites were Makaweli, Kaua‘i (9 percent of time), Waihe‘e, Maui (about 25 percent of time at the lower lo‘i complex), and Waipi‘o, Hawai‘i (about 8 percent of time at B site). The coldest mean inflow temperature was at the Ke‘anae complex (20.0°C), and the warmest mean inflow temperature recorded was at the lower Waihe‘e lo‘i complex (24.9°C), both on Maui. The lo‘i complexes with the most stable inflow temperatures were Waihe‘e and Hale‘iwa on O‘ahu, and Waikani on Maui (0.7°C mean daily range). The complex with the most variable inflow temperature value was the Waihe‘e lower (B) lo‘i complex on Maui (7.6°C mean daily range). All 15 of the sites (11 lo‘i sites, 4 lo‘i complex sites) where outflow temperature was measured had some temperature values greater than 27°C. The percentage of time that outflow temperature values exceeded 27°C ranged from 2.5 percent (Waiāhole lo‘i complex, O‘ahu) to about 40 percent (Hanalei lo‘i, Kaua‘i). Mean outflow temperature values ranged from 23.0°C (Waiāhole lo‘i complex, O‘ahu) to 26.7°C (Hanalei lo‘i, Kaua‘i).

References Cited

Berg, N., McGurk, B., and Calhoun, R.S., 1997, Hydrology and land use effects in the Hanalei National Wildlife Refuge, Kaua‘i, Hawai‘i (Final Report, Interagency Agreement 14-48-0001-94588): Albany, California, United States Department of Agriculture Forest Service, Pacific Southwest Research Station, 62 p.

Brasher, A.M.D., Wolff, R.H., and Luton, C.D., 2004, Associations among land use, habitat characteristics, and invertebrate community structure in nine streams on the Island of O‘ahu, Hawai‘i: *U.S. Geological Survey Water-Resources Investigations Report 03-4256, 47 p.*

Gingerich, S.B. and Wolff, R.H., 2005, Effects of surface-water diversions on habitat availability for native macrofauna, northeast Maui, Hawaii: *U.S. Geological Survey Scientific Investigations Report 2005-5213, 93 p.*

Table 8. Summary of discharge measurements and areas for selected lo‘i complexes, Island of Hawai‘i.

[Mgal/d, million gallons per day; gad, gallons per acre per day; average water use is determined by summing the averages of each complex or lo‘i and dividing by the number of lo‘i or lo‘i complexes]

Complex							
Geographic designation	Area	Station	Irrigation area (acre)	Date	Measurement time	Discharge (Mgal/d)	Water use (gad)
Windward	Waipi‘o (A)	Ha07A-CI	7.66	6/11/2006	1022	8.5	1,100,000
				8/8/2006	1325	6.3	820,000
Windward	Waipi‘o (B)	Ha07B-CI	5.47	6/11/2006[a]	1335	0.56	100,000
				8/8/2006[b]	0906	1.7	310,000
				8/8/2006[c]	1021	1.5	270,000
number			2				2
minimum			5.47				100,000
maximum			7.66				1,100,000
average			6.57				710,000

[a]Farmer indicated that flow was substantially less than normal because upstream diversion was damaged by recent flooding.

[b]Upstream diversion remained unrepaired, but the flow was increased due to rain over night.

[c]Second measurement.

Miles, K., 1931, Report on study of water requirements of taro in Hanapēpē Valley, cooperative study by the Territory of Hawai‘i and McBryde Sugar Co.: ‘Ele‘ele, Hawai‘i, 52 p.

Oki, D.S., Wolff, R.H., and Perreault, J.A., 2006, Effects of surface-water diversion and groundwater withdrawal on streamflow and habitat, Punalu‘u Stream, O‘ahu, Hawai‘i: *U.S. Geological Survey Scientific Investigations Report 2006-5153, 104 p.*

Ooka, J.J., 1994, Taro diseases — A guide for field identification: Honolulu, Hawai‘i, University of Hawai‘i at Mānoa, College of Tropical Agriculture and Human Resources, Hawai‘i Institute of Tropical Agriculture and Human Resources Research Extension Series 148, 13 p.

Penn, D. C., 1997, Water and energy flows in Hawai‘i taro pondfields: Honolulu, Hawai‘i, University of Hawai‘i at Mānoa, Ph.D. dissertation, 376 p.

Rantz, S.E., and others, 1982, Measurement and computation of streamflow—Volume 1, Measurement of stage and discharge: *U.S. Geological Survey Water-Supply Paper 2175, 284 p.*

Reppun v. Board of Water Supply, 1982, 65 Haw. 531, 656 P.d 57, cert. denied, 471 U.S. 014, 105 S. Ct 2016, 85 L Ed 2d 298 (1985), variously paged.

State of Hawai‘i, 2000, In re Water Use Applications, Petitions for Interim Instream Flow Standard Amendments, and Petitions for Water Reservations for the Waiāhole Ditch Combined Contested Case Hearing, 94 Hawai‘i 97, 9 P.3d 409.

Watson, L.J., ed., 1964, Observations made with respect to irrigation and growth of taro at certain patches at Waiāhole and Kahaluu: Honolulu, Hawai‘i, City & County of Honolulu Board of Water Supply Water Resources Division *in* Reppun v. Board of Water Supply, variously paged.

U.S. Geological Survey, 1997 to present, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A9, 2 v., variously paged. [Also available online at URL:*http://pubs.water.usgs.gov/twri9A*]. Chapters originally were published from 1997 to 1999; updates and revisions are ongoing and are summarized at *http://water.usgs.gov/owq/FieldManual/mastererrata.html*.

Table 9. Water-temperature statistics based on measurements collected at 15-minute intervals for lo‘i complexes on the Island of Hawai‘i.

[˚C, degrees Celsius; na, not applicable]

Geographic designation	Area	Station	Period of record	Temperature (˚C)			Range of times daily peak temperatures occurred	Temperature measurements greater than 27˚C		
				Mean	Range	Mean daily range		Percent	Earliest time of day	Latest time of day
Windward	Waipi‘o (A)	Ha07A-CI	6/11/2006 – 8/8/2006	21.4	19.3 – 24.8	1.6	1000 – 2200	0.0	na	na
		Ha07A-LI	6/11/2006 – 8/8/2006	21.8	19.4 – 28.6	3.0	0900 – 2015	0.4	1230	1515
		Ha07A-LO	6/11/2006 – 8/8/2006	23.8	20.8 – 29.8	3.9	1030 – 1800	5.3	1115	1900
Windward	Waipi‘o (B)	Ha07B-CI	6/11/2006 – 8/2/2006	23.4	19.8 – 31.2	5.4	1030 – 1715	7.7	1045	1845
		Ha07B-LI	6/11/2006 – 8/2/2006	24.3	20.3 – 36.2	7.1	1000 – 1700	15.7	1000	2100
		Ha07B-LO	6/11/2006 – 8/2/2006	25.6	21.1 – 38.1	8.6	1030 – 1630	21.7	0930	2145

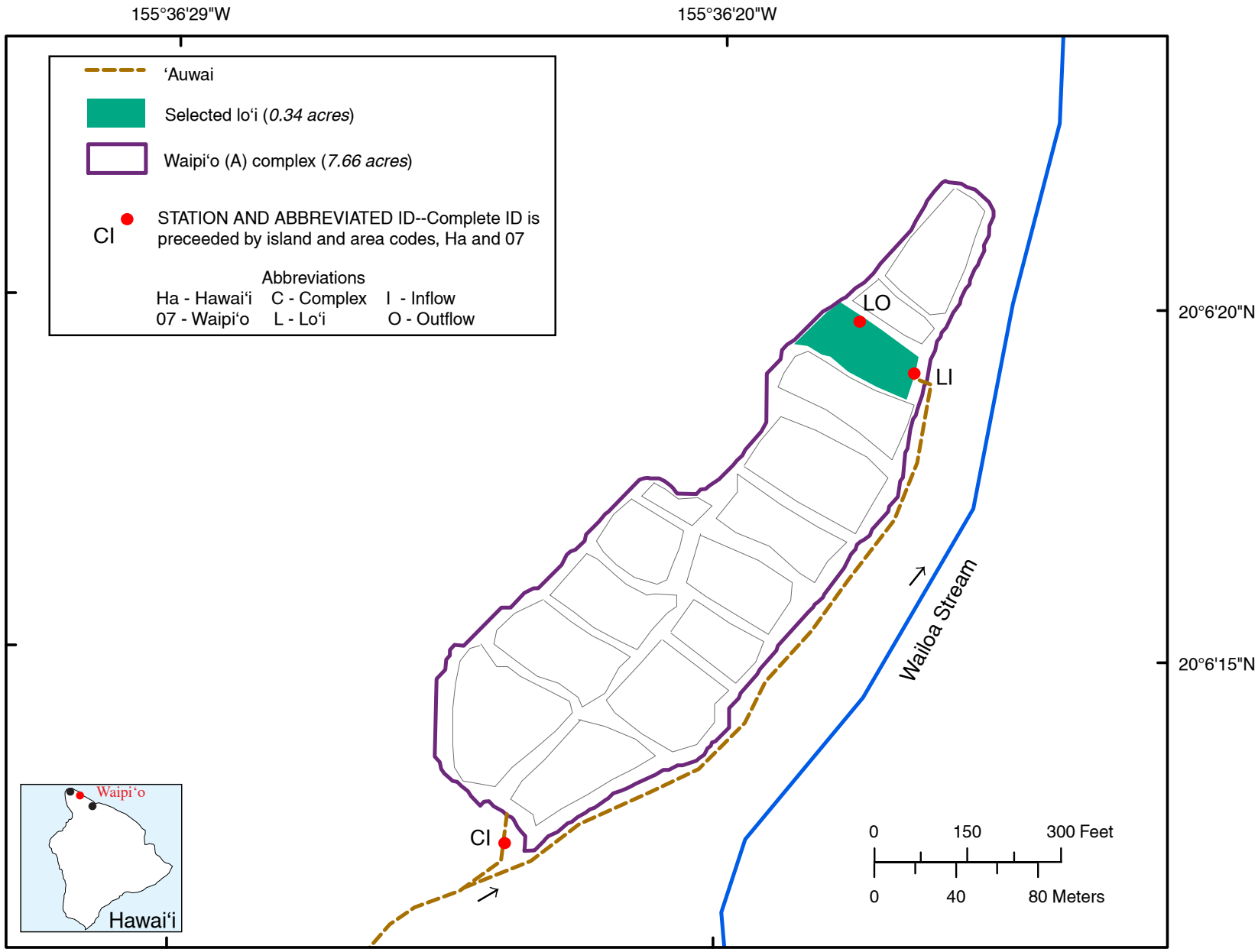


Figure 38. Waipi'o (A) lo'i complex, Island of Hawai'i.

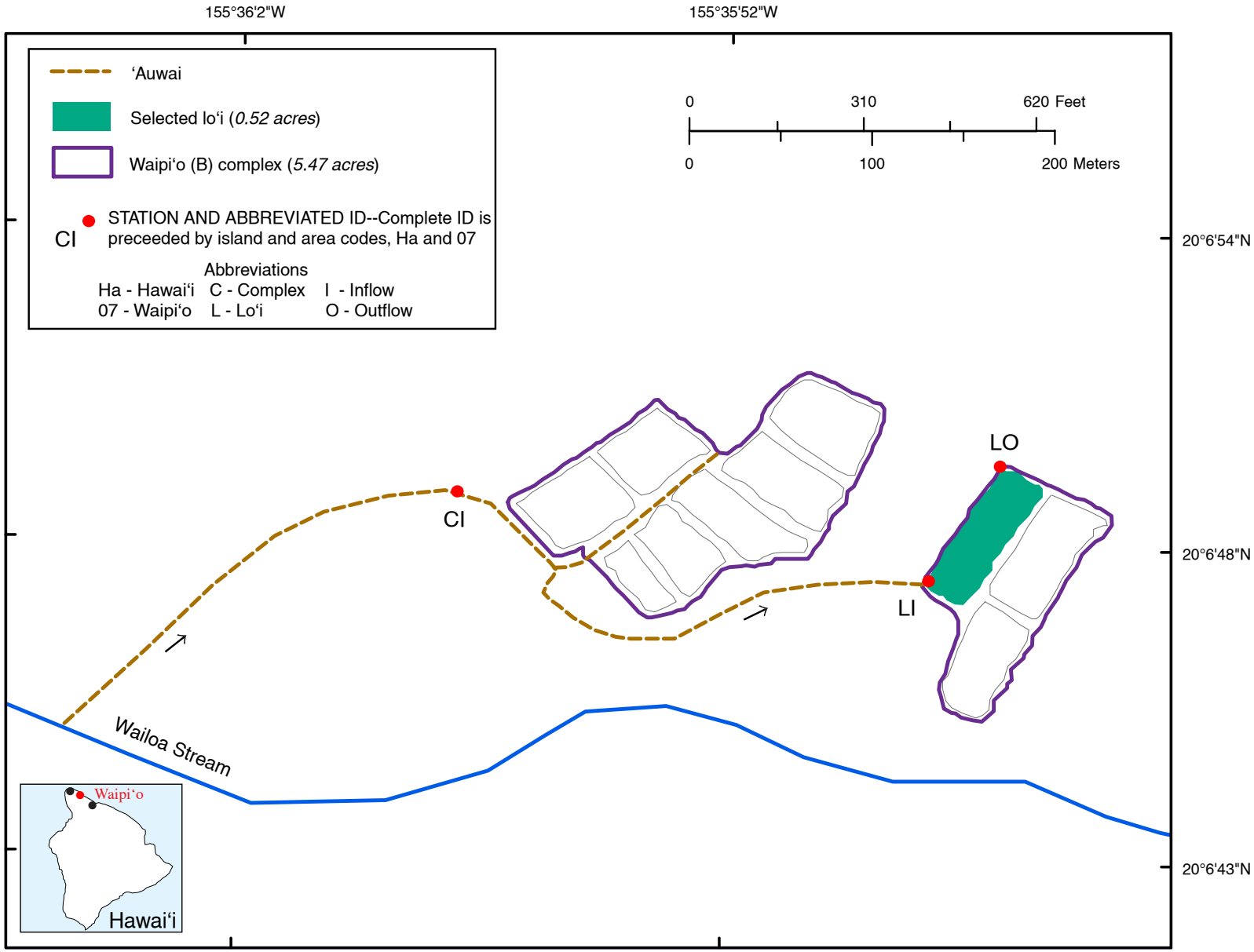


Figure 39. Waipi'o (B) lo'i complex, Island of Hawai'i.

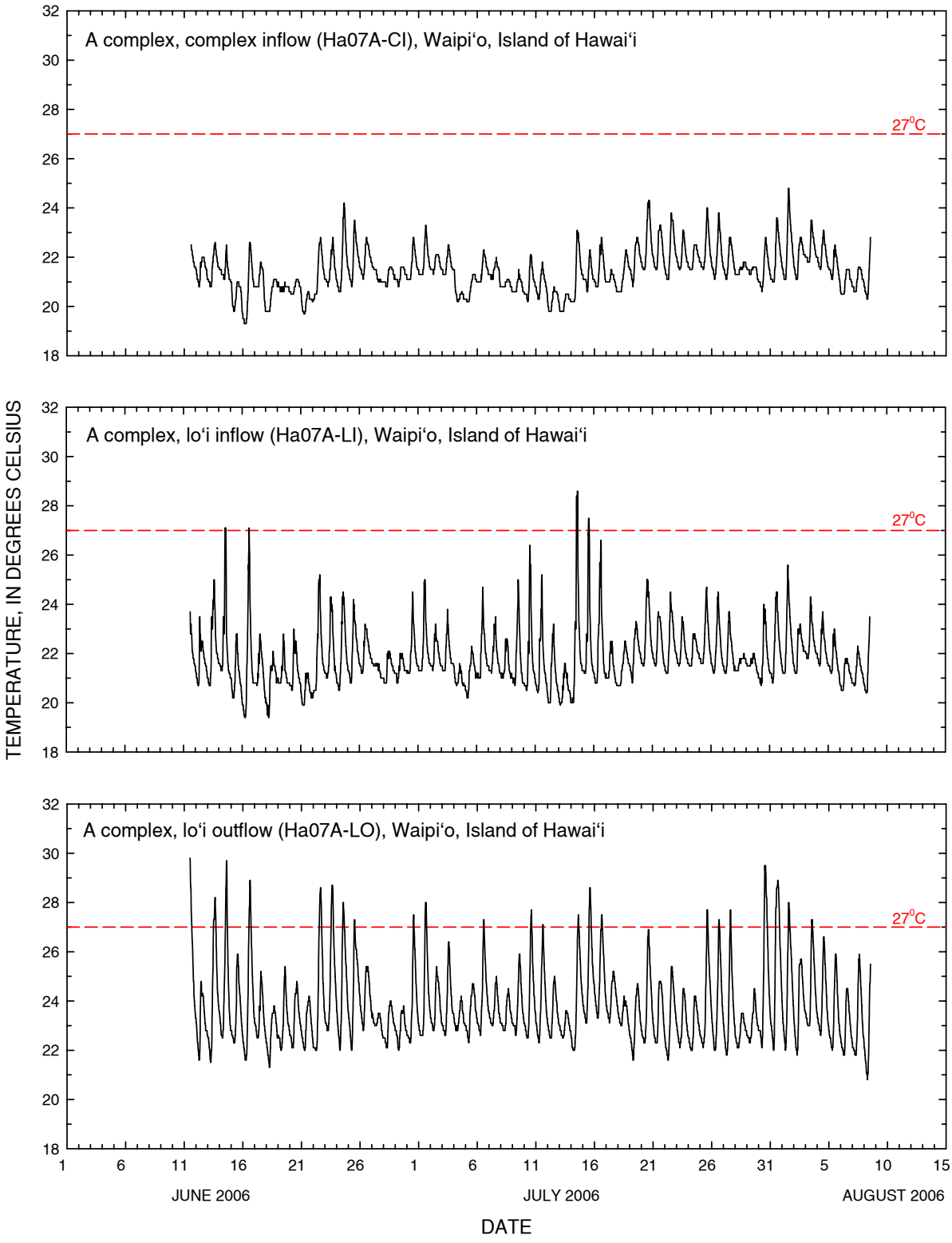


Figure 40. Water temperature in Waipiʻo (A) loʻi complex, Island of Hawaiʻi.

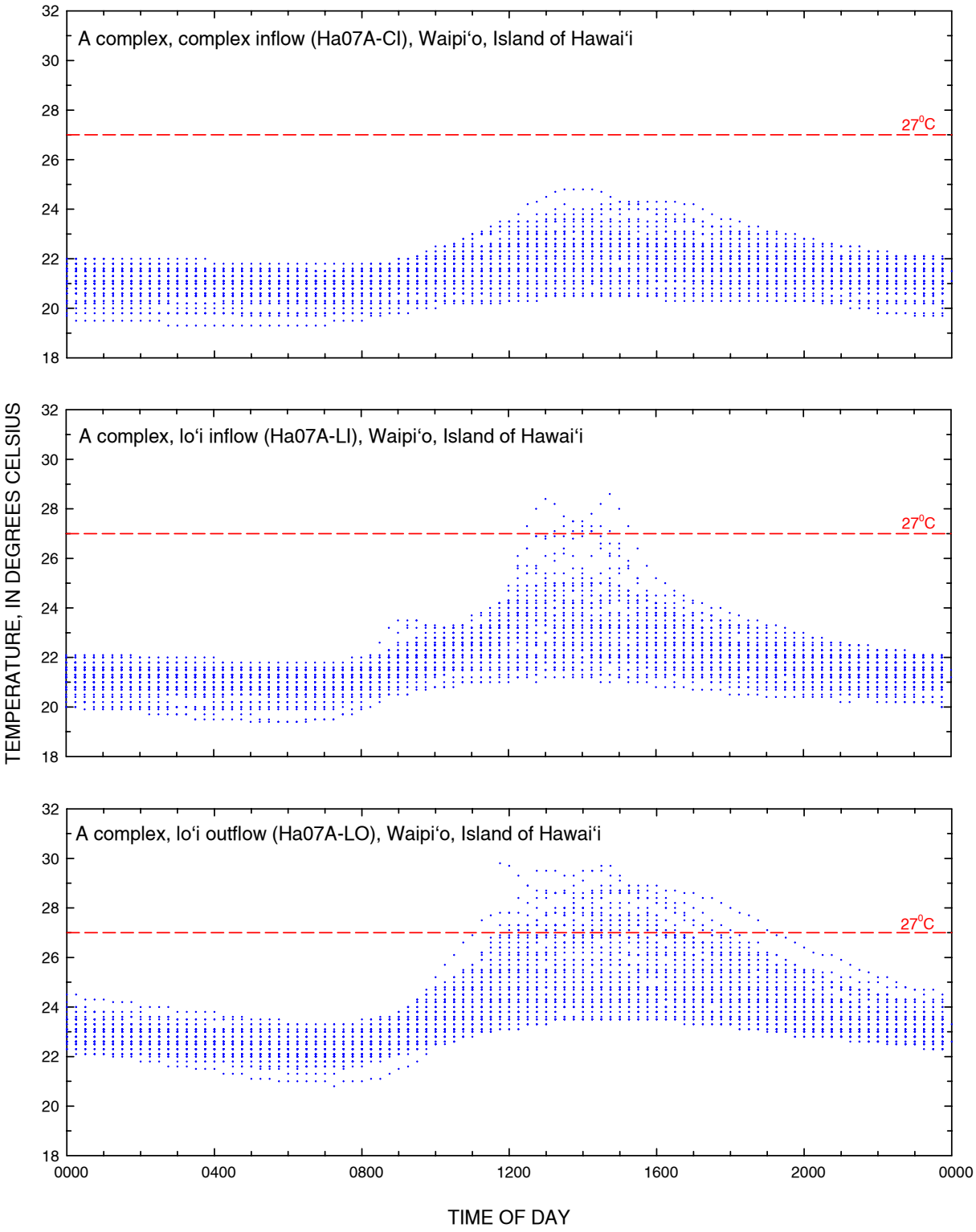


Figure 41. Daily pattern of water temperature in Waipiʻo (A) loʻi complex, Island of Hawaiʻi. Plot shows all temperature data plotted against the time of day that each measurement was recorded.

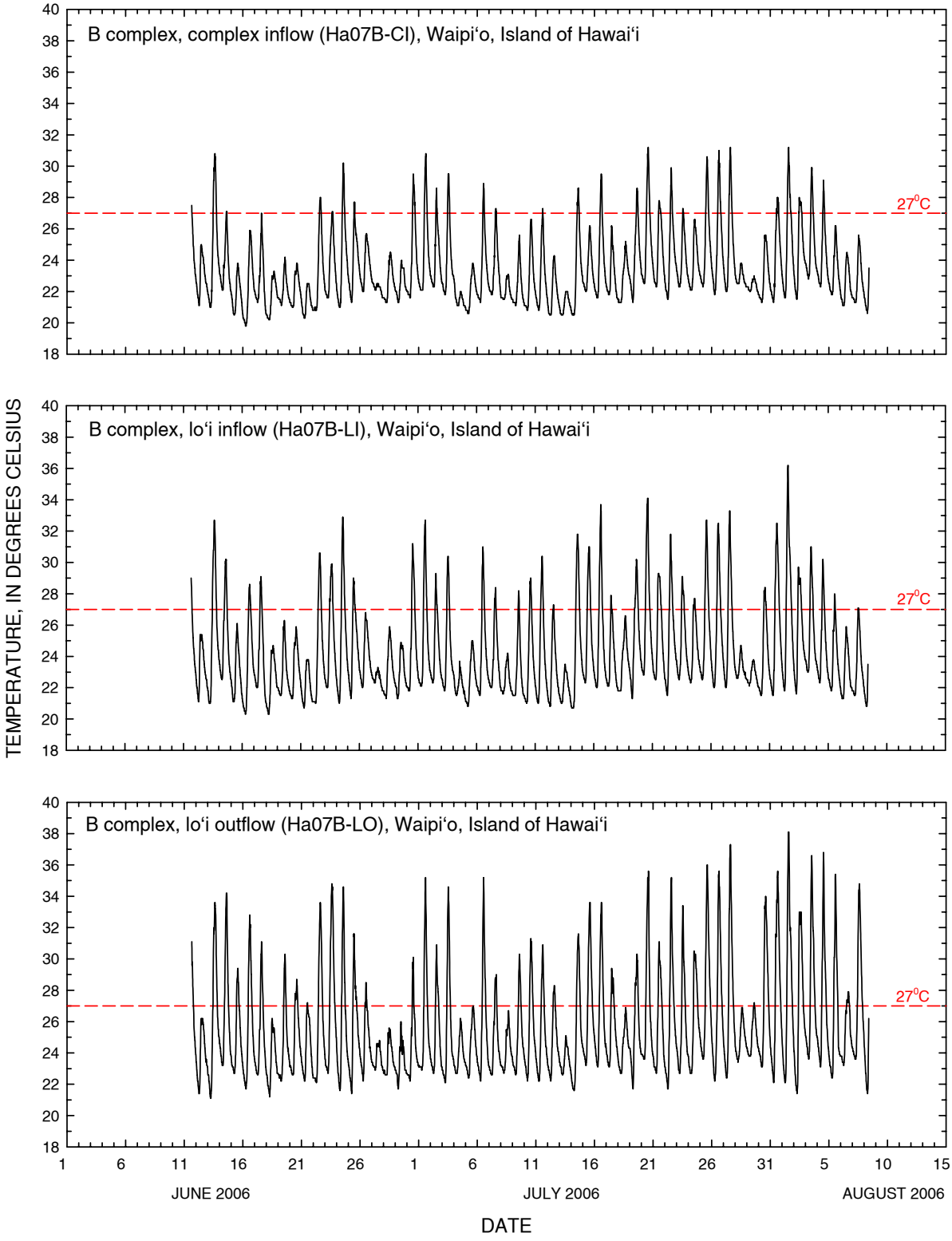


Figure 42. Water temperature in Waipiʻo (B) loʻi complex, Island of Hawaiʻi.

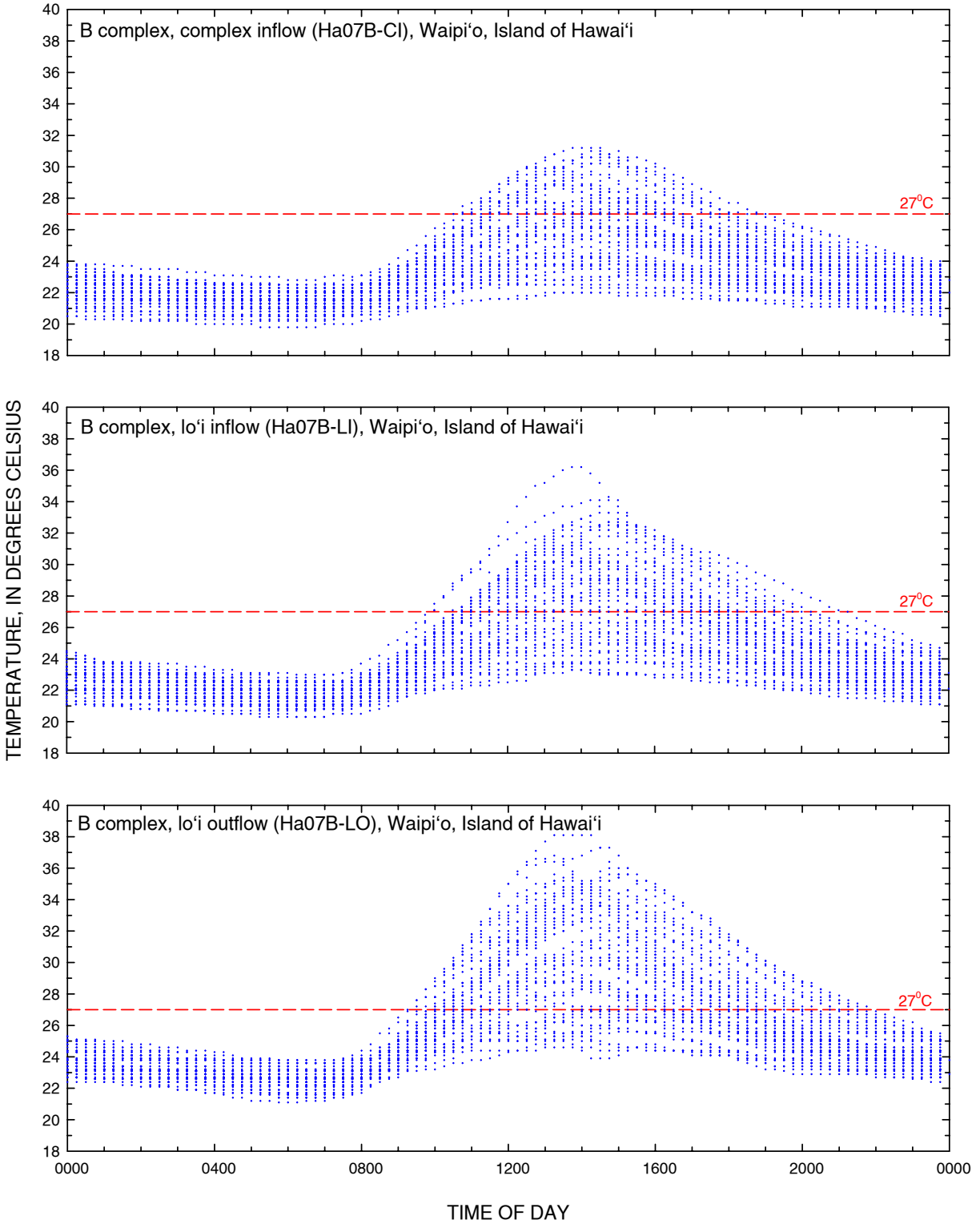


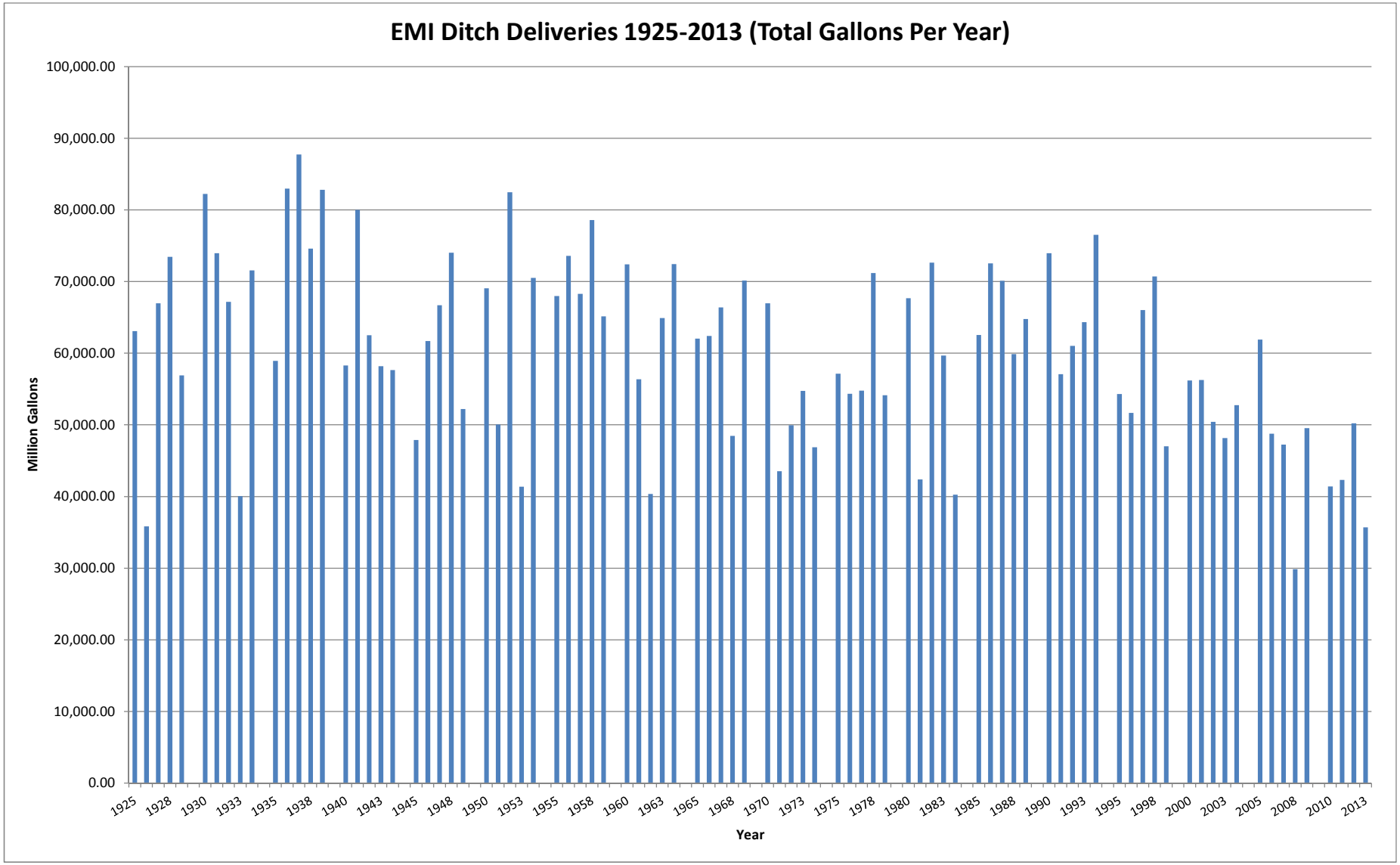
Figure 43. Daily pattern of water temperature in Waipiʻo (B) loʻi complex, Island of Hawaiʻi. Plot shows all temperature data plotted against the time of day that each measurement was recorded.

Table 10. Summary of water use calculated for lo‘i and lo‘i complexes by island, State of Hawai‘i.

[gad, gallons per acre day; na, not available]

Island	Complex				Lo‘i			
	Number	Average water use (gad)	Average windward water use (gad)	Average leeward water use (gad)	Number	Average water use (gad)	Average windward water use (gad)	Average leeward water use (gad)
Kaua‘i	6	120,000	97,000	260,000	2	220,000	220,000	na
O‘ahu	5	310,000	380,000	44,000	4	400,000	460,000	210,000
Maui	6	230,000	230,000	na	na	na	na	na
Hawai‘i	2	710,000	710,000	na	na	na	na	na
Average of all measurements		260,000	270,000	150,000		350,000	370,000	210,000
Median of all measurements		150,000	150,000	150,000		270,000	320,000	210,000

This page intentionally left blank


EMI Ditch Deliveries 1925-2013 (Total Gallons Per Year)
Million Gallons
100,000.00
90,000.00
80,000.00
70,000.00
60,000.00
50,000.00
40,000.00
30,000.00
20,000.00
10,000.00
0.00
1925
1928
1930
1933
1935
1938
1940
1943
1945
1948
1950
1953
1955
1958
1960
1963
1965
1968
1970
1973
1975
1978
1980
1983
1985
1988
1990
1993
1995
1998
2000
2003
2005
2008
2010
2013
Year

Total Monthly and Annual East Maui Ditch Deliveries from 1925

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MGD
1925	4,303.43	3,087.41	4,591.30	7,290.80	6,814.60	6,436.55	4,432.52	6,446.91	5,917.76	4,504.53	6,695.99	2,558.26	63,080.06	172.82
1926	2,882.05	2,934.57	1,483.04	2,875.44	2,570.90	2,737.91	1,836.94	5,952.86	3,313.43	3,619.26	3,075.88	2,538.04	35,820.32	98.14
1927	6,647.42	3,066.52	5,611.29	6,345.42	6,689.47	3,933.38	5,594.10	7,615.93	6,265.26	3,568.58	4,912.52	6,725.49	66,975.38	183.49
1928	6,306.48	5,348.39	3,277.50	5,342.43	7,055.42	4,514.56	8,541.91	7,948.26	6,564.74	3,784.44	6,884.87	7,873.49	73,442.49	201.21
1929	6,798.31	5,692.52	7,242.98	6,089.50	5,005.91	3,451.19	3,639.79	4,469.81	2,041.88	3,116.45	3,571.57	5,766.67	56,886.58	155.85
1930	5,626.15	4,501.33	6,904.31	8,637.39	8,703.71	7,479.20	7,868.63	8,512.84	6,905.36	5,944.95	5,870.56	5,281.41	82,235.84	225.30
1931	2,893.67	3,875.87	3,450.85	6,658.28	6,180.53	4,136.66	7,140.37	9,239.78	9,787.06	7,358.04	8,526.17	4,697.89	73,945.17	202.59
1932	7,493.50	5,780.93	3,930.84	9,228.44	9,097.34	5,723.39	8,097.63	4,825.58	4,177.13	1,497.07	2,766.66	4,543.75	67,162.26	184.01
1933	7,232.60	4,498.95	5,517.97	4,316.76	2,945.56	2,557.66	4,074.86	2,283.71	1,629.15	831.50	1,890.61	2,263.25	40,042.58	109.71
1934	3,232.56	3,132.03	2,729.29	8,838.88	9,299.48	8,580.74	7,692.85	4,436.45	4,352.10	5,550.36	8,507.63	5,224.00	71,576.37	196.10
1935	6,864.32	4,480.03	5,423.73	8,746.27	5,420.70	5,163.73	5,134.80	4,274.04	4,171.57	2,951.51	4,147.46	2,163.52	58,941.68	161.48
1936	2,412.37	2,090.74	8,545.70	7,754.23	10,532.92	5,974.51	8,868.48	9,221.76	7,645.23	4,880.99	6,771.97	8,277.65	82,976.55	227.33
1937	8,190.72	5,000.01	6,490.57	8,140.96	9,652.08	5,840.65	9,544.82	9,996.24	6,100.23	5,589.56	7,524.51	5,675.86	87,746.21	240.40
1938	6,822.80	4,415.97	7,223.31	6,817.88	9,471.51	8,415.98	4,500.46	6,555.38	3,615.42	5,186.53	5,022.70	6,556.93	74,604.87	204.40
1939	8,943.35	6,672.16	6,603.33	6,948.34	8,010.78	7,660.09	7,657.75	6,831.34	5,770.57	3,635.85	8,045.19	6,022.36	82,801.11	226.85
1940	2,262.44	3,923.84	3,175.00	3,321.98	5,692.40	2,966.59	4,827.85	8,789.40	7,154.24	5,562.87	6,134.62	4,470.30	58,281.53	159.68
1941	4,354.23	2,082.83	6,427.79	6,316.16	8,679.48	5,705.08	6,966.39	7,673.22	7,967.40	9,383.70	6,733.34	7,729.96	80,019.58	219.23
1942	3,251.52	4,046.14	8,713.68	8,417.26	6,429.35	4,702.85	4,899.52	5,747.95	5,563.71	4,731.05	3,043.04	2,978.89	62,524.96	171.30
1943	3,578.08	4,355.90	6,918.84	8,005.72	6,418.15	4,604.52	7,794.94	5,550.98	3,086.49	1,580.11	1,727.23	4,581.29	58,202.25	159.46
1944	2,594.60	2,240.56	3,417.13	6,420.43	5,617.38	4,286.31	5,554.08	4,613.76	3,592.90	4,448.98	8,329.88	6,519.66	57,635.67	157.91
1945	2,228.69	2,387.43	8,455.19	3,781.00	1,589.31	3,081.73	2,554.21	7,982.63	4,043.92	2,803.41	5,046.98	3,947.56	47,902.06	131.24
1946	3,211.77	3,453.68	8,714.93	10,132.55	4,093.29	2,230.05	7,772.82	3,608.93	2,821.69	3,445.58	4,724.26	7,476.75	61,686.30	169.00
1947	5,800.74	2,541.56	7,178.62	6,115.38	8,009.77	3,586.24	5,798.34	6,042.28	5,069.51	4,396.22	5,126.44	7,044.39	66,709.49	182.77
1948	4,999.06	3,777.84	8,075.89	8,298.76	6,351.44	4,242.61	7,947.84	5,660.28	3,728.95	6,411.85	7,710.69	6,806.62	74,011.83	202.77
1949	4,097.26	2,697.62	4,911.36	7,004.55	3,536.85	2,780.70	5,158.41	5,693.25	1,971.01	2,368.19	6,299.45	5,677.41	52,196.06	143.00
1950	3,354.31	4,394.62	6,858.95	8,662.24	9,646.70	5,260.58	6,839.49	5,683.31	3,584.43	3,553.04	5,279.56	5,933.24	69,050.47	189.18
1951	5,698.28	3,675.32	5,698.17	4,172.38	2,351.22	2,773.62	3,621.99	5,709.75	2,824.25	2,565.98	5,992.30	4,961.29	50,044.55	137.11
1952	5,934.22	5,117.99	8,344.81	6,451.89	7,525.06	8,779.98	7,943.66	4,505.14	4,743.40	6,181.96	9,435.19	7,491.55	82,454.85	225.90
1953	1,870.86	2,546.54	5,285.27	2,051.55	5,557.06	4,002.66	3,463.71	4,410.02	1,243.12	1,743.89	3,958.14	5,232.35	41,365.17	113.33
1954	3,127.21	2,157.37	7,186.48	4,125.05	9,834.32	6,552.34	10,229.01	10,353.71	5,697.28	2,809.81	2,191.05	6,264.49	70,528.12	193.23

Total Monthly and Annual East Maui Ditch Deliveries from 1925

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MGD
1955	5,225.83	6,564.21	7,572.03	7,440.09	9,059.90	4,089.84	6,170.30	8,199.50	4,297.65	3,727.34	3,369.66	2,253.35	67,969.70	186.22
1956	3,479.20	4,205.76	6,261.83	9,093.41	9,427.37	9,911.20	6,465.94	8,399.15	3,068.64	6,359.67	3,376.20	3,532.23	73,580.60	201.59
1957	4,534.51	5,311.57	3,998.16	7,319.28	5,933.00	1,818.63	5,546.83	9,108.34	5,015.42	4,192.16	6,737.44	8,775.81	68,291.15	187.10
1958	5,653.06	2,907.30	3,966.33	4,108.51	6,737.62	6,390.03	10,179.78	10,010.38	5,960.02	7,475.68	7,785.59	7,394.92	78,569.22	215.26
1959	4,557.12	5,363.62	7,196.64	7,671.36	6,814.94	3,081.04	4,449.01	6,981.90	3,996.67	1,976.43	4,514.96	8,541.50	65,145.19	178.48
1960	6,484.57	5,490.97	7,409.68	9,852.02	7,028.71	5,008.38	4,281.41	4,771.95	4,791.83	3,474.48	7,689.32	6,119.46	72,402.78	198.36
1961	3,823.10	6,103.46	4,492.00	4,595.20	4,229.67	5,255.74	3,353.29	3,963.30	2,217.63	5,997.53	7,339.67	5,004.57	56,375.16	154.45
1962	2,266.49	2,067.99	8,037.26	4,385.09	4,229.88	1,277.60	3,921.05	4,115.55	2,774.71	1,800.48	1,903.08	3,568.22	40,347.40	110.54
1963	2,767.16	2,045.59	4,358.38	6,926.61	9,583.66	6,618.77	7,637.61	4,669.74	3,984.54	7,376.43	5,525.46	3,426.50	64,920.45	177.86
1964	6,188.35	6,094.77	7,049.35	5,967.65	8,583.95	3,805.09	5,434.39	4,888.26	4,746.66	7,862.05	7,298.12	4,503.53	72,422.17	198.42
1965	3,734.29	4,634.31	6,813.10	6,156.54	5,614.37	4,979.03	6,195.10	4,239.53	1,390.29	2,595.49	7,372.91	8,318.31	62,043.27	169.98
1966	6,727.25	5,860.62	5,453.79	6,174.12	3,493.28	2,918.01	5,170.33	5,977.35	3,968.65	6,622.16	4,998.58	5,044.28	62,408.42	170.98
1967	5,996.93	5,129.49	6,116.04	6,512.20	4,546.51	3,231.31	7,326.27	7,121.25	2,296.44	2,621.08	9,011.88	6,481.88	66,391.28	181.89
1968	4,404.71	1,917.58	7,000.65	7,742.19	5,680.01	3,900.17	3,331.23	4,232.83	2,894.27	2,357.35	1,843.95	3,138.66	48,443.60	132.72
1969	3,090.52	4,730.63	7,389.86	8,382.51	6,850.29	3,744.62	8,342.95	8,599.16	7,567.33	3,707.59	3,399.03	4,325.54	70,130.03	192.14
1970	3,651.75	2,626.43	4,659.20	8,150.19	6,870.80	4,183.63	8,484.90	6,868.97	6,053.38	5,500.71	5,563.49	4,354.29	66,967.74	183.47
1971	1,719.70	2,227.05	5,076.79	6,565.25	5,678.05	2,741.52	2,556.16	1,436.59	2,275.36	2,543.22	5,112.11	5,587.08	43,518.88	119.23
1972	3,919.94	4,775.12	2,026.16	6,581.80	4,262.66	2,350.37	4,848.40	4,835.59	2,685.19	4,221.65	6,319.54	3,132.91	49,959.33	136.87
1973	4,042.48	5,768.89	9,816.83	6,628.37	6,251.20	3,939.28	3,352.14	1,284.89	1,373.41	3,065.56	5,217.84	4,000.15	54,741.04	149.98
1974	3,064.30	3,801.82	4,484.01	5,861.78	6,497.22	3,242.85	3,076.25	2,117.04	999.77	1,964.25	6,056.60	5,704.40	46,870.29	128.41
1975	7,670.20	6,130.15	7,561.60	6,783.15	4,128.65	2,127.67	3,050.68	5,042.61	2,353.69	5,557.26	4,271.06	2,449.61	57,126.33	156.51
1976	4,691.94	4,726.32	7,295.90	8,722.21	5,144.60	2,345.51	3,953.86	2,935.72	2,235.84	3,909.87	5,669.55	2,701.00	54,332.32	148.86
1977	956.60	2,201.04	10,528.01	7,806.57	5,850.80	2,525.16	6,329.28	6,066.37	2,844.74	2,909.78	3,350.13	3,397.01	54,765.49	150.04
1978	3,292.67	1,374.07	5,423.97	5,562.40	6,296.64	6,487.45	8,455.96	8,233.99	6,237.30	6,913.00	6,609.26	6,302.93	71,189.64	195.04
1979	4,579.05	3,917.12	4,791.17	4,364.90	4,455.28	5,149.81	5,723.65	3,923.29	2,262.44	2,944.99	6,576.75	5,435.21	54,123.66	148.28
1980	2,691.58	2,802.89	5,954.60	7,424.84	7,844.87	7,396.37	9,232.49	7,153.63	5,948.81	5,560.95	3,974.67	1,705.54	67,691.24	185.46
1981	1,471.00	2,861.57	3,524.84	2,865.84	3,767.67	1,108.79	1,511.72	3,908.69	2,765.07	4,748.61	7,883.74	5,954.92	42,372.46	116.09
1982	3,555.40	3,585.18	5,198.18	5,581.11	7,156.23	4,490.55	10,204.67	10,464.13	7,238.19	6,813.33	4,380.52	3,959.57	72,627.06	198.98
1983	2,638.40	1,090.57	1,707.00	4,993.85	8,192.66	5,036.94	6,832.82	5,201.45	6,603.98	9,545.81	5,350.81	2,479.47	59,673.76	163.49

Total Monthly and Annual East Maui Ditch Deliveries from 1925

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MGD
1984	5,140.19	5,765.63	2,783.96	7,467.90	4,703.61	2,949.64	2,254.77	1,924.47	810.39	436.99	2,207.56	3,817.07	40,262.18	110.31
1985	1,837.19	2,636.95	10,110.66	7,611.06	10,444.71	2,937.15	5,271.47	6,076.50	2,976.02	4,782.60	4,324.49	3,519.46	62,528.26	171.31
1986	4,054.52	1,703.10	5,181.68	8,268.54	7,254.26	8,870.49	8,592.28	6,303.96	1,750.36	5,341.06	8,757.05	6,455.22	72,532.52	198.72
1987	7,127.04	4,624.31	3,969.40	7,017.39	7,487.70	8,489.88	7,768.64	2,856.99	3,929.51	4,574.76	6,560.43	5,711.49	70,117.54	192.10
1988	4,676.36	5,939.81	6,845.31	7,159.25	6,573.55	3,332.25	4,301.19	4,014.75	2,511.98	3,770.67	6,108.35	4,636.08	59,869.55	164.03
1989	6,550.34	3,190.98	4,196.19	5,747.72	7,873.24	6,851.57	8,789.35	6,274.27	5,705.83	4,691.30	2,445.90	2,462.35	64,779.04	177.48
1990	5,189.72	5,441.76	4,854.56	4,104.08	7,102.61	7,075.17	6,743.98	6,519.43	7,881.18	8,530.93	5,249.64	5,268.87	73,961.93	202.64
1991	4,254.31	3,547.39	5,718.15	6,236.30	5,467.93	5,121.48	5,131.90	7,061.56	4,612.20	2,709.79	2,078.12	5,148.84	57,087.97	156.41
1992	4,088.44	3,714.17	1,761.86	1,564.70	3,457.24	5,147.67	8,052.26	8,853.13	8,994.62	4,562.56	5,859.25	4,978.14	61,034.04	167.22
1993	3,002.78	2,323.38	5,424.46	5,800.88	7,692.26	3,782.02	7,078.51	6,599.97	3,549.80	5,532.19	6,987.15	6,545.37	64,318.77	176.22
1994	6,146.04	6,338.01	5,452.04	5,858.49	4,850.49	6,725.53	7,496.48	7,170.85	6,572.27	3,125.17	8,956.09	7,829.69	76,521.15	209.65
1995	4,234.21	1,407.37	2,491.06	5,381.35	6,253.12	4,710.01	5,979.35	7,139.55	3,771.63	5,807.45	4,752.58	2,366.38	54,294.06	148.75
1996	4,050.99	5,394.73	5,196.07	6,298.45	3,902.91	3,699.19	5,906.88	3,178.24	2,763.92	1,011.91	4,912.46	5,344.07	51,659.82	141.53
1997	4,939.11	2,845.90	7,746.13	4,111.75	6,723.54	8,557.44	9,316.25	4,577.26	3,839.24	2,596.14	6,006.90	4,764.54	66,024.20	180.89
1998	3,419.05	2,047.62	2,785.51	9,432.68	8,838.08	7,939.19	5,486.61	5,409.51	5,463.83	7,370.22	5,772.46	6,765.40	70,730.16	193.78
1999	4,746.81	5,184.76	5,693.19	6,307.93	2,037.17	1,416.85	2,674.63	4,264.34	2,838.92	1,934.25	3,215.93	6,693.94	47,008.72	128.79
2000	6,617.02	2,357.25	2,356.60	6,765.52	2,601.51	1,270.37	4,377.21	6,123.99	6,135.85	6,794.52	7,729.98	3,059.37	56,189.19	153.94
2001	1,286.89	3,764.72	3,629.81	6,686.42	5,065.53	2,725.24	3,254.72	6,452.96	3,182.26	7,148.75	6,769.56	6,287.41	56,254.27	154.12
2002	5,288.72	5,690.39	6,107.25	2,613.87	4,672.32	3,074.27	6,143.04	5,211.54	3,657.10	2,814.91	1,522.71	3,630.41	50,426.53	138.15
2003	2,338.49	3,804.40	2,571.73	4,645.14	2,103.81	2,261.36	5,115.13	6,943.94	3,589.64	2,810.28	5,048.70	6,926.57	48,159.19	131.94
2004	4,390.66	4,302.40	5,965.80	6,634.36	7,227.53	5,298.48	3,021.38	2,865.51	1,929.51	2,816.40	3,714.58	4,588.81	52,755.42	144.54
2005	2,173.69	2,898.15	5,122.25	7,015.48	3,158.03	5,167.20	7,385.34	4,914.13	6,161.25	7,801.24	6,744.12	3,363.98	61,904.86	169.60
2006	5,615.33	5,999.21	5,784.47	5,670.21	5,906.58	2,948.93	3,342.72	2,819.31	2,078.52	2,476.94	2,888.23	3,245.26	48,775.71	133.63
2007	3,607.32	3,422.56	4,634.82	4,745.55	2,458.27	1,634.47	3,337.82	3,574.15	5,080.02	6,402.87	3,921.95	4,415.63	47,235.43	129.41
2008	5,298.10	3,860.63	2,489.23	2,785.10	1,820.13	765.41	2,133.55	3,561.19	1,416.23	1,285.64	1,841.51	2,601.27	29,857.99	81.80
2009	3,361.73	4,324.76	6,456.78	6,969.87	2,302.05	1,774.53	3,102.92	4,093.80	2,945.83	4,457.04	5,455.56	4,282.95	49,527.82	135.69
2010	2,581.13	1,818.23	7,317.38	5,885.58	2,930.21	1,683.39	2,279.64	2,504.48	1,605.97	3,854.54	5,104.37	3,842.88	41,407.80	113.45
2011	2,377.96	1,789.89	3,972.19	2,192.98	3,138.06	4,071.95	3,500.99	5,264.41	2,174.60	1,689.50	5,134.61	7,017.06	42,324.20	115.96
2012	2,505.23	2,679.89	6,750.81	4,267.34	5,076.42	5,362.79	6,813.83	4,107.94	5,002.22	1,916.61	2,041.05	3,694.64	50,218.77	137.59

Total Monthly and Annual East Maui Ditch Deliveries from 1925

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MGD
2013	4,836.61	5,469.24	4,028.11	2,065.93	3,920.46	3,252.01	1,827.20	2,901.72	1,737.58	1,435.83	2,249.38	1,971.94	35,696.01	97.80
2014	2,925.78	2,132.09	5,158.43	6,408.32	4,970.75	2,488.84	5,069.22	2,468.27						

APPROX. SCALE: 1" = 200'

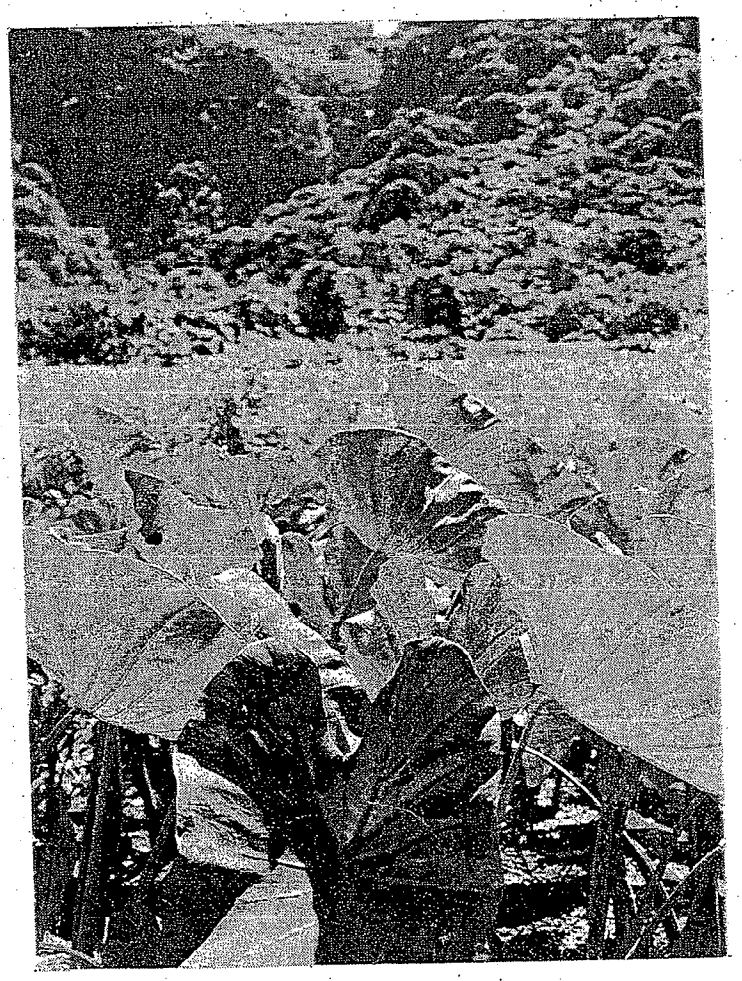
WAILUA HOMESTEADS

DATE OF PHOTO: 10-3-85

Exhibit A-54

KALO KANU O KA 'ĀINA

A CULTURAL LANDSCAPE STUDY OF KE'ANAE AND WAILUANUI, ISLAND OF MAUI



Prepared by

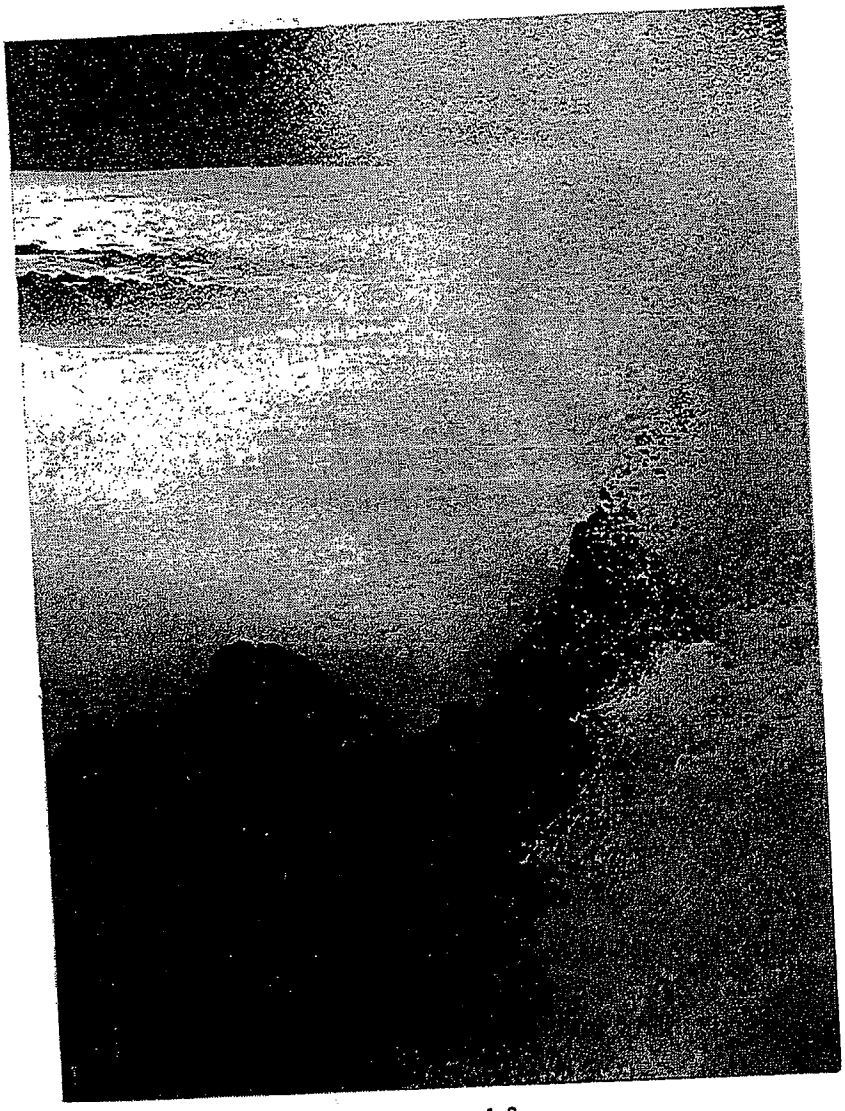
THE COUNTY OF MAUI
PLANNING DEPARTMENT
250 South High Street
Wailuku, Hawaii

July 1995

EXHIBIT "B-123"

KALO KANU O KA 'ĀINA

A CULTURAL LANDSCAPE STUDY
OF
KE'ANAE AND WAILUANUI,
ISLAND OF MAUI



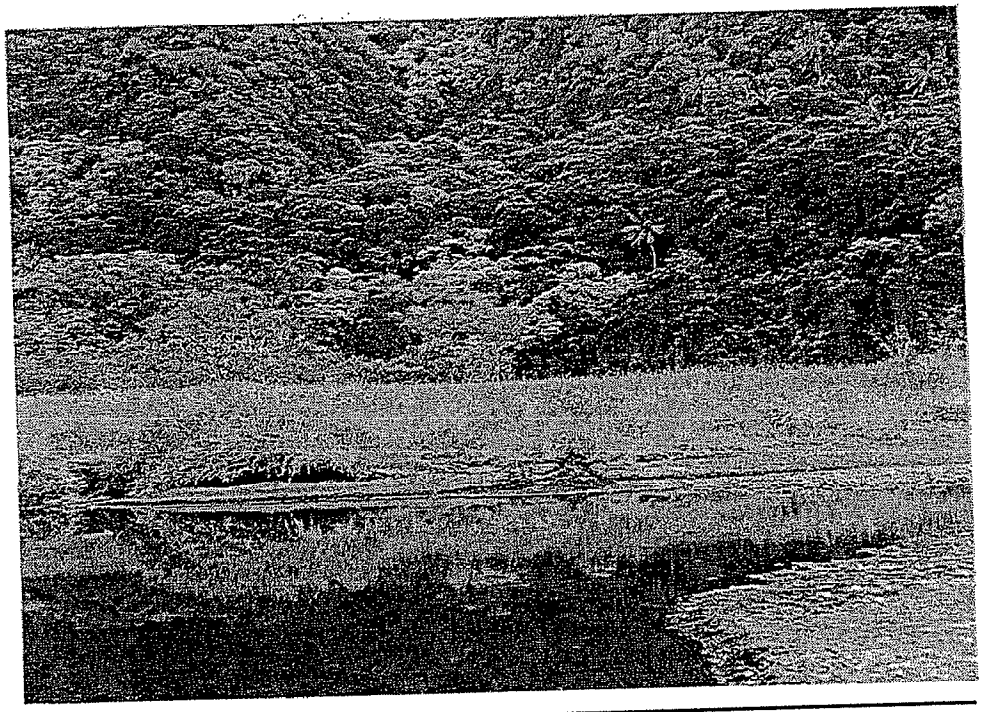
Prepared for

THE COUNTY OF MAUI PLANNING DEPARTMENT
and
THE MAUI COUNTY CULTURAL RESOURCES COMMISSION

by the consultant team of
GROUP 70 INTERNATIONAL, INC.
DAVIANNA McGREGOR, Ph.D.
and
CULTURAL SURVEYS HAWAII, INC.

July 1995

This program received Federal funds from the National Park Service. Regulations of the U.S. Department of Interior strictly prohibit unlawful discrimination in departmental Federally Assisted Programs on the basis of race, color, national origin, age or handicap. Any person who believes he or she has been discriminated against in any program, activity, or facility operated by a recipient of Federal assistance should write to: Director, Equal Opportunity Program, U.S. Department of the Interior, National Park Service, P.O. Box 37127, Washington, D.C. 20013-7127.



...they have everything. They have the taro patch, they have the fishing ground, they have the 'opae, they have the o'opu...you know, they have everything what you want. It's that, you have to do it yourself, you see...you got to work hard for everything you want.

-- Mary Ka'auamo

This is the place. We're blessed, we took such good care of everything we had. Awapuhi said, and til today I remember the word she used is "selfish." The word selfish is for the people over here, to protect the area...Selfish is because the area, we don't want it to get spoiled.

-- Kimo Kimokeo

ACKNOWLEDGEMENTS

The County of Maui Planning Department wishes to acknowledge the efforts of Keoni Fairbanks and the Maui County Cultural Resources Commission to initiate this study of the taro-growing, historic vernacular landscape at Ke'anae and Wailuanui. State Representative Peter Apo and Dr. Don Hibbard, Administrator of the State Historic Preservation Division, along with the Hawai'i Cultural Landscape Task Force, provided a foundation for the study.

The Maui County Planning Department commends the dedicated work of the consultant team: George Atta of Group 70 International Inc.; Dr. Hallett Hammatt and Rodney Chiogioji of Cultural Surveys Hawaii, Inc.; and Dr. Davianna McGregor. Their enthusiasm for the project and commitment to a thorough report carried the project beyond the requirements Maui County had been able to establish with limited grant funding.

Group 70 International Inc. and Cultural Surveys Hawaii received generous cooperation from the following members of Ke'anae and Wailuanui communities: Enos Akina, Maggie Alu, the late Apolonia Day, James Hueu, Isaac and Gladys Kānoa, Bill and Lu Kepler, Dorothea Lum Hoy, Moses Lum Hoy, Helen Nakanelua, Sharon Norrod, and Edward "Kimo" Wendt.

Dr. McGregor would like to acknowledge and thank the thirteen community informants who gave their time and *mana'o* to be interviewed for this study. She also thanks Charmaine, Moki, Amy, and Patrick Day for their hospitality while she stayed in Ke'anae-Wailuanui to conduct the interviews for this study. In addition she thanks Elaine Wender for her input and *mana'o*. Finally, she acknowledges Uncle Harry Kunihi Mitchell who first introduced her to the Ke'anae-Wailuanui community in 1980 and continued to share his knowledge and experience about Hawaiian customs, beliefs, and practices until he passed away in 1990.

Also acknowledged are the staffs of the Department of Land and Natural Resources, the Maui Historical Society, and the Bishop Museum Archives; and Garrett Hew of East Maui Irrigation Company. Review of the report was provided by staff of the State Historic Preservation Division, including Dr. Don Hibbard, Dodie Lau, Dr. Ross Cordy, Theresa Donham, Holly McEldowney, Dr. Sara Collins, and Rose Chismar. Keoni Fairbanks also reviewed the final draft.

The authors wish to acknowledge the integral participation of Elizabeth Anderson of the Maui County Planning Department during all phases of this report's production.

The Group 70 team engaged in this project includes:

Ralph E. Portmore, AICP	Principal-in-Charge
George I. Atta, AICP	Project Manager
Francis S. Oda, AIA, AICP	Architect
Paula Kaneshiro	CAD draftsperson
Kathryn Tsukano	Graphics Manager
Chad Asuncion	Graphics
Jeanne Tomita	Graphics

Participating Cultural Surveys Hawaii staff includes:

Hallett H. Hammatt, Ph.D.	Chief Archaeologist
Victoria Creed, Ph.D.	Researcher
William Folk	Field researcher
Zoe Hammatt	Field researcher
Mark Stride	Field researcher
Patrick Walsh, M.A.	Field researcher
Rodney Chiogioji	Researcher
Daria Creed	Draftsperson

Maui County Planning Department staff members coordinating the project include Brian Miskae, Julie Higa, Bill Medeiros and Elizabeth Anderson.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS i

LIST OF FIGURES vi

GLOSSARY ix

SUMMARY 1

I. PROJECT BACKGROUND AND GOAL 5
- A. Project Background 5
  - 1. Cultural Landscape Task Force 5
  - 2. The Maui County General Plan and the Hāna Community Plan 6
- B. Tasks of the Ke'anae-Wailuanui Cultural Landscape Study 8
- C. Goal of the Ke'anae-Wailuanui Cultural Landscape Study 9

II. ORIENTATION TO THE STUDY AREA AND METHODOLOGY 10
- Cultural Landscape Boundary 10
- Traditional Cultural Practices Region 13
- Methodology 13
- Community Interviews 15

III. NATURAL SETTING 18

IV. CULTURAL AND HISTORICAL CONTEXT 21
- Prehistory to 1852 21
- 1852-1925 26
- 1926-1946 37
- 1946 to the Present 38

V. TARO IN HAWAIIAN CULTURE AND WITHIN THE KE'ANAE-WAILUANUI LANDSCAPE 42

VI. INVENTORY OF CULTURAL LANDSCAPE COMPONENTS 44
- A. Taro Cultivation 44
  - 1. Ke'anae Peninsula 45
  - 2. Wailuanui 49
  - 3. Ke'anae Arboretum 56
  - 4. Waianu Valley 58
  - 5. Lākini *lo'i* 60
  - 6. Waiokamilo Stream *Lo'i* 60
  - 7. Formerly Cultivated Lands in the *'ili* of Kupa'u 60
  - 8. Formerly Cultivated Lands in the Valley of Nua'ailua 63
  - 9. Other Formerly Cultivated Lands 65
- B. Other Vegetation 65
  - 1. Ornamentals 65
  - 2. Endemic or Indigenous Plants 65
  - 3. Forest 65

TABLE OF CONTENTS (continued)

C. Circulation Networks 67
D. Buildings, Structures, Non-Structural Facilities, and Objects 70
1. Residences 70
2. Public Buildings and Facilities 78
a. Churches 78
b. Ke'anae School 81
c. Ke'anae YMCA Camp Complex 84
d. County of Maui Corporation Yard 84
e. Ke'anae Arboretum 86
3. Roadside Stands 86
4. Accessory Structures 86
5. Bridges 86
6. Cemeteries 88
E. Clusters 89
F. Internal Boundaries 91
G. Ko'olau Ditch, East Maui Irrigation Company (EMICo) 91
H. Archaeological and Historic Sites 91
1. Previously Recorded Sites 93
2. Newly Recorded Sites 93
3. Archaeological Sites as a Landscape Component 95
I. Small-Scale Elements 95
J. Open Areas 97
K. Viewing Points 97
L. Cultural Resources and Use Areas 99

VII. *MANA'O O KA 'ĀINA* 102
A. Traditional Life Ways 102
B. Subsistence Practices and Resources 104
C. Cultural Practice and Subsistence Use Areas 113
1. Areas within the Traditional Cultural Practices Region 114
2. Additional Areas of Traditional Cultural Practice 122

VIII. LANDSCAPE USE PATTERNS 125
A. Spatial Organization 125
1. Land Use and Settlement Pattern 125
2. Irrigation Systems and Circulation 126
3. Viewsheds 126
4. Subsistence Use Areas 127
B. Natural Determinants of Settlement and Construction 128
1. Flatlands 128
2. Rugged Terrain and Isolation 128
3. Rainfall 128
4. Slopes and Irrigation 129
5. Ocean Access 129
6. Land Access 129
7. Building Materials 130
8. Vernacular Architecture 130

TABLE OF CONTENTS (continued)

C. Taro Cultivation: Economy and Land Tenure 130
1. Poi Mills 130
2. Land Tenure in Ke'anae Peninsula Taro Fields 131
D. Cultural Determinants of Land Use Patterns 132

IX. INTEGRITY AND SIGNIFICANCE 133
A. Period of Significance 133
B. Integrity 133
1. Spatial Organization 133
2. Physical Setting 133
3. Historic Associations 133
C. Significance 134
National Register Criterion A 134
National Register Criterion B 135
National Register Criterion C 136
National Register Criterion D 136
Criterion E (as defined by the State Historic Preservation Division) 137

X. POTENTIAL IMPACTS ON THE CULTURAL LANDSCAPE 138
A. Transfer of State Lands to Department of Hawaiian Home Lands Jurisdiction 138
B. Tourism 138
C. Highway Improvements 140
D. Water Use 140

XI. RECOMMENDATIONS 142
Economic Activity 142
Land Use 143
Environment 144
Design 144
Cultural Resources 145

XII. REFERENCES 147

APPENDICES
A. Table of Land Commission Awards - Ke'anae to Wailuanui
B. Table of Ke'anae-Wailuanui Archaeological Sites
C. Table of Ke'anae-Wailuanui Historic Sites
D. A Compilation of Place Names in Ke'anae and Wailuanui
E. Ke'anae-Wailuanui Bridges (from *Historic Bridge Inventory and Evaluation: Islands of Maui and Molokai* [Hawaii Heritage Center 1990])
F. Vegetation
G. Buildings
H. Ke'anae and Wailuanui Cemeteries (from *Maui County Cemetery Directory* [Maui Historical Society 1990])

LIST OF FIGURES

Figure 1 Location Map 7

Figure 2 Existing Conditions 11

Figure 3 Cultural Landscape Boundary 12

Figure 4 Area of Traditional Practices 14

Figure 5 Wooden flume across Palauhulu Stream, Ke'anae - ca. 1883 by C.J. Hedemann (Bishop Museum) 29

Figure 6 Thatched houses above Wailuanui Bay, Wailuanui - ca. 1880s (W.T. Brigham Collection, Bishop Museum) 30

Figure 7 Waikani Falls and Wailuanui Stream, Wailuanui - ca. 1880s (W.T. Brigham Collection, Bishop Museum) 31

Figure 8 Ke'anae Peninsula - 1903 Map by S.M. Kanakanui 32

Figure 9 Kupau *'ili* and *makai* portion of Wailuanui - 1896 Map by S.M. Kanakanui (RM 1760) 33

Figure 10 *Makai* portion of Wailuanui - 1903 Map by G.F. Wright (RM 2234) 34

Figure 11 Waianu Valley - 1908 Map by S.M. Kanakanui (RM 2972) 35

Figure 12 Taro Growing Areas 46

Figure 13 Ke'anae Peninsula *lo'i* complex (State site 50-50-07-3933) 47

Figure 14 Taro Patches, Ke'anae, Maui (Bishop Museum) 50

Figure 15 Wailuanui *lo'i* complex (left and center) (State site 50-50-07-3934) and Wailuanui east *lo'i* complex (right) (State site 50-50-07-3935) 51

Figure 16 Wailuanui, ca. 1936 (Bishop Museum) 53

Figure 17 Wailuanui - western portion, June 8, 1966 (Bishop Museum) 54

Figure 18 Wailuanui - eastern portion, June 8, 1966 (Bishop Museum) 55

Figure 19 Ke'anae Arboretum *lo'i* complex (State site 50-50-07-3932) 57

Figure 20 Waianu *lo'i* complex (State site 50-50-07-3938) 59

Figure 21 Lakini *lo'i* complex (State site 50-50-07-3936) 61

LIST OF FIGURES (continued)

Figure 22 Waiokamilo Stream Complex 62

Figure 23 Ke'anae and Wailuanui, September 28, 1950 (Bishop Museum) 64

Figure 24 Vegetation 66

Figure 25 Forests 68

Figure 26 Ferry Landings 71

Figure 27 Existing buildings (Ke'anae) with structures over 50 years of age identified 72

Figure 28 Existing buildings (Wailuanui) with structures over 50 years of age identified 73

Figure 29 Residences 74

Figure 30 Residences 75

Figure 31 Residences 76

Figure 32 Ke'anae Congregational Church 79

Figure 33 Saint Gabriel's Church, Wailuanui 80

Figure 34 Religious Structures 82

Figure 35 Ke'anae School 83

Figure 36 Ke'anae YMCA Camp Complex 85

Figure 37 Accessory Structures and Bridges 87

Figure 38 Residential Clusters 90

Figure 39 East Maui Irrigation Company Ditch 92

Figure 40 Archaeological and historic sites in Ke'anae and Wailuanui (identified by state site number) 94

Figure 41 Small-scale Elements 96

Figure 42 Viewing Points 98

Figure 43 Views 100

LIST OF FIGURES (continued)

Figure 44 Ke'anae-Wailuanui Community 124

Figure 45 Lands Transferred to Department of Hawaiian Home Lands 139

GLOSSARY

ahu	—heap, pile, collection, mass, altar, shrine; a traplike stone enclosure made by fishermen for fish
ahupua'a	—a traditional Hawaiian land unit extending from the mountain to the sea
akua	—god, goddess, spirit
ali'i	—chief, chiefess, nobility
apana	—piece, slide, portion, a *kuleana* land division may consist of several *apana*
archaeological feature	—the discrete remains of past activity preserved in the ground
artifact	—any object made by people
'aumakua	—personal or family god; protective spirit
'auwai	—ditch
heiau	—native Hawaiian place of worship, shrine
historic	—in Hawaii, the period (post-contact) after the landing of Captain Cook in 1778
hui	—a group cooperative
'ili	—a small land unit, a subdivision of an ahupua'a
kahawai	—stream, river, ravine, whether wet or day; valley
kihapai	—garden
kīpuka	—an "island" of land (where there may be greenery) left surrounded by a lava flow
ko'a	—shrine, often consisting of circular piles of coral or stone, built along the shore or by a pond or stream, used in ceremonies to ensure success in fishing
konohiki	—headman of an *ahupua'a*, under the chief
kukui	—tree with oily nut used for food or as fuel for light
kula	—plain, field, open country, pasture

GLOSSARY (continued)

kuleana —land holding of the common people; right, privilege, responsibility, jurisdiction, as in *kuleana'āina* (owned land - in land documents of 1860s)

kupūna —elder

lelekawa —Hawaiian sport of cliff leaping

lo'i —a wetland taro field

loko —fishpond

Mahele —the division of lands among the crown, the government, and the *konohiki*

mahi'ai'ana —cultivation of the land

makai —towards the sea

maka'ainana —common people

mauka —towards the mountains

mō'ī —king, sovereign, monarch; according to Kepelino and Kamakau, a rank of chiefs who could succeed to the government but who were of lower than chiefs descended from the god Kāne

mo'o —lizard, dragon, water spirit, genealogical line

muliwai —river; river mouth; pool near mouth of a stream, as behind a sand bar, enlarged by ocean water left there by high tide; estuary

noni —a tree used medicinally (*Morinda citrifolia*)

'ohana —a kin group of extended families

pali —cliff

poi —Hawaiian staff of life-cooked taro pounded and mixed with water

ti —a plant the leaf of which is used for food preparation and ornamentation (*Cordyline terminalis*)

tsunami —tidal wave

SUMMARY

This report's title - *Kalo Kanu o ka 'Āina* - is a poetic saying drawn from Mary Kawena Pukui's collection of Hawaiian proverbs and sayings, *'Ōlelo No'eau* (1983: 157). Literally, "taro planted on the land", but interpreted by Pukui as a metaphor of "natives of the land from generations back", the saying mirrors both the land and the people of the adjoining *ahupua'a* of Ke'anae and Wailuanui, located in the Ko'olau region of the Hāna District on the island of Maui.

The two *ahupua'a* have a long history of relative isolation from the rest of Maui. The local topography is rugged: deep valleys and high cliffs cut into the sides of the great shield volcano, Haleakalā; sea cliffs and boulder beaches stretch along the coast. Abundant rainfall creates perennial streams and encourages vigorous forest growth. Until the Hāna Highway was completed in 1926, the *ahupua'a* were largely inaccessible except by foot, horseback or boat. This physical isolation has insulated the community of Ke'anae and Wailuanui, allowing it to retain many characteristics of local indigenous culture which have been lost in more readily accessible areas of the state of Hawai'i. This is most strikingly evidenced in the expanses of taro patches spread across Ke'anae peninsula and Wailuanui valley. The sustained presence of cultural traditions within a relatively isolated context was a key criterion for the selection of the Ke'anae-Wailuanui community as the subject of a prototype cultural landscape study project.

This report presents a general inventory and analysis of the Ke'anae-Wailuanui cultural landscape and includes:

1. identification of the historic context of the landscape through literature and archival research;
2. identification and mapping of the boundaries and physical components of the cultural landscape;
3. recording of community history, traditions and insights through interviews, visits and resident-guided field trips;
4. description of historical trends and existing conditions;
5. assessment of integrity and significance;
6. recommendations applicable to economic activity, land use, design and preservation of cultural resources.

Methodology

The research team undertaking this study included archaeologists, ethnographers, architects and planners. This multi-disciplinary framework facilitated a comprehensive approach to the study. Investigative methodology included: archival searches, document reviews, aerial photo interpretation, field surveys and interviews.

Inventory

Five distinct localities in Ke'anae-Wailuanui in which taro is presently cultivated were identified during the study: Ke'anae Peninsula, Wailuanui, Ke'anae Arboretum, Waianu Valley and Lākini. (An additional small area of cultivation exists at Waiokamilo Stream just *makai* of its crossing of Wailuanui Road. Small taro *lo'i* are located on both sides of the stream. These *lo'i* were not examined during the present study.)

Comparisons with historic maps indicate notable continuity and integrity in these systems in both the configuration of the *lo'i* and the methods of irrigation. What has changed significantly over time is the extent of the areas in planting; taro cultivation has expanded and contracted several times with a long-term trend toward contraction due to population and economic changes.

The long settlement history has modified the landscape in many ways. The vegetation is predominantly of foreign or Polynesian introduction; most endemic or indigenous vegetation has retreated to the uplands. Changing technology, economics and lifestyles have affected systems of circulation and land use which date back to historic and pre-contact periods. Archaeological sites are present but only a few have retained their structural integrity. The dominant feature of the modified landscape under current or recent cultivation - the *lo'i* and *'auwai* systems - have historical and cultural value as well as significant economic value.

The architecture of the community manifests a certain consistency, although architecturally significant, historic residences are not generally evident and many buildings need repair. (According to county property records, there are 36 buildings older than 50 years. However, it is clear these records are incomplete: buildings no longer standing are still listed and several structures that clearly predate 1946 are not assigned construction dates.) The predominant residential architectural pattern is plantation style with newer construction incorporating elements from recent subdivision tract homes. The evolution of the local vernacular architecture has paralleled the community's evolution, taking advantage of new materials and techniques while retaining key elements such as generally small size and plantation design features.

Traditional Practices

Boundaries of areas where traditional subsistence activities are practiced were determined through a series of interviews with long-time residents. These traditional practices - including fishing, hunting and gathering - have persisted as valuable activities, benefitting the practitioners economically and culturally. Continuing access to the areas where these activities are practiced is a concern of the Ke'anae-Wailuanui community.

Integrity and Significance

The Ke'anae-Wailuanui cultural landscape shows a high level of integrity in the spatial organization of the taro fields, with the arrangement of the *lo'i* and the pattern of irrigation supply little changed since the system was built by the early Hawaiians. The spatial organization of a community physically isolated from other areas has resulted in a cohesive settlement characterized by integrity of settlement pattern and architecture. The physical setting retains a high degree of integrity. The location remains remote and rural. Tourists travel the Hāna Highway in increasing numbers, but development of suburbs or tourist attractions has not yet impacted the traditional landscape. In addition, the Ke'anae peninsula *lo'i* may also be the only example of wetland taro cultivation on an 'a'a flow.

Integrity is further manifested by the persistence into the end of the twentieth century of Hawaiian cultural and subsistence practices, and spiritual customs and practices. Rural Hawaiian communities such as Ke'anae-Wailuanui are "cultural *kipuka*", sources of regeneration and revitalization in modern Hawai'i. There is a growing recognition that

protection of the natural resources and the integrity of the lifestyle and livelihoods of "cultural *kipuka*" such as Ke'anae-Wailuanui are essential for the perpetuation of Hawaiian culture for future generations.

The Ke'anae and Wailuanui cultural landscape is evaluated as significant under the four National Register criteria of significance and an additional Hawai'i state criterion:

National Register Criterion A (properties that have association with significant events affecting broad patterns of history): Ke'anae-Wailuanui evidences the development of Hawaiian wetland irrigation systems. It is an example of a system demanding planning, organization of labor, clear definition of water rights and community cooperation. Hawaiian culture, as expressed in religion, art, language, dance, social structure and chiefly political system evolved over nearly fifteen hundred years in these islands, sustained by highly-developed and well-managed systems of wetland taro cultivation.

During the plantation era, Ke'anae and Wailuanui were impacted by the development of an extensive network of irrigation ditches and tunnels which diverted, collected, stored, and transported water from over 50,000 acres of the East Maui watershed. Additionally, many Chinese immigrants who left sugar plantations on Maui settled in Ke'anae-Wailuanui, engaged in rice cultivation and intermarried with Hawaiian women of the district.

The cultural landscape encompasses the last completed segment of the Hāna Belt Road which opened the Ko'olau region and Hāna to increased contact with the rest of Maui.

National Register Criterion B (associations with famous people): While the Ke'anae-Wailuanui region was not itself identified with notable Hawaiian personages, traditions identify it as the scene of significant events associated with some of these figures. During the 14th century, Wailuaiki and Wailuanui became a war canoe landing area in the early unification battles between Umi-a-Liloa and Ho'olae-Makua. In 1778, Kalani'opu'u and Kamehameha came aboard Captain James Cook's ship, the Resolution, while it anchored off Wailua during Cook's second voyage to the Hawaiian islands. This took place in the midst of a second series of unification battles involving the Hāna district.

National Register Criterion C (quality and integrity of a property in which it can be described as an excellent example of its type): The cultural landscape at Ke'anae and Wailuanui centers on wetland taro cultivation, the scale of cultivation, the layout of the fields, the *'auwai*, the source and delivery of water, the management and labor practices, the associated residential pattern, the continuity of use, and the setting of an isolated rural Hawaiian community. These systems have high integrity and are excellent examples of Hawaiian taro cultivation. The features show little or no influence of the period of rice cultivation from the 1880s to the 1930s.

Two churches dating to 1860, Ke'anae School, and Waikani Bridge all have been listed or have been evaluated as qualifying for listing on the State Register of Historic Places. Cumulatively, these components add to the significance of the cultural landscape.

National Register Criterion D (the potential for yielding information important in history or prehistory): Further studies of the cultural landscape and archaeological resources at Ke'anae-Wailuanui have a potential to yield information on the origins, chronology and

development of Hawaiian taro cultivation, as well as the complex social structures which both sustained and were perpetuated by the agricultural technology.

Criterion E (as defined by the State Historic Preservation Division): This criterion refers to traditional cultural significance. The Ke'anae-Wailuanui landscape qualifies under this criterion because it represents an important resource in the perpetuation of traditional Hawaiian cultural practices - such as taro cultivation, hunting, fishing, and gathering - and Hawaiian social interaction.

Recommendations

The apparent significance and integrity of the cultural landscape at Ke'anae and Wailuanui presents an opportunity to use accumulated experience to achieve the goals of the Maui County General Plan and the Hāna Community Plan. Recommendations generated by this study and report fall into three general categories:

1. Land use management actions and decisions to support and maintain the taro cultivation systems and existing traditional land uses in the community.

2. Measures - including a managed approach to tourism - to protect and enhance the lifestyles, resources, environment and values of the community.

3. Potential treatments and further studies to identify, assess and map historic, archaeological and cultural resources.

I. PROJECT BACKGROUND AND GOAL

Waikani Falls, Wailuanui

I. PROJECT BACKGROUND AND GOAL

A. Project Background

This Ke'anae-Wailuanui Cultural Landscape project is an outgrowth of a concern among state, county and community groups in Hawai'i to protect portions of the Hawaiian landscape which continue to preserve the cultural activities which have characterized the rich history of these islands.

1. Cultural Landscape Task Force

In June of 1993, the Hawai'i State Legislature approved a bill, introduced by Representative Peter Apo, which found that, pursuant to the Constitution of the State of Hawai'i, it is within the power of the state to conserve and develop objects and places of historic or cultural interest. The bill, adopted as Act 156, refers to sections of the Hawai'i Revised Statutes requiring planning for the state's physical environment and for socio-cultural enhancement, recognized the significance of cultural landscapes and established a task force to examine Hawaiian cultural landscapes (1993 Hawai'i Session Laws, page 235, Act 156, Relating to Cultural Landscapes). The task force was to develop designation criteria, specify activities and uses consistent with cultural landscape districts, develop procedures for definition of cultural landscape districts and their boundaries, and report their findings to the legislature.

In January of 1994, the Hawai'i Department of Land and Natural Resources Cultural Landscape Task Force reported to the Hawai'i State Legislature on the importance of landscape preservation within a vital everyday living context. Cultural landscapes, as defined by members of this task force, are:

> Geographic areas which may be as small as a neighborhood, or may encompass an entire island which exhibit monolithic characteristics of an ethnic, economic or cultural nature.
>
> The portion of our heritage that reflects the interaction of cultural, economic, and natural forces on the environment.
>
> A geographically definable area which clearly defines the settlement or use of the land, water or living systems (plants and animals) over a long period of time as well as cultural values, norms, and attitudes toward the land, water or living systems.
>
> Geographically definable areas possessing a significant concentration, linkage or continuity of landscape components (i.e., vegetation, buildings and structures, archaeological sites, roads and trials, waterways, religious and natural features and resources) which are united by human use and past events and/or aesthetically by plan or physical development.

The task force identified a typology of cultural landscapes in Hawai'i, such as: 1) abandoned villages or agricultural systems; 2) taro-producing areas; 3) sugar lands; 4) ranches; 5) fishing areas; 6) religious and legendary sites; 7) fishponds; 8) traditional gathering areas; and 9) entire islands.

One of the task force's concluding recommendations was for support of a model project focusing on the Ke'anae-Wailuanui area on the island of Maui (Figure 1). They recognized this community as a taro growing area with long continuity of use and with local support for preservation (Department of Land and Natural Resources 1994 and National Register Bulletin 30).

2. The Maui County General Plan and the Hāna Community Plan

This cultural landscape study is an inventory and assessment of resources which are relevant to the Hāna Community Plan policies on land use, environment, cultural resources, and economic activity.

The first major theme of the recommendations for amendments to the Maui County General Plan in 1990 was to "protect Maui County's agricultural land and rural identity." Therefore, the first objective listed under land use in the General Plan is:

> To preserve for present and future generations existing geographic, cultural and traditional community lifestyles by limiting and managing growth through environmentally sensitive and effective use of land in accordance with the individual character of the various communities and regions of the County.

The Ke'anae-Wailuanui Cultural Landscape study was initiated by the County of Maui Planning Department pursuant to the Hāna Community Plan, adopted as part of the General Plan in July, 1994, under Section 2.80.050 of the Maui County Code. The Hāna Community Plan calls for government to "compile special plans and studies necessary to implement the recommendations of the Community Plan."

This study follows the recommendations of the Hāna Community Plan towards the following goals, policies and implementing actions.

Land Use: Preservation and enhancement of the current land use patterns which establish and enrich the Hāna Community Plan region's unique and diverse qualities.

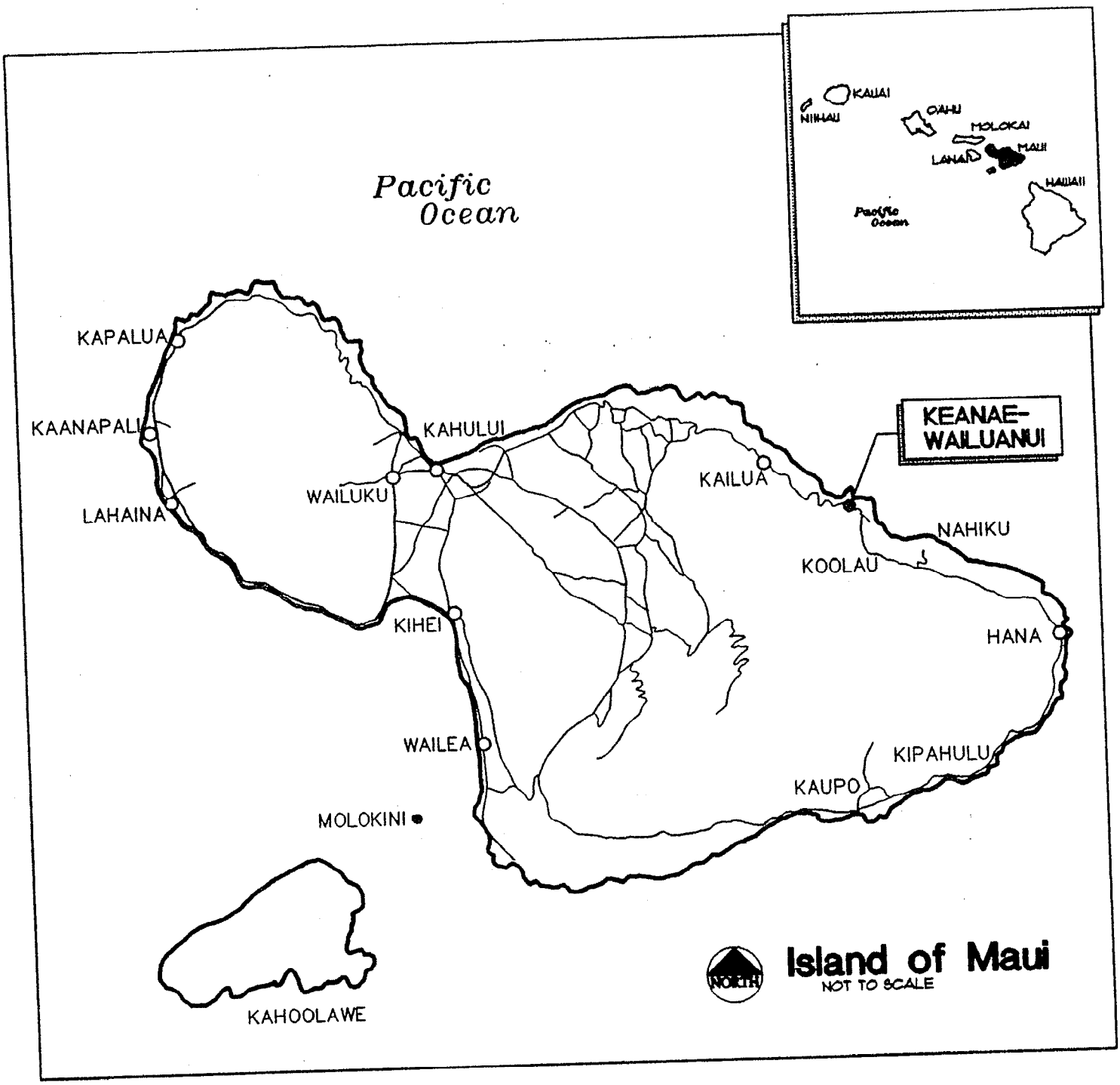
- Identify and inventory exceptional open space resources and viewsheds. Explore protective management measures such as covenants, easements, and other planning tools.
- Explore alternative land use and overlay zoning designations that recognize and preserve the unique natural and cultural characteristics of each community within the Hāna region.
- Encourage the availability of agriculturally suitable lands to provide opportunities for small diversified agricultural activities with residential tenancy for farmers.

Environment: Protection and management of Hāna's land, water and ocean resources to ensure that future generations can enjoy the region's exceptional environmental qualities.

- Recognize residents' traditional uses of the region's natural resources which balance environmental protection and self sufficiency.

Cultural resources: Identification, preservation, protection and where appropriate, restoration of significant cultural resources and practices, that provide a sense of history and identity for the Hāna region.

- Identify, preserve and protect historically, archaeologically and culturally significant areas, sites, and features within the Hāna district.



Location Map

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE

Figure 1

- Promote the cultural resources of the Hāna region as an identifying characteristic of the people and the place.
- General site types and areas that should be flagged for preservation during development review include the following: Hāna Highway and historic bridges, fishponds, landings, habitation complexes, *lo'i* terraces and *'auwai*, plantation ditch systems, religious structures.
- Acknowledge and respect family ancestral ties to cultural resources.
- Encourage the restoration and use of *lo'i kalo* (taro terraces) found in the Hāna region.

Economic Activity: A balanced local economy which provides long-term viability and sustainability while meeting residents' needs and respecting the cultural and natural resources of Hāna.

- Utilize existing components of the local economy to establish a framework for balanced regional economic development.
- Encourage economic activities which are: of substantive economic benefit to the residents of the area; environmentally benign; and compatible with the cultural sensitivities of the residents of the Hāna region.
- Promote and maintain agriculture as a major economic activity with emphasis on a regional diversified agricultural industry.
- Maintain taro farming, ranching and floriculture as major economic activities and promote their economic viability and sustainability. Promote aquaculture and horticulture as economic activities.

B. Tasks of the Ke'anae-Wailuanui Cultural Landscape Study

Due to the mandates of the task force, as well as stated planning policies, the Maui County Planning Department allocated federal preservation services (certified local government) grant funding for a preliminary study of the cultural landscape at Ke'anae and Wailuanui. This study involved three general tasks:

1. Identification of the historic context of the landscape: Archaeological research to determine time depth of wetland taro cultivation and a literature search, including a summary of Land Commission Awards (LCAs) for the *ahupua'a* of Ke'anae and Wailuanui, focused on agricultural or other uses of the claims, as well as sources of ethnic influences on land use, such as rice cultivation in former taro lands, were to be noted.

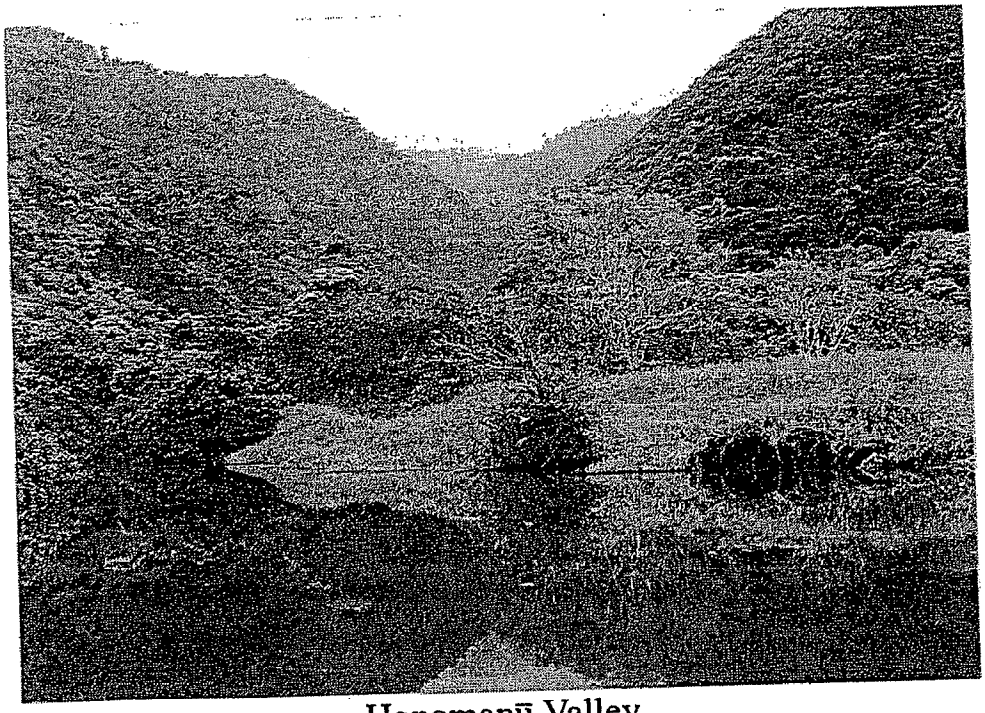
2. Identification of cultural landscape components: Land currently and historically in use for farming, water control, gathering, hunting, homes, commercial and community buildings, and ocean related activities, as well as areas associated with legends and history were to be identified. Existing crops and major vegetation types were identified, along with existing traditional architectural styles and their functions. Interviews were to be conducted to determine traditional agricultural and gathering areas and practices.

3. Preliminary mapping: Historical maps, aerial photographs, and detailed land classification maps were to be used to identify existing land use ares. Boundaries of the cultural landscape were to be determined.

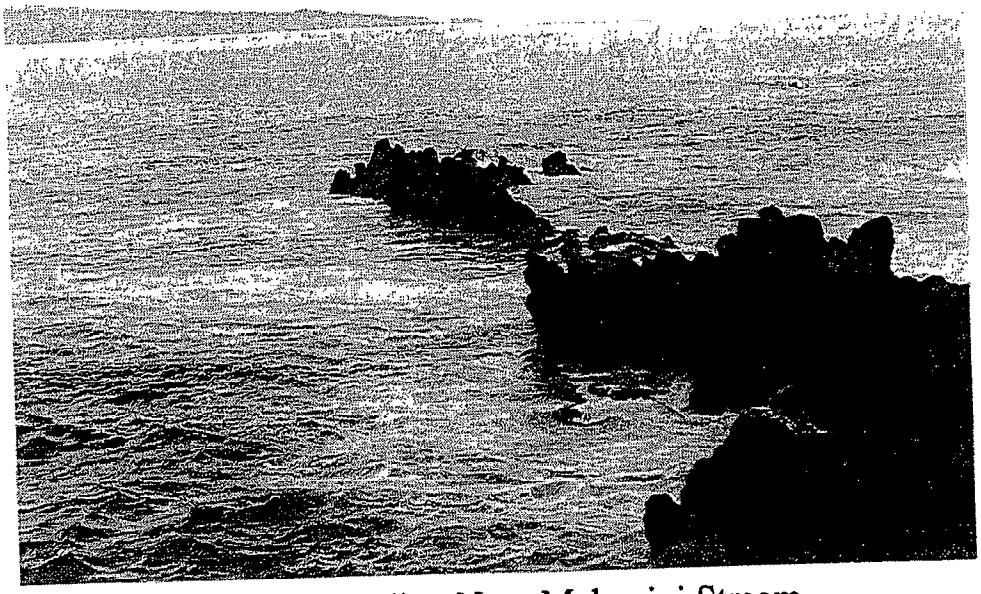
C. Goal of the Ke'anae-Wailuanui Cultural Landscape Study

The goal of this Ke'anae-Wailuanui cultural landscape study is to describe and quantify conditions and traditions which have shaped the land and which still affect the patterns of land use. Land use management policies based on a broad foundation of knowledge of resources will better enable the community and its representatives in county and state government to make effective decisions appropriate to this and other rural and agricultural areas.

II. ORIENTATION TO THE STUDY AREA AND METHODOLOGY



Honomanū Valley



Nāhiku Landing Near Makapipi Stream

II. ORIENTATION TO THE STUDY AREA AND METHODOLOGY

The Ke'anae-Wailuanui settlement is the second most populous area within the Maui County Hāna Community Plan region (Figure 2). The Hāna region encompasses approximately 145,000 acres of the eastern portion of the island of Maui, and contains a resident population of approximately 2,000 (1,895 in the 1990 census). The region's economy is based primarily on diversified agriculture, the visitor industry, government service and subsistence activities. The populated areas in this district are located within a few miles of the ocean, with the mountainous inland tracts largely left to wilderness or used as ranch land.

The context of the study area is the Ko'olau region on the windward coast of the Hāna District. Natural attributes of the area are detailed in Section III of this report.

Discernible within the Ke'anae-Wailuanui region are:

1) a central area of intensive land use where the human impact on the landscape is both currently and readily visible; this area also encompasses adjacent lands formerly intensively used for cultivation;

and

2) the extended land and ocean area still in use by the local population for traditional hunting, fishing and gathering; this second, more extensive area includes locales which were previously cultivated but have been abandoned.

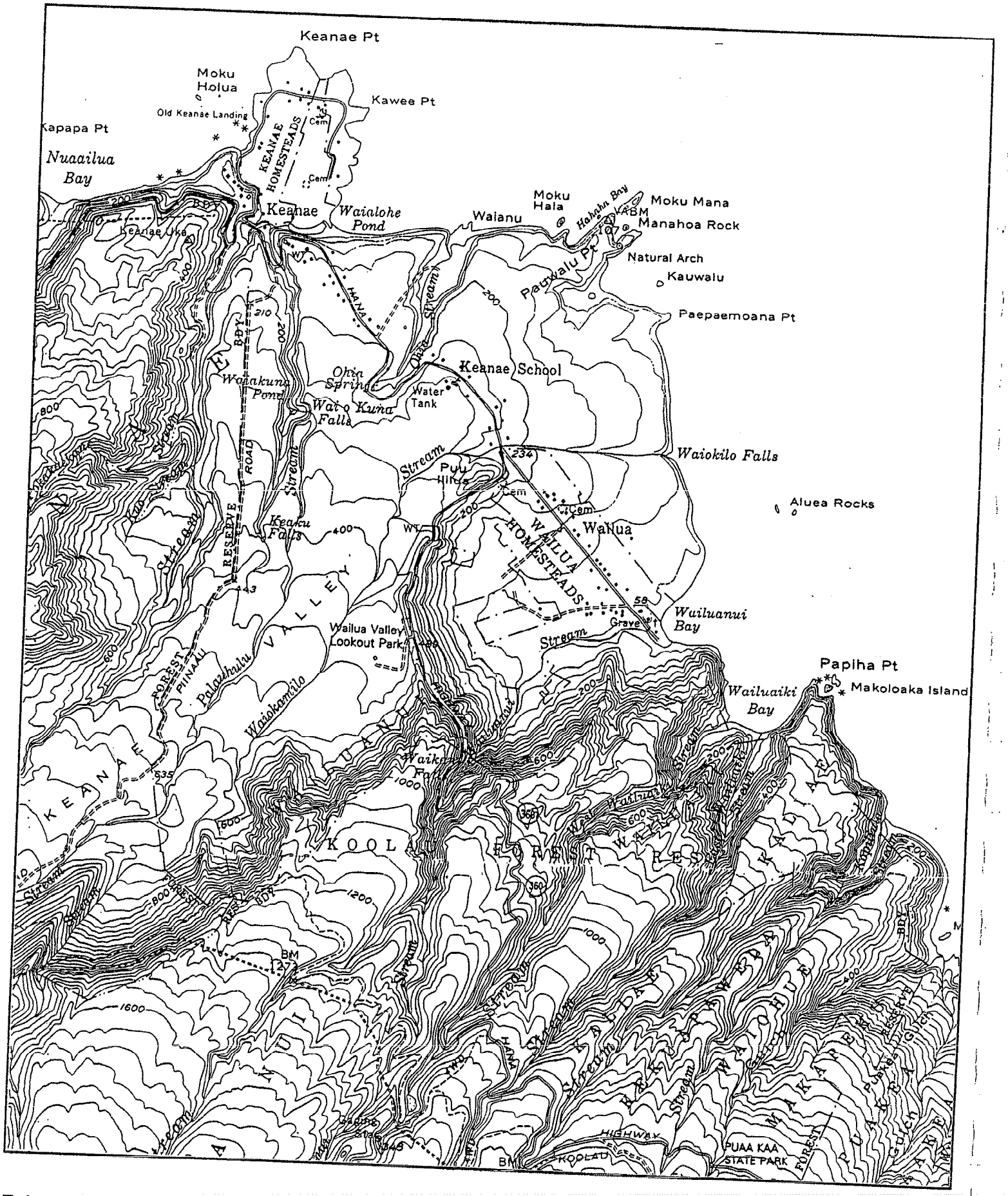
Cultural Landscape Boundary

This portion of the Ke'anae and Wailuanui landscape most clearly represents agricultural and residential land uses which include: areas of taro cultivation, irrigation networks, and the associated settlement and circulation systems. This central area of intensive contemporary use, manifesting continuity with the past, has been selected as the cultural landscape for purposes of this study (Figure 3).

As much as possible, the boundary of the cultural landscape follows natural features, such as ridges and streams. It begins on the west at the YMCA camp and includes all land *makai* (towards the ocean) of the Hāna Road extending to the southeast ridge of the Wailuanui Valley. All lands 600 feet *mauka* (towards the mountain) of the Hāna Highway stretching from the YMCA camp to the ridge on the east side of Waikani Falls are included. The Ke'anae Arboretum within Pi'ina'au Stream valley is also included. The boundary, as defined herein, includes all lands of both communities presently in taro cultivation as well as the connected residential community and major natural landmarks, including the coastline. Two extant heiau structures, Kukuiaupuni, near Ke'anae School and Makehau in Wailuanui, are major archaeological sites within the cultural landscape.

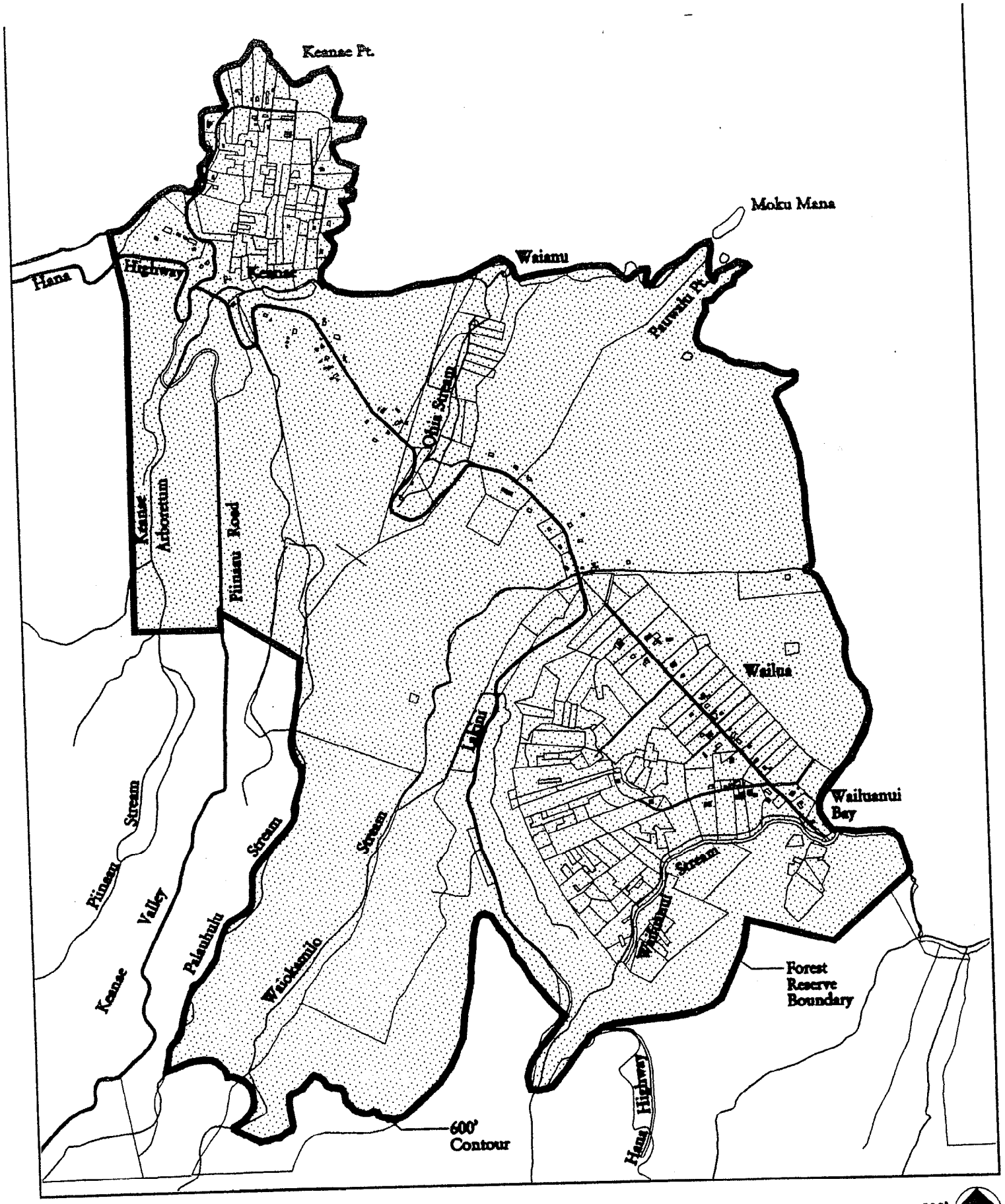
Included in the core cultural landscape are formerly cultivated rice lands at Kupa'u and in upper Ke'anae Valley. Also included are important and well-preserved former taro lands on the southeast side of Wailuanui Stream which are geographically connected to the presently operating Wailuanui system.

The Ke'anae-Wailuanui cultural landscape is traversed by the scenic Hāna Highway, which is also the only arterial road around East Maui.



Existing Conditions

0' 200' 400'



Cultural Landscape Boundary

Figure 3

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE

Traditional Cultural Practices Region

The region traditionally and customarily used and cared for by the Hawaiian families of Ke'anae-Wailuanui extends from Makapipi in the east to Honomanū in the west, and *mauka* to Pohaku Palaha on the northern rim of the Haleakalā Crater (Figure 4). The Makapipi stream and forest access road forms the boundary between Ke'anae-Wailuanui and Nāhiku on the east. The Kaumahina ridge above Honomanū forms the boundary on the West.

While the traditional ocean boundary for *ahupua'a* is the reef, or one mile out where there is no reef, most of the Ke'anae-Wailuanui residents who fish regularly go out as far as the offshore buoy, 11 nautical miles out at sea. (Civil Code of 1859, sections 384 - 396) The entire shoreline and near shore waters have abundant marine resources. Informants speak of fishing and gathering *opihi* by boat along the coast from Kailua in the west and over as far as the Hāna Airport, to a place called Honoma'ele in the east.

For the purpose of hunting and gathering, the 2,000-foot elevation is usually as high as most hunters and gatherers need to venture to get pigs. Nevertheless, informants indicate that they also go as high as the 3,000-foot elevation, frequently go into the Waikamoi area and up to Olinda, and have hiked up the *mauka* trail all the way into Haleakalā Crater through the Ko'olau Gap.

In addition, the families living in Ke'anae-Wailuanui are part of *'ohana* from Kailua, Nāhiku, Hāna and Kaupō. They have continued to exercise their access and gathering rights in those *ahupua'a*. For example, Awapuhi Carmichael said: "All I know is that my mom said that because they came from Kaupō all the way back, we use from Kaupō to Punalu'u, that's near Kailua. And we have always practiced our gathering rights that way, from Kaupō all the way to Punalu'u, by Kailua."

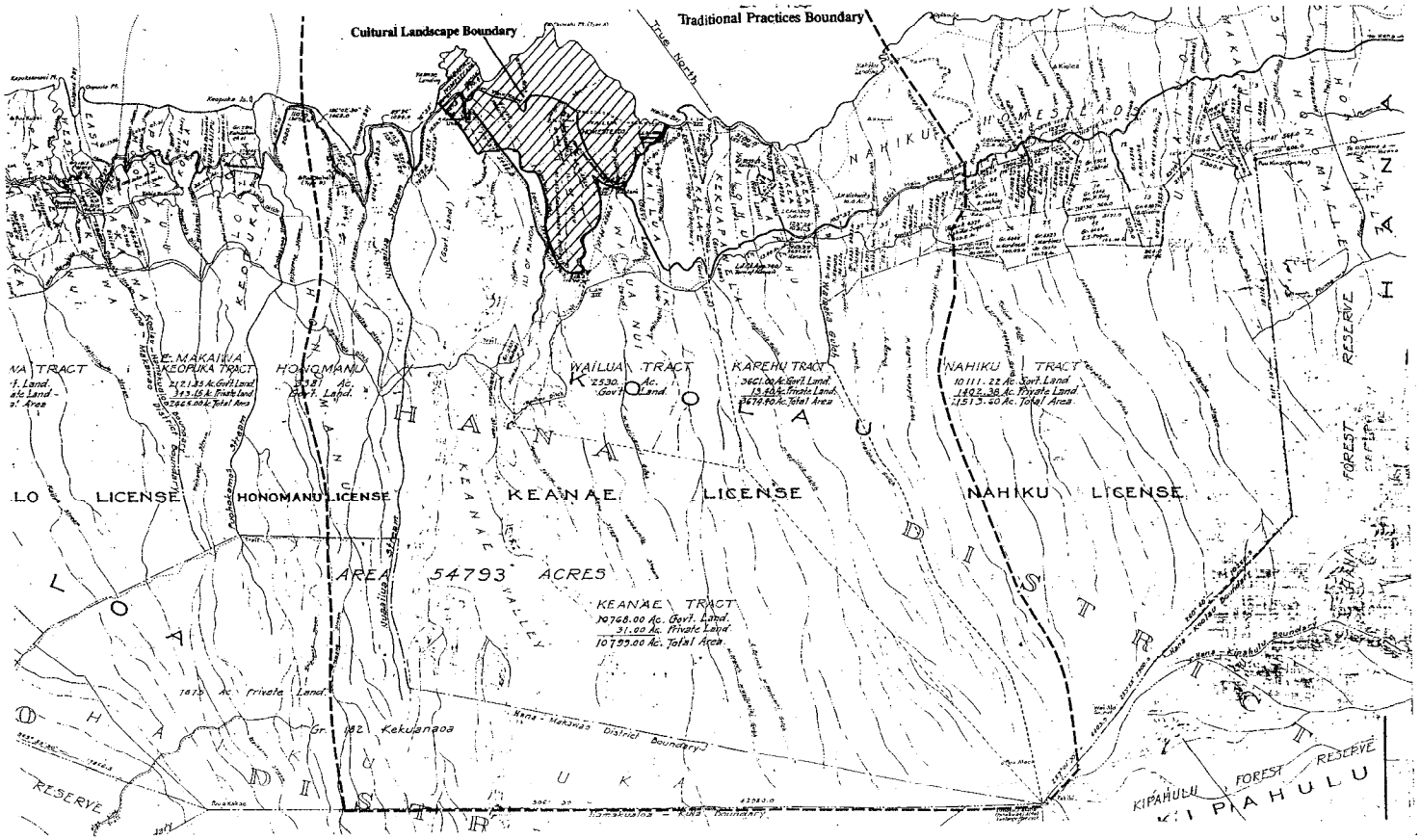
The area included within the boundaries described above, therefore, constitutes the traditional practices zone of the Ke'anae-Wailuanui cultural landscape, as established through custom, use, and practice for cultural, religious, and subsistence purposes by the people of Ke'anae-Wailuanui.

Methodology

Research procedures undertaken by the interdisciplinary team for the Ke'anae-Wailuanui cultural landscape inventory study included: 1) literature and document search; 2) field surveys; and 3) personal interviews. Members of the study team participated in all three methods of data collection.

Literature and document search included: library searches, review of State Historic Preservation Division files and reports, aerial photo analysis, Maui County data such as property records and archival documents, and photos and maps obtained from the State of Hawai'i and Bishop Museum archives. Team members shared any information they obtained.

Field Surveys were conducted between September and November 1994. An enlarged U.S.G.S. topographic map (1 in. = 500 ft. scale), Ke'anae Quadrangle, and a 1982 color aerial photograph of the same scale were utilized for location and orientation during fieldwork.



Area of Traditional Practices

No Scale

KE'ANAE – WAILUANUI CULTURAL LANDSCAPE

Figure 4

Field investigation of architectural and botanical resources involved recording and photographing of sites, and verification on the ground of aerial photo interpretations and document file data. Coverage of architectural resources during field trips was basically limited to the areas under current habitation or cultivation.

Field investigation of archaeological and cultural resources - including taro cultivation areas - was accomplished during September and October 1994 and included interviews with local residents. Major emphasis was placed on defining, mapping and describing the taro-growing areas of Ke'anae and Wailuanui. The most intensive effort in field mapping was directed to the Ke'anae peninsula *lo'i* complex. In this case all *lo'i* were mapped with water flow, associated buildings and major *'auwai*. The main Wailuanui *lo'i* complex was mapped from the 1982 color aerial photograph. Also mapped were *lo'i* at Waianu and the Ke'anae Arboretum, and Mrs. Helen Nakanelua's *lo'i* at Lākini.

To place these presently cultivated areas in an historic context, effort was made to locate former taro lands. Field trips, in some cases guided by local residents, were taken to formerly cultivated lands, including Nua'ailua Valley, Ke'anae Valley *mauka* of the Ke'anae Arboretum, Waianu, Kupau, and forested lands adjacent to taro lands in Wailuanui on the southeast side of Wailuanui Stream, extending into the *'ili* of Ka'ake'e near the mouth of Wailuanui Stream.

Other field trips were taken to the coastline from Waianu to Moku Mana and to archaeological sites, such as Pu'uola Fishpond, two recorded *heiau*, the stone foundation of the Protestant church in Wailuanui, rice mills, poi factories, the Ke'anae stone quarry and prominent natural features in Ke'anae and Wailuanui. Also investigated were possible locations of formerly cultivated native plants such as *olonā*, which was mentioned frequently in the Land Commission Award documents (see Cultural and Historic Context section above).

During all phases of field work, an attempt was made to solicit the knowledge and expertise of Ke'anae and Wailuanui residents and former residents. Personal interviews and field trips with these residents were an integral component of this study. (During one field trip a tsunami alert was in effect and many long time residents reflected and shared their personal experience during the 1946 tsunami which resulted in two Ke'anae deaths.)

Other interviews were conducted with representatives of various agencies or private groups which have collected information about the region, including employees of the East Maui Irrigation Company, Department of Land and Natural Resources forestry personnel, and staff from the State Historic Preservation Division. These interviews, whether face-to-face or by telephone, provided valuable information about the area.

Community Interviews

From November 1 through 4, 1994, Dr. Davianna McGregor conducted in-depth interviews with *kūpuna* and subsistence practitioners in the Ke'anae-Wailuanui community to identify and map important cultural use areas.

To prepare for the interviews, Dr. McGregor reviewed documents and interviews that she had used as resources for the writing of a chapter on the Ko'olau region of Maui for her 1989 PhD dissertation, "Kupa'a I Ka 'Āina: Persistence on the Land". These included notes

from taped interviews with *kūpuna* of the Hāna district that had been conducted by Mary Kawena Pukui in 1961 and the transcription of an in-depth interview with the late Harry Kunihi Mitchell of Ke'anae-Wailuanui. This body of information described cultural practices and resource areas in the 1930s and 40s. Thus, they formed the basis for the interview format and served as a reference point for gathering information from the community informants regarding contemporary cultural and subsistence practices and use areas.

Interviews were conducted with 13 residents of the Ke'anae-Wailuanui community:

1. Moki Day, 50 years old, fisherman, taro farmer; (MD)
2. Charmaine Day, 36 years old, wife of Moki, president of the Ke'anae Wailuanui Community Association; (CD)
3. James Hueu, 80 years old, caretaker of the YMCA Ke'anae Camp; (JH)
4. Awapuhi Carmichael, 57 years, gatherer, genealogist for the Kaauamo *'ohana*; (AC)
5. Paul Sinenci, Jr., 27 years old, taro farmer, EMI employee, Kaauamo descendant; (PS)
6. Harry Pahukoa, late 50's, taro farmer, county worker; (HP)
7. Doug Chong, 40's, hunter; (DC)
8. Helen Nakanelua, 83 years old, taro farmer, gatherer; (HN)
9. Maggie Alu, 79, *kūpuna*; (MA)
10. Kaipo Kimokeo, 50's, caretaker of the Ke'anae Arboretum; (KK)
11. Enos Akina, 94, *kūpuna*, retired taro farmer, *la'au lapa'au* practitioner; (EA)
12. Apolonia Day, 72, *kūpuna*; (AD)
13. Mary Kaauamo, 82, *kūpuna*, taro farmer; (MK)

Initials of informants' names are used to identify their statements in the *Mana'o o ka 'Āina* section of this report.

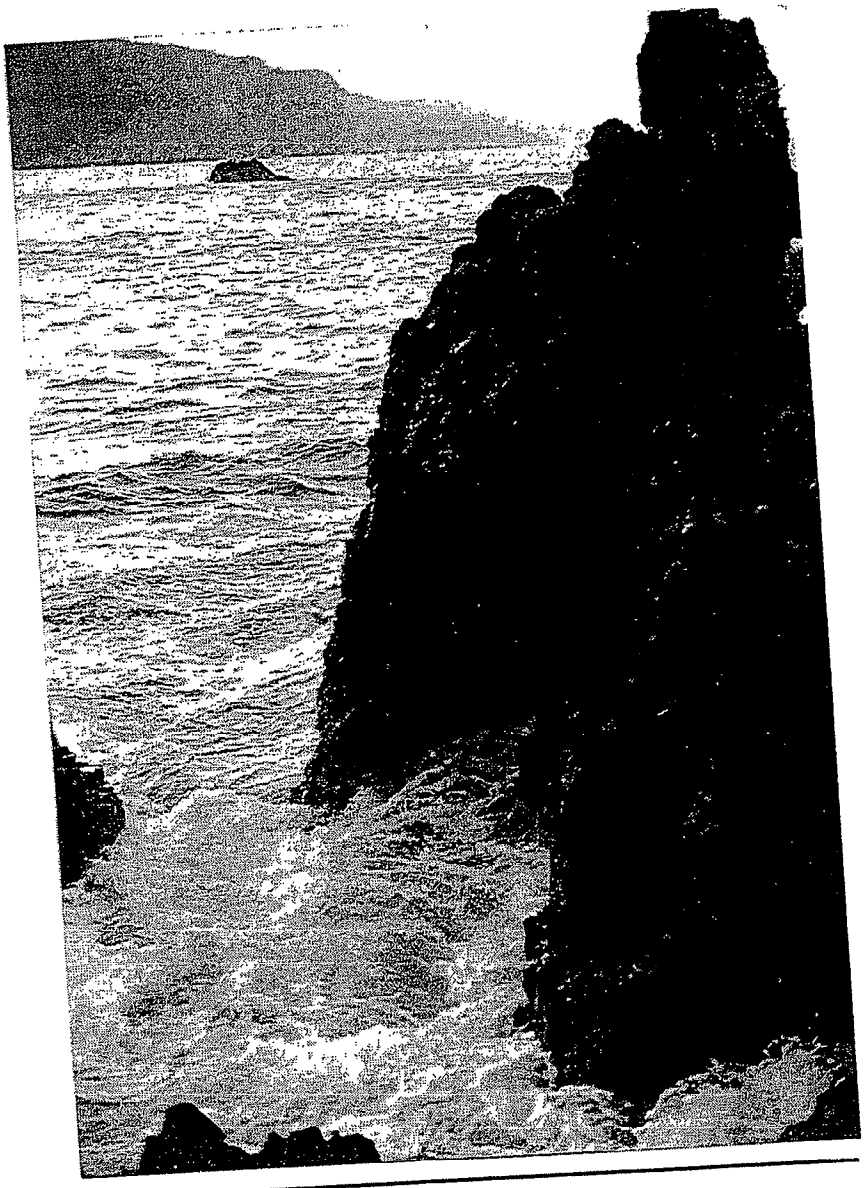
A semi-structured interview format was used; however the interviews were free-flowing. Informants were asked to describe the background of their *'ohana* in Ke'anae-Wailuanui: where they live; where they cultivate taro; lands that they own and lease; who cares for the lands; who will care for the land in the future; and how long and for how many generations their *'ohana* had lived in Ke'anae-Wailuanui. They were also asked to share information regarding: Hawaiian *lā'au lapa'au* or medicinal plants; the locations of poi factories and stores; place names; and *mo'olelo* or traditional stories about places in the district.

During the interviews, informants were asked to point out on the U.S.G.S. quad maps for Ke'anae, Ha'ikū, and Nāhiku, the areas that they customarily use for hunting, gathering, fishing, recreation and taro cultivation, as well as historic sites. Informants indicated areas for hunting, fishing, stream and ocean gathering, forest gathering, taro cultivation, historic sites, swimming and surfing, and trails and roads used to access the resources.

Informants were also asked to share their concerns and suggestions about the designation and management of Ke'anae-Wailuanui as a cultural landscape district and the transfer of ceded public lands from the Department of Land and Natural Resources to the Department of Hawaiian Home Lands.

The interviews were transcribed and the information provided by the informants was categorized and summarized for inclusion in this report. Draft copies of this report were circulated among the informants for their review; their corrections and additions were included in this final report. Following a review of the interview transcripts and with their consent, the full transcription of the interviews will appear in a supplemental report. The micro-cassette tapes will be stored at the Maui County Planning Department.

III. NATURAL SETTING



Ke'anae Coastline

III. NATURAL SETTING

The Ke'anae-Wailuanui area is part of Maui's rugged Ko'olau coast. This region is dominated by deep valleys cut into the northeastern slopes of the now dormant Haleakalā volcano. These valleys generally have steep side slopes with narrow ridges between them forming sea cliffs along the coast. The shoreline along the valley floors is a combination of small boulder-strewn beaches and lava outcrop eroded by consistently strong waves. Today these valleys can be accessed by the Hāna Highway which winds along the coast on the edges of the sea cliffs and over the valley floors.

Located on the windward side of Maui, the Ke'anae-Wailuanui area receives a significant amount of rainfall and is considered to be within the wettest part of the island. The rainfall maxima of eastern Maui, the Hāna maxima, is located about 17 miles to the southeast of Ke'anae at approximately 2000 feet above sea level and receives between 300 and 350 inches of rain per year. Rainfall decreases both downslope toward the coast, to between 100 and 150 inches per year, and upslope to the summit of Haleakalā, which receives only 20 to 30 inches per year (Giambelluca *et al.*, 1986:15). The Ko'olau region is the watershed used by the East Maui Irrigation Company to supply domestic water to all of upcountry Maui (approximately 21,000 persons) and agricultural water to thousands of acres in drier parts of east Maui and to the central isthmus which joins the two mountain ranges comprising the island.

According to the *Atlas of Hawaii* (Armstrong, ed., 1973:58), the Ke'anae-Wailuanui area enjoys a climate characterized by equable temperatures with small seasonal variation. Temperatures range from an average (mean) minimum of 60 degrees Fahrenheit to an average (mean) maximum of 82 degrees Fahrenheit at 61 feet above sea level (Hāna Airport Station). At 2100 feet above sea level, temperatures range from an average (mean) minimum of 52 degrees Fahrenheit to an average (mean) maximum of 72 degrees Fahrenheit (Makawao Station).

The valleys along the northeastern coast of Maui have been created by streams fed by orographic rains carried in on the prevailing trade winds. As the most recent volcanic activity on Haleakalā, the Hāna Series, slowed and eventually ceased altogether, the streams had opportunity to cut into the slopes of the mountain and carry sediments from the eroding slopes onto the valley floors below. The current distribution of soil types and natural vegetation reflects this process.

The soil survey of the Hawaiian Islands conducted by the U.S. Department of Agriculture, identified four land or soil types within the Ke'anae-Wailuanui area; two within the upland slopes and two within the valley floors (Foote *et al.*, 1972: Sheet 121). The ridge tops and slopes are comprised predominately of *Rough Mountainous Land* (rRT) which is described as very steep land broken by intermittent drainage channels (Ibid:119). Scattered throughout the upland slopes are also soils classified as *Kailua Silty Clay* (KBID) which are well-drained soils developed in volcanic ash (*Ibid.*:52). It is within these areas that the upland forests thrive.

Vegetation in the upland forests, "below the upper elevation grass and shrublands at approximately 7,200 feet [are] a diversity of forest communities dominated by *'Ōhi'a lehua*

(Metrosideros polymorpha)" (East Maui Irrigation Company 1993:5). Much of the native forest cover in the lower elevations, which included *'Ōhi'a lehua*, *Koa* (Acacia koa), *kopiko* (Psychotria kaduana), and *hame* (Antidesma platyphyllum), has been largely replaced by introduced and naturalized species including; *kukui* (Aleurites moluccana, common guava (Psidium guajava), strawberry guava (Psidium cattleianum), *hau* (Hibiscus tiliaceous), lantana (Lantana camara), False Staghorn (Dicranopteria sp.), treefern (Cibotium sp.), yellow foxtail (Setaria gracilis), Java plum (Eugenia cumini), Christmasberry (Schinus terebinthifolius), paperbark (Melaleuca leucadendra), and various species of Eucalyptus (Eucalyptus spp.).

On the valley floors, *Stony Alluvial Land* (rSM) predominates. This type of land consists of stones, boulders and soil deposited by streams along the bottoms of gulches and on alluvial fans (Ibid:120). In addition, the valley floors contain pockets of *Tropaquepts* (TR). Tropaquepts occur on nearly level flood plains and consist of poorly drained soils that are periodically flooded by irrigation in order to grow crops that thrive in water (Ibid:121). It is within these pockets that taro production occurs. Other vegetation on the valley floors include; *kukui*, guava, Christmasberry, lantana, *hau*, strawberry guava, Java plum, rose apple (Syzygium jambos), *'ōhi'a 'ai* - mountain apple (Eugenia malaccensis), *'ulu* (Artocarpus altilis), *waiawi* (Psidium littorale), and hilograss (Paspalum conjugatum).

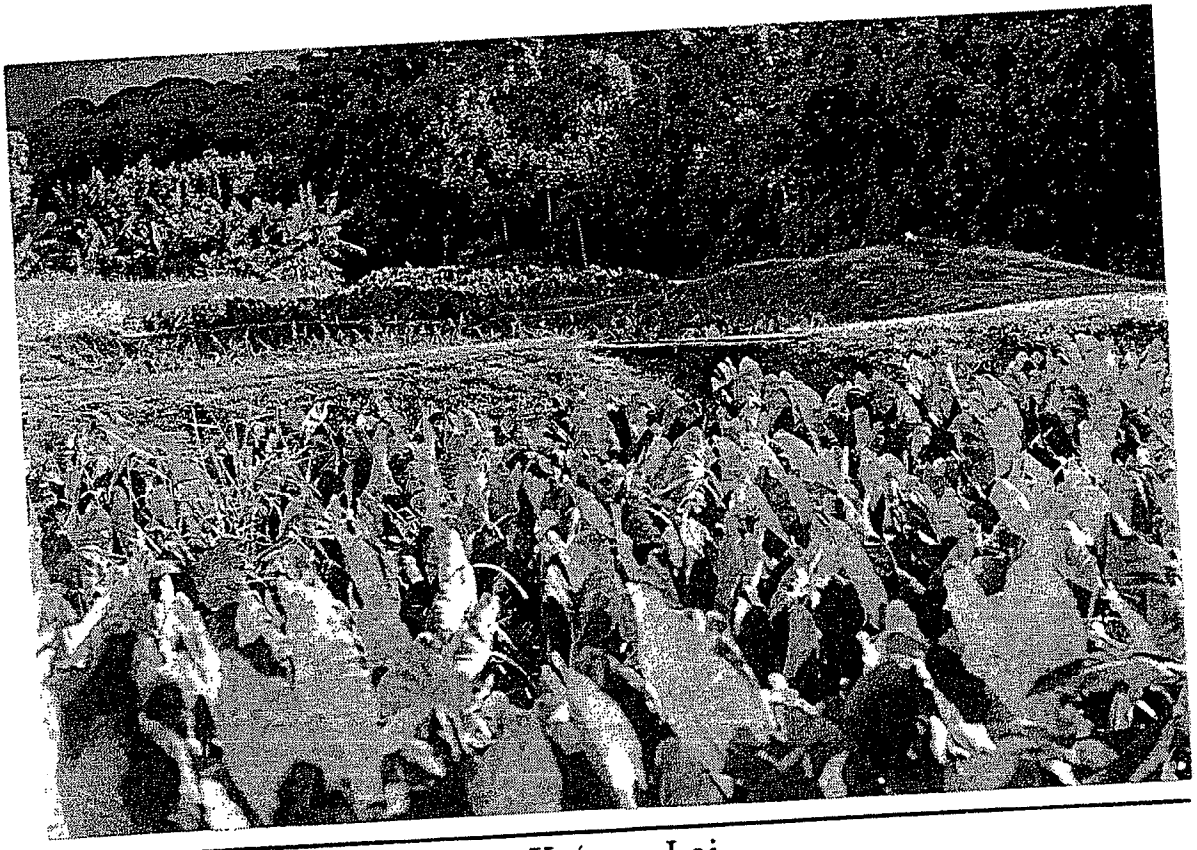
The Ke'anae-Wailuanui area is subject to a variety of storms which, although infrequent, occur throughout the Hawaiian Islands. These storms include cold front or winter storms, Kona storms, and hurricanes or tropical storms. The impact of such storms on the Ke'anae-Wailuanui region can be quite severe, for the orographic effect of Haleakalā traps storms carried in on the trade winds and collects the rains on the northern and eastern slopes. These heavy rains are channelled into the steep and narrow valleys creating flash floods which can cause landslides and washouts along the Hāna Highway and flooding of the valley floors. In a report on flood hazards for the Island of Maui, the villages of Ke'anae and Wailua are identified as having localized flooding problems and as having suffered damage to agricultural lands, as well as to private and public property (Department of the Army 1971:30).

Another source of flooding on Maui (and all of the Islands of the Pacific) is seismic sea waves, or tsunami. Since 1813, approximately 85 tsunamis have been observed in Hawai'i, seven of which are known to have caused fatalities (Cox 1987:n.p.). The Ke'anae region has suffered loss of life and considerable property damage caused by tsunamis. The most severe tsunamis were those that occurred on April 1, 1946, and May 23, 1960. During the 1946 tsunami, "waves up to 16 feet swept over the entire end of Ke'anae Peninsula" (Department of the Army 1971:31). Several newspaper articles described Ke'anae Peninsula as having been "swept clean" except for the stucco church which had been moved off its foundation. According to the late Harry Kunihi Mitchell, the tsunami obliterated sand dunes at Honomanū and seasonal sand beaches at Ke'anae and Wailuanui that have not reappeared since. A Civil Defense tsunami inundation map classifies the Ke'anae Peninsula and the coastal areas of all of the valleys in this region as being potential danger areas (*Ibid.* 1971:Plate 5).

Other natural disasters to which the Ke'anae-Wailuanui region is potentially subject are earthquakes and further volcanic activity. Damage from one locally generated

earthquake was reported on January 25, 1938, and included rock and mud slides across the Hāna Highway. The potential for further volcanic activity in the region is from Haleakalā, which is considered to be a dormant volcano, not an extinct one. The most recent activity was the 1790 eruption along the southeastern coast where the lava flowed into the sea and formed a part of what is now called LaPerouse Bay (Macdonald and Abbott 1970).

IV. CULTURAL & HISTORICAL CONTEXT



Ke'anae Loi

IV. CULTURAL AND HISTORICAL CONTEXT

My people have been cultivators from very ancient times; it was by agriculture that they made a living for themselves, for their families, and for those dependent on them. For some it was a favorite occupation.
— Samuel Kamakau (*Na Hana a ka Po'e Kahiko*)

Mahi'ai'ana — cultivation of the land: the quietly proud words of the pioneering 19th century Hawaiian historian Samuel Kamakau articulate a heritage reaching long before Kamakau's time and which continues today in portions of the Hawaiian islands — including the lands of Ke'anae and Wailuanui on Maui. The taro *lo'i* carpeting the landscape of these two *ahupua'a* today represent a centuries-old relationship with the land enduring through the changes of history.

Prehistory to 1852

With no written documentation before the 19th century, the record of the earliest Hawaiian settlement of Ke'anae and Wailuanui remains obscure. It can be imagined, however, that the rich volcanic soil and abundant water sources of these *ahupua'a* would have captivated a people skilled at cultivation. Legends associated with Ke'anae and Wailuanui express the Hawaiians' sense of the unique origin of the *ahupua'a* resources. Typical is a Ke'anae legend about the gods Kāne and Kanaloa who travelled among the islands "establishing springs of water and seeing that they are kept clear for drinking purposes or for uses of the chief." In the uplands of Ke'anae the two gods discover that they lack water.

> They discuss whether it can be obtained at this height. "Oi-ana (Let it be seen)!" says Kanaloa; so Kane thrusts his staff made of heavy, close-grained kauila wood (*Alphitonia excelsa*) and water gushes forth. (Beckwith 1970:64)

Other oral traditions passed down through generations until they were recorded in this century, give hints of the rich drama and social values that animated life in the two *ahupua'a* during the centuries before western contact.

At Wailuanui is recounted the dramatic story of a shark-man, known by the mark of a shark's mouth upon the back, who can change form from man to shark but who goes undetected until people realize that the man's warnings to swimmers are always followed by a fatal attack by a shark (Beckwith 1970:140).

> Pau-walu (Eight dead) lives at Wailua, Maui. He warns men as they go to the sea that eight will be dead before they return and a shark always kills eight of them as predicted. He is therefore suspected as a shark-man. Akeake the strong is born beside the stream Hau-ola and while yet a little boy starts about Maui fighting champions. After overcoming Lohelohe, he, with his companion Pakolea, spends the night at a friend's house named Ohia and learns about Pauwalu. The shark-man scoffs at so little an antagonist, but Akeake easily binds him, exposes the shark's mouth on his back, and casts him into the fire. (*Ibid.*:141)

And a legend of Ke'anae tells of a mysterious shark, an *'aumakua* or protective spirit:

> According to this story, two families in the area used to exchange food, a common practice, the couple living seaside at Ke-'anae giving fish and the couple living upland giving garden produce.
>
> One day the woman from the shore gave her sister-in-law on the hillside nothing but a fishtail in exchange for bananas and sweet potatoes. The woman took the fishtail home in her calabash, saying nothing about the scanty trade.
>
> That night both she and her husband dreamed of a shark, and when they woke up in the morning they found a live shark swimming around in the calabash, where only a tail had been the night before.
>
> The excited couple freed the shark in an upland pool and made offerings to it. During a heavy rain, the shark was washed down to the ocean, where...it lives to this day in an underground cave near the Ke-'anae wharf. (Lueras 1983:92)

The legend speaks of a reciprocity - the exchange of foodstuffs between Ke'anae folk working the land and the sea - necessary for the maintenance of life in the *ahupua'a* and of the consequences when the exchange relationship is not respected.

Visible today in Ke'anae and Wailuanui are many physical evidences of the works of the Hawaiians of old: complexes of taro *lo'i*, fishponds, and, in the uplands, agricultural terraces. A legend recounts the origin of the taro *lo'i* on the Ke'anae peninsula:

> Anciently...the peninsula was barren lava. But a chief, whose name is not remembered, was constantly at war with the people of neighboring Wailua and was determined that he must have more good land under cultivation, more food, and more people. So he set all his people to work (they were then living within the valley and going down to the peninsula only for fishing), carrying soil in baskets from the valley down to the lava point. The soil and the banks enclosing the patches were thus, in the course of many years, all transported and packed into place. Thus did the watered flats of Ke'anae originate. (Handy and Handy 1972:500)

While Ke'anae and Wailuanui may once have been rivals constantly at war, it would be warfare among other chiefly rivals that drew the two *ahupua'a*, if only peripherally, into the larger course of Hawaiian history.

Sometime in the 14th century, two brothers - sons of Pi'ilani, the ruling chief of Maui - became political rivals after their father's death at Lahaina. Lono-a-Pi'ilani, the eldest, had become the new chief of Maui and during the first years of his reign "all was well, and the people were content" (Kamakau 1961:22). But Lono-a-Pi'ilani became convinced that his younger brother, Kiha-a-Pi'ilani intended to seize the kingdom for himself. Kiha-a-Pi'ilani fled to Moloka'i and Lāna'i before returning in secret to Maui where, after numerous adventures, he married Kolea-moku, daughter of the chief of Hāna, Ho'olae-makua. Ho'olae-makua, recognizing Kiha's identity, refused to support him and declared his loyalty to Lono. Kiha-a-Pi'ilani, his anger "so great that he bided the day of vengeance when he would destroy

his enemies and take the whole of Maui" (*Ibid.*:27) sailed to Hawai'i to seek the help of his brother-in-law, 'Umi-a-Liloa, chief of northern Hawai'i island. 'Umi-a-Liloa, perhaps seeing the rivalry of the two chiefly brothers as an opportunity to extend his own power to neighboring Maui, vowed to support Kiha-a-Pi'ilani. Preparations for war were immense, apparently unprecedented in enormity at the time, a full year being spent making canoes and war implements. The target of the assault across the Alenuihaha Channel was to be Hāna and its chief Ho'olae-makua.

> There was no war prior to that time to compare with this one, in which there were so many canoes. The first ones reached Hana, Maui, while the last ones were still on Hawaii. (Kamakau 1961:29)

Ho'olae-makua and his forces successfully repulsed the first onslaughts of the Hawai'i canoes. According to Samuel Kamakau, when 'Umi-a-Liloa arrived on the scene and learned how "his canoemen were unable to go ashore and how they were held at bay by the mighty Maui warrior, Ho'olae-makua," he asked Kiha-a-Pi'i-lani,

> "Is there no other way of getting the war canoes ashore? we can fight them better on shore, for our present position is an unstable one." Kiha-a-Pi'ilani answered, "There is a small harbor at Ko'olau called Wailua-iki, and if all the canoes cannot land there, there is another landing at Wailua-nui." The blocked canoes turned about and sailed for Wailua-iki at Ko'olau. (*Ibid.*:29)

Kamakau reports that the canoes reached Wailua-iki where the "innumerable war canoes from Hawaii" were beached and the Hawai'i warriors "began to go overland to the site of battle" at Hāna. 'Umi-a-Liloa, Kiha-a-Pi'ilani and their forces defeated Ho'olae-makua in Hāna and then sailed on toward Wailuku to challenge Lono-a-Pi'ilani for primacy on Maui. Lono-a-Pi'ilani, trembling "with fear of death," died before they reached Wailuku and Kiha-a-Pi'ilani assumed reign of Maui. Thus, the reign of a significant figure in Maui history, Kiha-a-Pi'ilani, and the now very real threat of future invasions from across the Alenuihaha Channel, had their origins in the landing of the Hawai'i canoe fleet at Wailua.

Centuries later, the coast of the Wailua-Ke'anae area would be the backdrop for an historic first encounter involving new personages from Hawai'i island (again invading Maui) and one from further afar. In 1778, Kalani'opu'u, ruling chief of Hawai'i island, was in Ko'olau, Maui, engaged in a drawn-out battle with Kahekili, the chief of Maui. Among the Hawai'i island warriors with Kālani'opu'u was Kamehameha, the future king. Late in November 1778, Kalani'opu'u began receiving reports of a ship sailing southeast along the northeast coast of Maui.

> It was seen at Kahakuloa, and the news spread over the island, then at Hamakua, and at evening it was seen in Ko'olau. The night passed, and the next day the ship was anchored at Ha'aluea just below Wailua. (Kamakau 1961:97)

The Hawaiians believed the vessel to be the "'tower of Lono! Lono the god of our fathers!'" (*Ibid.*:97) but the ship was the *Resolution* commanded by Captain James Cook on his second, and fatal, voyage to the Hawaiian islands. Kalani'opu'u and his retinue travelled to Wailuanui where they set off in canoes to meet the ship anchored offshore. Most of the Hawaiian group stayed aboard the *Resolution* a few hours, but "six or eight spent the night

on the ship, one of them being the chief Kamehameha" (Kuykendall 1938:15). Neither Cook nor his men came ashore on Maui - provisions were bartered from Hawaiians paddling out to the ship in canoes - before the *Resolution* continued on its fateful voyage toward Hawai'i island. As for Kalani'opu'u, in 1781 the Hawai'i chief would be forced back to Hawai'i island when Kahekili regained possession of the Hāna district. (A tradition associates Kahekili with a Ke'anae cliff, Pali Ka-hekili, where the Maui ruler is said to have enjoyed the sport of *lelekawa* - cliff leaping.)

Kamehameha would attempt to regain possession of Hāna in 1786; he was unsuccessful then, but would succeed in 1790 at the beginning of his campaign to consolidate power throughout the Hawaiian islands. Local traditions note that no great battles were fought in the Ke'anae region during the unification campaign of Kamehameha. One reason given for this exemption from warfare, apart from the remoteness of the area, was the productivity of the agricultural fields which, the traditions suggest, acted as a supply breadbasket for warring factions on both sides.

The anonymous Hawaiians of Wailuanui and Ke'anae who observed the extraordinary sight off their coast in November 1778 could not have realized what they were witnessing: the initial moment in the unsettling of the traditionally-evolved Hawaiian society by the burgeoning presence of foreign visitors. During the first decades of the post-contact era, the isolated situation enjoyed by Ke'anae and Wailuanui may have spared them from the more baleful effects - the newly-introduced diseases to which the Hawaiians had no immunity - of the foreign presence. The first visitors seeking access to the more remote sections of Maui, the Protestant missionaries who had begun arriving in the islands in 1820, testified to the difficulties of travel around East Maui during the early 19th century; Jocelyn Linnekin recounts their predicament:

> The Hana region was known as "one of the most isolated places in these Islands, remote and difficult of access"...Because of the many treacherous ravines and unpredictable flooding, travelers usually rode on horseback to a point before Keanae, then completed the journey to Hana by canoe. The wild middle stretch of the Hana coast belonged historically to Koolau District. This section of the windward coast was impassable, except by footpath...Over land, Keanae was inaccessible - at least to haoles - from both Hana and Wailuku...Mission duty in Hana District was one of the most severe in the islands and took a heavy toll on the missionary families who served there. Before the Hana station was founded in 1837, missionaries reached East Maui no more than once or twice a year...Koolau [*i.e.* the area including Ke'anae and Wailua] was visited even less frequently than Hana. (Linnekin 1985:18)

With the establishment in 1837 of the Hāna station - by Rev. Daniel Toll Conde - increasing numbers of Hawaiians on East Maui were drawn into the congregation. By 1841 Rev. Conde could report attendances at his sermons of up to three thousand people, drawn from as far as Kipahulu and Ko'olau. It is likely that among the congregation at Hāna from Ko'olau were people from Ke'anae and Wailua. Construction of Ke'anae's own Protestant church would begin in 1857.

The Catholic mission had also been making inroads on Maui during the same period. In 1843, the arrest, instigated by the Protestant mission in Hāna - of a small group of Hawaiian women instructed in the Catholic religion at Kahikinui would lead to a remarkable

incident in Maui history. A judge in Wailuku had ordered their arrest; the women were tied together and started on the ninety-mile trip to Wailuku to face the judge.

> As the forced march began, word quickly traveled ahead along the Kiha-a-Piilani Highway. Soon at every turn small groups of Catholics were gathering to profess their faith and be tied with the Kaupo converts. As the proud procession passed through Kipahulu, Wailua, Pu'uiki and Hamoa, it grew steadily in size. The new Catholics, dressed in their best, draped leis upon the prisoners, and fell in step. The procession continued on, enjoying the bountiful hospitality of communities along the trail, sometimes remaining two or three days in the same village, holding prayer meetings at every opportunity and bringing in new members at Wailua, Keanae, and Huelo. The procession was in a carnival mood when it finally neared Wailuku. It had been more than a month on the trail and had grown a hundredfold. (Wenkam 1970:51)

The judge, apparently unwilling to risk disciplining the now sizeable group, dismissed the case without judgement. The converts at Ke'anae and Wailua inspired by the 1843 procession may represent the first step in the establishment of the Catholic presence at Wailuanui.

The Organic acts of 1845 and 1846 initiated the process of the *mahele* - the division of Hawaiian lands - which introduced private property into Hawaiian society. In 1848 the crown and the *ali'i* (royalty) received their titles; the common people received their *kuleana* (individual parcels) in 1850. It is through records for Land Commission Awards generated at *mahele* that the first specific documentation of life in Ke'anae and Wailua, as it had evolved up to the mid-19th century, come to light. Much of Ke'anae and Wailuanui were retained by the Crown. However, Land Commission Awards were also granted to commoners within the two *ahupua'a* (as was the case throughout the Hawaiian islands), giving them fee simple title to parcels they were actively cultivating or living upon.

Twenty-one Land Commission Awards were recorded in Ke'anae and the adjacent Waianu Valley, and thirty-nine in Wailua. Locations of most of the Land Commission Award parcels are shown in historic maps of Ke'anae, Waianu Valley and Wailuanui (see Figures 8-11 below). Testimonies given by applicants and their neighbors for these awards reveal locations, boundaries, land usages, place names, length of occupancy - all indicating complex relationships to the land. (Information supplied in the award testimonies is presented in a table in Appendix A of this report.)

Predominant among the claimed land usages in Ke'anae and Wailuanui are 490 *lo'i*, irrigated taro patches, of various sizes. Clearly, wetland taro cultivation was the primary agricultural pursuit within the *ahupua'a* at mid-19th century, likely reflecting a long history of taro farming. Other crops mentioned include dryland taro and sweet potatoes. Several claims include pools and fishponds. In the more *mauka* reaches of the *ahupua'a* are claims for wooded or forested areas, *kula* (pasture land), and *hala* (pandanus) groves. Notable among of the claimed land uses is the number of *olonā* planting areas mentioned. *Olonā* appears in 16 of the Land Commission Award claims, suggesting a significant role in the life of the inhabitants of Ke'anae and Wailua.

> Chief among the cordage fibers in Hawaii was the bast of the *olonā*, a plant of the nettle family, scientifically known as Touchardia latifolia...Now rather rare,

> this species of plant was formerly fairly abundant in the lower and middle forest zones of our mountains, principally in deep, cool, gloomy ravines. Here it received a kind of "cultivation" by the natives, good patches being searched out and cleared of weeds and obstructions...
>
> It was extensively used for making fish line, fish nets, koko or slings for carrying calabashes, and the network to which feathers were tied in making the famous Hawaiian feather capes and cloaks. The fiber is so strong that it could be used for several generations without apparent deterioration. Several nets and capes of olona fiber, now in B.P. Bishop Museum, which have had over a hundred years of use, are still in a good state of preservation. (Bryan 1965:132-133)

According to Samuel Kamakau

> *Olona* was highly prized by one and all. It was very valuable for trading, and planters raised it extensively...There are, however, few places where *olona* will grow, and hence not all people cultivated *olona*...
>
> Maui and Molokai people were noted in the old times for growing and scraping *olona* for making fish nets, and for twisting into fishing lines, and that was the source of wealth of those lands. (Kamakau 1976:44-45)

The people of Ke'anae and Wailuanui may have numbered among the Maui folk noted for growing and scraping *olonā* which provided a special "source of wealth" throughout the pre-contact period. However, none of the claimed *olonā* patches were awarded (Linnekin 1983:181) and, since they do not appear on subsequent maps locating Land Commission Awards in Ke'anae and Wailua, their exact locations remain undocumented.

1852-1925

During the second half of the 19th century further opportunities for land ownership opened in Ke'anae and Wailua:

> Royal Patent Grants, which originated after the Mahele, were sales of crown lands to individual applicants, with no restrictions on the buyer's identity. Beginning in 1855, Keanae [and Wailua] Hawaiians began to acquire Royal Patent Grants, either individually or as a cooperative group, or *hui*...Between 1855 and 1906, twenty-one such awards were made in the Keanae [and Wailua] area, involving a total area of 769.35 acres...All but one of the Royal Patent Grants went to Hawaiians. (Linnekin 1985:24-25)

Among the Ke'anae royal patent grants, four were awarded to *hui* consisting of 7 to 19 members for areas ranging in size from 43.5 to 115 acres (Linnekin 1983:182). These *hui* allowed Hawaiians of Ke'anae and Wailua access to *kula* lands - identified as Kalii and Pauwalu-*mauka*, Pahoa and Waianu, Pauwalu-*makai*, and Paehala - that had not been claimed at the Mahele.

> Historically, all the *hui* lands have been unirrigated except for a few taro patches immediately adjacent to streams. The lands of Pahoa and Pauwalu

> form a single raised, grassy plateau between Keanae and Wailua, cut by a narrow gulch called Waianu. Pahoa is the land west of Waianu, Pauwalu the east. Pauwalu-*mauka* and -*makai* refer to sections on either side of the state highway. There is no overlap between these areas and the *kuleana* lands. (Linnekin 1983:181)

Records from later in the nineteenth century indicate the *hui* lands were used as pasturage for horses, mules and cows but, as Linnekin notes, these lands would also play a significant role in sustaining the Hawaiian community:

> In Keanae, Hawaiians formed land *huis* to regain access to the upland *kula* after the Mahele instituted the principle of private and exclusive property. The *huis* effectively kept local lands in Hawaiian hands, and prevented their appropriation by foreigners who might turn the *kula* into sugar plantations, cattle ranches, or - in more recent times - condominiums. (*Ibid.*:185)

Later in the century, the Land Act of 1895 created homestead parcels from government land in Ke'anae and Wailuanui. An applicant, having built a house and cultivated a portion of the parcel during a 6-year probationary period, could secure the parcel in a 999-year lease. These land acts may have secured some stability for the Hawaiians of Ke'anae and Wailuanui after the 1850s, although they simultaneously served to concentrate a formerly dispersed population in Wailuanui.

Nevertheless, and despite their continuing physical isolation, Ke'anae and Wailuanui would be drawn into the social and economic changes transforming the Hawaiian kingdom. Both churches that are established today at Ke'anae and Wailuanui were built in 1860. Our Lady of Fatima Shrine, a part of Saint Gabriel's Church in Wailuanui, and Ke'anae Church were constructed with coral boulders and rocks strewn on the beach during extraordinary storms.

Hāna - the scene of power struggles among the ali'i into which the two ahupua'a had been drawn - once again would be the site of developments determining the future of Ke'anae and Wailua. In 1849, the first sugar works on the east coast of Maui were constructed at Hāna where sixty-acres of cane had been planted. By 1883 there were six separate sugar plantation on the Hāna coast.

At first the sugar plantations had been worked by Hawaiians of the district (contracted to work for up to ten years). As the sugar industry throughout the Hawaiian kingdom expanded, the need for increased numbers of field laborers prompted passage of contract labor laws. In 1852 the first Chinese contract laborers arrived at Hāna. Contracts were for five years, and pay was $3 a month plus room and board. Upon completion of their contracts, a number of the immigrants remained on Maui, many becoming merchants or rice farmers.

The Hawaiian islands were well-positioned for rice cultivation. A market for rice in California had developed as increasing numbers of Chinese laborers immigrated there since the mid-19th century. Similarly, as Chinese immigration to the islands also accelerated, a domestic market opened.

As was happening in other locales, in the early 1880s, groups of Chinese began leasing from the Hawaiians of Ke'anae and Wailua, former taro lands for conversion to rice farming. Sadly, the taro lands' availability throughout the islands in the late 1800s reflected the declining demand for taro as the native Hawaiian population diminished.

Historic photographs from the 1880s show Ke'anae and Wailuanui in the midst of these changes (Figures 5-7). According to local traditions, the wooden flume across Palauhulu Stream at Ke'anae peninsula shown in Figure 5 was called "*wai-kau-i-ka-la'au*" or "*kawaikau*" and was considered an engineering feat dating to the pre-contact period. A noted Ke'anae *kūpuna*, the late Harry Kunihi Mitchell, is reported to have explained that old canoes were used to make the flume which is also mentioned in several songs about Ke'anae.

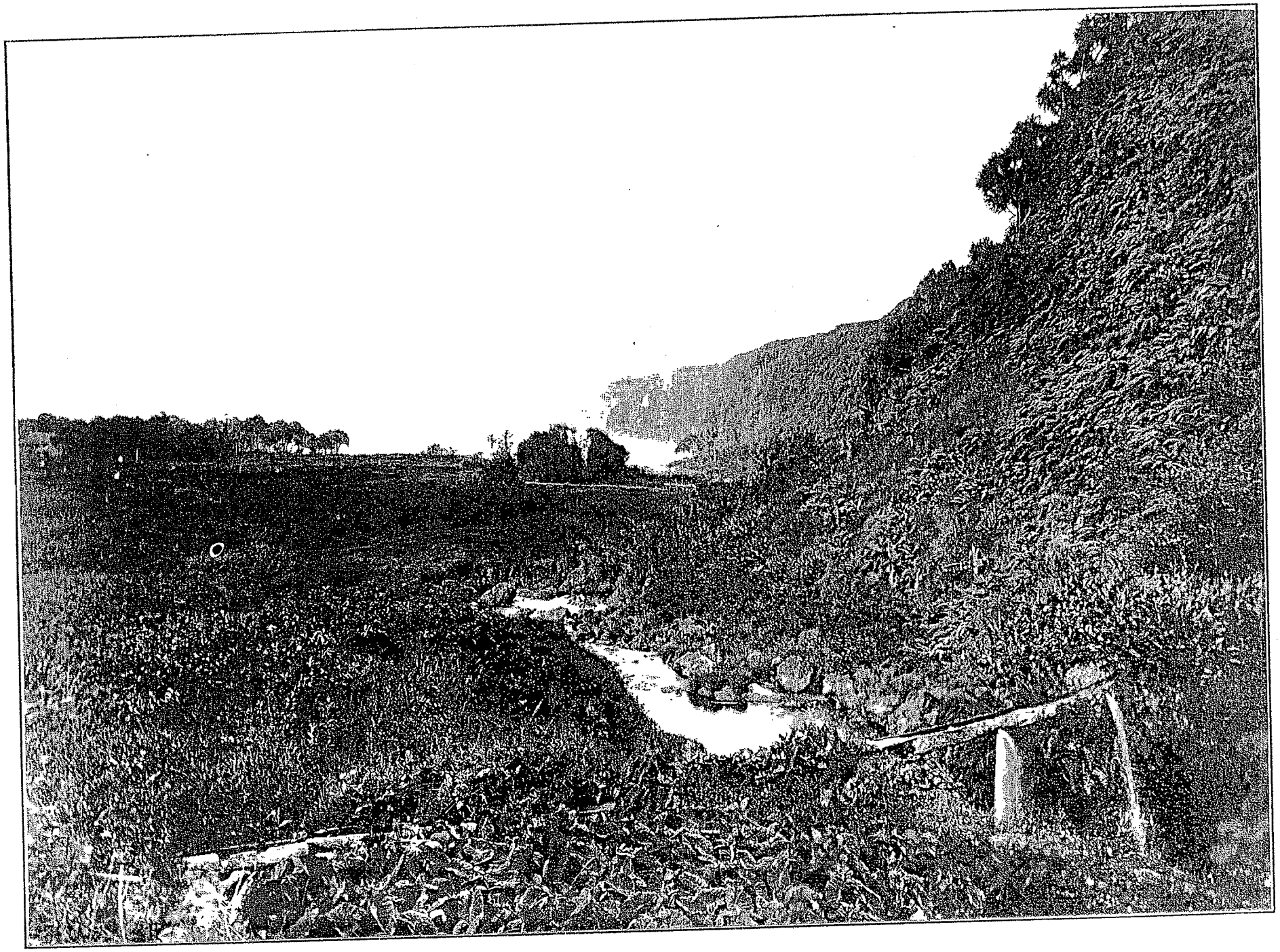
The Ko'olau Ditch - drawing water to central Maui for irrigation of sugar cane and pineapple fields - was constructed during the last quarter of the 19th century. The ditch was not a single project but a series of systems developed over a period of time that was eventually connected into one system. The first ditch was built in 1876 by Japanese laborers and the last section was completed in 1923 (EMI records). No ditches were built past Honomanū before this century because the land to the east were crown lands.

Tax records for 1890 indicate rice land in Ke'anae and Wailuanui comprised 67.84 acres compared to 95.482 acres still in taro (Linnekin 1985:30). By 1892, 75 acres of Ke'anae and Wailuanui were planted in rice. Rice land in other Maui districts included 25 acres in Honokowai, and 150 acres among Waikapu, Wailuku, Waiehu, and Waihee (Coulter and Chun 1937:17).

Historic maps of Wailuanui and of the Ke'anae peninsula (Figures 8-10) show the patterns of rice paddies and taro *lo'i* at the end of the 19th and beginning of the 20th centuries. (Figure 11 map shows locations of Land Commission Awards and grants in Waianu Valley between Ke'anae peninsula and Wailuanui.)

The buildings - and their layout - of the rice plantations at Wailuanui and Ke'anae likely were similar to those described by John Wesley Coulter and Chee Kwon Chun (1937). Typically, the buildings were arranged in three groups.

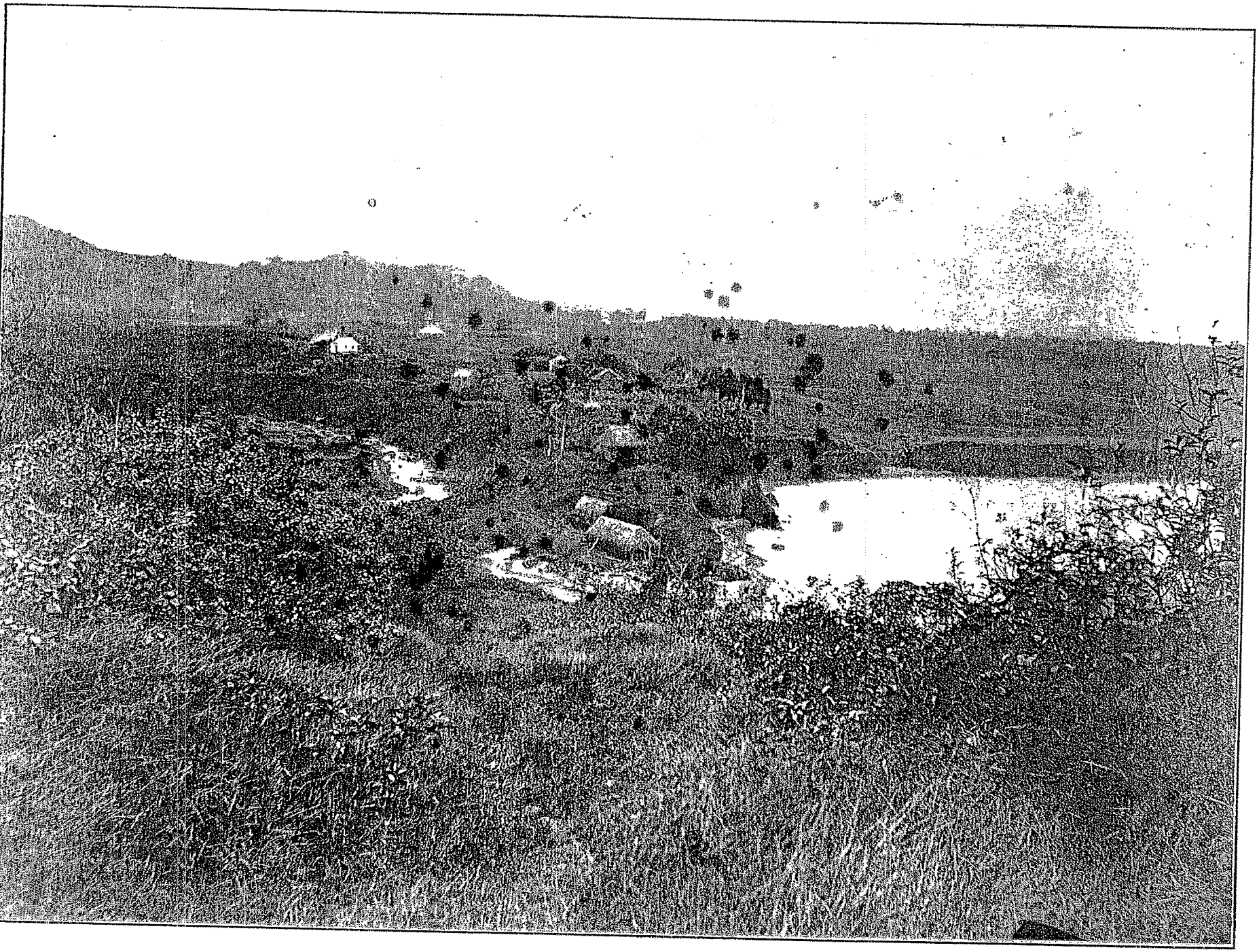
> Two of the groups were near together, and the third a short distance away. The structures were of wood and had roofs of shingles or galvanized iron. They were on or near a stream, on land a little higher than the paddy fields surrounding them, and generally situated in a group of trees.
>
> The more conspicuous structures, one- or two-story buildings, were dormitories for laborers; they were box shaped, made of unplaned, unpainted boards...
>
> Near the dormitories stood a dining hall similarly constructed...
>
> Adjoining the dining hall was a spacious kitchen with a concrete or wooden floor. The most conspicuous object in it was a large rectangular stove built of cement and bricks, into the top of which were fixed large cauldrons...
>
> A short distance from the main buildings, a square box-like shack equipped with cold water facilities served as a bath house...



Wooden Flume Across Palauhulu Stream, Ke'anae Peninsula - ca. 1883 (C.J. Hedemann, Bishop Museum)

Figure 5

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE



hed Houses Above Wailuanui Bay, Wailuanui - ca. 1880s (W.T. Brigham Collection, Bishop Museum)

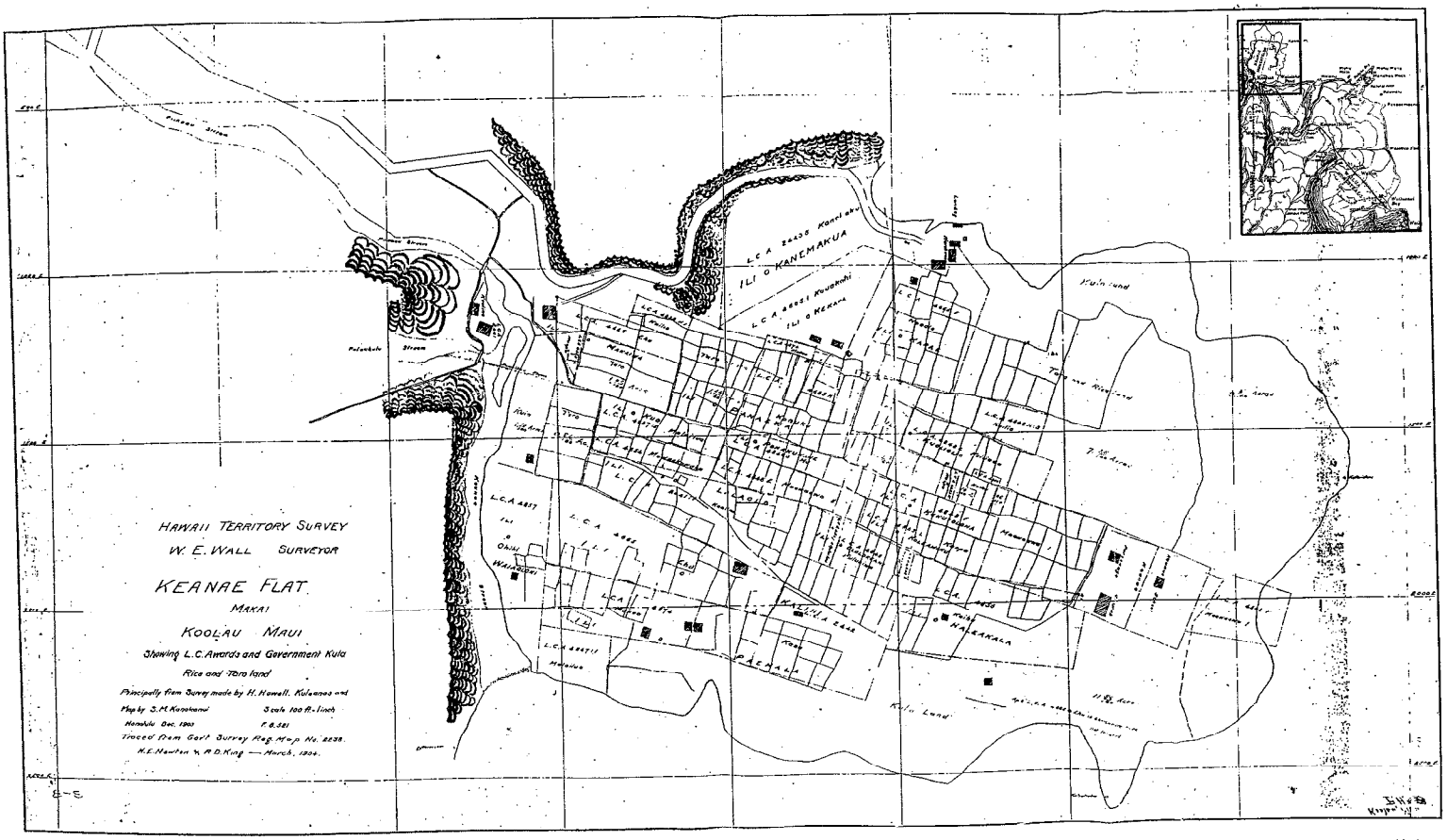
ANAE - WAILUANUI CULTURAL LANDSCAPE

Figure 6

Waikani Falls and Wailuanui Stream, Wailuanui - ca.1880s (W.T. Brigham Collection, Bishop Museum)

Figure 7

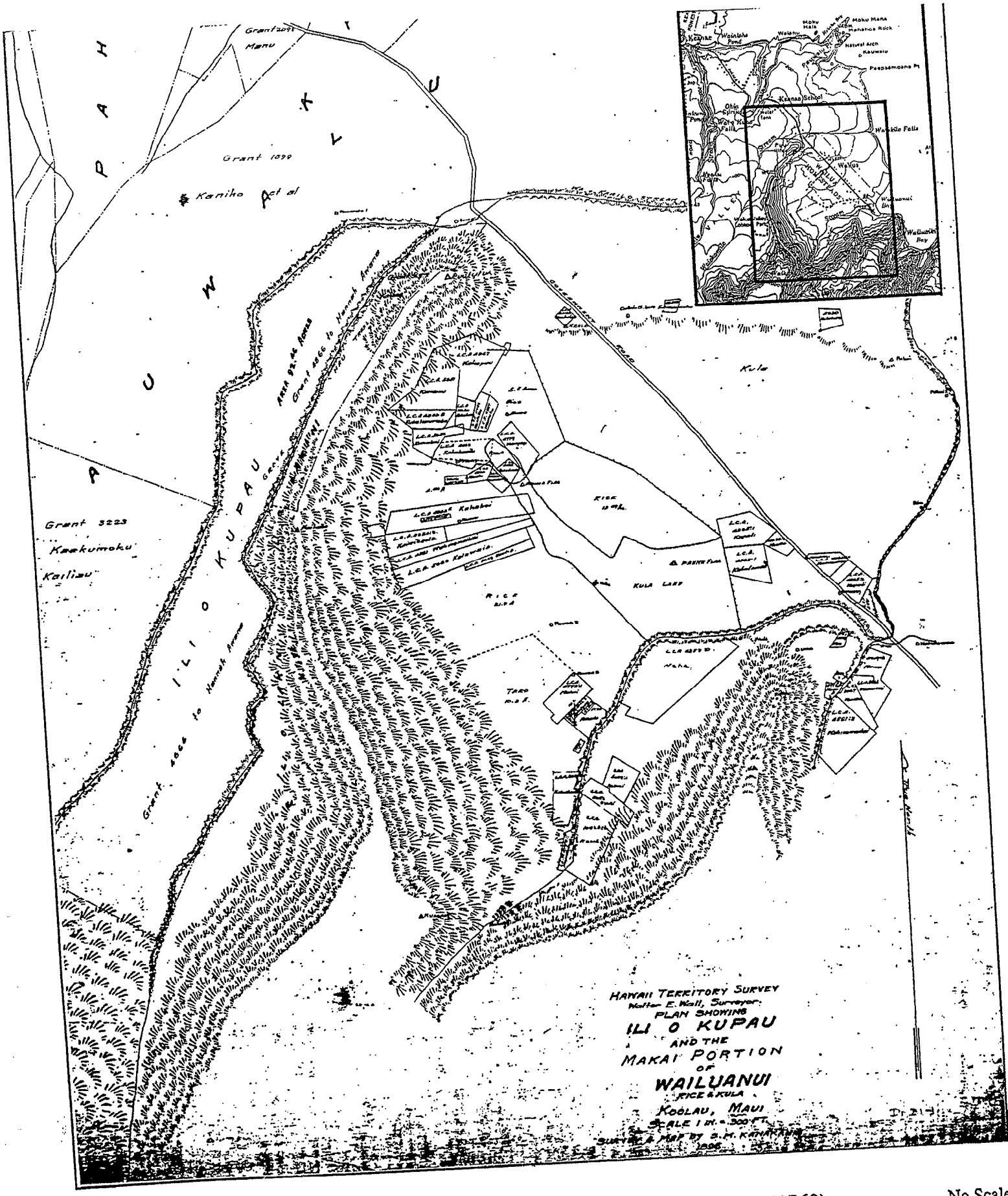
KE'ANAE - WAILUANUI CULTURAL LANDSCAPE



Ke'anae Peninsula - 1903 Map by S.M. Kanakanui

No Scale

Figure 8

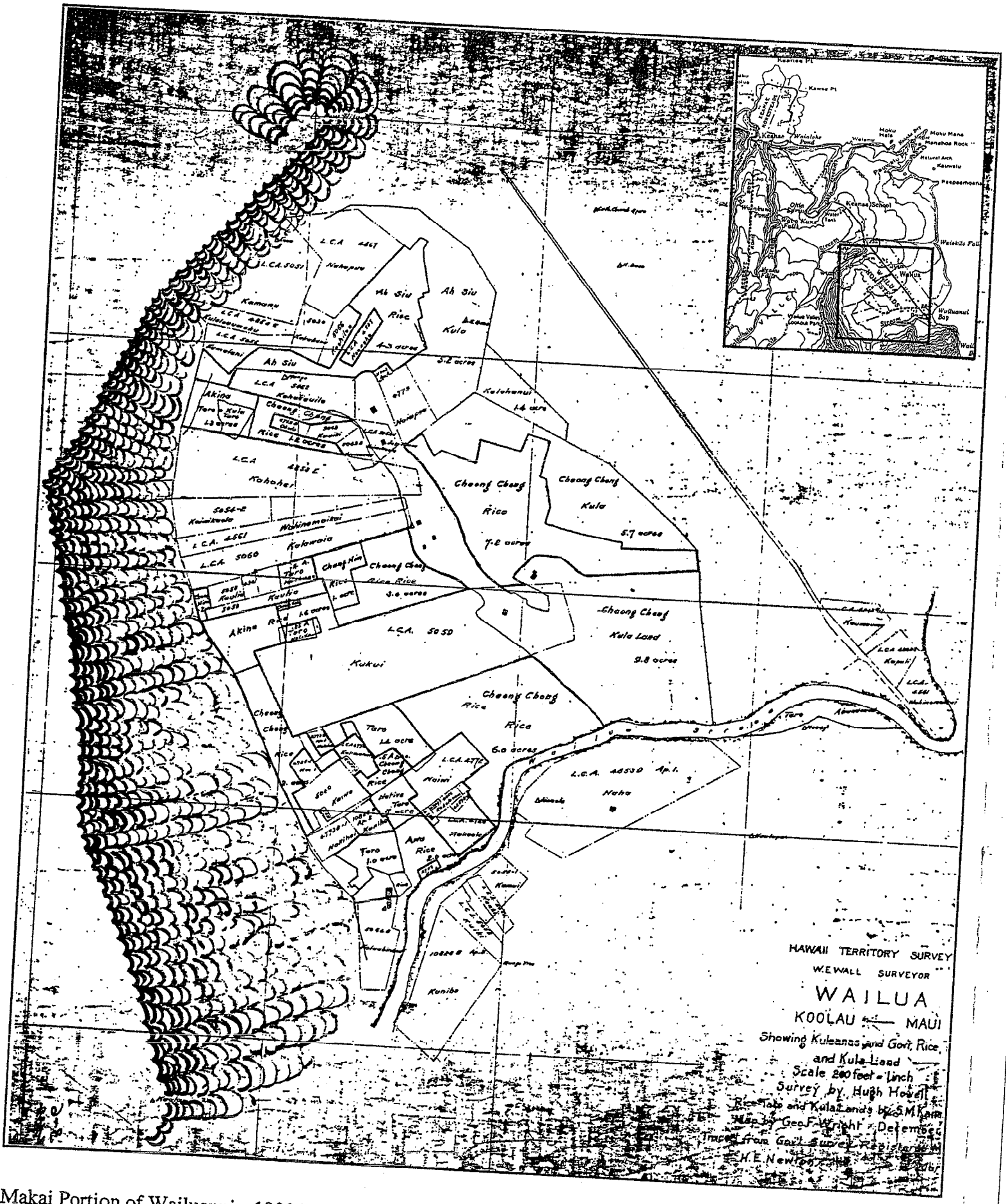


No Scale

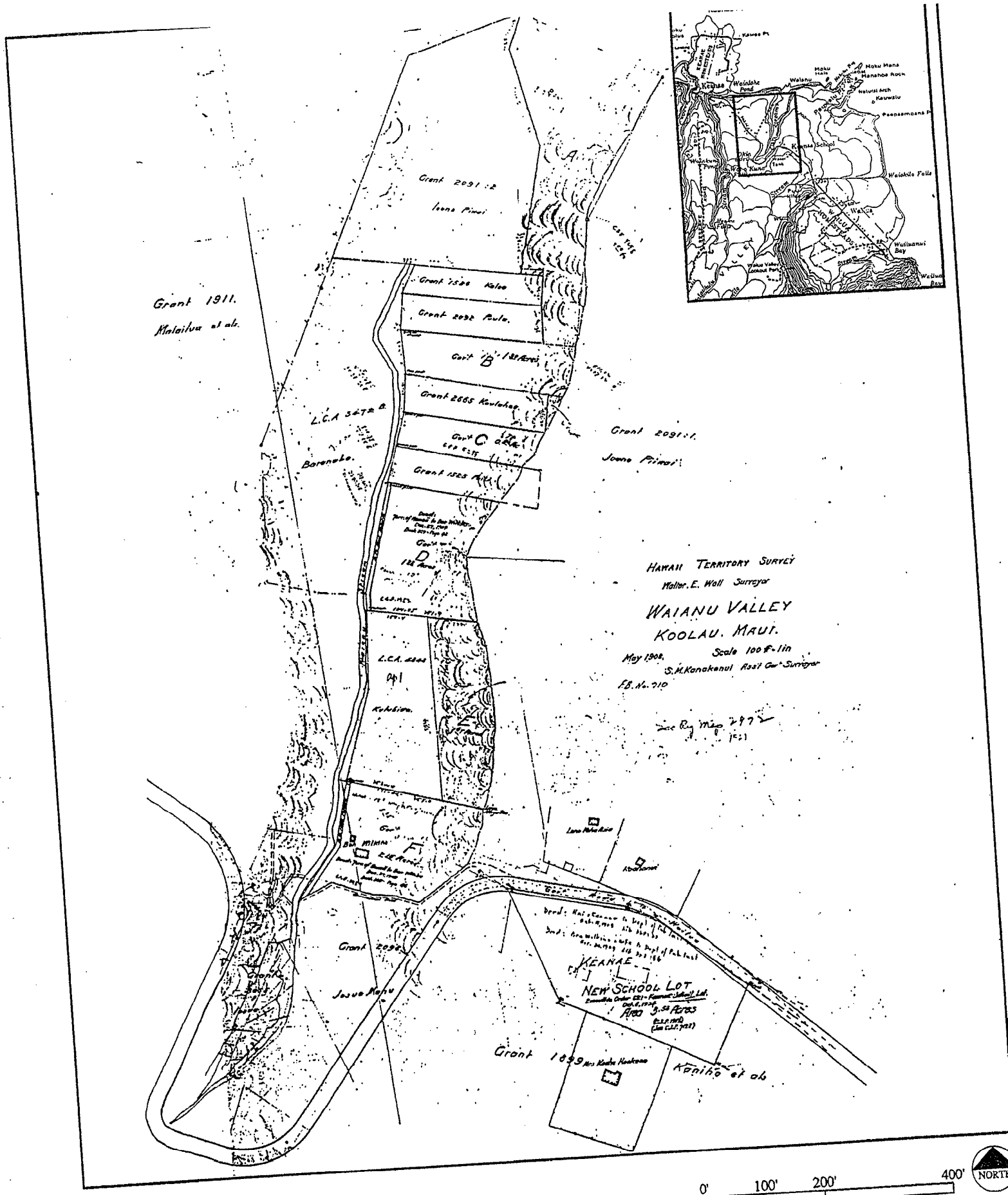
au 'ili and makai Portion of Wailuanui - 1896 Map by S.M. Kanakanui (R.M. #1760)

Figure 9

NAE - WAILUANUI CULTURAL LANDSCAPE



Makai Portion of Wailuanui - 1903 M



Waianu Valley - 1908 Map by S.M. Kanakanui (R.M. #2972)

Figure 1

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE

> Apart from the buildings used by the working force on the plantation, a small, painted cottage was the headquarters and home of the "boss" or manager...
>
> Of the buildings in the second group in the plantation unit, the more outstanding were the mill and granary. The former, near a stream, was a large frame building in which was housed machinery. In the early years of the industry water was the chief source of power, and a great mill wheel was conspicuous. In later years steam and gasoline engines were used to drive the machinery. In the granary were stored paddy and cleaned rice, and bran and rice middlings. A combined tool and implement shed was the remaining building in the second group.
>
> Close to the mill and granary, exposed to the trade winds, was the threshing floor. It was generally square, each side about 100 feet long, built of cement, and surrounded by a low wall, in one corner of which was an entrance...
>
> The third group of buildings, set off at a little distance from the other two, was composed of structures used to house work animals and animals raised for food for the plantation personnel. The former consisted of stables for horses and water buffalo, and the later included a pig pen and chicken house. There were also kennels for dogs (Coulter and Chun 1937:23-24).

Foundations of some of these buildings and relics of milling machinery remain at Wailuanui.

Club house buildings were also elements of the Chinese farming communities:

> In large rice farming areas where there were a considerable number of wealthy planters, a Chinese club or society was formed and a commodious club house was built. Those who could afford it contributed sums of money towards the construction of the club house and others contributed labor during their time off from work in the fields. (*Ibid.*:51)

The Lin Hing Society was organized in Ke'anae and a two-story club house was built on the peninsula in 1908. (The club house was last used in the early 1950s and was demolished in 1981.)

Toward the close of the 19th century, the Nāhiku Rubber Company planted thousands of rubber trees in Nāhiku and the adjacent Wailuanui and Ke'anae forest areas. Their operations continued until 1912.

During the second half of the 19th century, a profitable inter-island steamship service had been established in the Hawaiian islands. By the 1880s, steamships regularly serviced the sugar plantation at Hāna, though the northeast coast of Maui between Maliko and Hāna was known to be particularly treacherous, with several vessels wrecked while loading (Thomas 1983:64). This may have led to the refusal of steamship companies to land at Ke'anae, forcing, in 1901, a Chinese merchant to begin running a junk from Ke'anae to accommodate the Chinese rice growers (Linnekin 1985:19). However, by the 1910s, Ke'anae was one of forty-seven landings serviced by ships of the Inter-Island Steam Navigation

Company (Thomas 1983:133). (According to local residents, steamship service to Ke'anae Landing was terminated in the late 1920s after the opening of the Hāna Belt Road, though the landing continued in use until the 1940s.)

New buildings were constructed during the early years of the 20th century. In 1912 a new Ke'anae School was built on property, acquired in November 1909, on the *mauka* side of the Hāna Belt Road. The original Ke'anae school had been located near the Congregational Church on the peninsula. The new school building had two rooms and a front lanai.

Rice farming declined sharply throughout the islands after the first decade of the 20th century: total acreage dropped from a high of 9,425 acres in 1909 to 1,130 acres in 1935. One Chinese continued to lease Ke'anae land for rice-growing in 1926 (Linnekin 1985:31). However, by the 1930s the rice industry had ceased entirely on the islands of Hawaii, Maui and Moloka'i (Coulter and Chun 1937:62).

It is unlikely that the abandoned rice fields of the late 1920s in Ke'anae and Wailuanui were immediately returned to taro production. The economic viability of taro farming remained a question.

1926-1946

In 1926 a cinder-paved stretch of road was opened connecting Ke'anae to Kailua. The previous year, the Territorial Government had authorized the road construction which was then accomplished by a work crew of prison inmates who were housed in a camp at Ke'anae (on the present site of the Ke'anae YMCA camp). The contemporary topography of the YMCA site, which slopes down to a large flat field, was created by quarry excavations for construction of the road. The completion of the Hāna Belt Road was accomplished with the construction of nine more bridges in the Keanae and Wailuanui cultural landscape area during 1926. This marked a new epoch in the life of Ke'anae and Wailua, the now easier access to and from the rest of Maui creating new pressures on the communities. In the social and economic spheres, as identified by Jocelyn Linnekin, there evolved a

> ...transition from farming to wage labor as the primary source of household income in Keanae - a shift that occurred after the opening of the Hana road...The 1890 commercial directory (the equivalent of today's telephone directory) lists twenty-eight Hawaiian taro planters, a storekeeper, a carpenter, and a policeman residing in Keanae. Between 1890 and 1920, Chinese rice planters and storekeepers make their appearance, but most Hawaiians are still engaged in taro farming. In 1920, three Hawaiians are listed as laborers, and there is a haole foreman for E.M.I. [East Maui Irrigation] living in Keanae. Between 1920 and 1930, the occupations of Hawaiian men in the village change dramatically. In the 1930 directory, taro planters and homesteaders are outnumbered by laborers and truck drivers employed by E.M.I., the road department, and the Keanae Prison Camp. (Linnekin 1985:76-77)

Population in the Ke'anae area was estimated to be 527 in 1930 (*Ibid.*:20).

A Mormon church building in Wailuanui on the *mauka* side of the Hāna Belt Road was constructed in 1934 and dedicated in 1935. It served a small Mormon community which had developed in the area.

The prison camp in Ke'anae continued in use through the 1930s and 40s. (In 1931, as the *Maui News* [30 June:1] reported, an investigative committee of the Maui Board of Supervisors found no perceptible laxity of supervision at the camp and "no evidence of the fact that sugar from the camp has been used in the making of intoxicating liquor.") In 1934 it was converted into a Civilian Conservation Corps camp. The federally-funded CCC program provided "jobs for islanders from other areas of the [territory], financing the planting of thousands of eucalyptus and assorted other trees on the upper slopes above Hāna as well as the mantle of ironwood trees on Ka-'uiki" (Lueras 1983:62). (According to several older residents of Ke'anae and Wailua, the lands toward the west were mostly grasslands prior to the work of the CCC. Species such as eucalyptus, Formosan koa and paperbark were used because these trees grew quickly. Native trees such as the Hawaiian koa (Acacia koa) grew too slowly for the purposes of the CCC.)

In December 1942, a year into the United States' involvement in World War II, the camp once again housed a group of prison inmates. About 40 inmates from Oahu Prison were quartered in Ke'anae to work the old Nāhiku Rubber Company's plantation. Officials expected the plantation, whose trees were last tapped in 1911 when the company failed, could yield 20,000 to 50,000 pounds of crude rubber annually. The plan had been initiated by Gov. Ingram M. Stainback who "did not view it as a commercial enterprise, but [as a means] to augment in a very small way the nation's supply of raw rubber" (*Maui News* Dec. 9, 1942:1).

But even before December 1941, the Territory of Hawai'i had been taking measures in preparation for a possible war with Japan:

> Throughout Hawaii's last year of peace, residents were told of measures being taken to protect them should war strike. Medical supplies were laid in, blood plasma was banked, and stocks of food were gathered with housewives being specifically ordered to buy up a supply for their own homes. Meanwhile, committees representing business, government, and the military all met, planned, and took first aid lessons. (Brown 1989:17)

The residents of Ke'anae and Wailuanui were also involved in precautionary measures. According to a local resident, two caves were dug in Nua'ailua where explosives were cached. The explosives were to be used to blow up the Hāna Belt Road in the event of a Japanese invasion. The war's peril was made real to East Maui when, on January 25, 1942, a Japanese submarine torpedoed the transport ship *Gen. Royal T. Frank* in the Alenuihaha Channel, leaving 29 persons killed and 33 survivors who were brought to Hāna. And while no invasion brought the war to the people of Ke'anae and Wailuanui, they were nonetheless vulnerable to the war's cost. In the words of the same local resident, the "young men left their taro fields [to fight in the war] and many never came back."

1946 to the Present

In the early morning hours of April 1, 1946, an earthquake in the Aleutian Islands generated a tremendous *tsunami*, tidal wave, that struck the Hawaiian islands about 6:30 a.m. The disaster hit all the islands; Ke'anae was not spared:

> The height reached by the waves at the head of the bay west of the peninsula was 17 feet, and that at the end of the peninsula 16 feet. Although the waves swept over the entire end of the peninsula, damaging several buildings and killing two persons, the wave heights were not great, considering that normal

storm waves dash up nearly to the level of the top of the peninsula, 13 to 15 feet above sea level. (Shepard *et al.* 1950:434)

Fourteen persons died on Maui, total deaths on all islands numbered 159 (*Ibid.*:463). The two people killed on the Ke'anae peninsula were Walter A. Hardy (age 87) and Helen Tau'a (age 49). The 1946 *tsunami* also impelled many residents of the peninsula whose homes were destroyed to resettle along the Hāna Highway (Linnekin 1985:16).

Between 1819 and 1946, 37 *tsunamis* were recorded in the Hawaiian islands. Damage from the *tsunami* is recorded as "severe" in five instances - in 1837, 1868 (twice), 1877, and 1946 (*Ibid.*:401). These statistics suggest that the Hawaiian islands have long been subjected to periodic, sometimes severe *tsunami* inundation. The Ke'anae peninsula, because of its especially vulnerable position, likely has experienced episodes of destruction, similar to that of 1946, throughout its unrecorded past.

A 1959 study reported a population of 195 in the Ke'anae-Wailuanui (Linnekin 1985:20). Two years earlier, the Ke'anae area had been determined in a state population survey as the "most Hawaiian in the Islands" possessing the "greatest concentration of Hawaiians of any community in Hawaii, with 94.8 percent of the residents having pure- or part-Hawaiian ancestry" (Lueras 1975:A3).

In 1971, the six-acre Ke'anae Arboretum, operated under the jurisdiction of the Department of Land and Natural Resources, was developed by district forester Wesley H.C. Wong, Jr. The arboretum sits on land once farmed by the Hawaiians; during the 1940s, "territorial foresters planted a number of timber and fruit trees to make use of the fertile bottom land. The old taro patches were renovated in 1946 and put back into use by prisoners from the Ke'anae prison camp. This continued into the 1950s and then was abandoned when the prison camp was closed" (Frankel 1984:A17). The land had remained unused until the arboretum was created.

From October 1974 to October 1975, Jocelyn Linnekin conducted fieldwork in Ke'anae and Wailuanui for an ethnographic study, *Children of the Land*, published in 1985, which examined the structures and values shaping the lives of the Hawaiian population in the midst of modern complexities. According to Linnekin's field census, the total population of Ke'anae and Wailua in 1975 was 148, comprising 100 adults (18 and over) and 48 children. She notes that the "unbalanced age structure, with twice as many adults as children, does not seem auspicious for Keanae's future," especially since, of "fifty-one Hawaiian households, 65 percent are presently childless, and 27 percent are occupied by single persons." However, as her study shows, "this population is a response to limited opportunities for schooling and working inside [*i.e.* within the immediate Ke'anae-Wailua lands] and does not necessarily portend the community's demise" (Linnekin 1985:20).

Linnekin perceives the predicament confronting the Hawaiians of Ke'anae-Wailuanui, striving to maintain their identity in the 1970s and 80s:

> Taro is now far more important symbolically and as a market commodity than as a food staple. Although some villagers wax poetic over fish and poi, the outside monetary economy provides the staff of life, not taro. Keanae villagers are not subsistence planters. All but one of the taro farmers are part-timers, holding full-time salaried jobs. Of forty-eight household heads, eight men

commute daily or weekly to jobs outside in construction or roadwork. Over half the households in Keanae are occupied by retirees who rely on pensions or social security for their livelihood. (*Ibid.*:34-35)

During the years following Linnekin's study up to the present, the economic viability of taro farming throughout the Hawaiian islands has grown sharply, increasing the possibilities for livelihood - and for the preservation of a distinct Hawaiian lifestyle and identity - within the Ke'anae-Wailuanui landscape. According to local residents, the community currently has seven families farming taro full-time. Other community members work for the state or county, for East Maui Irrigation Co., or commute to jobs outside the area. Because of the taro farmers' dependence on access to the area's water resources, water issues have been a long-standing focus of the community's concern. While strong demand for taro continues unabated, the future survival of taro farming in the two *ahupua'a* may hinge on the resolution of these issues.

Emblematic of the challenges facing the community of Ke'anae and Wailuanui as it strives to maintain its identity is the ongoing struggle to keep the Ke'anae School open. Enrollment at the school, in grades one through eight, was sixty-three in 1930, forty in 1965, twenty in 1969, and thirty-one in 1975. By 1991, enrollment had dwindled to fourteen in kindergarten through third grade. Newspaper headlines summarize the unfolding story:

"Keanae School, State's tiniest, expected to close soon"
(*Star-Bulletin* 31 May 1991:A7)

"Parents want Keanae School despite small enrollment"
(*Advertiser* 31 May 1991:A3)

"Keanae, State's smallest public school, may close"
(*Star-Bulletin* 1 June 1991:A3)

"Maui parents plead to keep Keanae School open"
(*Star-Bulletin* 18 June 1991:A4)

"Keanae School on Maui, Hawaii's smallest with only 14 students, will remain open for the time being"
(*Star-Bulletin* 29 June 1991:A3)

"State's smallest school to lose 2 students, 10 left"
(*Star-Bulletin Advertiser* 7 June 92:A18)

In 1994 the enrollment is "now down to a single class of 11 kindergartners to third graders" and the Maui school superintendent, citing operating costs of more than $200,000 a year, is considering closing the school (Kubota 1994:A3). Some Ke'anae residents "want state officials to reopen the school...to students in the fourth through the eighth grade" seeing the school as linked to local tradition that is "disappearing as Keanae School shrinks" (*Ibid.*:A3).

One recent hopeful sign in the Ke'anae-Wailuanui area has been the increase in population to 241 in 1990, an indicator of natural increase and young people returning to the community.

After the myriad changes experienced at Ke'anae and Wailuanui during the now more than two centuries of recorded history in the Hawaiian islands, the continuing presence of expanses of taro *lo'i* in the two *ahupua'a* during this last decade of the 20th century attests to the tenacity and perseverance implicit in the words of Samuel Kamakau: "My people have been cultivators from very ancient times..." The historical record can only document the economic, political and social forces that have pressed upon the people of the two *ahupua'a*. Perhaps the most enduring force remains the mythic identification - recounted in the story of Hāloa, born to Wakea and Ho'ohoku-ka-lani - of the taro plant with the origins of Hawaiian people, which is recounted below in Section V of this report.

V. TARO IN HAWAIIAN CULTURE AND WITHIN THE KE'ANAE-WAILUANUI LANDSCAPE

V. TARO IN HAWAIIAN CULTURE AND WITHIN THE KE'ANAE-WAILUANUI LANDSCAPE

The choice of a taro-growing area as the subject of a cultural landscape model study is especially appropriate in view of the intimate connection of taro cultivation to Hawaiian culture. Taro (*kalo; Colocassia esculenta*) was probably brought to Hawai'i by the earliest Polynesian voyagers and has been a staple crop on the islands ever since. Taro is intimately connected mythologically to the origins of Hawaiians as a people. There are different versions of this myth, but all of them make the connection between the first born Hawaiian and the taro plant. According to Mary Kawena Pukui:

> The first Haloa, born to Wakea and Ho'ohoku-ka-lani, became a taro plant. His younger brother, also named Haloa, became the ancestor of the people. In this way, taro was the elder brother and man the younger — both being children of the same parents. (in Handy and Handy 1972:80)

The physical attributes, the growth patterns and the propagation of taro all reflect the structure of Hawaiian kinship and an obvious relationship to the human body. The main plant in the center is the *makua* (parent), the smaller plants budding out of the *makua* are the *'ohā* (offspring). The center of the leaf where it connects to the stem is the growth center of the veins of the leaf and is called the *piko* (belly button). The stem is called the *ha*, which is also a word for breath, the basis of life. The cycle of planting is a reflection of the human life cycle. When the taro is harvested the *kalo* (corm) is cut right below the green top, the cut top is called the *huli* (turning, returning or transforming). The *huli* is replanted and the family of taro once again continues its growth cycle. The generations of taro are thought of interchangeably with the generations of Hawaiians as reflected in the saying "Kalo kanu o ka 'āina" – literally "taro planted on the land" but figuratively referring to successive generations of natives (Pukui 1983:157). Both the *'ohā* and the *makua* can be used as *huli*, but, as in a family, the *'oha* (child) must be separated — to become independent of the parent and — to become a parent itself. If it is not, it remains a dependent attachment, overshadowed by the leaves of the *makua*. Another saying, "*I maika'i ke kalo i ka 'ohā*" - "the goodness of the taro is judged by the young plant it produces" (*Ibid*:133), is a metaphor for the parents being judged by the behavior of their children.

All parts of the taro plant are used for food: the corm is cooked and eaten as table taro or steamed and pounded into poi; the stem can be steamed and used in various soup and stew dishes; the young leaves are used for *laulau* and *lu'au* dishes mixed with fish, squid, pork, chicken and beef. Generally, the leaves are not harvested from the plants designated for corm production because continuous cutting makes the corms soft and tasteless (*loli*). Taro growers who grow leaf for home use or commercial purposes always have specially designated *lu'au* patches. It is the traditional Hawaiian practice to use all the coarse green cuttings that are the by-product of the harvesting of the corms as food for the pigs. This green material, when cooked and fed to the animals, is highly nutritious. For this reason, raising pigs is traditionally in symbiotic relationship to taro production. In a traditional taro field no space is wasted. The *lo'i* are used for the taro and any extra space on the banks is used for subsistence, utilitarian and medicinal plants, such as bananas, *noni*, and ti.

The practice of taro cultivation most resembles gardening in its scale and methods. Much of the work is done by family members or an individual and is done by hand. The *lo'i* and banks are beautifully manicured, ostensibly for weed control but the result is

aesthetically like a garden. Yet, taro production remains viable even on this small scale because of its high per-acre productivity.

Nowhere else in the world was taro cultivation more developed than in Hawai'i (Kirch 1985:215). It was the staple for the hundreds of thousands of Hawaiians living here before European contact. It was grown in areas with sufficient rainfall (above 30-50 inches per annum) under dryland management. In areas of suitable water sources extensive and sophisticated irrigated systems were developed for its cultivation. The social requirement for the planning, development and maintenance of these irrigated systems was a stable political system and community cooperation. Although the cultivation and maintenance of individual fields could be the purview of single families or individuals, the maintenance of the water supply system, on which the entire system depended, had to be organized on a community level.

Although less than 100 varieties of taro survive today, there may have at one time been as many as 300 varieties in the islands, distinguished by leaf shape, corm, morphology, color and use. The labels of wetland and dryland taro do not refer to different taro varieties, but only to different cultivation practices. All varieties of taro can be grown in dryland fields and all but a few in *lo'i* (flooded fields). Today there are only a few widely-grown commercial varieties. For example, five varieties are grown in Ke'anae: Moi black, and Moi white, Light and dark Lehua, and Mokohe (short one). Mechanical devices are used, such as tillers and small tractors; in some cases PVC pipes have replaced earthen or stone *'auwai* and commercial fertilizers are routinely used. A typical taro crop will take from 10 to 14 months to mature. With modern farming methods taro is one of the most productive per-acre staple crops in the world. However, in spite of these modern overlays, the bulk of the labor is done by hand in the context of the family and the essence of traditional taro growing — community cooperation in management of water and land resources — remains an integral part of this lifestyle.

In pre-contact Hawai'i, during the late prehistoric era, as documented by archaeological studies, taro cultivation was practiced in virtually every suitable locality, including floodplains in windward valleys with perennial streams, open lava and beach flats near stream systems, and moist leeward slopes. Taro was such an important crop it was even grown in artificial micro environments created by mulching pits in lava fields.

Since European contact there has been a slow but steady decline in taro cultivation. In the late 19th and early 20th century, many of the large taro-growing areas were given over to rice planting. Taro cultivation returned on a smaller scale to these areas after development of the California rice industry. Today, commercial Hawaiian taro cultivation is confined to few areas in the islands: Hānalei/Waioli, Hanapēpē and Waimea on Kaua'i, Waikāne/Waiāhole on O'ahu, Honokohau, Waihe'e, Ke'anae/Wailuanui on Maui, and Waipi'o Valley on the island of Hawai'i.

The taro landscape of Ke'anae-Wailuanui manifests a viable traditional economy which has maintained historic and cultural integrity, traditional lifestyle and social continuity to an equal or greater extent than any of the other taro growing landscapes in Hawai'i. Physical isolation, economic constraints, the characteristics of the environment itself, and the traditional attitude of the community have all contributed to this integrity.

VI. INVENTORY OF CULTURAL LANDSCAPE COMPONENTS

VI. INVENTORY OF CULTURAL LANDSCAPE COMPONENTS

Typically, a cultural landscape is composed of physical elements which manifest the technological and cultural basis of human use of the land through time. In addition, as discussed above, this report recognizes that the landscape area traditionally utilized by the Ke'anae-Wailuanui residents for subsistence, cultural, and spiritual practices includes a broader and more extensive of natural resources and features. Therefore, in the course of the study of Ke'anae and Wailuanui, the following components of both the cultural landscape and the traditional cultural practices region were identified for examination:

A) Taro cultivation.
B) Other vegetation.
C) Circulation networks.
D) Buildings, structures, non-structural facilities, and objects.
E) Clusters.
F) Internal boundaries.
G) Ko'olau Ditch, East Maui Irrigation Company (EMICo).
H) Archaeological and historic sites.
I) Open areas.
J) Small-scale elements.
K) Viewing points.
L) Cultural resources and use areas.

Each component was investigated by appropriate members of the interdisciplinary research team. Results of their study are presented below and in the following section, *Mana'o O Ka 'Āina*.

A. Taro Cultivation

Considering its visual impact as well as its economic importance, wetland taro cultivation comprises the most important single component of the cultural landscape of Ke'anae-Wailuanui. Wetland taro cultivation requires a precisely defined, stable field system with a continuous and reliable source of water. The system must be designed so that cool, fresh water can be delivered constantly to every field. In this sense, a taro landscape is designed as a single system with interrelated elements (fields, streams and *'auwai*). Alteration of any of these elements could affect the entire system. The ancient Hawaiians who designed this landscape were limited in the degree to which they could alter the natural topography. They dealt with this constraint by flexibility of design. Seen as a whole, the taro landscape appears as a simple network of inter-connected rectangles defined by banks which hold in water. Upon closer inspection, it is apparent that field design, water flow, and water delivery are a response to subtle variations in the natural landscape. A taro landscape is extremely complex in its internal workings.

Taro cultivation has modified the landscape more than any other component. Significant aspects of the Ke'anae-Wailuanui cultural landscape directly attributable to taro cultivation and documented in this study include:

- the sodding, irrigation and transformation of a naturally barren and waterless lava rock peninsula into a cultivated wetland;
- a topographical pattern of step-like terraces blanketing coastal valley slopes
- diversion of stream waters out of their originating watersheds in order to create expansive, manmade, terraced wetlands;

- the naming of the region;
- the intricate and dispersed land ownership patterns;
- the resulting pattern of habitation and use.

Five distinct localities in Ke'anae-Wailuanui in which taro is presently under cultivation were identified during the study: Ke'anae peninsula, Wailuanui, Ke'anae Arboretum, Waianu Valley, and Lākini *'ili* (Figure 12).

Additionally, there are two small *lo'i* areas which are under cultivation near the junction of Hāna Highway and Waiokamilo Stream. There are a number of patches here which were not examined during the project. They have been under cultivation for over 100 years, according to local informants. They are not included among the five major taro-growing areas. The water for these patches comes from Waiokamilo Stream, downstream from the diversion that waters the northwestern portion of the Wailuanui system.

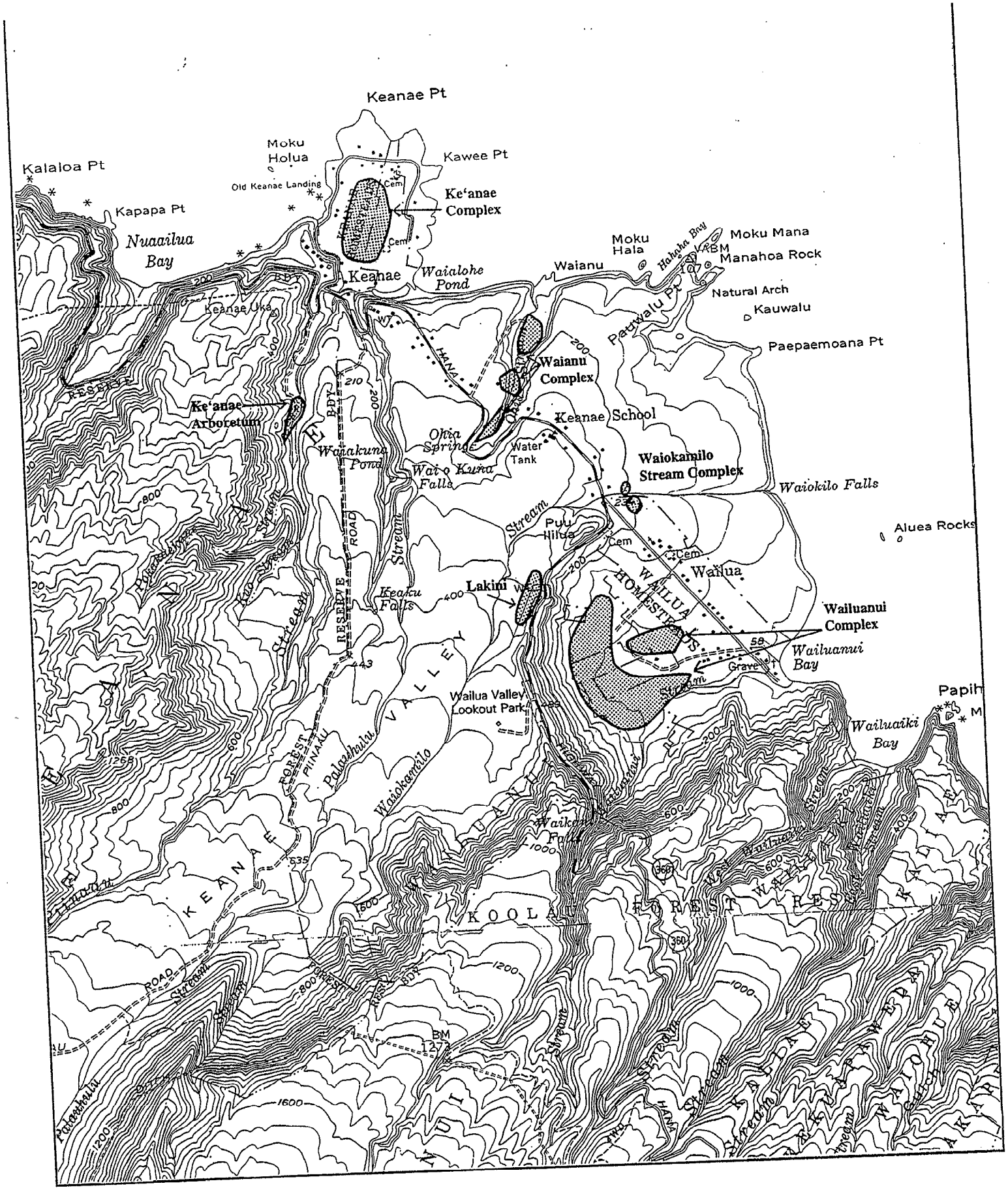
The five major localities and the two small *lo'i* areas watered by Waiokamilo Stream are described below. Adjacent to some of the five major taro growing areas are abandoned fields which are, in some cases, under forest cover, but are still preserved as intact *lo'i* systems. These abandoned components of the active systems are also described along with former cultivated lands *mauka* of Wailuanui in Kupa'u and west of Ke'anae at Nua'ailua.

1. Ke'anae Peninsula

The central portion of the Ke'anae peninsula contains the most tightly clustered concentration of taro *lo'i* in the area, totalling approximately 185 *lo'i* presently in production (Figure 13). All of these *lo'i* are irrigated by the *Ka wai kau o Ke'anae* - "the suspended water of Ke'anae" - a flume which is tapped from Palauhulu Stream. This present-day metal pipe flume - the descendent of the 19th century wooden flume shown in Figure 5 - in turn feeds an *'auwai* which runs through the center of the Ke'anae *lo'i*. This *'auwai* splits after it has flowed about 500 feet north from the flume. One branch continues for another 350 feet through the center of the *lo'i* system where it turns west and disperses into the western *lo'i*. The other branch turns east and then north to feed the *lo'i* in the northeastern segment of the system. It is reported that previously there were other sources of irrigation water for this system, but the present flume has been in operation throughout this century as indicated on the 1903 S.M. Kanakanui map (see Figure 8).

Water flows into the patches adjacent to the *'auwai* directly from the *'auwai* and also flows *lo'i* to *lo'i*, especially in the more *makai* areas of the system. This system is clearly of different design and configuration from a typical floodplain *lo'i* network. Ke'anae peninsula is a broad contoured 'a'a flow with much micro-variation in topography controlled by lack of uniformity in the underlying bedrock. Therefore, elevation from field to field is quite variable. This feature alone distinguishes it from a floodplain system, in which elevational change is minimal and uniform. In Ke'anae the fields were configured around the 'a'a bedrock outcrops, some of which are seen protruding from the banks.

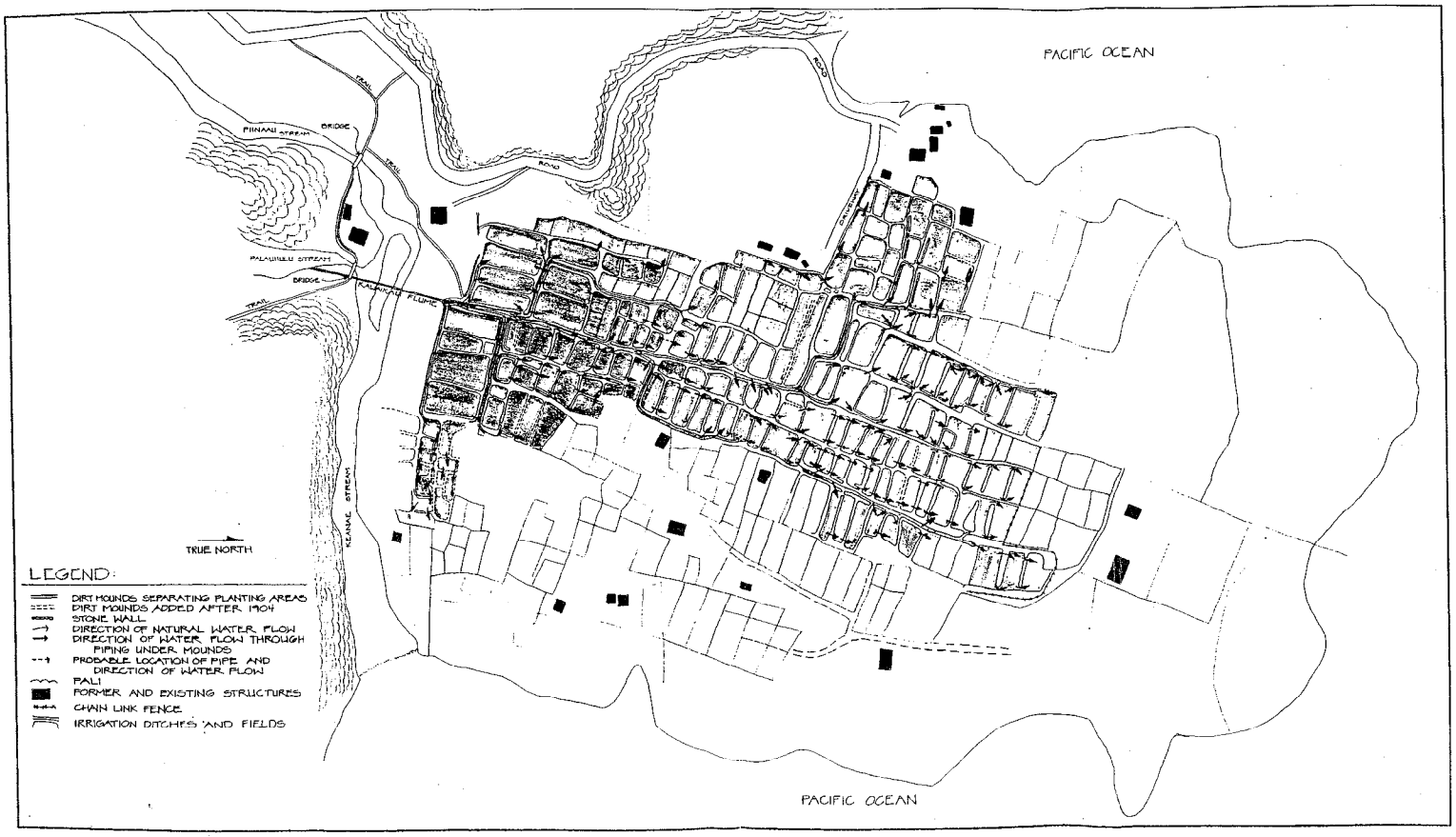
The *lo'i* themselves are surrounded by convex earthen banks. These banks serve as dividers between the fields as well as trails for foot traffic (one person, single file). The wider banks, some of which measure 8 to 10 feet, provide access for tractors and all-terrain vehicles (ATVs). These banks are kept stable with continuously mowed, broad blade grass covering. At the base of many of the banks, particularly in the *mauka* part of the system, stone alignments and walls are visible. These hint at an underlying stone terrace system probably



Taro Growing Areas

Figure 12

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE



Ke'anae Peninsula Lo'i Complex (State site 50-50-07-3933)

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE

Figure 13

buried beneath these high earthen banks which have been built up over centuries of weeding and maintenance. The banks are also used for cultivation of bush and tree crops; bananas grow on the wider banks, providing shade, and ti and *noni* are scattered along the narrower banks. To a certain extent, the banks are considered community throughways; but the management, use and ownership of each individual patch is clearly delineated.

Along the broader banks and on the corners of fields are worksheds of plywood and corrugated roofing, which are individually owned and house personal or family equipment for farming the adjacent *lo'i*. Some of these sheds are open, two or three sided, and serve as shelters during rain squalls. In a few cases the larger sheds serve as living quarters for families working the fields.

A new facet of the taro history of Ke'anae is the 5 to 6 year long fight against the yellow apple snail (*Pomacea canliculata*). Some farmers are successfully fighting the snail infestation with imported Cayuga Ducks (New York State ducks). The ducks are trained to leave their cages, head straight for the *lo'i*, to eat snails, and then return to their cages when signalled by a hand clap.

Continuity and Integrity

The map of the present-day *lo'i* of Ke'anae was plotted on the 1903 Kanakanui map which formed the base map. The Kanakanui map shows LCA awards as well as the boundaries of each *lo'i*.

It was clear from this mapping exercise that the layout of the fields and *'auwai*, and by implication, the configuration of the water flow through the system, has not changed since 1903. The mid-19th century LCA records also describe a system essentially the same as that seen today. Given the complex layout and the constraints of the bedrock typography it is likely that the configuration of the Ke'anae *lo'i* system has remained essentially the same since its initial layout long before European contact. Ke'anae farmers attest to the difficulties of mechanically altering fields and water flow: if one portion of the system is altered - e.g., a field is cleaned and made too deep - water flow to adjacent fields will be deleteriously affected. This suggests that the initial layout of the system, probably followed by a period of adjustment, could never be improved upon, even after the introduction of the mechanical conveniences and labor-saving devices of modern farming.

Another aspect related to the integrity of this Ke'anae system is the apparent lack of modification during the late 19th and early 20th centuries in a shift to rice cultivation. Because of the limitations imposed by the bedrock typography, by the location of the *'auwai*, by the requirement of gravity feed, these fields have remained small compared to other systems in Hawai'i (Hanalei, for example). These fields could not have been consolidated into larger units for rice cultivation and continue functioning as an integrated system.

All this evidence points to the high degree of historic integrity of the Ke'anae system, which also constitutes a unique cultural adaptation to a specific environment. It is interesting to note that the legend of the origin of the Ke'anae *lo'i* system refers to "... carrying soil in baskets down to the lava point. The soil and the banks enclosing the patches were thus, in the course of many years all transplanted and packed into place" (Handy 1985:110). The legend implies intensive planning and labor required to redesign an 'a'a flow into an irrigated landscape which has remained in delicate balance ever since. The authors

of the present study, participating in weeding and planting in these patches, could feel the 'a'a floor beneath the mud of the *lo'i*: disturbance or removal of this layer of mud would endanger the capacity of the *lo'i* to support a taro crop.

Historic Antecedents

Although the layout of the present system is essentially the same as that recorded in the 1903 Kanakanui map of Ke'anae peninsula, it is clear that the area of cultivated land has diminished considerably. For example, 183 *lo'i* are in production today, but there were a total of 265 plotted on the 1903 map. Differences can also be noted in a 1934 photograph of the Ke'anae peninsula (Figure 14).

Many *lo'i* have been abandoned; the largest abandoned area lies on the east side of the peninsula, but there are also empty fields at the *makai* end just *mauka* of the Congregational church. *Lo'i* have been turned into house lots and yards, pasture, and citrus groves, and some have been taken over by thick growths of *hau*. The *mauka* end of the system appears always to have been well defined by topographic constraints and has been limited to the flats *makai* of Ke'anae Stream. Other smaller systems existed along the upper reaches of Pi'ina'au Stream but are not geographically connected to the Ke'anae peninsula system.

2. Wailuanui

The Wailuanui *lo'i* system (Figure 15) is much larger than the Ke'anae peninsula system. In some aspects, the Wailuanui system shares more characteristics with a typical floodplain system found elsewhere in Hawai'i. However, there are still many variations in the typography which have complicated the system of water delivery and challenged the ingenuity of its creators. Information on the water sources for the Wailuanui *lo'i* was gathered from field reconnaissance as well as discussions with local residents and information obtained from East Maui Irrigation Company, Ltd. (EMI).

There appear to be three sources of water for the irrigated fields at Wailuanui. The eastern source is Wailuanui Stream which is tapped from the pool at the base of Waikani Falls. This pool and stream, according to residents, have long been prone to periodic flooding which destroys the intake of the ditch at the pool. The problem has been partially remedied by the recent installation of a 300-ft. long buried pipeline which taps water from the pool from an underwater intake and parallels the stream within the flood zone. This pipe then empties into a partly concrete-lined *'auwai* which runs northwestward through heavy forest paralleling and downslope of Hāna Highway. There are small tributary streams that run into and augment the water in the *'auwai* from upslope. During the present study, this *'auwai* was followed for approximately 1,000 ft. to a point at which the water is tapped from the *'auwai* and runs downslope in a unlined ditch to feed the upslope patches at the south end (Keononalu) of the system. The original northwestern-trending *'auwai* continues parallel to the slope but is presently non-functional. It was followed for a short distance only. It is assumed to continue along the slope to the northwest. According to Mr. Sam Akina, this *'auwai* ends a short distance beyond where it is presently tapped. Along the unlined ditch are many well-constructed, rock-lined and walled, abandoned *lo'i* presently in forest. These abandoned *lo'i* are located immediately upslope from the presently cultivated Wailuanui system.

The second source of water is from Kualani Stream which parallels Waiokamilo Stream on its east side. The name "Kualani" appears on a map provided by EMI Co. Ltd. but

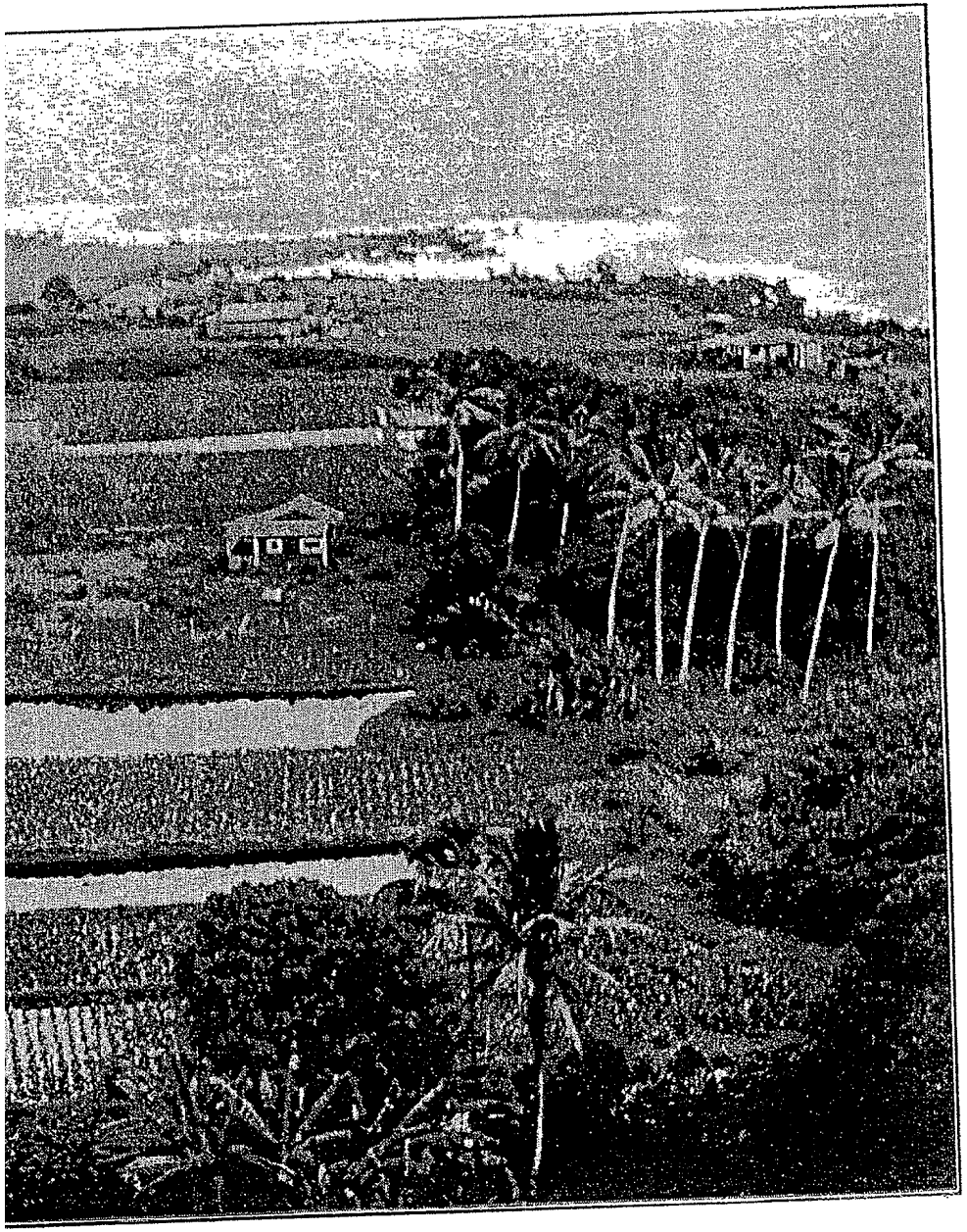
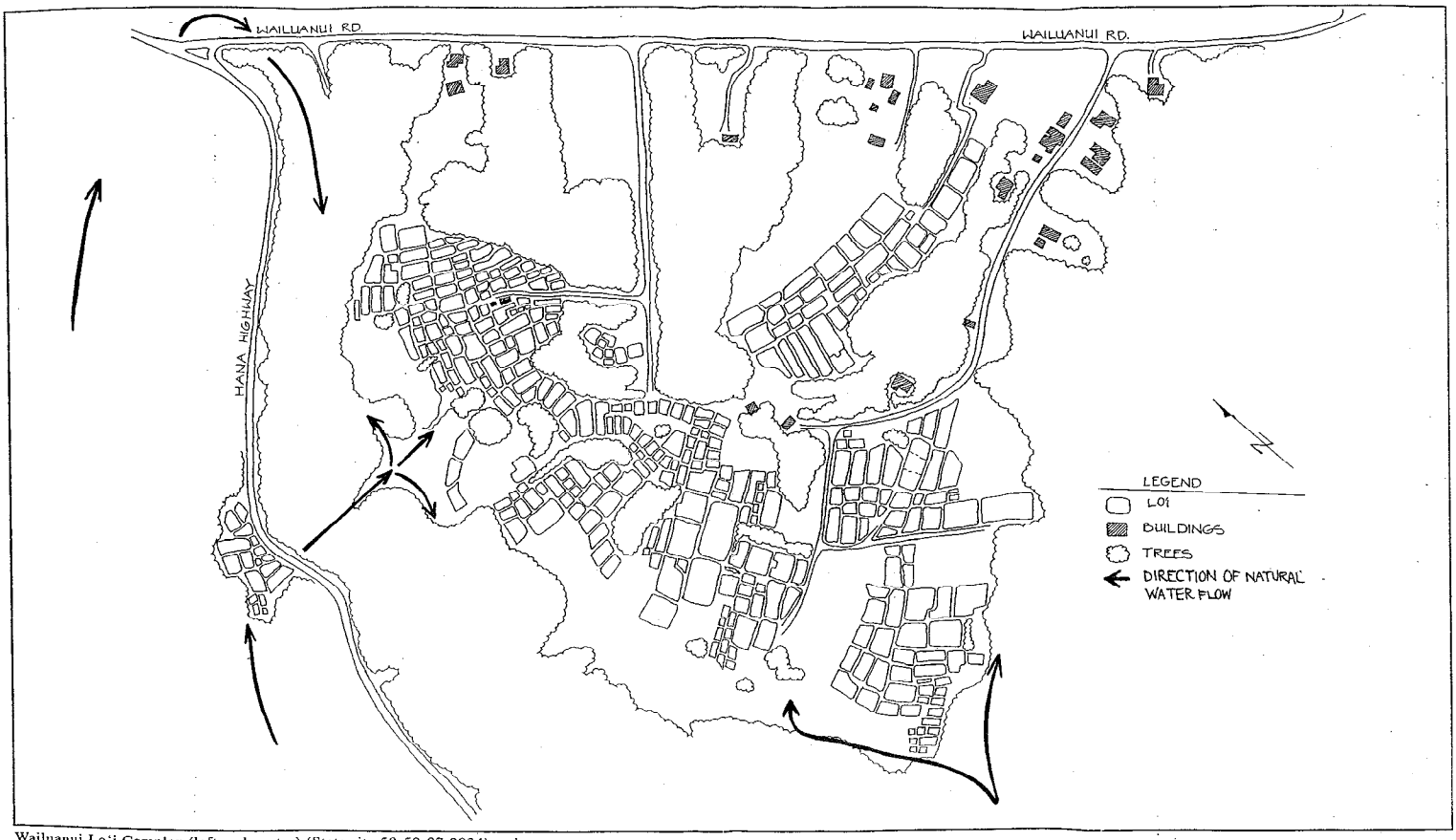


Figure 14



Wailuanui Lo'i Complex (left and center) (State site 50-50-07-3934) and
Wailuanui East Lo'i Complex (right) (State site 50-50-07-3935)

No Scale

Figure 15

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE

is not mentioned in any other source of which we are aware. In Handy and Handy (1972:499) the stream is named "Hamau". Water from Kualani Stream is tapped to feed the Lākini *lo'i* of Mrs. Helen Nakanelua. The 'auwai then runs under the road to feed the central portion of the Wailuanui *lo'i*, dividing into three branches flowing northwest, southeast and straight *makai*. This source is considered to be very dependable. The ridge line at Lākini has been cut to bring water from a different watershed into the Wailuanui taro cultivation area. This system was established prior to contact, and should be counted among the engineering feats of the early Hawaiian cultivators of Wailuanui.

The third source is tapped from Waiokamilo Stream just as it crosses under the Hāna Highway at the junction with the Wailuanui Road. This *'auwai* circles back to the southwest, crosses under Wailuanui Road and feeds the northwest portion of the Wailuanui *lo'i*.

The Wailuanui system was not mapped in detail during the present fieldwork, however, portions of it were examined and documented through sketches and photographs.

The complexity of the Wailuanui system is testimony to the engineering ingenuity that shaped it. The system is by far the largest within the area, with 339 *lo'i* plotted off the 1982 aerial photograph. The design of the system is adapted to the variable topography, particularly the steepness of the terrain in the more *mauka* reaches. *Lo'i* banks were observed as high as 6 to 8 ft. The steepest part of the system today lies abandoned at the *mauka* end under the *hau* forest.

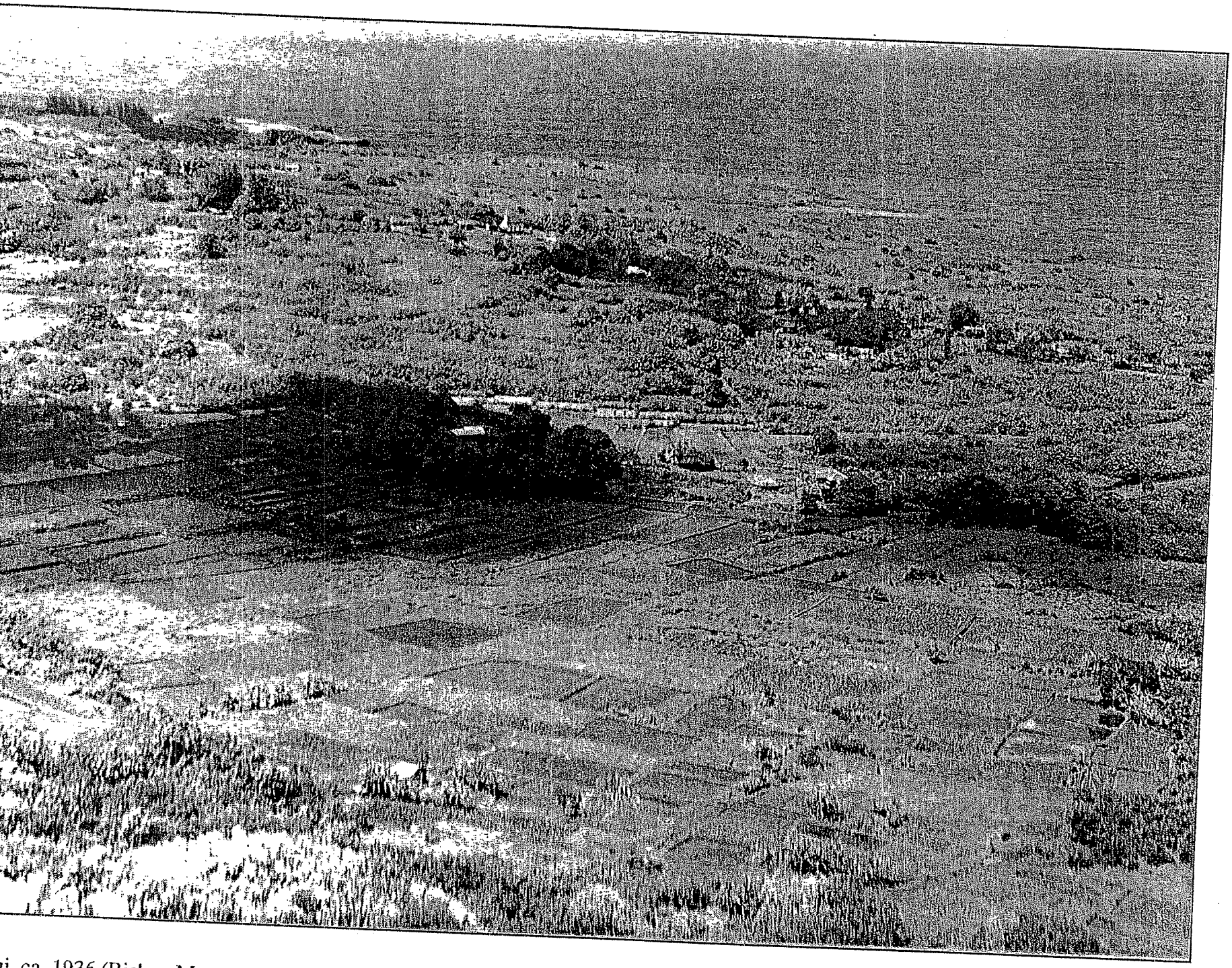
Generally, the fields are smaller at the upslope end with the larger fields to the east and southeast towards Wailuanui Stream. As the system functions today, it is confined between Wailuanui Stream and Hāna Highway in the Wailua Homesteads area. In contrast to the Ke'anae system, it displays uncultivated islands dispersed throughout. Similar to the Ke'anae system, it is separated from the main residential area.

Integrity and Continuity

Unfortunately, there is no detailed historic map of the Wailuanui *lo'i* system itself, however taro cultivation for the entire area is well documented in the 1850s Land Commission Award documents. According to an 1896 map of the *makai* portion of Wailuanui (see Figure 9), much of the central portion of the system was given to rice cultivation, although the southeastern portion fronting Wailuanui Stream remained in taro. In a subsequent 1903 map (see Figure 10) a similar pattern is shown, indicating mixed taro and rice cultivation in the northern portion of the system. According to some residents, rice growing was preferred in the larger patches because water temperature was not the crucial consideration as it is in taro cultivation. A 1936 photograph of Wailuanui (Figure 16) shows the system with considerably less tree and bush vegetation than is present today and the majority of the patches appear to be under taro cultivation. Two photographs of 1966 (Figures 17 & 18) show all of the planted patches in taro with a dramatic increase in forest growth along the periphery.

Historic Antecedents

Field reconnaissance during the study resulted in the discovery of two intact irrigation systems on the southeast side of Wailuanui Stream. A small but well-preserved system of abandoned terraces was found on the state property just south of Wailuanui Bay. A well-preserved *'auwai* was tapped from a tributary of Wailuanui Stream and runs northward along the eastern edge of the ridge separating this valley from the main valley of Wailuanui.



ui, ca. 1936 (Bishop Museum)

AE - WAILUANUI CULTURAL LANDSCAPE

Figure 16

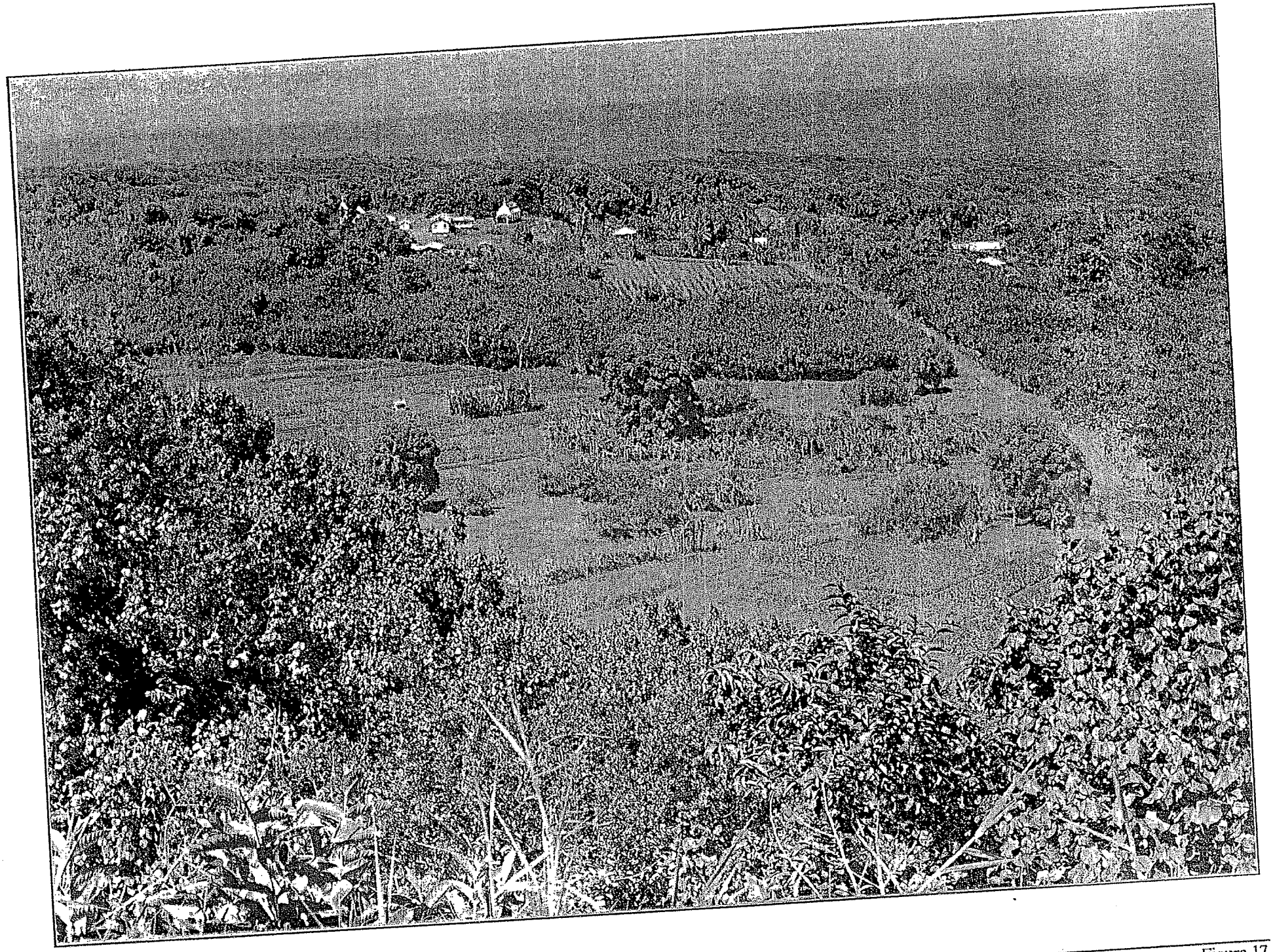
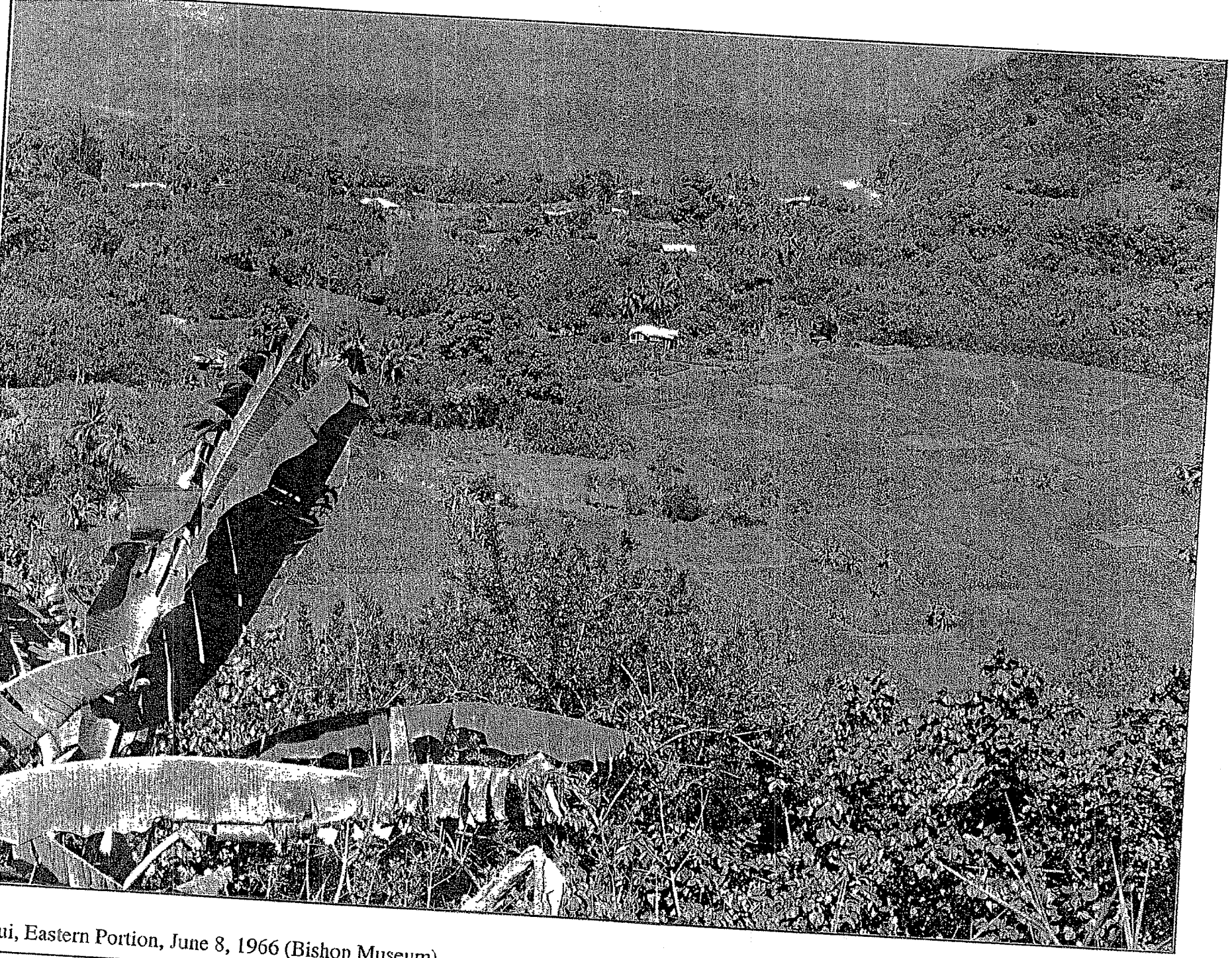


Figure 17

Wailuanui, Western Portion, June 8, 1966 (Bishop Museum)

WAILUANUI CULTURAL LANDSCAPE



ui, Eastern Portion, June 8, 1966 (Bishop Museum)

AE - WAILUANUI CULTURAL LANDSCAPE

Figure 18

This *'auwai* was cut directly from the soil and soft bedrock of the ridge. This *lo'i* system conforms to the location of six LCAs (4561:2; 5067; 5066; 5049:2; 4562:2; and 4772) indicated on the 1896 map.

Farther upstream, running all the way along the flat land on the south side of Wailuanui Stream, are well-developed abandoned terraces in thick forest. As many as six terrace levels were counted. The terrace walls are well constructed, some partly free standing and core-filled. An intact stone-lined *'auwai* was traced for more than 1,000 ft. Upslope of this *'auwai*, terraces were observed along the sides of two tributary streams, the flow which originally fed into the main *'auwai*. The *'auwai* was traced to within 300 ft. of the pool below Waikani Falls. Clearly, this *'auwai* tapped the pool although portions of the *'auwai* were removed by flooding.

Considering these abandoned *lo'i* systems on the southeast side of Wailuanui Stream, as well as abandoned *lo'i* on the northeast side of the stream upslope of those presently in cultivation, it is safe to estimate that at one time the Wailuanui system was nearly twice its present size. Interviews with local residents indicated no living memory of taro cultivation on the southeast side of Wailuanui Stream. Therefore, the area must not have been in cultivation within the last 50 to 100 years.

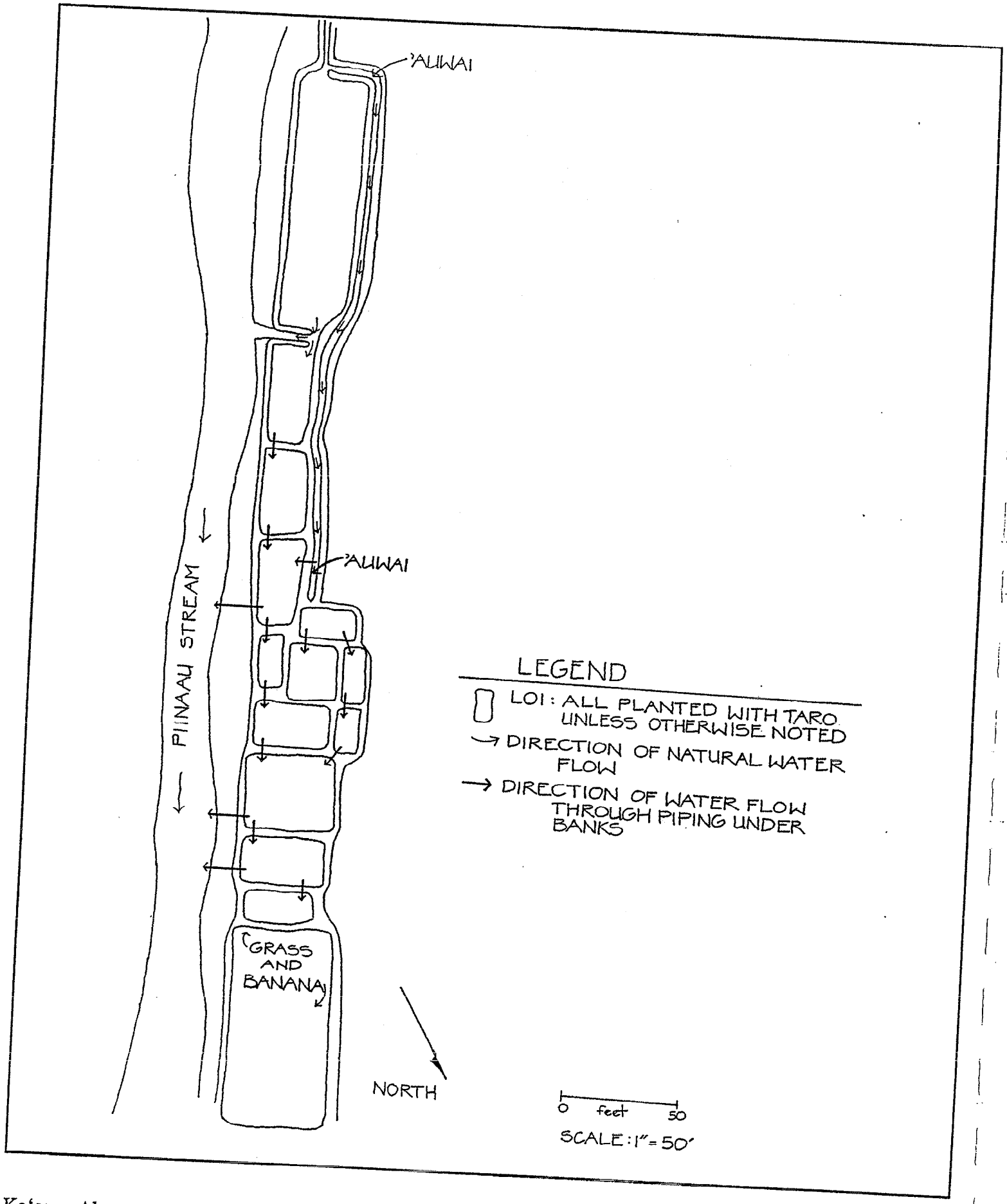
3. Ke'anae Arboretum

The *lo'i* system of Ke'anae Arboretum comprises 14 *lo'i* on the west side of Pi'ina'au Stream (Figure 19). As was documented earlier in this report, the arboretum was opened in the 1970s but its *lo'i* system, which comprises only 2 or 3 acres, is known to have been in existence much earlier, having once before been renovated (in 1946) by prisoners from the Ke'anae prison camp. The water for the system is tapped from the stream at a diversion, cut directly into bedrock, which lies 300 ft. *mauka* of the highest field. The water is channeled through a pipe over a 120 ft.-long portion of this route. The pipe empties into an open *'auwai* and then into the first field which is also the largest.

An examination and mapping of this system during the present fieldwork shows that the *lo'i* have been restored to their original configuration, delimited by the constraints of the physical setting. The fields are set in a linear pattern, parallel to Pi'ina'au Stream, along a flat natural terrace which lies 15 to 20 feet above the present level of the stream. This terrace is retained and separated from the stream by a large and impressive wall, incorporating huge boulders. The *lo'i* walls themselves are made of stone and average 1 to 2 feet high, with some as high as 3 feet. The water generally flows from patch to patch downslope, except for a separate *'auwai* that circles half-way around the upper field on the west side and continues down the west side of the *lo'i* to water three more fields. Some of the walls show core filling and in some cases PVC pipes are used for inner *lo'i* flow at the lower end of the system. These *lo'i* are not used for commercial or sustenance cultivation, but for demonstration and education purposes. Banana, breadfruit and ti are growing on the upslope bank of the *lo'i*. The *lo'i* are maintained by a full-time caretaker, a resident of Ke'anae.

Continuity and Integrity

The system appears to have retained its historic integrity. The configuration of the natural terrace on which the system occurs precludes any major alteration from the traditional system that would have been placed there. For example, the impressive retaining wall that separates the system from the stream bed and protects it from flooding is assumed to be part of the traditional design.



Ke'anae Aboretum Lo'i Complex (State site 50-50-07-3932)

Historic Antecedents

No Land Commission Awards were located on this west bank of Pi'ina'au Stream. However, a 1903 Ke'anae Flat Mauka map by S.M. Kanakanui (R.M. 2235) shows this system in cultivation. The fieldwork of the present project included a reconnaissance upstream of this *lo'i* system to locate other irrigated fields. Stream-side flats upstream for half a mile showed remains of small areas of irrigated terraces. These were not contiguous with the Arboretum *lo'i*. Downslope of the arboretum *lo'i* in the arboretum proper, are the remains of continuous, large terraced fields. Only traces of the outline of these fields remain today because they have been planted with various species of trees. Also, extensive sheetwash erosion has eliminated many of the terraces.

4. Waianu Valley

Waianu Valley is a fairly deep and straight gulch between Ke'anae peninsula and Wailuanui. The stream which courses this gulch is fed by 'Ōhi'a Spring which flows out of the ground at a major curve in the Hāna Road at the *mauka* end of the steep valley. The stream, which is certainly fed by other sources as well, has been referred to by Mr. James Hueu as "Waianu" above the spring, "Kaluanui" below the spring and "Kilo stream" close to the ocean. Other residents have also used the word Kilo to describe the *makai* portion of this valley.

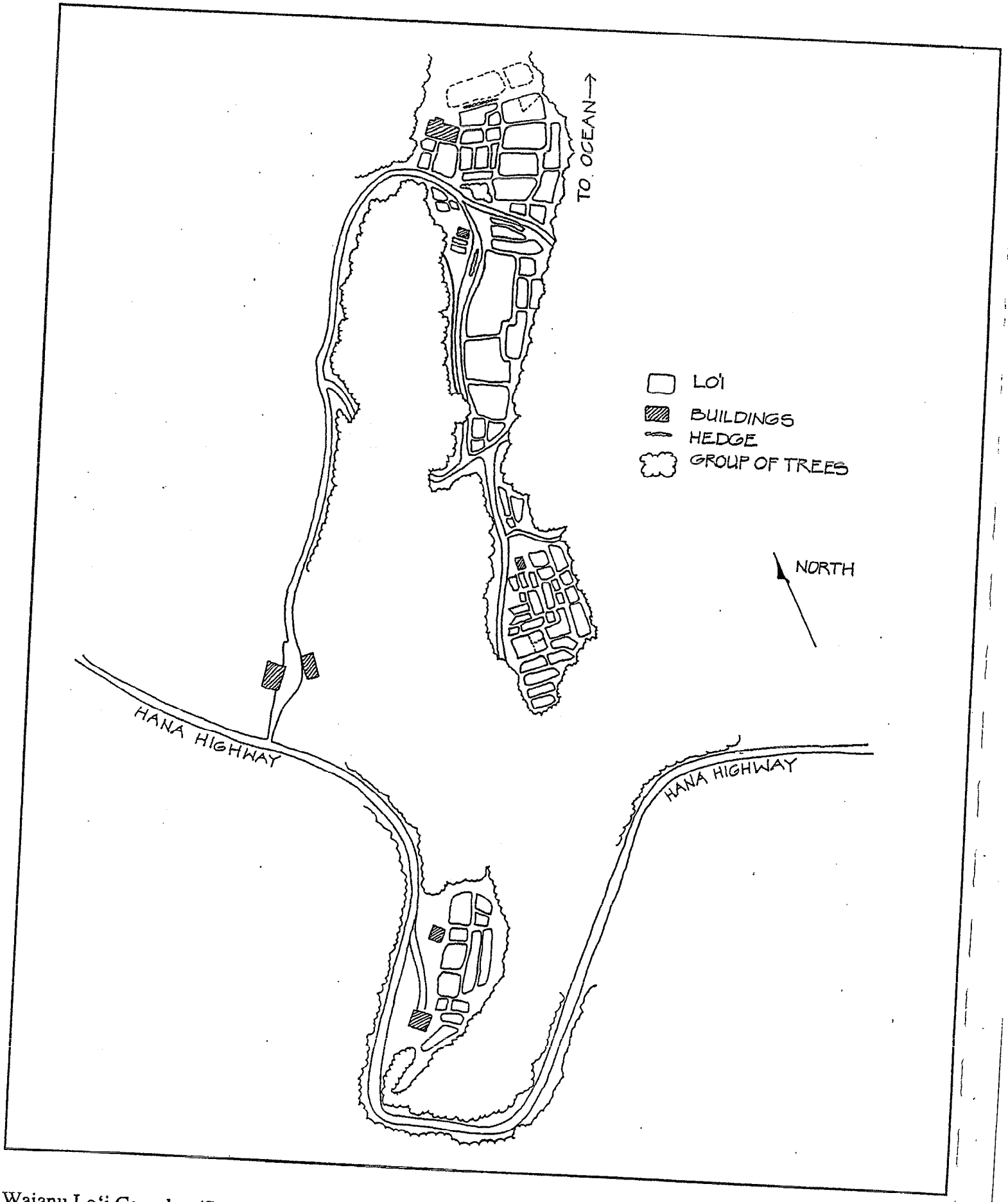
The *lo'i* system was not mapped or inspected in detail for this study. It was viewed from above on the east side of Waianu Valley and the *lo'i* system was mapped from the 1982 aerial photograph. The system consists of between 70 and 80 distinct *lo'i*, although more may have been hidden under vegetation or by shadows on the photograph. Figure 20 maps the layout of this system. At the upper end are small patches which are presently planted in watercress. These patches are easily visible on the *makai* side of the Hāna Road at 'Ōhi'a Spring. They have clearly been mechanically modified from their original configuration: the walls and *'auwai* incorporate stream gravel and boulders as well as soil, showing mechanical mixing. Downstream, the *lo'i* appear to be more intact; there are some larger *lo'i* in the central portion of the system, the largest of which measures 125 ft. *mauka/makai* paralleling the stream and 50 ft. east/west perpendicular to the stream. Most of the *lo'i* measure less than 50 ft. on a side and many are as small as 25 ft. Judging by the 1982 aerial photograph this system was in active use at that time. According to local residents, a shrimp-raising venture was attempted in the central and lower portion of the system, which resulted in the alteration of the original configuration of some *lo'i*.

Continuity and Integrity

It appears that most of the system is intact and maintains a traditional configuration, probably dating back to the 1850s and earlier. The upper part of the system appears to have been completely altered: the original *lo'i* configuration has been replaced with patches now used for watercress. These patches have been created by mechanical grading of the stream gravels. As mentioned, the central and lower portion of the system may have been altered for a shrimp venture, but the extent of this alteration is not known. Only a few of the patches are in traditional use for taro today. The 1982 aerial photograph shows many more patches in taro production than observed recently.

Historic Antecedents

Because of the steep configuration of the valley walls, particularly on the east side, taro production was limited to the valley bottom. There are probably not long-abandoned *lo'i*



Waianu Lo'i Complex (State site 50-50-07-2000)

in the lower portion of the valley. Field search was not made to confirm this. Abandoned systems may occur in isolated areas on the west side of the stream, which is now forested, and a few abandoned systems could also occur upstream, *mauka* of the Hāna Road. A 1908 map of Waianu valley (see Figure 11) shows only two Land Commission Awards (LCAs) within the area of the *lo'i* system. Award documents mention taro cultivation, establishing the presence of the Waianu *lo'i* system in the mid-19th century and, likely, earlier.

5. Lākini *lo'i*

A small area of current *lo'i* cultivation lies *mauka* of Hāna Highway in the *'ili* of Lākini. This entire system is operated and maintained by Mrs. Helen Nakanelua (83 years) and her grandson, Kyle Nakanelua. These *lo'i* were visited on Oct. 6th, 1994 with gracious permission and guidance of Mrs. Nakanelua. The system was mapped and consists of 17 separate patches (Figure 21). The *'auwai* and banks are mainly of earthen construction, although stone foundations could be buried underneath the soil as was observed in portions of the Ke'anae system. Because of the typography, the banks were sometimes 4 ft. or more high and wide enough for several persons to walk together. This system is very well maintained. It is a crucial element of the Wailuanui system, although it is spatially separated. One of the more reliable water sources for the *makai lo'i* of Wailuanui flows through this system. Bananas, *'awa*, ti, noni, pumpkins and *pohole* fern are grown along the banks on the hillsides surrounding the *lo'i*. Mrs. Nakanelua's *lo'i* are the only ones in Ke'anae—Wailuanui that are not infested with the apple snail pest, since she is upstream of all the other patches.

Integrity and Continuity

It is documented through oral history that this system has been in cultivation for over 100 years. The mapping and inspection seems to indicate little or no alteration from a traditional Hawaiian *lo'i* system, except for the use of PVC pipes which appears in virtually every system in the area.

Historic Antecedents

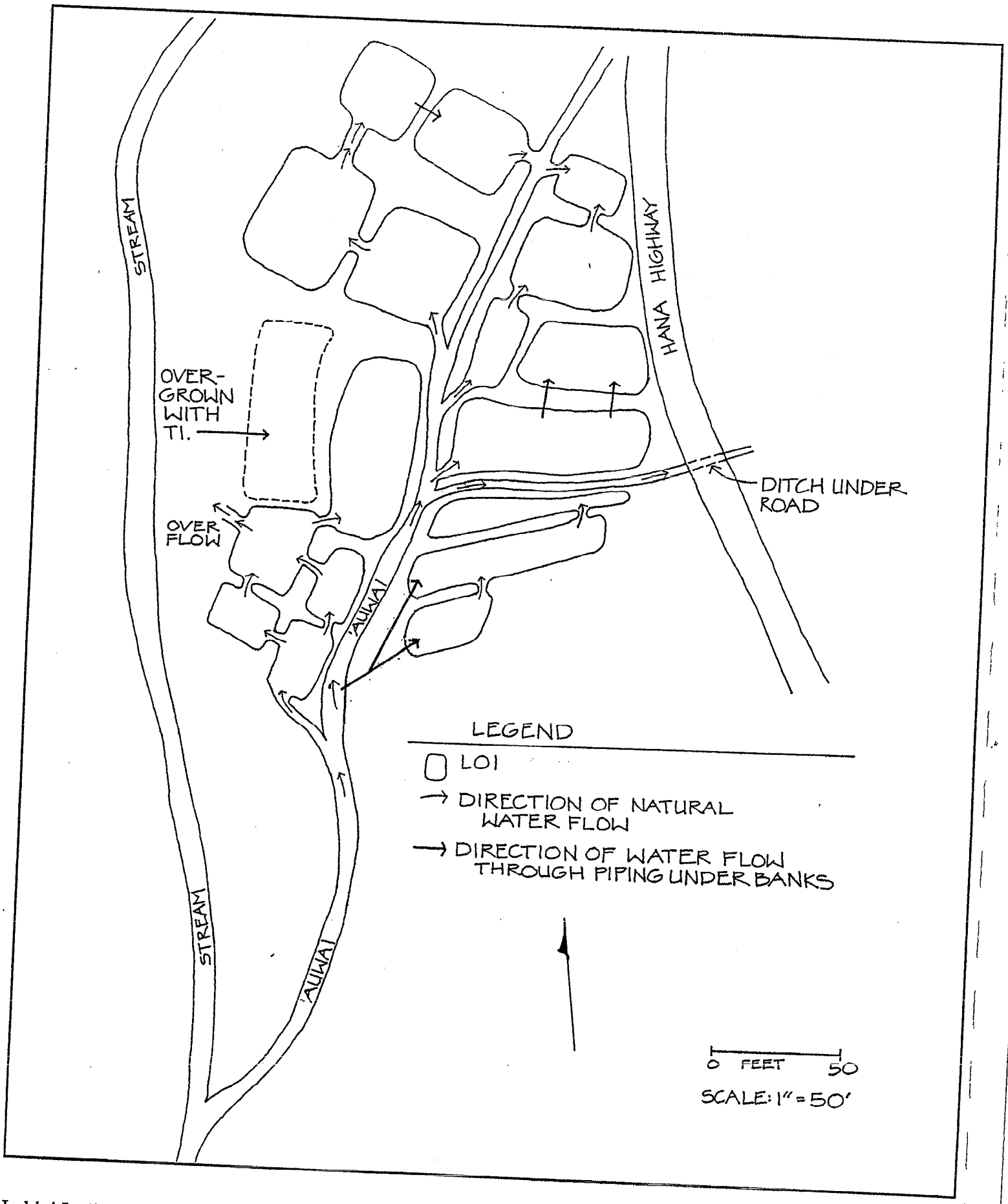
The Lākini *lo'i* have been in Mrs. Nakanelua's family for at least 140 years, and probably much longer. LCA 3472 recorded in 1849 was awarded to Kaihaa, who is Mrs. Nakanelua's great great great grandfather. This award describes a *mo'o* of *lo'i*. According to Mrs. Nakanelua there are more *lo'i* now in cultivation than there were in certain periods in her earlier life. It is likely that this system shares the same characteristic as the others in Ke'anae and Wailuanui, in that it was once much larger. It may have extended *mauka* and west from its present location.

6. Waiokamilo Stream *Lo'i* (Figure 22)

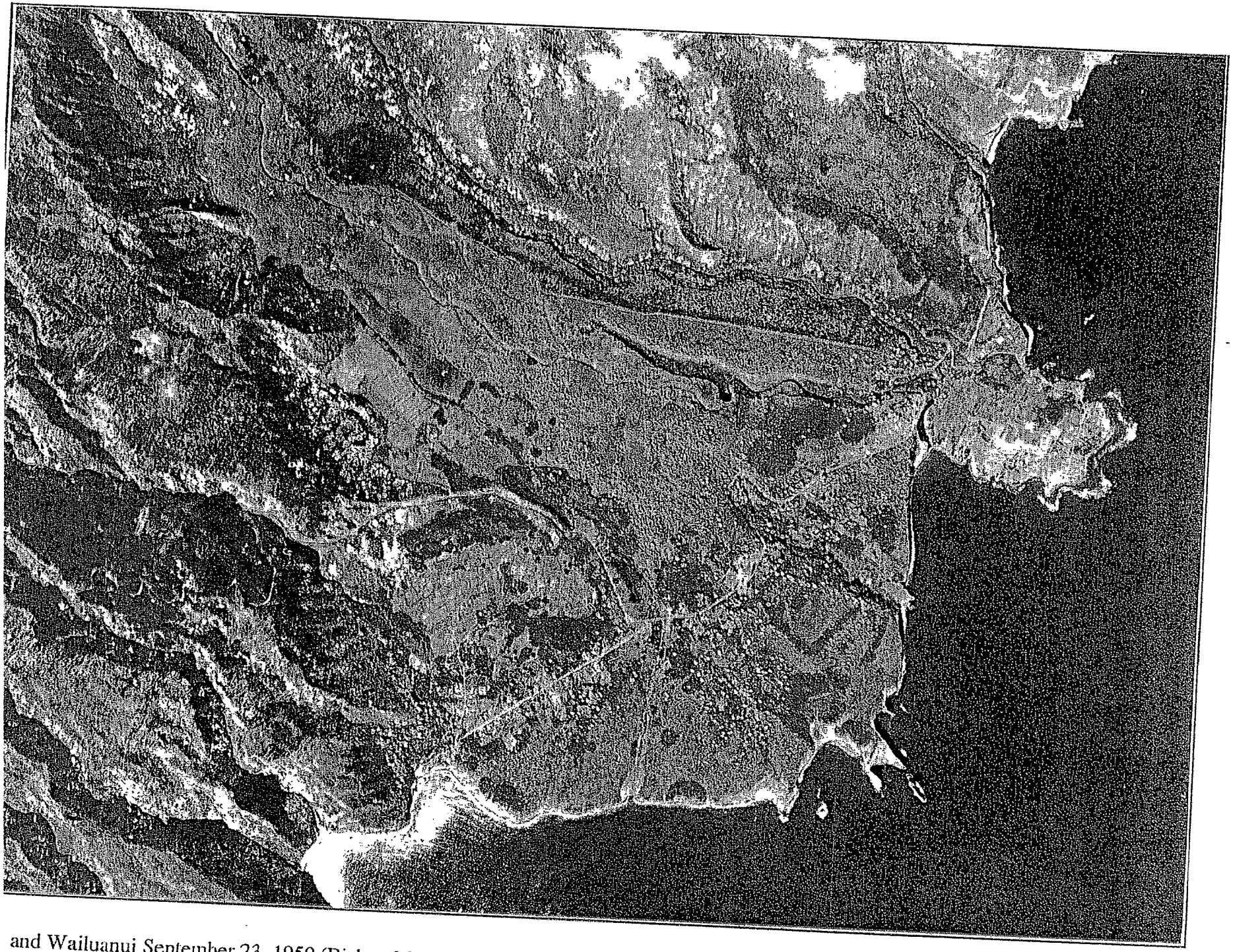
A small complex of *lo'i* is located on two sides of Waiokamilo Stream, a short distance behind the Harry K. Mitchell family compound. The group of *lo'i* - fed by water diverted from Waiokamilo Stream - is cultivated by two separate families. These *lo'i* have been cultivated for over 100 years, according to personal communications to Ke'anae resident Elaine Wender. These *lo'i* were not field checked by the study team and the layout shown in Figure 22 is based on interpretation of an October 1982 aerial photograph. This complex should be mapped in greater detail in the field at a later date.

7. Formerly Cultivated Lands in the *'ili* of Kupa'u

During fieldwork for the present study, the upstream end of East Waiokamilo Stream was inspected. Ke'anae residents Isaac and Gladys Kānoa accompanied the study team.



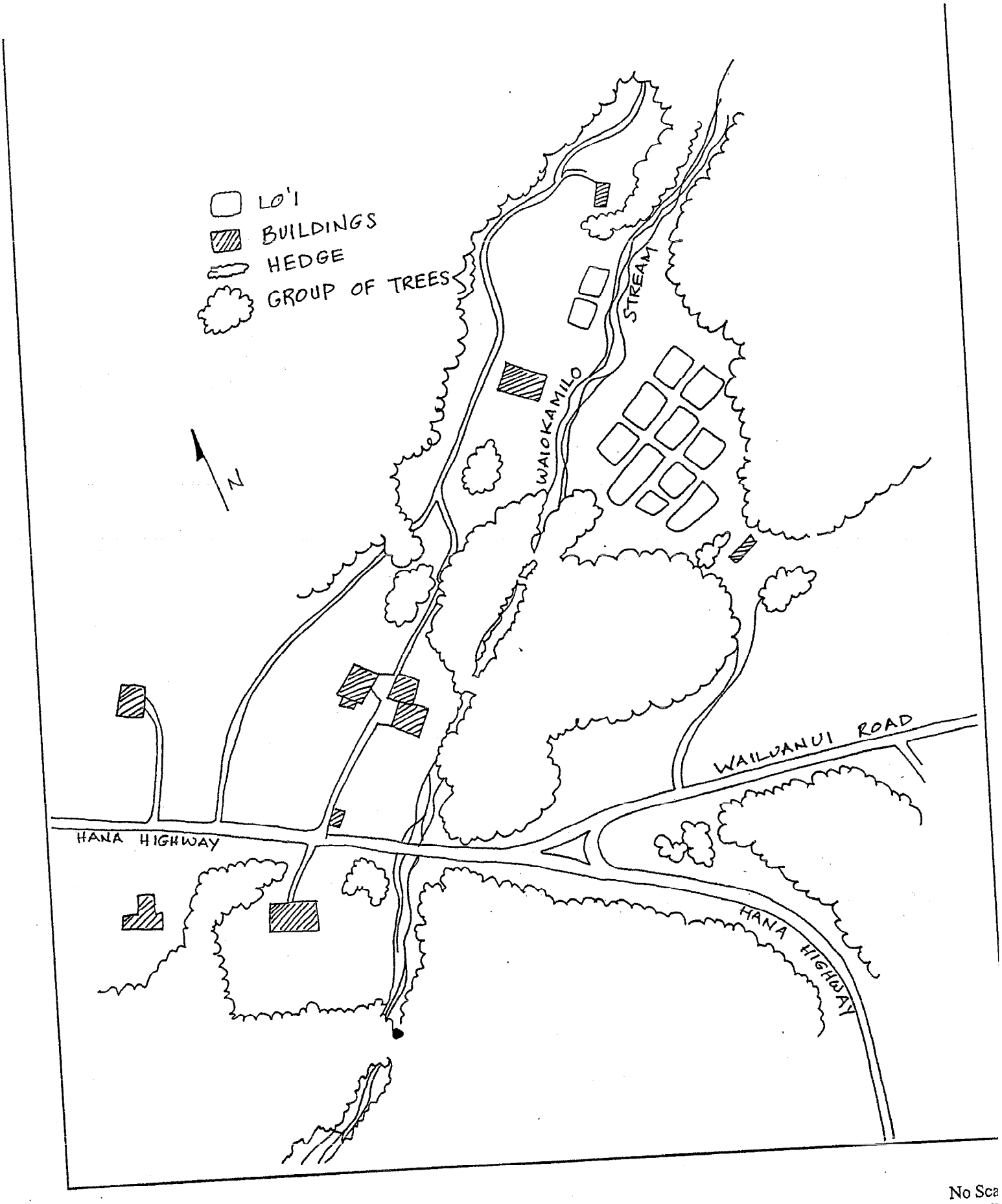
Lakini Lo'i Complex (State site 50-50-07-3936)



and Wailuanui September 23, 1950 (Bishop Museum)

IAE - WAILUANUI CULTURAL LANDSCAPE

Figure 23



No Sca

Figure

Waiokamilo Stream Complex

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE

The stream is diverted; a well constructed and preserved abandoned *'auwai* runs along the base of a ridge. This *'auwai* once provided water to a large irrigated complex which was abandoned in the 1950s according to the Kānoas' testimony. The terraces are still visible in the 1982 aerial photograph. The irrigated area is estimated to cover approximately 30 to 50 acres. Presently, the terraces are quickly returning to forest. However, cultivated *lo'i* are clearly visible on a 1950 aerial photograph (Figure 23). This system is spatially separated from the Wailuanui system but shares the same stream source. It appears from the aerial photograph and from the observation of the surviving terraces that the fields were fairly large and the terrace walls were 1 to 2 ft. in height. Although there were no claimed LCAs in this area, the extent of this system, particularly the *'auwai* network, would indicate its long-term use. Similar to the other system of Ke'anae—Wailuanui, it probably has pre-contact origins.

8. Formerly Cultivated Lands in the Valley of Nua'ailua

Nua'ailua, where taro lands were still under cultivation in the early 1940s, is the next major valley to the west of Ke'anae. According to Mr. Isaac Kānoa Jr., Nua'ailua constitutes the western boundary of the Ke'anae-Wailuanui cultural area. Those farming the taro patches in Nua'ailua in the early 20th century resided in Ke'anae; its use for taro growing was discontinued when the young men of Ke'anae went off to serve in World War II. Recently Mr. Kānoa has used certain lands in the lower section of the old taro patches to grow the edible fern, while the shoreline in Nua'ailua valley is still used by fisherman. A sign at a trailhead on the *mauka* side of the Hāna Highway acknowledges that the upper region of the valley is also still used for collecting *lā'ī*, or the leaves of the ti plant (*Cordyline terminalis*).

The taro patches in Nua'ailua, which extend from a few hundred meters *mauka* of Hāna Highway and below the highway to near the inland edge of the boulder beach, have the appearance of considerable antiquity. The system of terraces was likely constructed long before the arrival of western civilization, by and for the local populace and probably includes some residential sites though none were identified in this reconnaissance.

The terraces below the highway are formed by long cross-slope walls roughly paralleling the stream; two levels were counted on the east bank. These north-south oriented terraces are then divided by short walls between and perpendicular to the long cross-slope walls, creating a rectangular pattern that steps down, from patch to patch toward the sea. Wild taro was observed in some patches. The patches appear to have been watered by patch-to-patch flow as no distinct *'auwai* was found; irrigation water was obtained from a tributary to the main stream near the east side of the road bridge. Some of the taro terraces are now buried beneath a new beach access road created by the dumping, in the valley, of fill derived from road repair work on the Hāna Highway.

Terraces above the highway on the east bank are small discontinuous wall sections, crudely constructed around medium-sized boulders on a small flood plain. These terraces are prone to severe flooding and may have been used for plantings other than taro. The west bank of the river is a talus slope with a cliff fifteen feet or higher cut by the river. This bank was free of sites in the areas inspected, except at an area just *mauka* of Hāna Highway where the *mauka*-most thirty feet of a three-foot high wall juts out from beneath a dense growth of *hau* (*Hibiscus tiliaceous*). The nature of the site was not determined. The far reaches of Nua'ailua stream were not investigated due to the possibility of flash flooding.

9. Other Formerly Cultivated Lands

According to informants, taro was cultivated in *'ili* or gulches and valleys along streams both *mauka* and *makai* of the Hāna Highway throughout the Ko'olau region. Some of the areas mentioned were: Pi'ina'au, above the arboretum; Awiowio; Pohole; Pāhoa; and Waipi'o. These patches were probably taken out of active production due to declining population and to consolidation of residences and taro patches into the Wailuanui area during the land awards of the late 1800's .

B. Other Vegetation (Figure 24)

1. Ornamentals

The Ke'anae-Wailuanui landscape has a garden-like quality, with both natural and cultivated ornamentals blending into taro *lo'i* and other cultivated fields. Because there are few fences the scenery has an open, uninterrupted character. The scale of cultivation is small and field sizes and distances from residences are generally short. Additionally, certain plants are found repeatedly in many yards and along roadsides. These plants include: many varieties of ti (*Cordyline terminalis*), various kinds of croton (*Codiaeum variegatum*), plumeria (*Plumeria acuminata* sp.), gingers (*Zingiber* sp.), heliconia, and various ferns, especially hapuu (*Cibotium menziesii* and *chamissoi*). The use of red ti as an ornamental is especially noticeable since this plant is used profusely throughout the region. It almost serves as a signature ornamental for the community.

In addition to the above plants, several tall fruit-bearing trees and palms are found repeatedly in residential areas. These are coconut palms (*Cocos nucifera*), mango (*Mangifera indica*), avocado (*Persea americana*) and various types of citrus, including tangerines and oranges.

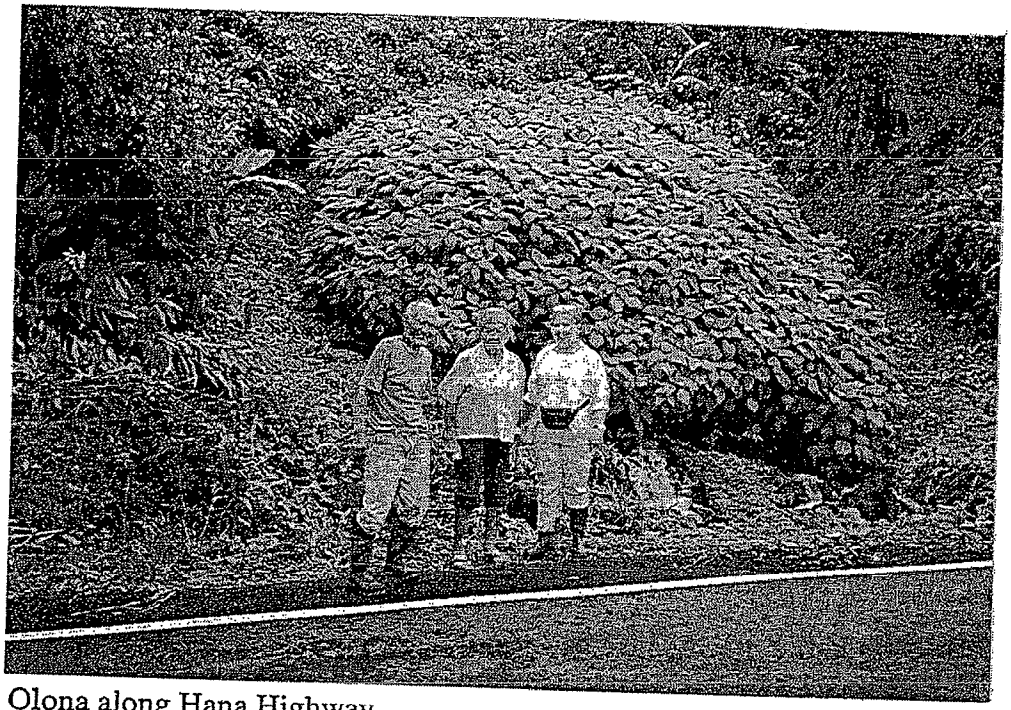
It should be noted that plants used ornamentally frequently possess other traditional and current uses in Polynesian and Asian cultures. For example, the hala tree (*Pandanus* sp.) was used for basket weaving, cordage and medicine. Also, fruit-bearing trees and bushes as well as edible and medicinal herbs are often intermixed with more strictly ornamental plants. Banana varieties (*Musa* sp.), guava (*Psidium guajava, cattleianum*), and *noni* (*Morinda citrifolia*) are commonly found in gardens and along *lo'i kalo*, functioning as ornamental windbreaks or boundary markers. Other frequently used landscape plants are: Manila palm *(Veitchia merrillii)*, African tulip *(Spathodea campanulata)*, gardenia or kiele *(Gardenia Jasminoides)*.

2. Endemic or Indigenous Plants

The Ke'anae Wailuanui landscape has been subject to human intervention for centuries. Therefore, no significant stands of endangered endemic or indigenous plant colonies were identified. However, stands of *olonā* and *'ie'ie* growing in treetops, both indigenous plants of Hawai'i, can still be seen along the roadside from Wailuanui to Nāhiku.

3. Forest

Since the Ke'anae-Wailuanui area is isolated, with a small population, the cultivated landscape is relatively small and much of the region is covered with forests. The forest effectively represents the edge of human control of the landscape, the boundary between forest and field changing with the size of the population. In general, there seems to be a long-term decline in the area of cultivation over the last 100 years or more with the forest regaining much of the formerly cultivated lands.



Olona along Hana Highway

Home with ornamentals

The Ke'anae-Wailuanui landscape has been extensively modified by man. At the time of Western contact, the lower regions had already been stripped of the native wet rainforest cover of *'Ōhia lehua* (*Metrosideros collina*), *Kopiko* (*Psychotria* spp.) and *Hame* (*Antidesma platyphyllum*). Much of the lowlands below 1,000 feet were cultivated or covered with Polynesian introductions such as *Hau* (*Hibiscus tileaceaus*) and *Kukui* (*Aleurites moluccana*). Much of the land was also in grassland. Mr. James Hueu recalls that the ridges between Ke'anae and Haiku were a mix of shrubs and grassland before the Civilian Conservation Corps (CCC) planted the area during the 1930s. Oral tradition indicates dry land cultivation and grazing in upper Ke'anae Valley (Figure 25).

The current forest cover is predominantly introduced species. On the Haiku side of the region, the most common trees are various species of Eucalyptus, Formosan koa and paperbark (*Melaleuca leucadendra*) that were planted by the CCC. Above Ke'anae peninsula, *Hau*, Christmasberry (*Schinus terebinthifolius*) *Kukui* and Guava (*Psidium guajava*) predominate. Moving towards Nāhiku the Para rubber trees (*Hevea brasiliensis*) planted around 1905 become noticeable. The predominant mix is still the CCC-introduced species such as Eucalyptus and paperbark.

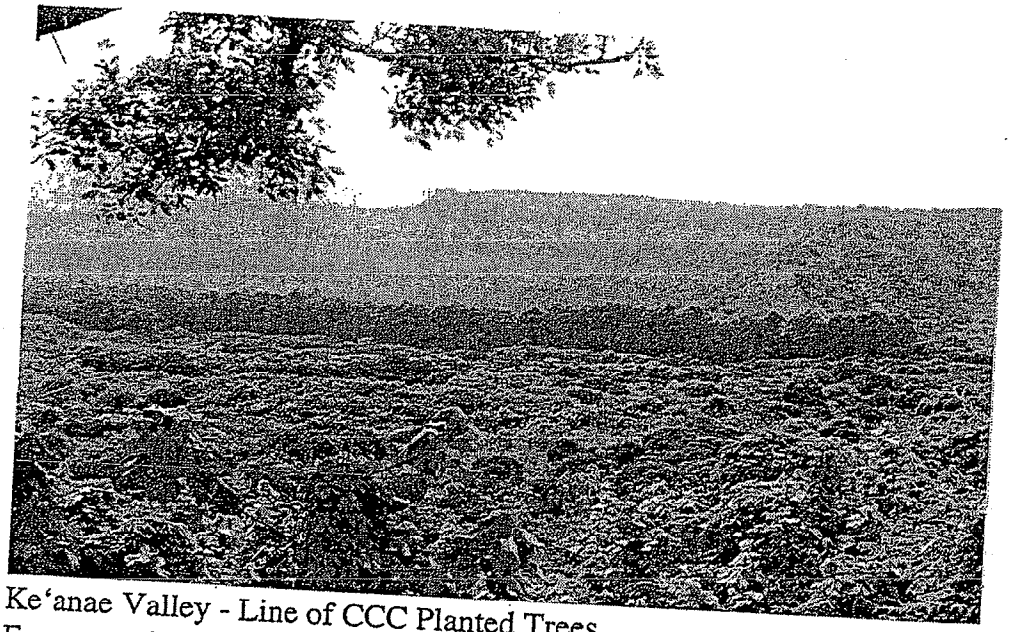
Kukui nut *(Aleurites moluccana)*, breadfruit *(Artocarpus communis)*, coconut, and hala are noticeable in forested areas, even well above the Hāna Highway and outside of areas presently settled or frequented by residents. These trees may mark formerly settled areas or circulation routes in abandoned areas now overgrown with forest.

C. Circulation Networks

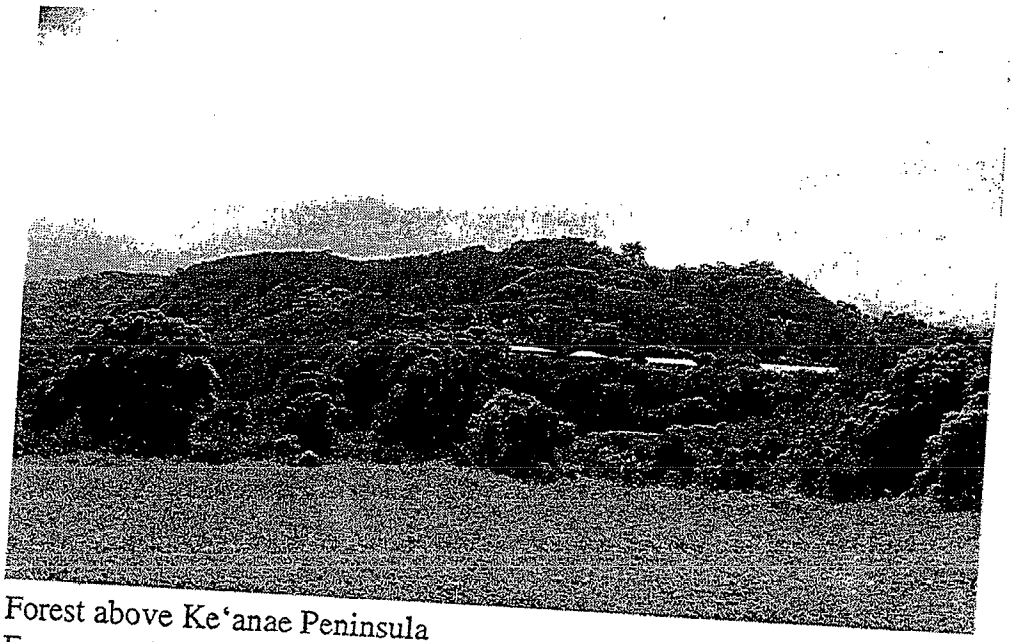
Circulation networks are generally dominated by major roadways for automobile traffic. This is certainly true for the Ke'anae-Wailuanui region. However, in a cultural landscape it is important to look at circulation patterns in light of the available technology and infrastructure over time. In an isolated place such as Ke'anae it is also important to evaluate historic methods of transport and movement in comparison to the current conditions. Before the Hāna highway was completed, the Pi'ilani trail the ditch trail and canoe were the main modes of transportation to and from Ke'anae. Canoe was the fastest way to get to Nahiku. To go to Hāna or Kailua, the ditch trail was faster than the old Pi'ilani trail. A trail along Kualani ridge, paralleling the current highway, was the route from Wailuanui to the ditch trail. Another trail down from the ditch trail to Ke'anae came out through the arboretum area.

The Hāna Highway (State Highway 360) is clearly the most important roadway in the region, providing a relatively convenient access to the more urban areas westward to Kahului and eastward to Hāna, the main settlement community in East Maui. This roadway right of way varies along its length but it is generally a two-lane roadway between 25 to 35 feet wide. Bridges along its route are generally narrow (about 20 feet) with occasional one-lane crossings. Before the highway was completed in 1926 the journey to the Ke'anae-Wailuanui region was accomplished over wagon roads or horse trails. An alternative means of travel was by steamer with a landing at Ke'anae when ocean conditions allowed. A report by the Hawaii Heritage Center notes:

> As early as 1900 the Maui News editorialized in favor of a good wagon road connecting Hāna and Central Maui. Five years later a rudimentary road in the Nahiku and Ke'anae areas was completed. Because of the extreme difficulty of the terrain, however, its cost was prohibitive and the roads were inadequate for



Ke'anae Valley - Line of CCC Planted Trees
Foreground - Introduced forest cover



Forest above Ke'anae Peninsula
Foreground - Abandoned loi kalo

frequent automobile traffic, The 1905 SPW report stated that "very rough country is encountered in these districts. On account of the great expense of road construction, the road has been made as narrow as possible in order to construct, with the money available, the maximum length of road."

East Maui's tourism potential was recognized as early as the turn of the century and was one of the incentives for the construction of a belt highway to Hāna. Development of the highway was accomplished in segments; construction proceeded at different times in different places depending on funding. As early as 1905 and 1908, concrete bridges were built near Nāhiku to support a proposed 60-mile long, paved road between Hāna and Kailua. A narrow road and bridges were constructed from Kailua to Nua'ailua by 1912. On the opposite side a road from Hāna to Nāhiku-Ke'anae was built by 1915. However, this road dead-ended in the Ko'olau Forest Reserve.

In 1914 Territorial Governor Lucius Pinkham disapproved further funding for the belt road. Construction recommenced during the 1920s when new bonds were floated to finance the road's completion. A.P. Low, County Engineer from 1916 to 1928 appears to have played an important role in the construction of the final Ko'olau segments of the Hāna Highway through the Ke'anae area. Once completed, the road became the primary means of access between Ke'anae and the rest of Maui. The completion of the road caused the decline and demise of the ferry service to Ke'anae.

There are two other important paved roads that play a significant role in area circulation: Ke'anae Homestead Road and Wailua Homestead Road. Ninety percent of all residences and public buildings in the region are located along these roadways and a short branch road off of Wailua Homestead Road.

Most of the other roads in the area are unpaved dirt roads better accessed by the four-wheel drive vehicles which are owned by many residents. These unpaved dirt roads are important to the local residents. Many serve to link residences and fields to the main roads. Other link hunting, gathering, fishing and other traditional practices areas to the main roads and make these areas readily accessible to the residents. This is especially true of roads that lead to the ocean along valley bottoms and roads such as Pi'ina'au Road and the various ditch service roads which provide access to *mauka* regions in upper Ke'anae Valley and other *mauka* areas.

A noticeable circulation pattern associated with the roads is the access to the taro. In both Ke'anae and Wailuanui the roads are generally located along the perimeter of the cultivated *lo'i*. While no historical records were found to explain the reason for this pattern it seems reasonable to speculate that this pattern reflects the fact that the *lo'i* were there before the vehicular roads. The *lo'i* are cultivated in small patches with multiple ownership. The water is shared through a single integrated network traveling from one *lo'i* to the next. Roadways built into this system would have altered the flow of water and taken up valuable lowlands that could be used for cultivation.

Circulation networks also involve walking paths. In contrast to the roadways, the walkway systems are integrated through the *lo'i*. In an area such as Ke'anae where fences are scarce and nearly everyone knows their neighbors, people walk through each others' lands and fields and the pedestrian circulation patterns extend beyond the paved roadways to footpaths along streams and through fields and vacant lands. The pedestrian system

probably developed in association with the indigenous taro culture, long predating the vehicular network. It reflects the community land management system of the native Hawaiian culture.

An additional circulation network component is the Ke'anae Landing (Figure 26) which constituted the area's link to sea-borne commercial transportation until the 1920s. Remnants of the landing are clearly evident along the road accessing the peninsula. Concrete stair remnants connect the flat area above the high-water mark and extend to mean sea level. Concrete footings with rusted metal anchors are still in place. These footings and anchors held the boom equipment used to load and unload goods onto the ferries, which, because of rough shoreline conditions, anchored offshore. A small boat would convey a rope and pulley system from the ferry to the landing where it could be connected to the boom. Goods were transferred back and forth with this system which was maneuvered to adjust for wave conditions. *Kupuna* James Hueu remembers watching these activities and helping in the operations. Some rusted chains and mechanical fragments from this system are still located at the landing. Anchors and footings similar to the Ke'anae Landing remnants are also found at Nāhiku Landing on the edge of the traditional practices area. Ke'anae Landing was placed on the State Inventory of Historic Places in 1992, designated site 50-50-07-2957.

Circulation networks support the pattern of land use. Historic maps show previous roadway and pedestrian path alignments that reflected earlier patterns. The 1903 Ke'anae map (see Figure 8) suggests the importance of the Ke'anae Landing during a time when the ferry was a major mode of transportation. The old King's Highway, the Pi'ilani Highway, follows alignments that reflect the influence of geography and the pattern of settlements at the time; coming to the shore at Wailuanui Bay and rising above the ridge before the approach to Nua'ailua Valley.

D. Buildings, Structures, Non-Structural Facilities, and Objects

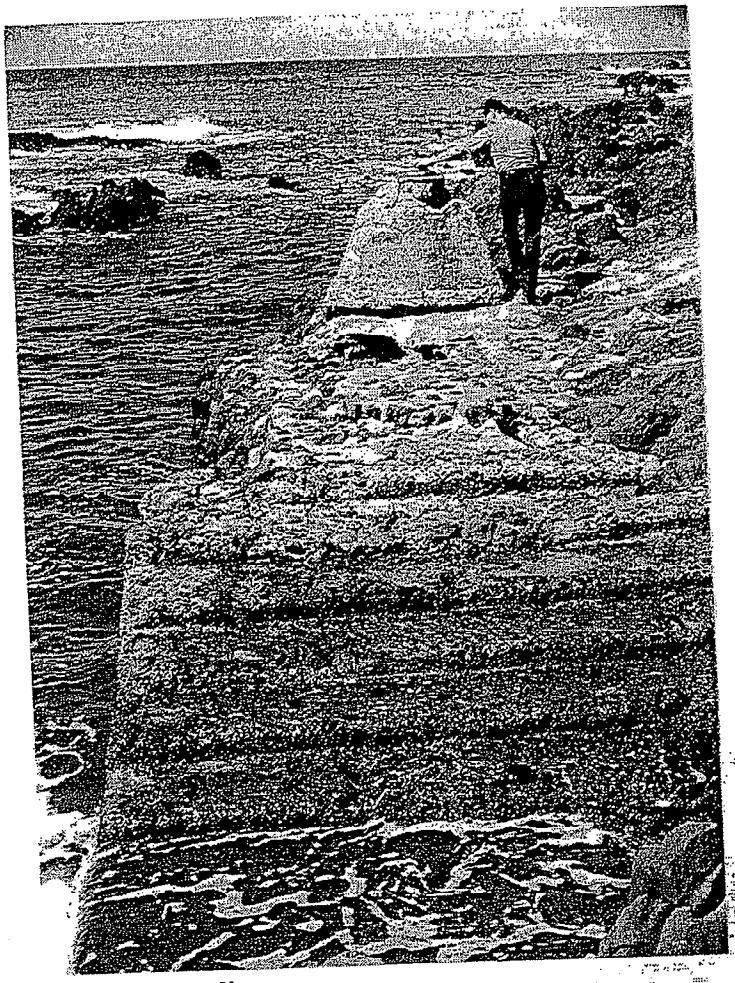
1. Residences (Figures 27-31)

Ke'anae-Wailuanui is sparsely settled. Many of the residential structures are over 50 years of age. Figures 27 & 28 show the area's buildings with structures over 50 years of age identified. The residences of significance are all built of wood and designed in the plantation era style of architecture. Typical features of this style include hip roofs made of corrugated metal, wide overhangs, double hung windows with wide trim, and porches and verandas. Screen windows and doors are typical. Houses are generally built on posts with crawl spaces below. Crawl spaces are generally partly screened with horizontal or vertical, wooden slat aprons. Walls and floors are usually constructed with board and batten. Colors tend to be earth tones with a contrasting or complementary trim. Most houses are modest in size ranging from around 500 to 1,000 square feet with older homes tending to be smaller.

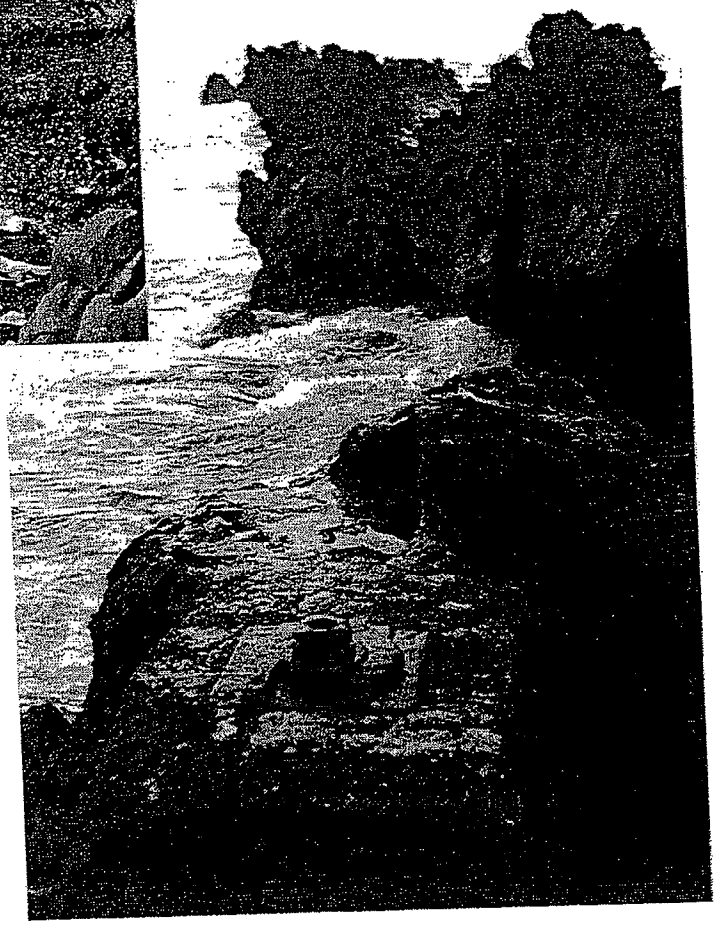
While newer homes in the area are generally compatible with the older homes in architectural style and scale, there are significant differences based on periods of construction. Older, traditional homes are those generally built before World War II.

a. Pre-1900

Historic photographs taken in the late 1800s and early twentieth century show traditional Hawaiian grass houses. An 1883 photo of Wailuanui show that most structures in this period were grass thatch houses with only a few wooden buildings (see Figure 6). It is likely that use of these grass houses began to decline around the turn of the century. Later



Ke'anae Landing

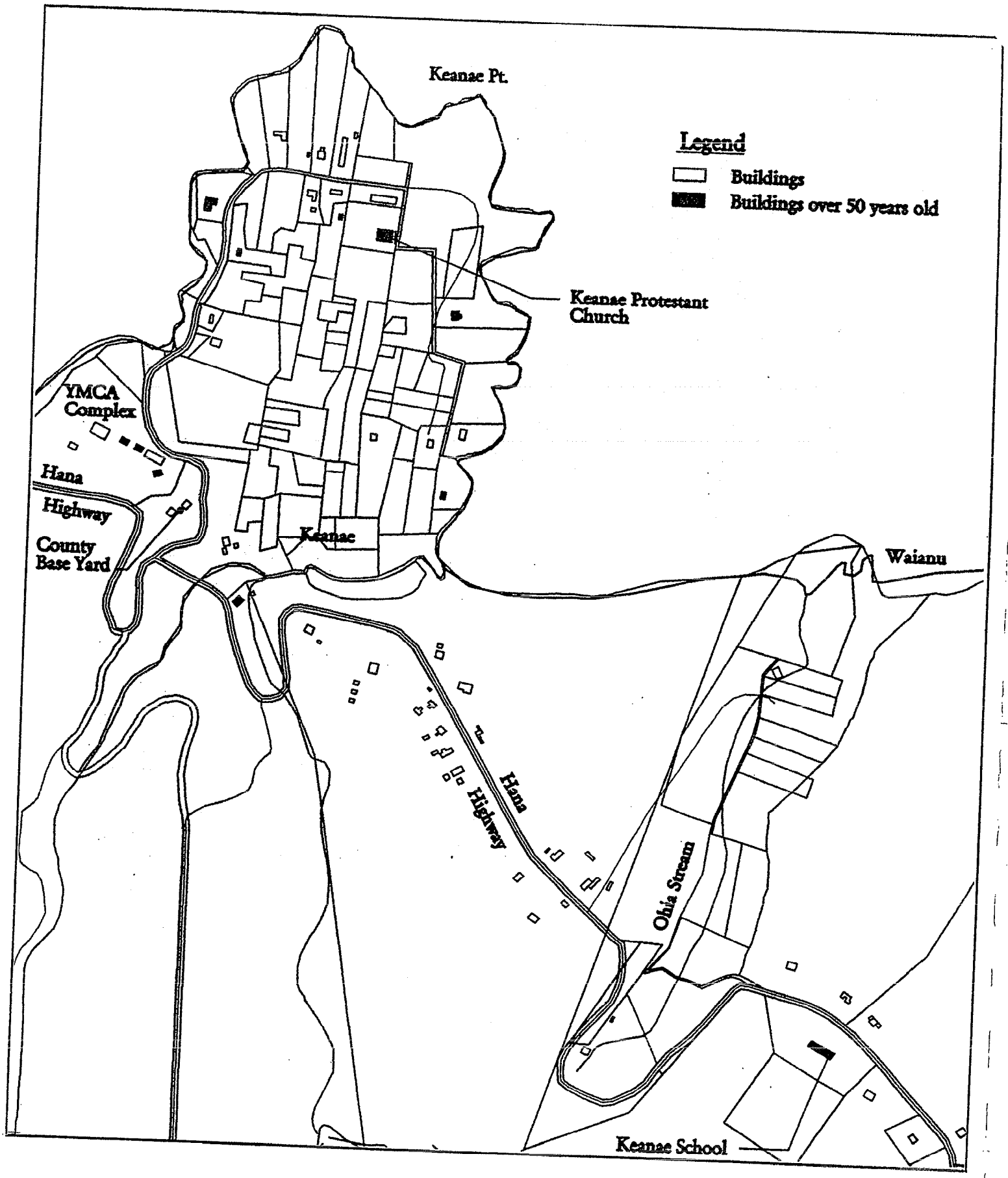


Nahiku Landing

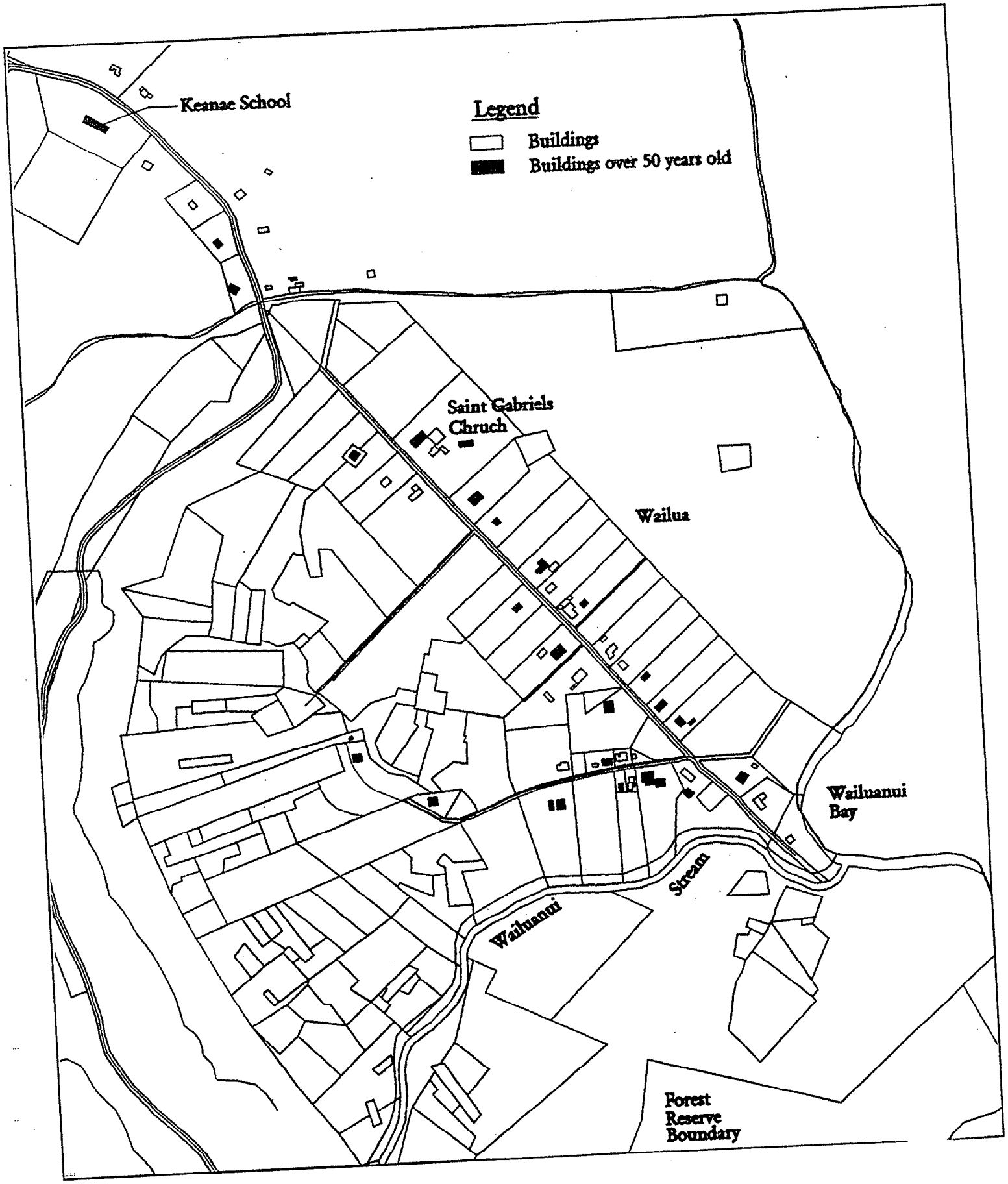
Ferry Landings

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE

Figure 26



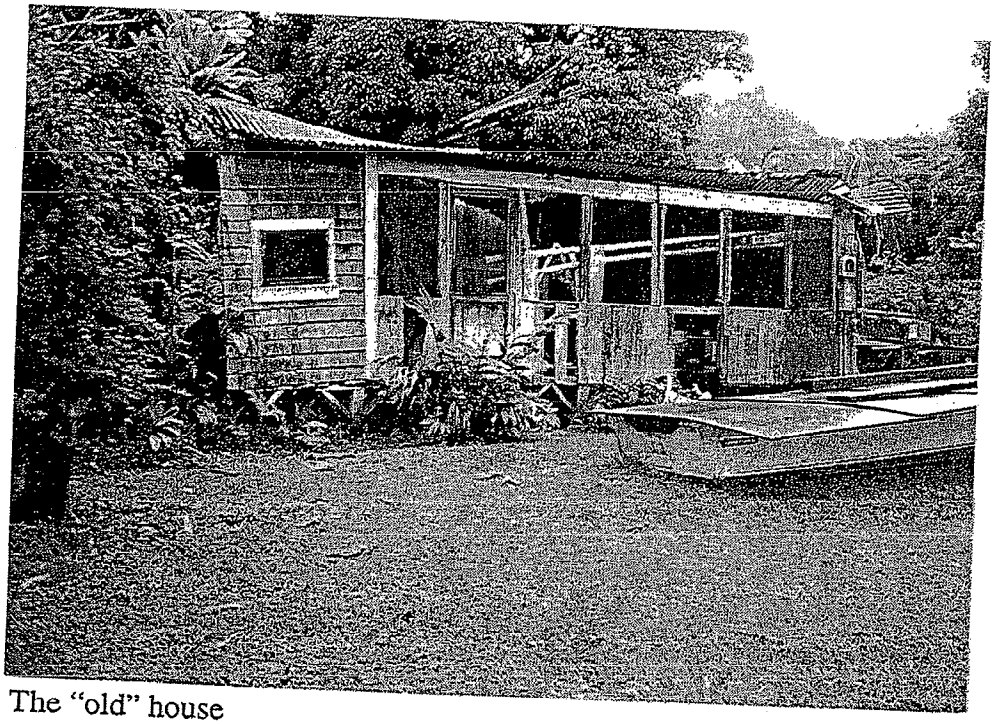
Existing Buildings (Ke'anae) With Structures Over 50 Years of Age



Existing Buildings (Wailuanui) With Structures Over 50 Years of Age

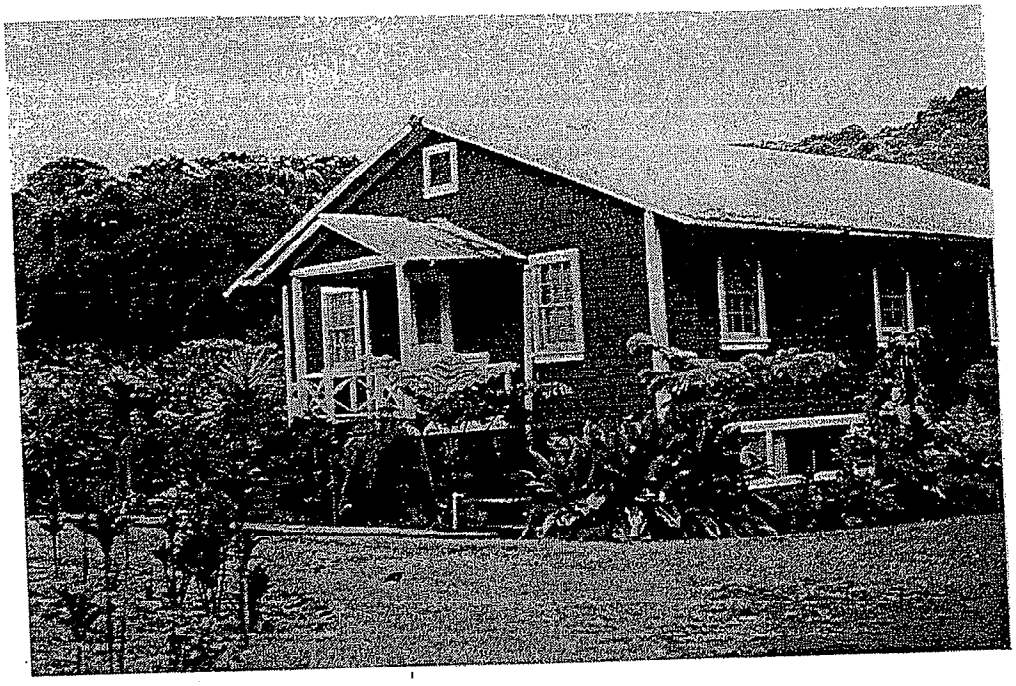
Figure 28

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE

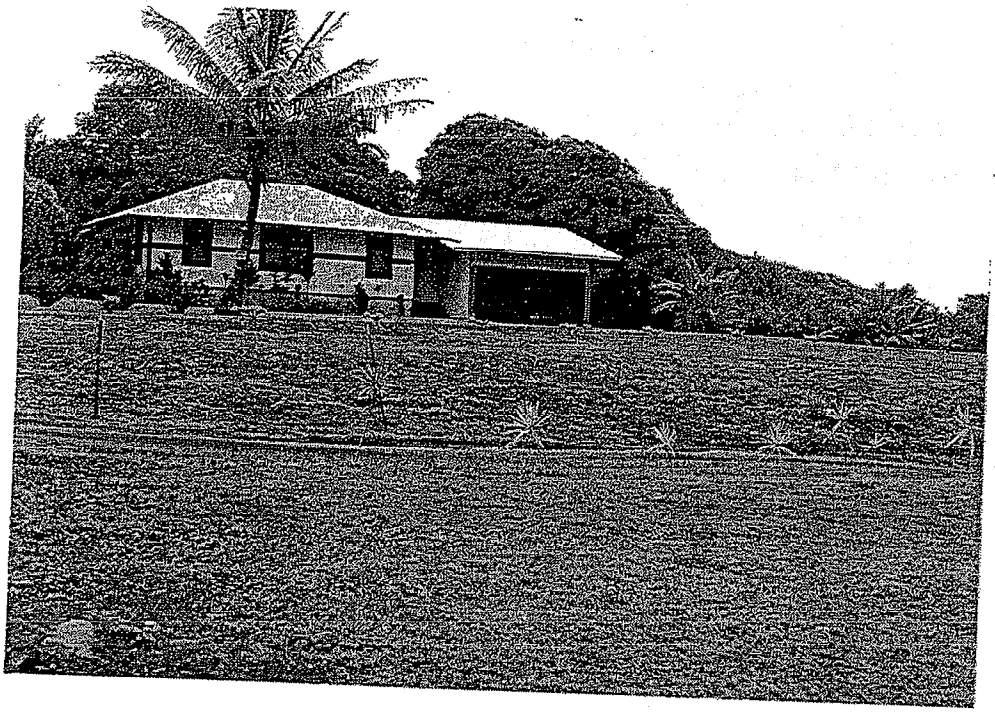


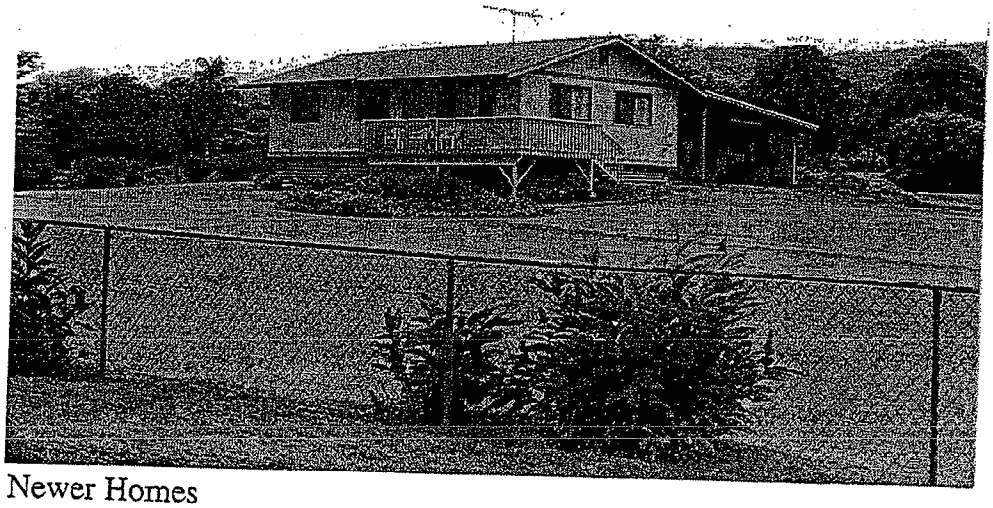
The "old" house

House on Rice Mill Site



Older Homes 1900-1946





Newer Homes

Residences

photographs and interviews indicate a settlement pattern into "regular" wooden homes in the early part of this century.

In Wailuanui, Enos Akina remembers growing up in "the old house" adjacent to the Apolonia Day residence before building his present house in the 1920s. Several of the older residents in their eighties and nineties speak of the same "old house" as the oldest in Wailuanui and the site from which many of them grew up and moved out into their own homes in the 1920s and 30s. The specific age of the old house is not known with certainty, but one account places its age at 134 years (Apolonia Day interview). Given other sources, this seems possible. The roof of this house has fallen in, but its character is still discernible in photographs and from remains (see Figure 29).

b. 1900-1946

All of the old houses still standing and occupied appear to date from this period. The Florentine Ramos house, dating from 1907, seems to be the oldest of these. A survey of Maui County building records indicated a preliminary count of 36 structures dated 1946 and earlier. This is surely an underaccounting as many structures have no construction date assigned to them. All of the residential structures in this period are of wood construction.

These older residences have metal hip roofs with occasional gable ends. They have vertical siding and are built on posts. Some of the vertical siding extends to the ground. Most have horizontal slats (1" x 3") across the crawl space below. An atypical feature of these older homes is the use of asphalt shingles on all or most of the walls of the buildings. This is not a common feature in Hawai'i residences and may reflect the need for additional protection against the rain in this wet Koolau district. The use of sheet metal siding on some other structures from this period seems consistent with this theory. These homes also have wider window trims (3" or wider) bordering the common double hung glass windows. These windows also tend to be smaller than those in newer homes. The living rooms of these older homes tend to be smaller and darker while porches are generally more substantial and are often partly enclosed. This seems to reflect an earlier lifestyle where activities often focused outdoors and the large porch served as both an indoor and outdoor space. Many of the older residences have a more complex shape and floor pattern than the newer homes. Shapes range from the simple rectangle to multiple polygons. This is probably reflective of changes and later additions as families grew and shrank. A final note of importance is the relationship of the house to the garage. The relationship of the older homes to the carport or garage is irregular. In many cases, there are no adjacent carports. In other cases there are free-standing carports nearby. In a few cases the carport is immediately adjacent. These differences are probably reflective of car ownership and use patterns of the residents and reflect a time when auto ownership was not such a universal phenomenon.

c. Newer Residences (Post WW II) (see Figure 31)

Most of the newer homes are compatible with or complementary to the older houses. However, there are significant differences. Roof designs tend more toward single pitches with gable ends. Roof materials have expanded to include wooden shingles, asphalt and tile along with traditional metal sheets. House construction material has begun to include masonry in some or all of the structure. Window trim has become narrower and less significant. Window styles have changed to jalousies and picture windows rather than the old sliding or double hung sashes. In most cases porch spaces have shrunk and function for access and circulation rather than as a living spaces. Living rooms have become larger, probably reflecting a more indoor lifestyle. Carports are either built into the house or immediately

adjacent. The influence of car ownership and television - which have affected employment and lifestyle patterns - is visible in the evolution of residential architecture. Newer homes are also more likely to have fences around them.

2. Public Buildings and Facilities

Public buildings and facilities are sites in and around which community activities are conducted, or which are focuses of community traditions. While none plays a central role in the Ke'anae-Wailuanui community, most have long histories as traditional meeting places for the citizenry. These buildings and facilities include: two churches, the Ke'anae School, the YMCA camp complex, and the Ke'anae Arboretum.

a. Churches

The two active churches in the study area - Ke'anae Congregational Church on Ke'anae peninsula and Saint Gabriel's Church in Wailuanui - were built around 1860 as part of the early missionary expansion on Maui. With their steeples, the church buildings are the tallest buildings in the landscape.

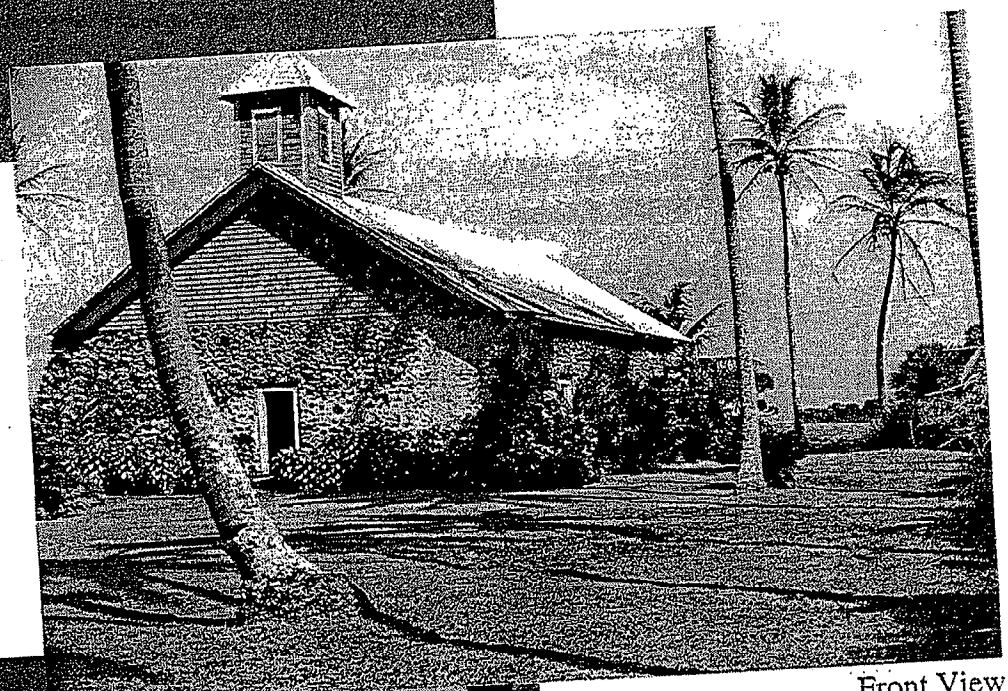
The Ke'anae Congregational Church is a good example of an early stone missionary church constructed with indigenous material (Figure 32). The church was constructed in 1860 but final improvements were not completed until 1863. It has smaller windows than Saint Gabriel's and short clipped eaves, influences from the New England missionary architecture. The rock walls are unpainted and frame rectangular double hung windows. Buttresses have been added to the walls to stabilize them. The corrugated metal roof is framed with wooden members. A small rectangular steeple projects above the entrance of the church.

The church was renovated in the 1960s and asphalt tile shingles cover the wall below the gable roof above the stone wall. An inscription - "Lanakila Ihiihi O Iehova Ona Kaua" - was uncovered during the renovation. Translated, it means "Sacredness, Success of Jehova, the Son of God". Previously there was a society hall in this complex but it was destroyed in the 1946 *tsunami*. Presently, there is a newer structure that serves as a storage/meeting facility between the road and the historic church.

Saint Gabriel's Church (Figure 33) - located along Wailuanui Road near the entrance to Wailuanui from the Hāna Highway - is comprised of two sanctuary structures. Both are historic. The smaller structure, the white stuccoed church next to the cemetery, was built in 1860 and has been called the "miracle church" because of an incident at the time of its construction. A tradition recounts that a Protestant church was being built with coral rocks washed on to the shore during a series of unusual storms. But after the builders of this church selfishly kept all the rocks, claiming that it was on their side of the land, another storm washed all the rocks back into the ocean. Subsequently, rocks for the "miracle church" were washed back on to the Catholic side of the land and while none returned to the Protestant side.

The "miracle church" was the original sanctuary for Saint Gabriel's Church. It is associated with other early Catholic churches in the East Maui region: Saint Joseph's at

Back View



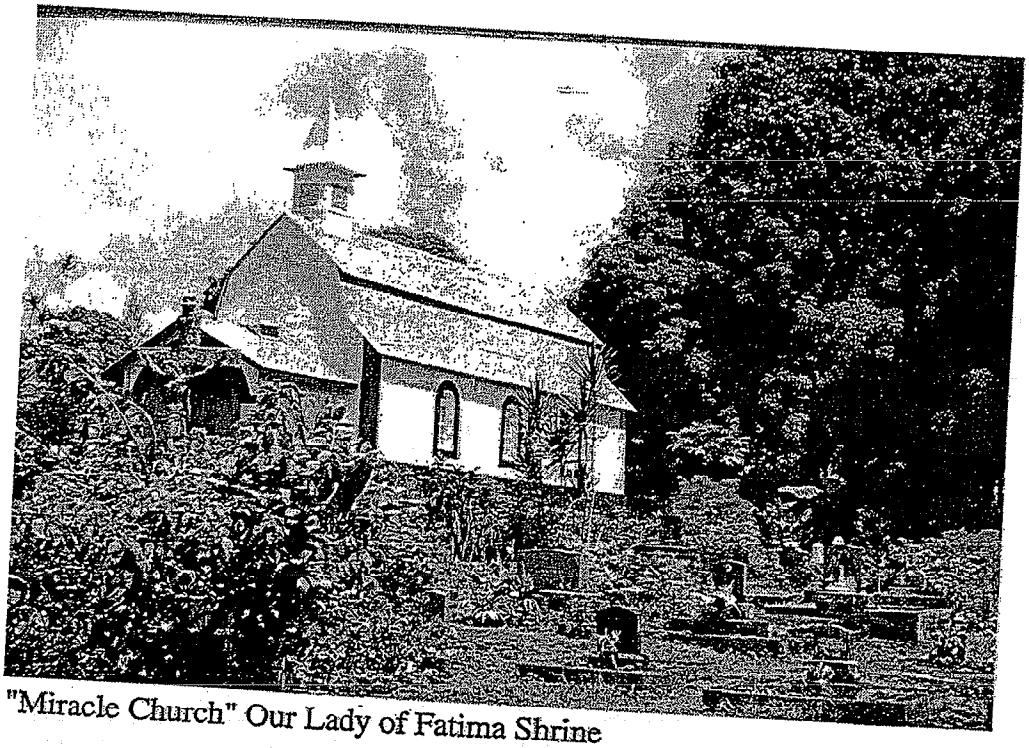
Front View

Interior of Sanctuary

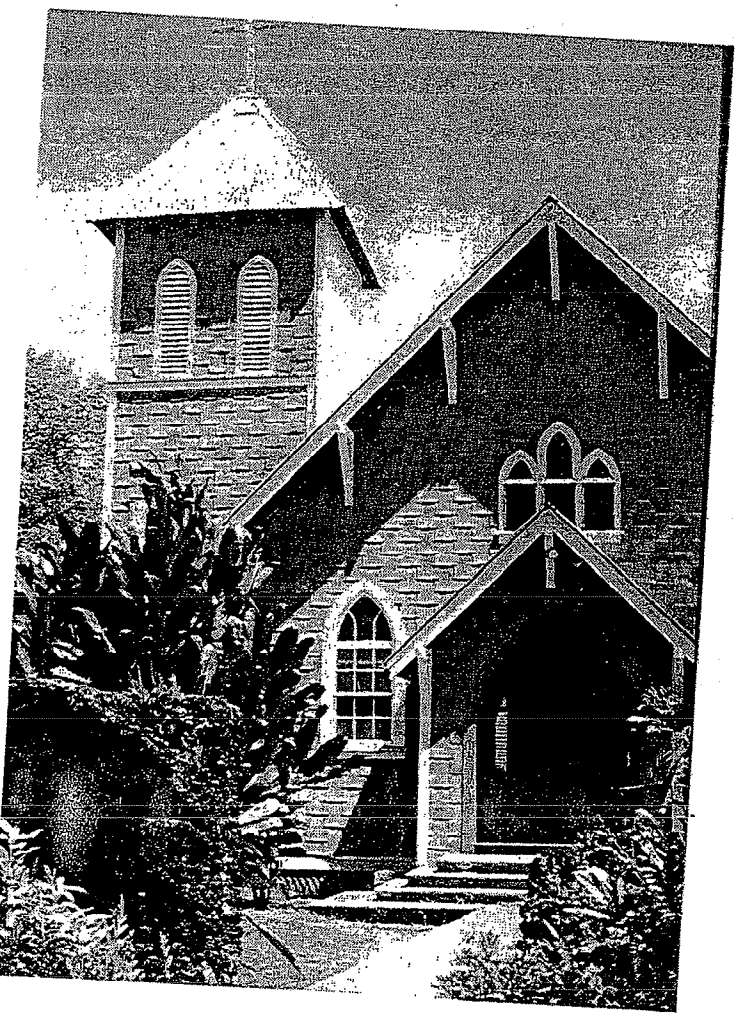
Ke'anae Congregational Church

Figure 3

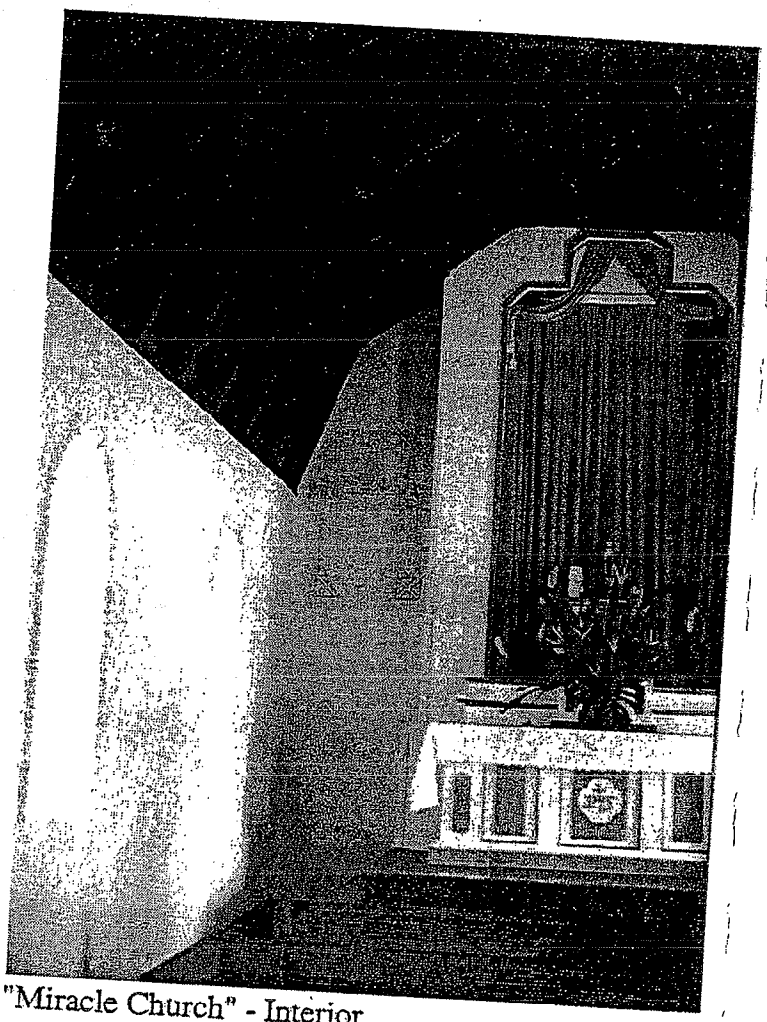
KE'ANAE - WAILUANUI CULTURAL LANDSCAPE



"Miracle Church" Our Lady of Fatima Shrine



Saint Gabriel's Church, Wailuanui



"Miracle Church" - Interior

Kaupō and Saint Peter's at Pu'uiki, just outside of Hāna. In 1937, the second and larger church building was constructed. In 1950, the original church was rededicated as the Shrine to Our Lady of Fatima.

Saint Gabriel's Church is constructed of materials similar to those used for Ke'anae Congregational Church but its architecture is different. It is one of the few stone churches in Hawai'i with a gambrel roof. The gambrel roof has raised speculation that the architect is the same Catholic priest, name unknown, who designed the only other church of this period with a gambrel roof: the Saint Joseph's at Kaupō. It is possible this represents the Belgian or French influence of the Catholic Church whose best known representative in Hawai'i is Father Damien.

The white stucco walls of coral limestone are reminiscent of Mediterranean architecture but the steep pitched roof shows a New England or Northern European influence. Some have said the design is Portuguese but its construction predates the arrival of Portuguese to Hawai'i. The blue stenciling on the interior walls is also a unique feature of this building. The first mass was held at Saint Gabriel's on Christmas day 1860. This church has just been renovated and is in excellent condition.

That Saint Gabriel's is Catholic and Ke'anae Church is Protestant may have been based on historic circumstances. To this day the residents of Wailuanui are predominantly Catholic and the residents of Ke'anae tend to be Protestant. The previously detailed episode regarding the 19th century march of Catholic converts through East Maui (see Cultural and Historic Context section above) may explain this religious separation, as several of these converts, according to some present-day Wailua residents, later settled in Wailuanui and built Saint Gabriel's Church.

Other churches were also founded within Ke'anae and Wailuanui but have not lasted (Figure 34). The oldest is the previously mentioned Protestant Stone Church ruins in Wailuanui. Today the stone walls still stand with doorways and window openings. The structure has no roof but, in proportions, fits into the classic church forms of the period. The ruins are hidden by a thicket of *hau*.

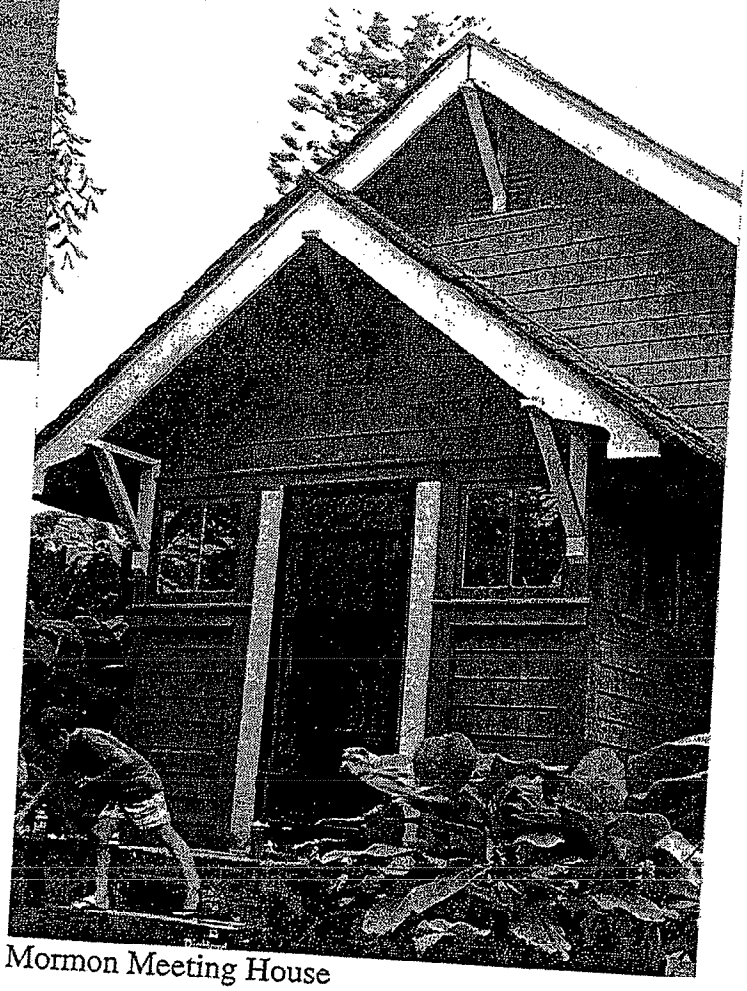
The Lin Hing Society building at Ke'anae has been referred to as "The Buddhist Temple" by many of the residents. While not exclusively religious, it supported some of the cultural and religious traditions of the Chinese residents of area. This structure was a two-story, wooden building and is largely destroyed, buried under roadwork fill.

The last historic period religious building was the Mormon Church meeting house which was a converted residence. Constructed in 1934, the facility is no longer active as a church. As recently as 1974 there were five church members. The former church building is a green and white wooden structure with wall shingles, located *mauka* of the Hāna Highway just west of Waiakamilo Stream. The building is currently used as a residence (Figure 34).

b. Ke'anae School (Figure 35)

Ke'anae School was originally located on the peninsula next to the Ke'anae Congregational Church. The present school site resulted from a land exchange in 1909 between the Territory of Hawai'i, Ben Laka Peniamana and Kamalawalu Wilkins and was built in 1912 by contractor Hugh Howell.

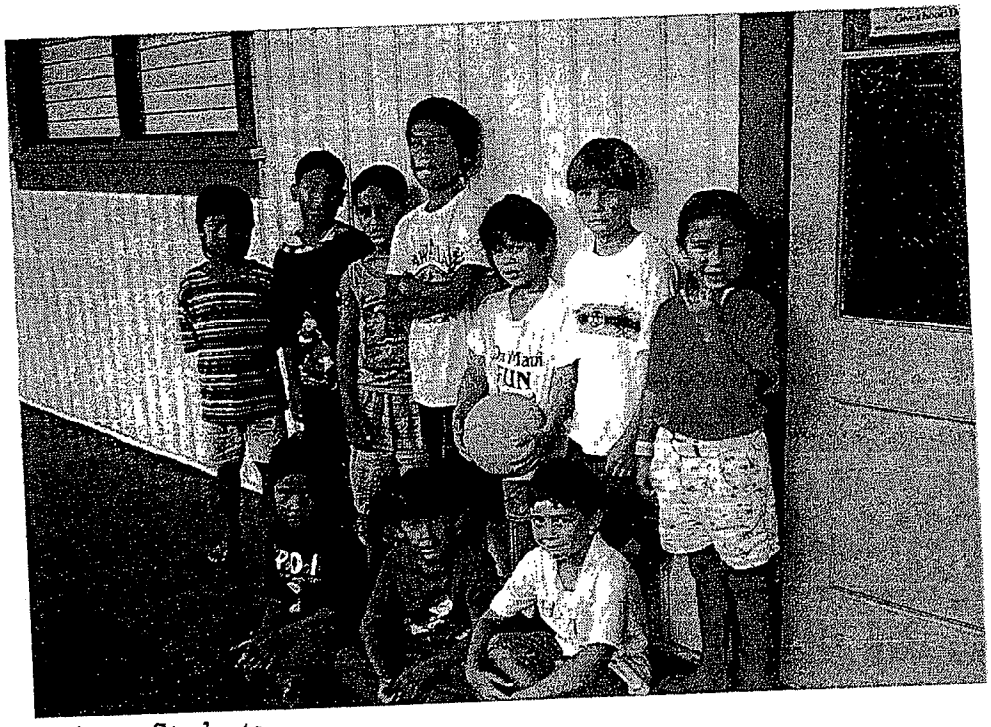
Protestant Stone Church Ruins-
Hau thicket



Mormon Meeting House

Religious Structures

Ke'anae School



Ke'anae Students

Ke'anae School is a long, elevated single story wooden structure with corrugated metal roofs. The main portion was constructed during the plantation era and its architecture reflects this period. The front facade is defined by a long lanai under the corrugated roof which connects rooms along the length of the building which open out onto the lanai. The gable roofs have vents on the ends. Walls are board and batten. The building colors are green and white, typical of plantation style architecture.

The school is a rare example of a surviving plantation style rural school built with simple wood construction. In the 1920s Maui County adopted a policy of building schools with masonry construction. As a result of this policy, most historic schools in Maui are of masonry construction. Ke'anae School was added to the Hawai'i Register of Historic Places in 1992.

From its earliest days the school served a widely scattered community and housed many grade levels. Many students lived with relatives nearby to avoid travelling over great distances by difficult trails. Students traveled from as far away as Wahinepe'e, at the 10- and 11-mile markers on the present Hāna Highway. The student population has changed with the population in the region. A 1907 Maui News article reported that Ke'anae School had 63 students. Presently, there are less than a dozen students from kindergarten through grade three. The older students travel daily to Hāna School to finish their education.

Ke'anae School is the smallest public school in the State of Hawai'i and there has been pressure to close it (see Cultural and Historic Context section above).

c. Ke'anae YMCA Camp Complex (Figure 36)

The YMCA camp complex began as a prison base camp for laborers building the Hāna Highway around the turn of the century. In 1934 the site was converted to a base camp for the Civilian Conservation Corps (CCC). Eventually, the YMCA received the lease in 1949. A portion of the site is retained for use as a base yard by the Maui County Public Works Department.

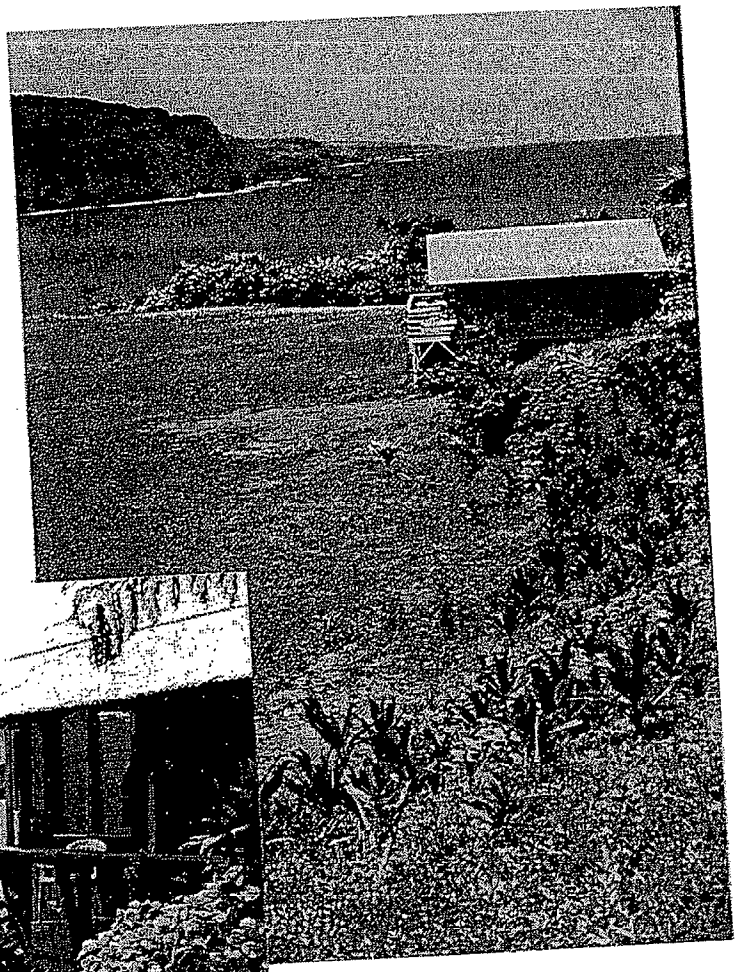
The YMCA complex is a group of wooden buildings constructed in the plantation style. The oldest remaining structure in the complex is the manager's residence which was built in 1934. Two other buildings are of comparable age, built in 1935 and 1939, and are used as offices and meeting/activity rooms for the YMCA. The newest building on the site was constructed in 1981. The largest building on the site is the gymnasium, which was re roofed and extensively repaired in 1994.

Despite the range of assigned dates of construction (from 1934 to 1981) the architectural styles are remarkably compatible. Mr. James Hueu recalls that the older structures were constructed between 1925 and 1928. These older structures have some railing and hurricane window details that are slightly different but, overall, the complex retains architectural integrity. All roofs are of corrugated metal and all structures are post on pier with hip and gable roofs. The color scheme is also consistent with this style of architecture.

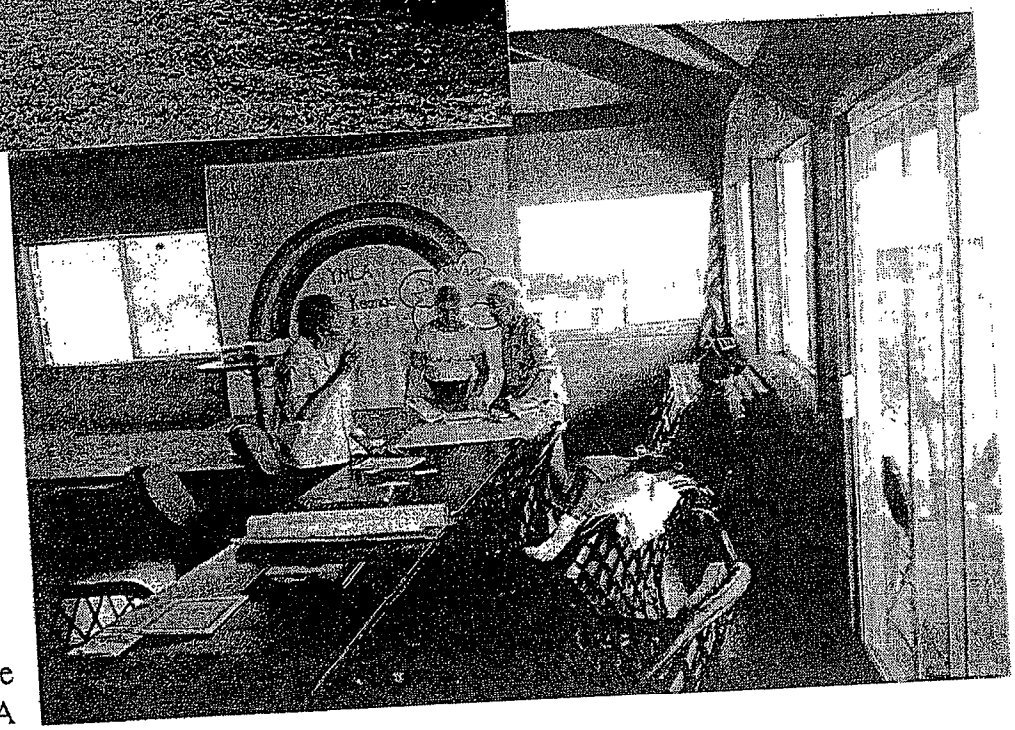
d. County of Maui Corporation Yard

The County of Maui baseyard is used for storage and staging for county public works activities and responsibilities. Two older wooden structures are used for offices and

Playfield and View towards Honomanu



YMCA Complex



Kupuna Discussing Place Names at YMCA

Ke'anae YMCA Complex

Figure 36

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE

equipment storage. Though originally part of the YMCA complex, the yard has been a separate facility since 1949.

e. Ke'anae Arboretum

The Ke'anae Arboretum, along with Ke'anae landing, and the lookout points are significant non-structural public facilities in the cultural landscape area. The Arboretum is not classified as historic, as it was created in 1971 by the Department of Land and Natural Resources. However, it is a public facility and there are prehistoric *lo'i* in the arboretum. Deliberate plantings of trees in this area date from 1942 and today the arboretum possesses a wide variety of tropical forest flora from many parts of the globe such as Malaysia, Africa and South America. Most are introduced tropical species. A list of trees planted in the arboretum is included in the appendix of this report.

3. Roadside Stands

There are no retail commercial establishments serving the community in the Ke'anae-Wailuanui area. Historically, when the ferry was active and for a time thereafter, there were stores and warehouses near the Ke'anae Landing. Also, long-time residents recall neighborhood stores such as the Ching Store along the Hāna Highway that serviced the community. At one time there was also a movie theater located adjacent to Ching store.

