DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 1109
WAILUKU, MAUI, HAWAII 96793-6109
TELEPHONE (808) 270-7816 • FAX (808) 270-7833 • www.mauiwater.org

May 10, 2002

Ms. Genevieve Salmonson, Director
Office of Environmental Quality Control
235 South Beretania Street, Suite 702
Honolulu, Hawaii 96813

Dear Ms. Salmonson,

RE: Final Environmental Assessment (FEA), for the Kupaa Well No. 1 and Water Transmission Line at Waihee, Maui, Hawaii (TMK: 3-2-001:003 portion)

The Department of Water Supply has reviewed the final environmental assessment for the subject project, and has determined that a Findings of No Significant Impact (FONSI) is warranted. Please publish notice of availability for this project in the May 23, 2002, OEQC Environmental Notice.

We have enclosed four (4) copies of the Final EA, and will be transmitting a completed OEQC Publication form and project summary via e-mail (e-mail will be transmitted by Chris Hart & Partners). Should you have any questions, please call our Engineering Division at 270-7835, or Mr. Rory Frampton of Chris Hart & Partners at 242-1955.

Very truly yours,

David Craddick, Director
County of Maui, Department of Water Supply

Encls.

Cc: Mr. Herbert Kogasaka
Mr. Carl Takumi
Mr. Rory Frampton

EXPANSION INDEX TEST REPORT
ASTM D 4829-95

SAMPLE LOCATION	DEPTH	MOLDING WATER CONTENT	INITIAL DRY DENSITY (PCF)	% SAT. (note A)	FINAL WATER CONTENT	EXPANSION INDEX MEASURED	CORR. E.I. AT 50% SAT.
Boring 2	4.0'	18.4%	104.5	55.4	28.9%	8.2	11

note A: The specific gravity was determined in accordance with ASTM D 854-92 and the results indicate this soil has a specific gravity of 3.77.

EXPANSION CLASSIFICATION

Expansion Index, EI	Potential Expansion
0 to 20	Very Low
21 to 50	Low
51 to 90	Medium
91 to 130	High
over 130	Very High

Project: NORTH WAIHEE 500,000 GALLON RESERVOIR Project No.: 99214-FM

ISLAND GEOTECHNICAL ENGINEERING, INC. PLATE 9

EXHIBIT D

OEQC BULLETIN

(3) North Waihee Exploratory Wells (Kupaa Well No. 1 and Kanoa Well No. 1)

District: Wailuku
TMK: 3-2-01:por. 3
Applicant: County of Maui, Department of Water Supply
200 South High Street
Wailuku, Hawaii 96793
Contact: David Craddick (243-7816)
Approving Agency/Accepting Authority: County of Maui, Department of Water Supply
200 South High Street
Wailuku, Hawaii 96793
Contact: David Craddick (243-7816)
Consultant: C. Takumi Engineering, Inc.
18 Central Avenue
Wailuku, Hawaii 96793
Contact: Carl Takumi (249-0411)
Public Challenge Deadline: July 23, 1997
Status: FEA/FONSI issued, project may proceed.

The County of Maui, Department Water Supply (DWS) is proposing the drilling of Kupaa Well No. 1 and Kanoa Well No. 1 in order to conduct pumping tests to gather data regarding the North Waihee Aquifer. The proposed exploratory well sites are located to the north of the existing North Waihee Well Nos. 1 and 2. Kupaa Well No. 1 is located approximately 650 feet mauka (west) of Kahekili Highway at approximate elevation of 600 feet above sea level. Kanoa Well No. 1 is located mauka (west) of Kahekili Highway, approximately 100 feet inland from the existing Kanoa monitoring well and at approximate elevation of 300 feet above sea level.

The project will comply with the Hawaii Well Construction Standards prepared by the Department of Land and Natural Resources Commission on Water Resource Management.

The proposed action will also include the temporary installation of diesel powered test pumps and appurtenant facilities in order to conduct well pump testing. In addition, testing will be conducted to determine if the water quality conforms to the State Department of Health's Drinking Water Standards. After completion of the well testing, the pumps and other appurtenant facilities will be removed. The wells will then be capped until the well pump data and water quality can be carefully reviewed. If data shows that allowable withdrawls can be successfully accomplished, DWS will then proceed with the development of the wells by installing a pump and necessary appurtenances and then connecting them to the Central Maui Water System.

Access to Kupaa Well No. 1 will be via an existing dirt road which traverses undeveloped pasture land. Kupaa Well No. 1 is easily accessible from the dirt road and therefore will not require any roadway improvements or grading.

Access to Kanoa Well No. 1 will be via an existing unimproved access easement which also traverses undeveloped pasture land. The access easement is on slightly sloping lands which are relatively easy to access and therefore will not require any roadway improvements or grading.

The proposed project is not anticipated to have any significant environmental impacts, therefore, a "Finding of No Significant Impact" has been made by DWS.

National Environmental Policy Act (NEPA)

(4) Kahului Airport Wildlife Hazard Management (FONSI)

District: Wailuku
Applicant: U.S. Department of Agriculture
Animal Damage Control
3375 Koapaka Street, Suite H420
Honolulu, Hawaii 96819

USDA, Animal and Plant Health Inspection Service, Animal Damage Control (ADC) has reviewed its current activities at Kahului Airport in managing wildlife hazards to protect human safety. APHIS-ADC has determined that the need for action and those issues identified in the March 1997 environmental assessment are best addressed by continuing the existing program.

Any comments relative to this decision should be addressed to: State Director, USDA, APHIS-Animal Damage Control, 720 O'Leary St., SW, Olympia, Washington 98502 or by calling (360) 753-9884.

COUNTY OF MAUI
BOARD OF WATER SUPPLY
WATER QUALITY LABORATORY
614 PALAPALA DRIVE
KAHULUI,MAUI,HAWAII 96732

REPORT DATE: MARCH 19, 1999

SITE: KUPAA WELL

MATRIX: WATER

DATE/TIME SAMPLED: 3/18/99 @ 0815

SAMPLER: K. KUBA

DATE/TIME RECEIVED: 3/19/99 @ 1220

TEMP.CONTROL: 4 ^{0} C

EPA METHOD:

TOTAL COLIFORM:	9222B
FECAL COLIFORM:	9221C
HPC:	9215B

SAMPLE ID	TOTAL COLIFORM BACTERIA [# / 100 ML]	FECAL COLIFORM VERIFICATION	HPC [CFU/100 ML]
KU PAA WELL [S-401]	CONFLUENT W/ COLIFORMS	NEGATIVE	1000

ANALYST: L.POOLE

APPPROVED BY: C.CERIZO
W.M. IV

FILE COPY

COUNTY OF MAUI
DEPARTMENT OF WATER SUPPLY
WATER QUALITY LAB
614 PALAPALA DRIVE
KAHULUI, MAUI, HAWAII 96732

REPORT DATE: MARCH 22, 1999

CLIENT: **TAKUMI ENGINEERING**
18 CENTRAL AVENUE
WAILUKU, MAUI, HAWAII 96793
PHONE #: 249-0411

MATRIX: WATER

SAMPLER: KENSON KUBA

SAMPLE DATE: MARCH 18, 1999

EPA METHOD:
CONDUCTIVITY: 2510B
pH: *4500-H⁺*
TEMPERATURE: 2550B

SITE	TEST	RESULT
KUPAA #1	Conductivity	173 uS
	pH	7.9
	Temperature	19.5°C

APPROVED BY: C.CERIZO
W.M. IV

COUNTY OF MAUI
DEPARTMENT OF WATER SUPPLY
WATER QUALITY LAB
614 PALAPALA DRIVE
KAHULUI, MAUI, HAWAII 96732

REPORT DATE: MAR 22, 1999

CLIENT: **TAKUMI ENGINEERING**
18 CENTRAL AVENUE
WAILUKU, MAUI, HAWAII 96793
PHONE #: 249-0411

MATRIX: WATER

SAMPLER:

EPA METHOD: CHLORIDE: 4500-Cl^-

SAMPLE ID KUPAA WELL 1	CHLORIDE mg/L		SAMPLE ID KUPAA WELL 1	CHLORIDE mg/L
3/15/99 @ 0935 by WS	20		3/18/99 @ 0806 by KK	25
3/15/99 @ 2100 by ?	22		3/18/99 @ 0900 by WS	25
3/16/99 @ 0900 by ?	22		3/18/99 @ 2100 by NR	20
3/16/99 @ 2100 by MR	20		3/19/99 @ 0900 by NR	21
3/17/99 @ 0900 by MR	21			
3/17/99 @2100 by MR	25			

APPROVED BY: C.CERIZO
W.M. IV

APPENDIX – D

Comment and Response Letters

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
OFFICE OF ENVIRONMENT QUALITY CONTROL
235 SOUTH BERETANIA STREET
SUITE 702
HONOLULU, HAWAII 96813
TELEPHONE (808) 586-4185
FACSIMILE (808) 586-4186

GENEVIEVE SALMONSON
DIRECTOR

March 11, 2002

Mr. David Craddick, Director
Department of Water Supply
County of Maui
200 South High Street
Wailuku, Hawaii 96793

Dear Mr. Craddick:

Subject: Draft Environmental Assessment for the Kupaa Well No. 1 & Transmission Line, Maui

Thank you for the opportunity to review the subject document. We have the following comments and questions.

1. Please evaluate the cultural impacts of this project in accordance with the attached "Guidelines for Assessing Cultural Impacts."

2. Please consult with the Commission on Water Resources Management as well as affected individuals and community groups.

Should you have any questions, please call Jeyan Thirugnanam At 586-4185.

Sincerely,

Genevieve Salmonson
Director

Attachment

c: Chris Hart & Partners

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 1109
WAILUKU, MAUI, HAWAII 96793-6109
TELEPHONE (808) 270-7816 • FAX (808) 270-7833 • www.mauiwater.org

May 10, 2002

Ms. Genevieve Salmonson
Director
State of Hawaii
Office of Environmental Quality Control
235 South Beretania Street, Suite 702
Honolulu, Hawaii 96813

Dear Ms. Salmonson:

RE: Draft Environmental Assessment for the North Waihee Water Source Development -- Kupaa Well No. 1 & Transmission Line (TMK: (2) 3-2-001:por. 3).

Thank you for your letter dated March 11, 2002, regarding the above-referenced Draft Environmental Assessment.

In response to your comments, we offer the following responses:

1. Cultural Impacts. A new section, which evaluates cultural impacts, has been added to the EA.

2. Pre-consultation. The Commission on Water Resource Management has been reviewing and commenting on the project through the well drilling and pump installation permitting processes. The nearest property owners are the Mendes family, owners of Mendes Ranch which lease the subject parcel for ranching activities, and the Boy Scouts of America owner of Camp Maluhia which is located approximately 3/4 of a mile from the project site. Contact was made with the Mr. Charlie Jencks, President of the Maui County Council of the Boy Scouts of America. Mr. Jencks indicated that he is supportive of additional water source development in the area, and is hopeful that future source development projects in the area will result in a more reliable water system for Camp Maluhia. The Water Department has been in contact with the Mendes family since prior to the construction of the well at the site and will continue to keep the family apprised of the project as it proceeds through the construction phase. There are no established community groups in the area due to the sparsely populated nature of the surrounding area.

Thank you for your comments. Should you have any questions, please contact myself, or Mr. Rory Frampton, Chris Hart & Partners, at 242-1955.

Sincerely yours,

David Craddick
Director

Enclosure

cc. Mr. Rory Frampton, Chris Hart & Partners

HK

March 10, 2002

County of Maui
Department of Water Supply
200 South High Street
Wailuku, Hawaii 96793
Herbert Kogasaka

Dear Mr. Kogasaka,

The following comments are about the **Draft Environmental Assessment for North Waihee Water Source Development, Kupaa Well No. 1 and Transmission Line, (Project Nos. 02-10 & 02-11), TMK: 3-2-01: por.3.**

In Section VI, pp. 20-24:
there are actually two sections VI's, "Environmental Assessment Significance Criteria", followed by "Findings and Conclusions". Only the latter is listed in the table of contents, but it follows logically from the first.

In the analysis on pages 20-23, 7 out of 13 conclusions emphasize the need to relieve "stess" on the Iao aquifer, which provides potable water for Central and South Maui. The Kupaa project, a fifth well with tank and transmission line planned for the North Waihee aquifer part of the County water system, is presented as helping to provide relief for that stress through "additional source".

Conclusion No. 10 asserts that total (estimated) production of 3.645 mgd from all five North Waihee wells will not exceed sustainable yield, and no impact is expected on surface streams because they do not "traverse or border the well site". It is not clear how No. 10 is supported beyond an (unattributed) June 1997 Deptartment of Water Supply opinion.

A paper (Exhibit A in Appendix C) from April 1997 by John F. Mink, of Mink and Yuen Inc., titled "The North Waihee Aquifer, an additional water supply source for Central Maui" is presented as hydrological authority and includes statements that:

a) The Iao Aquifer has a sustainable yield of 20mgd. Drinking water demand has reached and will exceed that level.

b) The North Waihee Aquifer can be treated as "quasi-independent" from the Iao Aquifer.

c) "In the entire North Waihee Aquifer System the sustainable yield is estimated as 8 mgd; between Waihee and Makamakaole it is less."

Note that all five wells are between Waihee and Makamakaole, and that the expected average use of 3.645 mgd from the five wells is presumably the limit of estimated sustainable yield, even though actual pumping capacity at the wells is 8.2 mgd.

1. It is surprising that work by Mr. Mink from 1997 is used as the principal authority when there is much more recent work by him available that incorporates water data collected over the intervening years.

For example, a John F. Mink, of Mink and Yuen Inc. report to the Department of Water Supply, County of Maui, Hawaii, on Iao Aquifer system recovery test, dated 2001, gives a figure of **14.7 mgd** maximum estimated sustainable yield for the Iao Aquifer.

In fact, a similar study from Yuen and Associates (also by Mr. Mink) in 1992 gave a maximum estimated sustainable yield for the Iao Aquifer of **9.6 mgd.**

These figures follow inexorably from Mink's own Robust Analytical Model (RAM), developed for the Commission on Water Resource Management's 1990 Water Resource Protection Plan.

The maximum estimated groundwater recharge figures used in the RAM models are also Mink's own. If there is an error, it will have to be attributed to Mink.

2. The very fact, as reported by both the United States Geological Survey water resources group in Hawaii and the State Commission on Water Resource Management, that **all** of the Board of Water Supply production wells in the Iao Aquifer are suffering salt water intrusion and generally declining heads is inescapable evidence that the Iao has been seriously overpumped, probably for many years because these kind of large scale changes take time to manifest.

It is our contention that any water from the North Waihee aquifer (which may be virtually indistinguishable underground from the Iao aquifer) should be considered only as **replacement water for reduced pumping** in the Iao until salt levels decline and heads show a sustained rise.

It is ironic that Mr. Mink used head height in Waihee wells (see his 1997 paper quoted previously) as almost his only evidence that Waihee is "quasi-independent" from the Iao (to thereby justify treating it as new source), yet called currently falling Iao well head levels so insignificant as to be "frivolous" when concerns on that issue were expressed before the Maui County Water Board on 10/22/01.

The State Commission on Water Resource Management staff and John Mink both stated at the same (10/22/01) meeting that full sustainable yield for **any** aquifer is impossible to achieve without "optimum" spacing of wells- that is, drilling many smaller wells and spreading them as far apart as possible.
Given costs of wells and infrastructure, this is not a likely outcome.

3. Another concern that was not addressed in the Draft Environmental Assessment is the effect that Wailuku Agribusiness' vast system of water collection (conservatively estimated at 50 mgd, although the company has refused figures on the grounds they are "proprietary") will have on sustainable yield, and how Waihee wells will be affected by the Wailuku Ag use. (I was only able to find mention of three small private wells regarding other water users in the area.)

4. This leads to another question that was not mentioned in the Draft Environmental Assessment: what effect will the State Supreme Court Waiahole Appeal decision have on a project that plans to take water away from one part of the island to another, for, among other things, commercial real estate development and large subdivisions for non-residents?

It is clear that most of the development pressure causing "stress" on the Iao Aquifer is coming from large landowners with large projects waiting for water so they can proceed.

It is only in Upcountry, East Maui and Kula and Hawaiian Homestead

lands where appreciable numbers of families have been waiting for many years to get water meters for homes, farms and family subdivisions. Since there is no connection between their water system and the Central/South Maui system, it is unlikely they would ever get any water developed from Waihee.

5. On page 11, Appendix B, there is reference to a drainage channel (Figures 4, 5, and 6). I am unable to find figures 4 and 5, and am unclear about both the channel and what role the 75 m rock wall plays. Paragraph 4 on page 11 describes heavy impacts from "fast-moving water" like tumbling boulders. The pipeline route crosses steep terrain, including Kupaa gulch. The only picture of the route shows a gently sloping dirt road, which does not address the difficulty of the terrain and erosion potential.

Finally, the site photographs (figure 6 in the "Figures" section following page 25 of the *first* section of the Draft Environmental Assessment) appear to have their directions mixed up. (The table of contents and page numbering system could use some work, too.)
The east view is probably northeast, the south view is *almost* due east, and the picture that purports to be "looking north at hill where transmission line will run down towards Kanoa Well No. 1" flatly contradicts the map (figure 3b, Kupaa Well No. 1 and Waterline" which shows no part of the transmission line as being north of the well; the direction is south-southeast. These kinds of errors and omissions do not inspire confidence in the rest of the report; I would probably not have noticed these if I had not recently been on a Water Board visit to the site.

I am writing as chair of the Maui Sierra Club, P.O. Box 791180, Paia, HI, 96779.

Please Cc: a reply to Daniel Grantham, HC1, Box 47, Haiku, HI, 96708.

Thank you.

Daniel Grantham
3/11/02

2002/144
HK

County of Maui
Department of Water Supply
200 South High Street
Wailuku, Hawaii 96793
Herbert Kogasaka

March 12, 2002

Dear Mr. Kogasaka,

The following is a correction to my March 11, 2002 comments about the **Draft Environmental Assessment for North Waihee Water Source Development, Kupaa Well No. 1 and Transmission Line, (Project Nos. 02-10 & 02-11), TMK: 3-2-01: por.3.**

On the second page, comment #2, below:

2. The very fact, as reported by both the United States Geological Survey water resources group in Hawaii and the State Commission on Water Resource Management, that **all** of the Board of Water Supply production wells in the Iao Aquifer are suffering salt water intrusion and generally declining heads is inescapable evidence that the Iao has been seriously overpumped, probably for many years because these kind of large scale changes take time to manifest.

Please correct as follows: add the language ***in bold italics***.

2. The very fact, as reported by both the United $tates Geological Survey water resources group in Hawaii and the State Commission on Water Resource Management, that **all** of the Board of Water Supply production wells in the ***basal part of the*** Iao Aquifer are suffering salt water intrusion and generally declining heads is inescapable evidence that the Iao has been seriously overpumped, probably for many years, because these kind of large scale changes take time to manifest.

Thank you,

Daniel Grantham

Daniel Grantham
HC1, Box 47
Haiku, HI 96708

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 1109
WAILUKU, MAUI, HAWAII 96793-6109
TELEPHONE (808) 270-7816 • FAX (808) 270-7833 • www.mauiwater.org

May 10, 2002

Mr. Daniel Grantham
Chair, Maui Sierra Club
P. O. Box 791180
Paia, Hawaii 96779

Dear Mr. Grantham:

Re: **DRAFT ENVIRONMENTAL ASSESSMENT FOR THE NORTH WAIHEE WATER SOURCE DEVELOPMENT KUPAA WELL NO. 1 & TRANSMISSION *LINE (TMK (2) 3-2-001:POR. 3)***

Thank you for your letter dated March 10, 2002 regarding the Draft Environmental Assessment for the above-referenced project. In response to your comments, we offer the following responses:

1. Section VI, pp. 20-24: Please note that appropriate corrections will be made to the Final Environmental Assessments's table of contents to identify "Environmental Assessment Significance Criteria" as Section VI and "Findings and Conclusions" as Section VI of the report.

2. We have amended the later part of Conclusion No. 10 on page 22 of the Draft EA to clarify that it is discussing the potential impacts to stream water quality as a result of runoff or discharges from the project. This is a separate issue from the impact of groundwater withdrawals on stream water flows. The potential impact to stream flows is addressed in Section 11 on page 10 of the Draft EA and will be supplemented by the information contained in the first paragraph of John Mink's letter dated March 12, 2002 which is attached hereto.

3. Your comments, which are numbered 1, 2, and 3, are addressed in the attached letters by John Mink, dated March 12, 2002 and April 30, 2002.

Regarding your question about the effect of Wailuku Agribusiness withdrawal of water for irrigation purposes, Mink's April 30, 2002 reply letter implies that there is no negative impact to sustainable yield of the basal aquifer since Wailuku Agribusiness' water withdrawals are from surface water sources. In fact, use of the water for irrigation would positively contribute to sustainable yield in the form of recharge. The

pre-irrigation recharge is therefore less than recharge with irrigation. As such, the 35 mgd estimate of pre-irrigation recharge used by USGS is conservative.

4. With respect to the implications of the Waiahole decision regarding this project, we have no intention of transporting ground water from an area to the detriment of that area. The Waiohole decision covers ground water that supply surface water system. Neither the Water Code nor State law prohibits the transfer of ground water, not effecting surface water, from one area to another area.

5. Appendix B has been corrected with reference to figures 4 and 5. According to the project archaeologist, the rock wall is interpreted to have functioned as a historic retaining wall built to alleviate impacts of a sloping terrain. This site has been appropriately documented and as such is no longer considered a significant site. Please see the attached letter from the State Historic Preservation Division dated January 17, 2002.

6. With regard to erosion potential, as noted on pages 16 and 17 of the Draft EA, erosion control measures will be implemented to control soil loss from the project site. The crossing of Kupaa Gulch will be underground within the existing dirt road corridor which traverses the gulch, generally following existing contours as shown on Figure 3b.

Where the pipeline is traversing steep terrain, appropriately sized and spaced concrete footings will be used to anchor the pipeline so as to minimize any potential impacts to the pipeline due to erosion. The crossing of the unnamed gulch to the north of Kanoa Well No. 1 will be buried and encased in concrete in order to minimize the potential damage to the pipeline from fast-moving water or boulders.

7. In order to assist in your review of the photographs in Figure 6 we have incorporated a numbered photograph key (see Figure 6,a). To avoid any confusion regarding the locations of Kanoa Well No. 1 verses Kupaa Well No. 1, the described-directions in Figure 6,b are generally correct. We hope the added photograph key helps you to more accurately understand the photograph locations.

Thank you for your consideration of our application. Should you have any questions, please contact the undersigned at 270-7816 or Mr. Rory Frampton of Chris Hart and Partners at 242-1955.

Sincerely,

David R. Craddick
Director of Water Supply

DRC/HK:ar
Enclosures

Mink & Yuen, Inc.

1670 Kalakaua Avenue • Suite 605 • Honolulu, Hawaii 96826 • Telephone: (808) 943-1822 • Fax: (808) 943-1821

Date: March 12, 2002

Subject: Responses to comments by Don Grantham re the North Waihee Water Source Development, Kupaa Well no.1 and Transmission Line.

From: John F. Mink, Mink and Yuen, Inc.

Conclusion 10: Impact on streams ..... The Kupaa and other North Waihee wells exploit the basal groundwater in the Wailuku Basalt. The basal water table lies 10 feet or less above sea level while the stream channel inverts are much higher except at the coast. There is no connection between stream flow and the basal groundwater in the Wailuku formation.

Item b: Hydraulic connection between the Iao Aquifer and the North Waihee Aquifer is strongly resisted by the low permeability sediments and depth of weathering zone in Waihee Valley. The drop in head across the valley is on the order of 10 feet over a distance of approximately 500 feet. Free connection between the two Aquifer Systems would result in less than about 0.25 feet head loss across the valley.

Item 1: Mink has supported a sustainable yield of 20 mgd since his seminal report on the Iao Aquifer System of 1977 for Hawaiiana Investment Corp., who at the time along with the Joint Venture and the County, were basing planning on a potential yield of 36 mgd.

The purported suggested sustainable yields of 14.7 and 9.6 mgd attributed to Mink are not included in published reports and obviously do not supercede the sustainable yield of 20 mgd that Mink has recommended over the past 25 years. Mr. Grantham makes broad but unfocused statements about Mink and the Robust Analytical Model (RAM). He needs to be more specific to justify a rational response.

Item 2: The rise in salinity in some (not all) of the Iao Aquifer System wells is the consequence of wells extending toofar below sea level (Mokuhau and Waiehu Heights), being spaced too closely (Mokuhau), and having too great capacities (Mokuhau). The aquifer is not at fault. Water table elevations are fickle and are not a reliable indicator of the state of the aquifer. For example, in August, 2001, the water table elevation at the Waiehu monitor well was 8.06 feet, while five and a

half months later in February, 2002, it was 10.35 feet. The depth of the lens below sea level, on the other hand, remained constant. The depth of the fresh water lens is the valid index of the condition of the aquifer.

The argument that North Waihee is quasi-independent is based on analysis of head change across Waihee Valley. The boundaries of the Aquifer Systems have been drawn for management purposes. If North Waihee were to be added to Iao to constitute a single Aquifer System, then the sustainable yield of this System would have to be increased substantially to incorporate the effects of recharge to North Waihee.

Mink did not refer to the decline in water table elevations as "frivolous" in his written statements to the BWS, the Council and CWRM. The term was directed to the suggestion that a "lag" in the movement of the fresh/salt waters interface prevented a correlation between the water table elevation and the depth of the lens. "Lag" has not been scientifically studied, and therefore to use it as the reason for the non-correlation is indeed frivolous.

Mink & Yuen, Inc.
1870 Kalakaua Avenue • Suite 605 • Honolulu, Hawaii 96826 • Telephone: (808) 943-1622 • Fax: (808) 943-1621

April 30, 2002

Carl Takumi
C. Takumi Engineering, Inc.
18 Central Avenue
Wailuku, HI 96793

Paragraph 1 and 2.

The Iao and North Wailuku Aquifer Systems may be hydraulically connected, but the connection is weak, and that is why they are referred to as quasi-independent. Nowhere in the studies used by the CWRM to assign sustainable yields are Aquifer Systems defined as absolutely independent of neighboring Aquifer Systems. The sustainable yields for both the Iao and North Wailuku Aquifer Systems were computed independently of each other, so that if the Systems are combined into one large System the sustainable yield of that System will be the sum of the sustainable yields of the two Systems.

With regard to the measured water table levels, which erroneously are referred to as heads, they are not the real measure of the state of the aquifer. Water table levels are highly variable and at any moment are inconsistent with the depth of the fresh water lens as approximated by the Ghyben-Herzberg ratio. The use of the word 'frivolous' by Mink refers to the attention given to water table levels in which they are assumed to meet scientific hydraulic criteria as absolute determinants of the volume of storage in the fresh water lens.

The sustainable yield given for an Aquifer System in Hawaii is computed from a hydrologic budget and is predicated on optimal development practices. Exploitation of the Iao Aquifer System, however, is far from optimal because extraction is concentrated in a few large pumping centers (Shaft 33; Mokuhau wells; Waiahu wells). Eventually pumping from the System will have to be distributed among smaller capacity wells properly spaced. This is a necessary requirement.

Paragraph 3

The USGS computed water budgets for the Iao Aquifer System with and without contributions to recharge from irrigation by Wailuku Agribusiness. The recharge budget for the Aquifer System under pre-irrigation conditions is 35 mgd, about 1.75 times the sustainable yield of 20 mgd. This recharge to sustainable yield ratio is considerably higher than for similar Aquifer Systems elsewhere in the State.

John F. Mink

John F. Mink

Mink & Yuen, Inc.
1870 Kalakaua Avenue • Suite 605 • Honolulu, Hawaii 96826 • Telephone: (808) 943-1622 • Fax: (808) 943-1621

April 30, 2002

Carl Takumi
C. Takumi Engineering, Inc.
18 Central Avenue
Wailuku, HI 96793

Paragraph 1 and 2.

The Iao and North Wailuc Aquifer Systems may be hydraulically connected, but the connection is weak, and that is why they are referred to as quasi-independent. Nowhere in the studies used by the CWRM to assign sustainable yields are Aquifer Systems defined as absolutely independent of neighboring Aquifer Systems. The sustainable yields for both the Iao and North Waihee Aquifer Systems were computed independently of each other, so that if the Systems are combined into one large System the sustainable yield of that System will be the sum of the sustainable yields of the two Systems.

With regard to the measured water table levels, which erroneously are referred to as heads, they are not the real measure of the state of the aquifer. Water table levels are highly variable and at any moment are inconsistent with the depth of the fresh water lens as approximated by the Ghyben-Herzberg ratio. The use of the word 'frivolous' by Mink refers to the attention given to water table levels in which they are assumed to meet scientific hydraulic criteria as absolute determinants of the volume of storage in the fresh water lens.

The sustainable yield given for an Aquifer System in Hawaii is computed from a hydrologic budget and is predicated on optimal development practices. Exploitation of the Iao Aquifer System, however, is far from optimal because extraction is concentrated in a few large pumping centers (Shaft 33; Mokuhau wells; Waiahu wells). Eventually pumping from the System will have to be distributed among smaller capacity wells properly spaced. This is a necessary requirement.

Paragraph 3

The USGS computed water budgets for the Iao Aquifer System with and without contributions to recharge from irrigation by Wailuku Agribusiness. The recharge budget for the Aquifer System under pre-irrigation conditions is 35 mgd, about 1.75 times the sustainable yield of 20 mgd. This recharge to sustainable yield ratio is considerably higher than for similar Aquifer Systems elsewhere in the State.

John F. Mink

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

GILBERT S. COLOMA-AGARAN, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

DEPUTIES
JANET E. KAWELO
LINNEL NISHIOKA

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND
STATE PARKS

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, Hawaii 96707

January 17, 2002

Robert Spear, Ph.D.
Scientific Consultant Services, Inc
711 Kapiolani Boulevard, Suite 1475
Honolulu, Hawaii 96813

LOG NO: 28949
DOC NO: 0201MK02

Dear Dr. Spear,

SUBJECT: **Historic Preservation Review - 6E-42 - Archaeological Inventory Survey**
Water Pipeline Corridor in Waihe'e
Waihe'e Ahupua'a, Wailuku District, Maui
TMK (2) 3-2-1:3

Thank you for the opportunity to review this report which our staff received on December 20, 2001 (Calis, 2001, *Archaeological Inventory Survey for the Water Pipeline Corridor in Waihe'e Ahupua'a, Wailuku District, Island of Maui, Hawai'i, TMK 3-2-1:3*...SCS ms.)

The background section reviewing the ahupua'a settlement pattern and likely project area site patterns is acceptable. Victoria Kamamalu was awarded the *konohiki* lands in Waihe'e (LCA 7713). No other LCA were awarded in the project area.

The inventory survey has adequately covered the project area documenting one historic property in the project area. SIHP Site 50-50-04-5179 consists of a remnant retaining wall. The evidence suggests that the wall dates after European contact, exactly when is uncertain. The interpretation indicates that the wall served as a "retaining wall". Specific function was not determined although the wall could have served as a retaining wall for a trail, or to alleviate erosion in the steep terrain. The wall runs parallel to an unnamed drainage channel, and has been heavily impacted by rapid water flow. There was no evidence suggesting that the site was used for agricultural terracing or habitation.

We agree with the assessment that Site 5179 is "no longer significant". It contained significant information which was reasonably and adequately recorded during the survey, making the site "no longer significant". Thus, no significant sites remain within the project area. The historic preservation review process is concluded.

We find this report to be acceptable.

Aloha,

Don Hibbard, Administrator
State Historic Preservation Division

MK:jen

Post-it® Fax Note 7671	Date 1-29-02	# of pages ▶ 1
To Mike Summers	From Carl Takumi	
Co./Dept. Chris Hart & Part.	Co. C. Takumi Engineering	
Phone #	Phone #	
Fax #	Fax #	

c: John Min, Director, Department of Planning, County of Maui, FAX 270-7634
Bert Ratte, County of Maui, Land Use and Codes, FAX 270-7972
Glen Ueno, County of Maui, Land Use and Codes, FAX 270-7972

FINAL
ENVIRONMENTAL ASSESSMENT
FOR

North Waihee Water Source Development
Kupaa Well No. 1 & Transmission Line

(Project Nos. 02-10 and 02-11)

Prepared for

Department of Water Supply

County of Maui

200 South High Street

Wailuku, HI 96793

Prepared by

Chris Hart & Partners

1955 Main Street

Wailuku, Maui, Hawaii 96793

Kihei ● Maui ●Hawaii

TMK: 3-2-01:por.3

Waihee ● Maui ● Hawai`i

CHRIS HART & PARTNERS

May 2002

FINAL
ENVIRONMENTAL ASSESSMENT
FOR

North Waihee Water Source Development
Kupaa Well No. 1 & Transmission Line

(Project Nos. 02-10 and 02-11)

TMK: 3-2-01:por.3

Waihee ● Maui ● Hawai`i

CHRIS HART & PARTNERS

May 2002

TABLE OF CONTENTS

REFERENCES

FIGURES

APPENDICES

I. INTRODUCTION

A. IDENTIFICATION OF THE PROPOSING/ACCEPTING AUTHORITY AND CONSULTANTS

Proposing Agency/Accepting Authority:
County of Maui
Department of Water Supply
200 South High Street
Wailuku, Maui, Hawaii 96793

Engineering Consultant:
C. Takumi Engineering, Inc.
18 Central Avenue
Wailuku, Hawaii 96793

Planning Consultant:
Chris Hart & Partners
Landscape Architecture and Planning
1955 Main Street, Suite 200
Wailuku, Hawaii 96793

B. OVERVIEW OF THE REQUEST

The County of Maui, Department of Water Supply (DWS), is proposing the development and pump installation of Kupaa Well No. 1, and an accessory 16-inch water transmission line, at Waihee, Maui, Hawaii; TMK: (2) 3-2-01: por. 03 (See Figure 1 and 2).

The purpose of Kupaa Well No. 1, which will be the fifth well developed in the North Waihee Aquifer, is to provide an additional water source for the Central Maui Water System and to relieve stress on the Iao Aquifer. At present, the Central Maui Water System is highly dependent upon the Iao Aquifer, which has an assigned sustainable yield of 20 mgd, as set by the Commission on Water Resources Management (CWRM). The Iao Aquifer is currently being pumped at or near its sustainable yield in order to accommodate present water demand.

The Central Maui Water System services the communities of Wailuku/Kahului, Waikapu, Maalaea, Kihei/Makena, Waiehu, Waihee, Spreckelsville, Paia/Kuau, Kihei and Puunene (See Figure 7). This region serves as the business-industrial-resort hub of Maui and is also the island's population center. Given the significance of this region, and its current dependence upon the Iao Aquifer, it is essential to develop alternative sources in order to prevent over pumping of the Iao Aquifer, and to have additional supply available to accommodate projected population growth over the next several years. According to Mink

and Yuen (1997), preliminary testing and monitoring indicates that the North Waihee Aquifer can be used to supplement the Central Maui system with approximately 8 mgd (See Exhibit A, in Exhibit C, "The North Waihee Aquifer, An Additional Water Source", Mink and Yuen, Inc., 1997).

DWS prepared and processed a Final Environmental Assessment (FEA) for the Waihee Wells and Transmission line in March 1994 (Michael T. Munekiyo Consulting, 1994). The 1994 FEA document examined the activation of Waihee Well Nos. 1 and 2, installation of a new 500,000-gallon water tank, construction of approximately 4.26 miles of underground transmission line, and the drilling of Kupaa Well No. 1 and Kanoa Well No. 1. This project is now collectively referred to as the North Waihee Water Source Project.

The particular focus of the 1994 FEA document was the activation of Well Sites 1 and 2 and the construction of the 4.26 miles of transmission line, including the Waihee Stream crossing, and connection to the Central Maui Water System. Development of Kupaa Well No. 1 and Kanoa Well No. 1 were discussed. However, at the time the actual sites had not been chosen and thus the specific impacts could not be assessed.

Thereafter, the DWS prepared and processed a FEA to assess the potential impacts associated with the exploratory drilling of Kupaa Well No. 1 and Kanoa Well No. 1 (Chris Hart & Partners, 1997). Subsequently, in November 1999 DWS prepared and processed a FEA for the Development of Kanoa Well Nos. 1 and 2. Thus, as part of the North Waihee Water Source Development Project, FEA's have been prepared and processed for the development and pump installation of four wells, including the North Waihee Well Nos. 1 and 2 and Kanoa Well Nos. 1 and 2. In addition, DWS is proposing exploratory drilling for the Maluhia Well.

The purpose of this Draft EA is to assess the potential impacts associated with the well development of Kupaa Well No. 1, which will be the fifth well developed within the system.

C. BACKGROUND INFORMATION

The Central Maui Water System receives the majority of its water from the Iao Aquifer, which has an assigned sustainable yield of 20 mgd. As discussed, withdrawl from the Iao Aquifer is nearing the sustainable yield and as such the DWS has initiated the North Waihee Water Source Development Project as a means to relieve stress on the Iao Aquifer System by providing additional water sources for the Central Maui water system. Preliminary testing and monitoring indicates that the North Waihee Aquifer can be used to supplement the Central Maui system.

The North Waihee Aquifer is defined as the region extending northward from Waihee Valley to Kahakuloa Valley. Testing has indicated that the Waihee Aquifer is quasi-independent from the Iao Aquifer System and that the direction and flow of the Iao Aquifer is toward and across Waihee Valley (See Exhibit A, in Appendix C, "The North Waihee

Aquifer, An Additional Water Source", Mink and Yuen, Inc., 1997). It has been estimated that the entire North Waihee Aquifer could supply the Central Maui Water System with a sustainable yield of 8 mgd (See Exhibit A, in Appendix C, "The North Waihee Aquifer, An Additional Water Source", Mink and Yuen, Inc., 1997).

The North Waihee Water Source Development Project presently consists of 5 well fields, associated transmission lines, pumps, electrical buildings, and related improvements. North Waihee Wells Nos. 1 and 2 (State Well No. 5631-02 & 5631-03, respectively) and transmission lines to the Central Maui Water System were placed into operation in 1999 and Designed Average Consumption is approximately 1.35 mgd. Kanoa Well No. 1 (State Well No. 5731-02) and Kanoa Well No. 2 (State Well No. 5731-04) had a FEA prepared and processed in November 1999 and are currently being developed. In addition, DWS anticipates the future development of an additional well north of Kupaa Well No. 1, in the vicinity of Camp Maluhia. The following 5 wells comprise the DWS's North Waihee Water Source Project:

WELL	STATUS	PUMPING CAPACITY	DESIGNED AVERAGE CONSUMPTION
North Waihee Wells 1 and 2 (State Well Nos. 5631-02, 03)	Developed	3.0 mgd	1.35 mgd
Kanoa Well Nos. 1 and 2 (State Well Nos. 5731-02, 04)	Drilled and development under construction	3.4 mgd	1.53 mgd
Kupaa Well No. 1 (State Well Nos. 5731-03)	Drilled and Proposed for Development	1.7 mgd (proposed)	.765 mgd
TOTAL		**8.2 MGD**	**3.645 MGD**

Source: C. Takumi Engineering, Inc.

Several private wells also exist within the North Waihee Aquifer System. These wells include:

WELL	STATUS	PUMPING CAPACITY
Marino Well A and B (State Well Nos. 5631-04, 05)	Developed	Unknown
Mendes Well (State Well No. 5731-01)	Developed	144,000 gpd
Unknown (State Well No. 5832-01)	Developed	Unknown
Kahakuloa Acres (State Well No. 5832-02)	Developed	Unknown
Kahakuloa Acres / Wailena State Well No. 5832-03)	Developed	288,000 gpd

Source: State Commission on Water Resources Management.

The Marino and Mendez Wells are small residential wells. The Kahakuloa and Wailena wells are used for residential and irrigation purposes. Current water use in the area has been limited due to limited development in the region. The North Waihee Aquifer has not been designated as a water management area; as such, the Commission on Water Resource Management has not established controls on the use of this water.

The North Waihee Water Source Development Project is being implemented to develop new sources of water to meet the needs of existing and future development in the Central Maui Service Area.

D. DESCRIPTION OF PROPOSED ACTION

The DWS is proposing the development of Kupaa Well No. 1, which is proposed to be the fifth well developed in the North Waihee system. The subject well is located on the northern slopes of the West Maui Mountains north of the village of Waihee, approximately one mile north of Waihee Stream on the Island of Maui. The project site is situated approximately 1,000 feet mauka (west) of Kahekili Highway, at an approximate elevation of 640 feet above mean sea level and approximately 4,000 feet from the ocean. The nearest residence is over 1,000 feet north of the well site (See Figure No. 1 and 2).

Construction of the well was completed in March 1999. Results of the Well test results and the Driller's Well Completion Form are contained in Exhibit A-1 of the attached Preliminary Engineering Report (See Appendix C). The Completed configuration of the well is as follows:

Depth: 687 ft. (49 ft. BSL)
Boring Diameter: 21 inches
Blank Casing Diameter: 16 inches (depth 633 ft. - 4 ft. ASL)
Perforated Casing Diameter: 16 inches (length 53 ft.)
Grout: 0 to 630 ft. (7 ft. ASL)
Gravel: 633 to 686 ft.

Based on the results of the pumping tests, the recommended pump size is 1200 gpm (See Exhibit A-1 in Appendix C).

Access to Kupaa Well No. 1 is via an existing unpaved road over undeveloped pasture owned by Wailuku Agribusiness Co. The access easement is on slightly sloping lands that are relatively easy to access.

The owner of the Kupaa Well No. 1 facility will be the Board of Water Supply, County of Maui. Upon completion, the DWS will operate and maintain the facility. The landowner is Wailuku Agribusiness, Inc.

Development of Kupaa Well No. 1 will consist of clearing, grubbing, grading; installation of a pump and related electrical controls; a 500,000 gallon reservoir; equipment building with disinfection and electrical equipment; piping, fencing, and related work (See Figure 4). The 16-inch transmission line will run from the well site in a southeasterly direction approximately 2,000 feet to Kanoa Well No. 1, where it will connect to an existing 24-inch transmission line (See Figure No. 3). The 16-inch waterline will have a design flow of 3 mgd, which will accommodate additional well development. Water from Kupaa Well No. 1 will be used to service the DWS's Central Maui Water System.

A control building will house the electrical equipment for the pump motor controls, reservoir level, well level, SCADA equipment and other electrical appliances. A separate enclosed room will house the disinfection facility. The building will be built slab on grade, using CMU with asphalt shingle roofing. A 500,00 gallon concrete reservoir will also be constructed as part of the project (See Figure No. 4). The reservoir will allow a 30-minute disinfection contact period and provide additional storage for the system.

The pumping facility for the site will have the following specifications:

Pump Type:	Deepwell Submersible
Pump Rating:	1,200 gpm @ 680' TDH
Motor:	Submersible, 350 HP, 1750 RPM
Power Supply:	480 volt, 3 phase, 60 Hz
Piping:	Ductile Iron
Appurtenances:	Check Valve, Air and Vacuum Valve
Flow Tubes:	Cast Iron with a bronze liner with transmitters and receivers

The subject site will be cleared, grubbed, and graded. Grading will incorporate diversions at appropriate intervals to prevent erosion. The adjacent slopes will be grassed. Access to the site will be from Kahekili Highway along an existing graveled driveway, which also provides access to the Mendes Ranch Stables.

Electrical power will be obtained from the Maui Electric Company. No emergency power is proposed at the present time since the existing water system has emergency power available which would be sufficient to provide for water requirements should power fail.

The Maui County Board of Water Supply will provide funding for the project. Operation and maintenance will be the responsibility of the Department of Water Supply. It is estimated that the cost of the proposed improvements will be approximately $2.74 million (See Appendix C, "Preliminary Engineering Report for New Potable Water Source Kupaa Well No. 1", C. Takumi Engineering, Inc., January 2000). The design and operation of both wells will be in conformance with the "Water System Standards," Department of Water Supply, County of Maui, 1985 (See Appendix C, "Preliminary Engineering Report for New Potable Water Source Kupaa Well No. 1", C. Takumi Engineering, Inc., January 2000).

EXISTING ENVIRONMENTAL SETTING, POTENTIAL IMPACTS, AND PROPOSED MITIGATION MEASURES

A. PHYSICAL ENVIRONMENT

1. Orientation/Land Use Data

Tax Map Key:	(2) 3-2-001:003 (portion)
State Land Use Classification:	Agricultural
County Zoning:	Agricultural
Wailuku/Kahului Community Plan:	Agricultural
Flood Zone:	C

The proposed well is located on the northern slopes of the West Maui Mountains north of the village of Waihee, one mile north of Waihee Stream, on the Island of Maui (See Figure 1 and 2). The subject well is located approximately 1,000 feet mauka of Kahekili Highway at approximate 640 feet above mean sea level. The proposed well is approximately 4,000 feet from the ocean and the nearest adjacent structure is over 1,000 feet north of the well.

2. Existing Land Use

Kupaa Well No. 1 is located within an area that was previously cleared during the well drilling phase. The surrounding area is pastureland and is presently covered with various grass, weeds, and shrubs. The subject property has been used in recent times for agricultural pursuits, principally the grazing of cattle and horses.

Analysis. The proposed well, and appurtenant facilities are located within a sparsely populated and largely undeveloped area that is buffered by pasturelands, gullies, and hills. Once in operation, the subject facility will not negatively impact agricultural uses due to the low intensity nature of ranching operations.

3. Surrounding Land Uses

The well site, which is located approximately six miles north of the urbanized region of Wailuku Town, is surrounded by an area that is characterized by an open pastoral setting, comprised of various agricultural settlements interspersed with low density residential uses.

Specific uses surrounding the site include the following:

- North: Vacant undeveloped lands in pastoral use. Further north is the Camp Maluhia and the Kahakuloa Homesteads beyond.
- South: Vacant undeveloped lands in pastoral use. Further south is the town of Waihee.
- East (Makai): Across Kahekili Highway, additional lands in pastoral use and further east is the rugged shoreline.
- West (Mauka): Vacant undeveloped lands in pastoral use. Further west is the West Maui Forest Reserve.

Analysis. The short-term activities associated with drilling and construction, are not anticipated to have a significant impact upon land uses in the vicinity of the project. Long-term impacts are not considered significant due to the low intensity nature of existing ranching operations and the significant distance between the proposed facility and neighboring residences.

4. Climate

Located on the coastal uplands of the West Maui Mountains, Waihee's climatic pattern is heavily influenced by the northeasterly tradewinds as is typical of windward areas in the Hawaiian Islands. In the absence of the tradewinds, diurnal heating and cooling of the Island produces onshore sea breezes during the day and offshore land breezes at night. The average annual rainfall at the well site is approximately 30 to 40 inches, with showers usually more frequent during the night and early morning. Average temperatures range from lows in the mid 60's to highs in the mid 80's.

The proposed well will not be impacted by climatic conditions.

5. Topography

The topography of the surrounding area is characterized as having slopes cut by numerous erosional gullies and established drainage patterns. The elevation at the well site is approximately 640 feet above mean sea level. The topography slopes in a mauka-makai direction with the slopes around 20%. There does not appear to be any significant topographical constraints within the area proposed for the well or transmission line.

Analysis. Development of the subject site will be done using Best Management Practices and steps will be taken to avoid permanent changes to topographical features in the vicinity of the well site. Access provided to the site will be via an existing graveled driveway and the disturbed area around the project site will be grassed to minimize

runoff and erosion during periods of heavy rain. A grading plan will consider steep slopes and allow for runoff. As such, once completed, the proposed project is not anticipated to have a significant impact upon topographical features of the surrounding area.

6. Soils

The soil type specific to the subject property is Naiwa silty clay loam, 3 to 20 percent slopes (NAC). The Naiwa Series consists of well-drained soils on uplands on the islands of Lanai, Molokai, and Maui. These soils developed in volcanic ash and material weathered from basic igneous rock (USDA, 1972, pp. 97 and Plate 98).

7. Geology and Foundation Conditions

The geologic profile of the area consists of alluvium at the surface above Honolua series andesitic basalt lavas and the highly permeable Wailuku series basalts. The alluvium and andesitic lavas are fairly low permeability, which suggests that the wells to basal ground water would not interfere with stream flows above the low permeability layers (See Appendix C, "Preliminary Engineering Report for New Potable Water Source Kupaa Well No. 1", C. Takumi Engineering, Inc., January 2000). A foundation investigation has been performed for the 500,000-gallon reservoir, which concluded that the proposed structures can be supported on spread or continuous footings (See Exhibit C, in Appendix C, "Soils Investigation", Island Geotechnical Engineering, Inc., April 1999).

8. Flood and Tsunami Hazard

Kupaa Well No. 1 lies within Flood Zone C, an area of minimal flood and tsunami hazard, as determined by the Flood Insurance Rate Map for this region. A Drainage and Erosion Control Plan conforming to the Maui County Grading Permit requirements will be prepared to mitigate local flooding and erosion during construction.

The proposed project will have no effect upon the existing flood or tsunami areas.

9. Aquifer Unit Status

Sustainable Yield: The North Waihee Aquifer System is defined as the region extending northward from Waihee Valley to Kahakuloa Valley (See Figure 5). However, the basal aquifer may be disrupted near Makamakaole Valley by massive Honolua dikes. The sustainable yield for the entire North Waihee Aquifer is estimated at 8 mgd and the estimated sustainable yield for the area between Waihee and Makamakaole will be less (See Exhibit A, in Exhibit C, "The North Waihee Aquifer, An Additional Water Source", Mink and Yuen, Inc., 1997).

Current and pending installed capacity: The Board of Water Supply, by agreement with Wailuku Agribusiness Co., Inc. has perpetual easements for the development of 5 well fields within Wailuku Agribusiness Company properties between Waihee Stream and Kupaa Gulch.

The two existing North Waihee Wells No. 1 and 2 have a pumping capacity of 3 mgd. Pumping from the proposed sites should not affect the Wailena Well because of its distance from the proposed wells. Kupaa Well No. 1 is proposed to have a pumping capacity of 1.7 mgd. Once on line, Kanoa Well Nos. 1 and 2 will have a combined pumping capacity of 3.4 mgd. Thus, total pumping capacity from the North Waihee Aquifer will be just over 8.2 mgd. It is anticipated that the pumps will not run simultaneously, or continuously, except under emergency conditions. Designed Average Consumption use is expected to be approximately 3.645 mgd, depending upon demand.

Private well use is limited and consists of the Mendes Well (State Well No. 5731-01), a small residential well; the Wailena well (State Well No. 5832-03), a residential subdivision well at Wailena; and, the Marino Well (State Well No. 5631-04), a small residential subdivision well. The lack of development in the area has kept pumpage from of these wells at a minimum. The Commission on Water Resource Management has no record of the current water use totals.

10. Contamination Analysis and Vulnerability Assessment

The recharge area estimated for the Waihee Aquifer is about 12 square miles between the Waihee and Kahakuloa Valleys. Kupaa Well No. 1 is located within an agriculturally zoned area that has predominantly been used for rangeland. No known pesticides have been used on the property for decades. There are no known sources of agricultural and industrial pollutant sources in the area that would affect the source. The nearest existing residence is located more than 1,000 feet northwest (makai) of the well. Forest reserve lands are approximately 2,000 feet southwest (mauka) of the site. Camp Maluhia, which is situated on state owned land, is to the north of the subject project. Agricultural and conservation zoning within the recharge area limits future land use options and restricts population growth in the area. Conservation zoning requires that permits be obtained prior to urban or agricultural uses being conducted. There are no feedlots, sanitary landfills, or public dumps within the aquifer recharge area. The limited residential development that exists is serviced by individual wastewater disposal systems.

Water quality samples taken from the North Waihee Wells 1 and 2, Kupaa Well 1, and Kanoa Well 1 and 2 during well pumping testing confirms that the subject water is free of pesticides and other contaminants. All wells are disinfected to mitigate potential contamination. The space around the well casings have been grouted from just above the aquifer level to ground surface to prevent surface waters from entering the wells.

The well has been constructed and developed in strict accordance with the Department of Land and Natural Resources, Commission on Water Resource Management, "Hawaii Well Construction & Pump Installation Standards" to insure that the proposed action does not result in pollutants penetrating the aquifer. Designed Average Consumption is anticipated to be approximately 3.645 mgd for the five wells that currently comprise the system.

11. Hydrologic Impact Analysis

The North Waihee Aquifer System is defined as the region extending northward from Waihee Valley to Kahakuloa Valley. Testing has indicated that the Waihee Aquifer is quasi-independent from the Ioa Aquifer System and that the direction and flow of the Iao Aquifer is toward and across Waihee Valley (See Exhibit A, in Exhibit C, "The North Waihee Aquifer, An Additional Water Source", Mink and Yuen, Inc., 1997). It has been estimated that the entire North Waihee Aquifer could supply the Central Maui Water System with a sustainable yield of 8 mgd . A summary and interpretation of the well test pumping results for Kupaa Well No. 1 and Kanoa Well No. 1 by Mink and Yuen, Inc., is include in Exhibit A-1 within Appendix C. Based on analysis of data from the pumping tests at both wells, the conclusion is that the North Waihee aquifer is highly permeable and capable of supplying low salinity water at the recommended pumping rates.

Streams: There are no perennial streams in close proximity to the well sites. The nearest perennial streams are Waihee and Makamakaole.

The Kupaa and other North Waihee wells exploit the basal groundwater in the Wailuku Basalt. The basal water table lies 10 feet or less above sea level while the stream channel inverts are much higher except at the coast. Except for the mouth of Waihee Stream, the water table in the aquifer lies below the invert of the Waihee stream channel. Any effect on stream flow will be very small and not likely to be measurable (Department of Water Supply, June 1997). The stream is about 4,000 feet distant from the proposed wells.There is no connection between stream flow and the basal groundwater in the Wailuku formation (See Appendix D, Mink Letter Dated April 30, 2002).

