TECHNICAL STUDIES

ENVIRONMENTAL IMPACT STATEMENT

FOR THE

WAIAHOLE VALLEY AGRICULTURAL PARK

AND

RESIDENTIAL LOTS SUBDIVISION

PREFACE

The studies contained in this volume were prepared by subconsultants for the planning and environmental assessment of Waiahole Valley Agricultural Park and Residential Lots Subdivision. Findings from these studies have been incorporated in the EIS. These studies are being made available in this volume for those who desire more detailed information than what is contained in the EIS.

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Agricultural Feasibility and Environmental Impact
Waiahole Valley Agricultural Park

Prepared For

Calvin Kim & Associates, Inc.

(Modification and Update of Report
Prepared for M & E Pacific, Inc.,
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By

Frank S. Scott, Jr.

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Study Bureau. Also, the Soil Conservation Service capability ratings conform more closely with what is being experienced under existing crop production in Waiahole Valley.

The various Soil Conservation Service classifications as imposed on the lot layout and topographical contour map in Figure 1 are discussed below in relation to existing and potential crops.

Soils Adaptable to Agriculture

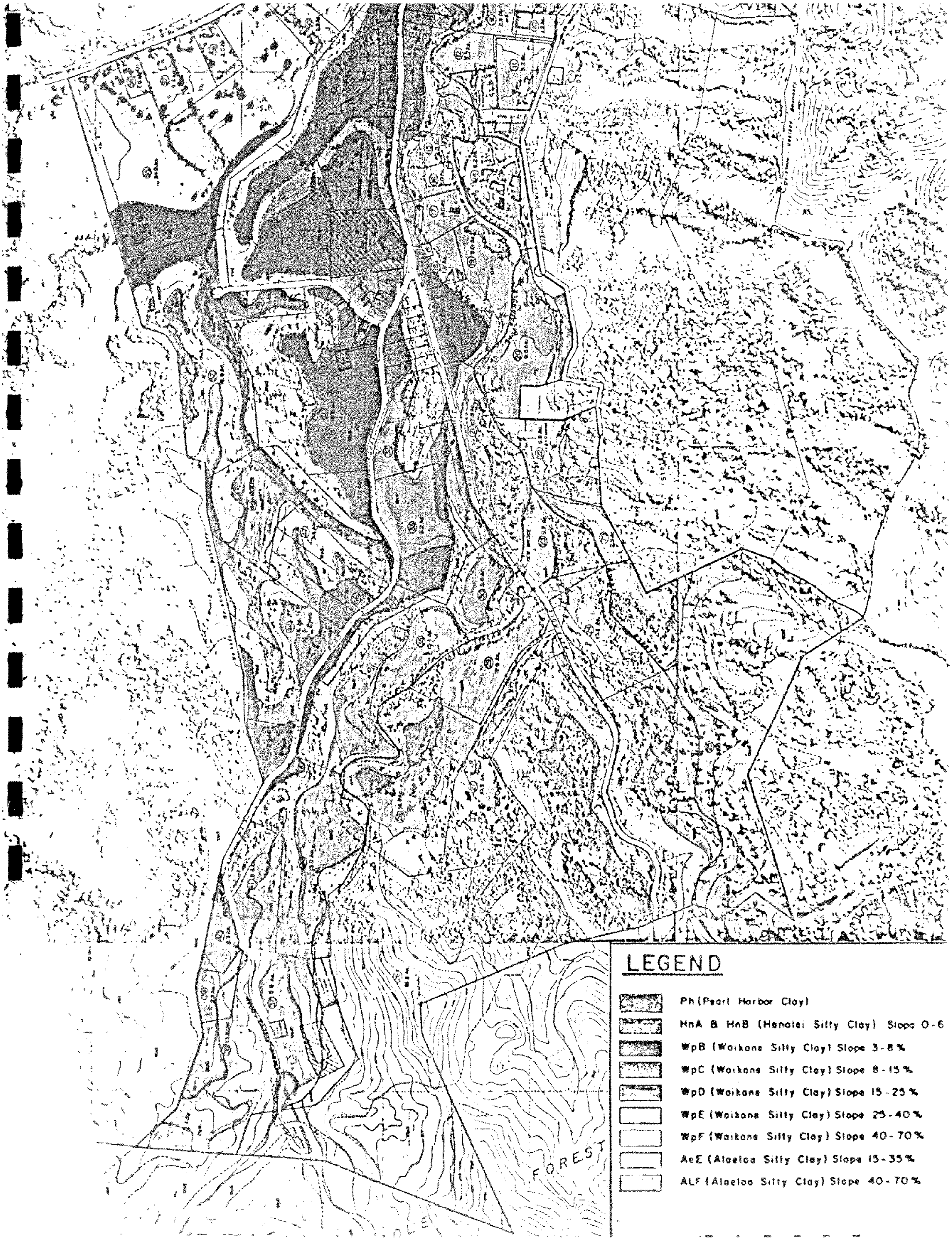
1. Pearl Harbor Clay Series (Ph)

These soils are level or near level and consist of a topsoil of very dark gray mottled clay about 12 inches in depth and a subsoil of very dark gray or very dark grayish-brown mottled clay 19 inches thick with an angular or sub-angular blocky structure. The substratum is muck or peat. The surface layer is neutral in Ph and the subsoil is midly to moderately alkaline. Permeability is low, runoff is slow and drainage is poor. Areas in which these soils predominate are subject to flooding. Water capacity is about 1.4 inches per foot in the topsoil and subsoil. There is a high shrink-swell potential and workability is very difficult. In the lower levels adjacent to Kalanianaole Highway the brackish water table may be found at a depth of 20 to 33 inches.

These soils are good for taro, pasture, prawns and sugar cane. Bananas and vine type vegetables may be grown successfully on these soils with proper drainage. It is a good area for shade house production of flowers and foliage, which are grown in pots or media and do not require planting in the natural soil.

2.a Hanalei Silty Clay, 0 - 2% Slope (HnA)

These soils are found in stream bottoms and flood plains.


LEGEND
Ph (Pearl Harbor Clay)
HnA & HnB (Hanalei Silty Clay) Slope 0-6
WpB (Waikane Silty Clay) Slope 3-8%
WpC (Waikane Silty Clay) Slope 8-15%
WpD (Waikane Silty Clay) Slope 15-25%
WpE (Waikane Silty Clay) Slope 25-40%
WpF (Waikane Silty Clay) Slope 40-70%
AeE (Alaeloa Silty Clay) Slope 15-35%
ALF (Alaeloa Silty Clay) Slope 40-70%
FOREST

The top soil is about 10 inches thick and consists of dark gray or very dark gray silty clay with dark brown and reddish mottles. The subsoil is about 13 inches thick and consists of mottled, dark gray and dark grayish-brown silty clay loam, with angular, blocky structures. The sub-stratum is stratified alluvium. The surface layer is strongly to very strongly acid and the subsoil is neutral in Ph. Permeability is moderate, runoff is slow and drainage is somewhat poor to poor. Erosion is slight, but flooding is a hazard. Roots of some crops penetrate to the water table. The shrink-swell potential is moderate and workability is good.

These soils are excellent for taro and prawns and good for bananas and vine type vegetables if properly drained. Sugar cane was previously grown on these soils in the project area. It is a good area for shadehouse production of flowers and foliage, which are grown in pots or media and do not require planting in the natural soil.

2.b. Hanalei Silty Clay, 2 to 6% Slope (HnB)

The description of these soils is the same as for HnA. Because of the slope, these soils are only fair to good for taro and poor to fair for prawns. They are fair to good for bananas and vine type vegetables and fair for papayas and sweet potatoes, if properly drained. These soils are also fair to good for shade-house production of flowers and foliage.

3. Waikane Silty Clay, 3 to 8% Slope (WpB)

The Waikane series consists of well drained soils on alluvial fans and terraces. The topsoil consists of dark brown silty clay about 8 inches thick. The subsoil is dark reddish brown silty clay about 52 inches thick with a sub-angular blocky structure.

The substratum is soft, weathered, gravelly alluvium and colluvium. Both the topsoil and subsoil are very strongly acid. Permeability is moderately rapid, runoff is slow, erosion is slight and drainage is good. The shrink-swell level is low and workability is good.

These soils, with moderate slopes of 3 to 8% are very good for sweet potatoes, staked tomatoes, string beans, cucumbers, egg plant and various other vegetables. The soils are excellent for bananas and good for papayas. Occasional very strong winds pose a problem for both bananas and papayas in areas where these soils prevail. Fungal root rot of papayas is aggravated during wet periods. Melons do well on these soils, but melon flies pose a serious problem in the area.

4. Waikane Silty Clay, 8 to 15% Slope (WpC)

The description of these soils is the same as for Waikane silty clay of lesser slope except that runoff is slow to medium, the erosion hazard is slight to moderate and workability is slightly difficult. Terracing or contour farming is required.

The Waikane silty clay soils of 8 to 15% slope are fair to good for sweet potatoes, staked tomatoes, string beans, cucumbers, egg plant and various other vegetables. These soils are good for bananas and fair for papayas. Wind problems for bananas and papayas are somewhat more serious than on the Waikane soils of lesser slope. Melons would do reasonably well on these soils, but melon flies pose a serious problem.

5. Waikane Silty Clay, 15 to 25% Slope (WpD)

The description of these soils is the same as for Waikane silty clays of lesser slope, except that runoff is medium to rapid, the erosion hazard is moderate to severe and workability is difficult.

These soils are marginal for vegetables, melons and papayas, but fair for bananas.

Soils Generally Not Adaptable to Agriculture

6. Waikane Silty Clay, 25 to 40% Slope (WpE)

The description of these soils is the same as for Waikane silty clays of lesser slope, except that runoff is rapid, the erosion hazard is moderate to severe and workability is very difficult. Only a very small percentage of these soils in areas where they border soils of lesser slope can be used for agriculture. Extensive terracing is required.

7. Waikane Silty Clay, 40 to 70% Slope (WpF)

The description of these soils is the same as for Waikane silty clays of lesser slope, except that runoff is rapid to very rapid and the erosion hazard is severe. Workability is prohibitive and these soils cannot be used for any type of agriculture.

8. Alaeloa Silty Clay, 15 to 35% Slope (AoE)

These soils occur on smooth side slopes and on toe slopes in upland areas. The few acres of this series in the project area have slopes of 25 to 35%.

The top soil consists of dark reddish brown silty clay about 10 inches thick. The subsoil consists of dark-red and red silty clay about 48 inches thick, with a sub-angular blocky structure. the substratum is soft, weathered basic igneous rock. The topsoil is medium acid and the subsoil is strongly acid. Permeability is moderately rapid, runoff is medium, and the erosion hazard is moderate. Roots can penetrate to a depth of 5 feet or more. Workability is difficult because of the slope. Since the small areas of these soils in the project are in the upper area of the slope range, none are recommended for agriculture.

9. Alaeloa Silty Clay, 40 to 70% Slope (AlF)

The description of these soils is the same as for AoE, except that runoff is rapid to very rapid, the erosion hazard is severe and workability is prohibitive. The small areas of these soils in the project are not recommended for any type of agriculture.

Arable Land

Of the 403.7 acres of land assigned to agricultural lots by Calvin Kim and Associates, 315 acres or 78 percent are designated for agricultural production (Table 1). Of the remainder, 12.8 acres are assigned to home-sites at 7,500 square feet per lot and 75.9 acres are classified as unsuitable for agriculture. With some exceptions, silty clay soils of 15 to 25 percent slope are considered marginal for any type of agriculture and those of 25 percent slope or greater are not recommended for agriculture. There are some instances where a limited amount of minimally erode steep land might be effectively terraced for agriculture where it joins land of lesser slope and which is well adapted to agriculture. In view of this, each of the 74 lots was assessed individually to obtain an estimate of the proportion which could be viable for agricuture, either in its present form or through terracing (Table 1).

Historical and Sociological Factors

Any plan for the conversion of Waiahole Valley into an agricultural

Table 1. Arable Land By Farm Lot

Lot Number	Total Acreage	% Arable	Acres Arable
1-21	86.4	100	86.4
22	6.9	70	4.8
23	7.4	80	5.9
24	12.3	90	11.1
25	7.1	60	4.3
26	9.9	40	4.0
27-28	13.6	100	13.6
29	5.4	70	3.8
30	1.0	90	0.9
31	3.3	80	2.6
32	4.8	60	2.9
33	9.2	90	8.3
34	2.4	60	1.4
35	15.1	70	10.6
36	15.0	70	10.5
37	8.9	70	6.2
38	14.2	60	8.5
39-40	3.5	100	3.5
41	5.6	60	3.6
42-43	4.0	100	4.0
44	4.4	80	3.5
45	2.3	80	1.8
46	0.8	100	0.8
47	5.2	45	2.3
48	18.8	40	7.5
49	2.0	90	1.8
50	18.9	70	13.2
51	2.5	100	2.5
52	18.9	50	9.5
53-70	85.5	100	85.5
71	2.0	20	0.4
72	2.0	20	0.4
73	2.4	20	0.5
74	2.0	60	1.2
Total	403.7	81.2	327.8
− House + Yard (7500 sq. ft. x 74 lots)			12.8
Net in Agriculture		78.0	315.0

park must consider the historical and sociological factors of existing settlements.

Prior to purchase by the State of Hawaii in 1978, most of the productive agricultural area in the Valley was owned by Mrs. Elizabeth Marks and leased to tenants, with one exception, on revocable leases. Leased lots were not identified by boundary surveys. Approximately 110 tenancies were identified by the Hawaii Housing Authority in 1977. The leased area comprised approximately 262 acres of which 251 acres were in active and inactive farm lots and 11 acres were in residential use. Thirty-one of the tenancies consisted of one acre of land or less. In addition, 6.3 acres were occupied by the Waiahole Elementary School and the Waiahole Poi Factory, and 24 acres were in fee simple ownerships.

The layout of lots by Calvin Kim and Associates, Inc., has been designed in a manner which accommodates the indicated needs of existing tenants.

The majority of the existing tenants earn the major proportion of their income from employment outside the Valley. Some, however, are full time farmers in the Valley. Most of the tenants want to keep the Valley primarily in agriculture and to retain the rural life style.

The design of lots for the agricultural park to conform with existing tenancies poses some problems in optimizing size and configuration with respect to slope and contour. A significant proportion of existing lots, however, have been laid out in a manner which permits optimization of land use. Size of farm on many of these lots under existing types of agriculture is too small to provide the entire family income from the farm. This is discussed in detail in another section of this report on size of farm.

Agricultural Feasibility

The selection of crops for Waiahole Agricultural Park was based on three criteria: 1) ecological adaptability, 2) comparative costs of production in relation to competing areas, and 3) the sales potential. Crops currently grown successfully in the Valley and expressed interest in crops on the part of residents also played a role in crop selection. Crops selected for project planning based on the above criteria are bananas, papayas, tomatoes, snap beans, cucumbers, sweet potatoes, taro, potted flowers and foliage and prawns. It is expected that a variety of other truck crops such as sweet corn, melons, Chinese peas, and other miscellaneous vegetables would be grown. A mean of costs and returns for vegetables analyzed is considered sufficiently applicable for miscellaneous vegetables not specifically indicated. Also, the composite budget presented for flowers and foliage is considered to provide a reasonably good indication of costs and returns for other types of intensive crop production in shade structures.

Citrus, avocado, mango, and other fruit trees are expected to be grown in the Valley, but probably not on a commercial scale in the near future. An undetermined amount of land will probably remain in pasture and some poultry, hog and cattle production might be expected if permitted. Exclusion of these items in the budget analyses would be expected to have very little effect on projected total returns to the State from lease rent.

Agricultural and economic feasibility analyses for each crop considered in the development plan for the Waiahole Valley Agricultural Park are presented in the following sections of the report.

Bananas

Ecological Adaptation

Bananas are adaptable in varying degrees to all land areas of the project considered feasible for agricultural production in Table 1.

Waikane silty clay soils of less than 15% slope, which predominate on the mesas in the middle and upper sections of the Valley are excellent for banana growing. Waikane silty clay soils of 15 to 25% slope are fair for bananas, but would require minimum terracing. Hanalei silty clay soils, which predominate along streams in the middle and upper setions of the Valley, are good for banana production, if properly drained. Bananas can be grown on the Pearl Harbor clay soils in lower sections of the project near Kamehameha Highway, if properly drained. However, drainage is difficult because of the heavy clay or muck texture of the subsoil and because flood runoff is blocked by the highway. These soils are also very difficult to work. Thus, bananas are only marginally adaptable to this area, at best.

For optimal production, sprinkler or drip irrigation would be required for periods totaling 4 to 6 months annually.

Mean annual temperatures are highly favorable to banana production and extremes are not of sufficient magnitude to have an applicable effect on yields. Humidity is sufficiently high to promote black leaf streak disease, but this is not a serious problem in the area and can be controlled with fungicide sprays.

Soil treatment for nematodes is essential in all areas prior to planting new stands of bananas.

Wind damage from prevailing trade winds is minimal but severe losses can be expected from Kona storms on an average of one year out of three.

Staking of the bunches is recommended for Williams Hybrid bananas and this would also provide some protection from wind damage.

Demand and Supply

Hawaii was self sufficient in banana production until 1967, but since then imports from Central and South America have taken over the major share of the Hawaii market. During 1980 imports amounted to 9,528,000 pounds or 67% of the Hawaii market supply of 14,128,000 pounds. Research conducted by the Department of Agricultural and Resource Economics of the University of Hawaii indicates that the decline in the share of the market supplied by Hawaii producers is due to lack of quality control in production and harvesting and because of the conversion of banana lands to higher use values, such as housing and industry. The research further indicated that certain Hawaii varieties, such as Williams Hybrid, can equal imported bananas in appearance and have a superior flavor. Thus it has been concluded that through quality control, including uniform ripening with ethylene gas and assuring availability of land, the import trend can be reversed and Hawaii could again become self sufficient in banana production.

It would require an additional 272 acres of Hawaii production to displace 1980 imports at an average per acre yield of 35,000 pounds projected for Waiahole in this study. Although some of this potential output would come from other production areas in the state, it is assumed that 100 acres of bananas is a reasonable projection for Waiahole Agricultural Park. The net increase would be less than 100 acres, since an estimted 10 to 20 acres are currently in banana production in the project area.

Costs and Returns

A 5-acre Williams Hybrid banana farm is budgeted for this analysis, since this size of farm under proper management would be large enough to provide an adequate income for a farm family and is comparable in size to several land parcels which will be available for lease. A larger farm would make somewhat more efficient use of buildings and equipment and would provide a higher net return per acre. A smaller farm would have less economy of scale and the net income per acre would be lower than for the 5-acre farm.

The inventory of buildings and equipment as presented in Table 2 would have an anual depreciation and interest cost of $3,809.50 for the 5-acre farm or $761.90 per acre.

A summary of annual costs and returns per acre and for the 5-acre farm is shown in Table 3. At an average annual yield of 35,000 pounds per acre and at a 1981 price of 25 cents per pound, the 5-acre farm would gross $8,800 per acre or $44,000 per farm. Net returns to a family farm, with no out-of-pocket costs for labor and management, amount to $6,188.61 per acre and $30,943.05 for the 5-acre farm. For the same farm, except that labor and management constitute cash costs, the residual return to risk amounts to $3,934.61 per acre and $19,673.05 for the farm.

Papayas

Ecological Adaptation

Only the Waikane silty clay soils in the mesa areas in the central-mauka area of the Valley provide the proper soil medium for papaya production. Phytophthora root rot poses a serious problem in the poorly drained heavy clay soils along stream beds and in the lower section of the Valley near the highway. With proper fertilization, irrigation and cultural practices, papayas produce well on Waikane silty clay soils of

Table 2. Buildings and Equipment, 5-Acre Williams Hybrid Banana Farm, Waiahole Agricultural Park

Item	Cost	Life (years)	Depreciation[a/]	Interest (12% ÷ 2)	Depreciation & Interest
Building: garage, packing, storage (1000 sq. ft. @ $8)	$8,000.00	20	$360.00	$480.00	$840.00
Pickup, 3/4 ton, used	6,000.00	8	675.00	360.00	1,035.00
Trailer	900.00	15	54.00	54.00	108.00
Power Sprayer, 50 gallon	700.00	10	61.00	42.00	103.00
Knapsack Sprayer	150.00	10	13.50	9.00	22.50
Irrigation System (Sprinkler)	6,000.00	10	540.00	360.00	900.00
Support Poles, 800 @ $3	2,400.00	5	432.00	144.00	576.00
Miscellaneous Equipment	1,500.00	10	135.00	90.00	225.00
Total, 5 Acres	$25,650.00				$3,809.50
1 Acre	5,130.00				761.90

a/ Calculated on the basis of initial cost minus 10% salvage value ÷ estimated useful life.

Table 3. Costs and Returns Per Acre and Per Farm, 5-Acre Williams Hybrid Banana Enterprise, Waiahole Valley Agricultural Park

Item	Per Acre	Per 5-Acre Farm
GROSS REVENUE, 35,000[a] # @ 25¢	$8,800.00	$44,000.00
OPERATING COSTS		
Labor, 364 hours @ $4.50	1,638.00	8,190.00
Operating costs other than labor	1,223.00	
Gross income tax, 0.5%	44.00	
Lease rent, $100 + 0.9 % of gross	179.20	
FIXED COSTS		
Interest on operating capital, 12%/2	185.05	
Establishment of planting, amortized	218.24	
Depreciation & interest on bldgs & equip	761.90	
TOTAL COSTS, EXCEPT LABOR & MANAGEMENT	2,611.39	
NET RETURNS TO LABOR, MGT & RISK	6,188.61	30,943.05
TOTAL COSTS, EXCEPT MANAGEMENT	4,249.39	
NET RETURNS TO MANAGEMENT & RISK	4,550.61	22,753.05
Management charge, 7% of gross revenue	616.00	
TOTAL COSTS	4,865.39	
NET RETURNS TO RISK	3,934.61	19,673.05

a/Average annual yield per acre for 10-year stand.

less than 15% slope. Production on slopes of 15 to 25 percent would require substantial terracing.

Rainfall is inadequate during the dry season, which usually occurs during the summer months, but may occur during other seasons. Sprinkler or drip irrigation would be required for a total of 4 to 6 months annually.

Trade winds would not seriously affect production of papayas in the upper section of the Valley, but Kona winds during winter storms would occasionally be devastating. This could be alleviated to some extent through the planting of windbreaks.

Virus and fungal diseases would require more control than in less humid production areas.

Demand and Supply

Through 1980 Hawaii papaya production was below what the local market, U.S. Mainland and foreign markets could assimilate. Utilized production of Hawaii produced papayas in 1980 amounted to approximately 48,916,000 pounds, of which 45,360,000 pounds were sold fresh and 3,556,000 pounds were processed. Exports of fresh papayas to the U.S. Mainland and foreign countries amounted to 33,335,000 pounds, and 12,025,000 pounds were consumed in Hawaii. This represents a decline in total production from 64,000,000 pounds in 1978, resulting from storm damage and business failures.

A serious marketing problem developed during the latter part of 1981, resulting from a California restriction on accepting fruit treated with EDB for fruit flies. This has resulted in the loss of most of the California market, which is the major market after Oahu. The industry has been unable to compensate for this loss through increasing sales in other markets, and there is indication that the California market will be difficult to recapture even if a substitute for EDB can be found, which doesn't appear likely at this time.

Because of probable virus and fungal disease problems, uncertainty of the market and an indication of somewhat higher costs of production in Waiahole than in certain other areas of the state, the acreage budgeted for papayas is limited to 25 acres, which is sufficient to include existing production plus the indicated interest in additional production expressed by Waiahole tenants.

The estimated total production of 750,000 pounds would constitute about 6 percent of Oahu requirements and would have very little impact on the total supply situation. The Waiahole Valley production might be expected to supplement rather than displace production in other areas of the State. Since papayas are currently being produced in the project area, only part of the 750,000 pounds would be additional production. If diseases can be controlled and comparative costs of production reduced, there would be justification for a larger acreage in the future.

Costs and Returns

Considering the comparatively low net income per acre that can be expected in papaya production under current conditions, a farm of 10 acres would be required to provide an adequate family living. However, because of the small size of the land parcels in the Waiahole Agricultural Park, a 5-acre farm is budgeted for this analysis.

The annual depreciation and interest cost for buildings and equipment as shown in Table 4 amounts to $4,763.50 per 10-acre farm and $476.35 per acre, which is a major, but not a prohibitive, cost item for this size of farm.

At an average yield of 21,000 pounds per acre for a 3-year stand and at

Table 4. Buildings and Equipment, 5-Acre Papaya Farm, Waiahole Valley Agricultural Park

Item	Cost	Life (years)	Depreciation[a/]	Interest (12% ÷ 2)	Depreciation & Interest
Building; garage, packing, storage (1000 sq. ft. @ $8)	$8,000.00	20	$360.00	$480.00	$840.00
Pickup, ½ ton, used	4,000.00	8	450.00	240.00	690.00
Trailer	900.00	15	54.00	54.00	108.00
Power Sprayer, 50 gallon	700.00	10	61.00	42.00	103.00
Knapsack Sprayer	150.00	10	13.50	9.00	22.50
Irrigation System (Sprinkler)	6,000.00	10	540.00	360.00	900.00
Miscellaneous Equipment	1,000.00	10	90.00	60.00	150.00
Total, 5 Acres	$20,750.00				$2,813.50
1 Acre	4,150.00				562.70

a/ Calculated on the basis of initial cost minus 10% salvage value ÷ estimated useful life.

the 1980 price of 25 cents per pound, papayas would gross $5,375.00 per acre or $26,875.00 per 5-acre farm (Table 5). Net returns to the family farm with no out-of-pocket costs for labor and management amount to $3,226.02 per acre and $16,130.10 per farm. Where labor and management constitute cash costs, the residual net income to risk amounts to only $824.77 per acre or $4,123.85 for the 10-acre farm.

Tomatoes

Ecological Adaptation

Waikane silty clay soils in areas of less than 15 percent slope in the central and upper sections of the valley provide an excellent medium for staked tomato production. Terracing would be required on slopes in excess of 10 percent. Production on slopes of 15 to 25 percent would be feasible with more extensive terracing. Tomato production would be marginal in the low lying areas of Hanalei soils with good drainage. Production could be improved through composting. Tomato production is not recommended in poorly drained Pearl Harbor clay soils near the highway.

Temperatures in Waiahole are favorable to tomato production and winds would generally not pose serious problems, except during Kona storms. Disease problems would be expected to be minimal for virus resistant hybrids. The leaf miner and fruit flies can readily be controlled with approved chemical sprays.

Demand and Supply

As in the case of bananas, the demand for additional tomato production would consist of the displacement of imports for the Hawaii market. With the availability of quality, virus resistant, hybrid varieties and

Table 5. Costs and Returns Per Acre and Per Farm, 5-Acre Papaya Enterprise, Waiahole Valley Agricultural Park

Item	Per Acre	Per 5-Acre Farm
GROSS REVENUE, 21,500# @ 25¢[a]	$5,375.00	$26,875.00
OPERATING COSTS		
Labor, 450 hours @ $4.50	2,025.00	10,125.00
Operating costs other than labor	900.00	
Gross income tax, 0.5%	26.88	
Lease rent, $100 + 0.9 % of gross	148.38	
FIXED COSTS		
Interest on operating capital, 12%/2	186.02	
Establishment of planting, amortized	325.00	
Depreciation & interest on bldgs & equip	476.35	
TOTAL COSTS, EXCEPT LABOR & MANAGEMENT	2,148.98	
NET RETURNS TO LABOR, MGT & RISK	3,226.02	16,130.10
TOTAL COSTS, EXCEPT MANAGEMENT	4,173.98	
NET RETURNS TO MANAGEMENT & RISK	1,201.02	6,005.10
Management charge, 7% of gross revenue	376.25	
TOTAL COSTS	4,550.23	
NET RETURNS TO RISK	824.77	4,123.85

a/ Average annual yield for 3-year stand.

increasing costs of transportation, gradual displacement of imports can be expected. In 1980 the Hawaii market utilized 15,814,000 pounds of fresh tomatoes of which 8,114,000 pounds were imported. At the estimated yield of 42,000 pounds per acre projected for Waiahole, an additional 193 acres of Hawaii production would be required to displace imports. It is conservatively estimated that 20 acres of this amount could be grown in Waiahole with very little impact on the local damand-supply situation. Farmers in the area are expected to have a greater interest in outside staked, vine ripened tomatoes once they become more familiar with the potentials of the virus resistant hybrids.

Costs and Returns

A farm family could make a very good living on a 5-acre staked tomato enterprise and a farm of that size is budgeted in this analysis. The inventory of buildings and equipment presented in Table 6 is considered applicable for most 5-acre truck crop enterprises, including tomatoes. Minor differences in machinery, equipment and fixed material requirements are allowed for in the miscellaneous equipment item. The annual cost for depreciation and interest on buildings and equipment is $4,313.50 for a 5-acre farm or $862.70 per acre (Table 6).

At a projected yield of 42,000 pounds annually at the 1981 price of 40 cents per pound, staked tomatoes would gross $16,800 per acre and $84,000 for a 5-acre farm for one crop (Table 7). This could be increased by raising 1-1/2 to 2 crops of tomatoes per year or alternating with another vegetable. Annual net returns to the family farm, with no out-of-pocket costs for labor and management, amount to $11,754.60 per acre and $58,773.00 per 5-acre farm. Treating labor and management as cash costs reduces the net income to $6,767.10 per acre or $33,835.50 per 5-acre farm.

Table 6. Buildings and Equipment, 5-Acre Truck Crop Farm, Waiahole Valley Agricultural Park

Item	Cost	Life (years)	Depreciation[a]	Interest (12% ÷ 2)	Depreciation & Interest
Building: garage packing, storage (1000 sq. ft. @ $8)	$8,000.00	20	$360.00	$480.00	$840.00
Pickup, ½ ton, used	4,000.00	8	450.00	240.00	690.00
Tractor, used	6,000.00	10	540.00	360.00	900.00
Plow, used	1,000.00	10	90.00	60.00	150.00
Disk, used	1,000.00	10	90.00	60.00	150.00
Trailer	900.00	15	54.00	54.00	108.00
Power Sprayer, 50 gallon	700.00	10	61.00	42.00	103.00
Knapsack Sprayer	150.00	10	13.50	9.00	22.50
Irrigation System (Sprinkler)	6,000.00	10	540.00	360.00	900.00
Miscellaneous Equipment[b]	3,000.00	10	270.00	180.00	450.00
Total, 5 Acres	$30,750.00				$4,313.50
1 Acre	6,150.00				862.70

a/ Calculated on the basis of initial cost minus 10% salvage value ÷ estimated useful life.

b/ Varies by crop.

Table 7. Costs and Returns Per Acre and Per Farm, 5-Acre Staked Tomato Enterprise, Waiahole Valley Agricultural Park

Item	Per Acre	Per 5-Acre Farm
GROSS REVENUE, 42,000# @ 40¢[a/]	$16,800.00	$84,000.00
OPERATING COSTS		
Labor, 847 hours @ $4.50	3,811.50	19,057.50
Operating costs other than labor	3,395.00	
Gross income tax, 0.5%	84.00	
Lease rent, $100 + 0.9 % of gross	251.20	
FIXED COSTS		
Interest on operating capital, 12%/2	452.50	
Establishment of planting, amortized	00.00	
Depreciation & interest on bldgs & equip	862.70	
TOTAL COSTS, EXCEPT LABOR & MANAGEMENT	5,045.40	
NET RETURNS TO LABOR, MGT & RISK	11,754.60	58,773.00
TOTAL COSTS, EXCEPT MANAGEMENT	8,856.90	
NET RETURNS TO MANAGEMENT & RISK	7,943.10	39,715.50
Management charge, 7% of gross revenue	1,176.00	
TOTAL COSTS	10,032.90	
NET RETURNS TO RISK	6,767.10	33,835.50

a/ Yield for one crop per year.

A somewhat smaller tomato enterprise would utilize buildings and equipment less efficiently than the 5-acre farm but could provide an adequate family income.

Snap Beans

Ecological Adaptation

Snap beans are currently grown in several areas in Waiahole Valley. They are best adapted to Waikane silty clay of less than 15 percent slope but can be grown with marginal success on the same soils with up to 25 percent slope if terraced to permit adequate fertilizer application, irrigation and ease of land preparation and harvesting.

Snap beans are marginally adapted to the lower lying Hanalei silty clay and Pearl Harbor clay soils, if adequately drained, composted and fertilized.

Leaf miner infestations are often severe in Waiahole Valley, but can be controlled with approved chemical sprays.

Demand and Supply

The projected market for additional production of snap beans as for most other vegetable crops, consists of the displacement of imports. Hawaii approaches self sufficiency in snap bean production and in 1980 imported only 292,000 pounds or 21 percent of the Hawaii market supply of 1,392,000 pounds. Only 24 acres would have been required to displace 1980 imports at an estimated yield of 12,000 pounds per acre. Because of the small amount of additional production required to displace imports, only 10 acres is allocated to this crop in the cropping plan for the project. Since small acreages of snap beans are currently grown in the project area, the 10-acre allocation would result in little or no displacement of existing Hawaii production.

Costs and Returns

Building and equipment requirements are essentially the same as indicated for tomatoes in Table 6, except for minor modifications. As is the case for most vegetable crops, a 5-acre snap bean enterprise is considered adequate in size to provide living expenses for a farm family. The budget in Table 8 provides a gross revenue per crop of $8,400 per acre and $42,000 for a 5-acre farm based on a conservative yield of 12,000 pounds per acre and the 1981 price of 70 cents per pound. Net returns per crop for a family operated farm, with no out-of-pocket costs for labor and management, amount to $6,059.64 per acre and $30,298.20 per 5-acre enterprise. With labor and management considered as cash costs, residual net returns to risk amount to $4,121.64 per acre or $20,608.20 per 5-acre farm. An undetermined proportion of snap bean farmers would be expected to plant more than one crop per year, either in beans or in some other vegetable. This is accounted for in a following section of the report on multicropping.

Cucumbers

Ecological Adaptation

The Waikane silty clay soils in the middle and upper sections of the Valley are excellent for cucumber production. Some farmers have been producing staked cucumbers in Hanalei silty clay soils in lower lying areas near stream beds, but these areas are considered only fair for cucumbers, even when properly drained. Considerably higher yields are attained in the Hamakua area of the Island of Hawaii than on Oahu. The average yield per

Table 8. Costs and Returns Per Acre and Per Farm, 5-Acre Snap Bean Enterprise, Waiahole Valley Agricultural Park

Item	Per Acre	Per 5-Acre Farm
GROSS REVENUE, 12,000 # @ 70¢	$8,400.00	$42,000.00
OPERATING COSTS		
Labor, 300 hours @ $4.50	1,350.00	6,750.00
Operating costs other than labor	1,100.00	
Gross income tax, 0.5%	42.00	
Lease rent, $100 + 0.9 % of gross	175.60	
FIXED COSTS		
Interest on operating capital, 12%/2	160.06	
Establishment of planting, amortized	00.00	
Depreciation & interest on bldgs & equip	862.70	
TOTAL COSTS, EXCEPT LABOR & MANAGEMENT	2,340.36	
NET RETURNS TO LABOR, MGT & RISK	6,059.64	30,298.20
TOTAL COSTS, EXCEPT MANAGEMENT	3,690.36	
NET RETURNS TO MANAGEMENT & RISK	4,709.64	23,548.20
Management charge, 7% of gross revenue	588.00	
TOTAL COSTS	4,278.36	
NET RETURNS TO RISK	4,121.64	20,608.20

acre on Hawaii during 1980 was 32,800 pounds and some producers had yields as high as 55,000 pounds. This compares with a per acre yield of only 13,100 pounds on Oahu.

Research by Mollett indicated that the difference in yield appeared to be due to climatic conditions. Yields of improved varieties are potentially much greater than current yields on Oahu, and horticulturists at the University of Hawaii indicate that a marketable yield of at least 30,000 pounds of staked cucumbers is attainable on Oahu in field (non-greenhouse) production.

Terracing would be required for cucumber production on slopes of over 10 percent and production would not be feasibble on slopes of 25 percent or over.

Demand and Supply

The total Hawaii market supply of cucumbers in 1980 was 5,960,000 pounds of which 1,360,000 pounds were imported. At the estimated yield of 30,000 pounds for Waiahole, an additional 45 acres of Hawaii production would have been required to displace 1980 imports. Because of the limited additional acreage required and the apparent production advantages on the Island of Hawaii, only 20 acres are budgeted for cucumbers for Waiahole. The net increase would be less than this, since some farmers are currently producing staked cucumbers in Waiahole.

Costs and Returns

A 5-acre farm is budgeted for staked cucumbers as for other vegetables. The net return to the family-operated farm with no charges for labor or management is comparable to that of most of the other vegetable farms, but residual return to risk is less. The annual charge for depreciation and interest on buildings and equipment for a 5-acre truck crop farm in Table 6 is considered appropriate for this crop.

At the indicated yield of 30,000 pounds per acre and the 1980 price of 30 cents per pound, staked cucumbers would gross $9,000 per crop acre or $45,000 per 5-acre farm (Table 9). Net returns to the family operated farm, with no out-of-pocket costs for labor and management, amount to $6,223.66 per acre and $31,118.30 for the 5-acre farm. Because of the high labor cost, residual net returns to risk amount to only $1,948.66 per acre and $9,743.30 per 5-acre farm. Multiple cropping would be expected and this is discussed in that section of the report.

Sweet Potatoes

Ecological Adaptation

Sweet potatoes do extremely well in the Waikane silty clay soils in the central and upper sections of the Valley. The highly workable texture of this soil provides very good planting and harvesting conditions. The production of this crop is not recommended on slopes of over 15 percent. Sweet potatoes are only marginally adaptable to Hanalei silty clay soils and should not be grown in Pearl Harbor clay soils in the lower section of the Valley because of poor workability and poor drainage.

The climate is good for sweet potato production, except that irrigation is required for a period of 4 to 6 months during a typical year. Weevils, leaf miners and other insects, to a lesser extent, require periodic control.

Supply and Demand

During 1980, the Hawaii market supply of sweet potatoes amounted to

Table 9. Costs and Returns Per Acre and Per Farm, 5-Acre Cucumber Enterprize, Waiahole Valley Agricultural Park

Item	Per Acre	Per 5-Acre Farm
GROSS REVENUE, 30,000# @ 30¢	$9,000.00	$45,000.00
OPERATING COSTS		
Labor,810 hours @ $4.50	3,645.00	18,225.00
Operating costs other than labor	1,400.00	
Gross income tax, 0.5%	45.00	
Lease rent, $100 + 0.9 % of gross	154.00	
FIXED COSTS		
Interest on operating capital, 12%/2	314.64	
Establishment of planting, amortized	00.00	
Depreciation & interest on bldgs & equip	862.70	
TOTAL COSTS, EXCEPT LABOR & MANAGEMENT	2,776.34	
NET RETURNS TO LABOR, MGT & RISK	6,223.66	31,118.30
TOTAL COSTS, EXCEPT MANAGEMENT	6,421.34	
NET RETURNS TO MANAGEMENT & RISK	2,578.66	12,893.30
Management charge, 7% of gross revenue	630.00	
TOTAL COSTS	7,051.34	
NET RETURNS TO RISK	1,948.66	9,743.30

2,067,000 pounds of which 767,000 pounds were imported. Approximately 26 acres would be required to displace the quantity imported in 1980 at an annual uield of 30,000 pounds per acre. Sweet potatoes do well under good management in Waiahole and it is estimated that there are currently about 25 acres planted to this crop. It seems reasonable to assume that Waiahole would be a logical area for expansion in sweet potato production to displace imports. On this basis, a total of 40 acres is included in the cropping plan, assuming good management and improved quality control. Although the projections seem valid, sweet potato lands could readily be converted to bananas, papayas or other recommended vegetables if conditions warrant.

Costs and Returns

Building and equipment requirements for sweet potatoes are similar to those indicated for a truck crop farm in Table 6. The only major modification would be the addition of a plow or digger attachment for harvesting the potatoes. There is provision under miscellaneous equipment for this modification.

Based on the input and output assumptions in Table 10, the sweet potato enterprise would gross $9,900 per acre or $49,500 per 5-acre farm. Net returns to the family-operated farm with no out-of-pocket costs for labor and management amount to a substantial 7,408.43 per acre or $37,042.15 per 5-acre farm where labor and management are treated as cash costs. The residual net return to risk amounts to $4,917.07 per acre or $24,585.35 for a 5-acre sweet potato enterprise.

Table 10. Costs and Returns Per Acre and Per Farm, 5-Acre Sweet Potato Enterprise, Waiahole Valley Agricultural Park

Item	Per Acre	Per 5-Acre Farm
GROSS REVENUE, 30,000# @ 33¢	$9,900.00	$49,500.00
OPERATING COSTS		
Labor, 385 hours @ $4.50	1,732.50	8,662.50
Operating costs other than labor	1,200.00	
Gross income tax, 0.5%	49.50	
Lease rent, $100 + 0.9 % of gross	189.10	
FIXED COSTS		
Interest on operating capital, 12%/2	190.27	
Establishment of planting, amortized	00.00	
Depreciation & interest on bldgs & equip	862.70	
TOTAL COSTS, EXCEPT LABOR & MANAGEMENT	2,491.57	
NET RETURNS TO LABOR, MGT & RISK	7,408.43	37,042.15
TOTAL COSTS, EXCEPT MANAGEMENT	4,224.07	
NET RETURNS TO MANAGEMENT & RISK	5,675.93	28,379.65
Management charge, 7% of gross revenue	693.00	
TOTAL COSTS	4,917.07	
NET RETURNS TO RISK	4,982.93	24,585.35

Miscellaneous Truck Crops

Several miscellaneous vegetables and melons are currently grown in the project area and some expansion in the production of these crops can be expected as development of the agricultural park is implemented. Based on current production and interests in expansion expressed by the residents, it is projected that 20 acres would be utilized for the production of minor vegetables and melons. These crops might be expected to yield gross and net returns per acre comparable to the mean values for the vegetables analyzed, thus grossing approximately $9,000 per acre and providing a net return to risk of $4,500 per acre.

Multicropping of Truck Crops

All vegetable crops analyzed have been budgeted for one crop per year. All of these crops have a growing season of less than 6 months and at least one additional crop and in some instances two additional crops could be produced annually. These might be duplicates of the same crops or alternative crops. It is estimated that 60% of the 100 acres programmed for truck crops would be planted to at least one additional crop annually. Thus gross and net returns to agriculture are increased by the income from 60 acres in truck crops in excess of the total project acreage designated for agriculture. It is assumed that these crops would provide a per acre income equal to the mean income of the crops budgeted. This would amount to a gross revenue of $9,000 per acre and a net return to risk of $4,500 per acre.