Two permanent roadside stands are the closest equivalents to commercial stores currently operating in the area: "Uncle Harry's Hawaiian Crafts and Fresh Fruits" and "Waianu Store", both are located along the Hāna Highway, one *makai* and one *mauka* within a short distance of each other, on the upland area between the lower elevation areas of Ke'anae peninsula and Wailuanui Valley.

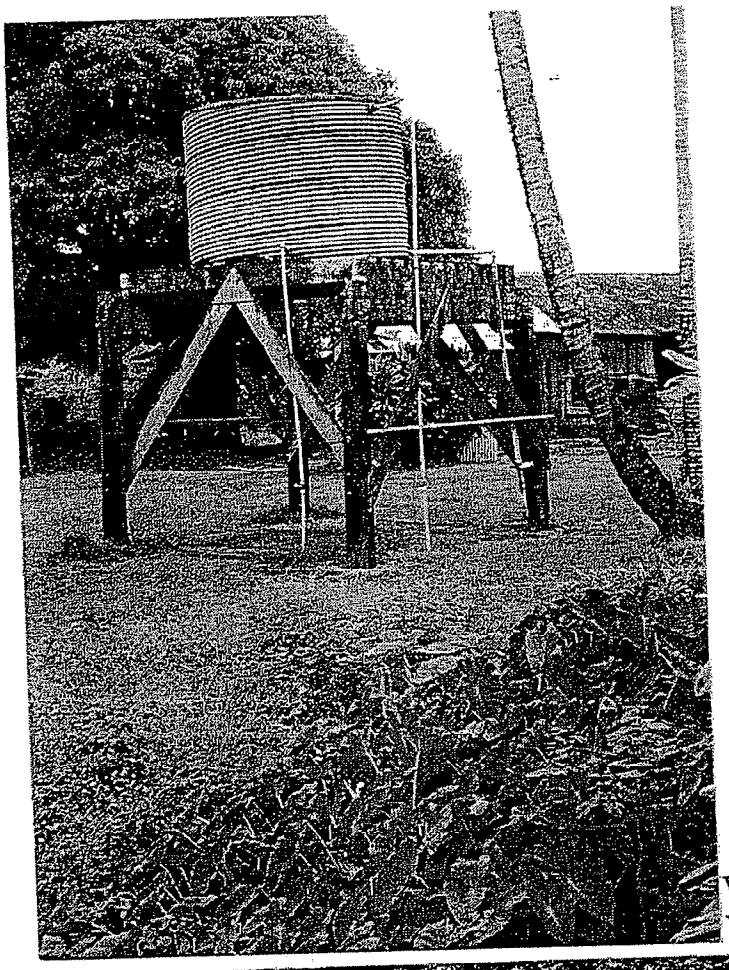
Both stands sell fruits, flowers, crafts, snacks, conveniences and drinks. The fruits and flowers are products of the local economy. While local residents also stop by, both stands are geared to drive-through resident and tourist traffic on the highway. The facilities are simple, free-standing wooden sheds located near adjacent residences. Colors and designs match the general pattern of the community. The parking spaces are flat, dirt and gravel areas. Waianu Store also provides picnic tables and benches in a shady place adjacent to the store.

4. Accessory Structures (Figure 37)

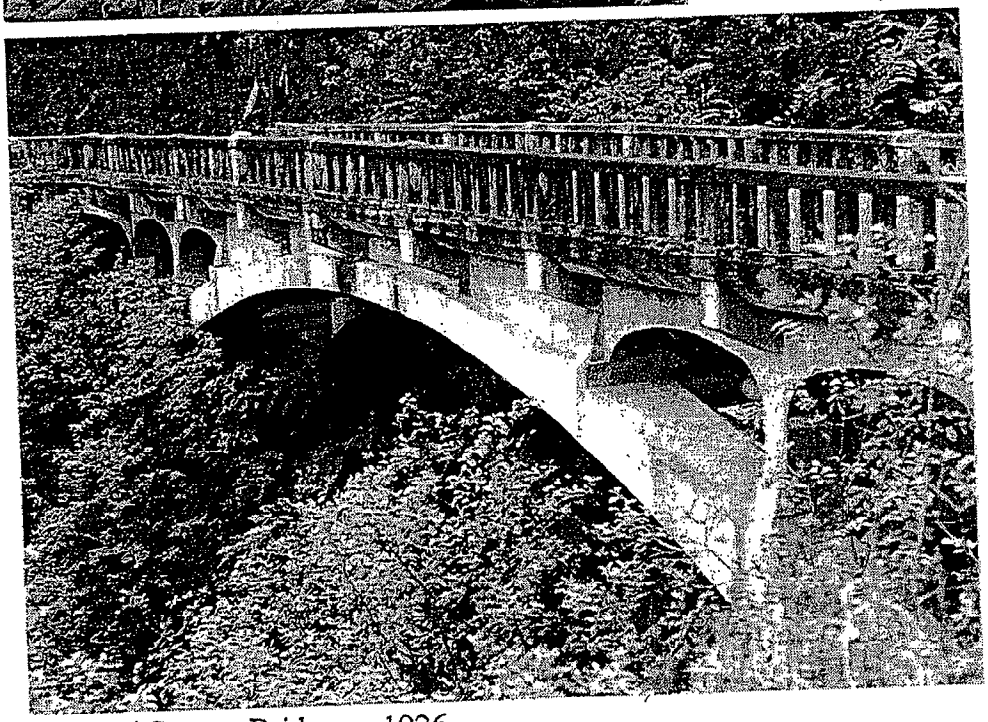
Many accessory structures are found in the landscape. Within the system of cultivated *lo'i* many small, free standing sheds are constructed to store supplies and tools. Some small shelters are also found in these fields. Several home sites in the area have small pig pens and chicken coops in the back yard between the house and the fields. Storage sheds, open carports and water catchment facilities are generally located near residences. These structures are generally made of wood and have corrugated metal roofs (Figure 37).

5. Bridges (Figure 37)

There are nineteen bridges which carry the Hāna Highway in the region claimed for traditional cultural practices by the residents of Ke'anae and Wailuanui. The distance covered by this winding road is less than six miles in a straight line; it measures approximately 10 miles on the ground. The number of bridges, occurring at an average of half-mile intervals, required to complete the Hāna Belt Road is unusual and evidences the significance of rain, topography, streams, and erosion which isolated the Ko'olau region from overland traffic for decades.



Water Tank -
YMCA/County Corp Yard



Waikani Stream Bridge c. 1926

Seventeen of the 19 bridges found in this region are classified as historic in a federally mandated study:*Historic Bridge Inventory and Evaluation, Islands of Maui and Molokai* (Hawaii Heritage Center 1990). The remaining two bridges were constructed in 1930, but were rebuilt in 1974. The 17 historic bridges, grouped by date of construction, include:

1911 Honomanū, Nua'ailua
1916 Pi'ina'au, Palauhulu
1920 unnamed stream
1920 Waiokamilo
1926 Waikani, East Wailuaiki, Kapiliula, Puakaa, Kapaula, Hanawī, East Hanawī, Makapipi, Kūhiwa
1937 West Wailuaiki, Waiohue

In 1926, the year when nine bridges were constructed, Maui County used federal funding to complete the Hāna Belt Road and solidify reliable access from Hāna to Kahului, central and west Maui.

The Waikani Stream Bridge, across Wailuanui stream, is especially noteworthy; it is described in the *Historic Bridge Inventory and Evaluation* as:

> ...one of the most impressive bridges on Maui. The superstructure is typical of open railing, concrete design of that era...The substructure is visible from the road and the bridge itself is located at the head of a dramatic valley....The bridge has one spectacular span with a maximum span length of 83 feet. The structure length is 108 feet....the surface of the roadway is approximately 50 feet above the stream bed which curves and thunders down to Wailua Valley, and eventually into the Pacific Ocean....Built in 1926, the Waikani bridge is unique on Maui for its structure type of continuous concrete arch-deck. Seen from the side, the substructure is an excellent example of the arch-deck design. The bridge is one of the most aesthetically appealing on Maui. The dramatic use of the single 83 feet long arch gives the Waikani Bridge a spectacular appearance and compliments the dramatic rugged ravines and mountains of scenic Hana Highway....Waikani is aptly named, for it means sounding water. (Hawaii Heritage Center 1990:41)

The Waikani Stream Bridge, along with the Pi'ina'au Stream Bridge, the Palauhulu Stream Bridge, and the Waiokamilo Stream Bridge are all located within the smaller Ke'anae-Wailuanui cultural landscape boundary.

6. Cemeteries

Historic cemeteries are located next to the two remaining churches and are still in use by the local community. In the past other burial areas were also used. In Wailuanui there was a Chinese cemetery near the entrance to the valley, located on TMK parcel 1-1-04: 45. Moses Lum Hoy, who was born and raised in the area, stated that the cemetery was on the hillside because that is where Chinese typically place their burials. The site is presently abandoned; the remains have been reburied in other locations. There is a small private cemetery along the edge of the taro *lo'i* at Ke'anae peninsula.

The *Maui County Cemetery Directory*, prepared by Nanette Napoleon Purnell for the Maui Historical Society in 1990, documents these four cemeteries. The cemeteries project

field workers compiled data on tombstone inscriptions, but did not record unmarked graves, or early Hawaiian burials. Excerpts from the directory, listing names and dates as old as 1844 which were copied from tombstones, are included in Appendix H.

Other burial areas, some of which date to the precontact era, are located along portions of the Wailuanui shoreline. Mr. James Hueu also mentions finding many bones near the site of the YMCA camp and speculates that it was a burial or the site of some great battle in the past.

E. Clusters

Clusters are groupings of buildings and other features which result from function, social tradition, climate or other influences, cultural or natural. The Ke'anae-Wailuanui region has several types of clusters that are unique to the region.

One special cluster consists of the buildings in the YMCA camp area. There are five buildings associated with the camp and two buildings used by the County of Maui. This cluster of buildings was established around near the turn of century and three of the structures in the complex are over 50 years old. The most recent buildings have been constructed in the last fifteen years. Through many transitions in use, the site has remained in public or quasi-public use and the architecture has remained consistent.

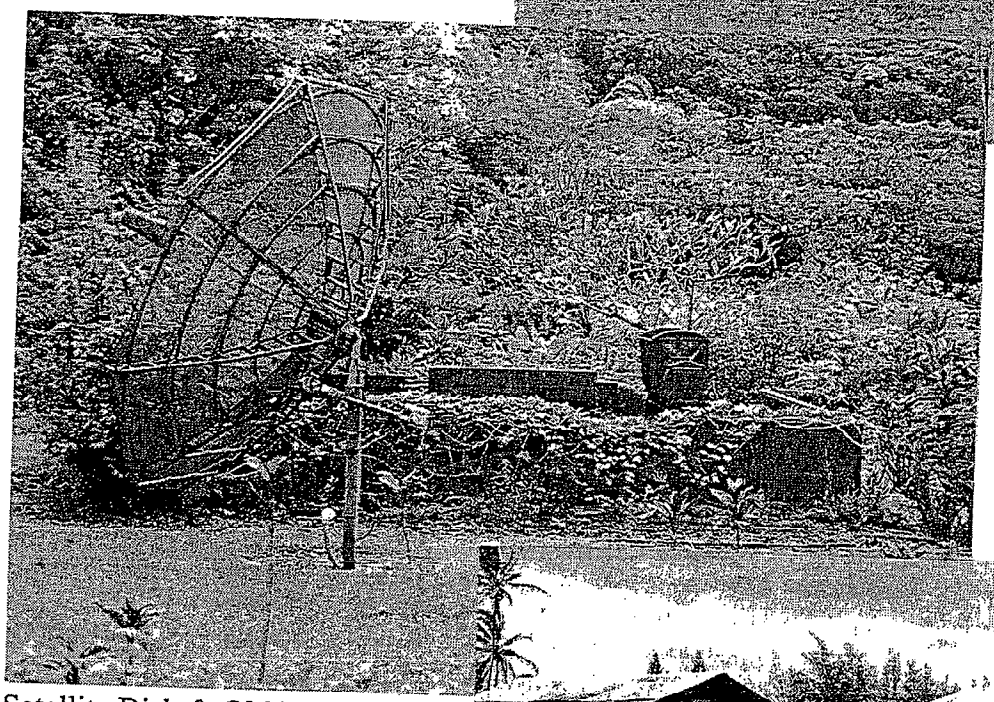
Religious clusters are associated with the two churches: Ke'anae Congregational Church on the peninsula and Saint Gabriel's Church in Wailuanui. Both churches have cemeteries next to their worship halls. There are also carports and caretaker cottage/meeting facilities at both sites.

Saint Gabriel's is a complex of five buildings including the 1860 "miracle church", a newer sanctuary, a priest's residence and two auxiliary buildings. A small cemetery has been placed adjacent to the miracle church which is officially called the Shrine in Memory of Our Lady of Fatima. It was recently restored with funds and labor provided by a private benefactor.

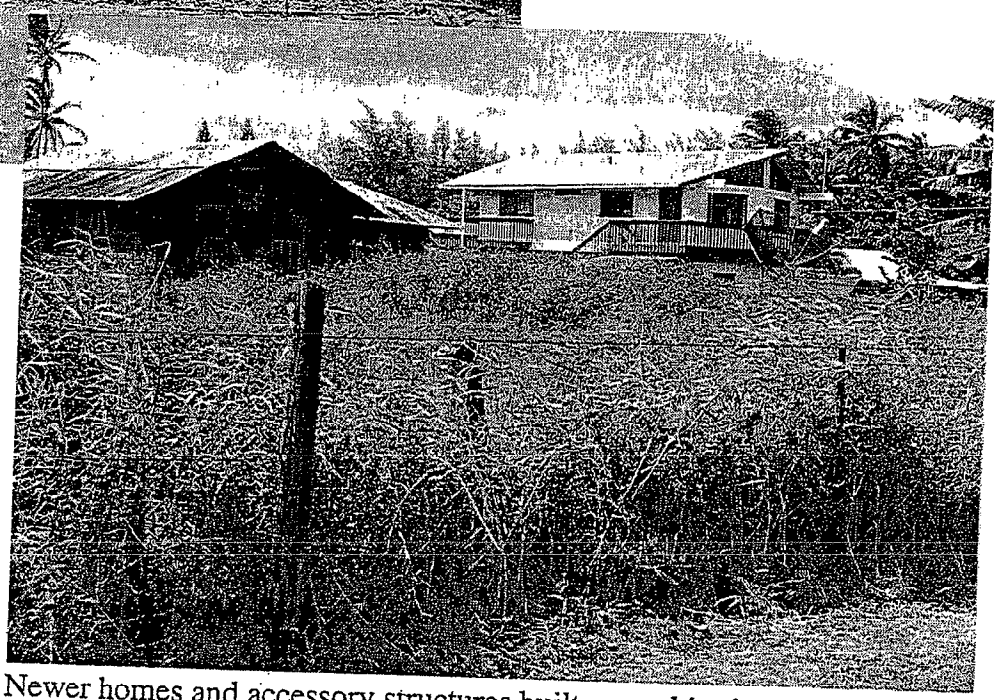
Another type of cluster is associated with agriculture and includes residences, carports, storage sheds and small structures. According to local residents, pigs were a common part of the area lifestyle. Pigs were fed the cut tops of the taro which was not used for replanting. This top was cooked with a mash called *haha* and fed to the pigs. The pigs, in turn, were cooked in an *imu* and eaten during *luau* for holidays and special events. Nearly every family had pigs, chickens and dogs, and the associated structures for their care and feeding.

In many instances there are newer houses and structures built on lots with older houses. Both roadside stands are free-standing structures on large lots with other structures and residences on them. Common additions are garages, storage sheds and newer homes in association with older residences. These clusters represent accommodations to evolving needs of extended families as family sizes and composition changed along with economic and lifestyle changes. Sometimes the older structures or houses are demolished or abandoned but in many cases they remain occupied until they become structurally unsound. The evolution is also seen in changes such as a satellite dish antenna being placed next to an old poi factory which is next to an old but occupied residence (Figure 38).

Mitchell Family Cluster



Satellite Dish & Old Poi Factory



Newer homes and accessory structures built near older homes

F. Internal Boundaries

Most of the boundaries in the region are natural, such as streams, ridgelines, cliffs and the ocean. It is interesting to note that the *ahupua'a* on Maui extend from stream to stream, rather than from ridge to ridge as they do on O'ahu or from *pu'u* (hill) to *pu'u* on the island of Hawai'i or from *lae* (point) to *lae* on the island of Moloka'i.

Manmade boundaries that pertain to the cultural landscape are primarily roads, irrigation features and vegetation lines. There is a noticeable lack of fencing and walls, creating an open landscape. Fences in rural areas are generally the result of ranching, to keep animals in and poachers out. Ranching has not been a prominent use in the region and most people keep the few animals they own penned or tied to a post or tree.

Property boundaries are generally marked by vegetation lines, *lo'i*, *'auwai* or the edges of fields. Between residential homes a line of croton or a line of ti will frequently be the only indicator of a property boundary. The *'auwai* bringing water to the fields will often serve as a property boundary. Sometimes a row of loosely spaced rocks will also serve as a boundary.

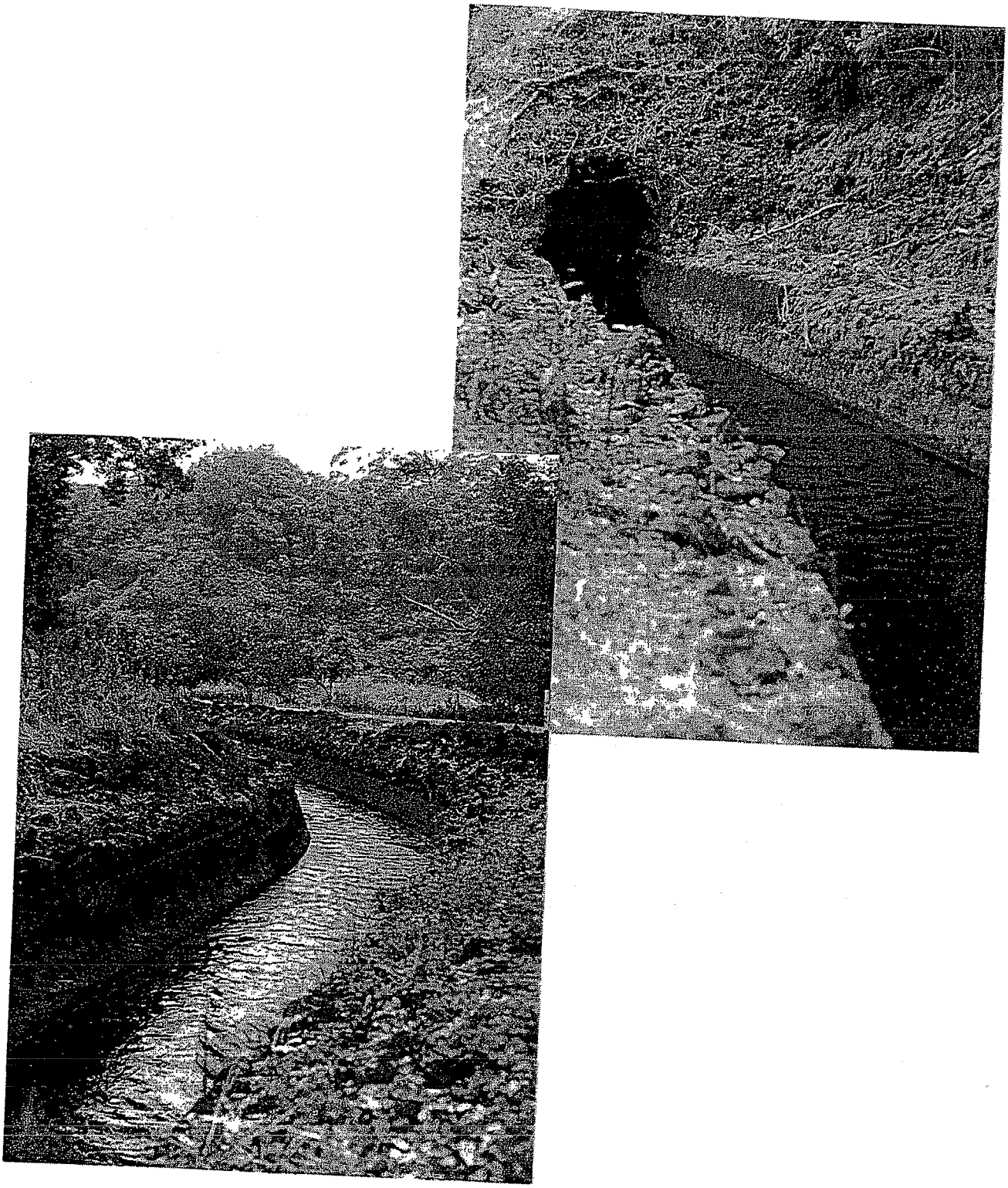
G. Ko'olau Ditch, East Maui Irrigation Company (EMICo)

Within the East Maui watershed area, which extends from Haiku to Nāhiku and includes the valleys of Ke'anae and Wailuanui, an extensive ditch system has been developed to collect surface runoff. Construction of ditches, tunnels and aqueducts was begun in 1876 by Henry P. Baldwin, one of the founders of Alexander and Baldwin, who obtained a lease from King Kalākaua. This system of surface water diversion began with the construction of the Hamakua Ditch, with Kauhikoa and Ko'olau Ditches being added before World War II, and the Wailoa Ditch completed in 1923. The water is drawn to central Maui to be used for irrigation of sugar cane, pineapple as well as municipal water supplies. This system of water control and delivery, owned and operated by the East Maui Irrigation Company (EMICo), is one of the more complex and extensive in the State of Hawai'i (Figure 39).

Upstream surface waters are diverted far outside of the immediate cultural landscape limits. The only ditch system visible in the cultural landscape is that which crosses the cliff in upper Wailuanui Valley near the headwaters of Waiokamilo Stream. However, the EMI Company aqueduct system has had a profound impact upon the community. Today EMICo is an employer of some of the residents. The roads and trails constructed as part of the system are used by the community residents for collecting stream resources, forest gathering and pig hunting. The trail that follows the ditch was used as the main overland access between Hāna and Ke'anae before the construction of the Hāna Highway in the 1920s.

H. Archaeological and Historic Sites

Archaeological and historic sites of the Ke'anae-Wailuanui area are considered in this study as components of a cultural landscape. The emphasis is on characterizing the nature, condition and spatial patterning of these sites, and to define the extent to which they contribute to this landscape. No attempt was made to perform a systematic archaeological survey of any area. Background research on archaeological sites consisted of gathering information on previously recorded sites, known from earlier surveys. These surveys include: Thomas Thrum (1909), J.F.G. Stokes (1916), Winslow Walker (1931), Lloyd Soehren (1963), Inez Ashdown (1971), and some recent reconnaissance work connected to land use permits. Fieldwork consisted of relocation of a few easily accessible major sites, especially *heiau* (Sites 50-07-96 and 50-07-97). Also, one fishpond - Pu'u Olu - was inspected (Site 50-07-538). Most importantly, most of the effort in the field was expended in documenting existing and former



East Maui Irrigation Company Ditch

lo'i systems. These are the major archaeological components of this particular landscape and have not been previously recorded as archaeological sites. These *lo'i* complexes are described elsewhere in this report. Each complex was given a state site number.

Figure 40 shows locations of all previously and newly recorded archaeological and historic sites - identified by state site numbers - within the Ke'anae-Wailuanui area. A table listing all previously and newly recorded sites is presented in the appendix of this report.

1. Previously Recorded Sites

There are 26 previously recorded archaeological and historic sites within the Ke'anae-Wailuanui area. Eighteen of these are archaeological sites, 6 are historic buildings, and 2 are bridges. The majority of the archaeological sites are *heiau*. This area seems to have had a comparatively large number of heiau recorded. Unfortunately, many of these have been destroyed.

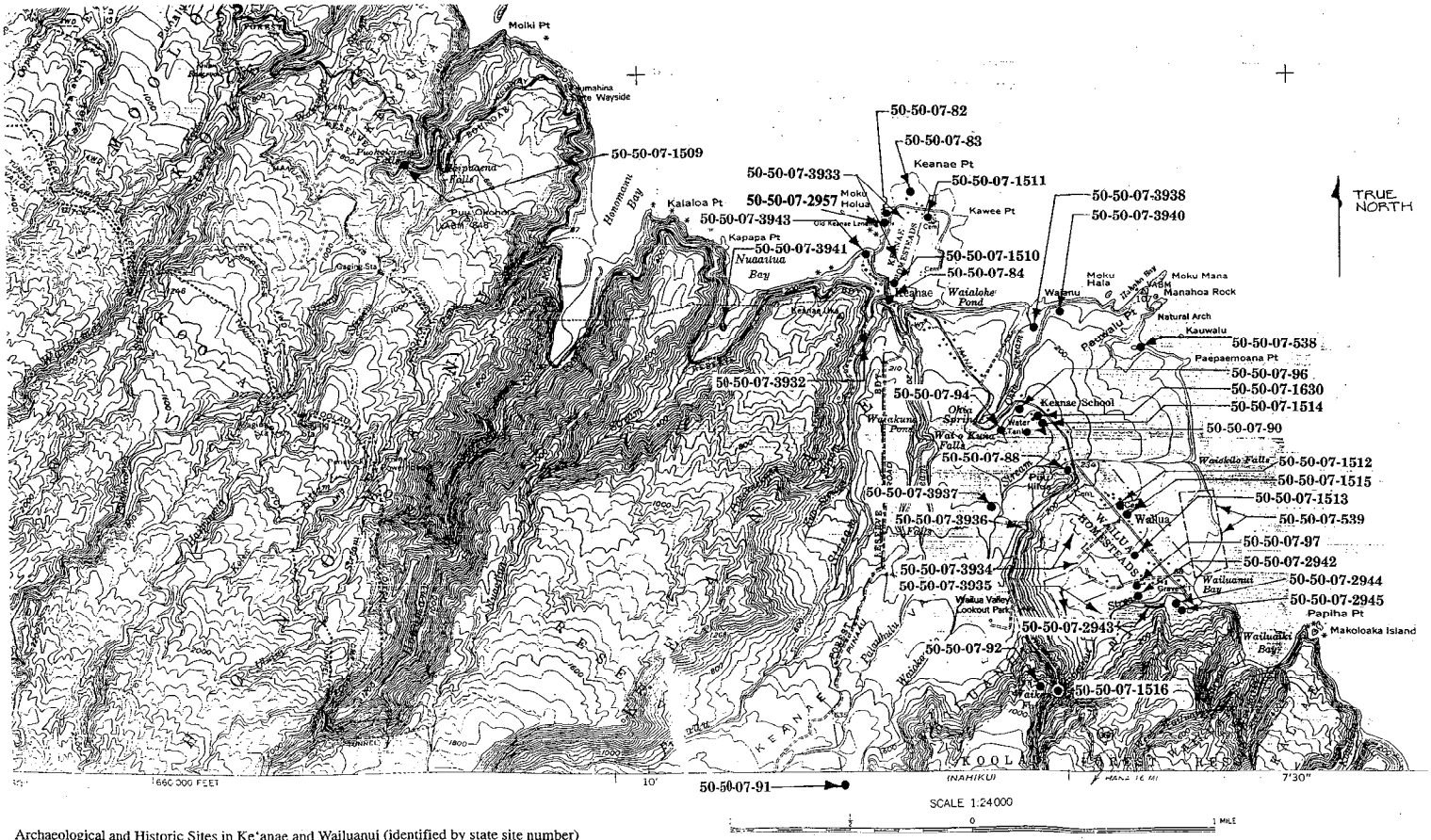
Two of the surviving *heiau* sites were inspected during fieldwork. Kukuiaupuni *heiau* (Site 50-07-96) was relocated, with the assistance of local residents, in a heavily forested area near Ke'anae School. The present configuration and condition appear similar to that described by Soehren (1963) and on the State-wide survey forms (1973-74). Two distinct structures are visible and both are intact. The other *heiau* inspected was Site 50-07-97, referred to as Makehau *heiau*. This locality is densely overgrown with *hau* and is marked by coconut trees. In the 1970s, eight coconut trees were counted. Apparently some have died in the last 20 years. The present inspection confirmed that the site is still present and in the condition previously described in the State-wide survey.

Also inspected was Pu'u Olu Fishpond (Site 50-07-538) which lies just south of Moku Mana island, behind a boulder beach. A well-preserved and well-constructed wall (*kuapa'a*) was observed on the southwest side, covered with *hala* and other thick vegetation. The inspection confirmed, to some extent, Soehren's description of 1963. This is, indeed, a traditionally constructed fishpond, probably the only one along the coast between Ke'anae-Wailuanui.

Another major site complex, worthy of mention as part of the Ke'anae-Wailuanui landscape, is the site identified as the Wailuanui Complex (Site 50-07-539). This site is located along the coast just north of Wailuanui Bay. It was not inspected as part of the present survey but has been described as containing 15 graves and 2 possible house sites. This complex probably represents the remains of prehistoric or early historic habitation associated with the adjacent canoe landing at Wailuanui Bay.

2. Newly Recorded Sites

During field reconnaissance to document presently used and abandoned irrigation systems, a previously unrecorded complex of archaeological sites was located at Kilo (Site 50-07-3940), east of the mouth of Ōhi'a Stream (Waianu Valley). The sites found at Kilo consist of low terraces and a habitation enclosure measuring from 5 to 8 m. square. These appear to be isolated habitation sites. At this locality access to the coast would have been difficult, except down a steep cliff trail to Waianu Valley. Local residents mentioned an association of this site with a tale of robbers and kidnappers. Most of the coastal land between Kilo and Moku Mana island was covered and no other archaeological sites were encountered.



Archaeological and Historic Sites in Ke'anae and Wailuanui (identified by state site number)

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE

Figure 40

Another site that was identified during the present fieldwork is a stone quarry on the cliff just *makai* of the YMCA camp, overlooking the Ke'anae peninsula (State site 50-50-07-3943). The site was pointed out by some local residents who stated that the quarry was in use in the 1920s for construction of the Hāna Road. At this quarry site, there is abandoned machinery, including a large winch and crusher (Indiana Road Machine Co., Fort Wayne Indiana, #9C13). A rectangular stone platform - measuring 8 ft. long, 4 ft. wide, and 3 ft. high - was identified as a possible grave of one of the quarry workers who died in a blasting accident. This locality also contains a World War II concrete gun emplacement.

In addition to the sites mentioned above, eight discrete present and former wetland taro complexes were recorded during the present fieldwork. These include the presently cultivated *lo'i* of Ke'anae and Wailuanui, as well as the former taro lands of the area from Nua'ailua to the east portion of Wailuanui. These sites were described earlier in this section of the report.

3. Archaeological Sites as a Landscape Component

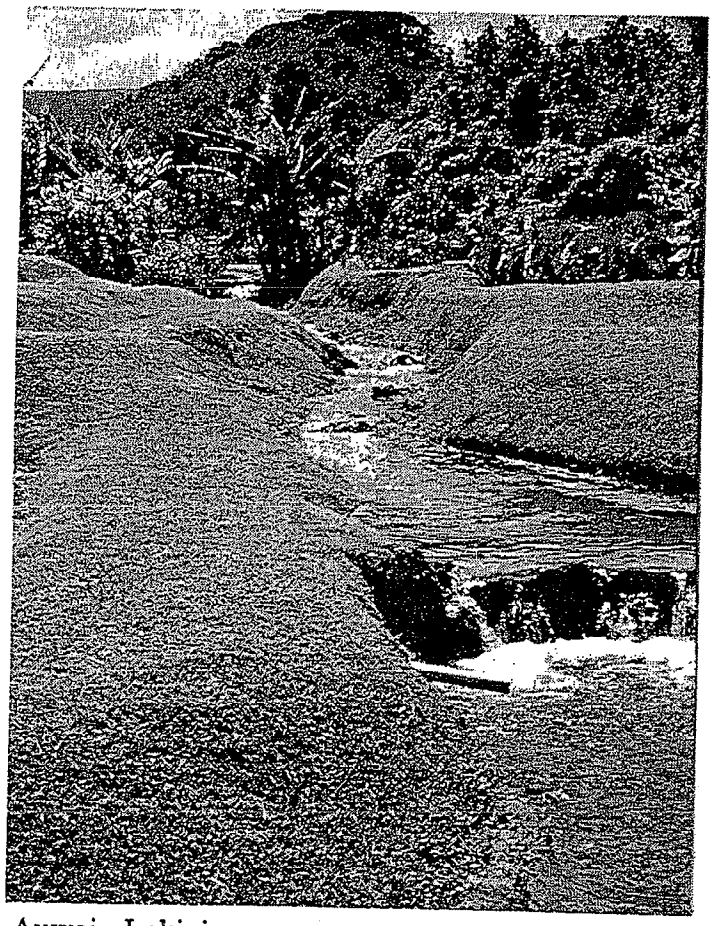
Considering the previously recorded and newly recorded archaeological sites collectively, it is clear that the wetland irrigation systems (both presently in use and abandoned) represent the most significant archaeological element of the landscape. Major prehistoric habitation sites have not been located. They could be present, but still undiscovered, along the coastline between Ke'anae and Wailuanui or in the large unsurveyed *kula* land between the two communities. However, it is more likely that the pattern of settlement of Ke'anae and Wailuanui has been stable from the time of initial permanent settlement and the development of wetland agriculture. This pattern is of dispersed house sites on high ground throughout the irrigated areas. Surface archaeological traces of this former habitation pattern would be constantly altered and mixed by successive use. In Ke'anae, habitation layers would be expected along the coastal areas and on high ground surrounding the fields. In Wailuanui, habitation was probably concentrated exactly where it is today, in the *kula* land just *makai* of the irrigated fields and on the lava bluffs in the irrigated areas themselves. Coastal settlement would have been represented by sites like Site 50-07-539, clustered around Wailuanui Bay.

I. Small-Scale Elements

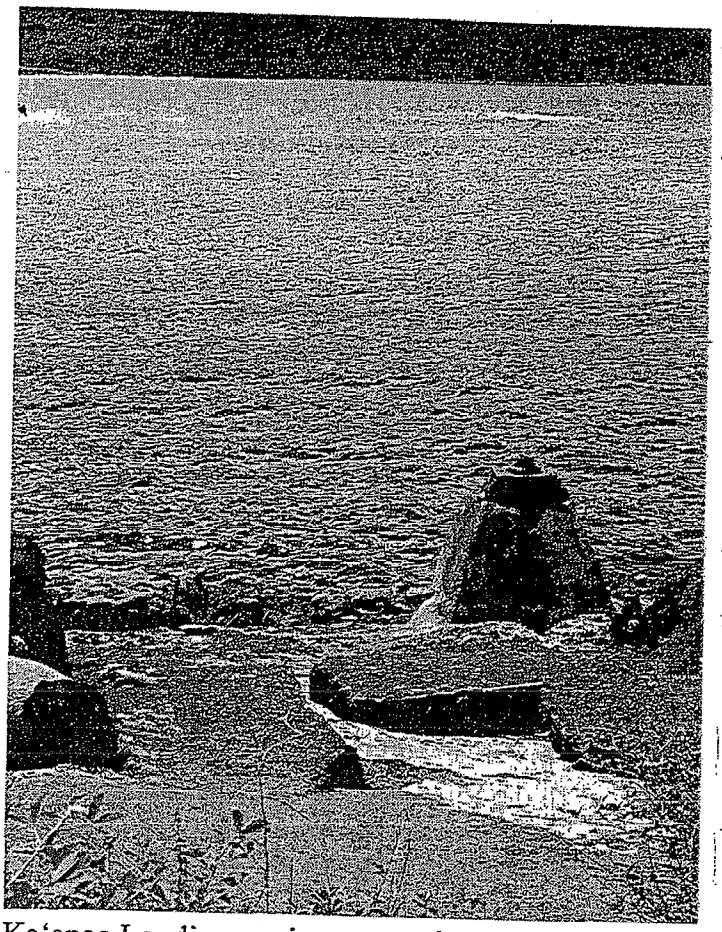
Small-scale elements are smaller structures and features of the landscape that reflect human presence and influence on the land. They range from signs and mail boxes to small water tanks and storage sheds. They do not dominate the landscape individually but together affect the character and texture of a place. They add detail and color to the dominant structures and facilities.

The most immediately evident small-scale elements in the Ke'anae-Wailuanui landscape are features related to the area's agricultural activities: water tanks, irrigation gates, plank bridges, ditches, flumes, utility sheds, pipes and culverts, as well as a couple of small roadside cattle pens and loading chutes (Figure 41).

There are very few signs in the area. Except for the Hāna Highway, Ke'anae Homestead Road and Wailuanui Road, the streets are not named. Signs are found at the County Corporation Yard, Ke'anae Arboretum, Ke'anae School, the two churches, the two fruit stands and the scenic lookouts. Most of the signs are small and unobtrusive.

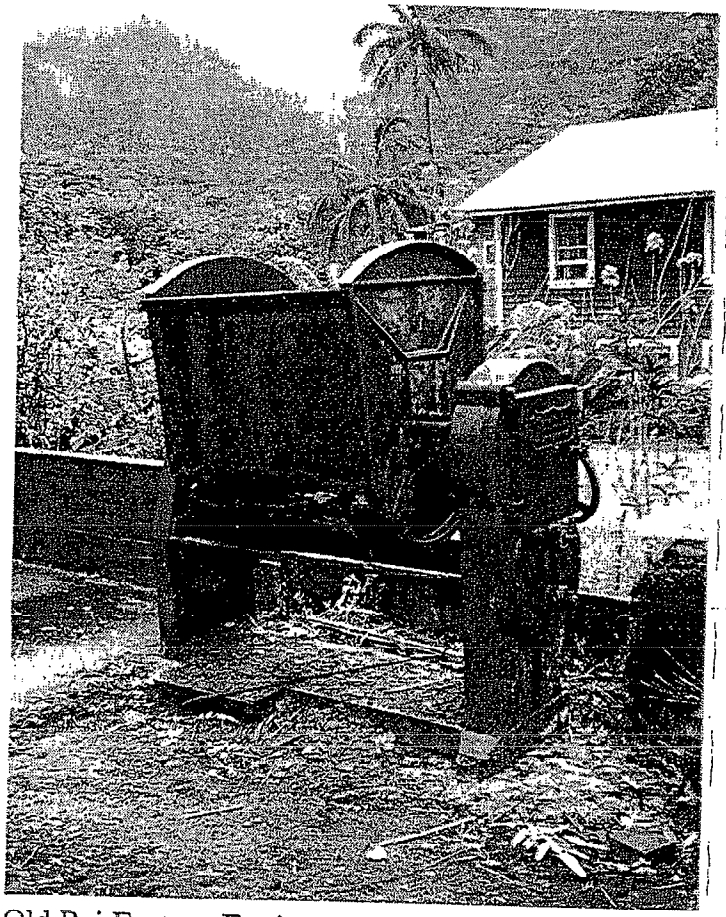


Auwai - Lakini



Ke'anae Landing equipment anchors

Water Tank Behind Ke'anae School



Old Poi Factory Equipment-Lum Hoy Property

Small-scale Elements

J. Open Areas

Open areas are lands that have no structures or are not under current cultivation. While agricultural fields are open spaces, they are not open areas in that the direct cultivation restricts other uses. Pasture land is a hybrid kind of area because the intensity of use is light.

Open spaces act as buffers between settlements and uses. They are characterized by a lack of structures or facilities signalling the direct influence of man. They function to maintain and define a level of density and characterize certain patterns of settlement. In a wet environment like Maui's Ko'olau Coast, open spaces, except fora few rocky coastal strips, generally become vegetated. In drier climates, open spaces would exhibit more of the underlying geology, such as sand, lava or depositional soils. In the Ke'anae-Wailuanui landscape, open, uncultivated areas become overgrown quickly. There is a clear pattern of vegetative succession with abandoned or uncultivated areas. In drier areas with less water grasses such as California grass (*Brachiaria mutica*) take over and eventually give way to guava and christmasberry. In wet areas such as abandoned taro *lo'i* the succession also starts with California grass but the transition is then into *hau* and Java plum (*Eugenia cuminii*). Areas that are used for grazing tend to remain as pasture and most of this pasture is Brachiaria or Panicum.

K. Viewing Points

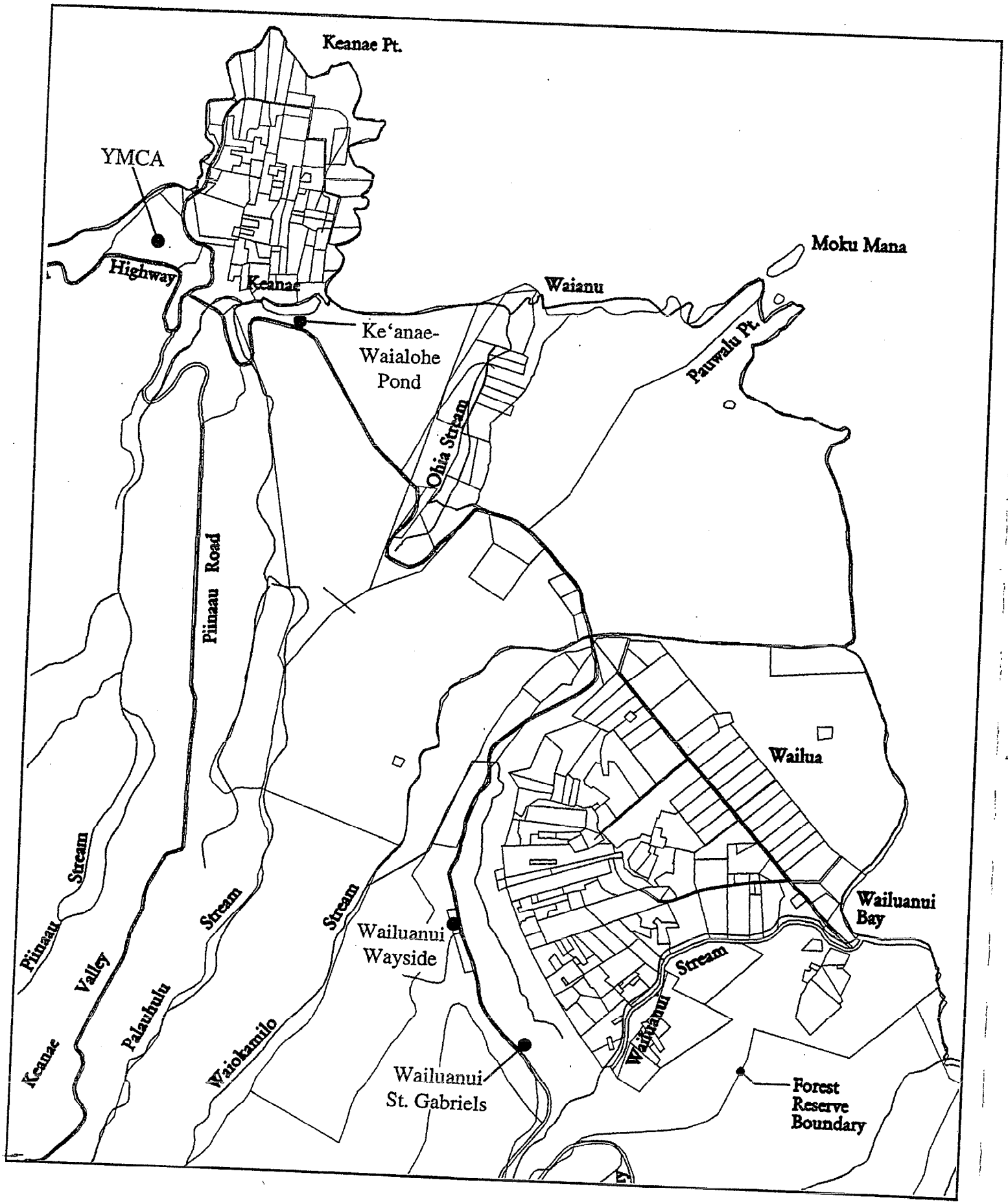
Viewing points are places that offer significant and panoramic views of the community and surrounding landscape. For visitors, viewing points function as scenic lookouts, affording a more holistic perspective on the land. For the local community, they may represent landmarks offering reference points for direction or orientation, and, occasionally, meeting places in times of emergency. In the Ke'anae-Wailuanui area, these viewing points, which are on high ground, were most recently used as assembling places for families during the tsunami alert of October 4, 1994.

Occasionally, there are historic events or cultural traditions associated with a viewing point but its value is generally unrelated to any site-specific association.

For Ke'anae-Wailuanui, important viewing points are found at Kaumahina State Park, the YMCA camp site, the view of Ke'anae peninsula from above Waialohe Pond, the Wailuanui Wayside Lookout and the Wailuanui Saint Gabriel's Lookout before Waikani Falls (Figure 42).

Kaumahina State Park: This site is at the edge of the traditional practices zone and represents the first real view of the cultural landscape region. It has the dramatic view of Ke'anae peninsula found on many post cards. Due to its distance from the central cultural landscape area, it is unlikely to be affected by changes in the cultural landscape. Additionally, the closer, intervening valleys of Honomanū and Nua'ailua are uninhabited and should not be affected by development in the foreseeable future.

YMCA Complex: This site provides panoramic views northwest towards Kailua and southeast to Nāhiku. Ke'anae peninsula is located below, and the site overlooks the old quarry and Ke'anae Landing. It is a popular gathering place for the community with ample parking, public facilities and open space. Changes to Ke'anae peninsula would impact views from this site. This site is also the gateway to the central cultural district.



Viewing Points

KE'ANAE - WAILUANUI SUITE

Ke'anae/Waialohe Pond: This is a small (3 or 4 cars) lookout located above Ke'anae peninsula and Waialohe Pond. It provides the best view of the Ke'anae peninsula. Its primary shortcoming is inadequate parking.

Wailuanui Wayside Lookout: Located on the *mauka* side of the Hāna Highway, this lookout provides a spectacular view of the Ko'olau Gap of Haleakalā and the broad expanses of Ke'anae Valley as it winds its way below the Gap. Views of the waterfall and the East Maui Irrigation ditch system are clearly observable as well as the line of trees planted by the Civilian Conservation Corps in the 1930s. Wailuanui and Nāhiku are also visible from this site. This lookout provides the best views of the *mauka* areas that are part of the larger traditional practices zone which generally extends to the 3,000-foot elevation with occasional forays extending to the Haleakalā summit rim at Pohaku Palaha. Parking is in an unpaved area.

Wailuanui/Saint Gabriel's: This is the last major lookout before leaving the central cultural landscape region. It provides a spectacular view of Wailuanui Valley and its settlements. Nearly the entire amphitheater-like valley is visible with a picturesque view of Saint Gabriel's Church consisting of a New England-like postcard scene amid tropical vegetation. Parking is limited to 8-10 cars.

While spectacular views are found throughout the region, those just described represent exceptional public and quasi-public view sites that are important for the preservation of viewsheds (Figure 43). Viewsheds are the landscape that is being preserved and the viewing points are the locations from which the quality of the viewshed and its protection is evaluated.

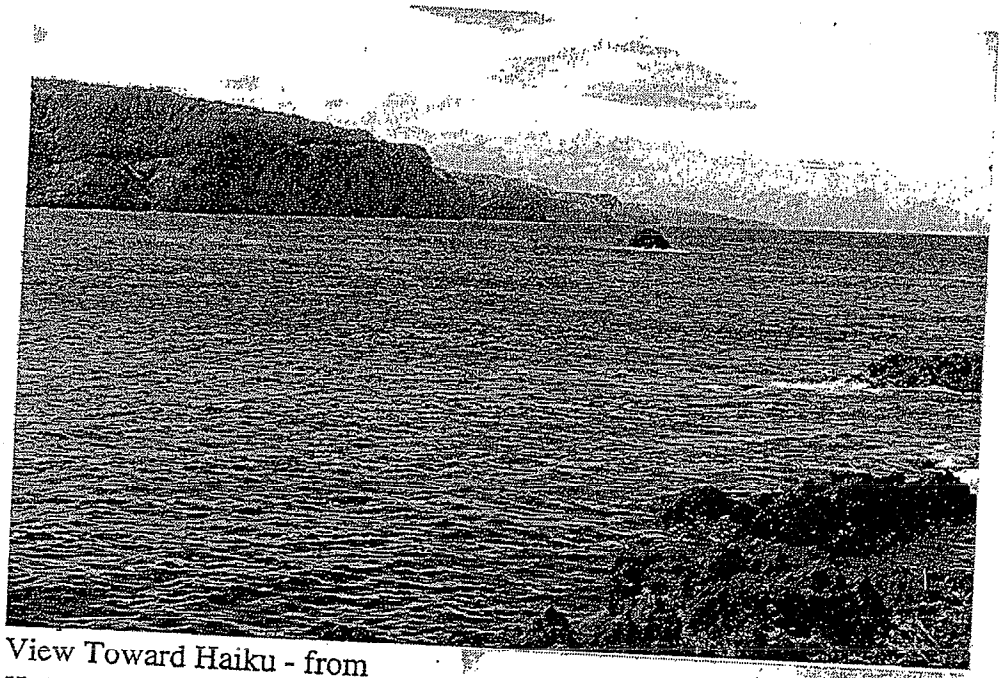
L. Cultural Resources and Use Areas

The components described above are all elements within the Cultural Landscape Boundary. Cultural resources and areas used for the exercise of traditional Hawaiian cultural, subsistence, and spiritual customs, beliefs, and practices are important components of both the Ke'anae-Wailuanui Cultural Landscape and the Traditional Cultural Practices Region. These resources and use areas include:

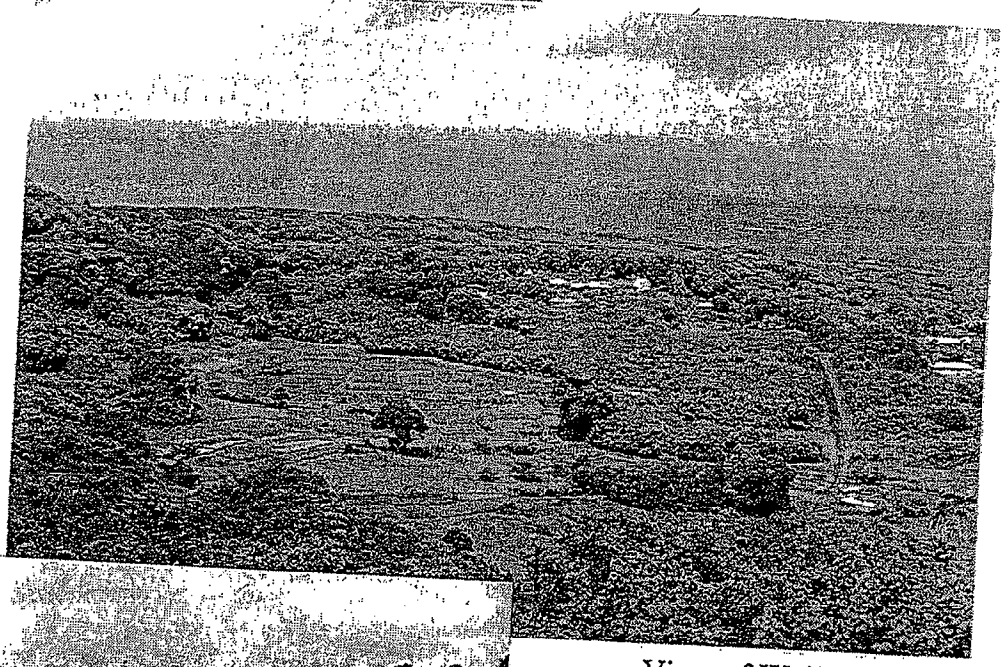
1. *Wahi Pana*: These are sacred sites such as *heiau*, shrines, burial caves and graves and geographic features associated with deities and significant natural, cultural, spiritual or historical phenomenon or events. Edward Kanahele offered the following description of *wahi pana* in the introduction to *Ancient Sites of O'ahu* by Van James (1991):

> The gods and their disciples specified places that were sacred. The inventory of sacred places in Hawai'i includes the dwelling places of the gods, the dwelling places of venerable disciples, temples, and shrines, as well as selected observation points, cliffs, mounds, mountains, weather phenomena, forests, and volcanoes.

In addition to the archaeological sites listed in Appendix B, informants provided *mo'olelo* or legendary histories about the Moku Mana and Manahoa islets; the Kāne and Kanaloa springs in 'Ohi'a; the *'ili* of Wahinepe'e; Ke'anae peninsula; Ke'anae Arboretum; Waialohe Pond; the *'ili* of Wailuaiki; Polai; Kuo; Pohole; Waiohue Bay; Kapiha Point; and Pauwalu point.



View Toward Haiku - from
Ke'anae Landing



View of Wailuanui from
Saint Gabriel's Lookout

Ke'anae Loi from YMCA
Complex

2. Streams and Springs: These waters are important as habitats for native species of marine life, for taro cultivation, and for domestic use. The important streams and springs mentioned by the community informants included Hanawī spring and stream; Honomanū stream; Kāne and Kanaloa springs Kapa'ula Gulch; Kopili'ula stream; Makapipi stream; Nua'ailua stream; 'Ōhi'a spring; Palauhulu stream; Pi'ina'au stream; Kikokiko gulch; Wahinepee stream; Waialohe pond; Waianu stream; Wailuaiki stream; Wailuanui stream; Waikani Falls; Waiohue stream; Waiokamilo stream; Honopou stream; Kolea stream; and Kailua stream.

3. Shorelines, Reefs, Nearshore and Offshore Ocean: These areas are important for gathering of foods, medicine and for conducting cultural and spiritual customs. The entire shoreline, from Kailua to the Hāna Airport and out 11 nautical miles to the buoy is used by the fishermen of Ke'anae-Wailuanui for fishing, gathering of *'opihi*, and gathering *limu*. The community informants noted that the bays are especially important for the spawning of the fish. Some of the bays and landings noted as significant included Honomanū; Ke'anae Landing; Nua'ailua; Wailuaiki; Wailuanui; Waiohue; and Nāhiku Landing. Pu'u Olu fishpond was described as historically important and there was interest in restoring it for the propagation of fish.

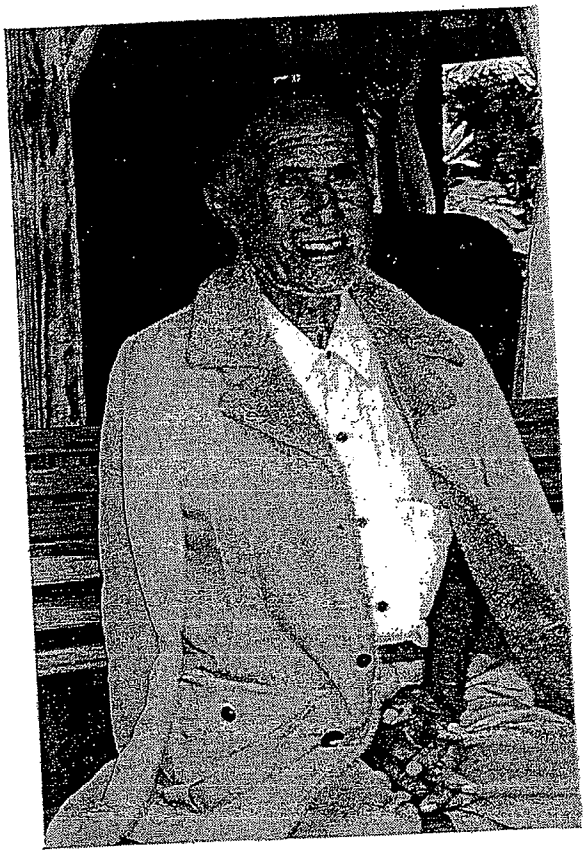
4. Forests: Forests are important for hunting pigs and other animals; for gathering plants used for medicine, foods, ceremonial adornment, ritual offerings; and for the conduct of spiritual customs. Most of the area *mauka* of the Hāna Highway, from Honomanū to Makapipi is part of the Ko'olau forest reserve. The local residents are allowed to access the forests to exercise their subsistence, cultural, and spiritual customs, beliefs and practices.

5. Domains of *'Aumakua* or Ancestral Deities: Particular natural and cultural areas are important as traditional domains of *'aumakua* or ancestral spirits and deities, where Hawaiians renew their ties to ancestors through experiencing natural phenomena and witnessing *ho'ailona* or natural signs. Out of respect for the personal and private nature of spiritual and family beliefs and customs, interviews did not inquire about this aspect of cultural resources and use areas.

6. Trails and Dirt Roads: Trails and dirt roads are indispensable to afford access to the cultural resources and use areas, both *mauka* to forests and streams and *makai* to streams and the ocean. Informants identified the trails and four-wheel roads which they and their ancestors have customarily used on a map which is on file with the Maui Planning Department.

Community informants were asked to identify important cultural use areas and resources. These are described below in section VII - *Mana'o O Ka 'Āina*. Appendix D provides a compilation of place names and their significance.

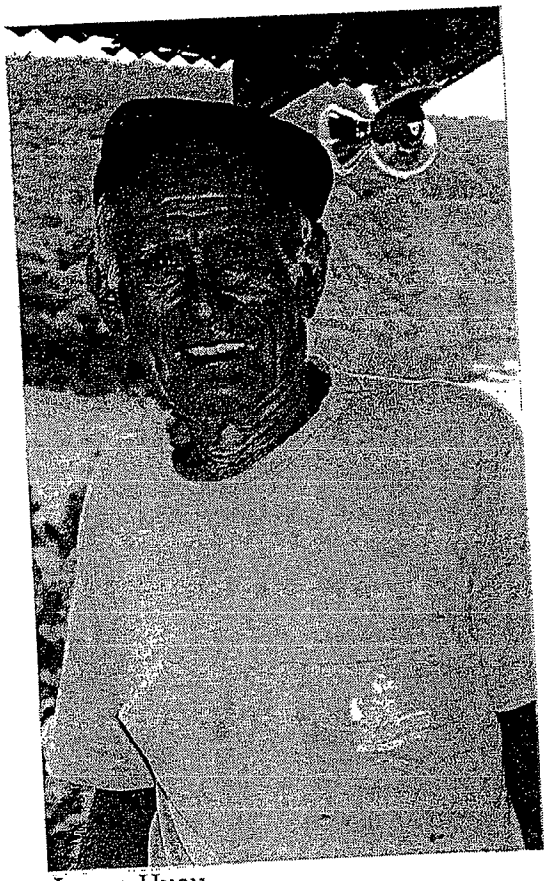
VII. MANA'O O KA 'ĀINA



Enos Akina

Helen Nakanelua

Mary Kaauamo



James Hueu

VII. *MANA'O O KA 'ĀINA*

This section presents the insights of community residents who share their knowledge of traditional customs and practices in the Ke'anae-Wailuanui region. The residents also describe the important cultural and subsistence-use areas in the Ke'anae-Wailuanui landscape.

A. Traditional Life Ways

The resources used for traditional customs and practices in the Ke'anae-Wailuanui area are located at all elevations, from sea level up to the summit of Haleakalā. Rainfall in the area varies from 100 inches a year to over 300 inches a year in the rainforests. The forests above Ke'anae-Wailuanui are part of the East Maui watershed which is the largest single source of surface water in the state, with an average flow of 60 billion gallons a year harvested out of the Ko'olau region via the EMI Ko'olau Ditch. In addition, artesian water is harvested from wells within the watershed.

The area mauka of the Hāna Highway is dominated by the state-owned Ko'olau Forest Reserve and Hanawī Natural Area Reserve. Vegetation varies according to elevation. The upper elevations have grass and shrublands. The forest begins at approximately 7,200 feet and extends down to the coastline. This upper forest is dominated by 'ōhi'a lehua but includes native koa, kopiko and hame. Some of the most intact and extensive native forests occur here and support the state's greatest concentration of endangered forest birds. The forests are home to 12 native Hawaiian birds, native insects, snails, and other invertebrates. The native species and ecosystems provide a stable and beautiful watershed which would be nearly impossible to replace if destroyed.

The lower elevation forests are dominated by introduced species such as eucalyptus, java plum, kukui, 'ōhi'a 'ai, guava, and christmasberry. Much of this forest is a result of plantings by the Civilian Conservation Corps and of Polynesian and later introductions that have spread and gone wild. This altered forest system is also used by local residents to support their traditional practices.

In discussing what was special about the way of life in Ke'anae- Wailuanui, informants highlight their ability to make a living from taro cultivation, fishing, gathering, and hunting. Some of the comments included:

> *Life is easier here than the outside world. Here, can hunt, can fish, can farm.* (Charmaine Day)

> *Over here, I got free things to eat . . . That's how we live over here, 'opae, o'opu, hīhīwai, 'opihi. The sea clear, we go get 'opihi, fish.* (Enos Akina)

> *We're lucky. This is the place. We're blessed, we took such good care of everything we had. Awapuhi said, and till today I remember the word she used is "selfish". The word selfish is for the people over here, to protect the area. Selfish doesn't mean that we going to make money, selfish is because the area, we don't want it to get spoiled. This is the difference between selfish and stingy. We have to be selfish.* (Kaipo Kimokeo)

Waīluanui they have everything. They have the taro patch, they have the fishing ground, they have the ʻopae, they have the oʻopu, they have the shell in the patch, you know, they have everything what you want. It's that, you have to do it yourself, you see . . . you got to work hard for everything that you want. (Mary Kaauamo)

The informants emphasized that the natural resources continued to be abundant because they and their ancestors had taken deliberate measures to care for and protect the land, its forests, streams, shoreline, nearshore waters, and offshore ocean. Most importantly, the families in the district continued to honor and respect traditional Hawaiian cultural values and customs which guide subsistence harvesting of natural resources.

Such values and customs include but are not limited to the following:

1. Only take what is needed.

2. Don't waste natural resources.

3. Gather according to the life cycle of the resources. Allow the resources to reproduce. Don't catch fish during their spawning seasons.

4. Alternate areas to gather, fish and hunt. Don't keep going back to the same place. Allow the resource to replenish itself.

5. If an area has a declining resource, observe a kapu on harvesting until it comes back. Replant if appropriate.

6. Resources are always abundant and accessible to those who possess the knowledge about their location and have the skill to obtain them. There is no need to overuse a more accessible area.

7. Respect and protect the knowledge which has been passed down intergenerationally, from one generation to the next. Do not carelessly give it away to outsiders.

8. Respect each other's areas. Families in Keʻanae-Wailuanui usually fish, hunt, and gather in the areas traditionally used by their ancestors. If they go into an area outside their own for some specific purpose, they usually go with people from that area.

9. Throughout the expedition keep focussed on the purpose and goal for which you set out to fish, hunt, or gather.

10. Be aware of the natural elements and stay alert to natural signs, e.g. falling boulders as a sign of flash flooding.

11. Share what is gathered with family and neighbors.

12. Take care of the kūpuna who passed on the knowledge and experience of what to do and are now too old to go out on their own.

13. Don't talk openly about plans for going out to subsistence hunt, gather, or fish.

14. Respect the resources. Respect the spirits of the land, forest, ocean. Don't get loud and boisterous.

15. Respect family 'aumakua. Don't gather the resources sacred to them.

B. Subsistence Practices and Resources

Subsistence gathering, fishing, hunting, and gathering allows the residents of Ke'anae-Wailuanui to obtain a substantial amount of their basic needs outside of the cash economy. In addition, food, goods, and services are often exchanged, thereby extending the non-market subsistence network. All those who share in the network benefit from the practices of living off the land and the ocean. Informants shared the following information about their subsistence practices and the resources involved.

1. Gathering

Family members of all ages engage in some level of gathering activity in the Ke'anae-Wailuanui district. Like in most rural areas, families gather limu, 'opihi and other shellfish along the shoreline.

What is unique about the gathering activities in Ke'anae-Wailuanui is the abundance of marine stream life. Kūpuna Helen Nakanelua still goes out and gathers 'opae with her homemade 'a'aniu net in the 'auwai that runs through her property at Lākini. Waiokamilo Stream still has 'opae which is accessible to the kūpuna. The Kaauamo family is best known for their gathering activities. Awapuhi Kaauamo Carmichael still goes out gathering for 'opae, hīhīwai, and 'opihi from Kailua and over through Kūhiwa. Paul Sinenci, a younger member of the Kaauamo 'ohana does extensive gathering with friends his age.

Awapuhi Carmichael identified some of the areas they regularly access for gathering of 'opae, hīhīwai, and o'opu:

> *We have our own names. Kapa'ula, gather 'opae. We use Puaakaa, we call it Kaunoa. Above the road, the ditch above the road, we use that stream, and then it branches off. Even Makapipi, we use Makapipi stream. We use all the way to the tunnel. We use it. Kūhiwa gulch is used by our family. Kūhiwa gulch we use also. Makapipi is just mauka. Kūhiwa is mauka.*

Gathering from a variety of places is important in order to maintain the resources. The choice of place to gather is determined by the weather and other natural signs. Awapuhi Carmichael described the factors which affected her decision as to where to gather on a particular expedition:

> *It depends on what we're getting, and how we feel, the ocean. We never go to the same place. You know how the Hawaiians used to do, they don't go back to the same place, so can restore. It depends on the weather, and then we go by the moon, the stars. If use one place, then go to another place, depends on the moon and the stars. We go up far. Especially for hunting too, we go all the way up. We all go to the same places, although each of us have our favorite hole, places, where we go for 'opae, you know. All mauka for 'opae. And then below have the*

o'opū and the prawns, they introduced the prawns, and hīhīwai. Above the road is more the 'opae. Above the road is where all the 'opae are. Above the main highway. And then below the road has hīhīwai, o'opu, you know.

Within the traditional cultural landscape area for Ke'anae-Wailuanui unoccupied areas with flowing pristine streams and the forested areas are integral to the livelihoods of the families in the district. For example, nobody lives in the area from Wailuaiki to Kōpili'ula and over to Hanawī but there are many gulches and streams flourishing with hīhīwai and o'opu.

2. 'Opae

Ke'anae-Wailuanui is one of the few remaining areas in the Hawaiian islands where 'opae can be gathered. Virtually every stream has 'opae at some time during the year. The irrigation ditch is an excellent breeding area for the 'opae because it has flowing water year round. Some streams below the ditch, however, don't have enough flowing water to sustain the 'opae year round when the water is diverted into the ditch system.

Commercial sale of 'opae is prohibited under a state law that went into effect in 1993. Prior to that, certain families gathered 'opae for sale in Honolulu. The kūpuna explained that when they were growing up, the gathering of 'opae for sale was an important source of income for their parents and grandparents who did not hold full-time jobs. Helen Nakanelua described how she would accompany her grandmother to gather and dry 'opae for sale to the Otani market in Honolulu:

And I used to go along with my grandma, with a five gallon can, you know those tall ones, and I pack some wood, and I pack salt, so that whenever my grandma goes with the 'upena net, do you have an idea what the 'upena net looks like and they have a little bag there? Some of the bags are small, but she used to have these long bags, And then she leaves that where I am, she takes that out, we clean it and we cook it in this can. Salt it and cook it there, with the wood that I take, we cook it. And after it's cooked, I begin spreading it on an oil tablecloth and a mat I used to pack along. And then she leaves me there. I attend that 'opae while it's drying. By the time she comes back here, it's partly dried, I gather that 'opae again, and separate it in another bag, because that's partly dried, and we continue on. She gets another bag to do the same thing. I cook. So that by the time she ends up her day, most of the 'opae, except the last one she has, is partly half dried already. Do you know how the 'upena look like? I show you, cause I have made some for me, because I use it.

Although 'opae is not gathered for commercial sale today, it is still a popular delicacy among the families in the district. They also gather 'opae to share with family and friends outside and on different islands. 'Opae, the 'a'aniu net used to gather it, and the methods of preparing it will continue to be a distinctive aspect of the cultural lifestyle for which Ke'anae-Wailuanui is known and distinguished.

3. O'opu and Hīhīwai

O'opu and hīhīwai are becoming increasingly scarce in the Hawaiian islands. Certain species of o'opu are endangered and others are rare. They require pristine and flowing

stream waters to exist. Ke'anae-Wailuanui is one of the few areas where they still thrive in sufficient size and abundance to be occasionally caught for subsistence food.

The gathering of hīhīwai is also carefully managed. The location of the hīhīwai is knowledge that has been passed down from generation to the next for their protection and proper management. It is not information that is made available to the general public.

4. Plants and Trees

Traditionally, the mountain area above Ke'anae, Wailuanui, and Kōpili'ula was forested with native trees and plants such as *koa* and *'ōhi'a lehua*. There was also sandalwood at Nāhiku. The plateau looking from Ke'anae and over toward Honomanū had grass, *pia*, and *'olena*. Beginning in 1934, the CCC project planted the foreign trees which are now dominant in the lowland forests.

Most native Hawaiian plants have some medicinal property. Native plants throughout the district are still used for medicinal purposes, such as the maile 'ie'ie, koali, noni, uhaloa, and pōpolo. Introduced plants such as honohono, laua'e, and even watercress also have medicinal properties and are used by the residents for healing.

Makou (*peucedanum sandwicense*) is a large parsley-scented herb which grows in only a few places in Hawai'i on the windward coastlines. The root was used for curing some diseases of children. James Hueu recounted how he had been recruited by two kūpuna, his father and brother when he was just 11 years old to climb the small islet called Keopuka for makou. It was collected for the Hawaiian herbalist, Dr. Kaonohi. He described the experience as follows:

> *But way back in 1931, two old men from Honolulu, they came up and they wanted this medicine. One of the old patients he used to live here, his name was Kalilimoku. So he knew, when he left here he was a young boy, he knew where the medicine was. My dad was living yet, my brother was supposed to climb that moku. You see that moku down there?* (Points toward Ha'ikū side, in the ocean.) *We call that Keōpuka, but it's Puohokamoa Bay, but we call it Keōpuka.*
>
> *When we went down there, I was young, I was only about 11 years old. So my brother was to climb, so I told my brother I think I better climb because you have a family and I'm a single boy. So I did climb and I brought that herb. And till today I ask all these lapa'au people. They don't know the name. The medicine they told me was makou. So I told Larry about it and then he made a song about it. It was about me going up on that moku. About that makou and that island. The herb is something like a dahlia, it grows like a dahlia plant. It grows something like a taro or a lily, and then certain times of the year, it dies. Then, certain times of the year, it grows. So when I went it just was growing, that's why I knew, but I didn't know what kind of herb that was, but my grandfather said that's the one. Anyway I tried, I taste, oh boy, it burn in my chest. So what for, I don't know. They came to collect that for a doctor by the name of Kaonohi. He was the first Hawaiian herbalist, from down Kāne'ohe or somewhere. That's what they came for. It grows only on that kind of moku. This think is like a dahlia. A dahlia grows something like a lily. The color is green. I never seen the flower. But the leaves are similar to taro. And in the*

bottom has a potato. I got the whole thing. The potato, but I don't know what part he used. That grows just like the 'olena, certain time of the year it dies.

A native Hawaiian black banana, as well as 'ie'ie and the Hawaiian bamboo were at one time used for weaving mats and hats of natural fiber.

Pohole, a native fern is popular for eating as a salad. It is blanched and mixed with tomatoes or with pake 'opae or mayonnaise. There is a pohole which is native to Ke'anae-Wailuanui. It is fuzzy and has to be rinsed and cleaned. Another type of pohole was introduced in the district from the Big Island by Mrs. Isaac Kānoa, Sr. The old folks prefer to eat the native variety. It has a different taste. They only gather it in the morning.

5. Fishing

The entire shoreline, reef and nearshore area has abundant marine resources. Those who have boats dive, fish and gather marine life from Kailua to Hāna and go out as far as the HO buoy, 11 nautical miles offshore. They gather 'opihi, crab, and other shellfish from the rocks; dive for squid and lobster and reef fish such as uhu; bottom fish for weke, ehu, 'ōpakapaka and uku; and troll for ono, aku, 'ahi and mahimahi. They occasionally surround akule in the bays such as at Honomanū. Āholehole, 'ama'ama, and uouoa are also caught by Ke'anae fishermen who use gill nets. It is possible to use the hukilau method of surrounding and catching fish in any of the bays, but they don't do it because it depletes the fish resources.

Launching points for fishing are Ke'anae Landing, Honomanū Bay, Wailuanui Bay, and Hāna Harbor.

The bays where the fresh water mixes into the ocean water are important spawning grounds for the fish. Moki Day described how the bays are important breeding grounds which deserve protection:

> *You can consider all the shoreline area between here and Kaupō as breeding grounds for all these shoreline species of fish. They come into our rivers here because we have the fresh water, and they come in here and breed here and lay their eggs here. You go around here in certain seasons or certain times of the year and you see them, they come out in schools. I remember when we were small, before we even started grade school we used to go out with my grandfather and set net, and do all this fishing, you know, pole fishing, we used to hook moi. We seen 50 lb. moi already. They look like sharks in the water. But the only difference is that you see them as a school, a great big school, and there are these big huge monsters in there, and they're all in the waves, and I seen them. My brother and I have been fortunate to see them. And that's what I'd like to see again. And the only way to do that is to do this. And so I'd like to see the fishponds open up so we can restock the moi, and clamp down on fishing, block it up for a couple of years. They're hooking babies.*

The men and young boys can fish in any number of areas, all along the shoreline. For this reason, fishing down at Ke'anae, Honomanū, and Wailuanui is reserved for the kūpuna. It is easy for them to access these two areas. Unfortunately, outsiders who are unfamiliar with the variety of fishing and gathering spots also go to these easy areas, making it more

difficult for the kūpuna to get a good catch. Moki Day explained how the easily accessible areas are reserved for the kūpuna:

> *It seems like everyone here has their spot, where they go and harvest. Like Wailua Bay to Wailuaiki, this is an area that we keep for our kūpuna because it's easy to go to. If you are an 'ōpio or makua, well you have to hoof it. You haven't reached that age or to be honored in such a manner. That's why we have problems with the outside people because they come here and this is where they go. Because they see the 'opihi. Little do they know that it's for our kūpuna.*

There is interest among the members of the community in restoring the fishpond down near Pauwalu Point. On the map it is identified as Pu'uolu fishpond, however James Hueu says that the fishpond is called Po'ulu fishpond. It has brackish water and is now swampy. The wild ducks used to go there every year. The fishermen believe that it would be worth restoring.

6. Hunting

The area above the highway is accessed for the hunting of wild pigs. On the Wailuku side, hunters usually go as far as Honomanū. Above Ke'anae, local residents can access the ditch road and look for pig tracks and then go deeper up into the forest once the tracks are sighted. Hunters go to Wahinepe'e and up as far as Waikamoi. Kupa'u is a popular hunting spot. However above Wailuanui, the gulches get deeper and harder to hunt. The hunters go as far as Makapipi. They access along the four-wheel drive road at Makapipi and go up mauka as far as Kūhiwa. There used to be a cabin above Kūhiwa for hunters to use for overnight stays. A hunting license is required. Most of the good hunting area mauka of the highway is part of the forest reserve and a stool test is required to get a license to hunt in there. Pigs are tracked using hunting dogs which pin a pig down to be killed using a knife.

7. Swimming and Surfing

Fresh water ponds are popular swimming areas. Probably the most popular is Ching's Pond, originally known as Pāhoa Pond. As the stream continues down to the ocean, there are pools and additional swimming places.

Along the shoreline, Wailuanui Bay, Ke'anae Landing, and Honomanū are popular swimming areas. Nua'ailua is a beach for both swimming and surfing. Honomanū and Wailua Bays are also popular surfing spots.

8. Trails

The Pi'ilani "Highway" Trail is the primary shoreline access route for gathering and fishing all around the island of Maui. It is a well engineered route that circumscribed the Island of Maui. In the Ko'olau region, it travelled just above the rugged coastline with numerous switchbacks descending into each valley and out the other side. It is a marvelous example of Hawaiian engineering skills, social commitment, and the ability to mobilize a large human work force.

In the Ke'anae-Wailuanui district it is still used, particularly from Wailuanui over to Wailuaiki and to Kalia'e and over to Kōpili'ula. Some areas of the trail are overgrown by dense forest and the local residents are interested in having the trail maintained for future generations.

There are several makai to mauka access trails and four-wheel drive roads between the highway and the shoreline. Informants emphasized their use of a trail at Kalia'e running makai from the highway to the beach. There are also trails which go down the face of the cliff at Kalia'e. A new landowner from outside had recently put up a fence and bulldozed his land there. He had tried to restrict community access, but the community insisted on maintaining their access and received representation by the Native Hawaiian Legal Corporation. There is also an access trail along the top of the cliff between Wailua Bay and Waiokamilo Stream. Another trail from Waiokamilo which goes down to Moku Mana and Ke'anae is somewhat overgrown, but still used.

Awapuhi Carmichael described some of the trails used by her family:

Kapa'ula gulch, there would be a road, there is a trail from the highway going down. We go all over here. From the road, we go down, on the ridge, not the gulch, (makai), right down to Waiohue, right down in the bay. And then there's the island there, and from here you go to Kōpili'ula too. All over here is the King's Highway, you can walk all along the shoreline. We have gathering rights all over here, along the stream. You can go either way. But for our family, we walk 'em. We walk, we walk from the main highway down and along the coast. We used to walk with my mom up until 1988 we walked this whole area, from the main highway down to the beach and to the rivers. And we used to take like a caravan. My brothers were in high school and they would carry the provisions and the 'opihi. And on the way back to the highway we would stop for 'opae. And my dad, he used to cut all the trails. Like he used to say, oh I think we should go to this part, like to Kōpili'ula. So then a day before he would go down and cut the trail. And then, you know, he had a four wheel jeep and we would go just up to Kalia'e and then walk from there to Kōpili'ula.

Four-wheel drive roads are the primary access routes from the highway to mauka hunting and gathering areas. One of the main four-wheel drive roads used by local residents now begins at Pāhoa. Helen Nakanelua described how she and her grandmother accessed the streams mauka of the highway using this route:

You know where the arboretum is? There used to be a bridge there. But because the bridge was broken, the county did not want to build another bridge. So they brought the bridge to where the swimming pool is. So that's the road you go up to Pi'ina'au they call it. So looking from the school, you can see that trail that goes up on that mountain there. That's were we used to go on horseback until we get to Kōpili'ula, Wailuaiki, Wailuanui. Way up Pi'ina'au on the mountain, that's where they had a camp for all the irrigation company to live, and across there, you cross that kahawai, and there is that trail there to go. If you go by the school and you look, you can see it. Pi'ina'au is toward the mountain, you take the road to this way, you go to Wailuaiki, Wailuanui and all that, that the trail you take. To Pa'akeke from Pi'ina'au, but I went with my grandma, Wailuaiki, Kōpili'ula, that's where the end of the trail, when people go to Hāna, we go there and we stay there in a cave to get a car to go to Hāna. Now we would climb up that river, to get 'opae, every week we were doing that my grandma and I because my brothers and sisters, they didn't want to go to that kind of place.

9. East Maui Irrigation Ditch Road

Before the main Hāna road was constructed, the ditch road was used to travel from Ke'anae-Wailuanui to Hāna or to Wailuku. According to Enos Akina,

> *If you go Hāna, telephone to the one who get car to go Kōpili'ula, wait for you. Go with horse along ditch trail to Kōpili'ula, leave horse, go on car. You like go outside, you go on the horse until Kailua. From Kailua on, you get car to go Wailuku. Come back, get the horse, come back. Bumbye they open this road, get car. Like go outside, go outside.*

Informants also referred to the EMI ditch road as the old road since it was regularly used for travel between Kōpili'ula and Kailua by their parents and grandparents. They are therefore still accustomed to using it for their hunting and gathering activities.

There are three ditches in the traditional practices area - the New Hamakua, Lowrie, and the Spreckels dam that falls into the Hamakua. In certain areas, one goes into another, like at Makapipi. The ditch trails goes right up to Opana and Ulumalu. James Hueu who used to work for EMI described the ditch system:

> *Ha'ikū is the lowest ditch. The top ditch is Wailoa. That's the one that comes from Nāhiku, from Māliko side. Then comes Kauhikoa. And then comes the Lowrie, then the Haiku ditch is the lowest. From Nāhiku to Waikamoi is Ko'olau ditch. And then when you get to Honomanū, you have the Spreckels ditch. The Spreckels ditch went by some where over there. And then right out there you see Manuel Luis. That's a Pokagi guy, Manuel Luis. Sometimes they change names on the way over, like they call it center ditch. But Manuel Luis starts from Kolea to Waikamoi. That's the Manuel Luis ditch. They did away with the New Hamakua Ditch, and that's Kauhikoa. We used to have a new Hamakua. We used to have the old Hamakua, but they did away. Then they put in that Kauhikoa. They replaced the old Hamakua.*

10. Water

Ke'anae-Wailuanui is part of the East Maui watershed where 48 streams originate. Of these, 35 are perennial, flowing to the sea year round, and 13 are intermittent, flowing year round in the upper elevation and intermittently at the lower elevations. East Maui Irrigation (EMI) collects, stores, and transports water from over 50,000 acres of the East Maui watershed, including from the Ke'anae-Wailuanui cultural landscape. The system, owned and built by EMI, consists of approximately 400 intakes (stream diversions), 7 reservoirs, 75 miles of aqueduct (50 miles of tunnel and 25 miles of open ditches), 60 miles of four-wheel drive jeep roads, and numerous miles of trails. The system provides irrigation water for agricultural plains in central Maui, county water to upcountry Maui residents and farmers, and domestic water for Kula, Pukalani, Makawao, Hali'imaile, Ha'ikū, and Peahi (Dept. of Water Supply, County of Maui: Draft Water Use and Development Plan for the Island of Maui (1992): 2-34).

Fresh water is an integral part of the cultural landscape for taro cultivation, the gathering of stream resources, recreation and domestic use. Awapuhi Carmichael explained:

> *All of our streams need to be protected for recreational and gathering purposes, because if we don't, then they'll divert all of the water, and then the streams will*

be empty. Fishes need water too. Certain fishes need water to spawn. That's why we're lucky, we have enough water for the fishes.

Water flows throughout the Ke'anae-Wailuanui landscape from both streams and springs. Stream waters from higher elevations are diverted into the East Maui Irrigation ditch system. The main sources of water for the taro patches of Ke'anae-Wailuanui are springs that arise below the ditch. There is continuing concern about the impact of water diversion upon marine life and taro cultivation. Some community members maintain that the diversion of water during dry times causes the taro patches, which are normally fed only by springs which arise below the ditch, to suffer from insufficient and warm water, leading, in some cases, to the rotting of the taro which thrives on constantly flowing running water.

Awapuhi Carmichael, the genealogist for the Kaauamo family discovered a letter written in 1881 to commissioners A.P. Carter and J.S. Walker by her ancestors to oppose the turning over of the water rights in Honomanū to Claus Spreckels. In part the letter reads:

> Keanae, Ko'olau / September 12, 1881 Hon. A.P. Carter a me Hon. J.S. Walker Na Komisina (Commissioners)
>
> 'O makou o na komimike, ke nonoi aku nei i ko olua 'a'ole lilo ke kahi pono wai o na 'aina lei ali'i o Honomanu, Keanae, Wailua i na ona miliona.
>
> We are the committee members, we request of the two of you not to turn over the water rights of the crown lands of Honomanu, Ke'anae, Wailua to the millionaire (Claus Spreckels).
>
> Signed by: I. W. Kehuhu (Kahuhukaunihiakami Halemano), K. Makaena I.K. Hueu (John Kalawaianui Hueu), S. Kamakahiki, K.E. Maiailua, D.W. Napihaa, M. Kaleba, B.B. Kalilimoku, Kamanele, I.S. Lono, J. Kuluhiawa, Keli'i (Keli'iaukai), J.B. Kaakuamoku.

Historically, another 'auwai carried water into Ke'anae from a creek named Waihāowa. James Hueu told the story of how J.A. Chamberlain dug the 'auwai for his taro patch in Ke'anae:

> *The guy dug an auwai from there, irrigated his taro patch down Ke'anae and has his name under, J.A. Chamberlain. The name of that creek is Waihaowa. Waihāowa iki is the one above, so there must be a Waihāowa nui. Waihāowa means the separating water. So it was separated up there and then they met again up there. So this man, he dug a ditch to use in his taro patch and he named the ditch, the ditch name is 'auwai ho'omanawanui, and he put his name under, J.A. Chamberlain.*

In one of the 'ili between Ke'anae and Wailuanui is the 'Ōhi'a spring. James Hueu provided a description of the spring waters which feed this *'ili*:

> *Where the watercress is, that's the 'Ōhi'a Spring. That's Waikane and Kanaloa. Well they call it 'Ōhi'a Spring. Waikāne and Kanaloa is right under the road. There's two holes where the water comes out, right when you make that turn. Right under there is where.*

That stream, the Palauhulu stream, on the east side, until the other way, they call that Pāhoa-Waianu. Waianu is at that spring, Waikāne Kanaloa, and Pāhoa is that river.

In recent years there has been a problem with hau bushes overrunning the streams and clogging up the water. It affects the East Maui Irrigation system, state lands, and the taro farmers. During heavy rain debris gets caught in the hau bushes and causes flooding. There is general interest in having the streams cleared through a cooperative effort between the state, EMI and the taro farmers. A representative of EMI pointed out that the entire system would need to be cleared at one time to avoid flooding in any one section. The company feels that a government agency is in the best position to initiate and coordinate the clean-up with the cooperation of the state, EMI, and the taro farmers.

11. Taro

The Ke'anae-Wailuanui district is famous for its taro and the community is proud of this legacy. Informants proudly shared traditional family accounts of how their district was never touched by the wars between the Maui and Hawai'i chiefs during the time of Kamehameha I. According to the informants, their district was very important to the chiefs as a source of taro and poi and water. To ravage the landscape would have been reckless and wasteful. Moki Day provided the following insights:

Thousands of canoes came in for water and for poi. But Ke'anae Wailuanui were never touched by war. The people took food to Hāna and to Nāhiku by the Pi'ilanihale heiau where the war was. They carried the food to Nāhiku and came back to mahi'ai (farm).

This is the bread basket of Maui, this area here all the way to Kipahulu. There are more taro patches here than anywhere else on our island. So there's any valley that you can go in here and see taro patches, lo'i formations. These things are still here.

As noted in Section III of this report on the cultural history of the district, some of the historic taro patches in the district were converted to rice paddies beginning in the 1880's and through the 1920's. During that period, taro was primarily grown for home consumption rather than for commercial sale. James Hueu shared his insights on the origins of some of the taro patches in the district as follows:

They say, the Chinese make the taro patch. I say not. The taro patches were there before the Chinese ever came to Hawai'i. But because the Chinese came, they planted rice in the taro patches and they marry into the Hawaiian women. But they never did the taro patches. The taro patches were there long before that. I have two taro patches down here [at the YMCA camp]. It wasn't made by the old Hawaiians, I made 'em. I made that on the dry land. But over here, when we started the CCC camp, I saw terraces over here. So I think they had taro patches, long time ago. There's one taro patch over here on that land, Chamberlain's land, now it's Kepler's, it's a small taro patch. If you don't go around that taro patch, you didn't see Ke'anae. The name of that taro patch is Ke'anae. And they have some taro patches named Kalihi, they have Maka'iwa.

The taro patches had a name. Even me I don't know some of the names. But for Ke'anae, I knew that from way back. In the back of the Kepler house, that area is called Ke'anae. My son takes care of the patches. I told him, you take care of that patch, even if you not even get half a bag of taro, but that patch has history, so don't let it get filled up with grass.

Taro began to be produced for commercial sale to Hāna and to Wailuku beginning in the 1920s. However, many of the informants who are now producing taro for commercial sale indicate that their families mainly began to sell taro for poi after World War II. Before that, most of the taro in the district was grown for home consumption. Currently, many of the families sell taro to supplement their income from employment with the Maui county road crew, East Maui Irrigation Company, or jobs outside in Kahului or Wailuku. However, there are a few families whose sole source of income is from taro production.

Throughout the district old taro terraces can be found and taro still grows in the wild in the valleys, along streams. Informants speak of going out and gathering lu'au leaves from the wild taro because it has a good flavor, distinct from the cultivated varieties. Some of the areas for the gathering of wild lū'au include Pi'ina'au, Nua'ailua, Kupa'u, Waipi'o, Awiowio, Pohole and Pāhoa.

Given the current demand for poi, taro production is a profitable venture. There is a lot of interest in taro production. Taro is being farmed by kūpuna, mākua and 'ōpio. As the kūpuna are growing old their children and grandchildren are carrying on the work. As the mākua generation reach retirement age, they are beginning to return to their family lands to maintain and open up ancestral taro patches.

The cultivation of taro is currently a viable economic enterprise. However, informants also speak of the cultural and personal satisfaction of continuing to cultivate the taro lands of their ancestors. Kaipo Kimokeo described how he felt a spiritual connection to his ancestors when he worked with the taro:

Anyway, I got this job at the arboretum. We started to open the taro patch. Spiritually, I can see my family around me, because, that was the main food. So now, spiritually, I'm involved . . . spiritually motivated this way [to grow taro], because what I can see tells me. All these valleys. We supplied an army. We had all our taro patches. We supplied Kamehameha when he came here. Aunty Mary Kaauamo told me. I was asking her about the apowai taro. She told me that water is spiritual water. It doesn't touch the ground. That water, it can be used for medicine and things like that.

C. Cultural Practice and Subsistence Use Areas

The areas listed below were described as cultural practice, subsistence use, and recreational areas by the informants. It is not an inclusive list of all of the many places used, but it is a list of the areas for which information has been provided at this phase of the study. Additional information about these areas and other important areas should be gathered in future phases of this study.

According to James Hueu, University of Hawaii at Hilo professor of Hawaiian language Larry Kimura should be consulted regarding the names of places in the district and

the mo'olelō or historical legends connected to those names. He has conducted extensive interviews in Hawaiian with kūpuna informants. Notwithstanding, some mo'olelo about places in Ke'anae-Wailuanui were shared by informants and are included below in the description of specific areas. Informants - identified by initials following individual mo'olelo - were: Moki Day (MD); Charmaine Day (CD); James Hueu (JH); Awapuhi Carmichael (AC); Paul Sinenci, Jr. (PS); Harry Pahukoa (HP); Doug Chong (DC); Helen Nakanelua (HN); Maggie Alu (MA); Kaipo Kimokeo (KK); Enos Akina (EA); Apolonia Day (AD); and Mary Kaauamo (MK).

1. Areas within the Traditional Cultural Practices Region

Unless otherwise noted, the places discussed below are *'ili* located between Honomanū Stream and Makapipi Stream, the area described by informants as their *ahupua'a* and traditional cultural practices region.

Hanawī

Got hīhīwai, 'opae, taro, dryland taro, the kind 50 pounds. PS

Hanawī spring is a big spring. PS

Even Hanawī, we use Hanawī for gathering rights ...definitely, the Hanawī stream. Big springs is right here, ya. Here's the gate. Here's the pump. The trail would be right around there and right down to Hanawī. Hanawī, all the way down. From the ridge, then you go down to the stream. This would be the big waterfall, so you stop over here. There's a high waterfall. Here you also collect hīhīwai, till you get down to the beach. When you get down to the beach, you can have your gathering rights for 'opihi, and then you go fishing over there too. In fact this whole place over here, they use it for gathering rights. All along the shoreline, use for gathering rights. Too bad my dad is not you know, they were the only ones, our family used to walk from the mountain to the shoreline in all of these places. AC

Honomanū

People use it for everything. You can get anything in there. They gather pepeiao. The stream doesn't have much . . . cause sometimes we get water in the stream . . . and sometimes we don't get water in the stream. And then there's pohole. And they fish. Moki guys fish over there . . . and 'opihi. They launch over there, surround akule in that bay. CD

This side, got fern, get kukui nut, with the kukui nut we make inamona. PS

They fish there. And have gathering rights. AC

In about 1891, 1885-86, when Spreckels wanted to build the ditch, Spreckels wanted to close Honomanū. There were families here who wrote to the water commissioner, to oppose the diverting of the water from Honomanū, but they never listened. And its all documented. In fact, part of my family, the Kalilimoku, Napiha'a and that belongs to the Kānoa family, Hueu, Keli'i'aukai, most all of them is my family. They wrote to the commissioner, the water commissioner, about 1885-86. You know there's hardly any water that comes down, only if there's an overflow, then the water comes down. All of the water, they diverted the water from there. AC (see page 111)

Olinda is at Makawao. That's where they have the watershed. It comes up to Waikamoi. It comes on top of Honomanū. It has the pipeline, all up there. JH

Honomanū, you cannot go through the upper gate, you going to hit a dead end. If you follow the river at Honomanū, you go up there, it gets steep, then the Ko'olau ditch is up there. So you have to get on the ditch trail before you can get across and go right up. JH

Honomanū they go up too. O'opu. I think there's more 'opae than o'opu. I don't know if Honomanū has hīhīwai. In there easy to get up. Maybe the people who go tenting they go up. JH

Kapa'ula

Kapa'ula - gulch. There would be a road. There is a trail from the highway going down. It would be between Kapa'ula. We go all over here. From the road, we go down, on the ridge, not the gulch, (makai), right down to Waiohue, right down in the bay. And then there's the island there. And from here you go to Kōpili'ula too. All over here is the King's Highway, you can walk all along the shoreline. We have gathering rights all over here, along the stream. You can go either way. You can go on the mountain, too. AC

Kapa'ula - there is a four wheel drive road. Most all of it is EMI roads, and I have a key, so we drive up there. AC

Ke'anae

Ke'anae, the peninsula Ke'anae is a lava flow, and the taro patches down there were built. The dirt was hand-carried from the so-called "Devil's Hole". That's the reason why the hole is there. They took the dirt out of there and made their lo'i down below in Ke'anae. I do not know the chief or the konohiki, but I'm pretty sure there was one for the people to come together to move that much soil. MD

Get kupe'e down at Ke'anae side . . . still get everything - hīhīwai, 'opihi, whatever. Got to keep people from outside away, so that we can still have all these things. CD

Ke'anae point is also a good fishing spot. PS

Kōpili'ula

We go gathering there. We fish, get hīhīwai. Good diving grounds. The stream branches. Got hīhīwai, 'opae, bananas up Wailuaiki. PS

Kōpili'ula is one of the places that has big hīhīwai. There, Waiohue is another place. This is where my family has gone for generations. And I find myself chasing the general public out from these areas. I've chased Filipinos out. MD

Kupa'u

Waterfall by lookout - Kupa'u. EA

Kupa'u is just this side. The Ko'olau Gap is way up and Pi'ina'au, comes down. Get the gap coming down. Get the lodge up there . . . Waikau Cabin. From Waikau Cabin, you come down, then you come to the Ko'olau Gap. Waikamoi is up there. That gap comes right down. And that Kupa'u gap, that's the one get that bridge. Get that waterfall and then it goes around. That's the gap, right up here, we are talking about, Kupa'u. HP

Makapipi stream
One of the major streams, but the place stay empty. The place stay dry cause Maui Irrigation is taking the water. Up here get nice ponds - blue water, cold water. Better than Ching's pond. PS

Hunting- Makapipi is the main place. That's the place. Plenty guys go over here, all the Portuguese. Makapipi where says 4 wheel drive road. Can put a few over here. Got some hunting kind names too, such as what kind of tree grows there, or bush, or a Hawaiian name. PS

Moku Mana Islet
We have a place up here. We have the other rock out here by the point. Before Bird Island, by the point out there, get a rock that points straight up. He said the reason for that is that the gods had turned this man into the rock. Well I guess he used to fool around on the wife. The gods took pity on the wife and they turned him into this rock to show his erection for all time. I forgot the name of that guy. CD

Sometimes they say "bird island". I say it's not bird island, it's Moku Mana. And mana means, well that is double. And they get this Manahoa rock, is right in the back. And they get a natural arch there. And I told him, the legend about this. Moku Mana was a pretty girl. But this guy attacked her. That's why it split. Mana means two. They say bird island, I say nah. Those birds were living over here. That's why I told Larry Kimura, the name of this place nobody knows, but it's Manupakiʻi. That's where those birds used to live. But when they had the lava flow and over here was a river When had the lava flow it was covered with lava so they went away. And they went to that Moku Mana. That's why when they were trying to cut the hill this side, those birds all came back. For about one week those iwa birds came back. The haole ask, why those birds? I said they don't want you to cut that hill down. Elaine Wender tried to stop them, but they went ahead and cut that cliff. Manupākiʻi is this. This point. What they have on the map? They no more name, only Larry Kimura has the name. Manahoa is the man. Mokumana is the woman. The legend says he attack her, that's why. JH

Go fishing, get ʻopihi. Hahaha Bay - that bay got plenty ʻopihi too. PS

Nuaʻailua
In there too the kids go fishing and they go swimming or surfing over there. There's the legend of the shark that lives over there. CD

Get awa, fern, opae. Go surfing. Gather. PS

Do you have Nuaʻailua in there? Below, that's taro. JH

ʻŌhiʻa Spring
Well the legend of Kāne and Kanaloa, sometime long, long ago there were two old men, they were going to drink ʻawa. So they had the ʻawa all pounded but they had no water. So one of them said, well I know how to get water. So he cut an ʻōhiʻa branch, well they call the mountain apple ʻōhiʻa, and then he punctured the wall. Out came the water. So the other old fellow said, oh if you can do it, so can I. So he punched the wall too, and the other water

came out. As the stream goes down, the name changes. From 'Ōhi'a, all the names change. The name of the stream was Waianu stream, as you go down, you have Kalua nui and at the bottom is Kilo. JH

Watercress is cultivated here by the daughter of James Hueu. JH

Pāhoa

Where the watercress is, that's the 'Ōhi'a Spring. That's Waikāne and Kanaloa. Well they call it 'Ōhi'a Spring. Waikāne and Kanaloa is right under the road. There's two holes where the water comes out, right when you make that turn. Right under there is where, even the water that is under there is good spring water and they call that Waiokuna Spring. That spring, you walk right up above the swimming hole. You go right up. There are some taro patches up there, but I haven't seen anyone plant taro. But there are taro patches up there. They call that Palauhulu stream. Waikuna pond is where they have a waterfall right there. That's Palauhulu stream. There are taro patches on the way down, not above the waterfall, cause its a high waterfall there, but below the waterfall. Below Waikuna, not too far from the main road. But I haven't seen anybody raise taro. But the taro patches are there. That land belongs to the state. That stream, the Palauhulu stream, on the east side, until the other way, they call that Pāhoa-Waianu. Waianu is at that spring, Waikāne-Kanaloa, and Pāhoa is that river. That hui land is 107 acres, but these are flat land, not taro patch. JH

Palauhulu Stream

Use all of Palauhulu stream, they have hīhīwai, maybe he could tell you. Palauhulu - way above Waikuna. Way above, past the Palauhulu pond. We use the reserve road as a reserve. AC

Pi'ina'au

Pi'ina'au flows all the time. Get 'opae, hīhīwai. PS

Pi'ina'au is above Palauhulu, and then it goes right through the forest to Kikokiko Gulch. AC

Kikokiko - waterfall - further up. EA

In fact at Pi'ina'au, our kūpuna say has taro. AC

Pi'ina'au and Kupau are the hunting areas. Below the ditch. Get forest line up there, and then get the gate. From there is forest already so you got to get hunting license and the state license and everything to go up above. But see, like us now, like how you were saying, that's our lifestyle that. When I was small, that's what we used to do. We go up hunting, we go catch 'opae, we go up there, we pick up wild taro, lū'au, all kind, watercress, everything, still get up there. But now when you go up there, just like they're the boss up there. Somebody stopped me, I never get license. License is not cheap too nowadays. You know, to be one hunter today, cost a lot of money. You got to take care your dogs. Cost a lot of money. And you got to buy hunting license, and you got to by hunting things for you to go hunt. Not like before, we just go. Today, you got to pay for all kind things. Yeah, I used to hunt with my dad when I was young, I was going to Ke'anae School. Me and my brother go hunting. That was our lifestyle, but now today you no can do the kind stuff like that, they shut you out. But now, when you go hunting like this, open to the public. The guys from Lahaina, Makawao,

they all can come over here hunt. So what they do now, they get the hunting club. You call this week, you like go Pi'ina'au, you call first, you get 'em. If I call too late, I no can get 'em, you get 'em. One hunter go up there. Like how I see, up Pi'ina'au get hunting area over here, hunting area over here and you get the license only for one guy. One group go inside. You can hunt all over. But they don't like, I don't know. Me I like go up there hunt and you go hunt over here, I go different place to hunt. You know what I mean, get plenty places to hunt, inside that area. But I don't know. Before I used to go that kind hunting club but I give up. You go up there, you only grumble, grumble, waste time. HP

Wahinepe'e

At Wahinepe'e - a woman hid under a stone when Kamapua'a was chasing her. JH

Hunting ground - pretty much. Hunting and gathering area. We go Wahinepe'e. We can go pretty much four different areas in Wahinepe'e - one of them is high falls, red flower, Manuel Luis, and one other one. By the ditch and above the ditch. PS

The trail begins by the highway. PS

Go along the stream to gather, also go along the ditch to gather. Lots of 'opae in the tunnels. PS

They used to have taro patches by Wahinepe'e, across from Wahinepe'e. Just before you enter the forest, there are some graves there. There's taro on the Wailuku side. PS

Wahinepe'e had pineapple field too. You know , he was one of the operators who came all the way over here to work. He was one of the operators. But he said was spooky, you know, our 'ohana graveyard. Down here is another one. Down here, you know the flat by the church. That's graveyard down there, and then they went bulldoze. They went bulldoze over here to clean this pasture out. But the graveyard is still there. They never push the rocks from there. KK

Waialohe Pond

Well, in the days of long ago, there used to be a lot of mullet in there. Mullet, āhole. But that place belong to my family. Had o'opu in there, and hīhīwai. So one time there's a haole guy,he came to be the director for the YMCA, so he goes to the library, he comes back, he says, Jimmy what is Lelekaua? I look at him, he says, what is Lelekaua? Well, you know the Hawaiians, that's their spot. They know how to dive, head first, lelekaua, they jump. I hear Kahekili was a master lelekaua. I said, oh yes. Kahekili was the champion lelekaua king. Oh I hear somewhere over here he jumped. I said, oh yes. He said where? I said at Waialohe. One day, he overestimated, he landed on the dry land and that was the end of Kahekili. I don't know if it is the truth or not, but his remains is hanging down in that pond. He look at me, he laugh. There's a cave and there are the two hanging down. I go in there with my canoe I used to tie my canoe to that rock. But one time, big water, one got lost, and had one more left. So when Napokā came, I told him, eh Nathan go in there and look. He told me no more. But I didn't go back to look in the pond, and in the cave. Hanging in the cave, there were two of these, the privates of Kahekili, hanging there, and I see 'em. I talk about it because I seen that. I used to tie my canoe in there, and I hook o'opu in there. They don't believe me, but I think there's only one lady living here and she's seen that. And she's about

88, 89 years. She's Mrs. Kulahiwa, and she's a pure Filipino lady. But when she got here, my aunt hanai her. I guess she seen that. But I say, I seen 'em, but if not there, well . . . JH

Where is the cave?

It's right down there in the Waialohe pond. That's a long pond, go right down to the ocean. It's really not a cave, it's kind of a hollow. The thing was hanging right in there. But I'm waiting for this boy to go dive. Maybe it broke off and it's down. It was hanging right there, and I seen 'em. JH

The mountain people used to bring 'olonā, potato, and they come down to the village to trade. The village people are fishermen. They supposed to give them fish. So one time the mountain guys came down, and these people, they were lazy or what, they never catch fish. So they stuffed old fish tails, bones, they put 'em all in the bag. So when they went back up there, they pulled out the bag, and out came all the tail of the fish. Somehow the tail of the fish turn into a shark, and they raised 'em up there. And so when grew kind of big, he came down through that river, Palauhulu stream. And he came down to Waialohe. Down Waialohe has a rock, and the color is reddish, and then they call that Luahi'u. And the shark came under there, and there's a cave from there, until Kepler's place, under Ke'anae. So this shark stayed under there. Once in a while he come here and then he go back. So if you go are related to the shark, no matter what, you swim in the ocean from that point, and they call it Hawini, but that is Huelo until Pauwalu, you don't have to worry about getting into the ocean. That's what this old man told me. And I kinda believe his story. Only a legend, but that story, I think he's right. And I know where that rock is, they call it Luahi'u and we were so afraid before to go swim in there. And that rock is right down there, before you go into the ocean, at the end of the pond. And anyway, that was the story that he told me. It's a red, long, it's a ledge, but right under there, they have a hole. But nobody went in there. But the shark used to live under there. When you go down there to Kepler's place, there's a inlet that goes in there, and it comes out. But I think now it's all covered. So that shark live under there. A lava tube that goes from Waialohe to down there, the landing. JH

What I heard Waialohe was, you know in the old days, you used to yell, you hear echo, eh. So lot of people think, eh that water went hear, that's why they call it the hearing waters, eh. But you yell and you hear your own self, and they think someone is answering you. But no, it's the echo, eh. Then somebody said, lohe is certain people, not hairy, olohe (lua masters). JH

Wailua Iki

We have a story and a chant about in Wailuaiki where she turns into a rock. Pele turned into a rock to hide from Kamapua'a. CD

One time there was a fisherman down at Wailuaiki. This fisherman went out fishing. Somehow this guy Kamapua'a changed himself into a man and the fisherman's wife, he was trying to make good with the fisherman's wife, but she didn't want. So another guy gave some kind of a signal to the fisherman. He came back. When he came up on shore, he attacked Kamapua'a. He changed himself into a pig. They call that eku, the pig. He tossed him up to that place Polai. That's the hill up there by Wailua. Then he went up there, he gave him another toss. He fly him up, here, they call that Kūō. Kūō mean, you know, he sort of cry. And he slid down the pali and he had a pohole. Pohole, that was the story of the legend. That's why they call it Pohole up there. But they got a place name up here they call Kūō. So when he landed up there he Kūō, he sob. Then on the hill up there,

pohole, they get, watcha call in English, they call the skin pohole, not laceration, you slide and then you hemo skin. So the Hawaiian get all kind of legend. Most time it comes out. JH

Landed in Wailuaiki - Konohiki went out fishing with Kamapua'a. He saw beautiful Hawaiian girl, wife of konohiki. Fisherman said to divide fish. The fisherman flung Kamapua'a to Kupa'u and he landed at Pohole. He got scraped, got a strawberry or pohole, thus the place is pohole. There was no name for the fern. Called the fern pohole. AD

Kamapua'a also landed on a boulder in the arboretum. Kūō. Pig's cry when hurt. See pig tracks around the rock. AD

We go by trail, over the rocks to surf and its a fishing spot too. PS

But way down at the end, a person by the name of Adams has his land now. There are a lot of terraces. And they have a little creek there. They have o'opu, they have 'opae, and hīhīwai in there. You wouldn't believe it. In that main Wailua, I don't know, it's all polluted. But in that little river where Adams has his place, there's a name but, you don't have it on your map. Inside of West Wailuaiki, on the Wailuku side, its a spring water. It goes into a creek. It comes out right at the Wailuanui river. It doesn't come from way up. It just starts from somewhere in the hills. That Enos Akina, he used to get his drinking water from there, from the hill. But since they made pipeline over here, then he went to the county pipeline. He had pipe. He took it from way up. So with the pressure, he get the water to his house. From the top, not right by Adams. And there's no river above that. It must have just come out of the hill. When it comes down it runs off by where Adams bought his place. All my life here, I didn't see anyone using that land until Adams came. Then he made the people all shook up. JH

Wailuanui Bay/Stream

Get all kinds, go out so far and drop. In some places used to have land and then the land dropped. If you look down here at Wailua - land would go way out. If you go out there and look, get a part in the middle of the whole bay, can see the water kind of crest around there. It was all connected at one time, and I think an earthquake or something and the whole thing went drop. That's where the women used to go and do their lauhala. You got one area in the middle where it is part land which has fallen down. CD

Wailuanui has hīhīwai. JH

Wailuanui is hard to get to, there's a high waterfall, so you cannot get much. Maybe you go above the waterfall. Above the main road okay. But the 'o'opu cannot climb up a steep waterfall. I think the only one that can go up. I was talking with the guy, the one who comes around and he makes a study of 'o'opu, he told me the one that they call nopili and the one with the red tail, hi'ukole can go up. I said, well o'opu hi'ukole, even the sharks don't want to eat that. JH

We are known as Wailuanui, from Uncle Harry's to here, go on further, that's Wailuanui. From the school, go down to where they have the eating snack stand, the Wai'anu stand run by the Chongs. Ke'anae is further down. The intersection coming down from the YMCA, that is Ke'anae. But within Ke'anae, there are names for each place. Like here now, it is Wailua, but within Wailua we have a certain name for a certain area. Some they call it Pahu'a, that's the piece of land here. And some people call it Keone Nalu, that's a place where the road goes in

the right off the road coming in from the well, that belongs to Keone Nalu, that's where Aunty Maggie comes in. There are different names to different places. It's inside that has the areas that have the different names. On across on the other side, back of Charmaine, well that's Palolena, but it's within Wailua. They call that Palolena. And then this side over here where Akina has his taro patches, it is in Wailua, they call it, I can't remember now. We had different names to different areas. So that people will know within Wailua, there is that part named that and this is that part, it's not known as all Wailua. Otherwise people will not be able to find it. So if you say, in Wailua, Palolena, they know already where it is, they just go right across there, because they know where is Palolena. Oh, it's Makekū, it's on this side of Palolena. Makekū they call it, they have a name. And further on this way, up this way, they call 'em Pahu'a. See how all the different names. HN

Keonenalu, and that's Pahu'a below, here. And there's Hula, they call Hula, they have different places, the portions. All the different names. And so like where the section is that I have now, that I have turned over to Kyle, and he has somebody to take care of the land now, the people named that place Pikanoa, because that was the man. His first wife (deceased) was a relative of my grandmother. Because my grandmother was a relative of his first wife and she had kept this section for many years, Pikanoa's second wife, Alice Kahakuleana gave her the first choice to purchase the land. Instead, Helen Nakanelua and her husband, Paul, purchased this land. HN

And then I have another piece of land right down Wailua, across the river, they call that Palolena. It's taro land, but I haven't seen taro growing there. Palolena is across the Wailuanui stream. From Wailuanui, you have West Wailuaiki, East Wailuaiki. Keone Nalu is, as you go into Wailua, on the right hand side, you know the road junction, there's a road that goes inside. I have 2.933 acres at Palolena. JH

At Wailua, across the river is Palolena. Get one haole who bought one place over there. Makekū, up in Wailuanui. On top up Wailua stream, right next is that other bay, and then up top is Kalia'e. Then Wailuaiki, right after Wailuaiki, that's where that haole guy bought that area, come down. At Kalia'e, another haole guy bought, comes down from the road and goes down to the beach. JH

Waiohue

Fishing, 'opae. All the streams got 'opae, but us, we go to certain places, you got to move too. O'opu, yeah. All of these streams. Got fishing all along the shoreline. This is where they breed - by the stream water and the open water. The brackish water is where they breed. O'opu, mullet, moi, āholehole, the silver fishes, oama, they all go up stream too. Special kind of place over here. All the bays. PS

Waiokamilo Stream

We also use Waiokamilo stream. We go through the lookout, this road here, and go into what they call Waiokamilo. There are different names. That's what we call Moana. Above Wailua Lookout, that's Kupa'u, you got to go through Kupa'u, then you reach the stream. Then you go to Moana, that's another part, that's above. You got to go from Pi'ina'au, and then to Moana. Go on the Pi'ina'au road. Pi'ina'au road, this is the Ko'olau (ditch), the 4 wheel drive road, You go on the four wheel drive road, go across Palauhulu stream to get up here, some place up here. We go all the way up to Moana, we go up to the forest, and that's what we call Akeke. That would be in the forest. Moana to Akeke, and that would be in the forest. Akeke is springs, they call it banana springs. Now they call it banana springs, we go right up to there

Go through Pi'ina'au, cross Palauhulu stream, get to below Waiokamilo, there is a water fall there, and then we go up to Akeke, they call it Banana springs now. AC

Its hard to tell you, because each section has a name. And all the old people know. Even in this village, each section, each rock has a different name. And if I made a mistake, then Moki would know because he uses the same. He goes to Moana. And that's what we call it, Moana. Way up above, yeah, we call it Moana. Then Moana goes into Akeke, the springs. AC

The springs just come out of the ground, and then there are taro patches. Let Moki explain. We go all the way up Pi'ina'au stream, all the way up to Kikokiko Gulch. Pi'ina'au Stream or Palauhulu Stream. Pi'ina'au goes into Palauhulu. They change the names so much from when we were little, Palauhulu goes up into Pi'ina'au. AC

2. Additional Areas of Traditional Cultural Practice

Unless otherwise noted, these areas are 'ili. While these 'ili are located outside of what the informants identify as their traditional cultural practices region, many of the families access these areas for subsistence gathering and fishing. In some cases families originated from these areas and still have family burials and kuleana lands there. Their parents, grandparents, uncles, and aunts continued to access those areas and passed on the knowledge about these areas and the resources in these areas to them.

Honopou

Honopou too. Get taro patches down there . . . more down by the ocean side. There is a stream. Honopou stream. From the highway down, there are taro patches. Now get taro patches all in here too. Old taro patches and pretty much I think its this whole green area. Get plenty trees now, but there was once all taro patches. PS

Kolea

Look for Kolea, Punalu'u, right over there has taro patches. Just past Wahinepe'e, at Punalu'u, makai of the road, on the Wailuku side. Kolea, even above had some terraces, and below. On the main road, but above in the forest, they had terraces, above the reservoir. JH

Makaiwa

Fishing, very good gathering. PS

This is a trail too - this is a ridge, go this way, I think it goes down again, I haven't gone down the trail for a long time. Go down from Kailua. Kailua is my place too. Come little bit more back, there's a gate from the highway, follow the ridge, we have a cabin over there for the EMI folks at Maka'iwa. PS

Māliko

We go to Māliko. PS

Ko'olau forest reserve. PS

Olinda

We go up Olinda - I pick maile, 'ohi'a, make lei, personal kind. PS

Ke'anae-Wailuanui has persisted into the end of the twentieth century as a center of traditional Hawaiian culture and lifestyle. While living in distinct households and cultivating individual patches of taro for their own families and for commercial sale, the residents share in the abundance of natural resources from Honomanū to Makapipi. Together, they respect and care for the springs and streams that feed their individual lo'i kalo and sustain an abundance of gathering resources. Together, they continue to respect the balance of natural resources with their own needs, taking only what is necessary for their family's daily sustenance and respecting the reproductive cycles of the animal and plant life in the valleys along the Ko'olau coast of Maui. Their children have played together, attended school together and matured to adulthood, sometimes intermarrying.

The Hawaiian way of life has continued to thrive among the households and taro patches of Ke'anae-Wailuanui, despite the influx of retired Chinese plantation workers who farmed taro at the turn of the nineteenth century, and the post statehood settlement of outsiders seeking a quiet lifestyle in rural Maui. The persistence of the Hawaiian lifestyle in Ke'anae-Wailuanui has provided an important continuity for all Hawaiians, not just those living there, to their rich heritage (Figure 44).

Ke'anae - Wailuanui Community

Figure

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE

VIII. LANDSCAPE USE PATTERNS

Noni

VIII. LANDSCAPE USE PATTERNS

A. Spatial Organization

1. Land Use and Settlement Pattern

The Ke'anae-Wailuanui area is sparsely settled in a linear pattern. Residences are found along major roadways and adjacent to cultivated lands. Homes are clustered in Wailuanui, Waianu, and Ke'anae. With very few exceptions, all houses and major buildings are found within 200 feet of the Hāna Highway, Ke'anae Homestead Road, Wailuanui Road or the main tributary road in Wailuanui. Aerial photographs show a relatively even pattern along these roadways. Setbacks from roadways are deep. Along Ke'anae Homestead Road and the roadway in Wailuanui, setbacks average 50 feet. Along the Hāna Highway, setbacks average 80 feet.

There is almost no clustering of public buildings and there is no clear sense of a town or community center, although the community gathers at the school, the YMCA and at the church halls. Community members have a clear sense of place and frequently refer to travel beyond the cultural landscape boundaries as "going outside". In the recent past, local stores and poi mills may have provided informal, but regular, community gathering places. The YMCA camp is located on a ledge above the cliffs at the entry to Ke'anae. The Congregational Church is sited on Ke'anae peninsula at sea level. As the crow flies, Ke'anae School is located roughly at midpoint between Ke'anae and Wailuanui. Saint Gabriel's Church and Our Lady of Fatima shrine are farther east on the sloping lands descending into Wailuanui.

Another general pattern is the building of houses on flat lands whether they are the bottomlands of Wailuanui, the peninsula at Ke'anae or the uplands of Ke'anae Valley. With a few exceptions, houses are not built on steep slopes or cliffs. Some public buildings, such as the Ke'anae School and Our Lady of Fatima Shrine, are built on level areas at the top of terraces or small hills, taking advantage of the perspective above the road.

Determinants of the settlement pattern include historic events and changes, and adaptation to taro cultivation and other agriculture. During the 19th century, the *Mahele* and the Land Act of 1895 precipitated a consolidation of the population at Ke'anae and Wailuanui; previously, the population had been more dispersed through the traditional use area. While these acts established individual property holdings, they may also have diminished the property rights of individuals who formerly had variable land uses within an *ahupua'a*. Within the 20th century, the abandonment of the Ke'anae Landing, after the opening of the Hāna Highway during the 1920s, shifted the locations of poi mills and storage buildings. The destruction of homes and lives during the 1946 tsunami doubtless caused a preference for building at a higher elevation (Homeowner's insurance now complicates such site selection further). Completion of the Hāna Belt Road and ever-increasing automobile traffic has caused residents, particularly those who work outside the cultural landscape area, to choose the convenience of residence along the Hāna Highway. School buses transport older school children to Haiku, Makawao, or Hāna.

The residential pattern seems related to agriculture and the closeness of the people to the lands they cultivate. The taro *lo'i* and the few other diversified crops that are grown are generally cultivated on relatively flat lands. Many of the people walk to their fields. Proximity increases efficiency in the closely tended taro fields.

2. Irrigation Systems and Circulation

It is quite clear that at Wailuanui and Ke'anae the *'auwai* and *lo'i* systems were constructed first and subsequent residences and circulation networks accommodated the already established systems. The pattern of cultivated *lo'i* at Ke'anae has remained relatively intact since at least the turn of the century according to early survey maps. In all likelihood this pattern existed at the time of the *mahele* when the lands were parceled out. At Wailuanui the individual *lo'i* system is not as intact as at Ke'anae but the overall pattern is similar. The differences probably developed due to the extent of rice cultivation from around 1880 until 1927. Wailuanui had a rice mill and more extensive rice cultivation than Ke'anae. There was probably some alteration to the *lo'i* pattern during this period. However, the broad pattern remains since both crops are wetland agricultural products and the irrigation system plays a critical role in their cultivation. The mechanics of irrigation systems must follow gravity. Residences are found on slightly elevated areas at the edges of the fields, not in the center of the *lo'i* which would be the low spot and subject to periodic flooding. The roadway network serving these residences skirts the cultivated areas and does not cut into the system of *lo'i*. This pattern involves frequent tending and fits the horticultural character of Hawaiian agriculture where the cultivated fields are relatively small and are within walking distance of residences. It is a pattern developed before automobiles and mechanized agriculture. The field was central, not the residence. This pattern is found even in areas where residences are not nearby. Mrs. Helen Nakanelua's Lākini *lo'i* are not located near any homes today. However, in the past there was a house nearby which has been destroyed by fire. Mrs. Nakanelua's relatives are buried next to the house site. In upper Ke'anae Valley, which was cultivated into the 1950s, Mrs. Maggie Alu and her husband lived on the land adjacent to the *lo'i* until they decided to close the poi factory they operated next to the cultivated area.

3. Viewsheds

From the vantage point of the Hāna Highway, Ke'anae is best comprehended looking towards the ocean: the *lo'i*, the houses, and palm trees framed by the rugged black lava coastline and the white surf give the peninsula its unique character. The tongue of land is held precariously above the ocean like the back of the mullet (*'anae*), to which it owes its name.

The essence of Wailuanui is water (*wai* = water). Wailuanui is best viewed looking *mauka* (inland). The taro *lo'i*, as seen from *makai*, are framed by the steep green slopes of the valley with Waikani Falls to the east and Waiokamilo Stream waters entering from the center and the west. The *lo'i* themselves, as they ascend the slopes, decrease in size to accommodate the requirements of water control. Nowhere else in Hawai'i are such miniature fields still cultivated in this kind of topography with such integrity.

The value of a cultural landscape is closely associated with its visual qualities. Concepts such as historical integrity, architectural consistency, settlement patterns and rural character - all important criteria for cultural landscapes - are most readily grasped from points within a landscape that offer a comprehensive view or series of views of that landscape. The preservation of viewsheds is potentially a goal for management of the cultural landscape.

In effect, the entire drive along the Hāna Highway comprises a significant viewshed. The lush vegetation, numerous streams and cultivated landscape along the highway route all suggest travelling through a garden. This garden-like quality is

important qualities of the landscape. Flowers and fruit trees both cultivated and wild, dot the landscape on both sides of the road. Housing setbacks are wide and landscaping of individual lots enhance this quality. The well managed taro *lo'i* and yards blend with the natural landscape and generally provides a seamless view experience along the road that is equal to any in the State. Setbacks, landscaping, architecture, uses, borders, vegetation and natural features all play a part in creating this garden-like character.

4. Subsistence Use Areas

Subsistence gathering, hunting and fishing is an integral part of the lives of the residents of Ke'anae-Wailuanui. As discussed in the *Mana'o O Ka 'Āina* section, the pattern of subsistence use of the land is determined by: family and ancestral connections to particular land areas; the distribution of water; access; the type of resource to be obtained; the life cycle of the resource; in the case of animals, their diet and feeding habits; the weather; and *ho'ailona* or spiritual signs in natural phenomena.

There is general agreement among the informants that their traditional cultural practices region extends from Honomanū in the west to Makapipi in the east and *mauka* from Pohaku Palaha on the rim of the Haleakalā crater, *makai* to the shoreline, and into the ocean as far as the buoy. Additional areas are used by residents of Ke'anae-Wailuanui depending on where their family ancestors originated and established subsistence practices. For example, some families fish and gather as far east as Kaupo or as far west as Honopou and *mauka* to Waikamoi.

The location and distribution of water is the primary determinant of the distribution of natural resources. Traditional land use boundaries were defined in relation to the amount and location of water. The change of season from wet to dry does affect the distribution and availability of subsistence resources. When there is a lot of rain, the resources are more abundant and spread out over a larger area. During the dry period, the amount of resources shrink and they are distributed around water sources.

Most subsistence use areas can only be accessed by land through a trail or a dirt road. The Pi'ilani Trail affords an important route of access between *'ili* along the coastline. The Ke'anae-Wailuanui residents also use an extensive network of *mauka* to *makai* trails to carry out their subsistence activities. Hunters say that one can readily catch a decent size pig without venturing far up the mountain. However, the network of trails allows access to upper regions where the larger animals roam. Informants marked many of these trails the map which is on file with the Maui County Planning Department.

Fishing resources vary by ocean depth. Along the rocky shoreline fishermen gather crab, *'opihi*, *ha'uke'uke*, and other shellfish. In the reef residents gather *limu*, and catch squid, lobster, and reef fish such as *uhu*, *kala*, and *manini*. At greater depths bottom fish are caught such as *weke*, *ehu*, *'opakapaka* and *uku*. In the bays nets are used to surround *akule*. *Aholehole*, *'ama'ama*, and *uouoa* are also caught with gill nets. In the deep ocean and out to the buoy the fishermen troll for *ono*, *aku*, *'ahi*, marlin, and *mahimahi*. Ocean resources are accessed by land through *mauka*-to-*makai* trails and along the Pi'ilani Highway. Boats are also used for ocean subsistence activities. The launching areas are Honomanū Bay, Ke'anae Landing, Wailuanui Bay and Hāna Harbor.

Resource gathering patterns are also influenced by *ho'ailona* or spiritual signs in natural phenomena. The Ke'anae-Wailuanui residents stay alert to the direction and

patterns of clouds, winds, rain, the flight birds, rainfall and all natural elements to inform them about where is the ideal place to gather on any given day. They also keep track of the moon phases and the affect on the shifts in the tide. Ancestral knowledge of the interpretation of place names in the district also informs Hawaiians about the special features or qualities of that particular area for subsistence and cultural use.

B. Natural Determinants of Settlement and Construction

The natural environment of the region has clearly played a vital role in the development of its history and settlement patterns. Its influence has ranged from the type of agriculture practiced to the reduction of external influences for change.

1. Flatlands

The cultural landscape of Ke'anae-Wailuanui has been developed on the windward flanks of Haleakalā. The topography of the region is rugged and steep. The shoreline is predominantly sea cliffs and boulder beaches with few alluvial flatlands suited for cultivation. The heavy rainfall has carved deep valleys into the broad slope of the mountain. The limited amount of flat lands has directed human settlement onto these few areas due to the needs of agriculture. While archaeological evidence shows cultivation on steeper lands in earlier times, those fields have been abandoned for decades. Long time residents in their eighties and nineties do not remember seeing these steeper hillsides, flanking Wailuanui Valley along the Nāhiku side, in cultivation. It seems clear that these fields were abandoned over a hundred years ago. It is likely that other terraces, which were abandoned as population declined, are located in steeper, less accessible areas of the region.

Settlements and cultivation areas are found on the flats of Ke'anae, Wailuanui and in Ke'anae Valley. To a lesser extent there is some taro cultivation within the narrow valley bottoms of the smaller streams, but these are minor areas in comparison to the flats. This is a constraint of geography. In addition to these constraints, the flatlands are where the richer and deeper soils are generally located.

2. Rugged Terrain and Isolation

Due to its rugged terrain, the Ko'olau region of the Hāna District has been isolated from the flow of population and commerce that has affected much of the rest of Maui. Until the Hāna Highway was completed in 1926 there was no easy overland route to the region. Due to the rugged shoreline, large boats were unable to dock along the shore. Even with the construction of the Hāna Highway the region remains relatively isolated. These constraints have served to preserve the integrity of the cultural landscape as well as knowledge and values of the Hawaiian culture and lifestyle.

Even within the district, the steep cliffs and deep valleys have created clear distinctions between areas. Each valley or promontory has its own character and story. Despite the proximity of the two *ahupua'a*, Ke'anae and Wailuanui have different qualities. The rivalry between chiefs of the two *ahupua'a* mentioned in the legend may have been rooted in this geographic separation.

3. Rainfall

Rainfall has clearly affected the human settlement of the Ke'anae-Wailuanui landscape. Since the region's volcanic soils are porous and do not hold water well, it is due to the abundance of rainfall and the reliability of stream and ground water sources that the

region has developed wetland agriculture for its source of sustenance. The taro culture which defines the identity of Ke'anae and Wailuanui is only possible because of the abundance of rainfall. Other diversified crops which are grown for sale such as ginger, *pohole* and *hāpu'u* ferns are also plants that thrive on high rainfall.

The second impact of the rainfall is on the architecture of the area. Wide overhangs and corrugated roofs that come from the plantation era are responses to the climate, providing durability and protection from the frequent rains.

4. Slopes and Irrigation

The ample water sources and the slope of the land have resulted in an irrigation system that is highly efficient. Water sources are streams or springs and the irrigation system works by channeling diversions from these sources. Within the system, gravity directs the water flow from one field to the next.

Currently, two areas of the system are located *mauka* of the Hāna Highway: the small independent system that feeds the Ke'anae Arboretum *lo'i* and the more significant system in the Lākini property of Mrs. Helen Nakanelua which subsequently feeds the lower Wailuanui *lo'i*, *makai* of the Hāna Highway, the major portion of the system.

Archaeological evidence indicates the system of gravity-based irrigation fields formerly extended into the steeper slopes of Wailuanui and even higher elevations up Ke'anae Valley. As recently as 1950, cultivated fields and the associated irrigation system could be observed at the 400- to 500-foot elevation of Ke'anae Valley.

5. Ocean Access

The strong northeast trades, steep sea cliffs and lack of protected harbors along the coast have limited the accessibility of the region from the sea. Since there are no good harbors in the region, both the Nāhiku landing and the Ke'anae Landing are located on a part of the shoreline that is slightly protected from the wind by the peninsula or coastline. Outrigger canoes were frequently used for transportation before the construction of the road. Stories about the ferry, which operated until the Hāna Highway made it obsolete (*ca.* 1927), focus on ocean conditions when the ship unloaded its goods at the landings. Older residents recall times when rough seas made landing at Ke'anae impossible and the ferry went on to Hāna. Sometimes the goods were unloaded at Hāna and hauled back to Ke'anae by horses. At other times, the ferry would attempt a landing at Ke'anae on its return journey to Kahului. If wave conditions were still bad and a landing was again impossible, the people of Ke'anae-Wailuanui would be left without outside provisions or mail for two months since the ferry generally made only one trip a month.

6. Land Access

Before 1900, much travel in Hawai'i was by canoe, although there were many famous "runners" who specialized in running over difficult terrain at phenomenal speeds. A Maui high chief, Pi'ilani built a stone trail, the *Alaloa* or "long road" around Maui, and the Ke'anae-Wailuanui area still has remnants of that trail. An early traveler, George Bowser, recorded that "we went floundering and creeping along at anything but a lively pace" along the road (Bowser 1880:514). According to Enos Akina, the oldest living resident of this area at age 94, the road once went through every gulch where it had a wire bridge which could be walked across if the water was too deep or too strong for a horse to cross (Enos Akina in McGregor interview 1994). The steep topography and heavy rainfall have impacted the

engineering of the Hāna Highway and all the roadways in the region. Erosion is prevalent and roadbeds often wash out. Many bridges are needed to cross streams and gulches as the Hāna Highway winds up and down across the landscape. Between 1922 and 1923 the County of Maui began to make the road beyond Kailua. Prisoner labor was used to build this road, and a work camp for prisoners and free road gangs was established at Ke'anae in the area now forming the YMCA camp (Hawaii Heritage Center 1990:6). The road to Ke'anae was complete by 1924, and by 1928 the road work forged ahead to Hāna, still using the prison labor from the Ke'anae Prison Camp. The bridges in this area were completed by 1926. They cross the major perennial streams in the cultural landscape region. They are the Wailuanui, Waiokamilo, Palauhulu, and Pi'ina'au Stream crossings (see Appendix E for bridge details). Prior to bridge completion, vehicular travel outside of the cultural landscape area, or from Kahului to Hana, was unreliable.

7. Building Materials

Building materials are predominantly local, likely due to the region's isolation as outside materials were not readily available. Stone was used to build churches and walls. *Hau* wood was commonly used for fence posts. Walls and berms for *lo'i* are made of basalt rock and dirt.

Available materials were limited in quantity and variety. The impact of the environment in this case is evidenced by the lack or abundance of specific materials; e.g., there is little coral in the sea here and coral is not generally used for walls, road fill or houses as it is in some other parts of the Hawaiian islands.

8. Vernacular Architecture

The vernacular architecture of Ke'anae-Wailuanui is related to the local "*kama'āina* (long-term resident) architecture" that has developed over time. Strongly influenced by the plantation style architecture which was dominant during that era, the specific vernacular of the region has some unusual features that are associated with its history, climate and people. An exception is the gambrel roof at Saint Gabriel's Church which represents a unique style found only in Wailuanui and the Catholic church at Kaupō. The use of asphalt shingles on the older residences is unusual and probably represents a response to the windy and rainy climate. The uniformity of building materials and colors is probably associated with the region's isolation which fosters the use of local materials and limits the variety of commercially produced materials. This may change as outside influences and access increase in the area.

The relative homogeneity of the architecture is probably also due to the pattern of long-term residence in the region, with a small community of families influencing one another over the generations. Architectural change occurs in incremental and compatible ways.

C. Taro Cultivation: Economy and Land Tenure

1. Poi Mills

During the fieldwork for this study, which included field trips as well as interviews, it became apparent that the Ke'anae-Wailuanui communities have a long history of small commercial ventures associated with processing and marketing of local taro. Besides the store which once stood at Ke'anae landing (People's Store/Ah Chan), there were six separate poi mills. Each was in operation over a different span of time. Each sold local taro processed into poi to the community itself and also exported taro.

Taro was exported in two separate directions: to Hāna and to Ha'ikū/Kahului/Wailuku. In most cases these poi mills or stores were located adjacent to the major thoroughfare. According to oral histories, the first poi mill in operation was the Alama Poi Shop on the *makai* side of the Hāna Highway, just east of its junction with the Ke'anae peninsula road. Operation of this mill probably began in the 1920s when the Hāna Road was being constructed, and continued into the 1950s.

Another mill - the Ching Poi Mill - was located across from the Ke'anae Lookout. It was part of a complex which included a theater, a coffee shop, and a store. A local resident recalls the theater building was still in existence during the 1950s but by then the poi mill was no longer in operation. Later the concrete pad for the poi mill was removed. This mill exported to Kahului and Hāna.

Farther east, halfway between Ke'anae and Wailuanui, across from Ke'anae School was another poi mill, said to be the second mill in operation. It was run by the Ng family. This mill exported poi to Hāna.

In Wailuanui, by the present Wailuanui Wayside Lookout Park, *mauka* of the Hāna Road, was the Kupa'u Poi Mill, run by the Alu family. This was in operation from the late 30s to the early 50s. Poi from this mill was exported to Wailuku.

The Lum Hoy Poi Mill, next to the existing Lum Hoy residence in Wailuanui, still contains the concrete pad and some machinery, although the building has no roof. This mill overlapped in time of operation with the Kupa'u Poi Mill and also exported to Wailuku. It was operated through the 1940s.

The last mill - called the Ke'anae-Wailua Poi Mill - was started in 1975 by Mr. Eddie (Kimo) Wendt. It was operational until 1984.

The communities of Ke'anae and Wailuanui were clearly of sufficient size to support small family-operated commercial ventures within living memory, dating back to the 1920s and 1940s. The viability of these poi mills or poi shops is a reflection of the fluctuations in population within the two communities, as well as a slow but steady decrease in taro production itself. These ventures have vanished as a result of the development of complex transportation networks and centralized markets.

2. Land Tenure in Ke'anae Peninsula Taro Fields

Given the greater availability of historical and local resident information on the Ke'anae *lo'i* system, this system was chosen as the "type-locality" for extensive mapping during the present study. All 194 *lo'i* presently or recently used for taro cultivation were mapped, with water delivery and water flow pattern indicated for each field.

Through the generosity and interest of two Ke'anae taro farmers this map was taken a step further to show the present pattern of land use and ownership. The owner and cultivator of each of the 194 fields was recorded and this information was collected on two separate color-coded maps. These maps are on file at the Maui County Planning Department.

The 194 *lo'i* in the taro complex at Ke'anae peninsula are divided among 21 separate owners. Generally, an individual owner's *lo'i* are not grouped in one place but are arrayed in

clusters over separate portions of the complex. The present ownership boundaries match the boundaries of the Land Commission Awards granted over 150 years ago.

It appears that, presently, six of the owners are also cultivators of their *lo'i* and that the remaining owners lease out their *lo'i* to others. There are 18 separate parties - either lessees or owners - who are presently cultivating the *lo'i* on Ke'anae peninsula. Most of these cultivators appear to have 12 or fewer patches; however, one individual seems to have 35 patches. Generally, each cultivator's *lo'i* are spread in separate clusters over the complex, similar to the dispersed pattern of *lo'i* ownership.

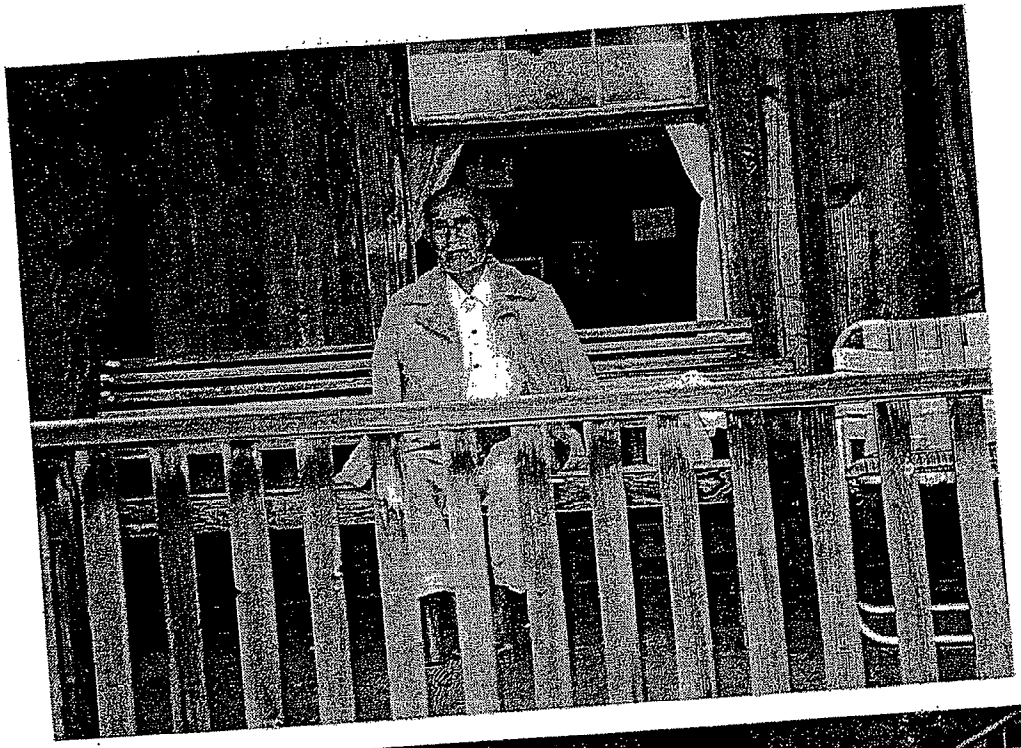
Thus, both the ownership and cultivator pattern of the *lo'i* show a lack of complete spatial contiguity. This is an expression of the traditional concept of land use. Here, although the land is owned by individuals, the right of passage anywhere in the system belongs to the community. In both patterns of use and ownership, the groupings of *lo'i* tend to be parallel to the lines of the water flow — not perpendicular. This pattern is probably related to - and may be based on - the traditional arrangements for water rights.

One of the most notable aspects of this analysis is the fact that there are only six owners who are also cultivators of *lo'i*, possibly indicating a general trend away from family-oriented farming. In only 35 *lo'i* are the owners and cultivators the same people. However, nine of these are not presently under taro cultivation (in lime trees, grass and papaya). Thus, out of a total 194 *lo'i* in Ke'anae, only 26 are cultivated by their owners.

D. Cultural Determinants of Land Use Patterns

The land use patterns of the Ke'anae-Wailuanui region detailed above have also been shaped by Hawaiian cultural mores and practices, some of which were communicated by the residents in the *Mana'o O Ka 'Āina* section of this report. The *'ohana* values and practices of the community stress the conservation of natural resources for the benefit of present and future generations. Rules of behavior are based on respect of the *'āina*, the virtue of sharing, and a holistic perspective of organisms and ecosystems that emphasizes balance and coexistence. The Hawaiian outlook which shapes these customs and practices is *lokahi* or maintaining spiritual, cultural, and balance with nature. In the course of their travels through the various *'ili* of the traditional cultural practices region, practitioners of Ke'anae and Wailuanui are able to renew their knowledge and understanding of the landscape, the place names, names of the winds and the rains, traditional legends, *wahi pana*, historical cultural sites, and the location of various native plants and animals. The region is thus experienced as a part of their *'ohana*, necessitating the same care as would a member of their family.

IX. INTEGRITY & SIGNIFICANCE



IX. INTEGRITY AND SIGNIFICANCE

A. Period of Significance

The Ke'anae-Wailuanui region is important for several reasons. The period of significance parallels the general change of Hawai'i from an isolated precontact society to a rural community facing the pressures of the modern world and its global networks. For the purposes of this report, this is the period from precontact to 1945, the end of World War II. Significant structures built during this period are eligible for inclusion in the National Register (over 50 years in age). During this period the population gradually evolved from an isolated, traditional Hawaiian community to a modern, predominantly Hawaiian community which retains aspects of its traditional character. As explained below the region is significant as a "cultural *kipuka*".

B. Integrity

The Ke'anae-Wailuanui cultural landscape is evaluated for integrity of spatial organization and physical components, and for historic associations that it attained during the period of significance. This landscape reflects the impact of an isolated, but socially integrated community based on subsistence and commercial taro cultivation and a general traditional rural economy.

1. Spatial Organization

The areas used for taro farming have not changed since the establishment of wetland cultivation in pre-historic times, although the total area under cultivation has decreased. Also, it seems the layout of the fields themselves, within the two major systems of Ke'anae and Wailuanui, has not changed since pre-history. For example, the layout of the Ke'anae *lo'i* follows the same pattern as that indicated for mid-19th century Land Commission Awards and, likely, has changed very little since their initial construction. The layout at Ke'anae appears to have not been significantly altered for the rice cultivation occurring there earlier in this century. In Wailuanui, the smaller fields, as shown by 19th- and early 20th-century maps, were never taken out of taro, even during the heyday of rice production. These characteristics distinguish the Ke'anae-Wailuanui taro landscape from that of Hanalei on Kaua'i. The Hanalei system, with its large squared-off fields, represents a landscape, originally planted in taro, which was redesigned for rice cultivation and which retained that design when taro replaced rice in this century. The Ke'anae and Wailuanui systems have never lost their character as a taro landscape.

2. Physical Setting

The physical setting of Ke'anae-Wailuanui contributes to its integrity as a cultural landscape. The region is isolated from urban centers and contains, within a small area, all the subtle and dramatic variations of a windward Hawaiian landscape. Ke'anae peninsula itself is an 'a'a lava flow surrounded by the ocean with no natural stream drainage. Waterflow was diverted to the peninsula by design of the pre-historic Hawaiians solely for the purpose of taro cultivation. This use of such a rugged landscape is unexpected. This may be the only example in Hawai'i of wetland irrigation on an 'a'a lava flow.

3. Historic Associations: Cultural *Kipuka*

The most distinctive historic association of the Ke'anae-Wailuanui landscape is its unbroken relationship to the foundations of Hawaiian culture through the traditional cultivation of taro, the major component of the cultural landscape. The traditional cultural

practices region is also significant as a surviving enclave of Hawaiian subsistence, cultural, and spiritual beliefs, customs, and practices.

Botanists who study the volcanic rainforest have observed that eruptions which destroy large areas of forest land leave oases of native trees and plants which are called *kipuka*. From these natural *kipuka* come the seeds and spores for the eventual regeneration of the native flora upon the fresh lava. Rural Hawaiian communities like that at Ke'anae and Wailuanui are cultural *kipuka* - places where Hawaiians have maintained a close relationship to the land through their livelihoods and customs - that play a vital role in the survival of Hawaiian culture. There is a growing recognition that protection of the natural resources and the integrity of the lifestyle and livelihoods within rural districts is essential for the perpetuation of Hawaiian culture.

Persisting through 20th century development, cultural *kipuka* such as Ke'anae-Wailuanui have depended upon undeveloped natural resources which provided an abundance of foods for the Native Hawaiians living there. Production in these districts was primarily oriented around home consumption. Small stores, often run by Chinese, provided some access to basic modern amenities such as kerosene, lanterns, tools, and coffee. Money to purchase basic provisions came from selling taro or fish or an occasional day's labor for a local entrepreneur or the government road crew.

Primarily, rural Hawaiians who lived in these districts were able to acquire the basic necessities for their families through subsistence activities upon the land by employing traditional knowledge and practices passed down to them from their *kupuna* (elders). Family knowledge about prime fishing grounds and the types of fish which frequent the ocean at different times of year usually assured Hawaiian fishermen of successful fishing expeditions. Taro and other domestic crops were planted by the moon phases to assure excellent growth. Seasonal fruits and marine life was part of their diet. Native plants were used for healing illness. Cultural knowledge in general informed Hawaiian families about how their ancestors had coped with the natural elements and assisted them in understanding and adjusting to the natural elements and resources of their district. Hawaiians in these districts continued to trace unbroken lineal descent from the original Hawaiians who had settled their district as well as to the spiritual life forces and ancestral deities of the land itself.

The comprehensive knowledge of local resources and traditions shared by the residents of Ke'anae and Wailuanui in the *Mana'o O Ka 'Āina* section above give evidence of the possibility for the survival of the Hawaiian culture through the dynamic forces of political and economic change during the twentieth century.

C. Significance

Federal and state criteria for determining historic significance were applied to the Ke'anae-Wailuanui cultural landscape.

National Register Criterion A

Criterion A applies to properties that have association with significant events affecting broad patterns of history. The broad pattern of history that most represents the essence of this landscape is the development of Hawaiian agricultural systems. Wetland irrigations systems, in general, were developed and maintained as public works only in the context of a system based on planning, organization of labor, clear definition of water rights and community cooperation. Hawaiian culture, as expressed in religion, art, lan

social structure and chiefly political system, developed over nearly fifteen hundred years in these islands with the sustenance provided by the highly-developed and well-managed systems of wetland taro cultivation. Nowhere else in the Pacific did the cultivation of this staple crop reach such a degree of development. Because of the importance of taro in Hawaiian culture and history, and because of the degree of integrity with which the Ke'anae-Wailuanui landscape manifests this development, this landscape is eligible under this criterion. This landscape also qualifies in consideration of the time-depth of agricultural development represented by the abandoned irrigated networks which fringe the Wailuanui system to the south and southeast.

The Ke'anae-Wailuanui cultural landscape also bears the evidence of the early competition between the American board of Foreign Missions, of the Calvinist tradition, and the Roman Catholic missionary efforts. After the mid-nineteenth century the intensity of this rivalry subsided as religious pluralism evolved in the kingdom. However, a result of the rivalry is represented in the two remaining church buildings in the area: the Protestant Church in Ke'anae and the Catholic Church in Wailuanui. There is a local anecdote regarding the remains of a stone church which was once a construction effort in Wailuanui not far from Saint Gabriel's and the "miracle church". Under the hau trees the unfinished building can be located and is still in relatively good condition. Stories told by several old timers say that the structure is part of a Protestant church that was never completed. The rocks for the church were washed away when the Protestants selfishly announced their intent to keep the coral rocks that were washed onto the shore during the first of a series of unusual storms by claiming that the rocks were on their side of the land. Another storm washed all the rocks back into the ocean. Subsequently, rocks for the "miracle church" were washed on to the Catholic side of the land and none on the Protestant side. Ultimately, the Protestant Church was built in Ke'anae and the Catholic Church was built in Wailuanui, both in 1860, although the Ke'anae church did not hold its first service until 1863.

The region's participation in the immigrant and plantation heritage tie it to this important historic period of Hawai'i's history. While the headquarters of the major players and companies in the region were generally based in Hāna, Haiku, or Wailuku, Ke'anae-Wailuanui has rich associations with this history. The role of Japanese immigrant workers in the construction of the East Maui Irrigation Company (EMI) ditch through the region was an important factor in Japanese immigration to Maui. Additionally, many Chinese plantation workers at the completion of their contracts, left the plantations and moved to Ke'anae and Wailuanui to lease the wetland irrigation systems there to grow rice. Oral histories document the interaction of immigrant Chinese and native Hawaiians. Historic features associated with rice cultivation still remain.

The widespread recognition of the spiritual as well as physical basis which taro provides for the Hawaiian culture, adds significance to the traditions of taro growing evident in the cultural landscape area. The largely Hawaiian population and persistence of many aspects of traditional Hawaiian lifestyles make the area a cultural *kipuka* - a repository from which a renewal of a more traditional Hawaiian society can be drawn.

National Register Criterion B

Criterion B refers to associations with famous people. Though no significant personages are specifically identified with the area, there are accounts of incidents involving famous persons in the vicinity, from time to time. In pre-contact events during the 14th century, Wailuaiki and Wailuanui became the war canoe landing area in the battle for Hāna

which was a part of the early unification battles between Umi-a-Lilōa and Ho'olae-Makua. Three centuries later battles between Kalani'opu'u, Chief of the Big Island, and Kahekili, Chief of Maui, were fought in the Ko'olau region. Kamehameha was one of the warriors under Kalani'opu'u during these battles. In 1778 Captain Cook's second voyage to Hawai'i occurred during this period; Ke'anae and Wailua were along his sailing route. Kalani'opu'u and his entourage came aboard Cook's ship - the Resolution- while it anchored off Wailua and Kamehameha spent a night aboard the ship.

National Register Criterion C

This criterion refers to the quality and integrity of a property in which it can be described as an excellent example of its type. The Ke'anae-Wailuanui cultural landscape is undoubtedly an excellent example of a landscape whose main focus is wetland taro cultivation. There is both purity and continuity of form expressed in the scale of cultivation, the layout of the fields, the *'auwai*, the source and delivery of irrigation water, the management and labor practices, the associated residential pattern, the continuity of use and the setting of an isolated rural Hawaiian community. The current research has established that the configuration of the Ke'anae system of irrigated taro patches has not changed since it was mapped in 1903, and the Land Commission Award records, ca. 1850, describe a system essentially the same as that seen today. It is also an excellent example because of the beauty and variety of its natural setting. Also to be considered as part of this landscape are the excellent examples of abandoned, but still intact, wetland irrigated systems, along the south and southeast perimeter of the Wailuanui *lo'i*. Here, ancient rock terraces, as many as six levels, and intact *'auwai*, represent "fossilized" versions of the present working systems.

Ke'anae-Wailuanui has good examples of buildings that are representative of those typically constructed in Hawaii from 1850 to 1945. Both Ke'anae Church and Our Lady of Fatima Shrine are in good repair. Both have gone through recent restoration work by the congregation and friends of the churches. Wooden domestic and public structures dating from the early decades of the 20th century also exist in the dispersed settlement pattern typical of rural landscapes.

Waikani Bridge has been evaluated as being of high significance (Hawaii Heritage Center 1990: 40). Its continuous concrete arch deck makes it an excellent example of this type of design and one of the most aesthetic on the island of Maui. The bridge was also among the last constructed to complete a reliable road between population centers on Maui.

In proportion to the total number of residential structures in the community, the number of residences built more than 50 years ago also establishes the area's value and integrity as a cultural landscape. Although some of these structures are in disrepair, many are occupied and in reasonable condition. They provide a physical record of the past along with a record of the evolutionary adaptation of domestic architecture with available materials and environmental and social conditions. Many of these houses are occupied by the original residents or families who built them and this provides a further value in its historical continuity.

National Register Criterion D

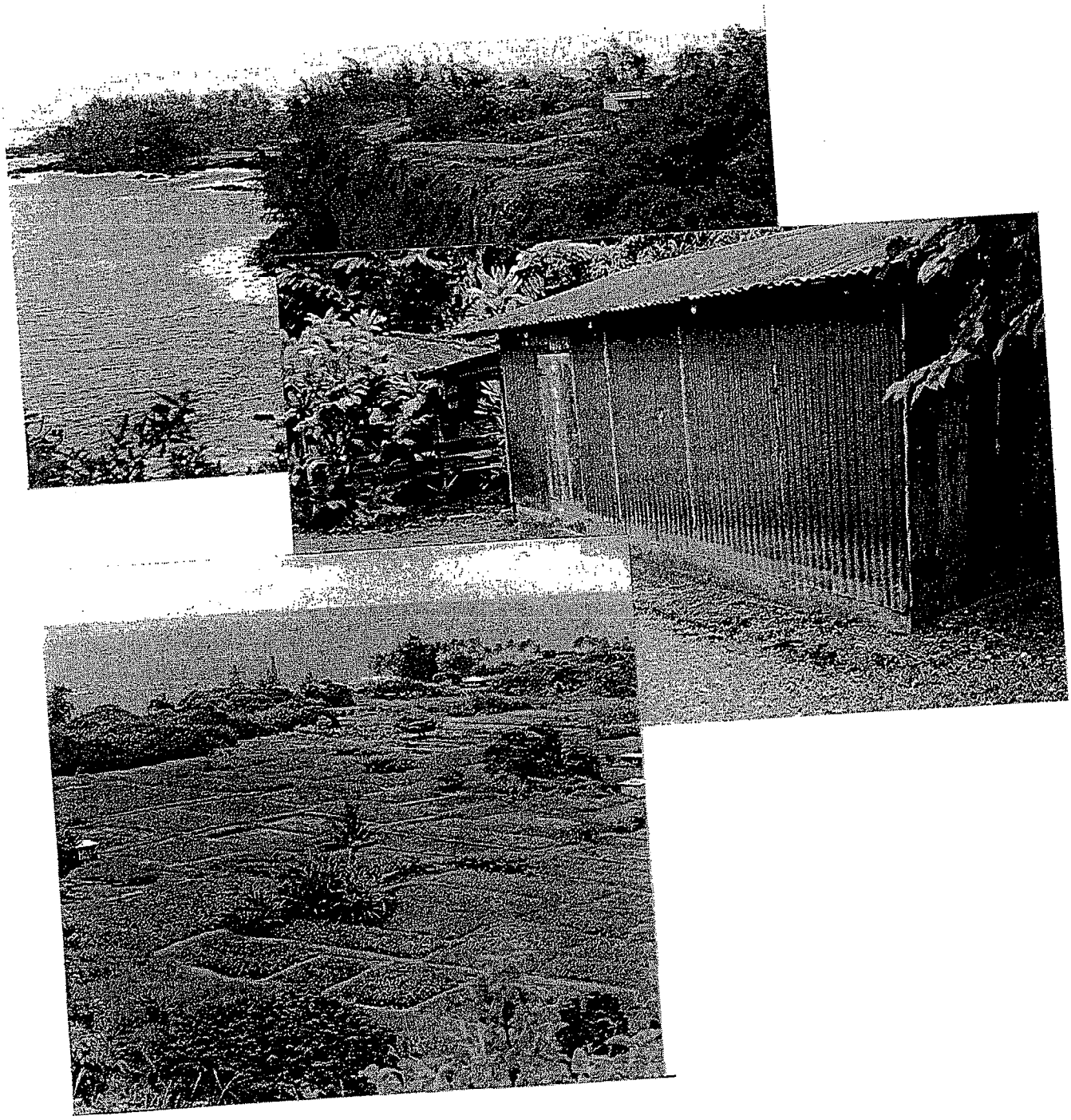
This criterion refers to the potential for yielding information important in history or prehistory. The Ke'anae-Wailuanui landscape qualifies under this criterion because of its potential for yielding information on the origins, chronology and development of Hawaiian taro cultivation and the development of the associated Hawaiian community. The integrity

and apparent time depth of the irrigated agricultural systems, combined with an absence of modern development in most areas and continuity of cultural traditions, indicate that further research has a high potential to yield information on both taro cultivation and early Hawaiian social development.

Criterion E (as defined by the State Historic Preservation Division)

This criterion refers to traditional cultural significance. The Ke'anae-Wailuanui landscape qualifies under this criterion because it represents an important resource in the perpetuation of traditional Hawaiian cultural practices - such as taro cultivation, hunting, fishing, and gathering - and Hawaiian social interaction.

X. POTENTIAL IMPACTS ON THE CULTURAL LANDSCAPE



X. POTENTIAL IMPACTS ON THE CULTURAL LANDSCAPE

Both the research consultant team and the Maui County Planning Department staff have noted current issues and activities which may jeopardize the integrity of the cultural landscape found at Ke'anae and Wailuanui. While there may be other future threats to the significance of the area, the current concerns noted fall into four categories which are discussed below. Changing administrative jurisdiction, the increasing popularity of travel along the Hāna Highway by tourists, road and bridge improvements, and use of water resources are either currently affecting or have the potential to affect the cultural landscape. Several of the recommendations in the following section of this report are suggested as means to mitigate these impacts.

A. Transfer of State Lands to Department of Hawaiian Home Lands Jurisdiction

On October 28, 1994, as part of a settlement agreement, the State of Hawai'i transferred 16,518 acres of land to the state Department of Hawaiian Home Lands (DHHL) along with an agreement to provide nearly $600 million in funding to develop these lands. Twenty-four parcels - totalling 242.3 acres - in the Ke'anae-Wailuanui region were included in the final transfer: two parcels on Ke'anae peninsula, one parcel in Ke'anae Valley and 21 parcels in Wailuanui (Figure 45). These parcels include *kula*, coastal and taro lands.

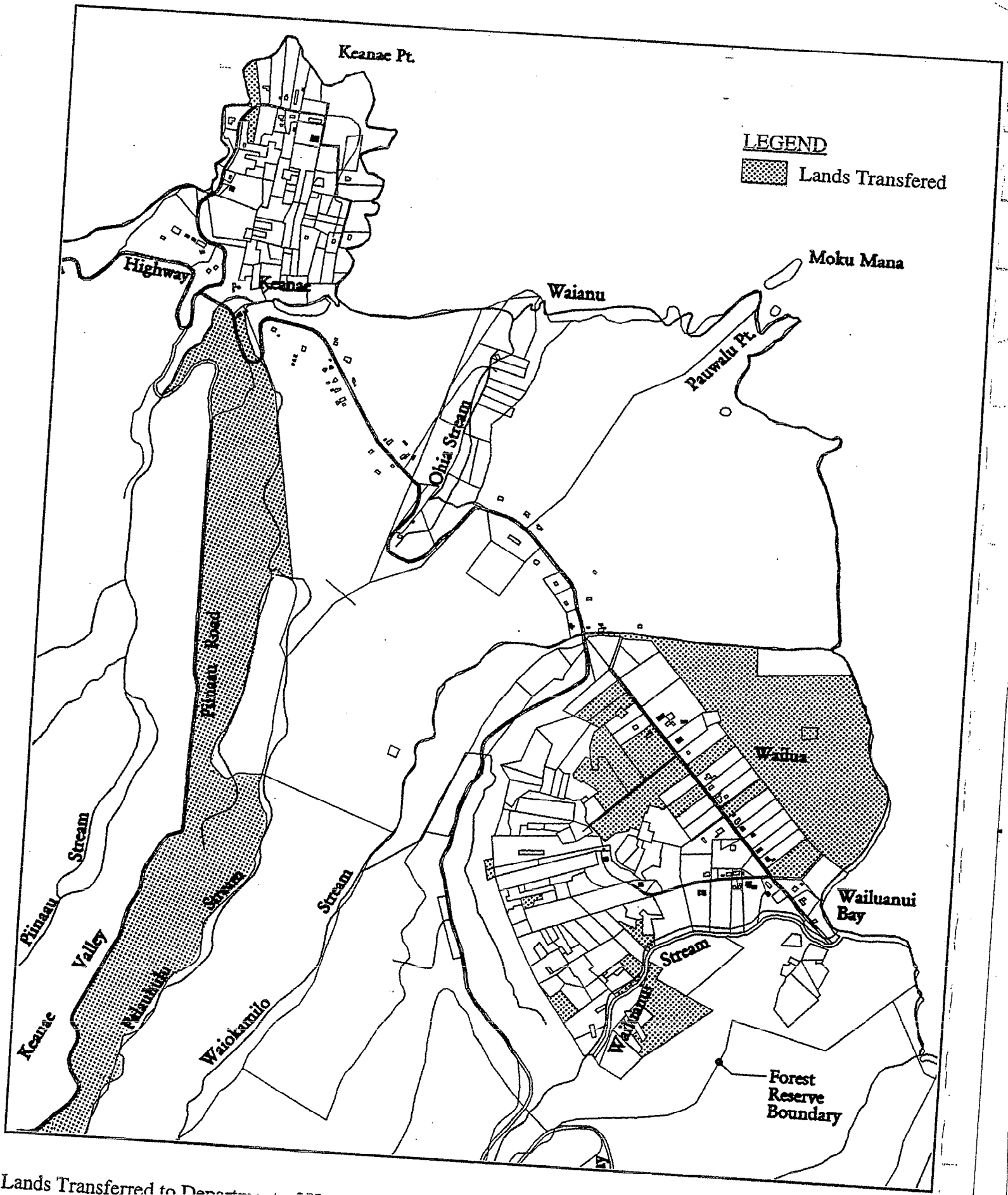
DHHL distributes 99-year leases of house lots to qualified applicants of at least 50% Hawaiian ancestry. Awards of leases are made on a first-come, first-served basis and the waiting list of applicants has long exceeded the number of lots available. No priority is assigned to applicants on the basis of geographical or family affiliation. In discussions of the land trust with Ke'anae and Wailuanui community members during the present study, there was a consensus among the informants that the ceded public lands in the Ke'anae-Wailuanui area should benefit the families who have lived in the community for several generations.

It has been established in court cases that the counties have no land use jurisdiction over DHHL lands. Maui County regulations and personnel do not regulate or control development on DHHL lands. The parcels involved in the transfer are scattered throughout critical areas of the Ke'anae-Wailuanui cultural landscape area and potential development of these parcels could have a major impact on the character, quality and integrity of the landscape.

Hawaiian Homeland developments are usually designed as single-family, small-lot subdivisions. However, at Ke'anae and Wailuanui, residential lots have been tied traditionally to agricultural lots and there has been a strong relationship between homes and the taro cultivation on nearby lands. The upcoming lease assignments and conditions may serve to strengthen or weaken these connections which are important to the preservation of the rural, agricultural lifestyle and systems that are currently in place. Several of the parcels included in the transfer are currently used for pasture or are fallow taro lands that could be brought back into cultivation. If used primarily for house sites, development of these lands may begin to erode some of the agricultural roots of the community.

B. Tourism

Hundreds of tourists daily take the scenic Hāna Highway which has been described in this report as a significant viewshed. Tour publications, hotel concierges, and television



Lands Transferred to Departm

stations publicize the charms of the road to Hāna with its 52 bridges and stunning views. Some tourist-oriented publications recommend a drive down onto the Ke'anae peninsula. A Ke'anae taro farmer has estimated that a tour van comes down the road to the peninsula every 20 minutes during the daytime. While there is certainly scenic beauty on Ke'anae peninsula to be experienced by tourists, the need of the residents to conduct undisturbed their daily labor-intensive farming activities must be considered. Other, less intrusive, opportunities for tourists to examine the Ke'anae-Wailuanui landscape are available: panoramic views from the lookout above Ke'anae and from the two lookouts above Wailuanui provide a far better perspective over the mosaic of taro lands. Additionally, the state park at Waianapanapa, a customary stop for tourists to Hāna, provides far more spectacular views of the same type of black lava dramatically meeting the ocean as at Ke'anae peninsula, along with paved parking and acres of public shoreline access.

Public facilities in the Ke'anae-Wailuanui portion of the Hāna Highway are at capacity or overburdened. Parking at the overlooks, as well as at the Ke'anae Arboretum, is inadequate for the number of visitors attempting to use them. Additionally, roadside picnic, rubbish and restroom facilities are limited to a few state parks, which appear to be experiencing an increasing maintenance burden. Swimming in pools along the route to Hāna is also encouraged by tourist-oriented media, but potential impacts on the streams from human use have not been addressed by the tourist industry.

C. Highway Improvements

The Hāna Highway winds along the north shore of Maui, crossing numerous streambeds by means of approximately 50 bridges, several of which were built in the early 1900s and are only one lane wide. Improvements to the Hāna Highway, including bridge replacement, are an ongoing project of the state Department of Transportation Highways Division. The department has had prepared an *Historic Bridge Inventory and Evaluation: Islands of Maui and Molokai* (1990) which documents nineteen historic bridges (over 50 years old) located in the Ke'anae-Wailuanui cultural landscape area. At least one of these bridges, Waikani Stream Bridge, has been established as significant architecturally and historically, having a high degree of integrity. Road improvements and replacement of any of the bridges in the area will affect the integrity of the cultural landscape: Ke'anae and Wailuanui would be made more accessible to increasing numbers of tourists in larger buses, and more susceptible to development, including residential subdivisions for commuters to more urban areas.

D. Water Use

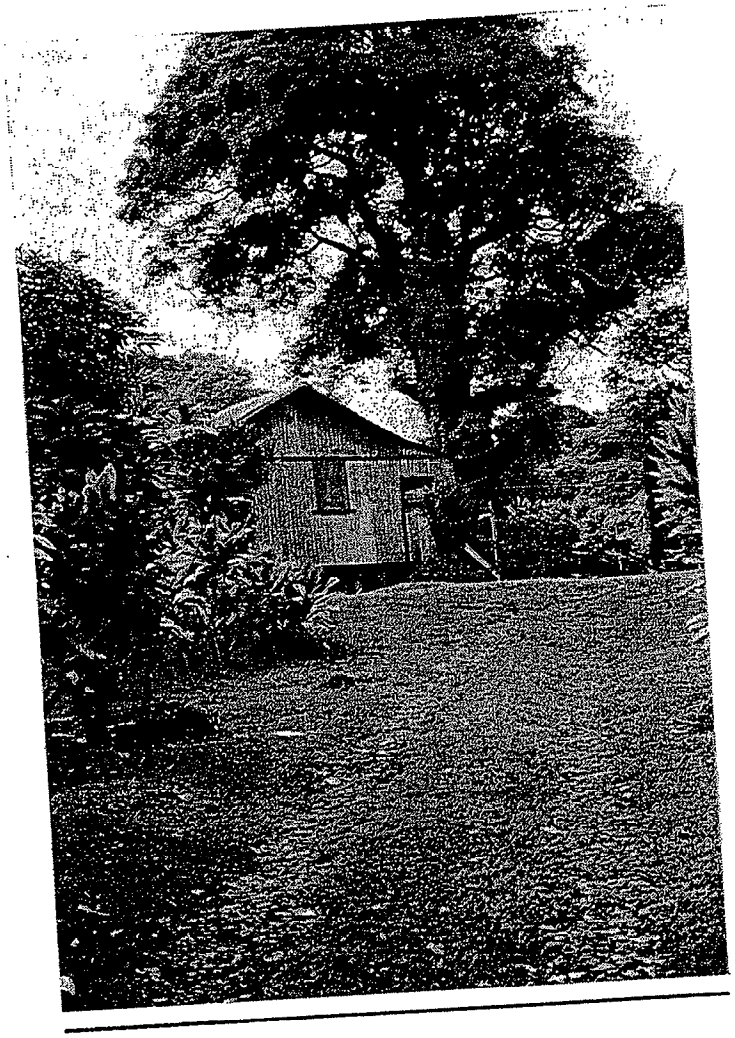
The diversion of streams in the Ko'olau watershed via the East Maui Irrigation (EMI) Company system, has reduced the surface water flow in the region *mauka* of the cultural landscape. The system currently provides most of the irrigation water for central Maui's large-scale agriculture and is the main source for county water supplies to upcountry Maui residents and farmers.

While the degree of reduction has not been quantified, the volumes of water carried by the ditch are significant and impact on the stream ecology in Ke'anae and Wailuanui is probable. Native endemic and indigenous species such as *'o'opu*, *'opae* and *hīhīwai* are likely to have been affected within the last few generations, with consequent impact on the traditional gathering practices that are part of the local lifestyle. During interviews for the

present study, Ke'anae and Wailuanui some residents expressed concern over the impact of the diversion of water by EMI Co. on the ecology of the region. They also question the effects that the EMI diversion may have on the temperature and consistent flow of the water to taro lands. Other residents view EMI Co. as a steady economic mainstay of the community. The ditch system itself has also been used by residents for access to hunting and gathering areas.

In the future the diversion of water may become an important issue as both agricultural and residential uses increase on East Maui.

XI. RECOMMENDATIONS



XI. RECOMMENDATIONS

Landscapes are dynamic by nature and will change with technology, human needs, cultural practices and beliefs. The purpose of this inventory has been to identify what is historically and culturally notable about the contemporary settlement at Ke'anae and Wailuanui. It appears that a high degree of cultural and historical significance can be attributed to the existing distribution of features throughout the landscape, particularly to the taro fields and the irrigation system that feeds them.

This cultural landscape study can be used for land-use planning and decision-making purposes by individual land owners and lessees, by potential developers, and by state and county agencies whose work affects the region. If these decision-makers follow the recommendations of the Hāna Community Plan in retaining the cultural identity of the region and promoting economic activities which are environmentally benign and compatible with the cultural sensitivities of the area, then significant portions of the cultural landscape will be preserved and their continued traditional use assured.

The following policy recommendations are offered as potential steps in an on-going effort to preserve the integrity of the Ke'anae-Wailuanui landscape while accommodating its dynamic nature.

Economic Activity

A. Taro Cultivation

1. The perpetuation of taro cultivation in Ke'anae and Wailuanui as a viable economic activity is critical for the future maintenance of the cultural landscape. For this to happen, there must be continued incentives for taro growing and community support which encourages maintenance of the water sources and *'auwai* on which the cultivation depends.

2. In response to requests from taro farmers, the Maui County Council has provided tax relief for parcels used for taro farming as of April 18, 1994 (Ordinance No. 2315, amending Sections 3.48.175 and 3.48.590 of the Maui County Code). This policy and others which provide economic incentives for taro farming should be continued.

3. In ancient Hawai'i, responsibilities for maintenance of the irrigation systems were delegated by the administrative chief or *konohiki*. Today, the community must act in cooperation to achieve this maintenance. State or county agencies should be identified to assist in coordinating the cleaning and maintenance of agricultural irrigation systems.

B. Subsistence Activities

1. Access. The traditional trails, especially the Pi'ilani Trail along the shoreline, as well as the trails and unimproved roads running *makai* from the highway to the beach, and the trails and unimproved roads running *mauka* into the forest reserve should be maintained and their significance in the cultural landscape assessed. The residents continue to exercise their rights of access for gathering, fishing, and hunting via these roads and trails.

FAY

2. Watershed Management. In accord with the East Maui Watershed Management Plan and the varied cultural and subsistence uses of the watershed by the Ke'anae-Wailuanui community, the forest in the watershed should be protected. Access for cultural, subsistence, and spiritual customs and practices should be afforded to those residents of the community who will maintain traditions of respect and stewardship of the land and water resources.

C. Tourism

1. The Department of Land and Natural Resources Division of Forestry and Wildlife (DLNR/DOFAW) created the Ke'anae Arboretum as an educational and recreational facility for both local residents and visitors. It appears that the location and the environment of the Ke'anae Arboretum and its functioning *lo'i* are ideal for presentation of the theme of taro growing and other traditional Hawaiian practices. The arboretum could be developed to offer interpretation and education, with emphasis on practical and even hands-on experience. These elements could be developed to minimize the adverse impact of visitors to the taro-growing areas of Ke'anae and Wailuanui, which are so important to the economy of the community. The development of this facility could be a source of further part- or full-time employment of local residents. DLNR/DOFAW has indicated that they are open to the discussion of planning options for further educational development of the arboretum with the Ke'anae and Wailuanui community.

2. With regard to the viewing points, it is noted that the lookout points above Ke'anae, Wailuanui and the Ko'olau Gap, like the roadside stands and Ke'anae Arboretum, are the facilities that specifically accommodate tourist needs in the area. To enhance public facilities and to mitigate tourism impact on the community, lookout points should be improved with better paving, approach signage, interpretive signage, landscaping, and benches.

3. The two historic churches could be included in any tourism and/or educational plan for the area; however, the church administrations should be consulted before the churches are featured in any general tour information or directional signage. Inclusion of the churches in a tourism plan also raises the dilemma of encouraging tourists to leave the Hāna Highway and travel into the heart of the local communities, potentially disrupting the daily activities of the community.

Land Use

A. Department of Hawaiian Home Lands (DHHL)

1. Assignment of DHHL leases and land use conditions tied to homestead awards should consider impacts on traditional cultural practices. Mitigative conditions for agricultural use should be included where practical. When possible, members of the existing community who wish to engage in agriculture or others interested in traditional and/or environmentally benign agricultural pursuits should be given some preference in the assignment of awards.

2. Lands transferred to the DHHL are vacant or under agricultural leases. Developing or subdividing land currently in agricultural use or having the potential for agricultural use should be discouraged. If any subdivision is planned, design should be distinctively rural, to blend successfully with existing conditions.

B. County/State Controls

1. Land use regulations should encourage the availability of agriculturally suitable lands to provide opportunities for small diversified agricultural activities with residential tenancy for farmers.

2. State and county agencies should explore protective management measures such as covenants, easements and other planning tools for exceptional open space resources and viewsheds.

3. County government should establish zoning standards with varying minimum lot sizes to prevent improper use and reflect the different kinds of agricultural activities within the agricultural district.

4. Re-establishment of a small grocery store, or other local commercial enterprises which provide essential services or cater to domestic needs of the residents would enhance the sense of community within the area. Any such development would necessitate some design constraints and specific limits on size.

Environment

1. Many invasive species of plants have already taken hold in the rain forest of the Ko'olau region, and care should be taken prior to introducing any new species - ornamental or agricultural - to the region.

2. Private and public agencies should explore methods to ensure that groundwater and surface water resources are preserved and maintained at capacities and levels to meet the current and future demands of each area in the Hāna District.

Design

1. Significant view corridors should be identified and protected.

2. A dominant architectural style at Ke'anae and Wailuanui is not as well established or readily visible as it is at Haleiwa, Lahaina, or other more developed areas. Additionally, architectural details are less important in the rural landscape than are the relationships of the landscape features and the scale, building materials and siting of structures within it. New development in this rural cultural landscape should be attentive to design in terms of siting relevant to: landforms and existing buildings, setbacks, maintenance of existing landscape features, and relationships to viewsheds.

3. Road width, drainage improvements and siting should be considered in terms of the rural cultural landscape as well. Roadways should have a minimum

pavement width of 16 feet and should not exceed 20 feet in width, in accord with the Hāna Community Plan. Standard curbs, gutters and sidewalks should not be required.

4. Existing bridges should be retained to maintain the integrity of the cultural landscape as well as the identity of the Hāna region. Whenever a wider or stronger bridge is established as necessary, the old bridge should be retained as an element of the design - e.g. as a turnout for scenic purposes, or as a portion of the newer bridge.

5. The Department of Hawaiian Home Lands (DHHL) and any other potential developers should work with Maui County and the Ke'anae-Wailuanui community in establishing guidelines and site planning to ensure that development on DHHL parcels is consistent and compatible with the existing community and cultural landscape. New development components - including lot sizes, lot coverage, setbacks, subdivision layout, settlement patterns and architecture - should be compatible with the nature of the existing community.

Cultural Resources

1. There are two large, intact, documented *heiau* structures within this landscape which are impressive reminders of the power of ancient religion and politics in this land. Both of these have associated names, and both lie neglected under thick forest vegetation. Individual landowners should consider taking steps necessary to preserve and maintain these and other sites as sources of interest to the community and visitor.

2. Archaeological survey is appropriate to further define the pre-historic antecedents of the wetland taro system in Wailuanui. Excellent examples of terraces, fields and *'auwai* lie in forest on the south and southeast side of the presently cultivated areas. Mapping and description of these sites as well as the adjacent residential areas could be the first step in their preservation, and in developing a greater understanding of the social dynamics which created them.

3. Among the resources gathered is wild taro growing in abandoned taro terraces in the valleys along streams. Abandoned taro terraces within the cultural landscape should be prioritized for documentation and designated for protection.

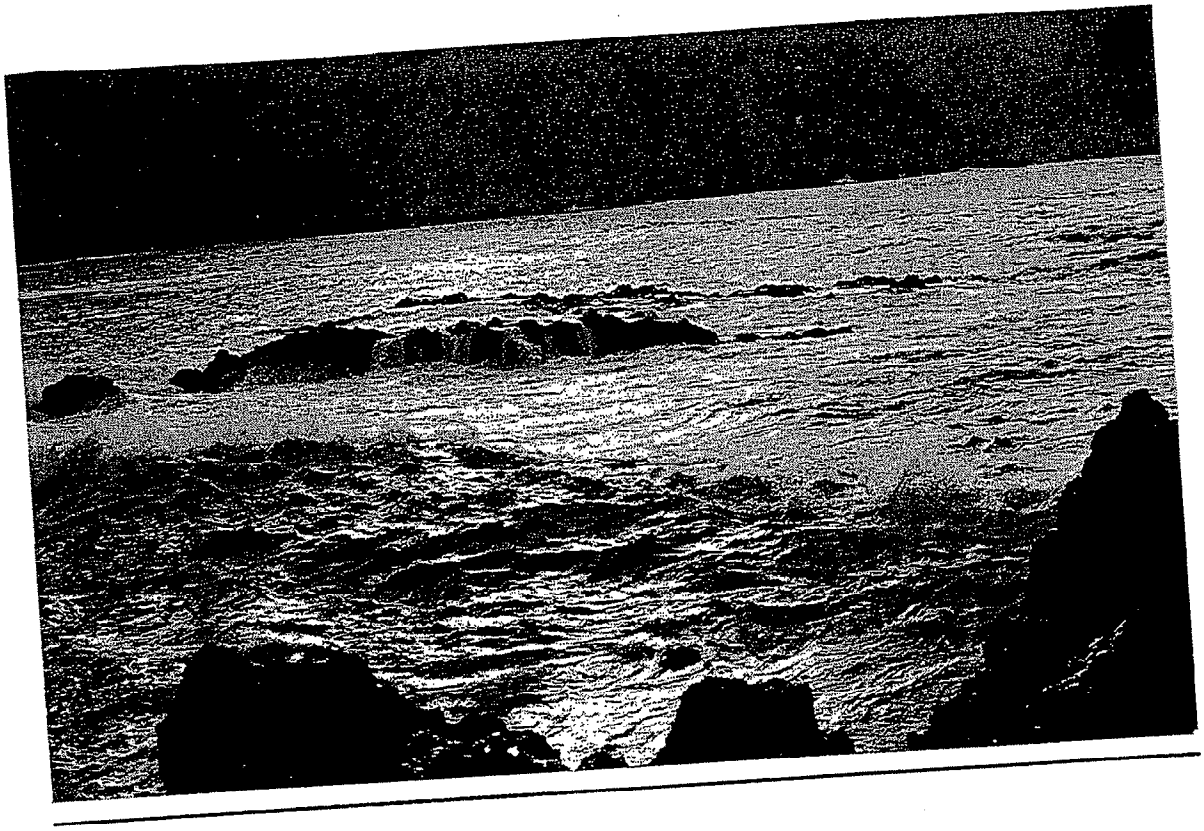
4. It is noted that several of the parcels transferred to DHHL contain known archaeological and important agricultural features. Some of the parcels have not been surveyed in detail but show a high potential for such features due to hydrogeological characteristics of the land. It is recommended that before any development plans are made for the lands, a more detailed archaeological survey be conducted to ensure the protection of potential sites on these parcels.

5. The Pi'ilani Trail is the best example of a traditional trail which was maintained for fishing and gathering activities until quite recently. In the Ko'olau region it is found just above the coastline with num

descending into each valley; it is constructed with cuts into the steep slopes which are faced with rock revetments. The trail is an excellent example of early Hawaiian engineering skills, social commitment, and organization: it should be identified and preserved for future generations. Part of its preservation should focus on low-key local use rather than promotion or signage for general use. Maintenance of the Pi'ilani Trail is also helpful to the local economy in providing access for subsistence activities.

The landscape at Ke'anae and Wailuanui has been shown to be culturally significant and management options should be considered. It appears that there may be some threats to the integrity of the traditional landscape and community lifestyle from the recent transfer of lands to DHHL, from the increases in tourism, from potential sale of large parcels in the region to non-agricultural interests and from the ongoing economic difficulties of diversified subsistence and intensive cultivation farming. Implementation strategies should be developed to perpetuate the significant aspects of the cultural landscape without hampering changes beneficial to the community and its residents.

XII. REFERENCES



XII. REFERENCES

Abbott, Isabella A.
1992 *La'au Hawaii: Traditional Hawaiian Uses of Plants*. Honolulu: Bishop Museum Press.

Andrews, Lorrin
1985 *Dictionary of the Hawaiian Language* (orig. 1865). Rutland, Vermont & Tokyo, Japan: Charles E. Tuttle Company.

Andrews, Lorrin
1922 *Dictionary of the Hawaiian Language* (orig. 1865), Revised by Henry Parker, 1922.

Armstrong, R. Warwick (Editor)
1973 *Atlas of Hawaii*. Honolulu: The University Press of Hawaii.

Ashdown, Inez
1971 *Ke Ala Loa o Maui*. Wailuku, Maui: Ace Printing Co.

Birnbaum, Charles A.
1994 *Protecting Cultural Landscape: Planning Treatment and Management of Historic Landscape*. National Park Service.

Bowser, George
1880 *An Itinerary of the Hawaiian Islands with a Description of the Principal Towns & Places of Interest*, v. 3, Bishop Museum, Honolulu.

Brenzel, Kathleen Norris
1992 "Hawaii's Wild Gardens." *Sunset Magazine* (Jan.).

Brown, DeSoto
1989 *Hawaii Goes To War*. Honolulu: Editions Limited.

Bryan, E.H.,Jr.
1965 "Fiberwork" in *Ancient Hawaiian Civilization* by E.S. Craighill Handy *et al.* Rutland, Vermont: Charles E. Tuttle Co.

Carlquist, Sherwin
1970 *Hawaii, A Natural History*. The Natural History Press.

Chapman, William
1990 *The Madison Historic Preservation Manual*. Madison Historic Preservation Commission.

Coulter, John Wesley, and Chee Kwon Chun
1937 *Chinese Rice Farmers in Hawaii*. Bulletin 16:5. Honolulu: University of Hawaii.

REFERENCES (continued)

County of Maui
1922 "Register of Voters for the Territorial Primary Election" (October 7).

County of Maui
1990 *The General Plan of the County of Maui, 1990 Update*

County of Maui
1994 *Hana Community Plan*

County of Maui, Committee on Public Works
1928 "Report to Board of Supervisors."

Cox, Doak C.
1987 *Tsunami Casualties and Mortality in Hawaii*, SR:0040. University of Hawaii, Environmental Center.

Cuddihy, Linda W. and Charles P. Stone
1990 *Alteration of Natural Hawaiian Vegetation*. Honolulu: University of Hawaii Press.

Degener, Otto
1975 *Plants of Hawaii National Park*. Braun Brumfield Inc.

Department of Land and Natural Resources
1994 *Cultural Landscapes Task Force Report to the Seventeenth Session of the Hawaii State Legislature*, State of Hawaii, Honolulu, HI.

Department of Land and Natural Resources (DLNR)
1993 *Fruitful Fields: American Missionary Churches in Hawaii*, State Historic Preservation Division, Honolulu.

Department of the Army Pacific Ocean Division, Corps of Engineers
1971 *Flood Hazard Information: Island of Maui*, Report R39. State of Hawaii Department of Land and Natural Resources Division of Water and Land Development, Honolulu.

Department of Transportation, State of Hawai'i
1986 *Environmental Assessment for Structures Transportation Network* (November).

Donham, Theresa K.
1993 *Field Inspection of Revised Road Easement Route for Mike Adams, Wailua, Koolau, Maui (TMK 1-1-06:71 and 1-1-08:1)*, State Historic Preservation Division, Honolulu, HI.

East Maui Irrigation Company, Ltd. and A&B - Hawaii, Inc.
1993 *East Maui Watershed Management Plan.*

Elliot, Margaret E. and Erin Marie Hall
1977 *Wetlands and Wetland Vegetation of Hawaii*. U.S. Army Corps of Engineers.

Feher, Joseph and Edward Joesting
1969 *Hawaii: A Pictorial History*. Honolulu: Bishop Museum Press.

Foote, Donald E., *et al.*
1972 *Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii*. U.S. Department of Agriculture, U.S. Government Printing Office.

Frankel, Charles
1984 "60 Types of Taro Near Hana." Honolulu Star-Bulletin 29 November:A17.

Gholkar, Satish K. (Gholkar & Associates)
1992 "Environmental Assessment/Determination: An Access Easement over State owned property for Mr. & Mrs. Mike T. Adams" (December).

Giambelluca, Thomas W., Michael A. Nullet and Thomas A. Schroeder
1986 *Rainfall Atlas of Hawaii*, Water Resources Research Center, University of Hawaii at Manoa.

Handy, E.S. Craighill
1985 *The Hawaiian Planter*, Volume 1, Bishop Museum, Bulletin No. 161., Honolulu, Kraus Reprint, Millwood, N.Y.

Handy, E.S. Craighill, and E.G. Handy
1972 *The Native Planters in Old Hawaii: Their Life, Lore, and Environments*. Bulletin No. 233. Honolulu: Bernice P. Bishop Museum.

Hawaii Heritage Center
1990 *Historic Bridge Inventory and Evaluation, Islands of Maui and Molokai*, Department of Transportation Highways Division and U.S. Department of Transportation, Federal Highway Administration, Honolulu, HI.

Hobdy, Bob; Hawaii Department of Land and Natural Resources, Forestry Division
1994 "List of Trees/Plants at Ke'anae Arboretum" (November 23).

James, Van
1991 *Ancient Sites of O'ahu: A Guide to Hawaiian Archaeological Places of Interest*. Honolulu: Bishop Museum Press.

Kamakau, Samuel
1976 *Na Hana a ka Po'e Kahiko: The Works of the People of Old*. Honolulu: Bishop Museum Press.

Kamakau, Samuel
1961 *Ruling Chiefs of Hawaii*. Honolulu: Kamehameha Schools Press.

Ke'anae-Wailuanui Community Association
1993 "Response Letter to Draft EIS, CDUA for Levy and Botelho Private Residential Ranch." (November 15?)

REFERENCES (continued)

Kepler, Angela Kay
1983 *Hawaiian Heritage Plants*. Honolulu: Oriental Publishing Co.

Kirch, Patrick V.
1985 *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory*. Honolulu: University of Hawaii Press.

Kraus, Beatrice H.
1993 *Plants in Hawaiian Culture*. Honolulu: University of Hawaii Press.

Kuykendall, Ralph
1938 *The Hawaiian Kingdom: 1778-1854*. Honolulu: University of Hawaii Press.

Kyselka, Will and Ray Lanterman
1980 *Maui: How it Came to Be*. Honolulu: The University Press of Hawaii.

Linnekin, Jocelyn
1983 "The *Hui* Lands of Keanae: Hawaiian Land Tenure and the Great Mahele." *Journal of the Polynesian Society* 92:169-188.

Linnekin, Jocelyn
1985 *Children of the Land*. New Brunswick: Rutgers University Press.

Lueras, Leonard
1975 "Keanae: The Hawaii That Used to Be." *Honolulu Advertiser* 18 December:A1.

Lueras, Leonard
1983 *On the Hana Coast*. Honolulu: Emphasis International Ltd.

Macdonald, Gordon A. and Agatin T. Abbott
1970 *Volcanoes in the Sea: The Geology of Hawaii*. Honolulu: University Press of Hawaii.

Melnick, Robert Z. with Daniel Sponn and Emma Jane Saxe
1984 *Cultural Landscapes: Rural Historic Districts in the National Park Service*. Washington, D.C.: National Park Service.

Melnick, Robert Z.
1985 *Landscape Thinking*. Cultural Resources Management 8, no.1: pp.1-2.

Minerbi, Luciano, Davianna McGregor, and Jon Matsuoka (editors)
1993 *Native Hawaiian and Local Cultural Assessment Project; Phase I: Problems/Assets Identification*. Honolulu: University of Hawaii at Mānoa.

National Park Service
1992 *Guidelines for the Treatment of Historic Landscapes*, DRAFT, Preservation Assistance Division, U.S. Department of the Interior, Washington, D.C.

National Park Service
n.d. *National Register Bulletin 18*: "How to Evaluate and Nominate Designed Historic Landscapes" by J. Timothy Keller and Genevieve P. Keller. U.S. Department of the Interior.

National Park Service
n.d. *National Register Bulletin 30*: "Guidelines for Evaluating and Documenting Rural Historic Landscapes" by Linda F. McClelland, J. Timothy Keller, Genevieve P. Keller, and Robert Z. Melnick. U.S. Department of the Interior.

National Park Service
n.d. *National Register Bulletin 38*: "Guidelines for Evaluating and Documenting Traditional Cultural Properties" by Patricia L. Parker and Thomas F. King. U.S. Department of the Interior.

Neal, Marie C.
1965 *In Gardens of Hawaii*. Honolulu: Bishop Museum Press.

Pukui, Mary Kawena
1983 *Olelo No'eau: Hawaiian Proverbs and Poetical Sayings*, Bishop Museum Special Publication No.71. Honolulu: Bishop Museum Press.

Pukui, Mary Kawena and Samuel H. Elbert
1981 *Hawaiian Dictionary*. Honolulu: University of Hawaii Press.

Pukui, Mary K., Samuel H. Elbert and Esther Mookini
1974 *Place Names of Hawaii*. Honolulu: University of Hawaii Press.

Soehren, Lloyd J.
1963 *An Archaeological Survey of Portions of East Maui, Hawaii*. Honolulu: B.P. Bishop Museum.

Shepard, F.P., G. A. MacDonald, and D. C. Cox
1950 *The Tsunami of April 1, 1946*. Berkeley and Los Angeles: University of California Press.

Somer, S.H. and R. Gustafson
1987 *Plants and Flowers of Hawaii*. Honolulu: University of Hawaii Press.

Speakman, Jr. Cummins E.
1981 *Mowee: An Informal History*. San Rafael: Pueo Press.

Stokes, John F.G.
1916 *Maui Notes, Nov. - Dec. 1916*, MS, In Bishop Museum Dept. of Anthropology, Honolulu.

REFERENCES (continued)

Thomas, Mifflin
1983 *Schooner from Windward*. Honolulu: University of Hawaii Press.

Thrum, Thomas G.
1918 "Maui's Heiaus and Heiau Sites Revised", *Hawaiian Almanac*, Honolulu.

Thrum, Thomas G.
1909 "Heiaus and Heiau Sites Throughout the Hawaiian Islands; Island of Maui" IN *Hawaiian Almanac and Annual for 1909*, pp. 38-43, Honolulu.

Tomonari-Tuggle, Myra Jean F. and Nancy E. Brown
1980 *Labor and Regional Planning Program*. Honolulu: University of Hawaii Press.

Wagner, Warren L., Derral R. Herbst and S.H. Sohmer
1991 *Manual of the Flowering Plants of Hawai'i*, 2 vols. Honolulu: University of Hawaii Press.

Walker, Winslow
1931 *Archaeology of Maui*, Manuscript at B.P. Bishop Museum, Honolulu.

Waterford Foundation
1992 *Linking the Past to the Future: A Landscape Conservation Strategy for Waterford, Virginia*. Land Ethics.

Wenkam, Robert
1970 *Maui: The Last Hawaiian Place*. San Francisco: Friends of the Earth.

Youngblood, Ron *et al.*
1983 *On the Hana Coast*. Honolulu: Emphasis International Ltd. and Link Inc. Honolulu.

Yzendoorn, Reginald
1927 *History of the Catholic Mission in the Hawaiian Islands*. Honolulu.

APPENDICES

A. TABLE OF LAND COMMISSION AWARDS - KE'ANAE TO WAILUANUI

A. Table of Land Commission Awards — Ke'anae to Wailuanui

Compiled by Victoria S. Creed, Ph.D.

The table below presents information from the Native Register (NR), the Foreign Testimony (FT) and the Native Testimony (NT). In all cases the document which contained the most specific details about land use within a parcel was used in this table. In general, the NR is much more specific than are the FT and the NT. For instance, where the FT and NT would document a *mo'o*, the NR might specify a *mo'o* with 10 *lo'i*. Where LCAs have a letter after the number, no NR document was found and all the information comes from the FT and NT. The number of pieces claimed is derived from the FT and NT. This table makes no attempt to show which pieces were awarded.

LCA#	Claimant	Location	Claimed Use	# of Pieces
2441	Tito Kealina	Keanae, Lalaloa	19 *lo'i*, *kula*, upland wooded area, *olonā* area, houselot	7 pieces
2442	Kaea	Keanae Analoa Kiapu Analoa mauka	6 *lo'i*, *kula*, forested area *kula* a *hala* grove pasture	3 pieces
2443	Kamakau	Keanae Palolena Pololua	*'ili* land	
2443B	Kanehaku	Keanae Pololua Kanemakue	2 *lo'i*, pond, *kula*, forested area *olonā*, forested area	2 pieces
3472	Kaihaa	Pauwalu	*mo'o* (*lo'i*) pasture	2 pieces
3472B	Bareneba	Keanae Waianu Pahoa Koleamoku Kuapohaku Kalihi Waiaolohe Kukuiohoku	*'ili* *'ili* 2 *lo'i* 1 *lo'i* 1 *lo'i* 1 *lo'i* clump *olonā*	7 pieces

LCA#	Claimant	Location	Claimed Use	# of Pieces
3499	Kiowai	Wailua Keonalu Paehala Pauhala Waiele Paakamaka Paolena Kealaalaea	1 *lo'i* 1 *lo'i* *kula*, houselot *hala* grove 7 *lo'i* 5 *lo'i* 27 *lo'i* *kula*	6 pieces
3701	Makaonaona	Wailua	2 stream branches	
4537 See 4587	Hoonoho	Wailua Keonoaulu	*mo'o*	
4537B See 4587B & 6778	Kapahukaa	Wailua Waikani Waeli Piikalawa	*mo'o* kihapai (3), 3 *lo'i* houselot	6 pieces
4561	Wahinemaikai	Wailua Waieleiki Kakee Koili Paulae	*'ili*, *mo'o*, *lo'i* *mo'o* *mo'o* houselot	5 pieces
4562	Wailaahia	Wailua Kaakee Maulu Palolena	4 *lo'i* houselot, *mo'o* 7 *lo'i*	4 pieces
4587	Hoonoho	Wailua Keononalu Paakamaka Paehala	*mo'o* (12 *lo'i*) & *kula* 1 *lo'i* houselot	3 pieces
4587B	Kapahukaa	Wailua Waikani	*mo'o*	
4665F	Naeole	Keanae Kapae Kanemakue	land, pasture houselot	3 pieces

LCA#	Claimant	Location	Claimed Use	# of Pieces
4665G	Ehu	Keanae Kalihi Kukuiohoku Pahoa 1 Pahoa 2	*ʻili*, 2 *loʻi*, houselot 9 *loʻi*, *olonā* 6 *loʻi*	7 pieces
4665H	Ohiki	Keanae Waiaolohi Leo Pahoa Kawaaune	10 *loʻi*, muliwai, sweet potato *kula*, taro *olonā kula* *olonā*	3 pieces
4665I	Kauakahi/ Kalawaia	Keanae Kipapa Kapae Waianu Keanae mauka	*ʻili* Houselot 2 *olonā* *olonā* *olonā*	5 pieces
4665K	Kanuku	Keanae Panaewa Makaiwa Kuoo Kapae	*ʻili*, pasture, 2 *loʻi* 1 *loʻi* *olonā*	5 pieces
4725	Moo	Wailua Paakamaka	9 *loʻi* & *kula*	
4726	Makaole	Wailua Paulae Waileku Kaala Kalaioa	9 *loʻi* & *kula* *olonā* dry taro *ʻili*	2 pieces
4726B	Makaole	Wailua Kaala Kalaioa	dry taro *ʻili*	
4729	Moo II	Wailua Makaku Paulae Palolena Maulu	3 *loʻi* 2 *loʻi* 3 *loʻi* houselot	4 pieces

LCA#	Claimant	Location	Claimed Use	# of Pieces
4772	Naiwi	Wailua Makuku Waieli Keononalu Kalimapuhi Waikani Maulu Kaahu	houselot *lo'i*, 5 "kiowai" /pools/, houselot *lo'i* *lo'i* *lo'i* 3 *lo'i* *lo'i*	4 pieces
4773	Nakihei	Wailua Kalimapuhi Paakanaka	9 *lo'i* 1 *lo'i*	2 pieces
4774	Nalimanui	Wailua Kealia	houselot, *mo'o*	1 piece
4779	Naiapea	Wailua Keononalu Paakamaka	8 *lo'i*, *kula* 10 *lo'i*	2 pieces
4787	Namakaimau	Wailua	houselot	
4832	Kamahine ma	Far mauka	*olonā* for six persons	
4847	Malaelua	Keanae Huo/Kuo Kalihi Ololokeahi Paehala Pohakuokane Lolokeahi	*'ili*, 8 *lo'i* 2 *lo'i*, houselot 1 *lo'i* houselot 1 *lo'i* 1 *lo'i*	6 pieces
4848	Kuluhiwa	Keanae Ololokeahi Waianu "Pilaniolipi"	*'ili*, *kula* *'ili*	3 pieces
4848B	Kane	Keanae Wailoea Kipapa Kanemakue Wailoea mauka	*'ili* 2 *lo'i* houselot "*pauku*"	4 pieces

LCA#	Claimant	Location	Claimed Use	# of Pieces
4848C	Keliiaea	Keanae Kuo Waianu	*ʻili*, pasture *olonā*	3 pieces
4848D	Umikanaha	Keanae Makaiwa Manonui	*ʻili* pasture	2 pieces
4848E	Maewaewa II	Keanae Lalaola II Ololokeahe	*ʻili* 1 *loʻi*	2 pieces
4848F	Maewaewa I	Keanae Kekaele & Kukuiolono	*ʻili*	
4848G	Mu	Keanae Pohakuokane Lalaola Haleakea Waiapuka Kaaunaku Lonowai	*ʻili*, pasture 2 *loʻi* 1 *loʻi* *olonā*, 4 *kiha-pai* *olonā* (2, 3) *olonā* (4)	8 pieces
4848H	Kailio	Keanae Kealokekua Makaiwa Kanemakue	*moʻo* 5 *loʻi* houselot	3 pieces
4853C	Umaikealani	Wailua Waialuaiki Kahu Waieli Palolena	houselot 2 *loʻi*, *loʻi* 2 *loʻi*, 1 *loʻi*, 4 *loʻi* 1 *loʻi*	7 pieces
4853D	Naha	Wailua Palolena Paulae	*ʻili*, *olonā* 2 *loʻi*	2 pieces
4853E	Kahahahei	Wailua Waeli Paakamaka Waiapuka	*moʻo*, houselot *olonā* 2 *loʻi*	2 pieces

LCA#	Claimant	Location	Claimed Use	# of Pieces
4853F	Kahaaiea	Wailua Palolena Paakamaka Paehala	 *moʻo* *olonā* *olonā*	3 pieces
4853G	Kuheleaumoku	Keanae Keononalu Kakee Kapae Wailua Keononalu Kaku Kapae Kalaalaea	 *moʻo* *olonā* *olonā* *moʻo* *olonā* *olonā* houselot	4 pieces
4853K	Poolai	Wailua Kukuihoku Waiapuka Waeli	 2 *loʻi* *moʻo*	4 pieces
4853L	Kaopea	Keanae Koleaamoku Waioea Makaiwa	 *ʻili* 2 lois houselot	3 pieces
4854	Mamaekawaha	Keanae Kipapa Waioea	 *ʻili*	2 pieces
4856	Kaihu	Keanae Hakakea Waiolea Waianu	 *ʻili* 4 loʻi, *kula* 2 *loʻi* *olonā*	3 pieces
4857 See 4665H	Naohiki / Ohiki			
4859	Kikowahine	Keanae Pahoa Keanae	 *olonā* *olonā*	
4865	Kapali	Wailua Kealia Paulae	 *moʻo* houselot	2 pieces

LCA#	Claimant	Location	Claimed Use	# of Pieces
4866	Kaholawaa	Wailua Keononalu Waieli Paulae Paakamaka	*moʻo* *loʻi* (2) 4 *loʻi* houselot	5 pieces
4867	Wahapuu	Wailua Keononalu	*moʻo* of kalo	1 piece
4874 See 4853H	Makea	Keanae Paihala	*ʻili*	
5030	Kekahuna	Wailua Keononalu Paehala Palolena Paulae	*moʻo* (10 *loʻi*) houselot	4 pieces
5043B	Manu	Wailua Kuokoa	houselot, 3 *loʻi*, *loʻi*(s)	3 pieces
5049	Kaiwa	Wailua Paakamaka Kakee	*moʻo* houselot	2 pieces
5051	Kamanu	Wailua Keononalu Pauwalu Paakamaka Kaeli/Waieli Waielinui	*moʻo* (26 *loʻi* & a *kula*) *loʻi* *loʻi* houselot, 3 *loʻi* 3 *loʻi*	4 pieces
5052	Kuiki	Wailua Palolena	2 *moʻo* (14 & 15 *loʻi*), house lot	2 pieces
5054	Kaiwikaola	Wailua Waieli	2 *moʻo*, house lot	3 pieces

LCA#	Claimant	Location	Claimed Use	# of Pieces
5055	Kamai	Wailua Kalolena /Palolena Waikani Paakamaka Kalimapuhi Kakee	11 *lo'i* 11 *lo'i* 2 *lo'i* 4 *lo'i* houselot	4 pieces
5056	Kumulani	Wailua Keononalu	21 *lo'i* & *kula*	1 piece
5058	Kaulia	Wailua Waieli	22 *lo'i* (2 *mo'o*)	2 pieces
5059	Kuikui	Wailua Pukalawa	*'ili*	1 piece
5060	Kalawaia	Wailua Waieli	10 *lo'i* & *kula* houselot	2 pieces
5062	Kahakauwila	Wailua Keononalu Waikani Waieleiki	20 *lo'i* & *kula* *olonā* 1 *lo'i*	3 pieces
5064	Keahi	Wailua Waikani Palolena Keononalu Waieli nui Kalii	*'ili* *'ili* 1 *lo'i* 4 *lo'i* *ahupua'a*	4 pieces
5064B	Kaluahinanui	Wailua Waikani Palolena	2 *mo'o* 2 *lo'i*, *lo'i*	3 pieces
5065	Kiaha/ Kaohilae	Wailua Maulu Paikalawa Keononalu	houselot houselot *mo'o*	2 pieces
5066	Kaumiumi	Wailua Kaakee Palolena Kaonoulu	*mo'o* *lo'i* (2) 2 *lo'i*	4 pieces

LCA#	Claimant	Location	Claimed Use	# of Pieces
5066B	Kaohilau	Wailua Kaononalu		
5067	Kalama	Wailua Kaakee Wailua Maulu	10 *lo'i* & *kula* 25 *lo'i*, *kula* & houselot 1 *lo'i*	2 pieces
5068	Kauiki	Wailua Waieli nui Keononalu	24 *lo'i* & *kula* 2 *lo'i*	2 pieces
5068B	Kakahunaaiole			
6769B	Ohule	Wailua Waieli Kaliai	6 *lo'i* *'ili*	
7784	Kahaukomo	Keanae Nauaailua	*'ili*	1 piece
10828B	Kaniho	Wailua Palolena Kalimapuhi Kealaalaea Wailuaiki Piikalawa	*mo'o*, 3 *lo'i* *mo'o* *'ili* *'ili* fish pond	6 pieces
11043B	Kaumauna	Wailua Waieli Keononalu Kalimapuhi Piikalawa	*mo'o* 2 *lo'i*, *kihapai* *'ili* houselot	4 pieces

B. TABLE OF KE'ANAE-WAILUANUI ARCHAEOLOGICAL SITES

B. Table of Ke'anae-Wailuanui Archaeological Sites

(BM A--- = Bishop Museum Maui site number)

Archaeo-logical Sites	State Site # & Form Informa-tion	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Kukuiolono *heiau* (Ke'anae)	State site 50-50-07-82 (BM A4-1)			Kukuiolono on point of Keanae peninsula, Heiau site destroyed or not found. (Walker 1931:167) [possibly Kukuiopuni of other references ?]	"Kukuiolono heiau was destroyed at an unknown date (Walker 1931, p. 167, site 82). [This] site was pointed out to J.F.G. Stokes in 1916, who said it was 150 feet from the sea at Keanae Point. The site was not identified on this survey." (Soehren 1963:200)		Not investigated during present study
Lalaola *heiau* (Ke'anae)	State site 50-50-07-83 (BM A4-2)			Lalaola, on point of Keanae peninsula, Heiau site destroyed or not found. (Walker 1931:167)	"Lalaola heiau (Walker 1931, p. 167, site 83) was said to have stood on land of the same name, on the east side of Keanae peninsula. Its site was pointed out in 1916 to J.F.G. Stokes, but the structure had been destroyed long before." (Soehren 1963:201)		Not investigated during preser study

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Pakanaloa *heiau* (Ke'anae)	State site 59-50-07-84 (BM A4-3)	"Pakanaloa - 'Keanae. A war heiau dedicated to Kanehekili'." (Thrum 1909:39) "The temple of Pakanaloa, has a tradition claiming origin in the worship of the thunder to the effect that its Kahu, Kanehekili, died within its walls, ... The people of Hamakualoa, wondering at his disappearance, searched till they found his body in the temple at Keanae, ..." (Thrum 1909:48)	"Pakanaloa, on upper slopes of Keanae, not far from sea; a platform heiau; not seen." (Stokes in Thrum 1918:125)	Pakanaloa, upper slopes Keanae peninsula, "said to have been a war heiau to Kanehekili", Heiau site destroyed or not found. (Walker 1931:167)	"Pakanaloa heiau is said to have been a platform heiau located on the upper slopes of Keanae, but not seen by J.F.G. Stokes in 1916. The site was not located on this survey or by Walker (1929, p. 167, site 84)," (Soehren 1963:202)	"In Ke'anae stands the temple named Pakana-loa where the Kahuna Kahekili was *kahu* of that place." (Ashdown 1971-:44)	Not investigated during present study

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Kamokukupeu *heiau* (Wailua)	State site 50-50-07-88 (BM A5-2)			Kamokukupeu; Heiau sites destroyed or not found (Walker 1931:167)	"Kamokukupeu heiau was reported by Walker (1031, p. 167, site 88) to be above the road on the east side of Kamilo Stream, but was not found. Presumably it was destroyed, but Walker makes no mention of its condition. It was not located on this survey." (Soehren 1963:212)		Not investigated during present study
Kawalimukala *heiau* (Pauwalu)	State site 50-50-07-90 (BM A4-7)			Kawalimukala at Pauwalu; Heiau sites destroyed or not found. (Walker 1931:167)	"Kawalimukala heiau was reported by Walker (1931, p. 167, site 90) but not located. It is said to be above the road in the land of Pauwalu. It was not located on this survey." (Soehren 1963:206)		Not investigated during preser study

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Kupau *heiau* (Kupa'u) (according to P. Sinenci in McGregor interview 1994 - this is a *wahine heiau*)	State site 50-50-07-91 (BM A5-1)			"Kupau above the road in Keanae valley toward the ditch trail 84 feet of terrace wall is all that remains." (Walker 1931:167) [this description is contained in the list of "Heiau sites destroyed or not found"]	"Kupa'u heiau was reported by Walker (1931, p. 167, site 91) as being almost completely destroyed, with only 84 feet of terrace wall remaining. No other particulars are given. Its location is presumably in the land of the same name, which has the Tax Map Key [1-1-08:6?] suggested above. It was not located on this survey." (Soehren 1963:211)		Not investigated during present study
Kualani *heiau*	State site 50-50-07-92 (BM A5-3)			"Kualani on top of ridge on west side of Waiokane Falls." (Walker 1931:167)	"Kualani heiau was reported by Walker (1931, p. 167, site 92) as standing on top of the ridge west of Waiokane Falls (Waikani of USGS map), but no further particulars are given. The site was not located during this survey." (Soehren 1963:213)		Not investigated during present study

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Kamilo *heiau* (Wailua)	State site 50-50-07-93 (BM A5-8)			Kamilo - "Location: At Kawaloa on the north side of the stream in a dense grove of hau and puhala. Description: A small enclosure 22 x 25 feet built of rough basalt and some pebbles. Walls 3 feet high and 3 feet thick." (Walker 1931:168)	"Kamilo heiau was reported by Walker (193'1, p. 168, site 93) as lying on the north side of a stream, presumably Waiokamilo. It was an enclosure measuring 22 feet by 25 feet with 3 feet high and 3 feet thick built of rough basalt. The site was not located on this survey." (Soehren 1963:207)		Not investigated during present study
Ohia *heiau*	State site 50-50-07-94 (BM A4-5)			Heiau of Ohia - "Location: At Ohia in the valley three quarters of a mile from the sea. Description: Stones removed to build pig pen, and outlines thus lost. Probably an agricultural heiau built by a chief Kaimuki." "(Information obtained by Stokes in 1916)." (Walker 1931:169)	"Ohia heiau was reported by J.F.G. Stokes in 1916 to be in the land of the same name and attributed to a chief named Kaimuki. The structure was destroyed to provide stones for building a pig pen. ... The site was not located by Walker (1931, p. 169, site 94) or on this survey." (Soehren 1963:204)		Not investigated during preser study

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Kaluanui *heiau* (Wailua)	State site 50-50-07-95 (BM A5-9)	Kaluanui - listed; "No particulars learned of these Keanae temples." (Thrum 1909:39)	"Kaluanui, a small heiau, 41 x 42 ft., on land of same name, at Wailua nui, below a *koa ia* known as Ohia, one-third of a mile from sea; on side of taro patch; of two sections, enclosure and platform, the latter running into the hill and seeming to have continued up the slope. Said to have been for sacrifice, and that the drums are heard." (Stokes in Thrum 1918:-125)	Kaluanui - "Location: At Kaluanui on the east side of taro patches a third of a mile from the sea. Description: Combination of enclosure with higher terrace on one side. The enclosure measures 15 x 29 feet and the terrace at the south end is 11 feet wide. The west side is 6 feet wide and 4 feet high. Stokes in 1916 saw an oval pit in the terrace pavement near the southern end, 6.5 feet long, 4 feet wide, and about 2 feet deep. This can not now be seen." (Walker 1931:170)	"Kaluanui heiau was reported by Stokes in 1916 and by Walker in 1929 (site 95), but could not be located on this survey. The structure was described as being in two sections, an enclosure measuring 15 by 29 feet and an adjoining platform or terrace extending to the hillside and possibly continuing upward. Stokes was informed that the heiau was for sacrifice, and that drums were sometimes heard there." (Soehren 1963:203)		Not investigated during present study

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Kukuiopuni *heiau* (Ke'anae)	State site 5050-07-96 (BM A5-6) This site is known as Kukuiaupuni heiau. Walker reported it in 1931 (p. 171). ... The heiau is situated on a small knoll in very dense vegetation consisting of guava, hau, mango, rose apple, ferns, ti, and unidentified grasses. Kukuiaupuni is a platform heiau of irregular shape. Its approximate dimensions are 26 x 18 m. It is in fair condition. Distinct boundaries cannot be seen on the N side (except the NW corner), the E end of the S side, and the E side of the heiau. The main platform is fairly level and is paved with waterworn basalt rocks (average diameter of -.2 to 0.3 m.). The platform ranges from 0.9 to 3 m. in height on the S, and from 1.4 to 3 m. in height on the W. (Hawaii Register of Historic Places 1973).	"At Keanae, Kukuiopuni (not Kuikuiaupuni as formerly listed [in Thrum 1909:39]), was a sacrificial *heiau* of large size, of platform character, with entry way, located at Puuwalu adjoining Waihea-nui, the foundation of which only remain. Kanekauolono, on land of same name, was a small *heiau* near the shore, now destroyed, also one called Lalaola, on land of same name." (Thrum 1917:60)		"Kukuiaupuni, Location: At Pauwalau [Pauwalu?] on the top of the slope 300 feet south of the road and 500 feet southwest of the school. Description: A terraced platform facing NW. by N. and with a height of 12 feet at this point. Length 50 feet width 42 feet. The other platform is about 200 feet away and measures 47 x 51 x 5 feet (Walker 1931:-171). [This site is listed in the "Wailuanui Region" of Walker 1931].	"Kukuiaupuni heiau was described by Stokes in 1916 and by Walker (1931, p. 171 site 96) as a terrace 50 feet long and 42 feet wide, extending northwest by west from the top of a hill, and standing from 8 feet to 12 feet high on the down hill side. Its surface was then greatly disturbed and no interior features could be ascertained. The entire area is now thickly covered with trees and brush, and the structures is in very poor condition. Traces of a low wall were observed around portions of the pavement, and a few waterworn stones were seen among the rubble on this survey" (Soehren 1963:-205).	"At Ke'anae stands the Heiau Kukui-o-Puni, with its entry way at Pu'u Walu adjoining Wai-kea-nui." (Ashdown 1971:54)	Located behind Ke'anae School, covered by dense growth of trees. Condition is little changed from earlier descriptions.

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Kukuiopuni cont'	"In the NW corner, the height ranges from 0.4 to 0.9 m. On the S and W, the platform sides slope down and much rubble is present. Just N of the NW corner is a wall oriented E-W. It is of multiple-stacked waterworn basalt rocks. The wall averages 1 m. in width and ranges from 0.8 to 0.9 m. in height. It is not certain whether the wall is part of the heiau." (Hawaii Register of Historic Places 1973)						Not investigated during present study

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Makehau *heiau* (Wailua)	State site 50-50-07-97 (BM A5-4) This site is known as Makehau heiau. Walker reported it in 1931... Despite Soehren's comment of "complete ruins" the vegetation prevented the inventory survey team from verifying (1963:214). This heiau could not be mapped by the inventory team because of the extremely dense growth of hau that completely covers it. There are also 8 palm trees growing here. The approximate size of the heiau is 24 x 12 m. The inventory team could see a platform and a possible enclosure through the hau but could not accurately determine their sizes. (Hawaii Register of Historic Places 1973)	Makehau - listed; "No particulars learned of these Keanae temples." (Thrum 1909:39)	"Makehau heiau, on flat land of same name, at Wailua nui, mauka of main lower road, and one hundred and fifty feet south of Makehau road. Disturbed; of platform character, 43 x 72 remaining with indications that it extended to greater width. Eight coconut trees on platform, said to have been planted by Kaniho, who took care of the temple, and was remembered as an old man by Kalo, the guide and informant." (Stokes in Thrum 1918:-125)	Makehau - "Location: At Makehau on a level piece of land 1/4 of a mile from the Wailua road and 150 feet in from the Makehau road. Description: Said to have been a heiau of two platforms of which only the upper preserves much of its original outline. It measures 72 x 43 feet and is 5 feet high. The eight coconuts growing on it were said to have been planted by Kaniho, the last kahu of the heiau. Waterworn stones and pebbles on the platform." "(Information obtained by Stokes in 1916)" (Walker 1931:172)			"Located Makehau *heiau* in Wailuanui. The condition of the site is little changed from earlier descriptions; i is still overgrown with very dense *hau*. The coco nut trees are still present, but of very ol age and begir ning to die"

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Pu'u Olu Pond [fish-pond] (Pauwalu)	State site 50-50-07-538 (BM A4-9)				"Pu'u Olu Pond [fishpond] appears to be almost an arm of the sea, cut off by a large gravel and sand bar. It lies at the mouth of a small, steep valley south of Pauwalu Point and is about 100 feet in diameter. No flow of water was observed, and the depth does not appear to be great. Most of the surface is covered with pond scum. Some portions of a fairly massive stone wall can still be seen bordering the north side of the pond." (Soehren 1963:208)		Located fish-pond and observed sections of *kuapā* on the W and SW sides. Fresh spring water was flowing into the pond from beneath the west wall (pond level was low with base of the west wall exposed). Searched for house site on the SE side of the pond and for modern shrine erected in the vicinity to commemorate the late "Uncle Harry" Mitchell; these sites were not found.

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
small house platform overlooking Puu Olu (Pauwalu)	State site 50-50-07-538 (BM A4-10)				"A small house platform overlooks Puu Olu pond from the east side of the valley. The platform, or terrace, is about 12 feet by 15 feet and is built on the slope of the valley a few feet from the pond and about 10 feet above it. The side toward the pond is faced with waterworn stone. The site commands a fine view of the natural arch under Pauwalu Point." (Soehren 1963:209)		

Archaeo-logical Sites	State Site # & Form Informa-tion	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
foundation platform of a grass house near Paepae-moana Pt.	State site 50-50-07-538 (BM A4-11)				Near Paepae-moana Point. On the grass covered flat about 200 feet from the top of the sea cliff, is what may be the foundation of a grass house. A rectangular area about 18 feet by 24 feet is covered with rough cobbles, except for a portion about 9 feet by 12 feet which is still fairly smooth and appears to have been delineated by large stones set carefully around the perimeter. The whole is greatly disturbed, mostly by cattle which graze in the area. (Soehren 1963 :208)		Possibly modern? A local resident related that Woody Brown, a well known surfer lived here for a while in the 1950s-1960s in a thatched house built for his use.

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Wailuanui complex (Wailuanui)	State site 50-50-07-539 This site was named Wailuanui Complex by the inventory the features in 1963. ... The complex covers an area of about 520 x 180 m. The features include 15 graves and two possible house sites. More features in the area were seen; however time did not allow the inventory team to map or record them. Most of the features are within 25 m from the edge of the cliff (Hawaii Register of Historic Places 1973). T. Donham conducted a field inspection on 4/29/93 and recorded 5 additional features, not previously recorded (a wall, a terrace and 3 modified outcrops). "It appears likely that additional features are present within the complex, and inland on the current complex boundaries" (SHPD letter Log no. 8374, Doc. No. 9305KD07, May 27, 1993)						Not investigated during presen study

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Portion of Wailuanui complex	State Site 50-50-07539 (BM A5-5) This feature category represents the 15 graves found in Wailuanui complex. They are situated in an area of about 27 x 13 m. The graves range in size from 1.2 x 1.4 m. to 4 x 2.5 m. All are rectangular or roughly rectangular in shape. The graves are in fair condition. Only rock alignments are visible on all graves. The visible rocks are waterworn basalt. It could not be ascertained how the graves were constructed. Soehren reported in 1963 that these are probably historic graves. Excavation should be carried out to determine when they were placed here. The graves are situated next to Feature B, a possible house site. In fact, one grave site on the platform of the house site. No artifacts or midden were found (Hawaii Register of Historic Places 1973).						Not investigated during present study

Archaeo-logical Sites	State Site # & Form Informa-tion	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Portion of Wailuanui Complex (Feature A)	State site 50-50-07-539 (BM A5-6) This feature is a possible house site, situated about 2380 m N of the graves and feature B in a thick growth of Christmas berry and guava. ... The inventory team observed a very deteriorated wall which abuts a natural aa ledge and a possible platform extending E from the S end of the wall. The wall is of multiple-stacked construction and is built with aa. It ranges from 0.7 to 0.9 m in width and from 0.4 to 0.6 m. in height. The possible platform is about 9 m in length and ranges from 0.4 to 0.6 m in height. No E border cold be seen. The interior slopes toward the S and in-cludes many natural aa out-crops. The natural aa ledge which appears to be the N border of the feature ranges from 1.3 to 1.5 m in height. There was evidence of con-struction on the ledge, perhaps to build it up further (Hawaii Register of Historic Places 1973).						Not investigated during presen study

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Portion of Wailuanui complex (Feature B)	State site 50-50-07-539 (BM A5-7) This feature is a possible house site. Because a dense growth of hau covers almost the entire structure, the inventory team was unable to accurately map the feature. Only the NE corner of an enclosure and a large rectangular platform are visible. The enclosure walls are of multiple-stacked construction and are built with aa. In the NE corner, they range from 1 to 1.3 m in width and from 0.2 to 0.6 m in height. On the E side of the enclosure is a deteriorated platform. The platform measures about 15.5 x 4.8 m. At the NE and SW corners, the platform ranges from 0.2 to 0.4 m in height. Most of the E side of the platform is deteriorated and grass-covered. A grave outline measuring 2.7 x 1.7 m is situated on the platform in the center and is half obscured by the hau (Hawaii Register of Historic Places 1973).						Not investigated during present study

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Rock terraces on State land (Wailuanui)	State site 50-50-07-2942 "at 104 m. from Makehau street, rock terraces were observed 2.0 m. south from the centerline. At 108 m., the route crosses a 6.0 m. long terrace wall; at 114 m., a second terrace is crossed. These features re part of a terrace complex which continued down the hill to the stream. ... In general, they are in poor condition and have been disturbed by erosion or other factors (Field Inspection of Revised Road Easement Route for Mike Adams, Wailua, Koolau, Maui, Jan. 13, 1993).						
wall for an old roadbed (Wailuanui)	State site 50-50-07-2943 The proposed road will pass over ... pushed berm and stay to the south side of the old retaining wall. Intact portions of the retaining wall are within 3.5 to 2.5 m. from the marked centerline of the route (Field Inspection of Revised Road Easement Route for Mike Adams, Wailua, Koolau, Maui, Jan. 13, 1993).						

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
terrace wall (Wailuanui)	State site 50-50-07-2944 The wall is comprised of both natural outcrop boulders and stacked wall sections, constructed from cobbles and small boulders. Several sections of the wall are washed out. The area above the wall is generally flat. Along the wall feature, ... a midden scatter was noted under an overhanging boulder. Opihi shells, kukui nuts, dark brown bottle glass, clear glass, and a whiteware bowl sherd were observed. ... The amount and types of artifacts observed here suggest a possible late nineteen/early 20th century habitation site. The proposed route will be positioned along the eastern (downhill) side of the retaining wall (Field Inspection of Revised Road Easement Route for Mike Adams, Wailua, Koolau, Maui, Jan. 13, 1993).						
cultural ace on analua rch erty luanui)	State site 50-50-07-2945 ... an agricultural terrace wall occurs to the northeast side of the proposed route ... road route [curved] in this area [to avoid] the terrace (Field Inspection of Revised Road Easement Route for Mike Adams, Wailua, Koolau, Maui, Jan. 13, 1993).						

Archaeo-logical Sites	State Site # & Form Informa-tion	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Ke'anae Arboretum Taro Complex	State site 50-50-07-3932						Described in this report
Ke'anae Peninsula Taro Complex	State site 50-50-07-3933						Described in this report
Wailuanui Taro Complex	State site 50-50-07-3934						Described in this report
Wailuanui East Taro Complex	State site 50-50-07-3935						Described in this report
Lākini Taro Complex	State site 50-50-07-3936						Described in this report
Kupa'u Taro Complex	State site 50-50-07-3937						Described in this report
Waianu Taro Complex	State site 50-50-07-3938						Described in this report
Kilo Habitation	State site 50-50-07-3940						Described in this report
Nua'ailua Taro Complex	State site 50-50-07-3941						

Archaeo-logical Sites	State Site # & Form Information	Thrum (1909)	Stokes (1916)	Walker (1931)	Soehren (1963)	Ashdown (1971)	Cultural Surveys Hawaii (1994)
Kanekauo Lono *heiau*						"Heiau Kane-kau-o-Lono is on land of that name at the shore, and is similar to the Heiau La-la-ola at Hale Haku in Huelo." (Ash-down 1971-:54)	Not investigated during present study
eleiwi		Leleiwi - "Koolau. A sacred shrine situate near the shore; visited by Kamehameha III. on his royal prog-ress." (Thrum 1909:39)		Leleiwi at Koolau, destroyed or not found (Walker 1931:167).			Not investigated during present study
liuli *au* e'anae)		Paliuli - listed; "No particulars learned of these Keanae temples." (Thrum 1909:39)		Paliuli; Heiau sites destroyed or not found (Walker 1931:167)			Not investigated during present study

C. TABLE OF KE'ANAE-WAILUANUI HISTORIC SITES

C. Table of Historic Sites Located at Ke'anae-Wailuanui

Historic Sites	State Site Number and Decription
Puohokamoa Bridge	State site 50-50-07-1509 In Honomanū, Puohokamoa Bridge is a reinforced concrete structure of flat slab design with a single tapered pier in the stream bed, located slightly toward the south end of the bridge. The bridge is approximately 45 feet long and 20 feet wide. Cast into the railing on the east side is "A.D. 1912," the date it was built." (Hawaii Register of Historic Places 1974)
Lin Hing Society Building	State site 50-50-07-1510 "The Lin Hing Society Building in Ke'anae was built in 1908 and served the religious, social, and educational needs of the Chinese in the area; last used about 1950 and abandoned; the surviving materials from the building are stored at the Kwock Hing Society, Keokea, Kula." (Hawaii Register of Historic Places 1974)
Lanakila Ihiihi o Iehova Ona Kau/ Lanakila Ihiihi o Iehova Ona Kauwa (JH)	State site 50-50-07-1511 Name of Congregational church on Ke'anae Peninsula, Meaning: sacredness of Jehovah, Son of God" (DLNR, *Fruitful Fields* 1993) or God's Sacred Wishes for the Outcasts (JH & AKD); built in 1856, restored by members of Ke'anae's Pahukoa family (On the Hana Coast 1983:95); begun in 1857, completed in 1863, restored and rededicated in 1969 (DLNR 1993).
St. Gabriel Shrine	State site 50-50-07-1512 Catholic chapel in Wailua, "The building is particularly unusual because of its miniature size (20 by 40 feet) and its high proportioned triple slope gambrel roof, surrounded by a small square steeple ... On Christmas Day, 1860, the first Mass was celebrated in the church." (Hawaii Register of Historic Places form 1974)
Wailua Stone Church Ruins	State site 50-50-07-1513 "The stone ruins at Wailua, Maui, stand in a level, overgrown field about 160 feet back from the village road. They consist of rough fieldstone walls with cement mortar, approximately eleven feet high and 27 to 30 inches thick, enclosing a rectangle 25 by 60 feet. There is one door opening on the northwest end and one on each long side. Window openings are located two on each long side and one on the southeast end. There is no indication left of a floor or roof. The form of these ruins is very similar to many known early mission stone churches and it is assumed that this was also a church, either fallen in over the years, or never completed" (Hawaii Register of Historic Places 1973). Cultural Surveys Hawaii: Wailua Stone Church remains presently covered with *hao* and a palm is growing in the middle of the building, walls are still standing; Report is that church was commenced in 1860, at the same time the Catholic church was begun, and like the latter, coral was needed to make lime. A storm supposedly littered the shore with coral and was used for both churches. Another storm shortly thereafter washed all the coral away and there was not enough left to complete this church and the work was abandoned (Per. Comm. G. Kanoa 1994).
Wailua Mormon Church	State site 50-50-07-1514 "The church was built during 1934 and dedicated in 1935. It served the small Mormon community in the area. The building was abandoned for many years and recently has been used mainly as a residence ... The Mormon Church is a one-story wooden structure with an intersecting gable roof. The squat L-plan is raised approximately two feet above the grade. There is a gabled entrance way with double entrance doors. This projecting unit has shingle covering like the remainder of the structure ... The church is located on the upper or mountain side of Hana Highway, Route 36, between Keanae School and Wailua Homesteads Road." (Hawaii Register of Historic Places 1974)

Historic Sites	State Site Number and Decription
Ramos House	State site 50-50-07-1515 The oldest house in Wailuanui (State site 50-50-07-1515), lived in by Florentine Ramos and his wife since 1927. Appears to have been built around 1900-1910. (Hawaii Register of Historic Places 1974)
Waikani Bridge	State site 50-50-07-1516 Bridge near Wailua (State site 50-50-07-1516) built in 1926 with a main arch of 36 feet; one of the larger bridges along the Hana Highway (Hawaii Register of Historic Places, 1974).
Ke'anae School	State site 50-50-07-1630 Built in 1912, an example of a surviving plantation-style rural school of wood construction (Hawaii Register of Historic Places, 1992).
Ke'anae Landing	State site 50-50-07-2957, recorded by SHPD in 1992; "Landing Sites of Maui" by T. Donham for 5th Annual Symposium on Maritime Archaeology and History of Hawaii and the Pacific, Honolulu, n.d. (State Historic Preservation Division) Concrete piers and other structural remnants of the former Ke'anae Landing (Cultural Surveys Hawaii 1994)
Ke'anae Quarry	State site 50-50-07-3943 Cultural Surveys Hawaii identified a stone quarry located on cliff below the Ke'anae YMCA, winch and stone crusher on site; the rock quarried here was used for building the Hana road. There is a stone platform here, perhaps a burial platform for one of the quarry workers who reportedly died in an explosion.

D. A COMPILATION OF PLACE NAMES IN KE'ANAE AND WAILUANUI

D. A Compilation of Place Names in Ke'anae and Wailuanui, Ko'olau District

by Victoria S. Creed, Ph.D.

A special concern of this cultural landscape study has been the collection and cataloging of place names in Ke'anae and Wailuanui. These names have been recorded in 19th century Land Commission Award (LCA) documents and Boundary Commission records, on historic maps, and in various writings on the area (including archaeological reports and personal documents).

Presented below is a compilation of place names in Ke'anae and Wailuanui collected during the course of the present study. The compilation also includes information generously provided by local residents during the study. Each entry includes a short description, locational information (when available), and source. There are also many stories about the place names which appear in the body of this report and have not been repeated here.

The map which follows the place name compilation uses U.S.G.S. topographic maps - Ke'anae and Nāhiku quads - as a base. The names presented on the map include those shown on historic maps which are located as exactly as possible. Names mentioned in written documents are located as accurately as possible.

This compilation is only a first effort to register the heritage of Ke'anae and Wailuanui preserved in the region's names. It is hoped that others with knowledge about the place names in this area will contribute to this list, adding further details, correcting any errors, or deleting items which do not belong.

Named Places[1] in Ke'anae and Wailuanui, Ko'olau District

R.M. = Registered Map
Informant Sources:
JH = James Hueu, Ke'anae kupuna; AKD = Apollonia K. Day, Ke'anae kupuna; HN = Helen Nakanelua, Wailuanui kupuna; EW = Elaine Wender; For other sources see Reference Section

Āhole
—Promontory near Pauwalu Point, *āhole* is a fish (*kuhlia sandvicensis*) (U.S.G.S. map Ke'anae quad) Sea arch beneath promontory; scenes from the movies "Teenage Mutent Ninja Turtles" and "Papillon were filmed here."

'Aihonu
—place in Pauwalu along Waiokamilo stream, means: eating of turtle (Soehren 1963:192); shown on Handy and Handy map (1972:499); (See following map).

Ainakiki
—boundary marker along Pahoa on a ridge separating Wailua and Ke'anae (Boundary Commission, 1895, Maui, vol. 2, p. 49) (Not shown on any known maps).

Akeke/Kaakeke/Paakeke
—spring, in the forest above Moana, above Kupa'u along Waiokamilo Stream, also called Banana Springs (HN & A. Carmichael in McGregor interview 1994); (Map on pages following Place Names dictionary).

Alaloa ("Long Road") See Pi'ilani Trail
—paved trail that ran around both east and west ends of Maui. "Between Wailua and Ke'anae the old trail and present road cross and recross each other" (Handy and Handy 1972:490). Same as Pi'ilani Trail.

Ālia See also Keālia
—'ili or place name in LCAs for Wailua meaning: Salt pond or salt encrustation (Pukui, Elbert and Mookini 1986); LCA 4865

Alenuihāhā Channel
-Channel between Maui and Hawaii (A-P); Lit. great billows smashing (Pukui, Mookini, Elbert 1986); "great waves pursuing."

Aluea Rocks
—Rock islet (0.14 acres, 40 feet elevation) Ke'anae quad (Pukui, Mookini and Elbert 1986); off coast at Wailua (U.S.G.S. map, Ke'anae Quad); means "sagging" (Soehren 1963:194).

Analoa
—'ili or place name in LCAs for Ke'anae; meaning: long cave (Pukui and Elbert 1986); (See LCA 2442 on 1904 map of Ke'anae Flat, Makai).

'Auwai Ho'omanumanui? Honomanu?
—Ditch, Name means "Patient ditch." (JH).

Baldwin Camp
—site shown in *'ili* of Pahoa in upper Ke'anae (R.M. 2235 Ke'anae Flat Mauka Map); Ko'olau Ditch Trail camp for irrigation company workers (McGregor Interview, 1994).

---

[1] The Hawaiians use the words "wahi pana" for places of distinction.

NO.	NAME	BIRTH DATE	DEATH DATE	RELATIONSHIP	PHOTO	MADE OF	TYPE	OTHER INSCRIPTION INFO
1	MATZ, BONNIE JEAN K.	07-20-1949	01-22-1954			MARBLE/GRANITE	UPRIGHT	
2	QUNOHL, MAY	00-00-0000	05-30-1944			CONCRETE	UPRIGHT	
3	SOON, LOOK	00-00-0000	03-30-1921			CONCRETE	UPRIGHT	46 YRS. OLD

SITE DATA FORM: WAILUA COUNTY CEMETERY

ALSO KNOWN AS: _____

LOCATION: Wailua Road AREA: Wailua

APPROX. SIZE: 1.0 Acres STATUS: ___Active X C

RECORDED TOMBSTONES: 3 # UNMARKED GRAVES: ___

CONDITION OF SITE: ___Abandoned/Overgrown/No maintenance
___Some individual graves maintained
Irregular X Regular maintenance of entire site
X Poor ___Fair ___Good ___Excellent

MAINTAINED BY: X Owner ___ Cemetery Assoc. ___ Individual Families ___ Unk

OWNER: County of Maui

CONTACT PERSON: George Kaya, Chief of Field Operations & Maintenan
Name Title

243-7869 1827 Kaohu Sta., Wailuku, HI 96793
Phone Address Zip

CONTACT PERSON: Geraldine Carroll Informant
Name Title

Phone Address Zip

NOTES:

done

done

Banana Springs/see also Akeke
—spring along Waiokamilo (Kamilo) stream.

Hahāha Bay
—Bay to the east of Pauwalu Pt. (U.S.G.S. map Ke'anae quad); noted as a place for shell fish, means pant, breathe hard (Soehren 1963:192).

Ha'ikū (Uka)
—*ahupua'a*, boundary lines meets with Wailua across Ko'olau Gap (Boundary Commission, 1895. Maui, vol. 2, p. 49-50) (U.S.G.S. map

Haipua'ena
—stream in Ke'anae quad (Pukui, Elbert and Mookini 1986); swimming place (P. Sinenci in McGregor interview 1994) (U.S.G.S. map between Puohokamoa and Kolea Streams, Honomanū)

Hakakea See Haleakeā
—'ili or place name in LCAs for Ke'anae, means house of light (Soehren 1963:192) (See 1904 map of Ke'anae Flat Makai; LCA 4856).

Haleakalā
—'ili or place name in LCAs for Ke'anae; Lit. House of the sun (Pukui, Elbert and Mookini 1986) (R.M. 2238 1904 map of Ke'anae Flat Makai, LCA 4856).

Haleakea see also Haleakala
—'ili or place name in LCAs for Ke'anae meaning: broad or spacious house (Pukui and Elbert 1986) (See 1904 map of Ke'anae Flat Makai, LCA 4856).

Hamau
—stream, shown on Handy and Handy map (1972:499) flowing behind Lakini and flowing into Waiokamilo Stream in Wailuanui; also shown on map of Grant 4866 of Kupa'u, no date, no. map no.)

Hanawī
—stream, Ke'anae quad, "seeking fresh water shellfish," stream in Ko'olau (A-P); "supported small terraces on diminutive flats near the sea" (Handy 1985:110); in Nāhiku (U.S.G.S. map).

Hau'oli Wahine/Hauolowahine
—Gulch, stream and water falls shown in upper Ke'anae Valley (HTS Plat 1607-A); Hau'oli Wahine? feminine happiness (Soehren 1963:192) (U.S.G.S. map); R.M. 2235 Ke'anae Flat Mauka).

Honomanū
—Land division and bay, Ke'anae quad (Pukui, Mookini and Elbert 1986); Land division to the west of Ke'anae (U.S.G.S. map).

Ho'okuli
—land area shown on Ke'anae Flat Mauka map (R.M. 2235); means "disobedient" (Soehren 1963:192).

Ho'olio
—hill used as marker in Wailua *ahupua'a* boundary (Boundary Commission 1895, Maui, Vol. 2:53-54) (Not seen on any of present maps used).

Huo see Kuoo
—'ili or place name in LCAs for Ke'anae Name of an unidentified star (Pukui and Elbert 1986) (See LCA 4847 on 1904 map of Ke'anae Flat Makai).

Ka'alani see Kualani
—trig. station, southeastern side of Wailuanui (R.M. 2234).

Kaaunaku
—'ili or place name in LCAs for Ke'anae (LCA 4848G; not shown on any of presently used maps).

Ka'awale/Kuawale
—falls and place or ridge above Kupa'u, means "separate" (Soehren 1963:194);

water fall is boundary along Gov't land for Wailuanui-Wailuaiki *ahupua'a* (Boundary Commission, 1895, Maui, Vol. 2:57-58); Handy and Handy 1972:499).

Kaelua
—islet, Ke'anae quad (Pukui, Elbert and Mookini 1986); in Nāhiku (U.S.G.S. map).

Kahukahu
—trig. station at Ke'anae Park on northeast side of peninsula (R.M. 2238 Ke'anae Flat Makai map); means "dedicate with prayer," probably an older name than Kawee for the same place (Soehren 1963:192).

Kahekili's Leap, See also Pali Kahekili
—Leaping place above Waiolohi Pond in Ke'anae where Kahekili took his last leap (JH) Kahekili ruled Maui for 27 years beginning in 1766 (Pukui, Elbert and Mookini 1986); Ke'anae Peninsula Overlook.

Kake'e/Kaahaakee
—'ili or place name in LCAs for Wailua where *olonā* grows (LCAs); means "abrupt turn" (Soehren 1963:194); LCA 5049:2 (R.M. 1760); (See following map).

Kakū see Makaku
—area name in Keononalu in Wailua where *olonā* grows (LCAs).

Kala'alaea (also Kealaalaea)
—'ili or place name in LCAs for Wailua means "remove red ochre" (Soehren 1963:194) (LCA 4853G, shown near Catholic Church on R.M. 1760).

Kalālo'i
—'ili or place name in LCAs for Waianu; means "the day to cultivate taro" (Soehren 1963:194); LCA 3472B R.M. 2972 Waianu Valley).

Kaleiomaui/Laemomaui
—Stream in far upper Ke'anae Valley (HTS Plat 1607-A); trig. station (R.M. 2235 Ke'anae Flat Mauka).

Kalia'e
—'ili or place name in LCAs for Wailua, "wait awhile," Land section in Ko'olau (A-P) toward Hana side beyond Wailua (HTS Plat 1607-A) (U.S.G.S. map).

Kalihi
—'ili or place name in LCAs for Ke'anae meaning: the edge (Pukui, Elbert and Mookini 1986) (LCAs 2442 & 4665 on R.M. 2238 Ke'anae Flat Makai).

Kali'i
—land area *makai* of Pauwalu *'ili* in Wailuanui (R.M. 1760); Handy and Handy (1972:499) show this area planted in *uala* (sweet potatoes); (See following map).

Kalimapuhi/Kalunapuhi
—'ili or place name in LCAs for Wailua; Kalunapuhi means "the high place for burning (Soehren 1963:194); LCA 4773B:1 on R.M. 2234 Wailua).

Kaluanui
—stream (below 'Ohi'a Spring name changes from Waianu to Kaluanui — JH in McGregor interview 1994) and *heiau* State site 50-50-07-95 (BM A5-9); "No particulars learned of these Keanae temples" (Thrum 1909:39); "Kaluanui, a small heiau, 41 x 42 ft., on land of same name, at Wailua nui below a *koa ia* known as Ohia, one-third of a mile from sea; on side of taro patch; of two sections ... Said to have been for sacrifice, and that the drums are heard" (Stokes in Thrum 1918:125); (Walker 1931:170); (See following map).

Kamilo
—*heiau*, State site #93 (BM A5-8)

"Location: At Kawaloa on the north side of the stream in a dense grove of hau and puhala: Description: A small enclosure 22 x 25 feet built of rough basalt and some pebbles. Walls 3 feet high and 3 feet thick" Walker 1931:168); —Kamilo Stream (Boundary Commission, 1895, Maui, Vol. 2:57-58) see Waiokamilo Stream).

Kamaino
—trig. station; short ridge in Ke'anae Valley; means "bad child" (Soehren 1963:192); shown in upper Ke'anae valley overlooking Pi'ina'au Stream (Handy and Handy 1972:499) (R.M. 2235, Ke'anae Flat Mauka)

Kamakaihe/Kamakaaihe
—'ili or place name in LCAs for Ke'anae (not seen on any maps presently used).

KānekauoLono
—*heiau* at Ke'anae on lands of that name at the shore (Ashdown 1971:54) (Not seen on any maps presently used).

Kānemakua
—'ili or place name in LCAs for Ke'anae; name of a Maui chief (AKD); (R.M. 2238 Ke'anae Flat Makai); area known for growing *olonā* in LCAs; Kānemāku'e? means dark brown Kāne (god) (Soehren 1963:192).

Kano/Kanou
—stream and falls shown in upper Ke'anae Valley (HTS Plat 1607-A); (R.M. 2235); means hard, stiff (Soehren 1963:192); falls is boundary marker for land of Wailuanui and Wailuaiki (U.S.G.S. map).

Kaoiki
—place name shown on Handy and Handy map (1972:499) in upper Pauwalu valley; beneath Kuawale Ridge; (See following map). dictionary).

Kapa'akea (See also Pa'akea)
—stream, land division, Ke'anae quad; also called Pa'akea. Lit., the coral or limestone surface (Pukui, Elbert and Mookini 1986) (U.S.G.S. map between Waiohue and Kapaula Streams).

Kapae
—'ili or place name in LCAs for Ke'anae; Lit. the landing (Pukui, Elbert and Mookini 1986) (R.M. 2238 Ke'anae Flat Makai); area known for growing *olonā* in LCAs.

Kapahukū/Ka Pahu Kū
—place in Ke'anae Valley (Soehren 1963:192); "Ka Pahu Ku", a place marking the boundary between Ke'anae and Wailua *ahupua'a* (Boundary Commission, 1895. Maui, vol. 2, p. 49); (not seen on maps presently used).

Kapa'ula
—trig. station between Waiohue and Paakea Streams (U.S.G.S. map); "red enclosure," Land section in Ko'olau (A-P); Kapa'ula Gulch, see also Pa'ula near Kapili'ula along the ocean (McGregor Interviews 1994)

Kapiha Point
—Sacred area for fishing folk (P. Sinenci, McGregor Interview 1994) (not seen on maps presently used).

Kaulanamoa
—land area shown for Ke'anae Flat Mauka (R.M. 2235), located across stream from ili of Pi'ina'au and *mauka* of Pahoa; means "chicken roost" (Soehren 1963:192).

Kaulani
—land area shown for far *mauka* land in Ke'anae Flat Mauka (R.M. 2235); means "for support of the chief" (Soehren 1963:192).

Kaumakani/Maumakani
—hill forming boundary of Wailua *ahupua'a* (Boundary Commission, 1895, Maui, vol. 2, p. 54-54) (Not seen on maps presently used).

Kauwalu
—islet off Pauwalu Pt. (U.S.G.S. map Ke'anae quad); means "eight landed" (Soehren 1963:192).

Kawaaune hill
—place name in LCAs for Ke'anae, place claimed for growing olonā, meaning: to pry up the canoe? (Pukui and Elbert 1986) (not seen on any maps presently used).

Kawaikuu?/Kawaikau Flume
—flume used in 1904 from Palauhulu Stream to Ke'anae peninsula (R.M. 2238 Ke'anae Flat Makai).

Kawalimukala
—*heiau* at Pauwalu; "Heiau sites destroyed or not found" (Walker 1931:167); State site 50-50-07-90.

Kawe'e Point
—Area of park on Ke'anae peninsula, also trig. station of Kahukahu (U.S.G.S. map, Ke'anae quad); earlier maps show place as Kahukahu.

Keaku
—falls on Palauhulu stream (Soehren 1963:192); located on Handy and Handy map (1972:499); boundary for Ke'anae and Wailua (Boundary Commission 1895:49-50); at 400' elevation (U.S.G.S. map).

Keala'alaea
—'ili or place name in LCAs for Wailua (LCA 10828B:3, R.M. 1760).

Keālia See also Kaliea
—'ili or place name in LCAs for Wailua; Lit. the salt encrustation (Pukui, Elbert and Mookini 1986).

Kealokekua
—'ili or place name in LCAs at Kaluawaa; LCA 4848H:1 on western *mauka* side of Ke'anae Peninsula (1904 map of Ke'anae Flat Makai).

Ke'anae
—ahupua'a in Ko'olau District of Maui in LCAs; Here, the god Kāne, accompanied by Kanaloa, thrust his *kauila* staff into solid rock, and water gushed forth; *ke'anae* Lit. the mullet (Pukui, Elbert and Mookini 1986); Ashdown heard that it meant "the Inheritance from Heaven," because Kāne, the creator, visits this particular area, thrusts his staff into solid rock and draws forth water; —A small *lo'i* near the western side of the land formerly belonging to the chief of Ke'anae and has the name Ke-anae (the big mullet); it is said that the entire locality took its name from this small sacred *lo'i*" (Handy 1985:110); (Inez Ashdown Ke Alaloa o Maui, 1971:54); Others, like Harry Kuuilii MItchell believed the name derived from *nae* "out of breath" from the crosspiece *ke'a* needed to carry the dirt down to the peninsula (EW); *ahupua'a* area of 11,148 acres (Boundary Commission 1895:50) (U.S.G.S. map).

Ke'anae Arboretum
—Arboretum started by Henry C. Inciong, Forest ranger in 1942 (JH); around the bend from YMCA on Hana Highway 6 acres; taro patches were renovated in 1946 by prisoners from the Ke'anae prison camp. In 1971 ... district forester, Wesley H.C. Wong Jr., began to develop the arboretum" 60 varieties of taro listed (*Star Bulletin*: 11/29/84:A17); The arboretum taro complex has been assigned State site 50-50-07-3932.

Ke'anae Landing
—Landing on the west side of the Ke'anae Peninsula. Used by the inter-island steamer to bring supplies and mail once a month. No longer used after the road went through to Hana in 1927 (JH) (U.S.G.S. map).

Ke'anae Peninsula
—"It is on the broad flat peninsula of lava that extends for nearly a mile into the sea from the western line of the valley, that Ke'anae's famed taro patches are spread out in striking evidence of old Hawaii's ingenuity ... Anciently, according to Henry Ikoa, the peninsula was barren lava. But a chief, whose name is not remembered, was constantly at war with the people of Wailua and determined that he must have more good land under cultivation, more food, and more people. So he set all his people to work (they were then living within the valley and going down to the peninsula only for fishing), carrying soil in baskets from the valley down to the lava point. The soil and the banks enclosing the patches were thus, in the course of many years, all transplanted and packed into place; area shown in "kalo loi" shown on Handy and Handy map (1972:499) (U.S.G.S. map). The Ke'anae Peninsula taro complex has been assigned State site 50-50-07-3933.

Ke'anae Prison Camp
—Prison camp used by workers building the Road to Ke'anae and beyond. It's use began in 1925 (JH) and was in use until about 1939 when it was given over to the Civilian Conservation Corps (CCC) for corps workers to forest the mountains of Maui. The arboretum history indicates that it was used again by prisoners as late as 1946, when the prisoners worked the taro patches at the arboretum. The prison camp was closed in the 1950s (*Star Bulletin*: 11/29/84:A17); The Gymnasium on the site was first built in 1925 (JH).

Ke'anae Quarry
—quarry on hill beneath YMCA; in use when road was being built in 1920s; blue rock quarry with crusher. Isaac Kanoa II said there is a story that a quarry worker died during blasting and rock platform could be possible grave for this worker; crusher machine and winch handle still there; crusher is marked "Indiana road Machine Co. Ft. Wayne Ind. #9C13" (Hammatt notes 1994); This has been assigned State site 50-50-07-3943.

Ke'anae Uka
—Land section, Ke'anae, Maui. Lit., upland Ke'anae (Pukui, Elbert and Mookini 1986); Trig. station (R.M. 2235); "in the extensive confines of Keanae Valley, now a water reserve with no inhabitants, the old Hawaiians planted a great deal of dry-or forest-land taro ... It would seem that the greater part of the valley was, until recent times, boggy forest" (Handy 1985:110); (U.S.G.S. map).

Keawaluka
—ridge above Hana road in Ke'anae; shown on Handy and Handy map (1972:499); (See following map).

Ke'elaimaka
—land area shown in upper Ke'anae between Kuo and Pi'ina'au (R.M. 2235, Ke'anae Flat Mauka); Keālaimaka? means "fascinates the eyes" (Soehren 1963:192).

Kekaele
—'ili or place name in LCA 4848F for Ke'anae; (See following map).

Kekapa
—'ili of Ke'anae, meaning: the kapa (or tapa) (R.M. 2238 Ke'anae Flat Makai).

Kekuapo'owai
—falls along "Puuhaoa" marking the Wailua/Ke'anae boundary at S 58° 8' E (Boundary Commission 1895, Maui, Vol. 2:53-54) (not seen on any maps presently used).

Keononalu/Keonenalu?
—'ili or place name in LCAs 4779 & 4587 for Wailua; area where taro and *olonā* grow (LCAs); means the sixth wave? (Soehren 1963:194); (See following map).

Kepo'ookamoku/Ke Po'o a ka Moku
—place in Ke'anae Valley, means "the head of the district" (Soehren 1963:192); "Ka Poo o ka Moku" marks boundary line between Ke'anae and Wailua *ahupua'a* boundaries (Boundary Commission, 1895, Maui, vol. 2, p. 49) (not seen on maps presently used).

Kiapu/Kiapo'o
—'ili or place name in LCAs for Ke'anae Ki'apu, Lit. ti-leaf drinking cup (Pukui, Elbert and Mookini 1986) (See LCA 2442 on Ke'anae Flat Makai).

Kīkahō
—small ridge in Kupa'u; means abrupt, rude (Soehren 1963:194); located on Handy and Handy map (1972:499) as a bluff at source of Hamau Stream in Wailua; (See following map).

Kikau
—hill forming boundary between Ha'ikū and Wailua at the "south corner of the land of Honomanu" (Boundary Commission, 1895. Maui, vol. 2, p. 49-50); (See following map).

Kikokiko
—place in Ke'anae Valley, means "hatch" (Soehren 1963:192); waterfall (E. Akina, McGregor Interview, 1994); on Waiokamilo Stream, water diversion from Ko'olau Ditch (EW); (See following map).

Kilo
—area near the base of Waianu Valley; stream name below Ohia changed from Waianu Stream first to Kaluanui and then at the ocean is called Kilo (JH in McGregor interview 1994); The prehistoric habitation here has been assigned State site 50-50-07-3940; (See following map).

Kīlo'ia
—Kilo is a place name in lower Waianu Valley, fish sighting areas (JH).

Kīpapa
—'ili or place name in LCAs for Ke'anae, Lit. placed prone (Pukui, Elbert and Mookini 1986) (See LCA 4665:1 as Kekapa on Ke'anae Flat Makai).

Koali
—Land forming boundary beyond Wailua (Boundary Commission, 1895, Maui, vol. 2: 53-54) (not seen on any maps presently used).

Koleamoku
—'ili or place name in LCAs for Ke'anae; (R.M. 2238 Ke'anae Flat Makai); name of a deity (Soehren 1963:192).

Ko'oiki
—site shown on Ke'anae Flat Mauka map at *mauka* end of the *'ili* of Pahoa Gr. 3223 (R.M. 2235); means "small prop or support" (Soehren 1963:192).

Ko'olau Ditch
—Ditch system in the uplands of Ke'anae (HTS Plat 1607-A) (U.S.G.S. map).

Kōpili'ula
—stream, gulch and falls, at boundary towards Nahiku, on stream of same name, stream east of East Wailuaiki

Stream; The stream here never runs dry (JH); Kopiliula -means "red together" (JH); also a tunnel and horseback trail. There is a cave which was cut in the hill so people waiting for car to come from Hana could get out of rain (JH). "If you go Hana, telephone to the one who get car - go Kopili'ulu, wait for you; Go with horse along ditch trail to Kopili'ula, leave horse, go on car" (E. Akina, McGregor Interview, 1994); U.S.G.S. map.

Kualani
—Trig. station above Pu'u Ililua (R.M. 2235); *heiau*, means: sour, as unclean food container (Soehren 1963:194); "Kualani on top of ridge on west side of Waiokane Falls" (Walker 1931:167); shown on Handy and Handy map (1972:499); (See following map).

Kuaimoa
—'ili or place name in LCAs for Ke'anae, meaning "chicken ridge?" area known for growing *olonā* in LCAs; not seen on any presently used maps.

Kuapohaku
—'ili or place name in LCAs for Ke'anae, meaning "stone ridge?" Not located on any maps presently used.

Kuawale
—bluff or hill shown in upper Wailuanui (Handy and Handy 1972:499); (See following map).

Kukuiohoko
—'ili or place name in LCAs for Ke'anae; area known for growing *olonā* in LCAs; houselot for Ehu (LCA 4665G); (See map of Ke'anae Flat Makai).

Kukuiolona/same as Kukuiolono?
—*'ili* of Ke'anae (R.M. 2238; map of Ke'anae Flat Makai, just *mauka* of parsonage).

Kukuiolono
—trig. station at the point Ke'anae peninsula (R.M. 2238 map of Ke'anae Flat Makai); *heiau*, means "light of Lono (deity) (Soehren 1963:192); "heiau site destroyed or not found (Walker 1931:167); State site 50-50-07-82.

KukuioPuni/Kukui'aupuni
—"*heiau* at Ke'anae with its entry way at Pu'uWalu adjoining Waikeanui" (Ashdown 1971:54); near Ke'anae School under dense growth of trees (CSH 1994); State site 50-50-07-96.

Kukuipuka
—stream leading down to Ke'anae peninsula; shown on Handy and Handy map (1972:499); shown on U.S.G.S. maps as Kuo Stream.

Kūō (See also Kuoo)
—'ili or place name in LCAs for Ke'anae (R.M. 2238 Ke'anae Flat Makai and also on R.M. 2235 Ke'anae Flat Mauka in upland); stream leading into Pi'ina'au Stream (HTS Plat 1067-A).

Kūōli'olio
—'ili or place name in LCAs for Ke'anae (R.M. 2238 map of Ke'anae Flat Makai); means "loud cries of birds" *heiau*, means "light of Lono (deity) (Soehren 1963:192).

Kū'oko'a
—'ili or place name in LCAs for Wailua; LCA 5051 to Manu or Kamanu; (See following map).

Kuoo/See Kūō
—'ili or place name in LCAs for Ke'anae.

Kupa'u
—'ili in Wailuanui, meaning: stand exhausted (after working hard)(JH) (HTS Plat 1607-A); *heiau* "Kupau above the road in Keanae valley toward the ditch trail 84 feet of terrace wall is all that

remains (Walker 1931:167) State site 50-50-07-91; a *wahine heiau* (P. Sinenci in McGregor interview 1994); the large abandoned taro complex in this area has been assigned State site 50-50-07-3937 (R.M. 2235 map of Ke'anae Flat Mauka).

Laenomaui/see also Kaleiomaui
—Trig. station shown in uplands of Ke'anae Flat Mauka (R.M. 2235); means "brow of Maui (Soehren 1963:192).

Lākini
—variously an *'ili* or *mo'o* name in LCAs for Pauwalu *ahupua'a* in Wailua area (R.M. 1760 map of Kupa'u and Wailuanui) (HTS Plat 1607-A); meaning "many days" or "many generations" (HN). This taro complex has been assigned State site 50-50-07-3936.

Lālāola
—'ili or place name in LCAs for Ke'anae Meaning: living branch (Pukui and Elbert 1986) (R.M. 2238 map of Ke'anae Flat Makai): *heiau* on point of Ke'anae peninsula, destroyed (Walker 1981:94); State site 50-50-07-83.

Lanakila Ihiihi o Iehova Ona Kau
—Name of Congregational church (State Site #50-50-07-1511) on Ke'anae Peninsula, Meaning: sacredness of Jehovah, Son of God" (DLNR, *Fruitful Fields* 1993) or God's Sacred Wishes for the Outcasts (JH & AKD); built in 1856, restored by members of Ke'anae's Pahukoa family (On the Hana Coast 1983:95); begun in 1857, completed in 1863, restored and rededicated in 1969 (DLNR 1993).

Lin Hing Society
—The Lin Hing Society Building (State site 50-50-07-1510) in Ke'anae was built in 1908 and served the religious, social, and educational needs of the Chinese in the area; last used about 1950 and abandoned; the surviving materials from the building are stored at the Kwock Hing Society, Keokea, Kula (Hawaii Register of Historic Places 1974) (See map of archaeological sites in this report).

Lolokeahi see Ololokeahi
—'ili or place name in LCAs for Ke'anae.

Lonowai
—'ili or place name in LCAs for Ke'anae; Meaning: Water of Lono (Pukui and Elbert 1986); area known for growing *olonā* in LCAs (LCA 4848G; also claims land in Pōhakuokāne, which is both on the peninsula and in the uplands) name not found on the maps presently used.

Makahuna
—site shown on Ke'anae Flat Mauka (R.M. 2235); means "hidden eyes" (Soehren 1963:192); also shown on Handy and Handy map (1972:499); (See following map).

Makaīwa/Maka'iwa
—'ili or place name in LCAs for Ke'anae; Lit. mother-of-pearl eyes (as in an image) (Pukui, Elbert and Mookini 1986) Name of Lono's gods (Andrews 1985); "beautiful eye," Land section in Ko'olau (A-P); (R.M. 2238); —fishing grounds (P. Sinenci, McGregor interview 1994); R.M. 2238 Map of Ke'anae Flat Makai).

Makakū/Makahū
—'ili or place name in LCAs for Wailua; means "landmark" (Soehren 1963:194); LCA 4729 R.M. 1760); (See following map).

Makoloaka
—islet, Ke'anae, Maui (Pukui, Elbert and Mookini 1986); means "creeping shadows" (Soehren 1963:194); U.S.G.S map.

Manahoa Rock
—Rock islet, Ke'anae, Maui (Pukui,

Elbert and Mookini 1986) (U.S.G.S. map Ke'anae quad). (See also Ule o Nānāhoa)

Manonui
—a land name in LCAs for Ke'anae, described as land *mauka*; meaning: big shark? (Pukui and Elbert 1986); not found on maps presently used.

Manupaki'i
—place name for area where YMCA is situated, meaning: flat where (*'iwi*) birds used to land (JH); (See following map).

Mā'ulu
—'ili or place name in LCAs for Wailua; means "stiff from exercise" (Soehren 1963:194); R.M. 1760 Ili o Kupau and Wailuanui; LCA 4562:2; (See following map).

Menehune Trail
—Trail along Ditch in Wailuanui above Young Estate said to have been used by the *menehune* (Kanoa family, 1994)

Moana
—area above Kupa'u as you go up to the forest (McGregor interview, 1994); not located on any maps presently used.

Moku Hala
-Islet to the northeast of Pauwalu Pt.; (U.S.G.S. map, Ke'anae quad); meaning: "hala or pandanus island" (Soehren 1963:192).

Moku Hōlua
—Islet Ke'anae, Maui, Lit. sled island (Pukui, Elbert and Mookini 1986)(U.S.G.S. map, Ke'anae quad).

Moku-huki
—Islet Ke'anae, Maui, Lit. Pulling island (Pukui, Elbert and Mookini 1986); U.S.G.S. map.

Moku Mana
—islet, Lit. divided island or divided district (AKD) (Pukui, Elbert and Mookini 1986); bird sanctuary, island off Pauwalu Pt.; (U.S.G.S. map Ke'anae quad).

Nua'ailua/Nauailua/Nuailua
—Name of gulch, stream, and bay Hamakua side of Ke'anae, claimed in LCA for Ke'anae, "large abundance" (Hawaii Heritage Center 1990:79); "now uninhabited, was formerly the site of a settled community which raised wet taro in terraces (Handy 1985:109) (U.S.G.S. map Ke'anae quad).

Nunumea
—Boundary marker above Pahoa for Ke'anae and Wailua *ahupua'a*, on a ridge (Boundary Commission, 1895, Maui, Vol. 2: 49-50;57), not located on any maps presently used.

O'ao
—place in Kupa'u, means "glimmer of light" (Soehren 1963:194); shown on Handy and Handy map as Oao (1972:499); (See following map).

'Ōhi'a
—'ili area of Waianu in LCAs, — spring, Lit. ōhi'a tree (Pukui, Elbert and Mookini 1986); Ohi'a gulch is the location of two famous springs called WaiaKane and WaiaKanaloa (Ashdown 1971:54); U.S.G.S. map; —*heiau* (State site 50-50-07-94); "Location: At Ohia in the valley three quarters of a mile from the sea. Description: Stones removed to build pig pen, and outlines thus lost. Probably an agricultural heiau built by a chief Kaimuki" (Walker 1931:169); Wailuanui region.

Ololokeahe
—'ili or place name in LCAs for Ke'anae (R.M. 2238 map of Ke'anae Flat Makai).

Pa'akea (See also Kapa'akea)
—land division, Ke'anae quad; also called Kapa'akea. Lit., the coral or limestone surface (Pukui, Elbert and Mookini 1986); U.S.G.S. map.

Pa'akamaka
—'ili or place name in LCAs for Wailua; area known for growing *olonā* in LCAs; means "close the eye" (Soehren 1963:194); not located on maps presently used.

Paehala
—'ili or place name in LCAs for Ke'anae (R.M. 2238 map of Ke'anae Flat Makai), *'ili* name for Wailua where *olonā* was grown (LCA 4587 see R.M. 1760 map of Kupa'u and Wailuanui); means "row of pandanus trees" (Soehren 1963:192).

Paepaemoana Pt./Pa'epa'emoana
—Point or cape just south of Pauwalu Pt. (U.S.G.S. map Ke'anae quad); means "deep-sea canoe landing? (Soehren 1963:192); (McGregor interview 1994).

Pāhoa/Pahoa/Puuhaoa
—'ili or ahupua'a, place name in LCAs just east of Ke'anae, meaning: I touch my partner (JH); area known for growing *olonā*; (R.M. 1760 map of Kupau and Wailuanui); (R.M. 2235 map of Ke'anae Flat Mauka); means "short dagger, tabu sign (Soehren 1963:192); boundaries of Wailua and Ke'anae *ahupua'a*; goes along the Government land of Pahoa; Ke'anae boundary named Pahoa, Wailua called Puuaoa (same place?) (Boundary Commission, 1895, Maui vol. 2: 49-50; 53-54).

Pakanaloa
—*heiau* where Kahuna Kahekili was *kahu* of that place. He was of the Kane-Ku order of priesthood...He was a descendant of the earliest "gods" (Ashdown 1971:45); "A kahuna named Kahekili who at one time kept the heiau of Pakana-loa, erected back of Keanae on Maui at a place where violent thunderstorms occur, came to be regarded as possessed by the spirit of Kane-hekili. He was feared as a sorcerer, but any plot against his life seemed invariably to be checked by a violent thunderstorm. When he died, his brother-in-law sought his body inside the heiau and carried away the head to Lanai and worshiped it as a god. Parts of the body were distributed, and men became known as worshipers of 'eyes of Kahekili' or 'mouth of Kahekili' (underlining added)" (Beckwith 1986:48-49); State site 50-50-07-84; Possibly located in *'ili* of Analoa (?) shown on R.M. 2238 map of Ke'anae Flat Makai.

Pakui
—Trig. Station near shore beneath Catholic church in Wailuanui; Also two land areas shown near the shore between the trig. station and Wailua Homestead Road (R.M. 1760 map of Kupa'u and Wailuanui).

Palaha
—place name where the "Pōhaku 'oki 'āina" is found on brink of Haleakalā Crater, (Boundary Commission, 1895, Maui, vol. 2: 49-50); not located on maps presently used.

Palauhulu
—stream in Ke'anae, "Leaf-sheltered" (Hawaii Heritage Center 1990:83); (R.M. 2238); Pālauhulu, means "chief takes all" (Soehren 1963:192); U.S.G.S. map.

Pali Kahekili
—Leaping place above Waiolohi Pond in Ke'anae where local tradition has it the king injured his genitals so that he could no longer father children (Speakman, Jr. 1984); (See following map).

Paliuli
—*heiau* "No particulars learned of these Keanae temples" (Thrum 1909:39); "Heiau sites destroyed or not found" (Walker 1931:167); not located on maps presently used.

Palolena
—'ili or place name in LCAs in Wailua; area known for growing *olonā* in LCAs; area beneath Waikani falls; (See following map).

Palolua
—'ili or place name in LCAs in Ke'anae, identified as *mauka*; not located on maps presently used.

Pana'ewa
—'ili or place name in LCAs for Ke'anae (R.M. 2238 map of Ke'anae Flat Makai).

Papīhā
—promontory, east beyond Wailuaniki Bay, earlier maps show Poahonu, means "choked with debris" (Soehren 1963:194); U.S.G.S. map.

Pa'ula
—area by ocean near Kopili'ula (McGregor interview, 1994); two valleys before Nahiku with many old terraces (Hammatt notes 1994).

Paulae
—'ili or place name in LCAs for Wailua, one LCA lists the name as Paula, which means both "gun powder" and "a full grown tree when timber becomes red" (Andrews 1985); (same as Pa'ula?); (See following map).

Pauna
—Trig. station, and land areas in Wailuanui (R.M. 1760 map of Kupa'u and Wailuanui).

Paumoni/Paunoni
—'ili or place name in LCAs for Ke'anae. From description in LCA 4853K it appears to be near present Ke'anae beach park.

Pauwalu
—ahupua'a or 'ili place name in LCAs for Wailuanui, west of Kupa'u (R.M. 1760 map of Kupa'u and Wailuanui); trig. station, Point (R.M. 2235); "this point is one of several spots in East Maui where ghosts described as marching warriors are said to appear" (*On the Hana Coast* 1983:89); name means "eight no more" or where eight persons were eaten by sharks (JH, AKD); Handy and Handy (1972:499) show in mid Pauwalu valley lower limit between *kalo maloo* [dryland] and upper valley *kalo* [wetland taro]. Figure * is sea arch beneath Pauwalu Point and Figure * is on top of Pauwalu Point looking southeast to Hana; U.S.G.S. map.

Pi'ikalawa
—'ili or place name in LCAs for Wailua; fishpond mentioned in LCA 10828B; (See following map).

Pi'ilani Trail
—old trail, became the Old Government Road (AKD), Pi'ilani was famous Maui chief; this trail passes across Pauwalu Point; night marchers walk on this trail (AKD); same as Alaloa (Trail); "from Wailuanui ... it goes all the way to Kalia'e" (C. Day in McGregor Interview 1994).

Pi'inā'au
—stream, *'ili* or place name in LCAs for Ke'anae, Pinaoa Lit. "Kind-hearted" (Hawaii Heritage Center 1990:81) "guts come out (JH); stream (R.M. 2238); means "swim upstream" (Soehren 1963:194); U.S.G.S. map.

Pilanolipi
—'ili or place name in LCAs for Ke'anae; pasture land *mauka*; not located on maps presently used.

Poahonu
—promontory, see Papiha (Soehren 1963:194).

Pōhakukāne
—'ili or place name in LCAs for Ke'anae, meaning: Kane's stone (Pukui and Elbert 1986) (R.M. 2238 map of Ke'anae Flat Makai and R.M. 2235 map of Ke'anae Flat Mauka); means "male stone" (Soehren 1963:194).

Pōhaku 'oki 'āina
—"large rock on the brink of Haleakala crater ... where all the large lands of East Maui meet" (Boundary Commission, 1895, Maui, vol. 2:49-50); not located on maps presently used.

Pōhakuokāne
—stream leading into Pi'ina'au Stream (HTS Plat 1067-A); means stone of Kāne (deity) (Soehren 1963:194); R.M. 2235 Map of Ke'anae Flat Mauka.

Pōhakuoluakai
—ridge, shown above Kukuipuka Stream in Ke'anae valley (Handy and Handy 1972:499); (See following map).

PōhakuuleoKahekili
— "There is a large black stone below Pali Kahekili at Keanae and its name ... "The stone of Kahekili's penis" (Speakman, Jr. 1984); See Pali Kahekili.

Pohaluakai
—Trig. station between Pohakuokane and Kuo in uplands of Ke'anae (R.M. 2235 map of Ke'anae Flat Mauka).

Poi factories
—one of the old poi factories in on the Mary Lum Hoy property in Wailuanui (JH). Another poi factory (Ngs) was across from Ke'anae school, dates from about 1936 (JH) and lasted the longest (HN); The Alama Poi shop by the old Ching store at the YMCA intersection was the oldest in the area (HN); Eddie Wendt had a poi factory for four years in the 70s (HN) and there was a poi factory in Kupa'u. Ben Tau'a poi shop in Ke'anae, past the landing on the makai side of the road.

Pueo
—hilltop on west rim of Ke'anae Valley, means "owl" (Soehren 1963:194); not located on maps presently used.

Pukalawa see Piikalawa
—'ili or place name in LCAs for Wailua.

Puohakumoa/Puohokamoa
—where bridge is at Wahinepee (P. Sinenci in McGregor interview 1994); meaning: frightened or excited chicken (JH); Bridge is State site 50-50-07-1509; U.S.G.S. map.

Pu'u Alaea
—a hill in Wailua, boundary is north of this hill (Boundary Commission, 1895, Maui, vol. 2:49-50); not located on maps presently used.

Pu'u Ililua
—hill, trig. station, Puuililua is directly across from and above Wailua Homestead Road (R.M. 1760); means "two sided hill?" (Soehren 1963:194); Handy and Handy suggest the name written as Puuili lua (1972:499); U.S.G.S. map.

Pu'u Kaunohua
—Trig. Station on hill above Waialohi Pond; R.M. 2235 Ke'anae Flat Mauka.

Pu'u Maiaoiao
—peak near end of ridge in Wailua

(Soehren 1963:194); shown on Handy and Handy map (1972:499) just south of Pu'uililua.

Pu'u Olu
—fishpond at southeastern edge of Pauwalu Point (R.M. 1760); means "restful place" (Soehren 1963:194); shown on Handy and Handy map (1972:499); State site 50-50-07-538; B.M. A4-9; U.S.G.S. map.

Ramos House
—the oldest house in Wailuanui (State site 50-50-07-1515), lived in by Florentine Ramos and his wife since 1927. Appears to have been built around 1900-1910 (Hawaii Register of Historic Places 1974); See map of archaeological and historic sites in this report.

Rice factories
—there were two rice factories on the Ke'anae Peninsula (JH), one on the present Kepler property across from the Ke'anae Landing; the other not located.

St. Augustine Shrine
—Catholic shrine in Wailuanui; see archaeological and historic map in this report.

St. Gabriel's Catholic Church
—Catholic church in Wailua, one of the first stops for Roman Catholic priests in the islands (*On the Hana Coast)*; R.M. 1760 map of Kupa'u and Wailuanui.

St. Gabriel Shrine/Shrine in Memory of Our Lady of Fatima
—Catholic chapel in Wailua, (State site 50-50-07-1512) "The building is particularly unusual becaue of its miniature size (20 by 40 feet) and its high proportioned triple slope gambrel roof, surmounded by a small square steeple ... On Christmas Day, 1860, the first Mass was celebrated in the church" (Hawaii Register of Historic Places form 1974) see map of archaeological and historic sites in this report.

Ulenānāhoa
—"Statue of Liberty" rock near Moku Mana, fertility rock (AKD); same as Manahoa Rock? U.S.G.S. map.

Uluhane
—Trig. station and land area far *mauka* in Ke'anae Flat Mauka (R.M. 2235).

Wahinepee
—gathering spot mentioned by P. Sinenci (McGregor interview 1994); also listed on 1922 Ke'anae voter register as location of residence; located several streams west of Honomanū; U.S.G.S. map.

Waiaka
—pond, meaning: shadow water (JH) or reflection water (Pukui, Elbert and Mookini 1986); not located on maps presently used.

Waihāowa
—creek and gulch on *'auwai* built by J.A. Chamberlain to get water down to Ke'anae peninsula (JH in McGregor interview 1994); not located on maps presently used.

Waihiumalo
—falls marking the Wailua *ahupua'a* boundary (Boundary Commission; Maui, vol.2:53-54); not located on maps presently used.

Waiakamoi, See also Waikamoi
—watershed, Ke'anae quad; Lit., the water [acquired] by the threadfish (Pukui, Elbert and Mookini 1986); stream west of Honomanū; U.S.G.S. map.

Waiakuna/Wai o Kuna
-Falls, place name along upper Palauhulu Stream; shown on Handy and Handy map (1972:499); U.S.G.S. map.

Waianu
—ahupua'a in LCAs for area between Ke'anae and Wailuanui; stream; Lit. cold water (Pukui, Elbert and Mookini 1986); a place where Mr. Pogue planted experimental rubber trees (Ashdown 1971:54); area known for growing *olonā* in LCAs; the old Waianu taro complex has been assigned State site 50-50-07-3938; (See following map).

Waiaolohe/Waiolohi
—'ili or place name in LCAs for Ke'anae meaning: shining water? (Pukui and Elbert 1986); meaning: hearing water (echoes) (JH) *muliwai* name & trig. station on cliffs above Waiaolohi Pond (R.M. 2238 map of Ke'anae Flat Makai).

Wai'apuka
—'ili or place name in LCAs for Ke'anae upland; Lit. water coming out (Pukui, Elbert and Mookini 1986); area known for growing *olonā* in LCAs; not located on maps presently used.

Wai'eli
—'ili or place name in LCAs for Wailua Lit. dug water (Pukui, Elbert and Mookini 1986); (See following map).

Wai'eliiki
—'ili or place name in LCAs for Wailua meaning: little dug water (Pukui and Elbert 1986); (See following map).

Wai'elinui
—'ili or place name in LCA 5068 for Wailua; meaning: big dug water (Pukui and Elbert 1986); (See following map).

Waihau owā
—place where 2 streams meet just Hamakua side of Ke'anae (JH), meaning: roaring ice water (Pukui and Elbert 1986).

Waikamilo/Waiokamilo
—stream in Wailuanui (U.S.G.S. map Ke'anae quad) (HTS Plat 1607 A); "water of the milo tree" (Soehren 1963:194).

Waikamoi
—land division, stream, and ridge trail, Ke'anae quad; Lit. water [of] the *moi* taro (Pukui, Elbert and Mookini 1986); west of Honomanū; U.S.G.S. map.

Waikani see also Wai o Kane
—waterfall in Wailuanui, meaning "roaring water" (JH); *'ili* area where *olonā* grown at time of LCAs below Waikani Falls.

Waikani Bridge
-Bridge near Wailua (State site 50-50-07-1516) built in 1926 with a main arch of 36 feet; one of the larger bridges along the Hana Highway (Hawaii Register of Historic Places, 1974).

Wailolena
—Trig station near Palauhulu Stream on Ke'anae Flats (R.M. 2235); shown on Handy and Handy map (1972:499) in upper Pauwalu valley.

Wailua
—*ahupua'a* and *'ili* of Wailua, East Maui, Ko'olau District; Kalani'opu'u is said to have boarded Captain Cooks' flagship Resolution off Wailua (Speakman, Jr. 1984); means "two waters" (Soehren 1963:194); "Wailua-nui has even more extensive terracing than Keanae, sloping seaward from the base of the cliff around which the road winds. About half the terraces are still cultivated by Hawaiians. On the whole, Wailua is today richer agriculturally than Keanae" (Handy 1985:110); map showing "terraced Kalo loi" (Handy and Handy 1972:499); area of 380 acres, of which 130 acres are below the waterfall (Boundary Commission, 1895, Maui, Vol. 2:53-54); The east side of Wailua has been assigned State site 50-50-07-3935; U.S.G.S. map.

Wailua Stone Church Ruins
— "The stone ruins at Wailua, Maui, stand in a level, overgrown field about 160 feet back from the village road. They consist of rough fieldstone walls with cement mortar, approximately eleven feet high and 27 to 30 inches thick, enclosing a rectangle 25 by 60 feet. There is one door opening on the northwest end and one on each long side. Window openings are located two on each long side and one on the southeast end. There is no indication left of a floor or roof.

The form of these ruins is very similar to many known early mission stone churches and it is assumed that this was also a church, either fallen in over the years, or never completed" (Hawaii Register of Historic Places 1973); see map of archaeological and historic sites in this report.

Wailua Mormon Church
— "The church was built during 1934 and dedicated in 1935. It served the small Mormon community in the area. The building was abandoned for many years and recently has been used mainly as a residence ... The Mormon Church is a one-story wooden structure with an intersecting gable roof ... The church is located on the upper or mountain side of Hana Highway, Route 36, between Ke'anae School and Wailua Homesteads Road (Hawaii Regiester of Historic Places 1974); see map of archaeological and historic sites in this report.

Wailuaiki
—stream, *'ili* or place name in LCAs for Wailua, land division Nāhiku quad, Maui. Lit. small Wai-lua (Pukui, Elbert and Mookini 1986); "Wailua-iki, Waiohue, and Hanawi Streams supported small terraces on diminutive flats near the sea (Handy 1985:110); Boundary Commission puts Wailua Nui and Wailua Iki together as one unit containing 3034 acres (Boundary Commission, 1894, Maui, Vol. 2:58); U.S.G.S. map.

Wailuanui
—'ili or place name in LCAs for Wailua, land division, Nāhiku quad Maui, where Kapo saved Pele from Kamapua'a, Stones represent a vagina, See Kohe-leplepe. Lit. big Wai-lua (Pukui, Elbert and Mookini 1986); stream (U.S.G.S. map Ke'anae quad); Boundary Commission puts Wailua Nui and Wailua Iki together as one unit containing 3034 acres (Boundary Commission, 1894, Maui, Vol. 2:58); The Wailuanui area has been assigned State site 50-50-07-3935.

Waioea/Waloea
—'ili or place name in LCAs for upland Ke'anae; not located on maps presently used.

Waiohue
—Stream in Wailua which supported small terraces (Handy 1985:110); also known to fishermen (P. Sinenci in McGregor interview 1994); *lo'i* terraces still extent (Hammatt 1994 notes); valley two streams east of Kaliae; U.S.G.S. map.

WaioKāne Falls/Waikani
—water falls in Wailuanui, meaning: water of Kane (JH); (HTS Plat 1607-A); U.S.G.S. map.

Waiokilo Falls/Waikolo
—falls at base of Waiokamilo stream in Wailuanui (R.M. 1760); means "landmark water" (Soehren 1963:194); U.S.G.S. map.

Waiokukui
—falls on Waiokamilo stream, means "water of the candlenut tree" (Soehren 1963:194); shown on Handy and Handy map (1972:499) in far uplands; (See following map).

WaioKuna
—falls on Palauhulu stream, means "water of Kuna (a fresh water eel) (Soehren 1963:194); Boundary line of

Ke'anae and Wailua *ahupua'a* (Boundary Commission, 1895, Maui, vol. 2: 49-50); U.S.G.S. map.

Waiolohi, see Waiaolohi/Waiaolohe —'ili or place name in LCAs for Ke'anae meaning: shining water? (Pukui and Elbert 1986), hearing water (echoes) (JH); R.M. 2238 map of Ke'anae Flat Makai.

REFERENCES FOR PLACE NAMES

Other Sources: A-P = Andrews, Lorrin, *Dictionary of the Hawaiian Language*, Revised by Henry Parker, 1922 (Glossary at SHPD)

Andrews, Lorrin
1922 *Dictionary of the Hawaiian Language* (orig. 1865), Revised by Henry Parker, 1922.

Andrews, Lorrin
1985 *Dictionary of the Hawaiian Language* (orig. 1865), Charles E. Tuttle Company, Rutland, Vermont & Tokyo, Japan

Ashdown, Inez
1971 *Ke Ala Loa o Maui*, Ace Printing Col, Wailuku, Maui.

Handy, E.S. Craighill
1985 *The Hawaiian Planter*, Volume 1, Bishop Museum, Bulletin No. 161., Honolulu, Kraus Reprint, Millwood, N.Y.

Handy, E.S. Craighill and Elizabeth G. Handy
1972 *Native Planters in Old Hawaii: Their Life, Lore, and Environment*, Bishop Museum Bulletin 233, Honolulu.

Hawaii Heritage Center
1990 *Historic Bridge Inventory and Evaluation: Islands of Maui and Molokai*, Honolulu.

Pukui, Mary Kawena and Samuel H. Elbert
1981 *Hawaiian Dictionary*, University of Hawaii Press, Honolulu.

Pukui, Mary K., Samuel H. Elbert and Esther Mookini
1974 *Place Names of Hawaii*, University of Hawaii Press, Honolulu.

Soehren, Lloyd
1963 *An Archaeological Survey of Portions of East Maui, Hawaii*, Bishop Museum, Honolulu, HI

Speakman, Jr. Cummins E.
1981 *Mowee: An Informal History*, Pueo Press, San Rafael, CA.

Stokes, John F.G.
1918 *Maui Heiau Sites*, Hawaiian Almanac and Annual.

Thrum, Thomas G.
1918 "Maui's Heiaus and Heiau Sites Revised", *Hawaiian Almanac*, Honolulu.

Thrum, Thomas G.
1909 "Heiaus and Heiau Sites Throughout the Hawaiian Islands; Island of Maui, IN *Hawaiian Almanac and Annual for 1909*, pp. 38-43, Honolulu.

Walker, Winslow
1931 *Archaeology of Maui*, Manuscript at B.P. Bishop Museum, Honolulu.

Youngblood, Ron et al.
1983 *On the Hana Coast*, Emphasis International Ltd. and Link Inc., Honolulu.

Maps Used for Names

1972 Handy, E.S. Craighill and Elizabeth G. Handy
Native Planters in Old Hawaii: Their Life, Lore, and Environment, Bishop Museum Bulletin 233, Honolulu:499

1896 Kanakanui, S.M., Plan Showing Ili o Kupau and the Makai Portion of Wailuanui, Rice & Kula, Koolau, Maui, Survey & Map by S. M. Kanakanui, Traced from Govt. Survey Reg. Map No. 1760, Scale 1"=300'.

1903 Kanakanui, S.M. and G.F. Wright, Keanae Flat Mauka, Koolau, Maui, Showing Government Ili o Pahoa, Traced from Gov't Survey Reg. Map 2235 by H.E. Newton in 1904, Scale 1"=500'.

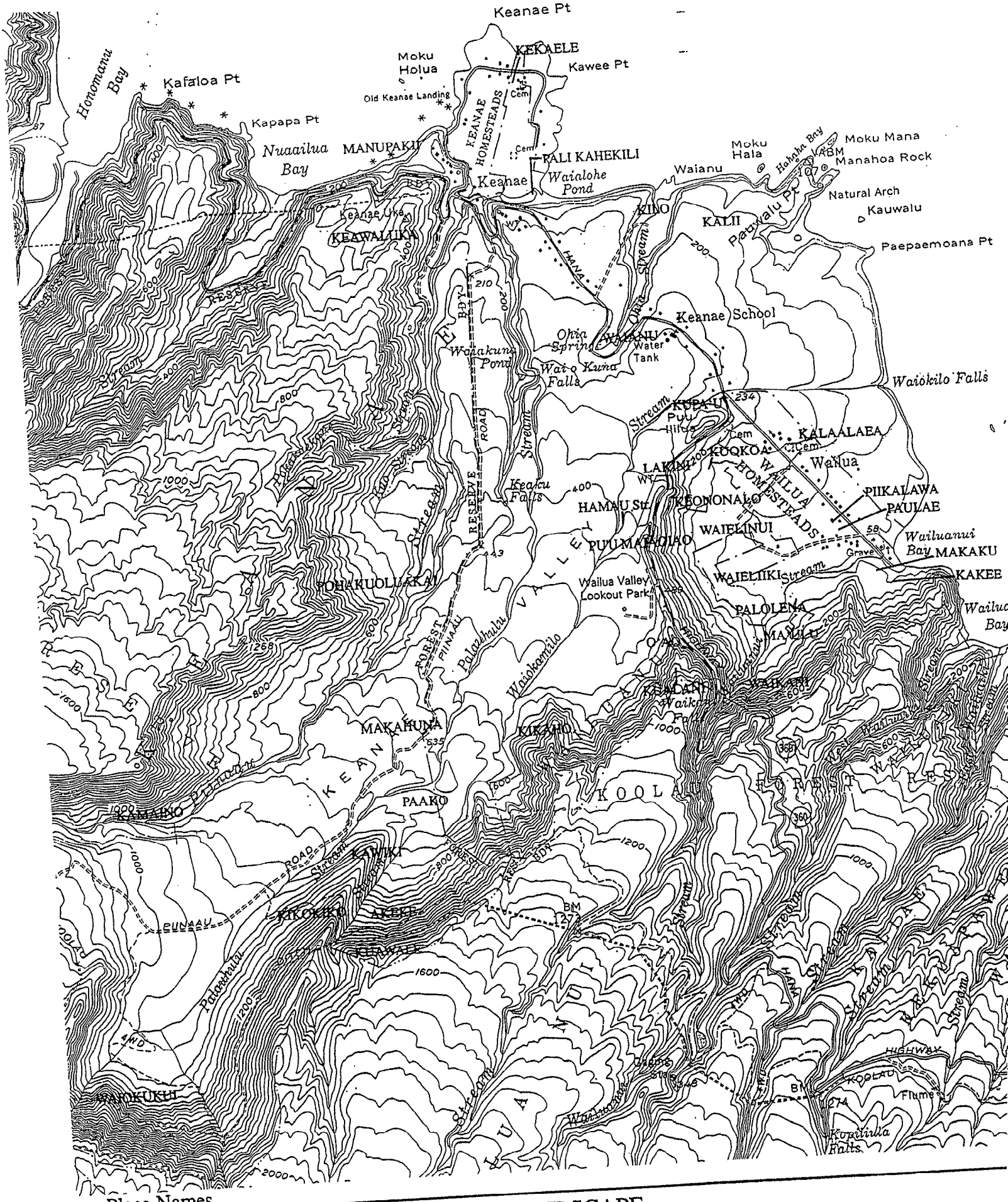
1903 Kanakanui, S.M., Keanae Flat Makai, Koolau, Maui, Showing L.C. Awards and Government Kula, Rice and Taro land., Survey made by H. Hawell. Kuleanas and Map by S.M. Kanakanui, Traced from Gov't Survey Reg. Map No. 2238 in 1904 by H.E. Newton & R.D. King, March, 1904, Scale 1"=100.'

1904 Wright, Geo. F. Wailua, Koolau Maui, Showing Kuleanas and Gov't Rice, Taro and Kula Land, Survey by Hugh Howell, Rice Taro and Kula Lands by S.M. Kanakanui, Traced from Registered Map No. 2234 by H.E. Newton, Scale 1"=200'.

1908 Kanakanui, S.M., Waianu Valley, Koolau, Maui, Hawaii Territory Survey, R.M. 2972, Scale 1":100'

1932 King, Robert D., Koolau Forest Reserve and Makawao (County) Districts, Island of Maui, Traced from R.M. 2891 by R. Lane, Jr. July 1932, Additions and Revisions, Dec. 1934, HTS Plat 1067-A, Scale 1":3000'.

U.S.G.S. Topographic map of Ke'anae and Nāhiku Quads, Scale 1:24,000.



Place Names

KE'ANAE - WAILUANUI CULTURAL LANDSCAPE

E. KE'ANAE AND WAILUANUI BRIDGES

(from *Historic Bridge Inventory and Evaluation: Islands of Maui and Molokai* [Hawaii Heritage Center 1990])

HISTORIC BRIDGE INVENTORY AND EVALUATION

ISLANDS OF MAUI AND MOLOKAI

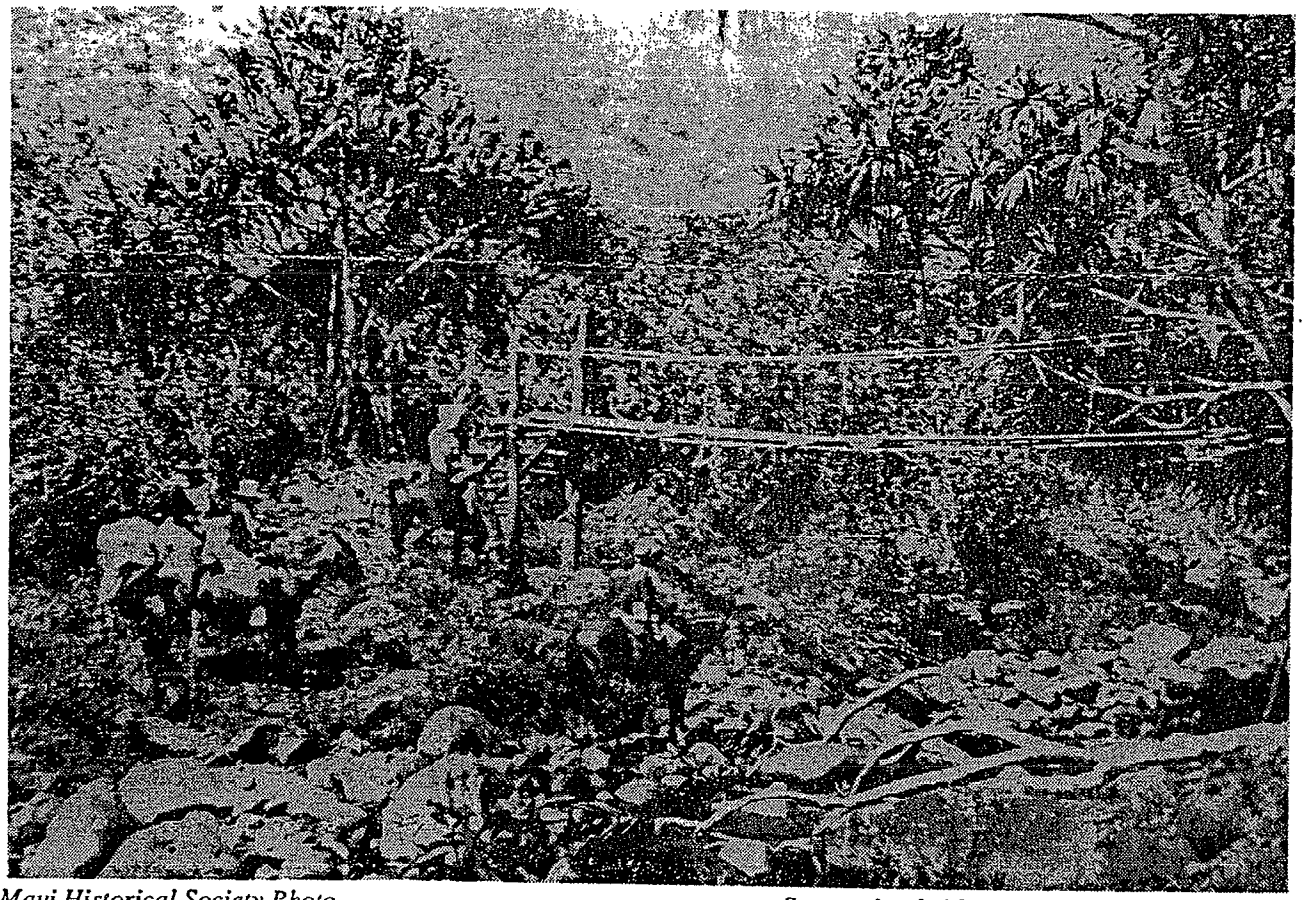
by
Hawaii Heritage Center

Prepared for the
State of Hawaii
Department of Transportation Highways Division
In Cooperation with the
U.S. Department of Transportation
Federal Highway Administration

September 1990

Chapter

Road and Bridge Building on Maui and Molokai



Maui Historical Society Photo

Suspension bridge on Koolau Trail, Maui, 1990's.

Before 1900, most travel in Hawaii was by sea. The Hawaiian Kingdom lacked an extensive system of interior roads, making land travel in all the islands difficult.[1] Hawaiian chiefs before Cook had attempted to build rudimentary roads, however, and the remains of one built of 'ala stones can still be seen between Kawaihapapa and Honomaele near the Hana Highway in East Maui.[2]

By the mid-nineteenth century, the increasing use of horses and wagons necessitated a better system of interior roads. The Kingdom in 1846 established an Interior Department to oversee internal improvements. Over the road on Maui between Ulupalakua in the Makawao District and Wailuku was built.[3]

The Kingdom made use of the abundant timber and stone as construction materials for 19th century bridges. Some wagon roads were built on Oahu, Hawaii and Maui, but for the most part the government lacked the engineering skills and funds for extensive highway systems. The Kingdom's road building, according to one historian, consisted of little more than clearing a right of way, doing a little rough grading and putting up wooden bridges where they could not be dispensed with.[4] As a result, timber bridges were routinely washed

which in East Maui made it difficult t travel between Hana and the rest of th island. Most of the kingdom's scarce funds were absorbed by repairs t bridges and maintenance of existin roads.[5]

In 1887 King David Kalakaua transferred much of his kingdom's contr over internal improvements to local roa boards financed by a road tax. These boards were semi-autonomous an charged with the construction of publi highways in their taxation districts. Roa boards on Maui and Molokai represented each of the islands' districts.

Upon annexation in 1900, the Int

Works (SPW), which had responsibility for expending territorial funds on road and bridge work. Five years later, the Territorial Legislature established the county governments on the separate islands, granting them taxing and spending powers in their jurisdictions. Hence, the County of Maui was composed of the islands of Maui, Lanai and Molokai, and county road-building was to be planned and financed by an elected Board of Supervisors.

Road Building After 1900

The forty-year period of bridge-building covered by this study witnessed rapid economic expansion and population growth on all of the major islands. From 1898 to 1940, commercial sugar planters in Hawaii increased their acreage under cane cultivation by 88 percent, from 125,000 to 235,110 acres.[6]

During the same period, Maui County's population more than doubled, from 27,920 to 55,980.[7] Most of this growth took place around the large sugar and pineapple plantations in central and upcountry Maui. The Wailuku District, which includes prime sugar lands as well as Maui's principal shipping port, nearly tripled its population from 7,953 in 1900 to 21,051 in 1940.[8] At the same time, the population of neighboring Makawao District doubled from 7,236 to 14,915.[9] Only the Hana District, traditionally isolated from the central area by lack of good roads, witnessed a decline in population during this period.

The county's growing population meant increased demand for housing, schools, utilities and physical infrastructure. In the same year Henry Baldwin completed Hawaii's highest railroad bridge, a steel trestle over the Maliko Gulch near Haiku in Makawao District, for the Kahului Railroad. Horses and carriages gave way to automobiles, trucks and buses, which meant a need for wider, more durable roads. With more acreage being brought under cultivation, better roads were needed to service the trucks hauling crops from the fields to the mills or canneries.

Road and Bridge Financing

Before 1905 nearly all funds for bridge construction came from the Territorial government through the Superintendent of Public Works (SPW). For example, the 1903 SPW report showed an appropriation of $75,800 for Maui's roads and bridges, broken down by district as follows:

Hana	$11,000
Makawao	30,000
Wailuku	17,200
Lahaina	14,500
Molokai	2,800
TOTAL	$75,800 [10]

After the counties were granted independent taxing powers in 1905, Maui County still relied on legislative appropriations to supplement county funds for internal improvements. The history of road-building on Maui, especially the development of the Hana Highway, was closely tied to Territorial and Federal government largesse to the county.

Consequently, throughout much of the 1900-1940 period the county's road- and bridge-building seriously lagged behind the island's economic development and infrastructural needs (refer to Figure 1 and Table 1). As late as 1928, County road-building funds were so scarce that in the Haiku area the gravel roads were maintained by the Haiku Fruit and Packing Company.[11] The belt road from Peahi to Kailua on the windward north coast was likewise maintained by the East Maui Irrigation Company.[12] Increased automobile traffic and damage from heavy rains had increased the maintenance cost of these roads, and by the late 1920's private planters demanded that the County administration shoulder the burden of road upkeep.

The Hana Highway

The most critical infrastructural issue facing the newly-created Board of Supervisors was the development of a belt road from central Maui to Hana along the north coast. Before 1930, the journey to Hana was made partly over unpaved wagon roads and horse trails, often rendered impassable by damage from frequent rains. An alternative route through the island's south side took the traveler through the drier ranch country ending up at Kipahulu. Since both land routes were arduous and slow, the most common means of travel to Hana was by steamer ship.

As early as 1900 the *Maui News* editorialized in favor of a good wagon road connecting Hana and central Maui. Five years later a rudimentary road in the Nahiku and Keanae areas was completed. Because of the extreme difficulty of the terrain, however, its cost was prohibitive and the roads were inadequate for frequent automobile traffic. The 1905 SPW report stated that "very rough country is encountered in these districts. On account of the great expenses of road construction, the road has been made as narrow as possible in order to construct, with the money available, the maximum length of road."[13]

East Maui's potential tourism value gave the county a strong incentive to promote the idea of a belt highway to Hana. Between 1905 and 1908, concrete bridges were built in the ditch country near Nahiku to support a proposed 60-mile paved road between Hana and Kailua. No bridges were built on Maui in 1909, but five were built in 1910 on the Piilani Highway south of Hana along the southern route.

Bridge building on Maui surged in 1911, when the Territorial Legislature established a Loan Fund Commission to oversee a special fund for belt roads. Out of the $1,270,000 appropriated by the Commission in 1911, Maui received $370,000. This made possible the building of 21 Maui bridges: four on the Hana Belt Road, four on the Piilani Highway south of Hana, six in the upcountry district, six in Central Maui and one in West Maui.

The Maui Board of Supervisors created the Office of the County Engineer in 1915, naming Hugh Howell to the post. Howell would later be involved in Maui road building as a private contractor.

Work on the northern Hana Belt Road proceeded from different areas and at different times, depending on the extent of funding. A narrow road and bridges from Kailua in Makawao to Nuaailua Bay near Keanae was built by 1912 with territorial funds. From Hana, contractors Wilson and McCandless had completed a road to the Nahiku-Keanae section by 1915. This road, however, did not link up with the Kailua extension, but instead dead-ended in the Koolau Forest Reserve. The lack of a continuous paved road prompted one Maui legislator to complain that "Maui is the only island on which you cannot traverse by road around it."[14]

After 1914 Territorial governor Lucius E. Pinkham disapproved of further loan fund monies for the Keanae-Hana Belt Road. The Territory made no

effort until 1920 to sell bonds to finance Belt Road construction on Maui, and relatively few bridges were built between 1915 and 1926. No bridges were built in 1918, 1919 and 1923.

Hana was by 1922 the site of the large Kaeleku sugar plantation and mill. The plantation's manager, Mr. Joseph Herscherr, favored the proposed Hana Belt Road as "a wonderful tourist asset."[15] He even offered to buy $300,000 worth of bonds floated by the Territorial government to finance road construction.

Most of Maui's business interests also favored the construction of a road to Hana but disagreed about the route and means of financing. County Engineer A.P. Low estimated in 1923 that the Hana Belt Road through the ditch country would cost about $692,000.[16] Citing the highway's high cost, Maui businessman A.F. Tavares instead urged funding for a less expensive Kipahulu-Kaupo belt road around Maui's south side.[17] But Maui businessmen objected to all financing proposals which included either county bonds or a special road tax.

(Some indication of the bridge-building can be seen by comparing 1936 costs with those of the present day. Construction of the large Waiale Drive Bridge, a 79-foot concrete bridge with steel girders in Wailuku, cost $23,700 in 1936. In comparison, repairs alone to the Anahulu bridge in Haleiwa, built in 1921, will cost the City & County of Honolulu an estimated $735,000 in 1989.[18])

Despite its then-prohibitive cost, the county eventually decided to complete the paved road through the ditch country. Some territorial funds were provided in 1922 and 1923, and the County set to work completing the extension between Kailua and Keanae. To lower costs, the county administration regularly used convict labor shipped in from other islands and established work camps for convict and free roads gangs at either end of the extension. Materials and heavy equipment were driven in from Kahului or shipped to Hana and transported to Keanae.

Federal Financing

Completion of the Hana Belt Road was finally made possible by the federal government, which in 1925 appropriated to Hawaii Federal Aid funds alloted to mainland states since 1917. The Territory's newly-created Highways Department then began a systematic replacement of narrow and hazardous bridges, constructing twelve new bridges on Maui in 1926. By 1927 the Maui News remarked that "very few wooden structures are left on Maui ... concrete bridges have been put in all over the County."[19]

Work on Maui bridges continued throughout the 1930s with monies from several sources—the Emergency Relief Funds, Hawaii Special Funds and the Public Highway Funds. By the mid-1930s the Federal Government financed roughly 75% of Maui County's road building. The Federal Act of 1931 had provided the County with $765,177.15 road aid funds that year. Washington's yearly contributions for Maui roads topped the one million dollar mark by 1935, amounting to $1,161,225 in 1936.[20] Sixteen bridges were constructed on Maui from 1936 to 1940, including the Naniloa Overpass (Control No. 9) and the Waiale Drive(Control No. 10) Bridges in Wailuku.

Throughout this period of extensive road-building, the County Engineer played a key role in overseeing bridge construction. Hugh Howell, senior engineer under the Loan Fund Commission, authorized building of the 1911-1912 bridges and later constructed some Belt Road bridges as a private contractor.

A.P. Low, County Engineer from 1916 to 1928, appears to have been influential in developing the Hana Belt Road and bridges during the 1920s. A.H. Wong, his assistant and eventual successor, also oversaw the completion of the Belt Road and construction of many federally-funded bridges during the 1930s. Wong was succeeded by Lyman Bigelow, former Superintendent of Public Works, during the latter part of the 1930s.

The longest serving Chairman of the Maui Board of Supervisors was Samuel E. Kalama of Makawao. Under his chairmanship from 1913 to 1933, a total of 54 bridges in the study were built, many of them in the Upcountry region he represented. The rapid development of Upcountry Maui can be ascribed partly to his influence. The Kailua Gulch Bridge (Control No. 45), built in 1929, was subsequently named the Sam

encircling the entire island (the Piilani Highway south of Kipahulu to Kihei is still unpaved), overland access to East Maui from the rest of the island was finally assured with the completion of the belt road and bridges in the 1920s and 1930s.

Bridge Materials and Design

(Refer to Table 2)

The oldest bridge in this study, the Mokulehua Stream Bridge (Control No. 78) on the Hana Highway, is a concrete slab structure built in 1908. The 48-foot bridge is typical of early-twentieth century concrete structures.

However, the Mokulehua Stream Bridge is by no means the first bridge built on Maui, however. Many of the bridges in the study were originally timber and steel bridges which between 1900 and 1940 were partially replaced as the County extended paved roads over previous horse trails.

Concrete, previously used for the arch ring of masonry bridges, became widespread after the Superintendent of Public Works made construction of strong, low-maintenance bridges its stated policy shortly after annexation.[21] According to the 1905 report of the Assistant SPW, the foundations of all bridges and culverts, were to be "constructed that they are good for all time." The report went on to state that

"Wherever practicable, bridges have... been built of concrete, and where the span was too great so as to make the cost excessive, timber bridges (treated with creosote) have been designed preferably to the steel structures which we have found ... to be the most expensive to maintain and keep in repair."[22]

In particular, concrete deck girders and concrete slabs dominated Maui's modern bridge designs. As their strength and economy became apparent, concrete deck girders replaced concrete arches and open-spandrel arches for short spans.[23] Early 20th century bridges built with county funding often consisted of simple concrete decks built over the original 19th century stone abutments.

Later bridges built with Federal funds were not only larger but also more elaborate. Federal bridges were apt to contain arched pier columns, haunched girders and railing brackets

only one of the longer bridges on Maui, but also distinguished by two twin-arch substructure columns.

The various types of bridges in the study are shown in Table 2.

Bridge Distribution

(Refer to Table 3)

Sam Kalama's Makawao District is the site of 18 bridges or 17.5% of the bridges in this study. The Wailuku District has 9 bridges or 8.7%. Lahaina has 11 bridges or 10.7%.

The majority of Maui's bridges (61 bridges or 59.2% in the study) is located in East Maui, reflecting the government's strenuous efforts to forge a road through the wilderness of the ditch country. Most of this construction occurred between 1910 and 1940. By the end of this period the highway was substantially complete. A journalist driving through the ditch country at the time called the Hana Belt Road a "paved trail following the line of the ditch through the wild jungle."[24] Today the 60-mile road to Hana from Wailuku, State Highway 360, offers residents and tourists alike one of the most spectacularly scenic automobile routes in the state of Hawaii.

Footnotes

[1]Ralph S. Kuykendall, The Hawaiian Kingdom, Vol. II, 1854-1874, (Honolulu: The University of Hawaii Press, 1953), p.23.

[2]Elspeth Sterling, *Sites of Maui County*, 14 unpublished volumes, (Bishop Museum, Department of Archaeology).

[3]Kuykendall, p. 25.

[4]Kuykendall, p. 26.

[5]Kuykendall, p. 26.

[6]Robert C. Schmitt, Historical Statistics of Hawaii, Honolulu: University Press of Hawaii, 1977, pp.359-360.

[7]Schmitt, pp. 13-14.

[8]Schmitt, pp. 13-14.

[9]Schmitt, pp. 13-14.

[10]Hawaii, Report to the Governor, Territory of Hawaii by the Superintendent of Public Works for the Year Ending June 30, 1903.

[11]*Pine Planters Demand Better Roads Makawao*, Maui News, May 30, 1928, p. 1:3.

[12]*County Committee Endorses Division Makawao District*, Maui News, January 14, 1928, p. 1:6.

[13]Hawaii, Report to the Governor, Territory of Hawaii by the Superintendent of Public Works for the Year Ending June 30, 1905.

[14]*Roads First Need View of Fassoth*, Maui News, February 11, 1921, p. 1:5.

[15]*Belt Road Bonds Can Be Taken Up*, Maui News, May 5, 1922. p. 1:5.

[16]*Estimate Made of Belt Road Cost By Way of Kailua*, Maui News, January 13, 1923, p. 1:1.

[17]*Supervisors And Committee Agree As to Belt Road*, Maui News, February 8, 1923, p. 1:1.

[18]*Anahulu Bridge to Get Repairs*, Honolulu Advertiser, July 21, 1989, p. A14.

[19]*Roads and Bridges of County Weather Heavy Rain Storms*, Maui News, April 6, 1927, p. 1:6.

[20]Patricia M. Alvarez, *Historic Bridge Inventory and Evaluation, Island of Hawaii*, unpublished manuscript prepared for the Dept. of Transportation Highways Division, State of Hawaii, July, 1987, p. 34-35.

[21]Alvarez, p. 74.

[22]Hawaii, Report to the Governor, Territory of Hawaii by the Superintendent of Public Works for the Year Ending June 30, 1905.

[23]Alvarez, p. 73.

[24]*Writer Takes You 'Round The Isle' – Maui This Time*, Honolulu Advertiser, April 27, 1940, p. 3:3.

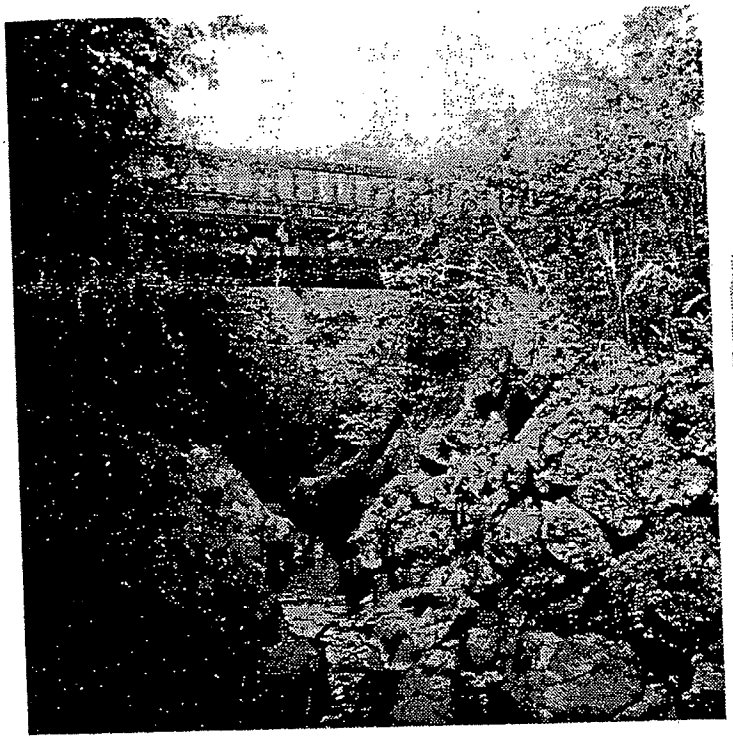
Bridge No. 29
Name of Bridge PIINAAU STRM
Structure type: CONCRETE/TEE BEAM
Structure No. 009003600501662

Factors Comprising the Evaluation Criteria for Historic Significance of Maui and Molokai Bridges

	Points	Comments
ENVIRONMENTAL (65%) or 26 pts max		
1. INTEGRITY		
A. Location and setting	0-3	3
B. Workmanship	0-3	1
C. Design	0-3	1
D. Feeling and association	0-3	2
E. Material	0-3	1
	15 pts max	8
2. AESTHETICS		
A. Poor	0	0
B. Average	2	0
C. Excellent	3	0
	3 pts max	0
3. HISTORY		
A. Poor	0	0
B. Average	4	0
C. Excellent	8	0
	8 pts max	0
		8 Sub Total
DOCUMENTATION (17.5%) or 7 pts max		
1. BUILDER/DESIGNER		
A. Unknown	0	0
B. Known	1	0
C. Known, Prolific	2	0
D. Known, Noted	3	0
	3 pts max	0
2. CONSTRUCTION DATES (original)		
A. 1936 - 1940	1	0
B. 1926 - 1935	2	0
C. 1911 - 1925	3	3
D. Pre 1910	4	0
	4 pts max	3
		3 Sub Total
TECHNOLOGY (17.5%) or 7 pts max		
1. TECHNICAL		
A. Spans (no.) more than 1	1	0
B. Span lengths (varying)	1	0
C. Height (over 25')	1	0
D. Special features	1	0
	4 pts max	0
2. GEOMETRIC CONFIGURATION		
A. Unique	3	0
B. Unusual	2	0
C. Typical	0	0
	3 pts max	0
		0 Sub Total
		11 Grand Total

PIINAAU STREAM BRIDGE

Maui County
Hana District
State Highway 360
Located 0.04 miles east of Keanae Homestead Road
Structure File No. 009003600501662
Crosses Piinaau Stream



The Piinaau Stream Bridge is located along Hana Highway over Piinaau Stream near the entrance to Keanae Peninsula. Built in 1916, the bridge's main structure type is concrete tee beam. It has one span and is 28 feet long.

The correct name of the stream and bridge is "Pi-na-oa," which means "kind-hearted."

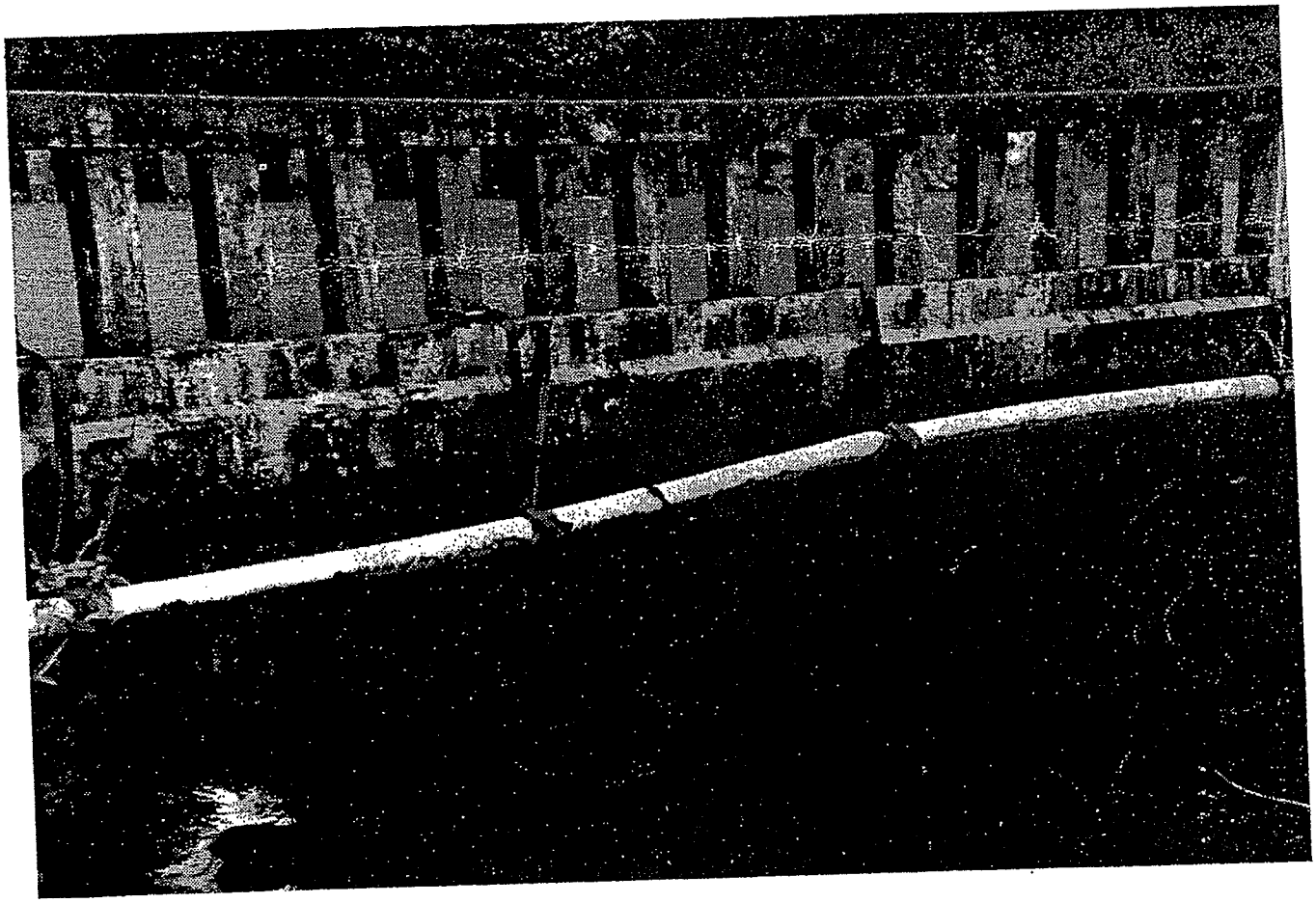
Bridge No. 30
Name of Bridge PALAUHULU STRM
Structure type: CONCRETE/TEE BEAM
Structure No. 009003600501679

Factors Comprising the Evaluation Criteria for Historic Significance of Maui and Molokai Bridges

	Points	Comments
ENVIRONMENTAL (65%) or 26 pts max		
1. INTEGRITY		
A. Location and setting	0-3	3
B. Workmanship	0-3	1
C. Design	0-3	1
D. Feeling and association	0-3	2
E. Material	0-3	1
	15 pts max	8
2. AESTHETICS		
A. Poor	0	0
B. Average	2	0
C. Excellent	3	0
	3 pts max	0
3. HISTORY		
A. Poor	0	0
B. Average	4	0
C. Excellent	8	0
	8 pts max	0
		8 **Sub Total**
DOCUMENTATION (17.5%) or 7 pts max		
1. BUILDER/DESIGNER		
A. Unknown	0	0
B. Known	1	0
C. Known, Prolific	2	0
D. Known, Noted	3	0
	3 pts max	0
2. CONSTRUCTION DATES (original)		
A. 1936 - 1940	1	0
B. 1926 - 1935	2	0
C. 1911 - 1925	3	3
D. Pre 1910	4	0
	4 pts max	3
		3 **Sub Total**
TECHNOLOGY (17.5%) or 7 pts max		
1. TECHNICAL		
A. Spans (no.) more than 1	1	0
B. Span lengths (varying)	1	0
C. Height (over 25')	1	0
D. Special features	1	0
	4 pts max	0
2. GEOMETRIC CONFIGURATION		
A. Unique	3	0
B. Unusual	2	0
C. Typical	0	0
	3 pts max	0
		0 **Sub Total**
		11 **Grand Total**

PALAUHULU STREAM BRIDGE

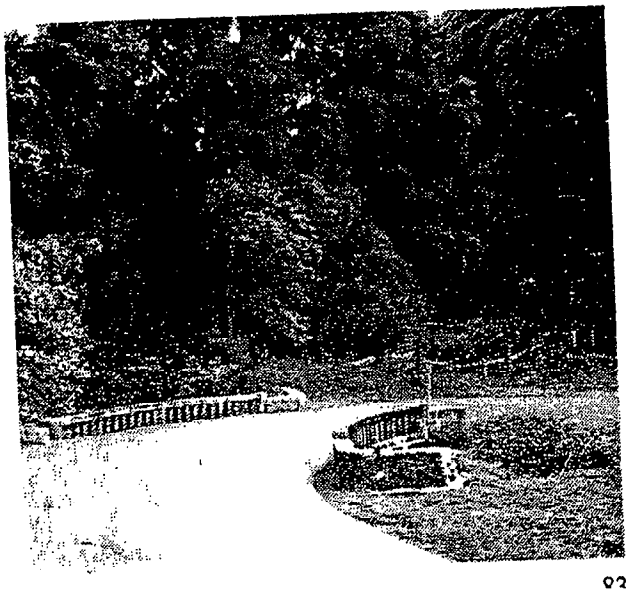
Maui County
Hana District
State Highway 360
Located 0.21 miles east of Keanae Homestead Road
Structure File No. 009003600501679
Crosses Palauhulu Stream



The Palauhulu Stream Bridge is located along Hana Highway over Palauhulu Stream near the entrance to Keanae Peninsula. Built in 1916, the bridge's main structure type is concrete tee beam. It has one span and is 31 feet long.

Until a road was constructed through this area in 1916, Keanae valley was accessible only from the sea. Its inhabitants were Hawaiians who followed the traditional Hawaiian customs and activities. Until recently, taro farming and fishing were Keanae's primary industries.

The meaning of "Pa-lauhulu" is "leaf sheltered."



Bridge No. 31
Name of Bridge WAIOKAMILO STRM
Structure type: CONCRETE/TEE BEAM
Structure No. 009003600501811

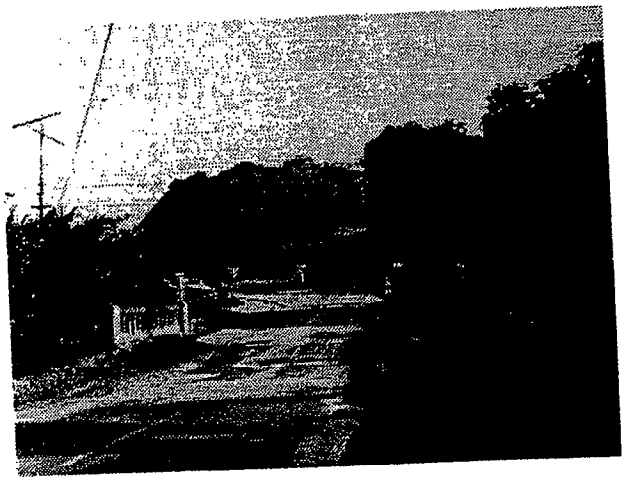
Factors Comprising the Evaluation Criteria for Historic Significance of Maui and Molokai Bridges

	Points	Comments
ENVIRONMENTAL (65%) or 26 pts max		
1. INTEGRITY		
A. Location and setting	0-3	2
B. Workmanship	0-3	1
C. Design	0-3	1
D. Feeling and association	0-3	1
E. Material	0-3	1
	15 pts max	6
2. AESTHETICS		
A. Poor	0	0
B. Average	2	2
C. Excellent	3	0
	3 pts max	2
3. HISTORY		
A. Poor	0	0
B. Average	4	0
C. Excellent	8	0
	8 pts max	0
		8 Sub Total
DOCUMENTATION (17.5%) or 7 pts max		
1. BUILDER/DESIGNER		
A. Unknown	0	0
B. Known	1	1
C. Known, Prolific	2	0
D. Known, Noted	3	0
	3 pts max	1
2. CONSTRUCTION DATES (original)		
A. 1936 - 1940	1	0
B. 1926 - 1935	2	0
C. 1911 - 1925	3	3
D. Pre 1910	4	0
	4 pts max	3
		3 Sub Total
TECHNOLOGY (17.5%) or 7 pts max		
1. TECHNICAL		
A. Spans (no.) more than 1	1	0
B. Span lengths (varying)	1	0
C. Height (over 25')	1	0
D. Special features	1	0
	4 pts max	0
2. GEOMETRIC CONFIGURATION		
A. Unique	3	0
B. Unusual	2	0
C. Typical	0	0
	3 pts max	0
		0 Sub Total

Control No. 31

WAIOKAMILO STREAM BRIDGE

Maui County
Hana District
State Highway 360
Located 0.02 miles west of Wailua Homestead Road
Structure File No. 009003600501811
Crosses Waiokamilo Stream



The Waiokamilo Stream Bridge is located along Hana Highway over Waiokamilo Stream near St. Gabriel's Church and the town of Wailua. Built in 1921, the bridge is 24 feet long. Its main structure type is concrete tee beam, one span.

The bridge was designed by D.K. Kapohakimoheu.

The meaning of "Wai-o-ka-milo" is "whirling waters."

Name of Bridge WAIKANI STRM
Structure type: CONC CON/ARCH-DECK
Structure No. 009003600501942

Factors Comprising the Evaluation Criteria for Historic Significance of Maui and Molokai Bridges

ENVIRONMENTAL (65%) or 26 pts max	Points	Comments
1. INTEGRITY		
A. Location and setting	0-3	3
B. Workmanship	0-3	2
C. Design	0-3	3
D. Feeling and association	0-3	3
E. Material	0-3	2
	15 pts max	13
2. AESTHETICS		
A. Poor	0	0
B. Average	2	0
C. Excellent	3	3
	3 pts max	3
3. HISTORY		
A. Poor	0	0
B. Average	4	4
C. Excellent	8	0
	8 pts max	4
		20 Sub Total
DOCUMENTATION (17.5%) or 7 pts max		
1. BUILDER/DESIGNER		
A. Unknown	0	0
B. Known	1	1
C. Known, Prolific	2	0
D. Known, Noted	3	0
	3 pts max	1
2. CONSTRUCTION DATES (original)		
A. 1936 - 1940	1	0
B. 1926 - 1935	2	2
C. 1911 - 1925	3	0
D. Pre 1910	4	0
	4 pts max	2
		3 Sub Total
TECHNOLOGY (17.5%) or 7 pts max		
1. TECHNICAL		
A. Spans (no.) more than 1	1	0
B. Span lengths (varying)	1	0
C. Height (over 25')	1	0
D. Special features	1	0
	4 pts max	0
2. GEOMETRIC CONFIGURATION		
A. Unique	3	3
B. Unusual	2	0
C. Typical	0	0
	3 pts max	3
		3 Sub Total
		26 Grand Total

HHC/DOT CC N 17986
11/20/86

WAIKANI STREAM BRIDGE

Maui County
Hana District
State Highway 360
Located 0.33 miles east of Wailua Valley Road
Structure File No. 009003600501942
Crosses Waikani Stream

The Waikani Stream Bridge is located along Hana Highway over the Waikani Stream where the road enters the Koolau Forest Reserve. Here, the Hana Highway turns inland and proceeds through dense tropical growth until the Hana Airport.

One of the most impressive bridges on Maui. The superstructure is typical open railing, concrete design of that era. The substructure is unique and impressive – prominent concrete arch. The substructure is visible from the road and the bridge itself is located at the head of a dramatic valley.

The bridge serves as a highway and waterway and no pedestrian traffic is allowed. The bridge has one spectacular span with a maximum span length of 83 feet. The structure length is 108 feet. The bridge roadway from curb to curb is approximately 50 feet above the stream bed which curves and thunders down to Wailua Valley, and eventually into the Pacific Ocean.

The material used in the substructure and superstructure is reinforced concrete and the wearing-surface is asphalt. The design load is unknown.

Built in 1926, the Waikani Bridge is unique on Maui for its structure type of continuous concrete arch-deck. Seen from the side, the substructure is an excellent example of the arch-deck design. The bridge is one of the most aesthetically appealing on Maui.

The dramatic use of the single 83 feet long arch gives the Waikani Bridge a spectacular appearance and compliments the dramatic, rugged ravines and mountains of scenic Hana Highway. The name "Waikani" is aptly named for [illegible] (wai). Especially during the heavy rainy seasons, when the water thundered from the top of the falls down the mountain side to the stream bed, the local Hawaiians liked the special sound of the falling water, and therefore, named the falls and waterway, Waikani.

The Waikani Bridge was built by the Moses Akiona Construction Company of Honolulu. Mr. Akiona was born in Kailua, in the Keanae district, then moved to Honolulu to seek his fortune in construction. It was prophetic that he would return to build the Waikani Bridge.

Lyman H. Bigelow was the Superintendent of Public Works for the Territory of Hawaii at the time of construction of this bridge and A.P. Low was the Maui County Engineer.

F. VEGETATION

KEANAE ARBORETUM
Alphabetical by Common Name

5/26/89

Common Name	Scientific Name	Origen	Area
	Chukrasia tabularis	India	4
	Gyrocarpus jaquinii	Kenya	8
	Ptychosperma robustum	-unknown-	5
	Terminalia ivorensis	Africa	4
African tulip	Spathodea campanulata	Africa	2
African tulip	Spathodea campanulata	Tropical Africa	2
Alexandra palm	Archontophoenix alexandrae	Australia	5
Angels trumpet	Datura candida	Tropical America	9&10
Arabian coffee	Coffea arabica	Tropical Africa	6&7
Bagras	Eucalyptus deglupta	Indonesia	5
Banana shrub	Michelia figo	China	9&10
Barrigon	Pseudobombax septenatum	Tropical America	8
Betelnut palm	Areca catheeu	Malaya	1
Betelnut palm	Areca catheeu	Malaya	5
Black sapote	Diospyros ebenaster	Caribbean	6&7
Blue latan palm	Latania loddigesii	Mauritius	1
Blue latan palm	Latania loddigesii	Mauritius	5
Blue marble tree	Elaeocarpus grandis	Australia	2
Blue marble tree	Elaeocarpus grandis	Australia	6&7
Bottle palm	Mascarena lagenicaulis	Mauritius	1
Bottle palm	Mascarena lagenicaulis	Mauritius	5
Bottlebrush	Callistemon citrinus	Australia	6&7
Breadfruit	Artocarpus altilis	Indonesia	6&7
Brownea	Brownea grandiceps	South America	6&7
Brownea	Brownea grandiceps	Tropical America	2
Buttercup tree	Cochlospermum vitifolium	Tropical America	6&7
Calabash tree	Crescentia cujete	Tropical America	5
Cashew nut	Anacardia occidentale	Caribbean	2
Chinese fan palm	Livistonia chinensis	China	3
Chinese fan palm	Livistonia chinensis	China	5
Chinese rice flower	Aglaia odorata	China	9&10
Chinese taro	Alocasia cucullata	India	1
Common Mango	Mangifera indica	India	1
Common bamboo	Bambusa vulgaris	Java	2
Cook pine	Araucaria columnaris	New Caledonia	2
Coral tree	Erythrina variegata	Indonesia	6&7
Coyure palm	Aiphanes caryotaefolia	Columbia	5
Crepe myrtle	Lagerstroemia speciosa	Indonesia	2
Cycad	Cycas revoluta	Japan	1
Dwarf date palm	Phoenix roebelinii	Tropical Asia	1
Edible pandanus	Pandanus sp.	Micronesia	2
Eggfruit	Pouteria campechiana	Tropical America	6&7
False wiliwili	Adenanthera pavonina	Tropical Asia	8
Fish tail palm	Caryota urens	Tropical Asia	1
Fishtail fern	Nephrolepis biserrata	Indonesia	2
Fishtail palm	Caryotia mitis	Southeast Asia	5
Flame of the forest	Butea monosperma	India	6&7
Flame tree	Brachychiton acerifolium	Australia	2
Flame tree	Cordia alliodora	Australia	2
Formosan sweetgum	Liquidambar formosana	Taiwan	6&7
Fragrant dracaena	Pleomele fragrans	Tropical Africa	9&10

Common Name	Scientific Name	Origen	Area
Golden fruited palm	Chrysalidocarpus lutescens	Madagascar	1
Golden fruited palm	Chrysalidocarpus lutescens	Madagascar	5
Gourka	Garcinia dulcis	Southeast Asia	4
Grapefruit	Citrus paradisi	Cultigen	2
Guava	Psidium guajava	Tropical America	1
Guiana chestnut	Pachira aquatica	Tropical America	5
Hala	Pandanus odoratissimus	Pacific Islands	9&10
Heliconia	Heliconia rostrata	Peru	9&10
Impatiens	Impatiens sultani	East Africa	1
Indian bulang	Gmelina arborea	India	6&7
Ivorynut palm	Metroxylon amicarum	Micronesia	1
Jabon	Citrus maxima	Southeast Asia	6&7
Jaboticaba	Eugenia cauliflora	Brazil	2
Jakfruit	Artocarpus heterophylla	Southeast Asia	6&7
Jucaro	Bucida buceras	Central America	4
Kamani	Calophyllum inophyllum	Western Pacific	4
Khirni	Manilkara hexandra	Southeast Asia	6&7
Kokio	Hibiscus saintjohnianus	Kauai	9&10
Kokio keokeo	Hibiscus immaculatus	Molokai	9&10
Kokio ula ula	Hibiscus clayi	Kauai	9&10
Lemongum	Eucalyptus citriodora	Australia	5
Liberian coffee	Coffea liberica	Tropical Africa	6&7
Lime	Citrus aurantifolia	Southeast Asia	2
Lipstick plant	Bixa orellana	Tropical America	6&7
Longan	Euphoria longan	China	4
Loulu palm	Pritchardia brevicalyx	Molokai	1
Loulu palm	Pritchardia forbesiana	Maui	1
Loulu palm	Pritchardia gaudichaudii	Molokai	1
Loulu palm	Pritchardia munroii	Maui	1
Mabolo	Diospyros discolor	Philippines	6&7
Macarthur palm	Ptychosperma macarthuri	Indonesia	1
Male bamboo	Dendrocalamus strictus	Southeast Asia	2
Mammee apple	Mammea americana	Tropical America	6&7
Mango	Mangifera indica	India	2
Mangosteen	Garcinia mangostana	Malaya	4
Manila palm	Veitchia merrillii	Philippines	1
Marang	Artocarpus odoratissimus	Indonesia	4
Mokineria	Molineria recurvata	Indonesia	1
Monstera	Monstera deliciosa	Central America	5
Moreton Bay chestnut	Castanospermum australe	Australia	2
Moreton Bay chestnut	Castanospermum australe	Australia	8
Narra	Pterocarpus echinatus	Philippines	2
Niusawa palm	Veitchia joannis	Fiji	5
Noni	Morinda citrifolia	Indonesia-Polynesi	9&10
Oil palm	Elaeis guineensis	Africa	5
Oil palm	Elaeis guineensis	Tropical Africa	1
Orange bauhinia	Bauhinia galpinii	Africa	6&7
Panama hat palm	Carludovica palmata	Peru	1
Pandanus	Pandanus sp. (cultivar)	Pacific Islands	9&10
Parana pine	Araucaria angustifolia	Paraguay	2
Parlor palm	Chamaedorea tepejilote	Mexico	1
Payang	Pangium edule	Malaya	4

Alphabetical by Common Name

Common Name	Scientific Name	Origen	Area
Peach palm	Guilelma gasipaes	Peru	5
Pinanga palm	Pinanga kuhlii	Indonesia	1
Pinanga palm	Pinanga kuhlii	Indonesia	5
Pink poui	Tabebuia rosea	Caribbean	6&7
Pink tecoma	Tecoma pentaphylla	Tropical America	6&7
Plumeria	Plumeria rubra	Tropical America	9&10
Pomelo	Citrus paradisi	Cultigen	5
Pua alo alo	Hibiscus kokio	Maui	9&10
Puakenikeni	Fragraea berteriana	South Pacific	6&7
Purple bauhinia	Bauhinia purpurea	India	6&7
Queen Emma spiderlily	Crinum augustum	Mauritius	9&10
Queen palm	Arecastrum romanzoffianum	Brazil	1
Queen palm	Arecastrum romanzoffianum	Brazil	5
Queensland maple	Flindersia brayleyana	Australia	8
Rainbow shower	Cassis fistula x javanica	Cultigen	8
Rattan palm	Rhapis excelsa	China	1
Rattan palm	Rhapis excelsa	China	5
Red ginger	Alpinia purpurata	Polynesia	9&10
Red lehua haole	Calliandra inaequilarera	Bolivia	8
Red pandanus	Pandanus japonsis	Micronesia	2
Rosegum	Eucalyptus grandis	Australia	5
Royal palm	Roystonea regia	Cuba	1
Royal palm	Roystonea regia	Cuba	5
Sadang	Livistonia rotundifolia	Indonesia	1
Sausage tree	Kigelia pinnata	Africa	2
Seville orange	Citrus aurantium	Southeast Asia	5
Shoebutton ardisia	Ardisia humilis	Southeast Asia	2
Sissoo	Dahlbergia sissoo	India	4
Soapberry	Sapindus saponaria	Tropical America	2
Solitaire palm	Ptychosperma elegans	Australia	5
Sugar apple	Annona squamosa	Caribbean	6&7
Surinam cherry	Eugenia uniflora	Brazil	3
Sweet Orange	Citrus sinensis	Southeast Asia	2
Sword fern	Nephrolepis multiflora	Indonesia	2
Syagrus palm	Syagrus coronata	Brazil	5
Sydney bluegum	Eucalyptus saligna	Australia	1
Synechanthus palm	Synechanthus mexicanus	Mexico	5
Teak	Tectona grandis	Southeast Asia	4
Three angled palm	Neodypsis decaryi	Madagascar	5
Torch ginger	Phaeomeria speciosa	Mauritius	9&10
Turpentine tree	Syncarpia glomulifera	Australia	1
Wallichia palm	Wallichia disticha	India	5
White bauhinia	Bauhinia variegata	Southeast Asia	6&7
White champak	Michelia alba	Java	9&10
White lehua haole	Calliandra inaequilarera	Bolivia	8
White sapote	Casimiroa edulis	Mexico	2
Wi tree	Spondias dulcis	Tahiti	6&7
Yellow ginger	Hedychium flavescens v.furc	India	2
Yesterday-today-tomor	Brunfelsia americana	Caribbean	9&10
Ylang Ylang	Artabotrys uncinatus	India	9&10

Total Plant Count: 153

APPENDIX

Source: La'au Hawaii
Isabella A. Abbott
1992

Flowering Plant and Fern Names

List of Hawaiian names, common names (English common names are given preference), and scientific names of flowering plants and ferns mentioned in this book. Species without Hawaiian names are listed at the end of the Appendix and are alphabetized according to their common names. Scientific names for flowering plants follow W. L. Wagner et al., 1990. Scientific names for ferns are from W. H. Wagner, Jr. *Limu,* or edible seaweeds, are listed in chapter 6.

Hawaiian Name	Common Name	Scientific Name
ʻaʻaliʻi	——	*Dodonaea viscosa*
ʻahakea	——	*Bobea elatior*
ʻahuʻawa	(a sedge)	*Mariscus javanicus*
ʻaiea (hālena)	——	*Nothocestrum* species
ʻakaʻakai	great bullrush	*Schoenoplectus lacustris*
	(a sedge)	subsp. *validus*
ʻākala	Hawaiian raspberry	*Rubus hawaiiensis* and
		Rubus macraei
ʻākia	——	*Wikstroemia* species
ʻalaʻalawainui	——	*Peperomia* species
ʻalaheʻe	——	*Canthium odoratum*
alani	——	*Pelea (Melicope)* species
ʻaliʻipoe	shot	*Canna indica*
ʻamaʻu	(a tree fern)	*Sadleria* species
ʻape	elephant's ear	*Alocasia macrorrhiza*
ʻauhuhu	——	*Tephrosia purpurea*
ʻawa	kava	*Piper methysticum*
ʻawapuhi	shampoo ginger	*Zingiber zerumbet*
ʻāwikiwiki	——	*Canavalia galeata*
ʻekaha	bird's nest fern	*Asplenium nidus*
haʻā (hame)	——	*Antidesma platyphyllum*
hala	——	*Pandanus tectorius*

Hawaiian Name	Common Name	Scientific Name
halapepe	——	*Pleomele* spp.
hame (haʻā)	——	*Antidesma platyphyllum*
hāpuʻu	(a tree fern)	*Cibotium* species
hau	——	*Hibiscus tiliaceus*
hoi	bitter yam	*Dioscorea bulbifera*
hōlei	——	*Ochrosia* species
ʻieʻie	——	*Freycinetia arborea*
ʻiliahi	sandalwood	*Santalum* species
ʻīlieʻe	——	*Plumbago zeylanica*
ʻilima	——	*Sida fallax*
ipu (kilu), hue	gourd	*Lagenaria siceraria*
kalo	taro	*Colocasia esculenta*
kamani	Alexandrian laurel	*Calophyllum inophyllum*
kauila	——	*Alphitonia ponderosa*
kāwaʻu	Hawaiian holly	*Ilex anomala*
kī (tī)	ti leaf plant	*Cordyline fruticosa*
kō	sugarcane	*Saccharum officinarum*
koa	——	*Acacia koa* subsp. *koa*
koaiʻa (koaiʻe)	——	*Acacia koa* subsp. *koaia*
koali ʻawa	bitter morning glory	*Ipomoea indica*
koali ʻai (kūpala)	wild morning glory	*Ipomoea cairica*
kohekohe	(a sedge)	*Elaeocharis* species
koʻokoʻolau	——	*Bidens* species
kou	——	*Cordia subcordata*
kūkaenēnē	——	*Coprosma ernodeoides*
kūkaepuaʻa	itchy crabgrass	*Digitaria setigera*
kukui	candlenut tree	*Aleurites moluccana*
kūpala (koali ʻai)	wild morning glory	*Ipomoea cairica*
kūpaoa	——	*Dubautia* subgenus *Railliardia*
laʻamia	calabash tree	*Crescentia cujete*
lama	——	*Diospyros sandwicensis* and

Hawaiian Name	Common Name	Scientific Name
laua'e	(a fern)	*Phymatodes scolopendrium**
loulu	native fan palm	*Pritchardia* species
ma'aloa	——	*Neraudia* species
maile	——	*Alyxia oliviformis*
mai'a	banana	*Musa acuminata* hybrids
makaloa	(a sedge)	*Cyperus laevigatus*
māmaki	——	*Pipturus* species
māmane	——	*Sophora chrysophylla*
ma'o	Hawaiian cotton	*Gossypium tomentosum*
mau'u lā'ili	(a native iris)	*Sisyrinchium acre*
milo	portia tree	*Thespesia populnea*
mokihana	——	*Pelea anisata*
naio	false sandalwood	*Myoporum sandwicense*
nānū (nā'ū)	Hawaiian gardenia	*Gardenia* species
nā'ū (nānū)	Hawaiian gardenia	*Gardenia* species
nīoi	chili pepper	*Capsicum frutescens*
niu	coconut	*Cocos nucifera*
noni	Indian mulberry	*Morinda citrifolia*
'ohai	——	*Sesbania tomentosa*
'ohe	Hawaiian bamboo	*Schizostachyum glaucifolium*
'ohelo	——	*Vaccinium* species
'ōhi'a 'ai	mountain apple	*Syzygium malaccense*
'ōhi'a hā	——	*Syzygium sandwicensis*
'ōhi'a lehua	——	*Metrosideros polymorpha*
'ōlapa	——	*Cheirodendron* spp.
'ōlena	turmeric	*Curcuma longa*
olonā	——	*Touchardia latifolia*
olopua (pua)	——	*Nestegis sandwicensis*
ōpuhe	——	*Urera* species
pala	(a fern)	*Marattia douglasii*

*According to one of the foremost students of Hawaiian ferns, W. H. Wagner, Jr., *Phymatodes scolopendrium* is a recent introduction. See chapter 7, note 33.

Hawaiian Name	Common Name	Scientific Name
palaʻā	lace fern	*Odontosoria chinensis*
palapalai (palai)	(a fern)	*Microlepia strigosa*
pāpala kēpau	——	*Pisonia* species
pia	Polynesian arrowroot	*Tacca leontopetaloides*
piʻa	yam	*Dioscorea pentaphylla*
pili	tanglehead (grass)	*Heteropogon contortus*
poʻaʻaha (wauke)	paper mulberry	*Broussonetia papyrifera*
pōhuehue	beach morning glory	*Ipomoea pes-caprae*
polapola	(erect banana)	*Musa troglodytarum*
pōpolo	glossy nightshade	*Solanum americanum*
pua (olopua)	——	*Nestegis sandwicensis*
pūkiawe	——	*Styphelia tameiameiae*
tī (kī)	ti leaf plant	*Cordyline fruticosa*
ʻuala	sweet potato	*Ipomoea batatas*
ʻuhaloa	——	*Waltheria indica*
ʻuhi	yam	*Dioscorea alata*
uhiuhi	——	*Caesalpinia kavaiensis*
ʻuki	——	*Machaerina angustifolia*
ʻukiʻuki	——	*Dianella sandwicensis*
ʻūlei	——	*Osteomeles anthyllidifolia*
ʻulu	breadfruit	*Artocarpus altilis*
wauke (poʻaʻaha)	paper mulberry	*Broussonetia papyrifera*
wiliwili	——	*Erythrina sandwicensis*
——	betel nut	*Arecha catechu*
——	betel pepper	*Piper betle*
——	cabbage tree	*Cordyline australis*
——	kudzu	*Pueraria lobata*
——	pink velvet banana	*Musa velutina*
——	pulach	*Cyrtosperma chamissonis*
——	sago palm	*Metroxylon* species
——	swamp cabbage	*Ipomoea aquatica*

G. BUILDINGS

Keanae-Waluanui
Property Records

TMKM	Area Code			Area	Materials	Age
2110020090000	A	sf	1) 2)	1628 576	Wood Resid - 1, 7 Conc - 2, 3, 4	1) 1934 2) 1939 3) 1935 4) 1981 7) 1981
2110020100000	A	sf				
2110030010000	A	sf				
2110030010000	A	sf				
2110030030000	A	sf	2)	1536-B 754-P	Wood	1975
2110030030000	F	sf	1)	603-B	Wood	1917
2110030050000	A	sf	1)	524-B 162-P	Wood	1931
2110030050000		sf				1931
2110030070000		sf	1)	363-B	Wood	1940
2110030070000						
2110030120000		sf	1)	810-B 318-P	Wood	1990
2110030300000		sf	1)	1596-B 96-B	Wood Wood	1939
2110030310000		sf	1) 2)	144-B 660-B 260-G 120-P	Wood Wood	1987 1967
2110030410000		sf	1)	1150-B 801-P	Wood	1980
2110030530000	A	sf		947-B 144-P	Wood	1939
2110030570000	F	sf		648-B	Wood	1946

B- Building
P- Porch
G- Car/Storage

TMKM	Area Code			Area	Materials	Age
2110030580000	F	sf	1)	852-B 579-G 576-P	Wood	1986
2110030590000	A	sf	1)	1153-B	230-O O-Masonry	1970
2110030610000	A	sf	1)	1132-B	Wood	1935
2110030680000	F	sf	1)	1130-B 400-C 360-P	Wood	1942
2110030700000	F	sf	1)	1216-B 240-P	Wood	1973
2110030700000	F	sf				
2110030890000		sf	1)	880-B	Wood	1963
2110030900000						
2110030910000	F Church	sf	1)	2368-B		1860
2110040010000	F	sf	1)	754-B	Wood	1907
2110040020000	A	sf	1)	648-B	Wood	1939
2110040040000	A 2) Hall 3) Church 4) Church 5) Dwelling	sf	2) 3) 4) 5)	2456-B 1810-B 840-B 828-B	2) Wood 3) Wood/Conc 4) Wood 5) Wood	2) 3) 1937 4) 1860 5)
2110040350000	A	sf	2) 1)	424-B 2408-B	24-0 Wood Wood	1920 1975
2110040390000	A	sf	1)	948-B	Wood	1953
2110050030000	A	sf	1)	816-B	Wood	1910
2110050040000	F	sf	1)	400-B	Wood	1940

B- Building
P- Porch
C- Car/Storage

TMKM	Area Code			Area	Materials	Age
2110050050000	A	sf	1)	452-B	Wood	1919
2110050060000	A	sf	1)	664-B 264-G 191-P	Wood	1962
2110050070000	F	sf	1)	1004-B 336-G 20-P	Wood	1964
2110050090000	S	sf	1) 2) 3)	312-B 96-P 908-B 266-G 20-P 400-B, 600-C, 200-P	Wood Wood Masonry	1910 1965 1981
2110050100000	A	sf	1)	400-B 144-P	Wood	1971
2110050110000	F	sf	1)	1344-B 288-C	Wood	1937
2110050150000	F	sf	1)	999-B 96-P	Wood	1934
2110050160000	A	sf	1)	748-B 480-G	Wood	1970
2110050260000	A	sf	1)	948-B	Wood	1920
2110050350000	F	sf	1)	416-B	Wood	1915
2110050400000	A	sf				
2110050430000	F	sf	1)	940-B	Wood	1929
2110050470000	A	sf	1)	768-B 76-P	Wood	1988
2110050500000	A	sf	1)	768-B 76-P	Wood	1939
2110050560000	F	sf	1)	1284-B 24-P	Wood	1935
2110050580000	A	sf	1)	952-B 60-P	Wood	1949
2110060020000	A	sf	1)	1156-B 650-P	Wood	1972
2110060030000	F	sf	1)	960-B 400-C 261-P	Wood	1967

B- Building
P- Porch
C- Car/Storage

TMKM	Area Code			Area	Materials	Age
2110060050000	A	sf	1)	784-B	Wood	1940
2110060070000	F	sf	1) 2)	540-B 698-B	Wood Wood	1920 1920
2110060080000	F	sf	1) 2)	1086-B 1056-B 560-G 60-P	Wood Masonry	1930 1975
2110060090000	A	sf	1) 2)	800-B 1056-B 560-G 460-P	Wood Masonry	1949 1978
2110060110000	F	sf	1)	1088-B 674-P	Wood	1919
2110060710000	F	sf	1)	184-B	Wood	1940
2110070050000	F	sf	1) 2)	1300-B 152-P 500-B	Wood Wood	1980 1980
2110070200000	A	sf	1)	1120-B 800-G	Wood	1981
2110080070000	A	sf				
2110080100000	A	sf	1)	1232-B	Masonry	1974
2110080180000	F	sf	1)	678-B	Wood	1936
2110080200000	A -School					1912
2110080210000	A	sf	1)	1946-B 270-G 168-P	Wood	1940

B- Building
P- Porch
C- Car/Storage

H. KE'ANAE AND WAILUANUI CEMETERIES
(from *Maui County Cemetery Directory*
[Maui Historical Society 1990])

ISLAND OF MAUI

CEMETERY (MAP & HISTORY) DIRECTORY

Sponsored by:

THE MAUI HISTORICAL SOCIETY

Funded by:

THE STATE FOUNDATION ON CULTURE AND THE ARTS

THE UNIVERSITY OF HAWAI'I
COMMITTEE FOR THE PRESERVATION AND STUDY
OF HAWAIIAN LANGUAGE, ART AND CULTURE

MAUI LAND AND PINEAPPLE CO.