In addition, Makamakaole stream flows on the Honolua formation and nowhere does it intersect the Wailuku formation, which is the aquifer proposed for development. Pumping in the Wailuku formation will have no effect on the Makamakaole stream flow (Department of Water Supply, June 1997). The stream is located approximately 3,500 feet away from the proposed wells.

Wetlands: A large wetland occurs in the headwater region of Makamakaole Stream, and a smaller wetland occurs at the mouth of Waihee Stream.

The Makamakaole wetlands extend irregularly over a distance of about 2.5 miles from Eke crater toward the sea and range in elevation from 4,500 feet above MSL to 2,800 feet above MSL. They lie on the Honolua formation and are sustained by perched water in the formation. There is no hydraulic continuity between these wetlands and the Wailuku formation. They will not be affected by pumping in the Wailuku aquifer. The lowest reach of the wetlands is two miles from the proposed wells.

The wetlands at the mouth of Waihee Stream are a mile away from the proposed well. A reduction in head in the Wailuku aquifer may diminish seepage into the wetlands but likely not enough to be detectable (Department of Water Supply, June 1997). The wetlands are in valley fill alluvium and are sustained mostly by seepage from Waihee Stream.

12. Watershed and Land Use Analysis

As noted, the Central Maui Water System receives the majority of its water from the Iao Aquifer System, which has an assigned sustainable yield of 20 mgd as set by the CWRM. Withdrawl from the Iao Aquifer is nearing the sustainable yield and as such the DWS has initiated the North Waihee Water Source Development Project as a means to relieve stress on the Iao Aquifer System by providing additional water sources for the Central Maui water system. Preliminary testing and monitoring indicates that the North Waihee Aquifer can be used to supplement the Central Maui system.

The Central Maui Water System services the communities of Wailuku/Kahului, Waikapu, Maalaea, Kihei/Makena, Waiehu, Waihee, Spreckelsville, Paia/Kuau, Kihei and Puunene (See Figure 6). This region comprises the majority of the County's economic activity, and maintained a resident population of approximately 49,750 persons in 1990, about 54% of the Island of Maui's resident population.

The Department of Water Supply estimates that year 2010 demand within the Central Maui Water System will be approximately 30 mgd (Water Use and Development Plan, 1990). The "Historical Trend" method, utilized by the DWS in the Water Use and Development Plan, uses a linear extrapolation of 0.5 mgd/year, which equates to a forecasted water use of 17.1 mgd in 1995. The 1995 water consumption reported in the Annual Report for Fiscal Years 1994, 1995, Board of Water Supply, County of Maui for the Wailuku District averaged nearly 18.7 mgd, or a 8.5% deviation. Using the linear extrapolation of 0.5 mgd/year, the estimated water use in 1997 was 18.1 mgd. Comparatively, the water consumption reported by the Annual Report for Fiscal Year 1997, Board of Water Supply, County of Maui, averaged 19.3 mgd, or a 6.6% deviation, and a 2 year increase in water demand of 0.6 MGD (See Appendix C, "Preliminary Engineering Report for New Potable Water Source Kupaa Well No. 1", C. Takumi Engineering, Inc., January 2000).

The future requirements of service as forecasted above are based upon a mix of residential, commercial, institutional and other needs of the community. The Community Plans for the Kihei-Makena, Wailuku-Kahului, and Paia-Haiku regions are the primary planning documents adopted by the County to assess and designate potential growth areas within the Central Maui Water System. The DWS is charged with the responsibility of providing a sufficient water supply for the area. Potential growth and future requirements may vary due to changes in the Community Plans, economy, and population changes.

13. Flora and Fauna

The subject property is situated within the pastoral setting of Waihee. Natural environmental features, such as plant and animal life, therefore, are reflective of this pastoral setting. Existing vegetation at the actual well site is non-existent due to previous clearing for well drilling and access way construction. There are no rare, endangered or threatened species of plants at the well site.

The 16-inch transmission line will run from the well site in a southeasterly direction approximately 2,000 feet to Kanoa Well No. 1, where it will connect to an existing 24-inch transmission line (See Figure No. 3). The subject transmission line will parallel an existing graveled roadway and then traverse down a steep bank to Kanoa Well No. 1. No rare, endangered or threatened species of plants were identified on the affected property.

Animal life in the vicinity similarly reflects the pastoral setting of the region. Avifauna typically found within Waihee's pastoral area include the common myna, several species of dove, cardinal, house finch, and house sparrow. Mammals common to this area include cats, dogs, rodents, and mongoose.

There are no known significant habitats of rare, endangered or threatened species of flora and fauna located on the subject property. Therefore, the proposed well and transmission line will not have an adverse impact upon the flora or fauna found in the area.

14. Air Quality

Waihee's constant exposure to tradewinds creates a clean air environment. There are no point sources of airborne emissions in the immediate vicinity of the subject property, and the air quality at the site is considered good.

Air quality impacts attributed to the development of the well and appurtenant facilities could include dust generated by short-term drilling and construction-related activities. Mitigation measures for dust control, such as regular watering and sprinkling, will be implemented as needed to minimize wind-blown emissions. The pump utilized during

previously unrecorded site was identified, Site 50-50-04-5179, that consisted of a remnant retaining wall built into a drainage slope. Based on architectural construction materials and general land-use patterns in the area, the site is interpreted to have functioned as a historic retaining wall built to alleviate impacts of a sloping terrain. No auxiliary features near the wall suggested that it was used for terracing or habitation. The degree of slope above site 50-50-04-5179 increased dramatically with ascension. As terrain is an integral factor in site distribution, this sloped terrain was not likely to support anthropogenic modification for habitation, agricultural or ranching activities.

Site 50-50-04-5179 is deemed significant under Criterion "D" of the Federal and State historic preservation guidelines. The site has now yielded sufficient data through the current Inventory Survey, addressing any potential impact, and is, therefore, considered to be "no longer significant." No additional sites were identified within the transmission line corridor. Subsequently, no further archaeological work is recommended.

18. Cultural Resources

The potential of the project to have significant impacts to cultural resources or activities is considered minimal based on the following analysis.

Historical Evidence of Cultural Activities

Archaeological Resources. Two archaeological studies have been performed in order to assess the impacts to historic sites as a result of the proposed action (See Appendix A and B). Only one historic era site (rock retaining wall) was located within in the project site. The lack of sites in the project area is likely due to the impacts of large scale intensive agricultural cultivation of project area. Large scale agricultural practices have dominated use of the project area since the mid 1800s.

Land Commission Awards. Current tax maps show no record of land commission awards (LCAs) in the project vicinity. The entire project site (well and transmission line) is encompassed within TMK 3-2-1: 03, a 369 acre parcel owned by Wailuku Agribusiness Company, Inc. The presence, of LCAs is one indicator of native Hawaiian activities or presence during the mid to later half of the nineteenth century.

Potential for Impacts to Existing or Future Cultural Activities

Current land use at the project site and surrounding vicinity consists of low to medium intensity cattle grazing and ranching activities. As documented in the Draft EA, this agricultural practice, which some consider to be culturally significant, will not be impacted by the proposed action.

Examination of the area immediately affected by the proposed action reveals no physical resources, either natural or man-made, which would be of cultural significance. The

drilling will be diesel driven and may produce diesel fumes which could impact local air conditions. Permanent pumps will be electrical and will produce no air emissions. During drilling, the DWS will adhere to the State Department of Health's rules and requirements for air emission controls regarding this issue. As such, development of the proposed well is not anticipated to be detrimental to local air quality.

15. Noise Characteristics

Background noise at the well site is natural, except for intermittent noise generated by vehicles on Kahekili Highway.

It is anticipated that the above ground pump may impact noise levels, however, the nearest potentially sensitive receptor site is a dwelling located more than 1000 feet to the north. This distance will mitigate potential noise impacts.

16. Visual Resources

The well site is located on the mauka side of Kahekili Highway. Scenic resources in the area include views of the nearby shoreline, open space natural drainage ways (gulch areas), and views of Haleakala's northshore.

Once completed, the well will be at or near grade. The proposed single-story accessory structures are minimal in mass and bulk and are permitted within the State and County Agricultural Districts. The proposed 500,000-gallon storage tank, which will be approximately 20 feet high, will be visible from portions of Kahekili highway but will not significantly impact significant Mauka or Makai views. The tank will be painted using non-reflective colors, which will be chosen to blend in with the background environment. As such, the proposed project is not anticipated to produce adverse impacts to scenic resources.

17. Archaeological/Historical Resources

An Archaeological/Historical Resources Survey was conducted for the Kupaa Well No. 1 well site on March 27, 1997. No significant remains were located in the area proposed for well development (See Appendix A, "Archaeological Reconnaissance Surface Survey by Xamanek Researchers dated March 31, 1997)".

Scientific Consultant Services, Inc. (SCS) (December 2001) conducted an Archaeological Inventory Survey for the proposed water pipeline corridor (See Appendix B, "Archaeological Inventory Survey for the Water Pipeline Corridor in Waihe`e Ahupua`a, Wailuku District, Island of Maui, Hawai`i dated December 2001)". The bulk of land area within the water pipeline corridor, i.e. between the Kanoa Well No. 1 and Kupaa Well No. 1, has been previously disturbed by construction of an existing road and clearing of lands for pineapple and sugarcane cultivation. One

vegetation is dominated by pasture grass on mild to moderately sloping terrain. Within gulches or on steep slopes vegetation is dominated by mostly alien shrubs and trees. No religious or other ceremonial sites or features have been identified in the immediate area. As such, there will be no significant impact to physical resources which could be supportive of cultural activities.

While there are no known cultural activities or resources occurring within the immediate project vicinity, there does exist the possibility that portions of the larger parcel on which the site is located could be used as an access to resources which exist mauka of the project site (e.g., within forest reserve lands). There will be no impact to access to resources which may exist mauka of the project site as a result of the project due to the limited nature of the improvements.

Potential Impacts to Cultural Activities related to Stream Water Use

The potential for impacts to streamwater flows in the area is addressed in Mink's letter dated March 12, 2002. Mink concludes that the Kupaa and other North Waihee Wells utilize basal groundwater in the Wailuku Basalt. The basal water table lies 10 feet or less above sea level while the stream channel inverts are much higher except at the coast. As such, there is no connection between stream flow and the basal groundwater in the Wailuku formation, and therefore, there would be no impacts to any activities which may be associated with nearby perennial streams, the closest being Waihee to the south and Makamakaole to the north.

B. SOCIO-ECONOMIC ENVIRONMENT

1. Population and Economy

The population of the County of Maui has exhibited relatively strong growth over the past decade with the year 2000 population estimated to be 124,562, an approximate 24% increase over the 1990 population of 100,504 (County of Maui Data Book, 1996-97). Growth in the County is expected to continue, with resident population to the year 2005 and 2010, estimated to be 134,064 and 140,060, respectively.

The Wailuku-Kahului region is the island's center of commerce, including a wide range of commercial, service, professional, and governmental activities. The large agricultural tracts of lands that encompass the region, mainly owned by Hawaiian Commercial & Sugar and Wailuku Agribusiness Company, are also a vital part of the region's economy.

The Central Maui Water System services both the residential and commercial areas of Central Maui, including Paia and South Maui, which are expected to continue to grow. The growth rate of these regions continues to place additional stress on the Iao Aquifer System, which is currently at or near its sustainable yield. The North Waihee Water

Source Development Project is intended to relieve stress on the Iao Aquifer System by providing additional source and transmission systems. The well is intended to provide additional alternatives to service the region's population and economic centers.

C. PUBLIC SERVICES

1. Recreational Facilities

The well site is in close proximity to numerous recreational opportunities, including Maui War Memorial Complex, Waihee Beach Park, and Waiehu Golf Course. In addition, there are numerous ocean related activities nearby.

The subject wells will not impact existing recreational facilities.

2. Police and Fire Protection

Police protection for the region is provided by the County Police Department headquartered at the Wailuku station approximately six miles away. The Central Maui Patrol includes approximately 100 full time personnel.

The County Department of Fire Control's Wailuku Station and Kahului Station provide fire prevention, suppression, and protection services.

The proposed project is not anticipated to affect police or fire protection.

3. Solid Waste

The County of Maui provides weekly solid waste collection services to residential properties in the area. Drilling will produce residual crushed rock and soil materials. These materials will be spread out evenly at the drilling sites. After completion of the wells, there will be no long-term generation of solid waste products. Therefore, the project will have no impact upon solid waste services.

4. Health Care

Medical facilities are located approximately six miles from the well sites at Maui Memorial Hospital and at various private practices and clinics in Kahului and Wailuku.

The subject well is not anticipated to have an impact upon medical services in terms of service area.

5. Schools

Public schools that serve residents in the Waihee area include Waihee Elementary School, Grades K-5; Maui Waena Intermediate, Grades 6-8; and Maui High School, Grades 10-12.

The exploratory wells are not anticipated to have an impact upon the region's public school system.

D. INFRASTRUCTURE

1. Roadways

Access to the proposed well is off of Kahekili Highway, a two-lane State highway that provides access from Central Maui to Kahakuloa and further on to Kapalua.

An existing access driveway will be utilized to access the subject well site. The proposed project will generate a limited number of trips during the construction phase of the project. Thereafter, periodic trips will be required to maintain the well. It is not anticipated that the existing roadways will be significantly impacted by the development.

2. Wastewater

Wastewater disposal in the Waihee community is accommodated via cesspools or individual wastewater treatment systems such as septic tanks. There are no existing County or private wastewater collection and treatment facilities in this area.

The proposed wells will not have any impact upon the County's wastewater system.

3. Water

As noted in the background section, The Central Maui Water System receives the majority of its water from the Iao Aquifer, which has an assigned sustainable yield of 20 mgd as set by the Commission on Water Resource Management (CWRM). Withdrawl from the Iao Aquifer is nearing the sustainable yield and as such the DWS has initiated the North Waihee Water Source Development Project as a means to relieve stress on the Iao Aquifer System by providing additional water sources for the Central Maui water system. Preliminary testing and monitoring indicates that the North Waihee Aquifer can be used to supplement the Central Maui system.

DWS has completed construction of the transmission lines to connect North Waihee Well Nos. 1 and 2 to the Central Maui Water System. Kanoa Well No. 1 and 2 are currently being developed. Kupaa Well No. 1 will be the fifth well developed. The entire project is designed to provide an alternative source of water for the Central Maui

Water System, and as such, should have a beneficial impact upon the Iao Aquifer System by minimizing the potential for over pumping. In addition, the proposed wells will provide valuable data regarding the long-term sustainable yield potential for the North Waihee Aquifer.

4. Drainage

Storm-water runoff generated at the well site percolates into the ground or sheet flows across the site from the high points to the low points and eventually into adjacent gulches.

The proposed action involves minimal land alteration activities and will not significantly alter drainage patterns in the area.

Normal erosion control measures during construction should be adequate to control soil loss from the well sites. These measures include the following:

- Leave natural vegetation undisturbed in areas not needed for immediate construction;
- Use sprinklers to control dust; and
- Water down any disturbed areas after drilling activity has ceased for the day and during weekends and holidays.

In addition, access roads to each site will be paved and surrounding vegetation planted to mitigate runoff and erosion during periods of heavy rain. As such, the subject wells are not anticipated to have an adverse affect upon the existing hydrologic conditions, adjoining or downstream properties, or coastal waters.

III. RELATIONSHIP TO GOVERNMENTAL PLANS, POLICIES, AND CONTROLS

A. STATE LAND USE DISTRICT

Chapter 205, Hawaii Revised Statutes, relating to the Land Use Commission, establishes the four major land use districts in which all lands in the State are placed. These districts are designated "Urban", "Rural", "Agricultural" and "Conservation". The subject parcel is within the "Agricultural" District. The proposed project is permitted within the "Agricultural" District as a "public utility".

B. COUNTY ZONING

The proposed project is situated within the County's Agricultural District and is permitted as a "minor utility facility".

C. MAUI COUNTY GENERAL PLAN

The Maui County General Plan (1990 Update) sets forth broad objectives and policies to help guide the long-range development of the County. As stated in the Maui County Charter, "The purpose of the General Plan is to recognize and state the major problems and opportunities concerning the needs and the development of the County and the social, economic and environmental effects of such development and set forth the desired sequence, patterns and characteristics of future development."

The proposed action is in keeping with the following General Plan Objective and Policies:

Objective:

To supply an adequate supply of potable and irrigation water to meet the needs of Maui County's Residents.

Policy:

Support the improvement of water transmission systems to those areas that historically experience critical water supply problems provided the improvements are consistent with the water priorities and the County's Water Use Development Plan provisions for the applicable community plan area.

Policy:

Seek new sources of water by exploration in conjunction with other government agencies.

D. WAILUKU-KAHULUI COMMUNITY PLAN

The well site is located in the Wailuku-Kahului Community Plan region, one of nine Community Plan regions established in the County of Maui. Planning for each region is guided by the respective Community Plans, which are designed to implement the Maui County General Plan. Each Community Plan contains recommendations and standards that guide the sequencing, patterns, and characteristics of future development in the region.

The Wailuku-Kahului Community Plan Land Use Map identifies the subject property "Agricultural". The proposed project is consistent with the "Agricultural" designation.

Approval of the proposed request would be consistent with the Wailuku-Kahului Community Plan by addressing the following objectives:

- Coordinate water system improvement plans with growth rates to ensure adequate supply and a program to replace deteriorating portions of the distribution system. Future growth should be phased to be in concert with the service capacity of the water system.

IV. LIST OF ALTERNATIVES

The DWS has studied alternative means of water supply, i.e. surface water treatment and desalinization. Groundwater development remains the most viable alternative for potable water due to the high cost associated with meeting new surface water treatment rules promulgated by the Safe Drinking Water Act, and as experienced during the course of operating several surface water treatment plants currently in use.

The East Maui Development Plan prepared by the DWS planned for additional sources for the Central Maui System to come from east Maui. Two wells in the Hamakuapoko area have been drilled; however, the East Maui Development Plan has been held up until an Environmental Impact Statement can be finalized. It may be several years before any East Maui Sources can be utilized for Central Maui.

The DWS has also pursued demand reduction measures including the promotion of water conservation, wastewater reuse, and non-potable water use, as follows:

Wastewater Reuse: The County of Maui has long initiated wastewater reuse measures in the Central Maui Water Service Area. Presently, wastewater reuse is used for irrigation at The Silversword Golf Course, Kalama Park, Kihei Fire Station and Kihei Library, Haleakala Ranch, Dekalb Seed Corn Project, Kihei Waste Water Treatment Plant, Kahului Wastewater Treatment Plant, and for dust control.

Catchment: Rainfall catchment is not a viable alternative in the dry central Maui area where long dry periods occur during the summer.

Conservation: The DWS and the County of Maui have already initiated programs to promote conservation measures. The use of low flow fixtures is required by County ordinance for all new construction and renovations. In addition, the DWS is engaged in promoting a xeriscape program, leak detection and repair program, and a low flow fixture retrofit program.

Non-potable Sources: Many Central Maui parks and golf courses have their own irrigation wells that use predominantly non potable (brackish) water. Sugar growing, the primary agricultural crop in Central Maui, is supported by long developed surface water and non potable water sources.

Despite the active pursuit of the alternatives listed above, the DWS needs to initiate additional source development in order to relieve the stress on the Iao Aquifer and to accommodate increased demand for water.

V. OTHER REQUIRED PERMITS AND APPROVALS

In order to proceed with the proposed action, DWS will need approval of a Pump Installation Permit from the Commission on Water Resource Management.

VI. ENVIRONMENTAL ASSESSMENT SIGNIFICANCE CRITERIA

In accordance with Title 11, Department of Health, Chapter 200 and Subchapter 6, Section 11-200-12, Environmental Impact Statement Rules, and based on the detailed analyses contained within this document, the following conclusions are supported:

1. The proposed action will *not* result in an irrevocable commitment to loss or destruction of natural or cultural resources.
   Analysis. Development of the proposed well, water storage tank, and transmission line involves a relatively small area within the subject property. The proposed site has been used for cattle grazing for several decades and the proposed action will not affect this use. In addition, the proposed action will relieve stress on the Iao Aquifer System by providing additional source and transmission systems. It is not anticipated that the pump will run simultaneously, nor continuously, except under emergency conditions. Designed Average Consumption is expected to be approximately 3.645 mgd, depending upon demand. The estimated sustainable yield from the North Waihe'e Aquifer system is 8.0 mgd.

2. The proposed action will *not* curtail the range of beneficial uses of the environment.

   Analysis. The minimal scope of the proposed action should not have a significant impact upon existing or future land uses in the area. The proposed well is a permitted use within the State and County Agricultural Districts. As discussed, water drawn from the well will be used to service the Central Maui Water System, which serves the eastern slopes of the West Maui Mountains, the Central isthmus of Maui, and the lower western slopes of Haleakala. The water will be available to existing and future residential, commercial, and agricultural users.

3. The proposed action will *not* conflict with State or County long-term environmental policies and goals as expressed in Chapter 344, HRS.

   Analysis. As noted, the purpose of the proposed action is to relieve stress currently being placed upon the Iao Aquifer System and to meet projected demand for residential, commercial, industrial, and agricultural water uses. All required permits will be obtained

prior to construction and the project will comply with all required State and County water quality standards.

4. The proposed action will *not* substantially affect the economic or social welfare and activities of the community, county or state.

   Analysis. The Iao Aquifer System is the primary source of water for Central Maui residents. Unfortunately, the system is now being pumped at or near its sustainable yield. The proposed action will benefit the County of Maui by providing an alternative source of water to supplement the Central Maui Water System; thereby, relieving stress currently being placed upon the Iao Aquifer System, while accommodating future water demand.

5. The proposed action will *not* substantially affect public health.

   Analysis. The proposed well will be owned and operated by the Department of Water Supply. As noted previously, water samples taken from North Waihee, Kanoa, and Kupaa Wells during well testing indicated that disinfection is the only necessary treatment for the water. All applicable State Safe Drinking Water Regulations will be strictly adhered to.

6. The proposed action will *not* result in substantial secondary impacts.

   Analysis. The proposed well will be developed in strict accordance with the Department of Land and Natural Resources, Commission on Water Resource Management, "Hawaii Well Construction & Pump Installation Standards." As noted, the purpose of the well is to provide an alternative source of water for the County's Central Maui Water System; thereby, relieving stress currently being placed upon the Iao Aquifer System. The water will be available to existing and future residential, commercial, and agricultural users. In addition, development of the well will provide valuable information regarding the condition of the aquifer system.

7. The proposed action will *not* involve substantial degradation of environmental quality.

   Analysis. The recharge area for the Waihee Aquifer System is about 12 square miles between the Waihee and Kahakuloa Valleys. Presently, there are no known sources of agricultural and industrial pollutant sources in the area that would affect the source. Water quality samples have indicated the North Waihee Aquifer System is free of contaminants. The proposed well will be developed in strict accordance with the Department of Land and Natural Resources, Commission on Water Resource Management, "Hawaii Well Construction & Pump Installation Standards" to insure that the proposed action does not result in pollutants penetrating the aquifer. Designed Average Consumption anticipated to be approximately 3.645 mgd for the five wells that currently comprise the system, depending upon demand, but will not exceed the system' sustainable yield.

8. The proposed project will not produce cumulative impacts and does *not* have considerable effect upon the environment or involve a commitment for larger actions.

   Analysis. As noted, the well will be utilized to supplement the Central Maui Water System, which serves the eastern slopes of the West Maui Mountains, the central isthmus of Maui, and the lower western slopes of Haleakala and includes the communities of Wailuku/Kahului, Waikapu, Maalaea, Kihei/Makena, Waiehu, Waihee, Spreckelsville, Paia/Kuau, Kihei, Maalaea, and Puunene. The proposed well is necessary to relieve stress currently being placed upon the Iao Aquifer System, which is being pumped near its sustainable yield, and to accommodate increasing demand arising from projected population growth.

9. The proposed project will *not* affect a rare, threatened, or endangered species, or its habitat.

   Analysis. The well site is located on pasturelands. The proposed 16-inch transmission line will be located on pasture and within an area of undeveloped brush land. Natural environmental features, such as plant and animal life, therefore, are reflective of this pastoral setting. Existing vegetation within the well sites include various weeds, grasses, and shrubs. There are no rare, endangered, or threatened species of plants or animal life within the areas to be developed.

10. The proposed action will *not* substantially or adversely affect air and water quality or ambient noise levels.

    Analysis. As discussed, the well site will be developed in strict accordance with the Department of Land and Natural Resources, Commission on Water Resource Management, "Hawaii Well Construction & Pump Installation Standards" to insure that the well will not result in pollutants penetrating the aquifer. In addition, Designed Average Consumption is anticipated to be approximately 3.645 mgd for the five wells that comprise the system, depending upon demand, but will not exceed the systems sustainable yield. Surface water resources and water quality will not be directly impacted since there are no perennial streams in close proximity to the well site that would be impacted by runoff from the project. The discharge water from the well tests will be transported and discharged into nearby drainage gulches and will avoid any perennial streams. Inasmuch as there are no surface streams that traverse or border the well site, the proposed action is not anticipated to produce any long-term affect upon the region's surface waters. As noted previously, there are not anticipated to be any adverse air or ambient noise level impacts.

11. The proposed action will *not* substantially affect or be subject to damage by being located in an environmentally sensitive area, such as flood plain, shoreline, tsunami zone, erosion-prone areas, estuary, fresh waters, geologically hazardous land or coastal waters.

    Analysis. The well lies within Flood Zone C, an area of minimal flood and tsunami hazard, as determined by the Flood Insurance Rate Map for the region. A Drainage and Erosion

Control Plan conforming to the Maui County Grading Permit requirements will be prepared to mitigate local flooding and erosion during construction. The proposed project will have no effect upon the existing flood or tsunami areas.

12. The proposed action will *not* substantially affect scenic vistas or view planes identified in county or state plans or studies.

    Analysis. The well will be situated approximately 1,000 feet mauka (west) of Kahekili Highway and will not create a significant impact to adjacent property owners or to vehicles traveling along Kahekili Highway. Thus, visual resources will not be significantly affected.

13. The proposed action will *not* require substantial energy consumption.

    Analysis. Electric pumps will be utilized in the well. It is not anticipated that the pumps will require substantial energy consumption.

VII. FINDINGS AND CONCLUSIONS

The North Waihee Water Source Development Project is intended to relieve stress on the Iao Aquifer System by providing additional source and transmission systems. The development of Kupaa Well No. 1, which will be the fifth well developed within the system, will provide additional alternatives to service the region's population and economic centers.

Development of the project will consist of clearing, grubbing, grading, installation of a pump and related electrical controls, 500,000 gallon reservoir, equipment building with disinfection and electrical equipment, piping, fencing, and related work. A 16-inch transmission waterline is planned to carry water from the Kupaa 500,000 gallon reservoir to an existing 24-inch transmission water line from the North Waihee Well Project where the water will then be transported to the Central Maui Water System. The short-term impacts associated with these activities are not anticipated to have a significant impact upon existing land uses at the sites or in the region.

The project is not anticipated to have any adverse impacts upon any existing environmental features such as flora and fauna, topography, soils, or air quality. The project is not anticipated to have an impact upon archaeological or historical features.

The proposed project will not have an adverse impact upon existing socio-economic conditions nor will it have an adverse effect upon existing public services or infrastructure.

Therefore, as a result of the findings of this report, the proposed project is not anticipated to have any significant environmental impacts and it is anticipated that a "Finding of No Significant Impact" (FONSI) will be made by DWS.

VIII. AGENCIES CONTACTED DURING THE PREPARATION OF THE DRAFT ENVIRONMENTAL ASSESSMENT

County of Maui

- Department of Water Supply
- Department of Planning

Private/Public Individual

- Wailuku Agribusiness Co., Inc.

REFERENCES

C. Takumi Engineering, Inc., Preliminary Engineering Report for New Potable Water Source Kanoa Well No. 1 (State Well No. 5731-02), Waihee, Maui, Hawaii, August 1999.

Community Resources, Inc., Maui County Community Plan Update Program Socio-Economic Forecast Report, March 1992.

County of Maui, Office of Economic Development, Maui County Data Book 1996-97, 1997.

County of Maui, Maui Planning Department. Community Plan: Wailuku-Kahului Community Plan.

County of Maui, Maui Planning Department. The General Plan of the County of Maui. 1990 Update.

John F. Mink, Mink and Yuen, Inc., The North Waihee Aquifer: An Additional Water Source For West Maui, April 1997.

Michael T. Munekiyo Consulting, Inc., Waihee Wells and Transmission System Final Environmental Assessment, March 1994.

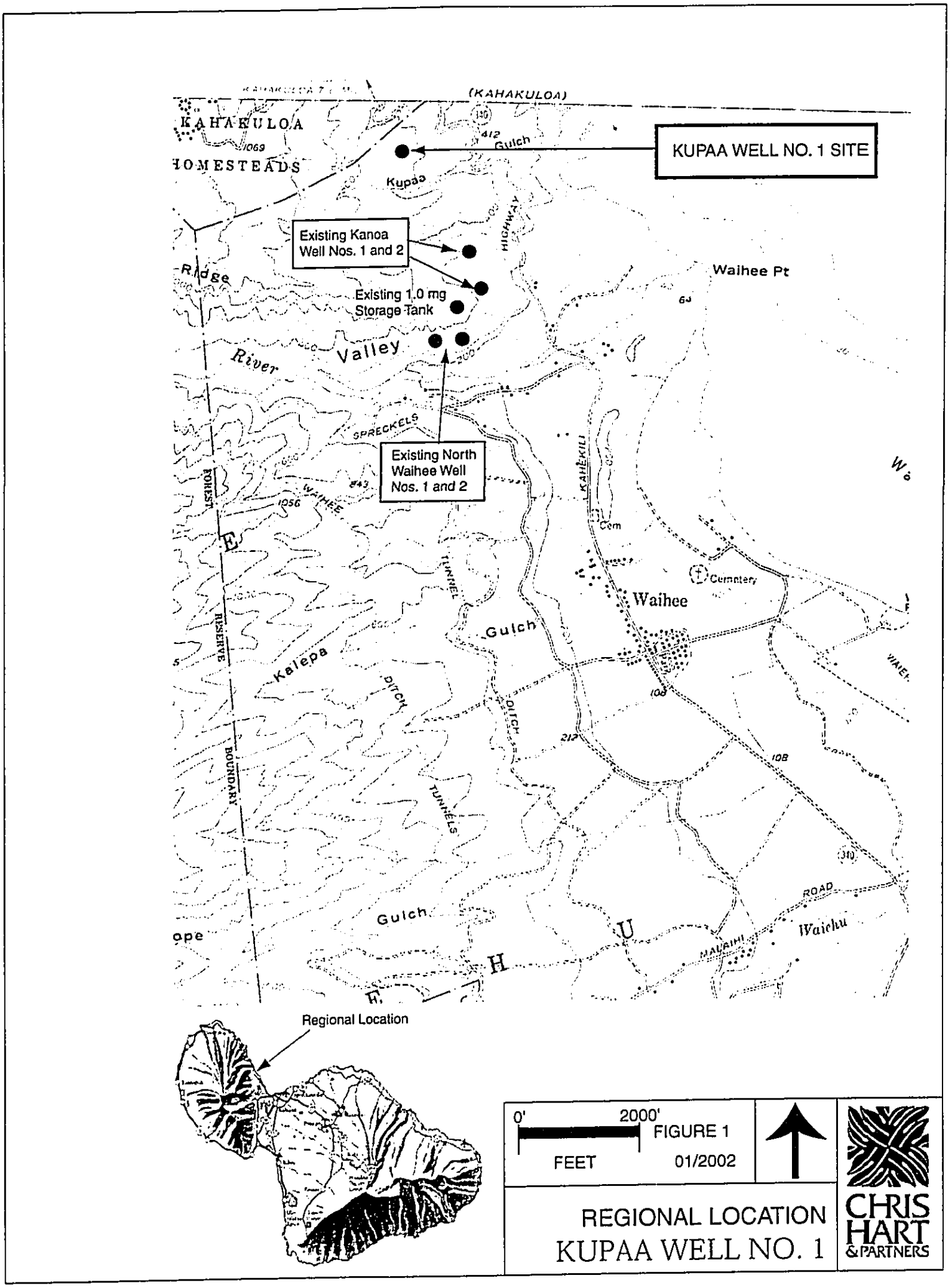
State of Hawaii, Department of Business and Economic Development, Data Book, 1990.

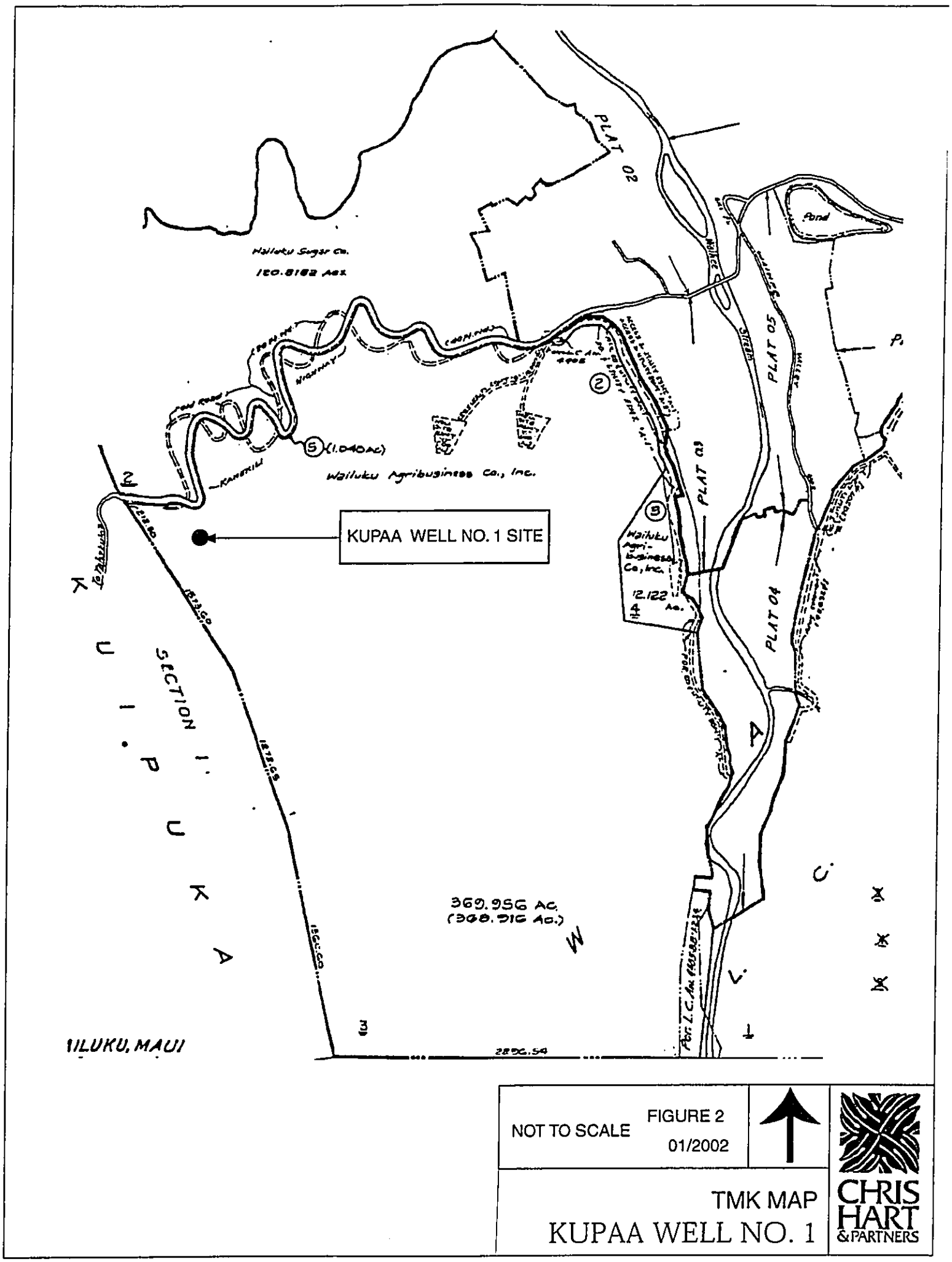
University of Hawaii, Department of Geography, Atlas of Hawaii, Second Edition, 1983.

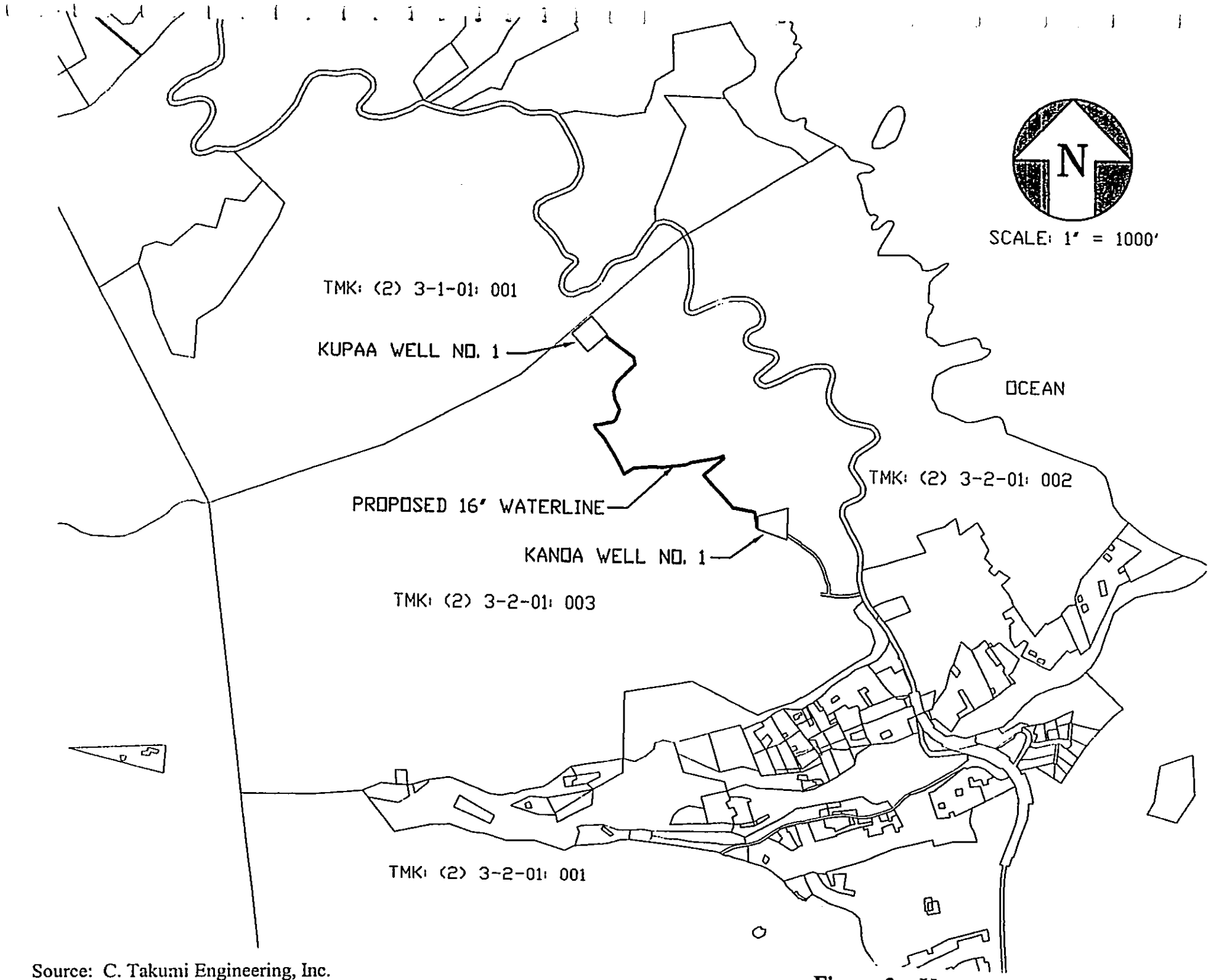
University of Hawaii, Land Study Bureau, Detailed Land Classification - Island of Maui, L.S.B. Bulletin No.7, May 1967.

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

Wilson, Okamoto and Associates, Maui Community Plan Update, Land Use Technical Study, June 1992.

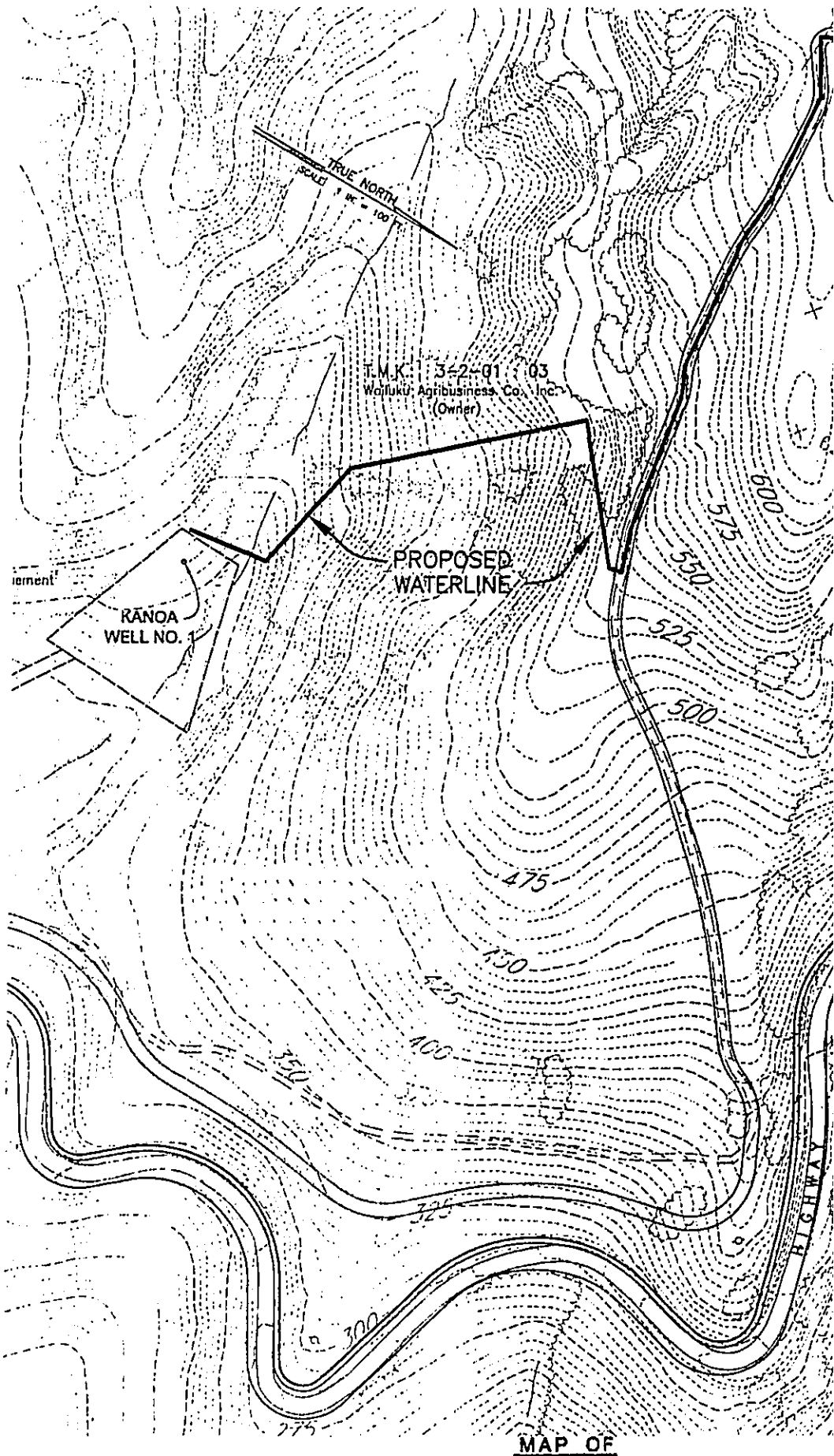






Source: C. Takumi Engineering, Inc.

Figure 3a, Kupaa Well 1 and Waterline



MAP OF
T.M.K.: 3-2-01 : 03
WAIHEE, MAUI, HAWAII
0 100 200 300 400
SCALE: 1 IN. = 100 FT.

Source: C. Takumi Engineering, Inc.

DOCUMENT CAPTURED AS RECEIVED

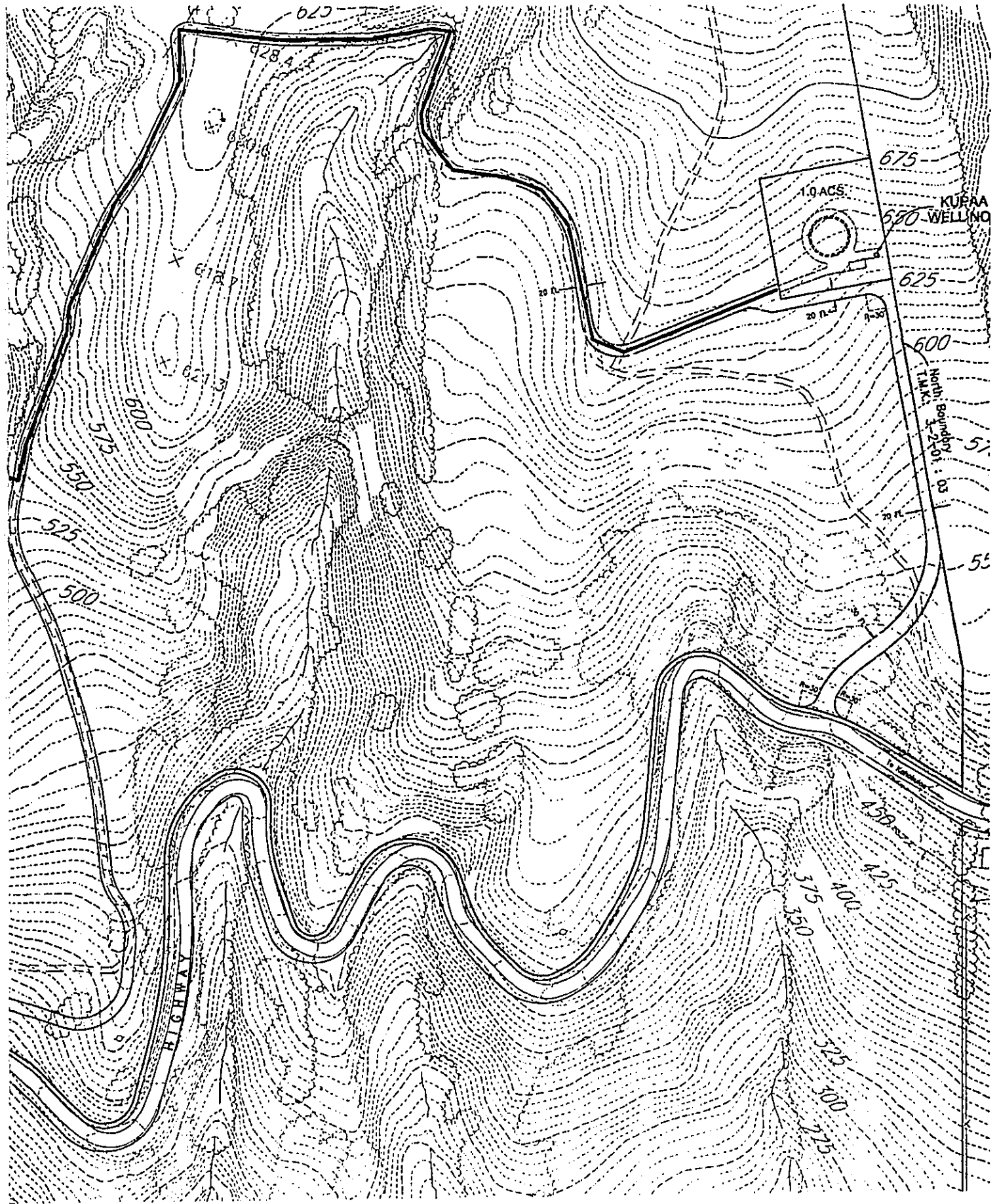
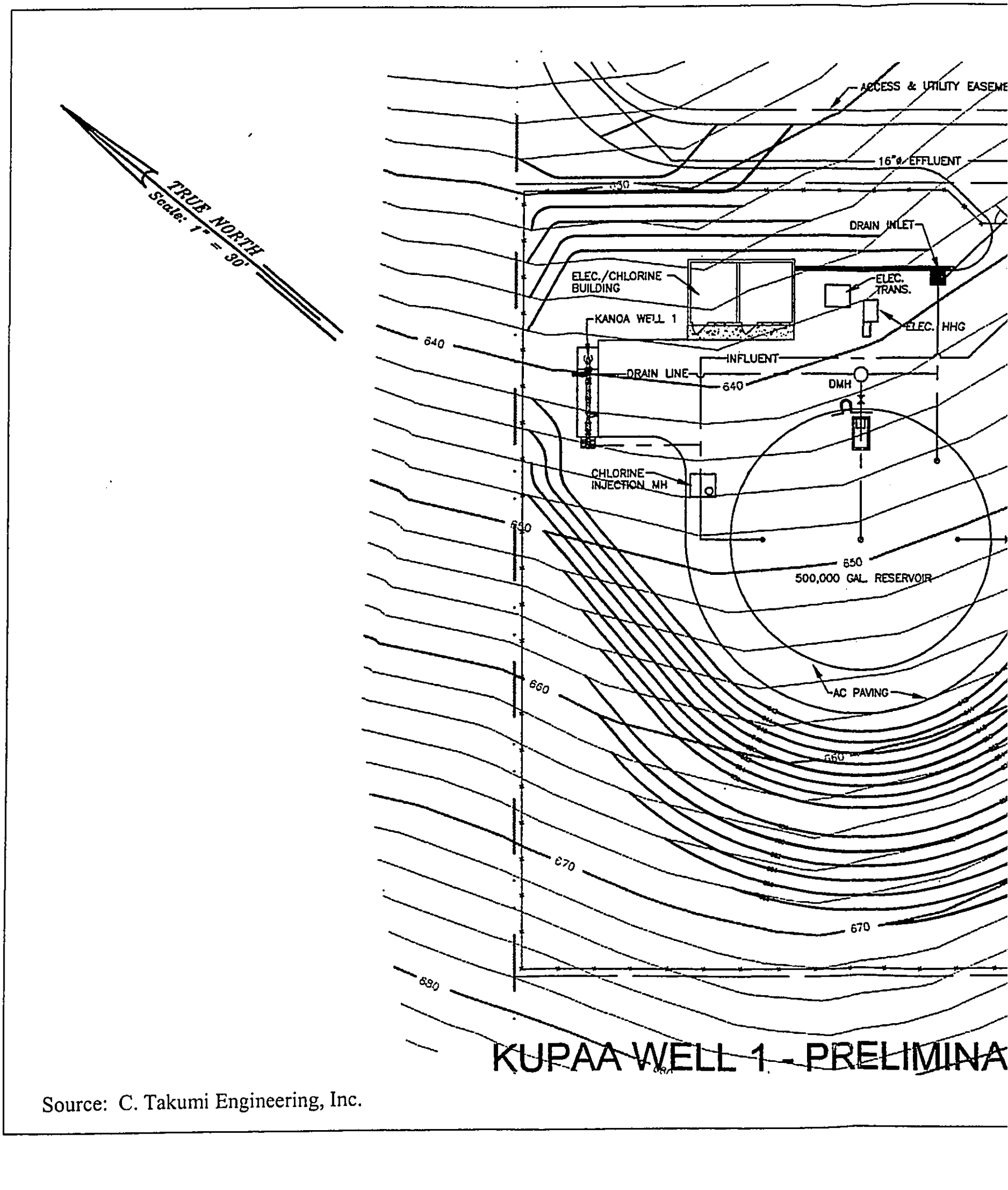


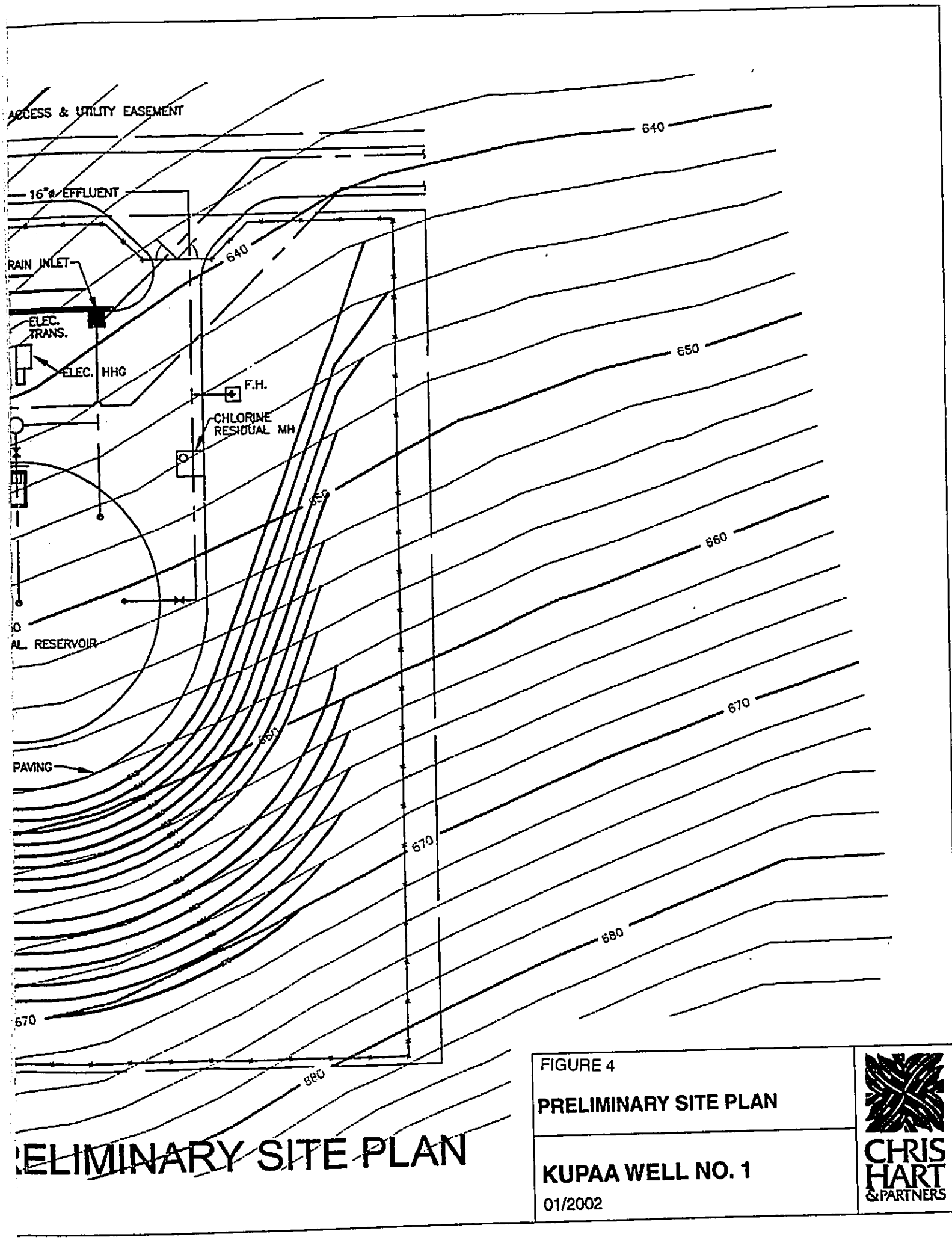
Figure 3b, Kupaa Well No. 1 and Waterline January 4, 2000

DOCUMENT CAPTURED AS RECEIVED



Source: C. Takumi Engineering, Inc.