Potted Flowers and Foliage Plants

Ecological Adaptation

Production capability of soils in the project area would impose no restrictions on the production of potted flowers and foliage plants, since these crops would only require shadehouse bench space. Nursery plant stock requiring planting in the ground could be grown on most soils in the project area, except in the poorly drained, sticky clay soils along streams and in the lower section of the Valley. Fill would be required as a foundation for shadehouses in poorly drained areas which are subject to flooding.

Temperatures and the degree of sunlight are favorable to the prouction of a large variety of flowers and foliage plants, but winter rainfall and light intensity would pose some restrictions on certain other plants.

An estimated 40 acres in the project are currently used primarily for the production of flowers and foliage plants.

Demand and Supply

Flower and nursery production in Hawaii have been in a stage of very rapid growth for several years. The wholesale value of flowers and nursery products produced in the state increased by 281 percent from $9,767,000 in 1975 to $27,441,000 in 1980. The wholesale value of potted flowers and foliage plants increased by an even greater 305 percent from $3,586,000 to $10,948,000 during the same period.

The 1980 wholesale value of Oahu production of flowers and nursery products amounted to $10,395,000 or 38 percent of sales in the state. Oahu produced 50% of the Hawaii output of potted flowers and foliage plants in 1980 at a wholesale value of $5,485,000.

In spite of the very encouraging expansion in flower and nursery production in Hawaii, caution is required in projecting sales potentials because of an increasing threat of competition from other producing areas, both in the United States and in foreign countries. Competition is also keen among producing areas in Hawaii, some of which have climatic advantages over others for certain crops. Because of uncertainty, only 50 acres is allocated to potted flowers and foliage plants in projecting a cropping plan for the Waiahole Valley Agricultural Park. This is only slightly in excess of existing and intended plantings in the project area. Because of the high value of this enterprise, the pay back on the State's investment in Waiahole Valley would become more attractive if production should exceed the 50 acres projected.

Costs and Returns

Based on the input-output assumptions in the budget analysis, a 1-1/2-acre potted flower and foliage plant enterprise would provide a more than adequate family income. Per acre costs and returns are also estimated for a 10-acre farm to reflect approximate mean values of costs and returns, considering sizes of units currently in production or in planning stages in the project area. An inventory of the investment in buildings and equipment for a 1-1/2-acre potted and foliage plant enterprise is shown in Table 11. This does not include the investment in pots and plants, which is considered under operating costs. Based on this inventory, the annual depreciation and interest on buildings and equipment amount to $8,255.00 for a 1-1/2-acre enterprise or $5,503.33 per acre.

The composite budget presented in Table 12 shows a gross revenue of $83,333.33 per acre or $125,000.00 per 1-1/2-acre farm. A family operated farm, with no out-of-pocket costs for labor and management, would provide a

Table 11. Buildings and Equipment, 1½-Acre Potted Flower and Foliage Plant Enterprise, Waiahole Valley Agricultural Park

Item	Cost	Life (years)	Depreciation[a/]	Interest (12% ÷ 2)	Depreciation & Interest
Shade House (42,000 sq. ft.)[b/]	$16,000.00	10	$1,400.00	$960.00	$2,360.00
Service Building (1000 sq. ft. @ $9)	9,000.00	20	405.00	540.00	945.00
Benches	15,000.00	10	1,350.00	900.00	2,250.00
Irrigation System (Sprinkler)	7,500.00	10	675.00	450.00	1,125.00
Pickup, 3/4 ton	8,000.00	10	720.00	480.00	1,200.00
Small Equipment & Tools	1,500.00	5	270.00	105.00	375.00
Total, 1½ Acres	$57,000.00				$8,255.00
1 Acre	38,000.00				5,503.33

a/ Calculated on the basis of initial cost minus 10% salvage value ÷ estimated useful life.

b/ Including 25,000 sq. ft. of bench space.

Table 12. Costs and Returns Per Acre and Per Farm, 1½-Acre Potted Flower and Foliage Plant Enterprise, Waiahole Valley Agricultural Park

Item	Per Acre (1½-Acre Farm)	Per Acre (10-Acres)	Per 1½ Acres
GROSS REVENUE	$83,333.33	100,000.00	$125,000.00
OPERATING COSTS[a/]			
Labor,	15,500.00	18,600.00	23,250.00
Operating costs other than labor	32,000.00		
Gross income tax, 0.5%	416.67		
Lease rent, $100 + 0.9 % of gross	850.00		
FIXED COSTS			
Interest on operating capital, 12%/2	2,924.00		
Establishment of planting, amortized	00.00		
Depreciation & interest on bldgs & equip	3,668.89		
TOTAL COSTS, EXCEPT LABOR & MANAGEMENT	39,826.22		
NET RETURNS TO LABOR, MGT & RISK	43,507.11	52,208.54	65,260.67
TOTAL COSTS, EXCEPT MANAGEMENT	55,326.22		
NET RETURNS TO MANAGEMENT & RISK	28,007.11	33,608.54	42,010.67
Management charge, 7% of gross revenue	5,833.33		
TOTAL COSTS	61,159.55		
NET RETURNS TO RISK	22,173.78	26,608.54	33,260.67

a/ Estimated for a composite budget based on primary data plus updating of cost data from Florida and Hawaii.

net return of $43,507.11 per acre or $65,260.67 for the 1-1/2 acre farm. For the same farm, except that labor and management constitute cash costs, the residual net return to risk amounts to $22,173.78 per acre or $33,260.67 for the 1-1/2-acre enterprise.

A larger enterprise would make more efficient use of land area and a 10-acre farm would gross $100,000 per acre and yield net returns per acre of $52,208.54 to labor, management and risk and a residual of $26,608.54 to risk.

Wetland Taro

Ecological Adaptation

Wetland taro is adaptable to most of the near level Hanalei silty clay soils in Waihole Valley where an adequate supply of fresh surface water is available. The crop is only marginally adaptable to the heavy Pearl Harbor clay soils because of low fertility and poor workability.

Water temperatures in excess of 78° F during summer months contribute to a serious fungus disease problem (Pythium). A water flow of 77,000 gallons per acre per day is required to keep the temperature under 78° and the disease under control. Pythium can be transmitted by stream flow to other taro patches, if not properly controlled.

Demand and Supply

The current demand for taro in Honolulu exceeds the supply from Hawaii production and an undetermined amount is being imported. Although taro is produced in many of the windward valleys of Oahu, the major supply comes from the outside islands, with 64 percent of the 1978 crop coming from Kauai.

Taro is a labor intensive crop and Hawaii producers face potentially serious competition from areas where farm wages are low.

Taro, when planted for corm (root) production, is the least economic of the crops analyzed, except for papayas, for project planning. No budget analysis was made for taro tops, but it is believed that this product may be more economic than corm utilization. In spite of the problems indicated, taro production is a "way of life" for interested farmers and it is suggested for this reason that development of the Valley provide for continuing production of taro in areas where it is now produced. It is very roughly estimated that the total area of small patches would total 10 acres and this figure is used in the crop feasibility study.

Costs and Returns

A 5-acre taro farm is budgeted in the analysis because any smaller unit would make only a minimal contribution to family living expenses. The annual depreciation and interest on buildings and equipment for taro is estimated at $521.35 per acre, which is less than for other vegetables because a sprinkler irrigation system is not required.

Gross returns at an estimated yield of 25,000 pounds per acre and a current price of 25 cents per pound amount to $5,000.00 per acre or $25,000.00 per 5-acre farm (Table 13). Net returns to a family operated farm, with no out-of-pocket costs for labor and management, amount to $3,229.43 per acre and $16,121.50 per 5-acre farm. After deducting costs for labor and management, the residual net return to risk amounts to only $962.43 per acre or $4,812.15 per 5-acre farm.

Table 13. Costs and Returns Per Acre and Per Farm, 5-Acre Wetland Taro Enterprise, Waiahole Valley Agricultural Park

Item	Per Acre	Per 5-Acre Farm
GROSS REVENUE, 25,000# @ 25¢	$5,000.00	$25,000.00
OPERATING COSTS		
Labor, 426 hours @ $4.50	1,917.00	9,585.00
Operating costs other than labor	900.00	
Gross income tax, 0.5%	25.00	
Lease rent, $100 + 0.9 % of gross	145.00	
FIXED COSTS		
Interest on operating capital, 12%/2	179.22	
Establishment of planting, amortized	00.00	
Depreciation & interest on bldgs & equip	521.35	
TOTAL COSTS, EXCEPT LABOR & MANAGEMENT	1,770.57	
NET RETURNS TO LABOR, MGT & RISK	3,229.43	16,121.50
TOTAL COSTS, EXCEPT MANAGEMENT	3,687.57	
NET RETURNS TO MANAGEMENT & RISK	1,312.43	6,652.15
Management charge, 7% of gross revenue	350.00	
TOTAL COSTS	4,037.57	
NET RETURNS TO RISK	962.43	4,812.15

Prawns

Ecological Adaptation

Primary investigations of prawn farms in windward areas similar to Waiahole indicate that prawn production would be feasible in the lower, level sections of the Valley where heavy clay soils predominate and fresh stream water can readily be diverted to ponds. The heavy clay soils in the lower sections of the Valley have good characteristics for the construction of prawn ponds. The ponds would, however, require a construction design that would protect the ponds from polluted flood waters. Water temperatures in the area are considered satisfactory, but not optimal for prawn production.

Demand and Supply

Prawn production in Hawaii is a new industry and serious production and marketing uncertainties exist. Current production in Hawaii is insufficient to supply the Hawaii market, although small quantities are exported. The Hawaii market consists primarily of large restaurants, many of which cater to tourists. The frozen product is available in a limited number of retail outlets. Information on the market potential and characteristics of consumer demand for Malaysian prawns is limited, but marketing research is currently being conducted by the University of Hawaii. Interest in prawn production in Waiahole has been indicated, but only 10 acres is budgeted for prawns in this analysis, because of the uncertainties facing the industry. Should implementation bring highy positive results in relation to other enterprises, prawn production might be expected to occupy a larger acreage than projected.

Costs and Returns

Prawn production requires economy of scale in the utilization of equipment, even though the ponds are usually constructed in multiples of one acre each. In consideration of the need for economy of scale, plus the fact that the high labor requirement makes the net return to risk only moderate, a 5-acre enterprise is budgeted in this analysis.

Under good production practices, Malaysian prawns are capable of producing 3,000 pounds per acre annually. At the current price of $4.50 per pound, this would gross $13,500.00 per acre and $67,500.00 per 5-acre farm (Table 14). The family operated farm, with no charges for labor and management would net $7,197.97 per acre and $35,989.85 for the 5-acre enterprise. If labor and management are considered cash costs or opportunity costs, the prawn operation provides a residual net return to risk of only $1,973.47 per acre or $9,867.35 per 5-acre farm.

Summary of Costs and Returns by Farm Size

A summary of costs and returns for each recommended crop by farm size is presented in Table 15. As indicated previously, the preferred criteria for farm size is a unit large enough to provide sufficient income to provide an adequate standard of living for a farm family. For some crops, however, the required farm size would exceed the size of most lots in the agricultural park. All farm models in the analysis were therefore limited to 5 acres in size, even though net income in some instances is considered inadequate. The budgets of all crops analysed except for papayas and taro would provide a very good net income to the farm family of $30,000 or over,

Table 14. Costs and Returns Per Acre and Per Farm, 5-Acre Malaysian Prawn Enterprise, Waiahole Valley Agricultural Park

Item	Per Acre	Per 5-Acre Farm
GROSS REVENUE, 3,000# @ $4.50	$13,500.00	$67,500.00
OPERATING COSTS		
Labor, 947 hours @ $4.50	4,261.50	21,307.50
Operating costs other than labor	4,300.00	
Gross income tax, 0.5%	67.50	
Lease rent, $100 + 0.9 % of gross	221.50	
FIXED COSTS		
Interest on operating capital, 12%/2	531.03	
Establishment of planting, amortized	00.00	
Depreciation & interest on bldgs & equip	1,200.00[a/]	
TOTAL COSTS, EXCEPT LABOR & MANAGEMENT	6,320.03	
NET RETURNS TO LABOR, MGT & RISK	7,179.97	35,899.35
TOTAL COSTS, EXCEPT MANAGEMENT	10,581.53	
NET RETURNS TO MANAGEMENT & RISK	2,918.47	14,592.35
Management charge, 7% of gross revenue	945.00	
TOTAL COSTS	11,526.53	
NET RETURNS TO RISK	1,973.47	9,867.35

a/ Including costs of pond construction.

Table 15. Gross and Net Returns Per Farm to Factors of Production for Specified Crops, Waiahole Valley Agricultural Park

Crop	Acres Per Farm[a/]	Gross Returns	Net Returns to Mgt, Labor & Risk	Net Returns to Management & Risk	Net Returns to Risk
Bananas	5	$44,000.00	$30,943.05	$22,753.05	$19,673.05
Papayas	5	26,875.00	16,130.10	6,005.10	4,123.85
Tomatoes	5	84,000.00	58,773.00	39,715.50	33,835.50
Snap Beans	5	42,000.00	30,298.20	23,548.20	20,608.20
Cucumbers	5	45,000.00	31,118.30	12,893.30	9,743.30
Sweet Potatoes	5	49,500.00	37,042.15	28,379.65	24,585.35
Misc. Truck Crops	5	45,000.00	35,650.00	25,650.00	22,500.00
Flowers & Foliage	1½	125,000.00	65,260.67	42,010.67	33,260.67
Taro	5	25,000.00	16,121.50	6,652.15	4,812.15
Prawns	5	67,500.00	35,899.35	14,592.35	9,867.35

a/ Farm sizes may differ from those in the engineering report for Waiahole Valley Agricultural Park. Size adjustments have been made to better reflect the size of farm required to provide an adequate standard of living for a farm family.

where labor and management do not constitute out-of-pocket costs (Table 15). The 1-1/2-acre potted flower and foliage enterprise would provide a very attractive net return of $65,260.67 to the family. Even with no charges for labor and management, the 5-acre papaya and taro farms would only provide an annual income to the farm family of slightly in excess of $16,000.

Net returns to risk after charging for all costs, including labor and management amount to over $33,000 for the 5-acre tomato farm and the 1-1/2-acre potted flower and foliage enterprise. Net returns to risk are also attractive for bananas, snap beans and sweet potatoes, ranging from over $19,000 for bananas to more than $24,000 for sweet potatoes. Net returns to risk are marginal at slightly less than $10,000 for cucumbers and prawns. Net returns to risk of less than $5,000 for papayas and taro are inadequate. Thus these crops would be feasible only if the farms are family operated and cash costs are not incurred for labor and management.

All crops were budgeted for one crop annually. Multicropping is possible on all dry land vegetable farms. Thus, gross and net returns for these crops could be considerably in excess of those indicated and some of the more intensive vegetable crops have the potential of providing an adequate family living from perhaps 3 acres of land designated for agriculture.

Cropping Plan and Economic Impacts

The proposed intensive agricultural development of Waiahole Valley is based on a cropping plan which would not be expected to displace production in other areas of the State, with some minor exceptions. The estimated production would be expected to displace imports or to supplement exports.

The projected output, to the extent that it exceeds existing production in the Valley, would thus constitute a net increase in the value of marketings of diversified crops in the State.

All crops in the analysis are considered ecologically adapted to Waiahole and all would be profitable in varying degrees. The primary limiting factors in designating a specified acreage for each crop are: (1) sales potential, (2) comparative production feasibility in relation to competing areas, (3) disease and insect problems and (4) water requirements. The cropping plan constitutes, in effect, the best approximation of what might be expected as determined from secondary and primary data utilized for this purpose. It is not to be construed as a guideline to be imposed upon tenants.

The projected cropping plan would provide an aggregate annual gross revenue of $8,083,375 from the 315 acres designated for agricultural production (Table 16). It would provide an aggregate annual net return to farmers of $4,818,000 before deducting labor and management costs. The residual net return to risk for the entire project, after deducting all costs, including labor and management is projected at $2,616,455, annually.

Rate of Return on Investment

Rate of return on capital investment, although a commonly used indicator of profitability, is somewhat arbitrary because of the difficulty in determining what consititutes capital investment for dissimilar agricultural enterprises. In this analysis, rate of return on investment is defined as the percentage return to factors of production as related to the investment in buildings and equipment plus operatng costs through harvesting of the first crop.

Table 16. Cropping Plan and Projected Gross and Net Returns from Agricultural Production, Waiahole Valley Agricultural Park

Crop	Acres	Gross Per Acre	Total Gross	Net Returns to L, M & R[a/] Per Acre	Net Returns to L, M & R[a/] Total	Net Returns to Risk[b/] Per Acre	Net Returns to Risk[b/] Total
Bananas	100	$8,800	$880,000	$6,188	$618,800	$3,935	$393,500
Papayas	25	5,375	134,375	3,226	80,650	825	20,625
Tomatoes	30	16,800	504,000	11,755	352,650	6,767	203,010
Snap Beans	10	8,400	84,000	6,060	60,600	4,122	41,220
Cucumbers	20	9,000	180,000	6,224	124,480	1,949	38,980
Sweet Potatoes	40	9,900	396,000	7,408	296,320	4,983	199,320
Misc. Truck Crops	20	9,000	180,000	7,130	142,600	4,500	90,000
Truck Crops Multicropped	60[c/]	9,000	540,000	7,130	427,800	4,500	270,000
Flowers & Foliage	50	100,000	5,000,000	52,209	2,610,450	26,609	1,330,450
Taro	10	5,000	50,000	3,229	32,290	962	9,620
Prawns	10	13,500	135,000	7,180	71,800	1,973	19,730
Total	315		$8,083,375[d/]		$4,818,440[d/]		$2,616,455[d/]

a/ L, M & R equal Labor, Management and Risk, respectively.

b/ Residual net returns to risk after charging for all costs of production, including labor, management and land, rounded to the nearest dollar.

c/ Not included in total acreage. The multi-cropping plan, at 2 crops per year, would, however, increase the total acreage planted to 375. The numbers indicated are for the 2nd crop. The first crop has already been accounted for in the totals for the various vegetables.

d/ These estimates might be expected to increase 6 to 10 percent per year to reflect inflation.

Table 17 shows a very substantial rate of return to the family operated farm, before deducting labor and management costs, for all crops analyzed. This ranges from 41.3 percent for prawns to 75.3 percent for bananas. Rate of return to risk, after charging for all costs including labor and management, is very favorable for all crops except papayas, prawns and taro. Excluding the latter three crops, the rate of return to risk ranges from 19.5 percent for cucumbers to 53.5 percent for sweet potatoes (Table 17). Rates of return to risk of 14 percent or below for papayas, prawns and taro are considered submarginal and these crops provide a favorable investment only for family operated farms.

Water Requirements

Estimated water requirements for the 320-acre cropping plan are shown in Table 18. Requirements are based on the probable acreage which would be devoted to each crop multiplied by estimated water use during periods of negligible rainfall. The maximum requirement at any one time would be $2,269,685 gallons per day if all crops were irrigated at the sme time. Actually, for all crops except taro, prawns and shadehouse plants, irrigation intervals would range from twice a week to once every two weeks for sprinkler or furrow irrigation. Crops served by drip irrigation would require water every day. With respect to sprinkler irrigation, where water might be applied in larger amounts at less frequent intervals, it would be essential to develop a scheduling system for application. Otherwise the amount of water required in any one day would exceed the capacity of the water system to meet maximum daily requirements.

Table 17. Rate of Return Per Acre on Investment for Selected Crops, Waiahole Valley Agricultural Park

Crop	Investment Cost Per Acre	Net Returns to Lab, Mgt & Risk	Rate of Return to Lab, Mgt & Risk	Net Return to Risk	Rate of Return to Risk
Bananas	$8,214	$6,188	75.3	$3,935	47.9
Papayas	7,250	3,226	44.5	825	11.4
Tomatoes	13,692	11,755	85.9	6,767	48.4
Snap Beans	8,818	6,060	68.7	4,122	46.7
Cucumbers	11,394	6,224	54.6	1,949	19.5
Sweet Potatoes	9,321	7,408	79.5	4,983	53.5
Flowers & Foliage	100,000	52,209	52.2	26,609	26.6
Taro	6,862	3,229	47.1	962	14.0
Prawns	17,398	7,180	41.3	1,973	11.3

Table 18. Water Requirements for Agricultural Cropping Plan, Waiahole Valley Agricultural Park

Crop	Gallons/Acre Per Day	Acreage	Total Requirements (gallons per day)a/
Bananas	5,431	100	543,100
Papayas	4,073	25	101,825
Tomatoes	4,073	30	122,190
Snap Beans	4,073	10	40,730
Cucumbers	4,073	20	81,460
Sweet Potatoes	4,073	40	162,920
Miscellaneous Truck Crops	4,073	20	81,460
Flowers & Foliage	3,000	50	150,000
Sub-total		295	1,283,685
Taro	77,000	10	770,000
Prawns	21,600	10	216,000
Sub-total		20	986,000
TOTAL		315	2,269,685

a/ Water requirements are based on the amount of water required during dry periods when rainfall is negligible. Only supplemental irrigation or no irrigation would be required during the rainy season for all crops, except potted flowers and foliage, taro and prawns. Stream requirements for taro and prawns do not take into consideration water that could be re-used.

Labor and Management Requirements

Labor requirements for the agricultural cropping plan for Waiahole Agricultural Park are summarized and aggregated in Table 19. The project would utilize the equivalent of 150 full time agricultural workers at a total value of $1,481,255 (Table 19). It is assumed that most farm tasks would be performed by family labor, and out-of-pocket or cash costs for labor would be minimal. Nevertheless, the project would provide an equivalent of full time employment for 150 people, not including management.

Management costs are computed at 7% of gross revenue, which is a method currently used by the U.S. Department of Agriculture in computing costs of producing agricultural products. On this basis the total value of management for the entire project would be $183,152 (7% of $2,616,455). At an estimated price of $10 per hour, this would convert to 18,315 hours annually or 8.8 man units at 2,080 hours per man unit.

Chemical Protection and Fertilization

Fungicides, herbiciddes and pesticides approved for listing by the U.S. Environmental Protection Agency for the protection of crops considered in this report would not be expected to cause health hazards for humans or to endanger marine life if used according to specifications. According to Dr. John Hylin, Chairman of the Department of Agricultural Biochemistry at the University of Hawaii, assurance against harm to human and animal life is one of the criteria for approved listings of chemicals for agricultural use. A detailed report of legislation concerning use of chemicls in agriculture is presented in the Federal Pesticide Act of 1978 by the

Table 19. Annual Labor Requirements for Agricultural Cropping Plan, Waiahole Valley Agricultural Park

Crop	Hours Per Acre	Cost Per Acre[a]	Man Units Per Acre	Acres	Total Man Units	Total Cost
Bananas	364	$1,638.00	0.175	100	17.5	$ 163,800
Papayas	450	2,025.00	0.216	25	5.4	50,625
Tomatoes	847	3,811.50	0.407	30	12.2	114,345
Snap Beans	300	1,350.00	0.144	10	1.4	13,500
Cucumbers	810	3,645.00	0.389	20	7.8	72,900
Sweet Potatoes	385	1,732.50	0.185	40	7.4	69,300
Misc. Truck Crops	444	2,000.00	0.213	20	4.3	40,000
Truck Crops Multicropped	444	2,000.00	0.213	60	12.8	120,000
Flowers & Foliage	3,100	15,500.00	1.490	50	74.5	775,000
Taro	426	1,917.00	0.205	10	2.1	19,170
Prawns	947	4,216.50	0.455	10	4.6	42,615
Mean	832	$3,950.00	0.40			
Total				375	150.0	$1,481,255

a/ Labor priced at $4.50 per hour for all crops, except potted flowers and foliage. Labor for potted flowers and foliage priced at $5.00 per hour.

Environmental Protection Agency, which is appended to this report (Appendix A).

Most chemical sprys are absorbed by the plants to which they are applied. Proper use, as specified on labels would prevent damage to other plants or irritation to humans. Any small quantities which might enter streams during periods of heavy runoff would cling to the soil particles and not endanger aquatic species in the coastal areas. Farmers must receive permits for use of chemical sprays which are approved by the EPA for commercial use, but are not available to home gardeners. In order to receive a permit, the farmer is expected to comply with regulations concerning the use of any approved chemical.

Even for chemicals which are approved for restricted use, such as EDB (Ethylenedibromide) have not been known to pose environmental problems in Hawaii if properly used. Users of restricted chemicals must be certified by the State Department of Agriculture. Training is provided by the University of Hawaii Cooperative Extension Service. There is a fine for mis-use.

Pythium, a fungus disease of taro, can be controlled by the application of 40 pounds of Captan 50-W per acre before planting, by cleaning the area and leaving the land fallow for a period of 3 months between crops, and by keeping water temperature below 78° F. Without proper control, the disease can be transmitted through stream flow to healthy taro patches. According to the Director of the Plant Disease Clinic at the University of Hawaii, slight chlorination of 1 to 2 ppm in water collected for re-use will prevent transmission of the disease in the event that runoff from this water should re-enter taro patches. The Plant Disease Clinic also has indicated that this particular fungus would not affect other species of crops in the Valley.

Chemical fertilizers are available to all prospective users without restriction. Fertilizers are generally absorbed by the crop to which they are applied and, according to Dr. John Hylin, there is no known evidence of damage to aquatic life in adjacent coastal waters as a result of runoff from streams in windward valleys. As with chemical sprays, chemical fertilizers tend to cling to particles of soil. In instances where excess runoff of fertilizer from farms can be identified, appropriate action may be taken to eliminate the problem.

Fertilizer requirements for individual crops vary according to type of soil, location in the Valley and availability of water. During implementation of the project, it is recommended that borings be made for each soil type and at various locations in the Valley as a basis for determining fertilizer needs of the various crops which would probably be grown in those areas. Approximations of maximum annual applications for the purpose of providing data for environmental considerations are:

Bananas

Mean anual requirement: 3,000 pounds of 10-5-22 or (800# urea, 1,000# triple super phosphate, 900# muriate of potash, 200# potassium sulfate) applied 6 times/year.

Papayas

Mean annual requirement: 3,000 pounds of 10-10-20, applied monthly.

Vegetables

Requirement per crop: 2,500 pounds of 10-20-20, with some variation in requirements for specific crops.

Taro

Requirement for 15 months cycle: 1,250 pounds of 16-16-16 or (435# urea, 900# super phosphate and 385# muriate of potash. One-third of the fertilizer is applied before planting by broadcasting and mixing with the soil. Two to 3 months later, the patch is drained and another one-third of the fertilizer is broadcast. The last one-third is applied 5 to 6 months after planting, using the same method as for the second third. A small amount of fertilizer is lost through stream runoff after the patches are flooded. Most of this would stick to soil particles and is not known to be sufficient to endanger aquatic life.

Agricultural Production and Marketing Association

Justification

The formation of the Waiahole Valley agricultural production and marketing association is crucial to the optimal development of agriculture in the proposed Waiahole Valley Agricultural Park. Most farms in the project are too small to optimize the use of heavy equipment, such as tractors and trucks. Small farmers, acting independently, would also be faced with problems in quality control, transportation, marketing, purchasing and financing.

The projected total value of product output from the Valley of over 2 million dollars annually is sufficient to support a production and marketing association, which would increase the efficiency of production and marketing, resulting in greater net returns to farmers. Such an association might take the form of an agricultural cooperative or a corporation. The primary differences between the two options are type of ownership and distribution of net earnings or profit.

Type of Organization

The conventional cooperative is controlled by it membes, with one vote for each member, and most profits are returned to members according to patronage as a reduction in marketing costs for marketing cooperatives or as a reuction in costs of goods purchased for purchasing cooperatives. Some cooperatives handle goods for non-members who are not given voting privileges. Cooperative savings to producers are not taxed.

A corporation formed to serve the producers might be producer-owned, in which profits would be returned to producers in somewhat similar manner as for a cooperative. On the other hand, the corporation might sell stock to outside interests as well as to producers. Corporate profits would be taxed in contrast to tax free savings to members of cooperatives.

Good management is vital to the success of the organization, whether it is a cooperative or a corporation. Success of a cooperative also depends upon patronage.

Production Services

An important function of the proposed association would be to provide contract services for land preparation and disease, insect and weed control for farms requiring these services and for which the cost of individual ownership of the required equipment would be prohibitive. Particularly for crops like bananas and papayas which require infrequent land preparation, an inventory of heavy equipment cannot be justified.

Marketing

The association would provide marketing services for fruits and vegetables and possibly other commodities, such as floral and nursery products. The provision of marketing services by one large unit could encourage quality control and orderly marketing by equating demand and supply. This system would permit sales direct to retailers, thus offering the opportunity to provide the functions of the wholesaler at reduced cost.

Transportation

Transportation is costly for small farmers where volume is not sufficient to justify the cost of a truck. With grower cooperation, the association could provide trucking services at minimal cost through optimal use of truck capacity.

The entire daily output of banana production from the projected 125 acres, could be delivered by two 2-ton trucks making 2 trips a day per truck to Honolulu markets. The association could also provide the required banana ripening facility at minimal cost of service to farmers.

Production Technology and Financial Assistance

The management of the production and marketing association could provide a link between producers and research and extension agencies with respect to improved production techniques and control of weeds, insects and disease. This would also provide a mechanism for keeping farmers informed as to the supply-demand situation for various commodities and the feasibility of shifting into differenct agricultural enterprises as conditions change.

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APPENDIX A

federal register

FRIDAY, JANUARY 19, 1979

PART VIII

ENVIRONMENTAL PROTECTION AGENCY

FEDERAL PESTICIDE ACT OF 1978

Implementation Plan and Preliminary Solicitation of Views

[6560-01-M]

ENVIRONMENTAL PROTECTION AGENCY

[FRL 1029-4; OPP-00063]

FEDERAL PESTICIDE ACT OF 1978

Implementation Plan and Preliminary Solicitation of Views

AGENCY: Environmental Protection Agency (EPA or Agency), Office of Pesticide Programs.

ACTION: Agency's plan for carrying out the Federal Pesticide Act of 1978, and solicitation of views.

SUMMARY: On September 30, 1978, the President signed into law the Federal Pesticide Act of 1978 (Pub. L. 95-396, 92 Stat. 819) amending the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 U.S.C. 136 et seq. This notice summarizes the changes these new amendments will effect in the FIFRA, and the Agency's general plan and timing for implementing them. Any comments on the Agency's general approach in addressing issues and implementation plans are invited.

DATES: Comments on this notice should be submitted by February 21, 1979.

ADDRESS: Address all comments to: Federal Register Section, Program Support Division, (TS-757), Office of Pesticide Programs EPA, 401 M Street, SW., Washington, D.C. 20460. Comments received will be available for public inspection in Room E-401, Waterside Mall East Tower, 401 M Street, SW., Washington, D.C.

FOR FURTHER INFORMATION CONTACT:

Ms. Susan H. Sherman, Chief, External Affairs Unit (TS-766), (see mailing address above), telephone 202/755-8020.

SUPPLEMENTARY INFORMATION: The following information describes the legislative history of the Federal Pesticide Act of 1978, the legislation itself, and a section-by-section implementation plan.

LEGISLATIVE HISTORY

In March of 1977, the Administrator of EPA testified before the House Committee on Agriculture and the Senate Committee on Agriculture, Nutrition, and Forestry that the pesticide registration and reregistration program was in need of modification and streamlining, requiring statutory amendment as well as administrative changes. The Administration shortly thereafter presented for the Committees' consideration a proposed bill intended to significantly alter the pesticide law. The objectives of the Administration bill were to provide greater flexibility to the Agency in regulating pesticides, eliminate inequitable aspects of the registration process, and provide a framework for a simpler, more focused registration and reregistration program. These issues were explored in testimony by EPA, the States, the pesticide-producing industry, farm and other user organizations, and environmental groups during hearings held in the spring and summer of 1977.

On July 29, 1977, the Senate passed S. 1678, a comprehensive bill designed to remedy the problems identified by the Administration and the other parties who presented views. The House, after holding further hearings, passed H.R. 8681 on October 31, 1977. The House bill contained some of the same basic elements of the Senate bill (although treating some of the issues differently) and added other unique provisions. A Conference Committee convened in April 1978 and issued a Conference Report on September 12, 1978. The Conference bill was adopted by the Senate on Septemberr 18, 1978, by the House on September 19, 1978, and was signed into law on September 30, 1978.

DESCRIPTION OF THE LEGISLATION

The FIFRA has been the primary vehicle for regulating pesticides since 1947. Until 1972, the law was focused on the proper labeling of pesticide products shipped in interstate commerce. In 1972, however, Pub. L. 92-516 strengthened the law considerably, changing it from a labeling law to a comprehensive regulatory statute. The 1972 amendments reflected the public concern about potential adverse health impacts of pesticides only then becoming apparent, the need to adequately assess the "reasonableness" of the risks posed by these products and to permit continued sale and use of those products found to not pose unreasonable risks. Pub. L. 92-516 charged EPA with the responsibility not only for requiring adequate premarket data review of new products, but also for reexamining previously registered products, and reregistering those which continue to meet today's safety standards.

The Agency encountered numerous obstacles in attempting to carry out the registration responsibilities imposed by the 1972 law. Registration came to a near standstill due to ongoing litigation over use of one company's data by another, and because for many products data sufficient to meet today's data requirements have not yet been generated. At the same time, however, the law allowed earlier-registered products, identical to those for which registration is now sought, to remain on the market pending reregistration, giving rise to a "double standard" among manufacturers of like products. The new legislation recognizes and remedies the inequities of the present system, and permits some far-reaching changes in the registration program which will simplify the regulation of pesticides in this country.

The new law incorporates several important features considered by the Administration and Congress to be laudable goals of contemporary environmental legislation:

o Regulatory reform—lessening burdens on the private sector and simplifying the regulatory process;

o Decision making in the "sunshine"—making the Agency's information base accessible to the public; and

o Direction of resources to highest priority health and safety questions.

1. *Registration.* Several major provisions of the legislation significantly affect the registration process. These provisions authorize EPA to:

*Issue conditional registrations, to expedite the registration process, and give the Agency and the industry greater flexibility in fulfilling data requirements.

*Develop generic pesticide standards for each pesticide active ingredient encompassing all of its approvable formulations and uses. The Agency in the future will adopt a chemical-by-chemical approach to registration rather than the current product-by-product approach.

*Classify registered pesticides for restricted use by regulation prior to full reregistration.

*Waive the finding of efficacy, reducing data requirements to industry, allowing the marketplace to determine efficacy, and allowing the Agency to devote its limited resources primarily to the assessment of health and safety questions.

The Agency plans to review all pesticides currently on the market chemical-by-chemical over the next 10-15 years, and to develop a generic standard (basically a profile of formulations and uses which the Agency has determined will not pose unreasonable adverse effects on humans or the environment) for each pesticide active ingredient. This process involves the review and validation of all data in EPA files, the identification and filling of data gaps by registrants, and the reregistration of currently registered products which are approvable under the standard. Conditional registration will under sections 3(c)(7) (A) and (B) serve as a bridge to generic standards involving "old" chemicals over a 10-15 year period. In other words, a product will be conditionally registered until the generic standard for its active ingredient is developed, after that time, it will be reregistered unconditionally if it is in compliance with the new standard. Conditional registration will be used after a standard is developed only when the Administrator imposes a new data requirement in order to allow applicants an appropriate amount of time to meet the new requirement.

Under section 3(c)(7)(C) of the Act EPA is also authorized to issue conditional registrations for new chemicals under certain special circumstances. These include cases where the early registration is in the public interest as a substitute for an RPARed or cancelled pesticide, would provide control for a pest now having no adequate control or would provide other socially beneficial effects.

An important change in thrust of the registration program expressed by the Administration during the legislative process is the rejection of a piecemeal approach to data consideration for individual registration actions, which wastes both Agency resources and applicant effort. This change in philosophy underlies both the generic standards (reregistration) program and the conditional registration program. The Agency will use all relevant data available in establishing generic standards. The standard will not be based on one item of data, or five items of data or any particular pieces or combinations of individual items of data—it will be based on *all* data reviewed by the Agency which is pertinent to a finding of no unreasonable adverse effects. The legislative history provides added incentive to adopt this course by endorsing the Agency's proposal to validate data only once for each chemical rather than on a product-by-product basis.

As the Agency explained in Congressional testimony, it has no intention of examining the existing data base on a chemical in reaching conditional registration decisions, for product uses similar or identical to currently registered products. Comprehensive review of this data base will occur systematically with the establishmentof generic standards. Therefore, EPA will be implicitly relying on what is already known (i.e., the existing decision base) about pesticides now on the market in granting conditional registrations; only new data in support of a new use or a new chemical will be actually reviewed and scientifically assessed.

This approach to data consideration will effect changes in the registration process. In the long run, it will result in simpler, more efficient procedures for registrants who apply for registration under an established generic standard, and increased saving of EPA's time and resources since it will make health and safety decisions once for each chemical rather than hundreds of times over for individual applications. The Agency envisions in the future—after the data base has been validated, data gaps have been filled, and generic standards established—a system under which (in most cases) an applicant will certify that his product is in conformance with the standard, will submit only limited product—specific data, and will certify that he has taken the appropriate steps to comply with the data compensation provisions of the Act. Applicants will need to submit substantial data only when they propose new uses, new chemicals or other deviations from the established standard.

In the short run, this approach means that we expect to change the data citation and compensation procedures (discussed in detail below) which may cause some initial, temporary confusion. Because the Agency is relying on its "institutional knowledge" about pesticides, based on all data already in the files, rather than relying on individual ad hoc review of discrete items of data, we are proposing that applicants for conditional registration must rely on (and offer to pay for) all items of data in Agency files pertinent to the active ingredient contained in the product for which registration is sought, if those data are the kinds of data required under today's criteria to support the *initial* registration of such a product. These procedures are contained in draft conditional registration regulations now out for public review. During the interim three options are available to the registrant which are detailed in PR Notice 78-5, issued on December 8, 1978. In any case, the universe of data for which any registrant must actually pay compensation is limited by three primary factors: (1) The 1970 cut-off date for compensation in the statute; (2) the Agency's waiver of efficacy data requirements for many use patterns; and (3) the separation between data on technical active ingredients and formulated products for compensation purposes. These factors are discussed in the following section and in number 2 below.

2. *Data Sharing and Disclosure.* The degree of control over data any registrant should be allowed to maintain after the data are submitted to EPA to support a pesticide registration was a major issue in developing the new legislation.

The two principal concepts discussed by the Conferees were: (1) Compensation for data (registrants who rely on data submitted by another must pay the submitter compensation for use of that data) and (2) exclusive use of data (data submitter has the right to allow or deny use of data by other registrants, at his discretion). The compromise struck by the Conferees combines part of each of these concepts.

The new law provides for compensation for data for a period of 15 years after submission for active ingredients in already-registered pesticides ("old" chemicals). That provision applies to data already in EPA files, and to new data which will be required by EPA in the future to maintain registrations of "old" active ingredients ("defensive data"). The compensation requirement does not apply to data submitted prior to 1970 (nor did it under the prior law).

The Federal Pesticide Act further provides that data pertaining to a pesticide containing a new active ingredient in a product first registered after September 30, 1978, will be entitled to exclusive use protection for 10 years after the date of initial registration. Any data supporting new uses of such new active ingredients will enjoy whatever period of exclusive use is still in effect from the initial registration. Exclusive use will in no case apply to defensive data.

Any disputes between registrants over the amount of compensation will be resolved by binding arbitration under the rules of the Federal Mediation and Conciliation Service. The old FIFRA provided that the EPA Administrator would decide such disputes by formal adjudication with opportunity for court review.

A new concept in cost sharing is also introduced by the Federal Pesticide Act of 1978. Some of the data required for registration are generated by tests on the active ingredient or technical product alone, while others are conducted with the pesticide product as formulated. The new cost sharing concept recognizes this fact by assigning costs of data on active (technical) ingredients to registrants of such ingredients and costs of data on formulated products to registrants of formulated products. In other words, compensation will operate horizontally between registrants competing at the same market level, not vertically between registrants at different market levels. The Act specifies that formulators (who purchase registered active ingredient chemicals for use in making end-use products) will not have to pay separate compensation to producers of the active ingredients for data concerning the safety of the active ingredients, beyond that amount of compensation implicit in the price of purchased technical materials. This provision should reduce the administrative and financial problems of formulators who no longer will be obliged to separately compensate producers of active technical ingredients for use of their expensive long term safety testing data submitted to EPA.

The law also clarifies the degree to which data underlying Agency regulatory decisions should be accessible to the public. It reflects the agreement of the Administration and the Congress that most data underlying EPA's decisions on pesticide regulation should be routinely available to the general public, so they can review Agency decisions. Bona fide trade secrets, however, such as confidential formula, manufacturing process, quality control processes, and production and sales data, will not be routinely releasable to the public. (These data can be disclosed in certain circumstances, if procedural safeguards are followed.)

The Act also provides that representatives of multinational pesticide producers will not have access to data otherwise available to the public. This prohibition was introduced because Congress was concerned about the impact of use of data overseas on international competition, when compensation provisions would not pertain. However, data pertaining to a pesticide which is the subject of an intensive public review proceeding (e.g., rebuttable presumption against registration, suspension, or cancellation) will be accessible to multinational companies in order to assure complete public accessibility to the data, and in order to permit such companies to participate in the proceedings.

3. *State responsibilities.* The Federal Pesticide Act provides additional flexibility and authority to States in two areas: State registrations for special local needs, and primary use enforcement authority. The States played a very active role in the legislative process, and the amended Act provides expanded responsibilities for States in permitting uses of pesticides and ensuring their proper use within State boundaries.

4. *Other changes.* The new legislation defines "use inconsistent with the label"; imposes new requirements on exporters of pesticides cancelled or never registered in the United States; mandates the priority reregistration of food use pesticides insofar as practicable; confirms the Agency authority to certify applicators in States without approved plans; directs the Agency to consider restriction of a pesticide as an alternative to cancellation; requires an agricultural impact statement for any regulations promulgated under the Act; directs EPA to work with USDA in developing a list of agricultural pests; requires an annual report on conditional registrations issued over the previous year; and directs the Agency to conduct special studies on ultra-low-volume pesticide applications; minor use pesticides, and the possibility of charging fees for pesticide registrations.