- 1990 -

SITE DATA FORM: HALEMANO FAMILY CEMETERY

ALSO KNOWN AS: _____

LOCATION: Taro patch near end of main road into Ke'anae. AREA: Ke'anae

APPROX. SIZE: .42 Acres STATUS: ___Active X Closed

RECORDED TOMBSTONES: 2 # UNMARKED GRAVES: 2

CONDITION OF SITE: ___Abandoned/Overgrown/No maintenance
X Some individual graves maintained
___Regular maintenance of entire site
___Poor X Fair ___Good ___Excellent

MAINTAINED BY: ___Owner ___Cemetery Assoc. X Individual Families ___Unknown

OWNER: Ernest Wilhelm Jr.

CONTACT PERSON: Mrs. Nancey Ihu (Name) Decendant (Title)
244-0112 (Phone) 137 Waiale Road, Wailuku (Address) 96793 (Zip)

CONTACT PERSON: James Hueu (Name) Decendant (Title)
248-8355 (Phone) Ke'anae YMCA (Address) (Zip)

NOTES: Halemano graves at this site are great-grandparents of Nancy Ihu and James Hueu.

	BIRTH DATE	DEATH DATE	RELATIONSHIP	PHOTO	MADE OF	TYPE	OTHER INSCRIPTION INFO
ANO, DAVID	01-25-1880	09-21-1883			CONCRETE	TOMB	(SAME MARKER AS: JOS. HALEMANO)
ANO, JOS. A.	07-04-1878	06-12-1904			CONCRETE	TOMB	(SAME MARKER AS: DAVID HALEMANO)

	BIRTH DATE	DEATH DATE	RELATIONSHIP	PHOTO	MADE OF	TYPE	OTHER INSCRIPTION INFO
MOSES LUM	11-26-1900	02-03-1961			MARBLE/GRANITE	CROSS/UPRIGHT	
ANDREW F.	02-09-1936	05-21-1953	SON		MARBLE/GRANITE	UPRIGHT	
MAKAEHA OUNG KIN	00-00-1878	00-00-1905			MARBLE/GRANITE	UPRIGHT	(SAME MARKER AS: ROSEMARY YOUNG AND RAYMOND AKINA)
RAYMOND	00-00-1939	00-00-1939			MARBLE/GRANITE	UPRIGHT	(SAME MARKER AS: ROSEMARY YOUNG AND MAKAEHA AKINA
BEATRICE S.	00-00-0000	00-00-0000			CONCRETE	UPRIGHT	
HELENA	10-29-1869	11-05-1937	MOTHER		MARBLE/GRANITE	UPRIGHT	
JAMES A.	04-24-1901	08-30-1934			MARBLE/GRANITE	UPRIGHT	
SAMSON	05-16-1929	09-04-1938			MARBLE/GRANITE	UPRIGHT	
SARAH	07-06-1896	02-11-1937	MOTHER		MARBLE/GRANITE	UPRIGHT	
SARAH	07-06-1896	02-11-1937	MOTHER		MARBLE/GRANITE	UPRIGHT	
BEL WONG SIU	06-06-1906	06-25-1953	FATHER		MARBLE/GRANITE	UPRIGHT	
OUISE K.	11-07-1908	01-19-1976	MOTHER		MARBLE/GRANITE	RAISED	
ARY	01-00-1887	??-??-????			CONCRETE	UPRIGHT	
ENJAMIN A.	02-04-1886	12-04-1947			MARBLE/GRANITE	UPRIGHT	
SS ANNA	05-17-1917	03-16-1918			CONCRETE	CROSS/UPRIGHT	
UGENE SR.	10-10-1922	02-05-1970			MARBLE/GRANITE	UPRIGHT	
OSEPH AH TIN	10-16-1898	04-20-1936	FATHER		MARBLE/GRANITE	CROSS/UPRIGHT	

NAME	BIRTH DATE	DEATH DATE	RELATIONSHIP	PHOTO	MADE OF	TYPE	OTHER INSCRIPTION INFO
HARDY, LOUISA R.	01-22-1878	11-13-1955			MARBLE/GRANITE	UPRIGHT	(SAME MARKER AS: AUGUST ROBACK)
HARDY, WALTER A.	00-00-1861	00-00-1946			MARBLE/GRANITE	UPRIGHT	
HISSINS, HENRY	00-00-0000	00-00-1930			CONCRETE	CROSS/UPRIGHT	
HISSINS, KAHALEHINA	00-00-0000	01-25-1931			CONCRETE	CROSS/UPRIGHT	
HU, MRS. LEI YOUNG	00-00-0000	07-08-1936			CONCRETE	UPRIGHT	
KAAUAMO, ELLEN KAPEKA	06-13-1887	05-20-1967			MARBLE/GRANITE	UPRIGHT	(SAME MARKER AS: FRANK KAAUAMO)
KAAUAMO, FRANK BENJAMIN	11-19-1884	04-06-1938			MARBLE/GRANITE	UPRIGHT	(SAME MARKER AS: ELLEN KAAUAMO)
KEALOHAN??, ?NOS	??-??-1877	07-25-19??			CONCRETE	TOMB	
NAKANELUA, HARTWELL P.	05-19-1950	05-19-1950			MARBLE/GRANITE	UPRIGHT	
PAAHAO, ROSE KALANI	11-17-1892	10-22-1942			MARBLE/GRANITE	UPRIGHT	
ROBACK, AUGUST	09-04-1844	01-20-1926			MARBLE/GRANITE	UPRIGHT	(SAME MARKER AS: LOUISA HARDY
ROBACK, JOSEPHINE KEAOOPUAOKALANI	05-16-1904	04-15-1952	MOTHER		MARBLE/GRANITE	UPRIGHT	KIND AND LOVING WERE YOUR WAYS. FAITHFUL, FOND AND TRUE. TEARS AND HEARTACHES STILL REMAIN, BUT MOTHER DEAR, WE LOVE YOU.
ROBACK, WILLIAM	01-01-1901	04-13-1958			MARBLE/GRANITE	CROSS/UPRIGHT	HE GAVE HIS LIFE IN SERVICE OF HIS PEOPLE, HIS MEMORY IS BLESSED.
SOON, AH YOUNG	09-23-1913	06-19-1988			METAL	TEMPORARY	
WAILAAHIA, NAINOLUA KAIHE	00-00-0000	00-00-1910	GREAT GRANDMOTH		MARBLE/GRANITE	UPRIGHT	
YOUNG, JOHN K.	08-10-1919	06-14-1977			MARBLE/GRANITE	UPRIGHT	SSGT. US ARMY, WWII

AME	BIRTH DATE	DEATH DATE	RELATIONSHIP	PHOTO	MADE OF	TYPE	OTHER INSCRIPTION INFO
UNG, ROSEMARY	00-00-1922	00-00-1922			MARBLE/GRANITE	UPRIGHT	(SAME MARKER AS: RAYMOND AKINA AND MAKAEHA AKINA)
UNG, VICTORIA	11-25-1893	01-15-1952	MOTHER		MARBLE/GRANITE	UPRIGHT	
UNG-SON, HANA AWAI	00-00-0000	10-14-1947	MOTHER		MARBLE/GRANITE	UPRIGHT	

NATIVE HAWAIIAN LEGAL CORPORATION
1164 Bishop St., Suite 1205
Honolulu, Hawaii 96813

NATIVE HAWAIIAN LEGAL CORPORATION
1164 Bishop St., Suite 1205
Honolulu, Hawaii 96813

1 BOARD OF LAND AND NATURAL RESOURCES

2 STATE OF HAWAII

3 In the Matter of Contested)DLNR FILE: 01-05-MA
Case Regarding Water Licenses)
4 at Honomanu, Keanae, Nahiku and)
Huelo, Maui)
5 _____)

6 CONTESTED CASE HEARING

7

8 Held on October 10, 2005, commencing at 3:35 p.m., at

9 Maui County Conference Room, 250 South High Street,

10 First Floor, Wailuku, Hawaii 96793.

11

12

13

14 BEFORE: JEAN MARIE McMANUS
Hawaii CSR #156, California CSR #3119
15 Notary Public, State of Hawaii

16

17

18

19

20

21

22

23

24

25

HEARINGS OFFICER:	HONORABLE E. JOHN McCONNELL 33 N. Market Street, Ste. 200 Wailuku, Hawaii 96793
BLNR Attorney:	LINDA CHOW, ESQ. Deputy Attorney General 465 S. King Street, Rm. 300 Honolulu, Hawaii 96813
For EMI and A&B:	DAVID SCHULMEISTER, ESQ. ELIJAH YIP, ESQ. Cades Schutte Fleming & Wright 1000 Bishop Street, Ste. 1200 Honolulu, Hawaii 96813
For Maui Land & Pineapple:	DAVID B. MERCHANT, ESQ. Kiefer & Merchant 444 Hana Highway, Ste. 204 Kahului, Hawaii 96732
For County of Maui:	JANE E. LOVELL, ESQ. Deputy Corporation Counsel 200 S. High Street Wailuku, Hawaii 96793
For Maui Tomorrow:	ISAAC HALL, ESQ. 2087 Wells Street Wailuku, Hawaii 86793
For Na Moku Aupuni O Ko'olau Hui, et al:	ALAN T. MURAKAMI, ESQ. MOSES K.N. HAIA, ESQ. 1164 Bishop Street, Ste. 1205 Honolulu, Hawaii 96813

INDEX

WITNESSES: PAGE

MAUI TOMORROW

ERNEST SCHUPP

DIRECT EXAMINATION BY MR. HALL..... 7
CROSS-EXAMINATION BY MR. MURAKAMI..... 37
CROSS-EXAMINATION BY MR. SCHULMEISTER..... 39
REDIRECT EXAMINATION BY MR. HALL..... 60
RECROSS-EXAMINATION BY MR. SCHULMEISTER..... 64
FURTHER REDIRECT EXAMINATION BY MR. HALL..... 69

TESTIMONY AND EXHIBITS RECEIVED INTO EVIDENCE

Direct Written Testimony Ernest Schupp.....5
Direct Written Testimony Neola Caveny.....5
Exhibit No. 20..... 10
Exhibit No. 24..... 11
Exhibit No. 25..... 12
Exhibit No. 29..... 13
Exhibit No. 28-B..... 22
Exhibit Nos. 28-C and 28-D..... 27
Exhibit Nos. 28-E and 28-F..... 31
Exhibit Nos. 28-E, F and G..... 32

1 HEARINGS OFFICER McCONNELL: This is the
2 contested case hearing in the matter regarding water
3 licenses at Honomanu, Keanae, Nahiku and Huelo, Maui.
4 DLNR File No. 01-05-MA.
5 I am John McConnell, the board's hearing
6 officer in this proceeding. And I would ask counsel
7 to make their appearances for the record and introduce
8 their parties.
9 MR. MERCHANT: David Merchant on behalf of
10 Maui Land & Pineapple Company.
11 MR. SCHULMEISTER: David Schulmeister and
12 Elijah Yip for East Maui Irrigation Company and
13 Alexander & Baldwin. Also present, Garrett Hew,
14 President of East Maui Irrigation Company.
15 MS. LOVELL: Jane Lovell, Deputy
16 Corporation Counsel, County of Maui.
17 MR. HALL: Isaac Hall for Maui Tomorrow,
18 and Ernest Schupp and Neola Caveny.
19 MR. MURAKAMI: Good afternoon, Alan
20 Murakami for the other intervenors, some of whom are
21 with us today in the audience, Ms. Marjorie Wallett,
22 Beatrice Kekahuna.
23 HEARINGS OFFICER McCONNELL: And for the
24 record, I understand that Mr. Thomas, on behalf of
25 Farm Bureau, is not here today, but will be -- he

1 waived his appearance for Mr. Hall's evidence, which
2 is first on our schedule. I just read that email just
3 now.
4 So also for the record we have had a site
5 visit to a number of the sites in question, and that
6 has been done, and that's why we're starting at 3:30
7 this afternoon. Let's try to go for at least an hour,
8 and pursuant to the parties' understanding and
9 agreement and earlier minute orders, Mr. Hall, you're
10 offering the direct testimony of both your clients in
11 evidence?
12 MR. HALL: I am.
13 HEARINGS OFFICER McCONNELL: They will be
14 received.
15 (Direct written testimony of Ernest
16 Schupp and Neola Caveny were received
17 into evidence.)
18 MR. HALL: You mean the direct written
19 testimony?
20 HEARINGS OFFICER McCONNELL: Yes.
21 MR. HALL: I don't know how you want to
22 mark those. I'm just looking at my own exhibit list
23 as amended, and Mr. Schupp's testimony could be marked
24 as Exhibit 35.
25 HEARINGS OFFICER McCONNELL: I don't know

1 that it's really necessary to mark it.
2 MR. HALL: I don't know how it's going to
3 come in. Is it a pleading?
4 HEARINGS OFFICER McCONNELL: It is
5 evidence, as far as I'm concerned. We can mark it,
6 but that's his testimony. That testimony comes in, if
7 there's no objection.
8 MR. MURAKAMI: No objection.
9 HEARINGS OFFICER McCONNELL: You have the
10 right to cross-examine of course, but the idea was to
11 get as much done in writing so we can shorten the
12 hearing as much as possible.
13 MR. HALL: Okay, fine.
14 HEARINGS OFFICER McCONNELL: Let me think
15 about how we want to mark that. I think it is a good
16 point you raise, Mr. Hall, because we have enough
17 paper in this matter that we want to make sure how
18 we're going to handle -- all of the parties have
19 direct testimony. And let me just say now that the
20 direct testimony of your two witnesses will be in
21 evidence.
22 MR. HALL: So that will be Mr. Schupp and
23 Ms. Caveny?
24 HEARINGS OFFICER McCONNELL: Correct.
25 MR. HALL: Thank you.

1 HEARINGS OFFICER McCONNELL: Mr. Merchant,
2 did we hear you for the record?
3 MS. CHOW: Yes.
4 HEARINGS OFFICER McCONNELL: We also have
5 Ms. Chow from the Attorney General's office who is the
6 counsel to the Board of Land and Natural Resources.
7 Mr. Hall, you may proceed.
8 MR. HALL: I would like to call my first
9 witness, Mr. Ernie Schupp.
10 HEARINGS OFFICER McCONNELL: Mr. Schupp,
11 would you raise your right hand, please.
12 ERNEST SCHUPP
13 was called as a witness, was sworn to tell the truth,
14 was examined and testified as follows:
15 HEARINGS OFFICER McCONNELL: State your
16 name.
17 THE WITNESS: Ernest John Schupp.
18 DIRECT EXAMINATION
19 BY MR. HALL:
20 Q. Can you state your address, please?
21 A. Across from the Door of Faith church, in the
22 taro patch.
23 Q. Is that in Huelo?
24 A. In Huelo.
25 Q. How long have you lived in Huelo?

A. About 14-and-a-half years.

Q. And have you reviewed your direct written testimony.

A. And I would like to clarify --

Q. Just you have reviewed it?

A. Yes.

Q. Are there any clarifications to that that you would like to make at this point in time?

A. Yes, there is.

Q. Can you explain?

A. On page two, third paragraph, there are now eight taro lo'i in active cultivation. That was a misunderstanding. There is eight that can be put into operation, and additional six need repairs on the taro walls and a lot of trees and rubbish need to be cleaned out.

HEARINGS OFFICER McCONNELL: Your testimony is that eight are ready?

THE WITNESS: Can be put in operation within a matter of a week or so.

HEARINGS OFFICER McCONNELL: And additional six --

THE WITNESS: Additional six further downstream.

HEARINGS OFFICER McCONNELL: That would

1 require further work?
2 THE WITNESS: Yes, sir.
3 Q. (By Mr. Hall): I would like to have you look
4 at Exhibit 20. That is Intervenor's Exhibit 20. Is
5 that the caretaker agreement to which you occupy the
6 property you were talking about?
7 A. Correct.
8 Q. Is that through the owners of the property?
9 A. Correct.
10 Q. And who are the owners?
11 A. George Keala, and his daughter Mary Keala.
12 And it's overseen by Elizabeth Lapenia, that would be
13 George's niece. She lives in Huelo.
14 Q. Do you have some obligations through that
15 caretaker agreement?
16 A. To farm. To keep the place from getting
17 overgrown, more or less, and using the farming
18 potential.
19 Q. And are the owners Hawaiians?
20 A. Yes, they are.
21 Q. And has taro been grown on that property?
22 A. Yes, it has.
23 Q. How long has taro been grown, to the best of
24 your knowledge?
25 A. Up to probably a year-and-a-half ago.

1 Q. Before that historically?
2 A. Before that continuously.
3 Q. Beginning when?
4 A. From me down to right after -- what was that
5 -- drawing a blank here -- Johnnie Kahiamoe. He took
6 care of the place until I came along. George gave him
7 permission to farm it. Before him it was Lehua
8 Lapenia with her grandmother.
9 Q. How long did they grow taro there?
10 A. From early '50s.
11 Q. Like to move Exhibit 20 into evidence.
12 HEARINGS OFFICER McCONNELL: 20 will be
13 in.
14 (Exhibit No. 20 was received into
15 evidence.)
16 Q. MR. HALL: I would like you to look at
17 Exhibits 24 and 25. First have you looked at Exhibit
18 24? Do you recognize Exhibit 24?
19 A. Yes, I do.
20 Q. What is that?
21 A. That's where I live. That's --
22 Q. Does it have a TMK?
23 A. Yes, it does.
24 Q. What is that?
25 A. Zone two, section nine, plat eight.

1 Q. Which parcel?
2 A. 14 and 15.
3 Q. And does the stream either run through it or
4 by it?
5 A. It runs through it. And also this map is
6 kind of incorrect because the property pin is on the
7 stream edge of the property. The pins were in the
8 middle of the stream, then it cuts back up to the top
9 of the hill.
10 Q. And what's the name of the stream?
11 A. Puolua.
12 Q. Like to move Exhibit 24 into evidence.
13 HEARINGS OFFICER McCONNELL: Any
14 objections?
15 MR. SCHULMEISTER: No.
16 HEARINGS OFFICER McCONNELL: 24 is in.
17 (Exhibit No. 24 was received into
18 evidence.)
19 Q. (By Mr. Hall): Like to show you Exhibit No.
20 25. Are you familiar with that document?
21 A. Yes.
22 Q. What is that?
23 A. This is a tax key map showing a larger area
24 where I live at.
25 Q. Where do you live as shown on that map?

A. On this map it would be where it says Pualima. That would be Matson's piece of property there, which George Keala has permission to oversee that property at this time.

Q. So that also shows Puolua Stream going through or next to the property?

A. Actually -- yes, some maps call it Koela (phonetic) Stream.

MR. HALL: Like to move Exhibit 25 into evidence.

HEARINGS OFFICER McCONNELL: Any problems? It will be in.

(Exhibit No. 25 was received into evidence.)

Q. (By Mr. Hall): Were the water rights to that particular property that you're farming registered with the Water Commission?

A. Yes, it was.

Q. Like to show you Exhibit 29. Did Lehua Lapenia, as one of the people who signed your caretaker agreement, did she register the water rights for your parcel?

A. Yes, she did.

Q. Is Exhibit 29 the registration of those water rights in 1989?

A. Yes, it is.

MR. HALL: Like to move Exhibit 29 into evidence.

HEARINGS OFFICER McCONNELL: Any problems? Mr. Hall, I'm looking at your --

MR. HALL: The amended.

MS. CHOW: The one you just got today.

(Exhibit No. 29 was received into evidence.)

Q. (By Mr. Hall): Are you familiar with Puolua Stream?

A. Yes, I am.

Q. Are you familiar with Hanehoi Stream?

A. Yes, I am.

Q. For that full 14-and-a-half years that you've lived in Huelo?

A. Correct.

Q. Are you familiar with the diversions of those streams?

A. Yes, I am.

Q. With Puolua, how many times has Puolua diverted?

A. That would be twice.

Q. And by which ditches is Puolua diverted?

A. Lowrie Ditch and new Haiku Ditch.

Q. How many time is Hanehoi Stream diverted?
A. About four times.
Q. Do you know the names of the ditches that divert?
A. The new Haiku Ditch, Lowrie, new Hamakualoa. And there's another diversion up there. I forget the name.
Q. Like to show you Exhibit 19. Do you recognize that exhibit?
A. Yes, I do.
Q. Can you tell me what it is?
A. It's showing the diversions on both the Hanehoi and -- the Puolua and Hanehoi Stream.
Q. Who drew that document?
A. I can't remember who drew that document. I think Hawaiian Legal Corp drew this when they were at the time representing the taro patches.
Q. Does it indicate a certain relationship between Puolua Stream and Hanehoi Stream?
A. Meaning diversions?
Q. No, just locations.
A. I'm not following what you mean.
Q. Does Puolua Stream terminate into Hanehoi Stream?
A. Yes, it does.

Q. Can you describe the diversions on that Puolua Stream starting with Lowrie Ditch?

A. On Puolua Stream at Lowrie Ditch we have two three-inch pipes that go into an eight-inch pipe. And don't -- back into the stream as it crosses over the Lowrie Ditch.

Q. And is -- how much water is coming down in Puolua Stream before those pipes?

A. Before those pipes?

Q. Is it a full flow of the stream, is it just a little bit of water? How much water comes down?

MR. SCHULMEISTER: I'm going to object without some kind of as to when --

THE WITNESS: The stream isn't diverted any further --

HEARINGS OFFICER McCONNELL: Hold on. Let me make a ruling. I'll sustain the objection, but explain how you acquired whatever knowledge you have, and then see where -- we'll take it from there.

Q. (By Mr. Hall): Above Lowrie, does Puolua Stream -- what contributes to Puolua Stream?

A. Just run-offs. I believe it was in '91 I followed that stream all the way up until where it came out from underneath the ground. Underground stream. And that's almost at the third diversion on

1 the Hanehoi.
2 Q. And does it go -- does that stream go up and
3 down based on rain flow or storms?
4 A. Basically, yeah. There's always water
5 flowing down it, but if it rains, more water; less
6 rain, less water.
7 Q. Is the Lowrie -- when we talk about the
8 Lowrie Ditch, is that a diversion of whatever is in
9 the Puolua Stream, with certain exceptions?
10 A. I receive --
11 Q. I'm asking you a question. Does the Lowrie
12 Ditch divert whatever is coming down above it?
13 A. Correct.
14 Q. What does it do with it?
15 A. It goes into the Lowrie Ditch.
16 Q. What gets let down below the Lowrie Ditch?
17 A. Two three-inch pipes.
18 Q. Into an eight-inch pipe?
19 A. Into an eight-inch pipe.
20 Q. And in your view, does it make any difference
21 that there is an eight-inch pipe below the two
22 three-inch pipe?
23 A. No difference whatsoever.
24 Q. Why not?
25 A. Because the two three-inch pipes only put out

1 what the maximum capacity can and that's it.
2 Q. Is there any floodgate in the Lowrie Ditch at
3 Puolua Stream?
4 A. No, there is not.
5 Q. So based on whatever flows downstream of the
6 Lowrie Ditch at Puolua Stream is whatever can fit
7 through two three-inch pipes?
8 A. Correct.
9 Q. And then what's below that? Is there a
10 diversion below that?
11 A. That would be the new Haiku Ditch.
12 Q. Can you describe that?
13 A. It's another diversion of a concrete wall,
14 floodgate, and usually the floodgates are closed and
15 whatever the two three-inch pipes put out, that's it.
16 Q. So there's two three-inch pipes there?
17 A. Correct.
18 Q. And you said there's also a floodgate?
19 A. Correct.
20 Q. Can you tell me what you mean by a floodgate?
21 A. It's a gate probably three-feet wide, maybe
22 about four-foot high, and it's controlled just by
23 sliding up and down.
24 Q. And let's say in the 14-and-a-half years
25 you've been at the property that you're -- the kuleana

1 you've been working at, how often has that floodgate
2 been open?
3 A. Maybe five times.
4 Q. We went on the site inspection today. Was
5 the floodgate open?
6 A. Yes, it was.
7 Q. When was the last time before today that you
8 saw that floodgate open?
9 A. It would probably be -- well, last year they
10 came and cleaned out the rubbish, so had to open to
11 flush that out, then closed it again. Before that
12 probably '89, we had a fairly large rain come.
13 Q. So between last year and 1989 you've never
14 seen the floodgate open except for today?
15 A. Correct.
16 Q. Was the floodgate closed again today?
17 A. I closed it this morning.
18 Q. Was it closed after the site inspection?
19 A. Yes, it was.
20 Q. So at the conclusion of the site inspection,
21 the floodgate was closed and the only thing coming
22 through the new Haiku Ditch was two three-inch pipes?
23 A. And because of the gate being open there is
24 still leakage around the gate, but other than that,
25 just two three-inch pipes.

1 Q. So your taro patch or your auwai is 60 feet
2 below the new Haiku Ditch diversion?
3 A. Roughly, that's about it.
4 Q. And I'm going to come back to -- you have an
5 auwai that leads into your taro patch, and then what
6 is left over after you use it is put back into the
7 stream?
8 A. Correct.
9 Q. Goes down in Puolua Stream until it hits
10 Hanehoi?
11 A. Correct.
12 Q. Then that goes down -- I'm going to come back
13 to your taro operation.
14 Let's go to Hanehoi Stream. You said
15 Hanehoi was diverted four times, but let's go to
16 Lowrie. Can you describe the Lowrie diversion works
17 of Hanehoi Stream?
18 A. At the Lowrie there's a spillway and there's
19 two pipes there. But for the past 14-and-a-half years
20 until today, they were always blocked off.
21 Q. And did you have a picture of those pipes at
22 Hanehoi?
23 A. You can see one pipe in one of these
24 pictures. The other one's setback in there further.
25 Q. I'm showing you Exhibit 28-B. I want to

1 apologize, I haven't had a chance to xerox these, but
2 I will pass these around.
3 MR. SCHULMEISTER: 28?
4 MR. HALL: 28-B.
5 Q. 28-B shows the diversion works at Hanehoi
6 Stream, shows the pipe. And you're saying that pipe
7 for the last 14-and-a-half years was blocked?
8 A. Correct.
9 Q. So it didn't let any water down?
10 A. Correct.
11 Q. It's to the left --
12 MR. MURAKAMI: Can you point it out?
13 THE WITNESS: (Indicating.)
14 MR. HALL: Did you see it? Anybody else
15 want to see it?
16 MR. SCHULMEISTER: Yeah.
17 Are you going to put a date on this?
18 MR. HALL: Yeah.
19 MR. MURAKAMI: But just to be clear, when
20 Ernie just testified, he testified as to 28-B?
21 MR. HALL: Yes.
22 MR. MURAKAMI: He testified to the pipe
23 that is showing up in dark shadow to the left side of
24 the wall?
25 MR. HALL: That's right.

HEARINGS OFFICER McCONNELL: Point that out.

THE WITNESS: (Indicating.)

Q. (By Mr. Hall): Ernie, did you take this picture?

A. Yes, I did.

Q. When did you take this picture?

A. This would be about 2000.

Q. All right. And you attended the site inspection this morning?

A. Correct.

Q. And you saw that there was a pipe that was allowing water through the Hanehoi-Lowrie Ditch Stream diversion?

A. Correct.

Q. And you say that's the first time you've seen any water coming through there in 14-and-a-half years?

A. Correct.

MR. MURAKAMI: I'm asking -- it's unclear. Where is this water, this new water coming down from?

Q. (By Mr. Hall): The pipe that you saw today, is it in the same general location as the pipe that's shown in the photograph?

A. Correct.

HEARINGS OFFICER McCONNELL: What was the

1 exhibit number again?
2 MR. HALL: 28-B.
3 I would like to move 28-B into evidence.
4 HEARINGS OFFICER McCONNELL: Any
5 objection? It will be in evidence.
6 (Exhibit No. 28-B was received into
7 evidence.)
8 Q. (By Mr. Hall): In your years of going up --
9 I take it you've gone up to look at this diversion
10 works over time?
11 A. I have to go up there periodically because
12 Huelo's water system comes from that stream. There's
13 a two-inch pipe that runs further up over the
14 spillway, and when we have storms, we have to go back
15 up and put the pipe back in.
16 That's community water. That's where we
17 get the water unless we have a well.
18 Q. Was there a time when water flowed over the
19 top of this diversion?
20 A. During storms.
21 MR. MURAKAMI: What are we referring to?
22 MR. HALL: I was talking about the Lowrie
23 EMI diversion of Hanehoi Stream at Lowrie Ditch.
24 Was all of Hanehoi Stream, everything that
25 flowed from Hanehoi Stream above the Lowrie Ditch

1 diversion works when the pipe wasn't working, being
2 diverted into Lowrie Ditch?
3 A. Everything goes into the Lowrie Ditch.
4 Whatever is coming down Hanehoi above the Lowrie goes
5 into the Lowrie Ditch.
6 Q. So up until today when that pipe started was
7 the first time you saw the pipe function up until
8 today, everything in Hanehoi Stream was being diverted
9 into the Lowrie Ditch?
10 A. Correct.
11 Q. And that's 14-and-a-half years, to the best
12 of your knowledge?
13 A. Correct.
14 Q. And then below the Lowrie Ditch diversion
15 works is the new Haiku Ditch diversion works on
16 Hanehoi Stream, is that right?
17 A. Correct.
18 Q. Are you familiar with that as well?
19 A. Yes, I am.
20 Q. Does the new Haiku Ditch diversion work
21 divert anything that happens to be flowing in Hanehoi
22 Stream above that diversion?
23 A. If anything comes down from the Lowrie in the
24 Hanehoi to the new Haiku Ditch, unless it's a storm,
25 it falls in the spillway. Nothing comes over that

1 wall unless there is a storm or something.
2 Q. There was a time when water came over the
3 wall in the new Haiku Ditch, is that right?
4 A. Correct.
5 Q. Can you explain that?
6 A. These walls were completely covered up until
7 about, I believe it was 2000, might have been '99.
8 Q. You've got to explain that more clearly.
9 A. There's some walls --
10 Q. I'm showing Mr. Schupp Exhibits 28-C and
11 28-D. Are these pictures that you took?
12 A. Correct.
13 Q. Of the new Haiku diversion works of Hanehoi
14 Stream?
15 A. Correct.
16 Q. And when did you take these pictures?
17 A. These were taken at the same time, 2000.
18 Q. Okay. And they show a wall?
19 A. Correct.
20 Q. Now, what were you saying, that there was a
21 time before the picture when there was dirt and rocks
22 all the way to the top of the wall?
23 A. This basin here was completely filled over
24 with rocks. Could not see this wall.
25 MR. SCHULMEISTER: Could I ask that the

1 picture be circulated.
2 MR. HALL: Let me circulate the picture
3 first.
4 MS. LOVELL: I didn't hear, just the last
5 sentence.
6 MR. HALL: He's saying there was a time
7 when there was dirt and rocks all the way up to the
8 top of the wall.
9 Q. So what effect did that have that there was
10 dirt and rocks all the way up to the top of the wall?
11 MR. SCHULMEISTER: Only talking about
12 28-C, right?
13 MR. HALL: And D.
14 Q. What effect did that have? Did it allow
15 water to flow over?
16 A. Whatever water did come because of heavy rain
17 flowed completely over because it looked just like a
18 riverbed. I never knew that wall was there until it
19 was cleaned up.
20 HEARINGS OFFICER McCONNELL: Until when?
21 THE WITNESS: I believe it was cleaned
22 out. What happened I heard a bunch of machinery from
23 my house.
24 Q. (By Mr. Hall): When was this?
25 A. These pictures were taken in 2000. Could

1 have been in '99 when they cleaned it out or beginning
2 of 2000.
3 Q. And what happened in 2000? You heard heavy
4 machinery. What happened?
5 A. That's when I went back and saw this.
6 Q. What did you see?
7 A. There was a wall there now.
8 Q. What happened?
9 A. It was completely all covered up. I never
10 knew that was there. You couldn't see none of it.
11 Q. Were the dirt and rocks cleaned out?
12 A. Everything was cleaned.
13 Q. And what effect did that have?
14 A. No more water came past that wall unless that
15 gate was open.
16 HEARINGS OFFICER McCONNELL: Could I see
17 it again?
18 Q. MR. HALL: So because the dirt and rocks had
19 been there before, water went right over?
20 A. It was like a natural riverbed.
21 Q. And when the dirt and rocks were removed, it
22 began to completely divert all the water again?
23 A. Everything that came down there unless it was
24 a heavy storm.
25 Q. I'd like to move Exhibits 28-C and D into

1 evidence.
2 HEARINGS OFFICER McCONNELL: In evidence.
3 (Exhibit Nos. 28-C and 28-D were received
4 into evidence.)
5 Q. (By Mr. Hall): Is there a floodgate in the
6 new Haiku Ditch as it diverts Hanehoi Stream?
7 A. Yes, there is.
8 Q. Can you see it in the pictures?
9 A. Right over here in the corner of 28-C.
10 Q. Near the spillway?
11 A. Correct.
12 Q. And is that floodgate open much?
13 A. Today was the first time I ever seen it open.
14 Q. How often have you gone up there?
15 A. I used to ranch that whole area. Used to
16 ride horse in there. That's why I never knew that
17 wall was there. Unless that was cleaned out, never
18 knew that was there.
19 Q. You never saw that gate open?
20 A. No. Today was the first time.
21 Q. Okay. So that floodgate was open today for
22 the first time in the 14-and-a-half years that you've
23 been there?
24 A. Correct.
25 Q. And it was allowing water to flow down from

1 Hanehoi through the new Haiku Ditch diversion works
2 down into Hanehoi Stream below the new Haiku Ditch?
3 A. Correct.
4 Q. So today you saw three new things that you
5 had never seen before?
6 A. Correct.
7 Q. Saw the floodgate open at the new Haiku Ditch
8 at Puolua?
9 A. At Puolua.
10 Q. You saw a pipe at Lowrie-Hanehoi that hadn't
11 been open in 14 years?
12 A. Correct.
13 Q. And you saw a floodgate open at the new Haiku
14 Ditch that you had never seen open for 14-and-a-half
15 years?
16 A. Correct.
17 Q. Did that explain to you or do something to
18 explain to you why you saw the amounts of water you
19 saw in Hanehoi Stream today?
20 A. Correct.
21 Q. Tell me why.
22 A. Because those gates are never open. With
23 these gates closed at the Puolua Stream and the
24 Hanehoi, the only water that the Hanehoi receives is
25 what comes through the two three-inch pipes on the

1 Puolua, which goes downstream and dumps into the
2 Hanehoi.
3 Q. So when -- for instance, you were at the site
4 inspection. You saw the amount of water at Neola
5 Caveny's?
6 A. Correct.
7 Q. Would that you explain why you saw the
8 amounts of water you saw at Neola Caveny?
9 A. Correct.
10 Q. Would it explain why you saw the amounts of
11 what you saw at your place?
12 A. Correct. Well, my place it's the same.
13 Q. But the floodgate was open at your place
14 where it's normally not?
15 A. Correct.
16 Q. Do you have any assurance from EMI that
17 they're going to leave that eight-inch pipe in at the
18 Lowrie Ditch in Hanehoi?
19 A. I have no written -- nothing in writing.
20 Q. Do you have any assurances from EMI that
21 they're going to leave the floodgates open at the new
22 Haiku Ditch or either at Puolua or Hanehoi?
23 A. Never seen them open until, you know, today.
24 Q. Did you see them, as we left the site
25 inspection, closing both of them?

A. Correct.

Q. So --

A. Well, I closed the first one, Puolua Stream this morning.

Q. Can you describe growing taro on the parcel that you have the caretaker agreement for?

A. At one time all -- not all the patches, but eight of them were open and all of them were being farmed in taro.

Q. I would like to show you Exhibits 28-E and 28-F. Did you take those photographs?

A. Yes, I did.

Q. What do they show?

A. They show taro grown in the parcel of land in which I take care of.

Q. When did you take those photographs?

A. This would have been in 2000.

Q. How many patches were open in 2000?

A. Eight patches were open.

MR. HALL: I would like to move 28-E and 28-F.

Q. Was there taro being grown?

MS. LOVELL: Was there a ruling?

HEARINGS OFFICER McCONNELL: No, I was waiting for everyone to see it.

1 MR. HALL: I'll wait.
2 MR. MURAKAMI: No objection.
3 MS. LOVELL: No objection.
4 MR. MERCHANT: No objection.
5 HEARINGS OFFICER McCONNELL: It will be in
6 evidence, 28-E and F.
7 (Exhibit Nos. 28-E and 28-F were received
8 in evidence.)
9 Q. (By Mr. Hall): Did, in the registration of
10 water rights, Lehua Lapenia also registered another
11 parcel in the area?
12 A. Correct.
13 Q. And you took a picture of taro that was grown
14 on that parcel?
15 A. Correct.
16 Q. Is 28-G a picture that you took of the taro
17 being grown on that parcel?
18 A. Correct.
19 Q. And that parcel is being served by Hanehoi
20 Stream?
21 A. By the Hanehoi and the Puolua.
22 Q. And that picture -- was taro being grown on
23 that parcel in 2001?
24 A. Correct.
25 Q. That's 28-G, the top one.

1 I would like to move 28-E, F and G into
2 evidence.
3 HEARINGS OFFICER McCONNELL: They'll be
4 in.
5 MR. HALL: Thank you.
6 (Exhibit Nos. 28-E, F and G were received
7 into evidence.)
8 Q. Your taro patches today don't look like the
9 taro patches that are shown in 28-E and F?
10 A. No, they don't.
11 Q. Have you had problems growing taro?
12 A. Constantly, because the water gets too warm.
13 Q. Why does the water get too warm?
14 A. Not enough water to flow through the patches
15 to keep it cool enough.
16 Q. Why is there not enough water?
17 A. It's being diverted.
18 Q. Has that frustrated you -- does that have
19 some relationship to why you're not growing taro right
20 now?
21 A. Well, after you do it for years and years you
22 get sick of watching your own crop die due to root
23 rot, crayfish digging around them, water being too
24 warm, and you're not getting the corm size with the
25 cooler water, you end up with rotten taro.

1 Q. Let's take that the other way around.
2 Because the water -- you're not getting enough water,
3 the water's too warm, what happens to the taro?
4 A. You'll end up with -- there is bacterias that
5 harm the taro, corm itself. Root rot will set in.
6 Because what will happen is if we end up in a drought
7 situation, all this water you won't see in there. It
8 will turn like a desert floor, it will crack.
9 And what it does, it tears all the root
10 systems apart. And then you get root rot. Crayfish
11 dig down in there deeper. They burrow themselves
12 right next to the corm, the taro. They don't eat the
13 taro, but their claws are so sharp, because they're
14 digging in there, all they got to do is start a taro
15 and that's it, rot sets in. The damage is done.
16 And most of the time you won't know that
17 until you start seeing the plant fall over. By then
18 it's too late.
19 Q. So have you tried to grow healthy taro?
20 A. For many years.
21 Q. And what happened?
22 A. I end up growing enough just to give away and
23 the rest is -- it's wasted.
24 Q. Have you tried to get more water from EMI?
25 A. We've been to meetings, that's why we're

1 here. I haven't personally asked Mr. Garrett Hew to
2 give me any more water. Just the way the system is
3 set up now and that's what I get.
4 Q. So will you be able to grow healthy taro if
5 you can't get more water?
6 A. If I can't get?
7 Q. Cannot.
8 A. It's useless.
9 Q. If you can get the amount of water from EMI
10 and the state that it takes to grow healthy taro, are
11 you going to put all these patches into production?
12 A. Yes, I am.
13 Q. Are you going to get help from people in the
14 area?
15 A. Everybody is lined up willing to go as soon
16 as more water is released.
17 Q. Can you tell me who's expressed interest in
18 the neighborhood?
19 A. Person that farmed this before me, John
20 Kahiamoe, his son, Moses Kahiamoe, the Lapenias. The
21 Door of Faith, some of the people at Door of Faith
22 Church and including myself.
23 Q. Is there -- are there many areas in Huelo
24 left to grow taro?
25 A. Once -- like the Lapenias' property sold.

1 This is the last lo'i.
2 Q. So is there interest among Hawaiians in the
3 area in keeping this patch going?
4 A. Yes, there is.
5 Q. And how much more water do you need to grow
6 healthy taro?
7 A. What we did test last year and the water
8 temperatures are too warm, so whatever those pipes are
9 putting out right now, it's not working.
10 Q. So how much -- if you want the hearing
11 officer to order EMI to let more water down, how much
12 more water do you want the hearing officer to order
13 EMI to let down to your auwai or to your patch or --
14 A. Well, I think when EMI came and took flow
15 measurements, the new Haiku Ditch was putting out
16 261,000 gallons. And at that time when we took the
17 water temperatures, the water temperatures in the
18 first couple of taro patches was cool enough for taro.
19 The rest became too warm and that's when the rot and
20 damage was happening.
21 Q. So you need the water at the last patch --
22 what's the temperature got to be in the last patch for
23 you to grow healthy taro?
24 A. From what I understand, it can't get no
25 higher than 77 degrees.

1 Q. So the water -- you need enough water to keep
2 the temperature in your last patch at 77 degrees or
3 below?
4 A. Or below.
5 Q. And you don't have that right now?
6 A. No, I do not.
7 Q. And that's what you're asking the hearing
8 officer to order EMI to do, to let down enough water
9 to keep the water in your patches in the last patch 77
10 degrees or below?
11 A. Correct.
12 Q. By the way, when you're done using the water
13 in your taro patches, you put it back in the stream?
14 A. Correct.
15 Q. And it goes back into Puolua and then
16 eventually into Hanehoi?
17 A. Correct. Actually when these patches are
18 full of water and the ground is saturated, almost 95
19 percent of the water that moves through here goes
20 right back into the stream.
21 MR. HALL: I don't have any further
22 questions.
23 HEARINGS OFFICER McCONNELL: Is there
24 anything you wanted to add, Mr. Murakami?
25 MR. MURAKAMI: No.

1 MR. MERCHANT: No questions.
2 HEARINGS OFFICER McCONNELL: Mr.
3 Schulmeister.
4 MR. MURAKAMI: Judge, while we're waiting
5 I looked at one note. Can I ask some cross to clarify
6 a point?
7 HEARINGS OFFICER McCONNELL: Are you
8 ready?
9 MR. SCHULMEISTER: Yeah.
10 MR. MURAKAMI: Just one thing.
11 HEARINGS OFFICER McCONNELL: Okay.
12 CROSS-EXAMINATION
13 BY MR. MURAKAMI:
14 Q. I was unclear, Ernie, about your answer with
15 respect to the new Haiku Ditch and the point where
16 this pile of rocks covered the gate.
17 A. Correct.
18 Q. And just so that I'm clear, you mean the
19 rocks covered the gate on the mauka side or makai
20 side?
21 A. Whole thing, couldn't see that wall.
22 Q. So entire bed of the stream ran over the top
23 of this -- is it a wall or a gate?
24 A. It's a wall and a gate.
25 Q. Wall and a gate. So basically -- and nothing

1 to stop it from coming back, holding it back?
2 A. Nothing to stop it.
3 Q. So by removing that surrounding or that
4 covering material, what you ended up with is basically
5 a wall and that stopped the water?
6 A. Correct.
7 Q. So the entire streambed was cleaned out?
8 A. Correct.
9 Q. To what depth?
10 A. It would probably be about, I would say,
11 three feet. The wall was three feet, now it's filling
12 in again, as we seen today.
13 Q. And that condition had not -- that streambed
14 covering this wall and gate was like that for how many
15 years, did you say?
16 A. It looked like it was there for many, many
17 years up until --
18 Q. When was the first time that you observed
19 that condition at that point in the stream at the new
20 Haiku Ditch?
21 A. That there was a wall there?
22 Q. That the streambed was like that. When was
23 the first time that you saw that?
24 A. That would have been at least '91.
25 Q. And the first time you saw it different was

1 when it was cleared some time in 2000?
2 A. I believe it's 2000.
3 Q. Okay. Thanks.
4 HEARINGS OFFICER McCONNELL: Thank you,
5 Mr. Schulmeister.
6 CROSS-EXAMINATION
7 BY MR. SCHULMEISTER:
8 Q. Just wanted to go back over your residency in
9 the area. In your written testimony you say since
10 March 1, 1991 you resided on the same parcel we have
11 been talking about, the one acre?
12 A. Correct.
13 Q. And when you began to live there, were you --
14 I mean other than whatever you were doing as part of
15 the caretaker agreement, were you employed otherwise?
16 A. I was doing just odd jobs, roofing,
17 carpentry.
18 Q. Now, when you actually moved on the parcel in
19 March of 1991, was someone else living there
20 immediately prior to that?
21 A. Actually there was two houses down there.
22 One house got burned down. Johnnie Kahiamoe at that
23 time let me take over the lease. There was some kind
24 of trouble down there and the boy got burned out and
25 they didn't want him back.

1 Q. There were two houses. One burned down. The
2 one that you moved into, was someone else living
3 there?
4 A. No, that was empty.
5 Q. So that had been empty for awhile?
6 A. Correct.
7 Q. So when you moved in, were these 14 lo'i that
8 you described as being on the parcel being cultivated?
9 A. Six open at that time from Johnnie Kahiamoe.
10 He managed the land. He's the one that had all the
11 cattle around there at the time that we ranched.
12 Q. Six that were open. When you say open, you
13 mean actively cultivated?
14 A. Yes.
15 Q. Were they located at the same area where the
16 eight are that you described as being currently ready
17 for cultivation?
18 A. There was five of them open at the time.
19 Q. There were five?
20 A. Five. I mean because the rest of them -- you
21 have to take into consideration Johnnie Kahiamoe was
22 in his late seventies and he could only work so many.
23 And when I moved onto that property, I paid 200 a
24 month and worked off 200 a month in taro patches to
25 take care of them.

1 Q. So in 1991 there were five being actively
2 cultivated?
3 A. Correct.
4 Q. And the reason why it was only five was
5 because the guy who was -- what was his name?
6 A. Johnnie Kahiamoe.
7 Q. He was -- that was as much as he was
8 physically able to operate at that time?
9 A. Correct.
10 Q. Now, those five that were being operated,
11 again, were they -- you know, we went down on the site
12 visit today, we went down, saw that there was a group
13 of lo'i that are not actually being cultivated right
14 now that were visible from the area where the intake
15 to your auwai is; right?
16 A. Correct.
17 Q. Were the five that were being actively
18 operated when you first moved on to the parcel visible
19 from that same place?
20 A. Correct.
21 Q. So close to the intake?
22 A. Intake.
23 Q. What was the nature of the diversion
24 structure at that time in 1991? And specifically I
25 guess what I'm getting, when we went there today, we

1 saw that apparently some recent work on a dam that's
2 across part of the stream, and then there was the
3 entrance to the auwai, but no water was going into the
4 auwai.
5 A. Right.
6 Q. What was it like in 1991 when you first moved
7 on to the parcel?
8 MR. HALL: Can I clarify? You're talking
9 about -- not the new Haiku Ditch diversion, but auwai?
10 MR. SCHULMEISTER: Talking about intake to
11 his auwai.
12 A. At that time I had an eight-inch pipe. There
13 was a mud bank there and I had an eight-inch pipe
14 feeding the auwai system.
15 Q. And the mud bank separated the auwai from the
16 streambed, is that right?
17 A. What you seen today, the mud bank went all
18 the way to the wall, you didn't see that channel,
19 that's where the pipe was. Then I reconstructed it
20 last year and cleaned everything back out. Lot of
21 sediment from storms.
22 Q. So the bank went across the entire mouth of
23 the auwai and there was an eight-inch pipe that
24 allowed water into the auwai?
25 A. Correct.

Q. So was that regulated at all or just whatever --

A. Whatever was coming down the stream went into that pipe.

Q. And at the time that -- and what was the condition at the actual ditch diversion right above that?

A. At the new Haiku Ditch?

Q. Right.

A. That's been the same.

MR. MURAKAMI: I'm sorry, object to that. Can I have clarification? What do you mean right above that? Talking about Haiku Ditch or some other dam?

MR. SCHULMEISTER: Talking about the Haiku Ditch -- maybe it would help if I ask another question.

Q. How close is the -- estimate for me the distance between the Haiku Ditch diversion -- or the pipes that pass the Haiku Ditch and the entrance to the auwai?

A. Sixty feet, something like that maybe.

Q. So when I said right above, that's what I was referring to. So 60 feet above the entrance to the auwai.

1 A. New Haiku Ditch.
2 Q. Right. So the two pipes that we saw there
3 today, they were also there in 1991?
4 A. Correct.
5 Q. So 1991 those two pipes were essentially --
6 that was the source?
7 A. That was all we're getting.
8 Q. That was being used to raise the taro in the
9 five operational lo'i?
10 A. Correct.
11 Q. But -- all right. So now once you moved in,
12 did Johnnie -- can I call him Johnnie K?
13 A. That's fine.
14 Q. Did he continue to operate the lo'i?
15 A. I pretty much took over that. And then when
16 it came time to harvest, him and his wife and couple
17 of grandchildren would come down to help, including
18 myself.
19 Q. So 1991 you sort of took over and started off
20 with some occasional help from him and his family?
21 A. Correct.
22 Q. And let's say over the next four years, '91
23 to 1995, did the number of lo'i being cultivated
24 change?
25 A. I opened up the rest of the taro patches that

1 I could at that time.
2 Q. So how many?
3 A. Probably eight at that time.
4 Q. A total of eight?
5 A. Total of eight.
6 Q. So you added another three, basically?
7 A. What was there -- yeah.
8 Q. So that eight, the five plus the three, is
9 that the same eight that you described in your direct
10 testimony as being ready to be cultivated?
11 A. Correct.
12 Q. And did there come a time when you weren't
13 getting any assistance from Johnnie K or his family?
14 A. Yeah, there was some humbug that happened
15 over there. That's when the owners came along and saw
16 what was going on. The thing was he was collecting
17 rent from me and they weren't collecting nothing.
18 When they came over and saw what was happening, they
19 kind of gave me the lease.
20 Q. I'm a little confused. This is after 1991?
21 A. This is after '91.
22 Q. After '91 they're collecting rent from you.
23 I didn't follow what the humbug was.
24 A. Then the owners, George Keala and daughter
25 Mary Keala, they didn't know any houses built down

1 there. Just supposed to be for farming. So he was
2 building houses and collecting rent. They came down
3 there and saw that, and they weren't getting nothing.
4 Q. This is on the parcel?
5 A. This is on the parcel.
6 Q. Same parcel you were living on?
7 A. Correct. So they gave the lease to me, and
8 that was it for Johnnie.
9 Q. So then he wasn't around to help any more?
10 A. Right.
11 Q. So that was about what, 1995?
12 A. '95, '96.
13 Q. Between '95 and '96 was the taro that was
14 being raised healthy -- I mean between '91 and '95,
15 '96?
16 A. All the time there's always complaint about
17 the water being too warm and losing a lot -- as
18 Johnnie used to say, it's a lot of work for nothing.
19 Q. And then so did you then continue to
20 continuously farm the eight lo'i from that point
21 forward?
22 A. Correct.
23 Q. Anybody else helping? Just you?
24 A. Just occasional friend would come by and
25 help. But most of the time just me, myself and I.

1 Q. Now, so where did the water go back into the
2 stream?
3 A. At that time it would dump in from about the
4 sixth taro patch.
5 Q. And how does that relate to how the water
6 would flow through if all 14 were in cultivation?
7 A. Well, each taro patch or most of the taro
8 patches has a pipe that feeds back into the stream.
9 So I can shutdown certain patches if I need to for
10 fertilizing or harvesting from or weed pulling.
11 So wherever I needed to shut the water off
12 for whatever patch I was working in, then it would go
13 back into the stream from that patch. If not, it went
14 all the way down through the lo'i, and when it hit the
15 last lo'i, it went back into the stream.
16 So if it went down six taro patches, from
17 the sixth one, it dumped back into the stream.
18 Q. So are you saying you could actually channel
19 the water back into the stream from any of the
20 patches?
21 A. Correct. Except for the ones closer to where
22 we walked down the road.
23 Q. Now, when you had eight in cultivation, it
24 was about the sixth one you were saying is where there
25 was a pipe that allowed you to have a flow through

1 water going to the stream?
2 A. Going back into the stream?
3 Q. Right.
4 A. Actually there is two more taro patches up
5 around that I can also divert water back into the
6 stream. If I shut the sixth one down to fertilize or
7 harvest from, the water would go from the fifth one
8 in.
9 Q. And in terms of the slope from like the sixth
10 patch back to the stream, is that different from what
11 the slope would be if it was further down? In other
12 words, if there was -- to be able to draw the water at
13 any kind of velocity?
14 A. From the auwai system?
15 Q. Right.
16 A. It would flow in and then -- yes, there was
17 enough droppage there. I can drop it right back into
18 the stream from several taro patches.
19 Q. Do you have any knowledge as to when the
20 rest -- in other words, the other six, 14 total, eight
21 that you were cultivating between '91 and 1995, the
22 other six, when were they last cultivated?
23 A. It was probably up until when I would say
24 probably -- I'm just trying to think when -- Lehua
25 Lapenia was the last one there with her grandmother.

1 And I think that was in mid '80s, that's when Johnnie
2 took over.
3 Q. At that time, as far as you know, was the
4 situation at the ditch with the two pipes the same?
5 A. Yes, it was.
6 Q. So at one time all 14 were being cultivated
7 with water from the two pipes?
8 A. Correct.
9 Q. Now, from '95 forward, you had eight in
10 cultivation in '95, so going forward, did that ever
11 change? Or when did it change? Obviously it changed
12 because you don't have them in cultivation right now.
13 A. Well, as I learned, you open up more taro
14 patches, you need more water. And, of course, the sun
15 beating down each patch gets warmer and warmer and
16 warmer. As I found out there isn't substantial flow
17 to keep all those patches open.
18 Q. Okay, but I think what I'm trying to do is
19 trying to figure out when it changed. In other words,
20 you had eight, currently none of them are actually in
21 cultivation. So I'm just trying to follow the change.
22 In other words, eight were being
23 continuously cultivated by you approximately 1991 to
24 1995. Today there's none currently. What happened
25 between '95 and today? Just kind of track that for

1 me.
2 A. That's when all these meetings started taking
3 place. Everybody was coming down there. A lot of
4 people seen them open, and took the water
5 temperatures, after years of growing and trying to
6 figure out why the taro is rotting in there. And at
7 times we had droughts, there was no water. Sit there
8 and watch the taro patches turn to desert floors,
9 nothing you could do.
10 Q. When you stopped cultivating the eight, did
11 you stop all at one time or just phase them out?
12 A. Yes, I did.
13 Q. Just stop at one time?
14 A. (Witness nods head up and down.)
15 Q. Just one time?
16 A. I tried to pick them up last year after I got
17 my auwai system up and running, and the same thing
18 happened again.
19 Q. 1995 they were in operation. When did you
20 shut them down?
21 A. Probably a year-and-a-half, two years ago.
22 Q. So from 1995 all the way until 2000, 2001 you
23 were continuously cultivating?
24 A. Probably 2002, 2003.
25 Q. Okay. And it was continuous?

A. Continuous.

Q. And eight patches?

A. And eight patches.

Q. And the flow-through water was going back to the stream from the sixth?

A. Basically back from the sixth one.

Q. Through a PVC pipe?

A. From a pipe, yes.

Q. But during that period you were having trouble with rot?

A. With, they call it root rot. Bacteria starts affecting the taro. Diseases start affecting it. The crayfish multiply, you wouldn't believe, because the water is so warm.

Q. Was any of the taro from 1991 through 2002 -- so actually 11, 12 years you worked continuously operating the lo'i; is that right?

A. Right.

Q. Was any of that taro sold?

A. No. Give it all to the local Hawaiian families and people that wanted it, because I lost a lot of it. Whatever was pulled, you couldn't sell. Wasn't enough to say sell. You couldn't go to Aloha Poi with a couple 80 pound bags because we didn't have it. Might end up with an 80 pound bag. Best thing to

1 do is give it away.
2 Q. Any agencies that you're aware of that
3 provide information and assistance to people who are
4 trying to farm or raise taro?
5 A. I haven't been in touch with any of them.
6 Q. Are you aware of any?
7 A. Only recently starting to find out about
8 different agencies. I knew there was something
9 through UH, but I didn't know how to go about the
10 process. I live off the grid. I don't have a fax
11 machine or anything like that, just have a telephone.
12 Q. Do you have handy the photographs that were
13 marked 28 with a bunch of sub letters?
14 Is it okay if I stand up and go next to
15 him so I can look at it the same time he's looking at
16 it?
17 HEARINGS OFFICER McCONNELL: Yes. How
18 much more do you have?
19 MR. SCHULMEISTER: Not too much.
20 HEARINGS OFFICER McCONNELL: We'll press
21 our luck then.
22 MR. SCHULMEISTER: Just looking at 28-E
23 and F for a second, there's handwriting between the
24 two photos, Ernie Schupp's lo'i.
25 Q. Whose handwriting is that?

1 A. This handwriting?
2 Q. Right.
3 A. It's not mine.
4 Q. In parenthesis says C and then 2000, looks
5 like one, do you see that? Is that what it looks like
6 to you?
7 A. Looks like to me.
8 Q. Looks like some whiteout. Something else was
9 written underneath it. Do you see that?
10 A. Correct.
11 Q. Did you take these pictures?
12 A. Yes, I did.
13 Q. Did you date them?
14 A. No, I didn't. I didn't think I had to at the
15 time.
16 Q. Do you have any idea why it looks like one
17 date and why it was whited out?
18 A. I would think they just got dates mixed up.
19 Mostly these were taken 2000, 2001, so that might have
20 been.
21 Q. 28-G, we have the same thing.
22 A. Lapenia's --
23 Q. The handwriting is not yours?
24 A. No, it's not my handwriting.
25 Q. And you don't know why the date is whited out

1 and written over?
2 A. Just a misunderstanding, I guess.
3 Q. Now, 28-E, it looks like there's a picture of
4 this lo'i with water and the water isn't actually in
5 the entire patch; is that right?
6 A. This is called -- this is like a growth, they
7 call it a zola. It floats on the water, helps cut
8 down the sunlight to keep the water from warming up.
9 Q. You're talking about the water to the left?
10 A. Yes.
11 Q. So water there -- something floating on the
12 water?
13 A. Called a zola, helps keep the water cooler.
14 Q. When this picture was taken, was the water
15 circulating?
16 A. It was running. Actually had to shut it
17 down. When you're working in the taro patch, you
18 don't want mud and all going into the stream because
19 you have sediment problems there.
20 Q. Now, you mentioned that there was a time when
21 somebody took a temperature measurement.
22 A. There was a whole bunch of people down there
23 a couple years ago and they took water temperatures.
24 And I remember in the Pualima, which would be Matson's
25 piece of property that was growing at that time, I'm

1 pretty sure I remember it was 89 degrees. And one of
2 them had -- this is zola, growing in one of the
3 sections of it. Actually the one big taro patch was
4 broken into three taro patches. I've taken, put it
5 back into one taro patch. They made mud walls there.
6 So just to keep the water cooler as coming
7 through, because smaller patches warms up quicker. So
8 you got to figure this large taro patch was cut into
9 three. The one with the zola on it was like about
10 maybe six degrees cooler than the one that didn't
11 have. And I remember 89 degrees.
12 Q. Did you -- from 1991 until -- well, strike
13 that.
14 About what year was it that you recall
15 someone coming and taking a temperature reading?
16 A. Just a couple years ago.
17 Q. And had you ever taken temperature readings
18 from '91 to a couple years ago?
19 A. No, I did not.
20 Q. Or since?
21 A. No, I haven't.
22 Q. And you mention that you have this
23 understanding that the water needs to be 77 degrees or
24 cooler?
25 A. Well, actually I heard it wasn't suppose to

1 get over 70 degrees but now I hear 77.
2 Q. Where did you hear this from?
3 A. Just certain meetings.
4 Q. Have you ever done any research or consulted
5 any acknowledged expert to find out whether that's
6 true?
7 A. I just read books, try to learn from that.
8 Q. Sorry?
9 A. Just reading books.
10 Q. Did you get that from a book?
11 A. Yes.
12 Q. Do you happen to recall what book it was?
13 A. It's back in my truck. That's Anahulu
14 project. It was done on Oahu. USGS was there. They
15 dug through sites. And I'm not sure the author's
16 name. But that's where I dug up most of my
17 information.
18 Q. Now, two or three years ago is when you
19 stopped cultivating the eight lo'i; right?
20 A. About 2003.
21 Q. At that time was the mud bank still there
22 with eight-inch pipe?
23 A. Yes, it was.
24 Q. So from '91 until when you stopped
25 cultivating the lo'i, that was the way the intake was?

1 A. That's what it was.
2 Q. What happened to that?
3 A. A big storm took the pipe out. And then we
4 had a meeting down there last year, and that's when I
5 had to get my auwai system up and running -- or not up
6 and running, but redo the whole thing.
7 Q. When was the big storm?
8 A. I can't remember exact time.
9 Q. When the big storm came that wiped out the
10 mud bank and the pipe, were you cultivating at that
11 time?
12 A. Yes, I was.
13 Q. Have you ever cultivated since the big storm
14 came and wiped out --
15 A. Oh, yeah. I went back downstream, picked up
16 the pipe, brought it back up, put it back in. When a
17 storm comes, everything goes. Have to go downstream,
18 find your stuff and redid it again.
19 Q. Okay. So at the time that you stopped
20 cultivating, the mud bank was all rebuilt again. And
21 was the eight-inch pipe in?
22 A. Back the same way it was when I started
23 there.
24 Q. So then did another big storm come?
25 A. No. After last year when Mr. Garrett was

1 there, everything had to be redone. There was old
2 carpets. Whatever Johnnie could find, he patched up
3 pukas, holes in the dam with tarps, carpets. And
4 there was no drainage so you couldn't drain out the
5 sediment because just basically had to tear everything
6 down and start over again.
7 Q. But Johnnie hadn't been there since --
8 A. About '96.
9 Q. So like eight or nine years earlier?
10 A. Every time storms came, wiped it out, I had
11 to rebuild it.
12 Q. What I'm trying to understand, the storm came
13 and wiped it out after you had already stopped
14 cultivating? I thought you said it was before and you
15 built it back.
16 A. In the past time I've been living there
17 probably had about six major storms come through and
18 take everything out.
19 Q. And the last one, was it after you had
20 already stopped, or did that cause you to stop?
21 A. Actually I took out the pipe and started
22 redoing the whole auwai system last year.
23 Q. So for awhile it was still there even though
24 you weren't cultivating?
25 A. Yeah, it had to be rebuilt.

1 Q. What caused you to start rebuilding it? What
2 prompted that?
3 A. With the hopes of receiving more water.
4 Q. When we were there today, part of the area,
5 there's quite a little structure of rocks basically, a
6 loose rock wall. Did you just do that recently?
7 A. Last year.
8 Q. Last year?
9 A. Last year.
10 Q. And that was part of the effort to get ready
11 to cultivate again?
12 A. Correct.
13 Q. And what's left to be done?
14 A. Just put in a gate, that's it, so I can
15 channel the water straight into the taro patches.
16 Q. And is there some reason why you didn't do
17 that in the last year?
18 A. Because I'm waiting on the -- to receive more
19 water so we can open up the rest of the lo'i, all the
20 lo'i. Why would I have water going into grass?
21 Q. So you don't plan to put the gate in unless
22 there is more water?
23 A. In case there is a flash flood just like a
24 couple weeks ago, I don't want to lose that wall.
25 Which big water -- where we were standing in the taro

1 patches today '98 or '99, picture that whole thing
2 being a river. Three feet from my house that was all
3 river from one flash flood. In fact, it took out the
4 Lowrie Ditch road up at Puolua Stream. That was a lot
5 of water.
6 Q. I have no further questions.
7 MS. LOVELL: No questions by the county.
8 HEARINGS OFFICER McCONNELL: Redirect? I
9 only have one.
10 When you got there, Johnnie K, that's what
11 we'll call him, was cultivating five; correct?
12 THE WITNESS: Correct.
13 HEARINGS OFFICER McCONNELL: And you
14 increased that to eight, is that right?
15 THE WITNESS: Correct.
16 HEARINGS OFFICER McCONNELL: Even though
17 you were having problems with the five?
18 THE WITNESS: Correct.
19 HEARINGS OFFICER McCONNELL: All right, go
20 ahead.
21 REDIRECT EXAMINATION
22 BY MR. HALL:
23 Q. Let's take care of the pictures. These are
24 your photographs?
25 A. Correct.

1 Q. And you know when you took them?
2 A. 2000, 2001.
3 Q. And somebody else wrote the text on here,
4 right?
5 A. Correct.
6 Q. So you had that person correct the date once
7 you informed her of what the date was when you took
8 the picture?
9 MR. SCHULMEISTER: Object that this is
10 leading.
11 THE WITNESS: Either 2000, 2001, would
12 have been December, could have been January.
13 HEARINGS OFFICER McCONNELL: The question
14 really related to do you remember who did the writing.
15 Q. (By Mr. Hall): Who did the writing?
16 A. Neola.
17 Q. When there was a date other than the correct
18 one on, you had the correct date put on?
19 A. I didn't know it was corrected. Maybe she
20 misunderstood or something, I don't know.
21 Q. But your testimony is, bottom line, you took
22 the picture and you took the picture sometime between
23 2000, 2001?
24 A. Correct.
25 Q. And that's for 28-E, F and G?

1 A. Correct.
2 Q. Now, there's some discussion about why you
3 converted from an eight-inch pipe and a mud bank to an
4 auwai. Isn't it true that Mr. Garrett from EMI
5 criticized you for not having a good auwai system?
6 A. About a year ago when we were all there.
7 Q. And EMI said that one of the reasons why you
8 didn't have use -- he had said to you that you had
9 enough water but you had a faulty auwai system, so you
10 said okay, I'll fix my auwai system. Isn't that
11 partly why you did it?
12 A. That's basically it.
13 Q. You wanted to put an auwai system in there so
14 EMI couldn't criticize you any more?
15 A. What I did was put it back to what it was
16 probably many, many years ago.
17 Q. Just to get it straight, have you ever had
18 enough water below the new Haiku Ditch let down by EMI
19 and the State of Hawaii to grow healthy taro in your
20 patch from '91 to present?
21 A. I've never had enough water to grow healthy
22 taro.
23 Q. Do you need to go to an agency somewhere to
24 figure that out or do you know that as a taro grower?
25 A. Just know it as a grower.

1 Q. Your not having enough water, is that what
2 leads to warm water?
3 A. Correct.
4 Q. And the warm water leads to the diseases that
5 you were talking about?
6 A. Correct.
7 Q. And are those the primary problems that
8 you're dealing with as a taro grower?
9 A. Correct.
10 Q. So they all lead back to the fact that EMI
11 and the state won't let down enough water?
12 A. Yeah.
13 HEARINGS OFFICER McCONNELL: Mr. Hall,
14 that's a little leading.
15 MR. HALL: I'll cut it a little short
16 here.
17 HEARINGS OFFICER McCONNELL: I understand
18 the argument fully.
19 MR. HALL: It's a fact.
20 HEARINGS OFFICER McCONNELL: Fine.
21 Q. (By Mr. Hall): The amount of water that you
22 said you needed -- well, does the amount of water that
23 comes down vary based on rainfall or storm event or
24 drought?
25 A. It varies a lot.

1 Q. And this amount that you're asking the
2 hearing officer to order EMI and the State of Hawaii
3 to let down is 24-hours-a-day and seven days a week
4 irrespective of drought, storm event?
5 A. Correct.
6 Q. I believe you testified that Johnnie Kahiamoe
7 even was having problems growing healthy taro?
8 A. Correct.
9 Q. For the same reasons that you're having
10 problems growing healthy taro?
11 A. Correct.
12 Q. I don't have any further questions.
13 HEARINGS OFFICER McCONNELL: Any other
14 questions?
15 RECROSS-EXAMINATION
16 BY MR. SCHULMEISTER:
17 Q. Just following up on this issue about EMI or
18 Garrett Hew having, I guess, commented to you on your
19 auwai system. If I understood correctly what you just
20 testified, you went to a meeting, was it Garrett Hew
21 from EMI or someone else that said there was a problem
22 with your auwai system?
23 A. There was probably about seven, eight of us.
24 Alan Murakami was here with us. Moses Haia was with
25 us. Skippy Hau was with us and few people from EMI

1 when all the temperatures and everything.
2 Q. Do you remember who it was that criticized
3 your auwai system?
4 A. Well, Garrett, and I think it was Henry and
5 Mark, they were going to jump right in and help me dig
6 the thing out, right then and there.
7 Q. What did they say they thought was wrong with
8 it?
9 A. It wasn't done right. It was just a
10 shambles. It was what Johnnie Kahiamoe, the old man,
11 could accomplish by himself. Then I basically kept it
12 going until I finally realized when Lehua Lapenia came
13 down there, and of course, Garrett verified that the
14 auwai system used to be deeper and it used to run all
15 the way up.
16 Q. When they criticized the system, did you
17 disagree?
18 A. I told them I got to tear the whole thing
19 down, start over. Had carpets, a lot of rubbish.
20 Q. So because you believed them, that's what you
21 are doing, right?
22 A. Well, I'm trying to please everybody, set
23 everything up the way it's supposed to be set up.
24 Q. But you have never run the auwai system after
25 fixing it because you haven't completed fixing it?

1 A. Yeah. I had three taro patches open last
2 year, but then the water slowly from August to
3 December of last year, we were kind of in a drought
4 right there, so the three patches I opened up which I
5 just pulled the taro out about three weeks ago out of
6 the grass and everything else.
7 Had three patches growing, they dried up,
8 water slowed down. We were in kind of a drought
9 situation. Then about December of last year, that's
10 when all this rain started coming in again and it's
11 been going continuously.
12 Q. So what was the storm that came through and
13 knocked out the whole thing?
14 A. When we were back a few years, yeah. But
15 when we were just talking about me rebuilding the
16 whole thing, that's one of the stipulations, hey, get
17 your auwai up.
18 Q. So you did rebuild it?
19 A. I rebuilt it.
20 Q. And then you planted three patches?
21 A. Correct.
22 Q. When was that?
23 A. This was -- I think our meeting was in, let's
24 say, about April or May of last year and that's when I
25 got on the auwai system, redid that. Planted three

1 taro patches, had the water going in there. Then from
2 about August to December, everything slowed down,
3 didn't hardly have any rain.
4 Q. So that little rock, the loose rock dam
5 structure, was that put in before you planted these
6 three patches?
7 A. The auwai system was built before I started
8 the three patches.
9 Q. So the area that's open now that needs the
10 gate --
11 A. That was closed off.
12 Q. How was it closed off?
13 A. I took one of the carpets that were on the
14 dam, pulled it up, stuck it on there, put a couple
15 pohakus on top of that. So it was about this high,
16 and the water would go straight on in.
17 Q. So you didn't have a gate where you could
18 adjust the flow?
19 A. I didn't want to cut nothing and make it
20 permanent yet until we settle this issue and all the
21 patches can be open up. Then I know how much water I
22 can set in.
23 Q. And you're saying there wasn't enough water
24 coming through those two pipes just for three patches?
25 A. Well, we went into a drought situation. The

1 water was getting warmer. The third taro patch the
2 water wouldn't even stay in there, just started
3 cracking like a desert floor.
4 Then I said, you know what, this is enough
5 until we settle this water issue. I let the water go.
6 Like I say, I got an army to go down there and farm,
7 but right now they look at me and they go, Ernie, we
8 are not going to help you farm unless you get the
9 water. We are not going to go down there and do it
10 for nothing.
11 And they've done it for years. Moses
12 Kahiamoe working with his grandfather down there
13 whenever he could. Lehua Lapenia, all the way back to
14 when she was a child. There wasn't even a road, there
15 was a ditch trail.
16 Q. That was with the two pipes?
17 A. That's all they could get.
18 Q. All 14 lo'i with two pipes?
19 A. I don't know exactly how many patches they
20 had open when she was a kid, because I wasn't born
21 yet. But she told me, and also the three-and-a-half
22 acres down there on their taro patches on the Hanehoi
23 Stream, her and her grandmother. But they were just
24 dealing with the elements, what they had. That's why
25 she went and filed for her water rights.

1 Q. I have no further questions.
2 MR. HALL: I would like to clarify.
3 FURTHER REDIRECT EXAMINATION
4 BY MR. HALL:
5 Q. When you fixed your auwai for Garrett, that
6 was with -- were you hoping that once you fixed your
7 auwai, you would get some more water?
8 A. I thought that was the understanding. I get
9 that fixed. Then I never heard from nobody until
10 recently.
11 Q. And in your view the primary reason why you
12 can't grow healthy taro is because you can't get
13 enough water?
14 A. There is not enough water. We have already
15 proven there is not enough water. The water gets too
16 warm. And we estimate that was too --
17 Q. In your view is it because of the drought or
18 because EMI and the state won't let down enough?
19 A. It's both, drought and EMI won't let enough
20 down. We've seen the diversions today. Two
21 three-inch pipes can only put out so much, that's it.
22 Q. And so you tried to grow taro after you put
23 in your new auwai system and could not grow healthy
24 taro, there wasn't enough water?
25 A. There wasn't enough water.

1 HEARINGS OFFICER McCONNELL: That's it?
2 MR. HALL: Yes.
3 HEARINGS OFFICER McCONNELL: Thank you,
4 Ernie. Appreciate your testimony. You're excused. I
5 guess there's no choice but to adjourn until 9:00
6 o'clock tomorrow. And our location?
7 MS. CHOW: State office building,
8 conference room A and B.
9 (The proceedings recessed at 5:00 o'clock
10 p.m.)
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

1 CERTIFICATE

2 STATE OF HAWAII)

3) SS.

4 COUNTY OF HONOLULU)

5

6 I, JEAN MARIE McMANUS, do hereby certify:

7 That on October 10, 2005 at 3:35 p.m., the

8 proceedings contained herein was taken down by me in

9 machine shorthand and was thereafter reduced to

10 typewriting under my supervision; that the foregoing

11 represents, to the best of my ability, a true and

12 correct copy of the proceedings had in the foregoing

13 matter.

14 I further certify that I am not of counsel for

15 any of the parties hereto, nor in any way interested

16 in the outcome of the cause named in this caption.

17 Dated this 28th day of October, 2005,

18 in Honolulu, Hawaii.

19

20

21 Jean Marie McManus

JEAN MARIE McMANUS, CSR #157

22

23

24

25

1 BOARD OF LAND AND NATURAL RESOURCES

2 STATE OF HAWAII

3 In the Matter of Contested)DLNR FILE: 01-05-MA
Case Regarding Water Licenses)
4 at Honomanu, Keanae, Nahiku and)
Huelo, Maui)
5 _____)

6 CONTESTED CASE HEARING

7

8 Held on October 11, 2005, commencing at 9:15 a.m., at

9 Maui State Building Conference Room A and B, 54 South

10 High Street, Third Floor, Wailuku, Hawaii 96793.

11

12

13

14

15

16

17

18

19

BEFORE: JEAN MARIE McMANUS
20 Hawaii CSR #156, California CSR #3119
Notary Public, State of Hawaii

21

22

23

24

25

HEARINGS OFFICER:	HONORABLE E. JOHN McCONNELL 33 N. Market Street, Ste. 200 Wailuku, Hawaii 96793
BLNR Attorney:	LINDA CHOW, ESQ. Deputy Attorney General 465 S. King Street, Rm. 300 Honolulu, Hawaii 96813
For EMI and A&B:	DAVID SCHULMEISTER, ESQ. ELIJAH YIP, ESQ. Cades Schutte Fleming & Wright 1000 Bishop Street, Ste. 1200 Honolulu, Hawaii 96813
For Maui Land & Pineapple:	DAVID B. MERCHANT, ESQ. Kiefer & Merchant 444 Hana Highway, Ste. 204 Kahului, Hawaii 96732
For County of Maui:	JANE E. LOVELL, ESQ. Deputy Corporation Counsel 200 S. High Street Wailuku, Hawaii 96793
For Maui Tomorrow:	ISAAC HALL, ESQ. 2087 Wells Street Wailuku, Hawaii 86793
For Na Moku Aupuni O Ko'olau Hui, et al:	ALAN T. MURAKAMI, ESQ. MOSES K.N. HAIA, ESQ. 1164 Bishop Street, Ste. 1205 Honolulu, Hawaii 96813

INDEX

WITNESSES: PAGE

Maui Tomorrow

NEOLA CAVENY 6
DIRECT EXAMINATION BY MR. HALL:..... 6
CROSS-EXAMINATION BY MR. SCHULMEISTER..... 22
REDIRECT EXAMINATION BY MR. HALL:..... 50

Na Moku

DAVIANNA POMAIKAI McGREGOR 54
DIRECT EXAMINATION BY MR. MURAKAMI..... 55
CROSS-EXAMINATION BY MR. SCHULMEISTER..... 87
REDIRECT EXAMINATION BY MR. MURAKAMI..... 123

PAUL REPPUN 131
DIRECT EXAMINATION BY MR. HAIA..... 131
CROSS-EsXAMINATION BY MS. LOVELL..... 167
CROSS-EXAMINATION BY MR. MERCHANT..... 168
CROSS-EXAMINATION BY MR. SCHULMEISTER..... 170
REDIRECT EXAMINATION BY MR. HAIA..... 180

BEATRICE KEKAHUNA 180
DIRECT EXAMINATION BY MR. MURAKAMI..... 181
CROSS-EXAMINATION BY MR. SCHULMEISTER..... 205
REDIRECT EXAMINATION BY MR. MURAKAMI..... 213

TESTIMONY AND EXHIBITS RECEIVED INTO EVIDENCE

Written Testimony of Beatrice Kekahuna.....182
Exhibit Nos. 28-K, L, M and N..... 53

1 HEARINGS OFFICER McCONNELL: Good morning
2 everyone. The hearing is convened. I apologize for
3 my tardiness. Mr. Hall -- I think, and for the
4 record, all counsel and parties are present.
5 MR. HALL: I will start -- I think we have
6 a stipulation with regard to the exhibits that we may
7 put on the record now.
8 MR. SCHULMEISTER: We were talking about
9 it. Thought it would make the hearing go a little
10 faster if we just stipulate that everything that has
11 been marked and put on the list just be received as
12 evidence with everyone reserving their rights to argue
13 whatever they want in terms of how credible or
14 relevant it is. And I believe all the counsel have
15 agreed.
16 HEARINGS OFFICER McCONNELL: No objections
17 for the record?
18 MS. LOVELL: County agrees.
19 HEARINGS OFFICER McCONNELL: Everything
20 marked on the exhibit list filed by the county in this
21 will be in evidence. We also have the written
22 testimony that we mentioned yesterday.
23 MR. HALL: By all parties.
24 MR. SCHULMEISTER: On the written
25 testimony some of it is signed and some of it isn't.

1 I think having people confirm their written testimony
2 ought to still be a condition for it being received.
3 But as far as all the exhibits, that's what I meant by
4 the stipulation on the subject.
5 HEARINGS OFFICER McCONNELL: I understand.
6 Mr. Schupp's is in.
7 MR. HALL: I would like to clarify what
8 that is going to mean for my case. I filed an amended
9 exhibit list that has Exhibits 1 through 34 and it has
10 photographs marked generically 28 and we've marked
11 them individually as we have dealt with them. So I
12 have a few more photographs that we're going to deal
13 with today that I need to mark.
14 HEARINGS OFFICER McCONNELL: And they
15 would pick up at 35 then.
16 Mr. HALL: Well, I don't know whether we
17 marked Mr. Schupp's direct testimony or not. If we
18 did not --
19 HEARINGS OFFICER McCONNELL: We did not.
20 MR. HALL: If we did not, then I brought
21 in two additional exhibits today. One would replace
22 Exhibit 32 and be 32-A which I have given a copy of to
23 everybody and an Exhibit 35. So that would do it for
24 our exhibits.
25 MR. SCHULMEISTER: It would replace it or

1 supplement it? Are you withdrawing 32?
2 MR. HALL: Yeah, I'm going to withdraw 32
3 and replace it with 32-A. And 35 would be the letter
4 of Jeffrey Trudeau dated October 5th, 2005.
5 HEARINGS OFFICER McCONNELL: Okay. I
6 think it's going to be confusing if we mark the
7 testimony.
8 MR. SCHULMEISTER: I agree, I think it was
9 filed and I think being filed it's in the record.
10 People can refer to the testimony.
11 HEARINGS OFFICER McCONNELL: I'll just
12 admit it as each witness testifies to it unless
13 there's some problem. Okay.
14 MR. HALL: I would like to call as my next
15 witness, Neola Caveny.
16 NEOLA CAVENY
17 called as a witness, was sworn to tell the truth, was
18 examined and testified as follows:
19 HEARINGS OFFICER McCONNELL: State your
20 name.
21 THE WITNESS: Neola Caveny.
22 DIRECT EXAMINATION
23 BY MR. HALL:
24 Q. Can you tell me where you live?
25 A. 445 Huelo Road, Haiku.

1 Q. How long have you lived in the County of
2 Maui?
3 A. Thirty-one years.
4 Q. And how long have you lived at the address
5 you just gave us?
6 A. Three years.
7 Q. Did you prepare some direct written
8 testimony?
9 A. Yes, I did.
10 Q. And that's the direct written testimony that
11 was filed with DLNR August 1st, 2005?
12 A. Correct.
13 Q. Have you reviewed that for accuracy or
14 modifications or changes?
15 A. Yes, I have.
16 Q. Are there any changes that need to be made at
17 this point in time?
18 A. Yes. Page 2. Where it says the second
19 paragraph -- actually that's correct, that is what he
20 saw, I'm sorry.
21 Q. Are you clarifying? You're not necessarily
22 seeking the amount that he sought?
23 A. Correct.
24 Q. Other than that change, is this true and
25 correct?

1 A. Yes, it is.
2 Q. I would like to have the hearing officer
3 receive the direct written testimony of Neola Caveny
4 into evidence.
5 HEARINGS OFFICER McCONNELL: Any problem?
6 It will be in evidence.
7 MR. HALL: Thank you.
8 Q. Could you look at Exhibit 14, the intervenors
9 Exhibit 14. Is that the deed to your property?
10 A. Yes, it is.
11 Q. All right. And was your property, were the
12 water rights to that property registered with the
13 Commission on Water Resource Management? I would ask
14 you to look at Exhibit 16 and 17.
15 A. Yes, that's correct.
16 Q. When were they registered?
17 A. May of 1989.
18 Q. And who registered them with the Commission?
19 A. The former owner of the property, Stanley
20 Rushworth.
21 Q. Was there an amount of water that was
22 registered by your former owner?
23 A. 100,000 gallons a day he was registering.
24 Q. I would like to have you look at Exhibit 31.
25 I think it's in the amended exhibits.

1 A. Yes.
2 Q. Was that a chart that was submitted to the
3 Commission on Water Resources Management at the time?
4 A. Yes.
5 Q. Was that an effort to determine how much
6 water was flowing in Hanehoi Stream at your property
7 at the time of the registration?
8 A. Right.
9 Q. Are you able to explain what that chart
10 shows?
11 A. Yes, I am. It shows a 22-foot long section
12 of the stream measuring five-feet wide at one end,
13 seven feet at the other, and average of 18-inches
14 deep. And Mr. Rushworth measured a flow -- excuse me,
15 a velocity of 45 seconds from the top -- in that 22
16 feet. So 45 seconds to traverse 22 feet.
17 Q. Could you look at Exhibit 15? Is that a
18 survey map of your property?
19 A. Yes. It's a survey map with my additions on
20 it when I was filing for the farm plan.
21 Q. Does that show that a stream runs through
22 your property?
23 A. Yes.
24 Q. What stream is that?
25 A. The Hanehoi Stream.

1 Q. So that runs through your property?
2 A. Uh-huh.
3 Q. So you have a farm plan for the property?
4 A. Yes.
5 Q. Can you explain what that farm plan is?
6 A. Approximately two-and-a-quarter acres, and
7 about 60 percent of it is planted in various kinds of
8 ag. The majority of it is tropical flowers. It was
9 planted as commercial tropical flower farm with the
10 rest divided between bananas -- there are a lot of
11 bananas, vegetables, I have some taro and some citrus.
12 Q. Are you operating a commercial farm on your
13 property?
14 A. Yes, I am.
15 Q. Can you explain how that works?
16 A. It's called Pualana Farms and it's basically
17 tropical, large tropical heliconia and red and pink
18 gingers and ornamental foliage, different ornamental
19 teas.
20 Q. Could you look at exhibit -- let's not go
21 there. First off, is your property served by the
22 water system of the County of Maui?
23 A. No, it's not.
24 Q. Is your property served by the private Huelo
25 water system?

A. No.

Q. Is there any water system that serves your property?

A. No water system. I put in a catchment tank.

Q. Can you explain your own personal water system?

A. My system is a 30,000 gallon above-ground catchment tank with a pump, powered by solar energy because we're off grid.

Q. And in your farming operations are you able to rely on any water from Hanehoi Stream?

A. No.

Q. Why not?

A. Because the majority of the time it's dry.

Q. Let's come back to that. Can you go to Exhibit 18. Can you tell me what Exhibit 18 is?

A. It is my tax I.D. number for the business.

Q. Pualana Farms?

A. Pualana Farms, actually the second page.

Q. So that's for your commercial farm operated on the property?

A. Correct.

Q. Let me show you Exhibits 28 -- while we're on the photographs, let me go backward for a second and cover some of these photographs that Ernie Schupp

1 testified about, namely 28-E, F and G and I. Were you
2 the person that made the markings on these exhibits?
3 A. Yes, I did.
4 Q. And there was some testimony about erasures.
5 A. Right.
6 Q. Were you the person that made the erasures?
7 A. Yes, I did.
8 Q. Can you explain why you made the erasure on
9 28-E, 28-F, 28-G, and 28-I?
10 A. I was putting the photographs together to be
11 more easily handable. I was the person who had the
12 card stock and the glue, so I put them together. Then
13 I double checked with Ernie on the dates. I thought
14 it said they were taken in '99, he said actually more
15 like 2000, 2001. So in the interest of accuracy, I
16 changed the date on there, and I used yellow whiteout
17 on a green background, so I don't think I was trying
18 to fool anybody.
19 Q. Now, I would like to have you look at
20 Exhibits 28-K, 28-L, 28-M and 28-N. Did you take all
21 four of those photographs?
22 A. Yes, I did.
23 MS. LOVELL: Are those photos that we
24 have seen before?
25 MR. HALL: No. Let me pass them around.

1 And actually we have copies, a number of copies this
2 time. Some are unmarked but they're in a set here.
3 MS. CHOW: I need one copy for the record.
4 Q. (By Mr. Hall): Can you tell me what these
5 four pictures are pictures of?
6 A. These are pictures of the streambed.
7 Q. What stream?
8 A. Hanehoi Stream where it's adjacent to my
9 property, and they're taken either from the bridge
10 that crosses the stream right above my property, or
11 from actually in the streambed looking up. I think
12 they're labeled as such.
13 Q. When were these photographs taken?
14 A. I believe I took these around the beginning
15 of the year. I don't have exact date.
16 Q. This year?
17 A. Beginning of this year, beginning of 2005.
18 Q. So January 2005?
19 A. I think that's correct.
20 Q. That's when you took all four photographs?
21 A. I took them all at the same time. Don't
22 remember the exact date.
23 Q. And in a year, the year's period of time --
24 well, can you describe, is there any water in Hanehoi
25 Stream in any of these pictures?

A. Tiny little puddle down below the bridge here.

Q. On 28-N?

A. May or may not be a puddle, hard to tell, but might be.

Q. Is there any other water in any of the other pictures?

A. I don't see any other water.

Q. In an average year, how much of the time is Hanehoi Stream, does Hanehoi Stream at your property look like what is shown in these pictures?

A. I would say approximately -- talking average?

Q. Yes.

A. Obviously weather makes a difference, approximately maybe 80 percent of the time.

Q. Eighty five?

A. 80 to 85 percent.

Q. So no water in Hanehoi Stream for 80 percent of an average time of the year?

A. Yeah (Witness nods in the affirmative.)

Q. And when is there water in Hanehoi Stream by your property?

A. Normally after a very heavy rainfall that continues for at least a day, sometimes it takes two days, unless we have a real downpour such as we had

1 several weeks ago, and then the flow lasts maybe three
2 days after that, reducing gradually every day down to
3 a trickle, then eventually dry within a few days.
4 Q. And that's -- so there's a storm and then the
5 streamflow diminishes down to what is shown in these
6 pictures within two or three days?
7 A. Two to three days, three, four days depending
8 how much water came down.
9 Q. Okay. And so can you use any water in
10 Hanehoi Stream for farming as a result of that
11 pattern?
12 A. No. It's not reliable.
13 Q. Now, we all saw water in Hanehoi Stream by
14 your property yesterday.
15 A. Correct.
16 Q. Was that -- how often is water in Hanehoi
17 Stream at your property in the amounts that we saw
18 yesterday?
19 A. Well, again, normally that would be what it
20 would look like a couple days after a storm.
21 Q. So would that be the 20 percent of the time?
22 A. Yes, that's not -- doesn't last like that,
23 though.
24 Q. Is the lack -- what causes the lack of water
25 in Hanehoi?

A. The four diversions, four working diversions on the stream which appear to be diverting basically 100 percent of the water.

Q. If the diversions were not there, would there be water in the Hanehoi?

A. Yes, I believe there would be. There's plenty of flow up above them.

Q. You went on a site inspection earlier. Is there a flow in Puolua that makes it down to Hanehoi on occasion?

A. If there's enough flow in Puolua Stream, which is supplied by the pipes into Puolua, some of it will make it down to my stream. The majority of the time it doesn't make it down and my stream stays dry.

Q. Is it your understanding that there used to be a regular streamflow in Hanehoi by your property?

A. From everything I've heard from residents of much longer standing in the area than myself, Hanehoi was basically a perennial stream. The fact that they had to construct a concrete bridge over it to get in and out I think speaks to that. The bridge was constructed about 20 years ago.

MS. LOVELL: About how many?

THE WITNESS: About 20 years ago.

Q. (By Mr. Hall): You're talking about the

1 bridge above your property?
2 A. Right.
3 Q. Did you conduct -- did you make an effort to
4 try to determine how much water you need for your
5 property?
6 A. Yes, I did.
7 Q. Can you look at Exhibit 32-A, and can you
8 explain what you did to try to determine how much
9 water you need?
10 A. Well, after talking to the people at the USGS
11 who gave me -- and also Skippy Hau, who gave me an
12 idea of how to conduct a stream flow study to
13 determine volume, I basically tried to duplicate what
14 Stan Rushworth had done back in 1989 except I used a
15 smaller section of the stream.
16 I used a ten-foot length of the stream, he
17 used 22 feet. I used string to measure across, and I
18 took a number of depth readings to get an average
19 depth. And I came up with cross-section 9.66 feet
20 wide by ten feet long by eight feet wide, average
21 depth was five inches. And this was on September
22 24th.
23 Then I put in a little foam rubber ball,
24 and I measured about 20 runs of the ball, how long it
25 took it to traverse that ten feet. Using formulas

1 provided by the USGS, I then estimated -- although
2 there was quite a range of error here -- that the flow
3 was 1.226 cubic feet per second, which converts to
4 point 792 million gallons per day.
5 That seemed high to me, so I used a
6 co-efficient that they tend to use to allow for error
7 of .85. This brings it down to a flow of 671 thousand
8 gallons per day as of that date. I think the margin
9 of error in there, as we saw in one study, it was
10 maybe 20 to 25 percent.
11 Q. And so what are you asking that the hearing
12 officer require that EMI let down from either Hanehoi
13 and/or -- I'm sorry, that you're asking the hearing
14 officer to require the state and/or EMI to let down
15 from Hanehoi and/or Puolua Streams to get to your
16 property?
17 A. Based on my study, I would say somewhere in
18 the vicinity of three quarters of a million gallons a
19 day.
20 Q. And that's --
21 A. 750,000.
22 Q. Gallons per day?
23 A. Yes.
24 Q. And that's an amount of water at your
25 property?

1 A. At my property, correct.
2 Q. Not just to be released below the ditch?
3 A. Correct.
4 Q. At your property?
5 A. Yeah.
6 Q. And that's 24-hours-a-day seven days a week?
7 A. Yes.
8 Q. And do you need that amount for your farming
9 activities?
10 A. In order to generate enough flow to get the
11 water out of the stream and also to get it to flow
12 through what would be wetland taro where I'm growing
13 dryland taro now, I think that would be a minimum.
14 Q. Is that amount consistent with what was
15 flowing in the stream in the past?
16 A. No, it's much less.
17 Q. It's less?
18 A. According to Stan Rushworth's studies.
19 Q. Did you try to calculate what was flowing in
20 the stream when Stan Rushworth registered with the
21 Commission on Water Resource Management?
22 A. He had registered in his study merely the
23 numbers, he hadn't done the conversions. Took me
24 awhile to get that formula. Using that formula, I
25 applied it to his study, his numbers. He had an

1 average depth of 18 inches. Only time I've seen that
2 stream flow 18-inches deep was after a storm.
3 I don't know what the precipitation was
4 during that time. I tried to get that information
5 from the weather service and I'm still waiting to get
6 it. But applying the same formula, it appears that
7 when he did his study, the flow, the streamflow volume
8 was 16.5 million gallons a day.
9 Again, being conservative, applying the
10 co-efficient of .85 takes us down to 14 million
11 gallons a day.
12 Q. Are you also concerned about having some sort
13 of minimum stream flow in Hanehoi?
14 A. Yes, I am.
15 Q. Can you explain that?
16 A. Hanehoi is historically, both long time
17 historical and within very recent memory, a perennial
18 stream. It should return to being a perennial stream.
19 Talking to all the people in the neighborhood, there
20 was always a great deal of stream life in it,
21 particularly prawns. Two boys the other day were out
22 prawning in the stream. They caught two. At least it
23 was something.
24 And I believe that a perennial stream
25 should be a place of life. It should have water in

1 it.
2 MR. HALL: I don't have any further
3 questions.
4 HEARINGS OFFICER McCONNELL: Na Moku
5 parties have anything?
6 MR. MURAKAMI: No.
7 MR. MERCHANT: No questions.
8 MS. LOVELL: I just have two questions on
9 behalf of the county.
10 Exhibit 32-A references some attachments.
11 Are those -- there is a printout that's mentioned in
12 paragraph two, and there is an attached copy of Mr.
13 Rushworth's streamflow study referenced in the last
14 paragraph. Are those documents going to be made a
15 part of 32-A?
16 MR. HALL: It can be.
17 MS. LOVELL: I would suggest either that
18 they be made a part of 32-A or that that part of 32-A
19 referencing them be stricken, one or the other.
20 MR. HALL: Well, we can make the -- I have
21 the first part here, so I'll make that part of 32-A.
22 Mr. Rushworth's I think is already in evidence, that's
23 that chart.
24 MS. LOVELL: Can you give us the exhibit
25 number for reference, please.

1 MR. HALL: Thrity-one.
2 MS. LOVELL: No further questions.
3 MS. CHOW: My copy doesn't have 32-A.
4 MR. HALL: I gave it to the Judge. I'll
5 get you 32-A.
6 MS. CHOW: I need to get the copy because
7 this is what is going to go into the record.
8 HEARINGS OFFICER McCONNELL: You'll get
9 it.
10 MR. HALL: Yes.
11 HEARINGS OFFICER McCONNELL: Mr.
12 Schulmeister, any cross?
13 MR. SCHULMEISTER: Yes.
14 CROSS-EXAMINATION
15 BY MR. SCHULMEISTER:
16 Q. As I understand, you bought the property, and
17 you moved there in 2001?
18 A. I built the house and then I moved there.
19 HEARINGS OFFICER McCONNELL: It was 2001?
20 THE WITNESS: I bought the property in
21 2001, yes.
22 Q. (By Mr. Schulmeister): On Exhibit 14, the
23 deed, it's dated April 27, is that pretty close to the
24 time you closed?
25 A. Yes, closed May something.

1 Q. Prior to that, were you familiar with the
2 area?
3 A. Yes, I was.
4 Q. And had you observed Hanehoi and Puolua
5 Streams prior to buying the property?
6 A. Yes, I had.
7 Q. And how familiar were you with those streams
8 prior to buying the property?
9 A. I had friends who lived in the area, and I
10 had gone walking over in that area with them, and I
11 don't think I had actually been down to Puolua Stream
12 at that point, but I had been around Hanehoi and
13 pretty familiar with the area just from hiking around
14 the East Maui area.
15 Q. Over what period of years did you acquire
16 that familiarity?
17 A. In the general area over the last 30 years.
18 Q. So for 25 years prior to buying the property
19 you hiked in that area regularly?
20 A. In that general area.
21 Q. Along Hanehoi Stream?
22 A. I crossed it a couple of times, yes.
23 Q. Did you -- and did the areas that you
24 observed during that 25 years or so, were those all
25 below the Lowrie diversion?

A. Yes, they were.
Q. Were they below the Haiku diversion?
A. Probably sometimes, sometimes I was above.
Q. Above Haiku?
A. Yeah.
Q. So generally it was below Lowrie though?
A. In general. Sometimes above Lowrie.
Q. So did you notice the two pipes in the Lowrie diversion at any time during the 25 years before you bought the property?
A. No, I wasn't really looking for pipes at that point.
Q. You weren't focused on the pipes?
A. I wasn't focused on the pipe, I was focused on the scenery.
Q. Nature, which was really nice?
A. Right.
Q. What did you observe in the stream?
A. In what time period?
Q. The 25 years that you were hiking the area before you bought the property?
A. I can't say that specifically I can remember being around Hanehoi 25 years ago. I was just in the general area, I just know East Maui pretty well. In general I saw a lot of dry streams. Specifically for

1 Hanehoi, I can't really be specific.
2 Q. Do you have any specific memory of what sort
3 of flow -- strike that.
4 Do you have any specific recollection of
5 having observed stream flow in Hanehoi Stream prior to
6 buying the property?
7 A. Yes.
8 Q. Could you tell me about that?
9 A. There wasn't any.
10 Q. So when you bought the property what you
11 observed was there was no water in the stream?
12 A. (Witness nods head up and down).
13 MR. HALL: I object. I don't know what
14 he's trying to get at but I don't think you can waive
15 your riparian rights whether there was any water in
16 there or not. She has a right to her riparian rights
17 now to get the stream flowing again.
18 HEARINGS OFFICER McCONNELL: That doesn't
19 go to the admissibility of the evidence. You can make
20 the argument.
21 MR. HALL: It's irrelevant whether she
22 knew there was water flowing in it before she bought
23 it. She had a right when she bought it to assert her
24 riparian rights to get the water back in the stream.
25 HEARINGS OFFICER McCONNELL: I understand.

1 I'm going to be fairly liberal on the relevance.
2 MR. HALL: I understand. I want that on
3 the record.
4 Q. (By Mr. Schulmeister): Can we take a look at
5 Exhibit 35.
6 A. Remind me again, which one was that? Yes.
7 Q. This is one of the new exhibits that I
8 believe was just put in, and it's a letter from Mr.
9 Jeffrey Trudeau; is that right?
10 A. Uh-huh.
11 Q. And do you know how it came an about that Mr.
12 Trudeau prepared this letter?
13 A. Yes. I had asked, in preparation for this
14 case, I had asked several of the long-time residents
15 in the area if they would be willing to state that
16 they remembered within fairly recent times, within
17 their period of residency, if water had flowed on a
18 pretty regular basis in the stream and would they be
19 willing to attest to that. And Jeff is one of my
20 neighbors and he was one of the people that said yes,
21 I'll write something for you.
22 Q. And he indicates this is for the past 15
23 years, so that would take it back to about ten years
24 before, ten or 11 years before you bought the
25 property?

1 A. Yes, that's correct.
2 Q. But that wasn't something that you ever saw?
3 A. I saw -- since I've been there in the three
4 years that I have, actually four years that I've been
5 there, I have seen this stream flow basically only
6 after heavy rainfall. I have not seen it flow on a
7 regular basis.
8 Q. But in talking to your neighbors you gathered
9 information for at least a ten-year period prior to
10 when you bought indicating that previously there had
11 been a regular flow?
12 A. Yes, a regular flow.
13 Q. Now, when did you first become conscious of
14 the fact that there were these two pipes up at the
15 Lowrie diversion of Hanehoi?
16 A. It was when I first got involved in this
17 case, and needed to find out more about what was
18 happening with these diversions.
19 Q. And what did you find out about those two
20 pipes?
21 A. That they were -- we're talking about two
22 pipes in lower Haiku?
23 Q. Lowrie.
24 MR. HALL: Lowrie on Hanehoi.
25 MR. SCHULMEISTER: Hanehoi.

A. That they were -- not the pipes that provide the water to the Huelo system -- that it was two four-inch pipes.

Q. Would you look at Page 2 of your written testimony, it might refresh your memory. I think about little past halfway down you discuss there being two four-inch pipes in the Lowrie Ditch diversion works which were intended at some time in the past to allow water to flow downstream of the Lowrie Ditch.

Then within the last ten to 15 years, these two four-inch pipes were either totally blocked or were allowed to become totally blocked so that no water, except in extreme storm events, flows downstream of Lowrie Ditch.

Did I read that correctly?

A. You did.

Q. This is your testimony, right?

A. This is what I understood as the reason that I basically saw no water in my stream unless there was a storm.

Q. How did you get this information? In other words, that the two four-inch pipes -- number one that they were four inches, how did you get that information?

A. From talking to several people in the

1 neighborhood who go up, regularly up to the diversions
2 to maintain the Huelo water supply. There's a pipe up
3 there, and it's always needing to get repaired. So
4 several of the neighbors are very familiar with that
5 area.
6 Q. And they told you that those two four-inch
7 pipes were intended to allow water to flow downstream
8 of Lowrie Ditch?
9 A. Just told me two four-inch pipes there.
10 Q. Did they tell you they used to flow but now
11 they don't?
12 A. I don't recall what they said about the
13 pipes. Just about what reaches my area in the stream.
14 Q. Did they tell you who installed the pipes?
15 A. No.
16 Q. Did they tell you who used to maintain the
17 pipes?
18 A. No.
19 Q. Did you learn anything in any of these
20 conversations to suggest that anything other than
21 these two pipes, being free flowing, was responsible
22 for the regular flow of Hanehoi Stream that's
23 described in Mr. Trudeau's letter and some of the
24 other letters that you submitted?
25 A. I can't really speak to that. I don't know.

1 Q. I mean, do you believe that there was
2 anything more than two four-inch pipes passing Lowrie
3 Ditch at any time in the last 20 or 30 years?
4 A. Bypassing the ditch, we're not talking about
5 the floodgate?
6 Q. No, I'm talking -- right.
7 A. Do I believe that there was another pipe,
8 that there were bigger pipes?
9 Q. Any other means of passing water.
10 A. I don't know, I wasn't around at the time.
11 Q. But you were told that the two four-inch
12 pipes used to flow?
13 A. I was told that there was water in the stream
14 on a regular basis. Now, whether it was coming
15 through those pipes or coming over the top, I don't
16 know.
17 Q. So it might have been?
18 A. It's possible, I don't know.
19 Q. Now, what about the Haiku diversion of water
20 from Hanehoi Stream? Did you learn anything about any
21 efforts that were made or any practices that were
22 employed to bypass water from above the Haiku
23 diversion of Hanehoi to below the Haiku diversion of
24 Hanehoi Stream?
25 A. Well, I had seen the pictures of the, I guess

1 we'll call it a dam, that concrete wall, that goes
2 across the width, the entire width of Hanehoi Stream
3 at that new Haiku diversion. The wall, it's about
4 three feet, three feet, four feet high.
5 Q. I'll try to be a little more specific with my
6 question, and ask you to pay attention to the
7 question.
8 In your conversations with people about
9 how it used to be, did anyone tell you anything or did
10 you learn anything about any practices that were
11 employed by any of the people along the stream to
12 route water from above Hanehoi Stream -- I'm sorry,
13 from above Haiku diversion to below Haiku diversion of
14 Hanehoi Stream?
15 MR. HAIA: Sorry to interrupt. I lodge an
16 objection to this line of questioning. It's pretty
17 much irrelevant to the claims that Ms. Caveny is
18 making with respect to her property.
19 HEARINGS OFFICER McCONNELL: I'll permit
20 it.
21 THE WITNESS: As far as uses of the stream
22 above the new Haiku diversion, no one lives above the
23 new Haiku diversion.
24 Q. (By Mr. Schulmeister): So you have no
25 knowledge of any farming having taken place below the

1 Lowrie Ditch before you bought your property?
2 A. I have no knowledge.
3 Mr. HALL: Below the Lowrie Ditch, between
4 the Lowrie and new Haiku Ditch?
5 MR. SCHULMEISTER: That's right.
6 A. On Hanehoi?
7 Q. On Hanehoi.
8 A. I have no knowledge of any current farming
9 going on there, no.
10 MR. HAIA: Judge, I'd just like to lodge a
11 running objection to this line of questioning.
12 HEARINGS OFFICER McCONNELL: That's fine.
13 Q. (By Mr. Schulmeister): What about Mrs.
14 Lapenia, she's below Haiku?
15 A. She's below. You were talking about between
16 new Haiku and Lowrie.
17 Q. Were you aware that she used to farm taro?
18 A. Yes.
19 Q. And there was water in the stream to do that?
20 A. There was water in Puolua Stream at the time
21 to provide some water to the lo'i, and I did see water
22 in the lo'i. As far as being able to grow viable
23 taro, I don't know. But, yes, at the time that I
24 acquired the property, they were attempting to farm
25 lo'i there.

1 Q. And did you ever talk to Mrs. Lapenia?
2 A. Yes.
3 Q. And what happened to the flow-through water
4 from her lo'i?
5 A. Evidently from what she said, they weren't
6 getting enough water to grow viable taro, so they just
7 cleared the lo'i at that point. I think the auwai,
8 they stopped using the auwai that they had which was
9 actually on Hanehoi Stream, that particular auwai.
10 They have been keeping the property clear since then,
11 but they are no longer farming the lo'i.
12 Q. So based on what you said so far, would it be
13 fair to say that in gathering this information that
14 you gathered about streamflow in Hanehoi before you
15 bought your property, that you don't know how the
16 water was passing Haiku Ditch?
17 A. Before I bought the property?
18 Q. Right.
19 A. Other than coming over the diversion during a
20 rainfall, no.
21 Q. What about when there was no rain, was it
22 your understanding that nothing was passing --
23 A. My understanding that nothing was passing the
24 diversion, right.
25 Q. So the regular flow for the ten or 15 years

1 was not coming from Hanehoi, was coming from Puolua?
2 A. I don't know, I don't know the answer to
3 that.
4 Q. You didn't ask anybody that?
5 A. I'm not sure if anybody knew. In order to
6 see where Puolua does flow into Hanehoi you have to
7 get down in the stream and get down in the hau and go
8 up and see it.
9 Q. Now, you were here when Mr. Schupp testified,
10 right?
11 A. Right.
12 Q. You heard him say that for a significant
13 number of years he was cultivating, I think, eight
14 lo'i off of Puolua Stream?
15 A. Six to eight, I believe, yes.
16 Q. And he said that when he got them all going
17 and the ground is saturated, that 95 percent of the
18 water that he takes into the auwai flows back into the
19 stream.
20 A. Right.
21 Q. To your knowledge, was that occurring at any
22 time since 2001 when you bought the property?
23 A. I have not been up there to see the water
24 flowing back into the -- back into the stream, because
25 he's been -- since I've known him, he has been cutting

1 back, because he was not able to make a successful
2 grow of taro.
3 Q. Did you see him grow any taro in the last
4 year-and-a-half?
5 A. Yes.
6 Q. When?
7 A. Maybe a year or so ago. Could have been a
8 year-and-a-half.
9 Q. Was there flow-through water?
10 A. There was some, there was some. There wasn't
11 very much.
12 Q. But that didn't make it down to your --
13 Mr. HALL: Judge, I'm going to object at
14 this point on the record that EMI is making -- they're
15 really starting to harass the downstream people with
16 riparian and appurtenant rights, who have a right to
17 the water. And EMI does not own the water, and they
18 have no standing to challenge downstream people's
19 appurtenant and riparian rights.
20 The water is owned by the State of Hawaii,
21 and EMI's -- any right EMI has to water is conditioned
22 by the State of Hawaii on respecting the riparian and
23 appurtenant rights of downstream owners. And they
24 have no right to come into a hearing of this nature
25 and start to harass downstream owners with testimony

1 or questions of this sort. They have no standing. If
2 the state wanted to come in here and make some type of
3 arguments that are being made now they could, but EMI
4 has no standing, because any right that they have to
5 divert is conditioned on respecting riparian and
6 appurtenant rights.
7 I've established that Ms. Caveny has
8 riparian rights. And they don't have any right or
9 standing to come in and start, you know, asking these
10 kind of questions about what's happening to the water
11 downstream, when it's plain that they are breaching
12 their license or whatever agreement they have with the
13 state by cutting off riparian and appurtenant right
14 holders from the water.
15 And now they're trying to make it look
16 like the people downstream, their practices are the
17 source of the problem when the source of the problem
18 is EMI is illegally breaching their license or
19 agreement with the state by not respecting the rights
20 of appurtenant and riparian holders of water rights.
21 So we're getting way, way, way afield with
22 the wrong party. They don't even own the water. They
23 act like they conceded the diversion up there and
24 dictate who gets to do what kind of farming below the
25 diversions. And we're so far afield that this ought

1 to be, you know, stopped at this point. They've asked
2 enough questions, and we move on.
3 We've established that Ms. Caveny has got
4 riparian rights by the law in the State of Hawaii,
5 that's the right to the natural flow in the stream.
6 That's the end of it. They have to -- by the license
7 that they have, or whatever they have now, they are
8 required to, by the State of Hawaii, to respect
9 anybody that has riparian and appurtenant rights. So
10 why we're getting into, you know --
11 HEARINGS OFFICER McCONNELL: But if I
12 accept that, and I'm not disagreeing with you
13 necessarily, but everything we've done in the last day
14 would be a waste of time essentially.
15 MR. HALL: I'm agreeing with that. I
16 totally agree. I think once we establish that there's
17 a riparian or appurtenant right and give to you the
18 amount of water, then all this that's going on by Mr.
19 Schulmeister about what people are doing with their
20 water and how their auwai is not in the best shape in
21 the world and on and on and on is a waste of time.
22 And we've got the wrong party doing it.
23 If the state wants to come in here and say something,
24 maybe the state could, but EMI, they don't own the
25 water and they have no standing to do it.

1 HEARINGS OFFICER McCONNELL: I appreciate
2 that argument.
3 MR. HAIA: I want to reiterate our running
4 objection.
5 HEARINGS OFFICER McCONNELL: You've got
6 it. You've got it. But as I said earlier, we spent a
7 lot of time on understanding the parties' property and
8 situation with regard to the water, and I've been
9 pretty liberal in the testimony with what's going on.
10 MR. HALL: The other problem I have is if
11 we carry this out, then we're going to get into the
12 minutiae of why A & B chose to urbanize its land and
13 give up the water out there and what its practices are
14 with how it farms, and how Maui Land & Pine farms and
15 the minutiae of how it farms and how the Farm Bureau
16 farms and how the County of Maui decides to distribute
17 water through its system, any leaks in its pipe where
18 water drips into the ground and gets wasted, and we'll
19 be here forever.
20 And I thought -- and these are your
21 words -- that we're here on an interim hearing to do
22 rough justice. Those are your words.
23 HEARINGS OFFICER McCONNELL: Yes.
24 MR. HALL: But it seems like what we are
25 here to do is to allow EMI to continue to harass

1 downstream owners.
2 MR. SCHULMEISTER: May I respond? I
3 object to all this argument. I think we should have
4 post hearing briefs. And I'm just asking questions on
5 the same ground covered in direct. I'm entitled to do
6 that to challenge credibility, and I would object to
7 chewing up all this time with long legal arguments
8 that you can put in a brief when we can have everybody
9 here for the purpose of being able to do
10 cross-examination.
11 There's a lot of talk about due process.
12 Is due process only for one side? Due process is
13 being able to confront, challenge and cross-examine.
14 HEARINGS OFFICER McCONNELL: I'll overrule
15 the objection. I understand both of you. Your record
16 is preserved. But if we get too far afield, then I'll
17 call a halt. I do think it goes to credibility.
18 MR. HALL: What she knows about Ernie
19 Schupp's growing taro goes to her credibility? I fail
20 to see that.
21 HEARINGS OFFICER McCONNELL: Mr. Hall.
22 MR. SCHULMEISTER: Is Mr. Schupp's
23 credibility not an issue here?
24 MR. HAIA: Judge.
25 HEARINGS OFFICER McCONNELL: Don't

1 continue this sort of running bickering. It's not
2 proper trial procedure. It's not professional. It's
3 not helpful. Please don't do it.
4 MR. HAIA: With all due respect, to
5 clarify the position of Na Moku, our objection on
6 relevance is, you know, he could have objected to the
7 testimony being provided by Ms. Caveny if it went
8 outside the scope of her claim of riparian rights.
9 And all Na Moku is saying is that his examination at
10 this point in time, his cross-examination is
11 irrelevant to the issue with respect to her claimed
12 right for her property. That's all I want to say.
13 HEARINGS OFFICER McCONNELL: I understand.
14 Thank you.
15 Q. (By Mr. Schulmeister): Look at Page 5 of
16 your within testimony, please. In the first full
17 paragraph you describe the commercial tropical flower
18 farm. And I think one of the exhibits was your tax
19 I.D. number for that operation.
20 A. Right.
21 Q. Do you have any employees?
22 A. No.
23 Q. So you do all the work yourself?
24 A. Yes.
25 Q. Now, the sentence here says: Taro lo'i

1 existed on my property.
2 A. Correct.
3 Q. When we went to the property, we weren't
4 shown --
5 A. We were not on my property, we were looking
6 at it.
7 Q. How do you know taro lo'i existed on your
8 property?
9 A. Because former owners of the property, this
10 is way before Stan Rushworth, who were in the
11 Lapenia's family had told me that. Lehua Lapenia told
12 me that she would go and help farm taro on those lo'i
13 when she was a girl. She's in her sixties now.
14 I've also found remains further down on
15 the property of walls, rock walls and such.
16 Q. Could you look at Exhibit 15, please.
17 Exhibit 15, this is a surveyor's map that was then
18 annotated by you?
19 A. It's a tax key map.
20 Q. Oh, it's a tax map?
21 A. Yes.
22 Q. And the boundary of your property on this as
23 it relates to Hanehoi Stream -- well, there is a
24 horizontal line across the top. That's not the
25 boundary of your property, right?

A. Yes, it is.

Q. The horizontal line at the top is the boundary?

A. You can see the surveyor's marks on it.

Q. Indicating that it's the boundary?

A. Uh-huh.

HEARINGS OFFICER McCONNELL: So yesterday when we were there, we were standing roughly over in this area?

THE WITNESS: To the extreme left. It's actually almost off the map there. Up in the extreme left, that's were the bridge is.

Q. (By Mr. Schulmeister): When we were looking at the stream, the property slopes up to the right from where we were standing; is that right?

A. There's a slight slope to it. From where we were standing, it slopes down slightly.

Q. Towards what?

A. Makai.

Q. On the lot?

A. Down to the right.

Q. Now, where were the lo'i, as you understand it, on the lot?

A. As I understand it, basically this whole somewhat open area here up on the left was lo'i. And

1 I can definitely --
2 MR. HALL: Wait, wait. Just for the
3 record, can you explain more clearly where you mean?
4 Here on the left doesn't translate.
5 THE WITNESS: Sorry. From the left-hand
6 side of the --
7 MR. HALL: From the house to the ginger --
8 THE WITNESS: All right. Basically from
9 the bananas, which is the old government road, that's
10 the other boundary of the property, down where we show
11 the house -- actually all the way down through where
12 the ginger is now. Now, past there is uncleared.
13 It's pretty much rose apple and such now. And that's
14 where I've seen actual walls still remain down in that
15 uncleared portion. And that would be down to the
16 extreme right.
17 MR. HALL: To the right of the ginger?
18 THE WITNESS: To the right of the ginger,
19 right.
20 Q. (By Mr. Schulmeister): And someone told you
21 those lo'i were in production within the last 50
22 years?
23 A. Say 50 years, yeah.
24 Q. And do you know where the auwai intake was?
25 A. I believe it was from the road. There's a

1 sort of a swale, I guess you would call it, depression
2 from the road.
3 Q. Can you point where on this map?
4 A. Where the culvert is. Can you see the
5 culvert? Bottom left where it says heliconia, on my
6 driveway.
7 Q. Intake would have been from the stream
8 though, right?
9 A. I'm not certain. I would think the auwai
10 would have been from the stream, but I never got
11 specific with Lehua about that.
12 Q. Now, the plants that you grow now, do you
13 irrigate them?
14 A. Sometimes.
15 Q. Is that from catchment water?
16 A. Catchment, yes.
17 Q. And that's adequate for the flowers and the
18 bananas?
19 A. Not always. The pink ginger could definitely
20 use some more water.
21 Q. So in terms of irrigation water, what you
22 want is enough irrigation water to grow wetland taro;
23 is that right?
24 A. To grow some wetland taro. To maintain my
25 vegetable garden. I've got a rather large vegetable

1 garden that does need to be irrigated on a regular
2 basis. And also to hopefully grow some other kinds of
3 flowers that do require more water than they're
4 getting and improve the quality of the pink gingers.
5 They're not very good.
6 Q. Can you look at Exhibit 32-A. There's a
7 reference in the last paragraph to May of 1989 study
8 done by Stan Rushworth, is that right?
9 A. Uh-huh.
10 Q. How do you know about that?
11 A. Because that was the study that he used when
12 he filed his declaration of water rights with the
13 CWRM.
14 Q. The one where he indicated he was trying to
15 register 100,000 gallons per day?
16 A. Correct.
17 Q. Now, and how did you learn about this? How
18 do you know he did that?
19 MR. HALL: Well, that's ambiguous or
20 vague. Did what?
21 Q. (By Mr. Schulmeister): How do you know he
22 did a study?
23 A. It's in the records of CWRM.
24 Q. Did you ever talk to him about it?
25 A. Yes, I did.

1 Q. Did he tell you about it?
2 A. Yes.
3 Q. So a lot of what you know about it is from
4 having spoken with him?
5 A. Yes. He personally visited the property back
6 in July, I think.
7 Q. Now, but you say you've been unable to
8 determine what the rainfall was at the time that he
9 did the study in May of 1989?
10 A. Yes. I got on the internet on the historical
11 precipitation records with NOAA, and brought up the
12 records from the Kailua gauge from May of 1989. They
13 were supposed to e-mail it to me, and there's been a
14 holiday in between. I didn't really do this until
15 last week. And I'm still waiting for those records.
16 Q. Did Mr. Rushworth say whether in May of 1989
17 the two four-inch pipes were flowing from Lowrie?
18 A. I don't think he knew that.
19 Q. Did you ever talk to him?
20 A. I did not ask him.
21 Q. Did he tell you that 14 million gallons per
22 day was what he determined?
23 A. I have not spoken to him since I did these.
24 I just did these calculations last week when I got the
25 formula from USGS.

1 Q. When you did talk to him, did he tell you
2 what he figured the flow was when he did his
3 measurements?
4 A. No. We weren't talking about flow at that
5 point.
6 Q. Did you ever talk to him about why it was
7 that he used the figure 100,000 gallons per day as
8 being what he was trying to register?
9 A. No, I did not.
10 Q. Now, you've testified that you need 750,000
11 gallons per day; is that right?
12 A. According to this study, that seems correct.
13 Q. Explain to me how this study indicates that
14 you need 750,000 gallons per day.
15 A. The figures are there. The day that I
16 measured -- and this is as accurate as I can make it,
17 USGS does not lend out their streamflow gauges,
18 believe me, I asked -- the day that I did these
19 measurements, the stream was flowing probably a little
20 bit less than we saw yesterday. It was a steady flow.
21 It was more than a trickle. And if that was,
22 according to these measurements, somewhere around 600
23 to 750 million gallons --
24 Q. Thousand?
25 A. I'm sorry, thousand, excuse me. Probably

1 that flow would be enough -- this is all guess work --
2 would be enough to provide enough flow to get it to my
3 land and to keep the stream flowing and healthy.
4 More than that, obviously, would be
5 preferable, but this is where I measured that day.
6 Q. So basically you're saying you need it
7 because based on looking at it, in other words, seeing
8 what the stream looked like when you determined that
9 there was about 750,000 gallons in it, that looked
10 like the amount of water you would like to have there?
11 MR. HALL: I'm going to object. The
12 standards for riparian water rights, according to
13 Hawaii case law, is not what you need, so that's
14 irrelevant as a matter of law. The standard is that
15 you're entitled to the natural flow of the stream. So
16 that is what --
17 HEARINGS OFFICER McCONNELL: We just went
18 through that, Mr. Hall.
19 MR. HALL: No, we didn't. I'm placing
20 this on the record. That's what's in her testimony
21 and that's what our position is, that by the law that
22 has to be followed by this hearing officer and BLNR,
23 is that someone with riparian water rights, that she's
24 established she has, that she's entitled to the
25 natural flow of the stream since she has riparian

1 water rights.
2 She's testified what the natural flow of
3 the stream is. It's irrelevant that he's examining
4 her on what she needs, that's not relevant.
5 MR. SCHULMEISTER: That was her testimony.
6 MR. HALL: That was not her testimony.
7 HEARINGS OFFICER McCONNELL: That's what I
8 heard.
9 MR. SCHULMEISTER: So you're saying she
10 doesn't need it?
11 MR. HALL: I'm not saying she doesn't need
12 it. I'm saying it's irrelevant what she needs. What
13 is relevant is what is the natural flow in the stream.
14 MR. SCHULMEISTER: Just so we're clear,
15 the reason why I asked the question, because when I
16 was listening to your testimony on Exhibit 32-A, what
17 I heard was that this was an exercise you engaged in
18 to figure out how much water you needed. And I
19 believe Mr. Hall used the word "needed" in his
20 question to you.
21 MR. HALL: I did not. What I asked her
22 was what she's asking the hearing officer to order you
23 to release to her.
24 Q. (By Mr. Schulmeister): If what you said was
25 that's what you needed, can we just all agree that the

1 testimony is really that's what you want but not what
2 you need?
3 A. What I want is to have natural flow of the
4 stream restored. That is what I want.
5 Q. In other words, don't divert anything from
6 the stream at all, right?
7 A. Ideally, yes.
8 Q. But you're not saying that you need 750,000
9 gallons per day --
10 A. I'm saying that's what was --
11 Q. -- in order to cultivate taro on your
12 property, you're not saying that, are you?
13 A. No, I'm not.
14 MR. SCHULMEISTER: I have no further
15 questions.
16 HEARINGS OFFICER McCONNELL: Any other
17 questions? Any redirect?
18 MR. HALL: Yes.
19 REDIRECT EXAMINATION
20 BY MR. HALL:
21 Q. How do you feel about EMI?
22 MR. SCHULMEISTER: Let me object. Now if
23 anything is irrelevant, that's got to be.
24 THE WITNESS: It's not bad, don't worry.
25 I can only speak for myself. I think this applies to

1 most of us in this case.
2 I certainly want EMI, HC&S, A & B to have
3 all the water that they need to continue to do
4 agriculture, growing cane, whatever they want to grow.
5 That's so important. We need to keep up the
6 agriculture.
7 However, I do not believe that they need
8 all the water.
9 HEARINGS OFFICER McCONNELL: That's the
10 dilemma that we have. It's a big one.
11 THE WITNESS: Exactly. We need to
12 maintain agriculture. We don't want them to go out of
13 business. That's all.
14 Q. (By Mr. Hall): So you're testifying that you
15 want the natural flow?
16 A. Yes.
17 Q. But not to get -- do you also want water for
18 your own agricultural pursuits?
19 A. Yes.
20 MR HALL: And because these photographs
21 aren't on the list, I would just like to make sure
22 they're listed, 28-K, 28-L, 28-M and 28-N as being on
23 our list of exhibits.
24 HEARINGS OFFICER McCONNELL: Right, and
25 you'll supply them to Linda.

1 MR. HALL: Yes.
2 MR. SCHULMEISTER: These aren't marked.
3 MR. HALL: If you want me to mark them,
4 I'll mark them.
5 MR. SCHULMEISTER: Yes, I would be
6 guessing which one is which.
7 HEARINGS OFFICER McCONNELL: Where did
8 they come from?
9 MR. SCHULMEISTER: They came from Isaac.
10 If I could just be provided with a copy at some point.
11 MR. MURAKAMI: Can we put on the record
12 what those will be numbered?
13 HEARINGS OFFICER McCONNELL: I thought we
14 just did.
15 MR. MURAKAMI: Those are the ones you just
16 said?
17 MR. HALL: Yes.
18 HEARINGS OFFICER McCONNELL: 28-K, L, M,
19 N.
20 MR. MURAKAMI: Are they admitted?
21 HEARINGS OFFICER McCONNELL: You're
22 offering -- I can't remember.
23 MR. HALL: Anything listed goes in.
24 HEARINGS OFFICER McCONNELL: They will be
25 in evidence.

1 (Exhibit Nos. 28-K, L, M and N were
2 received into evidence.)
3 MR. HALL: I have no further questions.
4 HEARINGS OFFICER McCONNELL: Okay. Thank
5 you very much, ma'am. You're excused.
6 Can we take a short break? We'll take a
7 break for ten minutes or so.
8 (Recess was taken.)
9 HEARINGS OFFICER McCONNELL: We're back on
10 the record. Mr. Hall, you've essentially rested.
11 That's your case?
12 MR. HALL: Yes.
13 HEARINGS OFFICER McCONNELL: There was a
14 request to allow some videotaping of this hearing, and
15 I believe that A & B objects. Is that correct, Mr.
16 Schulmeister?
17 MR. SCHULMEISTER: Yes. We weren't duly
18 noticed, don't know what it's going to be used for,
19 how it's going to be done. So we would object.
20 MR. MURAKAMI: Judge, this is not a court
21 of law. BLNR has no rules against videotaping.
22 HEARINGS OFFICER McCONNELL: I know of
23 nothing that prohibits it, although I do think I have
24 the power to control the orderly proper conduct of
25 this hearing, even by excluding if necessary.

1 MR. MURAKAMI: I agree.
2 HEARINGS OFFICER McCONNELL: The only
3 concern I have is I didn't want the attorneys to make
4 speeches that aren't for me and for the benefit of the
5 parties here and are directly related to the
6 proceeding, but rather are for some other forum which
7 would be recorded.
8 So that's my only concern. If we're
9 having speeches for the press, then I think we have
10 gone astray and I might stop it. But I'll permit it
11 to go forward. You understand my concern?
12 VIDEOGRAPHER: Yes.
13 MR. HALL: For Maui Tomorrow, I'm going to
14 absent myself for awhile. I'll be back for further
15 witnesses.
16 HEARINGS OFFICER McCONNELL: That's fine.
17 And I guess Na Moku parties are up next. Alan.
18 MR. MURAKAMI: Calling our first witness,
19 Dr. Davianna McGregor.
20 DAVIANNA POMAIKAI McGREGOR
21 was called as a witness, was sworn to tell the truth,
22 was examined and testified as follows:
23 HEARINGS OFFICER McCONNELL: State your
24 name.
25 THE WITNESS: Davianna Pomaikai McGregor.

1 HEARINGS OFFICER McCONNELL: Go ahead.
2 DIRECT EXAMINATION
3 BY MR. MURAKAMI:
4 Q. Dr. McGregor, can you basically state your
5 address.
6 A. 1942 Naio Street and I also live in Honolulu.
7 I also live on Lot 46 in Ho'olehua, Molokai.
8 Q. You split your time?
9 A. Yes.
10 Q. Did you -- was there a time that you prepared
11 some written direct expert testimony on behalf of Na
12 Moku Aupuni O Koolau Hui, Beatrice Kekahuna and
13 Marjorie Wallett?
14 A. Yes.
15 Q. And is that particular document entitled
16 Petitioner's Direct Expert Testimony of Dr. Davianna
17 Pomaikai McGregor, Ph.D. is -- I'm going to hand you a
18 copy of what has been labeled as such.
19 Is this the testimony that you prepared
20 and in consultation with me at the Native Hawaiian
21 Legal Corporation?
22 A. Yes, it is.
23 Q. And consisting of a total of 21 pages?
24 A. Yes, it is.
25 Q. And do you affirm that all the statements

1 made in that particular document which has been filed
2 in this proceeding is true, correct and to the best of
3 your knowledge?
4 A. Yes.
5 MR. MURAKAMI: Your Honor, on that basis I
6 move to admit the direct testimony of -- expert
7 testimony of Dr. Davianna Pomaikai McGregor.
8 HEARINGS OFFICER McCONNELL: Mr.
9 Schulmeister.
10 MR. SCHULMEISTER: No objection.
11 HEARINGS OFFICER McCONNELL: It will be in
12 evidence.
13 Q. (By Mr. Murakami): You provided a curriculum
14 vitae that outlined your prior training, your
15 publications and other professional experiences,
16 correct?
17 A. Yes.
18 Q. Which was marked, as I understand it,
19 admitted as B-121?
20 A. Yes.
21 Q. And just to summarize the gist of that CV, is
22 it your testimony that your area of expertise is in
23 the general category of what's known as Hawaiian
24 tradition, custom and practice?
25 A. Yes, correct. Primarily in Native Hawaiian

1 rural communities.
2 MR. MURAKAMI: Your Honor, based on
3 testimony in her written and her curriculum vitae ask
4 that she be qualified as expert in Hawaiian
5 traditional and customary practices.
6 HEARINGS OFFICER McCONNELL: Any
7 objection?
8 MS. LOVELL: No objection.
9 MR. SCHULMEISTER: No objection.
10 MR. MERCHANT: No objection.
11 Q. (By Mr. Murakami): Part of that experience
12 of your professional experience in this arena has
13 ranged across the State of Hawaii, is that correct?
14 A. Yes.
15 Q. And can you briefly summarize what some of
16 those projects entailed?
17 A. I did a cultural impact study of the impact
18 of a space port in Ka'u on the Island of Hawaii. I
19 did a study on traditional customs and practices in
20 Waiahole and Waikane and Hakipu'u to determine what
21 kind of water usage was necessary to sustain
22 traditional and customary practices in the
23 Waiahole-Waikane and Hakipu'u Valley for the Waiahole
24 water case.
25 I did a study on the cultural impact of

1 development of geothermal energy in the District of
2 Puna on the Island of Hawaii, and I did a study called
3 Kala Kanu O Ka 'Aina, which was a study of -- didn't
4 do it by myself, but I did a study in conjunction with
5 Culture Surveys and Group 70 on the -- Kalo Kanu O Ka
6 'Aina, to study Keanae-Wailuanui as a historic
7 cultural landscape as a prototype for how to determine
8 what is a historic cultural landscape under federal
9 law in the context of Hawaii.
10 Q. Thank you. On Page 3 of your testimony you
11 stated, in general talking about these various
12 professional experiences and projects, that these -- I
13 take it you're referring to the Hawaiian traditions
14 and customs you've recorded are, quote, resilient and
15 persistent, unquote?
16 A. Yes, that's correct.
17 Q. Can you explain to the hearings officer what
18 exactly is the extent and scope of this conclusion in
19 terms of your professional experience with these
20 various studies and why you made this particular
21 statement on Page 3?
22 A. For my doctoral dissertation I studied oral
23 history testimonies that had been conducted by Mary
24 Kawena Pukui in the 1960s and she interviewed kupuna
25 in the Hana district of Maui which goes from Haiku to

1 Kaupo, and she also interviewed kupuna on the Island
2 of Molokai which I was doing study of as well.
3 I also did a study of Waipio Valley and
4 oral history interviews by the ethnic studies oral
5 history project.
6 Through the course of reviewing these oral
7 histories, I came to the conclusions that in these
8 rural communities in particular that there had been a
9 strong continuity of Hawaiian custom and practice as
10 well as Hawaiian language and that this was linked to
11 the persistence of subsistence practices in these
12 areas.
13 And then subsequently, through my work on
14 the Puna geothermal study I also interviewed families
15 in the Puna District and looked at oral history that
16 had been done earlier in the 1970s by Department of
17 Anthropology and also found in that case as well that
18 there was a strong persistence of Hawaiian custom and
19 practice.
20 And so in the course of my study for the
21 Ph.D., then subsequently I went back to these
22 communities, I went back to Molokai and worked with
23 the community on the Molokai subsistence study where
24 we documented the persistence of subsistence and
25 linked to custom and practice on the Island of Molokai

1 and found that across the island 28 percent of their
2 diet comes from subsistence farming and fishing and
3 hunting, and for Native Hawaiians it was 35 percent.
4 And then I, in conjunction with the study
5 that we did for the County of Maui in
6 Keanae-Wailuanui, I also interviewed 13 people, nine
7 of whom were kupuna. And they also talked about the
8 persistence of Hawaiian custom and practice in
9 Keanae-Wailuanui.
10 And so I've also come to call these areas
11 cultural kipuka. Kipuka comes from the botanical term
12 where in the volcanic rain forest you have where Pele
13 goes through and covers the forest with lava, she also
14 leaves these whole oasis of forest from the old growth
15 trees to the young vines and mosses. And these are
16 called kipuka.
17 And then the important feature of these
18 kipuka is that from these kipuka then the forest can
19 regenerate on the raw lava land.
20 What I found also is that these areas,
21 especially Keanae-Wailuanui and Molokai, played this
22 function for Native Hawaiian culture. They had been
23 bypassed by the mainstream of political and economic
24 development in our islands, very isolated communities
25 for a long time. And where the culture and custom and

1 practice and language had been perpetuated, and these
2 communities in particular have played an important
3 role in the regeneration of Hawaiian culture in the
4 1970s and '80s, especially through the kupuna from
5 these areas, Uncle Harry Mitchell in particular who
6 was a taro farmer in Wailuanui, played a very
7 important role in the whole culture Renaissance around
8 the Island of Kahoolawe. And Uncle Harry in
9 particular also came to the University campus and
10 helped reopen a traditional taro terrace, a lo'i kalo
11 system that was there on the campus.
12 And so kupuna like Uncle Harry Mitchell
13 and kupuna from Molokai who have perpetuated Hawaiian
14 custom and practice have been able to pass that on and
15 share it to our generation and we in turn pass it onto
16 future generations.
17 And so these areas such as
18 Keanae-Wailuanui are very important culturally for
19 Hawaiian people as a whole.
20 Q. That's a very good summary of the importance
21 of these cultural kipuka to basically Hawaiian culture
22 and the extension of the culture throughout time. Is
23 there any ramification of these kinds of areas, and
24 cultural landscapes as Keanae-Wailuanui, Maui is to
25 what the general public and what important policy

1 implications are to have these kinds of areas
2 documented, recorded and preserved as well?
3 A. Well, through our study that we did for the
4 County of Maui, Kalo Kanu O Ka 'Aina, we determined
5 that Keanae-Wailuanui as an important historic
6 cultural landscape, means it has value as a national
7 treasure, not only for Native Hawaiians but for
8 Hawaii, as well as meeting standards as a national
9 cultural landscape of national importance under
10 federal standards. And the key is that it has a very
11 long continuity of sustained cultivation in taro. And
12 the taro cultivation in turn has sustained key aspects
13 of the Native Hawaiian culture and custom.
14 So there is a whole range of custom and
15 practice that has developed, as well as spiritual
16 beliefs that centers on taro cultivation. And taro
17 cultivation is at the core of our traditional culture
18 and it's at the core of the persistence of our culture
19 in these rural communities.
20 So it is a historic landscape, both -- and
21 also this in particular is for other reasons besides
22 taro cultivation, is associated with important
23 historical figures as well as Umi-a-Liloa's battles
24 here on Maui, and also Kalani'opu'u's attempts to
25 usurp Kahekili in the Hana District.

1 Q. So these kinds of areas promoted the health,
2 I take it from your testimony, of the Hawaiian
3 culture; it also sustains the continuity of the
4 culture, but why should the general public here care
5 that this occurs in terms of its own self-interest in
6 the future that these communities are healthy, that
7 taro can continue, that subsistence and cultural
8 activities can be supported by the resource protection
9 that is needed to sustain these practices?
10 A. What I've also found is that in these areas
11 where Native Hawaiian custom and practice has guided
12 subsistence, farming, fishing, gathering, that there
13 has also been an important part of that subsistence
14 practice, and really what is at the core of it is that
15 the people have taken responsibility to sustain the
16 resources in as pristine a condition as possible.
17 So subsistence, custom and practice
18 demands that you are the steward and the caretaker of
19 the land and you malama this land. And when I
20 interview families, they speak of the surrounding
21 forest, the streams, the stream life, the ocean as if
22 they are part of their extended ohana. That they take
23 care of the land as they do take care of their
24 families.
25 When they go out to gather, they're always

1 alert to the condition of the landscape. They're
2 always conscious if an area is lacking in water, and
3 therefore, the resource is not as abundant and
4 therefore they might go to another area.
5 So they're very conscious constantly of
6 the condition of the resources. They might, in a
7 place, replant if necessary. In Puna where it tends
8 to be dryer, they will even go and water in some
9 certain areas of the forest.
10 But here in Keanae-Wailuanui what is
11 significant is that in the larger gathering area we
12 have protected now one of the most pristine and
13 diverse forest systems in our islands. That the whole
14 of the area mauka of Hana is one of the premier
15 forest, the rain forest that are protected in a most
16 pristine condition with a lot of the original native
17 species both fauna and flora intact.
18 And I attribute that to the practices of
19 the native Hawaiians in this community, that they have
20 been effective stewards and caretakers of this land.
21 And it's no mistake that the areas where Hawaiians
22 have been -- continue to be the majority of the
23 population -- well, in Hana almost the majority, about
24 40 percent or in Molokai, 60 percent, that there is --
25 there are healthy and abundant resources. And I

1 directly attribute it to the customs and practices
2 related to subsistence that are traditional and
3 customary practices.
4 Q. In your testimony you talk about the cultural
5 landscape of Keanae-Wailuanui, correct?
6 A. Yes.
7 Q. And you describe basically the boundaries of
8 that area generally stretching slightly to the west of
9 Keanae Peninsula to the ridges that form the eastern
10 most boundaries of the Wailuanui Stream watershed
11 area; correct?
12 A. There's an immediate area that they -- that
13 the community considers as their immediate area, which
14 is like from the Keanae YMCA and up mauka, and maybe I
15 think 600 yards or so mauka of the Hana Highway, and
16 then over in the east to the ridge, southeast ridge at
17 Wailuanui Valley.
18 But that's sort of their cultivation area
19 and their domestic use area, but the gathering area
20 for the gathering of marine species and aquatic
21 species such as hihiwai and o'opu and 'opae is a much
22 larger area and goes from Honomanu and up to actually
23 Pohaku-Palaha at the rim of Haleakala and over in the
24 east to Makapi'i Stream.
25 Q. Well, turning to the taro part of this, you

1 describe basically taro landscape -- I guess taro
2 landscape within this larger cultural landscape.
3 A. Correct.
4 Q. And describe the components of the streams,
5 auwai and lo'i being very integral to that landscape?
6 A. Yes.
7 Q. And any disruption can really disrupt the
8 natural systems that have been perpetuated over
9 generations.
10 A. Right.
11 Q. Based on that, you also were able to describe
12 and record the extent of that taro landscape, correct?
13 Could you summarize -- I'm sorry?
14 A. The study did that. I wasn't involved in the
15 actual mapping, but we as a team collaborated on the
16 report. So I'm familiar with the report and what was,
17 you know, the findings.
18 Q. Okay. So you go into some detail in your
19 testimony, but can you give the hearing officer an
20 appreciation of this taro landscape in terms of the
21 extent of the lo'i, their placement and location
22 within the Keanae-Wailuanui cultural landscape and how
23 people are dependent upon it?
24 A. Well, based on my oral interviews that I
25 conducted myself, then those that I relied upon when I

1 did my research, the taro landscape that's laid out in
2 Wailuanui and Keanae, it's from historic times. It's
3 probably one of the areas where there's still taro
4 production that has the longest history of continuous
5 cultivation in taro and where the lo'i have been laid
6 out very much interdependent upon each other.
7 So once the stream waters enter the lo'i
8 complex, they all flow one to the other and then back
9 into the stream again. So that something that happens
10 upstream will eventually affect all of the lo'i
11 downstream.
12 And so there is like -- there was great
13 concern, for example, when we were interviewing people
14 like, for example, these pesticides and if someone
15 upstream did it, even though downstream they didn't.
16 And they were very concerned not to -- they wanted to
17 be concerned that the person upstream would not use
18 pesticides because it would impact upon their manner
19 of cultivating taro downstream.
20 When I first went into Keanae-Wailuanui in
21 the late '80s with Uncle Harry Mitchell, there was a
22 lot more taro being produced, and it was being
23 exported from the valleys. I live on Molokai
24 part-time, so I know that on Molokai we had been
25 receiving taro from Keanae-Wailuanui from early 90s,

1 but we no longer have it because production has
2 decreased from there. So we no longer on Molokai get
3 the taro from Keanae-Wailuanui.
4 Q. Let's turn real quickly to the physical
5 layout of the taro landscape. On Figure 15 of your
6 report marked B-123. Could you describe for the
7 hearing officer -- like this appears to be entitled
8 the Wailuanui -- Keanae-Wailuanui Cultural Landscape.
9 Can you describe how Figure 15 was
10 developed?
11 A. The archeologist with Cultural Surveys went
12 out and walked the area, and then mapped each of the
13 lo'i. And I think they did a comparison with earlier
14 maps and photographs of the area to establish the
15 continuity, that the configuration here was similar to
16 the earlier cultivation configuration.
17 Q. Let me break in there. When you say earlier
18 continuity, was it -- did you reach a conclusion as to
19 whether or not the system of growing taro in
20 Wailuanui-Keanae approximated what had been used to
21 grow taro since the time of the Mahele, for example?
22 A. Well, what was there, according to oral
23 history interviews, had been there from the time of
24 the Mahele or even at the time of Kamehameha many of
25 them would say.

1 But there had been a more extensive area
2 that was under cultivation at the time of the Mahele
3 and prior to that according to oral history.
4 Q. So even though there was less taro growing
5 going on in contemporary times, the means by which the
6 taro was being grown and the delivery of water to
7 those taro to grow it approximated what was going on
8 at the time of the Mahele; is that correct?
9 A. It was much more extensive at the time of the
10 Mahele, but what was still in existence was being
11 cultivated at the time of the Mahele, but my
12 understanding they also were cultivating higher up in
13 the east valley and that was -- that the east valley
14 mauka of the waterfall was also in cultivation.
15 But we didn't go to validate it, but that
16 was what the oral history --
17 Q. When you say the waterfall, are you speaking
18 of Waikani Waterfall that you see from the highway?
19 A. Yes -- no, not the one that comes down from
20 Lakini, the one to the east.
21 Q. Yes, Waikani to the east, located toward the
22 eastern boundary of the immediate cultural landscape
23 area, taro landscape area?
24 A. Yeah. And when you look -- the lookout that
25 looks mauka where there's a lot of the hau bush, they

1 said was formerly cleared and had been cultivated in
2 taro in historic time according to the testimony.
3 Q. Did you map that particular mauka area?
4 A. No, that was not mapped. We only mapped what
5 was in active cultivation. But they did note -- they
6 actually did go to some of the areas where there was
7 wild taro growing. And they also observed that there
8 were previously -- where the wild taro was growing
9 there were also taro terraces in those gulches as
10 well.
11 Q. Can you give the hearing officer an idea of
12 where you're speaking of when you say where the wild
13 taro was?
14 A. It's in my testimony. Pi'ina'au, Nua'ailua,
15 Kupa'u, Waipio, Awiowio, Pohole and Pahoa.
16 Q. So these are areas mauka of the highway,
17 correct?
18 A. No, I'm sorry, areas within the
19 Keanae-Wailuanui landscape not just mauka, these are
20 all the areas. These areas are not mauka of the
21 highway, these are areas that were in the gulches. I
22 think these are mostly makai of the highway, the ones
23 that I just read. But as I said, they didn't go out
24 to look into the mauka area, it was just based on oral
25 histories that north of the Hana Highway there had

1 been previously cultivated areas.
2 Q. Your testimony also mentioned 339 lo'i. In
3 what areas were the 339 lo'i?
4 A. In the Wailuanui area.
5 Q. Does that include the Keanae area as well?
6 A. No, no, that was just the Wailuanui area.
7 Q. And the Keanae area had a similar map like
8 Figure 15 to document the areas of cultivation
9 historically by the Keanae community?
10 A. Yes.
11 Q. And I think that's Figure 14?
12 HEARINGS OFFICER McCONNELL: I have to
13 find that.
14 THE WITNESS: 13.
15 Q. (By Mr. Murakami): That's a few pages before
16 and it's a foldout like Figure 15?
17 A. Yes.
18 MR. MURAKAMI: It should be just a few
19 pages before that, Your Honor.
20 HEARINGS OFFICER McCONNELL: 13, 14?
21 MR. MURAKAMI: 13 is the layout of the
22 Keanae Peninsula lo'i, and 15 is the layout for
23 Wailuanui Valley.
24 Q. I think you testified it's the lower part of
25 the valley on Figure 15, not the mauka part.

A. Right. I think they included Lakini though.

Q. When you say including Lakini --

A. Wait, wait. Yeah, they have Lakini in here.

Q. When you say Lakini, then you're pointing to the area to the left -- toward the bottom corner of Figure 15 to the left of the figure that's labeled "Hana Highway".

MS. LOVELL: Are we back to 15?

MR. MURAKAMI: Fifteen, yes.

Q. And that area to the left of Hana Highway toward the bottom left corner of Figure 15 is the Lakini area?

A. Yes.

Q. And what are the arrows on Figure 15 representing?

A. They show the flow of the water, in this case from the spring through Lakini and then down under the Hana Highway and then into Wailuanui, and then also from the water, Waikani.

Q. So this -- these arrows indicate that the direction of flow from the Waiokamilo Stream entering Lakini on the left, is that correct?

A. Yes.

Q. And then on the right the arrows depict flow of water as it enters the valley from Waikani Falls?

A. Yes.

Q. Now, you've indicated that over time the cultivation of taro in the Keanae-Wailuanui taro landscape has diminished?

A. Yes.

Q. Can you give a brief description of what that extent of reduction has been in terms of time? I think you've gone over some of this in your testimony earlier, and how you reach that conclusion.

A. I think, as I said, I didn't do the mapping, but their testimony is based on the 1903 map. And that -- the 1903 map had the same configuration of lo'i, but the number of lo'i from that time to when the mapping was conducted had been reduced.

Q. And this had been, according to the report, after studies of the aerial photographs and maps that documented this particular area?

A. Yes, that's correct.

Q. Now, I guess there's some issue that's been raised about whether or not this reduction is the result of water being -- water flows into the valley being diminished or some other cause such as people simply just moving to the cities purportedly because taro farming is so hard to do.

Have you reached any conclusion about

1 whether the reduction in taro cultivation is a result
2 of one or more factors, historical factors?
3 A. Yeah, there's a combination, an interplay of
4 the different factors. So in the Keanae-Wailuanui --
5 along the Hana coastline you have -- when the streams
6 were tapped, and the stream waters were diverted, some
7 of the land that was in taro production became more
8 marginal because it didn't have the cold fresh running
9 water that taro needs to grow.
10 So some of those areas became more
11 marginal to the core of the taro production in
12 relation to the core areas. And some of those farmers
13 traditionally who were situated on the more marginal
14 areas, they were no longer to sustain themselves by
15 planting of taro, so many of them moved into the city
16 to seek alternate livelihood.
17 Q. So the diminishment of the water preceded the
18 movement into the city?
19 A. At the turn of the century. My Ph.D. I
20 studied 1900 to 1930, and that's why I actually
21 started to look at the rural areas because I started
22 off looking at Honolulu, and then I see this influx of
23 population of Native Hawaiians into the city and
24 there's no way to accommodate them. They have to be
25 squatters in Iwilei and out where -- in Kewalo.

1 And so then I started to look at why was
2 there this exodus of Hawaiians at the turn of the
3 century into Honolulu. And then you know, there
4 was -- through looking at these rural communities that
5 they came from, you saw that in almost every area --
6 well, all the areas I looked at the irrigation
7 networks had gone in. You know, the first irrigation
8 system went here in Hana area when Spreckles came
9 after the reciprocity came, he wanted to bring water
10 to Puunene.
11 Q. When was the reciprocity?
12 A. 1876. But the other -- because irrigation
13 networks was very expensive, no one else invested in
14 it until after Hawaii became a territory. Then the
15 market for Hawaii Sugar was secured. And with that
16 security, then there was more investment in
17 infrastructure. So there is statistics that was done
18 by Molei (phonetic) and his study of capital
19 investment and infrastructure.
20 So there's little investment in
21 infrastructure up to 1900, and then after 1900
22 becoming a territory there was a lot more investment
23 in infrastructure and primarily putting in irrigation
24 systems that brought water from the windward side of
25 the island to the leeward side of the island.

1 So at that point in early 1900s is when
2 you begin to have this also, the marginal -- a lot of
3 the taro growing areas on all of our islands becoming
4 marginalized as the stream flows are diverted.
5 So while there still is enough stream flow
6 to sustain sufficient kalo, there is a number of
7 farmers in marginal areas that don't have sufficient
8 water to continue their cultivation. So they then
9 leave their areas and move into the cities.
10 Q. And you mentioned the Reciprocity Treaty in
11 1876. Did there come a time when -- I think you
12 mentioned Mr. Spreckles was able to get some water
13 rights from the government, correct?
14 A. Yes.
15 Q. The kingdom at the time?
16 A. Yes.
17 Q. And there was -- was there some instrument
18 that allowed him to do this at that time?
19 A. I don't have the instrument, but in the
20 report there's a letter that was shared with me by
21 Awapuhi Carmichael. She had a petition -- she had
22 found a petition that members of the Keanae-Wailuanui
23 community had sent at the time in 1881 to the
24 commissioners for water and asking that the rights
25 to -- the water rights on the crown land in their area

1 not be given over to Spreckles, but nevertheless it
2 was.
3 Q. So these were residents of Keanae-Wailuanui
4 in 1881 who were opposing the taking of water being
5 sanctioned by the government at that time?
6 A. Yes.
7 Q. And that particular effort, was it successful
8 to oppose that?
9 A. No, Mr. Spreckles was granted the water.
10 Q. And this preceded by at least a couple of
11 decades the period of time when some of those intense
12 infrastructure investments were made after 1900?
13 A. Yes.
14 Q. And let's see, let me turn to -- there was a
15 time, was there not, when rice entered the picture for
16 cultivation in Wailuanui Valley?
17 A. Yes.
18 Q. Did you do a historic analysis of why rice
19 was introduced into the valley as opposed to taro?
20 A. Of course there was a market for it at the
21 time before the California industry developed and
22 there were Chinese who were leaving the plantations
23 and wanting to have alternative livelihood. And so
24 they approached Native Hawaiians to lease land and
25 rent lands.

1 And for the Native Hawaiians, they did
2 rent out their marginal taro lands for the production
3 of rice. And this is pretty consistent. I've
4 interviewed -- from the interviews in Waipio Valley as
5 well as Keanae-Wailuanui as well as Waiahole, it all
6 speaks to leasing out marginal taro lands, where the
7 stream water slowed. It was much slower flow. It was
8 a warmer temperature, and rice could do very well in
9 that kind of water. But it was marginal as far as
10 taro production was concerned.
11 And so the Native Hawaiians leased out
12 these lands to get extra money. And, you know, some
13 of them later intermarried with the Chinese as well.
14 Q. Just to be clear, when you said rice did as
15 well, what did you mean by that?
16 A. Rice could grow better in that kind of water
17 that was marginal -- that would have been otherwise
18 marginal for taro to grow.
19 Q. What would happen to taro in that same kind
20 of water?
21 A. Taro root gets rotten. I forget the term,
22 it's not coming to me. Gets loliloli, as we call it.
23 Q. You also mentioned a larger cultural
24 landscape beyond the valley, Keanae Peninsula and
25 Wailuanui for more traditional and customary

gathering.

A. Yes.

Q. How important has that larger area been to compliment the overall cultural landscape and the residential lifestyle of Keanae-Wailuanui?

A. It's integral to their life. A lot of the people who live there, their diet comes from gathering 'opae and o'opu. And they still gather hihiwai as well. And then, of course, gathering along the coastline and then fishing, and they say they fish out as much as 11 miles offshore is the area.

But that's all essential to the lifestyle of the people who live in the area. And it's always been part of their livelihood to supplement whatever income they have with subsistence gathering and hunting and fishing.

Q. How is that related to water being available in the area?

A. Well, water is needed for the aquatic life in the streams, the o'opu, hihiwai, 'opae, they're all reliant on cold fresh running water.

Then also the water, the flow of the water into the ocean is important for the marine life nearshore to flourish. The kupuna speak of when the fish spawn, they come to the freshwater source because

1 the young fish need the mixture of fresh with ocean
2 water or brackish water when they're still young.
3 Then as they grow older and more mature,
4 then they can go out into the saltwater. And the
5 lifecycle of the o'opu is reliant upon the flow of the
6 stream into the water because, according to Uncle
7 Harry Mitchell, when the first big rain comes, the
8 o'opu wash down the streams and into the ocean and
9 then they spawn and then the young o'opu need to be in
10 that saltwater and freshwater mix to -- until they're
11 stronger. And then they begin to make their way
12 upstream.
13 And then, of course, when the next stream
14 comes, the cycle begins all over again. But they need
15 to have that flow of the streams into the ocean for
16 the o'opu, they're of course stream and freshwater,
17 but the marine life along the shoreline also depend on
18 that.
19 Not only people in Keanae-Wailuanui have
20 addressed this, but fishermen on Molokai in our
21 subsistence study also testified to the importance of
22 the freshwater springs bubbling in the ocean for the
23 young fish in their young stages to grow.
24 And also in the Waiahole area there was
25 similar testimony that the marine life was dependent

1 on the flow of freshwater and they noticed an increase
2 in the fishponds and also in the estuary, Kaneohe
3 estuary when the water was restored.
4 Q. So there was nothing particularly unique
5 about the Keanae-Wailuanui area experiencing these
6 changes from diminishment of freshwater flows into the
7 ocean as it impacted these marine life on which they
8 relied for gathering, fishing, et cetera?
9 A. Right. It's very consistent in the rural
10 communities that I've worked with, and according to
11 the oral history interviews that I've conducted with
12 the kupuna from these areas.
13 Q. To be precise, that's the same experience
14 that you had with respect to more mauka gathering of
15 'opae, hihiwai, o'opu with the diminishment of water?
16 A. Well, yeah. Keanae-Wailuanui is the premier
17 area where these aquatic native species have been
18 sustained. They've disappeared from almost every
19 other area. There's little to speak of in some of the
20 other areas that I've interviewed because the stream
21 life has -- the stream waters have diminished even
22 more.
23 In Waiahole you have to talk about
24 restoring those aquatic species to those streams. So
25 these Keanae-Wailuanui streams are very unique in that

1 you have an abundance of these very, what are rare
2 elsewhere -- 'opae is so rare that it's against -- I
3 think in the '60s they passed a law saying you can't
4 sell it commercially because they want to protect the
5 species.
6 Q. And so I know you talked about this briefly
7 initially about the importance of these kinds of
8 gathering activities, and the supplement to the diet
9 of Native Hawaiians and those in the Keanae-Wailuanui
10 cultural landscape. But can you give us a brief, I
11 guess, summary of what you anticipate would happen if
12 there was further diminishment of the resource on
13 which both the marine life and the stream life depend
14 on in this cultural landscape area to Hawaiians?
15 A. Well, water is what the lifestyles of the
16 Keanae-Wailuanui Native Hawaiians depend upon. It's
17 at the core of custom and practice in that region for
18 taro, for gathering of o'opu, 'opae and hihiwai, and
19 then for fishing. And also gathering other plants as
20 well.
21 So if the water resource is diminished and
22 these resources diminish, then the way of life would
23 be changed. You would see a transformation not only
24 in their cultural lifestyle, but also their physical
25 health, because they have healthy diets being able to

1 live through subsistence.
2 And if they were cut off from these
3 resources -- everybody knows rice is not as healthy as
4 taro and a lot of our problems as Native Hawaiians
5 related to health is because of changes in diet. And
6 if their diet is forced to change, then their health
7 conditions well also worsen.
8 And then also you might see more people
9 being reliant on welfare or assistance from public
10 assistance rather than being self-reliant as they can
11 be with the availability of these subsistence
12 resources for the diet of their family.
13 Q. Is there some benefit beyond the material
14 ones on this notion of being more self-reliant in the
15 Native Hawaiian community, intact Native Hawaiian
16 community?
17 A. Well, the whole culture would change. This
18 area would no longer be this cultural well spring for
19 the Native Hawaiian culture that it is today. And,
20 you know, it would be another instance of, you know,
21 the destruction of our culture.
22 And a key core area of our culture is
23 Keanae-Wailuanui, and it's very important, not only
24 for Maui County but for all of Native Hawaiians, I
25 believe. You know, I can't emphasize how important a

1 role it made in the whole cultural Renaissance,
2 cultural renewal that our students have been able to
3 go back there, learn how to plant taro. They have
4 gone out to work with the families there. And, you
5 know, learn to speak Hawaiian language while working
6 side by side with them in the kalo lo'i.
7 Q. When you say there, where are you talking
8 about?
9 A. In Wailuanui-Keanae, also further down in
10 Kipahulu as well. But Uncle Harry Mitchell and the
11 kupuna there in Keanae-Wailuanui, Aunty Maggie Alu,
12 and Apolonia Day, Helen Nakanelua, they all shared
13 their knowledge as well with the young generation.
14 And without their knowledge being passed
15 onto us, we would have less available to us of our
16 knowledge, and identity of ourself as Native
17 Hawaiians.
18 Q. If you take that away, the water that is so
19 integral to this whole lifestyle and taro landscape,
20 as well as the cultural landscape, have you reached
21 any conclusion as to whether there is any amount of
22 money that could compensate Hawaiians for this loss of
23 this resource in an area such as Keanae-Wailuanui?
24 A. No, it's an irreplaceable resource. The
25 impact might be irreversible. It's only reversible if

1 we can restore the water to it, to the flow of the
2 land. The land needs to live. And all the aquatic
3 marine resources need the water to survive.
4 You cannot really place a monetary value
5 on the impacts of taking away additional water to this
6 landscape.
7 Q. Finally, would your answer change if I asked
8 you that same question about an area much smaller than
9 this larger cultural landscape? For example, in an
10 area like Honopou which is a much smaller valley?
11 A. If the people there are still relying upon
12 the stream life and gathering and using the water,
13 stream waters for kalo cultivation, then it would have
14 a negative impact upon their way of life and their
15 cultural and traditional customs and practices as
16 well.
17 Q. Would it be compensible by some kind of
18 monetary payment in your estimation?
19 A. I -- you know, we were asked to try to come
20 up with a dollar figure when we did a study on what
21 are the external costs to the production of
22 electricity on different islands, and what would be
23 the external costs with regard to culture.
24 And the same thing when we did the
25 geothermal study, what would be the cost to the

1 culture in monetary value. And we just said that we
2 were not able to put a monetary cost, a price on
3 cultural custom, practice and belief.
4 And we came up and said with a mapping to
5 show the interrelation of the water systems to the
6 ocean systems and the whole watershed systems that
7 these streams feed, and we tried to show a
8 relationship between the Native Hawaiian communities
9 and where they lived and these important areas.
10 And we said what you need to do instead is
11 to say where do the Hawaiians live, what are the
12 natural resources they depend upon for their
13 subsistence and cultural, religious practice, and just
14 put a kapu on these areas and say the impact is too
15 great to develop anything here and leave these areas
16 alone.
17 Because there has been enough development
18 throughout the islands and that if you were to take
19 away these last remaining strongholds of Native
20 Hawaiian culture, then it would be tantamount to
21 genocide of the Native Hawaiian people. These are the
22 last remaining strongholds of our Native Hawaiian
23 culture and custom and tradition.
24 So you can't put a monetary value on that.
25 You have to just accept that knowledge, that impact

1 here to these areas is unacceptable, that it is too
2 detrimental to the Native Hawaiian way of life, and
3 the survival of the Native Hawaiian culture.
4 Q. Dr. McGregor, thank you very search for your
5 testimony. That's all I have.
6 MR. SCHULMEISTER: Short break.
7 HEARINGS OFFICER McCONNELL: Sure, five
8 minute break.
9 (Recess was taken.)
10 HEARINGS OFFICER McCONNELL: We're
11 reconvened. Cross-examination. Before you do that,
12 any other questions by the other parties?
13 MS. LOVELL: County has no
14 cross-examination at this time.
15 MR. MERCHANT: Not at this time.
16 HEARINGS OFFICER McCONNELL: Okay.
17 CROSS-EXAMINATION
18 BY MR. SCHULMEISTER:
19 Q. Good morning, Dr. McGregor.
20 A. Good morning.
21 Q. I'm David Schulmeister representing EMI and
22 Alexander & Baldwin, Inc.. I would like to talk a
23 little bit about the Exhibit B-123, which is the
24 culture landscape study.
25 A. Yes.

1 Q. You mentioned that there is a team of people
2 who worked on this, not just yourself; is that right?
3 A. That's connect.
4 Q. So you were bringing, I guess, one sort of
5 perspective to it, and others on the team were
6 bringing different perspectives; is that right?
7 A. Different skills and experience, I would say.
8 Q. And you mentioned that the mapping of the
9 lo'i, for example, was not something that you did
10 yourself?
11 A. That's correct.
12 Q. Could you look at Figure 3 in the report.
13 MR. MURAKAMI: Three?
14 MR. SCHULMEISTER: Three.
15 A. Okay.
16 Q. Figure 3 is entitled Cultural Landscape
17 Boundary, and it's got a map with certain areas sort
18 of shaded; is that right?
19 A. Yes.
20 Q. Is this the -- explain what this is supposed
21 to delineate?
22 A. This is what we call the core of the cultural
23 landscape where people, you know, primary area where
24 they resided and planted their kalo. And then we had
25 the wider area was expanded, and the whole of the

1 traditional gathering area.
2 But we delineated this as the core
3 cultural landscape area. The immediate -- where the
4 neighborhood and the community was centralized.
5 Q. Okay. And you were asked a number of
6 questions and gave some testimony about the physical
7 layout of the lo'i in this area, little bit about
8 Keanae and Wailuanui and above Hana Highway were the
9 Lakini taro patches, et cetera.
10 Do you recall that testimony, generally?
11 A. Yes.
12 Q. Were all of those areas within the area that
13 is shaded on Figure 3?
14 A. Yes. Except I think the area that I was
15 saying that had previously been in cultivation
16 according to the testimonies are outside of that area,
17 because it's further up the valley at the bottom of
18 the map here. But otherwise the study area, the --
19 also the areas where I said had wild taro growing are
20 not in these areas. These are areas still in active
21 cultivation.
22 Q. Could you look at Figure No. 12?
23 A. Okay.
24 Q. So Figure No. 12 has a portion of a
25 topographical map with description, taro growing

areas, Keanae-Wailuanui cultural landscape; is that right?

A. Yes.

Q. Again, there's some areas that are shaded, although a little harder to see because of all the contour lines, but it looks like there is an area that is circled and shaded in Keanae at the top; is that right?

A. Yes, that's correct.

Q. And then if you go upstream from there, there's a small area, Keanae Arboretum?

A. Yes.

Q. And then if you go over to the right, there's two -- next to the words Waianu Complex?

A. Yes.

Q. And then if you go further down, then there is two little ones called Waiokamilo Stream Complex?

A. Yes.

Q. And then about the center of the map there's an area called Lakini?

A. Yes.

Q. And then there's two more areas, one of which is the largest area, and those are both described by the words Wailuanui Complex with an arrow going to those two areas; is that right?

A. Yes, correct.

Q. So what was the purpose of designating these areas on Figure 12?

A. They were the areas that were in active cultivation and had been in continuous active cultivation from the 19th century until present. And probably the 18th century, but we know for sure the 19th century.

Q. Okay. Then Figure 15 was one that you talked about a little bit on your direct examination. I would like you to look at that and ask a few questions about it.

HEARINGS OFFICER McCONNELL: I'm sorry?

MR. SCHULMEISTER: Figure 15.

A. Yes.

Q. So Figure 15, I mean if we relate back on the topographical map, little area that was Lakini, that's the area you indicated on the mauka side of Hana Highway on the left side of this map, right?

MR. MURAKAMI: That last one was what figure?

THE WITNESS: The one before that was --

MR. SCHULMEISTER: Twelve.

A. Yes. So Lakini is the one on the bottom left.

1 Q. And then all the other lo'i shown on Figure
2 15 comprise the two areas that are described as
3 Wailuanui Complex on Figure 12, right?
4 A. Yes. And then I think also the Waiokamilo as
5 well at the top left side.
6 Q. Okay.
7 MR. MURAKAMI: She's referring to Figure
8 15, top left side.
9 MR. SCHULMEISTER: Okay.
10 Q. And when this particular diagram was
11 prepared, was the purpose to depict lo'i that were
12 identifiable, or was it to designate lo'i that were in
13 cultivation?
14 MR. MURAKAMI: Are you referring to Figure
15 15 or Figure 12?
16 MR. SCHULMEISTER: Figure 15.
17 A. I don't know for sure about that.
18 Q. Okay.
19 A. Of course, there was -- you know, there were
20 probably those that were fallow, but I think they
21 might have done all the ones that were identifiable.
22 I can't say for certain.
23 Q. Well, do you remember -- well, when you were
24 working on the survey, you physically went to this
25 area?

A. Yes.

Q. And could you just describe in general terms how much time you actually spent, you know, physically surveying or inspecting the area that's shown on Figure 15?

A. I can't recall. I think I was there for like the main part of the week. I don't know if it was four or five days at that time. But I've been out there before.

Q. Okay. What I would like -- just so we're clear, across the top of Figure 15, that's Wailuanui Road, right?

A. Yes.

Q. And Hana Highway, again, is down on the left side?

A. Uh-huh.

Q. And actually there's another figure that might be helpful to look at. Could you look -- don't lose this one, we're going to talk some more about it -- could you look at Figure 28, please?

A. Okay, uh-huh.

Q. Now, this figure is entitled Existing Buildings, parens, (Wailuanui) With Structures Over 50 Years of Age. And then it looks like it has the lot lines as well as the locations of the buildings.

A. Yes.

Q. And diagonal from the upper left, the lower right, there's a road. That's Wailuanui Road, right?

A. Yes.

Q. And then a diagonal from about the center of Wailuanui Road to the lower left there's another stretch of road, right?

A. Yes.

Q. And on both sides of Wailuanui Road there's a bunch of lots, right?

A. Yes.

Q. And some of -- these are home lots?

A. Homes, yes.

Q. And so if you go back to Figure 15 --

A. Yes.

Q. -- the areas that show the lots on either side of Wailuanui Road, those don't show any lo'i, right?

A. Right.

Q. Now, to your understanding was taro ever cultivated in those, what are now house lots, along Wailuanui Road?

A. No one ever testified to that. It never -- this configuration was after these people acquired the -- ninety-nine year homesteads. And the impression I

1 got was that they got a lot for the house, then they
2 got a plot for cultivation.
3 Q. And the plot for cultivation was typically
4 actually separated from the house lot?
5 A. Yes. That's apparently from the testimony,
6 how it went.
7 Q. So they got homestead lot and with that
8 homestead lot went rights to cultivate a particular
9 patch or area of lo'i, correct?
10 A. Well, they owned it. It was -- you know,
11 they got the homestead area and the cultivation area
12 as part of the allotment.
13 Q. When you were doing the survey -- I want you
14 to focus on the area that's in the center of Figure
15 15, the lower half. And to be more clear, I'm talking
16 about the area of lo'i. There's a fair number of them
17 there. It's between where the black arrows show water
18 coming down from the Hana Highway from the Lakini
19 patches and the two arrows that are coming over from
20 the Wailuanui Stream side.
21 So in that area between there, what's your
22 recollection as to whether those lo'i were actually
23 being cultivated when you were there doing your study?
24 A. Most of them were being cultivated when I was
25 there.

1 Q. Most of them were being cultivated?
2 A. Yeah.
3 Q. That was in the mid 1990s?
4 A. Yes.
5 Q. I want to ask you a few questions about, I
6 guess an area that's a particular expertise that you
7 have pertaining to the period, the end of the 1800s
8 and beginning of the 1900s.
9 A. Yes.
10 Q. I think you mentioned, I think you testified,
11 but I want you to correct me in case I get this wrong,
12 I think you testified that the diversion of water for
13 sugar caused or contributed to a decline in taro
14 cultivation in this area before 1900; is that right or
15 not?
16 A. Yes.
17 Q. And you mentioned the Spreckles Ditch in
18 particular.
19 A. No -- oh, wait, I'm sorry, let me correct
20 myself. I meant at the turn of the century, or it's
21 early 1900. And so I'm not sure what the impact of
22 the Spreckles Ditch was before the 1900s. I'm more
23 familiar with after the 1900s, and I'm not sure the
24 years that the subsequent ditches went in.
25 Q. Just so we're clear, Figure 3, I think you

1 indicated that this included the Keanae area as well
2 as the Wailuanui area that we're talking about.
3 Are you familiar with where the Spreckles
4 Ditch is?
5 A. No.
6 Q. Do you know whether the Spreckles Ditch
7 diverts any water or ever did divert any water from
8 Waiokamilo Stream?
9 A. I don't know.
10 Q. If I were to tell you that the Spreckles
11 Ditch doesn't go that far east, you have no reason to
12 disagree with that?
13 MR. MURAKAMI: Objection, lack of
14 foundation. There's no testimony as to whether or not
15 the Spreckles license for water relates to the
16 Spreckles Ditch. So beyond the scope of
17 cross-examination.
18 HEARINGS OFFICER McCONNELL: I'll sustain
19 that.
20 Q. (By Mr. Schulmeister): Would you agree with
21 me that if the Spreckles Ditch doesn't divert any
22 water and never has from Waiokamilo Stream and
23 Wailuanui Stream, that it couldn't have had an impact
24 on any of the lo'i that were cultivated with water
25 from the stream?

1 MR. MURAKAMI: Objection, lack of
2 foundation. She's not qualified to answer that
3 question. That's not part of her testimony.
4 HEARINGS OFFICER McCONNELL: I'll overrule
5 that.
6 MS. LOVELL: Well, I object to the form of
7 that question on the grounds it's overbroad and vague
8 as to what the effect might be. I think it could be
9 more specific in their question.
10 HEARINGS OFFICER McCONNELL: Do you want
11 to rephrase it?
12 MR. SCHULMEISTER: I'll withdraw the
13 question.
14 Q. Let me ask you this. Are you testifying here
15 today as an expert witness that the Spreckles Ditch,
16 when it was constructed before the turn of the
17 century, reduced the amount of water available in
18 either the Waiokamilo Stream or Wailuanui Stream?
19 A. No.
20 Q. Because you don't know?
21 A. I don't know. Like I said, it's post 1900.
22 Q. But you do know -- I assume you know that the
23 Koolau Ditch was completed in about 1904, 1905. Does
24 that sound right to you?
25 A. I would have to -- as I said, I didn't look

1 up that part of the history before coming. I'm not
2 that familiar with it right now. But I know that
3 there were additional ditches after 1900, don't know
4 the exact year.
5 Q. Could you look at Page 9 of your written
6 testimony, please. In particular, just below halfway
7 down the page, or just above the middle of the page
8 there's a question, says: Did you discover any other
9 evidence of the extent of taro growing in the valley
10 during different times in history following the
11 Mahele.
12 You have an answer says, apparently as an
13 1896 map -- and you refer to Figure 9 -- the lower
14 section of the valley reveals, by then there was a
15 sizeable area devoted to rice cultivation.
16 Do you see that?
17 A. Yes.
18 Q. And Figure 9, is that a reference to Figure 9
19 in the study?
20 A. Yes.
21 Q. So could we look at Figure 9 in the study,
22 please?
23 A. Uh-huh.
24 Q. Have you had a chance to find Figure 9?
25 A. Yeah, uh-huh.

1 Q. And so Figure 9 is a map that apparently
2 showed -- why don't you explain what Figure 9 is?
3 A. The ili ahupua'a of Wailuanui and shows rice
4 cultivation in some of the areas and taro cultivation.
5 Q. So if the Koolau Ditch wasn't diverting water
6 until 1904, then whatever amount of rice cultivation
7 was taking place in earlier in 1896, that was not
8 caused by lands becoming marginal because of
9 diversions that weren't yet taking place, right?
10 MR. MURAKAMI: Objection, lack of
11 foundation as to any evidence yet introduced about the
12 completion of the Koolau Ditch in 1903.
13 HEARINGS OFFICER McCONNELL: I'll permit
14 it, hypothetical.
15 MR. SCHULMEISTER: If it would help, can I
16 withdraw that question and direct you to Exhibit 13
17 which was put in by Maui Tomorrow.
18 A. Pardon me?
19 Q. Exhibit 13, one of Maui Tomorrow's exhibits.
20 I'm sorry, Mr. Murakami, Exhibit 13 by Maui Tomorrow.
21 MR. MURAKAMI: Not sure we have that here.
22 MR. SCHULMEISTER: I'll show you my copy.
23 HEARINGS OFFICER McCONNELL: What is it?
24 MR. SCHULMEISTER: It's Carol Wilcox's
25 article, SUGAR WATER, Hawaii's Plantation Ditches,

1 which has a history of when they were built.
2 HEARINGS OFFICER McCONNELL: I've got it.
3 MR. SCHULMEISTER: Do you have it?
4 MR. MURAKAMI: I don't, sorry.
5 Is this beyond direct examination? I
6 never looked at this exhibit. I'll object for the
7 record.
8 HEARINGS OFFICER McCONNELL: I'll overrule
9 it.
10 MR. SCHULMEISTER: I think you said lack
11 of foundation with regard to when it was completed.
12 We have this exhibit and I would just like to show the
13 witness. It does show when it was completed.
14 Q. My first question: Are you familiar with
15 this article? Have you ever seen it before?
16 A. No.
17 Q. On the third page there's a discussion about
18 the -- I'm sorry, it's the fourth page.
19 MR. MURAKAMI: What's the numbered page on
20 the bottom?
21 MR. SCHULMEISTER: At the top 116, page
22 number at the top.
23 Paragraph says: The next big project for
24 Hamakua Ditch Company was the Koolau Ditch built in
25 1904/1905. Do you see that?

1 A. Uh-huh.
2 Q. Do you have any reason to believe that this
3 is inaccurate?
4 A. No.
5 Q. So could you refer to Page 112 of the
6 Cultural Landscape Study, which is Na Moku's Exhibit
7 B-123.
8 A. Okay.
9 Q. By the way, are there certain portions of
10 this study that you authored as opposed to someone
11 else on the team?
12 A. Yes. I authored the sections based on the
13 oral history.
14 Q. Looking at Page 112, does that look like a
15 section that you authored or not?
16 A. Yes, it would be a section I authored.
17 Q. Subheading No. 11 says: Taro, then you talk
18 about Keanae-Wailuanui District. So that's the same
19 district that we saw shaded on Figure 3, right?
20 A. Yes.
21 Q. Then if you go down to the second full
22 paragraph, says: As noted in Section III of this
23 report on the cultural history of the district, some
24 of the historic taro patches in the district were
25 converted to rice paddies beginning 1880s and through

1 the 1920s.
2 A. Correct.
3 Q. So conversion to rice actually began in 1880s
4 some 25 years before the Koolau Ditch was completed,
5 right?
6 A. Yes.
7 Q. So it wasn't caused by the ditch, right?
8 A. In the period before 1900, I don't -- but I
9 don't know -- up to 1927 there might have been some
10 changes after that. So initially they went into
11 the -- you know, I would still say that the lands that
12 they had given them initially were probably marginal,
13 and as the commercial value of it expanded, they
14 probably expanded the production of rice.
15 And then I'm not sure after 1900 if there
16 was additional impact from the ditches that would have
17 caused the expansion of rice, given both the
18 diminishing of the water and the commercial value of
19 the crop until it, you know, it crashed in '27.
20 Q. But if lands had been cultivated in taro in
21 1880s, being converted to rice -- I think what you
22 said was you thought probably these were marginal
23 lands?
24 A. Initially probably, according to what history
25 indicates, that they were initially marginal areas.

1 Q. But they wouldn't have been made marginal by
2 the ditch because it wasn't there, right?
3 A. Not in the early period, that's correct.
4 Q. Now, on the next page, Page 113, there's a
5 full paragraph, says: Taro began to be produced for
6 commercial sale to Hana and to Wailuku beginning
7 1920s.
8 Now, prior to that had there been a
9 commercial market for taro?
10 A. I would have to go back and look. I don't
11 recall offhand. As I recall -- because they were
12 providing taro to Kalaupapa and I don't remember if
13 that was before 1900 or after 1900. I thought they
14 were also providing taro to Kalaupapa in the earlier
15 period. I'm not -- I would have to go back and review
16 it.
17 Q. The next sentence says: However many of the
18 foremens who are now producing taro for commercial
19 sale indicate that their family mainly began to sell
20 taro for poi after World War II. Before that most of
21 the taro in the district was grown for home
22 consumption. Did I read that correctly?
23 A. Yes.
24 Q. Back when the, what you call marginal, taro
25 areas were started to be converted to rice in 1880s,

1 do you know whether there was any market at all for --
2 commercial market for taro at that time, or was it
3 only rice that was sold commercially?
4 A. No, there's another section in my testimony I
5 talk about the poi mills that were in production. I
6 thought they were in the earlier period. Talk about
7 six different poi mills at different periods of time.
8 The first one they talk about is in the
9 1920s. And then so the poi mills evidently that they
10 talk of were beginning in 1920s. But I believe they
11 sold -- what they sell kalo and pa'i 'ai, not
12 manufactured poi. And they were exporting that, I
13 believe, to Kalaupapa. But I would have to go back
14 and look. But I'm pretty sure that they were
15 providing Kalaupapa with, but not the manufactured,
16 you know, the real processed poi, but more the kalo
17 and what they call the pa'i 'ai also.
18 Q. Then going back to Page 112, that same full
19 paragraph near the bottom talking about the period
20 between the 1880s and 1920s, you say: During that
21 period, taro was primarily grown for home consumption
22 rather than for commercial sale; is that right?
23 A. Yes.
24 Q. And that was based on the oral history?
25 A. Yes.

1 Q. So there was a commercial market for rice
2 during this period, but not for taro apparently?
3 A. Well, as I said, aside from what they were
4 selling to the government in terms of exporting it
5 outside of Hawaii, the main crop there was rice. They
6 weren't selling taro outside of -- except to the
7 government, I would say.
8 We're talking about this area being
9 primarily subsistence taro farmers. So in the main,
10 you know, we're talking about people living off of the
11 the land here in this period of time and not really
12 having that much interaction with the outside world.
13 And then as the Chinese come in, they
14 introduce -- even at that time, it's still primarily
15 the Chinese who are going in and out of Keanae and
16 bartering and then bringing manufactured goods back
17 into Wailuanui and Keanae. And they would take it
18 out, take out taro and then bring back -- and fish and
19 'opae and bring back manufactured goods and such.
20 Q. Could you turn to Page 37 of the study?
21 MS. LOVELL: I'm sorry, what page?
22 MR. SCHULMEISTER: Thirty seven.
23 THE WITNESS: What is the topic -- oh,
24 here. Got it, okay.
25 Q. Is this also a section of the study that you

1 authored?
2 A. No, I don't think I wrote this section.
3 Q. By the way, before the study was published or
4 turned over -- this was a study that was done for, or
5 prepared by the County of Maui Planning Department, is
6 that right?
7 A. Yes.
8 MS. LOVELL: For the county.
9 Q. (By Mr. Schulmeister): Were you engaged,
10 hired to be on this team?
11 A. Yes, I was under contract.
12 Q. Then the product -- then when it was
13 completed it was delivered to the Planning Department
14 for the County of Maui?
15 A. Yes.
16 Q. Before it was turned over, did everyone on
17 the team have a chance to review the entire study?
18 A. Yes, that's correct.
19 Q. So if there was anything that you thought was
20 incorrect or disagreed with, you had an opportunity
21 to --
22 A. To change it. Yes, that's correct.
23 Q. So again, looking at page 37, and in
24 particular the second full paragraph, which says that:
25 Rice farming declined sharply throughout

1 the islands after the first decade of the 20th
2 century: Total acreage dropped from a high of 9,425
3 acres in 1909 to 1,130 acres in 1935.
4 One Chinese continued to lease Keanae land
5 for rice growing in 1926. However, by the 1930s the
6 rice industry had ceased entirely on the Islands of
7 Hawaii, Maui and Molokai. And they cited a source to
8 that. Do you see that?
9 A. Right.
10 Q. Was that consistent with your oral history
11 that you had taken that after this period from -- that
12 started in 1880s through the '20s where former taro
13 land was put in rice, by the '30s there was no rice
14 being grown at all?
15 A. Right, that's correct.
16 Q. But there was rice being grown after 1904,
17 right?
18 A. Yes.
19 Q. The peak year was 1909?
20 A. Yes.
21 Q. And the reason why the rice stopped being
22 cultivated was because of market conditions, right?
23 A. Yes.
24 Q. Because California entered the market?
25 A. Right, correct.

1 Q. And then the next paragraph says:
2 It is unlikely that the abandoned rice
3 fields of the late 1920s in Keanae and Wailuanui were
4 immediately returned to taro production. The economic
5 viability of taro farming remained a question.
6 Do you see that?
7 A. Right. That contradicts what I had written
8 earlier that the 1920s was when the commercial
9 production started in the taro mill, the poi mills
10 began. It contradicts the earlier statement we
11 referred to and my testimony.
12 Q. I hear you, but I'm just trying to find --
13 A. Oh, in my testimony on Page 11, the Alama Poi
14 Shop operated from the 1920s to the 1950s. And the
15 earlier statement you had me refer to said that in the
16 1920s the commercial production of poi resumed.
17 So, yeah. I didn't catch that statement
18 in that section, but, yeah. My section is based on
19 oral histories, and this was written by someone with
20 Cultural Surveys, but I didn't catch that section in
21 the final report.
22 Q. Okay. So just so we're clear on the
23 implications of that, what you're saying is that the
24 result of the work that you did led you to believe
25 that it was economically viable to farm taro in the

1 '20s and '30s?
2 A. Yeah. I guess what might be open for issue
3 is if the taro production that we talk about in 1920s
4 was on the abandoned rice fields or not. So that
5 could have been the fact that it was in other areas,
6 not in the abandoned rice fields.
7 But the implication of this statement on
8 Page 237 is that taro production didn't pick up. So
9 it could have been taro was produced in other areas
10 and the abandon rice fields remained abandoned, but I
11 don't know. I just know that commercial taro picked
12 up in the '20s, although I believe they had been
13 supplying taro also to the government for Kalaupapa
14 earlier than that.
15 Q. And then I just want to go over briefly the
16 area of your testimony where you commented on the
17 reduction in taro cultivation essentially in this
18 century. And in particular if you look at page --
19 MR. MURAKAMI: Objection, vague as to what
20 this century means.
21 MR. SCHULMEISTER: Let me withdraw that.
22 I think I was referring to the last century.
23 MR. MURAKAMI: You're dating yourself
24 there.
25 MR. SCHULMEISTER: Well, from the point of

1 view of the report, it would have been the same
2 century.
3 MS. MURAKAMI: So you're referring to the
4 20th century?
5 MR. SCHULMEISTER: I'm referring to the
6 20th century. I think it's Page 52, and I think it
7 corresponds to the discussion in your written
8 testimony.
9 MS. LOVELL: So page 52 of Exhibit 123?
10 HEARINGS OFFICER McCONNELL: Yes.
11 MR. MURAKAMI: B-123.
12 Q. (By Mr. Schulmeister): I think there's some
13 discussion on Page 9 of your written testimony at the
14 bottom of the page. Basically that there's a
15 reference to a 1936 aerial photograph which is Figure
16 16?
17 A. Oh, yes, uh-huh.
18 Q. And also a 1966 photograph?
19 A. Yes.
20 Q. And according to your written testimony on
21 Page 9 you say: A 1936 photograph shows that a
22 majority of the valley was under taro cultivation,
23 with considerably less tree and bush vegetation than
24 was present in 1994 when I conducted my field
25 research.

1 Did I read that correctly?
2 A. Yes.
3 Q. So if we look at Figure 16, there was a
4 photograph. And by the way, these photographs,
5 because they're black and white, are a little bit hard
6 to -- do you happen to have the color on the original
7 exhibit?
8 A. The original is black and white, and it's
9 actually three by four -- it's a very small picture,
10 so it's hard -- it's not a postcard. It's in the
11 Bishop Museum.
12 Q. Looking at Page 16, could you orient us in
13 terms of what we're seeing there?
14 A. We're looking at the Wailuanui Valley. It
15 looks like it's from the lookout from Hana Road and
16 looking toward Wailuanui.
17 Q. And so if it's from the lookout on Hana Road,
18 then it would be between where the Lakini water
19 crosses the highway and Waikani Falls?
20 A. Yes, I think so.
21 Q. So looking back down on the valley?
22 A. Yes.
23 Q. And then Figure 17 -- by the way, that's a
24 1936 photo, right?
25 A. Yes.

1 Q. And it shows quite a lot of taro being
2 cultivated in that area?
3 A. Yes.
4 Q. And this is long after the Koolau Ditch was
5 already diverting Waiokamilo Stream, is that right?
6 A. That was 1904?
7 Q. 1904.
8 A. Yes.
9 Q. And Figure 17, that is a 1966 photograph; is
10 this taken also from Hana Highway, to the best of your
11 knowledge?
12 A. I think, yeah. But it looks like it's from a
13 different angle. Looks like it's more from the
14 bridge.
15 Q. Waikani Falls Bridge?
16 A. Yeah. That's what it looks like. But it's a
17 Bishop Museum photo so I have no way of knowing.
18 That's what it looks like.
19 Q. I guess the question that that causes me to
20 ask, if it's taken from Waikani and partially obscured
21 by brush on the left, how can you tell whether there's
22 been reduction in taro between 1936 and 1966?
23 A. Oh, I see. Because the areas on the west end
24 is hidden by the hau bush?
25 Q. Right.

1 A. Different view.
2 Q. But anyway, what you know for sure is that
3 there's been a reduction between 1936 and 1996 when
4 you were doing your study, or 1994?
5 A. Yes, that's correct.
6 Q. During that entire time the Waiokamilo Stream
7 was being diverted by the Koolau Ditch, right?
8 A. Yes.
9 Q. And so the water source was principally the
10 springs below the Koolau diversion, right?
11 MR. MURAKAMI: Objection, Your Honor, lack
12 of foundation. This witness has not testified about
13 what the sources of the irrigation flow to the valley
14 have been and where the water has been taken from.
15 There are multiple sources of irrigation, not just a
16 spring. And she's not qualified to answer that
17 question. He's asking her to speculate.
18 MS. LOVELL: I have an objection to the
19 latter part of the question, assumes facts not in
20 evidence or not yet in evidence.
21 HEARINGS OFFICER McCONNELL: True.
22 MR. SCHULMEISTER: I'll withdraw the
23 question.
24 HEARINGS OFFICER McCONNELL: How much more
25 do you have? It's 12:30 almost.

1 MR. SCHULMEISTER: I would say about 30
2 more minutes.
3 HEARINGS OFFICER McCONNELL: Maybe we
4 better take a lunch break, say 1:45.
5 (Noon recess was taken.)
6 HEARINGS OFFICER McCONNELL: I believe
7 we're all here. We're back on the record. You may
8 continue, Mr. Schulmeister.
9 MR. SCHULMEISTER: Thank you.
10 Q. So Na Moku Exhibit B-123, which is the study
11 that we have spent some time on.
12 A. Yes.
13 Q. Could you go to Page 60, please? Are you on
14 Page 60?
15 A. Yes, I am.
16 Q. The bottom of the page there's an Arabic
17 numeral 7 heading.
18 A. Yes.
19 Q. Formerly cultivated lands in the ili of
20 Kupa'u, is that right?
21 A. Yes.
22 Q. And you mentioned this earlier as having been
23 just outside of the shaded area on Figure 3, right?
24 A. Yes.
25 Q. And with regard to this area, apparently you

1 interviewed Isaac and Gladys Kanoa; is that right?
2 A. No, the archeologist did.
3 Q. Did you participate in any interviews of
4 Isaac and Gladys Kanoa?
5 A. No, I didn't.
6 Q. Did you participate in any interviews in
7 which this area up above in the area called Kupau were
8 described as having been cultivated?
9 A. It's mostly based on the archeologist who
10 went there. And then we were sharing our findings,
11 then it was mostly from their statements that they
12 talked about Kupau and the other areas I mentioned.
13 Q. Did you see this area?
14 A. No.
15 Q. So you never actually went up and saw it?
16 A. I saw Lakini. But if it's above Lakini, no.
17 Q. If you continue on Page 64 is were the text
18 continues in a discussion about this area called
19 Kapau. It says: This auwai once provided water to a
20 large irrigated complex which was abandoned in the
21 1950s according to the Kanoa's testimony. The
22 terraces are still visable in the 1982 aerial
23 photograph.
24 Irrigated areas estimated cover
25 approximately 30 to 50 acres. Presently the terraces

are quickly return to forest, however cultivated lo'i are clearly visable on 1950 aerial photograph, Figure 23.

If you turn to page -- actually if you go back one page, I don't know if this is a copy, double sided pages, there's Figure 23.

A. Right.

Q. Can you tell from looking at Figure 23 what is meant by the area that is clearly visible?

MR. MURAKAMI: Objection. She just stated she hasn't been there. She didn't conduct this part of the study. Lack of competence to answer this question.

HEARINGS OFFICER McCONNELL: We all can look at it. I'll overrule that.

THE WITNESS: I can see where Lakini is, which is mauka of the highway. I don't know. I'm not really sure which direction Kupau is. It might be there across from Lakini. I don't really know. That's not Lakini, so this is Wailuanui -- I don't know. I can't say, I can't guess. No, I cannot, sorry.

MR. SCHULMEISTER: That's fine.

Q. Going back to the text. The next sentence says: This system is spatially separated from the

1 Wailuanui system which shares the same stream source.
2 Do you see that?
3 A. Yeah, uh-huh.
4 Q. Was it your understanding that the stream
5 source it shares is Waiokamilo Stream?
6 A. I don't know.
7 Q. So basically you just don't know?
8 A. I don't know about Kupau. I just know
9 evidence of taro there.
10 Q. But the archeologists on the team
11 apparently --
12 A. Right. They were the ones who went out with
13 the Kanoas.
14 Q. And concluded it was being cultivated?
15 A. That's their conclusion, yes, based on this.
16 Q. 1950 or so?
17 A. That's what it says, yeah.
18 Q. And it described, this is under the -- that's
19 fine.
20 So at least as far as this report is
21 concerned, the conclusion is that in the 1930s there
22 was much more taro being cultivated in Wailuanui
23 Valley than there is today. In addition, up above in
24 Kapua there was also taro being cultivated up through
25 at least the early '50s?

A. Yes, according to the report, yes.

Q. And that was all -- and that's much more taro than is being cultivated today?

A. Yes, that's correct.

Q. And that was all after the Koolau Ditch was already diverting Waiokamilo Stream?

A. After the 1904 --

Q. After the 1904 completion of the Koolau Ditch.

A. Yes.

Q. Could you look at Page 142 of the study, B-123?

HEARINGS OFFICER McCONNELL: I'm sorry, the reference again?

MR. SCHULMEISTER: Page 142 of the study. And there is a Roman numeral heading number XI, RECOMMENDATION. Do you see that?

A. Yes, yes.

Q. Did you participate in authoring any portion of this section?

A. Yes.

Q. Under Economic Activity, there is a capital A, Taro Cultivation. Then three subparagraphs. Do you see that?

A. Yes.

1 Q. Did you draft this?
2 A. I didn't draft it, but I read it.
3 Q. There is a number of recommendations here
4 about incentives for taro growing, is that right?
5 A. Yes.
6 Q. And what was the theory behind that, making
7 these recommendations?
8 A. All of these, all of the ones -- economic and
9 subsistence and all that?
10 Q. Well, I'm focusing on Section A, which is
11 taro cultivation.
12 A. It was to support -- recommend to the county
13 what kind of measures they could do to help perpetuate
14 taro cultivation and to protect Keanae-Wailuanui as a
15 cultural landscape.
16 Q. In particular it says: There must be
17 continued incentives for taro growing.
18 What kind of incentives?
19 A. I think we suggested -- I think we said tax
20 relief for parcels that are in taro.
21 Q. And community support which encourages
22 maintenance of the water sources and auwai on which
23 cultivation depends. What is that in reference to?
24 A. Assisting in, if they need, you know, heavy
25 equipment to go out and clear some areas, that the

1 county could assist them.
2 Q. I think you testified and the report
3 indicates that the amount of taro being cultivated in
4 the Wailuanui-Keanae area diminished fairly
5 substantially over the course of the 20th century.
6 A. Yes.
7 Q. And since 1904, that was all after the Koolau
8 Ditch was already in place?
9 A. Yes.
10 Q. So do you have an opinion as to what the
11 factors were besides the ditch that contributed to the
12 diminishing of the reduction in taro cultivation?
13 A. Well, throughout the 20th century?
14 Q. Right.
15 A. I think a major turning point came with World
16 War II when some of the men were drawn out to the
17 service, and then, you know, didn't return. And
18 until, you know, the '50s some of them returned. But
19 that drew some of the -- that generation of young men
20 out of the Keanae-Wailuanui area.
21 I suppose that some of the market issues
22 and problems that, you know, have been problematic to
23 taro farmers in other areas are also factored in. But
24 those are the main issues I suppose.
25 Q. And as areas ended up being withdrawn from

1 taro, did that result in some of the portions of the
2 auwai system falling in disrepair?
3 A. I think what we're noting in the pictures is
4 the old -- you know, coming back of the forest, the
5 forest coming back and covering certain areas.
6 My understanding is that the auwai are
7 still there but they might be covered over. If the
8 area were cleared up, if the auwai is still there, it
9 could be reopened.
10 Q. And I think earlier in your direct testimony
11 you commented that in this area the configuration of
12 the patches, one next to the other, was very important
13 to the irrigation system because the water flows from
14 patch to patch to patch?
15 A. Yes, that's correct.
16 Q. So if you have large areas that are not being
17 cultivated, then that takes away the intervening
18 patches where the water would go from patch to patch,
19 right?
20 A. Yes.
21 Q. And so does that pose a problem? Is that one
22 of the reasons why the amount of taro that is being
23 cultivated has diminished?
24 A. I couldn't say. I'm assuming they were able
25 to alter the flow, but I couldn't say for sure.

1 MR. SCHULMEISTER: I have no further
2 questions.
3 HEARINGS OFFICER McCONNELL: Any other
4 questions? Any redirect?
5 MR. MURAKAMI: Yes.
6 REDIRECT EXAMINATION
7 BY MR. MURAKAMI:
8 Q. In the series of questions Mr. Schulmeister
9 asked you, Dr. McGregor, concerning the timing of the
10 construction and completion of the Koolau Ditch
11 relative to the amount of taro that was available and
12 photographed apparently in 1936, are you aware of any
13 of the details and the features of the Koolau Ditch
14 collection system in Wailuanui Valley to give you any
15 basis to say how much water was being taken out in
16 1904 versus say 1936 or any other point in time
17 thereafter?
18 A. I'm sorry, no, I don't know.
19 Q. So without knowing -- is your direct
20 testimony related to the presence and the importance
21 of water as being part of the taro landscape, correct?
22 A. Right, that's correct.
23 Q. So could you make any kind of determination
24 as to what that contribution, that is the presence of
25 water, was to different levels of taro cultivation

1 without that information about how much water was in
2 the valley?
3 MR. SCHULMEISTER: I'm going to object to
4 the form. I think it was ambiguous.
5 HEARINGS OFFICER McCONNELL: Maybe you
6 could rephrase.
7 Q. (By Mr. Murakami): You don't have any water
8 data, correct?
9 A. I don't have specific water data.
10 Q. No water data pre-1904 versus post-1904?
11 A. No, I don't.
12 Q. And you don't have any water data that
13 contrasts the conditions in Wailuanui Valley as to the
14 availability of irrigation water in 1936?
15 A. No, I don't.
16 Q. And similarly, you don't have any data with
17 respect to the amount of water being taken out of the
18 valley or available in the valley in 1966?
19 A. No, I do not.
20 Q. Or in 1994?
21 A. No, I do not.
22 Q. So not having any of those pieces of
23 information, can you make any kind of conclusion about
24 the cause of diminishment of taro as it might relate
25 to the amount of water available to taro farmers in

1 Wailuanui Valley?
2 A. I just know what the taro farmers say, and
3 they attribute, you know, the diversions as having an
4 impact upon their capacity to expand taro production.
5 But I don't have actual figures. I just
6 have, you know, what their statements are, that it has
7 impacted their ability to, you know, expand the taro
8 production.
9 Q. And more precisely, do you know what the
10 amount of water was taken from the valley in 1904 upon
11 the completion of the Koolau Ditch?
12 A. No, I do not know.
13 Q. Do you know whether or not the amount of
14 water taken out of the valley in 1904 is the same or
15 any different from what water is taken out in 1995?
16 A. No, I don't.
17 Q. Or say 1936?
18 A. No.
19 Q. Thank you.
20 HEARINGS OFFICER McCONNELL: Anything
21 else?
22 MR. MURAKAMI: Just a second, Mr.
23 Hearings Officer. That's all I have, thank you.
24 MR. SCHULMEISTER: No further questions.
25 HEARINGS OFFICER McCONNELL: Thank you,

1 Doctor.
2 MR. HAIA: Our next witness is Paul
3 Reppun. Before we call Mr. Reppun, probably a couple
4 of issues I wanted to try and resolve at this point in
5 time.
6 First one is, prior to this hearing, I
7 sent an e-mail to the party requesting information on
8 whether or not they would agree to the direct
9 testimonies without having to produce the witness.
10 And it was my understanding after some correspondence
11 with A & B's attorney, Mr. Schulmeister, that they
12 would not object to the direct written testimony of
13 Kepa Maly and Paul Reppun, as long as we provided them
14 with sworn signed direct testimonies.
15 And so we did that. You didn't receive
16 anything?
17 MR. SCHULMEISTER: Actually not provided
18 us with it, but I think it should be part of the
19 record.
20 MR. HAIA: We provided the parties with
21 it, and you're saying you didn't receive anything?
22 MR. SCHULMEISTER: Not yet. I haven't
23 checked with my office today.
24 MR. HAIA: Luckily I have copies of Kepa
25 Maly. We're not going to call him based upon your --

1 and we believe that no other parties was going to
2 examine --
3 HEARINGS OFFICER McCONNELL: If you have
4 those affidavits, then we will just file them and
5 testimony well be received.
6 MR. HAIA: We'll take care of that later
7 then.
8 HEARINGS OFFICER McCONNELL: Or now, if
9 you have it all ready.
10 MS. CHOW: Do you want to have them file
11 it back in Honolulu and distribute --
12 MR. SCHULMEISTER: Actually when you file
13 the original with the board.
14 MR. MURAKAMI: Give you copies now.
15 MR. SCHULMEISTER: You can give us copies
16 now.
17 MR. HAIA: At some point in time when it's
18 filed, we would request that the direct testimony be
19 received along with Mr. Maly's exhibits.
20 HEARINGS OFFICER McCONNELL: I'm assuming
21 on your representation that it will be filed, and I'm
22 going to receive the testimony on that basis.
23 MR. HAIA: Conditioned upon the filing of
24 Mr. Maly's direct testimony, we would request that his
25 exhibits also be received.

1 MR. SCHULMEISTER: You mean the
2 cultural --
3 HEARINGS OFFICER McCONNELL: I just don't
4 know what -- is there any --
5 MR. SCHULMEISTER: Are you talking about
6 the three volumes? I don't have a problem with that.
7 MR. HAIA: His resume and the two volume
8 study that he did for EMI.
9 HEARINGS OFFICER McCONNELL: Can I have
10 the exhibit number just so the record is clear?
11 MR. SCHULMEISTER: We already stipulated
12 everything was in.
13 HEARINGS OFFICER McCONNELL: Yeah.
14 MR. SCHULMEISTER: This is kind of
15 unnecessary.
16 MR. HAIA: We were concerned with respect
17 to not having him here.
18 The other issue is --
19 HEARINGS OFFICER McCONNELL: Then the two
20 exhibits that go with the testimony of Mr. Maly will
21 be in evidence as all other exhibits. Okay.
22 MR. MURAKAMI: What about the testimony
23 itself?
24 HEARINGS OFFICER McCONNELL: It's in.
25 MR. HAIA: The next issue is with respect

1 to the documents that I provided to you and you
2 reviewed this in camera. I took your e-mail --
3 HEARINGS OFFICER McCONNELL: Correctly, I
4 think. You took it to mean you didn't have to give
5 them the actual powers of attorney, which I don't
6 know, I guess it was an abundance of caution. I
7 didn't want to invade any kind of attorney/client
8 communication. Not sure it really matters. I notice
9 in Mr. Schulmeister's prehearing brief he raises that,
10 but certainly they exist.
11 MR. HAIA: And we would argue that they're
12 attorney/client privileged documents.
13 MR. SCHULMEISTER: I don't think you can
14 have it both ways.
15 HEARINGS OFFICER McCONNELL: I was having
16 a little --
17 MR. SCHULMEISTER: If you use it as
18 evidence, then it's not privileged. Privilege is
19 something you use to protect something from having to
20 be put it in evidence.
21 MR. HAIA: We've provided the hearings
22 officer with information we believed would potentially
23 be used that didn't need to be released because of the
24 information provided therein, that is our relationship
25 with these clients and the specific scope of that

1 relationship, and that's what we want to keep private.
2 We've provided an exhibit, for the most
3 part, with all the information we believe these other
4 parties need providing the names of the Na Moku
5 members that we have powers of attorneys for, and the
6 TMKs that are at issue, and they are cross-referenced
7 to the Na Moku member, and their mailing or home
8 addresses.
9 And the reason I'm bringing it up is
10 because I would like to move that into evidence also.
11 HEARINGS OFFICER McCONNELL: Which?
12 MR. SCHULMEISTER: Move what into
13 evidence?
14 MR. HAIA: The exhibit that we provided.
15 It was another spread sheet.
16 MR. SCHULMEISTER: We marked it.
17 MR. HAIA: I don't ever believe it was on
18 our exhibit list.
19 MR. SCHULMEISTER: No, we put it on ours.
20 That's among the additional exhibits I gave you.
21 MR. MURAKAMI: Talking about A-50.
22 HEARINGS OFFICER McCONNELL: Let's go off
23 the record.
24 (Discussion off the record.)
25 HEARINGS OFFICER McCONNELL: We're back on

1 the record.
2 MR. HAIA: We're going to call Paul
3 Reppun. And before we get started, Your Honor, I just
4 want to reiterate our objection on the record to
5 having to come forward with the evidence to prove
6 superior rights. And that's based upon the common law
7 that the would be diverter has the entire burden of
8 coming forward.
9 HEARINGS OFFICER McCONNELL: I understand
10 your record has to be amply preserved in that regard.
11 MR. HAIA: Thank you.
12 PAUL REPPUN
13 was called as a witness, was sworn to tell the truth,
14 was examined and testified as follows:
15 HEARINGS OFFICER McCONNELL: Could you
16 state your name?
17 THE WITNESS: Paul Reppun.
18 DIRECT EXAMINATION
19 BY MR. HAIA:
20 Q. Mr. Reppun, did you provide written testimony
21 on behalf of Na Moku Aupuni O Ko'olau Hui, Beatrice
22 Kekahuna and Marjorie Wallett for this case?
23 A. Yes, I did.
24 Q. And I'm going to hand to you what was filed
25 with the Board of Land and Natural Resources on August

1, 2005.

Can you look through that and tell me whether that is your direct written testimony?

A. Yes, it is.

Q. Do you have any corrections or revisions you would like to make to that written testimony at this point in time?

A. No.

Q. Mr. Reppun, what is your occupation?

A. I'm a farmer on Oahu in Waiahole Valley.

Q. Could you tell me what type of farmer?

A. Grow all kinds of crops, but one of our major crops is taro, wetland taro. And my wife runs a poi business, so I also work in that making poi.

Q. How long have you farmed taro?

A. For 31 years.

Q. And where did you begin farming taro?

A. Began farming taro in Ka'alaea on Oahu. And then another farm in Waihe'e on Oahu. At one time we had Ka'alaea, Waihe'e and Waiahole. Have since given up the Ka'alaea. We now farm Waihe'e and Waiahole.

Q. During that 31 years you've been farming taro, has that been without interruption?

A. Yes.

Q. So you've been a full-time taro farmer for 31

1 years?
2 A. Full-time farmer. And taro has always been
3 one of the crops we grow.
4 Q. What is your educational background?
5 A. I have a Bachelor's degree in biology, and
6 that's it.
7 Q. Where did you get that from?
8 A. Harvard University.
9 Q. Have you testified as a witness in
10 proceedings related to taro farming or the water
11 requirements for wetland taro?
12 A. Yes. I testified as a witness in the
13 Waiahole Ditch water case on Oahu.
14 Q. Do you know whether or not you were qualified
15 as an expert witness on the water requirements for
16 wetland taro?
17 A. I don't recall.
18 Q. In your 31 years of farming taro, have you
19 come to a knowledge, a working knowledge of what
20 wetland taro requires in terms of water?
21 A. I believe I have. When we first started
22 farming taro in Waihe'e Valley on Oahu, there was
23 Board of Water Supply diversion of water mauka of us.
24 They drilled four wells into the base of
25 the mountain, started taking water, and the stream

1 declined. And that was right about the time we
2 started growing taro in Waihe'e. And the farmers
3 there all began to fight with each other over the lack
4 of water and claimed that the other guy was building
5 his ditch too tight, things like that, or they weren't
6 keeping the auwais clean. And what was really
7 happening was the stream level was declining.
8 So we got involved in a water case in that
9 valley. That became known as Reppun v. Board of Water
10 Supply. And that involved measuring water and it
11 involved, you know, water right issues and things. So
12 very early on we became educated in this subject.
13 Q. Thanks. Just to be clear though, you said in
14 your testimony that you came to find out that the
15 water levels in the streams was declining, and that
16 was because of the pumping of ground water by the
17 Board of Water Supply, or were they also pumping water
18 out of the stream?
19 A. No, they were taking water only out of the
20 ground. They were taking it out of the mountain.
21 They had already diverted water with the tunnel, and
22 then to that they added four wells that took out more
23 water. So the stream was already seriously depleted.
24 Q. Okay. But you're saying that in pumping
25 groundwater there was an affect on the flow in the

1 streams?
2 A. It was stipulated in that case that a gallon
3 taken out of the mountain was a gallon taken out of
4 the stream.
5 Q. So there was a one-to-one correlation between
6 stream water and groundwater in that instance?
7 A. In that instance, yes.
8 MR. HAIA: You know, at this point in
9 time, Judge, I would move to have Mr. Reppun qualified
10 as an expert witness in the cultivation of wetland
11 taro, with an emphasis on water requirements for
12 wetland taro.
13 HEARINGS OFFICER McCONNELL: I'll accept
14 his opinions in evidence.
15 MR. HAIA: Thank you.
16 Q. You know, you've already talked about the
17 1970s and the problem you had in Waihe'e. Have you
18 experienced any other problems in any other areas in
19 your connection with being a taro farmer? And when I
20 say problems, I mean water problems.
21 A. Well, I would say that for two-thirds of the
22 time that I've been growing taro, we've experienced
23 chronic water shortage. The normal state has been too
24 little water. And that has manifested itself in
25 disease problems, and difficulty in getting the water

1 from the stream into the auwai.
2 Well, it became normal for us. And we had
3 all kind of strategies to try and deal with that. But
4 it wasn't an easy way to farm taro. Only since water
5 was restored to Waiahole Stream in 1995, I believe it
6 was, that we have had an abundance of water and water
7 shortage has not been a problem.
8 Q. So when you talk about Waiahole, I assume
9 you're referring to the diversions that had occurred
10 previously when Oahu Sugar Company was growing sugar
11 out in Central Oahu?
12 A. The Waiahole Ditch was completed in 1916, and
13 there are additions to the diversion over a period of
14 time. And our experience was -- evidence is that the
15 streamflow didn't decline all at once, but declined
16 gradually as the dike system drained down and the
17 storage capacity of the mountain gradually decreased.
18 So over quite a long period of time
19 streamflow decreased. And by the time we came along,
20 the stream was already fairly low level. And we had
21 very -- we were on Waianu Stream, which is a tributary
22 of Waiahole Stream. And we had difficulty getting
23 water from that stream into our auwais without
24 practically diverting the whole flow of the stream,
25 which is something that is undesirable from the point

1 of view of the stream. So --
2 Q. I have a question for you. Are you
3 suggesting that even though, for instance, in
4 Waiahole, even though in 1916, you know, the same
5 amount of water was being diverted in 1916 -- I'm not
6 sure if this is true -- but let's just say, for
7 instance, the same amount of water was diverted in
8 1916 as was being diverted in 1994, I think just
9 before Oahu Sugar Company went out of business, that
10 taro farmers on the windward side started to feel the
11 affects of the lack of water increasingly over time?
12 A. Taro farming declined for a lot of reasons.
13 Probably the chief among them was the taro farmers
14 were dying from disease from early days.
15 So, you know, you cannot say that
16 necessarily the sugar taking water is what caused taro
17 to disappear, but certainly it prevented taro from
18 making a come back. And there's a strong interest in
19 growing taro again. And that interest will not be
20 realized unless water is restored to the stream where
21 people are allowed to use that water to grow taro
22 again.
23 Q. I'm more interested though in your statement
24 that there was an eventual decline in the level of --
25 upper level dike systems within these mountains.

1 A. That's what appears to be what happened in
2 Waiahole. There wasn't -- the affect of the tunnel
3 wasn't immediate. It took place over a considerable
4 period of time. I'm not sure what that is.
5 In the case of Waiahole, there were -- I
6 think the last diversion resulted as an extension of
7 the Uwao Tunnel. I think that was 1964. So there was
8 a further decline in the stream at that point. And
9 again, that may have taken several years to manifest
10 itself. I don't know how long that took. It's
11 difficult to say.
12 One thing about taro farmers is they tend
13 to be irrationally stubborn. And even though they
14 don't have enough water and encounter increasing
15 problems, they tend not to give up. And some of them
16 continue on for very long time growing poorer and
17 poorer taro, and harder time because they refuse to
18 admit they just can't do it any more.
19 From personal experience I know several
20 farmers in our area who are like that and who
21 continued on well past the time a normal person would
22 have given up because the problems were too great.
23 MS. LOVELL: Your Honor, just for the
24 record, I have no trouble whatsoever stipulating to
25 Mr. Reppun's expertise in taro growing, but I do have

1 some difficulty, both with foundation of expertise and
2 relevance to the hydrological situation of the high
3 level dike sources on the Island of Oahu, and the
4 affect of tunnels on the Island of Oahu on certain
5 streams on Oahu to our situation here in Maui, at
6 least without further foundation as to that expertise
7 in hydrogeology.
8 HEARINGS OFFICER McCONNELL: Well, I don't
9 think there's been any connection necessarily at this
10 point. Go ahead. I'll overrule that.
11 MR. HAIA: Thank you, Your Honor.
12 Q. You know, Mr. Reppun, you go through the
13 various stages of taro cultivation from beginning when
14 you prepare the fields through planting and then, you
15 know, actually cultivating them and taking them out
16 and taking the taro or the corm.
17 Is there anything specifically you would
18 like to state with respect to the life cycle of taro
19 and its relationship to water? Because it's in your
20 written direct. And if not, then I'm going to move
21 onto some other area.
22 A. I think my written direct fairly well
23 describes it. I think the main point is that water
24 requirement varies over time. You don't just run a
25 certain amount of water through and keep it at that

1 rate the whole time.
2 The same with depth of water. That there
3 are a lot of factors that control how much water
4 you're using at any one time.
5 There is a period of time when you need a
6 maximum amount of water, and that is a critical time
7 that if you don't get that maximum water at that
8 critical time, then you can hurt your crop.
9 Q. What's, in your opinion, the best way to come
10 to that realization or that conclusion about how much
11 water is needed at any one time? Is it through having
12 farmed?
13 A. I guess you could say the proof is in the
14 pudding, or in this case the poi. Because if your
15 taro rots, you did something wrong. And it can be a
16 number of factors that cause that to go wrong, but my
17 experience over the time I'm doing it I can correlate
18 the presence of diseases with the water regiment.
19 And I've talked to many, many farmers and
20 all the major taro growers, areas on these islands,
21 partly because I'm involved in an organization called
22 Onipa'a Na Hui Kalo, which is a support group for taro
23 farmers. And we've gone to a lot of places and worked
24 and talked with other farmers and tried to help them
25 resolve some of their problems.

1 And I think that it's almost invariably
2 true that farmers will say they need more water,
3 almost invariably. And it's a rare case where a
4 farmer says he has more than enough. They all feel
5 they need more water. And they all agree that if they
6 had more water, they could grow better taro. Colder
7 water means harder taro, better quality taro, less
8 disease.
9 Q. I guess that leads us into the next area.
10 What are the variables that would affect
11 the amount of water besides the time of the
12 cultivation cycle?
13 A. Besides the stage of the crop, you have your
14 soil type, the weather, the season of the year, the
15 amount of insulation, the variety of taro you grow.
16 The way you fertilize it. The starting temperature of
17 the water in the stream, whether or not there are
18 upstream users. Whether or not that water has been
19 used before. Whether or not there is some kind of
20 impoundment of water upstream that allows that water
21 to heat up. That would cover most of it.
22 Q. So in any given circumstance then, one lo'i's
23 water requirement may differ either, you know,
24 nonsignificantly or greatly depending upon the area in
25 which you're farming and topography, et cetera?

1 A. It does, it varies greatly.
2 Q. So there's no one set water requirement,
3 right?
4 A. No. I can give you an example. And that is
5 in the Hanapepe case McBryde v. Robinson. There were
6 studies done of how much water taro needed. And there
7 was a distinct pattern of less water used mauka and
8 more water used makai. And it ranged from, I believe
9 it was 200,000 gallons per acre per day to more than a
10 million gallons per acre per day. And that was for
11 mauka to makai.
12 And I believe what makes sense to me,
13 because I've observed it, is that as that water comes
14 down the stream, water that a farmer uses upstream
15 gets returned to the stream, which increases the
16 temperature of the stream. And the farmer below that
17 needs to use more water to compensate for the
18 increased temperature of the water.
19 So the farmer upstream evidently had as
20 much water available as a farmer downstream, he just
21 had better quality water, much, much colder. So he
22 didn't need to use as much water. I believe that's
23 what that gradient is from.
24 Q. So in your experience then, the temperature
25 of the water entering into any given lo'i is important

1 and may require, based upon the use of some of that
2 water that's entering upstream by another lo'i, there
3 may need to be more water to bring that temperature to
4 an ideal rate downstream in other lo'i?
5 A. Yes. The way I think of it is in terms of
6 new water. If your water coming in has not been used
7 before and it's at natural temperature of that stream,
8 then the minimum amount of water you can flow -- that
9 you need to flow into your lo'i -- or let's say the
10 maximum amount you need to flow in is that amount
11 which keeps temperatures at an acceptable level. And
12 it can be argued what an acceptable level is.
13 The farmer downstream, if he mixes that
14 water with an equal amount of water, he needs to use
15 twice as much. So the amount of new water he uses is
16 the same, but the total amount of water he's using is
17 twice as much because he's used up some of the heat
18 absorbing capacity of that water.
19 Q. So if I understand this then, the hotter the
20 water is downstream, the more water is going to be
21 needed for the lo'i downstream.
22 A. The warmer the water, the more water you
23 need. Because taro needs cold water. It's unlike
24 rice. If you can flood the field, you can grow rice.
25 With taro you can flood the field, but you also need

1 to throw that water away once it becomes too warm.
2 My experience has been if the water is too
3 warm, you're better off not putting any water. You
4 might as well just dry your field up.
5 Q. And that's -- the obvious question is why?
6 A. Because too warm water causes your taro to
7 rot. No water causes the weeds to grow and all kinds
8 of other problems, but for a period of time you can
9 dry your field up without hurting it. But if you run
10 too warm water in your field for extended period of
11 time, you'll cause that taro to rot.
12 Q. In your opinion, based upon your 31 years of
13 experience in taro farming, do you have or do you know
14 of a certain temperature which the water should not
15 exceed in order for it to be suitable for taro
16 cultivation or irrigation of taro?
17 A. Only one study I know of and that's by Donald
18 Plunknett, who did a study that said that 77
19 degrees --
20 HEARINGS OFFICER McCONNELL: Could you
21 repeat the name?
22 THE WITNESS: Donald Plunknett.
23 MR. HAIA: Plunknett or Plunkman?
24 A. I believe it's Plunknett. It's mentioned in
25 my testimony someplace. He said 77 degrees was the

1 temperature in which it began to accelerate
2 unacceptably. And so what that says to me is 77
3 degrees is all right. 78 degrees is still all right,
4 but not as all right. And you can go on up. It's a
5 continuum. When you get up to 80 degrees, 85 degrees,
6 you start to get more problems, may still be something
7 you can live with, but when it hits 90 degrees, you're
8 in trouble.
9 And it's, again, it's not a simple linear
10 relationship. It depends on all kind of other
11 factors. One of them would be if that field has been
12 planted to taro before or has been successfully
13 planted over many years, and if disease has been a
14 problem in that field, you'll have a buildup of
15 disease organisms. So having that warmer water will
16 exacerbate the problem. That's one factor.
17 Other factors are how that farmer
18 fertilizes his fields, whether he uses excessive
19 chemical fertilizers, that can cause a problem too.
20 It has a lot to do with the quality of the
21 water. If you have upstream users that have a lot of
22 rot, you might have diseased organisms introduced that
23 way.
24 But what we do know is this: Colder water
25 inhibits fungus. And so the colder the water is, the

1 less fungus you tend to get. And that's true mostly
2 about pythium rot, which is the classic soft rot of
3 taro which has traditionally been a big problem.
4 Q. How do you spell pythium?
5 A. P-y-t-h-u-m.
6 Another factor that's kind of interesting,
7 a lot of these different diseases of taro have
8 appeared in this last century. And so that's one
9 reason that taro may need more water today than it
10 used to need before, because pythium rot -- I think
11 the Hawaiians always had that, but it's a mutating
12 type of a fungus and new strains of it appear.
13 And I think it was maybe ten, 15 years ago
14 that what they called pocket rot appeared, which may
15 be some kind of a mutation of a fungus we already had.
16 And that pocket rot was devastating for awhile. The
17 taro seems to be developing some defense mechanisms
18 against it.
19 But another thing that's happened was
20 phytopthera, which is a leaf blight, which the
21 Hawaiians didn't have. It came in during this
22 century, and has caused some devastation to the taro.
23 We have leaf hopper that we never had before.
24 And then the most recent one, probably the
25 biggest problem of all is apple snail. And the apple

1 snail is a pest that can destroy taro overnight. And
2 I've done a lot of looking at the apple snail, looked
3 at lot of places where the apple snail is a problem.
4 And it appears to be much less of a problem in the
5 upper reaches of streams than in the lower reaches.
6 And I think that's largely because colder water
7 inhibits the metabolism of apple snails, slows down
8 the growth rate. And I think that's a big factor.
9 And I think one of the solutions to the
10 apple snail problem, which actually threatens the
11 entire industry, is to put more water back into
12 streams. And I think that will help the problem.
13 Q. With specific respect to this temperature of
14 77 degrees, are you saying that beyond 77 degrees, the
15 taro farmer clearly starts to take a risk with his
16 product?
17 A. No. According to the study that's when
18 pythium began to accelerate. Myself, I feel that
19 figure is too low. I think taro can tolerate warmer
20 temperatures, but as I said it depends on the history
21 of the crop. If you have a problem with rot in that
22 field, and you have had over the years, then the
23 warmer water is going to cause rot to appear faster.
24 It's going to be more of a problem.
25 Q. Understood. So let's go on then.

1 In your 31 years of experience as a taro
2 farmer, and you were talking about new water, what do
3 you believe the amount of new water is needed for each
4 acre of taro?
5 A. I believe it's about 100,000 gallons per acre
6 per day.
7 Q. And why is that?
8 A. That's my experience of what a minimum amount
9 is. Myself I would like to -- in my own auwais I run
10 quite a bit more than that. 300,000 is a much more
11 common figure for us. And I believe that when you
12 have colder water, you get denser, better quality
13 taro.
14 Q. Well, when you say 100,000 gallons of water
15 per day, are you saying actual use in each acre of
16 lo'i?
17 A. I would say that's in each acre of lo'i.
18 What that means is that some of your fields -- now we
19 are assuming that we have a complex of taro patches,
20 which is somebody who might be growing either
21 commercially or they're growing enough patches to feed
22 their family that they can rotate their patches around
23 so they have taro in all different stages, so they
24 have a continuous supply of taro to eat.
25 If you have taro in all different stages,

1 some fields could be dry, some fields could be dry
2 fallowed. Some fields could be very low water because
3 you just planted them. Some fields might have maximum
4 irrigation because the taro's getting big, and there
5 is lot of taro there vulnerable to rot. And if you
6 want to hold the taro for long period of time, so you
7 need colder water. So on the average you're going to
8 need 100,000 gallons per day, I think that's a
9 minimum.
10 Q. So at a minimum 100,000 gallons of water per
11 day per acre?
12 A. Yes.
13 Q. In your direct written testimony you provide
14 a range from 100,000 to 300,000. And you know, what
15 are the circumstances under which a lo'i, an acre of
16 lo'i would need 300,000?
17 A. That minimum, I think, if you have cold water
18 to begin with -- and our stream temperatures can vary.
19 If you're down at the bottom of Hanalei Stream, the
20 stream temperature is going to be quite high. You're
21 going to need at least 300,000. It would be good to
22 have at least that.
23 If you're up closer to the mountain where
24 you have colder water in the stream and you have less
25 insulation, then you can get away with smaller

1 amounts.
2 Q. I'm sorry. You know what, to go back to the
3 temperature, because I don't think we covered this.
4 With respect to 77 degrees. At which point do you
5 measure this temperature?
6 A. That's the outflow of the taro patch after
7 it's fulfilled its cooling function and it's flowing
8 out of the taro patch.
9 Q. Before it goes into the stream or another
10 taro patch?
11 A. Before it's diluted with any other water, it
12 can be said to be used up.
13 Q. And at that point 77 degrees, but you
14 mentioned it could be a little higher than that?
15 A. It's very difficult to pinpoint exactly. It
16 depends on other factors too.
17 Q. Do you want to discuss those other factors?
18 A. I think I did. I explained that. It depends
19 on the history of the field and practices of the
20 farmer.
21 Q. So given your numbers, there's some dramatic
22 differences in your numbers as opposed to other
23 numbers from other test results. And you provided
24 information on that, Kirk Miles for McBryde's Sugar
25 Company, and Austin & Associates for Gay & Robinson,

1 in 1959 they did studies on water requirements.
2 What were their conclusions?
3 A. Well, start with McBryde, because I already
4 mentioned the farmers upstream use 200,000 gallons and
5 at the bottom of the stream, more than a million
6 gallons. The conclusion in that study was that
7 farmers needed 60,000 gallons.
8 What they did was they measured the water
9 flowing into the taro patch and out of the taro patch.
10 They took the difference and said that's how much
11 water taro needs. And so they come up with this
12 figure of 60,000 gallons when there were no farmers
13 using that little water. They were always using a
14 minimum at least of 200,000.
15 And so it's very misleading in that study
16 that they say that the water duty of taro is 60,000
17 gallons, because that's not what they measured. It's
18 equivalent to drinking a glass of water and then half
19 an hour later going and taking a piss and taking the
20 difference and saying what you need is what didn't
21 come out. So next time you don't get a full glass of
22 water, you get a full glass of water minus what you
23 peed, then you get that much of water, maybe it's half
24 a glass of water.
25 So theoretically, you don't ever have to

1 make shishi again. And that's what they have done
2 with taro. There have been so many studies that have
3 done this exact same thing. It's been very
4 frustrating for us because we have explained this over
5 and over again, and many people just don't get it, you
6 know, it is you figure out how much water taro needs.
7 There is no one who measured water flowing into taro
8 patches, you know, less than like 60,000 gallons.
9 The other big study that was done was done
10 by Watson. He did studies in Waiahole and Waihe'e.
11 He did the same thing. Measured water flowing in,
12 measured water flowing out, and said what taro needs
13 is the difference.
14 So he came up with this figure of 15 to
15 60,000 gallons, which actually is the water that is
16 consumed in the taro patch. It's lost through
17 percolation, evaporation and transpiration. And he
18 said that's how much water taro needs. Essentially,
19 he's saying what taro needs is enough water to grow
20 dryland.
21 He's not taking any account of
22 flow-through. He mentions in his report,
23 flow-through. He talks about it, but when it comes up
24 with what the water duty of taro is, he takes that
25 difference and says that is what the water duty of

1 taro is. And that's been repeated over and over
2 again.
3 Q. Were any of these people that did these
4 studies, like McBryde, and Gay, Robinson and Watson,
5 do you know whether they were taro farmers?
6 A. I don't think any of them were taro farmers.
7 I think they were very familiar with taro though. I
8 know in Hanapepe and Leslie Watson in Waiahole, I know
9 he was intimate with the taro farmers and he
10 understood how to grow taro, and he talked about all
11 the factors that dictate how much water taro needs and
12 things. It's just that one method of measuring water,
13 water duty of taro that is objectionable.
14 Q. Do you know of any other studies?
15 A. There's several other studies. Most
16 significant one, I think, would be the study by Ramon
17 de la Pena in recent times. And he did some studies
18 to try and figure out how much water taro needs. I
19 think it's quite instructive to note that he came out
20 with a figure of 30,000 gallons per acre per day,
21 which is very close to what everybody else measured as
22 the difference in water flowing in and water flowing
23 out.
24 So all the other studies measured water
25 far higher than what he did and came up with the

1 conclusion that what was consumed in the taro patch
2 was anywhere from 15 to 60,000 gallons. That's what's
3 consumed in the taro patch. Doesn't flow out again.
4 And de la Pena, figure of 30,000 would
5 indicate that if you flowed that amount in to a normal
6 commercial taro patch, that nothing would come out.
7 Because 30,000 is less than 60,000.
8 I've looked at Ramon de la Pena's report
9 and I've thought about it, and thought about it, and
10 I -- you know, I have some things I have questions
11 about. It was a study done one time, never repeated
12 again as far as I can tell.
13 And by way of example, I think it's
14 instructive to note we did a study on our farm this
15 summer. We measured fertilizer rates. We were using
16 fish bonemeal, we put four different rates of fish
17 bonemeal, two replications of each. And this is in
18 conjunction with a soil scientist.
19 When we harvested the crop, there was no
20 difference. We were flabbergasted. That's how
21 science is sometimes. You cannot do an experiment
22 only one time and say this is how it is.
23 In this de la Pena study he did not
24 measure water temperatures. He didn't tell us what
25 the depth was. He doesn't tell us if he varied the

1 water when the crop was young to when the crop was
2 older. He doesn't tell us what the quality of the
3 taro was that was produced, whether it was dense taro,
4 whether it was loliloli taro, whether it was good to
5 eat, what the yield of poi would have been out of it,
6 what the percentage yield would have been.
7 He doesn't tell us what the outflow was.
8 He speculates that it would have flowed out at a rate
9 of 20 to 25,000 gallons per acre per day, which means
10 that why in the world would you put 30,000 if you
11 could put 10,000 and still have outflow.
12 Q. I have a question. What do you mean by
13 loliloli?
14 A. Loliloli taro is spongy; it's not starchy.
15 Q. And that's a result of --
16 A. It can be a result of a lot of things.
17 Usually it's the nutrient balance, those kind of
18 things. If your taro is not real dense, it might not
19 be loliloli, it might just be less dense. You might
20 take a pound of taro and make poi out of it and get 70
21 percent yield, or you might get 90 percent yield, or
22 you might get 100 percent, or you might get 50
23 percent.
24 The higher your percentage of yield is,
25 the better quality the taro is, the more dense it is.

1 So not knowing what that is, you don't know whether
2 the taro was really a good crop or not. So if you get
3 a crop that's 50 percent yield of poi, versus a crop
4 that's 100 percent yield, a 100 percent yield could be
5 half the yield in total weight, but yield as much poi.
6 Much better quality.
7 Q. What does water have to do with that
8 difference?
9 A. Colder water for some reason tends to produce
10 denser taro. I think it's something physiological
11 that I don't understand and I have talked with a lot
12 of scientists about it and they don't understand it.
13 They don't quite understand why taro grows the way it
14 does.
15 Q. I'm a little puzzled with -- because Dr. de
16 la Pena has provided rebuttal testimony, and he's
17 basically taking issue with your claims of the water
18 requirement. And he's saying that you don't get any
19 better yield once you go over 30,000 gallons per acre
20 per day. And so why would you want to use more than
21 that in areas that are, you know, for lack of a better
22 term, pinched for water?
23 In other words, there's not enough water
24 to go around. And bottom line -- and I'm reading to
25 you, he says: I believe that 30,000 gallons a day,

1 you know, and it doesn't say whether or not it's per
2 acre, but I'm assuming that's what it is.
3 A. It is.
4 Q. Will result in 20 to 25,000 gallons per day
5 of flow-through water exiting the irrigated plot. And
6 so long as the water is constantly moving, the soil
7 temperature should be adequately controlled to prevent
8 pythium rot.
9 So my question is: We got an acre of
10 taro, and he's saying you only need to put 30,000
11 gallons into that acre. The actual amount of water
12 that will be lost in that acre of taro is 5,000
13 gallons, and 20 to 25,000 gallons of that that was
14 originally put into that acre will exit and be usable
15 for another lo'i, or another acre of lo'i.
16 So can you explain that to me? I mean --
17 A. No, I can't.
18 Q. Well, can you give an example of what it
19 would look like for 30,000 gallons of water per acre
20 per day flowing through an acre, how much would
21 actually flow through?
22 A. I can give several examples, because we have
23 done this experiment. We've done a workshop to try to
24 show people how to measure water.
25 One method that we've used is, if I've got

1 a bucket, you just fill up a five-gallon bucket with
2 water, the number of seconds it takes to fill out will
3 tell you how much -- what your rate of flow is.
4 So if you take a five-gallon bucket and
5 you fill it up with water and it takes 15 seconds to
6 fill up with water, the water is flowing at a rate of
7 30,000 gallons per acre per day.
8 Q. Can you --
9 A. What that amounts to would be an area, say,
10 the size of a football field with, say, two, or let's
11 be generous, three hose faucets, regular standard 60
12 pound pressure, three-quarter inch faucets on the
13 edges of that field and that's expected to flood that
14 football field and have 20,000 gallons flowing out at
15 the other end. I think it's something that -- I can't
16 even conceive of it.
17 If you break it down to, say, a room this
18 size -- I did the math last night. I've done this
19 several times. On a 1000 square foot room, which is
20 approximately what this room is, it would take 15
21 seconds to fill one cup of water. And it's difficult
22 to run that faucet that slow. It would just be a
23 trickle coming out of that faucet, 15 seconds just to
24 fill one cup.
25 I don't understand it. He did the

1 experiment one time. If he had done that over again,
2 he might have run into all kind of rot problems,
3 because he would have built up pythium, and like I say
4 he didn't measure the outflow; he didn't measure
5 temperature; he didn't tell us what the depth of water
6 was; he didn't tell us what the weather was; he didn't
7 tell us what the quality of the taro was.
8 And one other thing we do know is that the
9 taro with the most flow of water was vegetatively the
10 biggest at the end of the experiment, which indicates
11 to me that the taro hadn't completed its life cycle
12 and was going to produce yet more, that that taro was
13 holding longer and going longer and going to produce
14 more, but who knows.
15 As a scientific experiment, I think it
16 leaves a lot of questions open.
17 Q. I just want to get it clear in my mind. When
18 you talk about this room and the square footage in
19 this room and you're applying it to 30,000 gallons per
20 acre per day, what you're saying is -- how big is the
21 cup, 12 ounces?
22 A. What we're talking about is the rate of water
23 flow. So if we take the rate of water flow of 30,000
24 gallons per acre per day and we apply it to this room,
25 this room, if it's a thousand square feet, is roughly

1/43rd of an acre. So we're taking 1/43rd of that 30,000 gallons, figure out how much water that is. Then you break that down to how many seconds it would take, and there's, what, 86,400 seconds in a day or something like that. Break it down to how many seconds it would take to fill a container of a certain amount, certain size. It's just a trickle of water, just a trickle of water coming in.

And if you take his figure of 30,000 gallons per acre per day and you compare it to all the other studies that have been done, all the other studies show that that is the amount of water roughly that is consumed in a taro patch. His plots were six meters by nine meters. Those are pretty tiny, 18 feet by 27 feet, smaller than this half of the room.

Maybe you just can't extrapolate that into a large taro patch. I don't know how he puddled the soil. Maybe he puddled it super well, he tamped it so that no water was percolating through. I don't know. Maybe he did actually get some water flowing out of it. But normal situation, you wouldn't. In an open field, you wouldn't.

Q. You're suggesting then that there may be circumstances under which you could grow wetland taro with 30,000 acres and getting 20 to 25,000 -- I mean

1 with 30,000 gallons of water per day and still getting
2 20 to 25,000 gallons of flow-through?
3 A. Based on all the other studies that have been
4 done, I say that can't be done. I just don't think it
5 can be done. I think that quantity of water would
6 take a long time just to saturate the soil.
7 Q. You mentioned dryland taro. Can you explain
8 the difference between dryland taro and wetland taro
9 and the difference between how you grow them and what
10 the water requirement is for dryland and wetland?
11 A. Dryland taro is a dryland crop like any other
12 dryland crop, like lettuce or tomatoes or anything.
13 If you give it too much water, you saturate the soil,
14 you can hurt it. It doesn't like stagnant water.
15 Doesn't like saturated soil condition. So dryland
16 taro is like any other crop.
17 In terms of the taro itself, it's almost
18 like a different form of starch. Dryland taro is not
19 as sticky, not as -- the starch doesn't have the same
20 quality to it. I don't want to insult people who grow
21 dryland taro, but it doesn't make as good poi. And
22 there are places like upland Kona, they grow dryland
23 taro. They have some varieties that make pretty good
24 poi, they like their poi.
25 But Hawaiians grew wetland taro every

1 place they could possibly get water to. And that was
2 for a reason, because the wetland taro produces more.
3 Takes longer but it produces more and produces
4 different quality of taro that is suitable for making
5 poi.
6 Q. So assuming that I would be vigilant and
7 water like dryland taro plants, I could probably grow
8 my own dryland taro in my backyard which is at, you
9 know, sea level with a garden hose?
10 A. Anybody can do that. Anybody can grow
11 dryland taro. It's easy.
12 HEARINGS OFFICER McCONNELL: Let's take a
13 short break. How much more do you have?
14 MR. HAIA: Probably about ten minutes.
15 (Recess was taken.)
16 HEARINGS OFFICER McCONNELL: We're
17 reconvened. Mr. Haia.
18 MR. HAIA: Thank you, Judge.
19 Q. You mention a 1980 report by Farrington and
20 Bellwood on the Prehistoric Irrigation Hydrology of
21 Pondfield Taro.
22 Is there any significance to that report
23 with respect to what we've been talking about today?
24 A. Only that they use a different methodology.
25 As I remember, they tried to gage what the capacity of

1 the auwai was and to measure the area in the complex
2 of taro lo'i and try to correlate the two and
3 determine how much water taro needed that way.
4 Q. I forgot to ask you if there's anything that
5 you wanted to add to your testimony. Is there
6 anything that you wanted to elaborate on in your
7 written testimony? I know I asked you whether or not
8 you had any changes or revisions.
9 A. I think the only thing -- I think I probably
10 have added whatever I needed to add. One thing I
11 might want to stress is that the biggest problem
12 facing taro farmers today is apple snail. And that I
13 think the temperature of the water is relevant to
14 control of the apple snail.
15 Q. So that was it?
16 A. Yes.
17 Q. I just have one more line of questioning for
18 you. There's, I believe it's rebuttal testimony by
19 Mr. Garrett Hew, and in that testimony Mr. Hew at Page
20 6 -- or 18, says, Mrs. Kekahuna's unsigned written
21 testimony suggested the temperature of the water
22 coming into her auwai is too warm to allow cultivation
23 of a healthy taro crop, Exhibit A-13. And I'm going
24 to let you look at A-13.
25 Exhibit A-13 shows that the water measured

1 at her auwai over a 14-month period has not risen
2 above 20 degree celsius, paren, 77 degrees farenheit,
3 close paren, and has been as low as 18 degrees
4 celsius, paren, 64.4 degrees farenheit, close paren,
5 as such insufficiently cool to allow cultivation of a
6 healthy taro crop, even under the standard stated in
7 the direct testimony of Paul Reppun.
8 And the standards that you provided were
9 the 100 to 300,000 gallons per acre per day.
10 Can you take a look at the Exhibit A-13
11 and determine from a review of A-13 whether or not the
12 statement made by Mr. Hew is accurate?
13 A. These are temperatures taken on the water
14 flowing into the lo'i?
15 Q. At the intake -- at the point of the auwai,
16 where it enters into the auwai.
17 A. So before it's been used in the lo'i?
18 Q. Right.
19 A. The first thing I notice, these are all taken
20 in the early morning when water is coldest. I see
21 some very cold temperatures here, but as the year goes
22 along, the cold temperatures, 18 degrees is in March,
23 19 -- temperatures begin to rise as the year goes
24 along. Middle of the summertime the temperatures are
25 all 25 or 24 degrees centigrade. So that means the

1 water entering the taro patches in the morning time in
2 the middle of the year is at the point where some
3 authorities might say it's been used up already.
4 So I would say that you could grow taro
5 with that kind of water, but you need a lot of water
6 to do it. My guess would be that as the day wore on,
7 as you got into the hottest part of the day, which
8 would be around 2:00 o'clock in the afternoon, your
9 water temperatures would be up in the nineties, would
10 be my guess.
11 We like to measure water in order to
12 determine what negative effect it might have at about
13 2:00 o'clock in the afternoon at the outflow of the
14 taro patch, and that's going to tell you whether your
15 water is too warm or not. Measuring the water on the
16 inflow is not very helpful. You can extrapolate from
17 that.
18 Q. Would it make a difference if there are
19 upstream users of that water and may at different
20 times of the day choose to pump water out of the
21 stream above Ms. Kekahuna's diversion? Would you want
22 to know that to make that determination?
23 A. If these figures were taken selectively to
24 avoid a time when somebody else was using water, then
25 it would make a difference. But if these are just,

1 you know, this was done on a schedule randomly or
2 whatever, you know, this shows that there's an
3 adequate amount of water at an adequate temperature
4 for most of the year but not during the hottest month
5 of the year. I would say that this shows that during
6 the hottest month of the year, there's not going to be
7 enough water. That water's going to be too warm.
8 I don't know anything about upstream.
9 Q. Mr. Hew also says that when taking -- at Page
10 5, paragraph 16 of his testimony -- when taking
11 measurements of the flow rate at Kekahuna's auwai, it
12 was necessary each time to open the gate to the auwai
13 completely in order to obtain an accurate reading of
14 the full amount of water available for diversion into
15 the auwai.
16 My understanding is that at the point in
17 time that they're going to measure the water into the
18 auwai, they take as much water into the auwai, in
19 other words, away from the stream, as possible, to get
20 these readings. Do you know?
21 A. I don't know what the gate looked like,
22 whether it takes the full flow of the stream or not.
23 I can tell you, if it's taking the entire flow of the
24 stream, I guess I wouldn't want to be an o'opu
25 downstream.

1 Q. Well, I don't know whether or not it takes
2 the entire flow of the stream, but in order for -- all
3 I'm saying is that, you know, as a taro farmer -- and
4 this is just for you, Mr. Reppun, are you going to, at
5 the risk of aquatic species downstream users, take all
6 the water out of the stream to satisfy your --
7 A. No. I would never take the entire flow of
8 the stream. That's -- I think it's in the interest of
9 the stream for the taro farmer to minimize his
10 diversion.
11 Q. Thank you. That's all I have.
12 MS. LOVELL: I have just a couple of
13 questions.
14 CROSS-EXAMINATION
15 BY MS. LOVELL:
16 Q. I would just like to clarify, Mr. Reppun,
17 that when you talk about doing taro farming in
18 Waihe'e, you're talking about on Oahu?
19 A. Yes.
20 Q. And not Maui?
21 A. No.
22 Q. And again to clarify, your lawsuit against
23 the Board of Water Supply, that was against the Board
24 of Water Supply of the City and County of Honolulu;
25 correct?

1 A. Yes.
2 Q. You have never sued the Department of Water
3 Supply on Maui, have you?
4 A. No.
5 MR. MURAKAMI: Not yet.
6 Q. MS. LOVELL: Or the Board of Water Supply on
7 Maui?
8 A. No.
9 Q. Very well. That's all I have.
10 MR. MERCHANT: Just real quickly.
11 CROSS-EXAMINATION
12 BY MR. MERCHANT:
13 Q. Have you been to any of the lo'i or streams
14 at issue in this case?
15 A. Yes, I have.
16 Q. Which ones?
17 A. I've been to Lakini and I've been to -- I'm
18 not sure exactly how I describe which ones, but some
19 of the ones that get fed from the Waikani side, at the
20 time I was there, there was no water flowing from that
21 side. But some of those lo'i there on the left side,
22 I've seen that.
23 Q. By the way, my name is David Merchant. I
24 represent Maui Land & Pineapple.
25 You listed a number of factors when you

1 were talking about lo'i water temperature in general.
2 The lo'i you visited that are part of this
3 controversy, were there any of those factors that came
4 into play, elevation, canopy cover that would affect
5 the water needs of the lo'i that we're talking about
6 in this case?
7 A. They appeared to have a real bad apple snail
8 problem. That was the most obvious thing I saw. And
9 I -- while I don't have apple snail myself, my
10 experience has been that people with colder water
11 don't have as bad a problem and that's very important.
12 It would be very important for those farmers to get
13 more water for that reason alone.
14 Other than that, they all seem to be, you
15 know, more or less equidistant from the mountains in
16 terms of that affecting the amount of sunlight they
17 get or the amount of cloud cover, that kind of thing.
18 Some were upstream of others, obviously
19 that makes a difference.
20 Q. But they would be within the parameters --
21 you made some generalization, 100 to 300,000, they
22 would be within the boundaries of your
23 generalizations? They would fall within? They're not
24 some outlying or super high or super low?
25 A. No. Only that the ones further downstream

1 might need more water because they're getting some
2 used water. I noticed that a lot of the lo'i, the
3 waters flowed from one lo'i to another, and that would
4 definitely mean that the lo'i further down would need
5 more water.
6 Q. No further questions. Thank you.
7 HEARINGS OFFICER McCONNELL: Thank you.
8 Mr. Schulmeister.
9 CROSS-EXAMINATION
10 BY MR. SCHULMEISTER:
11 Q. I'm David Schulmeister. I represent EMI and
12 Alexander & Baldwin, Inc.. Just a few questions.
13 First one is you've cited, I think it was
14 a study or experiment about water temperature and
15 taro, and I think we had a little bit of discussion
16 about the spelling of the name and you thought it was
17 in your written testimony.
18 A. No, it's not in my written testimony.
19 Q. Could you spell it?
20 A. I'm pretty sure, Plunknett,
21 P-L-U-N-K-N-E-T-T, I believe it's Donald Plunknett.
22 You can ask Ramon de la Pena, he's worked with him, so
23 he knows him.
24 Q. Do you remember like who published it?
25 A. I think it was a paper that he published

1 under the auspices of University of Hawaii or CTAHR.
2 Q. On the issue of the amount of water that's
3 absorbed, and you weren't here, but I guess it was
4 yesterday when Mr. Schupp testified that with -- have
5 you ever been to his taro patch on Puolua Stream?
6 A. No. Mr. Schupp?
7 Q. Earnest Schupp.
8 A. No.
9 Q. One of the things he said was that when he
10 was cultivating, he had eight lo'i there, not sure
11 what size, less than an acre. That once the ground
12 was saturated, that 95 percent of the water that came
13 in just went back into the stream. Do you think
14 that's plausible?
15 A. It's plausible, depends on soil type and
16 things like that, possible.
17 Q. Okay. And with regard to Dr. de la Pena's
18 testimony, he indicated that the plots in the study
19 that he did on Kauai, that he estimated that like 20,
20 25,000 gallons flowed through after 30,000 flowed in.
21 So that would be a consumption much higher than the
22 five percent, right?
23 A. This Mr. Schupp that you mentioned, did he
24 measure his water --
25 Q. I don't think he was asked that question.

1 A. -- measure water in and out? 95 is a very
2 easy figure to throw out without measuring. It may
3 have been 85 or may have been 80.
4 Q. That's why I asked you whether plausible.
5 A. It's possible. Really well-puddled soil, it
6 could be. My experience would be that 95 doesn't flow
7 out. Usually consumption is little higher than that.
8 Q. In other words, higher than five percent?
9 A. Usually it's higher.
10 Q. So maybe 15 or 20 percent?
11 A. I would say on the order of 20 percent, and
12 it can be much higher than that too.
13 Q. But so if you take the 25,000 gallons that's
14 flowing through, according to Dr. de la Pena's study,
15 that would be just over 80 percent, so that would be
16 consistent with that, right?
17 A. Yeah.
18 Q. So actually it's not that implausible as
19 Dr. de la Pena said he estimated about up to 25,000 of
20 30,000 gallons was flowing through?
21 A. I disagree that once your soil is saturated
22 most of it flows out. What happens once it's
23 saturated is your flow-through carries away heat, but
24 the taro is going to consume a certain amount through
25 evaporation and transpiration. So in the case of de

1 la Pena's experiments, I believe if you flowed 30,000
2 in, he would get nothing coming out.
3 Q. So it would consume everything, 100 percent?
4 A. Yes, yes. In his case, yes.
5 Q. Why is his case different from someone
6 else's?
7 A. Well, see, if you took my taro patch, I might
8 be flowing 200,000 in and might be getting 170 out.
9 Consumption is 30,000. If I flowed 30,000 in, my
10 consumption would still be 30,000.
11 Q. So we shouldn't focus on the percent, we
12 should focus on the absolute quantity consumed?
13 A. Yes.
14 Q. So what you're saying is that quantity is
15 what?
16 A. Which quantity?
17 Q. The gallons that are actually consumed by the
18 taro?
19 A. Consumed by the taro?
20 Q. By the taro.
21 A. From the studies I've seen, it ranges from
22 15,000 in the Watson study up to 60,000, and I think
23 sometimes it goes higher if you have rocky soil and,
24 you know, a lot of crayfish, that kind of thing. I
25 would say 15 to 60. The Watson figure is a pretty

1 good one.
2 Q. 50 to 60?
3 A. 15,000 to 60,000. And again, it depends on
4 the time of year and those kind of things. For
5 example, if your crop is mature and shrinking back
6 down, your leaf cover diminishes, you have more
7 sunlight hitting the water, evaporation increases.
8 Q. You mentioned that you had seen the Lakini
9 taro patches. When was that?
10 A. This was two years ago. I forget what time
11 of year it was.
12 Q. Could you estimate how many acres of taro
13 were in production at Lakini taro patches when you
14 visited them?
15 A. I would say there's more than an acre, around
16 -- it's difficult for me to say. I didn't walk the
17 perimeter. We were opening an auwai makai of that, so
18 we just kind of climbed up the hill and looked at it.
19 We didn't check it out very carefully.
20 Q. You were opening an auwai makai of that?
21 A. Yes.
22 Q. Where?
23 A. From where the water enters the middle of
24 Wailua Valley and splits in three different
25 directions. I believe it was already going in two

1 directions. One of them would be in the Kahului
2 direction and one would be straight over the cliff and
3 the one we opened was the one headed towards Waikani.
4 Q. Who were you with?
5 A. Four hundred other people.
6 Q. And is that what's sometimes referred to as
7 the upper ditch?
8 A. I never heard it referred to that.
9 Q. Does that begin from like a divert --
10 concrete diversion box that has holes in it?
11 A. I guess it has holes in it.
12 Q. Do you remember --
13 A. It's the water that comes across Lakini and
14 goes into a concrete diversion box. Some of it jumps
15 straight over the cliff, some of it goes off to the
16 left looking makai, and this auwai went off to the
17 right. There is a section of pipe there and then it
18 goes into an auwai and goes down the hill. Very steep
19 grade. It ends up joining into the auwai that comes
20 from Waikani Falls and doubling back towards that side
21 of Wailuanui.
22 Q. And what was going on the day that you were
23 opening up the auwai?
24 A. The thought was that they didn't have enough
25 water on that side of the valley and that this was a

1 way that water could be pushed in that direction.
2 And while everyone knew that it wouldn't
3 increase the amount of water, that the hope was that
4 if more water was released into the stream, they would
5 be able to better spread it around, was the idea
6 behind it. And in a sense it was a symbolic act.
7 Q. What was the extent of the work that was
8 done?
9 A. This was, I estimate, three quarters of a
10 mile of almost solid hau tree, and it was chainsawed
11 out and cleared out and all the branches pushed on the
12 side and debris cleaned out of the auwai and some
13 sections down at the lower part. I would say at least
14 100 feet was dug two feet deep or so through dirt, and
15 then it was -- the water was brought down. It was
16 finished by lunchtime. Four hundred people did that.
17 Q. And did the work go all the way to -- well,
18 you said this ditch connects to one that goes to
19 Waikani Falls?
20 A. Yes.
21 Q. Did the work go all the way to Waikani Falls?
22 A. No.
23 Q. Is there a section where the auwai from
24 Waikani Falls is actually an underground pipe?
25 A. Not the section that we let this water into.

1 It's kind of an unusual situation. The water comes
2 down, then it goes down a little gully and underneath
3 the auwai, as I remember. And then joins the auwai a
4 little bit farther down the Waikani auwai.
5 Q. And where it joins the auwai, the work went
6 all the way down to that point?
7 A. It went all the way down -- the Waikani auwai
8 was cleaned as well, even though it had no water in
9 it, we cleaned the Waikani auwai.
10 Q. And you mentioned that there's some pipe in
11 the section of this auwai?
12 A. I think, at the very beginning coming off of
13 that cement box, I think there is a little bit of pipe
14 in there.
15 Q. And so does the water go through the pipe?
16 Is that the idea?
17 A. Yes.
18 Q. What's the dimension of the pipe?
19 A. I think it might be ten inches or eight
20 inches, something like that. I saw it. I don't
21 remember very well because I wasn't working on that
22 end.
23 Q. From your visits and whatever work you've
24 done on this, do you have any idea what the acreage of
25 lo'i is that is supposed to be serviced by this

1 particular auwai?
2 A. Which particular auwai?
3 Q. The one we just described that you worked on.
4 A. The one I worked on?
5 Q. Right.
6 A. I'm not sure how the water exactly was
7 divided down in Wailua, but I would guess it's a
8 substantial area. My guess would be it might be ten
9 or 15 acres. That's a pretty wild guess. But
10 something on that order. All I can say is what I
11 think the whole of Wailuanui looked to me like it has
12 considerable area where taro could have been grown.
13 And it's only a small fraction of that that is being
14 grown at this time.
15 Q. Do you have an estimate of what the
16 percentage of the Wailuanui area lo'i is that would be
17 serviced by this auwai and couldn't be by any other
18 auwai?
19 A. No, I don't have a good guess. I could make
20 a guess, but it would be too rough.
21 Q. That's okay.
22 In all this work that you've done in taro
23 and irrigating taro, has that given you a sense, like,
24 for any sort of rule of thumb in terms of how many
25 gallons per day can be passed through pipes of

1 different dimensions?
2 A. Depends entirely on the fall of the pipe. I
3 do have an idea if a pipe is running more or less on
4 the level at the same grade that a normal auwai would
5 run, yes, I have a sense of that.
6 Q. In that situation, how much water would pass
7 through a ten-inch pipe?
8 A. In the case of Wailuanui, the auwai that I
9 worked on?
10 Q. No, the relatively level -- the example you
11 gave.
12 A. Through ten-inch pipe?
13 Q. Yes.
14 A. I think could probably easily carry 300,000
15 gallons a day or maybe more. If it was full, or --
16 depends.
17 Q. Now, you mentioned that they had a bad apple
18 snail problem that you witnessed?
19 A. Yes.
20 Q. Was that in Lakini or down below?
21 A. Lakini had apple snails but didn't seem to be
22 a problem, hardly visible. Down below, highly
23 visible.
24 Q. I don't have any further questions.
25 HEARINGS OFFICER McCONNELL: Anything

1 else?
2 MR. HAIA: I have one redirect.
3 REDIRECT EXAMINATION
4 BY MR. HAIA:
5 Q. Both Mr. Schulmeister and Mr. Merchant asked
6 you about the apple snail. I don't think Mr. Merchant
7 asked you, but you mentioned the apple snail, and Mr.
8 Schulmeister followed up with that.
9 You're saying Lakini is one of the higher
10 lo'i systems, then Wailuanui Valley is beneath it.
11 And I believe your testimony was while Lakini shows
12 evidence of apple snails, the problem is much more
13 defined in Wailuanui Valley.
14 Do you have anything that you would
15 attribute that to?
16 A. Colder water.
17 Q. That's all I have. Thank you.
18 HEARINGS OFFICER McCONNELL: Thank you.
19 Would you raise your right hand.
20 BEATRICE KEKAHUNA
21 was called as a witness, was sworn to tell the truth,
22 was examined and testified as follows:
23 HEARINGS OFFICER McCONNELL: Can you state
24 your name, please?
25 THE WITNESS: My name is Beatrice Pualani

1 Kepani Kekahuna.
2 MR. MURAKAMI: Can I proceed?
3 HEARINGS OFFICER McCONNELL: You may.
4 DIRECT EXAMINATION
5 BY MR. MURAKAMI:
6 Q. Beatrice, would you give us your address, if
7 you can?
8 A. Post office.
9 Q. Okay.
10 A. P.O. Box 427, Haiku, Maui.
11 Q. Do you recall helping to prepare with me
12 testimony for submission to this proceeding, this
13 contested case hearing here sometime earlier in
14 August?
15 A. Yes, I do.
16 Q. And I'm going to hand you a copy of what is
17 labeled Petitioner's Direct Testimony of Beatrice
18 Pualani Kepani Kekahuna, filed August 1, 2005 at
19 Department of Land and Natural Resources.
20 Is this that testimony that you reviewed
21 and prepared with my help back in August of this year?
22 A. Yes, it is.
23 Q. And you went through it more than once,
24 right?
25 A. Yes, I did.

1 Q. So do you affirm or do you say that this
2 testimony that I handed you is true and correct and
3 what you provided to me to put on this piece of paper
4 for submission to this contested case hearing?
5 A. It is true.
6 MR. MURAKAMI: Based on that testimony, I
7 move to admit this testimony.
8 HEARINGS OFFICER McCONNELL: It will be
9 received in evidence.
10 (Written Testimony of Beatrice Kekahuna
11 was received into evidence.)
12 Q. (By Mr. Murakami): We're not going to repeat
13 the whole testimony, but I want to ask you, first of
14 all, you were born in 1932, correct?
15 A. Correct.
16 Q. And your current residence is in the Honopou
17 area, correct?
18 A. Correct.
19 Q. And we went to visit that area yesterday?
20 A. Yesterday.
21 Q. And so the house that we went to when we
22 first parked, is that where you live?
23 A. That's right.
24 Q. How long have you been living down there?
25 A. About ten, 15 years.

1 Q. And that's as an adult, correct?
2 A. Yes.
3 Q. And as a girl, where did you grow up?
4 A. Right there, in that same house.
5 Q. So you left Honopou for some period of time?
6 A. Got married and moved, yeah, away, for
7 awhile.
8 Q. How long was that? How long awhile?
9 A. Raised my children out of there, not in
10 Honopou, but Honolulu for eight years, and I moved
11 back to Honopou.
12 Q. In your testimony you talked about as a girl
13 you remember helping your parents grow taro.
14 A. Yes, I do.
15 Q. Is it any different in terms of where the
16 lo'i were way back then as opposed to what we saw
17 yesterday?
18 A. It's the same.
19 Q. Same area?
20 A. Yes.
21 Q. Who did you help at that time way back as a
22 girl?
23 A. I helped my dad. He was a caretaker. He was
24 the one that raised taro to provide his family.
25 Q. And so you grew up eating taro?

1 A. Eating taro.
2 Q. And what other -- did you depend on the
3 Honopou Stream for other kinds of food?
4 A. Yes, we did.
5 Q. What were they?
6 A. As a little girl I had brothers and sisters
7 older than I am. I am the second to the last in the
8 family. We had 11 in the family, and I was second to
9 the last. And we used to go to the stream every
10 morning, early in the morning before the sunrise and
11 used to catch o'opu, pick them up and put it in a
12 pan -- in a big can, and leave them there. Because
13 when they -- you leave them there, then they clean up
14 themselves.
15 In the evening we used to use that for
16 dinner. Or sometimes we used to go to the beach and
17 hook fish, and come home dry it up. That's what we
18 used to live on.
19 Q. What kind of fish?
20 A. Moili'i. All kinds that we could get down
21 there, manini. My dad used to go get papio, even eel,
22 and opihi. Whatever my dad could bring home to raise
23 his family, that's what we used to live on.
24 Q. And did you, in those days as you remember
25 eating these kinds of food, did you buy much food in

1 addition to what you caught and what you grew?
2 A. Hardly, because my dad raised taro and we
3 lived on taro, sweet potato. And maybe sometimes
4 pumpkin. And we had our own -- my dad had a cow, used
5 to milk the cow. And that's what we used to drink in
6 the morning, milk from the cow.
7 Q. So let's see, you mentioned you eat taro?
8 A. Yes.
9 Q. You drank milk from the cow?
10 A. Yes.
11 Q. You caught o'opu to eat?
12 A. A lot of them.
13 Q. And you caught moili'i, manini and other
14 kinds of fish from the nearby ocean?
15 A. Uh-huh.
16 Q. Were there other things that you gathered
17 from the stream?
18 A. Yeah, hihiwai, 'opae and o'opu.
19 Q. So the hihiwai, the o'opu, the 'opae, all of
20 this became a regular part of the diet of your family
21 of 11 children and mother and father?
22 A. Yes, it was.
23 Q. This is how you grew up for the 18, 20 years
24 you grew up there?
25 A. Yes.

1 Q. Then you got married, moved away, still on
2 Maui?
3 A. Yeah, for some time in Maui. And then in, I
4 would say in the '50s, probably '57, we moved to
5 Honolulu. Stayed there a year, and we moved back,
6 because my father was getting old.
7 Q. What year did you move back?
8 A. Around '64, '65.
9 Q. Now, focusing on the time from 1964 to now,
10 were you able to follow those same kind of traditions
11 and customs about gathering your food and other
12 products and growing your taro like you did before you
13 left?
14 A. I couldn't get it out of my head, it was
15 there. It was in my head. It was in my heart. So my
16 dad passed away.
17 Q. What year was that?
18 A. '71.
19 Q. And at that point you were living in Honopou
20 full-time?
21 A. Right after that, right after my dad passed
22 away, I moved in there. It was in '80, '82, we moved
23 back there.
24 Q. '82?
25 A. It was in between '80 and '82.

1 Q. '80 and '82. Earlier you said -- did you
2 stay there from then on, because I thought earlier you
3 said you were living there for the past ten years?
4 A. Yes, it was probably ten years now.
5 Q. But between '80 and now is about 25 years.
6 A. Well, we moved there in '80. I remember that
7 because I had to quit my job, because I was feeling
8 kind of sick. So my husband and I moved there and we
9 stayed there from that time on until today.
10 Q. Now, after 1980 when you moved back, were you
11 able to grow the same amount types of taro that you
12 remember doing as a girl with your father?
13 A. No, we did -- I did try to plant taro many a
14 times, but taro rot. And it was hardly any taro to
15 eat, because there wasn't much water. And taro just
16 grow and not even a year it rots, so.
17 Q. Now, when you first got back there in 1980 or
18 thereabouts, where did you try to grow that taro?
19 A. Up at the house where I'm living right now,
20 that's where.
21 Q. And what about -- and was that like a couple
22 of lo'i there or one lo'i?
23 A. There were three. One of them have lot of
24 rocks in it, yeah. And I can't plant taro in there
25 because the water used to come high, you know, so high

1 that the rocks, little rocks, pebbles went into the
2 patch -- streams used to get high, and the rocks used
3 to go -- is in the taro patch, so if you dig it, you
4 have rocks in there. So I have only two patches up at
5 the house.
6 Q. So the pebbles and rocks came into the first
7 lo'i off of the intake?
8 A. Uh-huh.
9 Q. And you mean that the rocks and pebbles came
10 in, they flowed in through from the stream, through
11 the intake into the auwai, into the first taro patch?
12 A. Actually from the stream, you know, as the
13 water came down. Because when the water comes down
14 high, it comes not only where we saw, the stream where
15 we were standing at the mouth of the auwai, it comes
16 on the side, just pouring on the side.
17 Q. Makai of where that concrete intake was?
18 A. Yeah.
19 Q. And that first lo'i you said is near your
20 house, was it in the area near where all the cars were
21 parking?
22 A. Yes.
23 Q. And there were two more lo'i you said were
24 there, correct?
25 A. Yeah, there's still two more.

1 Q. And you tried to use those lo'i for taro
2 also?
3 A. Yeah, I did.
4 Q. And what happened?
5 A. The taro rotted, got rotten, so can't use it,
6 can't eat it, can't sell it, whatever.
7 Q. So those three lo'i that were near your
8 house, so none of them were planted yesterday when we
9 went on the site visit?
10 A. No.
11 Q. So they were basically empty?
12 A. Yes, it is.
13 Q. Because of those problems you mentioned?
14 A. Yes, it is.
15 Q. And when you got back there in 1980, were you
16 trying to plant the lo'i further makai as you go
17 toward your cousin Marjorie Wallett's house? In 1980
18 now, when you first got back.
19 A. No, no. Well, I did once at the house
20 because thinking that the water is cool there, and
21 just into that patch so maybe I can get good taro, but
22 as I tried that, nothing. So what happen is I didn't
23 want to go below. If I can't get it from the top, why
24 should I go down below? Just wasting my time.
25 Q. Now, since water was a problem growing taro,

1 were you having similar problems with finding o'opu in
2 the stream in 1980?
3 A. Oh, yeah. There weren't any.
4 Q. And were you surprised by that?
5 A. Not really.
6 Q. Why not?
7 A. Because I knew water wasn't enough, so that
8 o'opu can't go upstream, and didn't see anything in
9 that stream.
10 Q. When was the last time you remember regularly
11 getting o'opu and 'opae and hihiwai from the streams?
12 How old were you?
13 A. About ten, 11 years old.
14 Q. So that would be in the '40s then?
15 A. Yeah.
16 Q. You know you're not able now to get the same
17 foods you used to get. Has this affected you
18 financially living in Honopou now as you do, as
19 opposed to how you used to live back in the '30s and
20 '40s?
21 A. Oh, yeah, uh-huh.
22 Q. And how is that?
23 A. Everything is so expensive now. Even poi is
24 expensive. You buy it, it's expensive. Rice is
25 expensive, so.

1 Q. Would you say -- you're saying that you don't
2 have as much cash as you would like to to replace
3 those foods?
4 A. No, I don't.
5 Q. Can you buy o'opu in the store?
6 A. No way.
7 Q. You can buy taro and poi in the store?
8 A. Yes.
9 Q. How about 'opae?
10 A. No way.
11 Q. Hihiwai?
12 A. No.
13 Q. The manini and the moili'i, can you find
14 those in the store?
15 A. No.
16 Q. So what are you eating if you're not eating
17 those kinds of food?
18 A. Things in the market.
19 Q. Well, do you miss those foods that you used
20 to be able to --
21 A. Oh, yeah, I do. I even tried planting sweet
22 potato. I love sweet potatoes.
23 Q. You know Garrett Hew?
24 A. Yes, I do.
25 Q. And you've known him for many years?

1 A. Well, ever since he started to take Mr.
2 Cabral's place, yeah.
3 Q. You talking about Steven Cabral?
4 A. Yes.
5 Q. His predecessor at EMI?
6 A. Yes.
7 Q. And Mr. Hew at one point a couple years back
8 opened up some patches for you in the area between
9 your house and your cousin Marjorie Wallett's house,
10 right?
11 A. Yes, he did.
12 Q. Did you ask him to do that?
13 A. No. He asked me if he could help me. He
14 wanted to help me. So he asked me if he could help me
15 open -- plant some taros, and he did. He did help me.
16 Q. And how much taro did he plant?
17 A. A little patch. One of the smaller patches.
18 Q. And this is located right at the beginning of
19 the turn in the auwai, correct, as you go down toward
20 your cousin Marjorie's house?
21 A. Yes.
22 Q. Did you understand what Garrett was going to
23 do for you when he started this project?
24 A. Well, I told him he could do it. Really, I
25 did. Because he wanted to do it. But behind my mind

1 was this, that he probably thought that we couldn't
2 open any of the taro patches, he probably thought
3 that. But in back of my mind, I know we could.
4 Q. And did he tell you that he was going to tell
5 the story of his helping you at these contested case
6 hearings two years later?
7 A. No.
8 Q. Did he tell you he was going to record
9 temperature and take other readings that he was going
10 to report to this contested case hearing two years
11 later?
12 A. No.
13 Q. And did he tell you that he was going to
14 measure the water coming into your auwai at one point
15 in 2004 when we were talking story about whether to
16 put in another pipe above the new Haiku diversion dam?
17 A. Yes, yeah. They were going to measure the
18 water. Yes, he did.
19 Q. At that point when he said he was going to
20 measure the water to -- let me step back.
21 EMI then put in in early 2004, a third
22 four-inch pipe to bring water over the new Haiku
23 Ditch, correct?
24 A. Correct.
25 Q. And that was an attempt to try to get you --

1 A. More water.
2 Q. More water.
3 A. Yes.
4 Q. Hopefully enough water that you could reopen
5 your taro patches?
6 A. Yes.
7 Q. And so the arrangement was made to at least
8 try to measure that water now coming down after the
9 pipe was installed, correct?
10 A. Yes.
11 Q. When that happened, I guess, it was either
12 Mr. Hew or one of his employees came down to measure
13 for some period of time after that?
14 A. Yes, they did.
15 Q. And when they did that, were you at home each
16 time that they measured?
17 A. Well, there were times that I couldn't be
18 home, but most of the time I was there.
19 Q. And did they tell you that what they would be
20 doing when they measured your taro, had this auwai,
21 intake water, in this period of time, did they tell
22 you that they were going to open up the gates to your
23 auwai intake to increase the flow every time they took
24 a measurement?
25 A. Yes, yes, they did.

Q. And in other words, they changed what you had already set up for your intake every time they made a measurement, right?

A. They always open the gate to the auwai.

Q. So is there a reason why you have a gate at the intake to your auwai?

A. Yes.

Q. What is that reason?

A. I want some water to go in the stream, drop in the stream.

Q. You don't want to take all the water from the stream?

A. No.

Q. Why is that?

A. Because I have -- in there I have o'opu now, now that the o'opu is back, napili back, and I have put some hihiwai in there, I just want the water in there.

Q. So basically you don't want to take all the water from the stream while you take some water for your taro?

A. Just so I have enough water for the taro, and maybe a little bit go down to the stream, because I use the pond. My whole family use the little pond down there. We used to do that to go swimming, teach

1 the kids how to swim. It's an old pu'u.
2 Q. You were talking about how you have certain
3 things that you want to preserve for your family and
4 others to use in the stream. And I think you started
5 talking about a swimming area?
6 A. Yeah.
7 Q. What exactly is that arrangement down there?
8 A. There's a little pool over there, it's part
9 of the property that I'm on. For years when we were
10 little kids, we used the pond a lot. We swam in it.
11 Sometimes took a bath in it. And my children and my
12 nieces and nephew, they learn how to swim from that
13 little pool down there.
14 Now, I have my great grandchildren, and
15 they're learning how to swim and they want to go catch
16 the fishes in there. They want to learn how.
17 Q. So rather than taking all the water from the
18 stream, you want water for recreation as well?
19 A. Yes.
20 Q. And to pass down some knowledge about the
21 stream to your children and grandchildren?
22 A. And great grandchildren.
23 Q. And great grandchildren. Sorry, missed a
24 generation.
25 A. Yes.

1 Q. How important is that to you to have this
2 water in the stream so that there's the hihiwai,
3 'opae, o'opu, as well as the ability to have the
4 people go down and enjoy this water in the stream?
5 A. To me it's part of my life right there, yeah.
6 And I would like to hand it down to my children,
7 nieces and nephew and my great grandchildren and
8 grandchildren.
9 Q. But how important is that to be able to do
10 that, to you personally?
11 A. A lot, a lot. It's a memory, when my dad
12 used to teach us how to swim. He never taught us how
13 to swim, he pushed us in the water and made us swim.
14 And we learned.
15 Q. Okay. So getting back a little bit to this
16 time when the third pipe was added and the
17 measurements were being taken, you understood, did you
18 not, that Garrett was taking water measurements
19 between 8:00 and 10:00 in the morning, generally
20 speaking?
21 A. Yes, I did.
22 Q. Taking measurements of water and water
23 temperature at that time, does that affect the water
24 that's available, taking temperatures and measurements
25 at that time in the morning? Does that have an affect

1 on what kind -- what you can do with that water?
2 A. During the morning the water is cool, very
3 cool. And sometimes it rains above. When the
4 mountain rains and more water comes down, it may take
5 awhile but it reaches down.
6 But later part of the day, sometimes the
7 water go, you know, real down, maybe somebody's
8 pumping water, I don't know and I'm not going to go up
9 there and look. So maybe the sun took some of it out.
10 Q. So if you have real cold water, let's say in
11 the early morning, 8:00 to 10:00, and the same day if
12 you take that kind of temperature reading, do you have
13 the same kind of water temperature throughout the
14 whole day?
15 A. I don't know, because I haven't measured.
16 But I don't think so, because when you go into the
17 stream the water temperature is, certain part of the
18 day it's warm, it's not cool. Early in the morning
19 you go there, it's cooler.
20 Q. How about on your lot where most of the lo'i
21 are between your house and your cousin Marjorie's
22 house, is the temperature in that area the same during
23 the morning as it is say 2:00 o'clock in the afternoon
24 on a sunny day?
25 A. No. In the morning it's cooler, comes in the

1 afternoon, I would say just about 10:00, 11:00, the
2 water gets warmer. And 2:00 o'clock it's -- so the
3 kids want to go in there and splash.
4 Q. Because it's hot?
5 A. Yeah.
6 Q. Now, you farmed, practically all your life
7 you've farmed except for the times you left Hawaii --
8 left Maui, at least?
9 A. Yeah.
10 Q. During that time did you ever learn how to
11 measure the flow of water so that you can say so many
12 gallons per hour, so many gallons per day as a farmer?
13 A. No, sir.
14 Q. And during that same period of time, did you
15 ever learn how to, you know, take measurements in the
16 stream so that you know what the temperature of the
17 water is, then take all that down on a piece of paper
18 so that you can record it?
19 A. No.
20 Q. So if you say the water is too warm for taro,
21 are you saying that on the basis of anything you've
22 measured or put down on paper?
23 A. No.
24 Q. How do you know then?
25 A. The feel of the water. You touch the water

1 different times of the day, like in the morning, early
2 in the morning, the water is cool, like I said. But
3 when you get into the afternoon, it gets warm, warm
4 and warmer. Sometimes we don't have to put the heater
5 on, you know, to take the bath because the water's
6 warm.
7 Q. In testimony that Mr. Hew presented to this
8 hearing officer, he says on Page 4 of his rebuttal
9 testimony, after talking about his experiment with 378
10 square foot taro patch that he planted, Mrs. Kekahuna
11 hoped to get assistance from her family to complete
12 the planting of patch number three, plant patches
13 numbers one and four, and to care for all taro
14 patches, I guess that he had opened up for you. Her
15 family who have full-time jobs and other obligations
16 were fortunately -- were unfortunately not available
17 to assist her with the planting of the rest of the
18 patches.
19 EMI rototilled and weeded the patches that
20 were not planted several times so that if Mrs.
21 Kekahuna could get assistance she needed, they would
22 be ready for planting. Unfortunately this hope for
23 assistance never materialized.
24 Auntie Beatrice is your family refusing to
25 help you to plant taro when you asked them to on the

1 lands at Honopou that we saw during the site visit
2 yesterday?
3 A. No, sir, they all willing.
4 Q. And when you need to, have you been able to
5 get all the labor you needed to help you clear those
6 patches in order to plant taro on that land?
7 A. Yes.
8 Q. And except for the fact that the water you
9 believe is not sufficient to support all that planting
10 on that land, would you have opened up the lands at
11 Honopou that you control with your cousin Marjorie
12 Wallett for taro growing?
13 A. Yes.
14 Q. And at the time that we talked of the --
15 certainly you had the help this time around, this last
16 month or so to clear the patches that we saw
17 yesterday, correct?
18 A. Yes.
19 Q. And that was from the help of your ohana?
20 A. Yes.
21 Q. Have you done that before?
22 A. No, we just waiting for more water. Once we
23 open one patch, you open one patch, you don't need
24 that much water, but if you're going to open the patch
25 and water shooting in, running from right to left --

1 from top to bottom, it's going to take a lot of water.
2 Q. And at the time that we were talking about
3 putting in that third pipe over the new Haiku Ditch,
4 do you recall whether or not your ohana helped you at
5 that time to clear those same patches that we saw
6 yesterday?
7 A. Uh-huh, they did.
8 Q. And so back in March or February of 2004,
9 because I believe that the pipe went in in March,
10 April of 2004, did you get your family at that time to
11 clear those patches as well?
12 A. Yeah, we tried. We did try.
13 Q. And when you did that clearing, was it to the
14 extent or more than what we saw yesterday at the lands
15 for which we had a site visit?
16 A. No, yesterday was more. What you saw
17 yesterday was more. And they not stop there.
18 Q. I'm sorry?
19 A. They are not stopping. Right now I'm here,
20 but there's somebody there.
21 Q. And you can still tap that labor in the
22 future if you need it, if you have the amount of water
23 you need, correct?
24 A. Oh, yes, yes.
25 Q. Did Mr. Hew try to convince you to grow

1 dryland taro?
2 A. He asked me to try, if I wanted to try.
3 Q. And did you want to?
4 A. No, I told him no.
5 Q. Why is that?
6 A. We always had wetland taro. My dad had grown
7 this taro always wetland, that's why, I can remember.
8 I don't want to plant dryland taro. Sometimes the
9 dryland taro to me mushy, you know, whereas the
10 wetland taro tastes better and firmer. That's why I
11 like the wetland taro.
12 Q. Is that what they call loliloli?
13 A. Yeah.
14 Q. Is that right?
15 A. Yeah.
16 Q. And you heard Paul Reppun testify?
17 A. Yes.
18 Q. And can you agree that that is what can
19 happen with dryland taro, it becomes what they call
20 loliloli?
21 A. Yes.
22 Q. And what does that mean to Hawaiians like you
23 that have eaten taro all your life?
24 A. To me, speaking for myself, I just don't like
25 it, and my children don't like it too.

1 Q. And so if you had as much water as you need
2 to grow taro, would you then choose to grow wetland
3 taro?
4 A. Yes.
5 Q. Above dryland taro?
6 A. Yes, I do, wetland taro.
7 Q. And how important is it to you to be able to
8 do that, to be able to have the kind of wetland taro
9 that you're familiar with growing up in Honopou as a
10 girl, today so that it's available to you, your
11 children, grandchildren and great grandchildren? How
12 important is that?
13 A. To me it's -- to me it's everything that I do
14 remember, everything I did, everything my dad did. I
15 want my children to keep this, whatever I'm doing now,
16 to carry on. My children, my grandchildren great
17 grandchildren. This is significant.
18 Q. What if EMI -- as EMI has said, it would be
19 better and cheaper to grow dryland if you do it the
20 way Garrett did with the weed cover, for example, that
21 would help you keep your weeds down.
22 A. I would say that would be good for farmers,
23 like vegetable farmers. But wetland taro, no.
24 Q. What's wrong with having this weed cover?
25 Isn't that good?

1 A. Well, maybe you're going to work extra hard,
2 but that's already -- to me that's what it's all
3 about, working hard.
4 Q. What happens if you leave that weed cover in
5 the lo'i crop after crop after crop?
6 A. I don't know. I haven't tried it. That was
7 the first time.
8 Q. Can you just leave it there forever?
9 A. I don't know. I haven't tried it.
10 Q. Can EMI pay you any money so that you would
11 stop growing wetland taro and instead grow dryland
12 taro, any amount of money that would make it worth it
13 for you to drop wetland taro?
14 A. No, no. Money is nothing to me, it's not
15 worth it.
16 Q. That's all I have.
17 HEARINGS OFFICER McCONNELL: Questions?
18 MS. LOVELL: No questions.
19 MR. MERCHANT: No questions.
20 CROSS-EXAMINATION
21 BY MR. SCHULMEISTER:
22 Q. Hello. I was listening to the testimony, but
23 I'm not sure I got clear when it was that you resumed
24 living in the house. About when was that?
25 A. It was in 1980, between 1980 and 1982.

1 Q. And before that, when was the last time that
2 you lived in the house?
3 A. When I was 19 years old.
4 Q. And you were born in 1932?
5 A. Yes.
6 Q. So 1941, about the time World War II started
7 -- '51, I'm sorry, excuse me. Three years before I
8 was born.
9 Okay, and when you -- could you recall
10 actually being aware when you grew up in the house
11 being a little girl, that these four ditches were
12 there diverting --
13 A. Yes, I did.
14 Q. And so these memories about the lo'i that
15 were on the land and helping your dad, this was
16 notwithstanding all the water being diverted by the
17 four ditches?
18 MR. MURAKAMI: Objection, assumes facts
19 not in evidence. He hasn't related to what period of
20 time, which ditches. And there's lack of foundation
21 as to at least three, if not four ditches.
22 HEARINGS OFFICER McCONNELL: Well, she
23 said she was aware of it.
24 THE WITNESS: I know there were ditches.
25 I know that the Haiku Ditch and there was one above

1 that, but we didn't go further up.
2 Q. (By Mr. Schulmeister): But Haiku Ditch
3 wasn't that far from the house?
4 A. Haiku Ditch was already there.
5 Q. So you saw it?
6 A. Yeah.
7 Q. You remember being aware that it was there?
8 A. Yeah.
9 Q. And was there something that was passing
10 water through that diversion when you were a child?
11 A. What you have -- what the pipes they have
12 now, it wasn't there when I was a little girl. It was
13 put in maybe in the '60s, '70s. I don't recall. But
14 before that, there weren't three pipes. It was coming
15 through a tunnel.
16 Q. Through what?
17 A. The tunnel.
18 Q. What tunnel?
19 A. There's a tunnel. Where the water come out
20 in the Honopou Stream from the ditch, there's -- used
21 to come under the tunnel. And not there, there was a
22 little hole on top of the irrigation ditch that you
23 folks have now. It was on top of that. And there's a
24 hole over there. There was a gate there. That's
25 where the water used to come out.

1 Q. Okay. And when you moved back in 1980, there
2 were pipes there?
3 A. Pardon?
4 Q. The pipes you said you thought got put in the
5 '60s or something, did you say that?
6 A. No. Maybe it was within the '60s, '70s, but
7 right after my father died, they put pipe there.
8 There was one pipe. And they closed up the other
9 gate, the one that's coming from underground.
10 Q. '64 or '65 is when your dad passed away?
11 A. No, '71, '70, '71.
12 Q. And was your dad farming taro in the '60s?
13 A. Yes, he was.
14 Q. And you're saying it was after your dad
15 passed away that the pipes were put in?
16 A. Yes.
17 Q. So sometime in the '70s?
18 A. I believe so.
19 Q. Because they were there when you went back
20 there in 1980?
21 A. Yeah.
22 Q. Did anybody grow taro between 1970 and 1980
23 in that area?
24 A. No.
25 Q. And then after you moved back in 1980, there

1 was -- so when you moved back in 1980, no one was
2 growing taro on either of those property?
3 A. No, that's when we started.
4 Q. And when was -- what was the period during
5 which you grew taro or tried to grow taro in 1980?
6 A. Are you saying during the summertime or
7 wintertime?
8 Q. Which years, how many years? All of those
9 years?
10 A. Oh, we tried two years, I think it was, that
11 we tried. The taro wasn't big enough, you know. It
12 was so small and then it got rot, rotten. Even Steven
13 helped me with the taro.
14 Q. Who?
15 A. Steven Cabral.
16 Q. What did he do?
17 A. He brought some taro over for me to plant.
18 Q. What kind of taro was it?
19 A. I think it was -- I think it was called
20 aweoweo.
21 Q. Was that a wetland type taro?
22 A. Yes.
23 Q. And that's while he was working for EMI?
24 A. Yes.
25 Q. And at the time that you -- in the '80s you

said it was a couple of years, early '80s is that when this took place?

A. I think it was -- not sure.

Q. Whenever it was, the auwai was in the same place, right?

A. Yes.

Q. And was the intake the same way? In other words, when we went there yesterday, we saw the intake off the stream, then it came to a point where there's like about a ten-inch pipe that is covered by some rocks and you use that as your gate, right?

A. Yes.

Q. Was it like that back then?

A. Yes. The same pipe when my father was alive, that's the same pipe that's there.

Q. And he controlled the water the same way?

A. Yes.

Q. And so the size of the auwai, you know how deep it is and how wide it is, that's all pretty much the same as it was when your dad used it?

A. Yes, it is.

Q. And was it operated basically the same way? In other words, the gate's not all the way open so you wouldn't be taking all the water from the stream?

A. Yes.

Q. I think you testified that when it rains heavy and the stream gets high, the water actually comes over the bank, right?

A. Not all the time. Only when the water is real, real high. And that means when the water is high and go over the ditch, that means the water go over the bridge way above, you know, the beginning of the road, our bridge. So that's the only time. So that means we have water from the stream, water from the pasture. That's when it overflows like that.

Q. So was it maybe a couple years in the early '80s that you tried growing this taro?

A. Yeah, I did.

Q. And then when did that stop?

A. I stopped it because didn't have enough water, enough -- taro rot. I didn't know what to do.

Q. Was the amount of water that was in the auwai, how would you compare that to the water that we saw yesterday?

A. The water that is in there yesterday, it's more than what I used to -- years back when I started to plant taro.

Q. Has there been more water ever since that third pipe got put in at the Haiku Ditch?

A. Not really.

1 Q. So you haven't noticed any increase in the
2 water at all?
3 A. Sometimes there's a little more water and
4 sometimes there's less water. Like I said, people
5 above may be taking water, or maybe the sun, water
6 evaporates.
7 Q. Did you try growing taro in the 1990s?
8 A. I think I did. Don't really remember, but I
9 think we did. That was before my husband died.
10 Q. And now that you've opened up additional lo'i
11 that we saw yesterday, are you going to go ahead and
12 plant those?
13 A. Yes, we are.
14 Q. And has anything changed in terms of why
15 you're willing to go through that effort now but you
16 haven't been over the last few years?
17 A. Last couple of years, like I say, we didn't
18 have enough water. I would like to have more water so
19 we can feed all the patches, and if we don't have
20 enough water, I don't think we can feed the patches.
21 Q. Is there something that makes you think
22 there's enough water now?
23 A. I don't think there's enough water now. I'm
24 not being greedy, but I don't think there's enough
25 water, because of the fact when you start opening all

1 the patches, there won't be enough water.
2 Q. So why are you going through all this effort
3 to plant the taro if you don't think there's enough
4 water?
5 MR. MURAKAMI: Objection, she has stated
6 she is going to plant it if she gets enough water. I
7 object, it's argumentative.
8 MR. SCHULMEISTER: I'll withdraw the
9 question. I have no further questions.
10 HEARINGS OFFICER McCONNELL: Anything
11 else?
12 MR. MURAKAMI: Yes, if nobody else has.
13 HEARINGS OFFICER McCONNELL: Go ahead.
14 REDIRECT EXAMINATION
15 BY MR. MURAKAMI:
16 Q. You talked about the gate that used to be at
17 the new Haiku Ditch before your father died in 1971.
18 A. Yeah.
19 Q. I'm going to hand you what has been admitted
20 as Exhibit B-10-A. Do you recognize this picture,
21 where it depicts?
22 A. Yes.
23 Q. What does it show?
24 A. Shows the irrigation ditch.
25 Q. This is at the Haiku Ditch?

1 A. Yeah.
2 Q. This is the ditch just below the highway on
3 Honopou Road?
4 A. Yes.
5 Q. The first one you come to, correct?
6 A. Uh-huh. Just above here, in the back here,
7 there's a hole there where you can go down. There's a
8 gate --
9 Q. Let's stop there. When you say here --
10 MR. SCHULMEISTER: We can't see what is
11 being pointed to.
12 Q. (By Mr. Murakami): And you pointed to the
13 extreme left top of this picture.
14 A. Yes.
15 Q. And you're saying that there is a tunnel
16 there under the ground?
17 A. Yeah, yeah. That's where the water come out
18 into here. So it's above.
19 Q. So above the diversion ditch there's
20 something that allows water to flow past the diversion
21 ditch. Is that what you're saying?
22 A. Yeah.
23 Q. And that's controlled by a gate, you said?
24 A. Yes.
25 Q. And that's in the same area -- I'm going to

1 hand you a copy of what's marked as Exhibit 10-B. Is
2 that the area that would be to the left of these pipes
3 that are depicted in Exhibit 10-B?
4 A. It's out.
5 Q. It's out of the picture but it's to the left,
6 correct, and above?
7 A. Above. (Witness nods head up and down).
8 Q. And your testimony was that your father, when
9 he was alive growing taro, I guess up until '71, he
10 relied upon this tunnel and the gate to let water pass
11 over the Haiku Ditch so it would reach the lower parts
12 of Honopou Stream, right?
13 A. What's that again?
14 Q. Your father relied upon this tunnel that you
15 talked about?
16 A. Yeah.
17 Q. Not the pipes?
18 A. No.
19 Q. Which weren't there, but the tunnels that
20 bypassed the Haiku Ditch so that more water would come
21 down to Honopou Stream?
22 A. Yeah. The water used to come out there. And
23 we had -- the water was so cool, not like the water we
24 have now. And used to go down in the stream and reach
25 down to our place.

1 Q. Did you see that gate?
2 A. Yes, it's there.
3 Q. How big is it? If you use this, anything on
4 this table.
5 A. Maybe it's my shoulder.
6 Q. If you stood up?
7 A. Yeah, maybe it's my shoulder.
8 Q. What is your shoulder?
9 A. The height of -- to my shoulder the height.
10 Q. If you stood up, it's as high as up to your
11 shoulder, the gate?
12 A. Yeah.
13 Q. So you lifted -- how wide is it? That's how
14 tall it is. How wide is it? Is it wider than you
15 are?
16 A. Probably the table.
17 Q. As wide as the table in front of me?
18 A. Probably.
19 Q. So about three-and-a-half feet?
20 A. I guess so.
21 Q. Three, three-and-a-half feet?
22 A. I guess.
23 Q. You guess so or do you know?
24 A. I don't measure it.
25 Q. Could you walk through it if it was wide

1 open?
2 A. No, because it opens (indicating.)
3 Q. Let's say it's open. Can you walk through it
4 if it was open and no water there?
5 A. No. It just opens a little bit. It rises
6 up.
7 Q. And how high, how much of an opening, if you
8 raised the gate, can it be? How much opening is
9 there? Like a foot, two feet?
10 A. About a foot.
11 Q. About a foot?
12 A. Yeah, or less.
13 Q. And as wide as this table?
14 A. Probably.
15 Q. So easily you could fit more than three pipes
16 in that space, right?
17 A. Yeah, I would say. That's the water we had,
18 by the gate.
19 Q. But it fits more than three pipes in that
20 space that you can open with the gate?
21 A. I believe so.
22 Q. So basically the width of this table, about
23 three, three-and-a-half feet, a foot high, correct?
24 A. I think so. Not very sure.
25 Q. Thank you.

1 And that was what the -- that was how much
2 water you could release if your father needed it when
3 he was alive to grow taro when he needed it
4 downstream?
5 A. Yeah. And the water was, like I said, the
6 water was cooler. Right now the water coming down
7 straight from the mountain, it's all open, so by the
8 time the water gets down to us, it's warm.
9 Q. When you had that problem in 1980, did you
10 try to get Mr. Cabral to open that gate so that water
11 would come down?
12 A. No. I was told they couldn't -- they
13 condemned the tunnel.
14 Q. They condemned the gate or the tunnel?
15 A. The tunnel.
16 Q. That allows the water to come through?
17 A. Yeah.
18 Q. When they say condemn, do you know what they
19 meant by that?
20 A. I took it for granted that something was
21 wrong with the tunnel.
22 Q. Did he say that you just had to live with
23 whatever the pipes delivered?
24 A. Yeah.
25 Q. And did you try to ask the state to help you

1 get this water down?
2 A. No. No, sir.
3 Q. Has the state ever come to you and said if
4 you ever have a problem with enough water coming down
5 to you, call this number and we can help you?
6 A. No.
7 Q. Thank you. That's all.
8 HEARINGS OFFICER McCONNELL: Anything
9 else?
10 MR. SCHULMEISTER: No.
11 HEARINGS OFFICER McCONNELL: Thank you,
12 ma'am.
13 THE WITNESS: Thank you, sir.
14 HEARINGS OFFICER McCONNELL: We'll recess
15 until tomorrow morning at 8:30.
16 MR. SCHULMEISTER: If we are going to be
17 starting with de la Pena, his flight arrives at 8:00,
18 so probably 9:00 would be --
19 HEARINGS OFFICER McCONNELL: 9:00. That
20 closes the record for today.
21 (The proceedings recessed at 4:50 p.m.)
22
23
24
25

1 CERTIFICATE

2 STATE OF HAWAII)

3) SS.

4 COUNTY OF HONOLULU)

5

6 I, JEAN MARIE McMANUS, do hereby certify:

7 That on October 11, 2005, at 9:15 a.m., the

8 proceedings contained herein was taken down by me in

9 machine shorthand and was thereafter reduced to

10 typewriting under my supervision; that the foregoing

11 represents, to the best of my ability, a true and

12 correct copy of the proceedings had in the foregoing

13 matter.

14 I further certify that I am not of counsel for

15 any of the parties hereto, nor in any way interested

16 in the outcome of the cause named in this caption.

17 Dated this 28th day of October, 2005,

18 in Honolulu, Hawaii.

19

20

21 Jean Marie McManus

JEAN MARIE McMANUS, CSR #157

22

23

24

25

1 BOARD OF LAND AND NATURAL RESOURCES

2 STATE OF HAWAII

3 In the Matter of Contested)DLNR FILE: 01-05-MA
Case Regarding Water Licenses)
4 at Honomanu, Keanae, Nahiku and)
Huelo, Maui)
5 _____)

6 CONTESTED CASE HEARING

7

8 Held on October 12, 2005, commencing at 9:10 a.m., at

9 Maui State Building, Conference Room A and B, 54 South

10 High Street, Third Floor, Wailuku, Hawaii 96793.

11

12 HEARINGS OFFICER: E. JOHN McCONNELL
BLNR Attorney: LINDA CHOW, ESQ.
13
For EMI and A&B: DAVID SCHULMEISTER, ESQ.
14 ALIJAH YIP, ESQ.

15 Na Moku, et al: MOSES K.N. HAIA, ESQ.
ALAN MURAKAMI, ESQ.
16
Maui Tomorrow: ISAAC HALL, ESQ.
17
For County of Maui: JANE LOVELL, ESQ.
18
Maui Land & Pine: DAVID MERCHANT, ESQ.
19

20
BEFORE: JEAN MARIE McMANUS
21 Hawaii CSR #156, California CSR #3119
Notary Public, State of Hawaii
22

23

24

25

HEARINGS OFFICER:	HONORABLE E. JOHN McCONNELL 33 N. Market Street, Ste. 200 Wailuku, Hawaii 96793
BLNR Attorney:	LINDA CHOW, ESQ. Deputy Attorney General 465 S. King Street, Rm. 300 Honolulu, Hawaii 96813
For EMI and A&B:	DAVID SCHULMEISTER, ESQ. ELIJAH YIP, ESQ. Cades Schutte Fleming & Wright 1000 Bishop Street, Ste. 1200 Honolulu, Hawaii 96813
For Maui Land & Pineapple:	DAVID B. MERCHANT, ESQ. Kiefer & Merchant 444 Hana Highway, Ste. 204 Kahului, Hawaii 96732
For County of Maui:	JANE E. LOVELL, ESQ. Deputy Corporation Counsel 200 S. High Street Wailuku, Hawaii 96793
For Na Moku Aupuni O Ko'olau Hui, et al:	ALAN T. MURAKAMI, ESQ. MOSES K.N. HAIA, ESQ. 1164 Bishop Street, Ste. 1205 Honolulu, Hawaii 96813

1 HEARINGS OFFICER McCONNELL: Good morning.
2 For the record the contested case hearing in this
3 matter, DLNR File No. 01-05-MA is reconvened. For the
4 record counsel are present. Mr. Schulmeister's
5 witness we're going to take out of order.
6 MR. SCHULMEISTER: Dr. Ramon de la Pena.
7 RAMON DE LA PENA
8 was called as a witness, was sworn to tell the truth,
9 was examined and testified as follows:
10 THE WITNESS: Good morning.
11 HEARINGS OFFICER McCONNELL: State your
12 name.
13 THE WITNESS: My name is Ramon de la Pena.
14 DIRECT EXAMINATION
15 BY MR. SCHULMEISTER:
16 Q. Good morning, Dr. de la Pena.
17 A. Good morning.
18 Q. Could you -- did you by any chance bring a
19 copy of your written testimony or your --
20 A. Yes, I have.
21 Q. -- your curriculum vitae? If you don't, I
22 have a copy here that I can --
23 A. I have.
24 Q. Do you have it?
25 A. Yes, I have it.

1 Q. Is that dated August 19th? Let me show you
2 the one I've got.
3 A. I don't have my -- maybe you can give me a
4 copy.
5 Q. Let me show you what was filed in this
6 proceeding on August 22nd. That's the first page, and
7 just take a moment --
8 A. Yeah. This is the same as I have in here,
9 but -- yes, these are the same I have.
10 Q. Is that your signature?
11 A. Yes, that's right.
12 Q. Okay. Dr. de la Pena, a few months ago did I
13 call you up and ask you whether or not you'd be
14 willing to provide some expert testimony in this case?
15 A. Yes, you did. I was made to believe that I
16 need to explain some of the resource, the experiments
17 that I conducted that I -- when I was still working as
18 agronomist for experiment station.
19 Q. The written testimony that you just looked at
20 that you signed on August 19th, 2005, does that
21 essentially reflect the opinions that you agreed to
22 give in this case after I spoke with you?
23 A. Yes, that's right.
24 MR. SCHULMEISTER: At this time I would
25 like to move the declaration of Ramon de la Pena into

1 evidence.
2 MR. MURAKAMI: Objection, Mr. Hearing
3 Officer. The only filed copy that we received of this
4 testimony was file stamped October 6th, and the
5 deadline, as I understand it for rebuttal, was August
6 22nd. So this is late testimony, and it's untimely.
7 MR. SCHULMEISTER: I think what happened,
8 you have the unsigned one.
9 MR. MURAKAMI: We have the --
10 HEARINGS OFFICER McCONNELL: The one I
11 have is signed and was filed on the 22nd of August.
12 MR. MERCHANT: I have a pdf signed with
13 August 22nd right here.
14 MR. MURAKAMI: Why do I have an October 6?
15 MR. SCHULMEISTER: The copies went out on
16 the 22nd, the original for the file was added as
17 another document. So in other words, the original
18 that the board has is an original rather than a xerox
19 or a fax.
20 HEARINGS OFFICER McCONNELL: I'll receive
21 it. Let's go on.
22 MR. MURAKAMI: Thank you.
23 Q. (By Mr. Schulmeister): Dr. de la Pena,
24 before we get into the opinions, I would like to ask
25 you just briefly to summarize the experience you've

1 had in the area of tropical agriculture and
2 particularly taro cultivation.
3 A. I started working for the experiment station,
4 College of Tropical Agriculture in 1967. But before
5 that in 1964, I started my first experiment with taro
6 in Hanalei Valley. So actually I started working,
7 doing field experiments with taro since 1964 until I
8 retired in December 2001.
9 Q. We have in evidence a curriculum vitae that
10 you've given us which is Exhibit A-7, and in there --
11 let me show it to you.
12 Is that your curriculum vitae that you
13 provided to us?
14 A. Yeah, this is my personal data.
15 Q. And have you published any papers or research
16 materials relating to taro cultivation in your career?
17 A. Yes, I did, that's part of my work.
18 Q. Are those listed in Exhibit A-7?
19 A. Yes, they are listed under my bibliography.
20 In addition to my work on taro, I have done some work
21 on rice and other crops. And all in all I have in
22 here 87 publications.
23 Q. Have you ever testified as an expert witness
24 in an area of taro cultivation and water requirements
25 of taro?

1 A. Yes, I did when they had that hearing on
2 water in Honolulu, that's the return of water from the
3 leeward irrigation back to the windward irrigation.
4 Q. Is that the Waiahole Ditch case?
5 A. That's right.
6 Q. So your testimony was received as an expert
7 in that case?
8 A. Yes, I was at that time.
9 Q. Any other cases where you've testified?
10 A. Not that I remember.
11 Q. And at this time I would ask that Dr. de la
12 Pena be qualified as expert witness in the area of
13 taro cultivation and the water requirements.
14 HEARINGS OFFICER McCONNELL: I'll receive
15 his opinions in that area in evidence.
16 Q. (By Mr. Schulmeister): One of the things I
17 asked you to do was to review the written testimony of
18 Paul Reppun and comment on whether you agree with it
19 or not, is that correct?
20 A. Yes, I can do that.
21 Q. And I think specifically I had asked you to
22 comment on his opinion that the cultivation of taro
23 requires 100,000 to 300,000 gallons per acre per day,
24 and I think in your written declaration, you state
25 that you strongly disagree with that, paragraph four.

1 Could you just explain to the hearings
2 officer why you disagree with Mr. Reppun's opinion
3 that 100,000 to 300,000 gallons of water per acre per
4 day is required to cultivate taro?
5 A. Based on the experiments that I have
6 conducted, I disagreed with that alleged requirement
7 of 100,000 to 300,000 gallons per acre per day to grow
8 wetland taro because my experimental resource clearly
9 showed that even 30,000 gallons per acre per day was
10 sufficient to grow wetland taro.
11 Q. The experiment that you conducted, was that
12 the one published?
13 A. It was published in '84. Actually I
14 presented that in '83, but I conducted that experiment
15 within 1980 and '81 in Hanapepe Valley.
16 Q. And that was published in the Sixth Symposium
17 of the International Society for Tropical Root Crops?
18 A. That's right.
19 Q. And what is that society?
20 A. It's a society of scientists, workers who do
21 research, extension and education using root crops,
22 which includes taro, casava, sweet potato, potato,
23 yams. So crops that are harvested from underground,
24 whether they are roots or tubers, are included under
25 that society.

1 Q. Is taro grown elsewhere besides Hawaii?
2 A. Oh, yes. In fact, most of the taro is grown
3 in Africa. They have most. Right now the number one
4 growing country for taro is Nigeria.
5 Q. And is it grown elsewhere in the Pacific
6 region?
7 A. Oh, yes. It's as important a crop as it is
8 here in Hawaii, Cook Islands, Samoa, Fiji, all the
9 Pacific island countries grow taro as a staple food,
10 very important.
11 Q. Now, the experiments that you conducted in
12 Hanapepe in the early '80s, who were you working for
13 when you conducted those experiments?
14 A. I was working for the College of Tropical
15 Agriculture.
16 Q. And so how did it come about that these
17 experiments were done?
18 A. Well, there has always been questions about
19 how much taro -- I mean how much water does taro
20 actually need to, you know, for production. So I
21 thought it's a good idea to do some work along that
22 line.
23 Of course, aside from water, I've done
24 some work on fertilizer, weed control and variety
25 of -- so that was one of the experiments that we

1 conducted in Hawaii.
2 Q. Was that sponsored by any of the sugar
3 companies?
4 A. No, no. I wish we did. I wish we had that
5 kind of sponsorship so we can do more work on taro.
6 But that particular experiment, most of that work that
7 I did was as agronomist not being sponsored by any
8 private company, all from the College of Tropical
9 Agriculture.
10 Q. And when you say the College of Tropical
11 Agriculture, you mean associated with the University
12 of Hawaii?
13 A. Yes.
14 Q. And you were a tenured professor?
15 A. Yes, I was an agronomist professor at that
16 time.
17 Q. Are you still affiliated with the University
18 of Hawaii?
19 A. I retired in December, 2001.
20 Q. Now, are you on the Board of Regents?
21 A. Right now I am, but I'm here not as Board of
22 Regent member, I'm here as retired agronomist for the
23 College of Topical Agriculture.
24 Q. So when you conducted these experiments, were
25 you trying to set out to prove anything in particular?

1 A. Well, we always need to find out how best to
2 use our resources in growing crops that we depend on,
3 of course, here in Hawaii. Taro is of importance.
4 And right now I would like to actually
5 applaud and commend our taro farmers for continuing to
6 grow taro, because it's important.
7 So when we, our job -- part of my job is
8 not just to conduct experiments, but to find out how
9 best to grow the crops using our resources efficiently
10 as possible. And, of course, water is one of our most
11 important resources because it's used not only for
12 growing crops but also used for urban, for drinking
13 and other uses.
14 So our objectives is always to find the
15 best way of using the resources that we have, land,
16 water, labor, fertilizers, everything that's required
17 for growing any crop. Taro, of course, is one of
18 them.
19 Q. Now, in terms of the experiments that were
20 done in the early '80s in Hanapepe, could you explain
21 how it was set up in order to be able to draw some
22 conclusions about the water requirements for taro?
23 A. Okay. First of all, I would like to say that
24 this was done in Hanapepe in the farm of Mr. Nagamine,
25 because his irrigation system was set up using pipes

1 to draw water from the source, bring it down to his
2 farm.
3 I selected that because with pipes we can
4 regulate the amount of water going into his taro
5 patch. Right now, of course, a lot of the taro
6 farmers all over Hanalei are also using pipes to bring
7 water to their lo'is, but at that time, only Mr.
8 Nagamine had pipes bringing water to his fields.
9 So we connected pipes and we had plots as
10 similar in size as possible, randomly selected as any
11 statistician will require.
12 The plots or treatments were replicated
13 three times to make it possible for statistical
14 analysis. And everything that was done in the fields
15 or in the plots were the same when it comes to
16 fertilizer, variety, distance of planting, they all
17 the same except for the amount of water going into its
18 plot. And that was varied from 30,000 gallons per
19 acre per day to 100 -- was about 100 to 105,000
20 gallons per acre per day.
21 Q. Okay. And was -- how long did the experiment
22 continue?
23 A. This was one growing cycle. I believe it was
24 14 or 15 months when we harvested it. I have it here.
25 Forgive me for referring, when you get to be 69 like

me, sometimes you forget data, but...

Q. We have this as Exhibit A-8, if anyone wants to follow it along.

A. Yeah, the crop was harvested 15 months after planting, which is a typical growing period for wetland taro here in Hawaii.

Q. And when you refer to wetland taro, what does that mean?

A. Wetland taro is taro that's grown under flooded condition. When you flood the field, you call it wetland or lowland taro.

Q. So not a particular variety?

A. No. In this case we planted Lehua, but you have to know, of course, that we have several other varieties of taro that are grown here in Hawaii.

There are hundreds of other varieties grown worldwide. But let me state right now that all taro, regardless of where they came from, can be grown under what we call dryland or upland condition.

Dryland doesn't mean that the soil is dry but of course it has to have some water or else nothing would grow. But not all taro will grow under wetland or flooded condition. That's a statement that I can say for any taro that you can get from anyplace in the world. There are taro varieties that cannot

1 grow or -- well, they'll grow, but not as well under
2 wetland conditions. Some will just drown like dashine
3 (phonetic) type doesn't grow well under wetland
4 condition, the taro will rot. They're just not sort
5 of for growing in flooded or wetland condition.
6 Q. So so-called wetland taro can actually grow
7 in a nonflooded condition, but some dryland taro can't
8 be growing in a flooded condition?
9 A. That's right.
10 Q. So Lehua is one that can be grown --
11 A. Lehua is one of several dozen Hawaiian
12 varieties that can be grown under both wetland or
13 dryland, or even the old Hawaiian way of growing taro
14 in mounds.
15 Q. What are you referring to? What do you mean
16 old Hawaiian way of growing taro?
17 A. Well, according to Handy in his book The
18 Hawaiian Planter, he cited or described the old way of
19 growing taro, Page 42 here, that planting in mounds,
20 according to him, was the true old Hawaiian method of
21 wet planting.
22 Taro, of course, can be grown at several
23 ways of cultural conditions starting from dry all the
24 way down to wetland.
25 Q. And mound is something in between?

1 A. Mound is kind of in between and where the
2 farmer makes mounds in the field or the taro patch and
3 he plants the hulis on the mound and then lets water
4 go inside but not flooding the whole lo'i.
5 This take like -- actually not unique to
6 Hawaii, it's used in other South Pacific islands like
7 Cook Islands or Samoa, but they don't grow it in
8 individual mounds, they just plant the taro in flat
9 area but dig a trench around the field or around the
10 taro.
11 But they allow water only in the trench
12 but not over the taro. So water actually seeps into
13 the growing area. So that's kind of in between
14 dryland and wetland.
15 Q. But the same Lehua can be grown --
16 A. Oh, yeah. Most varieties can be grown that
17 way.
18 Q. All right. So getting back to the Hanapepe
19 experiment, the soil, was the soil that was in the
20 plots, was there anything about that soil that was any
21 different from the soil that you find in areas like
22 East Maui where they're still growing taro today?
23 A. No, essentially the same. Soil formation of
24 course is controlled by environmental factors. And
25 here in Hawaii soils are essentially volcanic in

origin. And under waterlogged conditions, they all develop into what we call wetland soil, classified as Hanalei soil. So essentially they're the same.

Q. And so the water was put, I mean, in at different rates into all of these different plots?

A. That's right.

Q. And I think Mr. Reppun -- by the way, he's right here.

A. I know Paul and Charlie.

Q. And he testified yesterday, he commented that if you had a plot back in Hanapepe that you put only water in at a rate of only 30,000 gallons per acre per day, that he couldn't conceive that any of the water would flow out, it would all just be absorbed in the plot.

Is that what happened when you did your experiment?

A. No, no, because the soil -- well, the farmer actually did a good job of preparing his lo'i so you have a fairly impermeable bed below the plowed area. So water didn't seep through -- so the extra water just flowed through the plots.

After all, the taro did not use up all 30,000 gallons per acre per day.

Q. In your written testimony you said the

1 outflow wasn't measured but you estimated it would
2 have been 20 to 25,000 gallons per --
3 A. That's right, based on other experiments. I
4 was talking to some agricultural engineers that
5 conduct irrigation experiments that basically the taro
6 used -- when I say used, actually absorbed water and
7 part of it is evaporated, of course. That's what we
8 mean by consumptive use of water, between five to
9 10,000 gallons per acre per day.
10 It's almost like you ask how much water is
11 used by your household. Everybody uses maybe 150
12 gallons per day, but you don't drink 150 gallons. So
13 the taro, the consumptive use of water -- consumptive
14 use of taro between five to 10,000 gallons per acre
15 per day. And the rest just flow out. As long as you
16 keep the water flowing, extra water flows out.
17 Q. And so what was the result -- I mean what
18 conclusions were drawn from the result of the
19 experiment? That is after the entire 14 or 15 months
20 was completed, how did you measure how well the taro
21 did?
22 A. Well, we harvested the taro and just like
23 went to send it out for poi or for the market. So all
24 marketable cormels, and the main corms were weighed,
25 and compared, you know, treated statistically, because

1 they are replicated three times. And they show that
2 there is no significant difference among the
3 treatments from 30,000 gallons per acre per day up to
4 100 to 105,000 gallons per acre per day. Yeah, 105.
5 So I have a table in here that shows that
6 the yields range from 60 to about 67 tons per metric
7 tons per hectare. Average of 64,000 metric tons per
8 acre.
9 Q. Now, as far as you know, has this experiment
10 been -- has anyone tried to redo it or published
11 anything to discredit it?
12 A. No, I haven't seen anybody do a similar
13 experiment.
14 Q. And it was published and it was well-known
15 since '84?
16 A. Yes, far as I know.
17 Q. Now, one of the other issues that I asked you
18 to comment on for Mr. Reppun's written testimony was
19 his opinion and his statements to the effect that you
20 needed to increase the flow of the water in order to
21 prevent root rot. In other words, you had to have
22 100,000 to 300,000 gallons per acre per day. And the
23 water temperature had to be 77 degrees or lower,
24 something to that effect.
25 Do you recall that testimony?

1 A. Yeah, I've seen that. But the thing, of
2 course, about disease is it's not caused by the water.
3 It's a fungus that causes the disease. If you are a
4 good farmer, you keep the fungus from getting worse or
5 bad in your field.
6 There are ways of controlling disease
7 culturally. Even in the early Hawaii days, early
8 Hawaiian farmers recognized several cultural methods
9 of keeping your taro lo'i in good health. And like
10 any other production, you have to maintain sanitation,
11 and as long as the water is flowing, regardless of how
12 fast, you can control your disease problem.
13 Q. Now, in your experience, is it necessary to
14 have the water 77 degrees or cooler in order to
15 prevent root rot?
16 A. No, I don't think so.
17 Q. What is your experience?
18 A. My feeling is that you can have water as high
19 as 85 or 86 degree fahrenheit. As long as the soil
20 temperature stays below 80 degrees, you're okay.
21 Q. What is that based on? You described it as
22 your feeling. How do you develop that feeling?
23 A. Well, I've done some temperature measurements
24 also back then, and I've gone to some farmers' fields,
25 measured their water temperature, especially during

1 the summer.
2 Water temperature, of course, by virtue of
3 the ambient air temperature, goes up. But the water
4 actually insulates, acts like a roof that keeps the
5 soil temperature from going up. So if the water is
6 moving, the soil temperature stays fairly low.
7 Doesn't mean that because your water is 85 that the
8 soil is also 85. You can easily test that by stepping
9 into a lo'i.
10 So I've done some measurements in the
11 middle of the day when temperature are fairly high
12 that the water is 85 but the soil temperature is below
13 80. It's like you go up on the roof, the temperature
14 is hot, but down here even without air-condition, it's
15 not that hot.
16 Q. What difference does it make if the water is
17 moving?
18 A. Moving water provides oxygen for the taro.
19 Especially under flooded conditions. That's the only
20 way taro can get oxygen, have to get the water moving.
21 Otherwise it keeps it stagnant, then the use of the
22 oxygen in the water -- and even fish will drown if you
23 have ditches or streams that are stagnant because they
24 get depleted of oxygen. So you have to keep the water
25 moving.

1 Q. What if the water -- you described earlier
2 that Handy, in his book, describes old Hawaiian method
3 of having then to plant the huli in mounds and have
4 the water around the mounds but actually not up to the
5 stalk.
6 A. That's right. That's according to Handy,
7 that's the old Hawaiian way of growing taro. Even
8 under that condition, you don't have to make the water
9 move, because after all the taro is not submerged.
10 Q. So then it gets its oxygen directly from the
11 air?
12 A. That's right, oxygen directly from the air
13 and water just seeps under the taro so that the soil
14 is actually moist or saturated.
15 Q. So the movement of the water oxygenates the
16 water?
17 A. Yes.
18 Q. And does the movement of the water also
19 assist in keeping the soil from getting too warm?
20 A. That's right.
21 Q. So in your written declaration I think you
22 commented that most taro crop failures are associated
23 with lo'i where water is allowed to be stagnant. So
24 you meant in a flooded condition?
25 A. That's right. Under flooded conditions with

1 the water above the soil surface, you have to keep it
2 moving, you cannot let it go stagnant.
3 Q. So if you are going to have stagnant water,
4 then you have to have the taro plant in a mound above
5 the water?
6 A. That's right. If you don't have enough water
7 to keep it flowing, make it go down so that the taro
8 is not under water.
9 Q. Mr. Reppun yesterday also commented that the
10 apple snails, as I think is well-known, is a problem
11 with taro cultivation. Is that your understanding?
12 A. Unfortunately it's a problem statewide, not
13 just in taro. Anywhere you have water, like even
14 aquaculture, you have snail all over, because they
15 multiply.
16 Q. Are you familiar with conditions in Hanalei?
17 A. More or less.
18 Q. Do they have an apple snail problem there?
19 A. It's a bad problem, yes. Spread all over the
20 taro growing area there.
21 Q. Do they have a lot of water there?
22 A. Hanalei Valley is probably, as far as taro
23 growers are concerned, is the place where they have
24 more water than they can use. That's because it's
25 being maintained by the U.S. Wildlife -- Fish and

1 Wildlife, very centrally, so have to keep a lot of
2 water even where there is no taro growing.
3 Q. Mr. Reppun commented yesterday that he
4 thought that the cooler water would cause less
5 problems or make it less of a problem with apple
6 snails. Do you agree with that?
7 A. Well, if you make it cool enough to freeze
8 the snail, well, it will help. But I don't think you
9 have freezing water in Hanalei.
10 Q. So you, in your experience, you haven't noted
11 any correlation between the temperature of the
12 water --
13 A. The apple snail in Hanalei is year round,
14 winter or summer, and it's just as bad.
15 Q. In Mr. Reppun's written testimony he said: I
16 can say that I have never seen lo'i with inflows
17 approaching this small quantity of water by choice of
18 the farmer.
19 And he's referring to Watson's 1970 paper
20 that talks about use from 15,000 to 40,000 gallons per
21 acre per day.
22 Have you ever seen cultivated lo'i that
23 have water inflow of 40,000 gallons per acre per day
24 or less?
25 A. Oh, yes. There is a taro farmer in Haleiwa,

1 started with about ten acres, using a small pump to
2 bring the water out of the ditch to the taro fields.
3 And the pump had a capacity of 200,000 gallons per
4 day, and he had ten acres. So he was irrigating ten
5 acres with a small pump that brings in 200,000 gallons
6 per acre per day. So 200,000 divides by ten is 20,000
7 gallons per acre per day. And he was getting good
8 yields. He's still doing it now, still using it.
9 Q. What is the name of that?
10 A. This is the farm operated by Honolulu Poi
11 Company, Ernest Tatori. You can visit his farm. All
12 you have to do, visit his farm. He has almost 30
13 acres of taro fields now, because he puts 20 acres in
14 production most all the time. Most taro farmers have
15 to keep some fields in fallow because they stagger
16 their planting.
17 So for anybody to verify my statement all
18 you have to do is visit his farm and find out what
19 he's doing. I've visited his farm several times and
20 he uses a small diesel pump to bring water into his
21 fields.
22 Q. Have you ever grown taro for your own use?
23 A. I grow dryland taro because I don't have
24 fields good for lo'i. I live up Wailua Homestead.
25 Q. What do you grow?

1 A. I grow several varieties, including hybrids
2 that I produce myself. One of the work that I did
3 before I retired is do hybridization, crossing
4 different varieties to produce hybrid.
5 So I have several growing in my yard right
6 now that I'm trying to evaluate mainly for poi.
7 Q. You like poi?
8 A. Oh, yes, I do. That's why I'm happy that we
9 still have farmers growing taro.
10 Q. I have no further questions.
11 MR. MERCHANT: No questions.
12 MS. LOVELL: No questions.
13 HEARINGS OFFICER McCONNELL: Mr. Murakami.
14 CROSS-EXAMINATION
15 BY MR. MURAKAMI:
16 Q. Good morning, Mr. de la Pena.
17 A. Yes, good morning.
18 Q. I took a look at your curriculum vitae and
19 your list of publications you say you have.
20 A. Yeah.
21 Q. Is it 80 something, you say?
22 A. Yes.
23 Q. Of the 80 something, how many of those
24 publications were books?
25 A. One was a chapter in a book. It's not the

book itself. I didn't write the whole book. The chapter of the book that we collaborated and produced with several other authors.

Q. Which book is that?

A. That's taro --

Q. What number is that?

A. I don't think I have it -- I don't have the list here.

Q. I have a copy here of Exhibit A-7 I can hand you, unless your attorney --

A. The book that was edited by Jaw Kai Wang -- number 51.

Q. How many of these publications were published in scientific journals?

A. Well, I have to count.

Q. Okay. Is there more than ten?

A. Oh, yeah.

Q. More than 20?

A. I have to count.

Q. Of those publications that were in the journals, do you know how many were in university affiliated institutions?

A. I don't keep track of the counts, but they were all edited, reviewed and edited if that's what you're trying to ask.

1 Q. Were they refereed articles?
2 A. Yeah.
3 Q. All of them?
4 A. Most of them.
5 Q. Did you have the chapter refereed as well?
6 A. Oh, yes, it has to be. I have several edited
7 chapters in books. Of course, the editors wouldn't
8 publish it if it was not refereed and edited.
9 Q. So in 19 -- wait a minute. Where did I see
10 it -- 19 -- sometime after 1965, I'm trying to find
11 when you got your Ph.D..
12 A. '67.
13 Q. So in the past -- is that 28 -- how many
14 years has it been -- since 1967 you had your Ph.D.,
15 correct?
16 A. Right.
17 Q. Is that 38 years?
18 A. Just about.
19 Q. In 38 years then, you have been able to
20 publish one chapter in a book?
21 A. Well, there's another chapter in another
22 book.
23 Q. Two chapters?
24 A. Just call it two.
25 Q. Two chapters in two books. And maybe a

1 couple dozen publications in university affiliated
2 journals?
3 A. Yeah, journals, yeah.
4 Q. Now, those are all in fact refereed, correct?
5 A. Right.
6 Q. And the purpose of refereeing?
7 A. They have to be edited.
8 Q. And edited. So that others in your field can
9 criticize it?
10 A. Right.
11 Q. Contribute to it and say what's wrong maybe
12 with it?
13 A. Yeah.
14 Q. Give you some input so that you can figure
15 out what you need to edit?
16 A. That's right.
17 Q. And that way hopefully you add to the body of
18 works that have some scientific basis that has been
19 judged by your peers?
20 A. That's right. You cite other works that are
21 relevant to your work.
22 Q. So in the Sixth Symposium of the National
23 Society for Tropical Root Crops, was this published in
24 a refereed university affiliated professional
25 publication?

1 A. Yes, this was. This was actually published
2 by the National Potato Center.
3 Q. Is that a university?
4 A. It's not a university, but it's an
5 international research center.
6 Q. Much like the Sugar Planters Association?
7 A. No. Way more than that. It's funded by AID,
8 and USDA, the CTAHR, all these big funding
9 organizations hoping to promote the production of food
10 worldwide.
11 Q. So it's in part a government sponsored and
12 funded professional group?
13 A. Oh, yes, we are, very.
14 Q. But, in fact, is it affiliated with any
15 particular university?
16 A. Well, most of their faculty are also
17 affiliated with university.
18 Q. But the symposium itself and the publication
19 of this article itself, was that affiliated with an
20 academic institution like the University of Hawaii,
21 with the College of Tropical Agriculture and Economic
22 faculty?
23 A. It's hard to explain, because like this
24 international centers are manned by topnotch
25 scientists. They are just as good as any professors

in any --

Q. I understand. I'm sure there are many people like you joining this. My question is simple. Is it affiliated with an academic institution?

A. No.

Q. Was it, in fact, refereed?

A. Yes. The editor refereed it.

Q. But it was not refereed by an academic institution that published it, correct?

A. Many of the members of the editorial board are from different universities.

Q. They may be. But, again, was this particular article refereed by an academic institution that published it?

A. I can't remember. I don't know. Because when these things are edited, they don't tell us who refereed it or who critiqued it.

Q. Your answer is you don't know?

A. I don't know.

Q. Then -- let's see. In this article I wanted to ask if you were familiar at the time you wrote this paper, this abstract, I guess it's called, of the studies done by Miles and Watson on the water requirements for wetland taro?

A. Yes, I am.

1 Q. At the time of the publication of this
2 abstract?
3 A. That's right, yes.
4 Q. And did you understand that in those studies
5 the consumption figures for lo'i, taro lo'i, was
6 between 15,000 to 70,000 gallons per day per acre?
7 A. That's what Watson cited. I've seen the
8 paper. In fact, I have a copy of it.
9 Q. So you knew at the time you wrote this
10 abstract that there were other studies that indicated
11 that the consumption rate of a taro lo'i, depending on
12 those studies, ranged between 15,000 to 70,000 acres
13 per day -- gallons per day per acre, correct?
14 A. That's according to Watson.
15 Q. So I think what this says is that depending
16 on the type of experiment conducted, perhaps it's
17 location, and difference from what you did in
18 Hanapepe, the consumption rate for taro can be as high
19 as 70,000 gallons per day per acre?
20 A. What do you mean consumption? I think
21 consumption -- you have to define consumption.
22 Q. The use of water by that acre of taro per
23 day.
24 A. When I said consumptive use, it's the amount
25 of water that the taro actually absorbs and then

1 evaporated. So talking about consumption, that just
2 being water going through the taro lo'i, that's
3 different.
4 Q. Are you saying Mr. Watson --
5 A. The way he used consumption, just the amount
6 of water flowing through.
7 Q. That's not --
8 A. That's not consumptive use.
9 Q. Your statement Watson and Miles and their
10 figures of 15,000 gallons per day per acre to 70,000
11 gallons per acre was measuring flow-through and not
12 the consumptive use of water by taro?
13 A. Just the amount of water that went inside.
14 Q. To be precise, that's for per day per acre of
15 taro?
16 A. That's right.
17 Q. And that Miles and Watson calculated this to
18 be the flow through, not the consumptive use?
19 A. That's right, that's how I understood it, not
20 the consumptive use.
21 HEARINGS OFFICER McCONNELL: You're
22 saying, if I understand your testimony, just correct
23 me if I am wrong, that the term "consumption" as used
24 by Watson when he came up with 15 to 70,000 per day
25 figure, just meant the difference between the input

1 and the output?
2 THE WITNESS: That's right, just flowing
3 through the lo'i.
4 MR. MURAKAMI: Did I hear your question
5 right? Did you say the difference between the input
6 and output?
7 HEARINGS OFFICER McCONNELL: No. The
8 question was that was the definition, if you will, of
9 consumption as used by Watson.
10 THE WITNESS: That's right, just water
11 flowing through the lo'i.
12 HEARINGS OFFICER McCONNELL: Is that your
13 definition of consumption?
14 THE WITNESS: Consumptive use is
15 different.
16 HEARINGS OFFICER McCONNELL: And when
17 you're talking about -- I've forgotten, I'm not 69,
18 but not far behind -- when you're talking about
19 consumption of five to ten or 15, are you using the
20 same definition?
21 THE WITNESS: No, no. What I said
22 consumptive use is the amount of water that the taro
23 actually absorbs and uses. It's not the amount of
24 water that flows through.
25 HEARINGS OFFICER McCONNELL: The plant

1 itself, how much it absorbs?
2 THE WITNESS: That's right.
3 HEARINGS OFFICER McCONNELL: How do you
4 measure that?
5 THE WITNESS: You can do it under
6 controlled conditions. You can have a plant growing
7 in a sealed condition with the water, and put
8 exactly -- you measure the amount of water that you
9 apply, and after one day, you measure the amount of
10 water that's left behind. You don't let the water
11 flow out, otherwise that's not water that's used by
12 the taro. You just -- like you can give somebody five
13 gallon bucket, after one day find out how much he
14 drunk from it. All you have to do is measure it
15 again.
16 HEARINGS OFFICER McCONNELL: So is there a
17 difference between your method and Watson's?
18 THE WITNESS: You mean the definition?
19 Yes, different.
20 HEARINGS OFFICER McCONNELL: The method
21 used in your experiments at Hanapepe.
22 THE WITNESS: It's the same as Watson did,
23 just letting the water flow through.
24 HEARINGS OFFICER McCONNELL: But what
25 measurements did you take that were different than

his?

THE WITNESS: All I did was put the amount of water going into the plots the same throughout. Of course, I had different treatment. I started from 30,000 gallons per acre to 105,000 gallons. So I just measured the amount of water going into a lo'i.

HEARINGS OFFICER McCONNELL: Want to continue?

MR. MURAKAMI: Let me follow up with that.

Q. Your statement was you just measured water flowing into the lo'i at those six different flow rates?

A. Right.

Q. You did not measure the water flowing out of the lo'i in each of those instance?

A. No. I wish I did, but, you know, when you conduct experiments, you only have so much resource available. You can do that now with all this high technology, you can easily do that. You can plant sensors in the fields that can do -- you working round the clock, measurement. But in the early '80s, we did not have that kind of technology.

So what I measured is just the amount of water flowing into its lo'i.

Q. And so when you say in paragraph seven on

1 Page 3 of your rebuttal testimony or declaration, I
2 should say, I believe that 30,000 gallons per acre per
3 day will result in 20,000 to 25,000 acres per day of
4 flow-through water exiting the irrigated plots.
5 Then what you mean is that you're
6 assuming, not having measured, that the outflow in
7 your experiment, at least at the 30,000 gallons per
8 acre per day, was 20,000 to 25,000 gallons?
9 A. That's right. Based on the assumption that
10 the consumptive use is five to 10,000 gallons per acre
11 per day.
12 Q. So that assumption was made in order for you
13 to cal -- to calculate what you assumed to be the
14 outflow from the lo'i in your Hanapepe experiment?
15 When was it, 25 years ago?
16 A. Back in 1981, yeah, 25 years ago.
17 Q. But you have nothing that you did in 1981 at
18 the time of the experiment to show that it is 20,000
19 to 25,000 gallons per acre?
20 A. No. Unfortunately I did not measure that. I
21 was just basing it on what we feel is the consumptive
22 use.
23 Q. In fact, you say that that was what you feel.
24 So let me ask you about your basis for how you felt.
25 The assumption you used was based on other studies of

1 what the water requirements are for taro?
2 A. Right, that's right.
3 Q. Not your experiment?
4 A. No. But as you asked earlier, you know, we
5 relied on the sites of other works. We cannot conduct
6 every experiment, so we have to rely on other workers'
7 data also.
8 Q. But under the scientific methodology for
9 which you've been trained to apply, the standard of
10 your industry is to measure as much of the changes and
11 input and output of any experiment, correct, to get
12 adequate data?
13 A. You do the best you can.
14 Q. Let me step back. Not about what the best
15 you can, but under scientific methodology, isn't it
16 better to measure, in this instance, the outflow at
17 the time of the experiment so you have the data on
18 paper recorded rather than to take a formula and
19 assumption and apply it for what might have happened
20 25 years ago?
21 A. Right.
22 Q. Thank you.
23 Now, the experiment you said -- I wrote
24 down as you testified that you replicated this
25 experiment in 1981 three times; is that right?

A. The plots were replicated three times.

Q. When you say three times, do you mean that you had three plots and that you applied the six rates of flow to each plot?

A. No. We had six rates, so we had 18 plots. Three of those received 30,000 gallons per acre per day, three received the other treatment, and 200 --

Q. So every three plots received the set level of irrigation?

A. Right.

Q. And so you were able to --

A. This was randomized. They were not side by side.

Q. And the plot sizes were how big?

A. They were about 20 by 30 feet, that's about 600 square feet.

Q. Twenty by 30 feet. If you took this room that we're in, would you estimate the size of this room to be relative to one plot?

A. I would have probably two plots in this room.

Q. Two plots in this room?

A. Yes, yeah.

Q. And did you -- and each plot was the same size?

A. Yeah. We made them as close in size as

1 possible. After all, you have to make levies. It's
2 all individual levies.
3 Q. And you said in your testimony that you went
4 to Mr. Nagamine's farm. And among your testimony, I
5 can't quite pinpoint exactly what you said, but that
6 the plots that he used were pretty well tamped down?
7 A. Yeah. Like most farmers, when you prepare a
8 lo'i, you --
9 Q. And that the soil was the same in Kauai as it
10 is in East Maui?
11 A. Oh, yeah, it is.
12 Q. So by way of those two statements, are you
13 saying here today that the rate of percolation from a
14 -- from the experiment plots you used 25 years ago in
15 Hanapepe, Kauai, would be the same as the percolation
16 rates that you would find in a taro field in Wailuanui
17 Valley?
18 A. Well, if they were prepared well, the same
19 way as has been described in the early days, it would
20 be very similar. I'm sure you'll find some
21 variations.
22 Q. Do you know what the extent of that variation
23 would be?
24 A. No, I don't know.
25 Q. Have you done any studies to determine the

1 extent of variation?
2 A. No, I don't have that kind. I wish I did.
3 Q. At this point if you try to make this
4 comparison, and you made the statement on your direct,
5 can you say on the basis of any scientific study that
6 the percolation rates of the taro plot you used in
7 Hanapepe Valley 25 years ago and Mr. Nagamine's farm
8 does not vary significantly, statistically or
9 otherwise, from what you would find for the
10 percolation rates of lo'i in Wailuanui Valley?
11 A. I think they're very similar.
12 Q. Can you cite on the basis of any site study?
13 A. No.
14 Q. Can you say on any study that you have done
15 on the percolation rates, that it's the same as the
16 percolation rates in Auntie Beatrice Kekahuna's lo'i?
17 A. No, I cannot say anything like that.
18 Q. Now, in answer to the hearing officer's
19 question, you said that you would -- you came up with
20 this figure of between 20 to 25,000 per day per acre
21 based on your belief and your feelings about what this
22 might be. I think you started answering it
23 theoretically by saying that you would take the
24 measurements of the inflow and take the measurements
25 of the outflow, which you didn't do?

A. No, I did not do that. But if I did, that is what I would suspect it to be.

Q. Were you trying to say that that was what Watson and Miles didn't do or that they did do to come up with the 15,000 to 70,000 gallons per acres per day?

A. They did, they measured inflow and outflow.

Q. So it's the same thing as what you talked about in your experiment. Correct?

A. Right, uh-huh.

Q. The difference between inflow and outflow?

A. Right.

Q. And that is your consumption rate, that difference of flow?

A. That's right.

HEARINGS OFFICER McCONNELL: I thought in the Hanapepe experiments you didn't have an outflow figure.

THE WITNESS: No.

HEARINGS OFFICER McCONNELL: Only had an inflow figure.

THE WITNESS: That's right.

HEARINGS OFFICER McCONNELL: So you made assumptions based on the studies as to what the absorption for the plants would be?

1 THE WITNESS: That's right. But you have
2 to consider the fact that what's important is what
3 goes in, as long as -- the rate of water flowing out
4 of the lo'i, it's not that important.
5 MR. MURAKAMI: Let me ask you then. Talk
6 about that.
7 Q. You say it's not important, but there is a
8 difference, isn't there? I mean 30,000 going in
9 doesn't mean 30,000 going out, right? It's always
10 something less?
11 A. That's right, because the water -- taro uses
12 the water.
13 Q. You said that in response to Judge
14 McConnell's question about that difference that the
15 taro plant uses that water, correct?
16 A. Yes. The taro plant uses the water. Based
17 on irrigation experts' figures, regardless of how much
18 water goes inside, if it's above five to 10,000
19 gallons per acre per day, the extra flows out.
20 Q. And you're saying that that happens
21 irrespective of the percolation rate that might occur
22 in any particular lo'i, right?
23 A. No, no, no. The amount that flows out, of
24 course if you have high percolation rate, if you have
25 sandy soil, well, you don't have much going out.

1 Q. And, of course, plant uses some, it absorbs
2 it, correct?
3 A. Oh, yes, obviously.
4 Q. What about evaporation, did you account for
5 that in any of your statements?
6 A. That's what the consumptive use of water is
7 all about.
8 Q. You said the only thing that makes up the
9 difference is the use of the plant of that water. You
10 didn't mention evaporation?
11 A. I said consumption is the evapotranspiration,
12 so it's both the evaporation and transpiration.
13 Q. Okay. So now there is three things. There's
14 the water use of the plant, right?
15 A. Right.
16 Q. There is the evaporation of the water from
17 the surface of the water?
18 A. Right.
19 Q. Then evapotranspiration, which is evaporation
20 through the leaves?
21 A. That's what we call consumptive use.
22 Q. So the consumptive use is made up of those
23 three things?
24 A. Evaporation and transpiration.
25 Q. So did you attempt to measure any of those

1 three things in your experiment 25 years ago?
2 A. No, I didn't have the facility to do that.
3 HEARINGS OFFICER McCONNELL: Did the
4 studies that you relied on consider those factors?
5 THE WITNESS: Beg pardon?
6 HEARINGS OFFICER McCONNELL: Did the
7 studies that you relied on to come up with a
8 consumptive -- come up with the five to ten, did those
9 studies take into account evaporation, transpiration?
10 THE WITNESS: Yes, yes. That's the
11 general definition of consumptive use, is the amount
12 of water that is evaporated and transpired by the
13 plant.
14 HEARINGS OFFICER McCONNELL: So
15 essentially in the Hanapepe experiment, you knew the
16 input and you got the best figures you could from the
17 literature?
18 THE WITNESS: Right.
19 HEARINGS OFFICER McCONNELL: As far as the
20 consumptive uses?
21 THE WITNESS: That's right.
22 Q. (By Mr. Murakami): Dr. de la Penia, what
23 were those studies upon which you relied to derive the
24 consumptive use of taro and the evaporation and
25 transpiration?

1 A. Well, I have checked with our agriculture
2 engineers. Some of them were our agricultural
3 engineers -- cited by our agricultural engineers, so
4 I've done --
5 Q. Can you cite me to a study that documents
6 what the consumptive evapotranspiration and
7 evaporation of taro plants are?
8 A. I don't have it right now, but personal
9 communication with Dr. Jaw Kai Wang. He's the one
10 that provided me that figure. I don't have his
11 citation.
12 Q. But whatever it was that you used from
13 Dr. Wang, you did not include any percolation rate of
14 the lo'i, potential percolation into the lo'i?
15 A. No.
16 Q. Now, when you mentioned the Handy and Handy
17 study and the fact that this mound system occurs in
18 the Cook Islands and Samoa, did you intend to say that
19 the result that you might find in the Cook Islands and
20 Samoa with respect to the water needs of taro, are the
21 same in those island environments as in East Maui? Is
22 that what you meant?
23 A. What do you mean same?
24 Q. In terms of consumptive use of water by taro
25 or inflow and outflow you would expect to see of water

1 into those kinds --
2 A. Well, the consumptive use will vary depending
3 on temperature and the environment. That's why we
4 have range of five to 10,000 gallons per acre per day.
5 Q. Are you talking about ambient temperature?
6 The temperature around the taro patch?
7 A. That's right.
8 Q. You didn't measure the temperature throughout
9 the period of your experiment in 1981, did you?
10 A. No.
11 Q. So it could -- if you have, let's say 80
12 degrees temperature in an experiment over a period of
13 time of the sort that you used back in '81, would you
14 expect that the evapotranspiration and evaporation
15 rates would be the same as if you found a taro patch
16 that is in an area that has ambient temperature of 95
17 degrees?
18 A. Definitely not, because one is warmer than
19 the other.
20 Q. So temperature matters, ambient temperature
21 matters?
22 A. Right.
23 Q. And it would vary the results of any
24 experiment?
25 A. Yes.

1 Q. Similarly, with respect to the temperature of
2 the water going into the taro patch, I think you
3 testified that you believe 85 degrees is your
4 threshold temperature level, correct?
5 A. That's about right.
6 Q. So if you have water going in at 30,000
7 gallons per day at say 86 degrees, would you not
8 expect different results to your taro yield than if
9 the water was going in at say 77 degrees?
10 A. Yes, you will have some differences.
11 Q. And that's in terms of root rot, correct?
12 A. Not only root rot but probably the yield too.
13 The lower the temperature, the less yield you'll get.
14 Q. The less yield?
15 A. Right.
16 Q. So you're saying that you would get smaller
17 taro with cooler temperatures, and higher root rot
18 with higher temperatures; is that right?
19 A. You'll have that, that's possible, assuming
20 that you have root rot in the field. But if you don't
21 have, you won't have root rot.
22 Q. And so that's another factor?
23 A. That's right.
24 Q. Whether or not there is the level of fungal
25 incidence in the soil?

1 A. That's right. That's why farmers have to be
2 careful and they can control the incidence of root rot
3 in their field by practicing sanitation.
4 Q. And did you document -- well, your article
5 does not document the sanitation measures nor the
6 fungal incidence in Mr. Nagamine's soil.
7 A. In the experiment that we conducted, we had
8 no disease problem. We had no fungal or soft rot, the
9 whole experimental field.
10 Q. So your assumption is that -- you didn't
11 measure that though, did you?
12 A. Well, I would have measured it if there was
13 root rot, but there was no root rot.
14 Q. So you're assuming no fungus of significance?
15 A. There was no disease.
16 Q. But you're assuming no fungus of significance
17 in Mr. Nagamine's plots?
18 A. That's right.
19 Q. Should there be fungus in some other plot in,
20 let's say on East Maui, as a result of whatever
21 conditions, then you would expect the same experiment
22 to yield different results, wouldn't you?
23 A. Oh, yes. Depending on conditions in the
24 field, you're talking about?
25 Q. Right. And if you have, let's say, higher

1 incidence of fungal incidence in the soils of East
2 Maui, would you not expect to have to use more and/or
3 cooler water to control the incidence of root rot in
4 those fields?
5 A. That's right, yeah. You can -- from 30 to
6 maybe 50,000 gallons, just make sure that the water
7 flows through, or you can practice the old Hawaiian
8 way of not flooding the field.
9 Q. Let me -- you said 30 to 50,000. Any basis
10 that you're saying if you can use 30, you can use 50?
11 Have you documented that level of water inflow to
12 manage any conditions of higher incidence of fungus in
13 the soil to control pythium rot in taro?
14 A. No.
15 Q. It could be higher?
16 A. But I'm just basing that on many of the
17 fields that I have visited. Many of them don't have
18 that kind of water flow.
19 Q. But all I'm saying is that the water flow to
20 control that kind of rot could be higher than 50,000
21 gallons per day per acre?
22 A. Could be, but I haven't seen that kind of
23 problem.
24 Q. And if you had to try to control it further,
25 wouldn't cooler water, even if it was 50,000 gallons

1 per day per acre, wouldn't cooler water reduce the
2 incidence of root rot?
3 A. Yes, regardless of the rate, cooler water
4 will control it.
5 HEARINGS OFFICER McCONNELL: Just for my
6 clarity, your definition of percolation is what?
7 THE WITNESS: Water that goes through the
8 soil instead of going up. You lose it through
9 percolation.
10 HEARINGS OFFICER McCONNELL: So it goes
11 into the soil, does not go into the plant, does not go
12 out?
13 THE WITNESS: Yes, you lose it.
14 HEARINGS OFFICER McCONNELL: That's what I
15 thought. I wanted to make it clear.
16 Q. (By Mr. Murakami): Dr. de la Pena, we talked
17 about the ambient temperature. You didn't take any
18 measurements, did you, of the water temperature going
19 into your experimental plots in Hanapepe 25 years ago?
20 A. Actually we did. We had very little
21 variation, so I did not include it in the paper.
22 Q. Is there anywhere in your paper that mentions
23 that fact, the degrees to which the water temperature
24 did not vary?
25 A. No, I did not put it in there.

1 Q. Normally in a scientific paper -- you'll
2 agree, right, that temperature is a critical factor,
3 whatever the ideal temperature, is a critical factor
4 in any experiment to determine whether there is affect
5 on taro root rot?
6 A. That's right. But don't forget that all the
7 treatments were subjected to the same, whether the
8 temperature was low or high.
9 Q. I understand that. But at this point the
10 reader of this abstract could not tell what the
11 temperature of the water was going through your
12 experiment.
13 A. No.
14 Q. Now, the use of your 85 degree temperature
15 threshold, is that based on a scientific study of the
16 sort you did in Hanapepe 25 years ago so that you
17 could reach a scientifically based --
18 A. No, that's --
19 Q. Let me finish my question. Referee based
20 conclusion that 85 degrees is the threshold
21 temperature at which taro begins to suffer pythium
22 root rot?
23 A. That's not based on my experience. Based on
24 other peoples' experiments.
25 Q. Are there other experiments?

A. We have plants -- others who did experiments. They're the ones that work on --

Q. Can you cite to me an article?

A. Dr. Trujillo had a paper published on it.

Q. Is that something that you're relying on to reach this conclusion about this 85 degree threshold?

A. That's right.

Q. And this -- is it your testimony, your opinion, expert opinion today, that the community, the industry of taro growing accepts 85 degrees to be the threshold temperature at which taro suffers root rot in taro lo'i across the State of Hawaii?

A. I don't know if they accept that, but our plant pathologist, that's what the plant pathologist has recommended. So I don't know if other farmers follow that basis.