DOCUMENT CAPTURED AS RECEIVED



PRELIMINARY SITE PLAN

FIGURE 4

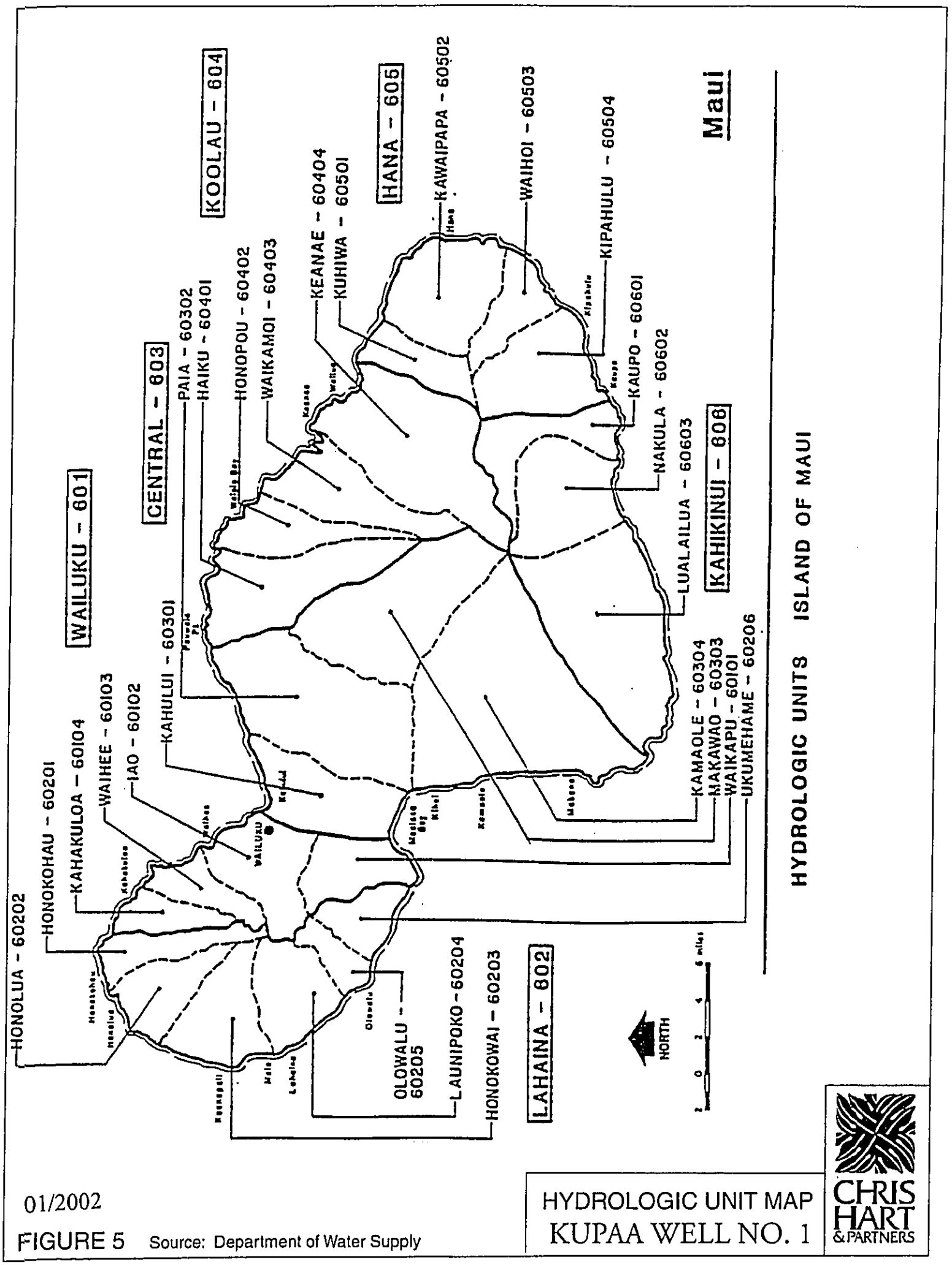
PRELIMINARY SITE PLAN

KUPAA WELL NO. 1

01/2002

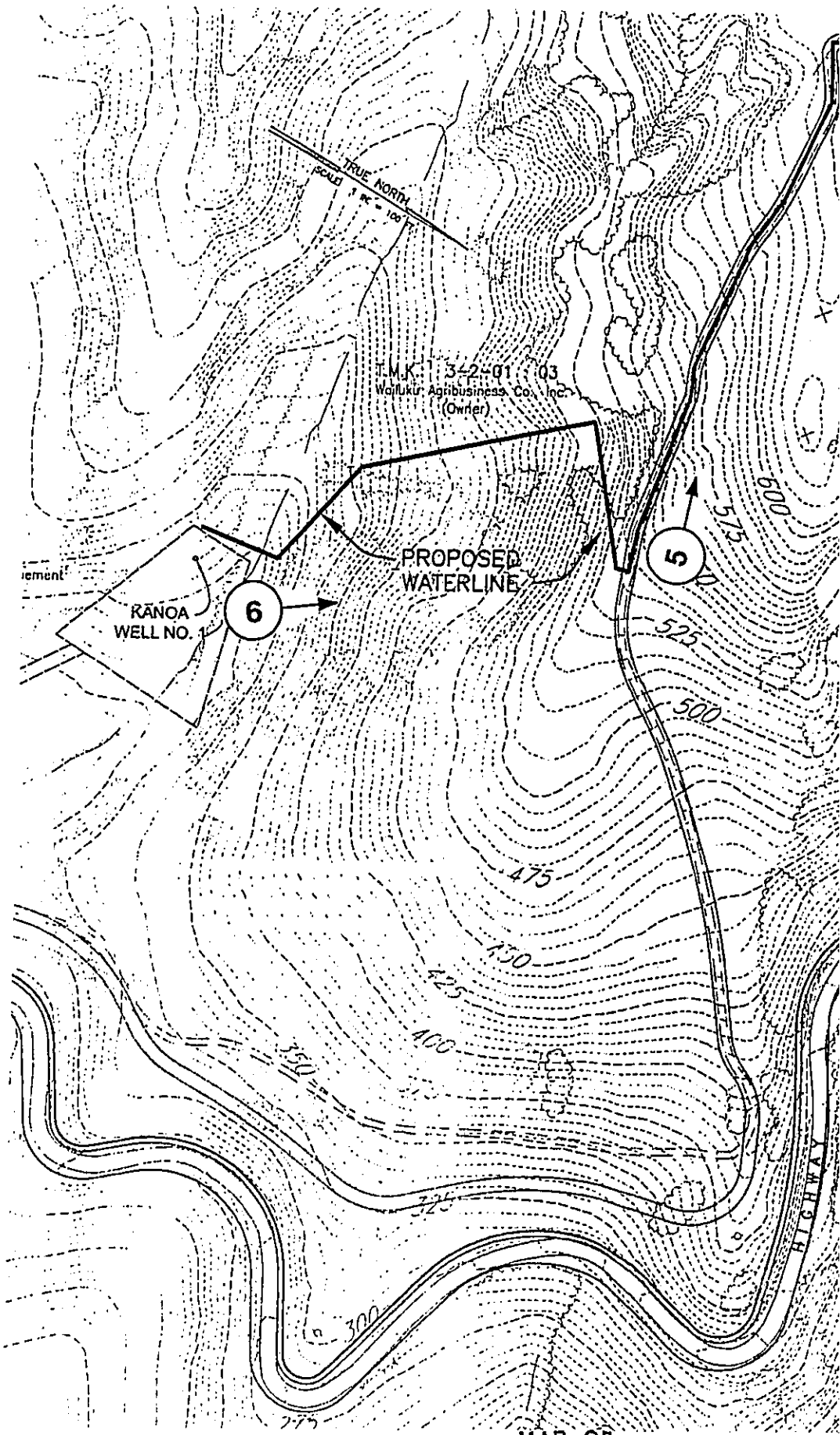
CHRIS HART & PARTNERS

DOCUMENT CAPTURED AS RECEIVED



01/2002

FIGURE 5 Source: Department of Water Supply



Source: C. Takumi Engineering, Inc.

DOCUMENT CAPTURED AS RECEIVED

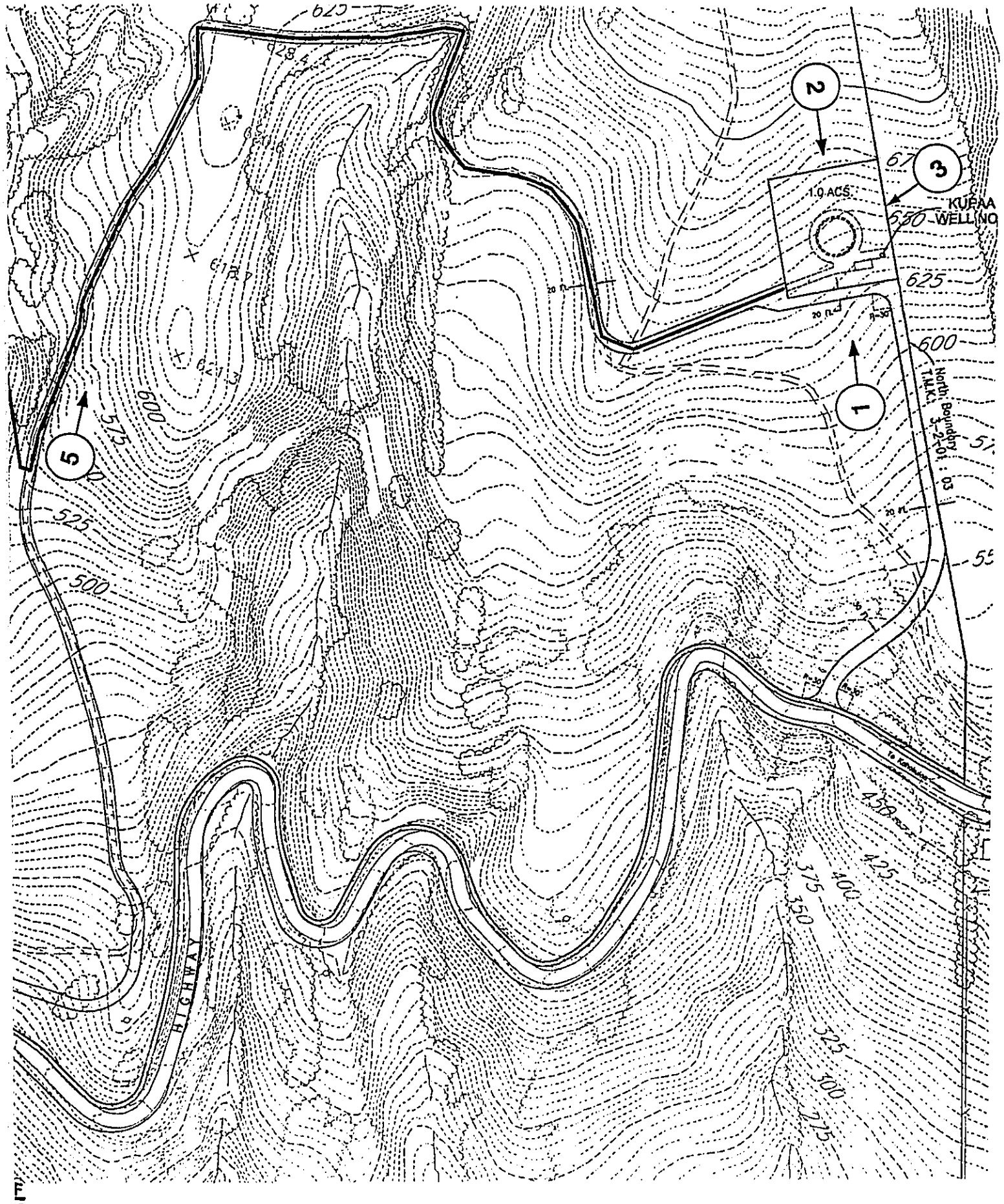
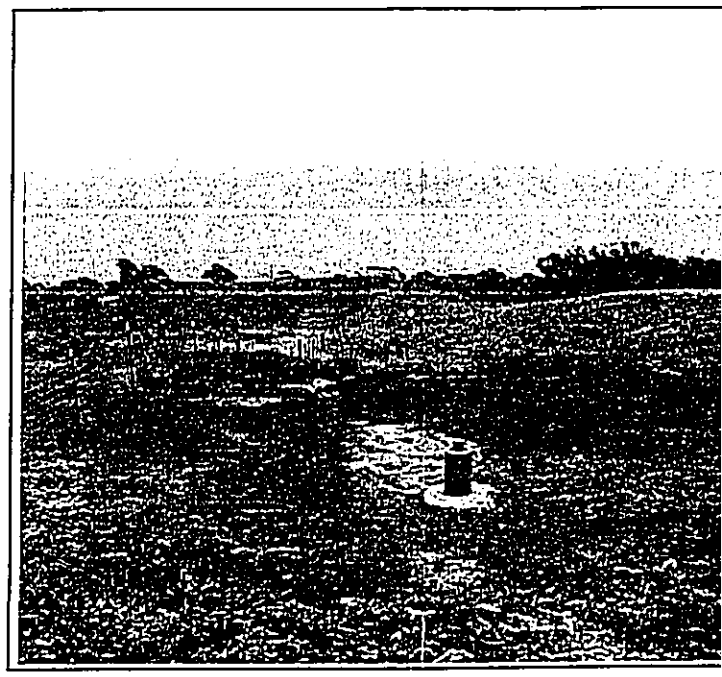


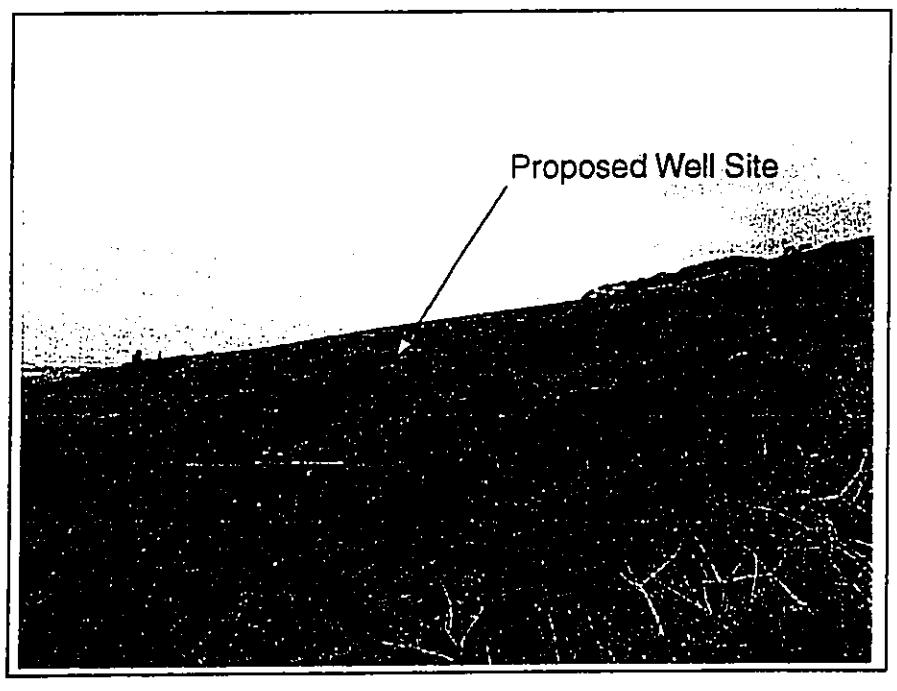
Figure 6a, Site Photo Key

January 4, 2000

1. Looking west at the Kupaa Well No. 1 site.

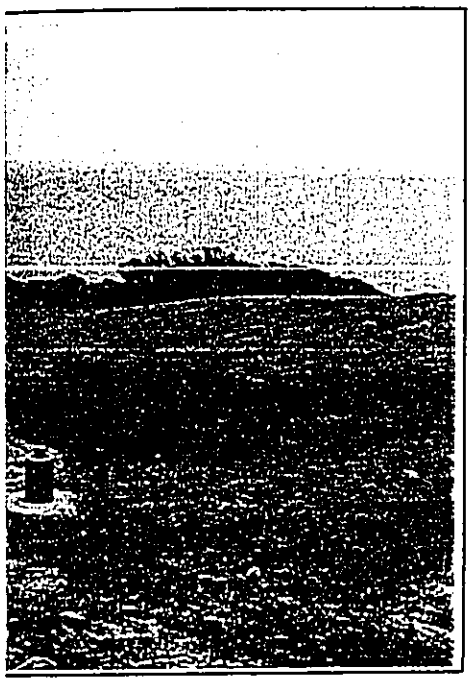


2. Looking east at the Kupaa Well No. 1 site.

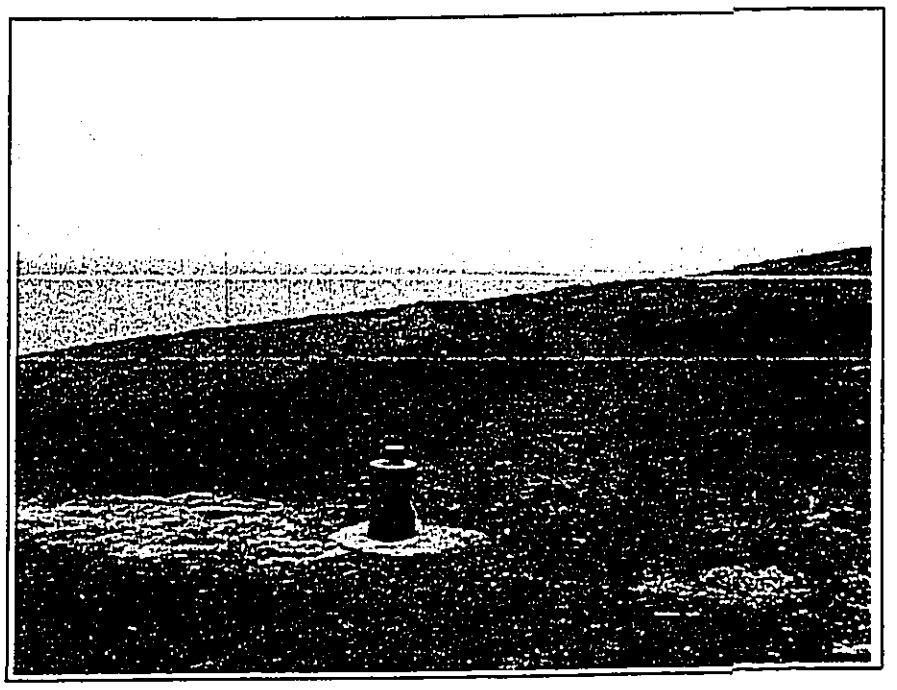


4. Looking south from Kahekili Highway at the Kupaa Well No. 1 site.

5. Looking at portion of existing dirt road where tran
will be placed.



Well No. 1 site.



3. Looking southeast at the Kupaa Well No. 1 site.

dirt road where tranmission line

6. Looking north at hill where transmission line will run down towards Kanoa Well No. 1.

FIGURE 6,b

SITE PHOTOGRAPHS

KUPAA WELL NO. 1

01/2002

CHRIS HART & PARTNERS

APPENDICES

APPENDIX – A

Archaeological Reconnaissance Surface Survey by Xamanek Researchers,
Dated March 31, 9997,

XAMANEK RESEARCHES
P.O. BOX 131
PUKALANI, MAUI, HI 96788
Phone/FAX: 572-8900

C. Takumi Engineering, Inc.
18 Central Avenue
Wailuku, HI 96793-1724
FAX: 249-0311

Attn: Carl Takumi

31 March 1997

SUBJECT: Letter report on a reconnaissance surface survey for a proposed exploratory well (Kupa'a Well No. 1) and an existing monitoring well (Kanoa Well No. 1) site in the North Waihe'e Water Source Development, Phases 6 & 7, Waihe'e, Island of Maui. (TMK: 03-02-01: 03) [Note: Proposed water transmission line easement not finalized.]

An archaeological reconnaissance surface survey was conducted for C. Takumi Engineering, Inc. by Xamanek Researches on 27 March 1997. An earlier field visit was made on 25 March 1997 with Mr. Wade Shimabukuro of C. Takumi Engineering, Inc. to view the study area. The survey was undertaken in order to assess the presence of cultural resources at 2 proposed wells (Kanoa Well No. 1 and Kupa'a Well No. 1) that will eventually feed into the North Waihe'e Water Transmission system.

The first proposed well project (Kanoa Well No. 1) will be located c. 30 to 50 m. from an existing monitoring well. The present monitoring well rests at c. 300 ft. AMSL and the proposed well will likely be situated at a higher elevation. Vegetation in the general vicinity consists of pasture grasses and annual weeds in the low lying areas with moderately dense tree growth covering the surrounding slopes. At least two native plant species observed growing on the slopes include *kukui* (Aleurites moluccana) and *'ulei* (Osteomeles anthyllidofolia). Kanoa Well No. 1 will not be placed on the slopes where 1 probable rock feature was noted within c. 100 m. of the existing monitoring well.

The second proposed well project (Kupa'a Well No. 1) will be located in a pasture likely between 630 to 640 ft. AMSL. Two possible areas were inspected (A and B) in this pasture. At location A (c. 635 ft. AMSL), the surface was vegetated with pasture grasses and alien weed species. There was no surface evidence of significant material culture remains in the immediate vicinity. However, a likely site remnant was observed c. 100 m. to the north. It consisted of stacked basalt cobbles and small boulders. A portion of it appears to have been bulldozed in the past. At location B (c. 550 ft. AMSL) the surface was also vegetated with pasture grasses and alien weed species. This second possible location (less favored than A) is near the north boundary of the parcel. A possible site remnant lies at this location. It was covered with lantana and consists of

roughly stacked rocks. Portions of this feature may have been pushed by a bulldozer. No other surface evidence of material culture remains was observed in area B.

Both of the proposed well sites are in relatively open locations. The Kanoa Well No. 1 site will be located in pasture land within 30 to 50 m. of the present monitoring well and away from thick vegetation and the 1 probable rock feature in the vicinity of the existing monitoring well. The exploratory Kupa'a Well No. 1 will likely be drilled at area A in open pasture land. Location B is less favorable and may contain a site remnant. Both Kanoa Well No. 1 and Kupa'a Well No. 1 will eventually feed into the North Waihe'e Water Transmission Line project. Kupa'a Well No. 1 will need to be tested before water transmission line design can be finalized. The following recommendations are based on the results of the reconnaissance surface survey.

Kanoa Well No. 1

1. Limited subsurface testing at the inventory level should be undertaken if the permanent well will be placed beyond the area previously cleared for the existing monitoring well.
2. Monitoring of the initial placement of the permanent Kanoa Well No. 1 should be undertaken. Care must be utilized in order to avoid the adjacent areas covered with trees. The possibility exists that 1 or more indigenous sites are contained in the densely wooded areas.

Kupa'a Well No. 1

1. Area A is the recommended location for this exploratory well. This portion of the pasture appears to have been bulldozed in the past and has a low probability of containing subsurface cultural materials. Area B may contain a site remnant.
2. Work at the inventory level is recommended for Area B if it is chosen for the exploratory well.

Future pipeline trench pathways

1. An archaeological inventory survey is recommended for future transmission lines associated with both Kanoa Well No. 1 and Kupa'a Well No. 1.

Please contact us if you have any questions about this letter report.

Sincerely,

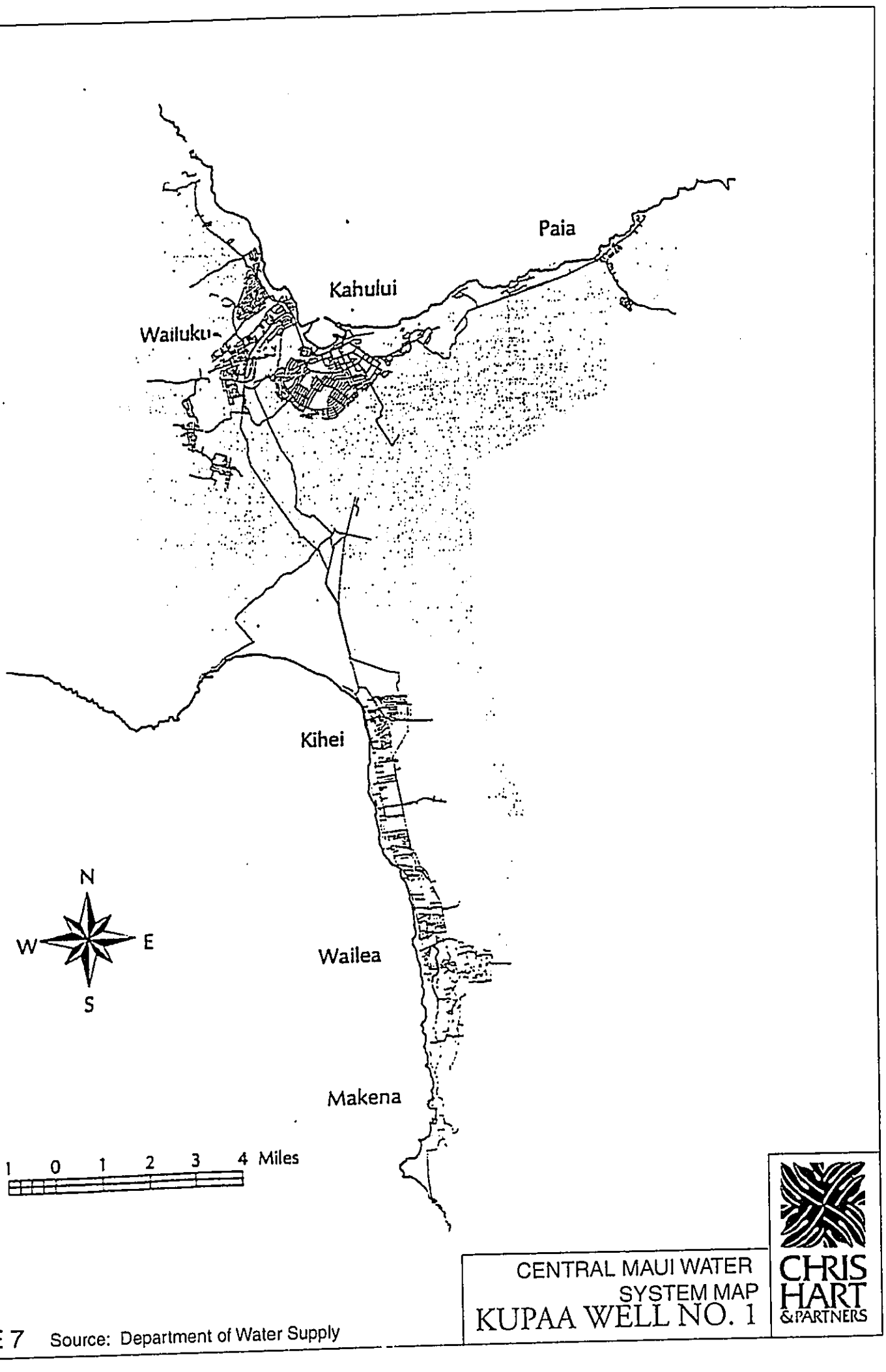
Erik Fredericksen

Erik Fredericksen

c. Sara Collins, SHPD

APPENDIX – B

Archaeological Inventory Survey for the Water Pipeline Corridor in Waihe`e Ahupua`a, Wailuku District, Island of Maui, Hawai`i by Scientific Consultant Services Dated December 2001



CENTRAL MAUI WATER SYSTEM MAP

KUPAA WELL NO. 1

CHRIS HART & PARTNERS

01/2002

FIGURE 7 Source: Department of Water Supply

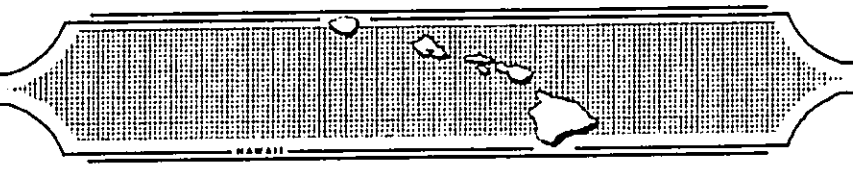
SCS Project Number 291-2

ARCHAEOLOGICAL INVENTORY SURVEY FOR THE WATER PIPELINE CORRIDOR IN WAIHE`E AHUPUA`A, WAILUKU DISTRICT, ISLAND OF MĀUI, HAWAI`I [TMK: 3-2-1:3]

Prepared by:
Irene Calis, M.A.
Revised March 2002

Prepared for:
C. Takumi Engineering, Inc.
18 Central Avenue
Wailuku, HI 96793

SCIENTIFIC CONSULTANT SERVICES Inc.



711 Kapiolani Blvd. Suite 1475 Honolulu, Hawai`i 96813

ABSTRACT

At the request of Mr. Carl Takumi with C. Takumi Engineering, Inc., Scientific Consultant Services, Inc. (SCS) conducted Archaeological Inventory Survey for a water pipeline corridor in Waihe`e Ahupua`a, Wailuku District, on the island of Māui [TMK:3-2-1:3]. The water pipeline corridor measures approximately 2800 feet and is located on the upland slopes of Waihe`e Valley. One previously unrecorded site was identified, Site 50-50-04-5179, that consisted of a remnant retaining wall built into a drainage slope. Based on architectural construction materials and general land-use patterns in the area, the site is interpreted to have functioned as a historic retaining wall built to alleviate impacts of a sloping terrain. Modification of the slope may curtail excessive alluvial deposition into the underlying drainage that could, otherwise, hinder water accessibility. We argue that sufficient archaeological work has allowed for the complete documentation of the site, and therefore, no further archaeological work is deemed necessary.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

At the request of Mr. Carl Takumi with C. Takumi Engineering, Inc., Scientific Consultant Services, Inc. (SCS) conducted Archaeological Inventory Survey for a water pipeline in the Waihe`e area. The project area is located in Waihe`e Ahupua`a, Wailuku District, on the island of Māui [TMK:3-2-1:3] (Figures 1 and 2). The water pipeline corridor measured approximately 2800feet long and extended from Kanoa Well No.1 to Kupaa Well No.1 (Figure 3).

GENERAL PROJECT AREA AND LANDFORM

Māui is the second largest island in the Hawaiian chain and is geologically composed of two volcanic mountains, Haleakalā forming east Māui and Pu`u Kukui on west Māui. Waihe`e *ahupua`a* is situated on the windward side of west side of Māui where rainfall averages 30 to 60 inches annually (Price 1983).

The west Māui mountains are cut by deep valleys that are overlapped on the east side by lava flows from Haleakalā. The largest basaltic dykes found in the islands are situated within these mountains where thin-bedded `a`a and pahoehoe erupted through narrow cracks. The mountains are largely comprised of basaltic eruptions that form the Wailuku volcanic series. The basaltic eruptions were followed by a dormant period during which layers of soil formed (Stearns 1966).

Magma of dioritic and syenitic composition erupted as quickly cooled lava from fissures and local vents, this resulting in the formation of andesite and trachyte (Chesterman 1978). A thin layer of these igneous-volcanic rocks, forming the Honolua series, almost entirely covered the surface of the west Maui mountain dome. The light color of the andesite and trachyte, produced by weathering, contrasts with the darker products of basalt decomposition (Stearns 1966).

The current project parcel is situated in the upland slopes of Waihe`e Ahupua`a, portions of which fall within an unnamed drainage north of Kupaa Gulch. The surveyed area was comprised of three distinct sections. The northern boundary of the pipeline corridor, terminating

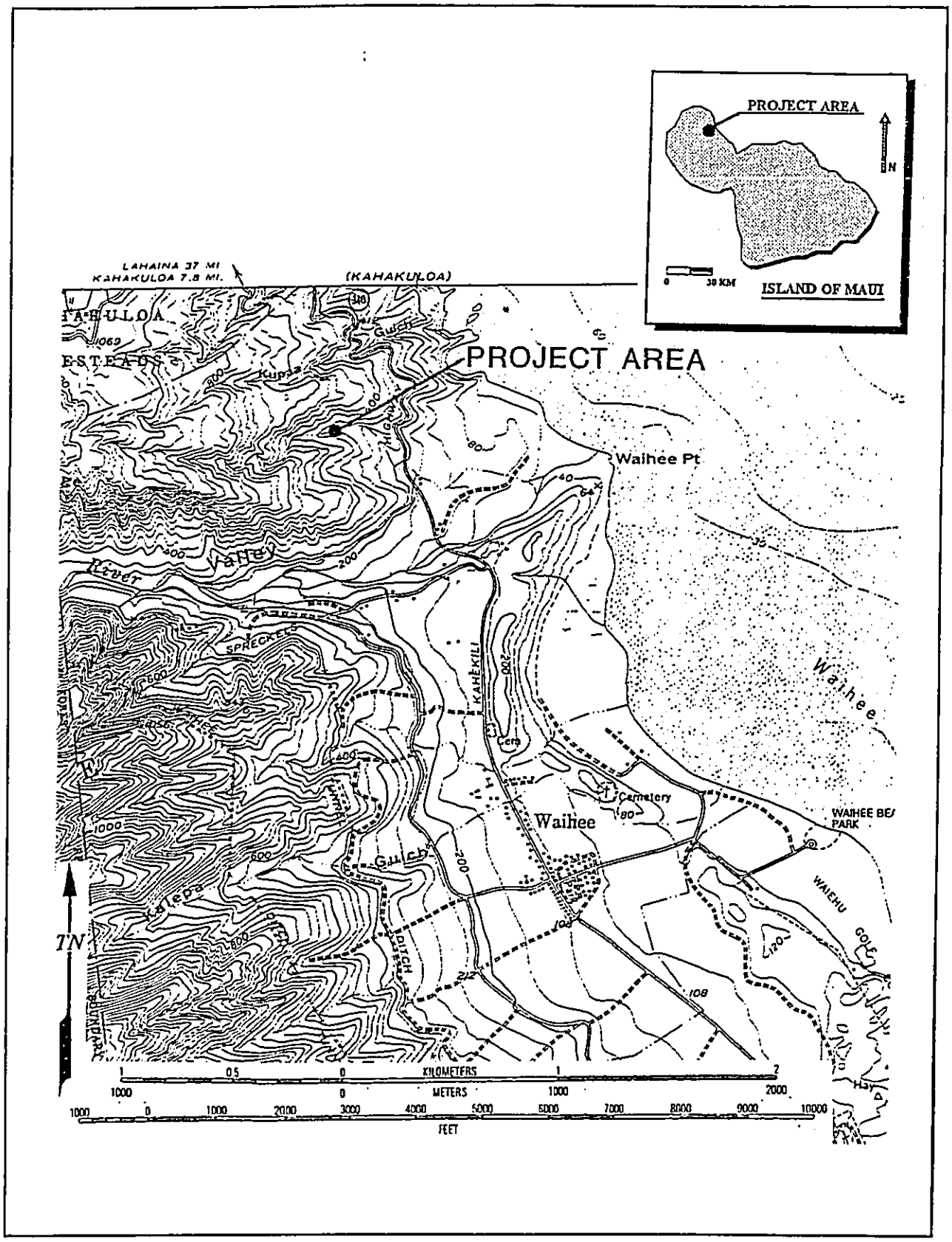


Figure 1: USGS Wailuku Quadrangle Map Showing Project Area.

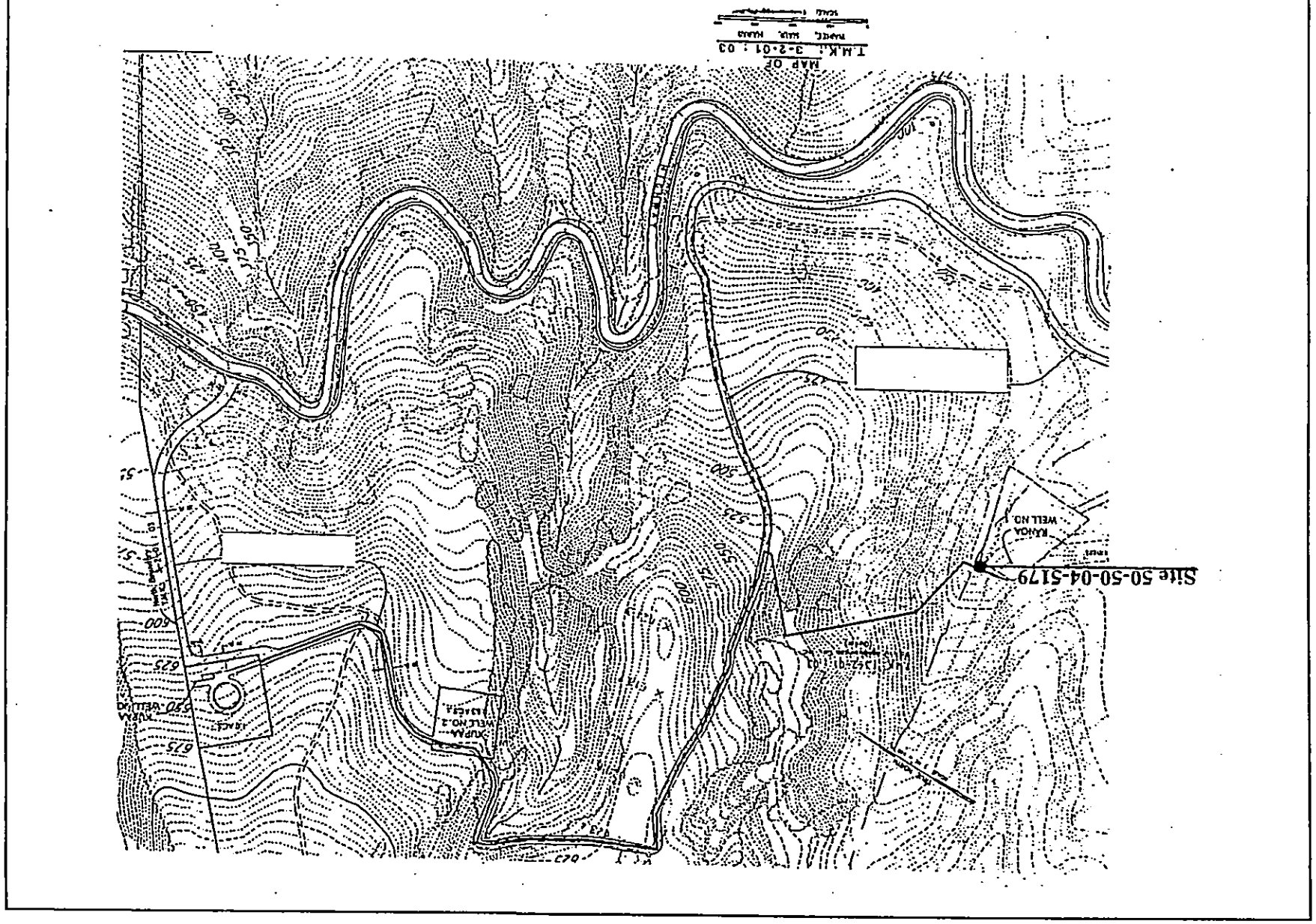


Figure 2: Topographic Map Depicting Proposed Waterline and Site 50-50-04-5179.

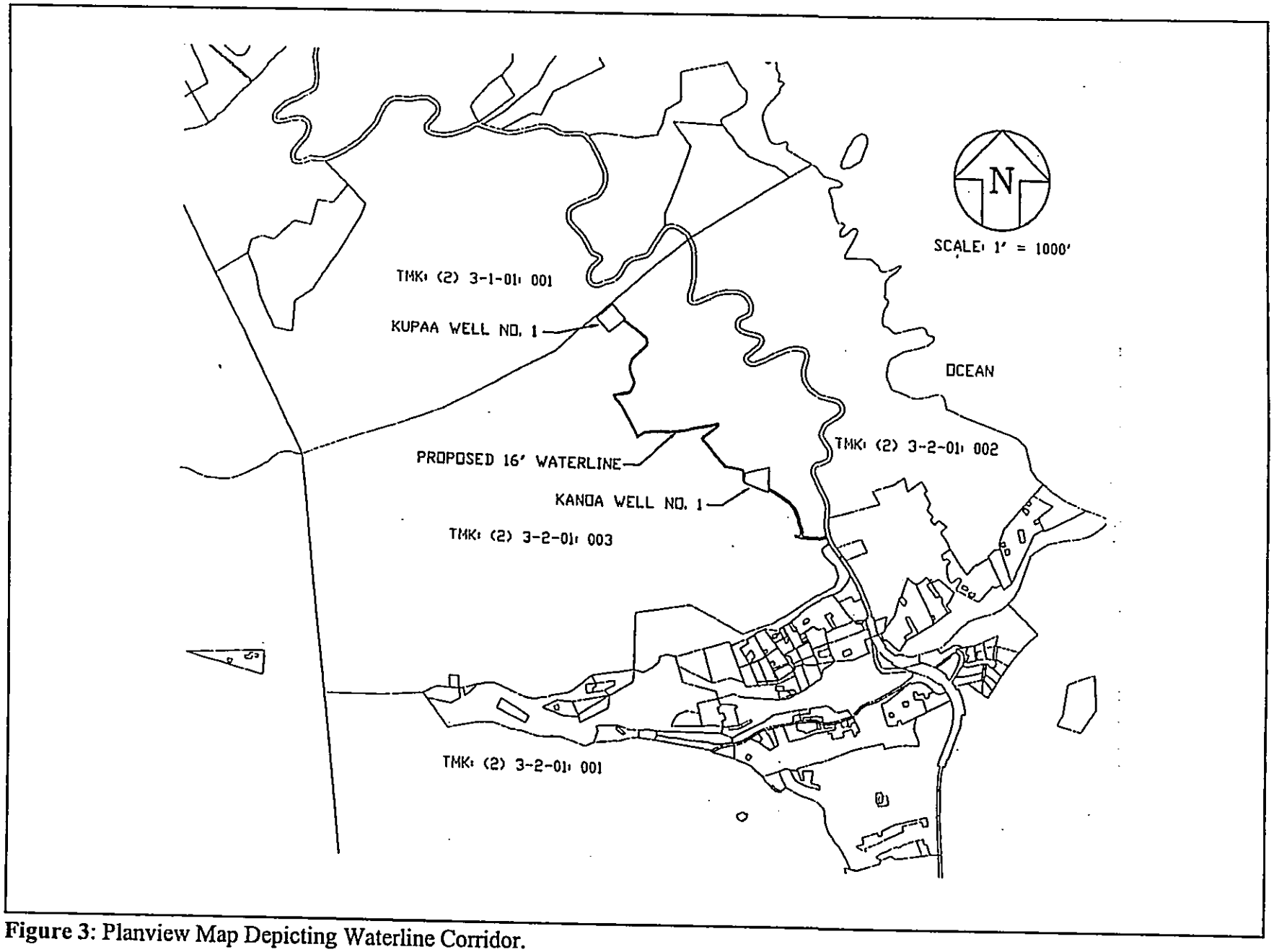


Figure 3: Planview Map Depicting Waterline Corridor.

at Kupaa Well No.1., is a cleared grassy area situated just below Kukuipuka *Heiau* (Walker's Site 27). The southern boundary of the pipeline corridor terminates at Kanoa Well No. 1. This section of the project parcel, in which Site 50-50-04-5179 was encountered, encompasses a densely forested drainage (Figure 4). The bulk of land area between these two wells has been previously disturbed by construction of an existing paved road and clearing of lands for pineapple and sugarcane cultivation.

Figure 4: General Overview of the Project Area Slope. View to Northeast.

SOILS

According to Foote *et al.* (1972:Sheet #98), soils within the project parcel consist of Wailuku cobbly silty clay (WwC) from the Wailuku series. This series consists of well-drained soils that occur as alluvial fans on the island of Māui. The soils are derived from weathered igneous rock and are characterized by 7 to 15% slopes with slow runoff and slight erosion hazard. The soils are largely used for sugarcane cultivation (Foote *et al.* 1972).

VEGETATION

Much of the forest vegetation within the project parcel has been introduced to Hawai'i since the arrival of Captain Cook in 1778. These species have largely replaced indigenous plants. *Eucalyptus camaldulensis* has been extensively planted in Hawai'i and was the

predominant tree species within the project area. Also observed was Strawberry guava (*Psidium cattleianum),* a plant that is common above 1000 feet and tends to dominate disturbed slopes, and secondary growth shrubs and post-cultivation grasses.

Polynesian-introduced Hau (*Hibiscus tiliaceus*), often found in high rainfall areas on the windward sides of the islands, was also identified. This species occurs primarily in areas of fresh groundwater and along permanent streams.

TRADITIONAL SETTING

Waihe`e Valley is one of four within the old land division of *Na Wai Eha* (The Four Waters) that drain the watershed of Pu`u Kukui. The name of the valley is associated with a number of meanings and traditional stories. One story links the name to a large *lo`i* situated by the sea, named Waihe`e, which once belonged to the *ali`i* (Handy and Handy 1972). The name is also associated with the wind in Waihe`e, the Kili`o`opu wind (meaning faint odors of the *`o`opu*) (Sterling in Cordy *et al.* 1978). The *mo`olelo* says:

> *The `o`opu fish could be eaten only by the ali`i alone when in season. If the fish were cooked in ti leaves by the commoners in the uplands, this aroma would escape through the wind to the chief's house. The commoners would then be caught and dealt severe punishment. However, if the o`opu were wrapped in `ōlena leaves when cooked, the aroma did not escape (ibid).*

The rich and fertile Waihe`e Valley and stream supported a substantial population (Cordy *et al.* 1978). *Kalo* (taro) was a food staple throughout the Hawaiian Islands and its vitality depended largely on water. Hawaiians developed extensive irrigated taro terraces (*lo`i)* and drainage systems (*`auwai)* that provided water for these terraces. Flooded *kalo* systems were fed by streams upon which all residents depended. Water utilization was regulated through time schedules ranging from a few hours to a few days. Ownership of resources as essential as water was not sustainable in a society that depended heavily on communal accessibility. The Kalae`ili`ili Battle of c. 1765 was a local uprising ignited by the unequal distribution of these agricultural and offshore marine resources by chief Keeaumoku and several Molokai`i chiefs. The local residents felt that such abundance should ensure food for everyone and consequently, the Molokai`i chiefs were driven out of Waihe`e (Kamakau 1961).

In prehistoric Hawai`i, Waihe`e to Wailuku Valley was said to be the most expansive area of continuous pond-field taro agricultural farming in the Hawaiian Islands. By 1934, "the northern and southern slopes and the mouth of Waihe`e Valley were well cultivated, about a third of the patches being used as commercial plantations, some worked by Hawaiians, some by Japanese, some by Portugese" (Handy and Handy 1972:496).

LAND TENURE

The land *tenure* system in prehistoric Hawai`i was rooted in a different epistemological framework than is understood today as land ownership. The idea of holding land was not synonymous with owning it, but was closer to a trusteeship between the *Ali`i nui* (ruling chiefs) of the island and the nature gods Lono and Kane (Handy and Handy 1972:41). Each island was divided into *moku* (districts) that were solely geographical subdivisions. The number of these *moku* depended upon the size of each island. *Moku* were partitioned into landholding units known as ahupua`a that were governed by a chief or designated *konohiki*. The ahupua`a varied in size, but ideally encompassed land from the mountain to the sea, whereby, providing the chiefs and *maka`ainana* (commoners who cultivated the land) with both terrestrial and marine resources. All from the chief to the commoner were entitled to a portion of these resources (Chinen 1958:5)

Prehistory in Hawai`i came to an end with the arrival of Captain Cook in 1778. The years to follow would drastically change the political, agricultural, and social fabric of the Hawaiian Islands. Destabalization of Hawaiian society was further intensified by the profound reformation of traditional land systems. In 1848, the *Māhele* curtailed communal access to land. The *Māhele* system led to the introduction and implementation of privatization that required both chiefs and commoners to retain private land title (Kame`eleihiwa 1992). Hawaiians, if informed of the procedures, were permitted to claim lands in which they had worked or lived.

As a result of the *Māhele,* Victoria Kamamalu was awarded the *konohiki* lands in Waihe`e (LCA 7713), within which the waterline corridor is included. Victoria Kamamalu was the daughter of Kinau, the wife of Kamehameha II. She was only 10 years old when the lands were transferred to her (Mrantz, 1982:22 in Donham 1989).

Post-contact land use of the area centered around the production of sugarcane. Sugarcane cultivation in Waihe`e Valley began in 1862 when Captain J. Hobron acquired land from T.H.

Hobron to build the Waihe'e Sugar Mill (Donham 1989). By 1865, the Waihe'e Sugar Company was producing over 700 tons of sugar and 45,000 gallons of molasses. Production continued for 29 more years (*ibid).* The Waihe'e Dairy and Farm was established in 1919 primarily to provide milk and meat for the sugar plantation workers. The Dairy was closed in 1967 (*ibid).*

As a result of growth in the sugar industry, two irrigation ditches were constructed to channel water into the plantations. In 1882, a sugar entrepreneur named Claus Spreckels began construction of the Spreckels Ditch (Cordy *et al.* 1978) that extended from Waihe'e to Kalua. The ditch measured four miles long and emptied into a reservoir of the Hawaiian Commercial and Sugar Company. In 1905, construction of the Waihe'e Ditch, to parallel Waihe'e Stream from the head of Waihe'e Valley to the Wailuku Sugar Plantation, began under the supervision of James Taylor. The ditch was completed in two years by Japanese laborers (*ibid).*

PREVIOUS ARCHAEOLOGY

One of the earliest archaeological investigations of the Waihe'e area was included in Walker's seminal work on the archaeology of Maui in 1929. Walker recorded eight *heiau* including: Ulukua (Sites 28 & 29), Koihale (Site 30), Kalaekaho'omano (Site 31), Kapokea (Site 32), Kapoho (Site 33), Kakaolika (Site 34), Pu'ukuma (Site 35), and Paulani (Site 36).

In a reconnaissance survey conducted in 1978 for a proposed hydroelectric power project in portions of Waihe'e Valley, Cordy *et al.* (1978) identified 13 sites containing over 71 features. These included four terraced platforms, two enclosures, a rock alignment, a pavement, and a number of canals and terraces (Cordy 1978). The sites were divided into two general functional categories. The first category was comprised of agricultural sites that were largely used as irrigated terraces located on stream flats and fed by *'auwai*. The second consisted of habitation sites, many of which were associated with adjacent terraces *(ibid).*

David Clark of the Catholic University of America conducted excavations in the Waihe'e Midden Site (Site 1796) located just north of Kalepa Gulch, on the shoreline (Clark and Balicki 1988). Identified features included four hearths, ash lenses and burn episodes, an *imu*, a rock alignment, and three artifacts clusters. A radiocarbon sample, recovered from over two meters below surface, yielded a date of A.D. 1010-1150 (*ibid).*

Extensive archeological work in the Waihe`e area resulted from the Waihe`e Golf Club Project. In 1989, PHRI conducted an inventory survey of the 270 acre parcel that included coastal flats and sand dunes, swampy lowlands, high inland dunes, and a broad alluvial fan. Eighty-eight sites with over 195 component features were identified. Eleven functional categories were derived from the investigations, of which 37 were habitation and 78 were associated with agriculture and water control. Four cemeteries and four isolated human graves were also encountered (Donham 1989). Subsequent inventory survey investigations (Donham, Goodfellow and Rosendahl 1992; Jensen and Boudreau 1992; Boudreau; Henry and Rosendahl 1992) were conducted that led to the identification of additional sites and burials. These investigations led to preservation of several of the sites. Due to the archaeological importance of the area, the proposed Golf Club Project was suspended.

A reconnaissance survey of the Marino property, located on the north side of Waihe`e River, was conducted in 1990 by Fredericksen and Fredericksen (1990). The survey identified several terraces in good condition of preservation and a historic house site. Additional archaeological research on the Marino property was conducted by SCS Archaeology in 1994 (Burgett and Spear 1995). By the time this inventory occurred, the previously recorded terraces and house site had been bulldozed to make a concrete roadway. However, several additional sites were recorded that included extensive areas of terraced taro pondfields and an *`auwai*. Preservation for the lower terraces and data recovery for the upper terraces was recommended.