DESCRIPTION OF EACH SECTION AND IMPLEMENTATION PLAN

Most of the provisions of the Federal Pesticide Act of 1978 are immediately effective. Plans to issue regulations to further define Administrative procedures which are not clear under the statute or as required by the statute are noted.

The Administrative Procedure Act, 5 U.S.C. 552-553, requires that Agency rules of general applicability and future effect be published in the FEDERAL REGISTER. Thus, when the Agency determines that in the future it will implement a provision of FIFRA in a certain uniform manner, it will publish an explanation of its intended manner of implementing the Act as a rule or general policy statement, as appropriate. Additionally, various changes in existing Agency regulations will be necessary to conform the regulations to the new provisions of FIFRA. Regulations will be promulgated in accordance with Executive Order 12044, with opportunity provided for public comment and participation.

A description of each section of the Federal Pesticide Act and a discussion of the Agency implementation plans follow.

1. *Definitions* (effective immediately; amendment to §7 regulations to follow).

Section 1 of the new amendments defines for the first time the phrase, "to use any registered pesticide in a manner inconsistent with its labeling," as meaning any use not permitted by labeling with the exception of four specific use practices as well as any uses otherwise authorized by other sections of the Act, and permits the Administrator to find other uses "consistent" which are not in literal accord with the label. It is the Agency's view that this definition is effective immediately, and does not require implementing regulations. EPA will publish a FEDERAL REGISTER notice formally rescinding those Pesticide Enforcement Policy Statements (PEPS) which were rendered obsolete by the new law. In addition, the Agency plans to develop regulations, to be published in the FEDERAL REGISTER establishing procedures for declaring other uses which are not in literal accord with labeling in the future to be "consistent" with the purposes of the Act.

The new legislation also specifies that an applicator of pesticides who follows label directions and applies registered pesticides as a service to control pests is not a seller or distributor of pesticides, changes the definition of "commercial applicator," and clarifies the term "producer." Because these are but three of several sections affecting certain applicators, a concise description of all changes in this area should be clearer than piecemeal attention. That discussion is found in number 17 below.

Section 1 of the new amendments also amends the definition of "Establishment" in the Act to include "any place where a pesticide or device *or active ingredient used in producing a pesticide*" (new words italicized). This new definition will require a change in the §7 regulations, "Registration of Establishments."

Two other changes in definitions concern exporters of pesticides and ultra-low-volume pesticide application, which will be discussed in numbers 13 and 27 below respectively.

2. *Use of data* (effective immediately, regulations to follow).

(a) *Compensation and exclusive use.* Section 2 of the new legislation amends §3(c)(1)(D) of the FIFRA to specify how data submitted by one registrant can be used for registration purposes by subsequent applicants. The general scheme envisioned by the amendments (i.e., 15 years of compensation from the date of submission of data, and 10 years of exclusive use from the date of first registration of future new pesticides containing new active ingredients) has been discussed above.

Draft 3(c)(1)(D) regulations have been publicly available since October 5, 1978, and have been discussed in a public meeting November 6, 7, and 8 in Washington. The Agency plans to issue final regulations by February 1979 in conjunction with the regulations implementing conditional registrations (discussed in number 6 below).

The new procedures dealing with compensation and exclusive use are effective now, and will be clarified in regulations. Thus, for all registrations issued after September 30, 1978, registrants must comply with the compensation and exclusive use portions of the Federal Pesticide Act of 1978. This means that in addition to furnishing to EPA a statement offering to pay reasonable compensation when applicable as in the past, applicants must also write directly to the submitters of data pertinent to their registration, and EPA must be notified by the applicant that the data submitters have been contacted.

In addition, data on a new active ingredient first registered after September 30, 1978, will be entitled to 10 years exclusive use from the date of the original registration, and can be used by subsequent applicants only with the express permission of the data submitter.

The Agency procedures for implementing compensation for data and other changes to the registration process which are applicable between the enactment of the new amendments and the effective date of regulations is explained in detail in PR Notice 78-5, available from the Registration Division, Office of Pesticide Programs (TS-767), EPA, Washington, D.C. 20460.

(b) *Compensation disputes.* The concept of required sharing of data and compensation is not new. The 1972 and 1975 FIFRA amendments provided for reasonable compensation of owners of data submitted in support of product registration when those data were used by subsequent applicants to support additional registrations. Disputes over the appropriate amount of compensation were to be settled by the Administrator, and reviewable in the court.

The new amendments substantially change the procedures for settling disputed compensation issues arising from registrations issued after September 30, 1978. Henceforth, disputes will be resolved by binding arbitration under the auspices of the Federal Mediation and Conciliation Service. The findings and determinations of the arbitrator shall be final and conclusive, and not subject to judicial review except upon verified complaint of fraud, misrepresentation or other misconduct. However, claims resulting from registrations issued prior to enactment of the new amendments will be settled in accordance with the old procedures unless the parties mutually elect to use binding arbitration or otherwise resolve their disputes.

As under the old Act, the law directs that the Agency need not wait until a compensation dispute is resolved to issue a registration to an applicant who has offered to pay compensation. The Act provides that if the Administrator determines that the original data submitter has failed to participate in binding arbitration or failed to honor the terms of the arbitration, the submitter forfeits his rights to compensation. On the other hand, the Act provides that the Administrator shall deny or cancel the registration without any further hearing if the applicant fails to enter into arbitration or fails to honor an arbitration decision. In either case EPA will advise the party of the intended action by certified mail, and will allow 15 days for response before taking action.

3. *Minor uses* (effective immediately; policy statement of current practice; regulations as part of guidelines).

The new legislation directs the Administrator to consider the anticipated extent of use, pattern of use, and the level and degree of potential exposure to the pesticide in determining appropriate data requirements for registration. The Agency will review the regulations governing data requirements in light of this amendment; in the interim, EPA will issue a general policy statement on various aspects of the minor use problem, including the relationship of registration to the tolerance setting procedures of the Federal Food, Drug, and Cosmetic Act (FFDCA), in the FEDERAL REGISTER in the next month. In addition, the Agency will complete a report to Congress by June 30, 1979 (see number 25 below) regarding the minor use problem.

As a result of these analyses, EPA may well find areas where changes in regulations are necessary and appropriate. The most likely examples involve the specification of data requirements in the Registration guidelines. Regulations will be issued to reflect such changes in data requirements as needed.

4. *Simplified registration* (Act mandates regulations within 9 months; exemption for data citation effective immediately).

As noted above, one of the innovations in the new legislation is the concept of limiting direct compensation transactions according to whether safety data are generated on the active ingredient or formulated product. This provision is effective immediately, and is discussed in the data compensation registration regulations which are scheduled to be completed by February 1979.

It was also in the context of this limitation on compensation transactions that the Committees discussed the generic approach to registration. As EPA testimony explained, "* * * it has become increasingly clear that we are spending far too much time on individual end-use formulation applications, and that the whole structure for registration needs to be focused primarily on the chemicals themselves rather than thousands of individual applications for products containing mixtures of chemicals. Section 1 of our bill would facilitate that restructuring. We envision a system in which it is the technical material which becomes the focal point for registration, with the bulk of the safety data obtained from manufacturing-use, rather than end-use, registrations." Section 1 of the administration bill—the "generic pesticides standards" amendment—is embodied in § 4 of the Federal Pesticide Act of 1978. The Agency plans to publish a FEDERAL REGISTER notice within the next month describing how EPA will go about the development of generic standards and the reregistration program.

5. *Efficacy waiver* (effective immediately; waiver to be stated in conditional registration regulations preamble; amendment to § 3 regulations to follow as needed.)

The new legislation allows EPA to waive submission of efficacy data and to register a product without a determination that the pesticide's composition is such as to warrant claims of efficacy. EPA sought this amendment in order to concentrate limited Agency resources in the health and safety area, and because efficacy demonstrations in the laboratory or in field trials do not necessarily remain valid for very long, because of regional climatic situations, crop production technology changes and pest resistance factors. In order to implement the efficacy waiver provision, the Agency will incorporate a new efficacy waiver policy in the conditional registration regulations (see number 6 below). As a general rule, efficacy data will continue to be required in cases in which a human health impact could result from ineffectiveness of the product. The Conference Committee Report also gives EPA the option of waiving review of efficacy data if needed to determine efficacy of a product if the Agency has established data requirements and test protocols for such a product, if the required data are submitted and if the applicant provides a certified summary stating the product meets the efficacy requirements.

Congress, USDA, industry, and user groups have generally applauded the concept, but some States and other interested parties believe it will signal an open season to fly-by-night operators who will defraud the public. Since this is a major deregulation action, EPA will consider it an experiment in social policy and EPA, in cooperation with the Experimental Technology Incentives Program of the National Bureau of Standards, will monitor the impacts of the efficacy waiver policy to determine if:

* Consumer fraud increases;
* Consumer fraud is effectively reported and curtailed through existing market institutions including State regulation processes, USDA and the Extension Service, farmers associations, and the marketplace;
* Reductions in data requirements have any impact on innovation in the pesticide industry;
* Expected Agency resource savings (because of reduced data review) are realized.

6. *Registration under special circumstances* (effective immediately; regulations to follow).

The Agency believes that this provision will provide the greatest relief to pesticide formulators and users, and also believes it has a commitment to the Congress to implement this program immediately. Coupled with new data use and trade secret provisions, it will remove the double standard that has existed for three years and has caused the rejection of numerous applications. EPA is therefore planning to issue interim final regulations which specify the basis on which it will grant conditional registrations for products identical or substantially similar to those already on the market, and for new uses of old (already registered) chemicals. The Agency's current schedule calls for the regulations to be issued by February 1979. Regulations regarding the conditional registration of new chemicals will be proposed 6 to 10 months after the promulgation of interim final regulations pertaining to old chemicals. Any application for a conditional registration of a new chemical will be handled on a case-by-case basis until that time.

The Agency desires to reconcile the need for public participation in the rulemaking process. Thus, in the FEDERAL REGISTER of July 25, 1978, EPA announced its intention to issue final regulations governing conditional registration of old and new uses of old chemicals without first formally proposing regulations. This expedited procedure, authorized by § 553(b)(3)(B) of the Administrative Procedure Act, is considered necessary due to the serious hardship being experienced by companies in certain segments of the pesticide producing industry who have been essentially deprived of a mechanism to attain registration since 1975. Public comment was solicited. EPA held three days of public meetings on November 6, 7 and 8, during which the public was invited to express views and ask questions about the proposed approach to conditional registration. A draft of the regulations and preamble has been sent out to all interested parties, and is available upon request from Bob Rose, Registration Division, Office of Pesticide Programs (TS-767), EPA, 401 M Street, SW., Washington, D.C. 20460.

Section 6 of the new law also prohibits the Agency from initiating an interim administrative review process (i.e., a notice of rebuttable presumption against registration) unless it is based on "a validated test or other significant evidence." The Act also directs the Agency to define those terms in the FEDERAL REGISTER.

The Agency will shortly publish a FEDERAL REGISTER notice in compliance with this requirement.

7. *Classification prior to reregistration; change in classification from restricted use to general use* (effective immediately; regulations required; partially issued)

The new amendments authorize classification of pesticides by regulation, prior to full reregistration.

The first 23 pesticide active ingredients having restricted uses were classified in this manner (final regulations were published on February 9, 1978, in the FEDERAL REGISTER (43 FR 5783)) and the Agency published on January 9, 1979, proposed rulemaking in the FEDERAL REGISTER to classify uses of an additional 14 active ingredients.

The Act now provides that a registrant may petition the Agency to change a classification from restricted use to general use. The Agency is directed to act upon such a petition within 60 days after receipt; any denial of such a petition by the Administrator will be subject to judicial review under § 16 of FIFRA. The Agency will modify its current regulations to accommodate the procedures to be used in petitioning for such change.

8. *Priority of food uses in reregistration* (effective immediately).

The new amendments direct EPA to reregister food use pesticides on a priority basis to the extent practicable. The Agency's compliance with this provision will be discussed in the forthcoming generic standards notice which will explain the rationale for and describe the generic standards approach. The notice will be submitted to USDA and the Scientific Advisory Panel for review and comment.

9. *Certification in States without approved plans* (effective immediately; regulations to follow).

The new amendments give the Administrator explicit authority to certify applicators who intend to purchase and use restricted use pesticides in States which do not have approved plans. Although the 1972 FIFRA was silent on the question of the consequences of a State's not having an approved plan for certification purposes, EPA believed all applicators should have the opportunity to come into compliance with the statute. EPA thus decided to provide a program in the absence of State action. Federal programs have been instituted in the States of Nebraska and Colorado, and the procedures followed in those States were consistent with the requirements of the new law, i.e., consultation with the Governor, publication of the plan in the FEDERAL REGISTER, and opportunity for a hearing in the State. The 1978 amendments also provide that EPA may by regulation require record keeping by commercial applicators in those States in which a Federal certification program is conducted. The Agency will amend current regulations as necessary to accomplish this.

10. *Experimental Use Permits* (effective immediately; Act requires final § 5(f) regulations).

The new amendments direct the Agency to review applications for experimental use permits within 120 days, and to issue regulations implementing § 5(f) of the FIFRA authorizing States to issue experimental use periods to support State registrations under § 24(c) of the Act.

The Agency will continue to review applications for experimental use permits as quickly as possible and expects that such review will be completed in less than 120 days in most cases. It would be of great assistance to EPA if applicants would submit applications at regular intervals throughout the year, rather than inundating the Agency with applications shortly before the growing season for which experimental use is sought.

Regarding § 5(f) regulations, proposed regulations were published for comment on September 3, 1975 (40 FR 40545). The Agency is planning to publish final regulations in the FEDERAL REGISTER in the next six months.

11. *Alternative to cancellation* (effective immediately; no regulations required).

The new amendments direct the Agency to consider restriction of a pesticide as an alternative to cancellation. One of the benefits of the restricted use/certified applicator program has always been to retain uses of pesticides which would otherwise have to be cancelled unless used by knowledgeable applicators. For example, the Agency modified an earlier cancellation decision to allow use of sodium cyanide in the M-44 device with additional restrictions on who may use the device, where and in what situations.

Likewise when the Agency suspended registrations of products containing dibromochloropropane (DBCP), the suspension action did not apply to certain DBCP products if the products' registrations were amended to restrict use to certified applicators and appropriate labeling changes to safeguard applicators were made. The viability of this option will depend on a continuing applicator certification program in the future.

12. *Cancellation of conditional registrations* (effective immediately; regulations to follow with conditional registration regulations).

The amendments provide for an expedited cancellation procedure for conditional registrations if the registrant fails to meet the conditions specified at the time of registration. Any hearing pursuant to such a cancellation will be limited to the issue of whether the condition was or was not met, rather than a full risk/benefit determination for the chemical in question. Cancellation procedures will be included in the conditional registration regulation package scheduled for early 1979 completion.

13. *Establishment registration for manufacturers of active ingredients* (effective immediately; amendment of § 7 regulations to follow).

The new bill amends § 7 of FIFRA to require manufacturers of any "active ingredient used in producing a pesticide subject to this Act" to register their establishments with EPA. The Agency will propose an amendment to the § 7 regulations regarding this provision.

The amendments also provide that the names of pesticides or active ingredients used in producing pesticides produced, sold, or distributed at an establishment which are submitted to EPA in accordance with § 7 are not confidential under § 10 of the FIFRA, and are thus available under the Freedom of Information Act.

14. *Inspection of Books and Records* (effective immediately).

Section 14 of the amendments requires any individual conducting an inspection under § 8 of FIFRA to present his or her credentials and a written statement as to the reason for the inspection, including a statement as to whether a violation of the law is suspected, to the owner, operator, or agent in charge of the establishment. The amendment also specifies that inspections shall be completed with reasonable promptness.

These requirements have been spelled out in the Pesticides Inspection Manual, which is the procedural guidebook for EPA inspectors. This manual is available to the public through Freedom of Information Act Procedures. All pesticide enforcement personnel in the EPA Regional Offices were advised by memorandum of August 22, 1978, that these procedures would be required by the amendment to FIFRA § 8.

15. *Trade Secrets* (effective immediately; regulations to follow; Act requires regulations on contractor access to trade secret information).

One of the most important amendments sought by the Agency was a clarification in the statute of what information is to be made generally available to the public, and what is to be released only under specified conditions.

The new amendments provide a clear and detailed answer on this point. The Agency may routinely disclose pesticide effects data, including human, animal and plant hazard evaluation data, efficacy data, and environmental chemistry data, after complying with procedures to safeguard data submitters' legitimate rights. Four categories of data are not routinely disclosable: (1) Data on manufacturing and quality control processes; (2) data on methods for testing, detecting, or measuring deliberately added inert ingredients; (3) data on the identity or percentage quantity of deliberately added inerts; and (4) data on production, distribution, sale and inventories of pesticides. However, the Federal Pesticide Act provides that these data may be released under circumstances in which disclosure is necessary to protect health or the environment. Procedures for such release will be covered in regulations which the Agency will be proposing governing the confidentiality of business information.

The Agency may disclose data entitled to confidential treatment to any contractor with the Federal government who is performing work required by the FIFRA. Such disclosure will be made only when required so the contractor can successfully complete his work for the government. However, contractors (and their employees) are required to keep such data in confidence and are subject to penalties of up to $10,000 or one year imprisonment for willful or knowing disclosure of any confidential information. In addition, the Agency will be proposing regulations specifically required by the new amendments to prescribe the proper security precautions a contractor must take in order to ensure confidential treatment of data which are trade secrets.

In addition, the new amendments prohibit the Agency from knowingly disclosing *any* data submitted by an applicant or registrant to foreign or multinational pesticide producers or pesticide exporters without consent of the data owner (except, as explained earlier, if the chemical in question is undergoing an intensive public review). The Agency will be developing procedures for data release, including a statement from the party seeking access to the data that he or she does not intend and will not purposefully or negligently deliver such data to foreign or multinational pesticide producers.

As noted, the Agency plans to amend existing regulations governing confidentiality of business information to reflect the changes of FIFRA § 10. However, because the provisions of the Federal Pesticide Act are effective immediately and because the amendment of the existing regulations will take some time in order to afford appropriate opportunity for review and comment, the Agency published a FEDERAL REGISTER notice on December 19, 1978, detailing interim procedures.

16. *Sale of restricted pesticides to an uncertified applicator* (effective upon promulgation of regulations; regulations to be amended).

The Federal Pesticide Act of 1978 amends § 12(a)(2)(F) of FIFRA so that it shall not be unlawful for an individual to sell a restricted use pesticide to an uncertified applicator for application by a certified applicator as authorized in regulations promulgated by EPA. This provision was added to the law to allow uncertified farmers to continue the traditional practice of purchasing pesticides (some of which will be restricted) in advance of actually contracting with an applicator to apply the products. Often this practice results in substantial economic savings to farmers.

Conditions under which this practice may be continued are described in the Preamble to the classification regulations (43 FR 5783, February 9, 1978). The procedures outlined in that preamble will remain in effect until regulations amending the FIFRA § 4 regulations (40 CFR Part 171) are promulgated.

17. *Penalty provisions* (effective immediately).

Several sections of the Federal Pesticide Act of 1978 affect "for hire" applicators, notably the definitions section (§ 1) and the penalty provisions (§ 17).

The new legislation specifies that "any applicator who holds or applies registered pesticides, or use dilutions of registered pesticides consistent with section 2(ee) of this Act, only to provide a service of controlling pests without delivering any unapplied pesticide to any person so served is not deemed to be a seller or distributor of pesticides under this Act." For purposes of brevity these applicators referred to above who provide a service of controlling pests, where that service is in whole or in part their occupation, shall henceforth be referred to as "for hire" applicators. Previously, it had been EPA's position that "for hire" applicators "distributed" pesticides as a part of their service when they applied them (policy memorandum of March 25, 1976). As distributors, these applicators were held to a higher standard under the law than other users. For example, their place of business and their books and records were subject to administrative inspection and they were liable for higher penalties for misuse of pesticides.

The new Act treats these applicators somewhat differently. "For hire" applicators are no longer to be considered sellers or distributors except in certain circumstances (for example, if they hold or apply an *unregistered* pesticide, or they deliver any unapplied pesticide to the customer). In situations such as these, the applicator would be considered a seller or distributor for any violation of FIFRA, and subject to the higher penalties set forth in § 14(a)(1) and § 14(b)(1).

Section 1 of the new amendments also changes the definition of the term "Commercial Applicator" in section 2(e)(3) of the FIFRA. Previously, the term "commercial applicator" meant "*a certified* applicator who uses or supervises the use of any pesticide which is classified for restricted use for any purpose or on any property other than [as a private applicator]" (emphasis added). The new Act reads, "The term 'commercial applicator' means *an applicator* * * * who uses or supervises * * *." (emphasis added). In other words, a commercial applicator is no longer defined as being a *certified* applicator. Thus, *any* applicator (except a certified private applicator) who uses or supervises the use of a restricted use pesticide, whether or not that applicator is certified, is a commercial applicator subject to the higher penalties under § 14(a)(1) and § 14(b)(1) of the Act.

Section 1 of the new amendments also specifies that an individual who dilutes a formulated pesticide for his own use in accordance with the label directions cannot be considered a "producer" under the Act.

Section 17 of the new amendments revises §14(a) of the FIFRA regarding civil penalties for violations of the Act. The new amendments, unlike the 1972 FIFRA, differentiate between restricted use and general use pesticides in terms of the maximum fine that a "for hire" applicator can incur. Any "for hire" applicator who violates any provision of FIFRA while holding or applying a registered *general use or unclassified* pesticide is liable for a maximum fine of $500 for the first offense and $1000 for subsequent offenses; the maximum fine for a violation which occurs with a *restricted use* pesticide is $5,000. Previously, the Agency had considered "for hire" applicators subject to a maximum penalty of $5,000 whether they were using general or restricted pesticides.

The new law also recasts a provision of the 1972 Act which directs the Agency to consider the size of the business of the person charged with the violation, the effect on the person's ability to continue in business and the gravity of the violation in determining the size of a civil penalty. The Agency has the discretion to issue a warning in lieu of assessing a civil penalty in situations where a violation occurred "despite the exercise of due care or did not cause significant harm to health or the environment." This amendment, directed principally at misuse violations governed by §12(a)(2)(G), will be taken into account when determining whether to take action under §14 (civil penalties) or § 9(c)(3) (minor warnings for use of a pesticide in a manner inconsistent with labeling). The agency plans to publish a new chart providing guidance on assessing civil penalties in the FEDERAL REGISTER which will take the legislative changes into account.

18. *Pesticides and devices intended for export* (effective within 180 days after enactment; regulations required).

Exporters of pesticides will be significantly affected by the new legislation. Under the 1972 *FIFRA*, an exporter did not have to meet any labeling or packaging requirements other than those specified by the foreign purchaser. The new amendments, however, specify that a pesticide intended for export will be misbranded if it does not conform to several provisions of § 2 of *FIFRA*, meaning that exporters have to conform to certain U.S. labeling requirements for the first time. The new amendments also specify that exporters are subject to § 7, establishment registration, as well as § 8, books and records, of the Act.

In addition, labels of pesticides which are not registered in the U.S. and which are intended for export must bear the following statement: "Not Registered for Use in the United States of America." The foreign purchaser must sign a statement acknowledging that he understands that such pesticides are not registered for use in the U.S. and cannot be sold in the U.S. under FIFRA. A copy of the statement must be transmitted to an appropriate official of the government of the importing country.

The amendment also directs EPA to provide foreign nations with information on alternatives to cancelled pesticides upon request. This provision augments the current requirement that EPA notify foreign governments, via the State Department, of all significant pesticide cancellation actions.

The provisions of modifying section 17 of FIFRA regarding labeling for exports, and related § 7 and § 8 requirements, become effective 180 days after enactment (March 29, 1979). EPA will, within that time, notify pesticide registrants and export firms of the new requirements through the FEDERAL REGISTER. The Agency plans to amend to § 8 regulations to accommodate the additional recordkeeping to which exporters will be subjected and to develop procedures for transmittal of the acknowledgement statements.

19. *Disposal* (effective immediately).

The new amendments direct EPA to provide information on pesticide disposal when action is taken to finally cancel a pesticide. The Agency will do so as cancellations occur in the future. A directive to Agency employees will be included in internal procedural manuals.

20. *IPM & Monitoring* (effective immediately).

In accordance with the new amendments, EPA will continue to coordinate programs in integrated pest management (IPM) with the U.S. Department of Agriculture. The Conference Committee's directives on monitoring humans and environmental media for pesticide exposure will be accommodated in the National Monitoring Plan already being developed under § 20 of the 1972 FIFRA.

21. *State Cooperation, Aid, and Training* (effective FY 1980; EPA general grant regulations to follow).

Section 21 of the new bill provides that EPA may enter into cooperative agreements with States and Indian tribes to assist in enforcement of the Act, and to assist in developing and administering State and Indian programs to train and certify applicators.

The legislation also authorizes to be appropriated such funds as necessary for EPA to provide through cooperative agreements an amount equal to 50 percent of the anticipated costs to each State and Indian tribe. If funds sufficient to pay 50 percent are not appropriated, each State's and tribe's share shall be reduced in a like proportion.

EPA is planning to propose regulations in the next 6 months governing general grant procedures for enforcement and certification and training purposes. Development of proposed regulations was nearing completion when the law was amended, and draft regulations are now being revised accordingly. In addition, the Agency will be working closely with the States and Indian tribes in deciding what costs should be included in the 50/50 sharing plan. EPA will ask each State what proportion of Federal funding supports their certification programs, since estimates were available only on National totals rather than a State by State basis at the time the Conferees considered the funding amendment.

The Agency will report its findings to the States and to the House and Senate agriculture committees before the appropriations hearings next spring.

This amendment is an authorization but not a guarantee of appropriations. Funds for each year will still need to be justified and appropriated through the normal budget process.

22. *State Registration for Special Local Needs* (certain portions effective immediately; remainder upon issuance of regulations).

The new legislation amends §24(c) of FIFRA to provide the States with greater flexibility and independence in issuing registrations for "special local needs." There are certain changes in FIFRA §24(c) which are effective immediately upon enactment of the Federal Pesticide Law of 1978. Most notable of these are:

* States no longer need to submit a program for EPA approval in order to obtain permission to issue local needs registrations;
* EPA cannot disapprove a State registration on the basis of lack of essentiality of a pesticide or if its composition and use patterns are similar to those of a Federally registered pesticide (unless such use has been previously denied, disapproved, or cancelled by the Administer.) EPA can, however, disapprove State registrations within a 90-day period if the use pattern or composition is dissimilar to a Federally registered product (and if EPA determines that such a registration would be harmful to health or the environment.) EPA can immediately disapprove registrations for use of a pesticide on a food crop for which there is no established tolerance under the FFDCA, or if the State registration constitutes an imminent hazard.
* EPA must notify States if it intends to disapprove a State registration and provide time for the State to respond.
* States may register uses not considered, or considered and approved, by EPA in disapproving, cancelling, or denying registration of other uses of such products. Products containing an ingredient subject to an intensive review of risks and benefits (i.e., rebuttable presumption against registration) are also eligible for State registrations if otherwise acceptable under the new amendment.

Because of these changes, and the obvious need for cooperative guidelines, the Agency in consultation with the States has prepared a policy memorandum which addresses the transition period between enactment of the new amendments and development of new §24(c) regulations. This document is now available to the public. Copies may be obtained by writing to Mr. Ralph Collell, Operations Division, Office of Pesticide Programs (TS-770), EPA, 401 M Street, SW., Washington, D.C. 20460.

Because the new amendments have significantly affected the State registration provisions of the law, the Agency intends to repropose §24(c) regulations in the FEDERAL REGISTER. EPA will work closely with the States through the State FIFRA Issues Research and Evaluation Group in the development of these regulations.

23. *Agricultural vs. non-agricultural uses, agricultural impact statements, Scientific Advisory Panel* (effective immediately.)

Section 23 of the new amendments directs EPA to consider the differences in environmental risk and the appropriate data for evaluating such risk between agricultural and non-agricultural pesticides. This amendment was developed primarily in response to complaints by registrants of household products that EPA does not properly distinguish between the potential risks their pesticides may pose as compared to pesticides used on crops.

EPA has considered the differences in risk potential of various product types in establishing data requirements. The amendment ensures that the Agency will continue to do so in the future.

In a effort to clarify how the Agency in its regulations distinguishes between crop uses and households uses of pesticides regarding data requirements and hazard evalution, EPA will publish a descriptive paper as a Pesticide Regulation notice in Spring 1979.

Section 23 of the new legislation also directs EPA to analyze the impact of regulations promulgated under FIFRA on the agricultural economy, and to publish that analysis in the FEDERAL REGISTER. The Agency will comply with this requirement during the rulemaking process. The Agency has published on July 11, 1978 (43 FR 29891), a proposed plan for improving environmental regulations which require the Agency to analyze all routine regulations for "insights into the potential effects on the economy and on those who are subject to the regulation." Factors to be taken into consideration in these economic analyses are described in that notice.

Regarding the Scientific Advisory Panel, the new legislation extends the termination date of the Panel to September 30, 1981. It also directs the Panel to consult and coordinate its activities with the Science Advisory Board. In addition, §23 of the new bill directs the EPA Administrator to "solicit from the advisory panel comments, evaluations, and recommendations for operating guidelines to improve the effectiveness and quality of scientific analyses made by personnel of the Environmental Protection Agency * * *" We intend to present questions of scientific policy to the Panel as they arise in the future.

24. *State Enforcement, Pest List, Annual Report* (effective as described below).

The Federal Pesticide Act of 1978 adds two new sections to FIFRA (Sections 26 and 27) which outline conditions under which a State will be judged to have primary authority to enforce FIFRA's prohibitions on the misuse of pesticides and the conditions under which EPA can exercise such enforcement responsibilites.

A State has primary use enforcement authority if EPA determines that it has adequate use laws and regulations, has adequate procedures for the enforcement or those laws and regulations, and will keep records and make reports as the Administrator may require by regulation. The new law further provides that any State which has a cooperative enforcement agreement with EPA "automatically" has primary use enforcement authority. It also directs EPA to review State plans submitted in accordance with §4 of FIFRA within six months of the enactment of the amendments to determine if the laws and regulations in those States meet the criteria to grant them the responsibilty for primary use enforcement.

Those States that currently have Cooperative Enforcement Agreements with EPA, and thus have "automatic" primary use enforcement responsibilities, are:

Arizona*	Nevada
Arkansas	New Hampshire
California	New Jersey
Connecticut	New Mexico
Delaware	New York
District of Columbia	North Carolina
Guam	Oklahoma
Hawaii	Oregon
Idaho	Pennsylvania
Indiana	Puerto Rico
Iowa	South Dakota
Kansas	Tennessee
Kentucky	Texas
Louisiana	Vermont
Maryland	Virginia
Michigan	Virgin Islands
Mississippi	Washington
Montana	West Virginia

*EPA has a cooperative enforcement agreement with the State's Structural Pest Control Board only. Primary use enforcement responsibility has therefore been delegated only for the structural pest control area. Primary use enforcement responsibility in the agricultural area is retained by EPA.

Those States with no cooperative enforcement agreement and which therefore do not have automatic primary use enforcement responsibility are:

Alabama**	Nebraska
Alaska**	North Dakota**
Arizona**	Ohio**
Colorado	Rhode Island**
Florida**	Samoa
Georgia	South Carolina**
Illinois	Trust Territories
Maine**	Utah**
Massachusetts	Wisconsin**
Minnesota**	Wyoming**
Missouri**	

** States with fully approved § 4 plans.

The Agency will examine the § 4 State plans for the States with fully approved plans to determine whether their enforcement authorities are appropriate to qualify them for primary use enforcement authority. Failure to review such plans within six months will result in automatic State primary use authority for the the unreviewed States.

For those States without either a cooperative enforcement agreement or fully approved § 4 plan, no primary use enforcement responsibility will be conferred until such time as (a) the State's § 4 plan is given full approval by EPA and its enforcement authorities have been reviewed for adequacy, or (b) the State applies for review of its enforcement authorities and EPA finds they are consistent with FIFRA § 26(a).

In addition, the Agency plans to propose regulations to implement the suspension provisions of the new § 27 concerning a State's failure to carry out its primary use enforcement responsibilities. These regulations will address the procedures for referral of complaints to States, define "appropriate enforcement action" and "significant violation of the pesticide use provisions" of the Act describe when an "emergency condition" exists, and outline procedures for rescinding primary use enforcement responsibility as appropriate. These proposed regulations will be developed with cooperation from the States and other interested groups.

Regarding the provision of § 4 of the Federal Pesticide Act of 1978 directing the EPA Administrator to identify agricultural pests in coordination with the Secretary of Agriculture, the Agency plans to solicit the assistance of USDA in this endeavor. EPA anticipates that a list can be developed in 12 months.

The new Act also directs the Agency to submit an annual report to Congress before February 15 of each year beginning in 1979 describing the conditional registrations issued for the previous year. The Agency will comply with this requirement as specified in the legislation.

25. Studies

Section 27 of the Federal Pesticide Act of 1978 directs the Agency to conduct three studies:

(a) Feasibility of charging fees for Federal registration of pesticide products, in order to reduce taxpayer expense. Statutory deadline: nine months after enactment.

(b) Review of all available scientific information dealing with methods of pesticide application, particularly ultra-low-volume application. Statutory deadline: Six months after enactment.

EPA plans to work with the States, USDA, and concerned private industry and environmental groups and user groups on this study. EPA has published (43 FR 54697) a FEDERAL REGISTER notice soliciting comment on the issues believed by the Agency to be the most important to resolution of the safety questions surrounding ultra-low-volume application. The study to Congress will be followed by a regulation or advisory opinion by March 31, 1979. If the Agency fails to issue any regulation or advisory opinion by that date, ultra-low-volume application becomes "consistent" with the label as defined in FIFRA § 2.

(c) An updated review of the problems of minor uses. The Agency will coordinate with the States, the experiment stations, IR-4, and other interested parties in re-examining the minor use area. Statutory deadline: nine months after enactment.

SUMMARY

The following regulations will be developed by the Agency under the Federal Pesticide Act of 1978. Generally speaking, the Agency anticipates proposing new regulations where appropriate within the next 9–12 months. Better estimates will be provided in Advance Notices of Proposed Rulemaking as developed.

Amend § of FIFRA	Per § of FPA	Purpose and Timing
24(c)	22	Repropose State special local needs registration regulations.
3(c)(1)(D)	2	Final regulations on compensation (by February 1979).
3 (addition to)	6	Interim final conditional regulations (by February 1979).
3 (addition to)	4	Simplified registration: line between data requirements for registration of technical materials & formulations (by February 1979).
3 (addition to)	5	Condition of efficacy waiver: conditional registration regulations.
26 & 27 (new)	24	Proposed primary use enforcement regulations.
10	15	Proposed regulations on disclosure of information to the public and to contractors.
3(d)	7	Procedural regulations have been issued (FR February 1978), additional pesticides proposed (FR January 1979).
4	9	Proposed regulations for record keeping for dealers in States without approved plans.
5(f)	10	Final regulations for state experimental use permit authority
7	13	Proposed amendment to regulations to add producers of active ingredients.
4	18	Proposed amendment to allow sale to uncertified applicators.
8	12	Proposed amendment to include exporters.
2	1	Propose regulation regarding procedures for finding uses "consistent."

The following additional policy statements, FEDERAL REGISTER notices, Pesticide Registration notices, or other public documents will be prepared.

§ of FIFRA	§ of FPA	Purpose and Timing
2	1	Rescind PEPS (Pesticide Enforcement Policy Statement); FR notice by Spring 1979.
17	18	FR notice describing new export requirements by March 29, 1979
2	1, 27	FR notice published asking for public comment on ULV (Ultra Low Volume); comment period closed December 22, 1978 Study on advisability of ULV (Ultra Low Volume) by March 31, 1979 Regulation or advisory opinion by March 31, 1979
3	4	FR notice describing generic standards plans in February 1979
	27	Minor use policy statement by January 1979; Minor use study to Congress by June 30, 1979. Guidelines and/or registration regulations as needed by September 1979

§ of FIFRA	§ of FPA	Purpose and Timing
3	6	FR notice defining "validated test" and "other significant evidence" in February 1979.
10	15	FR notice regarding trade secret policy published December 19, 1978.
14	17	New civil penalty schedule in FR by Spring 1979.
24(c)	22	Notice detailing transition policy already issued.
25	23	FR (Pesticide Regulation) notice—agricultural vs. nonagricultural by Spring 1979.
26	24	Publish names of States which have automatic authority/which § 4 plans OK by March 29, 1979.
29 (new)	26	Annual conditional registration report beginning February 15, 1979.
	27	Study to Congress on feasibility of registration fees by June 30, 1979.
28 (new)	24	Pest list by October 1, 1979. Will be published for public comment.

Dated: December 18, 1978.

STEVEN D. JELLINEK,
Assistant Administrator for Toxic Substance.

Dated: January 10, 1979.

MARVIN B. DURNING,
Assistant Administrator for Enforcement.

[FR Doc. 79-1718 Filed 1-18-79; 8:45 am]

PRELIMINARY

ENGINEERING REPORT

COVERING

WATER RESOURCES

IN

WAIAHOLE VALLEY

Prepared for the

Hawaii Housing Authority

of the

State of Hawaii

Honolulu, Hawaii

by

THE RUSS SMITH CORPORATION
Honolulu, Hawaii
January 31, 1980

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Appendices

INTRODUCTION

I-1 Purpose of this Report

This report is provided in compliance with the 12th of October, 1979 Agreement to provide services by and between Hawaii Housing Authority and The Russ Smith Corporation. This report outlines the studies and research performed in the preliminary engineering phase which was conducted to provide a schematic planning service from which a Development Plan for Water Facilities for the Waiahole Valley Agricultural Park could be formulated.

I-2 This Report's Objective

In the Waiahole Valley report of January 1978, prepared by Architects Hawaii, page 3 of Appendix D, it was stated that a possible development of 3.4 million gallons of water per day (on a yearly average) was possible in upper Waiahole Valley. This water development was of domestic quality considered capable of meeting the requirements of PL93-523. It was towards the preservation of this possible domestic source and the development of sufficient water of irrigation quality to meet the Valley needs that this report is directed. By meeting the irrigation requirements of the Waiahole Valley Agricultural Park, while leaving the domestic source untouched at this time, this consultant believes that the maximization of the Waiahole Valley water resources is attained.

I-3 Scope of Work

Information discussed in this report has been compiled from actual field measurements or taken from published streamflow and rainfall data published by the U. S. Geological Survey and/or State of Hawaii Department of Land and Natural Resources. The report covers the following items:

1. Review of available reports, and data related to stream flows and rainfall which pertained to the Waiahole Area.
2. Review and incorporate into the schematic planning the applicable government and utility standards, ordinances and regulations relevant to water facilities.
3. Review and describe the physical features of the project area and identify any special problems which might arise in the development of water within the project area.
4. Investigate the water supplies of the area and their use to provide for the water needs of the project, taking into consideration availability, adequacy, quality, cost of development and operation.
5. Based on the findings and recommendations of the selected water facilities plan, prepare schematics and cost estimates.
6. Determine the facilities needed to implement the water facilities, showing the alignment, location and size of proposed support facilities and utilities on appropriate drawings.

7. Prepare a Development Plan and Preliminary Engineering Report describing the Waiahole water facilites and proposed support facilities. Describe the improvement costs and continuing operating and maintenance costs and user charges. Present the alternative plans, briefly discussing their advantages and disadvantages and the reasons for the selection of the recommended plan.

Chapter A

THE WAIAHOLE DRAINAGE BASIN

A-1. Major Streams

Waiahole Stream flows eastward from the Koolau Range to Kaneohe Bay, a distance of approximately 3 miles. It has one main tributary, Waianu Stream, which enters from the north. Both of these streams have been affected by the Waiahole ditch-tunnel system.

Waianu Stream flows eastward until it joins with its main tributary, Uwau Stream, from that point it flows southeastward until it joins Waiahole Stream.

Figure A is a duration-discharge curve of Waiahole Stream recorded flows for the twelve year period of 1955 through 1967 at stream elevation 250 feet. The curve shows that the stream flowed 50% of the time at, or below, 3.25 million gallons per day (mgd) during that period of records. The minimum recorded flow was 1.5 MGD and the recorded flow at 90% is shown to be 2.3 mgd.