Q. Did you actually read this in his article?

A. Yeah, I did.

Q. Or did you ask him?

A. It's in a paper.

Q. Have you -- you haven't done any independent research on your own to determine that --

A. No.

Q. -- 85 degrees is adequate?

A. No, I'm not a plant pathologist. Plant

1 pathologist do that kind of work.
2 Q. So basically that's something beyond your
3 field of competence?
4 A. That's right.
5 Q. And so 25 years ago in your experiment you
6 had no measurements for outflow, correct?
7 A. Right.
8 Q. No measurements for ambient temperature,
9 correct?
10 A. Well, I had measurement. I did not put it in
11 the paper because there was very little difference.
12 Q. Okay. And you had no measurements for water
13 temperature, at least in the abstract?
14 A. No, not in the paper.
15 Q. And is it your testimony that the Hanapepe
16 experiment conditions that you utilized in 1981 is not
17 significantly different from areas in East Maui
18 regardless of elevation and other conditions that you
19 find in East Maui?
20 A. No, no, I'm not saying that.
21 Q. Thank you.
22 Now, I had a question here about your
23 statement on Page 99. Do you have your abstract?
24 A. Yeah.
25 Q. On the first full paragraph after Results and

1 Discussion, you make the statement that: There was no
2 significant effect of rate of water flow on growth and
3 development of lowland taro. You state that the
4 vegetative yield tended to increase with high water
5 flow rates. Correct?
6 A. That's right.
7 Q. In other words, you get bigger plants with
8 high flow?
9 A. That's right.
10 Q. And that, you know, and that -- in fact, 11
11 percent difference apparently, is that correct?
12 A. That's right.
13 Q. And that the total leaf yield difference was
14 16, almost 17 percent, correct?
15 A. Yeah. That's measuring the leaf, the top of
16 the taro, not the corm or the column.
17 Q. And, in fact, if you turn to the next page on
18 table two, the difference between the -- all I can
19 read is your experiment on the depth of this flooding.
20 A. This is -- to begin with, this was done in a
21 different site. This was in controlled cement tanks.
22 This is not the one in Hanapepe Valley.
23 Q. My only question was, while I understand the
24 difference in the heights and measurements of your
25 heights for those closed tanks, I guess those were the

1 cement lined ones?
2 A. Yeah.
3 Q. You don't have any similar measurements for
4 the flow rates, do you, on the height of the taro
5 plant in this chart?
6 A. No. The flow rates would be the same, all of
7 those tanks.
8 Q. I understand. But the yield that you
9 calculated in your text part of your article or
10 publication is the only place where you talk about the
11 height of the taro in terms of how it was affected by
12 flow rate, correct? The page before, page 99. I'm
13 just trying to see if I'm mistaken.
14 A. Yeah, that's right. The flow rate, yeah.
15 Q. And in terms of your measurements on the
16 yields of taro grown in your experiment, I guess you
17 basically are concluding that there's no significant
18 difference in the development of the corm or the yield
19 of the corm?
20 A. In Hanapepe, yeah.
21 Q. What is the difference in your definition of
22 corm versus market cormel?
23 A. Cormel are the oha. Ohas or the kalo.
24 Q. Tell us the difference between oha and the
25 kalo?

1 A. Kalo is the main plant and oha, that's the
2 young ones.
3 Q. When you say marketable cormels, are these
4 are the ones --
5 A. They're big enough you can cook it and eat
6 it. Some of them too small, you don't want to sell
7 it.
8 Q. When you say marketable cormel, you're saying
9 baby taro on the side that can still be marketed to
10 sell to eat?
11 A. Yeah, for making poi. Just like any
12 commercial taro grower, you harvest the taro. If they
13 big enough, you put in the bag; if too small, you
14 don't put in, because the poi mill don't like cleaning
15 very small one-inch oha.
16 So everything we did, this was as if
17 you're a taro farmer yourself. So the harvesting was
18 all the same. Tried to do everything the same for all
19 the plots. And like I said, the only difference is
20 the amount of water flowing into its plot. So air
21 temperature, water temperature, they're all the same.
22 Q. I think it goes on saying, Dr. de la Pena,
23 that you have done no experiment of this sort of the
24 taro yields that could be affected by water flow in
25 East Maui?

A. No, not in East Maui.

Q. And specifically in Wailuanui Valley?

A. No.

Q. Or in Keanae?

A. I did this in Hanapepe.

Q. Nothing replicated in Keanae?

A. No, no. I have no ability to do that, or I had no ability to do that, come all the way from Kauai to do work here in Maui.

HEARINGS OFFICER McCONNELL: Why don't we take just a ten-minute break.

(Recess was taken.)

We are reconvened. Mr. Murakami.

Q. (By Mr. Murakami): Let me ask a point of clarification here. I know we talked about the fact that you relied on Dr. Trujillo's study for how temperature can affect the incidence of root rot in taro, correct?

A. That's right.

Q. You didn't do any independent studies on your own?

A. No. Like I said, that's a plant pathologist line of work.

Q. So you wouldn't know how long and for what period of time you would -- it would take for taro to

1 start suffering root rot if it went above the
2 threshold temperature where it might make a
3 difference?
4 A. No.
5 Q. And in your testimony you make a statement on
6 page two, paragraph four, towards the bottom or
7 middle --
8 A. Yes.
9 Q. While it is clear that taro can tolerate
10 being irrigated at certain times during its crop cycle
11 with this amount of water -- and I think you're
12 referring to Paul Reppun's 100,000 to 300,000 gallon
13 per day per acre?
14 A. Right.
15 Q. -- I believe it's well-established,
16 particularly by the experiment that I conducted in
17 Hanapepe in 1983/84, that there is no significant
18 increase in taro caused by supplying more than 30,000
19 gallons per acre per day.
20 When you say tolerate there, are you
21 saying that there would be a harmful effect on taro if
22 in if fact water is applied in the rate that Mr.
23 Reppun advocates?
24 A. When you apply that much water, then the
25 waterflow, to be able to apply that much water, the

1 velocity has to increase. You cannot just let it
2 trickle in. So especially if the taro has just been
3 planted, you allow that kind of taro to flow through
4 there, it will care away the hulis.
5 HEARINGS OFFICER McCONNELL: Carry away --
6 THE WITNESS: Carry away the plants,
7 because 100,000 to 300,000 gallons of water would --
8 instead of just letting the water flow at the slow
9 rate, you have to increase it to be able to apply that
10 amount of water.
11 And it'd also carry a lot of soil and
12 fertilizer elements from the field if you allow that
13 much water to flow in. And if you let that kind of
14 water flow through, you have to, according to the new
15 Clean Water Act, I think you have to develop a
16 sedimentation pond so that whatever the water carries
17 out of the field gets cleaned first before it goes
18 back into the stream.
19 Q. (By Mr. Murakami): So is it your testimony
20 and blanket statement that no farmer would ever apply
21 100,000 to 300,000 gallons of water per day per acre
22 to this --
23 A. I did not say that. But I don't think
24 anybody has that kind of water -- that's a luxurious
25 consumption of water.

1 Q. Your opinion is that's luxurious, but the
2 question is: Have you observed this amount of water
3 causing the kinds of problems you just articulated in
4 the field, particularly in East Maui, for example?
5 A. No, not in East Maui.
6 Q. So it is on the basis of your speculation
7 that these problems could occur, correct?
8 A. Yes, that's right.
9 HEARINGS OFFICER McCONNELL: You have not
10 observed it in other places?
11 THE WITNESS: No, not in East Maui.
12 HEARINGS OFFICER McCONNELL: Well,
13 anywhere in Hawaii?
14 THE WITNESS: The experiment station we
15 have that kind of work. So when we let water flow,
16 especially we just had the strong rain and the water
17 goes into our irrigation ditches, we have that kind of
18 rate could flow into our fields and carry away the
19 taro.
20 So I assume that if you deliberately let
21 that kind of rate go into the taro fields, well, you
22 have to be careful, because that amount of water
23 flowing -- it's just like a water hose. You let water
24 hose at the high rate, that's what they use to blow
25 people down.

1 HEARINGS OFFICER McCONNELL: So in Hanalei
2 where they have all the water they want? Where was it
3 that you said they had as much water --
4 THE WITNESS: No, in commercial taro
5 fields I haven't seen that kind of rate applied in the
6 taro fields, even in Hanalei.
7 HEARINGS OFFICER McCONNELL: That's my
8 question.
9 THE WITNESS: That's a lot of water, 100
10 to 300,000 gallons is a little too much. Whether you
11 need 100,000 when it's sufficient -- 30 or 50,000
12 gallons is sufficient, I mean, you have to be -- you
13 have to be judicial in your use of water. After all,
14 it's an important resource. You don't want to use too
15 much.
16 HEARINGS OFFICER McCONNELL: But you have
17 not seen, even in Hanalei where they have it,
18 100,000 --
19 THE WITNESS: No, I haven't seen that kind
20 of rate applied in taro fields commercially.
21 Q. (By Mr. Murakami): I'm sorry. But you are
22 aware that in Hanalei they do apply that much water?
23 A. No, I haven't seen that kind of rate.
24 Q. You understand, do you not, that when Mr.
25 Reppun talks about this amount of water, he's not

1 talking about the stage of the taro, the plant cycle
2 where you're planting huli?
3 A. It says in the requirement here, I mean in
4 the request is on a regular basis, so I guess I assume
5 that it's almost any time when the taro is planted.
6 Q. I'm going to read to you a section on Page 2
7 of Paul Reppun's direct testimony where he says, on
8 Page 2, on the bottom:
9 When you prepare the field, you flood it,
10 you don't need very much water, just need enough to
11 cover the surface.
12 A. That's right.
13 Q. So you understand, do you not, that at the
14 time of putting huli in the ground, which is the
15 planting stage, right?
16 A. Right.
17 Q. What he's talking about is not putting a huge
18 amount of water in the field?
19 A. That's right, yeah.
20 Q. So your statement that this could destroy
21 huli coming into lo'i would not apply?
22 A. At that time, yeah. That's why the farmer
23 has to be, you know, has to be akamai when and how
24 much to put at a different time of the growing.
25 Q. But you understand Mr. Reppun is not talking

about putting in large amounts of water at the planting stage?

A. No. Yeah, that's right.

Q. And if you say that in fact it really depends on the farmer, then is Paul Reppun an akamai taro farmer after 31 years?

A. I cannot judge that, that he's a taro farmer.

Q. So you have no opinion about that?

A. No.

Q. Now, you talked about soil temperature being the critical element in terms of root rot, correct?

A. Well, that's -- I'm basing my statement on the result of experiments conducted by plant pathologists, because they're the ones that do that kind of work.

Q. Let me ask you this then. You talk about the need for moving water, correct?

A. Correct.

Q. To keep taro healthy, is that right?

A. Right.

Q. But -- and I think you agree with Mr. Reppun that moving water is important to keep temperatures down to certain levels?

A. Right.

Q. Your only disagreement is that --

1 A. The rate.
2 Q. Let me back up. That the amount, the
3 threshold level of temperature that is below which
4 taro will not rot is in Mr. Reppun's opinion, 77
5 degrees in the water; and in your opinion, 85 degrees
6 in the water?
7 A. From 85 down.
8 Q. So we are talking about a difference of
9 basically those eight degrees?
10 A. That's right.
11 Q. But yet you do agree, do you not, that the
12 movement of water is important?
13 A. Yes.
14 Q. Whether 85 or 77?
15 A. That's right.
16 Q. And that's what keeps the temperature down,
17 correct?
18 A. You mean the movement of water?
19 Q. Yes.
20 A. Yes, that's right, when water moves.
21 Q. In other words, if it's 90 degrees out and
22 you let the water stand there, theoretically
23 ultimately if it's a real hot day, it's going to reach
24 the same ambient temperature, 90 degrees?
25 A. I did not get you.

1 Q. If you have water standing and not moving in
2 a lo'i and there is no cover, no shade, if it's 90
3 degrees out, wouldn't that water ultimately reach 90
4 degrees if it's not moving?
5 A. Oh, yes, of course. Yeah. But you don't
6 want to do that.
7 Q. So the key is really at what rate the water
8 is moving to keep the temperatures down to either 85
9 or 77 degrees, that's the key, correct?
10 A. Not necessarily. The key is to get the water
11 oxygenated.
12 Q. Okay. It can stand there not moving, as long
13 as its oxygenated, then it's okay?
14 A. No. You have to make it move. How it get
15 oxygenated, if you don't make it move?
16 Q. That's my question. You have to make it
17 move?
18 A. You have to make it move, otherwise it's
19 stagnant. And you don't want to do that in your taro
20 field. That's established fact that you have to have
21 moving water.
22 Q. And at least the two key elements to the
23 movement of water is that it will affect temperature?
24 A. Right.
25 Q. And it well affect the oxygenation level?

1 A. Right.
2 Q. You're saying you need that movement of water
3 for those two reasons, correct, to keep taro healthy,
4 oxygen and temperature?
5 A. Yeah, that's right.
6 Q. So if oxygen is necessary with the movement
7 of taro --
8 MR. SCHULMEISTER: Movement of water.
9 MR. MURAKAMI: I'm sorry, movement of
10 water.
11 Q. What is in fact affecting the level of
12 dissolved oxygen in the water as it moves?
13 A. Its interaction with the air.
14 Q. So as the movement of the water -- as water
15 moves over a surface, it is interacting with the air
16 and adding oxygen to it?
17 A. That's right.
18 Q. If the taro plant does not get dissolved
19 oxygen, what happens? If the dissolved oxygen level
20 drops because there is no movement.
21 A. Then if you leave it long enough, the taro
22 will not grow, will rot. Even if you do not have
23 pythium rot, fungus.
24 Q. That's my question. You can have either
25 pythium rot or some other rot without oxygen?

A. Right, because the taro will drown, just like fish.

Q. That's what you mean by drown in your testimony?

A. Right. The fish in the stream if the water is not moving, stagnant, he drowns. You have to have oxygen.

Q. You said apple snails will not be affected by cooler water unless the water was freezing, correct?

A. Well, that's a general statement. What do you mean affected by?

Q. Stop growing, stop multiplying.

A. Oh, if you freeze it, it will stop growing, probably die.

Q. Will the difference between 85 degrees and 77 degrees have and affect --

A. I don't think so.

Q. Let me finish -- on the reproductive rate of these snails or their growth rate?

A. I have no data to support that.

Q. So when you say that you believe that it would have to be freezing water to affect the growth or reproductive rate of apple snails, you have no scientific study on which you're making that statement?

A. No, no, I don't have any.

Q. This is simply, again, your belief?

A. That's just my personal feeling. Because regardless of the season, I go to Hanalei, the apple snails are all over the taro fields, wintertime or summertime. So I don't have any data to show that during the winter they reproduce less or more than in the summer.

Q. But you don't know whether there's been any change in the population of apple snails controlled for all other factors in Hanalei between summer and winter months?

A. No, I don't have that.

Q. So at this point you don't have any basis at all to make the statement that cooler water does not affect the reproductive rate or growth of the snails, do you?

A. No, I don't have. But they still have snails there regardless of temperature, whether summertime or winter.

Q. Sure. Could there be less reproduction in population?

A. The rate the apple snails are infesting Hanalei, ten percent is not very much. Still devastating the taro fields.

1 Q. That's right, but have you measured that
2 difference to see whether it's ten percent?
3 A. No.
4 Q. Have you measured to see whether it's 20
5 percent?
6 A. No. Haven't done anything on that, not on
7 apple snails.
8 Q. So you really can't say what the difference
9 is relative to water temperature?
10 A. No.
11 Q. With respect to Mr. Tatori's taro crop, is it
12 your testimony that 200,000 gallons per day is being
13 applied in Haleiwa on ten acres of fully cultivated
14 taro?
15 A. That's what I understand. I visited his
16 field, and told me that's all the water he gets.
17 Q. Wait a minute. Let's see. You basically
18 asked Mr. Tatori how much water he's using to irrigate
19 200 -- ten acres?
20 A. Yeah.
21 Q. And he told you I have this pump and it's
22 designed to pump 200,000 per day?
23 A. It's pumping 200,000 gallons per day.
24 Q. Per day?
25 A. Uh-huh.

1 Q. So all you need -- your assumption is that
2 he's applying 200,000 gallons per day based on the
3 capacity of his pump on ten acres?
4 A. Uh-huh.
5 Q. What does that come to per acre per day?
6 A. About 20,000.
7 Q. And so isn't it true that Mr. Tatori's
8 cultivation, if he's applying this amount as you have
9 assumed, based on his word, is less than what your
10 experiment in Hanapepe apparently demonstrates as the
11 level of growing that could allow taro to grow without
12 pythium rot?
13 A. No, I did not say that.
14 MR. SCHULMEISTER: Objection, lack of
15 foundation.
16 Q. (By Mr. Murakami): Did you ask him whether
17 he's getting rot in those fields?
18 A. He has some, but not serious enough to stop
19 him from growing taro.
20 Q. Do you know to what degree that pythium rot
21 is occurring?
22 A. No. I didn't ask him. But he has good
23 yields, so that's a good indication that he's okay.
24 Q. And he has good yields because of what he
25 told you?

1 A. Yeah, what I have to rely on his word.
2 Q. You didn't go out there and pull taro and
3 sample how much rot is out there?
4 A. No.
5 Q. So you don't know on the basis of scientific
6 observation whether what he says is good yield is the
7 same as what you would say based on your observation
8 through the pulling and sampling of taro?
9 A. No, I did not sample any of his taro.
10 Q. So if he just wanted to say that it was good
11 taro yields, you wouldn't know whether it's based on
12 80, 90 percent less yield -- any number --
13 A. No, no.
14 Q. -- that you might judge it on, correct?
15 A. No, no. I have no basis for comparing his
16 yields, whether they are good or better than any other
17 farmers.
18 Q. And would you put that statement in
19 scientific refereed publication as a result of your
20 research on taro yields and water levels necessary for
21 those yields?
22 A. No, I wouldn't. I have no basis for doing
23 that.
24 Q. Dr. de la Pena, that statement in your
25 testimony sounds like what I believe your academic

1 field would term as anecdotal, correct?
2 A. I don't know what you mean.
3 Q. Is it not anecdotal to report what Mr. Tatori
4 reported to you?
5 A. Well, you know, when I visit farmers, I ask
6 questions, how they're doing, what their practices
7 are. If that's what you mean, yeah, well, based on
8 what I gather from him, that's what I got from him.
9 Q. So the truth or falsity of that statement is
10 based on what Mr. Tatori meant at the time?
11 A. That's right. You can verify it by visiting
12 with him.
13 Q. We will. Let me just gather my notes here.
14 Dr. de la Pena, in your 1981 study, isn't
15 it true that you have no objective measurement other
16 than quantity of yield of the corms for whether or not
17 those corms were in fact of a quality that would be
18 necessary to make good commercial grade poi?
19 A. Oh, we make poi. We cook them.
20 Q. You cooked them?
21 A. Yeah. They all good.
22 Q. But it was based on your assessment then of
23 the quality of those corms?
24 A. Right.
25 Q. That gave you -- that you made a judgement --

1 A. We weighed them and we cleaned them just like
2 any other farmer would do.
3 Q. Do you know what is loliloli?
4 A. Uh-huh.
5 Q. Is there any way in your abstract published
6 here to determine whether or not any of the yield of
7 the taro that you recorded in 1981 included taro that
8 was loliloli?
9 A. I did not observe any loliloli. They were
10 all good.
11 Q. What is the standard at which you measure
12 whether taro is loliloli?
13 A. We cut, we clean. We cut the kokole, the
14 base part so you can tell whether they're good or not.
15 Q. Is there a standard of measurement of the
16 degree or some kind of scientific measurement of the
17 carbohydrate content of a corm?
18 A. I did not go -- if I observed a kalo or an
19 oha to have loliloli, I just count it as and incident
20 of loliloli.
21 Q. You say you had no incidence of loliloli?
22 A. Not this one. We had very good yield in all
23 plots.
24 Q. But in essence, your judgement as to what is
25 loliloli is based on your own personal standards?

A. Right.

Q. Would you agree that some other Hawaiian out there looking at that same plant could judge that corm to be loliloli when you would not?

A. I don't think so.

Q. You don't think so?

A. No. Loliloli is loliloli. It's like, you know, if it's rotten, anybody can tell you it's rotten. Why would it be different?

Q. Wait a minute now. I'm not saying that the -- what is your definition of loliloli?

A. Over mature, spongy. You cannot make good poi out of it.

Q. It's over mature?

A. That's one cause of loliloli.

Q. Can you have loliloli taro that's the same age, one growing dryland, one grow wetland, same age?

A. No, I don't think so. Because dryland matures faster than the wetland. So if they are the same age, dryland's going to -- depending on the age, you'll have different -- they will be different because it's -- one matures faster than the other.

Q. At the stage of harvesting dryland and stage of harvesting wetland taro -- can you have loliloli taro in wetland?

1 A. Yes, you have.
2 Q. Can you have it in dryland?
3 A. Right, you can.
4 Q. Is there any differece between dryland and
5 wetland taro in terms of taste to a poi eater?
6 A. Yes.
7 Q. There is a difference?
8 A. Oh, yes.
9 Q. And so in between the dryland taro and
10 wetland taro can there be differences of taste based
11 on whether or not this is poi grade taro?
12 A. Yes, definitely. And the difference also
13 whether it's good or better, which one is better
14 depends on the guy who is eating it.
15 Like if you recall in Handy's work, people
16 in Kona who are used to eating upland poi don't like
17 lowland poi. So it's hard to compare.
18 Q. So it's a subjective thing?
19 A. Very subjective.
20 Q. So somebody used to wetland poi then -- have
21 you come across the incidence where a typical wetland
22 poi eater would prefer dryland poi over wetland poi?
23 A. No, I haven't come across somebody like that.
24 But if you ask me personally, they are just as good.
25 Q. So in your opinion, irrespective of what that

1 typical wetland poi eater would say, you would accept
2 dryland taro over wetland?
3 A. Right. And I have seen somebody who likes
4 both wetland and dryland poi.
5 Q. I'm asking for yourself, you're saying no
6 difference?
7 A. There is difference in taste, but I still
8 like them anyway.
9 Q. And you would accept either one?
10 A. Oh, yeah, that's right.
11 Q. No preference?
12 A. No, no.
13 Q. Dr. de la Pena, you've been paid to appear
14 here today?
15 A. That's right.
16 Q. By Mr. Schulmeister?
17 A. That's right.
18 Q. How much have you been paid?
19 A. Haven't been paid anything.
20 Q. How much are you contracted to --
21 A. David agreed he'd give me $350 a day.
22 Q. Per day?
23 A. Uh-huh.
24 Q. How much time have you put into this case?
25 A. Some hours reviewing all this, about six

1 hours.
2 Q. Six hours. So you haven't put in a full day?
3 A. Well, I've been awake since 4:00 o'clock.
4 Q. But that's a per day figure?
5 A. Right.
6 Q. And nothing else, no other charges other than
7 your daily rate?
8 A. I talked to David and he told me he will take
9 care -- I ask him $350 dollars for a day, and that's
10 what I get. After all, you know, I would not come
11 here if he did not ask me.
12 Q. Have you been contracted and hired by East
13 Maui or Alexander & Baldwin or any of its affiliates
14 before?
15 A. No. I just talk to only David.
16 Q. But for any other case?
17 A. Well, way back in '87 actually came here for
18 the same problem.
19 Q. Hired by A & B to come here?
20 A. I'm not sure. I think it was EMI. They
21 asked me to look at some of the taro lo'is and taro
22 ditches, you know. That's about all.
23 Q. And have you been hired before by Waiahole
24 Irrigation Company to provide testimony?
25 A. No.

1 Q. How about Amfac?
2 A. No. No, I haven't been paid for anything.
3 Q. Were you paid to testify in the Waiahole
4 Ditch case?
5 A. No.
6 Q. Who called you?
7 A. Gee, was it Apple something? I can't
8 remember any more.
9 Q. You don't know who called you to appear on
10 their behalf?
11 A. I can't remember his name.
12 Q. You don't know what company?
13 A. No.
14 Q. Was it a landowner or --
15 A. I don't know. The truth is that I was
16 actually explained that there is also my experiments,
17 and the results of my experiments are public property,
18 anybody can use them. So I agreed with or without
19 pay. I was not interested in the pay, just interested
20 in explain the results of my experiment.
21 Q. Any taro farmer asked you to come and explain
22 the public results of your experiments in support of
23 their petition for water before?
24 A. No, nobody.
25 Q. Thank you. That's all I have.

1 HEARINGS OFFICER McCONNELL: Redirect?
2 Ms. Lovell?
3 MS. LOVELL: None.
4 MR. MERCHANT: No.
5 HEARINGS OFFICER McCONNELL: Go ahead.
6 REDIRECT EXAMINATION
7 BY MR. SCHULMEISTER:
8 Q. Just briefly, revisit the issue of
9 percolation through the soil. There was some
10 discussion of that.
11 A. Right.
12 Q. I wanted to ask you, is there anything that
13 taro farmers do to try to control the amount of
14 percolation through the soil and the lo'i before they
15 plant?
16 A. Yes. They make sure that you have a hard pan
17 underneath, and when they bother the soil by tamping
18 on it or walking all around it, it for some reason,
19 because even now with equipment, puddling the soil,
20 the pores in the hard pan get covered, so water will
21 not -- you cannot completely remove or exclude
22 percolation, but you can minimize. And that includes,
23 you know, seepage through the levies. You can --
24 MR. MURAKAMI: I'm sorry. Seepage through
25 the what?

1 THE WITNESS: Levies or dikes. That is
2 where some of the water is lost also, not just the
3 water that the plant itself uses.
4 Q. (By Mr. Schulmeister): You talked earlier
5 about Hanalei type soil. Is that type of soil, is
6 that susceptible to being compacted in that fashion to
7 reduce the percolation?
8 A. Yes.
9 Q. Is that the same kind of soil they have at
10 Waiahole Valley?
11 A. Oh, yes, essentially the same throughout the
12 whole state wherever you have taro fields or lo'is,
13 the hard pan is developed, and then the upper part is
14 softened by plowing and rotating so you can plant.
15 Otherwise if it is all hard, you cannot plant the
16 taro.
17 Q. The other thing I wanted to go back over just
18 briefly is this issue of consumption. I just want to
19 make sure there's no confusion about what your
20 testimony is on that. In particular, what I want you
21 to do -- do you have your copy of Leslie Watson's
22 article, the LEGAL IMPORTANCE OF THE WATER
23 REQUIREMENTS OF TARO, part of Exhibit A-8, toward the
24 back of it. It's the last four pages.
25 A. I have my copy here.

1 Q. That was in what I handed to you the first
2 day.
3 (Discussion off the record.)
4 MR. MURAKAMI: Right after the Hanapepe?
5 MR. SCHULMEISTER: The fourth to the last
6 page of Exhibit A-8.
7 Do you have it?
8 MR. MURAKAMI: Yes?
9 Q. (By Mr. Schulmeister): So this is the Watson
10 study or article describing it, or one of the Watson
11 studies?
12 A. That's right, yeah.
13 Q. And looking to the second page, which at the
14 bottom has a number 150, and there's a heading that
15 starts about a third of way down says:
16 THE WATER REQUIREMENTS OF WETLAND TARO, do
17 you see that?
18 A. Right.
19 Q. That's where his discussion begins about the
20 water requirements. And near the bottom of that same
21 column he says:
22 Recognizing the extreme variation in the
23 many reports which were available, the Honolulu Board
24 of Water Supply in 1962 undertook a major study to
25 determine the water requirement of taro at Waiahole,

1 Oahu.
2 Is that your understanding of the area
3 where they did this study, that he describes in here?
4 A. It's in Waiahole, Oahu.
5 Q. And then at top of next column he describes
6 in general terms what was done over the period of
7 October 1962 to June 1964: Numerous measurements were
8 made of water entering and leaving groups of patches.
9 Days of excessive rainfall were excluded. The
10 principal areas included were a group of 17 patches
11 and a group of nine patches.
12 Then he goes onto make his conclusion
13 after that; is that right?
14 A. Right.
15 Q. Now, on this issue of consumption, et cetera,
16 I mean the word he uses here is representative water
17 use, not consumption?
18 A. That's right, yeah.
19 Q. And he says that: The conclusion reached was
20 that, in the locality studied, representative water
21 use is in the range of from 140,000 to 372,000 liters
22 per hectare per day in parenthesis, converts to 15,000
23 to 40,000 gallons per acres. And he says, allowing
24 for sufficient outflow to assure good circulation.
25 A. That's right.

1 Q. So the amount of 15 to 40,000 per acre,
2 that's the gross amount that's being applied to the
3 field, not the net between the inflow and outflow,
4 right?
5 MR. MURAKAMI: Objection, assumes facts
6 not in evidence. I don't read it that way.
7 HEARINGS OFFICER McCONNELL: I'll overrule
8 that.
9 THE WITNESS: That's what I understand,
10 the amount flowing through into the field.
11 Q. (By Mr. Schulmeister): And the next
12 paragraph: Since all stages of the crop were included
13 in the 26 patches, the author, as project manager of
14 the study, recommended that any future negotiation or
15 controversy in the area, a gross flow of 373,00 liters
16 per hectar per day, which in parenthesis, converts to
17 40,000 gallons per acre, be recognized as the fair
18 requirement for an area of several taro patches in
19 various stages of crop development.
20 Do you understand that?
21 A. Yes.
22 Q. As and expert in this field, when you're
23 reading this article, when he talks about gross flow,
24 he's talking about the amount that is applied to
25 the --

1 A. That's right, the amount that you let into a
2 taro field.
3 Q. And this would, according to Dr. Watson,
4 allow for sufficient outflow to assure good
5 circulation?
6 A. Yes. That would allow for enough water to
7 flow out, because it's way above --
8 Q. And this was in the early '60s that this was
9 done?
10 A. That's right.
11 Q. And it was later, it was about 20 years later
12 that you did your experiment at Hanapepe?
13 A. That's right.
14 Q. And Dr. Watson, he wasn't doing a controlled
15 experiment like you were, just studying what farmers
16 were actually using?
17 A. That's right.
18 Q. So he -- his conclusion wasn't that this was
19 the optimum amount, just representative of what they
20 were using?
21 A. That's right. He measured water flow into
22 several farmers' fields.
23 Q. But what you were trying to do was not to
24 find out what farmers were using, but you were trying
25 to find what the affect on the taro would be by

1 measuring the yield?
2 A. That's right, in the same field.
3 MR. MURAKAMI: Objection, leading.
4 HEARINGS OFFICER McCONNELL: I'll permit
5 it.
6 Q. (By Mr. Schulmeister): And I believe Mr.
7 Murakami asked some questions about the meaning or the
8 fact that 30,000 was required for healthy taro.
9 Did your experiment conclude that you
10 absolutely had to have at least 30,000 gallons per
11 acre in order to have healthy taro?
12 A. It's hard to say that, because like I said,
13 taro has survived without being flooded.
14 HEARINGS OFFICER McCONNELL: I'm sorry, I
15 didn't hear you.
16 THE WITNESS: Taro will grow from dry or
17 upland conditions, so you know, you don't necessarily
18 need 30,000 gallons per acre per day to grow a crop of
19 taro.
20 Q. (By Mr. Schulmeister): And, in fact, the
21 Honolulu Poi Company taro patches apparently, based on
22 what you've been told, don't even have 30,000 gallons
23 per day?
24 A. Yeah. Based on the information I got from
25 the farmer.

1 Q. But if you wanted to have the optimum yield
2 per, you know -- you want to have at least 30,000
3 gallons per acre?
4 MR. MURAKAMI: Objection, vague as to
5 optimum yield.
6 MR. SCHULMEISTER: Meaning the weight --
7 Q. Could you explain the yield?
8 A. If you're going to ask me for a
9 recommendation like how much should a farmer -- how
10 much water should a farmer -- let's say you have a
11 farmer with ten or 20 acres --
12 MR. MURAKAMI: Objection, nonresponsive.
13 HEARINGS OFFICER McCONNELL: I'm going to
14 permit it. I want to hear.
15 THE WITNESS: For planting purposes, you
16 cannot be very strict on how much water should go into
17 a farmers field. Give him some leeway, you know, 40
18 to 50,000 gallons per acre per day would be a good
19 figure, if you ask me. This is my personal opinion.
20 This will give him enough leewway so that sometimes he
21 needs to put a little more in some field and sometimes
22 he's not irrigating.
23 Because taro farmers stagger their
24 planting. They don't have -- if you have 20 acres,
25 you don't plant 20 acres all at one time. So they're

1 not all at the same stages. So some fields are in
2 fallow or dry, don't need water; some just planted and
3 some are ready for harvest.
4 So if you are going to ask me about a
5 recommendation for planting purposes, you give a
6 farmer, with 20 acres or ten acres, equivalent of 40
7 to 50,000 gallons per acre per day so that he can
8 manage -- you got to allow him to manage his
9 irrigation. You cannot just say you got to use this.
10 I don't think that's possible. You got to give the
11 farmer the independence to think for himself and
12 decide how much to put in its field.
13 So that's how I feel.
14 MR. SCHULMEISTER: Thank you very much.
15 No further questions.
16 HEARINGS OFFICER McCONNELL: Anything
17 else?
18 MR. MURAKAMI: Yes.
19 HEARINGS OFFICER McCONNELL: Go ahead
20 RECROSS-EXAMINATION
21 BY MR. MURAKAMI:
22 Q. Dr. de la Pena, you talked about this whole
23 issue about the requirements of taro. Is it your
24 testimony that Watson, in his report, is observing
25 that the flow-through rate of water for taro

1 cultivation in Waiahole Valley was 40,000 gallons per
2 day per acre. Is that what you're saying?
3 A. Say that again.
4 Q. Is it your testimony that the Watson study
5 establishes that the flow-through rate, the water
6 going in and coming out of a taro patch, is flowing at
7 the rate of 40,000 gallons per day per acre and not
8 40,000 gallons per day per acre of consumptive use
9 because of percolation, plant intake,
10 evapotranspiration and evaporation?
11 A. My understanding that's what he's allowing to
12 go into a field.
13 Q. That's the intake?
14 A. Yeah. Allowing for sufficient flow to flow
15 out.
16 Q. And there's no measurement of outflow here,
17 are there, in his study?
18 A. I thought he had.
19 Q. What is the outflow? Isn't it true all he
20 says in that same paragraph that there is sufficient
21 outflow that Mr. Schulmeister read?
22 A. Just says allow for sufficient outflow.
23 Q. But no measurement of outflow?
24 A. No.
25 Q. Without that measurement, isn't it true that

1 the 40,000 can only mean what the consumptive use per
2 acre per day is?
3 A. No, I don't think it's consumptive use. Like
4 I said, my feeling is this includes water that
5 percolates and seeps out of the levies, not
6 consumptive use.
7 Q. This is a figure that is greater than
8 consumptive use?
9 A. Yeah, that's right.
10 Q. With respect to your figure of 30,000 gallons
11 per day per acre, how high would a square foot of land
12 have, assuming that there is no evaporation or seepage
13 or evapotranspiration by a taro plant --
14 MR. SCHULMEISTER: I'm going to object,
15 incomplete hypothetical.
16 MR. MURAKAMI: I haven't finished the
17 question.
18 Q. -- assuming none of those factors exist and
19 a controlled environment, how much water -- how high
20 would the water occupy in a space that's a square foot
21 in an area that is receiving the input of 30,000
22 gallons per day per acre?
23 A. Is that if nothing moves, just put it in
24 there?
25 Q. Yes.

A. It will be over an inch.
Q. An inch high?
A. Over.
Q. How much over?
A. About 27, 28,000 gallons.
Q. 30,000 gallons per day?
A. What I'm saying is if you put 30,000 gallons in one acre and nothing moves, you have one inch.
Q. So little over that then if 30,000?
A. Say about that much.
Q. So you're saying that that one inch will supply all the water you need for taro cultivation each and every day, right?
A. Right.
Q. And that would be enough, regardless of the temperature of the air around it?
A. Well, based on this experiment, yeah.
Q. But it would be -- okay. Regardless of the outside temperature?
A. Right.
Q. Regardless of the temperature of the soil beneath that water?
A. Right.
Q. Regardless of the amount of water that is flowing through that taro patch, correct?

A. Right.

Q. And regardless of the level of fungus in the soil, correct?

A. That's right, yes.

Q. And finally that with that amount -- that would also be sufficient for a place like Wailuanui Valley which has a series of multiple lo'i downstream of it in which the water will flow, that would be sufficient for those downstream lo'i as well?

A. I don't know. I cannot not say that.

Q. Cannot say that. Thank you.

HEARINGS OFFICER McCONNELL: Anything else? Thank you, Doctor, you're excused.

THE WITNESS: Thank you very much.

MR. HAIA: We're going to call Ed Wendt.

(Recess was taken.)

HEARINGS OFFICER McCONNELL: Back on the record.

EDWARD WENDT

was called as a witness, was sworn to tell the truth, was examined and testified as follows:

HEARINGS OFFICER McCONNELL: State your name.

THE WITNESS: My name is Edward Wendt.

HEARINGS OFFICER McCONNELL: You may

1 proceed.

2 DIRECT EXAMINATION

3 BY MR. HAIA:

4 Q. Mr. Wendt, I'm going to hand to you what has

5 been filed with the Board of Land and Natural

6 Resources August 1, 2005 and ask you if you recognize

7 that?

8 A. I do.

9 Q. And what do you recognize it as?

10 A. It's a Petitioner's Direct Testimony of

11 Edward Wendt.

12 Q. Did you prepare this direct written testimony

13 with the help of your attorneys?

14 A. Yes, sir.

15 Q. Have you reviewed the entire document for its

16 accuracy and content?

17 A. Yes, sir.

18 Q. To the best of your knowledge, are all the

19 answers to the questions asked of you in this direct

20 written testimony true and accurate to the best of

21 your knowledge?

22 A. Yes, sir.

23 MR. HAIA: Based on that, Judge, like to

24 offer this into evidence.

25 HEARINGS OFFICER McCONNELL: It will go in

1 evidence.
2 (Written Testimony of Edward Wendt was
3 received into evidence.)
4 MR. HAIA: Thank you.
5 Q. Mr. Wendt, is it true that you live in
6 Wailuanui?
7 A. Yes. I live in the ahupua'a of Wailuanui in
8 Maui Hikina, East Maui.
9 Q. And you're also a taro farmer in that area?
10 A. I farm taro in Maui Hikina.
11 Q. And how long have you been farming taro in
12 Maui Hikina?
13 A. I've been around Maui Hikina from day one
14 when I was born.
15 Q. How long have you been farming taro?
16 A. I've been around the lo'is most of my life.
17 Q. The people before you, your parents, did they
18 also farm taro?
19 A. I farm on the same lands my ancestors farmed.
20 Q. How far back?
21 A. From time immemorial.
22 Q. So at least -- do you recall whether or not
23 your ancestors farmed the land that you now wish to
24 farm since at least the Mahele in 1842?
25 A. Yes, sir.

1 Q. And also are you a member of Na Moku Aupuni O
2 Ko'olau Hui?
3 A. Yes, sir.
4 Q. And you're also its current president, right?
5 A. Yes, I am president.
6 Q. And to try and make this as short as
7 possible, I am just going to ask you whether or not Na
8 Moku Aupuni -- and I'm going to refer to Na Moku
9 Aupuni O Ko'olau Hui from now on as just Na Moku, is
10 that okay with you?
11 A. Yes, sir.
12 Q. That that's a nonprofit corporation organized
13 by the Native Hawaiian residents of the
14 Keanae-Wailuanui ahupua'a and that encompasses Nahiku,
15 Keanae and Honomanu license areas. And when I refer
16 to those license areas, I mean the licenses issued by
17 the State of Hawaii for the use of approximately, in
18 total, including one more license area, 33,000 acres
19 of state Crown lands?
20 A. Yes, sir.
21 Q. And was Na Moku, in fact, formed to promote
22 the general welfare of the tenants and descendants of
23 the original tenants of the ahupua'a of
24 Keanae-Wailuanui in social, spiritual, cultural,
25 educational and economic affairs?

1 A. Yes.
2 Q. Was that further to preserve, protect and
3 enhance the quality of life for the people within
4 those ahupua'a and to provide a formal voice and
5 organization through which the residents of the
6 community can participate fully and more meaningfully
7 in the determination and development of policies and
8 decisions affecting their destiny?
9 A. Yes, sir.
10 Q. Do you see this current proceeding as fitting
11 into that purpose?
12 A. Yes, sir.
13 Q. Does Na Moku's purpose also encompass, on
14 behalf of its members, asserting their appurtenant and
15 riparian water rights, their rights as beneficiaries
16 of the public trust, the Hawaiian Homes Commission
17 Act, the trust created by Section 5(f) of the
18 Admissions Act, and their Constitutionally protected
19 traditional and customary Native Hawaiian practices
20 for religious, cultural and subsistence purposes?
21 A. Yes, sir.
22 Q. And is the purpose, part of the purpose of
23 your testimony as president of Na Moku today, to
24 inform the hearings officer in this case that as the
25 president you retain the legal services of Native

1 Hawaiian Legal Corporation to assert the superior
2 water rights of Na Moku members?
3 A. Yes, sir.
4 Q. And further that certain members of Na Moku
5 who have property interests in the ahupua'a of
6 Wailuanui have authorized the Native Hawaiian Legal
7 Corporation to act as their attorney in fact to do
8 that?
9 A. Yes, sir.
10 Q. And is it also your testimony that in
11 furtherance of that authority vested in Native
12 Hawaiian Legal Corporation that Native Hawaiian Legal
13 Corporation prepared a spreadsheet for Na Moku and its
14 members which identifies members' property interest
15 and the corresponding historical documentation which
16 establishes that the lands to which these property
17 interests attach were either in taro cultivation at
18 the time of the Mahele and therefore have appurtenant
19 rights to water or entitled to water based upon Native
20 Hawaiian traditional and customary practice of taro
21 cultivation?
22 A. Yes, sir.
23 Q. And do you know also that this information is
24 contained within the written direct testimony of Teri
25 Gomes, a paralegal with the Native Hawaiian Legal

1 Corporation?
2 A. Yes, sir.
3 Q. And do you also testify that given certain
4 past and recent incidences, Na Moku is concerned that
5 releasing the identities and other relevant
6 information of its members asserting these claims may
7 result in retaliation and/or other reprisal?
8 A. Yes, sir.
9 Q. And that given those concerns, Na Moku,
10 through its attorneys, have sought leave to file those
11 identities and information under seal?
12 A. Yes, sir.
13 Q. And can you just provide some examples of why
14 that concern exists?
15 A. Through past history, as I said earlier, I've
16 been in Wailuanui all my life. And I personally and
17 others has witness retaliation by other members of
18 East Maui Irrigation that wasn't a very pleasant way
19 that they approached our people.
20 Q. I need you to be more specific.
21 A. Well, I would say bully form. In the past
22 that I recognize East Maui Irrigation, whoever was
23 sent out to our community, to be intimidating to our
24 people.
25 Q. How so?

1 A. Our communities also based with people that
2 are employed by East Maui Irrigation and have been
3 employed for generations. And it's a family, more a
4 family situation where people will just be literally
5 afraid to come forward.
6 Q. I know that Steven Cabral was at one time --
7 well, he's Mr. Hew's -- he's the previous manager of
8 EMI. Do you have any knowledge of incidences with Mr.
9 Cabral?
10 A. I've witnessed Mr. Cabral utilizing his
11 authority as East Maui Irrigation, oppressing members
12 of our community throughout the years.
13 Q. How so?
14 A. By just his figure and his voice of
15 expression. There are many incidents that I believe
16 too that Mr. Cabral whatever he stated was not true.
17 In fact, it was false propagation.
18 Q. We'll move on, and we'll actually ask you
19 whether with the information that was obtained and
20 provided to the Board of Land and Natural Resources,
21 more specifically the hearings officer on behalf of Na
22 Moku's members, whether the intent of that is to seek
23 to restore stream flow and streams within the Nahiku,
24 Keanae and Honomanu license areas to levels sufficient
25 to assure and protect Na Moku members of appurtenant

1 and riparian rights and their other traditional and
2 customary rights embodied in Hawaii's Constitution,
3 Article XI, subsections 1 and 7; Article XII,
4 subsection 7; and HRS subsection 174C-63?
5 A. Yes, sir.
6 Q. And have you prepared a photographic -- a set
7 of exhibits, photographic exhibits, to truly and
8 accurately depict the conditions of Wailuanui Valley
9 and the mauka diversions affecting it?
10 A. Yes, sir.
11 MR. HAIA: And at this time, Judge, we
12 request that when we come back from -- I would like to
13 go through more just oral testimony, rather than go
14 through these exhibits right now -- when we come back
15 we get to those.
16 HEARINGS OFFICER McCONNELL: I don't care
17 how you use the time as long as we use it.
18 MR. HAIA: We will get back to those
19 photographs.
20 Q. As a Native Hawaiian resident and taro farmer
21 in Wailuanui, do you engage in any other traditional
22 and customary native Hawaiian activities in the area?
23 A. Yes.
24 Q. What?
25 A. We do gather. We do go to the oceans. Our

1 streams and rivers which we gather o'opu and 'opae and
2 hihiwai are literally dewatered. There's nothing for
3 us to gather now.
4 Also with the lease of East Maui
5 Irrigation, they have denied us access to mauka,
6 simply because they lease the lands. We were always
7 told we do not belong up there. It was illegal for us
8 to be up there. But now with the dewatering of the
9 streams, it has been very difficult to gather. All we
10 find is rocks in the rivers.
11 Q. So would it be fair to say that your exercise
12 of the traditions and customs that have been passed
13 down to you by your ancestors has been substantially
14 curtailed by low to no streamflow within the streams
15 within that ahupua'a?
16 A. Yes, sir.
17 Q. And would those streams include Wailuanui,
18 Hamau or it's sometimes referred to as Kulaniyes, sir?
19 Q. Would it also include Waiokamilo?
20 A. Yes, sir.
21 Q. Any other streams?
22 A. These streams you just mentioned is our
23 streams that are in our ahupua'a that service our
24 lo'is. But we also gather from Makapipi from Nahiku
25 to Makaiwa, which is the Ko'olau boundaries.

1 Q. Okay. So there are other streams from
2 Nahiku?
3 A. To Makaiwa?
4 Q. Makaiwa.
5 A. Which is the Koolau district that we have
6 gathered throughout time immemorial.
7 Q. You specifically? Have you gathered in those
8 streams?
9 A. Yes, sir.
10 Q. What I am going to be referring to now is an
11 exhibit that Alexander & Baldwin has tendered. It's
12 actually Native Hawaiian Legal Corporation's response
13 to Judge McConnell's October 3rd, 2005 order. It's
14 been included as Exhibit A-49.
15 HEARINGS OFFICER McCONNELL: Hold on.
16 MR. HAIA: There's a set of supplemental
17 exhibits and the Exhibit number is A-49.
18 HEARINGS OFFICER McCONNELL: I have it.
19 MR. HAIA: So I'm going to ask you a
20 series of questions, and just respond to them.
21 Q. Do you know who Nelson Akiu is?
22 A. Yes, sir.
23 Q. Is he a member of Na Moku?
24 A. Nelson, that I know of, is an employee of
25 East Maui Irrigation.

1 Q. Is he also a member?
2 A. I don't know. The list of membership is 500
3 plus members.
4 Q. Do you know whether or not his name appears
5 on that list?
6 A. I'm not sure right now. I don't have the
7 list myself.
8 Q. Then we will go to Lucy Acain?
9 A. Yes, sir.
10 Q. Is Lucy Acain a member of Na Moku?
11 A. Yes, sir.
12 Q. And do you know whether she has property
13 within the ahupua'a of Wailuanui?
14 A. Yes, sir, she does.
15 Q. Do you know whether or not she has taro lo'i
16 on that property?
17 A. Yes, sir.
18 Q. Does she?
19 A. Yes, sir.
20 Q. Do you know who James Akiona, Junior is?
21 A. Yes, sir.
22 Q. Is he a member of Na Moku?
23 A. Yes, sir.
24 Q. Does he have property within the ahupua'a of
25 Wailuanui?

A. Yes, sir.
Q. Do you know whether he has taro lo'i on that property?
A. Yes, sir.
Q. Do you know who Samuel Akina is?
A. Yes, sir.
Q. Is he member of Na Moku?
A. Yes, sir.
Q. And do you know whether he has property within the ahupua'a of Wailuanui?
A. Yes, sir.
Q. And on that property does he have taro lo'i?
A. Yes, sir.
Q. Do you know who Terry Akuna is?
A. Yes, sir.
Q. Is Terry Akuna a member of Na Moku?
A. Yes, sir.
Q. And I should have asked you, how do you know that the previous Lucy Acain, James Akiona, Samuel Akina and Terry Akuna, how do you know these people are members of Na Moku?
A. I'm affiliated with them more than any employee of East Maui Irrigation, and I know they are members.
Q. So in your capacity as president of Na Moku,

1 do you know that they are members?
2 A. Yes, sir.
3 Q. Does Terry Akuna live within the ahupua'a of
4 Wailuanui?
5 A. Yes, sir.
6 Q. Does he have any property within that
7 ahupua'a?
8 A. Yes, sir.
9 Q. Does he have any taro lo'i on that property?
10 A. Yes, sir.
11 Q. What about Charles Barclay, is he a member of
12 Na Moku?
13 A. Yes, sir.
14 Q. Does he have any property interest in the
15 ahupua'a of Wailuanui?
16 A. Yes, sir.
17 Q. And on that property that he has interest in,
18 does he have taro lo'i?
19 A. Yes, sir.
20 Q. Kimo Day, is he a member of Na Moku?
21 A. Yes, sir.
22 Q. Does he live within the ahupua'a of
23 Wailuanui?
24 A. Yes, sir.
25 Q. Does he have a property interest within the

1 ahupua'a of Wailuanui?
2 A. Yes, sir.
3 Q. And does he have taro lo'i within that
4 property?
5 A. Yes, sir.
6 Q. I'm just going to read names to you.
7 Claressa Ho'okano?
8 A. Yes, sir.
9 Q. Stephanie Ho'okano?
10 A. Yes, sir.
11 HEARINGS OFFICER McCONNELL: When you read
12 the names, I just want to clarify for the record what
13 you're asking the witness to testify to, which I
14 assume is that they're members, that they own property
15 in the ahupua'a and that they have lo'i.
16 MR. HAIA: Right.
17 Q. And so, Mr. Wendt, I'm going to read names to
18 you, and the question that I -- questions I want you
19 to answer with respect to the names I read is whether
20 they are a member of Na Moku, whether they have a
21 property interest in the Wailuanui ahupua'a, whether
22 they have taro lo'i within that property.
23 A. Uh-huh.
24 Q. Right. So do you know Claressa Ho'okano?
25 A. Yes, sir.

1 Q. What are the answers to that?
2 A. Exactly what you just -- they are landowners,
3 have lo'is.
4 Q. Stephanie Ho'okano?
5 A. Yes, sir.
6 Q. Steven Ho'okano?
7 A. Yes, sir.
8 Q. Henry Ka'ilila'au?
9 A. Yes, sir.
10 Q. Francis Ka'auamo?
11 A. Yes, sir.
12 Q. Frank Ka'auamo?
13 A. Yes, sir.
14 Q. Are Frank and Francis different people?
15 A. Yes, sir.
16 Q. Hannah Ka'auamo?
17 A. Yes, sir.
18 Q. Nalani Ka'auamo?
19 A. Yes, sir.
20 Q. Solomon Ka'auamo?
21 A. Yes, sir.
22 Q. Wilkins P. "Jackie" "Jack" Ka'auamo?
23 A. Yes, sir.
24 Q. Pua'ala Kekiwi?
25 A. Yes, sir.

1 Q. Michael Kirkpatrick?
2 A. Yes, sir.
3 Q. Norman Martin?
4 A. Yes, sir.
5 Q. Pearl Pahukoa?
6 A. Yes, sir.
7 Q. Do you know whether or not Pearl Pahukoa also
8 has property interest in Keanae?
9 A. She does. She lives in Keanae but also has
10 property interest in Wailuanui.
11 Q. But in Keanae does she also have taro lo'i?
12 A. Yes, sir.
13 Q. Tau-a Pahukoa?
14 A. Yes, sir.
15 Q. Do you know whether Tau-a Pahukoa also has
16 property interest in Keanae?
17 A. Yes, sir.
18 Q. He does?
19 A. Yes, sir. Also Wailuanui.
20 Q. Do they have taro?
21 A. Yes, sir.
22 Q. Gunther Tau-a?
23 A. Yes, sir.
24 Q. Carl Wendt?
25 A. Yes, sir.

1 Q. Chad Alita Wendt?
2 A. Yes, sir.
3 Q. Emily Wendt?
4 A. Yes, sir.
5 Q. Alice Williams?
6 A. Yes, sir.
7 Q. And Joseph "Jojo" Young?
8 A. Yes, sir.
9 Q. Now, with respect to all those names that I
10 read off with the exception of Nelson Akiu, have you
11 had the opportunity in your individual capacity and as
12 the president of Na Moku, have you had the opportunity
13 to observe lo'i on all of those properties, or have
14 you observed attempts to farm those lo'i by these
15 members?
16 A. All of these members that you just mentioned
17 have had their lo'is open at a time. Some of these
18 people's lo'is were closed, because when we had that
19 bad weather, there was a serious drought effect.
20 People closed their farms. They literally shut it
21 down. Everyone that you mentioned on there is farmers
22 or some of them are attempting to restore lo'i.
23 Q. Are they all seeking more water or a
24 sufficient amount of water for the lo'i that they want
25 to cultivate on their property?

A. Yes, sir.

Q. And, you know, for the member in Keanae, the Pahukoas, do you know, is Tau'a and Pearl, do you know whether or not the sources for their lo'i are Pi'ina'au Stream and Palauhalu Stream?

A. For Keanae?

Q. Yes.

A. Yes, sir.

Q. Do you know whether they are asserting their rights in that area for increased streamflow in those streams?

A. As I said earlier, I come from the ahupua'a of Wailuanui, I do not go to Keanae and ask the farmers in Keanae exactly what is going on on their water situation. I know there's members in Keanae that has been collaborating with different agencies in obtaining to get the flume fixed, but the amount of water necessary for Keanae, I cannot give you an answer.

Q. Just on your personal observations, have you been down to Keanae?

A. I passed there today.

Q. Are there lo'is that are in production?

A. Yes, there are. And I also recognize that there are other farmers starting to go back to their

1 lo'is in Keanae.
2 Q. Do you know who those farmers are?
3 A. I've seen the Kimokea family starting to
4 reopen there lo'is in Keanae.
5 Q. Are the Kimokeas members of Na Moku?
6 A. Yes, sir.
7 Q. Do they have property interest in Keanae?
8 A. I'm not sure under the ownership of the
9 properties, but I know they're representing or leasing
10 lands out in Keanae area.
11 Q. Do you know -- strike that.
12 MR. SCHULMEISTER: Are they on the list?
13 MR. HAIA: No. The Kimokeas?
14 MR. SCHULMEISTER: Right.
15 MR. HAIA: No.
16 Q. Mr. Wendt, I'm going to show you what has
17 been marked and received as Exhibit A-45, and I
18 believe this is another A & B exhibit, but I believe
19 it's a compilation of three TMK maps. The TMK for one
20 of those maps is 114, and it includes the parcels
21 contained within 114.
22 HEARINGS OFFICER McCONNELL: 45 you said?
23 MR. HAIA: Exhibit A-45, yes.
24 MR. SCHULMEISTER: Here, Judge. Does
25 anybody else not have it?

1 MS. LOVELL: I have it.
2 MR. HAIA: Realizing that we only have a
3 couple of minutes until 12:00 o'clock, I'm going to
4 show you what's been marked and received as Exhibit
5 A-45 and ask you if you recognize this.
6 A. Yes, I do.
7 Q. And what do you recognize this as?
8 A. This is the plot plan for the ahupua'a of
9 Wailuanui. It designates house lots and the lo'is.
10 Q. And is it the entire ahupua'a of Wailuanui?
11 A. No. This is just the makai portion of the
12 ahupua'a of Wailuanui.
13 Q. Can you say whether it's above or below the
14 Hana Highway?
15 A. It's below the Hana Highway.
16 Q. Okay. And when you say the Hana Highway, you
17 refer to a portion from the very top right-hand side
18 of the Hana Belt Road, which is in orange?
19 A. Yes, sir.
20 Q. So that road continues around and stays mauka
21 of the parcels that are depicted on this map?
22 A. Yes, sir.
23 Q. And are you familiar with these parcels that
24 are contained within that map?
25 A. Yes, sir, very much.

1 Q. And there is another road towards -- that
2 runs perpendicular on the right-hand side. And I
3 believe that is Wailua Road?
4 A. Wailua Road, sir.
5 Q. Does this road separate the house lots, which
6 are makai of that road, from the taro lo'i, or are
7 there some house lots also on either side?
8 A. There are house lots on either side.
9 Q. But a majority of house lots are on the makai
10 side?
11 A. No, both sides. They're both sides.
12 Q. Okay. Are there any taro lo'i on the mauka
13 side of the Wailua Road?
14 A. Yes, sir.
15 HEARINGS OFFICER McCONNELL: When you say
16 Wailua Road, I don't see any label to that effect.
17 THE WITNESS: The orange.
18 MR. HAIA: I'm sorry, Judge.
19 HEARINGS OFFICER McCONNELL: It's labeled
20 as what, 30-foot road?
21 MR. HAIA: Thirty-foot road.
22 HEARINGS OFFICER McCONNELL: Just so the
23 record is clear.
24 Q. (By Mr. Haia): So your testimony is that
25 there are taro lo'i makai of the 30-foot road?

1 A. Yes, sir.
2 Q. And is there or has there ever been an auwai
3 that fed those taro lo'i?
4 A. Yes, sir. If you look at the entry, when you
5 go into Wailua on the far right hand, I guess you
6 would call, where you got the Hana Highway then goes
7 down to Wailua, right in this junction right here in
8 this corner, where it says the County of Maui.
9 Q. When you're pointing to this point on the
10 map, you're talking about the very top right-hand
11 corner of the map?
12 A. Yes, sir.
13 Q. And there's an intersection and part of that
14 intersection at the very right-hand side says, to
15 Keanae?
16 A. Right.
17 Q. So that Keanae road intersects with the
18 30-foot road which is Wailua Road?
19 A. Yes, sir.
20 Q. So I just wanted to make sure that everybody
21 was in the same --
22 A. Many years ago, and I don't know the exact
23 year, but they cut this water off from this corner.
24 Q. Before you go on, who is they?
25 A. East Maui Irrigation. Cut it off. Because

there was an auwai, and it's still there but no water. It goes parallel to the 30-foot road and went right through all these house lots.

Q. So you remember an auwai that came off of Waiokamilo Stream?

A. Right, in that corner.

Q. Just at the point of this road that says to Keanae or above it?

A. Right, right here. Come in here, right here. Right in this area comes across.

MR. SCHULMEISTER: Can I -- just for a second, can I make a suggestion that you may find useful? I've got a much larger copy of this that I was intending to be the original.

MR. HAIA: That would be great.

MR. SCHULMEISTER: What I was going to do is go ahead, if he wants to mark on that and initial it and whatnot, then we can eventually later get it duplicated. I've got the smaller one so people can follow along and make notes and I've got the bigger one that he can follow along and make notes, but it's noon now. That's my --

HEARINGS OFFICER McCONNELL: How much time we need for lunch? At least an hour and a half, 1:30. We'll try to start on time then.

(Noon recess taken.)

Let's go back on the record. We are reconvened.

MR. SCHULMEISTER: Did you want to decide how to use this?

HEARINGS OFFICER McCONNELL: Off the record.

(Discussion held off the record.)

HEARINGS OFFICER McCONNELL: We're back on the record. You may proceed, Mr. Haia, with testimony of Mr. Wendt.

Q. (By Mr. Haia): Before we took our break, we were discussing an auwai that no longer exists that you recall used to run through the house lots that are on the makai side of the road that's designated as the 30-foot road, and shaded in orange.

A. Yes, sir.

Q. Do you remember that?

A. Yes, sir.

Q. What I'm going to do is I'm going to give you a pink magic marker and ask for you on the map to draw the auwai in the position that you recall it ran through the house lots. Can you do that?

A. Right over here.

HEARINGS OFFICER McCONNELL: Hold on, go

1 ahead and do that. Maybe you can take the pointer and
2 then maybe I can see the map.
3 THE WITNESS: Right around in this area
4 right here, coming off Waiokamilo is a little box
5 right here, or little auwai. This auwai comes down
6 through here and it did go through all the properties
7 where it entered into the ocean roughly around in this
8 area, and also in this diversion -- this direction to
9 Hawaiian Home Lands. Hawaiian Home Lands is all in
10 the back of this parcel.
11 So from my understanding from kupuna,
12 Waiokamilo extends to the mountain. When the
13 diversion, extra diversions was put in --
14 Q. (By Mr. Haia): What do you mean by extra
15 diversions? Sorry to interrupt.
16 A. We understand that the flume was in for many,
17 many years up in Kikokiko area, but when the pipe went
18 into the waterfall and cut the surface water from
19 coming down --
20 Q. Which waterfall?
21 A. Kikokiko. The surface water, it reduced
22 water into the Waiokamilo, because up in this area,
23 which it don't show, up in this area here --
24 Q. And for the record, you're pointing to the
25 very center top of the map?

A. Yeah, above Lakini. There's little diversions that East Maui Irrigation put in many years ago directing the water from Waiokamilo this way (indicating), and less amount of water was going down.

Q. And by this way, you're pointing from mauka to makai?

A. Yeah. Came from the Wailuku side and went toward the Hana side. So goes down to makai. This is all makai, this area.

Q. But also still being diverted in the ditch system?

A. Diverted in the ditch system. So it reduced the flow of water. So the rest of the water would come and service all of this.

This is all lo'i. This is all lo'i. These are the house lots. This is house lot, this is house lot up to here. And somebody said before, I think it was yesterday, one house lot, then they had taro patches.

This water system was used also for domestic and farming. People did do subsistence farming in their backyards. And also the back portion, which has turned into pastoral, was house lots of ancient Hawaiian people. Because this water system also went this way, this direction too.

1 Q. When you say pastoral lots, you refer to the
2 DHHL lands now?
3 A. Yes, sir, Hawaiian Home Lands.
4 Q. I have a question about -- is there still
5 evidence of this auwai --
6 A. Yes.
7 Q. -- that you drew in pink?
8 A. Yeah. This auwai still exists up to this
9 point. There's lo'is right in here, existing lo'is.
10 And then this auwai is right around in this area.
11 Direction goes this way.
12 Q. So there's --
13 HEARINGS OFFICER McCONNELL: Is that still
14 in operation?
15 THE WITNESS: Yes, sir. This goes down
16 and services these people down in this area. These
17 are all lo'is now.
18 MR. HAIA: For the record, to hopefully
19 make this clear, there is a, I guess it's TMK 1-1-4
20 parcel 40, State of Hawaii. I guess it's State of
21 Hawaii property. But there's a series of lo'i in
22 there.
23 Q. And the auwai has been diverted towards the
24 east?
25 A. Yeah.

1 Q. Over or under the 30-foot road?
2 A. Under the 30-foot road.
3 MR. MERCHANT: That's west.
4 MR. HAIA: West, sorry.
5 Q. So it goes under the road and then any water
6 that's flowing in this auwai is diverted into lo'i?
7 A. Lo'i.
8 Q. On the west side of the 30-foot road?
9 A. Lo'i, yes. Also lo'i right in here.
10 Q. But to be clear though, is there still
11 evidence of the auwai --
12 A. Yes.
13 Q. -- that's past the lo'i?
14 A. Yes, sir.
15 Q. But no water in there?
16 A. No water in there. This kind of -- actually
17 this corner and this way, there's no water in here,
18 bone dry.
19 Q. Do you know whether the water in this auwai
20 has always been sent westward under --
21 A. Yes.
22 Q. -- the 30-foot road?
23 A. Yeah.
24 Q. But in addition to being sent westward, it
25 used to also flow to the house lots on the east side

1 of the 30-foot road?
2 A. Yes, sir. Yes, sir. When it reduced the
3 flow above this here, they sacrificed this.
4 MR. MURAKAMI: Just so the record is clear
5 on this, you know there is a lot of east/west
6 directions here. Just for your information, there is
7 a north indication on the top left here. It's
8 pointing to kind of like top right, pointing towards
9 the top right. So north is in that direction. And
10 so, you know, we should be clear when we describe
11 where it is relative to north.
12 HEARINGS OFFICER McCONNELL: Right.
13 MR. HAIA: Kind of mixed up because I was
14 thinking East Maui, and further towards Hana is east.
15 But in fact true north would be that way.
16 A. Right.
17 Q. So at the point that the water on parcel 40
18 is diverted under the road, it is traveling west?
19 A. Right.
20 Q. Okay.
21 MR. MURAKAMI: More precisely, southwest.
22 MR. SCHULMEISTER: Did you mean parcel 40
23 or parcel 5?
24 MR. HAIA: I'm sorry, you're correct.
25 It's TMK 1-1-04: Parcel 5.

1 HEARINGS OFFICER McCONNELL: While we're
2 at it, we will call that Exhibit A-45-1. That is the
3 one that's been marked by Mr. Wendt.
4 Q. (By Mr. Haia): Mr. Wendt, earlier before we
5 went to break, I was asking you a question about some
6 of your written testimony, and that was more
7 specifically the concern over Na Moku members being
8 retaliated against or suffering reprisal if they came
9 in person to assert their claims.
10 And I asked you for specific examples. I
11 wanted to give you another opportunity to provide
12 examples that you're aware of in past times or more
13 recent times of the concerns, and what those concerns
14 are based on.
15 A. I've got a few, a couple. There were times
16 that I witnessed Mr. Cabral, in meetings that was held
17 at the Keanae school, that he would be very vocal in
18 his voice, his aggressiveness with his size of body
19 towards the Hawaiian people, which the kupunas are
20 much more older people. And where he would always
21 kind of use that force to contradict the voice of the
22 people, the elders, whoever was speaking.
23 He did that with grace. It was just
24 something that he had the abilities to do.
25 Also when we first started this case, and

1 Mr. Hew was present at that time too -- Mr. Cabral is
2 no longer there any more, he's retired. But Garrett
3 was there.
4 I think it was in 2001, when the first
5 hearing of this 30-year lease was held at the ILWU
6 Hall where Alexander & Baldwin came out in numbers
7 with their employees, with their different shirts
8 representing, you know, different parts of their
9 affiliation, which was worrisome to the members and
10 landowners of our community to step forward.
11 In fact, I was the only one that was sent
12 forward to this meeting, based upon what was about to
13 happen. Fear, lot a fear was put into the community
14 by East Maui Irrigation, and also with Mr. Cabral
15 throughout the years.
16 Mr. Cabral has worked for EMI for very
17 long time and Garrett is a student of Mr. Cabral.
18 Q. Staying on that one example, would that have
19 been the meeting of the Board of Land and Natural
20 Resources to consider A & B, EMI's application for
21 long-term lease and/or their application for revocable
22 permits?
23 A. Yes, sir.
24 Q. Okay. And do you recall if there were any
25 reactions to testimony -- reactions by A & B or EMI

1 employees or supporters to testimony about restoring
2 water to the streams during that hearing?
3 A. I don't believe anything about restoring
4 water to the stream was spoken at that time.
5 Q. I'm talking about like, for instance, if you
6 testified and you testified on behalf of the members
7 of Na Moku, and you said that you're here because you
8 want to see streamflow, restore the streams for the
9 practice of tradition and custom and taro lo'i, do you
10 recall any responses?
11 A. As I parked my truck and just walking into
12 the ILWU, there were confrontation in the parking lot,
13 and as I walked through the doors of ILWU, those
14 things did happen.
15 Q. Like what?
16 A. By the members, putting pressure upon me for
17 speaking up on behalf of the community.
18 Q. The members?
19 A. Members, I would say affiliation of Alexander
20 & Baldwin, East Maui Irrigation, because they came in
21 different shirts. They wore different color shirts in
22 this meeting.
23 Q. So you mean if it was an employee of HC&S,
24 they were in a shirt that was of different color?
25 A. Yes.

1 Q. If employee of EMI, they were in a different
2 color shirt?
3 A. Yes, sir.
4 Q. Can you estimate how many people, how many
5 employees or supporters A & B and EMI were at that
6 meeting?
7 A. The building was full. It was held at the
8 ILWU. If anybody know how big the ILWU is, it was
9 standing room only. And I believe there was a small
10 handful of people that came there for the purpose that
11 was not employed by Alexander & Baldwin or EMI.
12 Q. Would it be a fair statement to say that the
13 vast majority of attendees at that meeting were A & B,
14 EMI, HC&S employees or supporters?
15 A. Yes, they were all supporters. They also had
16 -- I don't know her name, can't remember her name --
17 the vice president stating too that there was no --
18 the diversion does not affect anyone below. All the
19 people live below the diversions.
20 Q. Let me ask you this. In your estimation were
21 there more or less than 20 employees or supporters?
22 A. More than that. They came in force.
23 Q. More than 30?
24 A. Yes, sir, more than 30.
25 Q. More than 40?

1 A. I imagine more than 40.
2 Q. What about more than 50?
3 A. There's a good possibility more than 50.
4 Q. So the turnout was substantial?
5 A. Substantial. Everything was in favor of
6 Alexander Baldwin, East Maui Irrigation. That was one
7 of the big reasons our people did not want to come.
8 They were afraid. There was fear. Myself, like I
9 said, as I walked in, there were people who wore
10 different color shirts. I would call it harassment.
11 Q. Now, are there any -- just from what you
12 know, your own personal knowledge, any members of Na
13 Moku that also have family members that are employed
14 by A & B, HC&S?
15 A. Yes, sir.
16 Q. And do you ever talk to those members about
17 what that relationship does to their ability to come
18 forward and express their opinions?
19 A. Well, I guess we've chatted indirectly, but
20 we've never ever approached anyone that works for
21 Alexander & Baldwin or East Maui to speak up against
22 or on behalf of East Maui Irrigation. What little
23 chatting we have done, fear, again, losing their jobs.
24 We don't want nobody to lose their jobs.
25 Q. That's the actual Na Moku member that's an

1 employee of one of A & B's companies?
2 A. Yes.
3 Q. What about family members of those employees?
4 A. That's a question, a good one. It's very
5 difficult for families to -- has always been a
6 difficult thing about family members working for East
7 Maui Irrigation, and the rest of the family who don't,
8 a topic to be spoken about in the community because of
9 its sensitivity.
10 I've heard people say the effort towards
11 East Maui Irrigation family members of the employees,
12 but again, you know, it's not something that we try to
13 enforce anyone to speak up against East Maui
14 Irrigation.
15 Q. Thanks.
16 MR. HAIA: What I would like to do now,
17 Judge, is just to show the photos that we have of the
18 area, of the diversion, and then have Mr. Wendt
19 describe the photos and ask him some questions about
20 those photos.
21 HEARINGS OFFICER McCONNELL: Are the
22 photos -- are they already marked as exhibits?
23 MR. HAIA: There are some that are
24 exhibits and there are others that are not yet
25 exhibits. I think that what we had planned was to

1 provide the Judge with the background on what's going
2 on in that area. And so I don't know whether or not
3 we're going to include -- I mean, the exhibits that we
4 have as photos are already received, and so the ones
5 that have not been yet put into evidence, I don't know
6 whether or not we're actually -- we're going to offer
7 them or not. So just for information purposes.
8 MS. LOVELL: Just for demonstrative
9 purposes, so to speak.
10 HEARINGS OFFICER McCONNELL: All right,
11 anybody wants them in, can ask that they be received.
12 MR. HAIA: I'm going to turn this light
13 off.
14 (Slide show.)
15 This is not an exhibit, just an
16 introduction to while you're driving out to Wailuanui,
17 Keanae this picture is taken -- well, anyway, it's a
18 double rainbow over the peninsula of Keanae.
19 And this is a part of the ditch system.
20 And I'll ask Mr. Wendt to provide more information on
21 that.
22 A. This, in this area here, you can see how EMI
23 has made the diversions. The river supposed to come
24 this way, but in here that's where the water go,
25 redirection. It's redirected.

1 Q. Why don't you use this pointer.
2 A. Thank you.
3 Q. So can you state specifically where we're at
4 the point along the ditch system?
5 A. This here, I think it's -- and Garrett would
6 know exactly where we're at -- Kikokiko, it's the
7 waterfall from Waiokamilo, Kikokiko. And above
8 Kikokiko this is the continuation of Waiokamilo, it
9 goes from makai to mauka and this has been put in.
10 Q. So that's actually not the point at which the
11 waterfall has gone dry as a result of the diversion,
12 that's above?
13 A. This is above. This is all above.
14 Q. So that's a separate waterfall above
15 Kikokiko?
16 A. Yeah, Waiokamilo.
17 Q. And what happens when that water is captured
18 in that system? Where does it go?
19 A. This goes into the ditch system. Which the
20 ditch system, from what we understand, can carry out
21 160 million gallons of water a day, that's not due to
22 rain.
23 So whatever comes from above falls into
24 this system and goes out, nothing comes over.
25 Q. You say can carry, but I think actually the

1 maximum capacity of the entire system is much more
2 than that?
3 A. Four hundred million gallons a day. Like
4 right now we have lot of rain going on. This year has
5 been the most wettest year. We have the rainfalls
6 coming over, so it's going over. So 400 million.
7 Now, this here is the flume that was put
8 in many, many years ago. And what we saw the first
9 picture is diverting water into their flume. This
10 flume goes parallel to Waiokamilo, all the way down to
11 the waterfall, which is called Kikokiko.
12 Now, this is the bridge, and the waterfall
13 goes over and goes under the bridge and falls down.
14 Q. When you say the bridge?
15 A. To Kikokiko, this is where we had lunch.
16 Q. But these other people don't know where we
17 had lunch.
18 A. We got a story behind that. Garrett know, he
19 was there. This here was put in what, I think 1920s
20 or something, '21. But this pipe here is in the
21 waterfall, in the mouth of the waterfall.
22 So remember the flume, what we saw, it
23 parallels. It was taking water from the top, falls in
24 their flume and it goes down to the ditch system which
25 is emptied into the ditch.

1 Here we go. This is a better picture.
2 Here's the bridge. You can see all their pipes, and
3 this pipe comes across, goes under the road, under the
4 bridge, and this is part of it. It empties into their
5 ditch, goes into the ditch system.
6 Q. So at the point of the bridge, Mr. Wendt, if
7 the water was not diverted from Waiokamilo, it would
8 flow as a waterfall?
9 A. It would go over the waterfall.
10 Q. So that right there, that --
11 A. This here.
12 Q. That's the side of the mountain?
13 A. Yes.
14 Q. And the water would flow down that side of
15 the mountain?
16 A. It would go right here, go right over,
17 continue falls down, falls right into Waiokamilo.
18 Q. So what is that large white pipe?
19 A. This white pipe goes in here under here,
20 along here and goes up like this. This is where the
21 water comes out the waterfall, right here.
22 Q. That's where it would come out?
23 A. It would come out right here. But this is
24 setup here, right in the mouth of it. So this is
25 capturing whatever, seeps through and whatever they

1 cannot catch from the flume, the first picture with
2 the flume.
3 Q. So I see there's water emptying out of that
4 large -- do you know what the diameter of that pipe
5 is?
6 A. Just roughly looking at it, ten to 12 inches.
7 Q. And so the water falls into another -- what
8 is that, a catchment?
9 A. It's like a catchment here and then it goes
10 this direction into the ditch.
11 Q. And so that water eventually enters into the
12 ditch and is diverted out?
13 A. Diverted out. At this point from here,
14 nothing comes by.
15 Q. Where is the ditch in relation to that point?
16 A. Around in this area, goes back this way.
17 Q. And where does it run to? Where is it going
18 to go now? Where is that water going to go in the
19 ditch?
20 A. Comes this way and goes that direction,
21 underground. This is the flume.
22 Q. You're kind of cutting off almost half of the
23 picture.
24 A. That there -- this one here is part of the
25 diversions up above.

1 Q. So is that like off -- can you see that from
2 the maintenance road that goes to Kikokiko?
3 A. Yeah. We were walking on the maintenance
4 road. You have to go up a little bit.
5 Q. Right. So if you're actually on the road --
6 A. Cannot see.
7 Q. You can't see it. You have to kind of hike
8 back into it?
9 A. Hike back up.
10 Q. Could you describe the pipe that is kind of
11 hidden by some of the overgrowth, but is that -- what
12 is happening right there?
13 A. Well, you can see, see the cement -- whatever
14 water is up in here, it collect in here, and then it
15 goes into their system, diverted.
16 Q. Is it a stream?
17 A. It's a streambed.
18 Q. So water gets captured again, goes through
19 that pipe, then where does it end up?
20 A. All goes back to the ditch system.
21 Q. There is another.
22 A. That's another pipe too.
23 Q. Is that the same pipe?
24 A. No, this is another area.
25 Q. Are you sure?

A. I'm pretty sure this is another pipe. It's above -- it's in the same area, above the same area.

Q. The water captured in that pipe ends in the ditch?

A. Same principle, same principle.

Q. What is this right here?

A. This one here is -- water is coming from this way, coming down. Now, this supposed to be stream, but they got it going into here, into their tunnel system, and then down to the main ditch.

Q. Well, which way is the water flowing? Is the water flowing from the top of the photo down?

A. Top down.

Q. And then it's captured?

A. Right in here.

Q. And where does it go?

A. It's going this direction. See the fellow looking down and over here, coming through here and going this direction.

Q. And eventually into the ditch?

A. Into the ditch.

Q. Where is the ditch at this point in relation to that?

A. Well, it's underground. You can't see.

Q. I guess --

A. I'm looking into a ditch. That's the side of the --

Q. There's another white pipe that comes out?

A. That's a four-inch pipe. It goes up and stuck into the mountains.

Q. Do you know where that is? Is that just off of the maintenance road?

A. Just off of the maintenance road.

Q. Is that PVC pipe?

A. PVC pipe. It empties. They have many pipes like this above.

Q. Where does that pipe come from?

A. It goes alongside the maintenance road, up the hill. And you can see that as it is. And they got it stuck into little cracks and crevices where little water comes out.

Q. So capturing water that is seeping from the side of the mountain?

A. Right. That's exactly what it's doing. Not allowing it to percolate down to the spring, it's being captured.

Q. Well, would the water also flow out but for those -- do you know whether that water would reach Wailuanui Valley?

A. Oh, yes, it would.

1 Q. How do you know that?
2 A. Water goes downhill. All it is, all of these
3 areas we been looking at is above Wailuanui.
4 Q. And so this picture is a weir four-inches
5 high?
6 A. Yeah. This weir here. Right below this
7 weir, maybe about 4, 500 feet, Akeke Springs. That's
8 the water we getting right now. But if you capture
9 all of this, it don't percolate down, one-inch pipe
10 falls into here, and then pipes takes it away, and all
11 goes back to the first picture with the one was the
12 eight, ten-inch pipe, one-foot pipe, it goes back into
13 that system back into the ditch system.
14 Q. So for the most part at any point where
15 there's seepage, streamflow, waterfall, it's captured
16 and diverted to the ditch system to be taken over to
17 the other side of the island?
18 A. Yes, sir; 100 percent all tributaries, all
19 streams and rivers are diverted.
20 Q. This picture, where is this?
21 A. This picture is in the valley. These are the
22 patches that -- I don't know what year you guys took
23 these pictures --
24 Q. You know what, I have a question for you,
25 before you go on.

1 If you look at the center of the picture
2 at the top, what is that, Hana Highway?
3 A. This is Hana Highway.
4 Q. So there's a point on that highway that
5 people can go to look down onto and see basically the
6 whole panorama of the Wailuanui Valley?
7 A. That's right.
8 Q. Be able to see all the auwai?
9 A. Yes, sir.
10 Q. And so these lo'i are the lo'i that members
11 of Na Moku are attempting to get water for?
12 A. Yeah. Yes, sir.
13 Q. What area of Wailuanui Valley, is this the
14 lower part of the valley?
15 A. Yeah, this is one of the lower parts. That's
16 the same area, just different.
17 Q. Is this in the same area?
18 A. Same area. This is all the same area.
19 Q. There's a waterfall in the background?
20 A. Waikani is a separate waterfall from Waio
21 River from Waiokamilo. Waiokani is Wailuanui River.
22 Q. Does that waterfall have a consistent flow?
23 In other words, is it flowing like that all the time?
24 A. No, sir.
25 Q. Why not?

A. The only time you see Waikani flow like that is when the big rains come and above, the diversions cannot handle. Remember we said ditches can go maximum 400 million. So after that it overflows.

Q. And results in --

A. Increase of flow. Now, that flow what you saw can change in one day, that flow there. One day time. But if it's in the morning, no rain all day, that will change.

Q. Change to what?

A. Less.

Q. Where is this picture taken from?

A. Look like you're up probably Lakini area, on the highway, from the Hana Highway down. Maybe not, this could be from the lookout.

Q. Do you see the church on the right-hand side?

A. Yeah, this could be the lookout.

Q. So this is pretty much looking --

A. From the Hana side of the valley.

Q. Looking west?

A. Yeah.

Q. So in other words, looking west, we're looking as if we were going back to Wailuku, Kahului?

A. Yeah.

Q. And this is basically the same picture,

1 right?
2 A. Yeah. No, this one probably from the
3 lookout, as you look out.
4 Q. So all this overgrown area from the left-hand
5 side to the right-hand side, what is that?
6 A. All these areas, all grassy areas are lo'i,
7 all lo'i.
8 Q. And the date is November 2004. So my
9 question is: Do you know whether or not this was a
10 picture taken of the conditions of the Wailuanui
11 ahupua'a in November of 2004?
12 A. Yeah.
13 Q. Okay. And this is just from a different
14 angle?
15 A. Different angle.
16 Q. So the entire area from this part is all
17 lo'i?
18 A. This is all lo'is.
19 Q. That are overgrown?
20 A. Yes.
21 Q. And why?
22 A. A lot of the farmers shutdown to the water
23 situation. Lot of water could not reach this areas,
24 because of the lack of flow that was coming down
25 Waiokamilo. So some farmers up in this area literally

1 walked away because there was -- and it was open, and
2 there was no water.
3 Q. You see some lo'i that is in different stages
4 of cultivation on the right-hand side?
5 A. Uh-huh, uh-huh.
6 Q. Where are they getting their water from?
7 A. This section down here, some of it was coming
8 off the top ditch from the Lakini system, but then
9 also from Waikani.
10 Q. When you talk about Lakini --
11 A. It's up in this area.
12 Q. It's mauka of Hana Highway?
13 A. Right, and comes off Waiokamilo.
14 Q. And the source of their water is Waiokamilo?
15 A. Waiokamilo.
16 Q. Any others?
17 A. Kulani.
18 Q. Which is Hamau, it's also known as Hamau?
19 A. Yeah.
20 Q. So how come the people on the right-hand side
21 could get water to their lo'is but the others --
22 A. This one here?
23 Q. Right. But the others that you were saying
24 literally walked away, can't get water?
25 A. Because this is a higher elevation than this

1 elevation. The water that come from this cannot go
2 uphill.
3 Q. So even if that water that is being used in
4 those lo'i weren't being used, it couldn't be used for
5 the upper level?
6 A. No. It goes this way, downhill.
7 Q. Okay. This picture was taken in June of
8 2005. Can you attest to that fact?
9 A. Yes, sir.
10 Q. And what is the significance of that white
11 circle, if you know?
12 A. The farming in this area at one point could
13 not farm, because of the lack of water that was coming
14 down from the Waikani section.
15 Q. And is this the same area that was circled?
16 A. Yeah, yeah.
17 Q. Is that a member of Na Moku?
18 A. Looks like it.
19 Q. Is that Sam Akina's lo'i?
20 A. This is Sam Akina's area. Some of it comes
21 from -- actually all of this right now is coming from
22 Waikani.
23 Q. In June of 2005, when these pictures were
24 taken, what were the weather conditions like around
25 that time? If you don't recall, that's fine.

1 A. We were going through some very harsh times,
2 lack of water. And for the kupuna to say not enough
3 water, that means there wasn't enough water at that
4 time.
5 Q. Well, in the background, beyond the white
6 circle, are those also lo'i?
7 A. All lo'i.
8 Q. Are they in taro cultivation in June of 2005?
9 A. No, not yet.
10 Q. That's it.
11 (End of slide show.)
12 HEARINGS OFFICER McCONNELL: Do you
13 have --
14 MR. HAIA: That's pretty much it.
15 HEARINGS OFFICER McCONNELL: That's all
16 your questions. Ms. Lovell, any questions?
17 MS. LOVELL: No, no questions. I'm just
18 standing up so people can get in and out.
19 HEARINGS OFFICER McCONNELL: Mr. Merchant.
20 MR. MERCHANT: I do have a few questions.
21 CROSS-EXAMINATION
22 BY MR. MERCHANT:
23 A. I'm Dave Merchant. I represent Maui Land &
24 Pineapple Company. I just have about four or five
25 questions.

1 Your testimony, do you recall your
2 testimony that the lo'i had been shutdown during
3 periods of droughts?
4 A. Like I said, it has been hard times. I
5 cannot really say it's 'cause of drought, because at
6 one time there was abundance of water, then all of a
7 sudden no more.
8 Q. We have had testimony from a variety of
9 people that 2005 in general has been relatively wet,
10 June might have been an exception to that, but
11 generally 2005 was relatively wet. During periods
12 when it is relatively wet, has there been enough water
13 into the Wailuanui ahupua'a?
14 A. When it rains a lot and the ditch overflows,
15 we get the surface water. But just to bank on the
16 spring is very difficult.
17 Q. But periods of times when it is wet and the
18 water is coming over the ditch, then there is enough
19 water to --
20 A. To accommodate.
21 Q. So if you could be guaranteed that it was
22 always wet like that, you would have enough water to
23 farm?
24 A. Yes, sir.
25 Q. Have you observed the ditch flows with

respect to whether the ditch flows are higher when it is generally a wet period, lower when it is generally a dry period?

A. Naturally it would be in a wet period you're going to see, because today you don't see water in the rivers like you used to see, perennial. They're gone. So it's very difficult to tell what's going on up there. All I know, we don't see the water like we used to see.

Q. Is that irrespective of the ditches or just talking about --

A. I believe the ditches are just taking too much water above.

Q. My question was really more -- I was trying to figure out if you were making a climatic observation, if there's just not as much rain these days, or are you making a comment about the ditches?

A. Well, today we got a lot of rain. It's been a wet year this year. It does fluctuate the amount of water coming over. Like right now there's a lot of water, raining, there's been a lot of rain.

Q. The reason I'm asking is Maui Land & Pine is a customer of East Maui Irrigation as opposed to running the ditch system, and our contract allows us to take some water when the ditches are relatively

high. It's more complicated. But very simplistic when there's a lot of water in the ditch, we have rights to get some water. That's why I'm asking how the conditions are for the folks in Wailuanui when there's generally a lot of water in the ditches.

A. Well, we don't usually go up to the ditch system. Not supposed to be there, so we don't go up there. The only time we can get, we can see visual, is when we see the waterfalls, you know, the size of water coming over. That would be the closest that, you know, we get to the system.

Q. If you can see the waterfall coming over, does that generally correspond to a time period when you have enough water down in the Wailuanui area?

A. Yes, the surface water.

MR. MERCHANT: Thank you.

HEARINGS OFFICER McCONNELL: Mr. Schulmeister.

CROSS-EXAMINATION

BY MR. SCHULMEISTER:

A. Good afternoon, Mr. Wendt. I have some questions for you.

I would like to start with just some basic background facts. When were you born?

A. 1948.

1 Q. And where were you born?
2 A. Wailuku.
3 Q. Was your family living in Wailuku at the
4 time?
5 A. Hana.
6 Q. Did you grow up in Hana?
7 A. My parents leave Hana -- very young. My dad
8 was the electrical engineer for Maui Electric, so we
9 lived in Kahului. Then I also attended -- every
10 weekend I would go back to Wailuanui, the exact spot
11 where I am located today on my ancestors' aina.
12 Q. So how old were you when the family moved
13 from Hana to Kahului?
14 A. I was young, very young.
15 Q. Was it before you started school?
16 A. Yeah, probably before school.
17 Q. So you went to school in the Kahului area?
18 A. Kahului.
19 Q. Was that through high school?
20 A. Yes, sir.
21 Q. And which high school did you go to?
22 A. Baldwin High School.
23 Q. And so during that time you were living in
24 Kahului, is that right?
25 A. Yes, sir.

1 Q. But there was a family connection to
2 Wailuanui?
3 A. Yes, sir. The land I live on is my
4 ancestors' lands.
5 Q. And just so we can be clear, which parcel is
6 it on Exhibit A-45-1? If you want to mark it, you can
7 go ahead and do so.
8 MR. HAIA: Just for the record, you're
9 going to be marking it with a red pen.
10 THE WITNESS: Right here. I live there.
11 MR. MERCHANT: What's the parcel number
12 there?
13 MR. HAIA: I believe that's going to be
14 TMK: 1-1-5:9.
15 Q. (By Mr. Schulmeister): And you have family
16 who owns that parcel?
17 A. Uh-huh.
18 Q. And do you have an ownership interest in
19 that?
20 A. Oh, no. It was turned over to my son, Alika
21 Chad Wendt.
22 Q. Is that the -- did you have grandparents who
23 lived there?
24 A. Yes, sir, that's my grandparents.
25 Q. When you said that on the weekends you would

1 visit Wailuanui, was it your parents -- I mean
2 grandparents on that particular parcel that you
3 visited?
4 A. Say again.
5 Q. You said a little earlier that on weekends
6 when you were growing up, that you would spend some
7 time in Wailuanui?
8 A. Yes, sir.
9 Q. Was it on this particular parcel?
10 A. That one there and others.
11 Q. And when did you graduate from Baldwin High
12 School?
13 A. '66.
14 Q. By the way, this parcel that you just marked,
15 were there any lo'i on that parcel?
16 A. Like I say, when they put the water out, I
17 don't know if the lo'is were there personally, but
18 from my grandparents speaking, they did farm on those
19 properties.
20 Q. On those properties?
21 A. Right. On that particular side of the road.
22 Q. So on the house lots you mean?
23 A. There were lo'i on the house lot. Some of
24 them had lo'is.
25 Q. That is what you were told by your

1 grandparents?
2 A. Grandparents.
3 Q. After you graduated from Baldwin High School
4 in 1966, did you move away from Kahului?
5 A. Yes, sir. Yes, I did.
6 Q. And where did you relocate to?
7 A. I had a scholarship for the University of
8 Hawaii to play ball, but I got drafted. I was sent to
9 Vietnam and I served as a paratrooper, ranger in
10 Vietnam, infantry.
11 Q. What years?
12 A. '68 and '69 and then after that -- after that
13 I returned to Maui, and I was part-time farming and
14 became a tradesman, construction.
15 Q. And where were you living at that time?
16 A. I lived upcountry. I lived in Kula 200,
17 which I built my own home and farmed at the same time
18 too.
19 Q. Was that truck farming?
20 A. Truck farming.
21 Q. So what period of time did you do that?
22 A. Say again.
23 Q. How long did you do that? Until what year?
24 A. Oh, '85.
25 Q. And during that time, were you still visiting

1 your grandparents in Wailuanui?
2 A. Until '85?
3 Q. Yes.
4 A. Yes, sir.
5 Q. But you were living in Kula?
6 A. Yes, sir.
7 Q. Now, any time up through 1985, were you
8 farming taro?
9 A. Yes, I was.
10 Q. And when was that?
11 A. All the way up to '85.
12 Q. And where was the first place that you farmed
13 taro?
14 A. On this parcel right here.
15 Q. On the house lot?
16 A. I had dryland taro in the back of the house
17 lot. And I also farmed in the valley, in the lot that
18 belongs to -- the same parcel.
19 Q. Which lot is that?
20 MR. HAIA: For the record, Mr. Wendt is
21 pointing to -- I'm not sure which TMK this is. I
22 think it may be 1-1-5; parcel 23. It is L and H
23 Akiona, and I think it's Abraham Akiona.
24 THE WITNESS: This one too.
25 MR. HAIA: And then the parcel -- Mr.

1 Wendt also is referring to the parcel to its immediate
2 left, parcel 22.
3 THE WITNESS: This one too.
4 MR. HAIA: Just above it, parcel 29 and to
5 the immediate left of parcel 22 is 21.
6 Can you find those, Dave?
7 MR. SCHULMEISTER: Yeah.
8 THE WITNESS: This one too.
9 MR. HAIA: Also parcel 24. And then --
10 and I think it's on TMK: 1-1-4: Parcel 9.
11 MR. SCHULMEISTER: You mean the house lot?
12 MR. HAIA: No, no, 1-1-4: Parcel 9, and
13 it's in the middle, upper middle. It's Land
14 Commission Award 4779. Do you see that?
15 MR. SCHULMEISTER: Yes.
16 A. Also I farmed in Lakini, above the highway.
17 Q. All before 1985?
18 A. Yeah.
19 Q. So when did you first engage in farming taro?
20 A. I've been around these taro patches for all
21 my life. Was only a few years that I was not there.
22 Q. So while you were living in Kahului growing
23 up, you were working in all of these lo'i?
24 A. (Witness nods head up and down).
25 Q. So that would have been on the weekends?

A. Weekends.

Q. And so the first one you mentioned, the house lot, that was dryland taro?

A. Uh-huh, because there was no water in the back.

Q. With regard to the other parcels, 21 -- 1-1-5: 21, 22, 23, 29, 24, those are all next to each other, right?

A. Wetland, (Witness nods head up and down).

Q. Were they all farmed by -- was there one person in charge of all those?

A. The lots that I just talked about?

Q. Right.

A. Yeah, I was. I was farming it.

Q. No one else was farming it, just you?

A. Oh, I had some employees at that time.

Q. All right. So what I really want to do is clarify the time. Was this when you were still in grade school and high school?

A. Oh, no, no. Other people did that. I just there as --

Q. Helping on weekends?

A. Yeah.

Q. Okay. But there came a time when you farmed these with the assistance of some employees?

A. Uh-huh.
Q. When was that?
A. Oh, from the '70s to '85.
Q. So that was while you were living in Kula?
A. Uh-huh.
Q. And were you selling the taro?
A. Yes.
Q. Now, where was the water coming from for those lots?
A. It came from Lakini, Waiokamilo.
Q. You have a copy of Exhibit A-45 in front of you. And when we put this together, we tried to mark in blue the auwai that were marked on the tax maps, and the only ones that we could find to do that were the two that seem to be coming down across from the top to the bottom. Do you see those?
A. Uh-huh.
Q. Are there auwai in those locations?
MR. HAIA: You know, I'm going to object to this line of questioning just because as we previously noted in A & B's request for responses to their interrogatories, they were asking about auwais and we believe it's totally irrelevant where the auwais are.
The specific issue here to be addressed is

1 whether there are claimed rights and the amount of
2 water related to those rights that we, you know,
3 prove. And so with that respect we would object to
4 any request for where auwais are in this valley. And
5 that's for the record.
6 HEARINGS OFFICER McCONNELL: I'll overrule
7 that.
8 MR. HAIA: He's overruling my objection.
9 You can answer the question.
10 THE WITNESS: Yeah. These are auwais.
11 Q. (By Mr. Schulmeister): The one that's on the
12 left, does that go all the way up to the Hana Highway?
13 A. Yeah.
14 Q. And does that -- is that auwai fed by water
15 that flows through the Lakini taro patch?
16 A. Yes, sir.
17 Q. And what about the one just to the right of
18 it, where is that one reaching?
19 A. Some of it will service from Lakini, the
20 Lakini area. And see that auwai I draw over there,
21 goes under the road, ties into that.
22 Q. So that, the one that originates -- that
23 originates in the stream itself below Hana Highway,
24 right?
25 A. Some of it, yeah.

1 Q. So at some point they converge?
2 A. Uh-huh.
3 Q. So there's at least two auwai that come down
4 from the flow-through water from Lakini taro patches,
5 is that right?
6 A. That's what you got here.
7 Q. Is there a third one?
8 A. Yes.
9 Q. Where is that one relative to these auwai on
10 these tax map parcels? Actually, could I ask you to
11 go to Exhibit A-45-1, and --
12 MR. HAIA: Judge, just to note our running
13 objection to this line of questioning.
14 HEARINGS OFFICER McCONNELL: Okay.
15 MR. HAIA: Do you want him to use any --
16 MR. SCHULMEISTER: If you don't mind, the
17 same color that he used for the auwai and the road
18 would be good.
19 MR. HAIA: Mr. Wendt, just for purposes of
20 clarity, if you could try to make directional
21 relationships with where you draw, just describe where
22 you're drawing when you start to draw.
23 THE WITNESS: I assume that this is coming
24 off Lakini, this auwai right here. This, you see
25 right here, this part here. Right here got a box. In

1 this box, you have the pipe that Joe young --
2 COURT REPORTER: I'm sorry. You have to
3 speak up, I'm not hearing you. Would you repeat that,
4 please?
5 THE WITNESS: This is the Hana Highway.
6 This is all the lo'is. These are the lo'is. In this
7 box, the water comes from this direction, goes into
8 this box.
9 MR. HAIA: Can I interrupt? Maybe -- I
10 want to try and assist you, Mr. Wendt. When you say
11 this is Hana Highway, Hana Belt Road is what you refer
12 to as Hana Highway?
13 THE WITNESS: Yeah.
14 MR. HAIA: At the middle of the map there
15 is Hana Highway, what you're referring to as Hana
16 Highway disappears. So when you talk about over here
17 as being Hana Highway, are you suggesting that this
18 road comes back this way?
19 THE WITNESS: Exactly, right. So this
20 road here just swings around here, right through here.
21 Q. (By Mr. Schulmeister): Somewhere there's a
22 lookout. Maybe if you put the lookout --
23 A. Lookout is around in this area.
24 MR. HAIA: When you say this area --
25 MR. SCHULMEISTER: Put a big "LO" right in

1 the white area where the lookout is.
2 A. Then this road swings, like coming around --
3 we'll will make it all orange or pink -- continues.
4 Now, goes under the road, the water. And over here
5 you got an auwai, comes like this, around here. In
6 here another auwai, comes around in here about this
7 section.
8 The water from here comes down into these
9 fields, services some of this, comes into here. Right
10 in here another auwai tie into this auwai.
11 So you got two auwais on there that you
12 don't even have.
13 Q. But you put them in there now, right?
14 A. Yeah, these are the two.
15 Q. And one of them connects into a ditch from
16 the pool under the waterfall?
17 A. Yeah. All of this auwais come off the
18 Waiokamilo.
19 Q. What about the one that originates in the
20 water -- the Waikani?
21 A. Waikani would be up here. This would be
22 Waikani Waterfall.
23 Q. When we were having the slide show, there was
24 some lo'i of Sam Akina that you mentioned get their
25 water from Waikani Falls.

A. This one here.

Q. Can you draw that one in?

A. This one just comes this way.

Q. Does it actually join into the one that comes from Lakini?

A. This would dump also, falls into this.

Q. Now, the parcels that you mention that you had worked on, which were 21, 22, 23, 24.

A. All this area, some over here.

Q. Right. Did any of the water for those parcels come from Waikani Falls?

A. No, came from here.

Q. Are they upstream or downstream of the end of the ditch that comes from Waikani Falls?

A. The Waikani Falls do not reach all of this section up here.

Q. So there is a point, because of the lay of the land you can't get the water from Waikani Falls?

A. Yeah.

Q. Can you show me where that line of demarcation is?

A. All of this is from Waikani.

Q. And that's as far as the Waikani water can be used, is that right?

A. Uh-huh.

1 MR. HAIA: I think the record is going to
2 be hard --
3 MS. LOVELL: Going to look like we have
4 got a lot of auwais.
5 HEARINGS OFFICER McCONNELL: He's drawn a
6 large big circle that encompasses --
7 THE WITNESS: Waikani.
8 HEARINGS OFFICER McCONNELL: The Waikani
9 area, and which overlaps Wailua Stream. It's on the
10 lower left portion of the map.
11 MR. MURAKAMI: Technically, it's Wailuanui
12 Stream.
13 HEARINGS OFFICER McCONNELL: I'm reading
14 Wailua off the map, that's why.
15 THE WITNESS: There's lo'is in here too.
16 Q. (By Mr. Schulmeister): How do you know that?
17 A. Ancient lo'is.
18 Q. Are you familiar -- were you here when
19 Dr. McGregor testified?
20 A. No, I wasn't here.
21 Q. Have you read the study?
22 A. Yeah, I have.
23 Q. And it says that none of the areas on that
24 side of Wailua Stream were cultivated in the memory of
25 anybody that was interviewed. Is that consistent with

1 your understanding?
2 A. I didn't take it that she was talking about
3 this. I was taking that she was talking about another
4 area. There's lo'is in here.
5 Q. Have you talked to the someone who remembers
6 taro being cultivated --
7 A. My grandmother was born over there. Right in
8 this area, where Mr. Hueo is at.
9 Q. Has there been any attempt to grow taro on
10 the south side of Wailuanui Stream in the last hundred
11 years?
12 A. Oh, I don't know about hundred years, but
13 it's been awhile. Nobody has gone on that side of the
14 river.
15 Q. Not during your lifetime?
16 A. No, no.
17 Q. Has anyone -- well, this parcel, there's a
18 large parcel just south of the stream. That's
19 1-1-6:12. Do you know who has that parcel?
20 A. Talking about this one here?
21 Q. Yes.
22 A. Mr. Young is in there, Ho'okano.
23 Q. It's currently overgrown, right?
24 A. Yes.
25 Q. Has anyone -- is anyone trying to grow taro

1 there?
2 A. You know, I really don't know. But I heard
3 just through the grapevine this might be up for sale
4 or has been sold, not sure.
5 Q. What about the other parcel south?
6 A. This one?
7 Q. No. Basically what -- just so you
8 understand -- what we tried to do when we created the
9 highlighting was, when we received the list from Na
10 Moku of the persons who were making claims through Na
11 Moku, we just took the TMKs and we highlighted them on
12 this map so we could see where they were. So with
13 regard to the -- there's one other parcel that's south
14 of Wailuanui Stream, little smaller. Which member has
15 that parcel?
16 A. Ho'okano.
17 Q. And again, no taro has been cultivated there
18 in your lifetime, right?
19 A. Not in my memory, but I've heard that they
20 want to farm it.
21 Q. If they were to farm -- do you know how that
22 was cultivated historically? In other words, where
23 the water came from?
24 A. It all came from here, from Waikani.
25 MR. SCHULMEISTER: Is this a good time for

1 a break?
2 HEARINGS OFFICER McCONNELL: Yeah, good
3 point. Yes.
4 (Recess was taken.)
5 Let's go back on the record. We're back
6 on the record. Why don't we finish up with Mr. Wendt.
7 MS. LOVELL: For the record, I don't
8 think I have moved for the record on the record the
9 admission of the testimony of the Department of Water
10 Supply.
11 MR. MERCHANT: Nor have I.
12 HEARINGS OFFICER McCONNELL: I understand
13 that, that's fine. You can do that at this time, if
14 you wish.
15 MS. LOVELL: I make that motion.
16 MR. MERCHANT: And I move that Wes
17 Nohara's testimony be accepted into the record.
18 HEARINGS OFFICER McCONNELL: And nobody
19 has any objections to that, so those testimonies, the
20 written testimony of Wes Nohara and the Director of
21 the Water Department Mr. Tengan will be received in
22 evidence.
23 (Written testimony of Wes Nohara and
24 Director of the Water Department, Mr. Tengan, were
25 received into evidence.)

1 Let's go ahead and finish Mr. Wendt. See
2 how long that takes.
3 Q. (By Mr. Schulmeister): I'm just going to try
4 to focus on one major area right now, and that is
5 basically a continuation of the question about the
6 cultivation you were doing of these parcels that you
7 identified, 1-1-5: 21, 22, 23, 24, 25, you know,
8 basically in this area right here.
9 And I think you indicated that while you
10 were truck farming in Kula, that you were commercially
11 raising taro on those parcels; is that right?
12 A. Uh-huh.
13 Q. Did you have an ownership interest in any of
14 those parcels?
15 A. No, I was leasing, renting, family.
16 Q. Do you currently have an interest in those
17 parcels?
18 A. Just one parcel, the same parcel. My
19 family's land that I've been putting around with,
20 opening up fields.
21 Q. Number 23?
22 A. Yeah.
23 Q. And that -- the acreage on that one is .67,
24 is that right?
25 A. Something like that.

1 Q. Other than that, is there any other parcel
2 that you have an interest in?
3 A. No.
4 Q. And that one is through family members?
5 A. Uh-huh.
6 Q. Which family member has the interest in the
7 parcel?
8 A. Chad Wendt.
9 Q. Is that your son?
10 A. My son.
11 Q. Does he live in Wailuanui?
12 A. No. At this time he's in the United States
13 Coast Guard.
14 Q. And he's overseas?
15 A. Stationed in Boston.
16 Q. Boston?
17 A. Harbor.
18 Q. So while you were living in Kula, and before
19 you relocated to Wailuanui, which I think you said was
20 in 1985, is that right?
21 A. No, no, I stopped on a full-time scale in
22 '85.
23 Q. '85 was when you stopped full-time scale
24 doing what?
25 A. Taro farming.

1 Q. And truck farming also?
2 A. Yeah.
3 Q. So you were full-time truck farming in Kula?
4 A. No, no. Truck farming only in that
5 Wailuanui, farm in Wailuanui.
6 Q. But living in Kula?
7 A. Yeah.
8 Q. I thought one time you said you were truck
9 farming in Kula?
10 A. No, I meant Wailua. It was just a
11 residential ag land, I raised horses.
12 Q. So were you commuting daily between Kula and
13 Wailuanui from '70s through '85?
14 A. Pretty much.
15 Q. And were you also working as a tradesman, you
16 said?
17 A. At that time I kind of gave up the tradesman,
18 about '75 maybe. I went full-time.
19 Q. So about '75 to '85?
20 A. Uh-huh.
21 Q. Was there a period of time when you lived on
22 the mainland?
23 A. Yeah, '85 to '90.
24 Q. And while you were living on the mainland,
25 were you doing any farming in Wailuanui?

1 A. No, no, I was not.
2 Q. And then when did you actually -- well,
3 you're living in Wailuanui now, right?
4 A. Uh-huh.
5 Q. And going back, how long have you
6 continuously had that as your permanent residence?
7 A. 1990.
8 Q. So when you returned from the mainland in
9 1990, that's when you took up permanent residence in
10 Wailuanui?
11 A. Yes, sir.
12 Q. At any time prior to 1990 was Wailuanui your
13 permanent residence?
14 A. No, it's been --
15 Q. I'm sorry?
16 A. It's been my permanent residence.
17 Q. Since 1990?
18 A. Yeah.
19 Q. But not at any time prior to that, right?
20 A. No.
21 HEARINGS OFFICER McCONNELL: You were on
22 the mainland between '85 and '90?
23 THE WITNESS: Yeah.
24 Q. (By Mr. Schulmeister): So if we go back to
25 the '70s, in the 1970s, so you were familiar, because

1 you were out there working on those particular
2 parcels, right?
3 A. Uh-huh.
4 Q. And what was -- was that whole area, this
5 whole area up here -- and I'm just -- basically the
6 area that's above the auwai and below the road, was
7 that whole area pretty much in taro in the '70s?
8 A. Pretty much.
9 Q. I notice that there's this one fairly large
10 parcel, 1-1-5:18, and I believe that's 3.4 acres. Is
11 that your understanding?
12 MR. HAIA: Dave, 1-1-5:18, which was a
13 portion of Land Commission Award 5059?
14 MR. SCHULMEISTER: Yeah.
15 Q. What's the acreage on that, to your
16 understanding?
17 A. I don't really know the total acreage on
18 that. What is that? Five acres.
19 MR. HAIA: Can't read it.
20 MR. SCHULMEISTER: It might be --
21 A. I don't know the exact amount of acreage of
22 that.
23 Q. Did you ever farm that particular area?
24 A. No.
25 Q. Was that actively being cultivated in taro

1 when you were cultivating the lots to the -- that are
2 right north of it?
3 A. Pretty much that area had some taro patches
4 in that farm.
5 Q. Are you aware that there was a period of
6 time, turn of the century and shortly thereafter, that
7 that area was being cultivated in rice? Are you
8 familiar with that?
9 A. I don't know.
10 Q. Are you familiar with the history of rice
11 cultivation and the transition of rice back to taro?
12 A. Yes, I heard about it. I never saw no rice
13 grow.
14 Q. Now, there's a photograph that's part of A-23
15 that I would like you to take a look at.
16 MR. HAIA: Is that a supplemental exhibit?
17 MR. SCHULMEISTER: Yes.
18 MR. MURAKAMI: Talking about a photograph?
19 MR. SCHULMEISTER: Yes.
20 MR. HAIA: There's three photos?
21 MR. SCHULMEISTER: There's three
22 photographs. The one I was going to point you to was
23 the second one.
24 MR. HAIA: How do we orient him? Which
25 side is --

1 MR. SCHULMEISTER: Whatever is more
2 comfortable. I think it's more comfortable to look at
3 it with the highway in the background.
4 MS. LOVELL: And the waterfall going down
5 instead of up.
6 MS. CHOW: Which picture are we looking
7 at?
8 MR. SCHULMEISTER: Second page of the
9 exhibit.
10 Q. Does this look like -- do you recognize
11 what's in this picture?
12 A. Yes, sir.
13 Q. Is this the Wailuanui Valley basically?
14 A. Yes, sir.
15 Q. Up in the left corner is the Waikani Falls
16 and Hana Highway or belt road that meanders across the
17 top, and then there is a horizontal road at the
18 bottom. Is that Wailuanui Road?
19 A. Yes, sir.
20 Q. So to orient ourselves to these parcels that
21 are shown on Exhibit A-45 and the ones that you just
22 described as having been the ones that you worked on
23 in the '70s and up through 1985, could you -- would
24 those be in an area in that photograph that is shown
25 as either being grass or overgrown?

1 A. Say that again.
2 Q. Why don't you just try -- point with your
3 finger where on this picture these tax map keys we
4 identified as being where you farmed from '75 to '85.
5 A. Right in this area.
6 MR. HAIA: You're going to have to
7 describe it more clearly.
8 MR. SCHULMEISTER: Can you hold that up so
9 we can see?
10 A. Right in this area.
11 Q. Okay.
12 I would also like you to look at, if your
13 attorney will put it in front of you, Figure 16 and 17
14 from Exhibit B-123.
15 MR. HAIA: 120 --
16 MR. SCHULMEISTER: 23, that's the cultural
17 landscape study.
18 HEARINGS OFFICER McCONNELL: Figures --
19 MR. SCHULMEISTER: 16 and 17. These are
20 the 1936 and 1966 Bishop Museum photos taken from the
21 Hana Highway lookout.
22 Q. Now, with regard to --
23 MS. LOVELL: What figure are we talking
24 about, Dave?
25 MR. SCHULMEISTER: 16 and 17.

1 MS. LOVELL: Thank you. Do you have it?
2 MR. HAIA: Yes.
3 Q. (By Mr. Schulmeister): Now, the area I guess
4 I'm interested in is basically the area that these
5 lo'i that you described as having worked on is right
6 in the middle of. In the second page of A-23 it looks
7 like there's a fairly large area in the central part
8 of the picture that at the time this photograph was
9 taken was not being cultivated. Do you see that?
10 MR. HAIA: Just want to make sure that you
11 and he are actually looking at the same area.
12 THE WITNESS: This one here.
13 MR. SCHULMEISTER: Talking about the area
14 right here.
15 A. Yeah.
16 Q. And to the left it looks like there is
17 some --
18 A. Taro patches.
19 Q. And that's where Sam Akina's taro patches are
20 at?
21 MR. HAIA: You want to ask your question
22 again, Dave?
23 MR. SCHULMEISTER: The area in the
24 photograph that's to the left towards the Waikani
25 Falls just before what looks like the dark green

1 forest sort of takes over as you go through Wailuanui
2 Stream, there's an area of apparent taro cultivation,
3 is that right?
4 A. Yeah.
5 Q. And my question is: Is that where the
6 lo'i -- the person you described as Sam Akina is
7 located?
8 A. Yes.
9 Q. And on A-45, are any of those -- any of the
10 yellow parcel -- or which of the yellow parcels are --
11 represent the area that's being cultivated near -- on
12 that side of the picture, is basically what I'm
13 asking.
14 MR. HAIA: Dave, Mr. Wendt is pointing to
15 TMK 1-1-5 parcels -- -- it's hard to tell you whether
16 or not it's 5 or 6.
17 THE WITNESS: You want me to point it out?
18 MR. SCHULMEISTER: On the bigger one,
19 maybe that would be good. In fact, you can use orange
20 for that, although I guess if the orange goes on the
21 yellow -- yeah, if the pink goes on the yellow it
22 looks orange.
23 A. From this, you're talking about this lo'i,
24 right?
25 Q. Well, the ones that you know of as being Sam

1 Akina's.
2 A. It would be right in this --
3 MR. HAIA: Wait, Mr. Wendt. Hold on. My
4 concern is, you know, this photograph is -- you know,
5 it's not the same dimensions as this map. I just have
6 concerns about the map and trying to convert in terms
7 of, you know, scale what we're talking about here.
8 And if you're asking Mr. Wendt for, you know, rough
9 estimations, that's a different story.
10 MR. SCHULMEISTER: No. Let me withdraw
11 the question. Let me ask it this way.
12 Q. We were looking at the photograph which was
13 interesting and gave some general ideas of things.
14 But what I would like you to mark on here is where you
15 know Sam Akina's lo'i are, based on the parcels.
16 MR. HAIA: I have the same objection with
17 respect to the scale.
18 HEARINGS OFFICER McCONNELL: If he knows,
19 I'll permit it. Go ahead.
20 MR. HAIA: If you know.
21 THE WITNESS: This portion here is Sam
22 Akina, but what you see on that picture, I would say,
23 is just like right around where this orange mark --
24 around these lo'is and some of this is open right now.
25 This area, that is Sam's.

1 Q. (By Mr. Schulmeister): Do those have parcel
2 numbers on them 38, 39, 40, 41, 42, 43?
3 A. Uh-huh.
4 Q. And those are below the line that you
5 previously drew that represented the limit of how far
6 north the Wailuanui water could be used?
7 A. Just about, yeah.
8 Q. So the area that you were cultivating was
9 further north, and I think you already indicated you
10 were getting the water from Lakini taro patches?
11 A. Yes.
12 Q. Okay.
13 MR. HAIA: Just for the record, when
14 you're answering him, she also has to hear you.
15 THE WITNESS: Yes.
16 Q. (By Mr. Schulmeister): These ones that are
17 highlighted down here which are 22, 23, 67 and 24 on
18 plat 116, those are more towards Wailuanui Stream from
19 the ones that you just described were Sam Akina's
20 lo'is, correct?
21 A. Yes.
22 Q. When's the last time that they were, to your
23 knowledge, that they were cultivated in taro?
24 A. I just -- I don't know that exact answer of
25 that one.

1 Q. If we go back to the 8/23 photograph you were
2 just looking at, could you do that?
3 MR. HAIA: Are you going to ask him to go
4 back up there, so I can just bring it over there?
5 MR. SCHULMEISTER: I'll try to minimize
6 it. Actually, why don't you bring it over, that would
7 probably be helpful.
8 MR. HAIA: Which photo?
9 MR. SCHULMEISTER: The same one, the
10 second page of Exhibit A-23.
11 Q. You see in the photograph as you go south
12 towards Wailuanui Stream -- by the way, the waterfall
13 that you see there, right beneath it there's some
14 light green. Are those Kukui nut leaves?
15 A. Uh-huh.
16 Q. That's at the bottom of the falls?
17 A. Uh-huh.
18 Q. The stream -- you can really see from the
19 photograph exactly how the stream goes, but it
20 basically goes down and to the left of the picture,
21 right?
22 A. Uh-huh.
23 Q. But it's shown on the TMK map which is A-45,
24 you can kind of see the profile of the stream, right?
25 So I guess my question to you is: These parcels that

1 I just asked you about that are highlighted, further
2 towards Wailuanui Stream from Sam Akina's lo'i, are
3 those in an area that are dark green in the
4 photograph?
5 A. You talking about this section right here?
6 Q. Yes.
7 A. Yes, that's dark green.
8 Q. And that dark green area, is that basically
9 forest?
10 A. Well, now it's overgrown, as you can see, but
11 it's lo'i underneath.
12 Q. But you don't have any recollection of those
13 lo'i having been cultivated?
14 A. No, sir.
15 Q. Okay, now, the --
16 A. Let me reframe that.
17 As a young person, I seen the whole valley
18 open, when I was young, that's all the way to the
19 river.
20 Q. Now, has anyone, any of the members of the Na
21 Moku that are -- strike that.
22 There have been some efforts in the last
23 two years or so to open some -- to reopen some of
24 these lo'i, right?
25 A. Yes, sir.

1 Q. And can you identify the TMKs where those
2 efforts took place?
3 MR. HAIA: You're talking about the last
4 two years? Confining it to the last two years?
5 MR. SCHULMEISTER: You can make it five
6 years if you want, that's fine.
7 A. That it's being open?
8 Q. Yes, where efforts have been involved to open
9 it. I think there were some photographs in the slide
10 show --
11 A. In this area.
12 HEARINGS OFFICER McCONNELL: I can't see.
13 THE WITNESS: Slides that were shown in
14 this area.
15 Q. (By Mr. Schulmeister): Now, the area that
16 you just circled, there's another landmark from the
17 photograph that I would like you to look at. The
18 photograph is right there.
19 A. That would be right here, this area, right
20 here. All this area.
21 Q. All right. It actually, in the photograph,
22 shows that it's open?
23 A. Yeah.
24 Q. Beyond that, anything else?
25 A. In this central area where we talk about.

1 Q. That you used to farm?
2 A. Right. It's being -- not being, it's in the
3 process right now that would be on the map all the way
4 up to here, East Maui Irrigation from here up, but all
5 in this area great attempt -- not attempt, but it's
6 being worked at this time.
7 Q. And so that's very close to the area where
8 you used to farm between '75 and '85?
9 A. Uh-huh.
10 Q. You mentioned you stopped in 1985, is that
11 right?
12 A. Uh-huh.
13 Q. In 1985 were those lo'i, on the parcels
14 you've earlier described, were those all in active
15 cultivation in 1985?
16 A. Yes, sir.
17 Q. And when you left, what happened?
18 A. Others continued the practice.
19 Q. But then at some point they stopped as well?
20 A. Yes, sir.
21 Q. And about when was that?
22 A. I don't know the exact dates.
23 Q. Was it between 1985 and 1990 when you were on
24 the mainland?
25 A. It had to be that time, closer to 1990.

1 Q. Okay. Now, with regard to the Waikani
2 intake, have you ever farmed any lo'i in Wailuanui
3 Valley that took water from the Waikani Falls intake?
4 MR. HAIA: Objection, vague as to Waikani
5 intake. Are you talking about the Waikani Falls,
6 which empties into Wailua Stream?
7 MR. SCHULMEISTER: Let me withdraw the
8 question.
9 Q. Are you familiar with how water gets
10 transported from Wailuanui Stream to Sam Akina's lo'i?
11 A. Yes, sir.
12 Q. Is there some sort of an intake from beneath
13 the falls that water is directed to?
14 A. Yes, sir.
15 Q. Would you describe your understanding? Have
16 you ever seen it?
17 A. Yes, sir.
18 Q. Could you please describe it?
19 A. The intake was put in by the County of Maui.
20 I don't know the exact date. It's a bell system that
21 was put in, like a bell, eight-inch pipe that comes
22 from the pond with a bell system with lots of rubbish
23 and stuff into the pipe, that's broken off. But
24 there's a piece of pipe laid in the ground maybe 40
25 feet or more into a flume.

1 And that is transported this direction.
2 From here it comes across, service this section.
3 Q. Now, you said it was put in by the County of
4 Maui?
5 A. Uh-huh.
6 Q. How do you know that?
7 A. There are people from the community who work
8 for the county and participated on the project.
9 Q. Was that while you were farming taro between
10 1985 and 1985?
11 A. It was done, that was done just before.
12 Q. Before?
13 A. Yeah.
14 HEARINGS OFFICER McCONNELL: You said '85
15 and '85.
16 MR. SCHULMEISTER: What did I say? I
17 meant '75.
18 A. It was done in the '70s, late '60s.
19 Q. So before you were farming taro?
20 A. Uh-huh.
21 Q. When you were farming taro between 1975 and
22 1985, is that when you became familiar with it?
23 A. No. I became familiar with the area growing
24 up in the area.
25 Q. No, no. I mean familiar with what the county

1 did at that intake?
2 A. Was I familiar?
3 Q. Right.
4 A. Just from what I -- going there when the
5 county wasn't even there, wasn't working, we would go
6 and look what they were doing.
7 Q. That was before you moved there -- I mean was
8 that before 1975?
9 A. That was done before 1975.
10 Q. I know it was done before, but when is the
11 first time you saw it?
12 A. Oh, I don't know. I can't give you a
13 specific date.
14 Q. You mentioned a part is broken off?
15 A. Yeah.
16 Q. That's the way it is now?
17 A. Uh-huh.
18 Q. What's broken off?
19 A. Just the bell that goes up and down. It
20 broke off, so now just got a pipe sticking into the
21 pond.
22 Q. And what was the function of what you call
23 the bell?
24 A. I believe it was for rubbish, collection of
25 rubbish, not to be able to go down into the pipe and

1 stuff, get stuck into the pipe.
2 Q. Was there any siphon?
3 A. That's what it would be called, a siphon. We
4 call it a bell. It's shaped like a bell.
5 Q. So when it was working, it could -- water
6 could be directed into the stream from below where the
7 intake actually comes into the pool?
8 A. Uh-huh. It still works.
9 Q. It does still work?
10 A. Uh-huh. Only we don't have the siphon, just
11 the bell.
12 Q. The fact that it's broken, does that reduce
13 the amount of water that can be directed into this
14 area?
15 A. Not really, no, sir.
16 Q. It does not. Do you have A-26 there?
17 MR. HAIA: You said A-26?
18 MR. SCHULMEISTER: Yes, please.
19 MR. HAIA: It's not a supplemental
20 exhibit, is it?
21 MR. SCHULMEISTER: It should be right
22 there.
23 MR. HAIA: It goes from A-23 to A-41.
24 MS. LOVELL: A-26 is in the original
25 submission, looks like this (indicating).

1 MR. HAIA: Okay.
2 Q. (By Mr. Schulmeister): Do you see Exhibit
3 A-26?
4 A. Uh-huh, yes, sir.
5 Q. Does that look familiar?
6 A. Yes, sir.
7 Q. Is that the diversion box just below Hana
8 Highway from below the Lakini taro patch?
9 A. Yes, sir.
10 Q. It looks -- by the way, what is the
11 approximate dimension -- why don't we wait a second.
12 HEARINGS OFFICER McCONNELL: Yeah, hold
13 on. Go ahead.
14 Q. (By Mr. Schulmeister): It looks like there's
15 some water going off to the left, upper left; is that
16 right?
17 A. Yes, sir.
18 Q. So that would be going downhill from the box?
19 A. Yes, sir.
20 Q. And it's going through a puka in the box
21 basically?
22 A. Yes, sir.
23 Q. Where does that go?
24 MR. HAIA: Before you answer, Mr. Wendt.
25 I've been really patient, but from this point on, I

1 would like to note on the record my running objection
2 to this line of questioning regarding auwais and the
3 delivery system for the lo'i in the Wailuanui Valley.
4 And that objection is based upon, you know, the burden
5 of proof that's been placed on Na Moku and others who
6 are claiming superior rights.
7 As the order provides, all that is
8 required is to establish the claimed interest and
9 provide --
10 HEARINGS OFFICER McCONNELL: Hasn't this
11 been made ad nauseam?
12 MR. HAIA: And we're continuing to ask
13 these questions --
14 HEARINGS OFFICER McCONNELL: I know, but
15 we have a limited amount time and we are trying to get
16 finished.
17 MR. MURAKAMI: That's what we are pointing
18 out, Your Honor.
19 HEARINGS OFFICER McCONNELL: Your
20 objection is noted for the record.
21 MR. HAIA: Thank you.
22 Q. (By Mr. Schulmeister): So the puka on the
23 left side where the water comes out, where does that
24 water go?
25 A. That water would get all the way down where I

1 was farming in that section.
2 Q. Okay. And what's on the right side of the
3 box?
4 A. The right side of that is an intake, and
5 remember that other --
6 MR. HAIA: Just for purposes of
7 clarification and direction, when you're talking about
8 the right side of the box, is this looking mauka or
9 makai?
10 MR. SCHULMEISTER: From the point of view
11 of looking at the picture.
12 MR. HAIA: Okay. And do you know whether
13 or not that picture is taken from the makai side of
14 the diversion or the mauka?
15 MR. SCHULMEISTER: I think Mr. Wendt
16 already testified you're looking downstream here.
17 Q. Is that right? The water goes down from
18 here, right?
19 A. (Witness nods head up and down.)
20 Q. So there's a metal grate on the right corner?
21 A. Yes, sir.
22 Q. What is that?
23 A. That is another -- leads into another auwai.
24 And I've drawn that out up there on the top auwai.
25 Q. Is that the uppermost?

A. Yeah. You see that box I made on the very top, there's two auwais. And that's the top one, the one you just mentioned.

Q. When you drew these, you drew two that went south?

A. Right.

Q. Was one of those two the puka?

A. The bottom one is the puka.

Q. And so from here the water comes down and can come to parcel 22?

A. Yes, sir.

Q. And this other one?

A. Goes all the way across, comes down.

Q. And that one -- so when this picture was taken -- strike that.

When's the last time that upper -- the highest ditch was in use?

A. We had a -- with Hui Kalo a few years ago, we cleaned the ditch open. We released the water. And after we released it, we closed it back up because it denied water from the bottom. So we shut it down again. That's what you see, the way it is.

Q. So that's deliberately being blocked?

A. Yes, sir.

Q. By the --

1 A. Farmers.
2 Q. Farmers, okay.
3 And when it was open a few years ago, was
4 that when Mr. Reppun said that there was 400 people
5 out there clearing it?
6 A. Yes, sir.
7 Q. What was -- where were the lo'i that it was
8 intended at that time that that uppermost ditch was
9 going to serve?
10 A. It's just -- with Sammy -- it come and
11 service these patches here too, these top patches.
12 And some of it would come down and service some of
13 this, not all of it. But it was more into this area.
14 Q. So when you say the uppermost ones, that
15 would be like 21, 20, 19, 38?
16 A. Yes, sir.
17 Q. So some of those actually -- so those lo'i
18 could be serviced with either Waiokamilo water -- or
19 some of them, I guess, some of them could be served?
20 A. Some of them. Not all of them.
21 Q. Okay. But the ones you were farming,
22 including 23 which you have an interest in, those
23 would be served by the auwai where -- that's being fed
24 by the puka from the diversion water?
25 A. Yes, sir.

1 HEARINGS OFFICER McCONNELL: When you say
2 puka, can you just clarify?
3 MR. SCHULMEISTER: Do you want him to
4 point it out?
5 HEARINGS OFFICER McCONNELL: Here on the
6 pipe, just so we're clear.
7 MR. SCHULMEISTER: Well, on the concrete.
8 HEARINGS OFFICER McCONNELL: On the
9 concrete, I'm sorry.
10 MR. SCHULMEISTER: And that's one of the
11 things we'll look at tomorrow.
12 Q. Can you go to A-27, please. Does A-27 look
13 familiar to you?
14 A. Yes, sir.
15 Q. Is that another spot where water -- that
16 outflows from Lakini, crosses or goes under the Hana
17 Highway?
18 A. Yes, sir.
19 Q. And is this in fairly close proximity to the
20 box?
21 A. Yes, sir.
22 Q. Now, you had drawn on A-45-1 where the box
23 is. Where is this grate in relation to the box?
24 A. I would say 30 yards away.
25 Q. In which direction?

1 A. Go back -- what is that, south -- or north.
2 Q. Towards Hana or towards Wailuku?
3 A. Kahului, towards Keanae direction.
4 Q. And back in 1975 to 1985 when you were
5 farming taro, was that grate there?
6 A. No, they just put that grate in recently.
7 Q. And prior to that grate being there -- well,
8 before we get there. What happens to the water after
9 it goes through the grate?
10 A. It goes under the road, and it services the
11 taro patches right below that area. We talking about
12 this is the box, right around in this area. And it
13 goes down -- there's another auwai that goes down in
14 here and service all these lo'is.
15 Q. Why don't you use the pink one?
16 A. It service the lo'is in this area.
17 Q. And the grate?
18 A. The grate is about right in this area.
19 Q. And maybe just draw an arrow from there to
20 the circle.
21 Okay. And before the grate was put in,
22 how did the water -- was the water also used in the
23 same area before the grate was put in?
24 A. Yes, sir. The grate was put in because of
25 safety. Tourists used to fall in the hole head first

with their vehicles, that's what happened.

Q. So how did the water get under the highway before that?

A. Same way. They just had a hole, and there's a pipe, existing pipe that was put in many years ago.

Q. So the grate didn't change anything about where the water went, just created --

A. No, safety precaution. Every day tourist fall in that hole.

Q. So whatever goes into that grate, only services the area you put the circle on?

A. Yeah.

Q. Where does that water end up when it flows out from those patches?

A. From lo'i to lo'i and it eventually will get back into the auwai.

Q. And that auwai is the one that comes down -- where is the final discharge?

A. It will get into this auwai here, and then this auwai continues. It continues, and it comes into here. It enters into the ocean.

HEARINGS OFFICER McCONNELL: It's still there?

THE WITNESS: Still intact, sir. The only auwai change, this one. Other than that, all existing

1 auwais are intact.
2 Q. (By Mr. Schulmeister): So right now, can you
3 just kind of show -- point out on A-45-1 all the areas
4 that receive water that it is basically outflow water
5 from Lakini?
6 A. All the areas?
7 Q. Right.
8 A. Where I put this mark in, all of this.
9 Q. So most of the valley?
10 A. Yeah. Yes, sir.
11 Q. So it's a very small percentage that actually
12 takes off of the stream itself below Hana Highway,
13 right, Waiakamilo?
14 A. Yes, sir. Waiokamilo?
15 Q. Yeah.
16 A. It's the main source.
17 Q. Because Waiakamilo feeds Lakini up above?
18 A. Yes, sir.
19 Q. But there's some water taken from Waiakamilo
20 below Hana Highway which you talked about earlier?
21 A. Yes, sir.
22 Q. That's the auwai that comes in and used to go
23 down to the house lots and under the road, but now
24 just goes under the road?
25 A. Yes, sir.

1 Q. So vast majority of the lo'i in Wailuanui
2 Valley basically need to get their water from
3 Waikomilo through Lakini under the highway?
4 A. Yes, sir.
5 Q. So now, when you were farming in 1975 to 1985
6 -- let's back up.
7 You said the water originally comes in
8 Waiakamilo Stream then goes into Lakini?
9 A. Yes, sir.
10 Q. Are you familiar -- and you also, I think,
11 testified that you farmed taro in Lakini as well,
12 right?
13 A. Yes, sir.
14 Q. Do you currently farm taro in Lakini?
15 A. Little bit, yes, sir.
16 Q. And so are you familiar with the diversion
17 that is used to bring in water to Lakini?
18 A. Yes, sir.
19 Q. And it's not going to be on that map. I
20 think we're done with that map for awhile, so if you
21 want to go back over there, that's fine.
22 MR. HAIA: How about A-27, are you done
23 with that?
24 MR. SCHULMEISTER: Could you look at
25 Figure 21 in B-123.

1 MR. HAIA: Do you have a page number?
2 MR. SCHULMEISTER: Yeah. It's, I think
3 it's page 61 -- right around 59 or 60 or thereabouts
4 -- actually it's Page 61.
5 MR. HAIA: Figure 21.
6 MR. SCHULMEISTER: Okay,?
7 Q. Figure 21 is schematic of the Lakini lo'i
8 complex that was included in the cultural or the
9 landscape -- cultural landscape done by Dr. McGregor
10 and a team of associates; is that right? Are you
11 familiar with this?
12 MR. HAIA: He's asking if you're familiar
13 with the study.
14 THE WITNESS: I've read it. Yes, sir.
15 Q. (By Mr. Schulmeister): Okay. Is it your
16 understanding that this Figure 21 is intended to
17 depict schematically the Lakini lo'i complex?
18 A. Yes, sir.
19 Q. Does it look familiar?
20 A. Yes, sir.
21 Q. And so on the left side of the schematic
22 there's indication of a stream?
23 A. Yes, sir.
24 Q. And what stream is that?
25 A. You know, I really don't know the name of

1 that stream.
2 Q. Is that one some people call Kulani and some
3 people call Hamau?
4 A. I don't know the exact name of that stream.
5 Q. It's not Waiakamilo Stream?
6 A. No, no. It's parallel to Waiokamilo.
7 Q. But you're familiar with the fact that there
8 is a stream just above Lakini?
9 A. Yes, sir.
10 Q. That is diverted and that is what -- that's
11 the source of water for the Lakini taro patch, right?
12 A. Yes, sir.
13 Q. So now is there one particular or two or
14 three lo'i in here that you farm currently?
15 A. Yes, sir.
16 Q. And can you identify them on here?
17 A. Where the ditch goes across the road. The
18 auwai that goes under the road that feeds the box, you
19 know, where the box is at.
20 Q. That would be just to the right or just above
21 where it says ditch under road, is that right?
22 A. Just above that. I would say that's the
23 mauka side -- you see those three right in that area,
24 right there?
25 Q. Could you hold it up?

1 A. This one right here, these three.
2 HEARINGS OFFICER McCONNELL: I got it.
3 South of the ditch under the road.
4 Q. (By Mr. Schulmeister): So in the course of
5 cultivating that particular patch, do you have any --
6 do you do anything in connection with the diversion
7 from the stream into the auwai that's at the bottom
8 left corner of the schematic?
9 MR. HAIA: Wait a minute. Object as being
10 vague, do anything.
11 MR. SCHULMEISTER: Let me withdraw that.
12 I agree with you.
13 Q. Does any part of your cultivation activity
14 include doing work at the diversion from the stream
15 into the auwai?
16 A. It's just -- it's a process that we all go
17 through, that you need to clean every once in awhile.
18 Q. What about adjusting the flow? Anything to
19 adjust the flow?
20 A. No, we do not adjust the flow.
21 Q. Okay. During times when it's not raining, is
22 most of the water from this particular stream diverted
23 into the auwai or not?
24 A. Most of the water -- I don't believe it's
25 most of the water. It carries its fair share. It

1 comes down. Whatever comes off of the stream.
2 Q. So some of the water goes into the auwai, its
3 fair share. Now fair share, does that mean like 50
4 percent? What do you mean?
5 A. That's a tough one because I'm not a
6 scientist to calculate how much water really coming in
7 through. Because when East Maui Irrigation ditches
8 cannot carry 400 million gallons that they transfer
9 from Nahiku and overflow the volume coming down.
10 Q. So that's why I asked the question.
11 A. I don't know. I don't have the answer, sir.
12 Q. Okay. But in order for there to be enough
13 water for all of the lo'i down below the highway, that
14 depends on outflow from Lakini?
15 A. Yes, sir.
16 Q. This is where the water would have to
17 originate, right?
18 A. Yes, sir.
19 Q. And so I guess my question, is anything done
20 to regulate how much water gets into Lakini so that
21 there will be enough to service all these many lo'i
22 below from the outflow that crosses the highway?
23 A. There are diversions above this that was put
24 in by East Maui Irrigation many years ago. And we
25 just did some work with East Maui Irrigation, so

1 there's diversions above, dams, little dams that come
2 into this area, pushes all the water from Waiokamilo
3 over back to this section here.
4 Q. Could you look at A-25?
5 HEARINGS OFFICER McCONNELL: Are you ready
6 for a break? I'm ready for a break.
7 MR. SCHULMEISTER: Why don't we take a
8 break.
9 (Recess was taken.)
10 HEARINGS OFFICER McCONNELL: We're
11 reconvened.
12 Q. (By Mr. Schulmeister): Okay. Just one last
13 topic here, and that is the Kupau area. And A-23, the
14 third photograph.
15 MR. HAIA: That's the supplemental?
16 MR. SCHULMEISTER: And the other exhibit
17 referred to also in connection with this is Page 60 of
18 B-123, which is the cultural landscape survey.
19 MR. HAIA: Page 60?
20 Q. (By Mr. Schulmeister): Mr. Wendt, are you
21 familiar with an area above Hana Highway called Kupau
22 where taro was historically cultivated?
23 A. Yes, sir.
24 Q. If we look at the third page of Exhibit A-23,
25 which is another photograph of the valley, this one is

1 taken from a more distant vantage point. You can see
2 the highway, is that right?
3 A. Yes, sir.
4 Q. And you can kind of see in the lower quarter
5 of the photograph where the Lakini taro patches are
6 right almost adjacent to Hana Highway, right?
7 A. Yes, sir.
8 Q. Then if you go up further a little bit up to
9 the left there is another area looks like it's been
10 cultivated. Do you see that?
11 A. Yes, sir.
12 MR. HAIA: I want to make sure it's the
13 same area you're referring.
14 HEARINGS OFFICER McCONNELL: Could you
15 point it out? Just hold it up. And then Lakini on
16 the photo is -- okay.
17 Q. (By Mr. Schulmeister): Now, where is the
18 area that you understand to be Kupau?
19 A. From the highway, Hana Highway and all in
20 this area, ili of Kupau. And you can see the
21 waterfall of Kikokiko way in the background that is
22 diverted.
23 Q. And so the Kupau area is below Kikokiko?
24 A. Yes, sir.
25 Q. And if you look at Page 60 of B-123. And at

1 the bottom there is a section, I don't know if you
2 were here when I asked, Formerly Cultivated Lands in
3 the 'ili of Kupau. Do you see that?
4 A. Yes, sir.
5 Q. Says, during fieldwork for the present study,
6 the upstream end of East Waiokamilo Stream was
7 inspected. Ke'anae residents Isaac and Gladys
8 Kanoa accompanied the study team.
9 And it continues on Page 64 after the
10 photographs, saying: The stream is diverted; a well
11 constructed and preserved abandoned auwai runs along
12 the base of a ridge. This 'auwai once provided water
13 to a large irrigated complex which was abandoned in
14 the 1950s according to the Kanoas' testimony.
15 Do you see that?
16 A. Yes, sir.
17 Q. Now, I asked Dr. McGregor about that but
18 apparently someone else on the team had done those
19 interviews, so she wasn't familiar. Are you familiar
20 with this area?
21 A. Yes, sir.
22 Q. Can you tell me whether this description here
23 is correct?
24 A. The stream is diverted, a well constructed
25 and preserved abandoned auwai. You talking about

1 that? Yes, sir. There is one.
2 Q. And the next sentence saying: This auwai
3 once provided water to a large irrigated complex which
4 was abandoned in the 1950s.
5 A. Not sure it was abandoned in the '50s, but it
6 did service a large area of lo'is.
7 Q. At any time in your lifetime was that area
8 being fully cultivated?
9 A. Not in my time. But I been up there in the
10 '70s when the people who was up there were farming.
11 Not where Gladys is at. Further down.
12 Q. Okay. When you say where Gladys is at, what
13 are you referring to?
14 A. That spot we cleared out, this area.
15 Q. Okay. That's Gladys Kanoa?
16 A. Yes, sir.
17 Q. So at one time that was being -- fairly
18 recently that was being cultivated?
19 A. That's recent taro patches.
20 Q. I think this photograph was taken 2004.
21 A. No longer. There's no farming up there no
22 longer.
23 Q. Right. But you understood -- did you talk to
24 any old-timers that described taro being cultivated in
25 this complex?

A. Yes, sir.

Q. And here it says: The irrigated area is estimated to cover approximately 30 to 50 acres. Do you see that?

A. Yes, sir.

Q. Does that seem right to you?

A. Yes, sir.

Q. And is it your understanding that that much acreage was cultivated up through in the '30s and '40s up to the '50s?

A. Yes, sir.

Q. And that was also being irrigated from Waiokamilo Stream, is that right?

A. Yes, sir. And other tributaries, not only Waiokamilo, not only Waiokamilo serviced those lo'is.

Q. Okay. So as you go down further in this paragraph it says: This system is spatially separated from the Wailuanui system but shares the same stream source. Do you see that?

A. Yes, sir.

Q. So you don't agree with that statement?

A. It's separated in the sense that it's in the uplands and we're makai of that. But water arrived in the ili of Kupau was not only from Kikokiko, which is the waterfall, this waterfall here in the back. And

1 as Alan described his -- what he showed on the video,
2 all along in here got waterfalls also that was
3 diverted that fell into the ili of Kupau and then it
4 works its way down toward Lakini complex.
5 Q. So you're talking about the pipes that were
6 taking seepage from the --
7 A. Yes. It's all above in this area, up high.
8 So water all went down.
9 Q. Wouldn't that water all have ended up in
10 Waiokamilo Stream?
11 A. Oh, yes -- not really. Not to Waiokamilo,
12 because that little stream we talked about in the back
13 of Lakini.
14 Q. Kulani?
15 A. Kulani. It goes into there.
16 Q. But Kulani eventually becomes part of
17 Waiokamilo, right?
18 A. It will return some water back to Waiokamilo,
19 but not all because the complex of Wailuanui taro has
20 taken majority of the water and dried up Waiokamilo,
21 the bottom section.
22 Q. So in the '30s and '40s and '50s, you have
23 not only all of the taro being grown that we see in
24 the 1936 photo below Hana Highway that was dependent
25 on Waiokamilo Stream, but also Lakini and plus ili

1 Kupau above also?
2 A. Yes, sir.
3 MR. SCHULMEISTER: I have no further
4 questions.
5 HEARINGS OFFICER McCONNELL: Any
6 questions?
7 MR. MERCHANT: No questions.
8 MS. LOVELL: No questions.
9 HEARINGS OFFICER McCONNELL: Any redirect?
10 MR. HAIA: Yes.
11 REDIRECT EXAMINATION
12 BY MR. HAIA:
13 Q. First of all, Mr. Wendt, when you indicated
14 on Exhibit A-45-1 where that grate is, it's supposed
15 to be above Hana Highway?
16 A. It should be above the road.
17 Q. But you drew it below.
18 A. I'm on the wrong side. Got to go above the
19 road. The little box with the grate goes above the
20 road.
21 HEARINGS OFFICER McCONNELL: That's the
22 one with the arrow? The arrow into the --
23 THE WITNESS: Yes, sir.
24 HEARINGS OFFICER McCONNELL: -- circle.
25 THE WITNESS: Just above the highway.

1 Q. (By Mr. Haia): Can you take a pen and
2 correct that showing an arrow where it should be? Let
3 the record reflect that Mr. Hew is doing the
4 correction.
5 HEARINGS OFFICER McCONNELL: Okay, saves
6 time.
7 THE WITNESS: Thank you, Garrett.
8 MR. HEW: You're welcome.
9 Q. (By Mr. Haia): Now, Mr. Schulmeister, in his
10 last line of questioning, was talking about Kupau and
11 the water source for the auwai -- not the auwai but
12 the lo'i in the ili of Kupau and he was asking you
13 whether or not the water that you are referring to
14 that would come down in waterfalls along the ridge
15 next to Kikokiko and down past Kikokiko would actually
16 all flow into Waiokamilo Stream.
17 A. It would not go back into Waiokamilo.
18 Q. Where would it go?
19 A. It would go into here.
20 Q. What is that?
21 A. This is Waiokamilo.
22 Q. Okay. So is this stream, and for everyone,
23 this is Exhibit A-25, the schematic.
24 HEARINGS OFFICER McCONNELL: Would you
25 point that out? Would you point out that area on the

1 photograph?
2 THE WITNESS: This is Kikokiko Waterfall.
3 Then all along in here, sir, in the ridge line also
4 waterfall that come down and service this area, not
5 only this area.
6 MR. MURAKAMI: Did you want to see Kupau?
7 THE WITNESS: This is the Kupau one.
8 Q. (By Mr. Haia): So that water that would, but
9 for being diverted, flow down the valley, would
10 eventually end up in this middle blue line that
11 designates, I think, Kualani or Kulani Stream, which
12 is also referred to as Hamau?
13 A. Yes, sir.
14 Q. Okay. And at the point of dam number one,
15 does all that water continue to go?
16 A. You talking here?
17 Q. Past down number one. Would all that water
18 if it were not diverted continue to go by dam number
19 one?
20 A. Yes, sir.
21 Q. It would?
22 A. If all wasn't diverted here?
23 Q. No. If it wasn't diverted by the ditch
24 system above, and it came down Kulani Stream, would it
25 continue into Waiokamilo Stream?

A. It would not be here, but would be down here. Not like this picture.

Q. So you're saying that you're having a problem with the dimensions and the way this was drawn?

A. Yeah.

Q. Okay. But what I'm really asking you is if the water that is diverted from all of these waterfalls that you mentioned in the ili of Kupau were to be allowed to flow in its natural course, would all of it end up in Waiokamilo Stream?

A. If in its natural course, eventually it will go right back down to Waiokamilo.

Q. But what I'm asking you is, is there any other place that this water would end up, like -- okay. If you look at Exhibit A-23, this last photo, in the ili of Kupau the ridge line, right?

A. This is the ridge line.

Q. Okay. And the waterfalls that you claim are being diverted presently, all the water goes into the ditch system, right?

A. Uh-huh.

Q. If that water was not being collected by the ditch system, is your testimony that all of that water would eventually end up in Waiokamilo Stream, or would that water be able to be used at some point so that it

1 didn't end up in Waiokamilo Stream, ended up in some
2 other alternative source that would feed the valley?
3 A. There's one waterfall that comes down over
4 here that's no longer. All this water that service
5 will come down to Lakini.
6 Q. Okay. When you look at this schematic, for
7 Exhibit A-25, the water that we're talking about,
8 would it come down to Dam 1 and then into the Lakini
9 taro patches?
10 A. That direction.
11 Q. So it doesn't necessarily go into Waiokamilo
12 Stream?
13 A. No, not at that point.
14 Q. You're familiar with Akeke Springs?
15 A. Yes, sir.
16 Q. Where is Akeke Springs looking at Exhibit
17 A-25? Is Akeke Springs on there?
18 A. No, sir, I don't see it.
19 Q. Okay. So Akeke Springs is above the Dam 3
20 that is depicted in Exhibit A-25?
21 A. Yes, sir.
22 Q. And do you know whether or not it's below
23 Kikokiko?
24 A. It is below Kikokiko, sir.
25 Q. So if all the water for Waiokamilo is being

1 diverted at Kikokiko, what provides the source of
2 water below Kikokiko?
3 A. Akeke Springs.
4 Q. And is Akeke Springs a reliable consistent
5 source of water for Wailuanui Valley?
6 A. No, sir.
7 Q. And why not?
8 A. Recently and in the past we have seen Akeke
9 Springs not being able to produce the amount of water
10 that needs to service Wailuanui alone. For us, our --
11 the way we identify it is it's not being charged, so
12 the spring is not being able to produce the volume of
13 water. And we've literally seen it trickles. And
14 that's another reason why farmers did shutdown their
15 farms.
16 Q. When you say that you've literally seen it
17 trickles, can you be more specific? Akeke Springs at
18 some point in time has been measured between 3 and 3.5
19 million gallons of water.
20 A. Yes, sir.
21 Q. So what do you mean by a trickle compared to
22 3.5?
23 A. When we -- a few years ago when East Maui
24 Irrigation and Mr. Hew assisted us in fixing, I think
25 it was Dam 3 up in this area, which is just above

1 Lakini, after it was completed, we sat there, and
2 it -- there wasn't very much water coming down from
3 Akeke which enters into Waiokamilo. There wasn't very
4 much water at all.
5 And at that time we realized that because
6 the surface -- when you look at this picture, this is
7 Kikokiko with water coming over. When there's no
8 rain, this does not flow. And all we got is Akeke
9 Springs. And it's not -- was not consistent to our
10 practice.
11 Q. So when you mentioned trickle, you mean that
12 there is not a consistent enough flow at Akeke Springs
13 for a taro farmer to be able to rely on a consistent
14 flow in order for him to operate his lo'i on a
15 consistent basis?
16 A. Yes, sir.
17 Q. Okay. So do you know, or is this Dam No. 3,
18 do you know whether or not Dam No. 3 was erected
19 because -- well, erected to compensate for the loss of
20 water as a result of the diversions in Kupau?
21 A. Constructed --
22 Q. Right. What I'm saying is, in your opinion,
23 if the diversions in Kupau were closed such that that
24 water would flow into the valley, would there be a
25 need for Dam No. 3?

1 A. No, sir.
2 Q. So is it accurate to say that Dam No. 3 is
3 only needed to compensate for the water loss from the
4 Kupau diversions?
5 A. Yes, sir.
6 Q. Now -- so even if those diversions of Kupau
7 were released and given the diversion at Kikokiko of
8 Waiokamilo, if you got the water back from Kupau and
9 the water from Akeke, would that be sufficient for the
10 entire valley?
11 A. When you say the water from Kupau, do you
12 mean only Waiokamilo or all of it?
13 Q. Well, I'm not referring to -- when I refer to
14 Kikokiko, I mean the waterfalls that you say are
15 diverted. I'm not referring to Wailuanui River or
16 Stream, Waikani Waterfall. I'm just referring to what
17 you have or personally know is being diverted in Kupau
18 itself?
19 A. So if you're saying there was no diversion in
20 Kikokiko and all the waterfalls in this Kupau?
21 Q. No. Given that there is a diversion on
22 Waiokamilo and you're only going to get water from
23 Akeke springs to feed into Waiokamilo, and if you were
24 provided with water from the diversions that are
25 presently made in Kupau, would that amount to enough

1 water?
2 A. No, sir.
3 Q. All the members that we went through in that
4 list that I read to you, members of Na Moku who have
5 property interests, are you personally familiar with
6 the property to which their interest is related?
7 A. Yes, sir.
8 Q. Do you know whether or not each one of those
9 members wants to farm the lo'i on those properties?
10 A. Yes, sir.
11 Q. And do you know the reason why they aren't
12 farming the lo'i on those property?
13 A. Some of them is not farming because of lack
14 of water. Some of them are not there, living there,
15 but is willing to let other farmers farm their land.
16 Q. So the actual owners of the property who do
17 not reside in Wailuanui have provided authority to
18 others to farm that land?
19 A. Yes, sir.
20 Q. And in other words, it's your understanding
21 that those owners who do not live in the valley want
22 to put their property into -- the lo'i on their
23 property into taro production?
24 A. Yes, sir.
25 MR. HAIA: Judge, no further questions.

HEARINGS OFFICER McCONNELL: Anything else?

MR. MERCHANT: No. Thank you, Mr. Wendt.

THE WITNESS: Thank you.

HEARINGS OFFICER McCONNELL: So we'll go off the record.

(Discussion held off the record.)

Let's go back on the record. Tomorrow we'll have another site visit this time of the Keanae-Wailuanui area. And we'll all meet at the parking lot at Haiku Community Center at 9:00 a.m.

I apologize to Ms. Gomes who has had to wait and still hasn't testified. We're going to need two more days, I think, at least reserved, and so I would ask you to all please bring your calendars so we can set that tomorrow. And we will not have a court reporter tomorrow.

Thank you very much.

(The proceedings recessed at 5:05 p.m.)

1 CERTIFICATE

2 STATE OF HAWAII)

3) SS.

4 COUNTY OF HONOLULU)

5

6 I, JEAN MARIE McMANUS, do hereby certify:

7 That on October 12, 2005, at 9:05 a.m., the

8 proceedings contained herein was taken down by me in

9 machine shorthand and was thereafter reduced to

10 typewriting under my supervision; that the foregoing

11 represents, to the best of my ability, a true and

12 correct copy of the proceedings had in the foregoing

13 matter.

14 I further certify that I am not of counsel for

15 any of the parties hereto, nor in any way interested

16 in the outcome of the cause named in this caption.

17 Dated this 28th day of October, 2005,

18 in Honolulu, Hawaii.

19

20

21 JEAN MARIE McMANUS, CSR #157

22

23

24

25

1 BOARD OF LAND AND NATURAL RESOURCES

2 STATE OF HAWAII

3 In the Matter of Contested)DLNR FILE: 01-05-MA
Case Regarding Water Licenses)
4 at Honomanu, Keanae, Nahiku and)
Huelo, Maui)
5 _____)

6 CONTESTED CASE HEARING

7

8 Held on November 14, 2005, commencing at 9:45 a.m., at

9 Haiku Community Center, Haiku, Hawaii.

10

11

12

13

14

15

16

17

18

19

20

21

22

BEFORE: JEAN MARIE McMANUS
23 Hawaii CSR #156, CA CSR #3119

24

25

HEARINGS OFFICER:	HONORABLE E. JOHN McCONNELL 33 N. Market Street, Ste. 200 Wailuku, Hawaii 96793
BLNR Attorney:	LINDA CHOW, ESQ. Deputy Attorney General 465 S. King Street, Rm. 300 Honolulu, Hawaii 96813
For EMI and A&B:	DAVID SCHULMEISTER, ESQ. ELIJAH YIP, ESQ. Cades Schutte Fleming & Wright 1000 Bishop Street, Ste. 1200 Honolulu, Hawaii 96813
For Maui Land & Pineapple:	DAVID B. MERCHANT, ESQ. Kiefer & Merchant 444 Hana Highway, Ste. 204 Kahului, Hawaii 96732
For County of Maui:	JANE E. LOVELL, ESQ. Deputy Corporation Counsel 200 S. High Street Wailuku, Hawaii 96793
For Maui Tomorrow:	ISAAC HALL, ESQ. 2087 Wells Street Wailuku, Hawaii 86793
For Na Moku Aupuni O Ko'olau Hui, et al:	ALAN T. MURAKAMI, ESQ. MOSES K.N. HAIA, ESQ. 1164 Bishop Street, Ste. 1205 Honolulu, Hawaii 96813
Hawaii Farm Bureau:	SAT KHALSA FREEDMAN, ESQ. 1600 Pauahi Tower 1001 Bishop Street Honolulu, Hawaii 96813

INDEX

WITNESSES:

TERESA M. "TERI" GOMES
DIRECT EXAMINATION BY MR. HAIA..... 7
CROSS-EXAMINATION BY MS. LOVELL..... 46
CROSS-EXAMINATION BY MR. SCHULMEISTER..... 47

GARRET HEW
DIRECT EXAMINATION BY MR. SCHULMEISTER..... 74
CROSS-EXAMINATION BY MS. LOVELL..... 122
CROSS-EXAMINATION BY MR. HAIA..... 126

WARREN WATANABE
CROSS-EXAMINATION BY MR. HAIA..... 138
CROSS-EXAMINATION BY MR. HALL..... 144

GARRET HEW
CROSS-EXAMINATION CONTINUED BY MR. HAIA..... 148

EXHIBITS RECEIVED INTO EVIDENCE

Na Moku's Exhibit No. B-14A..... 18
Written testimony of Warren Watanabe..... 138

1 HEARINGS OFFICER JUDGE McCONNELL: The
2 hearing will come to order. This is in the matter of
3 the Contested Case regarding Water Licenses, DLNR File
4 No. 01-05-MA. Since we've been recessed for awhile,
5 maybe we should have appearances.
6 I'm John McConnell the hearing officer.
7 MR. HALL: Isaac Hall for Intervenor Maui
8 Tomorrow.
9 MS. LOVELL: Jane Lovell, Deputy
10 Corporation Counsel for County of Maui and our
11 Department of Water Supply.
12 MR. HAIA: Good morning, Judge, good
13 morning everyone. Moses Haia and Alan Murakami on
14 behalf of Petitioners Na Moku Aupuni O Ko'olau Hui,
15 Beatrice Kekahuna and Marjorie Wallett.
16 MR. SCHULMEISTER: David Schulmeister and
17 Elijah Yip for Alexander & Baldwin and East Maui
18 Irrigation Company and also Garret Hew for EMI, Inc.
19 MR. FREEDMAN: Sat Freedman appearing for
20 Intervenor Hawaii Farm Bureau Federation and Mr.
21 Thomas who is on the mainland.
22 MR. MERCHANT: David Merchant for Maui
23 Land & Pineapple.
24 HEARINGS OFFICER JUDGE McCONNELL: And for
25 the record we have Linda Chow who is the Deputy

1 Attorney General assigned to the board.
2 If I recall correctly, we were to proceed
3 this morning with A&B and EMI's case.
4 MR. HAIA: We have one more.
5 HEARINGS OFFICER JUDGE McCONNELL: That's
6 right. I knew that we hadn't gotten to her, but if
7 you're ready to proceed, that would be your final
8 witness then?
9 MR. HALL: Judge, can I take care of one
10 quick matter with regard to the evidence before you
11 start?
12 HEARINGS OFFICER JUDGE McCONNELL: Sure.
13 MR. HALL: I've distributed and placed
14 before you our second amended exhibit list as well as
15 a set of exhibits which has the pictures and exhibits
16 that we described during our case.
17 There's nothing new in any of these. They
18 were already discussed during the examination and I
19 promised the hearing officer and the parties that I
20 would bring these exhibits with me when the hearing
21 reconvened and that's what I've done. I just wanted
22 to place that on the record.
23 HEARINGS OFFICER JUDGE McCONNELL: Okay.
24 And I assume they will be in evidence then.
25 MR. HALL: I think they were already in

1 evidence subject to my bringing them and I brought
2 them. And I'm not going to be able to attend the
3 whole of this hearing, so I will excuse myself.
4 HEARINGS OFFICER JUDGE McCONNELL: Thank
5 you very much. Sorry we got a late start.
6 MR. SCHULMEISTER: In terms of
7 housekeeping, I have tried to sort of estimate with
8 Terry Gomes testifying today, and then we will call
9 Garret Hew and Mark Vaught, that probably will take
10 most of the day. With that anticipation I told Mr.
11 Holaday and Mr. Jakeway, my final two witnesses, to be
12 available tomorrow morning at 9:00. If anyone has a
13 problem with that estimate --
14 MR. HAIA: Well, what we, Sat and I talked
15 about, is he -- Warren Watanabe is only available
16 today. So if we can work him in today in the
17 afternoon.
18 MR. FREEDMAN: I need about 90 minute lead
19 time. He's up in Kula and we'd prefer to have him in
20 the afternoon if possible, because he has a meeting in
21 town at 5:30 and that way he doesn't have to make two
22 trips.
23 HEARINGS OFFICER JUDGE McCONNELL: Okay.
24 Remind me at lunchtime then. All right.
25 Raise your right hand, please.

1 TERESA M. "TERI" GOMES
2 was called as a witness by and on behalf of Na Moku,
3 et al, was sworn to tell the truth, was examined and
4 testified as follows.
5 HEARINGS OFFICER JUDGE McCONNELL: State
6 your name, please.
7 THE WITNESS: My name is Teresa,
8 T-e-r-e-s-a, middle initial M. I'm often called Teri,
9 T-e-r-i. My sir name is Gomes, G-o-m-e-s
10 DIRECT EXAMINATION
11 BY MR. HAIA:
12 Q. Ms. Gomes, what is your current occupation?
13 A. I'm a parallel with the Native Hawaiian Legal
14 Corporation.
15 Q. As a paralegal with the Native Hawaiian Legal
16 Corporation, what are your primary duties?
17 A. My primary duties to research and review
18 historical documents relating to land and land use.
19 Q. And what purposes are served generally by the
20 research and review that you do?
21 A. Primarily to identify the ownership of real
22 property, the conditions of title, and the
23 marketability of it.
24 Q. Are you also called upon to review these
25 historical documents to determine the traditional

1 historical use of a specific parcel or parcel in
2 Hawaii?
3 A. Yes.
4 Q. And how long have you done this type of
5 research?
6 A. Over 26 years now.
7 Q. And is that reflected in your resume that's
8 attached or that is identified as Exhibit B-11?
9 A. Only as it relates to real estate land
10 titles.
11 Q. Now, I'm going to hand to you what's been
12 filed with the Office of Conservation and Coastal
13 Lands of the Department of Land and Natural Resources
14 on August 1, 2005. That's entitled Petitioners'
15 Direct Testimony of Teresa M. "Teri" Gomes with
16 Exhibits B-11 and B-12.
17 Can you look at that?
18 A. It's a full and complete copy.
19 Q. In addition to being a full and complete
20 copy, does it also provide an accurate description of
21 your answers to various questions asked of you in this
22 written direct testimony?
23 A. Yes.
24 MR. HAIA: Judge, I'm unclear on whether
25 or not direct written testimony has already been

1 received. But if not, then I would ask that it be
2 received.
3 HEARINGS OFFICER JUDGE McCONNELL: So the
4 record is clear, any objection?
5 MR. SCHULMEISTER: No objection.
6 HEARINGS OFFICER JUDGE McCONNELL: It will
7 be in evidence.
8 MR. HAIA: Thank you.
9 Q. Ms. Gomes, in your capacity as parallel for
10 the Native Hawaiian Legal Corporation, were you tasked
11 with the job of researching LCA, that is Land
12 Commission Award, records for certain parcels of land
13 in East Maui to confirm whether taro cultivation
14 occurred on these parcels at the time of the Mahele?
15 A. Yes.
16 Q. And in doing this research, what type of
17 information or documentation would you look at?
18 A. If need be, the original land claims. The
19 original native register, which is the land claim; the
20 original native testimony; the original foreign
21 testimony; the original Land Commission proceeding
22 record.
23 Q. Just to be clear, when you speak about the
24 original Land Commission records, what specifically
25 are you referring to?

A. Documents written in 1848, 1849, 1850.

Q. What is a Land Commission Award?

A. A Land Commission Award is a legal binding document which vests title in a claimant, a title that has been adjudicated by the Commissioners of the Board to quiet land titles in the Hawaiian islands.

Q. So would it be safe to say that that is an official document establishing private ownership in a parcel identified by that Land Commission Award?

A. Title has been adjudicated, yes.

Q. And you refer to native registers. Can you explain what native registers are?

A. Native registers was what the Commission called a compilation of all the land claims filed. Does not necessarily designate the person as being Native Hawaiian. It just meant that these were all the claims that were received by the Commission on these lands.

Q. So native registers is information or documentation that occurs prior to the actual awarding of a parcel of land via the Mahele?

A. Yes.

Q. What about foreign registers, are there any such thing?

A. No such thing.

1 Q. Are there native testimonies related to Land
2 Commission Awards?
3 A. Native, yes.
4 Q. And what would those be?
5 A. The statutes require that the Commissioners
6 hear from what was called native testimony, what we
7 now call kama'aina testimony, preferably from people
8 who live on either side or all sides of the parcel
9 being claimed. Those were called native kama'aina
10 testimony because they lived next door, they lived
11 upon the land.
12 Foreign testimony was usually what was
13 taken from the konohiki, the land agent, who may not
14 have lived right next to the parcel being claimed.
15 Q. And so who were these testimonies provided
16 to?
17 A. The Board of Land Commissioners.
18 Q. And what would the Board of Land
19 Commissioners use this information for?
20 A. To adjudicate land titles.
21 Q. What about foreign testimonies, any such
22 thing?
23 A. Foreign testimonies, yes.
24 Q. And what are those?
25 A. Those usually were acquired from the

1 konohikis, or if need be, the agent of the king, or if
2 need be the agent of the governor. Someone who could
3 confirm and possibly resolve cross-claims or
4 objections to the claimant coming before the
5 Commission and saying this is my land. Someone will
6 object, the next door neighbor will, say, object, say
7 no, no, that's not his land. So they will call in the
8 konohiki or the agent for the governor and have them
9 confirm, did you give this parcel to this person or is
10 what he's saying true.
11 When they took the testimony from someone
12 outside the kama'aina area, then it will be called
13 foreign.
14 Q. And, in essence, was all of this evidence
15 used to establish title to a property during the time
16 of the Mahele?
17 A. That was required by statute, yes.
18 Q. I already asked you whether or not you
19 conducted detailed research on a number of parcels
20 contained within the ahupua'a of Wailuanui to confirm
21 whether and to what extent taro cultivation occurred
22 on these designated parcels, and you answered yes.
23 A. Yes.
24 Q. Can you describe the steps you took to arrive
25 at the information which you provide in what has been

1 identified as Exhibit B-12, which is a spreadsheet of
2 the information you documented?
3 A. I was first provided with tax map keys
4 identified in the spreadsheet. I confirmed the
5 assignment of each TMK at the State Survey Division,
6 Department of Land and Natural Resources, utilizing
7 the old and new tax maps made available to the general
8 public.
9 I then examined each tax map to identify
10 the original land title source document for each
11 assessed parcel. True and correct copies of these tax
12 maps will be submitted as exhibits at the appropriate
13 time.
14 I then researched each -- I then
15 researched each land title at the Hawaii State
16 Archives using the records of the Land Commissioners
17 to quiet land titles as my primary reference source.
18 I examined each kuleana land claim as
19 documented in the native register, foreign testimony,
20 native testimony, and LCA records.
21 I then searched the City and County of
22 Honolulu's Tax Assessment Office records to determine
23 assessed owners for each TMK.
24 The spreadsheet is a culmination of my
25 research work and reflects the matters I found of

1 record.
2 Q. I would ask you now to turn to Exhibit B-12.
3 And I just want to do one example of the information
4 provided in Parcel Number 1. The very first one is
5 identified as Maui Tax Map Key 1-1-04-09, and it is an
6 area of .62 acres. And then you note that there's a
7 Royal Patent number 3279.
8 What's a royal patent?
9 A. Royal patent was issued -- confirmation of
10 commutation being paid.
11 Q. So commutation meaning taxes upon the land?
12 A. No. Real property taxes didn't come into
13 existence in Hawaii until 1859.
14 Q. What did commutation serve the purpose of?
15 A. Commutation was established basically to pay
16 for the proceedings before the Land Commission. The
17 surveying, calling in witnesses, paying the
18 Commissioners.
19 HEARINGS OFFICER JUDGE McCONNELL: So when
20 you got the patent, you still had to pay?
21 THE WITNESS: No. The statute was set up
22 so that the Land Commissioners would adjudicate land
23 title. Title was vested by the Land Commission Awards
24 but commutation was still due and owing to the
25 government who footed the bill for all these

1 proceedings -- paying of the Commissioners -- and it
2 was given a value. For example, one-third or
3 one-fourth of the unimproved value of the land. That
4 became what commutation would be, and what the
5 claimant was awarded the land would have to pay to
6 commute the government's interested in the land. It
7 was less than allodial.
8 Upon payment of the commutation, the
9 Minister of Finance would then receive the money and
10 the money would be deposited into the Royal Treasury.
11 The Minister of Interior, along with the king and the
12 queen, would sign on behalf of the government and the
13 crown to release the government's commutation.
14 In other words, all sums of money due and
15 owing to the government for the proceedings to
16 adjudicate the land title was paid.
17 HEARINGS OFFICER JUDGE McCONNELL: So if
18 you didn't pay your commutation, what happened?
19 THE WITNESS: It is still due and owing to
20 the State of Hawaii under Chapter 172.
21 Q. MR. HAIA: So, Ms. Gomes, just to be clear,
22 if a Royal patent was issued, if I understand you
23 correctly, the commutation owed upon the Land
24 Commission Award had been paid and so the Royal patent
25 in essence became the final determination of allodial

1 title in a person?
2 A. Put that way, I would have to answer yes.
3 Q. Thank you.
4 So for Parcel Number 1, there is a Royal
5 Patent number 3279. Land Commission Award is 4779, so
6 the Land Commission Award was made, and then
7 subsequent to payment of commutation, the Royal patent
8 was issued?
9 A. Uh-huh.
10 Q. Okay. And the next column that you have is
11 entitled 'Ili?
12 A. Yes.
13 Q. Or Location. And for this TMK you have two
14 place names, correct?
15 A. Yes.
16 Q. Keononalu and Paakamaka, is that correct?
17 A. Yes.
18 Q. Then the next section is Lo'i Claimed.
19 Can you provide us with description of
20 what you mean by lo'i claimed? Is that from a native
21 testimony? Native register? Where do you get the
22 amount of lo'i claimed with respect to a certain
23 parcel of land?
24 A. When I reviewed the native register, the
25 foreign testimony, native testimony, I look to see

1 what was claimed. And if during the testimony it was
2 in any way noted as to confirm it, what was claimed in
3 the register, I tried to look to see if it was
4 confirmed by way of testimony.
5 Q. Okay. So, for instance, for Parcel Number 1,
6 are you saying that eight lo'i were claimed in
7 Keononalu, but none were noted in the testimony?
8 A. Yes.
9 Q. And then the place that you're getting these
10 numbers from are either from the native register,
11 foreign testimony or the native testimony?
12 A. Yes.
13 Q. And for this parcel, which says eight lo'i at
14 Keononalu and ten lo'i at Paakamaka, do you know where
15 you got that information from, which document or
16 series of documents?
17 A. In this case it's definitely from the native
18 register.
19 Q. Okay. And when we provide --
20 Judge, when we provided exhibits, I
21 believe it was on August 15th, we reserved certain
22 numbers for later exhibits, and most of the native
23 registers that are identified in this spreadsheet were
24 not provided on August 15th. And we have provided
25 them to the parties today.

1 And so with respect to Parcel Number 1, we
2 would ask that B-14A from the supplemental exhibits be
3 received into evidence. That's the native register
4 for this first parcel.
5 MR. SCHULMEISTER: No objection.
6 HEARINGS OFFICER JUDGE McCONNELL: B-14A
7 will be in evidence.
8 (Na Moku's Exhibit No. B-14A was received
9 into evidence.)
10 I didn't understand your testimony,
11 though. If you look at the spreadsheet, it says, "Not
12 noted" under "Lo'i". Could you explain? I thought I
13 heard --
14 THE WITNESS: No, you're correct, because
15 what I tried to do is the lo'i claimed column was from
16 the native register. If the claimant said I have
17 eight lo'i in this 'ili, ten in that one, I put it
18 under that column.
19 I then look to see if it was confirmed
20 during the testimony stage, whether from the native
21 testimony or the foreign testimony. If no one in
22 those proceedings made note that there were eight and
23 ten, I put down "not noted".
24 HEARINGS OFFICER JUDGE McCONNELL: So it
25 would be the claimant's testimony then?

1 THE WITNESS: Yeah.
2 Q. MR. HAIA: And, for example, I would refer
3 you to B-14A, and it is the native register for Parcel
4 Number 4779 to Naiapea, does that coincide with TMK
5 1-1-4-9; is that the same property?
6 A. Yes.
7 Q. And if you look at the native register --
8 well, can you show us where you got the information
9 from with respect to the number of lo'i?
10 A. Last sentence, first paragraph where it says:
11 "However, I have begun to make eight lo'i, and another
12 Kula."
13 Then it goes on the last paragraph, first
14 sentence: "In the 'ili of Paakamaka I have some land
15 with 10 lo'i".
16 Q. We're going to have to get into these
17 designations of 'ili, mo'o. What is your
18 understanding of an 'ili?
19 A. An 'ili is smaller than an ahupua'a, but then
20 so is a mo'o. A mo'o can be within an 'ili.
21 Q. So the largest land unit is moku, which is an
22 island?
23 A. Yes.
24 Q. And then you come down to ahupua'a which is a
25 section of an island. And then what is the next

1 smaller gradation?
2 A. 'ili.
3 Q. And generally what is the acreage in an 'ili?
4 A. I can't begin to answer that.
5 HEARINGS OFFICER JUDGE McCONNELL: Do they
6 also use the term "district" for 'ili?
7 THE WITNESS: These days I wouldn't be
8 surprised that they do. But whether or not something
9 was an 'ili was actually determined by use, cultural
10 and ancient traditional use.
11 Q. MR. HAIA: What is the connection between the
12 use and the description as an 'ili?
13 A. The only way I can describe it is to give an
14 example that's not, these days, not used very often.
15 It's the fact that we've dropped these
16 days what is called 'ili ku or 'ili kupono, those were
17 detached pieces of land, which were 'ilis.
18 Their title ran with the ahupua'a because
19 they were attached by title to the ahupua'a. The fact
20 physically they were detached made them 'ili ku.
21 Their usage was inseparable. There was no way you
22 could culturally, by custom and tradition, detach this
23 piece from the ahupua'a. The reason why, the
24 sustainability within the ahupua'a did not accommodate
25 this 'ili ku. The 'ili ku would then, for example, be

1 the place where they would cultivate kalo because the
2 rest of the ahupua'a could not.
3 So to make sure that, I guess, the diet of
4 the hoa'aina maka'aina would be well-rounded. This
5 'ili ku would be attached to this ahupua'a. It was
6 irrelevant how big that 'ili ku was by area, by
7 acreage. What mattered is the cultural use to sustain
8 those within the ahupua'a.
9 Q. So certain 'ili were limited to a specific
10 land use?
11 A. Yes.
12 Q. And when we speak of mo'o, can a mo'o also be
13 an 'ili or is that within an 'ili?
14 A. Usually a mo'o was encompassed within an
15 'ili.
16 Q. And can you describe the use of a mo'o or the
17 cultural significance of the word "mo'o" for that
18 piece of property?
19 A. Mo'o, when you say that word, to especially
20 kupunanui, very elderly people, you're getting more
21 into the realm of that which is spiritual as well as
22 cultural. Mo'o, whenever you say it, it signifies a
23 water lily or what some call a water lizard. In
24 Hawaiian it's usually symbolized by a woman.
25 And mo'o usually is a lizard, but the

1 symbolism is usually a female water lily, water fairy,
2 water lizard. So you're saying mo'o, you mean in
3 terms of land, it's an area smaller than an 'ili.
4 If you're talking about the use of that
5 word as it applies to land, I can only say I found
6 that this designated word to be used more often on
7 Maui land titles than I have on Oahu land titles. But
8 then certain Hawaiian words in conveyancing of the
9 original Commission records are more common to one
10 island sometimes than they are to another.
11 Mo'o is used more often -- I've come
12 across it more often in Maui land title than I have on
13 Oahu. On Oahu I've come across land title terminology
14 like lele more often than I do on Maui.
15 HEARINGS OFFICER JUDGE McCONNELL: Is an
16 'ili ever outside the ahupua'a?
17 THE WITNESS: Yes.
18 HEARINGS OFFICER JUDGE McCONNELL:
19 Sometimes?
20 THE WITNESS: Yes. On Oahu that would be
21 called a lele, but in ancient traditional times that
22 was called 'ili ku or 'ili kupono. If it was attached
23 to ahupua'a and title ran with the ahupua'a it was
24 actually a 'ili ku or 'ili kupono.
25 HEARINGS OFFICER JUDGE McCONNELL: But not

1 geographically?
2 THE WITNESS: Geographically it could be
3 two separate areas. An example I could give is like
4 Kewalo on Oahu. Everyone is familiar with the basin
5 area. Well, there were 'ili leles, in other words an
6 'ili that jumped away from ahupua'a, that's in the
7 Nu'uanu, the upper part of Nu'uanu where the Royal
8 Mausoleum is.
9 Those were called in the Commission
10 records by the claimant 'ili lele, meaning that it
11 jumped. But under traditional customary Hawaiian
12 usage that was actually an 'ili ku or 'ili kupono.
13 Title ran with the ahupua'a.
14 Q. MR. HAIA: Still sticking with Parcel number
15 1, the last column, "Comments/Notations Additional
16 Remarks", the very top it says: "NR6/542."
17 What does that stand for?
18 A. NR is native register, volume six, page 542.
19 Q. So at the native register, volume six, page
20 542 is where the information that you would get for
21 this specific parcel in the native register; is that
22 correct?
23 A. Yes, on file at the Hawaii State Archives.
24 Q. I'm going to take you down to Parcel Number
25 2, which is Maui Tax Map Key No. 1-1-04-10. You have

1 it designated as a .544 acre parcel. There's a Royal
2 Patent number, Land Commission Award, the 'ili or
3 location Waieli, and then the lo'i claimed is not
4 noted. And then lo'i or mo'o testified to you have
5 the word "mo'o" there.
6 So can you elaborate on why you indicate
7 there was a mo'o testified to, or is that what you're
8 actually indicating?
9 A. What was testified to was a mo'o. I put that
10 down because -- well, the presumption could be made
11 that there was other crops grown there. We cannot
12 rule out the fact that it was used for kalo. How many
13 lo'i could fit in a mo'o? Again, it depends on the
14 size of the mo'o.
15 Q. With respect to 1-1-4-10, the area is .544
16 acres, so a little more than half an acre, correct?
17 A. Yes.
18 Q. And same thing, the information you provide
19 in Comments/Notations Additional Remarks refers to the
20 place and the native register, the foreign testimony
21 and the native testimony where you can find specific
22 information on this parcel, correct?
23 A. Yes.
24 Q. And we're going to go through a couple more,
25 but with respect to all of the parcels noted on this

1 spreadsheet, do you know whether they're all within
2 the ahupua'a of Wailuanui?
3 A. Asked that way, I have to say no.
4 Q. Which ones would you point to which are not
5 within the ahupua'a of Wailua?
6 A. On Page 6, Parcel Number 48.
7 Q. Okay.
8 HEARINGS OFFICER JUDGE McCONNELL: I'm
9 sorry, give me that again.
10 MR. HAIA: Page 6, Parcel Number 48.
11 THE WITNESS: Wait, I may be mistaken. I
12 am mistaken, it's in Wailua, definitely.
13 HEARINGS OFFICER JUDGE McCONNELL: So any
14 others not in Wailuanui?
15 THE WITNESS: On this list, no, there
16 shouldn't be any.
17 Q. MR. HAIA: Now, before we go on with respect
18 to these specific parcels, I'm going to ask you if you
19 have any corrections, clarifications or additions you
20 would like to make to either your written testimony or
21 this spreadsheet?
22 A. Yes.
23 Q. And what would that be?
24 A. I prepared this Exhibit B-12 based upon
25 information that was provided to me by the Board of Na

1 Moku. I was then instructed to prepare, pursuant to
2 Judge McConnell's October 3rd, 2005 order, the list of
3 Na Moku members with property interest within the
4 ahupua'a of Wailuanui for which the Native Hawaiian
5 Legal Corporation was authorized to speak. That list
6 was provided to the parties and the state via
7 transmittal letter dated October 5th, 2005 and
8 subsequently filed and served on November 3rd, 2005.
9 When I compared the tax map key numbers in
10 Exhibit B-12 with the TMKs identified in the Na Moku
11 members landowner list, I found that there are certain
12 tax map keys that were not listed on my Exhibit B-12.
13 Q. And what were those numbers?
14 A. Tax Map Key 1-1-04-10.
15 HEARINGS OFFICER JUDGE McCONNELL: Give it
16 to me again.
17 THE WITNESS: 1-1-04-10, 1-1-4-11,
18 1-1-4-20, 1-1-4-22, 1-1-4-23, 1-1-4-28.
19 Then on Plat 5, that's 1-1-5, Parcel 30,
20 Parcel 31, Parcel 33, Parcel 46, and Parcel 52.
21 Then on Plat 1-1-6, Parcel 32, Parcel 34,
22 Parcel 36, Parcel 37, Parcel 45, Parcel 47, Parcel 72.
23 Q. MR. HAIA: So when you compared -- just for
24 clarification purposes -- when you compared Exhibit
25 B-12, which is this spreadsheet with TMKs that we were

1 just going through, with the spreadsheet of landowners
2 who are in Wailuanui who are members of Na Moku, you
3 found that the TMKs you just read do not appear within
4 B-12 or the landowner list?
5 HEARINGS OFFICER JUDGE McCONNELL: Yeah, I
6 don't think that was clear.
7 MR. HAIA: B-12 or the landowner list?
8 A. I was given the landowner list after I
9 completed B-12.
10 HEARINGS OFFICER JUDGE McCONNELL: Just
11 let me make sure I'm clear. B-12 is labeled Na Moku
12 Spreadsheet, correct?
13 THE WITNESS: Yeah.
14 HEARINGS OFFICER JUDGE McCONNELL: And so
15 that is not what you're referring to as the landowner
16 list, is that right?
17 THE WITNESS: For me the landowner list --
18 I really don't know how to answer that because I was
19 just given special limited powers of attorney, and
20 then those were made into a list.
21 MR. HAIA: You know, just let me try and
22 do something here.
23 Q. Here's the landowner list. This is the
24 landowner list, it was prepared prior -- subsequent to
25 the spreadsheet that we were just covering.

1 A. Yes.
2 Q. So are you saying that the TMK numbers that
3 you just read off, while on the landowner list, you
4 could not find on the spreadsheet? Or the opposite?
5 Are you saying that the TMKs you just read off were on
6 the spreadsheet but not on the landowner list?
7 A. Yes and no. Some of them were, some of them
8 weren't.
9 Q. Okay. Well, when I refer you to the TMKs, it
10 says: When the TMKs identified in Exhibit B-12 -- and
11 this is what you testified to -- are compared with
12 TMKs identified in the Na Moku member landowner list,
13 the following TMKs from Exhibit B-12 are not contained
14 within the landowner list.
15 So my understanding of what you're saying
16 is, in this Exhibit B-12, there are TMKs that are not
17 identified in this landowner list; and those TMK
18 numbers are the ones you read off.
19 MR. SCHULMEISTER: I object. That's
20 exactly the opposite of what I heard.
21 THE WITNESS: Yeah.
22 HEARINGS OFFICER McCONNELL: That's what I
23 thought, but I'm not sure.
24 MR. SCHULMEISTER: Can we go off the
25 record just for a second?

1 HEARINGS OFFICER JUDGE McCONNELL: Yeah,
2 okay. Let's go off the record.
3 (Discussion held off the record.)
4 HEARINGS OFFICER JUDGE McCONNELL: Let's
5 go back on the record.
6 Q. MR. HAIA: When you compare A-49, which is
7 the landowners' list, with B-12, what I want you to do
8 is, the landowner list has Parcel Number 1-1-4-10,
9 which is A-49, the landowner list, has Parcel Number
10 1-1-4-10 on it. Can you look at B-12 and tell me --
11 Judge, can I have a minute?
12 HEARINGS OFFICER JUDGE McCONNELL: Yeah.
13 Off the record.
14 (Discussion held off the record.)
15 HEARINGS OFFICER JUDGE McCONNELL: Back on
16 the record.
17 Q. MR. HAIA: So, once again, there are TMKs
18 identified in Exhibit B-12 which is the Na Moku
19 spreadsheet that are not also contained within Exhibit
20 A-49 which is the landowner list?
21 A. Yes.
22 Q. And those are the numbers that you read off?
23 A. Yes.
24 HEARINGS OFFICER JUDGE McCONNELL: And
25 those numbers are on B-12 but not on A-49, is that

1 correct?
2 THE WITNESS: B-12 is not on the
3 landowners' list because B-12 was made prior to the
4 owners' list.
5 HEARINGS OFFICER JUDGE McCONNELL: Well,
6 but whether --
7 MR. HAIA: You're saying the same thing.
8 HEARINGS OFFICER JUDGE McCONNELL: But I
9 just wanted it clear. You gave us a long list of tax
10 map keys. They show up on B-12, correct?
11 THE WITNESS: I'll say yes to that.
12 HEARINGS OFFICER JUDGE McCONNELL: And
13 they don't show up on A-49?
14 THE WITNESS: They're actually --
15 HEARINGS OFFICER JUDGE McCONNELL: I don't
16 care why or anything, just they're not on A-49. Is
17 that right?
18 MR. HAIA: So --
19 HEARINGS OFFICER JUDGE McCONNELL: She
20 didn't answer my question. You can explain later.
21 THE WITNESS: The following TMKs from
22 here --
23 HEARINGS OFFICER JUDGE McCONNELL: The
24 ones you read off.
25 THE WITNESS: Are not on the landowners'

1 list.
2 HEARINGS OFFICER JUDGE McCONNELL: Right.
3 And the landowners' list, as I understand it, is A-49.
4 Q. MR. HAIA: Hopefully for the last time, Ms.
5 Gomes. The TMKs that you just identified on the
6 record are contained in Exhibit B-12 but not also
7 contained in Exhibit A-49?
8 A. I'll say yes.
9 Q. Now, with respect to any of those TMKs that
10 you read out, do you have any further information that
11 you want to provide with respect to how those TMKs
12 should be handled in this matter?
13 A. TMK 1-1-4-11 should have been included in the
14 Na Moku member landowner list under Terry Akuna.
15 1-1-5-31 --
16 HEARINGS OFFICER JUDGE McCONNELL: You're
17 going too fast. We're taking notes on this.
18 THE WITNESS: TMK 1-1-5-31 was dropped
19 into tax map key 1-1-5-30.
20 Q. MR. HAIA: Let me stop you there. When you
21 say dropped into, what do you mean by that?
22 A. The tax map office took the parcel that was
23 being assessed as Parcel 31, for assessment purposes
24 dropped Parcel 31 into Parcel 30.
25 Q. So it was -- Parcel 31 was made a part of

1 Parcel 30, so now Parcel 30 is the entire acreage
2 provided for in previously separate Parcel 31 and
3 Parcel 30?
4 A. Yes.
5 Q. Okay.
6 A. Tax Map Key 1-1-5-31 was dropped into tax key
7 1-1-5-30. And 30 should have been included in
8 landowner list under Norman Martin.
9 HEARINGS OFFICER JUDGE McCONNELL: Okay,
10 hold on. So I got that one and I got 11, which should
11 have been included under Akuna?
12 THE WITNESS: Yes.
13 HEARINGS OFFICER JUDGE McCONNELL: That's
14 all so far, or did I miss one?
15 THE WITNESS: No, that's correct so far.
16 Tax Map Key 1-1-5 Parcel 33, and 1-1-6-72
17 should have been included in the landowner list under
18 Joseph Young.
19 And TMK 1-1-6-32 should have been included
20 in the landowner list under Samuel Akina.
21 HEARINGS OFFICER JUDGE McCONNELL: The
22 first one you mentioned was 72 and 33 of -- is that
23 correct -- of 5?
24 THE WITNESS: 1-1-5-33 and 1-1-6-72 under
25 Joseph Young.

1 MR. HAIA: Okay.
2 Q. So why are you saying that TMK 1-1-4-11
3 should be included in Exhibit A-49 under Terry Akuna?
4 A. The tax map's assessment shows that it's held
5 by Alexander Akuna, who is a relative and ancestor of
6 Terry Akuna, and EMI also owns an interest in Parcel
7 11.
8 Q. And I ask you the same question with respect
9 to 1-1-5-30 which you said should be included under
10 Joseph Young.
11 A. It's presently being assessed to Paul Young,
12 and Joseph Young is a relation to Paul Young and has
13 apparently his permission to be there.
14 HEARINGS OFFICER JUDGE McCONNELL: I
15 thought that was Martin.
16 MR. HAIA: I'm sorry, I was wrong. It
17 should be Norman Martin.
18 A. Norman Martin is assessed the Parcel
19 1-1-5-30.
20 Q. So Norman Martin is an assessed owner?
21 A. Yeah, along with Paul Young.
22 Q. So they each have an interest in this parcel?
23 A. Yes.
24 Q. And now with respect to 1-1-6-32.
25 A. That's presently being assessed to Samuel and

1 Libby Akina.
2 Q. And you're saying it should have been
3 included under Samuel Akina in Exhibit A-49?
4 A. Yes.
5 Q. Are there any others?
6 A. Not that I know of offhand.
7 Q. Now, with respect -- I guess now would be a
8 good time -- do you still have your Exhibit A-45?
9 It's that map.
10 MR. SCHULMEISTER: You mean the big one?
11 MR. HAIA: Yeah.
12 MR. SCHULMEISTER: That was left with the
13 Hearings Officer.
14 MS. CHOW: Unfortunately I left it back in
15 my office.
16 MR. SCHULMEISTER: You've got a smaller
17 one.
18 (Discussion held off the record.)
19 HEARINGS OFFICER JUDGE McCONNELL: We're
20 back on the record.
21 Q. MR. HAIA: Ms. Gomes, looking at Exhibit
22 A-45, did you review this map previously?
23 A. Yes.
24 Q. Okay. And you also reviewed Exhibit A-49,
25 which is a list of landowners of Wailuanui?

1 A. Yes.
2 Q. Is there any relationship that you can see
3 between Exhibit A-45, which is the map, and Exhibit
4 A-49, which is the landowner list?
5 A. Would you explain what you mean by
6 relationship?
7 Q. Well, is there anyway that you can look at
8 Exhibit A-45, the map, and determine whether a parcel
9 on Exhibit A-45 is also identified in Exhibit A-49,
10 the landowner list?
11 A. Yes.
12 Q. How do you do that? How can you do that?
13 A. By comparing the tax map key numbers listed
14 on Exhibit A-49 against the map itself, Exhibit A-45.
15 Q. Well, there are highlighted areas,
16 highlighted yellow Magic Marker on Exhibit A-45. Do
17 those have any significance in your mind?
18 A. No.
19 Q. Do they coincide, the highlighted areas, the
20 tax map keys that are highlighted, coincide with the
21 landowner list?
22 A. I believe so.
23 Q. So in other words, if -- for example, look at
24 James Akiona, Jr. on Exhibit A-49, TMK No. 1-1-4-9.
25 Is that highlighted on Exhibit A-45?

1 A. I would have to see Exhibit A-45.
2 Q. MR. HAIA: I'll ask you the question again.
3 Is TMK No. 1-1-4-9, which is identified in
4 Exhibit A-49, highlighted on the map which is Exhibit
5 A-45?
6 A. Yes.
7 Q. Now, with respect to the second landowner,
8 Lucy Acain, TMK numbers 1-1-8-4, can you find that
9 anywhere on this map?
10 A. No.
11 Q. And why is that?
12 A. Because this Plat 8 is not shown on this map.
13 Q. Do you know where Plat 8 is in relationship
14 to the map Exhibit A-45?
15 A. Plat 8, Plat 8, (indicating) so where it is,
16 I don't know.
17 HEARINGS OFFICER JUDGE McCONNELL: It's
18 generally mauka?
19 THE WITNESS: Yeah, up here.
20 Q. MR. HAIA: When you say up here, you're
21 pointing at the top middle portion of Exhibit A-45?
22 A. Yes, Hana Belt Road.
23 Q. In fact, there is a description just to the
24 right-hand side of the center top that says Plat 8, is
25 that the area that you're referring to?

1 A. Yes.
2 Q. So in fact, Lucy Acain and TMK 1-1-8-4 is not
3 identified on this map?
4 A. No.
5 Q. With respect to the TMKs that we just went
6 through that didn't match, and the ones that you said
7 should also be included in the landowner list, for
8 example, TMK 1-1-6-32. Can you find that on Exhibit
9 A-45?
10 A. (Indicating).
11 Q. For the record, you're pointing to the lower
12 center just above what is highlighted in blue and
13 identified as Wailua Stream to a parcel that borders
14 that stream?
15 A. Yes.
16 Q. Does the parcel go through Wailua Stream to
17 the other side?
18 A. No.
19 Q. So is it highlighted?
20 A. No.
21 Q. We're going to go onto -- maybe I should
22 clear this up.
23 This map is a compilation of three
24 different TMKs, isn't it?
25 A. It's a composite of three separate plats,

1 Plat 4 is basically up here. Plat 5 is in the middle
2 section and Plat 6 is on the bottom.
3 Q. Okay. So if we want to look for TMK
4 1-1-4-11, we're going to look at the top of this map,
5 right? And you've already indicated that you see TMK
6 1-1-4-11. Is it highlighted in yellow?
7 A. No, it's not.
8 Q. Let's go to 1-1-6-5. Can you find that?
9 This is reference to Terry Akuna, and that is
10 highlighted, right?
11 A. Right here.
12 Q. Would you locate TMK 1-1-5-30.
13 For the record you're pointing to the
14 middle left side of Exhibit A-45.
15 Can you tell whether or not that parcel is
16 highlighted in yellow?
17 A. No, it's not.
18 Q. What about 1-1-5-33, can you locate that?
19 A. (Indicating).
20 Q. And for the record, you're pointing to the
21 center of the map. And is that TMK highlighted?
22 A. No, it's not.
23 Q. I should go back to 1-1-5-30. Weren't you
24 saying that that now includes both 1-1-5-30 and
25 1-1-5-31?

1 A. Yes, 31 is shown as being dropped. The
2 designation used by the real property tax office to
3 show an assessment parcel number has been dropped is
4 usually indicated by a dash line on four sides of the
5 number.
6 Q. And is that indicated on this map in fact?
7 A. Yes, it is, around the number 31. And the
8 area formerly assessed to Parcel 31 was dropped and is
9 now being assessed only under Parcel 30.
10 Q. For the record, you're pointing at the middle
11 left-hand side of the map. And Parcel 1-1-5-30, as
12 you said, is not highlighted, correct?
13 A. Yes.
14 Q. Now, can you locate Parcel 1-1-6-72?
15 A. (Indicating).
16 Q. And for the record, you're pointing on the
17 middle left-hand side of Exhibit A-45 just above what
18 is identified as Wailua Stream and highlighted in
19 blue. Can you tell whether that parcel is highlighted
20 in yellow?
21 A. Yes.
22 Q. Is it?
23 A. No.
24 HEARINGS OFFICER JUDGE McCONNELL: So
25 basically you're saying they should have been?

1 MR. HAIA: Well, now they should be.
2 We're basically, through Ms. Gomes' testimony,
3 indicating that members of Na Moku have interest in
4 those parcels.
5 HEARINGS OFFICER JUDGE McCONNELL: And the
6 original intent of the yellow highlighting was to show
7 the same thing?
8 MR. HAIA: Right, except that in Exhibit
9 A-49 those TMKs were not included.
10 MR. SCHULMEISTER: Just to clarify.
11 Exhibit A-45 is an exhibit that EMI prepared.
12 And what we were trying to do is highlight the TMKs
13 that were provided to us by Na Moku in what is Exhibit
14 A-49.
15 I don't think they're saying that we
16 highlighted wrong, what they're saying is just trying
17 to supplement A-49.
18 HEARINGS OFFICER JUDGE McCONNELL: I
19 understand.
20 Q. MR. HAIA: So just to conclude, these are
21 corrections you believe are necessary to bring your
22 testimony into conformance with the evidence; is that
23 correct?
24 A. Yes.
25 Q. So go back to the original spreadsheet, which

1 is Exhibit B-12, and 1-1-4-13, the fourth column says
2 "G.L.S-3922". What does that stand for?
3 A. General Lease State of Hawaii No. 3922.
4 Q. And I notice that there's no information
5 provided in lo'i claimed or lo'i or mo'o testified to,
6 correct?
7 A. Correct.
8 Q. So if you know specifically why this is a
9 general lease, you can explain that, but more
10 generally my question is: Why would a piece of
11 property like this in Wailua be issued under a general
12 lease?
13 A. It's state land. And basically general
14 leases could be issued for any agriculture purposes in
15 an Agriculture District.
16 Q. Okay. And on Exhibit A-45, can you locate
17 TMK 1-1-4-13?
18 A. Can't see the number here. It's this yellow
19 parcel.
20 Q. For the record, you're pointing to the middle
21 left top of Exhibit A-45, and there appears to be a
22 blue wavy line running through the parcel; is that
23 correct?
24 A. It's designated as an 'auwai on the map.
25 Q. Is the blue wavy line what is designated as

1 an 'auwai?
2 A. Yes.
3 Q. Is that blue wavy line, does it run through
4 TMK 1-1-4-13?
5 A. Yes, it does.
6 Q. Is 1-1-4-13 highlighted?
7 A. Yes, it is.
8 Q. We'll go on to the next TMK 1-1- -- actually
9 we shouldn't move on yet.
10 So there's a general lease for this
11 property. And there's -- as far as you can tell in
12 your research, could you find any evidence that it
13 was -- that at the time of the Mahele, that parcel was
14 in taro cultivation?
15 A. I don't know how to answer that except to say
16 there is no evidence to contrary use.
17 Q. Does the fact that an 'auwai runs almost
18 through the center of that TMK suggest that?
19 A. Lo'i kalo?
20 Q. Yes.
21 A. Kalo cultivation, yes.
22 Q. So if an 'auwai was running through a
23 specific parcel, generally you would conclude, based
24 upon your experience, that there was taro cultivation
25 on that parcel?

1 A. Going back to ancient times, yes.
2 Q. Let's go onto TMK 1-1-4-18. Can you locate
3 that?
4 A. (Indicating).
5 Q. And you're pointing in the same general area
6 as you were with 1-1-4-13?
7 A. Yes.
8 Q. And does that 'auwai that ran through the
9 previous TMK, also run through that?
10 A. Yes, it does.
11 Q. And this says that it is Revocable Permit
12 6930. What does that mean?
13 A. The term of the permit is usually shorter
14 than the term permitted for general lease. It's
15 subject to revocation by the state.
16 Q. With respect to that specific parcel, ask you
17 like I did with the other parcel, does the fact that
18 an 'auwai runs through that parcel lead you to the
19 conclusion, with your experience, that there was more
20 likely than not taro cultivation on that parcel in
21 ancient times?
22 A. Yes.
23 MR. HAIA: Judge, I'm just trying to
24 figure out a way that we don't have to go through each
25 one of these TMKs, and unfortunately --

1 HEARINGS OFFICER JUDGE McCONNELL: Well,
2 unless there's something else in the records, we can
3 determine from the exhibit itself that an 'auwai runs
4 through or doesn't run through. I mean, all of that
5 can be argued, it seems to me.
6 Q. MR. HAIA: So in the revisions to the TMKs
7 that you provided for in B-12 that were not identified
8 in Exhibit A-49, do you need to make changes with
9 respect to the total acreage?
10 A. Yes.
11 Q. So can you explain what you need to do to do
12 that? How do you make the changes you need to make to
13 the total acreage of parcel of property that in your
14 testimony you were claiming were traditionally in taro
15 cultivation?
16 A. Add in, for example, all the areas, like
17 Parcel 72 that wasn't highlighted, Parcel 33, like
18 Parcel 30.
19 Q. Try and give the entire TMK number.
20 A. This would be 1-1-5-30.
21 Q. So you would include the total acreage for
22 that in the revised --
23 A. Spreadsheet.
24 Q. Okay. And how many acres are included in TMK
25 1-1-4-30 -- I'm sorry. That should be 1-1-5-30?

1 A. Yeah.
2 Q. So additionally, how much do we need to add
3 to the total?
4 A. Overall?
5 Q. Yes.
6 MR. SCHULMEISTER: Which total are you
7 talking about?
8 MR. HAIA: Well, yeah, you're right.
9 There are two totals. There is a total from B-12 and
10 there's a total from the landowner list, which is
11 A-49.
12 Let's go to the total from the landowner
13 list, because it corresponds with Exhibit A-45.
14 HEARINGS OFFICER JUDGE McCONNELL: And
15 that's also A-49?
16 MR. HAIA: That's correct.
17 MR. SCHULMEISTER: A-49 doesn't actually
18 have acreages on it.
19 MR. HAIA: No, we need to add them.
20 Q. But in any event, with respect to the TMKs
21 that you identified that are not on the landowner list
22 that should be on the landowner list, that's the
23 amount that needs to be included in the total amount
24 of acreage that Na Moku would be staking a claim to
25 for water, correct?

A. Yes.

Q. So if we found out the specific acreage tied to each TMK in Exhibit A-49 and also added the TMKs that we just identified through your testimony today, we would come up with a total amount of --

A. 61.14 acres only in Wailuanui, 61.14 acres.

Q. So you're revising your original testimony, which was approximately 56 acres up to 61 point --

A. 14.

Q. -- 14 acres?

A. 61.14.

Q. And that would -- that increase would account for the TMKs that you just identified today and located on Exhibit A-45?

A. Yes.

Q. Do you have anything else to add at this time?

A. No.

MR. HAIA: Judge, I'm done.

HEARINGS OFFICER JUDGE McCONNELL: Thank you. Would you like to go next?

MS. LOVELL: Sure, because I have what I think is only one question.

CROSS-EXAMINATION

BY MS. LOVELL:

1 Q. Do you have the total acreage then, the
2 total corrected acreage that we should be considering?
3 A. In Wailuanui, Wailuanui area I came up with
4 61.14 acres.
5 Q. So that's the total acreage then, not an
6 additional acreage, but the total?
7 A. Total.
8 Q. Thank you.
9 MR. MERCHANT: No questions.
10 MR. FREEDMAN: No questions.
11 HEARINGS OFFICER JUDGE McCONNELL: Mr.
12 Schulmeister
13 CROSS-EXAMINATION
14 BY MR. SCHULMEISTER:
15 Q. I'll just start right there with the 61.14,
16 because I'm a little confused about what that's a sum
17 of.
18 In your written testimony -- do you have
19 that handy, your written testimony?
20 A. Yes.
21 Q. And just focusing on the last two pages,
22 there's a question that starts at the bottom of Page
23 4. The question in your written testimony was:
24 "Based upon the results of your research,
25 are you able to draw a reasonable conclusion as to the

1 total acreage in active taro cultivation at the time
2 of the Mahele?"
3 And then your answer beginning on the
4 fifth page of your written testimony:
5 "Yes. First of all, the sum acreage of
6 the parcels identified in the attached spreadsheet is
7 56.355."
8 So the 56.355, that was the sum total of
9 the acreage of the tax map key parcels that are listed
10 in Exhibit B-12; is that right?
11 A. Yes.
12 Q. Now, the parcels that you just said needed to
13 be added to the owners' list, those were already
14 included in this total, right, 56.355?
15 A. No, not all of them.
16 Q. Well, the first one you mention that should
17 be added back in, 1-1-4-11, that's already in B-12,
18 and it's Parcel Number 3, right?
19 A. Yes.
20 Q. And the second one was 1-1-5-31, I believe,
21 and you're saying 1-1-5-31 actually should be part of
22 1-1-30. So 1-1 -- so if you go to the third page of
23 Exhibit B-12, 1-1-5-30 is already there, right?
24 A. Yes.
25 Q. Then the next one I think you mentioned

1 should be added is 1-1-6-32?
2 A. Yes.
3 Q. And if you go to the fourth page of Exhibit
4 B-12 -- I'm sorry -- so that one's not there.
5 And then 72, 1-1-6-72 -- 1-1-6-72 is on
6 the last page of Exhibit B-12, and that's already --
7 so that's already included in the total, right?
8 A. Yes.
9 Q. But if you go to Exhibit A-49 there's a bunch
10 of parcels on A-49 that weren't on B-12, right?
11 A. Yes.
12 Q. For example, if you have A-45 handy, that's
13 the map, Exhibit B-12 didn't have any of the house
14 lots that are on the makai side of Wailuanui Road,
15 right?
16 A. Yes.
17 Q. And so -- in fact, one of the things I wanted
18 to ask you about a little bit, when you came with your
19 estimate of the total acreage that was in taro
20 cultivation at the time of the Mahele, you used -- you
21 came up with 56.355 acres and then you discounted that
22 by ten percent per acreage that you assumed would have
23 been fallow; is that right?
24 A. Yes.
25 Q. So that leads me back to the first list, the

1 list that ended up making up the spreadsheet that's
2 Exhibit B-12. How was that list selected in the first
3 place?
4 A. You're asking me?
5 Q. Well, if you know. What was the theory
6 behind how a parcel got on that list?
7 A. I can't answer that question. I don't have
8 knowledge as to how we got those TMKs.
9 Q. I think you mentioned earlier during your
10 direct that it came from the Board of Directors of Na
11 Moku.
12 A. Yes. But how they got it --
13 Q. Were you involved in getting it from the
14 Board of Directors of Na Moku?
15 A. No, they gave it to me.
16 Q. You were given a list?
17 A. Yes.
18 Q. And did you -- and then from that list, you
19 did what you called -- well, you did the detailed
20 research of land titles and these other sources that
21 you referred to to determine whether or not taro was
22 cultivated on those parcels at the time of the Mahele?
23 A. Yes.
24 Q. And the spreadsheet shows the instances in
25 which you're able to find some specific indication

1 that there was taro cultivated, and for a lot of them
2 it's just blank, no indication one way or the other,
3 correct?
4 A. Yes.
5 Q. Beyond just looking at the records, did you
6 do anything else as part of the detailed research to
7 determine whether or not taro was cultivated on this
8 original list that ended up being the parcels that are
9 listed in Exhibit B-12?
10 A. Could you be more specific by what you mean
11 by "anything else"?
12 Q. Well, anything besides looking at land titles
13 and the registers that you described, any other type
14 of investigation?
15 A. Boundary Commission records, records of
16 commissions of private rights and water, maps on file
17 at the archives, maps on file at Hawaii State Survey
18 Division.
19 Q. In your written testimony on Page 3, and the
20 answer that is on the bottom of the page, you refer to
21 a number of parcels. And then basically I'm quoting
22 from about the fourth line down, the sentence that
23 starts near the right, says:
24 "Based upon the historical, cultural
25 landscape of the Wailuanui ahupua'a as fully detailed

1 in Kalo Kanu O Ka 'Aina: *A Cultural Landscape Study*
2 *of Ke'anae and Wailuanui, Island of Maui*", et cetera.
3 Do you see that?
4 A. Yes, I do.
5 Q. Is that the same study that is marked as
6 Exhibit B-123?
7 A. Yes, it is.
8 Q. So was that an additional piece of
9 investigation you did? You reviewed that study?
10 A. Not in thorough detail, to be honest with
11 you.
12 Q. Did you do any sort of a field survey? In
13 other words, on-the-ground survey of the area, of the
14 actual landscape?
15 A. No.
16 Q. Did you study any aerial photographs?
17 A. Could you define what you mean --
18 Q. I mean photographs taken from an aircraft
19 showing the layout?
20 A. Can you explain in what context?
21 Q. Well, let me do this. Among the new
22 exhibits, there's one that's -- A-55. A-55 is just a
23 copy that's been made of Figure 15.
24 A. Right.
25 Q. So have you seen this before?

1 A. Yes. It's in the Kalo Kanu book.
2 Q. And you were present when Dr. McGregor
3 testified?
4 A. Yes, I was.
5 Q. Do you remember her having described there
6 having been some archeologists who were on the team of
7 persons who did the cultural landscape studies?
8 A. Yes.
9 Q. And that they had actually done some mapping
10 of lo'i --
11 A. Yes.
12 Q. -- in Wailuanui?
13 A. Yes.
14 Q. And that this figure was the work of these
15 archeologists?
16 A. Yes.
17 Q. So did you study this Figure 15 at all in
18 trying to cross-reference it to the information you
19 were getting, for example, from the native register,
20 to see whether or not you could line-up the lo'i that
21 the archeologists were able to identify with ones that
22 are referred to in any of these title records?
23 A. Yes.
24 Q. Now, do you have any idea why -- well, do you
25 have any idea why in the second list that you were

1 given, the one that is A-49, there's all these house
2 lots that are included that weren't included in the
3 first one?
4 A. The only way I could explain it is to say I
5 presume that the Na Moku members wanted it understood
6 that they are residents there and that's where they
7 live.
8 And usually what happened in the Wailuanui
9 Homestead area, is because this was government land,
10 when the government gave out the grants in
11 satisfaction of the special purchase agreement, the
12 right of purchase agreement, with the house lot came a
13 taro lot.
14 So that they were -- the intent was one
15 was to be for residential purposes, the other for
16 agricultural purposes. But both were situated within
17 an agricultural district.
18 Q. So just because there's parcels that are
19 added to the second list that weren't on the first
20 list, didn't mean that the parcels that are being
21 added, such as the house lots, that those were being
22 claimed for taro on those house lots themselves?
23 A. I did not include the area, if that's what
24 you mean.
25 Q. How did you calculate -- let me withdraw that

1 question.
2 You had the original total that's referred
3 in your written testimony of 56-point-something acres.
4 So that didn't include any of the house lots?
5 A. No.
6 Q. But some of those parcels aren't on the
7 second list, although some of them you added back in,
8 I understand, but there are still others that aren't
9 on the second list.
10 MR. HAIA: Just I don't want to object,
11 it's just vague as to "second list".
12 MR. SCHULMEISTER: I'm referring to A-49
13 by the second list. Basically there's two lists that
14 we have prior to today. The first list was B-12,
15 which was your spreadsheet, and then the second list
16 was A-49. And then the second list has been somewhat
17 modified.
18 Q. Did you ever do a total of the acreage on
19 A-49?
20 A. Just separate by itself?
21 Q. Right.
22 A. No.
23 Q. So how do you get from the 56 to the 64?
24 A. I could have gotten more if I did all of A-49
25 exactly as it was, because A-49 includes parcels

1 outside of Wailuanui.
2 Q. Right, okay. So therefore, how you get from
3 the 56.355 -- let me withdraw that question.
4 Before I do that, the first list, the one
5 that's in B-12, doesn't have any house lots, right?
6 A. Correct.
7 Q. Did you know that when you prepared B-12 that
8 it didn't have any house lots?
9 A. It was my intent to exclude house lots
10 because we were looking towards cultivation of kalo.
11 Q. And did you exclude house lots?
12 A. I hope I did.
13 Q. The reason why I ask that is because so far
14 as I understand it, you were given a list by the Board
15 of Directors of Na Moku, and from that list you did
16 your research and that resulted in B-12?
17 A. Yes.
18 Q. Did you make any deletions from the original
19 list you were given before you got to B-12, of house
20 lots, for example?
21 A. Whatever the board gave me, I made B-12 out
22 of. It was their intent to only identify those
23 parcels which were under cultivation, open for
24 cultivation or fallow. So B-12 is exactly what they
25 gave me is what I produced.

1 Q. So it's your understanding that Na Moku,
2 before they gave you the list that ended up being in
3 the spreadsheet marked as B-12, they had already
4 weeded out, so to speak, the parcels that didn't have
5 taro, the house lots and properties that didn't have
6 taro on it; is that right?
7 A. I can't answer that.
8 Q. But there were no house lots?
9 A. I can only tell you that they did not give me
10 any TMKs upon which I could find there was a house on
11 it.
12 Q. And so it was because of that that you felt
13 comfortable saying that 90 percent of the total
14 acreage -- as I understand your written testimony,
15 basically you're saying 90 percent of the acreage,
16 it's reasonable to assume, was in taro at the time of
17 the Mahele?
18 A. Yes, sir.
19 Q. But if we were starting with acreage that
20 included all these house lots on this second list, you
21 wouldn't use that 90 percent factor any more?
22 A. On the second list?
23 Q. A-49, it includes a lot of house lots, right?
24 MR. HAIA: I'm going to object to the
25 characterization as "a lot of house lots". It's also

1 vague, and it assumes that the house lots were
2 included in the calculation of acreage.
3 HEARINGS OFFICER JUDGE McCONNELL: You
4 want to rephrase?
5 Q. MR. SCHULMEISTER: Do you know what I'm
6 referring to when I refer to the house lots that are
7 in Exhibit A-49 and are highlighted -- and let's just
8 focus to make it simple, focus on the ones that are
9 makai of Wailuanui Road on Exhibit A-45.
10 Do you understand what I'm referring to as
11 house lots?
12 A. Yes.
13 Q. Do you agree those are house lots?
14 A. Yes, sir.
15 Q. So since -- the 90 percent factor that you
16 used to estimate acreage in taro cultivation at the
17 time of the Mahele was applied to parcels that did not
18 include house lots, right?
19 A. Would you be more specific?
20 Q. B-12. B-12 is the list of parcels that you
21 used the 90 percent factor for, right?
22 A. Correct.
23 Q. And B-12 doesn't have any of these lots in
24 it, right?
25 A. There was a certainty with B-12 that I did

1 not get with A-49.
2 Q. Well, my question was whether or not B-12 had
3 any of these house lots on it.
4 A. To my knowledge, no.
5 Q. So if none of those house lots are on the
6 list applying the 90 percent factor, you felt
7 comfortable doing that because you didn't have to
8 discount areas that were not in taro cultivation?
9 A. Correct.
10 Q. Now, when we look at A-49, we do have the
11 house lots, right?
12 A. Yes, sir.
13 Q. And did you ever make a new calculation based
14 on TMKs listed in A-49?
15 A. In its entirety, you mean?
16 Q. Well, put it this way. Did you ever do a
17 calculation with regard to the parcels on A-49 that
18 was intended to have the corresponding purpose as the
19 calculation you did for B-12? In other words,
20 estimating the acreage that was in taro at the time of
21 the Mahele?
22 A. For those -- let me answer you this way.
23 That's how come I came up with 61.14 acres.
24 Q. Okay. When you came up -- is there a new
25 spreadsheet, a new B-12 that corresponds to A-49 where

1 we can see how you did it?
2 A. I did one for me. I wasn't sure if it would
3 be admissible or submittable.
4 Q. Let me just ask you. Did you use the same 90
5 percent factor?
6 A. I did not exclude the ten percent for fallow
7 out of the 61.14 acres.
8 Q. Well, where did the 61 come from?
9 A. As I said earlier, when we got what you're
10 calling Exhibit A-49, when I got them, what I found
11 was there -- we had gotten -- the Na Moku members had
12 then come forward and said, I also own this and that.
13 So I want this and that included in with this.
14 So when they then told us that, we
15 picked -- I picked up additional tax keys and did find
16 them assessed under their name. They may have been
17 down the list one of 11, one of 14, one of 26.
18 I then added that parcel on and into the
19 61, which brought about the 61.14 acres.
20 HEARINGS OFFICER JUDGE McCONNELL: So the
21 house lots really aren't included in the 61?
22 THE WITNESS: No. But the appurtenant
23 taro lot is.
24 Q. MR. SCHULMEISTER: Are the lots that you went
25 through in your direct testimony that were omitted

1 incorrectly as you've testified from A-49, did you
2 take the acreage of those and add it to the 56.355
3 that you previously totaled from Exhibit B-12?
4 A. Yes.
5 Q. So is it your testimony that -- this is where
6 I'm lost on this.
7 As I understand it, you gave us a list of
8 TMKs that were not on B-12. There was six from Plat
9 4, five from Plat 5, and seven from Plat 6. Those
10 ones that you read through one by one.
11 A. Yes.
12 Q. So my understanding is those were on B-12 but
13 not on A-49, right? But then you only added back in
14 four. So where do you subtract out the acreage of all
15 the other ones that weren't on A-49?
16 Do you understand my question?
17 MR. HAIA: Notwithstanding the fact that
18 these other parcels aren't necessarily Na Moku members
19 or, you know, they're either state land or there's not
20 a Na Moku member that's an assessed owner, the fact
21 remains that these parcels we're claiming were either
22 in taro at the time of the Mahele and should always be
23 included in the total acreage for which either water
24 is necessary, because somebody who is with Na Moku is
25 going to be growing taro on that; or as we've argued,

1 Judge, A & B, EMI has the burden of coming forward to
2 establish that they're not interfering with others
3 rights.
4 That's just not Na Moku members. There
5 are other parcels in that area that have appurtenant
6 rights. We're going to identify those appurtenant
7 rights. We're doing that right now, and we will be
8 asking A&B and EMI to establish that their
9 diversions -- I mean, you know, you may not agree with
10 this, but it's our contention that the burden is upon
11 A&B, EMI to show if there's prima facia evidence of an
12 interest in the water, that they weren't interfering
13 with those rights, notwithstanding that it's a Na Moku
14 member or not a Na Moku member, it doesn't matter.
15 So when we talk about the total acreage,
16 we're talking about whatever land is in that valley to
17 which we can claim appurtenant rights to
18 notwithstanding that a Na Moku member can't identify a
19 claimed interest. If that Na Moku member has an
20 opportunity to grow taro on that parcel, we're making
21 a claim for it.
22 So she may not be able to answer your
23 question, Dave, when it comes to that.
24 MR. SCHULMEISTER: I'm just trying to
25 understand the math. That's all I'm trying to do.

1 HEARINGS OFFICER JUDGE McCONNELL: Yeah.
2 I appreciate that. But your math started with the 56
3 and you've added these various other parcels to come
4 up with --
5 MR. HAIA: Actually --
6 HEARINGS OFFICER JUDGE McCONNELL: To come
7 up with the 61.
8 MR. HAIA: Actually, that's not totally
9 correct. The original total was, I think, 67.84
10 acres. We took ten percent off of that to get to 56
11 -- or I'm sorry, the total was 56. We brought it down
12 to 51 on that ten percent. Now she's saying it's
13 61.14, but that's not accounting for -- that's the
14 total. You've got to drop it -- you've got to take
15 ten percent out of that.
16 MR. SCHULMEISTER: I don't know. I was
17 trying to find out.
18 HEARINGS OFFICER JUDGE McCONNELL: Go
19 ahead, Dave.
20 MR. HAIA: Well, she testified to that
21 already. She said she didn't take the ten percent
22 off.
23 HEARINGS OFFICER JUDGE McCONNELL: Go
24 ahead.
25 Q. MR. SCHULMEISTER: All I want to do is

1 connect the dots between the 56.355 and the current
2 61.14. Is it okay, can I just hand you a piece of
3 paper and have you -- I'll just put the 56.355 and
4 could you just -- can we take a break and reconstruct
5 the calculation? Show what was minused out or added
6 to come to the 61.14. And if there's a TMK, identify
7 it and the acreage and that way we will have a record
8 of how the calculation is done.
9 MR. HAIA: You're proposing we're taking a
10 break right now for her to do that?
11 MR. SCHULMEISTER: That's right. We can
12 all sit and watch her, but I think she might get a
13 little nervous.
14 MR. HAIA: We don't necessarily need to
15 take a break. Can you go onto another area? We will
16 do this during lunchtime and come back. We are on a
17 tight schedule here, so that's my concern.
18 MR. SCHULMEISTER: I don't have a lot more
19 and this is kind of key.
20 HEARINGS OFFICER JUDGE McCONNELL: We'll
21 take a couple minutes.
22 (Recess was taken).
23 HEARINGS OFFICER JUDGE McCONNELL: We're
24 back on the record. Mr. Schulmeister.
25 MR. SCHULMEISTER: We had a discussion off

1 the record. Do you want to offer something?
2 MR. HAIA: Maybe if your understanding is
3 different than the way -- basically we did have an
4 off-the-record discussion, and I believe what A&B and
5 Na Moku have agreed to is that, notwithstanding the
6 fact that B-12 does not coincide with A-49, I think we
7 both agreed that the 51 acres which subtracts ten
8 percent from the total we had in Teri's original
9 testimony, is an agreeable number as long as there is
10 this understanding that some of that total 51 acres
11 may just be disputed as to whether or not there is an
12 interest held by a Na Moku member on some of that
13 property. Is that correct?
14 MR. SCHULMEISTER: I think so. Let me try
15 to paraphrase it the way I understand it. And maybe
16 we are on the same page here.
17 I was just trying to understand what the
18 61 -- how the 61 came about. And I think that in
19 discussions, in getting to the 61, some parcels that
20 weren't on B-49 were added back in --
21 MR. HAIA: A-49. I think you said B-49.
22 MR. SCHULMEISTER: Right, A-49. But they
23 may have been double counted to get to the 61, but the
24 51 continues to include parcels that are not on A-49,
25 and as long as I understand that that's what it is,

1 that's fine. I just wanted to understand what it was.
2 So with that clarification, I won't ask any more
3 questions about it.
4 MR. HAIA: That's how I understand it.
5 MR. SCHULMEISTER: So now I'll continue
6 with my cross-examination.
7 Q. So getting back to the 51 acres in terms of
8 what that represents, that represents your estimate of
9 the amount of acreage in Wailuanui Valley that was
10 cultivated in taro at the time of the Mahele,
11 regardless of whether or not it was cultivated on
12 lands that current Na Moku members own, correct?
13 MR. HAIA: Object as to vagueness.
14 HEARINGS OFFICER JUDGE McCONNELL: I'll
15 permit it.
16 THE WITNESS: Could you restate it,
17 please, the question?
18 Q. MR. SCHULMEISTER: The 51 acre estimate,
19 that's an estimate that was based on trying to arrive
20 at a figure that was, in your opinion, a reasonable
21 estimate of the acres in Wailuanui Valley that were
22 cultivated in taro at the time of the Mahele?
23 A. Stated that way I would have to say no.
24 Q. How would you characterize your 51 acres?
25 A. This 51 acres is only the amount of acreage

1 that is currently under controlled manager owned by
2 the Na Moku members. I cannot speak for land titles I
3 did not research.
4 Q. It was based on a list that was originally
5 given to you by the Na Moku Board of Directors?
6 A. Yes.
7 Q. But the second list, which a deleted some of
8 those, you didn't delete those from the 51 acres,
9 right? We haven't done that, right?
10 A. No, sir.
11 Q. So the 51 acres -- okay, I think the record
12 is clear.
13 Is the record clear?
14 HEARINGS OFFICER JUDGE McCONNELL: Maybe
15 not.
16 Q. MR. SCHULMEISTER: Could you put in front of
17 you what's A-51.1, which I just handed to counsel? If
18 you would take that and overlay it on A-45.
19 MR. HAIA: Dave, before you go there, I'm
20 going to object to it. The basis is we have no idea
21 of knowing whether or not this is to scale.
22 MR. SCHULMEISTER: I understand.
23 Q. But are you able to like roughly align the
24 roadway and the stream or the roadways?
25 A. Based on what you've given me, I can't. I

1 have a number of problems. First of all, I don't have
2 the scale for this. I don't have anything that could
3 correlate it -- I don't have the scale for this map.
4 It's a composite. I don't have whether or not -- what
5 date this was made and what period in time it's
6 representative of. And I don't have the same for
7 this.
8 Q. You did have Figure 15 prior to doing your
9 written testimony, right? Figure 15 from the Cultural
10 Landscape Study?
11 A. Yes.
12 Q. Exhibit A-55 is a Xerox of that that was
13 enlarged somewhat. And then 55.1 is a transparency
14 created from it.
15 Did you at any time make any effort to
16 correlate the information that the archeologists had
17 put together for the Cultural Landscape Study with
18 your estimate?
19 A. No, sir.
20 Q. So you just went with the 90 percent factor?
21 A. Yes, sir.
22 Q. So any parcel that was on the list, you just
23 assumed 90 percent of it was in taro at the time of
24 the Mahele?
25 A. Based on the Land Commission records.

1 Q. Is there a Land Commission record that says
2 that 90 percent of the land in this area could be
3 assumed to have been in taro at the time of the
4 Mahele?
5 A. I took them one at a time, sir. If testimony
6 showed that there were ten lo'i on a mo'o and the mo'o
7 was .55 acres, I presumed that meant 90 percent was
8 for cultivation purposes. I presumed the remaining
9 ten percent would be, if anything, for a hale.
10 Q. But without actually checking on the ground
11 to see whether or not 90 percent of the parcel or 100
12 percent of the parcel had evidence of taro
13 cultivation, pretty much guess work, right?
14 A. Not if the testimony and the actual Land
15 Commission Award record says that it's a lo'i kalo,
16 it's a mo'o kalo, there's an 'auwai, or it abuts the
17 adjoining lo'i.
18 Q. But for most of the parcels, there aren't
19 references like that, right?
20 A. Lo'i claimed is a specific type of parcel for
21 specific type of use.
22 Q. There's one area in particular I would just
23 like to ask you about, and that's the area -- if you
24 have A-55. Just pointing to the arrows that come from
25 the bottom showing direction of natural water flow.

1 MR. HAIA: Which arrows?
2 MR. SCHULMEISTER: Right here, right to
3 the upper right from where it says Exhibit A-55 on the
4 bottom of the page.
5 A. That's the natural water flow.
6 Q. Do you have an understanding as to where
7 Wailuanui Stream water is brought into cultivate taro
8 in Wailuanui?
9 A. This doesn't tell me where Wailua Stream is.
10 Q. Forgetting A-55 for a minute, do you know
11 where Wailuanui is?
12 A. Yes, sir.
13 Q. Do you understand what this A-55 depicts with
14 regard to the roadway and Hana Highway?
15 MR. HAIA: I'm going to object, Judge. I
16 think it's irrelevant to her testimony. All she was
17 asked to do was do a search of the records to
18 determine the amount of acreage in taro and it had
19 nothing to do with the 'auwai, the position of the
20 streams, et cetera.
21 HEARINGS OFFICER JUDGE McCONNELL: I'll
22 permit it.
23 Do you want to repeat it?
24 MR. SCHULMEISTER: Yeah.
25 Q. Do you know where Wailuanui Stream water

1 would come in on this?
2 A. According to the direction arrows, it's
3 coming in this way.
4 Q. To the arrows just next to where it says
5 A-55?
6 A. Yes, sir.
7 Q. Referring again to your testimony where you
8 talk about the reason for the 90 percent assumption.
9 This is on Page 3 of your written testimony. The
10 bottom paragraph, the last three-and-a-half lines
11 says:
12 "It is reasonable to conclude that most if
13 not all of the land contained within these parcels was
14 used for taro cultivation at the time of the Mahele.
15 These parcels are located in a floodplain, the ideal
16 location for taro cultivation."
17 Did I read that correctly?
18 A. Yes.
19 Q. Now, when you made the 90 percent assumption,
20 did you make any assumptions with regard to whether or
21 not anything about the slope of the land would make it
22 difficult to get water to some of the areas within the
23 tax map key parcel?
24 A. That was irrelevant.
25 Q. So like this gap that is shown on A-55

1 between these lo'i in the lower right corner, then the
2 ones in the central part of the valley, do you -- were
3 you present with when Mr. Wendt testified that water
4 can't flow uphill to the left?
5 A. Yes, sir.
6 Q. When you made your 90 percent calculation,
7 did you make any assumption that some of the areas,
8 based on the slope, you might not be able to get water
9 to 90 percent of the parcel?
10 MR. HAIA: Object as irrelevant and beyond
11 the scope of her testimony.
12 HEARINGS OFFICER JUDGE McCONNELL: I'll
13 permit it.
14 THE WITNESS: Do you mean did I take into
15 consideration the topographical features of land
16 titles?
17 MR. SCHULMEISTER: Yeah.
18 A. No, sir.
19 Q. I'm talking about specifically with regard to
20 the 90 percent assumption.
21 A. I came up with -- the 90 percent assumption
22 is based on through the years the practice of
23 cultivating kalo that I've come across and
24 experienced. However big the land was, about 90
25 percent would be kept in cultivation, the other ten

1 percent would be allowed to go fallow. Or out of ten
2 lo'i, nine would be cultivated, one would be fallow.
3 So that they then could then rotate their crops
4 around.
5 Q. Doesn't that also assume that none of the
6 land is used for anything else?
7 A. If it were, it would not have been awarded
8 for cultivation purposes. It would have been awarded
9 for a house lot, pahale.
10 Q. Did you do any work on the Answers to
11 Interrogatories that we had sent to Native Hawaiian
12 Legal Corporation in this case?
13 A. No, sir.
14 Q. I have no further questions.
15 HEARINGS OFFICER JUDGE McCONNELL:
16 Anything else? Thank you, ma'am. That completes
17 Native Hawaiian's case?
18 MR. HAIA: To the extent that, you know,
19 our direct testimony, but if something comes up on
20 their direct that --
21 HEARINGS OFFICER JUDGE McCONNELL:
22 Rebuttal is fine. Other than rebuttal. Okay. Why
23 don't we go off the record.
24 (Discussion held off the record.)
25 (Noon recess was taken.)

1 HEARINGS OFFICER JUDGE McCONNELL: We're
2 reconvened.
3 GARRET HEW
4 was called as a witness by and on behalf of A&B and
5 EMI, was sworn to tell the truth, was examined and
6 testified as follows:
7 MR. HAIA: I'm sorry to interrupt. I just
8 want to reassert our objection to this direct
9 testimony and the basis for that.
10 HEARINGS OFFICER JUDGE McCONNELL: All
11 right. I think your record is well made.
12 DIRECT EXAMINATION
13 BY MR. SCHULMEISTER:
14 Q. Mr. Hew, are you still employed by East Maui
15 Irrigation Company?
16 A. Yes, I am.
17 Q. Are you still the president?
18 A. Yes, I am.
19 Q. I'm going to hand you two declarations, one
20 of which is dated July 29th, 2005, and the other one
21 August 22nd, 2005. Ask you to take a look at those,
22 tell me whether those represent declarations that you
23 signed in this case?
24 A. Yes, I did.
25 Q. Is the testimony that is referred to in those

1 declarations, is that true, correct and the best of
2 your knowledge and belief?
3 A. Yes, it is.
4 Q. I think, although the signed testimony was
5 already received, if it wasn't, we just clarify that
6 this is now part of the record.
7 HEARINGS OFFICER JUDGE McCONNELL: You
8 have got two declarations that will be in evidence.
9 Q. MR. SCHULMEISTER: On the table in front of
10 you, there is that very colorful map, which is Exhibit
11 A-1. Could you just take a moment -- A-1 is the ditch
12 system -- could you just take a moment and just
13 describe briefly for Judge McConnell what it is?
14 A. Exhibit A-1 is a map of our EMI ditch system.
15 It extends out towards Nahiku, all the way out towards
16 Maliko Gulch. It indicates the ditch system. It
17 indicates which areas are tunnels by the solid lines.
18 The blue lines are areas where the ditch is open or
19 above ground.
20 It also shows the stream diversions
21 indicated by a square red dot. The map also shows the
22 four license areas, the Huelo, Honomanu, Keanae and
23 Nahiku license areas. These are state lands which we
24 lease from the State of Hawaii, and those are
25 indicated in yellow.

1 The green areas are lands owned by East
2 Maui Irrigation, and the orange lands are owned by our
3 parent company, Alexander & Baldwin, Inc. And
4 wherever there are no colors on these parcels, those
5 are privately owned parcels.
6 Q. Now, you've been working at EMI since 1985,
7 is that right?
8 A. That's right.
9 Q. And in the course of the time that you've
10 worked at EMI, have you learned about some of the
11 history of the ditch system?
12 A. Yes, I have.
13 Q. And you were present during the first few
14 days of this hearing during the testimony of
15 Dr. McGregor, right?
16 A. Correct.
17 Q. There was some discussion about when the
18 Koolau Ditch was completed. And there was an exhibit
19 that was referred to as dated of 1904.
20 Do you have any knowledge as to when the
21 Koolau Ditch was completed?
22 A. Yes. The Koolau Ditch was completed in 1904.
23 We have records that indicate construction of that
24 ditch.
25 Q. Could you point out where the Koolau Ditch is

1 on the map?
2 A. The Koolau Ditch on this map starts at
3 Makapipi Stream at the most eastern end, and it goes
4 in a westerly direction, and it goes all the way to
5 Alo Stream, which is here.
6 Now, when we're talking about the
7 Wailuanui area, Wailuanui Stream, Waiokamilo Stream,
8 and it's referred to sometimes as Kualani Stream and
9 sometimes it's Hamau Stream.
10 Q. Which of the ditches divert water from any of
11 those streams?
12 A. There's only one ditch in that Wailua area
13 and that's the Koolau Ditch.
14 Q. Now, there was some construction of the total
15 system that continued after 1904, is that right?
16 A. Yes, that's right.
17 Q. What's your understanding of the later
18 constructed portions of the system?
19 A. The later constructed portions of the system
20 included the Haiku Ditch, which was completed in 1914;
21 the Kauhikoa Ditch was just completed 1915 and the
22 last ditch to be completed was the Wailoa Ditch
23 completed in 1923.
24 Q. Could you point out the Wailoa Ditch?
25 A. The Wailoa Ditch starts from Alo Stream and

1 goes all the way to Kamole Weir on this map here.
2 HEARINGS OFFICER JUDGE McCONNELL: What
3 was the second one?
4 THE WITNESS: Haiku Ditch was completed in
5 1914, the Kauhikoa was in 1915 and the last to be
6 completed was the Wailoa.
7 Q. MR. SCHULMEISTER: Now, when the Koolau Ditch
8 was completed in 1904, was it diverting water from the
9 Keanae area between the time the Koolau Ditch was
10 constructed and the Wailoa Ditch was completed?
11 A. Yes. The Koolau Ditch was in operation from
12 1904.
13 Q. Is there any relation between water collected
14 in the Koolau Ditch and water collected in the Wailoa
15 Ditch?
16 A. From my understanding, the Koolau Ditch
17 diverted water in this Nahiku-Keanae area and it
18 brought the water over to this New Hamakua Ditch which
19 we still operate. And from my understanding the New
20 Hamakua Ditch was mainly open, and with the newer
21 technology and ditch construction, the Wailoa Ditch
22 replaced the New Hamakua from Alo Stream westward.
23 Q. And that was the one completed in 1923?
24 A. That is correct.
25 Q. Have there been any major changes since 1923?

1 A. On the ditch system itself? No major
2 changes.
3 Q. So as of the completion of Wailoa Ditch in
4 1923 to date the system has essentially been operated
5 in essentially the same way?
6 A. Yes, it has.
7 Q. Now, this other map here, which is A-6, could
8 you explain what this is?
9 A. A-6 is a schematic diagram of the EMI Ditch
10 System along with HC&S Ditch System. It shows all of
11 the ditches schematically starting from the Nahiku
12 area all the way to Maliko Gulch. Once it gets to
13 Maliko Gulch, the colored areas are operated by our
14 sister company Hawaiian Commercial & Sugar, and the
15 different colors I believe are related to the
16 different farms on the HC&S side of the plantation.
17 Q. Now, unlike A-1, this one, just looking at
18 it, it's not to scale, right?
19 A. No, it's not to scale.
20 Q. So it's just basically supposed to show how
21 the water is routed?
22 A. Just a schematic to give you a clear idea of
23 how the system is set up and from what areas the
24 streams are diverted from, and coming into the
25 plantation at its various levels.

1 HEARINGS OFFICER JUDGE McCONNELL: Do you
2 have a small version of that?
3 MR. SCHULMEISTER: Yes, I think you may
4 have it. If you don't, I can certainly give you a
5 small one. I think you have the large one.
6 Q. How many employees does EMI have?
7 A. EMI has a total of 17 employees.
8 Q. And they're all under your supervision as
9 president?
10 A. Yes, they are.
11 HEARINGS OFFICER JUDGE McCONNELL: I'm
12 sorry, how many?
13 THE WITNESS: Seventeen employees.
14 Q. MR. SCHULMEISTER: Can you give just a brief
15 thumbnail sketch, overview of what they do?
16 A. We have an operations manager, Mark Vaught,
17 he's in charge of the daily operations. We have one
18 technical clerical support person. The rest are out
19 in the field.
20 We have 15 out in the field. We have
21 about seven supervisory, and the rest are salaried,
22 not supervisory people.
23 On a daily basis we're responsible for
24 checking and making sure that the system is fully
25 operable. We have 75 miles of ditch and tunnel of

1 which 50 miles are underground, 25 are aboveground.
2 We do routine maintenance work such as
3 checking to see that stream diversions are clear and
4 working properly. We have 60 miles of private
5 four-wheel drive roads that we need to maintain to
6 access our ditch system.
7 MR. HAIA: I'm just going to object at
8 this point, being beyond the scope of the question.
9 HEARINGS OFFICER JUDGE McCONNELL: I'll
10 permit it. It's background. Go ahead.
11 Q. MR. SCHULMEISTER: At the various stream
12 diversions, why don't you just point out on A-1 where
13 we went our first day, the site inspection, and we
14 looked at diversions at Honopou, Haiku Ditch, right?
15 A. Yes. On the first day of our site
16 inspection, we were at the Haiku Ditch at Honopou,
17 which is the lowest ditch in elevation. We proceeded
18 to Huelo Stream here, and we went down to see Mr.
19 Schupp's diversion there along with Ms. Caveny. And
20 then we took a ride up to the Lowrie level and we
21 parked, because it was muddy, and we walked over to
22 that diversion where we have the pipe crossing over
23 the ditch.
24 (Isaac Hall present.)
25 Q. When we saw the diversion, the ditch at

1 Puolua, there was a gate that had been opened. Do you
2 recall what I'm referring to?
3 A. At the Haiku level or the --
4 Q. The Haiku level.
5 A. The Haiku level, yes. There was a gate that
6 was open at the Puolua Ditch, school intake, we call
7 that.
8 Q. Explain the purpose and function of that
9 gate.
10 A. That gate is actually a sluice gate we call
11 it.
12 HEARINGS OFFICER JUDGE McCONNELL: Can you
13 point that out?
14 THE WITNESS: Haiku Ditch, it's at this
15 point right here. That gate was opened because the
16 prior week we had forecast of very, very heavy
17 downpours. And what we wanted to do was make sure
18 that our system was not damaged by an intense
19 rainstorm.
20 So what we did was we controlled the level
21 of the ditch. And that gate basically was opened so
22 that if we did have storm floods, it would not
23 inundate our ditch and cause damage to our system or
24 to other peoples' property if it did overflow
25 downstream.

1 Q. And then at the Haiku Ditch at Hanehoi
2 Stream, there was a gate opened there too; is that
3 right?
4 A. That's correct. It was opened at Hanehoi
5 Stream also.
6 Q. And for the same reason?
7 A. Open for the same reason, because of storm
8 forecast the week before.
9 Q. Now, in terms of routine operations and
10 maintenance, under what circumstances are these gates
11 opened and closed?
12 A. They're mainly closed under normal
13 operations. The only time that they're opened is when
14 we have forecast of a severe storm coming with
15 imminent rains and we want to protect our system and
16 also the adjacent properties from flooding, and that's
17 when it's opened.
18 Other than that, if we do some maintenance
19 in the tunnel or repair, those gates are also opened
20 at times if need be.
21 Q. I'm going to talk for a few minutes now about
22 the Kekahuna taro patches. And in your testimony you
23 mentioned a number of exhibits and the history of some
24 efforts that EMI had made to assist her to open her
25 taro patches; do you recall that?

1 A. Yes.
2 Q. Now, is EMI committed to assuring Mrs.
3 Kekahuna enough water to grow taro in her lo'i?
4 A. Absolutely.
5 Q. What has EMI done to assure her that there is
6 enough water to do so?
7 A. First of all we had installed the additional
8 four-inch pipe over our Haiku Ditch at Honopou
9 diversion. That extra pipe I think we measured it,
10 and it came out to about 120,000 gallons of water per
11 day.
12 There are two existing pipes there
13 already, and that's a total of three four-inch pipes
14 passing water over our Haiku Ditch diversion. And
15 these pipes pass low-flow water. In other words, the
16 pipes are passing water at all times before any water
17 goes into our --
18 THE COURT REPORTER: I'm sorry, I lost the
19 end of that.
20 THE WITNESS: Yeah, these pipes are
21 designed so they take the low flow of water over our
22 ditch before any water can go into our stream
23 diversion at that point.
24 Q. MR. SCHULMEISTER: Now, based on your
25 observations and having gone out there and worked with

1 Mrs. Kekahuna, has she had enough water available in
2 her 'auwai during the last two years to open up the
3 patches that we saw on the site visit?
4 MR. HAIA: I'm going to object to that,
5 beyond the scope of this witness' expertise,
6 competence to testify to that.
7 HEARINGS OFFICER JUDGE McCONNELL: Well,
8 I'll permit it. You're going to cross.
9 THE WITNESS: Yes, I believe that she had
10 enough water to plant her open taro patches.
11 Q. MR. SCHULMEISTER: Now, has Mrs. Kekahuna
12 ever complained to you at any time in the last two
13 years that she did not have enough water available in
14 her 'auwai to open those patches?
15 A. No.
16 Q. Now, one of the things mentioned in your
17 written testimony is the fact that some taro was
18 planted and was harvested.
19 A. Yes. We had assisted Mrs. Kekahuna in
20 planting some taro, I believe it was in August of
21 2003. And it was Maui Lehua variety. And the taro
22 grew and it was harvested about one year later.
23 Q. And did Mrs. Kekahuna ever complain to you
24 that the taro when it was harvested from that patch
25 was not healthy?

A. No. She never said that it was not healthy.

Q. Did she ever complain that it wasn't tasty?

A. That I don't know, because I hadn't talked to her whether she had eaten the taro or not.

Q. Now, with regard to Ernie Schupp's taro patch on Puolua Stream. On the site visit we had gone up and we had looked at the patch which was right off of the Haiku Ditch, right?

A. Correct.

Q. Then we also went up and looked at the stream where it's diverted at the Lowrie Ditch, right?

A. That's correct.

Q. Then you might want to point that out again.

A. This is Hanehoi Stream and this is the Lowrie diversion further up here.

HEARINGS OFFICER JUDGE McCONNELL: The red dot?

THE WITNESS: At the Haiku level, but somehow there isn't a red dot.

HEARINGS OFFICER JUDGE McCONNELL: Not this?

THE WITNESS: No, the brown is actually the road. The ditch is this blue line here.

Q. MR. SCHULMEISTER: Now, when we went and saw the stream at the Lowrie diversion, there was a pipe

1 that went through the diversion, right?
2 A. There was a pipe going through the diversion,
3 yes.
4 Q. And one of the things that happened while we
5 were there was an effort was made to pull leaves and
6 things out of the pipe. Do you remember that?
7 A. At the Puolua diversion, you're talking
8 about?
9 Q. Right, at the Lowrie.
10 A. At the Lowrie, yes.
11 Q. And what was the purpose of doing that?
12 A. The purpose was to clear the pipe of any
13 debris that was blocking the flow of water crossing
14 over our Lowrie Ditch diversion.
15 Q. Now, if it's not periodically cleaned out,
16 what happens?
17 A. The pipe would get blocked up and the water
18 would fall into our Lowrie Ditch.
19 Q. Now, you know Mr. Schupp, right?
20 A. Yes, I do.
21 Q. Have you dealt with him over the years?
22 A. Yes, I have.
23 Q. And does he have permission and the ability
24 to go and clean those pipes if need be?
25 A. He has -- we have an informal agreement that

1 if he needs the water, he can go up there at any time
2 to go and clean the pipes to get water down, back into
3 the stream.
4 Q. Okay. So the water that goes through those
5 pipes, stays in the stream and then there is a couple
6 more pipes at Haiku that passes just above his 'auwai;
7 is that right?
8 A. Yes, that's right.
9 Q. Those pipes are right next to his property?
10 A. The pipes are adjacent to his property,
11 right.
12 Q. And again, he's free to clean those?
13 A. He's free to clean that to get the water in
14 the stream.
15 Q. Now, you were present when Mr. Schupp
16 testified?
17 A. Yes, I was.
18 Q. And one of the things that he testified about
19 was I guess a meeting with representatives of EMI
20 where there was some discussion or criticism of the
21 way that his diversion was constructed. Do you recall
22 him testifying to that effect?
23 A. Yes, I do.
24 Q. Do you recall ever criticizing the diversion?
25 In other words, the way it was physically constructed?

A. As I recall, we went to visit that area with a couple of EMI employees, and we looked at the pipe diversion and we walked downstream and just to see if Mr. Schupp had done anything to his diversion to get water to his lo'is. And at that time he showed up and he said he was busy, he didn't have the time to rebuild the diversion.

And at that time we offered our assistance to Mr. Schupp to help him with any work that he might have on the diversion.

Q. Could you look at Exhibit A-12. Exhibit A-12 on East Maui Irrigation Company letterhead. Do you know who prepared this?

A. I prepared this.

Q. And this refers to March 11th, 2004 site visit to Honopou and Puolua Stream?

A. That's correct.

Q. Is this the same site visit you were just referring to?

A. No, it was not.

Q. Was this earlier or later?

A. I believe we had visited Mr. Schupp later, after this site visit.

Q. Now, in this -- on this March 11th site visit, were any measurements taken of the flow at

1 Puolua at Haiku Ditch where Mr. Schupp's 'auwai is?
2 A. Yes, measurements were taken at the Haiku
3 Ditch Puolua intake.
4 Q. And are those referred to near the bottom of
5 the page?
6 A. Yes. It's referred to water measurements
7 Puolua at Haiku.
8 Q. And what was the flow on that day at Puolua
9 at Haiku? That's below the diversion, right?
10 MR. HALL: Objection, these measurements
11 were taken by CWRM and not Mr. Hew. He has no
12 personal knowledge, no foundation.
13 HEARINGS OFFICER JUDGE McCONNELL: Lay a
14 foundation.
15 MR. HALL: All he's doing is repeating
16 what's in Exhibit A-12.
17 Q. MR. SCHULMEISTER: Well, you prepared Exhibit
18 A-12, right?
19 A. That is correct.
20 Q. What does the last line of A-12 say?
21 MR. HALL: The document speaks for itself.
22 He still hasn't laid any foundation that he did
23 measurements. In fact he did not.
24 HEARINGS OFFICER JUDGE McCONNELL: It's in
25 evidence. Overruled.

1 MR. HALL: It should be clear on the
2 record he didn't make any measurements.
3 HEARINGS OFFICER JUDGE McCONNELL: You can
4 cross-examine, Mr. Hall.
5 MR. HALL: I don't want a record that's
6 unclear. They're trying to imply --
7 HEARINGS OFFICER JUDGE McCONNELL: He can
8 read from an exhibit in evidence.
9 THE WITNESS: The last line on Exhibit
10 A-12 reads: Total for Puolua at Haiku equals 262,000
11 gallons per day.
12 Q. MR. SCHULMEISTER: Where did you get that?
13 A. I measured this.
14 Q. You measured this?
15 A. Yes, I did.
16 Q. On the same day, March 11?
17 A. Yes.
18 Q. Could you explain how you measured it?
19 A. We took a one-cubic-foot stainless steel box,
20 and what we did was we measured how long it took to
21 fill up the box several times and we got an average,
22 and we averaged it out to what -- how many seconds it
23 took to fill up the box to calculate what the flow
24 was.
25 Q. So just so we are clear, the 262,000 gallons

1 per day, that was the amount that was coming through
2 the pipes?
3 A. Coming out of the two pipes at Haiku Ditch at
4 Puolua Stream, correct.
5 Q. And so therefore available to be diverted
6 into Mr. Schupp's taro patch?
7 A. That's correct.
8 MR. HALL: Objection. I'll handle this on
9 cross.
10 Q. MR. SCHULMEISTER: Were you also present
11 during the testimony of Ms. Caveny?
12 A. Yes, I was.
13 Q. And do you recall her having testified that
14 she had done some research or investigation by talking
15 to residents in the area, and I think put in some
16 letters to the effect that Hanehoi Stream, in the ten
17 or 15 years prior to her acquiring her property on
18 Hanehoi Stream, used to have a modest but fairly
19 consistent flow; do you recall that?
20 A. Yes, I do.
21 Q. And she also testified that since she's
22 acquired her property, that it's been frequently
23 completely dried, so not having this consistent flow
24 that she had heard used to exist previously; do you
25 recall that?

A. Yes.

Q. Now, you started working at EMI in 1985; is that right?

A. Yes, I did.

Q. Do you have any knowledge of whether there was a continuous flow -- a relatively continuous flow in Hanehoi Stream along Ms. Caveny's property in the ten or 15 years prior to her acquiring it which the records indicate is 2001?

A. Yes, I do.

Q. Tell us what that is?

A. When I started to work for EMI in 1985, shortly thereafter, probably in 1988, '89, I went with our field superintendent, Mr. Cabral. And we went down to this Hanehoi intake on the Haiku Ditch, and at that time he introduced me to this gentleman. His nickname was Poncho. I don't know what his real name was.

Poncho apparently had resided on the property downstream of our Haiku Ditch, I believe on the Lee property. He was the caretaker for the Lee property. And at that time Poncho was probably in his late eighties or early nineties. And I believe he was retired and he was just living out there and raising some vegetables, raising some chickens.

He did say that he used to raise taro before down below of the Haiku Ditch.

Q. Now, Hanehoi, we went on the site visit. We looked at where the Lowrie Ditch diverts Hanehoi as well, right?

A. That's right.

Q. And there we saw, there was two pipes through the diversion; is that right?

A. There were two pipes passing water -- correct that. There are two pipes going from the stream over our ditch.

Q. And the day that we went there, one of them was passing water?

A. One of them was passing water, the other one was plugged.

Q. Do you know what the history of those two pipes are?

A. From my understanding those two pipes used to pass water over the Lowrie Ditch, come down to the stream, and before the Haiku Ditch at Hanehoi Stream, Poncho had a ditch, small little ditch. He diverted water off Hanehoi Stream via a small ditch. I believe it was a one-by-one foot ditch. A very small 'auwai. And he used to take that water over our Haiku Ditch tunnel, and he used to use that water for, not only

1 taro, but also for domestic purposes.
2 Q. What happened to the water after he diverted
3 it?
4 A. I believe the water that was not used up by
5 Poncho ended up back in Hanehoi Stream.
6 Q. And where in relation to the Haiku Ditch?
7 A. Below of the Haiku Ditch. It entered the
8 stream below the Haiku Ditch.
9 Q. And during that period who, if anybody, would
10 maintain the pipes at the Lowrie diversion of Hanehoi
11 Stream?
12 A. I would have to assume that it was Poncho
13 because he needed that water to be diverted off of
14 Hanehoi Stream for his domestic use and also for his
15 garden and taro cultivation.
16 Q. Now, the written testimony submitted by Ms.
17 Caveny indicated that there used to be pipes that
18 passed Hanehoi water at the Haiku diversion.
19 To your knowledge is that true?
20 A. To my knowledge we have never had any pipes
21 in the Haiku Ditch-Hanehoi diversion that passed water
22 over that diversion.
23 Q. So any water that was being passed at Lowrie
24 that was passed below Haiku, it wasn't passed through
25 any pipes at the Haiku Ditch?

A. It wasn't passed at the Haiku Ditch.

Q. If anything, it went through Mr. Poncho's auwai?

A. If anything it was diverted off of Hanehoi Stream into Poncho's 'auwai, over our Haiku Ditch tunnel and eventually back into Hanehoi Stream.

Q. Was EMI involved in maintaining the Lowrie pipes or maintaining Poncho's 'auwai?

A. No, we were not.

Q. And is your understanding that Poncho is no longer there?

A. I understand that Poncho had passed away in the early '90s sometime.

Q. And do you know what's happened with his 'auwai since?

A. His 'auwai I know is grassed up. And down at the Lee property, I went down there maybe four, five years ago for a land matter, there was evidence of his 'auwai and also there was a small reservoir at the end where he caught some of that water and used it for domestic purposes.

Q. Now, I take it that when Poncho was diverting the water that passed the Lowrie diversion and he diverted it and was able to put it back in below Haiku, when you were at EMI, did EMI ever object to

1 that?
2 A. No, we didn't have any objections to that.
3 Q. And would EMI have a problem with essentially
4 the same amount of water being passed around the Haiku
5 diversion as it used to be when Poncho used to operate
6 his auwai?
7 A. No, we would not have a problem with that.
8 Q. Talk a little bit about the Wailuanui area.
9 Could you explain to Judge McConnell what
10 Kikokiko is?
11 A. Kikokiko is an area above Wailua. It is
12 actually part of the Waiokamilo Stream system. How
13 the name Kikokiko got there, I don't know. But at
14 Waiokamilo Stream at Kikokiko intake, from my
15 understanding, the stream is very, very porous in that
16 area.
17 So what EMI did when they built the Koolau
18 Ditch was that instead of having the diversion at the
19 Koolau Ditch, they went further up the stream, maybe
20 another three quarters to a mile. And what they did
21 was they diverted the stream way above there.
22 And this diverted water went into a small
23 concrete ditch, maybe 18 inches by 18 inches. And
24 what the ditch essentially did was to bypass that
25 leaky area of the stream.

1 So we got the water into our Koolau Ditch
2 by bypassing that leaky stream section.
3 HEARINGS OFFICER JUDGE McCONNELL: And
4 that's above Kikokiko?
5 THE WITNESS: That's at Kikokiko above the
6 Koolau Ditch.
7 Q. MR. SCHULMEISTER: When we went on the site
8 visit, we went to the mauka lookout and looked mauka,
9 we could see there was one waterfall kind of off in
10 the distance -- actually if you look at Exhibit A-23.
11 We have the photo A-23.
12 A. A-23 has no photo.
13 MR. SCHULMEISTER: Do you have A-23.
14 MS. LOVELL: I've got a different --
15 MR. SCHULMEISTER: There are three photos
16 that make up A-23.
17 HEARINGS OFFICER JUDGE McCONNELL: I
18 remember it, but I can't find it.
19 Q. MR. SCHULMEISTER: Can you point out in the
20 photo where Kikokiko is?
21 A. Kikokiko is up on the top just above to the
22 left of center, this waterfall right here.
23 Q. Is that the primary location at which
24 Waiokamilo Stream is diverted into the Koolau Ditch?
25 A. Yes, it is, through our Kikokiko Ditch

1 further above.
2 Q. And then what's below that? There's a
3 waterfall. Are there springs somewhere below that?
4 A. Below this waterfall there's a spring there.
5 People call it either Banana Spring or Akeke Spring.
6 And that spring feeds the taro growing area of Wailua.
7 Q. Could you look at Exhibit A-29, please? Do
8 you have Exhibit A-29?
9 A. Yes, I do.
10 Q. And this is referred to in your direct
11 testimony as being a CWRM water registration that you
12 worked on?
13 A. Yes. This is the registration of stream
14 diversion works and declaration of water use for
15 Waiokamilo, Kualani, Puolua and Waikani Streams.
16 Q. How did it come about -- strike that.
17 Did you work personally on helping to put
18 this together?
19 A. Yes, I assisted at that time Mrs. Apolonia
20 Day who was the president of the Wailuanui Taro
21 Growers Association.
22 Q. And what was the purpose of this registration
23 statement?
24 A. The purpose of registration statement was
25 requirement by the Commission on Water Resource

1 Management to have all stream diversions registered
2 by, I believe it was 1989.
3 Q. A-25. The diversion works that are
4 registered on A-29 that you just looked at, are they
5 shown somewhere on your schematic, A-25?
6 A. Yes, it is.
7 Q. Could you just briefly describe it to Judge
8 McConnell?
9 A. On Exhibit A-25 there are diversions, I think
10 you have one that's colored, the ones colored in
11 yellow are the stream diversions. Starting at the
12 very top on your right-hand side, it's Dam No. 3. And
13 as you move down, Waiokamilo Stream, there's Dam No.
14 2. And where Dam No. 2 diverts Waiokamilo water
15 eastwards towards Kualani Stream, there's Dam No. 1
16 where it says Roseapple.
17 Q. Now, when we went on the site visit the last
18 day that we were here, and we went up and looked at
19 Dam 3 and Dam 2; is that right?
20 A. Yes, we did.
21 Q. And we also went to Lakini taro patches and
22 looked at Dam 1?
23 A. Yes, we did.
24 Q. Now, we talked about Kikokiko diverting water
25 into the Koolau Ditch from Waiokamilo Stream. Does

1 EMI divert water from Kualani Stream or also what's
2 been referred to as Hamau Stream?
3 A. You know, upon review of our ditch map and
4 going out there on a field inspection a couple of
5 weeks ago, it appeared that our map is incorrect in
6 Kualani Stream. It needs to be revised. But what we
7 had found out in the field is that what is shown as
8 Kualani on this map is actually not Kualani Stream.
9 Q. Okay. So getting back to my question, does
10 EMI divert water into the Koolau Ditch, or does EMI
11 divert water at all from Kualani Stream?
12 A. No, we do not.
13 HEARINGS OFFICER JUDGE McCONNELL: And
14 what you're referring to is this (indicating)?
15 THE WITNESS: That there on the left-hand
16 side of the page is Wailuanui Stream. Kualani Stream
17 is --
18 HEARINGS OFFICER JUDGE McCONNELL: This
19 one?
20 THE WITNESS: Yes, that's the one.
21 Q. MR. SCHULMEISTER: And the reference you just
22 made to having gone to the field and found that the
23 map is in error, which map are you referring to?
24 A. I'm referring to this EMI ditch map, the
25 colored map.

1 Q. Exhibit A-1?
2 A. Exhibit A-1.
3 Q. And in what regard is it not correct?
4 A. As it is shown on the EMI map, it's shown as
5 Kualani Stream. You can see the numbers on the map by
6 close to number 69. We have two diversions, one at 69
7 and one at 73. And actually those diversions are
8 tributaries of Waiokamilo Stream and not Kualani
9 Stream.
10 Q. And how did you determine that that's the
11 case?
12 A. Well, first of all, when we went out there,
13 went up on West Wailua-Iki Road, came up to the
14 intersection of the Upper Ditch Road and West
15 Wailua-Iki Road, and what we did basically was count
16 the turns going towards Kikokiko. And what we did was
17 we stopped off at various points. And what we had
18 believed was Kualani based on this map here, we
19 climbed to a point so that we could see where exactly
20 that water was going.
21 It was a very, very rainy day. It was
22 hard to see, but it was clear in my mind that that
23 water was not Kualani as depicted on this Exhibit A-1
24 map.
25 Q. Now, were you present during the testimony of

1 Mr. Wendt?
2 A. Yes, I was.
3 Q. And do you recall him having testified that
4 Dam 3 would not be necessary if it weren't for the EMI
5 diversions? In other words, that there would be
6 enough water in Kualani Stream to go into Lakini, then
7 cross Lakini down below, even without diverting water
8 at Dam 3, if it weren't for the EMI diversion?
9 A. Yes, I recall that.
10 MR. HAIA: Objection. Misstates his
11 testimony.
12 HEARINGS OFFICER JUDGE McCONNELL: I'll
13 permit it. I mean, you know, the record will speak
14 for itself.
15 THE WITNESS: Yes, I recall that.
16 Q. MR. SCHULMEISTER: Do you agree with that
17 testimony?
18 A. No, I don't.
19 Q. Can you explain why?
20 A. Because of the fact that if Dam 3 was not
21 present, the water that goes into Waiokamilo Stream
22 would basically sink into that porous pond and it
23 would not be diverted towards Kualani Stream to be
24 diverted at Dam No. 1, which is the main diversion
25 into Lakini and subsequently into Wailua.

1 Q. Now, were you involved in some repairs to Dam
2 3 that were done towards the end of 2004?
3 A. Yes, I was.
4 Q. What was -- what were those repairs
5 basically, just describe for the judge.
6 A. The repairs was basically Dam No. 3 was a
7 concrete dam. And I believe what happened was because
8 of storms in the past, and things like that, the dam
9 got washed away. And when we went up there, what we
10 noticed was that in order for the dam to continue to
11 divert water around that porous pool, some rocks with
12 some sandbags and some dirt and some other stuff had
13 been put in the stream so that the water would be
14 diverted around that porous pond.
15 Q. Do you have A-30?
16 A. Yes, I do.
17 Q. Do you recognize A-30?
18 A. Yes, I do.
19 Q. Does Exhibit A-30 relate to the repairs that
20 were done to Dam 3?
21 A. Yes, it does relate to the repairs done to
22 Dam 3. Exhibit A-30 is an interim agreement regarding
23 the taro water in East Maui. And as agreed upon by
24 both EMI, A & B along with Native Hawaiian Legal
25 Corporation that we would work in good faith to try

1 and repair some of these areas, and one of the areas
2 was Dam No. 3, to reconstruct Dam No. 3 to a solid
3 concrete dam as it was originally.
4 Q. All right. Is Dam 1, Dam 2 or Dam 3, are any
5 of those dams EMI Irrigation Company diversion works?
6 A. None of those dams belong to us. We do not
7 have any control over those diversions.
8 HEARINGS OFFICER JUDGE McCONNELL: What
9 did you say, 1, 2 and 3?
10 MR. SCHULMEISTER: Yeah.
11 Q. And did EMI pay for the repairs that were
12 done to Dam 3?
13 A. Yes, we did.
14 Q. Why did EMI do that if it's not an EMI dam?
15 A. Because we wanted to do it in good faith and
16 to try to help other taro growers in Wailua to get
17 more water to their taro patches.
18 Q. In the schematic it shows how it crosses the
19 road and goes down the road, or Waiokamilo?
20 A. Correct.
21 Q. What about Wailuanui Stream?
22 MR. HAIA: Can I interrupt for a minute?
23 Exhibit A-30 is a confidential document. It was one
24 that was entered into pursuant to Rule 408. I have a
25 real concern with releasing that.

1 If you look at Page 2, first paragraph,
2 last sentence: "The parties agree that this interim
3 agreement is made in the course of settlement
4 discussions in accordance with Rule 408 of the Hawaii
5 Rules of Evidence, and shall not be construed as an
6 admission and cannot be used for any purposes
7 prohibited thereby".
8 MR. SCHULMEISTER: It's been on our
9 exhibit list for a long time.
10 MR. HAIA: I'm objecting to it right now.
11 HEARINGS OFFICER JUDGE McCONNELL: It's
12 offered only to show that they were interested in the
13 repair of Dam 3. Right?
14 MR. HAIA: That's not what he's testifying
15 to.
16 HEARINGS OFFICER JUDGE McCONNELL: I know,
17 but that's all I heard.
18 MR. HAIA: It doesn't seem to be any
19 applicability with respect to Rule 408 if it's not
20 going to apply.
21 HEARINGS OFFICER JUDGE McCONNELL: It
22 won't be in then for any other -- he's testified
23 though that basically it was a deal to fix Dam 3.
24 MR. HAIA: I move to strike it, judge.
25 HEARINGS OFFICER JUDGE McCONNELL: Strike

1 what?
2 MR. HAIA: The exhibit.
3 HEARINGS OFFICER JUDGE McCONNELL: I'm not
4 receiving the exhibit.
5 MR. HAIA: And the testimony based upon
6 the exhibit.
7 HEARINGS OFFICER JUDGE McCONNELL: I'll
8 deny that.
9 MR. SCHULMEISTER: Do you have your
10 schematic A --
11 HEARINGS OFFICER JUDGE McCONNELL:
12 Although I think --
13 MR. SCHULMEISTER: I think previously we
14 had a stipulation that everything --
15 HEARINGS OFFICER JUDGE McCONNELL: It was
16 in any way, wasn't it?
17 MS. LOVELL: My copy is heavily redacted.
18 MR. SCHULMEISTER: The one that is in is
19 also heavily redacted.
20 MR. HALL: That's not point.
21 HEARINGS OFFICER JUDGE McCONNELL: This
22 one here is not redacted.
23 MS. LOVELL: No, the attachments to it.
24 MR. HALL: The redactions weren't
25 redacted --

1 THE COURT REPORTER: You have to speak up.
2 I can't hear you.
3 MR. HALL: The purposes of the redaction
4 wasn't to remove the essential materials, the whole
5 document is a settlement document.
6 HEARINGS OFFICER JUDGE McCONNELL: First
7 off, if it's already in, it's already in anyway.
8 MR. HALL: I thought you just struck it.
9 HEARINGS OFFICER JUDGE McCONNELL: Well,
10 any objection? I'll strike it. I don't have a
11 problem with that. It's -- to the extent it shows the
12 agreement to repair 3, that's all I'm taking from it.
13 Otherwise struck, hearing no other argument.
14 MR. SCHULMEISTER: Well, just for the
15 record, I don't want to belabor this, but I just
16 wanted to just note for the record that -- I can't put
17 my finger on it right now -- but there has been some
18 testimony in some of the declarations that have been
19 submitted to the effect that EMI has been unresponsive
20 to the taro farmers and unavailable and unwilling to
21 do anything to assist them or make sure that they have
22 enough water for taro. And to the extent that that
23 indicates to the contrary, I would submit that they've
24 opened the door to it, but I don't want to get into
25 it.

1 MR. HALL: I take great offense to that
2 because we have had so many settlement discussions
3 that have gone nowhere. The fact that Garret Hew
4 takes some taro down to one of the taro growers and
5 then EMI shuts off the water, that's the heart of the
6 matter.
7 HEARINGS OFFICER JUDGE McCONNELL: I've
8 already ruled on it.
9 MR. HALL: We wouldn't be here if EMI
10 would do what is essentially being requested, which is
11 to let down more water.
12 MR. SCHULMEISTER: I won't take that bait.
13 MR. HALL: Just let down more water.
14 MR. SCHULMEISTER: Could we take a short
15 break?
16 HEARINGS OFFICER JUDGE McCONNELL: Okay.
17 (Recess was taken.)
18 HEARINGS OFFICER JUDGE McCONNELL: We're
19 back on the record.
20 MR. FREEDMAN: I just have an
21 administrative thing about my witness. If I call him
22 now, he will be here about 4:10. I'm getting the
23 sense that this won't be finished by then. Is it okay
24 if we just interrupt or take out of order or whatever
25 opposing counsel --

1 MR. HAIA: I have no problem with that.
2 HEARINGS OFFICER JUDGE McCONNELL: I don't
3 care.
4 MR. FREEDMAN: I appreciate that.
5 HEARINGS OFFICER JUDGE McCONNELL: Let's
6 start already.
7 Q. MR. SCHULMEISTER: You have Exhibit A-56?
8 A. A-56.1 through A-56.5.
9 Q. Could you explain what that is?
10 A. Exhibit A-56.1 is a picture of Waikani
11 Waterfall on Wailuanui Stream.
12 Q. Is that right -- basically at the Hana
13 Highway?
14 A. Just below the Hana Highway. Exhibit A-56.2
15 is a picture of the pond, where this Waikani Waterfall
16 goes into.
17 Exhibit A-56.3 is a picture of Sam Akina
18 standing next to a boulder. And right in front of him
19 is where the intake pipe from Waikani goes to Wailua.
20 Exhibit A-56.4 is a section of pipe that
21 was broken off of that existing pipe due to a
22 landslide.
23 And Exhibit A-56.5 is the existing intake
24 into -- from Wailua Stream going into Wailua minus the
25 intake pipe, which is on Exhibit A-56.4.

1 Q. Is this also referred to as a siphon?
2 A. Yes, it is.
3 Q. And did you take these pictures?
4 A. Yes, I did.
5 Q. And what were the circumstances that led to
6 you taking these pictures?
7 A. I got a call from Council Member Bob Carrol
8 one day asking if EMI could provide some assistance to
9 the taro growers in regards to repairing this pipe
10 which was damaged by landslide.
11 Q. About when was that?
12 A. I believe these pictures were taken I think
13 about three years ago.
14 Q. And did anything come of that?
15 A. No. We have not gone up there to repair this
16 pipe. One of the reasons is because flows were too
17 high and we needed to coordinate some of this work
18 activity with the County of Maui who was agreeable
19 with helping, and also with the taro grower on that
20 end.
21 Q. Now, what affect, if any, did the landslide
22 and this broken pipe have on the ability of the taro
23 growers to use water from this pond?
24 A. I think during normal periods, I don't think
25 it's a problem. The pipe, actually that siphon pipe

1 in Exhibit A-56.4 was connected to this Exhibit
2 A-56.5. It went into this pond about four feet under
3 the level of the water. And what it did was it
4 prevented any leaves or any debris from going into
5 this pipe, since this pipe was underwater it would be
6 always taking freshwater. That would relieve the need
7 of maintenance of this pipe to a certain extent.
8 Q. I have handed you Exhibit A-53. Could you
9 explain what Exhibit A-53 is?
10 A. Exhibit A-53 is an aerial photo of Wailuanui
11 taken on October 25th, 2005. And the areas that are
12 outlined in black and numbered are areas that are in
13 taro production.
14 Q. How do you know that?
15 A. By looking at the area you can see areas that
16 are open and cultivated and planted, based on this
17 photo.
18 Q. And do you have Exhibit A-52 in front of you?
19 A. Yes, I do.
20 Q. What is A-52?
21 A. Exhibit A-52 is a summary of the Wailuanui
22 acreage and taro as of 10/25/05.
23 Q. How was this prepared?
24 A. This was prepared first of all with this
25 aerial photo by identifying each particular area that

1 was under cultivation with the assistance of a
2 Keanae-Wailua taro farmer indicating the lo'is, the
3 farmer, and looking up on the tax map key who was the
4 owner and the acres.
5 MR. HAIA: Excuse me. Did I hear
6 correctly? Did you say this draft was done with the
7 assistance of each taro farmer?
8 THE WITNESS: No. What I said was this
9 summary was done with the assistance of one
10 Keanae-Wailuanui taro farmer.
11 Q. MR. SCHULMEISTER: Could you look at Exhibit
12 A-54, which is in front of you. This one I have ten
13 full size copies so anyone who wants one, you're
14 welcome to it.
15 Could you explain what Exhibit A-54 is?
16 A. Exhibit A-54 is an aerial photo taken on
17 October 3rd, 1985 of the Wailuanui area.
18 Q. What's the shaded areas?
19 A. The highlighted areas in yellow on this
20 Exhibit A-54, corresponds to this aerial photo taken
21 10/25/2005 and transposed on this aerial photo dated
22 10/3/85.
23 MR. HAIA: Judge, I just want to object to
24 both of these exhibits. They are way past the
25 deadline. Never any indication to the parties that

1 these exhibits were going to be produced. It's taking
2 us by total surprise and I would move to strike them.
3 MR. SCHULMEISTER: Your Honor, I would
4 like to point out in response to interrogatories that
5 we gave to -- one of the things we asked for was for
6 them to tell us what the acreage was that was in
7 cultivation. And they basically didn't answer those.
8 So we just did the best we could.
9 MR. HAIA: That's A & B's burden.
10 MR. SCHULMEISTER: Well, and we're trying
11 to meet that, and that's why we're putting it in.
12 MR. HAIA: A little late, Dave.
13 HEARINGS OFFICER JUDGE McCONNELL: I'll
14 overrule that.
15 Q. MR. SCHULMEISTER: With regard to the last
16 column on A-52, the acres.
17 A. Yes.
18 Q. Can you explain how the acres that are listed
19 there, how those were determined?
20 A. The acres that were -- the acres on the
21 right-hand side of Exhibit A-52 was determined by
22 scaling off all of these highlighted colored areas by
23 our registered surveyor and using the approximate
24 scale to determine the acres for each individual
25 number lo'is.

1 MR. HAIA: You know, Judge, I'm not going
2 to agree to take Mr. Hew's word for it that there was
3 someone else that did the scaling for him without
4 having the opportunity to have that person before us.
5 HEARINGS OFFICER JUDGE McCONNELL: I've
6 already ruled, let's go on.
7 MR. HAIA: With respect to the scale, and
8 that's how they got these numbers?
9 Q. MR. SCHULMEISTER: Do you know what the scale
10 is --
11 HEARINGS OFFICER JUDGE McCONNELL: I'm not
12 accepting it as gospel, you can cross-examine.
13 MR. HAIA: I don't think I need to
14 cross-examine. This stuff shouldn't be coming in.
15 HEARINGS OFFICER JUDGE McCONNELL: All
16 right. But it is, it's coming in. It's an
17 administrative hearing. I'm not going to keep it out.
18 Q. MR. SCHULMEISTER: Do you know what the scale
19 is on the photo?
20 A. The scale on Exhibit A-54 indicates one inch
21 equals 200 feet.
22 Q. When you say it was scaled, is that what
23 you're referring to? You're scaling it off the one
24 inch equals 200 feet?
25 A. What you're doing is taking each individual

1 highlighted parcel and measuring each parcel to
2 determine how many feet it is to calculate area.
3 Q. If you go back to Exhibit A-53 for a moment.
4 The area that has the number seven on the
5 left-hand side, do you see that?
6 A. Yes.
7 Q. On A-52, number seven is listed as having the
8 farmer being Norman Martin; is that right?
9 A. Yes, that's correct.
10 Q. And the acreage is listed at 2.505 acres?
11 A. That's correct.
12 Q. Now, do you know where Norman Martin gets the
13 water to irrigate the taro that's in that area
14 identified as number seven?
15 A. Norman Martin gets his water from Wailuanui
16 Stream.
17 Q. And to your knowledge, do any of the other
18 areas -- any of the other numerical listings on A-53,
19 any of those other patches get their water from
20 Wailuanui Stream?
21 A. From my knowledge right now, just number
22 seven gets water from Wailuanui Stream.
23 Q. So looking at A-52 then, if what we wanted to
24 do is calculate the acreage that gets their water from
25 Waiokamilo Stream, would we then take out the 2.505

1 acres that Norman Martin is farming?
2 A. Yes.
3 Q. So what does the 16.979 at the bottom of A-52
4 represent?
5 A. That 16.979 acres represent taro utilizing
6 Waiokamilo Stream water.
7 Q. A-54, which is the 1985 aerial photo, in
8 looking at that, does there appear to have been more
9 taro in cultivation in 1985 than in October of 2005?
10 A. Yes.
11 Q. And you were at EMI in 1985?
12 A. Yes, I was.
13 Q. Is that consistent with your memory of what
14 was going on in Wailuanui?
15 A. Yes, it is.
16 Q. So between 1985 and 2005 you've witnessed a
17 reduction in the amount of taro being cultivated in
18 that area?
19 A. Yes, I have.
20 Q. Now, has there been any increase in the
21 amount of water that EMI is diverting from Waiokamilo
22 Stream or Wailuanui Stream in those 20 years?
23 A. No. No, there has been no increase.
24 Whatever we were diverting in 1985 is the same amount
25 that we are diverting in 2005, so the structures have

1 not changed.
2 Q. Look at A-51, Exhibit A-51. Have you seen
3 that before?
4 A. Yes, I have.
5 Q. And that's a March 10th letter?
6 A. March 10th, 2005 letter, yes.
7 HEARINGS OFFICER JUDGE McCONNELL: I don't
8 have it.
9 MR. SCHULMEISTER: That would have been
10 given to you last time.
11 MR. HAIA: Are these the exhibits just
12 handed out this morning?
13 MR. SCHULMEISTER: No.
14 This is our supplemental exhibits from the
15 last hearing March 10th letter 2005.
16 MR. HAIA: Before we begin though I just
17 want to say, our position is that this is another
18 letter intended to try and reach an agreement to
19 prevent this actual hearing right here. And so based
20 upon that, we would want it struck.
21 It says: The purpose of this letter is to
22 follow up on our meeting of February 25, 2005 at Randy
23 Ishikawa's office --
24 HEARINGS OFFICER JUDGE McCONNELL: Yeah, I
25 can read that.

1 MR. HAIA: And it says: To obviate the
2 need for a hearing on interim releases pending the
3 conclusion of the above-referenced contested case
4 hearing.
5 HEARINGS OFFICER JUDGE McCONNELL: Yeah,
6 the rule says that an offer of settlement is not
7 admissible to prove liability; and it also says if you
8 make statements in the course of a mediation, that
9 those can't be used.
10 MR. HAIA: Well, my understanding is that
11 Mr. Schulmeister is going to use this to argue --
12 HEARINGS OFFICER JUDGE McCONNELL: What's
13 it offered for?
14 MR. SCHULMEISTER: Well, what it's offered
15 for basically is in March of 2005 it was stated that
16 more water was needed down in Wailuanui. And also
17 that I guess Ed Wendt and Na Moku did not want to deal
18 with Mr. Hew. So they asked us to authorize Mr.
19 Vaught, I guess, to be contacted.
20 And this letter that confirms that, and
21 also states what EMI is willing to do in terms of
22 working with them to get more water for their taro.
23 And at that point, you know, basically Mr.
24 Vaught was to receive a call from Mr. Ed Wendt and
25 from there efforts would be made to try to work it

1 out. And Mr. Wendt never made the call.
2 MR. HALL: Judge, those are ongoing
3 settlement discussions going on since 2001 and never
4 comes to fruition because EMI never lets down any
5 water. It's as simple as that. It can't be received
6 into evidence.
7 MR. SCHULMEISTER: Well, it's actually
8 already been stipulated in, number one; and number
9 two, I would also like to point out that Mr. Wendt in
10 one of the declarations -- what was also going on at
11 this time was that Na Moku took an appeal to the
12 circuit court, and he put in a declaration which is
13 also in the exhibits stating that this happened and
14 stating that the reason why he didn't call Mr. Vaught
15 was because he thought he didn't have enough authority
16 or something to that effect.
17 So Na Moku itself in the testimony of Mr.
18 Wendt in the declaration has put the circumstances of
19 all this into issue. And so I think it is appropriate
20 for it to come in.
21 MR. HAIA: How does this have anything to
22 do with the interim relief, Judge? That's what I want
23 to know.
24 HEARINGS OFFICER JUDGE McCONNELL: Well,
25 there's a great deal of evidence here that I would

1 agree may have relatively little to do with that
2 question. But, you know, the question was apparently
3 opened if Mr. Schulmeister's representations are
4 correct. And it's already stipulated in, so I'll
5 receive it.
6 Just while we're talking though, I am
7 concerned about acreage. And if you folks have any
8 technical problem with the amount of acreage, I would
9 submit some rebuttal -- permit rebuttal on that.
10 Because I understand they didn't give you this map
11 earlier.
12 MR. HAIA: Thank you.
13 Q. MR. SCHULMEISTER: Could you just read out
14 loud the second to last paragraph of Exhibit 51?
15 A. This is the March 10th, 2005 letter, Page 3.
16 Once the 'auwai is cleared, if adequate
17 water is not reached in the lo'i, please have your
18 client contact Mark Vaught. If the condition of Dam
19 No. 1 is such that closing EMI's west Kualani intake,
20 if six-inch diversion downsized to a four-inch pipe
21 above Kualani Stream would allow more water to be
22 directed into the Lakini taro patches, EMI is prepared
23 to do so as well as to consider other alternatives on
24 a trial and error basis as you requested in our
25 meeting of February 25th, 2005.

1 Q. Now, that reference to intake above Kualani,
2 was that before you discovered that the map was in
3 error?
4 A. That's correct.
5 Q. So what intake does that actually refer to?
6 A. This intake would refer to the east tributary
7 of Waiokamilo Stream.
8 Q. And to your knowledge did anyone from Na Moku
9 ever respond to this?
10 A. No.
11 Q. In terms of calling Mr. Vaught?
12 A. No one from Na Moku had contacted Mr. Vaught
13 on this issue.
14 MR. SCHULMEISTER: I have no further
15 questions.
16 HEARINGS OFFICER JUDGE McCONNELL: Any
17 questions by county first?
18 MS. LOVELL: I've got just a couple.
19 CROSS-EXAMINATION
20 BY MS. LOVELL:
21 Q. Can I stand here, Mr. Hew? You've got A-1
22 there, right?
23 A. A-1 is the map of our ditch system, correct.
24 Q. Now, over in the left-hand bottom corner do
25 you see Kamole Weir?

1 A. Yes, I do.
2 Q. And the way the map looks it kind of looks as
3 if the Wailoa Ditch ends there and all the water in
4 the ditch ends up in Kamole Weir, but that's not how
5 it works, is it?
6 A. Actually the water in the Wailoa Ditch ends
7 up in Kamole Weir where it is divided into several
8 different places. One is for the County of Maui for
9 their up-country water system, and from there the rest
10 of the water, depending on the amount of flow, is
11 divided into different ditches that we operate through
12 hydroelectric plants.
13 Q. So just so the record is clear, did you
14 happen to read the county's written testimony which
15 explains how much water the county uses through Kamole
16 Weir?
17 A. Yes.
18 Q. And did that seem accurate to you?
19 A. It did seem accurate, yes.
20 Q. So at the moment it's my understanding that
21 there's sort of a maximum capacity for the county to
22 take about 8 million gallons a day.
23 A. That's correct.
24 Q. Thank you.
25 I have one other set of questions. Same

1 exhibit. In the license areas there are different
2 percentages where it says government water, private
3 water. Do you see those?
4 A. Yes.
5 Q. Could you explain what is meant by government
6 water there?
7 A. Government water is actually water that is --
8 that arises on state-owned land. And the way they
9 figured out the percentages was by taking a map and
10 having that map indicate state land versus EMI land.
11 And what they did was they took that map
12 and it was an isohyetal map. An isohyetal map is a
13 map that indicates belts of rainfall. Like for
14 example, this section here gets 300 inches, this one
15 250, this one here -- so what they did was calculate
16 the proportionate amount of rainfall that fell on each
17 area in each water license area, and that's how they
18 came up with these percentages.
19 Q. And the government that's referred to there
20 is the state government?
21 A. State of Hawaii, that's correct.
22 Q. Not the county government?
23 A. Not the county.
24 HEARINGS OFFICER JUDGE McCONNELL: What do
25 you call those maps again?

1 THE WITNESS: Isohyetal.
2 HEARINGS OFFICER JUDGE McCONNELL: You
3 said -- what did you say the maximum capacity for the
4 county to take, 8 million? What was that testimony?
5 I was doing two things at once.
6 THE WITNESS: The county, our agreement
7 with the county, they can take maximum of about almost
8 8 million gallons at the Kamole Weir.
9 HEARINGS OFFICER JUDGE McCONNELL: That's
10 by agreement?
11 THE WITNESS: That's by agreement,
12 correct.
13 MR. MERCHANT: It's also by capacity.
14 HEARINGS OFFICER JUDGE McCONNELL: By
15 capacity of the weir?
16 THE WITNESS: And it's also by the
17 capacity of their treatment plant, as I understand.
18 MS. LOVELL: If you look, Judge McConnell,
19 at -- you don't need to do it now, but I can give you
20 a reference. In the county's written testimony in
21 paragraph three --
22 MR. HALL: I'm going to object --
23 HEARINGS OFFICER JUDGE McCONNELL: Yeah,
24 right. I don't need it. I understand the question.
25 Let's go on.

1 No questions over there. I assume, Mr.
2 Haia, you have some questions.
3 MR. HAIA: Thank you, Judge.
4 CROSS-EXAMINATION
5 BY MR. HAIA:
6 Q. Just so I don't forget, I'm going to go along
7 the lines that Jane was asking you.
8 When you refer to government water, are
9 you suggesting that the State of Hawaii owns that
10 water?
11 A. No, I'm not saying that. What I'm just
12 saying is that she pointed to this map and asked what
13 is government water. And what I replied was that
14 government water meant rainfall that fell on
15 state-owned land.
16 Q. So what about the water that falls on what
17 you claim to be A & B or EMI's property, whose water
18 is that?
19 MR. SCHULMEISTER: I object, calls for
20 legal conclusion.
21 Q. MR. HAIA: Your understanding, that's all I
22 want to know, what's your understanding?
23 HEARINGS OFFICER JUDGE McCONNELL: You
24 know, the difficulty it's a legal issue completely,
25 so --

1 MR. HAIA: All I'm asking for is his
2 understanding, Judge. You've given plenty of leeway
3 the other way.
4 HEARINGS OFFICER JUDGE McCONNELL: I will
5 give you leeway. What is your understanding?
6 THE WITNESS: My understanding is that I'm
7 not a legal counsel, I'm not trained to be, and it's a
8 very gray area. And all I know is where the water
9 falls, falls on the land. And as far as the legality
10 to that, like I say, I'm not a legal counsel.
11 Q. MR. HAIA: You said it's a gray area. What's
12 gray about it?
13 A. Well, there's a lot of issues related to
14 water and some of these has not been fully resolved as
15 of this point in time.
16 Q. What issues are those?
17 A. There are a lot of issues.
18 Q. For instance --
19 HEARINGS OFFICER JUDGE McCONNELL: You're
20 out of the scope of his expertise, Mr. Haia.
21 MR. HAIA: There were a lot of things that
22 he was testifying to out of his scope, Judge, that you
23 allowed.
24 HEARINGS OFFICER JUDGE McCONNELL: You're
25 asking him what gray areas there are in Hawaii water

1 law. I find that --
2 MR. HAIA: I'll go on.
3 HEARINGS OFFICER JUDGE McCONNELL: Okay,
4 thank you.
5 Q. MR. HAIA: When you look at Exhibit A-1 and
6 the ditch systems that are controlled by A & B and
7 EMI, what purpose does the ditch system serve?
8 A. In what capacity?
9 Q. Why is it there? What is it doing?
10 A. The ditch system was built, first ditch was
11 built in 1876. And this was to divert stream waters
12 in the wet part of the island over to the dry area for
13 sugar cultivation.
14 Q. And with respect to each ditch system, are
15 there any occasions when A & B or EMI releases less --
16 that they don't carry the full capacity of the ditch
17 system? In other words, does A & B, EMI ever let
18 water go past the ditch system that it could catch?
19 A. If you're asking if we're diverting water
20 from this area, yes, we are, up to the capacity of our
21 system.
22 Q. What is that capacity?
23 A. 450 million gallons per day.
24 Q. Mr. Schulmeister was asking you about Exhibit
25 A-1 and the various color coded areas, and you were

1 saying that, I believe, the green area are A & B owned
2 properties?
3 A. No. The green areas are owned by East Maui
4 Irrigation Company.
5 Q. Okay. And the light brown areas?
6 A. This light brown or kind of orange area is
7 owned by our parent company, Alexander & Baldwin, Inc.
8 Q. Okay. I just want to know what the basis is
9 for your claim that that is in fact an accurate
10 depiction of the property owned by A & B and/or EMI.
11 How do you come to that conclusion?
12 A. I didn't prepare this map. It was prepared
13 back in 1970 originally, so I can't answer that
14 question.
15 Q. Who's responsible for the preparation of
16 Exhibit A-1?
17 A. This map here was prepared by our survey
18 department in 1970, and we have been using this map
19 for our operational purposes.
20 Q. I observe that, based upon your personal
21 observations, you found there was a problem with
22 a portion of that map, correct?
23 A. We found an error in one particular area that
24 needs to be revised.
25 Q. Since 1970, have you ever, or do you know if

A & B or EMI has ever tried to update that map to find out whether in fact it's an accurate depiction?

A. Yes, we have.

Q. When was that?

A. This map was originally made in April of 1970. It was revised on June 5th, 2003 and also February 28, 2004.

Q. So once again I ask you, do you know who's responsible for making these claims? Who produced that map specifically, a name?

A. This map was produced by Ronald M. Fukumoto Engineering, Inc.

Q. Do you know who Mr. Fugimoto --

A. Mr. Fukumoto is president of the company.

Q. Any explanation why the depiction as it regards Puolua Stream and Kualani Stream and its diversion was erroneous?

A. It was carried over from 1970.

Q. Who provided Mr. Fukumoto with the information to make the map?

A. He didn't make this map in 1970. I believe it was our A & B survey department that did this original map. And we had retained Mr. Fukumoto's services back in June of 2003 whereby we had this map digitized.

1 Q. Okay, I understand. With respect to Kualani
2 Stream, are you saying that there is no way that water
3 from Kualani Stream gets into Wailuanui Valley?
4 A. Can you repeat that, please?
5 Q. Yeah, I can. With respect to Kualani Stream,
6 given your correction on the record, is it also your
7 opinion, based upon the information you now have, that
8 Kualani Stream does not flow somehow someway into
9 Wailuanui Valley?
10 A. No, that is not correct.
11 Q. What is correct on your understanding?
12 A. My understanding, after doing the field
13 check, is that EMI does not divert water from Kualani
14 Stream. Kualani Stream arises below our ditch system,
15 and it does go into Wailuanui, or rather it meets up
16 with Waiokamilo Stream waters.
17 Q. I'm just having a problem with you not
18 finding out sooner that Kualani Stream did not extend
19 above the ditch system for 30-something years.
20 Wouldn't that be something that would be
21 obvious to you or one of your workers that Kualani
22 Stream did not extend beyond the ditch?
23 A. Not really.
24 Q. You know, you make it sound like it's fairly
25 obvious to you at this point. I'll move on.

1 Now, you also testified that there have
2 been no major changes to the system of ditches that
3 comprised this ditch system; is that correct, since
4 1923?
5 A. Which ditch system are you referring to?
6 Q. Haiku Ditch, Wailua, Kauhikoa, every other
7 part of the system.
8 A. In other words, the entire ditch system?
9 Q. Right.
10 A. Yes, that's correct.
11 Q. What is your definition of major change?
12 A. In terms of --
13 Q. I don't know. I'm asking you. Because you
14 said in answer to Mr. Schulmeister's question that
15 there has been no major changes to these ditch
16 systems. I just want to know what you mean.
17 A. Well, major change is constructing a brand
18 new stream diversion on a major stream. Altering the
19 course of the ditch system is a major change.
20 Q. Anything else?
21 A. No.
22 Q. I was going to leave this for Mr. Hall, but
23 you were saying that there were two gates that were
24 left open because of your guy's concern for some storm
25 systems on the way. And that they had been opened a

1 week previous to the anticipated storm, correct?
2 A. As I recall, I was off-island that week, and
3 there was a forecast of heavy downpours in East Maui
4 with, I believe, anywhere from half to nine inches of
5 rain predicted to fall overnight. And we made a
6 decision that we would cut the flow back in our EMI
7 system in order to avoid any damage to our ditch
8 system and/or to property adjacent to our ditch system
9 and also to HC&S.
10 Q. More specifically though, when was the storm
11 predicted to hit Maui?
12 A. I can't remember the exact date, sometime in
13 September though.
14 Q. Was it your testimony that you opened the
15 gates a week before?
16 A. No. We opened the gates, I believe it was
17 probably one or two days prior to anticipation of that
18 storm hitting the island.
19 Q. You know what, I want to direct your
20 attention to some other exhibits of A & B that you're
21 responsible for, and that would be A-2, A-3, and A-4.
22 Are you at A-2 right now?
23 A. Yes.
24 Q. And what is your understanding, what is this
25 exhibit?

1 A. Exhibit A-2 is Revocable Permit S-7264,
2 covers Alexander & Baldwin, Inc. Revocable Permit for
3 the Huelo License area.
4 Q. Is that permit still in effect?
5 MR. SCHULMEISTER: Object, calls for legal
6 conclusion.
7 HEARINGS OFFICER JUDGE McCONNELL: I'll
8 sustain that.
9 Q. MR. HAIA: Mr. Hew, do you know whether or
10 not Alexander & Baldwin and EMI are still operating
11 under Revocable Permit S-7264 to take water out of
12 East Maui?
13 A. Yes, I believe that's correct. We still are
14 operating under that premise.
15 Q. Okay. Now, this permit is for what is called
16 the Huelo area, correct?
17 A. Yes.
18 Q. And that is an area of what, approximately
19 8,752.690 acres, correct?
20 A. Yes.
21 Q. And for this permit, A & B, EMI was paying
22 6,000 -- or maybe still is paying, do you know,
23 whether or not they're still paying $6,588.40?
24 A. That is a rental per month, yes.
25 Q. And A & B is still presently paying that

1 amount?
2 A. I believe that's the correct amount.
3 Q. And what is your understanding of what this
4 payment is for?
5 A. This payment is for the privilege of renting
6 that watershed area, to have the right to divert water
7 off of state-owned lands for the use of sugar
8 cultivation and domestic purposes in Central Maui.
9 Q. So I made some calculations -- and I brought
10 along a calculator if you want to verify my
11 calculations -- but for any given year for this area
12 of almost 9,000 acres, A & B, EMI is paying
13 $79,060.80. Would you have any reason to not agree
14 with my calculation? Because if you do, then I'll let
15 you calculate it yourself.
16 A. It's a simple math. If you did the math, it
17 should be correct.
18 Q. I appreciate your faith in me.
19 Do you know how much water on average is
20 developed in the Huelo License area per year?
21 A. Right offhand, no.
22 Q. Can you turn to Page 4 of A-2. And I would
23 direct your attention to Paragraph 7, or provision 7,
24 and I'm going to read it to you.
25 "This Permit or any rights hereunder shall

1 not be sold, assigned, conveyed, leased, mortgaged, or
2 otherwise transferred or disposed of."
3 My question is: Does EMI have an
4 agreement with Maui Land & Pine that allows Maui Land
5 & Pine to divert water from your ditch system?
6 A. Yes, we do have an agreement with Maui Pine.
7 Q. And what is that agreement?
8 A. That is an agreement for Maui Pine to use a
9 portion of our ditch system to transport water that
10 they pump into our ditch system for use for pineapple
11 cultivation in Central Maui.
12 Q. Do you know if there's also an agreement that
13 would allow Maui Land & Pine to take more than what
14 they pump into the ditch system?
15 A. Yes.
16 Q. What is your understanding of what that
17 agreement provides for?
18 A. That agreement, it depends upon the flow of
19 the ditch at a particular time of day, and they have
20 the right to access up to 1.5 million gallons per day.
21 Q. And are there any stipulations or conditions
22 upon which Maui Land & Pine can take that water out of
23 the system?
24 A. It's basically based on ditch flow at that
25 one particular time of the day.

1 Q. Can you be more specific? Do you know what
2 the flow needs to be in order for this provision to
3 kick in?
4 A. The flow is taken at 7:00 a.m. in the
5 morning. And if the flow is above a certain amount,
6 the rate that is set for that flow, if it's below a
7 certain amount, the rate is set for that amount below
8 that flow.
9 Q. What is the minimum amount of water flowing
10 at a given point that needs to be in the ditch system
11 in order for this condition to kick in?
12 A. I believe the Wailoa-New Hamakua Ditch has to
13 be at 100 million gallons at the Honopou boundary at
14 7:00 a.m. in the morning. If it's 100 million gallons
15 or above, they can access the water from our system;
16 if it's below 100, they cannot access any water from
17 the system.
18 They can take what they put into the
19 system.
20 HEARINGS OFFICER JUDGE McCONNELL: Take a
21 short recess.
22 (Recess was taken.)
23 HEARINGS OFFICER JUDGE McCONNELL: We're
24 back on the record. Without objection, we're going to
25 take a witness, Mr. Watanabe for the Farm Bureau.

1 WARREN WATANABE
2 was called as a witness by and on behalf of the Farm
3 Bureau, was sworn to tell the truth, was examined and
4 testified as follows:
5 HEARINGS OFFICER JUDGE McCONNELL: Would
6 you state your name, please.
7 THE WITNESS: Warren Watanabe.
8 MR. FREEDMAN: Can I submit Mr. Watanabe's
9 written testimony?
10 HEARINGS OFFICER JUDGE McCONNELL: Yes,
11 that will be in evidence.
12 (Written testimony of Warren Watanabe was
13 received into evidence.)
14 You have no further questions?
15 MR. FREEDMAN: No.
16 HEARINGS OFFICER JUDGE McCONNELL: Mr.
17 Schulmeister.
18 MR. SCHULMEISTER: No questions.
19 CROSS-EXAMINATION
20 BY MR. HAIA:
21 Q. Mr. Watanabe, I'm Moses Haia, an attorney
22 representing Na Moku and a couple of other individual
23 petitioners in this contested case. I had just a
24 couple questions for you.
25 Do you have a copy of your written

1 testimony?
2 A. Yes, I do.
3 Q. Can you turn to -- it would be, I guess, it's
4 Page 1 of your testimony, and Paragraph 3.
5 You mention your concern that Maui
6 farmers' ability to continue farming would be severely
7 impacted and irreparably harmed if they didn't have
8 enough water. And then you go onto say that it would
9 be a true tragedy if one of the last vestiges of
10 traditional Maui would be irretrievably lost. And
11 you're referring to agriculture, correct?
12 A. Correct.
13 Q. Would you also agree that one of the last
14 vestiges of tradition on Maui is taro growing?
15 A. Yes.
16 Q. Would you also agree that it would be tragic
17 if that was lost?
18 A. Yeah, I would agree.
19 Q. Then you also talk about how -- at Page 3,
20 Paragraph 8, you say:
21 Unlike other sugar companies of the past
22 that have closed, the outlook for the remaining sugar
23 company on Maui is positive.
24 What sugar company are you referring to?
25 A. Hawaiian Commercial & Sugar.

1 Q. And this opinion of yours, what's it based
2 on?
3 A. Well, I think it's based on part of the
4 record. They do have some -- they have a track record
5 of being committed to agriculture on Maui.
6 Q. Would it surprise you at all if you learned
7 that in recent times the sugar operation here posted a
8 profit of $5 million, 600-some-odd-dollars, and at the
9 same time received a federal subsidy of $5 million?
10 MR. FREEDMAN: Objection, Your Honor,
11 assumes facts not in evidence and calls for
12 speculation.
13 MR. HAIA: I can bring that --
14 HEARINGS OFFICER JUDGE McCONNELL: I'll
15 permit it. If you know?
16 Q. MR. HAIA: I'm asking you would it surprise
17 you if you were to find out that very recently
18 Hawaiian Commercial & Sugar posted a profit of 5
19 million, 600-some-odd-thousand-dollars and had a
20 federal subsidy of $5 million? Do you know what that
21 means?
22 A. Yeah.
23 Q. What does that mean?
24 A. Well, I mean that --
25 MR. FREEDMAN: Objection, Your Honor.

1 This calls for an expert opinion. I'm not sure he's
2 an expert on federal subsidies.
3 MR. HAIA: He answered he knows what it
4 means.
5 HEARINGS OFFICER JUDGE McCONNELL: Can we
6 get to the original question. Does that surprise you?
7 THE WITNESS: No.
8 Q. MR. HAIA: It doesn't surprise you?
9 A. No.
10 Q. If that was the case, you still believe that
11 the outlook for this company is positive?
12 A. Yes.
13 Q. And that's because --
14 A. Their commitment to agriculture and because
15 of their direction that they plan to take to keep the
16 company going and sugar growing.
17 Q. And this understanding is based on what?
18 A. I think part of it is because they have a
19 line of specialty sugars that probably right now
20 doesn't meet the current demands, so there's room for
21 expansion of that. Transing renewable energy
22 nationwide.
23 Q. Hawaiian Commercial & Sugar?
24 A. Right.
25 Q. At Paragraph 10 you talk about how

1 agriculture is protected by the Hawaii Constitution
2 and I'm not going to read the whole thing, but I would
3 ask you, is it your understanding that taro production
4 and cultivation is also agriculture?
5 A. Yes.
6 Q. So would it fall into the same protection?
7 A. Yes. We don't argue against that. We
8 support all of the agriculture.
9 Q. You support it. Then would you also support
10 additional water for taro production in East Maui?
11 A. Well, I think our position is that we want
12 fair distribution of the resource.
13 Q. So if there were on average 165 million
14 gallons of water taken out of East Maui and into
15 Central Maui and also up-country, do you think that
16 that's a fair distribution of water vis-a-vis East
17 Maui taro growers?
18 MR. FREEDMAN: Objection, Your Honor,
19 again, speculation, beyond his expertise. Not sure if
20 he knows what every other industry needs are as far as
21 water.
22 MS. LOVELL: I object to this. It's an
23 incomplete hypothetical.
24 HEARINGS OFFICER JUDGE McCONNELL: Oh,
25 answer the question.

1 THE WITNESS: Can you repeat the question?
2 Q. MR. HAIA: I'll try to make it a complete
3 hypothetical.
4 HEARINGS OFFICER JUDGE McCONNELL: If you
5 can.
6 Q. MR. HAIA: There is on record an average of
7 165 million gallons of water per day diverted out of
8 East Maui by this ditch system and that water goes to
9 Hawaiian Commercial & Sugar and various other water
10 uses outside of East Maui.
11 With respect to East Maui, the taro
12 growers in East Maui, do you think there's a fair
13 distribution of water in that allocation?
14 MR. MERCHANT: Objection, incomplete
15 hypothetical.
16 HEARINGS OFFICER JUDGE McCONNELL: I've
17 already ruled.
18 MR. HAIA: Don't ask me to repeat it.
19 A. For me it's difficult because I don't know
20 all the requirements of everybody. What the
21 requirements are, I don't know. I don't have that
22 knowledge.
23 MR. HAIA: That's all the questions I have
24 for you.
25 MR. HALL: Mr. Watanabe --

1 MR. FREEDMAN: Is this on behalf of Maui
2 Tomorrow?
3 MR. HALL: Yes.
4 MR. FREEDMAN: I was told that at all the
5 status conferences they never indicated an intent to
6 cross our guy.
7 HEARINGS OFFICER JUDGE McCONNELL: I'll
8 permit it.
9 CROSS-EXAMINATION
10 BY MR. HALL:
11 Q. You're testifying today on behalf of Hawaii
12 Farm Bureau Federation and Maui County Farm Bureau?
13 A. Correct.
14 Q. And you have membership in the Maui County
15 Farm Bureau all over Maui, correct?
16 A. Correct.
17 Q. And you have some members in Huelo and
18 Keanae, correct?
19 A. I'm not positive.
20 Q. You have some taro growers, some flower
21 growers in Huelo that are members of the Maui Farm
22 Bureau?
23 A. Yes.
24 Q. And you're here to support them as well?
25 A. Yeah. Well, they are members.

1 Q. You're here to support them to?
2 A. (Witness nods head up and down).
3 Q. You say in Paragraph 13: Water is the
4 critical component of the success of competitive and
5 diverse agriculture.
6 When you say diverse agriculture, you mean
7 flower farming?
8 A. Yes.
9 Q. You mean taro growing?
10 A. Yes.
11 Q. So water is critical for both of those forms
12 of diverse agriculture?
13 A. (Witness nods head up and down.)
14 Q. Especially when they're members of the Maui
15 Farm Bureau too?
16 A. Yes.
17 MR. FREEDMAN: Objection, Your Honor,
18 argumentative.
19 HEARINGS OFFICER JUDGE McCONNELL: It is
20 argumentative, Mr. Hall. We have got a lot of work to
21 do.
22 MR. HALL: This is very important to this
23 proceeding.
24 HEARINGS OFFICER JUDGE McCONNELL: It's an
25 argumentative question.

1 Q. MR. HALL: In Huelo you're aware there is no
2 county source of water?
3 A. Yes.
4 Q. And those who are engaged in agriculture in
5 Huelo depend upon streamflow in many instances for
6 their water in order to engage in diversified
7 agriculture, you are aware of that?
8 A. Uh-huh.
9 Q. You are?
10 A. Yes.
11 Q. So you would support them having a sufficient
12 amount of water in their streams in order to engage in
13 diversified agriculture?
14 MR. FREEDMAN: Objection, Your Honor,
15 asked and answered. I think he's made it very clear
16 he supports all agriculture in Hawaii.
17 MR. HALL: I would like this question
18 answered.
19 HEARINGS OFFICER JUDGE McCONNELL: I'll
20 permit it.
21 THE WITNESS: Yes.
22 Q. MR. HALL: You would?
23 A. Yes.
24 Q. And you testify in Paragraph 15 about the
25 needs of up-country Maui farmers?

1 A. Correct.
2 Q. And those farmers are on the County of Maui
3 water system, correct?
4 A. Correct.
5 Q. So they get some of the 8 million gallons a
6 day that the county gets from EMI, is that correct?
7 A. Yes.
8 Q. So their source is no different from the
9 County of Maui source, correct?
10 A. As long as you're not in the ag park.
11 Q. And you're not in the ag park yourself. You
12 talk about your own needs, correct?
13 A. No.
14 Q. So you get in the county system which is part
15 of the 8 million gallons a day, correct?
16 A. Correct.
17 Q. And are you aware that EMI, of that 8 million
18 gallons that county gets from EMI, some of that comes
19 from the state and some of that comes from EMI itself?
20 A. Yes.
21 Q. Are you aware of the percentage as between
22 EMI and the state?
23 A. No.
24 Q. Are you aware that the 8 million gallons
25 could be satisfied from EMI's own water rather than

1 the state's water?
2 MS. LOVELL: Objection, argumentative and
3 again it's an incomplete hypothetical and assumes
4 facts.
5 HEARINGS OFFICER JUDGE McCONNELL: I'll
6 sustain that.
7 Q. MR. HALL: You're not aware of the percentage
8 as between the state and EMI, correct?
9 A. That's correct.
10 Q. So you're not aware of whether the county's
11 needs would be satisfied from EMI?
12 A. Yeah.
13 MR. HALL: I have no further questions.
14 HEARINGS OFFICER JUDGE McCONNELL: Any
15 other questions? Thank you, Mr. Watanabe. Okay,
16 we'll resume with Mr. Hew.
17 For the record, Mr. Hew is on the stand.
18 GARRET HEW
19 CROSS-EXAMINATION CONTINUED
20 BY MR. HAIA:
21 Q. If you recall, we were -- I was asking you
22 questions about Exhibit A-2, and the last series of
23 questions was directed to your, that is EMI's
24 agreement with Maui Land & Pine that allows Maui Land
25 & Pine to take an additional amount of water out of

1 the ditch system -- and when I say additional, I mean
2 in addition to what they actually -- Maui Land & Pine
3 actually pumps into the ditch system. Do you recall
4 all that discussion?
5 A. Yes.
6 Q. And you charge them for that, right, A & B
7 charges -- A & B and EMI charges Maui Land & Pine, for
8 lack of a better term, privilege of taking that water
9 out of the system, correct?
10 A. No, that's not correct. We do not charge
11 them for the water. We charge them a transportation
12 fee for getting that water to their point of delivery.
13 Q. Okay. So you're charging Maui Land & Pine
14 for, in essence, diverting water from a series of
15 watersheds, and taking it to a certain point at which
16 Maui Land & Pine is able to take it out of the system;
17 right?
18 A. That's correct.
19 Q. Do you have any other agreements with any
20 other parties or individuals that allow that party or
21 individual to pay for the transportation of water in
22 your ditch system?
23 A. No, we don't.
24 MR. SCHULMEISTER: Did you mean to exclude
25 County of Maui?

1 MR. HAIA: Yeah.
2 Q. What about the county?
3 A. Well, right now the last agreement expired
4 and we're working on an informal agreement with the
5 county at the present time.
6 Q. So there is no agreement in effect at the
7 present time between A & B, EMI and the county?
8 A. No formal agreement.
9 Q. Is there another type of agreement?
10 A. We're just working off of the last agreement
11 that expired probably four or five years ago.
12 Q. How much do you charge Maui County for the
13 transmission of water?
14 A. We charge Maui County six cents per thousand
15 gallons for the transportation of water.
16 Q. I would like to take you to the next Exhibit,
17 A-3. Are you there?
18 A. Yes.
19 Q. That is Revocable Permit No. S-7263, and it
20 is referred to as -- well, it is for an area of 3,381
21 acres more or less, correct, in the Honomanu area?
22 A. That's correct.
23 Q. And I'll ask you again like I did with
24 respect to the previous permit. Is it your
25 understanding that A & B, EMI pays the state $1,698.32

1 per month pursuant to this permit for this 3,381
2 acres?
3 A. That's correct.
4 Q. I also did math again, Mr. Hew, and I
5 calculated that to a yearly payment. I come up with
6 $20,379.84. Do you have any reason or basis to
7 dispute that? Because once again I'll let you
8 calculate it on your own.
9 A. No, I believe your math is correct.
10 Q. Do you have any idea of the average amount of
11 water developed per year in this permit area?
12 A. No, I don't.
13 Q. Could you access records that would allow you
14 to find out what that is?
15 A. Yes.
16 Q. And what records are those?
17 A. Those are records prior to 1987 when the
18 amount that was diverted out of each area was reported
19 to the state.
20 Q. So do I understand you to say that the
21 numbers that the state and A & B and EMI are currently
22 operating under were developed in 1987?
23 MR. SCHULMEISTER: Let me object. When
24 you say numbers, what are you referring to?
25 MR. HAIA: The amount of water developed

1 in each of these license areas.
2 A. No.
3 Q. So you have -- go ahead.
4 A. What was your question? Could you clarify
5 your question, please?
6 Q. I'm asking you whether or not the numbers
7 that are used in terms of amount of water developed in
8 a specific license area are from 1987 to determine the
9 lease rents or the permit amount that you pay for the
10 use of this acreage?
11 A. I don't know what you mean by develop, but
12 this is what the state charges us for that license
13 area.
14 Q. And do you know whether or not the data used
15 to come to those numbers is current? In other words,
16 as recent as -- well, July 1st, 2000 when these
17 permits were entered into?
18 A. No, I don't.
19 Q. Would you turn to -- I would ask you, are the
20 conditions in each one of these permits -- they're
21 four license areas, so there's four permits?
22 A. Correct.
23 Q. Are the conditions the same for each one of
24 the permits?
25 A. As far as I understand it, they are all the

1 same.
2 Q. Okay. So this permit would not allow A & B,
3 EMI to sell water?
4 MR. SCHULMEISTER: Objection --
5 MR. HAIA: To sell their --
6 MR. SCHULMEISTER: When you're done with
7 your question, I'll make my objection.
8 Q. MR. HAIA: Let me refer you to Page 4,
9 Paragraph 7 of this exhibit. It reads:
10 "This Permit or any rights thereunder
11 shall not be sold, assigned, conveyed, leased,
12 mortgaged, or otherwise transferred or disposed of."
13 MR. SCHULMEISTER: Are you asking whether
14 you read it correctly? I think we will stipulate to
15 that.
16 Q. MR. HAIA: So I'm asking you -- well,
17 basically that applies to this specific area too,
18 right, that A & B cannot sell, assign, convey, lease,
19 mortgage or otherwise transfer, dispose of any of the
20 rights provided under this permit?
21 A. First of all I heard you say something about
22 selling water. And just to clarify, you cannot sell
23 water. You can charge a transportation fee.
24 Q. Okay.
25 HEARINGS OFFICER JUDGE McCONNELL: And

1 your answer would be the same for all of the permits?
2 THE WITNESS: That's correct.
3 Q. MR. HAIA: Go to the next exhibit which is
4 A-4. And this permit is for Keanae License area.
5 Correct?
6 A. Yes, it is.
7 Q. Comprised of 10,768 acres more or less,
8 correct?
9 A. Yes, it is.
10 Q. And A & B pays to the state $3,476.72 for
11 this permit per month?
12 A. Correct.
13 Q. And once again, my calculation per year is
14 $41,720.64. And once again, if you have any concern
15 for the accuracy of this, I have my calculator for
16 you.
17 A. I believe it's accurate.
18 Q. So once again, you don't independently, off
19 the top of your head, have any idea of how much water
20 is developed in Keanae per year?
21 A. No. When you say develop --
22 Q. Well, diverted.
23 A. Diverted?
24 Q. Captured.
25 A. No.

1 Q. Is there any other understanding you have,
2 you asked that question? When I say developed, is
3 there any other way A & B, EMI acts under this permit
4 with respect to Keanae?
5 A. I just wanted clarification on the word
6 "developed".
7 Q. Let's go now to Exhibit A-5 Revocable Permit
8 S-7266 for the Nahiku License area, which is made up
9 of 10,111.220 acres more or less, correct?
10 A. That's correct.
11 Q. And for which A & B, EMI pays $1,426.88 per
12 month, correct?
13 A. Yes.
14 Q. And my calculation per year is $17,122.56 per
15 year. Do you have any reason to dispute my math?
16 A. No.
17 Q. Do you have any idea of how much water is
18 developed per year in Nahiku?
19 A. No, I don't.
20 Q. But, Mr. Hew, you do have an average for all
21 four areas of how much water is developed from all
22 four areas per year, don't you?
23 A. We have a figure comprising all four license
24 areas, how much water is diverted out of these four
25 license areas.

1 Q. Per year?
2 A. Per year.
3 Q. What is that number?
4 A. It varies from year to year.
5 Q. What was it last year? Do you have an
6 average from those variances? That's what I want, an
7 average.
8 A. I know it's somewhere around 58, 59 billion
9 gallons a year. I know for the last 11 years we've
10 been in a low drought situation, so I think only a
11 couple of those years were above that figure.
12 Q. So average around 58, 59 billion gallons of
13 water per year from these four license areas?
14 A. Correct.
15 Q. I also added up the yearly rent payments for
16 all four permitted areas, and I come up with
17 $158,283.84.
18 Do you have any reason to dispute my math?
19 A. No.
20 Q. And conservatively speaking, let's say 58
21 billion gallons of water per year is taken out of
22 those four license areas. And I broke that down in
23 terms of how much A & B, EMI pays per thousand gallons
24 of water out of that area and I come up with a number
25 that is around a fifth of a cent per thousand gallons.

1 Would you dispute that?
2 A. No.
3 Q. Do you have a better estimate of what that
4 total is?
5 A. Based strictly on what we pay for our
6 revocable permits and the amount diverted, that seems
7 accurate.
8 Q. So A & B, EMI pays a fifth of a cent per
9 thousand gallons of water diverted out of these four
10 license areas, correct?
11 HEARINGS OFFICER JUDGE McCONNELL: Per
12 gallon or per thousand?
13 MR. HAIA: Per thousand gallons.
14 A. That's correct. But it doesn't include the
15 cost of operation of the system.
16 Q. But with specific respect to these four
17 permits, that's my question, A & B, EMI pays a fifth
18 of a cent per thousand gallons?
19 A. If your math is correct, I believe it is.
20 Q. Once again, I ask you, do you have any
21 concerns --
22 A. I believe it's correct.
23 Q. Thank you.
24 And you, once again, you charge the county
25 six cents per thousand gallons?

1 A. We charge them a transportation fee.
2 Q. Right.
3 A. Six cents per thousand gallons.
4 Q. Do you have any idea what the average rate on
5 agricultural water is in Hawaii today? How much are
6 agricultural users generally being charged for a
7 thousand gallons of water?
8 A. I don't know the average in Hawaii.
9 Q. You know, you testified today, and I believe
10 it's in your direct written testimony, that A & B and
11 EMI stand ready, willing and able to help the
12 Kekahunas, the taro farmers in Wailuanui; is that
13 correct?
14 A. That's correct.
15 Q. In our last visit out to the Kekahuna parcel
16 we saw some changes, correct, in terms of land opened
17 ready for cultivation? Are you ready, willing and
18 able to ensure that the Kekahunas receive a sufficient
19 amount of water to grow taro adequately in those lo'i,
20 and as they open up more, provide additional water so
21 that their needs are met with respect to those lo'i?
22 A. I believe they have sufficient water now to
23 plant all of the lo'i with what's in Honopou Stream
24 right now.
25 Q. What if it turns out that they don't? The

1 same question, you stand, ready, willing and able to
2 help them?
3 MR. SCHULMEISTER: Calls for speculation,
4 lack of foundation. What if it turns out that they
5 don't. I mean that's a lack of foundation.
6 HEARINGS OFFICER JUDGE McCONNELL: Yeah.
7 You got to be more specific.
8 Q. MR. HAIA: If in fact the water that you
9 believe is sufficient to grow taro on the Kekahuna
10 parcel, is A & B, EMI still ready, willing and able to
11 provide additional water to meet those needs?
12 A. First of all, we would be willing to help
13 Mrs. Kekahuna to see what is going on with the system,
14 if anything.
15 Q. Would that include providing her with
16 additional water if need be?
17 A. Like I mentioned, I think there is sufficient
18 water right now in the stream to meet all of her taro
19 growing needs.
20 Q. That's not responsive. I'm asking him
21 whether, if there is not enough water, A & B will
22 stand ready, willing and able to provide additional
23 water to meet those needs?
24 MR. SCHULMEISTER: Same objection. Vague
25 as to under what circumstances there wouldn't be

1 enough water. He's asking him to assume something he
2 doesn't believe is true.
3 MR. HAIA: Mr. Hew --
4 HEARINGS OFFICER JUDGE McCONNELL:
5 Rephrase the question.
6 Q. MR. HAIA: Mr. Hew, it's your belief that
7 presently there is enough water flowing to the
8 Kekahuna property to allow -- I guess this is the
9 question.
10 Do you believe there is enough water that
11 presently flows to the Kekahuna property that would
12 allow every lo'i on that property to receive a
13 sufficient amount of irrigation water?
14 A. Yes.
15 Q. And now I'm asking you, if at a point in time
16 when full build-out at Kekahuna parcels, and in fact
17 there is not enough water for taro cultivation and
18 irrigation on all of those lo'i, is A & B, EMI ready,
19 willing and able to provide the Kekahunas with
20 additional water?
21 A. We would be willing to help Mrs. Kekahuna as
22 long as taro is being grown on those parcels.
23 Q. If that requires A & B, EMI to release more
24 water so that it gets to the Kekahuna parcel, would
25 they stand ready, willing and able to do that?

1 A. I think we would but first -- I think we
2 would try to investigate if there is a problem in the
3 stream, any sinkholes or anything that is happening
4 abnormally as far as flow, why it's not getting down
5 there.
6 Q. Okay. So you would investigate, determine
7 whether there are other things that are standing in
8 the way of her getting enough water; correct?
9 A. That's right.
10 Q. And if you get to a point where you do that
11 investigation and clearly you need -- they need more
12 water, is A & B going to provide them with more water?
13 A. If there's water available and we can provide
14 it, as long as she's growing taro on an active basis,
15 I don't see a problem.
16 Q. The point at which you allow Maui Land & Pine
17 to take water out of the ditch system is not the point
18 at which you determine how much water you need in the
19 ditch system before you allow them to take it out,
20 right?
21 At what point -- my question is, at what
22 point in the system do you determine whether there's
23 sufficient amount of water to allow Maui Land & Pine
24 to exercise its option to take water out of the ditch
25 system?

1 MR. MERCHANT: Objection, vague. He's
2 talking from a geographic point --
3 MR. HAIA: The point in the ditch system.
4 MR. MERCHANT: So geographic?
5 MR. HAIA: Yes.
6 A. Can you clarify the question?
7 Q. At what point are you measuring the flow to
8 determine whether or not Maui Land & Pine can exercise
9 their option to take additional water out of the
10 system?
11 A. We're measuring that point at Honopou Stream
12 boundary on the two ditches, Wailoa and the New
13 Hamakua Ditch.
14 Q. So they can take at least 1.5 million gallons
15 of water a day as long as there's a certain amount of
16 water at Honopou Stream, and you would allow Maui Land
17 & Pine to do that -- never mind, that's argumentative.
18 What I am getting to is, if you're making
19 that determination at Honopou Stream, what is that
20 based upon?
21 MR. SCHULMEISTER: Talking about Maui Land
22 & Pine's determination?
23 MR. HAIA: Yes.
24 A. That's based on the flows that we believe we
25 need at HC&S. So at any time if the flow at the

1 Honopou boundary is less than 100 million gallons,
2 we're in a period of low flows, shorter water, and we
3 have to make up that water by pumping salty
4 undesirable groundwater. So at that point Maui Land &
5 Pine can only access what they put into the system.
6 Q. Do you have a way of determining how many
7 days out of the year at Honopou Stream there is less
8 than 100 million gallons of water per day?
9 A. There is a way.
10 Q. How is that?
11 A. Through our gauging station.
12 Q. If you know, how often does that occur, that
13 at Honopou Stream there is less than 100 million
14 gallons of water?
15 A. That I don't know. And with the Maui Pine
16 agreement, it's specific to one time at any one day.
17 Q. What stream does the water come out of for
18 the Kekahuna parcel?
19 A. That would be Honopou Stream.
20 Q. At Honopou Stream you said A & B, EMI
21 installed a third pipe -- actually at the ditch system
22 on Honopou Stream, that's Waiola Ditch, right?
23 A. No, that's not correct. That's at the Haiku
24 Ditch level.
25 Q. Okay. So you added a third pipe. Do you

1 know how far water has to travel from that point to
2 get to the Kekahuna parcel?
3 A. No, I don't. I haven't measured it.
4 Q. Do you know how many landowners that are
5 riparian to the stream, Honopou Stream, are between
6 that point and the Kekahuna parcel?
7 A. No, I don't.
8 Q. Do you know whether or not any of the
9 landowners above the Kekahunas are diverting water
10 from that stream?
11 A. Only to the extent that the Commission had
12 provided a list of people that had registered
13 diversions in between those two points.
14 Q. So do you have any idea how many people have
15 registered diversions above the Kekahunas?
16 A. Above the Kekahunas and between the Kekahunas
17 and the Haiku Ditch, I believe there were three or
18 four people that had registered diversions with the
19 Commission.
20 Q. Okay. So we can't be sure then, given those
21 diversions, that the water that is added by this third
22 pipe is actually reaching the Kekahuna parcel,
23 correct?
24 A. No. I believe it's incorrect, because the
25 people who were diverting water were still diverting

1 water with the two pipes. So whatever they're
2 diverting remains the same. So addition of the third
3 pipe would only bring more water down.
4 Q. If there was more water in the stream -- if
5 there's more water in the stream by this third pipe --
6 and you're saying that these people that have
7 registered diversions will take the same amount of
8 water that they have always been taking, is that what
9 you're really saying here? That the water will get
10 down to the Kekahunas because these other people above
11 her aren't going to take any more water than they have
12 been traditionally taking?
13 A. That's what I'm saying. These people who
14 were taking water, they're taking it via two-inch pipe
15 or one-inch pipe and that is limited to the diameter
16 of the pipe.
17 Q. You don't know whether anyone has an electric
18 pump that pulls water out of the stream?
19 A. I saw someone with a gas powered pump that
20 had access to the stream and also had a registered
21 diversion, correct.
22 Q. Do you know whether or not you can adjust the
23 flow on these kinds of pumps?
24 A. Some of them you can, and some of them you
25 cannot.

1 Q. And whether the one you saw can be adjusted?
2 A. I didn't look at it that carefully.
3 Q. But it is possible if you have an electric
4 pump to adjust the flow higher or lower?
5 A. On an electric pump?
6 Q. Yeah.
7 A. Probably not.
8 Q. A gas pump?
9 A. It could be, based on how fast you run the
10 engine.
11 Q. But you don't think you could do that with an
12 electric pump?
13 MS. LOVELL: Objection, incomplete
14 hypothetical, depends on the pump.
15 HEARINGS OFFICER JUDGE McCONNELL: I'll
16 permit it.
17 THE WITNESS: I think on an electrical
18 pump, the pump runs on electricity, it's a steady
19 revolutions per minute or RPM. Whatever that motor is
20 spinning at, that is the capacity of the pump.
21 Q. MR. HAIA: You know, you also said that you
22 never received any complaints about the efforts you
23 testified to in attempting to help the Kekahunas with
24 their lo'i, getting additional water there. And you
25 said you didn't receive any complaints from Mrs.

1 Kekahuna herself.
2 Did you receive any complaints from anyone
3 else on behalf of Mrs. Kekahuna?
4 A. No, we have not.
5 Q. You didn't receive any complaints from the
6 Native Hawaiian Legal Corporation on behalf of Mrs.
7 Kekahuna?
8 A. Well, if you're talking about Mrs. Kekahuna
9 or her family, no.
10 Q. Wait a minute. I asked you whether or not --
11 HEARINGS OFFICER JUDGE McCONNELL: Well,
12 we know about -- you know, we don't need to beat the
13 horse to death.
14 Q. MR. HAIA: Do you recall her testimony at
15 this hearing last month?
16 A. Yes, I do.
17 Q. Do you recall her saying she doesn't have
18 enough water?
19 A. I recall that.
20 Q. You know what, I'm interested in your
21 statement about, you know, you had to correct that
22 map, that there's actually no diversion from Kualani
23 Stream, right?
24 A. Right.
25 Q. I'm going to hand to you -- they've been

1 marked and received as exhibits, B-7B, B-7C, B-7A,
2 B-6B, B-6A, B-5A and B-5C.
3 What I would like you to do is take a look
4 at these.
5 HEARINGS OFFICER JUDGE McCONNELL: Wait,
6 let us get them.
7 MR. SCHULMEISTER: Are those photographs?
8 MR. HAIA: Yes, and I'm going to come
9 over --
10 HEARINGS OFFICER JUDGE McCONNELL: They're
11 all B-7?
12 MR. MURAKAMI: A couple B-6.
13 MR. HAIA: I'll try and put them in
14 numerical order. B-5A, B-5C, B-6A, B-6B, B-7A, B-7B,
15 and B-7C.
16 MR. SCHULMEISTER: What is the first one
17 you're going to ask about?
18 MR. HAIA: B-5A.
19 Q. Can you take a look at B-5A. Do you know
20 where that is?
21 A. I believe this is up in the Kikokiko area.
22 Q. What does that photograph depict?
23 A. Depicts a person standing next to our stream
24 diversion and the pipeline that comes from that
25 diversion, looks like an eight-inch PVC pipe.

1 Q. Are you able to point out on your Exhibit A-1
2 the point of that diversion? You said the diversions
3 are identified as -- is it red boxes?
4 A. I believe this diversion -- I think what we
5 need to do first is make sure that the map is revised
6 before we correlate any of these pictures to that map
7 for reasons of clarity.
8 Q. Revised in what way? For the Kualani
9 diversion?
10 A. That's correct.
11 Q. Okay. We know already that your testimony is
12 that there is no diversion on Kualani. I'm asking you
13 to show us where this diversion is on this map.
14 A. My understanding is that this diversion is at
15 this point here, (indicating.)
16 Q. So it's right here? This is the diversion
17 right here?
18 A. I think it's somewhere around there and this
19 pipe runs through this diversion right here.
20 Q. And for the record, Mr. Hew is pointing to
21 Kualani Stream at its highest point as depicted on
22 A-1, which is nearly intersected by what is identified
23 as Filipino Ditch.
24 So, in fact, this diversion is not
25 depicted on that map, is it?

1 A. On this map here, the major diversion --
2 Q. My question is: Is this diversion depicted
3 on this map?
4 A. The diversion is not depicted on the map
5 because we have many diversions that are small such as
6 this and it's not depicted on the map.
7 Q. Okay. So one diversion you characterize as
8 small is not depicted on Exhibit A-1. What about the
9 same for Exhibit B-5C?
10 A. This diversion would be at this point here.
11 Q. Is that diversion depicted on the map?
12 A. It's depicted on the map but not correctly
13 labeled as to what stream.
14 Q. Okay. So is this Kualani?
15 A. No, it's not.
16 Q. Okay. So there's another problem with this
17 map?
18 A. No. There was only one problem.
19 Q. Wasn't your testimony that it's not correctly
20 depicted?
21 A. Kualani is not correctly depicted on this
22 map.
23 Q. I'm asking you about this exhibit.
24 A. What is your question again?
25 Q. Whether or not it's depicted on the map,

1 Exhibit B-5B.
2 MR. SCHULMEISTER: B or C?
3 MR. HAIA: I'm sorry, B-5C.
4 A. The same one, right?
5 Q. The same one as what?
6 A. Well, I'm just reading here, same eight-inch
7 PVC pipe depicted in B-5B.
8 MR. SCHULMEISTER: We haven't talked about
9 5B, only talked about 5A.
10 MR. HAIA: Right, we skipped 5B.
11 Q. So do you know whether or not the pipe
12 depicted in this exhibit, which is B-5C, is the same
13 or a continuation of the pipe depicted in B-5A?
14 A. I believe this pipe in Exhibit B-5A is the
15 start of this diversion, and the eight-inch pipe on
16 the middle right-hand corner of Exhibit B-5C is the
17 terminus of that pipe.
18 Q. And I pulled out Exhibit B-5B just to
19 hopefully clarify. B-5C says same eight-inch PVC pipe
20 depicted in Exhibit B-5B.
21 If you look at Exhibit B-5B, do you agree
22 or disagree, Mr. Hew, that it's the same pipe?
23 A. It's hard to tell, just a section of pipe,
24 but it could be.
25 Q. In your definition of major changes, you

1 don't consider this -- let me ask you. Was this the
2 state of that diversion before 1923?
3 A. I don't know.
4 Q. What would help you to be able to answer that
5 question?
6 A. Obviously, I wasn't around in 1923, so I
7 don't know.
8 Q. Are there records which would have shown that
9 this is the same diversion presently depicted that was
10 begun in or prior to 1923?
11 A. That I don't know.
12 Q. So, in fact, when you testify that there are
13 no major changes since 1923, could this have been a
14 major change that occurred after 1923?
15 A. Like I said, a major change to me is a change
16 in the rerouting of a certain ditch or large stream
17 diversion or something of that sort.
18 Q. Do you know the flow capacity of an
19 eight-inch pipe?
20 A. No, I don't.
21 Q. Do you know the flow capacity of a four-inch
22 pipe?
23 A. No, I don't.
24 Q. What would it take for you to know what the
25 flow capacity of a four-inch pipe is?

1 A. Probably the head and the pressure that's
2 exerted on that four-inch pipe and a flow meter.
3 Q. And I'm asking you, if at its full flow, how
4 much water could flow through an eight-inch pipe; do
5 you know?
6 A. I don't know.
7 Q. In any event, your answer to my original
8 question of whether or not this is depicted on Exhibit
9 A-1 is that it's not depicted on A-1; is that correct?
10 A. This diversion here?
11 Q. Exhibit B-5A.
12 A. And this is Exhibit A-1, right?
13 Q. Yeah.
14 A. So what is your question?
15 Q. Is this diversion depicted on that Exhibit
16 A-1? I thought you answered no.
17 A. No, I said it's probably on this stream here,
18 but the stream is labeled incorrectly.
19 Q. So the stream that is labeled Kualani Stream,
20 what stream is that then?
21 A. I believe that's an east tributary of
22 Waiokamilo Stream.
23 Q. Can you point out on this map where
24 Waiokamilo Stream is?
25 A. Waiokamilo Stream is this stream right here

1 going down.
2 Q. And what is designated as Kualani Stream,
3 it's your testimony that this is an east tributary of
4 Waiokamilo Stream?
5 A. That's correct.
6 Q. In other words, at some point it flows into
7 or comes off of?
8 A. It flows into Waiokamilo Stream.
9 Q. So it's not an individual stream in itself?
10 A. It appears to be a tributary.
11 Q. So is there a Kualani Stream?
12 A. I believe there is a Kualani Stream.
13 Q. Where is that on this map, can you show it?
14 A. I believe Kualani Stream is more towards the
15 east here. And this is the ridge that sticks out when
16 we looked up at the lookout that day, I believe
17 Kualani Stream starts on this side and goes along here
18 and intersects Waiokamilo further down.
19 Q. So for the record, you're pointing to below
20 the ditch system?
21 A. That's correct.
22 Q. And you're saying that Kualani Stream begins
23 below the ditch system so that the ditch system could
24 not possibly be diverting Kualani Stream, your
25 understanding of Kualani Stream?

A. That's correct.

Q. Can you show us one more time -- and I was wondering if we could mark this map about his understanding of Kualani Stream.

MR. SCHULMEISTER: Can we go off the record for a second.

(Discussion held off the record.)

HEARINGS OFFICER JUDGE McCONNELL: We will recess until 9:00 o'clock tomorrow morning.

1 CERTIFICATE

2 STATE OF HAWAII)

3) SS.

4 COUNTY OF HONOLULU)

5

6 I, JEAN MARIE McMANUS, do hereby certify:

7 That on November 14, 2005 at 10:00 a.m., the

8 proceedings contained herein was taken down by me in

9 machine shorthand and was thereafter reduced to

10 typewriting under my supervision; that the foregoing

11 represents, to the best of my ability, a true and

12 correct copy of the proceedings had in the foregoing

13 matter.

14 I further certify that I am not of counsel for

15 any of the parties hereto, nor in any way interested

16 in the outcome of the cause named in this caption.

17 Dated this 27th day of November, 2005,

18 in Honolulu, Hawaii.

19

20

21 JEAN MARIE McMANUS, CSR #157

22

23

24

25

BOARD OF LAND AND NATURAL RESOURCES

STATE OF HAWAII

In the Matter of Contested)DLNR FILE: 01-05-MA
Case Regarding Water Licenses)
at Honomanu, Keanae, Nahiku and)
Huelo, Maui)
_____)

CONTESTED CASE HEARING

Held on November 14, 2005, commencing at 9:45 a.m., at Haiku Community Center, Haiku, Hawaii.

BEFORE: JEAN MARIE McMANUS
Hawaii CSR #156, CA CSR #3119

HEARINGS OFFICER: HONORABLE E. JOHN McCONNELL
33 N. Market Street, Ste. 200
Wailuku, Hawaii 96793

BLNR Attorney: LINDA CHOW, ESQ.
Deputy Attorney General
465 S. King Street, Rm. 300
Honolulu, Hawaii 96813

For EMI and A&B: DAVID SCHULMEISTER, ESQ.
ELIJAH YIP, ESQ.
Cades Schutte Fleming & Wright
1000 Bishop Street, Ste. 1200
Honolulu, Hawaii 96813

For Maui Land & Pineapple: DAVID B. MERCHANT, ESQ.
Kiefer & Merchant
444 Hana Highway, Ste. 204
Kahului, Hawaii 96732

For County of Maui: JANE E. LOVELL, ESQ.
Deputy Corporation Counsel
200 S. High Street
Wailuku, Hawaii 96793

For Maui Tomorrow: ISAAC HALL, ESQ.
2087 Wells Street
Wailuku, Hawaii 86793

For Na Moku Aupuni O Ko'olau Hui, et al: ALAN T. MURAKAMI, ESQ.
MOSES K.N. HAIA, ESQ.
1164 Bishop Street, Ste. 1205
Honolulu, Hawaii 96813

Hawaii Farm Bureau: SAT KHALSA FREEDMAN, ESQ.
1600 Pauahi Tower
1001 Bishop Street
Honolulu, Hawaii 96813

INDEX

WITNESSES:

TERESA M. "TERI" GOMES
DIRECT EXAMINATION BY MR. HAIA..... 7
CROSS-EXAMINATION BY MS. LOVELL..... 46
CROSS-EXAMINATION BY MR. SCHULMEISTER..... 47

GARRET HEW
DIRECT EXAMINATION BY MR. SCHULMEISTER..... 74
CROSS-EXAMINATION BY MS. LOVELL..... 122
CROSS-EXAMINATION BY MR. HAIA..... 126

WARREN WATANABE
CROSS-EXAMINATION BY MR. HAIA..... 138
CROSS-EXAMINATION BY MR. HALL..... 144

GARRET HEW
CROSS-EXAMINATION CONTINUED BY MR. HAIA..... 148

EXHIBITS RECEIVED INTO EVIDENCE

Na Moku's Exhibit No. B-14A..... 18
Written testimony of Warren Watanabe..... 138

HEARINGS OFFICER JUDGE McCONNELL: The hearing will come to order. This is in the matter of the Contested Case regarding Water Licenses, DLNR File No. 01-05-MA. Since we've been recessed for awhile, maybe we should have appearances.

I'm John McConnell the hearing officer.

MR. HALL: Isaac Hall for Intervenor Maui Tomorrow.

MS. LOVELL: Jane Lovell, Deputy Corporation Counsel for County of Maui and our Department of Water Supply.

MR. HAIA: Good morning, Judge, good morning everyone. Moses Haia and Alan Murakami on behalf of Petitioners Na Moku Aupuni O Ko'olau Hui, Beatrice Kekahuna and Marjorie Wallett.

MR. SCHULMEISTER: David Schulmeister and Elijah Yip for Alexander & Baldwin and East Maui Irrigation Company and also Garret Hew for EMI, Inc.

MR. FREEDMAN: Sat Freedman appearing for Intervenor Hawaii Farm Bureau Federation and Mr. Thomas who is on the mainland.

MR. MERCHANT: David Merchant for Maui Land & Pineapple.

HEARINGS OFFICER JUDGE McCONNELL: And for the record we have Linda Chow who is the Deputy

Attorney General assigned to the board.

If I recall correctly, we were to proceed this morning with A&B and EMI's case.

MR. HAIA: We have one more.

HEARINGS OFFICER JUDGE McCONNELL: That's right. I knew that we hadn't gotten to her, but if you're ready to proceed, that would be your final witness then?

MR. HALL: Judge, can I take care of one quick matter with regard to the evidence before you start?

HEARINGS OFFICER JUDGE McCONNELL: Sure.

MR. HALL: I've distributed and placed before you our second amended exhibit list as well as a set of exhibits which has the pictures and exhibits that we described during our case.

There's nothing new in any of these. They were already discussed during the examination and I promised the hearing officer and the parties that I would bring these exhibits with me when the hearing reconvened and that's what I've done. I just wanted to place that on the record.

HEARINGS OFFICER JUDGE McCONNELL: Okay. And I assume they will be in evidence then.

MR. HALL: I think they were already in

evidence subject to my bringing them and I brought them. And I'm not going to be able to attend the whole of this hearing, so I will excuse myself.

HEARINGS OFFICER JUDGE McCONNELL: Thank you very much. Sorry we got a late start.

MR. SCHULMEISTER: In terms of housekeeping, I have tried to sort of estimate with Terry Gomes testifying today, and then we will call Garret Hew and Mark Vaught, that probably will take most of the day. With that anticipation I told Mr. Holaday and Mr. Jakeway, my final two witnesses, to be available tomorrow morning at 9:00. If anyone has a problem with that estimate --

MR. HAIA: Well, what we, Sat and I talked about, is he -- Warren Watanabe is only available today. So if we can work him in today in the afternoon.

MR. FREEDMAN: I need about 90 minute lead time. He's up in Kula and we'd prefer to have him in the afternoon if possible, because he has a meeting in town at 5:30 and that way he doesn't have to make two trips.

HEARINGS OFFICER JUDGE McCONNELL: Okay. Remind me at lunchtime then. All right.

Raise your right hand, please.

TERESA M. "TERI" GOMES
was called as a witness by and on behalf of Na Moku, et al, was sworn to tell the truth, was examined and testified as follows.
HEARINGS OFFICER JUDGE McCONNELL: State your name, please.
THE WITNESS: My name is Teresa, T-e-r-e-s-a, middle initial M. I'm often called Teri, T-e-r-i. My sir name is Gomes, G-o-m-e-s
DIRECT EXAMINATION
BY MR. HAIA:
Q. Ms. Gomes, what is your current occupation?
A. I'm a parallel with the Native Hawaiian Legal Corporation.
Q. As a paralegal with the Native Hawaiian Legal Corporation, what are your primary duties?
A. My primary duties to research and review historical documents relating to land and land use.
Q. And what purposes are served generally by the research and review that you do?
A. Primarily to identify the ownership of real property, the conditions of title, and the marketability of it.
Q. Are you also called upon to review these historical documents to determine the traditional

historical use of a specific parcel or parcel in Hawaii?
A. Yes.
Q. And how long have you done this type of research?
A. Over 26 years now.
Q. And is that reflected in your resume that's attached or that is identified as Exhibit B-11?
A. Only as it relates to real estate land titles.
Q. Now, I'm going to hand to you what's been filed with the Office of Conservation and Coastal Lands of the Department of Land and Natural Resources on August 1, 2005. That's entitled Petitioners' Direct Testimony of Teresa M. "Teri" Gomes with Exhibits B-11 and B-12.
Can you look at that?
A. It's a full and complete copy.
Q. In addition to being a full and complete copy, does it also provide an accurate description of your answers to various questions asked of you in this written direct testimony?
A. Yes.
MR. HAIA: Judge, I'm unclear on whether or not direct written testimony has already been

received. But if not, then I would ask that it be received.
HEARINGS OFFICER JUDGE McCONNELL: So th record is clear, any objection?
MR. SCHULMEISTER: No objection.
HEARINGS OFFICER JUDGE McCONNELL: It will be in evidence.
MR. HAIA: Thank you.
Q. Ms. Gomes, in your capacity as parallel for the Native Hawaiian Legal Corporation, were you tasked with the job of researching LCA, that is Land Commission Award, records for certain parcels of land in East Maui to confirm whether taro cultivation occurred on these parcels at the time of the Mahele?
A. Yes.
Q. And in doing this research, what type of information or documentation would you look at?
A. If need be, the original land claims. The original native register, which is the land claim; the original native testimony; the original foreign testimony; the original Land Commission proceeding record.
Q. Just to be clear, when you speak about the original Land Commission records, what specifically are you referring to?

A. Documents written in 1848, 1849, 1850.
Q. What is a Land Commission Award?
A. A Land Commission Award is a legal binding document which vests title in a claimant, a title that has been adjudicated by the Commissioners of the Board to quiet land titles in the Hawaiian islands.
Q. So would it be safe to say that that is an official document establishing private ownership in a parcel identified by that Land Commission Award?
A. Title has been adjudicated, yes.
Q. And you refer to native registers. Can you explain what native registers are?
A. Native registers was what the Commission called a compilation of all the land claims filed. Does not necessarily designate the person as being Native Hawaiian. It just meant that these were all the claims that were received by the Commission on these lands.
Q. So native registers is information or documentation that occurs prior to the actual awarding of a parcel of land via the Mahele?
A. Yes.
Q. What about foreign registers, are there any such thing?
A. No such thing.

Q. Are there native testimonies related to Land Commission Awards?
A. Native, yes.
Q. And what would those be?
A. The statutes require that the Commissioners hear from what was called native testimony, what we now call kama'aina testimony, preferably from people who live on either side or all sides of the parcel being claimed. Those were called native kama'aina testimony because they lived next door, they lived upon the land.
Foreign testimony was usually what was taken from the konohiki, the land agent, who may not have lived right next to the parcel being claimed.
Q. And so who were these testimonies provided to?
A. The Board of Land Commissioners.
Q. And what would the Board of Land Commissioners use this information for?
A. To adjudicate land titles.
Q. What about foreign testimonies, any such thing?
A. Foreign testimonies, yes.
Q. And what are those?
A. Those usually were acquired from the

konohikis, or if need be, the agent of the king, or if need be the agent of the governor. Someone who could confirm and possibly resolve cross-claims or objections to the claimant coming before the Commission and saying this is my land. Someone will object, the next door neighbor will, say, object, say no, no, that's not his land. So they will call in the konohiki or the agent for the governor and have them confirm, did you give this parcel to this person or is what he's saying true.
When they took the testimony from someone outside the kama'aina area, then it will be called foreign.
Q. And, in essence, was all of this evidence used to establish title to a property during the time of the Mahele?
A. That was required by statute, yes.
Q. I already asked you whether or not you conducted detailed research on a number of parcels contained within the ahupua'a of Wailuanui to confirm whether and to what extent taro cultivation occurred on these designated parcels, and you answered yes.
A. Yes.
Q. Can you describe the steps you took to arrive at the information which you provide in what has been

1 identified as Exhibit B-12, which is a spreadsheet of
2 the information you documented?
3 A. I was first provided with tax map keys
4 identified in the spreadsheet. I confirmed the
5 assignment of each TMK at the State Survey Division,
6 Department of Land and Natural Resources, utilizing
7 the old and new tax maps made available to the general
8 public.
9 I then examined each tax map to identify
10 the original land title source document for each
11 assessed parcel. True and correct copies of these tax
12 maps will be submitted as exhibits at the appropriate
13 time.
14 I then researched each -- I then
15 researched each land title at the Hawaii State
16 Archives using the records of the Land Commissioners
17 to quiet land titles as my primary reference source.
18 I examined each kuleana land claim as
19 documented in the native register, foreign testimony,
20 native testimony, and LCA records.
21 I then searched the City and County of
22 Honolulu's Tax Assessment Office records to determine
23 assessed owners for each TMK.
24 The spreadsheet is a culmination of my
25 research work and reflects the matters I found of

1 record.
2 Q. I would ask you now to turn to Exhibit B-12.
3 And I just want to do one example of the information
4 provided in Parcel Number 1. The very first one is
5 identified as Maui Tax Map Key 1-1-04-09, and it is an
6 area of .62 acres. And then you note that there's a
7 Royal Patent number 3279.
8 What's a royal patent?
9 A. Royal patent was issued -- confirmation of
10 commutation being paid.
11 Q. So commutation meaning taxes upon the land?
12 A. No. Real property taxes didn't come into
13 existence in Hawaii until 1859.
14 Q. What did commutation serve the purpose of?
15 A. Commutation was established basically to pay
16 for the proceedings before the Land Commission. The
17 surveying, calling in witnesses, paying the
18 Commissioners.
19 HEARINGS OFFICER JUDGE McCONNELL: So whe
20 you got the patent, you still had to pay?
21 THE WITNESS: No. The statute was set up
22 so that the Land Commissioners would adjudicate land
23 title. Title was vested by the Land Commission Awards
24 but commutation was still due and owing to the
25 government who footed the bill for all these

1 proceedings -- paying of the Commissioners -- and it
2 was given a value. For example, one-third or
3 one-fourth of the unimproved value of the land. That
4 became what commutation would be, and what the
5 claimant was awarded the land would have to pay to
6 commute the government's interested in the land. It
7 was less than allodial.
8 Upon payment of the commutation, the
9 Minister of Finance would then receive the money and
10 the money would be deposited into the Royal Treasury.
11 The Minister of Interior, along with the king and the
12 queen, would sign on behalf of the government and the
13 crown to release the government's commutation.
14 In other words, all sums of money due and
15 owing to the government for the proceedings to
16 adjudicate the land title was paid.
17 HEARINGS OFFICER JUDGE McCONNELL: So if
18 you didn't pay your commutation, what happened?
19 THE WITNESS: It is still due and owing to
20 the State of Hawaii under Chapter 172.
21 Q. MR. HAIA: So, Ms. Gomes, just to be clear,
22 if a Royal patent was issued, if I understand you
23 correctly, the commutation owed upon the Land
24 Commission Award had been paid and so the Royal patent
25 in essence became the final determination of allodial

1 title in a person?
2 A. Put that way, I would have to answer yes.
3 Q. Thank you.
4 So for Parcel Number 1, there is a Royal
5 Patent number 3279. Land Commission Award is 4779, so
6 the Land Commission Award was made, and then
7 subsequent to payment of commutation, the Royal patent
8 was issued?
9 A. Uh-huh.
10 Q. Okay. And the next column that you have is
11 entitled 'Ili?
12 A. Yes.
13 Q. Or Location. And for this TMK you have two
14 place names, correct?
15 A. Yes.
16 Q. Keononalu and Paakamaka, is that correct?
17 A. Yes.
18 Q. Then the next section is Lo'i Claimed.
19 Can you provide us with description of
20 what you mean by lo'i claimed? Is that from a native
21 testimony? Native register? Where do you get the
22 amount of lo'i claimed with respect to a certain
23 parcel of land?
24 A. When I reviewed the native register, the
25 foreign testimony, native testimony, I look to see

1 what was claimed. And if during the testimony it was
2 in any way noted as to confirm it, what was claimed in
3 the register, I tried to look to see if it was
4 confirmed by way of testimony.
5 Q. Okay. So, for instance, for Parcel Number 1,
6 are you saying that eight lo'i were claimed in
7 Keononalu, but none were noted in the testimony?
8 A. Yes.
9 Q. And then the place that you're getting these
10 numbers from are either from the native register,
11 foreign testimony or the native testimony?
12 A. Yes.
13 Q. And for this parcel, which says eight lo'i at
14 Keononalu and ten lo'i at Paakamaka, do you know where
15 you got that information from, which document or
16 series of documents?
17 A. In this case it's definitely from the native
18 register.
19 Q. Okay. And when we provide --
20 Judge, when we provided exhibits, I
21 believe it was on August 15th, we reserved certain
22 numbers for later exhibits, and most of the native
23 registers that are identified in this spreadsheet were
24 not provided on August 15th. And we have provided
25 them to the parties today.