Data Recovery excavations on the Marino property were conducted in 1995 (Burgett, McGerty and Spear 1996) during which pollen samples were taken. Pollen analysis indicated that the area was used for taro cultivation. Radiocarbon dating yielded date ranges from the mid-1600s to the late 1700s and into modern times.

Aki Sinoto Consulting conducted an Inventory Survey of a 5 mile corridor for the Waihe`e Wells Transmission Waterline Project (Sinoto *et al.* 1996). Five archaeological sites were identified. These included terraces and an artifact scatter. Construction monitoring for the waterline corridor located near the sand dunes was recommended.

Fredericksen and Fredericksen (1998) conducted an inventory survey of the North Waihe`e Water Source Project. Three sites were identified, and included one previously recorded site and two new sites. The previously recorded site, a terrace with a possible

ceremonial function, was re-interpreted to be associated with past pineapple production. The two new sites consisted of an historic gulch crossing and a historic soil retention feature. Both sites had low research potential.

ARCHAEOLOGICAL SETTLEMENT PATTERN

According to an early archaeological settlement model, initial settlement of West Maui occurred in coastal and windward areas between A.D. 300 to 600 (Kirch 1979). A radiocarbon sample from an archaeological investigation conducted by Clark in the Waihe'e area has, thus far, yielded the earliest date of A.D. 1010-1150 (Clark and Balicki 1988). Cordy *et al.* (1978) proposed a settlement model for Waihe'e Valley that is based upon the ecological and political aspects of development that are unique to each ahupua'a. The model proposes a general settlement pattern of temporary habitation and wetland agricultural activities within the upper valley areas and permanent habitation, with associated *heiau* and burials, along the lower valley slopes and along the coast. Dryland agricultural sites may more likely occur along non-valley slopes or on broad alluvial fans at the base of mountain slopes. Using dates from other Hawaiian islands, Cordy postulates that the coast and portions of Waihe'e's lower valleys were occupied between 300 and 600 A.D. (Cordy *et al. 1978*:66). According to Cordy's model, the inherent natural topographical constrictions of the narrow upper valleys were less likely to support population activities associated with permanent habitation, unlike the life-sustaining areas of the alluvial plains and marine resource accessibility along the coast.

Given the location of the current project parcel, Cordy's model would suggest that the most likely archaeological sites to be encountered would be dryland agricultural sites. Historic sites would most likely be associated with plantation agriculture or animal husbandry. As shown below, based on the present research, this model has gained some support.

METHODOLOGY

Field work for the Inventory Survey project was conducted on December 12th, 2001 by SCS archaeologists Michael Dega, PhD. (Project Director) and Irene Calis, M.A. A thorough pedestrian inspection of the pipeline corridor was undertaken in transect sweeps along the

sloping terrain. Depending on visibility within the forest vegetation, the sweeps were conducted with pedestrian spacing approximately 10 m apart. A plan view map was generated of the single archaeological site that was identified, using metric tape and a compass, and a sample profile segment of the architectural construction style was also generated. The site was documented both photographically and through detailed notes. The data generated during the Inventory Survey is being curated in the SCS laboratory, Honolulu.

FIELDWORK RESULTS

Pedestrian sweeps of the project area resulted in the identification of one previously unrecorded site, Site 50-50-04-5179, that consisted of a retaining wall segment built into the northern slope of a small drainage (see Figure 4; Figures 5, 6, and 7). The wall measured over 75 m long (east-west) by 0.6 m wide with a maximum height of 1.2 m on its exterior. The interior portion of the wall was flush with the slope, retaining a soil deposit commingled with 2-3 cm of humic debris (leaves and twigs). The eroded soil surface consisted of a gravelly dark brown to dark reddish brown silt.

The wall was constructed with large cobbles and very large boulders (several measuring almost one meter long), the latter used mainly at the base of the wall. The rock architecture was stacked four to seven courses high and was comprised of distinct igneous-volcanic rock (Figure 8). In place of the ubiquitous basalt that dominates Hawaiian archaeological construction materials, the cobble and boulder rock architecture was of locally-derived andesite.

The site occurred at the base of a slope, running parallel to an un-named drainage channel (Figure 9). The site's exposure to natural water weathering was evidenced in the soft, rounded architecture and the light color of the andesite that occurs through such decomposition. The terrain reflected a narrow, steep-sloped drainage of a non-perennial stream.

The site had been heavily impacted in several areas during erosion on the sloping terrain and in the drainage below (Figure 10). Several sections of the wall were tumbled and had collected a thick layer of alluvially-transported humic matter and sediment.

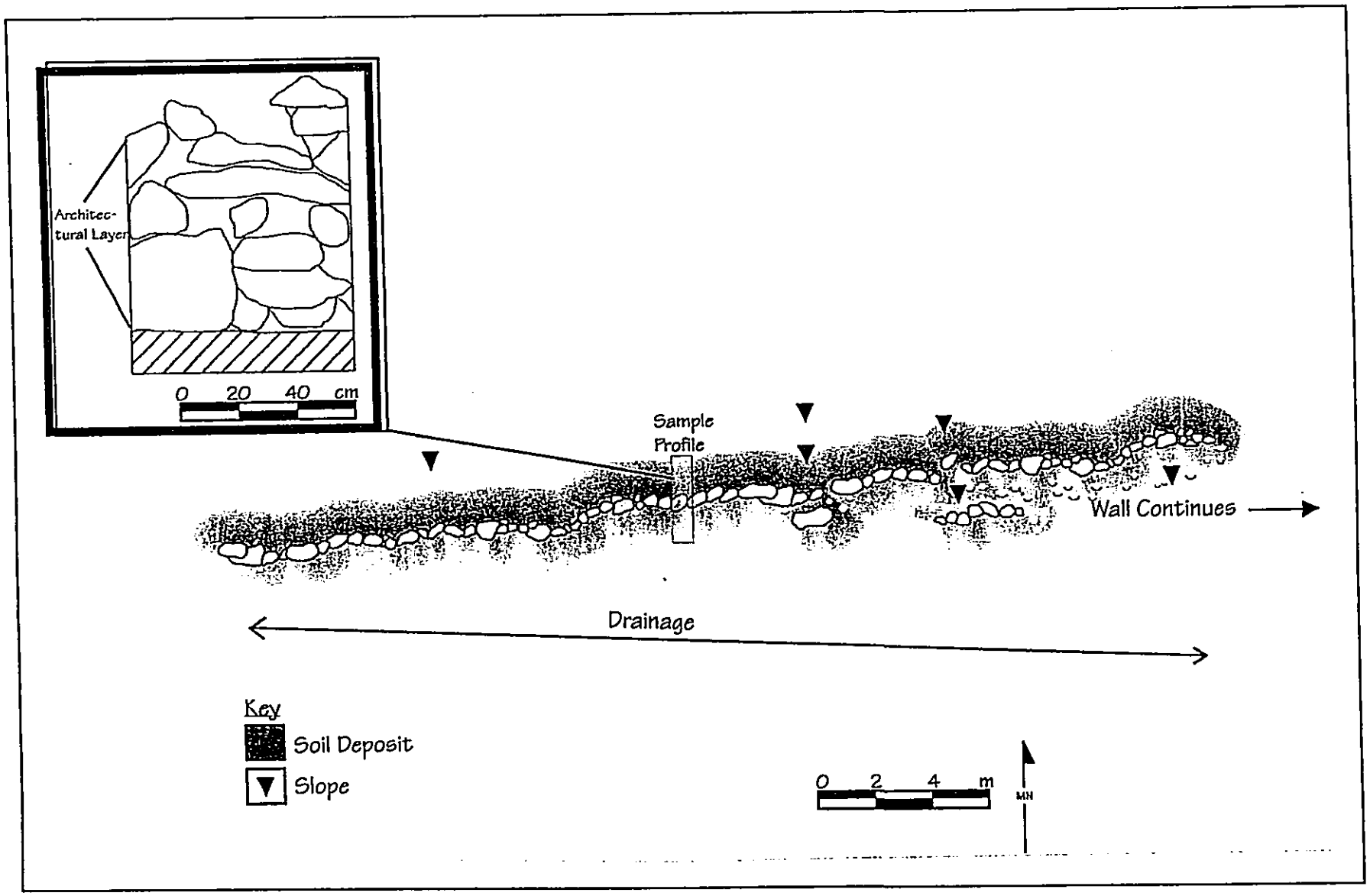


Figure 5: Planview Map and Sample Profile of Site 50-50-04-5179.

Figure 6: Intact Wall Section at Site 50-50-04-5179. View to North.

Figure 7: Intact Wall Section at Site 50-50-04-5179. View to East.

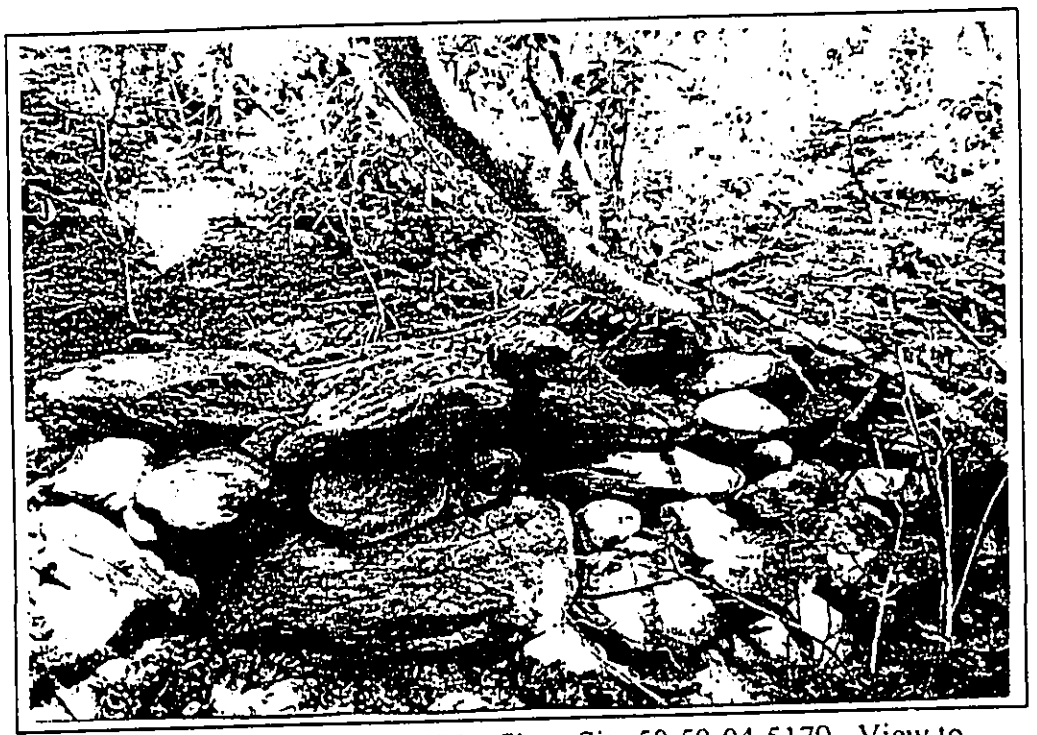


Figure 8: Western Edge of Wall Profile at Site 50-50-04-5179. View to North.

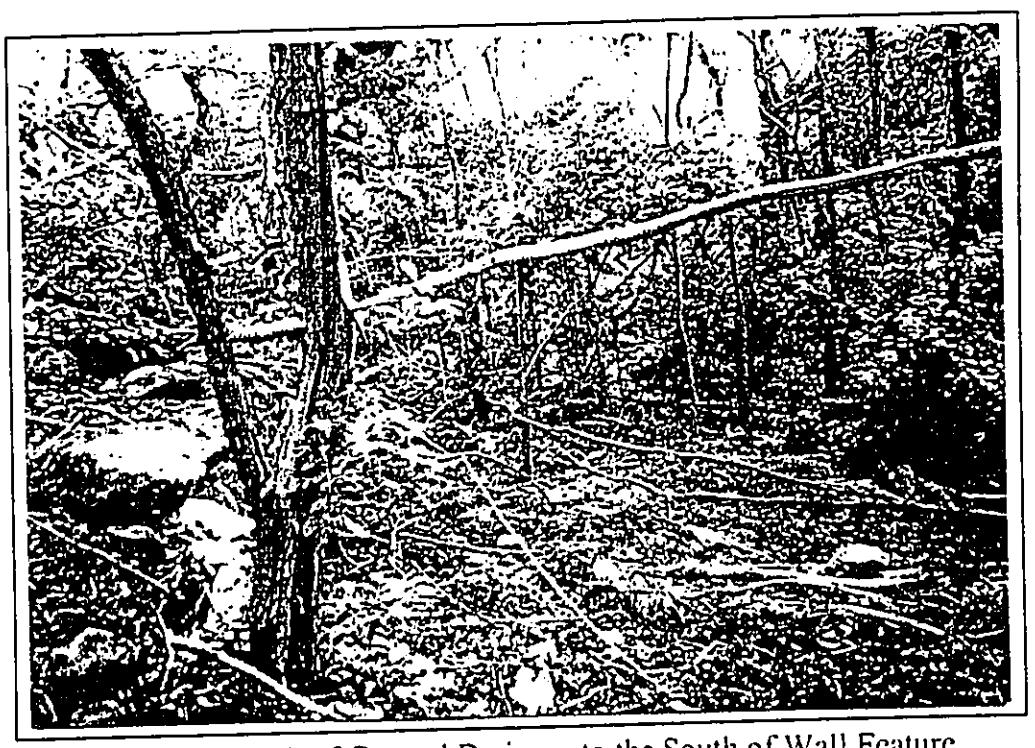


Figure 9: Photograph of General Drainage to the South of Wall Feature. View to Southeast.

Figure 10: Western Portion of a Retaining Wall. View to Northwest.

Site 50-50-04-5179 is interpreted to have functioned as a retaining wall built to alleviate impacts of a sloping terrain. Modification of the slope may curtail excessive alluvial deposition into the underlying drainage that could, otherwise, hinder water accessibility. The size of the rock architecture and construction pattern of the wall strongly suggest that the site was constructed in historic times.

DISCUSSION AND CONCLUSION

One archaeological site, Site 50-50-04-5179, was identified on the project parcel during the current Inventory Survey. No associated artifacts were encountered that may have linked the site to a general time period. Based on the architectural construction materials and general land-use patterns in the area, the wall appeared to be a historic construction that functioned as a retaining wall for both slope and drainage. No auxiliary features near the wall suggested that it was used for terracing or habitation. The degree of slope above Site 50-50-04-5179 increased dramatically with ascension. As terrain is an integral factor in site distribution, this sloped terrain

was not likely to support anthropogenic modification for habitation, agricultural or ranching activities.

SIGNIFICANCE ASSESSMENTS AND RECOMMENDATIONS

Site 50-50-04-5179 is deemed significant under Criterion "D" of the Federal and State historic preservation guidelines. The site has now yielded sufficient data through the current Inventory Survey, addressing any potential impact, and is, therefore, considered to be "no longer significant." Subsequently, no further archaeological work is recommended.

REFERENCES

Chesterman, Charles W.
1978 *The Audubon Society Field Guide to North American Rocks and Minerals.* Alfred A. Knopf, Inc. New York.

Chinen, Jon J.
1958 *The Great Māhele: Hawai`i's Land division of 1848.* University of Hawai`i Press. Honolulu.

Clark, David T. and Joseph F. Balicki
1988 *Preliminary Research Report: The Maui Archaeology Project of Waihe`e.* Department of Anthropology, The Catholic University of America, Washington, D.C.

Cordy, Ross, Marion Kelly and Clayton Hee
1978 *Cultural Reconaissance of Hydro-electric Power Plant Sites: Waihe`e Valley, Maui.* B.P. Bishop Museum, Honolulu.

Donham, Theresa K.
1989 *Archaeological Inventory Survey, Proposed Waihee Golf Club Project Area, Lands of Waihe`e and Waiehu, Wailuku District, Island of Maui.* PHRI Report 549-062589.

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stephens
1972 *Soil Survey of Kaua`i, Oahu, Maui, Molokai, and Lanai, State of Hawai`i.* United States Department of Agriculture. Soil Conservation Service.

Fredrickson, Erik M. and Demaris L. Frederickson
1998 *Archaeological Inventory Survey of Hases IV and V, North Waihe`e Water Source Project, Waihe`e Ahupua`a, Wailuku District, Maui Island (TMK: 3-2-01:por. 03).* On file, SHPD, Kapolei, HI.

Handy, E.S. Craighill and Elizabeth Green Handy
1972 *Native Planters in Old Hawai`i: Their Life, Lore, and Environment.* Bishop Museum Press. Honolulu.

Kamakau, S.
1961 *Ruling Chiefs of Hawai`i.* Kamehameha Schools Press. Honolulu.

Price, S.
1973 Climate. In *Atlas of Hawai`i,* ed. By W. Armstrong. The University Press of Hawai`i. Honolulu.

Sinoto, Aki, Bruce A. Jones, and Jeffrey Pantaleo
1996 *An Archaeological Inventory Survey for the North Waihe`e Wells Waterline Project, Waihe`e and Waiehu Ahupua`a, Wailuku District, Maui Island.* On file, SHPD, Kapolei, HI.

Stearns, Harold T.
1966 *Geology of the State of Hawai`i.* Pacific Books. California

Sterling, Elspeth P.
1998 *Sites Of Maui.* Bishop Museum Press. Honolulu.

Wagner, Warren, Derral R. Herbst and S.H. Sohmer
1990 *Manuel of the Flowering Plants of Hawai`i, Volume 1 & 2.* Bishop Museum Press. Honolulu.

Walker, W.
1931 *Archaeology of Māui.* Dept. of Anthropology. B.P. Bishop Museum.

APPENDIX – C

Preliminary Engineering Report For New Potable Water Source Kupaa Well No. 1

PRELIMINARY ENGINEERING REPORT
FOR NEW
POTABLE WATER SOURCE
KUPAA WELL NO. 1
(State Well No. 5731-03)
Waihee, Maui, Hawaii

PREPARED FOR:

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
200 S. HIGH STREET
WAILUKU, HAWAII 96793

PREPARED BY:

C. TAKUMI ENGINEERING, INC.
18 CENTRAL AVENUE
WAILUKU, HAWAII 96793

JANUARY 31, 2000

PRELIMINARY ENGINEERING REPORT
FOR NEW
POTABLE WATER SOURCE
KUPAA WELL NO. 1

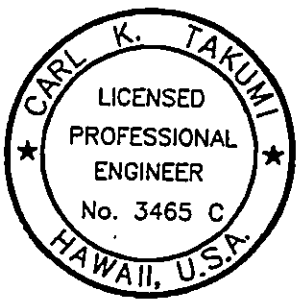
TABLE OF CONTENTS PAGE

C. Takumi Engineering, Inc.
Civil Engineering Consultants
18 Central Avenue
Wailuku, Hawaii 96793
Phone: (808) 249-0411 Fax: (808) 249-0311

The undersigned, being a licensed professional engineer, certifies that:

1. He has prepared the attached report and the information contained therein is true to the best of his information and belief; and

2. The water produced by Kupaa Well No. 1 (State Well No. 5731-03), the potable water system indentified in the attached report, will comply with the State primary potable water regulations contained in Hawaii Administrative Rule, Title 11, Chapter 20, Rules Relating to Potable Water Systems, and will comply with the Rules and Regulations of the Department of Water Supply, County of Maui, when said drinking water system is operated and maintained in accordance with the instructions and information contained in this report.



This work was prepared by
me or under my supervision.

Carl K. Takumi, P. E.
C. Takumi Engineering, Inc.

PRELIMINARY ENGINEERING REPORT
FOR NEW
POTABLE WATER SOURCE
KUPAA WELL NO. 1

1. Introduction

This Preliminary Engineering Report was prepared to conform to the provisions of Hawaii Administrative Rules, Title 11, Chapter 20, relating to new potable water source development. The rules requires all new potable water sources serving a public water system be approved by the Director of Health prior to its use.

2. General Information

a. Description of project and location, including phasing schedule, persons served by new water source and/or service connection, name and public water system number.

The Kupaa Well No. 1 (State Well No. 5731-03) project is part of the North Waihee Water Source Development Project and consists of developing a basal well located on the northern slopes of West Maui Mountains on the Island of Maui. The project consists of clearing, grubbing, grading, installation of a pump and related electrical controls, 500,000 gallon reservoir, equipment building with disinfection and electrical equipment, piping, fencing and related work.

Water from Kupaa Well No. 1 will be used to service the Department of Water Supply's Wailuku District or commonly known as the Central Maui Water System (CMWS) which provides water for the Central Maui area bounded by the communities of Paia-Kuau on the east, Kihei-Makena on the south, Maalaea on the west and Waihee on the north. The project is needed to supplement the rising demands for water in the Central Maui Region and relieve some of the stresses being made on the Iao Aquifer

The North Waihee Wells 1 and 2 (State Well No. 5631-02 & 5631-03 respectively), is also located in the Waihee Aquifer (60103) and have been placed into operation. Kanoa Well No. 1 (State Well No. 5731-02), also in the Waihee Aquifer, is in the process of being developed by the Department of Water Supply. Provisions have been made with the landowner for two future wells which may be later developed in the area.

b. **Owner and authorized representative**

The owner of the Kupaa Well No. 1 (State Well No. 5731-03) facility will be the Board of Water Supply, County of Maui. Upon completion, the Maui County Department of Water Supply (DWS) will operate and maintain the facility. The landowner is Wailuku Agribusiness, Inc. and the Board has a perpetual easement for the well and its appurtenances.

c. **Site Plan with contours and drawn to scale.**

A preliminary site grading plan with existing and proposed contours is attached. Besides the well and pump, the site will have disinfection/electrical building, 500,000 gallon reservoir for pump control/disinfection, parking, fencing and related site work.

3. **Physical and Hydrological Characteristics of Area**

a. **Location.**

The project is on the northern slopes of the West Maui Mountains north of the village of Waihee and Waihee Stream on the Island of Maui. The tax map key for the parcel is TMK (2) 3-2-1: 3. A location map is attached. Kupaa Well No. 1 is located within pasture land. The well is located on a one acre perpetual easement at approximate elevation 640 mean sea level (MSL) and approximately 4,000 feet from the ocean. The nearest residence is over a 1,000 feet north of the well.

b. **Climate.**

The site is influenced by the northeasterly trade winds as is typical of windward areas of the Hawaiian Islands. The annual rainfall at the site averages 30 to 40 inches with average temperatures in mid 60's to mid 80's range.

c. **Topography including detailed study of project site.**

A preliminary site grading plan with existing and proposed contours is attached. The site is located at about elevation 640 mean sea level (msl). The area slopes in the mauka-makai direction with slopes around 20%.

d. **Geology and foundation conditions.**

The geological profile of the area consists of alluvium at the surface above

Honolua series andesitic basalt lavas and the highly permeable Wailuku series basalts. The alluvium and andesitic lavas are fairly low permeability which suggests that wells to basal ground water would not interfere with stream flows above the low permeability layers. A foundation investigation has been performed for the 500,000 reservoir and is attached.

e. Earthquake considerations and design parameters.

According to Seismic Zone Maps in the Uniform Building Code, the island of Maui is in Zone 2B. This translates to only moderate seismic hazard. All structures will be designed accordingly. On Maui, there is no record of deep well casings being damaged by earthquakes.

f. Groundwater conditions.

The Central Maui Water System has been primarily dependent on water from the Iao Aquifer and withdrawl from the Iao Aquifer is nearing the aquifer's 20 MGD sustainable yield as set by the State Commission on Water Resource Management (CWRM). Hence, the Department of Water Supply started seeking new sources of water to meet the increasing demand. Attention was given to developing of groundwater in East Maui; however, the East Maui initiative has been delayed due to the discovery of pesticides in the wells and legal challenges, leaving the North Waihee groundwater source as the choice for timely development. The "Water Resource Protection Plan, Volume I & II," CWRM, June 1990, estimates that the sustainable yield for the Waihee Aquifer (60103) is 8 MGD.

Groundwater studies "The North Waihee Aquifer, An Additional Water Supply Source for Central Maui," Dr. John Mink, Mink and Yuen, Inc. dated April 10, 1997 provides initial studies for the project. Since information on the aquifer and other groundwater conditions is limited in the area, this project will help with the accumulation of data on the North Waihee Aquifer. In summary, the report states that the North Waihee Aquifer is a adjacent and hydraulically connected to the Iao Aquifer; however, the lack of response in the test holes within the Iao Aquifer during test pumping of the North Waihee Wells suggests that the Waihee Aquifer is quasi-independent aquifer. The estimated sustainable yield of the Waihee Aquifer is 8 MGD. The North Waihee Wells has a pumping capacity of 1.5 MGD for each well but it is anticipated that the pumps will not run simultaneously nor run continuously except under emergency conditions. The Kupaa Well is the northern most of the five planned well fields and will aid in determining the extent of the aquifer, better quantify the aquifer sustainable yield and generally provide better information of

the Waihee Aquifer for future development potential including the development of Well Field 3 (Kanoa Well No. 2) and Well Field 4 (Kupaa Well No. 2).

g. Flood problems including tsunami inundation zones and preventive measures that may be used.

The elevation of the site makes it obvious that the site is not located within any tsunami inundation zone. According to the Federal Emergency Management Agency (FEMA) Flood Zone maps, the site is in an area of minimal flooding (zone c). A Drainage and Erosion Control Plan conforming to the Maui County Grading Permit requirements will be prepared to mitigate local flooding prior to beginning the well development project. The development of the site should have no significant impact of its surroundings.

h. Information confirming the conformance with local land use planning and zoning regulations.

The site is located within an area designated as "Agricultural" by the State Land Use Commission. The Maui County Wailuku-Kahului Community Plan designates the project site as within "Agricultural" land use. The proposed project is considered as a minor utility facility and a permitted use within the "Agricultural" designation.

i. Discussion of water rights and future uses by others.

The wells within the Waihee Aquifer on record with the CWRM are as follows:

State Well No.	Well Name
5631-02	North Waihe'e Well 1 (DWS)
5631-03	North Waihe'e Well 2 (DWS)
5631-04	Marino Well A (Private)
5631-05	Marino Well B (Private)
5731-01	Mendes Well (Private)
5731-02	Kanoa Well 1 (Under construction)
5731-03	Kupa'a Well 1 (Project well)
5832-01	Unknown
5832-02	Kahakuloa Acres (Private)
5832-03	Kahakuloa Acres (Wailena) (Private)

The Board of Water Supply, by agreement with Wailuku Agribusiness Co., Inc. has perpetual easements for the development of 5 well fields within Wailuku Agribusiness Company properties between Waihee Stream and Kupaa Gulch. North Waihe'e Well 1 & 2 (5631-02 & 5631-03) is in well field one; well field three is the Kanoa Well No. 1 (5731-02) presently under construction; this project, the Kupa'a Well No. 1 (5731-03) is located in well field five. The DWS has received a well drilling permit for Kanoa Well No. 2 (5731-04) which will be located in well field 2. The DWS can potentially develop one additional wells (well field 4); however, future well development will require well drilling and pump installation permits from the CWRM and analysis of pump test results. The CWRM has received no new well applications for wells in this aquifer.

4. Extent of Water Works System.

a. Description of the nature and extent of the existing area and future *area to be served.*

The North Waihee Water Source Development project will be used to service the Maui County Department of Water Supply's Wailuku District Water System which serves the eastern slopes of the West Maui Mountains, the central isthmus of Maui, and the lower western slopes of Haleakala. The water system service area is bounded by Paia/Kuau to the east, Kihei/Makena to the south, Maalaea on the west and Waihee on the north and includes the communities of Wailuku/Kahului, Waikapu, Maalaea, Kihei/Makena, Waiehu, Waihee, Spreckelsville, Paia/Kuau, Kihei, Maalaea and Puunene. The water system service area is shown in the attached figure.

Upon completion of the proposed improvements, the well will be connected to an existing nearby water transmission line at the North Waihee Wells source which is already serving the Central Maui Water System.

b. Description of population served, land use and consumption data including forecasting the water demands.

The Central Maui area varies in land use, population and services. The Kahului-Wailuku communities serves as the business-industrial hub and the population center of the island with Kahului Airport and Kahului Harbor as the main transportation centers for traveling off the island and importing and exporting goods and produce. Wailuku is also the governmental center of Maui. Destination resorts of Wailea and Makena are also served

by the Central Maui Water System. Paia-Kuau present a more residential setting with small stores serving the community and limited tourist activity. The Maui County Water Use and Development Plan, 1992, estimates that residential consumption for Wailuku to be about 52%, compared to Kihei at 72% and Kahului at 48%.

Anticipated water demand from the Maui County Water Use and Development Plan (Water Use and Development Plan), 1992, estimates that the future demand within the Central Maui Water System to range between 25 million gallons per day (mgd) to 30 mgd depending upon the method of forecast used. The "Historical Trend" used in the Water Use and Development Plan uses a linear extrapolation of 0.5 mgd/year with a forecasted water use of 17.1 mgd in 1995. The 1995 water consumption reported in the Annual Report for Fiscal Years 1994, 1995, Board of Water Supply, County of Maui for the Wailuku District averaged nearly 18.7 mgd or a 8.5% deviation.

Using the linear extrapolation of 0.5 mgd/year, the estimated water use in 1997 is 18.1 mgd. Comparatively, the water consumption reported by the Annual Report for Fiscal Year 1997, Board of Water Supply, County of Maui, averaged 19.3 MGD or a 6.6% deviation and a 2 year increase in water demand of 0.6 MGD.

c. Appraisal of the future requirements for service, including existing and potential industrial, commercial, institutional and other water supply needs.

The future requirements of service as forecasted above is based upon a mix of residential, commercial, institutional and other needs of the community as development occurs. The Community Plans for the Kihei-Makena, Wailuku-Kahului, and Paia-Haiku are the primary planning documents adopted by the County to assess and zone potential growth areas within the Central Maui Water System. The Department of Water Supply is charged with the responsibility of providing a sufficient water supply for the area. Potential growth and future requirements may vary due to changes in the Community Plans, economy, and population changes. As stated previously, the Department of Water Supply uses a linear demand model based upon historical experience for predicting future water demand. The model includes potential residential, industrial, commercial, institutional and other water supply needs.

Water withdrawl from the Iao Aquifer is nearing the sustainable yield and the Department have embarked upon developing the North Waihee

Aquifer not only for future anticipated water demand but to reduce the stress being placed upon the Iao Aquifer.

d. Provisions for extending water works system to include consideration of additional area required, easements, and right-of-way acquisition for facilities and utilities.

A 16-inch transmission waterline is planned to be constructed as part of this project to connect to an existing 24-inch transmission waterline approximately 3,000 feet from the well site.

As mentioned previously, the Maui County Board of Water Supply has secured easements from Wailuku Agribusiness Company, Inc. for the development of five well fields. The North Waihee Wells No. 1 & 2 have been placed into service (well field #1). The Kupaa Well (well field #5) is at the northern limit of Wailuku Agribusiness Company, Inc. property and the Board of Water Supply is in the process of obtaining the final metes and bounds location of this well field, along with appropriate easements for the transmission waterline needed to connect this well site to the Central Maui Water System.

e. Required capacity to meet fire protection and pressure requirements.

The DWS generally plans reservoirs within the local service area to provide fire protection and assure adequate pressure for it users. A 500,000 gallon reservoir is planned at the Kupaa Well site as part of this project. The reservoir will act primarily as a control reservoir and disinfection purposes; however, the reservoir will also add to the available storage for fire protection and to maintain adequate water system pressures.

f. Alternative solutions considered and supporting data for recommended plan.

Approximately 90% of the water used to serve the Central Maui Water System comes from the Iao Aquifer. Since the Iao Aquifer is close to being pumped to its sustainable yield, the DWS began pumping from the North Waihee Aquifer. Two wells have been placed on line within the water system. The third well, Kanoa Well No. 1, (State Well No. 5731-02) is presently being developed into a production well. Kanoa Well No. 2 (5731-04) is in the drilling and well testing phase. If successful, the Kanoa Well No. 2 will be placed into production. The Kupaa Well has been tested; the next phase will be to place the well into production.

The Kupaa Well and the Kanoa Well will reduce DWS dependence on the Iao Aquifer and the possibility of over pumping the Iao Aquifer.

The East Maui Development Plan prepared by the DWS planned for additional sources from east Maui. Two wells in the Hamakuapoko area have been drilled; however, the East Maui Development Plan has been held up until an Environmental Impact Statement can be finalized. It may be several years before any East Maui Sources can be utilized for Central Maui.

g. Environmental and economic impact.

The land is presently undeveloped and used as range land. Environmental impacts once the facility is in place should not be significant. An environmental assessment (EA) was prepared for the project prior to drilling the exploratory well. A finding of no significant impact (FONSI) was published in the OEQC bulletin on June 23, 1997. A copy of the OEQC Bulletin is attached as an Exhibit D. Another Environmental Assessment is being processed for the development of the Kupaa Well. The development of the Kupaa Well will relieve the stress being placed upon the Iao Aquifer and provide an adequate water supply for the growth anticipated in the County Community Plans. The project is not being completed to encourage any special development nor any single developer. This will enable the Department of Water Supply to continue to provide water to its consumers without restriction.

The short term economic impacts of the project by itself creates construction jobs. The monies will come from the Board of Water Supply. The long term economic impacts of the project will mean continuous maintenance, electrical and the purchase of disinfectants.

5. Potential Sources of Contamination.

a. Description of well site:

1) coordinates (latitude, longtitude), State Well No., and Tax Map Key Number.

Latitude: 20° 57' 24"
Longitude: 156°31' 37"
State Well No. 5731-03
Tax Map Key: (2) 3-2-1: 0.3

2) **land surface elevation, topographic map of well site.**

A preliminary site plan and topographic map of the well site is attached. The ground elevation at the well is approximately 640 feet MSL.

3) **Size and topography of catchment area, slope of ground surface.**

The "Water Resources Protection Plan," Commission on Water Resource Managment, Department of Land and Natural Resources, State of Hawaii, June 1990, reports that the aquifer catchment area is approximately 12.87 square miles. Elevation ranges from sea level to elevation 4,480 at Eke Crater over a distance of approximately 24,000 feet from the ocean to the top of the crater. This equates to an average overall slope of 18%.

4) **general summary of soil and substrata.**

"The North Waihee Aquifer, An Additional Water Supply for Central Maui," Mink & Yuen, April 10, 1997 was initially prepared for this project; the report is attached as Exhibit A. The report also provides insight as to the soil and substrata and the initial design criteria for the well.

The "North Waihee Aquifer System, Kupaa 1 and Kanoa 1 Wells Test Results and Interpretation," John F. Mink, Mink & Yuen, June 2, 1999 presents soil data encountered during the drilling Kupaa 1 Well. The report is attached as Exhibit A-1.

5) **anticipated well depth and depth of groundwater.**

The well has been drilled 685 feet below ground surface or about 47 feet below mean sea level (MSL). The water surface elevation of the basal aquifer encountered is at elevation 7.8 feet MSL.

b. **Design well draft.**

The design well draft is 1,200 gpm.

c. **Water quality data on any existing wells in the area.**

Water quality data was taken at North Waihee Well 2 (State Well No.

5631-03) and the results of the analysis is attached as Exhibit B-1. The North Waihee Well 2 is also in the same basal aquifer as the Kupaa Well. A water quality sample was taken during the well testing of the Kanoa Well No. 1 (State Well No. 5731-02) and is attached as Exhibit B-2. The water quality analysis for the sample taken during this well test is attached as Exhibit B-3.

d. Land use classification of surrounding area.

Land Use Classification of the surrounding area is Agricultural

e. Existing or potential sources of contamination in recharge area:

1) extent of recharge area likely to contribute water to source including population.
2) type of contaminants.
3) distance to proposed well.
4) method of disposal, i.e. surface, subsurface - above groundwater table, subsurface - in groundwater table.
5) depth from base on contaminant source to groundwater table including but not limited to urban development, agricultural areas, pasture lands, feedlots, sanitary landfills, dumps, subsurface disposal units.

The recharge area estimated for the Waihee Aquifer is about 12 square miles. Located between the Waihee and Kahakuloa Valleys. The well is located within an agricultural zoned area. The area is relatively undeveloped and is used as rangeland; no known pesticides have been used on the property for decades. There is no public (County) wastewater system servicing the area and existing residences are serviced by individual waster water disposal systems. The nearest existing residence is located more than 1,000 feet northeast (makai) of the well. Forest reserve lands are approximately 2,000 feet southwest (mauka) of the site. The State of Hawaii owns lands north of the site which is presently being leased by the Maui County Council of the Boy Scouts of America as part of Camp Maluhia. Camp Maluhia is approximately 2,000 north of the project.

The Kupaa Well is located in a recharge area composed of conservation and agricultural lands and away from dense populated areas, potential for contamination from external sources appears unlikely. The agricultural zoned areas will allow for limited residences to be built. However, no development can occur in the conservation zoned forest reserve area with out proper permits and authorizations. The geology of the area, consisting

of a thick andesite layer makes potential for contamination unlikely from sources makai of the well.

Presently, there are no known sources of agricultural and industrial pollutant sources in the area that would affect the source. The area is being used as rangeland and has been for a very long time. The agricultural/conservation zoning within the recharge area limits land use and population. There are no feedlots, sanitary landfills or public dumps within the aquifer recharge area. Wastewater disposal for the few residences are limited to individual wastewater disposal units.

f. Approximate groundwater contour.

"North Waihee Aquifer System, Kupaa 1 and Kanoa 1 Wells Test Results and Interpretation," prepated by John F. Mink, Mink & Yuen, Inc., June 21, 1999 provides well data, pump test results, estimated ground water contours and transmissivity of the aquifer. The report is attached as Exhibit A-1.

6. Sources of Water Supply.

a. Nature of soil and stratum within and overlaying the water source, with special emphasis on identification of fissures and faults as it relates to the natural purification or treatment of percolating fluids from existing or future activities.

Discussed previously.

b. The probability and effect of surface drainage or contaminated underground water entering the subject water source.

Discussed previously.

c. Depth to water table, laction and description of wells in vicinity in use and/or abandoned.

Discussed previously.

d. Slope of water table, preferably as determined from observation wells, or studies of wells in the area.

Discussed previously.

e. Site data relating to potential flooding and/or earthquake data.

Discussed previously.

f. Data relating to quality and quantity of the source waters under normal conditions and during stress periods of drought or heavy precipitation, as determined by field and laboratory analysis and investigations of available records; if records are not available or are inadequate to determine source quality under stress conditions, an estimate of expected quality and quantity during stress conditions should be established and related to the hydrologic budget to the aquifer or isopiestic area. At a minimum, analysis for all of the contaminants listed in the table "Contaminants to be Tested in All New Sources of Potable Water" shall be performed by the Department of Health, State Laboratories Division, for all sources being addressed in the report. For example, when approval of a well field is being sought, all of the wells must be tested for all of the required contaminants.

Laboratories performing the analysis must be currently certified by the Hawaii Department of Health, State Laboratories Division. While the lab data has often been conveniently summarized in a table, some reports have failed to note when analyses have been subcontracted to another lab. The lab reports from all of the laboratories involved must be included in the engineering report to allow the Department to verify that the analyses were performed by an approved lab. Failure to do so may delay the review process.

A water sample of the aquifer at Kupaa Well was taken during well testing. The sample was analyzed by Montgomery Watson Laboratories. The results are included in this report as Exhibit B-3. Water sample analysis from the North Waihee Well #2 and Kanoa Well 1 are included as Exhibit B-1 and B-2 respectively. The North Waihee Wells and the Kanoa Well are also in the same aquifer as the Kupaa Well.

g. Identification of all significant factors having potential for contaminating or reducing the quality of the water source or which would cause the quality of water delivered to users of the system to be in violation of any state primary drinking water regulation.

h. For each present and projected potential source of contamination, identification and evaluation of alternative control measures which could be implemented to reduce or eliminate the potential for contamination of the water source, including treatment of the water

source if subject to contamination, and evaluation of the physical, economic and social effects of implementing such control measures.

The lands surrounding the site is zoned either agricultural or conservation. The zoning in itself limits the potential for contamination. The conservation lands are mauka of the site. Conservation land uses are severely restricted and requires a permit to develop the land. Similarly, agricultural development has limited uses. Presently, the lands are used mainly for cattle grazing. Waste water treatment facilities for the existing homes in the area do not penetrate down to the aquifer and water quality samples show that individual waste water treatment facilities have not affected the quality of water from the aquifer. Changes in potential sources of contamination may change if the Community plan designations of these lands change; however, if zoning changes occur, the changes can be mitigated by changes in method of wastewater disposal.

i. **A summary section indicating how the proposed development and improvements will provide reasonable assurance that the new water source is not subject to actual or potential contamination such as may result in the water not complying with any state primary drinking water regulation or as may otherwise adversely affect the health of persons.**

The geology of the area, consisting of a thick andesite layer, makes potential of contamination unlikely from sources makai of the well.

The Maui County Community plan for the area shows that the lands have been designated as either agricultural lands or conservation lands. The conservation lands are above the project site.

7. **Proposed Treatment Works. Inaddition to information required under sections 2 through 4, the engineering report shall include the items below. Pilot studies may also be required.**

a. **Summary description of proposed processes and unit parameters for treating the specific water under consideration. Include pertinent information on built up and packaged plant systems.**

Water samples taken during well testing show only disinfection will be needed. Water from the well will be treated by a 12.5% premixed sodium hypochlorite solution disinfection system. To obtain a chlorine residual of 0.9 ppm (value DWS currently trying to obtain), the solution will have to be

injected at a rate of 0.5 gallons per hour. The hypochlorite solution will be injected before the water enters the 500,000 gallon control reservoir. The reservoir should provide sufficient contact period to allow thorough disinfection of the basal waters. The system located in a separate room within the control building (electrical and chlorine residual analyzer to be located in adjacent electrical room) at the proposed well site includes the following:

Storage for 12.5% sodium hypochlorite solution with spill containment.
Potable water supply.
Metering pumps.
Plastic tubing accessories and PVC Schedule 80 piping within the control building, below ground to a common injection point.

Operation and maintenance consist of field visits to the site primarily to measure chlorine residual and to resupply sodium hypochlorite solution when required. Adjustments to chlorine injection will be made to assure adequate chlorine residual.

b. **Site: Discuss various sites available indicating proximity to developed areas, availability of utilities, and accessibility of plant site. Show on a topographic map the treatment plant and arrangement of present and proposed treatment facilities.**

The project is a water development project within the Waihee Aquifer, located north of Waihee Stream. The Kupaa Well site is one of five well fields that is available to the Department of Water Supply. The remainder of the well fields are located between the North Waihee Wells (State Well No. 5631-02 & 5631-03) and this Kupaa Well (5731-03). A preliminary site plan of the proposed well development site is attached. Electrical power will be brought to the site by Maui Electric Company, the local electric utility.

c. **Basis of Design:**
   1) **Design Period**
   2) **Design population and flow demand data**
   3) **Nature and characteristics of flow**
   4) **Design flow rate for plant**
   5) **Reserve capacity**
   6) **Treatment processes and unit parameters including calculations for design of units. Include description of equipment, capacities, size, operational factors and plant**

hydraulics.

7) **If components are to be modified in stages, discuss staging, sequence, and future changes as required.**

The sustainable yield of the Iao Aquifer is 20 MGD. In the past, the DWS has come close to pumping near the sustainable yield levels. It is important to provide additional sources of water to reduce the stress being placed on the Iao Aquifer and to provide an adequate source of water to meet the demands of the water system. The well, pumping, storage and appurtenances will be designed and constructed in compliance with the County of Maui Department of Water Supply and State Department of Health Drinking Water Standards. The facility will be owned by the Maui County Board of Water Supply and operated by the DWS. Their staff is thoroughly familiar with and have the experience and qualified personnel that are committed to provide water that will be in compliance with the requirements of the State Safe Drinking Water Regulations. Water samples taken from the North Waihee Well, Kanoa Well 1 and this Well during the well testing phases of each well indicate that disinfection is the only treatment needed for the water. The proposed treatment process was described earlier.

d. **Waste Disposal: Discuss various wastes from the water treatment plant, their volume, proposed treatment and disposal, and points of discharge.**

No wastes are anticipated for the treatment process.

e. **Operation and maintenance: provide general information operation and maintenance requirements, automatic equipment and justification for system proposed.**

The operation and maintenance of the disinfection system will be by the Maui County Department of Water Supply. The Department has several similar disinfection systems and the qualified personnel to operate and maintain the equipment. Regularly scheduled field visits will be made to the site to measure chlorine residual and to resupply hypochlorite solution for injection.

8. **Pumping Facilities. In addition to information required under sections 2 through 4, the following information should be provided in the engineering report:**
   a. **Purpose of service**
   b. **Pumping layout and sizing of force main**

c. **Design flow requirements including maximum, average, minimum, variations in demand, and effect of storage**
d. **Liquid characteristics**
e. **Pump selection including system and characteristic curves**
f. **Pumping arrangement.**

Submersible deep well pumps are planned for the project. The layout of the project site is shown in attached figure. Potable water will service the CMWS. The pumping facility will have the following attributes:

Pump Type:	Deepwell Submersible
Pump Rating:	1,200 gpm @ 680' TDH
Motor:	Submersible, 350 HP, 1750 RPM
Power Supply:	480 volt, 3 phase, 60 Hz.
Piping:	Ductile Iron
Appurtenances:	Check Valve, Air and Vacuum Valve.
Flow Tubes:	Cast Iron with a bronze liner with transmitters and receivers.

Pump Control: Pump controls will be through a pressure sensing line (water level) placed in the 500,000 gallon reservoir. A signal proportional to tank level will be sent to a receiver in the control building on site. As water level in the reservoir reaches a certain level (to be set by operator), the pump will turn on. After reservoir fills, the pump will turn off by signal from the reservoir level sensor. High level and low level alarms will be installed to warn operator of malfunction.

Well level control: An electronic well drawdown sensing device will be placed in a well level monitoring tube to record water levels within the well. The information will be used as part of the data gathering information that will provide better understanding of aquifer conditions of the Waihee Aquifer and will set off an alarm if well level get below a certain draw down.

A 16-inch transmission waterline is planned to carry water from the Kupaa 500,000 gallon reservoir to an existing 24-inch transmission waterline from the North Waihee Well Project where the water will then be transported to the Central Maui Water System. A flow control valve at the 24-inch transmission waterline connection will open when the system calls for water. The control is located at the existing North Waihee Reservoir where the same flow controller will operate a booster pump system. The 16-inch waterline will have a design flow of 3 mgd which allows for a future second well.

The Kupaa Well is part of a system of wells planned for the area by the Department of Water Supply. The design and operation of the well will be in conformance with the "Water System Standards," Department of Water Supply, County of Maui, 1985. Since the Maui County Department of Water Supply is a public agency, the pumping unit must go through a bidding process. A specific pumping unit with pump curves cannot be presented at this time; however, an example pump curve is attached. The pump parameters were previously provided.

g. **Electric power available:** Electrical power will be brought to the site. Electrical power will be supplied by Maui Electric Company. At present, no emergency power is planned. Existing wells in the water system has emergency power available and would be sufficient to provide for water requirements should power fail.

h. **Proposed building and other structural improvements**

A control building will be constructed as part of the project. The building will house the electrical equipment for the pump motor controls, reservoir level, well level, SCADA equipment and other electrical appliances. A separate, enclosed room will house the disinfection facility. The building will be a slab on grade, CMU building with asphalt shingle roofing.

A 500,000 gallon concrete control reservoir will also be constructed as part of the project. The reservoir will be used to control the pump, allow a 30 minute disinfection contact period and provide storage for the system.

i. **Water hammer consideration.**

Water hammer effects will be mitigated by the use of slow opening/slow closing pump control valves and check valves.

j. **Descriptions of essential features of construction and operation, including staging sequence if applicable**

The staging sequence will be left up to the contractor; however, the following is the most likely staging sequence for the project construction:

a. Mobilize.
b. Clear and grub site.
c. Grading and earthwork at the reservoir site and construct access road.
d. Grass exposed slopes.

e. Install piping under the reservoir.

f. Begin reservoir construction. The construction of the reservoir is the critical path on the schedule. Concrete pours will start with the piping under the reservoir. The reservoir floor will take two concrete pours. The concrete walls of the reservoir will take three concrete pours while the roof will be poured at one time. There are concrete curing intervals of at least 14 days between pours, installing and removing form work. Concrete columns within the reservoir will also need time to form, pour and cure.

g. In the meantime, the building can be constructed, the pump and related piping installed and the paved area prepared for paving.

h. Complete the paving within the reservoir site.

i. Electrical and telemetry equipment installation simultaneously with the disinfection equipment. Meanwhile, MECO will provide power to the site.

j. Finally, the fence can be completed.

k. **Electrical system including provisions in the event of power failure, and telemetering and supervisory control systems**

Electrical Power will be obtained from Maui Electric Company, the local power company providing service to the island. In the event of power failure, the control valve will automatically close. The Department of Water Supply has other wells in the system with stand-by power which can be activated during power emergencies.

9. **Finished Water Storage. Describe location, type and sizing of storage facilities. Include discussion on drains, overflows, telemetering and supervisory controls, painting and protective coating and other important and pertinent considerations.**

A concrete 500,000 gallon reservoir will be used to store the finished water. The reservoir is large enough to allow at least a 30 minute contact period for disinfection purposes. Separate pipes will be installed for inflow and outflow to obtain reasonable circulation within the tank. The site will be drained to an existing swale east of the project. The tank overflow will also be connected to the drainage system.

Protective coating within the tank consist of Sikagard Hi-Bild Prime Coat and a finish coat of Sikagard Hi-Bild. Interior metal shall be either copper or stainless steel (unpainted) except for the inflow, outflow and overflow piping which will be ductile iron pipe with cement lining.

Exterior surfaces of the concrete tank shall be Ramuc Exterior Masonry paint or approved equal. Exterior metal surfaces except copper, stainless steel or bronze shall be coated with rust inhibitive primer and two coats of Sherwin Williams Enameloid or approved equal.

Water level sensors will be placed within the tank to control the well pump. The controller shall have a pump off setting, pump on setting and a low level alarm. The system will be connected to the Department of Water Supply SCADA system for monitoring at their Central Maui Baseyard.

10. **Water Distribution Systems.**

a. **Provide general layout of the system.**
b. **Indicate materials, valves, hydrants, meters, etc.**
c. **Proximity of other utilities**
d. **Include effects of incremental or phased construction, possibilities of future developments as applicable**
e. **Provide information, profiles or sections showing pipe cover, *location, groundwater conditions and other important* data affecting installation of the distribution system.**

The Central Maui System service area has been described previously. A layout of the Central Maui Water System is attached. A description of the total service area was previously described. The water distribution system is one of the existing public water systems maintained by the Maui County Department of Water Supply. The water system materials, construction and maintenance are in accordance to the standards set forth by the Maui County Department of Water Supply. This project is not planned for any specific development but to meet the rising demand for water throughout the water system and to reduce stressing the Iao Aquifer.

11. **Financing. Provide information on estimated costs of installation, phasing, operation and maintenance and other related information.**

The project will be funded by the Maui County Board of Water Supply. A preliminary cost estimate is attached. Operation and maintenance will be performed by the Department of Water Supply as part of their daily operations on all of the wells in the area.

An estimate of the project construction cost are as follows:

Site improvements including pump, reservoir, electrical\equipment building,

electrical, disinfection, fencing, paving, drainage and miscellaneous piping:
$ 1,330,000.00

16" Transmission Waterline from site to connect to existing transmission line including flow regulating valve, gate valve and connection to existing waterline:
$ 955,000.00

Total construction estimate for project:	$2,285,000.00
Contingencies:	$ 457,000.00
Total project cost not including MECO charges:	$2,742,000.00

REFERENCES

1. Water Resource Protection Plan, Volume I & II, Commission on Water Resource Management, June 1990.

2. The North Waihee Aquifer, An Additional Water Supply Source for Central Maui, Dr. John Mink, Mink & Yuen, April 10, 1997.