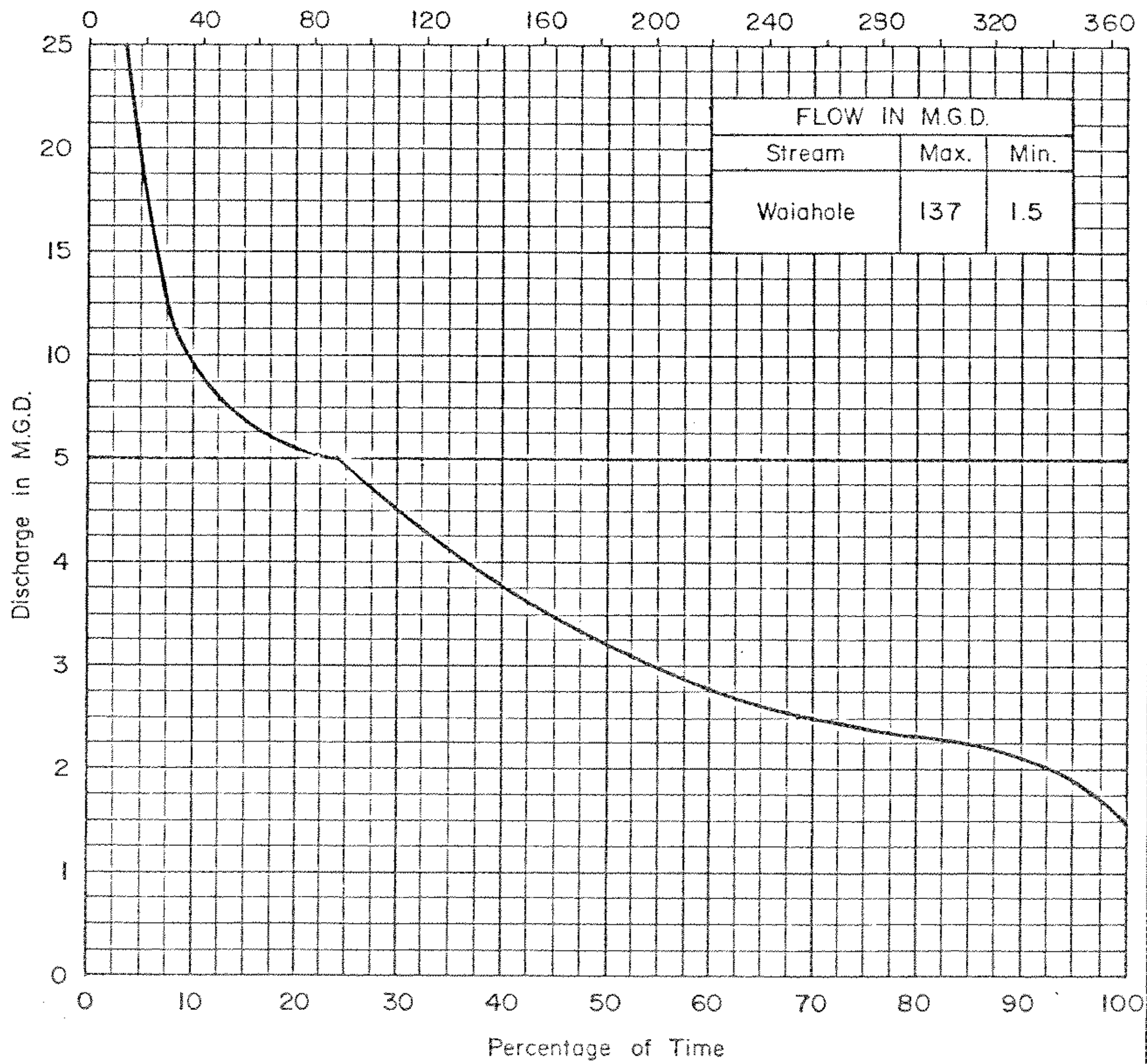
Turning to Water Resources of Windward Oahu, Hawaii, Geological Survey Water Supply Paper 1894, by K. J. Takasaki, G. T. Hirashima, and E. R. Lubke, we find the following information on page 75:

DURATION DISCHARGE CURVE

WAIAHOLE STREAM AT 250' ALTITUDE NEAR WAIAHOLE

Record - 12 Years
1955-1967

Period of Record 4383 days	Discharge Equal to or Exceeding - in M.G.D.							
	20	15	10	5	4	3	2	1.5
	219	334	420	1059	1665	2388	4090	4383
No. of Days in Avg. Yr.	18	28	35	88	139	199	341	365
Percentage of Time	5.00	7.62	9.58	24.2	38.0	54.4	93.3	100



WAIAHOLE STREAM
DURATION DISCHARGE CURVE

THE RUSS SMITH CORPORATION
CONSULTING ENGINEERS

FIGURE A

"A gaging station was established on Waiahole Stream in July 1955, but streamflow date obtained must be corrected for occasional pumping of water from the stream to Waiahole ditch tunnel and for some wastage of tunnel water to the stream. On the basis of adjusted records from Waiahole Stream station (Site 177) observed average flow of 4.75 mgd and observed Q_{90} of 3.4 mgd were obtained; and by correlating Waiahole Stream discharge with those of East Branch Manoa Stream, long-term average discharge 4.9 mgd and long-term Q_{90} of 3.1 mgd were computed."

"Flow measurements show that the point of maximum base flow of Waiahole Stream is at its confluence with Waianu Stream (Site 178). Base-flow gain between the gaging station and Site 178 on July 19, 1960, was 25.4 percent. Long-term Q_{90}, therefore, is 125 percent of 3.1 mgd, or 3.9 mgd. Long-term average is estimated to be 6.9 mgd, which includes the 25 percent groundwater gain and surface water storm runoff based on a ratio of drainage areas."

The same water resource paper states the following on Waianu Stream:

"The point of maximum base flow is at its confluence with Waiahole Stream. Correlation of base-flow measurements at this point (Site 185) with concurrent flows at Waiahole Stream gaging station (Site 177) indicates that long-term average and Q_{90} discharges at this point are 1.2 and 0.5 mgd, respectively."

It is important to notice that Figure A indicates that stream flow at the 250' elevation is 2.3 mgd 90% of the time while the U. S. Geological Survey paper states 3.4 mgd. Consideration of 1.1 mgd being pumped from Waiahole Stream at or near the 450' elevation is not given in Figure A but is recognized and has been included in the 3.4 mgd. Quite often Waiahole Stream is dry immediately below the Waiahole Water Company pumping station ($450^{\pm}$') while the low flow at the 250' elevation has been recorded at 1.5 mgd. The U. S. Geological Survey paper would have set the low stream flow at about 2.6 mgd had the 1.1 mgd not been diverted before reaching the gaging station. We concur with these flows.

On October 17, 1979, a stream flow measurement was taken at the old weir at elevation 250'. The Waiahole Stream flow was 1.68 mgd. Increasing this flow 25% as was computed in the U. S. Geological Survey paper, the flow at the confluence of Waianu Stream would have been 2.1 mgd. The measured flow of Waianu Stream just above its confluence with Waiahole was 0.55, thereby giving a combined flow of 2.65 mgd at Waianu-Waiahole confluence. By increasing the combined flow by 25% again between the confluence and a point some 400 feet mauka of Kamehameha Highway the flow would be 3.31 mgd. The measured stream flow of Waiahole on October 17, 1979 was 3.32 mgd. This check indicates that the base flow of Waiahole Stream increases throughout its reach into the lower portions of the valley as does the adjacent Waikane Stream.

A-2. The Effects of Waiahole Tunnel System

Normally, when water is developed from the dike systems by tunneling or drilling of wells so that groundwater is diverted from its natural water course; the stream flow is affected. The reduction in the base stream flow may be considered approximately equal to that quantity that is diverted away from the stream sources after sufficient time has passed so that the diverted flows stabilize. The gaging station at the north portal of the Waiahole Tunnel indicates that the natural yield averaged 26.3 mgd from January 1951 through June of 1960. In addition, the gaging station at Adit 8 of the main transmission bore through the Koolau Range shows an increase of 5.31 mgd for that section of the system from August of 1956 to June of 1960. The total average flow for these several years was therefore some 31.61 mgd.

The Water Supply Paper 1894 states on page 74 that the flows of Waiahole, Waikane, and Kahana Streams have been affected by the Waiahole ditch tunnel system which diverts water at an altitude of 800 feet (Elevation changes from 785 feet near Waianu down to 709 feet at Adit 8). The report does not attempt to determine the actual amount of the affect.

Researching historical data sheds some interesting light on the situation and provides information needed to substantiate our position on how to maximize the water resource potentials of Waiahole Valley, as they exist today, without further disruption of the environment. The U. S. Geological Survey Water Supply Paper 318, printed sometime after 1913, contains some important and thought provoking data on Waiahole and Waianu

Streams on pages 178 through 186 from which we quote the following:

> "Waiahole basin lies on the eastern slope of Koolau Range, south of Waikane basin and north of Kaalaea basin. All the upper part of the basin is held in public ownership, but the lower part is in private ownership. There are two branches of the main stream, Halona on the south and Waihi on the north, with another tributary from the north, Waianu Stream, farther down. Uwau Stream is tributary to Waianu Stream on the north. All these streams rise in springs which are about 1,000 feet above sea level, and the flow is fairly constant. A part of the water is used for irrigating rice and taro lands in the lower part of the valley."

In September of 1911 a gaging station was established in Waiahole Stream about 2 miles from the shoreline. (This location roughly corresponds to the 250' elevation gaging station set up by the U. S. Geological Survey in 1955.) From September 25 through December 31 of 1911 daily readings were taken. The average discharge for that 98-day period was 17.7 mgd (27.3 sec. ft.). Daily readings were also taken for the same 98-day period at a point in Waiahole Stream approximately 100 feet above the bridge at Waiahole. This station measured the stream discharge going into Kaneohe Bay below all diversions. This flow averaged 30.2 mgd (46.6 sec. ft.). This flow was not caused by heavy rains, low flow during the entire month of November was 44 sec. ft. (28.7 mgd) while the high flow was 49 sec. ft. (31.7 mgd).

From 1955 through 1966 the same 98-day period provided an average base flow of only 3.95 mgd at the 250' elevation.

Other readings were taken during this same time frame which are even more interesting, especially when compared with present day flow readings.

During August, September and October a few (31) readings were taken in Waihi Stream at 750 foot elevation which showed the ordinary flow of the stream. The high flow was 4.6 sec. ft. (2.9 mgd) and the low was 3.7 sec. ft. (2.4 mgd). Today that stream is dry.

During this same period similiar readings (27) were taken on Halona Stream, which is the south fork of the upper Waiahole Stream, at 750 foot elevation. The low flow of this stream was 9.0 sec. ft. (5.8 mgd) and the high flow was 11 sec. ft. (7.1 mgd). Today this stream is dry except during rainy days.

In Waianu Stream, a temporary gaging station was established to take 22 readings in September, October and November of 1911. The station was above all ditch diversions that were then active. The average flow these readings was 12.5 sec. ft. (8.1 mgd) with a high of 15 sec. ft. (9.7 mgd) and a low of 12.0 sec. ft. (7.7 mgd).

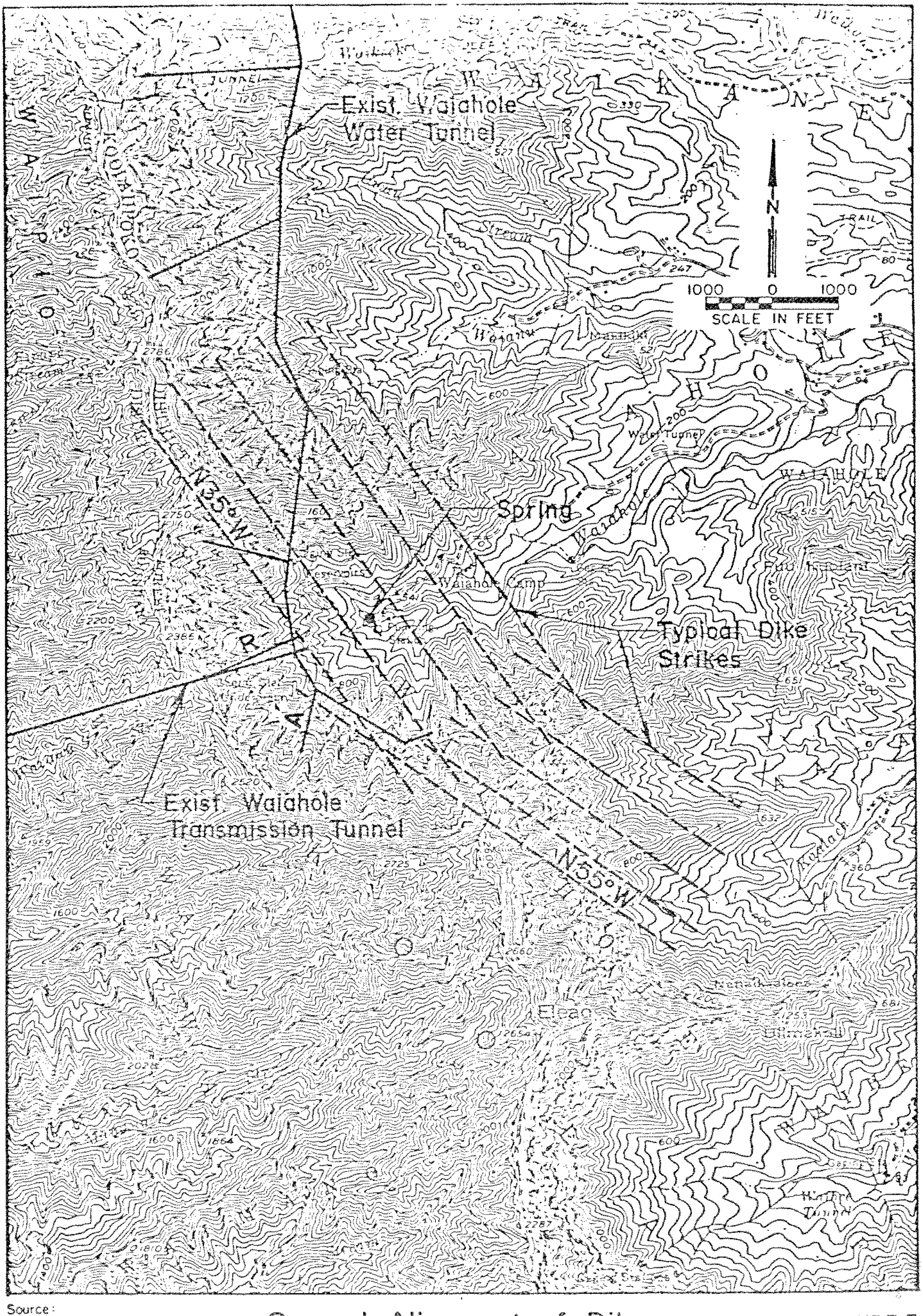
On October 17, 1979, the measured flow at the 250' elevation of Waiahole was 1.68 mgd. At Waianu, near its confluence with Waiahole the measured flow was 0.55 mgd of which some .2 mgd was from the 4-inch McCandless Irrigation water source in upper Waianu. The measured flow just mauka of Kamehameha Highway was 3.32 mgd. The measured flow in lower Waiahole, in 1979 was 26.9 mgd lower than it was in the fall of 1911. Not only has the Waiahole tunnel system greatly affected the water environment of Waiahole Valley, it also appears that the vast majority of the water developed by the tunnel system originally reached the sea by way of Waiahole Stream. This will be examined more closely in the determining of proper steps to maximize the remaining water resources within the Waiahole-Waianu drainage basins.

A-3. Analysis of Groundwater Sources

a. Halona Stream

In the preceding section, it was discussed that Halona Stream, the south branch of Waiahole Stream, flowed at a fairly constant 5+ mgd rate in late 1911 prior to the driving of the Waiahole ditch tunnels. It was also quoted from the Water Resources of Windward Oahu that the Transmission Tunnel of the Waiahole System shows an increase of 5.31 mgd between the north portal and Adit 8. The actual amount of this increase that normally would have reached upper Waiahole or Halona Stream is unknown. Owing to lack of detailed information the authors of Water Supply Paper 1894 assigned one half of the flow (2.6 mgd) to the windward side.

When we realize that prior to the driving of Tunnel A (Figure B) south of the Waiahole Transmission bore, Halona Stream was provided a relatively constant flow above 750 foot



Source:
Water Supply Paper 1894

General Alignment of Dikes

FIGURE B

elevation by springs; and when we recognize that Tunnel A reduced the flow of these springs; and, in addition, that Tunnel A dried up when the lower transmission bore was completed; we can safely assume that the source of groundwater for the Halona Springs was from the northwest.

Figure B shows the trend of the dikes in the Waiahole-Waianu basins. It can be seen that the strike of the dikes of the southern portion of Waiahole Valley is N 55° W. It was quite possible for rainfall entering the volcanic soils of the upper Koolau Range north of the transmission bore, and prior to its being, to filter through the porous volcanics and parallel the dike structures to emerge as springs in the southwestern rim of Waiahole Valley above the 750 foot elevation. This statement is further substantiated on page 65 of Water Supply Paper 1894 where it is stated:

> "Since 1913, when the Waiahole ditch tunnel system was begun, groundwater flow in the Koolau Mountains has been readjusting to the new outlets. Tunnels intercept water that once discharged at springs. By providing a lower outlet, a tunnel shifts the groundwater divide. In his low-flow studies, Hirashima (1963) concluded that the tunnel in Haiku Valley intercepted 1 mgd of water that once flowed into Kahaluu Valley, 2-1/2 miles to the northwest."

b. Waihi Stream

In like manner to Halona Stream sources, the high level springs that fed the northern branch of Waiahole Stream, Waihi, were reduced in flow by the Waiahole tunnel system. Figure B again shows how the dikes which swing to a N 35° W strike can direct the groundwater southeastward to lower level outlets in Waiahole. When the tunnel was driven in a northerly direction from the north portal of the transmission bore it intercepted the groundwater coming from the northwest along the strike of the dikes. As a result, the springs dried up as the groundwater was redirected to the lower tunnel. One spring located immediately above the pumping station in Waiahole Valley near the 450 foot elevation still flows at an approximate discharge rate of 1 mgd. This is the primary source of water for the existing pumping station to boost to Waiahole tunnel from the upper Waiahole basin. It is believed that this $1^{\pm}$ mgd flow passes under the Waiahole tunnel system, below 750 foot elevation, and, then paralleling the dike system, issues forth at the 450 foot level in Waiahole Valley.

c. <u>Waianu Stream</u>

Measurements taken in late 1911 show the stream's uniform flow to be about 8 mgd just below the confluence of Uwau Stream. This stream, like those in Waiahole, was fed by springs near the 1000 foot elevation. On October 11, 1911, the North, Middle and South Forks of Waianu Stream were measured at about the 650 foot elevation well above the junction of Uwau Stream. Respective readings were 2.33 sec. ft. (1.5 mgd); 4.22 sec. ft. (2.7 mgd); and, 1.86 sec. ft. (1.2 mgd) for a total flow of 5.4 mgd. On October 17, 1979, the measured flow of Waianu Stream just prior to the confluence of Waiahole Stream was 0.55 mgd. The point of measurement was taken in the area indicated by the U. S. Geological Survey as that which showed maximum groundwater flow for the stream.

Referring again to Figure B and the black dashed lines which are representative of the dike formation in the Waiahole-Waianu and Waikane Valleys, it can be seen how rainfall falling along the Koolau ridgeline as far north and west as Waipio could seep parallel to the dikes and issue forth as spring water in Waianu and Waiahole Valleys at or near the 1,000 foot level. With the tunnel penetration of the dikes at or near 750 to 800 feet, the flow to the 1,000 foot springs ceased as the high level water was diverted into the lower level of the tunnel and was then directed to the central plain of Oahu.

d. Uwau Stream

Two miscellaneous measurements of Uwau Stream were made in 1911. On September 9, 1911, the Uwau Stream flow was 1.99 sec. ft. (1.3 mgd) and on October 11, 1911 it was 2.21 sec. ft. (1.4 mgd). This latter measurement shows that Uwau Stream was a minor contributor to the total Waiahole basin discharge of groundwater flows. On a day that Waianu Stream had a 5.4 mgd flow at the 650 foot level, the total flow of Uwau was but 1.4 mgd. With a gaged flow of 7.7 mgd at 225± feet, just below the confluence of Waianu and Uwau, it can be computed that Waianu Stream increased its flow from 5.4 mgd to 6.3 in the stream's reach from 650 foot elevation to the 225 foot elevation, a distance of approximately 4,500 lineal feet. The increase in flow in Waianu Stream within the 4,500 feet of streambed was only .9 mgd, in October of 1911.

e. Waiahole Basin Stream Flows for October 11, 1911

(1) Halona Stream 750' elev. = 9.0 sec. ft. (5.8 mgd)

(2) Waihi Stream 750' elev. = 3.8 sec. ft. (2.4 mgd)

Waiahole Stream flow totaled 8.2 mgd at 750' elevation.

(3) Waiahole Stream 250±' elev. = 25.0 sec. ft. (16.2 mgd)

Waiahole Stream increased 8 mgd in a distance of 4,000± feet.

(4) Waianu Stream 650' elev. = 8.4 sec. ft. (5.4 mgd)

(5) Uwau Stream 230±' elev. = 2.2 sec. ft. (1.4 mgd)

(6) Waianu Stream 225±' elev. = 12.0 sec. ft. (7.7 mgd)

Waianu Stream increased .9 mgd in distance of 4,500± feet.

(7) Adding 3 and 6 total flow at Waiahole-Waianu Confluence should have exceeded (23.9 mgd).

(8) Waiahole Stream at Bridge 39 sec. ft. (25.2 mgd).

In the above tabulation it can be seen that Waiahole Stream increased in flow some 8 mgd in a 4,000 foot reach of its streambed while Waianu increased only 0.9 mgd in a slightly longer reach of 4,500 feet from the 650± feet elevation to the 250 feet elevation.

f. Comparative Rainfall Data

No single rainfall gaging station in the Waiahole basin spans the periods discussed above. However a rainfall station just ewa of the Koolau ridgeline existed above Waiahole from 1910 to 1914. This Station (837.1) was situated about 4,000 feet from Station 837, which is an active station that has remained so since 1916. In the current isohyetal map of Oahu, Station 837.1 lies in a higher rainfall area than does Station 837.

Records for a 140-day period, from August 16, 1911 through January 3, 1912, at Station 837.1, showed a total rainfall of 60.4 inches for a daily average of .43 inches per day. Rainfall records for October through December, at Station 837, for the 12-year period of 1955 through 1966 showed an average daily rainfall of .41 inches. With rainfall

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The rainfall and streamflow data of 1911 compared with 1955-1966 are noted as follows:

(1) $\frac{\text{Daily Rainfall for 1955-1966}}{\text{Daily Rainfall for 1911}} = \frac{.41''}{.43''} = 95.3\%$

The current isohyetal map of Oahu places Station 837 in an area of annual rainfall close to 125 inches while Station 837.1 lies in an area of annual rainfall above 150 inches.

(2) $\frac{\text{Streamflow, Waiahole 250' for 1955-1966}}{\text{Streamflow, Waiahole 250' for 1911}} = \frac{3.95\text{ mgd}}{17.7\text{ mgd}} = 22.3\%$

(3) $\frac{\text{Streamflow, Waiahole at Bridge 1979}}{\text{Streamflow, Waiahole at Bridge 1911}} = \frac{3.32\text{ mgd}}{30.5\text{ mgd}} = 10.9\%$

g. Comparative Water Resource Potentials - Waiahole

Water Supply Paper 318 briefly discussed the springs in Waiahole, Waianu and Waikane Valleys which issued forth at about 1,000 feet above sea level. These springs undoubtedly were situated at the low points of the dikes behind which saturated volcanic rocks could be found. If we refer to the dike formation trends indicated in Figure B, we can see that the most easterly indicated dike on the N 35° W portion of the formation cuts through the head of Waianu Valley near the 700 foot contour and in Waiahole Valley at or near the 350 foot contour. High level rainfall, confined behind this dike near the 1,800 foot elevation of the Koolau Range in Uwau, or Waikane, would slowly seek its way southeastward towards Waiahole Valley. Water standing at or above 700 foot elevation would spill over the dike in upper Waianu as a spring while waters lower than 700 feet would continue to seep into Waiahole Valley at the 350 to 400 foot levels. This same principle holds for each successive dike lying westward of that first dike of the complex.

Although Figure B shows a highly simplied dike complex, it must be recognized that some dikes may actually cross other dikes as is shown at the junction of the N 35° W dikes and the N 55° W dikes near the south rim of Waiahole. It is known that dikes of the N 55° W strike become less predominate the farther north one travels from Waiahole, however, by no means should it be thought that such dikes do not exist in Waianu, Uwau and Waikane Valleys. The crossing of such a dike with the N 35° W complex, may well block the dike confined water in its southeasterly seep.

Turning to the section of Waianu Stream bed that reaches from the Uwau confluence at 225 feet above sea level to the 650 foot contour, a distance of some 4,500 feet, we found that streamflow only increased .9 mgd even in 1911 prior to the driving of the Waiahole ditch tunnel system. At the same time, we found that Waiahole Stream increased 8 mgd in approximately the same length of reach. Figure B indicates that different dikes probably feed these two different streambeds. The Waianu dikes in 1911, were either (a) leaking dikes which had lost their confined water in Waikane or Uwau, or (b) crossed by another dike that stopped the water from flowing in a southeasterly direction, or (c) dikes that were completely dry; the later being the least likely.

In Waiahole, the inflow of groundwater to the stream from the 750 foot level to the 250 foot contour was 8 mgd in 1911. This indicates that the dike complex shown in Figure B that opens into the streambed between the gaging station and the present pumping station was much more productive than was the Waianu complex. Even today, with the Waiahole ditch tunnel system diverting all water above the tunnel invert (780-740$^{\pm}$) the Waiahole Stream continues to have an active spring near the 450 foot level which contributes some 1 mgd to Waiahole Stream. With that water removed from the streambed by the pump operations, an inflow of at least 1.5 mgd continues to reach the streambed mauka of the gaging station. - Where 16.2 mgd once flowed in 1911, some 2.5 mgd still remains if the pumped water is included as the total stream flow.

It has been discussed previously herein, that much of the dike confined water travels in a southeasterly direction in its movement through the volcanic soils of the Koolau Range. If the rain, which falls on the ridgeline of Uwau and Waianu Valleys and infiltrates the soil to become groundwater, is to be developed for Waiahole Valley use, it may be collected as it issues forth into Waiahole Valley mauka of the 250 foot contour and below the Waiahole ditch tunnel system.

A tunnel, driven at the 400 foot elevation in Waianu Valley could penetrate the dikes which provide the 1.5 mgd seepage below the pump station. The tunnel, however would have to penetrate under the Waiahole ditch tunnel in order to reach the dike compartments which probably contribute to the spring. This could not be accomplished without partially draining the ditch tunnel system and is therefore not only impractical from an economic point of view but also impossible from a legal point of view.

It appears more economical to develop Waianu Valley water by removing it from the ground in Waiahole Valley as it enters the stream. However, diversion of this water into a pipe system above the 250 foot contour may have far reaching environmental impacts which would not be compatible with the intent of the Waiahole Valley Development Plan. These points will be discussed hereinafter.

Chapter B

WATER REQUIREMENTS WITHIN WAIAHOLE VALLEY

B-1. Domestic Water Demands

At the present time, an 8-inch Board of Water Supply pipeline extends along Waiahole Road from Kamehameha Highway to the mauka side of Waiahole Elementary School. This pipeline supplies fire flow requirements to the school as well as domestic water needs. Several of the existing residential lots fronting on both Waiahole Road and the Homestead Road are served domestic water by the Honolulu Board of Water Supply.

The proposed Waiahole Agricultural Park Development indicates that some 35 new house lots and 13 new agricultural lots are to be added to those presently existing. The total usable lots anticipated within the valley, that would require domestic water service equal in quality to the limits of the Safe Drinking Water Act (PL 93-523), are 80. The estimated average daily requirements needed to meet the domestic demands of these lots is 80,000 gallons per day. The maximum daily demand could be as high as 120,000 to 150,000 gallons per day.

A meeting with the Board of Water Supply Planning Division has indicated that the Board of Water Supply will not extend its water supply to include these new lots as new Board of Water

Supply Domestic Water Consumers. This statement was made based on the present limited supply of water on the windward side and the existing requests for new services. It therefore appears that a domestic system capable of delivering at least 150,000 gallons of domestic quality water must be considered for the Waiahole Agricultural Park Development.

B-2. Irrigation Water Demands

Studies by Agricultural consultants working for the Hawaii Housing Authority, have established the total irrigation daily water requirements of 2.5 million gallons. Some 700,000 gallons of this demand is for use on wet land taro along the lower reaches of Waiahole Stream. There are approximately ten acres of taro under cultivation within Waiahole Valley at the present time. In 1911 there were three ditches (auwais) that supplied water for rice and taro cultivation from Waiahole Stream and four such ditches, or auwais, on the Waianu Stream. The acreage so irrigated at that time is unknown.

In the fall of 1911 measured flow in the Waianu ditches equaled 6.9 mgd while the measured ditch flows within Waiahole Valley were 15.5 mgd. During this same period, gaged flows within Waiahole Stream, about 100 feet above the Waiahole Bridge (at Kam Highway) showed that the Waiahole Stream discharge, below all diversions was about 25.2 mgd. Measured flow in Waiahole

Stream above the Waiahole Bridge was found to be 3.32 mgd on October 17, 1979.

From the above domestic and irrigation demands, it appears that a total water requirement of $2.7^{\pm}$ mgd is necessary to meet the Waiahole Valley Agricultural Park Development needs. Approximately 200,000 gallons would be used for domestic needs and 2,500,000 gallons for irrigation needs.

B-3. <u>System Management</u>

Preliminary planning dictates that operation and management of the Waiahole Valley Agricultural Park water system will be accomplished by the Department of Land and Natural Resources thru D.O.W.A.L.D. The Department of Land and Natural Resources currently manages other water systems throughout the State and therefore has the required expertise.

Chapter C

DEVELOPMENT OF WATER REQUIREMENTS WITHIN WAIAHOLE VALLEY

C-1. General

Chapter A of this report discussed the large flows of water formerly found in Waiahole Stream. It also discussed the source of these waters being above the 650 foot level, close to the 1,000 foot elevation. The indenture made on December 30, 1912 between L. L. McCandless, Waikane Water Company and the Waiahole Water Company conveyed the water rights for all waters in Uwau, and Waianu, above the 450 foot elevation to Waiahole Water Company. In return for these water rights, Waiahole Water Company paid certain specified monies and agreed to provide forever, not less than 500,000 gallons of the high level water to a point in Waianu Valley and thence through a pipeline to the main government road near Waiahole Bridge. In 1971, the lower pipeline was conveyed back to the McCandless interests, however the supplying of the 500,000 gallons of water to the Waianu basin was to continue.

It appears that any water rights that may have been conveyed to the State of Hawaii, in the purchase of McCandless lands in recent years, all pertain to rights to waters that might exist below the 450 foot elevation in Uwau and Waianu lands of Waiahole Valley, not above 450 feet.

A present lease between Waiahole Irrigation Company (Amfac) and the State of Hawaii, allows waters at or above the 450 foot elevation in Waiahole Valley to be diverted, by pumping, to Waiahole Tunnel and to the leeward plain for irrigation purposes. This lease is revokable after due time and due cause. However, as long as this lease is in effect, water development by anyone other than the Waiahole Irrigation Company must be below the 450 foot elevation.

Even were the water lease cancelled, extreme care must be exercised in water development in upper Waiahole Valley so that the water of Waiahole Tunnel is not taken inadvertantly. The discussion of dike formations and groundwater flows in Section A indicates how this would be possible.

C-2. Upper Waiahole Valley Development - Alternative I

a. Surface Water from Waiahole Stream

In the previous sections of this report it has been pointed out by the U. S. Geological Survey (Paper 1894) that Waiahole Stream flowed 2.3 mgd or better at the 250 foot elevation. This however, includes the water that Amfac pumped at the 450 foot elevation.

It is possible to construct an intake at the 450 foot spring and a diversion dam within Waiahole Stream at elevation 250 feet. This surface water intake system could provide

2.2 mgd into the Waiahole Irrigation Water System with the remaining .3 mgd being supplied by the surplus water of the "McCandless System" in Waianu. The cost of this irrigation system is estimated at $2,577,000. The domestic water system that would have its supply from .2 mgd of the McCandless System is estimated to cost an additional $770,000. This proposed domestic system is shown on a separate map of the Waiahole Valley Agricultural Park. Complete recovery of the construction capital outlay over a 40-year period, plus operating and maintenance charges for this development would require an irrigation water charge of 22.7 cents per 1,000 gallons. The breakdown of the cost estimates and finance charges are included hereinafter in Appendix A.

b. Advantages

(1) This system, although second in capital costs, will produce the least costly water as no pumping will be required.

c. Disadvantages

(1) This system will remove all low flows from Waiahole Stream and Waianu Streams so that at points in the streambed where stream flows were once 17.7 mgd and 5.4 mgd in 1911, the stream discharge of the future would be zero.

(2) The greatest environmental change within the valley would be brought about by this system.

(3) The development of this surface water precludes all possibilities of developing additional groundwater for sale by other agencies than the Hawaii Housing Authority.

(4) Water development within Waiahole, therefore, cannot be maximized under this plan.

(5) This system would require the voiding of the State of Hawaii - Amfac lease for the pumped water at the 450 foot level.

We believe the disadvantages far outweigh the advantages of this system and therefore do not recommend this alternative for development of irrigation water in Waiahole Valley.

C-3. Upper Waianu Valley Development - Alternative II

a. Tunnel Water from Waianu

It is possible to construct a tunnel at the 400 foot level in Waianu Valley. The total cost of this system would be $4,443,000 and if water were developed, it would be suitable for both domestic and irrigation supplies. Amortization of construction, maintenance and operating costs would require water charges of 37 cents per 1,000 gallons of water. The breakdown of these costs are provided in Appendix B.

b. Advantages

(1) The only advantage this system would have is that the need for a separate domestic system would be eliminated.

c. Disadvantages

(1) Development of water by driving a tunnel in Waianu is the most expensive method of developing water.

(2) Because records show little inflow along the stream below 650 foot elevation, it is believed the dike structure of the lower valley is very tight and will yield small flows to the tunnel. By the time that the dike system becomes productive, the new tunnel would have penetrated under the existing Waiahole Ditch System and water would be taken from that higher tunnel.

The cost and possible legal implications involved with this development alternative force us to disregard this system as a viable solution.

C-4. Lower Waiahole Valley Development - Alternative III

a. Pumped Water near Waiahole Bridge and "McCandless Water" Usage

It is proposed to establish a pumping station at a point some 300 feet mauka of Farrington Highway from which 2.2 mgd of Waiahole stream flow will be pumped into the irrigation system each day. The .5 mgd of the McCandless system will be split near the 350 foot elevation in Waianu so that approximately 200,000 gpd can be filtered and chlorinated for domestic use while the remaining 300,000 gpd will irrigate Waiahole lands mauka of the 200 foot elevation near the Waikane boundary. This irrigation system is estimated to cost $1,814,000. The domestic system which is identical to that required in Alternative I will be $770,000. The capital cost for this system is the lowest of the three Alternatives but produces the second lowest water charge for construction amortization and operations because of the pumping charges. It is estimated that water charges for this system should be 24.8 cents per 1,000 gallons. These figures are indicated hereinafter as Appendix C.

b. Advantages

(1) This system requires the least capital outlay.

(2) This system leaves the water flows of upper Waiahole Valley untouched for future domestic development.

(3) Amfac may continue its lease of water at the 450 foot level.

(4) The groundwater potential remains untouched. The sale of this groundwater for domestic purposes outside of Waiahole Valley can more than offset the additional

costs of pumping. As cost of future pumping increases, future increased domestic water income should continue to offset the pumping costs.

(5) This system does not change the stream environment of Waiahole Valley from its present status.

(6) This system utilizes the "McCandless" source in Waianu for both domestic and irrigation purposes.

(7) This system sets the stage for future domestic water development in upper Waiahole Valley by others, and provides a 2.5 mgd irrigation system at the least capital expense to the Hawaii Housing Authority.

c. Disadvantages

(1) Operating costs for this system are highest, however capital recovery costs are lowest. Result is second lowest, rather than lowest water charges for construction amortization and operating cost recovery.

(2) Slight Chlorination (1 to 2 ppm) will be required at the pump station to counteract possible fungus affects found in water of the lower valley areas.

The fact that this alternative requires the least capital cost, leaves the domestic water development potential of the upper valley untouched, and does not change the water environment of Waiahole Valley above the 10 foot contour, urges us to recommend this system for the Waiahole Agricultural Park Subdivision. The preliminary layout of this proposed irrigation system is shown on a separate map of the Agricultural Park for Waiahole Valley.

CHAPTER D

SPECIAL CONSIDERATIONS

D-1 General

Although the main thrust of this report is toward the development of a quantity of irrigation water for use within Waiahole Valley, certain other conditions or requirements have been given due consideration in planning of the recommended systems of irrigation and domestic water distribution for the Waiahole Valley Agricultural Park. These considerations are briefly discussed in the following paragraphs.

a. Federal Considerations

The Corps of Engineers takes no responsibility in the control of streamflows in Waiahole as the stream is not considered a navigable one. The Corps is, however; concerned with flood control and debris control of the stream. The Flood Plain Map for Waiahole indicates the 100 year storm flood level to be as high as to the 70 foot elevation along the stream bed with a flow restriction at the Kamehameha Highway bridge.

In our planning, we have considered the control weir, to be placed at the irrigation pump station, to be sized for a volumetric flow that will be greater than the capacity of the Kam Highway bridge. The pump station will also be sited high enough to be above the 100 year flood plain level at the station lot.

Drainage of the valley should be improved. We believe this should be limited to the removal of certain trees and brush that overhang the banks to the point of empeding stream flow. The stream waterway should be kept clear so that full flow may be accomplished within the stream embankments without dislodging fallen trees and logs. It is not recommended that the stream bed be enlarged and straightened as erosion would result which would adversely affect the environment of Kaneohe Bay near the mouth of Waiahole Stream.

b. State Considerations

No minimum stream flow value has been established for Waiahole Stream at this date. It is recognized, however, that complete stoppage of the stream flow would adversely affect the natural flora and fauna of the water course. Prior sections of this report indicate that there is an increased flow near the lower end of the valley than that found above the 250 foot contour. This is true today and it will tend to be even more pronounced when 2.5 mgd is used within the valley for irrigation. This will be especially true when all of the irrigation is accomplished below the 250 foot contour. Records indicate than when 1.8 mgd is the total flow of Waiahole and Waianu streams at the 250 ft. level (a volume not sufficient to meet the irrigation requirement), the stream flow near the highway bridge is about 2.7 mgd.

Although a restricted flow will occur between the pump station and the mouth of Waiahole Stream during an "on pump cycle", the flow will still be sufficient to allow opae and other small stream life to survive and to move along the streambed in a normal manner.

c. City and County Considerations

The Honolulu Board of Water Supply, which is a City and County agency, establishes the fire protection standards for subdivisions. Tentative approval of the fire flow requirements being provided by the larger irrigation system was granted during a meeting with the Board of Water Supply Planning Division in early December. This approach permits the distribution piping of the domestic system to be much smaller than normal. This smaller sized distribution system results in a considerable savings in capital outlay.

Because the irrigation system will have the responsibility of providing fire protection for the valley, the fire hydrants have been included in that systems cost. Also, a stand-by emergency generator will be installed within the pump station so that fire flows may be attained even though normal electric power is not available.

d. Cost Considerations

It should be noted that costs reflected in the Appendices of this report are based on today's prices. Projecting a May 1981 construction start, adding an inflationary factor, and further adding the existing preliminary planning contracts, the total cost of the recommended irrigation system and the domestic system, as discussed in Appendix C and Appendix D, is estimated at $3,285,400.

APPENDIX A

IRRIGATION SYSTEM - ALTERNATIVE I

Construction Cost = $2,146,900	Say	$2,147,000
10% Contingency		215,000
10% Engineering and Administration		215,000
TOTAL		$2,577,000

Item	No.	Unit	Unit Cost	Cost
SOURCE				
Intake				
Trench Excavation/Backfill[a]	30	C.Y.	80	$ 2,400
6" ø D.I. Pipe[a]	100	L.F.	12	1,200
Piping (from existing pump station to 1.0 MG Reservoir)				
12" ø D.I. Pipe[b]	5,150	L.F.	100	515,000
8" ø D.I. Pipe[b]	3,230	L.F.	40	129,200
Valves		L.S.		10,000
Dam		L.S.		100,000
				$757,800
DISTRIBUTION				
Piping (Distribution System)				
Trench Excavation/Backfill	8,300	C.Y.	40	$332,000
6" ø A.C. Pipe	6,800	L.F.	8	54,400
8" ø A.C. Pipe	8,480	L.F.	12	101,800
12" ø A.C. Pipe	10,900	L.F.	22	239,800
F.H. Assembly	50	Each	2,000	100,000
6" Gate Valve	5	Each	500	2,500
8" Gate Valve	6	Each	800	4,800
12" Gate Valve	15	Each	1,500	22,500
				$857,800

[a] Piping from existing weir box to 0.1 MG reservoir.

[b] Include cost for trench excavation/backfill.

APPENDIX A

Alternative I
(Continued)

Item	No.	Unit	Unit Cost	Cost
STORAGE				
1.0 MG Reservoir				
Fine Grading/Compaction		L.S.		$ 50,000
Sand/Gravel	130	C.Y.	30	3,900
Foundation/Concrete	20	C.Y.	400	8,000
1,000,000 Gallon Steel Tank	1	Each	216,000	216,000
Sandblasting/Paint, Interior	12,000	S.F.	4.10	49,200
Sandblasting/Paint, Exterior	12,000	S.F.	2.90	34,800
Float Controls/Wiring	1	Set	10,000	10,000
Access Road/Fencing		L.S.		40,000
				$ 411,900
0.1 MG Reservoir				
Fine Grading/Compaction		L.S.		$ 10,000
Sand/Gravel	18	C.Y.	50	900
Foundation/Concrete	8	C.Y.	400	3,200
100,000 Gallon Steel Tank	1	Each	60,000	60,000
Sandblasting/Paint, Interior	2,900	S.F.	4.10	11,890
Sandblasting/Paint, Exterior	2,900	S.F.	2.90	8,410
Float Controls/Wiring	1	Set	5,000	5,000
Access Road/Fencing		L.S.		20,000
				$ 119,400
			TOTAL	$2,146,900

COMMENTS: 0.9 MGD will be obtained from existing Amfac pumping station, 1.3 MGD from new Waiahole Stream dam, additional 0.3 MGD from existing weir box.

APPENDIX A
(Continued)

RECOVERY OF CONSTRUCTION, OPERATING AND MAINTENANCE COSTS

I. Capital Cost

Source:	
Intake	$ 757,800
Distribution:	
Piping	857,800
Storage:	
1.0 MG Reservoir	411,900
0.1 MG Reservoir	119,400
Total	$2,146,900

Capital recovery = \$2,146,900 (crf-i%-n) = \$2,146,900 (crf-8%-40)

= \$2,146,900 (0.08386) = \$180,000/year

II. Operating and Maintenance Cost

Maintenance Costs

Labor	
(1) Man @ \$1,200/month	$ 14,400/year
(1) Vehicle @ \$300/month	3,600/year
	$ 18,000/year
Repairs and preventative maintenance hardware \$500/month	$ 6,000/year
Total	$ 24,000/year

III. Total Annual Cost

Capital Recovery Cost	$ 180,000
Operating/Maintenance Cost	24,000
Total Annual Cost	$ 204,000

IV. At 2.5 MGD

$$\frac{204{,}000}{2{,}500{,}000 \times 360} = \underline{\underline{\$0.227/1{,}000 \text{ gallons}}}$$

APPENDIX B

IRRIGATION SYSTEM - ALTERNATIVE II

Construction Cost = $3,703,300	Say	$3,703,000
10% Contingency		370,000
10% Engineering and Administration		370,000
TOTAL		$4,443,000

Item	No.	Unit	Unit Cost	Cost
SOURCE				
Tunnel				
Mobilization/Demobilization		L.S.		$ 60,000
Tunnel Driving	2,000	L.F.	800	1,600,000
Concrete Lining	100	L.F.	1,000	100,000
12" ø D.I. Pipe[a]	1,900	L.F.	70	133,000
Bulkhead		L.S.		10,000
				$1,903,000
DISTRIBUTION				
Piping (from tunnel to 1.0 MG Reservoir)				
12" ø D.I. Pipe[a]	2,000	L.F.	100	$ 200,000
Piping (from existing weir box to tunnel)				
6" ø D.I. Pipe[a]	1,100	L.F.	33	36,000
Piping (Distribution System)				
Trench Excavation/Backfill	11,400	C.Y.	40	456,000
6" ø A.C. Pipe	2,820	L.F.	8	22,560
8" ø A.C. Pipe	10,200	L.F.	12	122,400
12" ø A.C. Pipe	13,820	L.F.	22	304,040
F.H. Assembly	50	Each		100,000
6" Gate Valve	9	Each	500	4,500
8" Gate Valve	5	Each	800	4,000
12" Gate Valve	13	Each	1,500	19,500
				$1,269,000

[a]Include cost for trench excavation/backfill.