1 And so with respect to Parcel Number 1, we
2 would ask that B-14A from the supplemental exhibits be
3 received into evidence. That's the native register
4 for this first parcel.
5 MR. SCHULMEISTER: No objection.
6 HEARINGS OFFICER JUDGE McCONNELL: B-14A
7 will be in evidence.
8 (Na Moku's Exhibit No. B-14A was received
9 into evidence.)
10 I didn't understand your testimony,
11 though. If you look at the spreadsheet, it says, "Not
12 noted" under "Lo'i". Could you explain? I thought I
13 heard --
14 THE WITNESS: No, you're correct, because
15 what I tried to do is the lo'i claimed column was from
16 the native register. If the claimant said I have
17 eight lo'i in this 'ili, ten in that one, I put it
18 under that column.
19 I then look to see if it was confirmed
20 during the testimony stage, whether from the native
21 testimony or the foreign testimony. If no one in
22 those proceedings made note that there were eight and
23 ten, I put down "not noted".
24 HEARINGS OFFICER JUDGE McCONNELL: So it
25 would be the claimant's testimony then?

1 THE WITNESS: Yeah.
2 Q. MR. HAIA: And, for example, I would refer
3 you to B-14A, and it is the native register for Parcel
4 Number 4779 to Naiapea, does that coincide with TMK
5 1-1-4-9; is that the same property?
6 A. Yes.
7 Q. And if you look at the native register --
8 well, can you show us where you got the information
9 from with respect to the number of lo'i?
10 A. Last sentence, first paragraph where it says:
11 "However, I have begun to make eight lo'i, and another
12 Kula."
13 Then it goes on the last paragraph, first
14 sentence: "In the 'ili of Paakamaka I have some land
15 with 10 lo'i".
16 Q. We're going to have to get into these
17 designations of 'ili, mo'o. What is your
18 understanding of an 'ili?
19 A. An 'ili is smaller than an ahupua'a, but then
20 so is a mo'o. A mo'o can be within an 'ili.
21 Q. So the largest land unit is moku, which is an
22 island?
23 A. Yes.
24 Q. And then you come down to ahupua'a which is a
25 section of an island. And then what is the next

1 smaller gradation?
2 A. 'ili.
3 Q. And generally what is the acreage in an 'ili?
4 A. I can't begin to answer that.
5 HEARINGS OFFICER JUDGE McCONNELL: Do the
6 also use the term "district" for 'ili?
7 THE WITNESS: These days I wouldn't be
8 surprised that they do. But whether or not something
9 was an 'ili was actually determined by use, cultural
10 and ancient traditional use.
11 Q. MR. HAIA: What is the connection between the
12 use and the description as an 'ili?
13 A. The only way I can describe it is to give an
14 example that's not, these days, not used very often.
15 It's the fact that we've dropped these
16 days what is called 'ili ku or 'ili kupono, those were
17 detached pieces of land, which were 'ilis.
18 Their title ran with the ahupua'a because
19 they were attached by title to the ahupua'a. The fact
20 physically they were detached made them 'ili ku.
21 Their usage was inseparable. There was no way you
22 could culturally, by custom and tradition, detach this
23 piece from the ahupua'a. The reason why, the
24 sustainability within the ahupua'a did not accommodate
25 this 'ili ku. The 'ili ku would then, for example, be

1 the place where they would cultivate kalo because the
2 rest of the ahupua'a could not.
3 So to make sure that, I guess, the diet of
4 the hoa'aina maka'aina would be well-rounded. This
5 'ili ku would be attached to this ahupua'a. It was
6 irrelevant how big that 'ili ku was by area, by
7 acreage. What mattered is the cultural use to sustain
8 those within the ahupua'a.
9 Q. So certain 'ili were limited to a specific
10 land use?
11 A. Yes.
12 Q. And when we speak of mo'o, can a mo'o also be
13 an 'ili or is that within an 'ili?
14 A. Usually a mo'o was encompassed within an
15 'ili.
16 Q. And can you describe the use of a mo'o or the
17 cultural significance of the word "mo'o" for that
18 piece of property?
19 A. Mo'o, when you say that word, to especially
20 kupunanui, very elderly people, you're getting more
21 into the realm of that which is spiritual as well as
22 cultural. Mo'o, whenever you say it, it signifies a
23 water lily or what some call a water lizard. In
24 Hawaiian it's usually symbolized by a woman.
25 And mo'o usually is a lizard, but the

1 symbolism is usually a female water lily, water fairy,
2 water lizard. So you're saying mo'o, you mean in
3 terms of land, it's an area smaller than an 'ili.
4 If you're talking about the use of that
5 word as it applies to land, I can only say I found
6 that this designated word to be used more often on
7 Maui land titles than I have on Oahu land titles. But
8 then certain Hawaiian words in conveyancing of the
9 original Commission records are more common to one
10 island sometimes than they are to another.
11 Mo'o is used more often -- I've come
12 across it more often in Maui land title than I have on
13 Oahu. On Oahu I've come across land title terminology
14 like lele more often than I do on Maui.
15 HEARINGS OFFICER JUDGE McCONNELL: Is an
16 'ili ever outside the ahupua'a?
17 THE WITNESS: Yes.
18 HEARINGS OFFICER JUDGE McCONNELL:
19 Sometimes?
20 THE WITNESS: Yes. On Oahu that would be
21 called a lele, but in ancient traditional times that
22 was called 'ili ku or 'ili kupono. If it was attached
23 to ahupua'a and title ran with the ahupua'a it was
24 actually a 'ili ku or 'ili kupono.
25 HEARINGS OFFICER JUDGE McCONNELL: But no

1 geographically?
2 THE WITNESS: Geographically it could be
3 two separate areas. An example I could give is like
4 Kewalo on Oahu. Everyone is familiar with the basin
5 area. Well, there were 'ili leles, in other words an
6 'ili that jumped away from ahupua'a, that's in the
7 Nu'uanu, the upper part of Nu'uanu where the Royal
8 Mausoleum is.
9 Those were called in the Commission
10 records by the claimant 'ili lele, meaning that it
11 jumped. But under traditional customary Hawaiian
12 usage that was actually an 'ili ku or 'ili kupono.
13 Title ran with the ahupua'a.
14 Q. MR. HAIA: Still sticking with Parcel number
15 1, the last column, "Comments/Notations Additional
16 Remarks", the very top it says: "NR6/542."
17 What does that stand for?
18 A. NR is native register, volume six, page 542.
19 Q. So at the native register, volume six, page
20 542 is where the information that you would get for
21 this specific parcel in the native register; is that
22 correct?
23 A. Yes, on file at the Hawaii State Archives.
24 Q. I'm going to take you down to Parcel Number
25 2, which is Maui Tax Map Key No. 1-1-04-10. You have

1 it designated as a .544 acre parcel. There's a Royal
2 Patent number, Land Commission Award, the 'ili or
3 location Waieli, and then the lo'i claimed is not
4 noted. And then lo'i or mo'o testified to you have
5 the word "mo'o" there.
6 So can you elaborate on why you indicate
7 there was a mo'o testified to, or is that what you're
8 actually indicating?
9 A. What was testified to was a mo'o. I put that
10 down because -- well, the presumption could be made
11 that there was other crops grown there. We cannot
12 rule out the fact that it was used for kalo. How many
13 lo'i could fit in a mo'o? Again, it depends on the
14 size of the mo'o.
15 Q. With respect to 1-1-4-10, the area is .544
16 acres, so a little more than half an acre, correct?
17 A. Yes.
18 Q. And same thing, the information you provide
19 in Comments/Notations Additional Remarks refers to the
20 place and the native register, the foreign testimony
21 and the native testimony where you can find specific
22 information on this parcel, correct?
23 A. Yes.
24 Q. And we're going to go through a couple more,
25 but with respect to all of the parcels noted on this

1 spreadsheet, do you know whether they're all within
2 the ahupua'a of Wailuanui?
3 A. Asked that way, I have to say no.
4 Q. Which ones would you point to which are not
5 within the ahupua'a of Wailua?
6 A. On Page 6, Parcel Number 48.
7 Q. Okay.
8 HEARINGS OFFICER JUDGE McCONNELL: I'm
9 sorry, give me that again.
10 MR. HAIA: Page 6, Parcel Number 48.
11 THE WITNESS: Wait, I may be mistaken. I
12 am mistaken, it's in Wailua, definitely.
13 HEARINGS OFFICER JUDGE McCONNELL: So any
14 others not in Wailuanui?
15 THE WITNESS: On this list, no, there
16 shouldn't be any.
17 Q. MR. HAIA: Now, before we go on with respect
18 to these specific parcels, I'm going to ask you if you
19 have any corrections, clarifications or additions you
20 would like to make to either your written testimony or
21 this spreadsheet?
22 A. Yes.
23 Q. And what would that be?
24 A. I prepared this Exhibit B-12 based upon
25 information that was provided to me by the Board of Na

1 Moku. I was then instructed to prepare, pursuant to
2 Judge McConnell's October 3rd, 2005 order, the list of
3 Na Moku members with property interest within the
4 ahupua'a of Wailuanui for which the Native Hawaiian
5 Legal Corporation was authorized to speak. That list
6 was provided to the parties and the state via
7 transmittal letter dated October 5th, 2005 and
8 subsequently filed and served on November 3rd, 2005.
9 When I compared the tax map key numbers in
10 Exhibit B-12 with the TMKs identified in the Na Moku
11 members landowner list, I found that there are certain
12 tax map keys that were not listed on my Exhibit B-12.
13 Q. And what were those numbers?
14 A. Tax Map Key 1-1-04-10.
15 HEARINGS OFFICER JUDGE McCONNELL: Give it
16 to me again.
17 THE WITNESS: 1-1-04-10, 1-1-4-11,
18 1-1-4-20, 1-1-4-22, 1-1-4-23, 1-1-4-28.
19 Then on Plat 5, that's 1-1-5, Parcel 30,
20 Parcel 31, Parcel 33, Parcel 46, and Parcel 52.
21 Then on Plat 1-1-6, Parcel 32, Parcel 34,
22 Parcel 36, Parcel 37, Parcel 45, Parcel 47, Parcel 72.
23 Q. MR. HAIA: So when you compared -- just for
24 clarification purposes -- when you compared Exhibit
25 B-12, which is this spreadsheet with TMKs that we were

1 just going through, with the spreadsheet of landowners
2 who are in Wailuanui who are members of Na Moku, you
3 found that the TMKs you just read do not appear within
4 B-12 or the landowner list?
5 HEARINGS OFFICER JUDGE McCONNELL: Yeah, I
6 don't think that was clear.
7 MR. HAIA: B-12 or the landowner list?
8 A. I was given the landowner list after I
9 completed B-12.
10 HEARINGS OFFICER JUDGE McCONNELL: Just
11 let me make sure I'm clear. B-12 is labeled Na Moku
12 Spreadsheet, correct?
13 THE WITNESS: Yeah.
14 HEARINGS OFFICER JUDGE McCONNELL: And so
15 that is not what you're referring to as the landowner
16 list, is that right?
17 THE WITNESS: For me the landowner list --
18 I really don't know how to answer that because I was
19 just given special limited powers of attorney, and
20 then those were made into a list.
21 MR. HAIA: You know, just let me try and
22 do something here.
23 Q. Here's the landowner list. This is the
24 landowner list, it was prepared prior -- subsequent to
25 the spreadsheet that we were just covering.

1 A. Yes.
2 Q. So are you saying that the TMK numbers that
3 you just read off, while on the landowner list, you
4 could not find on the spreadsheet? Or the opposite?
5 Are you saying that the TMKs you just read off were on
6 the spreadsheet but not on the landowner list?
7 A. Yes and no. Some of them were, some of them
8 weren't.
9 Q. Okay. Well, when I refer you to the TMKs, it
10 says: When the TMKs identified in Exhibit B-12 -- and
11 this is what you testified to -- are compared with
12 TMKs identified in the Na Moku member landowner list,
13 the following TMKs from Exhibit B-12 are not contained
14 within the landowner list.
15 So my understanding of what you're saying
16 is, in this Exhibit B-12, there are TMKs that are not
17 identified in this landowner list; and those TMK
18 numbers are the ones you read off.
19 MR. SCHULMEISTER: I object. That's
20 exactly the opposite of what I heard.
21 THE WITNESS: Yeah.
22 HEARINGS OFFICER McCONNELL: That's what I
23 thought, but I'm not sure.
24 MR. SCHULMEISTER: Can we go off the
25 record just for a second?

1 HEARINGS OFFICER JUDGE McCONNELL: Yeah,
2 okay. Let's go off the record.
3 (Discussion held off the record.)
4 HEARINGS OFFICER JUDGE McCONNELL: Let's
5 go back on the record.
6 Q. MR. HAIA: When you compare A-49, which is
7 the landowners' list, with B-12, what I want you to do
8 is, the landowner list has Parcel Number 1-1-4-10,
9 which is A-49, the landowner list, has Parcel Number
10 1-1-4-10 on it. Can you look at B-12 and tell me --
11 Judge, can I have a minute?
12 HEARINGS OFFICER JUDGE McCONNELL: Yeah.
13 Off the record.
14 (Discussion held off the record.)
15 HEARINGS OFFICER JUDGE McCONNELL: Back o
16 the record.
17 Q. MR. HAIA: So, once again, there are TMKs
18 identified in Exhibit B-12 which is the Na Moku
19 spreadsheet that are not also contained within Exhibit
20 A-49 which is the landowner list?
21 A. Yes.
22 Q. And those are the numbers that you read off?
23 A. Yes.
24 HEARINGS OFFICER JUDGE McCONNELL: And
25 those numbers are on B-12 but not on A-49, is that

1 correct?
2 THE WITNESS: B-12 is not on the
3 landowners' list because B-12 was made prior to the
4 owners' list.
5 HEARINGS OFFICER JUDGE McCONNELL: Well,
6 but whether --
7 MR. HAIA: You're saying the same thing.
8 HEARINGS OFFICER JUDGE McCONNELL: But I
9 just wanted it clear. You gave us a long list of tax
10 map keys. They show up on B-12, correct?
11 THE WITNESS: I'll say yes to that.
12 HEARINGS OFFICER JUDGE McCONNELL: And
13 they don't show up on A-49?
14 THE WITNESS: They're actually --
15 HEARINGS OFFICER JUDGE McCONNELL: I don't
16 care why or anything, just they're not on A-49. Is
17 that right?
18 MR. HAIA: So --
19 HEARINGS OFFICER JUDGE McCONNELL: She
20 didn't answer my question. You can explain later.
21 THE WITNESS: The following TMKs from
22 here --
23 HEARINGS OFFICER JUDGE McCONNELL: The
24 ones you read off.
25 THE WITNESS: Are not on the landowners'

1 list.
2 HEARINGS OFFICER JUDGE McCONNELL: Right
3 And the landowners' list, as I understand it, is A-49.
4 Q. MR. HAIA: Hopefully for the last time, Ms.
5 Gomes. The TMKs that you just identified on the
6 record are contained in Exhibit B-12 but not also
7 contained in Exhibit A-49?
8 A. I'll say yes.
9 Q. Now, with respect to any of those TMKs that
10 you read out, do you have any further information that
11 you want to provide with respect to how those TMKs
12 should be handled in this matter?
13 A. TMK 1-1-4-11 should have been included in the
14 Na Moku member landowner list under Terry Akuna.
15 1-1-5-31 --
16 HEARINGS OFFICER JUDGE McCONNELL: You'r
17 going too fast. We're taking notes on this.
18 THE WITNESS: TMK 1-1-5-31 was dropped
19 into tax map key 1-1-5-30.
20 Q. MR. HAIA: Let me stop you there. When you
21 say dropped into, what do you mean by that?
22 A. The tax map office took the parcel that was
23 being assessed as Parcel 31, for assessment purposes
24 dropped Parcel 31 into Parcel 30.
25 Q. So it was -- Parcel 31 was made a part of

1 Parcel 30, so now Parcel 30 is the entire acreage
2 provided for in previously separate Parcel 31 and
3 Parcel 30?
4 A. Yes.
5 Q. Okay.
6 A. Tax Map Key 1-1-5-31 was dropped into tax key
7 1-1-5-30. And 30 should have been included in
8 landowner list under Norman Martin.
9 HEARINGS OFFICER JUDGE McCONNELL: Okay,
10 hold on. So I got that one and I got 11, which should
11 have been included under Akuna?
12 THE WITNESS: Yes.
13 HEARINGS OFFICER JUDGE McCONNELL: That's
14 all so far, or did I miss one?
15 THE WITNESS: No, that's correct so far.
16 Tax Map Key 1-1-5 Parcel 33, and 1-1-6-72
17 should have been included in the landowner list under
18 Joseph Young.
19 And TMK 1-1-6-32 should have been included
20 in the landowner list under Samuel Akina.
21 HEARINGS OFFICER JUDGE McCONNELL: The
22 first one you mentioned was 72 and 33 of -- is that
23 correct -- of 5?
24 THE WITNESS: 1-1-5-33 and 1-1-6-72 under
25 Joseph Young.

1 MR. HAIA: Okay.
2 Q. So why are you saying that TMK 1-1-4-11
3 should be included in Exhibit A-49 under Terry Akuna?
4 A. The tax map's assessment shows that it's held
5 by Alexander Akuna, who is a relative and ancestor of
6 Terry Akuna, and EMI also owns an interest in Parcel
7 11.
8 Q. And I ask you the same question with respect
9 to 1-1-5-30 which you said should be included under
10 Joseph Young.
11 A. It's presently being assessed to Paul Young,
12 and Joseph Young is a relation to Paul Young and has
13 apparently his permission to be there.
14 HEARINGS OFFICER JUDGE McCONNELL: I
15 thought that was Martin.
16 MR. HAIA: I'm sorry, I was wrong. It
17 should be Norman Martin.
18 A. Norman Martin is assessed the Parcel
19 1-1-5-30.
20 Q. So Norman Martin is an assessed owner?
21 A. Yeah, along with Paul Young.
22 Q. So they each have an interest in this parcel?
23 A. Yes.
24 Q. And now with respect to 1-1-6-32.
25 A. That's presently being assessed to Samuel and

1 Libby Akina.
2 Q. And you're saying it should have been
3 included under Samuel Akina in Exhibit A-49?
4 A. Yes.
5 Q. Are there any others?
6 A. Not that I know of offhand.
7 Q. Now, with respect -- I guess now would be a
8 good time -- do you still have your Exhibit A-45?
9 It's that map.
10 MR. SCHULMEISTER: You mean the big one?
11 MR. HAIA: Yeah.
12 MR. SCHULMEISTER: That was left with the
13 Hearings Officer.
14 MS. CHOW: Unfortunately I left it back in
15 my office.
16 MR. SCHULMEISTER: You've got a smaller
17 one.
18 (Discussion held off the record.)
19 HEARINGS OFFICER JUDGE McCONNELL: We're
20 back on the record.
21 Q. MR. HAIA: Ms. Gomes, looking at Exhibit
22 A-45, did you review this map previously?
23 A. Yes.
24 Q. Okay. And you also reviewed Exhibit A-49,
25 which is a list of landowners of Wailuanui?

1 A. Yes.
2 Q. Is there any relationship that you can see
3 between Exhibit A-45, which is the map, and Exhibit
4 A-49, which is the landowner list?
5 A. Would you explain what you mean by
6 relationship?
7 Q. Well, is there anyway that you can look at
8 Exhibit A-45, the map, and determine whether a parcel
9 on Exhibit A-45 is also identified in Exhibit A-49,
10 the landowner list?
11 A. Yes.
12 Q. How do you do that? How can you do that?
13 A. By comparing the tax map key numbers listed
14 on Exhibit A-49 against the map itself, Exhibit A-45.
15 Q. Well, there are highlighted areas,
16 highlighted yellow Magic Marker on Exhibit A-45. Do
17 those have any significance in your mind?
18 A. No.
19 Q. Do they coincide, the highlighted areas, the
20 tax map keys that are highlighted, coincide with the
21 landowner list?
22 A. I believe so.
23 Q. So in other words, if -- for example, look at
24 James Akiona, Jr. on Exhibit A-49, TMK No. 1-1-4-9.
25 Is that highlighted on Exhibit A-45?

1 A. I would have to see Exhibit A-45.
2 Q. MR. HAIA: I'll ask you the question again.
3 Is TMK No. 1-1-4-9, which is identified in
4 Exhibit A-49, highlighted on the map which is Exhibit
5 A-45?
6 A. Yes.
7 Q. Now, with respect to the second landowner,
8 Lucy Acain, TMK numbers 1-1-8-4, can you find that
9 anywhere on this map?
10 A. No.
11 Q. And why is that?
12 A. Because this Plat 8 is not shown on this map.
13 Q. Do you know where Plat 8 is in relationship
14 to the map Exhibit A-45?
15 A. Plat 8, Plat 8, (indicating) so where it is,
16 I don't know.
17 HEARINGS OFFICER JUDGE McCONNELL: It's
18 generally mauka?
19 THE WITNESS: Yeah, up here.
20 Q. MR. HAIA: When you say up here, you're
21 pointing at the top middle portion of Exhibit A-45?
22 A. Yes, Hana Belt Road.
23 Q. In fact, there is a description just to the
24 right-hand side of the center top that says Plat 8, is
25 that the area that you're referring to?

A. Yes.
Q. So in fact, Lucy Acain and TMK 1-1-8-4 is not identified on this map?
A. No.
Q. With respect to the TMKs that we just went through that didn't match, and the ones that you said should also be included in the landowner list, for example, TMK 1-1-6-32. Can you find that on Exhibit A-45?
A. (Indicating).
Q. For the record, you're pointing to the lower center just above what is highlighted in blue and identified as Wailua Stream to a parcel that borders that stream?
A. Yes.
Q. Does the parcel go through Wailua Stream to the other side?
A. No.
Q. So is it highlighted?
A. No.
Q. We're going to go onto -- maybe I should clear this up.
This map is a compilation of three different TMKs, isn't it?
A. It's a composite of three separate plats,

Plat 4 is basically up here. Plat 5 is in the middle section and Plat 6 is on the bottom.
Q. Okay. So if we want to look for TMK 1-1-4-11, we're going to look at the top of this map, right? And you've already indicated that you see TMK 1-1-4-11. Is it highlighted in yellow?
A. No, it's not.
Q. Let's go to 1-1-6-5. Can you find that? This is reference to Terry Akuna, and that is highlighted, right?
A. Right here.
Q. Would you locate TMK 1-1-5-30.
For the record you're pointing to the middle left side of Exhibit A-45.
Can you tell whether or not that parcel is highlighted in yellow?
A. No, it's not.
Q. What about 1-1-5-33, can you locate that?
A. (Indicating).
Q. And for the record, you're pointing to the center of the map. And is that TMK highlighted?
A. No, it's not.
Q. I should go back to 1-1-5-30. Weren't you saying that that now includes both 1-1-5-30 and 1-1-5-31?

A. Yes, 31 is shown as being dropped. The designation used by the real property tax office to show an assessment parcel number has been dropped is usually indicated by a dash line on four sides of the number.
Q. And is that indicated on this map in fact?
A. Yes, it is, around the number 31. And the area formerly assessed to Parcel 31 was dropped and is now being assessed only under Parcel 30.
Q. For the record, you're pointing at the middle left-hand side of the map. And Parcel 1-1-5-30, as you said, is not highlighted, correct?
A. Yes.
Q. Now, can you locate Parcel 1-1-6-72?
A. (Indicating).
Q. And for the record, you're pointing on the middle left-hand side of Exhibit A-45 just above what is identified as Wailua Stream and highlighted in blue. Can you tell whether that parcel is highlighted in yellow?
A. Yes.
Q. Is it?
A. No.
HEARINGS OFFICER JUDGE McCONNELL: So basically you're saying they should have been?

MR. HAIA: Well, now they should be. We're basically, through Ms. Gomes' testimony, indicating that members of Na Moku have interest in those parcels.
HEARINGS OFFICER JUDGE McCONNELL: And th original intent of the yellow highlighting was to show the same thing?
MR. HAIA: Right, except that in Exhibit A-49 those TMKs were not included.
MR. SCHULMEISTER: Just to clarify. Exhibit A-45 is an exhibit that EMI prepared. And what we were trying to do is highlight the TMKs that were provided to us by Na Moku in what is Exhibit A-49.
I don't think they're saying that we highlighted wrong, what they're saying is just trying to supplement A-49.
HEARINGS OFFICER JUDGE McCONNELL: I understand.
Q. MR. HAIA: So just to conclude, these are corrections you believe are necessary to bring your testimony into conformance with the evidence; is that correct?
A. Yes.
Q. So go back to the original spreadsheet, which

is Exhibit B-12, and 1-1-4-13, the fourth column says "G.L.S-3922". What does that stand for?
A. General Lease State of Hawaii No. 3922.
Q. And I notice that there's no information provided in lo'i claimed or lo'i or mo'o testified to, correct?
A. Correct.
Q. So if you know specifically why this is a general lease, you can explain that, but more generally my question is: Why would a piece of property like this in Wailua be issued under a general lease?
A. It's state land. And basically general leases could be issued for any agriculture purposes in an Agriculture District.
Q. Okay. And on Exhibit A-45, can you locate TMK 1-1-4-13?
A. Can't see the number here. It's this yellow parcel.
Q. For the record, you're pointing to the middle left top of Exhibit A-45, and there appears to be a blue wavy line running through the parcel; is that correct?
A. It's designated as an 'auwai on the map.
Q. Is the blue wavy line what is designated as

an 'auwai?
A. Yes.
Q. Is that blue wavy line, does it run through TMK 1-1-4-13?
A. Yes, it does.
Q. Is 1-1-4-13 highlighted?
A. Yes, it is.
Q. We'll go on to the next TMK 1-1- -- actually we shouldn't move on yet.
So there's a general lease for this property. And there's -- as far as you can tell in your research, could you find any evidence that it was -- that at the time of the Mahele, that parcel was in taro cultivation?
A. I don't know how to answer that except to say there is no evidence to contrary use.
Q. Does the fact that an 'auwai runs almost through the center of that TMK suggest that?
A. Lo'i kalo?
Q. Yes.
A. Kalo cultivation, yes.
Q. So if an 'auwai was running through a specific parcel, generally you would conclude, based upon your experience, that there was taro cultivation on that parcel?

A. Going back to ancient times, yes.
Q. Let's go onto TMK 1-1-4-18. Can you locate that?
A. (Indicating).
Q. And you're pointing in the same general area as you were with 1-1-4-13?
A. Yes.
Q. And does that 'auwai that ran through the previous TMK, also run through that?
A. Yes, it does.
Q. And this says that it is Revocable Permit 6930. What does that mean?
A. The term of the permit is usually shorter than the term permitted for general lease. It's subject to revocation by the state.
Q. With respect to that specific parcel, ask you like I did with the other parcel, does the fact that an 'auwai runs through that parcel lead you to the conclusion, with your experience, that there was more likely than not taro cultivation on that parcel in ancient times?
A. Yes.
MR. HAIA: Judge, I'm just trying to figure out a way that we don't have to go through each one of these TMKs, and unfortunately --

HEARINGS OFFICER JUDGE McCONNELL: Well, unless there's something else in the records, we can determine from the exhibit itself that an 'auwai runs through or doesn't run through. I mean, all of that can be argued, it seems to me.
Q. MR. HAIA: So in the revisions to the TMKs that you provided for in B-12 that were not identified in Exhibit A-49, do you need to make changes with respect to the total acreage?
A. Yes.
Q. So can you explain what you need to do to do that? How do you make the changes you need to make to the total acreage of parcel of property that in your testimony you were claiming were traditionally in taro cultivation?
A. Add in, for example, all the areas, like Parcel 72 that wasn't highlighted, Parcel 33, like Parcel 30.
Q. Try and give the entire TMK number.
A. This would be 1-1-5-30.
Q. So you would include the total acreage for that in the revised --
A. Spreadsheet.
Q. Okay. And how many acres are included in TMK 1-1-4-30 -- I'm sorry. That should be 1-1-5-30?

A. Yeah.
Q. So additionally, how much do we need to add to the total?
A. Overall?
Q. Yes.
MR. SCHULMEISTER: Which total are you talking about?
MR. HAIA: Well, yeah, you're right. There are two totals. There is a total from B-12 and there's a total from the landowner list, which is A-49.
Let's go to the total from the landowner list, because it corresponds with Exhibit A-45.
HEARINGS OFFICER JUDGE McCONNELL: And that's also A-49?
MR. HAIA: That's correct.
MR. SCHULMEISTER: A-49 doesn't actually have acreages on it.
MR. HAIA: No, we need to add them.
Q. But in any event, with respect to the TMKs that you identified that are not on the landowner list that should be on the landowner list, that's the amount that needs to be included in the total amount of acreage that Na Moku would be staking a claim to for water, correct?

A. Yes.
Q. So if we found out the specific acreage tied to each TMK in Exhibit A-49 and also added the TMKs that we just identified through your testimony today, we would come up with a total amount of --
A. 61.14 acres only in Wailuanui, 61.14 acres.
Q. So you're revising your original testimony, which was approximately 56 acres up to 61 point --
A. 14.
Q. -- 14 acres?
A. 61.14.
Q. And that would -- that increase would account for the TMKs that you just identified today and located on Exhibit A-45?
A. Yes.
Q. Do you have anything else to add at this time?
A. No.
MR. HAIA: Judge, I'm done.
HEARINGS OFFICER JUDGE McCONNELL: Thank you. Would you like to go next?
MS. LOVELL: Sure, because I have what I think is only one question.
CROSS-EXAMINATION
BY MS. LOVELL:

Q. Do you have the total acreage then, the total corrected acreage that we should be considering?
A. In Wailuanui, Wailuanui area I came up with 61.14 acres.
Q. So that's the total acreage then, not an additional acreage, but the total?
A. Total.
Q. Thank you.
MR. MERCHANT: No questions.
MR. FREEDMAN: No questions.
HEARINGS OFFICER JUDGE McCONNELL: Mr. Schulmeister
CROSS-EXAMINATION
BY MR. SCHULMEISTER:
Q. I'll just start right there with the 61.14, because I'm a little confused about what that's a sum of.
In your written testimony -- do you have that handy, your written testimony?
A. Yes.
Q. And just focusing on the last two pages, there's a question that starts at the bottom of Page 4. The question in your written testimony was:
"Based upon the results of your research, are you able to draw a reasonable conclusion as to the

total acreage in active taro cultivation at the time of the Mahele?"
And then your answer beginning on the fifth page of your written testimony:
"Yes. First of all, the sum acreage of the parcels identified in the attached spreadsheet is 56.355."
So the 56.355, that was the sum total of the acreage of the tax map key parcels that are listed in Exhibit B-12; is that right?
A. Yes.
Q. Now, the parcels that you just said needed to be added to the owners' list, those were already included in this total, right, 56.355?
A. No, not all of them.
Q. Well, the first one you mention that should be added back in, 1-1-4-11, that's already in B-12, and it's Parcel Number 3, right?
A. Yes.
Q. And the second one was 1-1-5-31, I believe, and you're saying 1-1-5-31 actually should be part of 1-1-30. So 1-1 -- so if you go to the third page of Exhibit B-12, 1-1-5-30 is already there, right?
A. Yes.
Q. Then the next one I think you mentioned

should be added is 1-1-6-32?
A. Yes.
Q. And if you go to the fourth page of Exhibit B-12 -- I'm sorry -- so that one's not there.
And then 72, 1-1-6-72 -- 1-1-6-72 is on the last page of Exhibit B-12, and that's already -- so that's already included in the total, right?
A. Yes.
Q. But if you go to Exhibit A-49 there's a bunch of parcels on A-49 that weren't on B-12, right?
A. Yes.
Q. For example, if you have A-45 handy, that's the map, Exhibit B-12 didn't have any of the house lots that are on the makai side of Wailuanui Road, right?
A. Yes.
Q. And so -- in fact, one of the things I wanted to ask you about a little bit, when you came with your estimate of the total acreage that was in taro cultivation at the time of the Mahele, you used -- you came up with 56.355 acres and then you discounted that by ten percent per acreage that you assumed would have been fallow; is that right?
A. Yes.
Q. So that leads me back to the first list, the

list that ended up making up the spreadsheet that's Exhibit B-12. How was that list selected in the first place?
A. You're asking me?
Q. Well, if you know. What was the theory behind how a parcel got on that list?
A. I can't answer that question. I don't have knowledge as to how we got those TMKs.
Q. I think you mentioned earlier during your direct that it came from the Board of Directors of Na Moku.
A. Yes. But how they got it --
Q. Were you involved in getting it from the Board of Directors of Na Moku?
A. No, they gave it to me.
Q. You were given a list?
A. Yes.
Q. And did you -- and then from that list, you did what you called -- well, you did the detailed research of land titles and these other sources that you referred to to determine whether or not taro was cultivated on those parcels at the time of the Mahele?
A. Yes.
Q. And the spreadsheet shows the instances in which you're able to find some specific indication

that there was taro cultivated, and for a lot of them it's just blank, no indication one way or the other, correct?
A. Yes.
Q. Beyond just looking at the records, did you do anything else as part of the detailed research to determine whether or not taro was cultivated on this original list that ended up being the parcels that are listed in Exhibit B-12?
A. Could you be more specific by what you mean by "anything else"?
Q. Well, anything besides looking at land titles and the registers that you described, any other type of investigation?
A. Boundary Commission records, records of commissions of private rights and water, maps on file at the archives, maps on file at Hawaii State Survey Division.
Q. In your written testimony on Page 3, and the answer that is on the bottom of the page, you refer to a number of parcels. And then basically I'm quoting from about the fourth line down, the sentence that starts near the right, says:
"Based upon the historical, cultural landscape of the Wailuanui ahupua'a as fully detailed

in Kalo Kanu O Ka 'Aina: *A Cultural Landscape Study of Ke'anae and Wailuanui, Island of Maui*", et cetera.
Do you see that?
A. Yes, I do.
Q. Is that the same study that is marked as Exhibit B-123?
A. Yes, it is.
Q. So was that an additional piece of investigation you did? You reviewed that study?
A. Not in thorough detail, to be honest with you.
Q. Did you do any sort of a field survey? In other words, on-the-ground survey of the area, of the actual landscape?
A. No.
Q. Did you study any aerial photographs?
A. Could you define what you mean --
Q. I mean photographs taken from an aircraft showing the layout?
A. Can you explain in what context?
Q. Well, let me do this. Among the new exhibits, there's one that's -- A-55. A-55 is just a copy that's been made of Figure 15.
A. Right.
Q. So have you seen this before?

A. Yes. It's in the Kalo Kanu book.
Q. And you were present when Dr. McGregor testified?
A. Yes, I was.
Q. Do you remember her having described there having been some archeologists who were on the team of persons who did the cultural landscape studies?
A. Yes.
Q. And that they had actually done some mapping of lo'i --
A. Yes.
Q. -- in Wailuanui?
A. Yes.
Q. And that this figure was the work of these archeologists?
A. Yes.
Q. So did you study this Figure 15 at all in trying to cross-reference it to the information you were getting, for example, from the native register, to see whether or not you could line-up the lo'i that the archeologists were able to identify with ones that are referred to in any of these title records?
A. Yes.
Q. Now, do you have any idea why -- well, do you have any idea why in the second list that you were

given, the one that is A-49, there's all these house lots that are included that weren't included in the first one?
A. The only way I could explain it is to say I presume that the Na Moku members wanted it understood that they are residents there and that's where they live.
And usually what happened in the Wailuanui Homestead area, is because this was government land, when the government gave out the grants in satisfaction of the special purchase agreement, the right of purchase agreement, with the house lot came a taro lot.
So that they were -- the intent was one was to be for residential purposes, the other for agricultural purposes. But both were situated within an agricultural district.
Q. So just because there's parcels that are added to the second list that weren't on the first list, didn't mean that the parcels that are being added, such as the house lots, that those were being claimed for taro on those house lots themselves?
A. I did not include the area, if that's what you mean.
Q. How did you calculate -- let me withdraw that

1 question.
2 You had the original total that's referred
3 in your written testimony of 56-point-something acres.
4 So that didn't include any of the house lots?
5 A. No.
6 Q. But some of those parcels aren't on the
7 second list, although some of them you added back in,
8 I understand, but there are still others that aren't
9 on the second list.
10 MR. HAIA: Just I don't want to object,
11 it's just vague as to "second list".
12 MR. SCHULMEISTER: I'm referring to A-49
13 by the second list. Basically there's two lists that
14 we have prior to today. The first list was B-12,
15 which was your spreadsheet, and then the second list
16 was A-49. And then the second list has been somewhat
17 modified.
18 Q. Did you ever do a total of the acreage on
19 A-49?
20 A. Just separate by itself?
21 Q. Right.
22 A. No.
23 Q. So how do you get from the 56 to the 64?
24 A. I could have gotten more if I did all of A-49
25 exactly as it was, because A-49 includes parcels

1 outside of Wailuanui.
2 Q. Right, okay. So therefore, how you get from
3 the 56.355 -- let me withdraw that question.
4 Before I do that, the first list, the one
5 that's in B-12, doesn't have any house lots, right?
6 A. Correct.
7 Q. Did you know that when you prepared B-12 that
8 it didn't have any house lots?
9 A. It was my intent to exclude house lots
10 because we were looking towards cultivation of kalo.
11 Q. And did you exclude house lots?
12 A. I hope I did.
13 Q. The reason why I ask that is because so far
14 as I understand it, you were given a list by the Board
15 of Directors of Na Moku, and from that list you did
16 your research and that resulted in B-12?
17 A. Yes.
18 Q. Did you make any deletions from the original
19 list you were given before you got to B-12, of house
20 lots, for example?
21 A. Whatever the board gave me, I made B-12 out
22 of. It was their intent to only identify those
23 parcels which were under cultivation, open for
24 cultivation or fallow. So B-12 is exactly what they
25 gave me is what I produced.

1 Q. So it's your understanding that Na Moku,
2 before they gave you the list that ended up being in
3 the spreadsheet marked as B-12, they had already
4 weeded out, so to speak, the parcels that didn't have
5 taro, the house lots and properties that didn't have
6 taro on it; is that right?
7 A. I can't answer that.
8 Q. But there were no house lots?
9 A. I can only tell you that they did not give me
10 any TMKs upon which I could find there was a house on
11 it.
12 Q. And so it was because of that that you felt
13 comfortable saying that 90 percent of the total
14 acreage -- as I understand your written testimony,
15 basically you're saying 90 percent of the acreage,
16 it's reasonable to assume, was in taro at the time of
17 the Mahele?
18 A. Yes, sir.
19 Q. But if we were starting with acreage that
20 included all these house lots on this second list, you
21 wouldn't use that 90 percent factor any more?
22 A. On the second list?
23 Q. A-49, it includes a lot of house lots, right?
24 MR. HAIA: I'm going to object to the
25 characterization as "a lot of house lots". It's also

1 vague, and it assumes that the house lots were
2 included in the calculation of acreage.
3 HEARINGS OFFICER JUDGE McCONNELL: You
4 want to rephrase?
5 Q. MR. SCHULMEISTER: Do you know what I'm
6 referring to when I refer to the house lots that are
7 in Exhibit A-49 and are highlighted -- and let's just
8 focus to make it simple, focus on the ones that are
9 makai of Wailuanui Road on Exhibit A-45.
10 Do you understand what I'm referring to as
11 house lots?
12 A. Yes.
13 Q. Do you agree those are house lots?
14 A. Yes, sir.
15 Q. So since -- the 90 percent factor that you
16 used to estimate acreage in taro cultivation at the
17 time of the Mahele was applied to parcels that did not
18 include house lots, right?
19 A. Would you be more specific?
20 Q. B-12. B-12 is the list of parcels that you
21 used the 90 percent factor for, right?
22 A. Correct.
23 Q. And B-12 doesn't have any of these lots in
24 it, right?
25 A. There was a certainty with B-12 that I did

1 not get with A-49.
2 Q. Well, my question was whether or not B-12 had
3 any of these house lots on it.
4 A. To my knowledge, no.
5 Q. So if none of those house lots are on the
6 list applying the 90 percent factor, you felt
7 comfortable doing that because you didn't have to
8 discount areas that were not in taro cultivation?
9 A. Correct.
10 Q. Now, when we look at A-49, we do have the
11 house lots, right?
12 A. Yes, sir.
13 Q. And did you ever make a new calculation based
14 on TMKs listed in A-49?
15 A. In its entirety, you mean?
16 Q. Well, put it this way. Did you ever do a
17 calculation with regard to the parcels on A-49 that
18 was intended to have the corresponding purpose as the
19 calculation you did for B-12? In other words,
20 estimating the acreage that was in taro at the time of
21 the Mahele?
22 A. For those -- let me answer you this way.
23 That's how come I came up with 61.14 acres.
24 Q. Okay. When you came up -- is there a new
25 spreadsheet, a new B-12 that corresponds to A-49 where

1 we can see how you did it?
2 A. I did one for me. I wasn't sure if it would
3 be admissible or submittable.
4 Q. Let me just ask you. Did you use the same 90
5 percent factor?
6 A. I did not exclude the ten percent for fallow
7 out of the 61.14 acres.
8 Q. Well, where did the 61 come from?
9 A. As I said earlier, when we got what you're
10 calling Exhibit A-49, when I got them, what I found
11 was there -- we had gotten -- the Na Moku members had
12 then come forward and said, I also own this and that.
13 So I want this and that included in with this.
14 So when they then told us that, we
15 picked -- I picked up additional tax keys and did find
16 them assessed under their name. They may have been
17 down the list one of 11, one of 14, one of 26.
18 I then added that parcel on and into the
19 61, which brought about the 61.14 acres.
20 HEARINGS OFFICER JUDGE McCONNELL: So th
21 house lots really aren't included in the 61?
22 THE WITNESS: No. But the appurtenant
23 taro lot is.
24 Q. MR. SCHULMEISTER: Are the lots that you went
25 through in your direct testimony that were omitted

1 incorrectly as you've testified from A-49, did you
2 take the acreage of those and add it to the 56.355
3 that you previously totaled from Exhibit B-12?
4 A. Yes.
5 Q. So is it your testimony that -- this is where
6 I'm lost on this.
7 As I understand it, you gave us a list of
8 TMKs that were not on B-12. There was six from Plat
9 4, five from Plat 5, and seven from Plat 6. Those
10 ones that you read through one by one.
11 A. Yes.
12 Q. So my understanding is those were on B-12 but
13 not on A-49, right? But then you only added back in
14 four. So where do you subtract out the acreage of all
15 the other ones that weren't on A-49?
16 Do you understand my question?
17 MR. HAIA: Notwithstanding the fact that
18 these other parcels aren't necessarily Na Moku members
19 or, you know, they're either state land or there's not
20 a Na Moku member that's an assessed owner, the fact
21 remains that these parcels we're claiming were either
22 in taro at the time of the Mahele and should always be
23 included in the total acreage for which either water
24 is necessary, because somebody who is with Na Moku is
25 going to be growing taro on that; or as we've argued,

1 Judge, A & B, EMI has the burden of coming forward to
2 establish that they're not interfering with others
3 rights.
4 That's just not Na Moku members. There
5 are other parcels in that area that have appurtenant
6 rights. We're going to identify those appurtenant
7 rights. We're doing that right now, and we will be
8 asking A&B and EMI to establish that their
9 diversions -- I mean, you know, you may not agree with
10 this, but it's our contention that the burden is upon
11 A&B, EMI to show if there's prima facia evidence of an
12 interest in the water, that they weren't interfering
13 with those rights, notwithstanding that it's a Na Moku
14 member or not a Na Moku member, it doesn't matter.
15 So when we talk about the total acreage,
16 we're talking about whatever land is in that valley to
17 which we can claim appurtenant rights to
18 notwithstanding that a Na Moku member can't identify a
19 claimed interest. If that Na Moku member has an
20 opportunity to grow taro on that parcel, we're making
21 a claim for it.
22 So she may not be able to answer your
23 question, Dave, when it comes to that.
24 MR. SCHULMEISTER: I'm just trying to
25 understand the math. That's all I'm trying to do.

1 HEARINGS OFFICER JUDGE McCONNELL: Yeah.
2 I appreciate that. But your math started with the 56
3 and you've added these various other parcels to come
4 up with --
5 MR. HAIA: Actually --
6 HEARINGS OFFICER JUDGE McCONNELL: To com
7 up with the 61.
8 MR. HAIA: Actually, that's not totally
9 correct. The original total was, I think, 67.84
10 acres. We took ten percent off of that to get to 56
11 -- or I'm sorry, the total was 56. We brought it down
12 to 51 on that ten percent. Now she's saying it's
13 61.14, but that's not accounting for -- that's the
14 total. You've got to drop it -- you've got to take
15 ten percent out of that.
16 MR. SCHULMEISTER: I don't know. I was
17 trying to find out.
18 HEARINGS OFFICER JUDGE McCONNELL: Go
19 ahead, Dave.
20 MR. HAIA: Well, she testified to that
21 already. She said she didn't take the ten percent
22 off.
23 HEARINGS OFFICER JUDGE McCONNELL: Go
24 ahead.
25 Q. MR. SCHULMEISTER: All I want to do is

1 connect the dots between the 56.355 and the current
2 61.14. Is it okay, can I just hand you a piece of
3 paper and have you -- I'll just put the 56.355 and
4 could you just -- can we take a break and reconstruct
5 the calculation? Show what was minused out or added
6 to come to the 61.14. And if there's a TMK, identify
7 it and the acreage and that way we will have a record
8 of how the calculation is done.
9 MR. HAIA: You're proposing we're taking a
10 break right now for her to do that?
11 MR. SCHULMEISTER: That's right. We can
12 all sit and watch her, but I think she might get a
13 little nervous.
14 MR. HAIA: We don't necessarily need to
15 take a break. Can you go onto another area? We will
16 do this during lunchtime and come back. We are on a
17 tight schedule here, so that's my concern.
18 MR. SCHULMEISTER: I don't have a lot more
19 and this is kind of key.
20 HEARINGS OFFICER JUDGE McCONNELL: We'll
21 take a couple minutes.
22 (Recess was taken).
23 HEARINGS OFFICER JUDGE McCONNELL: We're
24 back on the record. Mr. Schulmeister.
25 MR. SCHULMEISTER: We had a discussion off

1 the record. Do you want to offer something?
2 MR. HAIA: Maybe if your understanding is
3 different than the way -- basically we did have an
4 off-the-record discussion, and I believe what A&B and
5 Na Moku have agreed to is that, notwithstanding the
6 fact that B-12 does not coincide with A-49, I think we
7 both agreed that the 51 acres which subtracts ten
8 percent from the total we had in Teri's original
9 testimony, is an agreeable number as long as there is
10 this understanding that some of that total 51 acres
11 may just be disputed as to whether or not there is an
12 interest held by a Na Moku member on some of that
13 property. Is that correct?
14 MR. SCHULMEISTER: I think so. Let me try
15 to paraphrase it the way I understand it. And maybe
16 we are on the same page here.
17 I was just trying to understand what the
18 61 -- how the 61 came about. And I think that in
19 discussions, in getting to the 61, some parcels that
20 weren't on B-49 were added back in --
21 MR. HAIA: A-49. I think you said B-49.
22 MR. SCHULMEISTER: Right, A-49. But they
23 may have been double counted to get to the 61, but the
24 51 continues to include parcels that are not on A-49,
25 and as long as I understand that that's what it is,

1 that's fine. I just wanted to understand what it was.
2 So with that clarification, I won't ask any more
3 questions about it.
4 MR. HAIA: That's how I understand it.
5 MR. SCHULMEISTER: So now I'll continue
6 with my cross-examination.
7 Q. So getting back to the 51 acres in terms of
8 what that represents, that represents your estimate of
9 the amount of acreage in Wailuanui Valley that was
10 cultivated in taro at the time of the Mahele,
11 regardless of whether or not it was cultivated on
12 lands that current Na Moku members own, correct?
13 MR. HAIA: Object as to vagueness.
14 HEARINGS OFFICER JUDGE McCONNELL: I'll
15 permit it.
16 THE WITNESS: Could you restate it,
17 please, the question?
18 Q. MR. SCHULMEISTER: The 51 acre estimate,
19 that's an estimate that was based on trying to arrive
20 at a figure that was, in your opinion, a reasonable
21 estimate of the acres in Wailuanui Valley that were
22 cultivated in taro at the time of the Mahele?
23 A. Stated that way I would have to say no.
24 Q. How would you characterize your 51 acres?
25 A. This 51 acres is only the amount of acreage

that is currently under controlled manager owned by the Na Moku members. I cannot speak for land titles I did not research.
Q. It was based on a list that was originally given to you by the Na Moku Board of Directors?
A. Yes.
Q. But the second list, which a deleted some of those, you didn't delete those from the 51 acres, right? We haven't done that, right?
A. No, sir.
Q. So the 51 acres -- okay, I think the record is clear.
Is the record clear?
HEARINGS OFFICER JUDGE McCONNELL: Mayb not.
Q. MR. SCHULMEISTER: Could you put in front of you what's A-51.1, which I just handed to counsel? If you would take that and overlay it on A-45.
MR. HAIA: Dave, before you go there, I'm going to object to it. The basis is we have no idea of knowing whether or not this is to scale.
MR. SCHULMEISTER: I understand.
Q. But are you able to like roughly align the roadway and the stream or the roadways?
A. Based on what you've given me, I can't. I

have a number of problems. First of all, I don't have the scale for this. I don't have anything that could correlate it -- I don't have the scale for this map. It's a composite. I don't have whether or not -- what date this was made and what period in time it's representative of. And I don't have the same for this.
Q. You did have Figure 15 prior to doing your written testimony, right? Figure 15 from the Cultural Landscape Study?
A. Yes.
Q. Exhibit A-55 is a Xerox of that that was enlarged somewhat. And then 55.1 is a transparency created from it.
Did you at any time make any effort to correlate the information that the archeologists had put together for the Cultural Landscape Study with your estimate?
A. No, sir.
Q. So you just went with the 90 percent factor?
A. Yes, sir.
Q. So any parcel that was on the list, you just assumed 90 percent of it was in taro at the time of the Mahele?
A. Based on the Land Commission records.

Q. Is there a Land Commission record that says that 90 percent of the land in this area could be assumed to have been in taro at the time of the Mahele?
A. I took them one at a time, sir. If testimony showed that there were ten lo'i on a mo'o and the mo'o was .55 acres, I presumed that meant 90 percent was for cultivation purposes. I presumed the remaining ten percent would be, if anything, for a hale.
Q. But without actually checking on the ground to see whether or not 90 percent of the parcel or 100 percent of the parcel had evidence of taro cultivation, pretty much guess work, right?
A. Not if the testimony and the actual Land Commission Award record says that it's a lo'i kalo, it's a mo'o kalo, there's an 'auwai, or it abuts the adjoining lo'i.
Q. But for most of the parcels, there aren't references like that, right?
A. Lo'i claimed is a specific type of parcel for specific type of use.
Q. There's one area in particular I would just like to ask you about, and that's the area -- if you have A-55. Just pointing to the arrows that come from the bottom showing direction of natural water flow.

MR. HAIA: Which arrows?
MR. SCHULMEISTER: Right here, right to the upper right from where it says Exhibit A-55 on the bottom of the page.
A. That's the natural water flow.
Q. Do you have an understanding as to where Wailuanui Stream water is brought into cultivate taro in Wailuanui?
A. This doesn't tell me where Wailua Stream is.
Q. Forgetting A-55 for a minute, do you know where Wailuanui is?
A. Yes, sir.
Q. Do you understand what this A-55 depicts with regard to the roadway and Hana Highway?
MR. HAIA: I'm going to object, Judge. I think it's irrelevant to her testimony. All she was asked to do was do a search of the records to determine the amount of acreage in taro and it had nothing to do with the 'auwai, the position of the streams, et cetera.
HEARINGS OFFICER JUDGE McCONNELL: I'll permit it.
Do you want to repeat it?
MR. SCHULMEISTER: Yeah.
Q. Do you know where Wailuanui Stream water

would come in on this?
A. According to the direction arrows, it's coming in this way.
Q. To the arrows just next to where it says A-55?
A. Yes, sir.
Q. Referring again to your testimony where you talk about the reason for the 90 percent assumption. This is on Page 3 of your written testimony. The bottom paragraph, the last three-and-a-half lines says:
"It is reasonable to conclude that most if not all of the land contained within these parcels was used for taro cultivation at the time of the Mahele. These parcels are located in a floodplain, the ideal location for taro cultivation."
Did I read that correctly?
A. Yes.
Q. Now, when you made the 90 percent assumption, did you make any assumptions with regard to whether or not anything about the slope of the land would make it difficult to get water to some of the areas within the tax map key parcel?
A. That was irrelevant.
Q. So like this gap that is shown on A-55

between these lo'i in the lower right corner, then the ones in the central part of the valley, do you -- were you present with when Mr. Wendt testified that water can't flow uphill to the left?
A. Yes, sir.
Q. When you made your 90 percent calculation, did you make any assumption that some of the areas, based on the slope, you might not be able to get water to 90 percent of the parcel?
MR. HAIA: Object as irrelevant and beyond the scope of her testimony.
HEARINGS OFFICER JUDGE McCONNELL: I'll permit it.
THE WITNESS: Do you mean did I take into consideration the topographical features of land titles?
MR. SCHULMEISTER: Yeah.
A. No, sir.
Q. I'm talking about specifically with regard to the 90 percent assumption.
A. I came up with -- the 90 percent assumption is based on through the years the practice of cultivating kalo that I've come across and experienced. However big the land was, about 90 percent would be kept in cultivation, the other ten

1 percent would be allowed to go fallow. Or out of ten
2 lo'i, nine would be cultivated, one would be fallow.
3 So that they then could then rotate their crops
4 around.
5 Q. Doesn't that also assume that none of the
6 land is used for anything else?
7 A. If it were, it would not have been awarded
8 for cultivation purposes. It would have been awarded
9 for a house lot, pahale.
10 Q. Did you do any work on the Answers to
11 Interrogatories that we had sent to Native Hawaiian
12 Legal Corporation in this case?
13 A. No, sir.
14 Q. I have no further questions.
15 HEARINGS OFFICER JUDGE McCONNELL:
16 Anything else? Thank you, ma'am. That completes
17 Native Hawaiian's case?
18 MR. HAIA: To the extent that, you know,
19 our direct testimony, but if something comes up on
20 their direct that --
21 HEARINGS OFFICER JUDGE McCONNELL:
22 Rebuttal is fine. Other than rebuttal. Okay. Why
23 don't we go off the record.
24 (Discussion held off the record.)
25 (Noon recess was taken.)

1 HEARINGS OFFICER JUDGE McCONNELL: We'r
2 reconvened.
3 GARRET HEW
4 was called as a witness by and on behalf of A&B and
5 EMI, was sworn to tell the truth, was examined and
6 testified as follows:
7 MR. HAIA: I'm sorry to interrupt. I just
8 want to reassert our objection to this direct
9 testimony and the basis for that.
10 HEARINGS OFFICER JUDGE McCONNELL: All
11 right. I think your record is well made.
12 DIRECT EXAMINATION
13 BY MR. SCHULMEISTER:
14 Q. Mr. Hew, are you still employed by East Maui
15 Irrigation Company?
16 A. Yes, I am.
17 Q. Are you still the president?
18 A. Yes, I am.
19 Q. I'm going to hand you two declarations, one
20 of which is dated July 29th, 2005, and the other one
21 August 22nd, 2005. Ask you to take a look at those,
22 tell me whether those represent declarations that you
23 signed in this case?
24 A. Yes, I did.
25 Q. Is the testimony that is referred to in those

1 declarations, is that true, correct and the best of
2 your knowledge and belief?
3 A. Yes, it is.
4 Q. I think, although the signed testimony was
5 already received, if it wasn't, we just clarify that
6 this is now part of the record.
7 HEARINGS OFFICER JUDGE McCONNELL: You
8 have got two declarations that will be in evidence.
9 Q. MR. SCHULMEISTER: On the table in front of
10 you, there is that very colorful map, which is Exhibit
11 A-1. Could you just take a moment -- A-1 is the ditch
12 system -- could you just take a moment and just
13 describe briefly for Judge McConnell what it is?
14 A. Exhibit A-1 is a map of our EMI ditch system.
15 It extends out towards Nahiku, all the way out towards
16 Maliko Gulch. It indicates the ditch system. It
17 indicates which areas are tunnels by the solid lines.
18 The blue lines are areas where the ditch is open or
19 above ground.
20 It also shows the stream diversions
21 indicated by a square red dot. The map also shows the
22 four license areas, the Huelo, Honomanu, Keanae and
23 Nahiku license areas. These are state lands which we
24 lease from the State of Hawaii, and those are
25 indicated in yellow.

1 The green areas are lands owned by East
2 Maui Irrigation, and the orange lands are owned by our
3 parent company, Alexander & Baldwin, Inc. And
4 wherever there are no colors on these parcels, those
5 are privately owned parcels.
6 Q. Now, you've been working at EMI since 1985,
7 is that right?
8 A. That's right.
9 Q. And in the course of the time that you've
10 worked at EMI, have you learned about some of the
11 history of the ditch system?
12 A. Yes, I have.
13 Q. And you were present during the first few
14 days of this hearing during the testimony of
15 Dr. McGregor, right?
16 A. Correct.
17 Q. There was some discussion about when the
18 Koolau Ditch was completed. And there was an exhibit
19 that was referred to as dated of 1904.
20 Do you have any knowledge as to when the
21 Koolau Ditch was completed?
22 A. Yes. The Koolau Ditch was completed in 1904.
23 We have records that indicate construction of that
24 ditch.
25 Q. Could you point out where the Koolau Ditch is

1 on the map?
2 A. The Koolau Ditch on this map starts at
3 Makapipi Stream at the most eastern end, and it goes
4 in a westerly direction, and it goes all the way to
5 Alo Stream, which is here.
6 Now, when we're talking about the
7 Wailuanui area, Wailuanui Stream, Waiokamilo Stream,
8 and it's referred to sometimes as Kualani Stream and
9 sometimes it's Hamau Stream.
10 Q. Which of the ditches divert water from any of
11 those streams?
12 A. There's only one ditch in that Wailua area
13 and that's the Koolau Ditch.
14 Q. Now, there was some construction of the total
15 system that continued after 1904, is that right?
16 A. Yes, that's right.
17 Q. What's your understanding of the later
18 constructed portions of the system?
19 A. The later constructed portions of the system
20 included the Haiku Ditch, which was completed in 1914;
21 the Kauhikoa Ditch was just completed 1915 and the
22 last ditch to be completed was the Wailoa Ditch
23 completed in 1923.
24 Q. Could you point out the Wailoa Ditch?
25 A. The Wailoa Ditch starts from Alo Stream and

1 goes all the way to Kamole Weir on this map here.
2 HEARINGS OFFICER JUDGE McCONNELL: Wha
3 was the second one?
4 THE WITNESS: Haiku Ditch was completed in
5 1914, the Kauhikoa was in 1915 and the last to be
6 completed was the Wailoa.
7 Q. MR. SCHULMEISTER: Now, when the Koolau Ditch
8 was completed in 1904, was it diverting water from the
9 Keanae area between the time the Koolau Ditch was
10 constructed and the Wailoa Ditch was completed?
11 A. Yes. The Koolau Ditch was in operation from
12 1904.
13 Q. Is there any relation between water collected
14 in the Koolau Ditch and water collected in the Wailoa
15 Ditch?
16 A. From my understanding, the Koolau Ditch
17 diverted water in this Nahiku-Keanae area and it
18 brought the water over to this New Hamakua Ditch which
19 we still operate. And from my understanding the New
20 Hamakua Ditch was mainly open, and with the newer
21 technology and ditch construction, the Wailoa Ditch
22 replaced the New Hamakua from Alo Stream westward.
23 Q. And that was the one completed in 1923?
24 A. That is correct.
25 Q. Have there been any major changes since 1923?

A. On the ditch system itself? No major changes.
Q. So as of the completion of Wailoa Ditch in 1923 to date the system has essentially been operated in essentially the same way?
A. Yes, it has.
Q. Now, this other map here, which is A-6, could you explain what this is?
A. A-6 is a schematic diagram of the EMI Ditch System along with HC&S Ditch System. It shows all of the ditches schematically starting from the Nahiku area all the way to Maliko Gulch. Once it gets to Maliko Gulch, the colored areas are operated by our sister company Hawaiian Commercial & Sugar, and the different colors I believe are related to the different farms on the HC&S side of the plantation.
Q. Now, unlike A-1, this one, just looking at it, it's not to scale, right?
A. No, it's not to scale.
Q. So it's just basically supposed to show how the water is routed?
A. Just a schematic to give you a clear idea of how the system is set up and from what areas the streams are diverted from, and coming into the plantation at its various levels.

HEARINGS OFFICER JUDGE McCONNELL: Do you have a small version of that?
MR. SCHULMEISTER: Yes, I think you may have it. If you don't, I can certainly give you a small one. I think you have the large one.
Q. How many employees does EMI have?
A. EMI has a total of 17 employees.
Q. And they're all under your supervision as president?
A. Yes, they are.
HEARINGS OFFICER JUDGE McCONNELL: I'm sorry, how many?
THE WITNESS: Seventeen employees.
Q. MR. SCHULMEISTER: Can you give just a brief thumbnail sketch, overview of what they do?
A. We have an operations manager, Mark Vaught, he's in charge of the daily operations. We have one technical clerical support person. The rest are out in the field.
We have 15 out in the field. We have about seven supervisory, and the rest are salaried, not supervisory people.
On a daily basis we're responsible for checking and making sure that the system is fully operable. We have 75 miles of ditch and tunnel of

which 50 miles are underground, 25 are aboveground.
We do routine maintenance work such as checking to see that stream diversions are clear and working properly. We have 60 miles of private four-wheel drive roads that we need to maintain to access our ditch system.
MR. HAIA: I'm just going to object at this point, being beyond the scope of the question.
HEARINGS OFFICER JUDGE McCONNELL: I'll permit it. It's background. Go ahead.
Q. MR. SCHULMEISTER: At the various stream diversions, why don't you just point out on A-1 where we went our first day, the site inspection, and we looked at diversions at Honopou, Haiku Ditch, right?
A. Yes. On the first day of our site inspection, we were at the Haiku Ditch at Honopou, which is the lowest ditch in elevation. We proceeded to Huelo Stream here, and we went down to see Mr. Schupp's diversion there along with Ms. Caveny. And then we took a ride up to the Lowrie level and we parked, because it was muddy, and we walked over to that diversion where we have the pipe crossing over the ditch.
(Isaac Hall present.)
Q. When we saw the diversion, the ditch at

Puolua, there was a gate that had been opened. Do you recall what I'm referring to?
A. At the Haiku level or the --
Q. The Haiku level.
A. The Haiku level, yes. There was a gate that was open at the Puolua Ditch, school intake, we call that.
Q. Explain the purpose and function of that gate.
A. That gate is actually a sluice gate we call it.
HEARINGS OFFICER JUDGE McCONNELL: Can yo point that out?
THE WITNESS: Haiku Ditch, it's at this point right here. That gate was opened because the prior week we had forecast of very, very heavy downpours. And what we wanted to do was make sure that our system was not damaged by an intense rainstorm.
So what we did was we controlled the level of the ditch. And that gate basically was opened so that if we did have storm floods, it would not inundate our ditch and cause damage to our system or to other peoples' property if it did overflow downstream.

Q. And then at the Haiku Ditch at Hanehoi Stream, there was a gate opened there too; is that right?
A. That's correct. It was opened at Hanehoi Stream also.
Q. And for the same reason?
A. Open for the same reason, because of storm forecast the week before.
Q. Now, in terms of routine operations and maintenance, under what circumstances are these gates opened and closed?
A. They're mainly closed under normal operations. The only time that they're opened is when we have forecast of a severe storm coming with imminent rains and we want to protect our system and also the adjacent properties from flooding, and that's when it's opened.
Other than that, if we do some maintenance in the tunnel or repair, those gates are also opened at times if need be.
Q. I'm going to talk for a few minutes now about the Kekahuna taro patches. And in your testimony you mentioned a number of exhibits and the history of some efforts that EMI had made to assist her to open her taro patches; do you recall that?

A. Yes.
Q. Now, is EMI committed to assuring Mrs. Kekahuna enough water to grow taro in her lo'i?
A. Absolutely.
Q. What has EMI done to assure her that there is enough water to do so?
A. First of all we had installed the additional four-inch pipe over our Haiku Ditch at Honopou diversion. That extra pipe I think we measured it, and it came out to about 120,000 gallons of water per day.
There are two existing pipes there already, and that's a total of three four-inch pipes passing water over our Haiku Ditch diversion. And these pipes pass low-flow water. In other words, the pipes are passing water at all times before any water goes into our --
THE COURT REPORTER: I'm sorry, I lost the end of that.
THE WITNESS: Yeah, these pipes are designed so they take the low flow of water over our ditch before any water can go into our stream diversion at that point.
Q. MR. SCHULMEISTER: Now, based on your observations and having gone out there and worked with

Mrs. Kekahuna, has she had enough water available in her 'auwai during the last two years to open up the patches that we saw on the site visit?

MR. HAIA: I'm going to object to that, beyond the scope of this witness' expertise, competence to testify to that.

HEARINGS OFFICER JUDGE McCONNELL: Well, I'll permit it. You're going to cross.

THE WITNESS: Yes, I believe that she had enough water to plant her open taro patches.

Q. MR. SCHULMEISTER: Now, has Mrs. Kekahuna ever complained to you at any time in the last two years that she did not have enough water available in her 'auwai to open those patches?

A. No.

Q. Now, one of the things mentioned in your written testimony is the fact that some taro was planted and was harvested.

A. Yes. We had assisted Mrs. Kekahuna in planting some taro, I believe it was in August of 2003. And it was Maui Lehua variety. And the taro grew and it was harvested about one year later.

Q. And did Mrs. Kekahuna ever complain to you that the taro when it was harvested from that patch was not healthy?

A. No. She never said that it was not healthy.

Q. Did she ever complain that it wasn't tasty?

A. That I don't know, because I hadn't talked to her whether she had eaten the taro or not.

Q. Now, with regard to Ernie Schupp's taro patch on Puolua Stream. On the site visit we had gone up and we had looked at the patch which was right off of the Haiku Ditch, right?

A. Correct.

Q. Then we also went up and looked at the stream where it's diverted at the Lowrie Ditch, right?

A. That's correct.

Q. Then you might want to point that out again.

A. This is Hanehoi Stream and this is the Lowrie diversion further up here.

HEARINGS OFFICER JUDGE McCONNELL: The re dot?

THE WITNESS: At the Haiku level, but somehow there isn't a red dot.

HEARINGS OFFICER JUDGE McCONNELL: Not this?

THE WITNESS: No, the brown is actually the road. The ditch is this blue line here.

Q. MR. SCHULMEISTER: Now, when we went and saw the stream at the Lowrie diversion, there was a pipe

that went through the diversion, right?

A. There was a pipe going through the diversion, yes.

Q. And one of the things that happened while we were there was an effort was made to pull leaves and things out of the pipe. Do you remember that?

A. At the Puolua diversion, you're talking about?

Q. Right, at the Lowrie.

A. At the Lowrie, yes.

Q. And what was the purpose of doing that?

A. The purpose was to clear the pipe of any debris that was blocking the flow of water crossing over our Lowrie Ditch diversion.

Q. Now, if it's not periodically cleaned out, what happens?

A. The pipe would get blocked up and the water would fall into our Lowrie Ditch.

Q. Now, you know Mr. Schupp, right?

A. Yes, I do.

Q. Have you dealt with him over the years?

A. Yes, I have.

Q. And does he have permission and the ability to go and clean those pipes if need be?

A. He has -- we have an informal agreement that

if he needs the water, he can go up there at any time to go and clean the pipes to get water down, back into the stream.

Q. Okay. So the water that goes through those pipes, stays in the stream and then there is a couple more pipes at Haiku that passes just above his 'auwai; is that right?

A. Yes, that's right.

Q. Those pipes are right next to his property?

A. The pipes are adjacent to his property, right.

Q. And again, he's free to clean those?

A. He's free to clean that to get the water in the stream.

Q. Now, you were present when Mr. Schupp testified?

A. Yes, I was.

Q. And one of the things that he testified about was I guess a meeting with representatives of EMI where there was some discussion or criticism of the way that his diversion was constructed. Do you recall him testifying to that effect?

A. Yes, I do.

Q. Do you recall ever criticizing the diversion? In other words, the way it was physically constructed?

A. As I recall, we went to visit that area with a couple of EMI employees, and we looked at the pipe diversion and we walked downstream and just to see if Mr. Schupp had done anything to his diversion to get water to his lo'is. And at that time he showed up and he said he was busy, he didn't have the time to rebuild the diversion.

And at that time we offered our assistance to Mr. Schupp to help him with any work that he might have on the diversion.

Q. Could you look at Exhibit A-12. Exhibit A-12 on East Maui Irrigation Company letterhead. Do you know who prepared this?

A. I prepared this.

Q. And this refers to March 11th, 2004 site visit to Honopou and Puolua Stream?

A. That's correct.

Q. Is this the same site visit you were just referring to?

A. No, it was not.

Q. Was this earlier or later?

A. I believe we had visited Mr. Schupp later, after this site visit.

Q. Now, in this -- on this March 11th site visit, were any measurements taken of the flow at

Puolua at Haiku Ditch where Mr. Schupp's 'auwai is?

A. Yes, measurements were taken at the Haiku Ditch Puolua intake.

Q. And are those referred to near the bottom of the page?

A. Yes. It's referred to water measurements Puolua at Haiku.

Q. And what was the flow on that day at Puolua at Haiku? That's below the diversion, right?

MR. HALL: Objection, these measurements were taken by CWRM and not Mr. Hew. He has no personal knowledge, no foundation.

HEARINGS OFFICER JUDGE McCONNELL: Lay a foundation.

MR. HALL: All he's doing is repeating what's in Exhibit A-12.

Q. MR. SCHULMEISTER: Well, you prepared Exhibit A-12, right?

A. That is correct.

Q. What does the last line of A-12 say?

MR. HALL: The document speaks for itself. He still hasn't laid any foundation that he did measurements. In fact he did not.

HEARINGS OFFICER JUDGE McCONNELL: It's in evidence. Overruled.

1 MR. HALL: It should be clear on the
2 record he didn't make any measurements.
3 HEARINGS OFFICER JUDGE McCONNELL: You ca
4 cross-examine, Mr. Hall.
5 MR. HALL: I don't want a record that's
6 unclear. They're trying to imply --
7 HEARINGS OFFICER JUDGE McCONNELL: He can
8 read from an exhibit in evidence.
9 THE WITNESS: The last line on Exhibit
10 A-12 reads: Total for Puolua at Haiku equals 262,000
11 gallons per day.
12 Q. MR. SCHULMEISTER: Where did you get that?
13 A. I measured this.
14 Q. You measured this?
15 A. Yes, I did.
16 Q. On the same day, March 11?
17 A. Yes.
18 Q. Could you explain how you measured it?
19 A. We took a one-cubic-foot stainless steel box,
20 and what we did was we measured how long it took to
21 fill up the box several times and we got an average,
22 and we averaged it out to what -- how many seconds it
23 took to fill up the box to calculate what the flow
24 was.
25 Q. So just so we are clear, the 262,000 gallons

1 per day, that was the amount that was coming through
2 the pipes?
3 A. Coming out of the two pipes at Haiku Ditch at
4 Puolua Stream, correct.
5 Q. And so therefore available to be diverted
6 into Mr. Schupp's taro patch?
7 A. That's correct.
8 MR. HALL: Objection. I'll handle this on
9 cross.
10 Q. MR. SCHULMEISTER: Were you also present
11 during the testimony of Ms. Caveny?
12 A. Yes, I was.
13 Q. And do you recall her having testified that
14 she had done some research or investigation by talking
15 to residents in the area, and I think put in some
16 letters to the effect that Hanehoi Stream, in the ten
17 or 15 years prior to her acquiring her property on
18 Hanehoi Stream, used to have a modest but fairly
19 consistent flow; do you recall that?
20 A. Yes, I do.
21 Q. And she also testified that since she's
22 acquired her property, that it's been frequently
23 completely dried, so not having this consistent flow
24 that she had heard used to exist previously; do you
25 recall that?

1 A. Yes.
2 Q. Now, you started working at EMI in 1985; is
3 that right?
4 A. Yes, I did.
5 Q. Do you have any knowledge of whether there
6 was a continuous flow -- a relatively continuous flow
7 in Hanehoi Stream along Ms. Caveny's property in the
8 ten or 15 years prior to her acquiring it which the
9 records indicate is 2001?
10 A. Yes, I do.
11 Q. Tell us what that is?
12 A. When I started to work for EMI in 1985,
13 shortly thereafter, probably in 1988, '89, I went with
14 our field superintendent, Mr. Cabral. And we went
15 down to this Hanehoi intake on the Haiku Ditch, and at
16 that time he introduced me to this gentleman. His
17 nickname was Poncho. I don't know what his real name
18 was.
19 Poncho apparently had resided on the
20 property downstream of our Haiku Ditch, I believe on
21 the Lee property. He was the caretaker for the Lee
22 property. And at that time Poncho was probably in his
23 late eighties or early nineties. And I believe he was
24 retired and he was just living out there and raising
25 some vegetables, raising some chickens.

1 He did say that he used to raise taro
2 before down below of the Haiku Ditch.
3 Q. Now, Hanehoi, we went on the site visit. We
4 looked at where the Lowrie Ditch diverts Hanehoi as
5 well, right?
6 A. That's right.
7 Q. And there we saw, there was two pipes through
8 the diversion; is that right?
9 A. There were two pipes passing water -- correct
10 that. There are two pipes going from the stream over
11 our ditch.
12 Q. And the day that we went there, one of them
13 was passing water?
14 A. One of them was passing water, the other one
15 was plugged.
16 Q. Do you know what the history of those two
17 pipes are?
18 A. From my understanding those two pipes used to
19 pass water over the Lowrie Ditch, come down to the
20 stream, and before the Haiku Ditch at Hanehoi Stream,
21 Poncho had a ditch, small little ditch. He diverted
22 water off Hanehoi Stream via a small ditch. I believe
23 it was a one-by-one foot ditch. A very small 'auwai.
24 And he used to take that water over our Haiku Ditch
25 tunnel, and he used to use that water for, not only

1 taro, but also for domestic purposes.
2 Q. What happened to the water after he diverted
3 it?
4 A. I believe the water that was not used up by
5 Poncho ended up back in Hanehoi Stream.
6 Q. And where in relation to the Haiku Ditch?
7 A. Below of the Haiku Ditch. It entered the
8 stream below the Haiku Ditch.
9 Q. And during that period who, if anybody, would
10 maintain the pipes at the Lowrie diversion of Hanehoi
11 Stream?
12 A. I would have to assume that it was Poncho
13 because he needed that water to be diverted off of
14 Hanehoi Stream for his domestic use and also for his
15 garden and taro cultivation.
16 Q. Now, the written testimony submitted by Ms.
17 Caveny indicated that there used to be pipes that
18 passed Hanehoi water at the Haiku diversion.
19 To your knowledge is that true?
20 A. To my knowledge we have never had any pipes
21 in the Haiku Ditch-Hanehoi diversion that passed water
22 over that diversion.
23 Q. So any water that was being passed at Lowrie
24 that was passed below Haiku, it wasn't passed through
25 any pipes at the Haiku Ditch?

1 A. It wasn't passed at the Haiku Ditch.
2 Q. If anything, it went through Mr. Poncho's
3 auwai?
4 A. If anything it was diverted off of Hanehoi
5 Stream into Poncho's 'auwai, over our Haiku Ditch
6 tunnel and eventually back into Hanehoi Stream.
7 Q. Was EMI involved in maintaining the Lowrie
8 pipes or maintaining Poncho's 'auwai?
9 A. No, we were not.
10 Q. And is your understanding that Poncho is no
11 longer there?
12 A. I understand that Poncho had passed away in
13 the early '90s sometime.
14 Q. And do you know what's happened with his
15 'auwai since?
16 A. His 'auwai I know is grassed up. And down at
17 the Lee property, I went down there maybe four, five
18 years ago for a land matter, there was evidence of his
19 'auwai and also there was a small reservoir at the end
20 where he caught some of that water and used it for
21 domestic purposes.
22 Q. Now, I take it that when Poncho was diverting
23 the water that passed the Lowrie diversion and he
24 diverted it and was able to put it back in below
25 Haiku, when you were at EMI, did EMI ever object to

that?
A. No, we didn't have any objections to that.
Q. And would EMI have a problem with essentially the same amount of water being passed around the Haiku diversion as it used to be when Poncho used to operate his auwai?
A. No, we would not have a problem with that.
Q. Talk a little bit about the Wailuanui area.
Could you explain to Judge McConnell what Kikokiko is?
A. Kikokiko is an area above Wailua. It is actually part of the Waiokamilo Stream system. How the name Kikokiko got there, I don't know. But at Waiokamilo Stream at Kikokiko intake, from my understanding, the stream is very, very porous in that area.
So what EMI did when they built the Koolau Ditch was that instead of having the diversion at the Koolau Ditch, they went further up the stream, maybe another three quarters to a mile. And what they did was they diverted the stream way above there.
And this diverted water went into a small concrete ditch, maybe 18 inches by 18 inches. And what the ditch essentially did was to bypass that leaky area of the stream.

So we got the water into our Koolau Ditch by bypassing that leaky stream section.
HEARINGS OFFICER JUDGE McCONNELL: And that's above Kikokiko?
THE WITNESS: That's at Kikokiko above the Koolau Ditch.
Q. MR. SCHULMEISTER: When we went on the site visit, we went to the mauka lookout and looked mauka, we could see there was one waterfall kind of off in the distance -- actually if you look at Exhibit A-23. We have the photo A-23.
A. A-23 has no photo.
MR. SCHULMEISTER: Do you have A-23.
MS. LOVELL: I've got a different --
MR. SCHULMEISTER: There are three photos that make up A-23.
HEARINGS OFFICER JUDGE McCONNELL: I remember it, but I can't find it.
Q. MR. SCHULMEISTER: Can you point out in the photo where Kikokiko is?
A. Kikokiko is up on the top just above to the left of center, this waterfall right here.
Q. Is that the primary location at which Waiokamilo Stream is diverted into the Koolau Ditch?
A. Yes, it is, through our Kikokiko Ditch

further above.
Q. And then what's below that? There's a waterfall. Are there springs somewhere below that?
A. Below this waterfall there's a spring there. People call it either Banana Spring or Akeke Spring. And that spring feeds the taro growing area of Wailua.
Q. Could you look at Exhibit A-29, please? Do you have Exhibit A-29?
A. Yes, I do.
Q. And this is referred to in your direct testimony as being a CWRM water registration that you worked on?
A. Yes. This is the registration of stream diversion works and declaration of water use for Waiokamilo, Kualani, Puolua and Waikani Streams.
Q. How did it come about -- strike that.
Did you work personally on helping to put this together?
A. Yes, I assisted at that time Mrs. Apolonia Day who was the president of the Wailuanui Taro Growers Association.
Q. And what was the purpose of this registration statement?
A. The purpose of registration statement was requirement by the Commission on Water Resource

Management to have all stream diversions registered by, I believe it was 1989.
Q. A-25. The diversion works that are registered on A-29 that you just looked at, are they shown somewhere on your schematic, A-25?
A. Yes, it is.
Q. Could you just briefly describe it to Judge McConnell?
A. On Exhibit A-25 there are diversions, I think you have one that's colored, the ones colored in yellow are the stream diversions. Starting at the very top on your right-hand side, it's Dam No. 3. And as you move down, Waiokamilo Stream, there's Dam No. 2. And where Dam No. 2 diverts Waiokamilo water eastwards towards Kualani Stream, there's Dam No. 1 where it says Roseapple.
Q. Now, when we went on the site visit the last day that we were here, and we went up and looked at Dam 3 and Dam 2; is that right?
A. Yes, we did.
Q. And we also went to Lakini taro patches and looked at Dam 1?
A. Yes, we did.
Q. Now, we talked about Kikokiko diverting water into the Koolau Ditch from Waiokamilo Stream. Does

EMI divert water from Kualani Stream or also what's been referred to as Hamau Stream?
A. You know, upon review of our ditch map and going out there on a field inspection a couple of weeks ago, it appeared that our map is incorrect in Kualani Stream. It needs to be revised. But what we had found out in the field is that what is shown as Kualani on this map is actually not Kualani Stream.
Q. Okay. So getting back to my question, does EMI divert water into the Koolau Ditch, or does EMI divert water at all from Kualani Stream?
A. No, we do not.
HEARINGS OFFICER JUDGE McCONNELL: And what you're referring to is this (indicating)?
THE WITNESS: That there on the left-hand side of the page is Wailuanui Stream. Kualani Stream is --
HEARINGS OFFICER JUDGE McCONNELL: This one?
THE WITNESS: Yes, that's the one.
Q. MR. SCHULMEISTER: And the reference you just made to having gone to the field and found that the map is in error, which map are you referring to?
A. I'm referring to this EMI ditch map, the colored map.

Q. Exhibit A-1?
A. Exhibit A-1.
Q. And in what regard is it not correct?
A. As it is shown on the EMI map, it's shown as Kualani Stream. You can see the numbers on the map by close to number 69. We have two diversions, one at 69 and one at 73. And actually those diversions are tributaries of Waiokamilo Stream and not Kualani Stream.
Q. And how did you determine that that's the case?
A. Well, first of all, when we went out there, went up on West Wailua-Iki Road, came up to the intersection of the Upper Ditch Road and West Wailua-Iki Road, and what we did basically was count the turns going towards Kikokiko. And what we did was we stopped off at various points. And what we had believed was Kualani based on this map here, we climbed to a point so that we could see where exactly that water was going.
It was a very, very rainy day. It was hard to see, but it was clear in my mind that that water was not Kualani as depicted on this Exhibit A-1 map.
Q. Now, were you present during the testimony of

1 Mr. Wendt?
2 A. Yes, I was.
3 Q. And do you recall him having testified that
4 Dam 3 would not be necessary if it weren't for the EMI
5 diversions? In other words, that there would be
6 enough water in Kualani Stream to go into Lakini, then
7 cross Lakini down below, even without diverting water
8 at Dam 3, if it weren't for the EMI diversion?
9 A. Yes, I recall that.
10 MR. HAIA: Objection. Misstates his
11 testimony.
12 HEARINGS OFFICER JUDGE McCONNELL: I'll
13 permit it. I mean, you know, the record will speak
14 for itself.
15 THE WITNESS: Yes, I recall that.
16 Q. MR. SCHULMEISTER: Do you agree with that
17 testimony?
18 A. No, I don't.
19 Q. Can you explain why?
20 A. Because of the fact that if Dam 3 was not
21 present, the water that goes into Waiokamilo Stream
22 would basically sink into that porous pond and it
23 would not be diverted towards Kualani Stream to be
24 diverted at Dam No. 1, which is the main diversion
25 into Lakini and subsequently into Wailua.

1 Q. Now, were you involved in some repairs to Dam
2 3 that were done towards the end of 2004?
3 A. Yes, I was.
4 Q. What was -- what were those repairs
5 basically, just describe for the judge.
6 A. The repairs was basically Dam No. 3 was a
7 concrete dam. And I believe what happened was because
8 of storms in the past, and things like that, the dam
9 got washed away. And when we went up there, what we
10 noticed was that in order for the dam to continue to
11 divert water around that porous pool, some rocks with
12 some sandbags and some dirt and some other stuff had
13 been put in the stream so that the water would be
14 diverted around that porous pond.
15 Q. Do you have A-30?
16 A. Yes, I do.
17 Q. Do you recognize A-30?
18 A. Yes, I do.
19 Q. Does Exhibit A-30 relate to the repairs that
20 were done to Dam 3?
21 A. Yes, it does relate to the repairs done to
22 Dam 3. Exhibit A-30 is an interim agreement regarding
23 the taro water in East Maui. And as agreed upon by
24 both EMI, A & B along with Native Hawaiian Legal
25 Corporation that we would work in good faith to try

1 and repair some of these areas, and one of the areas
2 was Dam No. 3, to reconstruct Dam No. 3 to a solid
3 concrete dam as it was originally.
4 Q. All right. Is Dam 1, Dam 2 or Dam 3, are any
5 of those dams EMI Irrigation Company diversion works?
6 A. None of those dams belong to us. We do not
7 have any control over those diversions.
8 HEARINGS OFFICER JUDGE McCONNELL: What
9 did you say, 1, 2 and 3?
10 MR. SCHULMEISTER: Yeah.
11 Q. And did EMI pay for the repairs that were
12 done to Dam 3?
13 A. Yes, we did.
14 Q. Why did EMI do that if it's not an EMI dam?
15 A. Because we wanted to do it in good faith and
16 to try to help other taro growers in Wailua to get
17 more water to their taro patches.
18 Q. In the schematic it shows how it crosses the
19 road and goes down the road, or Waiokamilo?
20 A. Correct.
21 Q. What about Wailuanui Stream?
22 MR. HAIA: Can I interrupt for a minute?
23 Exhibit A-30 is a confidential document. It was one
24 that was entered into pursuant to Rule 408. I have a
25 real concern with releasing that.

1 If you look at Page 2, first paragraph,
2 last sentence: "The parties agree that this interim
3 agreement is made in the course of settlement
4 discussions in accordance with Rule 408 of the Hawaii
5 Rules of Evidence, and shall not be construed as an
6 admission and cannot be used for any purposes
7 prohibited thereby".
8 MR. SCHULMEISTER: It's been on our
9 exhibit list for a long time.
10 MR. HAIA: I'm objecting to it right now.
11 HEARINGS OFFICER JUDGE McCONNELL: It's
12 offered only to show that they were interested in the
13 repair of Dam 3. Right?
14 MR. HAIA: That's not what he's testifying
15 to.
16 HEARINGS OFFICER JUDGE McCONNELL: I know
17 but that's all I heard.
18 MR. HAIA: It doesn't seem to be any
19 applicability with respect to Rule 408 if it's not
20 going to apply.
21 HEARINGS OFFICER JUDGE McCONNELL: It
22 won't be in then for any other -- he's testified
23 though that basically it was a deal to fix Dam 3.
24 MR. HAIA: I move to strike it, judge.
25 HEARINGS OFFICER JUDGE McCONNELL: Strike

1 what?
2 MR. HAIA: The exhibit.
3 HEARINGS OFFICER JUDGE McCONNELL: I'm no
4 receiving the exhibit.
5 MR. HAIA: And the testimony based upon
6 the exhibit.
7 HEARINGS OFFICER JUDGE McCONNELL: I'll
8 deny that.
9 MR. SCHULMEISTER: Do you have your
10 schematic A --
11 HEARINGS OFFICER JUDGE McCONNELL:
12 Although I think --
13 MR. SCHULMEISTER: I think previously we
14 had a stipulation that everything --
15 HEARINGS OFFICER JUDGE McCONNELL: It was
16 in any way, wasn't it?
17 MS. LOVELL: My copy is heavily redacted.
18 MR. SCHULMEISTER: The one that is in is
19 also heavily redacted.
20 MR. HALL: That's not point.
21 HEARINGS OFFICER JUDGE McCONNELL: This
22 one here is not redacted.
23 MS. LOVELL: No, the attachments to it.
24 MR. HALL: The redactions weren't
25 redacted --

1 THE COURT REPORTER: You have to speak up.
2 I can't hear you.
3 MR. HALL: The purposes of the redaction
4 wasn't to remove the essential materials, the whole
5 document is a settlement document.
6 HEARINGS OFFICER JUDGE McCONNELL: First
7 off, if it's already in, it's already in anyway.
8 MR. HALL: I thought you just struck it.
9 HEARINGS OFFICER JUDGE McCONNELL: Well,
10 any objection? I'll strike it. I don't have a
11 problem with that. It's -- to the extent it shows the
12 agreement to repair 3, that's all I'm taking from it.
13 Otherwise struck, hearing no other argument.
14 MR. SCHULMEISTER: Well, just for the
15 record, I don't want to belabor this, but I just
16 wanted to just note for the record that -- I can't put
17 my finger on it right now -- but there has been some
18 testimony in some of the declarations that have been
19 submitted to the effect that EMI has been unresponsive
20 to the taro farmers and unavailable and unwilling to
21 do anything to assist them or make sure that they have
22 enough water for taro. And to the extent that that
23 indicates to the contrary, I would submit that they've
24 opened the door to it, but I don't want to get into
25 it.

1 MR. HALL: I take great offense to that
2 because we have had so many settlement discussions
3 that have gone nowhere. The fact that Garret Hew
4 takes some taro down to one of the taro growers and
5 then EMI shuts off the water, that's the heart of the
6 matter.
7 HEARINGS OFFICER JUDGE McCONNELL: I've
8 already ruled on it.
9 MR. HALL: We wouldn't be here if EMI
10 would do what is essentially being requested, which is
11 to let down more water.
12 MR. SCHULMEISTER: I won't take that bait.
13 MR. HALL: Just let down more water.
14 MR. SCHULMEISTER: Could we take a short
15 break?
16 HEARINGS OFFICER JUDGE McCONNELL: Okay.
17 (Recess was taken.)
18 HEARINGS OFFICER JUDGE McCONNELL: We're
19 back on the record.
20 MR. FREEDMAN: I just have an
21 administrative thing about my witness. If I call him
22 now, he will be here about 4:10. I'm getting the
23 sense that this won't be finished by then. Is it okay
24 if we just interrupt or take out of order or whatever
25 opposing counsel --

1 MR. HAIA: I have no problem with that.
2 HEARINGS OFFICER JUDGE McCONNELL: I don'
3 care.
4 MR. FREEDMAN: I appreciate that.
5 HEARINGS OFFICER JUDGE McCONNELL: Let's
6 start already.
7 Q. MR. SCHULMEISTER: You have Exhibit A-56?
8 A. A-56.1 through A-56.5.
9 Q. Could you explain what that is?
10 A. Exhibit A-56.1 is a picture of Waikani
11 Waterfall on Wailuanui Stream.
12 Q. Is that right -- basically at the Hana
13 Highway?
14 A. Just below the Hana Highway. Exhibit A-56.2
15 is a picture of the pond, where this Waikani Waterfall
16 goes into.
17 Exhibit A-56.3 is a picture of Sam Akina
18 standing next to a boulder. And right in front of him
19 is where the intake pipe from Waikani goes to Wailua.
20 Exhibit A-56.4 is a section of pipe that
21 was broken off of that existing pipe due to a
22 landslide.
23 And Exhibit A-56.5 is the existing intake
24 into -- from Wailua Stream going into Wailua minus the
25 intake pipe, which is on Exhibit A-56.4.

1 Q. Is this also referred to as a siphon?
2 A. Yes, it is.
3 Q. And did you take these pictures?
4 A. Yes, I did.
5 Q. And what were the circumstances that led to
6 you taking these pictures?
7 A. I got a call from Council Member Bob Carrol
8 one day asking if EMI could provide some assistance to
9 the taro growers in regards to repairing this pipe
10 which was damaged by landslide.
11 Q. About when was that?
12 A. I believe these pictures were taken I think
13 about three years ago.
14 Q. And did anything come of that?
15 A. No. We have not gone up there to repair this
16 pipe. One of the reasons is because flows were too
17 high and we needed to coordinate some of this work
18 activity with the County of Maui who was agreeable
19 with helping, and also with the taro grower on that
20 end.
21 Q. Now, what affect, if any, did the landslide
22 and this broken pipe have on the ability of the taro
23 growers to use water from this pond?
24 A. I think during normal periods, I don't think
25 it's a problem. The pipe, actually that siphon pipe

1 in Exhibit A-56.4 was connected to this Exhibit
2 A-56.5. It went into this pond about four feet under
3 the level of the water. And what it did was it
4 prevented any leaves or any debris from going into
5 this pipe, since this pipe was underwater it would be
6 always taking freshwater. That would relieve the need
7 of maintenance of this pipe to a certain extent.
8 Q. I have handed you Exhibit A-53. Could you
9 explain what Exhibit A-53 is?
10 A. Exhibit A-53 is an aerial photo of Wailuanui
11 taken on October 25th, 2005. And the areas that are
12 outlined in black and numbered are areas that are in
13 taro production.
14 Q. How do you know that?
15 A. By looking at the area you can see areas that
16 are open and cultivated and planted, based on this
17 photo.
18 Q. And do you have Exhibit A-52 in front of you?
19 A. Yes, I do.
20 Q. What is A-52?
21 A. Exhibit A-52 is a summary of the Wailuanui
22 acreage and taro as of 10/25/05.
23 Q. How was this prepared?
24 A. This was prepared first of all with this
25 aerial photo by identifying each particular area that

1 was under cultivation with the assistance of a
2 Keanae-Wailua taro farmer indicating the lo'is, the
3 farmer, and looking up on the tax map key who was the
4 owner and the acres.
5 MR. HAIA: Excuse me. Did I hear
6 correctly? Did you say this draft was done with the
7 assistance of each taro farmer?
8 THE WITNESS: No. What I said was this
9 summary was done with the assistance of one
10 Keanae-Wailuanui taro farmer.
11 Q. MR. SCHULMEISTER: Could you look at Exhibit
12 A-54, which is in front of you. This one I have ten
13 full size copies so anyone who wants one, you're
14 welcome to it.
15 Could you explain what Exhibit A-54 is?
16 A. Exhibit A-54 is an aerial photo taken on
17 October 3rd, 1985 of the Wailuanui area.
18 Q. What's the shaded areas?
19 A. The highlighted areas in yellow on this
20 Exhibit A-54, corresponds to this aerial photo taken
21 10/25/2005 and transposed on this aerial photo dated
22 10/3/85.
23 MR. HAIA: Judge, I just want to object to
24 both of these exhibits. They are way past the
25 deadline. Never any indication to the parties that

1 these exhibits were going to be produced. It's taking
2 us by total surprise and I would move to strike them.
3 MR. SCHULMEISTER: Your Honor, I would
4 like to point out in response to interrogatories that
5 we gave to -- one of the things we asked for was for
6 them to tell us what the acreage was that was in
7 cultivation. And they basically didn't answer those.
8 So we just did the best we could.
9 MR. HAIA: That's A & B's burden.
10 MR. SCHULMEISTER: Well, and we're trying
11 to meet that, and that's why we're putting it in.
12 MR. HAIA: A little late, Dave.
13 HEARINGS OFFICER JUDGE McCONNELL: I'll
14 overrule that.
15 Q. MR. SCHULMEISTER: With regard to the last
16 column on A-52, the acres.
17 A. Yes.
18 Q. Can you explain how the acres that are listed
19 there, how those were determined?
20 A. The acres that were -- the acres on the
21 right-hand side of Exhibit A-52 was determined by
22 scaling off all of these highlighted colored areas by
23 our registered surveyor and using the approximate
24 scale to determine the acres for each individual
25 number lo'is.

1 MR. HAIA: You know, Judge, I'm not going
2 to agree to take Mr. Hew's word for it that there was
3 someone else that did the scaling for him without
4 having the opportunity to have that person before us.
5 HEARINGS OFFICER JUDGE McCONNELL: I've
6 already ruled, let's go on.
7 MR. HAIA: With respect to the scale, and
8 that's how they got these numbers?
9 Q. MR. SCHULMEISTER: Do you know what the scale
10 is --
11 HEARINGS OFFICER JUDGE McCONNELL: I'm no
12 accepting it as gospel, you can cross-examine.
13 MR. HAIA: I don't think I need to
14 cross-examine. This stuff shouldn't be coming in.
15 HEARINGS OFFICER JUDGE McCONNELL: All
16 right. But it is, it's coming in. It's an
17 administrative hearing. I'm not going to keep it out.
18 Q. MR. SCHULMEISTER: Do you know what the scale
19 is on the photo?
20 A. The scale on Exhibit A-54 indicates one inch
21 equals 200 feet.
22 Q. When you say it was scaled, is that what
23 you're referring to? You're scaling it off the one
24 inch equals 200 feet?
25 A. What you're doing is taking each individual

1 highlighted parcel and measuring each parcel to
2 determine how many feet it is to calculate area.
3 Q. If you go back to Exhibit A-53 for a moment.
4 The area that has the number seven on the
5 left-hand side, do you see that?
6 A. Yes.
7 Q. On A-52, number seven is listed as having the
8 farmer being Norman Martin; is that right?
9 A. Yes, that's correct.
10 Q. And the acreage is listed at 2.505 acres?
11 A. That's correct.
12 Q. Now, do you know where Norman Martin gets the
13 water to irrigate the taro that's in that area
14 identified as number seven?
15 A. Norman Martin gets his water from Wailuanui
16 Stream.
17 Q. And to your knowledge, do any of the other
18 areas -- any of the other numerical listings on A-53,
19 any of those other patches get their water from
20 Wailuanui Stream?
21 A. From my knowledge right now, just number
22 seven gets water from Wailuanui Stream.
23 Q. So looking at A-52 then, if what we wanted to
24 do is calculate the acreage that gets their water from
25 Waiokamilo Stream, would we then take out the 2.505

1 acres that Norman Martin is farming?
2 A. Yes.
3 Q. So what does the 16.979 at the bottom of A-52
4 represent?
5 A. That 16.979 acres represent taro utilizing
6 Waiokamilo Stream water.
7 Q. A-54, which is the 1985 aerial photo, in
8 looking at that, does there appear to have been more
9 taro in cultivation in 1985 than in October of 2005?
10 A. Yes.
11 Q. And you were at EMI in 1985?
12 A. Yes, I was.
13 Q. Is that consistent with your memory of what
14 was going on in Wailuanui?
15 A. Yes, it is.
16 Q. So between 1985 and 2005 you've witnessed a
17 reduction in the amount of taro being cultivated in
18 that area?
19 A. Yes, I have.
20 Q. Now, has there been any increase in the
21 amount of water that EMI is diverting from Waiokamilo
22 Stream or Wailuanui Stream in those 20 years?
23 A. No. No, there has been no increase.
24 Whatever we were diverting in 1985 is the same amount
25 that we are diverting in 2005, so the structures have

1 not changed.
2 Q. Look at A-51, Exhibit A-51. Have you seen
3 that before?
4 A. Yes, I have.
5 Q. And that's a March 10th letter?
6 A. March 10th, 2005 letter, yes.
7 HEARINGS OFFICER JUDGE McCONNELL: I don't
8 have it.
9 MR. SCHULMEISTER: That would have been
10 given to you last time.
11 MR. HAIA: Are these the exhibits just
12 handed out this morning?
13 MR. SCHULMEISTER: No.
14 This is our supplemental exhibits from the
15 last hearing March 10th letter 2005.
16 MR. HAIA: Before we begin though I just
17 want to say, our position is that this is another
18 letter intended to try and reach an agreement to
19 prevent this actual hearing right here. And so based
20 upon that, we would want it struck.
21 It says: The purpose of this letter is to
22 follow up on our meeting of February 25, 2005 at Randy
23 Ishikawa's office --
24 HEARINGS OFFICER JUDGE McCONNELL: Yeah,
25 can read that.

1 MR. HAIA: And it says: To obviate the
2 need for a hearing on interim releases pending the
3 conclusion of the above-referenced contested case
4 hearing.
5 HEARINGS OFFICER JUDGE McCONNELL: Yeah,
6 the rule says that an offer of settlement is not
7 admissible to prove liability; and it also says if you
8 make statements in the course of a mediation, that
9 those can't be used.
10 MR. HAIA: Well, my understanding is that
11 Mr. Schulmeister is going to use this to argue --
12 HEARINGS OFFICER JUDGE McCONNELL: What'
13 it offered for?
14 MR. SCHULMEISTER: Well, what it's offered
15 for basically is in March of 2005 it was stated that
16 more water was needed down in Wailuanui. And also
17 that I guess Ed Wendt and Na Moku did not want to deal
18 with Mr. Hew. So they asked us to authorize Mr.
19 Vaught, I guess, to be contacted.
20 And this letter that confirms that, and
21 also states what EMI is willing to do in terms of
22 working with them to get more water for their taro.
23 And at that point, you know, basically Mr.
24 Vaught was to receive a call from Mr. Ed Wendt and
25 from there efforts would be made to try to work it

1 out. And Mr. Wendt never made the call.
2 MR. HALL: Judge, those are ongoing
3 settlement discussions going on since 2001 and never
4 comes to fruition because EMI never lets down any
5 water. It's as simple as that. It can't be received
6 into evidence.
7 MR. SCHULMEISTER: Well, it's actually
8 already been stipulated in, number one; and number
9 two, I would also like to point out that Mr. Wendt in
10 one of the declarations -- what was also going on at
11 this time was that Na Moku took an appeal to the
12 circuit court, and he put in a declaration which is
13 also in the exhibits stating that this happened and
14 stating that the reason why he didn't call Mr. Vaught
15 was because he thought he didn't have enough authority
16 or something to that effect.
17 So Na Moku itself in the testimony of Mr.
18 Wendt in the declaration has put the circumstances of
19 all this into issue. And so I think it is appropriate
20 for it to come in.
21 MR. HAIA: How does this have anything to
22 do with the interim relief, Judge? That's what I want
23 to know.
24 HEARINGS OFFICER JUDGE McCONNELL: Well,
25 there's a great deal of evidence here that I would

1 agree may have relatively little to do with that
2 question. But, you know, the question was apparently
3 opened if Mr. Schulmeister's representations are
4 correct. And it's already stipulated in, so I'll
5 receive it.
6 Just while we're talking though, I am
7 concerned about acreage. And if you folks have any
8 technical problem with the amount of acreage, I would
9 submit some rebuttal -- permit rebuttal on that.
10 Because I understand they didn't give you this map
11 earlier.
12 MR. HAIA: Thank you.
13 Q. MR. SCHULMEISTER: Could you just read out
14 loud the second to last paragraph of Exhibit 51?
15 A. This is the March 10th, 2005 letter, Page 3.
16 Once the 'auwai is cleared, if adequate
17 water is not reached in the lo'i, please have your
18 client contact Mark Vaught. If the condition of Dam
19 No. 1 is such that closing EMI's west Kualani intake,
20 if six-inch diversion downsized to a four-inch pipe
21 above Kualani Stream would allow more water to be
22 directed into the Lakini taro patches, EMI is prepared
23 to do so as well as to consider other alternatives on
24 a trial and error basis as you requested in our
25 meeting of February 25th, 2005.

1 Q. Now, that reference to intake above Kualani,
2 was that before you discovered that the map was in
3 error?
4 A. That's correct.
5 Q. So what intake does that actually refer to?
6 A. This intake would refer to the east tributary
7 of Waiokamilo Stream.
8 Q. And to your knowledge did anyone from Na Moku
9 ever respond to this?
10 A. No.
11 Q. In terms of calling Mr. Vaught?
12 A. No one from Na Moku had contacted Mr. Vaught
13 on this issue.
14 MR. SCHULMEISTER: I have no further
15 questions.
16 HEARINGS OFFICER JUDGE McCONNELL: Any
17 questions by county first?
18 MS. LOVELL: I've got just a couple.
19 CROSS-EXAMINATION
20 BY MS. LOVELL:
21 Q. Can I stand here, Mr. Hew? You've got A-1
22 there, right?
23 A. A-1 is the map of our ditch system, correct.
24 Q. Now, over in the left-hand bottom corner do
25 you see Kamole Weir?

1 A. Yes, I do.
2 Q. And the way the map looks it kind of looks as
3 if the Wailoa Ditch ends there and all the water in
4 the ditch ends up in Kamole Weir, but that's not how
5 it works, is it?
6 A. Actually the water in the Wailoa Ditch ends
7 up in Kamole Weir where it is divided into several
8 different places. One is for the County of Maui for
9 their up-country water system, and from there the rest
10 of the water, depending on the amount of flow, is
11 divided into different ditches that we operate through
12 hydroelectric plants.
13 Q. So just so the record is clear, did you
14 happen to read the county's written testimony which
15 explains how much water the county uses through Kamole
16 Weir?
17 A. Yes.
18 Q. And did that seem accurate to you?
19 A. It did seem accurate, yes.
20 Q. So at the moment it's my understanding that
21 there's sort of a maximum capacity for the county to
22 take about 8 million gallons a day.
23 A. That's correct.
24 Q. Thank you.
25 I have one other set of questions. Same

1 exhibit. In the license areas there are different
2 percentages where it says government water, private
3 water. Do you see those?
4 A. Yes.
5 Q. Could you explain what is meant by government
6 water there?
7 A. Government water is actually water that is --
8 that arises on state-owned land. And the way they
9 figured out the percentages was by taking a map and
10 having that map indicate state land versus EMI land.
11 And what they did was they took that map
12 and it was an isohyetal map. An isohyetal map is a
13 map that indicates belts of rainfall. Like for
14 example, this section here gets 300 inches, this one
15 250, this one here -- so what they did was calculate
16 the proportionate amount of rainfall that fell on each
17 area in each water license area, and that's how they
18 came up with these percentages.
19 Q. And the government that's referred to there
20 is the state government?
21 A. State of Hawaii, that's correct.
22 Q. Not the county government?
23 A. Not the county.
24 HEARINGS OFFICER JUDGE McCONNELL: What d
25 you call those maps again?

1 THE WITNESS: Isohyetal.
2 HEARINGS OFFICER JUDGE McCONNELL: You
3 said -- what did you say the maximum capacity for the
4 county to take, 8 million? What was that testimony?
5 I was doing two things at once.
6 THE WITNESS: The county, our agreement
7 with the county, they can take maximum of about almost
8 8 million gallons at the Kamole Weir.
9 HEARINGS OFFICER JUDGE McCONNELL: That's
10 by agreement?
11 THE WITNESS: That's by agreement,
12 correct.
13 MR. MERCHANT: It's also by capacity.
14 HEARINGS OFFICER JUDGE McCONNELL: By
15 capacity of the weir?
16 THE WITNESS: And it's also by the
17 capacity of their treatment plant, as I understand.
18 MS. LOVELL: If you look, Judge McConnell,
19 at -- you don't need to do it now, but I can give you
20 a reference. In the county's written testimony in
21 paragraph three --
22 MR. HALL: I'm going to object --
23 HEARINGS OFFICER JUDGE McCONNELL: Yeah,
24 right. I don't need it. I understand the question.
25 Let's go on.

1 No questions over there. I assume, Mr.
2 Haia, you have some questions.
3 MR. HAIA: Thank you, Judge.
4 CROSS-EXAMINATION
5 BY MR. HAIA:
6 Q. Just so I don't forget, I'm going to go along
7 the lines that Jane was asking you.
8 When you refer to government water, are
9 you suggesting that the State of Hawaii owns that
10 water?
11 A. No, I'm not saying that. What I'm just
12 saying is that she pointed to this map and asked what
13 is government water. And what I replied was that
14 government water meant rainfall that fell on
15 state-owned land.
16 Q. So what about the water that falls on what
17 you claim to be A & B or EMI's property, whose water
18 is that?
19 MR. SCHULMEISTER: I object, calls for
20 legal conclusion.
21 Q. MR. HAIA: Your understanding, that's all I
22 want to know, what's your understanding?
23 HEARINGS OFFICER JUDGE McCONNELL: You
24 know, the difficulty it's a legal issue completely,
25 so --

1 MR. HAIA: All I'm asking for is his
2 understanding, Judge. You've given plenty of leeway
3 the other way.
4 HEARINGS OFFICER JUDGE McCONNELL: I will
5 give you leeway. What is your understanding?
6 THE WITNESS: My understanding is that I'm
7 not a legal counsel, I'm not trained to be, and it's a
8 very gray area. And all I know is where the water
9 falls, falls on the land. And as far as the legality
10 to that, like I say, I'm not a legal counsel.
11 Q. MR. HAIA: You said it's a gray area. What's
12 gray about it?
13 A. Well, there's a lot of issues related to
14 water and some of these has not been fully resolved as
15 of this point in time.
16 Q. What issues are those?
17 A. There are a lot of issues.
18 Q. For instance --
19 HEARINGS OFFICER JUDGE McCONNELL: You'r
20 out of the scope of his expertise, Mr. Haia.
21 MR. HAIA: There were a lot of things that
22 he was testifying to out of his scope, Judge, that you
23 allowed.
24 HEARINGS OFFICER JUDGE McCONNELL: You'r
25 asking him what gray areas there are in Hawaii water

1 law. I find that --
2 MR. HAIA: I'll go on.
3 HEARINGS OFFICER JUDGE McCONNELL: Okay,
4 thank you.
5 Q. MR. HAIA: When you look at Exhibit A-1 and
6 the ditch systems that are controlled by A & B and
7 EMI, what purpose does the ditch system serve?
8 A. In what capacity?
9 Q. Why is it there? What is it doing?
10 A. The ditch system was built, first ditch was
11 built in 1876. And this was to divert stream waters
12 in the wet part of the island over to the dry area for
13 sugar cultivation.
14 Q. And with respect to each ditch system, are
15 there any occasions when A & B or EMI releases less --
16 that they don't carry the full capacity of the ditch
17 system? In other words, does A & B, EMI ever let
18 water go past the ditch system that it could catch?
19 A. If you're asking if we're diverting water
20 from this area, yes, we are, up to the capacity of our
21 system.
22 Q. What is that capacity?
23 A. 450 million gallons per day.
24 Q. Mr. Schulmeister was asking you about Exhibit
25 A-1 and the various color coded areas, and you were

1 saying that, I believe, the green area are A & B owned
2 properties?
3 A. No. The green areas are owned by East Maui
4 Irrigation Company.
5 Q. Okay. And the light brown areas?
6 A. This light brown or kind of orange area is
7 owned by our parent company, Alexander & Baldwin, Inc.
8 Q. Okay. I just want to know what the basis is
9 for your claim that that is in fact an accurate
10 depiction of the property owned by A & B and/or EMI.
11 How do you come to that conclusion?
12 A. I didn't prepare this map. It was prepared
13 back in 1970 originally, so I can't answer that
14 question.
15 Q. Who's responsible for the preparation of
16 Exhibit A-1?
17 A. This map here was prepared by our survey
18 department in 1970, and we have been using this map
19 for our operational purposes.
20 Q. I observe that, based upon your personal
21 observations, you found there was a problem with
22 a portion of that map, correct?
23 A. We found an error in one particular area that
24 needs to be revised.
25 Q. Since 1970, have you ever, or do you know if

1 A & B or EMI has ever tried to update that map to find
2 out whether in fact it's an accurate depiction?
3 A. Yes, we have.
4 Q. When was that?
5 A. This map was originally made in April of
6 1970. It was revised on June 5th, 2003 and also
7 February 28, 2004.
8 Q. So once again I ask you, do you know who's
9 responsible for making these claims? Who produced
10 that map specifically, a name?
11 A. This map was produced by Ronald M. Fukumoto
12 Engineering, Inc.
13 Q. Do you know who Mr. Fugimoto --
14 A. Mr. Fukumoto is president of the company.
15 Q. Any explanation why the depiction as it
16 regards Puolua Stream and Kualani Stream and its
17 diversion was erroneous?
18 A. It was carried over from 1970.
19 Q. Who provided Mr. Fukumoto with the
20 information to make the map?
21 A. He didn't make this map in 1970. I believe
22 it was our A & B survey department that did this
23 original map. And we had retained Mr. Fukumoto's
24 services back in June of 2003 whereby we had this map
25 digitized.

1 Q. Okay, I understand. With respect to Kualani
2 Stream, are you saying that there is no way that water
3 from Kualani Stream gets into Wailuanui Valley?
4 A. Can you repeat that, please?
5 Q. Yeah, I can. With respect to Kualani Stream,
6 given your correction on the record, is it also your
7 opinion, based upon the information you now have, that
8 Kualani Stream does not flow somehow someway into
9 Wailuanui Valley?
10 A. No, that is not correct.
11 Q. What is correct on your understanding?
12 A. My understanding, after doing the field
13 check, is that EMI does not divert water from Kualani
14 Stream. Kualani Stream arises below our ditch system,
15 and it does go into Wailuanui, or rather it meets up
16 with Waiokamilo Stream waters.
17 Q. I'm just having a problem with you not
18 finding out sooner that Kualani Stream did not extend
19 above the ditch system for 30-something years.
20 Wouldn't that be something that would be
21 obvious to you or one of your workers that Kualani
22 Stream did not extend beyond the ditch?
23 A. Not really.
24 Q. You know, you make it sound like it's fairly
25 obvious to you at this point. I'll move on.

1 Now, you also testified that there have
2 been no major changes to the system of ditches that
3 comprised this ditch system; is that correct, since
4 1923?
5 A. Which ditch system are you referring to?
6 Q. Haiku Ditch, Wailua, Kauhikoa, every other
7 part of the system.
8 A. In other words, the entire ditch system?
9 Q. Right.
10 A. Yes, that's correct.
11 Q. What is your definition of major change?
12 A. In terms of --
13 Q. I don't know. I'm asking you. Because you
14 said in answer to Mr. Schulmeister's question that
15 there has been no major changes to these ditch
16 systems. I just want to know what you mean.
17 A. Well, major change is constructing a brand
18 new stream diversion on a major stream. Altering the
19 course of the ditch system is a major change.
20 Q. Anything else?
21 A. No.
22 Q. I was going to leave this for Mr. Hall, but
23 you were saying that there were two gates that were
24 left open because of your guy's concern for some storm
25 systems on the way. And that they had been opened a

1 week previous to the anticipated storm, correct?
2 A. As I recall, I was off-island that week, and
3 there was a forecast of heavy downpours in East Maui
4 with, I believe, anywhere from half to nine inches of
5 rain predicted to fall overnight. And we made a
6 decision that we would cut the flow back in our EMI
7 system in order to avoid any damage to our ditch
8 system and/or to property adjacent to our ditch system
9 and also to HC&S.
10 Q. More specifically though, when was the storm
11 predicted to hit Maui?
12 A. I can't remember the exact date, sometime in
13 September though.
14 Q. Was it your testimony that you opened the
15 gates a week before?
16 A. No. We opened the gates, I believe it was
17 probably one or two days prior to anticipation of that
18 storm hitting the island.
19 Q. You know what, I want to direct your
20 attention to some other exhibits of A & B that you're
21 responsible for, and that would be A-2, A-3, and A-4.
22 Are you at A-2 right now?
23 A. Yes.
24 Q. And what is your understanding, what is this
25 exhibit?

1 A. Exhibit A-2 is Revocable Permit S-7264,
2 covers Alexander & Baldwin, Inc. Revocable Permit for
3 the Huelo License area.
4 Q. Is that permit still in effect?
5 MR. SCHULMEISTER: Object, calls for legal
6 conclusion.
7 HEARINGS OFFICER JUDGE McCONNELL: I'll
8 sustain that.
9 Q. MR. HAIA: Mr. Hew, do you know whether or
10 not Alexander & Baldwin and EMI are still operating
11 under Revocable Permit S-7264 to take water out of
12 East Maui?
13 A. Yes, I believe that's correct. We still are
14 operating under that premise.
15 Q. Okay. Now, this permit is for what is called
16 the Huelo area, correct?
17 A. Yes.
18 Q. And that is an area of what, approximately
19 8,752.690 acres, correct?
20 A. Yes.
21 Q. And for this permit, A & B, EMI was paying
22 6,000 -- or maybe still is paying, do you know,
23 whether or not they're still paying $6,588.40?
24 A. That is a rental per month, yes.
25 Q. And A & B is still presently paying that

1 amount?
2 A. I believe that's the correct amount.
3 Q. And what is your understanding of what this
4 payment is for?
5 A. This payment is for the privilege of renting
6 that watershed area, to have the right to divert water
7 off of state-owned lands for the use of sugar
8 cultivation and domestic purposes in Central Maui.
9 Q. So I made some calculations -- and I brought
10 along a calculator if you want to verify my
11 calculations -- but for any given year for this area
12 of almost 9,000 acres, A & B, EMI is paying
13 $79,060.80. Would you have any reason to not agree
14 with my calculation? Because if you do, then I'll let
15 you calculate it yourself.
16 A. It's a simple math. If you did the math, it
17 should be correct.
18 Q. I appreciate your faith in me.
19 Do you know how much water on average is
20 developed in the Huelo License area per year?
21 A. Right offhand, no.
22 Q. Can you turn to Page 4 of A-2. And I would
23 direct your attention to Paragraph 7, or provision 7,
24 and I'm going to read it to you.
25 "This Permit or any rights hereunder shall

1 not be sold, assigned, conveyed, leased, mortgaged, or
2 otherwise transferred or disposed of."
3 My question is: Does EMI have an
4 agreement with Maui Land & Pine that allows Maui Land
5 & Pine to divert water from your ditch system?
6 A. Yes, we do have an agreement with Maui Pine.
7 Q. And what is that agreement?
8 A. That is an agreement for Maui Pine to use a
9 portion of our ditch system to transport water that
10 they pump into our ditch system for use for pineapple
11 cultivation in Central Maui.
12 Q. Do you know if there's also an agreement that
13 would allow Maui Land & Pine to take more than what
14 they pump into the ditch system?
15 A. Yes.
16 Q. What is your understanding of what that
17 agreement provides for?
18 A. That agreement, it depends upon the flow of
19 the ditch at a particular time of day, and they have
20 the right to access up to 1.5 million gallons per day.
21 Q. And are there any stipulations or conditions
22 upon which Maui Land & Pine can take that water out of
23 the system?
24 A. It's basically based on ditch flow at that
25 one particular time of the day.

1 Q. Can you be more specific? Do you know what
2 the flow needs to be in order for this provision to
3 kick in?
4 A. The flow is taken at 7:00 a.m. in the
5 morning. And if the flow is above a certain amount,
6 the rate that is set for that flow, if it's below a
7 certain amount, the rate is set for that amount below
8 that flow.
9 Q. What is the minimum amount of water flowing
10 at a given point that needs to be in the ditch system
11 in order for this condition to kick in?
12 A. I believe the Wailoa-New Hamakua Ditch has to
13 be at 100 million gallons at the Honopou boundary at
14 7:00 a.m. in the morning. If it's 100 million gallons
15 or above, they can access the water from our system;
16 if it's below 100, they cannot access any water from
17 the system.
18 They can take what they put into the
19 system.
20 HEARINGS OFFICER JUDGE McCONNELL: Take
21 short recess.
22 (Recess was taken.)
23 HEARINGS OFFICER JUDGE McCONNELL: We're
24 back on the record. Without objection, we're going to
25 take a witness, Mr. Watanabe for the Farm Bureau.

1 WARREN WATANABE
2 was called as a witness by and on behalf of the Farm
3 Bureau, was sworn to tell the truth, was examined and
4 testified as follows:
5 HEARINGS OFFICER JUDGE McCONNELL: Would
6 you state your name, please.
7 THE WITNESS: Warren Watanabe.
8 MR. FREEDMAN: Can I submit Mr. Watanabe's
9 written testimony?
10 HEARINGS OFFICER JUDGE McCONNELL: Yes,
11 that will be in evidence.
12 (Written testimony of Warren Watanabe was
13 received into evidence.)
14 You have no further questions?
15 MR. FREEDMAN: No.
16 HEARINGS OFFICER JUDGE McCONNELL: Mr.
17 Schulmeister.
18 MR. SCHULMEISTER: No questions.
19 CROSS-EXAMINATION
20 BY MR. HAIA:
21 Q. Mr. Watanabe, I'm Moses Haia, an attorney
22 representing Na Moku and a couple of other individual
23 petitioners in this contested case. I had just a
24 couple questions for you.
25 Do you have a copy of your written

1 testimony?
2 A. Yes, I do.
3 Q. Can you turn to -- it would be, I guess, it's
4 Page 1 of your testimony, and Paragraph 3.
5 You mention your concern that Maui
6 farmers' ability to continue farming would be severely
7 impacted and irreparably harmed if they didn't have
8 enough water. And then you go onto say that it would
9 be a true tragedy if one of the last vestiges of
10 traditional Maui would be irretrievably lost. And
11 you're referring to agriculture, correct?
12 A. Correct.
13 Q. Would you also agree that one of the last
14 vestiges of tradition on Maui is taro growing?
15 A. Yes.
16 Q. Would you also agree that it would be tragic
17 if that was lost?
18 A. Yeah, I would agree.
19 Q. Then you also talk about how -- at Page 3,
20 Paragraph 8, you say:
21 Unlike other sugar companies of the past
22 that have closed, the outlook for the remaining sugar
23 company on Maui is positive.
24 What sugar company are you referring to?
25 A. Hawaiian Commercial & Sugar.

1 Q. And this opinion of yours, what's it based
2 on?
3 A. Well, I think it's based on part of the
4 record. They do have some -- they have a track record
5 of being committed to agriculture on Maui.
6 Q. Would it surprise you at all if you learned
7 that in recent times the sugar operation here posted a
8 profit of $5 million, 600-some-odd-dollars, and at the
9 same time received a federal subsidy of $5 million?
10 MR. FREEDMAN: Objection, Your Honor,
11 assumes facts not in evidence and calls for
12 speculation.
13 MR. HAIA: I can bring that --
14 HEARINGS OFFICER JUDGE McCONNELL: I'll
15 permit it. If you know?
16 Q. MR. HAIA: I'm asking you would it surprise
17 you if you were to find out that very recently
18 Hawaiian Commercial & Sugar posted a profit of 5
19 million, 600-some-odd-thousand-dollars and had a
20 federal subsidy of $5 million? Do you know what that
21 means?
22 A. Yeah.
23 Q. What does that mean?
24 A. Well, I mean that --
25 MR. FREEDMAN: Objection, Your Honor.

1 This calls for an expert opinion. I'm not sure he's
2 an expert on federal subsidies.
3 MR. HAIA: He answered he knows what it
4 means.
5 HEARINGS OFFICER JUDGE McCONNELL: Can w
6 get to the original question. Does that surprise you?
7 THE WITNESS: No.
8 Q. MR. HAIA: It doesn't surprise you?
9 A. No.
10 Q. If that was the case, you still believe that
11 the outlook for this company is positive?
12 A. Yes.
13 Q. And that's because --
14 A. Their commitment to agriculture and because
15 of their direction that they plan to take to keep the
16 company going and sugar growing.
17 Q. And this understanding is based on what?
18 A. I think part of it is because they have a
19 line of specialty sugars that probably right now
20 doesn't meet the current demands, so there's room for
21 expansion of that. Transing renewable energy
22 nationwide.
23 Q. Hawaiian Commercial & Sugar?
24 A. Right.
25 Q. At Paragraph 10 you talk about how

1 agriculture is protected by the Hawaii Constitution
2 and I'm not going to read the whole thing, but I would
3 ask you, is it your understanding that taro production
4 and cultivation is also agriculture?
5 A. Yes.
6 Q. So would it fall into the same protection?
7 A. Yes. We don't argue against that. We
8 support all of the agriculture.
9 Q. You support it. Then would you also support
10 additional water for taro production in East Maui?
11 A. Well, I think our position is that we want
12 fair distribution of the resource.
13 Q. So if there were on average 165 million
14 gallons of water taken out of East Maui and into
15 Central Maui and also up-country, do you think that
16 that's a fair distribution of water vis-a-vis East
17 Maui taro growers?
18 MR. FREEDMAN: Objection, Your Honor,
19 again, speculation, beyond his expertise. Not sure if
20 he knows what every other industry needs are as far as
21 water.
22 MS. LOVELL: I object to this. It's an
23 incomplete hypothetical.
24 HEARINGS OFFICER JUDGE McCONNELL: Oh,
25 answer the question.

1 THE WITNESS: Can you repeat the question?
2 Q. MR. HAIA: I'll try to make it a complete
3 hypothetical.
4 HEARINGS OFFICER JUDGE McCONNELL: If you
5 can.
6 Q. MR. HAIA: There is on record an average of
7 165 million gallons of water per day diverted out of
8 East Maui by this ditch system and that water goes to
9 Hawaiian Commercial & Sugar and various other water
10 uses outside of East Maui.
11 With respect to East Maui, the taro
12 growers in East Maui, do you think there's a fair
13 distribution of water in that allocation?
14 MR. MERCHANT: Objection, incomplete
15 hypothetical.
16 HEARINGS OFFICER JUDGE McCONNELL: I've
17 already ruled.
18 MR. HAIA: Don't ask me to repeat it.
19 A. For me it's difficult because I don't know
20 all the requirements of everybody. What the
21 requirements are, I don't know. I don't have that
22 knowledge.
23 MR. HAIA: That's all the questions I have
24 for you.
25 MR. HALL: Mr. Watanabe --

1 MR. FREEDMAN: Is this on behalf of Maui
2 Tomorrow?
3 MR. HALL: Yes.
4 MR. FREEDMAN: I was told that at all the
5 status conferences they never indicated an intent to
6 cross our guy.
7 HEARINGS OFFICER JUDGE McCONNELL: I'll
8 permit it.
9 CROSS-EXAMINATION
10 BY MR. HALL:
11 Q. You're testifying today on behalf of Hawaii
12 Farm Bureau Federation and Maui County Farm Bureau?
13 A. Correct.
14 Q. And you have membership in the Maui County
15 Farm Bureau all over Maui, correct?
16 A. Correct.
17 Q. And you have some members in Huelo and
18 Keanae, correct?
19 A. I'm not positive.
20 Q. You have some taro growers, some flower
21 growers in Huelo that are members of the Maui Farm
22 Bureau?
23 A. Yes.
24 Q. And you're here to support them as well?
25 A. Yeah. Well, they are members.

Q. You're here to support them to?
A. (Witness nods head up and down).
Q. You say in Paragraph 13: Water is the critical component of the success of competitive and diverse agriculture.
When you say diverse agriculture, you mean flower farming?
A. Yes.
Q. You mean taro growing?
A. Yes.
Q. So water is critical for both of those forms of diverse agriculture?
A. (Witness nods head up and down.)
Q. Especially when they're members of the Maui Farm Bureau too?
A. Yes.
MR. FREEDMAN: Objection, Your Honor, argumentative.
HEARINGS OFFICER JUDGE McCONNELL: It is argumentative, Mr. Hall. We have got a lot of work to do.
MR. HALL: This is very important to this proceeding.
HEARINGS OFFICER JUDGE McCONNELL: It's a argumentative question.

Q. MR. HALL: In Huelo you're aware there is no county source of water?
A. Yes.
Q. And those who are engaged in agriculture in Huelo depend upon streamflow in many instances for their water in order to engage in diversified agriculture, you are aware of that?
A. Uh-huh.
Q. You are?
A. Yes.
Q. So you would support them having a sufficient amount of water in their streams in order to engage in diversified agriculture?
MR. FREEDMAN: Objection, Your Honor, asked and answered. I think he's made it very clear he supports all agriculture in Hawaii.
MR. HALL: I would like this question answered.
HEARINGS OFFICER JUDGE McCONNELL: I'll permit it.
THE WITNESS: Yes.
Q. MR. HALL: You would?
A. Yes.
Q. And you testify in Paragraph 15 about the needs of up-country Maui farmers?

A. Correct.
Q. And those farmers are on the County of Maui water system, correct?
A. Correct.
Q. So they get some of the 8 million gallons a day that the county gets from EMI, is that correct?
A. Yes.
Q. So their source is no different from the County of Maui source, correct?
A. As long as you're not in the ag park.
Q. And you're not in the ag park yourself. You talk about your own needs, correct?
A. No.
Q. So you get in the county system which is part of the 8 million gallons a day, correct?
A. Correct.
Q. And are you aware that EMI, of that 8 million gallons that county gets from EMI, some of that comes from the state and some of that comes from EMI itself?
A. Yes.
Q. Are you aware of the percentage as between EMI and the state?
A. No.
Q. Are you aware that the 8 million gallons could be satisfied from EMI's own water rather than

the state's water?
MS. LOVELL: Objection, argumentative and again it's an incomplete hypothetical and assumes facts.
HEARINGS OFFICER JUDGE McCONNELL: I'll sustain that.
Q. MR. HALL: You're not aware of the percentage as between the state and EMI, correct?
A. That's correct.
Q. So you're not aware of whether the county's needs would be satisfied from EMI?
A. Yeah.
MR. HALL: I have no further questions.
HEARINGS OFFICER JUDGE McCONNELL: Any other questions? Thank you, Mr. Watanabe. Okay, we'll resume with Mr. Hew.
For the record, Mr. Hew is on the stand.

GARRET HEW

CROSS-EXAMINATION CONTINUED

BY MR. HAIA:
Q. If you recall, we were -- I was asking you questions about Exhibit A-2, and the last series of questions was directed to your, that is EMI's agreement with Maui Land & Pine that allows Maui Land & Pine to take an additional amount of water out of

the ditch system -- and when I say additional, I mean in addition to what they actually -- Maui Land & Pine actually pumps into the ditch system. Do you recall all that discussion?
A. Yes.
Q. And you charge them for that, right, A & B charges -- A & B and EMI charges Maui Land & Pine, for lack of a better term, privilege of taking that water out of the system, correct?
A. No, that's not correct. We do not charge them for the water. We charge them a transportation fee for getting that water to their point of delivery.
Q. Okay. So you're charging Maui Land & Pine for, in essence, diverting water from a series of watersheds, and taking it to a certain point at which Maui Land & Pine is able to take it out of the system; right?
A. That's correct.
Q. Do you have any other agreements with any other parties or individuals that allow that party or individual to pay for the transportation of water in your ditch system?
A. No, we don't.
MR. SCHULMEISTER: Did you mean to exclude County of Maui?

MR. HAIA: Yeah.
Q. What about the county?
A. Well, right now the last agreement expired and we're working on an informal agreement with the county at the present time.
Q. So there is no agreement in effect at the present time between A & B, EMI and the county?
A. No formal agreement.
Q. Is there another type of agreement?
A. We're just working off of the last agreement that expired probably four or five years ago.
Q. How much do you charge Maui County for the transmission of water?
A. We charge Maui County six cents per thousand gallons for the transportation of water.
Q. I would like to take you to the next Exhibit, A-3. Are you there?
A. Yes.
Q. That is Revocable Permit No. S-7263, and it is referred to as -- well, it is for an area of 3,381 acres more or less, correct, in the Honomanu area?
A. That's correct.
Q. And I'll ask you again like I did with respect to the previous permit. Is it your understanding that A & B, EMI pays the state $1,698.32

per month pursuant to this permit for this 3,381 acres?
A. That's correct.
Q. I also did math again, Mr. Hew, and I calculated that to a yearly payment. I come up with $20,379.84. Do you have any reason or basis to dispute that? Because once again I'll let you calculate it on your own.
A. No, I believe your math is correct.
Q. Do you have any idea of the average amount of water developed per year in this permit area?
A. No, I don't.
Q. Could you access records that would allow you to find out what that is?
A. Yes.
Q. And what records are those?
A. Those are records prior to 1987 when the amount that was diverted out of each area was reported to the state.
Q. So do I understand you to say that the numbers that the state and A & B and EMI are currently operating under were developed in 1987?
MR. SCHULMEISTER: Let me object. When you say numbers, what are you referring to?
MR. HAIA: The amount of water developed

in each of these license areas.
A. No.
Q. So you have -- go ahead.
A. What was your question? Could you clarify your question, please?
Q. I'm asking you whether or not the numbers that are used in terms of amount of water developed in a specific license area are from 1987 to determine the lease rents or the permit amount that you pay for the use of this acreage?
A. I don't know what you mean by develop, but this is what the state charges us for that license area.
Q. And do you know whether or not the data used to come to those numbers is current? In other words, as recent as -- well, July 1st, 2000 when these permits were entered into?
A. No, I don't.
Q. Would you turn to -- I would ask you, are the conditions in each one of these permits -- they're four license areas, so there's four permits?
A. Correct.
Q. Are the conditions the same for each one of the permits?
A. As far as I understand it, they are all the

same.
Q. Okay. So this permit would not allow A & B, EMI to sell water?
MR. SCHULMEISTER: Objection --
MR. HAIA: To sell their --
MR. SCHULMEISTER: When you're done with your question, I'll make my objection.
Q. MR. HAIA: Let me refer you to Page 4, Paragraph 7 of this exhibit. It reads:
"This Permit or any rights thereunder shall not be sold, assigned, conveyed, leased, mortgaged, or otherwise transferred or disposed of."
MR. SCHULMEISTER: Are you asking whether you read it correctly? I think we will stipulate to that.
Q. MR. HAIA: So I'm asking you -- well, basically that applies to this specific area too, right, that A & B cannot sell, assign, convey, lease, mortgage or otherwise transfer, dispose of any of the rights provided under this permit?
A. First of all I heard you say something about selling water. And just to clarify, you cannot sell water. You can charge a transportation fee.
Q. Okay.
HEARINGS OFFICER JUDGE McCONNELL: And

your answer would be the same for all of the permits?
THE WITNESS: That's correct.
Q. MR. HAIA: Go to the next exhibit which is A-4. And this permit is for Keanae License area. Correct?
A. Yes, it is.
Q. Comprised of 10,768 acres more or less, correct?
A. Yes, it is.
Q. And A & B pays to the state $3,476.72 for this permit per month?
A. Correct.
Q. And once again, my calculation per year is $41,720.64. And once again, if you have any concern for the accuracy of this, I have my calculator for you.
A. I believe it's accurate.
Q. So once again, you don't independently, off the top of your head, have any idea of how much water is developed in Keanae per year?
A. No. When you say develop --
Q. Well, diverted.
A. Diverted?
Q. Captured.
A. No.

Q. Is there any other understanding you have, you asked that question? When I say developed, is there any other way A & B, EMI acts under this permit with respect to Keanae?
A. I just wanted clarification on the word "developed".
Q. Let's go now to Exhibit A-5 Revocable Permit S-7266 for the Nahiku License area, which is made up of 10,111.220 acres more or less, correct?
A. That's correct.
Q. And for which A & B, EMI pays $1,426.88 per month, correct?
A. Yes.
Q. And my calculation per year is $17,122.56 per year. Do you have any reason to dispute my math?
A. No.
Q. Do you have any idea of how much water is developed per year in Nahiku?
A. No, I don't.
Q. But, Mr. Hew, you do have an average for all four areas of how much water is developed from all four areas per year, don't you?
A. We have a figure comprising all four license areas, how much water is diverted out of these four license areas.

Q. Per year?
A. Per year.
Q. What is that number?
A. It varies from year to year.
Q. What was it last year? Do you have an average from those variances? That's what I want, an average.
A. I know it's somewhere around 58, 59 billion gallons a year. I know for the last 11 years we've been in a low drought situation, so I think only a couple of those years were above that figure.
Q. So average around 58, 59 billion gallons of water per year from these four license areas?
A. Correct.
Q. I also added up the yearly rent payments for all four permitted areas, and I come up with $158,283.84.
Do you have any reason to dispute my math?
A. No.
Q. And conservatively speaking, let's say 58 billion gallons of water per year is taken out of those four license areas. And I broke that down in terms of how much A & B, EMI pays per thousand gallons of water out of that area and I come up with a number that is around a fifth of a cent per thousand gallons.

Would you dispute that?
A. No.
Q. Do you have a better estimate of what that total is?
A. Based strictly on what we pay for our revocable permits and the amount diverted, that seems accurate.
Q. So A & B, EMI pays a fifth of a cent per thousand gallons of water diverted out of these four license areas, correct?
HEARINGS OFFICER JUDGE McCONNELL: Per gallon or per thousand?
MR. HAIA: Per thousand gallons.
A. That's correct. But it doesn't include the cost of operation of the system.
Q. But with specific respect to these four permits, that's my question, A & B, EMI pays a fifth of a cent per thousand gallons?
A. If your math is correct, I believe it is.
Q. Once again, I ask you, do you have any concerns --
A. I believe it's correct.
Q. Thank you.
And you, once again, you charge the county six cents per thousand gallons?

A. We charge them a transportation fee.
Q. Right.
A. Six cents per thousand gallons.
Q. Do you have any idea what the average rate on agricultural water is in Hawaii today? How much are agricultural users generally being charged for a thousand gallons of water?
A. I don't know the average in Hawaii.
Q. You know, you testified today, and I believe it's in your direct written testimony, that A & B and EMI stand ready, willing and able to help the Kekahunas, the taro farmers in Wailuanui; is that correct?
A. That's correct.
Q. In our last visit out to the Kekahuna parcel we saw some changes, correct, in terms of land opened ready for cultivation? Are you ready, willing and able to ensure that the Kekahunas receive a sufficient amount of water to grow taro adequately in those lo'i, and as they open up more, provide additional water so that their needs are met with respect to those lo'i?
A. I believe they have sufficient water now to plant all of the lo'i with what's in Honopou Stream right now.
Q. What if it turns out that they don't? The

same question, you stand, ready, willing and able to help them?
MR. SCHULMEISTER: Calls for speculation, lack of foundation. What if it turns out that they don't. I mean that's a lack of foundation.
HEARINGS OFFICER JUDGE McCONNELL: Yeah. You got to be more specific.
Q. MR. HAIA: If in fact the water that you believe is sufficient to grow taro on the Kekahuna parcel, is A & B, EMI still ready, willing and able to provide additional water to meet those needs?
A. First of all, we would be willing to help Mrs. Kekahuna to see what is going on with the system, if anything.
Q. Would that include providing her with additional water if need be?
A. Like I mentioned, I think there is sufficient water right now in the stream to meet all of her taro growing needs.
Q. That's not responsive. I'm asking him whether, if there is not enough water, A & B will stand ready, willing and able to provide additional water to meet those needs?
MR. SCHULMEISTER: Same objection. Vague as to under what circumstances there wouldn't be

enough water. He's asking him to assume something he doesn't believe is true.
MR. HAIA: Mr. Hew --
HEARINGS OFFICER JUDGE McCONNELL: Rephrase the question.
Q. MR. HAIA: Mr. Hew, it's your belief that presently there is enough water flowing to the Kekahuna property to allow -- I guess this is the question.
Do you believe there is enough water that presently flows to the Kekahuna property that would allow every lo'i on that property to receive a sufficient amount of irrigation water?
A. Yes.
Q. And now I'm asking you, if at a point in time when full build-out at Kekahuna parcels, and in fact there is not enough water for taro cultivation and irrigation on all of those lo'i, is A & B, EMI ready, willing and able to provide the Kekahunas with additional water?
A. We would be willing to help Mrs. Kekahuna as long as taro is being grown on those parcels.
Q. If that requires A & B, EMI to release more water so that it gets to the Kekahuna parcel, would they stand ready, willing and able to do that?

A. I think we would but first -- I think we would try to investigate if there is a problem in the stream, any sinkholes or anything that is happening abnormally as far as flow, why it's not getting down there.
Q. Okay. So you would investigate, determine whether there are other things that are standing in the way of her getting enough water; correct?
A. That's right.
Q. And if you get to a point where you do that investigation and clearly you need -- they need more water, is A & B going to provide them with more water?
A. If there's water available and we can provide it, as long as she's growing taro on an active basis, I don't see a problem.
Q. The point at which you allow Maui Land & Pine to take water out of the ditch system is not the point at which you determine how much water you need in the ditch system before you allow them to take it out, right?
At what point -- my question is, at what point in the system do you determine whether there's sufficient amount of water to allow Maui Land & Pine to exercise its option to take water out of the ditch system?

MR. MERCHANT: Objection, vague. He's talking from a geographic point --
MR. HAIA: The point in the ditch system.
MR. MERCHANT: So geographic?
MR. HAIA: Yes.
A. Can you clarify the question?
Q. At what point are you measuring the flow to determine whether or not Maui Land & Pine can exercise their option to take additional water out of the system?
A. We're measuring that point at Honopou Stream boundary on the two ditches, Wailoa and the New Hamakua Ditch.
Q. So they can take at least 1.5 million gallons of water a day as long as there's a certain amount of water at Honopou Stream, and you would allow Maui Land & Pine to do that -- never mind, that's argumentative.
What I am getting to is, if you're making that determination at Honopou Stream, what is that based upon?
MR. SCHULMEISTER: Talking about Maui Land & Pine's determination?
MR. HAIA: Yes.
A. That's based on the flows that we believe we need at HC&S. So at any time if the flow at the

Honopou boundary is less than 100 million gallons, we're in a period of low flows, shorter water, and we have to make up that water by pumping salty undesirable groundwater. So at that point Maui Land & Pine can only access what they put into the system.
Q. Do you have a way of determining how many days out of the year at Honopou Stream there is less than 100 million gallons of water per day?
A. There is a way.
Q. How is that?
A. Through our gauging station.
Q. If you know, how often does that occur, that at Honopou Stream there is less than 100 million gallons of water?
A. That I don't know. And with the Maui Pine agreement, it's specific to one time at any one day.
Q. What stream does the water come out of for the Kekahuna parcel?
A. That would be Honopou Stream.
Q. At Honopou Stream you said A & B, EMI installed a third pipe -- actually at the ditch system on Honopou Stream, that's Waiola Ditch, right?
A. No, that's not correct. That's at the Haiku Ditch level.
Q. Okay. So you added a third pipe. Do you

know how far water has to travel from that point to get to the Kekahuna parcel?
A. No, I don't. I haven't measured it.
Q. Do you know how many landowners that are riparian to the stream, Honopou Stream, are between that point and the Kekahuna parcel?
A. No, I don't.
Q. Do you know whether or not any of the landowners above the Kekahunas are diverting water from that stream?
A. Only to the extent that the Commission had provided a list of people that had registered diversions in between those two points.
Q. So do you have any idea how many people have registered diversions above the Kekahunas?
A. Above the Kekahunas and between the Kekahunas and the Haiku Ditch, I believe there were three or four people that had registered diversions with the Commission.
Q. Okay. So we can't be sure then, given those diversions, that the water that is added by this third pipe is actually reaching the Kekahuna parcel, correct?
A. No. I believe it's incorrect, because the people who were diverting water were still diverting

water with the two pipes. So whatever they're diverting remains the same. So addition of the third pipe would only bring more water down.
Q. If there was more water in the stream -- if there's more water in the stream by this third pipe -- and you're saying that these people that have registered diversions will take the same amount of water that they have always been taking, is that what you're really saying here? That the water will get down to the Kekahunas because these other people above her aren't going to take any more water than they have been traditionally taking?
A. That's what I'm saying. These people who were taking water, they're taking it via two-inch pipe or one-inch pipe and that is limited to the diameter of the pipe.
Q. You don't know whether anyone has an electric pump that pulls water out of the stream?
A. I saw someone with a gas powered pump that had access to the stream and also had a registered diversion, correct.
Q. Do you know whether or not you can adjust the flow on these kinds of pumps?
A. Some of them you can, and some of them you cannot.

Q. And whether the one you saw can be adjusted?
A. I didn't look at it that carefully.
Q. But it is possible if you have an electric pump to adjust the flow higher or lower?
A. On an electric pump?
Q. Yeah.
A. Probably not.
Q. A gas pump?
A. It could be, based on how fast you run the engine.
Q. But you don't think you could do that with an electric pump?
MS. LOVELL: Objection, incomplete hypothetical, depends on the pump.
HEARINGS OFFICER JUDGE McCONNELL: I'll permit it.
THE WITNESS: I think on an electrical pump, the pump runs on electricity, it's a steady revolutions per minute or RPM. Whatever that motor is spinning at, that is the capacity of the pump.
Q. MR. HAIA: You know, you also said that you never received any complaints about the efforts you testified to in attempting to help the Kekahunas with their lo'i, getting additional water there. And you said you didn't receive any complaints from Mrs.

Kekahuna herself.
Did you receive any complaints from anyone else on behalf of Mrs. Kekahuna?
A. No, we have not.
Q. You didn't receive any complaints from the Native Hawaiian Legal Corporation on behalf of Mrs. Kekahuna?
A. Well, if you're talking about Mrs. Kekahuna or her family, no.
Q. Wait a minute. I asked you whether or not --
HEARINGS OFFICER JUDGE McCONNELL: Well, we know about -- you know, we don't need to beat the horse to death.
Q. MR. HAIA: Do you recall her testimony at this hearing last month?
A. Yes, I do.
Q. Do you recall her saying she doesn't have enough water?
A. I recall that.
Q. You know what, I'm interested in your statement about, you know, you had to correct that map, that there's actually no diversion from Kualani Stream, right?
A. Right.
Q. I'm going to hand to you -- they've been

marked and received as exhibits, B-7B, B-7C, B-7A, B-6B, B-6A, B-5A and B-5C.
What I would like you to do is take a look at these.
HEARINGS OFFICER JUDGE McCONNELL: Wait, let us get them.
MR. SCHULMEISTER: Are those photographs?
MR. HAIA: Yes, and I'm going to come over --
HEARINGS OFFICER JUDGE McCONNELL: They'r all B-7?
MR. MURAKAMI: A couple B-6.
MR. HAIA: I'll try and put them in numerical order. B-5A, B-5C, B-6A, B-6B, B-7A, B-7B, and B-7C.
MR. SCHULMEISTER: What is the first one you're going to ask about?
MR. HAIA: B-5A.
Q. Can you take a look at B-5A. Do you know where that is?
A. I believe this is up in the Kikokiko area.
Q. What does that photograph depict?
A. Depicts a person standing next to our stream diversion and the pipeline that comes from that diversion, looks like an eight-inch PVC pipe.

Q. Are you able to point out on your Exhibit A-1 the point of that diversion? You said the diversions are identified as -- is it red boxes?
A. I believe this diversion -- I think what we need to do first is make sure that the map is revised before we correlate any of these pictures to that map for reasons of clarity.
Q. Revised in what way? For the Kualani diversion?
A. That's correct.
Q. Okay. We know already that your testimony is that there is no diversion on Kualani. I'm asking you to show us where this diversion is on this map.
A. My understanding is that this diversion is at this point here, (indicating.)
Q. So it's right here? This is the diversion right here?
A. I think it's somewhere around there and this pipe runs through this diversion right here.
Q. And for the record, Mr. Hew is pointing to Kualani Stream at its highest point as depicted on A-1, which is nearly intersected by what is identified as Filipino Ditch.
So, in fact, this diversion is not depicted on that map, is it?

A. On this map here, the major diversion --
Q. My question is: Is this diversion depicted on this map?
A. The diversion is not depicted on the map because we have many diversions that are small such as this and it's not depicted on the map.
Q. Okay. So one diversion you characterize as small is not depicted on Exhibit A-1. What about the same for Exhibit B-5C?
A. This diversion would be at this point here.
Q. Is that diversion depicted on the map?
A. It's depicted on the map but not correctly labeled as to what stream.
Q. Okay. So is this Kualani?
A. No, it's not.
Q. Okay. So there's another problem with this map?
A. No. There was only one problem.
Q. Wasn't your testimony that it's not correctly depicted?
A. Kualani is not correctly depicted on this map.
Q. I'm asking you about this exhibit.
A. What is your question again?
Q. Whether or not it's depicted on the map,

Exhibit B-5B.
MR. SCHULMEISTER: B or C?
MR. HAIA: I'm sorry, B-5C.
A. The same one, right?
Q. The same one as what?
A. Well, I'm just reading here, same eight-inch PVC pipe depicted in B-5B.
MR. SCHULMEISTER: We haven't talked about 5B, only talked about 5A.
MR. HAIA: Right, we skipped 5B.
Q. So do you know whether or not the pipe depicted in this exhibit, which is B-5C, is the same or a continuation of the pipe depicted in B-5A?
A. I believe this pipe in Exhibit B-5A is the start of this diversion, and the eight-inch pipe on the middle right-hand corner of Exhibit B-5C is the terminus of that pipe.
Q. And I pulled out Exhibit B-5B just to hopefully clarify. B-5C says same eight-inch PVC pipe depicted in Exhibit B-5B.
If you look at Exhibit B-5B, do you agree or disagree, Mr. Hew, that it's the same pipe?
A. It's hard to tell, just a section of pipe, but it could be.
Q. In your definition of major changes, you

don't consider this -- let me ask you. Was this the state of that diversion before 1923?
A. I don't know.
Q. What would help you to be able to answer that question?
A. Obviously, I wasn't around in 1923, so I don't know.
Q. Are there records which would have shown that this is the same diversion presently depicted that was begun in or prior to 1923?
A. That I don't know.
Q. So, in fact, when you testify that there are no major changes since 1923, could this have been a major change that occurred after 1923?
A. Like I said, a major change to me is a change in the rerouting of a certain ditch or large stream diversion or something of that sort.
Q. Do you know the flow capacity of an eight-inch pipe?
A. No, I don't.
Q. Do you know the flow capacity of a four-inch pipe?
A. No, I don't.
Q. What would it take for you to know what the flow capacity of a four-inch pipe is?

A. Probably the head and the pressure that's exerted on that four-inch pipe and a flow meter.
Q. And I'm asking you, if at its full flow, how much water could flow through an eight-inch pipe; do you know?
A. I don't know.
Q. In any event, your answer to my original question of whether or not this is depicted on Exhibit A-1 is that it's not depicted on A-1; is that correct?
A. This diversion here?
Q. Exhibit B-5A.
A. And this is Exhibit A-1, right?
Q. Yeah.
A. So what is your question?
Q. Is this diversion depicted on that Exhibit A-1? I thought you answered no.
A. No, I said it's probably on this stream here, but the stream is labeled incorrectly.
Q. So the stream that is labeled Kualani Stream, what stream is that then?
A. I believe that's an east tributary of Waiokamilo Stream.
Q. Can you point out on this map where Waiokamilo Stream is?
A. Waiokamilo Stream is this stream right here

going down.
Q. And what is designated as Kualani Stream, it's your testimony that this is an east tributary of Waiokamilo Stream?
A. That's correct.
Q. In other words, at some point it flows into or comes off of?
A. It flows into Waiokamilo Stream.
Q. So it's not an individual stream in itself?
A. It appears to be a tributary.
Q. So is there a Kualani Stream?
A. I believe there is a Kualani Stream.
Q. Where is that on this map, can you show it?
A. I believe Kualani Stream is more towards the east here. And this is the ridge that sticks out when we looked up at the lookout that day, I believe Kualani Stream starts on this side and goes along here and intersects Waiokamilo further down.
Q. So for the record, you're pointing to below the ditch system?
A. That's correct.
Q. And you're saying that Kualani Stream begins below the ditch system so that the ditch system could not possibly be diverting Kualani Stream, your understanding of Kualani Stream?

A. That's correct.
Q. Can you show us one more time -- and I was wondering if we could mark this map about his understanding of Kualani Stream.
MR. SCHULMEISTER: Can we go off the record for a second.
(Discussion held off the record.)
HEARINGS OFFICER JUDGE McCONNELL: We wi recess until 9:00 o'clock tomorrow morning.

CERTIFICATE

STATE OF HAWAII)
) SS.
COUNTY OF HONOLULU)

I, JEAN MARIE McMANUS, do hereby certify:

That on November 14, 2005 at 10:00 a.m., the proceedings contained herein was taken down by me in machine shorthand and was thereafter reduced to typewriting under my supervision; that the foregoing represents, to the best of my ability, a true and correct copy of the proceedings had in the foregoing matter.

I further certify that I am not of counsel for any of the parties hereto, nor in any way interested in the outcome of the cause named in this caption.

Dated this _____ day of _____, 2005, in Honolulu, Hawaii.

_____
JEAN MARIE McMANUS, CSR #157

#

#156
[1] 1:23
#157
[1] 176:21
#3119
[1] 1:23

$

$1,426.88
[1] 155:11
$1,698.32
[1] 150:25
$158,283.84
[1] 156:17
$17,122.56
[1] 155:14
$20,379.84
[1] 151:6
$3,476.72
[1] 154:10
$41,720.64
[1] 154:14
$5
[3] 140:8 140:9 140:20
$6,588.40
[1] 134:23
$79,060.80
[1] 135:13

'

'89
[1] 93:13
'90s
[1] 96:13
'Aina
[1] 52:1
'auwai
[20] 41:24 42:1 42:17 42:22 43:8 43:18 44:3 69:16 70:19 85:2 85:14 88:6 90:1 94:23 96:5 96:8 96:15 96:16 96:19 121:16
'ili
[35] 16:11 18:17 19:14 19:17 19:18 19:19 19:20 20:2 20:3 20:6 20:9 20:12 20:16 20:16 20:20 20:25 20:25 21:5 21:6 21:9 21:13 21:13 21:15 22:3 22:16 22:22 22:22 22:24 22:24 23:5 23:6 23:10 23:12 23:12 24:2
'ilis
[1] 20:17

0

01-05-MA
[2] 1:3 4:4

1

1
[13] 8:14 14:4 16:4 17:5 18:1 23:15 100:15 100:22 103:24 105:4 105:9 121:19 139:4
1-1
[2] 42:8 48:22
1-1-04-09
[1] 14:5
1-1-04-10
[3] 23:25 26:14 26:17
1-1-30
[1] 48:22
1-1-4-10
[3] 24:15 29:8 29:10
1-1-4-11
[6] 26:17 31:13 33:2 38:4 38:6 48:17
1-1-4-13
[5] 41:1 41:17 42:4 42:6 43:6
1-1-4-18
[1] 43:2
1-1-4-20
[1] 26:18
1-1-4-22
[1] 26:18
1-1-4-23
[1] 26:18
1-1-4-28
[1] 26:18
1-1-4-30
[1] 44:25
1-1-4-9
[3] 19:5 35:24 36:3
1-1-5
[2] 26:19 32:16
1-1-5-30
[11] 31:19 32:7 33:9 33:19 38:12 38:23 38:24 39:11 44:20 44:25 48:23
1-1-5-31
[6] 31:15 31:18 32:6 38:25 48:20 48:21
1-1-5-33
[2] 32:24 38:18
1-1-6
[1] 26:21
1-1-6-32
[4] 32:19 33:24 37:8 49:1
1-1-6-5
[1] 38:8
1-1-6-72
[5] 32:16 32:24 39:14 49:5 49:5
1-1-8-4
[2] 36:8 37:2
1.5
[2] 136:20 162:14
10
[2] 19:15 141:25
10,111.220
[1] 155:9
10,768
[1] 154:7
10/25/05
[1] 112:22
10/25/2005
[1] 113:21
10/3/85
[1] 113:22
100
[7] 69:11 137:13 137:14 137:16 163:1 163:8 163:13
1000
[1] 2:7
1001
[1] 2:19
10:00
[1] 176:7
10th
[4] 118:5 118:6 118:15 121:15
11
[5] 32:10 33:7 60:17 91:16 156:9
1164
[1] 2:17
11th
[2] 89:15 89:24
120,000
[1] 84:10
1200
[1] 2:7
1205
[1] 2:17
122
[1] 3:6
126
[1] 3:6
13
[1] 145:3
138
[2] 3:8 3:12
14
[5] 1:8 46:9 46:10 60:17 176:7
144
[1] 3:8
148
[1] 3:10
15
[8] 52:23 53:17 68:8 68:9 80:20 92:17 93:8 146:24
15th
[2] 17:21 17:24
16.979
[2] 117:3 117:5
1600
[1] 2:19
165
[2] 142:13 143:7
17
[1] 80:7
172
[1] 15:20
18
[3] 3:12 97:23 97:23
1848
[1] 10:1
1849
[1] 10:1
1850
[1] 10:1
1859
[1] 14:13
1876
[1] 128:11
1904
[5] 76:19 76:22 77:15 78:8 78:12
1914
[2] 77:20 78:5
1915
[2] 77:21 78:5
1923
[10] 77:23 78:23 78:25 79:4 132:4 172:2 172:6 172:10 172:13 172:14
1970
[6] 129:13 129:18 129:25 130:6 130:18 130:21
1985
[9] 76:6 93:2 93:12 113:17 117:7 117:9 117:11 117:16 117:24
1987
[3] 151:17 151:22 152:8
1988
[1] 93:13
1989
[1] 100:2
1st
[1] 152:16

2

2
[7] 23:25 100:14 100:14 100:19 105:4 105:9 106:1
2.505
[2] 116:10 116:25
20
[1] 117:22
200
[4] 2:1 2:12 115:21 115:24
2000
[1] 152:16
2001
[2] 93:9 120:3
2003
[3] 85:21 130:6 130:24
2004
[3] 89:15 104:2 130:7
2005
[19] 1:8 8:14 26:2 26:7 26:8 74:20 74:21 112:11 117:9 117:16 117:25 118:6 118:15 118:22 119:15 121:15 121:25 176:7 176:17
204
[1] 2:10
2087
[1] 2:14
22nd
[1] 74:21
25
[2] 81:1 118:22
250
[1] 124:15
25th
[2] 112:11 121:25
26
[2] 8:6 60:17
262,000
[2] 91:10 91:25
28
[1] 130:7
29th
[1] 74:20

3

3
[23] 48:18 51:19 71:9 100:12 100:19 103:4 103:8 103:20 104:2 104:6 104:20 104:22 105:2 105:2 105:4 105:9 105:12 106:13 106:23 108:12 121:15 139:4 139:19
3,381
[2] 150:20 151:1
30
[8] 26:19 31:24 32:1 32:1 32:3 32:7 39:9 44:18
30-something
[1] 131:19
300
[2] 2:4 124:14
31
[8] 26:20 31:23 31:24 31:25 32:2 39:1 39:7 39:8
32
[1] 26:21
3279
[2] 14:7 16:5
33
[5] 2:1 26:20 32:16 32:22 44:17
34
[1] 26:21
36
[1] 26:22
37
[1] 26:22
3922
[1] 41:3
3rd
[3] 26:2 26:8 113:17

4

4
[5] 38:1 47:23 61:9 135:22 153:8
408
[3] 105:24 106:4 106:19
444
[1] 2:10
45
[1] 26:22
450
[1] 128:23
46
[2] 3:3 26:20
465
[1] 2:4
47
[2] 34 26 22
4779
[2] 16 5 194
48
[2] 25 6 25 10
410
[1] 10 9 22

5

5
[5] 26 1 3 2 2 3 8 16 1:
9 14 0 18
50
[1] 8 11
51
[11] 6 3 1 2 6 5 7 6 5 10
6 5 2 6 6 7 6 6 1 6 6 2 4
6 6 2 6 7 6 6 7 1 1 1 2 1:
14
52
[1] 2 6 2 0
542
[2] 2 3 1 6 2 2 1 2
544
[2] 2 4 1 2 4 1 5
55
[1] 6 9 7
551
[1] 6 8 1 3
56
[5] 4 6 5 5 5 2 6 3 2 6 3:
1 0 6 3 1 1
56pointsomething
[1] 5 5 3
56355
[8] 4 8 7 4 8 9 4 8 1 4 4 9:
2 1 5 5 3 6 1 2 6 4 1 6 4 3
58
[3] 1 5 5 6 1 5 5 1 2 1 5 5 2 0
59
[2] 1 5 5 6 1 5 5 1 2
530
[1] 6 2 1
5A
[1] 1 7 1 9
5B
[2] 1 7 1 9 1 7 1 1 0
5th
[2] 2 6 7 1 3 0 6

6

6
[4] 2 5 6 2 5 1 0 3 8 2 6 1 9
6,000
[1] 1 3 4 2 2
60
[1] 8 1 4
600someodddollars
[1] 1 4 0 8
600someoddthousanddollars
[1] 1 4 0 1 9
61
[9] 4 6 6 0 6 0 6 0 1 6 6 0:
2 1 6 3 7 6 5 1 6 6 5 1 6 6 5
1 6 6 5 2 3
61.14
[11] 4 6 6 4 6 4 6 4 1 1 4 7:
4 4 7 1 5 9 2 2 6 0 7 6 0:
1 6 6 3 1 3 6 4 2 6 4 6
62
[1] 1 4 6
64
[1] 5 5 2 3
6784
[1] 6 3 9
69
[2] 1 0 2 6 1 0 2 6
6930
[1] 4 3 1 2

7

7
[4] 3 2 1 3 5 2 1 3 5 2 3
1 5 3 9
72
[4] 2 2 3 2 4 1 7
45
73
[1] 1 0 7
74
[1] 5
75
[1] 8 2 5
7:00
[1] 1 3 1 3 1 4

8

8
[1] 3 1 3 1 3 1 3 1 5
3 1 3 2 1 2 2 2
1 2 4 1 2 1 3 1 2 0
1 4 1 4 1 4 1 4 1 7
14:24
8752690
[1] 3 1 9
86793
[1] 5

9

9:00
[1] 3 1 2
90
[2] 0 1 5 1 5 1 5
5 2 5 1 5 2 5 6
6 4 6 2 6 2 6 2
6 6 6 1 7 1 7 1 9
7 7 7 1 7 2 7 2 1
7:24
95732
[1] 0
95793
[2] 2 1 3
96813
[2] 2 1 1 2 0
9:00
[4] 1 1 7 9
9:45
[1] 8

_

1 7 1 7

1 7 2 1

A

A&B
[2] 1 5 6 1 6 1 1
6:74
A1
[2] 7 1 7 1 7 1 7 1 4
7 1 8 1 1 0 1 1 0 2
1 0 2 1 2 2 1 2 2
2 1 2 1 1 2 2 1 2 9
1 1 8 1 1 8 2 1 7 8
1 7 1 7 1 7 1 7 1 2
17:16
A12
[8] 1 8 1 8 1 9 1 6
9 1 9 2 9 1 0
A2
[1] 3 2 1 3 2 1 3 4
1 3 2 1 4 2 2
A23
[9] 1 9 1 9 1 9 1 2
9 1 9 1 6
A25
[1] 0 1 0 1 0 1 0 9
A29
[9] 9 9 1 0 4
A3
[2] 1 3 2 1 5 1 7
A30
[1] 0 1 0 1 0 1 0 4
1 1 0 2 1 0 2 3
A4
[2] 1 3 2 1 5 4
A45
[2] 3 1 3 2 3 3 1 3 5

8 35:9 35:14 35:16 35:25 36:1 36:5 36:14 36:21 37:9 38:14 39:17 40:11 41:16 41:21 45:13 46:14 49:12 58:9 67:18
A-49
[47] 29:6 29:9 29:20 29:25 30:13 30:16 31:3 31:7 33:3 34:3 34:24 35:4 35:9 35:14 35:24 36:4 40:9 40:14 40:17 44:8 45:11 45:15 45:17 46:3 49:9 49:10 54:1 55:12 55:16 55:19 55:24 55:25 57:23 58:7 59:1 59:10 59:14 59:17 59:25 60:10 61:1 61:13 61:15 65:6 65:21 65:22 65:24
A-5
[1] 155:7
A-51
[2] 118:2 118:2
A-51.1
[1] 67:17
A-52
[8] 112:18 112:20 112:21 114:16 114:21 116:7 116:23 117:3
A-53
[5] 112:8 112:9 112:10 116:3 116:18
A-54
[6] 113:12 113:15 113:16 113:20 115:20 117:7
A-55
[9] 52:22 52:22 68:12 69:24 70:3 70:10 70:13 71:5 71:25
A-56
[1] 110:7
A-56.1
[2] 110:8 110:10
A-56.2
[1] 110:14
A-56.3
[1] 110:17
A-56.4
[3] 110:20 110:25 112:1
A-56.5
[3] 110:8 110:23 112:2
A-6
[2] 79:7 79:9
A.m.
[2] 137:4 137:14
Ability
[4] 87:23 111:22 139:6 176:11
Able
[18] 6:2 47:25 50:25 53:21 62:22 67:23 72:8 96:24 149:16 158:11 158:18 159:1 159:10 159:22 160:19 160:25 169:1 172:4
Abnormally
[1] 161:4
Above-referenced
[1] 119:3
Aboveground
[1] 81:1
Absolutely
[1] 84:4
Abuts
[1] 69:16
Acain
[2] 36:8 37:2
Accepting
[1] 115:12
Access
[7] 81:6 136:20 137:15 137:16 151:13 163:5 165:20
Accommodate
[1] 20:24
Accordance
[1] 106:4
According
[1] 71:2
Account
[1] 46:12
Accounting
[1] 63:13
Accuracy
[1] 154:15
Accurate
[7] 8:20 123:18 123:19 129:9 130:2 154:17 157:7
Acquired
[2] 11:25 92:22
Acquiring
[2] 92:17 93:8
Acre
[3] 24:1 24:16 66:18
Acreage
[39] 20:3 21:7 32:1 44:9 44:13 44:21 45:24 46:2 47:1 47:2 47:5 47:6 48:1 48:5 48:9 49:19 49:22 55:18 57:14 57:15 57:19 58:2 58:16 59:20 61:2 61:14 61:23 62:15 64:7 66:9 66:25 70:18 112:22 114:6 116:10 116:24 121:7 121:8 152:10
Acreages
[1] 45:18
Acres
[38] 14:6 24:16 44:24 46:6 46:6 46:8 46:10 47:4 49:21 55:3 59:23 60:7 60:19 63:10 65:7 65:10 66:7 66:21 66:24 66:25 67:8 67:11 69:7 113:4 114:16 114:18 114:20 114:20 114:24 116:10 117:1 117:5 134:19 135:12 150:21 151:2 154:7 155:9
Active
[2] 48:1 161:14
Activity
[1] 111:18
Acts
[1] 155:3
Actual
[4] 10:20 52:14 69:14 118:19
Add
[5] 44:16 45:2 45:19 46:16 61:2
Added
[15] 46:3 48:13 48:17 49:1 54:19 54:21 55:7 60:18 61:13 63:3 64:5 65:20 156:15 163:25 164:21
Addition
[3] 8:19 149:2 165:2
Additional
[16] 23:15 24:19 47:6 52:8 60:15 84:7 142:10 148:25 149:1 158:20 159:11 159:16 159:22 160:20 162:9 166:24
Additionally
[1] 45:2
Additions
[1] 25:19
Adequate
[1] 121:16
Adequately
[1] 158:19
Adjacent
[3] 83:16 88:10 133:8
Adjoining
[1] 69:17
Adjudicate
[3] 11:20 14:22 15:16
Adjudicated
[2] 10:5 10:10
Adjust
[2] 165:22 166:4
Adjusted
[1] 166:1
Administrative
[2] 109:21 115:17
Admissible
[2] 60:3 119:7
Admission
[1] 106:6
Aerial
[7] 52:16 112:10 112:25 113:16 113:20 113:21 117:7
Affect
[1] 111:21
Afternoon
[2] 6:17 6:20
Ag
[2] 147:10 147:11
Agent
[4] 11:13 12:1 12:2 12:8
Ago
[4] 96:18 101:5 111:13 150:11
Agree
[11] 58:13 62:9 103:16 106:2 115:2 121:1 135:13 139:13 139:16 139:18 171:21
Agreeable
[2] 65:9 111:18
Agreed
[3] 65:5 65:7 104:23
Agreement
[25] 54:11 54:12 87:25 104:22 106:3 108:12 118:18 125:6 125:10 125:11 136:4 136:6 136:7 136:8 136:12 136:17 136:18 148:24 150:3 150:4 150:6 150:8 150:9 150:10 163:16
Agreements
[1] 149:19
Agricultural
[4] 54:16 54:17 158:5 158:6
Agriculture
[15] 41:14 41:15 139:11 140:5 141:14 142:1 142:4 142:8 145:5 145:6 145:12 146:4 146:7 146:13 146:16
Ahead
[4] 63:19 63:24 81:10 152:3
Ahupua'a
[19] 12:20 19:19 19:24 20:18 20:19 20:23 20:24 21:2 21:5 21:8 22:16 22:23 22:23 23:6 23:13 25:2 25:5 26:4 51:25
Aircraft
[1] 52:18
Akeke
[1] 99:5
Akina
[4] 32:20 34:1 34:3 110:17
Akiona
[1] 35:24
Akuna
[6] 31:14 32:11 33:3 33:5 33:6 38:9
Al
[2] 2:17 7:3
Alan
[2] 2:16 4:13
Alexander
[6] 4:17 33:5 76:3 129:7 134:2 134:10
Align
[1] 67:23
Allocation
[1] 143:13
Allodial
[2] 15:7 15:25
Allow
[11] 121:21 136:13 149:20 151:13 153:2 160:8 160:12 161:16 161:19 161:23 162:16
Allowed
[2] 73:1 127:23
Allows
[2] 136:4 148:24
Almost
[3] 42:17 125:7 135:12
Alo
[3] 77:5 77:25 78:22
Altering
[1] 132:18
Alternatives
[1] 121:23
Amended
[1] 5:14
Amount
[34] 16:22 45:23 45:23 46:5 66:9 66:25 70:18 92:1 97:4 117:17 117:21 117:24 121:8 123:10 124:16 135:1 135:2 137:5 137:7 137:7 137:9 146:12 148:25 151:10 151:18 151:25 152:7 152:9 157:6 158:19 160:13 161:23 162:15 165:7
Ancestor
[1] 33:5
Ancient
[4] 20:10 22:21 43:1 43:21
Answer
[18] 16:2 20:4 27:18 30:20 42:15 48:3 50:7 51:20 57:7 59:22 62:22 114:7 129:13 132:14 142:25 154:1 172:4 173:7
Answered
[5] 12:22 141:3 146:15 146:18 173:16
Answers
[2] 8:21 73:10
Anticipated
[1] 133:1
Anticipation
[2] 6:10 133:17
Anyway
[2] 35:7 108:7
Apolonia
[1] 99:19
Appeal
[1] 120:11
Appear
[2] 27:3 117:8
Appearances
[1] 4:5
Appeared
[1] 101:5
Appearing
[1] 4:19
Applicability
[1] 106:19
Applied
[1] 58:17
Applies
[2] 22:5 153:17
Apply
[1] 106:20
Applying
[1] 59:6
Appreciate
[3] 63:2 110:4 135:18
Appropriate
[2] 13:12 120:19
Approximate
[1] 114:23
Appurtenant
[4] 60:22 62:5 62:6 62:17
April
[1] 130:5
Archeologists
[4] 53:6 53:15 53:21 68:16
Archives
[3] 13:16 23:23 51:17
Area
[63] 12:12 14:6 21:6 22:3 23:5 24:15 36:25 39:8 43:5 47:3 52:13 54:9 54:23 62:5 64:15 69:2 69:22 69:23 77:7 77:12 78:9 78:17 79:12 89:1 92:15 97:8 97:11 97:16 97:25 99:6 112:15 112:25 113:17 116:2 116:4 116:13 117:18 124:17 124:17 127:8 127:11 128:12 128:20 129:1 129:6 129:23 134:3 134:16 134:18 135:6 135:11 135:20 150:20 150:21 151:11 151:18 152:8 152:13 153:17 154:4 155:8 156:24 168:21
Areas
[38] 23:3 35:15 35:19 44:16 59:8 71:22 72:7 75:17 75:18 75:22 75:23 76:1 79:13 79:23 105:1 105:1 112:11 112:12 112:15 113:18 113:19 114:22 116:18 124:1 127:25 128:25 129:3 129:5 152:1 152:21 155:21 155:22 155:24 155:25 156:13 156:16 156:22 157:10
Argue
[2] 119:11 142:7
Argued
[2] 44:5 61:25
Argument
[1] 108:13
Argumentative
[5] 145:18 145:20 145:25 148:2 162:17
Arises
[2] 124:8 131:14
Arrive
[2] 12:24 66:19
Arrows
[4] 69:24 70:1 71:2 71:4
Assessed
[11] 13:11 13:23 31:23 33:11 33:18 33:20 33:25 39:8 39:9 60:16 61:20
Assessment
[4] 13:22 31:23 33:4 39:3
Assign
[1] 153:18
Assigned
[3] 5:1 136:1 153:11
Assignment
[1] 13:5
Assist
[2] 83:24 108:21
Assistance
[5] 89:8 111:8 113:1 113:7 113:9
Assisted
[2] 85:19 99:19
Association
[1] 99:21
Assume
[6] 5:24 57:16 73:5 95:12 126:1 160:1
Assumed
[3] 49:22 68:23 69:3
Assumes
[3] 58:1 140:11 148:3
Assumption
[5] 71:8 71:19 72:7 72:20 72:21
Assumptions
[1] 71:20
Assure
[1] 84:5
Assuring
[1] 84:2
Attached
[5] 8:8 20:19 21:5 22:22 48:6
Attachments
[1] 107:23
Attempting
[1] 166:23
Attend
[1] 6:2
Attention
[2] 133:20 135:23
Attorney
[5] 2:3 2:3 5:1 27:19 138:21
August
[5] 8:14 17:21 17:24 74:21 85:20
Aupuni
[2] 2:16 4:14
Authority
[1] 120:15
Authorize
[1] 119:18
Authorized
[1] 26:5
Auwai
[2] 96:3 97:6
Available
[7] 6:12 6:15 13:7 85:1 85:13 92:5 161:13
Average
[11] 91:21 135:19 142:13 143:6 151:10 155:20 156:6 156:7 156:12 158:4 158:8
Averaged
[1] 91:22
Avoid
[1] 133:7
Award
[9] 9:12 10:2 10:3 10:9 15:24 16:5 16:6 24:2 69:15
Awarded
[3] 15:5 73:7 73:8
Awarding
[1] 10:20
Awards
[2] 11:2 14:23
Aware
[7] 146:1 146:7 147:17 147:21 147:24 148:7 148:10
Awhile
[1] 4:4

B

B's
[1] 114:9
B-11
[2] 8:8 8:16
B-12
[53] 8:16 13:1 14:2 25:24 26:10 26:12 26:25 27:4 27:7 27:9 27:11 28:10 28:13 28:16 29:7 29:10 29:18 29:25 30:2 30:3 30:10 31:6 41:1 44:7 45:9 48:10 48:17 48:23 49:4 49:6 49:10 49:13 50:2 51:9 55:14 56:5 56:7 56:16 56:19 56:21 56:24 57:3 58:20 58:20 58:23 58:25 59:2 59:19 59:25 61:3 61:8

61:12 65:6
B-123
[1] 52:6
B-14A
[5] 3:12 18:2 18:6 18:8 19:3
B-49
[2] 65:20 65:21
B-5A
[7] 168:2 168:14 168:18 168:19 171:13 171:14 173:11
B-5B
[5] 171:1 171:7 171:18 171:20 171:21
B-5C
[7] 168:2 168:14 170:9 171:3 171:12 171:16 171:19
B-6
[1] 168:12
B-6A
[2] 168:2 168:14
B-6B
[2] 168:2 168:14
B-7
[1] 168:11
B-7A
[2] 168:1 168:14
B-7B
[2] 168:1 168:14
B-7C
[2] 168:1 168:15
Background
[1] 81:10
Bait
[1] 109:12
Baldwin
[5] 4:17 76:3 129:7 134:2 134:10
Banana
[1] 99:5
Based
[26] 25:24 42:23 47:24 51:24 59:13 66:19 67:4 67:25 68:25 72:8 72:22 84:24 102:18 107:5 112:16 118:19 129:20 131:7 136:24 140:1 140:3 141:17 157:5 162:20 162:24 166:9
Basin
[1] 23:4
Basis
[7] 67:20 74:9 80:23 121:24 129:8 151:6 161:14
Beat
[1] 167:12
Beatrice
[1] 4:15
Became
[2] 15:4 15:25
Begin
[2] 20:4 118:16
Beginning
[1] 48:3
Begins
[1] 174:22
Begun
[2] 19:11 172:10
Behalf
[9] 4:14 7:2 15:12 74:4 138:2 144:1 144:11 167:3 167:6
Behind
[1] 50:6
Belabor
[1] 108:15
Belief
[2] 75:2 160:6
Belong
[1] 105:6
Below
[17] 90:9 94:2 95:7 95:8 95:24 96:24 99:2 99:3 99:4 103:7 110:14 131:14 137:6 137:7 137:16 174:19 174:23
Belt
[1] 36:22
Belts
[1] 124:13
Best
[3] 75:1 114:8 176:11
Better
[2] 149:8 157:3
Between
[13] 20:11 35:3 64:1 72:1 78:9 78:13 117:16 147:21 148:8 150:7 164:5 164:13 164:16
Beyond
[6] 51:5 72:10 81:8 85:5 131:22 142:19
Big
[3] 21:6 34:10 72:24
Bill
[1] 14:25
Billion
[3] 156:8 156:12 156:21
Binding
[1] 10:3
Bishop
[3] 2:7 2:17 2:19
Bit
[2] 49:18 97:8
Black
[1] 112:12
Blank
[1] 51:2
BLNR
[1] 2:3
Blocked
[1] 87:17
Blocking
[1] 87:13
Blue
[7] 37:12 39:19 41:22 41:25 42:3 75:18 86:23
Board
[11] 1:1 5:1 10:5 11:17 11:18 25:25 50:10 50:14 56:14 56:21 67:5
Bob
[1] 111:7
Book
[1] 53:1
Borders
[1] 37:13
Bottom
[9] 38:2 47:22 51:20 69:25 70:4 71:10 90:4 117:3 122:24
Boulder
[1] 110:18
Boundary
[4] 51:15 137:13 162:12 163:1
Box
[3] 91:19 91:21 91:23
Boxes
[1] 169:3
Brand
[1] 132:17
Break
[4] 64:4 64:10 64:15 109:15
Brief
[1] 80:14
Briefly
[2] 75:13 100:7
Bring
[4] 5:20 40:21 140:13 165:3
Bringing
[1] 6:1
Broke
[1] 156:22
Broken
[2] 110:21 111:22
Brought
[6] 6:1 60:19 63:11 70:7 78:18 135:9
Brown
[3] 86:22 129:5 129:6
Build-out
[1] 160:16
Built
[3] 97:17 128:10 128:11
Bunch
[1] 49:9
Burden
[3] 62:1 62:10 114:9
Bureau
[9] 2:18 4:20 137:25 138:3 144:12 144:12 144:15 144:22 145:15
Busy
[1] 89:6
Bypass
[1] 97:24
Bypassing
[1] 98:2

C

CA
[1] 1:23
Cabral
[1] 93:14
Cades
[1] 2:6
Calculate
[7] 54:25 91:23 116:2 116:24 124:15 135:15 151:8
Calculated
[1] 151:5
Calculation
[10] 58:2 59:13 59:17 59:19 64:5 64:8 72:6 135:14 154:13 155:14
Calculations
[2] 135:9 135:11
Calculator
[2] 135:10 154:15
Cannot
[7] 24:11 67:2 106:6 137:16 153:18 153:22 165:25
Capacity
[14] 9:9 123:21 125:3 125:13 125:15 125:17 128:8 128:16 128:20 128:22 166:20 172:18 172:21 172:25
Caption
[1] 176:16
Captured
[1] 154:24
Care
[3] 5:9 30:16 110:3
Carefully
[1] 166:2
Caretaker
[1] 93:21
Carried
[1] 130:18
Carrol
[1] 111:7
Carry
[1] 128:16
Case
[13] 1:3 1:6 4:3 5:3 5:16 17:17 73:12 73:17 74:23 102:11 119:3 138:23 141:10
Catch
[1] 128:18
Caught
[1] 96:20
Caveny
[3] 81:19 92:11 95:17
Caveny's
[1] 93:7
Cent
[3] 156:25 157:8 157:18
Center
[6] 1:9 36:24 37:12 38:21 42:18 98:22
Central
[4] 72:2 135:8 136:11 142:15
Cents
[3] 150:14 157:25 158:3
Certain
[12] 9:12 16:22 17:21 21:9 22:8 26:11 112:7 137:5 137:7 149:15 162:15 172:16
Certainly
[1] 80:4
Certainty
[1] 58:25
CERTIFICATE
[1] 176:1
Certify
[2] 176:6 176:14
Cetera
[2] 52:2 70:20
Change
[6] 132:11 132:17 132:19 172:14 172:15 172:15
Changed
[1] 118:1
Changes
[9] 44:8 44:12 78:25 79:2 132:2 132:15 158:16 171:25 172:13
Chapter
[1] 15:20
Characterization
[1] 57:25
Characterize
[2] 66:24 170:7
Charge
[9] 80:17 149:6 149:10 149:11 150:12 150:14 153:23 157:24 158:1
Charged
[1] 158:6
Charges
[3] 149:7 149:7 152:12
Charging
[1] 149:13
Check
[1] 131:13
Checking
[3] 69:10 80:24 81:3
Chickens
[1] 93:25
Chow
[3] 2:3 4:25 34:14
Circuit
[1] 120:12
Circumstances
[4] 83:10 111:5 120:18 159:25
City
[1] 13:21
Claim
[7] 9:19 13:18 45:24 62:17 62:21 126:17 129:9
Claimant
[5] 10:4 12:4 15:5 18:16 23:10
Claimant's
[1] 18:25
Claimed
[14] 11:9 11:14 16:18 16:20 16:22 17:1 17:2 17:6 18:15 24:3 41:5 54:22 62:19 69:20
Claiming
[2] 44:14 61:21
Claims
[5] 9:18 10:14 10:17 12:3 130:9
Clarification
[3] 26:24 66:2 155:5
Clarifications
[1] 25:19
Clarify
[6] 40:10 75:5 152:4 153:22 162:6 171:19
Clarity
[1] 169:7
Clean
[4] 87:24 88:2 88:12 88:13
Cleaned
[1] 87:15
Clear
[17] 9:4 9:23 15:21 27:6 27:11 30:9 37:22 67:12 67:13 79:22 81:3 87:12 91:1 91:25 102:22 123:13 146:15
Cleared
[1] 121:16
Clearly
[1] 161:11
Clerical
[1] 80:18
Client
[1] 121:18
Climbed
[1] 102:19
Close
[1] 102:6
Closed
[3] 83:11 83:12 139:22
Closing
[1] 121:19
Coastal
[1] 8:12
Coded
[1] 128:25
Coincide
[4] 19:4 35:19 35:20 65:6
Collected
[2] 78:13 78:14
Color
[1] 128:25
Colored
[5] 79:13 100:10 100:10 101:25 114:22
Colorful
[1] 75:10
Colors
[2] 76:4 79:15
Column
[6] 16:10 18:15 18:18 23:15 41:1 114:16
Comfortable
[2] 57:13 59:7
Coming
[9] 12:4 62:1 71:3 79:24 83:14 92:1 92:3 115:14 115:16
Commencing
[1] 1:8
Comments/Notations
[2] 23:15 24:19
Commercial
[5] 79:14 139:25 140:18 141:23 143:9
Commission
[25] 9:12 9:21 9:24 10:2 10:3 10:9 10:13 10:17 11:2 12:5 14:16 14:23 15:24 16:5 16:6 22:9 23:9 24:2 51:15 68:25 69:1 69:15 99:25 164:11 164:19
Commissioners
[8] 10:5 11:5 11:17 11:19 13:16 14:18 14:22 15:1
Commissions
[1] 51:16
Commitment
[1] 141:14
Committed
[2] 84:2 140:5
Common
[1] 22:9
Community
[1] 1:9
Commutation
[11] 14:10 14:11 14:14 14:15 14:24 15:4 15:8 15:13 15:18 15:23 16:7
Commute
[1] 15:6
Companies
[1] 139:21
Company
[13] 4:18 74:15 76:3 79:14 89:12 105:5 129:4 129:7 130:14 139:23 139:24 141:11 141:16
Compare
[1] 29:6
Compared
[4] 26:9 26:23 26:24 28:11
Comparing
[1] 35:13
Competence
[1] 85:6
Competitive
[1] 145:4
Compilation
[2] 10:14 37:23
Complain
[2] 85:23 86:2
Complained
[1] 85:12
Complaints
[4] 166:22 166:25 167:2 167:5
Complete
[3] 8:18 8:19 143:2
Completed
[13] 27:9 76:18 76:21 76:22 77:20 77:21 77:22 77:23 78:4 78:6 78:8 78:10 78:23
Completely
[2] 92:23 126:24
Completes
[1] 73:16
Completion
[1] 79:3
Component
[1] 145:4
Composite
[2] 37:25 68:4
Comprised
[2] 132:3 154:7
Comprising
[1] 155:23
Concern
[5] 64:17 105:25 132:24 139:5 154:14
Concerned
[1] 121:7
Concerns
[1] 157:21
Conclude
[3] 40:20 42:23 71:12
Conclusion
[6] 43:19 47:25 119:3 126:20 129:11 134:6
Concrete
[3] 97:23 104:7 105:3
Condition
[2] 121:18 137:11
Conditions
[4] 7:22 136:21 152:20 152:23
Conducted
[1] 12:19
Conferences
[1] 144:5
Confidential
[1] 105:23

Confirm
[5] 9:13 12:3 12:9 12:20 17:2
Confirmation
[1] 14:9
Confirmed
[3] 13:4 17:4 18:19
Confirms
[1] 119:20
Conformance
[1] 40:22
Confused
[1] 47:16
Connect
[1] 64:1
Connected
[1] 112:1
Connection
[1] 20:11
Conservation
[1] 8:12
Conservatively
[1] 156:20
Consider
[2] 121:23 172:1
Consideration
[1] 72:15
Considering
[1] 47:2
Consistent
[3] 92:19 92:23 117:13
Constitution
[1] 142:1
Constructed
[5] 77:18 77:19 78:10 88:21 88:25
Constructing
[1] 132:17
Construction
[3] 76:23 77:14 78:21
Construed
[1] 106:5
Contact
[1] 121:18
Contacted
[2] 119:19 122:12
Contained
[7] 12:20 28:13 29:19 31:6 31:7 71:13 176:8
Contention
[1] 62:10
Contested
[5] 1:3 1:6 4:3 119:3 138:23
Context
[1] 52:20
Continuation
[1] 171:13
Continue
[3] 66:5 104:10 139:6
Continued
[3] 3:10 77:15 148:19
Continues
[1] 65:24
Continuous
[2] 93:6 93:6
Contrary
[2] 42:16 108:23
Control
[1] 105:7
Controlled
[3] 67:1 82:20 128:6
Convey
[1] 153:18
Conveyancing
[1] 22:8
Conveyed
[2] 136:1 153:11
Coordinate
[1] 111:17
Copies
[2] 13:11 113:13
Copy
[6] 8:18 8:20 52:23 107:17 138:25 176:12
Corner
[3] 72:1 122:24 171:16
Corporation
[9] 2:12 4:10 7:14 7:16 9:10 26:5 73:12 104:25 167:6
Correct
[108] 13:11 16:14 16:16 18:14 23:22 24:16 24:22 27:12 30:1 30:10 32:15 32:23 39:12 40:23 41:6 41:7 41:23 45:16 45:25 51:3 56:6 58:22 59:9 63:9 65:13 66:12 75:1 76:16 78:24 83:4 86:9 86:12 89:17 90:19 92:4 92:7 94:9 102:3 105:20 116:9 116:11 121:4 122:4 122:23 123:23 124:21 125:12 129:22 131:10 131:11 132:3 132:10 133:1 134:13 134:16 134:19 135:2 135:17 139:11 139:12 144:13 144:15 144:16 144:18 147:1 147:3 147:4 147:6 147:9 147:12 147:15 147:16 148:8 148:9 149:9 149:10 149:18 150:21 150:22 151:3 151:9 152:22 154:2 154:5 154:8 154:12 155:9 155:10 155:12 156:14 157:10 157:14 157:19 157:22 158:13 158:14 158:16 161:8 163:23 164:23 165:21 167:21 169:10 173:9 174:5 174:21 175:1 176:12
Corrected
[1] 47:2
Correction
[1] 131:6
Corrections
[2] 25:19 40:21
Correctly
[8] 5:2 15:23 71:17 113:6 153:14 170:12 170:19 170:21
Correlate
[3] 68:3 68:16 169:6
Corresponding
[1] 59:18
Corresponds
[3] 45:13 59:25 113:20
Cost
[1] 157:15
Council
[1] 111:7
Counsel
[7] 2:12 4:10 67:17 109:25 127:7 127:10 176:14
Count
[1] 102:15
Counted
[1] 65:23
Country
[3] 123:9 142:15 146:25
County
[29] 2:11 4:10 13:21 111:18 122:17 123:8 123:15 123:21 124:22 124:23 125:4 125:6 125:7 144:12 144:14 146:2 147:2 147:6 147:9 147:14 147:18 149:25 150:2 150:5 150:7 150:12 150:14 157:24 176:4
County's
[3] 123:14 125:20 148:10
Couple
[10] 24:24 64:21 88:5 89:2 101:4 122:18 138:22 138:24 156:11 168:12
Course
[4] 76:9 106:3 119:8 132:19
Court
[3] 84:18 108:1 120:12
Covering
[1] 27:25
Covers
[1] 134:2
Created
[1] 68:14
Critical
[2] 145:4 145:11
Criticism
[1] 88:20
Criticizing
[1] 88:24
Crops
[2] 24:11 73:3
Cross
[9] 12:3 53:18 66:6 85:8 91:4 92:9 103:7 115:14 144:6
Cross-claims
[1] 12:3
Cross-examination
[15] 3:3 3:4 3:6 3:6 3:8 3:8 3:10 46:24 47:13 66:6 122:19 126:4 138:19 144:9 148:19
Cross-examine
[3] 91:4 115:12 115:14
Cross-reference
[1] 53:18
Crosses
[1] 105:18
Crossing
[2] 81:22 87:13
Crown
[1] 15:13
CSR
[3] 1:23 1:23 176:21
Cubic
[1] 91:19
Culmination
[1] 13:24
Cultivate
[2] 21:1 70:7
Cultivated
[9] 50:22 51:1 51:7 66:10 66:11 66:22 73:2 112:16 117:17
Cultivating
[1] 72:23
Cultivation
[30] 9:13 12:21 42:14 42:21 42:24 43:20 44:15 48:1 49:20 56:10 56:23 56:24 58:16 59:8 69:8 69:13 71:14 71:16 72:25 73:8 95:15 113:1 114:7 117:9 128:13 135:8 136:11 142:4 158:17 160:17
Cultural
[9] 20:9 21:7 21:17 21:22 51:24 52:1 53:7 68:9 68:17
Culturally
[1] 20:22
Current
[5] 7:12 64:1 66:12 141:20 152:15
Custom
[1] 20:22
Customary
[1] 23:11
Cut
[1] 133:6
CWRM
[2] 90:11 99:11

D

Daily
[2] 80:17 80:23
Dam
[29] 100:12 100:13 100:14 100:15 100:19 100:19 100:22 103:4 103:8 103:20 103:24 104:1 104:6 104:7 104:8 104:10 104:20 104:22 105:2 105:2 105:3 105:4 105:4 105:4 105:12 105:14 106:13 106:23 121:18
Damage
[2] 82:23 133:7
Damaged
[2] 82:18 111:10
Dams
[2] 105:5 105:6
Dash
[1] 39:4
Data
[1] 152:14
Date
[3] 68:5 79:4 133:12
Dated
[5] 26:7 74:20 76:19 113:21 176:17
Dave
[4] 62:23 63:19 67:19 114:12
David
[4] 2:5 2:9 4:16 4:22
Days
[6] 20:7 20:14 20:16 76:14 133:17 163:7
Deadline
[1] 113:25
Deal
[3] 106:23 119:17 120:25
Dealt
[1] 87:21
Death
[1] 167:13
Debris
[2] 87:13 112:4
Decision
[1] 133:6
Declaration
[3] 99:14 120:12 120:18
Declarations
[6] 74:19 74:22 75:1 75:8 108:18 120:10
Define
[1] 52:17
Definitely
[2] 17:17 25:12
Definition
[2] 132:11 171:25
Delete
[1] 67:8
Deleted
[1] 67:7
Deletions
[1] 56:18
Delivery
[1] 149:12
Demands
[1] 141:20
Deny
[1] 107:8
Department
[5] 4:11 8:13 13:6 129:18 130:22
Depict
[1] 168:22
Depicted
[20] 102:23 169:21 169:25 170:2 170:4 170:6 170:8 170:11 170:12 170:20 170:21 170:25 171:7 171:12 171:13 171:20 172:9 173:8 173:9 173:15
Depiction
[3] 129:10 130:2 130:15
Depicts
[2] 70:13 168:23
Deposited
[1] 15:10
Deputy
[4] 2:3 2:12 4:9 4:25
Describe
[6] 12:24 20:13 21:16 75:13 100:7 104:5
Described
[3] 5:16 51:13 53:5
Description
[4] 8:20 16:19 20:12 36:23
Designate
[1] 10:15
Designated
[6] 12:22 22:6 24:1 41:24 41:25 174:2
Designation
[1] 39:2
Designations
[1] 19:17
Designed
[1] 84:21
Detach
[1] 20:22
Detached
[2] 20:17 20:20
Detail
[1] 52:10
Detailed
[4] 12:19 50:19 51:6 51:25
Determination
[3] 15:25 162:19 162:22
Determine
[15] 7:25 13:22 35:8 44:3 50:21 51:7 70:18 102:10 114:24 116:2 152:8 161:6 161:18 161:22 162:8
Determined
[3] 20:9 114:19 114:21
Determining
[1] 163:6
Develop
[2] 152:11 154:21
Developed
[10] 135:20 151:11 151:22 151:25 152:7 154:20 155:2 155:6 155:18 155:21
Diagram
[1] 79:9
Diameter
[1] 165:15
Diet
[1] 21:3
Different
[9] 37:24 65:3 79:15 79:16 98:14 123:8 123:11 124:1 147:8
Difficult
[2] 71:22 143:19
Difficulty
[1] 126:24
Digitized
[1] 130:25
Direct
[16] 3:3 3:5 7:10 8:15 8:22 8:25 50:10 60:25 73:19 73:20 74:8 74:12 99:10 133:19 135:23 158:10
Directed
[2] 121:22 148:23
Direction
[4] 69:25 71:2 77:4 141:15
Directors
[4] 50:10 50:14 56:15 67:5
Dirt
[1] 104:12
Disagree
[1] 171:22
Discount
[1] 59:8
Discounted
[1] 49:21
Discovered
[1] 122:2
Discussed
[1] 5:18
Discussion
[10] 29:3 29:14 34:18 64:25 65:4 73:24 76:17 88:20 149:4 175:7
Discussions
[4] 65:19 106:4 109:2 120:3
Dispose
[1] 153:19
Disposed
[2] 136:2 153:12
Dispute
[4] 151:7 155:15 156:18 157:1
Disputed
[1] 65:11
Distance
[1] 98:10
Distributed
[1] 5:13
Distribution
[3] 142:12 142:16 143:13
District
[3] 20:6 41:15 54:17
Ditch
[138] 75:11 75:14 75:16 75:18 76:11 76:18 76:21 76:22 76:24 76:25 77:2 77:12 77:13 77:20 77:21 77:22 77:22 77:24 77:25 78:4 78:7 78:9 78:10 78:11 78:14 78:15 78:16 78:18 78:20 78:21 78:21 79:1 79:3 79:9 79:10 80:25 81:6 81:14 81:16 81:17 81:23 81:25 82:6 82:14 82:21 82:23 83:1 84:8 84:14 84:22 86:8 86:11 86:23 87:14 87:18 90:1 90:3 92:3 93:15 93:20 94:2 94:4 94:11 94:19 94:20 94:21 94:21 94:22 94:23 94:24 95:6 95:7 95:8 95:21 95:25 96:1 96:5 97:18 97:19 97:23 97:24 98:1 98:6 98:24 98:25 100:25 101:3 101:10 101:24 102:14 122:23 123:3 123:4 123:6 128:6 128:7 128:10 128:10 128:14 128:16 128:18 131:14 131:19 131:22 132:3 132:5 132:6 132:8 132:15 132:19 133:7 133:8 136:5 136:9 136:10 136:14 136:19 136:24 137:10 137:12 143:8 149:1 149:3 149:22 161:17 161:19 161:24 162:3 162:13 163:21 163:22 163:24 164:17 169:23 172:16 174:20 174:23 174:23
Ditch-Hanehoi
[1] 95:21
Ditches
[5] 77:10 79:11 123:11 132:2 162:12
Diverse
[3] 145:5 145:6 145:12

Diversified
[2] 146:6 146:13
Diversion
[60] 81:19 81:22 81:25 84:9 84:14 84:23 86:15 86:25 87:1 87:2 87:7 87:14 88:21 88:24 89:3 89:4 89:7 89:10 90:9 94:8 95:10 95:18 95:21 95:22 96:23 97:5 97:18 99:14 100:3 103:8 103:24 105:5 121:20 130:17 132:18 165:21 167:22 168:24 168:25 169:2 169:4 169:9 169:12 169:13 169:14 169:16 169:19 169:24 170:1 170:2 170:4 170:7 170:10 170:11 171:15 172:2 172:9 172:17 173:10 173:15
Diversions
[19] 62:9 75:20 81:3 81:12 81:14 100:1 100:9 100:11 102:6 102:7 103:5 105:7 164:13 164:15 164:18 164:21 165:7 169:2 170:5
Divert
[9] 77:10 101:1 101:10 101:11 104:11 128:11 131:13 135:6 136:5
Diverted
[22] 78:17 79:24 86:11 92:5 94:21 95:2 95:13 96:4 96:24 97:21 97:22 98:24 103:23 103:24 104:14 143:7 151:18 154:22 154:23 155:24 157:6 157:9
Diverting
[14] 78:8 96:22 100:24 103:7 117:21 117:24 117:25 128:19 149:14 164:9 164:25 164:25 165:2 174:24
Diverts
[2] 94:4 100:14
Divided
[2] 123:7 123:11
Division
[2] 13:5 51:18
DLNR
[2] 1:3 4:3
Document
[8] 10:4 10:8 13:10 17:15 90:21 105:23 108:5 108:5
Documentation
[2] 9:17 10:20
Documented
[2] 13:2 13:19
Documents
[4] 7:18 7:25 10:1 17:16
Domestic
[4] 95:1 95:14 96:21 135:8
Done
[16] 5:21 8:4 46:19 53:9 64:8 67:9 84:5 89:4 92:14 104:2 104:20 104:21 105:12 113:6 113:9 153:6
Door
[3] 11:10 12:6 108:24
Dot
[3] 75:21 86:17 86:19
Dots
[1] 64:1
Double
[1] 65:23
Down
[31] 18:23 19:24 23:24 24:10 51:22 60:17 63:11 81:18 88:2 93:15 94:2 94:19 96:16 96:17 100:13 103:7 105:19 109:4 109:11 109:13 119:16 120:4 145:2 145:13 156:22 161:4 165:3 165:10 174:1 174:18 176:8
Downpours
[2] 82:17 133:3
Downsized
[1] 121:20
Downstream
[3] 82:25 89:3 93:20
Dr
[2] 53:2 76:15
Draft
[1] 113:6
Draw
[1] 47:25
Dried
[1] 92:23
Drive
[1] 81:5
Drop
[1] 63:14
Dropped
[8] 20:15 31:18 31:21 31:24 32:6 39:1 39:3 39:8
Drought
[1] 156:10
Dry
[1] 128:12
Due
[4] 14:24 15:14 15:19 110:21
During
[14] 5:16 5:18 12:15 17:1 18:20 50:9 64:16 76:13 76:14 85:2 92:11 95:9 102:25 111:24
Duties
[2] 7:16 7:17

E

Early
[2] 93:23 96:13
East
[20] 4:17 9:13 74:14 76:1 89:12 104:23 122:6 129:3 133:3 134:12 142:10 142:14 142:16 143:8 143:10 143:11 143:12 173:21 174:3 174:15
Eastern
[1] 77:3
Eastwards
[1] 100:15
Eaten
[1] 86:4
Ed
[2] 119:17 119:24
Effect
[6] 88:22 92:16 108:19 120:16 134:4 150:6
Effort
[2] 68:15 87:5
Efforts
[3] 83:24 119:25 166:22
Eight
[10] 17:6 17:13 18:17 18:22 19:11 168:25 171:15 171:19 172:19 173:4
Eight-inch
[6] 168:25 171:6 171:15 171:19 172:19 173:4
Eighties
[1] 93:23
Either
[7] 11:8 17:10 25:20 61:19 61:21 61:23 99:5
Elaborate
[1] 24:6
Elderly
[1] 21:20
Electric
[4] 165:17 166:3 166:5 166:12
Electrical
[1] 166:17
Electricity
[1] 166:18
Elevation
[1] 81:17
Elijah
[2] 2:6 4:17
EMI
[81] 2:5 4:18 33:6 40:11 62:1 62:8 62:11 74:5 75:14 76:6 76:10 79:9 80:6 80:7 83:24 84:2 84:5 88:19 89:2 93:2 93:12 96:7 96:25 96:25 97:3 97:17 101:1 101:10 101:10 101:24 102:4 103:4 103:8 104:24 105:5 105:11 105:14 105:14 108:19 109:5 109:9 111:8 117:11 117:21 119:21 120:4 121:22 124:10 128:7 128:15 128:17 129:10 130:1 131:13 133:6 134:10 134:21 135:12 136:3 147:6 147:17 147:18 147:19 147:22 148:8 148:11 149:7 150:7 150:25 151:21 153:3 155:3 155:11 156:23 157:8 157:17 158:11 159:10 160:18 160:23 163:20
EMI's
[5] 5:3 121:19 126:17 147:25 148:23
Employed
[1] 74:14
Employees
[4] 80:6 80:7 80:13 89:2
Encompassed
[1] 21:14
End
[5] 77:3 84:19 96:19 104:2 111:20
Ended
[4] 50:1 51:8 57:2 95:5
Ends
[3] 123:3 123:4 123:6
Energy
[1] 141:21
Engage
[2] 146:6 146:12
Engaged
[1] 146:4
Engine
[1] 166:10
Engineering
[1] 130:12
Enlarged
[1] 68:13
Ensure
[1] 158:18
Entered
[3] 95:7 105:24 152:17
Entire
[3] 32:1 44:19 132:8
Entirety
[1] 59:15
Entitled
[2] 8:14 16:11
Equals
[3] 91:10 115:21 115:24
Ernie
[1] 86:5
Erroneous
[1] 130:17
Error
[4] 101:23 121:24 122:3 129:23
Especially
[2] 21:19 145:14
ESQ
[9] 2:3 2:5 2:6 2:9 2:11 2:14 2:16 2:16 2:18
Essence
[3] 12:14 15:25 149:14
Essential
[1] 108:4
Essentially
[5] 79:4 79:5 97:3 97:24 109:10
Establish
[3] 12:15 62:2 62:8
Established
[1] 14:15
Establishing
[1] 10:8
Estate
[1] 8:9
Estimate
[10] 6:7 6:13 49:19 58:16 66:8 66:18 66:19 66:21 68:18 157:3
Estimating
[1] 59:20
Et
[4] 2:17 7:3 52:2 70:20
Event
[2] 45:20 173:7
Eventually
[1] 96:6
Evidence
[24] 3:11 5:10 5:24 6:1 9:7 12:14 18:3 18:7 18:9 40:22 42:12 42:16 62:11 69:12 75:8 90:25 91:8 96:18 106:5 120:6 120:25 138:11 138:13 140:11
Exact
[1] 133:12
Exactly
[4] 28:20 55:25 56:24 102:19
Examination
[6] 3:3 3:5 5:18 7:10 66:6 74:12
Examine
[2] 91:4 115:14
Examined
[5] 7:3 13:9 13:18 74:5 138:3
Example
[13] 14:3 15:2 19:2 20:14 20:25 23:3 35:23 37:8 44:16 49:12 53:19 56:20 124:14
Except
[2] 40:8 42:15
Exclude
[4] 56:9 56:11 60:6 149:24
Excuse
[2] 6:3 113:5
Exercise
[2] 161:24 162:8
Exerted
[1] 173:2
Exhibit
[139] 3:12 5:14 8:8 13:1 14:2 18:8 25:24 26:10 26:12 26:24 28:10 28:13 28:16 29:18 29:19 31:6 31:7 33:3 34:3 34:8 34:21 34:24 35:3 35:3 35:8 35:9 35:9 35:14 35:14 35:16 35:24 35:25 36:1 36:4 36:4 36:14 36:21 37:8 38:14 39:17 40:8 40:11 40:11 40:13 41:1 41:16 41:21 44:3 44:8 45:13 46:3 46:14 48:10 48:23 49:3 49:6 49:9 49:13 50:2 51:9 52:6 58:7 58:9 60:10 61:3 68:12 70:3 75:10 75:14 76:18 89:11 89:11 90:16 90:17 91:8 91:9 98:10 99:7 99:8 100:9 102:1 102:2 102:23 104:19 104:22 105:23 106:9 107:2 107:4 107:6 110:7 110:10 110:14 110:17 110:20 110:23 110:25 112:1 112:1 112:8 112:9 112:10 112:18 112:21 113:11 113:15 113:16 113:20 114:21 115:20 116:3 118:2 121:14 124:1 128:5 128:24 129:16 133:25 134:1 148:22 150:16 153:9 154:3 155:7 169:1 170:8 170:9 170:23 171:1 171:12 171:14 171:16 171:18 171:20 171:21 173:8 173:11 173:12 173:15
Exhibits
[18] 3:11 5:15 5:15 5:20 8:16 13:12 17:20 17:22 18:2 52:22 83:23 113:24 114:1 118:11 118:14 120:13 133:20 168:1
Exist
[1] 92:24
Existence
[1] 14:13
Existing
[3] 84:12 110:21 110:23
Expansion
[1] 141:21
Experience
[2] 42:24 43:19
Experienced
[1] 72:24
Expert
[2] 141:1 141:2
Expertise
[3] 85:5 127:20 142:19
Expired
[2] 150:3 150:11
Explain
[18] 10:12 18:12 30:20 35:5 41:9 44:11 52:20 54:4 79:8 82:8 91:18 97:9 103:19 110:9 112:9 113:15 114:18 124:5
Explains
[1] 123:15
Explanation
[1] 130:15
Extend
[2] 131:18 131:22
Extends
[1] 75:15
Extent
[6] 12:21 73:18 108:11 108:22 112:7 164:11
Extra
[1] 84:9

F

Facia
[1] 62:11
Fact
[22] 20:15 20:19 24:12 36:23 37:2 39:6 42:17 43:17 49:17 61:17 61:20 65:6 85:17 90:23 103:20 109:3 129:9 130:2 159:8 160:16 169:24 172:12
Factor
[6] 57:21 58:15 58:21 59:6 60:5 68:20
Facts
[2] 140:11 148:4
Fair
[3] 142:12 142:16 143:12
Fairly
[2] 92:18 131:24
Fairy
[1] 22:1
Faith
[3] 104:25 105:15 135:18
Fall
[3] 87:18 133:5 142:6
Fallow
[5] 49:23 56:24 60:6 73:1 73:2
Falls
[3] 126:16 127:9 127:9
Familiar
[1] 23:4
Family
[1] 167:9
Far
[9] 32:14 32:15 42:11 56:13 127:9 142:20 152:25 161:4 164:1
Farm
[9] 2:18 4:20 137:25 138:2 144:12 144:12 144:15 144:21 145:15
Farmer
[5] 113:2 113:3 113:7 113:10 116:8
Farmers
[4] 108:20 146:25 147:2 158:12
Farmers'
[1] 139:6
Farming
[3] 117:1 139:6 145:7
Farms
[1] 79:16
Fast
[2] 31:17 166:9
Features
[1] 72:15
February
[3] 118:22 121:25 130:7
Federal
[3] 140:9 140:20 141:2
Federation
[2] 4:20 144:12
Fee
[3] 149:12 153:23 158:1
Feeds
[1] 99:6
Feet
[4] 112:2 115:21 115:24 116:2
Fell
[2] 124:16 126:14
Felt
[2] 57:12 59:6
Female
[1] 22:1
Few
[2] 76:13 83:21
Field
[8] 52:12 80:19 80:20 93:14 101:4 101:7 101:22 131:12
Fifth
[4] 48:4 156:25 157:8 157:17
Figure
[9] 43:24 52:23 53:14 53:17 66:20 68:8 68:9 155:23 156:11
Figured
[1] 124:9
File
[5] 1:3 4:3 23:23 51:16 51:17
Filed
[3] 8:12 10:14 26:8
Filipino
[1] 169:23
Fill
[2] 91:21 91:23
Final

[3] 5:7 6:11 15:25
Finance
[1] 15:9
Fine
[2] 66:1 73:22
Finger
[1] 108:17
Finished
[1] 109:23
First
[30] 13:3 14:4 18:4 19:10 19:13 32:22 48:5 48:16 49:25 50:2 54:3 54:19 55:14 56:4 68:1 76:13 81:13 81:15 84:7 102:12 106:1 108:6 112:24 122:17 128:10 153:21 159:12 161:1 168:16 169:5
Fit
[1] 24:13
Five
[3] 61:9 96:17 150:11
Fix
[1] 106:23
Fleming
[1] 2:6
Flooding
[1] 83:16
Floodplain
[1] 71:15
Floods
[1] 82:22
Flow
[34] 69:25 70:5 72:4 84:15 84:21 87:13 89:25 90:8 91:23 92:19 92:23 93:6 93:6 123:10 131:8 133:6 136:18 136:24 137:2 137:4 137:5 137:6 137:8 161:4 162:7 162:25 165:23 166:4 172:18 172:21 172:25 173:2 173:3 173:4
Flower
[2] 144:20 145:7
Flowing
[2] 137:9 160:7
Flows
[6] 111:16 160:11 162:24 163:2 174:6 174:8
Focus
[2] 58:8 58:8
Focusing
[1] 47:21
Folks
[1] 121:7
Follow
[1] 118:22
Following
[2] 28:13 30:21
Follows
[3] 7:4 74:6 138:4
Foot
[2] 91:19 94:23
Footed
[1] 14:25
Forecast
[4] 82:16 83:8 83:14 133:3
Foregoing
[2] 176:10 176:12
Foreign
[11] 9:20 10:23 11:12 11:21 11:23 12:13 13:19 16:25 17:11 18:21 24:20
Forget
[1] 126:6
Forgetting
[1] 70:10
Formal
[1] 150:8
Formerly
[1] 39:8
Forms
[1] 145:11
Forward
[2] 60:12 62:1
Foundation
[5] 90:12 90:14 90:22 159:4 159:5
Four
[20] 39:4 61:14 75:22 84:13 96:17 112:2 150:11 152:21 152:21 155:21 155:22 155:23 155:24 156:13 156:16 156:22 157:9 157:16 164:18 173:2
Four-inch
[6] 84:8 84:13 121:20 172:21 172:25 173:2
Four-wheel
[1] 81:5
Fourth
[3] 41:1 49:3 51:22
Free
[2] 88:12 88:13
Freedman
[16] 2:18 4:19 4:19 6:18 47:10 109:20 110:4 138:8 138:15 140:10 140:25 142:18 144:1 144:4 145:17 146:14
Frequently
[1] 92:22
Freshwater
[1] 112:6
Front
[5] 67:16 75:9 110:18 112:18 113:12
Fruition
[1] 120:4
Fugimoto
[1] 130:13
Fukumoto
[3] 130:11 130:14 130:19
Fukumoto's
[1] 130:23
Full
[6] 8:18 8:19 113:13 128:16 160:16 173:3
Fully
[3] 51:25 80:24 127:14
Function
[1] 82:8

G

G-o-m-e-s
[1] 7:9
G.L.S-3922
[1] 41:2
Gallon
[1] 157:12
Gallons
[31] 84:10 91:11 91:25 123:22 125:8 128:23 136:20 137:13 137:14 142:14 143:7 147:5 147:15 147:18 147:24 150:15 156:9 156:12 156:21 156:23 156:25 157:9 157:13 157:18 157:25 158:3 158:7 162:14 163:1 163:8 163:14
Gap
[1] 71:25
Garden
[1] 95:15
Garret
[7] 3:5 3:9 4:18 6:9 74:3 109:3 148:18
Gas
[2] 165:19 166:8
Gate
[8] 82:1 82:5 82:9 82:10 82:10 82:15 82:21 83:2
Gates
[5] 83:10 83:19 132:23 133:15 133:16
Gauging
[1] 163:11
General
[10] 2:3 5:1 13:7 41:3 41:9 41:11 41:13 42:10 43:5 43:14
Generally
[6] 7:19 20:3 36:18 41:10 42:23 158:6
Gentleman
[1] 93:16
Geographic
[2] 162:2 162:4
Geographically
[2] 23:1 23:2
Given
[15] 15:2 27:8 27:19 50:16 54:1 56:14 56:19 67:5 67:25 118:10 127:2 131:6 135:11 137:10 164:20
Gomes
[10] 3:2 6:8 7:1 7:9 7:12 8:15 9:9 15:21 31:5 34:21
Gomes'
[1] 40:2
Gospel
[1] 115:12
Government
[14] 14:25 15:12 15:15 54:9 54:10 124:2 124:5 124:7 124:19 124:20 124:22 126:8 126:13 126:14
Government's
[2] 15:6 15:13
Governor
[2] 12:2 12:8
Gradation
[1] 20:1
Grants
[1] 54:10
Grassed
[1] 96:16
Gray
[4] 127:8 127:11 127:12 127:25
Great
[2] 109:1 120:25
Green
[3] 76:1 129:1 129:3
Grew
[1] 85:22
Ground
[2] 69:10 75:19
Groundwater
[1] 163:4
Grow
[4] 62:20 84:3 158:19 159:9
Grower
[1] 111:19
Growers
[9] 99:21 105:16 109:4 111:9 111:23 142:17 143:12 144:20 144:21
Growing
[7] 61:25 99:6 139:14 141:16 145:9 159:19 161:14
Grown
[2] 24:11 160:22
Guess
[8] 21:3 34:7 69:13 88:19 119:17 119:19 139:3 160:8
Gulch
[3] 75:16 79:12 79:13
Guy
[1] 144:6

H

Haia
[126] 2:16 3:3 3:6 3:8 3:10 4:12 4:13 5:4 6:14 7:11 8:24 9:8 15:21 19:2 20:11 23:14 25:10 25:17 26:23 27:7 27:21 29:6 29:17 30:7 30:18 31:4 31:20 33:1 33:16 34:11 34:21 36:2 36:20 40:1 40:8 40:20 43:23 44:6 45:8 45:16 45:19 46:19 55:10 57:24 61:17 63:5 63:8 63:20 64:9 64:14 65:2 65:21 66:4 66:13 67:19 70:1 70:15 72:10 73:18 74:7 81:7 85:4 103:10 105:22 106:10 106:14 106:18 106:24 107:2 107:5 110:1 113:5 113:23 114:9 114:12 115:1 115:7 115:13 118:11 118:16 119:1 119:10 120:21 121:12 126:2 126:3 126:5 126:21 127:1 127:11 127:20 127:21 128:2 128:5 134:9 138:20 138:21 140:13 140:16 141:3 141:8 143:2 143:6 143:18 143:23 148:20 150:1 151:25 153:5 153:8 153:16 154:3 157:13 159:8 160:3 160:6 162:3 162:5 162:23 166:21 167:14 168:8 168:13 168:18 171:3 171:10
Haiku
[41] 1:9 1:9 77:20 78:4 81:14 81:16 82:3 82:4 82:5 82:14 83:1 84:8 84:14 86:8 86:18 88:6 90:1 90:2 90:7 90:9 91:10 92:3 93:15 93:20 94:2 94:20 94:24 95:6 95:7 95:8 95:18 95:21 95:24 95:25 96:1 96:5 96:25 97:4 132:6 163:23 164:17
Hale
[1] 69:9
Half
[2] 24:16 133:4
Hall
[35] 2:14 3:8 4:7 4:7 5:9 5:13 5:25 81:24 90:10 90:15 90:21 91:1 91:4 91:5 92:8 107:20 107:24 108:3 108:8 109:1 109:9 109:13 120:2 125:22 132:22 143:25 144:3 144:10 145:20 145:22 146:1 146:17 146:22 148:7 148:13
Hamakua
[5] 78:18 78:20 78:22 137:12 162:13
Hamau
[2] 77:9 101:2
Hana
[5] 2:10 36:22 70:14 110:12 110:14
Hand
[5] 6:25 8:11 64:2 74:19 167:25
Handed
[3] 67:17 112:8 118:12
Handle
[1] 92:8
Handled
[1] 31:12
Handy
[2] 47:19 49:12
Hanehoi
[18] 83:1 83:4 86:14 92:16 92:18 93:7 93:15 94:3 94:4 94:20 94:22 95:5 95:10 95:14 95:18 95:21 96:4 96:6
Hard
[2] 102:22 171:23
Harmed
[1] 139:7
Harvested
[3] 85:18 85:22 85:24
Hawaii
[32] 1:2 1:9 1:23 2:2 2:4 2:8 2:10 2:13 2:15 2:17 2:18 2:20 4:20 8:2 13:15 14:13 15:20 23:23 41:3 51:17 75:24 106:4 124:21 126:9 127:25 142:1 144:11 146:16 158:5 158:8 176:2 176:18
Hawaiian
[17] 7:13 7:15 9:10 10:6 10:16 21:24 22:8 23:11 26:4 73:11 79:14 104:24 139:25 140:18 141:23 143:9 167:6
Hawaiian's
[1] 73:17
HC&S
[4] 79:10 79:16 133:9 162:25
Head
[4] 145:2 145:13 154:19 173:1
Healthy
[2] 85:25 86:1
Hear
[3] 11:6 108:2 113:5
Heard
[5] 18:13 28:20 92:24 106:17 153:21
Hearing
[14] 1:6 4:2 4:6 5:19 5:20 6:3 76:14 108:13 115:17 118:15 118:19 119:2 119:4 167:15
Hearings
[150] 2:1 4:1 4:24 5:5 5:12 5:23 6:4 6:23 7:5 9:3 9:6 14:19 15:17 18:6 18:24 20:5 22:15 22:18 22:25 25:8 25:13 26:15 27:5 27:10 27:14 28:22 29:1 29:4 29:12 29:15 29:24 30:5 30:8 30:12 30:15 30:19 30:23 31:2 31:16 32:9 32:13 32:21 33:14 34:13 34:19 36:17 39:24 40:5 40:18 44:1 45:14 46:20 47:11 58:3 60:20 63:1 63:6 63:18 63:23 64:20 64:23 66:14 67:14 70:21 72:12 73:15 73:21 74:1 74:10 75:7 78:2 80:1 80:11 81:9 82:12 85:7 86:16 86:20 90:13 90:24 91:3 91:7 98:3 98:17 101:13 101:18 103:12 105:8 106:11 106:16 106:21 106:25 107:3 107:7 107:11 107:15 107:21 108:6 108:9 109:7 109:16 109:18 110:2 110:5 114:13 115:5 115:11 115:15 118:7 118:24 119:5 119:12 120:24 122:16 124:24 125:2 125:9 125:14 125:23 126:23 127:4 127:19 127:24 128:3 134:7 137:20 137:23 138:5 138:10 138:16 140:14 141:5 142:24 143:4 143:16 144:7 145:19 145:24 146:19 148:5 148:14 153:25 157:11 159:6 160:4 166:15 167:11 168:5 168:10 175:8
Heart
[1] 109:5
Heavily
[2] 107:17 107:19
Heavy
[2] 82:16 133:3
Held
[8] 1:8 29:3 29:14 33:4 34:18 65:12 73:24 175:7
Help
[8] 89:9 105:16 158:11 159:2 159:12 160:21 166:23 172:4
Helping
[2] 99:17 111:19
Hereby
[1] 176:6
Herein
[1] 176:8
Hereto
[1] 176:15
Hereunder
[1] 135:25
Herself
[1] 167:1
Hew
[20] 3:5 3:9 4:18 6:9 74:3 74:14 90:11 109:3 119:18 122:21 134:9 148:16 148:17 148:18 151:4 155:20 160:3 160:6 169:20 171:22
Hew's
[1] 115:2
High
[2] 2:12 111:17
Higher
[1] 166:4
Highest
[1] 169:21
Highlight
[1] 40:12
Highlighted
[22] 35:15 35:16 35:19 35:20 35:25 36:4 37:12 37:19 38:6 38:10 38:16 38:21 39:12 39:18 39:19 40:16 42:6 44:17 58:7 113:19 114:22 116:1
Highlighting
[1] 40:6
Highway
[4] 2:10 70:14 110:13 110:14
Historical
[4] 7:18 7:25 8:1 51:24
History
[3] 76:11 83:23 94:16
Hit
[1] 133:11
Hitting
[1] 133:18
Hoa'aina
[1] 21:4
Holaday
[1] 6:11
Hold
[1] 32:10
Homestead
[1] 54:9
Honest
[1] 52:10
Honolulu
[6] 2:4 2:8 2:17 2:20 176:4 176:18
Honolulu's
[1] 13:22
Honomanu
[3] 1:4 75:22 150:21
Honopou
[16] 81:14 81:16 84:8 89:16 137:13 158:23

162:11 162:16 162:19 163:1 163:7 163:13 163:19 163:20 163:22 164:5
Honor
[6] 114:3 140:10 140:25 142:18 145:17 146:14
HONORABLE
[1] 2:1
Hope
[1] 56:12
Hopefully
[2] 31:4 171:19
Horse
[1] 167:13
House
[27] 49:13 54:1 54:12 54:21 54:22 55:4 56:5 56:8 56:9 56:11 56:19 57:5 57:8 57:10 57:20 57:23 57:25 58:1 58:6 58:11 58:13 58:18 59:3 59:5 59:11 60:21 73:9
Housekeeping
[1] 6:7
Huelo
[10] 1:4 75:22 81:18 134:3 134:16 135:20 144:17 144:21 146:1 146:5
Hui
[2] 2:16 4:14
Hydroelectric
[1] 123:12
Hypothetical
[5] 142:23 143:3 143:15 148:3 166:14

I

Idea
[9] 53:24 53:25 67:20 79:22 151:10 154:19 155:17 158:4 164:14
Ideal
[1] 71:15
Identified
[25] 8:8 10:9 13:1 13:4 14:5 17:23 26:10 28:10 28:12 28:17 29:18 31:5 35:9 36:3 37:3 37:13 39:18 44:7 45:21 46:4 46:13 48:6 116:14 169:3 169:22
Identify
[7] 7:21 13:9 53:21 56:22 62:6 62:18 64:6
Identifying
[1] 112:25
Imminent
[1] 83:15
Impacted
[1] 139:7
Imply
[1] 91:6
Important
[1] 145:22
Inc
[5] 4:18 76:3 129:7 130:12 134:2
Inch
[11] 84:13 115:20 115:24 165:14 165:15 168:25 171:15 171:19 172:19 173:2 173:4
Inches
[4] 97:23 97:23 124:14 133:4
Include
[7] 44:21 54:23 55:4 58:18 65:24 157:14 159:15
Included
[22] 31:13 32:7 32:11 32:17 32:19 33:3 33:9 34:3 37:7 40:9 44:24 45:23 48:14 49:7 54:2 54:2 57:20 58:2 60:13 60:21 61:23 77:20
Includes
[3] 38:24 55:25 57:23
Incomplete
[4] 142:23 143:14 148:3 166:13
Incorrect
[2] 101:5 164:24
Incorrectly
[2] 61:1 173:18
Increase
[3] 46:12 117:20 117:23
Independently
[1] 154:18
INDEX
[1] 3:1
Indicate
[4] 24:6 76:23 93:9 124:10
Indicated
[7] 38:5 39:4 39:6 75:21 75:25 95:17 144:5
Indicates
[5] 75:16 75:17 108:23 115:20 124:13
Indicating
[10] 24:8 36:15 37:10 38:19 39:15 40:3 43:4 101:14 113:2 169:15
Indication
[3] 50:25 51:2 113:25
Individual
[5] 114:24 115:25 138:22 149:21 174:9
Individuals
[1] 149:20
Industry
[1] 142:20
Informal
[2] 87:25 150:4
Information
[18] 9:17 10:19 11:19 12:25 13:2 14:3 17:15 19:8 23:20 24:18 24:22 25:25 31:10 41:4 53:18 68:16 130:20 131:7
Initial
[1] 7:8
Inseparable
[1] 20:21
Inspection
[3] 81:13 81:16 101:4
Installed
[2] 84:7 163:21
Instance
[2] 17:5 127:18
Instances
[2] 50:24 146:5
Instead
[1] 97:18
Instructed
[1] 26:1
Intake
[11] 82:6 90:3 93:15 97:14 110:19 110:23 110:25 121:19 122:1 122:5 122:6
Intended
[2] 59:18 118:18
Intense
[1] 82:18
Intent
[5] 40:6 54:14 56:9 56:22 144:5
Interest
[7] 26:3 33:6 33:22 40:3 62:12 62:19 65:12
Interested
[4] 15:6 106:12 167:20 176:15
Interfering
[2] 62:2 62:12
Interim
[4] 104:22 106:2 119:2 120:22
Interior
[1] 15:11
Interrogatories
[2] 73:11 114:4
Interrupt
[3] 74:7 105:22 109:24
Intersected
[1] 169:22
Intersection
[1] 102:14
Intersects
[1] 174:18
Intervenor
[2] 4:7 4:20
Introduced
[1] 93:16
Inundate
[1] 82:23
Investigate
[2] 161:2 161:6
Investigation
[4] 51:14 52:9 92:14 161:11
Involved
[3] 50:13 96:7 104:1
Irrelevant
[4] 21:6 70:16 71:24 72:10
Irreparably
[1] 139:7
Irretrievably
[1] 139:10
Irrigate
[1] 116:13
Irrigation
[8] 4:18 74:15 76:2 89:12 105:5 129:4 160:13 160:18
Isaac
[3] 2:14 4:7 81:24
Ishikawa's
[1] 118:23
Island
[7] 19:22 19:25 22:10 52:2 128:12 133:2 133:18
Islands
[1] 10:6
Isohyetal
[3] 124:12 124:12 125:1
Issue
[3] 120:19 122:13 126:24
Issued
[5] 14:9 15:22 16:8 41:11 41:14
Issues
[3] 127:13 127:16 127:17
Itself
[9] 35:14 44:3 55:20 79:1 90:21 103:14 120:17 147:19 174:9

J

Jakeway
[1] 6:11
James
[1] 35:24
Jane
[3] 2:11 4:9 126:7
JEAN
[3] 1:23 176:6 176:21
Job
[1] 9:11
John
[2] 2:1 4:6
Joseph
[4] 32:18 32:25 33:10 33:12
Jr
[1] 35:24
Judge
[170] 4:1 4:12 4:24 5:5 5:9 5:12 5:23 6:4 6:23 7:5 8:24 9:3 9:6 14:19 15:17 17:20 18:6 18:24 20:5 22:15 22:18 22:25 25:8 25:13 26:2 26:15 27:5 27:10 27:14 29:1 29:4 29:11 29:12 29:15 29:24 30:5 30:8 30:12 30:15 30:19 30:23 31:2 31:16 32:9 32:13 32:21 33:14 34:19 36:17 39:24 40:5 40:18 43:23 44:1 45:14 46:19 46:20 47:11 58:3 60:20 62:1 63:1 63:6 63:18 63:23 64:20 64:23 66:14 67:14 70:15 70:21 72:12 73:15 73:21 74:1 74:10 75:7 75:13 78:2 80:1 80:11 81:9 82:12 85:7 86:16 86:20 90:13 90:24 91:3 91:7 97:9 98:3 98:17 100:7 101:13 101:18 103:12 104:5 105:8 106:11 106:16 106:21 106:24 106:25 107:3 107:7 107:11 107:15 107:21 108:6 108:9 109:7 109:16 109:18 110:2 110:5 113:23 114:13 115:1 115:5 115:11 115:15 118:7 118:24 119:5 119:12 120:2 120:22 120:24 122:16 124:24 125:2 125:9 125:14 125:18 125:23 126:3 126:23 127:2 127:4 127:19 127:22 127:24 128:3 134:7 137:20 137:23 138:5 138:10 138:16 140:14 141:5 142:24 143:4 143:16 144:7 145:19 145:24 146:19 148:5 148:14 153:25 157:11 159:6 160:4 166:15 167:11 168:5 168:10 175:8
July
[2] 74:20 152:16
Jumped
[2] 23:6 23:11
June
[2] 130:6 130:24

K

K.N.
[1] 2:16
Kahului
[1] 2:10
Kalo
[10] 21:1 24:12 42:19 42:21 52:1 53:1 56:10 69:15 69:16 72:23
Kama'aina
[3] 11:7 11:9 12:12
Kamole
[6] 78:1 122:25 123:4 123:7 123:15 125:8
Kanu
[2] 52:1 53:1
Kauhikoa
[3] 77:21 78:5 132:6
Ke'anae
[1] 52:2
Keanae
[9] 1:4 75:22 78:9 78:17 113:10 144:18 154:4 154:20 155:4
Keanae-Wailua
[1] 113:2
Keanae-Wailuanui
[1] 113:10
Keep
[2] 115:17 141:15
Kekahuna
[23] 4:15 83:22 84:3 85:1 85:11 85:19 85:23 158:15 159:9 159:13 160:8 160:11 160:16 160:21 160:24 163:18 164:2 164:6 164:22 167:1 167:3 167:7 167:8
Kekahunas
[9] 158:12 158:18 160:19 164:9 164:15 164:16 164:16 165:10 166:23
Keononalu
[3] 16:16 17:7 17:14
Kept
[1] 72:25
Kewalo
[1] 23:4
Key
[13] 14:5 23:25 26:9 26:14 31:19 32:6 32:6 32:16 35:13 48:9 64:19 71:23 113:3
Keys
[5] 13:3 26:12 30:10 35:20 60:15
KHALSA
[1] 2:18
Kick
[2] 137:3 137:11
Kiefer
[1] 2:9
Kikokiko
[12] 97:10 97:11 97:13 97:14 98:4 98:5 98:20 98:21 98:25 100:24 102:16 168:21
Kind
[4] 64:19 98:9 123:2 129:6
Kinds
[1] 165:23
King
[3] 2:4 12:1 15:11
Knowing
[1] 67:21
Knowledge
[12] 50:8 59:4 75:2 76:20 90:12 93:5 95:19 95:20 116:17 116:21 122:8 143:22
Knows
[2] 141:3 142:20
Ko'olau
[2] 2:16 4:14
Konohiki
[2] 11:13 12:8
Konohikis
[1] 12:1
Koolau
[18] 76:18 76:21 76:22 76:25 77:2 77:13 78:7 78:9 78:11 78:14 78:16 97:17 97:19 98:1 98:6 98:24 100:25 101:10
Ku
[9] 20:16 20:20 20:25 20:25 21:5 21:6 22:22 22:24 23:12
Kualani
[43] 77:8 99:15 100:15 101:1 101:6 101:8 101:8 101:11 101:16 102:5 102:8 102:18 102:23 103:6 103:23 121:19 121:21 122:1 130:16 131:1 131:3 131:5 131:8 131:13 131:14 131:18 131:21 167:22 169:8 169:12 169:21 170:14 170:21 173:19 174:2 174:11 174:12 174:14 174:17 174:22 174:24 174:25 175:4
Kula
[2] 6:19 19:12
Kuleana
[1] 13:18
Kupono
[4] 20:16 22:22 22:24 23:12
Kupunanui
[1] 21:20

L

Labeled
[4] 27:11 170:13 173:18 173:19
Lack
[3] 149:8 159:4 159:5
Laid
[1] 90:22
Lakini
[5] 100:21 103:6 103:7 103:25 121:22
Land
[96] 1:1 2:9 4:23 7:18 7:18 8:9 8:13 9:11 9:12 9:18 9:19 9:21 9:24 10:2 10:3 10:6 10:9 10:14 10:21 11:1 11:11 11:13 11:17 11:18 11:20 12:5 12:7 13:6 13:10 13:15 13:16 13:17 13:18 14:11 14:16 14:22 14:22 14:23 15:3 15:5 15:6 15:16 15:23 16:5 16:6 16:23 19:14 19:21 20:17 21:10 22:3 22:5 22:7 22:7 22:12 22:13 24:2 41:13 50:20 51:12 54:9 61:19 62:16 67:2 68:25 69:1 69:2 69:14 71:13 71:21 72:15 72:24 73:6 96:18 124:8 124:10 124:10 126:15 127:9 136:4 136:4 136:13 136:22 148:24 148:24 149:2 149:7 149:13 149:16 158:16 161:16 161:23 162:8 162:16 162:21 163:4
Landowner
[29] 26:11 27:4 27:7 27:8 27:15 27:17 27:23 27:24 28:3 28:6 28:12 28:14 28:17 29:8 29:9 29:20 31:14 32:8 32:17 32:20 35:4 35:10 35:21 36:7 37:7 45:10 45:12 45:21 45:22
Landowners
[4] 27:1 34:25 164:4 164:9
Landowners'
[4] 29:7 30:3 30:25 31:3
Lands
[7] 8:13 10:18 66:12 75:23 76:1 76:2 135:7
Landscape
[6] 51:25 52:1 52:14 53:7 68:10 68:17
Landslide
[3] 110:22 111:10 111:21
Large
[2] 80:5 172:16
Largest
[1] 19:21
Last
[28] 19:10 19:13 23:15 31:4 47:21 49:6 71:10 77:22 78:5 85:2 85:12 90:20 91:9 100:17 106:2 114:15 118:10 118:15 121:14 139:9 139:13 148:22 150:3 150:10 156:5 156:9 158:15 167:15
Late
[3] 6:5 93:23 114:12
Law
[1] 128:1
Lay

[1] 90:13
Layout
[1] 52:19
LCA
[2] 9:11 13:20
Lead
[2] 6:18 43:18
Leads
[1] 49:25
Leaky
[2] 97:25 98:2
Learned
[2] 76:10 140:6
Lease
[8] 41:3 41:9 41:12 42:10 43:14 75:24 152:9 153:18
Leased
[2] 136:1 153:11
Leases
[1] 41:14
Least
[1] 162:14
Leave
[1] 132:22
Leaves
[2] 87:5 112:4
Led
[1] 111:5
Lee
[3] 93:21 93:21 96:17
Leeway
[2] 127:2 127:5
Left
[7] 34:12 34:14 38:14 41:21 72:4 98:22 132:24
Left-hand
[5] 39:11 39:17 101:15 116:5 122:24
Legal
[13] 7:13 7:15 9:10 10:3 26:5 73:12 104:24 126:20 126:24 127:7 127:10 134:5 167:6
Legality
[1] 127:9
Lehua
[1] 85:21
Lele
[3] 22:14 22:21 23:10
Leles
[1] 23:5
Less
[8] 15:7 128:15 150:21 154:7 155:9 163:1 163:7 163:13
Letter
[8] 26:7 118:5 118:6 118:15 118:18 118:21 119:20 121:15
Letterhead
[1] 89:12
Letters
[1] 92:16
Level
[8] 81:20 82:3 82:4 82:5 82:20 86:18 112:3 163:24
Levels
[1] 79:25
Liability
[1] 119:7
Libby
[1] 34:1
License
[17] 75:22 75:23 124:1 124:17 134:3 135:20 152:1 152:8 152:12 152:21 154:4 155:8 155:23 155:25 156:13 156:22 157:10
Licenses
[2] 1:3 4:3
Light
[2] 129:5 129:6
Likely
[1] 43:20
Lily
[2] 21:23 22:1
Limited
[3] 21:9 27:19 165:15
Linda
[2] 2:3 4:25
Line
[9] 39:4 41:22 41:25 42:3 51:22 86:23 90:20 91:9 141:19
Line-up
[1] 53:20
Lines
[4] 71:10 75:17 75:18 126:7
List
[74] 5:14 25:15 26:2 26:5 26:11 27:4 27:7 27:8 27:16 27:17 27:20 27:23 27:24 28:3 28:6 28:12 28:14 28:17 29:7 29:8 29:9 29:20 30:3 30:4 30:9 31:1 31:3 31:14 32:8 32:17 32:20 34:25 35:4 35:10 35:21 37:7 45:10 45:13 45:21 45:22 48:13 49:25 50:1 50:2 50:6 50:16 50:18 51:8 53:25 54:19 54:20 55:7 55:9 55:11 55:13 55:14 55:15 55:16 56:4 56:14 56:15 56:19 57:2 57:20 57:22 58:20 59:6 60:17 61:7 67:4 67:7 68:22 106:9 164:12
Listed
[8] 26:12 35:13 48:9 51:9 59:14 114:18 116:7 116:10
Listings
[1] 116:18
Lists
[1] 55:13
Live
[2] 11:8 54:7
Lived
[3] 11:10 11:10 11:14
Living
[1] 93:24
Lizard
[3] 21:23 21:25 22:2
Lo'i
[34] 16:18 16:20 16:22 17:6 17:13 17:14 18:12 18:15 18:17 19:9 19:11 19:15 24:3 24:4 24:13 41:5 41:5 42:19 53:10 53:20 69:6 69:15 69:17 69:20 72:1 73:2 84:3 121:17 158:19 158:21 158:23 160:12 160:18 166:24
Lo'is
[3] 89:5 113:2 114:25
Locate
[5] 38:12 38:18 39:14 41:16 43:2
Located
[2] 46:14 71:15
Location
[4] 16:13 24:3 71:16 98:23
Look
[26] 8:17 9:17 16:25 17:3 18:11 18:19 19:7 29:10 35:7 35:23 38:3 38:4 59:10 74:21 89:11 98:10 99:7 106:1 113:11 118:2 125:18 128:5 166:2 168:3 168:19 171:21
Looked
[10] 81:14 86:7 86:10 89:2 94:4 98:8 100:4 100:18 100:22 174:16
Looking
[9] 34:21 51:5 51:12 56:10 79:17 112:15 113:3 116:23 117:8
Lookout
[2] 98:8 174:16
Looks
[3] 123:2 123:2 168:25
Lost
[4] 61:6 84:18 139:10 139:17
Loud
[1] 121:14
Lovell
[16] 2:11 3:3 3:6 4:9 4:9 46:22 46:25 98:14 107:17 107:23 122:18 122:20 125:18 142:22 148:2 166:13
Low
[4] 84:15 84:21 156:10 163:2
Low-flow
[1] 84:15
Lower
[3] 37:11 72:1 166:4
Lowest
[1] 81:17
Lowrie
[14] 81:20 86:11 86:14 86:25 87:9 87:10 87:14 87:18 94:4 94:19 95:10 95:23 96:7 96:23
Lucy
[2] 36:8 37:2
Lunchtime
[2] 6:24 64:16

M

Ma'am
[1] 73:16
Machine
[1] 176:9
Magic
[1] 35:16
Mahele
[16] 9:14 10:21 12:16 42:13 48:2 49:20 50:22 57:17 58:17 59:21 61:22 66:10 66:22 68:24 69:4 71:14
Main
[1] 103:24
Mainland
[1] 4:21
Maintain
[2] 81:5 95:10
Maintaining
[2] 96:7 96:8
Maintenance
[4] 81:2 83:10 83:18 112:7
Major
[13] 78:25 79:1 132:2 132:11 132:15 132:17 132:18 132:19 170:1 171:25 172:13 172:14 172:15
Maka'aina
[1] 21:4
Makai
[2] 49:14 58:9
Makapipi
[1] 77:3
Maliko
[3] 75:16 79:12 79:13
Management
[1] 100:1
Manager
[2] 67:1 80:16
Map
[93] 13:3 13:9 14:5 23:25 26:9 26:12 26:14 30:10 31:19 31:22 32:6 32:16 34:9 34:22 35:3 35:8 35:13 35:14 35:20 36:4 36:9 36:12 36:14 37:3 37:23 38:4 38:21 39:6 39:11 41:24 48:9 49:13 68:3 71:23 75:10 75:14 75:21 77:1 77:2 78:1 79:7 101:3 101:5 101:8 101:23 101:23 101:24 101:25 102:4 102:5 102:18 102:24 113:3 121:10 122:2 122:23 123:2 124:9 124:10 124:11 124:12 124:12 124:13 126:12 129:12 129:17 129:18 129:22 130:1 130:5 130:10 130:11 130:20 130:21 130:23 130:24 167:22 169:5 169:6 169:13 169:25 170:1 170:3 170:4 170:6 170:11 170:12 170:17 170:22 170:25 173:23 174:13 175:3
Map's
[1] 33:4
Mapping
[1] 53:9
Maps
[5] 13:7 13:12 51:16 51:17 124:25
March
[8] 89:15 89:24 91:16 118:5 118:6 118:15 119:15 121:15
MARIE
[3] 1:23 176:6 176:21
Marjorie
[1] 4:15
Mark
[4] 6:9 80:16 121:18 175:3
Marked
[3] 52:5 57:3 168:1
Marker
[1] 35:16
Market
[1] 2:1
Marketability
[1] 7:23
Martin
[9] 32:8 33:15 33:17 33:18 33:20 116:8 116:12 116:15 117:1
Match
[1] 37:6
Materials
[1] 108:4
Math
[9] 62:25 63:2 135:16 135:16 151:4 151:9 155:15 156:18 157:19
Matter
[8] 1:3 4:2 5:10 31:12 62:14 96:18 109:6 176:13
Mattered
[1] 21:7
Matters
[1] 13:25
Maui
[72] 1:4 2:9 2:11 2:14 4:7 4:10 4:17 4:22 9:13 14:5 22:7 22:12 22:14 23:25 52:2 74:14 76:2 85:21 89:12 104:23 111:18 123:8 129:3 133:3 133:11 134:12 135:8 136:4 136:4 136:6 136:8 136:11 136:13 136:22 139:5 139:10 139:14 139:23 140:5 142:10 142:14 142:15 142:17 143:8 143:10 143:11 143:12 144:1 144:12 144:14 144:15 144:21 145:14 146:25 147:2 147:9 148:24 148:24 149:2 149:7 149:13 149:16 149:25 150:12 150:14 161:16 161:23 162:8 162:16 162:21 163:4 163:15
Mauka
[3] 36:18 98:8 98:8
Mausoleum
[1] 23:8
Maximum
[3] 123:21 125:3 125:7
McConnell
[154] 2:1 4:1 4:6 4:24 5:5 5:12 5:23 6:4 6:23 7:5 9:3 9:6 14:19 15:17 18:6 18:24 20:5 22:15 22:18 22:25 25:8 25:13 26:15 27:5 27:10 27:14 28:22 29:1 29:4 29:12 29:15 29:24 30:5 30:8 30:12 30:15 30:19 30:23 31:2 31:16 32:9 32:13 32:21 33:14 34:19 36:17 39:24 40:5 40:18 44:1 45:14 46:20 47:11 58:3 60:20 63:1 63:6 63:18 63:23 64:20 64:23 66:14 67:14 70:21 72:12 73:15 73:21 74:1 74:10 75:7 75:13 78:2 80:1 80:11 81:9 82:12 85:7 86:16 86:20 90:13 90:24 91:3 91:7 97:9 98:3 98:17 100:8 101:13 101:18 103:12 105:8 106:11 106:16 106:21 106:25 107:3 107:7 107:11 107:15 107:21 108:6 108:9 109:7 109:16 109:18 110:2 110:5 114:13 115:5 115:11 115:15 118:7 118:24 119:5 119:12 120:24 122:16 124:24 125:2 125:9 125:14 125:18 125:23 126:23 127:4 127:19 127:24 128:3 134:7 137:20 137:23 138:5 138:10 138:16 140:14 141:5 142:24 143:4 143:16 144:7 145:19 145:24 146:19 148:5 148:14 153:25 157:11 159:6 160:4 166:15 167:11 168:5 168:10 175:8
McConnell's
[1] 26:2
McGregor
[2] 53:2 76:15
McMANUS
[3] 1:23 176:6 176:21
Mean
[25] 16:20 22:2 31:21 34:10 35:5 43:12 44:4 51:10 52:17 52:18 54:20 54:24 59:15 62:9 72:14 103:13 132:16 140:23 140:24 145:6 145:9 149:1 149:24 152:11 159:5
Meaning
[2] 14:11 23:10
Means
[2] 140:21 141:4
Meant
[4] 10:16 69:7 124:5 126:14
Measured
[6] 84:9 91:13 91:14 91:18 91:20 164:3
Measurements
[6] 89:25 90:2 90:6 90:10 90:23 91:2
Measuring
[3] 116:1 162:7 162:11
Mediation
[1] 119:8
Meet
[5] 114:11 141:20 159:11 159:18 159:23
Meeting
[4] 6:20 88:19 118:22 121:25
Meets
[1] 131:15
Member
[9] 28:12 31:14 61:20 62:14 62:14 62:18 62:19 65:12 111:7
Members
[14] 26:3 26:11 27:2 40:3 54:5 60:11 61:18 62:4 66:12 67:2 144:17 144:21 144:25 145:14
Membership
[1] 144:14
Memory
[1] 117:13
Mention
[2] 48:16 139:5
Mentioned
[6] 32:22 48:25 50:9 83:23 85:16 159:17
Merchant
[9] 2:9 2:9 4:22 4:22 47:9 125:13 143:14 162:1 162:4
Met
[1] 158:21
Meter
[1] 173:2
Middle
[8] 7:8 36:21 38:1 38:14 39:10 39:17 41:20 171:16
Might
[4] 64:12 72:8 86:13 89:9
Mile
[1] 97:20
Miles
[3] 80:25 81:1 81:4
Million
[21] 123:22 125:4 125:8 128:23 136:20 137:13 137:14 140:8 140:9 140:19 140:20 142:13 143:7 147:5 147:15 147:17 147:24 162:14 163:1 163:8 163:13
Mind
[3] 35:17 102:22 162:17
Minimum
[1] 137:9
Minister
[2] 15:9 15:11
Minus
[1] 110:24
Minused
[1] 64:5
Minute
[6] 6:18 29:11 70:10 105:22 166:19 167:10
Minutes
[2] 64:21 83:21
Miss
[1] 32:14
Misstates
[1] 103:10
Mistaken
[2] 25:11 25:12
Mo'o
[23] 19:17 19:20 19:20 21:12 21:12 21:14 21:16 21:17 21:19 21:22 21:25 22:2 22:11 24:4 24:5 24:7 24:9 24:13 24:14 41:5 69:6 69:6 69:16
Modest
[1] 92:18

Modified
[1] 55:17
Moku
[40] 2:16 4:14 7:2 19:21 26:1 26:3 26:10 27:2 27:11 28:12 29:18 31:14 40:3 40:13 45:24 50:11 50:14 54:5 56:15 57:1 60:11 61:18 61:20 61:24 62:4 62:13 62:14 62:18 62:19 65:5 65:12 66:12 67:2 67:5 119:17 120:11 120:17 122:8 122:12 138:22
Moku's
[2] 3:12 18:8
Moment
[4] 75:11 75:12 116:3 123:20
Money
[3] 15:9 15:10 15:14
Month
[5] 134:24 151:1 154:11 155:12 167:15
Morning
[8] 4:12 4:13 5:3 6:12 118:12 137:5 137:14 175:9
Mortgage
[1] 153:19
Mortgaged
[2] 136:1 153:12
Moses
[3] 2:16 4:13 138:21
Most
[5] 6:10 17:22 69:18 71:12 77:3
Motor
[1] 166:19
Move
[5] 42:9 100:13 106:24 114:2 131:25
Muddy
[1] 81:21
Murakami
[3] 2:16 4:13 168:12

N

Nahiku
[7] 1:4 75:15 75:23 78:17 79:11 155:8 155:18
Nahiku-Keanae
[1] 78:17
Naiapea
[1] 19:4
Name
[8] 7:6 7:7 7:9 60:16 93:17 97:13 130:10 138:6
Named
[1] 176:16
Names
[1] 16:14
Nationwide
[1] 141:22
Native
[40] 7:13 7:15 9:10 9:19 9:20 10:11 10:12 10:13 10:16 10:19 11:1 11:3 11:6 11:9 13:19 13:20 16:20 16:21 16:24 16:25 17:10 17:11 17:17 17:22 18:3 18:16 18:20 19:3 19:7 23:18 23:19 23:21 24:20 24:21 26:4 53:19 73:11 73:17 104:24 167:6
Natural
[5] 1:1 8:13 13:6 69:25 70:5
Near
[2] 51:23 90:4
Nearly
[1] 169:22
Necessarily
[3] 10:15 61:18 64:14
Necessary
[3] 40:21 61:24 103:4
Need
[25] 6:18 9:18 12:1 12:2 44:8 44:11 44:12 45:2 45:19 64:14 81:5 83:20 87:24 112:6 115:13 119:2 125:19 125:24 159:16 161:11 161:11 161:18 162:25 167:12 169:5
Needed
[4] 48:12 95:13 111:17 119:16
Needs
[14] 45:23 88:1 101:6 129:24 137:2 137:10 142:20 146:25 147:12 148:11 158:21 159:11 159:19 159:23
Neighbor
[1] 12:6
Nervous
[1] 64:13
Never
[9] 86:1 95:20 113:25 120:1 120:3 120:4 144:5 162:17 166:22
New
[11] 5:17 13:7 52:21 59:13 59:24 59:25 78:18 78:19 78:22 132:18 162:12
Newer
[1] 78:20
Next
[15] 11:10 11:14 12:6 16:10 16:18 19:25 42:8 46:21 48:25 71:4 88:9 110:18 150:16 154:3 168:23
Nickname
[1] 93:17
Nine
[2] 73:2 133:4
Nineties
[1] 93:23
None
[4] 17:7 59:5 73:5 105:6
Noon
[1] 73:25
Normal
[2] 83:12 111:24
Norman
[8] 32:8 33:17 33:18 33:20 116:8 116:12 116:15 117:1
Note
[3] 14:6 18:22 108:16
Noted
[6] 17:2 17:7 18:12 18:23 24:4 24:25
Notes
[1] 31:17
Nothing
[2] 5:17 70:19
Notice
[1] 41:4
Noticed
[1] 104:10
Notwithstanding
[4] 61:17 62:13 62:18 65:5
November
[3] 1:8 26:8 176:7
Nowhere
[1] 109:3
NR
[1] 23:18
NR6/542
[1] 23:16
Nu'uanu
[2] 23:7 23:7
Number
[36] 12:19 14:4 14:7 16:4 16:5 17:5 18:1 19:4 19:9 23:14 23:24 24:2 25:6 25:10 29:8 29:9 39:3 39:5 39:7 41:18 44:19 48:18 51:21 65:9 68:1 83:23 102:6 114:25 116:4 116:7 116:14 116:21 120:8 120:8 156:3 156:24
Numbered
[1] 112:12
Numbers
[16] 17:10 17:22 26:9 26:13 28:2 28:18 29:22 29:25 35:13 36:8 102:5 115:8 151:21 151:24 152:6 152:15
Numerical
[2] 116:18 168:14

O

O'clock
[1] 175:9
Oahu
[5] 22:7 22:13 22:13 22:20 23:4
Object
[18] 12:6 12:6 28:19 55:10 57:24 66:13 67:20 70:15 72:10 81:7 85:4 96:25 113:23 125:22 126:19 134:5 142:22 151:23
Objecting
[1] 106:10
Objection
[21] 9:4 9:5 18:5 74:8 90:10 92:8 103:10 108:10 137:24 140:10 140:25 142:18 143:14 145:17 146:14 148:2 153:4 153:7 159:24 162:1 166:13
Objections
[2] 12:4 97:2
Observations
[2] 84:25 129:21
Observe
[1] 129:20
Obviate
[1] 119:1
Obvious
[2] 131:21 131:25
Obviously
[1] 172:6
Occasions
[1] 128:15
Occupation
[1] 7:12
Occur
[1] 163:12
Occurred
[3] 9:14 12:21 172:14
Occurs
[1] 10:20
October
[5] 26:2 26:7 112:11 113:17 117:9
Off-island
[1] 133:2
Off-the-record
[1] 65:4
Offense
[1] 109:1
Offer
[2] 65:1 119:6
Offered
[4] 89:8 106:12 119:13 119:14
Offhand
[2] 34:6 135:21
Office
[6] 8:12 13:22 31:22 34:15 39:2 118:23
Officer
[152] 2:1 4:1 4:6 4:24 5:5 5:12 5:19 5:23 6:4 6:23 7:5 9:3 9:6 14:19 15:17 18:6 18:24 20:5 22:15 22:18 22:25 25:8 25:13 26:15 27:5 27:10 27:14 28:22 29:1 29:4 29:12 29:15 29:24 30:5 30:8 30:12 30:15 30:19 30:23 31:2 31:16 32:9 32:13 32:21 33:14 34:13 34:19 36:17 39:24 40:5 40:18 44:1 45:14 46:20 47:11 58:3 60:20 63:1 63:6 63:18 63:23 64:20 64:23 66:14 67:14 70:21 72:12 73:15 73:21 74:1 74:10 75:7 78:2 80:1 80:11 81:9 82:12 85:7 86:16 86:20 90:13 90:24 91:3 91:7 98:3 98:17 101:13 101:18 103:12 105:8 106:11 106:16 106:21 106:25 107:3 107:7 107:11 107:15 107:21 108:6 108:9 109:7 109:16 109:18 110:2 110:5 114:13 115:5 115:11 115:15 118:7 118:24 119:5 119:12 120:24 122:16 124:24 125:2 125:9 125:14 125:23 126:23 127:4 127:19 127:24 128:3 134:7 137:20 137:23 138:5 138:10 138:16 140:14 141:5 142:24 143:4 143:16 144:7 145:19 145:24 146:19 148:5 148:14 153:25 157:11 159:6 160:4 166:15 167:11 168:5 168:10 175:8
Official
[1] 10:8
Often
[7] 7:8 20:14 22:6 22:11 22:12 22:14 163:12
Old
[1] 13:7
Omitted
[1] 60:25
On-the-ground
[1] 52:13
Once
[11] 29:17 79:12 121:16 125:5 130:8 151:7 154:13 154:14 154:18 157:20 157:24
One
[96] 5:4 5:9 14:3 14:4 18:17 18:21 22:9 32:10 32:14 32:22 34:10 34:17 43:25 46:23 48:16 48:20 48:25 49:17 51:2 52:22 54:1 54:3 54:14 56:4 60:2 60:17 60:17 60:17 61:10 61:10 69:5 69:22 73:2 74:19 74:20 77:12 78:3 78:23 79:17 80:5 80:5 80:17 85:16 85:22 87:4 88:18 91:19 94:12 94:14 94:14 94:23 94:23 98:9 100:10 101:19 101:20 102:6 102:7 105:1 105:23 107:18 107:22 109:4 111:8 111:16 113:9 113:12 113:13 114:5 115:20 115:23 120:8 120:10 122:12 123:8 123:25 124:14 124:15 129:23 131:21 133:17 136:25 139:9 139:13 152:20 152:23 163:16 163:16 165:15 166:1 168:16 170:7 170:18 171:4 171:5 175:2
One's
[1] 49:4
One-by-one
[1] 94:23
One-cubic-foot
[1] 91:19
One-fourth
[1] 15:3
One-inch
[1] 165:15
One-third
[1] 15:2
Ones
[10] 25:4 28:18 30:24 37:6 53:21 58:8 61:10 61:15 72:2 100:10
Ongoing
[1] 120:2
Open
[12] 56:23 75:18 78:20 82:6 83:7 83:24 85:2 85:10 85:14 112:16 132:24 158:20
Opened
[15] 82:1 82:15 82:21 83:2 83:4 83:11 83:13 83:17 83:19 108:24 121:3 132:25 133:14 133:16 158:16
Operable
[1] 80:25
Operate
[3] 78:19 97:5 123:11
Operated
[2] 79:4 79:13
Operating
[3] 134:10 134:14 151:22
Operation
[3] 78:11 140:7 157:15
Operational
[1] 129:19
Operations
[4] 80:16 80:17 83:9 83:13
Opinion
[4] 66:20 131:7 140:1 141:1
Opportunity
[2] 62:20 115:4
Opposing
[1] 109:25
Opposite
[2] 28:4 28:20
Option
[2] 161:24 162:9
Orange
[2] 76:2 129:6
Order
[10] 4:2 26:2 104:10 109:24 133:7 137:2 137:11 146:6 146:12 168:14
Original
[19] 9:18 9:19 9:20 9:20 9:21 9:24 13:10 22:9 40:6 40:25 46:7 51:8 55:2 56:18 63:9 65:8 130:23 141:6 173:7
Originally
[4] 67:4 105:3 129:13 130:5
Otherwise
[4] 108:13 136:2 153:12 153:19
Outcome
[1] 176:16
Outlined
[1] 112:12
Outlook
[2] 139:22 141:11
Outside
[4] 12:12 22:16 56:1 143:10
Overall
[1] 45:4
Overflow
[1] 82:24
Overlay
[1] 67:18
Overnight
[1] 133:5
Overrule
[1] 114:14
Overruled
[1] 90:25
Overview
[1] 80:15
Owed
[1] 15:23
Owing
[3] 14:24 15:15 15:19
Own
[5] 60:12 66:12 147:12 147:25 151:8
Owned
[8] 67:1 76:1 76:2 76:5 129:1 129:3 129:7 129:10
Owner
[3] 33:20 61:20 113:4
Owners
[1] 13:23
Owners'
[2] 30:4 48:13
Ownership
[2] 7:21 10:8
Owns
[2] 33:6 126:9

P

Paakamaka
[3] 16:16 17:14 19:14
Page
[22] 23:18 23:19 25:6 25:10 47:22 48:4 48:22 49:3 49:6 51:19 51:20 65:16 70:4 71:9 90:5 101:16 106:1 121:15 135:22 139:4 139:19 153:8
Pages
[1] 47:21
Pahale
[1] 73:9
Paid
[3] 14:10 15:16 15:24
Paper
[1] 64:3
Paragraph
[13] 19:10 19:13 71:10 106:1 121:14 125:21 135:23 139:4 139:20 141:25 145:3 146:24 153:9
Paralegal
[1] 7:15
Parallel
[2] 7:13 9:9
Paraphrase
[1] 65:15
Parcel
[92] 8:1 8:1 10:9 10:21 11:8 11:14 12:9 13:11 14:4 16:4 16:23 17:5 17:13 18:1 18:4 19:3 23:14 23:21 23:24 24:1 24:22 25:6 25:10 26:19 26:20 26:20 26:20 26:20 26:21 26:21 26:22 26:22 26:22 26:22 26:22 29:8 29:9 31:22 31:23 31:24 31:24 31:25 32:1 32:1 32:2 32:3 32:16 33:6 33:18 33:22 35:8 37:13 37:16 38:15 39:3 39:8 39:9 39:11 39:14 39:19 41:19 41:22 42:13 42:23 42:25 43:16 43:17 43:18 43:20 44:13 44:17 44:17 44:18 48:18 50:6 60:18 62:20 68:22 69:11 69:12 69:20 71:23 72:9 116:1

116:1 158:15 159:10 160:24 163:18 164:2 164:6 164:22
Parcels
[36] 9:12 9:14 12:19 12:22 24:25 25:18 40:4 48:6 48:9 48:12 49:10 50:22 51:8 51:21 54:18 54:20 55:6 55:25 56:23 57:4 58:17 58:20 59:17 61:18 61:21 62:5 63:3 65:19 65:24 69:18 71:13 71:15 76:4 76:5 160:16 160:22
Parent
[2] 76:3 129:7
Park
[2] 147:10 147:11
Parked
[1] 81:21
Part
[12] 23:7 31:25 48:21 51:6 72:2 75:6 97:12 128:12 132:7 140:3 141:18 147:14
Particular
[5] 69:22 112:25 129:23 136:19 136:25
Parties
[7] 5:19 17:25 26:6 106:2 113:25 149:20 176:15
Party
[1] 149:20
Pass
[2] 84:15 94:19
Passed
[9] 95:18 95:21 95:23 95:24 95:24 96:1 96:12 96:23 97:4
Passes
[1] 88:6
Passing
[5] 84:14 84:16 94:9 94:13 94:14
Past
[4] 104:8 113:24 128:18 139:21
Patch
[4] 85:24 86:5 86:7 92:6
Patches
[9] 83:22 83:25 85:3 85:10 85:14 100:21 105:17 116:19 121:22
Patent
[9] 14:7 14:8 14:9 14:20 15:22 15:24 16:5 16:7 24:2
Pauahi
[1] 2:19
Paul
[3] 33:11 33:12 33:21
Pay
[8] 14:15 14:20 15:5 15:18 105:11 149:21 152:9 157:5
Paying
[7] 14:17 15:1 134:21 134:22 134:23 134:25 135:12
Payment
[5] 15:8 16:7 135:4 135:5 151:5
Payments
[1] 156:15
Pays
[6] 150:25 154:10 155:11 156:23 157:8 157:17
Pending
[1] 119:2
People
[11] 11:7 21:20 80:22 99:5 164:12 164:14 164:18 164:25 165:6 165:10 165:13
Peoples'
[1] 82:24
Per
[35] 49:22 84:10 91:11 92:1 128:23 134:24 135:20 136:20 143:7 150:14 151:1 151:11 154:11 154:13 154:20 155:11 155:14 155:14 155:18 155:22 156:1 156:2 156:13 156:21 156:23 156:25 157:8 157:11 157:12 157:13 157:18 157:25 158:3 163:8 166:19
Percent
[29] 49:22 57:13 57:15 57:21 58:15 58:21 59:6 60:5 60:6 63:10 63:12 63:15 63:21 65:8 68:20 68:23 69:2 69:7 69:9 69:11 69:12 71:8 71:19 72:6 72:9 72:20 72:21 72:25 73:1
Percentage
[2] 147:21 148:7
Percentages
[3] 124:2 124:9 124:18
Period
[3] 68:5 95:9 163:2
Periodically
[1] 87:15
Periods
[1] 111:24
Permission
[2] 33:13 87:23
Permit
[32] 43:11 43:13 66:15 70:22 72:13 81:10 85:8 103:13 121:9 134:1 134:2 134:4 134:11 134:15 134:21 135:25 140:15 144:8 146:20 150:19 150:24 151:1 151:11 152:9 153:2 153:10 153:20 154:4 154:11 155:3 155:7 166:16
Permits
[7] 152:17 152:20 152:21 152:24 154:1 157:6 157:17
Permitted
[2] 43:14 156:16
Person
[6] 10:15 12:9 16:1 80:18 115:4 168:23
Personal
[2] 90:12 129:20
Personally
[1] 99:17
Persons
[1] 53:7
Petitioners
[2] 4:14 138:23
Petitioners'
[1] 8:14
Photo
[11] 98:11 98:12 98:20 112:10 112:17 112:25 113:16 113:20 113:21 115:19 117:7
Photograph
[1] 168:22
Photographs
[3] 52:16 52:18 168:7
Photos
[1] 98:15
Physically
[2] 20:20 88:25
Picked
[2] 60:15 60:15
Picture
[3] 110:10 110:15 110:17
Pictures
[5] 5:15 111:3 111:6 111:12 169:6
Piece
[5] 20:23 21:18 41:10 52:8 64:2
Pieces
[1] 20:17
Pine
[18] 136:4 136:5 136:6 136:8 136:13 136:22 148:24 148:25 149:2 149:7 149:13 149:16 161:16 161:23 162:8 162:17 163:5 163:15
Pine's
[1] 162:22
Pineapple
[3] 2:9 4:23 136:10
Pipe
[46] 81:22 84:8 84:9 86:25 87:2 87:6 87:12 87:17 89:2 110:19 110:20 110:21 110:25 111:9 111:16 111:22 111:25 111:25 112:5 112:5 112:7 121:20 163:21 163:25 164:22 165:3 165:5 165:14 165:15 165:16 168:25 169:19 171:7 171:11 171:13 171:14 171:15 171:17 171:19 171:22 171:23 172:19 172:22 172:25 173:2 173:4
Pipeline
[1] 168:24
Pipes
[24] 84:12 84:13 84:15 84:16 84:20 87:24 88:2 88:5 88:6 88:9 88:10 92:2 92:3 94:7 94:9 94:10 94:17 94:18 95:10 95:17 95:20 95:25 96:8 165:1
Place
[6] 5:22 16:14 17:9 21:1 24:20 50:3
Placed
[1] 5:13
Places
[1] 123:8
Plan
[1] 141:15
Plant
[3] 85:10 125:17 158:23
Plantation
[2] 79:16 79:25
Planted
[2] 85:18 112:16
Planting
[1] 85:20
Plants
[1] 123:12
Plat
[13] 26:19 26:21 36:12 36:13 36:15 36:15 36:24 38:1 38:1 38:2 61:8 61:9 61:9
Plats
[1] 37:25
Plenty
[1] 127:2
Plugged
[1] 94:15
Point
[41] 25:4 46:8 76:25 77:24 81:8 81:12 82:13 82:15 84:23 86:13 98:19 102:19 107:20 114:4 119:23 120:9 127:15 131:25 137:10 149:12 149:15 160:15 161:10 161:16 161:17 161:21 161:22 162:2 162:3 162:7 162:11 163:4 164:1 164:6 169:1 169:2 169:15 169:21 170:10 173:23 174:6
Pointed
[1] 126:12
Pointing
[11] 36:21 37:11 38:13 38:20 39:10 39:16 41:20 43:5 69:24 169:20 174:19
Points
[2] 102:17 164:13
Poncho
[10] 93:17 93:19 93:22 94:21 95:5 95:12 96:10 96:12 96:22 97:5
Poncho's
[3] 96:2 96:5 96:8
Pond
[5] 103:22 104:14 110:15 111:23 112:2
Pool
[1] 104:11
Porous
[4] 97:15 103:22 104:11 104:14
Portion
[3] 36:21 129:22 136:9
Portions
[2] 77:18 77:19
Position
[3] 70:19 118:17 142:11
Positive
[3] 139:23 141:11 144:19
Possible
[2] 6:20 166:3
Possibly
[2] 12:3 174:24
Posted
[2] 140:7 140:18
Powered
[1] 165:19
Powers
[1] 27:19
Practice
[1] 72:22
Predicted
[2] 133:5 133:11
Prefer
[1] 6:19
Preferably
[1] 11:7
Premise
[1] 134:14
Preparation
[1] 129:15
Prepare
[2] 26:1 129:12
Prepared
[12] 25:24 27:24 40:11 56:7 89:13 89:14 90:17 112:23 112:24 121:22 129:12 129:17
Present
[10] 53:2 72:3 76:13 81:24 88:15 92:10 102:25 103:21 150:5 150:7
Presently
[6] 33:11 33:25 134:25 160:7 160:11 172:9
President
[4] 74:17 80:9 99:20 130:14
Pressure
[1] 173:1
Presume
[1] 54:5
Presumed
[2] 69:7 69:8
Presumption
[1] 24:10
Pretty
[1] 69:13
Prevent
[1] 118:19
Prevented
[1] 112:4
Previous
[3] 43:9 133:1 150:24
Previously
[5] 32:2 34:22 61:3 92:24 107:13
Prima
[1] 62:11
Primarily
[1] 7:21
Primary
[4] 7:16 7:17 13:17 98:23
Private
[4] 10:8 51:16 81:4 124:2
Privately
[1] 76:5
Privilege
[2] 135:5 149:8
Problem
[13] 6:13 97:3 97:7 108:11 110:1 111:25 121:8 129:21 131:17 161:2 161:15 170:16 170:18
Problems
[1] 68:1
Proceed
[2] 5:2 5:7
Proceeded
[1] 81:17
Proceeding
[2] 9:21 145:23
Proceedings
[6] 14:16 15:1 15:15 18:22 176:8 176:12
Produced
[4] 56:25 114:1 130:9 130:11
Production
[3] 112:13 142:3 142:10
Profit
[2] 140:8 140:18
Prohibited
[1] 106:7
Promised
[1] 5:19
Properly
[1] 81:4
Properties
[3] 57:5 83:16 129:2
Property
[27] 7:22 12:15 14:12 19:5 21:18 26:3 39:2 41:11 42:11 44:13 65:13 82:24 88:9 88:10 92:17 92:22 93:7 93:20 93:21 93:22 96:17 126:17 129:10 133:8 160:8 160:11 160:12
Proportionate
[1] 124:16
Proposing
[1] 64:9
Protect
[1] 83:15
Protected
[1] 142:1
Protection
[1] 142:6
Prove
[1] 119:7
Provide
[13] 8:20 12:25 16:19 17:19 24:18 31:11 111:8 158:20 159:11 159:22 160:19 161:12 161:13
Provided
[15] 11:15 13:3 14:4 17:20 17:24 17:24 25:25 26:6 32:2 40:13 41:5 44:7 130:19 153:20 164:12
Provides
[1] 136:17
Providing
[1] 159:15
Provision
[2] 135:23 137:2
Public
[1] 13:8
Pull
[1] 87:5
Pulled
[1] 171:18
Pulls
[1] 165:18
Pump
[12] 136:10 136:14 165:18 165:19 166:4 166:5 166:8 166:12 166:14 166:18 166:18 166:20
Pumping
[1] 163:3
Pumps
[2] 149:3 165:23
Puolua
[13] 82:1 82:6 86:6 87:7 89:16 90:1 90:3 90:7 90:8 91:10 92:4 99:15 130:16
Purchase
[2] 54:11 54:12
Purpose
[9] 14:14 59:18 82:8 87:11 87:12 99:22 99:24 118:21 128:7
Purposes
[14] 7:19 26:24 31:23 41:14 54:15 54:16 69:8 73:8 95:1 96:21 106:6 108:3 129:19 135:8
Pursuant
[3] 26:1 105:24 151:1
Put
[18] 16:2 18:17 18:23 24:9 59:16 64:3 67:16 68:17 92:15 96:24 99:17 104:13 108:16 120:12 120:18 137:18 163:5 168:13
Putting
[1] 114:11
PVC
[3] 168:25 171:7 171:19

Q

Quarters
[1] 97:20
Queen
[1] 15:12
Questions
[18] 8:21 47:9 47:10 66:3 73:14 122:15 122:17 123:25 126:1 126:2 138:14 138:18 138:24 143:23 148:13 148:15 148:22 148:23
Quick
[1] 5:10
Quiet
[2] 10:6 13:17
Quoting
[1] 51:21

R

Rain
[1] 133:5
Rainfall
[3] 124:13 124:16 126:14
Rains
[1] 83:15
Rainstorm
[1] 82:19
Rainy
[1] 102:21
Raise
[2] 6:25 94:1
Raising
[2] 93:24 93:25

Ran
[4] 20:18 22:23 23:13 43:8
Randy
[1] 118:22
Rate
[3] 137:6 137:7 158:4
Rather
[2] 131:15 147:25
Reach
[1] 118:18
Reached
[1] 121:17
Reaching
[1] 164:22
Read
[16] 27:3 28:3 28:5 28:18 29:22 30:24 31:10 61:10 71:17 91:8 118:25 121:13 123:14 135:24 142:2 153:14
Reading
[1] 171:6
Reads
[2] 91:10 153:9
Ready
[9] 5:7 158:11 158:17 158:17 159:1 159:10 159:22 160:18 160:25
Real
[6] 7:21 8:9 14:12 39:2 93:17 105:25
Really
[4] 27:18 60:21 131:23 165:9
Realm
[1] 21:21
Reason
[10] 20:23 56:13 71:8 83:6 83:7 120:14 135:13 151:6 155:15 156:18
Reasonable
[4] 47:25 57:16 66:20 71:12
Reasons
[2] 111:16 169:7
Reassert
[1] 74:8
Rebuild
[1] 89:7
Rebuttal
[4] 73:22 73:22 121:9 121:9
Receive
[8] 15:9 119:24 121:5 158:18 160:12 166:25 167:2 167:5
Received
[12] 3:11 9:1 9:2 10:17 18:3 18:8 75:5 120:5 138:13 140:9 166:22 168:1
Receiving
[1] 107:4
Recent
[2] 140:7 152:16
Recently
[1] 140:17
Recess
[6] 64:22 73:25 109:17 137:21 137:22 175:9
Recessed
[1] 4:4
Recognize
[1] 104:17
Reconstruct
[2] 64:4 105:2
Reconvened
[2] 5:21 74:2
Record
[49] 4:25 5:22 9:4 9:22 14:1 28:25 29:2 29:3 29:5 29:13 29:14 29:16 31:6 34:18 34:20 37:11 38:13 38:20 39:10 39:16 41:20 64:7 64:24 65:1 67:11 67:13 69:1 69:15 73:23 73:24 74:11 75:6 91:2 91:5 103:13 108:15 108:16 109:19 123:13 131:6 137:24 140:4 140:4 143:6 148:17 169:20 174:19 175:6 175:7
Records
[20] 9:12 9:24 13:16 13:20 13:22 22:9 23:10 44:2 51:5 51:15 51:15 53:22 68:25 70:17 76:23 93:9 151:13 151:16 151:17 172:8
Red
[4] 75:21 86:16 86:19 169:3
Redacted
[4] 107:17 107:19 107:22 107:25
Redaction
[1] 108:3
Redactions
[1] 107:24
Reduced
[1] 176:9
Reduction
[1] 117:17
Refer
[9] 10:11 19:2 28:9 51:20 58:6 122:5 122:6 126:8 153:8
Reference
[6] 13:17 38:9 53:18 101:21 122:1 125:20
References
[1] 69:19
Referred
[13] 50:21 53:22 55:2 74:25 76:19 77:8 90:4 90:6 99:10 101:2 111:1 124:19 150:20
Referring
[17] 9:25 27:15 36:25 55:12 58:6 58:10 71:7 82:2 89:19 101:14 101:23 101:24 115:23 132:5 139:11 139:24 151:24
Refers
[2] 24:19 89:15
Reflected
[1] 8:7
Reflects
[1] 13:25
Regard
[8] 5:10 59:17 70:14 71:20 72:19 86:5 102:3 114:15
Regarding
[3] 1:3 4:3 104:22
Regardless
[1] 66:11
Regards
[2] 111:9 130:16
Register
[16] 9:19 13:19 16:21 16:24 17:3 17:10 17:18 18:3 18:16 19:3 19:7 23:18 23:19 23:21 24:20 53:19
Registered
[8] 100:1 100:4 114:23 164:12 164:15 164:18 165:7 165:20
Registers
[7] 10:11 10:12 10:13 10:19 10:23 17:23 51:13
Registration
[4] 99:11 99:13 99:22 99:24
Relate
[2] 104:19 104:21
Related
[3] 11:1 79:15 127:13
Relates
[1] 8:9
Relating
[1] 7:18
Relation
[3] 33:12 78:13 95:6
Relationship
[3] 35:2 35:6 36:13
Relative
[1] 33:5
Relatively
[2] 93:6 121:1
Release
[2] 15:13 160:23
Releases
[2] 119:2 128:15
Releasing
[1] 105:25
Relief
[1] 120:22
Relieve
[1] 112:6
Remaining
[2] 69:8 139:22
Remains
[2] 61:21 165:2
Remarks
[2] 23:16 24:19
Remember
[4] 53:5 87:6 98:18 133:12
Remind
[1] 6:24
Remove
[1] 108:4
Renewable
[1] 141:21
Rent
[1] 156:15
Rental
[1] 134:24
Renting
[1] 135:5
Rents
[1] 152:9
Repair
[5] 83:19 105:1 106:13 108:12 111:15
Repairing
[1] 111:9
Repairs
[6] 104:1 104:4 104:6 104:19 104:21 105:11
Repeat
[4] 70:23 131:4 143:1 143:18
Repeating
[1] 90:15
Rephrase
[2] 58:4 160:5
Replaced
[1] 78:22
Replied
[1] 126:13
Reported
[1] 151:18
REPORTER
[2] 84:18 108:1
Represent
[3] 74:22 117:4 117:5
Representations
[1] 121:3
Representative
[1] 68:6
Representatives
[1] 88:19
Representing
[1] 138:22
Represents
[3] 66:8 66:8 176:11
Requested
[2] 109:10 121:24
Require
[1] 11:5
Required
[1] 12:17
Requirement
[1] 99:25
Requirements
[2] 143:20 143:21
Requires
[1] 160:23
Rerouting
[1] 172:16
Research
[13] 7:17 7:20 8:5 9:16 12:19 13:25 42:12 47:24 50:20 51:6 56:16 67:3 92:14
Researched
[2] 13:14 13:15
Researching
[1] 9:11
Reserved
[1] 17:21
Reservoir
[1] 96:19
Resided
[1] 93:19
Residential
[1] 54:15
Residents
[2] 54:6 92:15
Resolve
[1] 12:3
Resolved
[1] 127:14
Resource
[2] 99:25 142:12
Resources
[3] 1:1 8:13 13:6
Respect
[26] 16:22 18:1 19:9 24:15 24:25 25:17 31:9 31:11 33:8 33:24 34:7 36:7 37:5 43:16 44:9 45:20 106:19 115:7 128:14 131:1 131:5 143:11 150:24 155:4 157:16 158:21
Respond
[1] 122:9
Response
[1] 114:4
Responsible
[4] 80:23 129:15 130:9 133:21
Responsive
[1] 159:20
Rest
[4] 21:2 80:18 80:21 123:9
Restate
[1] 66:16
Resulted
[1] 56:16
Results
[1] 47:24
Resume
[2] 8:7 148:16
Retained
[1] 130:23
Retired
[1] 93:24
Review
[5] 7:17 7:20 7:24 34:22 101:3
Reviewed
[3] 16:24 34:24 52:9
Revised
[6] 44:22 101:6 129:24 130:6 169:5 169:8
Revising
[1] 46:7
Revisions
[1] 44:6
Revocable
[7] 43:11 134:1 134:2 134:11 150:19 155:7 157:6
Revocation
[1] 43:15
Revolutions
[1] 166:19
Ride
[1] 81:20
Ridge
[1] 174:15
Right-hand
[4] 36:24 100:12 114:21 171:16
Rights
[9] 51:16 62:3 62:6 62:7 62:13 62:17 135:25 153:10 153:20
Riparian
[1] 164:5
Rm
[1] 2:4
Road
[9] 36:22 49:14 58:9 86:23 102:13 102:14 102:15 105:19 105:19
Roads
[1] 81:5
Roadway
[2] 67:24 70:14
Roadways
[1] 67:24
Rocks
[1] 104:11
Ronald
[1] 130:11
Room
[1] 141:20
Roseapple
[1] 100:16
Rotate
[1] 73:3
Roughly
[1] 67:23
Rounded
[1] 21:4
Routed
[1] 79:21
Routine
[2] 81:2 83:9
Royal
[10] 14:7 14:8 14:9 15:10 15:22 15:24 16:4 16:7 23:7 24:1
RPM
[1] 166:19
Rule
[5] 24:12 105:24 106:4 106:19 119:6
Ruled
[3] 109:8 115:6 143:17
Rules
[1] 106:5
Run
[4] 42:3 43:9 44:4 166:9
Running
[2] 41:22 42:22
Runs
[5] 42:17 43:18 44:3 166:18 169:19

S

S-7263
[1] 150:19
S-7264
[2] 134:1 134:11
S-7266
[1] 155:8
Safe
[1] 10:7
Salaried
[1] 80:21
Salty
[1] 163:3
Sam
[1] 110:17
Samuel
[3] 32:20 33:25 34:3
Sandbags
[1] 104:12
Sat
[3] 2:18 4:19 6:14
Satisfaction
[1] 54:11
Satisfied
[2] 147:25 148:11
Saw
[7] 81:25 85:3 86:24 94:7 158:16 165:19 166:1
Scale
[10] 67:21 68:2 68:3 79:18 79:19 114:24 115:7 115:9 115:18 115:20
Scaled
[1] 115:22
Scaling
[3] 114:22 115:3 115:23
Schedule
[1] 64:17
Schematic
[5] 79:9 79:22 100:5 105:18 107:10
Schematically
[1] 79:11
School
[1] 82:6
Schulmeister
[95] 2:5 3:4 3:5 4:16 4:16 6:6 9:5 18:5 28:19 28:24 34:10 34:12 34:16 40:10 45:6 45:17 47:12 47:14 55:12 58:5 60:24 62:24 63:16 63:25 64:11 64:18 64:24 64:25 65:14 65:22 66:5 66:18 67:16 67:22 70:2 70:24 72:17 74:13 75:9 78:7 80:3 80:14 81:11 84:24 85:11 86:24 90:17 91:12 92:10 98:7 98:13 98:15 98:19 101:21 103:16 105:10 106:8 107:9 107:13 107:18 108:14 109:12 109:14 110:7 113:11 114:3 114:10 114:15 115:9 115:18 118:9 118:13 119:11 119:14 120:7 121:13 122:14 126:19 128:24 134:5 138:17 138:18 149:24 151:23 153:4 153:6 153:13 159:3 159:24 162:21 168:7 168:16 171:2 171:8 175:5
Schulmeister's
[2] 121:3 132:14
Schupp
[5] 87:19 88:15 89:4 89:9 89:22
Schupp's
[4] 81:19 86:5 90:1 92:6
Schutte
[1] 2:6
Scope
[5] 72:11 81:8 85:5 127:20 127:22
Search
[1] 70:17
Searched
[1] 13:21
Second
[18] 5:14 28:25 36:7 48:20 53:25 54:19 55:7 55:9 55:11 55:13 55:15 55:16 57:20 57:22 67:7 78:3 121:14 175:6
Seconds
[1] 91:22
Section
[7] 16:18 19:25 38:2 98:

2 110:20 124:14 171:23
See
[24] 16:25 17:3 18:19 35:2 36:1 38:5 41:18 52:3 53:20 60:1 69:11 81:3 81:18 89:3 98:9 102:5 102:19 102:22 112:15 116:5 122:25 124:3 159:13 161:15
Seem
[3] 106:18 123:18 123:19
Selected
[1] 50:2
Sell
[4] 153:3 153:5 153:18 153:22
Selling
[1] 153:22
Sense
[1] 109:23
Sent
[1] 73:11
Sentence
[4] 19:10 19:14 51:22 106:2
Separate
[4] 23:3 32:2 37:25 55:20
September
[1] 133:13
Series
[3] 17:16 148:22 149:14
Serve
[2] 14:14 128:7
Served
[2] 7:19 26:8
Services
[1] 130:24
Set
[6] 5:15 14:21 79:23 123:25 137:6 137:7
Settlement
[5] 106:3 108:5 109:2 119:6 120:3
Seven
[6] 61:9 80:21 116:4 116:7 116:14 116:22
Seventeen
[1] 80:13
Several
[2] 91:21 123:7
Severe
[1] 83:14
Severely
[1] 139:6
Shaded
[1] 113:18
Shall
[3] 106:5 135:25 153:11
Short
[2] 109:14 137:21
Shorter
[2] 43:13 163:2
Shorthand
[1] 176:9
Shortly
[1] 93:13
Show
[12] 19:8 30:10 30:13 39:3 40:6 62:11 64:5 79:20 106:12 169:13 174:13 175:2
Showed
[2] 69:6 89:5
Showing
[2] 52:19 69:25
Shown
[8] 36:12 39:1 71:25 100:5 101:7 102:4 102:4 172:8
Shows
[7] 33:4 50:24 75:20 75:21 79:10 105:18 108:11
Shuts
[1] 109:5
Side
[13] 11:8 36:24 37:17 38:14 39:11 39:17 49:14 79:16 100:12 101:16 114:21 116:5 174:17
Sides
[2] 11:8 39:4
Sign
[1] 15:12
Signed
[2] 74:23 75:4
Significance
[2] 21:17 35:17
Signifies
[1] 21:22
Simple
[3] 58:8 120:5 135:16
Sink
[1] 103:22
Sinkholes
[1] 161:3
Siphon
[2] 111:1 111:25
Sister
[1] 79:14
Sit
[1] 64:12
Site
[11] 81:13 81:15 85:3 86:6 89:15 89:18 89:23 89:24 94:3 98:7 100:17
Situated
[1] 54:16
Situation
[1] 156:10
Six
[6] 23:18 23:19 61:8 150:14 157:25 158:3
Six-inch
[1] 121:20
Size
[2] 24:14 113:13
Sketch
[1] 80:15
Skipped
[1] 171:10
Slope
[2] 71:21 72:8
Sluice
[1] 82:10
Small
[9] 80:2 80:5 94:21 94:22 94:23 96:19 97:22 170:5 170:8
Smaller
[4] 19:19 20:1 22:3 34:16
Sold
[2] 136:1 153:11
Solid
[2] 75:17 105:2
Someone
[5] 12:2 12:5 12:11 115:3 165:19
Sometime
[2] 96:13 133:12
Sometimes
[4] 22:10 22:19 77:8 77:9
Someway
[1] 131:8
Somewhat
[2] 55:16 68:13
Somewhere
[4] 99:3 100:5 156:8 169:18
Sooner
[1] 131:18
Sorry
[10] 6:5 25:9 33:16 44:25 49:4 63:11 74:7 80:12 84:18 171:3
Sort
[4] 6:7 52:12 123:21 172:17
Sound
[1] 131:24
Source
[5] 13:10 13:17 146:2 147:8 147:9
Sources
[1] 50:20
Speaking
[1] 156:20
Speaks
[1] 90:21
Special
[2] 27:19 54:11
Specialty
[1] 141:19
Specific
[19] 8:1 21:9 23:21 24:21 25:18 42:23 43:16 46:2 50:25 51:10 58:19 69:20 69:21 137:1 152:8 153:17 157:16 159:7 163:16
Specifically
[5] 9:24 41:8 72:19 130:10 133:10
Speculation
[3] 140:12 142:19 159:3
Spinning
[1] 166:20
Spiritual
[1] 21:21
Spreadsheet
[22] 13:1 13:4 13:24 17:23 18:11 25:1 25:21 26:25 27:1 27:12 27:25 28:4 28:6 29:19 40:25 44:23 48:6 50:1 50:24 55:15 57:3 59:25
Spring
[4] 99:4 99:5 99:5 99:6
Springs
[1] 99:3
Square
[1] 75:21
SS
[1] 176:3
Stage
[1] 18:20
Stainless
[1] 91:19
Staking
[1] 45:24
Stand
[8] 23:17 41:2 122:21 148:17 158:11 159:1 159:22 160:25
Standing
[3] 110:18 161:7 168:23
Start
[5] 5:11 6:5 47:15 110:6 171:15
Started
[3] 63:2 93:2 93:12
Starting
[3] 57:19 79:11 100:11
Starts
[5] 47:22 51:23 77:2 77:25 174:17
State
[29] 1:2 7:5 13:5 13:15 15:20 23:23 26:6 41:3 41:13 43:15 51:17 61:19 75:23 75:24 124:10 124:20 124:21 126:9 138:6 147:19 147:22 148:8 150:25 151:19 151:21 152:12 154:10 172:2 176:2
State's
[1] 148:1
State-owned
[3] 124:8 126:15 135:7
Statement
[3] 99:23 99:24 167:21
Statements
[1] 119:8
States
[1] 119:21
Stating
[2] 120:13 120:14
Station
[1] 163:11
Status
[1] 144:5
Statute
[2] 12:17 14:21
Statutes
[1] 11:5
Stays
[1] 88:5
Ste
[4] 2:1 2:7 2:10 2:17
Steady
[1] 166:18
Steel
[1] 91:19
Steps
[1] 12:24
Sticking
[1] 23:14
Sticks
[1] 174:15
Still
[19] 14:20 14:24 15:19 23:14 34:8 55:8 74:14 74:17 78:19 90:22 134:4 134:10 134:13 134:22 134:23 134:25 141:10 159:10 164:25
Stipulate
[1] 153:14
Stipulated
[2] 120:8 121:4
Stipulation
[1] 107:14
Stipulations
[1] 136:21
Stop
[1] 31:20
Stopped
[1] 102:17
Storm
[7] 82:22 83:7 83:14 132:24 133:1 133:10 133:18
Storms
[1] 104:8
Stream
[144] 37:13 37:14 37:16 39:18 67:24 70:7 70:9 70:25 75:20 77:3 77:5 77:7 77:7 77:8 77:9 77:25 78:22 81:3 81:11 81:18 83:2 83:5 84:22 86:6 86:10 86:14 86:25 88:3 88:5 88:14 89:16 92:4 92:16 92:18 93:7 94:10 94:20 94:20 94:22 95:5 95:8 95:11 95:14 96:5 96:6 97:12 97:14 97:15 97:19 97:21 97:25 98:2 98:24 99:13 100:1 100:11 100:13 100:15 100:25 101:1 101:2 101:6 101:8 101:11 101:16 101:16 102:5 102:8 102:9 103:6 103:21 103:23 104:13 105:21 110:11 110:24 116:16 116:20 116:22 116:25 117:6 117:22 117:22 121:21 122:7 128:11 130:16 130:16 131:2 131:3 131:5 131:8 131:14 131:14 131:16 131:18 131:22 132:18 132:18 158:23 159:18 161:3 162:11 162:16 162:19 163:7 163:13 163:17 163:19 163:20 163:22 164:5 164:5 164:10 165:4 165:5 165:18 165:20 167:23 168:23 169:21 170:13 172:16 173:17 173:18 173:19 173:19 173:20 173:22 173:24 173:25 173:25 174:2 174:4 174:8 174:9 174:11 174:12 174:14 174:17 174:22 174:24 174:25 175:4
Streamflow
[1] 146:5
Streams
[5] 70:20 77:11 79:24 99:15 146:12
Street
[7] 2:1 2:4 2:7 2:12 2:14 2:17 2:19
Strictly
[1] 157:5
Strike
[5] 99:16 106:24 106:25 108:10 114:2
Struck
[3] 108:8 108:13 118:20
Structures
[1] 117:25
Studies
[1] 53:7
Study
[7] 52:1 52:5 52:9 52:16 53:17 68:10 68:17
Stuff
[2] 104:12 115:14
Subject
[2] 6:1 43:15
Submit
[3] 108:23 121:9 138:8
Submittable
[1] 60:3
Submitted
[3] 13:12 95:16 108:19
Subsequent
[2] 16:7 27:24
Subsequently
[2] 26:8 103:25
Subsidies
[1] 141:2
Subsidy
[2] 140:9 140:20
Subtract
[1] 61:14
Subtracts
[1] 65:7
Success
[1] 145:4
Sufficient
[7] 146:11 158:18 158:22 159:9 159:17 160:13 161:23
Sugar
[12] 79:14 128:13 135:7 139:21 139:22 139:24 139:25 140:7 140:18 141:16 141:23 143:9
Sugars
[1] 141:19
Suggest
[1] 42:18
Suggesting
[1] 126:9
Sum
[3] 47:16 48:5 48:8
Summary
[2] 112:21 113:9
Sums
[1] 15:14
Superintendent
[1] 93:14
Supervision
[2] 80:8 176:10
Supervisory
[2] 80:21 80:22
Supplement
[1] 40:17
Supplemental
[2] 18:2 118:14
Supply
[1] 4:11
Support
[7] 80:18 142:8 142:9 142:9 144:24 145:1 146:11
Supports
[1] 146:16
Supposed
[1] 79:20
Surprise
[5] 114:2 140:6 140:16 141:6 141:8
Surprised
[1] 20:8
Survey
[6] 13:5 51:17 52:12 52:13 129:17 130:22
Surveying
[1] 14:17
Surveyor
[1] 114:23
Sustain
[3] 21:7 134:8 148:6
Sustainability
[1] 20:24
Sworn
[3] 7:3 74:5 138:3
Symbolism
[1] 22:1
Symbolized
[1] 21:24
System
[67] 75:12 75:14 75:16 76:11 77:15 77:18 77:19 79:1 79:4 79:10 79:10 79:23 80:24 81:6 82:18 82:23 83:15 97:12 122:23 123:9 128:7 128:10 128:14 128:17 128:18 128:21 131:14 131:19 132:2 132:3 132:5 132:7 132:8 132:19 133:7 133:8 133:8 136:5 136:9 136:10 136:14 136:23 137:10 137:15 137:17 137:19 143:8 147:3 147:14 149:1 149:3 149:9 149:16 149:22 157:15 159:13 161:17 161:19 161:22 161:25 162:3 162:10 163:5 163:21 174:20 174:23 174:23
Systems
[3] 128:6 132:16 132:25

T

Table
[1] 75:9
Taro
[84] 9:13 12:21 42:14 42:24 43:20 44:14 48:1 49:19 50:21 51:1 51:7 54:13 54:22 57:5 57:6 57:16 58:16 59:8 59:20 60:23 61:22 61:25 62:20 66:10 66:22 68:23 69:3 69:12 70:7 70:18 71:14 71:16 83:22 83:25 84:3 85:10 85:17 85:20 85:21 85:24 86:4 86:5 92:6 94:1 95:1 95:15 99:6 99:20 100:21 104:23 105:16 105:17 108:20 108:22 109:4 109:4 111:9 111:19 111:22 112:13 112:22 113:2 113:7 113:10 116:13 117:5 117:9 117:17 119:22 121:22 139:14 142:3 142:10 142:17 143:11 144:20 145:9 158:12 158:19 159:9 159:18 160:17 160:22

161:14
Tasked
[1] 9:10
Tasty
[1] 86:2
Tax
[24] 13:3 13:7 13:9 13:11 13:22 14:5 23:25 26:9 26:12 26:14 30:9 31:19 31:22 32:6 32:6 32:16 33:4 35:13 35:20 39:2 48:9 60:15 71:23 113:3
Taxes
[2] 14:11 14:12
Team
[1] 53:6
Technical
[2] 80:18 121:8
Technology
[1] 78:21
Ten
[17] 17:14 18:17 18:23 49:22 60:6 63:10 63:12 63:15 63:21 65:7 69:6 69:9 72:25 73:1 92:16 93:8 113:12
Teresa
[5] 3:2 7:1 7:7 7:8 8:15
Teri
[5] 3:2 7:1 7:8 7:9 8:15
Teri's
[1] 65:8
Term
[4] 20:6 43:13 43:14 149:8
Terminology
[1] 22:13
Terminus
[1] 171:17
Terms
[10] 6:6 22:3 66:7 83:9 119:21 122:11 132:12 152:7 156:23 158:16
Terry
[5] 6:8 31:14 33:3 33:6 38:9
Testified
[21] 7:4 24:4 24:7 24:9 28:11 41:5 53:3 61:1 63:20 72:3 74:6 88:16 88:18 92:13 92:21 103:3 106:22 132:1 138:4 158:9 166:23
Testify
[3] 85:6 146:24 172:12
Testifying
[5] 6:8 88:22 106:14 127:22 144:11
Testimonies
[4] 11:1 11:15 11:21 11:23
Testimony
[80] 3:12 8:15 8:22 8:25 9:20 9:21 11:6 11:7 11:10 11:12 12:11 13:19 13:20 16:21 16:25 16:25 17:1 17:4 17:7 17:11 17:11 18:10 18:20 18:21 18:21 18:25 24:20 24:21 25:20 40:2 40:22 44:14 46:4 46:7 47:18 47:19 47:23 48:4 51:19 55:3 57:14 60:25 61:5 65:9 68:9 69:5 69:14 70:16 71:7 71:9 72:11 73:19 74:9 74:25 75:4 76:14 83:22 85:17 92:11 95:16 99:11 102:25 103:11 103:17 107:5 108:18 120:17 123:14 125:4 125:20 133:14 138:9 138:12 139:1 139:4 158:10 167:14 169:11 170:19 174:3
Themselves
[1] 54:22
Theory
[1] 50:5
Thereafter
[2] 93:13 176:9
Thereby
[1] 106:7
Therefore
[2] 56:2 92:5
Thereunder
[1] 153:10
They've
[2] 108:23 167:25
Third
[6] 48:22 163:21 163:25 164:21 165:2 165:5
Thomas
[1] 4:21
Thorough
[1] 52:10
Thousand
[10] 150:14 156:23 156:25 157:9 157:12 157:13 157:18 157:25 158:3 158:7
Three
[8] 37:23 37:25 84:13 97:20 98:15 111:13 125:21 164:17
Three-and-a-half
[1] 71:10
Thumbnail
[1] 80:15
Tied
[1] 46:2
Tight
[1] 64:17
Title
[18] 7:22 10:4 10:4 10:10 12:15 13:10 13:15 14:23 14:23 15:16 16:1 20:18 20:19 22:12 22:13 22:23 23:13 53:22
Titles
[10] 8:10 10:6 11:20 13:17 22:7 22:7 50:20 51:12 67:2 72:16
TMK
[29] 13:5 13:23 16:13 19:4 28:2 28:17 31:13 31:18 32:19 33:2 35:24 36:3 36:8 37:2 37:8 38:3 38:5 38:12 38:21 41:17 42:4 42:8 42:18 43:2 43:9 44:19 44:24 46:3 64:6
TMKs
[27] 26:10 26:25 27:3 28:5 28:9 28:10 28:12 28:13 28:16 29:17 30:21 31:5 31:9 31:11 37:5 37:24 40:9 40:12 43:25 44:6 45:20 46:3 46:13 50:8 57:10 59:14 61:8
Today
[10] 6:8 6:16 6:16 17:25 46:4 46:13 55:14 144:11 158:5 158:9
Together
[2] 68:17 99:18
Tomorrow
[5] 2:14 4:8 6:12 144:2 175:9
Took
[11] 12:11 12:24 31:22 63:10 69:5 81:20 91:19 91:20 91:23 120:11 124:11
Top
[8] 23:16 36:21 36:24 38:4 41:21 98:21 100:12 154:19
Topographical
[1] 72:15
Total
[36] 44:9 44:13 44:21 45:3 45:6 45:9 45:10 45:12 45:23 46:5 47:1 47:2 47:5 47:6 47:7 48:1 48:8 48:14 49:7 49:19 55:2 55:18 57:13 61:23 62:15 63:9 63:11 63:14 65:8 65:10 77:14 80:7 84:13 91:10 114:2 157:4
Totaled
[1] 61:3
Totally
[1] 63:8
Totals
[1] 45:9
Towards
[8] 56:10 75:15 75:15 100:15 102:16 103:23 104:2 174:14
Tower
[1] 2:19
Town
[1] 6:21
Track
[1] 140:4
Tradition
[2] 20:22 139:14
Traditional
[5] 7:25 20:10 22:21 23:11 139:10
Traditionally
[2] 44:14 165:12
Tragedy
[1] 139:9
Tragic
[1] 139:16
Trained
[1] 127:7
Transfer
[1] 153:19
Transferred
[2] 136:2 153:12
Transing
[1] 141:21
Transmission
[1] 150:13
Transmittal
[1] 26:7
Transparency
[1] 68:13
Transport
[1] 136:9
Transportation
[5] 149:11 149:21 150:15 153:23 158:1
Transposed
[1] 113:21
Travel
[1] 164:1
Treasury
[1] 15:10
Treatment
[1] 125:17
Trial
[1] 121:24
Tributaries
[1] 102:8
Tributary
[4] 122:6 173:21 174:3 174:10
Tried
[4] 6:7 17:3 18:15 130:1
Trips
[1] 6:22
True
[7] 12:10 13:11 75:1 95:19 139:9 160:2 176:11
Truth
[3] 7:3 74:5 138:3
Try
[10] 27:21 44:19 65:14 104:25 105:16 118:18 119:25 143:2 161:2 168:13
Trying
[11] 40:12 40:16 43:23 53:18 62:24 62:25 63:17 65:17 66:19 91:6 114:10
Tunnel
[4] 80:25 83:19 94:25 96:6
Tunnels
[1] 75:17
Turn
[4] 14:2 135:22 139:3 152:19
Turns
[3] 102:16 158:25 159:4
Two
[27] 6:11 6:21 16:13 23:3 45:9 47:21 55:13 74:19 75:8 84:12 85:2 85:12 92:3 94:7 94:9 94:10 94:16 94:18 102:6 120:9 125:5 132:23 133:17 162:12 164:13 165:1 165:14
Two-inch
[1] 165:14
Type
[6] 8:4 9:16 51:13 69:20 69:21 150:9
Typewriting
[1] 176:10

U

Unavailable
[1] 108:20
Unclear
[2] 8:24 91:6
Under
[30] 15:20 18:12 18:18 23:11 31:14 32:8 32:11 32:17 32:20 32:24 33:3 33:9 34:3 39:9 41:11 56:23 60:16 67:1 80:8 83:10 83:12 112:2 113:1 134:11 134:14 151:22 153:20 155:3 159:25 176:10
Underground
[1] 81:1
Understood
[1] 54:5
Underwater
[1] 112:5
Undesirable
[1] 163:4
Unfortunately
[2] 34:14 43:25
Unimproved
[1] 15:3
Unit
[1] 19:21
Unless
[1] 44:2
Unlike
[2] 79:17 139:21
Unresponsive
[1] 108:19
Unwilling
[1] 108:20
Up
[68] 6:19 14:21 30:10 30:13 36:19 36:20 37:22 38:1 46:5 46:8 47:3 49:21 50:1 50:1 51:8 57:2 59:23 59:24 60:15 63:4 63:7 72:21 73:19 79:23 81:20 85:2 86:6 86:10 86:15 87:17 88:1 89:5 91:21 91:23 95:4 95:5 96:16 97:19 98:16 98:21 100:18 102:13 102:13 104:9 108:1 111:15 113:3 118:22 123:4 123:7 123:9 124:18 128:20 131:15 136:20 142:15 145:2 145:13 146:25 151:5 155:8 156:15 156:16 156:24 158:20 163:3 168:21 174:16
Up-country
[3] 123:9 142:15 146:25
Update
[1] 130:1
Uphill
[1] 72:4
Upper
[3] 23:7 70:3 102:14
Usage
[2] 20:21 23:12
Users
[1] 158:6
Uses
[2] 123:15 143:10
Utilizing
[2] 13:6 117:5

V

Vague
[4] 55:11 58:1 159:24 162:1
Vagueness
[1] 66:13
Valley
[6] 62:16 66:9 66:21 72:2 131:3 131:9
Value
[2] 15:2 15:3
Variances
[1] 156:6
Varies
[1] 156:4
Variety
[1] 85:21
Various
[7] 8:21 63:3 79:25 81:11 102:17 128:25 143:9
Vaught
[8] 6:9 80:16 119:19 119:24 120:14 121:18 122:11 122:12
Vegetables
[1] 93:25
Verify
[1] 135:10
Version
[1] 80:2
Versus
[1] 124:10
Vested
[1] 14:23
Vestiges
[2] 139:9 139:14
Vests
[1] 10:4
Via
[4] 10:21 26:6 94:22 165:14
Vis-a-vis
[1] 142:16
Visit
[11] 85:3 86:6 89:1 89:16 89:18 89:23 89:25 94:3 98:8 100:17 158:15
Visited
[1] 89:22
Volume
[2] 23:18 23:19

W

Waieli
[1] 24:3
Waikani
[4] 99:15 110:10 110:15 110:19
Wailoa
[11] 77:22 77:24 77:25 78:6 78:10 78:14 78:21 79:3 123:3 123:6 162:12
Wailoa-New
[1] 137:12
Wailua
[16] 25:5 25:12 37:13 37:16 39:18 41:11 70:9 77:12 97:11 99:6 103:25 105:16 110:19 110:24 110:24 132:6
Wailua-Iki
[2] 102:13 102:15
Wailuanui
[43] 12:20 25:2 25:14 26:4 27:2 34:25 46:6 47:3 47:3 49:14 51:25 52:2 53:12 54:8 56:1 58:9 66:9 66:21 70:7 70:8 70:11 70:25 77:7 77:7 97:8 99:20 101:16 105:21 110:11 112:10 112:21 113:10 113:17 116:15 116:20 116:22 117:14 117:22 119:16 131:3 131:9 131:15 158:12
Wailuku
[3] 2:2 2:13 2:15
Waiokamilo
[22] 77:7 97:12 97:14 98:24 99:15 100:13 100:14 100:25 102:6 103:21 105:19 116:25 117:6 117:21 122:7 131:16 173:22 173:24 173:25 174:4 174:8 174:18
Waiola
[1] 163:22
Wait
[3] 25:11 167:10 168:5
Walked
[2] 81:21 89:3
Wallett
[1] 4:15
Wants
[1] 113:13
Warren
[6] 3:7 3:12 6:15 138:1 138:7 138:12
Washed
[1] 104:9
Watanabe
[10] 3:7 3:12 6:15 137:25 138:1 138:7 138:12 138:21 143:25 148:15
Watanabe's
[1] 138:8
Watch
[1] 64:12
Water
[221] 1:3 4:3 4:11 21:23 21:23 22:1 22:1 22:2 45:25 51:16 61:23 62:12 69:25 70:5 70:7 70:25 71:22 72:3 72:8 77:10 78:8 78:13 78:14 78:17 78:18 79:21 84:3 84:6 84:10 84:14 84:15 84:16 84:16 84:21 84:22 85:1 85:10 85:13 87:13 87:17 88:1 88:2 88:4 88:13 89:5 90:6 94:9 94:13 94:14 94:19 94:22 94:24 94:25 95:2 95:4 95:13 95:18 95:21 95:23 96:20 96:23 97:4 97:22 98:1 99:11 99:14 99:25 100:14 100:24 101:1 101:10 101:11 102:20 102:23 103:6 103:7 103:21 104:11 104:13 104:23 105:17 108:22 109:5 109:11 109:13 111:23 112:3 116:13 116:15 116:19 116:22 116:24 117:6 117:21 119:16 119:22 120:5 121:17 121:21 123:3 123:6 123:9 123:10 123:15 124:2 124:3

124:6 124:7 124:7 124:17 126:8 126:10 126:13 126:14 126:16 126:17 127:8 127:14 127:25 128:18 128:19 131:2 131:13 134:11 135:6 135:19 136:5 136:9 136:22 137:9 137:15 137:16 139:8 142:10 142:14 142:16 142:21 143:7 143:8 143:9 143:13 145:3 145:11 146:2 146:6 146:12 147:3 147:25 148:1 148:25 149:8 149:11 149:12 149:14 149:21 150:13 150:15 151:11 151:25 152:7 153:3 153:22 153:23 154:19 155:17 155:21 155:24 156:13 156:21 156:24 157:9 158:5 158:7 158:19 158:20 158:22 159:8 159:11 159:16 159:18 159:21 159:23 160:1 160:7 160:10 160:13 160:17 160:20 160:24 161:8 161:12 161:12 161:13 161:17 161:18 161:23 161:24 162:9 162:15 162:16 163:2 163:3 163:8 163:14 163:17 164:1 164:9 164:21 164:25 165:1 165:3 165:4 165:5 165:8 165:9 165:11 165:14 165:18 166:24 167:18 173:4

Waterfall
[6] 98:9 98:22 99:3 99:4 110:11 110:15

Waters
[2] 128:11 131:16

Watershed
[1] 135:6

Watersheds
[1] 149:15

Wavy
[3] 41:22 41:25 42:3

Weeded
[1] 57:4

Week
[5] 82:16 83:8 133:1 133:2 133:15

Weeks
[1] 101:5

Weir
[7] 78:1 122:25 123:4 123:7 123:16 125:8 125:15

Welcome
[1] 113:14

Well-rounded
[1] 21:4

Wells
[1] 2:14

Wendt
[7] 72:3 103:1 119:17 119:24 120:1 120:9 120:18

West
[3] 102:13 102:14 121:19

Westerly
[1] 77:4

Westward
[1] 78:22

Wet
[1] 128:12

Whereby
[1] 130:24

Whole
[3] 6:3 108:4 142:2

Willing
[10] 119:21 158:11 158:17 159:1 159:10 159:12 159:22 160:19 160:21 160:25

Withdraw
[2] 54:25 56:3

Witness
[60] 5:8 7:2 7:7 14:21 15:19 18:14 19:1 20:7 22:17 22:20 23:2 25:11 25:15 26:17 27:13 27:17 28:21 30:2 30:11 30:14 30:21 30:25 31:18 32:12 32:15 32:24 36:19 60:22 66:16 72:14 74:4 78:4 80:13 82:14 84:20 85:9 86:18 86:22 91:9 98:5 101:15 101:20 103:15 109:21 113:8 125:1 125:6 125:11 125:16 127:6 137:25 138:2 138:7 141:7 143:1 145:2 145:13 146:21 154:2 166:17

Witness'
[1] 85:5

Witnessed
[1] 117:16

Witnesses
[3] 3:1 6:11 14:17

Woman
[1] 21:24

Wondering
[1] 175:3

Word
[7] 21:17 21:19 22:5 22:6 24:5 115:2 155:5

Words
[13] 15:14 22:8 23:5 35:23 52:13 59:19 84:15 88:25 103:5 128:17 132:8 152:15 174:6

Workers
[1] 131:21

Works
[4] 99:14 100:3 105:5 123:5

Wright
[1] 2:7

Written
[22] 3:12 8:22 8:25 10:1 25:20 47:18 47:19 47:23 48:4 51:19 55:3 57:14 68:9 71:9 85:17 95:16 123:14 125:20 138:9 138:12 138:25 158:10

X

Xerox
[1] 68:12

Y

Year
[19] 85:22 135:11 135:20 151:11 154:13 154:20 155:14 155:15 155:18 155:22 156:1 156:2 156:4 156:4 156:5 156:9 156:13 156:21 163:7

Yearly
[2] 151:5 156:15

Years
[14] 8:6 72:22 85:2 85:13 87:21 92:17 93:8 96:18 111:13 117:22 131:19 150:11 156:9 156:11

Yellow
[9] 35:16 38:6 38:16 39:20 40:6 41:18 75:25 100:11 113:19

Yip
[2] 2:6 4:17

Young
[7] 32:18 32:25 33:10 33:11 33:12 33:12 33:21

Yourself
[2] 135:15 147:11

1 BOARD OF LAND AND NATURAL RESOURCES

2 STATE OF HAWAII

3 In the Matter of Contested)DLNR FILE: 01-05-MA
Case Regarding Water Licenses)
4 at Honomanu, Keanae, Nahiku and)
Huelo, Maui)
5 _____)

6 CONTESTED CASE HEARING

7

8 Held on November 15, 2005, commencing at 9:00 a.m., at

9 Haiku Community Center, Haiku, Hawaii.

10

11

12

13

14

15

16

17

18

19

20

BEFORE: JEAN MARIE McMANUS
21 Hawaii CSR #156, CA CSR #3119

22

23

24

25

HEARINGS OFFICER:	HONORABLE E. JOHN McCONNELL 33 N. Market Street, Ste. 200 Wailuku, Hawaii 96793
BLNR Attorney:	LINDA CHOW, ESQ. Deputy Attorney General 465 S. King Street, Rm. 300 Honolulu, Hawaii 96813
For EMI and A&B:	DAVID SCHULMEISTER, ESQ. ELIJAH YIP, ESQ. Cades Schutte Fleming & Wright 1000 Bishop Street, Ste. 1200 Honolulu, Hawaii 96813
For Maui Land & Pineapple:	DAVID B. MERCHANT, ESQ. Kiefer & Merchant 444 Hana Highway, Ste. 204 Kahului, Hawaii 96732
For County of Maui:	JANE E. LOVELL, ESQ. Deputy Corporation Counsel 200 S. High Street Wailuku, Hawaii 96793
For Maui Tomorrow:	ISAAC HALL, ESQ. 2087 Wells Street Wailuku, Hawaii 86793
For Na Moku Aupuni O Ko'olau Hui, et al:	ALAN T. MURAKAMI, ESQ. MOSES K.N. HAIA, ESQ. 1164 Bishop Street, Ste. 1205 Honolulu, Hawaii 96813

INDEX

WITNESSES:

G. STEPHEN HOLADAY

DIRECT EXAMINATION BY MR. SCHULMEISTER..... 6
CROSS-EXAMINATION BY MR. MURAKAMI..... 7
CROSS-EXAMINATION BY MR. HALL..... 31
FURTHER CROSS-EXAMINATION BY MR. MURAKAMI..... 38

GARRET HEW

CROSS-EXAMINATION CONTINUED BY MR. HAIA..... 43
CROSS-EXAMINATION BY MR. HALL..... 78
CROSS-EXAMINATION BY MR. MERCHANT..... 134

MARK VAUGHT

DIRECT EXAMINATION BY MR. SCHULMEISTER..... 135
CROSS-EXAMINATION BY MR. HAIA..... 136
CROSS-EXAMINATION BY MR. HALL..... 143

LEE JAKEWAY

DIRECT EXAMINATION BY MR. SCHULMEISTER..... 148
CROSS-EXAMINATION BY MR. MURAKAMI..... 149
FURTHER CROSS-EXAMINATION BY MR. MURAKAMI..... 162
CROSS-EXAMINATION BY MS. LOVELL..... 170
FURTHER CROSS-EXAMINATION BY MR. MURAKAMI..... 172

STEVEN GREG KAI HO'OKANO

DIRECT REBUTTAL EXAMINATION BY MR. MURAKAMI..... 175
CROSS-EXAMINATION BY MR. SCHULMEISTER..... 183

EDWARD WENDT

DIRECT REBUTTAL TESTIMONY BY MR. MURAKAMI..... 185

BEATRICE KEKAHUNA

DIRECT REBUTTAL EXAMINATION BY MR. MURAKAMI..... 207

EXHIBITS RECEIVED INTO EVIDENCE

Declaration of G. Stephen Holaday..... 7
Na Moku Exhibit No. B-126..... 23
Na Moku Exhibit No. 127..... 205
Na Moku's Exhibit No. B-128..... 211

1 HEARINGS OFFICER JUDGE McCONNELL: The
2 hearing will come to order. We're reconvened.
3 Counsel are all present except for Mr. Freedman whom
4 I'm informed will not be here today.
5 MR. SCHULMEISTER: He advised us before he
6 left yesterday he would not be coming today.
7 HEARINGS OFFICER JUDGE McCONNELL: And
8 we'll continue with the cross-examination of Mr. Hew.
9 MR. SCHULMEISTER: Actually what we're
10 going do is take Mr. Holaday out of order.
11 MR. HALL: I would object to that. I
12 thought we were going to finish Mr. Hew. I had
13 planned on that.
14 MR. MURAKAMI: So had I.
15 MR. SCHULMEISTER: The beginning of
16 yesterday I specifically brought that up first order
17 of business --
18 HEARINGS OFFICER JUDGE McCONNELL: How
19 long is he going to be?
20 MR. SCHULMEISTER: I'm just going turn him
21 over for cross.
22 MR. HALL: I didn't agree to that. The
23 only person I agreed to take out of order was Mr.
24 Watanabe.
25 MR. SCHULMEISTER: That was the very first

1 thing we were going to do this morning.
2 MR. HALL: No, it wasn't. You said you
3 thought you were going to do Mr. Hew and then after
4 that you were going to take your other two witnesses
5 and you thought it would be the next day. You didn't
6 say you were going to take them out of order.
7 HEARINGS OFFICER JUDGE McCONNELL: How
8 long is Mr. Hew going to be?
9 MR. HALL: We talked about that yesterday.
10 HEARINGS OFFICER JUDGE McCONNELL: I'll
11 let you take him out of order. You don't have any
12 direct examination?
13 MR. SCHULMEISTER: No, just putting in his
14 declaration.
15 MR. HALL: How many of these witnesses are
16 coming out of order? I think he thinks there's more
17 than one.
18 HEARINGS OFFICER JUDGE McCONNELL: That's
19 it, I hope.
20 MR. SCHULMEISTER: Well, I was planning to
21 take Mr. Jakeway as well, although I think he's
22 definitely more available.
23 HEARINGS OFFICER JUDGE McCONNELL: We will
24 just do one.
25

1 G. STEPHEN HOLADAY
2 was called as a witness by and on behalf of A&B and
3 EMI, was sworn to tell the truth, was examined and
4 testified as follows:
5 HEARINGS OFFICER JUDGE McCONNELL: State
6 your name, please, for the record.
7 THE WITNESS: G. Stephen Holaday.
8 HEARINGS OFFICER JUDGE McCONNELL: P-h?
9 THE WITNESS: Yes.
10 DIRECT EXAMINATION
11 BY MR. SCHULMEISTER:
12 Q. Mr. Holaday, can you state your employer?
13 A. My employer is Alexander & Baldwin.
14 Q. And your position?
15 A. I am general manager of Hawaiian Commercial &
16 Sugar Company and president of the agricultural group.
17 Q. You have in front of you a copy of a written
18 declaration purports to be signed by you on July 29th,
19 2005, is that correct?
20 A. Correct.
21 Q. Is that a true and correct copy of your
22 written testimony in this case?
23 A. Yes.
24 Q. Is that testimony true and correct to the
25 best of your belief?

A. Yes.

Q. I have no further questions.

HEARINGS OFFICER JUDGE McCONNELL: The declaration will be in evidence.

(Declaration of G. Stephen Holaday was received into evidence.)

Any questions?

CROSS-EXAMINATION

BY MR. MURAKAMI:

Q. Mr. Holaday, I'm Alan Murakami, counsel for Na Moku Aupuni O Ko'olau Hui and two individuals in Honopou where a couple of your ditches run through.

I understand from your testimony that, if I'm interpreting right, that HC&S is using water from the EMI ditch system in as efficient manner as possible, is that right?

A. Correct.

Q. You're using drip irrigation?

A. Correct.

Q. That which I guess is in agricultural parlance basically the state of the art for the best and most efficient use of water?

A. Correct.

Q. And you say here that you're using all but a small area of the cultivated cane land farmed by HC&S

1 with drip irrigation, on Page 2, Paragraph 4?
2 A. Correct.
3 Q. Does that mean that there are other lands
4 which are being irrigated without your drip
5 irrigation?
6 A. Correct. There's about 500 acres around the
7 Pu'unene Mill where we dispose of wastewater.
8 Q. And those would be by spray?
9 A. That's overhead sprinkler.
10 Q. As you drive along the highway and see all
11 that spraying going on, that's the part that is
12 exempted from your statement?
13 A. Correct.
14 Q. And that's wastewater?
15 A. That's recycled wash water, wastewater.
16 Q. And I take it that, based on your testimony,
17 you're saying here that the use of this water is at a
18 level at which you cannot sacrifice any additional
19 loss of that water for your operation; is that right?
20 A. I'm saying we use water as efficiently as
21 possible and generally we're water short.
22 Q. So that's what I'm saying. I'm trying to get
23 a gist of what you're saying is that you can't afford
24 to lose any water, because as efficiently as you're
25 using it, you can't afford to lose any water, correct?

1 A. That's generally correct.
2 Q. And is that the reason why you're only
3 willing to allow Maui Land & Pine to take water on a
4 sale basis after the -- is it the Haiku Ditch exceeds
5 100 million gallons per day?
6 A. I'll have to defer on that.
7 Q. You don't know that?
8 A. No.
9 Q. You don't know whether you're selling to Maui
10 Land & Pine under those conditions?
11 A. I don't know the terms.
12 Q. But you're aware that there is an arrangement
13 to sell that water above a certain threshold amount?
14 MR. MERCHANT: I'm going to object.
15 Characterization of selling the water. We talked
16 about it yesterday, transporting the water.
17 MR. MURAKAMI: That's an argument.
18 HEARINGS OFFICER JUDGE McCONNELL: I'll
19 permit it.
20 THE WITNESS: Could you repeat it?
21 Q. MR. MURAKAMI: You're aware of an arraignment
22 whereby Maui Land & Pine can sell or buy water from
23 you above a certain threshold amount, correct?
24 A. I think so.
25 Q. And I take it -- but because in those

1 situations there's plenty of water, it's raining, so
2 you don't need the water at that time?
3 A. I think that's an over-generalization.
4 Q. What is the rationale behind allowing some
5 third-party to take water which you otherwise say you
6 need for all the operations of HC&S?
7 A. I guess I'm not familiar enough with the Maui
8 Pine agreement, and it must predate me, because I just
9 don't know that much about it.
10 Q. And this operation by HC&S, it's part of a
11 pretty complex system of water delivery and cane
12 production that's been established over 100 years,
13 correct?
14 A. Correct.
15 Q. And you started what year?
16 A. 1996 with HC&S.
17 Q. And as part of HC&S' management -- I take it
18 you're a manager?
19 A. Correct.
20 Q. You were briefed, were you not, by your
21 predecessors and superiors to the various aspects of
22 this operation?
23 A. Sure, in general manner.
24 Q. And you were briefed how there is an
25 inter-relationship, obviously, between EMI and HC&S?

1 A. Correct.
2 Q. Were you briefed with the various conditions
3 under which EMI delivers this water to you?
4 A. In general terms.
5 Q. And do you have a basic familiarity, if not
6 an intimate one, about the system of water delivery
7 from EMI to the fields of HC&S?
8 A. I have a general understanding.
9 Q. And as I understand it also in your testimony
10 you have various fields, 30,000 of which are supplied
11 in part or in whole by EMI, correct?
12 A. Correct.
13 MR. SCHULMEISTER: 30,000 acres, right,
14 not fields.
15 MR. MURAKAMI: Right, 30,000 acres.
16 A. Yes.
17 Q. And an additional 7,000 which is irrigated
18 only by alternative sources from West Maui?
19 A. West Maui, correct.
20 Q. And that is through some kind of cooperative
21 arrangement with Wailuku Agribusiness?
22 A. Correct.
23 Q. So just for my familiarization, that 7,000
24 acres is pretty much being watered by Wailuku
25 Agribusiness' operations because of the topography of

1 those lands?
2 A. Well, there's a 1924 agreement with HC&S or
3 A&B, I can't remember, and Wailuku that jointly
4 developed that ditch system and jointly both parties
5 take water out of the system.
6 Q. So but basically the 7,000 acres that's
7 watered by that West Maui source, that's because of
8 the topography and the ability of that gravity flow
9 system to reach those fields?
10 A. Correct.
11 Q. That cannot be reached by the EMI sources
12 coming from the other side, is that right?
13 A. Water would have to come down and go back up
14 the hill.
15 Q. Right. And you couldn't make it go back up
16 the hill?
17 A. Well, if you have enough money and
18 electricity.
19 Q. If you are not pumping, in other words?
20 A. Correct.
21 Q. So to round out this understanding of this
22 system, you were in a position to review some of the
23 historical documents involving, as you say, some of
24 the agreements made with other companies and
25 conditions under which water is delivered to your

1 sugar fields?
2 A. I don't think I reviewed documents.
3 Q. You didn't?
4 A. Just a general understanding.
5 Q. Were you aware of any sorts of stipulations
6 or conditions for how HC&S was able to enjoy the
7 benefits from East Maui?
8 A. Just general company history.
9 Q. And are you familiar with the history of the
10 construction of that system?
11 A. Just what I've read, generally what I've
12 read.
13 Q. And I understand, for example, that there are
14 various stages of construction for the ditch system
15 resulted in the completion of various ditches over a
16 period that stretched over the early part of this past
17 century, correct?
18 A. And it may even predate this century, because
19 the original documents I believe were with the Kingdom
20 of Hawaii.
21 Q. Right. And then when the territorial
22 government took over, there were arrangements with
23 that government, were there not, to take water from
24 the lands that it assumed control over?
25 A. I would assume so.

1 Q. And were you aware of any conditions that
2 would allow you to take this water so long as certain
3 events or certain conditions were met?
4 A. I'm not sure I understand what you're asking
5 me.
6 Q. Were you aware of any conditions under which
7 you had to abide in order to receive this water?
8 A. Not specifically.
9 Q. Have you had a chance to look at any of the
10 original lease agreements governing the transport of
11 water from East Maui to Central Maui?
12 A. The only document I recall looking at
13 specifically just was the historical significance of
14 the original lease between the Kingdom and HC&S.
15 Q. How about the first lease between the
16 Territorial government and HC&S?
17 A. I don't think I've seen that.
18 Q. Who is H.P. Baldwin?
19 A. H.P. Baldwin was the co-founder of Alexander
20 & Baldwin.
21 Q. He's the Baldwin of A&B?
22 A. Correct.
23 Q. Were you aware that the Territory did allow
24 for the taking of water off of the -- for so-called
25 license areas which involve Nahiku, Keanae, Honomanu

1 and Huelo?
2 A. I would assume that.
3 Q. And were you aware that the only -- that
4 there was permission given by the Territorial
5 government for the relevant period of the construction
6 that occurred in the early part of the 1990s to grant
7 permission to Mr. Baldwin to construct the various
8 improvements that now constitute East Maui Irrigation
9 system ditch tunnel and other delivery systems?
10 A. I have to assume that, yes.
11 Q. Were you aware that one of the conditions
12 under which this arrangement was made, in other words,
13 the permission granted by the Territorial government,
14 was to protect the interests and rights of those taro
15 farmers that had water rights in Wailuanui Valley and
16 Keanae as a precondition of any of this construction
17 going forward?
18 A. As a specific condition, I did not know that.
19 I would assume that all -- whatever the document said
20 is what it said.
21 MR. MURAKAMI: Mr. Hearing officer, may I
22 approach the witness with this document?
23 HEARINGS OFFICER JUDGE McCONNELL: Yeah.
24 MR. SCHULMEISTER: Is this one of the
25 exhibits?

1 MR. MURAKAMI: No, it's not. And we just
2 got this, and I would like to make it available at the
3 appropriate time. I only have one copy today. But I
4 would like to make this an exhibit.
5 HEARINGS OFFICER JUDGE McCONNELL: Show it
6 to Mr. Schulmeister.
7 MR. SCHULMEISTER: Would you make a
8 representation for the record as to what it is?
9 MR. MURAKAMI: All right.
10 Q. I'm going to hand to you, Mr. Holaday, a copy
11 of what's got the number 539 on the top, and it
12 consists of seven pages if you disregard the cover
13 sheet, which I will not include. And it is a, what I
14 will represent to be a document out of the state
15 archives, which is a lease agreement between the
16 Territory of Hawaii and H.P. Baldwin.
17 Do you see that, of Haiku, Maui?
18 A. Okay.
19 Q. Is that the same H.P. Baldwin that's the part
20 of the half of A&B today?
21 A. I would assume so.
22 Q. Do you know of any other H.P. Baldwin in
23 Haiku, Maui that it would be otherwise?
24 A. No.
25 Q. All right. So this is the lease agreement,

1 and what I'm pointing out to you basically is the date
2 of this agreement and the parties signing at the back,
3 Pages 6 and 7 you'll see documents showing the signed
4 signature of H.P. Baldwin and Edward Smith, Commission
5 of Public Lands on Page 6.
6 A. I don't see a signature.
7 Q. It says "signed" which is a common practice
8 of the archives to have the original documents and
9 then to have copies made showing that there were
10 signatures on the originals.
11 A. Okay.
12 Q. And that this was signed on the 19th day of
13 May, 19 -- I believe that's '02, correct?
14 A. That's what it says.
15 Q. Have you seen this document before?
16 A. I don't recall seeing it.
17 Q. Do you see that this, if you read the first
18 page, describes the arrangement to allow for the use
19 of former Kingdom lands under the Territory of
20 Hawaii's control, and if you read it carefully it
21 describes the Keanae License area between Wailua-Iki
22 to the east and -- I'm sorry, and the eastern boundary
23 of the ahupua'a of Honomanu to the west.
24 Are you familiar with where Wailua-Iki is?
25 A. No, I'm not.

1 Q. You're not. But it does represent this is
2 that area between Honomanu and the gulch of
3 Wailua-Iki, is that right?
4 A. Without reading the document carefully,
5 that's what it says.
6 Q. And basically consists of some 12,000 plus
7 acres?
8 A. That's what it says.
9 Q. And basically allows and grants Mr. Baldwin
10 this ability to use this land which is formerly Crown
11 and government land of the Kingdom of Hawaii.
12 As you see on Page 2, subject, however, to
13 the vested interest in water of landowners in Keanae
14 and Wailuanui and all other third parties onto said
15 lease, et cetera; correct?
16 A. That's what it says, yes.
17 Q. And it repeats that on Page 3 where it
18 establishes certain conditions of this lease, again,
19 with a promise by Mr. Baldwin that he will not
20 interfere with the vested interest in water of
21 landowners in Keanae or Wailuanui or any other -- or
22 of other third parties, correct?
23 A. That's what it says.
24 Q. Were you aware or were you briefed on this
25 condition on the original construction of the East

1 Maui Irrigation system as it affected this area of
2 12,000 acres in the Keanae-Wailuanui area?
3 A. No, I was not.
4 Q. By the way, let me just show you, Mr.
5 Holaday, on page -- I'm sorry, I just read this
6 yesterday -- that this particular lease agreement is
7 in part for the privilege of using these lands and
8 includes the other three license areas that are
9 between Nahiku and -- says Maalaea Bay -- sounds like
10 all the way over towards Lahaina side -- for the
11 purpose of constructing, erecting, digging or in any
12 other manner placing and upon said public lands, any
13 dams, ditches, tunnels, flumes, sluiceways or water
14 pipes could be used for the purpose of conveying water
15 from the land hereby demised across said public lands
16 to such other lands as the lessee -- I take that to be
17 Mr. Baldwin -- or his executors, administrators or
18 assigns -- I take that to mean HC&S, does it not?
19 A. I was going to try and look at the front.
20 That's what it says.
21 Q. -- may desire and repairing, maintaining,
22 adding to and enlarging the same as may be necessary
23 during said term and for such purposes, et cetera.
24 Correct?
25 A. That's what it says.

1 Judge, the reason I ask is, Alexander
2 Baldwin is a partnership and always operated as a
3 partnership. Then it was incorporated, I believe, in
4 1900, if I remember right. So I'm just saying this is
5 with H.P. Baldwin and I'm not familiar with it.
6 Q. Right. He's a predecessor and interest in
7 A&B, correct?
8 A. He's a co-founder partnership in the
9 corporation.
10 Q. But in that line of succession, Mr. Baldwin
11 started the whole ball rolling?
12 A. Correct.
13 Q. And, of course, when you construct something
14 and maintain it over 100-plus years, you're operating
15 on the basis of that construction having happened 100
16 years ago, right?
17 A. Correct.
18 Q. You are not going to undo that construction
19 in the near term, are you?
20 MR. SCHULMEISTER: Let me just object as
21 vague.
22 Q. MR. MURAKAMI: You're not going to take away
23 any of the ditches, tunnels, sluiceways, et cetera, in
24 the near future? There's no plans to do that?
25 MR. SCHULMEISTER: You mean to demolish

1 it?
2 MR. MURAKAMI: Yes.
3 A. I don't know. I believe there are ditches
4 that have been abandoned.
5 Q. Okay. But there are a substantial number of
6 ditches and tunnels that are still operating for the
7 benefit of EMI and HC&S, correct?
8 A. Correct.
9 Q. And you're taking that water for the economic
10 benefit of the company to make money off the land of
11 Central Maui?
12 A. Correct.
13 Q. And the construction was done on the -- as I
14 think I've demonstrated -- on the explicit promise not
15 to interfere with the rights of East Maui's landowners
16 who have water rights, correct?
17 A. That's what the document says.
18 Q. Is that the current commitment of HC&S and
19 A&B today that this 100-year-old commitment is still
20 being observed?
21 A. My understanding is that the commitment in
22 those documents are being met.
23 Q. But my question to you earlier was whether
24 you were aware of this document before, correct?
25 A. Yeah.

1 Q. And you didn't know about it?
2 A. No.
3 Q. So how would you know about this 100-year-old
4 commitment, if you never seen this document before?
5 A. There is a lot of documents that the company
6 has that I'm not familiar with. I have to assume that
7 we're operating pursuant to the document.
8 Q. But nobody told you about this, correct, in
9 the past?
10 A. That's correct.
11 Q. And this is the first time you've heard of it
12 is today?
13 A. First time I've seen that document.
14 MS. LOVELL: Will that document be marked
15 for identification at least?
16 MR. MURAKAMI: Yes. And at this point I
17 will do so. If I may have leave -- or if there is
18 other arrangement to be made, I would be willing to
19 mark this document next in order and have copies made
20 available at the next opportunity.
21 HEARINGS OFFICER JUDGE McCONNELL: We will
22 mark it. It's B-126.
23 MR. MURAKAMI: May I have that also
24 received into evidence upon production of the
25 appropriate copies to the parties.

1 HEARINGS OFFICER JUDGE McCONNELL: Any
2 objection?
3 MR. SCHULMEISTER: No.
4 HEARINGS OFFICER JUDGE McCONNELL: Okay,
5 it will be in evidence, B-126, and you will provide
6 copies to all concerned.
7 MR. MURAKAMI: Yes, I will.
8 (Na Moku Exhibit No. B-126 was received
9 into evidence.)
10 MS. LOVELL: Is there a way we can get
11 copies before the end of the proceedings today?
12 MR. MURAKAMI: I will try to arrange that,
13 I will.
14 MS. LOVELL: Maybe somebody can run into
15 town at the lunch hour.
16 HEARINGS OFFICER JUDGE McCONNELL: If it
17 can be done today fine; if not, I guess I will prevail
18 on Ms. Chow.
19 MS. LOVELL: It limits people's
20 opportunities to --
21 HEARINGS OFFICER JUDGE McCONNELL: It will
22 be available here.
23 MS. CHOW: At the worst I will scan it
24 tomorrow and email it to everyone.
25 MS. LOVELL: Thank you, I appreciate that.

1 But it's not very helpful if that's done after the
2 hearing concludes. I'm thinking there might be a
3 Xerox machine in Paia or something.
4 MR. MURAKAMI: We'll make whatever
5 arrangements I can.
6 May I have leave to take it at the
7 appropriate time? You can keep it now.
8 HEARINGS OFFICER JUDGE McCONNELL: She can
9 make the copies, okay. If you're going to do it
10 today --
11 MR. MURAKAMI: I don't know if I can. I
12 don't know what's available.
13 HEARINGS OFFICER JUDGE McCONNELL: Neither
14 do I.
15 Q. MR. MURAKAMI: Mr. Holaday, earlier you
16 talked about you're, I guess, fundamentally familiar
17 with your arrangement with Maui Land & Pine.
18 A. Yes.
19 Q. And I'm going to hand you what has been
20 marked as Exhibit E-2 entitled License and Water
21 Transmission Agreement by and among East Maui
22 Irrigation Company, Limited, A&B, and Maui Land &
23 Pineapple.
24 Have you seen this agreement, transmission
25 agreement provided by Maui Land & Pine for these

1 proceedings?
2 MS. LOVELL: What was the number?
3 MR. MURAKAMI: E-2, echo dash two.
4 Q. Had you seen that before?
5 A. I don't think I have seen it before.
6 Q. It's a 1993 agreement. It precedes your
7 assumption of command of HC&S, correct?
8 A. It says it's 1991.
9 Q. '91, sorry. So precedes it by five years?
10 A. Correct.
11 Q. That particular agreement has apparently
12 expired or terminated but has been extended -- but has
13 been amended at one point by a 1993 agreement. And
14 I'm going to ask you if you've seen this amendment to
15 License and Water Transmission Agreement, which has
16 been submitted and I assume admitted as E-3.
17 Have you seen this document and/or
18 recognize the signatures on the back?
19 A. I don't think I have necessarily seen this
20 document. And I recognize what I think is Richard
21 Cameron's signature and a lady named Beverly Green. I
22 know those people.
23 Q. Were they predecessors to your management?
24 A. Richard Cameron was my predecessor. Beverly
25 Green did something in the law office of corporate or

1 legal department.
2 Q. Finally, that was a 1993 agreement that
3 precedes you by two years, correct? Or is it three
4 years?
5 A. 1996, three or four years.
6 Q. I assume that you weren't around when that
7 document was executed.
8 MS. LOVELL: Are you talking about E-3?
9 MR. MURAKAMI: Yes.
10 A. I worked for Alexander & Baldwin in Honolulu
11 at the time.
12 Q. Had you seen this document?
13 A. I don't think so.
14 Q. Let me hand you a copy of what has been
15 marked as Exhibit E-4, entitled Second Amendment to
16 License and Water Transmission Agreement. And I'm
17 going to ask -- this is a document dated December 17
18 of 1998, two years after you arrived.
19 And I'm going to ask you, have you seen
20 this document? Do you recognize the signatures on the
21 back of this document?
22 A. It's got my signature on it, so I must have
23 seen it.
24 Q. So E-4 is an amendment, is it not, that
25 compliments if not supplements the legal effect of

1 what has been marked as E-3 and E-2, correct?
2 A. Correct.
3 Q. So are you saying at this point that you had
4 not seen the documents for which you signed an
5 amendment to extend the life of that document, that is
6 E-2?
7 A. I think so.
8 Q. You just signed it?
9 A. (Witness nods head up and down).
10 Q. But you didn't review it?
11 A. Not the predecessor agreements.
12 Q. All right, thank you.
13 Mr. Holaday, having testified under oath
14 here that you are managing HC&S to the best of your
15 ability to assure an efficient distribution of water,
16 which should not be or cannot be sacrificed without
17 some detriment to HC&S, what I want to ask is:
18 Isn't it true that A&B is also planning to
19 expand its business park in Wailuku or Kahului?
20 A. My understanding is they're before someplace
21 in the rezoning process.
22 Q. Before the Maui County Planning Commission
23 process, correct?
24 A. Correct.
25 Q. And they need a rezoning to get that

1 approval?
2 A. Correct.
3 Q. As a part of that rezoning, isn't it a
4 requirement that you provide information to assure
5 that there is adequate water to support that proposed
6 expansion of the business park?
7 A. I'm not real familiar with how the real
8 estate part of the company works in the zoning
9 process.
10 Q. Now, isn't it about a 400-acre project?
11 A. I thought it was 130-something.
12 Q. So 130 acres of a business park expansion and
13 it's on the Alexander & Baldwin lands; is it not?
14 A. Correct.
15 Q. Or is it on HC&S side?
16 A. HC&S is a division of, so as a legal entity,
17 HC&S doesn't exist, so it would be A&B land.
18 Q. Okay. Is there or was there sugarcane on
19 those lands?
20 A. There is sugarcane on some of those lands.
21 Q. So you would be giving up a part of your
22 operation in order to satisfy this proposal for
23 planned expansion, correct?
24 A. That's where we dispose of wastewater.
25 Q. You dispose of wastewater there now?

1 A. Yes.
2 Q. Is that where the spraying is occurring?
3 A. Yes, part of it.
4 Q. Right next to Hana Highway?
5 A. Part of it, and part of it does not have any
6 cane on it.
7 Q. Just vacant?
8 A. Just vacant.
9 Q. Now, to support that request, isn't it true
10 that A&B and/or HC&S is planning to use 6 million
11 gallons of water per day that is being delivered by
12 the Wailoa Ditch after completion of the so-called
13 Waiawa Reservoir at the terminus of that ditch by
14 2008?
15 A. Can you resay that again?
16 Q. Yes. Isn't it true that the plans of A&B for
17 this business park expansion of 130 acres is -- under
18 the plans submitted under your proposal to the Maui
19 County for the rezoning necessitates the use of -- or
20 I should say is planning the use of Wailoa Ditch water
21 to the tune of 6 million gallons per day to be treated
22 and used for that expansion at the terminus of the
23 Wailoa Ditch?
24 A. My understanding is that that's not correct.
25 I think there's a proposal, I believe there's one from

1 Brewer, and one from A&B that would use West Maui
2 water, but I don't know where that's at.
3 So that proposal, as I understand it, is
4 West Maui water.
5 Q. At no time did A&B propose the use of Wailoa
6 Ditch water to the tune of about 6 million gallons per
7 day to be treated in order to support the business
8 park expansion?
9 A. Not to my knowledge. Because the up-country
10 water system is not connected to the central valley
11 system. That's always been a premise that we would
12 not want that to happen.
13 Q. Is it true that you never contemplated using
14 that much water from the EMI system in order to
15 support the business park expansion?
16 A. Not to my knowledge.
17 MR. MURAKAMI: At this point I don't have
18 any further questions except I want to reserve the
19 right and opportunity, since I was expecting to get
20 this document later for this examination, our ability
21 to get documents which I think will be shown
22 contradict Mr. Holaday's last statement as a matter of
23 rebuttal.
24 HEARINGS OFFICER JUDGE McCONNELL: We'll
25 deal with that. Yeah, if we get them, I'll make the

1 ruling. Your intent would be to offer them in
2 evidence?
3 MR. MURAKAMI: Yes.
4 HEARINGS OFFICER JUDGE McCONNELL: Mr.
5 Hall.
6 CROSS-EXAMINATION
7 BY MR. HALL:
8 Q. Could I have you look at Exhibit A-6, please.
9 That's your map of HC&S ditch system in part.
10 A. It's a schematic.
11 Q. Are you familiar with the Hawaiian Commercial
12 & Sugar ditch system?
13 A. I have general familiarization of it.
14 Q. And that's how the water from the EMI ditch
15 system is actually delivered to the plantation?
16 A. I assume so, yes.
17 Q. You don't know that?
18 A. Well, I can see the Hamakua Ditch. I can see
19 the Kauhikoa Ditch, the Lowrie Ditch and Haiku Ditch.
20 That's how we deliver East Maui water to the
21 plantation.
22 Q. And water that comes in from the Wailoa Ditch
23 can be dropped down while it's on the plantation to
24 the Hamakua Ditch and dropped down from there to the
25 Kauhikoa Ditch and dropped down from there to the

1 Lowrie Ditch and drop down from there to the Haiku
2 Ditch, correct?
3 MS. LOVELL: Objection, compound.
4 HEARINGS OFFICER JUDGE McCONNELL:
5 Overruled.
6 THE WITNESS: I would assume that. I
7 don't know how the ditch system works.
8 Q. MR. HALL: You don't know how the ditch
9 system works?
10 A. No.
11 Q. What is your position with the plantation?
12 A. General manager.
13 Q. And you don't know how the ditch system
14 works?
15 A. I don't know the details of how we would drop
16 water.
17 Q. Who does?
18 A. I would think that Garret would, the farm
19 manager for the Keahua division would know.
20 Q. You think Garret does?
21 A. I would think so.
22 Q. Has HC&S done any contingency planning with
23 regard to going out of business in the next 25 to 50
24 years?
25 A. Not to my knowledge.

1 Q. Now, you just testified that HC&S was a
2 subsidiary of A&B. You're familiar that in at least
3 the time that you've been with the plantation that
4 plantation lands have been taken out of plantation use
5 and either been put into agricultural subdivisions or
6 urban uses?
7 MR. SCHULMEISTER: Let me object to the
8 extent you said it was a subsidiary. I believe he
9 said it's a division.
10 MR. HALL: All right, fine.
11 A. Now, then you asked about three questions
12 there.
13 Q. Since you have been there --
14 A. Since I've been there, sugar growing areas,
15 I'm not sure.
16 Q. Lands that have been used for either sugar or
17 leased to Maui Land & Pine have been taken out of
18 those uses and devoted to agricultural subdivisions or
19 urban uses; is that correct?
20 A. I think that's not correct. The only land
21 that I know of comes to mind is the Maui Business Park
22 along Dairy Road. To my knowledge that's the only
23 one.
24 Q. Are you aware of an agreement by which the
25 plantation or A&B gave or sold, transferred lands in

1 and around the airport to the Kahului Airport for
2 airport uses?
3 A. That would predate me, so.
4 Q. Are you familiar with that?
5 A. Not the specific transaction.
6 Q. Are you aware that there were lands that did
7 surround Kahului Airport that were in sugarcane?
8 A. Not to my knowledge, that would have been
9 many years ago.
10 Q. Are you aware of -- you did testify about the
11 current industrial park. Were you aware of the
12 adjoining industrial area that was reclassified by
13 A&B?
14 A. That's what I was talking about the 130-some
15 acres that is presently in the process.
16 Q. But adjoining that, isn't there another area
17 that was in sugarcane that has already been
18 reclassified?
19 A. If I understand your question right, I don't
20 think so. But I'm not sure I fully understand the
21 question.
22 Q. Are you aware of an area that adjoins this
23 current area, the area subject to the current
24 application, that previously was in sugarcane and was
25 reclassified by A&B?

A. Are you talking about the area right along Dairy Road?

Q. Correct.

A. Yes.

Q. When was that in sugarcane?

A. I don't know what year the development was put in, so up until that point.

Q. Do you know how much acreage that was?

A. I think it was 60-some acres, I think.

Q. And that was taken out of sugarcane and reclassified urban for the shopping center that now exists there?

A. Yes.

Q. And there had been multiple lands that were in sugarcane that have been turned into agricultural subdivisions as well, is that correct?

A. I don't think so.

Q. Well, right down the road here we have Haiku Mauka, correct?

A. That was not in sugar.

Q. What was that?

A. Either pasture or pineapple.

Q. That belonged to A&B, correct?

A. I think so, but it was never in sugarcane.

Q. It was agriculture?

A. Correct.

Q. And Haiku Makai?

A. Anything this side of Maliko Gulch was never in sugar.

Q. How about the Manaoli subdivision?

A. The Manaoli subdivision predates me, but the years I've lived on Maui it was an abandoned pasture and I think it was pineapple before that.

Q. Leased by A&B, Maui Land & Pine?

A. I would assume so.

Q. And how many acres was that?

A. I don't know.

Q. Are there other areas -- so how -- there's been a steady, wouldn't you agree, taking out of agriculture by A&B of lands for either agriculture subdivisions or urban developments?

A. As regard to HC&S, the number of acres we farm has pretty much remained constant.

Q. That's not my question. There's been a steady taking out of agriculture lands, lands that were used for agriculture, and devoting those lands to nonagriculture uses like agricultural subdivisions and/or urban uses like shopping centers or industrial parks.