3. Wailuku-Kahului Community Plan, County of Maui, Adopted December 7, 1987.

4. Kihei-Makena Community Plan, County of Maui Adopted March 6, 1998.

5. Paia-Haiku Community Plan, County of Maui, May 17, 1995.

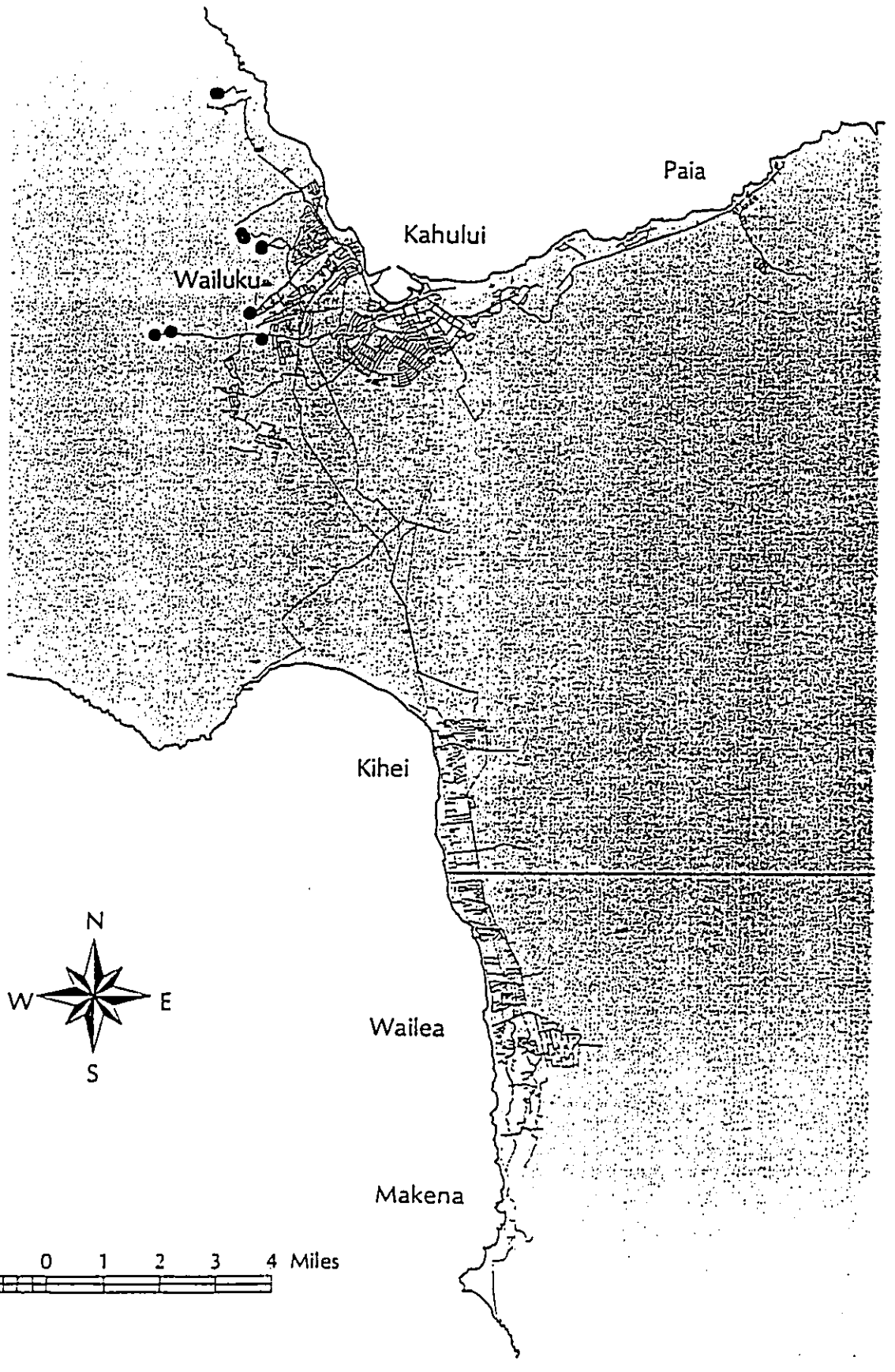
6. Annual Report for Fiscal Years 1994, 1995, Board of Water Supply, County of Maui.

7. Annual Report for Fiscal Year 1997, Board of Water Supply, County of Maui.

8. East Maui Development Plan, Department of Water Supply

9. Water System Standards, Department of Water Supply, County of Maui, 1985.

Maui Department of Water Supply
Central Maui System



10BKH

ENCLOSED TYPE IMPELLER 1760 RPM

NO. OF STAGES	EFF. CHANGE (NO. OF POINTS)
1	−3
2	−1
3	−0

HORSEPOWER WILL BE EFFECTED BY CHANGE IN EFFICIENCY

PERFORMANCE FOR:
Bowl Pattern No.: 547612-A-R0
Imp. Pattern No.: 547611-A-R0

PUMP DATA

Shaft Dia. (IN.)	1½
Maximum Sphere (IN.)	1
Maximum Head (FT.)*	950
Min. Submergence (IN.)**	20
Impeller Wt. (LBS.)	10.75
Thrust Constant (K)	10.0
Bowl O.D. (IN.)	9⅝

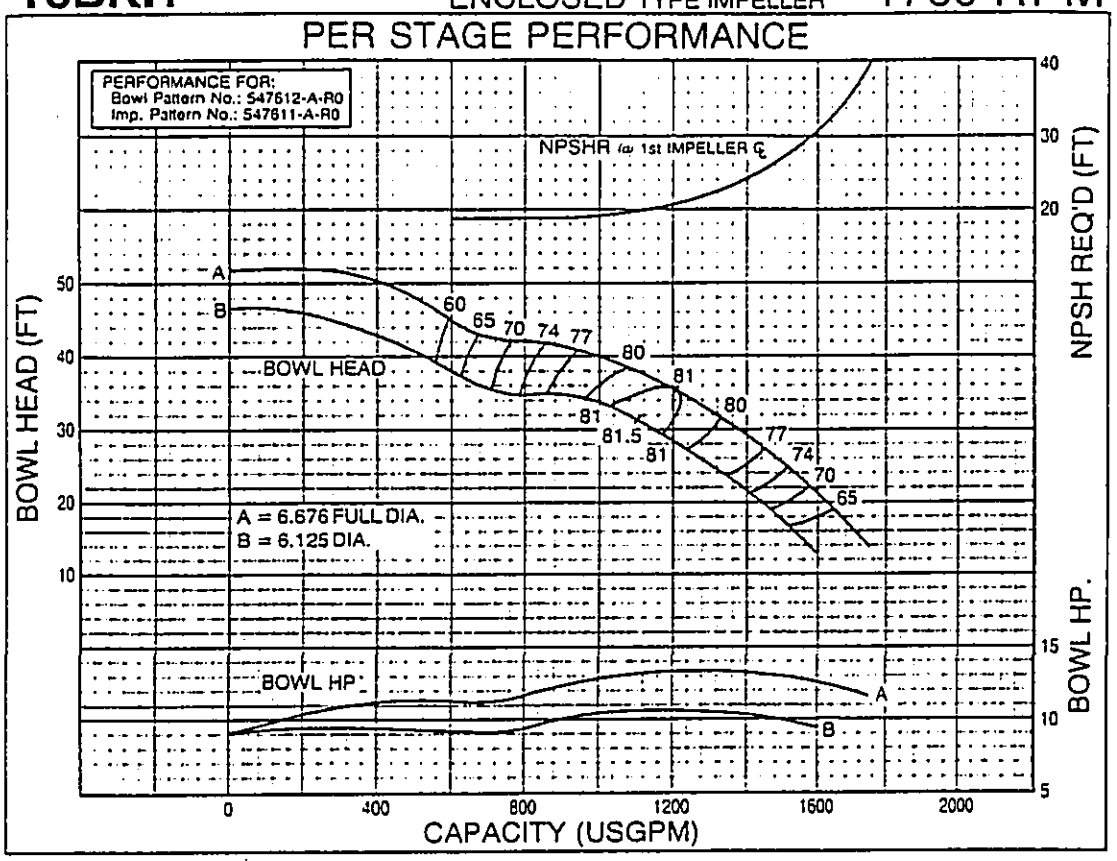
NOTES

Performance indicated based on cold water with a specific gravity of 1.0.

* Standard construction.

** Minimum submergence over lip of bell to prevent vortexing.

Efficiency improvements are available in certain instances. Please contact the factory.



10FKH

ENCLOSED TYPE IMPELLER 1770 RPM

NO. OF STAGES	EFF. CHANGE (NO. OF POINTS)
1	−2½
2	−1
3	−0

HORSEPOWER WILL BE EFFECTED BY CHANGE IN EFFICIENCY

PERFORMANCE FOR:
Bowl Pattern No.: 545320-A-R0
Imp. Pattern No.: 545324-A-R1

PUMP DATA

Shaft Dia. (IN.)	1 11/16
Maximum Sphere (IN.)	1
Maximum Head (FT.)*	769
Min. Submergence (IN.)**	20
Impeller Wt. (LBS.)	9.0
Thrust Constant (K)	13.3
Bowl O.D. (IN.)	9½

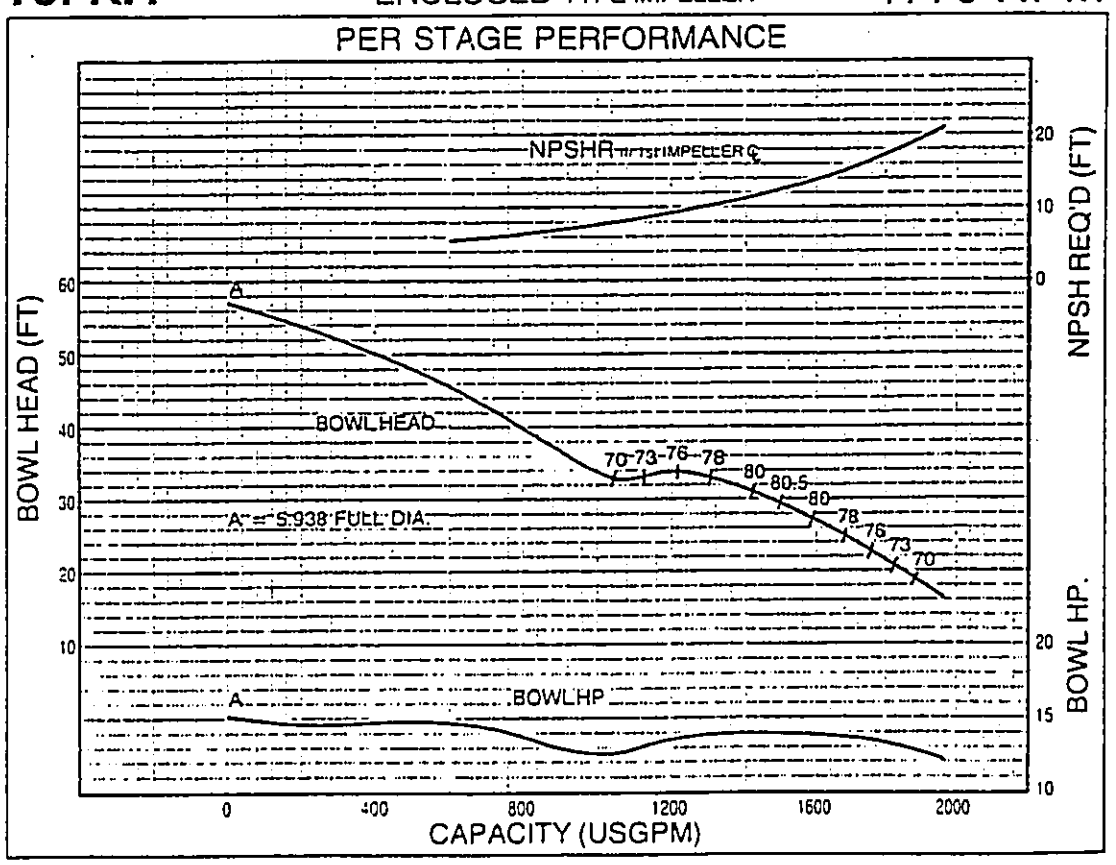
NOTES

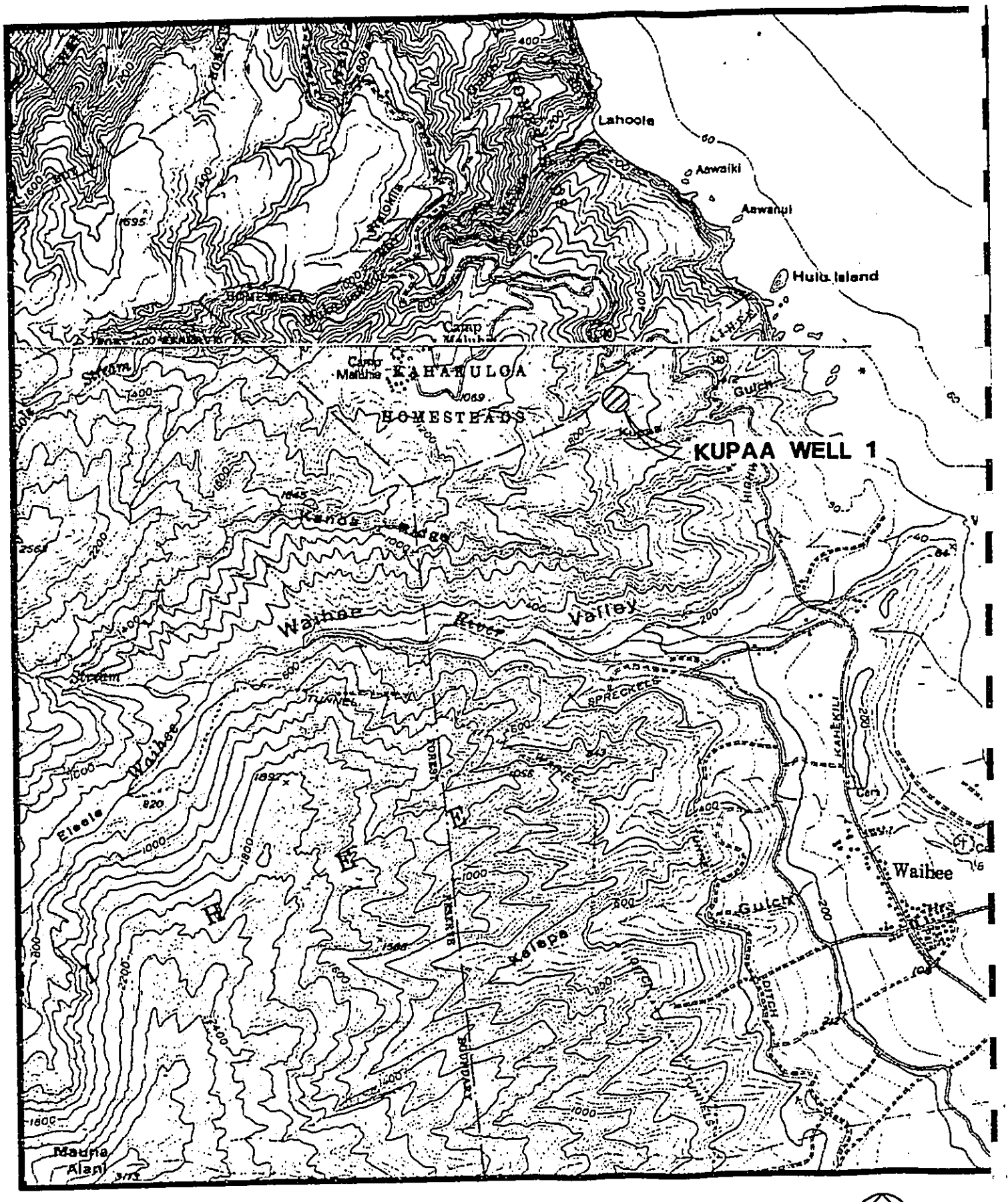
Performance indicated based on cold water with a specific gravity of 1.0.

* Standard construction.

** Minimum submergence over lip of bell to prevent vortexing.

Efficiency improvements are available in certain instances. Please contact the factory.

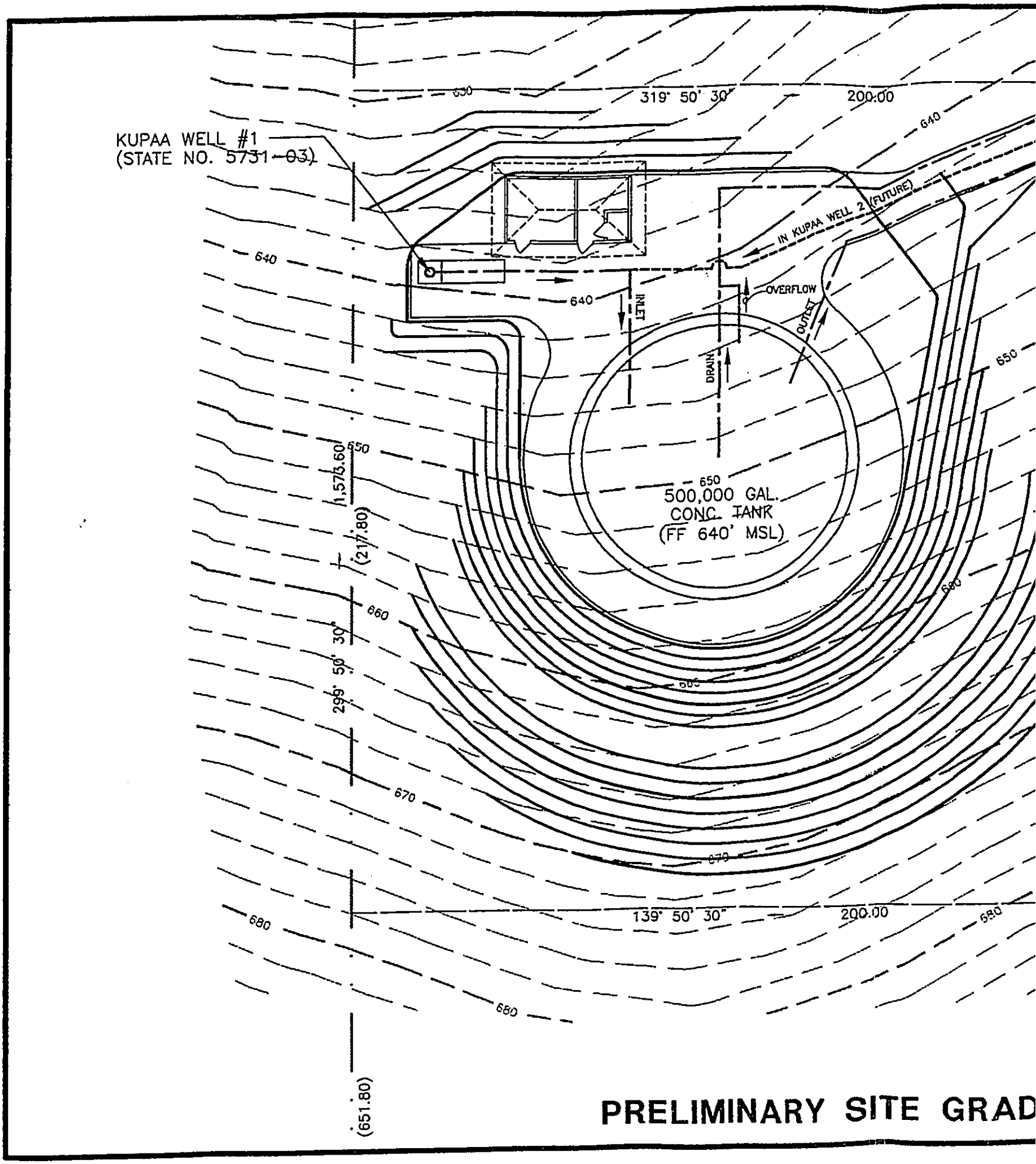




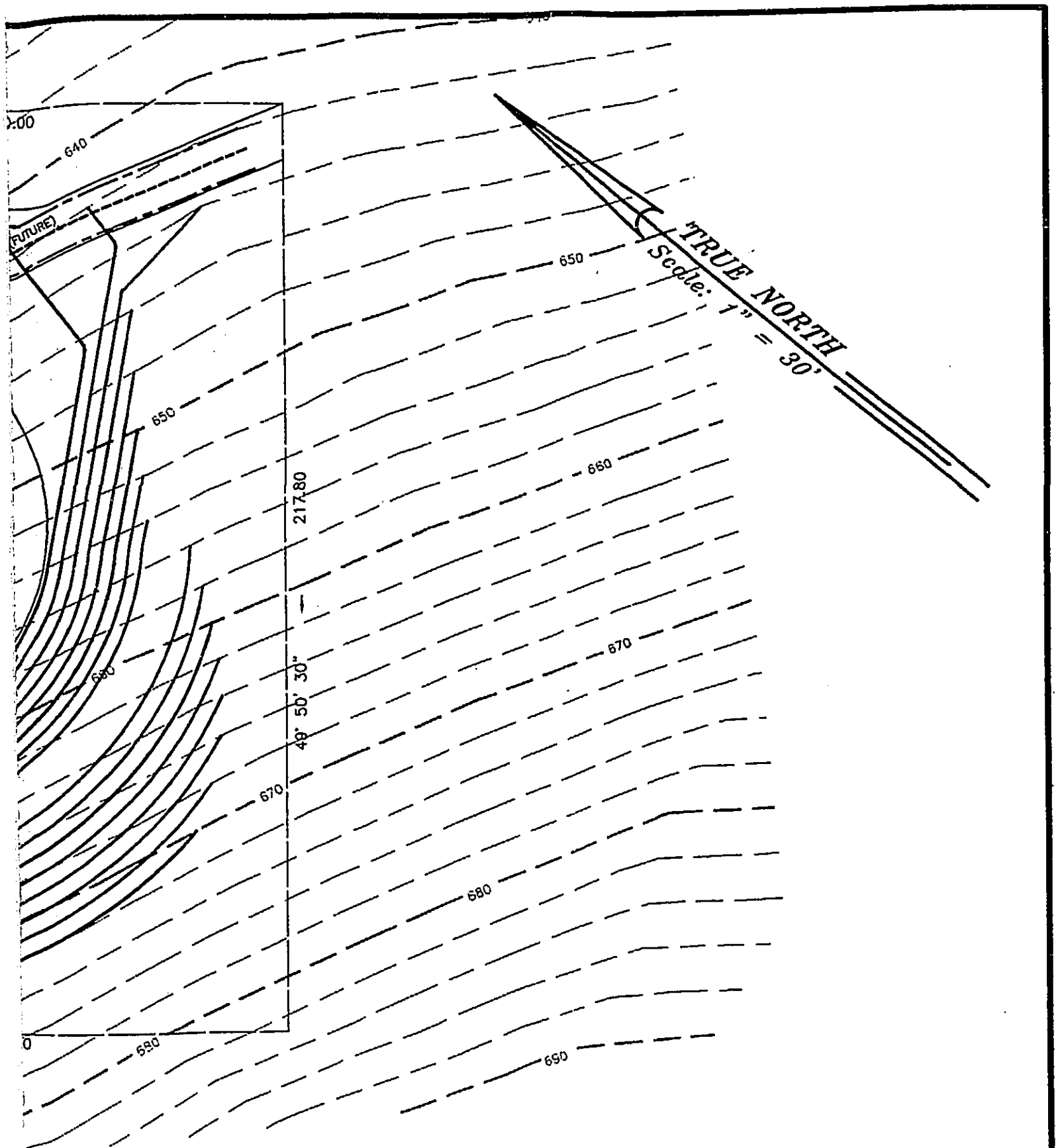
KUPAA WELL 1 (STATE WELL NO. 5731-03)

APPROXIMATE SCALE 1"=2000'

N



PRELIMINARY SITE GRAD



TE GRADING PLAN

EXHIBIT A

THE NORTH WAIHEE AQUIFER, AN ADDITIONAL WATER SOURCE

MINK & YUEN, INC.

THE NORTH WAIHEE AQUIFER

AN ADDITIONAL WATER SUPPLY SOURCE FOR CENTRAL MAUI

John F. Mink
Mink and Yuen, Inc.

April 10, 1997

Introduction

The Iao Aquifer System, which for managerial purposes is defined as the region between Waikapu Valley and Waihee Valley, has satisfactorily supplied Central Maui with drinking water since the Mokuhau wells were drilled more than 30 years ago. The aquifer system is large with an assigned sustainable yield of 20 mgd, but demand has already reached this level and threatens to substantially exceed it in the next few years. New sources of drinking water are needed to meet increasing demand.

As the exploitation of the Iao Aquifer was undergoing considerable expansion with the drilling of the Waiehu Heights and Waiehu wells in the late 1970s and the early 1980s, it became evident that additional sources needed to be located and put on line a decade or so in the future. The region north of Waihee Valley was considered a prime

candidate for groundwater production, but at first most attention was given to developing groundwater in East Maui. The East Maui initative has been delayed, however, by the discovery of pesticides in newly drilled wells and by legal challenges, leaving the North Waihee groundwater resource as the obvious choice for timely additional development.

Construction of a pipeline connecting North Waihee with the Central Maui distribution network is underway, and two potential production wells are in place. The North Waihee Aquifer will be developed in phases, the first of which incorporates the existing wells and the drilling of two new wells. Details of future phases will depend on the behavior of the aquifer in response to pumping following completion of the first phase.

Relationship Between Iao and North Waihee Aquifer Systems

After it was recognized that production from the Iao Aquifer System would not be able to match the increasing demand in Central Maui, attention turned to the region north of Waihee Valley as a prospective source of additional groundwater. In 1980 Dan Lum, then hydrologist with the State Department of Water and Land Development (DOWALD), suggested that exploratory drilling be attempted on the slope of the ridge

just north of the Waihee River to test whether the area was an extension of the Iao Aquifer System or could be treated as an independent groundwater province. About at the same time Stephen Bowles, consulting hydrologist, recommended essentially the same course of action. Subsequently John F. Mink was retained by C. Brewer Co., owner of the land, to locate drilling sites and design a drilling and testing program.

Two wells were drilled in 1981 and the groundwater data compared with the original premise that if North Waihee was an uninterrupted extension of the Iao Aquifer System, the head should be at least 15 feet, based on the head at Test Hole A-1 located 4000 feet across the valley to the south, and the corollary that if the head were 5 feet or less, the aquifer would be independent of the Iao System. In fact, the head at the exploratory wells was about 10 feet while the head at Test Hole A-1 was nearly 20 feet. This relationship suggested that the Iao Aquifer System was hydraulically connected to North Waihee but that Waihee Valley behaved as a low permeability impediment to hydraulic continuity. The lack of response of groundwater levels at Test Hole A-1 to pumping at the North Waihee wells further suggested that North Waihee could be treated as a quasi-independent aquifer

system.

The connection between the Iao and North Waihee Aquifer Systems, as well as the dampening effect on hydraulic continuity excercised by the low permeability associated with the alluvium and weathered zone in Waihee Valley, is indicated by comparing the continuous head records at Test Hole A-1 and North Waihee Well 1. The head trace for the test hole is synchronous with that at North Waihee but higher by about 7 feet. If the normal groundwater gradient in basal aquifers of the shield basalts characteristic of every island in Hawaii governed flow, the difference in head would be less than 1 foot. The exaggerated difference is a result of head loss as the groundwater moves through the valley. Global hydraulic conductivity in the valley is at least two magnitudes less than in the unweathered basalt aquifer. A derivation based on Darcy's law indicates that the global hydraulic conductivity of the impediment is about 25 ft./day compared with normal basalt conductivity of 1500 ft./day.

Knowledge of the hydrogeology of both the Iao and North Waihee Aquifer Systems is insufficient to unequivocally establish the pattern of groundwater flow in and from the

aquifers. However, assuming that the general direction of groundwater flow in the Iao Aquifer is toward and across Waihee Valley, the North Waihee System would then be recharged by excess groundwater from Iao as well as by recharge from the high rainfall region north of Waihee Valley. As a result, the sustainable yield of the North Waihee System is substantial. Its magnitude, now estimated to be 8 mgd, will be more accurately determined after an operational record of pumping is established. The sustainable yield refers to the entire North Waihee Aquifer System, which extends from Waihee Valley north to Kahakuloa Valley.

Hydrogeology of the North Waihee Aquifer System

In the Iao Aquifer System the basal aquifer in the Wailuku basalt formation is covered by a caprock of sediments extending to approximately 8000 feet inland of the coast. The inland boundary of the basal aquifer is the rift zone lying about 12,000 feet from the coast and approximately parallel to it. Heads are high in the aquifer because the low permeability of the caprock sediments prevent easy discharge of the groundwater.

This sedimentary blanket, which north of Iao Valley is more

than 1200 feet deep at the coast, is truncated at Waihee Valley. North of Waihee the volcanic rock formations reach to the coast; if a sedimentary blanket exists, it lies below sea level and does not play a role in the North Waihee hydrogeology. The absence of sediments north of Waihee Valley suggests that the sector to the south was displaced downward as a result faulting, and that the fault itself is along what is now Waihee Valley. South of Iao Valley the deep sediments continue beyond Waikapu, but are absent where the Isthmus terminates. The faulted block, therefore, is a wedge truncated on the north at Waihee Valley and ending in the south where the isthmus sediments abut the basalt bedrock.

Although a sedimentary caprock does not exist in the North Waihee Aquifer System, nevertheless north of Waihee Valley a caprock composed of a volcanic formation resists drainage from the basal lens into the sea. The formation constituting the aquifer is the Wailuku basalt, a highly permeable medium equivalent to other premium aquifers such as the Koolau basalt of Oahu in its water bearing properties. In the region between Waihee Valley and Waiolai Gulch, and perhaps beyond to Wailena Gulch, the Wailuku basalt is covered by the Honolua formation, a low permeability combination of

andesite and trachyte in which even lower permeability soil and ash layers are stratified. The Honolua averages about 100 feet in thickness and completely caps the Wailuku basalt to the coast and out to sea. This formation behaves as a caprock in the region where the proposed additional groundwater development is to take place. Figure 1 illustrates the geology of the region.

The Honolua formation is a pale tan to gray to white rock, massive and dense with platy cleavage. Individual andesite layers average about 40 feet thick, and trachyte layers are as much as 150 feet thick. In contrast, the primitive basalt of the Wailuku formation is piled in layers normally 10 feet or less thick throughout which many highly permeable clinker layers occur. A weak unconformity separates the Wailuku from the overlying Honolua, but the volcanism that produced these rocks was continuous, though eruptions were less frequent during the extrusion of the Honolua formation. Nowhere in West Maui is the Honolua exploited as an aquifer.

For convenience in classification and management, the North Waihee Aquifer System is defined as the region extending northward from Waihee Valley to Kahakuloa Valley. The basal portion may be disrupted near Makamakaole Valley by massive

Honolua dikes that connect the trachyte eruptive centers at Puu Kukui and Eke at the crest of the West Maui Mountains with trachyte bulbous domes near the coast, such as Puu Olai (Figure 1). Inland the basal sector ends at the rift zone which is about at and parallel to the Forest Reserve boundary 7000 feet from the coast. In the entire North Waihee Aquifer System the sustainable yield is estimated as 8 mgd; between Waihee and Makamakaole it is less.

North Waihee Wells 1 and 2: Drilling and Testing

In 1981 C. Brewer Co. had two wells drilled in its property on the north bank of Waihee Valley. The wells are located about 500 feet from the axis of the valley and 5200 feet inland from the valley mouth at Waihee Point. The purpose of drilling was exploratory, to determine aquifer characteristics, ground water levels and quality, but the wells were constructed and completed for use as production wells. The locations of wells in the North Waihee Aquifer System is given in Figure 2.

The wells were located to avoid a deep section of valley fill sediments. They were driven from elevation 280 feet through 100 feet of talus into the the Wailuku basalt. The Honolua formation is missing at this level on the slope of

the ridge. The initial head was 9 to 10 feet, which was higher than expected if the aquifer were independent of the Iao Aquifer System to the south yet lower if it were connected. At the time the head at Test Hole A-1, 4000 feet to the south in the Iao Aquifer, was 20 feet during periods of low to no pumping at the Mokuhau and Waiehu wells.

Each well was drilled to 105 feet below sea level (BSL) and fitted with 16 inch diameter blank casing to 5 feet BSL, and screen between 5 and 25 feet BSL. The remaining 80 feet was left open.

The pump test in 1982 employed North Waihee 2 as the pumping well and North Waihee 1 as an observation well. The wells are on a line parallel to the valley, 176 feet apart. A contnuous 48 hour test at a rate of 1700 gpm (2.45 mgd) was performed. Analysis of the test results determined the transmissivity of the aquifer as 325,000 sq.ft./day and the storage coefficient as .25. Salinity of the pumped water was very low and constant at 15 mg/l chloride. No effect on the head at Test Hole A-1 could be detected, nor were any boundary effects indicated by the drawdown curve.

The test proved the occurrence of a substantial groundwater

resource north of Waihee Valley, and the results implied that the connection with the Iao Aquifer System was weak. The wells were capped. Interest in them flagged because draft in the Iao Aquifer System was still significantly less than the assigned sustainable yield.

Interest was rekindled in 1989 when Iao pumpage began to approach sustainable yield. A longer test with expanded data collection opportunities was designed. An observation well was drilled in Kanoa Valley about 2000 feet north of the North Waihee wells and equipped with a continuous water level recorder. An existing small diameter well in Wailena, 13,500 feet north of the North Waihee wells, was also equipped with a continuous water level recorder. The Wailena well had been drilled in 1987. Test Hole A-1 and North Waihee Well 1 also had contnuous water level recorders. North Waihee 2 was selected as the pumping well. Another well in the region, the Mendes well (Figure 2), was not available for measurements. This well has a 4 inch diameter casing and is fitted with a 5 HP pump capable of yielding 20 to 30 gpm. It is infrequently pumped.

Ground elevation at the Kanoa observation well is 305 feet. The drilling log places the Honolua/Wailuku contact at depth

248 feet (57 feet ASL). The initial head was 12.4 feet. The Wailena well ground surface is at 608 feet, and the well lies at the inland turn of the road nearly on the axis of the valley. The Honolua formation is absent in Wailena, and the well penetrated only the Wailuku basalt. The initial head at completion of drilling in 1987 was 6.4 feet while just before commencement of the test it was 6.6 feet. At the start of the test head in North Waihee 1 was 11.5 feet and in North Waihee 2 it was 10.7 feet. At Test Hole A-1 in the Iao Aquifer System the head was 18.1 feet. Heads at Kanoa and North Waihee were inconsistent with a flow net that would have groundwater passing northward from Waihee Valley toward Makamakaole as might be interpreted if flow crossed Waihee Valley from Iao to North Waihee.

The pump test lasted four days, from May 15 to May 19, 1989. The average rate of pumping over the 96 hours was 2400 gpm (3.46 mgd). Drawdown in North Waihee 2, the pumping well, stabilized at 5.5 feet, and in North Waihee 1, 176 feet away, it reached 0.7 feet. At the Kanoa observation well drawdown peaked at 0.4 feet. Tidal efficiency at Kanoa is high because the well lies just 2000 feet from the coast, and the range and distribution of drawdowns on the chart reflected this efficiency. At Wailena and Test Hole A-1 no

change in head attributable to the pumping could be detected. The drawdown curves for North Waihee 1 and Kanoa did not indicate the presence of flow boundaries.

The test results were evaluated both graphically and by computer program to yield values for the fundamental aquifer properties of transmissivity and storage coefficient (effective porosity). At North Waihee 1 transmissivity computed from drawdown data was 320,000 sq.ft./day and storage coefficient .30, about the same as that determined for the 1982 test. The Kanoa data was not as easily interpreted because of the imposition of the tidal signal on the drawdown values. Transmissivity fell between 260,000 and 334,000 sq.ft./day and storage coefficient between .013 and .034. The transmissivity values are consistent with those obtained at North Waihee 1, but the storage coefficient values are a magnitude lower. At the North Waihee wells the computed storage coefficients may represent local phenomena, whereas the values determined at Kanoa may reflect a regional characteristic. For planning the arrangement of a well field the smaller storage coefficient is likely to be more realistic than the larger one. In the Pearl Harbor region of Southern Oahu, for example, where the Koolau formation resembles the Wailuku basalt the regional storage

coefficient is about .05.

For predictive purposes a transmissivity of 325,000 sq.ft./day and coefficient of storage of .05 will be employed. The transmissivity is representative of a highly permeable aquifer having a substantial depth of fresh water flow. Assuming a hydraulic conductivity of 1500 ft./day, which ia a value typical of primitive basalts like the Wailuku formation, and accepting the Ghyben-Herzberg relationship that depth below sea level to the 50 percent sea water isochlor is 40 times the head, the thickness of the fresh water core is calculated as 217 feet and that of the upper limb of the transition zone as 40*h - 217 (e.g. for a 10 feet head the upper limb would be 183 feet thick). The calculated thickness of the fresh water core is further constrained by the assumption that the groundwater flow contributing to transmissivity is restricted to this zone. These assumptions lead to approximate, not accurate, estimates of zonation in the basal lens. Nevertheless it is clear that the fresh water core is thick because even under the intense stress of pumping 3.46 mgd from a single well the salinity of the pumped water did not increase.

Proposed Development of the North Waihee Aquifer

The first phase of the North Waihee groundwater development program calls for activation of the two existing North Waihee wells and drilling two new wells. The existing wells were completed to construction standards meeting both the Department of Health and Commission on Water Resources Management recommendations. One of the new wells, Kupaa 1, will be located at an elevation of approximately 575 feet near the C. Brewer Co. property boundary line on a slope inland of Kahekili Highway. The other, Kanoa 1, will be drilled about 75 to 100 feet inland of the existing Kanoa monitor well.

The North Waihee wells are 16 inch diameter (casing) and bottom at 105 feet BSL. The new wells also will be completed as 16 inch diameter wells after testing proves acceptable production capability. However, the first stage in the drilling protocol for the new wells will consist of a pilot hole driven to 50 feet BSL into which a pump can be lowered for a preliminary test. An option will be included to drill deeper in 25 feet increments if results of the preliminary test fail to predict adequate production.

General specifications and the drilling protocol for the two

new wells are as follows.

1. Drill pilot hole to depth 50 feet BSL.
2. Conduct preliminary pump test in open hole; duration two hours or less.
3. Option to deepen drilling in 25 feet increments if preliminary tests fail to show sufficient production capability.
4. At selected depth, ream boring so it can hold 16 inch diameter casing while allowing for a 3 inch annular space for grouting.
5. Conduct another preliminary test of a few hours duration.
6. Select length of blank casing on basis of preliminary tests.
7. Screen is optional; at most, 10 to 20 feet of screen, the remainder of boring open hole.
8. Grout to water table, which is expected to lie about 10 feet above sea level.

Although the North Waihee 2 well was tested for a continuous run of 96 hours at 3.46 mgd, this rate is about twice that allowable for a production well. Upon reviewng the results of the pumping tests of 1982 and 1989, the preliminary recommendation was to fit the wells with 2 mgd (1390 gpm) pumps. This recommendation envisioned a single well field

comprising two wells in the North Waihee Aquifer. Expansion to more than two wells justifys a more prudent recommendation of 1.5 mgd (1040 gpm) per well. The new wells will be tested to determine whether a 1.5 mgd pump would be appropriate, but final pump size will depend on the results of the long term continuous test.

Total well capacity will be 6.0 mgd if each of the four wells is fitted with a 1.5 mgd pump. A scenario in which one of the existing North Waihee wells serves as an inactive stand-by but the other three wells are producers, and assuming that a peaking factor of 1.5 times average output is excercised for the three active wells, average production will total 3.0 mgd. If the capacity of the inactive well is included, the average output will be 4.0 mgd. Whether or not the North Waihee Aquifer between the C. Brewer Co. property line and Waihee Valley can sustain an average yield of 4.0 mgd is not predictable until a record of the effects of pumping operations on water levels and the quality of the pumped water accumulates.

The proposed location of Kupaa 1 is 1000 feet from the Mendes well and 2 miles south of the new Wailena well. At the time of testing the Wailena well had a 4 inch diameter

casing. In 1994 a new well with 6 inch diameter casing was drilled and successfully tested at 200 gpm. Pumping at Kupaa and Kanoa should not affect the Wailena well because of its distance from the proposed wells. The capacity of the Mendes well is too small for either the quality or quantity of its pumpage to be affected.

Figure 1

NORTH WAIHEE

(Waihee Valley to Kahakuloa Valley)

Scale: 1" = 1 mile.

01 Existing Wells

Proposed Wells

Geology

Ra; Qd: Recent alluvium and dunes

Pa: Old alluvium

Th: Honolua formation

Tw: Wailuku formation

Good moto... building

Bridge

Bench ... (supplementary ... shown by cross ... figures without ...

Intermitt... stream...

Wailena

Mendes

Kupaa 1

Kanoa 1

North Waihee 1

Hon... Ik... K... Loki...

Figure 2.
NORTH WAIHEE REGION
WELL SITES
Scale: 1inch = 2,000 feet.

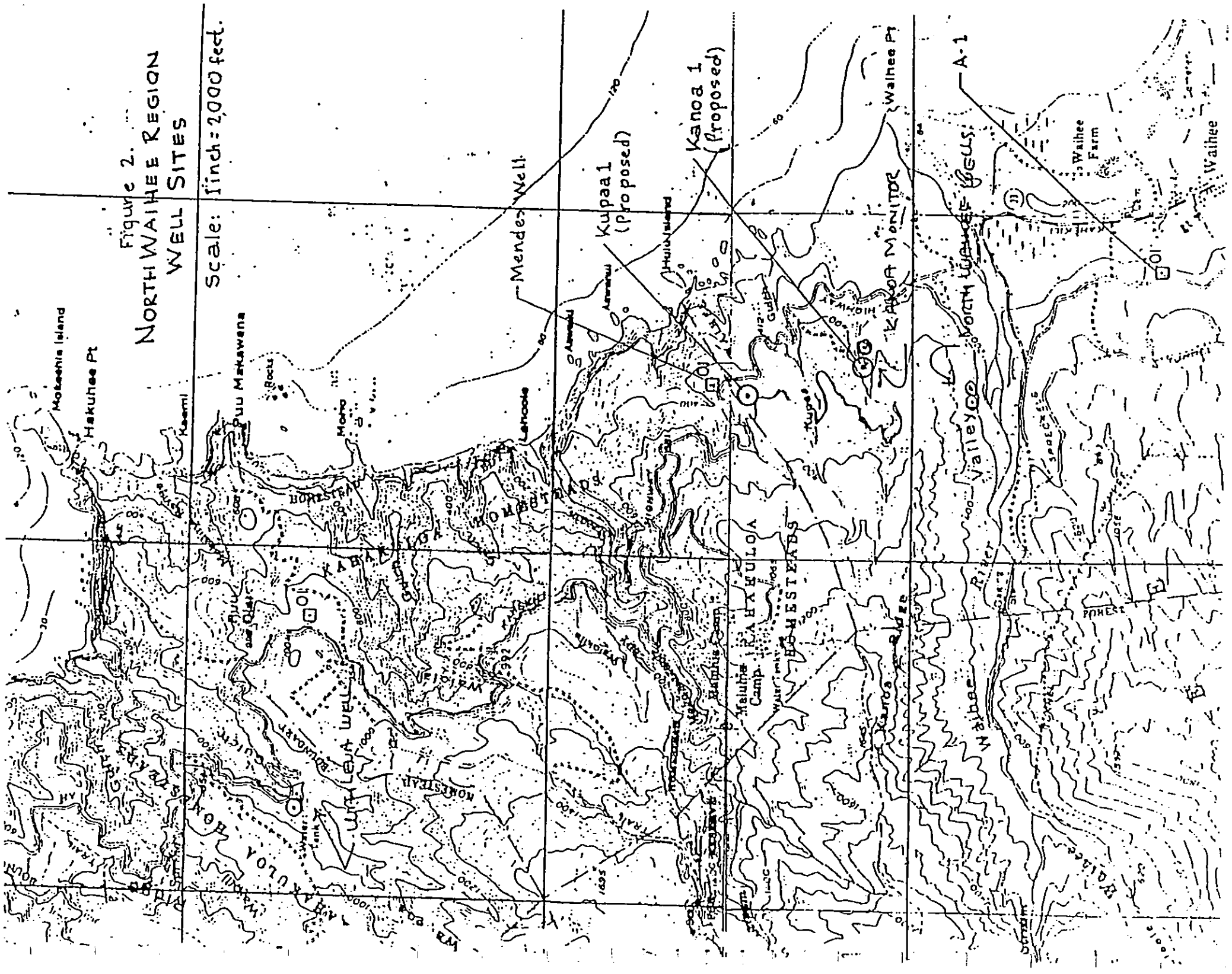


EXHIBIT A - 1

NORTH WAIHEE AQUIFER SYSTEM
KUPAA 1 AND KANOA 1 WELLS
TEST RESULTS AND INTERPRETATION

JOHN F. MINK
MINK & YUEN

NORTH WAIHEE AQUIFER SYSTEM

Kupaa 1 and Kanoa 1 Wells
Test Results and Interpretation

John F. Mink
Mink and Yuen, Inc.

June 21, 1999

Kupaa 1

The location of the well, which was completed in March of 1999, is plotted on Figure 1. The completed configuration of the well is as follows.

Depth 687 ft. (49 ft. BSL)
Boring diameter, 21 in.
Blank casing diameter, 16 in.; depth 633 ft. (4 ft. ASL)
Perforated casing, diameter 16 in.; length 53 ft.
Grout, 0 to 630 ft. (7 ft. ASL)
Gravel, 633 to 686 ft.

Further details are given in the Driller's Well Completion Form, which is attached. Note that the measuring point (MP) on the form differs from the surveyed elevation. The driller's MP elevation on the top of the casing is listed as 638.1 feet; the actual elevation is 639.37 feet, which is based on a vertical survey from a benchmark elevation of 631.87 feet located about 200 feet from the well. This correction affects computation of head but not of drawdown measured during the pumping tests.

Examination of the drill cuttings indicates that the unconformity between the overlying Honolua trachyte formation and the Wailuku basalt formation is 70 to 80 feet below ground surface, and that the weathering zone of the Wailuku extends another 55 feet before fresh Wailuku basalt is struck. The driller's lithology log is attached. Also attached is a drawing illustrating the relationship between the Honolua and Wailuku at both the Kupaa and Kanoa wells.

Step Drawdown Test

Head before pumping started was 7.41 feet (MP 639.37 ft. – DTW 631.96 ft. = 7.41 ft.), as measured with the Driller's tape. Putative stable drawdown at each pumping rate was:

Rate (gpm)	Drawdown (ft)
400	.35
700	.82
1000	1.34
1400	2.14

In the Appendix these data are used to calculate a transmissivity (T) value of 178,928 sq.ft./day employing the standard laminar-turbulent flow relationship between drawdown and pumping rate. Assuming depth of flow to the well equal to penetration of the well below the water table (about 50 feet), hydraulic conductivity (k) is 3566 ft./day This value is of the magnitude consistent with the usual values derived for other primary basalt aquifers in Hawaii.

Constant Rate Pump Test

The constant rate test at 1200 gpm began at 0900 on March 15, 1999, and went on for four days (96 hours). Initial drawdown was rapid, but after about 40 minutes it no longer decreased monotonically but began to oscillate within a range of approximately 0.5 feet. Tidal and barometric perturbations, randomized by apparent hysterisis in the transducer readings, contributed too much noise to the record to allow an accurate extraction of drawdowns due to pumping alone.

For the first 44 minutes of the test, however, the monotonic drawdowns can be employed in the Theis equation to derive an approximate value of T. The computer program, THEISFIT, yields a T value of 91,363 sq.ft./day, which for a 50 feet depth of flow translates to hydraulic conductivity of 1827 ft./day. This value is of the same magnitude as the one obtained from the step drawdown test data but is probably more accurate and is more consistent with typical values for other Hawaiian basalt aquifers (e.g. The Koolau aquifer of southern Oahu, which has an average hydraulic conductivity of 1500 ft./day). The printout of the THEISFIT computation is included in the Appendix. A realistic value for storage coefficient (S) is impossible to derive because a meaningful radius value for the pumping well is unknowable. The total bore diameter may be one or two feet, but the apparent diameter is likely to be greater.

The effort to disassociate tidal changes in groundwater level from drawdown did not produce clearly identifiable results. However, the tidal efficiency at the well site and Kanoa is 5 to 10 percent. For the maximum tidal change, about 2 feet, the effect on the water level in the well would be 0.10 to 0.20 feet. Change of this magnitude could not be discriminated from barometric and random perturbations after drawdown reached approximately 1.35 feet in less than an hour following the start of the test.

An effort was made to measure water levels in nearby wells during the test. The North Waihee wells were shut down to avoid interference. None of the wells (Kanoa monitor, Mendes, North Waihee) provided unambiguous, interpretable drawdown data.

During the four days of the test chloride content remained steady at 20 to 25 mg/l and temperature was 68 F. The temperature indicates that the source of recharge is from higher elevations where rainfall is copious, and the steady chloride content confirms that at 1200 gpm sea water intrusion does not affect the pumped water. A full spectrum analysis shows that the water is not contaminated with either volatile organics or heavy metals.

Recommended Pump Size

The sustained constant rate, 1200 gpm (1.73 mgd), is the recommended pump size. Initial head at Kupaa was 7.41 feet, which is adequate to avoid upconing of sea water during pumping in a well penetrating 50 to 100 feet below the water table. Should adherence to the full breadth of the DWS protocol on pumping be required, average daily yield will be 0.77 mgd (.444 x 1.73 mgd); if only the 16 hr/day pumping portion of the protocol were followed, average yield would be 1.15 mgd (.667 x 1.73 mgd).

Kanoa 1

Kanoa 1 was completed in April and tested in May, 1999. Its location is plotted on Figure 1. Final configuration of the well is as follows.

Depth: 359 ft. (50 ft. BSL)
Boring diameter: 22 in.
Blank casing diameter: 16 in.; depth
Perforated casing diameter: 16 in.;
Grout: 0 to 300 ft.
Gravel: 300 to 389 ft.

Further details are given in the attached Drillers Well Completion Form. The measuring point is 309.15 feet above sea level, and the depth to water (DTW) before testing was 301.34 feet, giving a head of 7.81 feet, 0.4 feet higher than at Kupaa 1 a month earlier.

The lithology log places the Honolua/Wailuku unconformity at an elevation of about 64 feet, which is virtually identical to the placement identified by well cuttings from the Kanoa monitor well. The thickness of the Honolua and unconformity is approximately 245 feet. The greater thickness at Kanoa than at Kupaa (75 feet) is due to the topography on to which the Honolua lavas flowed; the Kanoa site is in a pre-existing valley, while the Kupaa site is on a pre-existing ridge.

Step Drawdown Test

The step drawdown test was conducted on May 14, 1999, at rates to 1400 gpm. The results are summarized as follows.

Rate (gpm)	Drawdown (ft.)
350	.46
375	.51
500	.66
700	1.26
1100	2.16
1400	3.36

The computed transmissivity is 124,770 sq.ft./day (see Appendix), which, if the depth of flow is 50 feet, yields hydraulic conductivity of 2495 ft./day. The computed T is comparable to that determined by step drawdown data for Kupaa 1. However, values derived from step drawdown results are indicative rather than absolute; in both wells they are of the same high magnitude that indicates the Wailuku basalt is very permeable.

Constant Rate Pump Test

The 1200 gpm constant rate pump test was started at 0900, May 17, and completed at 0900, May 21, 1999, a period of 4 days. Maximum drawdown at the pumping well, uncorrected for tidal and barometric influences, was 2.77 feet. Instantaneous drawdown over the first few moments after the pump was turned on was 2.58 feet, which suggests a maximum aquifer drawdown of 0.19 feet. Transducers were placed in North Waihee Wells 1 and 2, but unambiguous drawdown data could not be deciphered from the computer print-out. Tidal efficiency and barometric

fluctuations compounded by inconsistencies in transducer readings relegate the use of the data to speculation. Similarly the transducer data from the Kanoa monitor well evidently did not reliably reflect pumping drawdown. During testing transducer readings have to be supplemented by tape measurements to check their accuracy and reliability.

Chloride content during the test remained constant at 20 to 24 mg/l (see Appendix), the same as at Kupaa, and temperature fell between 69 and 71 F.

Clearly the North Waihee aquifer is highly permeable and capable of supplying low salinity water at satisfactory pumping rates. When the North Waihee 1 and North Waihee 2 wells were tested in 1981 and 1989, the transmissivity values were 325,000 sq.ft./day for the original test, and 320,000 sq.ft./day for the 1989 test. The associated storage coefficient values were .25 and .30.

Recommended Pump Size

As for Kupaa, the recommended pump size is 1200 gpm (1.73 mgd). For the DWS standard factor of .444, average production will be 0.77 mgd, for the more liberal factor of .667, the average will be 1.15 mgd.

APPENDIX

Kupaa 1 Step Drawdown

A value of transmissivity (T) can be calculated from a step drawdown test by assuming that drawdown at each rate is stable and that it is expressed by the equation,

$$s = aQ + bQ^2$$

in which s is drawdown , Q is pump rate, a is the laminar flow (aquifer) constant, and b is the turbulent flow (well loss) constant. The equation is linearized by dividing by Q,

$$s/Q = a + bQ$$

which plots as a straight line with s/Q as the ordinate and Q the abcissa. The value, a, is the intercept, and b is the slope of the line. An attached graph shows the linear form of the step drawdown curve for Kupaa 1.

To determine T, the intercept, a, is substituted in the Thiem steady state formula for drawdown as a function of pumping. The Thiem equation is,

$$s = (Q/2\pi T) \ln (R/r)$$

in which R is the nearest distance from the well where s = 0, and r is the effective radius of the well. The value of R is unknown and has to be approximated.

Because s = aQ in the step drawdown equation refers to laminar flow in the aquifer, substitution in the Thiem equation gives,

$$aQ = (Q/2\pi T) \ln (R/r),$$

and,

$$T = (1/2\pi a) \ln (R/r).$$

The intercept, a, has a value of .00067 (see graph), thus,

$$T = (237.6) \ln (R/r).$$

The value of R is estimated as equal to the length of penetration of the well below the water table (Zanger; Polybarunova-Kochina), and assuming the radius of the well as 1 foot,

$$T = (237.6) \ln (50) = 929.5 \text{ gpm/ft}$$

which when converted to consistent units (feet and days) is,

$$T = 178{,}928 \text{ sq.ft./day.}$$

For a depth of flow of 50 feet, k = 3566 ft/day.

Kupaa 1 Constant Rate

Drawdown during the period of monotonic decline before oscillation of the water level set in is plotted on an attached graph. If the Jacob simplification is employed, the T value from the graph is calculated as,

$$T = (264)\ (1200)/\Delta s$$

In which Δs is drawdown over one log cycle of time. Thus, T = 70,588 sq.ft./day, which is comparable to the THEISFIT value of 91,363 sq.ft./day.

Unfortunately, none of the test result data allows for calculation of storage coefficient (S). In the most thoroughly studied Hawaii basaltic aquifer similar to the Wailuku basalt, the Koolau aquifer, storage coefficient as effective porosity is approximately .05, but rigorously conducted tests at North Waihee 1 and North Waihee 2 in 1981 and 1989 gave S values of .25 and .30, respectively.