APPENDIX B

Alternative II
(Continued)

Item	No.	Unit	Unit Cost	Cost
STORAGE				
1.0 MG Reservoir				
Fine Grading/Compaction		L.S.		$ 50,000
Sand/Gravel	130	C.Y.	30	3,900
Foundation/Concrete	20	C.Y.	400	8,000
1,000,000 Gallon Steel Tank	1	Each	216,000	216,000
Sandblasting/Paint, Interior	12,000	S.F.	4.10	49,200
Sandblasting/Paint, Exterior	12,000	S.F.	2.90	34,800
Float Controls/Wiring	1	Set	10,000	10,000
Access Road/Fencing		L.S.		40,000
				$ 411,900
0.1 MG Reservoir				
Fine Grading/Compaction		L.S.		$ 10,000
Sand/Gravel	18	C.Y.	50	900
Foundation/Concrete	8	C.Y.	400	3,200
100,000 Gallon Steel Tank	1	Each	60,000	60,000
Sandblasting/Paint, Interior	2,900	S.F.	4.10	11,890
Sandblasting/Paint, Exterior	2,900	S.F.	2.90	8,410
Float Controls/Wiring	1	Set	5,000	5,000
Access Road/Fencing		L.S.		20,000
				$ 119,400
			TOTAL	$3,703,300

COMMENTS: 2.2 MGD will be obtained from new water tunnel, additional 0.3 MGD from existing weir box.

APPENDIX B
(Continued)

RECOVERY OF CONSTRUCTION, OPERATING AND MAINTENANCE COSTS

I. Capital Cost

Source:	
Tunnel	$1,903,000
Distribution:	
Piping	1,269,000
Storage:	
1.0 MG Reservoir	411,900
0.1 MG Reservoir	119,400
Total	$3,703,300

Capital recovery = $3,703,300 (crf-8%-40) = $3,703,300 (0.08386)

= $310,559/year Say $310,600

II. Operating and Maintenance Cost

Maintenance Costs

Labor	
(1) Man @ $1,200/month	$ 14,400/year
(1) Vehicle @ $300/month	3,600/year
	$ 18,000/year
Repairs and preventative maintenance hardware $500/month	6,000/year
Total	$ 24,000/year

III. Total Annual Cost

Capital Recovery Cost	$ 310,600
Operating/Maintenance Cost	24,000
Total Annual Cost	$ 334,600

IV. At 2.5 MGD

$$\frac{334,600}{2,500,000 \times 360} = \underline{\underline{\$0.372/1,000\ \text{gallons}}}$$

APPENDIX C

IRRIGATION SYSTEM - ALTERNATIVE III

Construction Cost = $1,512,400	Say	$1,512,000
10% Contingency		151,000
10% Engineering and Administration		151,000
		$1,814,000

Item	No.	Unit	Unit Cost	Cost
SOURCE				
Intake (Piping from existing weir box to 0.1 MG Reservoir)				
Trench Excavation/Backfill	30	C.Y.	80	$ 2,400
6" ø D.I. Pipe	100	L.F.	12	1,200
Intake (Pumping station @ Waiahole Stream)				
Intake Structure		L.S.		36,000
Pump (2,000 gpm), Valves	2	Each	20,000	40,000
Reduced Voltage Starter	2	Each	9,000	18,000
Electrical Service to Site		L.S.		10,000
Chlorinator	2	Each	8,000	16,000
				$123,600
DISTRIBUTION				
Piping (Distribution System)				
Trench Excavation/Backfill	8,500	C.Y.	40	$340,000
6" ø A.C. Pipe	9,600	L.F.	8	76,800
8" ø A.C. Pipe	8,200	L.F.	12	98,400
12" ø A.C. Pipe	9,900	L.F.	22	217,800
F. H. Assembly	50	Each	2,000	100,000
6" Gate Valve	8	Each	500	4,000
8" Gate Valve	5	Each	800	4,000
12" Gate Valve	11	Each	1,500	16,500
				$857,500

APPENDIX C

Alternative III
(Continued)

Item	No.	Unit	Unit Cost	Cost
STORAGE				
1.0 MG Reservoir				
Fine Grading/Compaction		L.S.		$ 50,000
Sand/Gravel	130	C.Y.	30	3,900
Foundation/Concrete	20	C.Y.	400	8,000
1,000,000 Gallon Steel Tank	1	Each	216,000	216,000
Sandblasting/Paint, Interior	12,000	S.F.	4.10	49,200
Sandblasting/Paint, Exterior	12,000	S.F.	2.90	34,800
Float Controls/Wiring	1	Set	10,000	10,000
Access Road/Fencing		L.S.		40,000
				$ 411,900
0.1 MG Reservoir				
Fine Grading/Compaction		L.S.		$ 10,000
Sand/Gravel	18	C.Y.	50	900
Foundation/Concrete	8	C.Y.	400	3,200
100,000 Gallon Steel Tank	1	Each	60,000	60,000
Sandblasting/Paint, Interior	2,900	S.F.	4.10	11,890
Sandblasting/Paint, Exterior	2,900	S.F.	2.90	8,410
Float Controls/Wiring	1	Set	5,000	5,000
Access Road/Fencing		L.S.		20,000
				$ 119,400
		TOTAL		$1,512,400

COMMENTS: 2.2 MGD will be pumped from Waiahole Stream, additional 0.3 MGD from existing weir box.

APPENDIX C
(Continued)

RECOVERY OF CONSTRUCTION, OPERATING AND MAINTENANCE COSTS

I. Capital Cost

Source:

Intake Piping	$ 3,600
Intake Pumping Station	62,000 + $58,000[a]

Distribution:

Piping	857,500

Storage:

1.0 MG Reservoir	411,900	
0.1 MG Reservoir	119,400	
	$1,454,400 + $58,000	= $1,512,400

Capital recovery = $1,454,400 (crf-8%-40) = $1,454,400 (0.08386)
= $ 121,966 Say $122,000

Capital recovery for pump/valves and starter = $58,000 (crf-8%-20)
= $58,000 (0.10185) = $5,907 Say $5,900

II. Operating and Maintenance Cost

Pumping Cost

Assume 2.2 MGD @ TDH of 250'
($0.25/MG-ft.) (2.2) (250) = $137.50/day $49,500/year

Maintenance Costs

Labor

(2) Men @ $1,200/month	$28,800/year
(1) Vehicle @ $300/month	3,600/year
	$32,400/year
Repairs and preventative maintenance, hardware $1,000/month	12,000/year
Total	$44,400/year

Chlorine Cost $ 1,500/year

[a]$58,000 for pump/valves and starter.

III. Replacement Cost for Pump/Valve and Starter

$58,000 (pwf'-8%-20) = $ 58,000 (4.661) = $270,338

Capital recovery for 20 years

$270,338 (crf-8%-20) = $270,338 (0.10185) = $27,500/year

IV. Total Annual Cost (First 20 years)

Capital Recovery Cost	$122,000
Operating/Maintenance Cost	44,400
Chlorine Cost	1,500
Capital Recovery Cost for Pump/Valves	5,900
Pump Operation Cost	49,500
Total Annual Cost	$223,300

at 2.5 MGD

$$\frac{223,300}{2,500,000 \times 360} = \underline{\underline{\$0.248/1,000 \text{ gallons for first 20 years}}}$$

V. Total Annual Cost (Second 20 years)

Capital Recovery Cost	$122,000
Operating/Maintenance Cost	44,400
Chlorine Cost	1,500
Capital Recovery Cost for Pump/Valves	27,500
Pump Operation Cost	49,500
Total Annual Cost	$244,900

at 2.5 MGD

$$\frac{244,900}{2,500,000 \times 360} = \underline{\underline{\$0.272/1,000 \text{ gallons for second 20 years}}}$$

APPENDIX D

DOMESTIC WATER SYSTEM

Construction Cost =	$641,100	Say	$642,000
10% Contingency			64,000
10% Engineering and Administration			64,000
	TOTAL		$770,000

Item	No.	Unit	Unit Cost	Cost
SOURCE				
Intake				
Trench Excavation/Backfill	940	C.Y.	80	$ 75,200
6" ø D.I. Pipe	3,600	L.F.	12	43,200
				$118,400
DISTRIBUTION				
Piping				
Trench Excavation/Backfill	5,900	C.Y.	40	$236,000
2" ø PVC Pipe	8,000	L.F.	3.50	28,000
2-1/2" ø PVC Pipe	6,800	L.F.	4	27,200
3" ø PVC Pipe	500	L.F.	5	2,500
4" ø A.C. Pipe	7,100	L.F.	6	42,600
6" ø A.C. Pipe	3,900	L.F.	8	31,200
2" Valve	6	Each	150	900
2-1/2" Valve	6	Each	200	1,200
3" Valve	1	Each	300	300
4" Valve	4	Each	350	1,400
6" Valve	4	Each	500	2,000
				$373,300

APPENDIX D

Domestic Water System
(Continued)

Item	No.	Unit	Unit Cost	Cost
STORAGE				
0.1 MG Reservoir				
Fine Grading/Compaction		L.S.		$ 10,000
Sand/Gravel	18	C.Y.	50	900
Foundation/Concrete	8	C.Y.	400	3,200
100,000 Gallon Steel Tank	1	Each	60,000	60,000
Sandblasting/Paint, Interior	2,900	S.F.	4.10	11,890
Sandblasting/Paint, Exterior	2,900	S.F.	2.90	8,410
Float Control/Wiring		L.S.		5,000
Access Road/Fencing		L.S.		20,000
Filter	2	Each	10,000	20,000
Standby Chlorinator	1	Each	10,000	10,000
				$149,400
			TOTAL	$641,100

ENVIRONMENT
CAPITAL
MANAGERS
INC.

SUITE 805 CITY BANK BUILDING · P. O. BOX 1232 · HONOLULU, HAWAII 96807 · TELEPHONE (808) 537-3007

ECONOMIC BENEFIT-COST ANALYSIS

WAIAHOLE VALLEY AGRICULTURAL PARK

WAIAHOLE, OAHU

A Study Prepared For:

CALVIN KIM & ASSOCIATES, INC.
Under Contract With
Hawaii Housing Authority

December 1981

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LIST OF TABLES AND CHARTS

ABSTRACT

It was the charge of Environment Capital Managers, Inc. to explore and reveal the economic elements of impact by the development of Waiahole Valley Agricultural Park in terms of the costs and benefits to the public.

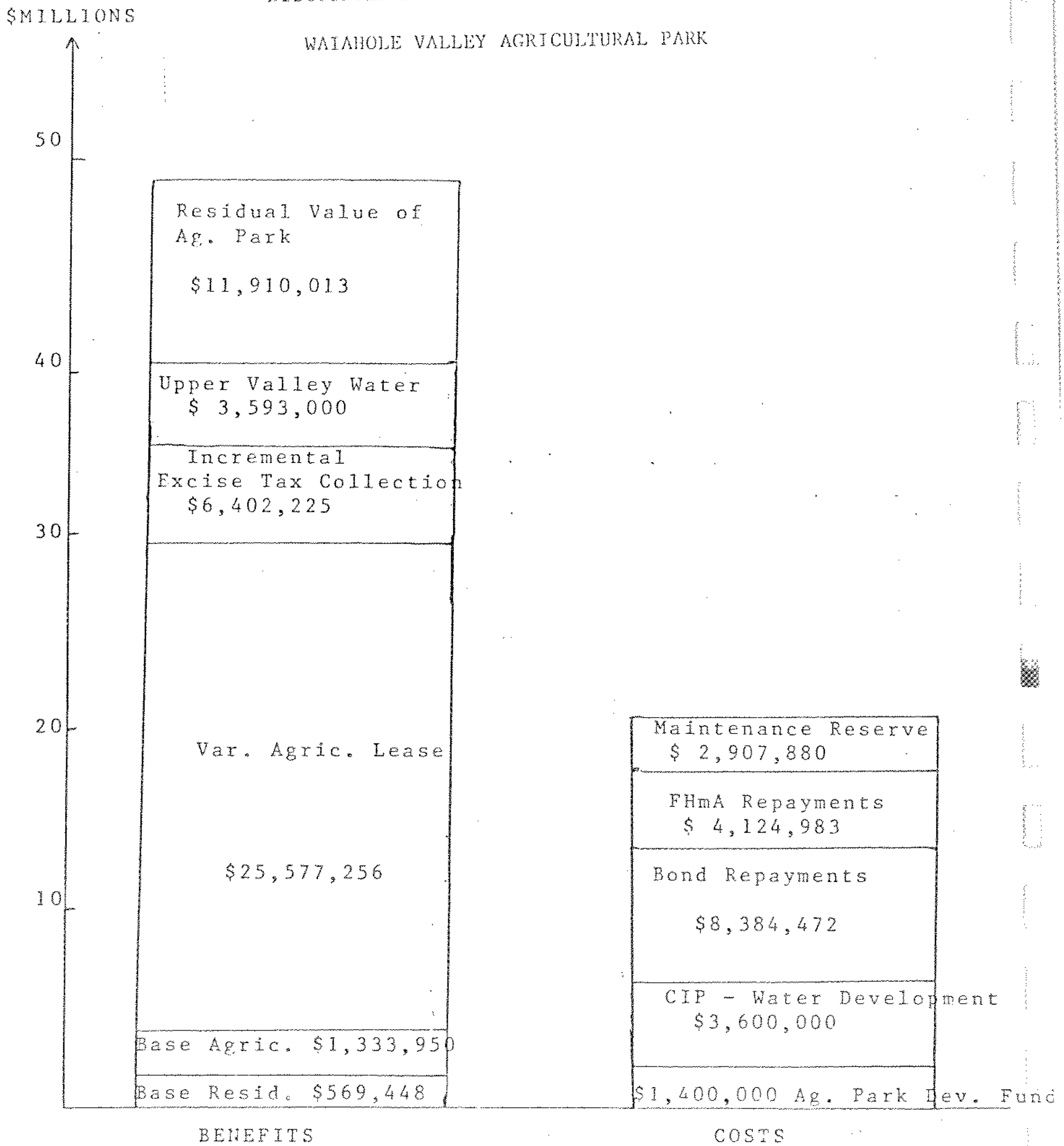
Using standard benefit-cost analysis techniques, we have projected a positive benefit-cost ratio of 2.42 : 1 to the State of Hawaii as the direct impact of developing Waiahole Valley Agricultural Park.

Present Value of BENEFITS	$ 49,385,892
Present Value of COSTS	$ 20,417,335
NET PRESENT VALUE	$ 28,968,557

Investigations of the indirect impacts also pointed to derived benefits outweighing the incremental costs associated with the development.

CHART ONE
DIRECT BENEFIT-COST ANALYSIS
DISCOUNTED PRESENT VALUE OF CASH FLOWS

WAIAHOLE VALLEY AGRICULTURAL PARK



($49,385,892) ($20,417,335)

BENEFIT-COST RATIO: 2.42 : 1

Source : Environment Capital Managers. Inc.

CHART TWO

DISCOUNTED CASH FLOW ANALYSIS
WAIAHOLE VALLEY AGRICULTURAL PARK.
BASE : 1 JANUARY 1982

YEAR	COMMERCIAL & RESIDENTIAL LEASE INCOME (01)	AGRICULTURAL BASE LEASE INCOME (02)	AGRICULTURAL %AGE LEASE INCOME (03)	INCREMENTAL EXCISE TAX REVENUE (04)	OTHER CASH INFLOWS (05)	BOND INT. REPAYMENTS 20YR 5.875% (06)	FHMA LOAN REPAYMENTS 40YR 5% P&I (07)	MAINTENANCE RESERVE (08)	OTHER CASH OUTFLOWS (09)	TOTAL ANNUAL OUTLAYS (	DISCOUNTED PRESENT VALUE	CUMULATIVE NET DISC P.V.
1982	$29,500	$77,370	$0	$18,107	$3,593,000	-$2,231,970	-$262,252	$0	-$5,000,000	-$3,776,245	-$3,706,544	-$3,706,544
1983	$29,500	$77,370	$0	$20,279	$0	-$381,875	-$262,252	-$184,228	$0	-$701,205	-$640,817	-$4,347,361
1984	$29,500	$77,370	$91,257	$22,713	$0	-$381,875	-$262,252	-$184,228	$0	-$607,513	-$524,028	-$4,871,410
1985	$29,500	$77,370	$102,208	$25,439	$0	-$381,875	-$262,252	-$184,228	$0	-$593,837	-$483,750	-$5,355,161
1986	$29,500	$77,370	$114,473	$28,491	$0	-$381,875	-$262,252	-$184,228	$0	-$578,519	-$445,059	-$5,800,221
1987	$29,500	$77,370	$128,210	$31,910	$0	-$381,875	-$262,252	-$184,228	$0	-$561,363	-$407,830	-$6,208,051
1988	$29,500	$77,370	$143,595	$35,740	$0	-$381,875	-$262,252	-$184,228	$0	-$542,149	-$371,942	-$6,579,994
1989	$29,500	$77,370	$160,827	$40,028	$0	-$381,875	-$262,252	-$184,228	$0	-$520,629	-$337,278	-$6,917,272
1990	$29,500	$77,370	$180,126	$44,832	$0	-$381,875	-$262,252	-$184,228	$0	-$496,526	-$303,726	-$7,220,999
1991	$29,500	$77,370	$201,741	$50,212	$0	-$381,875	-$262,252	-$184,228	$0	-$469,531	-$271,178	-$7,492,178
1992	$29,500	$77,370	$225,950	$56,237	$0	-$381,875	-$262,252	-$184,228	$0	-$439,296	-$239,528	-$7,731,706
1993	$29,500	$77,370	$253,064	$62,986	$0	-$381,875	-$262,252	-$184,228	$0	-$405,434	-$208,674	-$7,940,380
1994	$29,500	$77,370	$283,432	$70,544	$0	-$381,875	-$262,252	-$184,228	$0	-$367,508	-$178,515	-$8,118,896
1995	$29,500	$77,370	$317,444	$79,009	$0	-$381,875	-$262,252	-$184,228	$0	-$325,031	-$148,756	-$8,267,853
1996	$29,500	$77,370	$355,537	$88,490	$0	-$381,875	-$262,252	-$184,228	$0	-$277,456	-$119,900	-$8,387,753
1997	$38,350	$77,370	$398,201	$99,109	$0	-$318,229	-$262,252	-$184,228	$0	-$151,677	-$61,223	-$8,448,977
1998	$38,350	$77,370	$445,906	$111,003	$0	$0	-$262,252	-$184,228	-$6,500,000	-$6,273,770	-$2,517,961	-$10,966,938
1999	$38,350	$77,370	$499,504	$124,323	$0	$0	-$262,252	-$184,228	$0	$293,067	$109,149	-$10,857,789
2000	$38,350	$77,370	$559,445	$139,242	$0	$0	-$262,252	-$184,228	$0	$367,927	$129,128	-$10,728,661
2001	$38,350	$77,370	$626,570	$155,951	$0	$0	-$262,252	-$184,228	$0	$451,769	$149,504	-$10,579,156
2002	$38,350	$77,370	$701,767	$174,665	$0	$0	-$262,252	-$184,228	$0	$545,673	$170,343	-$10,408,813
2003	$38,350	$77,370	$785,929	$195,625	$0	$0	-$262,252	-$184,228	$0	$650,845	$191,711	-$10,217,101
2004	$38,350	$77,370	$880,297	$219,100	$0	$0	-$262,252	-$184,228	$0	$768,637	$213,677	-$10,003,423
2005	$38,350	$77,370	$985,933	$245,392	$0	$0	-$262,252	-$184,228	$0	$900,565	$236,310	-$9,767,113
2006	$38,350	$77,370	$1,104,245	$274,839	$0	$0	-$262,252	-$184,228	$0	$1,048,324	$259,692	-$9,507,410
2007	$38,350	$77,370	$1,236,754	$307,820	$0	$0	-$262,252	-$184,228	$0	$1,213,814	$283,869	-$9,223,541
2008	$38,350	$77,370	$1,385,165	$344,758	$0	$0	-$262,252	-$184,228	$0	$1,399,163	$308,945	-$8,914,616
2009	$38,350	$77,370	$1,551,385	$386,127	$0	$0	-$262,252	-$184,228	$0	$1,606,754	$334,992	-$8,579,623
2010	$38,350	$77,370	$1,737,551	$432,465	$0	$0	-$262,252	-$184,228	$0	$1,839,256	$362,093	-$8,217,530
2011	$38,350	$77,370	$1,946,057	$484,360	$0	$0	-$262,252	-$184,228	$0	$2,099,658	$390,332	-$7,827,197
2012	$38,350	$77,370	$2,179,584	$542,484	$0	$0	-$262,252	-$184,228	$0	$2,391,308	$417,801	-$7,409,396
2013	$38,350	$77,370	$2,441,134	$607,582	$0	$0	-$262,252	-$184,228	$0	$2,717,956	$450,573	-$6,956,802
2014	$38,350	$77,370	$2,734,070	$680,492	$0	$0	-$262,252	-$184,228	$0	$3,083,802	$482,805	-$6,473,997
2015	$38,350	$77,370	$3,062,159	$762,151	$0	$0	-$262,252	-$184,228	$0	$3,493,550	$516,539	-$5,957,457
2016	$38,350	$77,370	$3,429,618	$853,609	$0	$0	-$262,252	-$184,228	$0	$3,952,467	$551,903	-$5,405,554
2017	$38,350	$77,370	$3,841,172	$956,042	$0	$0	-$262,252	-$184,228	$0	$4,466,455	$590,010	-$4,815,544
2018	$38,350	$77,370	$4,302,113	$1,070,767	$0	$0	-$262,252	-$184,228	$0	$5,042,120	$627,974	-$4,188,570
2019	$38,350	$77,370	$4,818,366	$1,199,259	$0	$0	-$262,252	-$184,228	$0	$5,686,866	$668,721	-$3,519,849
2020	$38,350	$77,370	$5,396,570	$1,343,171	$0	$0	-$262,252	-$184,228	$0	$6,408,981	$711,982	-$2,807,867
2021	$38,350	$77,370	$6,044,159	$1,504,351	$0	$0	-$262,252	-$184,228	$0	$7,217,750	$757,291	-$2,050,574
2022	$38,350	$77,370	$6,769,458	$1,684,873	$0	$0	$0	-$184,228	$0	$8,385,824	$830,970	-$1,219,604
2023	$38,350	$77,370	$7,581,793	$1,887,058	$0	$0	$0	-$184,228	$0	$9,400,343	$879,774	-$339,830
2024	$38,350	$77,370	$8,491,600	$2,113,505	$0	$0	$0	-$184,228	$0	$10,536,606	$931,361	$591,531
2025	$38,350	$77,370	$9,510,601	$2,367,126	$0	$0	$0	-$184,228	$0	$11,809,219	$986,094	$1,577,625
2026	$38,350	$77,370	$10,651,873	$2,651,181	$0	$0	$0	-$184,228	$0	$13,234,547	$1,043,546	$2,621,173
2027	$38,350	$77,370	$11,930,098	$2,969,323	$0	$0	$0	-$184,228	$0	$14,830,913	$1,104,478	$3,725,671
2028	$38,350	$77,370	$13,361,709	$3,325,642	$0	$0	$0	-$184,228	$0	$16,618,844	$1,168,945	$4,894,617
2029	$38,350	$77,370	$14,965,115	$3,724,719	$0	$0	$0	-$184,228	$0	$18,621,326	$1,237,089	$6,131,706
2030	$38,350	$77,370	$16,760,928	$4,171,685	$0	$0	$0	-$184,228	$0	$20,864,106	$1,309,147	$7,440,854
2031	$38,350	$77,370	$18,772,240	$4,672,288	$0	$0	$0	-$184,228	$0	$23,376,020	$1,385,346	$8,826,200
2032	$38,350	$77,370	$21,024,909	$5,232,962	$0	$0	$0	-$184,228	$0	$26,189,343	$1,465,927	$10,292,128
2033	$38,350	$77,370	$23,547,898	$5,860,918	$0	$0	$0	-$184,228	$0	$29,340,388	$1,551,147	$11,843,275
2034	$38,350	$77,370	$26,373,646	$6,564,228	$0	$0	$0	-$184,228	$0	$32,869,366	$1,641,273	$13,484,549
2035	$38,350	$77,370	$29,538,483	$7,351,935	$0	$0	$0	-$184,228	$0	$36,821,911	$1,736,591	$15,221,140
2036	$38,350	$77,370	$33,083,101	$8,234,168	$0	$0	$0	-$184,228	$0	$41,248,761	$1,832,403	$17,053,541

Source : Environment Capital Managers, Inc.

I. INTRODUCTION

In November 1977 the State of Hawaii, through its Hawaii Housing Authority, purchased some 600 acres within Waiahole Valley from the Marks Estate. The Governor announced that the State would establish an Agricultural Park with the following objectives:

1. The expansion of agricultural potential within the State.

2. To provide for the continuance of the rural lifestyle Waiahole residents now enjoy.

3. The development and conservation of water resources, and

4. To provide passive recreation opportunities.

Presently 190 acres of Waiahole Valley are being farmed. Through infrastructure improvements, the State expects approximately 403.7 acres will be available for agricultural endeavors. This represents a doubling of agricultural potential. The Hawaii Housing Authority anticipates 74 residences agricultrual plots and 50 residential lots on which modest rural housing exists or will be constructed.

As a result of this plan there will be direct and indirect impacts on the State of Hawaii, the City and County of Honolulu, and its Citizenry. It is the charge of Environment Capital Managers Inc., to explore and reveal the economic elements of impact by the development of Waiahole Valley Agricultural Park in terms of the costs and benefits to the public.

Many of the benefits and costs can be measured with a degree of accuracy while other elements of impact can be discussed only in terms of direction or in qualitative measures. The quantifiable elements are important identifiable contributions and deductions from the economic base and reveal the monetary impact on the individual taxpayer. Nevertheless the non-quantifiable elements may also be important. The reader will be made cognizant of the degree of accuracy of the measurements as the report progresses.

A benefit-cost analysis such as this study has traditionally been used in identifying the economic impact of public projects. It may also serve as economic justification for significant public expenditures. The potential financial burden of roads, schools, sewers, water and other public facilities if increased as a result of a new development should be offset by gains from that development. The benefit-cost analysis identified and values the gains and losses to affected groups and the community at large of a particular course of action.

The use of benefit-cost analysis as a decision tool may suggest some predetermined standard to which the results may be compared, thus leading to a correct decision. Generally this is not the case. Experience provided by public projects suggest that measurable benefits should exceed measurable cost. The general rule adopted is that projects require a Benefit-Cost ratio greater than unity for acceptance, however, a margin is often required for safety. The benefit-cost analysis has a guidance value in decision-making.

The benefits and cost measured and compared in this study will be made in terms of current dollars as of January 1, 1982. This development project will yield employment benefits during the construction phase, but the majority of benefits will occur after the project is completed.

This study draws heavily upon Dr. Frank Scott's "Agricultural Feasibility-Waiahole Valley Agricultural Park" (December, 1981) to supply land use projections, crop yields, lot sizes, generation by crop, etc. Should the data presented in Dr. Scott's report change, this would materially affect the conclusions reached in our analysis.

The study relies upon the data supplied to us by the Hawaii Housing Authority. The estimated cost of developing Waiahole Valley Agricultural Park, as shown in Table 1, is approximately $16 million. Sources of funding for the development are found in Table 2. If the data should change, this would also materially affect the conclusions reached in our analysis.

TABLE 1

ESTIMATED COST OF DEVELOPMENT

WAIAHOLE VALLEY AGRICULTURAL PARK

Land Purchase		$ 6,000,000
Consultants, Attorneys, etc.		488,600
Development Construction Cost		
Roadway Improvements	$ 2,970,000	
Drainage Improvements	1,353,000	
Irrigation System	1,829,300	
Domestic Water System	776,000	
Electrical & Street Lighting	550,000	
Sub-Total	$ 7,478,900	
Surveying, Engineering & Admin.	1,006,500	
Contingency-Development	726,000	
Total Estimated Development Cost		9,211,400
Contingency-Project/General		300,000
TOTAL ESTIMATED COST		$ 16,000,000

Source: Calvin Kim & Associates, December 1981

TABLE 2

SOURCES OF FINANCING

WAIAHOLE VALLEY AGRICULTURAL PARK

State of Hawaii	
1. Government General Obligation Bond Issue	$ 6,500,000
November 1977 - 20 years @ 5-7/8%	
(Interest Payments: $381,875/year Principal Repayment (Nov, 1997): $6,500,000)	
2. Capital Improvement Project Appropriation	3,600,000
Water Development (no interest, no repayment)	
3. Agricultural Park Development	1,400,000
(no interest, no repayment)	
Farmer Home Administration	
1. Farmer Home Administration Loan(s)	4,500,000
January, 1982 - 40 years @ 5%	
(Principal and Interest Repayment: $349,669/year)	
FUNDS AVAILABLE	$16,000,000

Source: Hawaii Housing Authority, December 1981

II. TIME FRAME AND DISCOUNTING METHODOLOGY

This study has developed tangible benefits and costs to compare by way of a benefit-cost ratio.

These benefits and costs were measured over the period November 1977 to December 2036 to reflect the 55 year term of agricultural leases effective for calendar 1982. The cash flows were discounted to January 1, 1982 values at 5-7/8 per cent to represent the cost of debt to the public. Keep in mind that the cost of debt to the public differs from that to the private sector. Public long term debt financing normally accomplished via bonding will generally carry with it tax-exempt status and accordingly a lower rate of interest.

The rate of 5-7/8 percent is the actual interest rate of a State of Hawaii 1977 tax-exempt general obligation bond issue with a 40 year maturity. In November 1977, $6.5 million of this bond issue was appropriated to purchase the Waiahole Valley land from the Marks Estate (and for related administrative expenses). The Hawaii Housing Authority has also arranged (for January 1982) a $4.5 million financing package with the Farmers Home Administration (FmHA) at a lower 5% interest with a 40 year repayment period. Thus, use of 5-7/8 percent as a discount rate is conservative.

The discounting technique is best illustrated through an example. If $1 were invested at a return of 5-7/8 %, compounded annually, it would be worth $1.77 ten years hence. Conversely, it is true that at 5-7/8% rate of return the $1.77 received ten years hence is worth only $1.00 today.

III. IMPACT ANALYSIS

The benefits and costs measured are those tangible, measurable changes that impact on the State of Hawaii, City and County of Honolulu, and its Citizenry.

In each instance the incremental change was measured, i.e. the change that should occur with the development of Waiahole Valley Agricultural Park. Those changes that would have occurred without the development are not charged to the project.

The major impact of the project will be on the State government and the populace of the entire State. Nevertheless there will be some impact on the City and County of Honolulu and its Citizenry. The measurable items for the City and County are limited to those that could be directly traced to Waiahole Valley Agricultural Park.

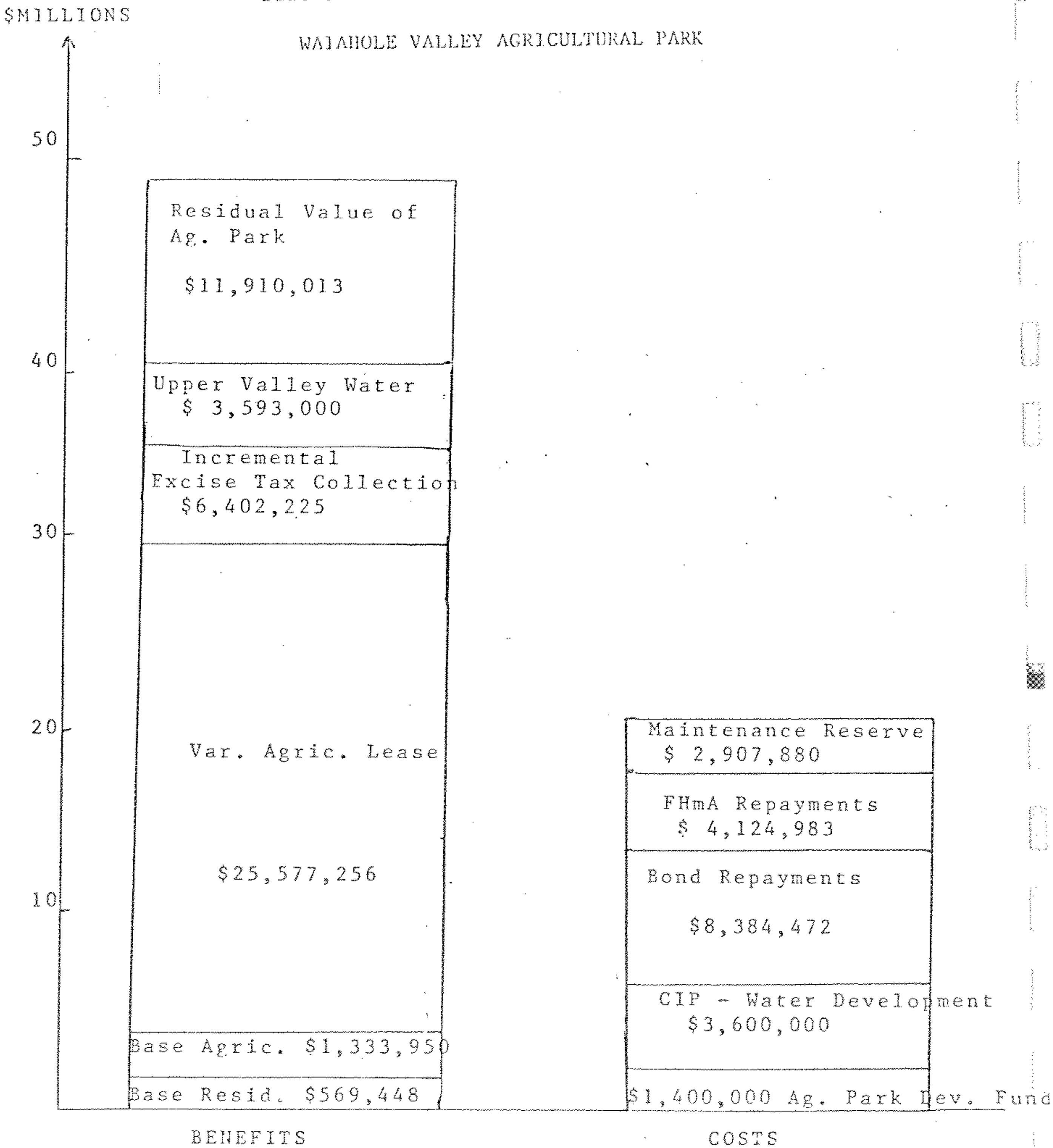
The approach in this study is multi-stage.

A. DIRECT IMPACTS - STATE OF HAWAII

The direct costs and benefits accruing to the State from Waiahole Valley Agricultural Park are compared. These are readily quantifiable changes, primarily those attributable to agricultural development. Tables 3 and 4 present the discounted present values of such cash outflows (costs) and cash inflows (benefits). The results are summarized in Chart 1, indicating a very positive 2.42 to 1 benefit-cost ratio.

CHART ONE
DIRECT BENEFIT-COST ANALYSIS
DISCOUNTED PRESENT VALUE OF CASH FLOWS

WAIAHOLE VALLEY AGRICULTURAL PARK



($49,385,892)

($20,417,335)

BENEFIT-COST RATIO: 2.42 : 1

Source : Environment Capital Managers, Inc.

TABLE THREE

DISCOUNTED PRESENT VALUE OF CASH OUTFLOWS
TO 1 JANUARY, 1982
WAIAHOLE VALLEY AGRICULTURAL PARK

CASH OUTFLOWS (COSTS)

1. Farmers Home Administration (FmHA) Loan
   $4.5 million ; January, 1982 for 40yrs @ 5.0%
   Repayment : $ 262,252/yr (Princ + Int.)
   Discounted Present Value .... $ 4,124,983

2. State of Hawaii General Obligation Bond Issue
   $6.5 million ; November 1977 for 20yrs @ 5.875%
   Repayment : $ 381,875/yr (Interest)
   $6,500,000 (Principal : 1997)
   Discounted Present Value .... $ 8,384,472

3. State of Hawaii Appropriations
   $3.6 million CIP - Water Development
   $1.4 million Ag. Park Development Fund
   Appropriated June, 1979
   No repayment, Non-interest bearing
   Discounted Present Value .... $ 5,000,000

4. Maintenance & Refurbishment Reserve[1)]
   2%/annum of Infrastructure Dev. Costs
   2% * $ 9,211,400 = $ 184,228/yr Reserve
   Discounted Present Value .... $ 2,907,880

DISCOUNTED PRESENT VALUE OF
CASH OUTFLOWS -- TOTAL $ 20,417,335

Source : Environment Capital Managers , Inc.

Notes : 1) This is not a direct cost , but as the maintenance of infrastructure within State Agricultural Parks is borne by the State, a reserve was established to fill an otherwise void.

TABLE FOUR

DISCOUNTED PRESENT VALUE OF CASH INFLOWS
TO JANUARY, 1982
WAIAHOLE VALLEY AGRICULTURAL PARK

CASH INFLOWS (BENEFITS)

1. Residential Lease Income
   59 house lots @ \$500/yr first 15yrs
   \$650/yr next 10yrs
   \$650/yr next 30yrs 1)
   Discounted Present Value .... \$ 569,448

2. Agricultural Base Lease Income
   403.7 acres @ \$100/acre/yr first 25yrs
   \$100/acre/yr next 30yrs 1)
   Discounted Present Value .... \$ 1,333,950

3. Agricultural Variable Lease Income
   3% of 30% of Previous Yr's Gross Income
   = 0.9% of \$ 8,083,375/yr for 1982 2)
   Discounted Present Value .... \$ 25,577,256

4. Incremental Excise Tax Collection
   ½% of Incremental Gross Income 3)
   = ½% of 40% of \$8,083,375 in 1981 terms
   Discounted Present Value .... \$ 6,402,225

5. Value of Upper Valley Water Supply 4)
   Estimated Unimproved Sales Price .... \$ 3,593,000

6. Residual Value of Property (@ 2036) 5)
   Net Income ....\$ 33,014,593
   Capitalized @ 8.333
   Estimated Value \$275,110,603
   Discounted Present Value .... \$ 11,910,013

DISCOUNTED PRESENT VALUE OF
CASH OUTFLOWS -- TOTAL \$ 49,385,892

Source : Environment Capital Managers, Inc.

Notes to Table Four :

1) At the end of the 25th and 40th years of the lease , renegotiation would establish new base lease rents. This analysis conservatively assumes no increases in base lease rents. Should higher base rents be negotiated (probable) , larger "benefits" (higher income) would accrue to the State. If the leases were renegotiated based on projected inflation, the benefits could exceed $ 5 million.

2) Per Dr. Frank Scott's projections based on 1981 prices. Gross revenues are projected to increase at 12% per annum.

3) The State will receive additional excise tax collections as a direct result of improving Waiahole Valley farmlands. Conservatively, we estimate this to flow from 60% of the incremental 214 acres expected to be utilized in agriculture (130 acres or 40% of 320 arable acres). This does not take into account the possibility of multi-cropping which would increase gross revenues. Excise tax on agricultural produce is collected @ ½% of Gross Revenue.

4) This represents the most conservative estimate placed on the Upper Valley Water Source by the Russ Smith Corporation (14 March, 1980).

5) All leases are scheduled to expire in 2036. The estimated value of the property (zoned primarily as agricultural lands) is based on the conventional capitalization of earnings principle.
Earnings (net cash flow) in 2036 are projected to be $ 33,014,593. The capitalization rate used is a function of the buyer's cost of capital . Attempts to crystal-ball the cost of capital 55 years hence carry little credence. However, a conservative projection is 12% ,consistent with the projected inflation rate. This yields a capitalization rate of 8.333 times earnings.
Note that the lower the cost of capital, the higher the capitalization rate and the higher the projected sales price (value).
Of course, the future sales price may be much higher if other than agricultural use is intended.

B. INDIRECT IMPACTS - STATE OF HAWAII

Several indirect benefits and costs may accrue to the State as a result of the development of Waiahole Valley Agricultural Park. These include benefits and costs more difficult to quantify or of uncertain magnitudes.

The initial approach adopted is to review the sources and applications of funds to the State of Hawaii and assess the effect on each category by the development of Waiahole Valley Agricultural Park.

Table 5 shows the sources of revenue to the State of Hawaii for 1980.

The flow of funds from the Waiahole Valley Agricultural Park to the State will come predominately through taxes and lease rent collections. Restricting this analysis only to those taxes displayed in Table 5 we are able to exhibit how Waiahole and its residents contribute to the State revenues.

TABLE 5

STATE OF HAWAII OPERATING REVENUES

FISCAL YEAR ENDING

JUNE 30, 1980

Sources	FY80
Taxes	
General Excise	$ 498,669,586
Specific Excise	124,298,806
Individual Income	311,403,845
Corporate Income	42,423,522
Unemployment Compensation	67,535,525
Other Taxes, Licenses & Permits	17,121,893
Sub-Total Taxes	1,061,453,177
Fines, Forfeits, & Escheats	5,989,050
Federal Grants-in-Aid	374,405,122
Revenues from other Agencies	1,745,250
Rents, Royalties & Land Income	86,849,056
Earnings - General Departments	97,798,377
- Public Service Enterprises	76,783,850
Repayment Debt Cost: Counties	150,747
Interest Earned	657,300
Miscellaneous	54,354,894
TOTAL	$ 1,760,186,829

Source: Government in Hawaii: A Handbook of Financial Statistics, 1981 (Tax Foundation of Hawaii), p19.

Notes to Table 5 (Definitions)

1. The General Excise Tax is charged "...on gross income, gross receipts, on gross proceeds of all business activities at the following rates: 0.5% on wholesaling, intermediary services, manufacturing, producing, canning and blind, deaf, or totally disabled persons; .15% on insurance solicitors; 4% on retail sales of goods, services and other activities."