MS. LOVELL: I object to the form of the

1 question. Vague as to time.
2 HEARINGS OFFICER JUDGE McCONNELL: I can't
3 hear.
4 MS. LOVELL: Vague as to time and
5 geography and a few other things.
6 MR. SCHULMEISTER: I'll join.
7 HEARINGS OFFICER JUDGE McCONNELL: I'll
8 sustain that. If you can be more specific.
9 Q. MR. HALL: Since you've been working for HC&S
10 on a fairly steady basis, A&B has been taking lands
11 out of agriculture uses and devoting them to
12 nonagricultural uses, correct?
13 A. A limited number of acres as we have been
14 taking, for example, Magarro Camp (phonetic), some of
15 the Pu'unene Camps, put those back into agriculture,
16 trying to maintain the acreage.
17 Q. Do you have any accounting of the number of
18 lands that were used for agriculture that were taken
19 out of agriculture and put into nonagriculture uses by
20 HC&S?
21 A. Probably someplace we have that information,
22 but it would be restricted to the acres in sugarcane.
23 Some of the acres that he's talked about were not in
24 sugarcane.
25 Q. Of the 130 acres that you testified to with

1 Mr. Murakami, actually all of that was in sugarcane at
2 one time; isn't that correct?
3 A. I don't know for sure that that's correct,
4 because the lands on the other side of Hana Highway,
5 some of those lands haven't been in sugar.
6 Q. When you say the other side of Hana Highway,
7 you mean the airport side?
8 A. Central power plant side. That would be the
9 airport side.
10 Q. Those were in sugarcane ten years ago, were
11 they not?
12 A. I don't think so.
13 Q. Those were in sugarcane 20 years ago, were
14 they not?
15 A. I don't know.
16 MR. HALL: I don't have any other
17 questions.
18 HEARINGS OFFICER JUDGE McCONNELL: Any
19 redirect, any other questions?
20 MS. LOVELL: No questions.
21 MR. MURAKAMI: I do have some.
22 FURTHER CROSS-EXAMINATION
23 BY MR. MURAKAMI:
24 Q. Regarding this question about the direction
25 of the company, Mr. Holaday, isn't it true that A&B is

1 a -- I don't know if it's diversified, but it had
2 different types of activities for its economic -- the
3 generation of economic revenues?
4 A. Correct.
5 Q. The main one is Matson Navigation.
6 A. Correct.
7 Q. And, in fact, it dwarfs, does it not, the
8 revenues that it receives from any sugar operations?
9 A. Correct.
10 Q. To a large extent -- my understanding is that
11 in 19 -- 2004 the revenues were probably only about --
12 less than 1/20th of the revenues in agriculture, as of
13 the revenues generated by Matson Navigation?
14 A. I don't know the math. I know ag group is
15 over $100 million. I don't recall the Matson's
16 revenues.
17 Q. You're saying $100 million in revenue, and
18 isn't that true that your revenues last year was only
19 about 5 million profit?
20 A. Pre-tax profit.
21 Q. Now, that $5 million, how much of that
22 constitutes the price support that you get from the
23 federal government for sugar?
24 A. We get no price support.
25 Q. You get no price support?

1 A. No, there are no price supports on the Farm
2 Bill.
3 Q. I'm not talking about the Farm Bill this
4 year, I'm talking about what you received last year.
5 A. We didn't receive any form of, to my
6 knowledge, any form of government payment last year.
7 Q. And none the year before?
8 A. In the past, one year we received a disaster
9 relief payment of about $5.5 million, but I don't
10 recall what year it was, but was not last year.
11 Q. And you received that only once?
12 A. We have received another payment this year.
13 Q. So you have received some price support this
14 year?
15 A. It's not price support, it's --
16 Q. I'm sorry. Let's get the terminology
17 correct. It's not a price support, it was what?
18 Disaster --
19 A. It was a disaster relief payment that was
20 paid in several counties throughout the United States,
21 Florida and Louisiana were involved. The County of
22 Maui was declared a weather disaster area, so you
23 could apply for federal disaster relief.
24 Q. All right. So are there any other federal
25 payments you received last year besides disaster

1 relief?
2 A. We didn't receive any last year.
3 Q. This year you're receiving some?
4 A. Yes.
5 Q. How much is that?
6 A. Approximately 5.5 million.
7 Q. And so isn't it also true that the real
8 estate development operations of A&B are also
9 significantly higher by in the tune of maybe six --
10 I'm sorry -- trying to do the math here, like about 15
11 times what you received in agriculture?
12 A. I would say that's generally correct.
13 Q. So the main operations at A&B are not sugar,
14 correct, in terms of at least dollar volume?
15 A. Correct.
16 Q. Mainly in shipping and real estate
17 development?
18 A. Real estimate development and real estate
19 management.
20 Q. And that includes such operations as the
21 recent award of A&B properties to develop the Kakaako
22 development in Honolulu?
23 A. That would be an example.
24 Q. And so given these numbers, is it still your
25 testimony that A&B has not done any planning for

1 basically giving up sugar operations as most sugar
2 companies in Hawaii have?
3 A. Not HC&S to my knowledge.
4 Q. No planning for potential shutdown?
5 A. Correct.
6 Q. And no planning for the use of this water
7 that's used for the current sugar operations to
8 support its real estate development?
9 A. Not to my knowledge.
10 Q. And would you be one to be consulted by the
11 A&B management team for this type of planning?
12 A. I would think so.
13 Q. And you've never been consulted?
14 A. No, I was consulted about the West Maui
15 water.
16 Q. I'm sorry?
17 A. The proposed 5 to 6 million gallon of West
18 Maui water, I was asked about that, my opinion to
19 support the development in the Central Valley.
20 Q. So you were consulted about possibly using
21 water sources that are available to HC&S from West
22 Maui for development of real estate ventures in
23 Central Maui?
24 A. Correct.
25 Q. But you've not been consulted with respect to

1 water that is available from East Maui for such
2 ventures?
3 A. I have not been consulted.
4 Q. Thank you. That's all.
5 HEARINGS OFFICER JUDGE McCONNELL:
6 Anything else? Thank you, sir. You're excused.
7 We'll take a five-minute recess.
8 (Recess was taken.)
9 HEARINGS OFFICER JUDGE McCONNELL: Let the
10 record reflect that we've resumed. Mr. Hew is on the
11 stand and remains under oath. Mr. Haia, you were
12 cross-examining.
13 GARRET HEW
14 CROSS-EXAMINATION CONTINUED
15 BY MR. HAIA:
16 Q. Mr. Hew, yesterday when we left off, you were
17 looking at the map. I think it's A-1 of the ditch
18 system and designation of lands owned by A&B, EMI. We
19 were talking about Kualani Stream, how you believed
20 that stream is not existed, that it's actually a
21 tributary of Waiokamilo. Is that right?
22 A. No, Kualani Stream exists but it's not shown
23 on that Exhibit A-1.
24 Q. And I wanted you to draw it in so we can
25 start there.

1 MR. SCHULMEISTER: So you want him to draw
2 on the original?
3 MR. HAIA: That's right.
4 MR. SCHULMEISTER: Any particular color?
5 MR. HAIA: Going to use a red pen to make
6 the designation of -- just to be clear, you're going
7 to be drawing in what?
8 A. What would you like me to draw in?
9 Q. The stream that you claim is Kualani.
10 A. On Exhibit A-1?
11 Q. Yeah, with a red pen.
12 A. It's difficult to draw this in on this map
13 because when we went out there, we looked at the
14 topography, and I'm not sure, based on this map, if
15 this little point here is that ridge we saw at the
16 lookout, so I cannot ascertain that.
17 Q. Well, let me ask you this.
18 HEARINGS OFFICER JUDGE McCONNELL: Little
19 point where?
20 THE WITNESS: This little point, this
21 area, Judge, right above the Hana Highway.
22 Q. MR. HAIA: Is there any geographical --
23 MR. MURAKAMI: What did the record -- what
24 happened on the record just now?
25 MR. HAIA: On the map in what is

1 identified -- it is really hard to explain though.
2 MR. MURAKAMI: Can we have a label of what
3 he just marked?
4 MR. HAIA: There's just a ridge line that
5 comes off called the Forest Reserve Line at the -- it
6 begins at that green-hatched area that is Palauhulu
7 Stream, a green-hatched area. And there's what's
8 labeled Forest Reserve Line. Well, that line, if you
9 follow it all the way down to a point where there's a
10 triangle with a dot in the middle and it says Kualani
11 right next to it. The point at which that line turns
12 back is the ridge line that Mr. Hew is referring to;
13 correct?
14 A. Right.
15 MR. MURAKAMI: That's in the vicinity of
16 Waiokani Falls?
17 MR. HAIA: Well, it's hard to say because
18 Waiokani Falls is not identified on this map. Is it,
19 Mr. Hew?
20 A. You're saying Waikani or Waiokani?
21 MR. MURAKAMI: Waiokani.
22 THE WITNESS: I don't know of any Waiokani
23 Falls. Waikani Falls is not identified on this map.
24 MR. MURAKAMI: You're talking about where
25 the horseshoe is in the roadway?

1 Q. MR. HAIA: So how can we be sure of the
2 accuracy of everything else that is described in this
3 map? If you have a concern for certain points and
4 whether or not the accuracy will allow you to draw in
5 what you believe is Kualani Stream, how can you be
6 certain that any other place on this map is accurate?
7 A. Because in working at EMI for the last 20
8 years, I've reviewed this map many, many times, and
9 only when we had a question about Kualani did we
10 really go out there and investigate and found out that
11 what we had on this map here was not accurately
12 depicted in the field when we did our taro field
13 investigation of that area.
14 Q. And that's why the concern arises with
15 respect to the other areas. It's only after you went
16 and made a site inspection that you determined that in
17 fact there was a problem with this map. Have you done
18 that with every other location on this map?
19 A. I've looked at most of the other locations
20 and what we have on the ground, and they appear to be
21 accurate.
22 Q. So once again, just so that I get it clear
23 here. You would prefer not to draw in what you
24 believe is Kualani Stream because you're concerned
25 that the area which you believe Kualani Stream is in

1 is not accurately depicted by this map?
2 A. No, I'm not saying that. What I'm saying is
3 that I cannot align any physical features, topography
4 on this map where I believe Kualani Stream is.
5 Q. Okay. And that's why I'm asking you the same
6 thing for everything else. Like, for instance, if you
7 can't identify where Kualani Stream is, how can you be
8 certain that West Wailuanui Stream is actually in the
9 area that is depicted in this map, or for that matter
10 any other stream in the area, given that you can't
11 find a place to locate Kualani Stream?
12 A. For Wailuanui Stream I know it's accurate up
13 in our diversion and down by the highway because this
14 is the horseshoe turn on Hana Highway.
15 Q. So there is no way to use that as a reference
16 to determine the approximate location of what you
17 believe is the Kualani Stream?
18 A. I can give you an approximate location, but
19 it may not be accurate because of the physical
20 features.
21 Q. I would like you to do that then with the
22 condition that this is an approximate location.
23 A. So if we follow the Forest Reserve Line from
24 Palauhulu and come across and follow that line where
25 it crosses so-called Kualani Stream and it makes a

1 little turn close to the Hana Highway and ends up at
2 this trig station called Kualani, and if this is the
3 ridge, that I believe it may be, I believe Kualani
4 Stream follows this direction over here, and
5 intersects Waiokamilo.
6 If this is Lakini, which I believe it may
7 be, Kualani probably intersects Waiokamilo in that
8 fashion.
9 Q. Okay. And so since that is your
10 understanding of Kualani, this is that red line that
11 you just drew in, what about there is no stream that
12 is identified as Kualani Stream, there is no such --
13 on the ground, there's no stream in that area.
14 A. Can you clarify that?
15 Q. Is there, in fact, still a stream at this
16 point on the map that is currently labeled as Kualani
17 Stream?
18 A. On the ground, yes.
19 Q. And what stream is that?
20 A. I believe that's an east tributary of
21 Waiokamilo Stream.
22 Q. Okay, so --
23 HEARINGS OFFICER JUDGE McCONNELL: So
24 you're saying the map is mislabeled?
25 THE WITNESS: The map, Judge, needs to be

1 revised as far as --
2 HEARINGS OFFICER JUDGE McCONNELL: But
3 what is labeled as Kualani -- I'm having trouble
4 reading it.
5 THE WITNESS: You can turn the map the
6 other way.
7 MR. HAIA: This is Kualani right here.
8 HEARINGS OFFICER JUDGE McCONNELL: And
9 you're saying that is incorrect?
10 THE WITNESS: I'm saying that the map --
11 HEARINGS OFFICER JUDGE McCONNELL: The
12 name Kualani.
13 THE WITNESS: The name Kualani, and also
14 the stream itself I believe connects with Waiokamilo
15 further up over here.
16 HEARINGS OFFICER JUDGE McCONNELL: Further
17 than here?
18 THE WITNESS: Right. Above this red point
19 where I had drawn Kualani Stream.
20 HEARINGS OFFICER JUDGE McCONNELL: Okay.
21 And this -- what is that?
22 THE WITNESS: I believe that line is the
23 Forest Reserve Line.
24 HEARINGS OFFICER JUDGE McCONNELL: Okay.
25 Go ahead.

1 Q. MR. HAIA: Okay. But what you're now saying,
2 Mr. Hew, is it's your belief that what is labeled as
3 Kualani Stream is actually a tributary of Waiokamilo
4 Stream, and that tributary at the point where the
5 ditch intersects with it is nonetheless diverted,
6 right?
7 A. That's correct.
8 Q. Yesterday we were also looking at some
9 exhibits, Mr. Hew, that was B-5A, B, C, B-6A, B, C --
10 actually B-6A, B-7A, B and C.
11 HEARINGS OFFICER JUDGE McCONNELL: Are we
12 finished with the map now?
13 MR. HAIA: Yeah, for the moment.
14 Q. And when we were looking at Exhibits B-5A, B
15 and C, you described where you believe this was with
16 respect to East Maui watershed, correct? And you
17 noted that all three of these exhibits appeared to be
18 different areas of the same diversion. Is that
19 correct?
20 A. I believe it to be the same diversion pipe.
21 Q. And I was also asking you about whether or
22 not you knew how much water could flow through an
23 eight-inch pipe, the full capacity of an eight-inch
24 pipe, and you did not know; correct?
25 A. That's correct.

1 Q. So if you don't know how much water -- do you
2 know how much water flows on average through that pipe
3 per day, that specific pipe?
4 A. No, I don't.
5 Q. Then how do you know whether or not it's a
6 major change after 1923 to the ditch system, if you
7 don't know how much water is being captured by that
8 diversion?
9 A. Like I had mentioned to you yesterday, a
10 major change, for example, is like a change in the
11 ditch location or a major construction in a stream to
12 divert more water.
13 Q. So in your mind if this pipe that diverts
14 water was put in after 1923, and with your lack of
15 knowledge of how much water is actually diverted, you
16 don't believe that's a major change despite not
17 knowing how much water is being diverted in that pipe
18 or diversion?
19 A. All I know is when I came to work in 1985,
20 this pipe was still in existence.
21 Q. But do you know whether or not it was in
22 existence at or prior to 1923?
23 A. That I don't know.
24 Q. So then you can't conclusively state that
25 there were no major changes to the ditch system after

1923, can you?

A. To my knowledge, there were no major changes after 1923 on the ditch system.

Q. Okay. Well, in this instance, do you know whether or not PVC pipe was around in 1923?

A. That I don't know.

Q. It may have been, in your mind you don't know?

A. That I don't know.

HEARINGS OFFICER JUDGE McCONNELL: In any event, you don't consider an eight-inch PVC pipe, if I understand your testimony, as a major change?

THE WITNESS: That is correct.

HEARINGS OFFICER JUDGE McCONNELL: Okay.

THE WITNESS: May I also point out one thing on that exhibit, please?

MR. HAIA: Which one?

A. I believe it was the third exhibit, the one on the bottom. On Exhibit B-5C I notice that this eight-inch pipe here has very, very little water coming out of the terminus of the pipe.

Q. And you can tell that by -- you can actually see how much water is flowing?

A. I can see that the pipe has very little water coming out of it.

1 Q. Okay. I would ask you then if that is -- if
2 this is the average flow out of that pipe, why are you
3 using an eight-inch pipe at that point?
4 A. I don't know if the pipe was installed before
5 when I came to work at EMI.
6 Q. Because -- well, let me ask you this.
7 If that's the average flow on a daily
8 basis, couldn't you use the two-inch pipe?
9 A. I don't know if that's the average flow.
10 Q. Thank you. We're going to go onto Exhibit 6A
11 and 6B, Mr. Hew.
12 I'm sorry, Judge, I do need that map back,
13 Exhibit 1.
14 Do you recognize those photographs, the
15 area of those photographs?
16 A. I recognize the area of these exhibits.
17 Q. What is that area?
18 A. This area here is what we refer to as No. 11
19 crosscut.
20 Q. Is there any rationale for referring to it as
21 No. 11 crosscut?
22 A. No, that was how it was relayed to me, and
23 this No. 11 crosscut tunnel is actually a
24 perpendicular tunnel to the main Koolau Ditch, and it
25 is one of the access points into the Koolau Ditch for

1 maintenance repair.
2 Q. Is it also a diversion?
3 A. There is a small diversion on the east side
4 of this No. 11 crosscut, yes.
5 Q. And is there any name to describe that
6 diversion?
7 A. We call that No. 11 crosscut diversion.
8 Q. Is that diversion identified on this map
9 Exhibit A-1?
10 A. No, it is not.
11 Q. Do you know -- would you have any knowledge
12 of why it's not identified on that map?
13 A. Yes, I do. The reason why it's not
14 identified on this map is because this map was
15 prepared for the purposes of showing the system, and
16 not every single small intake pipe that we have on the
17 system. Mostly the major intakes.
18 Q. Okay. But how many, in your words, small
19 diversions do you believe there are along this ditch
20 system?
21 MR. SCHULMEISTER: Entire system, all the
22 ditches?
23 MR. HAIA: As provided for on this map.
24 A. EMI?
25 Q. Yeah.

A. When I did the stream registration for EMI back in 1989, I believe I registered probably close to 400 stream diversions and probably more than half of them were so-called minor diversions.

Q. How many diversions in or around what is described as the Keanae License area are not depicted on this map, if you have a number?

A. Can you repeat that? I'm sorry.

Q. How many, in your words, small diversions are located in the Keanae License area that are not identified on that map?

A. Right offhand, I don't know. I would have to go back to the original stream diversions.

Q. Is it less than ten?

A. I would have to go back to give you an accurate count.

Q. Just approximately, less than ten?

A. I would say more than ten.

Q. Say less than 20?

A. I would have to go back. I don't know.

Q. Just approximately, is it around that ballpark? Is it around 20 or more than 20?

A. I really don't know and I don't like to guess.

Q. Okay. As far as you're concerned as your

1 position with EMI, small diversions don't need to be
2 documented because there's really no need to let the
3 authorities know how much water is being diverted by
4 small diversions, is that the position?
5 MS. LOVELL: Objection to the form of the
6 question as argumentative and assuming facts.
7 HEARINGS OFFICER JUDGE McCONNELL: I'll
8 permit it.
9 THE WITNESS: No, I'm not saying that.
10 All of our diversions, whether they're large stream
11 diversions or a small one-inch pipe or eight-inch pipe
12 or whatever it is, is registered with the Commission
13 on Water Resource Management.
14 Q. MR. HAIA: I'm going to show you what is
15 marked and received as B-7A, B-7B and B-7C and ask you
16 to take a look. Do you recognize that area as
17 depicted by those photos?
18 A. Yes, I do.
19 Q. And where is that area?
20 A. This is to the east of crosscut No. 11.
21 Q. Okay. Is there any identification -- is
22 there a number or a label for this area or this
23 diversion?
24 A. Yes. We call this No. 10 diversion.
25 Q. And do you know how much water is captured by

1 this diversion?
2 A. No, I don't.
3 Q. Okay. So did you also register this
4 diversion?
5 A. Yes, this was registered.
6 Q. So if we looked at the register, you would
7 have had to tell them how much water you were
8 diverting, right, if you wanted to register the stream
9 diversion?
10 A. On the form I believe there was a place, but
11 on the small diversions if it was a pipe, either I
12 used an estimate or I left it blank.
13 Q. Okay. So I previously asked you this
14 question about whether or not, you know, it was your
15 position that since it's a small diversion, you really
16 don't need to account for the water. And it appears
17 that in some instances that's correct, right? If you
18 left the area blank on the registration form that
19 asked for the amount of water being diverted, isn't
20 that right?
21 MS. LOVELL: I object to the form of the
22 question as argumentative and misstating the prior
23 question.
24 HEARINGS OFFICER JUDGE McCONNELL: I'll
25 permit it.

1 MR. SCHULMEISTER: I'll join.
2 THE WITNESS: No, I don't think that's
3 true, because I would have to go and look at the
4 original stream diversion works permit and see what
5 exactly I put on that permit.
6 Q. MR. HAIA: Are there some stream diversion
7 works permits that are -- that you categorize as small
8 diversions that you did not provide a number for in
9 terms of how much water was being diverted by that
10 diversion?
11 A. I believe on that stream diversion
12 registration, I believe it was a category of
13 divertable capacity or something like that. And I'm
14 not sure, unless I go and review what we had
15 registered with the Water Commission.
16 Q. But you did testify, didn't you, that there
17 were some stream registration forms that you left
18 blank when it asked for an amount being diverted?
19 A. I said it could have been left blank.
20 Q. Can I have Exhibit A-55?
21 Mr. Hew, take a look at Exhibit A-55.
22 A. Okay.
23 Q. You see those arrows that are on the
24 left-hand side where it says Wailuanui Road?
25 A. On the upper and lower left-hand side?

1 Q. Right.
2 A. Yes.
3 Q. Do you know what that designates? There's a
4 legend, it says direction of natural water flow.
5 A. I believe this is the direction of the flow
6 from the 'auwais into this Wailua area.
7 Q. The flow of 'auwais, right?
8 A. The flow of water in the 'auwai.
9 Q. So it's not the actual flow of streams in the
10 area, it's the flow of the 'auwai?
11 A. That's correct.
12 Q. Also I have an Exhibit A-52. And I believe
13 you testified that the person that helped you with
14 that exhibit was a taro farmer. That's the one with
15 the Wailuanui acreage in taro as of 10/25/05.
16 A. That's correct.
17 Q. And who is that?
18 A. That taro farmer is Isaac Kanoa.
19 Q. And what information did Mr. Kanoa provide?
20 A. Mr. Kanoa provided, based on that aerial
21 photo of 10/25/05, looking at the photo, he had
22 indicated areas that were in taro production and who
23 he believed the farmer was farming that particular
24 area.
25 Q. Okay. So in fact Exhibit A-52 is information

1 obtained from a Mr. Kanoa, and this information was
2 provided based upon his knowledge as of 10/25/05 of
3 who the farmer was on a specific lot or lo'i, and who
4 the owner was?
5 A. No. He provided the area on the aerial photo
6 and who the farmer was. The owner was determined by
7 looking at the tax map, comparing it to the area and
8 where it fell on the tax map.
9 Q. Okay. So the information from Mr. Kanoa was
10 based upon the aerial photo, right?
11 A. He looked at the aerial photo, that's
12 correct.
13 Q. And when was this, do you recall?
14 A. This was a couple weeks ago.
15 Q. A couple weeks ago or October 25th?
16 A. No. It was after October 25th, because the
17 aerial photo was taken on October 25th.
18 Q. After the aerial was taken you met with Mr.
19 Kanoa and went through the aerial photo and asked him
20 for information on it?
21 A. That's correct.
22 MR. HAIA: You know, Judge, I have a
23 problem with this exhibit and I objected to it
24 previously. I'm objecting to it again, unless I have
25 the opportunity to, you know, ask Mr. Kanoa questions

1 with respect to his understanding of who's farming the
2 area.
3 There's no way of me being able to agree
4 to allowing this -- you know, at least that
5 information on this exhibit into evidence in this
6 case.
7 HEARINGS OFFICER JUDGE McCONNELL: Well, I
8 think I've already ruled on that. I mean, I said it
9 was in, but I would permit you to rebut it in whatever
10 way you want.
11 MR. HAIA: Can I have the aerial photo?
12 I'm not sure what exhibit number it is.
13 MR. SCHULMEISTER: 53.
14 MR. HAIA: Dave, did you provide a copy to
15 everybody?
16 MR. SCHULMEISTER: Yes.
17 Q. MR. HAIA: Let me show you what has been
18 marked as Exhibit A-53. There appears to be drawing
19 of lines and numbers in the middle of those areas that
20 are drawn in. Is that correct?
21 A. Yes.
22 Q. And who did that?
23 A. We did this with the help of Isaac Kanoa.
24 Q. When you say "we", who's we?
25 A. It was Isaac Kanoa, myself and Mark Vaught.

1 Q. And so explain to me how this occurred.
2 You're sitting down at a table and Isaac is pointing
3 to the areas and someone is drawing the lines around
4 the area?
5 A. Isaac is looking at this aerial photo,
6 Exhibit A-53 and is very familiar with the area and
7 the people who farm in Wailua, and he's drawing a line
8 around each area and assigning a number and indicating
9 who's farming that particular area.
10 Q. So it's Isaac that's providing all this
11 information, drawing the line?
12 A. Giving us a map of such, and we had refined
13 the areas to look at all the taro patches that was in
14 cultivation to make sure that each area encompasses
15 the taro lo'i that were in cultivation.
16 MR. HAIA: Judge, I have a real problem
17 with Mr. Hew testifying to a map prepared by someone
18 else. It's just a huge concern that we're letting Mr.
19 Hew --
20 HEARINGS OFFICER JUDGE McCONNELL: If you
21 want to subpoena Mr. Kanoa, I'll make the time
22 available.
23 MR. HAIA: Thank you, I appreciate that.
24 Q. Now, going back to Exhibit A-52, the last
25 category is acres, correct?

A. Correct.

Q. And I know you told us how you got to those numbers, but would you state it once again how were those numbers arrived at?

A. Can you provide me that copy of that map that we had, the big map, I believe of Wailua 1985, that aerial photo.

Q. This is Exhibit A-54. Did you make that map, did you copy that map?

A. Yes, we did.

Q. I'm asking you individually specifically, did you do it?

A. I was there when we had the original photo of this Exhibit A-54 copied.

Q. The photo's the same size?

A. Photos is the exact same size.

Q. Okay. And you can swear to that because basically you were there, you watched as this was being copied?

A. That's correct.

Q. And then you used this approximate scale, right, just like in your concern about where you were going to draw where you believed Kualani is, this is an approximate scale and that scale is one inch equals approximately 200 feet, right?

1 A. This is what is indicated on this map, yes.
2 Q. An approximate scale. So why are these
3 acreages so specific, like for instance 2.738, .551,
4 .496, .362? That is just --
5 HEARINGS OFFICER JUDGE McCONNELL: Well,
6 let him answer.
7 Q. MR. HAIA: Why? Why are they so specific?
8 A. Well, first of all this map, Exhibit A-53,
9 was provided to our surveyor, and also this map,
10 Exhibit A-54, was also provided to him.
11 And what he did was transposed the area on
12 Exhibit A-53 onto this map Exhibit A-54. And how he
13 determined the specific areas of each individual
14 parcel was, he broke it down. For example, some of
15 these parcels are not rectangular.
16 So in some cases he broke down the parcel
17 so that to figure out the acreages he had an aggregate
18 of smaller areas and added it up to be as accurate as
19 possible.
20 HEARINGS OFFICER JUDGE McCONNELL: So
21 there was no comparison with the tax map?
22 THE WITNESS: No. The Exhibit A-52
23 right-hand column on acres is what our surveyor had
24 determined based on this map what the acreages were
25 that were colored based on this 10/25/05 aerial photo.

1 HEARINGS OFFICER JUDGE McCONNELL: Okay.
2 Maybe I misheard you, but I thought yesterday you said
3 well, then we took this and went to the tax map and we
4 figured out who owned what and what the acreages were.
5 That's not correct?
6 THE WITNESS: No, the tax map was just
7 looked at who owned the approximate area colored in
8 this exhibit.
9 Q. MR. HAIA: And in fact you actually used the
10 scale to determine the acreage, right?
11 A. That's correct.
12 Q. And the way that you got to that
13 determination is you looked at -- or whoever it was,
14 there was another person that did that, right?
15 A. Did what?
16 Q. That determined where these areas were on
17 this map.
18 A. That is our surveyor, he determined that.
19 Q. And that surveyor then, I guess he
20 highlighted the areas?
21 A. Yes, he did.
22 Q. And then based upon the areas indicated on
23 this map, which is nowhere close to the scale of that
24 map, right?
25 A. That's right.

1 Q. He determined, using this approximate scale,
2 the acreage of each one of these highlighted areas to
3 the 1000th, correct, in some instances to the 1000th
4 of an acre, right?
5 A. That's correct. Our surveyor is very
6 meticulous in doing work.
7 Q. Thank you. I'm going to have to -- I know
8 I'm going to skip around, Mr. Hew, and I apologize for
9 doing that. But I'm going to go back to Honopou and
10 I'm going to ask you, you know, the three two-inch
11 pipes at Honopou Stream that you said are low-flow
12 pipes.
13 A. I'm sorry, I'm not familiar with what you're
14 referring to.
15 Q. Let me get the exhibit. Exhibit B-10B. Do
16 you recognize that photo?
17 A. I recognize the area, yes.
18 Q. And are those the three two-inch pipes that
19 allow water to go over the ditch system on Honopou
20 Stream?
21 A. No, that's incorrect. These are three
22 four-inch pipes.
23 Q. I stand corrected. Those are three four-inch
24 pipes that allow water to go past the ditch diversion
25 at Honopou Stream, right?

A. That's correct.

Q. Who maintains those pipes?

A. Maintain in what capacity?

Q. They get clogged, don't they, from debris upstream?

A. Yes, they do.

Q. Who maintains that?

A. If we're there and doing our regular routine maintenance, if the pipes are blocked, our people at EMI unblocks these pipes. If the downstream users of Honopou Stream water do not have enough water in the stream and there is a problem, they usually come up to this area to unblock the pipes.

Q. How do you know that?

A. Because I've been told that.

Q. By whom?

A. Mrs. Kekahuna and some other family members and some other people that live down there.

Q. You remember yesterday we were also talking about the pumps that you observed at Honopou?

A. Correct.

Q. Does EMI keep a watch out for how much water is being pumped by those pumps on a daily basis and how long those pumps are pumping on a daily basis?

A. No, we do not.

1 Q. In your testimony, and I guess it was your
2 rebuttal testimony at Page 13, and I have a copy of
3 it. I'm going to ask you to read Paragraph No. 43.
4 MR. SCHULMEISTER: Which paragraph?
5 MR. HAIA: Forty three at Page 13.
6 A. You want me to read this?
7 Q. Yes, please.
8 A. Paragraph 43. "If Na Moku members would like
9 to resume the cultivation of taro in the patches that
10 were abandoned when the upper ditch ceased being used,
11 EMI is willing to assist in the repair and restoration
12 of the upper ditch. This is the necessary first step
13 in putting these patches back into production. There
14 is more than enough water in Waiokamilo Stream to
15 supply the upper ditch and double or triple the amount
16 of taro that is presently being cultivated.
17 If the upper ditch is repaired and for
18 some reason that EMI cannot presently anticipate there
19 is inadequate water available for taro cultivation,
20 EMI is willing to reduce its diversion above
21 Waiokamilo Stream."
22 Q. This still stands, right?
23 A. Absolutely.
24 Q. So you recall last month on the last day of
25 the hearings last month we did a site visit, we went

1 up to Lakini, correct?
2 A. Correct.
3 Q. And then it's my understanding that you and
4 Mr. Schulmeister went down past the box below Hana
5 Highway and walked down one of the 'auwais, correct?
6 A. That's correct.
7 Q. Is that the upper ditch that you refer to?
8 HEARINGS OFFICER JUDGE McCONNELL: Is that
9 what you're talking about?
10 THE WITNESS: Yes, we did walk the upper
11 ditch.
12 Q. MR. HAIA: And what was your -- what did you
13 observe?
14 A. We walked the upper ditch for several hundred
15 feet and the ditch was not in operation. There was
16 heavy brush and I had my K-knife and I had to cut the
17 brush so that we could continue to walk down the
18 ditch.
19 And we walked all the way down -- well,
20 from the diversion box, there's a pipe that is
21 connected to the diversion box, and that pipe runs
22 along that open ditch.
23 And we walked all the way to where that
24 pipe ended, and put water back into the open 'auwai.
25 And at that point we stopped because any further than

1 that would require a lot more effort to cut our way
2 through on the 'auwai, on that upper ditch.
3 Q. You know who Mr. Kepa Maly is?
4 A. Yes, I do.
5 Q. Who is Mr. Maly?
6 A. He's a cultural specialist.
7 Q. And in connection with A&B's application of
8 May 25 -- I guess their application was dated in
9 April. And the hearing before the BLNR on A&B's
10 application was on May 25th, 2005.
11 In connection with those proceedings did
12 A&B and/or EMI retain Mr. Maly for any purpose?
13 A. Yes, we did.
14 Q. What was that?
15 A. The purpose was to have Mr. Maly document the
16 native traditions of that Keanae-Wailuanui area.
17 Q. And in the discussions were you the person on
18 behalf of A&B that hired Mr. Maly to do this work?
19 A. I'm sorry, can you repeat that?
20 Q. Were you the person who, on behalf of A&B and
21 EMI, hired Mr. Maly to do that work?
22 A. I coordinated the effort with Mr. Maly,
23 correct.
24 Q. And so when Mr. Maly -- it's Exhibit B-113,
25 when Mr. Maly writes at page Roman Numeral II:1 of his

1 report:
2 "INTRODUCTION. Background.
3 "At the request of Garret Hew, Manager of
4 East Maui Irrigation Company, Kumo Pono Associates
5 conducted a two phase study of cultural-historical
6 resources in the lands of Hamakua Poko, Hamakua Loa
7 and Ko'olau in the region of Maui Hikina (East Maui),
8 Island of Maui. The study included-conducting
9 detailed research of historical records in public and
10 private collections (Volume 1) and conducting oral
11 history interviews with individuals known to be
12 familiar with the cultural and natural landscape, and
13 history of land use in Maui Hikina study area (Volume
14 II). This study was conducted in conjunction with the
15 Water License Application of the East Maui Irrigation
16 Company, and land use planning processes of the Board
17 of Land and Natural Resources of the State of Hawaii."
18 So when Mr. Maly writes this in his
19 report, is he being accurate as to the reason for his
20 retention and the work done?
21 A. Yes, I believe he is.
22 Q. What was your understanding of the necessity
23 to have this kind of work done in conjunction with A&B
24 and EMI's application for water?
25 A. Can you be more specific in your question,

1 please?
2 Q. Why did you believe this was necessary?
3 A. Well, first of all, we wanted to make sure
4 that we document some of these kupunas in that area
5 since they were getting very, very old. In fact, one
6 of them had passed away shortly thereafter. And we
7 wanted to make sure that we had proper documentation
8 of people that had lived and worked and were born in
9 that area.
10 Q. Well, did you look at certain parcels to find
11 out whether or not there were appurtenant rights
12 attached to them?
13 A. No, I didn't look at any parcels.
14 Q. Did you request Mr. Maly to do that?
15 A. I can't recall that.
16 Q. Can you recall if you requested Mr. Maly to
17 look at parcels in this area to determine whether
18 there were riparian rights attached to those
19 properties?
20 A. That I can't recall.
21 Q. So you could have asked, but you just can't
22 recall?
23 A. I can't recall if we asked or not.
24 Q. Mr. Schulmeister was asking you about the
25 level of your assistance in helping Ms. Apolonia Day

1 with the declaration of water use. Do you remember
2 that yesterday?
3 A. Yes.
4 Q. What was the level of your assistance?
5 A. My level of assistance with assisting Mrs.
6 Day was to provide her with the necessary Commission
7 forms, how to fill them out as to her diversions, and
8 I provided her with some of the TMKs which the
9 diversion are located on.
10 Q. I want to make it clear, she came to you for
11 this, yeah?
12 A. I believe she had talked to Mr. Cabral who
13 was our field superintendent, and Mr. Cabral had
14 talked to me about assisting her with her stream
15 diversions. And that's what we did.
16 Q. Is your understanding that Ms. Day went to
17 Mr. Cabral, Mr. Cabral referred Ms. Day to you?
18 A. Yes.
19 Q. You were also asked by Mr. Schulmeister about
20 Waikani Falls, the pipe system there, the condition of
21 the system. And I recall your testimony being that
22 EMI was attempting to assist that community, that is,
23 you know, Wailuanui, with repair of that system, so
24 that water could once again flow from that system into
25 the 'auwai. Is that correct?

1 A. Did you say Waikani or Waiokani?
2 Q. Waikani.
3 A. Can you repeat that question?
4 Q. My understanding that your testimony was that
5 EMI was attempting to assist the taro farmers of
6 Wailuanui Valley by making repairs to the system that
7 took water out of the pond below Waikani Falls, allow
8 it to go back into the 'auwai that would go and feed
9 some of the lo'i on the east side of the valley of
10 Wailuanui, correct?
11 A. First all, the pipe was broken, but it was
12 still operable when I went there. The water level was
13 above the top of the pipe and the 'auwai that fed the
14 eastern side of Wailua had water from Wailuanui Stream
15 at that time.
16 Q. Is it your testimony that you worked on a
17 solution to that for three years, you tried to solve
18 that problem over a three-year period?
19 A. I don't know if it was three years. I know
20 we first got involved with this when Council Member
21 Bob Carrol had called me and asked for our assistance
22 in looking at that situation and seeing if we could
23 provide any assistance.
24 And I did meet with his assistant and went
25 out there with one of our employees to assess the

1 situation.
2 Q. And what was your assessment?
3 A. The assessment was that there was a landslide
4 that had broken off the bell or the siphon of that
5 pipe, and filled up the pond below Waikani Falls, a
6 portion of that pond which diverted that water out of
7 there.
8 Q. Based upon your assessment, what did you or
9 any other person affiliated with EMI do thereafter?
10 A. First of all I went and tried to find out
11 information on who installed that pipe and how it was
12 designed and put in place.
13 And, you know, the problem with getting
14 the thing repaired is that there's no access up to
15 that area. Everything would have to be carried in or
16 flown in.
17 There was another problem also with the
18 landslide filling up the pond. So to put that elbow
19 or siphon back into the pond, some of those huge
20 boulders had to be cleared away.
21 We looked at trying to bring in air
22 compressors and break those rocks and try to get them
23 out of the way or to drill and blast some of the
24 rocks. That would be very, very difficult due to the
25 close proximity of the highway and also the taro

1 farmers in that valley.
2 And we never got around to fixing it
3 because the only time there was problems with that
4 system was when the pond would go lower than the top
5 of that pipe. So when the pond would go lower than
6 the top of the pipe, there was less flow going into
7 that system. And this was usually during very, very
8 dry periods.
9 And so far over the last couple of years
10 that we had contemplated repairing that pipe, I have
11 not heard from the person who uses that water and
12 farms that area as to lack of any water in that
13 particular area.
14 Q. Thanks. I'm going to you show you Exhibit
15 A-53 and point to the area marked as 7, and I believe
16 Mr. Schulmeister asked you if you knew who was farming
17 that area. You said it was Norman Martin, right?
18 A. That's correct.
19 Q. Mr. Schulmeister asked you whether you knew
20 where that water for those lo'i come from, and your
21 testimony was Wailuanui.
22 A. That's correct.
23 Q. Do you know for a fact that the water for
24 those parcels is exclusively from Wailuanui?
25 A. I learned about this parcel from Norman

1 Bush's grandfather, Sam Akina, who had accompanied us
2 on that assessment of that pipe. Sam Akina retired.
3 He was a long time taro farmer. He told me that his
4 patches here, which his grandson, Norman Martin, got
5 water from Waikani.
6 Q. And I'm asking you, do you know personally,
7 for a fact, that water that goes to those lo'i
8 presently is exclusively water from Wailuanui Stream?
9 A. I believe it is. From when I went out there
10 to do the field inspection and saw that area being
11 exclusively taking water from Wailuanui Stream.
12 Q. Are you a taro farmer?
13 A. I grew some taro before.
14 Q. Are you a taro farmer?
15 A. No, I'm not.
16 Q. And when you make statements in your
17 testimony in your declaration about water requirements
18 for taro, isn't it true that those -- the numbers that
19 you rely upon are based upon the testimony of the
20 expert called by A&B, Dr. de la Pena?
21 A. Yes.
22 Q. So I just need a minute, Judge, to see if
23 there's anything else I need to discover or ask about.
24 That's all I have.
25 HEARINGS OFFICER JUDGE McCONNELL: We will

1 take a short break before starting with Mr. Hall.
2 (Recess was taken.)
3 HEARINGS OFFICER JUDGE McCONNELL: We're
4 back on the record. Mr. Hall, you may cross-examine
5 CROSS-EXAMINATION
6 BY MR. HALL:
7 Q. Could I ask you to look at Exhibit A-1,
8 please.
9 A. Is that that EMI map?
10 Q. Yes.
11 The ditches that are shown on that map
12 exist partly on state lands and partly on EMI lands,
13 correct?
14 A. That's correct.
15 Q. So in 1938 the state or the Territory, that
16 is, and EMI entered into an agreement to which the
17 Territory agreed that the ditch system could be built
18 in part on its property, correct?
19 MR. SCHULMEISTER: Built?
20 THE WITNESS: No, that's not correct.
21 Q. MR. HALL: Could you look at our Exhibit No.
22 1. Do you recognize Exhibit No. 1 as the 1938
23 agreement between the Territory and East Maui
24 Irrigation Company?
25 A. I believe it is.

1 Q. And does that not grant EMI easements for the
2 ditches to be -- to exist on state-owned lands or
3 Territory-owned lands?
4 A. My understanding of this 1938 agreement is
5 basically an exchange between the Territory of Hawaii
6 and EMI at that time for the ditch, for the Territory
7 to grant EMI the right to have its ditch across the
8 Territory land at that time and for EMI to grant the
9 Territory the right for this to come on our land.
10 Q. So as we're looking at Exhibit A-1, wherever
11 we see the Wailoa Ditch or any of these ditches where
12 they crossover lands in yellow, they crossover these
13 lands in yellow based on an easement that was granted
14 by the Territory of Hawaii in 1938, correct?
15 A. That was what the 1938 agreement says, yes.
16 Q. And this A-1 shows the four license areas,
17 correct?
18 A. That's correct.
19 Q. And I would like you to look at our Exhibit
20 A-3, which you have in front of you, and it shows the
21 acreage that is covered by the state portion of each
22 one of those licensed areas.
23 MR. SCHULMEISTER: Just for the record, I
24 don't think it's A, is it?
25 HEARINGS OFFICER JUDGE McCONNELL: Yeah, I

1 was confused.
2 MR. HALL: Well, I used A as well. So
3 Intervenors A, and I've got it in front -- I guess
4 not, maybe it isn't. Just Exhibit 3.
5 HEARINGS OFFICER JUDGE McCONNELL: Why
6 don't we call those M or something just so we're
7 clear.
8 MR. HALL: I'll call them M.
9 HEARINGS OFFICER JUDGE McCONNELL: For the
10 time being, we'll consider it Maui Tomorrow exhibits,
11 just use the number.
12 Q. MR. HALL: The first page of that staff
13 report, 1985 under area, shows the area covered by the
14 state-owned portion of each one of those licensed
15 areas; is that correct?
16 A. Can you point out that exhibit for me,
17 please?
18 Q. Yes. Do you see that?
19 A. What was your question?
20 Q. The question is: Does that not accurately
21 depict the size of the state-owned lands that are in
22 each of those licensed areas.
23 In other words, Nahiku License covers
24 4,316 acres of state-owned lands.
25 Keanae License covers 16,095 acres of

1 state-owned land.
2 Huelo License covers 8,753 acres.
3 The Honomanu License covers 3,381 acres
4 for a total of 32,545 acres of state-owned lands.
5 A. I think the total area is off by a little.
6 Q. Do you think it's generally correct, that
7 figure?
8 A. My understanding of the total area that we
9 lease from the State of Hawaii is roughly 33,000
10 acres, so we're missing about 455 acres somewhere.
11 Q. And you, that is EMI, has leased all of the
12 streamflow arising on those 33,000 acres for the past
13 100 years, correct?
14 A. No, that is not correct. In our lease with
15 the Board of Land and Natural Resources we lease the
16 land.
17 Q. You're not leasing any water?
18 A. My understanding is we're leasing the land in
19 these particular areas for the right to divert water,
20 we're not leasing water.
21 Q. Can you turn to Page 2 of that document.
22 Sale of the Lease called a Water License. Says:
23 "PURPOSE: Water License - right,
24 privilege and authority to enter and go upon the
25 above-described license areas for the purpose of

1 developing, diverting, transporting and using
2 government-owned waters."
3 A. What was your question?
4 Q. Isn't that a correct description of the
5 rights you have obtained from the State of Hawaii for
6 the last 100 years on these 33,000 acres?
7 MS. LOVELL: I object to the form of the
8 question as calling for a legal conclusion.
9 HEARINGS OFFICER JUDGE McCONNELL: Well,
10 I'll permit it.
11 THE WITNESS: My understanding of this
12 area was that the company had leased from the King of
13 Hawaii at the time of the first ditch which was
14 constructed in 1876 the right to construct that ditch
15 and to operate it. Henceforth, the Territory, as I
16 understand it, leased the land area for this purpose.
17 Q. The one I just quoted to you?
18 A. That's correct.
19 Q. That is to develop, divert, transport and use
20 government-owned waters, correct?
21 A. Correct.
22 Q. I would like to have you look at exhibit --
23 we will call it M-12, and I'll find it for you.
24 Show you Exhibit M-12, is that list, at
25 least a correct list of some of the streams that exist

1 within that 33,000-acre area that are diverted by your
2 ditch system?
3 A. According to this Exhibit 12, streams
4 diverted, I see the first stream is Makapipi and I see
5 the last stream is Maliko. Our license area covers
6 from Makapipi Stream to Honopou Stream, so the last
7 eight streams are not in that license area.
8 Q. So from Makapipi to Honopou?
9 A. Makapipi to Honopou.
10 HEARINGS OFFICER JUDGE McCONNELL: The
11 last --
12 THE WITNESS: The bottom eight streams are
13 not incumbered under our lease with the state.
14 Q. MR. HALL: And your map shows that, as
15 Exhibit 12 notes, that some of those streams are
16 diverted in multiple places?
17 A. Based on the map or based on this Exhibit 12?
18 Q. Well, both the map and the exhibit both show
19 that some of those streams are diverted in multiple
20 places?
21 A. Some of those streams are diverted in
22 multiple places, correct.
23 Q. And for instance, Hanehoi Stream is diverted
24 in four places?
25 A. Based on Exhibit 12 I don't see Hanehoi on

here. On the map, Hanehoi we have four areas with stream diversions on Hanehoi Stream.

Q. Why does it make sense for EMI to divert a stream like Hanehoi at four places?

A. Because the ditch system was built in that fashion.

Q. Does Hanehoi -- let's say you collect it at a high level, what is the highest level at which you divert Hanehoi?

A. The highest level would be at the Wailoa level.

Q. Does water -- does Hanehoi Stream gain water below the Wailoa Ditch?

A. Hanehoi Stream below the Wailoa Ditch does gain water.

Q. And then so the next diversion is at what, what is the next diversion?

A. The next diversion below the Wailoa on Hanehoi Stream is the New Hamakua Ditch. Which is basically a stormwater ditch. There is no water from Hanehoi Stream at that level unless the stream is flowing at a great rate, a large rate.

Q. But Hamakua Ditch does divert Hanehoi Stream?

A. New Hamakua Ditch there is a stream diversion.

1 Q. And it would divert everything that is in
2 Hanehoi at that point?
3 A. Up to its capacity.
4 Q. And likewise, I forgot to say Wailoa, it
5 would do the same?
6 A. Up to its capacity, correct.
7 Q. And then below New Hamakua, Hanehoi would
8 gain water again?
9 A. To clarify that, from the Wailoa to the New
10 Hamakua Ditch on Hanehoi Stream it's a very, very
11 short distance, maybe not more than 100 feet or so.
12 And below of the New Hamakua down to the Lowrie level
13 it does gain water from springs, correct.
14 Q. From springs?
15 A. From springs.
16 Q. So at Lowrie, Lowrie would divert all the
17 water that had been gained from the springs up to its
18 capacity?
19 A. On a normal day it would divert that water.
20 There's also that Huelo pipeline in that stream that
21 is also diverting water above the Lowrie Ditch.
22 Q. By that you mean there is a waterfall and a
23 pool above some number of feet above the Lowrie Ditch
24 itself, correct?
25 A. That's right.

1 Q. And there's a private water system that has a
2 pipe that goes into the pool in that water system and
3 is the source for some residents of Huelo, correct?
4 A. I believe it is.
5 Q. And then below the Lowrie Ditch there is some
6 more gain in the Hanehoi Stream?
7 A. There is some gain below the Lowrie Ditch.
8 Q. And the next ditch is?
9 A. The Haiku Ditch.
10 Q. And the Haiku Ditch would divert whatever
11 that gain is up to its capacity again?
12 A. That's correct.
13 Q. Now, the subject matter of this contested
14 case is the leases and licenses that EMI pays to the
15 state or secures from the state for the waters that
16 arise in the streams that we have just discussed and
17 within the license areas, 33,000 acres of these
18 license areas, correct?
19 A. That's right.
20 Q. And you indicated on this map that the yellow
21 is government land, is that right?
22 A. The yellow is lands owned by the State of
23 Hawaii.
24 Q. And green is -- all green is EMI and green
25 with slash marks is undivided fee. What does that

1 mean?
2 A. The green, the solid green is lands owned in
3 fee by EMI. The green with the slashes are undivided
4 fee. In other words, those lands are owned by EMI and
5 other people as undivided interest land or hui land.
6 Q. In other words, if we see a parcel designated
7 like that, you would own that parcel with other
8 people?
9 A. That's correct, as an undivided interest.
10 Q. And with the crosshatch, I suppose -- says
11 multiple claim fee, what does that mean?
12 A. Means that there are some parcels that are
13 claimed by other individuals besides EMI, but as to no
14 specific area or percentage.
15 Q. And the reddish/brown means A&B owns it?
16 A. Reddish/brown means Alexander Baldwin, Inc.
17 land, correct.
18 Q. As we look at -- let's say let's look at
19 Huelo License area in the area of -- the Huelo area,
20 Honopou, Honokala, there's some areas in white there.
21 What does white mean? There's no designation for what
22 white meant.
23 A. White are lands that are privately owned.
24 Q. Now, there are lands shown above the Lowrie
25 Ditch and above the Haiku Ditch there that are in

1 white. Do you see those?
2 A. Yes.
3 Q. Does EMI hold leases or licenses with the
4 owners of the white lands to divert, transport and
5 develop the waters arising on those lands to Central
6 Maui?
7 A. Not to my knowledge.
8 Q. Now, the licenses that you talked about
9 Revocable Permits A-2, A-3, A-4, A-5, all in Paragraph
10 16 on Page 6, not my exhibits, your exhibits, say:
11 "The State reserves the right, subject to
12 not less than thirty (30) days written notice, to
13 withdraw water for this revocable permit to meet the
14 following requirements as the State in its sole
15 discretion may determine: Constitutionally protected
16 water rights."
17 What are constitutionally protected water
18 rights?
19 MR. SCHULMEISTER: Object to that, calling
20 for legal conclusion.
21 MR. HALL: To the best of your
22 understanding, what are constitutionally protected
23 water rights?
24 HEARINGS OFFICER JUDGE McCONNELL: I'll
25 sustain the objection. That's what we have to argue

1 about.
2 Q. MR. HALL: Mr. Hew, in your testimony you
3 were the one who applied for these revocable permits,
4 correct?
5 A. Yes.
6 Q. And you received this revocable permit,
7 correct, these revocable permits?
8 A. Which permit are you referring to?
9 Q. Your Exhibits A-2, A-3, A-4 and A-5.
10 A. I believe Exhibits A-2, A-3, A-4 are
11 revocable permits under Alexander & Baldwin, and
12 Exhibit A-5 is under East Maui Irrigation. So I'm an
13 employee of EMI and therefore only Exhibit A-5 would
14 apply.
15 Q. Let's talk about A-5 then. You received A-5?
16 A. Yes.
17 Q. And did you examine A-5 for the conditions
18 under which this revocable permit was received?
19 A. Yes, I did.
20 Q. And did you examine condition number 16 that
21 we were discussing on Page 6?
22 A. Yes.
23 Q. And did you inquire as to what
24 constitutionally protected water rights might mean?
25 A. No, I did not.

1 Q. You didn't, okay. Do you know -- you
2 testified earlier about riparian water rights. Can
3 you explain to me what your understanding of a
4 riparian right is?
5 MR. SCHULMEISTER: Objection, lack of
6 foundation.
7 MR. HALL: Mr. Haia asked him about
8 riparian water rights. He testified about it.
9 HEARINGS OFFICER JUDGE McCONNELL: I'll
10 permit that. I don't recall the testimony. Go ahead.
11 THE WITNESS: I also don't recall
12 testifying about riparian water rights. What was your
13 question, Mr. Hall?
14 Q. MR. HALL: What is your understanding of what
15 a riparian water right is?
16 A. My understanding, not being an attorney on
17 riparian water rights, is the right that a parcel has
18 adjacent to a stream to use water off of that stream
19 if it's touching that parcel.
20 Q. And what is your understanding of what an
21 appurtenant water right is?
22 MR. SCHULMEISTER: Objection, calls for
23 legal conclusion.
24 MR. HALL: He also discussed this term
25 with Mr. Haia.

1 HEARINGS OFFICER JUDGE McCONNELL: All
2 right. I'll permit it.
3 THE WITNESS: Like I say, I'm not an
4 attorney, so my limited knowledge of appurtenant
5 rights consists of a parcel that is not adjacent to a
6 stream that has rights to water for that particular
7 parcel.
8 Q. Has EMI, since it's had these licenses and
9 leases with the state, and since you work for EMI,
10 ever conducted any study of those who hold riparian
11 and appurtenant rights downstream of its diversions?
12 A. No.
13 Q. Has EMI engaged or sought to purchase the
14 water rights of those who own parcels downstream of
15 its diversions?
16 A. Not since I was with the company.
17 Q. Has it done so -- it's done so previously
18 though, correct?
19 A. I'm not sure of the meaning of purchase.
20 HEARINGS OFFICER JUDGE McCONNELL: I'm
21 sorry, could --
22 Q. MR. HALL: Has it sought to purchase the
23 water rights from those who own, third parties that
24 own parcels below its diversions?
25 A. I know we have some deeds that indicate that

1 the company reserves certain water rights off of a
2 parcel in compensation for other things, monetary
3 value or whatever it may be.
4 Q. And has EMI --
5 HEARINGS OFFICER JUDGE McCONNELL: You
6 mean it was land conveyed by the company for
7 reservation of water rights within the company?
8 THE WITNESS: I've seen documents of land
9 that the company has owned that was conveyed to others
10 that reserved the water rights off of that parcel
11 before it was conveyed.
12 Q. MR. HALL: And has EMI entered into
13 agreements with third parties below the ditch system
14 whereby the water rights to those parcels will be
15 given up in exchange for having a right to a certain
16 size pipe?
17 A. I recall some deeds that do that.
18 Q. That EMI has negotiated those agreements,
19 correct?
20 A. I don't know how it was negotiated. But I do
21 see some deeds that EMI has reserved the water rights
22 but will provide for a one-inch pipe for domestic use.
23 Q. With respect to the parcel currently owned by
24 Ms. Caveny, you're not aware, are you, of any
25 agreement whereby the water rights to her parcel were

1 reserved, correct?
2 A. I have not researched that.
3 Q. So you're not aware of such an agreement,
4 correct, with EMI?
5 A. I'm not aware of that.
6 Q. And with respect to the parcel owned by Ms.
7 Caveny, you're not aware of any agreement by which EMI
8 reserved water rights in return for a pipe of a
9 certain size?
10 A. I'm not aware of any agreement.
11 Q. You're also not aware of any agreement by
12 which EMI has ever purchased Ms. Caveny's water
13 rights?
14 A. I've not researched that, and I'm not aware
15 of that.
16 Q. With respect to the parcel that is being
17 caretaken by Mr. Schupp, you're not aware of any
18 documents through which water rights on that parcel
19 have been reserved, are you?
20 A. Which parcel are you referring to?
21 Q. The one that he is seeking more water from
22 EMI for in this case.
23 A. As I understand it, there's two parcels down
24 there, one owned by the Keala family and one owned by
25 Matson family.

1 Q. Let's talk about both of them.
2 A. No, I'm not aware of any.
3 Q. And you are not aware of any agreements with
4 respect to the Keala parcel or the Matson family for
5 which he has caretaker agreements by which EMI
6 reserved the water rights in return for a pipe in a
7 certain size?
8 A. No.
9 Q. And you are not aware of any agreements by
10 which EMI has purchased the water rights for those two
11 parcels, correct?
12 A. That's correct.
13 Q. Now, going back to map A-1, you have
14 designated these are the amounts of water each license
15 area that arise or -- well, segregated between private
16 water and government water. Do you see that?
17 A. Yes.
18 Q. And in the Huelo, let's take the Huelo
19 License area. Have you -- did you make any effort to
20 segregate out the water that belonged to others,
21 namely those who own the white parcels in the area?
22 A. No.
23 Q. Why not?
24 A. Because of the fact that we're dealing with
25 just state land and EMI land.

1 Q. Well, you say a large chunk of land in that
2 license area -- let's just deal with that.
3 Can you show me where the boundaries of
4 the Huelo License area that you designate license
5 areas are on this map?
6 A. The Huelo License boundary on the western
7 side is Honopou Stream.
8 Q. So that would be from the bottom of the map
9 as we're looking at it, would be the mountains,
10 correct? Would be mauka on the bottom of the map?
11 A. Can you clarify that? I don't follow.
12 Q. Where would we start on the western side?
13 I'll let you tell us. Would you start at the top of
14 the mountain?
15 A. As I understand it, the Huelo License area
16 encompasses on the eastern -- excuse me, on the
17 western side the Honopou boundary, which is the EMI
18 green, large green, and adjacent to it the state land
19 and it goes all the way up to wherever Honopou Stream
20 starts up at its beginning.
21 Q. I don't have a hard time understanding where
22 it starts, but does it go all the way to the ocean?
23 A. According to our lease with the state, it
24 goes only down to our lowest ditch.
25 Q. Okay. And that distance would be the Haiku

1 Ditch?
2 A. Correct.
3 Q. So you haven't made any effort to segregate
4 out the water rights of those owners of the white
5 parcels above the Haiku Ditch here?
6 A. No.
7 Q. But you would agree that they do have water
8 rights?
9 MR. SCHULMEISTER: Object, calls for legal
10 conclusion.
11 HEARINGS OFFICER JUDGE McCONNELL: I'll
12 sustain that.
13 Q. MR. HALL: You would agree that water arises
14 on those white parcels, correct?
15 A. I'm sure there's some water on those parcels,
16 correct.
17 Q. So this map is not entirely accurate when it
18 assigns 100 percent just between the government and
19 private, if it means just EMI, the private just means
20 EMI?
21 A. All I know is the map was prepared based on
22 state land and EMI land.
23 Q. So it's inaccurate to the extent that anybody
24 would assume that the 35.51 in Huelo is all EMI,
25 correct?

1 A. That I don't know.
2 Q. You don't know.
3 In your written testimony, you indicate
4 that 70 percent of the water arising in the license
5 area is state-owned water, in all of it together; is
6 that correct?
7 A. Yes.
8 Q. So what you mean by that is if we average out
9 what is stated here on map A-1 for government water.
10 For instance, Huelo government water is 64.49,
11 Honomanu is 47.39, Keanae is 79.19, and Nahiku is
12 95.02. Is this going to average to 70 percent?
13 A. No.
14 Q. That's not what you mean?
15 A. That's not correct the way you had asked the
16 question.
17 Q. Why is that incorrect?
18 A. Because if you add all of the so-called
19 government water in the four license areas and divide
20 it by four for the four license areas, that does not
21 come out to 70 percent.
22 Q. How would I correctly do it then?
23 A. Seventy percent was arrived by taking the
24 entire leased area along with the area owned by EMI,
25 determining through that isohyetal map what percentage

1 or what proportion of land fell in what particular
2 rainfall belt and determining from there rainfall
3 versus ownership of land.
4 Q. Let's use the 70 percent. Are you saying
5 conversely that 30 percent is water that arises on EMI
6 land?
7 A. Basically, yes.
8 Q. And you're testifying that the capacity of
9 the ditches together is 160 MGD?
10 A. That is not correct.
11 Q. What is it, 165?
12 A. You're asking what is the capacity of the
13 four ditches?
14 Q. The average.
15 A. I'm sorry. The average of the four ditches
16 on average is about 160, 165, but that is very, very
17 misleading, because --
18 Q. That's the figure you used, correct?
19 A. That's correct. But it's misleading to the
20 point where some days we don't even have that much
21 water in the whole system.
22 Q. Some days, but that's the average you use,
23 correct?
24 A. That's the average.
25 Q. So if 30 percent of that average is 48 MGD,

1 million gallons a day, correct?
2 A. I'm sorry, I couldn't hear.
3 Q. 30 percent which is what arises on EMI land
4 according to you, 30 percent of the 160 average is 48
5 million gallons a day?
6 A. If the math is correct, yes.
7 Q. And so you've heard testimony that the county
8 requires 8 million gallons a day, correct?
9 A. That's right.
10 Q. That could be satisfied on an average basis
11 from water that arises from your land, correct?
12 A. That's correct. But the entire ditch system
13 is one whole system. So to determine what percentage
14 it is on each ditch would be very difficult,
15 especially they're taking only off of one ditch
16 system.
17 Q. And even if you add on what Maui Land & Pine
18 requires, that could be satisfied through your
19 contract with them by the water that arises from the
20 land that you own, correct?
21 A. Based on those numbers.
22 Q. On an average basis?
23 A. Based on those numbers, yes.
24 Q. You testified under direct by your attorney
25 that you had no knowledge that the intervenors sought

1 more water. Would you look at Exhibit A-10 of our
2 exhibits, or M-10 is what we're calling them, that was
3 a petition to intervene filed by Na Moku.
4 I'll find it for you, be happy to.
5 MR. SCHULMEISTER: Let me object,
6 misstated his prior testimony.
7 MR. HALL: That's the petition to
8 intervene that was filed by Na Moku; and M-11 or A-11
9 was the petition, the next document, filed by Maui
10 Tomorrow.
11 Q. Do you see those two documents?
12 A. Yes.
13 Q. Wasn't EMI fully aware when it received these
14 documents that there were individuals represented by
15 these two groups that sought more water in the streams
16 for them?
17 A. I was aware of that, yes.
18 Q. That's as of 2001?
19 A. Correct.
20 Q. And EMI has not let down any water, any more
21 water for any of the people that are represented by
22 Native Hawaiian Legal Corp or through Maui Tomorrow
23 since 2001, has EMI?
24 MR. SCHULMEISTER: Objection, lack of
25 foundation.

1 HEARINGS OFFICER JUDGE McCONNELL: I'll
2 permit it.
3 THE WITNESS: That is incorrect.
4 Q. MR. HALL: EMI has not let down any more
5 water to satisfy the request of Neola Caveny, has EMI?
6 A. No, we have not.
7 Q. EMI has not let down any more water to
8 satisfy the request of Mr. Schupp, has EMI?
9 A. We had made repairs to the pipe on Puolua
10 Stream at the Lowrie diversion which produced more
11 water being passed over our ditch at the Lowrie level
12 for Mr. Schupp.
13 Q. Looking at Exhibit A-1 -- well, there are
14 some upper ditches above Wailoa. Are they shown on
15 this map?
16 A. Which ditches are you referring to?
17 Q. Well, there are higher level ditches than
18 Wailoa, correct?
19 A. The only ones that I can see on this map is
20 in the Keanae License area, Hauolo Tunnel.
21 Q. Talking about Waikamoi. Those ditches are
22 not shown on here, or those diversions?
23 A. On the county system?
24 Q. Yeah.
25 A. I see that they have a flume on the EMI land

1 above the state-owned parcel, and it's connected to
2 that Waikamoi pump, but that's all I see on this map
3 here. And that flume is no longer in service by the
4 county.
5 Q. Let's go back to A-1 and looking at Kamole
6 Weir, that's shown on the map?
7 A. Yes.
8 Q. To your knowledge, has A&B or EMI or any
9 affiliates entered into agreements by which water that
10 comes from the EMI system is used for nonagricultural
11 uses?
12 A. Can you clarify that?
13 Q. Yeah. I'm talking about water that comes
14 from Wailoa Ditch and terminates at Kamole Weir. And
15 I'm asking you if A&B or EMI has entered into any
16 agreements with third parties -- or no, has devoted
17 any of the water that is delivered to Kamole Weir for
18 nonagricultural uses?
19 A. Not that I'm aware of.
20 Q. Are you aware of how water that is
21 transmitted to Kamole Weir is devoted?
22 A. Generally, yes.
23 Q. Has Kamole Weir water been devoted for use in
24 agricultural subdivisions?
25 A. Probably just through the county system, but

1 not through agreement with EMI or A&B.
2 Q. Have some of A&B's own agricultural
3 subdivisions been served through water that is
4 delivered to Kamole Weir?
5 MS. LOVELL: I object to the form of that
6 question, unless the agricultural subdivisions in
7 question are identified.
8 MR. HALL: I would like to leave it wide
9 open.
10 HEARINGS OFFICER JUDGE McCONNELL: I'll
11 permit it.
12 THE WITNESS: As far as I know, Kamole
13 Weir, the county has its take of water. The county
14 serves the domestic needs of up-country residents,
15 farmers and businesses, and they serve ag
16 subdivisions, they serve farmers, they serve
17 residents.
18 As far as the other water that comes into
19 Kamole Weir, that water is used strictly by HC&S for
20 sugarcane cultivation. Some of that is used by Maui
21 Land & Pine, and some of that water is transported via
22 the HC&S Hamakua Ditch for the Kula Agricultural Park
23 which is nondomestic water or untreated water.
24 Q. MR. HALL: Did A&B subdivisions Haiku Mauka,
25 Haiku Makai, are they served by water that comes

1 through Kamole Weir?
2 MR. SCHULMEISTER: You mean directly?
3 MR. HALL: Indirectly or directly.
4 A. My jurisdiction ends at Kamole Weir, and
5 whether those subdivisions are served by water off of
6 the Wailoa, I think that question can be answered by
7 the Department of Water Supply.
8 Q. Well, do you know?
9 A. I don't know physically.
10 Q. Do you just know the answer to that question?
11 A. I don't know.
12 Q. Are there plans to expand Kamole Weir?
13 A. Not that I'm aware of.
14 Q. Are there plans to expand any of the
15 facilities that are -- that are adjacent to or
16 surround Kamole Weir, like treatment plants or
17 reservoirs?
18 A. I don't know.
19 Q. I would like you to look at your Exhibit A-6.
20 MR. SCHULMEISTER: That's the schematic.
21 Q. MR. HALL: A-6 shows the HC&S sugar company
22 ditch system and the EMI ditch system, correct?
23 A. That's correct.
24 Q. Let's just take the Wailoa Ditch for an
25 example. There is an effort here to depict each of

1 the license areas, is that right; Nahiku, Keanae,
2 Honomanu, Huelo?
3 A. Generally that's correct.
4 Q. And if we look at the Wailoa Ditch, just as
5 an example, it shows it expanding, I can't read the
6 first number, is that 25 MGD?
7 A. Where are you looking at?
8 Q. I'm starting in Nahiku.
9 A. Makapipi Stream?
10 Q. Yes.
11 A. Yes, I believe that's 25 MGD.
12 Q. And it grows to 55. Then we get into Keanae
13 at west -- certain stream there, and goes to 140. And
14 we get into the middle of Honomanu and it grows to
15 200. And then we get into Huelo and it diminishes to
16 160.
17 Can you explain what all of those numbers
18 mean?
19 A. What these numbers mean are the capacity,
20 carrying capacity of the ditch in that particular
21 area. For example, at Nahiku area from Makapipi to
22 Hanawi the carrying capacity of the ditch is 25
23 million. Once Hanawi Stream comes in, the ditch gets
24 bigger to 55 million and continues on.
25 When you look at the Honomanu area, that

1 area is at 140, and after it gets into the Huelo area
2 it goes to 200 million gallons. But then when you
3 look further down, it's reduced to 160 million gallons
4 because of the Wailua Ditch siphon on Naililihaele
5 Stream which maximum flow is at 160 million gallons
6 per day.
7 Q. Can you explain why some streams are shown
8 and not all streams?
9 A. I believe the schematic was made to depict
10 just major streams in the area.
11 Q. Isn't it true, though, that EMI moves water
12 between ditches downwards within some of these
13 streams?
14 A. Some of the streams are used to convey water
15 to other lower ditches, correct.
16 Q. And in Huelo, if we look at Wailoa, you could
17 move water from Wailoa Ditch to New Hamakua down to
18 Lowrie in those streams, correct?
19 A. Not all of them.
20 Q. But that's what EMI does with some of these
21 streams, correct?
22 A. Not normally.
23 Q. And then you show Waikamoi upper pipeline and
24 lower pipeline, you say those are county pipelines?
25 A. Yes, those are the county systems, but I

1 believe the Waikamoi upper pipeline should be revised
2 to say Waikamoi upper flume. It's actually not a
3 pipeline.
4 Q. You maintain those -- that system for the
5 county, correct?
6 A. We have an agreement with the County of Maui
7 Board of Water Supply to maintain both the upper
8 Waikamoi flume and the lower Waikamoi pipeline along
9 with our commitment for water at the Kamole Weir and
10 also at the Kula ag park.
11 Q. And you've got USGS gauging stations
12 designated on this map?
13 A. Yes, I do see some USGS gauge stations.
14 Q. Are those currently -- those exist now and
15 are operational?
16 A. Some of them are.
17 Q. Are the ones on Honopou Stream existing and
18 operational?
19 A. Yes, they are.
20 Q. And there's another designation for EMI
21 company gauge station, correct?
22 A. That's correct.
23 Q. And are the ones that are designated on this
24 map existing and optional?
25 A. Some of them are.

1 Q. And do you obtain daily data from these
2 gauging stations?
3 A. Some of these are hooked into our telemetry
4 system so we can ascertain what flow is at that moment
5 to operate our ditch system.
6 Q. Can you explain what you mean by that? Are
7 you receiving data electronically in some office?
8 A. Let me review this map. You know, I believe
9 this EMI company gauging station -- the circles here
10 are -- was with our old system. And I believe most of
11 these are not in operation at this time.
12 Q. So you have a new system?
13 A. We have a radio telemetry system which is
14 hooked into our office whereby we have a radio system
15 that you can call out on the phone and get
16 instantaneous data on the flow of the ditch system
17 throughout the system here.
18 Q. Is it providing data on just what's in the
19 ditch or what is being diverted at different streams?
20 A. It's providing data on what ditch flows are
21 at that moment.
22 Q. Are you receiving data in any way on what is
23 being diverted at different streams?
24 A. No, we're not.
25 Q. So you're just calculating what's being --

1 what volume is passing within the ditch system at
2 a certain point?
3 A. That's correct.
4 Q. And let's just take Wailoa as an example.
5 Where are your data receivers, receptors right now?
6 A. If you start on the left-hand side of this
7 schematic, on the Wailoa level, we have telemetry
8 system on Waiaaka Stream where you see that circle
9 with the X in it and No. 11 below there, I don't know
10 what the numbers mean.
11 Then we have one at Pinaau, measures water
12 there. And we have one at Spreckles Ditch right
13 before Puohokamoa Stream. And we have another one on
14 the Wailoa at Honopou Stream.
15 Q. And it gets transmitted to your office?
16 A. It gets transmitted to our office, correct.
17 Q. Could you look at our Exhibit M-3. I'll find
18 it for you.
19 I'm at M-3 and I'm on page, looks to be
20 six of M-3. M-3, it's a 1985 staff report from DLNR
21 with regard to a sale of a lease to EMI. And on Page
22 6 has some data on water taken from the various
23 license areas. Do you see that?
24 A. Yes.
25 Q. Do you recognize that data? Indicates what

1 was taken from the Nahiku License area, for instance,
2 from 74/75 then onwards to 84/85.
3 A. That's correct.
4 Q. Now, do you have any idea where that data
5 came from?
6 A. This data came from the USGS gauging
7 stations, the various water license areas.
8 Q. Are you still supplying this data to DLNR?
9 MR. SCHULMEISTER: Objection, lack of
10 foundation.
11 Q. MR. HALL: Do you supply this data annually
12 to DLNR?
13 MR. SCHULMEISTER: The USGS data?
14 MR. HALL: Yes.
15 Q. Do you supply data to DLNR regarding the
16 water taken from these license areas annually?
17 A. No. We supply total amount taken out of the
18 entire watershed area annually.
19 Q. So you no longer break it down for per
20 license area?
21 A. We have never broken this down. We've not
22 accumulated this data. This data was accumulated by
23 contract with USGS and the state.
24 Q. Is this data still being assembled by
25 contract with USGS and the state?

1 A. I don't believe it is.
2 Q. When did it stop being assembled?
3 A. I believe this stopped when the last of the
4 long-term license area, the Honomanu License area
5 expired in 1986. And I believe there was a one-year
6 holdover period that extended that license agreement.
7 And since that time, I believe the state just required
8 the total amount of water taken out of the four
9 license areas.
10 Q. So since '86 there's been no information
11 provided to DLNR by license areas in the amount of
12 water taken?
13 A. That's correct.
14 Q. And is it EMI that is now providing the data
15 annually on the amount of water taken out of the four
16 license areas together?
17 A. Yes. We are providing that data to the state
18 and with contract with U.S. Geological Survey to make
19 sure that the ratings are correct and that our
20 equipment are functioning properly. And we have an
21 agreement for them to do quarterly measurements and to
22 make any changes necessary to the rating table for
23 accuracy of the report to the state.
24 Q. What do you mean ratings and rating table?
25 A. Each ditch has a gauging station on it. And

1 gauging station is -- the way they calculate water is
2 by gauge height in feet.
3 And that particular level of water is
4 correlated to a particular amount, million gallons.
5 So, for example, at 2.5 feet it equals 100 million
6 gallons. Maybe at 3 feet it equals 200 million
7 gallons.
8 So the USGS goes out quarterly and
9 measures at the four ditches to make sure that the
10 accuracy of those gauging stations are accurate.
11 Q. So you rely on USGS to verify the accuracy of
12 those measurements?
13 A. To verify the accuracy of those rating tables
14 in those four gauging stations, correct.
15 Q. Where are those four gauging stations?
16 A. They're at the Honopou boundary on the four
17 ditches, the Wailoa, the New Hamakua, the Lowrie and
18 the Haiku Ditch.
19 Q. Did you supply that information in this
20 contested case hearing?
21 MR. SCHULMEISTER: What information?
22 Object.
23 Q. MR. HALL: Did you supply that information,
24 that being the total amount of water taken from the
25 four license areas from '86 to the present in this

1 contested case hearing?
2 A. I supplied that information to the state.
3 Q. Did you supply it as an exhibit in this
4 contested case?
5 A. I don't believe so.
6 Q. Looking at Exhibit A-6 again, Mr. Holaday
7 testified that you would be more familiar with the
8 Hawaiian Commercial & Sugar ditch system than he was;
9 is that correct?
10 A. I am generally familiar with the system, yes.
11 Q. What I had asked him was once you get onto
12 the HC&S side, which is in purple, green and blue and
13 the other colors, is it not possible to move water
14 from the Wailoa Ditch downwards to the Hamakua Ditch
15 to the Kauhikoa, to the Lowrie, to the Haiku Ditch on
16 the plantation?
17 A. Yes, that's possible.
18 Q. So you could distribute water throughout the
19 plantation downwards from these ditches, from any one
20 of these ditches?
21 A. From the Wailoa Ditch level you can
22 distribute water into these four ditches based on
23 irrigation needs, correct.
24 Q. You provided some rebuttal testimony with
25 respect to the direct testimony of Neola Caveny,

1 correct?
2 A. Yes.
3 Q. And in your Paragraph 44 you said:
4 Caveny alleges that two four-inch pipes in
5 the Lowrie Ditch that were intended to allow water to
6 flow downstream to the Lowrie Ditch into the Hanehoi
7 have been blocked within the last ten to 15 years.
8 And your rebuttal was only that her size
9 wasn't four inch, it was three; is that right?
10 A. I believe that's correct.
11 Q. You didn't challenge the fact that they had
12 been blocked for the last ten to 15 years, correct?
13 A. At those times that I've been at that area,
14 I've seen those pipes blocked, except for the last
15 field trip that we noticed that one pipe was running
16 water.
17 Q. That's when we went on the field trip because
18 someone from EMI cleaned it out a couple days before,
19 correct?
20 A. No, that's not correct.
21 Q. A little bit, a week before?
22 A. I don't believe anybody from EMI cleaned out
23 that pipe.
24 Q. And then in 46 you say that Ms. Caveny
25 testified that representatives of EMI alleged that

1 there's some sort of sump system or sump upstream of
2 her property that would prevent flows from getting to
3 her property.
4 And you said you're without knowledge as
5 to whether there would be a sump or sinkhole that
6 would prevent that; is that correct?
7 A. That's correct.
8 Q. So it's not EMI's position at this point in
9 time that there would be any sump or sinkhole that
10 would prevent any water that you released from getting
11 to her property, correct?
12 A. That I don't know.
13 Q. You don't know of any sump or sinkhole that
14 would prevent additional water from getting to her
15 property, correct?
16 A. That's correct.
17 Q. And then you wanted to rebut Mr. Schupp by
18 saying that he thought EMI had measured the
19 temperature of the water in his lo'i at 89 degrees.
20 And all you were saying was, it wasn't you that
21 measured it; right?
22 A. We've never taken any temperature
23 measurements in Mr. Schupp's lo'i.
24 Q. But you didn't dispute that someone measured
25 it at 89 degrees?

A. I don't know.
Q. You have no idea?
A. I have no idea.
Q. And in 51 you say: Mr. Schupp testified in his direct written that almost all the water is being diverted from Puolua Stream. But you took measurements and you measured the flow rate at Haiku Ditch 262 gallons per day.
That's what you testified to on direct, correct?
A. No, 262 thousand gallons per day.
Q. Right. That was your measurement using that system that you testified to, correct?
A. That was what we had measured in that particular day, correct.
Q. On that day, and that was never verified by USGS, correct?
A. I believe when we took that measurement --
Q. Was your measurement ever verified by USGS?
A. No, it was not.
Q. And it was never verified by CWRM, correct?
A. They were present when we took the measurement and they believed it was to be correct.
Q. You don't have any document that indicates CWRM thought your measurement was correct, isn't that

1 right?
2 A. If I recall that measurement --
3 Q. Is there any document that you can point to
4 where CWRM states that they thought your measurement
5 was correct?
6 A. I do not have any documentation.
7 Q. And you were measuring the outflow from the
8 pipe, correct?
9 A. I was measuring the outflow from the two
10 pipes passing water to the Haiku Ditch.
11 MR. SCHULMEISTER: Can I ask that the
12 witness not be interrupted before he finishes his
13 answer just as a matter of courtesy.
14 MR. HALL: Yes, I'm sorry.
15 Q. You were not measuring what was actually
16 entering his 'auwai, correct?
17 A. No. His 'auwai was not functional.
18 Q. But you've never measured what was entering
19 his 'auwai, correct?
20 A. We could never do that. I've never seen his
21 'auwai functional.
22 Q. You've never seen it functional?
23 A. That's correct.
24 HEARINGS OFFICER JUDGE McCONNELL: We're
25 going to have to take a break here. How much more do

1 you have?
2 MR. HALL: Not that much.
3 HEARINGS OFFICER JUDGE McCONNELL: The
4 question is whether you want to break for lunch or
5 push on and be hungry.
6 MR. SCHULMEISTER: I'd like to push on.
7 HEARINGS OFFICER JUDGE McCONNELL: We've
8 got to take a break for the reporter anyway.
9 MR. SCHULMEISTER: Five minutes?
10 (Recess was taken.)
11 HEARINGS OFFICER JUDGE McCONNELL: We're
12 back on the record. Mr. Hall.
13 THE WITNESS: Judge, can I make one
14 clarification before we begin? Mr. Hall had asked
15 about if we ever had reported how much we had taken
16 out of the watershed, and yes, we did. I would like
17 to point to Exhibit A-24, which is our hydrograph.
18 It's titled Billion Gallons Delivered at Honopou per
19 Fiscal year 1930 to 2004.
20 HEARINGS OFFICER JUDGE McCONNELL:
21 Delivered to where?
22 THE WITNESS: Billion gallons delivered at
23 Honopou and that's the Honopou boundary.
24 Q. MR. HALL: This exhibit A-24 that you're
25 looking at is an average figure per year? Is this the

1 total water that was reported to the state coming out
2 of the four license areas at the Honopou boundary
3 which is the western most boundary in all of your
4 ditches?
5 A. In our all our ditches, correct.
6 Q. And is there something that you have -- what
7 I'm looking for, is there something that has a
8 numerical figure instead of a graph that makes it hard
9 to read?
10 A. This is what we have here.
11 Q. Is this what you submit to the state?
12 A. No.
13 Q. What do you submit to the state?
14 A. We submit them a numerical total for each
15 ditch.
16 Q. And you haven't submitted that in this
17 contested case?
18 A. No, but we have submitted this graph that
19 gives you an idea of each fiscal year what the
20 deliveries are out of the watershed.
21 Q. You mean the four license areas?
22 A. Out of the four license areas, correct.
23 Q. I want to show you our Exhibits-28E and 28F,
24 and ask you if you recognize these as Mr. Schupp's
25 taro patches?

1 A. I believe they are, yes.
2 Q. So you've seen them in that condition as
3 they're shown in 28E and F?
4 A. No, I haven't.
5 Q. You haven't seen them yet?
6 A. No. I recognize this house in 28F though.
7 Q. So you've never seen them like this?
8 A. No.
9 Q. How many times since you've been at EMI have
10 you seen the property that Mr. Schupp is caretaker of?
11 A. I've been down there several times.
12 Q. Several times in how many years is that, 17
13 years?
14 A. Worked for EMI for 20 years.
15 Q. So you've been down there two or so times in
16 20 years?
17 A. I think more than that.
18 Q. Four?
19 A. When I go down there, it's usually to go and
20 look at our Haiku Ditch intake on Puolua Stream. If
21 Mr. Schupp is there, we go and say hello, see how
22 everything is going.
23 Q. So that's a total of four times in 20 years?
24 A. I wouldn't say four times. I would say it's
25 more than that.

1 Q. Less than ten?
2 A. Can't remember.
3 Q. And I would like you to look at Exhibit 19,
4 M-19, which is ours and I'll find it for you, if you
5 would like.
6 Do you recognize M-19, it says 19?
7 A. Yes, I do.
8 Q. Is that a diagram that either you or somebody
9 at EMI drew?
10 A. Yes. This is a diagram that I drew, but the
11 middle portion of it seems to have not copied quite
12 clearly.
13 Q. But on the left-hand side it shows Hanehoi
14 Stream and shows the diversions of Hanehoi Stream at
15 Wailoa Ditch, New Hamakua Ditch, Lowrie Ditch, Haiku
16 Ditch; is that right?
17 A. That's correct.
18 Q. And you already testified about that and
19 testified -- it also shows two three-inch pipes
20 blocked at the Lowrie Ditch level; correct?
21 A. On Hanehoi Stream, correct.
22 Q. Then Puolua Stream shows diversion at the New
23 Hamakua Ditch level and the Lowrie Ditch level and the
24 Haiku Ditch level, right; is that right?
25 A. Yes, correct.

1 Q. And you testified earlier that at the
2 Pualoa -- on Puolua Stream at the Lowrie Ditch level
3 there were two three-inch pipes that led into one
4 eight-inch pipe; correct?
5 A. Yes.
6 Q. So would it be true that the capacity of what
7 could pass through there would be limited to the two
8 three-inch pipe capacity?
9 A. I think it would be limited to the flow in
10 the stream. I think with bigger flow, you could get
11 more water.
12 Q. But you would agree that all that would pass
13 in normal conditions below the Lowrie Ditch would be
14 what would pass through the two three-inch pipes which
15 met in the eight-inch pipe; correct?
16 A. That's correct.
17 Q. And to be clear, that's a Y-type
18 configuration, the two three-inch pipes join in the
19 eight-inch pipe, right?
20 A. Yes. After we had done some work up there in
21 2004.
22 Q. And then at the Haiku Ditch level, all that
23 passes in Puolua Stream is whatever could pass through
24 the two three-inch pipes, correct?
25 A. That's right. Or if the intake was at

capacity and it rained a lot, it would spill over the diversion structure.

Q. And Mr. Schupp, the property he's caretaking, the two ones you referred to as Keala and Matson, are below the Haiku diversion but above where Hanehoi and Puolua join, correct?

A. That's right.

Q. And there is about 60 feet between his 'auwai and the Haiku diversion, correct?

A. I don't know. I've never measured it.

Q. But there's some distance?

A. There's some distance. I don't know if it's 60 feet.

Q. And on Hanehoi, the same thing we talked about the diversions and when we get to Lowrie the two three-inches that were blocked, and then we get to Haiku and Ms. Caveny's property is below the junction of Hanehoi and Puolua; correct?

A. That's correct.

Q. And below the junction of Hanehoi and Puolua the stream is called Hanehoi? In other words, Puolua dumps into Hanehoi and it continues being Hanehoi?

A. Are you asking me a question?

Q. Yes. In other words, what is the name of the stream below the junction with Puolua?

1 A. We call it Hanehoi Stream.
2 Q. That's right. And so it is Hanehoi Stream
3 that runs through Ms. Caveny's property; is that
4 correct?
5 A. Correct.
6 Q. And the sluices that you were talking about
7 before are in the New Hamakua Ditch diversion works on
8 Hanehoi and -- excuse me, on the Lowrie Ditch
9 diversion works on Hanehoi and on the Haiku Ditch
10 diversion works on Hanehoi; correct? Did you testify
11 to that on direct examination?
12 A. No, that's not correct.
13 Q. Okay, what's correct?
14 A. The two sluice gates we're talking about are
15 on Hanehoi Stream and Puolua Stream at Haiku Ditch
16 level.
17 Q. But there's also a sluice gate at the Lowrie
18 Ditch level, correct?
19 A. For what stream?
20 Q. Hanehoi.
21 A. No, there is not.
22 Q. How about Puolua?
23 A. There is not.
24 Q. So you testified that both of those gates
25 were open because of storm conditions, correct?

1 A. Correct.
2 Q. Had the storm occurred on the day of the site
3 inspection?
4 A. No, it occurred prior to the site inspection.
5 Q. And the storm -- there had been a storm and
6 it was over?
7 A. As I recall there was a storm. It rained a
8 lot. That's why these gates were opened. And it
9 continued to rain the following week, that's why these
10 gates were open. The day we did the site inspection
11 was a Monday and our crew was going along this Haiku
12 Ditch and Lowrie Ditch to make sure that all the gates
13 that were open due to the upcoming storm were to be
14 closed.
15 Q. So you closed both of them on the day of the
16 site inspection, correct? You ordered your workers to
17 do that?
18 A. No, that's not correct.
19 Q. Well, you asked them to do it?
20 A. No, that's not correct.
21 Q. When we were present on the site inspection
22 the day the judge was there, the sluice on Hanehoi was
23 closed, correct?
24 A. As I recall the day we did the site
25 inspection Mr. Schupp had closed the sluice gate on

1 Puolua Stream. And as we proceeded to Hanehoi Stream
2 on the Haiku Stream diversion that gate was open and
3 our field superintendent, Mr. Robello, had closed that
4 gate for us.
5 Q. So it was closed?
6 A. On Hanehoi Stream we closed it that day.
7 Q. And you came back and made sure that not any
8 bit of water escaped underneath it, correct?
9 A. That's the purpose of our sluice gate.
10 Q. To make sure no water got through that sluice
11 gate downstream, correct?
12 A. Correct.
13 Q. But EMI has a lot of ways to control how much
14 water passes over these diversion works, correct,
15 passes over or through them?
16 A. Can you clarify that question? I don't
17 understand that.
18 Q. If EMI wanted to let more water down to the
19 diversion works, they could place a pipe in the
20 diversion works?
21 A. That would be possible.
22 Q. And if it wanted to let a certain amount
23 through, it could gauge that amount by the capacity of
24 the pipe that it installed in the diversion works?
25 A. That would be possible.

1 Q. One could either choose, if you wanted to let
2 a certain amount, it could be a four-inch pipe, or if
3 wanted to let more down, could put an eight-inch pipe,
4 or two eight-inch pipes or three eight-inch pipes?
5 A. Bigger size of the area, the more flow would
6 flow through that area, correct.
7 Q. You heard Mr. Schupp testify that on Hanehoi
8 Stream the diversion work had a wall and there had
9 been a build-up of rocks and dirt over a long period
10 of time such that the water stream just came down,
11 went right over the top of the diversion work and the
12 water wasn't even being diverted. Do you recall that?
13 A. Yes.
14 Q. And that he heard that EMI, at a certain
15 point in time, came out and cleaned that dirt out and
16 that the whole stream, as a result, became diverted
17 again; do you recall that?
18 A. Yes.
19 Q. And you don't deny, do you, that EMI did what
20 you call that maintenance work, correct?
21 A. No. We did maintenance on that stream.
22 Q. And you don't deny the effect that that had?
23 In other words, whereas before you did the maintenance
24 work, the water went over the top and went downstream,
25 and after your maintenance work, the water no longer

1 went over the top and down and instead was diverted
2 into the ditch?
3 A. What we did was normal maintenance.
4 Q. But that's what the effect of that
5 maintenance work was, correct?
6 A. That I don't know because I haven't seen the
7 accumulation prior to the cleaning of that basin.
8 Q. So you're not denying the effect that Mr.
9 Schupp testified to, which was that before your
10 maintenance work it went over the top and downstream,
11 and after your maintenance work, it was totally
12 diverted?
13 A. That could possibly be.
14 Q. When you testified about a Poncho and his
15 system of delivering water to his taro patches or
16 whatever he had, you're not necessarily saying that
17 Poncho was the only one that had water rights on
18 Hanehoi or Puolua Stream, are you?
19 A. I don't know. All I know is Poncho had a
20 diversion ditch above the Haiku and below of the Hana
21 Highway that took Hanehoi water over the Haiku Ditch
22 tunnel to his place of residence.
23 Q. So your answer is he may not be the only
24 person who had water rights below the ditches?
25 A. I don't know.

1 Q. You don't know, okay. I noticed in your
2 testimony that you didn't deny that Mr. Schupp -- Mr.
3 Schupp in his direct testimony testified he had
4 appurtenant water rights. You haven't denied that in
5 your rebuttal, isn't that right?
6 MR. SCHULMEISTER: To the extent he's
7 asking him to testify about appurtenant rights, that's
8 beyond his competence.
9 MR. HALL: He can answer that.
10 MR. SCHULMEISTER: His testimony speaks
11 for itself.
12 MR. HALL: I want it clear on the record
13 they're not denying that.
14 MR. SCHULMEISTER: I object to the
15 question, calls for a legal conclusion.
16 MR. HALL: I think it's fair enough.
17 That's the heart of the matter.
18 HEARINGS OFFICER JUDGE McCONNELL: I'll
19 permit it.
20 Q. MR. HALL: In your rebuttal testimony -- Mr.
21 Schupp, in his direct testimony testified he has
22 appurtenant water rights; and in your rebuttal, you
23 did not deny that, correct?
24 A. I believe that's correct.
25 Q. And Ms. Caveny in her direct testimony

1 testified she has riparian water rights. And in your
2 rebuttal you did not deny that, correct?
3 MR. SCHULMEISTER: Same objection.
4 HEARINGS OFFICER JUDGE McCONNELL: I
5 understand your contentions may be otherwise, but he
6 can answer.
7 THE WITNESS: I'm not an attorney, so I'm
8 not an expert on riparian or appurtenant water rights.
9 Q. MR. HALL: But you did not deny it?
10 A. But I did not deny it.
11 Q. You understand that Mr. Schupp -- you were
12 here when he testified that he needs enough water to
13 grow healthy taro in his lo'i, which by his definition
14 is water in the lowest patch that's not higher in
15 temperature than 77 degrees. Did you hear that
16 testimony?
17 A. Yes.
18 Q. And you testified earlier, you're not a taro
19 grower, correct?
20 A. That's correct.
21 Q. So with respect to his testimony about what
22 he needs, you're going to rely on what your expert on
23 taro growth testified?
24 MR. SCHULMEISTER: Let me object. What
25 Mr. Hew is going to rely on is irrelevant. It's what

1 EMI and A&B is going to rely on. It's not an
2 appropriate question.
3 HEARINGS OFFICER JUDGE McCONNELL: I'll
4 sustain that.
5 Q. MR. HALL: Is EMI ready, willing and able to
6 supply Mr. Schupp 24 hours a day, seven days a week,
7 enough water to grow healthy taro defined as water
8 which is 77 degrees or less in the lowest of his taro
9 patches?
10 A. I believe once Mr. Schupp fixes his 'auwai
11 and starts to grow taro, I believe with the amount of
12 water passing over the Haiku Ditch diversion on Puolua
13 Stream, that he has sufficient water to attain his
14 desire to grow healthy taro.
15 Q. I'll ask you my question once more.
16 Is EMI ready, willing and able to supply
17 Mr. Schupp 24 hours a day, seven days a week, enough
18 water to grow healthy taro, which means 77 degrees in
19 his lowest patches? Are you willing to supply that
20 water?
21 A. Right now I cannot speculate what the future
22 is going to be, so I can't say at this point.
23 Q. When you made that earlier statement you
24 think he has enough water, you are not a taro grower,
25 correct?

A. I'm not a taro grower.

Q. And you don't know what it takes to grow healthy taro yourself, correct?

A. I know what it takes to grow taro because I've grown taro; but I'm not a taro grower, no.

Q. Have you ever experienced taro rot?

A. Not when I grew taro.

Q. Did you grow wetland taro?

A. I grew dryland taro and I was very familiar with wetland taro through my association with some people in the Keanae and Wailua area.

Q. So you yourself have only grown dryland taro?

A. Correct.

Q. When you say you've grown taro, all you're talking about is dryland taro?

A. That's correct.

Q. Is EMI ready, willing and able to provide Ms. Caveny with 670,000 gallons of water per day, 24 hours a day, seven days a week to her property?

A. What was the amount?

Q. 670,000 gallons a day.

A. I think EMI is willing to have those two pipes up at Hanehoi Stream on the Lowrie level to flow, and we also would be willing to have that flow go over the Haiku Ditch level on Hanehoi Stream.

1 Whether that 670,000 gallon can be obtained or not,
2 I'm not sure.
3 Q. So you're not willing to commit to having
4 670,000 gallons a day at her property, correct?
5 A. I cannot commit anything because I don't know
6 what the flow is in that stream.
7 Q. The State of Hawaii has not given you
8 permission to withhold water from individuals with
9 riparian rights, correct?
10 A. Can you clarify that?
11 Q. The State of Hawaii has not given you
12 permission to withhold water from those downstream of
13 your ditches who have riparian rights?
14 A. Nor have they --
15 Q. So the answer to the question is: No, they
16 haven't; correct?
17 A. No, they haven't.
18 Q. And the State of Hawaii has not given you
19 permission, that is EMI, to withhold water from those
20 downstream of your ditch system who have appurtenant
21 water rights; correct?
22 A. That's correct.
23 MR. HALL: I don't have any further
24 questions.
25 HEARINGS OFFICER JUDGE McCONNELL: Any

1 other questions?

2 CROSS-EXAMINATION

3 BY MR. MERCHANT:

4 Q. Earlier in testimony from Mr. Haia, he asked
5 you about questions related to your revocable permits,
6 specifically Paragraph 7 which discussed the ability
7 of A&B, EMI to sell, assign, convey, lease, mortgage
8 or otherwise transfer the rights under the license
9 agreement. Do you recall that testimony?

10 A. Yes, I do.

11 Q. Does that apply only to the license areas?

12 A. That applies only to the license area.

13 Q. And would not apply to what you today find in
14 Exhibit A-1 as private land or EMI, A&B lands, is that
15 correct?

16 A. That's correct.

17 Q. No further questions.

18 HEARINGS OFFICER JUDGE McCONNELL: Any
19 questions?

20 MR. HALL: So why intervene?

21 HEARINGS OFFICER JUDGE McCONNELL: Thank
22 you, Mr. Hew. That's all. We'll take a lunch break.

23 (Noon recess was taken.)

24 HEARINGS OFFICER JUDGE McCONNELL: Back on
25 the record.

1 MARK VAUGHT
2 was called as a witness by and on behalf of A&B and
3 EMI, was sworn to tell the truth, was examined and
4 testified as follows:
5 HEARINGS OFFICER JUDGE McCONNELL: State
6 your name for the record.
7 THE WITNESS: Mark Vaught.
8 HEARINGS OFFICER JUDGE McCONNELL: Mr.
9 Schulmeister.
10 DIRECT EXAMINATION
11 BY MR. SCHULMEISTER:
12 Q. Do you have in front of you the document
13 entitled DECLARATION OF MARK VAUGHT, the last page
14 dated August 22nd, 2005?
15 A. Yes.
16 Q. Is that your signature on the last page?
17 A. Yes, it is.
18 Q. Does this declaration -- does that represent
19 your direct testimony in this case?
20 A. Yes, it does.
21 Q. And the testimony in there is true and
22 correct to the best of your knowledge and belief?
23 A. Yes, it is.
24 MR. SCHULMEISTER: I have no further
25 questions. And I would ask this be received.

1 HEARINGS OFFICER JUDGE McCONNELL: It will
2 be in evidence. Any questions on this side?
3 MR. MERCHANT: No questions.
4 MR. HAIA: I have some questions, thank
5 you.
6 CROSS-EXAMINATION
7 BY MR. HAIA:
8 Q. First question is, Mr. Vaught, is your
9 declaration two pages?
10 A. In and about, yes.
11 Q. And does your copy have anything attached to
12 it?
13 A. Yes, it does.
14 Q. What is it?
15 A. Certificate of Service.
16 Q. And that's it?
17 A. Yes.
18 Q. Your declaration says, attached hereto, so I
19 assumed there was an exhibit attached.
20 A. Oh, sorry, no.
21 Q. It refers to Exhibit A-13. Do you have that
22 in front of you?
23 A. Yes, I do.
24 Q. I'm going to be asking you questions about
25 that exhibit.

1 In your testimony you state that you took
2 measurements of the Kekahuna 'auwai between March 15,
3 2004 and May 20th, 2005; is that correct?
4 A. That's correct, yes.
5 Q. When I look at Exhibit A-13, I notice that on
6 each occasion the measurements were taken no later
7 than 9:20 in the morning.
8 A. That's correct.
9 Q. That's correct. Did at any time anyone from
10 EMI go back later on in the day to take measurements
11 of streamflow in the 'auwai?
12 A. No.
13 Q. So there were no measurements taken in this
14 'auwai on any one of these dates or on any other day
15 after 9:20 in the morning?
16 A. That's correct.
17 Q. Are you aware that there are landowners above
18 the Kekahuna parcel that pump water out of Honopou
19 Stream?
20 A. I'm aware that there are people above that
21 that have access to pumps.
22 Q. And, in fact, if you look at the second page
23 and the date is September 10th, 2004?
24 A. That's correct.
25 Q. In the comment section of the last sentence

1 says, possible pumping upstream. So is that comment
2 made because the measurement was below 235,000 gallons
3 per day?
4 A. Yes, it was. It was a spontaneous comment
5 that I put in here because I didn't go and investigate
6 upstream what the reason was that there was less water
7 on that particular day.
8 Q. Okay. The best that can be said about this
9 information is that based upon the measurements you
10 took and the way you took those measurements on these
11 dates at that time, the flow into the Kekahuna 'auwai
12 is, according to your measurements, documented in the
13 fourth column entitled "flow"?
14 A. Yes, correct.
15 Q. And it's possible that later on in the day,
16 as on September 10th, 2004, that flow may have
17 decreased through pumping upstream?
18 A. It's possible.
19 Q. But you wouldn't know because these are the
20 only measurements you took on those days?
21 A. That's correct.
22 Q. I would like to go into the manner in which
23 you took these measurements. Can you just explain to
24 us, the hearing officer, how those measurements were
25 taken?

1 A. Basically we have a stainless steel
2 three-inch Parshall flume, which I believe we have
3 provided information on Parshall flumes and how they
4 work. And we take that to Mrs. Kekahuna's house, and
5 we set it in her 'auwai in pretty much the same place
6 every time.
7 We'd shore it up with sandbags, make sure
8 it was level. And then at that point, we would clean
9 the screen to the inlet of her 'auwai and then raise
10 the deflector plate to let the water come through.
11 At that point the water would run through
12 the flume. And the reason it says 235,000 plus is
13 because that's the capacity of the flume is 230, it
14 doesn't go higher than that.
15 And generally the water would be covering
16 the entire flume. We would take a measuring stick,
17 check the height of the water and compare it to the
18 corresponding rating table that goes along with that
19 flume.
20 Q. How long would the flume be in that position
21 before you took the measurement?
22 A. Maybe 60 seconds. It was about 12 feet from
23 the entrance to her 'auwai.
24 Q. So you put the flume in, within a minute
25 you'd taken the reading?

1 A. Put the flume in, set it. She always had
2 water coming through the 'auwai. Set it up so that
3 the water would be funneled into the flume. And then
4 maybe for about a minute we would set it, make sure
5 everything was level, and then take it up, let the
6 water run through it for awhile, stabilize and take
7 the reading.
8 Q. What was the purpose of the sandbags?
9 Because you just mentioned that you would direct the
10 water into the flume.
11 A. Yeah. The purpose of the sandbag is to get
12 the water to funnel through the flume.
13 Q. Where would it have gone otherwise?
14 A. Around the sides of the flume. The mouth of
15 the flume is maybe eight to ten inches wide, but the
16 'auwai might be 18 inches wide.
17 Q. So it's like putting the water into the
18 flume?
19 A. Directing it into the flume.
20 HEARINGS OFFICER JUDGE McCONNELL: All of
21 it?
22 THE WITNESS: Yes, as much as could have
23 been directed.
24 Q. MR. HAIA: So some of that water could have
25 remained in the stream?

1 A. I'm not understanding your question.
2 Q. That's okay. I'll move on.
3 HEARINGS OFFICER JUDGE McCONNELL: Well, I
4 have the same question.
5 THE WITNESS: Could you rephrase that
6 question, so I can understand it?
7 HEARINGS OFFICER JUDGE McCONNELL: You're
8 trying to measure the total flow in the 'auwai,
9 correct?
10 THE WITNESS: Correct.
11 HEARINGS OFFICER JUDGE McCONNELL: So you
12 put this thing in the stream.
13 THE WITNESS: I put it in the 'auwai.
14 HEARINGS OFFICER JUDGE McCONNELL: In the
15 'auwai, I'm sorry. And I don't see how you can do it
16 or measure a height on that unless you're trapping all
17 the water, but maybe I'm just not getting it.
18 THE WITNESS: Okay. I would set the flume
19 in place, put sandbags on the side of it where the
20 water would otherwise go around, and force the water
21 through the middle of the flume.
22 But if I lift the plate all the way up,
23 there's so much water in the 'auwai that the flume
24 would actually be under water.
25 So when I take the measurement, the flume

1 -- the flume only goes up to, if you look at the gauge
2 height on A-13, the flume only goes up to .5, but I'm
3 measuring at .8 because it exceeds .5, .5 is as high
4 as we can go and that's at 235,000 gallons per day.
5 So when I take the measurement, there's
6 more than 235,000 gallons per day. I can't tell you
7 how much there is, because our flume is not big enough
8 to handle the amount of water that's flowing through
9 there.
10 HEARINGS OFFICER JUDGE McCONNELL: Any
11 follow up? Go ahead.
12 Q. MR. HAIA: Did you also measure the water
13 that was remaining in the stream as it went by the
14 Kekahuna 'auwai?
15 A. No, I did not.
16 Q. You state that in Paragraph 3:
17 "Mrs. Kekahuna does not keep this gate
18 open because if she did, during periods of high stream
19 flow, the water would overflow the 'auwai into her
20 yard."
21 I understand what you're saying there, but
22 is it also possible that Mrs. Kekahuna doesn't want to
23 divert all the water into the 'auwai, she wants some
24 of the water to stay in the stream?
25 A. Could be possible, sure.

1 MR. HAIA: No more questions. Thank you.
2 HEARINGS OFFICER JUDGE McCONNELL: Mr.
3 Hall, any questions?
4 MR. HALL: Yeah.
5 CROSS-EXAMINATION
6 BY MR. HALL:
7 Q. Mr. Vaught, how long have you worked for EMI?
8 A. Six-and-a-half years.
9 Q. And I'm also looking at your declaration on
10 Paragraph 4, says that you and Henry Robello conducted
11 a field inspection on August 16th, 2005 of the
12 property of Mr. Schupp.
13 A. That's correct.
14 Q. Did you have the permission of Ernest Schupp
15 to conduct a field inspection of his property?
16 A. No, I did not.
17 Q. Did you ask for the permission of his
18 attorney, me, to conduct a field inspection?
19 A. No, I did not.
20 MR. HALL: I move to strike Paragraph 4 of
21 this document, and Exhibit A-40 as unauthorized
22 discovery in this case.
23 MR. SCHULMEISTER: Objection.
24 HEARINGS OFFICER JUDGE McCONNELL: I'll
25 overrule that.

1 MR. HALL: On what grounds?
2 HEARINGS OFFICER JUDGE McCONNELL: I don't
3 know that there's any grounds. If he's a trespasser,
4 there's other remedies for that.
5 MR. HALL: There is discovery, you want to
6 do discovery, you ask for discovery. You don't
7 trespass on somebody's property, and don't notify the
8 owner.
9 THE WITNESS: We have the right-of-way to
10 walk down to our intake there.
11 HEARINGS OFFICER JUDGE McCONNELL: Well,
12 but it's not grounds for exclusion of the evidence.
13 MR. HALL: If you don't follow the
14 discovery procedures in a case? We do have discovery.
15 MR. SCHULMEISTER: You're saying he can't
16 go on his right-of-way and record what he sees?
17 Q. MR. HALL: Your right-of-way is not on Mr.
18 Schupp's property, is it?
19 A. The ditch trail that comes down his driveway
20 is.
21 Q. But his taro patch --
22 A. I didn't walk into his taro patch.
23 Q. You said you conducted a field inspection of
24 the property of Ernest Schupp.
25 A. Yes. I could see his property from our

1 intake. When we walk down the stream a little bit
2 right to where his 'auwai takes water -- are you
3 familiar with his 'auwai?
4 Q. Of course.
5 A. Okay. Right where his 'auwai takes in, if we
6 stand over there in the stream, you can just look
7 right down into his property.
8 Q. Your ditch is a good 60 feet away from his
9 'auwai, correct?
10 A. I don't know the distance. I would say that
11 could be.
12 Q. And your right-of-way is to go to your ditch
13 and that's it; isn't it?
14 A. Correct.
15 Q. But you didn't just stay in your ditch,
16 correct?
17 A. That's correct.
18 Q. You went down to his 'auwai?
19 A. Yes.
20 Q. So you were outside of whatever right-of-way
21 you had, correct?
22 A. Yes.
23 Q. Without his permission and without my
24 permission, correct?
25 A. Yes.

1 Q. How many times have you been down to Mr.
2 Schupp's property in the six-and-a-half years?
3 A. Including that time, four.
4 Q. Four other times?
5 A. No, four times total.
6 Q. So three other times?
7 A. Correct.
8 Q. When were the three other times?
9 A. I don't know the exact dates, but Mr. Schupp
10 was present for all three. And he didn't tell me to
11 leave, so.
12 Q. So you looked at your Exhibit A-40. You sat
13 down and drew yourself a little map of everything that
14 you were looking at at the time?
15 A. Yes.
16 Q. How long did that take?
17 A. Oh, I didn't do the drawing there, I did the
18 drawing back in the office.
19 Q. And you said you did not see any taro growing
20 on Mr. Schupp's property, no water flowing into his
21 patch?
22 A. Correct.
23 Q. I want to show you exhibits, our Exhibits 28E
24 and 28F. Do you recognize these photographs as being
25 photographs of the lo'i on Mr. Schupp's property?

1 A. They look like they could be the lo'i on Mr.
2 Schupp's property.
3 HEARINGS OFFICER JUDGE McCONNELL: The
4 numbers again.
5 MR. HALL: M-28E and M-28F.
6 Q. Have you seen the lo'i with taro in them and
7 water like that?
8 A. No, never.
9 Q. But you've only been there three other times?
10 A. Yes.
11 Q. Mr. Vaught, how long would you continue to
12 try to drive a car when it didn't have gasoline in it?
13 A. I wouldn't.
14 Q. Thank you.
15 MR. HALL: I have no other questions.
16 HEARINGS OFFICER JUDGE McCONNELL: Any
17 other questions? Thank you, Mr. Vaught.
18 LEE JAKEWAY
19 was called as a witness by and on behalf of A&B, EMI,
20 was sworn to tell the truth, was examined and
21 testified as follows:
22 HEARINGS OFFICER JUDGE McCONNELL:
23 State your name, please.
24 THE WITNESS: Lee Jakeway.
25 HEARINGS OFFICER JUDGE McCONNELL: Mr.

1 Schulmeister.
2 DIRECT EXAMINATION
3 BY MR. SCHULMEISTER:
4 Q. Mr. Jakeway, do you have in front of you the
5 document entitled DECLARATION OF LEE JAKEWAY that was
6 signed on July 29th, 2005?
7 A. I do.
8 Q. Does this document include the testimony that
9 you provided in this case?
10 A. Yes, it does.
11 Q. And is the testimony that's contained in this
12 declaration true and correct to the best of your
13 knowledge and belief?
14 A. Yes, it is.
15 Q. Now, the first paragraph says you are
16 currently employed by HC&S as its Superintendent of
17 Water Coordination. Is that still the case?
18 A. I had a recent promotion that I should bring
19 to the attention of --
20 Q. What is your --
21 MS. LOVELL: I can't hear.
22 HEARINGS OFFICER JUDGE McCONNELL: You
23 have to speak way up.
24 THE WITNESS: Okay. I was recently
25 promoted to Director of Energy Development and

1 Planning.
2 (Isaac Hall leaves.)
3 MR. SCHULMEISTER: I have no further
4 questions.
5 HEARINGS OFFICER JUDGE McCONNELL: Mr.
6 Haia.
7 MR. HAIA: Mr. Murakami is going to do the
8 cross.
9 CROSS-EXAMINATION
10 BY MR. MURAKAMI:
11 Q. What is the title that you have?
12 A. Director of Energy, Development and Planning.
13 Q. And you work for HC&S?
14 A. Correct.
15 Q. So does your title infer that you have no
16 role in the agricultural operations of HC&S?
17 A. Currently I don't have direct involvement
18 with agricultural operations.
19 Q. So your whole purpose of your position is to
20 direct the energy development of HC&S and to plan for
21 it?
22 A. That is correct.
23 Q. So prior to this -- is it a promotion you
24 said?
25 A. Yes.

1 Q. Prior to this promotion then, did you have
2 duties to deal with the water use on HC&S lands?
3 A. Yes, I did.
4 Q. And you had responsibilities to coordinate
5 the application of that irrigation water from East
6 Maui Irrigation on HC&S land?
7 A. That is correct.
8 Q. How many staff did you supervise?
9 A. At that time I had four ditch coordinators
10 that I supervised.
11 Q. That would be opening the gates or whatever
12 else is needed to direct the water to the points you
13 directed?
14 A. That's correct.
15 Q. Now, I take it from your testimony that
16 basically what we're dealing with here is the
17 application of irrigation water from the East Maui
18 irrigation system on 5,000 acres on certain fields of
19 EMI water exclusively, correct?
20 A. That is correct.
21 Q. And on 25,000 acres of EMI water combined
22 with other sources of water, primarily groundwater
23 pumped by HC&S?
24 A. Yes.
25 Q. And your testimony on Page 3 is that the

1 range of this use varied from 134 million gallons per
2 day in the winter months to a high of 268 million
3 gallons during the peak months of May to October,
4 correct?
5 A. That is correct, that's what it states.
6 Q. Is that your testimony or not?
7 A. Yes, it is.
8 Q. Is that based on records that you have
9 compiled with HC&S?
10 A. That's -- yes, we do have records to attest
11 to that.
12 Q. And this is over what period of time?
13 A. This would be for 2002 to 2004.
14 Q. The same period that you mentioned for
15 determining the allocation of water between ground and
16 surface water?
17 A. That is correct.
18 Q. And so if you're using 134 million gallons a
19 day on 30,000 acres, is my math correct that your
20 average acreage usage is 4,467 gallons per day per
21 acre?
22 A. If 30,000 -- if 134 million gallons were
23 divided by 30,000 that sounds reasonable, yes.
24 Q. So that's during the off-peak use. And it
25 doubles during the peak months. So I would assume

1 that it would be doubling the gallons per day per
2 acre, correct?
3 A. Approaching that, yes.
4 Q. To the amount of 8,933 gallons per acre?
5 A. That would be correct.
6 Q. This is with the use of drip irrigation?
7 A. Yes.
8 Q. Isn't it true that the typical water use of
9 diversified crops is in the neighborhood of 2000
10 gallons per day per acre?
11 A. For diversified crops?
12 Q. Yes.
13 A. That could be for diversified crops, but for
14 sugarcane it would be on the order of eight to 10,000
15 gallons a day.
16 Q. Do you know how much it was during the period
17 when there was no drip irrigation --
18 THE COURT REPORTER: I can't hear you.
19 MR. MURAKAMI: Do you know what the usage
20 was per day per acre on 30,000 acres when you were not
21 using drip irrigation?
22 A. When we were using furrow irrigation?
23 Q. Yes.
24 A. I do not know. That was before my time.
25 Q. And you don't know whether or not that was

1 10,000 gallons per day per acre?
2 A. I do not, no.
3 Q. Now, is it true or not true that all 30,000
4 acres of HC&S land is currently being irrigated today,
5 that is being serviced by the EMI system in whole or
6 in part today, right now?
7 A. Can you clarify that?
8 Q. All 30,000 acres of land which is serviceable
9 by EMI water in whole or in part being irrigated to
10 today as we speak?
11 A. They would not be irrigated, technically, but
12 they would not be -- technically they would not be
13 irrigated, all of them irrigated today, but they have
14 the potential to be irrigated. The systems are in
15 place to be irrigated.
16 Q. How many acres of the 30,000 acres is
17 actually being irrigated today as we speak?
18 A. I wouldn't know because I'm not involved in
19 the operation.
20 Q. But you were responsible for applying the
21 water to the serviceable lands, weren't you?
22 A. Yes, I was. That was a function of the
23 percentage of soil moisture that was in the ground
24 that we would monitor. So depending on the soil
25 moisture status that those fields would get irrigated

1 water.
2 Q. But is it or is it not true that you would be
3 allowing some fields to lay in fallow without
4 irrigation water being applied to it in a typical
5 month, day, year?
6 MR. SCHULMEISTER: Let me object, vague.
7 Are you saying fallow means not irrigated?
8 MR. MURAKAMI: Yeah.
9 MR. SCHULMEISTER: I don't think that's
10 the typical understanding of the word.
11 HEARINGS OFFICER JUDGE McCONNELL: Could
12 you clarify that, because that's not my understanding.
13 Q. MR. MURAKAMI: Are all 30,000 acres of HC&S
14 lands cultivated at the same time?
15 A. Yes, that would be a true statement.
16 Q. So every acre of the 30,000 has some planting
17 on it of some sort?
18 A. There would be some fields in transition from
19 harvesting to planting, so there would be a certain
20 percentage that would be --
21 Q. What percentage would that be?
22 A. I wouldn't know the exact percentage of that.
23 Q. Who would know, if you don't know? You're
24 the one that were applying the water to the fields.
25 A. Probably farm managers for each individual

1 divisions.
2 Q. Don't they tell you, the Director of the
3 Operations, to irrigate these lands? You wouldn't
4 shut off the water. You wouldn't cut off the water
5 continuing if there were --
6 MR. SCHULMEISTER: Let me object. The
7 question implies today, right? And he doesn't --
8 MR. MURAKAMI: At any time. At any time
9 while he had his former position to direct irrigation
10 water to the fields that were in need of irrigation.
11 MR. SCHULMEISTER: You're assuming the
12 percentage was the same every day.
13 MR. MURAKAMI: I'm asking him.
14 A. There would always be a certain percentage
15 that would be in transition or fallow from harvesting
16 to planting.
17 Q. Is that percentage the same from day-to-day?
18 A. It would be a steady state, yes. I think
19 that would be a good way of characterizing that.
20 Q. So steady state, what is the percentage that
21 would not be under irrigation?
22 A. Are you asking me to take a guess on this?
23 Q. I'm assuming --
24 A. Or are you asking me if I know that?
25 Q. Do you know that?

1 A. I do not know that.
2 Q. Do you have any idea what the range of that
3 percentage is?
4 A. No, I cannot give you an accurate number on
5 that.
6 Q. So you cannot tell me from day-to-day whether
7 or not you need water for 30,000 acres -- while you
8 were responsible for irrigating the fields of HC&S,
9 you could not tell me on how many acres water was
10 being applied and where water was not being applied or
11 how many acres water was not being applied on; is that
12 what you're saying?
13 A. Let me explain. My main responsibility was
14 to respond to the request of the farm managers and
15 their needs for the water on each of the ditches. So
16 I did not commit to memory what their acreage
17 requirements were for irrigation.
18 Q. So you didn't know on a per acre basis how
19 much water was needed on various fields of HC&S at any
20 given time?
21 A. That would be correct in saying that.
22 Q. And you didn't know?
23 A. Not on a per acre basis.
24 Q. And you didn't know how many acres did not
25 have water, irrigation water being applied to it on

1 any given day?
2 A. There's a report in cultivated acres that
3 does detail the number of acres. And that was the
4 basis for the requirement for water for that ditch.
5 So that would take into account the acres that were
6 receiving water.
7 Q. But so you're saying you didn't commit it to
8 memory and you can't say what that percentage of
9 either irrigated land was or lands not being irrigated
10 at any given time?
11 A. That total would vary from day-to-day.
12 Q. Do you have an idea of what the range of that
13 variation is in terms of the percentage of lands being
14 irrigated or not being irrigated?
15 A. I would have to go back and review the
16 records. I do not know that right at this moment.
17 Q. And you have no idea --
18 A. No.
19 Q. -- whether it was ten percent, 25 percent?
20 A. If you want a range, I can hazard a guess.
21 Q. Based on your best estimate and years of
22 experience?
23 A. I would say it's less than ten percent.
24 Q. More than five percent?
25 A. I couldn't tell you exactly.

1 Q. So if, in fact, it would be no more than ten
2 percent being irrigated; is that right?
3 A. I would think that would be generally true,
4 yes.
5 Q. So based on your testimony, I would -- is it
6 true or not true then at any given time typically HC&S
7 was irrigating 27,000 acres of land per day -- I mean
8 every day?
9 A. Based on that math, yes, that would be close
10 to that.
11 Q. So if that's true, then if we use generally a
12 ten percent figure, then the figures I gave you
13 earlier as to the gallons per day per acre would have
14 to be increased by approximately ten percent to show
15 what amount of water was being applied to those lands
16 that were being irrigated by your operations on a per
17 day per acre basis?
18 A. Yes, that would be driven by whatever acres
19 are requiring irrigation water.
20 Q. So that would be more in the neighborhood of
21 5,000 gallons approximately per day per acre to 9,000
22 -- 10,000 gallons per day per acre, thereabouts. Is
23 that correct?
24 A. According to that math, yes.
25 Q. So is it also true then -- let me ask this.

1 As I understand your testimony, you need
2 to irrigate the lands of HC&S based on the rate of
3 evaporation and transpiration that you experience in
4 those fields?
5 A. That is correct. We try to keep up with
6 evapotranspiration rate.
7 Q. So what you would have to apply, as I
8 understand your testimony, is the same rate by which
9 water is evaporating or transpiring -- transpiration
10 is occurring from the fields that are affected by your
11 irrigation?
12 A. That is correct.
13 Q. At this point then, Mr. Jakeway, who has
14 taken charge of the actual irrigation operations of
15 HC&S?
16 A. You want a name?
17 Q. Yes.
18 A. Mr. Rodney Chin.
19 Q. So in essence was your position a new
20 position, or one which was split off from your old
21 position?
22 A. It was actually a new position.
23 Q. And Mr. Chin stepped into your position as
24 the person in charge of irrigation operations?
25 A. That is correct.

1 Q. What I didn't understand by that statement, I
2 guess, is if it's equal to evaporation and
3 transpiration, are you left with nothing for the
4 actual plant to absorb?
5 A. The transpiration by definition is what the
6 plant is -- water is going through the plant.
7 Q. It's going and leaving the plant.
8 A. Correct.
9 Q. Isn't there any water left over for the
10 plant, if you're just irrigating to the extent that
11 there's evaporation and transpiration?
12 A. You're irrigating to provide the soil
13 moisture reservoir for the plant to grow healthy
14 through whatever evaporation and transpiration is
15 going on. So it's a combination of soil evaporation
16 and transpiration through the plant.
17 Q. So you're basically assuming that whatever
18 the moisture content of the soil is at the time, is
19 sufficient for the plant to absorb whatever needs it
20 has for water?
21 A. It has to be maintained at a certain soil
22 percentage level, soil moisture level, in order to
23 maintain good growth crop in the growth of the plant.
24 Q. And, Mr. Jakeway, do you have any -- are you
25 provided with any information as to what authority,

1 legal or otherwise, HC&S has with respect to being
2 able to take water from the East Maui Irrigation Ditch
3 system without regard for the water needs of taro
4 farmers in East Maui?
5 MR. SCHULMEISTER: Beyond the scope of
6 direct. Calls for legal conclusion.
7 HEARINGS OFFICER JUDGE McCONNELL: I'll
8 sustain that.
9 MR. MURAKAMI: That's all I have.
10 HEARINGS OFFICER JUDGE McCONNELL: I just
11 wanted to get a general idea. Irrigation of sugar,
12 obviously there's a great variation in seasons. But
13 let's take the dry seasons.
14 Is a particular field being irrigated
15 24-hours-a-day? In other words, the water is turned
16 on.
17 THE WITNESS: Normally the way the
18 irrigation is planned is by irrigation rounds. So a
19 field will get a round that lasts on average 48 hours.
20 And that may be good for one week. And then during
21 that time the soil moisture will be depleted, you have
22 to come back and irrigate that field again. And that
23 varies depending on the time of year.
24 HEARINGS OFFICER JUDGE McCONNELL: Right,
25 so in the winter you would have to do that less often.

1 THE WITNESS: During the cooler winter
2 months when the evapotranspiration rate is lower.
3 HEARINGS OFFICER JUDGE McCONNELL: Okay.
4 Any other questions?
5 MR. MURAKAMI: Can I follow up with that
6 line of questioning?
7 FURTHER CROSS-EXAMINATION
8 BY MR. MURAKAMI:
9 Q. As I understood your earlier testimony you
10 said that at all times 27,000 acres were being
11 irrigated, correct?
12 A. No, I did not say that. Not all 27,000 acres
13 were being irrigated.
14 Q. For the lands for which you're irrigating,
15 excluding the lands under cultivation and/or some
16 other form of operation where there is no planting,
17 how many acres are being irrigated?
18 A. I stand corrected, yes, 27,000 of the 30,000,
19 if the ten percent figure is used for the fallow.
20 Q. You said that 27,000 acres are being
21 irrigated, correct?
22 A. Well, they're not all being irrigated.
23 Q. That's different than the answer you gave me
24 earlier. My question to you was at any given time,
25 how many acres were being irrigated outside of the

1 cultivation and other operations where there are no
2 plants in the ground.?
3 MR. SCHULMEISTER: When you say being
4 irrigated, you mean water is being applied?
5 MR. MURAKAMI: What else would it mean?
6 MS. LOVELL: I thought irrigation
7 schedules --
8 MR. MURAKAMI: I didn't say irrigation
9 schedule.
10 HEARINGS OFFICER JUDGE McCONNELL: Well,
11 but it's obvious, Mr. Murakami. I mean, you know, you
12 don't have the water on all the time.
13 MR. MURAKAMI: That's not true for taro,
14 why should it not be true for sugarcane?
15 HEARINGS OFFICER JUDGE McCONNELL: It is
16 true for taro.
17 MR. MURAKAMI: I'm sorry?
18 HEARINGS OFFICER JUDGE McCONNELL: It is
19 true for taro, but anyway taro would have no
20 application. The question is how do you define
21 irrigation. What I understand the witness to be
22 saying is that irrigation means that they are
23 providing water as-needed when measured by the soil
24 moisture.
25 MR. MURAKAMI: Can I ask him a different

1 way?
2 HEARINGS OFFICER JUDGE McCONNELL: Okay.
3 Q. MR. MURAKAMI: During the winter months, what
4 percentage of time on the 20,000 acres being irrigated
5 is water being applied?
6 MR. SCHULMEISTER: You mean to a
7 particular acre?
8 MR. MURAKAMI: All 20,000 acres.
9 MR. SCHULMEISTER: That assumes they're
10 all being irrigated at the same time.
11 MR. MURAKAMI: I'm asking. Half of the
12 acreage? Three-quarters of the acreage?
13 A. Can I use my calculator?
14 Q. Yes.
15 A. You make the assumption of two days per week
16 and each irrigation round last two days, it would be
17 about 28 percent.
18 Q. What?
19 A. Of that 20,000 acres that would be receiving
20 irrigation water, that would be irrigated during that
21 time.
22 Q. Basically -- wait, 2800, you said?
23 A. 28 percent of that 27,000.
24 Q. And 28 percent of 27,000 acres is how many
25 acres?

1 A. That's about 7,560 acres.
2 Q. 7,560 acres?
3 A. Yes.
4 Q. If you took 134 million gallons per day
5 divided by that figure, what would you get?
6 A. That 134 million gallons a day represents an
7 average.
8 Q. Fine. That's during the wet periods. I'm
9 asking you during the wet period what is it for 7,560
10 acres being irrigated at any given moment?
11 MR. SCHULMEISTER: Let me object. You
12 take a day, now you're transposing it to a moment? I
13 think it's lack of foundation. That doesn't make any
14 sense.
15 MR. MURAKAMI: I think it makes perfect
16 sense and I think it is admissible.
17 HEARINGS OFFICER JUDGE McCONNELL: I won't
18 comment on whether it makes sense or not, but I'll
19 allow it.
20 MR. MURAKAMI: Thank you.
21 A. I come up with approximate number of about
22 18,000 gallons.
23 Q. Per day per acre?
24 A. Per acre per day.
25 Q. So is my understanding correct that on the

1 average during the wet winter months, you're applying
2 at any given moment when there is a cycle of
3 irrigation on 28 percent of the lands, over 18,000
4 gallons per day per acre?
5 A. According to that math, yes, for two days out
6 of seven days a week, so you have to average that over
7 the entire seven days.
8 Q. I understand that. But if you go past the
9 two days, you're applying irrigation water to another
10 set of lands of about 7,560 acres on the average?
11 A. On an average, yes.
12 Q. And you rotate that after that two days?
13 A. Yeah.
14 Q. So every two-day cycle you're applying
15 approximately the same amount of water on average to
16 7,560 acres.
17 MR. SCHULMEISTER: To a different acre --
18 MR. MURAKAMI: I'm sorry, is it argument
19 or is there an objection?
20 MR. SCHULMEISTER: The objection is lacks
21 foundation, assumes facts not in evidence.
22 MR. MURAKAMI: I'm using all of his facts.
23 I'm using all of his evidence.
24 HEARINGS OFFICER JUDGE McCONNELL:
25 Clarify, rephrase.

1 Q. MR. MURAKAMI: So your testimony is there is
2 a rotation schedule for irrigation, correct?
3 A. That's correct.
4 Q. And that takes about two days at a time,
5 correct?
6 A. On average, yeah.
7 Q. I'm talking about the winter months now.
8 HEARINGS OFFICER JUDGE McCONNELL: What?
9 MR. MURAKAMI: The winter months, off
10 peak.
11 Q. And you're saying that in any given average
12 cycle approximately 7,560 acres are being actually
13 irrigated with water during that two-day cycle,
14 correct?
15 A. If there was rainfall, then there wouldn't be
16 any irrigation rounds, but this is on average.
17 Q. But you've already assumed some differences
18 in rainfall based on the peak and off-peak months,
19 correct? We're talking about the wet winter months,
20 correct?
21 A. Yeah, that's correct.
22 Q. So if you're applying water on the ground to
23 7,560 acres at a time approximately on the average,
24 and you're applying 134 million gallons a day on the
25 average to that acreage, then you are applying

1 18,000 -- over 18,000 gallons per day per acre,
2 correct?
3 A. For that two day irrigation rounds, that is
4 correct.
5 Q. Then the next two days you'll be doing the
6 same thing?
7 A. For another area, yes.
8 Q. The next two days after that, the same thing?
9 A. For another area.
10 Q. Yeah, for another area. And this goes on
11 throughout the whole off-peak period, correct?
12 A. It's being driven also by the soil moisture
13 program. So if it requires irrigation --
14 Q. You might put more or you might back off
15 depending on need?
16 A. Correct.
17 Q. But we're talking on the average now,
18 correct?
19 A. Yes.
20 Q. So throughout the wet winter periods, you're
21 applying over 18,000 gallons per day per acre?
22 A. No. I wouldn't characterize that. We don't
23 do that continuously throughout the winter period.
24 Q. I'm not asking you to do it continuously. I
25 said on the average you're applying 18,000 gallons per

1 day per acre during the wet winter months?
2 A. That would be correct from the math that we
3 worked through.
4 Q. And if you moved on to the dry months, you
5 would be applying over 36, maybe 37 gallons per day
6 per acre during the dry months, peak months, correct?
7 It's double, basically double on the average. Not on
8 every given day necessarily, but on the average
9 throughout that dry period of irrigation, correct?
10 MR. SCHULMEISTER: You mean on the average
11 day of the water being applied?
12 MR. MURAKAMI: An average peak period day
13 throughout the peak season, you would be applying
14 37,000-plus gallons per day per acre.
15 MS. LOVELL: I object. That's an
16 incomplete hypothetical.
17 MR. MURAKAMI: I can't respond to that not
18 knowing what the incompletion is.
19 MS. LOVELL: Reservoirs and tanks come to
20 mind.
21 MR. MURAKAMI: Your Honor, that has
22 nothing to do with it. I'm applying his figures to
23 what he says he applies to the ground. It has nothing
24 to do with tanks and reservoirs. It probably
25 incorporates the notion of tanks and reservoirs. It's

1 not my math.
2 HEARINGS OFFICER JUDGE McCONNELL: Sounds
3 like it to me. Anyway --
4 MR. MURAKAMI: I'd like to know. I'm
5 asking you. If my math is wrong, this is an important
6 point. I want you to correct it.
7 A. If that's what the water requirements are
8 required based on evapotranspiration requirements and
9 if that's what the math works out to be, that's
10 correct. It's just a different way of presenting it.
11 Q. Another way of looking at the same problem,
12 right?
13 A. Yeah.
14 MR. MURAKAMI: Thank you. That's all I
15 have.
16 HEARINGS OFFICER JUDGE McCONNELL: Any
17 questions?
18 MS. LOVELL: I have a couple of questions.
19 CROSS-EXAMINATION
20 BY MS. LOVELL:
21 Q. I'm Jane Lovell, one of the county's lawyers.
22 When you calculate water needs for the
23 30,000 acres that are available for cultivation, do
24 you also take into account water storage needs?
25 MR. MURAKAMI: Object, that's vague.

1 HEARINGS OFFICER JUDGE McCONNELL: I'll
2 permit it.
3 THE WITNESS: No, we do not. That's based
4 on what the crop needs, so there is no consideration
5 given to keeping a reservoir full.
6 Q. MS. LOVELL: That's what I was trying to get
7 at.
8 So the 18,000 gallon figure that we just
9 heard, that all would be applied to fields and none of
10 that figure would go into tanks or reservoirs?
11 A. Some of that -- well, if we're dealing with
12 averages here that come from EMI, some of that could
13 go to reservoirs.
14 Q. Could you just explain generally how storage
15 of water in tanks and reservoirs fits into your
16 irrigation scheme?
17 A. We have several reservoirs that are located
18 throughout our ditch system, so during periods of high
19 flow when irrigation -- when we have peak irrigation
20 or flows in the ditches, we will store water in our
21 reservoir system and then that water will be used
22 later on for irrigation rounds.
23 Q. So is it fair to say that during the wet
24 winter months, reservoirs will be filled and then that
25 water will be drawn upon during the dry months?

1 A. It will be drawn upon during the dry periods
2 during the winter seasons, because it's going to be
3 wet and dry periods.
4 MS. LOVELL: Thank you.
5 HEARINGS OFFICER JUDGE McCONNELL:
6 Anything else?
7 MR. MURAKAMI: Yes.
8 HEARINGS OFFICER JUDGE McCONNELL: Are you
9 going to keep going with this?
10 MR. MURAKAMI: He's giving inconsistent
11 answers. He just said this figure includes water put
12 in reservoirs, and I asked him earlier if it's water
13 put on the ground. Which one is it?
14 HEARINGS OFFICER JUDGE McCONNELL: I'll
15 let you ask the question.
16 FURTHER CROSS-EXAMINATION
17 BY MR. MURAKAMI:
18 Q. Let me ask the question. Is Paragraph 9 a
19 figure that you produced for the application of water
20 on the ground as opposed to water on the ground and
21 storage and reservoirs?
22 A. This was a figure that was produced based on
23 the evapotranspiration requirements of a plant, of the
24 sugarcane plant.
25 Q. So doesn't that necessarily mean that the

1 water amounts that you stated here is reflective of
2 what you're applying to the ground on the 7500 acres
3 at a time?
4 A. That would be correct.
5 Q. It doesn't include any amounts that you would
6 siphon off for storage in a reservoir?
7 A. If we had excess flows during that time that
8 would not be included during that time. That would be
9 stored and then used to supplement or to average out
10 this figure that is presented here in Paragraph 9.
11 Q. I'm not sure this is clear. Either amount,
12 the 134 million gallons per day or the 268 million
13 gallons per day, does any of that water -- is any of
14 that water being diverted for storage in the same
15 fashion that you just described in your earlier
16 testimony?
17 A. The numbers that are talked about in
18 Paragraph 9 refer to the evapotranspiration of the
19 water requirements of the crop typically during those
20 periods. So there could be water in the reservoirs
21 that are drawn upon to provide this need or this
22 average need during this time.
23 Q. Maybe I'm not making myself clear. But those
24 two figures, 134 million gallons per day and 268
25 million gallons per day, is that water being applied

1 to the plant or ground, whichever you want to choose,
2 as opposed to any amounts being diverted for storage
3 in reservoirs?
4 A. On average that would be applied to the
5 plant.
6 Q. Thank you.
7 HEARINGS OFFICER JUDGE McCONNELL: That's
8 all, thank you very much. Any other witnesses, Mr.
9 Schulmeister?
10 MR. SCHULMEISTER: No.
11 HEARINGS OFFICER JUDGE McCONNELL: Any
12 rebuttal?
13 MR. MURAKAMI: Yes, we do.
14 HEARINGS OFFICER JUDGE McCONNELL: What do
15 you have.
16 MR. MURAKAMI: I have at least two -- we
17 have three.
18 HEARINGS OFFICER JUDGE McCONNELL: We'll
19 take a couple minutes.
20 (Recess was taken.)
21 HEARINGS OFFICER JUDGE McCONNELL: We're
22 back on the record.
23 STEVEN GREG KAI HO'OKANO
24 was called as a rebuttal witness by and on behalf of
25 Na Moku, et al, was sworn to tell the truth, was

1 examined and testified as follows:
2 HEARINGS OFFICER JUDGE McCONNELL: Could
3 you state your name.
4 THE WITNESS: Steven Greg Kai Ho'okano.
5 HEARINGS OFFICER JUDGE McCONNELL: Could
6 you spell your last name, please.
7 THE WITNESS: H-o-o-k-a-n-o.
8 DIRECT REBUTTAL EXAMINATION
9 BY MR. MURAKAMI:
10 Q. Can you tell the hearing officer where you
11 live?
12 A. Two four five Wailuanui.
13 Q. What is your history with -- you say
14 Wailuanui, you mean Wailuanui Valley in East Maui?
15 A. Yeah.
16 Q. What is your connection to Wailuanui Valley
17 just briefly?
18 A. My family come from over there. We grow taro
19 and basically that's where we from. That's what we
20 do.
21 Q. And what are you doing today, not today, but
22 now in your life?
23 A. Right now I farming up in Wailua, some of my
24 uncle's patches. He let me take care and open up
25 patches that he used to have open at the time when he

1 was young. So I'm there to take over his patches.
2 Q. So during your young life you witnessed your
3 parents and uncles and aunts farming?
4 A. Yeah.
5 Q. Taro?
6 A. Taro.
7 Q. In Wailuanui Valley?
8 A. In Wailua.
9 Q. And in general looking at the valley from say
10 Wailuanui Road, Homestead Road, looking up mauka,
11 where generally are these patches of your family?
12 A. Right in the center, right in the valley
13 itself.
14 Q. In the center, how far up?
15 A. As far as you can go, as far as the ditch.
16 HEARINGS OFFICER JUDGE McCONNELL: Why
17 don't we have --
18 MR. MURAKAMI: I'm going to get there.
19 Q. So I'm going to hand you what has been marked
20 and admitted as Exhibit A-55 with the overlay provided
21 by East Maui Irrigation, A-55.1. Do you see this?
22 A. Yeah.
23 Q. And the overlay is lined up to coincide with
24 the Wailuanui Valley Road. Is it Homestead Road?
25 Which one is it?

1 A. Wailua.
2 Q. Wailua Road. And the two general
3 intersections in the valley that lead into the back of
4 the valley. Do you see that?
5 A. Yeah.
6 Q. And if you appply this overlay, you notice
7 that there are some lo'i that are depicted on the
8 acetate sheet, correct?
9 A. Yeah.
10 Q. And if you overlay it on A-55, it shows where
11 those lo'i are located or would be located on A-55,
12 correct?
13 A. Yeah.
14 Q. If you look at this map, can you describe to
15 me exactly where your ohana's lo'i are that you saw
16 cultivated and you're trying to cultivate today?
17 MR. SCHULMEISTER: That's A-45.
18 MR. MURAKAMI: My mistake, I overlaid
19 A-55.1 on A-45.
20 HEARINGS OFFICER JUDGE McCONNELL: Wait,
21 wait. That's --
22 MR. MURAKAMI: That's the foldout from the
23 Cultural Landscape Study. Your Honor, we could try to
24 make it available to you here as he points it out.
25 HEARINGS OFFICER JUDGE McCONNELL: I got

1 it.
2 Q. MR. MURAKAMI: Mr. Ho'okano, looking at A-45
3 and overlay with A-55.1, would you point to the area
4 where your ohana's lo'i are located on these two maps?
5 A. Lot 31, lot 30, that's lease, lot 28.
6 HEARINGS OFFICER JUDGE McCONNELL: Wait,
7 wait, where are you going?
8 MR. MURAKAMI: First of all, when you're
9 referring to these lots, you're pointing to the area
10 on A-45 that is located on the bottom middle portion
11 of the valley depicted by A-45, correct, the bottom
12 middle?
13 A. Yeah, yeah.
14 Q. And the numbers you just recited are those
15 lot numbers on A-45 which are 30, correct?
16 A. Yeah.
17 Q. Underlined with a 30 -- I mean with a line,
18 and 31 has looks like a cross through it, correct?
19 A. Yeah.
20 Q. And the other number is what?
21 A. 28.
22 Q. 28 which is located a couple of lots down
23 from or adjacent to actually lot 30, correct?
24 MR. SCHULMEISTER: All on plat 5, right?
25 MR. MURAKAMI: For the record, a

1 stipulation that it's on plat 5.
2 MR. SCHULMEISTER: That's what you're
3 pointing to on the map?
4 MR. MURAKAMI: Yes, plot 5.
5 HEARINGS OFFICER JUDGE McCONNELL: You
6 said 30 and what else?
7 MR. MURAKAMI: 30, 31. 31's kind of
8 crossed out, dropped into 30. And then 28 is located
9 little further makai but adjacent to and abutting lot
10 30.
11 Q. And so do you see here that the overlay does
12 not depict any lo'i on the most mauka portion of lot
13 30 and lot 31?
14 A. This?
15 Q. Do you see that?
16 A. Yeah, I see them.
17 Q. Does that match up with what you understand
18 to be what lo'i formations there are on the ground?
19 A. Right now currently working over there, I got
20 that place opened up, and there are lo'i in there.
21 And I talked to my Uncle Joe Young, and he told me
22 when he was young, he used to raise taro in those area
23 up there.
24 Q. Are you referring to the area that contain no
25 depictions of lo'i on A-55.1?

A. Yeah.

Q. And that's between the wall of the valley and the most mauka portion and the depictions that are on A-55.1, that area?

A. Yeah.

MR. MERCHANT: Are you asking right next to the No. 30?

MR. MURAKAMI: He's talking about the most mauka portions of lot 30, 31.

MR. MERCHANT: Right next to the number that has the underline?

MR. MURAKAMI: Yes, right in the area where the numbers are on A-45, bottom part of the map.

Q. And so in that blank area that shows no lo'i on A-55.1, would you describe again the extent of the lo'i you saw there, and know about through your ohana?

A. The lo'i still there and it's all intact, it's all there. But the size of the lo'i, it varies, but there's lo'i there.

And the ditch is right above the lo'i so you know that the ditch got to feed those lo'is in order to get to the next lo'is. So that's all lo'is.

Q. Now, when you say that's lo'is there, what are you relying on to say that that's lo'i?

A. The banks and existing pipes there to divert

1 the water.
2 Q. What are the banks made of?
3 A. Rock and mud.
4 Q. And in your lifetime have you seen taro
5 growing in those lo'i you say are there?
6 A. No, not up there.
7 Q. But you just see the banks?
8 A. Yeah.
9 Q. And you say that the 'auwai comes down like
10 right mauka of that parcel?
11 A. Yeah.
12 Q. Which numbered parcel are you speaking of, if
13 you can tell on the map where that 'auwai deposits
14 water onto the land?
15 A. Right above, right on the edge.
16 Q. So it's along the edge of the, what is kind
17 of like the bowl of the valley?
18 A. Yeah.
19 Q. Does it come out directly onto your land?
20 A. Right now no more water over there right now
21 because there is no water coming down there, so I'm
22 not using that ditch right now. So I in the process
23 of opening so hopefully one day when I get water I can
24 put it in my patch.
25 Q. If there was water that can be delivered on

1 that particular 'auwai, you would use it?
2 A. Depends if the thing would effect the other
3 farmers, because if they don't have enough water, then
4 I'm not going to go there and take their water because
5 they won't have enough water.
6 Q. Let's say there was enough water, there was
7 water in the 'auwai, would you use it?
8 A. Yeah, I would use that ditch.
9 Q. Is there any other source of water you could
10 use for a steady flow of water into that area?
11 A. No, that's the only one.
12 HEARINGS OFFICER JUDGE McCONNELL:
13 Where is the ditch? Where again? Just point it.
14 THE WITNESS: Right up here. This is the
15 top of the valley. This is where the water get
16 distributed, so just comes right up through here,
17 right on the ridge.
18 Q. MR. MURAKAMI: Just to be clear though,
19 you're familiar with two 'auwai along that wall of the
20 valley, correct?
21 A. Yeah.
22 Q. You're talking about this 'auwai that you
23 want to use. Can you tell me whether it's the more
24 mauka one or the one makai?
25 A. Makai, the lower 'auwai.

1 Q. Okay. So in general then when you see this
2 map and the overlay, you think that the -- based on
3 what you see on the ground and what you've used for
4 your lo'i, do you believe that this map is accurate in
5 the area around the numbers 30 and 31 and the portions
6 of 28 that do not show lo'i on A-55.1?
7 A. This map is inaccurate.
8 MR. MURAKAMI: Thank you.
9 HEARINGS OFFICER JUDGE McCONNELL: Any
10 cross?
11 CROSS-EXAMINATION
12 BY MR. SCHULMEISTER:
13 Q. You know the ditch you were just referring
14 to?
15 A. Yeah.
16 Q. Where does it come from?
17 A. Comes from Lakini.
18 Q. And up at Lakini there's, on the mauka side
19 of the road, there is one spot where water spills out
20 from the patch as it goes through a grate and under
21 the highway. Is it there -- are you familiar with
22 that?
23 A. Not too much.
24 Q. Are you familiar with a concrete diversion
25 box that is on the makai side of Hana Highway that

1 also has water that comes into from Lakini taro patch?
2 A. No, not too familiar with that. Just moved
3 in one year ago. Right now in the process of opening
4 my patch. So I don't know what is going on at the
5 box, all I know no more water coming down.
6 HEARINGS OFFICER JUDGE McCONNELL: But
7 when you said there were two 'auwais, I'm having a
8 difficulty --
9 THE WITNESS: I made it to the first
10 'auwai and I talked to my neighbor and he tells me
11 there is another 'auwai right above it. So he inform
12 me of that, but I don't know about the box itself,
13 like how everything comes out of the box. All I know
14 there is two ditches above me.
15 Q. MR. SCHULMEISTER: But the ditche you want to
16 use, that was completely dry?
17 A. Dry.
18 Q. When was the first time you saw it dry?
19 A. Since I came back last year, and I never have
20 water.
21 Q. From last year until now?
22 A. When I was young I saw water always coming
23 down from there, that's all I can say. When I come
24 back, no more water.
25 Q. When you were young, would that be the '80s?

1 A. '80s, late '70s.
2 Q. I have no further questions.
3 HEARINGS OFFICER JUDGE McCONNELL: Thank
4 you.
5 MR. MURAKAMI: Call Mr. Wendt back.
6 HEARINGS OFFICER JUDGE McCONNELL: For the
7 record, Mr. Wendt is back on the stand. I remind him
8 he's still under oath. Go ahead.
9 EDWARD WENDT
10 Having been previously sworn, was recalled on behalf
11 of Na Moku, et al., was examined and testified as
12 follows:
13 DIRECT REBUTTAL TESTIMONY
14 BY MR. MURAKAMI:
15 Q. You heard the testimony of Steven Ho'okano?
16 A. Yes, I did.
17 Q. And he described that area in which he's
18 trying to farm on lots 28, 30 and what has been
19 dropped lot 31, correct?
20 A. Yes, I did.
21 Q. And you have A-55.1 before you overlaid on
22 A-45?
23 A. Yes, I do.
24 Q. In that same area along the wall -- the mauka
25 most wall of Wailuanui Valley in the area the Ho'okano

1 ohana are trying to open up their lo'i, have you
2 observed the presence of lo'i in that area?
3 A. Yes, I have.
4 Q. Can you describe what you saw in that area in
5 the vicinity of what is marked as numbers 30 and the
6 dropped 31?
7 A. All in this area, 30 and 31 and also continue
8 all the way up to Lakini was all cultivation of taro,
9 there is lo'is all above in those areas.
10 Q. When you say those areas, would they include
11 areas that are not depicted on acetate sheet A-55.1?
12 A. Yes.
13 Q. And so what is your conclusion about the
14 accuracy of A-55.1 as it may or may not depict the
15 presence of historic areas for taro cultivation in
16 Wailuanui Valley?
17 A. This map is not accurate.
18 Q. Mr. Wendt, did you hear Mr. Hew testify about
19 the function and the use of dam, so-called Dam No. 3
20 on Waiokamilo Stream?
21 A. Yes.
22 Q. When was the first time that you saw that
23 concrete dam on Waiokamilo Stream?
24 A. The existing --
25 Q. Yeah, the existing concrete dam.

A. When one day when East Maui Irrigation put in.

Q. When was that?

A. Three years, four years.

Q. Recent years, in other words?

A. It was recent.

Q. As a younger man and boy growing up in the valley, did you have occasion to go to that same spot on Waiokamilo Stream?

A. Yes.

Q. Was there such a dam, at least to the extent that you saw recently in that stream?

A. No.

Q. And at that time, was water coming down into Wailuanui Valley from the sources mauka to feed the taro patches in the valley?

A. Yes.

Q. And so was there only water at that time -- in the earlier days, was there only water coming from Waiokamilo Stream?

A. No, it came from Kualani.

Q. And you heard the testimony, did you not, about Kualani Stream where it may or may not be on A-1, that big giant colored map?

A. Yes.

1 Q. When you talk about Kualani and did you
2 mention Kupau in your earlier testimony?
3 A. Yes.
4 MR. MURAKAMI: I'm going to have to ask
5 for the official copy of A-1.
6 HEARINGS OFFICER JUDGE McCONNELL: Before
7 you do that, Mr. Wendt you heard Mr. Ho'okano talk
8 about a dry 'auwai.
9 THE WITNESS: Yes.
10 HEARINGS OFFICER JUDGE McCONNELL: Is that
11 the upper one coming out of the box?
12 THE WITNESS: No, it's the bottom one, the
13 one that we saw all the water going through when we
14 looked at the box, one had water going through and one
15 was the pipe. The one with the water, there was no
16 pipe, that's the 'auwai he's talking about. Where
17 that water leaves that box, serviced the 'auwai that
18 he says is dry.
19 And the reason is, when you look at this
20 overlay right here, right now what we saw when we were
21 at the box, the water is going in this direction.
22 What needs to happen here is to split the amount of
23 water that is going down that continues into this
24 'auwai that comes across.
25 HEARINGS OFFICER JUDGE McCONNELL: Right,

1 that's the one that comes out of the pipe?
2 THE WITNESS: No, the bottom. The top
3 pipe has been cut off completely right now with water,
4 but the one that you seen at the box where the water
5 went through, an 'auwai continues to the Ho'okano and
6 to around right in this area, sir.
7 Q. MR. MURAKAMI: When you say this area, this
8 is the area past the Ho'okano?
9 A. Past the Ho'okano.
10 HEARINGS OFFICER JUDGE McCONNELL: How
11 many exits you got from the box?
12 THE WITNESS: Three. So this is a
13 different 'auwai going down, drops off. Then you got
14 the two, one with the pipe and the one without. This
15 one comes here and this ditch continues all the way
16 down into this area where it enters back into Waikani.
17 HEARINGS OFFICER JUDGE McCONNELL: And the
18 lower one is the pipe?
19 THE WITNESS: The lower one is an open
20 ditch, sir. Just the top one. And the thing goes
21 only so far in with pipe.
22 HEARINGS OFFICER JUDGE McCONNELL: Yeah, I
23 know it only goes so far. But I didn't climb that far
24 back in there.
25 THE WITNESS: Just right here, sir, where

1 this drops off, this one would continue. The water
2 here will be split to go into the ditch to service Mr.
3 Ho'okano.
4 HEARINGS OFFICER JUDGE McCONNELL: The one
5 where the pipe goes for the first several how many
6 feet, that would be split, you're saying?
7 THE WITNESS: No. This one here.
8 Q. MR. MURAKAMI: Mr. Wendt, at the concrete
9 box, in how many directions does the water alternate?
10 A. Three.
11 Q. If you're facing the concrete box looking
12 down the 'auwai toward the valley, where does the left
13 most version go? Can you point that out on the map as
14 it drops out of the box?
15 A. This is the box, I assume. Right here is
16 split. The box is divided right there. The one with
17 the pipe, comes all the way down --
18 Q. Wait a minute. Looking down on the valley
19 from where the box is makai or across the valley,
20 there's a left diversion, right?
21 A. It goes over the spill.
22 Q. Show on the map where that left diversion
23 goes on the map?
24 A. Right over here. Right where this arrow.
25 Q. And continues down where?

1 A. It continues down. There's an 'auwai to
2 service down in here, collect, you see this here?
3 Q. The top most 'auwai and the box, that's the
4 one you said was blocked off, correct, with some
5 gravel and whatever else?
6 A. Yes.
7 Q. That 'auwai has a 12-inch pipe that feeds it
8 along initially for a first several feet.
9 HEARINGS OFFICER JUDGE McCONNELL: Why
10 don't you let him testify.
11 THE WITNESS: 100 feet maybe.
12 Q. MR. MURAKAMI: So then that's the top most
13 'auwai, correct?
14 A. Right.
15 Q. And that 'auwai goes where?
16 A. That water service all the way down into this
17 area.
18 Q. Which is the eastern-most side of the mauka
19 side of the valley?
20 A. Towards Waikani.
21 Q. Does that combine with the Wailuanui Stream
22 water?
23 A. Yes, at that point.
24 Q. That's the top one?
25 A. Yeah.

1 Q. Now, in the middle there's a third one in the
2 middle?
3 A. The middle.
4 Q. How does that flow in relation to that
5 uppermost?
6 A. Parallel.
7 Q. But then does it go as far as the top?
8 A. No.
9 Q. Where does it end up?
10 A. Right past Ho'okano. Right in this area,
11 right where this arrow.
12 Q. You're looking at the parcel labeled in
13 parcel -- this is plat number 5, 20, correct?
14 A. 20.
15 Q. Around that area?
16 A. Yeah.
17 HEARINGS OFFICER JUDGE McCONNELL: But
18 there was water in there when we were there.
19 THE WITNESS: It went this direction,
20 nothing came down to Mr. Ho'okano's section.
21 MR. MURAKAMI: Let me try it this way.
22 Q. I'm going to hand you A-26. Is this the
23 concrete box?
24 A. Yes.
25 Q. That grate in the right, is that the entrance

1 to the top most 'auwai?
2 A. Yes.
3 Q. And the middle 'auwai, is that the water that
4 is flowing down through that square-ish hole in the
5 far most wall of the concrete box?
6 A. Yes, it is.
7 Q. You're saying that doesn't reach all the way
8 down to Steve Ho'okano's parcel, right?
9 A. This here supposed to reach Mr. Ho'okano's
10 property.
11 Q. Why doesn't it reach it?
12 A. Because if you walk down this ditch --
13 Q. Talking about the middle 'auwai?
14 A. This particular 'auwai with the water in, it
15 will fall off, which is right around in this area.
16 Q. You're pointing to an area that is marked on
17 plat 4 with parcel number 18, correct?
18 A. Around in that area.
19 Q. So it doesn't flow as far as it's supposed to
20 flow, correct?
21 A. Yeah, it's supposed to continue all the way
22 to Mr. Ho'okano.
23 Q. When I say parcel 18 and where it falls off,
24 we're talking about parcel 18 on plat 4 that's on
25 A-45, correct?

A. Yeah.

Q. And so is there a reason why the water in the middle or lower 'auwai falls off onto parcel 18 on A-45 instead of continuing down to where Mr. Ho'okano's parcel?

A. Right now there's lack of water. If this water continues to follow all the way down to where it enters, each parcel owners have a takeoff of this, so there's quite a bit of takeoffs. So and there wasn't enough water coming down, so we shut the top and Mr. Ho'okano and his family was generous enough not to use the water.

Q. So it's a system of allocation based on scarce water source?

A. Scarce water source.

Q. So if there was enough water in the concrete ditch, then would that water reach Mr. Ho'okano's parcel?

A. Yes, sir.

Q. If there was enough water in the concrete box flowing through Lakini, would there be water flowing through the uppermost 'auwai now blocked off by the gravel in the picture depicting the concrete box in A-26?

A. Yes, sir.

1 Q. And those would service water flow to
2 those -- in those directions simultaneously at the
3 same time if there was enough water?
4 A. Yes, sir.
5 Q. But the only reason that you have the current
6 situation is because of the current volume of water
7 which cannot accomplish all three 'auwais delivering
8 water to their points of irrigation?
9 A. Yes, sir.
10 HEARINGS OFFICER JUDGE McCONNELL: Thank
11 you.
12 Q. MR. MURAKAMI: And then, Mr. Wendt, when you
13 say you didn't see that concrete Dam 3 in Waiokamilo
14 Stream as a younger person, can you explain why that
15 dam is now necessary to bring water from Waiokamilo
16 Stream into the 'auwai that services your Lakini
17 patches?
18 A. Many years ago the elders, when Kualani was
19 cut off, when there was no farming in the ili of
20 Kupau, the elders made that 'auwai from Waiokamilo
21 back up Lakini.
22 So it was only made as an 'auwai, not a
23 river. And right now with the diversion there, the
24 volume of water is coming into the Lakini area,
25 there's more water when you have the big water, the

1 floods.
2 Q. And so if there wasn't as much water flowing
3 through that former smaller 'auwai from Waiokamilo to
4 Lakini, where was the water coming from for the rest
5 of the valley?
6 A. Kualani was one of the main sources, and
7 Waiokamilo used to have much more water flow than what
8 it is today.
9 Q. So is the Kualani, so-called Kualani source,
10 is that the area that drains off of the area known as
11 Kupau?
12 A. Yes.
13 Q. Could you point out on the map on A-1 before
14 you, move the A-45 before you aside, do you see the
15 Wailuanui Valley on that map?
16 A. Yes, I do.
17 Q. Do you see the designation for what is known
18 as Kualani stream?
19 A. Yes.
20 Q. And you see Wailua Homestead?
21 A. Yes.
22 Q. And basically the highway?
23 A. Yes.
24 Q. And Waiokamilo Stream is here, correct?
25 A. Yes.

1 Q. Would you point out to the hearing officer
2 where this area of Kupau is relative to Waiokamilo?
3 A. All in this area. All in this area is Kupau.
4 Q. That is an area that you're pointing to that
5 is on A-1, and the area between Waiokamilo Stream and
6 Wailuanui Stream?
7 A. Yes.
8 Q. And also mauka of the highway?
9 A. Yes.
10 Q. And below the ditch system?
11 A. Yes.
12 Q. So in that area, did you say that that was
13 the primary source of water in the old days for
14 Wailuanui Valley?
15 MR. SCHULMEISTER: Can we be clear about
16 the old days.
17 MR. MURAKAMI: When he was a young man.
18 MR. SCHULMEISTER: Approximate decade or
19 something.
20 Q. MR. MURAKAMI: Maybe you could describe that?
21 A. At one time the ili of Kupau was taro
22 patches, the water came off Kualani. The water of
23 Waiokamilo up in this area is an 'auwai that they took
24 from Waiokamilo, that was the original 'auwai, not
25 from Lakini, it was taken from here, serviced the

1 lo'is down Kualani.
2 Q. When you say, "taken from here," you're not
3 referring to the 'auwai just below Dam 3, correct?
4 A. No.
5 Q. You're referring to an area mauka of Dam 3,
6 right?
7 A. Mauka, yes.
8 Q. Is it mauka of Akeke Springs?
9 A. It's more east of Akeke.
10 Q. More east?
11 A. Yeah. Akeke would be right in this area, and
12 this 'auwai from Waiokamilo would be in around this
13 area.
14 Q. So little bit downstream?
15 A. Downstream.
16 Q. And there was an 'auwai that fed the Kupau
17 area?
18 A. Yes.
19 Q. And that water continued through and
20 ultimately ended up where?
21 A. Ended into Kualani.
22 Q. Where did Kualani feed the water to?
23 A. It went through Lakini, and then down to the
24 box.
25 Q. Are you telling me there were two sources of

1 water, Kupau and Waiokamilo?
2 A. Yes. At this time when you have rains, water
3 will naturally flow into Kualani. Water will come --
4 this is high mountain, and the water goes down there.
5 There's waterfalls. Where the waterfalls were at when
6 we looked in the back, it's all up in this area.
7 Q. And you used to see those sources of water
8 flowing into Kupau as a boy?
9 A. Yes.
10 Q. But you don't see them flowing today?
11 A. No.
12 Q. And if there were sources of water flowing
13 through Kupau as they were in the valley when you were
14 younger as a boy, would there be a need for the amount
15 of water being taken from Waiokamilo Stream, if there
16 was -- the Kupau sources were as they were before?
17 MR. SCHULMEISTER: Let me just object.
18 Lack of foundation. My understanding, he said all of
19 it came from Waiokamilo, even the Kupau one.
20 MR. MURAKAMI: That's not what he said.
21 A. Those are two sources, Waiokamilo and
22 Kualani. Waiokamilo also serviced the lower portion
23 of the highway too. So if Kualani is open -- for me
24 to say that Waiokamilo is enough, I cannot do that.
25 Q. I'm sorry, you're saying Kualani-Kupau area

1 is what?
2 A. If Waiokamilo is not opened, returned, then
3 there will not be enough water to go down, because you
4 also, the 'auwai does take from Waiokamilo.
5 Q. But is the only source of water coming from
6 Kupau the Waiokamilo Stream source, in the old days?
7 A. No, it was both.
8 Q. What was the other source?
9 A. Kualani.
10 Q. And what else? Was there only one stream
11 that fed Kupau?
12 A. And whatever tributaries that came out.
13 Q. You're talking about the smaller waterfalls
14 and other drips into the valley?
15 A. Yes.
16 Q. And that collectively formed what you say is
17 the water source of Kupau?
18 A. The water source of Kupau.
19 Q. So if that source of water, the Kupau water
20 sources as they were traditionally and historically
21 fed into Kupau, drained into the 'auwai, closer to
22 Lakini, would you have to have the dam that is now
23 called Dam 3 in Waiokamilo Stream?
24 A. No.
25 Q. So, Mr. Wendt, you were a contractor at one

1 time; is that right?
2 A. Yes, I was, sir.
3 Q. How many years?
4 A. In the early '70s.
5 Q. How many years did you work as a contractor?
6 A. I worked quite some years as a builder.
7 Q. More than ten years?
8 A. Yes.
9 Q. And did that experience expose you to having
10 to price materials for construction work?
11 A. Yes.
12 Q. Did they include PVC pipe?
13 A. Yes.
14 Q. Are you familiar with the relative values or
15 differences in value between say a two-inch pipe or
16 eight-inch pipe?
17 A. Yes. Quite some difference in price.
18 Q. What would that difference be?
19 A. I would say maybe ten 15 times.
20 Q. And are you familiar with when PVC piping
21 became available for contracting or construction work?
22 A. I really don't know what year it was put on
23 the market, but in the '70s there wasn't very much PVC
24 pipe used. It was more cast iron, steel and
25 galvanized. So that was in the '70s.

1 Q. So the predominant use of PVC did not occur
2 prior to the '70s?
3 A. That I cannot -- I have worked with PVC pipe,
4 you know, but it wasn't -- you know, it was just for
5 farm purposes in the '70s, and on the smaller size,
6 three-quarters to an inch, but nothing in eight inches
7 or ten inches of pipe.
8 Q. Were you ever familiar with whether there was
9 use of PVC in the '60s?
10 A. I could not really answer that question.
11 Q. Mr. Wendt, did you read the testimony of
12 Garret Hew?
13 A. I don't believe I did, sir.
14 Q. In Mr. Hew's rebuttal testimony -- on Page 13
15 and 14 of Mr. Hew's rebuttal testimony to our -- well,
16 to your testimony, Mr. Hew states: If the upper ditch
17 is repaired and for some reason that EMI cannot
18 presently anticipate there is inadequate water
19 available for taro cultivation, EMI is willing to
20 reduce its diversions above the Waiokamilo stream.
21 That's a statement. Number one, is the
22 ditch, upper ditch repaired?
23 A. We had a project maybe three, four years ago.
24 That's the project that we restored the 'auwai.
25 Q. Can that upper ditch take water from the

1 concrete box and deliver it to the point of irrigation
2 in the neighborhood of the junction with the Waikani
3 Falls water coming into Wailuanui Valley?
4 A. Yes.
5 Q. And that can happen today?
6 A. Yes, sir.
7 Q. And do you have the resources as the
8 President of Na Moku to assure that that ditch remains
9 open and available for that kind of transmission of
10 water?
11 A. We did it before, and no water was returned.
12 Q. And is there, in fact, after you restored
13 that 'auwai, was there now an ability of the members
14 of Na Moku to bring water from above Lakini to the
15 taro patches throughout Wailuanui Valley to satisfy
16 the needs of taro farmers?
17 A. There was great efforts.
18 Q. But was there enough water after you did that
19 improvement to service all the lo'i that need to be
20 opened up and irrigated?
21 A. No, no.
22 Q. And did you bring this issue to the Board of
23 Na Moku about what the board was willing to say
24 concerning its ability to assure that the upper ditch
25 is maintained?

1 A. This has been discussed.
2 Q. And did you adopt a resolution to reflect
3 that particular information and what the members of Na
4 Moku were willing to do --
5 A. Yes.
6 Q. -- in order to keep that upper ditch
7 serviceable?
8 A. Yes.
9 Q. I'm going to hand you a copy, and I think
10 this has been previously filed, of a resolution which
11 I would like for the hearing officer to mark as B-127.
12 HEARINGS OFFICER JUDGE McCONNELL: B-128.
13 Wait a minute.
14 Q. MR. MURAKAMI: Is that the resolution that
15 was adopted by the Board of Na Moku in order to
16 address this concern?
17 A. Yes, sir.
18 MR. MURAKAMI: Your Honor, may we have
19 this marked?
20 HEARINGS OFFICER JUDGE McCONNELL: We're
21 looking for it. Do you have a separate copy of it,
22 because it's attached to --
23 MR. MURAKAMI: I have a separate copy.
24 HEARINGS OFFICER JUDGE McCONNELL: What is
25 the next in order?

1 MR. SCHULMEISTER: The lease was B-126.
2 MS. CHOW: Yes, 126, so it would be 127.
3 HEARINGS OFFICER JUDGE McCONNELL: B-127.
4 MR. MURAKAMI: And I move to admit it.
5 HEARINGS OFFICER JUDGE McCONNELL: Any
6 objection?
7 MR. SCHULMEISTER: No objection.
8 HEARINGS OFFICER JUDGE McCONNELL: It will
9 be admitted.
10 (Na Moku Exhibit No. 127 was received into
11 evidence.)
12 Q. MR. MURAKAMI: Mr. Wendt, did you hear the
13 testimony of witnesses for EMI that claim that the
14 lo'i of Mr. Norman Martin was being fed by water from
15 Wailuanui Stream only?
16 A. Yes.
17 Q. Is that true?
18 A. Like I said, no, the top ditch service that
19 too.
20 Q. So it's a combination of the water from both
21 sources, correct?
22 A. Yes.
23 Q. Did you hear the testimony of Mr. Hew that
24 there are approximately 400 diversions along the ditch
25 system affected by the four water licenses?

A. Yes, I did, sir.

Q. Did you have an occasion to look at A-1 to count the number of diversions represented by the red squares depicted on that map?

A. Just during the lunch break counted about 75, about 100.

Q. So are you aware of other major diversions in Wailuanui that are not depicted on A-1?
It shows approximately two -- shows approximately, in the valley, mauka valley portions, three diversions. These appear to be beyond Wailuanui.

A. That's Wailua River.

Q. So actually if you look at Wailuanui River and exclude those, there's only two diversion points represented on A-1?

A. Yes.

Q. Is that true?

A. Well, with all the other pipes and whatever else was marked, not was -- was visual when we did that recon, to me there's more diversions there than on the map.

Q. Do you consider the diversion of water from a tributary in the mauka portion of Wailuanui Valley by an eight-inch pipe to be a minor diversion?

A. Major.

1 Q. That's all I have.
2 HEARINGS OFFICER JUDGE McCONNELL: Any
3 questions?
4 MR. SCHULMEISTER: No questions.
5 HEARINGS OFFICER JUDGE McCONNELL: Ms.
6 Kekahuna, you've already testified. You're still
7 under oath.
8 BEATRICE KEKAHUNA
9 having been previously sworn, was recalled on behalf
10 of Na Moku, et al, was examined and testified as
11 follows:
12 DIRECT REBUTTAL EXAMINATION
13 BY MR. MURAKAMI:
14 Q. Did you hear the testimony of Garret Hew that
15 you have sufficient water to grow all the taro on the
16 taro lo'i that you have on your property along Honopou
17 Stream?
18 A. Yeah, I did.
19 Q. In the past have you experienced cooperation
20 from EMI to meet your water needs to grow taro on your
21 kuleana and taro lands along the Honopou Stream?
22 A. When they used to come down and started to
23 raise taro, they said that was enough water. Well, at
24 the time it wasn't, it was not enough. But then we
25 had only two, three taro patches up at the house. Now

1 it's something else, there's a lot more below.
2 So right now there's a lot of water with
3 the rain, surely there is enough water, a lot. But
4 what happens when the rain stops?
5 Q. What happens?
6 A. The water is going to go down. Not going to
7 be enough water.
8 Q. Has that happened?
9 A. Well, right now we have the bottom one. Like
10 I said, if we start opening the water and letting the
11 water go into those patches, we won't have enough
12 water. And as the water go down, if, let's say,
13 there's a lot of water now, and we let the water go
14 down, but those taro patches are going to eat the
15 water. It's going to run from patch to patch.
16 Q. Auntie Beatrice, do you have the help that
17 you need to plant all those taro patches that you
18 opened up and showed the hearing officer during the
19 site visit a month ago?
20 A. Yes, I do.
21 Q. Are they continuing to help you today?
22 A. Yes, they are.
23 Q. And if there was enough water, would you in
24 fact plant all those lo'is so that you could grow taro
25 like you did in the old days?

1 A. Yes, we are.
2 Q. Has EMI, not just Mr. Hew, but his
3 predecessors promised you that they would get you the
4 water that you need?
5 A. That I can't say.
6 Q. You can't remember that?
7 A. No.
8 MR. MURAKAMI: Your Honor, I'm going to
9 ask the indulgence of the hearing officer and the
10 parties, we again, because of our discovery of the
11 past 1902 lease of the Keanae area, I was able to
12 obtain just today a copy of the -- well, it is now
13 known as the Huelo License area, but it was called
14 Haiku License at one time by the Kingdom of Hawaii.
15 And what I have are copies of that first
16 lease in the 1800s by the kingdom which conditions the
17 construction of this ditch system on the same
18 protection that would be afforded downstream
19 appurtenant right holders like Mrs. Kekahuna.
20 And I would like to offer that as Na
21 Moku's next in line, B-128.
22 HEARINGS OFFICER JUDGE McCONNELL: It will
23 be marked. Have you seen it, Mr. Schulmeister?
24 MR. SCHULMEISTER: No.
25 MR. MURAKAMI: And it's a little hard to

1 read, but basically this particular lease conditions
2 the permission to use the water and the lands
3 collecting that water as well as to construct what was
4 the beginnings then of the entire EMI ditch system on
5 protection of downstream water users like Mrs.
6 Kekahuna. And I'm going to offer that as testimony
7 relevant to your consideration of issues in this
8 hearing.
9 HEARINGS OFFICER JUDGE McCONNELL: Before
10 we get to that, any other questions for Mrs. Kekahuna?
11 Q. MR. MURAKAMI: Last question, Mrs. Kekahuna.
12 Is there currently enough water in your 'auwai, based
13 on whatever is being released through the three pipes
14 in the Haiku Ditch, for you to support the growing of
15 the taro that you are now opening up with the help of
16 your ohana for your lo'i?
17 A. Can you repeat it?
18 Q. Sure. Is there enough water to support the
19 taro in the lo'i you are opening up with your ohana's
20 help on your property along Honopou Stream with the
21 water coming out of the three pipes that crosses over
22 the Haiku Ditch?
23 A. I can't say, because the water is right now,
24 the water goes up and down, up and down. Right now
25 have lots of water, the stream overflowing. I can't

1 say right now. But I don't think so. After we get
2 those patches open, I don't think that there will be
3 enough water.
4 Q. Thank you. That's all the questions I have.
5 HEARINGS OFFICER JUDGE McCONNELL: Any
6 questions?
7 MR. SCHULMEISTER: No, thank you.
8 HEARINGS OFFICER JUDGE McCONNELL: Thank
9 you, you're excused. Any further rebuttal?
10 MR. MURAKAMI: No, Your Honor, but I would
11 like to move this particular document.
12 HEARINGS OFFICER JUDGE McCONNELL: B-128.
13 MR. SCHULMEISTER: I don't mind it coming
14 in, I haven't had a chance to look at it.
15 MR. MURAKAMI: I can represent that it was
16 taken out of the state archives today by my staff.
17 It's a little hard to read, but we have some language
18 here that, if necessary, I'll quote to show its
19 relevance.
20 HEARINGS OFFICER JUDGE McCONNELL: There
21 being no objection, I'll receive it.
22 (Na Moku's Exhibit No. B-128 was received
23 into evidence.)
24 MS. LOVELL: Actually I think it would be
25 really helpful if you can just direct us where on the

1 document the conditions are.
2 MR. MURAKAMI: I believe there are two
3 arrows on the fourth page toward the bottom.
4 MS. LOVELL: Okay, thank you.
5 MR. MURAKAMI: That reflect where to look.
6 And I can read what we thought it says, because there
7 is one or two words that are not quite decipherable,
8 but I think still convey the meaning of the conditions
9 attached to the kingdom's grant of permission to start
10 construction of this ditch system.
11 HEARINGS OFFICER JUDGE McCONNELL: If you
12 want to read it, read it for my benefit.
13 MR. MURAKAMI: Upon giving permission to
14 do so, in other words, to take the water and to
15 construct this system.
16 HEARINGS OFFICER JUDGE McCONNELL: Where
17 are you reading from?
18 MR. MURAKAMI: It starts with the word
19 "provided".
20 What we read it to be is: Provided
21 nevertheless, the continuance of the right herein
22 before granted is upon this condition the said water
23 course shall be constructed by the said parties of the
24 second part within two years from the date hereof, and
25 -- we're not sure what that next word is -- existing

1 rights of present tenants of said lands or occupiers
2 along said streams and shall in no -- we think --
3 way -- but we are not sure -- be lessened or affected
4 injuriously by reason of anything herein before
5 granted.
6 That's what we read it to be.
7 HEARINGS OFFICER JUDGE McCONNELL: Okay.
8 It's in evidence. Anything further?
9 MS. LOVELL: Not from the county.
10 MR. MERCHANT: Nothing.
11 HEARINGS OFFICER JUDGE McCONNELL: The
12 only other outstanding matter that I can recall will
13 be whether there was any desire to call Mr. Kanoa.
14 MR. HAIA: And the other matter would have
15 been your allowing us to provide rebuttal evidence to
16 A & B exhibits, I think it was A-53, A-54 and A-56.
17 HEARINGS OFFICER JUDGE McCONNELL: That's
18 the acreage issue?
19 MR. HAIA: Right.
20 HEARINGS OFFICER JUDGE McCONNELL: I take
21 it that you haven't made a decision on either of those
22 questions?
23 MR. HAIA: No, we haven't, but we will
24 make that decision within the next couple of days
25 easily.

1 HEARINGS OFFICER JUDGE McCONNELL: Say by
2 close of business Friday.
3 MR. MURAKAMI: You mean in writing?
4 HEARINGS OFFICER JUDGE McCONNELL: Yeah,
5 just so we know where we are. So if we hear nothing,
6 just so the record is clear, that the hearing would be
7 closed.
8 MR. SCHULMEISTER: I would just like to
9 comment on that on the issue of whether we should -- I
10 don't have a problem with continuing it for rebuttal
11 evidence on the acreage, but I do have a problem with
12 having Mr. Kanoa subpoenaed. The only reasons that A
13 & B, EMI put together what it did was because the
14 interrogatories that we gave to Na Moku were not
15 answered.
16 I mean the whole issue there is what the
17 farmers they, say they represent, are doing, and we
18 asked them in interrogatory before the hearing started
19 what they were doing and what the acreage was. They
20 refused to answer.
21 Now, if they want to change their mind and
22 call those farmers now, I have no problem with that,
23 but they should do that. They shouldn't subpoena Mr.
24 Kanoa. That would be my objection. They have it
25 within their power.

1 That's the direct evidence of what they're
2 doing, what the farmers themselves will say. It seems
3 to me, if they want to do that, I see no problem with
4 that. I don't object to that. In fact, that's why we
5 asked the questions in the interrogatories. If they'd
6 just answered the interrogatories, we wouldn't have
7 gone to the steps that we did.
8 MR. HAIA: If I could, I would like to
9 respond to that.
10 HEARINGS OFFICER JUDGE McCONNELL: But you
11 used Kanoa to make an estimate.
12 MR. SCHULMEISTER: To identify who the
13 farmers were is basically -- the estimate of acreage
14 was not done by Mr. Kanoa, that was done by EMI.
15 HEARINGS OFFICER JUDGE McCONNELL: Right.
16 MR. SCHULMEISTER: So if they're going to
17 say these aren't the farmers, the farmers themselves
18 can say that.
19 MR. HAIA: Just to respond to that. You
20 know, I would agree with the Judge that they're the
21 ones that went out and got Mr. Kanoa to come up with
22 this, to help with the number of acres they claim are
23 in production.
24 If you recall, we had a concern with
25 respect to identifying owners. We --

1 HEARINGS OFFICER JUDGE McCONNELL: I know,
2 I don't think it was well-founded, but I know you had
3 a concern.
4 MR. HAIA: Right, and we provided the
5 Judge under seal with the authority that we were
6 vested with from those landowners to make the claims
7 on their behalf. And that's what we did through the
8 testimony of Teri Gomes.
9 And that's, you know, pretty much all I
10 can tell you with respect to the argument that Mr.
11 Schulmeister is making.
12 HEARINGS OFFICER JUDGE McCONNELL: What do
13 you really need Kanoa for?
14 MR. HAIA: I'll let you know on Friday.
15 HEARINGS OFFICER JUDGE McCONNELL: Okay.
16 I'll reserve ruling on whether we have to convene just
17 to hear Kanoa. If there's a way to do it by telephone
18 or something, that would be appreciated.
19 The other issue you're going to let us
20 know about is on the acreage, correct? So you'll let
21 us know if you want to do anything on the acreage at
22 the same time.
23 Okay. For now then the hearing is closed
24 and if there's no request by the Na Moku parties, then
25 it will be closed for good.

1 I think we start -- we need to think about
2 the submittal of written argument and proposed
3 findings and conclusions.
4 MR. SCHULMEISTER: Could we get an
5 estimate of when the transcript will be ready for
6 these last two days?
7 HEARINGS OFFICER JUDGE McCONNELL: Okay,
8 why don't we go off the record.
9 (Discussion held off the record.)
10 HEARINGS OFFICER JUDGE McCONNELL: We're
11 back on the record, and we'll set the following
12 deadlines. Of course, as we said earlier by this
13 Friday, which is the November the 18th, Na Moku
14 parties well let us know if they want to offer any
15 further rebuttal evidence on the two issues we
16 discussed earlier.
17 The transcript will be ready by December
18 15th, the proposed findings and conclusions and
19 written argument are due on January 15th -- 13th and
20 we would appreciate electronic as well as the hard
21 copy. And by the 20th of January, we will issue a
22 minute order regarding oral argument and try giving
23 the parties some guidance as to where the hearing
24 officer's thinking is.
25 And we will permit replies in any event.

1 Anything else for the record? If not, thank you all
2 very much. I appreciate your patience and your
3 hospitality.
4 (The proceedings ended at 4:20 p.m.)
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

1 CERTIFICATE

2 STATE OF HAWAII)

3) SS.

4 COUNTY OF HONOLULU)

5

6 I, JEAN MARIE McMANUS, do hereby certify:

7 That on November 15, 2005, at 9:00 a.m., the
8 proceedings contained herein was taken down by me in
9 machine shorthand and was thereafter reduced to
10 typewriting under my supervision; that the foregoing
11 represents, to the best of my ability, a true and
12 correct copy of the proceedings had in the foregoing
13 matter.

14 I further certify that I am not of counsel for
15 any of the parties hereto, nor in any way interested
16 in the outcome of the cause named in this caption.

17 Dated this 29th day of November, 2005, in
18 Honolulu, Hawaii.

19

20

21 JEAN MARIE McMANUS, CSR #157

22

23

24

25

BOARD OF LAND AND NATURAL RESOURCES

STATE OF HAWAII

In the Matter of Contested)DLNR FILE: 01-05-MA
Case Regarding Water Licenses)
at Honomanu, Keanae, Nahiku and)
Huelo, Maui)
)

CONTESTED CASE HEARING

Held on November 15, 2005, commencing at 9:00 a.m., at Haiku Community Center, Haiku, Hawaii.

BEFORE: JEAN MARIE McMANUS
Hawaii CSR #156, CA CSR #3119

HEARINGS OFFICER: HONORABLE E. JOHN McCONNELL
33 N. Market Street, Ste. 200
Wailuku, Hawaii 96793

BLNR Attorney: LINDA CHOW, ESQ.
Deputy Attorney General
465 S. King Street, Rm. 300
Honolulu, Hawaii 96813

For EMI and A&B: DAVID SCHULMEISTER, ESQ.
ELIJAH YIP, ESQ.
Cades Schutte Fleming & Wright
1000 Bishop Street, Ste. 1200
Honolulu, Hawaii 96813

For Maui Land & Pineapple: DAVID B. MERCHANT, ESQ.
Kiefer & Merchant
444 Hana Highway, Ste. 204
Kahului, Hawaii 96732

For County of Maui: JANE E. LOVELL, ESQ.
Deputy Corporation Counsel
200 S. High Street
Wailuku, Hawaii 96793

For Maui Tomorrow: ISAAC HALL, ESQ.
2087 Wells Street
Wailuku, Hawaii 86793

For Na Moku Aupuni O Ko'olau Hui, et al: ALAN T. MURAKAMI, ESQ.
MOSES K.N. HAIA, ESQ.
1164 Bishop Street, Ste. 1205
Honolulu, Hawaii 96813

INDEX

WITNESSES:

G. STEPHEN HOLADAY

DIRECT EXAMINATION BY MR. SCHULMEISTER..... 6
CROSS-EXAMINATION BY MR. MURAKAMI..... 7
CROSS-EXAMINATION BY MR. HALL..... 31
FURTHER CROSS-EXAMINATION BY MR. MURAKAMI..... 38

GARRET HEW

CROSS-EXAMINATION CONTINUED BY MR. HAIA..... 43
CROSS-EXAMINATION BY MR. HALL..... 78
CROSS-EXAMINATION BY MR. MERCHANT..... 134

MARK VAUGHT

DIRECT EXAMINATION BY MR. SCHULMEISTER..... 135
CROSS-EXAMINATION BY MR. HAIA..... 136
CROSS-EXAMINATION BY MR. HALL..... 143

LEE JAKEWAY

DIRECT EXAMINATION BY MR. SCHULMEISTER..... 148
CROSS-EXAMINATION BY MR. MURAKAMI..... 149
FURTHER CROSS-EXAMINATION BY MR. MURAKAMI..... 162
CROSS-EXAMINATION BY MS. LOVELL..... 170
FURTHER CROSS-EXAMINATION BY MR. MURAKAMI..... 172

STEVEN GREG KALHO'OKANO

DIRECT REBUTTAL EXAMINATION BY MR. MURAKAMI..... 175
CROSS-EXAMINATION BY MR. SCHULMEISTER..... 183

EDWARD WENDT

DIRECT REBUTTAL TESTIMONY BY MR. MURAKAMI..... 185

BEATRICE KEKAHUNA

DIRECT REBUTTAL EXAMINATION BY MR. MURAKAMI..... 207

EXHIBITS RECEIVED INTO EVIDENCE

Declaration of G. Stephen Holaday..... 7
Na Moku Exhibit No. B-126..... 23
Na Moku Exhibit No. 127..... 205
Na Moku's Exhibit No. B-128..... 211

HEARINGS OFFICER JUDGE McCONNELL: The hearing will come to order. We're reconvened. Counsel are all present except for Mr. Freedman whom I'm informed will not be here today.

MR. SCHULMEISTER: He advised us before he left yesterday he would not be coming today.

HEARINGS OFFICER JUDGE McCONNELL: And we'll continue with the cross-examination of Mr. Hew.

MR. SCHULMEISTER: Actually what we're going do is take Mr. Holaday out of order.

MR. HALL: I would object to that. I thought we were going to finish Mr. Hew. I had planned on that.

MR. MURAKAMI: So had I.

MR. SCHULMEISTER: The beginning of yesterday I specifically brought that up first order of business --

HEARINGS OFFICER JUDGE McCONNELL: How long is he going to be?

MR. SCHULMEISTER: I'm just going turn him over for cross.

MR. HALL: I didn't agree to that. The only person I agreed to take out of order was Mr. Watanabe.

MR. SCHULMEISTER: That was the very first

thing we were going to do this morning.

MR. HALL: No, it wasn't. You said you thought you were going to do Mr. Hew and then after that you were going to take your other two witnesses and you thought it would be the next day. You didn't say you were going to take them out of order.

HEARINGS OFFICER JUDGE McCONNELL: How long is Mr. Hew going to be?

MR. HALL: We talked about that yesterday.

HEARINGS OFFICER JUDGE McCONNELL: I'll let you take him out of order. You don't have any direct examination?

MR. SCHULMEISTER: No, just putting in his declaration.

MR. HALL: How many of these witnesses are coming out of order? I think he thinks there's more than one.

HEARINGS OFFICER JUDGE McCONNELL: That's it, I hope.

MR. SCHULMEISTER: Well, I was planning to take Mr. Jakeway as well, although I think he's definitely more available.

HEARINGS OFFICER JUDGE McCONNELL: We will just do one.

G. STEPHEN HOLADAY

was called as a witness by and on behalf of A&B and EMI, was sworn to tell the truth, was examined and testified as follows:

HEARINGS OFFICER JUDGE McCONNELL: State your name, please, for the record.

THE WITNESS: G. Stephen Holaday.

HEARINGS OFFICER JUDGE McCONNELL: P-h?

THE WITNESS: Yes.

DIRECT EXAMINATION

BY MR. SCHULMEISTER:

Q. Mr. Holaday, can you state your employer?

A. My employer is Alexander & Baldwin.

Q. And your position?

A. I am general manager of Hawaiian Commercial & Sugar Company and president of the agricultural group.

Q. You have in front of you a copy of a written declaration purports to be signed by you on July 29th, 2005, is that correct?

A. Correct.

Q. Is that a true and correct copy of your written testimony in this case?

A. Yes.

Q. Is that testimony true and correct to the best of your belief?

A. Yes.
Q. I have no further questions.
HEARINGS OFFICER JUDGE McCONNELL: The declaration will be in evidence.
(Declaration of G. Stephen Holaday was received into evidence.)
Any questions?
CROSS-EXAMINATION
BY MR. MURAKAMI:
Q. Mr. Holaday, I'm Alan Murakami, counsel for Na Moku Aupuni O Ko'olau Hui and two individuals in Honopou where a couple of your ditches run through.
I understand from your testimony that, if I'm interpreting right, that HC&S is using water from the EMI ditch system in as efficient manner as possible, is that right?
A. Correct.
Q. You're using drip irrigation?
A. Correct.
Q. That which I guess is in agricultural parlance basically the state of the art for the best and most efficient use of water?
A. Correct.
Q. And you say here that you're using all but a small area of the cultivated cane land farmed by HC&S

with drip irrigation, on Page 2, Paragraph 4?
A. Correct.
Q. Does that mean that there are other lands which are being irrigated without your drip irrigation?
A. Correct. There's about 500 acres around the Pu'unene Mill where we dispose of wastewater.
Q. And those would be by spray?
A. That's overhead sprinkler.
Q. As you drive along the highway and see all that spraying going on, that's the part that is exempted from your statement?
A. Correct.
Q. And that's wastewater?
A. That's recycled wash water, wastewater.
Q. And I take it that, based on your testimony, you're saying here that the use of this water is at a level at which you cannot sacrifice any additional loss of that water for your operation; is that right?
A. I'm saying we use water as efficiently as possible and generally we're water short.
Q. So that's what I'm saying. I'm trying to get a gist of what you're saying is that you can't afford to lose any water, because as efficiently as you're using it, you can't afford to lose any water, correct?

A. That's generally correct.
Q. And is that the reason why you're only willing to allow Maui Land & Pine to take water on a sale basis after the -- is it the Haiku Ditch exceeds 100 million gallons per day?
A. I'll have to defer on that.
Q. You don't know that?
A. No.
Q. You don't know whether you're selling to Maui Land & Pine under those conditions?
A. I don't know the terms.
Q. But you're aware that there is an arrangement to sell that water above a certain threshold amount?
MR. MERCHANT: I'm going to object. Characterization of selling the water. We talked about it yesterday, transporting the water.
MR. MURAKAMI: That's an argument.
HEARINGS OFFICER JUDGE McCONNELL: I'll permit it.
THE WITNESS: Could you repeat it?
Q. MR. MURAKAMI: You're aware of an arraignment whereby Maui Land & Pine can sell or buy water from you above a certain threshold amount, correct?
A. I think so.
Q. And I take it -- but because in those

situations there's plenty of water, it's raining, so you don't need the water at that time?
A. I think that's an over-generalization.
Q. What is the rationale behind allowing some third-party to take water which you otherwise say you need for all the operations of HC&S?
A. I guess I'm not familiar enough with the Maui Pine agreement, and it must predate me, because I just don't know that much about it.
Q. And this operation by HC&S, it's part of a pretty complex system of water delivery and cane production that's been established over 100 years, correct?
A. Correct.
Q. And you started what year?
A. 1996 with HC&S.
Q. And as part of HC&S' management -- I take it you're a manager?
A. Correct.
Q. You were briefed, were you not, by your predecessors and superiors to the various aspects of this operation?
A. Sure, in general manner.
Q. And you were briefed how there is an inter-relationship, obviously, between EMI and HC&S?

A. Correct.
Q. Were you briefed with the various conditions under which EMI delivers this water to you?
A. In general terms.
Q. And do you have a basic familiarity, if not an intimate one, about the system of water delivery from EMI to the fields of HC&S?
A. I have a general understanding.
Q. And as I understand it also in your testimony you have various fields, 30,000 of which are supplied in part or in whole by EMI, correct?
A. Correct.
MR. SCHULMEISTER: 30,000 acres, right, not fields.
MR. MURAKAMI: Right, 30,000 acres.
A. Yes.
Q. And an additional 7,000 which is irrigated only by alternative sources from West Maui?
A. West Maui, correct.
Q. And that is through some kind of cooperative arrangement with Wailuku Agribusiness?
A. Correct.
Q. So just for my familiarization, that 7,000 acres is pretty much being watered by Wailuku Agribusiness' operations because of the topography of

those lands?
A. Well, there's a 1924 agreement with HC&S or A&B, I can't remember, and Wailuku that jointly developed that ditch system and jointly both parties take water out of the system.
Q. So but basically the 7,000 acres that's watered by that West Maui source, that's because of the topography and the ability of that gravity flow system to reach those fields?
A. Correct.
Q. That cannot be reached by the EMI sources coming from the other side, is that right?
A. Water would have to come down and go back up the hill.
Q. Right. And you couldn't make it go back up the hill?
A. Well, if you have enough money and electricity.
Q. If you are not pumping, in other words?
A. Correct.
Q. So to round out this understanding of this system, you were in a position to review some of the historical documents involving, as you say, some of the agreements made with other companies and conditions under which water is delivered to your

1 sugar fields?
2 A. I don't think I reviewed documents.
3 Q. You didn't?
4 A. Just a general understanding.
5 Q. Were you aware of any sorts of stipulations
6 or conditions for how HC&S was able to enjoy the
7 benefits from East Maui?
8 A. Just general company history.
9 Q. And are you familiar with the history of the
10 construction of that system?
11 A. Just what I've read, generally what I've
12 read.
13 Q. And I understand, for example, that there are
14 various stages of construction for the ditch system
15 resulted in the completion of various ditches over a
16 period that stretched over the early part of this past
17 century, correct?
18 A. And it may even predate this century, because
19 the original documents I believe were with the Kingdom
20 of Hawaii.
21 Q. Right. And then when the territorial
22 government took over, there were arrangements with
23 that government, were there not, to take water from
24 the lands that it assumed control over?
25 A. I would assume so.

1 Q. And were you aware of any conditions that
2 would allow you to take this water so long as certain
3 events or certain conditions were met?
4 A. I'm not sure I understand what you're asking
5 me.
6 Q. Were you aware of any conditions under which
7 you had to abide in order to receive this water?
8 A. Not specifically.
9 Q. Have you had a chance to look at any of the
10 original lease agreements governing the transport of
11 water from East Maui to Central Maui?
12 A. The only document I recall looking at
13 specifically just was the historical significance of
14 the original lease between the Kingdom and HC&S.
15 Q. How about the first lease between the
16 Territorial government and HC&S?
17 A. I don't think I've seen that.
18 Q. Who is H.P. Baldwin?
19 A. H.P. Baldwin was the co-founder of Alexander
20 & Baldwin.
21 Q. He's the Baldwin of A&B?
22 A. Correct.
23 Q. Were you aware that the Territory did allow
24 for the taking of water off of the -- for so-called
25 license areas which involve Nahiku, Keanae, Honomanu

1 and Huelo?
2 A. I would assume that.
3 Q. And were you aware that the only -- that
4 there was permission given by the Territorial
5 government for the relevant period of the construction
6 that occurred in the early part of the 1990s to grant
7 permission to Mr. Baldwin to construct the various
8 improvements that now constitute East Maui Irrigation
9 system ditch tunnel and other delivery systems?
10 A. I have to assume that, yes.
11 Q. Were you aware that one of the conditions
12 under which this arrangement was made, in other words,
13 the permission granted by the Territorial government,
14 was to protect the interests and rights of those taro
15 farmers that had water rights in Wailuanui Valley and
16 Keanae as a precondition of any of this construction
17 going forward?
18 A. As a specific condition, I did not know that.
19 I would assume that all -- whatever the document said
20 is what it said.
21 MR. MURAKAMI: Mr. Hearing officer, may I
22 approach the witness with this document?
23 HEARINGS OFFICER JUDGE McCONNELL: Yeah.
24 MR. SCHULMEISTER: Is this one of the
25 exhibits?

1 MR. MURAKAMI: No, it's not. And we just
2 got this, and I would like to make it available at the
3 appropriate time. I only have one copy today. But I
4 would like to make this an exhibit.
5 HEARINGS OFFICER JUDGE McCONNELL: Show
6 to Mr. Schulmeister.
7 MR. SCHULMEISTER: Would you make a
8 representation for the record as to what it is?
9 MR. MURAKAMI: All right.
10 Q. I'm going to hand to you, Mr. Holaday, a copy
11 of what's got the number 539 on the top, and it
12 consists of seven pages if you disregard the cover
13 sheet, which I will not include. And it is a, what I
14 will represent to be a document out of the state
15 archives, which is a lease agreement between the
16 Territory of Hawaii and H.P. Baldwin.
17 Do you see that, of Haiku, Maui?
18 A. Okay.
19 Q. Is that the same H.P. Baldwin that's the part
20 of the half of A&B today?
21 A. I would assume so.
22 Q. Do you know of any other H.P. Baldwin in
23 Haiku, Maui that it would be otherwise?
24 A. No.
25 Q. All right. So this is the lease agreement,

1 and what I'm pointing out to you basically is the date
2 of this agreement and the parties signing at the back,
3 Pages 6 and 7 you'll see documents showing the signed
4 signature of H.P. Baldwin and Edward Smith, Commission
5 of Public Lands on Page 6.
6 A. I don't see a signature.
7 Q. It says "signed" which is a common practice
8 of the archives to have the original documents and
9 then to have copies made showing that there were
10 signatures on the originals.
11 A. Okay.
12 Q. And that this was signed on the 19th day of
13 May, 19 -- I believe that's '02, correct?
14 A. That's what it says.
15 Q. Have you seen this document before?
16 A. I don't recall seeing it.
17 Q. Do you see that this, if you read the first
18 page, describes the arrangement to allow for the use
19 of former Kingdom lands under the Territory of
20 Hawaii's control, and if you read it carefully it
21 describes the Keanae License area between Wailua-Iki
22 to the east and -- I'm sorry, and the eastern boundary
23 of the ahupua'a of Honomanu to the west.
24 Are you familiar with where Wailua-Iki is?
25 A. No, I'm not.

1 Q. You're not. But it does represent this is
2 that area between Honomanu and the gulch of
3 Wailua-Iki, is that right?
4 A. Without reading the document carefully,
5 that's what it says.
6 Q. And basically consists of some 12,000 plus
7 acres?
8 A. That's what it says.
9 Q. And basically allows and grants Mr. Baldwin
10 this ability to use this land which is formerly Crown
11 and government land of the Kingdom of Hawaii.
12 As you see on Page 2, subject, however, to
13 the vested interest in water of landowners in Keanae
14 and Wailuanui and all other third parties onto said
15 lease, et cetera; correct?
16 A. That's what it says, yes.
17 Q. And it repeats that on Page 3 where it
18 establishes certain conditions of this lease, again,
19 with a promise by Mr. Baldwin that he will not
20 interfere with the vested interest in water of
21 landowners in Keanae or Wailuanui or any other -- or
22 of other third parties, correct?
23 A. That's what it says.
24 Q. Were you aware or were you briefed on this
25 condition on the original construction of the East

1 Maui Irrigation system as it affected this area of
2 12,000 acres in the Keanae-Wailuanui area?
3 A. No, I was not.
4 Q. By the way, let me just show you, Mr.
5 Holaday, on page -- I'm sorry, I just read this
6 yesterday -- that this particular lease agreement is
7 in part for the privilege of using these lands and
8 includes the other three license areas that are
9 between Nahiku and -- says Maalaea Bay -- sounds like
10 all the way over towards Lahaina side -- for the
11 purpose of constructing, erecting, digging or in any
12 other manner placing and upon said public lands, any
13 dams, ditches, tunnels, flumes, sluiceways or water
14 pipes could be used for the purpose of conveying water
15 from the land hereby demised across said public lands
16 to such other lands as the lessee -- I take that to be
17 Mr. Baldwin -- or his executors, administrators or
18 assigns -- I take that to mean HC&S, does it not?
19 A. I was going to try and look at the front.
20 That's what it says.
21 Q. -- may desire and repairing, maintaining,
22 adding to and enlarging the same as may be necessary
23 during said term and for such purposes, et cetera.
24 Correct?
25 A. That's what it says.

1 Judge, the reason I ask is, Alexander
2 Baldwin is a partnership and always operated as a
3 partnership. Then it was incorporated, I believe, in
4 1900, if I remember right. So I'm just saying this is
5 with H.P. Baldwin and I'm not familiar with it.
6 Q. Right. He's a predecessor and interest in
7 A&B, correct?
8 A. He's a co-founder partnership in the
9 corporation.
10 Q. But in that line of succession, Mr. Baldwin
11 started the whole ball rolling?
12 A. Correct.
13 Q. And, of course, when you construct something
14 and maintain it over 100-plus years, you're operating
15 on the basis of that construction having happened 100
16 years ago, right?
17 A. Correct.
18 Q. You are not going to undo that construction
19 in the near term, are you?
20 MR. SCHULMEISTER: Let me just object as
21 vague.
22 Q. MR. MURAKAMI: You're not going to take away
23 any of the ditches, tunnels, sluiceways, et cetera, in
24 the near future? There's no plans to do that?
25 MR. SCHULMEISTER: You mean to demolish

1 it?
2 MR. MURAKAMI: Yes.
3 A. I don't know. I believe there are ditches
4 that have been abandoned.
5 Q. Okay. But there are a substantial number of
6 ditches and tunnels that are still operating for the
7 benefit of EMI and HC&S, correct?
8 A. Correct.
9 Q. And you're taking that water for the economic
10 benefit of the company to make money off the land of
11 Central Maui?
12 A. Correct.
13 Q. And the construction was done on the -- as I
14 think I've demonstrated -- on the explicit promise not
15 to interfere with the rights of East Maui's landowners
16 who have water rights, correct?
17 A. That's what the document says.
18 Q. Is that the current commitment of HC&S and
19 A&B today that this 100-year-old commitment is still
20 being observed?
21 A. My understanding is that the commitment in
22 those documents are being met.
23 Q. But my question to you earlier was whether
24 you were aware of this document before, correct?
25 A. Yeah.

1 Q. And you didn't know about it?
2 A. No.
3 Q. So how would you know about this 100-year-old
4 commitment, if you never seen this document before?
5 A. There is a lot of documents that the company
6 has that I'm not familiar with. I have to assume that
7 we're operating pursuant to the document.
8 Q. But nobody told you about this, correct, in
9 the past?
10 A. That's correct.
11 Q. And this is the first time you've heard of it
12 is today?
13 A. First time I've seen that document.
14 MS. LOVELL: Will that document be marked
15 for identification at least?
16 MR. MURAKAMI: Yes. And at this point I
17 will do so. If I may have leave -- or if there is
18 other arrangement to be made, I would be willing to
19 mark this document next in order and have copies made
20 available at the next opportunity.
21 HEARINGS OFFICER JUDGE McCONNELL: We wil
22 mark it. It's B-126.
23 MR. MURAKAMI: May I have that also
24 received into evidence upon production of the
25 appropriate copies to the parties.

1 HEARINGS OFFICER JUDGE McCONNELL: Any
2 objection?
3 MR. SCHULMEISTER: No.
4 HEARINGS OFFICER JUDGE McCONNELL: Okay,
5 it will be in evidence, B-126, and you will provide
6 copies to all concerned.
7 MR. MURAKAMI: Yes, I will.
8 (Na Moku Exhibit No. B-126 was received
9 into evidence.)
10 MS. LOVELL: Is there a way we can get
11 copies before the end of the proceedings today?
12 MR. MURAKAMI: I will try to arrange that,
13 I will.
14 MS. LOVELL: Maybe somebody can run into
15 town at the lunch hour.
16 HEARINGS OFFICER JUDGE McCONNELL: If it
17 can be done today fine; if not, I guess I will prevail
18 on Ms. Chow.
19 MS. LOVELL: It limits people's
20 opportunities to --
21 HEARINGS OFFICER JUDGE McCONNELL: It will
22 be available here.
23 MS. CHOW: At the worst I will scan it
24 tomorrow and email it to everyone.
25 MS. LOVELL: Thank you, I appreciate that.

1 But it's not very helpful if that's done after the
2 hearing concludes. I'm thinking there might be a
3 Xerox machine in Paia or something.
4 MR. MURAKAMI: We'll make whatever
5 arrangements I can.
6 May I have leave to take it at the
7 appropriate time? You can keep it now.
8 HEARINGS OFFICER JUDGE McCONNELL: She ca
9 make the copies, okay. If you're going to do it
10 today --
11 MR. MURAKAMI: I don't know if I can. I
12 don't know what's available.
13 HEARINGS OFFICER JUDGE McCONNELL: Neithe
14 do I.
15 Q. MR. MURAKAMI: Mr. Holaday, earlier you
16 talked about you're, I guess, fundamentally familiar
17 with your arrangement with Maui Land & Pine.
18 A. Yes.
19 Q. And I'm going to hand you what has been
20 marked as Exhibit E-2 entitled License and Water
21 Transmission Agreement by and among East Maui
22 Irrigation Company, Limited, A&B, and Maui Land &
23 Pineapple.
24 Have you seen this agreement, transmission
25 agreement provided by Maui Land & Pine for these

1 proceedings?
2 MS. LOVELL: What was the number?
3 MR. MURAKAMI: E-2, echo dash two.
4 Q. Had you seen that before?
5 A. I don't think I have seen it before.
6 Q. It's a 1993 agreement. It precedes your
7 assumption of command of HC&S, correct?
8 A. It says it's 1991.
9 Q. '91, sorry. So precedes it by five years?
10 A. Correct.
11 Q. That particular agreement has apparently
12 expired or terminated but has been extended -- but has
13 been amended at one point by a 1993 agreement. And
14 I'm going to ask you if you've seen this amendment to
15 License and Water Transmission Agreement, which has
16 been submitted and I assume admitted as E-3.
17 Have you seen this document and/or
18 recognize the signatures on the back?
19 A. I don't think I have necessarily seen this
20 document. And I recognize what I think is Richard
21 Cameron's signature and a lady named Beverly Green. I
22 know those people.
23 Q. Were they predecessors to your management?
24 A. Richard Cameron was my predecessor. Beverly
25 Green did something in the law office of corporate or

1 legal department.
2 Q. Finally, that was a 1993 agreement that
3 precedes you by two years, correct? Or is it three
4 years?
5 A. 1996, three or four years.
6 Q. I assume that you weren't around when that
7 document was executed.
8 MS. LOVELL: Are you talking about E-3?
9 MR. MURAKAMI: Yes.
10 A. I worked for Alexander & Baldwin in Honolulu
11 at the time.
12 Q. Had you seen this document?
13 A. I don't think so.
14 Q. Let me hand you a copy of what has been
15 marked as Exhibit E-4, entitled Second Amendment to
16 License and Water Transmission Agreement. And I'm
17 going to ask -- this is a document dated December 17
18 of 1998, two years after you arrived.
19 And I'm going to ask you, have you seen
20 this document? Do you recognize the signatures on the
21 back of this document?
22 A. It's got my signature on it, so I must have
23 seen it.
24 Q. So E-4 is an amendment, is it not, that
25 compliments if not supplements the legal effect of

1 what has been marked as E-3 and E-2, correct?
2 A. Correct.
3 Q. So are you saying at this point that you had
4 not seen the documents for which you signed an
5 amendment to extend the life of that document, that is
6 E-2?
7 A. I think so.
8 Q. You just signed it?
9 A. (Witness nods head up and down).
10 Q. But you didn't review it?
11 A. Not the predecessor agreements.
12 Q. All right, thank you.
13 Mr. Holaday, having testified under oath
14 here that you are managing HC&S to the best of your
15 ability to assure an efficient distribution of water,
16 which should not be or cannot be sacrificed without
17 some detriment to HC&S, what I want to ask is:
18 Isn't it true that A&B is also planning to
19 expand its business park in Wailuku or Kahului?
20 A. My understanding is they're before someplace
21 in the rezoning process.
22 Q. Before the Maui County Planning Commission
23 process, correct?
24 A. Correct.
25 Q. And they need a rezoning to get that

1 approval?
2 A. Correct.
3 Q. As a part of that rezoning, isn't it a
4 requirement that you provide information to assure
5 that there is adequate water to support that proposed
6 expansion of the business park?
7 A. I'm not real familiar with how the real
8 estate part of the company works in the zoning
9 process.
10 Q. Now, isn't it about a 400-acre project?
11 A. I thought it was 130-something.
12 Q. So 130 acres of a business park expansion and
13 it's on the Alexander & Baldwin lands; is it not?
14 A. Correct.
15 Q. Or is it on HC&S side?
16 A. HC&S is a division of, so as a legal entity,
17 HC&S doesn't exist, so it would be A&B land.
18 Q. Okay. Is there or was there sugarcane on
19 those lands?
20 A. There is sugarcane on some of those lands.
21 Q. So you would be giving up a part of your
22 operation in order to satisfy this proposal for
23 planned expansion, correct?
24 A. That's where we dispose of wastewater.
25 Q. You dispose of wastewater there now?

1 A. Yes.
2 Q. Is that where the spraying is occurring?
3 A. Yes, part of it.
4 Q. Right next to Hana Highway?
5 A. Part of it, and part of it does not have any
6 cane on it.
7 Q. Just vacant?
8 A. Just vacant.
9 Q. Now, to support that request, isn't it true
10 that A&B and/or HC&S is planning to use 6 million
11 gallons of water per day that is being delivered by
12 the Wailoa Ditch after completion of the so-called
13 Waiawa Reservoir at the terminus of that ditch by
14 2008?
15 A. Can you resay that again?
16 Q. Yes. Isn't it true that the plans of A&B for
17 this business park expansion of 130 acres is -- under
18 the plans submitted under your proposal to the Maui
19 County for the rezoning necessitates the use of -- or
20 I should say is planning the use of Wailoa Ditch water
21 to the tune of 6 million gallons per day to be treated
22 and used for that expansion at the terminus of the
23 Wailoa Ditch?
24 A. My understanding is that that's not correct.
25 I think there's a proposal, I believe there's one from

1 Brewer, and one from A&B that would use West Maui
2 water, but I don't know where that's at.
3 So that proposal, as I understand it, is
4 West Maui water.
5 Q. At no time did A&B propose the use of Wailoa
6 Ditch water to the tune of about 6 million gallons per
7 day to be treated in order to support the business
8 park expansion?
9 A. Not to my knowledge. Because the up-country
10 water system is not connected to the central valley
11 system. That's always been a premise that we would
12 not want that to happen.
13 Q. Is it true that you never contemplated using
14 that much water from the EMI system in order to
15 support the business park expansion?
16 A. Not to my knowledge.
17 MR. MURAKAMI: At this point I don't have
18 any further questions except I want to reserve the
19 right and opportunity, since I was expecting to get
20 this document later for this examination, our ability
21 to get documents which I think will be shown
22 contradict Mr. Holaday's last statement as a matter of
23 rebuttal.
24 HEARINGS OFFICER JUDGE McCONNELL: We'll
25 deal with that. Yeah, if we get them, I'll make the

1 ruling. Your intent would be to offer them in
2 evidence?
3 MR. MURAKAMI: Yes.
4 HEARINGS OFFICER JUDGE McCONNELL: Mr.
5 Hall.
6 CROSS-EXAMINATION
7 BY MR. HALL:
8 Q. Could I have you look at Exhibit A-6, please.
9 That's your map of HC&S ditch system in part.
10 A. It's a schematic.
11 Q. Are you familiar with the Hawaiian Commercial
12 & Sugar ditch system?
13 A. I have general familiarization of it.
14 Q. And that's how the water from the EMI ditch
15 system is actually delivered to the plantation?
16 A. I assume so, yes.
17 Q. You don't know that?
18 A. Well, I can see the Hamakua Ditch. I can see
19 the Kauhikoa Ditch, the Lowrie Ditch and Haiku Ditch.
20 That's how we deliver East Maui water to the
21 plantation.
22 Q. And water that comes in from the Wailoa Ditch
23 can be dropped down while it's on the plantation to
24 the Hamakua Ditch and dropped down from there to the
25 Kauhikoa Ditch and dropped down from there to the

1 Lowrie Ditch and drop down from there to the Haiku
2 Ditch, correct?
3 MS. LOVELL: Objection, compound.
4 HEARINGS OFFICER JUDGE McCONNELL:
5 Overruled.
6 THE WITNESS: I would assume that. I
7 don't know how the ditch system works.
8 Q. MR. HALL: You don't know how the ditch
9 system works?
10 A. No.
11 Q. What is your position with the plantation?
12 A. General manager.
13 Q. And you don't know how the ditch system
14 works?
15 A. I don't know the details of how we would drop
16 water.
17 Q. Who does?
18 A. I would think that Garret would, the farm
19 manager for the Keahua division would know.
20 Q. You think Garret does?
21 A. I would think so.
22 Q. Has HC&S done any contingency planning with
23 regard to going out of business in the next 25 to 50
24 years?
25 A. Not to my knowledge.

1 Q. Now, you just testified that HC&S was a
2 subsidiary of A&B. You're familiar that in at least
3 the time that you've been with the plantation that
4 plantation lands have been taken out of plantation use
5 and either been put into agricultural subdivisions or
6 urban uses?
7 MR. SCHULMEISTER: Let me object to the
8 extent you said it was a subsidiary. I believe he
9 said it's a division.
10 MR. HALL: All right, fine.
11 A. Now, then you asked about three questions
12 there.
13 Q. Since you have been there --
14 A. Since I've been there, sugar growing areas,
15 I'm not sure.
16 Q. Lands that have been used for either sugar or
17 leased to Maui Land & Pine have been taken out of
18 those uses and devoted to agricultural subdivisions or
19 urban uses; is that correct?
20 A. I think that's not correct. The only land
21 that I know of comes to mind is the Maui Business Park
22 along Dairy Road. To my knowledge that's the only
23 one.
24 Q. Are you aware of an agreement by which the
25 plantation or A&B gave or sold, transferred lands in

1 and around the airport to the Kahului Airport for
2 airport uses?
3 A. That would predate me, so.
4 Q. Are you familiar with that?
5 A. Not the specific transaction.
6 Q. Are you aware that there were lands that did
7 surround Kahului Airport that were in sugarcane?
8 A. Not to my knowledge, that would have been
9 many years ago.
10 Q. Are you aware of -- you did testify about the
11 current industrial park. Were you aware of the
12 adjoining industrial area that was reclassified by
13 A&B?
14 A. That's what I was talking about the 130-some
15 acres that is presently in the process.
16 Q. But adjoining that, isn't there another area
17 that was in sugarcane that has already been
18 reclassified?
19 A. If I understand your question right, I don't
20 think so. But I'm not sure I fully understand the
21 question.
22 Q. Are you aware of an area that adjoins this
23 current area, the area subject to the current
24 application, that previously was in sugarcane and was
25 reclassified by A&B?

1 A. Are you talking about the area right along
2 Dairy Road?
3 Q. Correct.
4 A. Yes.
5 Q. When was that in sugarcane?
6 A. I don't know what year the development was
7 put in, so up until that point.
8 Q. Do you know how much acreage that was?
9 A. I think it was 60-some acres, I think.
10 Q. And that was taken out of sugarcane and
11 reclassified urban for the shopping center that now
12 exists there?
13 A. Yes.
14 Q. And there had been multiple lands that were
15 in sugarcane that have been turned into agricultural
16 subdivisions as well, is that correct?
17 A. I don't think so.
18 Q. Well, right down the road here we have Haiku
19 Mauka, correct?
20 A. That was not in sugar.
21 Q. What was that?
22 A. Either pasture or pineapple.
23 Q. That belonged to A&B, correct?
24 A. I think so, but it was never in sugarcane.
25 Q. It was agriculture?

1 A. Correct.
2 Q. And Haiku Makai?
3 A. Anything this side of Maliko Gulch was never
4 in sugar.
5 Q. How about the Manaoli subdivision?
6 A. The Manaoli subdivision predates me, but the
7 years I've lived on Maui it was an abandoned pasture
8 and I think it was pineapple before that.
9 Q. Leased by A&B, Maui Land & Pine?
10 A. I would assume so.
11 Q. And how many acres was that?
12 A. I don't know.
13 Q. Are there other areas -- so how -- there's
14 been a steady, wouldn't you agree, taking out of
15 agriculture by A&B of lands for either agriculture
16 subdivisions or urban developments?
17 A. As regard to HC&S, the number of acres we
18 farm has pretty much remained constant.
19 Q. That's not my question. There's been a
20 steady taking out of agriculture lands, lands that
21 were used for agriculture, and devoting those lands to
22 nonagriculture uses like agricultural subdivisions
23 and/or urban uses like shopping centers or industrial
24 parks.
25 MS. LOVELL: I object to the form of the

1 question. Vague as to time.
2 HEARINGS OFFICER JUDGE McCONNELL: I can't
3 hear.
4 MS. LOVELL: Vague as to time and
5 geography and a few other things.
6 MR. SCHULMEISTER: I'll join.
7 HEARINGS OFFICER JUDGE McCONNELL: I'll
8 sustain that. If you can be more specific.
9 Q. MR. HALL: Since you've been working for HC&S
10 on a fairly steady basis, A&B has been taking lands
11 out of agriculture uses and devoting them to
12 nonagricultural uses, correct?
13 A. A limited number of acres as we have been
14 taking, for example, Magarro Camp (phonetic), some of
15 the Pu'unene Camps, put those back into agriculture,
16 trying to maintain the acreage.
17 Q. Do you have any accounting of the number of
18 lands that were used for agriculture that were taken
19 out of agriculture and put into nonagriculture uses by
20 HC&S?
21 A. Probably someplace we have that information,
22 but it would be restricted to the acres in sugarcane.
23 Some of the acres that he's talked about were not in
24 sugarcane.
25 Q. Of the 130 acres that you testified to with

1 Mr. Murakami, actually all of that was in sugarcane at
2 one time; isn't that correct?
3 A. I don't know for sure that that's correct,
4 because the lands on the other side of Hana Highway,
5 some of those lands haven't been in sugar.
6 Q. When you say the other side of Hana Highway,
7 you mean the airport side?
8 A. Central power plant side. That would be the
9 airport side.
10 Q. Those were in sugarcane ten years ago, were
11 they not?
12 A. I don't think so.
13 Q. Those were in sugarcane 20 years ago, were
14 they not?
15 A. I don't know.
16 MR. HALL: I don't have any other
17 questions.
18 HEARINGS OFFICER JUDGE McCONNELL: Any
19 redirect, any other questions?
20 MS. LOVELL: No questions.
21 MR. MURAKAMI: I do have some.
22 FURTHER CROSS-EXAMINATION
23 BY MR. MURAKAMI:
24 Q. Regarding this question about the direction
25 of the company, Mr. Holaday, isn't it true that A&B is

1 a -- I don't know if it's diversified, but it had
2 different types of activities for its economic -- the
3 generation of economic revenues?
4 A. Correct.
5 Q. The main one is Matson Navigation.
6 A. Correct.
7 Q. And, in fact, it dwarfs, does it not, the
8 revenues that it receives from any sugar operations?
9 A. Correct.
10 Q. To a large extent -- my understanding is that
11 in 19 -- 2004 the revenues were probably only about --
12 less than 1/20th of the revenues in agriculture, as of
13 the revenues generated by Matson Navigation?
14 A. I don't know the math. I know ag group is
15 over $100 million. I don't recall the Matson's
16 revenues.
17 Q. You're saying $100 million in revenue, and
18 isn't that true that your revenues last year was only
19 about 5 million profit?
20 A. Pre-tax profit.
21 Q. Now, that $5 million, how much of that
22 constitutes the price support that you get from the
23 federal government for sugar?
24 A. We get no price support.
25 Q. You get no price support?

1 A. No, there are no price supports on the Farm
2 Bill.
3 Q. I'm not talking about the Farm Bill this
4 year, I'm talking about what you received last year.
5 A. We didn't receive any form of, to my
6 knowledge, any form of government payment last year.
7 Q. And none the year before?
8 A. In the past, one year we received a disaster
9 relief payment of about $5.5 million, but I don't
10 recall what year it was, but was not last year.
11 Q. And you received that only once?
12 A. We have received another payment this year.
13 Q. So you have received some price support this
14 year?
15 A. It's not price support, it's --
16 Q. I'm sorry. Let's get the terminology
17 correct. It's not a price support, it was what?
18 Disaster --
19 A. It was a disaster relief payment that was
20 paid in several counties throughout the United States,
21 Florida and Louisiana were involved. The County of
22 Maui was declared a weather disaster area, so you
23 could apply for federal disaster relief.
24 Q. All right. So are there any other federal
25 payments you received last year besides disaster

1 relief?
2 A. We didn't receive any last year.
3 Q. This year you're receiving some?
4 A. Yes.
5 Q. How much is that?
6 A. Approximately 5.5 million.
7 Q. And so isn't it also true that the real
8 estate development operations of A&B are also
9 significantly higher by in the tune of maybe six --
10 I'm sorry -- trying to do the math here, like about 15
11 times what you received in agriculture?
12 A. I would say that's generally correct.
13 Q. So the main operations at A&B are not sugar,
14 correct, in terms of at least dollar volume?
15 A. Correct.
16 Q. Mainly in shipping and real estate
17 development?
18 A. Real estimate development and real estate
19 management.
20 Q. And that includes such operations as the
21 recent award of A&B properties to develop the Kakaako
22 development in Honolulu?
23 A. That would be an example.
24 Q. And so given these numbers, is it still your
25 testimony that A&B has not done any planning for

1 basically giving up sugar operations as most sugar
2 companies in Hawaii have?
3 A. Not HC&S to my knowledge.
4 Q. No planning for potential shutdown?
5 A. Correct.
6 Q. And no planning for the use of this water
7 that's used for the current sugar operations to
8 support its real estate development?
9 A. Not to my knowledge.
10 Q. And would you be one to be consulted by the
11 A&B management team for this type of planning?
12 A. I would think so.
13 Q. And you've never been consulted?
14 A. No, I was consulted about the West Maui
15 water.
16 Q. I'm sorry?
17 A. The proposed 5 to 6 million gallon of West
18 Maui water, I was asked about that, my opinion to
19 support the development in the Central Valley.
20 Q. So you were consulted about possibly using
21 water sources that are available to HC&S from West
22 Maui for development of real estate ventures in
23 Central Maui?
24 A. Correct.
25 Q. But you've not been consulted with respect to

1 water that is available from East Maui for such
2 ventures?
3 A. I have not been consulted.
4 Q. Thank you. That's all.
5 HEARINGS OFFICER JUDGE McCONNELL:
6 Anything else? Thank you, sir. You're excused.
7 We'll take a five-minute recess.
8 (Recess was taken.)
9 HEARINGS OFFICER JUDGE McCONNELL: Let the
10 record reflect that we've resumed. Mr. Hew is on the
11 stand and remains under oath. Mr. Haia, you were
12 cross-examining.
13 GARRET HEW
14 CROSS-EXAMINATION CONTINUED
15 BY MR. HAIA:
16 Q. Mr. Hew, yesterday when we left off, you were
17 looking at the map. I think it's A-1 of the ditch
18 system and designation of lands owned by A&B, EMI. We
19 were talking about Kualani Stream, how you believed
20 that stream is not existed, that it's actually a
21 tributary of Waiokamilo. Is that right?
22 A. No, Kualani Stream exists but it's not shown
23 on that Exhibit A-1.
24 Q. And I wanted you to draw it in so we can
25 start there.

1 MR. SCHULMEISTER: So you want him to draw
2 on the original?
3 MR. HAIA: That's right.
4 MR. SCHULMEISTER: Any particular color?
5 MR. HAIA: Going to use a red pen to make
6 the designation of -- just to be clear, you're going
7 to be drawing in what?
8 A. What would you like me to draw in?
9 Q. The stream that you claim is Kualani.
10 A. On Exhibit A-1?
11 Q. Yeah, with a red pen.
12 A. It's difficult to draw this in on this map
13 because when we went out there, we looked at the
14 topography, and I'm not sure, based on this map, if
15 this little point here is that ridge we saw at the
16 lookout, so I cannot ascertain that.
17 Q. Well, let me ask you this.
18 HEARINGS OFFICER JUDGE McCONNELL: Little
19 point where?
20 THE WITNESS: This little point, this
21 area, Judge, right above the Hana Highway.
22 Q. MR. HAIA: Is there any geographical --
23 MR. MURAKAMI: What did the record -- what
24 happened on the record just now?
25 MR. HAIA: On the map in what is

1 identified -- it is really hard to explain though.
2 MR. MURAKAMI: Can we have a label of what
3 he just marked?
4 MR. HAIA: There's just a ridge line that
5 comes off called the Forest Reserve Line at the -- it
6 begins at that green-hatched area that is Palauhulu
7 Stream, a green-hatched area. And there's what's
8 labeled Forest Reserve Line. Well, that line, if you
9 follow it all the way down to a point where there's a
10 triangle with a dot in the middle and it says Kualani
11 right next to it. The point at which that line turns
12 back is the ridge line that Mr. Hew is referring to;
13 correct?
14 A. Right.
15 MR. MURAKAMI: That's in the vicinity of
16 Waiokani Falls?
17 MR. HAIA: Well, it's hard to say because
18 Waiokani Falls is not identified on this map. Is it,
19 Mr. Hew?
20 A. You're saying Waikani or Waiokani?
21 MR. MURAKAMI: Waiokani.
22 THE WITNESS: I don't know of any Waiokani
23 Falls. Waikani Falls is not identified on this map.
24 MR. MURAKAMI: You're talking about where
25 the horseshoe is in the roadway?

1 Q. MR. HAIA: So how can we be sure of the
2 accuracy of everything else that is described in this
3 map? If you have a concern for certain points and
4 whether or not the accuracy will allow you to draw in
5 what you believe is Kualani Stream, how can you be
6 certain that any other place on this map is accurate?
7 A. Because in working at EMI for the last 20
8 years, I've reviewed this map many, many times, and
9 only when we had a question about Kualani did we
10 really go out there and investigate and found out that
11 what we had on this map here was not accurately
12 depicted in the field when we did our taro field
13 investigation of that area.
14 Q. And that's why the concern arises with
15 respect to the other areas. It's only after you went
16 and made a site inspection that you determined that in
17 fact there was a problem with this map. Have you done
18 that with every other location on this map?
19 A. I've looked at most of the other locations
20 and what we have on the ground, and they appear to be
21 accurate.
22 Q. So once again, just so that I get it clear
23 here. You would prefer not to draw in what you
24 believe is Kualani Stream because you're concerned
25 that the area which you believe Kualani Stream is in

1 is not accurately depicted by this map?
2 A. No, I'm not saying that. What I'm saying is
3 that I cannot align any physical features, topography
4 on this map where I believe Kualani Stream is.
5 Q. Okay. And that's why I'm asking you the same
6 thing for everything else. Like, for instance, if you
7 can't identify where Kualani Stream is, how can you be
8 certain that West Wailuanui Stream is actually in the
9 area that is depicted in this map, or for that matter
10 any other stream in the area, given that you can't
11 find a place to locate Kualani Stream?
12 A. For Wailuanui Stream I know it's accurate up
13 in our diversion and down by the highway because this
14 is the horseshoe turn on Hana Highway.
15 Q. So there is no way to use that as a reference
16 to determine the approximate location of what you
17 believe is the Kualani Stream?
18 A. I can give you an approximate location, but
19 it may not be accurate because of the physical
20 features.
21 Q. I would like you to do that then with the
22 condition that this is an approximate location.
23 A. So if we follow the Forest Reserve Line from
24 Palauhulu and come across and follow that line where
25 it crosses so-called Kualani Stream and it makes a

1 little turn close to the Hana Highway and ends up at
2 this trig station called Kualani, and if this is the
3 ridge, that I believe it may be, I believe Kualani
4 Stream follows this direction over here, and
5 intersects Waiokamilo.
6 If this is Lakini, which I believe it may
7 be, Kualani probably intersects Waiokamilo in that
8 fashion.
9 Q. Okay. And so since that is your
10 understanding of Kualani, this is that red line that
11 you just drew in, what about there is no stream that
12 is identified as Kualani Stream, there is no such --
13 on the ground, there's no stream in that area.
14 A. Can you clarify that?
15 Q. Is there, in fact, still a stream at this
16 point on the map that is currently labeled as Kualani
17 Stream?
18 A. On the ground, yes.
19 Q. And what stream is that?
20 A. I believe that's an east tributary of
21 Waiokamilo Stream.
22 Q. Okay, so --
23 HEARINGS OFFICER JUDGE McCONNELL: So
24 you're saying the map is mislabeled?
25 THE WITNESS: The map, Judge, needs to be

1 revised as far as --
2 HEARINGS OFFICER JUDGE McCONNELL: But
3 what is labeled as Kualani -- I'm having trouble
4 reading it.
5 THE WITNESS: You can turn the map the
6 other way.
7 MR. HAIA: This is Kualani right here.
8 HEARINGS OFFICER JUDGE McCONNELL: And
9 you're saying that is incorrect?
10 THE WITNESS: I'm saying that the map --
11 HEARINGS OFFICER JUDGE McCONNELL: The
12 name Kualani.
13 THE WITNESS: The name Kualani, and also
14 the stream itself I believe connects with Waiokamilo
15 further up over here.
16 HEARINGS OFFICER JUDGE McCONNELL: Furthe
17 than here?
18 THE WITNESS: Right. Above this red point
19 where I had drawn Kualani Stream.
20 HEARINGS OFFICER JUDGE McCONNELL: Okay.
21 And this -- what is that?
22 THE WITNESS: I believe that line is the
23 Forest Reserve Line.
24 HEARINGS OFFICER JUDGE McCONNELL: Okay.
25 Go ahead.

1 Q. MR. HAIA: Okay. But what you're now saying,
2 Mr. Hew, is it's your belief that what is labeled as
3 Kualani Stream is actually a tributary of Waiokamilo
4 Stream, and that tributary at the point where the
5 ditch intersects with it is nonetheless diverted,
6 right?
7 A. That's correct.
8 Q. Yesterday we were also looking at some
9 exhibits, Mr. Hew, that was B-5A, B, C, B-6A, B, C --
10 actually B-6A, B-7A, B and C.
11 HEARINGS OFFICER JUDGE McCONNELL: Are we
12 finished with the map now?
13 MR. HAIA: Yeah, for the moment.
14 Q. And when we were looking at Exhibits B-5A, B
15 and C, you described where you believe this was with
16 respect to East Maui watershed, correct? And you
17 noted that all three of these exhibits appeared to be
18 different areas of the same diversion. Is that
19 correct?
20 A. I believe it to be the same diversion pipe.
21 Q. And I was also asking you about whether or
22 not you knew how much water could flow through an
23 eight-inch pipe, the full capacity of an eight-inch
24 pipe, and you did not know; correct?
25 A. That's correct.

1 Q. So if you don't know how much water -- do you
2 know how much water flows on average through that pipe
3 per day, that specific pipe?
4 A. No, I don't.
5 Q. Then how do you know whether or not it's a
6 major change after 1923 to the ditch system, if you
7 don't know how much water is being captured by that
8 diversion?
9 A. Like I had mentioned to you yesterday, a
10 major change, for example, is like a change in the
11 ditch location or a major construction in a stream to
12 divert more water.
13 Q. So in your mind if this pipe that diverts
14 water was put in after 1923, and with your lack of
15 knowledge of how much water is actually diverted, you
16 don't believe that's a major change despite not
17 knowing how much water is being diverted in that pipe
18 or diversion?
19 A. All I know is when I came to work in 1985,
20 this pipe was still in existence.
21 Q. But do you know whether or not it was in
22 existence at or prior to 1923?
23 A. That I don't know.
24 Q. So then you can't conclusively state that
25 there were no major changes to the ditch system after

1 1923, can you?
2 A. To my knowledge, there were no major changes
3 after 1923 on the ditch system.
4 Q. Okay. Well, in this instance, do you know
5 whether or not PVC pipe was around in 1923?
6 A. That I don't know.
7 Q. It may have been, in your mind you don't
8 know?
9 A. That I don't know.
10 HEARINGS OFFICER JUDGE McCONNELL: In any
11 event, you don't consider an eight-inch PVC pipe, if I
12 understand your testimony, as a major change?
13 THE WITNESS: That is correct.
14 HEARINGS OFFICER JUDGE McCONNELL: Okay.
15 THE WITNESS: May I also point out one
16 thing on that exhibit, please?
17 MR. HAIA: Which one?
18 A. I believe it was the third exhibit, the one
19 on the bottom. On Exhibit B-5C I notice that this
20 eight-inch pipe here has very, very little water
21 coming out of the terminus of the pipe.
22 Q. And you can tell that by -- you can actually
23 see how much water is flowing?
24 A. I can see that the pipe has very little water
25 coming out of it.

1 Q. Okay. I would ask you then if that is -- if
2 this is the average flow out of that pipe, why are you
3 using an eight-inch pipe at that point?
4 A. I don't know if the pipe was installed before
5 when I came to work at EMI.
6 Q. Because -- well, let me ask you this.
7 If that's the average flow on a daily
8 basis, couldn't you use the two-inch pipe?
9 A. I don't know if that's the average flow.
10 Q. Thank you. We're going to go onto Exhibit 6A
11 and 6B, Mr. Hew.
12 I'm sorry, Judge, I do need that map back,
13 Exhibit 1.
14 Do you recognize those photographs, the
15 area of those photographs?
16 A. I recognize the area of these exhibits.
17 Q. What is that area?
18 A. This area here is what we refer to as No. 11
19 crosscut.
20 Q. Is there any rationale for referring to it as
21 No. 11 crosscut?
22 A. No, that was how it was relayed to me, and
23 this No. 11 crosscut tunnel is actually a
24 perpendicular tunnel to the main Koolau Ditch, and it
25 is one of the access points into the Koolau Ditch for

1 maintenance repair.
2 Q. Is it also a diversion?
3 A. There is a small diversion on the east side
4 of this No. 11 crosscut, yes.
5 Q. And is there any name to describe that
6 diversion?
7 A. We call that No. 11 crosscut diversion.
8 Q. Is that diversion identified on this map
9 Exhibit A-1?
10 A. No, it is not.
11 Q. Do you know -- would you have any knowledge
12 of why it's not identified on that map?
13 A. Yes, I do. The reason why it's not
14 identified on this map is because this map was
15 prepared for the purposes of showing the system, and
16 not every single small intake pipe that we have on the
17 system. Mostly the major intakes.
18 Q. Okay. But how many, in your words, small
19 diversions do you believe there are along this ditch
20 system?
21 MR. SCHULMEISTER: Entire system, all the
22 ditches?
23 MR. HAIA: As provided for on this map.
24 A. EMI?
25 Q. Yeah.

A. When I did the stream registration for EMI back in 1989, I believe I registered probably close to 400 stream diversions and probably more than half of them were so-called minor diversions.
Q. How many diversions in or around what is described as the Keanae License area are not depicted on this map, if you have a number?
A. Can you repeat that? I'm sorry.
Q. How many, in your words, small diversions are located in the Keanae License area that are not identified on that map?
A. Right offhand, I don't know. I would have to go back to the original stream diversions.
Q. Is it less than ten?
A. I would have to go back to give you an accurate count.
Q. Just approximately, less than ten?
A. I would say more than ten.
Q. Say less than 20?
A. I would have to go back. I don't know.
Q. Just approximately, is it around that ballpark? Is it around 20 or more than 20?
A. I really don't know and I don't like to guess.
Q. Okay. As far as you're concerned as your

position with EMI, small diversions don't need to be documented because there's really no need to let the authorities know how much water is being diverted by small diversions, is that the position?
MS. LOVELL: Objection to the form of the question as argumentative and assuming facts.
HEARINGS OFFICER JUDGE McCONNELL: I'll permit it.
THE WITNESS: No, I'm not saying that. All of our diversions, whether they're large stream diversions or a small one-inch pipe or eight-inch pipe or whatever it is, is registered with the Commission on Water Resource Management.
Q. MR. HAIA: I'm going to show you what is marked and received as B-7A, B-7B and B-7C and ask you to take a look. Do you recognize that area as depicted by those photos?
A. Yes, I do.
Q. And where is that area?
A. This is to the east of crosscut No. 11.
Q. Okay. Is there any identification -- is there a number or a label for this area or this diversion?
A. Yes. We call this No. 10 diversion.
Q. And do you know how much water is captured by

this diversion?
A. No, I don't.
Q. Okay. So did you also register this diversion?
A. Yes, this was registered.
Q. So if we looked at the register, you would have had to tell them how much water you were diverting, right, if you wanted to register the stream diversion?
A. On the form I believe there was a place, but on the small diversions if it was a pipe, either I used an estimate or I left it blank.
Q. Okay. So I previously asked you this question about whether or not, you know, it was your position that since it's a small diversion, you really don't need to account for the water. And it appears that in some instances that's correct, right? If you left the area blank on the registration form that asked for the amount of water being diverted, isn't that right?
MS. LOVELL: I object to the form of the question as argumentative and misstating the prior question.
HEARINGS OFFICER JUDGE McCONNELL: I'll permit it.

MR. SCHULMEISTER: I'll join.
THE WITNESS: No, I don't think that's true, because I would have to go and look at the original stream diversion works permit and see what exactly I put on that permit.
Q. MR. HAIA: Are there some stream diversion works permits that are -- that you categorize as small diversions that you did not provide a number for in terms of how much water was being diverted by that diversion?
A. I believe on that stream diversion registration, I believe it was a category of divertable capacity or something like that. And I'm not sure, unless I go and review what we had registered with the Water Commission.
Q. But you did testify, didn't you, that there were some stream registration forms that you left blank when it asked for an amount being diverted?
A. I said it could have been left blank.
Q. Can I have Exhibit A-55?
Mr. Hew, take a look at Exhibit A-55.
A. Okay.
Q. You see those arrows that are on the left-hand side where it says Wailuanui Road?
A. On the upper and lower left-hand side?

Q. Right.
A. Yes.
Q. Do you know what that designates? There's a legend, it says direction of natural water flow.
A. I believe this is the direction of the flow from the 'auwais into this Wailua area.
Q. The flow of 'auwais, right?
A. The flow of water in the 'auwai.
Q. So it's not the actual flow of streams in the area, it's the flow of the 'auwai?
A. That's correct.
Q. Also I have an Exhibit A-52. And I believe you testified that the person that helped you with that exhibit was a taro farmer. That's the one with the Wailuanui acreage in taro as of 10/25/05.
A. That's correct.
Q. And who is that?
A. That taro farmer is Isaac Kanoa.
Q. And what information did Mr. Kanoa provide?
A. Mr. Kanoa provided, based on that aerial photo of 10/25/05, looking at the photo, he had indicated areas that were in taro production and who he believed the farmer was farming that particular area.
Q. Okay. So in fact Exhibit A-52 is information

obtained from a Mr. Kanoa, and this information was provided based upon his knowledge as of 10/25/05 of who the farmer was on a specific lot or lo'i, and who the owner was?
A. No. He provided the area on the aerial photo and who the farmer was. The owner was determined by looking at the tax map, comparing it to the area and where it fell on the tax map.
Q. Okay. So the information from Mr. Kanoa was based upon the aerial photo, right?
A. He looked at the aerial photo, that's correct.
Q. And when was this, do you recall?
A. This was a couple weeks ago.
Q. A couple weeks ago or October 25th?
A. No. It was after October 25th, because the aerial photo was taken on October 25th.
Q. After the aerial was taken you met with Mr. Kanoa and went through the aerial photo and asked him for information on it?
A. That's correct.
MR. HAIA: You know, Judge, I have a problem with this exhibit and I objected to it previously. I'm objecting to it again, unless I have the opportunity to, you know, ask Mr. Kanoa questions

with respect to his understanding of who's farming the area.

There's no way of me being able to agree to allowing this -- you know, at least that information on this exhibit into evidence in this case.

HEARINGS OFFICER JUDGE McCONNELL: Well, think I've already ruled on that. I mean, I said it was in, but I would permit you to rebut it in whatever way you want.

MR. HAIA: Can I have the aerial photo? I'm not sure what exhibit number it is.

MR. SCHULMEISTER: 53.

MR. HAIA: Dave, did you provide a copy to everybody?

MR. SCHULMEISTER: Yes.

Q. MR. HAIA: Let me show you what has been marked as Exhibit A-53. There appears to be drawing of lines and numbers in the middle of those areas that are drawn in. Is that correct?

A. Yes.

Q. And who did that?

A. We did this with the help of Isaac Kanoa.

Q. When you say "we", who's we?

A. It was Isaac Kanoa, myself and Mark Vaught.

Q. And so explain to me how this occurred. You're sitting down at a table and Isaac is pointing to the areas and someone is drawing the lines around the area?

A. Isaac is looking at this aerial photo, Exhibit A-53 and is very familiar with the area and the people who farm in Wailua, and he's drawing a line around each area and assigning a number and indicating who's farming that particular area.

Q. So it's Isaac that's providing all this information, drawing the line?

A. Giving us a map of such, and we had refined the areas to look at all the taro patches that was in cultivation to make sure that each area encompasses the taro lo'i that were in cultivation.

MR. HAIA: Judge, I have a real problem with Mr. Hew testifying to a map prepared by someone else. It's just a huge concern that we're letting Mr. Hew --

HEARINGS OFFICER JUDGE McCONNELL: If you want to subpoena Mr. Kanoa, I'll make the time available.

MR. HAIA: Thank you, I appreciate that.

Q. Now, going back to Exhibit A-52, the last category is acres, correct?

A. Correct.

Q. And I know you told us how you got to those numbers, but would you state it once again how were those numbers arrived at?

A. Can you provide me that copy of that map that we had, the big map, I believe of Wailua 1985, that aerial photo.

Q. This is Exhibit A-54. Did you make that map, did you copy that map?

A. Yes, we did.

Q. I'm asking you individually specifically, did you do it?

A. I was there when we had the original photo of this Exhibit A-54 copied.

Q. The photo's the same size?

A. Photos is the exact same size.

Q. Okay. And you can swear to that because basically you were there, you watched as this was being copied?

A. That's correct.

Q. And then you used this approximate scale, right, just like in your concern about where you were going to draw where you believed Kualani is, this is an approximate scale and that scale is one inch equals approximately 200 feet, right?

A. This is what is indicated on this map, yes.

Q. An approximate scale. So why are these acreages so specific, like for instance 2.738, .551, .496, .362? That is just --

HEARINGS OFFICER JUDGE McCONNELL: Well, let him answer.

Q. MR. HAIA: Why? Why are they so specific?

A. Well, first of all this map, Exhibit A-53, was provided to our surveyor, and also this map, Exhibit A-54, was also provided to him.

And what he did was transposed the area on Exhibit A-53 onto this map Exhibit A-54. And how he determined the specific areas of each individual parcel was, he broke it down. For example, some of these parcels are not rectangular.

So in some cases he broke down the parcel so that to figure out the acreages he had an aggregate of smaller areas and added it up to be as accurate as possible.

HEARINGS OFFICER JUDGE McCONNELL: So there was no comparison with the tax map?

THE WITNESS: No. The Exhibit A-52 right-hand column on acres is what our surveyor had determined based on this map what the acreages were that were colored based on this 10/25/05 aerial photo.

HEARINGS OFFICER JUDGE McCONNELL: Okay. Maybe I misheard you, but I thought yesterday you said well, then we took this and went to the tax map and we figured out who owned what and what the acreages were. That's not correct?

THE WITNESS: No, the tax map was just looked at who owned the approximate area colored in this exhibit.

Q. MR. HAIA: And in fact you actually used the scale to determine the acreage, right?

A. That's correct.

Q. And the way that you got to that determination is you looked at -- or whoever it was, there was another person that did that, right?

A. Did what?

Q. That determined where these areas were on this map.

A. That is our surveyor, he determined that.

Q. And that surveyor then, I guess he highlighted the areas?

A. Yes, he did.

Q. And then based upon the areas indicated on this map, which is nowhere close to the scale of that map, right?

A. That's right.

Q. He determined, using this approximate scale, the acreage of each one of these highlighted areas to the 1000th, correct, in some instances to the 1000th of an acre, right?

A. That's correct. Our surveyor is very meticulous in doing work.

Q. Thank you. I'm going to have to -- I know I'm going to skip around, Mr. Hew, and I apologize for doing that. But I'm going to go back to Honopou and I'm going to ask you, you know, the three two-inch pipes at Honopou Stream that you said are low-flow pipes.

A. I'm sorry, I'm not familiar with what you're referring to.

Q. Let me get the exhibit. Exhibit B-10B. Do you recognize that photo?

A. I recognize the area, yes.

Q. And are those the three two-inch pipes that allow water to go over the ditch system on Honopou Stream?

A. No, that's incorrect. These are three four-inch pipes.

Q. I stand corrected. Those are three four-inch pipes that allow water to go past the ditch diversion at Honopou Stream, right?

A. That's correct.
Q. Who maintains those pipes?
A. Maintain in what capacity?
Q. They get clogged, don't they, from debris upstream?
A. Yes, they do.
Q. Who maintains that?
A. If we're there and doing our regular routine maintenance, if the pipes are blocked, our people at EMI unblocks these pipes. If the downstream users of Honopou Stream water do not have enough water in the stream and there is a problem, they usually come up to this area to unblock the pipes.
Q. How do you know that?
A. Because I've been told that.
Q. By whom?
A. Mrs. Kekahuna and some other family members and some other people that live down there.
Q. You remember yesterday we were also talking about the pumps that you observed at Honopou?
A. Correct.
Q. Does EMI keep a watch out for how much water is being pumped by those pumps on a daily basis and how long those pumps are pumping on a daily basis?
A. No, we do not.

Q. In your testimony, and I guess it was your rebuttal testimony at Page 13, and I have a copy of it. I'm going to ask you to read Paragraph No. 43.
MR. SCHULMEISTER: Which paragraph?
MR. HAIA: Forty three at Page 13.
A. You want me to read this?
Q. Yes, please.
A. Paragraph 43. "If Na Moku members would like to resume the cultivation of taro in the patches that were abandoned when the upper ditch ceased being used, EMI is willing to assist in the repair and restoration of the upper ditch. This is the necessary first step in putting these patches back into production. There is more than enough water in Waiokamilo Stream to supply the upper ditch and double or triple the amount of taro that is presently being cultivated.
If the upper ditch is repaired and for some reason that EMI cannot presently anticipate there is inadequate water available for taro cultivation, EMI is willing to reduce its diversion above Waiokamilo Stream."
Q. This still stands, right?
A. Absolutely.
Q. So you recall last month on the last day of the hearings last month we did a site visit, we went

up to Lakini, correct?
A. Correct.
Q. And then it's my understanding that you and Mr. Schulmeister went down past the box below Hana Highway and walked down one of the 'auwais, correct?
A. That's correct.
Q. Is that the upper ditch that you refer to?
HEARINGS OFFICER JUDGE McCONNELL: Is that what you're talking about?
THE WITNESS: Yes, we did walk the upper ditch.
Q. MR. HAIA: And what was your -- what did you observe?
A. We walked the upper ditch for several hundred feet and the ditch was not in operation. There was heavy brush and I had my K-knife and I had to cut the brush so that we could continue to walk down the ditch.
And we walked all the way down -- well, from the diversion box, there's a pipe that is connected to the diversion box, and that pipe runs along that open ditch.
And we walked all the way to where that pipe ended, and put water back into the open 'auwai. And at that point we stopped because any further than

that would require a lot more effort to cut our way through on the 'auwai, on that upper ditch.
Q. You know who Mr. Kepa Maly is?
A. Yes, I do.
Q. Who is Mr. Maly?
A. He's a cultural specialist.
Q. And in connection with A&B's application of May 25 -- I guess their application was dated in April. And the hearing before the BLNR on A&B's application was on May 25th, 2005.
In connection with those proceedings did A&B and/or EMI retain Mr. Maly for any purpose?
A. Yes, we did.
Q. What was that?
A. The purpose was to have Mr. Maly document the native traditions of that Keanae-Wailuanui area.
Q. And in the discussions were you the person on behalf of A&B that hired Mr. Maly to do this work?
A. I'm sorry, can you repeat that?
Q. Were you the person who, on behalf of A&B and EMI, hired Mr. Maly to do that work?
A. I coordinated the effort with Mr. Maly, correct.
Q. And so when Mr. Maly -- it's Exhibit B-113, when Mr. Maly writes at page Roman Numeral II:1 of his

report:
"INTRODUCTION. Background.
"At the request of Garret Hew, Manager of East Maui Irrigation Company, Kumo Pono Associates conducted a two phase study of cultural-historical resources in the lands of Hamakua Poko, Hamakua Loa and Ko'olau in the region of Maui Hikina (East Maui), Island of Maui. The study included-conducting detailed research of historical records in public and private collections (Volume 1) and conducting oral history interviews with individuals known to be familiar with the cultural and natural landscape, and history of land use in Maui Hikina study area (Volume II). This study was conducted in conjunction with the Water License Application of the East Maui Irrigation Company, and land use planning processes of the Board of Land and Natural Resources of the State of Hawaii."
So when Mr. Maly writes this in his report, is he being accurate as to the reason for his retention and the work done?
A. Yes, I believe he is.
Q. What was your understanding of the necessity to have this kind of work done in conjunction with A&B and EMI's application for water?
A. Can you be more specific in your question,

please?
Q. Why did you believe this was necessary?
A. Well, first of all, we wanted to make sure that we document some of these kupunas in that area since they were getting very, very old. In fact, one of them had passed away shortly thereafter. And we wanted to make sure that we had proper documentation of people that had lived and worked and were born in that area.
Q. Well, did you look at certain parcels to find out whether or not there were appurtenant rights attached to them?
A. No, I didn't look at any parcels.
Q. Did you request Mr. Maly to do that?
A. I can't recall that.
Q. Can you recall if you requested Mr. Maly to look at parcels in this area to determine whether there were riparian rights attached to those properties?
A. That I can't recall.
Q. So you could have asked, but you just can't recall?
A. I can't recall if we asked or not.
Q. Mr. Schulmeister was asking you about the level of your assistance in helping Ms. Apolonia Day

with the declaration of water use. Do you remember that yesterday?
A. Yes.
Q. What was the level of your assistance?
A. My level of assistance with assisting Mrs. Day was to provide her with the necessary Commission forms, how to fill them out as to her diversions, and I provided her with some of the TMKs which the diversion are located on.
Q. I want to make it clear, she came to you for this, yeah?
A. I believe she had talked to Mr. Cabral who was our field superintendent, and Mr. Cabral had talked to me about assisting her with her stream diversions. And that's what we did.
Q. Is your understanding that Ms. Day went to Mr. Cabral, Mr. Cabral referred Ms. Day to you?
A. Yes.
Q. You were also asked by Mr. Schulmeister about Waikani Falls, the pipe system there, the condition of the system. And I recall your testimony being that EMI was attempting to assist that community, that is, you know, Wailuanui, with repair of that system, so that water could once again flow from that system into the 'auwai. Is that correct?

A. Did you say Waikani or Waiokani?
Q. Waikani.
A. Can you repeat that question?
Q. My understanding that your testimony was that EMI was attempting to assist the taro farmers of Wailuanui Valley by making repairs to the system that took water out of the pond below Waikani Falls, allow it to go back into the 'auwai that would go and feed some of the lo'i on the east side of the valley of Wailuanui, correct?
A. First all, the pipe was broken, but it was still operable when I went there. The water level was above the top of the pipe and the 'auwai that fed the eastern side of Wailua had water from Wailuanui Stream at that time.
Q. Is it your testimony that you worked on a solution to that for three years, you tried to solve that problem over a three-year period?
A. I don't know if it was three years. I know we first got involved with this when Council Member Bob Carrol had called me and asked for our assistance in looking at that situation and seeing if we could provide any assistance.
And I did meet with his assistant and went out there with one of our employees to assess the

situation.
Q. And what was your assessment?
A. The assessment was that there was a landslide that had broken off the bell or the siphon of that pipe, and filled up the pond below Waikani Falls, a portion of that pond which diverted that water out of there.
Q. Based upon your assessment, what did you or any other person affiliated with EMI do thereafter?
A. First of all I went and tried to find out information on who installed that pipe and how it was designed and put in place.
And, you know, the problem with getting the thing repaired is that there's no access up to that area. Everything would have to be carried in or flown in.
There was another problem also with the landslide filling up the pond. So to put that elbow or siphon back into the pond, some of those huge boulders had to be cleared away.
We looked at trying to bring in air compressors and break those rocks and try to get them out of the way or to drill and blast some of the rocks. That would be very, very difficult due to the close proximity of the highway and also the taro

farmers in that valley.
And we never got around to fixing it because the only time there was problems with that system was when the pond would go lower than the top of that pipe. So when the pond would go lower than the top of the pipe, there was less flow going into that system. And this was usually during very, very dry periods.
And so far over the last couple of years that we had contemplated repairing that pipe, I have not heard from the person who uses that water and farms that area as to lack of any water in that particular area.
Q. Thanks. I'm going to you show you Exhibit A-53 and point to the area marked as 7, and I believe Mr. Schulmeister asked you if you knew who was farming that area. You said it was Norman Martin, right?
A. That's correct.
Q. Mr. Schulmeister asked you whether you knew where that water for those lo'i come from, and your testimony was Wailuanui.
A. That's correct.
Q. Do you know for a fact that the water for those parcels is exclusively from Wailuanui?
A. I learned about this parcel from Norman

Bush's grandfather, Sam Akina, who had accompanied us on that assessment of that pipe. Sam Akina retired. He was a long time taro farmer. He told me that his patches here, which his grandson, Norman Martin, got water from Waikani.
Q. And I'm asking you, do you know personally, for a fact, that water that goes to those lo'i presently is exclusively water from Wailuanui Stream?
A. I believe it is. From when I went out there to do the field inspection and saw that area being exclusively taking water from Wailuanui Stream.
Q. Are you a taro farmer?
A. I grew some taro before.
Q. Are you a taro farmer?
A. No, I'm not.
Q. And when you make statements in your testimony in your declaration about water requirements for taro, isn't it true that those -- the numbers that you rely upon are based upon the testimony of the expert called by A&B, Dr. de la Pena?
A. Yes.
Q. So I just need a minute, Judge, to see if there's anything else I need to discover or ask about.
That's all I have.
HEARINGS OFFICER JUDGE McCONNELL: We wi

take a short break before starting with Mr. Hall.
(Recess was taken.)
HEARINGS OFFICER JUDGE McCONNELL: We're back on the record. Mr. Hall, you may cross-examine
CROSS-EXAMINATION
BY MR. HALL:
Q. Could I ask you to look at Exhibit A-1, please.
A. Is that that EMI map?
Q. Yes.
The ditches that are shown on that map exist partly on state lands and partly on EMI lands, correct?
A. That's correct.
Q. So in 1938 the state or the Territory, that is, and EMI entered into an agreement to which the Territory agreed that the ditch system could be built in part on its property, correct?
MR. SCHULMEISTER: Built?
THE WITNESS: No, that's not correct.
Q. MR. HALL: Could you look at our Exhibit No. 1. Do you recognize Exhibit No. 1 as the 1938 agreement between the Territory and East Maui Irrigation Company?
A. I believe it is.

Q. And does that not grant EMI easements for the ditches to be -- to exist on state-owned lands or Territory-owned lands?
A. My understanding of this 1938 agreement is basically an exchange between the Territory of Hawaii and EMI at that time for the ditch, for the Territory to grant EMI the right to have its ditch across the Territory land at that time and for EMI to grant the Territory the right for this to come on our land.
Q. So as we're looking at Exhibit A-1, wherever we see the Wailoa Ditch or any of these ditches where they crossover lands in yellow, they crossover these lands in yellow based on an easement that was granted by the Territory of Hawaii in 1938, correct?
A. That was what the 1938 agreement says, yes.
Q. And this A-1 shows the four license areas, correct?
A. That's correct.
Q. And I would like you to look at our Exhibit A-3, which you have in front of you, and it shows the acreage that is covered by the state portion of each one of those licensed areas.
MR. SCHULMEISTER: Just for the record, I don't think it's A, is it?
HEARINGS OFFICER JUDGE McCONNELL: Yeah,

was confused.
MR. HALL: Well, I used A as well. So Intervenors A, and I've got it in front -- I guess not, maybe it isn't. Just Exhibit 3.
HEARINGS OFFICER JUDGE McCONNELL: Why don't we call those M or something just so we're clear.
MR. HALL: I'll call them M.
HEARINGS OFFICER JUDGE McCONNELL: For th time being, we'll consider it Maui Tomorrow exhibits, just use the number.
Q. MR. HALL: The first page of that staff report, 1985 under area, shows the area covered by the state-owned portion of each one of those licensed areas; is that correct?
A. Can you point out that exhibit for me, please?
Q. Yes. Do you see that?
A. What was your question?
Q. The question is: Does that not accurately depict the size of the state-owned lands that are in each of those licensed areas.
In other words, Nahiku License covers 4,316 acres of state-owned lands.
Keanae License covers 16,095 acres of

state-owned land.
Huelo License covers 8,753 acres.
The Honomanu License covers 3,381 acres for a total of 32,545 acres of state-owned lands.
A. I think the total area is off by a little.
Q. Do you think it's generally correct, that figure?
A. My understanding of the total area that we lease from the State of Hawaii is roughly 33,000 acres, so we're missing about 455 acres somewhere.
Q. And you, that is EMI, has leased all of the streamflow arising on those 33,000 acres for the past 100 years, correct?
A. No, that is not correct. In our lease with the Board of Land and Natural Resources we lease the land.
Q. You're not leasing any water?
A. My understanding is we're leasing the land in these particular areas for the right to divert water, we're not leasing water.
Q. Can you turn to Page 2 of that document. Sale of the Lease called a Water License. Says:
"PURPOSE: Water License - right, privilege and authority to enter and go upon the above-described license areas for the purpose of

developing, diverting, transporting and using government-owned waters."
A. What was your question?
Q. Isn't that a correct description of the rights you have obtained from the State of Hawaii for the last 100 years on these 33,000 acres?
MS. LOVELL: I object to the form of the question as calling for a legal conclusion.
HEARINGS OFFICER JUDGE McCONNELL: Well, I'll permit it.
THE WITNESS: My understanding of this area was that the company had leased from the King of Hawaii at the time of the first ditch which was constructed in 1876 the right to construct that ditch and to operate it. Henceforth, the Territory, as I understand it, leased the land area for this purpose.
Q. The one I just quoted to you?
A. That's correct.
Q. That is to develop, divert, transport and use government-owned waters, correct?
A. Correct.
Q. I would like to have you look at exhibit -- we will call it M-12, and I'll find it for you.
Show you Exhibit M-12, is that list, at least a correct list of some of the streams that exist

within that 33,000-acre area that are diverted by your ditch system?
A. According to this Exhibit 12, streams diverted, I see the first stream is Makapipi and I see the last stream is Maliko. Our license area covers from Makapipi Stream to Honopou Stream, so the last eight streams are not in that license area.
Q. So from Makapipi to Honopou?
A. Makapipi to Honopou.
HEARINGS OFFICER JUDGE McCONNELL: The last --
THE WITNESS: The bottom eight streams are not incumbered under our lease with the state.
Q. MR. HALL: And your map shows that, as Exhibit 12 notes, that some of those streams are diverted in multiple places?
A. Based on the map or based on this Exhibit 12?
Q. Well, both the map and the exhibit both show that some of those streams are diverted in multiple places?
A. Some of those streams are diverted in multiple places, correct.
Q. And for instance, Hanehoi Stream is diverted in four places?
A. Based on Exhibit 12 I don't see Hanehoi on

here. On the map, Hanehoi we have four areas with stream diversions on Hanehoi Stream.
Q. Why does it make sense for EMI to divert a stream like Hanehoi at four places?
A. Because the ditch system was built in that fashion.
Q. Does Hanehoi -- let's say you collect it at a high level, what is the highest level at which you divert Hanehoi?
A. The highest level would be at the Wailoa level.
Q. Does water -- does Hanehoi Stream gain water below the Wailoa Ditch?
A. Hanehoi Stream below the Wailoa Ditch does gain water.
Q. And then so the next diversion is at what, what is the next diversion?
A. The next diversion below the Wailoa on Hanehoi Stream is the New Hamakua Ditch. Which is basically a stormwater ditch. There is no water from Hanehoi Stream at that level unless the stream is flowing at a great rate, a large rate.
Q. But Hamakua Ditch does divert Hanehoi Stream?
A. New Hamakua Ditch there is a stream diversion.

Q. And it would divert everything that is in Hanehoi at that point?
A. Up to its capacity.
Q. And likewise, I forgot to say Wailoa, it would do the same?
A. Up to its capacity, correct.
Q. And then below New Hamakua, Hanehoi would gain water again?
A. To clarify that, from the Wailoa to the New Hamakua Ditch on Hanehoi Stream it's a very, very short distance, maybe not more than 100 feet or so. And below of the New Hamakua down to the Lowrie level it does gain water from springs, correct.
Q. From springs?
A. From springs.
Q. So at Lowrie, Lowrie would divert all the water that had been gained from the springs up to its capacity?
A. On a normal day it would divert that water. There's also that Huelo pipeline in that stream that is also diverting water above the Lowrie Ditch.
Q. By that you mean there is a waterfall and a pool above some number of feet above the Lowrie Ditch itself, correct?
A. That's right.

Q. And there's a private water system that has a pipe that goes into the pool in that water system and is the source for some residents of Huelo, correct?
A. I believe it is.
Q. And then below the Lowrie Ditch there is some more gain in the Hanehoi Stream?
A. There is some gain below the Lowrie Ditch.
Q. And the next ditch is?
A. The Haiku Ditch.
Q. And the Haiku Ditch would divert whatever that gain is up to its capacity again?
A. That's correct.
Q. Now, the subject matter of this contested case is the leases and licenses that EMI pays to the state or secures from the state for the waters that arise in the streams that we have just discussed and within the license areas, 33,000 acres of these license areas, correct?
A. That's right.
Q. And you indicated on this map that the yellow is government land, is that right?
A. The yellow is lands owned by the State of Hawaii.
Q. And green is -- all green is EMI and green with slash marks is undivided fee. What does that

mean?
A. The green, the solid green is lands owned in fee by EMI. The green with the slashes are undivided fee. In other words, those lands are owned by EMI and other people as undivided interest land or hui land.
Q. In other words, if we see a parcel designated like that, you would own that parcel with other people?
A. That's correct, as an undivided interest.
Q. And with the crosshatch, I suppose -- says multiple claim fee, what does that mean?
A. Means that there are some parcels that are claimed by other individuals besides EMI, but as to no specific area or percentage.
Q. And the reddish/brown means A&B owns it?
A. Reddish/brown means Alexander Baldwin, Inc. land, correct.
Q. As we look at -- let's say let's look at Huelo License area in the area of -- the Huelo area, Honopou, Honokala, there's some areas in white there. What does white mean? There's no designation for what white meant.
A. White are lands that are privately owned.
Q. Now, there are lands shown above the Lowrie Ditch and above the Haiku Ditch there that are in

white. Do you see those?
A. Yes.
Q. Does EMI hold leases or licenses with the owners of the white lands to divert, transport and develop the waters arising on those lands to Central Maui?
A. Not to my knowledge.
Q. Now, the licenses that you talked about Revocable Permits A-2, A-3, A-4, A-5, all in Paragraph 16 on Page 6, not my exhibits, your exhibits, say:
"The State reserves the right, subject to not less than thirty (30) days written notice, to withdraw water for this revocable permit to meet the following requirements as the State in its sole discretion may determine: Constitutionally protected water rights."
What are constitutionally protected water rights?
MR. SCHULMEISTER: Object to that, calling for legal conclusion.
MR. HALL: To the best of your understanding, what are constitutionally protected water rights?
HEARINGS OFFICER JUDGE McCONNELL: I'll sustain the objection. That's what we have to argue

about.
Q. MR. HALL: Mr. Hew, in your testimony you were the one who applied for these revocable permits, correct?
A. Yes.
Q. And you received this revocable permit, correct, these revocable permits?
A. Which permit are you referring to?
Q. Your Exhibits A-2, A-3, A-4 and A-5.
A. I believe Exhibits A-2, A-3, A-4 are revocable permits under Alexander & Baldwin, and Exhibit A-5 is under East Maui Irrigation. So I'm an employee of EMI and therefore only Exhibit A-5 would apply.
Q. Let's talk about A-5 then. You received A-5?
A. Yes.
Q. And did you examine A-5 for the conditions under which this revocable permit was received?
A. Yes, I did.
Q. And did you examine condition number 16 that we were discussing on Page 6?
A. Yes.
Q. And did you inquire as to what constitutionally protected water rights might mean?
A. No, I did not.

Q. You didn't, okay. Do you know -- you testified earlier about riparian water rights. Can you explain to me what your understanding of a riparian right is?
MR. SCHULMEISTER: Objection, lack of foundation.
MR. HALL: Mr. Haia asked him about riparian water rights. He testified about it.
HEARINGS OFFICER JUDGE McCONNELL: I'll permit that. I don't recall the testimony. Go ahead.
THE WITNESS: I also don't recall testifying about riparian water rights. What was your question, Mr. Hall?
Q. MR. HALL: What is your understanding of what a riparian water right is?
A. My understanding, not being an attorney on riparian water rights, is the right that a parcel has adjacent to a stream to use water off of that stream if it's touching that parcel.
Q. And what is your understanding of what an appurtenant water right is?
MR. SCHULMEISTER: Objection, calls for legal conclusion.
MR. HALL: He also discussed this term with Mr. Haia.

HEARINGS OFFICER JUDGE McCONNELL: All right. I'll permit it.
THE WITNESS: Like I say, I'm not an attorney, so my limited knowledge of appurtenant rights consists of a parcel that is not adjacent to a stream that has rights to water for that particular parcel.
Q. Has EMI, since it's had these licenses and leases with the state, and since you work for EMI, ever conducted any study of those who hold riparian and appurtenant rights downstream of its diversions?
A. No.
Q. Has EMI engaged or sought to purchase the water rights of those who own parcels downstream of its diversions?
A. Not since I was with the company.
Q. Has it done so -- it's done so previously though, correct?
A. I'm not sure of the meaning of purchase.
HEARINGS OFFICER JUDGE McCONNELL: I'm sorry, could --
Q. MR. HALL: Has it sought to purchase the water rights from those who own, third parties that own parcels below its diversions?
A. I know we have some deeds that indicate that

the company reserves certain water rights off of a parcel in compensation for other things, monetary value or whatever it may be.
Q. And has EMI --
HEARINGS OFFICER JUDGE McCONNELL: You mean it was land conveyed by the company for reservation of water rights within the company?
THE WITNESS: I've seen documents of land that the company has owned that was conveyed to others that reserved the water rights off of that parcel before it was conveyed.
Q. MR. HALL: And has EMI entered into agreements with third parties below the ditch system whereby the water rights to those parcels will be given up in exchange for having a right to a certain size pipe?
A. I recall some deeds that do that.
Q. That EMI has negotiated those agreements, correct?
A. I don't know how it was negotiated. But I do see some deeds that EMI has reserved the water rights but will provide for a one-inch pipe for domestic use.
Q. With respect to the parcel currently owned by Ms. Caveny, you're not aware, are you, of any agreement whereby the water rights to her parcel were

reserved, correct?
A. I have not researched that.
Q. So you're not aware of such an agreement, correct, with EMI?
A. I'm not aware of that.
Q. And with respect to the parcel owned by Ms. Caveny, you're not aware of any agreement by which EMI reserved water rights in return for a pipe of a certain size?
A. I'm not aware of any agreement.
Q. You're also not aware of any agreement by which EMI has ever purchased Ms. Caveny's water rights?
A. I've not researched that, and I'm not aware of that.
Q. With respect to the parcel that is being caretaken by Mr. Schupp, you're not aware of any documents through which water rights on that parcel have been reserved, are you?
A. Which parcel are you referring to?
Q. The one that he is seeking more water from EMI for in this case.
A. As I understand it, there's two parcels down there, one owned by the Keala family and one owned by Matson family.

Q. Let's talk about both of them.
A. No, I'm not aware of any.
Q. And you are not aware of any agreements with respect to the Keala parcel or the Matson family for which he has caretaker agreements by which EMI reserved the water rights in return for a pipe in a certain size?
A. No.
Q. And you are not aware of any agreements by which EMI has purchased the water rights for those two parcels, correct?
A. That's correct.
Q. Now, going back to map A-1, you have designated these are the amounts of water each license area that arise or -- well, segregated between private water and government water. Do you see that?
A. Yes.
Q. And in the Huelo, let's take the Huelo License area. Have you -- did you make any effort to segregate out the water that belonged to others, namely those who own the white parcels in the area?
A. No.
Q. Why not?
A. Because of the fact that we're dealing with just state land and EMI land.

Q. Well, you say a large chunk of land in that license area -- let's just deal with that.
Can you show me where the boundaries of the Huelo License area that you designate license areas are on this map?
A. The Huelo License boundary on the western side is Honopou Stream.
Q. So that would be from the bottom of the map as we're looking at it, would be the mountains, correct? Would be mauka on the bottom of the map?
A. Can you clarify that? I don't follow.
Q. Where would we start on the western side? I'll let you tell us. Would you start at the top of the mountain?
A. As I understand it, the Huelo License area encompasses on the eastern -- excuse me, on the western side the Honopou boundary, which is the EMI green, large green, and adjacent to it the state land and it goes all the way up to wherever Honopou Stream starts up at its beginning.
Q. I don't have a hard time understanding where it starts, but does it go all the way to the ocean?
A. According to our lease with the state, it goes only down to our lowest ditch.
Q. Okay. And that distance would be the Haiku

Ditch?
A. Correct.
Q. So you haven't made any effort to segregate out the water rights of those owners of the white parcels above the Haiku Ditch here?
A. No.
Q. But you would agree that they do have water rights?
MR. SCHULMEISTER: Object, calls for legal conclusion.
HEARINGS OFFICER JUDGE McCONNELL: I'll sustain that.
Q. MR. HALL: You would agree that water arises on those white parcels, correct?
A. I'm sure there's some water on those parcels, correct.
Q. So this map is not entirely accurate when it assigns 100 percent just between the government and private, if it means just EMI, the private just means EMI?
A. All I know is the map was prepared based on state land and EMI land.
Q. So it's inaccurate to the extent that anybody would assume that the 35.51 in Huelo is all EMI, correct?

A. That I don't know.
Q. You don't know.
In your written testimony, you indicate that 70 percent of the water arising in the license area is state-owned water, in all of it together; is that correct?
A. Yes.
Q. So what you mean by that is if we average out what is stated here on map A-1 for government water. For instance, Huelo government water is 64.49, Honomanu is 47.39, Keanae is 79.19, and Nahiku is 95.02. Is this going to average to 70 percent?
A. No.
Q. That's not what you mean?
A. That's not correct the way you had asked the question.
Q. Why is that incorrect?
A. Because if you add all of the so-called government water in the four license areas and divide it by four for the four license areas, that does not come out to 70 percent.
Q. How would I correctly do it then?
A. Seventy percent was arrived by taking the entire leased area along with the area owned by EMI, determining through that isohyetal map what percentage

or what proportion of land fell in what particular rainfall belt and determining from there rainfall versus ownership of land.
Q. Let's use the 70 percent. Are you saying conversely that 30 percent is water that arises on EMI land?
A. Basically, yes.
Q. And you're testifying that the capacity of the ditches together is 160 MGD?
A. That is not correct.
Q. What is it, 165?
A. You're asking what is the capacity of the four ditches?
Q. The average.
A. I'm sorry. The average of the four ditches on average is about 160, 165, but that is very, very misleading, because --
Q. That's the figure you used, correct?
A. That's correct. But it's misleading to the point where some days we don't even have that much water in the whole system.
Q. Some days, but that's the average you use, correct?
A. That's the average.
Q. So if 30 percent of that average is 48 MGD,

million gallons a day, correct?
A. I'm sorry, I couldn't hear.
Q. 30 percent which is what arises on EMI land according to you, 30 percent of the 160 average is 48 million gallons a day?
A. If the math is correct, yes.
Q. And so you've heard testimony that the county requires 8 million gallons a day, correct?
A. That's right.
Q. That could be satisfied on an average basis from water that arises from your land, correct?
A. That's correct. But the entire ditch system is one whole system. So to determine what percentage it is on each ditch would be very difficult, especially they're taking only off of one ditch system.
Q. And even if you add on what Maui Land & Pine requires, that could be satisfied through your contract with them by the water that arises from the land that you own, correct?
A. Based on those numbers.
Q. On an average basis?
A. Based on those numbers, yes.
Q. You testified under direct by your attorney that you had no knowledge that the intervenors sought

more water. Would you look at Exhibit A-10 of our exhibits, or M-10 is what we're calling them, that was a petition to intervene filed by Na Moku.
I'll find it for you, be happy to.
MR. SCHULMEISTER: Let me object, misstated his prior testimony.
MR. HALL: That's the petition to intervene that was filed by Na Moku; and M-11 or A-11 was the petition, the next document, filed by Maui Tomorrow.
Q. Do you see those two documents?
A. Yes.
Q. Wasn't EMI fully aware when it received these documents that there were individuals represented by these two groups that sought more water in the streams for them?
A. I was aware of that, yes.
Q. That's as of 2001?
A. Correct.
Q. And EMI has not let down any water, any more water for any of the people that are represented by Native Hawaiian Legal Corp or through Maui Tomorrow since 2001, has EMI?
MR. SCHULMEISTER: Objection, lack of foundation.

HEARINGS OFFICER JUDGE McCONNELL: I'll permit it.
THE WITNESS: That is incorrect.
Q. MR. HALL: EMI has not let down any more water to satisfy the request of Neola Caveny, has EMI?
A. No, we have not.
Q. EMI has not let down any more water to satisfy the request of Mr. Schupp, has EMI?
A. We had made repairs to the pipe on Puolua Stream at the Lowrie diversion which produced more water being passed over our ditch at the Lowrie level for Mr. Schupp.
Q. Looking at Exhibit A-1 -- well, there are some upper ditches above Wailoa. Are they shown on this map?
A. Which ditches are you referring to?
Q. Well, there are higher level ditches than Wailoa, correct?
A. The only ones that I can see on this map is in the Keanae License area, Hauolo Tunnel.
Q. Talking about Waikamoi. Those ditches are not shown on here, or those diversions?
A. On the county system?
Q. Yeah.
A. I see that they have a flume on the EMI land

above the state-owned parcel, and it's connected to that Waikamoi pump, but that's all I see on this map here. And that flume is no longer in service by the county.
Q. Let's go back to A-1 and looking at Kamole Weir, that's shown on the map?
A. Yes.
Q. To your knowledge, has A&B or EMI or any affiliates entered into agreements by which water that comes from the EMI system is used for nonagricultural uses?
A. Can you clarify that?
Q. Yeah. I'm talking about water that comes from Wailoa Ditch and terminates at Kamole Weir. And I'm asking you if A&B or EMI has entered into any agreements with third parties -- or no, has devoted any of the water that is delivered to Kamole Weir for nonagricultural uses?
A. Not that I'm aware of.
Q. Are you aware of how water that is transmitted to Kamole Weir is devoted?
A. Generally, yes.
Q. Has Kamole Weir water been devoted for use in agricultural subdivisions?
A. Probably just through the county system, but

not through agreement with EMI or A&B.
Q. Have some of A&B's own agricultural subdivisions been served through water that is delivered to Kamole Weir?
MS. LOVELL: I object to the form of that question, unless the agricultural subdivisions in question are identified.
MR. HALL: I would like to leave it wide open.
HEARINGS OFFICER JUDGE McCONNELL: I'll permit it.
THE WITNESS: As far as I know, Kamole Weir, the county has its take of water. The county serves the domestic needs of up-country residents, farmers and businesses, and they serve ag subdivisions, they serve farmers, they serve residents.
As far as the other water that comes into Kamole Weir, that water is used strictly by HC&S for sugarcane cultivation. Some of that is used by Maui Land & Pine, and some of that water is transported via the HC&S Hamakua Ditch for the Kula Agricultural Park which is nondomestic water or untreated water.
Q. MR. HALL: Did A&B subdivisions Haiku Mauka, Haiku Makai, are they served by water that comes

through Kamole Weir?
MR. SCHULMEISTER: You mean directly?
MR. HALL: Indirectly or directly.
A. My jurisdiction ends at Kamole Weir, and whether those subdivisions are served by water off of the Wailoa, I think that question can be answered by the Department of Water Supply.
Q. Well, do you know?
A. I don't know physically.
Q. Do you just know the answer to that question?
A. I don't know.
Q. Are there plans to expand Kamole Weir?
A. Not that I'm aware of.
Q. Are there plans to expand any of the facilities that are -- that are adjacent to or surround Kamole Weir, like treatment plants or reservoirs?
A. I don't know.
Q. I would like you to look at your Exhibit A-6.
MR. SCHULMEISTER: That's the schematic.
Q. MR. HALL: A-6 shows the HC&S sugar company ditch system and the EMI ditch system, correct?
A. That's correct.
Q. Let's just take the Wailoa Ditch for an example. There is an effort here to depict each of

the license areas, is that right; Nahiku, Keanae, Honomanu, Huelo?
A. Generally that's correct.
Q. And if we look at the Wailoa Ditch, just as an example, it shows it expanding, I can't read the first number, is that 25 MGD?
A. Where are you looking at?
Q. I'm starting in Nahiku.
A. Makapipi Stream?
Q. Yes.
A. Yes, I believe that's 25 MGD.
Q. And it grows to 55. Then we get into Keanae at west -- certain stream there, and goes to 140. And we get into the middle of Honomanu and it grows to 200. And then we get into Huelo and it diminishes to 160.
Can you explain what all of those numbers mean?
A. What these numbers mean are the capacity, carrying capacity of the ditch in that particular area. For example, at Nahiku area from Makapipi to Hanawi the carrying capacity of the ditch is 25 million. Once Hanawi Stream comes in, the ditch gets bigger to 55 million and continues on.
When you look at the Honomanu area, that

area is at 140, and after it gets into the Huelo area it goes to 200 million gallons. But then when you look further down, it's reduced to 160 million gallons because of the Wailua Ditch siphon on Nailiihaele Stream which maximum flow is at 160 million gallons per day.
Q. Can you explain why some streams are shown and not all streams?
A. I believe the schematic was made to depict just major streams in the area.
Q. Isn't it true, though, that EMI moves water between ditches downwards within some of these streams?
A. Some of the streams are used to convey water to other lower ditches, correct.
Q. And in Huelo, if we look at Wailoa, you could move water from Wailoa Ditch to New Hamakua down to Lowrie in those streams, correct?
A. Not all of them.
Q. But that's what EMI does with some of these streams, correct?
A. Not normally.
Q. And then you show Waikamoi upper pipeline and lower pipeline, you say those are county pipelines?
A. Yes, those are the county systems, but I

believe the Waikamoi upper pipeline should be revised to say Waikamoi upper flume. It's actually not a pipeline.
Q. You maintain those -- that system for the county, correct?
A. We have an agreement with the County of Maui Board of Water Supply to maintain both the upper Waikamoi flume and the lower Waikamoi pipeline along with our commitment for water at the Kamole Weir and also at the Kula ag park.
Q. And you've got USGS gauging stations designated on this map?
A. Yes, I do see some USGS gauge stations.
Q. Are those currently -- those exist now and are operational?
A. Some of them are.
Q. Are the ones on Honopou Stream existing and operational?
A. Yes, they are.
Q. And there's another designation for EMI company gauge station, correct?
A. That's correct.
Q. And are the ones that are designated on this map existing and optional?
A. Some of them are.

Q. And do you obtain daily data from these gauging stations?
A. Some of these are hooked into our telemetry system so we can ascertain what flow is at that moment to operate our ditch system.
Q. Can you explain what you mean by that? Are you receiving data electronically in some office?
A. Let me review this map. You know, I believe this EMI company gauging station -- the circles here are -- was with our old system. And I believe most of these are not in operation at this time.
Q. So you have a new system?
A. We have a radio telemetry system which is hooked into our office whereby we have a radio system that you can call out on the phone and get instantaneous data on the flow of the ditch system throughout the system here.
Q. Is it providing data on just what's in the ditch or what is being diverted at different streams?
A. It's providing data on what ditch flows are at that moment.
Q. Are you receiving data in any way on what is being diverted at different streams?
A. No, we're not.
Q. So you're just calculating what's being --

what volume is passing within the ditch system at a certain point?
A. That's correct.
Q. And let's just take Wailoa as an example. Where are your data receivers, receptors right now?
A. If you start on the left-hand side of this schematic, on the Wailoa level, we have telemetry system on Waiaaka Stream where you see that circle with the X in it and No. 11 below there, I don't know what the numbers mean.
Then we have one at Pinaau, measures water there. And we have one at Spreckles Ditch right before Puohokamoa Stream. And we have another one on the Wailoa at Honopou Stream.
Q. And it gets transmitted to your office?
A. It gets transmitted to our office, correct.
Q. Could you look at our Exhibit M-3. I'll find it for you.
I'm at M-3 and I'm on page, looks to be six of M-3. M-3, it's a 1985 staff report from DLNR with regard to a sale of a lease to EMI. And on Page 6 has some data on water taken from the various license areas. Do you see that?
A. Yes.
Q. Do you recognize that data? Indicates what

was taken from the Nahiku License area, for instance, from 74/75 then onwards to 84/85.
A. That's correct.
Q. Now, do you have any idea where that data came from?
A. This data came from the USGS gauging stations, the various water license areas.
Q. Are you still supplying this data to DLNR?
MR. SCHULMEISTER: Objection, lack of foundation.
Q. MR. HALL: Do you supply this data annually to DLNR?
MR. SCHULMEISTER: The USGS data?
MR. HALL: Yes.
Q. Do you supply data to DLNR regarding the water taken from these license areas annually?
A. No. We supply total amount taken out of the entire watershed area annually.
Q. So you no longer break it down for per license area?
A. We have never broken this down. We've not accumulated this data. This data was accumulated by contract with USGS and the state.
Q. Is this data still being assembled by contract with USGS and the state?

A. I don't believe it is.
Q. When did it stop being assembled?
A. I believe this stopped when the last of the long-term license area, the Honomanu License area expired in 1986. And I believe there was a one-year holdover period that extended that license agreement. And since that time, I believe the state just required the total amount of water taken out of the four license areas.
Q. So since '86 there's been no information provided to DLNR by license areas in the amount of water taken?
A. That's correct.
Q. And is it EMI that is now providing the data annually on the amount of water taken out of the four license areas together?
A. Yes. We are providing that data to the state and with contract with U.S. Geological Survey to make sure that the ratings are correct and that our equipment are functioning properly. And we have an agreement for them to do quarterly measurements and to make any changes necessary to the rating table for accuracy of the report to the state.
Q. What do you mean ratings and rating table?
A. Each ditch has a gauging station on it. And

gauging station is -- the way they calculate water is by gauge height in feet.
And that particular level of water is correlated to a particular amount, million gallons. So, for example, at 2.5 feet it equals 100 million gallons. Maybe at 3 feet it equals 200 million gallons.
So the USGS goes out quarterly and measures at the four ditches to make sure that the accuracy of those gauging stations are accurate.
Q. So you rely on USGS to verify the accuracy of those measurements?
A. To verify the accuracy of those rating tables in those four gauging stations, correct.
Q. Where are those four gauging stations?
A. They're at the Honopou boundary on the four ditches, the Wailoa, the New Hamakua, the Lowrie and the Haiku Ditch.
Q. Did you supply that information in this contested case hearing?
MR. SCHULMEISTER: What information? Object.
Q. MR. HALL: Did you supply that information, that being the total amount of water taken from the four license areas from '86 to the present in this

contested case hearing?
A. I supplied that information to the state.
Q. Did you supply it as an exhibit in this contested case?
A. I don't believe so.
Q. Looking at Exhibit A-6 again, Mr. Holaday testified that you would be more familiar with the Hawaiian Commercial & Sugar ditch system than he was; is that correct?
A. I am generally familiar with the system, yes.
Q. What I had asked him was once you get onto the HC&S side, which is in purple, green and blue and the other colors, is it not possible to move water from the Wailoa Ditch downwards to the Hamakua Ditch to the Kauhikoa, to the Lowrie, to the Haiku Ditch on the plantation?
A. Yes, that's possible.
Q. So you could distribute water throughout the plantation downwards from these ditches, from any one of these ditches?
A. From the Wailoa Ditch level you can distribute water into these four ditches based on irrigation needs, correct.
Q. You provided some rebuttal testimony with respect to the direct testimony of Neola Caveny,

correct?
A. Yes.
Q. And in your Paragraph 44 you said:
Caveny alleges that two four-inch pipes in the Lowrie Ditch that were intended to allow water to flow downstream to the Lowrie Ditch into the Hanehoi have been blocked within the last ten to 15 years.
And your rebuttal was only that her size wasn't four inch, it was three; is that right?
A. I believe that's correct.
Q. You didn't challenge the fact that they had been blocked for the last ten to 15 years, correct?
A. At those times that I've been at that area, I've seen those pipes blocked, except for the last field trip that we noticed that one pipe was running water.
Q. That's when we went on the field trip because someone from EMI cleaned it out a couple days before, correct?
A. No, that's not correct.
Q. A little bit, a week before?
A. I don't believe anybody from EMI cleaned out that pipe.
Q. And then in 46 you say that Ms. Caveny testified that representatives of EMI alleged that

there's some sort of sump system or sump upstream of her property that would prevent flows from getting to her property.

And you said you're without knowledge as to whether there would be a sump or sinkhole that would prevent that; is that correct?

A. That's correct.

Q. So it's not EMI's position at this point in time that there would be any sump or sinkhole that would prevent any water that you released from getting to her property, correct?

A. That I don't know.

Q. You don't know of any sump or sinkhole that would prevent additional water from getting to her property, correct?

A. That's correct.

Q. And then you wanted to rebut Mr. Schupp by saying that he thought EMI had measured the temperature of the water in his lo'i at 89 degrees. And all you were saying was, it wasn't you that measured it; right?

A. We've never taken any temperature measurements in Mr. Schupp's lo'i.

Q. But you didn't dispute that someone measured it at 89 degrees?

A. I don't know.

Q. You have no idea?

A. I have no idea.

Q. And in 51 you say: Mr. Schupp testified in his direct written that almost all the water is being diverted from Puolua Stream. But you took measurements and you measured the flow rate at Haiku Ditch 262 gallons per day.

That's what you testified to on direct, correct?

A. No, 262 thousand gallons per day.

Q. Right. That was your measurement using that system that you testified to, correct?

A. That was what we had measured in that particular day, correct.

Q. On that day, and that was never verified by USGS, correct?

A. I believe when we took that measurement --

Q. Was your measurement ever verified by USGS?

A. No, it was not.

Q. And it was never verified by CWRM, correct?

A. They were present when we took the measurement and they believed it was to be correct.

Q. You don't have any document that indicates CWRM thought your measurement was correct, isn't that

right?

A. If I recall that measurement --

Q. Is there any document that you can point to where CWRM states that they thought your measurement was correct?

A. I do not have any documentation.

Q. And you were measuring the outflow from the pipe, correct?

A. I was measuring the outflow from the two pipes passing water to the Haiku Ditch.

MR. SCHULMEISTER: Can I ask that the witness not be interrupted before he finishes his answer just as a matter of courtesy.

MR. HALL: Yes, I'm sorry.

Q. You were not measuring what was actually entering his 'auwai, correct?

A. No. His 'auwai was not functional.

Q. But you've never measured what was entering his 'auwai, correct?

A. We could never do that. I've never seen his 'auwai functional.

Q. You've never seen it functional?

A. That's correct.

HEARINGS OFFICER JUDGE McCONNELL: We're going to have to take a break here. How much more do

you have?

MR. HALL: Not that much.

HEARINGS OFFICER JUDGE McCONNELL: The question is whether you want to break for lunch or push on and be hungry.

MR. SCHULMEISTER: I'd like to push on.

HEARINGS OFFICER JUDGE McCONNELL: We've got to take a break for the reporter anyway.

MR. SCHULMEISTER: Five minutes?

(Recess was taken.)

HEARINGS OFFICER JUDGE McCONNELL: We're back on the record. Mr. Hall.

THE WITNESS: Judge, can I make one clarification before we begin? Mr. Hall had asked about if we ever had reported how much we had taken out of the watershed, and yes, we did. I would like to point to Exhibit A-24, which is our hydrograph. It's titled Billion Gallons Delivered at Honopou per Fiscal year 1930 to 2004.

HEARINGS OFFICER JUDGE McCONNELL: Delivered to where?

THE WITNESS: Billion gallons delivered at Honopou and that's the Honopou boundary.

Q. MR. HALL: This exhibit A-24 that you're looking at is an average figure per year? Is this the

total water that was reported to the state coming out of the four license areas at the Honopou boundary which is the western most boundary in all of your ditches?

A. In our all our ditches, correct.

Q. And is there something that you have -- what I'm looking for, is there something that has a numerical figure instead of a graph that makes it hard to read?

A. This is what we have here.

Q. Is this what you submit to the state?

A. No.

Q. What do you submit to the state?

A. We submit them a numerical total for each ditch.

Q. And you haven't submitted that in this contested case?

A. No, but we have submitted this graph that gives you an idea of each fiscal year what the deliveries are out of the watershed.

Q. You mean the four license areas?

A. Out of the four license areas, correct.

Q. I want to show you our Exhibits-28E and 28F, and ask you if you recognize these as Mr. Schupp's taro patches?

A. I believe they are, yes.

Q. So you've seen them in that condition as they're shown in 28E and F?

A. No, I haven't.

Q. You haven't seen them yet?

A. No. I recognize this house in 28F though.

Q. So you've never seen them like this?

A. No.

Q. How many times since you've been at EMI have you seen the property that Mr. Schupp is caretaker of?

A. I've been down there several times.

Q. Several times in how many years is that, 17 years?

A. Worked for EMI for 20 years.

Q. So you've been down there two or so times in 20 years?

A. I think more than that.

Q. Four?

A. When I go down there, it's usually to go and look at our Haiku Ditch intake on Puolua Stream. If Mr. Schupp is there, we go and say hello, see how everything is going.

Q. So that's a total of four times in 20 years?

A. I wouldn't say four times. I would say it's more than that.

Q. Less than ten?
A. Can't remember.
Q. And I would like you to look at Exhibit 19, M-19, which is ours and I'll find it for you, if you would like.
Do you recognize M-19, it says 19?
A. Yes, I do.
Q. Is that a diagram that either you or somebody at EMI drew?
A. Yes. This is a diagram that I drew, but the middle portion of it seems to have not copied quite clearly.
Q. But on the left-hand side it shows Hanehoi Stream and shows the diversions of Hanehoi Stream at Wailoa Ditch, New Hamakua Ditch, Lowrie Ditch, Haiku Ditch; is that right?
A. That's correct.
Q. And you already testified about that and testified -- it also shows two three-inch pipes blocked at the Lowrie Ditch level; correct?
A. On Hanehoi Stream, correct.
Q. Then Puolua Stream shows diversion at the New Hamakua Ditch level and the Lowrie Ditch level and the Haiku Ditch level, right; is that right?
A. Yes, correct.

Q. And you testified earlier that at the Pualoa -- on Puolua Stream at the Lowrie Ditch level there were two three-inch pipes that led into one eight-inch pipe; correct?
A. Yes.
Q. So would it be true that the capacity of what could pass through there would be limited to the two three-inch pipe capacity?
A. I think it would be limited to the flow in the stream. I think with bigger flow, you could get more water.
Q. But you would agree that all that would pass in normal conditions below the Lowrie Ditch would be what would pass through the two three-inch pipes which met in the eight-inch pipe; correct?
A. That's correct.
Q. And to be clear, that's a Y-type configuration, the two three-inch pipes join in the eight-inch pipe, right?
A. Yes. After we had done some work up there in 2004.
Q. And then at the Haiku Ditch level, all that passes in Puolua Stream is whatever could pass through the two three-inch pipes, correct?
A. That's right. Or if the intake was at

capacity and it rained a lot, it would spill over the diversion structure.
Q. And Mr. Schupp, the property he's caretaking, the two ones you referred to as Keala and Matson, are below the Haiku diversion but above where Hanehoi and Puolua join, correct?
A. That's right.
Q. And there is about 60 feet between his 'auwai and the Haiku diversion, correct?
A. I don't know. I've never measured it.
Q. But there's some distance?
A. There's some distance. I don't know if it's 60 feet.
Q. And on Hanehoi, the same thing we talked about the diversions and when we get to Lowrie the two three-inches that were blocked, and then we get to Haiku and Ms. Caveny's property is below the junction of Hanehoi and Puolua; correct?
A. That's correct.
Q. And below the junction of Hanehoi and Puolua the stream is called Hanehoi? In other words, Puolua dumps into Hanehoi and it continues being Hanehoi?
A. Are you asking me a question?
Q. Yes. In other words, what is the name of the stream below the junction with Puolua?

A. We call it Hanehoi Stream.
Q. That's right. And so it is Hanehoi Stream that runs through Ms. Caveny's property; is that correct?
A. Correct.
Q. And the sluices that you were talking about before are in the New Hamakua Ditch diversion works on Hanehoi and -- excuse me, on the Lowrie Ditch diversion works on Hanehoi and on the Haiku Ditch diversion works on Hanehoi; correct? Did you testify to that on direct examination?
A. No, that's not correct.
Q. Okay, what's correct?
A. The two sluice gates we're talking about are on Hanehoi Stream and Puolua Stream at Haiku Ditch level.
Q. But there's also a sluice gate at the Lowrie Ditch level, correct?
A. For what stream?
Q. Hanehoi.
A. No, there is not.
Q. How about Puolua?
A. There is not.
Q. So you testified that both of those gates were open because of storm conditions, correct?

A. Correct.
Q. Had the storm occurred on the day of the site inspection?
A. No, it occurred prior to the site inspection.
Q. And the storm -- there had been a storm and it was over?
A. As I recall there was a storm. It rained a lot. That's why these gates were opened. And it continued to rain the following week, that's why these gates were open. The day we did the site inspection was a Monday and our crew was going along this Haiku Ditch and Lowrie Ditch to make sure that all the gates that were open due to the upcoming storm were to be closed.
Q. So you closed both of them on the day of the site inspection, correct? You ordered your workers to do that?
A. No, that's not correct.
Q. Well, you asked them to do it?
A. No, that's not correct.
Q. When we were present on the site inspection the day the judge was there, the sluice on Hanehoi was closed, correct?
A. As I recall the day we did the site inspection Mr. Schupp had closed the sluice gate on

Puolua Stream. And as we proceeded to Hanehoi Stream on the Haiku Stream diversion that gate was open and our field superintendent, Mr. Robello, had closed that gate for us.
Q. So it was closed?
A. On Hanehoi Stream we closed it that day.
Q. And you came back and made sure that not any bit of water escaped underneath it, correct?
A. That's the purpose of our sluice gate.
Q. To make sure no water got through that sluice gate downstream, correct?
A. Correct.
Q. But EMI has a lot of ways to control how much water passes over these diversion works, correct, passes over or through them?
A. Can you clarify that question? I don't understand that.
Q. If EMI wanted to let more water down to the diversion works, they could place a pipe in the diversion works?
A. That would be possible.
Q. And if it wanted to let a certain amount through, it could gauge that amount by the capacity of the pipe that it installed in the diversion works?
A. That would be possible.

Q. One could either choose, if you wanted to let a certain amount, it could be a four-inch pipe, or if wanted to let more down, could put an eight-inch pipe, or two eight-inch pipes or three eight-inch pipes?
A. Bigger size of the area, the more flow would flow through that area, correct.
Q. You heard Mr. Schupp testify that on Hanehoi Stream the diversion work had a wall and there had been a build-up of rocks and dirt over a long period of time such that the water stream just came down, went right over the top of the diversion work and the water wasn't even being diverted. Do you recall that?
A. Yes.
Q. And that he heard that EMI, at a certain point in time, came out and cleaned that dirt out and that the whole stream, as a result, became diverted again; do you recall that?
A. Yes.
Q. And you don't deny, do you, that EMI did what you call that maintenance work, correct?
A. No. We did maintenance on that stream.
Q. And you don't deny the effect that that had? In other words, whereas before you did the maintenance work, the water went over the top and went downstream, and after your maintenance work, the water no longer

went over the top and down and instead was diverted into the ditch?
A. What we did was normal maintenance.
Q. But that's what the effect of that maintenance work was, correct?
A. That I don't know because I haven't seen the accumulation prior to the cleaning of that basin.
Q. So you're not denying the effect that Mr. Schupp testified to, which was that before your maintenance work it went over the top and downstream, and after your maintenance work, it was totally diverted?
A. That could possibly be.
Q. When you testified about a Poncho and his system of delivering water to his taro patches or whatever he had, you're not necessarily saying that Poncho was the only one that had water rights on Hanehoi or Puolua Stream, are you?
A. I don't know. All I know is Poncho had a diversion ditch above the Haiku and below of the Hana Highway that took Hanehoi water over the Haiku Ditch tunnel to his place of residence.
Q. So your answer is he may not be the only person who had water rights below the ditches?
A. I don't know.

Q. You don't know, okay. I noticed in your testimony that you didn't deny that Mr. Schupp -- Mr. Schupp in his direct testimony testified he had appurtenant water rights. You haven't denied that in your rebuttal, isn't that right?
MR. SCHULMEISTER: To the extent he's asking him to testify about appurtenant rights, that's beyond his competence.
MR. HALL: He can answer that.
MR. SCHULMEISTER: His testimony speaks for itself.
MR. HALL: I want it clear on the record they're not denying that.
MR. SCHULMEISTER: I object to the question, calls for a legal conclusion.
MR. HALL: I think it's fair enough. That's the heart of the matter.
HEARINGS OFFICER JUDGE McCONNELL: I'll permit it.
Q. MR. HALL: In your rebuttal testimony -- Mr. Schupp, in his direct testimony testified he has appurtenant water rights; and in your rebuttal, you did not deny that, correct?
A. I believe that's correct.
Q. And Ms. Caveny in her direct testimony

testified she has riparian water rights. And in your rebuttal you did not deny that, correct?
MR. SCHULMEISTER: Same objection.
HEARINGS OFFICER JUDGE McCONNELL: I understand your contentions may be otherwise, but he can answer.
THE WITNESS: I'm not an attorney, so I'm not an expert on riparian or appurtenant water rights.
Q. MR. HALL: But you did not deny it?
A. But I did not deny it.
Q. You understand that Mr. Schupp -- you were here when he testified that he needs enough water to grow healthy taro in his lo'i, which by his definition is water in the lowest patch that's not higher in temperature than 77 degrees. Did you hear that testimony?
A. Yes.
Q. And you testified earlier, you're not a taro grower, correct?
A. That's correct.
Q. So with respect to his testimony about what he needs, you're going to rely on what your expert on taro growth testified?
MR. SCHULMEISTER: Let me object. What Mr. Hew is going to rely on is irrelevant. It's what

EMI and A&B is going to rely on. It's not an appropriate question.
HEARINGS OFFICER JUDGE McCONNELL: I'll sustain that.
Q. MR. HALL: Is EMI ready, willing and able to supply Mr. Schupp 24 hours a day, seven days a week, enough water to grow healthy taro defined as water which is 77 degrees or less in the lowest of his taro patches?
A. I believe once Mr. Schupp fixes his 'auwai and starts to grow taro, I believe with the amount of water passing over the Haiku Ditch diversion on Puolua Stream, that he has sufficient water to attain his desire to grow healthy taro.
Q. I'll ask you my question once more.
Is EMI ready, willing and able to supply Mr. Schupp 24 hours a day, seven days a week, enough water to grow healthy taro, which means 77 degrees in his lowest patches? Are you willing to supply that water?
A. Right now I cannot speculate what the future is going to be, so I can't say at this point.
Q. When you made that earlier statement you think he has enough water, you are not a taro grower, correct?

A. I'm not a taro grower.
Q. And you don't know what it takes to grow healthy taro yourself, correct?
A. I know what it takes to grow taro because I've grown taro; but I'm not a taro grower, no.
Q. Have you ever experienced taro rot?
A. Not when I grew taro.
Q. Did you grow wetland taro?
A. I grew dryland taro and I was very familiar with wetland taro through my association with some people in the Keanae and Wailua area.
Q. So you yourself have only grown dryland taro?
A. Correct.
Q. When you say you've grown taro, all you're talking about is dryland taro?
A. That's correct.
Q. Is EMI ready, willing and able to provide Ms. Caveny with 670,000 gallons of water per day, 24 hours a day, seven days a week to her property?
A. What was the amount?
Q. 670,000 gallons a day.
A. I think EMI is willing to have those two pipes up at Hanehoi Stream on the Lowrie level to flow, and we also would be willing to have that flow go over the Haiku Ditch level on Hanehoi Stream.

1 Whether that 670,000 gallon can be obtained or not,
2 I'm not sure.
3 Q. So you're not willing to commit to having
4 670,000 gallons a day at her property, correct?
5 A. I cannot commit anything because I don't know
6 what the flow is in that stream.
7 Q. The State of Hawaii has not given you
8 permission to withhold water from individuals with
9 riparian rights, correct?
10 A. Can you clarify that?
11 Q. The State of Hawaii has not given you
12 permission to withhold water from those downstream of
13 your ditches who have riparian rights?
14 A. Nor have they --
15 Q. So the answer to the question is: No, they
16 haven't; correct?
17 A. No, they haven't.
18 Q. And the State of Hawaii has not given you
19 permission, that is EMI, to withhold water from those
20 downstream of your ditch system who have appurtenant
21 water rights; correct?
22 A. That's correct.
23 MR. HALL: I don't have any further
24 questions.
25 HEARINGS OFFICER JUDGE McCONNELL: Any

1 other questions?
2 CROSS-EXAMINATION
3 BY MR. MERCHANT:
4 Q. Earlier in testimony from Mr. Haia, he asked
5 you about questions related to your revocable permits,
6 specifically Paragraph 7 which discussed the ability
7 of A&B, EMI to sell, assign, convey, lease, mortgage
8 or otherwise transfer the rights under the license
9 agreement. Do you recall that testimony?
10 A. Yes, I do.
11 Q. Does that apply only to the license areas?
12 A. That applies only to the license area.
13 Q. And would not apply to what you today find in
14 Exhibit A-1 as private land or EMI, A&B lands, is that
15 correct?
16 A. That's correct.
17 Q. No further questions.
18 HEARINGS OFFICER JUDGE McCONNELL: Any
19 questions?
20 MR. HALL: So why intervene?
21 HEARINGS OFFICER JUDGE McCONNELL: Thank
22 you, Mr. Hew. That's all. We'll take a lunch break.
23 (Noon recess was taken.)
24 HEARINGS OFFICER JUDGE McCONNELL: Back o
25 the record.

1 MARK VAUGHT
2 was called as a witness by and on behalf of A&B and
3 EMI, was sworn to tell the truth, was examined and
4 testified as follows:
5 HEARINGS OFFICER JUDGE McCONNELL: State
6 your name for the record.
7 THE WITNESS: Mark Vaught.
8 HEARINGS OFFICER JUDGE McCONNELL: Mr.
9 Schulmeister.
10 DIRECT EXAMINATION
11 BY MR. SCHULMEISTER:
12 Q. Do you have in front of you the document
13 entitled DECLARATION OF MARK VAUGHT, the last page
14 dated August 22nd, 2005?
15 A. Yes.
16 Q. Is that your signature on the last page?
17 A. Yes, it is.
18 Q. Does this declaration -- does that represent
19 your direct testimony in this case?
20 A. Yes, it does.
21 Q. And the testimony in there is true and
22 correct to the best of your knowledge and belief?
23 A. Yes, it is.
24 MR. SCHULMEISTER: I have no further
25 questions. And I would ask this be received.

1 HEARINGS OFFICER JUDGE McCONNELL: It will
2 be in evidence. Any questions on this side?
3 MR. MERCHANT: No questions.
4 MR. HAIA: I have some questions, thank
5 you.
6 CROSS-EXAMINATION
7 BY MR. HAIA:
8 Q. First question is, Mr. Vaught, is your
9 declaration two pages?
10 A. In and about, yes.
11 Q. And does your copy have anything attached to
12 it?
13 A. Yes, it does.
14 Q. What is it?
15 A. Certificate of Service.
16 Q. And that's it?
17 A. Yes.
18 Q. Your declaration says, attached hereto, so I
19 assumed there was an exhibit attached.
20 A. Oh, sorry, no.
21 Q. It refers to Exhibit A-13. Do you have that
22 in front of you?
23 A. Yes, I do.
24 Q. I'm going to be asking you questions about
25 that exhibit.

1 In your testimony you state that you took
2 measurements of the Kekahuna 'auwai between March 15,
3 2004 and May 20th, 2005; is that correct?
4 A. That's correct, yes.
5 Q. When I look at Exhibit A-13, I notice that on
6 each occasion the measurements were taken no later
7 than 9:20 in the morning.
8 A. That's correct.
9 Q. That's correct. Did at any time anyone from
10 EMI go back later on in the day to take measurements
11 of streamflow in the 'auwai?
12 A. No.
13 Q. So there were no measurements taken in this
14 'auwai on any one of these dates or on any other day
15 after 9:20 in the morning?
16 A. That's correct.
17 Q. Are you aware that there are landowners above
18 the Kekahuna parcel that pump water out of Honopou
19 Stream?
20 A. I'm aware that there are people above that
21 that have access to pumps.
22 Q. And, in fact, if you look at the second page
23 and the date is September 10th, 2004?
24 A. That's correct.
25 Q. In the comment section of the last sentence

1 says, possible pumping upstream. So is that comment
2 made because the measurement was below 235,000 gallons
3 per day?
4 A. Yes, it was. It was a spontaneous comment
5 that I put in here because I didn't go and investigate
6 upstream what the reason was that there was less water
7 on that particular day.
8 Q. Okay. The best that can be said about this
9 information is that based upon the measurements you
10 took and the way you took those measurements on these
11 dates at that time, the flow into the Kekahuna 'auwai
12 is, according to your measurements, documented in the
13 fourth column entitled "flow"?
14 A. Yes, correct.
15 Q. And it's possible that later on in the day,
16 as on September 10th, 2004, that flow may have
17 decreased through pumping upstream?
18 A. It's possible.
19 Q. But you wouldn't know because these are the
20 only measurements you took on those days?
21 A. That's correct.
22 Q. I would like to go into the manner in which
23 you took these measurements. Can you just explain to
24 us, the hearing officer, how those measurements were
25 taken?

A. Basically we have a stainless steel three-inch Parshall flume, which I believe we have provided information on Parshall flumes and how they work. And we take that to Mrs. Kekahuna's house, and we set it in her 'auwai in pretty much the same place every time.

We'd shore it up with sandbags, make sure it was level. And then at that point, we would clean the screen to the inlet of her 'auwai and then raise the deflector plate to let the water come through.

At that point the water would run through the flume. And the reason it says 235,000 plus is because that's the capacity of the flume is 230, it doesn't go higher than that.

And generally the water would be covering the entire flume. We would take a measuring stick, check the height of the water and compare it to the corresponding rating table that goes along with that flume.

Q. How long would the flume be in that position before you took the measurement?

A. Maybe 60 seconds. It was about 12 feet from the entrance to her 'auwai.

Q. So you put the flume in, within a minute you'd taken the reading?

A. Put the flume in, set it. She always had water coming through the 'auwai. Set it up so that the water would be funneled into the flume. And then maybe for about a minute we would set it, make sure everything was level, and then take it up, let the water run through it for awhile, stabilize and take the reading.

Q. What was the purpose of the sandbags? Because you just mentioned that you would direct the water into the flume.

A. Yeah. The purpose of the sandbag is to get the water to funnel through the flume.

Q. Where would it have gone otherwise?

A. Around the sides of the flume. The mouth of the flume is maybe eight to ten inches wide, but the 'auwai might be 18 inches wide.

Q. So it's like putting the water into the flume?

A. Directing it into the flume.

HEARINGS OFFICER JUDGE McCONNELL: All of it?

THE WITNESS: Yes, as much as could have been directed.

Q. MR. HAIA: So some of that water could have remained in the stream?

A. I'm not understanding your question.

Q. That's okay. I'll move on.

HEARINGS OFFICER JUDGE McCONNELL: Well, I have the same question.

THE WITNESS: Could you rephrase that question, so I can understand it?

HEARINGS OFFICER JUDGE McCONNELL: You're trying to measure the total flow in the 'auwai, correct?

THE WITNESS: Correct.

HEARINGS OFFICER JUDGE McCONNELL: So you put this thing in the stream.

THE WITNESS: I put it in the 'auwai.

HEARINGS OFFICER JUDGE McCONNELL: In the 'auwai, I'm sorry. And I don't see how you can do it or measure a height on that unless you're trapping all the water, but maybe I'm just not getting it.

THE WITNESS: Okay. I would set the flume in place, put sandbags on the side of it where the water would otherwise go around, and force the water through the middle of the flume.

But if I lift the plate all the way up, there's so much water in the 'auwai that the flume would actually be under water.

So when I take the measurement, the flume

-- the flume only goes up to, if you look at the gauge height on A-13, the flume only goes up to .5, but I'm measuring at .8 because it exceeds .5, .5 is as high as we can go and that's at 235,000 gallons per day.

So when I take the measurement, there's more than 235,000 gallons per day. I can't tell you how much there is, because our flume is not big enough to handle the amount of water that's flowing through there.

HEARINGS OFFICER JUDGE McCONNELL: Any follow up? Go ahead.

Q. MR. HAIA: Did you also measure the water that was remaining in the stream as it went by the Kekahuna 'auwai?

A. No, I did not.

Q. You state that in Paragraph 3:

"Mrs. Kekahuna does not keep this gate open because if she did, during periods of high stream flow, the water would overflow the 'auwai into her yard."

I understand what you're saying there, but is it also possible that Mrs. Kekahuna doesn't want to divert all the water into the 'auwai, she wants some of the water to stay in the stream?

A. Could be possible, sure.

MR. HAIA: No more questions. Thank you.

HEARINGS OFFICER JUDGE McCONNELL: Mr. Hall, any questions?

MR. HALL: Yeah.

CROSS-EXAMINATION

BY MR. HALL:

Q. Mr. Vaught, how long have you worked for EMI?

A. Six-and-a-half years.

Q. And I'm also looking at your declaration on Paragraph 4, says that you and Henry Robello conducted a field inspection on August 16th, 2005 of the property of Mr. Schupp.

A. That's correct.

Q. Did you have the permission of Ernest Schupp to conduct a field inspection of his property?

A. No, I did not.

Q. Did you ask for the permission of his attorney, me, to conduct a field inspection?

A. No, I did not.

MR. HALL: I move to strike Paragraph 4 of this document, and Exhibit A-40 as unauthorized discovery in this case.

MR. SCHULMEISTER: Objection.

HEARINGS OFFICER JUDGE McCONNELL: I'll overrule that.

MR. HALL: On what grounds?

HEARINGS OFFICER JUDGE McCONNELL: I don't know that there's any grounds. If he's a trespasser, there's other remedies for that.

MR. HALL: There is discovery, you want to do discovery, you ask for discovery. You don't trespass on somebody's property, and don't notify the owner.

THE WITNESS: We have the right-of-way to walk down to our intake there.

HEARINGS OFFICER JUDGE McCONNELL: Well, but it's not grounds for exclusion of the evidence.

MR. HALL: If you don't follow the discovery procedures in a case? We do have discovery.

MR. SCHULMEISTER: You're saying he can't go on his right-of-way and record what he sees?

Q. MR. HALL: Your right-of-way is not on Mr. Schupp's property, is it?

A. The ditch trail that comes down his driveway is.

Q. But his taro patch --

A. I didn't walk into his taro patch.

Q. You said you conducted a field inspection of the property of Ernest Schupp.

A. Yes. I could see his property from our

intake. When we walk down the stream a little bit right to where his 'auwai takes water -- are you familiar with his 'auwai?
Q. Of course.
A. Okay. Right where his 'auwai takes in, if we stand over there in the stream, you can just look right down into his property.
Q. Your ditch is a good 60 feet away from his 'auwai, correct?
A. I don't know the distance. I would say that could be.
Q. And your right-of-way is to go to your ditch and that's it; isn't it?
A. Correct.
Q. But you didn't just stay in your ditch, correct?
A. That's correct.
Q. You went down to his 'auwai?
A. Yes.
Q. So you were outside of whatever right-of-way you had, correct?
A. Yes.
Q. Without his permission and without my permission, correct?
A. Yes.

Q. How many times have you been down to Mr. Schupp's property in the six-and-a-half years?
A. Including that time, four.
Q. Four other times?
A. No, four times total.
Q. So three other times?
A. Correct.
Q. When were the three other times?
A. I don't know the exact dates, but Mr. Schupp was present for all three. And he didn't tell me to leave, so.
Q. So you looked at your Exhibit A-40. You sat down and drew yourself a little map of everything that you were looking at at the time?
A. Yes.
Q. How long did that take?
A. Oh, I didn't do the drawing there, I did the drawing back in the office.
Q. And you said you did not see any taro growing on Mr. Schupp's property, no water flowing into his patch?
A. Correct.
Q. I want to show you exhibits, our Exhibits 28E and 28F. Do you recognize these photographs as being photographs of the lo'i on Mr. Schupp's property?

A. They look like they could be the lo'i on Mr. Schupp's property.
HEARINGS OFFICER JUDGE McCONNELL: The numbers again.
MR. HALL: M-28E and M-28F.
Q. Have you seen the lo'i with taro in them and water like that?
A. No, never.
Q. But you've only been there three other times?
A. Yes.
Q. Mr. Vaught, how long would you continue to try to drive a car when it didn't have gasoline in it?
A. I wouldn't.
Q. Thank you.
MR. HALL: I have no other questions.
HEARINGS OFFICER JUDGE McCONNELL: Any other questions? Thank you, Mr. Vaught.

LEE JAKEWAY

was called as a witness by and on behalf of A&B, EMI, was sworn to tell the truth, was examined and testified as follows:

HEARINGS OFFICER JUDGE McCONNELL: State your name, please.
THE WITNESS: Lee Jakeway.
HEARINGS OFFICER JUDGE McCONNELL: Mr.

Schulmeister.

DIRECT EXAMINATION

BY MR. SCHULMEISTER:
Q. Mr. Jakeway, do you have in front of you the document entitled DECLARATION OF LEE JAKEWAY that was signed on July 29th, 2005?
A. I do.
Q. Does this document include the testimony that you provided in this case?
A. Yes, it does.
Q. And is the testimony that's contained in this declaration true and correct to the best of your knowledge and belief?
A. Yes, it is.
Q. Now, the first paragraph says you are currently employed by HC&S as its Superintendent of Water Coordination. Is that still the case?
A. I had a recent promotion that I should bring to the attention of --
Q. What is your --
MS. LOVELL: I can't hear.
HEARINGS OFFICER JUDGE McCONNELL: You have to speak way up.
THE WITNESS: Okay. I was recently promoted to Director of Energy Development and

Planning.
(Isaac Hall leaves.)
MR. SCHULMEISTER: I have no further questions.
HEARINGS OFFICER JUDGE McCONNELL: Mr. Haia.
MR. HAIA: Mr. Murakami is going to do the cross.

CROSS-EXAMINATION

BY MR. MURAKAMI:
Q. What is the title that you have?
A. Director of Energy, Development and Planning.
Q. And you work for HC&S?
A. Correct.
Q. So does your title infer that you have no role in the agricultural operations of HC&S?
A. Currently I don't have direct involvement with agricultural operations.
Q. So your whole purpose of your position is to direct the energy development of HC&S and to plan for it?
A. That is correct.
Q. So prior to this -- is it a promotion you said?
A. Yes.

Q. Prior to this promotion then, did you have duties to deal with the water use on HC&S lands?
A. Yes, I did.
Q. And you had responsibilities to coordinate the application of that irrigation water from East Maui Irrigation on HC&S land?
A. That is correct.
Q. How many staff did you supervise?
A. At that time I had four ditch coordinators that I supervised.
Q. That would be opening the gates or whatever else is needed to direct the water to the points you directed?
A. That's correct.
Q. Now, I take it from your testimony that basically what we're dealing with here is the application of irrigation water from the East Maui irrigation system on 5,000 acres on certain fields of EMI water exclusively, correct?
A. That is correct.
Q. And on 25,000 acres of EMI water combined with other sources of water, primarily groundwater pumped by HC&S?
A. Yes.
Q. And your testimony on Page 3 is that the

range of this use varied from 134 million gallons per day in the winter months to a high of 268 million gallons during the peak months of May to October, correct?
A. That is correct, that's what it states.
Q. Is that your testimony or not?
A. Yes, it is.
Q. Is that based on records that you have compiled with HC&S?
A. That's -- yes, we do have records to attest to that.
Q. And this is over what period of time?
A. This would be for 2002 to 2004.
Q. The same period that you mentioned for determining the allocation of water between ground and surface water?
A. That is correct.
Q. And so if you're using 134 million gallons a day on 30,000 acres, is my math correct that your average acreage usage is 4,467 gallons per day per acre?
A. If 30,000 -- if 134 million gallons were divided by 30,000 that sounds reasonable, yes.
Q. So that's during the off-peak use. And it doubles during the peak months. So I would assume

that it would be doubling the gallons per day per acre, correct?
A. Approaching that, yes.
Q. To the amount of 8,933 gallons per acre?
A. That would be correct.
Q. This is with the use of drip irrigation?
A. Yes.
Q. Isn't it true that the typical water use of diversified crops is in the neighborhood of 2000 gallons per day per acre?
A. For diversified crops?
Q. Yes.
A. That could be for diversified crops, but for sugarcane it would be on the order of eight to 10,000 gallons a day.
Q. Do you know how much it was during the period when there was no drip irrigation --
THE COURT REPORTER: I can't hear you.
MR. MURAKAMI: Do you know what the usage was per day per acre on 30,000 acres when you were not using drip irrigation?
A. When we were using furrow irrigation?
Q. Yes.
A. I do not know. That was before my time.
Q. And you don't know whether or not that was

10,000 gallons per day per acre?
A. I do not, no.
Q. Now, is it true or not true that all 30,000 acres of HC&S land is currently being irrigated today, that is being serviced by the EMI system in whole or in part today, right now?
A. Can you clarify that?
Q. All 30,000 acres of land which is serviceable by EMI water in whole or in part being irrigated to today as we speak?
A. They would not be irrigated, technically, but they would not be -- technically they would not be irrigated, all of them irrigated today, but they have the potential to be irrigated. The systems are in place to be irrigated.
Q. How many acres of the 30,000 acres is actually being irrigated today as we speak?
A. I wouldn't know because I'm not involved in the operation.
Q. But you were responsible for applying the water to the serviceable lands, weren't you?
A. Yes, I was. That was a function of the percentage of soil moisture that was in the ground that we would monitor. So depending on the soil moisture status that those fields would get irrigated

water.
Q. But is it or is it not true that you would be allowing some fields to lay in fallow without irrigation water being applied to it in a typical month, day, year?
MR. SCHULMEISTER: Let me object, vague. Are you saying fallow means not irrigated?
MR. MURAKAMI: Yeah.
MR. SCHULMEISTER: I don't think that's the typical understanding of the word.
HEARINGS OFFICER JUDGE McCONNELL: Could you clarify that, because that's not my understanding.
Q. MR. MURAKAMI: Are all 30,000 acres of HC&S lands cultivated at the same time?
A. Yes, that would be a true statement.
Q. So every acre of the 30,000 has some planting on it of some sort?
A. There would be some fields in transition from harvesting to planting, so there would be a certain percentage that would be --
Q. What percentage would that be?
A. I wouldn't know the exact percentage of that.
Q. Who would know, if you don't know? You're the one that were applying the water to the fields.
A. Probably farm managers for each individual

divisions.
Q. Don't they tell you, the Director of the Operations, to irrigate these lands? You wouldn't shut off the water. You wouldn't cut off the water continuing if there were --
MR. SCHULMEISTER: Let me object. The question implies today, right? And he doesn't --
MR. MURAKAMI: At any time. At any time while he had his former position to direct irrigation water to the fields that were in need of irrigation.
MR. SCHULMEISTER: You're assuming the percentage was the same every day.
MR. MURAKAMI: I'm asking him.
A. There would always be a certain percentage that would be in transition or fallow from harvesting to planting.
Q. Is that percentage the same from day-to-day?
A. It would be a steady state, yes. I think that would be a good way of characterizing that.
Q. So steady state, what is the percentage that would not be under irrigation?
A. Are you asking me to take a guess on this?
Q. I'm assuming --
A. Or are you asking me if I know that?
Q. Do you know that?

A. I do not know that.
Q. Do you have any idea what the range of that percentage is?
A. No, I cannot give you an accurate number on that.
Q. So you cannot tell me from day-to-day whether or not you need water for 30,000 acres -- while you were responsible for irrigating the fields of HC&S, you could not tell me on how many acres water was being applied and where water was not being applied or how many acres water was not being applied on; is that what you're saying?
A. Let me explain. My main responsibility was to respond to the request of the farm managers and their needs for the water on each of the ditches. So I did not commit to memory what their acreage requirements were for irrigation.
Q. So you didn't know on a per acre basis how much water was needed on various fields of HC&S at any given time?
A. That would be correct in saying that.
Q. And you didn't know?
A. Not on a per acre basis.
Q. And you didn't know how many acres did not have water, irrigation water being applied to it on

any given day?
A. There's a report in cultivated acres that does detail the number of acres. And that was the basis for the requirement for water for that ditch. So that would take into account the acres that were receiving water.
Q. But so you're saying you didn't commit it to memory and you can't say what that percentage of either irrigated land was or lands not being irrigated at any given time?
A. That total would vary from day-to-day.
Q. Do you have an idea of what the range of that variation is in terms of the percentage of lands being irrigated or not being irrigated?
A. I would have to go back and review the records. I do not know that right at this moment.
Q. And you have no idea --
A. No.
Q. -- whether it was ten percent, 25 percent?
A. If you want a range, I can hazard a guess.
Q. Based on your best estimate and years of experience?
A. I would say it's less than ten percent.
Q. More than five percent?
A. I couldn't tell you exactly.

Q. So if, in fact, it would be no more than ten percent being irrigated; is that right?
A. I would think that would be generally true, yes.
Q. So based on your testimony, I would -- is it true or not true then at any given time typically HC&S was irrigating 27,000 acres of land per day -- I mean every day?
A. Based on that math, yes, that would be close to that.
Q. So if that's true, then if we use generally a ten percent figure, then the figures I gave you earlier as to the gallons per day per acre would have to be increased by approximately ten percent to show what amount of water was being applied to those lands that were being irrigated by your operations on a per day per acre basis?
A. Yes, that would be driven by whatever acres are requiring irrigation water.
Q. So that would be more in the neighborhood of 5,000 gallons approximately per day per acre to 9,000 -- 10,000 gallons per day per acre, thereabouts. Is that correct?
A. According to that math, yes.
Q. So is it also true then -- let me ask this.

As I understand your testimony, you need to irrigate the lands of HC&S based on the rate of evaporation and transpiration that you experience in those fields?
A. That is correct. We try to keep up with evapotranspiration rate.
Q. So what you would have to apply, as I understand your testimony, is the same rate by which water is evaporating or transpiring -- transpiration is occurring from the fields that are affected by your irrigation?
A. That is correct.
Q. At this point then, Mr. Jakeway, who has taken charge of the actual irrigation operations of HC&S?
A. You want a name?
Q. Yes.
A. Mr. Rodney Chin.
Q. So in essence was your position a new position, or one which was split off from your old position?
A. It was actually a new position.
Q. And Mr. Chin stepped into your position as the person in charge of irrigation operations?
A. That is correct.

Q. What I didn't understand by that statement, I guess, is if it's equal to evaporation and transpiration, are you left with nothing for the actual plant to absorb?
A. The transpiration by definition is what the plant is -- water is going through the plant.
Q. It's going and leaving the plant.
A. Correct.
Q. Isn't there any water left over for the plant, if you're just irrigating to the extent that there's evaporation and transpiration?
A. You're irrigating to provide the soil moisture reservoir for the plant to grow healthy through whatever evaporation and transpiration is going on. So it's a combination of soil evaporation and transpiration through the plant.
Q. So you're basically assuming that whatever the moisture content of the soil is at the time, is sufficient for the plant to absorb whatever needs it has for water?
A. It has to be maintained at a certain soil percentage level, soil moisture level, in order to maintain good growth crop in the growth of the plant.
Q. And, Mr. Jakeway, do you have any -- are you provided with any information as to what authority,

legal or otherwise, HC&S has with respect to being able to take water from the East Maui Irrigation Ditch system without regard for the water needs of taro farmers in East Maui?
MR. SCHULMEISTER: Beyond the scope of direct. Calls for legal conclusion.
HEARINGS OFFICER JUDGE McCONNELL: I'll sustain that.
MR. MURAKAMI: That's all I have.
HEARINGS OFFICER JUDGE McCONNELL: I just wanted to get a general idea. Irrigation of sugar, obviously there's a great variation in seasons. But let's take the dry seasons.
Is a particular field being irrigated 24-hours-a-day? In other words, the water is turned on.
THE WITNESS: Normally the way the irrigation is planned is by irrigation rounds. So a field will get a round that lasts on average 48 hours. And that may be good for one week. And then during that time the soil moisture will be depleted, you have to come back and irrigate that field again. And that varies depending on the time of year.
HEARINGS OFFICER JUDGE McCONNELL: Right so in the winter you would have to do that less often.

THE WITNESS: During the cooler winter months when the evapotranspiration rate is lower.
HEARINGS OFFICER JUDGE McCONNELL: Okay Any other questions?
MR. MURAKAMI: Can I follow up with that line of questioning?
FURTHER CROSS-EXAMINATION
BY MR. MURAKAMI:
Q. As I understood your earlier testimony you said that at all times 27,000 acres were being irrigated, correct?
A. No, I did not say that. Not all 27,000 acres were being irrigated.
Q. For the lands for which you're irrigating, excluding the lands under cultivation and/or some other form of operation where there is no planting, how many acres are being irrigated?
A. I stand corrected, yes, 27,000 of the 30,000, if the ten percent figure is used for the fallow.
Q. You said that 27,000 acres are being irrigated, correct?
A. Well, they're not all being irrigated.
Q. That's different than the answer you gave me earlier. My question to you was at any given time, how many acres were being irrigated outside of the

1 cultivation and other operations where there are no
2 plants in the ground.?
3 MR. SCHULMEISTER: When you say being
4 irrigated, you mean water is being applied?
5 MR. MURAKAMI: What else would it mean?
6 MS. LOVELL: I thought irrigation
7 schedules --
8 MR. MURAKAMI: I didn't say irrigation
9 schedule.
10 HEARINGS OFFICER JUDGE McCONNELL: Well,
11 but it's obvious, Mr. Murakami. I mean, you know, you
12 don't have the water on all the time.
13 MR. MURAKAMI: That's not true for taro,
14 why should it not be true for sugarcane?
15 HEARINGS OFFICER JUDGE McCONNELL: It is
16 true for taro.
17 MR. MURAKAMI: I'm sorry?
18 HEARINGS OFFICER JUDGE McCONNELL: It is
19 true for taro, but anyway taro would have no
20 application. The question is how do you define
21 irrigation. What I understand the witness to be
22 saying is that irrigation means that they are
23 providing water as-needed when measured by the soil
24 moisture.
25 MR. MURAKAMI: Can I ask him a different

1 way?
2 HEARINGS OFFICER JUDGE McCONNELL: Okay.
3 Q. MR. MURAKAMI: During the winter months, what
4 percentage of time on the 20,000 acres being irrigated
5 is water being applied?
6 MR. SCHULMEISTER: You mean to a
7 particular acre?
8 MR. MURAKAMI: All 20,000 acres.
9 MR. SCHULMEISTER: That assumes they're
10 all being irrigated at the same time.
11 MR. MURAKAMI: I'm asking. Half of the
12 acreage? Three-quarters of the acreage?
13 A. Can I use my calculator?
14 Q. Yes.
15 A. You make the assumption of two days per week
16 and each irrigation round last two days, it would be
17 about 28 percent.
18 Q. What?
19 A. Of that 20,000 acres that would be receiving
20 irrigation water, that would be irrigated during that
21 time.
22 Q. Basically -- wait, 2800, you said?
23 A. 28 percent of that 27,000.
24 Q. And 28 percent of 27,000 acres is how many
25 acres?

1 A. That's about 7,560 acres.
2 Q. 7,560 acres?
3 A. Yes.
4 Q. If you took 134 million gallons per day
5 divided by that figure, what would you get?
6 A. That 134 million gallons a day represents an
7 average.
8 Q. Fine. That's during the wet periods. I'm
9 asking you during the wet period what is it for 7,560
10 acres being irrigated at any given moment?
11 MR. SCHULMEISTER: Let me object. You
12 take a day, now you're transposing it to a moment? I
13 think it's lack of foundation. That doesn't make any
14 sense.
15 MR. MURAKAMI: I think it makes perfect
16 sense and I think it is admissible.
17 HEARINGS OFFICER JUDGE McCONNELL: I won
18 comment on whether it makes sense or not, but I'll
19 allow it.
20 MR. MURAKAMI: Thank you.
21 A. I come up with approximate number of about
22 18,000 gallons.
23 Q. Per day per acre?
24 A. Per acre per day.
25 Q. So is my understanding correct that on the

1 average during the wet winter months, you're applying
2 at any given moment when there is a cycle of
3 irrigation on 28 percent of the lands, over 18,000
4 gallons per day per acre?
5 A. According to that math, yes, for two days out
6 of seven days a week, so you have to average that over
7 the entire seven days.
8 Q. I understand that. But if you go past the
9 two days, you're applying irrigation water to another
10 set of lands of about 7,560 acres on the average?
11 A. On an average, yes.
12 Q. And you rotate that after that two days?
13 A. Yeah.
14 Q. So every two-day cycle you're applying
15 approximately the same amount of water on average to
16 7,560 acres.
17 MR. SCHULMEISTER: To a different acre --
18 MR. MURAKAMI: I'm sorry, is it argument
19 or is there an objection?
20 MR. SCHULMEISTER: The objection is lacks
21 foundation, assumes facts not in evidence.
22 MR. MURAKAMI: I'm using all of his facts.
23 I'm using all of his evidence.
24 HEARINGS OFFICER JUDGE McCONNELL:
25 Clarify, rephrase.

1 Q. MR. MURAKAMI: So your testimony is there is
2 a rotation schedule for irrigation, correct?
3 A. That's correct.
4 Q. And that takes about two days at a time,
5 correct?
6 A. On average, yeah.
7 Q. I'm talking about the winter months now.
8 HEARINGS OFFICER JUDGE McCONNELL: What?
9 MR. MURAKAMI: The winter months, off
10 peak.
11 Q. And you're saying that in any given average
12 cycle approximately 7,560 acres are being actually
13 irrigated with water during that two-day cycle,
14 correct?
15 A. If there was rainfall, then there wouldn't be
16 any irrigation rounds, but this is on average.
17 Q. But you've already assumed some differences
18 in rainfall based on the peak and off-peak months,
19 correct? We're talking about the wet winter months,
20 correct?
21 A. Yeah, that's correct.
22 Q. So if you're applying water on the ground to
23 7,560 acres at a time approximately on the average,
24 and you're applying 134 million gallons a day on the
25 average to that acreage, then you are applying

1 18,000 -- over 18,000 gallons per day per acre,
2 correct?
3 A. For that two day irrigation rounds, that is
4 correct.
5 Q. Then the next two days you'll be doing the
6 same thing?
7 A. For another area, yes.
8 Q. The next two days after that, the same thing?
9 A. For another area.
10 Q. Yeah, for another area. And this goes on
11 throughout the whole off-peak period, correct?
12 A. It's being driven also by the soil moisture
13 program. So if it requires irrigation --
14 Q. You might put more or you might back off
15 depending on need?
16 A. Correct.
17 Q. But we're talking on the average now,
18 correct?
19 A. Yes.
20 Q. So throughout the wet winter periods, you're
21 applying over 18,000 gallons per day per acre?
22 A. No. I wouldn't characterize that. We don't
23 do that continuously throughout the winter period.
24 Q. I'm not asking you to do it continuously. I
25 said on the average you're applying 18,000 gallons per

day per acre during the wet winter months?
A. That would be correct from the math that we worked through.
Q. And if you moved on to the dry months, you would be applying over 36, maybe 37 gallons per day per acre during the dry months, peak months, correct? It's double, basically double on the average. Not on every given day necessarily, but on the average throughout that dry period of irrigation, correct?
MR. SCHULMEISTER: You mean on the average day of the water being applied?
MR. MURAKAMI: An average peak period day throughout the peak season, you would be applying 37,000-plus gallons per day per acre.
MS. LOVELL: I object. That's an incomplete hypothetical.
MR. MURAKAMI: I can't respond to that not knowing what the incompletion is.
MS. LOVELL: Reservoirs and tanks come to mind.
MR. MURAKAMI: Your Honor, that has nothing to do with it. I'm applying his figures to what he says he applies to the ground. It has nothing to do with tanks and reservoirs. It probably incorporates the notion of tanks and reservoirs. It's

not my math.
HEARINGS OFFICER JUDGE McCONNELL: Sounds like it to me. Anyway --
MR. MURAKAMI: I'd like to know. I'm asking you. If my math is wrong, this is an important point. I want you to correct it.
A. If that's what the water requirements are required based on evapotranspiration requirements and if that's what the math works out to be, that's correct. It's just a different way of presenting it.
Q. Another way of looking at the same problem, right?
A. Yeah.
MR. MURAKAMI: Thank you. That's all I have.
HEARINGS OFFICER JUDGE McCONNELL: Any questions?
MS. LOVELL: I have a couple of questions.
CROSS-EXAMINATION
BY MS. LOVELL:
Q. I'm Jane Lovell, one of the county's lawyers.
When you calculate water needs for the 30,000 acres that are available for cultivation, do you also take into account water storage needs?
MR. MURAKAMI: Object, that's vague.

HEARINGS OFFICER JUDGE McCONNELL: I'll permit it.
THE WITNESS: No, we do not. That's based on what the crop needs, so there is no consideration given to keeping a reservoir full.
Q. MS. LOVELL: That's what I was trying to get at.
So the 18,000 gallon figure that we just heard, that all would be applied to fields and none of that figure would go into tanks or reservoirs?
A. Some of that -- well, if we're dealing with averages here that come from EMI, some of that could go to reservoirs.
Q. Could you just explain generally how storage of water in tanks and reservoirs fits into your irrigation scheme?
A. We have several reservoirs that are located throughout our ditch system, so during periods of high flow when irrigation -- when we have peak irrigation or flows in the ditches, we will store water in our reservoir system and then that water will be used later on for irrigation rounds.
Q. So is it fair to say that during the wet winter months, reservoirs will be filled and then that water will be drawn upon during the dry months?

A. It will be drawn upon during the dry periods during the winter seasons, because it's going to be wet and dry periods.
MS. LOVELL: Thank you.
HEARINGS OFFICER JUDGE McCONNELL: Anything else?
MR. MURAKAMI: Yes.
HEARINGS OFFICER JUDGE McCONNELL: Are you going to keep going with this?
MR. MURAKAMI: He's giving inconsistent answers. He just said this figure includes water put in reservoirs, and I asked him earlier if it's water put on the ground. Which one is it?
HEARINGS OFFICER JUDGE McCONNELL: I'll let you ask the question.
FURTHER CROSS-EXAMINATION
BY MR. MURAKAMI:
Q. Let me ask the question. Is Paragraph 9 a figure that you produced for the application of water on the ground as opposed to water on the ground and storage and reservoirs?
A. This was a figure that was produced based on the evapotranspiration requirements of a plant, of the sugarcane plant.
Q. So doesn't that necessarily mean that the

water amounts that you stated here is reflective of what you're applying to the ground on the 7500 acres at a time?
A. That would be correct.
Q. It doesn't include any amounts that you would siphon off for storage in a reservoir?
A. If we had excess flows during that time that would not be included during that time. That would be stored and then used to supplement or to average out this figure that is presented here in Paragraph 9.
Q. I'm not sure this is clear. Either amount, the 134 million gallons per day or the 268 million gallons per day, does any of that water -- is any of that water being diverted for storage in the same fashion that you just described in your earlier testimony?
A. The numbers that are talked about in Paragraph 9 refer to the evapotranspiration of the water requirements of the crop typically during those periods. So there could be water in the reservoirs that are drawn upon to provide this need or this average need during this time.
Q. Maybe I'm not making myself clear. But those two figures, 134 million gallons per day and 268 million gallons per day, is that water being applied

to the plant or ground, whichever you want to choose, as opposed to any amounts being diverted for storage in reservoirs?
A. On average that would be applied to the plant.
Q. Thank you.
HEARINGS OFFICER JUDGE McCONNELL: That's all, thank you very much. Any other witnesses, Mr. Schulmeister?
MR. SCHULMEISTER: No.
HEARINGS OFFICER JUDGE McCONNELL: Any rebuttal?
MR. MURAKAMI: Yes, we do.
HEARINGS OFFICER JUDGE McCONNELL: What do you have.
MR. MURAKAMI: I have at least two -- we have three.
HEARINGS OFFICER JUDGE McCONNELL: We'll take a couple minutes.
(Recess was taken.)
HEARINGS OFFICER JUDGE McCONNELL: We're back on the record.
STEVEN GREG KAI HO'OKANO
was called as a rebuttal witness by and on behalf of Na Moku, et al, was sworn to tell the truth, was

1 examined and testified as follows:
2 HEARINGS OFFICER JUDGE McCONNELL: Could
3 you state your name.
4 THE WITNESS: Steven Greg Kai Ho'okano.
5 HEARINGS OFFICER JUDGE McCONNELL: Could
6 you spell your last name, please.
7 THE WITNESS: H-o-o-k-a-n-o.
8 DIRECT REBUTTAL EXAMINATION
9 BY MR. MURAKAMI:
10 Q. Can you tell the hearing officer where you
11 live?
12 A. Two four five Wailuanui.
13 Q. What is your history with -- you say
14 Wailuanui, you mean Wailuanui Valley in East Maui?
15 A. Yeah.
16 Q. What is your connection to Wailuanui Valley
17 just briefly?
18 A. My family come from over there. We grow taro
19 and basically that's where we from. That's what we
20 do.
21 Q. And what are you doing today, not today, but
22 now in your life?
23 A. Right now I farming up in Wailua, some of my
24 uncle's patches. He let me take care and open up
25 patches that he used to have open at the time when he

1 was young. So I'm there to take over his patches.
2 Q. So during your young life you witnessed your
3 parents and uncles and aunts farming?
4 A. Yeah.
5 Q. Taro?
6 A. Taro.
7 Q. In Wailuanui Valley?
8 A. In Wailua.
9 Q. And in general looking at the valley from say
10 Wailuanui Road, Homestead Road, looking up mauka,
11 where generally are these patches of your family?
12 A. Right in the center, right in the valley
13 itself.
14 Q. In the center, how far up?
15 A. As far as you can go, as far as the ditch.
16 HEARINGS OFFICER JUDGE McCONNELL: Why
17 don't we have --
18 MR. MURAKAMI: I'm going to get there.
19 Q. So I'm going to hand you what has been marked
20 and admitted as Exhibit A-55 with the overlay provided
21 by East Maui Irrigation, A-55.1. Do you see this?
22 A. Yeah.
23 Q. And the overlay is lined up to coincide with
24 the Wailuanui Valley Road. Is it Homestead Road?
25 Which one is it?

1 A. Wailua.
2 Q. Wailua Road. And the two general
3 intersections in the valley that lead into the back of
4 the valley. Do you see that?
5 A. Yeah.
6 Q. And if you appply this overlay, you notice
7 that there are some lo'i that are depicted on the
8 acetate sheet, correct?
9 A. Yeah.
10 Q. And if you overlay it on A-55, it shows where
11 those lo'i are located or would be located on A-55,
12 correct?
13 A. Yeah.
14 Q. If you look at this map, can you describe to
15 me exactly where your ohana's lo'i are that you saw
16 cultivated and you're trying to cultivate today?
17 MR. SCHULMEISTER: That's A-45.
18 MR. MURAKAMI: My mistake, I overlaid
19 A-55.1 on A-45.
20 HEARINGS OFFICER JUDGE McCONNELL: Wait,
21 wait. That's --
22 MR. MURAKAMI: That's the foldout from the
23 Cultural Landscape Study. Your Honor, we could try to
24 make it available to you here as he points it out.
25 HEARINGS OFFICER JUDGE McCONNELL: I got

1 it.
2 Q. MR. MURAKAMI: Mr. Ho'okano, looking at A-45
3 and overlay with A-55.1, would you point to the area
4 where your ohana's lo'i are located on these two maps?
5 A. Lot 31, lot 30, that's lease, lot 28.
6 HEARINGS OFFICER JUDGE McCONNELL: Wait,
7 wait, where are you going?
8 MR. MURAKAMI: First of all, when you're
9 referring to these lots, you're pointing to the area
10 on A-45 that is located on the bottom middle portion
11 of the valley depicted by A-45, correct, the bottom
12 middle?
13 A. Yeah, yeah.
14 Q. And the numbers you just recited are those
15 lot numbers on A-45 which are 30, correct?
16 A. Yeah.
17 Q. Underlined with a 30 -- I mean with a line,
18 and 31 has looks like a cross through it, correct?
19 A. Yeah.
20 Q. And the other number is what?
21 A. 28.
22 Q. 28 which is located a couple of lots down
23 from or adjacent to actually lot 30, correct?
24 MR. SCHULMEISTER: All on plat 5, right?
25 MR. MURAKAMI: For the record, a

1 stipulation that it's on plat 5.
2 MR. SCHULMEISTER: That's what you're
3 pointing to on the map?
4 MR. MURAKAMI: Yes, plot 5.
5 HEARINGS OFFICER JUDGE McCONNELL: You
6 said 30 and what else?
7 MR. MURAKAMI: 30, 31. 31's kind of
8 crossed out, dropped into 30. And then 28 is located
9 little further makai but adjacent to and abutting lot
10 30.
11 Q. And so do you see here that the overlay does
12 not depict any lo'i on the most mauka portion of lot
13 30 and lot 31?
14 A. This?
15 Q. Do you see that?
16 A. Yeah, I see them.
17 Q. Does that match up with what you understand
18 to be what lo'i formations there are on the ground?
19 A. Right now currently working over there, I got
20 that place opened up, and there are lo'i in there.
21 And I talked to my Uncle Joe Young, and he told me
22 when he was young, he used to raise taro in those area
23 up there.
24 Q. Are you referring to the area that contain no
25 depictions of lo'i on A-55.1?

1 A. Yeah.
2 Q. And that's between the wall of the valley and
3 the most mauka portion and the depictions that are on
4 A-55.1, that area?
5 A. Yeah.
6 MR. MERCHANT: Are you asking right next
7 to the No. 30?
8 MR. MURAKAMI: He's talking about the most
9 mauka portions of lot 30, 31.
10 MR. MERCHANT: Right next to the number
11 that has the underline?
12 MR. MURAKAMI: Yes, right in the area
13 where the numbers are on A-45, bottom part of the map.
14 Q. And so in that blank area that shows no lo'i
15 on A-55.1, would you describe again the extent of the
16 lo'i you saw there, and know about through your ohana?
17 A. The lo'i still there and it's all intact,
18 it's all there. But the size of the lo'i, it varies,
19 but there's lo'i there.
20 And the ditch is right above the lo'i so
21 you know that the ditch got to feed those lo'is in
22 order to get to the next lo'is. So that's all lo'is.
23 Q. Now, when you say that's lo'is there, what
24 are you relying on to say that that's lo'i?
25 A. The banks and existing pipes there to divert

1 the water.
2 Q. What are the banks made of?
3 A. Rock and mud.
4 Q. And in your lifetime have you seen taro
5 growing in those lo'i you say are there?
6 A. No, not up there.
7 Q. But you just see the banks?
8 A. Yeah.
9 Q. And you say that the 'auwai comes down like
10 right mauka of that parcel?
11 A. Yeah.
12 Q. Which numbered parcel are you speaking of, if
13 you can tell on the map where that 'auwai deposits
14 water onto the land?
15 A. Right above, right on the edge.
16 Q. So it's along the edge of the, what is kind
17 of like the bowl of the valley?
18 A. Yeah.
19 Q. Does it come out directly onto your land?
20 A. Right now no more water over there right now
21 because there is no water coming down there, so I'm
22 not using that ditch right now. So I in the process
23 of opening so hopefully one day when I get water I can
24 put it in my patch.
25 Q. If there was water that can be delivered on

1 that particular 'auwai, you would use it?
2 A. Depends if the thing would effect the other
3 farmers, because if they don't have enough water, then
4 I'm not going to go there and take their water because
5 they won't have enough water.
6 Q. Let's say there was enough water, there was
7 water in the 'auwai, would you use it?
8 A. Yeah, I would use that ditch.
9 Q. Is there any other source of water you could
10 use for a steady flow of water into that area?
11 A. No, that's the only one.
12 HEARINGS OFFICER JUDGE McCONNELL:
13 Where is the ditch? Where again? Just point it.
14 THE WITNESS: Right up here. This is the
15 top of the valley. This is where the water get
16 distributed, so just comes right up through here,
17 right on the ridge.
18 Q. MR. MURAKAMI: Just to be clear though,
19 you're familiar with two 'auwai along that wall of the
20 valley, correct?
21 A. Yeah.
22 Q. You're talking about this 'auwai that you
23 want to use. Can you tell me whether it's the more
24 mauka one or the one makai?
25 A. Makai, the lower 'auwai.

1 Q. Okay. So in general then when you see this
2 map and the overlay, you think that the -- based on
3 what you see on the ground and what you've used for
4 your lo'i, do you believe that this map is accurate in
5 the area around the numbers 30 and 31 and the portions
6 of 28 that do not show lo'i on A-55.1?
7 A. This map is inaccurate.
8 MR. MURAKAMI: Thank you.
9 HEARINGS OFFICER JUDGE McCONNELL: Any
10 cross?
11 CROSS-EXAMINATION
12 BY MR. SCHULMEISTER:
13 Q. You know the ditch you were just referring
14 to?
15 A. Yeah.
16 Q. Where does it come from?
17 A. Comes from Lakini.
18 Q. And up at Lakini there's, on the mauka side
19 of the road, there is one spot where water spills out
20 from the patch as it goes through a grate and under
21 the highway. Is it there -- are you familiar with
22 that?
23 A. Not too much.
24 Q. Are you familiar with a concrete diversion
25 box that is on the makai side of Hana Highway that

1 also has water that comes into from Lakini taro patch?
2 A. No, not too familiar with that. Just moved
3 in one year ago. Right now in the process of opening
4 my patch. So I don't know what is going on at the
5 box, all I know no more water coming down.
6 HEARINGS OFFICER JUDGE McCONNELL: But
7 when you said there were two 'auwais, I'm having a
8 difficulty --
9 THE WITNESS: I made it to the first
10 'auwai and I talked to my neighbor and he tells me
11 there is another 'auwai right above it. So he inform
12 me of that, but I don't know about the box itself,
13 like how everything comes out of the box. All I know
14 there is two ditches above me.
15 Q. MR. SCHULMEISTER: But the ditche you want to
16 use, that was completely dry?
17 A. Dry.
18 Q. When was the first time you saw it dry?
19 A. Since I came back last year, and I never have
20 water.
21 Q. From last year until now?
22 A. When I was young I saw water always coming
23 down from there, that's all I can say. When I come
24 back, no more water.
25 Q. When you were young, would that be the '80s?