Kanoa 1 Step Drawdown

Employing the same applicable parameters as for the Kupaa 1 step drawdown analysis and a value of .0009606 ft./gpm for the aquifer constant, a, the computed value of T is 124,770 sq.ft./day. If depth of flow is equal to depth of penetration of the well below the water table (50 ft.), hydraulic conductivity is 2495 ft./day.

Kanoa 1 Constant Rate

The water level data derived from transducer readings was too imprecise to allow for realistic determination of aquifer parameters.

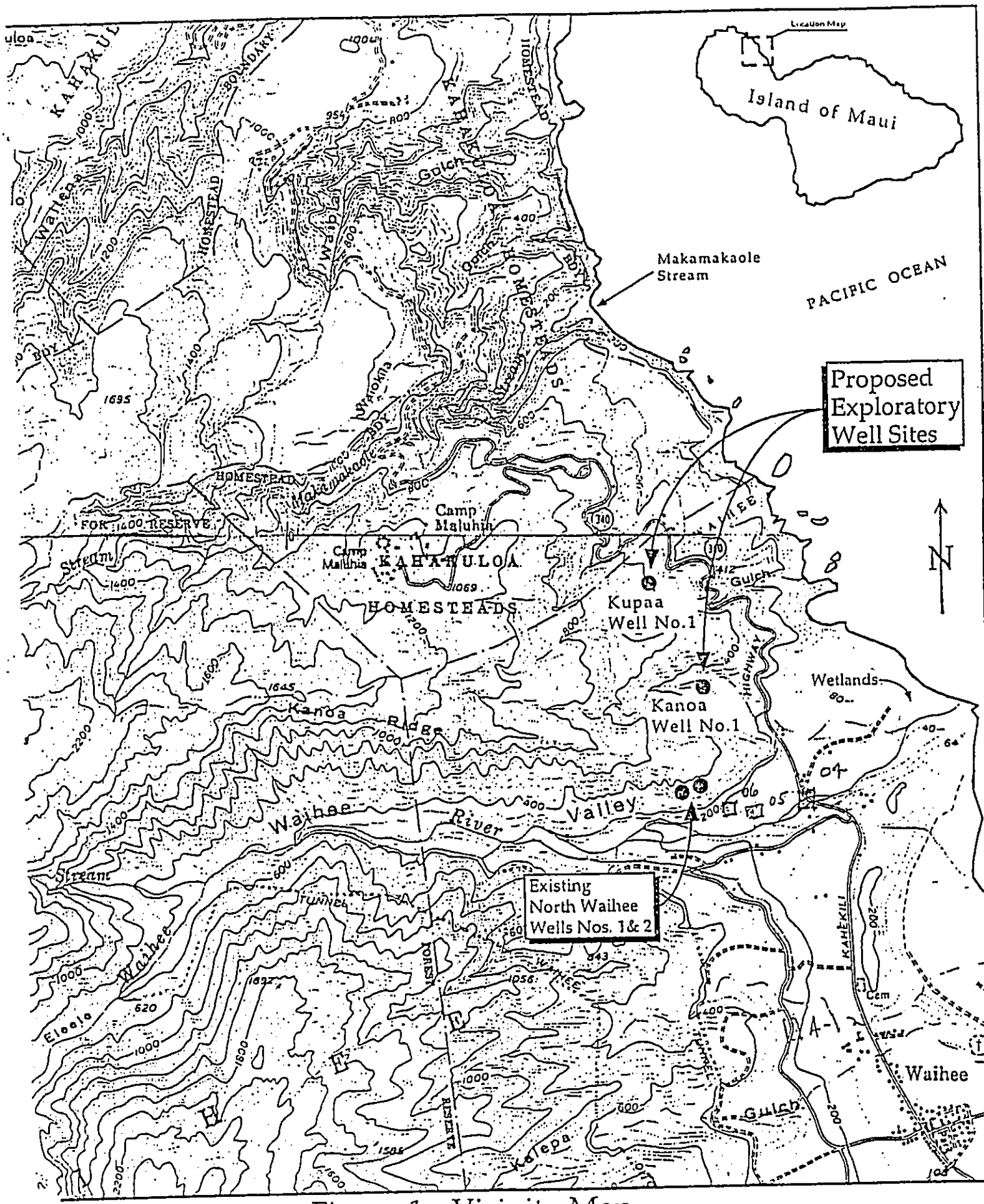


Figure 1 - Vicinity Map

Proposed Exploratory Well Sites

Kupaa Well NO.1 & Kanoa Well No.2

Waihee, Maui, Hawaii

State of Hawaii
COMMISSION ON WATER RESOURCE MANAGEMENT
Department of Land and Natural Resources

WELL COMPLETION REPORT

4/25/97 WCR Form

(Check Appropriate Box) ☑ Well Construction ☐ (Permanent) Pump Installation

Instructions: Please print or type and submit completed report within 30 days after well completion to the Commission on Water Resource Management, P.O. Box 621, Honolulu, Hawaii 96809. An as-built drawing of the well and chemical analysis should also be submitted. For assistance call the Commission Regulation Branch at 587-0225, or 1-800-468-4644 Extension 70225.

1. State Well No.: 5731-03 Well Name: Kōna'a Well Island: Maui
2. Location/Address: North Waihe'e, Wailuku Tax Map Key: 3-2-1:3

PART I. WELL CONSTRUCTION REPORT

3. Drilling Company: Wailani Drilling Inc.
4. Name of driller who performed work: Mike Robertson
5. Type of rig/construction: Air Rotary
6. Date(s) Well Construction and pump tests (if any) completed: 5/18/99
7. GROUND ELEVATION (referenced to mean sea level, msl): 637 ft.
   Well Bench Mark (description/location): Top of Casing Elevation(msl): 638.10 ft.
8. DRILLER'S LOG: *Please attach geologic log (if available or if required by permit)*

Depths (ft.)	Rock Description, Water Level, Dates, etc.	Depths (ft.)	Rock Description, Water Level, Dates, etc.
0 to 6	Red Clay	10 to 18	Grey Clay
6 to 10	Tan Clay & Assorted Rock	18 to 36	Grey Clay & Assorted Rock

(If more space is needed, continue on back.)

9. Total depth of well below ground: 687 ft.
10. Hole size: 22 inch dia. from 0 ft. to 687 ft. below ground
    — inch dia. from — ft. to — ft. below ground
    — inch dia. from — ft. to — ft. below ground
11. Casing installed: 16 in. I.D. x 3/8 in. wall solid section to 633 ft. below ground
    16 in. I.D. x 5/16 in. wall perforated section to 686 ft. below ground
    Casing Material/Slot Size: —
12. Annulus: Grouted from 0 ft. below ground to 630 ft. below ground
    Gravel packed from 633 ft. below ground to 686 ft. below ground
13. Initial water level: 631.35 ft. below ground. Date and time of measurement: 3/4/99
14. Initial chloride: 25 ppm Date and time of sampling: 3/4/99
15. Initial temperature: 71 °F Date and time of measurement: 3/4/99
16. PUMPING TESTS: Reference Point (R.P.) used: well casing, which elevation is 638.10 ft.
    (1) Step-Drawdown Test Date 3/12/99
    Start water level: 631.9 ft. below R.P.
    End water level 632.05 ft. below R.P.
    (2) Long-term Aquifer Test Date 3/15/99
    Start water level 631.90 ft. below R.P.
    End water level 632.20 ft. below R.P.
17. Aquifer Pump Test Procedures data & graphs *(1/9/96 LTAT Form)* attached? ✓ Yes __ No
18. As-built drawings attached attached? ✓ Yes __ No
19. Other remarks/comments: *(On back of this form)*

Well Drilling Contractor (print) Wailani Drilling Inc. C-57 Lic. No. C20115
Signature Mike Robertson Date 5/20/99

Surveyor (print) EDGARDO V. VALERA Lic. No. L.P.L.S. # 5076
Signature [signature] Date May 20, 1999

Applicant (print) Dept. of Water Supply
Signature [signature] Date 6/22/99

PART II. (PERMANENT) PUMP INSTALLATION REPORT

20. Pump Installation Company: _____
21. Name of person performing work: _____
22. Date Pump Installation Completed: _____
23. PUMP INSTALLATION:
    Pump Type, Make, Serial No.: _____ Capacity: _____ gpm
    Motor type, H.P., Voltage, rpm: _____
    Depth of Pump Intake Setting _____ ft. below _____, which elevation is _____ ft.
    Depth to bottom of airline _____ ft. below _____, which elevation is _____ ft.
    Pumping Head is _____ ft. Type of flow meter: _____ which measures in _____
24. As-built drawings attached attached? __ Yes __ No
25. Other remarks/comments: *(See below)*

Pump Installation Contractor (print) _____ C-57 Lic. No. _____

Signature _____ Date _____

Applicant (print) _____

Signature _____ Date _____

8.(cont'd) DRILLER'S LOG (cont'd):

Water Level Dates	(ft.)	Depth (ft.)	Rock Description, Remarks,
36	41		Weathered Basalt
41	59		Blue Rock
59	60		Weathered Basalt
60	80		Blue Rock
80	110		Assorted Rock & Coral
110	135		Brown Clay & Assorted Rock
135	160		Dense Basalt Blue Rock
160	170		Assorted Rock
170	315		Dense Basalt Blue Rock
315	325		Softer Basalt
325	340		Tan Clay & Basalt
340	355		Softer Basalt
355	375		Tan Rock
375	385		Soft Basalt
385	493		Basalt & Brown Rock
493	510		Tan Rock
510	535		Basalt - Brown Rock - Red Cinder
535	635		Basalt - Black & Red Cinders
635	685		Black & Red Cinders

Water Level Dates	(ft.)	Depth (ft.)	Rock Description, Remarks,

19.& 25. Remarks: _____

Wailani Drilling Inc.

655 Kulike Rd. Haiku, Maui, Hawaii 96708
Mike Robertson Ph. 808 572-2673
Fax 572-0925 Cellular 283-8481

Well Log

Kupaa well #1
8/27/98

Date / Time	Depth	Drill pipe	Drift Degree	Tooling / Geologic Formation	Air Press.	Bit Press.
8/27 3:30	0-6	N.A.		12 in. HAMMER + STAB = 7 ft.- TOP SUB =2 ft. RED CLAY	150	N.A.
	6-10	"		add 18 ft x 12 in. stabilizer/ TAN CLAY AND ASSORTED ROCK		
	10-18	"		GREY CLAY		
5:00	18-25	"	0.25	GREY CLAY AND ASSORTED ROCK		
8/28 11:45	25-31	"		add 58x12 inch stabilizer / GREY CLAY AND ASSORTED ROCK		
12:30	31-36	"		add 69x12 inch stabilizer/ GREY CLAY AND ASSORTED ROCK		
2:12	36-41	"		add 69x12 inch stabilizer/ WEATHERED BASALT		
2:33	41-46	"		add 69x12 inch stabilizer/ BLUEROCK		
3:20	46-49	"		add 67x12 inch stabilizer/ BLUEROCK		
3:31	49-54	"	0.2	add 67x12 inch stabilizer/ BLUEROCK		
3:45-4:30	54-60.41	"		add 67x12 inch stabilizer/ BLUEROCK- LAST FOOT(59-60.41)WEATHERED BASALT		
8/31 8:00				all pilot tools installed-install diverter-		
11:23	60-80	# 1		start drill pipe #1/ DENSE BASALT		
12:20	80-85		0.1	ASSORTED ROCK- CORAL		
1:04 1:27	85-110	# 2		SAME FORMATION		
2:25	110-135	# 3	0.6 *	BROWN CLAY AND ASSORTED ROCK		
3:05	135-160	# 4	0.4 *	DENSE BASALT		
	160-170		0.25	ASSORTED ROCK		
4:00 4:40	170-185	# 5	0.3	DENSE BASALT		
9/1 10:10	185-210	# 6	0.2	DENSE BASALT		
11:10	210-235	# 7	0.3	DENSE BASALT		
12:05	235-260	# 8	0.1	DENSE BASALT		
12:50	260-285	# 9	0.6 *	DENSE BASALT (Bluerock)		
1:50-3:50	285-310	# 10	0.2	DENSE BASALT (Bluerock)		

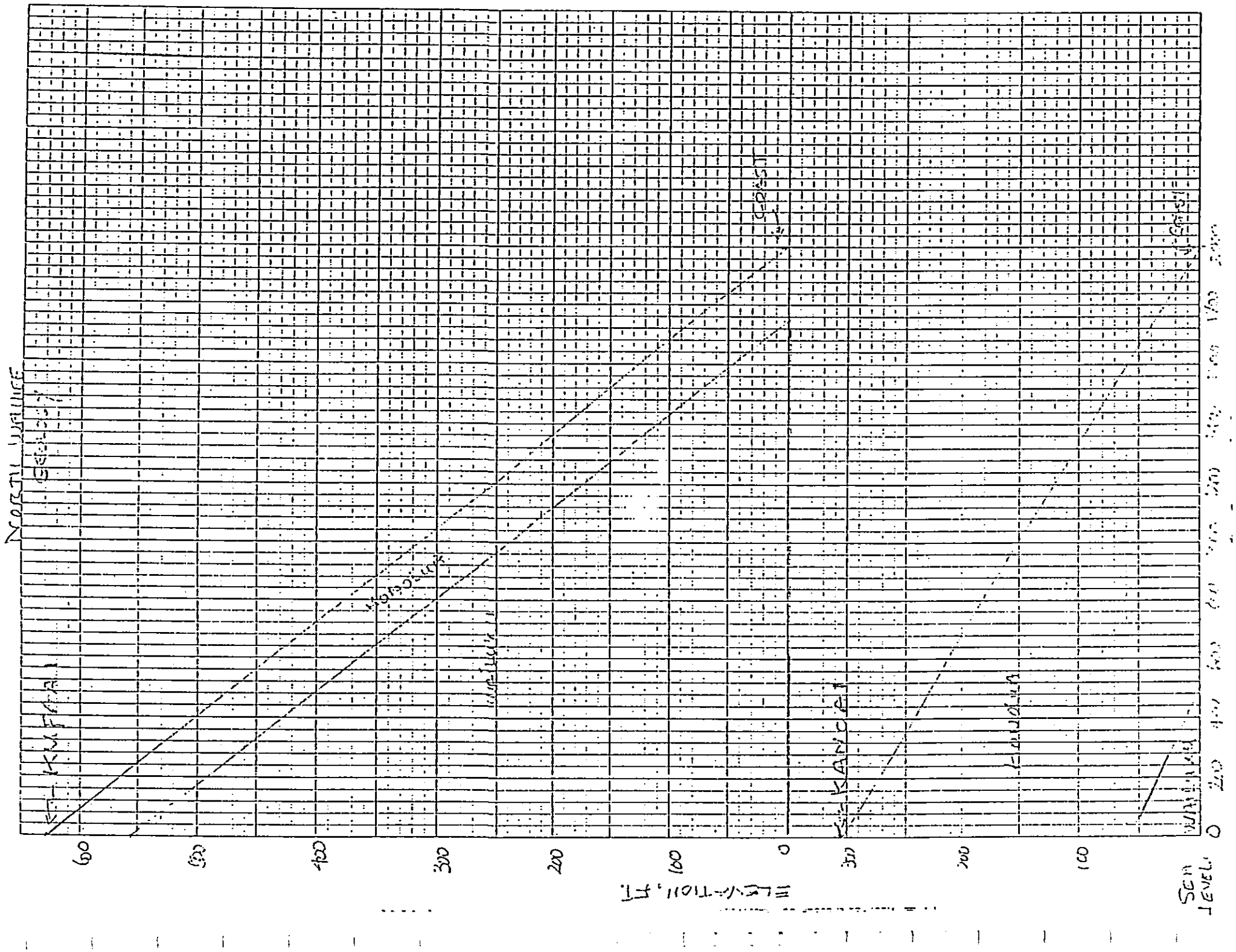
Wailani Drilling Inc.

655 Kulike Rd. Haiku, Maui, Hawaii 96708
Mike Robertson Ph. 808 572-2673
Fax 572-0925 Cellular 283-8481

Well Log

Kupaa well #1
9/2/98

Date / Time	Drill pipe no.	Depth	Drift Degree	Tooling / Geologic Formation	Air Press.	Bit Press.
9/2/98	Rain- No Drilling Today					
9/3 11:00	# 11	310-315		HARD BASALT	150	
	"	315-325		SOFTER BASALT		
12:00	"	325-335	0.25	TAN CLAY AND BASALT		
12:15	# 12	335-340		TAN CLAY AND BASALT		
		340-355		SOFTER BASALT		
1:15		355-360	0.1	TAN ROCK		
1:30-2:20	# 13	360-375	0.25	TAN ROCK		
		375-385		SOFTER BASALT		
2:30-320	# 14	385-410	0.25	BASALT AND BROWN ROCK		
3:30	# 15	410-435	0.2	BASALT AND BROWN ROCK		
4:30-5:15	# 16	435-460	0.24	BASALT AND BROWN ROCK		
9/4 9:30-10:15	# 17	460-485	0.3	BASALT AND BROWN ROCK		
10:45	# 18	485-493		BASALT AND BROWN ROCK		
11:55		493-510	0.1	TAN ROCK		
12:10	# 19	510-535	0.1	BASALT-BROWN ROCK-RED CINDERS		
2:00-3:05	# 20	535-560	0.3	BASALT - BLACK + RED CINDERS		
3:30-4:20	# 21	560-585	0.2	BASALT - BLACK + RED CINDERS		
4:45-5:18	# 22	585-610	0.4	BASALT - BLACK + RED CINDERS		
9/8 2:00-2:46	#23	610-635	0.01	BASALT - BLACK + RED CINDERS		
3:05-4:10	#24	635-660	0.02	BLACK + RED CINDERS		
410-4:40	#25	660-675		BLACK + RED CINDERS (Bit Stuck)		
11/30 9:30-11:50	#25	675-685		BLACK + RED CINDERS		



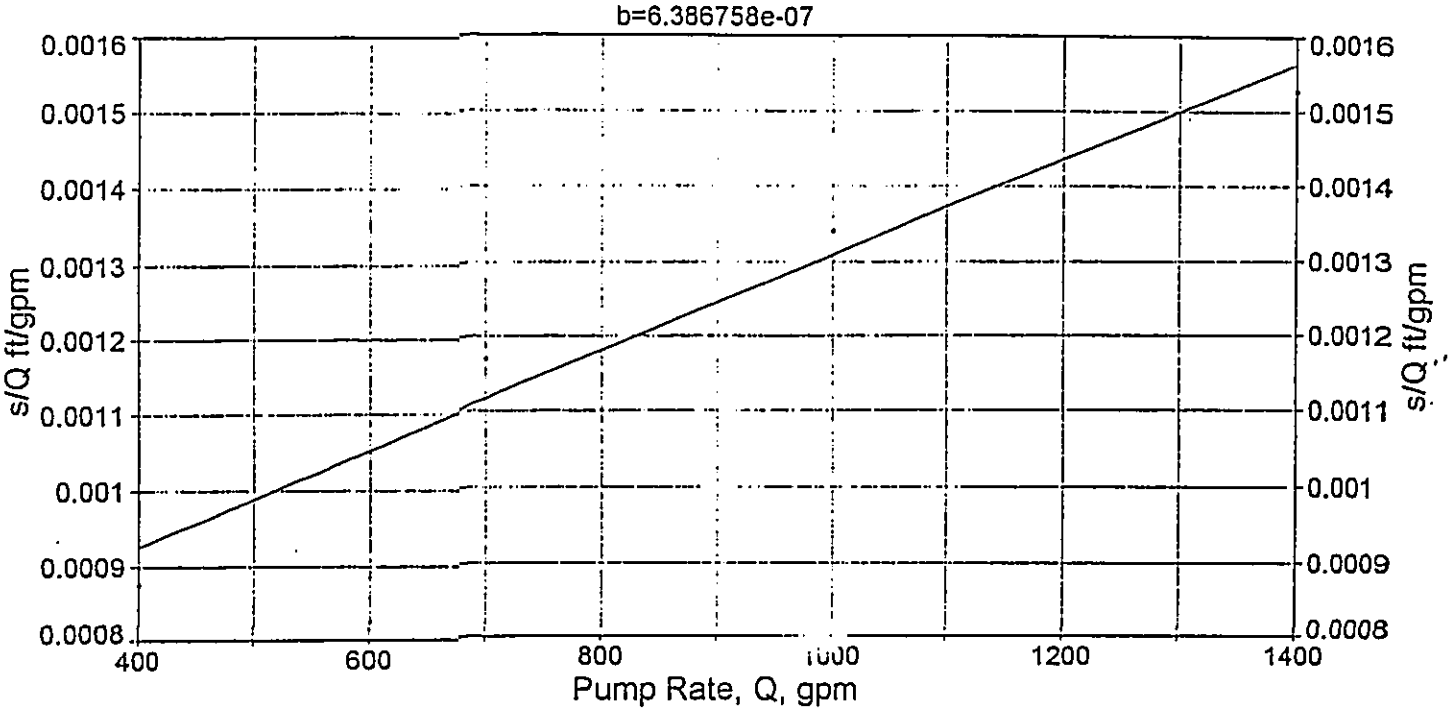
Kupaa 1 Step Drawdown Test

Rank 1 Eqn 8160 [Line Robust None, Gaussian Errors] y=a+bx

r^2=0.9667889 DF Adj r^2=0.90036669 FitStdErr=6.1934602e-05 Fstat=58.220822

a=0.00066990868

b=6.386758e-07



CALCULATION OF 'BEST FIT' TRANSMISSIVITY AND STORAGE COEFFICIENT BY AUTOMATICALLY FITTING EXPERIMENTAL PUMPTEST DATA TO THE THEIS EQUATION IN A LEAST SQUARES SENSE.

---

constant rate test

********** INPUT DATA **********

ENGLISH UNITS

PUMPAGE RATE: 1200 [GAL/MIN]
OBSERVATION DISTANCE FROM PUMPING WELL: 1 [FT]

NUMBER OF ENTERED TIME-DRAWDOWN DATA PAIRS: 8

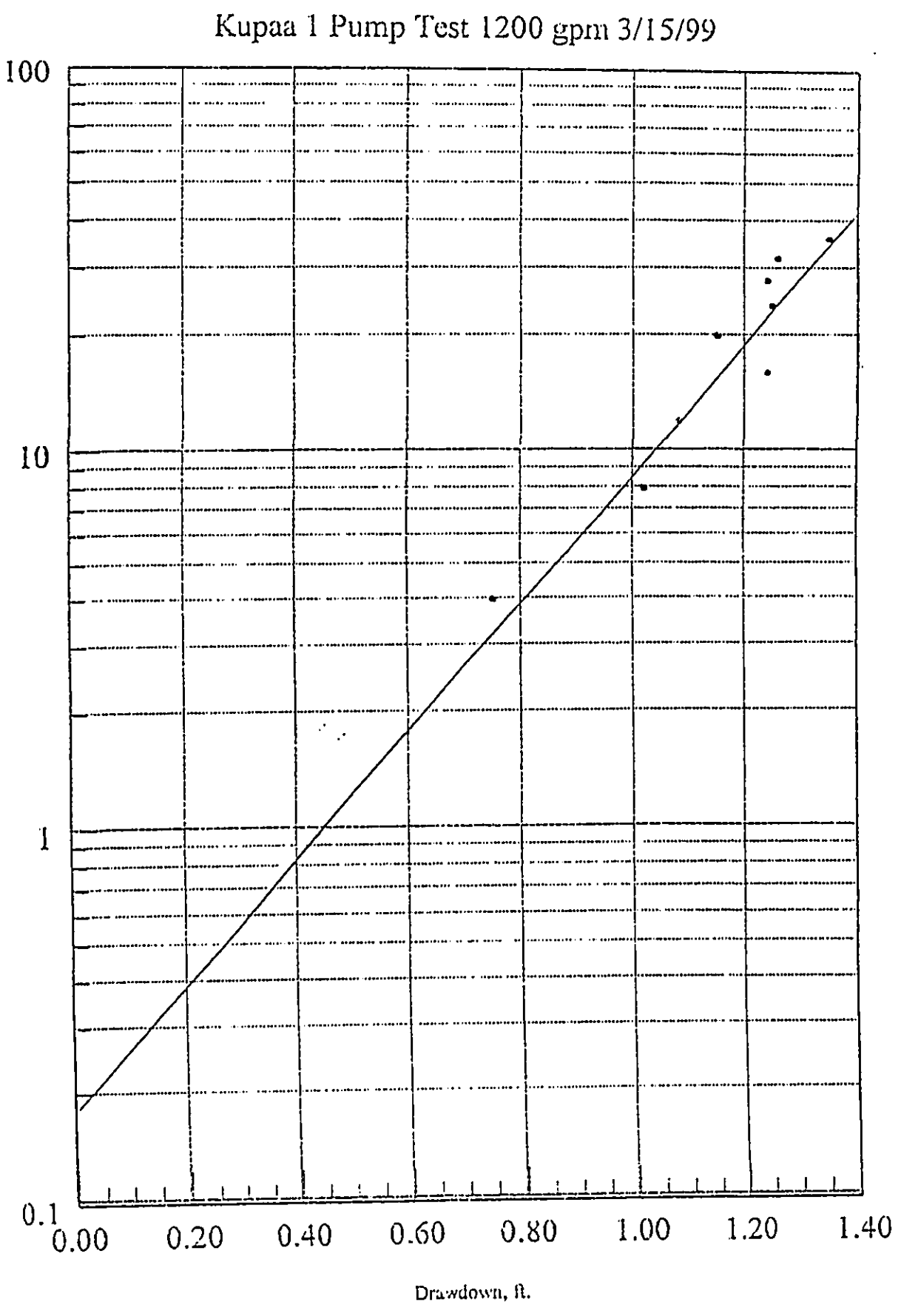
EXPERIMENTAL TIME-DRAWDOWN DATA

TIME [MIN]	DRAWDOWN [FT]
4	.75
8	1.02
12	1.08
16	1.24
24	1.25
32	1.26
36	1.35
44	1.36

********** RESULTS ********** PAGE

CALCULATED GUESS FOR TRANSMISSIVIY SC: 475.845 [GAL/MIN/FT]
CALCULATED GUESS FOR STORAGE COEFFICIENT SC: 7.113292

ITERATION 1 BEST FIT: KB = 378.8661 [GAL/MIN/FT] SC = 1
ITERATION 2 BEST FIT: KB = 433.6396 [GAL/MIN/FT] SC = 1
ITERATION 3 BEST FIT: KB = 460.354 [GAL/MIN/FT] SC = 1
ITERATION 4 BEST FIT: KB = 470.2363 [GAL/MIN/FT] SC = 1
ITERATION 5 BEST FIT: KB = 473.3729 [GAL/MIN/FT] SC = 1
ITERATION 6 BEST FIT: KB = 474.31 [GAL/MIN/FT] SC = 1
ITERATION 7 BEST FIT: KB = 474.5846 [GAL/MIN/FT] SC = 1


Kupaa 1 Pump Test 1200 gpm 3/15/99
100
10
1
0.1
Time, min.
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
Drawdown, ft.

COUNTY OF MAUI
DEPARTMENT OF WATER SUPPLY
WATER QUALITY LAB
614 PALAPALA DRIVE
KAHULUI, MAUI, HAWAII 96732

REPORT DATE: MAR 22, 1999

CLIENT: **TAKUMI ENGINEERING**
18 CENTRAL AVENUE
WAILUKU, MAUI, HAWAII 96793
PHONE #: 249-0411

MATRIX: WATER

SAMPLER:

EPA METHOD: CHLORIDE: 4500-Cl^-

SAMPLE ID KUPAA WELL 1	CHLORIDE mg/L		SAMPLE ID KUPAA WELL 1	CHLORIDE mg/L
3/15/99 @ 0935 by WS	20		3/18/99 @ 0806 by KK	25
3/15/99 @ 2100 by ?	22		3/18/99 @ 0900 by WS	25
3/16/99 @ 0900 by ?	22		3/18/99 @ 2100 by NR	20
3/16/99 @ 2100 by MR	20		3/19/99 @ 0900 by NR	21
3/17/99 @ 0900 by MR	21			
3/17/99 @2100 by MR	25			

APPROVED BY: C.CERIZO
W.M. IV

State of Hawaii
COMMISSION ON WATER RESOURCE MANAGEMENT
Department of Land and Natural Resources

WELL COMPLETION REPORT

4/25/97 WCR Form

(Check Appropriate Box) ☑ Well Construction ☐ (Permanent) Pump Installation

Instructions: Please print or type and submit completed report within 30 days after well completion to the Commission on Water Resource Management, P.O. Box 621, Honolulu, Hawaii 96809. An as-built drawing of the well and chemical analysis should also be submitted. For assistance call the Commission Regulation Branch at 587-0225, or 1-800-468-4644 Extension 70225.

1. State Well No.: 5731-02 Well Name: Kānoa Well Island: Maui
2. Location/Address: North Waihe'e, Wailuku Tax Map Key: 3-2-1:3

PART I. WELL CONSTRUCTION REPORT

3. Drilling Company: Wailani Drilling Inc.
4. Name of driller who performed work: Mike Robertson
5. Type of rig/construction: Air Rotary
6. Date(s) Well Construction and pump tests (if any) completed: 5/25/99
7. GROUND ELEVATION (referenced to mean sea level, msl): 307.76 ft.
   Well Bench Mark (description/location): Top of pump base plate Elevation(msl): 309.15 ft.
8. DRILLER'S LOG: *Please attach geologic log (if available or if required by permit)*

Depths (ft.)	Rock Description, Water Level, Dates, etc.	Depths (ft.)	Rock Description, Water Level, Dates, etc.
0 to 38	Gray Weathered Rock+Clay	60 to 70	Gray Rock
38 to 60	Same with less Clay	70 to 85	Gray Rock, Weathered Basalt

(If more space is needed, continue on back.)

9. Total depth of well below ground: 359 ft.
10. Hole size: 22 inch dia. from +2 ft. to 359 ft. below ground
    ____ inch dia. from ____ ft. to ____ ft. below ground
    ____ inch dia. from ____ ft. to ____ ft. below ground
    ____ inch dia. from ____ ft. to ____ ft. below ground
11. Casing installed: 16 in. I.D. x 3/8 in. wall solid section to 305 ft. below ground
    16 in. I.D. x 5/16 in. wall perforated section to 359 ft. below ground
    Casing Material/Slot Size: 1/4" full flow Louvered
12. Annulus: Grouted from 0 ft. below ground to 300 ft. below ground
    Gravel packed from 300 ft. below ground to 359 ft. below ground
13. Initial water level: 299.83 ft. below ground. Date and time of measurement: 5/17/99
14. Initial chloride: 35 ppm Date and time of sampling: 5/17/99
15. Initial temperature: 69 °F Date and time of measurement: 5/17/99
16. PUMPING TESTS: Reference Point (R.P.) used: pump base plate, which elevation is 309.15 ft.
    (1) Step-Drawdown Test Date 5/14/99
    Start water level 301.34 ft. below R.P.
    End water level 301.3 ft. below R.P.
    (2) Long-term Aquifer Test Date 5/17/99
    Start water level 301.22 ft. below R.P.
    End water level 301.3 ft. below R.P.
17. Aquifer Pump Test Procedures data & graphs *(1/9/96 LTAT Form)* attached? ✓ Yes __ No
18. As-built drawings attached attached? ✓ Yes __ No
19. Other remarks/comments: *(On back of this form)*

Well Drilling Contractor (print) Mike Robertson C-57 Lic. No. 20115
Signature Mike Robertson Date 5/25/99

Surveyor (print) EDGARDO GALERA Lic. No. L.P.L.S. Cert. # 5076
Signature [illegible] Date June 16, 1999

Applicant (print) Department of Water Supply
County of Maui
Signature [illegible] Date 6/28/99
Barry Fukunaga, Director

PART II. (PERMANENT) PUMP INSTALLATION REPORT

20. Pump Installation Company: _____
21. Name of person performing work: _____
22. Date Pump Installation Completed: _____
23. PUMP INSTALLATION:
    Pump Type, Make, Serial No.: _____ Capacity: _____ gpm
    Motor type, H.P., Voltage, rpm: _____
    Depth of Pump Intake Setting _____ ft. below _____, which elevation is _____ ft.
    Depth to bottom of airline _____ ft. below _____, which elevation is _____ ft.
    Pumping Head is _____ ft. Type of flow meter: _____ which measures in _____
24. As-built drawings attached attached? __ Yes __ No
25. Other remarks/comments: *(See below)*

Pump Installation Contractor (print) _____ C-57 Lic. No. _____

Signature _____ Date _____

Applicant (print) _____

Signature _____ Date _____

8.(cont'd) DRILLER'S LOG (cont'd):

Water Level Dates	(ft.)	Depth (ft.)	Rock Description, Remarks,
85	to 135		Hard Basalt Bluerock
135	to 225		Weathered Basalt
225	to 240		Hard Basalt
240	to 250		Hard Tan Rock
250	to 260		Weathered Basalt
260	to 305		Softer Black Lava (gg)
305	to 325		Dense Bluerock
325	to 359		Black + Red Cinders + Water
	to		
	to		Hit Water at 325'
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		

Water Level Dates	(ft.)	Depth (ft.)	Rock Description, Remarks,
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		

19.& 25. Remarks: _____

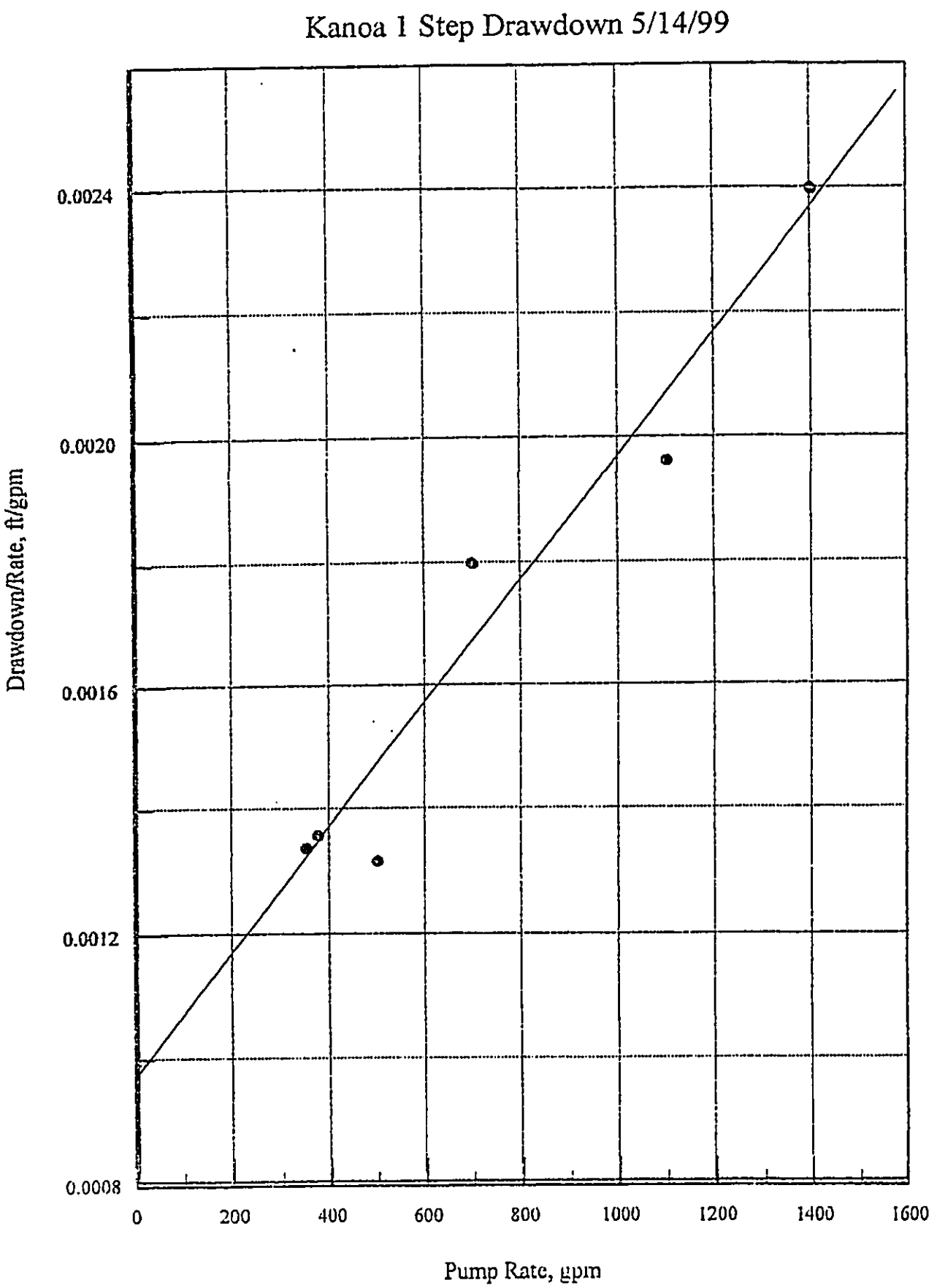
Wailani Drilling Inc.

655 Kulike Rd. Haiku, Maui, Hawaii 96708
Mike Robertson Ph. 808 572-2673
Fax 572-0925 Cellular 283-8481

Well Log

Kanoa Well #1
8/27/98

Date / Time	Drill Pipe #	Drift Degrees	Depth in feet	Tooling / Geologic Formation	Air Press.	Bit Press.
3/15/99 8:30			0-22	12 in. x 7 ft. hammer + 17 ft. stabilizer		
9:15			22-38	white gray weathered rock and clay		
9:40			38-60	add 5ft. 8in.x 12 in stab / gray rock and clay		
12:05				add 30 ft. of stabilizers total= 60 ft stabilization		
1:30	1	0.3	70-85	same formation- gray rock and less clay		
				gray rock -		
4:30	2	0.4	85-110	weathered basalt		
3/16/99 8:00	3	0.5	115-135	hard basalt		
				same		
9:45	4	0.5	135-160	softer basalt		
10:20	5	0.3	160-185	same		
11:15	6	0.7	185-210	same		
12:10	7	0.6	210-225	same		
			225-235	hard dense basalt		
3:15	8	0.5	235-240	same		
			240-250	hard tan rock		
			250-260	weathered basalt		
4:10	9	0.3	260-285	soft black lava (aa)		
4:40	10	0.6	285-305	same		
			305-310	bluerock basalt		
3/17/99 8:00	11	0.4	310-325	same		
			325-335	black and red cinders - hit water table	125	0
10:10	12		335-359	black and red cinders - water bearing	150	18
				Static Water Level = 299.68 ft.	163	32
				Reference elevation point = 307.76 ft.		
				Static Head = 8.08 ft.		



COUNTY OF MAUI
DEPARTMENT OF WATER SUPPLY
WATER QUALITY LAB
614 PALAPALA DRIVE
KAHULUI, MAUI, HAWAII 96732

REPORT DATE: JUNE 2, 1999

CLIENT: TAKUMI ENGINEERING
18 CENTRAL AVENUE
WAILUKU, MAUI, HAWAII 96793
PHONE #: 249-0411

MATRIX: WATER

SAMPLER:

EPA METHOD: CHLORIDE: 4500-Cl

SAMPLE ID KANOA WELL 1	CHLORIDE mg/L	SAMPLE ID KANOA WELL 1	CHLORIDE mg/L
5/14/99 by WS	20	5/19/99 @ 0900 by MR	24
5/17/99 @ 0930 by WS	20	5/20/99 @ 1430 by WS	24
5/18/99 @ 0820 by LP	21	5/21/99 @ 0900 by WS	24

ANALYST: L. AMANO

APPROVED BY: C.CERIZO
W.M. IV

CORRECTION

THE PRECEDING DOCUMENT(S) HAS
BEEN REPHOTOGRAPHED TO ASSURE
LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING

COUNTY OF MAUI
DEPARTMENT OF WATER SUPPLY
WATER QUALITY LAB
614 PALAPALA DRIVE
KAHULUI, MAUI, HAWAII 96732

REPORT DATE: JUNE 2, 1999

CLIENT: TAKUMI ENGINEERING
18 CENTRAL AVENUE
WAILUKU, MAUI, HAWAII 96793
PHONE #: 249-0411

MATRIX: WATER

SAMPLER:

EPA METHOD: CHLORIDE: 4500-Cl⁻

SAMPLE ID KANOA WELL 1	CHLORIDE mg/L	SAMPLE ID KANOA WELL 1	CHLORIDE mg/L
5/14/99 by WS	20	5/19/99 @ 0900 by MR	24
5/17/99 @ 0930 by WS	20	5/20/99 @ 1430 by WS	24
5/18/99 @ 0820 by LP	21	5/21/99 @ 0900 by WS	24

ANALYST: L. AMANO

APPROVED BY: C.CERIZO
W.M. IV

EXHIBIT B

WATER QUALITY TESTING RESULTS

EXHIBIT B-1

WATER QUALITY ANALYSIS

NORTH WAIHEE WELL NO. 2

COUNTY OF MAUI
BOARD OF WATER SUPPLY
WATER QUALITY LABORATORY
614 PALAPALA DRIVE
KAHULUI,MAUI,HAWAII 96732

REPORT DATE: JUNE 23, 1997

SITE: NORTH WAIHEE WELL # 2
USGS 56-31-03

MATRIX: WATER

DATE/TIME SAMPLED: 6/09/97 @ 1000 CL2: 0.0 [MG/L]
SAMPLER: K.KUBA

DATE/TIME RECEIVED: 6/09/97 @ 1228
TEMP.CONTROL: 7.0 ° C

EPA METHOD:
TOTAL COLIFORM: 9222B
FECAL COLIFORM: 9221C
HPC: 9215B

SAMPLE ID	TOTAL COLIFORM BACTERIA [# / 100 ML]	FECAL COLIFORM VERIFICATION	HPC [CFU/100 ML]
NORTH WAIHEE WELL #2 [S-574]	NOT FOUND		610

ANALYST: L.POOLE

APPPROVED BY: C.CERIZO
CHEMIST

County of Maui
Department of Water Supply
Water Quality Laboratory
614 Palapala Drive
Kahului, Maui, Hawaii 96732

June 23, 1997

Location: NORTH WAIHEE WELL #2
USGS 56-31-03

Date Sampled Collected: June 9, 1997

Sampler: K.Kuba

TEST	UNITS	METHOD	MCL	RESULTS
Conductivity	uS/cm	2510B	-	292
pH	-	4500H	6.5-8.5	7.2
Temperature				22°C
Turbidity	N.T.U.	2130B	< 1.0	0.88

MONTGOMERY WATSON LABORATORIES
555 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6324;
1 800 566 LABS (1 800 566 5227)

Laboratory
Report
#34716

Maui, County of, Department of
Water Supply
Cari Cerizo
614 Palapala Dr
Kahului , HI 96732

Samples Received

10-jun-1997 12:45:04

Anal	Method	Analyte	Result	Units	MDL
N. WAIHEE WELL 2 USGS 563103 (970610016)			Sampled on 06/09/97		
06/16/97	ML/S23208	Alkalinity	110	mg/l	2.0
06/10/97	ML/EPA 100.1	Asbestos by TEM	<0.13	MFL	0.13
06/16/97	EPA/ML 200.7	Calcium, Total, ICAP	13	mg/l	1.0
06/16/97	ML/S4500CN-F	Cyanide	ND	mg/l	0.025
06/20/97	ML/EPA 548.1	Endothall	ND	ug/l	5.0
06/16/97	SM 4500F	Fluoride	0.20	mg/l	0.10
06/12/97	ML/EPA 547	Glyphosate	ND	ug/l	6.0
06/16/97	EPA/ML 245.1	Mercury	ND	ug/l	0.50
06/10/97	ML/EPA 300.0	Nitrite, Nitrogen by IC	ND	mg/l	0.10
06/13/97	EPA 1613	2,3,7,8 - TCDD	ND	PGL	0.63
		525 Semivolatiles by GC/MS			
06/19/97	ML/EPA 525.2	2,4-Dinitrotoluene	ND	ug/l	0.10
06/19/97	ML/EPA 525.2	alpha-Chlordane	ND	ug/l	0.050
06/19/97	ML/EPA 525.2	Acenaphthylene	ND	ug/l	0.10
06/19/97	ML/EPA 525.2	Alachlor	ND	ug/l	0.050
06/19/97	ML/EPA 525.2	Aldrin	ND	ug/l	0.050
06/19/97	ML/EPA 525.2	Anthracene	ND	ug/l	0.020
06/19/97	ML/EPA 525.2	Atrazine	ND	ug/l	0.050
06/19/97	ML/EPA 525.2	Benz(a)Anthracene	ND	ug/l	0.050
06/19/97	ML/EPA 525.2	Benzo(a)pyrene	ND	ug/l	0.020
06/19/97	ML/EPA 525.2	Benzo(b)Fluoranthene	ND	ug/l	0.020
06/19/97	ML/EPA 525.2	Benzo(g,h,i)Perylene	ND	ug/l	0.050
06/19/97	ML/EPA 525.2	Benzo(k)Fluoranthene	ND	ug/l	0.020
06/19/97	ML/EPA 525.2	Di(2-Ethylhexyl)phthalate	ND	ug/l	0.60
06/19/97	ML/EPA 525.2	Butylbenzylphthalate	ND	ug/l	0.50
06/19/97	ML/EPA 525.2	Bromacil	ND	ug/l	2.0
06/19/97	ML/EPA 525.2	Butachlor	ND	ug/l	0.050
06/19/97	ML/EPA 525.2	Caffeine	ND	ug/l	0.020
06/19/97	ML/EPA 525.2	Chrysene	ND	ug/l	0.020
06/19/97	ML/EPA 525.2	Dibenz(a,h)Anthracene	ND	ug/l	0.050

MONTGOMERY WATSON LABORATORIES
555 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6324;
1 800 566 LABS (1 800 566 5227)

Laboratory
Report
#34716

Maui, County of, Department of
Water Supply
(continued)

Anal	Method	Analyte	Result	Units	MDL
06/19/97	(ML/EPA 525.2)	Di-(2-Ethylhexyl)adipate	ND	ug/l	0.60
06/19/97	(ML/EPA 525.2)	Diethylphthalate	ND	ug/l	0.50
06/19/97	(ML/EPA 525.2)	Dieldrin	ND	ug/l	0.20
06/19/97	(ML/EPA 525.2)	Dimethylphthalate	ND	ug/l	0.50
06/19/97	(ML/EPA 525.2)	Dimethoate	ND	ug/l	10
06/19/97	(ML/EPA 525.2)	Di-n-Butylphthalate	ND	ug/l	0.50
06/19/97	(ML/EPA 525.2)	Endrin	ND	ug/l	0.10
06/19/97	(ML/EPA 525.2)	Fluorene	ND	ug/l	0.050
06/19/97	(ML/EPA 525.2)	gamma-Chlordane	ND	ug/l	0.050
06/19/97	(ML/EPA 525.2)	Hexachlorobenzene	ND	ug/l	0.050
06/19/97	(ML/EPA 525.2)	Hexachlorocyclopentadiene	ND	ug/l	0.050
06/19/97	(ML/EPA 525.2)	Heptachlor	ND	ug/l	0.040
06/19/97	(ML/EPA 525.2)	Heptachlor Epoxide	ND	ug/l	0.020
06/19/97	(ML/EPA 525.2)	Indeno(1,2,3,c,d)Pyrene	ND	ug/l	0.050
06/19/97	(ML/EPA 525.2)	Isophorone	ND	ug/l	0.50
06/19/97	(ML/EPA 525.2)	Lindane	ND	ug/l	0.020
06/19/97	(ML/EPA 525.2)	Methoxychlor	ND	ug/l	0.050
06/19/97	(ML/EPA 525.2)	Metribuzin	ND	ug/l	0.050
06/19/97	(ML/EPA 525.2)	Molinate	ND	ug/l	0.20
06/19/97	(ML/EPA 525.2)	Metolachlor	ND	ug/l	0.050
06/19/97	(ML/EPA 525.2)	trans-Nonachlor	ND	ug/l	0.050
06/19/97	(ML/EPA 525.2)	Pentachlorophenol	ND	ug/l	1.0
06/19/97	(ML/EPA 525.2)	Phenanthrene	ND	ug/l	0.020
06/19/97	(ML/EPA 525.2)	Prometryn	ND	ug/l	0.50
06/19/97	(ML/EPA 525.2)	Propachlor	ND	ug/l	0.050
06/19/97	(ML/EPA 525.2)	Pyrene	ND	ug/l	0.050
06/19/97	(ML/EPA 525.2)	Simazine	ND	ug/l	0.050
06/19/97	(ML/EPA 525.2)	Thiobencarb	ND	ug/l	0.20
06/19/97	(ML/EPA 525.2)	Trifluralin	ND	ug/l	0.10
	(Surrogate)	Perylene-d12	103	% Rec	
		Aldicarbs			
06/17/97	(ML/EPA 531.1)	3-Hydroxycarbofuran	ND	ug/l	2.0
06/17/97	(ML/EPA 531.1)	Aldicarb (Temik)	ND	ug/l	0.50
06/17/97	(ML/EPA 531.1)	Aldicarb sulfone	ND	ug/l	0.80

MONTGOMERY WATSON LABORATORIES
555 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6324;
1 800 566 LABS (1 800 566 5227)

Laboratory
Report
#34716

Maui, County of, Department of
Water Supply
(continued)

Anal	Method	Analyte	Result	Units	MDL
06/17/97	(ML/EPA 531.1)	Aldicarb sulfoxide	ND	ug/l	0.50
06/17/97	(ML/EPA 531.1)	Baygon	ND	ug/l	2.0
06/17/97	(ML/EPA 531.1)	Carbofuran (Furadan)	ND	ug/l	0.90
06/17/97	(ML/EPA 531.1)	Carbaryl	ND	ug/l	2.0
06/17/97	(ML/EPA 531.1)	Methiocarb	ND	ug/l	2.0
06/17/97	(ML/EPA 531.1)	Methomyl	ND	ug/l	1.0
06/17/97	(ML/EPA 531.1)	Oxamyl (Vydate)	ND	ug/l	2.0
	(Surrogate)	BDMC	98	% Rec	
		Diquat and Paraquat			
06/18/97	(ML/EPA 549.1)	Diquat	ND	ug/l	0.40
06/18/97	(EPA 549.1)	Paraquat	ND	ug/l	2.0
		EDB and DBCP by GC-ECD			
06/14/97	(ML/EPA 504.1)	Dibromochloropropane (DBCP)	ND	ug/l	0.010
06/14/97	(ML/EPA 504.1)	Ethylene Dibromide (EDB)	ND	ug/l	0.010
	(Surrogate)	1,2-dibromopropane	121	% Rec	
		Herbicides by 515.1			
06/21/97	(ML/EPA 515.1)	2,4,5-T	ND	ug/l	0.20
06/21/97	(ML/EPA 515.1)	2,4,5-TP (Silvex)	ND	ug/l	0.20
06/21/97	(ML/EPA 515.1)	2,4-D	ND	ug/l	0.10
06/21/97	(ML/EPA 515.1)	2,4-DB	ND	ug/l	2.0
06/21/97	(ML/EPA 515.1)	Dichlorprop	ND	ug/l	0.50
06/21/97	(ML/EPA 515.1)	Acifluorfen (qualitative)	ND	ug/l	0.20
06/21/97	(ML/EPA 515.1)	Bentazon	ND	ug/l	0.50
06/21/97	(ML/EPA 515.1)	Dalapon (qualitative)	ND	ug/l	1.0
06/21/97	(ML/EPA 515.1)	3,5-Dichlorobenzoic acid	ND	ug/l	0.60
06/21/97	(ML/EPA 515.1)	DCPA	ND	ug/l	0.20
06/21/97	(ML/EPA 515.1)	Dicamba	ND	ug/l	0.080
06/21/97	(ML/EPA 515.1)	Dinoseb	ND	ug/l	0.20
06/21/97	(ML/EPA 515.1)	Pentachlorophenol	ND	ug/l	0.040
06/21/97	(ML/EPA 515.1)	Picloram	ND	ug/l	0.10
06/21/97	(ML/EPA 515.1)	4-Nitrophenol (qualitative)	ND	ug/l	5.0
	(Surrogate)	2,4-Dichlorophenylacetic acid	102	% Rec	

MONTGOMERY WATSON LABORATORIES
555 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6324;
1 800 566 LABS (1 800 566 5227)

Laboratory
Report
#34716

Maui, County of, Department of
Water Supply
(continued)

Anal	Method	Analyte	Result	Units	MDL
		ICPMS Metals			
06/13/97	(EPA/ML 200.8)	Arsenic, Total, ICAP/MS	ND	ug/l	5.0
6/13/97	(EPA/ML 200.8)	Barium, Total, ICAP/MS	ND	ug/l	10
6/13/97	(EPA/ML 200.8)	Beryllium, Total, ICAP/MS	ND	ug/l	1.0
06/13/97	(EPA/ML 200.8)	Cadmium, Total, ICAP/MS	ND	ug/l	0.50
06/13/97	(EPA/ML 200.8)	Chromium, Total, ICAP/MS	5.2	ug/l	5.0
6/13/97	(EPA/ML 200.8)	Copper, Total, ICAP/MS	ND	ug/l	50
06/13/97	(EPA/ML 200.8)	Nickel, Total, ICAP/MS	ND	ug/l	5.0
06/13/97	(EPA/ML 200.8)	Lead, Total, ICAP/MS	ND	ug/l	5.0
6/13/97	(EPA/ML 200.8)	Antimony, Total, ICAP/MS	ND	ug/l	2.0
6/13/97	(EPA/ML 200.8)	Selenium, Total, ICAP/MS	ND	ug/l	5.0
06/13/97	(EPA/ML 200.8)	Thallium, Total, ICAP/MS	ND	ug/l	1.0
		Nitrate by IC as NO3 & N			
06/10/97	(ML/EPA 300.0)	Nitrate-N by IC	1.7	mg/l	0.10
06/10/97	(ML/EPA 300.0)	Nitrate as NO3 by IC	7.5	mg/l	0.44
		SDWA Pesticides			
06/19/97	(ML/EPA 508)	PCB 1016 Aroclor	ND	ug/l	0.10
06/19/97	(ML/EPA 508)	PCB 1221 Aroclor	ND	ug/l	0.10
6/19/97	(ML/EPA 508)	PCB 1232 Aroclor	ND	ug/l	0.10
06/19/97	(ML/EPA 508)	PCB 1242 Aroclor	ND	ug/l	0.10
06/19/97	(ML/EPA 508)	PCB 1248 Aroclor	ND	ug/l	0.10
6/19/97	(ML/EPA 508)	PCB 1254 Aroclor	ND	ug/l	0.10
6/19/97	(ML/EPA 508)	PCB 1260 Aroclor	ND	ug/l	0.10
06/19/97	(ML/EPA 508)	Alpha-BHC	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Alachlor (Alanex)	ND	ug/l	0.050
6/19/97	(ML/EPA 508)	Aldrin	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Beta-BHC	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Chlordane	ND	ug/l	0.10
6/19/97	(ML/EPA 508)	Chlorthalonil (Draconil,Bravo)	ND	ug/l	0.010
6/19/97	(ML/EPA 508)	Delta-BHC	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	p,p' DDD	ND	ug/l	0.010

MONTGOMERY WATSON LABORATORIES
555 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6324;
1 800 566 LABS (1 800 566 5227)

Laboratory
Report
#34716

Maui, County of, Department of
Water Supply
(continued)

Anal	Method	Analyte	Result	Units	MDL
06/19/97	(ML/EPA 508)	p,p' DDE	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	p,p' DDT	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Dieldrin	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Endrin Aldehyde	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Endrin	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Endosulfan I (alpha)	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Endosulfan II (beta)	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Endosulfan sulfate	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Heptachlor	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Heptachlor Epoxide	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Lindane (gamma-BHC)	ND	ug/l	0.010
06/19/97	(ML/EPA 508)	Methoxychlor	ND	ug/l	0.050
06/19/97	(ML/EPA 508)	Toxaphene	ND	ug/l	0.50
	(Surrogate)	Dibutyl Chlorendate	92	% Rec	
	(Surrogate)	Tetrachlorometaxylene	96	% Rec	
		Volatile Organic Compounds			
06/17/97	(ML/EPA 502.2)	1,1,1,2-Tetrachloroethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,1,1-Trichloroethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,1,2-Trichloroethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,1-Dichloroethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,1-Dichloroethene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,1-Dichloropropene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,2,3-Trichloropropane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,2,3-Trichlorobenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,2,4-Trichlorobenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,2,4-Trimethylbenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,2-Dichloroethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,2-Dichlorobenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,2-Dichloropropane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,3,5-Trimethylbenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,3-Dichlorobenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,3-Dichloropropane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,4-Dichlorobenzene	ND	ug/l	0.50

MONTGOMERY WATSON LABORATORIES

555 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6324;
1 800 568 LABS (1 800 568 5227)

Laboratory
Report
#34716

Maui, County of, Department of
Water Supply
(continued)

Anal	Method	Analyte	Result	Units	MDL
06/17/97	(ML/EPA 502.2)	2,2-Dichloropropane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	2-Chlorotoluene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	4-Chlorotoluene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Bromodichloromethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Benzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Bromobenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Bromochloromethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Bromomethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	cis-1,2-Dichloroethene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Chlorobenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Carbon tetrachloride	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	cis-1,3-Dichloropropene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Bromoform	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Chloroform	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Chloroethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Chloromethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Dibromochloromethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,2-Dibromo-3-chloropropane	ND	ug/l	1.0
06/17/97	(ML/EPA 502.2)	Dibromomethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Dichlorodifluoromethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	1,2-Dibromoethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Ethylbenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Hexachlorobutadiene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Isopropylbenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Methylene chloride	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	m+p-Xylenes	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Methyl tert-butyl ether	ND	ug/l	5.0
06/17/97	(ML/EPA 502.2)	Naphthalene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	n-Butylbenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	n-Propylbenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	o-Xylene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Tetrachloroethylene (PCE)	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	p-Isopropyltoluene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	sec-Butylbenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Styrene	ND	ug/l	0.50

MONTGOMERY WATSON LABORATORIES
656 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6224;
1 800 566 LABS (1 800 566 5227)

Laboratory
Report
#34716

Maui, County of, Department of
Water Supply
(continued)

Anal	Method	Analyte	Result	Units	MDL
06/17/97	(ML/EPA 502.2)	trans-1,2-Dichloroethene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	tert-Butylbenzene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Trichloroethylene (TCE)	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Trichlorotrifluoroethane(Freon	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	trans-1,3-Dichloropropene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Toluene	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Trichlorofluoromethane	ND	ug/l	0.50
06/17/97	(ML/EPA 502.2)	Vinyl chloride	ND	ug/l	0.30
	(Surrogate)	Bromofluorobenzene-ELCD	84	% Rec	
	(Surrogate)	Bromofluorobenzene-PID	93	% Rec	
	(Surrogate)	Chlorofluorobenzene-ELCD	91	% Rec	
	(Surrogate)	Chlorofluorobenzene-PID	94	% Rec	

EXHIBIT B-2

WATER QUALITY ANALYSIS

KANOA WELL NO. 1
STATE WELL NO. 5731-02

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

for

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului, HI 96732

Attention: Cari Cerizo

HDS

Report#: 54445

Montgomery Watson Laboratories
, Los Angeles, CA 90051-3508
PHONE: 626-568-6400/FAX: 626-568-6324

ACKNOWLEDGMENT OF SAMPLES RECEIVED

Maui, County of, Department of Water Supply
614 Palapala Dr
Kahului, HI 96732
Attn: Cari Cerizo

Customer Code: MAUI
Group#: 54445
Project#: PHASEV
Proj Mgr: Hillary Strayer
Phone: (808) 243-7344

The following samples were received from you on 05/20/99. They have been scheduled for the tests listed beside each sample. If this information is incorrect, please contact your service representative. Thank you for using Montgomery Watson Laboratories.