2. Specific Excises - includes:

- Use Tax is "...on tangible personal property imported or purchased from an unlicensed seller. Rates are 0.5% on goods imported for resale; 4% on all other imports."

- Highway Use Fuel Tax is 8.5¢ per Gallon, Agricultural equipment refunds for off-highway use granted.

- Liquor Tax is "...on dealers at 20% of wholesale prices."

- Tobacco Tax is "...on wholesalers at 40% of wholesale prices of all tobacco products."

- Insurance Premium Tax is "...in lieu of General Excise and net income tax, on gross premiums as follows: life insurance 1.918% for domestic and 3.197% for foreign firms; surplus lines broker, 4.68%; casualty and other insurance 2.9647% for domestic and 4.2824% for foreign firms. Cash surrender values not deductible. Ocean marine insurance 0.8775% of gross underwriting profits."

- Public Service Company Tax is "...on public utility gross income at graduated rates based on ratio of net to gross income. Minimum rate, 5.885%; maximum, 8.2% except that land carriers are taxed at 5.35%. Utilities are exempt from general excise and property tax. Airlines, motor carriers, common carriers by water, and contract carriers taxed at 4% of gross income."

3. Income Tax - corporate and individual -- the individual rates are numerous, the corporate rates are 5.85% on net income up to $25,000.00 and 6.435% over $25,000.00.

4. Other Taxes, Licences, Permits to include:

- Inheritance and Estate tax is "...on shares of net estates having situs in Hawaii."

- Conveyance Tax is "...on actual and full consideration paid for the transfer of realty, including leases and subleases, a tax of 5¢ per $100 is imposed. Minimum tax on each transaction is $1.00."

Similarly, we may examine the operating expenditures of the State of Hawaii to project the public cost of this development. Table 6 shows the State's operating expenditures for fiscal 1980.

It must be stressed that this analysis relates only to the incremental change resulting from the development of Waiahole Valley Agricultural Park. The primary sources of benefits and costs to the State are treated in the "Direct Impact" section. However, part of the development plan for Waiahole Valley Agricultural Park includes providing rural housing lots for 35 families. The State has already expressed that first preference shall go to the local Waiahole-Waikane residents desiring to relocate within the park. This raises the problem of how to treat these 35 "new" families in our analysis. If they are considered to be a population transfer within the area (most likely), then our task is simplified.

1. General Excise Tax Collections: The incremental ½% excise tax revenues on agriculture were treated in the "Direct Impact" section. However, as income levels rise in the area (as a result of the development), increased family expenditures are likely, thus contributing to increased 4% general excise collections: a positive benefit of increasing magnitude. For the 35 families, if treated as a population transfer, the impact is nil. Otherwise, increasing positive benefit.

2. Individual Income Tax: the tax rate of individual farm operators is difficult to determine. The incremental revenues generated by each farmer as a result of the development are taxable and thus contribute to the economic base of the State. Based on Dr. Scott's projected revenues from agriculture, this would represent a significant tax flow into State revenues.

This development will also create employment in the construction industries, and other sectors supplying the agriculture and construction industries. The incremental tax revenues generated on such payrolls is another positive indirect benefit to the State.

For the 35 families, if treated as a population transfer, no impact on State revenues would be expected. Otherwise, at a conservative $15,000/family income level (1978 per capita income was $10,903): income tax collected by the State would be approximately $663/family (with four exemptions claimed) based on 1979 tax rates equals $23,205 (this amount would increase each year in line with the increase in income levels).

3. Land Income: Lease rents treated in "DIRECT IMPACT" section.

4. State Fuel Tax Collections: collected at 8.5¢/gallon. Increased agricultural activity would result in increased fuel consumption in the area and thus in a positive benefit to State revenues. The addition of 35 "new" families would conservatively add 35 new vehicles to the area at 581 gallons/vehicle/year equals $1,728/year.

TABLE 6

STATE OF HAWAII
OPERATING EXPENDITURES
FISCAL YEAR ENDED
JUNE 30, 1980

Function	
General Government - Control	$ 27,953,143
- Staff	62,878,777
Public Safety - Police and Fire	1,957,211
- Other Protection	46,448,275
Highways	32,456,523
Natural Resources	20,623,365
Health and Sanitation	39,585,829
Hospitals and Institutions	86,523,706
Public Welfare	253,411,383
Education - Higher	189,123,290
- Public Schools	305,617,928
- Libraries and others	17,324,127
Recreation	11,034,299
Utilities and other Enterprises	45,484,590
Debt Service	148,847,007
Retirement and Pensions	64,447,040
Employees' Health and Hospital Insurance	13,651,051
Unemployment Compensation	44,781,433
Grants-in-Aid to Counties	18,222,945
Urban Redevelopment and Housing	280,508,856
Miscellaneous	14,636,699
Cash Capital Improvements	90,337,802
TOTAL	1,815,855,280

Source: Government in Hawaii: A Handbook of Financial Statistics, 1981. (Tax Foundation of Hawaii) p.45

5. Other Revenues: Plans for the development of Waiahole Valley Agricultural Park include adding infrastructural improvements. The construction cost of this is estimated at approximately $7.5 million. Construction contracts with the State generally carry a tax exempt status, thus no direct excise tax would be generated. However, the indirect benefits may be sizeable. The purchase of raw materials, construction payroll, etc. will generate tax revenues to the State at each level of spending (the tax multiplier effect).

6. Education Cost: If the 35 families represent a regional population transfer, no incremental education costs will be incurred by the State. However, if the 35 families represent "new population", then with a conservative family size of 4, up to 70 school-aged children will be added. According to discussions with Mr. Nagai, Director of Facilities, Department of Education, the addition of 70 children into schools in the area would not result in any cost to the State. The enrollment in schools on the Windward side are declining (reflecting a population shift away from the area) and an addition of 70 children could easily be absorbed by Waiahole, Heeia, Kaawa and Kahaluu elementary schools.

SUMMARY

Any "indirect" costs (not covered specifically elsewhere) to the State would be by far outweighed by "indirect" benefits accruing the State. This would only serve to increase the benefit-cost ratio for the State of Hawaii.

C. <u>INDIRECT IMPACTS ON THE CITY AND COUNTY OF HONOLULU</u>

As Waiahole Valley is situated on Oahu, there may be an impact flowing from the development to the City and County of Honolulu. Benefits will accrue via taxation and other revenue producing services. Additional costs may be incurred in areas such as public safety.

Similar to the analysis performed for the State of Hawaii, we may trace possible cost and benefit flows by examining the sources and application of the City and County's funds.

A review of each revenue source sheds light on possible benefits the City and County may receive from the development of Waiahole Valley Agricultural Park.

1. Real Property Tax: "Assessments at 60% of "Fair Market Value". A maximum $12,000 home exemption is granted (maximum of $24,000 for persons over 60 and $30,000 for those over 70). Higher rate levied on land than on building for property classed unimproved residential, hotel-apartment, industrial and commercial; single rate levied on property classed improved residential, agricultural and conservation." (Source: <u>Government in Hawaii, 1979</u>, Tax Foundation of Hawaii, p. 32). Distribution is to the County General Fund.

Impact: The incremental increase in real property tax revenues arising from the development of Waiahole Valley Agricultural Park will be determined by the zoning ultimately given each lot. The proposed 35 additional residential lots, an improvement in agricultural land values, and commercial sites would yield increased property tax revenues to the City and County - a positive benefit of undeterminable magnitude.

2. Public Utilities Franchise Tax: On gross operating income of certain public utilities at 2.5% rate and distributed to County Highway Funds.

Impact: There will be a nominal increase in incremental energy consumed, resulting in higher revenues to the utility companies and thus to greater tax revenue to the county.

3. Fuel Tax: On distributors at 12.0¢/gallon in Honolulu for highway use (includes 8.5¢ state tax) except LPG at 2/3 of rate. Off highway rates for diesel, LPG and aviation fuel at 12¢/gallon. County Fuel Tax (3.5¢/gallon) distributed to Highway Fund.

Impact: Positive benefgit to City and County of Honolulu of 3.5¢ * 581g * 35 cars = $712 plus increased agricultural fuel consumption.

4. Motor Vehicle Weight Tax: In 1978, this was 1.5¢/lb. for commercial vehicles and 0.75¢/lb. for passenger vehicles, with a minimum of $12/vehicle. Average weight tax is $24.09 per vehicle.

Impact: Positive benefit to City and County of Honolulu. 35 @ $24.09 = $842/yr. plus increase in commercial/agricultural vehicles.

5. Licences and Permits: Nominal positive benefit expected.

6. State Grants-In-Aid: The means by which counties share in the General Exciese Tax Receipts.

Impact: As State General Excise Tax receipts are projected to increase directly as a result of this development, a flow-through benefit may be received by the City and County of Honolulu.

7. Charges for Services, Fines, and Forfeits, Miscellaneous: The remaining sources of funds to the City and County of Honolulu: nominal benefit.

Table 8 outlines the operating expenditures of the City and County of Honolulu for fiscal 1979.

We have earlier assumed State responsibility for maintenance of infrastructure within the Waiahole Valley Agricultural Park (an annual reserve was set up for this purpose under DIRECT IMPACTS - STATE OF HAWAII). This leaves the City and County responsible only for the necessary incremental public safety protection.

In the area of public safety - police and fire protetion - the determination of costs to the City and County of Honolulu is based on the ratios, of police per 1,000 resident population and a response time standard.

Discussion with Mr. Sathre, a police department research analyst, suggested 2.5 police per 1,000 resident population. Mr. Sathre indicated that development of Waiahole Valley Agricultural Park would not result in additional police protection being required. This conclusion was based on a declining Windward population and the level of development planned for Waiahole Valley Agricultural Park.

The cost of fire protection is a function of response time to an emergency call. Discussions with Major Stanley Tom, Fire Chief for the City and County of Honolulu indicated a State standard of five minutes or less to reach the scene of an emergency. Major Tom indicated prior experience of four to five minute response times from Kahaluu fire station to the Waiahole area. No addtional fire station would need to be constructed nor additonal firemen hired based on these standards and the planned level of development. This results in no incremental cost to the City and County of Honolulu.

SUMMARY:

If we assume the State has responsiblities for maintaining infrastructure (roadways, lighting, etc.) within Waiahole Valley Agricultural Park, the City and County of Honolulu is estimated to have benefits accruing to it at no incremental cost. This would then add to the economic base of the City and County of Honolulu, and further increase our projected Benefit-Cost ratio.

CASH FLOW ANALYSIS

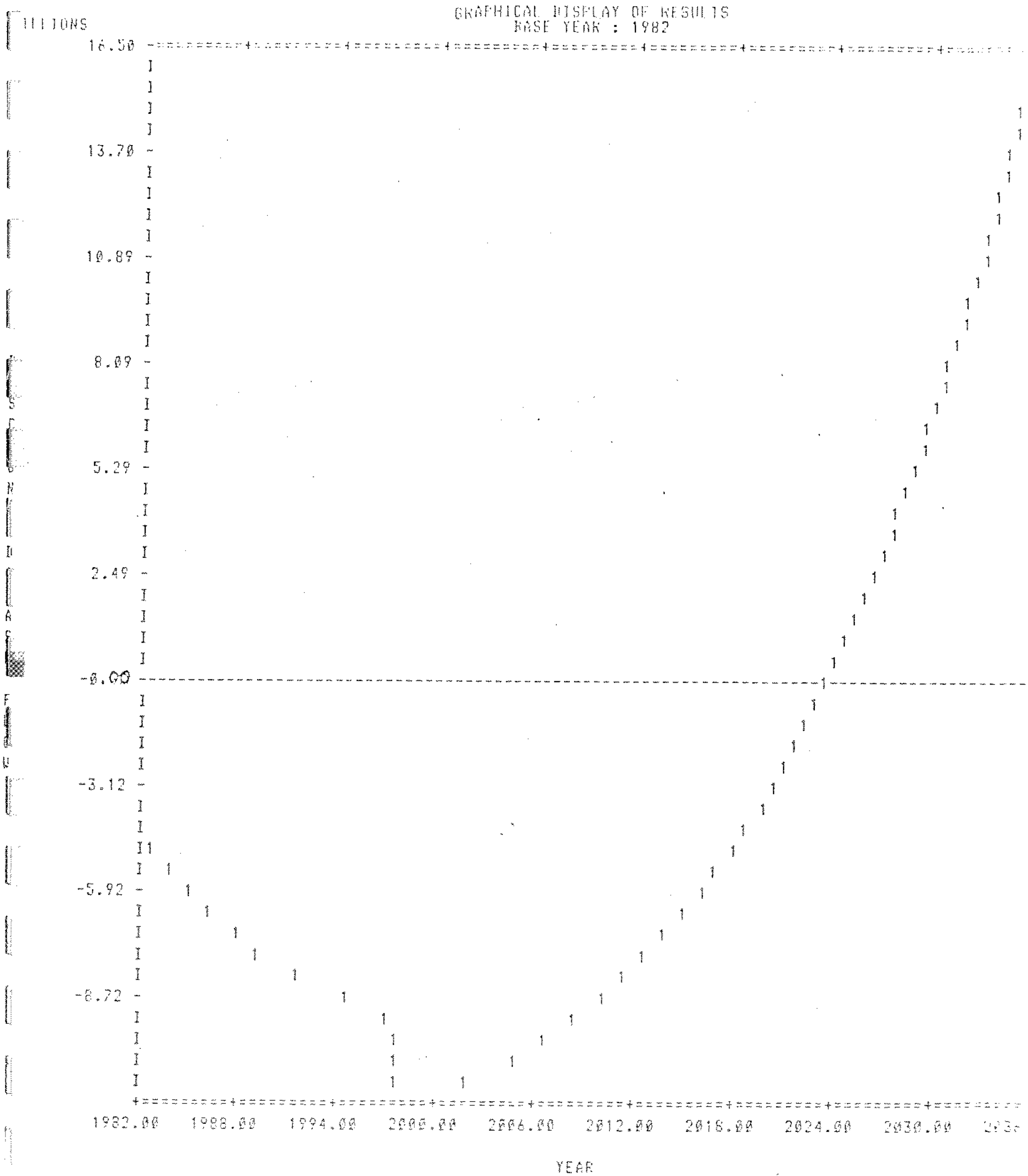
CHART TWO

DISCOUNTED CASH FLOW ANALYSIS
WAIAHOLE VALLEY AGRICULTURAL PARK.
BASE : 1 JANUARY 1982

YEAR	COMMERCIAL & RESIDENTIAL LEASE INCOME (01)	AGRICULTURAL BASE LEASE INCOME (02)	AGRICULTURAL %AGE LEASE INCOME (03)	INCREMENTAL EXCISE TAX REVENUE (04)	OTHER CASH INFLOWS (05)	BOND INT. REPAYMENTS 20YR 5.875% (06)	FHMA LOAN REPAYMENTS 40YR 5% P&I (07)	MAINTENANCE RESERVE (08)	OTHER CASH OUTFLOWS (09)	TOTAL ANNUAL OUTLAYS	DISCOUNTED PRESENT VALUE	CUMULATIVE NET DISC P.V.
1982	$29,500	$77,370	$0	$18,187	$3,593,000	-$2,231,970	-$262,252	$0	-$5,000,000	-$3,776,245	-$3,706,564	-$3,706,564
1983	$29,500	$77,370	$0	$20,279	$0	-$381,875	-$262,252	-$184,228	$0	-$781,285	-$640,917	-$4,347,481
1984	$29,500	$77,370	$91,257	$22,713	$0	-$381,875	-$262,252	-$184,228	$0	-$687,513	-$524,028	-$4,871,410
1985	$29,500	$77,370	$102,208	$25,439	$0	-$381,875	-$262,252	-$184,228	$0	-$593,837	-$483,750	-$5,355,161
1986	$29,500	$77,370	$114,473	$28,491	$0	-$381,875	-$262,252	-$184,228	$0	-$578,519	-$445,059	-$5,800,221
1987	$29,500	$77,370	$128,210	$31,910	$0	-$381,875	-$262,252	-$184,228	$0	-$561,363	-$407,830	-$6,208,051
1988	$29,500	$77,370	$143,595	$35,740	$0	-$381,875	-$262,252	-$184,228	$0	-$542,149	-$371,942	-$6,579,994
1989	$29,500	$77,370	$160,827	$40,028	$0	-$381,875	-$262,252	-$184,228	$0	-$520,629	-$337,278	-$6,917,272
1990	$29,500	$77,370	$180,126	$44,832	$0	-$381,875	-$262,252	-$184,228	$0	-$496,526	-$301,726	-$7,218,999
1991	$29,500	$77,370	$201,741	$50,212	$0	-$381,875	-$262,252	-$184,228	$0	-$469,531	-$271,178	-$7,490,177
1992	$29,500	$77,370	$225,950	$56,237	$0	-$381,875	-$262,252	-$184,228	$0	-$439,296	-$239,520	-$7,731,736
1993	$29,500	$77,370	$253,064	$62,986	$0	-$381,875	-$262,252	-$184,228	$0	-$405,434	-$208,674	-$7,940,370
1994	$29,500	$77,370	$283,432	$70,544	$0	-$381,875	-$262,252	-$184,228	$0	-$367,508	-$178,515	-$8,118,876
1995	$29,500	$77,370	$317,444	$79,009	$0	-$381,875	-$262,252	-$184,228	$0	-$325,031	-$148,956	-$8,267,953
1996	$29,500	$77,370	$355,537	$88,490	$0	-$381,875	-$262,252	-$184,228	$0	-$277,456	-$119,900	-$8,387,753
1997	$38,350	$77,370	$398,201	$99,109	$0	-$318,229	-$262,252	-$184,228	$0	-$151,677	-$61,223	-$8,448,977
1998	$38,350	$77,370	$445,986	$111,003	$0	$0	-$262,252	-$184,228	-$6,500,000	-$6,273,770	-$2,517,961	-$10,966,938
1999	$38,350	$77,370	$499,504	$124,323	$0	$0	-$262,252	-$184,228	$0	$293,867	$109,149	-$10,857,789
2000	$38,350	$77,370	$559,445	$139,242	$0	$0	-$262,252	-$184,228	$0	$367,927	$129,128	-$10,728,661
2001	$38,350	$77,370	$626,578	$155,951	$0	$0	-$262,252	-$184,228	$0	$451,769	$149,504	-$10,579,156
2002	$38,350	$77,370	$701,767	$174,665	$0	$0	-$262,252	-$184,228	$0	$545,673	$170,343	-$10,408,813
2003	$38,350	$77,370	$785,979	$195,625	$0	$0	-$262,252	-$184,228	$0	$650,845	$191,711	-$10,217,101
2004	$38,350	$77,370	$880,297	$219,100	$0	$0	-$262,252	-$184,228	$0	$768,632	$213,677	-$10,003,423
2005	$38,350	$77,370	$985,933	$245,392	$0	$0	-$262,252	-$184,228	$0	$900,565	$236,310	-$9,767,113
2006	$38,350	$77,370	$1,104,245	$274,839	$0	$0	-$262,252	-$184,228	$0	$1,040,324	$259,682	-$9,507,430
2007	$38,350	$77,370	$1,236,754	$307,820	$0	$0	-$262,252	-$184,228	$0	$1,213,814	$283,868	-$9,223,561
2008	$38,350	$77,370	$1,385,165	$344,758	$0	$0	-$262,252	-$184,228	$0	$1,399,163	$308,945	-$8,914,616
2009	$38,350	$77,370	$1,551,385	$386,129	$0	$0	-$262,252	-$184,228	$0	$1,626,754	$334,992	-$8,579,623
2010	$38,350	$77,370	$1,737,551	$432,465	$0	$0	-$262,252	-$184,228	$0	$1,839,256	$362,093	-$8,217,530
2011	$38,350	$77,370	$1,946,057	$484,360	$0	$0	-$262,252	-$184,228	$0	$2,099,658	$390,332	-$7,827,197
2012	$38,350	$77,370	$2,179,584	$542,484	$0	$0	-$262,252	-$184,228	$0	$2,391,300	$419,801	-$7,407,396
2013	$38,350	$77,370	$2,441,134	$607,582	$0	$0	-$262,252	-$184,228	$0	$2,717,956	$450,593	-$6,956,802
2014	$38,350	$77,370	$2,734,070	$680,492	$0	$0	-$262,252	-$184,228	$0	$3,083,882	$482,305	-$6,473,997
2015	$38,350	$77,370	$3,062,159	$762,151	$0	$0	-$262,252	-$184,228	$0	$3,493,550	$516,539	-$5,957,457
2016	$38,350	$77,370	$3,429,618	$853,609	$0	$0	-$262,252	-$184,228	$0	$3,952,467	$551,903	-$5,405,554
2017	$38,350	$77,370	$3,841,172	$956,042	$0	$0	-$262,252	-$184,228	$0	$4,466,455	$589,009	-$4,816,544
2018	$38,350	$77,370	$4,302,113	$1,070,767	$0	$0	-$262,252	-$184,228	$0	$5,042,120	$627,974	-$4,188,570
2019	$38,350	$77,370	$4,818,366	$1,199,259	$0	$0	-$262,252	-$184,228	$0	$5,686,866	$668,921	-$3,519,643
2020	$38,350	$77,370	$5,396,570	$1,343,171	$0	$0	-$262,252	-$184,228	$0	$6,408,981	$711,982	-$2,807,566
2021	$38,350	$77,370	$6,044,159	$1,504,351	$0	$0	-$262,252	-$184,228	$0	$7,217,758	$757,291	-$2,050,374
2022	$38,350	$77,370	$6,769,458	$1,684,873	$0	$0	$0	-$184,228	$0	$8,385,824	$830,970	-$1,219,404
2023	$38,350	$77,370	$7,581,793	$1,887,058	$0	$0	$0	-$184,228	$0	$9,400,343	$879,224	-$339,429
2024	$38,350	$77,370	$8,491,608	$2,113,505	$0	$0	$0	-$184,228	$0	$10,536,606	$931,141	$591,712
2025	$38,350	$77,370	$9,510,601	$2,367,126	$0	$0	$0	-$184,228	$0	$11,889,219	$985,914	$1,577,625
2026	$38,350	$77,370	$10,651,873	$2,651,181	$0	$0	$0	-$184,228	$0	$13,234,547	$1,043,546	$2,621,173
2027	$38,350	$77,370	$11,930,098	$2,969,323	$0	$0	$0	-$184,228	$0	$14,830,913	$1,104,498	$3,725,671
2028	$38,350	$77,370	$13,361,709	$3,325,642	$0	$0	$0	-$184,228	$0	$16,618,844	$1,168,945	$4,894,617
2029	$38,350	$77,370	$14,965,115	$3,724,719	$0	$0	$0	-$184,228	$0	$18,621,326	$1,237,089	$6,131,706
2030	$38,350	$77,370	$16,760,928	$4,171,685	$0	$0	$0	-$184,228	$0	$20,864,186	$1,309,147	$7,440,854
2031	$38,350	$77,370	$18,772,240	$4,672,288	$0	$0	$0	-$184,228	$0	$23,376,020	$1,385,346	$8,826,200
2032	$38,350	$77,370	$21,024,907	$5,232,962	$0	$0	$0	-$184,228	$0	$26,189,363	$1,465,927	$10,292,128
2033	$38,350	$77,370	$23,547,898	$5,860,918	$0	$0	$0	-$184,228	$0	$29,340,308	$1,551,147	$11,843,275
2034	$38,350	$77,370	$26,373,646	$6,564,228	$0	$0	$0	-$184,228	$0	$32,869,366	$1,641,273	$13,484,549
2035	$38,350	$77,370	$29,538,483	$7,351,935	$0	$0	$0	-$184,228	$0	$35,821,711	$1,736,591	$15,221,140
2036	$38,350	$77,370	$33,083,101	$8,234,168	$0	$0	$0	-$184,228	$0	$41,240,761	$1,837,401	$17,059,541

Source : Environment Capital Managers, Inc.

DISCOUNTED PRESENT VALUE OF CASH FLOWS
WAIAHOLE VALLEY AGRICULTURAL PARK



Source : Environment Capital Managers, Inc.
Note : Excludes residual value of property in yr 2036.

FLORA AND FAUNA SURVEY OF THE PROPOSED WAIAHOLE AGRICULTURAL PARK KOOLAUPOKO DISTRICT, OAHU

Prepared by:

Kenneth M. Nagata

January, 1982

FLORA AND FAUNA SURVEY OF THE PROPOSED WAIAHOLE AGRICULTURAL PARK KOOLAUPOKO DISTRICT, OAHU

INTRODUCTION

The project site is located within Waiahole Valley, Koolaupoko District, Oahu. It is bordered on the north by the land of Waikane and on the west by the Waiahole Forest Reserve. The south boundary is marked by the Waiahole Homestead Road and an uneven line from the end of that road to Puu Kuolani where it intersects the forest reserve boundary. Kamehameha Highway is the east boundary.

SCOPE OF WORK AND METHODOLOGY

The main focus of the survey was to determine the floristic composition of the uncultivated but arable lands within the project site. These lands were identified mainly through the use of soils and land classification maps. In addition, three other sites were surveyed in detail: the proposed pump site behind the former Waiahole Poi Factory, the proposed reservoir site located at approximately 350' elevation outside the main project area and within the Waiahole Forest Reserve, and the proposed intake site at a higher elevation beyond the proposed reservoir site. All lands presently under cultivation, including present roadways, and the perimeter or fringe area surrounding the project site were not surveyed in detail. All wild or feral animals encountered were included in this report.

Towards these ends, several walk-through surveys were undertaken throughout the project site. From vantage points on several ridges on the cliffs behind Waiahole Valley, much of the project site and the adjacent lands are visible. Areas of different floristic composition were then identified and reconnoitered. Although private property and extremely dense stands of hau (*Hibiscus tiliaceus*), elephantgrass (*Pennisetum purpureum*) and paragrass (*Panicum maximum*) precluded access to certain areas, the uncultivated but arable lands were surveyed as intensively as possible. In the areas of primary concern, all plant species encountered were included in the species list. However, only the prominent species in the fringe and cultivated areas were listed. Agricultural crops were excluded from the survey. Collections were made of plants which could not be positively identified in the field for later determination in the laboratory.

FLORA

Uncultivated But Arable Land

The vegetation in most of the land along the lower portion of Waiahole Stream consist of paragrass with scattered pluchea (*Pluchea odorata*), Christmas berry (*Schinus terebinthifolius*), guava (*Psidium guajava*), albizia (*Albizia falcataria*) and monkeypod (*Samanea saman*) and small groves of mango (*Mangifera indica*) and Java plum (*Eugenia cumini*). Occasional small thickets of the indigenous kākalaioa (*Caesalpinia major*) can be found entwined among the taller shrubs. Dense stands of elephantgrass and hau are also found, especially along the stream. The nature of the vegetation and the topography indicate that these presently uncultivated areas were once under cultivation -- undoubtedly with taro.

Further upstream, from approximately the fork in the Waiahole Valley Road, the vegetation becomes denser and trees predominate. The vegetation type through the remainder of the project area along Waianu and Waiahole Stream can be described as a mixed forest. The predominant species include mango, Java plum and hau. Often the hau forms impenetrable stands. Albizia, monkeypod, umbrella tree (*Brassaia actinophylla*), hala (*Pandanus* sp.) and kukui (*Aleurites moluccana*) are also found in this vegetation type. The herb and shrub layer consist largely of white ginger (*Hedychium coronarium*), yellow ginger (*H. flavescens*), laua'e (*Microsorium scolopendrium*), basketgrass (*Oplismenus hirtellus*), *Cyclosorus parasiticus*, and shoebutton ardisia (*Ardisia humilis*). In sunny areas, elephantgrass, paragrass, Job's tears (Coix lachryma-jobi) and honohono (Commelina diffusa) can be found.

A small grove of planted trees is located at the upper end of the project site along Waiahole Stream. These are species which were used in reforestation projects: trumpet tree (Cecropia peltata), elephant apple (Dillenia indica), Hydnocarpus, Brazilian plum (Eugenia dombeyi) and bamboo (Phyllostachys sp.). In addition, paper bark (Melaleuca leucadendra) and lemon-scented gum (Eucalyptus citriodora) which were planted in the forest reserve nearby have gained a foothold in the project site.

Most of the Uncultivated But Arable Land north of the north fork of the Waiahole Valley Road consist of bottom lands of ravines and gulches. Umbrella tree is the dominant tree species in this section. It forms an open-canopied forest under which can be found pāmoho (Nephrolepis exaltata), broomsedge (Andropogon virginicus), molassasgrass (Melinis minutiflora) and paragrass. Christmas berry, Java plum, hau, guava and small-flowered vitex (Vitex parviflora) are scattered throughout the gulches. Occasionally, Java plum forms small, dense groves. 'Ākia (Wikstroemia vacciniifolia), an endemic shrub more common on the agriculturally unsuitable eroded ridges, is occasionally found on the lower slopes and ravine floors.

Fringe Areas

The vegetation of the land adjacent to the project site is secondary in nature. The slopes to the south are dominated by a mixed open-canopied forest of umbrella tree, hala, Java plum and mango. Broomsedge is the dominant ground cover. Exotic species also dominate the lower western slopes of the valley but the floristics differ from that of the southern slopes. In addition to umbrella tree, the prominent tree species include mango, albizia, guava, strawberry guava (Psidium cattleianum) and ironwood (Casuarina eqisetifolia). Koa (Acacia koa), uluhe (Dicranopteris linearis), ie'ie (Freycinetia arborea) and hala represent the vestiges of the native forest which once inhabited these lower slopes. The thorny kākalaioa is common along the jeep road through the forest reserve at the end of the north fork of the Waiahole Valley Road. In the ravines, kukui, hau, mango and mountain apple (Eugenia malaccensis) are the dominant trees. Yellow ginger,'awapuhi kuahiwi (Zingiber zerumbet) and pi'oi (Dioscorea bulbifera) are also common in the ravines. Planted groves of feathery bamboo (Bambusa vulgaris) are scattered on these lower slopes. In addition, planted groves of lemon-scented gum, paper bark, swamp mahogany (Eucalyptus robusta), brush box (Tristania conferta) and Araucaria sp. are found in the forest reserve at the end of the south fork of Waiahole Valley Road. The vegetation on the northern fringe is one of open scrub on eroding ridges and mixed forest in the ravines. Scrubby Christmas berry, Java plum, small-flowered vitex and guava are common on the ridges. Broomsedge is the dominant ground cover. The trees increase in stature toward the ravine floors where they form a mixed forest. Occasionally, Java plum forms nearly pure stands. 'Ākia is common throughout this region.

Cultivated Areas

Mango, Java plum and umbrella tree are among the most common plants in the Cultivated Areas. These three species have become established throughout much of the valley and are dominant elements of the vegetation. Many of the most common plants are those with edible fruits. These include breadfruit (Artocarpus altilis), lychee (Litchi chinensis), coconut (Cocos nucifera), avocado (Persea americana), tangerine (Citrus reticulata), banana (Musa x paradisiaca) as well as the previously mentioned mango and Java plum. Common ornamentals include Moreton Bay fig (Ficus macrophylla), pua-kenikeni (Fagraea berteriana), areca (Chrysalidocarpus lutescens), tiare (Gardenia taitensis), plumeria (Plumeria obtusa, P. rubra and hybrids), shell ginger (Catimbium speciosum), red ginger (Alpinia purpurata), croton (Codiaeum variegatum var. pictum) and ti (Cordyline terminalis and vars.).

Along the fringes of agricultural fields, in fallow areas and along roadways, several wayside species are common. These include Hilo grass (Paspalum conjugatum), sensitive plant (Mimosa pudica var. unijuga), thimbleberry (Rubus rosaefolius), maile pilau (Padaeria foetida), spiny amaranth (Amaranthus spinosus) and Jamaica vervain (Stachytarpheta jamaicensis). In addition, koa haole (Leucaena leucocephala) and paragrass are abundant in certain areas.

Pump Site

The proposed Pump Site, situated behind the former Waiahole Poi Factory, is bounded by Waiahole Valley Road and Waiahole Stream and is within the Cultivated Areas section of the project site. However, only the most prominent species were recorded for the Cultivated Areas whereas every species found in the proposed Pump Site was recorded. Thus, many species found in the proposed Pump Site are not recorded in the Cultivated Areas section.

The vegetation consist of several cultivated species and numerous adventives. Avocado, mango, coconut, banana, monkeypod, ti, papaya (Carica papaya), taro (Colocasia esculenta) and red pepper (Capsicum annuum) are being cultivated. The lawn is mostly Hilo grass which has been invaded by wayside species such as goosegrass (Eleusine indica), synedrella (Synedrella nodiflora), buttonweed (Borreria laevis), kyllingia (Cyperus kyllinga), drymaria (Drymaria cordata) and sensitive plant. Paragrass, Spanish clover (Desmodium canum), slender mimosa (Desmanthus virgatus) and koa haole are common in the site and Guinea grass (Panicum maximum), elephantgrass and Java plum are abundant along the stream.

Reservoir Site

The proposed Reservoir Site is situated in the forest reserve along the jeep road at approximately 350' elevation. The vegetation can be described as an open-canopied mixed secondary forest. The indigenous uluhe (Dicranopteris linearis), the dominant species, forms a dense, nearly complete cover over much of the site. Few umbrella trees, guava, strawberry guava and Java plum of low to medium stature and shrubby shoebutton ardisia are scattered through the uluhe. Where the tree species form a more complete canopy, the uluhe is partially replaced by another indigenous fern, pāmoho. Along the roadside, pāmoho, shoebutton ardisia, Koster's curse (*Clidemia hirta*) and lantana (*Lantana camara*) become more abundant. The only other species present in the site are hala and guava.

Intake Site

The proposed Intake Site is situated in a ravine dominated by a closed forest of kukui and mountain apple. Few species are found in the dense shade created the the dominant trees. Guava, shoebutton ardisia, 'awapuhi kuahiwi and pi'oi are occasional in the site and Koster's curse, ie'ie, pāpala-kēpau (*Pisonia umbellifera*), thimbleberry, basketgrass and 'ape (*Alocasia macrorrhiza*) are uncommon or rare. Ferns present in the site include *Cyclosorus parasiticus*, *Blechnum occidentale*, *Vandenboschia* sp. and 'ekaha (*Asplenium nidus*). Despite being situated well outside the highly disturbed areas on the valley floor, the vegetation in the proposed Intake Site is predominantly exotic. The only native species recorded were pāpala-kēpau, 'ekaha and *Vandenboschia*.

Conclusion

The vegetation in the project site consist of agricultural crops, cultivated species, naturalized and wayside species and forestry plantings. The most common species are mango, Java plum and umbrella tree. Once cultivated, these species have now become naturalized throughout much of the project site as well as in the fringe areas. Guava and strawberry guava are also widespread. Most of the forestry plantings are restricted to the end of the south fork of Waiahole Valley Road. Four species that have been used for reforestation are now common in many sections of the project site. These are the small-flowered vitex, shoebutton ardisia, albizia and umbrella tree.

Only 14 native species were recorded. Of these only hala and pāmoho were found to be widespread. Uluhe, ie'ie, 'ākia and kākalaioa were present in the Uncultivated But Arable Land and the Fringe. The remainder of the native species were restricted to single sections of the project site. No proposed endangered species were found.

FAUNA

Eight species of birds were encountered in the project site. The red vented bulbul (Pycnonotus cafer), Kentucky cardinal (Richmondena cardinalis), Japanese white-eye (Zosterops japonica japonica), Brazilian cardinal (Paroaria coronata), barred dove (Geopelia striata striata) and common mynah (Acridotheres tristis tristis) were commonly observed in the Cultivated Areas, Uncultivated But Arable Lands and in areas immediately adjacent to the project site. The red vented bulbul, Kentucky cardinal, Japanese white-eye and shama thrush (Copsychus malabaricus) were observed in the vicinity of the proposed Reservoir Site and on the cliffs beyond the proposed Intake Site. A single migratory species, the Pacific golden plover (Pluvialis dominica fulva) was observed in a grassy field along the south fork of the Waiahole Valley Road.

Although perhaps common to rural and agricultural regions, no rats or mongoose were seen. Pigs (Sus scrofa) are apparantly common in the mountains to the south and west of the project site as several hunters with dogs were encountered along the south fork of the Waiahole Valley Road. In addition, pig wallows, rooting and tracks are common along Waiahole Stream especially in mountain apple groves and at the proposed Intake Site.

CHECKLIST OF VASCULAR PLANTS

F Families are listed alphabetically within each of four groups: Pteridophyta (Ferns and Fern Allies), Gymnospermae, Monocotyledonae, and Dicotyledonae. Genera and species are arranged alphabetically. Taxonomy and nomenclature of pteridophytes follow Wagner's unpublished Checklist of Hawaiian Pteridophytes and the taxonomy and nomenclature of flowering plants follow that of St. John (1973). Hawaiian names used in the checklist are in accordance with St. John or Porter (1972).

For each species the following information is provided:

1. Scientific name.
2. Common name or Hawaiian name when known.
3. Status of the species. The following symbols are employed:

   E = endemic to the Hawaiian Islands, i.e., occurring naturally nowhere else in the world.

   I = indigenous, i.e., native to the Hawaiian Islands but also occurring naturally elsewhere.

   X = exotic, i.e., plants introduced after the Western discovery of Hawaii.

   P = Polynesian introduction, i.e., plants brought by the Polynesian immigrants previous to Captain Cook's discovery of Hawaii.