1 A. '80s, late '70s.
2 Q. I have no further questions.
3 HEARINGS OFFICER JUDGE McCONNELL: Thank
4 you.
5 MR. MURAKAMI: Call Mr. Wendt back.
6 HEARINGS OFFICER JUDGE McCONNELL: For th
7 record, Mr. Wendt is back on the stand. I remind him
8 he's still under oath. Go ahead.
9 EDWARD WENDT
10 Having been previously sworn, was recalled on behalf
11 of Na Moku, et al., was examined and testified as
12 follows:
13 DIRECT REBUTTAL TESTIMONY
14 BY MR. MURAKAMI:
15 Q. You heard the testimony of Steven Ho'okano?
16 A. Yes, I did.
17 Q. And he described that area in which he's
18 trying to farm on lots 28, 30 and what has been
19 dropped lot 31, correct?
20 A. Yes, I did.
21 Q. And you have A-55.1 before you overlaid on
22 A-45?
23 A. Yes, I do.
24 Q. In that same area along the wall -- the mauka
25 most wall of Wailuanui Valley in the area the Ho'okano

1 ohana are trying to open up their lo'i, have you
2 observed the presence of lo'i in that area?
3 A. Yes, I have.
4 Q. Can you describe what you saw in that area in
5 the vicinity of what is marked as numbers 30 and the
6 dropped 31?
7 A. All in this area, 30 and 31 and also continue
8 all the way up to Lakini was all cultivation of taro,
9 there is lo'is all above in those areas.
10 Q. When you say those areas, would they include
11 areas that are not depicted on acetate sheet A-55.1?
12 A. Yes.
13 Q. And so what is your conclusion about the
14 accuracy of A-55.1 as it may or may not depict the
15 presence of historic areas for taro cultivation in
16 Wailuanui Valley?
17 A. This map is not accurate.
18 Q. Mr. Wendt, did you hear Mr. Hew testify about
19 the function and the use of dam, so-called Dam No. 3
20 on Waiokamilo Stream?
21 A. Yes.
22 Q. When was the first time that you saw that
23 concrete dam on Waiokamilo Stream?
24 A. The existing --
25 Q. Yeah, the existing concrete dam.

A. When one day when East Maui Irrigation put in.
Q. When was that?
A. Three years, four years.
Q. Recent years, in other words?
A. It was recent.
Q. As a younger man and boy growing up in the valley, did you have occasion to go to that same spot on Waiokamilo Stream?
A. Yes.
Q. Was there such a dam, at least to the extent that you saw recently in that stream?
A. No.
Q. And at that time, was water coming down into Wailuanui Valley from the sources mauka to feed the taro patches in the valley?
A. Yes.
Q. And so was there only water at that time -- in the earlier days, was there only water coming from Waiokamilo Stream?
A. No, it came from Kualani.
Q. And you heard the testimony, did you not, about Kualani Stream where it may or may not be on A-1, that big giant colored map?
A. Yes.

Q. When you talk about Kualani and did you mention Kupau in your earlier testimony?
A. Yes.
MR. MURAKAMI: I'm going to have to ask for the official copy of A-1.
HEARINGS OFFICER JUDGE McCONNELL: Before you do that, Mr. Wendt you heard Mr. Ho'okano talk about a dry 'auwai.
THE WITNESS: Yes.
HEARINGS OFFICER JUDGE McCONNELL: Is that the upper one coming out of the box?
THE WITNESS: No, it's the bottom one, the one that we saw all the water going through when we looked at the box, one had water going through and one was the pipe. The one with the water, there was no pipe, that's the 'auwai he's talking about. Where that water leaves that box, serviced the 'auwai that he says is dry.
And the reason is, when you look at this overlay right here, right now what we saw when we were at the box, the water is going in this direction. What needs to happen here is to split the amount of water that is going down that continues into this 'auwai that comes across.
HEARINGS OFFICER JUDGE McCONNELL: Right,

that's the one that comes out of the pipe?
THE WITNESS: No, the bottom. The top pipe has been cut off completely right now with water, but the one that you seen at the box where the water went through, an 'auwai continues to the Ho'okano and to around right in this area, sir.
Q. MR. MURAKAMI: When you say this area, this is the area past the Ho'okano?
A. Past the Ho'okano.
HEARINGS OFFICER JUDGE McCONNELL: How many exits you got from the box?
THE WITNESS: Three. So this is a different 'auwai going down, drops off. Then you got the two, one with the pipe and the one without. This one comes here and this ditch continues all the way down into this area where it enters back into Waikani.
HEARINGS OFFICER JUDGE McCONNELL: And th lower one is the pipe?
THE WITNESS: The lower one is an open ditch, sir. Just the top one. And the thing goes only so far in with pipe.
HEARINGS OFFICER JUDGE McCONNELL: Yeah, I know it only goes so far. But I didn't climb that far back in there.
THE WITNESS: Just right here, sir, where

this drops off, this one would continue. The water here will be split to go into the ditch to service Mr. Ho'okano.
HEARINGS OFFICER JUDGE McCONNELL: The on where the pipe goes for the first several how many feet, that would be split, you're saying?
THE WITNESS: No. This one here.
Q. MR. MURAKAMI: Mr. Wendt, at the concrete box, in how many directions does the water alternate?
A. Three.
Q. If you're facing the concrete box looking down the 'auwai toward the valley, where does the left most version go? Can you point that out on the map as it drops out of the box?
A. This is the box, I assume. Right here is split. The box is divided right there. The one with the pipe, comes all the way down --
Q. Wait a minute. Looking down on the valley from where the box is makai or across the valley, there's a left diversion, right?
A. It goes over the spill.
Q. Show on the map where that left diversion goes on the map?
A. Right over here. Right where this arrow.
Q. And continues down where?

A. It continues down. There's an 'auwai to service down in here, collect, you see this here?
Q. The top most 'auwai and the box, that's the one you said was blocked off, correct, with some gravel and whatever else?
A. Yes.
Q. That 'auwai has a 12-inch pipe that feeds it along initially for a first several feet.
HEARINGS OFFICER JUDGE McCONNELL: Why don't you let him testify.
THE WITNESS: 100 feet maybe.
Q. MR. MURAKAMI: So then that's the top most 'auwai, correct?
A. Right.
Q. And that 'auwai goes where?
A. That water service all the way down into this area.
Q. Which is the eastern-most side of the mauka side of the valley?
A. Towards Waikani.
Q. Does that combine with the Wailuanui Stream water?
A. Yes, at that point.
Q. That's the top one?
A. Yeah.

Q. Now, in the middle there's a third one in the middle?
A. The middle.
Q. How does that flow in relation to that uppermost?
A. Parallel.
Q. But then does it go as far as the top?
A. No.
Q. Where does it end up?
A. Right past Ho'okano. Right in this area, right where this arrow.
Q. You're looking at the parcel labeled in parcel -- this is plat number 5, 20, correct?
A. 20.
Q. Around that area?
A. Yeah.
HEARINGS OFFICER JUDGE McCONNELL: But there was water in there when we were there.
THE WITNESS: It went this direction, nothing came down to Mr. Ho'okano's section.
MR. MURAKAMI: Let me try it this way.
Q. I'm going to hand you A-26. Is this the concrete box?
A. Yes.
Q. That grate in the right, is that the entrance

193

to the top most 'auwai?
A. Yes.
Q. And the middle 'auwai, is that the water that is flowing down through that square-ish hole in the far most wall of the concrete box?
A. Yes, it is.
Q. You're saying that doesn't reach all the way down to Steve Ho'okano's parcel, right?
A. This here supposed to reach Mr. Ho'okano's property.
Q. Why doesn't it reach it?
A. Because if you walk down this ditch --
Q. Talking about the middle 'auwai?
A. This particular 'auwai with the water in, it will fall off, which is right around in this area.
Q. You're pointing to an area that is marked on plat 4 with parcel number 18, correct?
A. Around in that area.
Q. So it doesn't flow as far as it's supposed to flow, correct?
A. Yeah, it's supposed to continue all the way to Mr. Ho'okano.
Q. When I say parcel 18 and where it falls off, we're talking about parcel 18 on plat 4 that's on A-45, correct?

194

A. Yeah.
Q. And so is there a reason why the water in the middle or lower 'auwai falls off onto parcel 18 on A-45 instead of continuing down to where Mr. Ho'okano's parcel?
A. Right now there's lack of water. If this water continues to follow all the way down to where it enters, each parcel owners have a takeoff of this, so there's quite a bit of takeoffs. So and there wasn't enough water coming down, so we shut the top and Mr. Ho'okano and his family was generous enough not to use the water.
Q. So it's a system of allocation based on scarce water source?
A. Scarce water source.
Q. So if there was enough water in the concrete ditch, then would that water reach Mr. Ho'okano's parcel?
A. Yes, sir.
Q. If there was enough water in the concrete box flowing through Lakini, would there be water flowing through the uppermost 'auwai now blocked off by the gravel in the picture depicting the concrete box in A-26?
A. Yes, sir.

195

Q. And those would service water flow to those -- in those directions simultaneously at the same time if there was enough water?
A. Yes, sir.
Q. But the only reason that you have the current situation is because of the current volume of water which cannot accomplish all three 'auwais delivering water to their points of irrigation?
A. Yes, sir.
HEARINGS OFFICER JUDGE McCONNELL: Thank you.
Q. MR. MURAKAMI: And then, Mr. Wendt, when you say you didn't see that concrete Dam 3 in Waiokamilo Stream as a younger person, can you explain why that dam is now necessary to bring water from Waiokamilo Stream into the 'auwai that services your Lakini patches?
A. Many years ago the elders, when Kualani was cut off, when there was no farming in the ili of Kupau, the elders made that 'auwai from Waiokamilo back up Lakini.
So it was only made as an 'auwai, not a river. And right now with the diversion there, the volume of water is coming into the Lakini area, there's more water when you have the big water, the

196

floods.
Q. And so if there wasn't as much water flowing through that former smaller 'auwai from Waiokamilo to Lakini, where was the water coming from for the rest of the valley?
A. Kualani was one of the main sources, and Waiokamilo used to have much more water flow than what it is today.
Q. So is the Kualani, so-called Kualani source, is that the area that drains off of the area known as Kupau?
A. Yes.
Q. Could you point out on the map on A-1 before you, move the A-45 before you aside, do you see the Wailuanui Valley on that map?
A. Yes, I do.
Q. Do you see the designation for what is known as Kualani stream?
A. Yes.
Q. And you see Wailua Homestead?
A. Yes.
Q. And basically the highway?
A. Yes.
Q. And Waiokamilo Stream is here, correct?
A. Yes.

197

Q. Would you point out to the hearing officer where this area of Kupau is relative to Waiokamilo?
A. All in this area. All in this area is Kupau.
Q. That is an area that you're pointing to that is on A-1, and the area between Waiokamilo Stream and Wailuanui Stream?
A. Yes.
Q. And also mauka of the highway?
A. Yes.
Q. And below the ditch system?
A. Yes.
Q. So in that area, did you say that that was the primary source of water in the old days for Wailuanui Valley?
MR. SCHULMEISTER: Can we be clear about the old days.
MR. MURAKAMI: When he was a young man.
MR. SCHULMEISTER: Approximate decade or something.
Q. MR. MURAKAMI: Maybe you could describe that?
A. At one time the ili of Kupau was taro patches, the water came off Kualani. The water of Waiokamilo up in this area is an 'auwai that they took from Waiokamilo, that was the original 'auwai, not from Lakini, it was taken from here, serviced the

198

lo'is down Kualani.
Q. When you say, "taken from here," you're not referring to the 'auwai just below Dam 3, correct?
A. No.
Q. You're referring to an area mauka of Dam 3, right?
A. Mauka, yes.
Q. Is it mauka of Akeke Springs?
A. It's more east of Akeke.
Q. More east?
A. Yeah. Akeke would be right in this area, and this 'auwai from Waiokamilo would be in around this area.
Q. So little bit downstream?
A. Downstream.
Q. And there was an 'auwai that fed the Kupau area?
A. Yes.
Q. And that water continued through and ultimately ended up where?
A. Ended into Kualani.
Q. Where did Kualani feed the water to?
A. It went through Lakini, and then down to the box.
Q. Are you telling me there were two sources of

1 water, Kupau and Waiokamilo?
2 A. Yes. At this time when you have rains, water
3 will naturally flow into Kualani. Water will come --
4 this is high mountain, and the water goes down there.
5 There's waterfalls. Where the waterfalls were at when
6 we looked in the back, it's all up in this area.
7 Q. And you used to see those sources of water
8 flowing into Kupau as a boy?
9 A. Yes.
10 Q. But you don't see them flowing today?
11 A. No.
12 Q. And if there were sources of water flowing
13 through Kupau as they were in the valley when you were
14 younger as a boy, would there be a need for the amount
15 of water being taken from Waiokamilo Stream, if there
16 was -- the Kupau sources were as they were before?
17 MR. SCHULMEISTER: Let me just object.
18 Lack of foundation. My understanding, he said all of
19 it came from Waiokamilo, even the Kupau one.
20 MR. MURAKAMI: That's not what he said.
21 A. Those are two sources, Waiokamilo and
22 Kualani. Waiokamilo also serviced the lower portion
23 of the highway too. So if Kualani is open -- for me
24 to say that Waiokamilo is enough, I cannot do that.
25 Q. I'm sorry, you're saying Kualani-Kupau area

1 is what?
2 A. If Waiokamilo is not opened, returned, then
3 there will not be enough water to go down, because you
4 also, the 'auwai does take from Waiokamilo.
5 Q. But is the only source of water coming from
6 Kupau the Waiokamilo Stream source, in the old days?
7 A. No, it was both.
8 Q. What was the other source?
9 A. Kualani.
10 Q. And what else? Was there only one stream
11 that fed Kupau?
12 A. And whatever tributaries that came out.
13 Q. You're talking about the smaller waterfalls
14 and other drips into the valley?
15 A. Yes.
16 Q. And that collectively formed what you say is
17 the water source of Kupau?
18 A. The water source of Kupau.
19 Q. So if that source of water, the Kupau water
20 sources as they were traditionally and historically
21 fed into Kupau, drained into the 'auwai, closer to
22 Lakini, would you have to have the dam that is now
23 called Dam 3 in Waiokamilo Stream?
24 A. No.
25 Q. So, Mr. Wendt, you were a contractor at one

1 time; is that right?
2 A. Yes, I was, sir.
3 Q. How many years?
4 A. In the early '70s.
5 Q. How many years did you work as a contractor?
6 A. I worked quite some years as a builder.
7 Q. More than ten years?
8 A. Yes.
9 Q. And did that experience expose you to having
10 to price materials for construction work?
11 A. Yes.
12 Q. Did they include PVC pipe?
13 A. Yes.
14 Q. Are you familiar with the relative values or
15 differences in value between say a two-inch pipe or
16 eight-inch pipe?
17 A. Yes. Quite some difference in price.
18 Q. What would that difference be?
19 A. I would say maybe ten 15 times.
20 Q. And are you familiar with when PVC piping
21 became available for contracting or construction work?
22 A. I really don't know what year it was put on
23 the market, but in the '70s there wasn't very much PVC
24 pipe used. It was more cast iron, steel and
25 galvanized. So that was in the '70s.

1 Q. So the predominant use of PVC did not occur
2 prior to the '70s?
3 A. That I cannot -- I have worked with PVC pipe,
4 you know, but it wasn't -- you know, it was just for
5 farm purposes in the '70s, and on the smaller size,
6 three-quarters to an inch, but nothing in eight inches
7 or ten inches of pipe.
8 Q. Were you ever familiar with whether there was
9 use of PVC in the '60s?
10 A. I could not really answer that question.
11 Q. Mr. Wendt, did you read the testimony of
12 Garret Hew?
13 A. I don't believe I did, sir.
14 Q. In Mr. Hew's rebuttal testimony -- on Page 13
15 and 14 of Mr. Hew's rebuttal testimony to our -- well,
16 to your testimony, Mr. Hew states: If the upper ditch
17 is repaired and for some reason that EMI cannot
18 presently anticipate there is inadequate water
19 available for taro cultivation, EMI is willing to
20 reduce its diversions above the Waiokamilo stream.
21 That's a statement. Number one, is the
22 ditch, upper ditch repaired?
23 A. We had a project maybe three, four years ago.
24 That's the project that we restored the 'auwai.
25 Q. Can that upper ditch take water from the

1 concrete box and deliver it to the point of irrigation
2 in the neighborhood of the junction with the Waikani
3 Falls water coming into Wailuanui Valley?
4 A. Yes.
5 Q. And that can happen today?
6 A. Yes, sir.
7 Q. And do you have the resources as the
8 President of Na Moku to assure that that ditch remains
9 open and available for that kind of transmission of
10 water?
11 A. We did it before, and no water was returned.
12 Q. And is there, in fact, after you restored
13 that 'auwai, was there now an ability of the members
14 of Na Moku to bring water from above Lakini to the
15 taro patches throughout Wailuanui Valley to satisfy
16 the needs of taro farmers?
17 A. There was great efforts.
18 Q. But was there enough water after you did that
19 improvement to service all the lo'i that need to be
20 opened up and irrigated?
21 A. No, no.
22 Q. And did you bring this issue to the Board of
23 Na Moku about what the board was willing to say
24 concerning its ability to assure that the upper ditch
25 is maintained?

1 A. This has been discussed.
2 Q. And did you adopt a resolution to reflect
3 that particular information and what the members of Na
4 Moku were willing to do --
5 A. Yes.
6 Q. -- in order to keep that upper ditch
7 serviceable?
8 A. Yes.
9 Q. I'm going to hand you a copy, and I think
10 this has been previously filed, of a resolution which
11 I would like for the hearing officer to mark as B-127.
12 HEARINGS OFFICER JUDGE McCONNELL: B-128.
13 Wait a minute.
14 Q. MR. MURAKAMI: Is that the resolution that
15 was adopted by the Board of Na Moku in order to
16 address this concern?
17 A. Yes, sir.
18 MR. MURAKAMI: Your Honor, may we have
19 this marked?
20 HEARINGS OFFICER JUDGE McCONNELL: We're
21 looking for it. Do you have a separate copy of it,
22 because it's attached to --
23 MR. MURAKAMI: I have a separate copy.
24 HEARINGS OFFICER JUDGE McCONNELL: What i
25 the next in order?

1 MR. SCHULMEISTER: The lease was B-126.
2 MS. CHOW: Yes, 126, so it would be 127.
3 HEARINGS OFFICER JUDGE McCONNELL: B-127.
4 MR. MURAKAMI: And I move to admit it.
5 HEARINGS OFFICER JUDGE McCONNELL: Any
6 objection?
7 MR. SCHULMEISTER: No objection.
8 HEARINGS OFFICER JUDGE McCONNELL: It will
9 be admitted.
10 (Na Moku Exhibit No. 127 was received into
11 evidence.)
12 Q. MR. MURAKAMI: Mr. Wendt, did you hear the
13 testimony of witnesses for EMI that claim that the
14 lo'i of Mr. Norman Martin was being fed by water from
15 Wailuanui Stream only?
16 A. Yes.
17 Q. Is that true?
18 A. Like I said, no, the top ditch service that
19 too.
20 Q. So it's a combination of the water from both
21 sources, correct?
22 A. Yes.
23 Q. Did you hear the testimony of Mr. Hew that
24 there are approximately 400 diversions along the ditch
25 system affected by the four water licenses?

1 A. Yes, I did, sir.
2 Q. Did you have an occasion to look at A-1 to
3 count the number of diversions represented by the red
4 squares depicted on that map?
5 A. Just during the lunch break counted about 75,
6 about 100.
7 Q. So are you aware of other major diversions in
8 Wailuanui that are not depicted on A-1?
9 It shows approximately two -- shows approximately, in
10 the valley, mauka valley portions, three diversions.
11 These appear to be beyond Wailuanui.
12 A. That's Wailua River.
13 Q. So actually if you look at Wailuanui River
14 and exclude those, there's only two diversion points
15 represented on A-1?
16 A. Yes.
17 Q. Is that true?
18 A. Well, with all the other pipes and whatever
19 else was marked, not was -- was visual when we did
20 that recon, to me there's more diversions there than
21 on the map.
22 Q. Do you consider the diversion of water from a
23 tributary in the mauka portion of Wailuanui Valley by
24 an eight-inch pipe to be a minor diversion?
25 A. Major.

1 Q. That's all I have.
2 HEARINGS OFFICER JUDGE McCONNELL: Any
3 questions?
4 MR. SCHULMEISTER: No questions.
5 HEARINGS OFFICER JUDGE McCONNELL: Ms.
6 Kekahuna, you've already testified. You're still
7 under oath.
8 BEATRICE KEKAHUNA
9 having been previously sworn, was recalled on behalf
10 of Na Moku, et al, was examined and testified as
11 follows:
12 DIRECT REBUTTAL EXAMINATION
13 BY MR. MURAKAMI:
14 Q. Did you hear the testimony of Garret Hew that
15 you have sufficient water to grow all the taro on the
16 taro lo'i that you have on your property along Honopou
17 Stream?
18 A. Yeah, I did.
19 Q. In the past have you experienced cooperation
20 from EMI to meet your water needs to grow taro on your
21 kuleana and taro lands along the Honopou Stream?
22 A. When they used to come down and started to
23 raise taro, they said that was enough water. Well, at
24 the time it wasn't, it was not enough. But then we
25 had only two, three taro patches up at the house. Now

1 it's something else, there's a lot more below.
2 So right now there's a lot of water with
3 the rain, surely there is enough water, a lot. But
4 what happens when the rain stops?
5 Q. What happens?
6 A. The water is going to go down. Not going to
7 be enough water.
8 Q. Has that happened?
9 A. Well, right now we have the bottom one. Like
10 I said, if we start opening the water and letting the
11 water go into those patches, we won't have enough
12 water. And as the water go down, if, let's say,
13 there's a lot of water now, and we let the water go
14 down, but those taro patches are going to eat the
15 water. It's going to run from patch to patch.
16 Q. Auntie Beatrice, do you have the help that
17 you need to plant all those taro patches that you
18 opened up and showed the hearing officer during the
19 site visit a month ago?
20 A. Yes, I do.
21 Q. Are they continuing to help you today?
22 A. Yes, they are.
23 Q. And if there was enough water, would you in
24 fact plant all those lo'is so that you could grow taro
25 like you did in the old days?

1 A. Yes, we are.
2 Q. Has EMI, not just Mr. Hew, but his
3 predecessors promised you that they would get you the
4 water that you need?
5 A. That I can't say.
6 Q. You can't remember that?
7 A. No.
8 MR. MURAKAMI: Your Honor, I'm going to
9 ask the indulgence of the hearing officer and the
10 parties, we again, because of our discovery of the
11 past 1902 lease of the Keanae area, I was able to
12 obtain just today a copy of the -- well, it is now
13 known as the Huelo License area, but it was called
14 Haiku License at one time by the Kingdom of Hawaii.
15 And what I have are copies of that first
16 lease in the 1800s by the kingdom which conditions the
17 construction of this ditch system on the same
18 protection that would be afforded downstream
19 appurtenant right holders like Mrs. Kekahuna.
20 And I would like to offer that as Na
21 Moku's next in line, B-128.
22 HEARINGS OFFICER JUDGE McCONNELL: It will
23 be marked. Have you seen it, Mr. Schulmeister?
24 MR. SCHULMEISTER: No.
25 MR. MURAKAMI: And it's a little hard to

1 read, but basically this particular lease conditions
2 the permission to use the water and the lands
3 collecting that water as well as to construct what was
4 the beginnings then of the entire EMI ditch system on
5 protection of downstream water users like Mrs.
6 Kekahuna. And I'm going to offer that as testimony
7 relevant to your consideration of issues in this
8 hearing.
9 HEARINGS OFFICER JUDGE McCONNELL: Before
10 we get to that, any other questions for Mrs. Kekahuna?
11 Q. MR. MURAKAMI: Last question, Mrs. Kekahuna.
12 Is there currently enough water in your 'auwai, based
13 on whatever is being released through the three pipes
14 in the Haiku Ditch, for you to support the growing of
15 the taro that you are now opening up with the help of
16 your ohana for your lo'i?
17 A. Can you repeat it?
18 Q. Sure. Is there enough water to support the
19 taro in the lo'i you are opening up with your ohana's
20 help on your property along Honopou Stream with the
21 water coming out of the three pipes that crosses over
22 the Haiku Ditch?
23 A. I can't say, because the water is right now,
24 the water goes up and down, up and down. Right now
25 have lots of water, the stream overflowing. I can't

say right now. But I don't think so. After we get those patches open, I don't think that there will be enough water.

Q. Thank you. That's all the questions I have.

HEARINGS OFFICER JUDGE McCONNELL: Any questions?

MR. SCHULMEISTER: No, thank you.

HEARINGS OFFICER JUDGE McCONNELL: Thank you, you're excused. Any further rebuttal?

MR. MURAKAMI: No, Your Honor, but I would like to move this particular document.

HEARINGS OFFICER JUDGE McCONNELL: B-128

MR. SCHULMEISTER: I don't mind it coming in, I haven't had a chance to look at it.

MR. MURAKAMI: I can represent that it was taken out of the state archives today by my staff. It's a little hard to read, but we have some language here that, if necessary, I'll quote to show its relevance.

HEARINGS OFFICER JUDGE McCONNELL: There being no objection, I'll receive it.

(Na Moku's Exhibit No. B-128 was received into evidence.)

MS. LOVELL: Actually I think it would be really helpful if you can just direct us where on the

document the conditions are.

MR. MURAKAMI: I believe there are two arrows on the fourth page toward the bottom.

MS. LOVELL: Okay, thank you.

MR. MURAKAMI: That reflect where to look. And I can read what we thought it says, because there is one or two words that are not quite decipherable, but I think still convey the meaning of the conditions attached to the kingdom's grant of permission to start construction of this ditch system.

HEARINGS OFFICER JUDGE McCONNELL: If you want to read it, read it for my benefit.

MR. MURAKAMI: Upon giving permission to do so, in other words, to take the water and to construct this system.

HEARINGS OFFICER JUDGE McCONNELL: Where are you reading from?

MR. MURAKAMI: It starts with the word "provided".

What we read it to be is: Provided nevertheless, the continuance of the right herein before granted is upon this condition the said water course shall be constructed by the said parties of the second part within two years from the date hereof, and -- we're not sure what that next word is -- existing

rights of present tenants of said lands or occupiers along said streams and shall in no -- we think -- way -- but we are not sure -- be lessened or affected injuriously by reason of anything herein before granted.

That's what we read it to be.

HEARINGS OFFICER JUDGE McCONNELL: Okay. It's in evidence. Anything further?

MS. LOVELL: Not from the county.

MR. MERCHANT: Nothing.

HEARINGS OFFICER JUDGE McCONNELL: The only other outstanding matter that I can recall will be whether there was any desire to call Mr. Kanoa.

MR. HAIA: And the other matter would have been your allowing us to provide rebuttal evidence to A & B exhibits, I think it was A-53, A-54 and A-56.

HEARINGS OFFICER JUDGE McCONNELL: That's the acreage issue?

MR. HAIA: Right.

HEARINGS OFFICER JUDGE McCONNELL: I take it that you haven't made a decision on either of those questions?

MR. HAIA: No, we haven't, but we will make that decision within the next couple of days easily.

HEARINGS OFFICER JUDGE McCONNELL: Say by close of business Friday.

MR. MURAKAMI: You mean in writing?

HEARINGS OFFICER JUDGE McCONNELL: Yeah, just so we know where we are. So if we hear nothing, just so the record is clear, that the hearing would be closed.

MR. SCHULMEISTER: I would just like to comment on that on the issue of whether we should -- I don't have a problem with continuing it for rebuttal evidence on the acreage, but I do have a problem with having Mr. Kanoa subpoenaed. The only reasons that A & B, EMI put together what it did was because the interrogatories that we gave to Na Moku were not answered.

I mean the whole issue there is what the farmers they, say they represent, are doing, and we asked them in interrogatory before the hearing started what they were doing and what the acreage was. They refused to answer.

Now, if they want to change their mind and call those farmers now, I have no problem with that, but they should do that. They shouldn't subpoena Mr. Kanoa. That would be my objection. They have it within their power.

That's the direct evidence of what they're doing, what the farmers themselves will say. It seems to me, if they want to do that, I see no problem with that. I don't object to that. In fact, that's why we asked the questions in the interrogatories. If they'd just answered the interrogatories, we wouldn't have gone to the steps that we did.

MR. HAIA: If I could, I would like to respond to that.

HEARINGS OFFICER JUDGE McCONNELL: But you used Kanoa to make an estimate.

MR. SCHULMEISTER: To identify who the farmers were is basically -- the estimate of acreage was not done by Mr. Kanoa, that was done by EMI.

HEARINGS OFFICER JUDGE McCONNELL: Right.

MR. SCHULMEISTER: So if they're going to say these aren't the farmers, the farmers themselves can say that.

MR. HAIA: Just to respond to that. You know, I would agree with the Judge that they're the ones that went out and got Mr. Kanoa to come up with this, to help with the number of acres they claim are in production.

If you recall, we had a concern with respect to identifying owners. We --

HEARINGS OFFICER JUDGE McCONNELL: I know, I don't think it was well-founded, but I know you had a concern.

MR. HAIA: Right, and we provided the Judge under seal with the authority that we were vested with from those landowners to make the claims on their behalf. And that's what we did through the testimony of Teri Gomes.

And that's, you know, pretty much all I can tell you with respect to the argument that Mr. Schulmeister is making.

HEARINGS OFFICER JUDGE McCONNELL: What do you really need Kanoa for?

MR. HAIA: I'll let you know on Friday.

HEARINGS OFFICER JUDGE McCONNELL: Okay. I'll reserve ruling on whether we have to convene just to hear Kanoa. If there's a way to do it by telephone or something, that would be appreciated.

The other issue you're going to let us know about is on the acreage, correct? So you'll let us know if you want to do anything on the acreage at the same time.

Okay. For now then the hearing is closed and if there's no request by the Na Moku parties, then it will be closed for good.

1 I think we start -- we need to think about
2 the submittal of written argument and proposed
3 findings and conclusions.
4 MR. SCHULMEISTER: Could we get an
5 estimate of when the transcript will be ready for
6 these last two days?
7 HEARINGS OFFICER JUDGE McCONNELL: Okay,
8 why don't we go off the record.
9 (Discussion held off the record.)
10 HEARINGS OFFICER JUDGE McCONNELL: We're
11 back on the record, and we'll set the following
12 deadlines. Of course, as we said earlier by this
13 Friday, which is the November the 18th, Na Moku
14 parties well let us know if they want to offer any
15 further rebuttal evidence on the two issues we
16 discussed earlier.
17 The transcript will be ready by December
18 15th, the proposed findings and conclusions and
19 written argument are due on January 15th -- 13th and
20 we would appreciate electronic as well as the hard
21 copy. And by the 20th of January, we will issue a
22 minute order regarding oral argument and try giving
23 the parties some guidance as to where the hearing
24 officer's thinking is.
25 And we will permit replies in any event.

1 Anything else for the record? If not, thank you all
2 very much. I appreciate your patience and your
3 hospitality.
4 (The proceedings ended at 4:20 p.m.)
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

1 CERTIFICATE
2 STATE OF HAWAII)
3) SS.
4 COUNTY OF HONOLULU)
5
6 I, JEAN MARIE McMANUS, do hereby certify:
7 That on November 15, 2005, at 9:00 a.m., the
8 proceedings contained herein was taken down by me in
9 machine shorthand and was thereafter reduced to
10 typewriting under my supervision; that the foregoing
11 represents, to the best of my ability, a true and
12 correct copy of the proceedings had in the foregoing
13 matter.
14 I further certify that I am not of counsel for
15 any of the parties hereto, nor in any way interested
16 in the outcome of the cause named in this caption.
17 Dated this 29th day of November, 2005, in
18 Honolulu, Hawaii.
19
20
21 _____
22 JEAN MARIE McMANUS, CSR #157
23
24
25

#

#156
[1] 1:21
#157
[1] 219:21
#3119
[1] 1:21

$

$100
[2] 39:15 39:17
$5
[1] 39:21
$5.5
[1] 40:9

'

'02
[1] 17:13
'60s
[1] 202:9
'70s
[6] 185:1 201:4 201:23 201:25 202:2 202:5
'80s
[2] 184:25 185:1
'86
[2] 111:10 112:25
'91
[1] 25:9
'auwai
[75] 59:8 59:10 69:24 70:2 73:25 74:8 74:13 117:16 117:17 117:19 117:21 123:8 131:10 137:2 137:11 137:14 138:11 139:5 139:9 139:23 140:2 140:16 141:8 141:13 141:15 141:23 142:14 142:19 142:23 145:2 145:3 145:5 145:9 145:18 181:9 181:13 182:1 182:7 182:19 182:22 182:25 184:10 184:11 188:8 188:16 188:17 188:24 189:5 189:13 190:12 191:1 191:3 191:7 191:13 191:15 193:1 193:3 193:13 193:14 194:3 194:22 195:16 195:20 195:22 196:3 197:23 197:24 198:3 198:12 198:16 200:4 200:21 202:24 203:13 210:12
'auwais
[5] 59:6 59:7 69:5 184:7 195:7

0

01-05-MA
[1] 1:3

1

1
[4] 53:13 71:10 78:22 78:22
1/20th
[1] 39:12
10
[1] 56:24
10,000
[3] 152:14 153:1 158:22
10/25/05
[4] 59:15 59:21 60:2 64:25
100
[10] 9:5 10:12 20:15 81:13 82:6 85:11 96:18 112:5 191:11 206:6
100-plus
[1] 20:14
100-year-old
[2] 21:19 22:3
1000
[1] 2:7
1000th
[2] 66:3 66:3
10th
[2] 137:23 138:16
11
[7] 53:18 53:21 53:23 54:4 54:7 56:20 109:9
1164
[1] 2:17
12
[6] 1:8 83:3 83:15 83:17 83:25 139:22
12,000
[2] 18:6 19:2
12-inch
[1] 191:7
1200
[1] 2:7
1205
[1] 2:17
126
[1] 205:2
127
[3] 3:24 205:2 205:10
13
[3] 68:2 68:5 202:14
130
[3] 28:12 29:17 37:25
130-some
[1] 34:14
130-something
[1] 28:11
134
[9] 3:8 151:1 151:18 151:22 165:4 165:6 167:24 173:12 173:24
135
[1] 3:10
136
[1] 3:11
13th
[1] 217:19
14
[1] 202:15
140
[2] 105:13 106:1
143
[1] 3:11
148
[1] 3:13
149
[1] 3:14
15
[6] 41:10 114:7 114:12 137:2 201:19 219:7
15th
[2] 217:18 217:19
16
[2] 88:10 89:20
16,095
[1] 80:25
160
[6] 98:9 98:16 99:4 105:16 106:3 106:5
162
[1] 3:14
165
[2] 98:11 98:16
16th
[1] 143:11
17
[2] 26:17 120:12
170
[1] 3:15
172
[1] 3:15
175
[1] 3:17
18
[5] 140:16 193:17 193:23 193:24 194:3
18,000
[7] 165:22 166:3 168:1 168:1 168:21 168:25 171:8
1800s
[1] 209:16
183
[1] 3:18
185
[1] 3:20
1876
[1] 82:14
18th
[1] 217:13
19
[4] 17:13 39:11 121:3 121:6
1900
[1] 20:4
1902
[1] 209:11
1923
[6] 51:6 51:14 51:22 52:1 52:3 52:5
1924
[1] 12:2
1930
[1] 118:19
1938
[5] 78:15 78:22 79:4 79:14 79:15
1985
[4] 51:19 63:6 80:13 109:20
1986
[1] 111:5
1989
[1] 55:2
1990s
[1] 15:6
1991
[1] 25:8
1993
[3] 25:6 25:13 26:2
1996
[2] 10:16 26:5
1998
[1] 26:18
19th
[1] 17:12

2

2
[3] 8:1 18:12 81:21
2.5
[1] 112:5
2.738
[1] 64:3
20
[10] 38:13 46:7 55:19 55:22 55:22 120:14 120:16 120:23 192:13 192:14
20,000
[3] 164:4 164:8 164:19
200
[6] 2:1 2:12 63:25 105:15 106:2 112:6
2000
[1] 152:9
2001
[2] 100:18 100:23
2002
[1] 151:13
2004
[7] 39:11 118:19 122:21 137:3 137:23 138:16 151:13
2005
[9] 1:8 6:19 70:10 135:14 137:3 143:11 148:6 219:7 219:17
2008
[1] 29:14
204
[1] 2:10
205
[1] 3:24
207
[1] 3:22
2087
[1] 2:14
20th
[2] 137:3 217:21
211
[1] 3:25
22nd
[1] 135:14
23
[1] 3:24
230
[1] 139:13
235,000
[4] 138:2 139:12 142:4 142:6
24
[3] 131:6 131:17 132:18
24-hours-a-day
[1] 161:15
25
[6] 32:23 70:8 105:6 105:11 105:22 157:19
25,000
[1] 150:21
25th
[4] 60:15 60:16 60:17 70:10
262
[2] 116:8 116:11
268
[3] 151:2 173:12 173:24
27,000
[7] 158:7 162:10 162:12 162:18 162:20 164:23 164:24
28
[10] 164:17 164:23 164:24 166:3 178:5 178:21 178:22 179:8 183:6 185:18
2800
[1] 164:22
28E
[2] 120:3 146:23
28F
[3] 119:23 120:6 146:24
29th
[3] 6:18 148:6 219:17

3

3
[10] 18:17 80:4 112:6 142:16 150:25 186:19 195:13 198:3 198:5 200:23
3,381
[1] 81:3
30
[20] 88:12 98:5 98:25 99:3 99:4 178:5 178:15 178:17 178:23 179:6 179:7 179:8 179:10 179:13 180:7 180:9 183:5 185:18 186:5 186:7
30,000
[15] 11:10 11:13 11:15 151:19 151:22 151:23 152:20 153:3 153:8 153:16 154:13 154:16 156:7 162:18 170:23
300
[1] 2:4
31
[10] 3:5 178:5 178:18 179:7 179:13 180:9 183:5 185:19 186:6 186:7
31's
[1] 179:7
32,545
[1] 81:4
33
[1] 2:1
33,000
[4] 81:9 81:12 82:6 86:17
33,000-acre
[1] 83:1
35.51
[1] 96:24
36
[1] 169:5
362
[1] 64:4
37
[1] 169:5
37,000-plus
[1] 169:14
38
[1] 3:5

4

4
[5] 8:1 143:10 143:20 193:17 193:24
4,316
[1] 80:24
4,467
[1] 151:20
400
[2] 55:3 205:24
400-acre
[1] 28:10
43
[3] 3:7 68:3 68:8
44
[1] 114:3
444
[1] 2:10
455
[1] 81:10
46
[1] 114:24
465
[1] 2:4
47.39
[1] 97:11
48
[3] 98:25 99:4 161:19
496
[1] 64:4
4:20
[1] 218:4

5

5
[9] 39:19 42:17 142:2 142:3 142:3 178:24 179:1 179:4 192:13
5,000
[2] 150:18 158:21
5.5
[1] 41:6
50
[1] 32:23
500
[1] 8:6
51
[1] 116:4
53
[1] 61:13
539
[1] 16:11
55
[2] 105:12 105:24
551
[1] 64:3

6

6
[10] 3:4 17:3 17:5 29:10 29:21 30:6 42:17 88:10 89:21 109:22
60
[12] 12:12 113:
2148
60some
[39
6449
[910
670,000
[131 132 133:
134
6A
[510
6B
[311

7

7
[3:21:7:15
136
7,000
[111 112 16
7,560
[16 16:169
181 181 161 2
1623
70
[9:9:19:29:
4
7475
[112
75
[205
7500
[172
77
[131 131 131 8
78
[8
7919
[911

8

8
[9:143
8753
[82
8933
[154
8465
[112
86793
[15
89
[11:11:25

9

9
[17:17:17:173:
18
9,000
[1521
9502
[912
95732
[10
95793
[2:13
96813
[2:17
900
[12:7
920
[13:13:15

_

[2121

A

A&B
[4:3:1:121
122 212 122
212 212 123:
133 133 133
231 323 123

36:9 36:15 37:10 38:25 41:8 41:13 41:21 41:25 42:11 43:18 70:12 70:18 70:20 71:23 77:20 87:15 102:8 102:15 103:1 103:24 131:1 134:7 134:14 135:2 147:19
A&B's
[3] 70:7 70:9 103:2
A-1
[19] 43:17 43:23 44:10 54:9 78:7 79:10 79:16 94:13 97:9 101:13 102:5 134:14 187:24 188:5 196:13 197:5 206:2 206:8 206:15
A-10
[1] 100:1
A-11
[1] 100:8
A-13
[3] 136:21 137:5 142:2
A-2
[3] 88:9 89:9 89:10
A-24
[2] 118:17 118:24
A-26
[2] 192:22 194:24
A-3
[4] 79:20 88:9 89:9 89:10
A-4
[3] 88:9 89:9 89:10
A-40
[2] 143:21 146:12
A-45
[11] 177:17 177:19 178:2 178:10 178:11 178:15 180:13 185:22 193:25 194:4 196:14
A-5
[7] 88:9 89:9 89:12 89:13 89:15 89:15 89:17
A-52
[4] 59:12 59:25 62:24 64:22
A-53
[6] 61:18 62:6 64:8 64:12 76:15 213:16
A-54
[5] 63:8 63:14 64:10 64:12 213:16
A-55
[5] 58:20 58:21 176:20 177:10 177:11
A-55.1
[10] 176:21 177:19 178:3 179:25 180:4 180:15 183:6 185:21 186:11 186:14
A-56
[1] 213:16
A-6
[4] 31:8 104:19 104:21 113:6
Abandoned
[3] 21:4 36:7 68:10
Abide
[1] 14:7
Ability
[8] 12:8 18:10 27:15 30:20 134:6 203:13 203:24 219:11
Able
[7] 13:6 61:3 131:5 131:16 132:17 161:2 209:11
Above-described
[1] 81:25
Absolutely
[1] 68:23
Absorb
[2] 160:4 160:19
Abutting
[1] 179:9
Access
[3] 53:25 75:14 137:21
Accompanied
[1] 77:1
Accomplish
[1] 195:7
According
[6] 83:3 95:23 99:4 138:12 158:24 166:5
Account
[3] 57:16 157:5 170:24
Accounting
[1] 37:17
Accumulated
[2] 110:22 110:22
Accumulation
[1] 128:7
Accuracy
[7] 46:2 46:4 111:23 112:10 112:11 112:13 186:14
Accurate
[12] 46:6 46:21 47:12 47:19 55:16 64:18 71:19 96:17 112:10 156:4 183:4 186:17
Accurately
[3] 46:11 47:1 80:20
Acetate
[2] 177:8 186:11
Acre
[24] 66:4 151:21 152:2 152:4 152:10 152:20 153:1 154:16 156:18 156:23 158:13 158:17 158:21 158:22 164:7 165:23 165:24 166:4 166:17 168:1 168:21 169:1 169:6 169:14
Acreage
[17] 35:8 37:16 59:15 65:10 66:2 79:21 151:20 156:16 164:12 164:12 167:25 213:18 214:11 214:19 215:13 216:20 216:21
Acreages
[4] 64:3 64:17 64:24 65:4
Acres
[67] 8:6 11:13 11:15 11:24 12:6 18:7 19:2 28:12 29:17 34:15 35:9 36:11 36:17 37:13 37:22 37:23 37:25 62:25 64:23 80:24 80:25 81:2 81:3 81:4 81:10 81:10 81:12 82:6 86:17 150:18 150:21 151:19 152:20 153:4 153:8 153:16 153:16 154:13 156:7 156:9 156:11 156:24 157:2 157:3 157:5 158:7 158:18 162:10 162:12 162:17 162:20 162:25 164:4 164:8 164:19 164:24 164:25 165:1 165:2 165:10 166:10 166:16 167:12 167:23 170:23 173:2 215:22
Activities
[1] 39:2
Actual
[3] 59:9 159:14 160:4
Add
[2] 97:18 99:17
Added
[1] 64:18
Adding
[1] 19:22
Additional
[3] 8:18 11:17 115:14
Address
[1] 204:16
Adequate
[1] 28:5
Adjacent
[6] 90:18 91:5 95:18 104:15 178:23 179:9
Adjoining
[2] 34:12 34:16
Adjoins
[1] 34:22
Administrators
[1] 19:17
Admissible
[1] 165:16
Admit
[1] 205:4
Admitted
[3] 25:16 176:20 205:9
Adopt
[1] 204:2
Adopted
[1] 204:15
Advised
[1] 4:5
Aerial
[11] 59:20 60:5 60:10 60:11 60:17 60:18 60:19 61:11 62:5 63:7 64:25
Affected
[4] 19:1 159:10 205:25 213:3
Affiliated
[1] 75:9
Affiliates
[1] 102:9
Afford
[2] 8:23 8:25
Afforded
[1] 209:18
Ag
[3] 39:14 103:15 107:10
Aggregate
[1] 64:17
Ago
[10] 20:16 34:9 38:10 38:13 60:14 60:15 184:3 195:18 202:23 208:19
Agree
[7] 4:22 36:14 61:3 96:7 96:13 122:12 215:20
Agreed
[2] 4:23 78:17
Agreement
[30] 10:8 12:2 16:15 16:25 17:2 19:6 24:21 24:24 24:25 25:6 25:11 25:13 25:15 26:2 26:16 33:24 78:16 78:23 79:4 79:15 92:25 93:3 93:7 93:10 93:11 103:1 107:6 111:6 111:21 134:9
Agreements
[10] 12:24 14:10 27:11 92:13 92:18 94:3 94:5 94:9 102:9 102:16
Agribusiness
[1] 11:21
Agribusiness'
[1] 11:25
Agricultural
[12] 6:16 7:20 33:5 33:18 35:15 36:22 102:24 103:2 103:6 103:22 149:16 149:18
Agriculture
[11] 35:25 36:15 36:15 36:20 36:21 37:11 37:15 37:18 37:19 39:12 41:11
Ahead
[4] 49:25 90:10 142:11 185:8
Ahupua'a
[1] 17:23
Air
[1] 75:21
Airport
[6] 34:1 34:1 34:2 34:7 38:7 38:9
Akeke
[3] 198:8 198:9 198:11
Akina
[2] 77:1 77:2
Al
[4] 2:17 174:25 185:11 207:10
Alan
[2] 2:16 7:10
Alexander
[7] 6:13 14:19 20:1 26:10 28:13 87:16 89:11
Align
[1] 47:3
Alleged
[1] 114:25
Alleges
[1] 114:4
Allocation
[2] 151:15 194:13
Allow
[10] 9:3 14:2 14:23 17:18 46:4 66:19 66:24 74:7 114:5 165:19
Allowing
[4] 10:4 61:4 154:3 213:15
Allows
[1] 18:9
Almost
[1] 116:5
Alternate
[1] 190:9
Alternative
[1] 11:18
Amended
[1] 25:13
Amendment
[4] 25:14 26:15 26:24 27:5
Amount
[23] 9:13 9:23 57:19 58:18 68:15 110:17 111:8 111:11 111:15 112:4 112:24 126:22 126:23 127:2 131:11 132:20 142:8 152:4 158:15 166:15 173:11 188:22 199:14
Amounts
[4] 94:14 173:1 173:5 174:2
Annually
[4] 110:11 110:16 110:18 111:15
Answer
[10] 64:6 104:10 117:13 128:23 129:9 130:6 133:15 162:23 202:10 214:20
Answered
[3] 104:6 214:15 215:6
Answers
[1] 172:11
Anticipate
[2] 68:18 202:18
Anyway
[3] 118:8 163:19 170:3
Apologize
[1] 66:8
Apolonia
[1] 72:25
Appear
[2] 46:20 206:11
Appeared
[1] 50:17
Application
[10] 34:24 70:7 70:8 70:10 71:15 71:24 150:5 150:17 163:20 172:19
Applied
[13] 89:3 154:4 156:10 156:10 156:11 156:25 158:15 163:4 164:5 169:11 171:9 173:25 174:4
Applies
[2] 134:12 169:23
Apply
[5] 40:23 89:14 134:11 134:13 159:7
Applying
[14] 153:20 154:24 166:1 166:9 166:14 167:22 167:24 167:25 168:21 168:25 169:5 169:13 169:22 173:2
Appply
[1] 177:6
Appreciate
[4] 23:25 62:23 217:20 218:2
Appreciated
[1] 216:18
Approach
[1] 15:22
Approaching
[1] 152:3
Appropriate
[4] 16:3 22:25 24:7 131:2
Approval
[1] 28:1
Approximate
[10] 47:16 47:18 47:22 63:21 63:24 64:2 65:7 66:1 165:21 197:18
Appurtenant
[10] 72:11 90:21 91:4 91:11 129:4 129:7 129:22 130:8 133:20 209:19
April
[1] 70:9
Archives
[3] 16:15 17:8 211:16
Area
[141] 7:25 17:21 18:2 19:1 19:2 34:12 34:16 34:22 34:23 34:23 35:1 40:22 44:21 45:6 45:7 46:13 46:25 47:9 47:10 48:13 53:15 53:16 53:17 53:18 55:6 55:10 56:16 56:19 56:22 57:18 59:6 59:10 59:24 60:5 60:7 61:2 62:4 62:6 62:8 62:9 62:14 64:11 65:7 66:17 67:13 70:16 71:13 72:4 72:9 72:17 75:15 76:12 76:13 76:15 76:17 77:10 80:13 80:13 81:5 81:8 82:12 82:16 83:1 83:5 83:7 87:14 87:19 87:19 87:19 94:15 94:19 94:21 95:2 95:4 95:15 97:5 97:24 97:24 101:20 105:21 105:21 105:25 106:1 106:1 106:10 110:1 110:18 110:20 111:4 111:4 114:13 127:5 127:6 132:11 134:12 168:7 168:9 168:10 178:3 178:9 179:22 179:24 180:4 180:12 180:14 182:10 183:5 185:17 185:24 185:25 186:2 186:4 186:7 189:6 189:7 189:8 189:16 191:17 192:10 192:15 193:15 193:16 193:18 195:24 196:10 196:10 197:2 197:3 197:3 197:4 197:5 197:12 197:23 198:5 198:11 198:13 198:17 199:6 199:25 209:11 209:13
Areas
[45] 14:25 19:8 33:14 36:13 46:15 50:18 59:22 61:19 62:3 62:13 64:13 64:18 65:16 65:20 65:22 66:2 79:16 79:22 80:15 80:22 81:19 81:25 84:1 86:17 86:18 87:20 95:5 97:19 97:20 105:1 109:23 110:7 110:16 111:9 111:11 111:16 112:25 119:2 119:21 119:22 134:11 186:9 186:10 186:11 186:15
Argue
[1] 88:25
Argument
[6] 9:17 166:18 216:10 217:2 217:19 217:22
Argumentative
[2] 56:6 57:22
Arise
[2] 86:16 94:15
Arises
[6] 46:14 96:13 98:5 99:3 99:11 99:19
Arising
[3] 81:12 88:5 97:4
Arraignment
[1] 9:21
Arrange
[1] 23:12
Arrangement
[6] 9:12 11:21 15:12 17:18 22:18 24:17
Arrangements
[2] 13:22 24:5
Arrived
[3] 26:18 63:4 97:23
Arrow
[2] 190:24 192:11
Arrows
[2] 58:23 212:3
Art
[1] 7:21
As-needed
[1] 163:23
Ascertain
[2] 44:16 108:4
Aside
[1] 196:14
Aspects
[1] 10:21
Assembled
[2] 110:24 111:2
Assess
[1] 74:25
Assessment
[4] 75:2 75:3 75:8 77:2
Assign
[1] 134:7
Assigning
[1] 62:8
Assigns
[2] 19:18 96:18
Assist
[3] 68:11 73:22 74:5
Assistance
[5] 72:25 73:4 73:5 74:21 74:23
Assistant
[1] 74:24
Assisting
[2] 73:5 73:14
Associates
[1] 71:4
Association
[1] 132:10
Assume
[14] 13:25 15:2 15:10 15:19 16:21 22:6 25:16 26:6 31:16 32:6 36:10 96:24 151:25 190:15
Assumed
[3] 13:24 136:19 167:17
Assumes
[2] 164:9 166:21
Assuming
[4] 56:6 155:11 155:23 160:17

Assumption
[2] 25:7 164:15
Assure
[4] 27:15 28:4 203:8 203:24
Attached
[7] 72:12 72:18 136:11 136:18 136:19 204:22 212:9
Attain
[1] 131:13
Attempting
[2] 73:22 74:5
Attention
[1] 148:19
Attest
[1] 151:10
Attorney
[7] 2:3 2:3 90:16 91:4 99:24 130:7 143:18
August
[2] 135:14 143:11
Auntie
[1] 208:16
Aunts
[1] 176:3
Aupuni
[2] 2:16 7:11
Authorities
[1] 56:3
Authority
[3] 81:24 160:25 216:5
Available
[14] 5:22 16:2 22:20 23:22 24:12 42:21 43:1 62:22 68:19 170:23 177:24 201:21 202:19 203:9
Average
[38] 51:2 53:2 53:7 53:9 97:8 97:12 98:14 98:15 98:16 98:22 98:24 98:25 99:4 99:10 99:22 118:25 151:20 161:19 165:7 166:1 166:6 166:10 166:11 166:15 167:6 167:11 167:16 167:23 167:25 168:17 168:25 169:7 169:8 169:10 169:12 173:9 173:22 174:4
Averages
[1] 171:12
Award
[1] 41:21
Aware
[34] 9:12 9:21 13:5 14:1 14:6 14:23 15:3 15:11 18:24 21:24 33:24 34:6 34:10 34:11 34:22 92:24 93:3 93:5 93:7 93:10 93:11 93:14 93:17 94:2 94:3 94:9 100:13 100:17 102:19 102:20 104:13 137:17 137:20 206:7
Awhile
[1] 140:6

B

B-10B
[1] 66:15
B-113
[1] 70:24
B-126
[5] 3:24 22:22 23:5 23:8 205:1
B-127
[2] 204:11 205:3
B-128
[5] 3:25 204:12 209:21 211:12 211:22
B-5A
[2] 50:9 50:14
B-5C
[1] 52:19
B-6A
[2] 50:9 50:10
B-7A
[2] 50:10 56:15
B-7B
[1] 56:15
B-7C
[1] 56:15
Background
[1] 71:2
Baldwin
[20] 6:13 14:18 14:19 14:20 14:21 15:7 16:16 16:19 16:22 17:4 18:9 18:19 19:17 20:2 20:5 20:10 26:10 28:13 87:16 89:11
Ball
[1] 20:11
Ballpark
[1] 55:22
Banks
[3] 180:25 181:2 181:7
Based
[31] 8:16 44:14 59:20 60:2 60:10 64:24 64:25 65:22 75:8 77:19 79:13 83:17 83:17 83:25 96:21 99:21 99:23 113:22 138:9 151:8 157:21 158:5 158:9 159:2 167:18 170:8 171:3 172:22 183:2 194:13 210:12
Basic
[1] 11:5
Basin
[1] 128:7
Basis
[12] 9:4 20:15 37:10 53:8 67:23 67:24 99:10 99:22 156:18 156:23 157:4 158:17
Bay
[1] 19:9
Beatrice
[3] 3:21 207:8 208:16
Became
[2] 127:16 201:21
Begin
[1] 118:14
Beginning
[2] 4:15 95:20
Beginnings
[1] 210:4
Begins
[1] 45:6
Behalf
[9] 6:2 70:18 70:20 135:2 147:19 174:24 185:10 207:9 216:7
Behind
[1] 10:4
Belief
[4] 6:25 50:2 135:22 148:13
Bell
[1] 75:4
Belonged
[2] 35:23 94:20
Below
[24] 69:4 74:7 75:5 84:13 84:14 84:18 85:7 85:12 86:5 86:7 91:24 92:13 109:9 122:13 123:5 123:17 123:20 123:25 128:20 128:24 138:2 197:10 198:3 208:1
Belt
[1] 98:2
Benefit
[3] 21:7 21:10 212:12
Benefits
[1] 13:7
Best
[9] 6:25 7:21 27:14 88:21 135:22 138:8 148:12 157:21 219:11
Between
[18] 10:25 14:14 14:15 16:15 17:21 18:2 19:9 78:23 79:5 94:15 96:18 106:12 123:8 137:2 151:15 180:2 197:5 201:15
Beverly
[2] 25:21 25:24
Beyond
[3] 129:8 161:5 206:11
Big
[4] 63:6 142:7 187:24 195:25
Bigger
[3] 105:24 122:10 127:5
Bill
[2] 40:2 40:3
Billion
[2] 118:18 118:22
Bishop
[2] 2:7 2:17
Bit
[5] 114:21 126:8 145:1 194:9 198:14
Blank
[5] 57:12 57:18 58:18 58:19 180:14
Blast
[1] 75:23
BLNR
[2] 2:3 70:9
Blocked
[8] 67:9 114:7 114:12 114:14 121:20 123:16 191:4 194:22
Blue
[1] 113:12
Board
[7] 1:1 71:16 81:15 107:7 203:22 203:23 204:15
Bob
[1] 74:21
Born
[1] 72:8
Bottom
[11] 52:19 83:12 95:8 95:10 178:10 178:11 180:13 188:12 189:2 208:9 212:3
Boulders
[1] 75:20
Boundaries
[1] 95:3
Boundary
[7] 17:22 95:6 95:17 112:16 118:23 119:2 119:3
Bowl
[1] 181:17
Box
[26] 69:4 69:20 69:21 183:25 184:5 184:12 184:13 188:11 188:14 188:17 188:21 189:4 189:11 190:9 190:11 190:14 190:15 190:16 190:19 191:3 192:23 193:5 194:20 194:23 198:24 203:1
Boy
[3] 187:7 199:8 199:14
Break
[8] 75:22 78:1 110:19 117:25 118:4 118:8 134:22 206:5
Brewer
[1] 30:1
Briefed
[4] 10:20 10:24 11:2 18:24
Briefly
[1] 175:17
Bring
[5] 75:21 148:18 195:15 203:14 203:22
Broke
[2] 64:14 64:16
Broken
[3] 74:11 75:4 110:21
Brought
[1] 4:16
Brush
[2] 69:16 69:17
Build-up
[1] 127:9
Builder
[1] 201:6
Built
[3] 78:17 78:19 84:5
Bush's
[1] 77:1
Business
[10] 4:17 27:19 28:6 28:12 29:17 30:7 30:15 32:23 33:21 214:2
Businesses
[1] 103:15
Buy
[1] 9:22

C

CA
[1] 1:21
Cabral
[4] 73:12 73:13 73:17 73:17
Cades
[1] 2:6
Calculate
[2] 112:1 170:22
Calculating
[1] 108:25
Calculator
[1] 164:13
Cameron
[1] 25:24
Cameron's
[1] 25:21
Camp
[1] 37:14
Camps
[1] 37:15
Cane
[3] 7:25 10:11 29:6
Cannot
[14] 8:18 12:11 27:16 44:16 47:3 68:18 131:21 133:5 156:4 156:6 195:7 199:24 202:3 202:17
Capacity
[17] 50:23 58:13 67:3 85:3 85:6 85:18 86:11 98:8 98:12 105:19 105:20 105:22 122:6 122:8 123:1 126:23 139:13
Caption
[1] 219:16
Captured
[2] 51:7 56:25
Car
[1] 147:12
Care
[1] 175:24
Carefully
[2] 17:20 18:4
Caretaken
[1] 93:17
Caretaker
[2] 94:5 120:10
Caretaking
[1] 123:3
Carried
[1] 75:15
Carrol
[1] 74:21
Carrying
[2] 105:20 105:22
Case
[15] 1:3 1:6 6:22 61:6 86:14 93:22 112:20 113:1 113:4 119:17 135:19 143:22 144:14 148:9 148:17
Cases
[1] 64:16
Cast
[1] 201:24
Categorize
[1] 58:7
Category
[2] 58:12 62:25
Caveny
[8] 92:24 93:7 101:5 113:25 114:4 114:24 129:25 132:18
Caveny's
[3] 93:12 123:17 124:3
Ceased
[1] 68:10
Center
[4] 1:9 35:11 176:12 176:14
Centers
[1] 36:23
Central
[7] 14:11 21:11 30:10 38:8 42:19 42:23 88:5
Century
[2] 13:17 13:18
Certain
[22] 9:13 9:23 14:2 14:3 18:18 46:3 46:6 47:8 72:10 92:1 92:15 93:9 94:7 105:13 109:2 126:22 127:2 127:14 150:18 154:19 155:14 160:21
Certificate
[2] 136:15 219:1
Certify
[2] 219:6 219:14
Cetera
[3] 18:15 19:23 20:23
Challenge
[1] 114:11
Chance
[2] 14:9 211:14
Change
[6] 51:6 51:10 51:10 51:16 52:12 214:21
Changes
[3] 51:25 52:2 111:22
Characterization
[1] 9:15
Characterize
[1] 168:22
Characterizing
[1] 155:19
Charge
[2] 159:14 159:24
Check
[1] 139:17
Chin
[2] 159:18 159:23
Choose
[2] 127:1 174:1
Chow
[4] 2:3 23:18 23:23 205:2
Chunk
[1] 95:1
Circle
[1] 109:8
Circles
[1] 108:9
Claim
[4] 44:9 87:11 205:13 215:22
Claimed
[1] 87:13
Claims
[1] 216:6
Clarification
[1] 118:14
Clarify
[9] 48:14 85:9 95:11 102:12 126:16 133:10 153:7 154:12 166:25
Clean
[1] 139:8
Cleaned
[3] 114:18 114:22 127:15
Cleaning
[1] 128:7
Clear
[11] 44:6 46:22 73:10 80:7 122:17 129:12 173:11 173:23 182:18 197:15 214:6
Cleared
[1] 75:20
Clearly
[1] 121:12
Climb
[1] 189:23
Clogged
[1] 67:4
Close
[6] 48:1 55:2 65:23 75:25 158:9 214:2
Closed
[10] 125:14 125:15 125:23 125:25 126:3 126:5 126:6 214:7 216:23 216:25
Closer
[1] 200:21
Co-founder
[2] 14:19 20:8
Coincide
[1] 176:23
Collect
[2] 84:7 191:2
Collecting
[1] 210:3
Collections
[1] 71:10
Collectively
[1] 200:16
Color
[1] 44:4
Colored
[3] 64:25 65:7 187:24
Colors
[1] 113:13
Column
[2] 64:23 138:13
Combination
[2] 160:15 205:20
Combine
[1] 191:21
Combined
[1] 150:21
Coming
[20] 4:6 5:16 12:12 52:21 52:25 119:1 140:2 181:21 184:5 184:22 187:14 187:19 188:11 194:10 195:24 196:4 200:5 203:3 210:21 211:13
Command
[1] 25:7
Commencing
[1] 1:8
Comment
[5] 137:25 138:1 138:4 165:18 214:9
Commercial
[3] 6:15 31:11 113:8
Commission
[5] 17:4 27:22 56:12 58:15 73:6
Commit
[4] 133:3 133:5 156:16 157:7
Commitment

[5] 21:18 21:19 21:21 22:4 107:9
Common
[1] 17:7
Community
[2] 1:9 73:22
Companies
[2] 12:24 42:2
Company
[19] 6:16 13:8 21:10 22:5 24:22 28:8 38:25 71:4 71:16 78:24 82:12 91:16 92:1 92:6 92:7 92:9 104:21 107:21 108:9
Compare
[1] 139:17
Comparing
[1] 60:7
Comparison
[1] 64:21
Compensation
[1] 92:2
Competence
[1] 129:8
Compiled
[1] 151:9
Completely
[2] 184:16 189:3
Completion
[2] 13:15 29:12
Complex
[1] 10:11
Compliments
[1] 26:25
Compound
[1] 32:3
Compressors
[1] 75:22
Concern
[7] 46:3 46:14 62:18 63:22 204:16 215:24 216:3
Concerned
[3] 23:6 46:24 55:25
Concerning
[1] 203:24
Concludes
[1] 24:2
Conclusion
[7] 82:8 88:20 90:23 96:10 129:15 161:6 186:13
Conclusions
[2] 217:3 217:18
Conclusively
[1] 51:24
Concrete
[12] 183:24 186:23 186:25 190:8 190:11 192:23 193:5 194:16 194:20 194:23 195:13 203:1
Condition
[7] 15:18 18:25 47:22 73:20 89:20 120:2 212:22
Conditions
[16] 9:10 11:2 12:25 13:6 14:1 14:3 14:6 15:11 18:18 89:17 122:13 124:25 209:16 210:1 212:1 212:8
Conduct
[2] 143:15 143:18
Conducted
[5] 71:5 71:14 91:10 143:10 144:23
Conducting
[2] 71:8 71:10
Configuration
[1] 122:18
Confused
[1] 80:1
Conjunction
[2] 71:14 71:23
Connected
[3] 30:10 69:21 102:1
Connection
[3] 70:7 70:11 175:16
Connects
[1] 49:14
Consider
[3] 52:11 80:10 206:22
Consideration
[2] 171:4 210:7
Consists
[3] 16:12 18:6 91:5
Constant
[1] 36:18
Constitute
[1] 15:8
Constitutes
[1] 39:22
Constitutionally
[4] 88:15 88:17 88:22 89:24
Construct
[5] 15:7 20:13 82:14 210:3 212:15
Constructed
[2] 82:14 212:23
Constructing
[1] 19:11
Construction
[13] 13:10 13:14 15:5 15:16 18:25 20:15 20:18 21:13 51:11 201:10 201:21 209:17 212:10
Consulted
[6] 42:10 42:13 42:14 42:20 42:25 43:3
Contain
[1] 179:24
Contained
[2] 148:11 219:8
Contemplated
[2] 30:13 76:10
Content
[1] 160:18
Contentions
[1] 130:5
Contested
[7] 1:3 1:6 86:13 112:20 113:1 113:4 119:17
Contingency
[1] 32:22
Continuance
[1] 212:21
Continue
[6] 4:8 69:17 147:11 186:7 190:1 193:21
Continued
[4] 3:7 43:14 125:9 198:19
Continues
[8] 105:24 123:22 188:23 189:5 189:15 190:25 191:1 194:7
Continuing
[4] 155:5 194:4 208:21 214:10
Continuously
[2] 168:23 168:24
Contract
[4] 99:19 110:23 110:25 111:18
Contracting
[1] 201:21
Contractor
[2] 200:25 201:5
Contradict
[1] 30:22
Control
[3] 13:24 17:20 126:13
Convene
[1] 216:16
Conversely
[1] 98:5
Convey
[3] 106:14 134:7 212:8
Conveyed
[3] 92:6 92:9 92:11
Conveying
[1] 19:14
Cooler
[1] 162:1
Cooperation
[1] 207:19
Cooperative
[1] 11:20
Coordinate
[1] 150:4
Coordinated
[1] 70:22
Coordination
[1] 148:17
Coordinators
[1] 150:9
Copied
[3] 63:14 63:19 121:11
Copies
[7] 17:9 22:19 22:25 23:6 23:11 24:9 209:15
Copy
[17] 6:17 6:21 16:3 16:10 26:14 61:14 63:5 63:9 68:2 136:11 188:5 204:9 204:21 204:23 209:12 217:21 219:12
Corp
[1] 100:22
Corporate
[1] 25:25
Corporation
[2] 2:12 20:9
Correct
[320] 6:19 6:20 6:21 6:24 7:17 7:19 7:23 8:2 8:6 8:13 8:25 9:1 9:23 10:13 10:14 10:19 11:1 11:11 11:12 11:19 11:22 12:10 12:20 13:17 14:22 17:13 18:15 18:22 19:24 20:7 20:12 20:17 21:7 21:8 21:12 21:16 21:24 22:8 22:10 25:7 25:10 26:3 27:1 27:2 27:23 27:24 28:2 28:14 28:23 29:24 32:2 33:19 33:20 35:3 35:16 35:19 35:23 36:1 37:12 38:2 38:3 39:4 39:6 39:9 40:17 41:12 41:14 41:15 42:5 42:24 45:13 50:7 50:16 50:19 50:24 50:25 52:13 57:17 59:11 59:16 60:12 60:21 61:20 62:25 63:1 63:20 65:5 65:11 66:3 66:5 67:1 67:21 69:1 69:2 69:5 69:6 70:23 73:25 74:10 76:18 76:22 78:13 78:14 78:18 78:20 79:14 79:17 79:18 80:15 81:6 81:13 81:14 82:4 82:18 82:20 82:21 82:25 83:22 85:6 85:13 85:24 86:3 86:12 86:18 87:9 87:17 89:4 89:7 91:18 92:19 93:1 93:4 94:11 94:12 95:10 96:2 96:14 96:16 96:25 97:6 97:15 98:10 98:18 98:19 98:23 99:1 99:6 99:8 99:11 99:12 99:20 100:19 101:18 104:22 104:23 105:3 106:15 106:18 106:21 107:5 107:21 107:22 109:3 109:16 110:3 111:13 111:19 112:14 113:9 113:23 114:1 114:10 114:12 114:19 114:20 115:6 115:7 115:11 115:15 115:16 116:10 116:13 116:15 116:17 116:21 116:23 116:25 117:5 117:8 117:16 117:19 117:23 119:5 119:22 121:17 121:20 121:21 121:25 122:4 122:15 122:16 122:24 123:6 123:9 123:18 123:19 124:4 124:5 124:10 124:12 124:13 124:18 124:25 125:1 125:16 125:18 125:20 125:23 126:8 126:11 126:12 126:14 127:6 127:20 128:5 129:23 129:24 130:2 130:19 130:20 131:25 132:3 132:13 132:16 133:4 133:9 133:16 133:21 133:22 134:15 134:16 135:22 137:3 137:4 137:8 137:9 137:16 137:24 138:14 138:21 141:9 141:10 143:13 145:9 145:14 145:16 145:17 145:21 145:24 146:7 146:22 148:12 149:14 149:22 150:7 150:14 150:19 150:20 151:4 151:5 151:17 151:19 152:2 152:5 156:21 158:23 159:5 159:12 159:25 160:8 162:11 162:21 165:25 167:2 167:3 167:5 167:14 167:19 167:20 167:21 168:2 168:4 168:11 168:16 168:18 169:2 169:6 169:9 170:6 170:10 173:4 177:8 177:12 178:11 178:15 178:18 178:23 182:20 185:19 191:4 191:13 192:13 193:17 193:20 193:25 196:24 198:3 205:21 216:20 219:12
Corrected
[2] 66:23 162:18
Correctly
[1] 97:22
Correlated
[1] 112:4
Corresponding
[1] 139:18
Council
[1] 74:20
Counsel
[4] 2:12 4:3 7:10 219:14
Count
[2] 55:16 206:3
Counted
[1] 206:5
Counties
[1] 40:20
Country
[1] 30:9
County
[16] 2:11 27:22 29:19 40:21 99:7 101:23 102:4 102:25 103:13 103:13 106:24 106:25 107:5 107:6 213:9 219:4
County's
[1] 170:21
Couple
[9] 7:12 60:14 60:15 76:9 114:18 170:18 174:19 178:22 213:24
Course
[4] 20:13 145:4 212:23 217:12
COURT
[1] 152:18
Courtesy
[1] 117:13
Cover
[1] 16:12
Covered
[2] 79:21 80:13
Covering
[1] 139:15
Covers
[5] 80:23 80:25 81:2 81:3 83:5
Crew
[1] 125:11
Crop
[3] 160:23 171:4 173:19
Crops
[3] 152:9 152:11 152:13
Cross
[5] 4:21 43:12 149:8 178:18 183:10
Cross-examination
[27] 3:4 3:5 3:5 3:7 3:8 3:8 3:11 3:11 3:14 3:14 3:15 3:15 3:18 4:8 7:8 31:6 38:22 43:14 78:5 134:2 136:6 143:5 149:9 162:7 170:19 172:16 183:11
Cross-examine
[1] 78:4
Cross-examining
[1] 43:12
Crosscut
[6] 53:19 53:21 53:23 54:4 54:7 56:20
Crossed
[1] 179:8
Crosses
[2] 47:25 210:21
Crosshatch
[1] 87:10
Crossover
[2] 79:12 79:12
Crown
[1] 18:10
CSR
[3] 1:21 1:21 219:21
Cultivate
[1] 177:16
Cultivated
[5] 7:25 68:16 154:14 157:2 177:16
Cultivation
[11] 62:14 62:15 68:9 68:19 103:20 162:15 163:1 170:23 186:8 186:15 202:19
Cultural
[4] 70:6 71:5 71:12 177:23
Cultural-historical
[1] 71:5
Current
[7] 21:18 34:11 34:23 34:23 42:7 195:5 195:6
Cut
[5] 69:16 70:1 155:4 189:3 195:19
CWRM
[3] 116:21 116:25 117:4
Cycle
[4] 166:2 166:14 167:12 167:13

D

Daily
[4] 53:7 67:23 67:24 108:1
Dairy
[2] 33:22 35:2
Dam
[11] 186:19 186:19 186:23 186:25 187:11 195:13 195:15 198:3 198:5 200:22 200:23
Dams
[1] 19:13
Dash
[1] 25:3
Data
[20] 108:1 108:7 108:16 108:18 108:20 108:22 109:5 109:22 109:25 110:4 110:6 110:8 110:11 110:13 110:15 110:22 110:22 110:24 111:14 111:17
Date
[3] 17:1 137:23 212:24
Dated
[4] 26:17 70:8 135:14 219:17
Dates
[3] 137:14 138:11 146:9
Dave
[1] 61:14
DAVID
[2] 2:5 2:9
Day-to-day
[3] 155:17 156:6 157:11
Days
[25] 88:12 98:20 98:22 114:18 131:6 131:17 132:19 138:20 164:15 164:16 166:5 166:6 166:7 166:9 166:12 167:4 168:5 168:8 187:19 197:13 197:16 200:6 208:25 213:24 217:6
De
[1] 77:20
Deadlines
[1] 217:12
Deal
[3] 30:25 95:2 150:2
Dealing
[3] 94:24 150:16 171:11
Debris
[1] 67:4
Decade
[1] 197:18
December
[2] 26:17 217:17
Decipherable
[1] 212:7
Decision
[2] 213:21 213:24
Declaration
[14] 3:23 5:14 6:18 7:4 7:5 73:1 77:17 135:13 135:18 136:9 136:18 143:9 148:5 148:12
Declared
[1] 40:22
Decreased
[1] 138:17
Deeds
[3] 91:25 92:17 92:21
Defer
[1] 9:6
Define
[1] 163:20
Defined
[1] 131:7
Definitely
[1] 5:22
Definition
[2] 130:13 160:5
Deflector
[1] 139:10
Degrees
[5] 115:19 115:25 130:15 131:8 131:18
Deliver
[2] 31:20 203:1
Delivered
[9] 12:25 29:11 31:15 102:17 103:4 118:18 118:21 118:22 181:25
Deliveries
[1] 119:20
Delivering
[2] 128:15 195:7
Delivers
[1] 11:3
Delivery
[3] 10:11 11:6 15:9
Demised
[1] 19:15
Demolish

[1] 20:25
Demonstrated
[1] 21:14
Denied
[1] 129:4
Deny
[7] 127:19 127:22 129:2 129:23 130:2 130:9 130:10
Denying
[2] 128:8 129:13
Department
[2] 26:1 104:7
Depict
[5] 80:21 104:25 106:9 179:12 186:14
Depicted
[10] 46:12 47:1 47:9 55:6 56:17 177:7 178:11 186:11 206:4 206:8
Depicting
[1] 194:23
Depictions
[2] 179:25 180:3
Depleted
[1] 161:21
Deposits
[1] 181:13
Deputy
[2] 2:3 2:12
Describe
[5] 54:5 177:14 180:15 186:4 197:20
Described
[6] 46:2 50:15 55:6 81:25 173:15 185:17
Describes
[2] 17:18 17:21
Description
[1] 82:4
Designate
[1] 95:4
Designated
[4] 87:6 94:14 107:12 107:23
Designates
[1] 59:3
Designation
[5] 43:18 44:6 87:21 107:20 196:17
Designed
[1] 75:12
Desire
[3] 19:21 131:14 213:13
Despite
[1] 51:16
Detail
[1] 157:3
Detailed
[1] 71:9
Details
[1] 32:15
Determination
[1] 65:13
Determine
[5] 47:16 65:10 72:17 88:15 99:13
Determined
[7] 46:16 60:6 64:13 64:24 65:16 65:18 66:1
Determining
[3] 97:25 98:2 151:15
Detriment
[1] 27:17
Develop
[3] 41:21 82:19 88:5
Developed
[1] 12:4
Developing
[1] 82:1
Development
[11] 35:6 41:8 41:17 41:18 41:22 42:8 42:19 42:22 148:25 149:12 149:20
Developments
[1] 36:16
Devoted
[4] 33:18 102:16 102:21 102:23
Devoting
[2] 36:21 37:11
Diagram
[2] 121:8 121:10
Difference
[2] 201:17 201:18
Differences
[2] 167:17 201:15
Different
[9] 39:2 50:18 108:19 108:23 162:23 163:25 166:17 170:10 189:13
Difficult
[3] 44:12 75:24 99:14
Difficulty
[1] 184:8
Digging
[1] 19:11
Diminishes
[1] 105:15
Direct
[30] 3:4 3:10 3:13 3:17 3:20 3:22 5:12 6:10 99:24 113:25 116:5 116:9 124:11 129:3 129:21 129:25 135:10 135:19 140:9 148:2 149:17 149:20 150:12 155:9 161:6 175:8 185:13 207:12 211:25 215:1
Directed
[2] 140:23 150:13
Directing
[1] 140:19
Direction
[6] 38:24 48:4 59:4 59:5 188:21 192:19
Directions
[2] 190:9 195:2
Directly
[3] 104:2 104:3 181:19
Director
[3] 148:25 149:12 155:2
Dirt
[2] 127:9 127:15
Disaster
[6] 40:8 40:18 40:19 40:22 40:23 40:25
Discover
[1] 77:23
Discovery
[7] 143:22 144:5 144:6 144:6 144:14 144:14 209:10
Discretion
[1] 88:15
Discussed
[5] 86:16 90:24 134:6 204:1 217:16
Discussing
[1] 89:21
Discussion
[1] 217:9
Discussions
[1] 70:17
Dispose
[3] 8:7 28:24 28:25
Dispute
[1] 115:24
Disregard
[1] 16:12
Distance
[5] 85:11 95:25 123:11 123:12 145:10
Distribute
[2] 113:18 113:22
Distributed
[1] 182:16
Distribution
[1] 27:15
Ditch
[168] 7:15 9:4 12:4 13:14 15:9 29:12 29:13 29:20 29:23 30:6 31:9 31:12 31:14 31:18 31:19 31:19 31:19 31:22 31:24 31:25 32:1 32:2 32:7 32:8 32:13 43:17 50:5 51:6 51:11 51:25 52:3 53:24 53:25 54:19 66:19 66:24 68:10 68:12 68:15 68:17 69:7 69:11 69:14 69:15 69:18 69:22 70:2 78:17 79:6 79:7 79:11 82:13 82:14 83:2 84:5 84:13 84:14 84:19 84:20 84:23 84:24 85:10 85:21 85:23 86:5 86:7 86:8 86:9 86:10 87:25 87:25 92:13 95:24 96:1 96:5 99:12 99:14 99:15 101:11 102:14 103:22 104:22 104:22 104:24 105:4 105:20 105:22 105:23 106:4 106:17 108:5 108:16 108:19 108:20 109:1 109:12 111:25 112:18 113:8 113:14 113:14 113:15 113:21 114:5 114:6 116:8 117:10 119:15 120:20 121:15 121:15 121:15 121:16 121:20 121:23 121:23 121:24 122:2 122:13 122:22 124:7 124:8 124:9 124:15 124:18 125:12 125:12 128:2 128:20 128:21 131:12 132:25 133:20 144:19 145:8 145:12 145:15 150:9 157:4 161:2 171:18 176:15 180:20 180:21 181:22 182:8 182:13 183:13 189:15 189:20 190:2 193:12 194:17 197:10 202:16 202:22 202:25 203:8 203:24 204:6 205:18 205:24 209:17 210:4 210:14 210:22 212:10
Ditche
[1] 184:15
Ditches
[31] 7:12 13:15 19:13 20:23 21:3 21:6 54:22 78:11 79:2 79:11 98:9 98:13 98:15 101:14 101:16 101:17 101:21 106:12 106:15 112:9 112:17 113:19 113:20 113:22 119:4 119:5 128:24 133:13 156:15 171:20 184:14
Diversified
[4] 39:1 152:9 152:11 152:13
Diversion
[53] 47:13 50:18 50:20 51:8 51:18 54:2 54:3 54:6 54:7 54:8 56:23 56:24 57:1 57:4 57:9 57:15 58:4 58:6 58:10 58:11 66:24 68:20 69:20 69:21 73:9 84:16 84:17 84:18 84:25 101:10 121:22 123:2 123:5 123:9 124:7 124:9 124:10 126:2 126:14 126:19 126:20 126:24 127:8 127:11 128:20 131:12 183:24 190:20 190:22 195:23 206:14 206:22 206:24
Diversions
[27] 54:19 55:3 55:4 55:5 55:9 55:13 56:1 56:4 56:10 56:11 57:11 58:8 73:7 73:15 84:2 91:11 91:15 91:24 101:22 121:14 123:15 202:20 205:24 206:3 206:7 206:10 206:20
Divert
[13] 51:12 81:19 82:19 84:3 84:9 84:23 85:1 85:16 85:19 86:10 88:4 142:23 180:25
Divertable
[1] 58:13
Diverted
[23] 50:5 51:15 51:17 56:3 57:19 58:9 58:18 75:6 83:1 83:4 83:16 83:19 83:21 83:23 108:19 108:23 116:6 127:12 127:16 128:1 128:12 173:14 174:2
Diverting
[3] 57:8 82:1 85:21
Diverts
[1] 51:13
Divide
[1] 97:19
Divided
[3] 151:23 165:5 190:16
Division
[3] 28:16 32:19 33:9
Divisions
[1] 155:1
DLNR
[6] 1:3 109:20 110:8 110:12 110:15 111:11
Document
[34] 14:12 15:19 15:22 16:14 17:15 18:4 21:17 21:24 22:4 22:7 22:13 22:14 22:19 25:17 25:20 26:7 26:12 26:17 26:20 26:21 27:5 30:20 70:15 72:4 81:21 100:9 116:24 117:3 135:12 143:21 148:5 148:8 211:11 212:1
Documentation
[2] 72:7 117:6
Documented
[2] 56:2 138:12
Documents
[13] 12:23 13:2 13:19 17:3 17:8 21:22 22:5 27:4 30:21 92:8 93:18 100:11 100:14
Dollar
[1] 41:14
Domestic
[2] 92:22 103:14
Done
[13] 21:13 23:17 24:1 32:22 41:25 46:17 71:20 71:23 91:17 91:17 122:20 215:14 215:14
Dot
[1] 45:10
Double
[3] 68:15 169:7 169:7
Doubles
[1] 151:25
Doubling
[1] 152:1
Down
[75] 12:13 27:9 31:23 31:24 31:25 32:1 35:18 45:9 47:13 62:2 64:14 64:16 67:18 69:4 69:5 69:17 69:19 85:12 93:23 95:24 100:20 101:4 101:7 106:3 106:17 110:19 110:21 120:11 120:15 120:19 126:18 127:3 127:10 128:1 144:10 144:19 145:1 145:7 145:18 146:1 146:13 178:22 181:9 181:21 184:5 184:23 187:14 188:23 189:13 189:16 190:12 190:17 190:18 190:25 191:1 191:2 191:16 192:20 193:4 193:8 193:12 194:4 194:7 194:10 198:1 198:23 199:4 200:3 207:22 208:6 208:12 208:14 210:24 210:24 219:8
Downstream
[13] 67:10 91:11 91:14 114:6 126:11 127:24 128:10 133:12 133:20 198:14 198:15 209:18 210:5
Downwards
[3] 106:12 113:14 113:19
Dr
[1] 77:20
Drained
[1] 200:21
Drains
[1] 196:10
Draw
[7] 43:24 44:1 44:8 44:12 46:4 46:23 63:23
Drawing
[7] 44:7 61:18 62:3 62:7 62:11 146:17 146:18
Drawn
[5] 49:19 61:20 171:25 172:1 173:21
Drew
[4] 48:11 121:9 121:10 146:13
Drill
[1] 75:23
Drip
[6] 7:18 8:1 8:4 152:6 152:17 152:21
Drips
[1] 200:14
Drive
[2] 8:10 147:12
Driven
[2] 158:18 168:12
Driveway
[1] 144:19
Drop
[2] 32:1 32:15
Dropped
[6] 31:23 31:24 31:25 179:8 185:19 186:6
Drops
[3] 189:13 190:1 190:14
Dry
[13] 76:8 161:13 169:4 169:6 169:9 171:25 172:1 172:3 184:16 184:17 184:18 188:8 188:18
Dryland
[3] 132:9 132:12 132:15
Due
[3] 75:24 125:13 217:19
Dumps
[1] 123:22
During
[29] 19:23 76:7 142:18 151:3 151:24 151:25 152:16 161:20 162:1 164:3 164:20 165:8 165:9 166:1 167:13 169:1 169:6 171:18 171:23 171:25 172:1 172:2 173:7 173:8 173:19 173:22 176:2 206:5 208:18
Duties
[1] 150:2
Dwarfs
[1] 39:7

E

E-2
[4] 24:20 25:3 27:1 27:6
E-3
[3] 25:16 26:8 27:1
E-4
[2] 26:15 26:24
Early
[3] 13:16 15:6 201:4
Easement
[1] 79:13
Easements
[1] 79:1
Easily
[1] 213:25
East
[28] 13:7 14:11 15:8 17:22 18:25 21:15 24:21 31:20 43:1 48:20 50:16 54:3 56:20 71:4 71:7 71:15 74:9 78:23 89:12 150:5 150:17 161:2 161:4 175:14 176:21 187:1 198:9 198:10
Eastern
[4] 17:22 74:14 95:16 191:18
Eastern-most
[1] 191:18
Eat
[1] 208:14
Echo
[1] 25:3
Economic
[3] 21:9 39:2 39:3
Edge
[2] 181:15 181:16
Edward
[3] 3:19 17:4 185:9
Effect
[5] 26:25 127:22 128:4 128:8 182:2
Efficient
[3] 7:15 7:22 27:15
Efficiently
[2] 8:20 8:24
Effort
[5] 70:1 70:22 94:19 96:3 104:25
Efforts
[1] 203:17
Eight
[12] 50:23 50:23 52:11 83:7 83:12 127:4 127:4 140:15 152:14 201:16 202:6 206:24
Eight-inch
[14] 50:23 50:23 52:11 52:20 53:3 56:11 122:4 122:15 122:19 127:3 127:4 127:4 201:16 206:24
Either
[10] 33:5 33:16 35:22 36:15 57:11 121:8 127:1 157:9 173:11 213:21
Elbow
[1] 75:18
Elders
[2] 195:18 195:20
Electricity
[1] 12:18
Electronic
[1] 217:20
Electronically
[1] 108:7
ELIJAH
[1] 2:6
Email
[1] 23:24
EMI
[120] 2:5 6:3 7:15 10:25 11:3 11:7 11:11 12:11 21:7 30:14 31:14 43:18 46:7 53:5 54:24 55:1 56:1 67:10 67:22 68:11 68:18 68:20 70:12 70:21 73:22 74:5 75:9

78:9 78:12 78:16 79:1 79:6 79:7 79:8 81:11 84:3 86:14 86:24 87:3 87:4 87:13 88:3 89:13 91:8 91:9 91:13 92:4 92:12 92:18 92:21 93:4 93:7 93:12 93:22 94:5 94:10 94:25 95:17 96:19 96:20 96:22 96:24 97:24 98:5 99:3 100:13 100:20 100:23 101:4 101:5 101:7 101:8 101:25 102:8 102:10 102:15 103:1 104:22 106:11 106:20 107:20 108:9 109:21 111:14 114:18 114:22 114:25 115:18 120:9 120:14 121:9 126:13 126:18 127:14 127:19 131:1 131:5 131:16 132:17 132:22 133:19 134:7 134:14 135:3 137:10 143:7 147:19 150:19 150:21 153:5 153:9 171:12 202:17 202:19 205:13 207:20 209:2 210:4 214:13 215:14
EMI's
[2] 71:24 115:8
Employed
[1] 148:16
Employee
[1] 89:13
Employees
[1] 74:25
Employer
[2] 6:12 6:13
Encompasses
[2] 62:14 95:16
End
[2] 23:11 192:9
Ended
[4] 69:24 198:20 198:21 218:4
Ends
[2] 48:1 104:4
Energy
[3] 148:25 149:12 149:20
Engaged
[1] 91:13
Enjoy
[1] 13:6
Enlarging
[1] 19:22
Enter
[1] 81:24
Entered
[4] 78:16 92:12 102:9 102:15
Entering
[2] 117:16 117:18
Enters
[2] 189:16 194:8
Entire
[7] 54:21 97:24 99:12 110:18 139:16 166:7 210:4
Entirely
[1] 96:17
Entitled
[5] 24:20 26:15 135:13 138:13 148:5
Entity
[1] 28:16
Entrance
[2] 139:23 192:25
Equal
[1] 160:2
Equals
[3] 63:24 112:5 112:6
Equipment
[1] 111:20
Erecting
[1] 19:11
Ernest
[2] 143:14 144:24
Escaped
[1] 126:8
Especially
[1] 99:15
ESQ
[8] 2:3 2:5 2:6 2:9 2:11 2:14 2:16 2:16
Essence
[1] 159:19
Established
[1] 10:12
Establishes
[1] 18:18
Estate
[6] 28:8 41:8 41:16 41:18 42:8 42:22
Estimate
[6] 41:18 57:12 157:21 215:11 215:13 217:5
Et
[7] 2:17 18:15 19:23 20:23 174:25 185:11 207:10
Evaporating
[1] 159:9
Evaporation
[5] 159:3 160:2 160:11 160:14 160:15
Evapotranspiration
[5] 159:6 162:2 170:8 172:23 173:18
Event
[2] 52:11 217:25
Events
[1] 14:3
Evidence
[19] 3:23 7:4 7:6 22:24 23:5 23:9 31:2 61:5 136:2 144:12 166:21 166:23 205:11 211:23 213:8 213:15 214:11 215:1 217:15
Exact
[3] 63:16 146:9 154:22
Exactly
[3] 58:5 157:25 177:15
Examination
[13] 3:4 3:10 3:13 3:17 3:22 5:12 6:10 30:20 124:11 135:10 148:2 175:8 207:12
Examine
[2] 89:17 89:20
Examined
[6] 6:3 135:3 147:20 175:1 185:11 207:10
Examining
[1] 43:12
Example
[10] 13:13 37:14 41:23 51:10 64:14 104:25 105:5 105:21 109:4 112:5
Exceeds
[2] 9:4 142:3
Except
[3] 4:3 30:18 114:14
Excess
[1] 173:7
Exchange
[2] 79:5 92:15
Exclude
[1] 206:14
Excluding
[1] 162:15
Exclusion
[1] 144:12
Exclusively
[4] 76:24 77:8 77:11 150:19
Excuse
[2] 95:16 124:8
Excused
[2] 43:6 211:9
Executed
[1] 26:7
Executors
[1] 19:17
Exempted
[1] 8:12
Exhibit
[74] 3:24 3:24 3:25 16:4 23:8 24:20 26:15 31:8 43:23 44:10 52:16 52:18 52:19 53:10 53:13 54:9 58:20 58:21 59:12 59:14 59:25 60:23 61:5 61:12 61:18 62:6 62:24 63:8 63:14 64:8 64:10 64:12 64:12 64:22 65:8 66:15 66:15 70:24 76:14 78:7 78:21 78:22 79:10 79:19 80:4 80:16 82:22 82:24 83:3 83:15 83:17 83:18 83:25 89:12 89:13 100:1 101:13 104:19 109:17 113:3 113:6 118:17 118:24 121:3 134:14 136:19 136:21 136:25 137:5 143:21 146:12 176:20 205:10 211:22
Exhibits
[15] 3:23 15:25 50:9 50:14 50:17 53:16 80:10 88:10 88:10 89:9 89:10 100:2 146:23 146:23 213:16
Exhibits-28E
[1] 119:23
Exist
[5] 28:17 78:12 79:2 82:25 107:14
Existed
[1] 43:20
Existence
[2] 51:20 51:22
Existing
[6] 107:17 107:24 180:25 186:24 186:25 212:25
Exists
[2] 35:12 43:22
Exits
[1] 189:11
Expand
[3] 27:19 104:12 104:14
Expanding
[1] 105:5
Expansion
[7] 28:6 28:12 28:23 29:17 29:22 30:8 30:15
Expecting
[1] 30:19
Experience
[3] 157:22 159:3 201:9
Experienced
[2] 132:6 207:19
Expert
[3] 77:20 130:8 130:22
Expired
[2] 25:12 111:5
Explain
[10] 45:1 62:1 90:3 105:17 106:7 108:6 138:23 156:13 171:14 195:14
Explicit
[1] 21:14
Expose
[1] 201:9
Extend
[1] 27:5
Extended
[2] 25:12 111:6
Extent
[7] 33:8 39:10 96:23 129:6 160:10 180:15 187:11

F

Facilities
[1] 104:15
Facing
[1] 190:11
Fact
[15] 39:7 46:17 48:15 59:25 65:9 72:5 76:23 77:7 94:24 114:11 137:22 158:1 203:12 208:24 215:4
Facts
[3] 56:6 166:21 166:22
Fair
[2] 129:16 171:23
Fairly
[1] 37:10
Fall
[1] 193:15
Fallow
[4] 154:3 154:7 155:15 162:19
Falls
[10] 45:16 45:18 45:23 45:23 73:20 74:7 75:5 193:23 194:3 203:3
Familiar
[24] 10:7 13:9 17:24 20:5 22:6 24:16 28:7 31:11 33:2 34:4 62:6 66:13 71:12 113:7 113:10 132:9 145:3 182:19 183:21 183:24 184:2 201:14 201:20 202:8
Familiarity
[1] 11:5
Familiarization
[2] 11:23 31:13
Family
[7] 67:17 93:24 93:25 94:4 175:18 176:11 194:11
Far
[14] 49:1 55:25 76:9 103:12 103:18 176:14 176:15 176:15 189:21 189:23 189:23 192:7 193:5 193:19
Farm
[9] 32:18 36:18 40:1 40:3 62:7 154:25 156:14 185:18 202:5
Farmed
[1] 7:25
Farmer
[8] 59:14 59:18 59:23 60:3 60:6 77:3 77:12 77:14
Farmers
[14] 15:15 74:5 76:1 103:15 103:16 161:4 182:3 203:16 214:17 214:22 215:2 215:13 215:17 215:17
Farming
[7] 59:23 61:1 62:9 76:16 175:23 176:3 195:19
Farms
[1] 76:12
Fashion
[3] 48:8 84:6 173:15
Features
[2] 47:3 47:20
Fed
[5] 74:13 198:16 200:11 200:21 205:14
Federal
[3] 39:23 40:23 40:24
Fee
[4] 86:25 87:3 87:4 87:11
Feed
[4] 74:8 180:21 187:15 198:22
Feeds
[1] 191:7
Feet
[14] 63:25 69:15 85:11 85:23 112:2 112:5 112:6 123:8 123:13 139:22 145:8 190:6 191:8 191:11
Fell
[2] 60:8 98:1
Few
[1] 37:5
Field
[14] 46:12 46:12 73:13 77:10 114:15 114:17 126:3 143:11 143:15 143:18 144:23 161:14 161:19 161:22
Fields
[16] 11:7 11:10 11:14 12:9 13:1 150:18 153:25 154:3 154:18 154:24 155:10 156:8 156:19 159:4 159:10 171:9
Figure
[14] 64:17 81:7 98:18 118:25 119:8 158:12 162:19 165:5 171:8 171:10 172:11 172:19 172:22 173:10
Figured
[1] 65:4
Figures
[3] 158:12 169:22 173:24
FILE
[1] 1:3
Filed
[4] 100:3 100:8 100:9 204:10
Fill
[1] 73:7
Filled
[2] 75:5 171:24
Filling
[1] 75:18
Finally
[1] 26:2
Findings
[2] 217:3 217:18
Fine
[3] 23:17 33:10 165:8
Finish
[1] 4:12
Finished
[1] 50:12
Finishes
[1] 117:12
First
[25] 4:16 4:25 14:15 17:17 22:11 22:13 64:8 68:12 72:3 74:11 74:20 75:10 80:12 82:13 83:4 105:6 136:8 148:15 178:8 184:9 184:18 186:22 190:5 191:8 209:15
Fiscal
[2] 118:19 119:19
Fits
[1] 171:15
Five
[5] 25:9 43:7 118:9 157:24 175:12
Five-minute
[1] 43:7
Fixes
[1] 131:10
Fixing
[1] 76:2
Fleming
[1] 2:6
Floods
[1] 196:1
Florida
[1] 40:21
Flow
[39] 12:8 50:22 53:2 53:7 53:9 59:4 59:5 59:7 59:8 59:9 59:10 66:11 73:24 76:6 106:5 108:4 108:16 114:6 116:7 122:9 122:10 127:5 127:6 132:24 132:24 133:6 138:11 138:13 138:16 141:8 142:19 171:19 182:10 192:4 193:19 193:20 195:1 196:7 199:3
Flowing
[11] 52:23 84:22 142:8 146:20 193:4 194:21 194:21 196:2 199:8 199:10 199:12
Flown
[1] 75:16
Flows
[5] 51:2 108:20 115:2 171:20 173:7
Flume
[26] 101:25 102:3 107:2 107:8 139:2 139:12 139:13 139:16 139:19 139:20 139:24 140:1 140:3 140:10 140:12 140:14 140:15 140:18 140:19 141:18 141:21 141:23 141:25 142:1 142:2 142:7
Flumes
[2] 19:13 139:3
Foldout
[1] 177:22
Follow
[8] 45:9 47:23 47:24 95:11 142:11 144:13 162:5 194:7
Following
[3] 88:14 125:9 217:11
Follows
[7] 6:4 48:4 135:4 147:21 175:1 185:12 207:11
Force
[1] 141:20
Foregoing
[2] 219:10 219:12
Forest
[4] 45:5 45:8 47:23 49:23
Forgot
[1] 85:4
Form
[10] 36:25 40:5 40:6 56:5 57:10 57:18 57:21 82:7 103:5 162:16
Formations
[1] 179:18
Formed
[1] 200:16
Former
[3] 17:19 155:9 196:3
Formerly
[1] 18:10
Forms
[2] 58:17 73:7
Forty
[1] 68:5
Forward
[1] 15:17
Foundation
[6] 90:6 100:25 110:10 165:13 166:21 199:18
Founded
[1] 216:2
Four
[36] 26:5 66:22 66:23 79:16 83:24 84:1 84:4 97:19 97:20 97:20 98:13 98:15 111:8 111:15 112:9 112:14 112:15 112:16 112:25 113:22 114:4 114:9 119:2 119:21 119:22 120:18 120:

23 120:24 146:3 146:4 146:5 150:9 175:12 187:4 202:23 205:25
Four-inch
[4] 66:22 66:23 114:4 127:2
Fourth
[2] 138:13 212:3
Freedman
[1] 4:3
Friday
[3] 214:2 216:14 217:13
Front
[7] 6:17 19:19 79:20 80:3 135:12 136:22 148:4
Full
[2] 50:23 171:5
Fully
[2] 34:20 100:13
Function
[2] 153:22 186:19
Functional
[3] 117:17 117:21 117:22
Functioning
[1] 111:20
Fundamentally
[1] 24:16
Funnel
[1] 140:12
Funneled
[1] 140:3
Furrow
[1] 152:22
Future
[2] 20:24 131:21

G

Gain
[7] 84:12 84:15 85:8 85:13 86:6 86:7 86:11
Gained
[1] 85:17
Gallon
[3] 42:17 133:1 171:8
Gallons
[50] 9:5 29:11 29:21 30:6 99:1 99:5 99:8 106:2 106:3 106:5 112:4 112:6 112:7 116:8 116:11 118:18 118:22 132:18 132:21 133:4 138:2 142:4 142:6 151:1 151:3 151:18 151:20 151:22 152:1 152:4 152:10 152:15 153:1 158:13 158:21 158:22 165:4 165:6 165:22 166:4 167:24 168:1 168:21 168:25 169:5 169:14 173:12 173:13 173:24 173:25
Galvanized
[1] 201:25
Garret
[7] 3:6 32:18 32:20 43:13 71:3 202:12 207:14
Gasoline
[1] 147:12
Gate
[7] 124:17 125:25 126:2 126:4 126:9 126:11 142:17
Gates
[6] 124:14 124:24 125:8 125:10 125:12 150:11
Gauge
[5] 107:13 107:21 112:2 126:23 142:1
Gauging
[9] 107:11 108:2 108:9 110:6 111:25 112:1 112:10 112:14 112:15
General
[13] 2:3 6:15 10:23 11:4 11:8 13:4 13:8 31:13 32:12 161:11 176:9 177:2 183:1
Generalization
[1] 10:3
Generally
[13] 8:21 9:1 13:11 41:12 81:6 102:22 105:3 113:10 139:15 158:3 158:11 171:14 176:11
Generated
[1] 39:13
Generation
[1] 39:3
Generous
[1] 194:11
Geographical
[1] 44:22
Geography
[1] 37:5
Geological
[1] 111:18
Giant
[1] 187:24
Gist
[1] 8:23
Given
[17] 15:4 41:24 47:10 92:15 133:7 133:11 133:18 156:20 157:1 157:10 158:6 162:24 165:10 166:2 167:11 169:8 171:5
Gomes
[1] 216:8
Governing
[1] 14:10
Government
[16] 13:22 13:23 14:16 15:5 15:13 18:11 39:23 40:6 82:2 82:20 86:21 94:16 96:18 97:9 97:10 97:19
Government-owned
[2] 82:2 82:20
Grandfather
[1] 77:1
Grandson
[1] 77:4
Grant
[5] 15:6 79:1 79:7 79:8 212:9
Granted
[4] 15:13 79:13 212:22 213:5
Grants
[1] 18:9
Graph
[2] 119:8 119:18
Grate
[2] 183:20 192:25
Gravel
[2] 191:5 194:23
Gravity
[1] 12:8
Great
[3] 84:22 161:12 203:17
Green
[13] 25:21 25:25 45:6 45:7 86:24 86:24 86:24 87:2 87:2 87:3 95:18 95:18 113:12
Green-hatched
[2] 45:6 45:7
Greg
[3] 3:16 174:23 175:4
Grew
[3] 77:13 132:7 132:9
Ground
[15] 46:20 48:13 48:18 151:15 153:23 163:2 167:22 169:23 172:13 172:20 172:20 173:2 174:1 179:18 183:3
Grounds
[3] 144:1 144:3 144:12
Groundwater
[1] 150:22
Group
[2] 6:16 39:14
Groups
[1] 100:15
Grow
[13] 130:13 131:7 131:11 131:14 131:18 132:2 132:4 132:8 160:13 175:18 207:15 207:20 208:24
Grower
[4] 130:19 131:24 132:1 132:5
Growing
[5] 33:14 146:19 181:5 187:7 210:14
Grown
[3] 132:5 132:12 132:14
Grows
[2] 105:12 105:14
Growth
[3] 130:23 160:23 160:23
Guess
[12] 7:20 10:7 23:17 24:16 55:24 65:19 68:1 70:8 80:3 155:22 157:20 160:2
Guidance
[1] 217:23
Gulch
[2] 18:2 36:3

H

H.P.
[7] 14:18 14:19 16:16 16:19 16:22 17:4 20:5
Haia
[46] 2:16 3:7 3:11 43:11 43:15 44:3 44:5 44:22 44:25 45:4 45:17 46:1 49:7 50:1 50:13 52:17 54:23 56:14 58:6 60:22 61:11 61:14 61:17 62:16 62:23 64:7 65:9 68:5 69:12 90:7 90:25 134:4 136:4 136:7 140:24 142:12 143:1 149:6 149:7 213:14 213:19 213:23 215:8 215:19 216:4 216:14
Haiku
[38] 1:9 1:9 9:4 16:17 16:23 31:19 32:1 35:18 36:2 86:9 86:10 87:25 95:25 96:5 103:24 103:25 112:18 113:15 116:7 117:10 120:20 121:15 121:24 122:22 123:5 123:9 123:17 124:9 124:15 125:11 126:2 128:20 128:21 131:12 132:25 209:14 210:14 210:22
Half
[4] 16:20 55:3 146:2 164:11
Hall
[65] 2:14 3:5 3:8 3:11 4:11 4:22 5:2 5:9 5:15 31:5 31:7 32:8 33:10 37:9 38:16 78:1 78:4 78:6 78:21 80:2 80:8 80:12 83:14 88:21 89:2 90:7 90:13 90:14 90:24 91:22 92:12 96:13 100:7 101:4 103:8 103:24 104:3 104:21 110:11 110:14 112:23 117:14 118:2 118:12 118:14 118:24 129:9 129:12 129:16 129:20 130:9 131:5 133:23 134:20 143:3 143:4 143:6 143:20 144:1 144:5 144:13 144:17 147:5 147:15 149:2
Hamakua
[17] 31:18 31:24 71:6 71:6 84:19 84:23 84:24 85:7 85:10 85:12 103:22 106:17 112:17 113:14 121:15 121:23 124:7
Hana
[10] 2:10 29:4 38:4 38:6 44:21 47:14 48:1 69:4 128:20 183:25
Hanawi
[2] 105:22 105:23
Hand
[7] 16:10 24:19 26:14 64:23 176:19 192:22 204:9
Handle
[1] 142:8
Hanehoi
[42] 83:23 83:25 84:1 84:2 84:4 84:7 84:9 84:12 84:14 84:19 84:21 84:23 85:2 85:7 85:10 86:6 114:6 121:13 121:14 121:21 123:5 123:14 123:18 123:20 123:21 123:22 123:22 124:1 124:2 124:8 124:9 124:10 124:15 124:20 125:22 126:1 126:6 127:7 128:18 128:21 132:23 132:25
Happy
[1] 100:4
Hard
[7] 45:1 45:17 95:21 119:8 209:25 211:17 217:20
Harvesting
[2] 154:19 155:15
Hatched
[2] 45:6 45:7
Hauolo
[1] 101:20
Hawaii
[27] 1:2 1:9 1:21 2:2 2:4 2:8 2:10 2:13 2:15 2:17 13:20 16:16 18:11 42:2 71:17 79:5 79:14 81:9 82:5 82:13 86:23 133:7 133:11 133:18 209:14 219:2 219:18
Hawaii's
[1] 17:20
Hawaiian
[4] 6:15 31:11 100:22 113:8
Hazard
[1] 157:20
HC&S
[49] 7:14 7:25 10:6 10:10 10:16 10:25 11:7 12:2 13:6 14:14 14:16 19:18 21:7 21:18 25:7 27:14 27:17 28:15 28:16 28:17 29:10 31:9 32:22 33:1 36:17 37:9 37:20 42:3 42:21 103:19 103:22 104:21 113:12 148:16 149:13 149:16 149:20 150:2 150:6 150:23 151:9 153:4 154:13 156:8 156:19 158:6 159:2 159:15 161:1
HC&S'
[1] 10:17
Head
[1] 27:9
Healthy
[6] 130:13 131:7 131:14 131:18 132:3 160:13
Hear
[11] 37:3 99:2 130:15 148:21 152:18 186:18 205:12 205:23 207:14 214:5 216:17
Heard
[9] 22:11 76:11 99:7 127:7 127:14 171:9 185:15 187:22 188:7
Hearing
[18] 1:6 4:2 15:21 24:2 70:9 112:20 113:1 138:24 175:10 197:1 204:11 208:18 209:9 210:8 214:6 214:18 216:23 217:23
Hearings
[169] 2:1 4:1 4:7 4:18 5:7 5:10 5:18 5:23 6:5 6:8 7:3 9:18 15:23 16:5 22:21 23:1 23:4 23:16 23:21 24:8 24:13 30:24 31:4 32:4 37:2 37:7 38:18 43:5 43:9 44:18 48:23 49:2 49:8 49:11 49:16 49:20 49:24 50:11 52:10 52:14 56:7 57:24 61:7 62:20 64:5 64:20 65:1 68:25 69:8 77:25 78:3 79:25 80:5 80:9 82:9 83:10 88:24 90:9 91:1 91:20 92:5 96:11 101:1 103:10 117:24 118:3 118:7 118:11 118:20 129:18 130:4 131:3 133:25 134:18 134:21 134:24 135:5 135:8 136:1 140:20 141:3 141:7 141:11 141:14 142:10 143:2 143:24 144:2 144:11 147:3 147:16 147:22 147:25 148:22 149:5 154:11 161:7 161:10 161:24 162:3 163:10 163:15 163:18 164:2 165:17 166:24 167:8 170:2 170:16 171:1 172:5 172:8 172:14 174:7 174:11 174:14 174:18 174:21 175:2 175:5 176:16 177:20 177:25 178:6 179:5 182:12 183:9 184:6 185:3 185:6 188:6 188:10 188:25 189:10 189:17 189:22 190:4 191:9 192:17 195:10 204:12 204:20 204:24 205:3 205:5 205:8 207:2 207:5 209:22 210:9 211:5 211:8 211:12 211:20 212:11 212:16 213:7 213:11 213:17 213:20 214:1 214:4 215:10 215:15 216:1 216:12 216:15 217:7 217:10
Heart
[1] 129:17
Heavy
[1] 69:16
Height
[4] 112:2 139:17 141:16 142:2
Held
[2] 1:8 217:9
Hello
[1] 120:21
Help
[6] 61:23 208:16 208:21 210:15 210:20 215:22
Helped
[1] 59:13
Helpful
[2] 24:1 211:25
Helping
[1] 72:25
Henceforth
[1] 82:15
Henry
[1] 143:10
Hereby
[2] 19:15 219:6
Herein
[3] 212:21 213:4 219:8
Hereof
[1] 212:24
Hereto
[2] 136:18 219:15
Hew
[27] 3:6 4:8 4:12 5:3 5:8 43:10 43:13 43:16 45:12 45:19 50:2 50:9 53:11 58:21 62:17 62:19 66:8 71:3 89:2 130:25 134:22 186:18 202:12 202:16 205:23 207:14 209:2
Hew's
[2] 202:14 202:15
High
[7] 2:12 84:8 142:3 142:18 151:2 171:18 199:4
Higher
[4] 41:9 101:17 130:14 139:14
Highest
[2] 84:8 84:10
Highlighted
[2] 65:20 66:2
Highway
[17] 2:10 8:10 29:4 38:4 38:6 44:21 47:13 47:14 48:1 69:5 75:25 128:21 183:21 183:25 196:22 197:8 199:23
Hikina
[2] 71:7 71:13
Hill
[2] 12:14 12:16
Hired
[2] 70:18 70:21
Historic
[1] 186:15
Historical
[4] 12:23 14:13 71:5 71:9
Historically
[1] 200:20
History
[5] 13:8 13:9 71:11 71:13 175:13
Ho'okano
[14] 3:16 174:23 175:4 178:2 185:15 185:25 188:7 189:5 189:8 189:9 190:3 192:10 193:22 194:11
Ho'okano's
[5] 192:20 193:8 193:9 194:5 194:17
Holaday
[14] 3:3 3:23 4:10 6:1 6:7 6:12 7:5 7:10 16:10 19:5 24:15 27:13 38:25 113:6
Holaday's
[1] 30:22
Hold
[2] 88:3 91:10
Holders
[1] 209:19
Holdover
[1] 111:6
Hole
[1] 193:4
Homestead
[3] 176:10 176:24 196:20
Honokala
[1] 87:20
Honolulu
[7] 2:4 2:8 2:17 26:10 41:22 219:4 219:18
Honomanu
[10] 1:4 14:25 17:23 18:2 81:3 97:11 105:2 105:

14 105:25 111:4
Honopou
[25] 7:12 66:9 66:11 66:19 66:25 67:11 67:20 83:6 83:8 83:9 87:20 95:7 95:17 95:19 107:17 109:14 112:16 118:18 118:23 118:23 119:2 137:18 207:16 207:21 210:20
Honor
[5] 169:21 177:23 204:18 209:8 211:10
HONORABLE
[1] 2:1
HOOKANO
[1] 175:7
Hooked
[2] 108:3 108:14
Hope
[1] 5:19
Hopefully
[1] 181:23
Horseshoe
[2] 45:25 47:14
Hospitality
[1] 218:3
Hour
[1] 23:15
Hours
[4] 131:6 131:17 132:18 161:19
House
[3] 120:6 139:4 207:25
Huelo
[19] 1:4 15:1 81:2 85:20 86:3 87:19 87:19 94:18 94:18 95:4 95:6 95:15 96:24 97:10 105:2 105:15 106:1 106:16 209:13
Huge
[2] 62:18 75:19
Hui
[3] 2:16 7:11 87:5
Hundred
[1] 69:14
Hungry
[1] 118:5
Hydrograph
[1] 118:17
Hypothetical
[1] 169:16

I

Idea
[8] 110:4 116:2 116:3 119:19 156:2 157:12 157:17 161:11
Identification
[2] 22:15 56:21
Identified
[9] 45:1 45:18 45:23 48:12 54:8 54:12 54:14 55:11 103:7
Identify
[2] 47:7 215:12
Identifying
[1] 215:25
II
[1] 71:14
II:1
[1] 70:25
Iki
[1] 18:3
III
[2] 195:19 197:21
Implies
[1] 155:7
Important
[1] 170:5
Improvement
[1] 203:19
Improvements
[1] 15:8
Inaccurate
[2] 96:23 183:7
Inadequate
[2] 68:19 202:18
Inc
[1] 87:16
Inch
[25] 50:23 50:23 52:11 53:8 56:11 63:24 66:10 66:18 66:22 66:23 92:22 114:4 114:9 121:19 122:3 122:8 122:14 122:24 127:4 127:4 139:2 201:15 201:16 202:6 206:24
Inches
[5] 123:16 140:15 140:16 202:6 202:7
Include
[5] 16:13 148:8 173:5 186:10 201:12
Included
[2] 71:8 173:8
Included-conducting
[1] 71:8
Includes
[3] 19:8 41:20 172:11
Including
[1] 146:3
Incomplete
[1] 169:16
Incompletion
[1] 169:18
Inconsistent
[1] 172:10
Incorporated
[1] 20:3
Incorporates
[1] 169:25
Incorrect
[4] 49:9 66:21 97:17 101:3
Increased
[1] 158:14
Incumbered
[1] 83:13
INDEX
[1] 3:1
Indicate
[2] 91:25 97:3
Indicated
[4] 59:22 64:1 65:22 86:20
Indicates
[2] 109:25 116:24
Indicating
[1] 62:8
Indirectly
[1] 104:3
Individual
[2] 64:13 154:25
Individually
[1] 63:11
Individuals
[5] 7:11 71:11 87:13 100:14 133:8
Indulgence
[1] 209:9
Industrial
[3] 34:11 34:12 36:23
Infer
[1] 149:15
Inform
[1] 184:11
Information
[19] 28:4 37:21 59:19 59:25 60:1 60:9 60:20 61:5 62:11 75:11 111:10 112:19 112:21 112:23 113:2 138:9 139:3 160:25 204:3
Informed
[1] 4:4
Injuriously
[1] 213:4
Inlet
[1] 139:9
Inquire
[1] 89:23
Inspection
[12] 46:16 77:10 125:3 125:4 125:10 125:16 125:21 125:25 143:11 143:15 143:18 144:23
Installed
[3] 53:4 75:11 126:24
Instance
[6] 47:6 52:4 64:3 83:23 97:10 110:1
Instances
[2] 57:17 66:3
Instantaneous
[1] 108:16
Instead
[3] 119:8 128:1 194:4
Intact
[1] 180:17
Intake
[5] 54:16 120:20 122:25 144:10 145:1
Intakes
[1] 54:17
Intended
[1] 114:5
Intent
[1] 31:1
Inter
[1] 10:25
Inter-relationship
[1] 10:25
Interest
[5] 18:13 18:20 20:6 87:5 87:9
Interested
[1] 219:15
Interests
[1] 15:14
Interfere
[2] 18:20 21:15
Interpreting
[1] 7:14
Interrogatories
[3] 214:14 215:5 215:6
Interrogatory
[1] 214:18
Interrupted
[1] 117:12
Intersections
[1] 177:3
Intersects
[3] 48:5 48:7 50:5
Intervene
[3] 100:3 100:8 134:20
Intervenors
[2] 80:3 99:25
Interviews
[1] 71:11
Intimate
[1] 11:6
INTRODUCTION
[1] 71:2
Investigate
[2] 46:10 138:5
Investigation
[1] 46:13
Involve
[1] 14:25
Involved
[3] 40:21 74:20 153:18
Involvement
[1] 149:17
Involving
[1] 12:23
Iron
[1] 201:24
Irrelevant
[1] 130:25
Irrigate
[3] 155:3 159:2 161:22
Irrigated
[32] 8:4 11:17 153:4 153:9 153:11 153:13 153:13 153:14 153:15 153:17 153:25 154:7 157:9 157:9 157:14 157:14 158:2 158:16 161:14 162:11 162:13 162:17 162:21 162:22 162:25 163:4 164:4 164:10 164:20 165:10 167:13 203:20
Irrigating
[5] 156:8 158:7 160:10 160:12 162:14
Irrigation
[54] 7:18 8:1 8:5 15:8 19:1 24:22 71:4 71:15 78:24 89:12 113:23 150:5 150:6 150:17 150:18 152:6 152:17 152:21 152:22 154:4 155:9 155:10 155:21 156:17 156:25 158:19 159:11 159:14 159:24 161:2 161:11 161:18 161:18 163:6 163:8 163:21 163:22 164:16 164:20 166:3 166:9 167:2 167:16 168:3 168:13 169:9 171:16 171:19 171:19 171:22 176:21 187:1 195:8 203:1
Isaac
[8] 2:14 59:18 61:23 61:25 62:2 62:5 62:10 149:2
Island
[1] 71:8
Isohyetal
[1] 97:25
Issue
[6] 203:22 213:18 214:9 214:16 216:19 217:21
Issues
[2] 210:7 217:15
Itself
[5] 49:14 85:24 129:11 176:13 184:12

J

Jakeway
[8] 3:12 5:21 147:18 147:24 148:4 148:5 159:13 160:24
Jane
[2] 2:11 170:21
January
[2] 217:19 217:21
JEAN
[3] 1:21 219:6 219:21
Joe
[1] 179:21
JOHN
[1] 2:1
Join
[4] 37:6 58:1 122:18 123:6
Jointly
[2] 12:3 12:4
Judge
[178] 4:1 4:7 4:18 5:7 5:10 5:18 5:23 6:5 6:8 7:3 9:18 15:23 16:5 20:1 22:21 23:1 23:4 23:16 23:21 24:8 24:13 30:24 31:4 32:4 37:2 37:7 38:18 43:5 43:9 44:18 44:21 48:23 48:25 49:2 49:8 49:11 49:16 49:20 49:24 50:11 52:10 52:14 53:12 56:7 57:24 60:22 61:7 62:16 62:20 64:5 64:20 65:1 69:8 77:22 77:25 78:3 79:25 80:5 80:9 82:9 83:10 88:24 90:9 91:1 91:20 92:5 96:11 101:1 103:10 117:24 118:3 118:7 118:11 118:13 118:20 125:22 129:18 130:4 131:3 133:25 134:18 134:21 134:24 135:5 135:8 136:1 140:20 141:3 141:7 141:11 141:14 142:10 143:2 143:24 144:2 144:11 147:3 147:16 147:22 147:25 148:22 149:5 154:11 161:7 161:10 161:24 162:3 163:10 163:15 163:18 164:2 165:17 166:24 167:8 170:2 170:16 171:1 172:5 172:8 172:14 174:7 174:11 174:14 174:18 174:21 175:2 175:5 176:16 177:20 177:25 178:6 179:5 182:12 183:9 184:6 185:3 185:6 188:6 188:10 188:25 189:10 189:17 189:22 190:4 191:9 192:17 195:10 204:12 204:20 204:24 205:3 205:5 205:8 207:2 207:5 209:22 210:9 211:5 211:8 211:12 211:20 212:11 212:16 213:7 213:11 213:17 213:20 214:1 214:4 215:10 215:15 215:20 216:1 216:5 216:12 216:15 217:7 217:10
July
[2] 6:18 148:6
Junction
[4] 123:17 123:20 123:25 203:2
Jurisdiction
[1] 104:4

K

K-knife
[1] 69:16
K.N.
[1] 2:16
Kahului
[4] 2:10 27:19 34:1 34:7
Kai
[3] 3:16 174:23 175:4
Kakaako
[1] 41:21
Kamole
[13] 102:5 102:14 102:17 102:21 102:23 103:4 103:12 103:19 104:1 104:4 104:12 104:16 107:9
Kanoa
[18] 59:18 59:19 59:20 60:1 60:9 60:19 60:25 61:23 61:25 62:21 213:13 214:12 214:24 215:11 215:14 215:21 216:13 216:17
Kauhikoa
[3] 31:19 31:25 113:15
Keahua
[1] 32:19
Keala
[3] 93:24 94:4 123:4
Keanae
[17] 1:4 14:25 15:16 17:21 18:13 18:21 19:2 55:6 55:10 70:16 80:25 97:11 101:20 105:1 105:12 132:11 209:11
Keanae-Wailuanui
[2] 19:2 70:16
Keep
[6] 24:7 67:22 142:17 159:5 172:9 204:6
Keeping
[1] 171:5
Kekahuna
[14] 3:21 67:17 137:2 137:18 138:11 142:14 142:17 142:22 207:6 207:8 209:19 210:6 210:10 210:11
Kekahuna's
[1] 139:4
Kepa
[1] 70:3
Kiefer
[1] 2:9
Kind
[5] 11:20 71:23 179:7 181:16 203:9
King
[2] 2:4 82:12
Kingdom
[6] 13:19 14:14 17:19 18:11 209:14 209:16
Kingdom's
[1] 212:9
Knife
[1] 69:16
Knowing
[2] 51:17 169:18
Knowledge
[19] 30:9 30:16 32:25 33:22 34:8 40:6 42:3 42:9 51:15 52:2 54:11 60:2 88:7 91:4 99:25 102:8 115:4 135:22 148:13
Known
[4] 71:11 196:10 196:17 209:13
Ko'olau
[3] 2:16 7:11 71:7
Koolau
[2] 53:24 53:25
Kualani
[43] 43:19 43:22 44:9 45:10 46:5 46:9 46:24 46:25 47:4 47:7 47:11 47:17 47:25 48:2 48:3 48:7 48:10 48:12 48:16 49:3 49:7 49:12 49:13 49:19 50:3 63:23 187:21 187:23 188:1 195:18 196:6 196:9 196:9 196:18 197:22 198:1 198:21 198:22 199:3 199:22 199:23 199:25 200:9
Kualani-Kupau
[1] 199:25
Kula
[2] 103:22 107:10
Kuleana
[1] 207:21
Kumo
[1] 71:4
Kupau
[19] 188:2 195:20 196:11 197:2 197:3 197:21 198:16 199:1 199:8 199:13 199:16 199:19 199:25 200:6 200:11 200:17 200:18 200:19 200:21
Kupunas
[1] 72:4

L

Label
[2] 45:2 56:22
Labeled
[5] 45:8 48:16 49:3 50:2 192:12
Lack
[8] 51:14 76:12 90:5 100:24 110:9 165:13 194:6 199:18
Lacks

[1] 166:20
Lady
[1] 25:21
Lahaina
[1] 19:10
Lakini
[15] 48:6 69:1 183:17 183:18 184:1 186:8 194:21 195:16 195:21 195:24 196:4 197:25 198:23 200:22 203:14
Land
[56] 1:1 2:9 7:25 9:3 9:10 9:22 18:10 18:11 19:15 21:10 24:17 24:22 24:25 28:17 33:17 33:20 36:9 71:13 71:16 71:17 79:8 79:9 81:1 81:15 81:16 81:18 82:16 86:21 87:5 87:5 87:17 92:6 92:8 94:25 94:25 95:1 95:18 96:22 96:22 98:1 98:3 98:6 99:3 99:11 99:17 99:20 101:25 103:21 134:14 150:6 153:4 153:8 157:9 158:7 181:14 181:19
Landowners
[5] 18:13 18:21 21:15 137:17 216:6
Lands
[59] 8:3 12:1 13:24 17:5 17:19 19:7 19:12 19:15 19:16 28:13 28:19 28:20 33:4 33:16 33:25 34:6 35:14 36:15 36:20 36:20 36:21 37:10 37:18 38:4 38:5 43:18 71:6 78:12 78:12 79:2 79:3 79:12 79:13 80:21 80:24 81:4 86:22 87:2 87:4 87:23 87:24 88:4 88:5 134:14 150:2 153:21 154:14 155:3 157:9 157:13 158:15 159:2 162:14 162:15 166:3 166:10 207:21 210:2 213:1
Landscape
[2] 71:12 177:23
Landslide
[2] 75:3 75:18
Language
[1] 211:17
Large
[5] 39:10 56:10 84:22 95:1 95:18
Last
[30] 30:22 39:18 40:4 40:6 40:10 40:25 41:2 46:7 62:24 68:24 68:24 68:25 76:9 82:6 83:5 83:6 83:11 111:3 114:7 114:12 114:14 135:13 135:16 137:25 164:16 175:6 184:19 184:21 210:11 217:6
Lasts
[1] 161:19
Late
[1] 185:1
Law
[1] 25:25
Lawyers
[1] 170:21
Lay
[1] 154:3
Lead
[1] 177:3
Learned
[1] 76:25
Lease
[21] 14:10 14:14 14:15 16:15 16:25 18:15 18:18 19:6 81:9 81:14 81:15 81:22 83:13 95:23 109:21 134:7 178:5 205:1 209:11 209:16 210:1
Leased
[6] 33:17 36:9 81:11 82:12 82:16 97:24
Leases
[3] 86:14 88:3 91:9
Leasing
[3] 81:17 81:18 81:20
Least
[7] 22:15 33:2 41:14 61:4 82:25 174:16 187:11
Leave
[4] 22:17 24:6 103:8 146:11
Leaves
[2] 149:2 188:17
Leaving
[1] 160:7
Led
[1] 122:3
Lee
[4] 3:12 147:18 147:24 148:5
Left
[11] 4:6 43:16 57:12 57:18 58:17 58:19 160:3 160:9 190:12 190:20 190:22
Left-hand
[4] 58:24 58:25 109:6 121:13
Legal
[11] 26:1 26:25 28:16 82:8 88:20 90:23 96:9 100:22 129:15 161:1 161:6
Legend
[1] 59:4
Less
[11] 39:12 55:14 55:17 55:19 76:6 88:12 121:1 131:8 138:6 157:23 161:25
Lessee
[1] 19:16
Lessened
[1] 213:3
Letting
[2] 62:18 208:10
Level
[30] 8:18 72:25 73:4 73:5 74:12 84:8 84:8 84:10 84:11 84:21 85:12 101:11 101:17 109:7 112:3 113:21 121:20 121:23 121:23 121:24 122:2 122:22 124:16 124:18 132:23 132:25 139:8 140:5 160:22 160:22
License
[54] 14:25 17:21 19:8 24:20 25:15 26:16 55:6 55:10 71:15 79:16 80:23 80:25 81:2 81:3 81:22 81:23 81:25 83:5 83:7 86:17 86:18 87:19 94:14 94:19 95:2 95:4 95:4 95:6 95:15 97:4 97:19 97:20 101:20 105:1 109:23 110:1 110:7 110:16 110:20 111:4 111:4 111:6 111:9 111:11 111:16 112:25 119:2 119:21 119:22 134:8 134:11 134:12 209:13 209:14
Licensed
[3] 79:22 80:14 80:22
Licenses
[6] 1:3 86:14 88:3 88:8 91:8 205:25
Life
[3] 27:5 175:22 176:2
Lifetime
[1] 181:4
Lift
[1] 141:22
Likewise
[1] 85:4
Limited
[5] 24:22 37:13 91:4 122:7 122:9
Limits
[1] 23:19
LINDA
[1] 2:3
Line
[17] 20:10 45:4 45:5 45:8 45:8 45:11 45:12 47:23 47:24 48:10 49:22 49:23 62:7 62:11 162:6 178:17 209:21
Lined
[1] 176:23
Lines
[2] 61:19 62:3
List
[2] 82:24 82:25
Live
[2] 67:18 175:11
Lived
[2] 36:7 72:8
Lo'i
[36] 60:3 62:15 74:9 76:20 77:7 115:19 115:23 130:13 146:25 147:1 147:6 177:7 177:11 177:15 178:4 179:12 179:18 179:20 179:25 180:14 180:16 180:17 180:18 180:19 180:20 180:24 181:5 183:4 183:6 186:1 186:2 203:19 205:14 207:16 210:16 210:19
Lo'is
[7] 180:21 180:22 180:22 180:23 186:9 198:1 208:24
Loa
[1] 71:6
Locate
[1] 47:11
Located
[9] 55:10 73:9 171:17 177:11 177:11 178:4 178:10 178:22 179:8
Location
[5] 46:18 47:16 47:18 47:22 51:11
Locations
[1] 46:19
Long-term
[1] 111:4
Look
[36] 14:9 19:19 31:8 56:16 58:3 58:21 62:13 72:10 72:13 72:17 78:7 78:21 79:19 82:22 87:18 87:18 100:1 104:19 105:4 105:25 106:3 106:16 109:17 120:20 121:3 137:5 137:22 142:1 145:6 147:1 177:14 188:19 206:2 206:13 211:14 212:5
Looked
[10] 44:13 46:19 57:6 60:11 65:7 65:13 75:21 146:12 188:14 199:6
Looking
[26] 14:12 43:17 50:8 50:14 59:21 60:7 62:5 74:22 79:10 95:9 101:13 102:5 105:7 113:6 118:25 119:7 143:9 146:14 170:11 176:9 176:10 178:2 190:11 190:18 192:12 204:21
Lookout
[1] 44:16
Looks
[2] 109:19 178:18
Lose
[2] 8:24 8:25
Loss
[1] 8:19
Louisiana
[1] 40:21
Lovell
[29] 2:11 3:15 22:14 23:10 23:14 23:19 23:25 25:2 26:8 32:3 36:25 37:4 38:20 56:5 57:21 82:7 103:5 148:21 163:6 169:15 169:19 170:18 170:20 170:21 171:6 172:4 211:24 212:4 213:9
Low
[1] 66:11
Low-flow
[1] 66:11
Lower
[12] 58:25 76:4 76:5 106:15 106:24 107:8 162:2 182:25 189:18 189:19 194:3 199:22
Lowest
[4] 95:24 130:14 131:8 131:19
Lowrie
[27] 31:19 32:1 85:12 85:16 85:16 85:21 85:23 86:5 86:7 87:24 101:10 101:11 106:18 112:17 113:15 114:5 114:6 121:15 121:20 121:23 122:2 122:13 123:15 124:8 124:17 125:12 132:23
Lunch
[4] 23:15 118:4 134:22 206:5

M

M-10
[1] 100:2
M-11
[1] 100:8
M-12
[2] 82:23 82:24
M-19
[2] 121:4 121:6
M-28E
[1] 147:5
M-28F
[1] 147:5
M-3
[4] 109:17 109:19 109:20 109:20
Maalaea
[1] 19:9
Machine
[2] 24:3 219:9
Magarro
[1] 37:14
Main
[5] 39:5 41:13 53:24 156:13 196:6
Maintain
[6] 20:14 37:16 67:3 107:4 107:7 160:23
Maintained
[2] 160:21 203:25
Maintaining
[1] 19:21
Maintains
[2] 67:2 67:7
Maintenance
[10] 54:1 67:9 127:20 127:21 127:23 127:25 128:3 128:5 128:10 128:11
Major
[11] 51:6 51:10 51:11 51:16 51:25 52:2 52:12 54:17 106:10 206:7 206:25
Makai
[7] 36:2 103:25 179:9 182:24 182:25 183:25 190:19
Makapipi
[6] 83:4 83:6 83:8 83:9 105:9 105:21
Maliko
[2] 36:3 83:5
Maly
[12] 70:3 70:5 70:12 70:15 70:18 70:21 70:22 70:24 70:25 71:18 72:14 72:16
Man
[2] 187:7 197:17
Management
[5] 10:17 25:23 41:19 42:11 56:13
Manager
[5] 6:15 10:18 32:12 32:19 71:3
Managers
[2] 154:25 156:14
Managing
[1] 27:14
Manaoli
[2] 36:5 36:6
Manner
[4] 7:15 10:23 19:12 138:22
Map
[88] 31:9 43:17 44:12 44:14 44:25 45:18 45:23 46:3 46:6 46:8 46:11 46:17 46:18 47:1 47:4 47:9 48:16 48:24 48:25 49:5 49:10 50:12 53:12 54:8 54:12 54:14 54:14 54:23 55:7 55:11 60:7 60:8 62:12 62:17 63:5 63:6 63:8 63:9 64:1 64:8 64:9 64:12 64:21 64:24 65:3 65:6 65:17 65:23 65:24 78:9 78:11 83:14 83:17 83:18 84:1 86:20 94:13 95:5 95:8 95:10 96:17 96:21 97:9 97:25 101:15 101:19 102:2 102:6 107:12 107:24 108:8 146:13 177:14 179:3 180:13 181:13 183:2 183:4 183:7 186:17 187:24 190:13 190:22 190:23 196:13 196:15 206:4 206:21
Maps
[1] 178:4
March
[1] 137:2
MARIE
[3] 1:21 219:6 219:21
Mark
[8] 3:9 22:19 22:22 61:25 135:1 135:7 135:13 204:11
Marked
[14] 22:14 24:20 26:15 27:1 45:3 56:15 61:18 76:15 176:19 186:5 193:16 204:19 206:19 209:23
Market
[2] 2:1 201:23
Marks
[1] 86:25
Martin
[3] 76:17 77:4 205:14
Match
[1] 179:17
Materials
[1] 201:10
Math
[11] 39:14 41:10 99:6 151:19 158:9 158:24 166:5 169:2 170:1 170:5 170:9
Matson
[5] 39:5 39:13 93:25 94:4 123:4
Matson's
[1] 39:15
Matter
[9] 1:3 30:22 47:9 86:13 117:13 129:17 213:12 213:14 219:13
Maui
[61] 1:4 2:9 2:11 2:14 9:3 9:9 9:22 10:7 11:18 11:19 12:7 13:7 14:11 14:11 15:8 16:17 16:23 19:1 21:11 24:17 24:21 24:22 24:25 27:22 29:18 30:1 30:4 31:20 33:17 33:21 36:7 36:9 40:22 42:14 42:18 42:22 42:23 43:1 50:16 71:4 71:7 71:7 71:8 71:13 71:15 78:23 80:10 88:6 89:12 99:17 100:9 100:22 103:20 107:6 150:6 150:17 161:2 161:4 175:14 176:21 187:1
Maui's
[1] 21:15
Mauka
[19] 35:19 95:10 103:24 176:10 179:12 180:3 180:9 181:10 182:24 183:18 185:24 187:15 191:18 197:8 198:5 198:7 198:8 206:10 206:23
Maximum
[1] 106:5
McCONNELL
[168] 2:1 4:1 4:7 4:18 5:7 5:10 5:18 5:23 6:5 6:8 7:3 9:18 15:23 16:5 22:21 23:1 23:4 23:16 23:21 24:8 24:13 30:24 31:4 32:4 37:2 37:7 38:18 43:5 43:9 44:18 48:23 49:2 49:8 49:11 49:16 49:20 49:24 50:11 52:10 52:14 56:7 57:24 61:7 62:20 64:5 64:20 65:1 69:8 77:25 78:3 79:25 80:5 80:9 82:9 83:10 88:24 90:9 91:1 91:20 92:5 96:11 101:1 103:10 117:24 118:3 118:7 118:11 118:20 129:18 130:4 131:3 133:25 134:18 134:21 134:24 135:5 135:8 136:1 140:20 141:3 141:7 141:11 141:14 142:10 143:2 143:24 144:2 144:11 147:3 147:16 147:22 147:25 148:22 149:5 154:11 161:7 161:10 161:24 162:3 163:10 163:15 163:18 164:2 165:17 166:24 167:8 170:2 170:16 171:1 172:5 172:8 172:14 174:7 174:11 174:14 174:18 174:21 175:2 175:5 176:16 177:20 177:25 178:6 179:5 182:12 183:9 184:6 185:3 185:6 188:6 188:10 188:25 189:10 189:17 189:22 190:4 191:9 192:17 195:10 204:12 204:20 204:24 205:3 205:5 205:8 207:2 207:5 209:22 210:9 211:5 211:8 211:12 211:20 212:11 212:16 213:7 213:11 213:17 213:20 214:1 214:4 215:10 215:15

216:1 216:12 216:15 217:7 217:10
McMANUS
[3] 1:21 219:6 219:21
Mean
[31] 8:3 19:18 20:25 38:7 61:8 85:22 87:1 87:11 87:21 89:24 92:6 97:8 97:14 104:2 105:18 105:19 108:6 109:10 111:24 119:21 158:7 163:4 163:5 163:11 164:6 169:10 172:25 175:14 178:17 214:3 214:16
Meaning
[2] 91:19 212:8
Means
[8] 87:12 87:15 87:16 96:19 96:19 131:18 154:7 163:22
Meant
[1] 87:22
Measure
[3] 141:8 141:16 142:12
Measured
[8] 115:18 115:21 115:24 116:7 116:14 117:18 123:10 163:23
Measurement
[11] 116:12 116:18 116:19 116:23 116:25 117:2 117:4 138:2 139:21 141:25 142:5
Measurements
[14] 111:21 112:12 115:23 116:7 137:2 137:6 137:10 137:13 138:9 138:10 138:12 138:20 138:23 138:24
Measures
[2] 109:11 112:9
Measuring
[5] 117:7 117:9 117:15 139:16 142:3
Meet
[3] 74:24 88:13 207:20
Member
[1] 74:20
Members
[4] 67:17 68:8 203:13 204:3
Memory
[2] 156:16 157:8
Mention
[1] 188:2
Mentioned
[3] 51:9 140:9 151:14
Merchant
[9] 2:9 2:9 3:8 9:14 134:3 136:3 180:6 180:10 213:10
Met
[4] 14:3 21:22 60:18 122:15
Meticulous
[1] 66:6
MGD
[4] 98:9 98:25 105:6 105:11
Middle
[13] 45:10 61:19 105:14 121:11 141:21 178:10 178:12 192:1 192:2 192:3 193:3 193:13 194:3
Might
[5] 24:2 89:24 140:16 168:14 168:14
Mill
[1] 8:7
Million
[33] 9:5 29:10 29:21 30:6 39:15 39:17 39:19 39:21 40:9 41:6 42:17 99:1 99:5 99:8 105:23 105:24 106:2 106:3 106:5 112:4 112:5 112:6 151:1 151:2 151:18 151:22 165:4 165:6 167:24 173:12 173:12 173:24 173:25
Mind
[6] 33:21 51:13 52:7 169:20 211:13 214:21
Minor
[2] 55:4 206:24
Minute
[7] 43:7 77:22 139:24 140:4 190:18 204:13 217:22
Minutes
[2] 118:9 174:19
Misheard
[1] 65:2
Mislabeled
[1] 48:24
Misleading
[2] 98:17 98:19
Missing
[1] 81:10
Misstated
[1] 100:6
Misstating
[1] 57:22
Mistake
[1] 177:18
Moisture
[8] 153:23 153:25 160:13 160:18 160:22 161:21 163:24 168:12
Moku
[20] 2:16 3:24 3:24 7:11 23:8 68:8 100:3 100:8 174:25 185:11 203:8 203:14 203:23 204:4 204:15 205:10 207:10 214:14 216:24 217:13
Moku's
[3] 3:25 209:21 211:22
Moment
[7] 50:13 108:4 108:21 157:16 165:10 165:12 166:2
Monday
[1] 125:11
Monetary
[1] 92:2
Money
[2] 12:17 21:10
Monitor
[1] 153:24
Month
[4] 68:24 68:25 154:5 208:19
Months
[16] 151:2 151:3 151:25 162:2 164:3 166:1 167:7 167:9 167:18 167:19 169:1 169:4 169:6 169:6 171:24 171:25
Morning
[3] 5:1 137:7 137:15
Mortgage
[1] 134:7
MOSES
[1] 2:16
Most
[15] 7:22 42:1 46:19 108:10 119:3 179:12 180:3 180:8 185:25 190:13 191:3 191:12 191:18 193:1 193:5
Mostly
[1] 54:17
Mountain
[2] 95:14 199:4
Mountains
[1] 95:9
Mouth
[1] 140:14
Move
[7] 106:17 113:13 141:2 143:20 196:14 205:4 211:11
Moved
[2] 169:4 184:2
Moves
[1] 106:11
Mud
[1] 181:3
Multiple
[5] 35:14 83:16 83:19 83:22 87:11
Murakami
[115] 2:16 3:4 3:5 3:14 3:14 3:15 3:17 3:20 3:22 4:14 7:9 7:10 9:17 9:21 11:15 15:21 16:1 16:9 20:22 21:2 22:16 22:23 23:7 23:12 24:4 24:11 24:15 25:3 26:9 30:17 31:3 38:1 38:21 38:23 44:23 45:2 45:15 45:21 45:24 149:7 149:10 152:19 154:8 154:13 155:8 155:13 161:9 162:5 162:8 163:5 163:8 163:11 163:13 163:17 163:25 164:3 164:8 164:11 165:15 165:20 166:18 166:22 167:1 167:9 169:12 169:17 169:21 170:4 170:14 170:25 172:7 172:10 172:17 174:13 174:16 175:9 176:18 177:18 177:22 178:2 178:8 178:25 179:4 179:7 180:8 180:12 182:18 183:8 185:5 185:14 188:4 189:7 190:8 191:12 192:21 195:12 197:17 197:20 199:20 204:14 204:18 204:23 205:4 205:12 207:13 209:8 209:25 210:11 211:10 211:15 212:2 212:5 212:13 212:18 214:3
Must
[2] 10:8 26:22

N

Nahiku
[9] 1:4 14:25 19:9 80:23 97:11 105:1 105:8 105:21 110:1
Nailililhaele
[1] 106:4
Name
[10] 6:6 49:12 49:13 54:5 123:24 135:6 147:23 159:16 175:3 175:6
Named
[2] 25:21 219:16
Namely
[1] 94:21
Native
[2] 70:16 100:22
Natural
[5] 1:1 59:4 71:12 71:17 81:15
Naturally
[1] 199:3
Navigation
[2] 39:5 39:13
Near
[2] 20:19 20:24
Necessarily
[4] 25:19 128:16 169:8 172:25
Necessary
[7] 19:22 68:12 72:2 73:6 111:22 195:15 211:18
Necessitates
[1] 29:19
Necessity
[1] 71:22
Need
[21] 10:2 10:6 27:25 53:12 56:1 56:2 57:16 77:22 77:23 155:10 156:7 159:1 168:15 173:21 173:22 199:14 203:19 208:17 209:4 216:13 217:1
Needed
[2] 150:12 156:19
Needs
[14] 48:25 103:14 113:23 130:12 130:22 156:15 160:19 161:3 170:22 170:24 171:4 188:22 203:16 207:20
Negotiated
[2] 92:18 92:20
Neighbor
[1] 184:10
Neighborhood
[3] 152:9 158:20 203:2
Neola
[2] 101:5 113:25
Never
[18] 22:4 30:13 35:24 36:3 42:13 76:2 110:21 115:22 116:16 116:21 117:18 117:20 117:20 117:22 120:7 123:10 147:8 184:19
Nevertheless
[1] 212:21
New
[13] 84:19 84:24 85:7 85:9 85:12 106:17 108:12 112:17 121:15 121:22 124:7 159:19 159:22
Next
[20] 5:5 22:19 22:20 29:4 32:23 45:11 84:16 84:17 84:18 86:8 100:9 168:5 168:8 180:6 180:10 180:22 204:25 209:21 212:25 213:24
Nobody
[1] 22:8
Nonagricultural
[3] 37:12 102:10 102:18
Nonagriculture
[2] 36:22 37:19
Nondomestic
[1] 103:23
None
[2] 40:7 171:9
Nonetheless
[1] 50:5
Noon
[1] 134:23
Normal
[3] 85:19 122:13 128:3
Normally
[2] 106:22 161:17
Norman
[4] 76:17 76:25 77:4 205:14
Noted
[1] 50:17
Notes
[1] 83:15
Nothing
[7] 160:3 169:22 169:23 192:20 202:6 213:10 214:5
Notice
[4] 52:19 88:12 137:5 177:6
Noticed
[2] 114:15 129:1
Notify
[1] 144:7
Notion
[1] 169:25
November
[4] 1:8 217:13 219:7 219:17
Nowhere
[1] 65:23
Number
[25] 16:11 21:5 25:2 36:17 37:13 37:17 55:7 56:22 58:8 61:12 62:8 80:11 85:23 89:20 105:6 156:4 157:3 165:21 178:20 180:10 192:13 193:17 202:21 206:3 215:22
Numbered
[1] 181:12
Numbers
[17] 41:24 61:19 63:3 63:4 77:18 99:21 99:23 105:17 105:19 109:10 147:4 173:17 178:14 178:15 180:13 183:5 186:5
Numeral
[1] 70:25
Numerical
[2] 119:8 119:14

O

Oath
[4] 27:13 43:11 185:8 207:7
Object
[21] 4:11 9:14 20:20 33:7 36:25 57:21 82:7 88:19 96:9 100:5 103:5 112:22 129:14 130:24 154:6 155:6 165:11 169:15 170:25 199:17 215:4
Objected
[1] 60:23
Objecting
[1] 60:24
Objection
[16] 23:2 32:3 56:5 88:25 90:5 90:22 100:24 110:9 130:3 143:23 166:19 166:20 205:6 205:7 211:21 214:24
Observe
[1] 69:13
Observed
[3] 21:20 67:20 186:2
Obtain
[2] 108:1 209:12
Obtained
[3] 60:1 82:5 133:1
Obvious
[1] 163:11
Obviously
[2] 10:25 161:12
Occasion
[3] 137:6 187:8 206:2
Occupiers
[1] 213:1
Occur
[1] 202:1
Occurred
[4] 15:6 62:1 125:2 125:4
Occurring
[2] 29:2 159:10
Ocean
[1] 95:22
October
[4] 60:15 60:16 60:17 151:3
Off-peak
[3] 151:24 167:18 168:11
Offer
[4] 31:1 209:20 210:6 217:14
Offhand
[1] 55:12
Office
[6] 25:25 108:7 108:14 109:15 109:16 146:18
Officer
[175] 2:1 4:1 4:7 4:18 5:7 5:10 5:18 5:23 6:5 6:8 7:3 9:18 15:21 15:23 16:5 22:21 23:1 23:4 23:16 23:21 24:8 24:13 30:24 31:4 32:4 37:2 37:7 38:18 43:5 43:9 44:18 48:23 49:2 49:8 49:11 49:16 49:20 49:24 50:11 52:10 52:14 56:7 57:24 61:7 62:20 64:5 64:20 65:1 69:8 77:25 78:3 79:25 80:5 80:9 82:9 83:10 88:24 90:9 91:1 91:20 92:5 96:11 101:1 103:10 117:24 118:3 118:7 118:11 118:20 129:18 130:4 131:3 133:25 134:18 134:21 134:24 135:5 135:8 136:1 138:24 140:20 141:3 141:7 141:11 141:14 142:10 143:2 143:24 144:2 144:11 147:3 147:16 147:22 147:25 148:22 149:5 154:11 161:7 161:10 161:24 162:3 163:10 163:15 163:18 164:2 165:17 166:24 167:8 170:2 170:16 171:1 172:5 172:8 172:14 174:7 174:11 174:14 174:18 174:21 175:2 175:5 175:10 176:16 177:20 177:25 178:6 179:5 182:12 183:9 184:6 185:3 185:6 188:6 188:10 188:25 189:10 189:17 189:22 190:4 191:9 192:17 195:10 197:1 204:11 204:12 204:20 204:24 205:3 205:5 205:8 207:2 207:5 208:18 209:9 209:22 210:9 211:5 211:8 211:12 211:20 212:11 212:16 213:7 213:11 213:17 213:20 214:1 214:4 215:10 215:15 216:1 216:12 216:15 217:7 217:10
Officer's
[1] 217:24
Official
[1] 188:5
Often
[1] 161:25
Ohana
[3] 180:16 186:1 210:16
Ohana's
[3] 177:15 178:4 210:19
Old
[7] 72:5 108:10 159:20 197:13 197:16 200:6 208:25
Once
[8] 40:11 46:22 63:3 73:24 105:23 113:11 131:10 131:15
One
[88] 5:17 5:24 11:6 15:11 15:24 16:3 25:13 29:25 30:1 33:23 38:2 39:5 40:8 42:10 52:15 52:17 52:18 53:25 56:11 59:14 63:24 66:2 69:5 72:5 74:25 79:22 80:14 82:17 89:3 92:22 93:21 93:24 93:24 99:13 99:15 109:11 109:12 109:13 113:19 114:15 118:13 122:3 127:1 128:17 137:14 154:24 159:20 161:20 170:21 172:13 176:25 181:23 182:11 182:24 182:24 183:19

184:3 187:1 188:11 188:12 188:13 188:14 188:14 188:15 189:1 189:4 189:14 189:14 189:15 189:18 189:19 189:20 190:1 190:4 190:7 190:16 191:4 191:24 192:1 196:6 197:21 199:19 200:10 200:25 202:21 208:9 209:14 212:7
One-inch
[2] 56:11 92:22
One-year
[1] 111:5
Ones
[5] 101:19 107:17 107:23 123:4 215:21
Onwards
[1] 110:2
Open
[15] 69:22 69:24 103:9 124:25 125:10 125:13 126:2 142:18 175:24 175:25 186:1 189:19 199:23 203:9 211:2
Opened
[5] 125:8 179:20 200:2 203:20 208:18
Opening
[6] 150:11 181:23 184:3 208:10 210:15 210:19
Operable
[1] 74:12
Operate
[2] 82:15 108:5
Operated
[1] 20:2
Operating
[3] 20:14 21:6 22:7
Operation
[8] 8:19 10:10 10:22 28:22 69:15 108:11 153:19 162:16
Operational
[2] 107:15 107:18
Operations
[15] 10:6 11:25 39:8 41:8 41:13 41:20 42:1 42:7 149:16 149:18 155:3 158:16 159:14 159:24 163:1
Opinion
[1] 42:18
Opportunities
[1] 23:20
Opportunity
[3] 22:20 30:19 60:25
Opposed
[2] 172:20 174:2
Optional
[1] 107:24
Oral
[2] 71:10 217:22
Order
[19] 4:2 4:10 4:16 4:23 5:6 5:11 5:16 14:7 22:19 28:22 30:7 30:14 152:14 160:22 180:22 204:6 204:15 204:25 217:22
Ordered
[1] 125:16
Original
[10] 13:19 14:10 14:14 17:8 18:25 44:2 55:13 58:4 63:13 197:24
Originals
[1] 17:10
Otherwise
[7] 10:5 16:23 130:5 134:8 140:13 141:20 161:1
Outcome
[1] 219:16
Outflow
[2] 117:7 117:9
Outside
[2] 145:20 162:25
Outstanding
[1] 213:12
Over-generalization
[1] 10:3
Overflow
[1] 142:19
Overflowing
[1] 210:25
Overhead
[1] 8:9
Overlaid
[2] 177:18 185:21
Overlay
[8] 176:20 176:23 177:6 177:10 178:3 179:11 183:2 188:20
Overrule
[1] 143:25
Overruled
[1] 32:5
Own
[7] 87:7 91:14 91:23 91:24 94:21 99:20 103:2
Owned
[19] 43:18 65:4 65:7 79:3 80:14 82:2 82:20 86:22 87:2 87:4 87:23 92:9 92:23 93:6 93:24 93:24 97:5 97:24 102:1
Owner
[3] 60:4 60:6 144:8
Owners
[4] 88:4 96:4 194:8 215:25
Ownership
[1] 98:3
Owns
[1] 87:15

P

Page
[21] 8:1 17:5 17:18 18:12 18:17 19:5 68:2 68:5 70:25 80:12 81:21 88:10 89:21 109:19 109:21 135:13 135:16 137:22 150:25 202:14 212:3
Pages
[3] 16:12 17:3 136:9
Paia
[1] 24:3
Paid
[1] 40:20
Palauhulu
[2] 45:6 47:24
Paragraph
[14] 8:1 68:3 68:4 68:8 88:9 114:3 134:6 142:16 143:10 143:20 148:15 172:18 173:10 173:18
Parallel
[1] 192:6
Parcel
[32] 64:14 64:16 76:25 87:6 87:7 90:17 90:19 91:5 91:7 92:2 92:10 92:23 92:25 93:6 93:16 93:18 93:20 94:4 102:1 137:18 181:10 181:12 192:12 192:13 193:8 193:17 193:23 193:24 194:3 194:5 194:8 194:18
Parcels
[15] 64:15 72:10 72:13 72:17 76:24 87:12 91:14 91:24 92:14 93:23 94:11 94:21 96:5 96:14 96:15
Parents
[1] 176:3
Park
[10] 27:19 28:6 28:12 29:17 30:8 30:15 33:21 34:11 103:22 107:10
Parks
[1] 36:24
Parlance
[1] 7:21
Parshall
[2] 139:2 139:3
Part
[20] 8:11 10:10 10:17 11:11 13:16 15:6 16:19 19:7 28:3 28:8 28:21 29:3 29:5 29:5 31:9 78:18 153:6 153:9 180:13 212:24
Particular
[21] 19:6 25:11 44:4 59:23 62:9 76:13 81:19 91:6 98:1 105:20 112:3 112:4 116:15 138:7 161:14 164:7 182:1 193:14 204:3 210:1 211:11
Parties
[14] 12:4 17:2 18:14 18:22 22:25 91:23 92:13 102:16 209:10 212:23 216:24 217:14 217:23 219:15
Partly
[2] 78:12 78:12
Partnership
[3] 20:2 20:3 20:8
Pass
[4] 122:7 122:12 122:14 122:23
Passed
[2] 72:6 101:11
Passes
[3] 122:23 126:14 126:15
Passing
[3] 109:1 117:10 131:12
Past
[12] 13:16 22:9 40:8 66:24 69:4 81:12 166:8 189:8 189:9 192:10 207:19 209:11
Pasture
[2] 35:22 36:7
Patch
[10] 130:14 144:21 144:22 146:21 181:24 183:20 184:1 184:4 208:15 208:15
Patches
[21] 62:13 68:9 68:13 77:4 119:25 128:15 131:9 131:19 175:24 175:25 176:1 176:11 187:16 195:17 197:22 203:15 207:25 208:11 208:14 208:17 211:2
Patience
[1] 218:2
Payment
[4] 40:6 40:9 40:12 40:19
Payments
[1] 40:25
Pays
[1] 86:14
Peak
[11] 151:3 151:24 151:25 167:10 167:18 167:18 168:11 169:6 169:12 169:13 171:19
Pen
[2] 44:5 44:11
Pena
[1] 77:20
People
[10] 25:22 62:7 67:9 67:18 72:8 87:5 87:8 100:21 132:11 137:20
People's
[1] 23:19
Per
[60] 9:5 29:11 29:21 30:6 51:3 106:6 110:19 116:8 116:11 118:18 118:25 132:18 138:3 142:4 142:6 151:1 151:20 151:20 152:1 152:1 152:4 152:10 152:10 152:20 152:20 153:1 153:1 156:18 156:23 158:7 158:13 158:13 158:16 158:17 158:21 158:21 158:22 158:22 164:15 165:4 165:23 165:23 165:24 165:24 166:4 166:4 168:1 168:1 168:21 168:21 168:25 169:1 169:5 169:6 169:14 169:14 173:12 173:13 173:24 173:25
Percent
[22] 96:18 97:4 97:12 97:21 97:23 98:4 98:5 98:25 99:3 99:4 157:19 157:19 157:23 157:24 158:2 158:12 158:14 162:19 164:17 164:23 164:24 166:3
Percentage
[16] 87:14 97:25 99:13 153:23 154:20 154:21 154:22 155:12 155:14 155:17 155:20 156:3 157:8 157:13 160:22 164:4
Perfect
[1] 165:15
Period
[13] 13:16 15:5 74:18 111:6 127:9 151:12 151:14 152:16 165:9 168:11 168:23 169:9 169:12
Periods
[8] 76:8 142:18 165:8 168:20 171:18 172:1 172:3 173:20
Permission
[13] 15:4 15:7 15:13 133:8 133:12 133:19 143:14 143:17 145:23 145:24 210:2 212:9 212:13
Permit
[18] 9:19 56:8 57:25 58:4 58:5 61:9 82:10 88:13 89:6 89:8 89:18 90:10 91:2 101:2 103:11 129:19 171:2 217:25
Permits
[6] 58:7 88:9 89:3 89:7 89:11 134:5
Perpendicular
[1] 53:24
Person
[10] 4:23 59:13 65:14 70:17 70:20 75:9 76:11 128:24 159:24 195:14
Personally
[1] 77:6
Petition
[3] 100:3 100:7 100:9
PH
[1] 6:8
Phase
[1] 71:5
Phone
[1] 108:15
Phonetic
[1] 37:14
Photo
[13] 59:21 59:21 60:5 60:10 60:11 60:17 60:19 61:11 62:5 63:7 63:13 64:25 66:16
Photo's
[1] 63:15
Photographs
[4] 53:14 53:15 146:24 146:25
Photos
[2] 56:17 63:16
Physical
[2] 47:3 47:19
Physically
[1] 104:9
Picture
[1] 194:23
Pinaau
[1] 109:11
Pine
[10] 9:3 9:10 9:22 10:8 24:17 24:25 33:17 36:9 99:17 103:21
Pineapple
[4] 2:9 24:23 35:22 36:8
Pipe
[67] 50:20 50:23 50:24 51:2 51:3 51:13 51:17 51:20 52:5 52:11 52:20 52:21 52:24 53:2 53:3 53:4 53:8 54:16 56:11 56:11 57:11 69:20 69:21 69:24 73:20 74:11 74:13 75:5 75:11 76:5 76:6 76:10 77:2 86:2 92:16 92:22 93:8 94:6 101:9 114:15 114:23 117:8 122:4 122:8 122:15 122:19 126:19 126:24 127:2 127:3 188:15 188:16 189:1 189:3 189:14 189:18 189:21 190:5 190:17 191:7 201:12 201:15 201:16 201:24 202:3 202:7 206:24
Pipeline
[6] 85:20 106:23 106:24 107:1 107:3 107:8
Pipelines
[1] 106:24
Pipes
[25] 19:14 66:11 66:12 66:18 66:22 66:24 67:2 67:9 67:10 67:13 114:4 114:14 117:10 121:19 122:3 122:14 122:18 122:24 127:4 127:4 132:23 180:25 206:18 210:13 210:21
Piping
[1] 201:20
Place
[10] 46:6 47:11 57:10 75:12 126:19 128:22 139:5 141:19 153:15 179:20
Places
[5] 83:16 83:20 83:22 83:24 84:4
Placing
[1] 19:12
Plan
[1] 149:20
Planned
[3] 4:13 28:23 161:18
Planning
[13] 5:20 27:18 27:22 29:10 29:20 32:22 41:25 42:4 42:6 42:11 71:16 149:1 149:12
Plans
[5] 20:24 29:16 29:18 104:12 104:14
Plant
[16] 38:8 160:4 160:6 160:6 160:7 160:10 160:13 160:16 160:19 160:23 172:23 172:24 174:1 174:5 208:17 208:24
Plantation
[10] 31:15 31:21 31:23 32:11 33:3 33:4 33:4 33:25 113:16 113:19
Planting
[4] 154:16 154:19 155:16 162:16
Plants
[2] 104:16 163:2
Plat
[5] 178:24 179:1 192:13 193:17 193:24
Plate
[2] 139:10 141:22
Plenty
[1] 10:1
Plot
[1] 179:4
Plus
[2] 18:6 139:12
PM
[1] 218:4
Point
[37] 22:16 25:13 27:3 30:17 35:7 44:15 44:19 44:20 45:9 45:11 48:16 49:18 50:4 52:15 53:3 69:25 76:15 80:16 85:2 98:20 109:2 115:8 117:3 118:17 127:15 131:22 139:8 139:11 159:13 170:6 178:3 182:13 190:13 191:23 196:13 197:1 203:1
Pointing
[6] 17:1 62:2 178:9 179:3 193:16 197:4
Points
[6] 46:3 53:25 150:12 177:24 195:8 206:14
Poko
[1] 71:6
Poncho
[3] 128:14 128:17 128:19
Pond
[7] 74:7 75:5 75:6 75:18 75:19 76:4 76:5
Pono
[1] 71:4
Pool
[2] 85:23 86:2
Portion
[9] 75:6 79:21 80:14 121:11 178:10 179:12 180:3 199:22 206:23
Portions
[3] 180:9 183:5 206:10
Position
[15] 6:14 12:22 32:11 56:1 56:4 57:15 115:8 139:20 149:19 155:9 159:19 159:20 159:21 159:22 159:23
Possible
[12] 7:16 8:21 64:19 113:13 113:17 126:21 126:25 138:1 138:15 138:18 142:22 142:25
Possibly
[2] 42:20 128:13
Potential
[2] 42:4 153:14
Power
[2] 38:8 214:25
Practice
[1] 17:7
Pre
[1] 39:20
Pre-tax
[1] 39:20
Precedes
[3] 25:6 25:9 26:3
Precondition
[1] 15:16
Predate

[3] 10:8 13:18 34:3
Predates
[1] 36:6
Predecessor
[3] 20:6 25:24 27:11
Predecessors
[3] 10:21 25:23 209:3
Predominant
[1] 202:1
Prefer
[1] 46:23
Premise
[1] 30:11
Prepared
[3] 54:15 62:17 96:21
Presence
[2] 186:2 186:15
Present
[6] 4:3 112:25 116:22 125:21 146:10 213:1
Presented
[1] 173:10
Presenting
[1] 170:10
Presently
[5] 34:15 68:16 68:18 77:8 202:18
President
[2] 6:16 203:8
Pretty
[5] 10:11 11:24 36:18 139:5 216:9
Prevail
[1] 23:17
Prevent
[4] 115:2 115:6 115:10 115:14
Previously
[7] 34:24 57:13 60:24 91:17 185:10 204:10 207:9
Price
[9] 39:22 39:24 39:25 40:1 40:13 40:15 40:17 201:10 201:17
Primarily
[1] 150:22
Primary
[1] 197:13
Private
[6] 71:10 86:1 94:15 96:19 96:19 134:14
Privately
[1] 87:23
Privilege
[2] 19:7 81:24
Problem
[12] 46:17 60:23 62:16 67:12 74:18 75:13 75:17 170:11 214:10 214:11 214:22 215:3
Problems
[1] 76:3
Procedures
[1] 144:14
Proceeded
[1] 126:1
Proceedings
[6] 23:11 25:1 70:11 218:4 219:8 219:12
Process
[6] 27:21 27:23 28:9 34:15 181:22 184:3
Processes
[1] 71:16
Produced
[3] 101:10 172:19 172:22
Production
[5] 10:12 22:24 59:22 68:13 215:23
Profit
[2] 39:19 39:20
Program
[1] 168:13
Project
[3] 28:10 202:23 202:24
Promise
[2] 18:19 21:14
Promised
[1] 209:3
Promoted
[1] 148:25
Promotion
[3] 148:18 149:23 150:1
Proper
[1] 72:7
Properly
[1] 111:20
Properties
[2] 41:21 72:19
Property
[25] 78:18 115:2 115:3 115:11 115:15 120:10 123:3 123:17 124:3 132:19 133:4 143:12 143:15 144:7 144:18 144:24 144:25 145:7 146:2 146:20 146:25 147:2 193:10 207:16 210:20
Proportion
[1] 98:1
Proposal
[4] 28:22 29:18 29:25 30:3
Propose
[1] 30:5
Proposed
[4] 28:5 42:17 217:2 217:18
Protect
[1] 15:14
Protected
[4] 88:15 88:17 88:22 89:24
Protection
[2] 209:18 210:5
Provide
[13] 23:5 28:4 58:8 59:19 61:14 63:5 73:6 74:23 92:22 132:17 160:12 173:21 213:15
Provided
[17] 24:25 54:23 59:20 60:2 60:5 64:9 64:10 73:8 111:11 113:24 139:3 148:9 160:25 176:20 212:19 212:20 216:4
Providing
[6] 62:10 108:18 108:20 111:14 111:17 163:23
Proximity
[1] 75:25
Pu'unene
[2] 8:7 37:15
Pualoa
[1] 122:2
Public
[4] 17:5 19:12 19:15 71:9
Pump
[2] 102:2 137:18
Pumped
[2] 67:23 150:23
Pumping
[4] 12:19 67:24 138:1 138:17
Pumps
[4] 67:20 67:23 67:24 137:21
Puohokamoa
[1] 109:13
Puolua
[16] 101:9 116:6 120:20 121:22 122:2 122:23 123:6 123:18 123:20 123:21 123:25 124:15 124:22 126:1 128:18 131:12
Purchase
[3] 91:13 91:19 91:22
Purchased
[2] 93:12 94:10
Purple
[1] 113:12
Purports
[1] 6:18
Purpose
[11] 19:11 19:14 70:12 70:15 81:23 81:25 82:16 126:9 140:8 140:11 149:19
Purposes
[3] 19:23 54:15 202:5
Pursuant
[1] 22:7
Push
[2] 118:5 118:6
Put
[23] 33:5 35:7 37:15 37:19 51:14 58:5 69:24 75:12 75:18 127:3 138:5 139:24 140:1 141:12 141:13 141:19 168:14 172:11 172:13 181:24 187:1 201:22 214:13
Putting
[3] 5:13 68:13 140:17
PVC
[8] 52:5 52:11 201:12 201:20 201:23 202:1 202:3 202:9

Q

Quarterly
[2] 111:21 112:8
Quarters
[2] 164:12 202:6
Questioning
[1] 162:6
Questions
[34] 7:2 7:7 30:18 33:11 38:17 38:19 38:20 60:25 133:24 134:1 134:5 134:17 134:19 135:25 136:2 136:3 136:4 136:24 143:1 143:3 147:15 147:17 149:4 162:4 170:17 170:18 185:2 207:3 207:4 210:10 211:4 211:6 213:22 215:5
Quite
[5] 121:11 194:9 201:6 201:17 212:7
Quote
[1] 211:18
Quoted
[1] 82:17

R

Radio
[2] 108:13 108:14
Rain
[3] 125:9 208:3 208:4
Rained
[2] 123:1 125:7
Rainfall
[4] 98:2 98:2 167:15 167:18
Raining
[1] 10:1
Rains
[1] 199:2
Raise
[3] 139:9 179:22 207:23
Range
[4] 151:1 156:2 157:12 157:20
Rate
[7] 84:22 84:22 116:7 159:2 159:6 159:8 162:2
Rating
[4] 111:22 111:24 112:13 139:18
Ratings
[2] 111:19 111:24
Rationale
[2] 10:4 53:20
Reach
[5] 12:9 193:7 193:9 193:11 194:17
Reached
[1] 12:11
Read
[17] 13:11 13:12 17:17 17:20 19:5 68:3 68:6 105:5 119:9 202:11 210:1 211:17 212:6 212:12 212:12 212:20 213:6
Reading
[5] 18:4 49:4 139:25 140:7 212:17
Ready
[5] 131:5 131:16 132:17 217:5 217:17
Real
[9] 28:7 28:7 41:7 41:16 41:18 41:18 42:8 42:22 62:16
Really
[9] 45:1 46:10 55:23 56:2 57:15 201:22 202:10 211:25 216:13
Reason
[12] 9:2 20:1 54:13 68:18 71:19 138:6 139:12 188:19 194:2 195:5 202:17 213:4
Reasonable
[1] 151:23
Reasons
[1] 214:12
Rebut
[2] 61:9 115:17
Rebuttal
[22] 3:17 3:20 3:22 30:23 68:2 113:24 114:8 129:5 129:20 129:22 130:2 174:12 174:24 175:8 185:13 202:14 202:15 207:12 211:9 213:15 214:10 217:15
Recalled
[2] 185:10 207:9
Receive
[4] 14:7 40:5 41:2 211:21
Received
[19] 3:23 7:6 22:24 23:8 40:4 40:8 40:11 40:12 40:13 40:25 41:11 56:15 89:6 89:15 89:18 100:13 135:25 205:10 211:22
Receivers
[1] 109:5
Receives
[1] 39:8
Receiving
[5] 41:3 108:7 108:22 157:6 164:19
Recent
[4] 41:21 148:18 187:5 187:6
Recently
[2] 148:24 187:12
Receptors
[1] 109:5
Recess
[6] 43:7 43:8 78:2 118:10 134:23 174:20
Recited
[1] 178:14
Reclassified
[4] 34:12 34:18 34:25 35:11
Recognize
[14] 25:18 25:20 26:20 53:14 53:16 56:16 66:16 66:17 78:22 109:25 119:24 120:6 121:6 146:24
Recon
[1] 206:20
Reconvened
[1] 4:2
Record
[20] 6:6 16:8 43:10 44:23 44:24 78:4 79:23 118:12 129:12 134:25 135:6 144:16 174:22 178:25 185:7 214:6 217:8 217:9 217:11 218:1
Records
[4] 71:9 151:8 151:10 157:16
Rectangular
[1] 64:15
Recycled
[1] 8:15
Red
[5] 44:5 44:11 48:10 49:18 206:3
Reddish/brown
[2] 87:15 87:16
Redirect
[1] 38:19
Reduce
[2] 68:20 202:20
Reduced
[2] 106:3 219:9
Refer
[3] 53:18 69:7 173:18
Reference
[1] 47:15
Referred
[2] 73:17 123:4
Referring
[11] 45:12 53:20 66:14 89:8 93:20 101:16 178:9 179:24 183:13 198:3 198:5
Refers
[1] 136:21
Refined
[1] 62:12
Reflect
[3] 43:10 204:2 212:5
Reflective
[1] 173:1
Refused
[1] 214:20
Regard
[4] 32:23 36:17 109:21 161:3
Regarding
[4] 1:3 38:24 110:15 217:22
Region
[1] 71:7
Register
[3] 57:3 57:6 57:8
Registered
[4] 55:2 56:12 57:5 58:15
Registration
[4] 55:1 57:18 58:12 58:17
Regular
[1] 67:8
Related
[1] 134:5
Relation
[1] 192:4
Relationship
[1] 10:25
Relative
[2] 197:2 201:14
Relayed
[1] 53:22
Released
[2] 115:10 210:13
Relevance
[1] 211:19
Relevant
[2] 15:5 210:7
Relief
[4] 40:9 40:19 40:23 41:1
Rely
[5] 77:19 112:11 130:22 130:25 131:1
Relying
[1] 180:24
Remained
[2] 36:18 140:25
Remaining
[1] 142:13
Remains
[2] 43:11 203:8
Remedies
[1] 144:4
Remember
[6] 12:3 20:4 67:19 73:1 121:2 209:6
Remind
[1] 185:7
Repair
[3] 54:1 68:11 73:23
Repaired
[4] 68:17 75:14 202:17 202:22
Repairing
[2] 19:21 76:10
Repairs
[2] 74:6 101:9
Repeat
[5] 9:20 55:8 70:19 74:3 210:17
Repeats
[1] 18:17
Rephrase
[2] 141:5 166:25
Replies
[1] 217:25
Report
[6] 71:1 71:19 80:13 109:20 111:23 157:2
Reported
[2] 118:15 119:1
Reporter
[2] 118:8 152:18
Represent
[5] 16:14 18:1 135:18 211:15 214:17
Representation
[1] 16:8
Representatives
[1] 114:25
Represented
[4] 100:14 100:21 206:3 206:15
Represents
[2] 165:6 219:11
Request
[7] 29:9 71:3 72:14 101:5 101:8 156:14 216:24
Requested
[1] 72:16
Require
[1] 70:1
Required
[2] 111:7 170:8
Requirement
[2] 28:4 157:4
Requirements
[7] 77:17 88:14 156:17 170:7 170:8 172:23 173:19
Requires
[3] 99:8 99:18 168:13
Requiring
[1] 158:19
Resay
[1] 29:15

Research
[1] 71:9
Researched
[2] 93:2 93:14
Reservation
[1] 92:7
Reserve
[6] 30:18 45:5 45:8 47:23 49:23 216:16
Reserved
[6] 92:10 92:21 93:1 93:8 93:19 94:6
Reserves
[2] 88:11 92:1
Reservoir
[5] 29:13 160:13 171:5 171:21 173:6
Reservoirs
[13] 104:17 169:19 169:24 169:25 171:10 171:13 171:15 171:17 171:24 172:12 172:21 173:20 174:3
Residence
[1] 128:22
Residents
[3] 86:3 103:14 103:17
Resolution
[3] 204:2 204:10 204:14
Resource
[1] 56:13
Resources
[5] 1:1 71:6 71:17 81:15 203:7
Respect
[13] 42:25 46:15 50:16 61:1 92:23 93:6 93:16 94:4 113:25 130:21 161:1 215:25 216:10
Respond
[4] 156:14 169:17 215:9 215:19
Responsibilities
[1] 150:4
Responsibility
[1] 156:13
Responsible
[2] 153:20 156:8
Rest
[1] 196:4
Restoration
[1] 68:11
Restored
[2] 202:24 203:12
Restricted
[1] 37:22
Result
[1] 127:16
Resulted
[1] 13:15
Resume
[1] 68:9
Resumed
[1] 43:10
Retain
[1] 70:12
Retention
[1] 71:20
Retired
[1] 77:2
Return
[2] 93:8 94:6
Returned
[2] 200:2 203:11
Revenue
[1] 39:17
Revenues
[7] 39:3 39:8 39:11 39:12 39:13 39:16 39:18
Review
[5] 12:22 27:10 58:14 108:8 157:15
Reviewed
[2] 13:2 46:8
Revised
[2] 49:1 107:1
Revocable
[8] 88:9 88:13 89:3 89:6 89:7 89:11 89:18 134:5
Rezoning
[4] 27:21 27:25 28:3 29:19
Richard
[2] 25:20 25:24
Ridge
[5] 44:15 45:4 45:12 48:3 182:17
Right-hand
[1] 64:23
Right-of-way
[5] 144:9 144:16 144:17 145:12 145:20
Rights
[45] 15:14 15:15 21:15 21:16 72:11 72:18 82:5 88:16 88:18 88:23 89:24 90:2 90:8 90:12 90:17 91:5 91:6 91:11 91:14 91:23 92:1 92:7 92:10 92:14 92:21 92:25 93:8 93:13 93:18 94:6 94:10 96:4 96:8 128:17 128:24 129:4 129:7 129:22 130:1 130:8 133:9 133:13 133:21 134:8 213:1
Riparian
[12] 72:18 90:2 90:4 90:8 90:12 90:15 90:17 91:10 130:1 130:8 133:9 133:13
River
[3] 195:23 206:12 206:13
Rm
[1] 2:4
Road
[10] 33:22 35:2 35:18 58:24 176:10 176:10 176:24 176:24 177:2 183:19
Roadway
[1] 45:25
Robello
[2] 126:3 143:10
Rock
[1] 181:3
Rocks
[3] 75:22 75:24 127:9
Rodney
[1] 159:18
Role
[1] 149:16
Rolling
[1] 20:11
Roman
[1] 70:25
Rot
[1] 132:6
Rotate
[1] 166:12
Rotation
[1] 167:2
Roughly
[1] 81:9
Round
[3] 12:21 161:19 164:16
Rounds
[4] 161:18 167:16 168:3 171:22
Routine
[1] 67:8
Ruled
[1] 61:8
Ruling
[2] 31:1 216:16
Run
[5] 7:12 23:14 139:11 140:6 208:15
Running
[1] 114:15
Runs
[2] 69:21 124:3

S

Sacrifice
[1] 8:18
Sacrificed
[1] 27:16
Sale
[3] 9:4 81:22 109:21
Sam
[2] 77:1 77:2
Sandbag
[1] 140:11
Sandbags
[3] 139:7 140:8 141:19
Sat
[1] 146:12
Satisfied
[2] 99:10 99:18
Satisfy
[4] 28:22 101:5 101:8 203:15
Saw
[11] 44:15 77:10 177:15 180:16 184:18 184:22 186:4 186:22 187:12 188:13 188:20
Scale
[7] 63:21 63:24 63:24 64:2 65:10 65:23 66:1
Scan
[1] 23:23
Scarce
[2] 194:14 194:15
Schedule
[2] 163:9 167:2
Schedules
[1] 163:7
Schematic
[4] 31:10 104:20 106:9 109:7
Scheme
[1] 171:16
Schulmeister
[97] 2:5 3:4 3:10 3:13 3:18 4:5 4:9 4:15 4:20 4:25 5:13 5:20 6:11 11:13 15:24 16:6 16:7 20:20 20:25 23:3 33:7 37:6 44:1 44:4 54:21 58:1 61:13 61:16 68:4 69:4 72:24 73:19 76:16 76:19 78:19 79:23 88:19 90:5 90:22 96:9 100:5 100:24 104:2 104:20 110:9 110:13 112:21 117:11 118:6 118:9 129:6 129:10 129:14 130:3 130:24 135:9 135:11 135:24 143:23 144:15 148:1 148:3 149:3 154:6 154:9 155:6 155:11 161:5 163:3 164:6 164:9 165:11 166:17 166:20 169:10 174:9 174:10 177:17 178:24 179:2 183:12 184:15 197:15 197:18 199:17 205:1 205:7 207:4 209:23 209:24 211:7 211:13 214:8 215:12 215:16 216:11 217:4
Schupp
[22] 93:17 101:8 101:12 115:17 116:4 120:10 120:21 123:3 125:25 127:7 128:9 129:2 129:3 129:21 130:11 131:6 131:10 131:17 143:12 143:14 144:24 146:9
Schupp's
[7] 115:23 119:24 144:18 146:2 146:20 146:25 147:2
Schutte
[1] 2:6
Scope
[1] 161:5
Screen
[1] 139:9
Seal
[1] 216:5
Season
[1] 169:13
Seasons
[3] 161:12 161:13 172:2
Second
[3] 26:15 137:22 212:24
Seconds
[1] 139:22
Section
[2] 137:25 192:20
Secures
[1] 86:15
See
[49] 8:10 16:17 17:3 17:6 17:17 18:12 31:18 31:18 52:23 52:24 58:4 58:23 77:22 79:11 80:18 83:4 83:4 83:25 87:6 88:1 92:21 94:16 100:11 101:19 101:25 102:2 107:13 109:8 109:23 120:21 141:15 144:25 146:19 176:21 177:4 179:11 179:15 179:16 181:7 183:1 183:3 191:2 195:13 196:14 196:17 196:20 199:7 199:10 215:3
Seeing
[2] 17:16 74:22
Seeking
[1] 93:21
Sees
[1] 144:16
Segregate
[2] 94:20 96:3
Segregated
[1] 94:15
Sell
[3] 9:13 9:22 134:7
Selling
[2] 9:9 9:15
Sense
[4] 84:3 165:14 165:16 165:18
Sentence
[1] 137:25
Separate
[2] 204:21 204:23
September
[2] 137:23 138:16
Serve
[3] 103:15 103:16 103:16
Served
[3] 103:3 103:25 104:5
Serves
[1] 103:14
Service
[8] 102:3 136:15 190:2 191:2 191:16 195:1 203:19 205:18
Serviceable
[3] 153:8 153:21 204:7
Serviced
[4] 153:5 188:17 197:25 199:22
Services
[1] 195:16
Set
[7] 139:5 140:1 140:2 140:4 141:18 166:10 217:11
Seven
[6] 16:12 131:6 131:17 132:19 166:6 166:7
Seventy
[1] 97:23
Several
[7] 40:20 69:14 120:11 120:12 171:17 190:5 191:8
Shall
[2] 212:23 213:2
Sheet
[3] 16:13 177:8 186:11
Shipping
[1] 41:16
Shopping
[2] 35:11 36:23
Shore
[1] 139:7
Short
[3] 8:21 78:1 85:11
Shorthand
[1] 219:9
Shortly
[1] 72:6
Show
[15] 16:5 19:4 56:14 61:17 76:14 82:24 83:18 95:3 106:23 119:23 146:23 158:14 183:6 190:22 211:18
Showed
[1] 208:18
Showing
[3] 17:3 17:9 54:15
Shown
[9] 30:21 43:22 78:11 87:24 101:14 101:22 102:6 106:7 120:3
Shows
[14] 79:16 79:20 80:13 83:14 104:21 105:5 121:13 121:14 121:19 121:22 177:10 180:14 206:9 206:9
Shut
[2] 155:4 194:10
Shutdown
[1] 42:4
Side
[26] 12:12 19:10 28:15 36:3 38:4 38:6 38:7 38:8 38:9 54:3 58:24 58:25 74:9 74:14 95:7 95:12 95:17 109:6 113:12 121:13 136:2 141:19 183:18 183:25 191:18 191:19
Sides
[1] 140:14
Signature
[5] 17:4 17:6 25:21 26:22 135:16
Signatures
[3] 17:10 25:18 26:20
Signed
[7] 6:18 17:3 17:7 17:12 27:4 27:8 148:6
Significance
[1] 14:13
Significantly
[1] 41:9
Signing
[1] 17:2
Simultaneously
[1] 195:2
Single
[1] 54:16
Sinkhole
[3] 115:5 115:9 115:13
Siphon
[4] 75:4 75:19 106:4 173:6
Site
[9] 46:16 68:25 125:2 125:4 125:10 125:16 125:21 125:24 208:19
Sitting
[1] 62:2
Situation
[3] 74:22 75:1 195:6
Situations
[1] 10:1
Six
[3] 41:9 109:20 146:2
Six-and-a-half
[2] 143:8 146:2
Size
[10] 63:15 63:16 80:21 92:16 93:9 94:7 114:8 127:5 180:18 202:5
Skip
[1] 66:8
Slash
[1] 86:25
Slashes
[1] 87:3
Sluice
[6] 124:14 124:17 125:22 125:25 126:9 126:10
Sluices
[1] 124:6
Sluiceways
[2] 19:13 20:23
Small
[11] 7:25 54:3 54:16 54:18 55:9 56:1 56:4 56:11 57:11 57:15 58:7
Smaller
[4] 64:18 196:3 200:13 202:5
Smith
[1] 17:4
So-called
[7] 14:24 29:12 47:25 55:4 97:18 186:19 196:9
Soil
[10] 153:23 153:24 160:12 160:15 160:18 160:21 160:22 161:21 163:23 168:12
Sold
[1] 33:25
Sole
[1] 88:14
Solid
[1] 87:2
Solution
[1] 74:17
Solve
[1] 74:17
Someone
[4] 62:3 62:17 114:18 115:24
Someplace
[2] 27:20 37:21
Somewhere
[1] 81:10
Sorry
[19] 17:22 19:5 25:9 40:16 41:10 42:16 53:12 55:8 66:13 70:19 91:21 98:15 99:2 117:14 136:20 141:15 163:17 166:18 199:25
Sort
[2] 115:1 154:17
Sorts
[1] 13:5
Sought
[4] 91:13 91:22 99:25 100:15
Sounds
[3] 19:9 151:23 170:2
Source
[13] 12:7 86:3 182:9 194:14 194:15 196:9 197:13 200:5 200:6 200:8 200:17 200:18 200:19
Sources
[13] 11:18 12:11 42:21

150:22 187:15 196:6 198:25 199:7 199:12 199:16 199:21 200:20 205:21
Speaking
[1] 181:12
Speaks
[1] 129:10
Specialist
[1] 70:6
Specific
[10] 15:18 34:5 37:8 51:3 60:3 64:3 64:7 64:13 71:25 87:14
Specifically
[5] 4:16 14:8 14:13 63:11 134:6
Speculate
[1] 131:21
Spell
[1] 175:6
Spill
[2] 123:1 190:21
Spills
[1] 183:19
Split
[5] 159:20 188:22 190:2 190:6 190:16
Spontaneous
[1] 138:4
Spot
[2] 183:19 187:8
Spray
[1] 8:8
Spraying
[2] 8:11 29:2
Spreckles
[1] 109:12
Springs
[5] 85:13 85:14 85:15 85:17 198:8
Sprinkler
[1] 8:9
Square-ish
[1] 193:4
Squares
[1] 206:4
SS
[1] 219:3
Stabilize
[1] 140:6
Staff
[4] 80:12 109:20 150:8 211:16
Stages
[1] 13:14
Stainless
[1] 139:1
Stand
[5] 43:11 66:23 145:6 162:18 185:7
Stands
[1] 68:22
Start
[7] 43:25 95:12 95:13 109:6 208:10 212:9 217:1
Started
[4] 10:15 20:11 207:22 214:18
Starting
[2] 78:1 105:8
Starts
[4] 95:20 95:22 131:11 212:18
State
[48] 1:2 6:5 6:12 7:21 16:14 51:24 63:3 71:17 78:12 78:15 79:21 80:14 81:9 82:5 83:13 86:15 86:15 86:22 88:11 88:14 91:9 94:25 95:18 95:23 96:22 97:5 102:1 110:23 110:25 111:7 111:17 111:23 113:2 119:1 119:11 119:13 133:7 133:11 133:18 135:5 137:1 142:16 147:23 155:18 155:20 175:3 211:16 219:2
State-owned
[8] 79:2 80:14 80:21 80:24 81:1 81:4 97:5 102:1
Statement
[6] 8:12 30:22 131:23 154:15 160:1 202:21
Statements
[1] 77:16
States
[4] 40:20 117:4 151:5 202:16
Station
[5] 48:2 107:21 108:9 111:25 112:1
Stations
[7] 107:11 107:13 108:2 110:7 112:10 112:14 112:15
Status
[1] 153:25
Stay
[2] 142:24 145:15
Ste
[4] 2:1 2:7 2:10 2:17
Steady
[6] 36:14 36:20 37:10 155:18 155:20 182:10
Steel
[2] 139:1 201:24
Step
[1] 68:12
Stephen
[5] 3:3 3:23 6:1 6:7 7:5
Stepped
[1] 159:23
Steps
[1] 215:7
Steve
[1] 193:8
Steven
[4] 3:16 174:23 175:4 185:15
Stick
[1] 139:16
Still
[14] 21:6 21:19 41:24 48:15 51:20 68:22 74:12 110:8 110:24 148:17 180:17 185:8 207:6 212:8
Stipulation
[1] 179:1
Stipulations
[1] 13:5
Stop
[1] 111:2
Stopped
[2] 69:25 111:3
Stops
[1] 208:4
Storage
[6] 170:24 171:14 172:21 173:6 173:14 174:2
Store
[1] 171:20
Stored
[1] 173:9
Storm
[6] 124:25 125:2 125:5 125:5 125:7 125:13
Stormwater
[1] 84:20
Stream
[141] 43:19 43:20 43:22 44:9 45:7 46:5 46:24 46:25 47:4 47:7 47:8 47:10 47:11 47:12 47:17 47:25 48:4 48:11 48:12 48:13 48:15 48:17 48:19 48:21 49:14 49:19 50:3 50:4 51:11 55:1 55:3 55:13 56:10 57:8 58:4 58:6 58:11 58:17 66:11 66:20 66:25 67:11 67:12 68:14 68:21 73:14 74:14 77:8 77:11 83:4 83:5 83:6 83:6 83:23 84:2 84:2 84:4 84:12 84:14 84:19 84:21 84:21 84:23 84:24 85:10 85:20 86:6 90:18 90:18 91:6 95:7 95:19 101:10 105:9 105:13 105:23 106:5 107:17 109:8 109:13 109:14 116:6 120:20 121:14 121:14 121:21 121:22 122:2 122:10 122:23 123:21 123:25 124:1 124:2 124:15 124:15 124:19 126:1 126:1 126:2 126:6 127:8 127:10 127:16 127:21 128:18 131:13 132:23 132:25 133:6 137:19 140:25 141:12 142:13 142:18 142:24 145:1 145:6 186:20 186:23 187:9 187:12 187:20 187:23 191:21 195:14 195:16 196:18 196:24 197:5 197:6 199:15 200:6 200:10 200:23 202:20 205:15 207:17 207:21 210:20 210:25
Streamflow
[2] 81:12 137:11
Streams
[20] 59:9 82:25 83:3 83:7 83:12 83:15 83:19 83:21 86:16 100:15 106:7 106:8 106:10 106:13 106:14 106:18 106:21 108:19 108:23 213:2
Street
[6] 2:1 2:4 2:7 2:12 2:14 2:17
Stretched
[1] 13:16
Strictly
[1] 103:19
Strike
[1] 143:20
Structure
[1] 123:2
Study
[6] 71:5 71:8 71:13 71:14 91:10 177:23
Subdivision
[2] 36:5 36:6
Subdivisions
[11] 33:5 33:18 35:16 36:16 36:22 102:24 103:3 103:6 103:16 103:24 104:5
Subject
[4] 18:12 34:23 86:13 88:11
Submit
[3] 119:11 119:13 119:14
Submittal
[1] 217:2
Submitted
[4] 25:16 29:18 119:16 119:18
Subpoena
[2] 62:21 214:23
Subpoenaed
[1] 214:12
Subsidiary
[2] 33:2 33:8
Substantial
[1] 21:5
Succession
[1] 20:10
Sufficient
[3] 131:13 160:19 207:15
Sugar
[17] 6:16 13:1 31:12 33:14 33:16 35:20 36:4 38:5 39:8 39:23 41:13 42:1 42:1 42:7 104:21 113:8 161:11
Sugarcane
[18] 28:18 28:20 34:7 34:17 34:24 35:5 35:10 35:15 35:24 37:22 37:24 38:1 38:10 38:13 103:20 152:14 163:14 172:24
Sump
[5] 115:1 115:1 115:5 115:9 115:13
Superintendent
[3] 73:13 126:3 148:16
Superiors
[1] 10:21
Supervise
[1] 150:8
Supervised
[1] 150:10
Supervision
[1] 219:10
Supplement
[1] 173:9
Supplements
[1] 26:25
Supplied
[2] 11:10 113:2
Supply
[12] 68:15 104:7 107:7 110:11 110:15 110:17 112:19 112:23 113:3 131:6 131:16 131:19
Supplying
[1] 110:8
Support
[14] 28:5 29:9 30:7 30:15 39:22 39:24 39:25 40:13 40:15 40:17 42:8 42:19 210:14 210:18
Supports
[1] 40:1
Suppose
[1] 87:10
Supposed
[3] 193:9 193:19 193:21
Surely
[1] 208:3
Surface
[1] 151:16
Surround
[2] 34:7 104:16
Survey
[1] 111:18
Surveyor
[5] 64:9 64:23 65:18 65:19 66:5
Sustain
[5] 37:8 88:25 96:12 131:4 161:8
Swear
[1] 63:17
Sworn
[6] 6:3 135:3 147:20 174:25 185:10 207:9
System
[80] 7:15 10:11 11:6 12:4 12:5 12:9 12:22 13:10 13:14 15:9 19:1 30:10 30:11 30:14 31:9 31:12 31:15 32:7 32:9 32:13 43:18 51:6 51:25 52:3 54:15 54:17 54:20 54:21 66:19 73:20 73:21 73:23 73:24 74:6 76:4 76:7 78:17 83:2 84:5 86:1 86:2 92:13 98:21 99:12 99:13 99:16 101:23 102:10 102:25 104:22 104:22 107:4 108:4 108:5 108:10 108:12 108:13 108:14 108:16 108:17 109:1 109:8 113:8 113:10 115:1 116:13 128:15 133:20 150:18 153:5 161:3 171:18 171:21 194:13 197:10 205:25 209:17 210:4 212:10 212:15
Systems
[3] 15:9 106:25 153:14

T

Table
[4] 62:2 111:22 111:24 139:18
Tables
[1] 112:13
Takeoff
[1] 194:8
Takeoffs
[1] 194:9
Tanks
[5] 169:19 169:24 169:25 171:10 171:15
Taro
[75] 15:14 46:12 59:14 59:15 59:18 59:22 62:13 62:15 68:9 68:16 68:19 74:5 75:25 77:3 77:12 77:13 77:14 77:18 119:25 128:15 130:13 130:18 130:23 131:7 131:8 131:11 131:14 131:18 131:24 132:1 132:3 132:4 132:5 132:5 132:6 132:7 132:8 132:9 132:10 132:12 132:14 132:15 144:21 144:22 146:19 147:6 161:3 163:13 163:16 163:19 163:19 175:18 176:5 176:6 179:22 181:4 184:1 186:8 186:15 187:16 197:21 202:19 203:15 203:16 207:15 207:16 207:20 207:21 207:23 207:25 208:14 208:17 208:24 210:15 210:19
Tax
[6] 39:20 60:7 60:8 64:21 65:3 65:6
Team
[1] 42:11
Technically
[2] 153:11 153:12
Telemetry
[3] 108:3 108:13 109:7
Telephone
[1] 216:17
Temperature
[3] 115:19 115:22 130:15
Ten
[17] 38:10 55:14 55:17 55:18 114:7 114:12 121:1 140:15 157:19 157:23 158:1 158:12 158:14 162:19 201:7 201:19 202:7
Tenants
[1] 213:1
Teri
[1] 216:8
Term
[4] 19:23 20:19 90:24 111:4
Terminated
[1] 25:12
Terminates
[1] 102:14
Terminology
[1] 40:16
Terminus
[3] 29:13 29:22 52:21
Terms
[5] 9:11 11:4 41:14 58:9 157:13
Territorial
[4] 13:21 14:16 15:4 15:13
Territory
[13] 14:23 16:16 17:19 78:15 78:17 78:23 79:3 79:5 79:6 79:8 79:9 79:14 82:15
Territory-owned
[1] 79:3
Testified
[31] 6:4 27:13 33:1 37:25 59:13 90:2 90:8 99:24 113:7 114:25 116:4 116:9 116:13 121:18 121:19 122:1 124:24 128:9 128:14 129:3 129:21 130:1 130:12 130:18 130:23 135:4 147:21 175:1 185:11 207:6 207:10
Testify
[7] 34:10 58:16 124:10 127:7 129:7 186:18 191:10
Testifying
[3] 62:17 90:12 98:8
Testimony
[60] 3:20 6:22 6:24 7:13 8:16 11:9 41:25 52:12 68:1 68:2 73:21 74:4 74:16 76:21 77:17 77:19 89:2 90:10 97:3 99:7 100:6 113:24 113:25 129:2 129:3 129:10 129:20 129:21 129:25 130:16 130:21 134:4 134:9 135:19 135:21 137:1 148:8 148:11 150:15 150:25 151:6 158:5 159:1 159:8 162:9 167:1 173:16 185:13 185:15 187:22 188:2 202:11 202:14 202:15 202:16 205:13 205:23 207:14 210:6 216:8
Themselves
[2] 215:2 215:17
Thereabouts
[1] 158:22
Thereafter
[3] 72:6 75:9 219:9
Therefore
[1] 89:13
Thinking
[2] 24:2 217:24
Thinks
[1] 5:16
Third
[7] 18:14 18:22 52:18 91:23 92:13 102:16 192:1
Third-party
[1] 10:5
Thirty
[1] 88:12
Thousand
[1] 116:11
Three
[38] 19:8 26:3 26:5 33:11 50:17 66:10 66:18 66:21 66:23 68:5 74:17 74:18 74:19 114:9 121:19 122:3 122:8 122:14 122:24 123:16 127:4 139:2 146:6 146:8 146:10 147:9 164:12 174:17 187:4 189:12 190:10 195:7 202:6 202:23 206:10 207:25 210:13 210:21
Three-inch
[7] 121:19 122:3 122:8 122:14 122:18 122:24 139:2

Three-inches
[1] 123:16
Three-quarters
[2] 164:12 202:6
Three-year
[1] 74:18
Threshold
[2] 9:13 9:23
Throughout
[10] 40:20 108:17 113:18 168:11 168:20 168:23 169:9 169:13 171:18 203:15
Title
[2] 149:11 149:15
Titled
[1] 118:18
TMKs
[1] 73:8
Today
[25] 4:4 4:6 16:3 16:20 21:19 22:12 23:11 23:17 24:10 134:13 153:4 153:6 153:10 153:13 153:17 155:7 175:21 175:21 177:16 196:8 199:10 203:5 208:21 209:12 211:16
Together
[4] 97:5 98:9 111:16 214:13
Tomorrow
[5] 2:14 23:24 80:10 100:10 100:22
Took
[15] 13:22 65:3 74:7 116:6 116:18 116:22 128:21 137:1 138:10 138:10 138:20 138:23 139:21 165:4 197:23
Top
[19] 16:11 74:13 76:4 76:6 95:13 127:11 127:24 128:1 128:10 182:15 189:2 189:20 191:3 191:12 191:24 192:7 193:1 194:10 205:18
Topography
[4] 11:25 12:8 44:14 47:3
Total
[12] 81:4 81:5 81:8 110:17 111:8 112:24 119:1 119:14 120:23 141:8 146:5 157:11
Totally
[1] 128:11
Touching
[1] 90:19
Toward
[2] 190:12 212:3
Towards
[2] 19:10 191:20
Town
[1] 23:15
Traditionally
[1] 200:20
Traditions
[1] 70:16
Trail
[1] 144:19
Transaction
[1] 34:5
Transcript
[2] 217:5 217:17
Transfer
[1] 134:8
Transferred
[1] 33:25
Transition
[2] 154:18 155:15
Transmission
[5] 24:21 24:24 25:15 26:16 203:9
Transmitted
[3] 102:21 109:15 109:16
Transpiration
[7] 159:3 159:9 160:3 160:5 160:11 160:14 160:16
Transpiring
[1] 159:9
Transport
[3] 14:10 82:19 88:4
Transported
[1] 103:21
Transporting
[2] 9:16 82:1
Transposed
[1] 64:11
Transposing
[1] 165:12
Trapping
[1] 141:16
Treated
[2] 29:21 30:7
Treatment
[1] 104:16
Trespass
[1] 144:7
Trespasser
[1] 144:3
Triangle
[1] 45:10
Tributaries
[1] 200:12
Tributary
[5] 43:21 48:20 50:3 50:4 206:23
Tried
[2] 74:17 75:10
Trig
[1] 48:2
Trip
[2] 114:15 114:17
Triple
[1] 68:15
Trouble
[1] 49:3
True
[32] 6:21 6:24 27:18 29:9 29:16 30:13 38:25 39:18 41:7 58:3 77:18 106:11 122:6 135:21 148:12 152:8 153:3 153:3 154:2 154:15 158:3 158:6 158:6 158:11 158:25 163:13 163:14 163:16 163:19 205:17 206:17 219:11
Truth
[4] 6:3 135:3 147:20 174:25
Try
[8] 19:19 23:12 75:22 147:12 159:5 177:23 192:21 217:22
Trying
[9] 8:22 37:16 41:10 75:21 141:8 171:6 177:16 185:18 186:1
Tune
[3] 29:21 30:6 41:9
Tunnel
[5] 15:9 53:23 53:24 101:20 128:22
Tunnels
[3] 19:13 20:23 21:6
Turn
[5] 4:20 47:14 48:1 49:5 81:21
Turned
[2] 35:15 161:15
Turns
[1] 45:11
Two
[58] 5:4 7:11 25:3 26:3 26:18 53:8 66:10 66:18 71:5 93:23 94:10 100:11 100:15 114:4 117:9 120:15 121:19 122:3 122:7 122:14 122:18 122:24 123:4 123:15 124:14 127:4 132:22 136:9 164:15 164:16 166:5 166:9 166:12 167:4 167:13 168:3 168:5 168:8 173:24 174:16 175:12 177:2 178:4 182:19 184:7 184:14 189:14 198:25 199:21 201:15 206:9 206:14 207:25 212:2 212:7 212:24 217:6 217:15
Two-day
[2] 166:14 167:13
Two-inch
[4] 53:8 66:10 66:18 201:15
Type
[2] 42:11 122:17
Types
[1] 39:2
Typewriting
[1] 219:10
Typical
[3] 152:8 154:4 154:10
Typically
[2] 158:6 173:19

U

U.S.
[1] 111:18
Ultimately
[1] 198:20
Unauthorized
[1] 143:21
Unblock
[1] 67:13
Unblocks
[1] 67:10
Uncle
[1] 179:21
Uncle's
[1] 175:24
Uncles
[1] 176:3
Under
[25] 9:10 11:3 12:25 14:6 15:12 17:19 27:13 29:17 29:18 43:11 80:13 83:13 89:11 89:12 89:18 99:24 134:8 141:24 155:21 162:15 183:20 185:8 207:7 216:5 219:10
Underline
[1] 180:11
Underlined
[1] 178:17
Underneath
[1] 126:8
Understood
[1] 162:9
Undivided
[4] 86:25 87:3 87:5 87:9
Undo
[1] 20:18
United
[1] 40:20
Unless
[5] 58:14 60:24 84:21 103:6 141:16
Untreated
[1] 103:23
Up
[65] 4:16 12:13 12:15 27:9 28:21 30:9 35:7 42:1 47:12 48:1 49:15 64:18 67:12 69:1 75:5 75:14 75:18 85:3 85:6 85:17 86:11 92:15 95:19 95:20 122:20 132:23 139:7 140:2 140:5 141:22 142:1 142:2 142:11 148:23 159:5 162:5 165:21 175:23 175:24 176:10 176:14 176:23 179:17 179:20 179:23 181:6 182:14 182:16 183:18 186:1 186:8 187:7 192:9 195:21 197:23 198:20 199:6 203:20 207:25 208:18 210:15 210:19 210:24 210:24 215:21
Up-country
[2] 30:9 103:14
Upcoming
[1] 125:13
Upper
[20] 58:25 68:10 68:12 68:15 68:17 69:7 69:10 69:14 70:2 101:14 106:23 107:1 107:2 107:7 188:11 202:16 202:22 202:25 203:24 204:6
Uppermost
[2] 192:5 194:22
Upstream
[5] 67:5 115:1 138:1 138:6 138:17
Urban
[5] 33:6 33:19 35:11 36:16 36:23
Usage
[2] 151:20 152:19
Users
[2] 67:10 210:5
Uses
[12] 33:6 33:18 33:19 34:2 36:22 36:23 37:11 37:12 37:19 76:11 102:11 102:18
USGS
[10] 107:11 107:13 110:6 110:13 110:23 110:25 112:8 112:11 116:17 116:19

V

Vacant
[2] 29:7 29:8
Vague
[5] 20:21 37:1 37:4 154:6 170:25
Valley
[38] 15:15 30:10 42:19 74:6 74:9 76:1 175:14 175:16 176:7 176:9 176:12 176:24 177:3 177:4 178:11 180:2 181:17 182:15 182:20 185:25 186:16 187:8 187:15 187:16 190:12 190:18 190:19 191:19 196:5 196:15 197:14 199:13 200:14 203:3 203:15 206:10 206:10 206:23
Value
[2] 92:3 201:15
Values
[1] 201:14
Variation
[2] 157:13 161:12
Varied
[1] 151:1
Varies
[2] 161:23 180:18
Various
[9] 10:21 11:2 11:10 13:14 13:15 15:7 109:22 110:7 156:19
Vary
[1] 157:11
Vaught
[9] 3:9 61:25 135:1 135:7 135:13 136:8 143:7 147:11 147:17
Ventures
[2] 42:22 43:2
Verified
[3] 116:16 116:19 116:21
Verify
[2] 112:11 112:13
Version
[1] 190:13
Versus
[1] 98:3
Vested
[3] 18:13 18:20 216:6
Via
[1] 103:21
Vicinity
[2] 45:15 186:5
Visit
[2] 68:25 208:19
Visual
[1] 206:19
Volume
[6] 41:14 71:10 71:13 109:1 195:6 195:24

W

Waiaaka
[1] 109:8
Waiawa
[1] 29:13
Waikamoi
[7] 101:21 102:2 106:23 107:1 107:2 107:8 107:8
Waikani
[11] 45:20 45:23 73:20 74:1 74:2 74:7 75:5 77:5 189:16 191:20 203:2
Wailoa
[27] 29:12 29:20 29:23 30:5 31:22 79:11 84:10 84:13 84:14 84:18 85:4 85:9 101:14 101:18 102:14 104:6 104:24 105:4 106:16 106:17 109:4 109:7 109:14 112:17 113:14 113:21 121:15
Wailua
[13] 18:3 59:6 62:7 63:6 74:14 106:4 132:11 175:23 176:8 177:1 177:2 196:20 206:12
Wailua-Iki
[3] 17:21 17:24 18:3
Wailuanui
[38] 15:15 18:14 18:21 19:2 47:8 47:12 58:24 59:15 70:16 73:23 74:6 74:10 74:14 76:21 76:24 77:8 77:11 175:12 175:14 175:14 175:16 176:7 176:10 176:24 185:25 186:16 187:15 191:21 196:15 197:6 197:14 203:3 203:15 205:15 206:8 206:11 206:13 206:23
Wailuku
[7] 2:2 2:13 2:15 11:21 11:24 12:3 27:19
Waiokamilo
[34] 43:21 48:5 48:7 48:21 49:14 50:3 68:14 68:21 186:20 186:23 187:9 187:20 195:13 195:15 195:20 196:3 196:7 196:24 197:2 197:5 197:23 197:24 198:12 199:1 199:15 199:19 199:21 199:22 199:24 200:2 200:4 200:6 200:23 202:20
Waiokani
[6] 45:16 45:18 45:20 45:21 45:22 74:1
Wait
[7] 164:22 177:20 177:21 178:6 178:7 190:18 204:13
Walk
[6] 69:10 69:17 144:10 144:22 145:1 193:12
Walked
[4] 69:5 69:14 69:19 69:23
Wall
[6] 127:8 180:2 182:19 185:24 185:25 193:5
Wants
[1] 142:23
Wash
[1] 8:15
Wastewater
[5] 8:7 8:14 8:15 28:24 28:25
Watanabe
[1] 4:24
Watch
[1] 67:22
Watched
[1] 63:18
Water
[450] 1:3 7:14 7:22 8:15 8:17 8:19 8:20 8:21 8:24 8:25 9:3 9:13 9:15 9:16 9:22 10:1 10:2 10:5 10:11 11:3 11:6 12:5 12:13 12:25 13:23 14:2 14:7 14:11 14:24 15:15 18:13 18:20 19:13 19:14 21:9 21:16 24:20 25:15 26:16 27:15 28:5 29:11 29:20 30:2 30:4 30:6 30:10 30:14 31:14 31:20 31:22 32:16 42:6 42:15 42:18 42:21 43:1 50:22 51:1 51:2 51:7 51:12 51:14 51:15 51:17 52:20 52:23 52:24 56:3 56:13 56:25 57:7 57:16 57:19 58:9 58:15 59:4 59:8 66:19 66:24 67:11 67:11 67:22 68:14 68:19 69:24 71:15 71:24 73:1 73:24 74:7 74:12 74:14 75:6 76:11 76:12 76:20 76:23 77:5 77:7 77:8 77:11 77:17 81:17 81:19 81:20 81:22 81:23 84:12 84:12 84:15 84:20 85:8 85:13 85:17 85:19 85:21 86:1 86:2 88:13 88:16 88:17 88:23 89:24 90:2 90:8 90:12 90:15 90:17 90:18 90:21 91:6 91:14 91:23 92:1 92:7 92:10 92:14 92:21 92:25 93:8 93:12 93:18 93:21 94:6 94:10 94:14 94:16 94:16 94:20 96:4 96:7 96:13 96:15 97:4 97:5 97:9 97:10 97:19 98:5 98:21 99:11 99:19 100:1 100:15 100:20 100:21 101:5 101:7 101:11 102:9 102:13 102:17 102:20 102:23 103:3 103:13 103:18 103:19 103:21 103:23 103:23 103:25 104:5 104:7 106:11 106:14 106:17 107:7 107:9 109:11 109:22 110:7 110:16 111:8 111:12 111:15 112:1 112:3 112:24 113:13 113:18 113:22 114:5 114:16 115:10 115:14 115:19 116:5 117:10 119:1 122:11 126:8 126:10 126:14 126:18 127:10 127:12 127:24 127:25 128:15 128:17 128:21 128:24 129:4

129:22 130:1 130:8 130:12 130:14 131:7 131:7 131:12 131:13 131:18 131:20 131:24 132:18 133:8 133:12 133:19 133:21 137:18 138:6 139:10 139:11 139:15 139:17 140:2 140:3 140:6 140:10 140:12 140:17 140:24 141:17 141:20 141:20 141:23 141:24 142:8 142:12 142:19 142:23 142:24 145:2 146:20 147:7 148:17 150:2 150:5 150:12 150:17 150:19 150:21 150:22 151:15 151:16 152:8 153:9 153:21 154:1 154:4 154:24 155:4 155:4 155:10 156:7 156:9 156:10 156:11 156:15 156:19 156:25 156:25 157:4 157:6 158:15 158:19 159:9 160:6 160:9 160:20 161:2 161:3 161:15 163:4 163:12 163:23 164:5 164:20 166:9 166:15 167:13 167:22 169:11 170:7 170:22 170:24 171:15 171:20 171:21 171:25 172:11 172:12 172:19 172:20 173:1 173:13 173:14 173:19 173:20 173:25 181:1 181:14 181:20 181:21 181:23 181:25 182:3 182:4 182:5 182:6 182:7 182:9 182:10 182:15 183:19 184:1 184:5 184:20 184:22 184:24 187:14 187:18 187:19 188:13 188:14 188:15 188:17 188:21 188:23 189:3 189:4 190:1 190:9 191:16 191:22 192:18 193:3 193:14 194:2 194:6 194:7 194:10 194:12 194:14 194:15 194:16 194:17 194:20 194:21 195:1 195:3 195:6 195:8 195:15 195:24 195:25 195:25 196:2 196:4 196:7 197:13 197:22 197:22 198:19 198:22 199:1 199:2 199:3 199:4 199:7 199:12 199:15 200:3 200:5 200:17 200:18 200:19 200:19 202:18 202:25 203:3 203:10 203:11 203:14 203:18 205:14 205:20 205:25 206:22 207:15 207:20 207:23 208:2 208:3 208:6 208:7 208:10 208:11 208:12 208:12 208:13 208:13 208:15 208:23 209:4 210:2 210:3 210:5 210:12 210:18 210:21 210:23 210:24 210:25 211:3 212:14 212:22

Watered
[2] 11:24 12:7

Waterfall
[1] 85:22

Waterfalls
[3] 199:5 199:5 200:13

Waters
[4] 82:2 82:20 86:15 88:5

Watershed
[4] 50:16 110:18 118:16 119:20

Ways
[1] 126:13

Weather
[1] 40:22

Week
[8] 114:21 125:9 131:6 131:17 132:19 161:20 164:15 166:6

Weeks
[2] 60:14 60:15

Weir
[13] 102:6 102:14 102:17 102:21 102:23 103:4 103:13 103:19 104:1 104:4 104:12 104:16 107:9

Well-founded
[1] 216:2

Wells
[1] 2:14

Wendt
[11] 3:19 185:5 185:7 185:9 186:18 188:7 190:8 195:12 200:25 202:11 205:12

West
[11] 11:18 11:19 12:7 17:23 30:1 30:4 42:14 42:17 42:21 47:8 105:13

Western
[4] 95:6 95:12 95:17 119:3

Wet
[8] 165:8 165:9 166:1 167:19 168:20 169:1 171:23 172:3

Wetland
[2] 132:8 132:10

Whereas
[1] 127:23

Whereby
[4] 9:22 92:14 92:25 108:14

Whichever
[1] 174:1

White
[9] 87:20 87:21 87:22 87:23 88:1 88:4 94:21 96:4 96:14

Whole
[10] 11:11 20:11 98:21 99:13 127:16 149:19 153:5 153:9 168:11 214:16

Wide
[3] 103:8 140:15 140:16

Willing
[14] 9:3 22:18 68:11 68:20 131:5 131:16 131:19 132:17 132:22 132:24 133:3 202:19 203:23 204:4

Winter
[13] 151:2 161:25 162:1 164:3 166:1 167:7 167:9 167:19 168:20 168:23 169:1 171:24 172:2

Withdraw
[1] 88:13

Withhold
[3] 133:8 133:12 133:19

Witness
[63] 6:2 6:7 6:9 9:20 15:22 27:9 32:6 44:20 45:22 48:25 49:5 49:10 49:13 49:18 49:22 52:13 52:15 56:9 58:2 64:22 65:6 69:10 78:20 82:11 83:12 90:11 91:3 92:8 101:3 103:12 117:12 118:13 118:22 130:7 135:2 135:7 140:22 141:5 141:10 141:13 141:18 144:9 147:19 147:24 148:24 161:17 162:1 163:21 171:3 174:24 175:4 175:7 182:14 184:9 188:9 188:12 189:2 189:12 189:19 189:25 190:7 191:11 192:19

Witnessed
[1] 176:2

Witnesses
[5] 3:2 5:4 5:15 174:8 205:13

Word
[3] 154:10 212:18 212:25

Words
[14] 12:19 15:12 54:18 55:9 80:23 87:4 87:6 123:21 123:24 127:23 161:15 187:5 212:7 212:14

Workers
[1] 125:16

Works
[14] 28:8 32:7 32:9 32:14 58:4 58:7 124:7 124:9 124:10 126:14 126:19 126:20 126:24 170:9

Worst
[1] 23:23

Wright
[1] 2:7

Writes
[2] 70:25 71:18

Writing
[1] 214:3

Written
[7] 6:17 6:22 88:12 97:3 116:5 217:2 217:19

X

Xerox
[1] 24:3

Y

Y-type
[1] 122:17

Yard
[1] 142:20

Year
[25] 10:15 35:6 39:18 40:4 40:4 40:6 40:7 40:8 40:10 40:10 40:12 40:14 40:25 41:2 41:3 74:18 118:19 118:25 119:19 154:5 161:23 184:3 184:19 184:21 201:22

Years
[39] 10:12 20:14 20:16 25:9 26:3 26:4 26:5 26:18 32:24 34:9 36:7 38:10 38:13 46:8 74:17 74:19 76:9 81:13 82:6 114:7 114:12 120:12 120:13 120:14 120:16 120:23 143:8 146:2 157:21 187:4 187:4 187:5 195:18 201:3 201:5 201:6 201:7 202:23 212:24

Yellow
[4] 79:12 79:13 86:20 86:22

Yesterday
[11] 4:6 4:16 5:9 9:16 19:6 43:16 50:8 51:9 65:2 67:19 73:2

YIP
[1] 2:6

Young
[7] 176:1 176:2 179:21 179:22 184:22 184:25 197:17

Younger
[3] 187:7 195:14 199:14

Yourself
[3] 132:3 132:12 146:13

Z

Zoning
[1] 28:8

Integrative and Comparative Biology, volume 50, number 6, pp. 1185–1199
doi:10.1093/icb/icq070

SYMPOSIUM

Morphological Selection and the Evaluation of Potential Tradeoffs Between Escape from Predators and the Climbing of Waterfalls in the Hawaiian Stream Goby *Sicyopterus stimpsoni*

Richard W. Blob,[1,*] Sandy M. Kawano,* Kristine N. Moody,* William C. Bridges,[†] Takashi Maie,* Margaret B. Ptacek,* Matthew L. Julius[‡] and Heiko L. Schoenfuss[‡]

*Department of Biological Sciences, Clemson University, Clemson, SC 29634, USA; [†]Department of Applied Economics and Statistics, Clemson University, Clemson, SC 29634, USA; [‡]Aquatic Toxicology Laboratory, St Cloud State University, St Cloud, MN 56301, USA

From the symposium "Contemporary Approaches to the Study of the Evolution of Fish Body Plan and Fin Shape" presented at the annual meeting of the Society for Integrative and Comparative Biology, January 3–7, 2010, at Seattle, Washington.

[1]E-mail: rblob@clemson.edu

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

Synopsis Environmental pressures may vary over the geographic range of a species, exposing subpopulations to divergent functional demands. How does exposure to competing demands shape the morphology of species and influence the divergence of populations? We explored these questions by performing selection experiments on juveniles of the Hawaiian goby *Sicyopterus stimpsoni*, an amphidromous fish that exhibits morphological differences across portions of its geographic range where different environmental pressures predominate. Juvenile *S. stimpsoni* face two primary and potentially opposing selective pressures on body shape as they return from the ocean to freshwater streams on islands: (1) avoiding predators in the lower reaches of a stream; and (2) climbing waterfalls to reach the habitats occupied by adults. These pressures differ in importance across the Hawaiian Islands. On the youngest island, Hawai'i, waterfalls are close to shore, thereby minimizing exposure to predators and placing a premium on climbing performance. In contrast, on the oldest major island, Kaua'i, waterfalls have eroded further inland, lengthening the exposure of juveniles to predators before migrating juveniles begin climbing. Both juvenile and adult fish show differences in body shape between these islands that would be predicted to improve evasion of predators by fish from Kaua'i (e.g., taller bodies that improve thrust) and climbing performance for fish from Hawai'i (e.g., narrower bodies that reduce drag), matching the prevailing environmental demand on each island. To evaluate how competing selection pressures and functional tradeoffs contribute to the divergence in body shape observed in *S. stimpsoni*, we compared selection imposed on juvenile body shape by (1) predation by the native fish *Eleotris sandwicensis* versus (2) climbing an artificial waterfall (~100 body lengths). Some variables showed opposing patterns of selection that matched predictions: for example, survivors of predation had lower fineness ratios than did control fish (i.e., greater body depth for a given length), whereas successful climbers had higher fineness ratios (reducing drag) than did fish that failed. However, most morphological variables showed significant selection in only one treatment rather than opposing selection across both. Thus, functional tradeoffs between evasion of predators and minimizing drag during climbing might influence divergence in body shape across subpopulations, but even when selection is an important contributing mechanism, directly opposite patterns of selection across environmental demands are not required to generate morphological divergence.

Introduction

Efforts to understand how the morphology of animals relates to variation in the environments where they live have been a prominent focus of many evolutionary, ecological, and functional studies (Webb 1984; Losos 1990; Liem 1993; Wainwright and Reilly 1994; Walker 1997; Domenici 2003; Langerhans et al. 2003; McGuigan et al. 2003;

C-133

Advanced Access publication June 10, 2010
© The Author 2010. Published by Oxford University Press on behalf of the Society for Integrative and Comparative Biology. All rights reserved.
For permissions please email: journals.permissions@oxfordjournals.org.

Langerhans 2008; Rivera 2008). Fishes have served as a critical model in this research because of the wide range of functional studies that have helped to identify correlations between body shape and performance (Webb 1975, 1978, 1986; Westneat 1994; Drucker and Jensen 1997; Pettersson and Hedenström 2000; Walker 2000; Ferry-Graham et al. 2001; Rosenberger 2001; Wainwright et al. 2002; Walker and Westneat 2002; Lauder et al. 2003; Blake 2004, 2006; Carroll et al. 2004; Higham et al. 2005; Domenici et al. 2008; Blake et al. 2009). These functional studies provide a foundation for predicting how different body shapes should succeed or fail under pressures from different environments, and whether particular morphologies may entail functional tradeoffs, improving performance of some tasks at the expense of others (Ghalambor et al. 2003, 2004; Walker 2007; Langerhans 2009a). Because environmental pressures may vary over the range of a species, subpopulations may be exposed to divergent functional demands. How does exposure to competing demands shape fish morphology and influence divergence of populations? Understanding the potential for functional tradeoffs to contribute to population divergence is significant, because such divergence can be one of the first steps leading to speciation (Schluter 2001; Coyne and Orr 2004).

The stream gobies of the Hawaiian Islands provide a system that is particularly well suited for examining the roles that varying environmental conditions and resultant functional tradeoffs play in shaping fish morphology because of the distinctive life history of these fishes and the specific pressures exerted by their native habitats. All five native species of gobioid fishes inhabiting Hawaiian streams share an amphidromous life cycle: adults live and lay eggs in freshwater, but when larvae hatch they are swept downstream to the ocean, where they develop for several months before returning to habitats used by adults in island streams (Nishimoto and Fitzsimons 1999; Keith 2003; McDowall 2003, 2004; Schoenfuss and Blob 2007). Evidence indicating that these fishes home to their natal stream is lacking, and population-genetic data have suggested that fish hatched on one island may recruit to other islands (Chubb et al. 1998). Upon arriving at a stream, however, juvenile gobies returning from the ocean encounter two major, contrasting environmental challenges (Fig. 1). First, the lower reaches of Hawaiian streams are patrolled by a non-climbing, piscivorous member of the sleeper family, *Eleotris sandwicensis* (Fitzsimons et al. 1997; Schoenfuss and Blob 2007). Second, because of the volcanic origin of the islands (Carson and Clague 1995), Hawaiian streams typically descend from steep mountains and are punctuated by substantial waterfalls. For three goby species (*Awaous guamensis*, *Lentipes concolor*, and *Sicyopterus stimpsoni*), the habitats used by adults are upstream of waterfalls that can be thousands of body lengths high (Fitzsimons and Nishimoto 1995). Thus, to reach their destination, juveniles of these three species must first avoid being eaten by predators, and then climb up massive falls in the streams. One key to the waterfall-climbing ability of these fish is that, as members of the goby clade, they possess a distinctive ventral sucker formed from the fusion of the pelvic fins (Nishimoto and Fitzsimons 1999; Schoenfuss and Blob 2003). Moreover, gobies are free from native predators once above the falls, as *E. sandwicensis* does not climb and no birds or invertebrates are known to exert substantial predatory pressure on fish in upstream habitats of the Hawaiian Islands (Schoenfuss and Blob 2007).

Based on experimental studies of fish performance and hydrodynamic principles, body shapes that should enhance the ability of gobies to evade predators are expected to differ substantially from those that should promote successful climbing of waterfalls. Escape from predators would be aided by increased production of evasive thrust (Walker et al. 2005), which can be facilitated through increases in the depth of the posterior body and caudal peduncle relative to anterior regions like the head, and increases in the size of median fins (Walker 1997; Domenici et al. 2008). In contrast, climbing rock surfaces through flowing water should be aided by body shapes that improve adhesion and minimize drag (Blob et al. 2008). Successful climbers, therefore, might have larger suckers (Maie et al. 2007) as well as narrower, flatter bodies than those of unsuccessful climbers. This shape of the body would reduce the area exposed to flow (Hoerner 1958; Webb 1989; Vogel 1994; Domenici 2003) and contribute to values of morphological indices (e.g., fineness, lengthening, and flattening ratios) that are closer to optimal values for the reduction of drag in benthic fish (Arnold and Weihs 1978; Webb 1989; Blake 2006).

In addition to the contrasting demands presented to gobies by predation and climbing, differences in stream habitats across the Hawaiian Islands have the potential to cause one or the other of these pressures to predominate, so that divergent morphological phenotypes might be advantageous on different islands (Blob et al. 2008). On Kaua'i (the oldest major island), erosion has caused many waterfalls to recede far inland, creating streams with long,

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

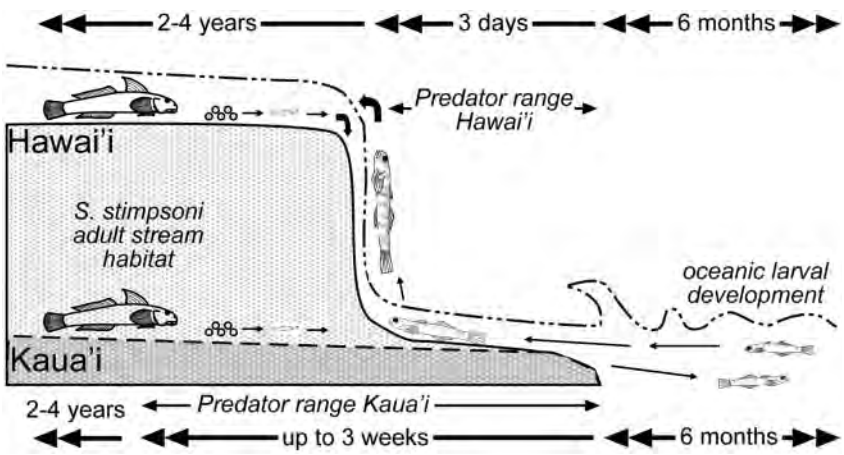


Fig. 1 Schematic illustration of the life cycle of *Sicyopterus stimpsoni* on the islands of Hawai'i (top) and Kaua'i (bottom), reproduced from Blob et al. (2008). Adults live upstream (left side of figure) on both islands. Larvae hatching from eggs (circles) are swept by stream currents to the ocean (right side of figure). Juveniles returning to freshwater and migrating upstream encounter predatory, non-climbing *Eleotris sandwicensis* before reaching waterfalls in the streams. The inland erosion of waterfalls on Kaua'i extends the exposure of juvenile *S. stimpsoni* to predators for up to 3 weeks (time scale at bottom of figure), whereas near-shore waterfalls on Hawai'i shorten the range of juveniles' exposure to predators to ~3 days (time scale at top of figure) but place an early premium on waterfall-climbing performance.

meandering stretches extending upstream from the ocean, thereby forcing juvenile gobies to swim through an extended gauntlet of non-climbing predators during their upstream migration (Fig. 1; Fitzsimons et al. 1997; Schoenfuss and Blob 2007; Blob et al. 2008). In contrast, on the Island of Hawai'i (the youngest island), waterfalls are typically close to shore, subjecting juvenile gobies to the challenge of extreme flow shortly after entering streams, but minimizing exposure to predators (Fig. 1; Fitzsimons et al. 1997; Schoenfuss and Blob 2007; Blob et al. 2008). Because of this difference in the predominant early selective pressures presented to gobies on each island, body shapes suited to improve evasion of predators might be favored on Kaua'i, whereas body shapes suited to improve climbing performance might be favored on Hawai'i. Differences in body shape among fish from these islands support this prediction: morphometric analyses of adult *S. stimpsoni* collected in 2005 indicated that, regardless of sex, fish from Kaua'i tended to have tall bodies advantageous for generating evasive thrust, whereas fish from Hawai'i tended to have low, narrow bodies better for reducing drag (Blob et al. 2008). However, direct comparisons of the potential for the competing selection pressures of predation and climbing to contribute to morphological divergence between subpopulations of stream gobies have not been performed.

To evaluate how competing selection pressures and functional tradeoffs might contribute to divergence in the body shapes of stream gobies across the Hawaiian Islands, we conducted two sets of laboratory-based selection experiments (Garland 2003; Fuller et al. 2005) on juvenile fish to compare how body shape might specifically be influenced by predation by the native fish *E. sandwicensis* versus climbing an artificial waterfall (~100 body lengths). Because different body shapes are thought to improve performance during evasive swimming versus climbing, we might expect such functional tradeoffs to be reflected by predation and climbing both exhibiting opposite patterns of selection for many morphological traits. In addition, we compared the body shapes of juvenile fish collected on Kaua'i and Hawai'i to assess how selection might be acting in the wild. If juvenile fish, as well as adults, differ in shape across the islands, then selection may have been contributing to divergence of subpopulations over many generations of recruits, and the possibility that divergence in the body shape of adults between islands is strictly a plastic response to the environment (DeWitt et al. 1998; Domenici et al. 2008) seems unlikely. For these analyses, we focused on *S. stimpsoni* as a model species. Juvenile *S. stimpsoni* average just over 2 cm in length and "inch up" surfaces by alternating advancement of the pelvic sucker and a second, oral sucker associated with the upper jaw (Schoenfuss et al. 1997; Nishimoto and Fitzsimons 1999; Schoenfuss and Blob 2003). Focus on juvenile *S. stimpsoni* simplifies expectations for the types of body shapes that minimize drag

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

(Walker et al. 2010), because its mode of climbing involves almost no lateral bending of the body axis for propulsion (Schoenfuss and Blob 2003; Blob et al. 2007). In addition, because previous studies by our group had established that adult *S. stimpsoni* from Kaua'i and Hawai'i differ in body shape, and had measured morphological selection imposed on juvenile *S. stimpsoni* by the demands of climbing (Blob et al. 2008, 2009), focus on the same species for our new analyses of morphological divergence among juveniles and selection imposed by predators could build from a substantial context in evaluating the influence of selection and tradeoffs in the evolution of body shape in Hawaiian waterfall-climbing gobies.

Materials and methods

Evaluation of selection imposed on gobies by predators

Juvenile *S. stimpsoni* for both sets of selection experiments (predation and climbing) were collected with dip nets from the lower reaches of Hakalau stream on the Island of Hawai'i, downstream from a 1-m vertical concrete embankment (same location as used by Schoenfuss and Blob 2003; Blob et al. 2006). Transparency of the fish indicated all were fresh recruits into the stream (Schoenfuss and Blob 2003, Blob et al. 2006), limiting previous in-stream exposure to selective pressures. Fish were transferred in stream water to laboratory facilities (provided by the Department of Land and Natural Resources, Division of Aquatic Resources in Hilo, Hawai'i) within 2 h of capture.

Experiments on predation were performed in 2007 following protocols based on those described by Swain (1992). To help ensure that all fish in our sample were similar in developmental stage, collections for each predation trial were limited to the number of fish we could collect in a single day, and Swain's (1992) protocols were modified accordingly. Each stock group of gobies collected for a predation trial was divided into "treatment" and "control" groups by drawing batches of juveniles from a stock tank with a dip net and alternately distributing these fish to separate treatment and control tanks (400-l cattle tanks half filled with aerated stream water). Dip-net withdrawals for treatment tanks contained twice as many fish (~20) as those for control tanks (~10), and the distribution of fish to tanks was repeated until each treatment tank approached a target of 100 fish and each control tank approached a target of 50 fish. This protocol helped to ensure that only chance differences should exist between fish in treatment and control groups, even if dip-net withdrawal is selective (Swain 1992). After distribution, juvenile gobies were allowed to acclimate for 1 day before 10 predatory *E. sandwicensis* (which had been starved for the prior 24 h) were added to the treatment tank. Experiments were run until approximately one-half of the juvenile *S. stimpsoni* in the treatment tank were eaten, which was consistently close to 36 h across all trials. At this point, predators were removed from the tanks and all remaining gobies (~50 survivors and 50 controls) were collected and preserved in 40% ethanol. Each fish was digitally photographed in lateral and ventral views and weighed to the closest 0.01 g. Linear measurements of anatomical variables (Fig. 2) hypothesized to be relevant to locomotor performance during either evasion of predators or climbing waterfalls (Blob et al. 2008) were obtained using NIH Image 1.62 or Image J v1.41.

The consumption of juvenile gobies by the predators forced us to make our comparisons for predation trials between surviving fish and control fish that had not been exposed to selection, rather than between surviving fish and fish that failed under selection. To accommodate this design, we evaluated the direction and strength of directional selection on morphological traits following the procedures outlined by Lande and Arnold (1983) for cross-sectional data. Prior to analysis, fish with a body condition index (BCI = body length^3/body mass) > ±2 SD from their population mean were excluded, and all variables for remaining fish were standardized for body size using the transformation [ln(variable) − ln(total length)] (Mosimann and James 1979). Newly recruited *S. stimpsoni* show a very limited range of body lengths, minimizing any potential effects of differences in allometric growth on our analyses (Blob et al. 2008). Because the rather small sample sizes we had available for individual predation trials limited our ability to detect significant results (Kingsolver et al. 2001), we focused our analyses of selection imposed by predation on data pooled across all five trials, thereby providing a total of 228 survivors of predation and 167 control fish.

We evaluated the significance of both direct and indirect directional selection by calculating and comparing two parameters: the selection differential and the selection gradient. Selection differentials (s) represent change in a character's mean due to both direct and indirect directional selection, and were calculated for each character as the difference between the mean value for surviving fish and the

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

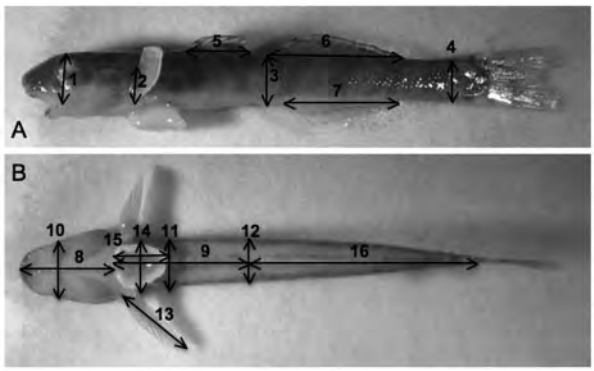


Fig. 2 Photographs of lateral (A) and ventral (B) views illustrating linear anatomical variables measured on juvenile *S. stimpsoni*. Note that standard length also was measured to enable standardization of other linear variables, and that tail length was included as a variable only in analyses comparing the morphology of fish from Kaua'i versus Hawai'i (not selection analyses).
1, Head height; 2, Basal length of pectoral fin; 3, Height at mid-body; 4, Height of caudal peduncle; 5, Basal length of first dorsal fin; 6, Basal length of second dorsal fin; 7, Basal length of anal fin; 8, Head length; 9, Trunk length; 10, Head width; 11, Trunk width; 12, Width of the body at the location of the anal pore; 13, Length of the margin of the pectoral fin; 14, Sucker width; 15, Sucker length; 16, Tail length.

mean value for all fish in the trial; each value of s was then divided by the standard deviation of the character to produce the standardized parameter s' (Lande and Arnold 1983). Assigning surviving fish a fitness (W) of 1 and control fish a W of 0, we transformed W to relative fitness (w) by dividing W by mean population fitness, and then tested the significance of s' values with Spearman rank correlations of relative fitness with transformed values for each character. Directional selection gradients (β) indicate the strength of only direct directional selection on each character, and standardized gradients (β') were calculated from the product $P^{-1}\ s'$, where P is the phenotypic variance–covariance matrix calculated from standardized measurements of control fish (representing the pre-selection or "young cohort" indicated by Lande and Arnold [1983]). Standard errors and significance tests for the gradients were performed by bootstrap methods (Efron and Gong 1983). This procedure used 1000 replicate samples from the data set to create an empirical sampling distribution of gradient values, and standard errors and significance tests were developed from this distribution. All gradient and Spearman rank analyses were conducted in SAS (Cary, NC, USA, Version 9.1).

To complement our analyses of linear measurements, we also evaluated selection on functional ratios associated with hydrodynamic performance, including fineness ratio (length/maximum height), flattening ratio (maximum width/maximum height), and lengthening ratio (length from rostrum to location of maximum height/length) (Arnold and Weihs 1978; Webb 1989; Blake 2006). Because these ratios are based on combinations of the linear morphological variables under study, they could not be included in calculations of selection gradients with the variables from which they were derived. However, we did calculate s' for these three ratios between survivors of predation and control fish, and used Spearman rank correlations to test if selection by predators favored taller bodies that could increase thrust, rather than values closer to optima for reduction of drag (10 for fineness ratio, 2 for flattening ratio, 0.3 for lengthening ratio [Blake 2006]).

Evaluation of selection imposed on gobies by waterfalls

Experiments to evaluate selection imposed on the morphology of juvenile *S. stimpsoni* by the demands of waterfall climbing were conducted in 2006; details of our procedures and results were reported previously (Blob et al. 2008), with the results corrected in a subsequent report (Blob et al. 2009). Two different experimental setups were implemented in our original study of selection related to climbing, but for comparison to selection parameters calculated for predation we considered only the results from experiments conducted on the longer of two climbing arenas in which fish were tested in groups of 20, thereby better simulating the tendency of juvenile *S. stimpsoni* to climb in large groups (Nishimoto and Fitzsimons 1999). To summarize these experiments, groups of juveniles were introduced into a basin containing stream water and challenged with a 240-cm climbing chute extending at ~70° from the horizontal. A siphon directed acclimated stream water down the chute at a rate of ~200 ml min^{-1} and a depth of 1–1.5 mm, stimulating the positively rheotactic fish to climb. Climbing performance was evaluated as either "success" for fish reaching the top of a chute, or "failure" for fish that failed to climb or that attempted climbing but failed to reach the top. Fish were collected upon completion of trials, preserved in 40% ethanol, and photographed and measured as described for predation trials.

Because individual fish could be distinguished as successful or failed, the strength of directional selection imposed on each morphological character by climbing was evaluated using procedures outlined by Lande and Arnold (1983) for longitudinal data. Procedures for the exclusion of outliers (leaving a

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

sample of 224 fish), standardization of measurements for differences in body size, and calculation of s' (for hydrodynamic ratios as well as linear measurements) were the same as those used in the study of predation. For the assessment of fitness, successful climbers were assigned an absolute fitness (W) of 1 and unsuccessful climbers a W of 0, with all-or-nothing designations reflecting an assumption that partial ascension of a waterfall still indicates failure to reach the habitat of reproductive adults. To calculate directional selection gradients (β), we followed the modifications of Lande and Arnold's (1983) methods recommended by Janzen and Stern (1998) and calculated a selection gradient vector (β_{avggrad}) from logistic multiple regression of relative fitness on all characters. Logistic regressions and Spearman rank correlations were calculated using SAS (Cary, NC, USA, Version 9.1).

Comparisons between selection imposed by predators and waterfalls and the evaluation of functional tradeoffs

We conducted several comparisons of the selection imposed by predation and waterfalls. First, for each variable, the signs and significance of s' and β were compared between selection regimes (DeWitt and Langerhans 2003). This allowed us to evaluate whether patterns of selection were direct or indirect, matched *a priori* expectations based on functional principles, and were opposing (i.e., different in sign) between regimes, similar (i.e., same sign) between regimes, or simply different (i.e., significant in one regime but not the other).

In addition, we more formally evaluated the nature of tradeoffs between the demands of avoidance of predators and climbing, using two approaches. First, we used our vectors of selection gradients for each regime to represent performance gradients (i.e., coefficients of partial regressions of morphology on functional performance, rather than on fitness) (Arnold 1983) and then constructed an **F** matrix showing the relationships between morphology and performance (Ghalambor et al. 2003; Walker 2007), in which predation gradients for all 16 morphological variables were in the first column, and climbing gradients for all 16 variables were in the second column. There are complications with this approach to **F**-matrix construction: for instance, our measure of performance in predation trials was simply survival, rather than a variable such as maximal fast start acceleration (Walker et al. 2005) that might mediate the relationship between morphology and survival (Arnold 1983), which is commonly considered a measure of fitness (Langerhans 2009b). Nonetheless, because both the ascension of a waterfall and the escape from a predator also could be considered a type of performance, we felt our simplification of the morphology–performance–fitness relationship (Arnold 1983) was appropriate to facilitate exploration of potential tradeoffs between the primary functional pressures in our system. After constructing **F**, we calculated the matrix $\mathbf{F}^{\mathbf{T}}\mathbf{F}$, allowing us to evaluate if there was a net tradeoff (negative off diagonals) or facilitation (positive off diagonals) between the functions of predator evasion and waterfall climbing (Ghalambor et al. 2003; Walker 2007). Further multiplication of $\mathbf{F}^{\mathbf{T}}\mathbf{F}$ by a column vector of ones produced the vector **c**, which provided ranks of the relative constraints on the evolution of predator evasion and climbing performance in *S. stimpsoni* (Ghalambor et al. 2003). In a complementary analysis, we also calculated the correlation (r) between the selection coefficients for predation and climbing to further assess the nature of the relationship between these functional pressures.

Morphometric comparisons of juvenile *S. stimpsoni* from Kaua'i and Hawai'i

Evaluations of morphological differentiation between juvenile *S. stimpsoni* recruiting to Kaua'i versus Hawai'i were performed using new collections made during February and March 2009. Fish were collected by dip nets near the mouths of streams on both islands (Waimea and Wailua on Kaua'i, Hakalau and Honoli'i/Maili on Hawai'i) before major exposure to predators or waterfalls had occurred. Fish were anesthetized with MS-222 and photographed in lateral and ventral views to allow the measurement of linear anatomical variables (Fig. 2) using Image J v1.41. Measurements were transformed and standardized for differences in body length as in the morphometric analyses for studies of selection. Morphological distinction of fish between the two islands was evaluated using principal components (PCs) analysis (based on the covariance matrix) (Neff and Marcus 1980) performed in JMP v.8.0.1 for Macintosh (SAS Institute, Cary, NC, USA).

Results

Selection imposed by predation on juvenile *S. stimpsoni*

Juvenile *S. stimpsoni* that survived predation by *E. sandwicensis* differed significantly in morphology from fish from control tanks. Of the 16 variables, 11 we evaluated showed significant s' values, but of

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

Table 1 Comparison of selection differentials and gradients for anatomical variables of juvenile *S. stimpsoni* assessed in predation and waterfall climbing experiments

	Predation		Climbing[a]	
Anatomical variable	s'	$\beta' \pm$ SE	s'	$\beta_{avggrad} \pm$ SE
Head height	0.069	0.005 ± 0.056	0.299**	0.102 ± 0.026**
Pectoral fin base length	0.115**	0.217 ± 0.063**	0.129**	0.054 ± 0.022**
Mid-body height	0.282**	0.129 ± 0.132	−0.204**	−0.047 ± 0.040
Caudal peduncle height	0.272**	0.254 ± 0.121**	−0.041	−0.011 ± 0.028
First dorsal fin base length	0.242**	−0.017 ± 0.081	0.060	−0.011 ± 0.021
Second dorsal fin base length	0.138**	−0.066 ± 0.048**	0.103**	0.027 ± 0.027
Anal fin base length	0.111**	0.055 ± 0.051	0.192**	0.111 ± 0.029**
Head length	0.191**	−0.056 ± 0.055	0.000	0.005 ± 0.026
Trunk length	0.065**	0.040 ± 0.055	−0.036	0.014 ± 0.025
Head width	0.053	−0.152 ± 0.079**	0.037	0.027 ± 0.025
Trunk width	0.181**	−0.020 ± 0.091	−0.106**	0.110 ± 0.048**
Anal width	0.258**	0.381 ± 0.113**	−0.205**	−0.171 ± 0.058**
Pectoral fin margin length	−0.028	−0.073 ± 0.052	−0.199**	−0.088 ± 0.025**
Sucker width	0.058	0.126 ± 0.058**	0.105*	0.055 ± 0.024**
Sucker length	−0.105**	−0.127 ± 0.048**	−0.014	−0.057 ± 0.025**
Mass	−0.044	−0.519 ± 0.118**	−0.113**	−0.017 ± 0.032

s', standardized directional selection differential (s/character SD); β', standardized directional selection gradient for cross-sectional data; $\beta_{avggrad}$, standardized directional selection gradient for longitudinal data (Janzen and Stern 1998).
[a]Revised values reported by Blob et al. (2009) for group climbing trials on 240-cm chute; *$P < 0.10$; **$P < 0.05$.

those 11 only 1, sucker length, was significantly smaller in survivors (Table 1). The remaining 10 variables were significantly larger in survivors of predation, and included several (e.g., mid-body height, caudal peduncle height, sizes of the dorsal and anal fins) that reflected greater depth and lateral area of the body, matching our expectations for features in which larger size would be predicted to improve the ability of fish to generate thrust and evade predators (Walker 1997; Domenici et al. 2008). The greater values of trunk width and anal width measurements among survivors compared to controls (Table 1) might reflect greater propulsive musculature or better body condition that could also aid in escape from predators, but the higher values of features such as head length and trunk length among survivors do not clearly follow hydrodynamic predictions. In addition to linear variables, all three hydrodynamic ratios showed s' values indicating a significant difference between control fish and those surviving predation (Table 2). Both fineness ratio and flattening ratio were significantly smaller among survivors of predation (Table 2), but because the height of the body is in the denominator of both of these indices, this comparison indicates that surviving fish actually have taller bodies than do controls, as would be expected to improve generation of evasive thrust (Walker 1997; Domenici et al. 2008). Lengthening ratio was significantly greater (Table 2) and closer to the optimum value for minimizing drag (Blake 2006) among survivors of predation versus control fish, potentially reducing drag without compromising production of thrust for surviving *S. stimpsoni*.

Selection gradients for the predation experiment were less uniform in pattern than were selection differentials (Table 1). Eight of the 16 variables showed significant gradients: 4 were positive and indicated direct directional selection for larger values (length of the base of the pectoral fin, height of the caudal peduncle, and widths of the sucker and the body at the location of the anal pore), and 4 were negative and indicated direct directional selection for smaller values (width of the head, lengths of the second dorsal fin and sucker, and body mass). The gradient for body mass in particular had a large (Kingsolver et al. 2001) negative magnitude (−0.519 ± 0.118), indicating a strong tendency of predatory *E. sandwicensis* to eat heavier juvenile gobies.

Comparisons of selection differentials with selection gradients reveal complexities in the pattern of selection imposed on juvenile *S. stimpsoni* by predators. For example, of the two primary body features for which greater height was predicted to improve production of thrust and which exhibited positive differentials (height at mid-body and height of the

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

Table 2 Comparison of directional selection differentials for hydrodynamic ratios assessed from predation and waterfall-climbing experiments for juvenile *S. stimpsoni* from the Island of Hawai'i

	Predation ($N = 228$ successful, 167 controls)			Climbing ($N = 159$ successful, 65 failed)		
	Fineness ratio	Flattening ratio	Lengthening ratio	Fineness ratio	Flattening ratio	Lengthening ratio
Optimal value for low drag	10	2	0.3	10	2	0.3
Trait mean ± SD (success)	8.403 ± 0.744	0.886 ± 0.048	0.213 ± 0.008	8.356 ± 0.451	0.919 ± 0.044	0.205 ± 0.008
Trait mean ± SD (all fish)	8.637 ± 0.836	0.897 ± 0.055	0.211 ± 0.011	8.272 ± 0.453	0.917 ± 0.045	0.205 ± 0.009
s'	−0.281**	−0.203**	0.180**	0.185**	0.044	0

Fineness ratio, (length/height); flattening ratio, (width/height); lengthening ratio, (length from rostrum to location of maximum height/length); s', standardized directional selection differential (s/character SD); data for climbing from Blob *et al.* (2009) for long-chute (240 cm) experiment; optimal values for low drag from Blake (2006); $^{**}P < 0.05$.

caudal peduncle), only caudal peduncle height also showed a significant positive selection gradient (Table 1). This indicates that of these two traits only the height of the caudal peduncle is under direct directional selection, and that the response of mid-body height to selection by predators must be an indirect effect due to selection on other traits. Moreover, with the large selection gradient favoring smaller body mass in juvenile *S. stimpsoni*, it might be expected that many other traits, even those with positive β' values (indicating direct selection favoring larger size), might show negative s' values indicating smaller size among survivors of predation due to indirect selection correlated with the negative selection observed for body mass. Instead, three of four traits that showed significant positive selection gradients also showed significant positive differentials (length of the base of the pectoral fin, height of the caudal peduncle, and width of the body at the location of the anal pore), indicating direct directional selection for larger size despite negative selection on body mass. In addition, seven other traits (height at mid-body; lengths of the bases of the first and second dorsal fins and anal fin; length of the head; and length and width of the trunk) showed significant positive s' values either without significant β' values or, for basal length of the second dorsal fin, despite a significant "negative" selection gradient. These patterns of indirect directional selection indicate that the potential for smaller sizes of these structures to be favored due to correlated selection for smaller body mass was superseded by selection on other correlated characters favoring larger size. In fact, even the very large negative selection gradient for body mass was masked by indirect selection, as the s' value for body mass was not significant. In other words, there was no difference in body mass between survivors and controls, even though body mass was the trait under the greatest direct selection in the entire experiment.

Comparisons between selection patterns imposed by predation and by climbing: evaluation of tradeoffs

Although the difference in body shapes expected to optimize predator evasion versus climbing performance had led us to predict that many traits would show opposing patterns of selection (i.e., opposite in sign) between these two regimes, this was true for very few of the linear variables (Table 1). Only one trait, width of the body at the location of the anal pore, showed a significant positive differential and gradient for predation, but a significant negative differential and gradient for climbing (directions consistent with functional expectations). A second trait, height at mid-body, showed a significant positive differential under predation and a significant negative differential under climbing—also consistent with functional expectations—but because gradients were not significant for mid-body height under either regime, these patterns must have resulted from indirect selection (Table 1).

Much more common than opposing patterns of selection between predation and climbing were instances in which selection for a trait was significant under one functional demand, but not the other. This was true for seven traits, of which four (basal length of first dorsal fin, head length, trunk length, and head width) showed only a significant differential or gradient, but not both, under one regime (Table 1). Of the remaining three traits, height of the caudal peduncle showed a significant positive differential and gradient under predation (matching functional expectations), head height showed a significant positive differential and gradient under climbing, and the length of the margin of the pectoral fin showed a significant negative differential and gradient under climbing. Somewhat surprisingly, also more common than opposing patterns of selection were instances in which significant selection on a trait was imposed in the same direction under both regimes. This occurred for five traits (body mass,

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

basal length of the anal fin, width and length of the sucker, and basal length of the pectoral fin), of which the latter three showed significant gradients (i.e., direct selection) under both predation and climbing (Table 1). Thus, both predation and climbing favored juveniles with wider, shorter suckers and longer bases of the pectoral fins.

Because patterns of selection for individual linear variables under both predation and climbing are complicated (Table 1), it is difficult to evaluate their correspondence with expectations based on functional assessments of the body shapes best suited to successfully navigate these pressures. However, the responses of hydrodynamic ratios to selection imposed by both climbing and predation show a prominent contrast, consistent with the expected demands of these functions. Of the three hydrodynamic ratios compared, only fineness ratio showed a significant differential under climbing (Table 2). This differential was positive, indicating greater body length for a given height in successful climbers and a closer approach to the optimum value for reducing drag in benthic fish (Blake 2006). It also directly opposes selection patterns for fineness ratio under predation, in which negative differentials reflected lower values for survivors (taller bodies better for generating evasive thrust) (Table 2).

Assessment of the tradeoffs between the functional demands of predation and of waterfall climbing in *S. stimpsoni* led to calculation of the $\mathbf{F^TF}$ matrix:

$$\begin{matrix} 0.6160 & -0.0499 \\ -0.0499 & 0.1576 \end{matrix}$$

The negative values of the off-diagonals for this matrix support the prediction of a functional tradeoff between predator-evasion and climbing. Further calculation of the **c** matrix:

0.5661 (Predator-evasion)
0.1077 (Climbing)

suggests that the evolution of predator-evasion performance, with the greater value, is less resisted than that of climbing performance. However, while calculation of the correlation (r) between the performance gradients for predator evasion and for climbing shows a negative value (-0.177), the slope of this relationship (Fig. 3) is not significant ($P = 0.512$).

Morphometric comparisons among juvenile *S. stimpsoni* from Kaua'i and Hawai'i

MANOVA of the 16 original morphological variables (Fig. 2) for juvenile *S. stimpsoni* collected in 2009 indicated significant morphological differentiation ($F = 63.193$, $P < 0.001$) between fish from Kaua'i ($N = 403$) versus fish from Hawai'i ($N = 318$), as did MANOVA of PCs calculated from the 16 original morphological variables ($F = 64.120$, $P < 0.001$). ANOVAs conducted on single PCs indicated significant differences between fish from Kaua'i and those from Hawai'i for two of the PCs (Fig. 4): PC1, accounting for 23.2% of sample variation ($F = 651.633$, $P < 0.001$), and PC3, accounting for 10.5% of sample variation ($F = 46.037$, $P < 0.001$). On PC1 fish from Hawai'i tended to have positive scores (mean ± SE = 1.496 ± 0.080) whereas fish from Kaua'i tended to have negative scores (mean ± SE = −1.180 ± 0.068), but on PC3 this pattern was reversed (Kaua'i mean ± SE = 0.282 ± 0.068; Hawai'i mean ± SE = −0.358 ± 0.062). The difference in mean PC score between fish from the two islands is smaller for PC3 than for PC1, but one factor contributing to this pattern is a group of about 30 fish from Kaua'i (~7% of the sample) with high-negative scores on PC3 that plot outside the main cluster for this island (Fig. 4).

PC loadings (Table 3) indicate that all of the original morphometric variables measured from juvenile *S. stimpsoni* were significantly correlated with PC1, but that large measurements of width and length of the sucker, and height and width of the head, have the strongest correlations with high-positive PC1 scores (i.e., fish from Hawai'i), whereas large measurements of height at mid-body and width of the body at the location of the anal pore had the strongest correlations with high-negative PC1 scores (i.e., fish from Kaua'i). For PC3, large measurements of the length of the bases of the dorsal and anal fins, length of the margin of the pectoral fin, height at mid-body, height of the caudal peduncle, and width of the body at the location of the anal pore had the strongest correlations with high-positive scores (i.e., fish from Kaua'i), whereas large measurements of basal length of the pectoral fin, length and width of the sucker, and length of the trunk had the strongest correlations with high-negative scores (i.e., fish from Hawai'i).

Discussion

Correspondence of results from selection experiments with functional expectations, and tradeoffs between the evasion of predators and the climbing of waterfalls

Juvenile *S. stimpsoni* re-entering freshwater streams face two primary functional pressures: evading predators and scaling waterfalls. Based on empirical data and models of fish locomotor performance, these

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

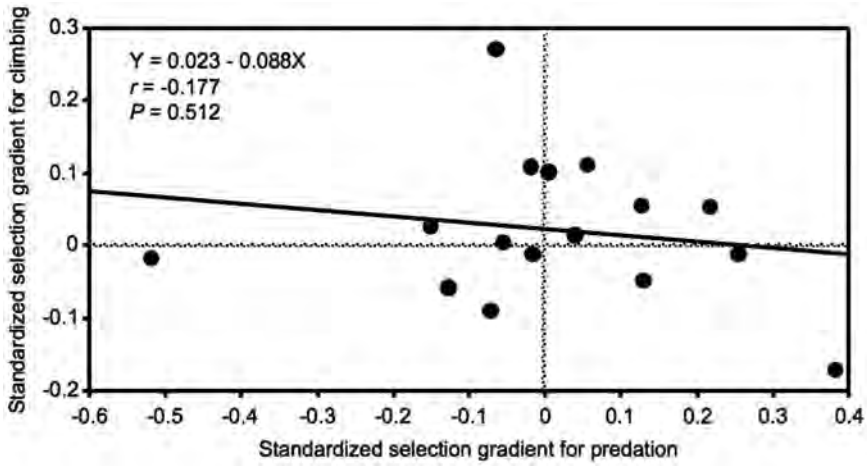


Fig. 3 Bivariate plot illustrating correlation of standardized selection gradients for juvenile *S. stimpsoni* derived from experiments on predation (*x*-axis) versus experiments on climbing (*y*-axis).

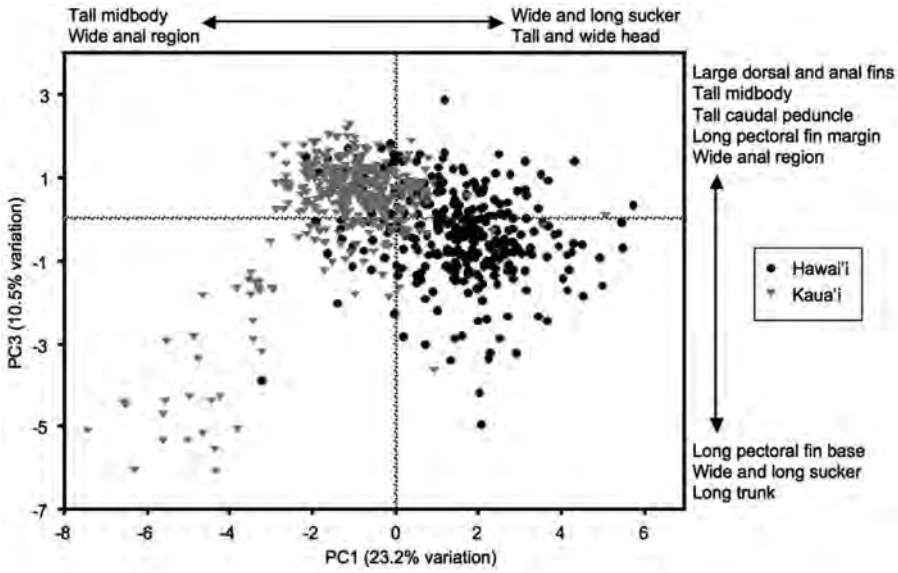


Fig. 4 Bivariate plot of PC1 versus PC3 for juvenile *S. stimpsoni* from Hawai'i (black circles) versus those from Kaua'i (grey triangles). The primary original variables contributing to dispersion along each axis are labeled (Table 3).

two pressures were expected to entail functional tradeoffs, such that their demands would be best met by contrasting body shapes. While the evasion of predators was expected to be aided by taller bodies and larger median fins that improve production of thrust (Walker 1997; Domenici et al. 2008), successful climbing of waterfalls was expected to be aided by body shapes with lower profiles that minimize drag, and larger suckers that improve adhesion (Blob et al. 2008). How closely do the body shapes favored in our selection experiments match these functional expectations?

Although patterns of selection for both evasion of predators and climbing are complicated, for many traits there was close correspondence in at least one selection regime between the direction of selection and the body shape that would be expected to improve performance under that regime. For example, in spite of strong countervailing pressure for smaller body mass, predation still imposed direct directional selection for taller caudal peduncles and indirect directional selection for a taller mid-body and larger median fins in survivors (Table 1), all features expected to improve generation of evasive thrust (Walker 1997). With regard to climbing, direct directional selection favored wider suckers in successful climbers that would improve adhesion, and direct (for width of the body at the location of the anal pore) or indirect (for trunk width and for height at mid-body) directional selection favored

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

Table 3 Correlations of measured anatomical variables with principal components calculated for juvenile *S. stimpsoni* from Hawai'i ($N = 318$) and Kaua'i ($N = 403$)

	Anatomical variable	PC1 (23.2% variation)	PC3 (10.5% variation)
1	Head height	0.739**	0.078**
2	Pectoral fin base length	0.703**	−0.262**
3	Mid-body height	−0.455**	0.380**
4	Caudal peduncle height	0.102**	0.281**
5	First dorsal fin base length	0.229**	0.519**
6	Second dorsal fin base length	0.467**	0.553**
7	Anal fin base length	0.429**	0.623**
8	Head length	0.287**	−0.018
9	Trunk length	0.214**	−0.214**
10	Head width	0.710**	−0.089**
11	Trunk width	0.264**	0.233**
12	Anal width	−0.198**	0.275**
13	Pectoral fin margin length	0.243**	0.332**
14	Sucker width	0.786**	−0.168**
15	Sucker length	0.757**	−0.239**
16	Tail length	−0.118**	0.199**

Numbers in first column correspond to measurements labeled in Fig. 2; note that tail length was not measured for individuals used in selection trials. **For df = 720, correlations greater than 0.077 are significant at $P < 0.05$ (Rohlf and Sokal 1995).

lower, narrower bodies that would be expected to reduce drag (Table 1; Blob et al. 2009). Direct directional selection for shorter lengths of the margins of the pectoral fins is also consistent with fin shapes previously reported for fish in high flow (Peres-Neto and Magnan 2004), although this result is somewhat surprising because these fins are folded against the body when juvenile *S. stimpsoni* climb (Schoenfuss and Blob 2003) and would have been expected to contribute little additional drag that might be selected against. Selection for hydrodynamic ratios also showed good correspondence with functional expectations. Successful climbers had fineness ratios closer to the optimal value for low drag (Blake 2006) than did unsuccessful climbers (Table 2; Blob et al. 2008), and survivors of predation showed fineness and flattening ratios that reflected taller bodies than those of control fish, potentially aiding production of evasive thrust, as well as lengthening ratios closer to the optimum than those of control fish, potentially reducing drag with limited reduction of thrust (Table 2). Although some results from selection experiments ran counter to functional expectations (e.g., larger heads among successful climbers) (Table 1; Blob et al. 2009), and other significant results were difficult to interpret in a functional context (e.g., direct directional selection for larger bases to the anal fin in climbing, which might provide increased friction against backsliding), such exceptions were generally more common for the climbing experiment, and overall correspondence between the results of selection trials and the body shapes that would be expected to improve performance was good.

The calculation of selection differentials and gradients for both evasion of predators and for scaling waterfalls provided an opportunity to assess the extent of functional tradeoff between the demands posed by these pressures. It is striking that despite hydrodynamic predictions that optimal shapes for these functions should run counter to each other, very few variables (2 of 16 linear variables and 1 of 3 ratio variables) showed completely opposing patterns of selection (i.e., s' and/or β opposite in sign) between predation and climbing. More variables (5 of 16 linear) actually showed selection in the same direction across both predation and climbing trials, suggesting that the evolution of some traits (e.g., body mass) may be constrained by selection (Wilson et al. 2003). However, the most common pattern was for selection to be significant under one regime, but not the other (7 of 16 linear traits and 2 of 3 ratio variables). In the context of these results, negative values of off diagonals of the $\mathbf{F}^{\mathbf{T}}\mathbf{F}$ matrix (Ghalambor et al. 2003; Walker 2007) calculated from gradients for evading predators and for climbing waterfalls still supported the prediction of a functional tradeoff between these demands. However, the weak correlation between the gradients calculated for each of these selection pressures (Fig. 3) suggests that this tradeoff might not be as strong as initially predicted, potentially reflecting a complex, high-dimensional adaptive landscape for *S. stimpsoni* (Conrad 1990; Gavrilets 1999; Pigliucci 2008).

The significance of selection in the morphological divergence of subpopulations of Hawaiian stream gobies

Differences in stream characteristics between Kaua'i and Hawai'i (Blob et al. 2008) suggest that juvenile *S. stimpsoni* re-entering freshwater streams should experience geographic variation in the two primary functional pressures they face during migration upstream, with the demand to avoid predators preeminent on Kaua'i, and the demands of climbing waterfalls greater on Hawai'i. Differences in body shape between adult *S. stimpsoni* from these islands were well suited to meet the functional demands

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

believed to be primary on each island (Blob et al. 2008), raising the possibility that the differing selective regimes on each island could be promoting morphological divergence of these subpopulations. Comparisons of the morphology of juvenile *S. stimpsoni* recruiting to Kaua'i and Hawai'i support this possibility. We have not ruled out phenotypic plasticity (DeWitt et al. 1998; Domenici et al. 2008) as a factor contributing to divergence in body shape among adult *S. stimpsoni* subpopulations between islands; in fact, it may contribute to some of the disparity among islands in the difference in shape between juveniles and adults (e.g., heads are larger for fish from Hawai'i among juveniles, but larger for fish from Kaua'i among adults [Fig. 4, Table 3] [Blob et al. 2008]). However, the finding that juvenile *S. stimpsoni* differ significantly in shape upon reaching the island to which they recruit, before they are exposed to substantial selection in the stream, indicates that selection may have been contributing to the divergence of subpopulations over many generations of recruits, and that divergence in the body shapes of adults between islands is probably not a strictly plastic response. Such patterns of divergence between juveniles from different subpopulations could result if pelagic goby larvae are entrained near their source island (Taylor and Hellberg 1996) more than previous population genetic data have suggested (Fitzsimons et al. 1990; Zink et al. 1996; Chubb et al. 1998). In addition, differences in several aspects of body shape between *S. stimpsoni* from Kaua'i and Hawai'i match well between juveniles and adults and correspond to the different functional demands posed by each island (e.g., taller bodies in fish from Kaua'i, lower bodies in fish from Hawai'i) (Table 3; Blob et al. 2008). These patterns are consistent with the differing selective regimes on each island.

Further support for geographic variation in selection regimes that contributes to divergence in *S. stimpsoni* comes from consistency between the results of selection experiments and the patterns of divergence in body shape observed between juvenile fish from Kaua'i and those from Hawai'i. For example, height at mid-body and width of the body at the location of the anal pore both experience positive directional selection under predation, but negative directional selection under climbing (Table 1). Greater mid-body heights and wider bodies at the anal region are also the two highest scoring variables on PC1 and among the top variables on PC3 characterizing juvenile *S. stimpsoni* from Kaua'i (Table 3, Fig. 4), the island where selection by predators is likely of greatest prominence (Blob et al. 2008). Head height also shows an interesting correspondence between the results of selection trials and the morphological differentiation of juveniles between islands. Contrary to adults (Blob et al. 2008), in juvenile *S. stimpsoni* head height (the third highest positive loading trait on PC1) is typically greater among fish from Hawai'i. Because production of thrust is enhanced by increased height of the posterior regions of the body relative to anterior regions (Walker 1997; Domenici 2003; Langerhans 2009b), it might be expected that the difference in head height between juvenile *S. stimpsoni* from Kaua'i and those from Hawai'i could have resulted from negative selection on head height during predation. However, our selection experiments indicate no significant selection on head height by predators; instead, we found significant "positive" selection on head height imposed by climbing (Table 1). Not only was this result somewhat surprising based on our hydrodynamic expectations (Blob et al. 2008, 2009), but it shows how complementary selection experiments can clarify the factors contributing to morphological differentiation in populations.

Future directions

One possible factor contributing to some differences we observed in patterns of selection versus the morphological differentiation seen across natural subpopulations of *S. stimpsoni* is the severity of selection we imposed. Although our failure rates in the predation and climbing experiments were ~50% and ~30%, respectively, the proportion of *S. stimpsoni* that fail to reproduce in nature is almost certainly much greater—for example, our own conservative estimate of rates of failure during the climbing of waterfalls in the wild was at least 90% (Blob et al. 2008). When subjected to the pressures of both climbing and predation, it is possible that only exceptional fish survive (Blob et al. 2006). Future experiments could evaluate whether similar patterns of selection emerge under more stringent failure rates, and what morphologies would emerge as successful if the pressures of predation and climbing were applied sequentially to the same animals, as they are in nature. Although we have focused on isolating the effects of selection imposed by predation or climbing, experiments subjecting survivors of predation to climbing trials could explore the interactions of these pressures in shaping the morphology of *S. stimpsoni*.

The group of roughly 30 juvenile *S. stimpsoni* from Kaua'i that plot outside the main cluster of fish from this island in our PCA of morphometric

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

variables (Fig. 4) suggest an intriguing possibility, potentially representing individuals that recruited to Kaua'i from other source islands, with morphology suited for different environmental conditions. Although these fish plot with the Kaua'i cluster along PC1, and with the Hawai'i cluster along PC3, they show the most extreme scores along both axes and, thus, do not exhibit clearly intermediate traits that might point toward an origin from one of the islands in the Hawaiian archipelago between Kaua'i and Hawai'i. Genetic comparisons of these individuals to fish from both of the islands in our sample, as well as the intervening islands, could resolve the likely source of these juveniles and help determine the extent to which morphological variation of fish within and between subpopulations is correlated with migration and gene flow.

An interesting result emerging from our analyses of functional tradeoffs was that the evolution of climbing performance appears to be more constrained than that of predator evasion. One factor potentially contributing to that result is that our selection trials were all conducted on fish from Hawai'i, the island where climbing performance is expected to be at a premium. If entrainment of oceanic larvae to their source island is more common than previously predicted (Zink et al. 1996, Chubb et al. 1998), then juvenile *S. stimpsoni* from Hawai'i may be derived from adults that have already been subjected to intense selection on climbing performance, leaving less opportunity for further change in response to selection, compared to potential responses to selection on other functions, such as evasion of predators. This possibility could be tested by conducting comparable selection trials on juvenile *S. stimpsoni* from other Hawaiian Islands, particularly Kaua'i, to evaluate whether the resistance of a specific functional attribute to evolutionary change varies depending on the primary pressure to which the population is exposed. Such population-level comparisons could be broadened to a wide range of other goby species, many of which are able to climb waterfalls on other volcanic island groups, ranging from the Caribbean to the Indian Ocean (Keith 2003; McDowall 2004; Maie et al. 2007). Such comparisons of the effects of similar selective pressures across a range of species are uncommon (Reznick and Ghalambor 2005; Irschick et al. 2007), but through the use of tools such as the selection experiments implemented in this study, they could provide substantial insight into the factors that link environmental variation with evolutionary divergence in the body form of fishes.

Funding

Clemson University Research Investment Fund Award (to R.W.B., M.B.P.); St Cloud State University Faculty Improvement Grant (to H.L.S.); National Science Foundation (grants IOS-0817794 and IOS-0817911).

Acknowledgments

We are grateful for the logistic support provided by the Hawai'i Division of Aquatic Resources that enabled us to pursue this research, especially Bob Nishimoto, Lance Nishiura, Wade Ishikawa, Troy Sakihara, Troy Shimoda, Tim Shindo, and Darrell Kuamo'o. Mike Fitzsimons has also provided valuable advice and support for our studies of Hawaiian stream fishes, and Jonatha Giddens provided help during field collection of fishes. We also thank Jeff Walker, Brian Langerhans, and Peter Wainwright for helpful suggestions and comments, Michael Childress for statistical advice on our morphological analyses, and Roberto Cediel, Jamie Dowd, Jenn Gander, and Katherine Shugart for assistance with image analysis. Finally, we thank Jeff Walker and Rita Mehta for their invitation to participate in this symposium. Research was conducted in accordance with Clemson AUP 40061 and ARC2007-090.

References

Arnold SJ. 1983. Morphology, performance, fitness. Am Zool 23:347–61.

Arnold GP, Weihs D. 1978. The hydrodynamics of rheotaxis in the plaice (*Pleuronectes platessa* L.). J Exp Biol 75:147–69.

Blake RW. 2004. Fish functional design and swimming performance. J Fish Biol 65:1193–222.

Blake RW. 2006. Biomechanics of rheotaxis in six teleost genera. Can J Zool 84:1173–86.

Blake RW, Li J, Chan KHS. 2009. Swimming in four goldfish *Carassius auratus* morphotypes: understanding functional design and performance employing artificially selected forms. J Fish Biol 75:591–617.

Blob RW, Bridges WC, Ptacek MB, Maie T, Cediel RA, Bertolas MM, Julius ML, Schoenfuss HL. 2008. Morphological selection in an extreme flow environment: body shape and waterfall-climbing success in the Hawaiian stream fish *Sicyopterus stimpsoni*. Int Comp Biol 48:734–49.

Blob RW, Bridges WC, Ptacek MB, Maie T, Cediel RA, Bertolas MM, Julius ML, Schoenfuss HL. 2009. Morphological selection in an extreme flow environment: body shape and waterfall-climbing success in the Hawaiian stream fish *Sicyopterus stimpsoni* (Erratum). Int Comp Biol 49:732–4.

Blob RW, Rai R, Julius ML, Schoenfuss HL. 2006. Functional diversity in extreme environments: effects of locomotor

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

style and substrate texture on the waterfall climbing performance of Hawaiian gobiid fishes. J Zool 268:315–24.

Blob RW, Wright KM, Becker M, Maie T, Iverson TJ, Julius ML, Schoenfuss HL. 2007. Ontogenetic change in novel functions: waterfall climbing in adult Hawaiian gobiid fishes. J Zool 273:200–9.

Carson HL, Clague DA. 1995. Geology and biogeography of the Hawaiian Islands. In: Wagner WL, Funk VA, editors. Hawaiian biogeography: evolution on a hotspot archipelago. Washington, DC: Smithsonian Institution Press. p. 14–29.

Carroll AM, Wainwright PC, Huskey SH, Collar DC, Turingan RG. 2004. Morphology predicts suction feeding performance in centrarchid fishes. J Exp Biol 207:3873–81.

Chubb AL, Zink RM, Fitzsimons JM. 1998. Patterns of mtDNA variation in Hawaiian freshwater fishes: the phylogeographic consequences of amphidromy. J Hered 89:8–16.

Conrad M. 1990. The geometry of evolution. BioSystems 24:61–81.

Coyne JA, Orr HA. 2004. Speciation. Sunderland, MA: Sinauer Associates Inc.

DeWitt TJ, Langerhans RB. 2003. Multiple prey traits, multiple predators: keys to understanding complex community dynamics. J Sea Research 49:143–55.

DeWitt TJ, Sih A, Wilson DS. 1998. Costs and limits of phenotypic plasticity. TREE 13:77–81.

Domenici P. 2003. Habitat, body design, and the swimming performance of fish. In: Bels VL, Gasc J-P, Casinos A, editors. Vertebrate biomechanics and evolution. Oxford: BIOS Scientific Publishers. p. 137–60.

Domenici P, Turesson H, Brodersen J, Brönmark C. 2008. Predator-induced morphology enhances escape locomotion in crucian carp. Proc Roy Soc B 275:195–201.

Drucker EG, Jensen JS. 1997. Kinematic and electromyographic analysis of steady pectoral fin swimming in the surfperches. J Exp Biol 200:1709–23.

Efron B, Gong G. 1983. A leisurely look at the bootstrap, the jackknife, and cross-validation. Am Stat 37:36–48.

Ferry-Graham LA, Wainwright PC, Bellwood DR. 2001. Prey capture in long-jawed butterflyfishes (Chaetodontidae): the functional basis of novel feeding habits. J Exp Mar Biol Ecol 256:167–84.

Fitzsimons JM, Nishimoto RT. 1995. Use of fish behaviour in assessing the effects of Hurricane Iniki on the Hawaiian island of Kaua'i. Environ Biol Fish 43:39–50.

Fitzsimons JM, Schoenfuss HL, Schoenfuss TC. 1997. Significance of unimpeded flows in limiting the transmission of parasites from exotics to Hawaiian stream fishes. Micronesica 30:117–25.

Fitzsimons JM, Zink RM, Nishimoto RT. 1990. Genetic variation in the Hawaiian stream goby, *Lentipes concolor*. Biochem Syst Ecol 18:81–3.

Fuller RC, Baer CF, Travis J. 2005. How and when selection experiments might actually be useful. Int Comp Biol 45:391–404.

Garland T Jr. 2003. Selection experiments: an under-utilized tool in biomechanics and organismal biology. In: Bels VL, Gasc J-P, Casinos A, editors. Vertebrate biomechanics and evolution. Oxford: BIOS Scientific Publishers. p. 23–56.

Gavrilets S. 1999. A dynamical theory of speciation on holey adaptive landscapes. Am Nat 154:1–22.

Ghalambor CK, Reznick DN, Walker JA. 2004. Constraints on adaptive evolution: the functional trade-off between reproduction and fast-start swimming performance in the Trinidadian guppy (*Poecilia reticulata*). Am Nat 164:38–50.

Ghalambor CK, Walker JA, Reznick DN. 2003. Multi-trait selection, adaptation, and constraints on the evolution of burst swimming performance. Int Comp Biol 43:431–8.

Higham TE, Malas B, Jayne BC, Lauder GV. 2005. Constraints on starting and stopping: behavior compensates for reduced pectoral fin area during breaking of the bluegill sunfish *Lepomis macrochirus*. J Exp Biol 208:4735–46.

Hoerner SF. 1958. Fluid-dynamic Drag. Midland Park, New Jersey: Published by the author.

Irschick D, Bailey JK, Schweitzer JA, Husak JF, Meyers JJ. 2007. New directions for studying selection in nature: studies of performance and communities. Physiol Biochem Zool 80:557–67.

Janzen FJ, Stern HS. 1998. Logistic regression for empirical studies of multivariate selection. Evolution 52:1564–71.

Keith P. 2003. Biology and ecology of amphidromous Gobiidae of the Indo-Pacific and Caribbean regions. J Fish Biol 63:831–47.

Kingsolver JG, Hoekstra HE, Hoekstra JM, Berrigan D, Vignieri SN, Hill CE, Hoang A, Gibert P, Beerli P. 2001. The strength of phenotypic selection in natural populations. Am Nat 157:245–61.

Lande R, Arnold SJ. 1983. The measurement of selection on correlated characters. Evolution 37:1210–26.

Langerhans RB. 2008. Predictability of phenotypic differentiation across flow regimes in fish. Int Comp Biol 48:750–68.

Langerhans RB. 2009a. Trade-off between steady and unsteady swimming underlies predator-driven divergence in *Gambusia affinis*. J Evol Biol 22:1057–75.

Langerhans RB. 2009b. Morphology, performance, fitness: functional insight into a post-Pleistocene radiation of mosquitofish. Biol Lett 5:488–91.

Langerhans RB, Layman CA, Langerhans AK, DeWitt TJ. 2003. Habitat-associated morphological divergence in two neotropical fish species. Biol J Linn Soc 80:689–98.

Lauder GV, Drucker EG, Nauen JC, Wilga CD. 2003. Experimental hydrodynamics and evolution: caudal fin locomotion in fishes. In: Bels VL, Gasc J-P, Casinos A, editors. Vertebrate biomechanics and evolution. Oxford: BIOS Scientific Publishers. p. 117–35.

Liem KF. 1993. Ecomorphology of the teleostean skull. In: Hanken J, Hall BK, editors. The Skull, Vol. 3. Chicago: University of Chicago Press. p. 422–52.

Losos JB. 1990. The evolution of form and function: morphology and locomotor performance in West Indian *Anolis* lizards. Evolution 44:1189–203.

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

Maie T, Schoenfuss HL, Blob RW. 2007. Ontogenetic scaling of body proportions in waterfall-climbing gobiid fishes from Hawai'i and Dominica: implications for locomotor function. Copeia 2007:755–64.

McDowall RM. 2003. Hawaiian biogeography and the islands freshwater fish fauna. J Biogeog 30:703–10.

McDowall RM. 2004. Ancestry and amphidromy in island freshwater fish faunas. Fish Fisheries 5:75–85.

McGuigan K, Franklin CE, Moritz C, Blows MW. 2003. Adaptation of rainbow fish to lake and stream habitats. Evolution 57:104–18.

Mosimann JE, James FC. 1979. New statistical methods for allometry with application to Florida red-winged blackbirds. Evolution 33:444–59.

Neff NA, Marcus LF. 1980. A survey of multivariate methods for systematics. New York: Privately published.

Nishimoto RT, Fitzsimons JM. 1999. Behavioral determinants of the instream distribution of native Hawaiian stream fishes. In: Séret B, Sire J-Y, editors. Proceedings of the Fifth Indo-Pacific Fish Conference, Nouméa. Paris: Societe Francaise d'Ichtyologie. p. 813–8.

Nishimoto RT, Kuamo'o DGK. 1997. Recruitment of goby postlarvae into Hakalau Stream, Hawai'i Island. Micronesica 30:41–9.

Peres-Neto PR, Magnan P. 2004. The influence of swimming demand on phenotypic plasticity and morphological integration: a comparison of two polymorphic charr species. Oecologia 140:36–45.

Pettersson LB, Hedenström A. 2000. Energetics, cost reduction, and functional consequences of fish morphology. Proc R Soc Lond B 267:759–64.

Pigliucci M. 2008. Is evolvability evolvable? Nat Rev Gen 9:75–82.

Reznick DN, Ghalambor CK. 2005. Selection in nature: experimental manipulations of natural populations. Int Comp Biol 45:456–62.

Rivera G. 2008. Ecomorphological variation in shell shape of the freshwater turtle *Pseudemys concinna* inhabiting different aquatic flow regimes. Int Comp Biol 48:769–87.

Rohlf FJ, Sokal RR. 1995. Statistical Tables. 3rd Edition. New York: WH Freeman.

Rosenberger LJ. 2001. Pectoral fin locomotion in batoid fishes: undulation *versus* oscillation. J Exp Biol 204:379–94.

Schluter D. 2001. Ecology and the origin of species. TREE 16:372–80.

Schoenfuss HL, Blanchard TA, Kuamo'o DGG. 1997. Metamorphosis in the cranium of postlarval *Sicyopterus stimpsoni*, an endemic Hawaiian stream goby. Micronesica 30:93–104.

Schoenfuss HL, Blob RW. 2003. Kinematics of waterfall climbing in Hawaiian freshwater fishes (Gobiidae): vertical propulsion at the aquatic-terrestrial interface. J Zool 261:191–205.

Schoenfuss HL, Blob RW. 2007. The importance of functional morphology for fishery conservation and management: applications to Hawaiian amphidromous fishes. Bishop Mus Bull Cult Environ Stud 3:125–41.

Swain DP. 1992. Selective predation for vertebral phenotype in *Gasterosteous aculateus*: reversal in the direction of selection at different larval sizes. Evolution 46:998–1013.

Taylor MS, Hellberg ME. 1996. Genetic evidence for local retention of pelagic larvae in a Caribbean reef fish. Science 299:107–9.

Vogel S. 1994. Life in Moving Fluids: The Physical Biology of Flow. 2nd Edition. Princeton, NJ: Princeton University Press.

Wainwright PC, Bellwood DR, Westneat MW. 2002. Ecomorphology of locomotion in labrid fishes. Env Biol Fishes 65:47–62.

Wainwright PC, Reilly SM. 1994. Ecological Morphology: Integrative Organismal Biology. Chicago: University of Chicago Press.

Walker JA. 1997. Ecological morphology of lacustrine threespine stickleback *Gasterosteus aculeatus* L. (Gasterosteidae) body shape. Biol J Linn Soc 61:3–50.

Walker JA. 2000. Does a rigid body limit maneuverability? J Exp Biol 203:3391–6.

Walker JA. 2007. A general model of functional constraints on phenotypic evolution. Am Nat 170:681–9.

Walker JA, Alfaro ME, Fulton CJ. 2010. Fluid dynamic drag, body shape, and endurance swimming performance among coral reef fishes. SICB 2010 Annual Meeting Abstracts. http://www.sicb.org/meetings/2010/SICB2010-oral.pdf.

Walker JA, Ghalambor CK, Griset OL, McKenney D, Reznick DN. 2005. Do faster starts increase the probability of evading predators? Funct Ecol 19:808–15.

Walker JA, Westneat MW. 2002. Performance limits of labriform propulsion and correlates with fin shape and motion. J Exp Biol 205:177–87.

Webb PW. 1975. Hydrodynamics and energetics of fish propulsion. Bull Fish Res Bd Can 190:1–159.

Webb PW. 1978. Fast-start performance and body form in seven species of teleost fish. J Exp Biol 74:211–26.

Webb PW. 1984. Body form, locomotion, and foraging in aquatic vertebrates. Am Zool 24:107–20.

Webb PW. 1986. Effect of body form and response threshold on the vulnerability of four species of teleost prey attacked by largemouth bass (*Micropterus salmoides*). Can J Fish Aquat Sci 43:763–71.

Webb PW. 1989. Station-holding by three species of benthic fishes. J Exp Biol 145:303–20.

Westneat MW. 1994. Transmission of force and velocity in the feeding mechanism of labrid fishes (Teleostei, Perciformes). Zoomorph 114:103–18.

Wilson AJ, Hutchings JA, Ferguson MM. 2003. Selective and genetic constraints on the evolution of body size in a stream-dwelling salmonid fish. J Evol Biol 16:584–94.

Zink RM, Fitzsimons JM, Dittmann DL, Reynolds DR, Nishimoto RT. 1996. Evolutionary genetics of Hawaiian freshwater fish. Copeia 1996:330–5.

Downloaded from http://icb.oxfordjournals.org/ by guest on February 5, 2015

Biology of Hawaiian Streams and Estuaries. Edited by N.L. Evenhuis & J.M. Fitzsimons. *Bishop Museum Bulletin in Cultural and Environmental Studies* 3: 11–21 (2007).

Behavioral Ecology of Indigenous Stream Fishes in Hawai‘i

J. Michael Fitzsimons & Mark G. McRae
Museum of Natural Science, Louisiana State University, Baton Rouge, Louisiana 70803, USA; email: fitzsimons@lsu.edu; mmcrae@lsu.edu

Robert T. Nishimoto
Division of Aquatic Resources, 75 Aupuni Street, Hilo, Hawai‘i 96720, USA; email: Robert.T.Nishimoto@hawaii.gov

Abstract

Five species of amphidromous fishes comprise the indigenous vertebrate fauna of Hawaiian streams. All have a marine larval phase, and, as adults, they live in freshwater and brackish environments marked by frequent flash floods. Although these fishes are closely related and live under similar conditions in the ocean and in streams, they are remarkably diverse in their behavior and ecology. They usually occupy species-typical sections of streams ranging from near the headwaters down to the mouth or estuary; species specificity is evident also in habitat selection by adults. Two species (*Eleotris sandwicensis* and *Stenogobius hawaiiensis*) are unable to climb waterfalls. Among the climbing species, two (*Awaous guamensis* and *Lentipes concolor*) use their pelvic disk and lateral fins for climbing, and the fifth species (*Sicyopterus stimpsoni*) uses the mouth and pelvic disk as holdfasts. The pattern of instream distribution coincides with the relative development of pelvic and oral suckers used in clinging to rocks and climbing waterfalls and with each species' station-holding ability in artificial streams, but the causal factors that prompt new recruits entering from the ocean to continue moving upstream to adult habitats is incompletely understood. One species is a carnivore, one is an herbivore, and the remaining three species are omnivorous. Males of all five species engage females in distinctive courtship behaviors that precede spawning, and all but one species provide some protection for the eggs by guarding the area in which one or more nests are included. Genetic studies for all species show sharp species-level differences among species, but there are no effects of isolation and subsequent differentiation among the five major islands. The data suggest that marine larvae disperse beyond their natal streams. In contrast, analyses of naturally occurring stable isotopes in new recruits indicate that they remain close to mouths of streams while at sea. Introduced freshwater fishes are the original source of potentially harmful parasites which have infected native stream fishes. Resident fishes differ in their susceptibility to parasites. The effect of other alien introductions on aquatic animals has not been determined. Adults in fresh water and free-living embryos and larvae in the ocean have a mix of characteristics within and among species attributable to r and K selection. Although Hawaii's stream fish species are diverse in behavior and ecology, their common amphidromous life cycle provides a basis for management and conservation. Hawaii's Division of Aquatic Resources has developed four levels of stream protection and a firm policy of "no net loss of habitat" to ensure the safety and continuance of the islands' indigenous fishes.

Introduction

No primary or secondary freshwater fishes occur naturally in Hawaiian streams and estuaries (Myers, 1938). However, over 40 species of fishes are known from the islands' fresh and brackish waters (Yamamoto & Tagawa, 2000). These include a few marine species that enter estuaries and lower stream reaches, a host of freshwater fishes introduced intentionally or by accident, and a small group of indigenous fishes that occur as adults in fresh and brackish water and have an obligate marine larval period in their amphidromous life cycle (Myers, 1949; McDowall, 2003). This latter group, derived from marine ancestors, includes two families of gobioid fishes, the Gobiidae and

Eleotridae, whose species are overwhelmingly predominant in island streams throughout the high islands of the tropical Pacific (Fitzsimons *et al.*, 2002). Among these islands, a resident stream fish is very likely to be a goby or an eleotrid, and it almost certainly will have an amphidromous life cycle. Among the amphidromous fishes in Hawai‘i, the low species richness (five) and high degree of endemism (four out of five species or 80%) are in keeping with the unsurpassed isolation of the five major islands (Hawai‘i, Maui, Moloka‘i, O‘ahu, and Kaua‘i) in the archipelago that have sufficient elevation to produce the orographic rain needed to sustain perennial streams on windward slopes. Although species richness among Hawaii's amphidromous fishes is small, the degree of ecological and behavioral diversity among the five species is remarkable. Information from publications, field notes from 1984–2004, presentations from meetings, and conversations is used in this report to emphasize species similarities and differences in (1) distribution within a single stream and between streams, (2) food sources and feeding behavior, (3) reproductive behavior, (4) climbing ability, (5) genetics, (5) stable isotope analyses, (6) susceptibility to parasites, and (7) r and K selection. These fishes share an amphidromous life cycle and live under similar conditions in island streams where frequent and naturally occurring flash floods maintain ecological succession at an early stage of colonization in which the pioneering species function also as the climax species (Fitzsimons & Nishimoto, 1995). These similarities are the basis for well-established, effective procedures for conserving these animals throughout the Hawaiian high islands.

Discussion

Species distribution within and between streams

All five species of Hawaiian amphidromous fishes occur on each of the five major high islands, but all five species do not occur in every stream on these islands. Understanding the differences in the distribution of these animals between streams is simplified by understanding their distribution within individual streams.

Stream fishes in Hawai‘i are species-specific in their selection of habitats along the length of a stream (Tate, 1997). During their amphidromous life cycle, all species enter the mouths of streams when their larvae move from the ocean toward adult habitats in brackish or fresh water. Two species, *Eleotris sandwicensis* (*‘o‘opu ‘akupa*) and *Stenogobius hawaiiensis* (*‘o‘opu naniha*), remain in the estuary and lower stream reaches in areas of reduced current while the other species continue their migrations to sites farther upstream. The eleotrid lacks the fused pelvic fins which form a holdfast in gobies, and, although *S. hawaiiensis* has a pelvic disk, the structure is elongate, delicate, and better adapted for sitting on loose substrate (sand and gravel) than for adhering to rocks in swift water. The upstream extent of *E. sandwicensis* and *S. hawaiiensis* often is sharply bounded by the first waterfall or other obstruction a meter or more in height. *Awaous guamensis* (*‘o‘opu nākea*) and *Sicyopterus stimpsoni* (*‘o‘opu nōpili*) usually occur in the middle reaches of streams, but, because they differ in microhabitat selection, they seldom are close together (Kinzie, 1988). *Awaous guamensis* most often remains on or near the bottom in pools and behind boulders, and *S. stimpsoni* is common in more rapidly flowing runs and riffles and along the sides and upper surfaces of large rocks and boulders. Juveniles and adults of *Lentipes concolor* [*‘o‘opu hi‘ukole* (males) and *‘o‘opu alamo‘o* (females)] typically occur the farthest upstream well beyond the range of the other amphidromous fishes and are well known for their ability to climb high waterfalls (Englund & Filbert, 1997).

The pattern of linear instream distribution of amphidromous fish species in Hawaiian streams was mirrored precisely by each species' ability to "hold station" during experiments in artificial streams (Fitzsimons *et al.*, 1997). However, it is not known whether the distribution pattern is a simple matter of climbing ability, competition for space or food, or a reflection of "ghosts of competition past" (Connell, 1980) that occurred among the ancestors of Hawaiian stream gobies in the far western Pacific. In the latter regard, it is noteworthy that congeners and other close relatives of Hawaiian stream species living in Oceania have patterns of instream distribution that are strikingly similar to those of their Hawaiian kin (Fitzsimons *et al.*, 2002). As suggested for Micronesian stream gobies (Parham, 1995; Nelson *et al.*, 1997), the presence of predators in Hawaiian streams, primarily *E. sandwicensis* and marine-born *Kuhlia xenura* (*āholehole*) in estuaries and lower stream sec-

tions, may be a driving force that promotes upstream dispersal and species segregation. The latter hypothesis appears testable.

Topography determines which species occur in a given stream. A stream whose basin slopes gradually from the headwaters to the ocean is likely to have all five fish species. In a relatively long stream of this type, the species are likely to be separated, but, if short, there may be sites where the three upstream species (*A. guamensis, S. stimpsoni,* and *L. concolor*) occur together (Kinzie, 1988). A stream with a much steeper incline and few or no areas of reduced flow near the mouth probably will not include the two downstream species, *E. sandwicensis* and *S. hawaiiensis*. A stream ending in a waterfall that drops directly onto the beach or into the sea will not have these latter two species, and, depending on the height of the waterfall, *A. guamensis* and *S. stimpsoni* may be absent also. Streams terminating in a waterfall in excess of 30 m probably will have only *L. concolor* above the falls. Finally, a stream with a long estuary (such as Hanalei, Kahana, and Hiʻilawe streams on Kauaʻi, Oʻahu, and Hawaiʻi, respectively) will have few or no *L. concolor* near its headwaters. The relationship between stream topography and the dispersal capabilities of resident fishes is sufficiently well known that it is often possible to predict species presence and distribution in a stream merely by consulting a topographic map that includes contour intervals.

A lack of knowledge or intentional disregard of natural trends in fish distribution and the relationship between fish behavior and stream morphology has led to erroneous conclusions with implications for the conservation and management of Hawaiian stream fishes. Early stream surveyors apparently did not know that the range of adult *L. concolor* often begins well inland of the ranges of the other stream fishes. Surveys usually began at the mouth of a stream and proceeded upstream until animals were no longer observed. *Lentipes concolor* was recorded as absent in many streams where it was present farther inland. This misinformation led to a statewide classification of all streams as Lentipes Streams and Non-Lentipes Streams (Timbol *et al.*, 1980), designations which prompted a local conservationist group to sue the U.S. Fish and Wildlife Service to have *L. concolor* listed as Threatened or Endangered throughout the Hawaiian Islands. Even when advised that the basis for the listing was unfounded, the group persisted until the Hawaiʻi Division of Aquatic Resources (DAR) began surveys that located populations of these fish at remote sites on all islands, including Oʻahu where the species was thought to have been extinct for many years (Higashi & Yamamoto, 1993). More recently, there have been several attempts (e.g., Kido & Smith, 1998) to standardize stream surveys in Hawaiʻi by using techniques arguably effective in streams of the mainland U.S. without regard to the connection between stream morphology and fish distribution, the implications of amphidromous life cycles, and the significance of the continuous cyclic recovery of streams from the frequent flash floods.

Food and feeding

Hawaiian amphidromous fishes run the gamut from carnivory (*E. sandwicensis*) to herbivory (*S. stimpsoni*) and omnivory (*S. hawaiiensis, A. guamensis,* and *L. concolor*).

Eleotris sandwicensis is a carnivore that feeds opportunistically on a wide variety of animal foods, including other fishes (even their own species), crustaceans, and aquatic snails. The fishʻs large head, protrusible upper jaw, underslung lower jaw extending beyond the tip of the upper jaw (prognathony), and conic teeth are adaptive for grabbing prey and swallowing it whole. The relatively short gut of *E. sandwicensis* in comparison to other gobioid fishes in Hawaiian streams (Kido, 1996a) is consistent with its carnivorous feeding habits. The fish makes short chases after small fishes, prawns, and shrimp, but usually sits motionless on the bottom until suitable prey comes within striking distance. *Eleotris sandwicensis* congregates in large numbers near the mouths of streams at times of peak recruitment of larval *ʻoʻopu* from the ocean and often feeds until the belly is distended, but the environmental or behavioral cues prompting such opportune concentrations of these predators have not been investigated. A comparative study of feeding morphology and food habits among Hawaiian stream fishes (Kido, 1996b) revealed a large amount of algae in the gut of *E. sandwicensis* from Wainiha River, Kauaʻi, but the author suggested that the plant material may have been ingested inadvertently while fish were feeding on animal material and noted that gut morphology and other features of these fish are indicative of carnivory.

Dentition, gut morphology, diet, and food selection (Kido, 1996a & b, 1997) distinguish *Sicyopterus stimpsoni* from other native freshwater fishes as an obligate herbivore. These fish feed preferentially on navicular, centric, and chain diatoms and pieces of filamentous green and blue-green algae which they scrape off rocks with brushing movements of the upper jaw armed with spatulate tricuspid teeth. Their feeding produces conspicuous scallop-edged patches or long trails on the sides and upper surfaces of rocks and boulders. Large patches prominently located on the surface of boulders near the center of the stream serve as the locus for the initiation of social behavior (territoriality and courtship) by usually large, conspicuously colored, dominant males (Fitzsimons *et al.*, 1993, 2003). While living offshore, young *S. stimpsoni* have a terminal mouth, but, upon entering fresh water, they are unable to feed (or climb) until the mouth migrates to a ventral (inferior) position. This extraordinary change in head morphology occurs within only 48 hours (Schoenfuss *et al.*, 1997).

The three omnivorous stream species occur in the estuary and lower stream reaches (*S.* hawaiiensis), the middle reaches (*Awaous guamensis*), and the upper sections of streams (*Lentipes concolor*). Although detailed studies are lacking, underwater observations suggest *S. hawaiiensis* are omnivores that ingest both plant and animal food by making stabbing bites at the upper surface of rocks or by swimming up into the water column to intercept items drifting downstream. *Awaous guamensis* feed on filamentous algae, diatoms, and small stream animals such as fly larvae and other benthic invertebrates (Kido, 1997). The fish usually bite off clumps of algae or take in a mouthful of sand or gravel from which algae and invertebrates are removed by comb-like gill rakers in the animal‘s “pharyngeal mill”. Once cleaned, the particles of sand and gravel are spit out or dropped from under the lower edge of the gill cover. All five gobioid species have a filtering apparatus formed by gill arches and associated bony or soft projections, but the structure is best developed in *A. guamensis*, an omnivore, and the least in *S. stimpsoni*, an herbivore (Kido, 1996a). Although typically bottom feeders, *A. guamensis* occasionally swim up from the bottom and ingest pieces of material being washed downstream. *Lentipes concolor* feed on green algae and opportunistically on stream invertebrates (Kido, 1996a). In many streams, the most common food items are the larvae of the extremely abundant chironomid flies that lay their eggs on dampened parts of rocks near the water line. These fish also frequently dart up from the bottom and intercept particles carried downstream in manner reminiscent of the sallying behavior of insectivorous birds that fly up from a perch and capture insect prey. It has not been determined to what extent the omnivorous fishes are actually digesting plant material rather than receiving nutrition from the periphyton (*aufwuchs*) attached to it. Gut morphology (length and number of loops) among the omnivores *S. hawaiiensis*, *Awaous guamensis*, and *Lentipes concolor* is intermediate between that of the carnivore (*E. sandwicensis*) and the herbivore (*S. stimpsoni*) (Kido, 1996a).

Reproductive behavior

Hawaii’s amphidromous stream fishes are egg layers. All but one species (*S. hawaiiensis*) are territorial and provide some degree of protection to egg masses by defending the larger area in which eggs are deposited. Eggs are extruded individually from the elongate urogenital papilla of females. Males fertilize the eggs shortly after they are deposited. Eggs are small (ca. 1/3 mm diameter) and encased in a gelatinous adhesive coat. The slightly buoyant eggs float up from the substrate where they have been attached, but the adhesive coat forms a stalk that anchors them and gives them the appearance of a tiny golf ball sitting on a tee. Eggs are deposited in one or more lines (*S. hawaiiensis* and small females of *E. sandwicensis*, *S. stimpsoni*, and *A. guamensis*) or in round and irregular patches (large females) sometimes reaching the diameter of a dinner plate (*A. guamensis*). Recently laid egg masses are white or light gray; patches of eggs where hatching has occurred are usually darker gray and have a ragged appearance. Eggs are deposited on the surface of rocks and boulders (*S. hawaiiensis* and occasionally *E. sandwicensis*), along the sides or underneath boulders (*E. sandwicensis*, *A. guamensis*, and *S. stimpsoni*), and in burrows usually located under piles of large rocks or under the downstream edge of large boulders (*L. concolor* and occasionally the other species).

All five species have an elaborate courtship ritual comprised of species-specific movements that precede pair-forming and spawning. Males approach females in or near their territories and begin a stereotypical sequence of display behavior that ends with the male leading the female to a spawning

site. Pair forming is determined by female choice, but, in one species, *E. sandwicensis,* females have a mid-water display that solicits approach by males. Males of *S. hawaiiensis* initiate courtship with females, and, if the female is receptive, the male leads her to the nearest natural burrow or flat rock often near the margin of the stream where current is reduced. After a bout of spawning, the male may engage the same female in additional courtship with spawning at the same or different site. However, males usually swim along the margins of streams and pursue females encountered opportunistically. *Stenogobius hawaiiensis* differ from other stream fishes in that apparently neither the female, the eggs, nor the spawning site are defended against conspecific males.

Awaous guamensis may be the only amphidromous fish species in Hawai‘i that has a spawning migration (Mainland in Titcomb, 1977; Yamamoto & Tagawa, 2000; Kido & Heacock, 1992). The fish are said to come downstream to sites near the mouths of streams in association with heavy rains during June or July. Streamside residents on Kaua‘i are often familiar with the movements of these fish, and taro farmers have used the expressions *‘o‘opu* rain and *‘o‘opu* flood when describing the conditions associated with the downstream migration of *A. guamensis* in the Hanalei River (Yamamoto & Tagawa, 2000). We have observed large aggregations of spawning fish in the lower section of Wainiha River after being told by a local resident that the fish moved there a week earlier in response to a moderate flash flood. An old Hawaiian proverb refers to *A. guamensis* as *Ka i‘ a ka wai nui i lawe mai ai* (“the fish borne along by the flood”; Pukui, 1983 [1323]). Although accounts are anecdotal, their frequency and similarity afford them at least a tentative “ring of truth”. The advantage of a downstream migration would be two-fold: The aggregation of adults at a common downstream spawning area would enhance the chances of an individual fish finding a receptive mate, and the newly hatched young would have a shorter distance to gain access to the sea. The latter would be of special significance in streams, such as Hanalei and Wainiha, which have long estuaries and adult fishes distributed farther inland than in most Hawaiian streams. In Japan, some amphidromous gobies (*Rhinogobius brunneus*) hatched far inland usually do not have sufficient yolk to sustain them during the long drift to the sea (Iguchi & Mizuno, 1999). The same may be true for gobies in certain Hawaiian streams.

Climbing

Hawaii’s amphidromous fishes differ in their climbing ability. Two species, *E. sandwicensis* and *S. hawaiiensis,* apparently do not climb and are limited to estuaries and the lower stream reaches below the first waterfall of a meter or more in height. However, both have morphological and behavioral adaptations that allow them to maintain position in flowing water (Fitzsimons *et al.*, 1997). The head and body of *E. sandwicensis* is slightly flattened dorsoventrally, and the head is sloped slightly downward from the nape to the tip of the snout. Water flowing over the fish tends to press it into the substrate rather than forcing it up and away from the bottom. These fish are proficient in their ability to wedge themselves between rocks and boulders while using the pelvic and pectoral fins to maneuver and to push forward or backward. By hugging the bottom and working their way upstream behind rocks and boulders, the eleotrids are capable of progressing against currents that would displace other fishes of similar size and shape attempting to swim against the flow. *Stenogobius hawaiiensis* swim off the bottom, but these fish take advantage of slack water along the margins of streams and in the shelter of large rocks and boulders.

The three upstream species, *S. stimpsoni, A. guamensis,* and *L. concolor*, can climb waterfalls and adhere to the surface of rocks and boulders in swift water with a suction disk formed by the fusion of the pelvic (ventral) fins. Even among these three species, the mode of climbing and climbing ability differ. *Awaous guamensis* and *L. concolor* rely on the pelvic disk as a holdfast when climbing, but *S. stimpsoni* uses both the pelvic disk and the mouth alternately when “inching” forward in a strong current and when climbing a cascade or waterfall (Schoenfuss *et al.*, 1997; Schoenfuss & Blob, 2003; Nishimoto & Kuamo‘o, 1997). The “powerburst climbers” (Schoenfuss & Blob, 2003), *Awaous guamensis* and *L. concolor,* push forward with the pectoral fins while detaching the pelvic disk and rapidly undulating the body from side to side. *Sicyopterus stimpsoni* and *A. guamensis* can negotiate waterfalls 10–20 m in height (Fitzsimons & Nishimoto, 1991), while adults of *L. concolor* reside in the pools above the highest waterfalls, such as Waipi‘o Valley‘s Hi‘ilawe Falls with a sheer drop of over 300 m (Englund & Filbert, 1997).

Genetics and isotope analysis

Surveys of genetic variation in Hawaiian stream fishes with protein electrophoresis (Fitzsimons *et al.*, 1990), mitochondrial DNA restriction site analysis (Zink *et al.*, 1996), and mtDNA sequencing (Chubb *et al.*, 1998) revealed no evidence of discernible geographic (island) structuring among the five species of amphidromous fishes. These data suggest that there is either a single offshore pool of larvae that recruit to each of the five major islands or that recruitment is from local offshore populations but with sufficient exchange of larvae between islands to prevent isolation and genetic differentiation.

A comparison of data from stable isotope analysis (carbon and nitrogen) of amphidromous fish recruits and fish species from marine habitats indicates that the source of nutrition for the stream species during their offshore larval period is near the mouths of streams (Hobson *et al.*, 2007). These findings support the idea that these larval fishes in the ocean remain close to freshwater plumes which function as nursery areas and suggest that amphidromous fish larvae may stay near their home island (or even natal stream?) rather than joining an offshore mass of larvae that contributes recruits to all the high islands. A finer focus with isotope analysis and genetics (such as microsatellite studies) may clarify details of the distribution, ecology, and population dynamics of amphidromous fishes during the marine period of their life cycle.

Parasites

The effects of alien species on indigenous aquatic animals are not well known. A striking exception is the investigation of parasites in native stream fishes associated with the introduction of alien fish species (Font, 1996, 1997a,b, 1998; Font & Tate, 1994). Fourteen species of helminth parasites have been found in stream fishes, but only three, a tapeworm (*Bothriocephalus acheilognathi*), leech (*Myzobdella lugubris*), and roundworm (*Camallanus cotti)*, which were introduced into the islands along with their alien fish hosts, are regarded as capable of causing disease in native fishes (Font, 2003). Hawaii's amphidromous fishes are diverse in their susceptibility to these potentially dangerous parasites. All three parasites are recorded by Font from *A. guamensis* and *E. sandwicensis*. *Lentipes concolor* has the roundworm, but not the other two parasite species. *Sicyopterus stimpsoni* often has leeches attached to the head and body but lacks both endoparasites. Finally, *Stenogobius hawaiiensis* has none of the three parasites.

r and K selection

Unbridled exponential growth is infrequent in natural populations. In the more universal logistic population growth, the rapid increase in number eventually peaks, slows, and stabilizes when the carrying capacity of the environment is reached. For this reason, population growth is more frequently represented by a sigmoid curve rather than a straight line. The equation for Logistic Population Growth is $I = rN (K - N / K)$, where I = the annual increase for the population, r = the annual growth rate, N = the population size, and K = the carrying capacity. The concepts of r and K selection originate from this equation. In a simplified definition, r selection is a form of natural selection that occurs when the environment has abundant resources that favor, among other things, a reproductive strategy of producing many offspring. Conversely, K selection is a type of selection in an environment that is at or near carrying capacity, and limited resources favor a reproductive strategy in which few offspring are produced. From that criterion alone, stream fishes in Hawai'i are clearly r-selected. However, there are other characteristics of r- and K-selected populations that can be considered: In environments where the availability of resources exceeds demands, the lack of competition promotes selection for early reproduction, fast growth, and short life spans (= r selection of Pianka, 1970). In environments where the demand for resources is about the same as the available supply, natural selection promotes competition among species that results in the evolution of slower growth, a delay in reproduction, and longer life spans [= K selection of Pianka (1970)]. In addition, extreme r-selected species are thought to be characteristic of unstable environments and density independent interactions, while extreme K-selected species are indicative of stable environments and density dependent interactions. These and other features of r- and K-selected species that appear most relevant to fishes in general are placed in Table 1 for a discussion of Hawaiian amphidromous fishes

Table 1. Characteristics of animals that are extreme r or K strategists. Loosely based on Campbell & Reece (2002); Gould (1997); Pianka (1970); Raven & Johnson (2002); and adapted for fishes.

r	K
unstable environment	stable environment
density independent interactions	density dependent interactions
small size	large size
energy used to make each individual is low (small size at birth)	energy used to make each individual is high (large size at birth)
weak, vulnerable	robust, well-protected
high mortality	low mortality
rapid growth	slow growth
early maturation	late maturation
short life expectancy	long life expectancy
each individual reproduces only once	individuals can reproduce more than once in their lifetime
little or no care for the offspring	much care for the offspring
variable population size	stable population size

with reference to the following questions: How do Hawaiian amphidromous fishes fit into the r-K selection continuum? Are they strongly associated with one extreme or do they show a blending or mosaic of the individual attributes of r and K selection?

To begin with, it can be argued that the equation for logistic population growth cannot be applied to indigenous stream fishes in Hawai‘i because r (the annual growth rate) is based on reproduction by members of the population in essentially a closed system. Because of their amphidromous life cycle, every fish in every Hawaiian stream is a migrant and may or may not have begun life in the stream where it is observed, and there is no certainty that young animals are the offspring of adults in the same stream. The equation perhaps can be salvaged for Hawaiian stream fishes merely by changing r to R_s, the latter representing the site specific (s) annual rate of increase (R) attributable to recruitment, and rewriting it as $I = R_sN (K – N / K)$. The emphasis here is that population increases are caused by recruitment whether or not the recruits originate from the stream in question.

Although juveniles and adults of amphidromous species in Hawai‘i live in an unstable environment because of recurring flash floods, it might be argued that their free-living embryos and larvae in the ocean live in a relatively more stable environment. If this assumption is correct, these fishes are r-selected in fresh water and K-selected in marine environments (Table 1). The situation in terms of r and K selection in the two environments is reversed when considering that density independent interactions, a feature of r-selected populations, are likely among the thousands of young fishes washed out of streams into the ocean, while the highly social adults are concentrated in finite sections of streams where interactions are density dependent, a feature of K-selected populations. Small size (r) characterizes the newly hatched free-living embryos (ca. 1.5 mm total length); adults are appreciably larger (K) even in comparison to the adults of most species of marine gobies and eleotrids. The energy used to make each individual, i.e., relative size at birth, is clearly low, an r-selected feature. Although the terms are subjective, amphidromous fishes offshore could be described as weak and vulnerable (r). In contrast, adults in streams, particularly the three upstream species, are much larger, robust, and mostly free from predators (K). Mortality rates are unknown

for amphidromous fishes, but it is likely that there is higher mortality (r) among recently hatched fishes and lower mortality (K) among adult fishes once they are established in species-specific stream habitats. Evaluating growth as rapid or slow among amphidromous fishes is tentative because age-and-growth studies are lacking. Depending on the species, newly hatched embryos can increase in total length as much as 16 times (e.g., 1.5 mm TL for embryos vs almost 24 mm for recruiting *S. stimpsoni*; Nishimoto & Kuamoʻo, 1997). Casual underwater observations suggest that males and females have indeterminant growth, but a change in size associated with the transition from juvenile to adult or with growth among adults is much less dramatic among stream-living fishes (K) than among conspecific young fishes in the ocean (r). Stream fishes mature late (K) when the lengthy larval period is added. Although there is no published information on age at maturity, the small size of spawning fishes observed underwater indicates they become reproductively competent in a short time (r), i.e., less than a year, after recruiting into streams. If *L. concolor* is typical of other stream fishes in Hawaiʻi, life expectancy would be considered long (K) in comparison to other similar sized fishes (Nishimoto & Fitzsimons, 1986). Stream gobies and eleotrids reproduce more than once in their lifetime (K); none die after spawning as do many species of anadromous fishes that also leave the marine environment and reproduce in fresh water. All but one species (*S. hawaiiensis*) are territorial at spawning sites and provide some amount of protection for the eggs (K). Population sizes are unknown for larval amphidromous fishes, but the potential for tracking changes in population size for adults in streams may be possible soon by using the freshwater database being developed by the Hawaiʻi Division of Aquatic Resources. In an island stream, population size reflects the balance between mortality and recruitment, but not reproduction, unless it can be demonstrated that recruitment involves significant homing to a natal stream. Recall that the equation proposed above for logistic population growth in Hawaiian streams substitutes recruitment for natural reproduction.

When the results of this discussion are tallied, larval fishes during the marine period of their life cycles appear to be mostly r-selected, while adults established in species-typical stream habitats are mostly K-selected.

Although this discussion is largely moot and academic, there are two possible conclusions that may have some practical merit. First, an amphidromous life cycle involving life in both fresh water and the sea makes it difficult, if not impossible, to apply to Hawaiian streams many analytical techniques basic to understanding the biology of streams and rivers on continents. Clearly, the biology of island amphidromous fishes is "strongly influenced by both these hydrologic systems" (Kinzie, 1988). Secondly, this discussion has proceeded mostly from educated guesses rather than hard data, and, instead of providing valuable reference material, it shows that even the most rudimentary baseline studies for Hawaiian stream fishes are either deficient or absent. The inevitable statement "more studies are needed" applies here.

Conservation

None of the five species of Hawaiian amphidromous fishes is currently threatened or endangered (Devick *et al.*, 1995). Because of the earthʻs rotation, trade winds continue to flow up the northeast sides of the high islands to cooler elevations where they produce the orographic rainfall that maintains forests, the perennial streams that run through them, and the animals that live in the clear, cold water. The larvae of amphidromous fishes, limpets, shrimp, and prawns continue to recruit from the ocean into brackish and fresh waters where they complete their life cycles. Periodic flash floods continue to clean out streams, and recruits from the ocean periodically "top off" populations of aquatic animals. This perpetual natural recycling maintains the dynamic conditions in Hawaiian streams that guarantee the persistence of a unique assemblage of organisms. These animals persist as living links to the evolutionary origins of both aquatic and terrestrial life on these islands, and they were vital to survival of the Polynesians who first colonized Hawaiʻi. The situation seems at once idyllic, perpetual, and maybe even unassailable. But there are catches.

In Hawaiʻi, freshwater organisms are confined to relatively small streams where they are easily vulnerable to human influences. Any material taken from a stream or dumped into it is likely to have an immediate effect. Any activity that blocks access to or from the sea shuts down the life cycles of the principal stream animals and eventually results in the loss of those species from the

stream. Fresh water is usually abundant on each of the major islands. However, it is not limitless, and it seldom occurs naturally on the leeward sides of islands. The disparity in the distribution of rainfall on the islands in combination with human needs and wants – and these are not necessarily synonymous – automatically makes water a potentially scarce resource.

Until the late 1980s, the prevailing attitude was that water flowing into the sea was wasted (Devick, 1995). Indiscriminate diversion of water for agriculture (mainly sugar cane), development (often in arid areas), and other activities led to a wide-spread diminution of flow or a complete dewatering of many streams. The result was a loss of aquatic communities, a decline in taro production, and a reduction of productivity in the ocean near the coast where streams once emptied. Conditions began improving in 1987 with the establishment of a State Water Code and the formation of the Commission on Water Resource Management (Devick, 1995; Devick *et al.*, 1992); these two actions gave the State, rather than individual landowners, authority over the use of streams.

Hawai‘i has been faulted for not joining other western states in the designation of minimum flow requirements to protect its stream animals. Critics do not understand the variable nature of flow in Hawaii's streams, know little or nothing of amphidromy, and have not experienced in their own states the flash floods that occur frequently in Hawai‘i. In lieu of setting meaningless minimum flow requirements for all Hawaiian streams, William S. Devick, Administrator of the Division of Aquatic Resources, established a policy of "no net loss of habitat" in stream-use decisions (Devick, 1995). This approach has been successful, and, in retrospect, it is infinitely more logical and amenable to implementation than mainland procedures because the focus is on the requirements of stream animals rather than on a range of numbers describing the amount of water that flows over a section of stream during a certain period of time.

During Devick‘s service as DAR Administrator, he established four levels of stream protection (Devick *et al.*, 1992) that go well beyond conservation measures developed for streams in other states. Conservation zoning places designated streams into discrete Conservation Districts (1) which extend protection to entire stream corridors and incorporate all perennial streams. Interim Instream Flow Standards (2) for individual streams are based on existing flows, and activities affecting the stream beds, i.e., animal habitats, are closely regulated. The program of Stream Ecosystem Protection (3) halts further development of selected streams and their corridors while retaining existing uses. The development of a Natural Areas Reserve System (NARS) (4) preserves and restores designated areas that represent important freshwater ecosystems.

The Endangered Species Act is viewed sometimes as the first and sometimes as the last defense against the extinction of a species. A correlative idea is that protection of one species provides protection for all the other organisms in the area. This notion seems applicable to Hawaiian stream fishes because of their amphidromous life cycles, but, as emphasized throughout this paper, the five species of fishes are different in where they live in a stream and what they do for a living. A focused effort for restoring and protecting one species may or may not provide assistance to others. Instead, actions that provide protection of habitat by preserving entire ecosystems are preferable to a limited concentration on single species (Devick *et al.*, 1995). An ideal tactic is to maintain aquatic ecosystems so that invoking the Endangered Species Act never becomes necessary. The five species of fishes discussed in this paper possess remarkable diversity in their behavior and ecology, but the key to their protection lies with their common amphidromous life cycle. For an unaltered stream that flows briskly into the ocean along an open coast, the best protection may be to do nothing at all. Simply leave the stream unaltered. The animals themselves will take it from there.

Literature Cited

Campbell, **N.E. & J.B. Reece**. 2002. *Biology*. 6th ed. Benjamin Cummings, San Francisco. 1247 p.

Chubb, **A.L.**, **R.M. Zink & J.M. Fitzsimons**. 1998. Patterns of mtDNA variation in Hawaiian freshwater fishes: The phylogenetic consequences of amphidromy. *Journal of Heredity* **89**: 8–16.

Connell, **J.H**. 1980. Diversity and coevolution of competitors, the ghost of competition past. *Oikos* **35**: 131–138.

Devick, **W.S**. 1995. The importance of stream beings. *'Elepaio* **55**: 45–48.

———., **J.M. Fitzsimons & R.T. Nishimoto**. 1992. *Conservation of Hawaiian freshwater fishes.* Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii, Honolulu. 26 p.

———., **J.M. Fitzsimons & R.T. Nishimoto**. 1995. Threatened fishes of the world: *Lentipes concolor* Gill, 1860 (Gobiidae). *Environmental Biology of Fishes* **44**: 325–326.

Englund, **R.A. & R. Filbert**. 1997. Discovery of the native stream goby, *Lentipes concolor*, above Hawaii's highest waterfall, Hi'ilawe Falls. *Bishop Museum Occasional Paper* **49**: 62–24.

Fitzsimons, **J.M. & R.T. Nishimoto**. 1991. Behavior of gobioid fishes from Hawaiian fresh waters. 106–124. *In:* W.S. Devick (ed.), *New directions in research, management, and conservation of Hawaiian freshwater stream ecosystems*. Proceedings of the 1990 Symposium on Freshwater Stream Biology and Management, Hawai'i Division of Aquatic Resources.

———. **& R.T. Nishimoto**. 1995. Use of fish behavior in assessing the effects of Hurricane Iniki on the Hawaiian island of Kaua'i. *Environmental Biology of Fishes* **43**: 39–50.

———., **M.G. McRae**, **H.L. Schoenfuss & R.T. Nishimoto**. 2003. Gardening behavior in the amphidromous Hawaiian fish *Sicyopterus stimpsoni* (Osteichthyes: Gobiidae). *Ichthyological Exploration of Freshwaters* **14**: 185–191.

———., **R.T. Nishimoto & A.R. Yuen**. 1993. Courtship and territorial behavior in the native Hawaiian steam goby, *Sicyopterus stimpsoni*. *Ichthyological Exploration of Freshwaters* **4**: 1–10.

———., **J.E. Parham & R.T. Nishimoto**. 2002. Similarities in behavioral ecology among amphidromous and catadromous fishes on the oceanic islands of Hawai'i and Guam. *Environmental Biology of Fishes* **65**: 123–129.

———., **H.L. Schoenfuss & T.C. Schoenfuss**. 1997. Significance of unimpeded flows in limiting the transmission of parasites from exotics to Hawaiian stream fishes. *Micronesica* **30**: 117–125.

———., **R.M. Zink & R.T. Nishimoto**. 1990. Genetic variation in the Hawaiian stream goby, *Lentipes concolor*. *Biochemical Systematics and Ecology* **18**: 81–83.

Font, **W.F**. 1996. Parasites in paradise: exotic parasites in native Hawaiian gobioid stream fishes. *Newsletter, Introduced Fish Section, American Fisheries Society* **15**: 5–6.

———. 1997a. Distribution of helminth parasites of native and introduced streamfishes in Hawaii. *Bishop Museum Occasional Papers* **49**: 56–62

———. 1997b. Improbable colonists: helminth parasites of freshwater fishes on an oceanic island. *Micronesica* **30**: 105–115.

———. 1998. Parasites in paradise: patterns of helminth distribution in Hawaiian stream fishes. *Journal of Helminthology* **72**: 307–311.

———. 2003. The global spread of parasites: What do Hawaiian streams tell us? *BioScience* **53**: 1061–1067.

———. **& D.C. Tate**. 1994. Helminth parasites of native Hawaiian freshwater fishes: An example of extreme ecological isolation. *Journal of Parasitology* **80**: 682–688.

Gould, **S.J**. 1997. *Ontogeny and phylogeny*. Belknap Press, Cambridge, Massachusetts. 528 p.

Higashi, **G.R. & M.N. Yamamoto**. 1993. Rediscovery of 'extinct' *Lentipes concolor* (Pisces: Gobiidae) on the island of Oahu, Hawaii. *Pacific Science* **47**: 115–117.

Hobson, **K.A.**, **R.J.F. Smith & P. Sorensen**. 2007. Applications of stable isotope analysis to tracing nutrient sources to Hawaiian gobioid fishes and other stream organisms. *In:* Evenhuis, N.L. & J.M. Fitzsimons (eds.), Biology of Hawaiian Streams and Estuaries. Proceedings of the Symposium on the Biology of Hawaiian Streams and Estuaries, Hilo, Hawai'i 26–27 April 2005. *Bishop Museum Bulletin in Culture and Environmental Studies* **3**: 99–111.

Iguchi, **K. & N. Mizuno**. 1999. Early starvation limits survival in amphidromous fishes. *Journal of Fish Biology* **54**: 705–712.

Kido, **M.H**. 1996a. Morphological variation in feeding traits of native Hawaiian stream fishes. *Pacific Science* **50**: 184–193.

———. 1996b. Diet and food selection in the endemic Hawaiian amphidromous goby, *Sicyopterus stimpsoni* (Pisces: Gobiidae). *Environmental Biology of Fishes* **45**: 199–209.

———. 1997. Food relations between coexisting native Hawaiian stream fishes. *Environmental Biology of Fishes* **49**: 481–494.

———. & D.E. Heacock. 1992. The spawning ecology of *ʻoʻopu nakea* (*Awaous stamineus*) in Wainiha River and other selected north shore Kauaʻi rivers, p. 142–157. *In*: W.S. Devick (ed.), *New directions in research, management, and conservation of Hawaiian freshwater stream ecosystems*. Proceedings of the 1990 Symposium on Freshwater Stream Biology and Management, Hawaii Division of Aquatic Resources.

———. **& G.C. Smith**. 1998. The Hawaii stream bioassessment protocol: a manual for biological monitoring and assessment of Hawaiian streams. Report to the Hawaii Department of Health, Honolulu.

Kinzie, **R.A**. 1988. Habitat utilization by Hawaiian stream fishes with reference to community structure in oceanic island streams. *Environmental Biology of Fishes* **22**: 179–192.

McDowall, **R.M**. 2003. Hawaiian biogeography and the islands' freshwater fish fauna. *Journal of Biogeography* **30**: 703–710.

Myers, **G.S**. 1938. Fresh-water fishes and West Indian zoogeography. *Annual Report of the Smithsonian Institution* **1937**: 339–364.

———. 1949. Usage of anadromous, catadromous, and allied terms for migratory fishes. *Copeia* **1949**: 89–97.

Nelson, **S.G.**, **J.E. Parham**, **R.B. Tibbatts**, **F.A. Camacho**, **T. Leberer & B.D. Smith**. 1997. Distributions and microhabitats of the amphidromous gobies in streams of Micronesia. *Micronesica* **30**: 83–91.

Nishimoto, **R.T. & J.M. Fitzsimons**. 1986. Courtship, territoriality, and coloration in the endemic Hawaiian freshwater goby, *Lentipes concolor*, p. 811–817. *In:* Uyeno, T., R. Arai, T. Taniuchi, & K. Matsuura (eds.), *Indo-Pacific fish biology*. Proceedings of the second International Conference on Indo-Pacific fishes, Ichthyological Society of Japan, Tokyo.

———. **& D. G.K. Kuamoʻo**. 1997. Recruitment of goby postlarvae into Hakalau Stream, Hawaiʻi Island. *Micronesica* **30**: 41–49.

Parham, **J.E**. 1995. Habitat use by an assemblage of tropical oceanic island streamfish. Unpublished M.S. Thesis, University of Guam, Mangilao. 118 p.

Pianka, **E.R**. 1970. On r and K selection. *American Naturalist* **104**: 592–597.

Pukui, **M.K**. 1983. *Olelo noʻeau, Hawaiian proverbs and poetical sayings*. Bishop Museum Press, Honolulu. 351 p.

Raven, **P.H. & G.B. Johnson**. 2002. *Biology.* 6th edition. McGraw-Hill, Boston. 1,238 p.

Schoenfuss, **H.L. & R.W. Blob**. 2003. Kinematics of waterfall climbing in Hawaiian freshwater fishes (Gobiidae): vertical propulsion at the aquatic-terrestrial interface. *Journal of Zoology* (London) **261**: 191–205.

———., **T.A. Blanchard & D.G.K. Kuamoʻo**. 1997. Metamorphosis in the cranium of postlarval *Sicyopterus stimpsoni*, an endemic Hawaiian stream goby. *Micronesica* **30**: 93–104.

Tate, **D.C**. 1997. The role of behavioral interactions of immature Hawaiian stream fishes (Pisces: Gobioidei) in population dispersal and distribution. *Micronesica* **30**: 51–70.

Timbol, **A.S.**, **A.J. Sutter & J.D. Parrish**. 1980. Distribution, relative abundance, and stream environment of *Lentipes concolor* (Gill 1860), and associated fauna in Hawaiian streams. Water Resources Research Center, University of Hawaii at Mānoa. 64 p.

Titcomb, **M**. 1977. *Native use of fish in Hawaii*. University Press of Hawaii, Honolulu. 175 p.

Yamamoto, **M.N. & A.W. Tagawa**. 2000. *Hawaii's native and exotic freshwater animals.* Mutual Publishing, Honolulu. 200 p.

Zink, **R.M.**, **J.M. Fitzsimons**, **D.L. Dittman**, **D.R. Reynolds & R.T. Nishimoto**. 1996. Evolutionary genetics of Hawaiian freshwater fish. *Copeia* **1996**: 330–335.

Courtesy Annette Tagawa

ʻOʻopu ʻakupa or Sandwich Island sleeper

Eleotris sandwicensis

SPECIES STATUS:
IUCN Red List – Data Deficient
Endemic

SPECIES INFORMATION: ʻOʻopu ʻakupa or Sandwich Island sleeper (*Eleotris sandwicensis)* is Hawaii's only endemic eleotrid. Adult ʻoʻopu ʻakupa are ambush predators that feed on a variety of invertebrates and fishes, including other native adult and post-larval gobies and some exotic fishes. One study shows that they are also opportunistic feeders. It can grow to 33 centimeters (13 inches) in length. Unlike Hawaii's native gobies, its pelvic fins are not fused into a disc. Without this sucking disc, they are unable to hold on to substrates and are not good climbers. Spawning occurs in freshwater; nests are made in crevices at the stream bottom. Eggs hatch within a day and are washed to the sea where they spend a few months as oceanic plankton. Post-larvae or hinana recruit to streams indiscriminately, and they depend on waves and currents to bring them inshore. This recruitment occurs year round but is most prevalent in the spring and usually takes place during nighttime hours. ʻOʻopu ʻakupa usually stay hidden, but can be seen darting and diving into leaf litter or mud or searching for shelter in rocks. There are two head morphs of the species.

DISTRIBUTION: Historically, ʻoʻopu ʻakupa were found on all the Main Hawaiian Islands. Today, they also are found on all the Main Hawaiian Islands in the lower reaches of streams and in estuaries below all man-made obstructions. Post-larvae are found in oceanic waters, but little is known of its oceanic distribution, but post-larvae do not show natal stream fidelity.

ABUNDANCE: Most common on Oʻahu. One study shows that ʻoʻopu ʻakupa are present in Pelekunu stream but rare in Waikolu stream, both on Molokaʻi. ʻOʻopu ʻakupa populations are stable in both altered and unaltered streams.

LOCATION AND CONDITION OF KEY HABITAT: ʻOʻopu ʻakupa are found only in estuaries and the lower reaches of streams. Their feeding habitat is primarily on the bottom of these streams and estuaries. Although they prefer clear, cool streams like the other gobies, they are better adapted than most gobies to live in degraded habitat. They can often be found living in cans and other trash items at the bottom of streams. Condition of key habitat varies depending on whether streams flow through protected or forested areas versus urban areas, but ʻoʻopu ʻakupa populations are stable in both altered and unaltered streams. For specific information on stream biota, the Division of Aquatic Resources of the Department of Land and

Natural Resources has a database of surveyed streams. Oceanic waters are important to the survival of post-larvae, but little is known of its oceanic distribution or habitat requirements.

THREATS:

- Habitat degradation results from water diversion, stream channelization, and dams. Water diversion, stream channelization, and dams result in habitat degradation through altered stream flows, which also causes a loss of riparian vegetation, shelter and erosion control; higher water temperatures; and lower dissolved oxygen levels. Because of their higher tolerance to stress, ʻoʻopu ʻakupa are not as threatened by altered streams as other Hawaiian gobies. However, reduced water flows can still limit larvae from reaching the ocean and recruitment back into streams;
- Non-point source water pollution such as nutrients, sedimentation, and chemicals may threaten ʻoʻopu ʻakupa; however, the consequence of these pollutants is relatively unknown and needs to be further studied;
- Introduction of exotic species, diseases and parasites such as tilapia are significant threats to ʻoʻopu ʻakupa. Historical introductions of game fish and more recent unwanted exotic fish from the aquarium trade are both problems. These exotic fish species prey on native fish, they compete native fish for food, and spread parasites and diseases;
- Fishing for ʻoʻopu ʻakupa occurs today and it is used as bait. In conjunction with the above threats, overfishing could become a threat in the future.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations, but to also establish further populations to reduce the risk of extinction. Past actions to restore fish populations have consisted of a ban on gill, drag, draw, and seine netting; stream clean-up efforts, and public outreach. In addition to common state-wide and island conservation actions, specific actions include:

- Improve altered or diverted streams;
    - Modify or remove gratings or diversions to allow for instream passage of fish;
    - Restore riparian vegetation to help decrease instream heating and reduce sediment loads;
    - Remove alien species;
    - Create pools in frequently dewatered stretches to provide safe usable habitat between flows.
- Collaborate with the Commission on Water Resources Management and the Land Board to ensure adequate Instream Flow and biological integrity of riparian areas;
- Work to clean streams with significant pollution;
- Continue developing GIS database and making it web-accessible;
- Use science-based management of recreational fishing;
- Increase education and outreach efforts, particularly on issues of fishing related life history, water pollution, and how to deal with unwanted aquarium pets;
- Continue on-going partnerships focused on environmental and fisheries education and conservation and expand partnerships.

MONITORING:

- Establish survey schedule to determine population size and distribution;
- Monitor number of returning hinana;

- Monitor number of fish taken in recreational fishing each year.

RESEARCH PRIORITIES:

- Determine effects of pollution on population;
- Better understand the role of estuaries in species ecology;
- Continue researching effects of stream channelization and diversion-specifically how this goby is able to have high numbers in altered streams;
- Initiate research to study source-sink population structure;
- Research impacts and methodologies to deal with alien species;
- Research effect of fishing on total population size and distribution.

References:

Brasher AM. 1997. Habitat use by fish (ʻoʻopu), snails (hihiwai), shrimp (ʻopae) and prawns in two streams on the island of Moloka`i. Technical Report. Honolulu HI: Cooperative National Park Resources Studies Unit University of Hawaii at Manoa. Report no 116. 92 pp.

Hau S. 1996. Post-larval migration of three native gobies (*Lentipes concolor, Awaous guamensis,* and*Sicyopterus stimpsoni*) in Iao stream on the island of Maui. Proceedings of the October 1994 Hawaii Stream Restoration Symposium; 1994; Hawaiʻi. State of Hawaiʻi, Department of Land and Natural Resources, Division of Aquatic Resources. 159 pp.

Kinzie RA III. 1990. Species profiles: life histories and environmental requirements of coastal vertebrates and invertebrates, Pacific Ocean region; Report 3, Amphidromous macrofauna of island streams. Technical Report EL-89-10. Vicksburg, MS: US Army Engineer Waterways Experiment Station.

Tate DC. 1997. The role of behavioral interactions of immature Hawaiian stream fishes (Pisces: Gobiodei) in population dispersal and distribution. Micronesica 30 (1): 51-70.

Yamamoto M, Tagawa A. 2000. Hawaii's native and exotic freshwater animals. Honolulu, HI: Mutual Publishing. 200 pp.

Journal of Water Resource and Protection, 2014, 6, 852-868
Published Online June 2014 in SciRes. http://www.scirp.org/journal/jwarp
http://dx.doi.org/10.4236/jwarp.2014.69080

Influence of Potential Evapotranspiration on the Water Balance of Sugarcane Fields in Maui, Hawaii

Javier Osorio[1], Jaehak Jeong[1], Katrin Bieger[1], Jeff Arnold[2]

[1]Blackland Research and Extension Center, Texas A & M AgriLife Research, Temple, USA
[2]Grassland, Soil and Water Research Laboratory, United States Department of Agriculture, Agricultural Research Service (USDA-ARS), Temple, USA
Email: josorio@brc.tamus.edu

Received 4 March 2014; revised 2 April 2014; accepted 27 April 2014

Copyright © 2014 by authors and Scientific Research Publishing Inc.
This work is licensed under the Creative Commons Attribution International License (CC BY).
http://creativecommons.org/licenses/by/4.0/
Open Access

Abstract

The year-long warm temperatures and other climatic characteristics of the Pacific Ocean Islands have made Hawaii an optimum place for growing sugarcane; however, irrigation is essential to satisfy the large water demand of sugarcane. Under the Hawaiian tropical weather, actual evapotranspiration (AET) is the primary mechanism by which water is removed from natural and agricultural systems. The Hawaiian Commercial and Sugar Company (HC&S), the largest sugarcane grower of the Hawaiian Islands, has developed a locally optimized AET equation for the purpose of water management on its 184.3 km^2 sugarcane plantation on the Island of Maui. In this paper, in order to assess the influence of AET on the hydrological water balance of the HC&S' sugarcane cropping system, the performance of the HC&S method was compared with three physically-based methods: Penman-Monteith, Priestley-Taylor, and Hargreaves, as well as, to a set of historical pan evaporation data. A Soil and Water Assessment Tool (SWAT) project was setup to estimate the water balance in two sugarcane fields: a windy lowland field and a rocky highland field on a hill slope. Under Hawaiian weather conditions, wind speed was found to be the most influential climatic parameter over potential evapotranspiration (PET); therefore, the results with both Hargreaves and Priestley-Taylor underpredicted PET by approximately 30%, presumably because these methods do not take wind speed into account. The HC&S method was demonstrated to be the most accurate PET method compared to the other commonly used PET equations, with less than 10% error. Of the annual total water supply of 3400 mm, AET accounted for 75% - 80% of the total water consumption. These findings can be used to improve the irrigation efficiency as well as other management scenarios to optimize water use on the Island of Maui.

How to cite this paper: Osorio, J., Jeong, J., Bieger, K. and Arnold, J. (2014) Influence of Potential Evapotranspiration on the Water Balance of Sugarcane Fields in Maui, Hawaii. *Journal of Water Resource and Protection*, **6**, 852-868.
http://dx.doi.org/10.4236/jwarp.2014.69080

Keywords

Evapotranspiration, Water Balance, Hydrological Modeling, Sugarcane, SWAT

1. Introduction

The year-long warm temperatures and other climatic characteristics of the Pacific Ocean Islands have made the Island of Maui an optimum place for growing sugarcane (*Saccharum officinarum* L.). Because of the high water demand of sugarcane, irrigation becomes one of Maui's major constraints [1]. According to McMahon *et al*. [2] irrigation is essential to satisfy the large water demand of sugarcane for optimum growth and yield. In Maui, large quantities of surface and ground water from the windward side of the island are diverted by intake structures into ditches and tunnels to transport the water to the leeward plains, where the best agricultural soils are located [1]. However, mild droughts and periods of low rainfall have adversely affected the perennial streams and depleted high-level groundwater aquifers that supply Maui's irrigation system. As water resources become limited, effective use of available water for irrigation is of concern throughout the sugarcane industry [3].

The Hawaiian Commercial & Sugar Company (HC&S), the largest sugarcane grower of the Hawaiian Islands, has an area of 184.3 km^2 under sugarcane production on the Island of Maui. The productivity of sugarcane on Maui (159.9 $t \cdot ha^{-1}$ sugarcane yield and 24.9 $t \cdot ha^{-1}$ sugar yield) is known to be above the national average (78.8 $t \cdot ha^{-1}$ sugarcane yield and 9.2 $t \cdot ha^{-1}$ sugar yield) and higher than other major sugarcane producing regions in USA like Louisiana (51.3 $t \cdot ha^{-1}$ sugarcane yield and 6.6 $t \cdot ha^{-1}$ sugar yield) or Texas (85.9 $t \cdot ha^{-1}$ sugarcane yield and 10.0 $t \cdot ha^{-1}$ sugar yield) [4]. The sugarcane cropping period is approximately 24 months. The company requires 760,000 $m^3 \cdot d^{-1}$ of fresh water for irrigation, which is obtained from surface (fog drip and rainfall) and ground water sources (16 deep brackish-water wells) and is applied directly to the root zone of the sugarcane plants through a drip irrigation system.

From the hydrological perspective, actual evapotranspiration (AET) is the primary mechanism by which water is removed from the hydrologic cycle [5]-[7]. AET returns land-based water to the atmosphere through processes such as transpiration, evaporation from the plant canopy and the soil and sublimation when snow is present [8]. The rate of AET for a given environment is a function of four critical factors: soil moisture, plant type, stage of plant development, and weather conditions. In addition, the transpiration rate is influenced by soil management practices [7] [9]. McCuen [10] asserts that the most influential climatic factors on ET are temperature, relative humidity, radiation rates and wind speed.

Large AET rates in agricultural regions impact water quantity and quality [11] [12]. Accordingly, the amount of water needed for irrigation of agricultural systems is frequently calculated based on estimated AET. Underestimation of AET leads to an insufficient water supply to the crop and consequently to water stress, while overestimation of AET leads to a waste of water for irrigation. Therefore, accurate estimation of AET plays a critical role in the assessment, planning and management of water resources in general [11]. Several methods are used to estimate AET based on mass transfer, energy budget, water budget, soil moisture budget, ground-water fluctuations or meteorological variables. Each method has advantages and disadvantages; moreover, none is applicable under all conditions because of assumptions in the method or type of required data [13]. Most of the hydrological models employ the concept of potential evapotranspiration (PET) as the driving function for the calculation of AET [7] [14] [15]. PET is defined as the amount of water that would be removed from a vegetated landscape with no restrictions other than the atmospheric demand [16], and is often measured with evaporation pans. Also, PET can be estimated using methods based on available climate data [7] [17]. Currently, a number of methods that vary in complexity and data requirements are employed for calculating PET [2] [7] [9]. Their ability to produce consistent and meaningful PET estimates depends on their assumptions, data requirements and consideration of atmospheric factors [2] [15]. HC&S has remained in the sugarcane industry for more than 100 years and during this time the company has made numerous innovations on sugarcane technology, irrigation techniques, and crop management for the sugarcane plantation on the Island of Maui. To optimize water usage for irrigation purposes, HC&S has developed a locally calibrated PET method, which is based on pan evaporation measurements and is specific to sugarcane.

The main objective of this study was to evaluate the efficiency of the HC&S irrigation system by comparing

the accuracy of AET estimation by the HC&S method against three physically-based methods: Penman-Monteith, Priestley-Taylor, and Hargreaves, as well as, to a set of historical pan evaporation data and to identify an AET method that is applicable to other crops and transferable to locations with similar characteristics.

2. Data and Methods

2.1. SWAT Model

SWAT is a physically based, semi-distributed, and long-term continuous watershed scale model that runs on a daily time step to predict the impact of climate, landuse, soil type, topographic characteristics, and land management practices on hydrology, sediment, nutrients, pesticides, and bacteria in large ungauged watersheds [18] [19]. SWAT estimates PET using physically based methods that are based on historical weather variables and plant/soil available water. The methods included are Hargreaves, Priestley-Taylor, and Penman-Monteith.

Runoff is estimated by the SCS Curve Number (CN) method (SCS, 1986) or the Green & Ampt method [20]. If the Green and Ampt method is used to calculate surface runoff, the model calculates canopy storage and evaporates any readily available water present in the canopy. In contrast, the CN method lumps canopy interception, surface storage and infiltration in its initial abstraction term. After calculating runoff, SWAT calculates the amount of transpiration under ideal conditions as a function of available water in the soil. Sublimation will occur if snow is present; otherwise, the actual amount of water evaporated from the soil is calculated as a function of soil depth, water content and the above-ground biomass.

SWAT simulates the water balance according to Equation (1), which includes AET, canopy interception, plant transpiration and soil evaporation, surface runoff, and vertical water movement in the unsaturated soil zone to the ground water:

$$\mathrm{SW}_i = \mathrm{SW}_0 + \left(\mathrm{R}_i + \mathrm{I}_i\right) - \left(\mathrm{Q}_i + \mathrm{AET}_i + \mathrm{PER}_i\right) \tag{1}$$

where, SW_i is the final soil water content (mm) in day i, SW_0 is the initial soil water content (mm), i is the time (days), R_i is the amount of precipitation (mm·day^{-1}), I_i is the amount of daily irrigation (mm·day^{-1}), Q_i is the amount of surface runoff (mm·day^{-1}), AET_i is the amount of actual evapotranspiration (mm·day^{-1}), and PER_i is the amount of water percolating through the soil profile (mm·day^{-1}).

2.2. PET Methods

The Penman-Monteith method [21] (Equation (2)) is a theoretically based approach that incorporates energy and aerodynamic considerations [22]. It includes a measure of the resistance to the diffusion of water vapor into the Penman's equation, which is a radiation-aerodynamic combination equation to predict evaporation from open water, bare soil, and grass [23]:

$$\lambda E = \frac{\Delta \times \left(H_{\mathrm{net}} - G\right) + \rho_{\mathrm{air}} \times c_p \times \left(e_z^0 - e_z\right) / r_a}{\Delta + \gamma \times \left(1 + \frac{r_c}{r_a}\right)} \tag{2}$$

where: λ is the latent heat flux density (MJ·m^{-2}kg^{-1}), E is the depth rate evaporation (mm·day^{-1}), Δ is the slope of the saturation vapor pressure-temperature curve (kPa˚C^{-1}), H_{net} is the net radiation (MJ·m^{-2}d^{-1}), G is the heat flux density to the ground (MJ·m^{-2}d^{-1}), ρ_{air} is the air density (kg·m^{-3}), c_p is the specific heat constant pressure (kPa·kg^{-1}˚C^{-1}), e_z^0 is the saturation vapor pressure of air at height z (kPa), e_z is the water vapor pressure of air at height z (kPa), γ is the psychometric constant (kPa˚C^{-1}), r_c is the plant canopy resistance (s·m^{-1}), and r_a is the diffusion resistance of the air layer (aerodynamic resistance) (s·m^{-1}).

The Priestley-Taylor method [24] (Equation (3)) is an energy-based approach. According to Jensen *et al*. [16] under wet conditions, evaporation from surfaces could be estimated using a simplified version of the Penman equation, in which the aerodynamic was deleted and the energy term is assumed to be a constant fraction $\alpha_0 = 1.28$.

$$\lambda E_0 = \alpha_0 \times \frac{\Delta}{\Delta + \gamma} \times \left(H_{\mathrm{net}} - G\right) \tag{3}$$

where: λ is the latent heat of vaporization (MJ·kg^{-1}), E_0 is the PET (mm·d^{-1}), α_0 is a coefficient, Δ is the slope of the saturation vapor pressure-temperature curve (kPa˚C^{-1}), γ is the psychometric constant (kPa˚C^{-1}), H_{net} is the net

radiation ($MJ \cdot m^{-2}d^{-1}$), and G is the heat flux density to the ground ($MJ \cdot m^{-2}d^{-1}$). In semiarid conditions this equation will underestimate PET.

The Hargreaves method [25] (Equation (4)) was originally derived from eight years of cool season Alta fescue grass lysimeter data from Davis, CA. According to Hargreaves and Allen [23] the main advantage of the Hargreaves approach to the other methods is the reduced data requirement.

$$\lambda E_0 = 0.002 \times H_0 \times \left(T_{\max} - T_{\min}\right)^{0.5} \times \left(\overline{T}_{av} + 17.8\right) \tag{4}$$

where: λ is the latent heat of vaporization ($MJ \cdot kg^{-1}$), E_0 is the PET ($mm \cdot d^{-1}$), H_0 is the extraterrestrial radiation ($MJ \cdot m^{-2}d^{-1}$), $T_{\max}$ is maximum air temperature for a given day (˚C), $T_{\min}$ is minimum air temperature for a given day (˚C), and T_{av} is the mean air temperature for a given day (˚C).

The HC&S method (Equation (5)) is specific for sugarcane and also site-specific to the central isthmus of Maui. It was developed to take into account that evapotranspiration is greatly modified by the marine surroundings and the topographic characteristics of the Island of Maui. The HC&S method to calculate PET is an empirical relationship that relates extensive pan evaporation data collected in the central isthmus of Maui [26] and locally measured meteorological parameters, such as air temperature, humidity, solar radiation and wind.