Sample#	Sample Id	Matrix / Tests Scheduled	Sample Date
990520027	KANOA WELL	Water @DIQUAT @EDB-DBC @MET-HI @ML502.2 @ML525 @ML531 @NPS3 @PESTSDW CA ENDOTHAL TCDD-DW CNDW HG NO2-N NO3 ALK	05/18/99 GLYPH F

Test Acronym Description

Test Acronym	Description
@DIQUAT	Diquat and Paraquat
@EDB-DBC	EDB and DBCP by GC-ECD
@MET-HI	ICPMS Metals
@ML502.2	Volatile Organic Compounds
@ML525	525 Semivolatiles by GC/MS
@ML531	Aldicarbs
@NPS3	Herbicides by 515.1
@PESTSDW	SDWA Pesticides
ALK	Alkalinity
CA	Calcium, Total, ICAP
CNDW	Cyanide
ENDOTHAL	Endothall
F	Fluoride
GLYPHOS	Glyphosate
HG	Mercury
NO2-N	Nitrite, Nitrogen by IC
NO3	Nitrate-N by IC
TCDD-DW	2,3,7,8 - TCDD

MONTGOMERY WATSON LABORATORIES
555 E. Walnut St., Pasadena, CA 91101
(626) 568-6400 (800) 566-5227

CHAIN OF CUSTODY RECORD

FED EX # _____
COOLER # _____
DESTINATION: MONTGOMERY WATSON LABORATORIES ☐
OTHER: _____ ☐

PROJECT NAME: COUNTY OF MAUI
PROJECT JOB # / P.O.#:
SAMPLER(S): PRINTED NAME AND SIGNATURE: L. POOLE

TIME	DATE	LOCATION	IDENTIFIER	QA/QC	GRAB	COMP	NUMBER / SIZE OF CONTAINERS	ANALYSES REQUIRED	REMARKS
0815	5/18/99		KANOA WELL		X		SEE ATTACHED		

	SIGNATURE	PRINT NAME	COMPANY / TITLE	DATE	TIME
RELINQUISHED BY:	L POOLE	L POOLE	DWS-MAUI	5-19-99	0800
RECEIVED BY:			MWL	5-20	
RELINQUISHED BY:					
RECEIVED BY:					
RELINQUISHED BY:					
RECEIVED BY:					

C-O-C # _____ ORIGINAL COPY: SEND WITH SAMPLE YELLOW COPY: RETAINED BY SAMPLER PINK: OFFICE COPY PAGE _____ OF _____

Report Summary of positive results, PR54445

Analyzed	990520027 KANOA WELL	Result	MDL	UNITS
05/23/99	Data Entry	05/26/99		--
05/24/99	Barium, Total, ICAP/MS	3.5	2.000	UGL
05/24/99	Chromium, Total, ICAP/MS	6.2	2.000	UGL
05/24/99	Data Entry	05/26/99		--
05/25/99	Data Entry	05/26/99		--
05/27/99	Data Entry	05/28/99		--
05/28/99	Alkalinity	80	2.000	MGL
05/25/99	Calcium, Total, ICAP	10.5	1.000	MGL
05/27/99	Fluoride	0.13	.100	MGL
05/20/99	Nitrate-N by IC	0.56	.100	MGL

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990520027 Sample ID KAHOA WELL Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 20-may-1999 Reported 11-jun-1999

Parameter		Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
Alkalinity	(ML/SM2320B)	mg/l	80				2			20-may-1999	huy
Calcium, Total, ICAP	(ML/EPA 200.7)	mg/l	10.5				1	25-may-1999	dtn	25-may-1999	dtn
Cyanide	(ML/SM 4500CN)	mg/l	ND				0.025			28-may-1999	opr
Endothall	(ML/EPA 548.1)	ug/l	ND				5	20-may-1999	ylp	27-may-1999	crw
Fluoride	(ML/SM 4500FC)	mg/l	0.13				0.1			27-may-1999	huy
Glyphosate	(ML/EPA 547)	ug/l	ND				6			21-may-1999	crw
Mercury	(EPA/ML 245.1)	ug/l	ND				0.2	24-may-1999	gar	28-may-1999	gsr
Nitrite, Nitrogen by IC	(ML/EPA 300.0)	mg/l	ND				0.1			20-may-1999	sal
Nitrate-N by IC	(ML/EPA 300.0)	mg/l	0.56				0.1			20-may-1999	sal

Report #: 54445

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990520027 Sample ID KANOA WELL Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 20-may-1999 Reported 11-jun-1999

Diquat and Paraquat (ML/EPA 549.1)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
Diquat	ug/l	ND				0.4	20-may-1999	YLP	21-may-1999	lls
Paraquat	ug/l	ND				2	20-may-1999	YLP	21-may-1999	lls

Report #: 54445

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Haui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990520027 Sample ID KANOA WELL Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 20-may-1999 Reported 11-jun-1999

EDB and DBCP by GC-ECD (ML/EPA 504.1)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
Dibromochloropropane (DBCP)	ug/l	ND				0.01	22-may-1999	cfl	23-may-1999	cfl
Ethylene Dibromide (EDB)	ug/l	ND				0.01	22-may-1999	cfl	23-may-1999	cfl
Data Entry	-->	05/26/99				0	22-may-1999	cfl	23-may-1999	cfl

Report #: 54445

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990520027 Sample ID KANOA WELL Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 20-may-1999 Reported 11-jun-1999

ICPMS Metals (ML 200.8)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
Arsenic, Total, ICAP/MS	ug/l	ND				1	24-may-1999	jps	24-may-1999	jps
Barium, Total, ICAP/MS	ug/l	3.5				2	24-may-1999	jps	24-may-1999	jps
Beryllium, Total, ICAP/MS	ug/l	ND				1	24-may-1999	jps	24-may-1999	jps
Cadmium, Total, ICAP/MS	ug/l	ND				0.5	24-may-1999	jps	24-may-1999	jps
Chromium, Total, ICAP/MS	ug/l	6.2				2	24-may-1999	jps	24-may-1999	jps
Copper, Total, ICAP/MS	ug/l	ND				2	24-may-1999	jps	24-may-1999	jps
Nickel, Total, ICAP/MS	ug/l	ND				5	24-may-1999	jps	24-may-1999	jps
Lead, Total, ICAP/MS	ug/l	ND				0.5	24-may-1999	jps	24-may-1999	jps
Antimony, Total, ICAP/MS	ug/l	ND				1	24-may-1999	jps	24-may-1999	jps
Selenium, Total, ICAP/MS	ug/l	ND				5	24-may-1999	jps	24-may-1999	jps
Thallium, Total, ICAP/MS	ug/l	ND				1	24-may-1999	jps	24-may-1999	jps

Report #: 54445

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990520027 Sample ID KANOA WELL Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 20-may-1999 Reported 11-jun-1999

Volatile Organic Compounds (ML/EPA 502.2)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
1,1,1,2-Tetrachloroethane	ug/l	ND				0.5			24-may-1999	rcw
1,1,1-Trichloroethane	ug/l	ND				0.5			24-may-1999	rcw
1,1,2,2-Tetrachloroethane	ug/l	ND				0.5			24-may-1999	rcw
1,1,2-Trichloroethane	ug/l	ND				0.5			24-may-1999	rcw
1,1-Dichloroethane	ug/l	ND				0.5			24-may-1999	rcw
1,1-Dichloroethene	ug/l	ND				0.5			24-may-1999	rcw
1,1-Dichloropropene	ug/l	ND				0.5			24-may-1999	rcw
1,2,3-Trichloropropane	ug/l	ND				0.5			24-may-1999	rcw
1,2,3-Trichlorobenzene	ug/l	ND				0.5			24-may-1999	rcw
1,2,4-Trichlorobenzene	ug/l	ND				0.5			24-may-1999	rcw
1,2,4-Trimethylbenzene	ug/l	ND				0.5			24-may-1999	rcw
1,2-Dichloroethane	ug/l	ND				0.5			24-may-1999	rcw
1,2-Dichlorobenzene	ug/l	ND				0.5			24-may-1999	rcw
1,2-Dichloropropane	ug/l	ND				0.5			24-may-1999	rcw
1,3,5-Trimethylbenzene	ug/l	ND				0.5			24-may-1999	rcw
1,3-Dichlorobenzene	ug/l	ND				0.5			24-may-1999	rcw
1,3-Dichloropropane	ug/l	ND				0.5			24-may-1999	rcw
1,4-Dichlorobenzene	ug/l	ND				0.5			24-may-1999	rcw
2,2-Dichloropropane	ug/l	ND				0.5			24-may-1999	rcw
2-Chlorotoluene	ug/l	ND				0.5			24-may-1999	rcw
4-Chlorotoluene	ug/l	ND				0.5			24-may-1999	rcw
Bromodichloromethane	ug/l	ND				0.5			24-may-1999	rcw
Benzene	ug/l	ND				0.5			24-may-1999	rcw
Bromobenzene	ug/l	ND				0.5			24-may-1999	rcw
Bromochloromethane	ug/l	ND				0.5			24-may-1999	rcw
Bromomethane	ug/l	ND				0.5			24-may-1999	rcw
cis-1,2-Dichloroethene	ug/l	ND				0.5			24-may-1999	rcw
Chlorobenzene	ug/l	ND				0.5			24-may-1999	rcw
Carbon tetrachloride	ug/l	ND				0.5			24-may-1999	rcw

Report #: 54445

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990520027 Sample ID KANOA WELL Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 20-may-1999 Reported 11-jun-1999

Volatile Organic Compounds (ML/EPA 502.2)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
cis-1,3-Dichloropropene	ug/l	ND				0.5			24-may-1999	rcw
Bromoform	ug/l	ND				0.5			24-may-1999	rcw
Chloroform	ug/l	ND				0.5			24-may-1999	rcw
Chloroethane	ug/l	ND				0.5			24-may-1999	rcw
Chloromethane	ug/l	ND				0.5			24-may-1999	rcw
Dibromochloromethane	ug/l	ND				0.5			24-may-1999	rcw
1,2-Dibromo-3-chloropropane	ug/l	ND				1			24-may-1999	rcw
Dibromomethane	ug/l	ND				0.5			24-may-1999	rcw
Dichlorodifluoromethane	ug/l	ND				0.5			24-may-1999	rcw
1,2-Dibromoethane	ug/l	ND				0.5			24-may-1999	rcw
Ethylbenzene	ug/l	ND				0.5			24-may-1999	rcw
Hexachlorobutadiene	ug/l	ND				0.5			24-may-1999	rcw
Isopropylbenzene	ug/l	ND				0.5			24-may-1999	rcw
Methylene chloride	ug/l	ND				0.5			24-may-1999	rcw
m,p-Xylenes	ug/l	ND				0.5			24-may-1999	rcw
Methyl tert-butyl ether	ug/l	ND				5			24-may-1999	rcw
Naphthalene	ug/l	ND				0.5			24-may-1999	rcw
n-Butylbenzene	ug/l	ND				0.5			24-may-1999	rcw
n-Propylbenzene	ug/l	ND				0.5			24-may-1999	rcw
o-Xylene	ug/l	ND				0.5			24-may-1999	rcw
Tetrachloroethylene (PCE)	ug/l	ND				0.5			24-may-1999	rcw
p-Isopropyltoluene	ug/l	ND				0.5			24-may-1999	rcw
sec-Butylbenzene	ug/l	ND				0.5			24-may-1999	rcw
Styrene	ug/l	ND				0.5			24-may-1999	rcw
trans-1,2-Dichloroethene	ug/l	ND				0.5			24-may-1999	rcw
tert-Butylbenzene	ug/l	ND				0.5			24-may-1999	rcw
Trichloroethylene (TCE)	ug/l	ND				0.5			24-may-1999	rcw
Trichlorotrifluoroethane(Freon	ug/l	ND				0.5			24-may-1999	rcw
trans-1,3-Dichloropropene	ug/l	ND				0.5			24-may-1999	rcw

Report #: 54445

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990520027 Sample ID KAHOA WELL Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 20-may-1999 Reported 11-jun-1999

Volatile Organic Compounds (ML/EPA 502.2)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
Toluene	ug/l	ND				0.5			24-may-1999	rcw
Trichlorofluoromethane	ug/l	ND				0.5			24-may-1999	rcw
Vinyl chloride	ug/l	ND				0.3			24-may-1999	rcw
Data Entry	--	05/26/99				0			24-may-1999	rcw

Report #: 54445

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990520027 Sample ID KANOA WELL Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 20-may-1999 Reported 11-jun-1999

525 Semivolatiles by GC/MS (ML/EPA 525.2)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
2,4-Dinitrotoluene	ug/l	ND	1			0.1	20-may-1999	csk	25-may-1999	mnb
alpha-Chlordane	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Diazinon	ug/l	ND	1			0.1	20-may-1999	csk	25-may-1999	mnb
Acenaphthylene	ug/l	ND	1			0.1	20-may-1999	csk	25-may-1999	mnb
Alachlor	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Aldrin	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Anthracene	ug/l	ND	1			0.02	20-may-1999	csk	25-may-1999	mnb
Atrazine	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Benz(a)Anthracene	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Benzo(a)pyrene	ug/l	ND	1			0.02	20-may-1999	csk	25-may-1999	mnb
Benzo(b)Fluoranthene	ug/l	ND	1			0.02	20-may-1999	csk	25-may-1999	mnb
Benzo(g,h,i)Perylene	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Benzo(k)Fluoranthene	ug/l	ND	1			0.02	20-may-1999	csk	25-may-1999	mnb
Di(2-Ethylhexyl)phthalate	ug/l	ND	1			0.6	20-may-1999	csk	25-may-1999	mnb
Butylbenzylphthalate	ug/l	ND	1			0.5	20-may-1999	csk	25-may-1999	mnb
Bromacil	ug/l	ND	1			0.2	20-may-1999	csk	25-may-1999	mnb
Butachlor	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Caffeine	ug/l	ND	1			0.02	20-may-1999	csk	25-may-1999	mnb
Chrysene	ug/l	ND	1			0.02	20-may-1999	csk	25-may-1999	mnb
Dibenz(a,h)Anthracene	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Di-(2-Ethylhexyl)adipate	ug/l	ND	1			0.6	20-may-1999	csk	25-may-1999	mnb
Diethylphthalate	ug/l	ND	1			0.5	20-may-1999	csk	25-may-1999	mnb
Dieldrin	ug/l	ND	1			0.2	20-may-1999	csk	25-may-1999	mnb
Dimethylphthalate	ug/l	ND	1			0.5	20-may-1999	csk	25-may-1999	mnb
Dimethoate	ug/l	ND	1			10	20-may-1999	csk	25-may-1999	mnb
Di-n-Butylphthalate	ug/l	ND	1			0.5	20-may-1999	csk	25-may-1999	mnb
Endrin	ug/l	ND	1			0.1	20-may-1999	csk	25-may-1999	mnb
Fluorene	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
gamma-Chlordane	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb

Report #: 54445

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Haui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990520027 Sample ID KAHOA WELL Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 20-may-1999 Reported 11-jun-1999

525 Semivolatiles by GC/MS (ML/EPA 525.2)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
Hexachlorobenzene	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Hexachlorocyclopentadiene	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Heptachlor	ug/l	ND	1			0.04	20-may-1999	csk	25-may-1999	mnb
Heptachlor Epoxide	ug/l	ND	1			0.02	20-may-1999	csk	25-may-1999	mnb
Indeno(1,2,3,c,d)Pyrene	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Isophorone	ug/l	ND	1			0.5	20-may-1999	csk	25-may-1999	mnb
Lindane	ug/l	ND	1			0.02	20-may-1999	csk	25-may-1999	mnb
Methoxychlor	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Metribuzin	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Molinate	ug/l	ND	1			0.2	20-may-1999	csk	25-may-1999	mnb
Metolachlor	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
trans-Nonachlor	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Pentachlorophenol	ug/l	ND	1			1	20-may-1999	csk	25-may-1999	mnb
Phenanthrene	ug/l	ND	1			0.02	20-may-1999	csk	25-may-1999	mnb
Prometryn	ug/l	ND	1			0.5	20-may-1999	csk	25-may-1999	mnb
Propachlor	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Pyrene	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Simazine	ug/l	ND	1			0.05	20-may-1999	csk	25-may-1999	mnb
Thiobencarb	ug/l	ND	1			0.2	20-may-1999	csk	25-may-1999	mnb
Trifluralin	ug/l	ND	1			0.1	20-may-1999	csk	25-may-1999	mnb

Report #: 54445

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Haui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990520027 Sample ID KANOA WELL Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 20-may-1999 Reported 11-jun-1999

Aldicarbs (ML/EPA 531.1)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
1-Hydroxycarbofuran	ug/l	ND				2			01-jun-1999	crw
Aldicarb (Temik)	ug/l	ND				0.5			01-jun-1999	crw
Aldicarb sulfone	ug/l	ND				0.7			01-jun-1999	crw
Aldicarb sulfoxide	ug/l	ND				0.5			01-jun-1999	crw
Baygon	ug/l	ND				2			01-jun-1999	crw
Carbofuran (Furadan)	ug/l	ND				0.9			01-jun-1999	crw
Carbaryl	ug/l	ND				2			01-jun-1999	crw
Methiocarb	ug/l	ND				2			01-jun-1999	crw
Methomyl	ug/l	ND				1			01-jun-1999	crw
Oxamyl (Vydate)	ug/l	ND				2			01-jun-1999	crw

Report #: 54445

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990520027 Sample ID KANOA WELL Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 20-may-1999 Reported 11-jun-1999

Herbicides by 515.1 (ML/EPA 515.1)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
2,4,5-T	ug/l	ND				0.2	20-may-1999	phk	25-may-1999	wpt
2,4,5-TP (Silvex)	ug/l	ND				0.2	20-may-1999	phk	25-may-1999	wpt
2,4-D	ug/l	ND				0.1	20-may-1999	phk	25-may-1999	wpt
2,4-DB	ug/l	ND				2	20-may-1999	phk	25-may-1999	wpt
Dichlorprop	ug/l	ND				0.5	20-may-1999	phk	25-may-1999	wpt
Acifluorfen (qualitative)	ug/l	ND				0.2	20-may-1999	phk	25-may-1999	wpt
Bentazon	ug/l	ND				0.5	20-may-1999	phk	25-may-1999	wpt
Dalapon (qualitative)	ug/l	ND				1	20-may-1999	phk	25-may-1999	wpt
3,5-Dichlorobenzoic acid	ug/l	ND				0.5	20-may-1999	phk	25-may-1999	wpt
DCPA	ug/l	ND				0.1	20-may-1999	phk	25-may-1999	wpt
Dicamba	ug/l	ND				0.08	20-may-1999	phk	25-may-1999	wpt
Dinoseb	ug/l	ND				0.2	20-may-1999	phk	25-may-1999	wpt
Pentachlorophenol	ug/l	ND				0.04	20-may-1999	phk	25-may-1999	wpt
Picloram	ug/l	ND				0.1	20-may-1999	phk	25-may-1999	wpt
4-Nitrophenol (qualitative)	ug/l	ND				5	20-may-1999	phk	25-may-1999	wpt
Data Entry	--	05/26/99				0	20-may-1999	phk	25-may-1999	wpt

Report #: 54445

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990520027 Sample ID KANOA WELL Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 20-may-1999 Reported 11-jun-1999

SDWA Pesticides (ML/EPA 508)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
PCB 1016 Aroclor	ug/l	ND				0.07	21-may-1999	kkc	27-may-1999	dst
PCB 1221 Aroclor	ug/l	ND				0.1	21-may-1999	kkc	27-may-1999	dst
PCB 1232 Aroclor	ug/l	ND				0.1	21-may-1999	kkc	27-may-1999	dst
PCB 1242 Aroclor	ug/l	ND				0.1	21-may-1999	kkc	27-may-1999	dst
PCB 1248 Aroclor	ug/l	ND				0.1	21-may-1999	kkc	27-may-1999	dst
PCB 1254 Aroclor	ug/l	ND				0.1	21-may-1999	kkc	27-may-1999	dst
PCB 1260 Aroclor	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Alpha-BHC	ug/l	ND				0.05	21-may-1999	kkc	27-may-1999	dst
Alachlor (Alanex)	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Aldrin	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Beta-BHC	ug/l	ND				0.1	21-may-1999	kkc	27-may-1999	dst
Chlordane	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Chlorthalonil (Draconil,Bravo)	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Delta-BHC	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
p,p' DDD	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
p,p' DDE	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
p,p' DDT	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Dieldrin	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Endrin Aldehyde	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Endrin	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Endosulfan I (alpha)	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Endosulfan II (beta)	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Endosulfan sulfate	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Heptachlor	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Heptachlor Epoxide	ug/l	ND				0.01	21-may-1999	kkc	27-may-1999	dst
Lindane (gamma-BHC)	ug/l	ND				0.05	21-may-1999	kkc	27-may-1999	dst
Methoxychlor	ug/l	ND				0.5	21-may-1999	kkc	27-may-1999	dst
Toxaphene	ug/l	ND				0	21-may-1999	kkc	27-may-1999	dst
Data Entry	..	05/28/99								

Report #: 54445

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

for

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului, HI 96732

Attention: Cari Cerizo

HDS

Report#: 55058

Montgomery Watson Laboratories
555 East Walnut Street
Pasadena, CA 91101
Ph (626) 568-6400 Fax (626) 568-6324

Date 06/11/99

Submittal Form

HDS 55058

To Nanny Estrada
nterra Environmental Services
Riverside Parkway
st Sacramento, CA 95605

Recipient: FEDEX ACCT: 2060-8019-1

) 373-5600

Reporting: One report for this MWL Project Number: 55058
Do Not Combine Report with any other samples submitted under different MWL project numbers!
Report & Invoice must have the MWL Project Number and Sub PO#: 99-0669
Report all quality control data according to Method. Include dates analyzed, date extracted (if extracted) and Method reference on the report. Fax results to 626-568-6324
Faxed results must have complete data &QC. Hardcopy report is due in hand on due date.
Please advise us immediately if Due Date will be missed.

HARDCOPY REPORT, FORMS, & INVOICE MUST BE SENT TO ATTENTION
Martha Frost, Sub-contracting Administrator
Montgomery Watson Laboratories 555 East Walnut Street Pasadena, CA 91101
Phone (626) 568-6437 Fax (626) 568-6324

For Specific Questions about samples: Hillary Strayer (626) 568-6412

MWL Project # 55058 — Report Due: 6/28/99

Qty	Test Code	Use MWL Lab # for ID	Client Sample ID for reference only	Analysis Requested	Sample Date	Matrix	Container
	TCDD-DW	990611009	KANOA WELL (99052027)	Dioxin in drinking water 1613b	05/18/99	dw	2 1L amber glass / no preservative

RECEIVED IN GOOD CONDITION
UNDER COC
JUN 12 1999
INI: _____

nquished by: _____ Sample Control Date 06/11/99 Time 4:14

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990611009 Sample ID KANOA WELL (990520027) Project PHASEV
Sample Type Water Sampled 18-may-1999 Received 11-jun-1999 Reported 30-jun-1999

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
2,3,7,8 - TCDD (EPA 1613)	Picograms/L	ND				2.5	18-jun-1999	gub	26-jun-1999	gub

Report #: 55058

ANALYTICAL REPORT

PROJECT NO. 55058

Lot #: G9F120155

Martha Frost

Montgomery Laboratories

QUANTERRA INCORPORATED

Nanny Estrada
Project Manager

June 28, 1999

Report 55058 Comment Page

Group Validation Comments

TCDD by Qunaterra (G9F120155)

99-0669

JUL 2 RECD

Quanterra

MAUI
55058

Quanterra Incorporated
880 Riverside Parkway
West Sacramento, California 95605

916 373-5600 Telephone
916 372-1059 Fax

June 28, 1999

QUANTERRA INCORPORATED PROJECT NUMBER: **G9F120155**
PO/CONTRACT: **99-0669**

Martha Frost
Montgomery Laboratories
555 East Walnut Street
Pasadena, CA 91101

Dear Ms. Frost,

This report contains the analytical results for the aqueous sample received under chain of custody by Quanterra Incorporated on June 12, 1999. This sample is associated with your project number 55058.

All applicable quality control procedures met method-specified acceptance criteria.

If you have any questions, please feel free to call me.

Sincerely,

Nanny Estrada

Nanny Estrada
Project Manager

Quanterra

SAMPLE SUMMARY

G9F120155

WO #	SAMPLE#	CLIENT SAMPLE ID	DATE	TIME
CWTJF	001	990611009	05/18/99	

NOTE(S):

- The analytical results of the samples listed above are presented on the following pages.
- All calculations are performed before rounding to avoid round-off errors in calculated results.
- Results noted as "ND" were not detected at or above the stated limit.
- This report must not be reproduced, except in full, without the written approval of the laboratory.
- Results for the following parameters are never reported on a dry weight basis: color, corrosivity, density, flashpoint, ignitability, layers, odor, paint filter test, pH, porosity pressure, reactivity, redox potential, specific gravity, spot tests, solids, solubility, temperature, viscosity, and weight.

QC DATA ASSOCIATION SUMMARY

G9F120155

Sample Preparation and Analysis Control Numbers

SAMPLE#	MATRIX	ANALYTICAL METHOD	LEACH BATCH #	PREP BATCH #	MS RUN#
001	WATER	EPA-5 1613B-Tetra		9167334	

Quanterra

MONTGOMERY LABORATORIES

Client Sample ID: 990611009

Dioxins

Lot-Sample #...: G9F120155-001 Work Order #...: CWTJF101 Matrix.....: WATER
Date Sampled...: 05/18/99 Date Received..: 06/12/99
Prep Date.....: 06/18/99 Analysis Date..: 06/26/99
Prep Batch #...: 9167334
Dilution Factor: 1

PARAMETER	RESULT	DETECTION LIMIT	UNITS	METHOD
2,3,7,8-TCDD	ND	2.5	pg/L	EPA-5 1613B-Tetra

INTERNAL STANDARDS	PERCENT RECOVERY	RECOVERY LIMITS
13C-2,3,7,8-TCDD	111	(25 - 141)

Quanterra

METHOD BLANK REPORT

Dioxins

Client Lot #...: G9F120155
MB Lot-Sample #: G9F160000-334

Work Order #...: CX0CE101

Matrix.....: WATER

Prep Date.....: 06/18/99
Prep Batch #...: 9167334

Analysis Date..: 06/25/99
Dilution Factor: 1

PARAMETER	RESULT	DETECTION LIMIT	UNITS	METHOD
2,3,7,8-TCDD	ND	2.3	pg/L	EPA-5 1613B-Tetra

INTERNAL STANDARDS	PERCENT RECOVERY	RECOVERY LIMITS
13C-2,3,7,8-TCDD	112	(25 - 141)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra

LABORATORY CONTROL SAMPLE DATA REPORT

Dioxins

Client Lot #...: G9F120155 Work Order #...: CX0CE102 Matrix.....: WATER
LCS Lot-Sample#: G9F160000-334
Prep Date.....: 06/18/99 Analysis Date..: 06/25/99
Prep Batch #...: 9167334
Dilution Factor: 1

PARAMETER	SPIKE AMOUNT	MEASURED AMOUNT	UNITS	PERCENT RECOVERY	METHOD
2,3,7,8-TCDD	200	223	pg/L	111	EPA-5 1613B T

INTERNAL STANDARD	PERCENT RECOVERY	RECOVERY LIMITS
13C-2,3,7,8-TCDD	106	(25 - 141)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

Quanterra

LABORATORY CONTROL SAMPLE EVALUATION REPORT

Dioxins

Client Lot #...: G9F120155 Work Order #...: CX0CE102 Matrix.....: WATER
LCS Lot-Sample#: G9F160000-334
Prep Date.....: 06/18/99 Analysis Date..: 06/25/99
Prep Batch #...: 9167334
Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	METHOD
2,3,7,8-TCDD	111	(73 - 146)	EPA-5 1613B-Tetras

INTERNAL STANDARD	PERCENT RECOVERY	RECOVERY LIMITS
13C-2,3,7,8-TCDD	106	(25 - 141)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

EXHIBIT B-3

WATER QUALITY ANALYSIS

KUPAA WELL NO. 1
STATE WELL 5731-03

COUNTY OF MAUI
DEPARTMENT OF WATER SUPPLY
WATER QUALITY LAB
614 PALAPALA DRIVE
KAHULUI, MAUI, HAWAII 96732

REPORT DATE: MAR 22, 1999

CLIENT: **TAKUMI ENGINEERING**
18 CENTRAL AVENUE
WAILUKU, MAUI, HAWAII 96793
PHONE #: 249-0411

MATRIX: WATER

SAMPLER:

EPA METHOD: CHLORIDE: 4500-Cl⁻

SAMPLE ID KUPAA WELL 1	CHLORIDE mg/L	SAMPLE ID KUPAA WELL 1	CHLORIDE mg/L
3/15/99 @ 0935 by WS	20	3/18/99 @ 0806 by KK	25
3/15/99 @ 2100 by ?	22	3/18/99 @ 0900 by WS	25
3/16/99 @ 0900 by ?	22	3/18/99 @ 2100 by NR	20
3/16/99 @ 2100 by MR	20	3/19/99 @ 0900 by NR	21
3/17/99 @ 0900 by MR	21		
3/17/99 @2100 by MR	25		

APPROVED BY: C.CERIZO
W.M. IV

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

for

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului, HI 96732

Attention: Cari Cerizo

HDS

Report#: 52800

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990319269 Sample ID KUPAA WELL Project PHASEV
Sample Type Water Sampled 18-mar-1999 Received 19-mar-1999 Reported 19-apr-1999

Parameter		Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
Alkalinity	(ML/SM2320B)	mg/l	52				2			26-mar-1999	acc
Calcium, Total, ICAP	(ML/EPA 200.7)	mg/l	6.0				1	22-mar-1999	dtn	22-mar-1999	dtn
Cyanide	(ML/SM 4500CN)	mg/l	ND				0.025			22-mar-1999	opr
Endothall	(ML/EPA 548.1)	ug/l	ND			4	20	22-mar-1999	YLP	30-mar-1999	crw
Fluoride	(ML/SM 4500FC)	mg/l	ND				0.1			25-mar-1999	opr
Glyphosate	(ML/EPA 547)	ug/l	ND				6			25-mar-1999	crw
Mercury	(EPA/ML 245.1)	ug/l	ND				0.5	25-mar-1999	gsr	25-mar-1999	gsr
Nitrite, Nitrogen by IC	(ML/EPA 300.0)	mg/l	ND				0.1			19-mar-1999	eyw
Nitrate-N by IC	(ML/EPA 300.0)	mg/l	0.34				0.1			19-mar-1999	eyw
2,3,7,8 - TCDD	(EPA 1613)	Picograms/L	ND				1.8	07-apr-1999	sub	07-apr-1999	sub

Report #: 52800

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990319269 Sample ID KUPAA WELL Project PHASEV
Sample Type Water Sampled 18-mar-1999 Received 19-mar-1999 Reported 19-apr-1999

Diquat and Paraquat (ML/EPA 549.1)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
Diquat	ug/l	ND				0.4	23-mar-1999	ylp	26-mar-1999	lls
Paraquat	ug/l	ND				2	23-mar-1999	ylp	26-mar-1999	lls

Report #: 52800

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990319269 Sample ID KUPAA WELL Project PHASEV
Sample Type Water Sampled 18-mar-1999 Received 19-mar-1999 Reported 19-apr-1999

EDB and DBCP by GC-ECD (ML/EPA 504.1)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
Dibromochloropropane (DBCP)	ug/l	ND				0.01	26-mar-1999	cfl	29-mar-1999	cfl
Ethylene Dibromide (EDB)	ug/l	ND				0.01	26-mar-1999	cfl	29-mar-1999	cfl
Data Entry	--	03/31/99				0	26-mar-1999	cfl	29-mar-1999	cfl

Report #: 52800

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990319269 Sample ID KUPAA WELL Project PHASEV
Sample Type Water Sampled 18-mar-1999 Received 19-mar-1999 Reported 19-apr-1999

ICPMS Metals (ML 200.8)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
Arsenic, Total, ICAP/MS	ug/l	ND				5	25-mar-1999	jps	25-mar-1999	jps
Barium, Total, ICAP/MS	ug/l	ND				10	25-mar-1999	jps	25-mar-1999	jps
Beryllium, Total, ICAP/MS	ug/l	ND				1	25-mar-1999	jps	25-mar-1999	jps
Cadmium, Total, ICAP/MS	ug/l	ND				0.5	25-mar-1999	jps	25-mar-1999	jps
Chromium, Total, ICAP/MS	ug/l	ND				5	25-mar-1999	jps	25-mar-1999	jps
Copper, Total, ICAP/MS	ug/l	ND				50	25-mar-1999	jps	25-mar-1999	jps
Nickel, Total, ICAP/MS	ug/l	ND				5	25-mar-1999	jps	25-mar-1999	jps
Lead, Total, ICAP/MS	ug/l	ND				5	25-mar-1999	jps	25-mar-1999	jps
Antimony, Total, ICAP/MS	ug/l	ND				2	25-mar-1999	jps	25-mar-1999	jps
Selenium, Total, ICAP/MS	ug/l	ND				5	25-mar-1999	jps	25-mar-1999	jps
Thallium, Total, ICAP/MS	ug/l	ND				1	25-mar-1999	jps	25-mar-1999	jps

Report #: 52800

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990319269 Sample ID KUPAA WELL Project PHASEV
Sample Type Water Sampled 18-mar-1999 Received 19-mar-1999 Reported 19-apr-1999

Volatile Organic Compounds (ML/EPA 502.2)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
1,1,1,2-Tetrachloroethane	ug/l	ND				0.5			25-mar-1999	rcw
1,1,1-Trichloroethane	ug/l	ND				0.5			25-mar-1999	rcw
1,1,2,2-Tetrachloroethane	ug/l	ND				0.5			25-mar-1999	rcw
1,1,2-Trichloroethane	ug/l	ND				0.5			25-mar-1999	rcw
1,1-Dichloroethane	ug/l	ND				0.5			25-mar-1999	rcw
1,1-Dichloroethene	ug/l	ND				0.5			25-mar-1999	rcw
1,1-Dichloropropene	ug/l	ND				0.5			25-mar-1999	rcw
1,2,3-Trichloropropane	ug/l	ND				0.5			25-mar-1999	rcw
1,2,3-Trichlorobenzene	ug/l	ND				0.5			25-mar-1999	rcw
1,2,4-Trichlorobenzene	ug/l	ND				0.5			25-mar-1999	rcw
1,2,4-Trimethylbenzene	ug/l	ND				0.5			25-mar-1999	rcw
1,2-Dichloroethane	ug/l	ND				0.5			25-mar-1999	rcw
1,2-Dichlorobenzene	ug/l	ND				0.5			25-mar-1999	rcw
1,2-Dichloropropane	ug/l	ND				0.5			25-mar-1999	rcw
1,3,5-Trimethylbenzene	ug/l	ND				0.5			25-mar-1999	rcw
1,3-Dichlorobenzene	ug/l	ND				0.5			25-mar-1999	rcw
1,3-Dichloropropane	ug/l	ND				0.5			25-mar-1999	rcw
1,4-Dichlorobenzene	ug/l	ND				0.5			25-mar-1999	rcw
2,2-Dichloropropane	ug/l	ND				0.5			25-mar-1999	rcw
2-Chlorotoluene	ug/l	ND				0.5			25-mar-1999	rcw
4-Chlorotoluene	ug/l	ND				0.5			25-mar-1999	rcw
Bromodichloromethane	ug/l	ND				0.5			25-mar-1999	rcw
Benzene	ug/l	ND				0.5			25-mar-1999	rcw
Bromobenzene	ug/l	ND				0.5			25-mar-1999	rcw
Bromochloromethane	ug/l	ND				0.5			25-mar-1999	rcw
Bromomethane	ug/l	ND				0.5			25-mar-1999	rcw
cis-1,2-Dichloroethene	ug/l	ND				0.5			25-mar-1999	rcw
Chlorobenzene	ug/l	ND				0.5			25-mar-1999	rcw
Carbon tetrachloride	ug/l	ND				0.5			25-mar-1999	rcw

Report #: 52800

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990319269 Sample ID KUPAA WELL Project PHASE V
Sample Type Water Sampled 18-mar-1999 Received 19-mar-1999 Reported 19-apr-1999

Volatile Organic Compounds (ML/EPA 502.2)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
cis-1,3-Dichloropropene	ug/l	ND				0.5			25-mar-1999	rcw
Bromoform	ug/l	ND				0.5			25-mar-1999	rcw
Chloroform	ug/l	ND				0.5			25-mar-1999	rcw
Chloroethane	ug/l	ND				0.5			25-mar-1999	rcw
Chloromethane	ug/l	ND				0.5			25-mar-1999	rcw
Dibromochloromethane	ug/l	ND				0.5			25-mar-1999	rcw
1,2-Dibromo-3-chloropropane	ug/l	ND				1			25-mar-1999	rcw
Dibromomethane	ug/l	ND				0.5			25-mar-1999	rcw
Dichlorodifluoromethane	ug/l	ND				0.5			25-mar-1999	rcw
1,2-Dibromoethane	ug/l	ND				0.5			25-mar-1999	rcw
Ethylbenzene	ug/l	ND				0.5			25-mar-1999	rcw
Hexachlorobutadiene	ug/l	ND				0.5			25-mar-1999	rcw
Isopropylbenzene	ug/l	ND				0.5			25-mar-1999	rcw
Methylene chloride	ug/l	ND				0.5			25-mar-1999	rcw
m,p-Xylenes	ug/l	ND				0.5			25-mar-1999	rcw
Methyl tert-butyl ether	ug/l	ND				5			25-mar-1999	rcw
Naphthalene	ug/l	ND				0.5			25-mar-1999	rcw
n-Butylbenzene	ug/l	ND				0.5			25-mar-1999	rcw
n-Propylbenzene	ug/l	ND				0.5			25-mar-1999	rcw
o-Xylene	ug/l	ND				0.5			25-mar-1999	rcw
Tetrachloroethylene (PCE)	ug/l	ND				0.5			25-mar-1999	rcw
p-Isopropyltoluene	ug/l	ND				0.5			25-mar-1999	rcw
sec-Butylbenzene	ug/l	ND				0.5			25-mar-1999	rcw
Styrene	ug/l	ND				0.5			25-mar-1999	rcw
trans-1,2-Dichloroethene	ug/l	ND				0.5			25-mar-1999	rcw
tert-Butylbenzene	ug/l	ND				0.5			25-mar-1999	rcw
Trichloroethylene (TCE)	ug/l	ND				0.5			25-mar-1999	rcw
Trichlorotrifluoroethane(Freon	ug/l	ND				0.5			25-mar-1999	rcw
trans-1,3-Dichloropropene	ug/l	ND				0.5			25-mar-1999	rcw

Report #: 52800

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990319269 Sample ID KUPAA WELL Project PHASEV
Sample Type Water Sampled 18-mar-1999 Received 19-mar-1999 Reported 19-apr-1999

Volatile Organic Compounds (ML/EPA 502.2)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
Toluene	ug/l	ND				0.5			25-mar-1999	rcw
Trichlorofluoromethane	ug/l	ND				0.5			25-mar-1999	rcw
Vinyl chloride	ug/l	ND				0.3			25-mar-1999	rcw
Data Entry	--	03/29/99				0			25-mar-1999	rcw

Report #: 52800

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990319269 Sample ID KUPAA WELL Project PHASEV
Sample Type Water Sampled 18-mar-1999 Received 19-mar-1999 Reported 19-apr-1999

525 Semivolatiles by GC/MS (ML/EPA 525.2)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
2,4-Dinitrotoluene	ug/l	ND				0.1	24-mar-1999	CSK	29-mar-1999	yks
alpha-Chlordane	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Acenaphthylene	ug/l	ND				0.1	24-mar-1999	CSK	29-mar-1999	yks
Alachlor	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Aldrin	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Anthracene	ug/l	ND				0.02	24-mar-1999	CSK	29-mar-1999	yks
Atrazine	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Benz(a)Anthracene	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Benzo(a)pyrene	ug/l	ND				0.02	24-mar-1999	CSK	29-mar-1999	yks
Benzo(b)Fluoranthene	ug/l	ND				0.02	24-mar-1999	CSK	29-mar-1999	yks
Benzo(g,h,i)Perylene	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Benzo(k)Fluoranthene	ug/l	ND				0.02	24-mar-1999	CSK	29-mar-1999	yks
Di(2-Ethylhexyl)phthalate	ug/l	ND				0.6	24-mar-1999	CSK	29-mar-1999	yks
Butylbenzylphthalate	ug/l	ND				0.5	24-mar-1999	CSK	29-mar-1999	yks
Bromacil	ug/l	ND				0.2	24-mar-1999	CSK	29-mar-1999	yks
Butachlor	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Caffeine	ug/l	ND				0.02	24-mar-1999	CSK	29-mar-1999	yks
Chrysene	ug/l	ND				0.02	24-mar-1999	CSK	29-mar-1999	yks
Dibenz(a,h)Anthracene	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Di-(2-Ethylhexyl)adipate	ug/l	ND				0.6	24-mar-1999	CSK	29-mar-1999	yks
Diethylphthalate	ug/l	ND				0.5	24-mar-1999	CSK	29-mar-1999	yks
Dieldrin	ug/l	ND				0.2	24-mar-1999	CSK	29-mar-1999	yks
Dimethylphthalate	ug/l	ND				0.5	24-mar-1999	CSK	29-mar-1999	yks
Dimethoate	ug/l	ND				10	24-mar-1999	CSK	29-mar-1999	yks
Di-n-Butylphthalate	ug/l	ND				0.5	24-mar-1999	CSK	29-mar-1999	yks
Endrin	ug/l	ND				0.1	24-mar-1999	CSK	29-mar-1999	yks
Fluorene	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
gamma-Chlordane	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Hexachlorobenzene	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks

Report #: 52800

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990319269 Sample ID KUPAA WELL Project PHASEV
Sample Type Water Sampled 18-mar-1999 Received 19-mar-1999 Reported 19-apr-1999

525 Semivolatiles by GC/MS (ML/EPA 525.2)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
Hexachlorocyclopentadiene	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Heptachlor	ug/l	ND				0.04	24-mar-1999	CSK	29-mar-1999	yks
Heptachlor Epoxide	ug/l	ND				0.02	24-mar-1999	CSK	29-mar-1999	yks
Indeno(1,2,3,c,d)Pyrene	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Isophorone	ug/l	ND				0.5	24-mar-1999	CSK	29-mar-1999	yks
Lindane	ug/l	ND				0.02	24-mar-1999	CSK	29-mar-1999	yks
Methoxychlor	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Metribuzin	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Molinate	ug/l	ND				0.2	24-mar-1999	CSK	29-mar-1999	yks
Metolachlor	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
trans-Nonachlor	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Pentachlorophenol	ug/l	ND				1	24-mar-1999	CSK	29-mar-1999	yks
Phenanthrene	ug/l	ND				0.02	24-mar-1999	CSK	29-mar-1999	yks
Prometryn	ug/l	ND				0.5	24-mar-1999	CSK	29-mar-1999	yks
Propachlor	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Pyrene	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Simazine	ug/l	ND				0.05	24-mar-1999	CSK	29-mar-1999	yks
Thiobencarb	ug/l	ND				0.2	24-mar-1999	CSK	29-mar-1999	yks
Trifluralin	ug/l	ND				0.1	24-mar-1999	CSK	29-mar-1999	yks

Report #: 52800

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990319269 Sample ID KUPAA WELL Project PHASEV
Sample Type Water Sampled 18-mar-1999 Received 19-mar-1999 Reported 19-apr-1999

Aldicarbs (ML/EPA 531.1)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
3-Hydroxycarbofuran	ug/l	ND				2			26-mar-1999	crw
Aldicarb (Temik)	ug/l	ND				0.5			26-mar-1999	crw
Aldicarb sulfone	ug/l	ND				0.7			26-mar-1999	crw
Aldicarb sulfoxide	ug/l	ND				0.5			26-mar-1999	crw
Baygon	ug/l	ND				2			26-mar-1999	crw
Carbofuran (Furadan)	ug/l	ND				0.9			26-mar-1999	crw
Carbaryl	ug/l	ND				2			26-mar-1999	crw
Methiocarb	ug/l	ND				2			26-mar-1999	crw
Methomyl	ug/l	ND				1			26-mar-1999	crw
Oxamyl (Vydate)	ug/l	ND				2			26-mar-1999	crw

Report #: 52800

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Haui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990319269 Sample ID KUPAA WELL Project PHASEV
Sample Type Water Sampled 18-mar-1999 Received 19-mar-1999 Reported 19-apr-1999

Herbicides by 515.1 (ML/EPA 515.1)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
2,4,5-T	ug/l	ND				0.2	26-mar-1999	phk	30-mar-1999	wpt
2,4,5-TP (Silvex)	ug/l	ND				0.2	26-mar-1999	phk	30-mar-1999	wpt
2,4-D	ug/l	ND				0.1	26-mar-1999	phk	30-mar-1999	wpt
2,4-DB	ug/l	ND				2	25-mar-1999	phk	30-mar-1999	wpt
Dichlorprop	ug/l	ND				0.5	26-mar-1999	phk	30-mar-1999	wpt
Acifluorfen (qualitative)	ug/l	ND				0.2	26-mar-1999	phk	30-mar-1999	wpt
Bentazon	ug/l	ND				0.5	26-mar-1999	phk	30-mar-1999	wpt
Dalapon (qualitative)	ug/l	ND				1	26-mar-1999	phk	30-mar-1999	wpt
3,5-Dichlorobenzoic acid	ug/l	ND				0.5	26-mar-1999	phk	30-mar-1999	wpt
DCPA	ug/l	ND				0.1	26-mar-1999	phk	30-mar-1999	wpt
Dicamba	ug/l	ND				0.08	26-mar-1999	phk	30-mar-1999	wpt
Dinoseb	ug/l	ND				0.2	26-mar-1999	phk	30-mar-1999	wpt
Pentachlorophenol	ug/l	ND				0.04	26-mar-1999	phk	30-mar-1999	wpt
Picloram	ug/l	ND				0.1	26-mar-1999	phk	30-mar-1999	wpt
4-Nitrophenol (qualitative)	ug/l	ND				5	26-mar-1999	phk	30-mar-1999	wpt
Data Entry	--	03-31-99				0	26-mar-1999	phk	30-mar-1999	wpt

Report #: 52800

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

Maui, County of, Department of Water Supply
614 Palapala Dr

Kahului , HI 96732
ATTN: Cari Cerizo

Sample # 990319269 Sample ID KUPAA WELL Project PHASEV
Sample Type Water Sampled 18-mar-1999 Received 19-mar-1999 Reported 19-apr-1999

SDWA Pesticides (ML/EPA 508)

Parameter	Units	Result	Conc.	%Rec	Dilution	Det.Limit	Prepared	By	Analyzed	By
PCB 1016 Aroclor	ug/l	ND				0.07	23-mar-1999	KKC	31-mar-1999	mdm
PCB 1221 Aroclor	ug/l	ND				0.1	23-mar-1999	KKC	31-mar-1999	mdm
PCB 1232 Aroclor	ug/l	ND				0.1	23-mar-1999	KKC	31-mar-1999	mdm
PCB 1242 Aroclor	ug/l	ND				0.1	23-mar-1999	KKC	31-mar-1999	mdm
PCB 1248 Aroclor	ug/l	ND				0.1	23-mar-1999	KKC	31-mar-1999	mdm
PCB 1254 Aroclor	ug/l	ND				0.1	23-mar-1999	KKC	31-mar-1999	mdm
PCB 1260 Aroclor	ug/l	ND				0.1	23-mar-1999	KKC	31-mar-1999	mdm
Alpha-BHC	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Alachlor (Alanex)	ug/l	ND				0.05	23-mar-1999	KKC	31-mar-1999	mdm
Aldrin	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Beta-BHC	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Chlordane	ug/l	ND				0.1	23-mar-1999	KKC	31-mar-1999	mdm
Chlorthalonil (Draconil,Bravo)	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Delta-BHC	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
p,p' DDD	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
p,p' DDE	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
p,p' DDT	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Dieldrin	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Endrin Aldehyde	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Endrin	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Endosulfan I (alpha)	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Endosulfan II (beta)	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Endosulfan sulfate	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Heptachlor	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Heptachlor Epoxide	ug/l	ND				0.01	23-mar-1999	KKC	31-mar-1999	mdm
Lindane (gamma-BHC)	ug/l	ND				0.05	23-mar-1999	KKC	31-mar-1999	mdm
Methoxychlor	ug/l	ND				0.5	23-mar-1999	KKC	31-mar-1999	mdm
Toxaphene	ug/l	ND				0	23-mar-1999	KKC	31-mar-1999	mdm
Data Entry	-	03/29/99								

Report #: 52800

Quanterra

METHOD BLANK REPORT

Dioxins

Client Lot #...: G9C240155
MB Lot-Sample #: G9C300000-266

Work Order #...: CT55C101
Prep Date.....: 03/30/99
Prep Batch #...: 9089266

Matrix.....: WATER

Analysis Date..: 04/06/99
Dilution Factor: 1

PARAMETER	RESULT	DETECTION LIMIT	UNITS	METHOD
2,3,7,8-TCDD	ND	2.7	pg/L	EPA-5 1613B-Tetra

INTERNAL STANDARDS	PERCENT RECOVERY	RECOVERY LIMITS
13C-2,3,7,8-TCDD	95	(25 - 141)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra

MONTGOMERY LABORATORIES

Client Sample ID: 990319269

Dioxins

Lot-Sample #...: G9C240155-001 Work Order #...: CRX0Q101 Matrix.....: WATER
Date Sampled...: 03/18/99 Date Received..: 03/24/99
Prep Date.....: 03/30/99 Analysis Date..: 04/07/99
Prep Batch #...: 9089266
Dilution Factor: 1

PARAMETER	RESULT	DETECTION LIMIT	UNITS	METHOD
2,3,7,8-TCDD	ND	1.8	pg/L	EPA-S 1613B-Tetra

INTERNAL STANDARDS	PERCENT RECOVERY	RECOVERY LIMITS
13C-2,3,7,8-TCDD	94	(25 - 141)

EXHIBIT C

SOILS INVESTIGATION

ISLAND GEOTECHNICAL ENGINEERING, INC.
Geotechnical Consultants

1007 Dillingham Blvd., Suite 115
Honolulu, Hawaii 96817
Phone: (808) 842-9526
Fax: (808) 843-8166

222-A Kawaipuna Place
Wailuku, Maui, Hawaii 96793
Phone: (808) 243-9355
Fax: (808) 244-8997

April 28, 1999
Project No. 99214-FM

C. Takumi Engineering, Inc.
18 Central Avenue
Wailuku, Maui, Hawaii 96793

Attention: Mr. Carl Takumi, P.E.