4. The presence of a particular species within each of the six sections of the project site is indicated by a plus (+) sign. The six sections are:

   UA = Uncultivated But Arable Lands

   F = Fringe Areas

   C = Cultivated Areas

   P = Proposed Pump Site

   R = Proposed Reservoir Site

   I = Proposed Intake Site

WAIAHOLE AGRICULTURAL PARK
PLANT SPECIES CHECKLIST

Scientific Name	Common Name	Status	UA	F	C	P	R	I
PTERIDOPHYTA								
ASPIDIACEAE								
Cyclosorus parasiticus (L.) Farwell		X	+	+	-	-	-	+
ASPLENIACEAE								
Asplenium nidus L.	'Ekaha	I	-	-	-	-	-	+
BLECHNACEAE								
Blechnum occidentale L.		X	-	-	-	-	-	+
DAVALLIACEAE								
Nephrolepis exaltata (L.) Schott	Pāmoho	I	+	+	-	+	+	-
GLEICHENIACEAE								
Dicranopteris linearis (Burm.) Underw.	Uluhe	I	+	+	-	-	+	-
HYMENOPHYLLACEAE								
Vandenboschia sp.		E	-	-	-	-	-	+
LINDSAEACEAE								
Sphenomeris chinensis (L.) Maxon ex Kramer	Pala'ā	I	+	-	-	-	-	-
POLYPODIACEAE								
Microsorium scolopendrium (Burm.) Copel.	Laua'e	X	+	+	-	-	-	-
GYMNOSPERMAE								
ARAUCARIACEAE								
Araucaria sp.		X	-	+	-	-	-	-
CUPRESSACEAE								
Cupressus sp.		X	+	-	-	-	-	-
MONOCOTYLEDONAE								
ARACEAE								
Alocasia macrorrhiza (L.) Sweet	'Ape	P	-	-	-	-	-	+
Colocasia esculenta (L.) Schott	Taro	P	-	-	+	+	-	-
Xanthosoma sagittifolium (L.) Schott		X	+	-	-	-	-	-

Scientific Name	Common Name	Status	UA	F	C	P	R	I
COMMELINACEAE								
Commelina diffusa Burm. f.	Honohono	X	+	-	-	+	-	-
CYPERACEAE								
Cyperus kyllinga Endl.	Kyllinga	X	-	-	-	+	-	-
C. rotundus L.	Nutgrass	X	+	-	+	-	-	-
DIOSCOREACEAE								
Dioscorea bulbifera L.	Pi'oi	P	-	+	-	-	-	+
GRAMINEAE								
Andropogon virginicus L.	Broomsedge	X	+	+	-	-	-	-
Bambusa vulgaris Schrad. ex Wendl. var. vulgaris	Feathery bamboo	X						
Brachiaria mutica (Forsk.) Stapf	Paragrass	X	+	-	+	+	-	-
Coix lachryma-jobi L.	Job's tears	X	+	+	+	-	-	-
Eleusine indica (L.) Gaertn.	Goosegrass	X	-	-	+	+	-	-
Melinis minutiflora Beauv.	Mosassesgrass	X	+	+	-	-	-	-
Oplismenus hirtellus (L.) Beauv.	Basketgrass	X	+	+	-	-	-	+
Panicum maximum Jacq.	Guinea grass	X	-	-	+	+	-	-
Paspalum conjugatum Berg.	Hilo grass	X	-	-	+	+	-	-
Pennisetum purpureum Schumach.	Elephant grass	X	+	-	-	+	-	-
Phyllostachys sp.	Bamboo	X	+	+	-	-	-	-
LILIACEAE								
Cordyline terminalis (L.) Kunth	Ti	P	-	-	+	+	-	-
MUSACEAE								
Heliconia spp.	Heliconia	X	-	-	+	-	-	-
Musa x paradisiaca L.	Banana	X	+	-	+	+	-	-
PALMAE								
Chrysalidocarpus lutescens (Bory) H. Wendl.	Areca	X	-	-	+	-	-	-
Cocos nucifera L.	Coconut	P	-	-	+	+	-	-
Livistona chinensis (Jacq.) Mart.	Chinese fan palm	X	+	-	-	-	-	-
PANDANACEAE								
Freycinetia arborea Gaud.	ie'ie	E	+	+	-	-	-	+
Pandanus sp.	hala	I(?)	+	+	+	+	+	-

Scientific Name	Common Name	Status	UA	F	C	P	R	I
ZINGIBERACEAE								
Alpinia purpurata (Vieill.) K. Schum.	Red ginger	X	-	-	+	-	-	-
Catimbium speciosum (Wendl.) Holttum	Shell ginger	X	-	-	+	-	-	-
Dimerocostus uniflorus (Poepp. ex Peters.) K. Schum.	Canagria	X	+	-	-	-	-	-
Hedychium coronarium Koenig. in Retz.	White ginger	X	+	-	-	-	-	-
H. flavescens Carey in Roscoe	Yellow ginger	X	+	+	-	-	-	-
Zingiber zerumbet (L.) Roscoe	'Awapuhi kuahiwi	P	-	+	-	-	-	+
DICOTYLEDONAE								
ACANTHACEAE								
Thunbergia alata Bojer ex Sims	Black-eyed Susan	X	+	-	-	-	-	-
AMARANTHACEAE								
Amaranthus spinosus L.	Spiny amaranth	X	-	-	+	+	-	-
ANACARDIACEAE *								
Mangifera indica L.	Mango	X	+	+	+	+	-	-
Schinus terebinthifolius Raddi	Christmas berry	X	+	+	-	-	-	-
APOCYNACEAE								
Plumeria obtusa L.	Singapore plumeria	X	-	-	+	-	-	-
P. rubra L.	Red plumeria	X	-	-	+	-	-	-
ARALIACEAE								
Brassaia actinophylla Endl.	Umbrella tree	X	+	+	+	-	+	-
BIGNONIACEAE								
Spathodea campanulata Beauv.	African tulip	X	+	-	-	-	-	-
CARYOPHYLLACEAE								
Drymaria cordata (L.) Willd. ex R. & S.	Drymaria	X	-	-	-	+	-	-
CASUARINACEAE								
Casuarina equisetifolia Stickm.	Common ironwood	X	+	+	-	-	-	-
COMPOSITAE								
Ageratum conyzoides L.	Ageratum	X	+	-	-	-	-	-
Bidens pilosa L. var. pilosa	Spanish needle	X	+	-	-	-	-	-
Emilia javanica (Burm. f.) C.B. Robins.	Red pua-lele	X	-	-	-	+	-	-

Scientific Name	Common Name	Status	UA	F	C	P	R	I
COMPOSITAE								
Pluchea odorata (L.) Cass.	Pluchea	X	+	-	-	-	-	-
Synedrella nodiflora (L.) Gaertn.	Synedrella	X	-	-	-	+	-	-
CONVOLVULACEAE								
Ipomoea alba L.	Moon flower	X	+	-	-	+	-	-
I. congesta R. Br.	Koali-'awahia	I	+	-	-	-	-	-
I. obscura (L.) Ker-Gawl.		X	+	-	-	+	-	-
DILLENIACEAE								
Dillenia indica L.	Elephant apple	X	+	-	-	-	-	-
EUPHORBIACEAE								
Aleurites moluccana (L.) Willd.	Kukui	P	+	+	-	-	-	+
Codiaeum variegatum var. pictum (Lodd.) Muell.-Arg.	Croton	X	-	-	+	-	-	-
Phyllanthus debilis Klein ex Willd.	Phyllanthus weed	X	-	-	-	+	-	-
FLACOURTIACEAE								
Hydnocarpus sp.		X	+	-	-	-	-	-
LABIATAE								
Hyptis pectinata (L.) Poit.	Comb hyptis	X	+	-	-	-	-	-
LAURACEAE								
Persea americana Mill	Avocado	X	-	+	+	+	-	-
LEGUMINOSAE								
Acacia koa Gray	Koa	E	-	+	-	-	-	-
Albizia falcataria (L.) Fosb.		X	+	+	-	-	-	-
Caesalpinia major (Medic.) Dandy & Exell.	Kākalaioa	I	+	+	-	-	-	-
Canavalia cathartica Thouars	Mauna-loa	X	+	-	-	-	-	-
C. ensiformis (L.) DC.	Jack bean	X	+	-	-	-	-	-
Desmanthus virgatus (L.) Willd.	Slender mimosa	X	-	-	-	+	-	-
Desmodium canum (Gmel.) Schinz & Thell.	Spanish clover	X	-	-	+	+	-	-
Leucaena leucocephala (Lam.) de Wit	Koa haole	X	+	-	+	+	-	-
Mimosa pudica var. unijuga (Duchass. & Walp.) Griseb.	Sensitive plant	X	-	-	+	+	-	-
Mucuna gigantea (Willd.) DC.	Kā'e'e	I	+	-	-	-	-	-

Scientific Name	Common Name	Status	UA	F	C	P	R	I
LEGUMINOSAE								
Samanea saman (Jacq.) Merr.	Monkeypod	X	+	-	-	+	-	-
LOGANIACEAE								
Fagraea berteriana Gray ex Benth.	Pua-kenikeni	X	-	-	+	-	-	-
MALVACEAE								
Hibiscus tiliaceus L.	Hau	I	+	-	-	-	-	-
Malvastrum coromandelianum (L.) Garcke	False mallow	X	+	-	-	+	-	-
MELASTOMATACEAE								
Clidemia hirta (L.) D. Don	Koster's curse	X	+	+	-	-	+	+
MORACEAE								
Artocarpus altilis (Parkins. ex Z) Fosb.	Breadfruit	P	-	-	+	-	-	-
Cecropia peltata Sandmark	Trumpet tree	X	+	-	-	-	-	-
Ficus macrophylla Desf.	Moreton Bay fig	X	-	-	+	-	-	-
F. microcarpa L. f.	Chinese banyan	X	-	-	+	-	-	-
MYRSINACEAE								
Ardisia humilis Vahl	Shoebutton ardisia	X	+	+	-	-	+	+
MYRTACEAE								
Eucalyptus citriodora Hook. in Mitchell	Lemon-scented gum	X	+	+	-	-	-	-
E. robusta Sm.	Swamp mahogany	X	-	+	-	-	-	-
Eugenia cumini (L.) Druce	Java plum	X	+	+	+	+	+	-
E. dombeyi (Spreng.) Skeels	Brazilian plum	X	+	-	-	-	-	-
E. jambos L.	Rose apple	X	+	-	-	-	-	-
E. malaccensis L.	Mountain apple	P	-	+	-	-	-	+
Melaleuca leucadendra (Stickm.) L.	Paper bark	X	+	+	-	-	-	-
Psidium cattleianum Sabine var. cattleianum	Strawberry guava	X	+	+	-	-	+	-
P. guajava L.	Guava	X	+	+	-	+	+	+
Tristania conferta R. Br. in Ait. f.	Brush box	X	-	+	-	-	-	-
NYCTAGINACEAE								
Pisonia umbellifera (J. R. & G. Forst.) Seem.	Pāpaḷa-kēpau	E	-	-	-	-	-	+
OXALIDACEAE								
Oxalis corniculata L.	Yellow wood sorrel	X	-	-	-	+	-	-

Scientific Name	Common Name	Status	UA	F	C	P	R	I
PASSIFLORACEAE								
Passiflora edulis f. flavicarpa Deg.	Yellow liliko'i	X	-	-	-	+	-	-
P. laurifolia L.	Yellow water melon	X	+	-	-	-	-	-
ROSACEAE								
Rosa hybrids	Rose	X	-	-	-	+	-	-
Rubus rosaefolius Sm.	Thimbleberry	X	-	-	+	-	-	+
RUBIACEAE								
Borreria laevis (Lam.) Griseb.	Buttonweed	X	-	-	-	+	-	-
Coffea arabica L.	Arabian coffee	X	+	+	-	-	-	-
Gardenia taitensis DC.	Tiare	X	-	-	+	-	-	-
Morinda citrifolia L.	Noni	P	-	+	-	-	-	-
Paederia foetida L.	Maile pilau	X	+	+	+	-	-	-
RUTACEAE								
Citrus reticulata Blanco	Tangerine	X	-	-	+	-	-	-
SAPINDACEAE								
Litchi chinensis Sonn.	Litchi	X	-	-	+	-	-	-
SOLANACEAE								
Capsicum annuum L.	Red pepper	X	-	-	-	+	-	-
THYMELIACEAE								
Wikstroemia vacciniifolia Skottsb.	'Ākia	E	+	+	-	-	-	-
VERBENACEAE								
Lantana camara L.	Lantana	X	-	+	-	-	+	-
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain	X	+	-	+	-	-	-
Vitex parviflora A. L. Juss.	Small-flowered vitex	X	+	+	-	-	-	-

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WAIAHOLE VALLEY OAHU: ARCHAEOLOGICAL RECONNAISSANCE

Prepared for:

M & E PACIFIC
190 S. King St.
Suite 600
Honolulu, Hawaii

CHINIAGO INC.
1040 B Smith Street
Honolulu, Hawaii 96817

APRIL 1982

This paper presents the results of a brief archaeological reconnaissance and review of literature concerning Waiahole Valley, Oahu. Our purpose was to determine the presence or absence of archaeological and historical values which might be affected by implementation of the Waiahole Valley Agricultural Park project, and to present recommendations for any further investigations that might be necessary.

In 1940 Handy reported on the status of native agriculture in the valley:

> "There were formerly terraces throughout the seaward lowlands of Waiahole, some in swampy lands but most of them irrigated from Waiahole Stream. Groups of terraces adjoining Waikane were planted in 1935. The land south of the stream and inland from the highway has reverted to swamp. Some _kuleana_ a short way up the main stream, beyond its junction with Waianu, are cultivated by Hawaiians living in the lower valley; there was also a sizable terrace section planted in taro about half a mile up Waianu in 1935. Formerly taro was planted in terraces at least a mile farther inland along both the north and south branches of Waianu; and small terraces used to extend along Waiahole up into what is now forest reserve" [Handy 1940: 95].

Kikuchi [1964] reports on a brief field excursion into the valley to look for archaeological sites:

> "The entire length and width of the valley was once extensively terraced into taro patches, _lo'i_, and was irrigated by a network of ditches, _auwai_, of which only _makai_ or seaward sections of Wai-ahole are still maintained. Traces of abandoned taro plots and ditches can be readily distinguished along the paths and inland trails. Wai-ahole and Wai-anu streams are the sources of the fresh water used to irrigate the taro lands. Low dams were thrown across the streams to back the water into ditches which were of higher elevation than the stream beds. Evidence of these dams are still seen in some parts of the valley."

> "At several upland places in the overgrown fields, there were stone remains suggesting the presence of house sites and possibly a corral for cattle or horses."

Kikuchi also reports surface finds of artifacts along the entire length of the valley. One locality, consisting of a concentration of flakes, chips, adze blanks, a slingstone, an 'ulumaika, a portion of a grinding stone and a complete tanged adze was found in a recently bulldozed field and designated as Site OW-1. A second site, designated OW-2, was an adze quarry situated on a ridge leading to Puu-Kuolani, and a third [OW-3, also an adze quarry], was found on a slope adjacent to Site OW-2. Unfortunately, Kikuchi did not include a map with his report, so our plots of the site locations are only approximate.

Our most useful source of information about the valley was a map dating from the 1890s on file at the Survey Office of the State of Hawaii. This shows the locations of numerous old kuleana, place names and structures [including grass houses] and identifies specific crops that were being grown in various agricultural plots. We have placed on this map certain relevant quotations from Handy and Kikuchi, locating each in the approximate area to which the quotation is referring, and are including it as a part of this report.

The map indicates a settlement pattern characterized by a primary concentration of population in the lower valley flatlands and near the coast. Holdings are also located inland along the major watercourses and become less frequent as the streams become restricted by the adjacent hillsides. Kuleana not located near a natural water source are serviced by auwai, one of which extends for nearly the entire length of the valley. Handy comments that certain of these inland patches were being cultivated by lower valley residents, a situation which possibly reflects a long-standing pattern of land utilization in the valley.

We have also roughly plotted the proposed construction areas on this map [allowances should be made for discrepancies due to inaccuracies in the 1890s version]. Solid red coloring indicates those areas in the middle and upper valley which have a nearly 100% probability of containing information of archaeological value. These consist primarily of old kuleana, auwai, and agricultural areas which with virtual certainty can be said to have been utilized during the prehistoric period. The entire area on the ocean side of the ticked red line contains so many tightly-clustered kuleana that to have colored them would have obscured valuable detail, but it should be considered equally as sensitive as the colored areas. Uncolored areas are felt less likely to have archaeological remains, but the possibility is present nonetheless.

The two adze quarries noted by Kikuchi on the ridges adjacent to Puu Kuolani [Sites OW-2 & 3] and some house sites near the ocean which had been placed on the State Register of Historic Places [Site 1086], are outside of any construction zones and will not be disturbed by the Agricultural Park project.

The only surface remains observed during our field inspection consist of an abandoned system of taro terraces in the vicinity of L.C.A. 10230, near the complex which includes the 100,000 gallon reservoir. Other such systems are to be expected in similar environmental situations, that is to say, flat alluvial terraces adjacent to streambeds.

Based on both the literature search and the field inspection, it is safe to say that the entire valley of Waiahole is probably eligible to the State and National Registers of Historic Places as an archaeological district. This is based on the criterion that it contains widespread evidence of former occupation and utilization, and therefore has the potential for providing valuable information regarding virtually every aspect of the aboriginal Hawaiian way of life.

It is our recommendation that a determination should be made as to which particular parcels of land will be impacted by the Waiahole Valley Agricultural Park, that these be clearly indicated on the ground and then subjected to an intensive archaeological survey. Because of the high probability that alluviation has buried valuable archaeological materials, test excavations sould be included in order to determine the nature of sub-surface deposits. In addition, an intensive literature search should be conducted to take advantage of additional written materials on file at the State of Hawaii archives. A report should be prepared defining areas of archaeological and historical significance and presenting recommendations regarding procedures for mitigating any adverse affects presented by the project. It is important that all research and mitigative measures be coordinated with the State Historic Preservation Office on a continuing basis.

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ARCHAEOLOGICAL RESOURCES
IN WAIĀHOLE VALLEY

An Archaeological Reconnaissance Survey for Waiahole Valley Agricultural Park

District of Ko'olaupoko, Island of O'ahu

Prepared by
M.J. TOMONARI-TUGGLE

For
M & E PACIFIC, INC.
Honolulu

JANUARY 1983

EXECUTIVE SUMMARY

An archaeological reconnaissance survey of portions of Waiāhole Valley, district of Ko'olaupoko, island of O'ahu, was carried out in November 1982, as part of environmental studies on the impact of Waiahole Valley Agricultural Park (Hawaii Housing Authority, State of Hawaii) development. Four areas of the valley were selected for survey, which was done by four persons over a six-day period.

Twenty-eight sites were found, 19 in the area around the junction of Waiāhole and Waianu Streams, one in the small gulch along the northern boundary of the valley, five along the low escarpment behind the coastal flat north of Waiāhole Stream, and two along the bed of lower Waiāhole Stream.

Archaeological sites found in this survey represent human occupation in the valley, spanning traditional Hawaiian times to the early 20th century, and include residential areas, possible stone tool manufacturing workshops, and numerous agricultural features reflecting both Hawaiian taro cultivation and historical rice irrigation agriculture.

One site, 50-80-10-3512, is a buried cultural deposit which has been exposed in a cut bank of Waiahole Valley Road, just <u>mauka</u> of the Waianu Stream crossing. It contains considerable evidence for Hawaiian occupation, including firepits and artifactual material. A wood sample from a firepit has been tentatively identified as <u>koa</u> (Acacia koa), a native forest tree extensively used by Hawaiians for a variety of purposes. There are no examples of this tree type in the vicinity of the site, suggesting some antiquity for the cultural deposit.

(See Section I for a summary of the settlement and land use history of the valley, which is used as a framework for interpreting and evaluating the historical significance of the archaeological sites. Section II presents a summary of survey results, with discussion organized by survey parcels.)

Recommendations for the disposition of archaeological sites are made in the context of preliminary evaluations of site significance, which are based on three frames of reference: research potential, cultural value, and public value (see Section III). Recommendations are separated into general and specific categories: the former addresses long-term responsibilities for managing archaeological resources in the valley, the latter are directed toward immediate plans for infrastructure and farmlot development.

General recommendation 1: development of a management plan for the archaeological resources in Waiāhole; the plan should include an inventory of known archaeological and documentary resources, a discussion of archaeological/scientific concerns and their relevance and applicability to management concerns, and a projection for the kinds, amounts, and scheduling of necessary work for resource conservation and mitigation.

General recommendation 2: continuing archaeological reconnaissance survey to ascertain a more comprehensive view of the extent and nature of the resources in the valley.

General recommendation 3: postpone nomination of the entire valley to the National Register of Historic Places (which was recommended in an earlier survey) until further survey and evaluation of site preservation in the valley has been completed.

Specific recommendation 1: all sites located within or at least 100 ft from the center line of the proposed Waiahole Valley Road should be further examined in detail. During construction of the roadway and associated utilities, monitoring by a qualified archaeologist should be undertaken.

Specific recommendation 2: monitoring by a qualified archaeologist should be carried out during waterline installation along Waiahole Homestead Road.

Specific recommendation 3: all sites falling within parcels to be awarded through the agricultural park development should be examined further, as listed in Table 8.

Specific recommendation 4: in areas where the present level of use is maintained, no further work is necessary. However, at the time that the level of use is intensified, a reassessment of this recommendation is necessary.

Specific recommendation 5: two sites, 50-80-10-3505 and 50-80-10-3506, are recommended for preservation within a buffer zone of at least 50 feet.

The appendices include detailed descriptions of all sites, National Register of Historic Places nomination forms for seven sites which have been evaluated as having exceptional significance, and an outline for a cultural resource management/data recovery plan.

ACKNOWLEDGEMENTS

Doing archaeology is rarely a one-person effort and this project was no exception. My thanks go to a willing crew: Agnes Estioko-Griffin, Michael W. Kaschko, and Stephan D. Clark; also to H.D. Tuggle and Nancy E. Brown for helping out on short excursions to tie up loose ends. In Waiāhole Valley, V. Texeira, C. Clark, and D. Bates were kind enough to provide information on sites in the survey areas; other residents were hospitable in allowing us to cross farm lots (although some of their dogs might have had other thoughts). In doing background research for the historical section, I was helped (once again) immensely by Charles Okino of the State Survey Office; Marty Lum of the U.S. Geological Survey helped me to locate the 1928 U.S. military air photograph of the valley.

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INTRODUCTION

An archaeological reconnaissance survey of portions of Waiāhole Valley, Ko'olaupoko district, island of O'ahu (Figure 1), was conducted for the Hawaii Housing Authority, through its engineering consultant, M & E Pacific, Inc. A total of 28 sites and site localities were identified in the survey.

The scope-of-work for the archaeological survey included the following tasks:

1) inventory of archaeological resources in four parcels in Waiāhole Valley, which would involve both archival research and field survey;

2) evaluation of significance of any located archaeological resources; and

3) documentation of any significant resources through completion of National Register of Historic Places nomination forms.

Completion of task 1 involved archival research and field survey. Archival research focused on land use and settlement changes in the valley, as these two topics lend themselves to the kinds of data which archaeological investigations produce. Further, research on historical changes are helpful in interpreting the impacts on (and therefore, the potential preservation of) prehistoric sites and in examining and evaluating the significance of 19th and 20th century archaeological resources.

Although land records and historical maps and aerial photographs were specified as research sources, other documentary sources, including 19th century government records, almanacs and business directories, journals and popular magazines, scholarly papers, and archaeological and historical reports, were also checked.* The historical summary is presented in Section I.

Field survey was carried out by four persons over a six-day period from 1 to 5 November and on 12 November 1982. The archaeological consultant spent an additional day with a University of Hawaii-Manoa class, on a field trip to relocate two previously identified adze quarries in the valley. Survey methodology and results are detailed in section II.

* Miyagi (1963) was an invaluable source of information for for this paper.

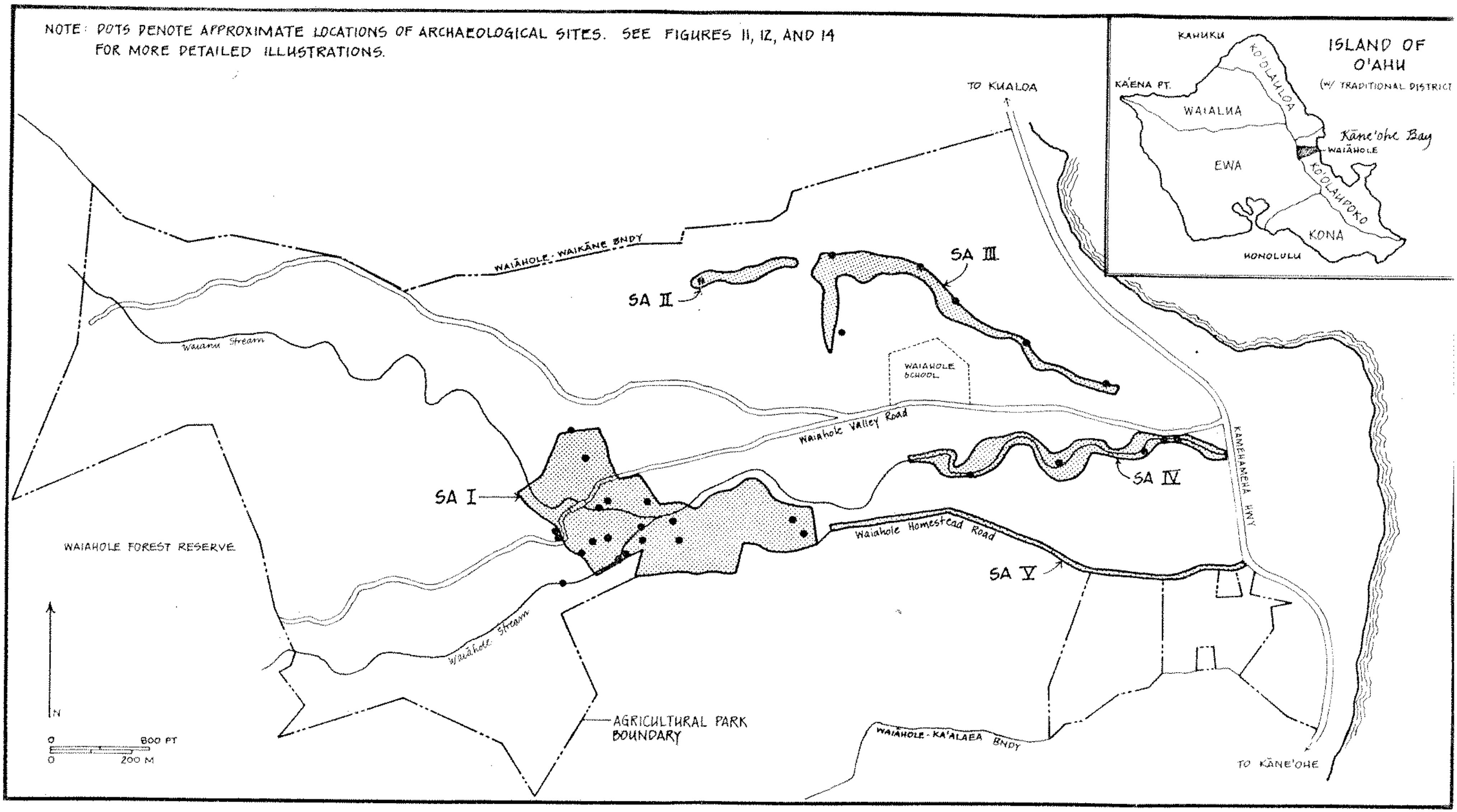


FIGURE 1. WAIĀHOLE VALLEY, DISTRICT OF KO'OLAUPOKO, ISLAND OF O'AHU.

Task 2, the evaluation of significance, was based on criteria established for the National Register of Historic Places, as well as on a more general, three-part scale of values (research, cultural, and public). These criteria are discussed in Section III on resource significance. A statement on the significance of archaeological resources in Waiāhole Valley in general and of selected sites in particular is also presented.

Section III also includes recommendations for additional archaeological activity in the valley. The need for further work is discussed in terms of current problems in Hawaiian archaeology and the potential for adverse impact on significant sites from continuing development.

Descriptions of sites and statements on site significance are detailed in Appendix I.

Task 3, which is the documentation of significant resources by means of the National Register of Historic Places nomination forms, is completed and presented as Appendix IV.

Section I

WAIĀHOLE VALLEY: ENVIRONMENT AND A BRIEF HISTORY

The valley and *ahupua'a* of Waiāhole lies at the northern end of Kāne'ohe Bay, which is a dominating physiographic feature on the windward coast of O'ahu (Figure 2). Kualoa Point and Mōkapu Peninsula define the northern and southern extremities of the bay. The region between can be divided into three sub-zones, which are marked by low ridges projecting from the Ko'olau *pali* to the bay.

The northern sub-area, of which Waiāhole is a part, consists of small valleys which are fronted by a narrow coastal strip. Lowlying areas are characterized by alluvial floodplain deposition, which at the valley mouths overlie lagoonal, peat, or muck bases (Trembly 1982, based primarily on USDA 1972).

The middle sub-zone is similar to the north section in the presence of floodplains and former lagoon, muck, or peat, but it has a greater occurrence of old alluvium or colluvium. In this sub-zone, the coastal flat is broader and the valleys are wider and shallower than the area to the north.

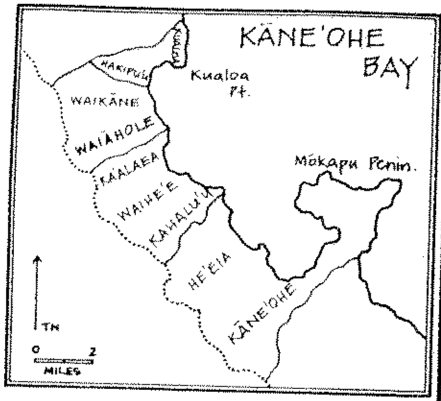
The third sub-zone encircles the southern embayment of Kāne'ohe Bay. This area is characterized by a high occurrence of old alluvium and colluvium, with relatively little floodplain development. Streams emanate from shallow and not well-defined valleys at the base of the Ko'olau range and cross a broad coastal plain.

Handy and Handy (1972: 452) describe this coastal plain and the mud-flat shoreline of the bay as distinguishing features of the Kāne'ohe Bay region, differentiating it from the "mountain-sheltered valley land" of Ko'olauloa district to the north. The northern sub-zone, then, with its narrow coastal flat and well-formed valleys, is transitional between the two regions.

It is in this regional context that the following discussion of Waiāhole Valley is presented.

The Environment of Waiāhole Valley

Waiāhole Valley is three miles deep and approximately three-fourths of a mile wide. It is defined by the high cliffs



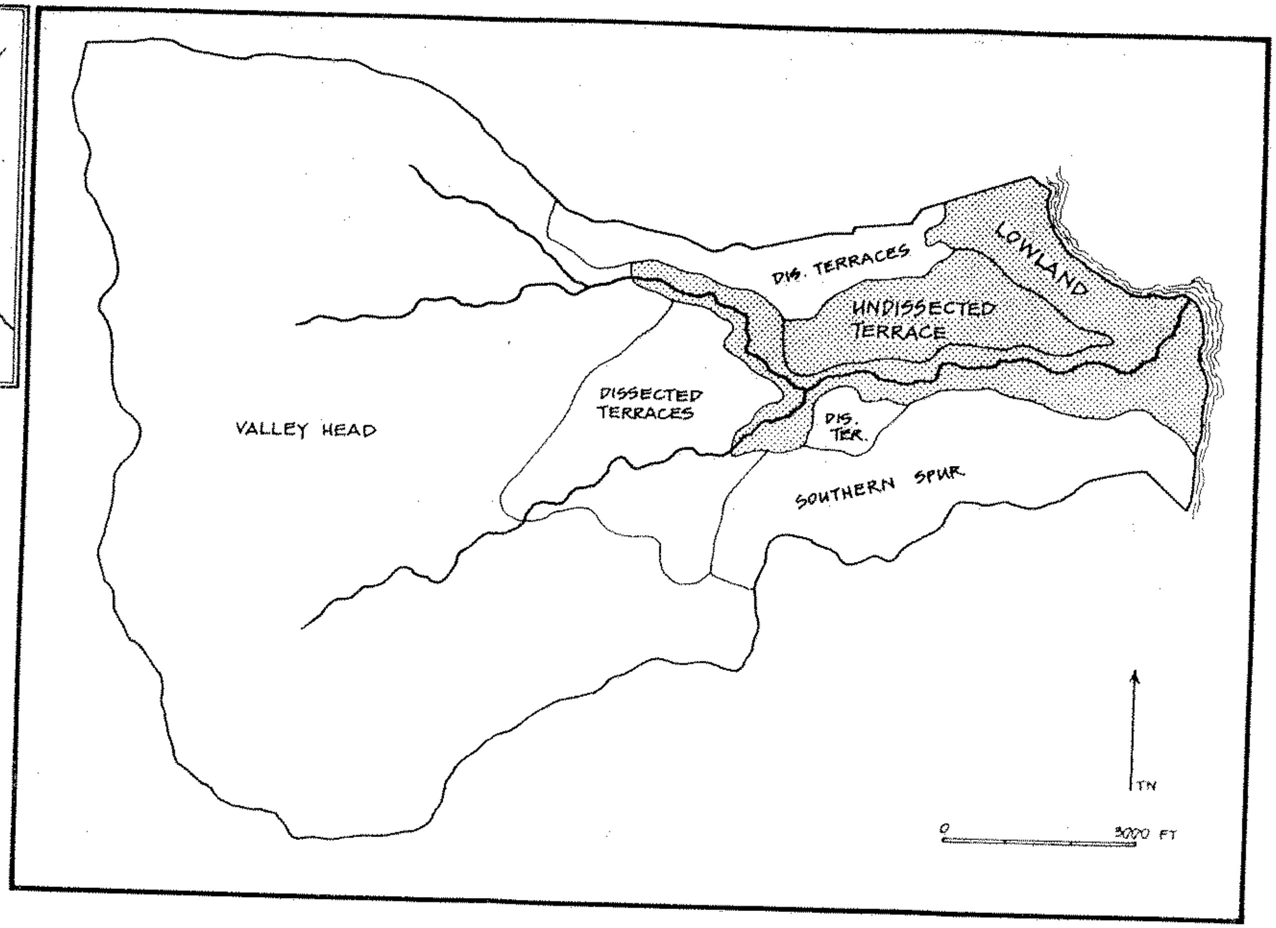


FIGURE 2.

PHYSIOGRAPHIC MICRO-SURFACE REGIONS OF WAIĀHOLE VALLEY, KĀNE'OHE BAY REGION, ISLAND OF O'AHU.

(Adapted from Miyagi 1963).

Stippling denotes areas of primary concern in the present survey.

of the Ko'olau range to the west and by low ridge spurs to the north and south. A narrow coastal flat fronts the valley.

Miyagi (1963: 7) divides the valley into five physiographic micro-surface regions (valley head, southern spur, lowlands, undissected terrace, and dissected terraces), of which the lowlands and the undissected terrace are of primary concern in the present survey (see Figure 2).

The lowlands front the coast and extend inland approximately 2.6 km (8,200 ft) following the course of the primary drainages, Waiāhole and Waianu Streams. At the coast, the gradient is 0 to 4 percent but this increases inland. Much of the lowlands is swampy, poorly drained, and subject to flooding during severe storms (Miyagi 1963: 14).

Trembly (1982: map 4) categorizes this zone as floodplain and drainageway, with the lower Waiāhole Stream drainage consisting of alluvial deposit over lagoon, muck or peat. She interprets the lower area as the result of a delta-like sedimentation process (1982: 24).

Vegetation in 1963 (at the time of Miyagi's study) included panicum grass in grazing areas with an overstory of Java plum, guava, and mango; hau and false kamani grew along the coast (see Appendix III for scientific names). While this description generally holds true for the areas surveyed in 1982, it should be noted that the abandonment of farm lots since 1963 has resulted in a secondary grassland succession in the former cultivation areas and the encroachment of forest growth, particularly hau, along the borders of farm lots.

The undissected terrace, called Kaneloa on a late 19th century public lands map (Dove 1897), occupies the middle of the valley, north of Waiāhole Stream and mauka of Kamehameha Highway (see Figure 1). It rises above the lowlands, with an escarpment ranging from 1.6 m (5 ft) high at the southeast end to 9.5 m (30 ft) at the northwest end. The slope of Kaneloa ranges from 3 to 8 percent (Miyagi 1963: 15).

Trembly describes this zone as clay on alluvial fans and talus slopes (1982: map 4).

Vegetation is characterized as an open forest with shrubs; the overstory is primarily Java plum and guava, with some koa haole, Java olive, and pandanus (Miyagi 1963: 50-51). Much of Kaneloa has been modified in historical times by residences and truck farms.

Miyagi (1963: 45) notes that rainfall records for Waiāhole Valley were begun in 1919. The minimum annual figure is 87"

(1953); the maximum annual figure is 235.09" (1938). The annual average (as of 1963) is 150". During the period of the present survey, there was only one day of heavy rains (out of a total of six days), although the ground and vegetation were usually wet in the mornings.

At the time of the construction of the Waiahole Water Tunnel in the early 1900s, Waiāhole (along with Waikāne, Kahana, and Punalu'u Valleys) was a part of the greatest water supply-producing area on O'ahu (Larrison 1916: 81). The only stream flow measurement taken before the tunnel disrupted the natural regime was in 1912, when the average daily discharge at the gauging station near the Forest Reserve boundary was 24 cubic feet per second. Between 1956 and 1958, the average daily discharge was 10 cubic feet per second. Two of the three springs feeding Waiāhole Stream were depleted by the tunnel (Miyagi 1963: 17-18).

Thus, Waiāhole Valley can be generally characterized as a small but lush environment, which combines the assets of windward valleys such as those which were highly cultivated in wet taro by Hawaiians of long ago (e.g. Hālawa, Moloka'i, Hanalei, Kaua'i, and Honokāne Nui, Hawai'i), with the advantages of the protected marine situation such as Kāne'ohe Bay provides. The coastal flat offered Hawaiians an additional agricultural area for taro cultivation and the Kaneloa terrace provided more land for dryland crops and residences.

A Brief History of Settlement and Land Use

Documented references to Waiāhole exist only from the period following Western contact in the late 18th century, but legends and archaeology suggest a much longer occupation in the valley.

Although there has not been any chronology-producing archaeological work done in Waiāhole*, investigations at Kahana Valley in Ko'olauloa to the north (Hommon and Bevacqua 1972) and at Kāne'ohe to the south (Rosendahl 1976) suggest the areas along this coastline may have been utilized from at least the 17th century. Burial salvage work at Mōkapu Peninsula (Davis et al 1976) yielded hydration-rind dates from the 13th century, and further south, at Kawainui Marsh (Kelly and Clark 1980; Allen-Wheeler 1981) and Bellows Beach (Pearson et al 1971; Cordy and Tuggle 1976), the chronology is pushed back to the AD 300s and 400s (the earliest dates for human occupation in Hawai'i).

* Two reconnaissance surveys have been carried out: Griffin and Pyle (1974) and Chiniago (1982). Neither reported any sites. Kikuchi (1964) reported on a brief survey in which two adze quarries and an artifact scatter (in a plowed field) were located.

Legendary references to Waiāhole suggest that agriculture was being practiced in the valley in the AD 1600s (calculated genealogically at a rate of 25 years/generation). For example, the warrior Kuapunohu is said to have dug up and burned the taro from a patch of four acres (Kaehuaea 1865, in Sterling and Summers 1978: 189). Fornander (1916: 222), in a variation of the same story, notes that because Kapunohu (his spelling) used the taro for firewood, "the saying, 'the hard taro of Waiahole,' is known from Hawaii to Niihau."

Other resource-related activities are passed on in Waiāhole stories recounted by Paglinawan (1964: 2-5): watercress collecting in Waianu Stream, *'opae-kuahiwi* (*Atya bisulcata* or *Ortmannia henshawi*) catching in Waiahole Stream, and fishing for *'ama'ama* (*Mugil cephalus*) and *awa* (*Chanos chanos*) in Kane'ohe Bay.*

The earliest documentation of land use and settlement in the valley is the Land Commission Award records of the mid-19th century. During this period, the traditional land tenure system of stewardship was replaced by a Western system of fee simple ownership. Commoners were given an opportunity to claim the land on which they lived and farmed. In Waiahole, a total of 53 such awards were granted. Four *'ili* grants (of more than ten acres) were awarded to *konohiki*.

The *kuleana* awards to commoners were spread out along the banks of the valley streams, from the coast to approximately 3.7 km (2.3 miles) inland (Figure 3). Some parcels were situated on the Kaneloa terrace and along the base of the southern spur near the ocean.

In general, the parcels along the stream edges were used for irrigated taro cultivation. The *kula* parcels were planted in a variety of crops, including potatoes, melons, sugar cane, *'awa*, and bananas. Houses were usually located with the *kula* farms and described as being "separate and not enclosed" (from Land Commission Award claims and testimonies).

Awards in the upper gulches and in the delta area of Waiāhole Steam did not have *kula* parcels.

Within twenty years, however, subsistence agriculture was supplanted by commercial rice growing. Thrum (1876: 48) writes that the rice industry took off with the decline of whaling in the early 1860s, and with such enthusiasm in some cases that good taro was pulled up and terraces replanted in rice.

* For other legends and traditions, see Sterling and Summers (1978: 189-190) and Paglinawan (1964: 2-5).

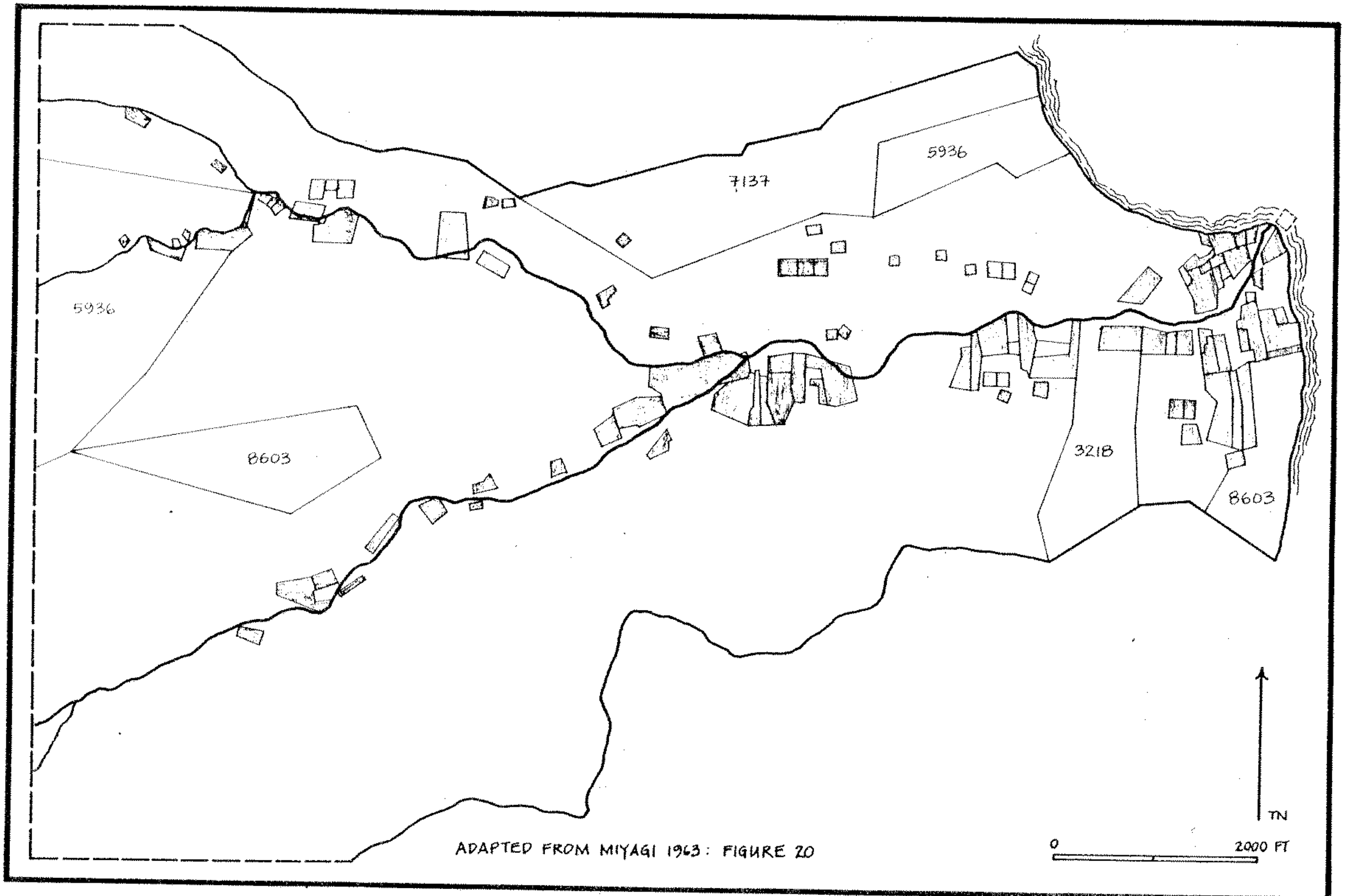


FIGURE 3. LAND COMMISSION (<u>KULEANA</u>) AWARDS IN WAIĀHOLE VALLEY.
(Four digit numbers refer to <u>'ili</u> awards to <u>konohiki</u>)

This industry made a tremendous impact on land use and settlement in Waiāhole Valley, which was one of the primary rice growing areas in the islands throughout the industry's life span. Many taro fields were converted to rice cultivation, and Miyagi (1963: 109) notes that rice farmers brought new areas into irrigated cultivation through the construction of more canals, particularly those which crossed the top of the Kaneloa terrace.

For example, in 1859, a survey of Land Grant 2703: 2 showed taro cultivation on the coastal flat portion of the grant parcel and kula or dry farming on the Kaneloa portion (Makalena 1859). By 1878, the coastal portion was largely under rice cultivation (Brown 1878) and by 1897, a portion of the kula parcel was also under irrigation (Figure 4).

Population, which had been on the decline since the early 1800s, began to rise with the influx of farm laborers (for both rice as well as sugar which was being developed to the south).

Bowser (1880: 484), on a tour of O'ahu, noted "no less than six rice plantations...rented by Chinamen" in Waiāhole. In his "Alphabetical Index of Landowners, Planters, Government Officers, Professional and Business Men, and of All White Residents" (1880: 4-127), he lists nine rice planters, one rice miller and planter, and three farmers, with 227 acres under rice cultivation and 12 acres under unspecified cultivation (Table 1).

The resident missionary for the district of Ko'olaupoko reported:

> Considerable effort has been made to induce the natives to be more industrious to cultivate the soil and particularly to try to the cultivation of rice...Foreigners too have begun the culture of rice in this district extensively and it was hoped their example would stimulate the natives to cultivate their own lands, but most of them choose to hire themselves to the foreigners at low wages and put their lands in the hands of the foreigners for a few dollars rather than cultivate or improve themselves (Mission Station report 1862: 1, in Devaney et al 1976: 49).

It would appear by the names in Bowser's list of rice planters (seven Chinese and two Caucasian) that the native Hawaiians of Waiāhole may have been little different from elsewhere in the district.