This method calculates PET by including a coefficient that multiplies the saturation vapor pressure, average actual vapor pressure, the slope of the saturation vapor pressure, a weighting function for temperature, net radiation expressed as equivalent evaporation and wind function.

$$E_0 = C \times W \times H_{\text{net}} + C \times (1 - W) \times \left(e_z^0 - \mathrm{e}_z\right) \times V_f \tag{5}$$

where E_0 is the PET ($mm \cdot d^{-1}$), C is a correction coefficient, H_{net} is the net radiation expressed in equivalent evaporation ($mm \cdot d^{-1}$), W is a weighting function for temperature, e_z^0 is the saturation vapor pressure of air at average temperature (kPa), e_z is the actual water vapor pressure of the air (kPa), and V_f is a wind function.

The correction coefficient (C) is calculated with a polynomial equation that includes eight coefficients and the ratio of average diurnal and nocturnal wind speed, solar radiation expressed in equivalent evaporation, and the mean wind speed. PET is multiplied by a crop coefficient (K_c) to calculate AET. To account for seasonal differences in crop growth and AET, two different crop coefficient curves are used depending on the time of planting.

3. Study Area

The study area is located on the Island of Maui, Hawaii (20˚54' latitude and 156˚26' longitude) (**Figure 1**) and consists of sugarcane fields (184.3 km^2) that lie on elevations between sea level and 332 m. The climate of Maui is controlled primarily by topography and the position of the North Pacific anticyclone and other migratory weather systems relative to the island [11]. The climate is characterized by mild temperatures, cool and persistent trade winds, a rainy winter season from October through April, and a dry summer season from May through September [8] [27]. Solar energy and length of day are relatively uniform throughout the year and the surrounding ocean provides moist air and keeps temperatures fairly constant without extremes throughout the year [27]. Mean annual precipitation on Maui Island ranges from 7000 mm to 400 mm or less [28]. According to NOAA [29], based on a 30-year dataset from the Kahului Station, Maui's Central Valley, where the HC&S Co. is located, receives an average rainfall of 453 mm per year and has an average daily temperature of 24.3˚C (ranges from 19.7˚C to 29.0˚C) and an average wind velocity of 5.7 $m \cdot s^{-1}$. Relative humidity ranges from 53% to 81%.

Two fields were selected for this analysis: 905 and 415. They are located in contrasting micro-climates and landscapes. Field 905 is located at a lower elevation (31.0 m a.s.l.) with a slope of 4.3%. The soil texture is classified as silt-loam and the soils are in hydrologic group B. In contrast, Field 415 is located at a higher elevation (195.4 m a.s.l.) with a slope of 6.0%. The soil texture is classified as silty-clay-loam and the soil belongs to hydrologic group C [30]. Solar radiation (**Figure 2(a)**), wind velocity (**Figure 2(b)**), average temperature (**Figure 2(c)**) and relative humidity (**Figure 2(d)**) are plotted for both fields. There are no significant differences between fields 415 and 905 with regard to average temperature (23.7˚C and 23.6˚C), relative humidity (0.71 and 0.68), and solar radiation (18.9 and 20.0 $MJ \cdot m^{-2}$). However, wind velocity shows significant differences between both fields (2.5 and 5.8 $m \cdot s^{-1}$), with higher speeds found in Field 905. Relative differences for average temperature, relative humidity and solar radiation are: 2.8%, 5.9% and 2.2% respectively, while the relative difference for wind velocity is 54.9%. Temperatures and humidity are higher at Field 415 while solar radiation and wind speed

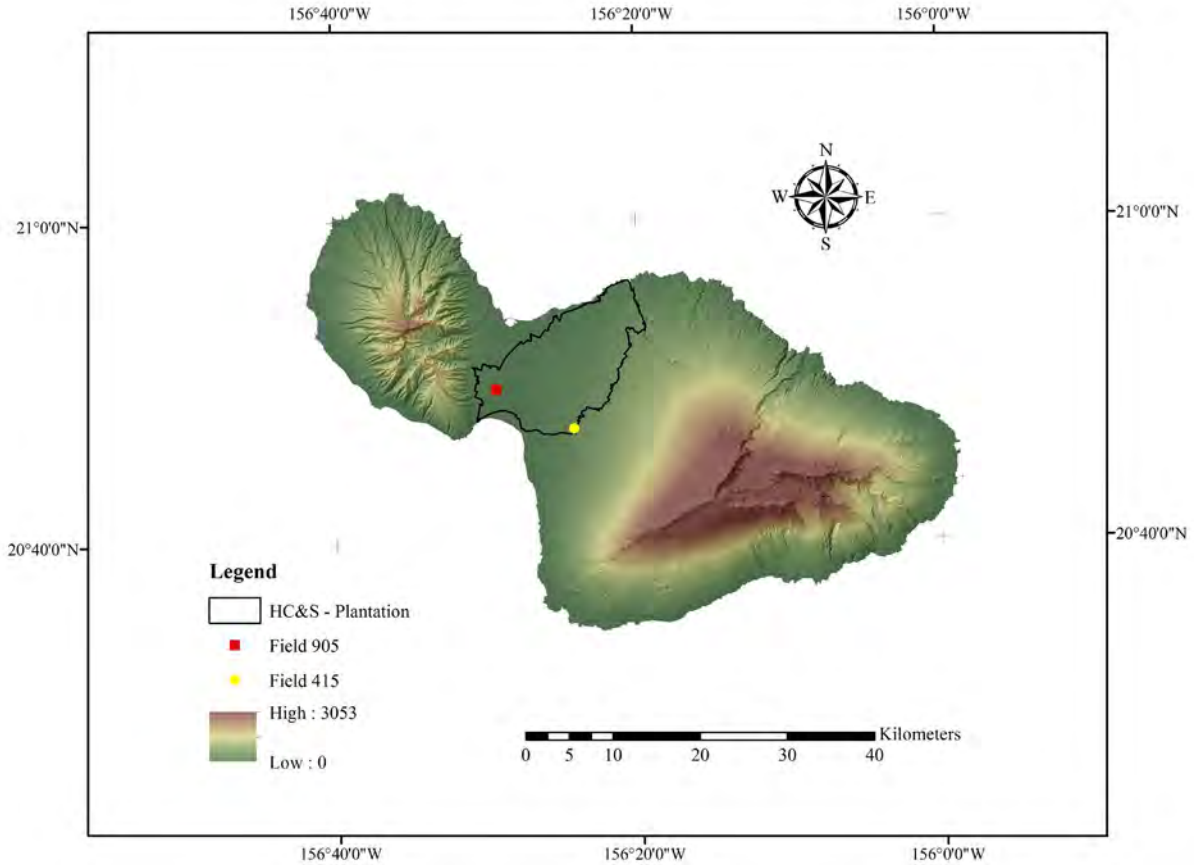


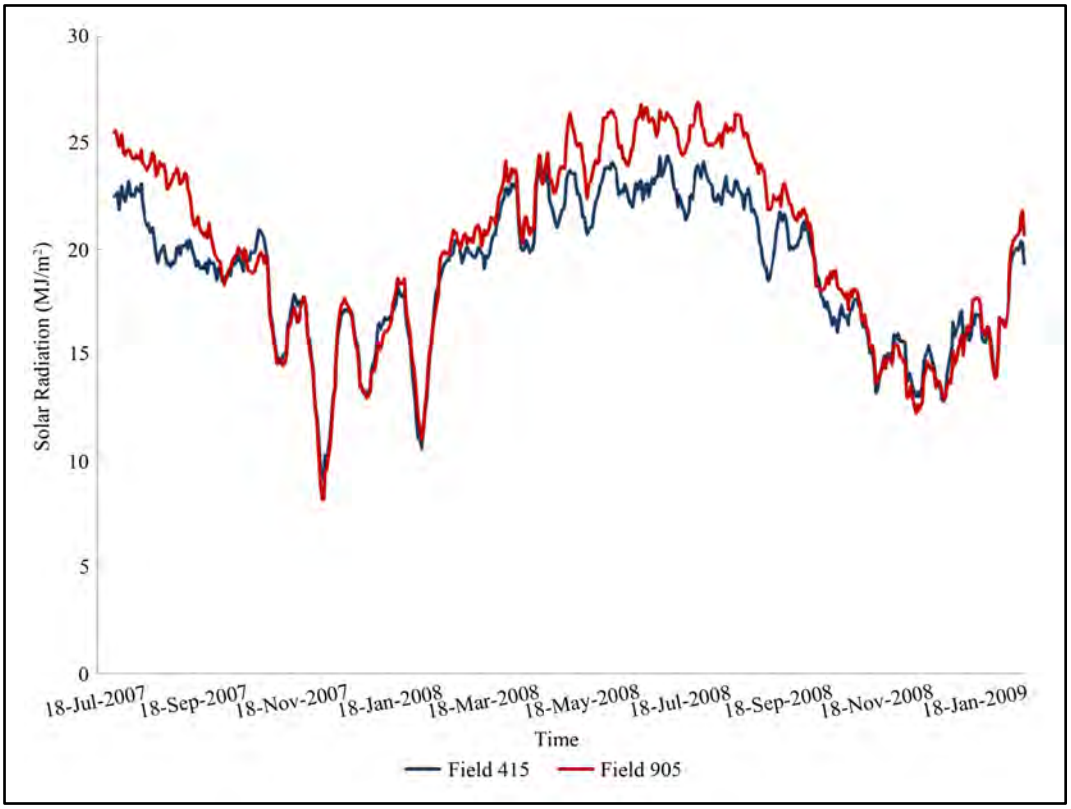
Figure 1. Location of the HC&S plantation on the Island of Maui, Hawaii.

are higher at Field 905. On Field 415, the sugarcane was planted in winter, while on Field 905 the crop was established in summer.

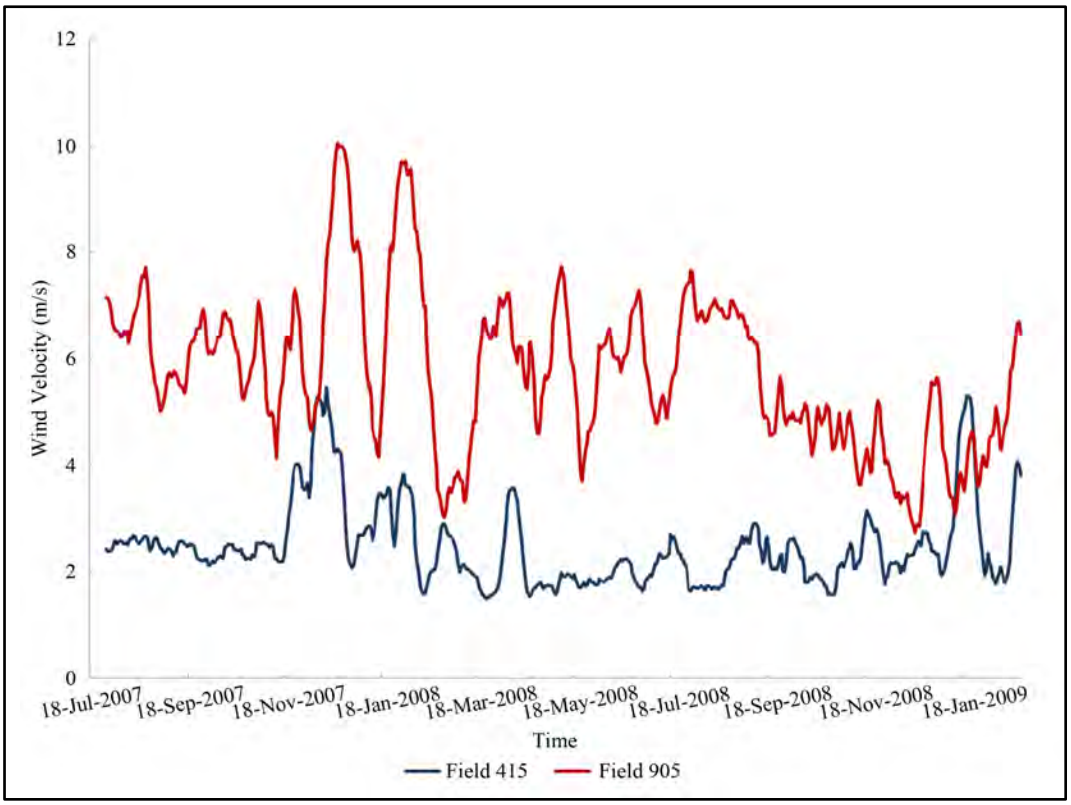
3.1. Input Data and Model Setup

The Digital Elevation Model (DEM) with a resolution of 10 m (1/3 arc-second) was acquired from the National Elevation Dataset (NED) [31] (available at http://viewer.nationalmap.gov/viewer/). Detailed soil map and properties for the study area were obtained from the Natural Resources Conservation Service (NRCS)—Soil Survey Geographic (SSURGO) Database (Soil Survey Staff NRCS-USDA, 2011) available at http://soildatamart.nrcs.usda.gov. The soils in the HC&S plantation area are classified as Mollisols (46.3%), Andisols (15.4%) and Aridisols (15.1%), Oxisols (10.4%), Entisols (6.0%), Inceptisols (4.2%) and Ultisols (2.3%). The landuse map and related information were obtained from the United States Geological Service (USGS) Land Cover Institute (LCI) [32] available at the USGS-Seamless Data Warehouse (http://seamless.usgs.gov/) with a resolution of 30 m (1 arc-second). The agricultural land was characterized as a 2-year sugarcane crop. The ArcGIS Interface for SWAT2012 was used to delineate the boundaries of 701 sugarcane plots, defining each plot as an individual Hydrologic Response Unit (HRUs) with sizes ranging from 1.4 to 166.0 ha.

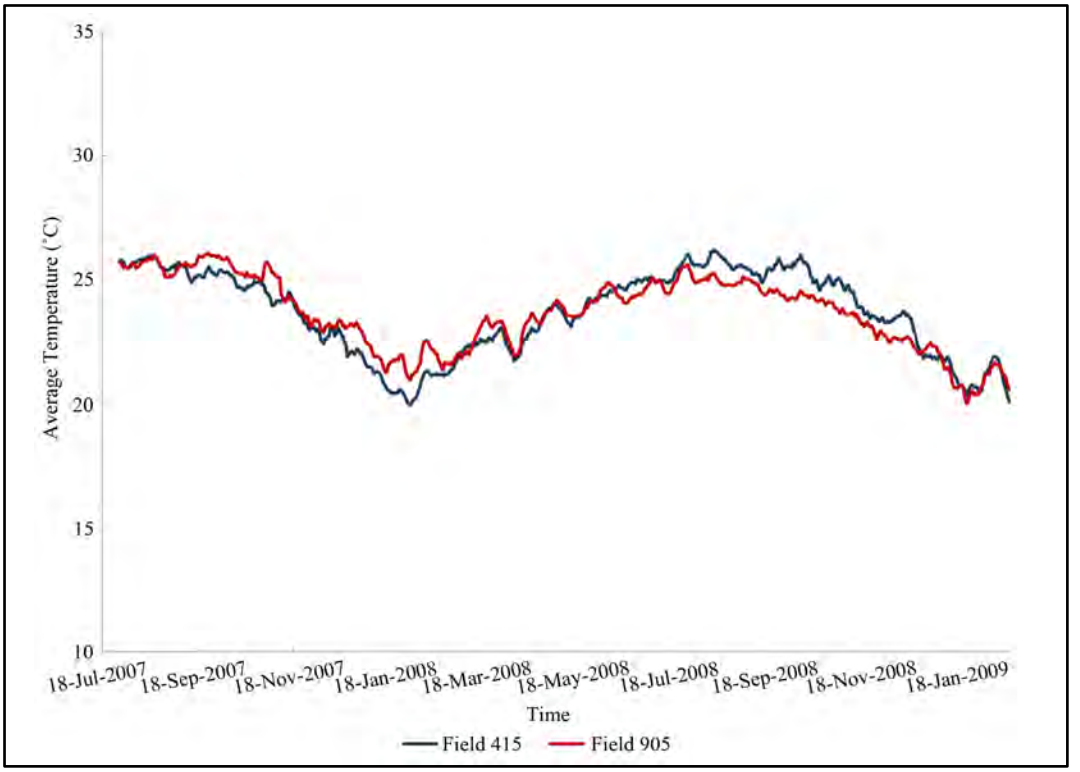
The model uses a 12-year dataset of daily climatic records from 39 rain gauges and 12 weather stations maintained by HC&S. The climatic variables included are precipitation, minimum and maximum temperature, relative humidity, solar radiation and wind speed. Missing values in the dataset were simulated by the model's built-in weather generator based on the weather statistics of the study area. HC&S applies water to the sugarcane fields through a drip irrigation system. The company maintains records of the applied volumes of water and the date of irrigation for each individual field. The SWAT model source code was modified to automatically read a database of dates and measured volumes of water applied to each field for irrigation purposes. For this study, historical daily irrigation data from 2003 to 2012 were acquired from the HC&S archive. Based on data availa-


30
25
20
15
10
5
0
Solar Radiation (MJ/m²)
18-Jul-2007
18-Sep-2007
18-Nov-2007
18-Jan-2008
18-Mar-2008
18-May-2008
18-Jul-2008
18-Sep-2008
18-Nov-2008
18-Jan-2009
Time
Field 415
Field 905

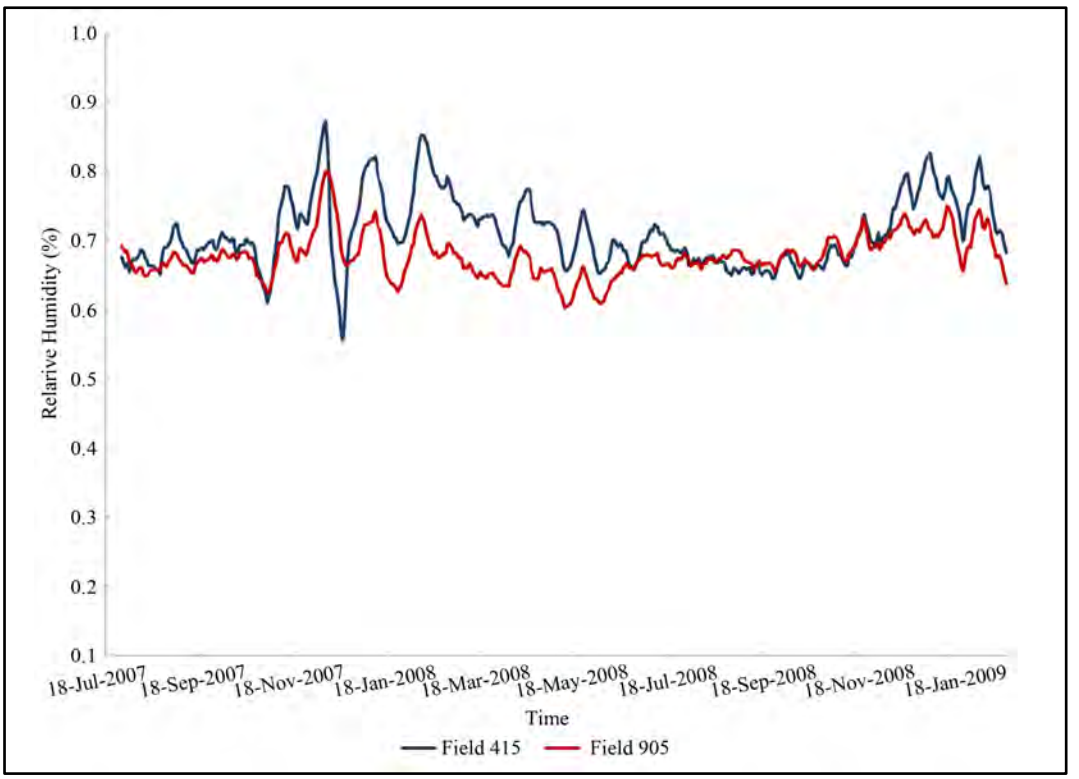
(a)


12
10
8
6
4
2
0
Wind Velocity (m/s)
18-Jul-2007
18-Sep-2007
18-Nov-2007
18-Jan-2008
18-Mar-2008
18-May-2008
18-Jul-2008
18-Sep-2008
18-Nov-2008
18-Jan-2009
Time
Field 415
Field 905

(b)



(c)



(d)

Figure 2. Measured climatic variables for the crop period at fields 415 and 905: (a) Solar radiation ($MJ \cdot m^{-2}$); (b) Wind velocity ($m \cdot s^{-1}$); (c) Average temperature (˚C); and (d) Relative humidity (%).

bility, the simulation period was set up for 10 years (2003-2012) with the first year of simulation set as a spin-up period. However, the analysis of model output was performed for the crop period that comprises the years 2007 through 2009.

The water balance analysis was done evaluating surface runoff, percolation, lateral flow, precipitation, irrigation and available soil water. In addition, the relative difference between the predicted average annual PET and measured pan evaporation was calculated for the four PET methods included in this study. Measurements of pan evaporation in Hawaii began in 1894 and include intermittent observations for over 200 sites [26]. Most sites had standard, galvanized Class A pans on the surface, but many were later replaced with stainless steel pans to avoid corrosion and set on 1.52 m (equivalent to 5 ft) high platforms. The pan evaporation data used in this study ware corrected to account for differences due to height and pan material. A total of 12 galvanized Class A pans provided a data set with accumulated monthly and annual evaporation for the interval between 1963 and 1983. There were no Pan A measurements at the fields evaluated in this study; therefore, the closest available information to each field was used for comparison.

3.2. Crop Yield Calibration

The water balance in agricultural watersheds is influenced by crop production [33]. Crop dry matter production in Hawaii depends on the amount of water available from rainfall and irrigation [34]. The yield of a given crop can generally be described as a function of cumulative AET [35]. The AET has been shown to be directly related to dry biomass production when factors such as fertility, sunshine, temperature, and soil moisture are not limiting [36]. The following SWAT parameters were used for the purpose of manually calibrating crop yield: the soil evaporation compensation coefficient (ESCO), the plant uptake compensation factor (EPCO) and the biomass-energy ratio (BIO_E) ($kg \cdot ha^{-1}/MJ \cdot m^{-2}$). ESCO adjusts the depth distribution of soil evaporation to meet soil evaporative demand and varies between 0.01 and 1.0. As the value of ESCO is reduced, the model is able to evaporate more water from deeper layers in the soil profile. EPCO compensates water between soil horizons to meet the potential water uptake and ranges from 0.01 to 1.0. As EPCO approaches 1.0, the model allows more of the water uptake demand to be met by lower layers in the soil. BIO_E is the amount of dry biomass produced per unit intercepted solar radiation in ambient CO_2 and varies between 10 and 90. The greater BIO_E, the greater the potential increase in total plant biomass on a given day. An important parameter governing crop growth in SWAT is the leaf area index (LAI), which controls the amount of light intercepted by the plant and converted to biomass. Also, LAI is used to calculate AET. When LAI is larger than 3, SWAT assumes that AET equals PET. To calibrate the LAI curve calculated by SWAT, it was compared to the crop coefficient curve used by the HC&S method. To evaluate crop yields simulated by SWAT, they were compared to field measurements of crop yield obtained between 2003 and 2012.

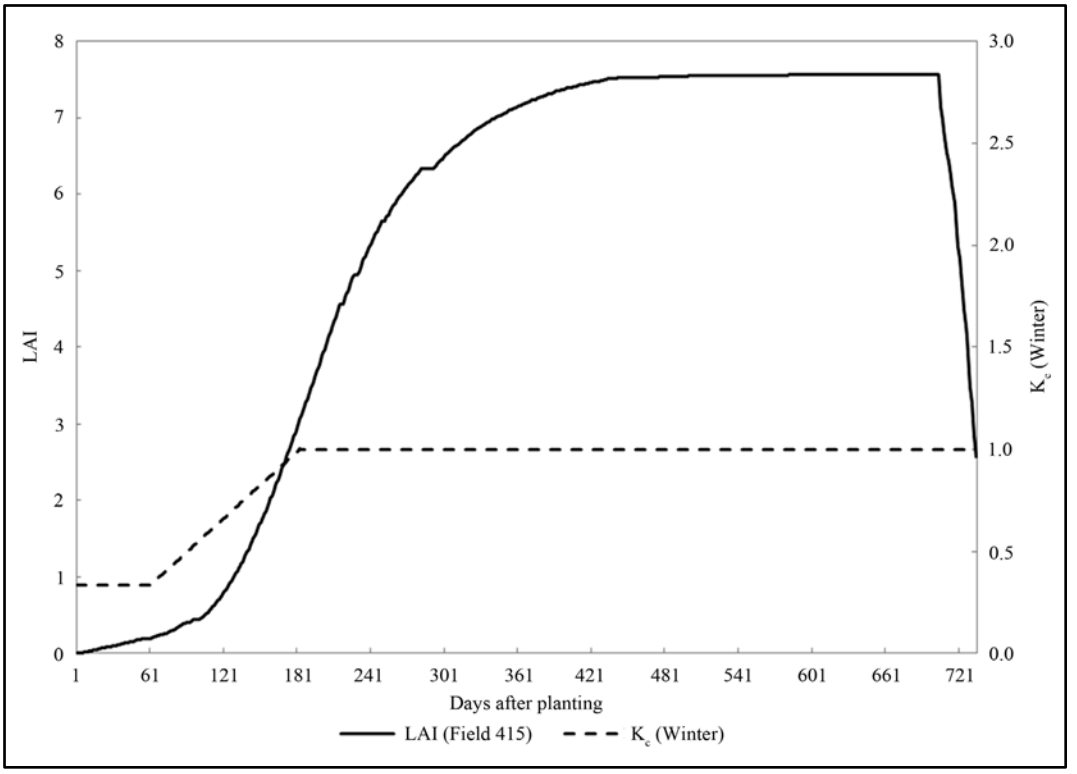
4. Results

4.1. Calibration of Sugarcane Yield

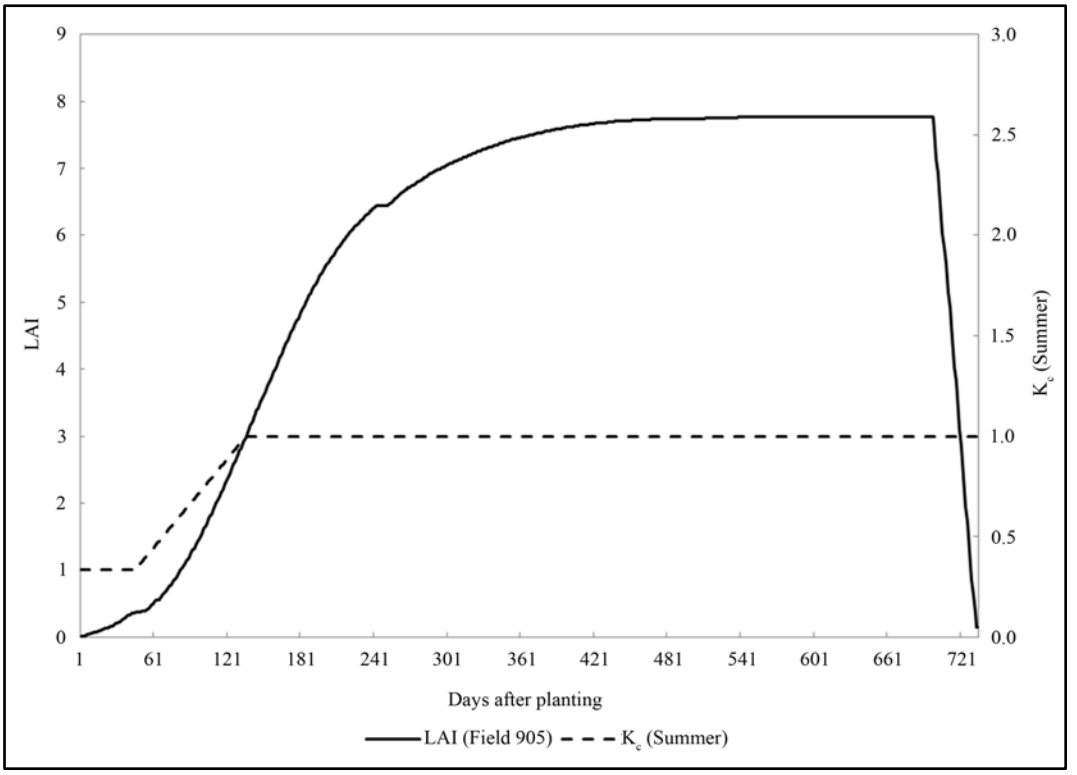
While the default values for the parameters ESCO and EPCO of 0.95 and 1.0 and BIO_E ($kg \cdot ha^{-1}/MJ \cdot m^{-2}$) of 25 were used to initialize the model; the calibrated values for the same parameters were 0.5, 0.98, and 22.5, respectively. By calibrating BIO_E, the leaf area index curve break point (LAI = 3) was adjusted to the break point of the crop coefficient (K_c = 1) used by HC&S for both winter (Field 415) and summer (Field 905) planting (**Figure 3(a)** and **Figure 3(b)**). Simulated average crop yields for the 2003-2012 period of time are 71.7 $t \cdot ha^{-1}$ (±11.3 $t \cdot ha^{-1}$) and 77.7 $t \cdot ha^{-1}$ (±12.0), for fields 415 and 905 respectively. Field measurements of crop yield for fields 415 and 905 provide an average value of 71.3 $t \cdot ha^{-1}$ (±7.7 $t \cdot ha^{-1}$) and 77.3 $t \cdot ha^{-1}$ (±10.0 $t \cdot ha^{-1}$), respectively. Predicted crop yields were not different from measured values for both fields (relative differences lower than 1%). No other goodness-of-fit metrics were used in this study due to limitations in measured data. Successful calibration of crop yield guaranteed that AET was adequately represented by the model and varied accordingly as a function of climatic variables and crop development. In addition, properly predicted AET assured appropriate partitioning of the remaining components of the water budget (**Figure 3(a)**, **Figure 3(b)**).

4.2. Potential Evapotranspiration (PET)

The PET values estimated by the four methods shared a concurrent spatial pattern and temporal trend. Calcula-



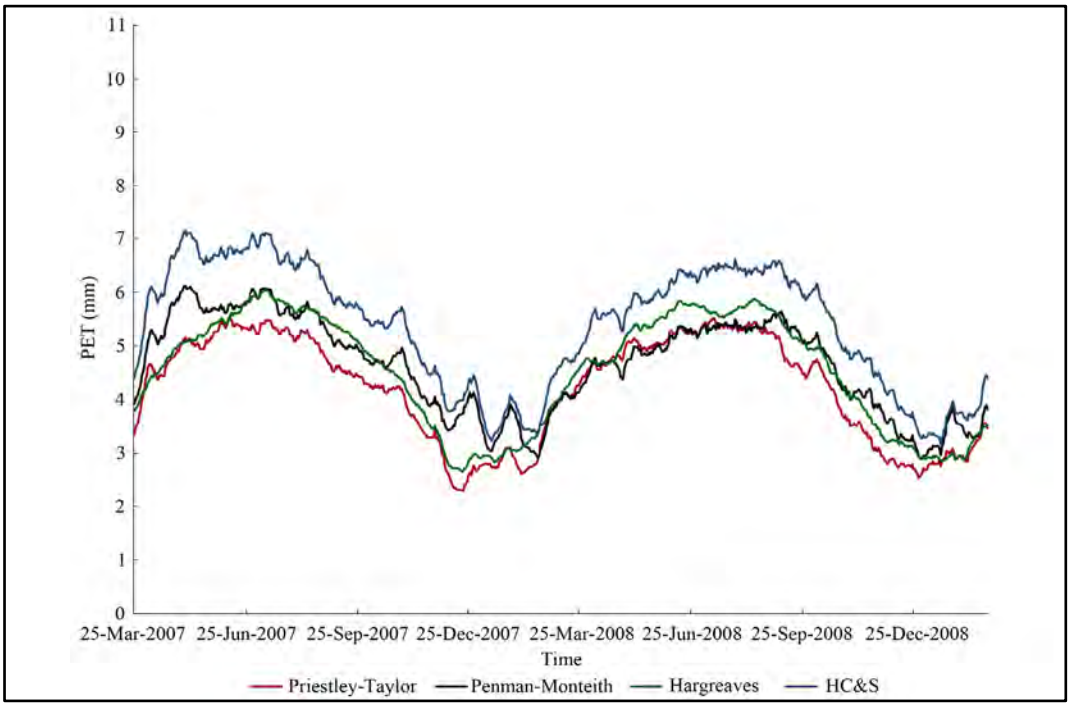
(a)



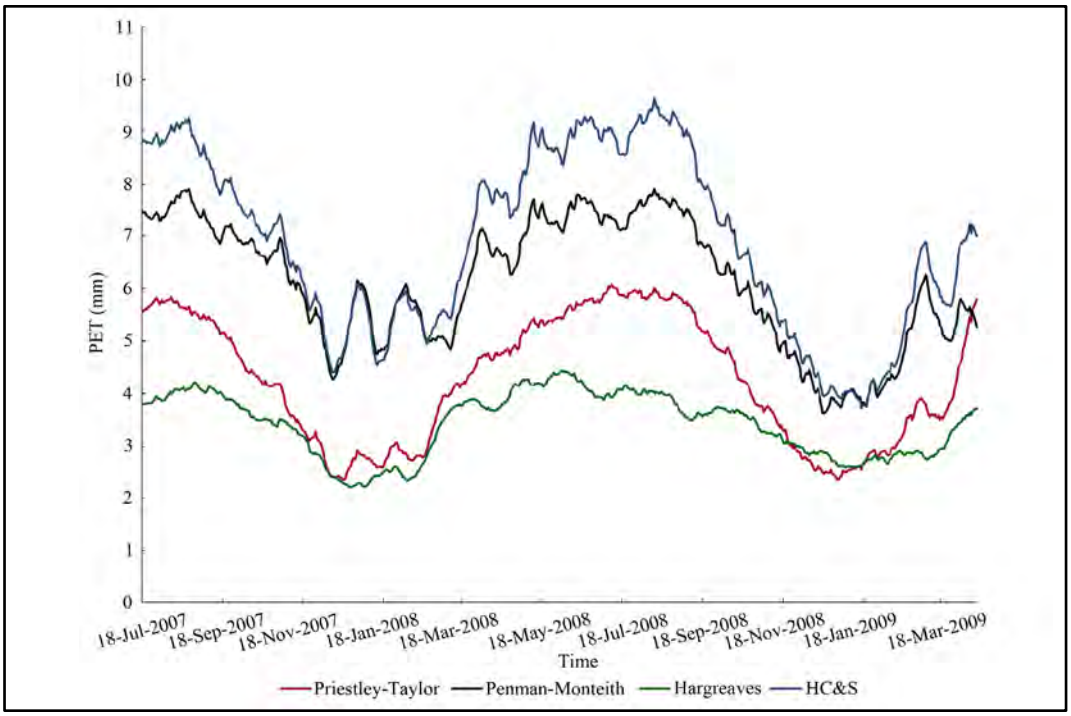
(b)

Figure 3. Leaf area index (LAI) compared to crop coefficient (K_c) for (a) the summer crop on field 415 and (b) the winter crop on field 905.

tion of PET with Hargreaves or Priestley-Taylor produced values that strongly deviate from the HC&S and Penman-Monteith methods. These differences are more obvious during the summer months (May to October) than during the winter months (November to April). A comparison of daily series of PET obtained with different methods is presented in **Figure 4(a)**, **Figure 4(b)**. At Field 415, predicted annual PET is 1964.3 mm using the



(a)



(b)

Figure 4. Comparison of PET calculated by the four tested methods at Fields 415 (a) and 905 (b).

HC&S method, 1693.6 mm using Penman-Monteith, 1656.5 mm using Hargreaves, and 1542.2 mm using Priestley-Taylor. At the nearest site, measured pan evaporation has an average of 2265.5 mm ± 193.3 mm. The relative errors of the simulated values with respect to pan measurements are 13.3% for the HC&S method, 25.2% for Penman-Monteith, 26.9% for Hargreaves, and 31.9% for Priestley-Taylor. At Field 905, PET calculated using the HC&S, Penman-Monteith, Priestley-Taylor, and Hargreaves methods is 2320 mm, 2059.5 mm, 1447.2 mm, and 1157.9 mm, respectively. Measured pan evaporation nearest to Field 905 has an average of 2466.55 mm ± 244.5 mm. The relative errors are 5.9%, 16.5% mm, 41.3%, and 53.1% for the HC&S, Penman-Monteith, Priestley-Taylor, and Hargreaves methods, respectively.

4.3. Actual Evapotranspiration (AET)

SWAT calculates AET based on LAI or the crop coefficient method until LAI equals 3. After that, the crop is assumed to be fully developed and the model assumes that all PET is partitioned to plant water uptake and soil evaporation is assumed to be negligible. However, regardless of the crop stage, soil moisture is the limiting factor that determines the volume of water that is evaporated in a given day. This critical process is well represented in SWAT. **Figure 5** shows the effect of shorter periods of low soil water contents, which reduce the AET rate to the minimum possible. A comparison of AET methods for both fields 415 and Field 905 are presented in **Figure 5(a)**, **Figure 5(b)**. Annual AET values predicted by SWAT range from 1081 mm to 1544 mm.

Table 1(a) and **Table 1(b)** show the average AET values and the corresponding standard deviations for four different crop stages. The crop cycle for sugarcane was divided into growth stages defined by the break points of the crop coefficient curves used by HC&S for winter and summer plantings. At Field 415 the highest average values of AET were found during the germination and establishment phase for all methods, while at Field 905 the highest average AET values correspond to the grand growth phase. One reason for this behavior is that both fields experienced several days of water stress during the grand growth phase, which caused AET to stop completely.

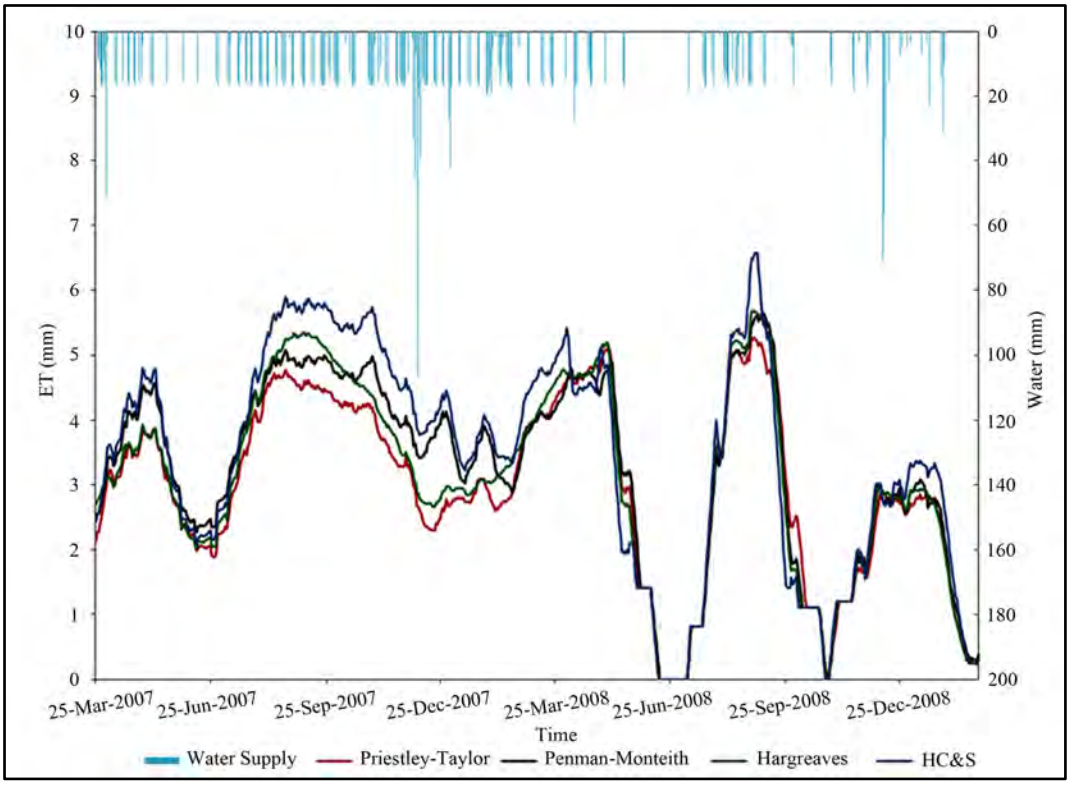
In addition, the ratio between AET estimated by the Penman-Monteith and HC&S methods were calculated for the period of time where PET is all partitioned to plant uptake and no soil evaporation occurs (grand growth phase). The ratio AET/PET can be interpreted as being equivalent to the pan coefficients, which are ratios of PET to pan evaporation for a given vegetative land cover. The calculated ratios are 1.16 ± 0.11 and 1.14 ± 0.12 for fields 415 and 905, respectively. The ratios found in this study are consistent with reported coefficients for sugarcane fields under Hawaiian conditions. USGS [37] used a sugarcane pan coefficient of 1.18 during the middle stage of growth. Reported by McMahon *et al*. [2], sugarcane can have a pan coefficient as high as 1.2.

4.4. Water Balance

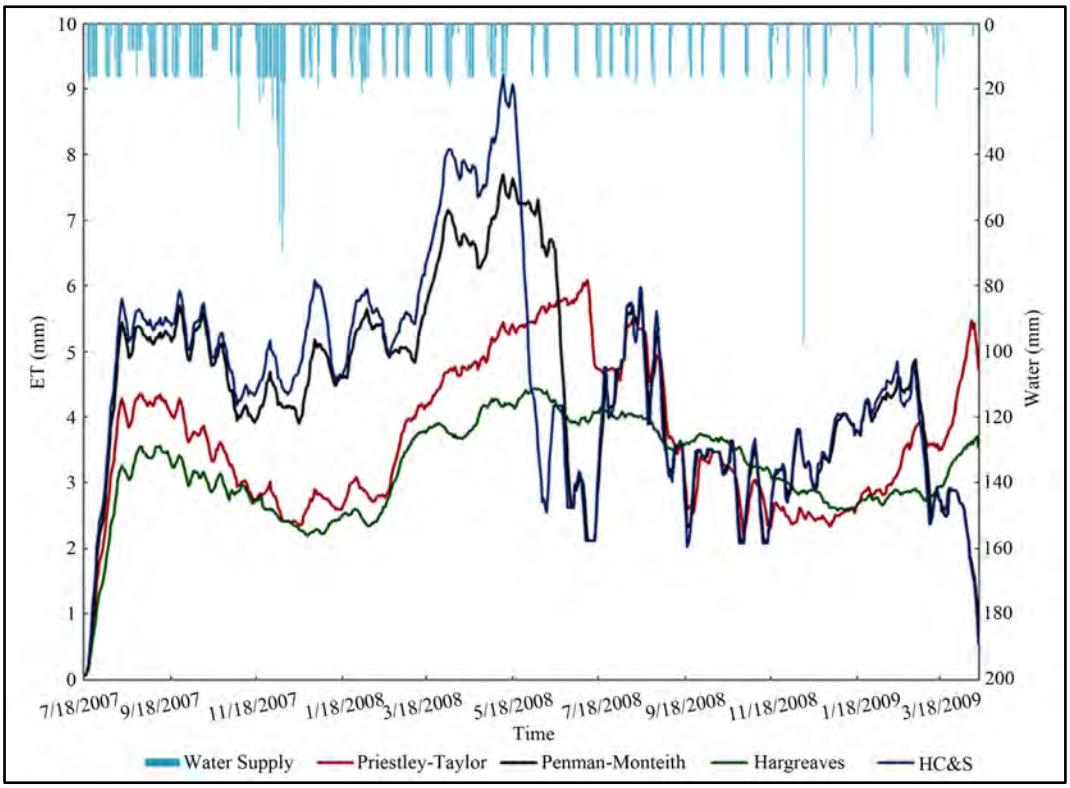
For hydrologic studies, the major purpose of estimating AET is to determine actual water that will be lost from the system (**Figure 6**). The SWAT simulated water balance for the crop period (2007-2009) is shown in **Table 2**. The study site at Field 415 receives a total of 3149 mm (686 mm precipitation + 2463 mm irrigation). Field 905 receives a total of 2079 mm (675 mm precipitation + 2863 mm irrigation). For both fields, precipitation has a very small contribution to the water budget (27.8% and 23.4%). Most of the water supply was provided by irrigation (72.2% and 76.6%). While runoff and lateral flow explain between 2.4% to 5.1% of the water balance, AET and percolation account for 94.9% to 97.6% of the water balance calculated with the HC&S method. According to the four applied methods Priestley-Taylor, Penman-Monteith, Hargreaves, and HC&S, AET accounts for 66%, 71%, 69%, and 76% and for 67%, 79%, 58%, and 81% of the total water supply at Field 415 and Field 905, respectively. The relative contribution of the runoff is very small for both fields (0.4% to 4.3%). Lateral flow also shows little variation among different methods (7.8% - 16.4%). The proportions of percolated water represent 26.5%, 24.4%, 32.1% and 16.9% of the water supply calculated with the Priestley-Taylor, Penman-Monteith, Hargreaves, and HC&S methods respectively.

5. Discussion

Comparison of the results of PET estimates using the four methods facilitated the identification of the most suitable method given a specific level of data availability and considering the specific characteristics of the growing environment. The Hargreaves method, which relies only on air temperature, failed to represent refer-



(a)



(b)

Figure 5. Comparison of actual evapotranspiration on Fields 415 (a) and 905 (b).

Table 1. Average and standard deviation of evapotranspiration by method and crop stage expressed in mm·day^{-1} for Fields 415 (a) and 905 (b).

(a)

Crop Phase	Hargreaves		Priestley-Taylor		Penman-Monteith		HC&S	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Germination	3.6	1.3	4.1	1.5	3.6	1.2	4.3	1.9
Tillering	3.1	1.4	3.4	1.4	3.3	1.5	3.6	1.8
Grand Growth	3.2	1.8	3.5	1.9	3.4	1.9	3.8	2.3
Ripening	2.3	2.0	2.3	2.2	2.3	2.1	2.4	2.5
All Crop Period	3.0	1.8	3.2	2.0	3.1	1.9	3.4	2.4

(b)

Crop Phase	Hargreaves		Priestley-Taylor		Penman-Monteith		HC&S	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Germination	3.9	1.4	4.9	1.8	3.1	1.1	5.2	2.0
Tillering	3.1	1.0	4.7	1.4	2.7	0.7	5.1	1.6
Grand Growth	4.5	1.8	5.1	3.0	3.8	0.6	5.1	3.8
Ripening	3.2	1.5	3.2	2.3	3.0	0.6	3.2	2.6
All Crop Period	3.8	1.6	4.4	2.6	3.3	0.8	4.5	3.1

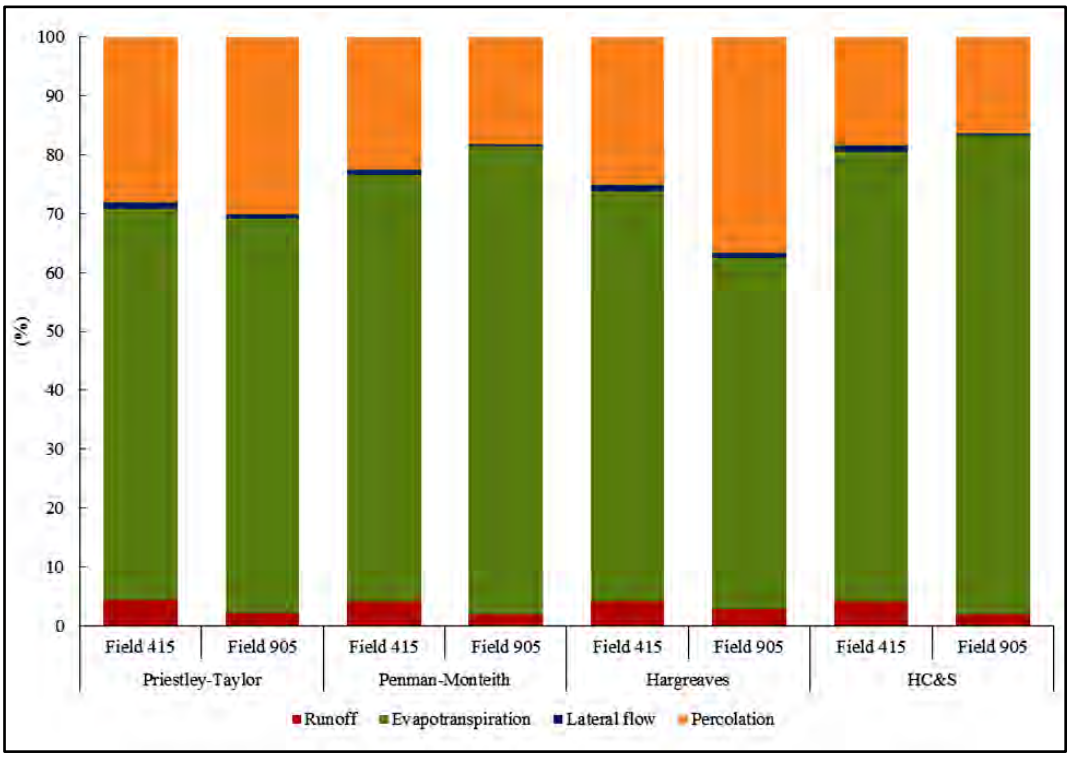


Figure 6. Water balance for Fields 415 and 905 expressed in percent of water supply.

Table 2. Water balance for Fields 415 (a) and 905 (b) expressed in mm of water. Results of the 2-year crop period.

(a)

Component	Priestley-Taylor	Penman-Monteith	Hargreaves	HC&S
Total Water Inflow	**3166.9**	**3162.4**	**3165.1**	**3147.6**
Soil Available Water Content	17.9	13.4	16.1	−1.4
Total Water Supply	3149.0	3149.0	3149.0	3149.0
Precipitation	685.7	685.7	685.7	685.7
Irrigation	2463.2	2463.2	2463.2	2463.2
Total Water Outflow	**3128.5**	**3132.8**	**3130.1**	**3145.0**
Runoff	135.7	131.8	132.2	129.4
Evapotranspiration	2079.5	2264.7	2175.8	2403.4
Lateral Flow	35.7	32.8	34.2	30.8
Percolation	877.7	703.5	787.8	581.5

(b)

Component	Priestley-Taylor	Penman-Monteith	Hargreaves	HC&S
Total Water Inflow	**3567.5**	**3567.9**	**3644.0**	**3567.6**
Soil Available Water Content	0.0	0.4	76.5	0.0
Total Water Supply	3567.6	3567.6	3567.6	3567.6
Precipitation	675.8	675.8	675.8	675.8
Irrigation	2891.7	2891.7	2891.7	2891.7
Total Water Outflow	**3561.5**	**3561.1**	**3485.3**	**3561.2**
Runoff	75.1	67.5	95.8	67.4
Evapotranspiration	2389.7	2828.8	2083.5	2896.9
Lateral Flow	25.0	17.6	28.5	16.4
Percolation	1071.7	647.2	1277.5	580.4

ence evapotranspiration in irrigated regions of Maui under windy conditions. In that regard, Hargreaves and Allen [23] stated that daily estimates by the Hargreaves equation are subject to error because of the influence of the temperature range caused by large variations in wind speed. Both Hargreaves and Priestley-Taylor methods produced predictions that tended to be smaller than those predicted by the Penman-Monteith and HC&S methods. Dingman [8] concluded that temperature is not a reliable indicator of sunlight and generally is a poor predictor of pan evaporation because air temperature in Hawaii is greatly modified by the marine surroundings. Under the conditions of the study site, whenever soil water content is not the limiting factor, differences in wind velocity account for most of the variation in PET calculated with different methods. In general, PET methods, that require wind and especially humidity data, such as Penman-Monteith and HC&S, will simulate windy and humid conditions more accurately [14] [38]. The observed trends of AET as a function of crop growth stage failed to match the trends reported in other publications in which AET rises from germination phase through tillering and reaches the maximum value at the grand growth phase to then decline during the ripening phase. For instance, Freire [39] reported AET values of 3.0 mm·day^{-1} for the germination phase, 3.8 mm·day^{-1} for tillering phase, 5.1 mm·day^{-1} for the grand growth period, and 3.1 mm·day^{-1} for the ripening phase. One reason for this result could be water stress. Sugarcane at both fields had to endure a lack of rainfall and irrigation for several days at late states of the crop development. As reported, AET in sugarcane fields is highly variable largely due to local cli-

matic conditions, hydrologic settings, and the type of production systems. However, predicted AET made by SWAT for the entire crop cycle with Penman-Monteith and HC&S methods in two different field conditions compared well to reported measured data of AET that ranges between 2.33 - 5.70 mm·day^{-1} [39]-[42].

Using the HC&S method, the proportion of percolated water (16.3% - 18.5%) compares reasonable well to 19% and 34% of recharge found as a proportion of the total water input by Izuka *et al*. [43] and Shade [44]. In addition, AET proportions calculated with the HC&S method (76.4% - 81.3%) are also supported by the comparisons made with measured Pan A evaporation datasets. Accordingly, it can be assumed that SWAT properly represents the system under analysis when using the HC&S method to account for AET. HC&S managers use their own modified ET equation to plan irrigation. In both fields (415 and 905), the amounts of irrigation (2463.2 mm and 2896.9 mm), *i.e*. the water supply, and AET (2403.4 mm and 2896.9 mm), *i.e*. the demand, are similar.

6. Conclusions

Considering the important role that evapotranspiration plays in the water cycle, the appropriate selection of the PET method to estimate AET is of great importance. Commonly, the PET method is selected based on the availability of climatic datasets to feed the models. The lack of climatic variables limits the use of physically sound PET approaches. However, the selection of the PET method should rather be taken based on site characteristics; the use of a PET method that takes into account the dominant climatic variables is highly recommended. By ignoring the dominant weather factor, predicted PET can be meaningless and likely not representative of the environmental conditions that need to be assessed. Based on the results of this study, the HC&S method appropriately represents the specific climatic and environmental conditions of the central valley in Maui, in which HC&S sugarcane plantations are located. However because the HC&S method was developed for very specific conditions, the Penman-Monteith method is recommended for other parts of the Hawaiian Islands, where climatic conditions are dominated by wind characteristics. In order to represent local conditions, PET during the grand growth phase of sugarcane should be calculated multiplying the Penman-Monteith PET by a coefficient that ranges between 1.14 and 1.16.

The present study assessed the influences of PET methods on the water balance of sugarcane cropping system in the Hawaiian Island of Maui. The results suggests that the proportions of ET, percolated water, lateral flow and runoff compare reasonably well with results reported in other studies performed on the Island of Maui. Accordingly, the HC&S Company allocates water for irrigation based on an appropriate estimation of AET. However, additional work should be done to analyze the entire system that includes water collection from the ditch system (including bypass water), analysis of ground water recharge and pumping system and the water budget for the entire island.

Acknowledgements

This study was funded by the US Department of Navy, Office of Naval Research & USDA-ARS Bioenergy Project in Hawaii. The authors are grateful to Mae Nakahata from HC&S for providing research access and assistance and to the anonymous reviewers for their valuable suggestions to improve the paper.

References

[1] Grubert, E. (2011) Freshwater on the Island of Maui: System Interactions, Supply, and Demand. Master's Thesis, Environmental Water Resource Engineering, University of Texas at Austin, Austin.

[2] McMahon, T.A., Peel, M.C., Lowe, L., Srikanthan, R. and McVicar, T.R. (2012) Estimating Actual, Potential, Reference Crop and Pan Evaporation Using Standard Meteorological Data: A Pragmatic Synthesis. *Hydrology and Earth System Sciences*, **9**, 11829-11910. http://dx.doi.org/10.5194/hessd-9-11829-2012

[3] Lloyd, B.R., Davidson, J.R. and Hogg, H.C. (1972) Estimating the Productivity of Irrigation Water for Sugarcane Production in Hawaii. *Economic Research Service Technical Report No.* 56, USDA—Natural Resource Economics Division, 72.

[4] National Agricultural Statistics Service (NASS) (2013) National Statistics for Sugarcane. http://www.nass.usda.gov

[5] Baumgartner, A. and Reichel, E. (1975) The World Water Balance. R. Oldenbourg-Verlag, Munchen, Wien, 1-179.

[6] Irmak, S., Howell, T.A., Allen, R.G., Payero, J.O. and Martin, D.L. (2005) Standardized ASCE Penman-Monteith: Impact of Sum-Of-Hourly vs. 24-Hour Timestep Computations at Reference Weather Station Sites. *Transactions of the*

ASAE, **48**, 1063-1077. http://dx.doi.org/10.13031/2013.18517

[7] Wang, X., Melesse, A.M. and Yang, W. (2006) Influences of Potential Evapotranspiration Estimation Methods on Swat's Hydrologic Simulation in a Northwestern Minnesota Watershed. *Transactions of the ASABE*, **49**, 1755-1772. http://dx.doi.org/10.13031/2013.22297

[8] Dingman, S.L. (1994) Physical Hydrology. Macmillan College Publishing Company, New York, 575.

[9] Allen, R.G., Pereira, L.S., Raes, D. and Smith, M. (1998) Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements. FAO Irrigation and Drainage Paper 566, UN-FAO, Rome.

[10] McCuen, R.H. (1998) Hydrologic Analysis and Design. 2nd Edition, Prentice-Hall, Upper Saddle River.

[11] Giambelluca, T.W. and Nullet, D. (1992) Evaporation at High Elevations in Hawaii. *Journal of Hydrology*, **136**, 219-235. http://dx.doi.org/10.1016/0022-1694(92)90012-K

[12] Farahani, H.J., Howell, T.A., Shuttleworth, W.J. and Bausch, W.C. (2007) Evapotranspiration: Progress in Measurement and Modeling in Agriculture. *Transaction of the ASABE*, **50**, 1627-1638. http://dx.doi.org/10.13031/2013.23965

[13] Shih, S.F. (1987) Using Crop Yield and Evapotranspiration Relations for Regional Water Requirement Estimation. *Water Resources Bulletin—American Water Resources Association*, **23**, 435-442.

[14] Gracel, B. and Quickl, B. (1998) A Comparison of Methods for the Calculation of Potential Evapotranspiration under the Windy Semi-Arid Conditions of Southern Alberta. *Canadian Research Hydrology*, **13**, 9-19.

[15] Blumenstock, D.I. and Price, S. (1967) Climate of Hawaii. In: *Climates of the States*, *No.* 60-51, *Climatography of the United States*, US Department of Commerce, Washington DC.

[16] Jensen, M.E., Burman, R.D. and Allen, R.G. (1990) Evapotranspiration and Irrigation Water Requirements. American Society of Civil Engineers Manual and Reports on Engineering Practice No. 70, New York, 360.

[17] Bezuidenhout, C.N., Lecler, N.L., Gers, C. and Lyne, P.W.L. (2006) Regional Based Estimates of Water Use for Commercial Sugarcane in South Africa. *Water South Africa*, **32**, 219-222.

[18] Arnold, J.G. and Fohrer, N. (2005) SWAT2000: Current Capabilities and Research Opportunities in Applied Watershed Modeling. *Hydrolocical Processes*, **19**, 563-572. http://dx.doi.org/10.1002/hyp.5611

[19] Gassman, P.W., Reyes, M., Green, C.H. and Arnold, J.G. (2007) The Soil and Water Assessment Tool: Historical Development, Applications, and Future Directions. *Transactions of the ASABE*, **50**, 1211-1250. http://dx.doi.org/10.13031/2013.23637

[20] Green, W.H. and Ampt, G.A. (1911) Studies on Soil Physics, Part 1, the Flow of Air and Water through Soils. *Journal of Agricultural Science*, **4**, 11-24.

[21] Monteith, J.L. (1965) Evaporation and the Environment. 19*th Symposia of the Society for Experimental Biology*, **19**, 205-234.

[22] Sumner, D.M. and Jacobs, J.M. (2005) Utility of Penman-Monteith, Priestley-Taylor, Reference Evapotranspiration, and Pan Evaporation Methods to Estimate Pasture Evapotranspiration. *Journal of Hydrology*, **308**, 81-104. http://dx.doi.org/10.1016/j.jhydrol.2004.10.023

[23] Hargreaves, G.H. (1975) Moisture Availability and Crop Production. *Transactions of the ASAE*, **18**, 980-984. http://dx.doi.org/10.13031/2013.36722

[24] Priestley, C.H.B. and Taylor, R.J. (1972) On the Assessment of Surface Heat Flux and Evaporation Using Large-Scale Parameters. *Monthly Weather Review*, **100**, 81-82. http://dx.doi.org/10.1175/1520-0493(1972)100<0081:OTAOSH>2.3.CO;2

[25] Hargreaves, G.H. and Allen, R.G. (2003) History and Evaluation of Hargreaves Evapotranspiration Equation. *Journal of Irrigation and Drainage Engineering*, **129**, 53-63. http://dx.doi.org/10.1061/(ASCE)0733-9437(2003)129:1(53)

[26] Ekern, P.C. and Chang, J.H. (1985) Pan Evaporation: State of Hawaii, 1894-1983. Hawaii. Department of Land and Natural Resources, Division of Water and Land Development, Honolulu, Rep. R74, viii + 172.

[27] Sanderson, M. (1993) Prevailing Trade Winds: Weather and Climate in Hawaii. University of Hawaii Press, Honolulu, 126.

[28] Mink, J.F. and Lau, L.S. (2006) Hydrology of the Hawaiian Islands. University of Hawaii Press, Honolulu.

[29] NOAA (National Oceanic and Atmospheric Administration) (2013) Comparative Climatic Data for the United States through 2012. http://ols.nndc.noaa.gov/plolstore/plsql/olstore.prodspecific?prodnum=C00095-PUB-A0001

[30] Anderson, R.G. and Wang, D. (2014) Energy Budget Closure Observed in Paired Eddy Covariance Towers with Increased and Continuous Daily Turbulence. *Agricultural and Forest Meteorology*, **184**, 204-209. http://dx.doi.org/10.1016/j.agrformet.2013.09.012

[31] Gesch, D.B. (2007) The National Elevation Dataset. In: Maune, D., Ed., *Digital Elevation Model Technologies and Ap-*

plications: *The DEM User's Manual*, 2nd Edition, American Society for Photogrammetry and Remote Sensing, Bethesda, 99-118.

[32] Fry, J.A., Coan, M.J., Homer, C.G., Meyer, D.K. and Wickham, J.D. (2009) Completion of the National Land Cover Database (NLCD) 1992-2001 Land Cover Change Retrofit Product. *US Geological Survey Open-File Report* 2008-1379, 18.

[33] Nair, S.S., King, K.W., Witter, J.D., Sohngen, B.L. and Fausey, N.R. (2011) Importance of Crop Yield in Calibrating Watershed Water Quality Simulation Tools. *JAWRA*: *Journal of the American Water Resource Association*, **47**, 1285-1297. http://dx.doi.org/10.1111/j.1752-1688.2011.00570.x

[34] Jones, C.A. (1980) A Review of Evapotranspiration Studies in Irrigated Sugarcane in Hawaii. *Hawaiian Planters' Record*, **59**, 195-214.

[35] Liu, W.Z., Hunsaker, D.J., Li, Y.S., Xie, X.Q. and Wall, G.W. (2002) Interrelations of Yield, Evapotranspiration, and Water Use Efficiency from Marginal Analysis of Water Production Functions. *Agricultural Water Management*, **56**, 143-151. http://dx.doi.org/10.1016/S0378-3774(02)00011-2

[36] Allison, F.E., Roller, E.M. and Raney, W.A. (1985) Relationship between Evapotranspiration and Yields of Crops Grown in Lysimeters Receiving Natural Rainfall. *Agronomy Journal*, **50**, 506-511. http://dx.doi.org/10.2134/agronj1958.00021962005000090004x

[37] United States Geological Service (USGS) (2007) Effects of Agricultural Land-Use Changes and Rainfall on Ground-Water Recharge in Central and West Maui, Hawaii, 1926-2004. *Scientific Investigations Report* 2007-5103, 69.

[38] Suleiman, A.A. and Hoogenboom, G. (2007) Comparison of Priestley-Taylor and FAO-56 Penman-Monteith for Daily Reference Evapotranspiration Estimation in Georgia. *Journal of Irrigation and Drainage Engineering*, **133**, 175-182. http://dx.doi.org/10.1061/(ASCE)0733-9437(2007)133:2(175)

[39] Da Silva, T.G.F.F. (2009) Análise de crescimento, interação biosfera-atmosfera e eficiência do uso de água da cana-de-açúcar irrigada no submédio do vale do São Francisco. TeseDoutorado—Universidade Federal de Viçosa, 194.

[40] Souza, E.F., Bernardo, S. and Carvalho, J.A. (1999) Função de produção da cana—Deaçúcaremrelação à água para três cultivares, em Campos dos Goytacazes. *Engenharia Agicola*, **19**, 28-42.

[41] Inman-Bamber, N.G. and McGlinchey, M.G. (2003) Crop Coefficients and Water-Use Estimates for Sugarcane Based on Long-Term Bowen Ratio Energy Balance Measurements. *Field Crops Research*, **83**, 125-138. http://dx.doi.org/10.1016/S0378-4290(03)00069-8

[42] Santos, M.A.L. (2005) Irrigação suplementar da cana-de-açúcar (Saccharumspp.): Um modelo de análise de decisão para o Estado de Alagoas. Tese Doutorado—Escola Superior de Agricultura "Luiz de Queiroz", Piracicaba, 101.

[43] Izuka, S.K., Oki, D.S. and Chen, C. (2005) Effects of Irrigation and Rainfall Reduction on Ground-Water Recharge in the Lihue Basin, Kauai, Hawaii. *Scientific Investigations Report* 2005-5146, US Department of the Interior, 48.

[44] Shade, P.J. (1999) Water Budget of East Maui, Hawaii. *Water-Resources Investigations Report* 98-4159, US Department of the Interior, 36.

A	B	C	D	E	F	G	H	I	J	K	L	M
Year	Annual Surface Water Deliveries (MG)	Annual Groundwater Pumping (MG)	Annual County Usage (MG)	Annual HC&S Industrial Usage (MG)	Annual Other Usage (MG)	Annual Seepage, Evaporation and Misc. System Losses (MG)	Total Annual Available for Irrigation (MG)	Irrigated Acres	Required Irrigation (gpad)	Actual Irrigation (gpad)	% Actual Irrigation of Required Irrigation	% Seepage, Evaporation and Misc. System Losses to Surface Water Delivered and Groundwater Pumped
2008 - 2013	41,505	25,512	1,034	2,283	150	15,206	48,345	28,941	5,146	4,579	89%	22.7%

A Years used for data averaging.
B Average for 6 years. Readings from official gaging stations.
C Average for 6 years. Volume is estimated from pump curves and run times.
D Average for 6 years. Volume is measured by flow meters.
E Average for 6 years. Value is based on 6 mgd per grinding day plus 2 mgd for boiling house and power plant makeup water.
F Average for 6 years. Water use by tenants including Ameron and Monsanto.
G Average for 6 years. All surface and ground water delivered and not utilized for irrigation or other usage. Includes reservoir and ditch seepage, evaporation and miscellaneous system losses
H Summation of all data related to available water and usage.
I Average for 6 years. Acreage actively cultivated throughout the year.
J Average for 6 years. Irrigation requirement in gpad as calculated by HC&S modified Penman equation for evapotranspiration.
K Average for 6 years. As calculated by HC&S water balance model utilizing run time and flow rate/acre to determine gpad.
L Percentage of actual irrigation to required irrigation. (column K divided by column J)
M Percentage of seepage, evaporation and miscellaneous system losses to surface water delivered and groundwater pumped

Figure 2–50 Method to estimate seepage losses from irrigation delivery systems (adapted from USDA 1985)

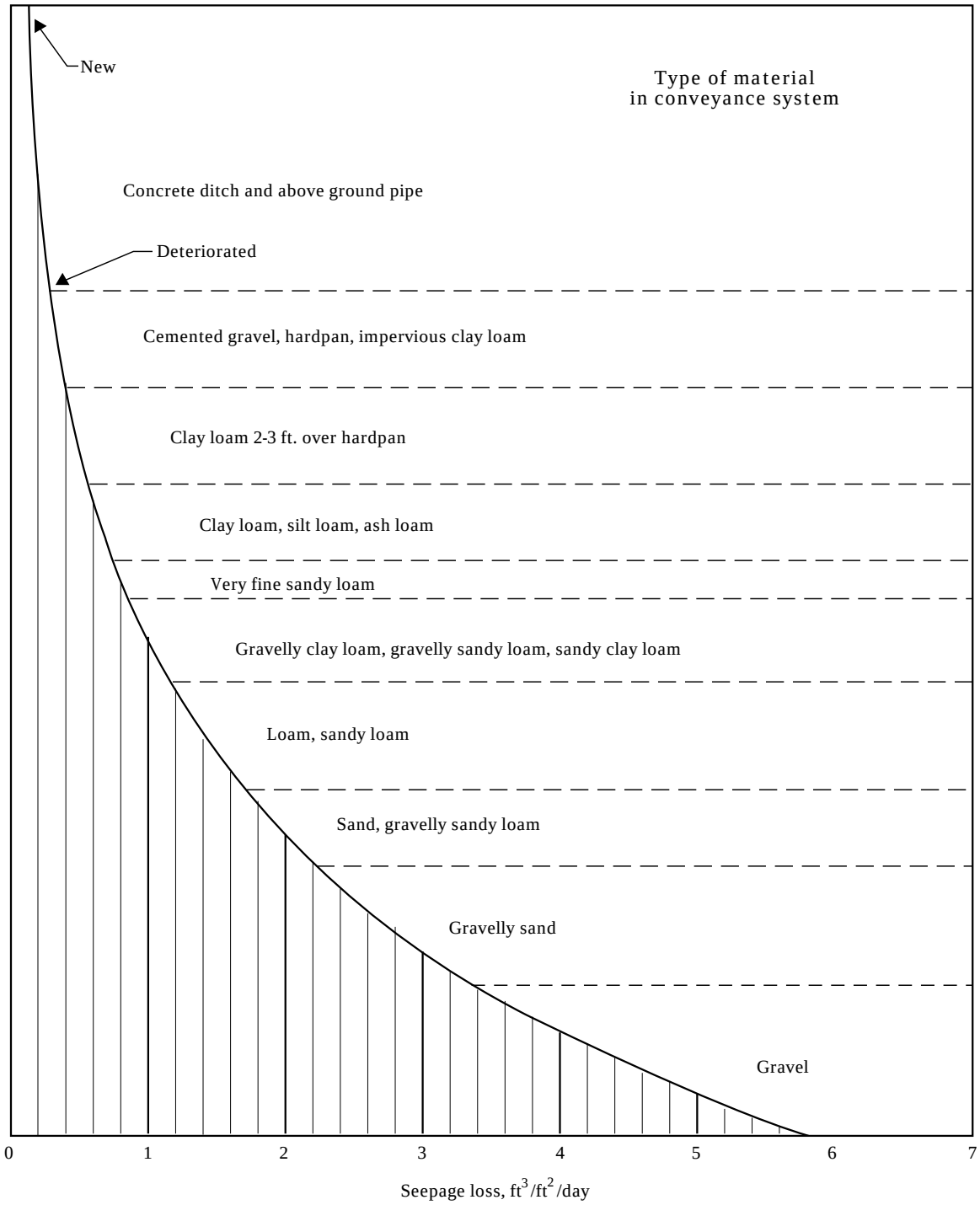


Exhibit E-R33

C-138

HC&S Seepage Loss - East Maui System

East Maui	Location	Ditch Length Miles	Ditch Length Feet	Sq. ft water area loss/foot	Type of ditch/reservoir	Low Seepage loss factor cubic feet/sq	High Seepage loss factor cubic feet/sq	Gal/sq ft loss factor cubic feet/sq (low factor)	Gal/sq ft loss factor cubic feet/sq (high factor)	Low Seepage loss/day (gal)	High Seepage loss/day (gal)
All Ditches	Eastern Portion of HC&S	41.60	219,648.00	7.00	Lined Concrete Ditch	0.20	0.40	1.50	2.99	2,300,461.36	4,600,922.73
All Reservoirs	Eastern Portion of HC&S	-	-	9,507,841.20	Unlined	0.40	0.85	2.99	6.36	28,451,264.01	60,458,936.01
									SUM >>>	30,751,725.37	65,059,858.74

East Maui	Location	Ditch Lineal (ft)	Width of water-feet	Total area in square feet	Acres	Evaporation rate of 0.40 acre-inch/day	Acre inch to gallons/day
All Ditches	Eastern Portion of HC&s	219,648.00	5.00	1,098,240.00	25.21	10.08	273,846.85
All Reservoirs	Eastern Portion of HC&S	-		9,507,841.20	218.27	87.31	2,370,786.31
						SUM >>>	2,644,633.16

East Maui Annual Delivery Average 2008-2013 (MGD)	
Total	67,017.00
Average/Day	183.48

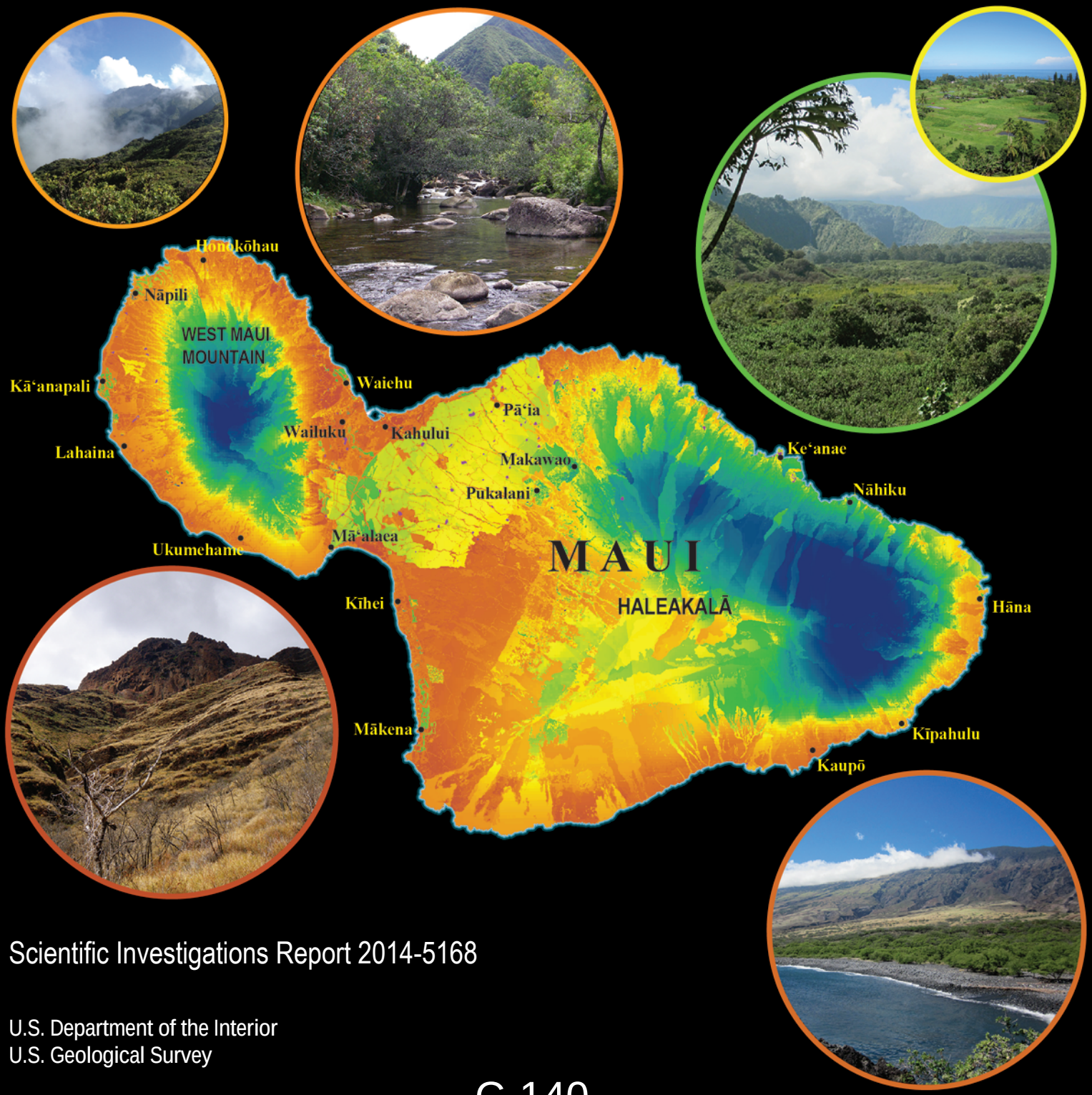
Low Seepage Loss Factor - MGD		Seepage and evap
Seepage loss/day	30.75	33.40
Percentage lost	16.76%	18.20%

High seepage Loss factor - MGD		Seepage and evap
Seepage loss/day	65.06	67.70
Percentage lost	35.46%	36.90%

Note 1: Reservoirs is total sq ft water area loss
Note 2: Lined Reservoirs were not considered
Note 3: Tunnel areas on the Kauhikoa ditch was excluded

Prepared in cooperation with the County of Maui Department of Water Supply and the State of Hawai‘i Commission on Water Resource Management

Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai‘i, 1978–2007



Scientific Investigations Report 2014-5168

U.S. Department of the Interior
U.S. Geological Survey

C-140

COVER

Top left: View toward summit of West Maui Mountain from a forested ridge near Honokōhau Valley on northern West Maui Mountain, Island of Maui, Hawai‘i. Photograph by Sarah N. Rosa, U.S. Geological Survey, 2013. Top center: View of Waihe‘e River on northeastern West Maui Mountain, Island of Maui, Hawai‘i, 2009. Top right: View of Ke‘anae Valley, on eastern Haleakalā, Island of Maui, Hawai‘i. Photograph by Adam G. Johnson, U.S. Geological Survey, 2014. Top right inset: Taro fields near Ke‘anae, eastern coast of Haleakalā, Island of Maui, Hawai‘i. Photograph by Adam G. Johnson, U.S. Geological Survey, 2014. Bottom right: View toward southern flank of Haleakalā from the coastline near Kaupō, Island of Maui, Hawai‘i. Photograph by Adam G. Johnson, U.S. Geological Survey, 2013. Bottom left: View of shrubs, grass, and barren rock on a steep valley wall near Ukumehame Gulch on southern West Maui Mountain, Island of Maui, Hawai‘i. Photograph by Adam G. Johnson, U.S. Geological Survey, 2010. Center: Map of the Island of Maui, Hawai‘i, showing the relative distribution of estimated mean annual recharge for average climate conditions. Estimated recharge is shown using a spectral color scale with red representing very low recharge and dark blue representing very high recharge.

Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai‘i, 1978–2007

By Adam G. Johnson, John A. Engott, and Maoya Bassiouni

Prepared in cooperation with the County of Maui Department of Water Supply and the State of Hawai‘i Commission on Water Resource Management

Scientific Investigations Report 2014–5168

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2014

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment—visit http://www.usgs.gov or call 1–888–ASK–USGS

For an overview of USGS information products, including maps, imagery, and publications, visit http://www.usgs.gov/pubprod

To order this and other USGS information products, visit *http://store.usgs.gov*

Suggested citation:
Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawai'i, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 53 p., http://dx.doi.org/10.3133/sir20145168.

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Although this information product, for the most part, is in the public domain, it also may contain copyrighted materials as noted in the text. Permission to reproduce copyrighted items must be secured from the copyright owner.

ISSN 2328-0328 (online)

Contents

Abstract 1
Introduction 1
Purpose and Scope 4
Previous Studies 4
Description of Maui 4
Physical Setting 4
Climate 5
Hydrogeology 5
Surface Water 7
Soils 7
Land Cover 7
Water-Budget Model 7
Conceptual Model 10
Model Calculations 10
Model Input 14
Land Cover 14
Impervious Surfaces 15
Rainfall 15
Monthly Rainfall 15
Daily Rainfall 15
Fog Interception 16
Irrigation 17
Irrigation Estimates 17
Irrigation Calibrations 18
Septic-System Leaching 18
Storm-Drain Systems 18
Direct Runoff 19
Computation of Seasonal Runoff-to-Rainfall Ratios 19
Runoff-to-Rainfall Ratios Assigned to Ungaged Catchment Zones 24
Runoff-to-Rainfall Ratios Assigned to Gaged Basins within a Single Catchment Zone 25
Runoff-to-Rainfall Ratios Assigned to Gaged Basins with Multiple Catchment Zones 25
Evapotranspiration 25
Forest-Canopy Evaporation and Net Precipitation 26
Potential Evapotranspiration 27
Reference Evapotranspiration 27
Crop Coefficients 27
Moisture-Storage Capacity of the Plant-Root Zone 30
Direct Recharge 30
Other Input 30
Model Exclusions and Limitations 32
Model Randomness 33
Water-Budget and Groundwater-Recharge Estimates 33

Water-Budget and Recharge Estimates for Average Climate Conditions 33
Comparison with Water Resources Protection Plan 42
Comparison with Previous Studies for the ʻĪao and Waiheʻe aquifer systems 42
Comparison with Evapotranspiration Estimates of Giambelluca and others (2014) 44
Recharge for Drought Conditions 45
Sensitivity Analysis 45
Suggestions for Future Study and Additional Data Collection 48
Summary and Conclusions 48
References Cited 49

Figures

1. Aquifer sectors and aquifer systems on the Island of Maui, Hawaiʻi 2
2. Major geographical features on the Island of Maui, Hawaiʻi 3
3. Mean annual rainfall (1978–2007) and locations of rain gages used in the water-budget calculations for Maui, Hawaiʻi 6
4. Land cover for Maui, Hawaiʻi 8
5. Generalized water-budget flow diagrams for both forest and nonforest land covers 11
6. Mean runoff-to-rainfall ratios for the Dry-season months: May through October and Wet-season months: November through April for drainage basins of selected stream-gaging stations and catchment zones on Maui, Hawaiʻi 20
7. Mean annual reference evapotranspiration for Maui, Hawaiʻi 28
8. Calculated moisture-storage capacity of the plant-root zone for Maui 31
9. The average absolute percentage change in recharge of all the water-budget subareas with each successive model simulation 33
10. The distribution of mean annual groundwater recharge for average climate conditions (1978–2007), Island of Maui, Hawaiʻi, calculated using the water-budget model 41
11. Fraction of total water inflow that becomes groundwater recharge in the water-budget calculations for average climate conditions (1978–2007) Island of Maui, Hawaiʻi 43
12. Percentage difference in mean annual groundwater recharge for drought conditions (1998–2002), relative to that for average climate conditions (1978–2007), Island of Maui, Hawaiʻi 46

Tables

1. Previous water-budget studies for parts of Maui, Hawaiʻi 4
2. General types of land cover, as a fraction of aquifer system area, Maui, Hawaiʻi 9
3. Mean fog-interception rates used in the water-budget calculation for average climate conditions for Maui, Hawaiʻi 16
4. Mean seasonal runoff-to-rainfall ratios for drainage basins of stream-gaging stations on Kauaʻi, Oʻahu and Maui, Hawaiʻi 21
5. Regional-regression equations used to compute mean seasonal runoff-to-rainfall ratios for catchment zones in ungaged areas on Maui Hawaiʻi 24
6. Land-cover parameters used in water-budget calculations for Maui, Hawaiʻi 29
7. Mean annual water-budget components from this study for aquifer sectors and all of Maui, Hawaiʻi 34
8. Mean annual water-budget components from this study for average climate and drought

conditions and components from the Water Resources Protection Plan for aquifer systems of Maui, Hawai‘i 35
9. Comparison of mean annual water-budget components from this study with components from previous studies for ‘Īao and Waihe‘e aquifer systems of Maui, Hawai‘i 44
10. Results of sensitivity testing for selected water-budget parameters performed for selected aquifer systems and the Island of Maui, Hawai‘i 47

Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m^3)
million gallons (Mgal)	3,785	cubic meter (m^3)
	Flow rate	
gallons per acre per day [(gal/acre)/d]	0.935396	cubic meter per square kilometer per day [(m^3/km^2)/d]
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

Vertical coordinate information is referenced to mean sea level.

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Acronyms

Acronyms	Meaning
CWI	Cloud water interception
EMI	East Maui Irrigation
ET	Evapotranspiration
HC&S	Hawaiian Commercial and Sugar Company
MDWS	County of Maui Department of Water Supply
TMK	Tax Map Key
USGS	U.S. Geological Survey
WRPP	State of Hawai‘i Water Resource(s) Protection Plan

Acknowledgments

This study was conducted in cooperation with the County of Maui Department of Water Supply and the State of Hawai‘i Commission on Water Resource Management. We thank Abby Frazier and Thomas Giambelluca of the University of Hawai‘i at Mānoa, Cary Yamashita of the County of Maui Department of Public Works, and Tui Anderson of the County of Maui Department of Water Supply for providing data and background information.

Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai‘i, 1978–2007

By Adam G. Johnson, John A. Engott, and Maoya Bassiouni

Abstract

Demand for freshwater on the Island of Maui is expected to grow. To evaluate the availability of fresh groundwater, estimates of groundwater recharge are needed. A water-budget model with a daily computation interval was developed and used to estimate the spatial distribution of recharge on Maui for average climate conditions (1978–2007 rainfall and 2010 land cover) and for drought conditions (1998–2002 rainfall and 2010 land cover). For average climate conditions, mean annual recharge for Maui is 1,340 million gallons per day, or about 45 percent of precipitation (rainfall and fog interception). Recharge for average climate conditions is about 40 percent of total water inflow consisting of precipitation, irrigation, septic leachate, and seepage from reservoirs and cesspools. Most recharge occurs on the wet, windward slopes of Haleakalā and on the wet, uplands of West Maui Mountain. Dry, coastal areas generally have low recharge. In the dry isthmus, however, irrigated fields have greater recharge than nearby unirrigated areas. For drought conditions, mean annual recharge for Maui is about 1,035 million gallons per day, which is 23 percent less than recharge for average climate conditions. For individual aquifer-system areas used for groundwater management, recharge for drought conditions is about 8 to 51 percent less than recharge for average climate conditions. The spatial distribution of rainfall is the primary factor determining spatially distributed recharge estimates for most areas on Maui. In wet areas, recharge estimates are also sensitive to water-budget parameters that are related to runoff, fog interception, and forest-canopy evaporation. In dry areas, recharge estimates are most sensitive to irrigated crop areas and parameters related to evapotranspiration.

Introduction

On the Island of Maui, the demand for freshwater is expected to increase. Groundwater is the chief source of freshwater for the County of Maui Department of Water Supply (MDWS) and is a potential source for satisfying additional freshwater demand. Average water production by MDWS was about 37.5 million gallons per day (Mgal/d) on the Island of Maui in 2013 (County of Maui, Hawai‘i, Department of Water Supply, 2014). Projected water demands from MDWS on the Island of Maui in 2030 (Haiku Design & Analysis, 2007, 2009, 2010) are between about 12 and 57 percent more than the water production in 2013. Groundwater pumped from wells in the ‘Īao and Waihe‘e aquifer systems (fig. 1) is the chief source of freshwater for MDWS and is supplied to consumers in Wailuku, Kahului, Pā‘ia, and Kīhei (fig. 2). Average groundwater pumpage from the ‘Īao aquifer system by the MDWS in 2013 was about 84 percent of the sustainable yield (David Taylor, MDWS, written commun., 2014). In upcountry Maui, which includes areas near Makawao on northwest Haleakalā (fig. 2), MDWS is faced with “a pressing need for additional water production capacity” and a considerable backlog of more consumers who are waiting for new water meters (Haiku Design & Analysis, 2009). Surface water, the chief source of freshwater for MDWS’ consumers in upcountry Maui, is already at its “practical limits” during the drier summer months and during drought conditions (Haiku Design & Analysis, 2009). In addition to MDWS, private water systems on Maui pump substantial amounts of groundwater. Some of these private water systems may also have increased groundwater demands in the future.

Estimates of the spatial distribution of groundwater recharge for Maui are needed to evaluate the availability of fresh groundwater. Recharge is water derived from precipitation and other sources of water, such as irrigation and leakage from septic systems, infiltrating the ground and replenishing aquifers. Recharge is used by the State of Hawai‘i Commission on Water Resource Management in the calculation of sustainable-yield values for aquifer systems in the State (State of Hawai‘i, 2008). For much of Haleakalā, including parts of upcountry Maui, the spatial distribution of recharge has not been estimated since 1999 (Shade, 1999). Although more recent recharge estimates for the isthmus and West Maui Mountain (fig. 2) are available (Engott and Vana, 2007; Gingerich and Engott, 2012), new spatial datasets of rainfall and evapotranspiration (ET) for the Hawaiian Islands have been developed since these previous recharge

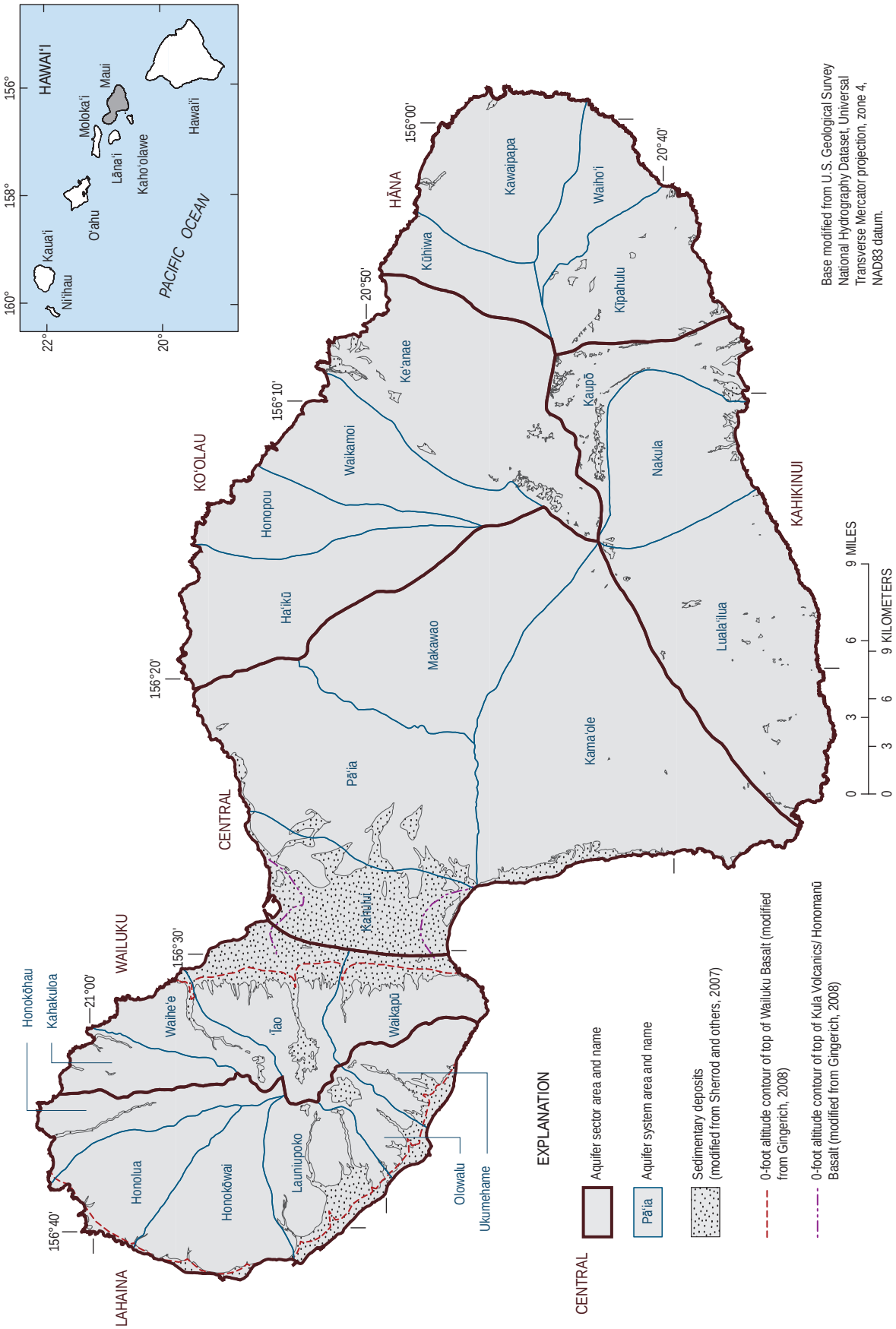


Figure 1. Aquifer sectors and aquifer systems on the Island of Maui, Hawai‘i (State of Hawai‘i, 2008).

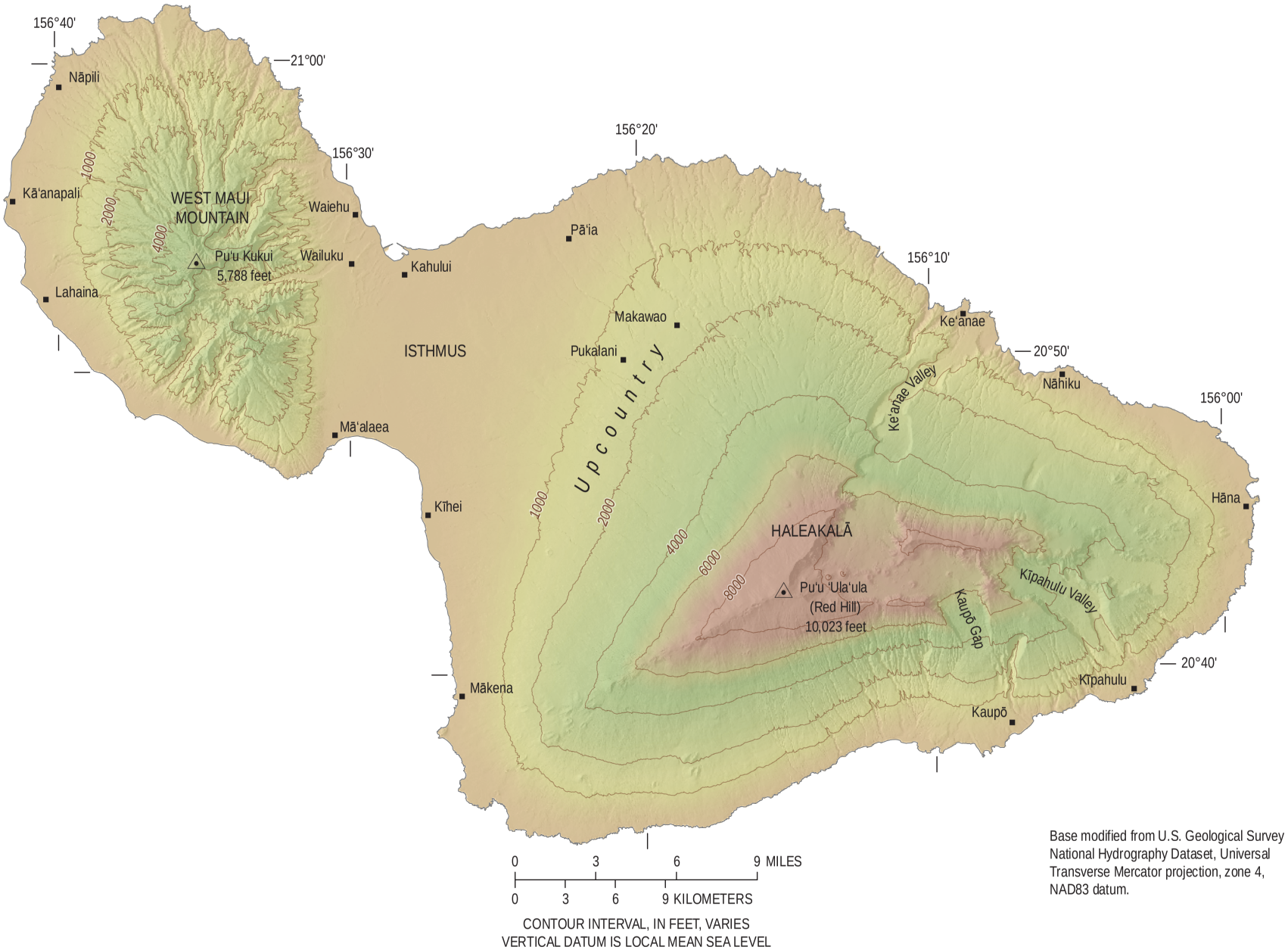


Figure 2. Major geographical features on the Island of Maui, Hawai'i.

studies. These new datasets of rainfall and ET (Frazier, 2012; Giambelluca and others, 2013; 2014) have better spatial and temporal resolution than the datasets that were used before. For this study, the water-budget model used by Gingerich and Engott (2012) was modified and expanded to include the entire Island of Maui. Recharge estimates were calculated using the new datasets in combination with the modified water-budget model. The recharge estimates from this study can be used in numerical groundwater models that have the capacity to evaluate the effects of additional groundwater withdrawals on groundwater levels, streamflow, coastal discharge, and salinities in public and private wells on Maui.

Purpose and Scope

This report describes the spatial distribution of mean annual groundwater recharge for the Island of Maui and the model that was used to estimate recharge for average and drought conditions. To estimate recharge, a water-budget model that uses a daily computational interval was developed. Hydrological processes and physical conditions that affect recharge on Maui were simulated in the water-budget model using the most current data available, including data from maps of rainfall for each month during 1978–2007 and mean monthly reference grass evapotranspiration (Frazier, 2012; Giambelluca and others, 2013, 2014). The water-budget model and the most current datasets were used to estimate the spatial distribution of mean annual recharge for two scenarios (1) average climate conditions (1978–2007 rainfall and 2010 land cover), and (2) drought conditions (1998–2002 rainfall and 2010 land cover). Recharge estimates from this study were compared with estimates of mean recharge from previous water-budget studies. Finally, the sensitivity of recharge estimates to selected water-budget components was evaluated.

Previous Studies

Several previous water-budget studies estimated recharge for various parts of Maui (table 1). Most of these previous water budgets used monthly or annual computational intervals, which can lead to biased evapotranspiration and recharge estimates (Oki, 2008). In general, uncertainty in recharge estimates is less for water budgets computed using a shorter computational interval that is consistent with the physical processes being represented (Oki, 2008). The water budget for this report used a daily computational interval, which provides a more realistic simulation of rainfall, soil moisture, ET, and recharge.

The most recent estimates of recharge for areas in central and west Maui were those of Engott and Vana (2007) and Gingerich and Engott (2012). Engott and Vana (2007) developed a water-budget model with a daily computational interval to estimate recharge for central and west Maui for six time periods spanning 1926–2004. Their estimates incorporated historical rainfall and accounted for changes in land cover and agricultural irrigation. Recharge was also estimated for several hypothetical rainfall and land-use scenarios, including drought conditions and cessation of plantation-scale agriculture. Gingerich and Engott (2012) reassessed recharge for the Lahaina aquifer sector (fig. 1) using a modified version of the water-budget model of Engott and Vana (2007). The water-budget model was modified to (1) directly represent canopy-interception processes in forests, (2) distinguish between native and alien forests, and (3) account for differences in the transpiration properties of forests depending on their location with respect to the fog zone.

Table 1. Previous water-budget studies for parts of Maui, Hawai‘i.

Reference	Area
Gingerich and Engott (2012)	Lahaina aquifer sector
Engott and Vana (2007)	west and central Maui
Shade (1999)	part of Maui east of 156°30’ 00”
Shade (1997)	‘Īao aquifer system
Shade (1996)	Lahaina aquifer sector
Austin, Tsutsumi and Associates (1991)	West Maui
State of Hawaii (1990)	Entire island by aquifer system
Takasaki (1972)	Central Maui
Takasaki (1971)	Southeast Maui
Yamanaga and Huxel (1970)	Wailuku Area
Division of Water and Land Development (1970)	Windward west Maui and central Maui
Belt, Collins and Associates (1969)	Lahaina District
Yamanaga and Huxel (1969)	Lahaina District
Caskey (1968)	‘Īao and Waikapū Valleys

Description of Maui

The Island of Maui has an area of about 728 square miles (mi^2). For groundwater management purposes, the State of Hawai‘i Commission on Water Resource Management divides the Island of Maui into 6 aquifer sectors and 25 aquifer systems (fig. 1).

Physical Setting

The Island of Maui was built by two shield volcanoes. The older West Maui Volcano is known as West Maui Mountain and may be extinct (fig. 2). The younger East Maui Volcano is known as Haleakalā and is considered dormant (Macdonald and others, 1983). The broad, gently sloping land between the two volcanoes is referred to as the isthmus (Stearns and Macdonald, 1942). Erosion of West Maui Mountain has carved deep valleys and sharp-crested ridges,

which radiate from near its summit, Pu‘u Kukui, at 5,788 feet (ft) (fig. 2). On Haleakalā, the rainy eastern slope has valleys that are separated by broad areas and ridges. The drier western slope of Haleakalā is less incised and retains the broad, shield shape of the volcano. The summit of Haleakalā, Pu‘u ‘Ula‘ula (Red Hill), is at 10,023 ft.

Climate

Weather patterns in Hawai‘i are affected by the interaction between northeast trade winds and the topography of the Hawaiian Islands (Schroeder, 1993). The Hawaiian Islands are in the path of persistent trade winds that originate from the north Pacific anticyclone, which is a region of high atmospheric pressure usually located northeast of the Islands. Mountains of the Hawaiian Islands obstruct trade-wind air flow and create wetter climates on north- and northeast-facing (windward) mountain slopes and drier climates on southwest-facing (leeward) mountain slopes (Sanderson, 1993). As moist air ascends windward mountain slopes, it cools and can form clouds. Persistent trade winds and orographic lifting of moist air result in recurrent clouds and frequent rainfall on windward slopes and near the peaks of all but the tallest mountains of the Hawaiian Islands (Giambelluca and others, 1986). Loss of moisture from air that ascends windward slopes leads to relatively drier climates along leeward slopes in the rain shadow of the mountains.

When trade winds are present, the vertical development of clouds is restricted by the trade-wind inversion layer. Within the trade-wind inversion layer air temperature increases with altitude, whereas below the inversion layer air temperature generally decreases with altitude (Schroeder, 1993). Cao and others (2007) determined the trade-wind inversion layer occurs about 82 percent of the time in Hawai‘i and has an average base altitude of about 7,100 ft. The altitude of the inversion, however, varies over time and space and is affected by thermal circulation patterns, such as land and sea breezes (Giambelluca and Nullet, 1991). Most of Maui is usually immersed in the moist air layer below the inversion. Areas near the summit of Haleakalā are high enough to extend into the layer of dry air above the inversion’s base altitude.

The variability of weather and rainfall patterns in Hawai‘i during the year is typically described in terms of dry and wet seasons. The dry season (May through September) has warm temperatures and steady trade winds that blow 80 to 95 percent of the time (Blumenstock and Price, 1967; Sanderson, 1993). The wet season (October through April) has cooler temperatures and less persistent trade winds. Statewide storm rainfall is more common during the rainy season when high- and low-pressure systems and frontal systems pass near the Islands (Giambelluca and others, 1986). Much of the rainfall on leeward sides of the Hawaiian Islands comes from these synoptic-scale systems (Schroeder, 1993). Low-pressure systems that develop to the west of the Hawaiian Islands can result in moist, southerly winds and rainfall that may persist for more than a week (Schroeder, 1993). During the early part of 2006, for example, a series of low-pressure systems to the west of the Hawaiian Islands persisted for nearly seven weeks and generated an onslaught of storms that resulted in an unusual extended rainy period across the Islands (Nash and others, 2006).

Steep gradients in mean annual rainfall patterns on Maui (fig. 3) reflect the influence of persistent trade winds and orographic rainfall (Giambelluca and others, 2013). On an island-wide basis, mean rainfall on Maui is about 81 inches per year (in/yr). Mean rainfall is more than 360 in/yr at Pu‘u Kukui, the summit of West Maui Mountain (figs. 2 and 3). About 5 mi southwest of Pu‘u Kukui, mean rainfall is less than 15 in/yr. Mean rainfall exceeds 100 in/yr for much of the interior uplands of West Maui Mountain. On Haleakalā, mean rainfall exceeds 200 in/yr on mid-altitude windward slopes. At a rain gage (not shown) near 5,400 ft altitude on windward Haleakalā, mean rainfall is about 404 in/yr, which is among the highest values in the Hawaiian Islands during 1978–2007 (Giambelluca and others, 2013). Leeward slopes in the rain shadow of Haleakalā are much drier. Mean rainfall is less than 25 in/yr for most leeward areas along the coastline and the isthmus. The summit area of Haleakalā is also relatively dry, with mean rainfall between about 35 and 50 in/yr.

Hydrogeology

West Maui Mountain and Haleakalā were built primarily by volcanic eruptions and layers of lava flows (Langenheim and Clague, 1987). The layers of lava flows were intruded in places by dikes, which consist of dense, low-permeability rock that formed when magma supplying lava flows solidified in narrow, near-vertical fissures below the ground surface. In the inland region of West Maui Mountain, near-vertical dikes radiating in all directions from the summit impound groundwater in compartments of volcanic rock in the caldera and permeable lava flows on the flanks. The water table of the dike-impounded groundwater systems in the West Maui Mountain interior may be more than 3,500 ft above sea level (Stearns and Macdonald, 1942). Seaward of the dike-impounded systems within West Maui Mountain, freshwater-lens groundwater systems exist in the dike-free high-permeability volcanic rocks and sedimentary deposits (Gingerich, 2008). A freshwater-lens system consists of a lens-shaped freshwater body, an intermediate brackish-water transition zone, and underlying saltwater (for example, Gingerich and Engott, 2012, p. 12). Water levels of groundwater bodies in the dike-free volcanic rocks of West Maui Mountain are typically less than a few tens of feet above sea level (for example, Gingerich, 2008, p. 46). Fresh groundwater within the freshwater-lens system generally flows in a seaward direction from inland areas of West Maui Mountain toward the coast. Wedges of low-permeability sedimentary material referred to as caprock impede the seaward flow of fresh groundwater in freshwater-lens systems along parts of the northeast and southwest flanks of West Maui Mountain. Wedges of caprock

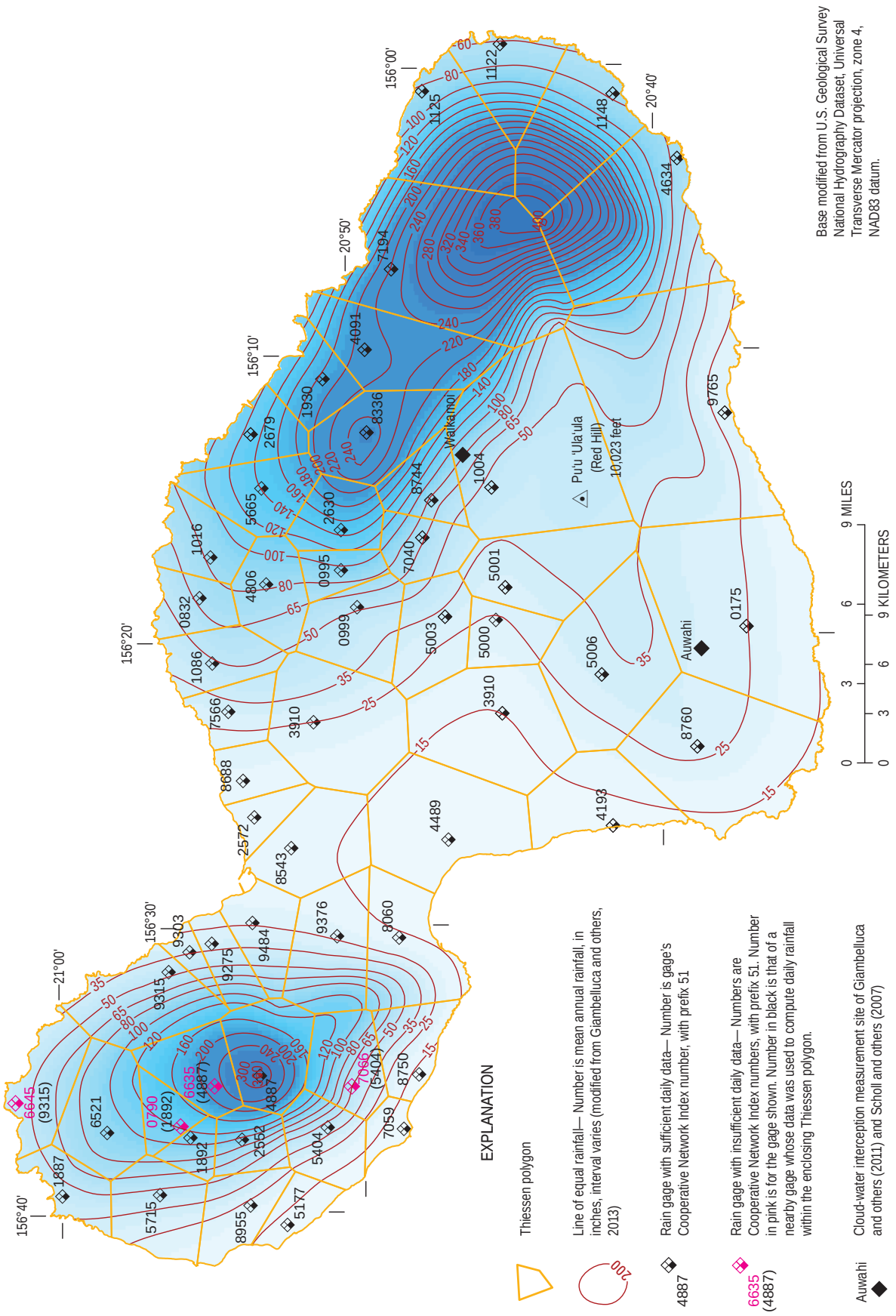


Figure 3. Mean annual rainfall (1978–2007) and locations of rain gages used in the water-budget calculations for Maui, Hawai‘i (modified from Giambelluca and others, 2011, 2013; Scholl and others, 2007).

between West Maui Mountain and Haleakalā also impede the flow of fresh groundwater between West Maui Mountain and the isthmus.

On northeast Haleakalā, in the area between Makawao and Keʻanae Valley, fresh saturated groundwater occurs as (1) perched, high-level water held up by relatively low-permeability geologic layers above an unsaturated zone, and (2) a freshwater-lens system underlain by seawater (Gingerich, 1999a, 1999b). The perched groundwater is several tens of feet below the ground surface within layers of thick lava flows, ash, weathered clinker beds, and soils. Collectively, this assemblage of layers has low permeability that impedes the downward movement of the perched, high-level groundwater. An unsaturated zone and a freshwater-lens system are beneath the high-level groundwater. The freshwater-lens system is located within high-permeability basalt lava flows and has a water table that is several feet above sea level. In the area between Keʻanae Valley and Nāhiku (fig. 2), the groundwater system appears to be saturated above sea level to altitudes greater than 2,000 ft. For southeast and southwest Haleakalā, information related to groundwater systems is sparse although perched and freshwater-lens systems are expected to be present.

Surface Water

Streams on Maui generally originate in the wet uplands of West Maui Mountain and Haleakalā and flow toward the coast. The upper reaches of some streams on West Maui Mountain flow perennially and are fed by persistent rainfall and groundwater discharging from dike-impounded water bodies (Stearns and Macdonald, 1942). During dry-weather conditions, lower reaches of some streams on West Maui Mountain have reduced or no streamflow as a result of water captured by diversion systems and water infiltrating the subsurface (Gingerich, 2008; Gingerich and Engott, 2012). Streams on windward Haleakalā are fed by abundant rainfall and groundwater discharge (Gingerich, 1999a, 1999b). In the area between Makawao and Keʻanae Valley (fig. 2), groundwater discharges to streams from a perched, high-level saturated groundwater system. East of Keʻanae Valley, groundwater discharges to streams from a vertically extensive freshwater-lens system (Meyer, 2000). Water is diverted from many streams on windward Haleakalā and is mainly used to irrigate sugarcane in the isthmus. Stream reaches on leeward Haleakalā tend to be ephemeral.

Soils

Factors influencing soil conditions in the Hawaiian Islands include parent material, duration of weathering, climate, topography, and drainage conditions (Macdonald and others, 1983). A soil's ability to absorb and store water affects direct runoff, evapotranspiration, and recharge. Properties of a soil that control its ability to absorb and store water include (1) soil texture, the relative percentages of sand-, silt-, and clay-sized particles, (2) porosity, a measure of how much water a soil can hold, and (3) permeability, a measure of a soil's ability to transmit water. Slope, vegetation, and soil-moisture content can also affect a soil's ability to absorb water.

Soils on Maui were mapped and described by the Natural Resources Conservation Service (2006a). Soil properties were estimated to depths of 60 inches for most soils on Maui. Estimates of available water capacity, the quantity of water that a soil is capable of storing for use by plants, range between 0 and 0.40 inch of water per inch of soil. Areas containing soil horizons with zero available water capacity in the top 40 inches of soil include (1) steep, narrow ravines, (2) steep uplands on West Maui Mountain, and (3) leeward parts of Haleakalā and West Maui Mountain below 2,000 ft altitude. In general, soil horizons with zero available water capacity are associated with bedrock. Steep slopes may have thin soils overlying bedrock owing to erosion removing soil as fast as the soil forms (Macdonald and others, 1983).

Land Cover

Current patterns of vegetation and land cover on Maui reflect the influence of steep climate gradients, agricultural practices, and land development (fig. 4). The dry summit of Haleakalā is sparsely vegetated with large areas of barren rock (U.S. Geological Survey, 2010). At middle and lower altitudes on Haleakalā, forests cover much of the wet windward slopes; alien forests, grasslands, and developed areas cover much of the arid leeward slopes. On West Maui Mountain, wet uplands are predominantly forests and shrublands, whereas dry lowlands are chiefly grasslands and developed areas. From the late 1800s to present, sugarcane fields have covered much of the isthmus (Dorrance and Morgan, 2000). During most of the 20th century, sugarcane and pineapple fields covered large parts of the leeward slopes of West Maui Mountain (for example, Engott and Vana, 2007, fig. 2). As a result of the cessation of these agricultural operations on West Maui Mountain, many of these fields are now grassland and shrubland. Coastal areas are developed in the vicinity of Lahaina, Kahului, Kīhei, and Wailuku (fig. 2). Mid-altitude areas on northwest Haleakalā are developed and have patches of pineapple and diversified agriculture.

About 38 percent of Maui is covered by forests (table 2). Alien forests and tree plantations include various introduced species, whereas native forests include species such as *Metrosideros polymorpha* (ʻōhiʻa) and *Acacia koa* (U.S. Geological Survey, 2010). Alien forests are typically at lower altitudes than native forests.

Water-Budget Model

Groundwater recharge replenishes aquifers and is fed mainly by precipitation and irrigation that infiltrates the ground surface and percolates beyond the root zone in the soil. For this study, we estimated spatially distributed mean annual groundwater recharge on Maui by using a

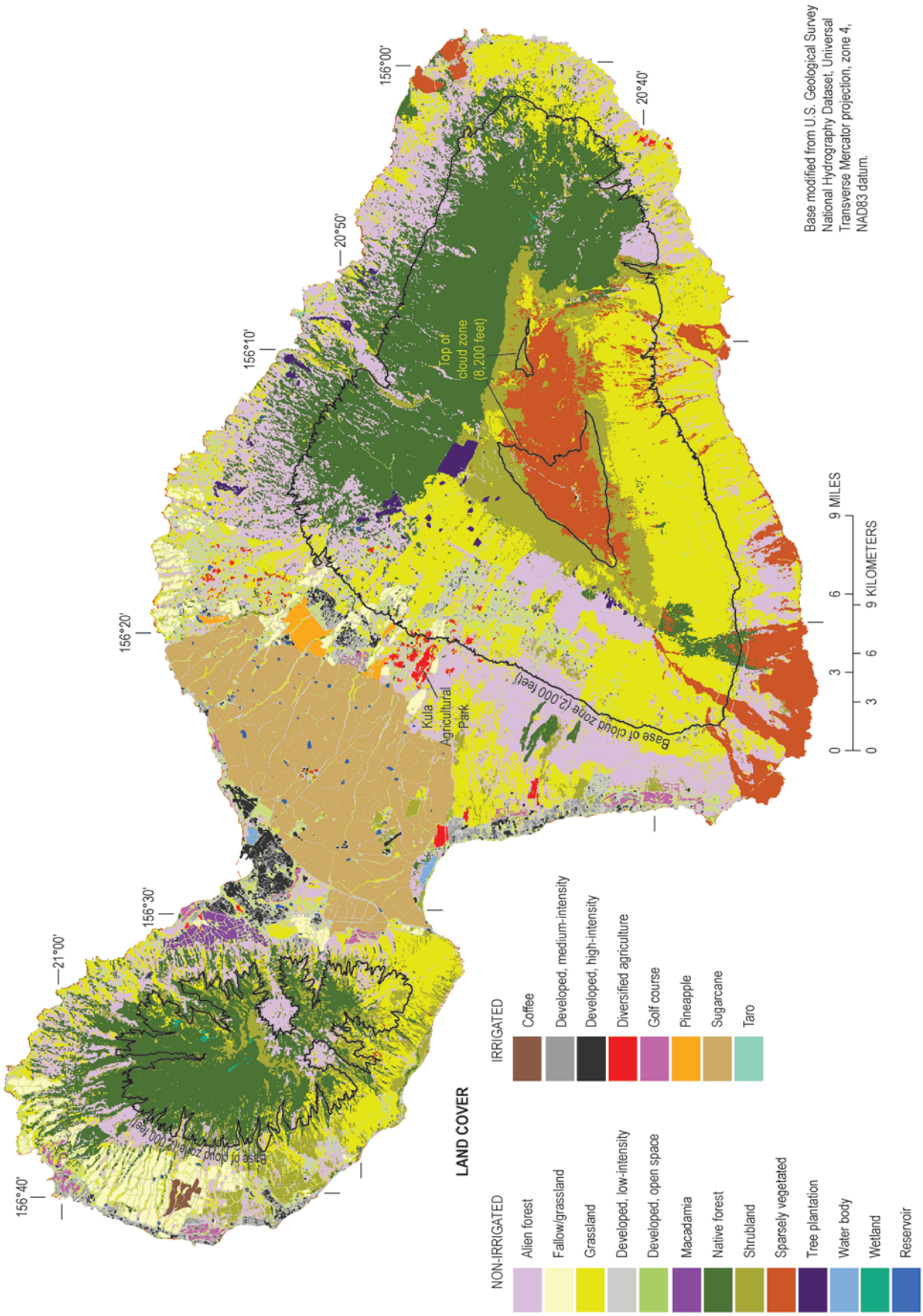


Figure 4. Land cover for Maui, Hawai‘i (modified from U.S. Geological Survey, 2010; Johnson, 2014). Reservoirs, taro, and developed land covers are difficult to see at this scale.

Table 2. General types of land cover, as a fraction of aquifer system area, Maui, Hawai‘i.

[See fig.1 for location of aquifer systems. See fig. 4 for a map of land cover. Agriculture–irrigated consists of coffee, diversified agriculture, pineapple, sugarcane, and taro land covers; Other consists of macadamia, reservoir, water body, and wetland land covers]

Aquifer system	Agriculture–irrigated	Developed and golf course	Grassland and fallow/grassland	Shrubland	Alien forest and tree plantation	Native forest	Sparsely vegetated	Other
Waikapū	0.10	0.08	0.43	0.12	0.13	0.14	0.00	0.00
‘Īao	0.00	0.23	0.10	0.14	0.22	0.22	0.00	0.09
Waihe‘e	0.00	0.08	0.22	0.16	0.17	0.36	0.01	0.00
Kahakuloa	0.00	0.02	0.13	0.06	0.25	0.53	0.00	0.01
Honokōhau	0.00	0.06	0.17	0.06	0.14	0.57	0.00	0.00
Honolua	0.00	0.23	0.19	0.03	0.17	0.38	0.00	0.00
Honokōwai	0.03	0.22	0.27	0.10	0.14	0.23	0.00	0.01
Launiupoko	0.00	0.15	0.18	0.27	0.10	0.29	0.01	0.00
Olowalu	0.00	0.06	0.37	0.24	0.15	0.17	0.01	0.00
Ukumehame	0.00	0.03	0.42	0.36	0.05	0.13	0.01	0.00
Kahului	0.55	0.31	0.02	0.02	0.07	0.01	0.00	0.02
Pā‘ia	0.78	0.10	0.05	0.02	0.04	0.00	0.00	0.01
Makawao	0.07	0.24	0.38	0.12	0.13	0.02	0.04	0.00
Kama‘ole	0.00	0.15	0.33	0.08	0.37	0.02	0.05	0.00
Ha‘ikū	0.02	0.22	0.28	0.01	0.31	0.16	0.00	0.00
Honopou	0.00	0.09	0.14	0.01	0.43	0.32	0.01	0.00
Waikamoi	0.00	0.02	0.04	0.09	0.26	0.59	0.00	0.00
Ke‘anae	0.00	0.01	0.05	0.11	0.15	0.53	0.15	0.00
Kūhiwa	0.00	0.02	0.07	0.03	0.35	0.52	0.01	0.00
Kawaipapa	0.00	0.05	0.29	0.03	0.25	0.33	0.05	0.00
Waiho‘i	0.00	0.02	0.32	0.05	0.17	0.44	0.00	0.00
Kīpahulu	0.01	0.02	0.18	0.10	0.21	0.47	0.01	0.00
Kaupō	0.00	0.01	0.40	0.19	0.02	0.02	0.36	0.00
Nakula	0.00	0.01	0.72	0.10	0.04	0.00	0.13	0.00
Lualaʻilua	0.00	0.02	0.49	0.08	0.12	0.05	0.24	0.00
Island of Maui (all aquifer systems)	0.09	0.11	0.26	0.09	0.18	0.20	0.06	0.01

water-budget model. The water-budget model is designed to simulate–on a daily basis–the hydrological processes and physical conditions that affect recharge on Maui. Hydrological processes simulated by the model include rainfall, fog interception, irrigation, runoff, and ET. The model represents physical conditions by using parameters that include the moisture-storage capacity of soils and properties of the vegetation and land cover that affect ET.

The water-budget model used for this study (as described herein) is a modified version of the models used for previous U.S. Geological Survey (USGS) recharge studies for west and central Maui (Engott and Vana, 2007), and leeward west Maui (Gingerich and Engott, 2012). The structure of the model used for this study is similar to that of the earlier models; however the model used for this study differs from previous versions by covering the entire Island of Maui and uses more recent maps of rainfall, land cover, and reference grass ET. Additionally, the model used for this study (1) includes a more robust method for using streamflow records to estimate the spatial distribution of direct runoff, and (2) quantifies precipitation that is intercepted by and evaporates from forest canopies.

The water-budget model used for this study is similar to other models that simulate a root-zone water balance and can be used to estimate recharge (for example, Leavesley and others, 1983; Hevesi and others, 2002; Westenbroek and others, 2010). However, for this study, the preferred approach was to build on previous water-budget models developed by the USGS for the Hawaiian Islands because (1) these models are better adapted to conditions unique to Maui, such as a persistent fog and cloud cover for many locations and a pronounced orographic influence on climate, and (2) a high degree of spatial detail is needed

for defining the model subareas. The high degree of spatial detail allows the model to represent the wide range of climate conditions, vegetation, soils, and land uses on Maui.

Conceptual Model

The water-budget model used here to estimate groundwater recharge is a “threshold-type” or “reservoir” model utilizing a variation of the Thornthwaite and Mather (1955) mass-balance procedure. The two generalized flow diagrams of the water-budget model—one for nonforest land covers and one for forest land covers are displayed in figure 5. The plant-root zone reservoir is included in the model for nonforest and forest land covers. The forest-canopy reservoir is included in the model for forest land covers only.

The volume of the plant-root zone reservoir is based on the estimated root depth of different plant types and the available water capacity of different soil types. The model uses a daily computational interval to account for water entering, leaving, and being stored within the plant-root zone reservoir. At the end of a day, if the volume of water entering the system exceeds the storage capacity of the plant-root zone reservoir, given the antecedent water content and water losses from ET, the reservoir overflows. This overflow is counted as groundwater recharge by the model. In some areas, recharge includes direct recharge from reservoir and cesspool seepage. All water infiltrating the substrate beneath the plant-root zone reservoir as overflow or direct recharge is considered recharge.

Direct runoff is the fraction of precipitation (rainfall and fog interception) that does not contribute to net moisture gain within the plant-root zone reservoir. Direct runoff excludes base flow, which is groundwater discharge to streams. Direct runoff is assumed either to be diverted to other areas or ultimately discharge to the ocean. Re-infiltration of direct runoff is not quantified in the model, although it is indirectly accounted for in the empirical functions used to compute direct runoff.

The forest-canopy reservoir is not treated as a true reservoir in the model calculations because precipitation is not allowed to be stored in it for more than a day. For each daily computational period, precipitation in the forest-canopy reservoir either evaporates as canopy evaporation or reaches the soil as part of net precipitation. Net precipitation is computed as the sum of fog interception and rainfall minus canopy evaporation, and thus represents outflow from the forest-canopy reservoir. Net precipitation is partitioned into direct runoff and inflow to the plant-root zone. The plant-root zone reservoir and the forest-canopy reservoir are herein referred to as the plant-root zone and the forest canopy, respectively.

Model Calculations

The water-budget model computes groundwater recharge for the Island of Maui using input data that quantify the spatial and temporal distribution of rainfall, fog interception, irrigation, ET, direct runoff, soil type, land cover, and seepage from reservoirs and septic systems. For the model calculations, the Island of Maui is subdivided into small areas with homogeneous properties, termed subareas. A map of subareas is generated using Esri ArcGIS software (*www.esri.com*) by intersecting (merging) spatial datasets that characterize the spatial distribution of rainfall, fog, irrigation, reference ET, direct runoff, soil type, and land cover. Intersecting the spatial datasets resulted in 318,429 subareas–with an average area of about 1.5 acres–for the Maui water-budget model.

The water-budget model treats each subarea independently. Water transfers between subareas are not included in the model calculations. The model domain of each subarea extends vertically from the vegetation canopy to the base of the plant-root zone, the part of the soil and bedrock containing roots. Properties of the substrate beneath the plant-root zone are not included in the model calculations.

For each subarea, the water-budget model calculates recharge on a daily basis for the period of the scenario. In this study, we used two scenarios: one for average climate conditions and one for drought conditions. Mean annual recharge for each scenario is determined for each subarea. Mean annual recharge for subareas is also summed over larger areas of interest, including Maui’s 25 aquifer systems.

For each subarea, the model calculates an interim moisture storage value at the start of each day. Interim moisture storage is the amount of water that enters the plant-root zone for the current day plus the amount of water already in the plant-root zone from the previous day. For the first day of the simulation, a value for the amount of water already in the plant-root zone from the previous day (initial soil moisture) is selected. For subareas with nonforest land covers, interim moisture storage, X_i, is given by the equation

$$X_i = R_i + F_i - U_i + I_i + L_i + W_i + M_{i-1}, \qquad (1a)$$

where

X_i = interim moisture storage for current day [L],
R_i = rainfall for current day [L],
F_i = fog interception for current day [L],
U_i = direct runoff for current day [L],
I_i = irrigation for current day [L],
L_i = septic-system leachate for current day [L],
W_i = excess water from the impervious fraction of the subarea distributed over the pervious fraction of the subarea [L],
M_{i-1} = moisture storage at the end of the previous day (i-1) [L], and
i = subscript designating current day.

For subareas with forest land covers, interim moisture storage is given by the equation

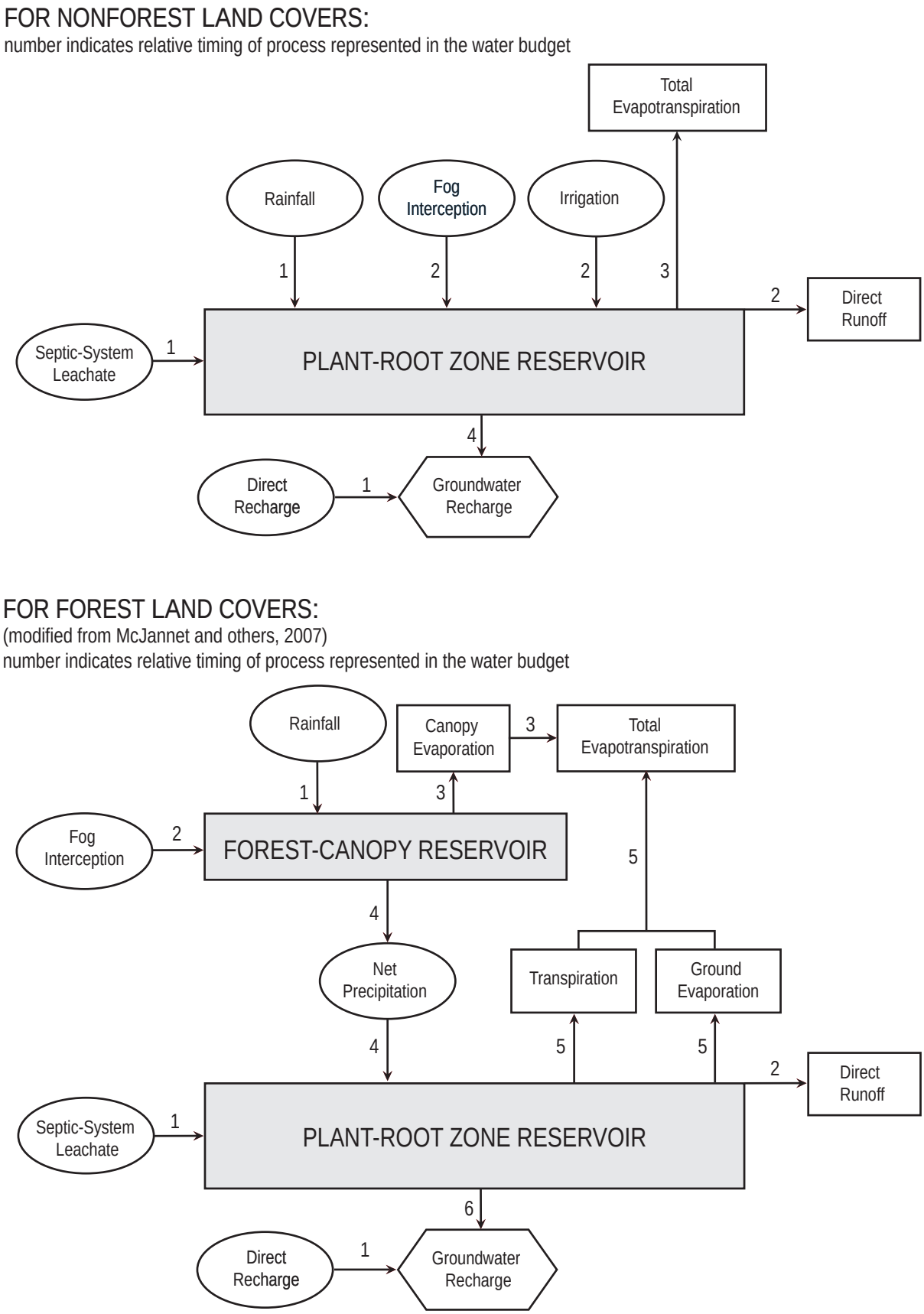


Figure 5. Generalized water-budget flow diagrams for both forest and nonforest land covers.

$$X_i = (NP)_i - U_i + L_i + W_i + M_{i-1}, \qquad (1b)$$

where

$(NP)_i$ = net precipitation for current day [L].

For subareas with forest land covers, net precipitation is computed as precipitation minus canopy evaporation, which is the amount of precipitation that is intercepted by and evaporates from the leaves, stems, and trunks of a forest. Precipitation is the sum of rainfall and fog interception:

$$P_i = R_i + F_i \qquad (2)$$

where

P_i = precipitation for current day [L].

Net precipitation is computed as:

$$(NP)_i = P_i - (CE)_i, \qquad (3)$$

where

$(CE)_i$ = forest-canopy evaporation for current day [L].

The water-budget model computes forest-canopy evaporation using an approach that is derived from the rainfall-interception model described by Gash and others (1995), herein referred to as the Gash model. Using this approach, canopy evaporation for a given day and location depends on precipitation amount, forest structure, and mean rates of evaporation and precipitation. The Gash model was modified for this study so that (1) precipitation includes rainfall and fog interception, instead of rain only, and (2) water cannot be stored on the forest canopy for more than a day. The forest structure is characterized in terms of canopy cover, canopy capacity, trunk-storage capacity, and the proportion of precipitation diverted to stemflow. Canopy cover, *c*, is the fraction of a forested subarea that is covered by leaves, stems, and branches of trees. Canopy capacity, *S*, is the depth of water left on the canopy when rainfall and throughfall have ceased (Gash and Morton, 1978). Evaporation of water from tree trunks is accounted for by the model using the proportion of precipitation that is diverted to stemflow, *p*, and trunk-storage capacity, *k*, which is considered in terms of an equivalent depth of precipitation. The last parameter needed for the Gash model is the ratio of the mean evaporation rate to the mean precipitation rate during saturated conditions, *V*.

To compute forest-canopy evaporation, the first step is to determine the minimum depth of precipitation necessary to saturate the forest canopy, *P’* (Gash and others, 1995). On the basis of equation 2 in Gash and others (1995), *P’* for subareas with forest land covers is computed as

$$P' = -\{S \div (c \times V)\} \times \ln(1 - V). \qquad (4)$$

where

P' = precipitation necessary to saturate the canopy [L],
S = canopy capacity per unit of ground area [L] (a constant),
c = canopy cover per unit of ground area [dimensionless], and
V = ratio of mean evaporation rate to mean precipitation rate during saturated conditions [dimensionless].

On the basis of the revised analytical form of the Gash model presented in table 1 of Gash and others (1995), forest-canopy evaporation for a given day, $(CE)_i$, was computed for three canopy conditions as follows:

for $P_i < P'$,

$$(CE)_i = c \times P_i,$$

for $P_i \geq P'$ and $P_i \leq k \div p$,

$$(CE)_i = c \times P' + c \times V \times (P_i - P') + p \times P_i,$$

for $P_i \geq P'$ and $P_i > k \div p$,

$$(CE)_i = c \times P' + c \times V \times (P_i - P') + k, \qquad (5)$$

where

k = trunk-storage capacity [L] (a constant), and
p = proportion of precipitation diverted to stemflow [dimensionless].

For each subarea with impervious surfaces, such as paved roads and buildings, the interim moisture-storage equations include the factor W_i (see equations 1a and 1b), which is a function of the fraction of the subarea that is impervious. For subareas with no impervious surfaces, W_i is zero. The fraction of the subarea that is impervious, *z*, is used to separate, from the total rain that falls in a subarea, a depth of water that is treated computationally as though it fell on an impervious surface. Based on the rainfall-retention capacity of the impervious surface, some water is subtracted to account for direct evaporation. The remaining water is considered excess water, W_i. For subareas without storm-drain systems, W_i is added to the water budget of the pervious fraction of the model subarea. In this case, the total daily water input for the pervious fraction of a subarea includes excess water from the impervious fraction (equations 1a and 1b). For subareas with storm-drain systems, W_i is assumed to be collected by storm-drain systems and is added to runoff or to direct recharge, depending on location.

For subareas with impervious surfaces, excess water, W_i, is determined using the following conditions:

$$X1_i = P_i - U_i + T_{i-1}, \quad (6)$$

for $X1_i \leq N$, $W_i = 0$, and $X2_i = X1_i$,

for $X1_i > N$, $W_i = (X1_i - N) \times z \div (1 - z)$, and $X2_i = N$, (7)

where

$X1_i$ = first interim moisture storage on the surface of impervious area for current day [L],
$X2_i$ = second interim moisture storage on the surface of impervious area for current day [L],
T_{i-1} = water storage (ponded water) on the surface of impervious area at the end of the previous day (i –1) [L],
N = rainfall-retention capacity of the impervious surface (maximum amount of water storage on the surface of impervious area) [L], and
z = fraction of area that is impervious [dimensionless].

The water storage on the surface of the impervious area at the end of the current day, T_i, is determined from the equation:

for $X2_i \leq G_i$, $T_i = 0$,

for $X2_i > G_i$, $T_i = X2_i - G_i$, and (8)

where

G_i = reference ET for current day [L], and
T_i = water storage (ponded water) on the surface of impervious area at the end of day [L].

The next step in the water-budget computation is to determine the amount of water that will be removed from the plant-root zone by ET. Actual ET is a function of potential ET and interim moisture, X_i. The plant-root zone loses water to the atmosphere at the potential-ET rate if sufficient water is available. At all sites, potential ET, $(PE)_i$, is computed as the product of (1) reference ET, G_i, the potential ET of a grass reference surface, and (2) crop coefficient, k_c, a factor that depends on vegetation and land cover.

$$(PE)_i = k_c \times G_i \quad (9)$$

where

$(PE)_i$ = potential-ET rate for the current day [L/T], and
k_c = crop coefficient of land cover [dimensionless].

For moisture storage greater than or equal to a threshold value, C_i, the actual-ET rate is assumed to be equal to the potential-ET rate. For moisture storage less than C_i, the actual-ET rate is assumed to occur at a reduced rate that declines linearly with soil-moisture content:

for $M \geq C_i$, $E = (PE)_i$, and

for $M < C_i$ and $C_i > 0$ $E = M \times (PE)_i \div C_i$, (10)

where

E = instantaneous actual-ET rate [L/T],
M = instantaneous moisture storage [L], and
C_i = threshold moisture storage for the current day below which the actual-ET rate is less than the potential-ET rate [L].

The threshold moisture storage, C_i, is estimated using the model of Allen and others (1998) for soil moisture. In this model, a depletion fraction, d, which ranges from 0 to 1, is defined as the fraction of maximum moisture storage that can be depleted from the plant-root zone before moisture stress causes a reduction in the actual-ET rate. Values for d are assigned to land-cover classes on the basis of data in Allen and others (1998). The threshold moisture, C_i, is estimated from d by the equation

$$C_i = (1 - d) \times M_m, \quad (11)$$

where

M_m = moisture-storage capacity of the plant-root zone [L].
d = depletion fraction [dimensionless].

The moisture-storage capacity of the plant-root zone, M_m, expressed as a depth of water, is equal to the plant-root depth, D, multiplied by the available water capacity of the soil, ϕ. Available water capacity is the difference between the volumetric field-capacity moisture content and the volumetric wilting-point moisture content:

$$M_m = D \times \phi, \quad (12)$$

where

D = plant root depth [L],
ϕ = available water capacity, $\theta_{fc} - \theta_{wp}$ [L^3/L^3],
θ_{fc} = volumetric field-capacity moisture content [L^3/L^3], and
θ_{wp} = volumetric wilting-point moisture content [L^3/L^3].

In the water-budget model, the actual-ET rate from the plant-root zone may be (1) equal to the potential-ET rate for part of the day and less than the potential-ET rate for the

remainder of the day, (2) equal to the potential-ET rate for the entire day, or (3) less than the potential-ET rate for the entire day. The total ET from the plant-root zone during a day is a function of the potential-ET rate, $(PE)_i$, interim moisture storage, X_i, and threshold moisture content, C_i. By recognizing that $E = -dM/dt$, the total depth of water removed by ET from the plant-root zone during a day, E_i, is determined as follows:

for $X_i > C_i$ and $C_i > 0$,

$$E_i = (PE)_i t_i + C_i\{1 - \exp[-(PE)_i(1-t_i) \div C_i]\},$$

for $X_i > C_i$ and $C_i = 0$,

$$E_i = (PE)_i t_i,$$

for $X_i \leq C_i$ and $C_i > 0$,

$$E_i = X_i\{1 - \exp[-(PE)_i \div C_i]\}, \text{ and}$$

for $X_i = C_i$, and $C_i = 0$,

$$E_i = 0, \qquad (13)$$

where

E_i = evapotranspiration from the plant-root zone during the day [L],

t_i = time during which moisture storage is above C_i [T]. It ranges from 0 to 1 day and is computed as follows:

for $(X_i - C_i) < (PE)_i(1 \text{ day})$

$$t_i = (X_i - C_i) \div (PE)_i, \text{ and}$$

for $(X_i - C_i) \geq (PE)_i(1 \text{ day})$,

$$t_i = 1. \qquad (14)$$

After accounting for runoff (equation 1a or 1b), actual ET from the plant-root zone for a given day is subtracted from the interim moisture storage, and any moisture remaining above the maximum moisture storage is assumed to be recharge. The daily rate of direct recharge from anthropogenic sources, including seepage from cesspools and reservoirs, is also added to daily recharge at this point. Recharge and moisture storage at the end of a given day are assigned according to the following conditions:

for $X_i - E_i \leq M_m$, $Q_i = DR$, and $M_i = X_i - E_i$, and

for $X_i - E_i > M_m$, $Q_i = (X_i - E_i - M_m) + DR$, and $M_i = M_m$, (15)

where

Q_i = groundwater recharge during the day [L], and

M_i = moisture storage at the end of the current day (i) [L], and

DR = daily rate of direct recharge [L] (a constant).

Model Input

Land Cover

A land-cover map for Maui representative of 2010 conditions, herein referred to as the 2010 land-cover map, was developed by Johnson (2014) for this study. The 2010 land-cover map identifies 21 types of land cover (fig. 4) and was intersected with other spatial datasets when creating the map of subareas for the water-budget model. The 2010 land-cover map was used in the computation of recharge for both scenarios of this study: average climate conditions and drought conditions. The 2010 land-cover map was created by modifying the LANDFIRE Existing Vegetation Type map for Maui (U.S. Geological Survey, 2010), herein referred to as the Landfire map. Modifications to the Landfire map included converting it from a raster dataset to a vector dataset, combining similar land-cover classes, and adding boundaries of golf courses and selected crops. These modifications were done using Esri ArcGIS software, as summarized next. Additional details are included in the metadata of Johnson (2014).

Some land-cover groups of the Landfire map were combined into more general classes for the 2010 land-cover map. Landfire groups “Hawaiian Dry Grassland,” “Hawaiian Mesic Grassland,” and “Introduced Perennial Grassland and Forbland” were combined into “Grassland” for the 2010 land-cover map (fig. 4). Landfire groups “Hawaiian Dry Shrubland,” “Hawaiian Mesic Shrubland,” and “Introduced Upland Vegetation – Shrub” were combined into “Shrubland.” Landfire groups “Hawaiian Dry Forest,” “Hawaiian Mesic Forest,” and “Hawaiian Rainforest” were combined into “Native forest.” The Landfire group “Introduced Upland Vegetation-Treed” was renamed as “Alien forest.”

Locations of golf courses and selected crops not specified in the Landfire map were delineated in the 2010 land-cover map to improve estimates of irrigation, ET, and recharge for parcels with these types of land cover. We defined the boundaries of sugarcane, coffee, pineapple, and taro fields, as well as golf courses, in the 2010 land-cover map (fig. 4) by using sources other than the Landfire map. We defined boundaries of sugarcane fields by using a 2000–04 land-cover map by Engott and Vana (2007) and a plantation-divisions map (Hawaiian Commercial & Sugar Company, 2008). We digitized the boundaries of golf courses and fields of coffee and pineapple by using 2010–13 satellite imagery in Google Earth (*earth.google.com*) and recent orthoimagery (U.S. Department of Agriculture,

2007). Fields of taro were digitized on the basis of those identified in Gingerich and others (2007).

Parcels classified as agriculture in the Landfire map (other than those within fields of sugarcane, pineapple, or coffee) were reclassified by the authors in the 2010 land-cover map as either macadamia, diversified agriculture, fallow/grassland, low-intensity developed, or open-space developed using the 2000–04 land-cover map of Engott and Vana (2007), recent orthoimagery, and 2010–13 satellite imagery. Agriculture parcels with groves of trees on the east slope of West Maui Mountain were classified as macadamia. All other agriculture parcels that appeared in the imagery as being actively cultivated were classified as diversified agriculture. Additionally, we used recent orthoimagery and satellite imagery to digitize the boundaries of diversified-agriculture fields within the Kula Agricultural Park (fig. 4) in the 2010 land-cover map. These boundaries were digitized because water-supply data for Kula Agricultural Park were used to calibrate irrigation rates for diversified agriculture. Agriculture parcels that appeared in the imagery as uncultivated and mostly covered by grass were defined as fallow/grassland. Parcels defined as fallow/grassland include former pineapple fields on leeward West Maui Mountain that were abandoned when Maui Land & Pineapple Company ceased its pineapple operations there at the end of 2009 (Maui News, December 24, 2009). The fallow/grassland land-cover class likely includes parcels that were used as grazing pastures. Parcels defined as Agriculture in the Landfire map and that were adjacent to, but not within, the fields of sugarcane, pineapple, or coffee were classified in the 2010 land-cover map as either grassland, open-space developed, or low-intensity developed on the basis of the land cover for nearby parcels.

Impervious Surfaces

Impervious surfaces include paved surfaces and buildings. Excess water from the impervious fraction of a subarea, W_i, that is distributed to the pervious fraction of the subarea depends on the impervious fraction of the subarea, z. The impervious fraction of each subarea was computed from a map of impervious surfaces on Maui (National Oceanic and Atmospheric Administration, 2008).

Rainfall

Monthly Rainfall

Gridded maps of rainfall for each of the 360 months during 1978–2007 for the Island of Maui were used to define the spatial and temporal distribution of rainfall in the water-budget calculations. These maps are a subset of the 1,056 maps of rainfall for each month during 1920–2007 for the Hawaiian Islands (Frazier, 2012) generated for the Rainfall Atlas of Hawai‘i (Giambelluca and others, 2013). The monthly rainfall maps for 1978–2007 were used in the water budget because they have the same base period as the mean monthly and mean annual rainfall datasets of the Rainfall Atlas of Hawai‘i. Rainfall maps are formatted 8.1-arcsecond grids, where each grid cell is about 14 acres (770 by 820 ft) and has an estimated rainfall value for each month during 1978–2007. Using Esri ArcGIS software, the monthly rainfall maps were converted from a raster grid to polygon format for use in the water-budget model. The rainfall polygons were intersected with the other spatial datasets when the map of subareas for the water-budget model was created.

Daily Rainfall

Estimates of the actual rainfall pattern on Maui for each day during 1978–2007 were not available and were not developed as part of this study. Although records of daily rainfall measurements at gages were available, reconstructing the actual daily rainfall pattern was not attempted because (1) records for many gages have considerable gaps, (2) the spatial interpolation of daily records for gages would have high uncertainty, and (3) the monthly rainfall maps of Frazier (2012) were considered to be the best dataset available for estimating historical rainfall patterns.

The water-budget model synthesized daily rainfall by disaggregating the monthly values of the 1978–2007 rainfall distribution maps using the method of fragments (for example, Oki, 2002). The method of fragments creates a synthetic sequence of daily rainfall from monthly rainfall by imposing the rainfall pattern from a rain gage with daily data. The synthesized daily rainfall data approximate the long-term average character of daily rainfall, such as frequency, duration, and intensity, but may not reproduce the historical daily rainfall record during 1978–2007.

Daily rainfall measurements at 52 rain gages on Maui during 1905–2011 were used to disaggregate monthly rainfall into daily rainfall for the water-budget model. Rain gages were selected on the basis of location and length and completeness of daily records. Daily rainfall data for the rain gages’ period of record were obtained from the National Climatic Data Center (*www.ncdc.noaa.gov*) and the USGS (*http://waterdata.usgs.gov/hi/nwis/nwis*). Thiessen polygons were drawn around each of the rain gages, and the daily rainfall pattern within each Thiessen polygon was assumed to be the same as the pattern at the rain gage within the Thiessen polygon (fig. 3).

For each rain gage, daily rainfall fragments were computed by dividing each daily rainfall measurement for a particular month by the total rainfall measured at the gage for that month. This resulted in a set of fragments for that particular month in which the total number of fragments was equal to the number of days in the month. Fragment sets were compiled for every gage for every month in which complete daily rainfall measurements were available. Fragment sets were grouped by month of the year and by rain gage. In the water-budget calculation, the fragment set to be used for a given gage for a given month was selected randomly from among all available sets for that gage for that month. Daily rainfall for a given month was synthesized

by multiplying total rainfall for that month (from the monthly rainfall maps) by each fragment in the set, thereby providing daily rainfall, R_i, for equation 1a or 1b.

Owing to insufficient daily records, fragment sets for each of the 12 calendar months were not available for rain gages with Cooperative Station Network numbers 0790, 6635, 6645, and 7066 (fig. 3). These four gages were assigned fragment sets from nearby gages with similar amounts of mean rainfall. Gage 0790 was assigned the gage 1892 fragment set, gage 6635 the gage 4887 fragment set, gage 6645 the gage 9315 fragment set, and gage 7066 the gage 5404 fragment set.

Fog Interception

In Hawai‘i, fog most frequently occurs where mountain slopes are immersed in a persistent layer of clouds. Clouds can form when moist air cools and condenses as it is forced upslope by trade winds and by thermal circulation systems such as sea breezes. As fog flows near the land surface, vegetation may intercept some of the fog moisture. Fog moisture that accumulates on vegetation is called “fog interception” or “cloud-water interception.” At places where fog is frequent, intercepted fog moisture that drips from the vegetation to the ground can be a substantial part of the water budget (Ekern, 1964; Juvik and Ekern, 1978; Juvik and Nullet, 1995; Heath and Huebert, 1999; Scholl and others, 2007; Giambelluca and others, 2011; Takahashi and others, 2011). Areas in Hawai‘i that frequently have fog are in the “cloud zone,” which is between altitudes of about 2,000 and 8,200 ft (fig. 4; DeLay and Giambelluca, 2010). Fog can also form in areas above the cloud zone (Juvik and Ekern, 1978).

Much effort has been to done to quantify cloud-water interception (CWI) for forests in Hawai‘i. According to a summary of fog research in Hawai‘i, CWI estimates range between 4 and 20 in/yr for most leeward sites within the cloud zone, and between 11 and 44 in/yr for most windward sites within the cloud zone (DeLay and Giambelluca, 2010). On Maui, Giambelluca and others (2011) and Scholl and others (2007) used different approaches to estimate CWI for two forested sites on Haleakalā: Auwahi and Waikamoi (fig. 3). Auwahi is near 4,000 ft altitude on leeward Haleakalā; Waikamoi is near 6,400 ft altitude on windward Haleakalā. Using a canopy water-balance approach, Giambelluca and others (2011) determined CWI to be about 6.5 in/yr at Auwahi and about 48 in/yr at Waikamoi. Using a stable isotopic mixing-model approach, Scholl and others (2007) estimated that cloud water was 46 and 37 percent of total precipitation at Auwahi and Waikamoi, respectively. By combining the results of Scholl and others (2007) with 1978–2007 mean annual rainfall near Auwahi (about 29 in/yr) and Waikamoi (about 82 in/yr), we computed CWI to be about 25 in/yr at Auwahi, and 48 in/yr at Waikamoi.

Fog interception was quantified in the water-budget model for four land-cover classes: alien forest, native forest, tree plantation, and shrubland. On the basis of previous fog and CWI estimates for Hawai‘i, mean annual fog interception for forests on Maui was assumed to vary with altitude and aspect for the water budget (table 3). For forests below the typical base of the cloud zone (2,000 ft altitude), fog interception was assumed to be negligible in both leeward and windward areas. For forests within the cloud zone (2,000–8,200 ft altitude) mean annual fog interception was assumed to be near the midpoints of the ranges of the CWI measurements for leeward and windward sites in Hawai‘i (table 3). The midpoints of the ranges were used because the existing set of fog and CWI measurements in Hawai‘i may not be representative of the majority of the cloud-forest area across the state (DeLay and Giambelluca, 2010). For example, many of the CWI estimates in Hawai‘i are from fog-gage measurements in large clearings or along ridges, or are based on canopy water-balance measurements at forest edges. At such exposed areas and forest edges, wind velocity and fog density is much higher than within the canopy of a closed canopy forest (DeLay and Giambelluca, 2010). Hence the cloud-water input at these measurement sites, including Auwahi and Waikamoi, may be greater than cloud-water input for large areas of continuous forests (Giambelluca and others, 2011).

Mean annual fog interception was assumed to decrease uniformly with altitude from the values for the cloud zone to 6 in/yr near the Haleakalā summit (table 3). The assumption of decreasing fog interception with altitude above the cloud zone is based on the fog-altitude relation shown in figure 35.3 of and DeLay and Giambelluca (2010). A fog-interception rate of 6 in/yr is based on three fog-interception studies conducted at about 11,200 ft altitude on northern Mauna Loa, Island of Hawai‘i (Juvik and Perreira, 1974; Juvik and Ekern, 1978) and summarized in DeLay and Giambelluca (2010, table 35.1). Much of the area above the cloud zone on Maui is not forested but is sparsely vegetated or shrubland (fig. 4).

Mean annual fog-interception rates for shrubland subareas were assumed to be half of the rates for forest subareas

Table 3. Mean fog-interception rates used in the water-budget calculation for average climate conditions for Maui, Hawai‘i.

[Fog-interception rates in this table were used for forest land covers: alien forest, native forest, and tree plantation. For areas with shrubland land cover, fog-interception rates were assumed to be half of the rates in this table. See fig. 4 for land covers and the cloud zone for Maui. The altitude range of the cloud zone is based on areas with frequent cloud contact, as defined by DeLay and Giambelluca (2010). See fig. 6 for boundary between windward and leeward areas. <, less than; >, greater than]

Altitude range, in feet above mean sea level		Location relative to cloud zone	Fog-interception rate, in inches per year	
From	To		Leeward aspect	Windward aspect
0	<2,000	Below	0	0
2,000	8,200	Within	14	30
>8,200	<9,000	Above	10	18
9,000 and higher		Above	6	6

(table 3). This assumption was also used in recent water budgets for Hawai‘i (for example, Engott and Vana, 2007; Engott, 2011), and is based on the premise that shrubs are usually shorter than trees and consequently have a smaller silhouette and less potential to intercept fog water. Fog interception was assumed to be negligible at all altitudes for land-cover classes other than forests and shrubland. Coffee and macadamia land covers, which have the potential to intercept fog moisture, were assumed to have no fog interception for this study because they are at altitudes below the cloud zone (fig. 4).

Owing to the sparseness of monthly fog data for Maui, mean annual fog interception for a given subarea was apportioned equally to each month of the year in the water-budget calculations. Fog interception was assumed to occur only on days with rainfall. Daily fog interception was computed in the water budget as a fraction of daily rainfall equivalent to the ratio of mean monthly fog interception and mean monthly rainfall during 1978–2007. These resulting fog-to-rainfall ratios were used to compute recharge for average climate conditions and for drought conditions.

Estimating fog interception in the water budget requires many assumptions because the magnitude, temporal variability, and spatial variability of fog interception on Maui are not well known. A better understanding of these characteristics would improve fog-interception estimates of the water budget. The fog-to-rainfall ratios used to compute fog interception for this study, however, result in fog-interception values that are within the range of most CWI and fog-interception measurements in Hawai‘i. Because of the uncertainty in fog-interception rates on Maui, alternative fog-interception rates are evaluated in the Sensitivity Analysis section of this report.

Irrigation

Irrigation was applied to golf courses and five agricultural land covers: coffee, diversified agriculture, pineapple, sugarcane, and taro (fig. 4). Irrigation was also applied to medium- and high-intensity developed subareas in order to simulate the watering of urban landscapes. Of these irrigated land-cover classes, sugarcane is the most expansive, totaling slightly less than 9 percent of the study area. The other irrigated land-cover classes total about 3 percent of the study area.

Irrigation Estimates

We estimated irrigation rates using a demand-based approach, similar to the approach used to estimate irrigation for the Hawaii Agricultural Water Use and Development Plan (Department of Natural Resources and Environmental Management, 2008). The estimated irrigation rate is intended to replenish the water content in the root zone to reach field capacity. Irrigation demand for a given subarea is estimated on the basis of monthly rainfall, runoff, and potential evapotranspiration:

for $(PE)_m + U_m > R_m$,

$$I_m = \{(PE)_m + U_m - R_m\} \div g$$

for $(PE)_m + U_m \leq R_m$,

$$I_m = 0 \qquad (16)$$

where

$(PE)_m$ = potential evapotranspiration for month m [L] (varies by location),
U_m = amount of runoff for month m [L],
R_m = amount of rainfall for month m [L],
I_m = amount of irrigation for month m [L], and
g = irrigation efficiency [dimensionless] (varies by irrigation method).

Irrigation rates also depend on the efficiency, g, of the irrigation method. Irrigation efficiency is the ratio of volume of water consumed by vegetation to the volume of water applied for irrigation. Hawaiian Commercial & Sugar Company (HC&S) uses drip irrigation for its sugarcane fields. On the basis of information provided by HC&S, the water budget of Engott and Vana (2007) computed drip irrigation for HC&S’ sugarcane fields using an irrigation efficiency of 0.80. An irrigation efficiency of 0.80 was also used to compute sugarcane irrigation in the water budget for this study. The irrigation efficiencies used in the water budget for all remaining irrigation methods were obtained from table 3.1 of Department of Natural Resources and Environmental Management (2008). Diversified agriculture and pineapple were assumed to use drip irrigation, which has an irrigation efficiency of 0.85. Coffee was assumed to use micro-spray irrigation, which has an irrigation efficiency of 0.80. Golf course, and medium- and high-intensity developed land covers were assumed to use sprinkler irrigation, which has an irrigation efficiency of 0.70.

For all irrigated land covers other than sugarcane, pineapple, and taro, monthly irrigation estimated from equation 16 was allocated in equal amounts for each day of a given month. To simulate irrigation practices for sugarcane on Maui, as described in detail by Engott and Vana (2007) and briefly summarized here, irrigation rates for sugarcane were varied throughout the cultivation cycle. Sugarcane was assumed to have a 24-month cultivation cycle. For a given sugarcane field, irrigation water was applied during for the first 20 months of the cycle. Monthly irrigation during the first 20 months of the cycle was computed according to equation 16 and was equally apportioned to the field on days 1, 2, 3, 8, 9, 10, 15, 16, 17, 22, 23, 24, 28 of each month. No irrigation was applied to the field during the last 4 months of the 24-month cycle. The sugarcane was assumed to be harvested at the end of month 22 of the 24-month cycle. The field was assumed to be fallow during the last 2 months of the cycle. HC&S staggers its cultivation cycles of sugarcane fields such that about half the fields will

be harvested in any one year. In the water-budget calculation, sugarcane fields were randomly divided into two groups such that half of each plantation began active cultivation at the start of the simulation and the other half after 12 months into the cultivation cycle.

Similar to the approach taken in Engott and Vana (2007) for pineapple irrigation, the monthly irrigation volume calculated for pineapple using equation 16 was uniformly distributed on days 1, 2, 3, 8, 9, 10, 15, 16, 17, 22, 23, 24, 28 of each month. Simulation of the pineapple cultivation cycle was not attempted in this study and irrigation was assumed for all months of the simulation period.

Owing to the nature of taro cultivation, the irrigation rate for taro was not computed using the demand-based approach (equation 16). Instead, the irrigation rate for taro was assumed to be 455 in/yr. A constant irrigation rate was used because wetland taro, which is grown in flood ponds, was assumed to have a constant recharge rate of 455 in/yr. A rate of 455 in/yr is the mean of the recharge rates derived from four water-use studies for various taro fields in Hawai‘i (Miles, 1931; Watson, 1964; La Pena and Melchor, 1984; Berg and others, 1997).

Irrigation Calibrations

Irrigation rates may be limited by the supply or availability of irrigation water. Irrigation rates in the water-budget model for diversified agriculture, and medium- and high-intensity developed land covers were calibrated on the basis of historical water-availability data. The calibrated irrigation rates for these land covers do not account for spatial variations in water availability or irrigation practices. Estimated irrigation rates for sugarcane were deemed to be consistent with average water availability. Irrigation rates for pineapple, coffee, taro, and tree plantations could not be calibrated because complete records of historical water availability were not readily available for areas with these land covers.

Irrigation rates for diversified agriculture were calibrated on the basis of water supplied to Kula Agricultural Park, on northwest Haleakalā (fig. 4). Mean annual water supplied to Kula Agricultural Park was about 0.56 Mgal/d for 2004–07 according to data provided by the County of Maui Department of Water Supply. If water losses are assumed to be 10 percent of the water supply, then about 0.50 Mgal/d is available for irrigation if other water uses are ignored. On the basis of rainfall during 2004–07 and an irrigation efficiency of 0.85, the demand-based water-budget irrigation rates for Kula Agriculture Park need to be multiplied by a calibration factor of 0.41 in order to be consistent with water availability. Irrigation practices for Kula Agricultural Park were assumed to be representative of irrigation practices for other areas with diversified agriculture on Maui. Accordingly, irrigation rates computed using equation 16 were multiplied by 0.41 for all subareas with diversified agriculture on Maui.

Irrigation rates for medium- and high-intensity developed land covers computed using equation 16 were multiplied by 0.37. This calibration factor, 0.37, was derived for the Island of O‘ahu by the authors using historical water availability for irrigation of abundant urbanized areas on the southern part of O‘ahu. Better information regarding actual irrigation rates in urbanized areas on Maui would improve estimates of urban irrigation in the water-budget model.

Irrigation rates for sugarcane estimated in the water-budget model for average climate conditions were not adjusted because they were deemed consistent with average water available for irrigation. HC&S reported that average water availability was 7,689 gallons per acre per day [(gal/acre)/d] for the majority of its sugarcane fields during 1984–2007 (State of Hawai‘i, 2010, p. G-3). After accounting for the HC&S estimated system losses and industrial uses (State of Hawai‘i, 2010, Exhibit G-1), average water available for irrigating these sugarcane fields was about 6,720 (gal/acre)/d. Average irrigation estimates of the water-budget model for these sugarcane fields was about 6,139 (gal/acre)/d when we used rainfall for average climate conditions (1978–2007), and was about 6,163 (gal/acre)/d when we used rainfall for the HC&S long-term period (1984–2007); these irrigation estimates are less than average water availability.

Septic-System Leaching

Some buildings and premises on Maui use on-site systems to dispose of wastewater. Whittier and El-Kadi (2013) compiled an inventory of on-site wastewater-disposal systems on Maui. For each tax map key (TMK) parcel, Whittier and El-Kadi (2013) specify the number and type (class) of on-site disposal systems and the total estimated wastewater effluent flux. For the water-budget calculation, all effluent flux for each TMK parcel was applied daily as a uniform depth over the parcel’s area. Each TMK parcel may contain one or more subareas. Hence all subareas, including those that do not have developed land cover, within a TMK parcel that contains an on-site disposal system can have septic effluent. For TMK parcels with cesspools, the effluent flux was considered direct recharge (fig. 5). For TMK parcels with other types of septic-systems, the effluent flux was added to the plant-root zone as septic-system leachate (fig. 5).

Storm-Drain Systems

Some developed areas on Maui have storm-drain systems that collect and divert of rainwater that runs off the surface. Water collected by storm-drain systems may be diverted into streams, gulches, the ocean, infiltration basins, and drywells. Hence, storm-drain systems can affect the water budget. The County of Maui Department of Public Works (Cary Yamashita, oral commun., 2013) provided information to help define the areas on Maui that have storm-drain systems and where these systems dispose of water.

For this study, a general approach was used to account for water collected and disposed by storm-drain systems. In the

water-budget calculation, subareas with medium- and high-intensity developed land covers were assumed to have storm-drain systems (fig. 4). For these subareas, excess water, W_i, that flows off of impervious surfaces was assumed to be collected by storm-drain systems instead of flowing to adjacent pervious surfaces (see equation 7). Excess water collected by storm-drain systems was counted in the water budget as either direct runoff or direct recharge, depending on location. For areas near Waiehu, Wailuku, Kahului, Pāʻia, and Kīhei, excess water collected by storm-drain systems was counted as runoff because it was assumed to be diverted into streams, gulches, and the ocean (fig. 2). For areas near Lahaina, Kāʻanapali, and Nāpili, excess water collected by storm-drain systems was halved into runoff and recharge because it was assumed to be diverted into streams and gulches as well as infiltration basins and dry wells. All other subareas with storm drains were assumed to have systems that divert excess water into infiltration basins or drywells; excess water collected by these systems was counted as recharge. Exceptions to the general approach likely exist, but would require additional investigation to identify and this was beyond the scope of the study. The effects on recharge owing to counting all excess water from medium- and high-intensity developed areas as either runoff or recharge are evaluated in the Sensitivity Analysis section of this report.

Direct Runoff

Direct runoff is the fraction of rainfall that does not contribute to net moisture gain within the plant-root zone (fig. 5). Direct runoff of rainfall consists of overland flow and subsurface storm flow that rapidly returns infiltrated water to the stream (Oki, 2003). In the water-budget calculation, direct runoff was estimated as a fraction of rainfall using runoff-to-rainfall ratios. This approach was used also in previous water-budget studies for Hawaiʻi and other Pacific islands (for example, Izuka and others, 2005; Engott and Vana, 2007; Engott, 2011; Gingerich and Engott, 2012; Johnson, 2012) and was shown to provide reasonable estimates of regional average direct runoff using a minimal level of complexity.

The spatial variability of runoff-to-rainfall ratios depends on numerous factors including geology, climate, soil type, topography, and land use. Runoff-to-rainfall ratios are expected to be highest where the rainfall amount and intensity are high, permeability of the soils and substrate is low, slopes are steep, and soil moisture is high (Oki, 2003). The temporal variability in runoff-to-rainfall ratios reflects event characteristics, such as antecedent soil moisture and rainfall intensity. In Hawaiʻi, runoff-to-rainfall ratios generally follow a seasonal pattern. Runoff-to-rainfall ratios are highest during the wet-season months and lowest during the dry-season months.

In the water-budget model, daily direct runoff, U_i, was computed by multiplying daily rainfall, R_i, with seasonal (wet and dry season) runoff-to-rainfall ratios assigned to drainage basins termed catchment zones. The runoff-to-rainfall ratio used to compute direct runoff was either (1) the observed runoff-to-rainfall ratio if available for the time and location of interest, or (2) the mean seasonal runoff-to-rainfall ratio, determined from data or regression equations, if the observed ratio was not available. For the analysis, May through October was considered the dry season; November through April was considered the wet season. Catchment zones were delineated by Rea and Skinner (2012) for a stream network developed using a 10-m digital elevation model and a flow-accumulation threshold of 20,000 cells. For our study, catchment zones were grouped into windward and leeward regions (fig. 6). The boundaries between windward and leeward regions on Maui's two volcanoes are based on topographic divides. The 20-inch mean annual isohyet was used as the boundary between the windward region on West Maui Mountain and the leeward region on the isthmus. In general, the boundaries between windward and leeward regions are consistent with those determined in previous studies (Yamanaga, 1972, Oki and others, 2010).

Seasonal runoff-to-rainfall ratios assigned to catchment zones in the water-budget model were computed from data for drainage basins of stream-gaging stations. Catchment zones in ungaged areas were assigned mean seasonal runoff-to-rainfall ratios derived from regional-regression models. For each gaged drainage basin within a single catchment zone, observed seasonal and mean seasonal runoff-to-rainfall ratios for the gaged basin were assigned to the catchment zone. For each gaged drainage basin containing multiple catchment zones, observed seasonal and mean seasonal runoff-to-rainfall ratios for the gaged drainage basin were spatially disaggregated to each catchment zone within the gaged basin.

Computation of Seasonal Runoff-to-Rainfall Ratios

Runoff and rainfall data for drainage basins of 56 stream-gaging stations (25 on Maui, 13 on Kauaʻi and 18 on Oʻahu) were used to derive seasonal runoff-to-rainfall ratios for the water-budget model (table 4). Data for stations on Kauaʻi and Oʻahu were included in the analysis to derive broadly applicable empirical models for estimating direct runoff in ungaged areas. Stream-gaging stations selected for the runoff analysis had (1) at least eight complete years of daily mean discharge records between 1920 and 2007, (2) a drainage-basin area greater than 0.2 mi^2, and (3) unregulated streamflow or regulated streamflow with complete and reliable records of daily mean diverted flow available to reconstruct total streamflow at the gage. For drainage basins with more than one stream-gaging station, only the station at the lowest altitude was used in the runoff analysis because it had the largest drainage basin. Additionally, concurrent streamflow data for two stations within a drainage basin was generally absent or insufficient for improving direct runoff estimates. The drainage basins of the selected stream-gaging stations were delineated using the USGS StreamStats application for Hawaiʻi (Rosa and Oki, 2010). Rainfall within each drainage basin was computed using gridded maps of monthly

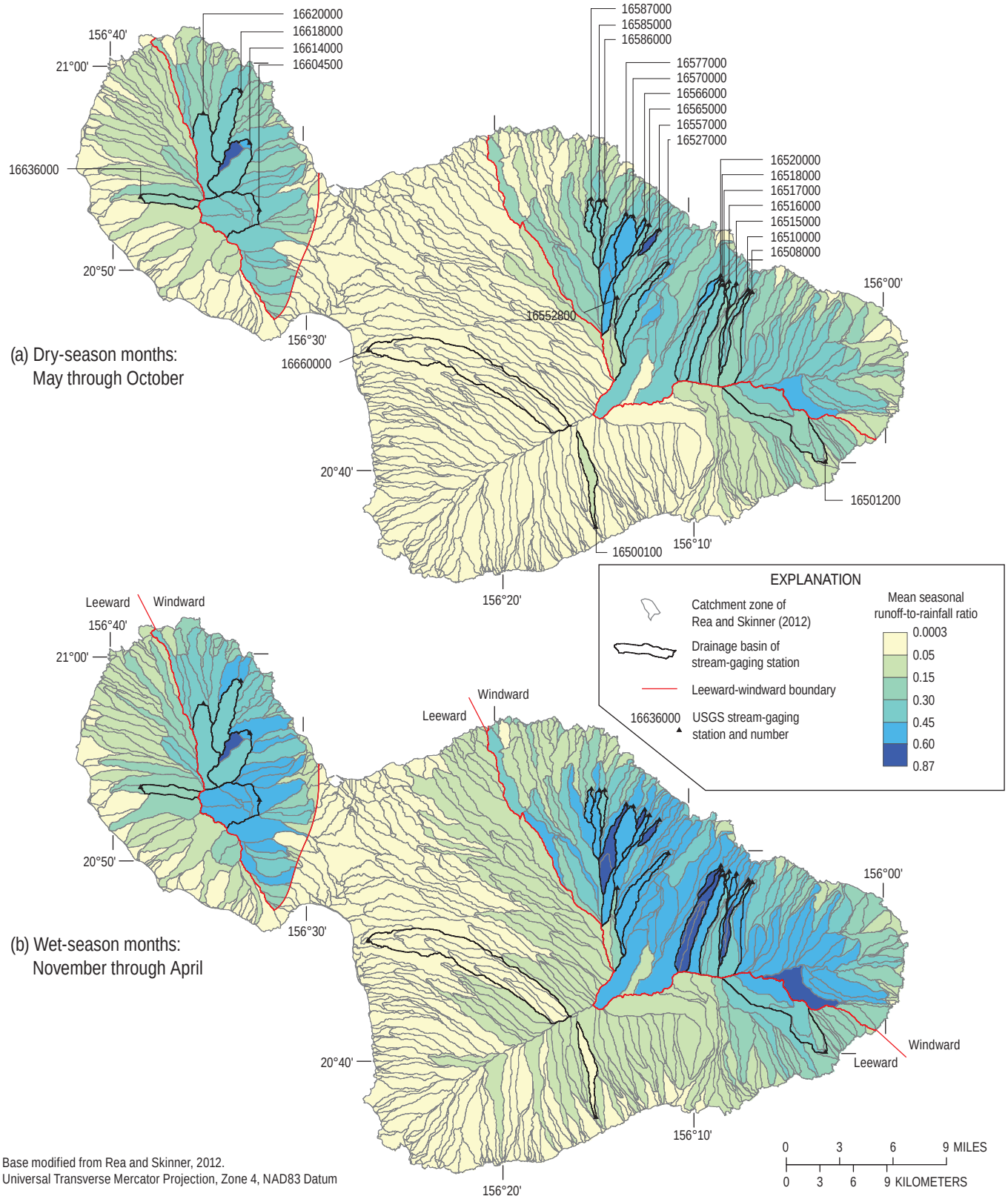


Figure 6. Mean runoff-to-rainfall ratios for the (a) Dry-season months: May through October and (b) Wet-season months: November through April for drainage basins of selected stream-gaging stations and catchment zones on Maui, Hawai‘i.

Table 4. Mean seasonal runoff-to-rainfall ratios for drainage basins of stream-gaging stations on Kaua‘i, O‘ahu and Maui, Hawai‘i.

[See fig. 6 for locations of drainage basins on Maui; *n*, number of days used for determining minimum flows in the base flow-separation program (Wahl and Wahl, 1995); E, the base flow-separation program (Wahl and Wahl, 1995) was not used to estimate direct runoff because the streamflow measured at station was ephemeral and was assumed to equal direct runoff; mean annual rainfall was estimated from Frazier (2012) and Giambelluca and others (2013)]

[1]Gaging-station number	Stream/river/gulch/valley	Island	Aspect	Drainage-basin area, in square miles	*n*	Period of record selected to compute mean runoff-to-rainfall ratios			Mean runoff-to-rainfall ratio		Mean annual rainfall	
						Start	End	Number of years	Wet season: November through April	Dry season: May through October	During 1978–2007, in inches	[2]Difference during selected period of record, percentage of mean during 1978–2007
16028000 (16022000, 16014000)	Waimea River	Kaua‘i	Leeward	43.68	5	1927	1947	21	0.31	0.24	89.0	1.0
16063000 (16100000, 16062000, 16061000)	North fork Wailua River	Kaua‘i	Windward	5.34	4	1957	1984	28	0.54	0.39	199.8	4.9
16068000	East bank of north fork Wailua River	Kaua‘i	Windward	6.24	4	1978	2007	30	0.50	0.27	129.0	0.0
16071500	Left branch ‘Ōpaeka‘a Stream	Kaua‘i	Windward	0.75	4	1978	2007	30	0.22	0.09	100.5	0.0
16089000 (16088000, 16087000)	Anahola Stream	Kaua‘i	Windward	5.45	4	1956	1985	30	0.49	0.36	108.5	4.3
16097500	Halaulani Stream	Kaua‘i	Windward	1.20	4	1978	2007	30	0.62	0.41	115.0	0.0
16103000	Hanalei River	Kaua‘i	Windward	18.51	4	1993	2007	15	0.54	0.32	175.4	4.0
16108000	Wainiha River	Kaua‘i	Windward	10.44	5	1978	2007	30	0.54	0.39	207.6	0.0
16114000	Limahuli Stream	Kaua‘i	Windward	1.37	4	1995	2005	11	0.36	0.21	116.5	3.1
16115000	Hanakāpī‘ai Stream	Kaua‘i	Windward	2.75	5	1941	1949	9	0.40	0.27	128.7	4.6
16116000	Hanakoa Stream	Kaua‘i	Windward	1.09	5	1939	1947	9	0.51	0.30	105.8	4.5
16117000	Kalalau Stream	Kaua‘i	Leeward	1.60	5	1932	1948	17	0.23	0.08	80.5	4.3
16130000	Nahomalu Valley	Kaua‘i	Leeward	3.79	E	1964	1971	8	0.04	0.01	36.6	24.6
16200000	North fork Kaukonahua Stream	O‘ahu	Leeward	1.38	4	1978	2007	30	0.48	0.49	232.4	0.0
16201000	Right bank of north fork Kaukonahua Stream	O‘ahu	Leeward	1.15	4	1940	1951	12	0.33	0.36	213.4	4.6

[1] Data for gaging-station numbers in parentheses were used to reconstruct streamflow at the gaging station whose number is not in parentheses.

[2] For example, mean annual rainfall on the drainage basin of station 16500100 was 22 percent greater during 1963–1972 than that during 1978–2007.

Table 4. Mean seasonal runoff-to-rainfall ratios for drainage basins of stream-gaging stations on Kaua‘i, O‘ahu and Maui, Hawai‘i.—Continued

[See fig. 6 for locations of drainage basins on Maui; n, number of days used for determining minimum flows in the base flow-separation program (Wahl and Wahl, 1995); E, the base flow-separation program (Wahl and Wahl, 1995) was not used to estimate direct runoff because the streamflow measured at station was ephemeral and was assumed to equal direct runoff; mean annual rainfall was estimated from Frazier (2012) and Giambelluca and others (2013)]

[1]Gaging-station number	Stream/river/gulch/valley	Island	Aspect	Drainage-basin area, in square miles	*n*	Period of record selected to compute mean runoff-to-rainfall ratios			Mean runoff-to-rainfall ratio		Mean annual rainfall	
						Start	End	Number of years	Wet season: November through April	Dry season: May through October	During 1978–2007, in inches	[2]Difference during selected period of record, percentage of mean during 1978–2007
16208000	South fork Kaukonahua Stream	O‘ahu	Leeward	4.10	5	1978	2007	29	0.32	0.28	168.9	
16211600	Mākaha Stream	O‘ahu	Leeward	2.12	5	1978	2007	30	0.13	0.04	71.2	0.0
16212800	Kīpapa Stream	O‘ahu	Leeward	4.25	4	1978	2004	27	0.19	0.13	178.3	-0.1
16216000	Waiawa Stream	O‘ahu	Leeward	25.19	4	1978	2004	27	0.21	0.12	93.7	-0.2
16226200	North Hālawa Stream	O‘ahu	Leeward	4.02	5	1983	2007	24	0.19	0.09	111.8	-2.8
16228000	Moanalua Stream	O‘ahu	Leeward	2.71	4	1949	1978	30	0.15	0.07	117.8	3.6
16229300	Kalihi Stream	O‘ahu	Leeward	5.21	4	1978	2003	26	0.21	0.11	97.6	-1.9
16244000	Pūkele Stream	O‘ahu	Leeward	1.15	5	1953	1982	30	0.14	0.08	114.6	3.4
16270500	Kamo‘olali‘i Stream	O‘ahu	Windward	3.20	3	1967	1976	9	0.18	0.07	82.8	1.9
16273950	South fork Kapunahala Stream	O‘ahu	Windward	0.42	3	1988	1997	10	0.13	0.09	78.4	2.9
16278000	‘Ioleka‘a Stream	O‘ahu	Windward	0.32	3	1944	1968	25	0.09	0.07	95.8	0.5
16283000	Kahalu‘u Stream	O‘ahu	Windward	0.28	3	1941	1970	30	0.12	0.08	119.2	2.5
16303000 (16302000)	Punalu‘u Stream	O‘ahu	Windward	2.78	4	1978	2006	29	0.21	0.14	186.6	0.2
16304200	Kaluanui Stream	O‘ahu	Windward	1.09	4	1978	2007	30	0.34	0.25	168.4	0.0
16325000	Kamananui Stream	O‘ahu	Leeward	3.15	4	1971	2000	30	0.29	0.15	132.0	0.6
16345000	‘Ōpae‘ula Stream	O‘ahu	Leeward	3.00	4	1978	2007	30	0.37	0.24	164.6	0.0
16500100	Kepuni Gulch	Maui	Leeward	1.93	E	1963	1972	10	0.04	0.06	33.1	22.0
16501200	‘Ohe‘o Gulch	Maui	Leeward	8.53	4	1990	1997	8	0.38	0.25	249.4	0.6
16508000	Hanawī Stream	Maui	Windward	3.29	4	1978	2007	30	0.41	0.23	248.7	0.0
16510000	Kapā‘ula Gulch	Maui	Windward	1.35	4	1933	1962	30	0.61	0.38	257.3	1.3
16515000	Waiohue Gulch	Maui	Windward	0.74	4	1933	1962	30	0.52	0.32	247.9	1.3

[1] Data for gaging-station numbers in parentheses were used to reconstruct streamflow at the gaging station whose number is not in parentheses.

[2] For example, mean annual rainfall on the drainage basin of station 16500100 was 22 percent greater during 1963–1972 than that during 1978–2007.

Table 4. Mean seasonal runoff-to-rainfall ratios for drainage basins of stream-gaging stations on Kaua‘i, O‘ahu and Maui, Hawai‘i.—Continued

[See fig. 6 for locations of drainage basins on Maui; n, number of days used for determining minimum flows in the base flow-separation program (Wahl and Wahl, 1995); E, the base flow-separation program (Wahl and Wahl, 1995) was not used to estimate direct runoff because the streamflow measured at station was ephemeral and was assumed to equal direct runoff; mean annual rainfall was estimated from Frazier (2012) and Giambelluca and others (2013)]

[1]Gaging-station number	Stream/river/gulch/valley	Island	Aspect	Drainage-basin area, in square miles	*n*	Period of record selected to compute mean runoff-to-rainfall ratios			Mean runoff-to-rainfall ratio		Mean annual rainfall	
						Start	End	Number of years	Wet season: November through April	Dry season: May through October	During 1978–2007, in inches	[2]Difference during selected period of record, percentage of mean during 1978–2007
16516000	Kopiliula Stream	Maui	Windward	3.56	4	1938	1957	20	0.43	0.24	197.8	2.8
16517000	East Wailuaiki Stream	Maui	Windward	3.14	4	1928	1957	30	0.58	0.35	201.2	4.5
16518000	West Wailuaiki Stream	Maui	Windward	3.59	4	1978	2007	30	0.64	0.39	183.5	0.0
16520000	East Wailuanui Stream	Maui	Windward	0.53	4	1928	1957	30	0.75	0.55	228.1	4.4
16527000	Honomanū Stream	Maui	Windward	2.94	4	1939	1963	25	0.55	0.45	149.8	3.8
16552800	Waikamoi Strream	Maui	Windward	2.50	4	1957	1967	11	0.17	0.12	62.9	1.3
16557000	Alo Stream	Maui	Windward	0.47	4	1928	1957	30	0.75	0.65	209.3	1.9
16565000	Ka‘aiea Gulch	Maui	Windward	0.68	4	1933	1962	30	0.50	0.44	216.5	0.0
16566000	‘O‘opuola Stream	Maui	Windward	0.25	4	1931	1957	27	0.64	0.54	189.4	1.5
16570000	Na‘ili‘ilihaele Stream	Maui	Windward	3.69	5	1945	1974	30	0.60	0.50	181.9	1.8
16577000	Kailua Stream	Maui	Windward	2.41	4	1928	1957	30	0.75	0.53	203.4	1.5
16585000	Ho‘olawanui Stream	Maui	Windward	1.34	5	1942	1971	30	0.50	0.32	174.9	0.6
16586000	Ho‘olawali‘ili‘i Stream	Maui	Windward	0.62	4	1931	1957	27	0.43	0.33	160.2	4.2
16587000	Honopou Stream	Maui	Windward	0.59	4	1978	2007	30	0.57	0.38	145.6	0.0
16604500	‘Īao Stream	Maui	Windward	6.13	4	1983	2007	24	0.49	0.40	178.1	-3.8
16614000	Waihe‘e River	Maui	Windward	4.27	3	1984	2007	24	0.49	0.45	184.6	-3.0
16618000	Kahakuloa Stream	Maui	Windward	3.40	4	1978	2007	30	0.43	0.33	127.0	0.0
16620000	Honokōhau Stream	Maui	Windward	4.18	4	1978	2007	28	0.35	0.31	200.3	-2.9
16636000	Kanahā Stream	Maui	Leeward	1.57	3	1920	1931	11	0.17	0.16	141.8	3.0
16660000	Kūlanihāko‘i Gulch	Maui	Leeward	15.03	E	1963	1970	8	0.01	0.00	22.4	35.6

[1] Data for gaging-station numbers in parentheses were used to reconstruct streamflow at the gaging station whose number is not in parentheses.

[2] For example, mean annual rainfall on the drainage basin of station 16500100 was 22 percent greater during 1963–1972 than that during 1978–2007.

rainfall (Frazier, 2012). Because streamflow measured at most gaging stations consists of direct runoff and base flow, the base-flow component was estimated and subtracted from the total streamflow. Streamflow at stations 16500100 and 16660000 on Maui was ephemeral and was assumed to have no base flow. Base flow at the other gaged basins was estimated using a computerized base-flow separation method (Wahl and Wahl, 1995). This method has been used in numerous other studies in Hawai‘i (for example, Izuka and others, 2005, Engott and Vana, 2007, Engott, 2011) and provides a reasonable estimate of base flow for perennial streams in Hawai‘i. The method defines local streamflow minimums within consecutive, non-overlapping *n*-day periods and requires two parameters (1) *f*, the turning-point test factor and (2) *n*, the number of days in a test window. In this study, the *f* value used for all stations was 0.9. The *n* values were determined for each station using the method described by Wahl and Wahl (1995) and ranged from 3 to 5 days (table 4). Daily base flow was subtracted from daily streamflow to determine daily direct runoff.

Observed seasonal and mean seasonal runoff-to-rainfall ratios were computed for drainage basins of stream-gaging stations. Observed seasonal runoff-to-rainfall ratios were computed for gaged drainage basins of stream-gaging stations on Maui that were operational during 1978–2007 (table 4). Each observed seasonal runoff-to-rainfall ratio for the gaged drainage basins was computed as the quotient of cumulative direct runoff and cumulative rainfall during the season. For example, the observed runoff-to-rainfall ratio for a gaged basin during the dry season of 2001 was computed as the quotient of cumulative direct runoff and cumulative rainfall during May–October 2001. For each of the 56 selected gaged drainage basins, mean seasonal runoff-to-rainfall ratios were computed for a period with rainfall and runoff conditions generally representative of those during 1978–2007 (table 4). Each mean seasonal runoff-to-rainfall ratio for the gaged drainage basins was computed as the quotient of cumulative direct runoff and cumulative rainfall during the appropriate season of the selected period. For example, the mean dry season runoff-to-rainfall ratio for stream-gaging station 16500100 was computed as the quotient of cumulative direct runoff and cumulative rainfall during May–October between 1963 and 1972.

Criteria for selecting periods of record were determined by examining temporal variations in seasonal runoff-to-rainfall ratios for stream-gaging stations that were operational during 1978–2007. For these stations, mean seasonal runoff-to-rainfall ratios computed for 1978–2007 were compared with those computed for smaller, subset periods during 1920–2007. Based on these comparisons, the difference between mean seasonal runoff-to-rainfall ratios computed for 1978–2007 and those computed for subset periods decreases with increasing record length of the subset period and with decreasing differences between mean annual rainfall during 1978–2007 and that of the subset period. Accordingly, the period of record selected to compute mean seasonal runoff-to-rainfall ratios was (1) the entire period during 1978–2007 for stream-gaging stations with at least 24 complete years of record during 1978–2007, (2) the longest contiguous period during 1920–2007 that had less than 5-percent difference in mean annual rainfall, relative to rainfall for 1978–2007, for all remaining stream-gaging stations on perennial streams with base flow, and (3) the entire period of record for three stream-gaging stations on ephemeral streams, including two stations on Maui. Despite the relatively high rainfall during their periods of record (table 4), the latter three stations were included in the analysis owing to the sparseness of runoff data for areas in the Hawaiian Islands with ephemeral streams.

Runoff-to-Rainfall Ratios Assigned to Ungaged Catchment Zones

Ungaged catchment zones are outside of the drainage basins of the 25 selected stream-gaging stations on Maui (fig. 6). Direct runoff for ungaged catchment zones was computed using mean seasonal runoff-to-rainfall ratios derived from the four regional-regression equations in table 5. Separate windward and leeward regression equations were derived for the wet and dry seasons. The regional-regression equations relate mean seasonal runoff-to-rainfall ratios and basin characteristics.

The regional-regression equations were derived from mean seasonal runoff-to-rainfall ratios and basin

Table 5. Regional-regression equations used to compute mean seasonal runoff-to-rainfall ratios for catchment zones in ungaged areas on Maui Hawai‘i.

[See fig. 6 for locations of leeward and windward regions on Maui. RMSE, prediction root mean square error; Overall RMSE and percentage bias are for the gaged basins on the islands of Kaua‘i, O‘ahu, and Maui used to developed the regional-regression equations; Wet season is November through April; Dry season is May through October; mean wet season rainfall and mean annual rainfall are from Giambelluca and others (2013); mean wet and dry season ETo, reference evapotranspiration, are from Giambelluca and others (2014); % HSG C is the percentage of a catchment zone’s area that contains hydrologic soil group C; % HSG D is the percentage of catchment zone’s area that contains hydrologic soil group D; Areas of hydrologic soil groups were derived from Natural Resources Conservation Service (2006a,b,c)]

Region	Season	Regression used to compute runoff-to-rainfall ratio	RMSE		Percentage bias	
			Overall	Maui	Overall	Maui
Leeward	Wet	0.00294 [mean wet season rainfall]	0.07	0.05	-2.1	27.6
Leeward	Dry	0.00175 [mean annual rainfall]	0.07	0.04	1.9	6.5
Windward	Wet	$[\%\ HSG\ C]^{0.177}\ [\%\ HSG\ D]^{0.261}\ [\text{mean wet season ETo}]^{(-0.751)}$	0.12	0.11	-5.4	-3.9
Windward	Dry	$[\%\ HSG\ C]^{0.177}\ [\%\ HSG\ D]^{0.348}\ [\text{mean dry season ETo}]^{(-0.942)}$	0.10	0.10	-6.8	-8.4

characteristics for the 56 stream-gaging stations in table 4. Thirty basin characteristics–including those related to climate, soil, and vegetation– were evaluated as possible explanatory variables (not shown). The regional regressions in table 5 were selected because they had the lowest residual sum of squares and met the following criteria. First, all regression coefficients were statistically significant at a 5-percent significance level. Second, the sign and magnitude of the fitted coefficients were physically meaningful. Finally, the cross-validated results indicated less than 10 percent bias. For leeward catchment zones, wet season runoff-to-rainfall ratios were estimated on the basis of mean wet season rainfall during 1978–2007 (Giambelluca and others, 2013); dry season runoff-to-rainfall ratios were estimated on the basis of mean annual rainfall during 1978–2007. For windward catchment zones, wet season runoff-to-rainfall ratios were estimated on the basis of mean wet season reference ET (Giambelluca and others, 2014) and the percentage of the catchment zone's area with hydrologic soil groups C and D (Natural Resources Conservation Service, 2006a,b,c); dry season runoff-to-rainfall ratios were estimated on the basis of mean dry season reference ET and the percentage of the zone's area with hydrologic soil groups C and D. The performance statistics of the regression equations in table 5 are used to examine the sensitivity of recharge to runoff-to-rainfall ratios (see Sensitivity Analysis).

Runoff-to-Rainfall Ratios Assigned to Gaged Basins within a Single Catchment Zone

Twelve of the selected stream-gaging stations on Maui have drainage basins with a single catchment zone (fig. 6). Nine of these stations (16500100, 16520000, 16557000, 16565000, 16566000, 16570000, 16585000, 16586000, and 16636000) were not operational during 1978–2007 (table 4). For the drainage basins of these nine stations, the model computed direct runoff by using mean seasonal runoff-to-rainfall ratios. For the drainage basins of the three remaining stations (16587000, 16618000, and 16620000), the model computed direct runoff by using (1) observed seasonal runoff-to-rainfall ratios, for seasons when observed ratios were available, and (2) mean seasonal runoff-to-rainfall ratios for seasons when observed ratios were not available.

Runoff-to-Rainfall Ratios Assigned to Gaged Basins with Multiple Catchment Zones

Thirteen of the selected stream-gaging stations on Maui (16501200, 16508000, 16510000, 16515000, 16516000, 16517000, 16518000, 16527000, 16552800, 16577000, 16604500, 16614000, and 16600000) have drainage basins containing multiple catchment zones (fig. 6). The model computed direct runoff for each of the catchment zones within these gaged basins by using adjusted seasonal runoff-to-rainfall ratios determined from equation 17:

$$\widetilde{rr}_{a,t} = \widetilde{RR}_a \times \frac{rr_{b,t} \times rf_{b,t}}{\sum_{i=1}^{j} \widetilde{RR}_i \times rf_{i,t}} \qquad (17)$$

where:

$\widetilde{rr}_{a,t}$ = adjusted runoff-to-rainfall ratio for catchment zone *a* during season *t*

$\widetilde{RR}_a$ = mean runoff-to-rainfall ratio for catchment zone *a* estimated using the appropriate regional-regression equation (table 5)

j = number of catchment zones in the gaged basin *b*

$\widetilde{RR}_i$ = mean runoff-to-rainfall ratio for catchment zone *i* estimated using the regional-regression equations

$rf_{i,t}$ = rainfall for catchment zone *i* during season *t*

$rr_{b,t}$ = observed runoff-to-rainfall ratio for the gaged basin *b* during season *t*. If the observed runoff-to-rainfall ratio for gaged basin *b* is not available during season *t*, the mean seasonal runoff-to-rainfall ratio is used (table 4).

$rf_{b,t}$ = rainfall for gaged basin *b* during season *t*.

Equation 17 uses the regional-regression models and seasonal rainfall to spatially disaggregate observed seasonal and mean seasonal runoff-to-rainfall ratios of a gaged basin for each catchment zone within a gaged basin. Hence, seasonal runoff-to-rainfall ratios were allowed to be spatially variable, instead of spatially uniform, across the catchment zones within gaged drainage basins containing multiple catchment zones.

Evapotranspiration

Evapotranspiration (ET) is the sum of all water that is evaporated or transpired from the forest canopy and plant-root zone. Evapotranspiration can be divided into three main evaporative processes (1) canopy evaporation, which is evaporation of intercepted rain and fog from the surface of vegetation; (2) ground evaporation, which is evaporation of water from the soil surface and overlying litter and mulch layers; and (3) transpiration, the process by which soil moisture taken up by vegetation is eventually evaporated through plant pores (Viessman and Lewis, 2003). Because these three processes are difficult to quantify individually, they are typically combined in water budgets.

Canopy evaporation in forested areas can substantially reduce the rainfall that reaches the ground beneath a forest

canopy (Gaskill, 2004; DeLay, 2005; McJannet and others, 2007; Giambelluca and others, 2011; Safeeq and Fares, 2014). Owing to the height of trees and their canopy structure, turbulent diffusion is much more efficient at removing intercepted water from forest canopies than from shorter vegetation. Moreover, canopy evaporation in forests tends to operate on much shorter time scales (hours) than transpiration (weeks or longer) (Savenije, 2004). This enhanced rate of evaporation from a wet forest canopy makes realistic estimates of ET from forests possible only if transpiration and canopy evaporation are evaluated separately (Shuttleworth, 1993).

For this study, total ET from subareas with forest land covers is computed by separately estimating forest-canopy evaporation and combined ground evaporation and transpiration from the plant-root zone (fig. 5). Evaporation from the forest canopy and evapotranspiration from plant-root zone are added together to yield total ET. For subareas with nonforest land covers, ET is computed using a more traditional approach in which canopy evaporation, ground evaporation, and transpiration are not separately estimated (fig. 5). The concept of potential ET, combined with empirical models when soil moisture is limited, is used to estimate ground evaporation and transpiration in forests and total ET for all other land covers.

Forest-Canopy Evaporation and Net Precipitation

As rain falls on a vegetated surface, a fraction of the droplets will accumulate on the leaves, trunks, or stems of the vegetation. Additional moisture from fog interception may supplement the amount of water that accumulates on vegetation. Canopy evaporation is the part of precipitation that accumulates on and then evaporates from the vegetation (Gerrits and Savenije, 2011). Net precipitation is the part of precipitation that reaches the forest floor (fig. 5).

In this study, the Gash model was used to compute forest-canopy evaporation for the following reasons. First, the Gash method accounts for gaps in the forest canopy, and this allows for a sparse canopy to be differentiated from a dense canopy. Second, canopy evaporation during a period of precipitation is dependent on the amount of precipitation during that period. Third, the Gash model has the capacity to account for spatial differences in climate, including climate differences between windward and leeward forests. One disadvantage of the Gash model, however, is that it is theoretical. Therefore, one of the parameters of the Gash model used to compute canopy evaporation in the water-budget model was calibrated to the wet canopy evaporation maps of Giambelluca and others (2014) as described below. Use of the Gash model, instead of the mean wet-canopy evaporation maps, in the water-budget model allows forest-canopy evaporation to be computed on a daily basis in response to daily variations in precipitation.

Forest-canopy evaporation is computed in the water budget according to equations 4 and 5, which require rainfall and the following parameters (1) canopy cover, (2) canopy capacity, (3) trunk-storage capacity, (4) proportion of precipitation diverted to stemflow, and (5) the ratio of the mean evaporation rate to mean precipitation rate during saturated conditions, *V*. For the water-budget calculations, the values assigned to parameters 1–4 were derived from published data for areas in Hawai‘i. The values assigned to *V* were derived using maps of mean wet canopy evaporation for the Islands of Kaua‘i, O‘ahu, and Maui (Giambelluca and others, 2014). An analysis of the sensitivity of the water-budget results to selected Gash-model parameters is included in the Sensitivity Analysis section of this report.

Canopy cover of forest land covers varies spatially across Maui. The canopy cover of each subarea with forest land cover in the water-budget model was estimated from a map of mean annual vegetation cover fraction (Giambelluca and others, 2014). This map quantifies the vegetation cover fraction at a spatial resolution of about 14 acres. A canopy cover of 0 implies an absence of canopy cover, whereas a value of 1 implies a dense canopy with no gaps. The estimated canopy-cover values for subareas with forest land covers in the water budget range from 0.03 to 1.

Canopy capacity, trunk-storage capacity, and the proportion of precipitation diverted to stemflow were assumed to be the same for all forests (table 6). Canopy capacity was set at 0.05 inches, the mean of the average values reported for six forested sites in Hawai‘i (DeLay, 2005, p. 42; Takahashi and others, 2011, Safeeq and Fares, 2014). Trunk-storage capacity was set at 0.01 inches, the mean of the values reported for four forest sites in Hawai‘i (DeLay, 2005, p. 42; Safeeq and Fares, 2014). The proportion of precipitation diverted to stemflow was assumed to be 0.04, the mean of the values reported for eight forest sites in Hawai‘i (Gaskill, 2004; DeLay, 2005, p. 42; Takahashi and others, 2011; Safeeq and Fares, 2014). Forest sites of Takahashi and others (2011) and Safeeq and Fares (2014) with an abundance of *Psidium cattleianum* (strawberry guava) had relatively high stemflow estimates ranging from 29 to 37 percent of rainfall. The relatively high stemflow values from these sites were excluded from the computed stemflow mean of 0.04 used in the water budget. The effect on recharge estimates owing to the use of a stemflow value of 0.37 for areas mapped as alien forests is examined in the Sensitivity Analysis section.

A map of mean annual wet canopy evaporation for the Hawaiian Islands (Giambelluca and others, 2014) was used to develop a regression model for estimating the spatial variability of *V*. This regression model was developed because estimates of *V* for sites in Hawai‘i are rare, and because canopy-evaporation estimates from the water-budget model are sensitive to *V*. The wet canopy evaporation map has mean annual wet canopy evaporation estimates at a spatial resolution of about 14 acres. To derive a regression model for estimating *V*, we first selected grid cells from the islands of Kaua‘i, O‘ahu, and Maui that consisted of forest land-cover classes only, based on the LANDFIRE Existing Vegetation Type map (U.S. Geological Survey, 2010). Data from Kaua‘i and O‘ahu were included in the analysis to supplement the data from Maui and provide the basis for

a broadly applicable V value for Hawai‘i. Next, for each of the selected grid cells, we determined the “calibrated V value” needed for mean annual canopy evaporation from the Gash model for Kaua‘i, O‘ahu, and Maui to equal wet canopy evaporation from Giambelluca and others (2014). The water budgets were computed with various V values to determine the calibrated V values for the selected grid cells. Last, we examined associations between the calibrated V values and various other parameters of the selected grid cells including estimates of mean annual rainfall, reference ET, Penman-Monteith ET from Giambelluca and others (2014), and estimates of mean annual wind speed from AWS Truewind, LLC (2004). Estimates of V from a linear-regression model (equation 18) relating V to the quotient of mean annual wind speed and mean annual rainfall resulted in the best agreement, in terms of bias and root mean square error, between estimates of canopy evaporation from the wet canopy evaporation maps (Giambelluca and others, 2014) and the estimates from the Gash model for Kaua‘i, O‘ahu, and Maui. The spatial distribution of V was estimated as follows:

for $w < 0.009$,

$$V = 0.01,$$

for $0.009 \leq w \leq 0.192$,

$$V = 2.677 \times (w) - 0.014, \text{ and}$$

for $w > 0.192$,

$$V = 0.50, \qquad (18)$$

where

w = mean annual wind speed divided by mean annual rainfall [(meters/second)/inch)]

The variable w is the quotient of (1) mean annual wind speed, in meters per second, which was derived from a map of mean annual wind speed at height of about 100 ft above the land surface (AWS Truewind, 2004), and (2) 1978–2007 mean annual rainfall, in inches (Giambelluca and others, 2013). In general, estimates of V are less for wet areas than for dry areas. Grid cells that had calibrated V values that were outside the range of 0.01–0.50 were excluded from the derivation of equation 18. A range of 0.01–0.50 was established for this analysis on the basis of the range of published estimates of V. The low end of the range, 0.01, was determined by Hutjes and others (1990) for a humid, tropical forest site in the African Ivory Coast. The high end of the range, 0.50, is the mean value reported by Safeeq and Fares (2014) for a forest site on leeward O‘ahu. A similar range of mean V estimates (about 0.03–0.40) was determined for 54 sites located in various climate zones across Australia (Wallace and others, 2013, fig. 6c).

Potential Evapotranspiration

Potential evapotranspiration (ET) is the maximum rate that water can be removed from the plant-root zone by ET if soil moisture is nonlimiting (Giambelluca, 1983). The actual-ET rate is a function of potential ET, soil-moisture content, and threshold-moisture content (see equation 13). The actual-ET rate becomes less than the potential rate with the onset of soil-moisture stress. As the soil dries, capillary and adsorptive forces bind the remaining water to the soil matrix, reducing water flow to roots. Soil-moisture stress occurs when the decreasing flow of water to the root system induces a response in the plant to slow down transpiration and prevent desiccation. The threshold-moisture content at which a plant begins to react to soil drying varies with the type of plant.

Potential ET is controlled by atmospheric conditions, topography, and land-cover characteristics (Giambelluca, 1983). Maps of mean monthly reference ET produced by Giambelluca and others (2014) were used in the water-budget model to estimate the influence of atmospheric conditions (radiation, air temperature, air humidity, and wind speed) on potential ET. Crop coefficients were used to estimate the integrated effects of land-cover and vegetation characteristics on potential ET. Potential ET for each subarea was computed in the water-budget model as the product of mean monthly reference ET and the crop coefficient assigned to the land cover (see equation 9).

Reference Evapotranspiration

Reference ET is the potential ET of a hypothetical grass surface with specific characteristics and optimum soil-water conditions for given climatic conditions (Allen and others, 1998). Reference ET is similar to pan evaporation, which has been used in previous water budgets for Maui and other Hawaiian Islands. Both pan evaporation and reference ET provide an index of the energy that is available for ET for a given area.

Maps of mean monthly reference ET (Giambelluca and others, 2014) for Maui were used in the water budget. These maps have the same grid resolution (about 14 acres) as the monthly rainfall maps produced by Frazier (2012). Mean annual reference ET ranges from about 28 to 113 inches on Maui (fig. 7). In general, mean annual reference ET is highest in dry lowlands, and is lowest in wet uplands within the cloud zone. In the water-budget calculation, monthly reference ET was not varied from year to year, and was assumed to equal mean monthly reference ET. Reference ET was assumed to be the same each day of a given month.

Crop Coefficients

A crop coefficient is an empirically derived ratio of the potential ET of a certain type of land cover and reference ET. Crop coefficients provide an index of the integrated effect of vegetation characteristics (reflectance, roughness, and plant physiology) on potential ET. Crop coefficients were assigned to each land-cover class (table 6). Crop coefficients were assumed

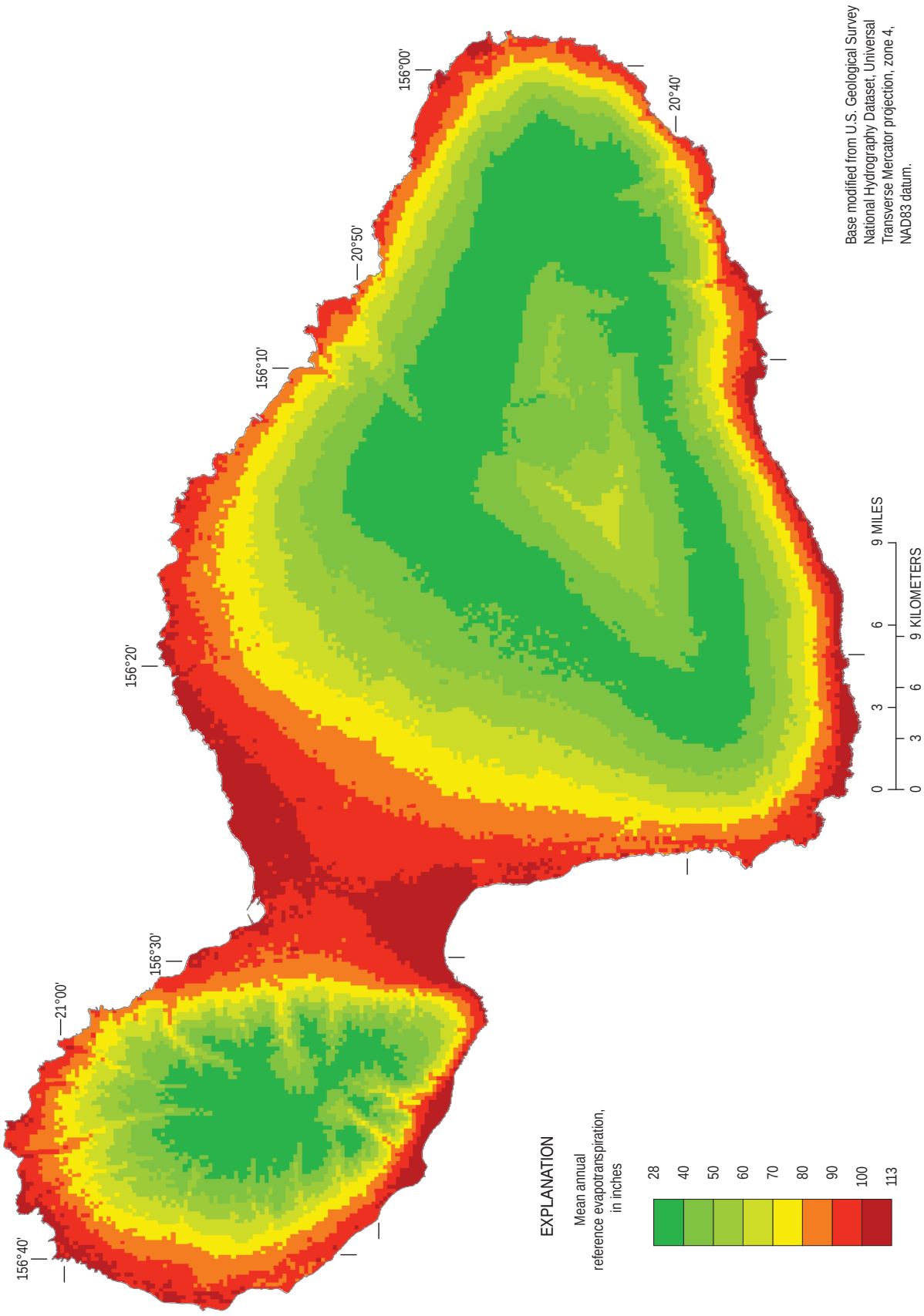


Figure 7. Mean annual reference evapotranspiration for Maui, Hawai‘i (modified from Giambelluca and others, 2014).

to be temporally constant for all classes other than sugarcane. For nonforest land-cover classes, crop coefficients integrated the effects of transpiration, ground evaporation, and canopy evaporation. For forested land-cover classes, crop coefficients integrated the effects of transpiration and ground evaporation; canopy evaporation was accounted for separately (fig. 5).

Crop coefficients for nonforest land covers (table 6) were obtained from published values or were derived from pan coefficients used for the same or similar land-cover classes in previous water budgets for Hawai‘i. A pan coefficient for a given land cover is the ratio of potential ET to pan evaporation. Hence, pan coefficients are analogous to crop coefficients. Pan coefficients for land-covers other than sugarcane were converted to crop coefficients by dividing the pan coefficients by 0.85, a factor that Engott (2011) used to convert crop coefficients to pan coefficients. Crop coefficients for fallow/grassland, grassland, pineapple, taro, wetland, water body, and reservoir land covers were obtained from Allen and others (1998). The midpoint of the range of crop coefficients for grazing pasture (rotated grazing) was used for fallow/grassland and grassland. The mean of the crop coefficients for wetlands with no frost was used for wetland. The crop coefficient for open water in the tropics was used for taro, water body, and reservoir. Crop coefficients for coffee and macadamia were obtained from Fares (2008). Crop coefficients for golf course and the developed land covers were derived from the pan coefficient used by Engott (2011) for developed land covers. Crop coefficients for diversified agriculture, shrubland, and sparsely vegetated were also derived from pan coefficients used by Engott (2011).

The crop coefficient for sugarcane was varied with time according to the growth stages of sugarcane. The stages of sugarcane growth used in previous water budgets for Kaua‘i (Izuka and others, 2005) and Maui (Engott and Vana, 2007) were also used for this study. The pan coefficients for the different growth stages of the sugarcane range between 0.25 and 1.0 (Engott and Vana, 2007, fig. 10) and were converted to crop coefficients by dividing them by 0.80. The factor 0.80 is the ratio of the pan coefficient, 1.0, and the crop coefficient, 1.25 (Fares, 2008), for the middle-growth stage of sugarcane.

Table 6. Land-cover parameters used in water-budget calculations for Maui, Hawai‘i.

[Crop coefficients for forests are used to compute the sum of transpiration and ground evaporation; canopy evaporation is computed separately. Crop coefficients for nonforests are used to compute the sum of all evaporative components]

Land-cover description	Root depth, in inches	Depletion fraction	Crop coefficient	Canopy capacity, in inches	Trunk-storage capacity, in inches
Forest land covers					
Alien forest	60	0.50	[a] 0.33, [b] 0.44	0.05	0.01
Native forest	30	0.50	0.30	0.05	0.01
Tree plantation	60	0.50	[a] 0.33, [b] 0.44	0.05	0.01
Nonforest land covers					
Coffee	48	0.40	0.91	0	0
Diversified agriculture	10	0.35	1.00	0	0
Fallow/grassland	39	0.60	0.95	0	0
Macadamia	60	0.50	0.91	0	0
Pineapple	18	0.50	0.30	0	0
Sugarcane	24	0.65	[c] 0.31–1.25	0	0
Taro	10	1.05	0.95	0	0
Developed, open space	12	0.50	1.18	0	0
Developed, low-intensity	12	0.50	1.18	0	0
Developed, medium-intensity	12	0.50	1.18	0	0
Developed, high-intensity	12	0.50	1.18	0	0
Golf course	30	0.50	0.85	0	0
Grassland	39	0.60	0.95	0	0
Shrubland	12	0.50	1.00	0	0
Sparsely vegetated	5	0.50	1.18	0	0
Water body and Reservoir	1	1.00	1.05	0	0
Wetland	39	0.50	1.18	0	0

[a] Value used for forests inside the cloud zone, which is between altitudes of 2,000 and 8,200 feet.

[b] Value used for forests outside the cloud zone.

[c] Sugarcane crop coefficients vary with time according to the growth stages of the sugarcane and are between 0.31 and 1.25.

Maps of mean soil (ground) evaporation and transpiration (Giambelluca and others, 2014) were used to derive crop coefficients for forest land covers. First, we computed water budgets for Kaua‘i, O‘ahu, and Maui using a range of crop coefficients for forest land covers. Data from Kaua‘i and O‘ahu were included in the analysis to develop regionally applicable crop coefficients. Next, the sum of ground evaporation and transpiration was determined for subareas on Kaua‘i, O‘ahu, and Maui with (1) native forest land cover inside the cloud zone, (2) native forest land cover outside the cloud zone, (3) alien forest land cover inside the cloud zone, and (4) alien forest land cover outside the cloud zone. The crop coefficients listed in table 6 resulted in the best match, in terms of ground evaporation plus transpiration, between the maps of Giambelluca and others (2014) and subareas with forest land covers in water budgets of Kaua‘i, O‘ahu, and Maui. The derived crop coefficient for alien forests in the cloud zone is less than that for alien forests outside the cloud zone. This difference could be related to spatial differences in tree species or reduced transpiration with the presence of fog. The crop coefficients for alien forests are also used for tree plantations. For native forests, one crop coefficient is used because the crop coefficient estimated for areas in the cloud zone is nearly identical to that for areas outside the cloud zone.

Moisture-Storage Capacity of the Plant-Root Zone

The moisture-storage capacity of the plant-root zone (fig. 8) was computed as the product of available water capacity and root depth (equation 12). The Natural Resources Conservation Service (2006a) soil map and corresponding tables of available water capacities were used to quantify the available water capacity of the soils on Maui. For each soil unit, the tables list the minimum and maximum available water capacities for various ranges of depth. A depth-weighted mean available water capacity was computed for each soil type in the water-budget model. All depths of the soil unit “rock outcrop” have zero available water capacity according to tables of Natural Resources Conservation Service (2006a). The rock outcrop soil unit covers steep parts of southwest West Maui Mountain and steep ravines west of Kaupō Gap (fig. 2). For this study, zero available water capacity for the rock outcrop soil unit was considered too low because many areas with this soil unit on Maui were mapped as grassland or shrubland. Therefore, for the water-budget calculations, available water-capacity values for the rock land soil unit were used for all subareas with the rock outcrop soil unit designation. The rock land soil unit was selected because it was mapped near rock outcrop soils and because its available water capacity exceeds zero in the top 8 inches of soil. Subareas with water body and reservoir land covers have zero available water capacity at all soil depths and therefore have zero soil-moisture storage capacity (fig. 8).

Root depths for each land-cover class were assigned values on the basis of published values and root depths used in previous water budgets in the Hawaiian Islands (table 6). The root depth used for sugarcane is the same as that used by Engott and Vana (2007). The root depth used for pineapple is the middle of the range of pineapple root depths reported in Fares (2008) and Allen and others (1998). The root depth used for diversified agriculture is near the middle of the range reported in Fares (2008) for typical diversified agriculture crops in the Hawaiian Islands. The root depth used for taro is the middle of the range reported in Fares (2008). The root depth used for wetland is the same as that used for grassland. For all other land-cover classes, the roots depths used are the same as those used by Engott (2011) in the water budget for the Island of Hawai‘i.

Direct Recharge

For this study direct recharge was defined as water that passes directly to the groundwater system, completely bypassing the plant-root zone (equation 15). Hence, direct recharge was not subject to direct runoff or ET processes. Direct recharge was estimated for subareas with cesspools, and water body and reservoir land covers (fig. 4). For subareas within TMK parcels with cesspools, the wastewater effluent fluxes estimated by Whittier and El-Kadi (2013) were applied as direct recharge (see Septic-System Leaching section). The direct recharge rate from subareas with water body land covers was set at 0 in/yr because these were mapped near the coast and were assumed to have no net recharge. Hawaiian Commercial & Sugar Company estimated that the total seepage rate was between about 23 and 31 Mgal/d for 31 of its easternmost reservoirs (State of Hawaii, 2010, p. C-2). To reproduce the middle of this range (27 Mgal/d) for these reservoirs in the water-budget model, a direct recharge rate of 1,268 in/yr was needed. Accordingly, a direct recharge rate of 1,268 in/yr was used in the water budget for subareas with reservoir land cover within the Pā‘ia, Kahului, Waikapū, and ‘Īao aquifer systems (figs. 1 and 4). For all remaining subareas with reservoir land cover on Maui, the direct recharge was set at a more conservative rate of 528 in/yr, which also was used by Engott and Vana (2007).

Other Input

In addition to the water-budget inputs already listed, several other parameter inputs were required. The initial moisture storage for pervious fraction of subareas was set at 50 percent of the soil moisture-storage capacity. The rainfall-retention capacity for impervious surfaces was assumed to be 0.25 inch. The initial moisture storage for the impervious fraction of subareas was set at 0.125 inch, 50 percent of the rainfall-retention capacity. These values were also used for other recent Hawai‘i water budgets (Izuka and others, 2005; Engott and Vana, 2007; Engott, 2011). The effects of these inputs on regional-scale mean annual recharge generally were minor because they either pertained to only a small area or were applicable during only a small fraction of time.

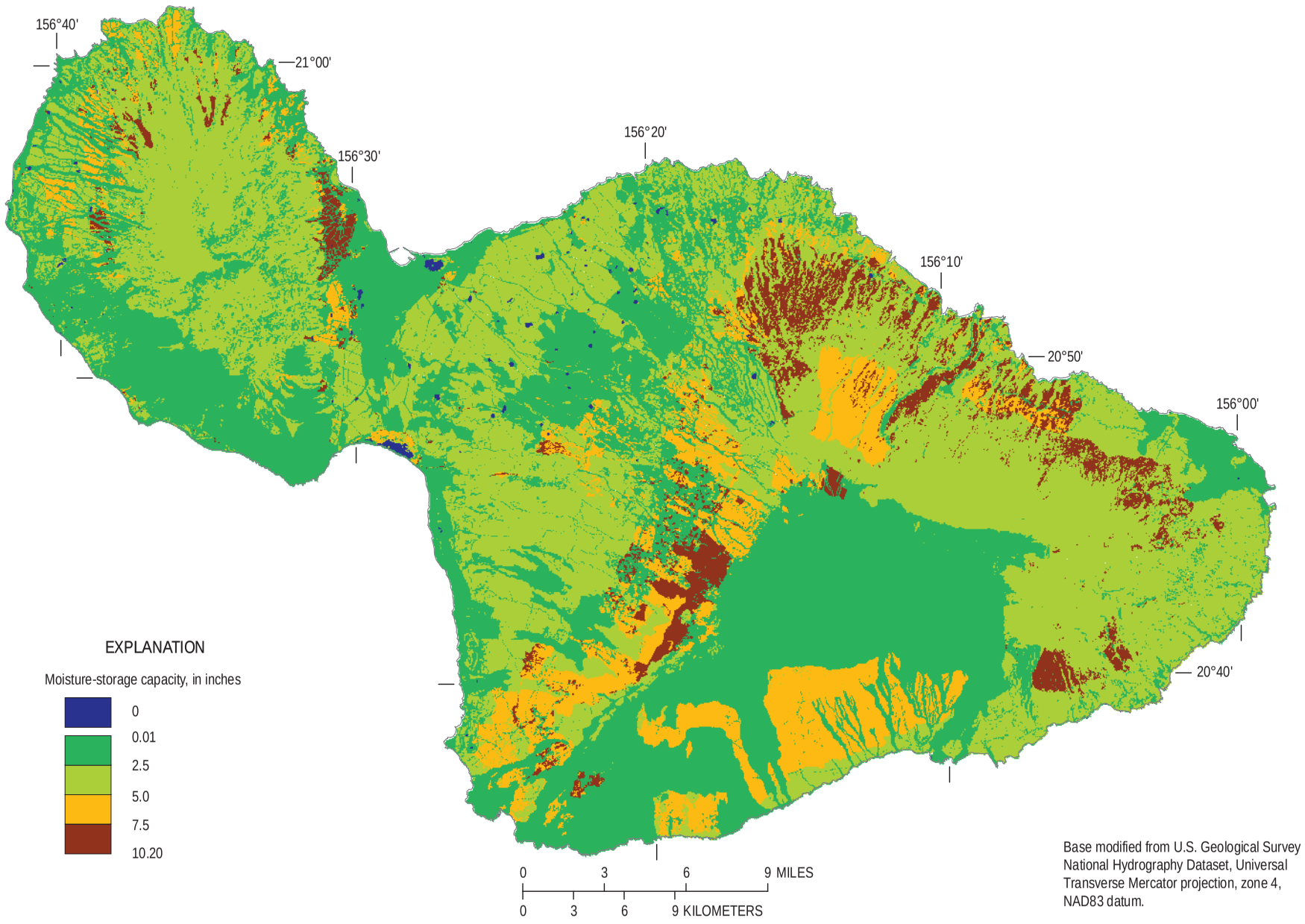


Figure 8. Calculated moisture-storage capacity of the plant-root zone for Maui.

Model Exclusions and Limitations

The water-budget model has several limitations. As described below, estimates of daily rainfall and runoff are the chief limitations of the model. We synthesized, rather than reconstructed, daily rainfall patterns during 1978–2007 from monthly rainfall maps using the method of fragments. Daily runoff was estimated from seasonal runoff-to-rainfall ratios. Additionally, some parameters and conditions excluded from the water-budget model were assumed to be inherent in other parameters used in the model, and could not be quantified owing to insufficient data, or were considered insignificant with respect to the study objectives.

Owing to sparseness of data and the use of synthesized daily rainfall, the water-budget model did not reconstruct the actual distributions of the water-budget components (rainfall, fog interception, irrigation, septic-system leachate, runoff, evapotranspiration, and recharge) on Maui each day during 1978–2007. The sets of rainfall fragments were assumed to represent the statistical properties of daily rainfall during 1978–2007 even though they may not have been from this period. The reconstruction of actual daily runoff was also prevented by the use of seasonal runoff-to-rainfall ratios and the assumption that runoff occurs in a single day in response to rainfall. Additionally, runoff may have been overestimated by the model on days with light rain and underestimated on days with intense rain. The water-budget model did, however, reproduce the spatial distribution of (1) monthly rainfall on Maui during 1978–2007 that was estimated by Frazier (2012), and (2) mean monthly and mean annual rainfall on Maui during 1978–2007 that was estimated by Giambelluca and others (2013). For gaged drainage basins, the water-budget model reproduced seasonal runoff estimates that were based on streamflow data from stream-gaging stations. Datasets for calibrating recharge estimates of the model, however, were not available.

To estimate runoff, recent water budgets for Maui (Engott and Vana, 2007; Gingerich and Engott, 2012) used mean monthly runoff-to-rainfall ratios, whereas this study used seasonal and mean seasonal runoff-to-rainfall ratios. Monthly and mean monthly runoff-to-rainfall ratios, although available for gaged drainage basins, were not used in this study for the following reasons. First, the regional-regression models (table 5) computed mean seasonal (not monthly) runoff-to-rainfall ratios. Assigning seasonal runoff-to-rainfall ratios to all areas was considered a more consistent approach than assigning monthly runoff-to-rainfall ratios to gaged drainage basins and seasonal runoff-to-rainfall ratios to ungaged drainage basins. Second, analysis of the variability of monthly runoff-to-rainfall ratios within a season indicated that a mean seasonal ratio was sufficient to predict monthly direct runoff. Observed monthly runoff for gaged basins, based on streamflow data, was compared with monthly runoff estimated using (1) mean monthly runoff-to-rainfall ratios and (2) mean seasonal runoff-to-rainfall ratios. Based on these comparisons, runoff estimated from mean monthly runoff-to-rainfall ratios was not significantly better than runoff estimated from mean seasonal runoff-to-rainfall ratios. Last, compared to methods used in previous water budgets for Maui, the regional-regression models (table 5) were considered a more robust method for estimating runoff in ungaged areas.

Some parameters and conditions not included in the calculations of the water-budget model were inherent in other parameters used in the model. For example, the permeability and vertical hydraulic conductivity of the plant-root zone and underlying substrate were not included in the model calculations. Their effect on direct runoff, however, would be inherent in streamflow records used to derive runoff-to-rainfall ratios that were used to compute direct runoff in the model. Also assumed to be inherent in streamflow records were reductions in runoff owing to ET of interflow in the subsurface. The reduction in potential ET of the plant-root zone in response to evaporation from the forest canopy was not included in the model calculations; it was, however, likely accounted for in the forest crop coefficients, which were calibrated to maps of mean transpiration and ground evaporation produced by Giambelluca and others (2014).

Re-infiltration of direct runoff, water that runs off one subarea and then infiltrates the plant-root zone of a different subarea, was not explicitly considered in the water-budget model. Re-infiltration of direct runoff within gaged basins was assumed to be inherent in streamflow records used to derive runoff-to-rainfall ratios. Spatial variations in the re-infiltration of direct runoff within a drainage basin, however, were not accounted for in the model. For example, if re-infiltration of direct runoff was considerable within streambeds, then recharge may have been underestimated in intra-channel (streambed) areas and overestimated in inter-channel (non-streambed) areas. Surface water diversion systems, however, can reduce or prevent streambed seepage in lower reaches of many streams on Maui.

Some processes and conditions were excluded from the water-budget calculations. Interannual variations in potential ET were not accounted for in the model. Potential ET was also assumed to be uniform each day of the month and consequently may have been overestimated on cloudy days and underestimated on clear days. The errors caused by assuming uniform daily potential ET may be minor because the variation in daily potential ET for a given area is likely small compared to the variation in daily rainfall. For example, estimates of daily potential ET ranged from about 0.02 to 0.26 inches for three climate stations at altitudes between 2,500 and 5,770 ft on West Maui Mountain during November 2003 through November 2005 (Engott and Vana, 2007). In contrast, daily rainfall on Maui ranges from zero to tens of inches. For subareas with impervious surfaces, potential ET was not reduced to account for evaporation from impervious surfaces. Adjustments to reference ET at scales less than the spatial resolution of the reference-ET maps, such as those related to shading in rugged terrain, were not accounted for in the model. Other conditions not considered in the model include the variability of soil moisture with depth within

the plant-root zone, the effect of soil texture on irrigation demand, and removal of water from saturated groundwater zones by transpiration. Additionally, daily irrigation estimates were based on monthly variations in rainfall, runoff, and potential ET instead of daily variations. The daily irrigation estimates of the water-budget model may also differ from actual irrigation rates because, in addition to the model not reproducing actual daily rainfall, the model does not account for other factors—such as field observations, non-irrigation water needs, and water availability—that may be considered by irrigation managers each day.

The water-budget model did not account for water inflows from injection wells or leakage from water-transmission systems. Major water-transmission systems on Maui include the MDWS system and several surface-water diversion systems. Annual water losses from the MDWS system on Maui were, on average, between about 3.7 and 5.4 Mgal/d for fiscal years 2007–11 (written commun., Tui Anderson, MDWS, 2012). The largest surface-water diversion system is the East Maui Irrigation (EMI) system on northeast Haleakalā. On the basis of discharge measurements, Cheng (2012) determined net seepage losses and gains for 26 reaches whose combined length was 15 mi. Cheng (2012) estimated that the total water lost from the losing reaches of the EMI diversion system was about 3.4 Mgal/d, and the total water gained from gaining reaches was about 6.2 Mgal/d. Although the losses may be locally important, the estimated water losses from the MDWS and EMI systems are minor compared to island-wide precipitation. Therefore losses from the MDWS and EMI systems and other water-transmission systems were not accounted for in the water-budget model.

Many limitations of the water-budget model are a consequence of insufficient data. As more data become available, these limitations can be addressed and recharge estimates can be improved.

Model Randomness

The selection of monthly rainfall fragment sets (see Rainfall section) introduces randomness into the water-budget model. To account for this randomness, the water-budget model was run for multiple simulations, and the results of the simulations were averaged. For example, if the model was run for ten simulations, then mean recharge would be the average of ten recharge values–one value for each simulation. To determine the appropriate number of simulations to use for this study, the water-budget model for Maui was run for 50 simulations. Next, the absolute percentage change in mean recharge between successive simulations was determined for each of the 318,429 subareas. Last, the absolute percentage change in mean recharge between successive simulations for all subareas was averaged for each number of simulations (fig. 9). After 25 simulations, the average percentage change did not exceed 0.1 percent, which was considered adequate for this study. Therefore, for each of the scenarios of this study, the water-budget model was run for 25 simulations, and the results of the 25 simulations were averaged. The water-budget model was run separately for each scenario because annual results were not included in the model output; only the time-averaged results for the entire simulation period were generated.

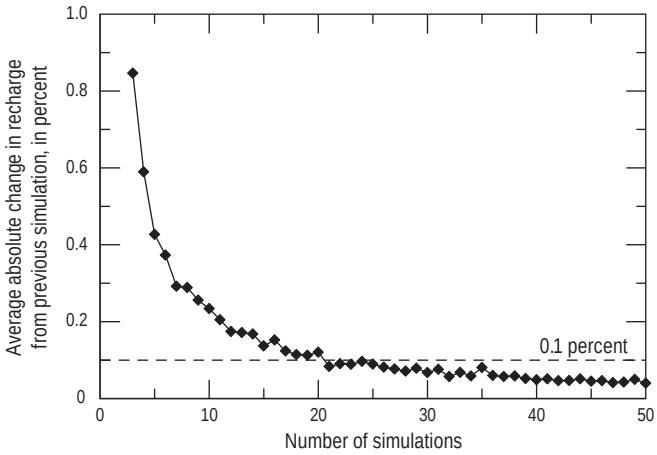


Figure 9. The average absolute percentage change in recharge of all the water-budget subareas with each successive model simulation.

Water-Budget and Groundwater-Recharge Estimates

The water-budget model was used to compute recharge for two scenarios: average climate conditions and drought conditions. Monthly rainfall during 1978–2007 was used for the average-climate-conditions scenario. Monthly rainfall during 1998–2002 was used for the drought-conditions scenario. Both scenarios used 2010 land cover and mean monthly reference ET. Water-budget estimates for average climate conditions are compared with previous estimates.

Water-Budget and Recharge Estimates for Average Climate Conditions

For the Island of Maui, mean annual recharge is about 1,340 million gallons per day (Mgal/d) for average climate conditions (table 7). Recharge is about 45 percent of precipitation (rainfall and fog interception) and is about 40 percent of total inflow (sum of precipitation, irrigation, septic leachate, and direct recharge). Direct recharge, which consists of seepage from reservoirs and cesspools, accounts for about 4 percent of overall recharge. Expressed as a depth of water uniformly distributed over the island, mean annual recharge is about 39 inches.

For Maui's six aquifer sectors (fig. 1), mean annual recharge ranges from about 88 to 411 Mgal/d for average climate conditions (table 7). Of Maui's total mean recharge for average climate conditions, 60 percent occurs in the Koʻolau and Hāna aquifer sectors on windward Haleakalā, 20 percent

occurs in the Lahaina and Wailuku aquifer sectors on West Maui Mountain, and 20 percent occurs in the Kahikinui and Central aquifer sectors on leeward Haleakalā and the isthmus. About 20 percent of the recharge for the Central aquifer sector comes from direct recharge, most of which is from reservoir seepage. Irrigation in the Central aquifer sector is also substantial and is about 43 percent of total inflow.

For Maui’s 25 aquifer systems (fig. 1), mean annual recharge ranges from about 13 to 222 Mgal/d for average climate conditions (table 8, see Water-budget area description A). Total mean annual recharge is about 150 Mgal/d for the Makawao, Ha‘ikū, and Honopou aquifers systems of upcountry Maui. In terms of recharge expressed as an average depth of water, the aquifer systems with the greatest recharge are Kūhiwa, Kīpahulu, and Waiho‘i, which are on windward Haleakalā; the aquifer systems with the least recharge are Kama‘ole, Lula‘ilua, and Makawao, which are on leeward Haleakalā. Irrigation is less than 10 percent of inflow for all aquifer systems other than Waikapū, Kahului, and Pā‘ia; irrigation in the latter two aquifer systems exceeds rainfall. Septic leachate is no more than 1 percent of total water inflow for Maui’s aquifer systems. Direct recharge is less than 10 percent of recharge for all aquifer systems other than ‘Īao, Kahului, and Pā‘ia.

The spatial pattern of mean annual recharge on Maui for average climate conditions (fig. 10) resembles the pattern of mean annual rainfall (fig. 3), but also reflects spatial variations in vegetation and soils, irrigation in agricultural and developed areas, and persistent cloud layers where fog interception supplements rainfall. Wet, upland parts of the island typically have more recharge than dry, coastal areas. Areas with the highest recharge include the mid-altitude slopes of windward Haleakalā and the uplands of West Maui Mountain. Areas with the lowest recharge include the leeward slopes of Haleakalā and coastal lowlands of West Maui Mountain. West Maui Mountain has steep gradients in mean recharge distribution: recharge exceeds 200 in/yr near the summit, but is less than 10 in/yr for most coastal areas. Half of Maui has mean recharge rates that are less than 20 in/yr. Only about 10 percent of the island has mean recharge rates that exceed 100 in/yr. In general, areas that

Table 7. Mean annual water-budget components from this study for aquifer sectors and all of Maui, Hawai‘i.

[See fig. 1 for locations of aquifer sectors; Irr, irrigation; Septic, septic-system leachate; Direct Rech, direct recharge; Canopy Evap, forest-canopy evaporation, Total ET, total evapotranspiration which includes canopy evaporation. Average climate conditions for this study are 1978–2007 rainfall and 2010 land cover; drought conditions for this study are 1998–2002 rainfall and 2010 land cover. Components may not balance because of rounding and direct recharge from cesspools and reservoirs. The source of water for direct recharge may be from external sources, including groundwater and imported streamflow. Some recharge may discharge to streams as base flow]

Location	Area, in square miles	Condition/ Scenario	Water-budget component, in million gallons per day								
			Rain	Fog	Irr	Septic	Direct Rech	Runoff	Canopy Evap	Total ET	Recharge
Island of Maui	727.93	Average climate	2,806.02	179.93	288.13	3.75	54.58	824.29	232.45	1,172.52	1,340.12
		Drought	2,282.93	149.87	301.29	3.75	54.58	683.99	208.73	1,080.42	1,034.63
Wailuku aquifer sector	65.81	Average climate	247.46	19.61	11.91	0.30	7.45	97.39	24.08	90.79	98.90
		Drought	188.77	15.51	12.54	0.30	7.45	73.69	20.46	80.03	71.51
Lahaina aquifer sector	95.88	Average climate	319.96	17.86	9.03	0.37	4.57	56.23	35.12	131.14	164.89
		Drought	260.33	15.17	9.84	0.37	4.57	47.41	31.14	117.54	125.85
Central aquifer sector	229.68	Average climate	296.67	15.00	264.37	1.96	36.80	19.06	18.93	419.69	180.47
		Drought	206.60	10.87	275.90	1.96	36.80	13.31	14.07	390.19	135.29
Ko‘olau aquifer sector	134.18	Average climate	945.13	78.48	2.46	0.96	5.32	366.27	91.52	255.04	410.55
		Drought	798.67	66.76	2.60	0.96	5.32	307.29	84.85	240.52	324.96
Hāna aquifer sector	89.41	Average climate	800.57	42.91	0.36	0.16	0.41	272.21	57.93	174.86	397.13
		Drought	682.11	36.97	0.41	0.16	0.41	232.40	54.55	165.41	321.50
Kahikinui aquifer sector	112.97	Average climate	196.23	6.07	0.00	0.00	0.03	13.13	4.87	101.00	88.18
		Drought	146.45	4.59	0.00	0.00	0.03	9.89	3.66	86.73	55.52

Table 8. Mean annual water-budget components from this study for average climate and drought conditions and components from the Water Resources Protection Plan (State of Hawai‘i, 1990; 2008) for aquifer systems of Maui, Hawai‘i.

[See fig. 1 for locations of aquifer systems; Irr, irrigation; Septic, septic-system leachate; Direct Rech, direct recharge; Canopy Evap, forest-canopy evaporation; Total ET, total evapotranspiration, which includes canopy evaporation. WRPP, Water Resources Protection Plan (State of Hawai‘i, 1990; 2008). Water-budget-area descriptions: A, entire aquifer-system area; B, entire aquifer-system area excluding areas seaward of the 0-ft elevation contour of the top of Wailuku Basalt (see fig. 1); C, entire aquifer-system area excluding caprock areas as defined in the WRPP; D entire aquifer-system area excluding areas seaward of the 0-ft elevation contour of the top of Honomanü Basalt/Kula Volcanics (see fig. 1). Average climate conditions for this study are 1978–2007 rainfall and 2010 land cover. Drought conditions for this study are 1998–2002 rainfall and 2010 land cover. Natural conditions for WRPP are 1916–83 mean rainfall and a uniform, unirrigated land cover. All WRPP components not in parentheses are from the 1990 WRPP. WRPP aquifer-system recharge values that were updated in the 2008 WRPP, shown in parentheses, were provided by the State of Hawai‘i Commission on Water Resource Management. n/a, not accounted for or not reported. Components may not balance because of rounding and direct recharge from cesspools and reservoirs. The source of water for direct recharge may be from external sources, including groundwater and imported streamflow. Some recharge may discharge to streams as base flow]

Aquifer sector	Aquifer system	Source of estimate	Water-budget-area description	Area, in square miles	Condition/ Scenario	Water-budget component, in million gallons per day								
						Rain	Fog	Irr	Septic	Direct Rech	Runoff	Canopy Evap	Total ET	Recharge
Wailuku	Waikapü	This study	A	17.31	Average climate	42.44	4.27	8.92	0.12	1.02	14.50	3.15	22.72	19.59
		This study	A	17.31	Drought	27.80	2.97	9.35	0.12	1.02	9.57	2.27	19.85	11.98
		This study	B	15.06	Average climate	40.47	4.27	2.73	0.01	0.94	14.37	3.11	16.23	17.84
		This study	B	15.06	Drought	26.63	2.97	2.93	0.01	0.94	9.49	2.24	13.60	10.49
		WRPP	C	13.53	Natural	27.70	n/a	n/a	n/a	n/a	1.90	n/a	20.00	6
Wailuku	‘Īao	This study	A	25.28	Average climate	98.52	7.44	2.81	0.11	6.37	41.39	8.61	33.52	40.64
		This study	A	25.28	Drought	74.84	5.86	3.01	0.11	6.37	30.96	7.35	29.29	30.43
		This study	B	18.21	Average climate	89.97	7.44	0.18	0.04	1.13	38.69	8.30	25.75	34.33
		This study	B	18.21	Drought	69.00	5.86	0.20	0.04	1.13	29.22	7.12	22.59	24.53
		WRPP	C	17.81	Natural	82.30	n/a	n/a	n/a	n/a	33.10	n/a	33.90	15 (27)
Wailuku	Waihe‘e	This study	A	12.44	Average climate	61.46	4.36	0.11	0.07	0.04	24.73	4.98	17.37	23.95
		This study	A	12.44	Drought	49.54	3.65	0.11	0.07	0.04	20.05	4.40	15.57	17.82
		This study	B	12.17	Average climate	61.04	4.36	0.09	0.06	0.03	24.56	4.95	17.11	23.91
		This study	B	12.17	Drought	49.23	3.65	0.09	0.06	0.03	19.93	4.37	15.36	17.79
		WRPP	C	11.87	Natural	62.70	n/a	n/a	n/a	n/a	28.30	n/a	22.60	12 (16)

Table 8. Mean annual water-budget components from this study for average climate and drought conditions and components from the Water Resources Protection Plan (State of Hawai'i, 1990; 2008) for aquifer systems of Maui, Hawai'i.—Continued

[See fig. 1 for locations of aquifer systems; Irr, irrigation; Septic, septic-system leachate; Direct Rech, direct recharge; Canopy Evap, forest-canopy evaporation; Total ET, total evapotranspiration, which includes canopy evaporation. WRPP, Water Resources Protection Plan (State of Hawai'i, 1990; 2008). Water-budget-area descriptions: A, entire aquifer-system area; B, entire aquifer-system area excluding areas seaward of the 0-ft elevation contour of the top of Wailuku Basalt (see fig. 1); C, entire aquifer-system area excluding caprock areas as defined in the WRPP; D entire aquifer-system area excluding areas seaward of the 0-ft elevation contour of the top of Honomanü Basalt/Kula Volcanics (see fig. 1). Average climate conditions for this study are 1978–2007 rainfall and 2010 land cover. Drought conditions for this study are 1998–2002 rainfall and 2010 land cover. Natural conditions for WRPP are 1916–83 mean rainfall and a uniform, unirrigated land cover. All WRPP components not in parentheses are from the 1990 WRPP. WRPP aquifer-system recharge values that were updated in the 2008 WRPP, shown in parentheses, were provided by the State of Hawai'i Commission on Water Resource Management. n/a, not accounted for or not reported. Components may not balance because of rounding and direct recharge from cesspools and reservoirs. The source of water for direct recharge may be from external sources, including groundwater and imported streamflow. Some recharge may discharge to streams as base flow]

Aquifer sector	Aquifer system	Source of estimate	Water-budget-area description	Area, in square miles	Condition/ Scenario	Water-budget component, in million gallons per day								
						Rain	Fog	Irr	Septic	Direct Rech	Runoff	Canopy Evap	Total ET	Recharge
Wailuku	Kahakuloa	This study	A	10.78	Average climate	45.04	3.54	0.07	0.00	0.02	16.77	7.34	17.18	14.72
		This study	A	10.78	Drought	36.59	3.03	0.07	0.00	0.02	13.11	6.44	15.32	11.28
		This study	B	10.78	Average climate	45.04	3.54	0.07	0.00	0.02	16.77	7.34	17.18	14.72
		This study	B	10.78	Drought	36.59	3.03	0.07	0.00	0.02	13.11	6.44	15.32	11.28
		WRPP	C	10.22	Natural	46.70	n/a	n/a	n/a	n/a	16.10	n/a	19.50	11
Lahaina	Honokōhau	This study	A	13.87	Average climate	73.34	5.72	0.11	0.00	0.01	22.92	8.96	23.81	32.44
		This study	A	13.87	Drought	61.65	5.03	0.11	0.00	0.01	19.98	8.11	21.44	25.35
		This study	B	13.80	Average climate	73.21	5.72	0.11	0.00	0.01	22.91	8.95	23.71	32.41
		This study	B	13.80	Drought	61.55	5.03	0.11	0.00	0.01	19.97	8.11	21.35	25.34
		WRPP	C	13.23	Natural	80.60	n/a	n/a	n/a	n/a	38.40	n/a	25.20	17
Lahaina	Honolua	This study	A	17.77	Average climate	67.18	2.17	2.31	0.06	0.85	9.54	10.08	35.79	27.26
		This study	A	17.77	Drought	55.67	1.92	2.59	0.06	0.85	7.91	9.01	32.59	20.59
		This study	B	16.94	Average climate	65.68	2.17	1.71	0.06	0.77	9.44	10.07	34.12	26.85
		This study	B	16.94	Drought	54.53	1.92	1.93	0.06	0.77	7.83	9.00	31.07	20.29
		WRPP	C	17.61	Natural	72.90	n/a	n/a	n/a	n/a	20.10	n/a	33.50	19
Lahaina	Honokōwai	This study	A	23.54	Average climate	70.40	3.50	5.88	0.05	2.99	10.34	7.45	36.07	36.75
		This study	A	23.54	Drought	57.63	3.04	6.38	0.05	2.99	8.68	6.67	32.51	29.33
		This study	B	22.70	Average climate	69.60	3.50	5.05	0.05	2.94	10.28	7.45	34.65	36.43
		This study	B	22.70	Drought	57.09	3.04	5.50	0.05	2.94	8.65	6.66	31.18	29.09
		WRPP	C	22.67	Natural	68.00	n/a	n/a	n/a	n/a	11.90	n/a	43.20	13

Table 8. Mean annual water-budget components from this study for average climate and drought conditions and components from the Water Resources Protection Plan (State of Hawai‘i, 1990; 2008) for aquifer systems of Maui, Hawai‘i.—Continued

[See fig. 1 for locations of aquifer systems; Irr, irrigation; Septic, septic-system leachate; Direct Rech, direct recharge; Canopy Evap, forest-canopy evaporation; Total ET, total evapotranspiration, which includes canopy evaporation. WRPP, Water Resources Protection Plan (State of Hawai‘i, 1990; 2008). Water-budget-area descriptions: A, entire aquifer-system area; B, entire aquifer-system area excluding areas seaward of the 0-ft elevation contour of the top of Wailuku Basalt (see fig. 1); C, entire aquifer-system area excluding caprock areas as defined in the WRPP; D entire aquifer-system area excluding areas seaward of the 0-ft elevation contour of the top of Honomanü Basalt/Kula Volcanics (see fig. 1). Average climate conditions for this study are 1978–2007 rainfall and 2010 land cover. Drought conditions for this study are 1998–2002 rainfall and 2010 land cover. Natural conditions for WRPP are 1916–83 mean rainfall and a uniform, unirrigated land cover. All WRPP components not in parentheses are from the 1990 WRPP. WRPP aquifer-system recharge values that were updated in the 2008 WRPP, shown in parentheses, were provided by the State of Hawai‘i Commission on Water Resource Management. n/a, not accounted for or not reported. Components may not balance because of rounding and direct recharge from cesspools and reservoirs. The source of water for direct recharge may be from external sources, including groundwater and imported streamflow. Some recharge may discharge to streams as base flow]

Aquifer sector	Aquifer system	Source of estimate	Water-budget-area description	Area, in square miles	Condition/ Scenario	Water-budget component, in million gallons per day								
						Rain	Fog	Irr	Septic	Direct Rech	Runoff	Canopy Evap	Total ET	Recharge
Lahaina	Launiu-poko	This study	A	20.75	Average climate	64.06	4.16	0.70	0.24	0.63	8.94	5.65	19.58	41.34
		This study	A	20.75	Drought	52.46	3.45	0.73	0.24	0.63	7.50	4.97	17.36	32.71
		This study	B	18.72	Average climate	62.85	4.16	0.29	0.24	0.62	8.83	5.57	18.35	41.01
		This study	B	18.72	Drought	51.70	3.45	0.31	0.24	0.62	7.44	4.92	16.33	32.55
		WRPP	C	18.29	Natural	65.30	n/a	n/a	n/a	n/a	14.80	n/a	34.80	16
Lahaina	Olowalu	This study	A	8.12	Average climate	21.34	1.11	0.03	0.02	0.09	2.35	1.79	7.09	13.19
		This study	A	8.12	Drought	16.43	0.87	0.03	0.02	0.09	1.83	1.48	6.19	9.45
		This study	B	7.12	Average climate	20.78	1.11	0.00	0.01	0.00	2.32	1.77	6.60	12.98
		This study	B	7.12	Drought	16.07	0.87	0.00	0.01	0.00	1.81	1.47	5.81	9.32
		WRPP	C	6.81	Natural	20.40	n/a	n/a	n/a	n/a	3.60	n/a	13.00	4
Lahaina	Ukume-hame	This study	A	11.83	Average climate	23.64	1.20	0.00	0.00	0.00	2.14	1.19	8.80	13.91
		This study	A	11.83	Drought	16.49	0.86	0.00	0.00	0.00	1.51	0.90	7.45	8.42
		This study	B	10.78	Average climate	22.99	1.20	0.00	0.00	0.00	2.11	1.16	8.36	13.72
		This study	B	10.78	Drought	16.08	0.86	0.00	0.00	0.00	1.50	0.88	7.13	8.34
		WRPP	C	10.61	Natural	25.30	n/a	n/a	n/a	n/a	3.50	n/a	18.20	4
Central	Kahului	This study	A	27.50	Average climate	20.19	0.00	76.58	0.09	5.88	1.68	0.59	79.06	25.17
		This study	A	27.50	Drought	12.70	0.00	78.85	0.09	5.88	0.96	0.40	77.00	23.09
		This study	D	23.05	Average climate	17.28	0.00	70.49	0.07	5.85	1.27	0.40	69.28	23.57
		This study	D	23.05	Drought	10.85	0.00	72.62	0.07	5.85	0.73	0.28	67.57	21.72
		WRPP	C	9.54	Natural	9.10	n/a	n/a	n/a	n/a	0.50	n/a	6.80	2

Table 8. Mean annual water-budget components from this study for average climate and drought conditions and components from the Water Resources Protection Plan (State of Hawai‘i, 1990; 2008) for aquifer systems of Maui, Hawai‘i.—Continued

[See fig. 1 for locations of aquifer systems; Irr, irrigation; Septic, septic-system leachate; Direct Rech, direct recharge; Canopy Evap, forest-canopy evaporation; Total ET, total evapotranspiration, which includes canopy evaporation. WRPP, Water Resources Protection Plan (State of Hawai‘i, 1990; 2008). Water-budget-area descriptions: A, entire aquifer-system area; B, entire aquifer-system area excluding areas seaward of the 0-ft elevation contour of the top of Wailuku Basalt (see fig. 1); C, entire aquifer-system area excluding caprock areas as defined in the WRPP; D entire aquifer-system area excluding areas seaward of the 0-ft elevation contour of the top of Honomanū Basalt/Kula Volcanics (see fig. 1). Average climate conditions for this study are 1978–2007 rainfall and 2010 land cover. Drought conditions for this study are 1998–2002 rainfall and 2010 land cover. Natural conditions for WRPP are 1916–83 mean rainfall and a uniform, unirrigated land cover. All WRPP components not in parentheses are from the 1990 WRPP. WRPP aquifer-system recharge values that were updated in the 2008 WRPP, shown in parentheses, were provided by the State of Hawai‘i Commission on Water Resource Management. n/a, not accounted for or not reported. Components may not balance because of rounding and direct recharge from cesspools and reservoirs. The source of water for direct recharge may be from external sources, including groundwater and imported streamflow. Some recharge may discharge to streams as base flow]

Aquifer sector	Aquifer system	Source of estimate	Water-budget-area description	Area, in square miles	Condition/ Scenario	Water-budget component, in million gallons per day								
						Rain	Fog	Irr	Septic	Direct Rech	Runoff	Canopy Evap	Total ET	Recharge
Central	Pā‘ia	This study	A	59.04	Average climate	70.55	0.00	176.96	0.11	26.20	4.10	1.04	196.45	74.60
		This study	A	59.04	Drought	50.38	0.00	185.09	0.11	26.20	2.98	0.76	192.97	67.70
		WRPP	C	60.73	Natural	78.10	n/a	n/a	n/a	n/a	2.90	n/a	54.90	17
Central	Makawao	This study	A	51.78	Average climate	107.85	5.57	3.54	1.22	3.18	9.67	4.84	64.78	46.83
		This study	A	51.78	Drought	78.54	4.20	4.25	1.22	3.18	7.11	3.83	56.66	27.91
		WRPP	C	52.93	Natural	95.80	n/a	n/a	n/a	n/a	7.60	n/a	70.60	15
Central	Kama‘ole	This study	A	91.36	Average climate	98.08	9.43	7.29	0.54	1.54	3.61	12.46	79.40	33.87
		This study	A	91.36	Drought	64.98	6.67	7.71	0.54	1.54	2.26	9.08	63.56	16.59
		WRPP	C	89.22	Natural	118.90	n/a	n/a	n/a	n/a	8.50	n/a	85.00	25
Ko‘olau	Ha‘ikū	This study	A	35.20	Average climate	161.52	12.80	0.68	0.84	4.13	39.54	17.55	75.52	64.74
		This study	A	35.20	Drought	130.93	10.55	0.81	0.84	4.13	31.79	15.47	69.07	46.26
		WRPP	C	35.71	Natural	163.20	n/a	n/a	n/a	n/a	34.00	n/a	68.00	61
Ko‘olau	Honopou	This study	A	17.70	Average climate	118.38	6.71	0.01	0.11	0.55	45.54	15.13	41.95	38.21
		This study	A	17.70	Drought	101.37	5.79	0.02	0.11	0.55	38.52	13.89	39.63	29.42
		WRPP	C	18.87	Natural	129.40	n/a	n/a	n/a	n/a	32.30	n/a	35.90	57
Ko‘olau	Waikamoi	This study	A	26.06	Average climate	210.90	18.49	0.00	0.00	0.55	95.48	22.76	48.41	85.91
		This study	A	26.06	Drought	184.91	16.19	0.00	0.00	0.55	83.45	21.36	46.45	71.27
		WRPP	C	26.08	Natural	223.50	n/a	n/a	n/a	n/a	83.20	n/a	49.70	91
Ko‘olau	Ke‘anae	This study	A	55.22	Average climate	454.33	40.48	1.77	0.01	0.09	185.71	36.08	89.16	221.69
		This study	A	55.22	Drought	381.46	34.23	1.77	0.01	0.09	153.53	34.13	85.37	178.01
		WRPP	C	55.56	Natural	489.40	n/a	n/a	n/a	n/a	195.80	n/a	105.80	188

Table 8. Mean annual water-budget components from this study for average climate and drought conditions and components from the Water Resources Protection Plan (State of Hawai‘i, 1990; 2008) for aquifer systems of Maui, Hawai‘i.—Continued

[See fig. 1 for locations of aquifer systems; Irr, irrigation; Septic, septic-system leachate; Direct Rech, direct recharge; Canopy Evap, forest-canopy evaporation; Total ET, total evapotranspiration, which includes canopy evaporation. WRPP, Water Resources Protection Plan (State of Hawai‘i, 1990; 2008). Water-budget-area descriptions: A, entire aquifer-system area; B, entire aquifer-system area excluding areas seaward of the 0-ft elevation contour of the top of Wailuku Basalt (see fig. 1); C, entire aquifer-system area excluding caprock areas as defined in the WRPP; D entire aquifer-system area excluding areas seaward of the 0-ft elevation contour of the top of Honomanü Basalt/Kula Volcanics (see fig. 1). Average climate conditions for this study are 1978–2007 rainfall and 2010 land cover. Drought conditions for this study are 1998–2002 rainfall and 2010 land cover. Natural conditions for WRPP are 1916–83 mean rainfall and a uniform, unirrigated land cover. All WRPP components not in parentheses are from the 1990 WRPP. WRPP aquifer-system recharge values that were updated in the 2008 WRPP, shown in parentheses, were provided by the State of Hawai‘i Commission on Water Resource Management. n/a, not accounted for or not reported. Components may not balance because of rounding and direct recharge from cesspools and reservoirs. The source of water for direct recharge may be from external sources, including groundwater and imported streamflow. Some recharge may discharge to streams as base flow]

Aquifer sector	Aquifer system	Source of estimate	Water-budget-area description	Area, in square miles	Condition/ Scenario	Water-budget component, in million gallons per day								
						Rain	Fog	Irr	Septic	Direct Rech	Runoff	Canopy Evap	Total ET	Recharge
Hāna	Kūhiwa	This study	A	13.59	Average climate	175.88	10.28	0.00	0.01	0.02	66.17	12.04	27.31	92.67
		This study	A	13.59	Drought	150.15	8.88	0.00	0.01	0.02	56.24	11.55	26.60	75.97
		WRPP	C	13.14	Natural	160.80	n/a	n/a	n/a	n/a	104.50	n/a	25.00	31
Hāna	Kawaipapa	This study	A	31.75	Average climate	255.24	12.52	0.17	0.12	0.32	87.48	18.39	66.38	114.44
		This study	A	31.75	Drought	216.84	10.91	0.19	0.12	0.32	74.45	17.33	62.38	91.33
		WRPP	C	32.60	Natural	263.90	n/a	n/a	n/a	n/a	93.10	n/a	62.10	109
Hāna	Waiho‘i	This study	A	14.40	Average climate	132.19	8.35	0.02	0.02	0.04	53.46	8.95	28.35	58.77
		This study	A	14.40	Drought	113.44	7.24	0.02	0.02	0.04	45.98	8.42	26.78	47.95
		WRPP	C	15.18	Natural	114.20	n/a	n/a	n/a	n/a	36.90	n/a	28.90	40
Hāna	Kīpahulu	This study	A	29.67	Average climate	237.26	11.76	0.17	0.01	0.03	65.10	18.55	52.82	131.25
		This study	A	29.67	Drought	201.68	9.94	0.20	0.01	0.03	55.73	17.25	49.65	106.25
		WRPP	C	30.22	Natural	213.00	n/a	n/a	n/a	n/a	59.00	n/a	57.60	96
Kahikinui	Kaupō	This study	A	20.31	Average climate	58.19	1.60	0.00	0.00	0.02	5.87	0.44	22.65	31.28
		This study	A	20.31	Drought	46.06	1.25	0.00	0.00	0.02	4.65	0.38	20.52	22.24
		WRPP	C	20.73	Natural	87.80	n/a	n/a	n/a	n/a	12.80	n/a	39.50	36
Kahikinui	Nakula	This study	A	30.21	Average climate	62.41	0.99	0.00	0.00	0.00	4.26	0.52	30.15	29.00
		This study	A	30.21	Drought	47.67	0.76	0.00	0.00	0.00	3.21	0.42	26.28	19.25
		WRPP	C	30.94	Natural	69.20	n/a	n/a	n/a	n/a	2.90	n/a	50.10	16

Table 8. Mean annual water-budget components from this study for average climate and drought conditions and components from the Water Resources Protection Plan (State of Hawai‘i, 1990; 2008) for aquifer systems of Maui, Hawai‘i.—Continued

[See fig. 1 for locations of aquifer systems; Irr, irrigation; Septic, septic-system leachate; Direct Rech, direct recharge; Canopy Evap, forest-canopy evaporation; Total ET, total evapotranspiration, which includes canopy evaporation. WRPP, Water Resources Protection Plan (State of Hawai‘i, 1990; 2008). Water-budget-area descriptions: A, entire aquifer-system area; B, entire aquifer-system area excluding areas seaward of the 0-ft elevation contour of the top of Wailuku Basalt (see fig. 1); C, entire aquifer-system area excluding caprock areas as defined in the WRPP; D entire aquifer-system area excluding areas seaward of the 0-ft elevation contour of the top of Honomanü Basalt/Kula Volcanics (see fig. 1). Average climate conditions for this study are 1978–2007 rainfall and 2010 land cover. Drought conditions for this study are 1998–2002 rainfall and 2010 land cover. Natural conditions for WRPP are 1916–83 mean rainfall and a uniform, unirrigated land cover. All WRPP components not in parentheses are from the 1990 WRPP. WRPP aquifer-system recharge values that were updated in the 2008 WRPP, shown in parentheses, were provided by the State of Hawai‘i Commission on Water Resource Management. n/a, not accounted for or not reported. Components may not balance because of rounding and direct recharge from cesspools and reservoirs. The source of water for direct recharge may be from external sources, including groundwater and imported streamflow. Some recharge may discharge to streams as base flow]

Aquifer sector	Aquifer system	Source of estimate	Water-budget-area description	Area, in square miles	Condition/ Scenario	Water-budget component, in million gallons per day								
						Rain	Fog	Irr	Septic	Direct Rech	Runoff	Canopy Evap	Total ET	Recharge
Kahikinui	Luala‘ilua	This study	A	62.45	Average climate	75.63	3.48	0.00	0.00	0.01	3.00	3.91	48.20	27.90
		This study	A	62.45	Drought	52.72	2.58	0.00	0.00	0.01	2.03	2.86	39.93	14.03
		WRPP	C	68.11	Natural	123.20	n/a	n/a	n/a	n/a	6.50	n/a	90.80	26

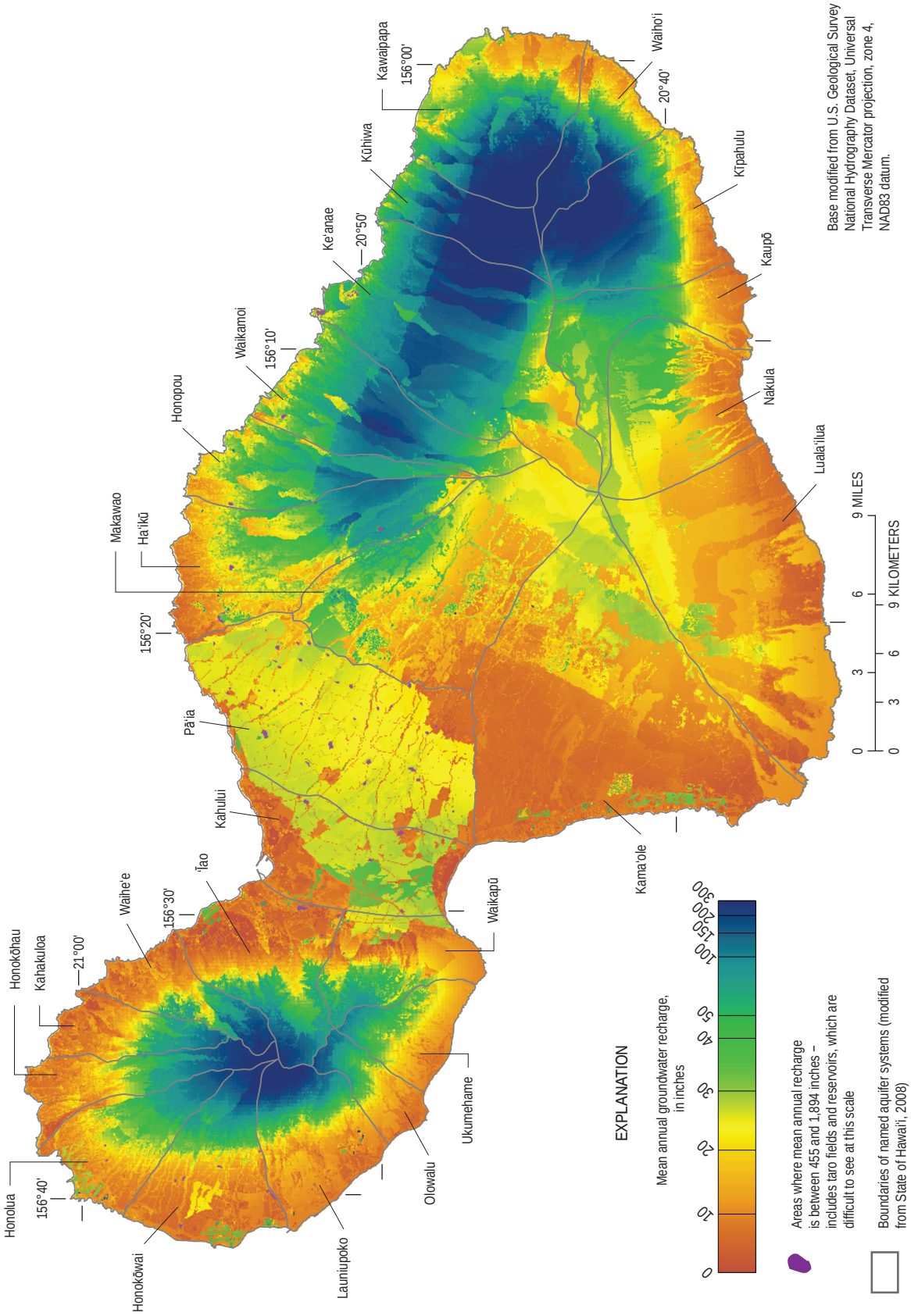


Figure 10. The distribution of mean annual groundwater recharge for average climate conditions (1978–2007), Island of Maui, Hawai'i, calculated using the water-budget model.

have water inflows from irrigation, septic-system leachate, and direct recharge have higher recharge than nearby areas without these supplemental water inflows. For example, in the isthmus, reservoirs and irrigated fields of sugarcane have higher recharge rates than nearby areas.

Mean annual recharge ranges spatially from 0 to 99 percent of total water inflow (fig. 11). Most of Maui has recharge rates that are less than 60 percent of water inflow. The areas with the highest fraction, greater than 80 percent, are mainly reservoirs. The areas with the lowest fraction, less than 20 percent are chiefly dry, lowland areas.

Comparison with Water Resources Protection Plan

The 1990 Water Resources Protection Plan (WRPP) included recharge estimates, in million gallons per day, for all aquifer systems on Maui for conditions without irrigation (State of Hawaii, 1990, p. B-7). Recharge estimates reported in the WRPP were based on a water budget that considered mean annual rainfall, runoff, and evapotranspiration. Estimates of precipitation, runoff, and ET reported in the WRPP were converted from units of inches per year to million gallons per day (table 8) on the basis of the aquifer-system areas provided by the State of Hawai‘i Commission on Water Resource Management (Roy Hardy, written commun., 2014).

Caprock areas were excluded from the calculation of aquifer-system recharge in the WRPP. Caprock consists primarily of sedimentary deposits that collectively have low permeability and overlie volcanic rocks with relatively high permeability. The spatial extent of caprock areas on Maui, however, was not defined in the WRRP. To facilitate comparisons between results of the WRPP and the results of this study, the spatial extent of caprock was estimated. Caprock was assumed to (1) consist of areas seaward of the 0-ft altitude contour of the top of the Wailuku Basalt for aquifer systems of the Lahaina and Wailuku aquifer sectors, (2) consist of areas seaward of the 0-ft altitude contour of the top of the Kula Volcanics/ Honomanū Basalt for the Kahului aquifer system, and (3) be negligible for all remaining aquifer systems (fig. 1). Water-budget components estimated for parts of aquifers inland from estimated caprock areas are shown in table 8, water-budget area descriptions B and D. Areas defined as caprock for this study were excluded from comparisons with the results of the WRPP, as described next.

Recharge estimates for average climate conditions from this study are greater than estimates of the WRPP for 22 of the 25 aquifer systems (table 8). The part of the Kahului aquifer system that was not considered as caprock for this study, however, is about 1.5 times greater than that reported in the WRPP. Area inconsistencies aside, the reasons for differences in the recharge estimates are related to methods and datasets used to estimate individual water-budget components. For most of these aquifer systems, total ET estimates of this study are less than those of the WRPP. The 1990 WRPP states that ET was estimated as (1) 40 in/yr for areas where mean rainfall was at least 55 in/yr and (2) 73 percent of rainfall for areas where mean rainfall was less than 55 in/yr. In the water budget for this study, ET is computed daily on the basis of available mean monthly potential ET, soil moisture, vegetative cover, and soil type. Runoff estimates from this study are less than those of the WRPP for some aquifer systems. The runoff-rainfall relations used to estimate runoff in the WRPP were developed from streamflow measurements without subtracting base flow. In contrast, base flow was subtracted from streamflow measurements when developing the runoff-rainfall relations for this study. Owing to the inclusion of fog interception, some precipitation estimates of this study are greater than those of the WRPP, which omit fog interception. Some differences in precipitation are also related to the source of rainfall data. Rainfall estimates of the WRPP are based on 1916–83 mean isohyets (Giambelluca and others, 1986), whereas estimates of this study are based on 1978–2007 monthly rainfall maps (Frazier, 2012). Additionally, the WRPP did not account for septic leachate, irrigation, and direct recharge from reservoirs and cesspools. Irrigation is a considerable source of recharge, especially in the isthmus. Even if direct recharge is omitted, however, recharge estimates from this study exceed the estimates of the WRPP by at least 5 percent for 21 aquifer systems.

Recharge estimates of this study for average climate conditions are less than estimates of the WRPP for the Honopou, Waikamoi, and Kaupō aquifer systems (table 8). Runoff estimates from this study for the Honopou and Waikamoi aquifer systems are considerably greater than those of the WRPP. The total ET estimate for the Honopou aquifer system is also much greater than that of the WRPP. Precipitation estimates of this study for parts of leeward Haleakalā, including the Kaupō aquifer system, are much lower than those of the WRPP.

The 1990 WRPP was updated in 2008. Recharge estimates for aquifer systems were not reported in the 2008 WRPP (State of Hawaii, 2008) but were provided by the State of Hawai‘i Commission on Water Resource Management (Roy Hardy, written commun., 2014). Recharge values used in the 2008 WRPP for Maui’s aquifer systems, other than ‘Īao and Waihe‘e, were the same as those presented in the 1990 WRPP. For the ‘Īao and Waihe‘e aquifer systems, recharge estimates for average climate conditions from this study are greater than the estimates used in the 2008 WRPP and those reported in the 1990 WRPP (table 8).

Comparison with Previous Studies for the ‘Īao and Waihe‘e aquifer systems

The ‘Īao and Waihe‘e aquifer systems, on the windward side of West Maui Mountain (fig. 1), are the principal sources of domestic water supply for the Island of Maui. Recharge estimates of this study for these aquifer systems are compared with recent estimates by Shade (1997) and Engott and Vana (2007). The recharge estimate of Shade (1997) for the ‘Īao aquifer system (table 9) is based on 1916–83 rainfall and 1986–95 land cover, which included irrigated sugarcane, macadamia nut trees, and pineapple. The recharge estimates of Engott and Vana (2007) for the ‘Īao and Waihe‘e aquifer systems are for a scenario referred to as land use II, which used 1926–2004 rainfall and 2000–04 land cover.

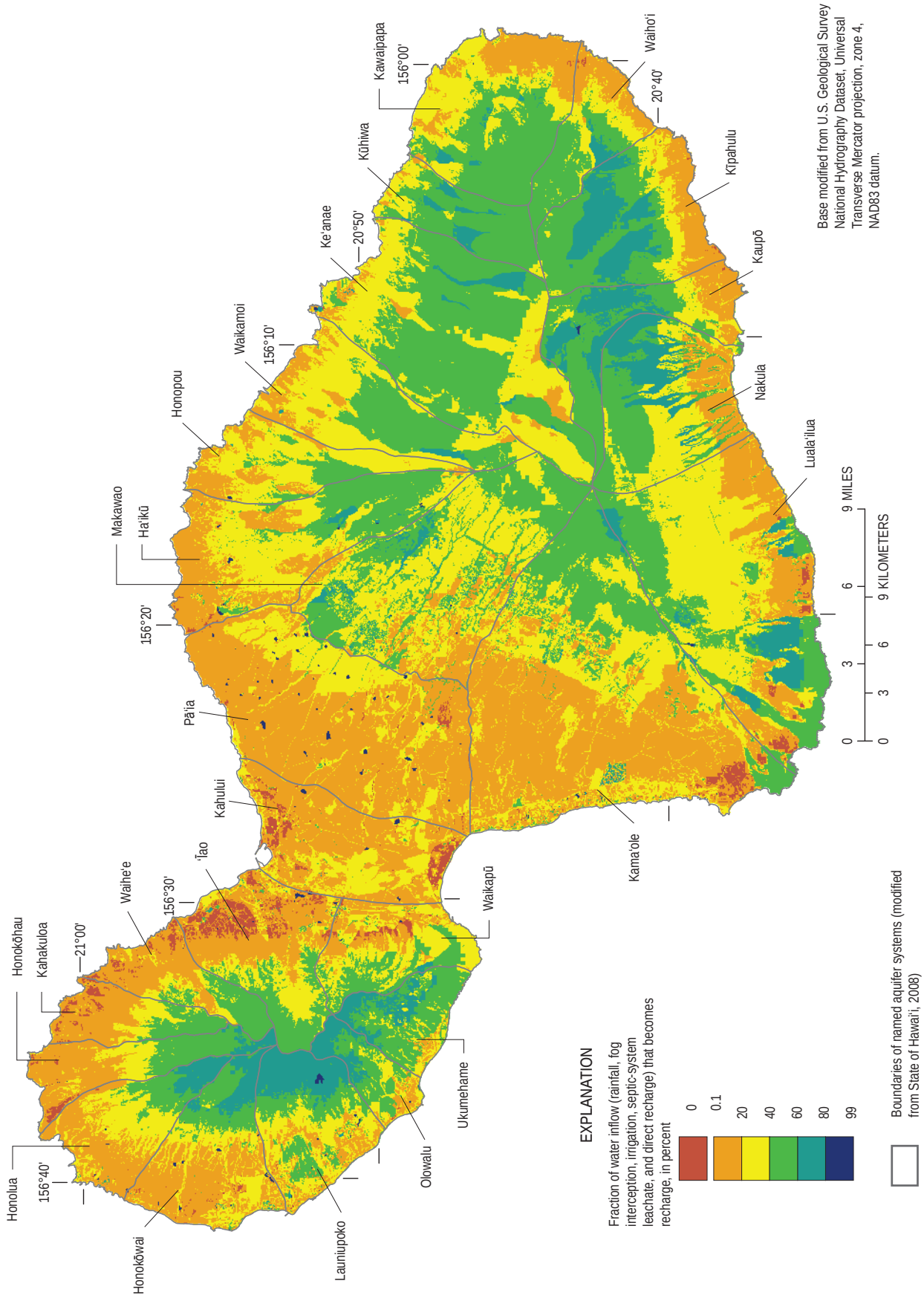


Figure 11. Fraction of total water inflow that becomes groundwater recharge in the water-budget calculations for average climate conditions (1978–2007) Island of Maui, Hawai'i.

Recharge estimated in this study for the ‘Īao aquifer system (table 9) is greater than recharge estimated by Shade (1997). The rainfall and runoff estimates of Shade (1997) are similar to those of this study even though they are based on different input datasets and computational methods. Fog interception was not accounted for by Shade (1997). The difference in total ET estimates is about the same magnitude as fog interception. Direct recharge from reservoirs and cesspools was also not accounted for by Shade (1997). Recharge is about 5 percent less than that estimated by Shade (1997) if direct recharge is not considered.

Recharge estimates of this study for the ‘Īao and Waihe‘e aquifer systems (table 9) are less than those of Engott and Vana (2007). One reason for these differences is that runoff estimates from this study are greater than those of Engott and Vana (2007). In general, the mean runoff-to-rainfall ratios for catchment zones within these aquifer systems (figs. 1 and 6) are greater than those of Engott and Vana (2007, p. 21–23), especially in the wet, inland areas during the wet season. Additionally, runoff estimates from this study for the drainage basins of stream-gaging stations 16604500 (on ‘Īao Stream) and 16614000 (on Waihe‘e River) (fig. 6), are based on observed seasonal runoff-to-rainfall ratios (when available). In contrast, runoff estimates from Engott and Vana (2007) are based solely on mean monthly runoff-to-rainfall ratios.

Comparison with Evapotranspiration Estimates of Giambelluca and others (2014)

For the Island of Maui, mean annual total ET of the water budget for average climate conditions is about 1,173 Mgal/d, which is within 15 percent of the mean annual ET derived from Giambelluca and others (2014). Compared to ET estimates of Giambelluca and others (2014), the mean annual total ET estimates of the Maui water budget are (1) about 17 percent more for subareas mapped as grassland, (2) about 11 percent more for subareas mapped as shrubland, (3) about 2 percent more for subareas mapped as native forest, alien forest, or tree plantation, (4) about 7 percent less for subareas mapped as developed, and (5) about 10 percent less for subareas mapped as sparsely vegetated. ET estimates are also less than estimates of Giambelluca and others (2014) for subareas with fallow/grassland land cover. The similarity in ET estimates for forests was expected because forest crop coefficients and canopy evaporation were calibrated to ET datasets of Giambelluca and others (2014). The ET estimate of the water budget for subareas mapped as sugarcane is about 57 percent more than that of Giambelluca and others (2014).

The differences in mean annual ET estimates may be related to differences in base periods, computational methods, and soil-moisture estimates. For example, in areas where ET estimates of the water budget are much greater

Table 9. Comparison of mean annual water-budget components from this study with components from previous studies for ‘Īao and Waihe‘e aquifer systems of Maui, Hawai‘i.

[See fig. 1 for locations of aquifer systems; Irr, irrigation; Septic, septic-system leachate; Direct Rech, direct recharge; Canopy Evap, forest-canopy evaporation; Total ET, total evapotranspiration, which includes canopy evaporation.; Average climate conditions for this study are 1978–2007 rainfall and 2010 land cover; Land use II conditions for Engott and Vana (2007) are 1926–2004 rainfall and 2000–04 land cover. 1986–95 conditions for Shade (1997) are 1916–83 rainfall and 1986–95 landcover. n/a, not accounted for or not reported. Components may not balance because of rounding and direct recharge from cesspools and reservoirs. The source of water for direct recharge may be from external sources, including groundwater and imported streamflow. Some recharge may discharge to streams as base flow]

Location	Source of estimate	Condition/ Scenario	Area, in square miles	Water-budget component, in million gallons per day								
				Rain	Fog	Irr	Septic	Direct Rech	Runoff	Canopy Evap	Total ET	Re-charge
‘Īao aquifer system	This study	Average climate	25.28	98.52	7.44	2.81	0.11	6.37	41.39	8.61	33.52	40.64
	Engott and Vana (2007)	Land use II	25.30	97.76	9.90	1.90	n/a	n/a	31.53	n/a	31.28	45.96
	Shade (1997)	1986–95	24.69	100.00	n/a	3.00	n/a	n/a	41.00	n/a	26.00	36.00
Waihe‘e aquifer system	This study	Average climate	12.44	61.46	4.36	0.11	0.07	0.04	24.73	4.98	17.37	23.95
	Engott and Vana (2007)	Land use II	12.45	56.66	6.24	0.02	n/a	n/a	16.07	n/a	17.11	29.72

than those of Giambelluca and others (2014)–including sugarcane fields– soil-moisture estimates of the water budget may be greater than those of Giambelluca and others (2014). On the other hand, in areas where ET estimates of the water budget are less than those of Giambelluca and others (2014)–including abandoned agriculture fields mapped as fallow/grassland– soil-moisture estimates of the water budget may be less.

Recharge for Drought Conditions

Maui has experienced drought conditions in recent years. For example, based on the 1978–2007 monthly rainfall datasets (Frazier, 2012), annual rainfall for the island of Maui was below average 8 out of the last 10 years (1998–2007). To assess the impact of drought conditions on recharge, rainfall during 1998–2002 was selected to represent drought conditions on Maui because this period had the lowest 5-yr mean rainfall during 1978–2007. Other than rainfall, all water-budget inputs used to compute recharge for drought conditions were the same as those used for average climate conditions. Because the fog-to-rainfall ratios used for average climate conditions were also used for drought conditions, fog-interception rates for drought conditions were less than those for average climate conditions.

For the Island of Maui, recharge for drought conditions, about 1,035 Mgal/d (table 7), is 23 percent less than recharge for average climate conditions. For Maui's aquifer systems, water-budget components estimated for drought conditions are shown in table 8. Aquifer-system precipitation for drought conditions ranges from 12 to 37 percent less than corresponding precipitation for average climate conditions. Aquifer-system recharge for drought conditions is about 8 to 51 percent less than corresponding recharge for average climate conditions.

The spatial pattern of mean annual recharge for drought conditions on the Island of Maui (not shown) resembles that for average climate conditions. Recharge for most areas, however, is lower for drought conditions (fig. 12). Hence, for most areas on the Island of Maui, recharge estimates are sensitive to precipitation. Compared with recharge for average climate conditions, recharge decreases between 10 and 50 percent for most upland areas on West Maui Mountain and windward Haleakalā; recharge decreases by more than 50 percent in most unirrigated lowland areas on West Maui Mountain and on leeward Haleakalā. Recharge decreases by 10 percent or less for some irrigated areas, including the sugarcane fields in the isthmus. Subareas mapped as golf courses had slightly more recharge for drought conditions owing to relatively more sprinkler irrigation. In some areas, runoff may have been overestimated for drought conditions owing to use of mean seasonal runoff-to-rainfall ratios representative of 1978–2007. Overestimating runoff would result in underestimating recharge. On the other hand, the assumption of constant reference ET may have resulted in underestimating ET for drought conditions, which would result in overestimating recharge.

Sensitivity Analysis

Uncertainty exists in many of the water-budget inputs used in this study. The inputs used in the water-budget calculations were considered to be those most reasonable. To analyze the effect that uncertainty in water-budget inputs has on estimated recharge, the water budget was rerun, changing one input value at a time within a reasonable range. The parameters tested were (1) available water capacity, (2) fog-interception rates, (3) root depth, (4) runoff-to-rainfall ratios, (5) crop coefficient, (6) canopy capacity, (7) ratio of mean evaporation rate to mean precipitation rate during saturated canopy conditions, and (8) the fate of excess water collected by storm-drain systems. Changes to trunk-storage capacity and the proportion of precipitation diverted to stemflow were also tested for subareas with forest land covers. For available water capacity, the low and high values published in Natural Resources Conservation Service (2006a) were tested. For fog-interception rates and root depths, the "baseline" values used in water-budget calculations for average climate and drought conditions were increased by 50 percent and decreased by 50 percent. Runoff-to-rainfall ratios were adjusted on the basis of bias and root-mean-square-error statistics (for Maui) of the region-regression models (table 5). For crop coefficients, baseline values were increased by 20 percent and decreased by 20 percent. Canopy-storage capacity values of 0.08 and 0.02 were tested. Values for V were increased by 0.10 units and were decreased by 0.10 units. For the latter case, however, V was assumed to be no less 0.01. Finally the effects of routing all water collected by storm-drain systems to runoff and to recharge were tested.

The recharge estimates for the sensitivity analysis were compared with recharge estimates for average climate conditions for Honokōwai, ʻĪao, Kahului, Kūhiwa, and Lualaʻilua aquifer systems and the Island of Maui (table 10). These five aquifer systems cover a range of climates on Maui. The Honokōwai and ʻĪao aquifer systems are on leeward and windward West Maui Mountain, respectively, and have steep rainfall gradients. The wet uplands of the Honokōwai aquifer system are mostly native forest; drier lowlands include alien forest, coffee, developed areas, and large areas of abandoned pineapple fields that are now fallow grasslands. Within the ʻĪao aquifer system, uplands are wet, steep, and mostly forest and shrubland; lowlands are drier and are a mixture of alien forest, macadamia, grassland, and developed areas. The area within the Kahului aquifer system, on the isthmus, is very dry but has substantial irrigation for sugarcane. The area within the Kūhiwa aquifer system, on windward Haleakalā, is very wet and is mostly forested. The area within the Lualaʻilua aquifer system, on southwest Haleakalā, is dry and is mostly grassland and sparsely vegetated (table 2).

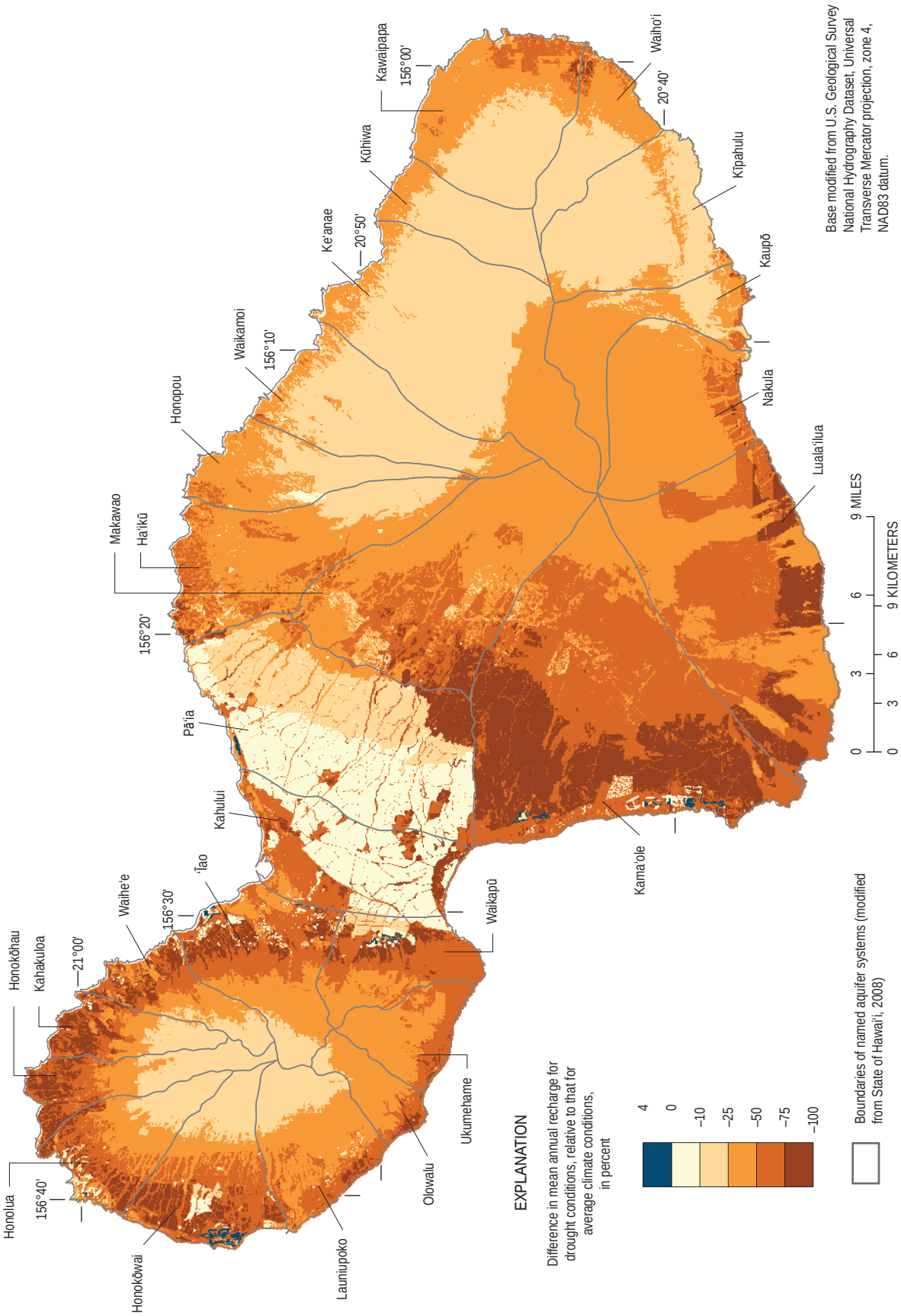


Figure 12. Percentage difference in mean annual groundwater recharge for drought conditions (1998–2002), relative to that for average climate conditions (1978–2007), Island of Maui, Hawai'i calculated using the water-budget model.

Table 10. Results of sensitivity testing for selected water-budget parameters performed for selected aquifer systems and the Island of Maui, Hawai‘i.

[See fig.1 for locations of aquifer systems; baseline parameters are those used for average climate conditions; RMSE, prediction root mean square error of regional-runoff regression; see table 5 for RMSE and bias for Maui; %, percent]

Parameter	Adjusted parameter value	Percentage difference in recharge relative to scenario for average climate conditions for aquifer systems and the Island of Maui					
		Honokōwai	**‘Īao**	Kahului	**Kūhiwa**	Lualaʻilua	Island of Maui
Available water capacity	Low reported value[1]	0.8	0.5	6.1	0.1	6.9	1.2
	High reported value[1]	-0.7	-0.4	-3.1	-0.1	-3.9	-0.8
Fog-interception rates	150% of baseline	4.3	8.6	0.0	5.5	4.6	6.2
	50% of baseline	-4.3	-8.5	0.0	-5.5	-4.4	-6.2
Root depth	150% of baseline	-2.2	-1.3	-7.7	-0.1	-6.8	-1.8
	50% of baseline	4.5	2.8	28.8	0.3	14.8	4.6
Runoff-to-rainfall ratios	Regression bias adjustment[2]	5.8	-1.4	0.2	-3.8	2.0	-0.5
	Increase by regression RMSE[3]	-7.0	-8.1	-1.2	-21.6	-8.2	-12.9
	Decrease by regression RMSE[3]	7.0	8.9	0.7	21.5	7.1	12.9
Crop coefficients	120% of baseline	-3.3	-4.3	20.2	-2.8	-6.9	-3.1
	80% of baseline	4.3	5.1	-15.4	3.0	9.0	4.2
Canopy capacity	Increase by 0.03 unit	-3.6	-3.9	0.0	-4.6	-0.4	-3.8
	Decrease by 0.03 unit	4.2	4.5	0.0	4.9	0.4	4.2
Ratio of the mean evaporation rate to mean precipitation rate during saturated conditions, *V*	Increase by 0.1 unit	-8.1	-11.9	-0.1	-17.6	-1.5	-12.4
	Decrease by 0.1 unit	6.2	5.5	0.1	1.4	1.6	4.6
Fate of excess water collected by storm-drain systems	All collected water goes to runoff	-0.3	-0.3	-0.2	0.0	0.0	-0.1
	All collected water goes to recharge	0.3	1.6	4.5	0.0	0.0	0.2

[1]Low and high values reported in Natural Resources Conservation Service (2006a).

[2]For leeward areas, runoff-to-rainfall ratios were decreased by 27.6 and 6.5 percent for the wet and dry seasons, respectively. For windward areas, runoff-to-rainfall ratios were increased by 3.9 and 8.4 percent for the wet and dry seasons, respectively.

[3]For leeward areas, runoff-to-rainfall ratios were adjusted by 0.05 and 0.04 unit for the wet and dry seasons, respectively. For windward areas, runoff-to-rainfall ratios were adjusted by 0.11 and 0.10 unit for the wet and dry seasons, respectively.

Adjusting the fate of water collected by storm-drain systems had a minor effect on the recharge estimates for the five aquifer systems examined in this analysis (table 10). If all water collected by storm-drain systems is assumed to be runoff, then aquifer-system recharge decreases by less than 1 percent. If all water collected by storm-drain systems is assumed to be recharge, then aquifer-system recharge increases by less than 5 percent. Although considerable areas are developed in the ‘Īao and Honokōwai aquifer systems, these areas typically have much less rainfall than the forested areas farther inland. Similarly, for the Kahului aquifer system, rainfall for the developed land covers is much less than the sum of irrigation and direct recharge from reservoirs. Adjustments to canopy capacity changes recharge by less than 5 percent for each aquifer system examined.

Recharge estimates for windward-facing aquifer systems (‘Īao and Kūhiwa) were most sensitive to adjustments to fog-interception rates, runoff-to-rainfall ratios, and *V*. This indicates the importance of fog, runoff, and canopy evaporation in the water budget for wet, forested areas. Adjustments to the remaining parameters tested affected recharge by no more than 6 percent. Recharge estimates for the Honokōwai aquifer system were also sensitive to runoff-to-rainfall ratios, and *V*. Adjustments to fog-interception rates, however, had less impact on recharge for this leeward-facing aquifer system relative to the windward-facing aquifer systems.

Recharge estimates for the dry aquifer systems on leeward Haleakalā (Kahului and Lualaʻilua) were more sensitive to available water capacity, root depth, and crop coefficients than the wetter aquifer systems examined. This indicates that moisture-storage capacity and ET, which are related to these three parameters, are important water-budget components in dry areas. Adjustments to fog-interception rates also had a noticeable effect on recharge for the Lualaʻilua aquifer system, which has patches of forest and shrubland in the cloud zone. Unlike recharge for the other aquifer systems examined, recharge for the Kahului aquifer system (1) was not sensitive to adjustments in runoff-to-rainfall ratios, and (2) increased when crop coefficients were increased. The reason for the latter difference is related to the chief source of recharge. Irrigation is the chief source of recharge for the Kahului aquifer system, whereas precipitation is the chief source of recharge in most unirrigated areas on Maui. In the water budget, increasing the crop coefficients for irrigated land covers increases potential ET and irrigation rates (see equation 16), which results in increased recharge rates.

For areas mapped as forests (native, alien, and tree plantation), recharge changes by 5 percent or less in response to selected adjustments to the baseline values used for trunk-storage capacity (0.01 inch), and the proportion of precipitation diverted to stemflow (0.04). Recharge for forested areas decreases by about 5 percent when the model uses a relatively high trunk-storage capacity value of 0.14 inch, the storage capacity determined by DeLay (2005) for epiphytes in a native cloud forest on the Island of Hawai‘i. Recharge for forested areas increases by about 2 percent when the model uses a relatively low trunk-storage capacity value of 0.001 inch and decreases by 0.2 percent when the model uses a relatively high stemflow value of 0.10. For areas mapped as alien forest, recharge decreases by 0.4 percent when the model uses a stemflow value of 0.37, determined by Safeeq and Fares (2014) for a site with an abundance of *Psidium cattleianum*.

Suggestions for Future Study and Additional Data Collection

The results of this study indicate that precipitation is a critical dataset for estimating recharge. Future studies that estimate recharge would benefit from additional sites where precipitation is measured. A large part of Maui is in the cloud zone and thus has the potential to intercept fog moisture. Recharge estimates for areas in the cloud zone are sensitive to fog-interception estimates. Fog and recharge estimates of this study could be improved with a better understanding of the spatial and daily variability of fog on Maui and fog-interception rates for different types of vegetation.

Streamflow data from stream-gaging stations is essential for determining direct runoff and base flow. Additionally, recharge estimates for most areas on Maui are sensitive to runoff-to-rainfall ratios. More stream-gaging stations on Maui would improve runoff and recharge estimates.

Irrigation is substantial on Maui, particularly for sugarcane on the isthmus. Records of water availability can be used to constrain irrigation rates of the water budget. Records of water applied to irrigated areas would help with replicating actual irrigation practices on Maui.

The gridded maps of ET-related parameters produced by Giambelluca and others (2014) were a valuable resource for estimating ET in the water budget of this study, although uncertainty in these parameters will result in uncertainty in recharge estimates. Recharge estimates could be further improved with estimates of the interannual and daily variations of reference ET across Maui. For example, ET measurements for different types of the dominant alien and native plants could be used to develop crop coefficients for land-cover types that are more specific than the general land-cover classes used here. Also helpful would be spatial estimates of *V*, which is the ratio of the mean evaporation rate to the mean precipitation rate during saturated canopy conditions. Additional canopy evaporation measurements on Maui could be used to confirm or calibrate the canopy evaporation estimates of the water-budget model.

Summary and Conclusions

The main objective of this study was to determine the spatial distribution of mean annual groundwater recharge for the Island of Maui. Recharge was computed with a water-budget model that used a daily computational interval. Hydrological

processes and physical conditions that affect recharge on Maui were simulated in the water-budget model using the most current datasets available– including maps of 2010 land cover, 1978–2007 monthly rainfall, and mean monthly reference evapotranspiration. The model disaggregated monthly rainfall into daily rainfall using the method of fragments and daily rainfall records from 52 rain gages. The water-budget model and the most current datasets available were used to estimate the spatial distribution of mean annual groundwater recharge for two scenarios: (1) average climate conditions, based on 2010 land cover and rainfall during 1978–2007 and (2) drought conditions, based on 2010 land cover and rainfall during 1998–2002.

For the Island of Maui, mean annual recharge is about 1,340 Mgal/d for average climate conditions. Recharge is about 45 percent of precipitation (sum of rainfall and fog interception) and is about 40 percent of total inflow (sum of precipitation, irrigation, septic-system leachate, and direct recharge).

The spatial pattern of mean annual recharge on Maui for average climate conditions resembles that of mean annual rainfall, but it also reflects spatial variations in vegetation and soils, irrigation in agricultural and developed areas, and persistent cloud layers that envelop upland areas. Wet, upland parts of the island typically have more recharge than dry, coastal areas. Areas with the highest recharge include the mid-altitude slopes of windward Haleakalā and the uplands of West Maui Mountain. In addition to having high rainfall, these locations have considerable fog interception and low reference ET owing to persistent cloud cover. In general, areas that have water inflows from irrigation, septic-system leaching, and direct recharge have more total recharge than nearby areas without these supplemental water inflows. Of Maui's total mean recharge for average climate conditions, about 60 percent occurs in the Koʻolau and Hāna aquifer sectors on windward Haleakalā. For Maui's 25 aquifer systems, mean annual recharge ranges from about 13 to 222 Mgal/d for average climate conditions. Compared to the aquifer-system recharge estimates of the 1990 State of Hawaiʻi Water Resources Protection Plan, recharge estimates from this study are (1) lower for the Honopou, Waikamoi, and Kaupō aquifer systems, and (2) higher for the remaining 22 aquifer systems on Maui. Compared to ET estimates of Giambelluca and others (2014), ET estimates of this study are (1) within 17 percent for areas mapped as forest, grassland, developed, shrubland, and sparsely vegetated and (2) about 57 percent greater for areas mapped as sugarcane.

Mean annual recharge on Maui for drought conditions, about 1,035 Mgal/d, is 23 percent less than recharge for average climate conditions. Aquifer-system precipitation for drought conditions ranges from 12 to 37 percent less than corresponding precipitation for average climate conditions. Aquifer-system recharge for drought conditions ranges from 8 to 51 percent less than corresponding recharge for average climate conditions. Compared with recharge for average climate conditions, recharge decreases between 10 and 50 percent for most upland areas on West Maui Mountain and on windward Haleakalā. Recharge decreases by more than 50 percent in most lowland areas on West Maui Mountain and on leeward Haleakalā. Recharge decreases by 10 percent or less for some irrigated areas, including the sugarcane fields on the isthmus.

The spatial distribution of rainfall is the primary factor determining spatially distributed recharge estimates for most areas on Maui. Recharge estimates of the Maui water-budget model are also sensitive to runoff-to-rainfall ratios except in areas such as the isthmus, where irrigation exceeds precipitation. For wet areas, recharge estimates are also sensitive to fog-interception rates and forest-canopy evaporation. Recharge estimates in drier areas are more sensitive to irrigated crop areas and parameters that are related to ET: available water capacity, root depth, and crop coefficient. The assumption that all water collected by storm-drain systems in urban areas becomes either runoff or recharge has a minor effect on regional-scale recharge.

References Cited

Allen, R.G., Pereira, L.S., Raes, Dirk, and Smith, Martin, 1998, Crop evapotranspiration; guidelines for computing crop water requirements: Food and Agriculture Organization of the United Nations, FAO Irrigation and Drainage Paper 56, 300 p.

Austin, Tsutsumi and Associates, Inc., 1991, West Maui water master plan: County of Maui Department of Water Supply, 270 p.

AWS Truewind, LLC, 2004, Wind energy resource maps of Hawaii: Prepared for Hawaiʻi Department of Business, Economic Development, and Tourism Strategic Industries Division, Honolulu, Hawaiʻi, 17 p., accessed January 25, 2012, at *http://planning.hawaii.gov/gis/download-gis-data/*.

Belt, Collins and Associates, Ltd., 1969, A water source development plan for Lahaina District, Island of Maui: Hawaiʻi Division of Water and Land Development Report R33, 101 p.

Berg, N., McGurk, B., and Calhoun, R.S., 1997, Hydrology and land use effects in the Hanalei National Wildlife Refuge, Kauai, Hawaii, Final Report, Interagency Agreement 14-48-0001-94588: Albany, Calif., United States Department of Agriculture Forest Service, Pacific Southwest Research Station, 62 p.

Blumenstock, D.I., and Price, Saul, 1967, Climate of Hawaii, *in* Climates of the States, no. 60-51, Climatography of the United States: U.S. Department of Commerce.

Cao, Guangxia, Giambelluca, T.W., Stevens, D.E., and Schroeder, T.A., 2007, Inversion variability in the Hawaiian trade wind regime: Journal of Climate, v. 20, p. 1145–1160, DOI: 10.1175/JCLI4033.1.

Caskey, M.C., 1968, The recharge of the Waikapu aquifer, Maui: Honolulu, University of Hawai‘i, M.S. thesis, 75 p.

Cheng, C.L., 2012, Measurements of seepage losses and gains, East Maui Irrigation diversion system, Maui, Hawai‘i: U.S. Geological Survey Open-File Report 2012–1115, 23 p.

County of Maui, Hawai‘i, Department of Water Supply, 2014, Monthly water production, accessed March 13, 2014, at *http://www.co.maui.hi.us/index.aspx?NID=572*.

DeLay, J.K., 2005, Canopy water balance on an elfin cloud forest at Alakahi, Hawai‘i: Honolulu, University of Hawai‘i, M.S. thesis, 78 p.

DeLay, J.K., and Giambelluca, T.W., 2010, History of fog and cloud water interception research in Hawai‘i, *in* Bruijnzeel, L.A., Scatena, F.N., and Hamilton, L.S., eds., Tropical montane cloud forests—Science for conservation and management: New York, Cambridge University Press, p. 332–341.

Department of Natural Resources and Environmental Management, 2008, Hawaii agricultural water use and development plan—Report submitted to Hawai‘i Department of Agriculture by College of Tropical Agriculture and Human Resources, University of Hawai‘i at Manoa, Honolulu, Hawai‘i.

Division of Water and Land Development, 1970, Water for Kihei-Makena, Island of Maui: County of Maui Department of Water Supply Report R38, 89 p.

Ekern, P.C., 1964, Direct interception of cloud water on Lanaihale, Hawaii: Soil Science Society of America Proceedings, v. 28, no. 3, p. 419–421.

Engott, J.A., and Vana, T.T., 2007, Effects of agricultural land-use changes and rainfall on ground-water recharge in central and west Maui, Hawai‘i, 1926–2004: U.S. Geological Survey Scientific Investigations Report 2007–5103, 56 p.

Engott, J.A., 2011, A water-budget model and assessment of groundwater recharge for the Island of Hawai‘i: U.S. Geological Survey Scientific Investigations Report 2011–5078, 53 p.

Fares, Ali, 2008, Water management software to estimate crop irrigation requirements for consumptive use permitting in Hawaii: State of Hawai‘i, Commission on Water Resource Management, at *http://files.hawaii.gov/dlnr/cwrm/publishedreports/PR200808.pdf*.

Frazier, A., 2012, Month-year rainfall maps of the Hawaiian Islands: Honolulu, University of Hawai‘i, M.A. thesis, 81 p.

Gash, J.H.C., Lloyd, C.R., and Lachaud, G., 1995, Estimating sparse forest rainfall interception with an analytical model: Journal of Hydrology, v. 170, p 79–86.

Gash, J.H.C., and Morton, A.J., 1978, An application of the Rutter model to the estimation of the interception loss from Thetford Forest: Journal of Hydrology, v. 38, p 49–58.

Gaskill, T.G.R., 2004, Hydrology of forest ecosystems in the Honouliuli Preserve; implications for groundwater recharge and watershed restoration: Honolulu, University of Hawai‘i, Ph.D. dissertation, 177 p.

Gerrits, A.M.G, and Savenije, H.H.G., 2011, Interception, chap. 2.04 *of* Wilderer, Peter, ed., Treatise on Water Science, Volume 2—The Science of Hydrology: Elsevier, p. 89–101, at *http://www.sciencedirect.com/science/referenceworks/9780444531995#ancv0015*.

Giambelluca, T.W., 1983, Water balance of the Pearl Harbor-Honolulu basin, Hawaii, 1946–1975: University of Hawai‘i Water Resources Research Center Technical Report no. 151, 151 p.

Giambelluca, T.W., Chen, Q., Frazier, A.G., Price, J.P., Chen, Y.-L., Chu, P.-S., Eischeid, J.K., and Delparte, D.M., 2013, Online Rainfall Atlas of Hawai‘i: Bulletin of the American Meteorological Society v. 94, p. 313–316, doi: 10.1175/BAMS-D-11-00228.1, at *http://rainfall.geography.hawaii.edu/*.

Giambelluca, T.W., DeLay, J.K., Nullet, M.A., Scholl, M.A., and Gingerich, S.B., 2011, Canopy water balance of windward and leeward Hawaiian cloud forests on Haleakalā, Maui, Hawai‘i: Hydrological Processes, v. 25, p. 438–447.

Giambelluca, T.W., and Nullet, Dennis, 1991, Influence of the trade-wind inversion on the climate of a leeward mountain slope in Hawaii: Climate Research, v. 1, p. 207–216.

Giambelluca, T.W., Nullet, M.A., and Schroeder, T.A., 1986, Rainfall atlas of Hawai‘i: Hawai‘i Department of Land and Natural Resources, Division of Water and Land Development Report R76, 267 p.

Giambelluca, T.W., Shuai, Xiufu, Barnes, M.L., Alliss, R.J., Longman, R.J., Miura, Tomoaki, Chen, Qi, Frazier, A.G., Mudd, R.G., Cuo, Lan, and Businger, A.D., 2014, Evapotranspiration of Hawai‘i, final report: Submitted to U.S. Army Corps of Engineers–Honolulu District and Commission on Water Resource Management, State of Hawai‘i, 178 p.

Gingerich, S.B., 1999a, Ground water and surface water in the Haiku area, East Maui, Hawaii: U.S. Geological Survey Water-Resources Investigations Report 98–4142, 38 p.

Gingerich, S.B., 1999b, Ground-water occurrence and contribution to streamflow, northeast Maui, Hawaii: U.S. Geological Survey Water-Resources Investigations Report 99–4090, 69 p.

Gingerich, S.B., Yeung, C.W., Ibarra, Tracy-Joy N., and Engott, J.A., 2007, Water use in Wetland Kalo Cultivation in Hawai‘i: U.S. Geological Survey Open-File Report 2007–1157, 68 p.

Gingerich, S.B., 2008, Ground-water availability in the Wailuku area, Maui, Hawai‘i: U.S. Geological Survey Scientific Investigations Report 2008–5236, 95 p.

Gingerich, S.B., and Engott, J.A., 2012, Groundwater availability in the Lahaina District, West Maui, Hawai‘i: U.S. Geological Survey Scientific Investigations Report 2012–5010, 90 p.

Hawaiian Commercial and Sugar Company, 2008, Map of Plantation Divisions: Puunene, Maui, Hawai‘i, Hawaiian Commercial and Sugar Company Engineering Department, scale 1:96,000.

Haiku Design & Analysis, 2007, Maui County water use and development plan, water use and demand, Department of Water Supply systems, draft: Haiku, Hawai‘i, 74 p.

Haiku Design & Analysis, 2009, Maui County water use and development plan, Upcountry District, report review draft: Haiku, Hawai‘i, 130 p.

Haiku Design & Analysis, 2010, Maui County water use and development plan, Central DWS District, plan update, exhibit A: Haiku, Hawai‘i, 165 p.

Heath, J.A., and Huebert, B.J., 1999, Cloudwater deposition as a source of fixed nitrogen in a Hawaiian montane forest: Biogeochemistry, v. 44, p. 119–134.

Hevesi, J.A., Flint, A.L., and Flint, L.E., 2002, Preliminary estimates of spatially distributed net infiltration and recharge for the Death Valley Region, Nevada–California: U.S. Geological Survey Water-Resources Investigations Report 02-4010, 36 p.

Hutjes, R.W.A, Wierda, A., and Veen, A.W.L., 1990, Rainfall interception in the Tai Forest, Ivory Coast—Application of two simulation models to a humid tropical system: Journal of Hydrology, v. 114, p. 259–275.

Izuka, S.K., Oki, D.S., and Chen, C., 2005, Effects of irrigation and rainfall reduction on ground-water recharge in the Lihue Basin, Kauai, Hawaii: U.S. Geological Survey Scientific Investigations Report 2005–5146, 48 p.

Johnson, A.G., 2012, A water-budget model and estimates of groundwater recharge for Guam: U.S. Geological Survey Scientific Investigations Report 2012–5028, 53 p.

Johnson, A.G., 2014, Land use for the Island of Maui, Hawaii, circa 2010: U.S. Geological Survey digital data, at *http://water.usgs.gov/lookup/getspatial?maui_land_use_circa_2010*.

Juvik, J.O., and Ekern, P.C., 1978, A climatology of mountain fog on Mauna Loa, Hawai‘i Island: University of Hawai‘i Water Resources Research Center Technical Report no. 118, 63 p.

Juvik, J.O., and Perreira, D.J., 1974, Fog interception on Mauna Loa, Hawai‘i: Proceedings of the Association of American Geographers, v. 6, p. 22–24.

Juvik, J.O., and Nullet, Dennis, 1995, Relationships between rainfall, cloud-water interception, and canopy throughfall in a Hawaiian montane forest, chap. 11 *of* Hamilton, L.S., Juvik, J.O., and Scatena, F.N., eds., Tropical montane cloud forests: New York, Springer-Verlag, p. 165–182.

La Pena, R.S. de, and Melchor, F.M., 1984, Water use and efficiency in lowland taro production, *in* Symposium of the International Society for Tropical Root Crops, 6th, Lima, Peru, February 21–26, 1983, Proceedings: Lima, Peru , International Society for Tropical Root Crops, p. 97–102.

Langenheim, V.A.M., and Clague, D.A., 1987, The Hawaiian-Emperor volcanic chain, part II, stratigraphic framework of volcanic rocks of the Hawaiian Islands, chap. 1 *of* Decker, R.W., Wright, T.L., and Stauffer, P.H., eds., Volcanism in Hawaii: U.S. Geological Survey Professional Paper 1350, v. 1, p. 55–84.

Leavesley, G.H., Lichty, R.W., Troutman, B.M., and Saindon, L.G., 1983, Precipitation-runoff modeling system, user’s manual: U.S. Geological Survey Water-Resources Investigations Report 83–4238, 207 p.

Macdonald, G.A., Abbott, A.T., and Peterson, F.L., 1983, Volcanoes in the sea (2d ed.): Honolulu, Hawai‘i, University of Hawai‘i Press, 517 p.

McJannet, David, Wallace, Jim, Fitch, Peter, Disher, Mark, and Reddell, Paul, 2007, Water balance of tropical rainforest canopies in north Queensland, Australia: Hydrological Processes, v. 21, p. 3473–3484.

Meyer, William, 2000, A reevaluation of the occurrence of ground water in the Nahiku area, East Maui, Hawaii, U.S. Geological Survey Professional Paper 1618, 81 p.

Miles, K., 1931, Report on study of water requirements of taro in Hanapēpē Valley, cooperative study by the Territory of Hawai‘i and McBryde Sugar Co.: ‘Ele‘ele, Hawai‘i, 52 p.

Nash, A., Rydell, N., and Kodama, K., 2006, Unprecedented extended wet period across Hawaii: Event summaries, National Weather Service Weather Forecast Office, Honolulu, HI, at *http://www.prh.noaa.gov/hnl/pages/events/weeksrain/*.

National Oceanic and Atmospheric Administration, 2008, Coastal Services Center, Coastal Change Analysis Program (C-CAP) Land Cover, Maui, Hawaii 2006, at *http://www.csc.noaa.gov/digitalcoast/dataregistry/#/*.

Natural Resources Conservation Service, 2006a, Soil survey geographic (SSURGO) database for the island of Maui: U.S. Department of Agriculture, Natural Resources Conservation Service, at *http://SoilDataMart.nrcs.usda.gov/*.

Natural Resources Conservation Service, 2006b, Soil survey geographic (SSURGO) database for the island of Kauai: U.S. Department of Agriculture, Natural Resources Conservation Service, at *http://SoilDataMart.nrcs.usda.gov/*.

Natural Resources Conservation Service, 2006c, Soil survey geographic (SSURGO) database for the island of Oahu: U.S. Department of Agriculture, Natural Resources Conservation Service, at *http://SoilDataMart.nrcs.usda.gov/*.

Oki, D.S., 2002, Reassessment of ground-water recharge and simulated ground-water availability for the Hāwī area of North Kohala, Hawaii: U.S. Geological Survey Water-Resources Investigations Report 02–4006, 62 p.

Oki, D.S., 2003, Surface water in Hawaii: U.S. Geological Survey Fact Sheet 045–03.

Oki, D.S., 2008, The significance of accounting order for evapotranspiration and recharge in monthly and daily threshold-type water budgets: U.S. Geological Survey Scientific Investigations Report 2008–5163, 11 p.

Oki, D.S., Rosa, S.N., and Yeung, C.W., 2010, Flood-frequency estimates for streams on Kaua‘i, O‘ahu, Moloka‘i, Maui, and Hawai‘i, State of Hawai‘i: U.S. Geological Survey Scientific Investigations Report 2010–5035, 121 p.

Rea, A., and Skinner, K.D., 2012, Geopatial datasets for watershed delineation and characterization used in the Hawaii StreamStats web application: U.S. Geological Survey Data Series 680, 12 p. at *http://water.usgs.gov/lookup/getspatial?ds680_statewidelayers*.

Rosa, S.N., and Oki, D.S., 2010, Hawaii StreamStats—A web application for defining drainage-basin characteristics and estimating peak-streamflow statistics: U.S. Geological Survey Fact Sheet 2010–3052, 4 p., at *http://water.usgs.gov/osw/streamstats/hawaii.html*.

Safeeq, Mohammad, and Fares, Ali, 2014, Interception losses in three non-native Hawaiian forest stands: Hydrological Processes, v. 28, p. 237–254, DOI: 10.1002/hyp.9557.

Sanderson, Marie, 1993, Introduction, chap. 1 *of* Sanderson, Marie, ed., Prevailing trade winds: Honolulu, Hawai‘i, University of Hawai‘i Press, p. 1–11.

Savenije, H.H.G., 2004, The importance of interception and why we should delete the term evapotranspiration from our vocabulary: Hydrological Processes, v. 18, p. 1507–1511.

Scholl, M.A., Giambelluca, T.W., Gingerich, S.B., Nullet, M.A., and Loope, L.L., 2007, Cloud water in windward and leeward mountain forests; the stable isotope signature of orographic cloud water: Water Resources Research, v. 43, W12411, 13 p.

Schroeder, Thomas, 1993, Climate controls, chap. 2 *of* Sanderson, Marie, ed., Prevailing trade winds: Honolulu, Hawai‘i, University of Hawai‘i Press, p. 12–36.

Shade, P.J., 1996, Water budget for the Lahaina District, Island of Maui, Hawaii: U.S. Geological Survey Water-Resources Investigations Report 96–4238, 27 p.

Shade, P.J., 1997, Water budget for the Iao area, Island of Maui, Hawaii: U.S. Geological Survey Water-Resources Investigations Report 97–4244, 25 p.

Shade, P.J., 1999, Water budget of East Maui, Hawaii: U.S. Geological Survey Water-Resources Investigations Report 98–4159, 36 p.

Sherrod, D.R., Sinton, J.M., Watkins, S.E., and Brunt, K.M., 2007, Geologic map of the State of Hawaii: U.S. Geological Survey Open-File Report 2007–1089.

Shuttleworth, W.J., 1993, Evaporation, chap. 4 *of* Maidment, D.R., ed., Handbook of hydrology: New York, McGraw-Hill, p. 4.1–4.53.

State of Hawai‘i, 1990, Water resources protection plan, volumes I and II, June 1990: State of Hawai‘i, Commission on Water Resource Management, variously paginated.

State of Hawai‘i, 2008, Water resource protection plan, June 2008: State of Hawai‘i, Commission on Water Resource Management, variously paginated.

State of Hawai‘i, 2010, Compilation of data submissions, Part II, PR-2010-01: Department of Land and Natural Resources, Commission on Water Resource Management.

Stearns, H.T., and Macdonald, G.A., 1942, Geology and ground-water resources of the island of Maui: Territory of Hawaii, Hawaii Division of Hydrography Bulletin 7, 344 p.

Takahashi, Mami, Giambelluca, T.W., Mudd, R.G, DeLay, J.K., Nullet, M.A., and Asner, G.P., 2011, Rainfall portioning and cloud water interception in native forest and invaded forest in Hawai‘i Volcanoes National Park: Hydrological Processes, v. 25, p. 448–464, DOI: 10.1002/hyp.7797.

Takasaki, K.J., 1971, Preliminary report on the water resources of southeast Maui: Hawai‘i Department of Land and Natural Resources, Division of Water and Land Development Circular C58, 36 p.

Takasaki, K.J., 1972, Preliminary report on the water resources of central Maui: Hawai‘i Department of Land and Natural Resources, Division of Water and Land Development Circular C62, 59 p.

Thornthwaite, C.W., and Mather, J.R., 1955, The water balance: Publications in Climatology, v. 8, no. 1, p. 1–104.

U.S. Department of Agriculture, 2007, Natural Color Orthophoto Mosaic of the Island of Maui, Maui County, Hawaii: U.S. Department of Agriculture, Natural Resources Conservation Service, scale 1:12,000.

U.S. Geological Survey, 2010, LANDFIRE Existing Vegetation Type (Refresh08): Earth Resources Observation and Science Center, U.S. Geological Survey, at *http://landfire.cr.usgs.gov/viewer*.

Viessman, Warren, Jr., and Lewis, G.L., 2003, Introduction to hydrology (5th ed.): Upper Saddle River, N.J., Prentice Hall, 612 p.

Wahl, K.L., and Wahl, T.L., 1995, Determining the flow of Comal Springs at New Braunfels, Texas: Proceedings of Texas Water ’95, a component conference of the American Society of Civil Engineers International Conference on Water Resources Engineering, 1st, San Antonio, Texas, 1995, p. 77–86.

Wallace, J., Macfarlane, C., McJannet, D., Ellis, T., Grigg, A., and van Dijk, A., 2013, Evaluation of forest interception estimation in the continental scale Australian Water Resources Assessment – Landscape (AWRA-L) model: Journal of Hydrology, v. 499, p. 210–223.

Watson, L.J., ed., 1964, Observations made with respect to irrigation and growth of taro at certain patches at Waiāhole and Kahaluu: Honolulu, Hawai‘i, City & County of Honolulu Board of Water Supply Water Resources Division *in* Reppun v. Board of Water Supply, variously paged.

Westenbroek, S.M., Kelson, V.A., Dripps, W.R., Hunt, R.J., and Bradbury, K.R., 2010, SWB—A modified Thornthwaite-Mather Soil-Water-Balance code for estimating groundwater recharge: U.S. Geological Survey Techniques and Methods, bk 6, chap. A31, 60 p.

Whittier, R.B., and El-Kadi, A.I., 2013, Human and environmental risk ranking of onsite sewage disposal systems for the Hawaiian Islands of Kauai, Maui, Molokai, and Hawaii (draft report January 2013): Department of Geology and Geophysics, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i.

Yamanaga, George, and Huxel, C.J., 1969, Preliminary report on the water resources of the Lahaina District, Maui: Hawai‘i Department of Land and Natural Resources, Division of Water and Land Development Circular C51, 47 p.

Yamanaga, George, and Huxel, C.J., 1970, Preliminary report on the water resources of the Wailuku area, Maui: Hawai‘i Department of Land and Natural Resources, Division of Water and Land Development Circular C61, 43 p.

Yamanaga, George, 1972, Evaluation of the streamflow-data program in Hawaii: U.S Geological Survey Open-File Report 72–453, 37 p.

Page intentionally left blank

Menlo Park Publishing Service Center, California
Manuscript approved for publication August 25, 2014
Edited by Larry Slack and Kate Jacques
Design and layout by Cory Hurd

Johnson and others—Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai'i, 1978–2007
—Scientific Investigations Report 2014–5168

http://dx.doi.org/10.3133/sir20145168
ISSN 2328-0328 (online)

PROCEEDINGS:

SIXTH SYMPOSIUM

of the

INTERNATIONAL SOCIETY FOR TROPICAL ROOT CROPS

Hosted by CIP in Lima, Peru
21-26 February 1983

1984

Exhibit A-8

INTERNATIONAL POTATO CENTER (CIP)
P.O. Box 5969 Lima - Peru. Cables: CIPAPA - Lima

Water Use and Efficiency in Lowland Taro Production

Authors: R.S. de la Peña and F.M. Melchor, Associate
Associate, respectively, Department of Agro
University of Hawaii, Honolulu, Hawaii. Work
ment of Agriculture under Cooperative Agreemen
Agriculture Coordinating Committee, State of
80-1.

re harvested

taken. Wat
140,000 t
made in

oxi-
by
i.

ABSTRACT

Experiments were conducted to determine the effects of different rates of water flow and depth of flooding on the yield and yield components of lowland taro.

Using rates of water flow of 280,470 l/ha/day to 981,640 l/ha/day (30,000 gal/A/day to 105,000 gal/A/day), no significant differences were obtained in total corm and cormel yields of lowland taro, variety Lehua Maoli. Corm, marketable cormel and total yields averaged 32.3, 31.7, and 64.0 tons/ha, respectively. Water use efficiency calculated on the basis of liters water needed to produce a kilogram of taro corms was 800 l/kg for the lowest rate of water flow and 2,790 l/kg for the highest.

Yields of lowland taro decreased as depth of flooding increased from 0 cm to 20 cm. Highest yields were obtained from plots where water depth was maintained at 0 cm. Flooding to a depth of 16 and 20 cm drastically reduced marketable cormel yields causing a severe drop in total yield. Optimum depth of flooding in lowland taro appear to be 4 to 8 cm as this is sufficient to keep weeds under control without causing severe yield losses. Total yield at 0 cm depth was 28.5 tons/ha compared to 16.9 tons/ha at 20 cm depth of flooding.

Taro, Colocasia esculenta (L.) Schott, is a crop grown throughout the tropics and sub-tropics under a wide range of environmental and edaphic conditions. It is grown under extremes of water regimes, i.e. dryland or unflooded culture to waterlogged or flooded culture. Although majority of the approximately 760,000 ha of land used for taro production is under dryland or upland growing conditions (FAO, 1975), almost all of the taro in Hawaii is grown under waterlogged or flooded culture (Plucknett and de la Peña, 1971). Under flooded growing conditions, taro is assumed to use excessive amounts of water during its cropping period. Water used to flood the taro fields is allowed to flow continuously assuring low water temperature which helps to prevent development of corm diseases and also enhances the growth of the taro plant. Estimates on the actual amount of water needed to grow lowland taro has varied from farmer to farmer. Even water measurements done in taro farms vary considerably depending on the season when measurements are

taken. Watson (1970) estimated that the average water requirement of taro is 140,000 to 373,000 l/ha/day (15,000 to 40,000 gal/A/day) based on measurements made in taro fields of Oahu, Hawaii between 1962 and 1964.

In Hawaii, taro is a crop of major commercial importance. It was cultivated by the early Hawaiians who used taro as the source of "poi," the staple food which is prepared from boiled taro corms, mashed and pounded into a paste. Early records of Hawaiian agriculture report large acreages of taro in Hawaii, however, production over the last decade has declined considerably. In 1972, Hawaii produced about 4.1 million kg while in 1981, the production was only about 2.8 million kg, showing a decline of approximately 31% (Hawaii Agricultural Reporting Service, 1982). Much of the decline in Hawaiian taro production is attributed to the declining acreage used for taro. The decrease in acreage of taro is again attributed to the urban encroachment which is not only squeezing out the land used for taro but also drastically reducing the availability of water for lowland taro production.

Farmers in Hawaii, in their efforts to save the declining taro lands have gone to the extent of suing the government for water needed in taro production. To assess the water needs of taro growers, especially in Oahu, Hawaii where population is concentrated, experiments were conducted to determine the effects of different rates of water flow and depth of flooding on the growth and yields of lowland taro. The experiments on the rate of water flow were conducted in a commercial field in Hanapepe Valley, Kauai while the experiments on depth of flooding were conducted at the Kauai Branch Research Station, Kapaa, Kauai.

Materials and Methods

xperiment I - Water Flow Rate

This experiment was in Hanapepe Valley on the Island of Kauai in a commercial taro farmer's field. The soil is a typic Fluvaquents (U.S. Soil Taxonomy) or Eutric Gleysols (FAO/UNESCO) (Beinroth, Ikawa and Uehara, 1974) which is used for lowland taro production in Hawaii.

Using a replicated randomized complete block design, six rates of water flow were assigned in plots approximately 6x9 m in size. The rates of water flow used ranged from 280,470 l/ha/day (30,000 gal/A/day) to 981,640 l/ha/day (105,000 gal/A/day). Water flowing into each individually diked plot was provided through plastic pipes with individual control valves.

Taro, variety Lehua Maoli, the commercial lowland variety used in Hawaii, was planted with a 60x45 cm spacing, a recommended plant density for lowland taro (de la Pena, 1978). Except for different rates of water flow, all management practices including fertilization and weeding were uniformly applied. Fertilization and soil amendments consisted of a pre-plant application of hydrated lime (calcium hydroxide) at 500 kg/ha and urea, treble superphosphate and potassium chloride to provide rates equivalent to 100 kg/ha each of N, P_2O_5, and K_2O. A complete fertilizer mix (16-16-16) was applied 2 months after planting at 312.5 kg/ha. Urea was applied at 110 kg/ha 5 months after planting. Irrigation was stopped and the plots allowed to drain before each fertilizer application. Irrigation was resumed 5 to 7 days after application of fertilizers.

The crop was harvested 15 months after planting. Twenty hills were harvested from each plot for yield and yield component estimation.

Experiment 2 - Depth of Flooding

The depth of flooding experiment was performed in concrete tanks approximately 2 m wide, 3 m long and 1 m deep containing Kapaa Soil (Typic Gibbsiorthox). Six depths of flooding were assigned in a randomized complete block design replicated three times. Depths of flooding used ranged from 0 cm to 20 cm. Flooding was continuous except when fertilizers were applied during which time tanks were drained before the fertilizers were broadcast. Flooding was resumed 5 to 7 days after fertilizer applications. Basal fertilizer used was 16-16-16 at 110 kg/ha immediately before the last puddling operation. Three weeks after planting, the plots were inoculated with Azolla filiculoides, a floating fern capable of fixing atmospheric nitrogen, at 100 kg/ha fresh weight basis. At 3 and 6 months after planting, 50 kg/ha each of P and K were applied using treble superphosphate and muriate of potash.

Taro, variety Lehua Maoli was planted at 45x45 cm spacing. Water was applied to each tank via individual faucets and depths of flooding were controlled by varying the height of the outlet. The 0 cm depth of flooding received continuous water but it was allowed to drain without causing flooding above the soil surface making the soil completely saturated only. Amount of water going into each tank was approximately 280,000 l/ha/day.

The crop was harvested 14 months after planting. All of the plants were harvested from each tank and used for estimation of yield and yield components.

Results and Discussion

There is no significant effect of rate of water flow on growth and development of lowland taro. However, vegetative yield tended to increase with high water flow rates. Height of plants at harvest were highest at the highest rate of water flow with a difference of approximately 11% over the lowest rate used. Total leaf yield difference between the two rates was 16.9%. The total corm and cormel yields were not significantly affected (Table 1).

Based on water use efficiency or amount of water used calculated to produce 1 kg of taro corms, the value ranges from 800 l/kg to 2,790 l/kg for the lowest and highest water flow rates. Current use of water for lowland taro in some areas are almost unlimited. It is obvious from the results of the experiments that lowland taro can be produced with much less water. With judicious water control, there is great potential for expanded taro production, especially in Hawaii.

The depth of flooding in Kapaa Soil (Typic Gibbsiorthox) has a great effect on growth and consequently yield and maturity of lowland taro. Table 2 shows that shallow flooding or soil saturation enhances early growth and development and hastens maturity of Lehua Maoli. Deep flooding slowed growth and prevented early development of suckers. This resulted in greatly reduced cormel yields (Table 3). The significant yield difference between 0 cm flooding and 20 cm flooding is a result of the detrimental effect of deep flooding on cormel yields which are over 54% of total yields for 0 cm flooding and only 14% for the 20 cm flooding. The slight increase in corm yield of 14.5 t/ha compared to 13.0 t/ha did not compensate for the great difference in cormel yields between 20 cm and 0 cm flooding.

Table 1. Effects of water flow rates on yields of taro grown in Hanalei sc

Water flow l/ha/day	(gal/A/day)	Corm yield mt/ha	Corm yield t/A	Marketable cormels mt/ha	Marketable cormels t/A	Tc mt/ha
280,470	(30,000)	36.5	(16.3)	31.4	(13.9)	67.9
420,700	(45,000)	35.0	(15.6)	30.3	(13.5)	65.3
560,900	(60,000)	29.6	(13.2)	37.0	(16.5)	66.7
701,200	(75,000)	27.2	(12.1)	29.6	(13.2)	56.8
841,400	(90,000)	28.0	(12.5)	32.3	(14.4)	60.3
981,640	(105,000)	37.5	(16.7)	29.2	(13.0)	66.7
Ave.		32.3	(14.4)	31.7	(14.1)	64.0

Location: Hanapepe Valley, Kauai

Age at harvest: 15 months

Table 2. Effects of depth of flooding on vegetative growth of taro.

Water depth cm	Water depth (in)	Height (cm) 6 MAP*	Height (cm) 14 MAP*	Le
0	(0)	56.7	56.5	
4	(1.5)	40.9	70.5	
8	(3.0)	46.2	72.5	
12	(4.75)	45.8	74.1	
16	(6.25)	45.2	76.3	
20	(7.75)	45.7	73.3	

*MAP = months after planting.

Table 3. Yield components of taro grown in a Kapaa Soil at different flooding.

Water depth cm	Water depth (in)	Yield components (t Corms	Yield components (t Cormels*
0	(0)	13.0	15.5
4	(1.5)	13.2	4.6
8	(3.0)	17.3	3.5
12	(4.75)	16.1	1.5
16	(6.25)	14.4	1.8
20	(7.75)	14.5	2.4

*Marketable cormels only.

In another experiment using Hanalei Soil, contrasting results were obtained (de la Peña and Melchor, 1982). Plants grown in Hanalei Soil performed better under flooded and highly reduced conditions. Continuously flooded taro in Hanalei Soil also grew better than plants which had been drained to a point where the soil started to crack. Addition of high rates of fertilizers, especially nitrogenous materials which is a customary practice among lowland taro farmers, proved detrimental. Excessive fertilizer in drained plants drastically reduced corm yields. There is also a strong relationship between over drying and application of high rates of lime and phosphorus with the occurrence of taro hard rot, a disease suspected to be physiological in nature.

The contrasting results obtained from drained and flooded soils of Hanalei and Kapaa Soils is speculated to be due to their contrasting chemical properties. Soil analysis data reveal that Kapaa Soil has extremely high free iron oxide and total iron contents compared to Hanalei Soil. Free iron oxide in Kapaa Soil is 33.9% compared to 8.9% for Hanalei Soil at 0 to 30 cm-depth (Soil Survey Staff, 1972).

In rice production, several researchers have shown that yields were better under soil moisture conditions of less than 100% saturation (Matsushima, 1976; Wang and Hagan, 1981). In a recent report from India, the beneficial effect of flooding was obtained from a Vertisol while soil saturation and soil water content below saturation gave better yields in an Alfisol (Dongale and Chavan, 1982). It is apparent from the present studies on water requirements of taro and rice that both crops' response to varying water regimes depend on the types of soils used.

Literature cited

Beinroth, F.H., H. Ikawa, and G. Uehara. 1974. Classification of the soil series of the State of Hawaii in different systems. AID Technical Series No. 10.

de la Peña, R.S. 1978. Yields of upland and lowland taro at varying plant densities. Field Crops Research 1:183-190.

de la Pena, R.S. and F.M. Melchor. 1982. Effects of water management on the growth and yield of taro. In press.

Dongale, J.H. and A.S. Chavan. 1982. Effect of moisture regime on rice yields in alfisols and vertisols. International Rice Research Newsletter 7(3):18.

FAO (Food and Agriculture Organization of the United Nations). 1975. FAO production yearbook 1974. Vol. 28-1. 325 pp.

Hawaii Agricultural Reporting Service. 1982. Statistics of Hawaiian Agriculture, 1981. Hawaii Department of Agriculture and USDA. 100 pp.

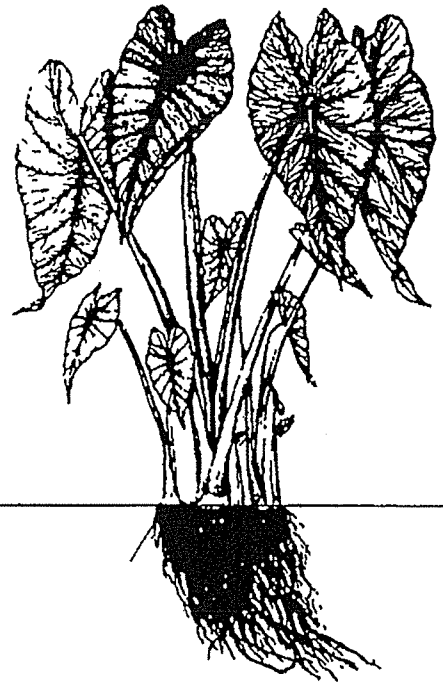
Plucknett, D.L. and R.S. de la Pena. 1971. Taro production in Hawaii. World Crops 23(5):244-249.

Matsushima, S. 1976. High-Yielding Rice Cultivation. Japan Scientific Societies Press, Tokyo, ix + 367.

Soil Survey Staff. 1972. Soil survey of the islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. USDA. Soil Conservation Service in cooperation with Univ. of Hawaii Agri. Expt. Station., U.S. Govt. Printing Office, Washington, D.C. 232 pp. with maps.

Wang, J.K. and R.E. Hagan. 1981. Irrigated Rice Production Systems: Design Procedures. Westview Tropical Agriculture Series 3, Westview Press, Colorado, xx + 300.

Watson, L.J. 1970. The legal importance of the water requirements on taro *Colocasia esculenta* in Hawaii. Proceedings of the Second International Symposium on Tropical Root and Tuber Crops 1:149-151.



Volume I

Proceedings of the Second International Symposium on Tropical Root and Tuber Crops

August 23 to 30, 1970
Honolulu, Hawaii and
Kapaa, Kauai, Hawaii

Sponsored by the College of Tropical Agriculture, University of Hawaii in cooperation with Institute for Technical Interchange East West Center, University of Hawaii

DONALD L. PLUCKNETT, EDITOR
Professor of Agronomy
College of Tropical Agriculture
University of Hawaii, Honolulu, Hawaii

THE LEGAL IMPORTANCE OF THE WATER REQUIREMENTS OF TARO *COLOCASIA ESCULENTA* IN HAWAII

Leslie J. Watson[1]

Abstract. Old-time Hawaiian practices in the growing of taro are a major factor in determining present-day ownership of water sources, which are of prime importance in the Hawaiian sugar industry. Fundamentally, water rights of today are determined by proof of water-use and jurisdiction as they were in the 1840s when constitutional government and property right supplanted the near-absolute monarchy. The present legal necessity of attempting to determine the probable water requirements of taro as it was grown at that time has brought together Hawaii's attorneys, agriculturists, civil engineers, and others whose professional field includes consideration of water rights in the Islands.

Based on the author's experience, the water requirement of paddy taro ranges from 15,000 to 60,000 gallons per acre per day, and the general average requirement is about 30,000 gallons per acre per day.

In many parts of the earth the historic patterns of water use and jurisdiction over water resources and the rights therein have presented great problems to mankind. These subject often have been and still are paramount in controversies between neighbors, tribes, and even nations.

The importance of water in Hawaii is succinctly expressed in the motto of the Honolulu Board of Water Supply, "uwe ka Lani ola ka Honua," which is translated: "When the heavens weep the earth lives," or more freely, "Water is the life of the land." The Hawaiian word for water is "woi" (pronounced "why") so it is significant that the word for law, code, or rule is "kanawai." Hawaiian language authorities say that perhaps laws are so called because many early customs and laws pertained to water rights.

The obvious principal reason for the great importance of water rights was in relation to the growing of taro, most of which was grown under flooded conditions using large quantities of circulating, cool water. To an extraordinary degree the poi produced from the mashed, cooked taro corms was the most important food, thus life literally depended upon the availability of water. Most early Polynesians settled in valleys in which there were perennial streams. Upon arrival, some 1,000 or so years ago, they lost no time in planting the taro brought with them. To do so it was necessary to prepare paddys with surrounding levees on the floors of the valleys near the sea, to terrace the sides of the valleys, and to excavate ditches ("auwais") to lead water to the terraces and lower patches.

The people brought with them the property system of their former homes. All land and water was the property of the highest chiefs ("alii") and jurisdiction over the individual districts was allotted among them and lesser chiefs, all of whom were subservient to those above them in the feudal order.

The typical land division, or "ahupuaa," was a valley suitable for settlement and the growing of taro by the common people, "hoaaina." The chief holding the individual ahupuaa was known as the "konohiki" and as such responsible for everything taking place within the ahupuaa.

The chief's tenure was entirely dependent upon his status under higher chiefs and there were great changes during constant wars. However the completion of the conquest by Kamehameha I in 1795 and his relocation of lands (the ahupuaas) stabilized property control in a system which evolved through constitutional means into the present pattern of ownership of the ahupuaa titles.

Within the ahupuaas both before and after 1795, the common people continued to cultivate the patches allocated to their families by the local konohiki. In the constitutional procedures which gave the chiefs fee title to ahupuaas, the rights of the common people to the land they had cultivated was preserved and so they received fee title during the 1840s to lands which, by testimony before a land commission, were shown to have been held by the occupants and their families since or prior to the time of Kamehameha I.

Many ahupuaas were set aside as Government and Crown Lands. Because of this the State is now the owner of important konohiki water rights.

During the period of transition from about 1795 until the establishment of individual land titles in the 1840s, and presumably prior to 1795, the local konohikis were responsible for the uninterrupted production of food—principally taro—from the land holdings or kuleanas of the commoners and for the collection of taxes (mostly food) for the support of the chiefs and their warriors. Thus it was necessary that the local konohiki and his aides supervise taro production. The all-important problems of water distribution were taken care of by a "luna wai" (water superintendent) who saw to it that each grower participated in the maintenance of dams and ditches and kept his taro patches and banks in a suitable condition to prevent waste of water.

In the establishment of land title nothing was said about water rights. It was simply understood that the kuleanas awarded to the people were entitled to such use of water as had been exercised under the old system and that, subject to such "kuleana water right," all other water within the ahupuaa was the property of the owner of the land wherein it appeared.

As the sugar industry which began in the 1830s developed, more and more water was diverted from streams for the irrigation of sugar cane plantations, and many controversies developed. In typical cases as the plantations grew their owners arranged by purchase or lease for the right to divert principal streams into their irrigation systems. The most important purchases and leases were obtained from the government and other owners of ahupuna titles, and it followed that the taro landowners in the valleys found less

[1]Consulting Civil Engineer and Appraiser, Honolulu, Hawaii.

and less water was available for their use There was also great competition for water between neighboring plantations

The new sugar plantation demand for water caused great controversy This resulted in many lawsuits from which the decisions of the court have given us our "water law" of today

The principal decisions have affirmed that kuleana owners are entitled to such water rights as were exercised on their lands in or about the 1840s, that water rights are not lost by non-use, and that landowners have the right to sell or lease their water rights to sugar plantations or others for transfer of use to distant lands The decisions also affirm that the owners of the ahupuaa titles are the owners of all water arising upon their lands except for that to which the kuleana owners are entitled

THE WATER REQUIREMENTS OF WETLAND TARO

As was stated previously the basic water right in Hawaii is the right of taro lands to that amount of water utilized on those lands in or about the 1840s Therefore, the legal question is not, "what is the amount of water required today to produce a successful taro crop?" but rather, "what was the amount of water required under the conditions of the 1840s in the respective areas of Hawaii to produce taro crops then considered satisfactory?"

Many tests have been conducted to ascertain the "duty of water" in wetland taro culture With but few exceptions the tests have covered only a patch or two and have been of short duration The many reports which are available are prepared by civil engineers experienced in water measurement who were retained by parties to litigation

Typical reports made by employees or retainees of parties interested in holding the figure to a minimum "find" that the requirement is an average of 140 000 liters per ha per day (15,000 gallons per acre), or even less Reports made by equally competent employees or retainees of parties interested in a higher figure "find" that the requirement is an average of 467,000 to 560,000 liters per ha per day (50,000 to 60,000 gallons per acre) and sometimes even more Thus many "findings" reflect inherent partisanship

The water requirement of taro in any locality at any time depends on many factors, include

1 The available supply, and therefore whether it is, or is not, necessary to conserve water
2 Whether or not the taro patch "floors" had been well puddled and the banks well tamped
3 The stage of the crop or crops
4 Rainfall, elevation, average hours of sunshine, and wind conditions
5 Soil characteristics
6 Whether or not there is a profit incentive

Recognizing the extreme variation in the many report which were available, the Honolulu Board of Water Supply in 1962 undertook a major study to determine the water requirement of taro at Waiahole, Oahu The purpose of the study was to obtain information for the settlement of possible water-right matters and particularly to ascertain the quantities of water to which owners of taro lands in the area were entitled

Over the period October 1962 to June 1964 numerous measurements were made of water entering and leaving groups of patches Days of excessive rainfall were excluded The principal areas included were a group of 17 patches totalling 0 89 ha (2 20 acres) and a group of 9 patches totalling 0 88 ha (2 17 acres)

The conclusion reached was that, in the locality studied, representative water use is in the range of from 140,000 to 373,000 liters per ha per day (15,000 to 40,000 gallons per acre), allowing for sufficient outflow to assure good circulation

Since all stages of the crop were included in the 26 patches the author (as project manager of the study) recommended that in any future negotiation or controversy in the area a gross flow of 373,000 liters per ha per day (40,000 gallons per acre) be recognized as the fair requirement for an area of several taro patches in various stages of crop development, including patches requiring maximum irrigation and those requiring none

It is emphasized that the foregoing comment cannot be applied to any other area than that tested and, furthermore, and most important, that the water requirement in or about 1846 (the determining year) might have been considerably greater or less, depending on the methods then prevailing and on the need of water conservation in the locality

In certain areas including Koloa on Kauai and Waimea on Oahu, it is well known that old Hawaiian irrigated taro areas of the 1840s were developed up to, and perhaps somewhat beyond, the available water supply Judging from present stream flow in these two localities the "average duty" of water was approximately 140,000 liters per ha per day (15,000 gallons per acre) This figure is of doubtful value today because of the probability that in the two localities stream flows were considerably greater 125 years ago than they are now

In summation, the author's opinion, based on 50 years' experience in such matters, is that the water requirement of wetland taro in modern methods of agriculture cannot be stated categorically However, it can be said to be in the range of 140,000 to as much as 560,000 liters per ha per day A general average of 280,000 liters per ha per day (30,000 gallons per acre) should be fair in the settlement of most controversies, subject however, to a greater allowance if reasonably proved Just what the corresponding figures would have been in the 1840s is conjectural, but in water-right litigation it is necessary for the litigants to attempt to introduce testimony relative to conditions and agricultural practices of over a hundred years ago

Such a water-right case involving the waters of Hanapepe River on Kauai was before the Circuit Court from March 1959 until January 1969 and is now before the State Supreme Court on appeal The case has had the attention of foremost attorneys, agriculturists, civil engineers, and many others It is obvious that in any such proceeding perhaps the most important factors are the effectiveness of attorneys' presentations and the apparent credibility of expert witnesses in reconstructing the manner in which taro was grown by old-time Hawaiians

REFERENCES

(1) Buck, Peter H. 1964. Arts and crafts of Hawaii. Vol. I. Bernice P. Bishop Museum Spec. Publ. 45. Honolulu.

(2) Feher, Joseph. 1969. Hawaii a pictorial history. Bernice P. Bishop Museum Press, Honolulu.

(3) Handy, E. S. C. 1940. The Hawaiian planter. Bernice P. Bishop Museum Bull. 161.

(4) Hutchins, Wells A. 1946. The Hawaiian system of water rights. Honolulu Board of Water Supply

(5) McCaughey, V., and J. S. Emerson 1913=1914. The kalo in Hawaii. The Hawaiian Forester and Agriculturist, Dep. of Agr., Terr. of Hawaii.

(6) Perry, Antonio. A brief history of Hawaiian water rights. Hawaiian Bar Association.

(7) Van der Cook, John W. 1939. King Cane. The story of sugar in Hawaii. Hawaiian Sugar Planters' Assoc., Honolulu.

DALO GROWING RESEARCH IN THE FIJI ISLANDS

Param Sivan[1]

Abstract. Trials at Koronivia have shown that the highest-yielding varieties for the alluvial soils of the river flats are Qawe ni Urau, Vavai Vula, Kurokece, Qere, and Vavai Dina. Trials at Loaivuna have shown that the highest-yielding varieties for the black, acidic sandstone soils of the hills are Mumu, Volo, Kaboa, Toa Kula, and the Samoan Varieties, Samoa, Samoa oriori, and Tausala ni Samoa. The Samoan varieties are preferred by consumers as they produce large, well-shaped corms of good eating quality In Fiji the best dalo yields are obtained from soils that are well-drained, porous, rich in humus, and well supplied with moisture throughout the growing season.

Dalo planted between September and November gives the best yield. Selection of the largest and healthiest suckers for planting is advisable if the tops are sold with the corms. Traditional Fijian methods of planting give high yields and better-quality dalo than split ridging and planting and ridging up methods. Planting at 0.9 X 2 feet (0.9 x 0.6m) spacing has been found to be superior to the traditional 3 x 3 feet (0.9 x 0.9m) spacing. At close spacing use of nitrogen is recommended. To control corm rot disease it is advisable to plant resistant varieties (Kurokece, Vavai Dina and Sisiwa) in areas which are poorly drained or subject to flooding. For weed control in dalo, Atrazine, Simazine, Linuron, and Monolinuron at 3 lb. per acre (3.36 kg. per ha) applied post-planting, pre-emergence have shown promise

INTRODUCTION

In Fiji dalo or taro (*Colocasia esculenta* (L.) Schott) is grown predominantly in the wet and intermediate zone with only a small acreage being grown in isolated patches in the dry zone. (Table 1. shows typical rainfall figures for wet, intermediate, and dry zones). In the dry zone, rainfall is very low during the winter months, and this adversely affects the yield and the quality of the corms and hence it is not grown to any great extent.

Table 1. Average rainfall in inches for wet, intermediate, and dry zones of Fiji

Month	Koronivia Research Station (Wet Zone) 18°03'S	Dobuilevu District Farm (Intermediate Zone)) 17°34'S	Nadi Airport (Dry Zone) 17°45'S
January	14.21	16.19	11.58
February	11.38	14.97	11.44
March	15.16	16.91	14.69
April	14.11	11.95	7.66
May	8.61	6.15	3.89
June	7.16	4 09	3.07
July	6.34	2 69	2.02
August	5.84	3.29	2.46
September	8.15	4.71	3.45
October	8.11	5.35	2.89
November	11.99	7.80	5.38
December	11.63	11.53	7.11
Total	122.69	105.63	75.64

[1]Koronivia Research Station, Nausori, Fiji.