Gentlemen:

The attached report presents the results of a soils investigation at the site of the proposed North Waihee 500,000 Gallon Reservoir project to be located in Waihee, Maui, Hawaii.

A summary of the findings is as follows:

1) Two (2) test borings were drilled to depths of 38.1 and 40 feet below the existing ground surface.

   At Boring 1, moderately stiff CLAY was found at the surface to a depth of 1.5 feet where the CLAY graded very stiff to a depth of 10 feet. From 10 feet to the final depth of the boring at 38.1 feet, very stiff to hard SILT and sandy SILT with gravel were encountered.

   At Boring 2, moderately stiff to stiff CLAY was found at the surface to a depth of 1.5 feet where the CLAY graded very stiff to a depth of 18.5 feet then stiff to a depth of 23.5 feet. At 23.5 feet, stiff sandy SILT with gravel was encountered and extended to the final depth of the boring at 40 feet below existing grade.

2) No groundwater was encountered in any of the test borings at the time of the investigation.

3) Based on the findings and observations, it is concluded that the proposed structures can be supported on spread or continuous footings.

4) The existing surface of the site slopes at about 5 horizontal to 1 vertical. The proposed site grading will require excavations of up to 15 feet deep in order to create a flat reservoir pad.

   HARD ROCK was not encountered in either of the test borings and excavation into the underlying soils may be accomplished with conventional excavation equipment.

   The soils below 6 feet from existing grade were found to be wet (indicated by high moisture content on the boring logs). It is recommended that once the subgrade elevation for the reservoir pad has been reached, the top 6 inches of the reservoir subgrade be aerated to adjust the moisture content of the soil to near optimum moisture content (ASTM D 1557-91). The reservoir subgrade should then be proof-rolled (compacted) with a vibratory sheepsfoot compactor weighing not less than 10,000 pounds.

Details of the findings and recommendations are presented in the attached report.

This investigation was made in accordance with generally accepted engineering procedures and included such field and laboratory tests considered necessary for the project. In the opinion of the undersigned, the accompanying report has been substantiated by mathematical data in conformity with generally accepted engineering principles and presents fairly the design information requested by your organization. No other warranty is either expressed or given.

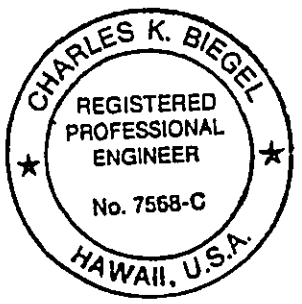
Respectfully submitted,

ISLAND GEOTECHNICAL ENGINEERING, INC.

Charles K. Biegel

Charles K. Biegel, P.E.
President

CKB:cb



This work was prepared by me
or under my supervision.

TABLE OF CONTENTS

INTRODUCTION

This investigation was made for the purpose of obtaining information on the subsurface conditions from which to base recommendations for foundation design for the proposed North Waihee 500,000 Gallon Reservoir to be located in Waihee, Maui, Hawaii. The location of the site, relative to the existing streets and landmarks, is shown on the Vicinity Map, Plate 1.

SCOPE OF WORK

The services included drilling 2 test borings to depths of 38.1 & 40 feet, obtaining samples of the underlying soils, performing laboratory tests on the samples, and performing an engineering analysis from the data gathered. In general, the following information is provided for use by the Architect and/or Engineer:

1. General subsurface conditions, as disclosed by the borings.
2. Physical characteristics of the soils encountered.
3. Recommendations for foundation design, including bearing values, embedment depth and estimated settlement.
4. Recommendations for placement of fill and backfill.
5. Special considerations.

PLANNED DEVELOPMENT

From the information provided, the project will consist of developing the site for a 70-foot diameter, 500,000 gallon reservoir. The proposed site grading will require an excavation

(cut) of the reservoir pad on the order of 1 to 15 feet (+/-).

SITE CONDITIONS

Surface

The property, designated by Tax Map Key number 3-2-1: 3 (portion), is located on the mauka side of Kahekili Highway in Waihee, Maui. The site is located 50 feet south of Kupaa Well No. 1 which was being installed during our field work.

At the time of the field investigation, the site was covered with weeds to 3 feet in height.

From the topographic map provided by C.Takumi Engineering, Inc. (dated 8-1-97), existing surface elevations at the reservoir site range from about +642 feet at the northeast side of the reservoir to +658 feet at the southwest side of the reservoir. Elevations shown on the test boring logs in this report were estimated by taping from existing features on the site and then performing a rough field interpolation of the above topographic map.

Subsurface

The subsurface conditions at the site were explored by drilling 2 test borings to depths of 38.1 and 40 feet. The locations of the test borings are shown on the Plot Plan, Plate 2. Detailed logs of the test borings are presented in the Appendix to this report.

At Boring 1, moderately stiff CLAY was found at the surface to a depth of 1.5 feet where the CLAY graded very stiff to a depth of 10 feet. From 10 feet to the final depth of the boring at 38.1 feet, very stiff to hard SILT and sandy SILT with gravel were encountered.

At Boring 2, moderately stiff to stiff CLAY was found at the surface to a depth of 1.5 feet where the CLAY graded very stiff to a depth of 18.5 feet then stiff to a depth of 23.5 feet. At 23.5 feet, stiff sandy SILT with gravel was encountered and extended to the final depth of the boring at 40 feet below existing grade.

No groundwater was encountered in any of the test borings at the time of the investigation.

From the USDA Soil Conservation Service "Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii", the site is located in an area designated as Naiwa silty clay loam, 3 to 20 percent slopes (NAC). The Naiwa Series consist of well-drained soils on uplands on the islands of Lanai, Molokai and Maui. These soils developed in volcanic ash and material weathered from basic igneous rock (USDA, 1972, pp. 97 and Plate 98).

Geology

The island of Maui is a volcanic doublet believed to have formed during the late Tertiary (between 1 and 12 million years ago) when lavas from Haleakala ponded against the older

West Maui Mountains.

The site is located on the easterly flank of the West Maui Mountains which was built by lavas flowing from rift zones trending north and south and a central vent. The lava flows which form the mountain have been separated into three groups: Wailuku, Honolua, and Lahaina Volcanic Series (Stearns and MacDonald, 1942). The main lava mass that makes up the West Maui Mountains is known as the Wailuku Volcanic Series which consist of primitive olivine basalts and associates pyroclastic and intrusive rock.

The on-site residual soils developed from weathering of the underlying parent bedrock.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on the findings and observations, it is concluded that the site may be developed for the intended use. Proposed structures can be supported on spread or continuous footings.

Special Considerations

The existing surface of the site slopes at about 5 horizontal to 1 vertical. The proposed site grading will require excavations of up to 15 feet deep in order to create a flat reservoir pad.

HARD ROCK was not encountered in either of the test borings and excavation into the

underlying soils may be accomplished with conventional excavation equipment.

The soils below 6 feet from existing grade were found to be wet (indicated by high moisture content on the boring logs). It is recommended that once the subgrade elevation for the reservoir pad has been reached, the top 6 inches of the reservoir subgrade be aerated to adjust the moisture content of the soil to near optimum moisture content (ASTM D 1557-91). The reservoir subgrade should then be proof-rolled (compacted) with a vibratory sheepsfoot compactor weighing not less than 10,000 pounds.

Foundations

For footings bearing on the underlying stiff to very stiff on-site soils or properly compacted structural fill, an allowable bearing value of 3,000 psf may be used. The minimum footing embedment depth shall be 12 inches below the lowest adjacent grade (measured to bottom of footing).

For footings located adjacent to new or existing utility trenches, the bottom of the footing shall be deepened below a 1 horizontal to 1 vertical plane projected upwards from the edge of the utility trench.

For footings located on or adjacent to slopes, the footing shall be deepened such that there is a minimum horizontal distance of 5 feet from the edge of the footing to the slope face.

The bearing value is for dead plus live loads and may be increased by one-third for momentary loads due to wind or seismic forces. If any footing is eccentrically loaded, the maximum edge pressure shall not exceed the bearing pressure for permanent or for momentary loads.

All loose and disturbed soil at the bottom of footing excavations shall be removed to firm soil or the disturbed soil shall be compacted prior to laying of steel or placing of concrete.

Settlement

Under the reservoir, it is estimated that settlement on the order of ½ inch will occur in the center of the tank, 3/4 inch on the downhill edge of the tank and 1/4 inch at the uphill edge of the tank. All footings shall bear on stiff to very stiff on-site soils or properly compacted structural fill.

Differential settlement between footings will vary according to the size and bearing pressure of the footing.

Lateral Resistance

For resistance of lateral loads, such as wind or seismic forces, an allowable passive resistance equivalent to that exerted by a fluid weighing 300 pounds per cubic foot may be used for footings, or other structural elements, provided the vertical surface is in direct

contact with undisturbed soil or properly compacted fill.

Frictional resistance between footings and the underlying on-site soils may be assumed as 0.4 times the dead load.

Lateral resistance and friction may be combined.

Retaining Walls

Foundations for retaining walls shall be designed as per the foundation section of this report.

Depending on the type of backfill material within a 1H:2V plane projected upwards from the bottom edge of the retaining wall footing, the following active earth pressures may be used for design of free-standing retaining walls:

On-site CLAY/SILT as retaining wall backfill material (*):

Backfill Slope	Horizontal Component (psf/ft.)	Vertical Component (psf/ft.)
Level	45	0
3H:1V	50	15
2H:1V	60	30

(*) It should be noted that some of the on-site soils (below 6 feet from existing grade) were found to be wet and will require drying in order to achieve proper compaction for wall backfill.

Imported granular soil as retaining wall backfill material:

Backfill Slope	Horizontal Component (psf/ft.)	Vertical Component (psf/ft.)
Level	30	0
3H:1V	35	10
2H:1V	40	20

Drainage for the retaining wall backfill shall be accomplished by providing 4-inch diameter weepholes spaced 6-feet on-center (horizontally as well as vertically) or by using a minimum 4-inch diameter perforated PVC footing drain pipe. A 2-foot thick layer of crushed gravel, which is wrapped with geotextile filter fabric, shall be placed above the pipe; the crushed gravel shall be continuous from weephole to weephole, or in the case of a footing drain pipe, laid throughout the full length of the pipe. Geotextile fabric shall be AMOCO 4545 or similar.

The backfill for the retaining wall shall be properly compacted in accordance with the Site Preparation and Grading section to this report.

The above active pressures do not include surcharge loads such as footings located within a 45 degree plane projected upwards from the heel of the footing, and/or from hydrostatic pressures. If such conditions occur, the active pressure shall be increased accordingly.

Slab-on-Grade

For maintenance buildings and exterior pedestrian sidewalks, concrete slabs-on-grade may

be designed using a minimum of 4-inches of concrete on 6 inches of base course gravel. The top 6 inches of the slab area subgrade shall be moisture conditioned to near optimum moisture content (ASTM D 1557-91) and compacted to a minimum of 95% of the maximum dry density as determined by ASTM D 1557-91 test procedure. Reinforcement for slabs shall be provided by others.

Site grading should be designed to minimize ponding of water adjacent to slab and footing areas.

It is recommended that floor slabs with moisture sensitive floor covering be protected with a moisture barrier.

Slopes

Cut and fill slopes shall not exceed 2 horizontal to 1 vertical. Exposed slopes shall be covered as soon as practical after construction to minimize erosion.

Fill slopes shall be constructed by either overfilling and cutting back to compacted soil.

Pavement Design

It is recommended that flexible pavement section consist of 2 inches of asphaltic concrete, 6 inches of base course gravel and 6 inches of compacted subgrade. In areas that

anticipate heavy axle loading (single axle loads in excess of 9,000 pounds), the asphaltic concrete thickness shall be increased to a minimum of 2.5 inches.

The base course gravel and top 6 inches of subgrade shall be compacted to at least 95 percent of the maximum dry density as determined by the ASTM D1557-91 test procedure.

All material quality requirements for the pavement section shall be in accordance with the "Hawaii Standard Specifications for Road, Bridge and Public Works Construction", dated 1994.

Site Preparation and Grading

It is recommended that the site be prepared in the following manner:

1. All vegetation, weeds, brush, roots, stumps, rubbish, debris, soft soil and other deleterious material shall be removed and disposed of off-site.

2. In areas to receive fill and at finished subgrade in cut areas, the exposed surface shall then be scarified to a depth of 6 inches, moisture conditioned to near optimum moisture (may require drying, see Special Considerations section of this report) and then compacted to the degree of compaction specified below. If soft or loose spots are encountered, the loose/soft areas shall be removed to firm material and the resulting depression shall be filled with properly compacted fill.

3. Where fill is placed on existing ground that is steeper than 5 horizontal to 1 vertical, the existing ground surface shall be benched into firm soil as the fill is placed.

4. Fill and Backfill in Structural Areas: Structural areas shall be defined as areas beneath and 3 feet beyond the edges of the reservoir, buildings and pavement areas.

Structural fill and backfill material shall consist of material which is free of organics and debris and is non-expansive. In the upper 3 feet from finished grade, the structural fill and backfill material shall be less than 3 inches in greatest dimension. Below 3 feet from finished grade, the structural fill material shall be less than 6 inches in greatest dimension, provided there is sufficient fines to fill the interstices. The on-site soils are acceptable for use as fill provided the above size requirements can be met.

Each layer of structural fill and backfill material shall be placed in lifts not exceeding 6 inches in compacted thickness. Each layer of structural fill and backfill shall be thoroughly compacted prior to placing of any subsequent lifts. Structural fill and backfill shall be compacted to at least 95 percent of the maximum dry density. The maximum dry density shall be determined by the ASTM D 1557-91 test procedure.

5. Fill and Backfill in Non-Structural Areas: Non-structural areas shall be defined as areas beyond 3 feet from the edge of any building and pavement areas.

Non-structural fill and backfill material shall consist of material which is free of organics and debris. In the upper 3 feet from finished grade, the fill and backfill material shall be less than 3 inches in greatest dimension. Below 3 feet from finished grade, the fill material shall be less than 12 inches in greatest dimension, provided there is sufficient fines to fill the interstices. The on-site soils are acceptable for use as non-structural fill provided the above size requirements can be met.

Each layer of non-structural fill and backfill material shall be placed in lifts not exceeding 12 inches in compacted thickness. Each layer of non-structural fill and backfill shall be thoroughly compacted prior to placing of any subsequent lifts. The top 2 feet of non-structural fill and backfill shall be compacted to at least 90 percent of the maximum dry determined by the ASTM D 1557-91 test procedure. Non-structural fill and backfill below 2 feet from finished grade shall be compacted to at least 85 percent of the maximum dry density as determined by the ASTM D 1557-91 test procedure.

6. Backfill Behind Retaining Walls Retaining wall backfill shall be defined as backfill

that extends from the stem of the retaining wall to 6 inches beyond the heel of the wall footing or the footing excavation line, whichever is greater.

All retaining wall backfill material shall consist of material that is in accordance with the project plans and specifications and meets the design criteria of the structural engineer.

Each layer of backfill shall be placed in layers not exceeding 6 inches in compacted thickness. Each layer of backfill shall be thoroughly compacted prior to placing of any subsequent lifts. All retaining wall backfill shall be compacted to at least 90 percent of the maximum dry density as determined by the ASTM D 1557-91 test procedure. Retaining wall backfill that will support structures or roadways shall be placed and compacted in accordance with the above requirements for Fill and Backfill in Structural Areas.

7. During construction, drainage shall be provided to minimize ponding of water adjacent to or on foundation and pavement areas. Ponded areas shall be drained immediately or water pumped out without damaging adjacent structures and property. If water accumulation softens the subgrade materials, the affected soils shall be removed and replaced with properly compacted fill.

It is particularly important to see that all fill and backfill soils are properly compacted in order to maintain the recommended design parameters provided in this report.

INSPECTION

During the progress of construction, so as to evaluate compliance with the design concepts, specifications and recommendations contained in this report, a representative from this office should be present to observe the following operations:

1. Site preparation.
2. Placement of fill and backfill.
3. Footing excavations.

REMARKS

The conclusions and recommendations contained herein are based on the findings and observations made at the test boring locations. If conditions are encountered during construction which appear to differ from those disclosed by the explorations, this office shall be notified so as to consider the need for modifications.

This report has been prepared for the exclusive use of C. Takumi Engineering, Inc. and their respective design consultants. It shall not be used by or transferred to any other party or to another project without the consent and/or thorough review by this facility. Should the project be delayed beyond the period of one year from the date of this report, the report

shall be reviewed relative to possible changed conditions.

Samples obtained in this investigation will deteriorate with time and will be unsuitable for further laboratory tests within one (1) month from the date of this report. Unless otherwise advised, the samples will be discarded at that time.

The following are included and complete this report:

Vicinity Map ---------- Plate 1

Plot Plan ---------- Plate 2

Appendix

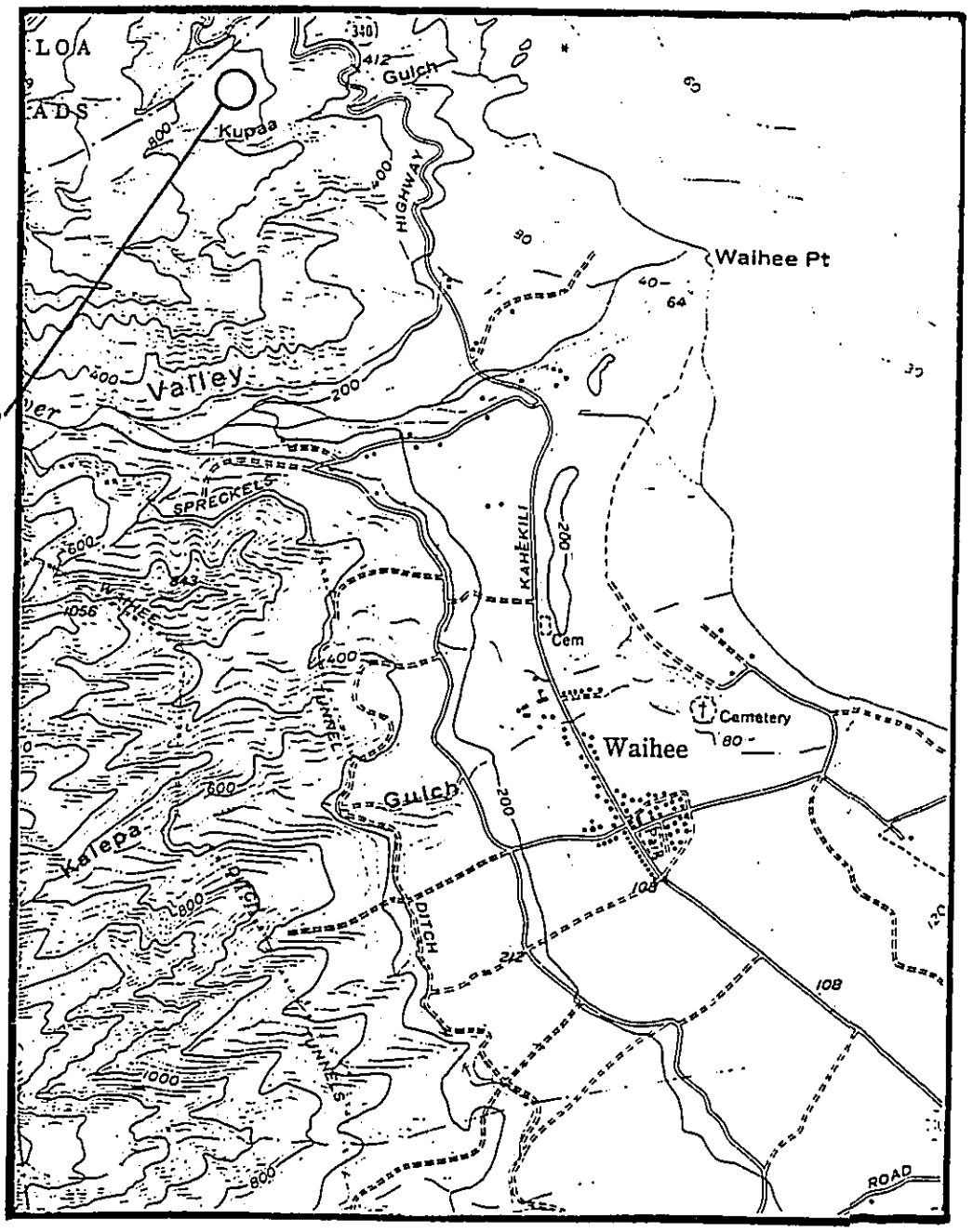
Field Investigation

Laboratory Testing

Logs of Test Borings

Results of Laboratory Tests

VICINITY MAP



REFERENCE:

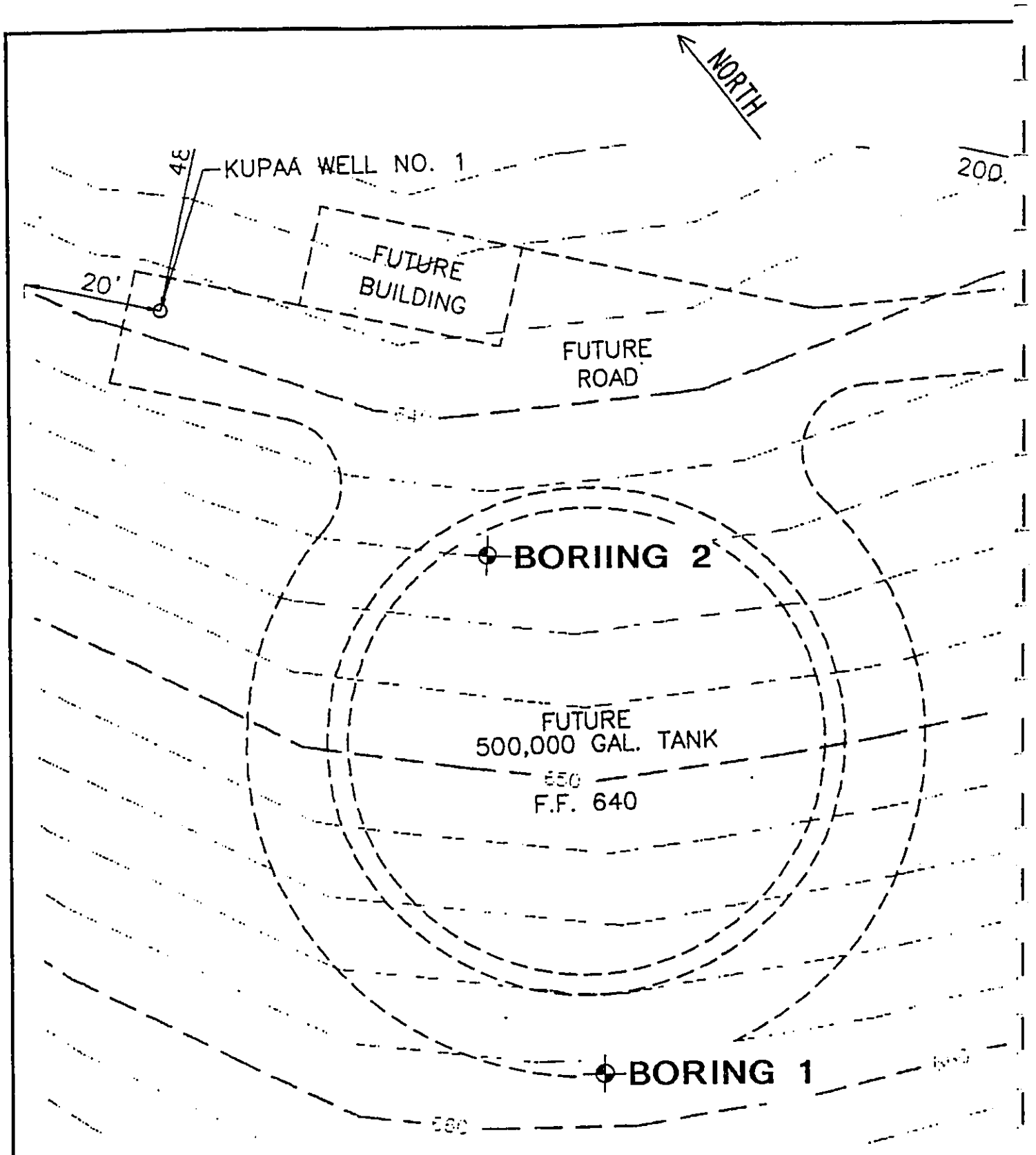
USGS TOPOGRAPHIC MAP
WAILUKU QUADRANGLE

Dated: 1983

NORTH WAIHEE 500,000 GAL. RESERVOIR

ISLAND GEOTECHNICAL ENGINEERING, INC.
Geotechnical Consultants

PROJECT NO.	99214-FM
DATE	Mar. 1999
SCALE	1"= 2000'
PLATE	1



PLOT PLAN
Scale: 1" = 20'

Project: North Waihee 500,000 Gallon Reservoir — Project No.: 99214-FM

ISLAND GEOTECHNICAL ENGINEERING, INC. — PLATE 2

APPENDIX

FIELD INVESTIGATION AND LABORATORY TESTING

FIELD INVESTIGATION

General

The field investigation consisted of performing explorations at the locations shown on the Plot Plan. The method used for the exploratory work is shown on the respective exploration log. A description of the various method or methods used is presented below.

Test Borings Using Truck-Mounted Drilling Equipment

Truck-mounted borings are drilled using a gas-powered drilling rig. The hole is advanced using continuous flight augers, wash boring and/or NX coring.

Auger drilling is used in soils where caving does not occur. The augers are 4-1/2 inch diameter continuous helical flight augers with the lead auger having a head equipped with changeable cutting teeth. Soil cuttings are brought to the surface by the continuous flights. After the bore hole is advanced to the required depth and cleaned of cuttings by additional rotation of the augers, the augers are retracted for soil sampling or in-situ testing.

In soils where caving of the bore hole occurs, the hole is advanced by wash boring or hollow-stem augering. Wash boring consists of advancing steel casing by rotary action and water pressure to flush the soil from the casing. The lead section of the casing is equipped with a carbide or diamond casing bit. After the casing has been advanced to the required depth, soil samples are obtained through the inside of the casing. Hollow-stem drilling consists of advancing the hole with 7-5/8 inch outside diameter and 4-1/4 inch inside diameter augers. The leading drill bit is connected to drilling rods through the central portion of the auger. At the required sampling depth, the interior drill rods and lead bit are removed, and the soil sample is taken by driving a sampler

through the "hollow" section of the augers.

Coring is used for hard formations such as rock, coral or boulders. The core barrel, consisting of a 5-foot long double tube, hardened steel barrel with either a carbide or diamond bit, is attached to drilling rods and set on the hard formation. The core barrel is advanced through the formation by rotation of the core barrel. Water is used to flush out the cuttings. Upon completion of the core run, the sample is removed from the core barrel and inspected. The total core recovery length and the sum of all intact pieces over 4-inch in length are measured. The length of core recovery divided by the length of the core run is the recovery ratio. The combined length of the 4-inch or longer pieces divided by the length of core run is the Rock Quality Designation (RQD). The values provide an indication of the quality of the formation.

Test Borings Using Portable Drilling Equipment

In areas inaccessible to truck-mounted equipment, portable drilling equipment is used to drill the test boring. The boring is advanced by either 1) continuous drive sampling or by 2) using a small gas-powered drill rig with continuous flight augers, wash boring or NX coring.

Soil samples are obtained with a tripod and cathead assembly using soil sampling methods described below.

Test Pits Using Excavators/Hopto

Test pits are excavated using a hopto or backhoe. Material excavated from the pit and the sides and bottom of the pit are visually inspected and a continuous log of the hole is kept.

Explorations Using Hand Tools

In inaccessible areas requiring only shallow explorations, borings and test pits are made using hand equipment. Borings are drilled using hand augers. Test pits are excavated using hand tools. Cuttings from the boring and/or pit are inspected and visually classified.

Soil Sampling

Relatively undisturbed samples of the underlying soils are obtained from borings by driving a sampling tube into the subsurface material using a 140-pound safety hammer falling from a height of 30 inches. Ring samples are obtained using a 3-inch outside diameter, 2.5 inch inside diameter steel sampling tube with an interior lining of one-inch long, thin brass rings. The tube is driven approximately 18 inches into the soil and a section of the central portion is placed in a close fitting waterproof container in order to retain field conditions until completion of the laboratory tests. Standard Penetration Test (SPT) values and disturbed soil samples are obtained with a 2-inch (outside diameter) split-barrel sampler instead of the 3-inch sampler. The number of blows required to drive the sampler into the ground is recorded at 6-inch intervals. The blow count for the last 12-inches is shown on the boring logs.

From test pit excavations, relatively undisturbed soil samples are obtained by pushing the 3 inch outside diameter sampling tube (mentioned above) into the ground with the backhoe bucket. In addition, undisturbed bulk samples are retained from cohesive type soil formations and disturbed bulk samples are retained from friable and cohesionless soil formations.

The soil samples are visually classified in the field using the Unified Soil Classification System. Samples are packed in moisture proof containers and transported to the laboratory for testing.

LABORATORY TESTING

General

Laboratory tests are performed on various soil samples to determine their engineering properties. Description of the various tests are listed below.

Unit Weight and Moisture Content

The in-place moisture content and unit weight of the samples are used to correlate similar soils at various depths. The sample is weighed, the volume determined, and a portion of the sample is placed in the oven. After oven-drying, the sample is again weighed to determine the moisture loss. The data is used to determine the wet-density, dry-density and in-place moisture content.

Direct Shear

Direct shear tests are performed to determine the strength characteristics of the representative soil samples. The test consists of placing the sample into a shear box, applying a normal load and then shearing the sample at a constant rate of strain. The shearing resistance is recorded at various rates of strain. By varying the normal load, the angle of internal friction and cohesion can be determined.

Consolidation Test

Consolidation tests are performed to obtain data from which time rates of consolidation and amounts of settlement may be estimated. The test is performed by placing a specimen in a consolidation apparatus. Loads are applied in increments to the circular face of a one (1) inch high sample. Deformation or changes in thickness of the specimen are recorded at selected time intervals. Water is introduced to or allowed to drain from the sample through porous disks placed

against the top and bottom faces of the specimen. The data is then used to plot a stress-volume strain curve which is used in estimating settlement.

Expansion Index Test

Expansion Index of fine-grained soils is determined in accordance with ASTM D 4829-88 test procedure. The soil specimen is compacted into a metal ring so that the degree of saturation is between 40 and 60 percent. The specimen and the ring are placed in a consolidometer. A vertical confining pressure of 1 psi is applied to the specimen and then the specimen is inundated with water. The deformation of the specimen is recorded for 24 hours. The data is used to determine the expansion potential of the soil.

Classification Tests

The soil samples are classified using the Unified Soil Classification System. Classification tests include sieve and hydrometer analysis to determine grain size distribution, and Atterberg Limits to determine the liquid limit, plastic limit and plasticity index.

California Bearing Ratio Test

California Bearing Ratio (CBR) tests are performed on materials to determine the bearing strength of the soil for determination of pavement sections. The sample is compacted into a 6-inch diameter mold in 5 equal layers. Each layer is compacted with a 10-pound hammer falling from a height of 18-inches, with each layer receiving 56 blows. The mold is then placed in a water bath for 4-days and the vertical swell is measured under a surcharge weight of 10 pounds. After the soaking period, the sample is placed in a CBR apparatus that has a 3-square inch penetrometer. The penetrometer is pressed vertically into the soil at constant strain and the loads required to

press the penetrometer are recorded. A plot of the load-strain relationship is made to determine the CBR value.

Maximum Dry Density/Optimum Moisture Content

The maximum dry density and optimum moisture content of the material is determined in accordance with the ASTM D1557-91 test procedure. The sample is compacted into a mold in 5 equal layers using a 10 pound hammer falling from a height of 18 inches. The diameter of the mold is either 4-inches or 6-inches depending on the proportion of gravel in the sample. The sample is compacted at various moisture contents to develop a compaction curve for the soil. The curve is usually bell-shaped with a peak indicating the maximum dry density and optimum moisture content.

Penetrometer Test

Penetrometer tests are performed on clayey soils to determine the consistency of the material and an approximate value of the unconfined compressive strength.

Torvane

Torvane tests are used to determine the approximate undrained shear strength of clayey soils. The torvane apparatus consists of a torque device with a small diameter plate that has vanes situated perpendicular to the plate. The vanes are pushed into the soil and torque is applied until failure occurs. The torque required to cause failure is converted to approximate undrained strength of the soil.

LOG OF BORING NO. 1

ELEVATION: +658' (estimate)

EQUIPMENT USED: Simco Truck Mounted Drill Rig

DEPTH OF BORING: 38.1

DATE DRILLED: March 25, 1999

DEPTH TO GROUNDWATER: unknown

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	BLOWS/FOOT	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)
0		CL	CLAY, with roots			dark reddish brown	moist to very moist	mod. stiff			
			---no roots								
2					25			very stiff	89.0	27.8	4.5
						dusky red					
4					34				100.0	27.0	4.5
6						dark red	very moist				
8					38				89.7	36.1	4.5
10		ML	SILT, with sand and gravel		22	yellowish red			60.7	56.7	4.5
12											
14		SM-ML	sandy SILT with gravel (highly to completely weathered rock)		33	yellowish brown			43.8	89.7	
16											
18			---rocky structure		30	light olive brown			66.0	53.1	
20											

PROJECT NAME: NORTH WAIHEE 500,000 GALLON RESERVOIR

PROJECT NO.: 99214-FM

ISLAND GEOTECHNICAL ENGINEERING, INC.

Geotechnical Consultants

PLATE 3

LOG OF BORING NO. 1

EQUIPMENT USED: Simco Truck Mounted Drill Rig

DATE DRILLED: March 25, 1999

ELEVATION: +658' (estimate)

DEPTH OF BORING: 38.1

DEPTH TO GROUNDWATER: unknown

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	BLOWS/FOOT	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)
23		SM-ML	sandy SILT with gravel			light olive brown	very moist	very stiff			
					140			hard	61.6	62.3	4.5
25											
								very stiff			
27											
		ML	SILT			dark gray					
29					24				58.9	69.6	2.5
31											
33			---rocky structure								
			---refusal at 34'-0"		144	gray		hard	69.6	50.4	
35											
37											
			---refusal at 38'-1"		30/1"						
39			END OF BORING								
41											

PROJECT NAME: NORTH WAIHEE 500,000 GALLON RESERVOIR

PROJECT NO.: 99214-FM

ISLAND GEOTECHNICAL ENGINEERING, INC.

Geotechnical Consultants

PLATE 3

LOG OF BORING NO. 2

ELEVATION: +644' (estimate)

EQUIPMENT USED: Simco Truck Mounted Drill Rig

DEPTH OF BORING: 40

DATE DRILLED: March 25, 1999

DEPTH TO GROUNDWATER: unknown

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	BLOWS/FOOT	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)
0		CL	CLAY			dark reddish brown	moist	mod. stiff			
								stiff			
2					34			very stiff	109.2	21.8	2.0
4			---Atterberg Limits at 4.0': LL=40 PL=21		30	dusky red			128.2	21.7	4.5
6							moist to very moist				
8					28				102.0	33.4	4.5
						dark reddish brown					
10					32				100.1	34.7	4.5
12											
14					35		very moist		69.4	57.3	4.5
						light yellowish brown					
16											
18			---few gravel and sand					stiff			
20					17				58.4	55.9	

PROJECT NAME: NORTH WAIHEE 500,000 GALLON RESERVOIR	ISLAND GEOTECHNICAL ENGINEERING, INC.	PLATE
PROJECT NO.: 99214-FM	*Geotechnical Consultants*	4

LOG OF BORING NO. 2

ELEVATION: +644' (estimate)

EQUIPMENT USED: Simco Truck Mounted Drill Rig

DEPTH OF BORING: 40

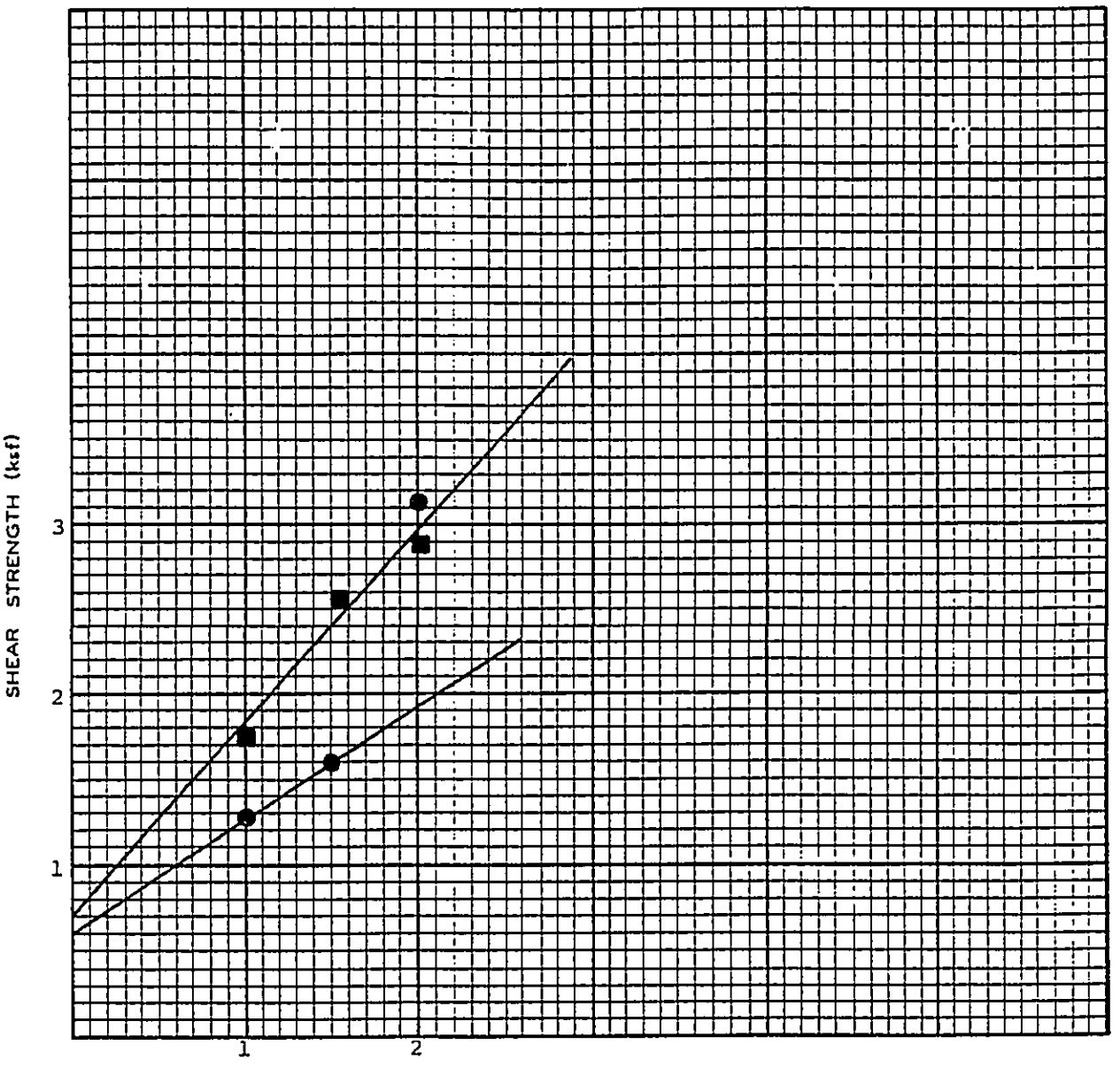
DATE DRILLED: March 25, 1999

DEPTH TO GROUNDWATER: unknown

DEPTH (FT.)	GRAPHIC SYMBOL	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	SAMPLE	BLOWS/FOOT	COLOR	MOISTURE	CONSISTENCY	DRY DENSITY (PCF)	MOISTURE CONTENT (% OF DRY WT.)	PENETROMETER (TSF)
23		CL	CLAY			light yellowish brown	very moist	stiff			
25		SM-ML	sandy SILT with gravel (highly to completely weathered rock)		18	dark yellowish brown	moist		79.3	22.9	
27											
29					14				71.3	23.5	
31											
33						dark brown					
35					16				87.2	22.2	
37						very dark gray					
39					14	very dark grayish brown			69.3	33.9	
41			END OF BORING								

PROJECT NAME: NORTH WAIHEE 500,000 GALLON RESERVOIR	ISLAND GEOTECHNICAL ENGINEERING, INC.	PLATE
PROJECT NO.: 99214-FM	*Geotechnical Consultants*	4

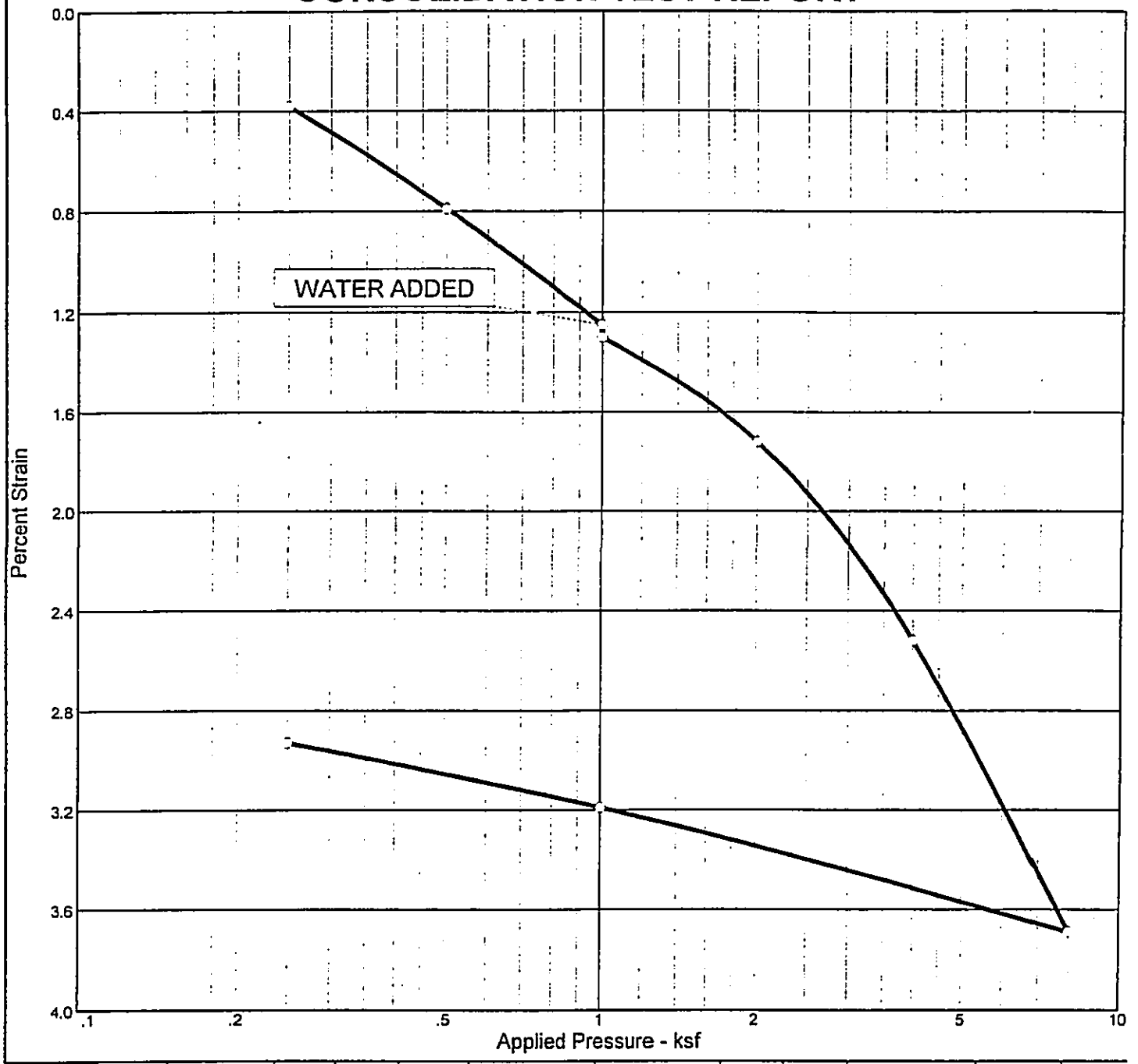
DIRECT SHEAR TEST



	LOCATION	DEPTH (ft.)	COHESION (psf)	ANGLE OF INTERNAL FRICTION	TEST CONDITIONS
●	Boring 1	4 to 4.5	600	33°	Field Density: Peak Strength
■	Boring 1	7 to 7.5	700	48°	Field Density: Peak Strength

PROJECT:	PROJECT NO.		PLATE
N. WAIHEE 500,000 GALLON RES.	99214-FM	ISLAND GEOTECHNICAL ENGINEERING, INC. *Geotechnical Consultants*	5

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_s	Swell Press. (ksf)	Swell %	e_o
Sat.	Moist.											
94.3 %	34.3 %	99.2			3.77	0.81	2.77	0.09	0.01			1.372

MATERIAL DESCRIPTION	USCS	AASHTO
dusky red CLAY	CL	

Project No. 99214-FM **Client:**

Project: NORTH WAIHEE 500,000 GALLON RESERVOIR

Location: Boring 2 at 7 feet.

Remarks:

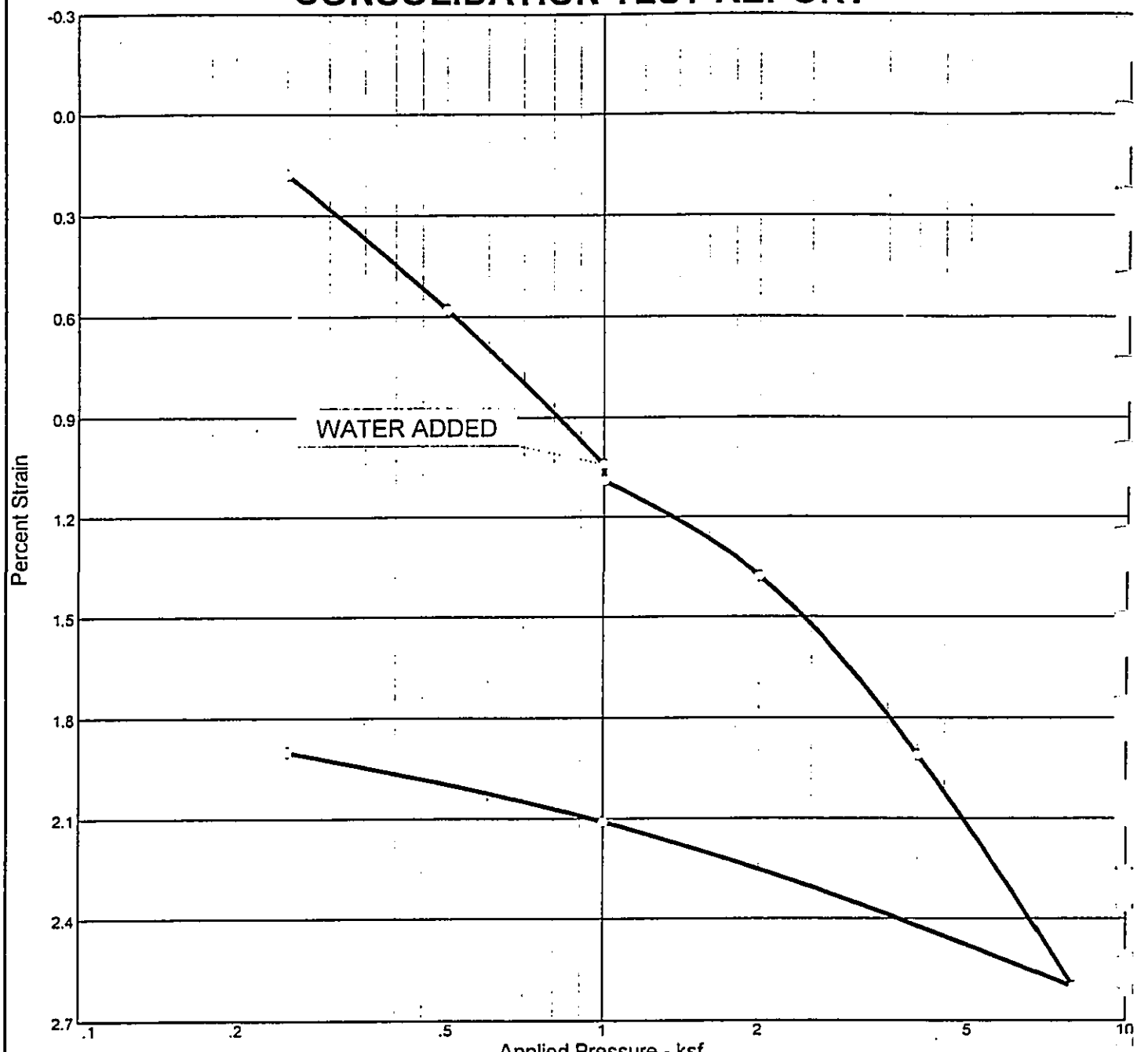
1. Undisturbed sample.

CONSOLIDATION TEST REPORT

Island Geotechnical Engineering, Inc.

Plate 6

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_s	Swell Press. (ksf)	Clpse. %	e_o
97.0 %	35.7 %	98.6			3.77	1.09	2.57	0.06	0.01		0.1	1.38

MATERIAL DESCRIPTION	USCS	AASHTO
dark reddish brown CLAY	CL	

Project No. 99214-FM **Client:**

Project: NORTH WAIHEE 500,000 GALLON RESERVOIR

Location: Boring 2 at 9.5 feet.

Remarks:

1. Undisturbed sample.

CONSOLIDATION TEST REPORT

Island Geotechnical Engineering, Inc.

Plate 7

FIELD-DENSITY EXPANSION TEST REPORT

ASTM D 4546-96: Method B modified (note 1)

SAMPLE LOCATION	DEPTH	INITIAL WATER CONTENT	INITIAL DRY DENSITY (PCF)	INITIAL % SAT. (note 2)	FINAL WATER CONTENT	MEASURED EXPANSION
Boring 2	4.0'	19.9%	129.4	91.7	21.4%	0.2%
"	"	20.2%	125.1	86.5	22.2%	0.5% (note 3)

note 1: This test was performed by placing the undisturbed sample ring (2.375 inch diameter & 1 inch height) into an expansion apparatus. A 144 psf surcharge was then placed on the sample. The sample was then submerged in water and the change in vertical height was recorded.

note 2: The specific gravity was determined in accordance with ASTM D 854-92 and the results indicate this soil has a specific gravity of 3.77.

note 3: This sample was air-dried to 2.7% moisture content prior to submerging in water.

Project: NORTH WAIHEE 500,000 GALLON RESERVOIR Project No.: 99214-FM

ISLAND GEOTECHNICAL ENGINEERING, INC. PLATE 8