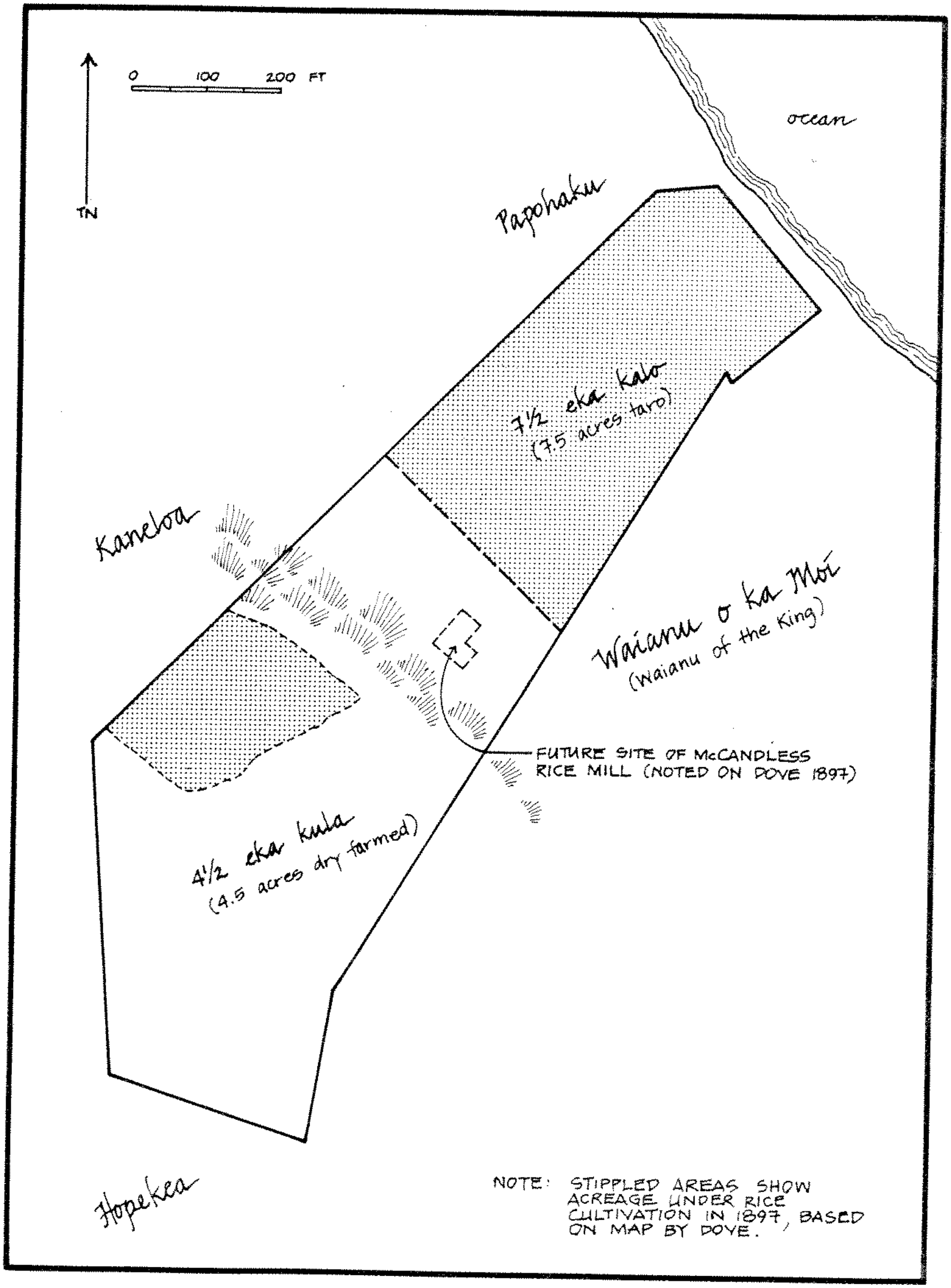


FIGURE 4. GRANT 2703: 2.

Table 1.

LIST OF PLANTERS AND LANDOWNERS
IN WAIAHOLE VALLEY, 1880
(from Bowser 1880)*

NAME	OCCUPATION	OWN	RENT	TOTAL ACRES	ACRES CULT.
Cullen, S.	Rice planter	x		300	20
Fogo, John	Farmer	x		5	5
Gleeson, Jno	Rice planter	x		90	15
Hoy Ah	Rice planter		x	15	15
Hoy Wah	Rice planter		x	30	30
Mana Ah	Rice planter		x	10	10
Pana Ah	Rice planter		x	17	17
Papa, D.	Farmer	x		4	4
Seu Ah	Rice planter		x	20	20
Swan Ah	Rice planter		x	40	40
Tryer, C.	Farmer (and overseer)	x		3	3
Wah Ah Sr.	Rice miller (and planter)		x	30	30
Wah Ah Jr.	Rice planter		x	30	30

* Compiled from "A Statistical Directory of the Hawaiian Kingdom", pp. 298-320, and "Island of Oahu Alphabetical Index of Landowners, Planters, Government Officers, Professional and Business Men, and of all White Residents", pp. 4-127.

During this period, some native Hawaiians remained in control of their land and continued to live in a traditional style; of eight parcels identified as taro fields on Dove's 1897 map, five correspond with Land Commission Awards. An informant of Miyagi's told him of three grass houses with adjacent taro fields in the upper valley which were still occupied in the early 1900s (Miyagi 1963: 97) and the famed photographer, R.J. Baker, photographed a Hawaiian couple pounding poi in front of their grass house in 1922 (Figure 5).

But in general, the character of the valley settlement changed along with the use of the land. Rice mills and other processing areas dotted the coastal flat, plantation quarters for laborers were located near fields, and private residences dotted the lower valley.

Dove's map of 1897 identifies 54 structures in the valley. Thirty-nine of them are clustered into ten groups, of which seven are associated with rice planters or processing and one with Waiahole School*; the other two groups are unspecified. The remaining 15 structures occur singly; these include two plantation houses, one grass house (along upper Waiāhole Stream), and one church (Figure 6).

From the turn of the century, the rice industry began a decline which culminated with the final blow caused by the appearance of the rice borer insect in the late 1920s. In Waiāhole, rice fields were abandoned as early as 1910, although some rice was being planted as late as 1920 (Miyagi 1963: 113).

Japanese replaced Chinese on the land during this period and truck farming replaced rice cultivation (Miyagi 1963: 172).

During this same period (1910 to 1925), pineapple growing underwent a rapid rise and equally rapid fall on the windward side of O'ahu. Focused at Libbyville , the Libby, McNiell, and Libby cannery in Kahalu'u, pineapple cultivation took over large tracts of land. In Waiāhole and Waikāne Valleys, Libby acquired leaseholds totalling 600 acres in 1912 (Devaney et al 1976: 63), and pineapple was grown by "individual Chinese and Japanese farmers on moderately sloped hill lands where rice and taro could not be grown"(Miyagi 1963: 115). Farmers used a train "to haul pineapples...from Waiahole to Waikane landing...and from Waikane

* The first public school on the windward side of O'ahu was built at Waiāhole in 1883. It had two rooms and 90 students, mostly Hawaiian and Chinese, were registered (Mudge 1937).

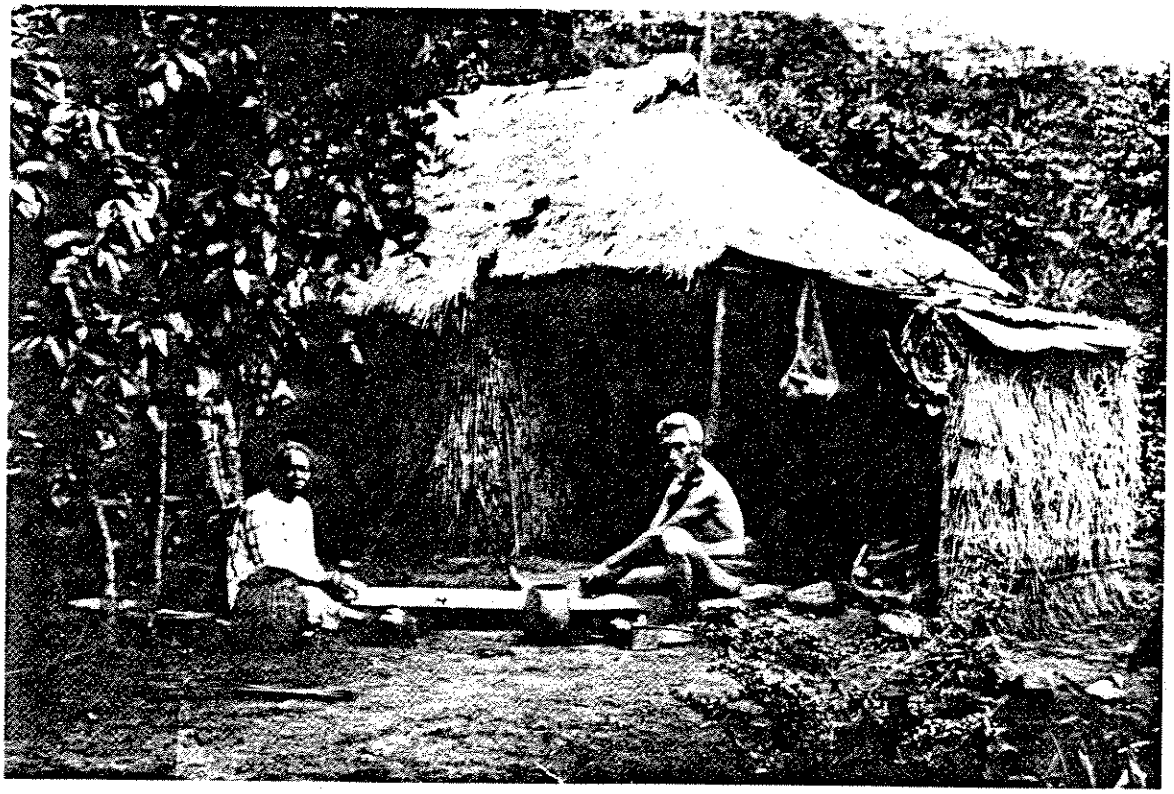


FIGURE 5. POI POUNDERS IN FRONT OF GRASS HOUSE. WAIĀHOLE VALLEY. Photograph by R.J. Baker, 1922.

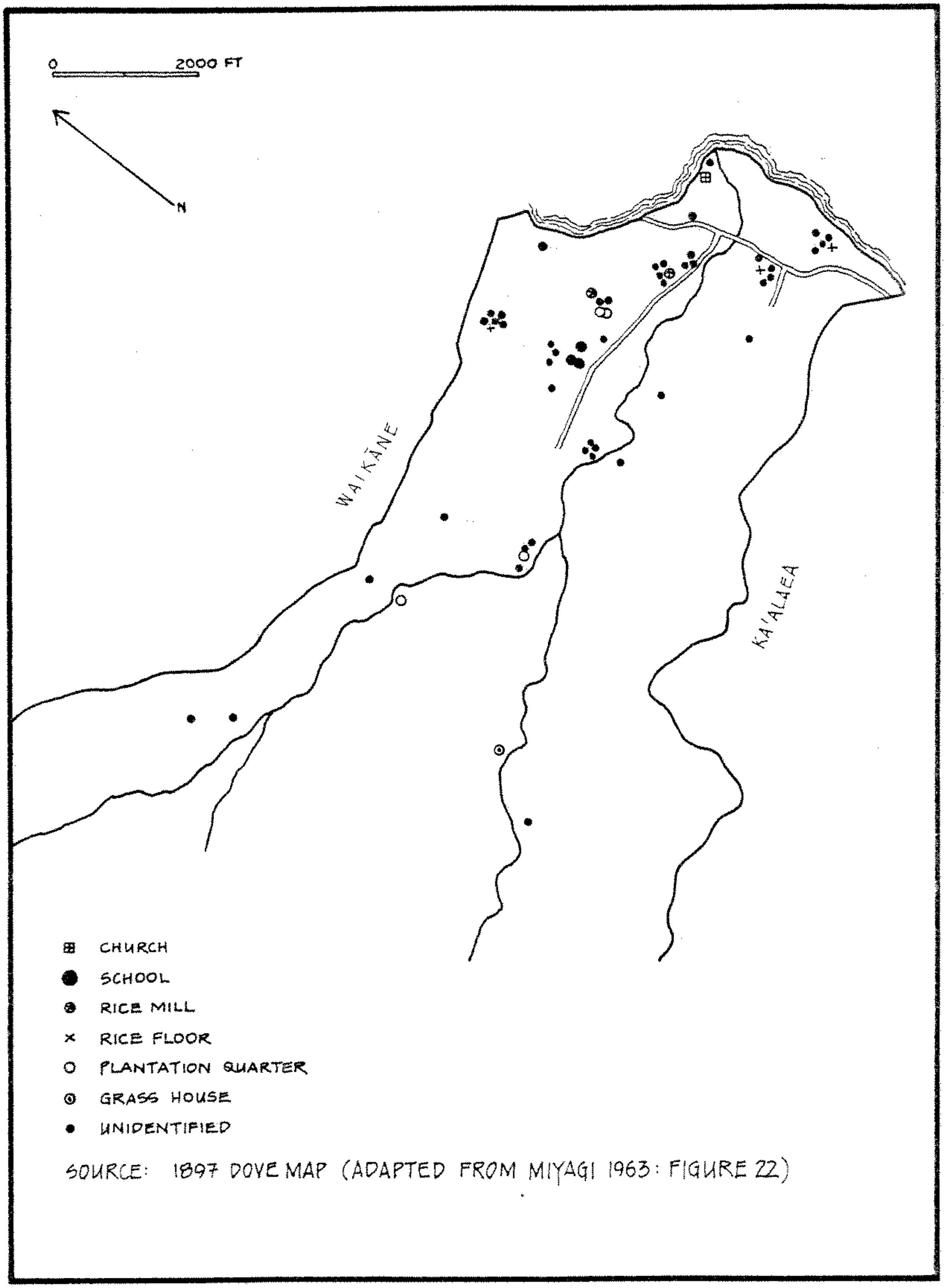


FIGURE 6. DISTRIBUTION OF STRUCTURES IN WAIAHOLE VALLEY. LATE 19TH CENTURY.

...by boat to the Libby cannery" (Armitage 1921, in Miyagi 1963: 115).

For economic reasons, the Libby cannery was closed in 1925 and production was shifted to the more profitable, central O'ahu operations. The closing took its toll on the small planters in Waiāhole, some of whom still remembered their losses, when interviewed by Miyagi in 1963 (1963: 115).

Throughout the decades of rice, pineapple, and truck farming, taro continued to be grown, though certainly at a lesser scale than pre-19th century Hawaiian land use. Miyagi (1963: 108) was told by a long-time Waiāhole resident that "the farmers of the valley sent their taro and other products to Honolulu by muleback by way of the Pali Road as late as 1910. They started early in the morning, sold their produce in the market and returned late in the evening." In 1921, a writer for Paradise of the Pacific noted that "on the road up the valley, there is a real grass hut with native Hawaiians actually living therein, tending a taro patch by day and stroking guitars and ukuleles by night (Armitage 1921: 48).

The Waiahole Poi Factory operated continuously from 1904 to 1971, processing taro from the valley as well as from other areas (Sichter n.d.; Paglinawan, pers. comm.). Miyagi (1963: 146) notes that in 1961, half of the taro processed by the poi factory came from the windward O'ahu area and half came from Kaua'i and Maui. The owner of the poi factory told Miyagi that the Kaua'i taro was a better product because of its lower water content (possibly a result of the shipping time).

Even after the factory closed in 1971, taro cultivation continued. It exists at present in two large fields of numerous patches (Figure 7), which, with truck farms producing bananas, papayas, sweet potatoes, and other vegetable crops, help to maintain the rural atmosphere of the valley.

Large nurseries occupy the coastal flat between Kamehameha Highway and the Kaneloa escarpment. Some cattle and horse grazing is also taking place. Residences line the main and northern segments of Waiahole Valley Road and cluster in the Waiahole Farm Homesteads area along the base of the southern spur.

Waiāhole Valley gained its secure place in island history as the site of the Waiahole Water Tunnel, which tapped the rich water resources of the Ko'olau range and carried them to the parched sugar fields of Ewa. Taking water from Kahana and Waikāne Valleys as well as Waiāhole and Waianu gulches,

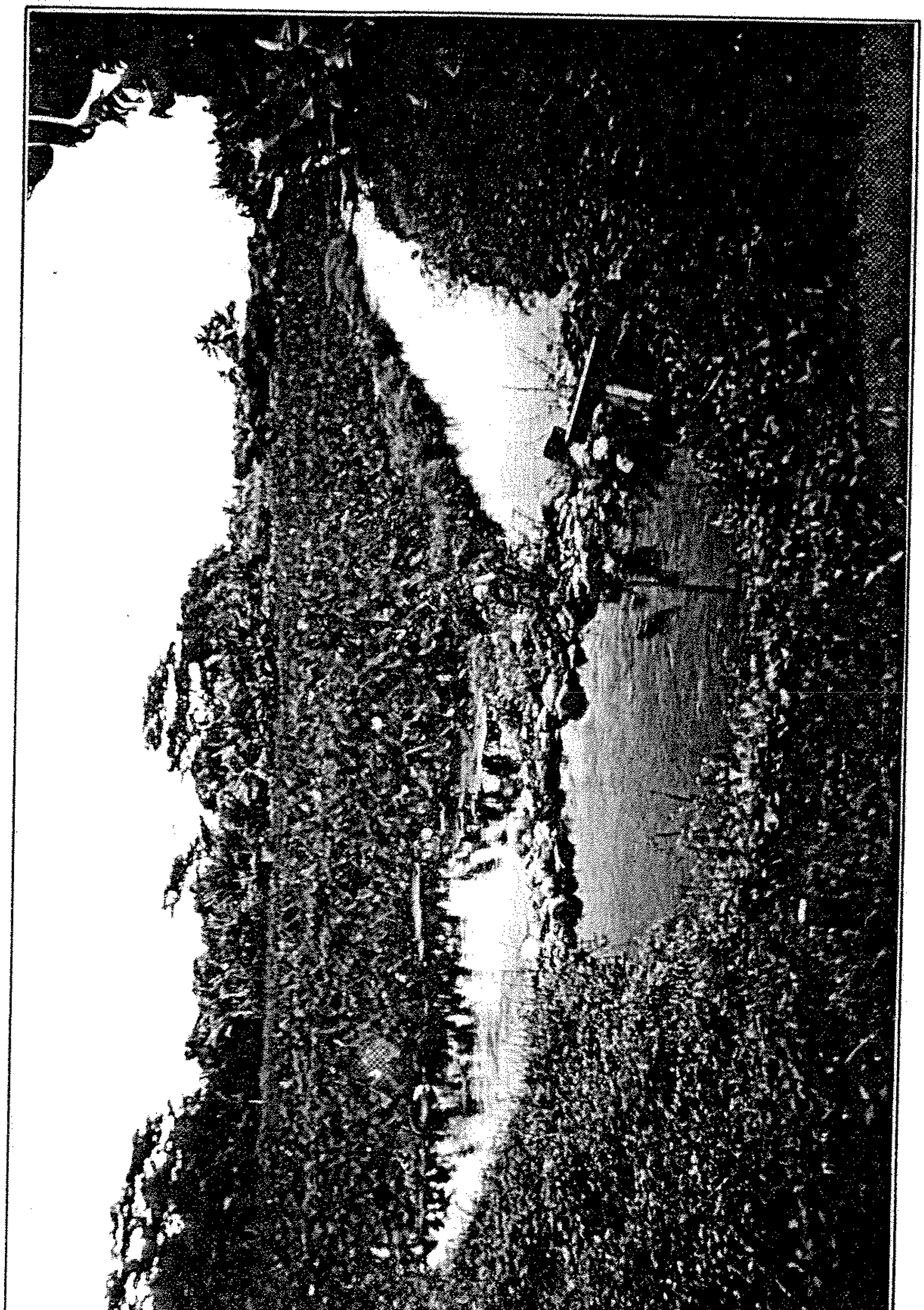


FIGURE 7. VIEW TOWARD MAKAI, OF TARO FIELDS IN LEASE 91.

it was begun in 1913 and completed in 1916 (see Appendix III for bibliographic references to the Waiahole Water Tunnel).

For additional background information on Waiāhole Valley, the reader is referred to Miyagi (1963), a master's thesis on land use in the valley from the 19th century to 1963 and to Sichter (n.d.), a student paper in urban planning on the recent history of land ownership, land control, and community organization in the valley. Devaney _et al_ (1974) is a history of the Kāne'ohe Bay area which provides a geographical and historical context for Waiāhole Valley.

Section II.
AN INVENTORY OF ARCHAEOLOGICAL RESOURCES

An archaeological reconnaissance survey was carried out in Waiāhole Valley over a period of six days, during which 28 sites or site localities were identified. Selected for survey were four separate parcels, determined by the engineering consultant on the basis of an earlier reconnaissance survey (Chiniago 1982)(Figure 8).

A late 19th century map of Waiāhole (n.d.) showing kuleana parcels, place names, structures (including grass houses), and agricultural areas was the primary data source for this earlier survey. Land Commission Award parcels (kuleana) and the entire coastal section of the valley below the school lot were evaluated as having the most probability for containing "information of archaeological value". It was also noted that other "areas are felt less likely to have archaeological remains, but the possibility is present nonetheless" (Chiniago 1982: 2).

The present survey areas were selected by overlaying a map of the "most probable areas" with a map of disturbed areas (i.e. those presently being used); those sections in which there was no overlap were chosen for survey.

An additional area along Waiahole Homestead Road was also selected because of plans for waterline construction along that route.

Survey Methodology and Problems

The original intent of this survey was to provide 100% coverage by walking transect sweeps across stipulated parcels. However, vegetation of varying densities of thickness precluded such a method. And, in fact, some areas remain unsurveyed due to the virtually impassable secondary growth which has developed since the abandonment of some farm lots.

Figure 9 illustrates the level of survey carried out in Survey Areas (SA) I, III, and IV (II and IV were adequately covered). The levels of survey are as follows:

1) unsurveyed: as stated above, vegetation (generally hau or secondary grassland) was the primary reason for not surveying these parcels (Figure 10). However, historical maps and aerial photographs were used to reconstruct past use of the land, and an

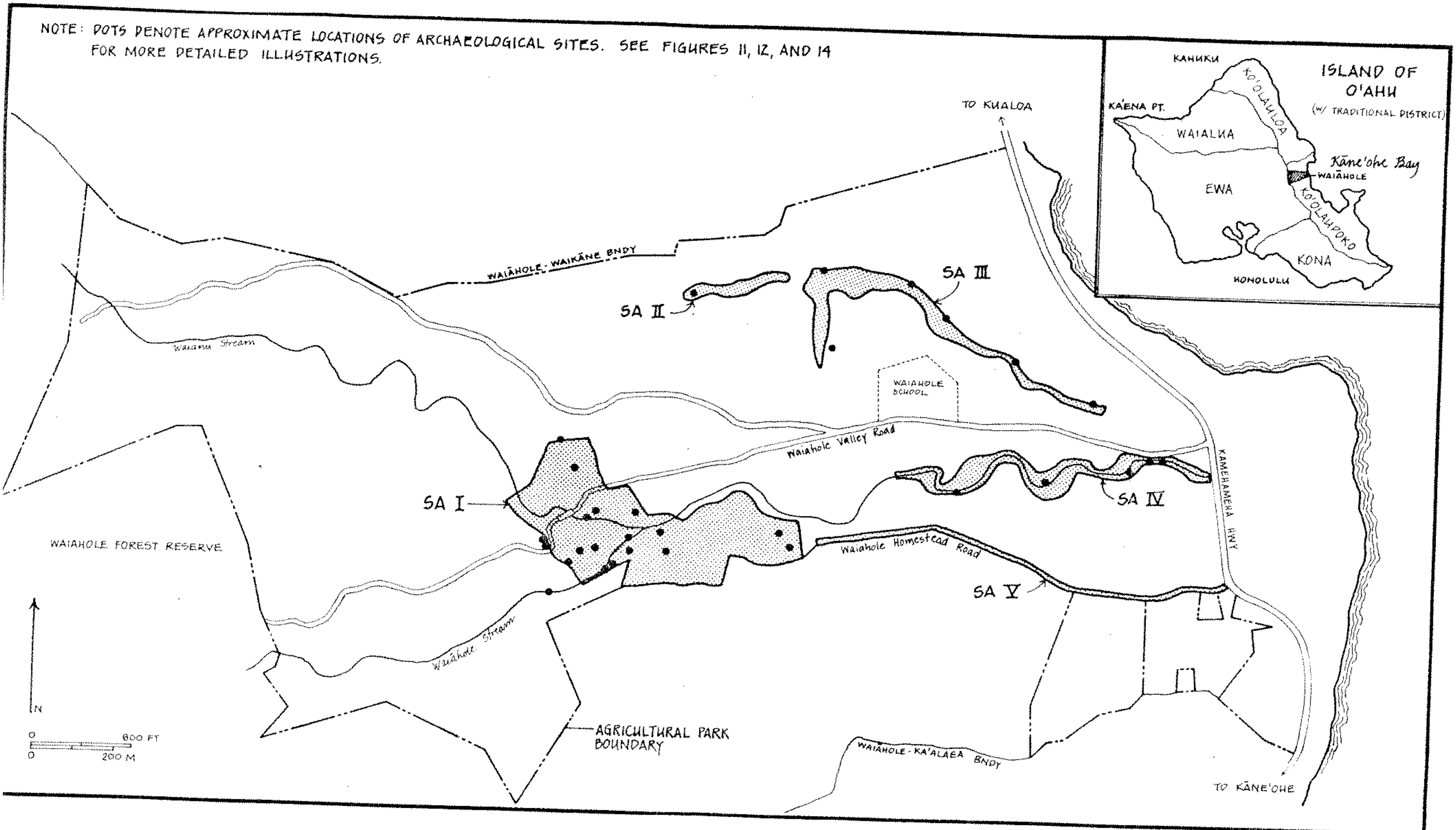


FIGURE 8. SURVEY AREAS IN WAIĀHOLE VALLEY, DISTRICT OF KO'OLAUPOKO, ISLAND OF O'AHU.

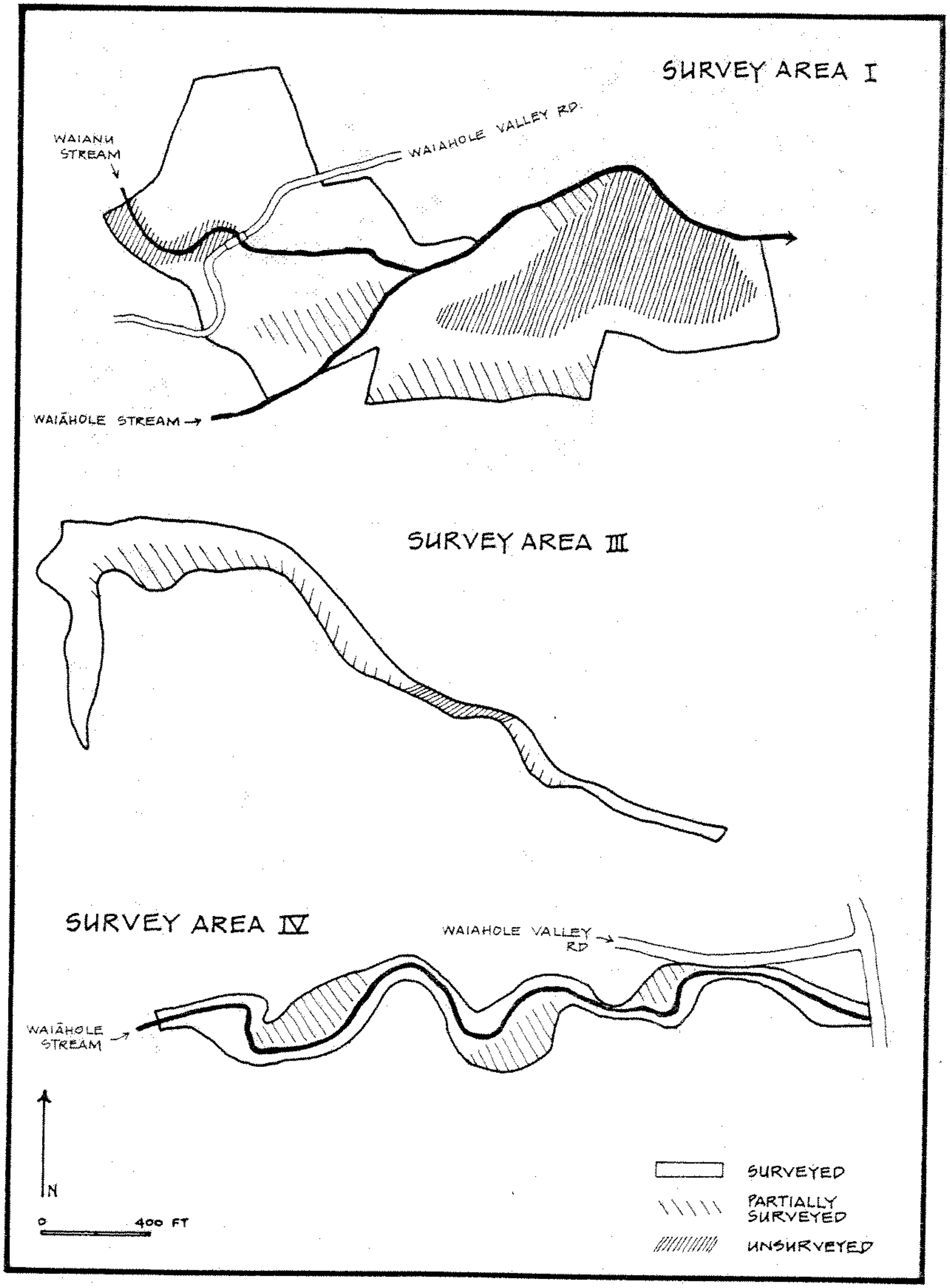


FIGURE 9. LEVELS OF SURVEY CARRIED OUT IN SURVEY AREAS I, III, AND IV.

FIGURE 10. EXAMPLE OF VEGETATION PROBLEM IN SOME SURVEY AREAS.

estimate of presence or absence of archaeological features (based on the cursory field inspection and any knowledge of landscape disturbance subsequent to abandonment) was made;

2) partially surveyed: widely spaced transects (more than 10 m apart) were made through areas of moderately thick vegetation; thus, only coverage of the actual survey lines, with limited visibility between the lines, was possible. Historical sources were used to supplement the limited survey; and

3) surveyed: total survey coverage by defined transects or by unstructured walk-through survey. Given the limitations of any survey of this kind, the results of this level of work are adequate for determining the presence or absence of surface archaeological features.

Survey Area IV is unique in that it largely encompasses the bed and banks of Waiāhole Stream. Survey in this area entailed walking up the flowing stream, perusing the banks for exposed buried cultural deposits. Drawings and/or photographs were made of four exposed profiles. Three small stream terraces were partially surveyed.

Survey Area V includes the area immediately adjacent to the Waiahole Homestead Road. It was surveyed by car from the Kamehameha Highway end and on foot from the *mauka* end near SA I.

Mapping of sites and appropriate surrounding natural features was carried out with a Brunton pocket transit and by pacing or metric tape. Sites were located on a 1971 aerial photograph (R.M. Towil, 1" = 1000') and on a map of existing tenancies for the Waiahole Valley Agricultural Park (1" = 200').

A 1928 aerial photograph of Waiāhole Valley (U.S. military) was located after completion of the field survey. Field notes were compared with features visible on the photograph and additional interpretations were made based on these comparisons.

Summary of Survey Results

A total of 28 sites and site localities were identified in the present reconnaissance survey (see Figure 8). Although most may have traditional Hawaiian associations, almost all show evidence of historical and/or recent modification. There are 16 agricultural features, six habitation sites, and six sites of other function. This last category includes a lithic site, two historical road beds, a possible railroad berm, a platform of unknown function, and the remains of McCandless Rice Mill (see Appendix I for detailed site descriptions).

The sites are numbered according to the four-part State site numbering system: "50" refers to the State of Hawaii; "80" refers to the island of O'ahu; "10" refers to the USGS quadrangle in which Waiāhole Valley falls; and a four-digit number refers to each specific site. All sites located in the present survey have the prefix "50-80-10-", which is therefore deleted in the following discussion.

Sites 3500 to 3518 are located in SA I, site 3519 is in SA II, sites 3520 to 3525 are in SA III, and sites 3526 and 3527 are in SA IV. No sites were found in SA V. (Sites are listed by survey area in Tables 3-5, and 7; a compiled list for the entire survey appears in Table 8, Section III).

Survey Area I

Survey Area I is located around the junction of Waiāhole and Waianu Streams (Figure 11). It extends <u>makai</u> from the knoll which separates the two streams to approximately 475 m (1500 ft) downstream of the junction. Most of the survey area falls within Miyagi's lowland zone, although the northwest section rises to the undissected terrace of Kaneloa.

The only difference with Miyagi's vegetation description is the extremely thick secondary succession of grasses and <u>hau</u> in formerly cultivated areas (see Figure 10).

The survey area encompasses 11 Land Commission Award parcels and one Land Grant (Table 2; see Figure 11). Claims and testimonies for these awards indicate that the valley bottom land was cultivated in taro, with possibly as many as 100 taro patches. Each LC award included separate <u>kula</u> lands where potatoes, melons, sugar, <u>'awa</u>, and bananas were grown; only the <u>kula</u> parcel for LCA 7572 falls within the survey area. Houselots were generally situated near the <u>kula</u> lands; only LCAs 7647 and 10228 indicate "house adjacent to <u>kalo</u> (taro) land" (see, in particular, sites 3606 and 3517).

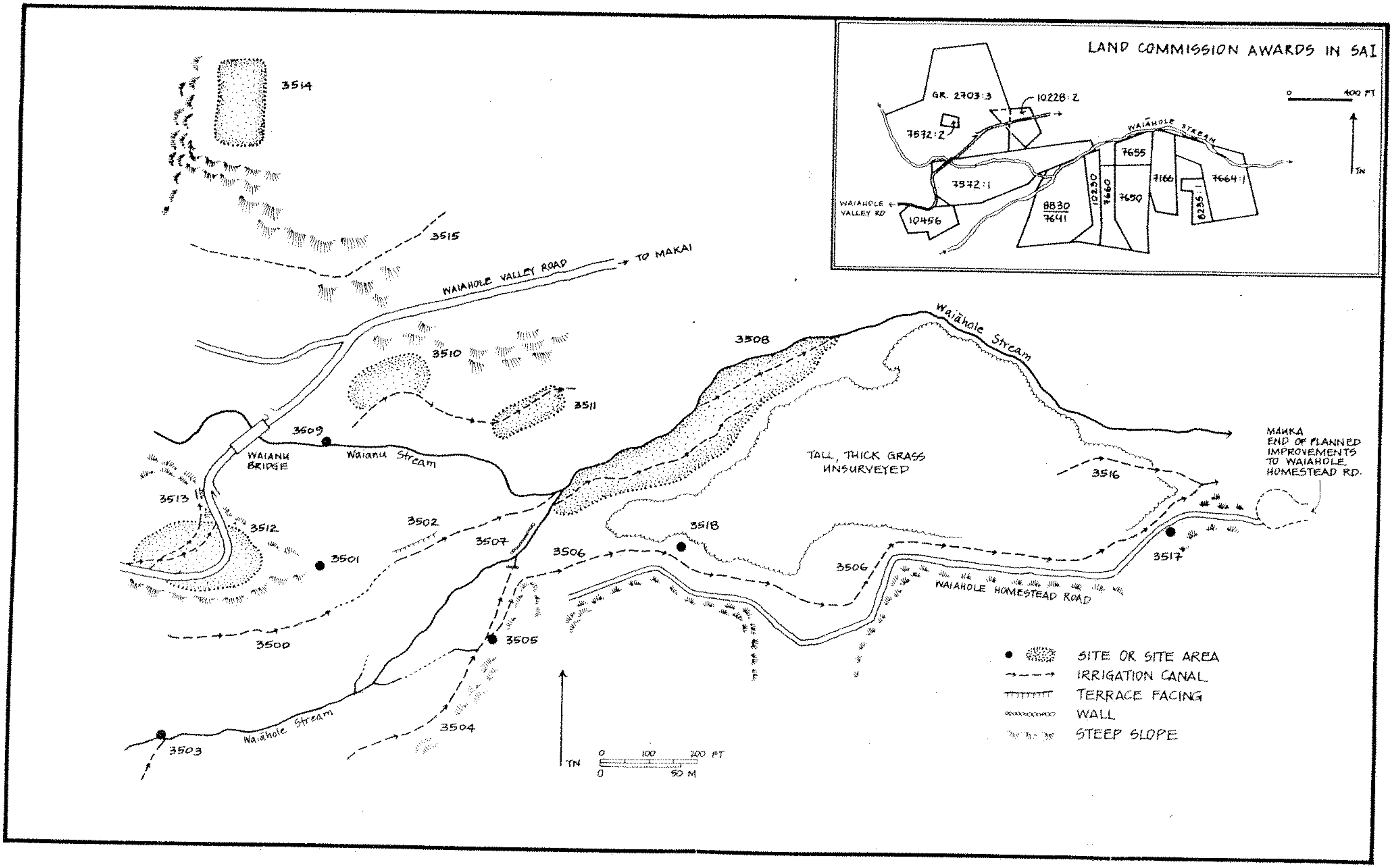


FIGURE 11. LOCATION OF SITES IN SURVEY AREA I.

Table 2.

LAND COMMISSION AWARDS IN SURVEY AREA I.

LCA No.	Awardee	Taro Patch	House	Kula	Māla* of 'awa	'Ili
7166	Naai/Kaai	1	unsp.	1		Nuole
		14				Poopepe
7572	Kupoepoe	12	1	1		Kapuwaihalulu
7649	Kalei	14	1	1		Poahamai
7650	Kaiwi 2	3	1			Makanilua
		2				Poahamai
		1				Poopepe
		1				Kualele
					1	Waianu
7655	Kaiwi 1	8	1	1		Makanilua
7660	Kekuinae	4		1	1	Makanilua
7664	Koa	7	1	2		Poopepe
			1			Kapalai
8235	Inulama	6			1	Hihimanu
		5	1			Waianu
8830	Makakehau					Poahamai
10228	Moo 2	15	1	1		Kauluioa
10230	Maikaaloa	5	1	1		Waianu
		2				Makanilua

There is some discrepency between the claims made by awardees and the testimonies of witnesses to corroborate those claims. Therefore, I have listed only the claims and not the testimonies, which in some cases are more detailed concerning land use in <u>kula</u> parcels (that is, in specifying types of crops). For information concerning testimonies, refer to the "Foreign Testimony" volumes of the Land Commission Award records, Hawaii State Archives.

* <u>Māla</u> means garden, plantation, cultivated field (Pukui and Elbert 1972).

Although the 1878 map by JF Brown does not show rice cultivation anywhere within this survey area, by the end of the century, most of the taro fields were probably converted to rice growing (Dove 1897). Taro is indicated for only one parcel, LCA 8830/7647; the other LCA parcels are shown as irrigated, with no crop specified (implying then that they were under rice cultivation).

The 1897 map also shows six structures, including one identified as "P.Cullen's house" and one shown as a "plantation house".

Nineteen sites were found in SA I. Eleven are interpreted as irrigation-related features (e.g. canals, terraces, levees), five are residence sites, one is a lithic deposit, and two are of unknown function (Table 3; see Figure 11).

Only two sites (3505 and 3512) are of probable prehistoric origin, with low probability of continuity into the historical period; both are buried cultural deposits containing substantial lithic material and charcoal. Site 3512 also contains firepits and identifiable fragments of burnt vegetation, implying a habitation locale rather than a non-residential lithic workshop area. No artifacts of the historical period were observed in either site.

Three sites (3509, 3517, and 3518) are clearly of 19th or early 20th century origin, based on construction materials (e.g. planed lumber and concrete) and associated debris (e.g. bottles, ceramic bathtub, a metal bedframe).

It is difficult to evaluate the chronological range of the other sites. The irrigation features were probably utilized in rice or 20th century taro cultivation; however, this cannot eliminate a prehistoric origin. Site 3514, an artifact scatter in a plowed field, contains both traditional Hawaiian (basalt and volcanic glass flakes and tools) and 19th century and modern (ceramic and glass sherds, aluminum fragments) debris. Sites, such as the 3501 platform, are enigmatic.

Two areas were not surveyed due to extremely thick vegetation (see Figure 9). The small area to the north of the Waianu Stream bridge is a stream terrace or levee and there is a low probability of sites in that locale. The large area on the south side of Waiāhole Stream below its junction with Waianu Stream is an abandoned farm lot, presently under lease 71. The vegetation in this area was impenetrable. Figure 11a shows the pattern of terracing as evidenced on the 1928 aerial photograph; an informant said that the area was under taro cultivation as late as the

Table 3.
SITES IN SURVEY AREA I

SITE NO.	SITE DESCRIPTION	DOCUMENTARY SOURCES	PROBABLE LCA OR GRANT	LEASE NO.
3500	Irrigation canal	Miyagi 1963: 23 1928, 1971 air photos	7572:1, 10456	90
3501	Platform	---	7572:1	89
3502	Terrace facing	Informant	7572:1	89
3503	Terrace facing and irrigation canal	Informant	7572:1	89
3504	Irrigation canal	---	---	---
3505	Flake deposit	---	8830/7647, 7572:1	---
3506	Irrigation canal	Miyagi 1963: 113,23 1928 air photo LCA testimonies	8830/7647, 10230, 7660, 7650, 7166, 8235, 7664	71
3507	Mounded wall	---	7572:1	---
3508	Irrigation system	1928 air photo Dove 1897	8830/7647, 10230, 7660, 7655	---
3509	Concrete/stone foundation	---	7572:1	---
3510	Possible occupation area	Dove 1897	Gr. 2703:3, 10228:2	---
3511	Irrigation canal and embankment	---	10228:2	89
3512	Buried occupation deposit	---	---	---
3513	"Kuleana Ditch"	Informant 1928 air photo Dove 1897	---	---
3514	Artifact scatter	---	Gr. 2703:3	74
3515	Old road bed	---	Gr. 2703:2	86
3516	Possible irrigation canal	LCA testimonies	7664:1	71
3517	Abandoned house and associated trash pit	1928 air photo Dove 1897 LCA testimony	7664:1	---
3518	Abandoned house	Informant 1971 air photo	8803/7647	---

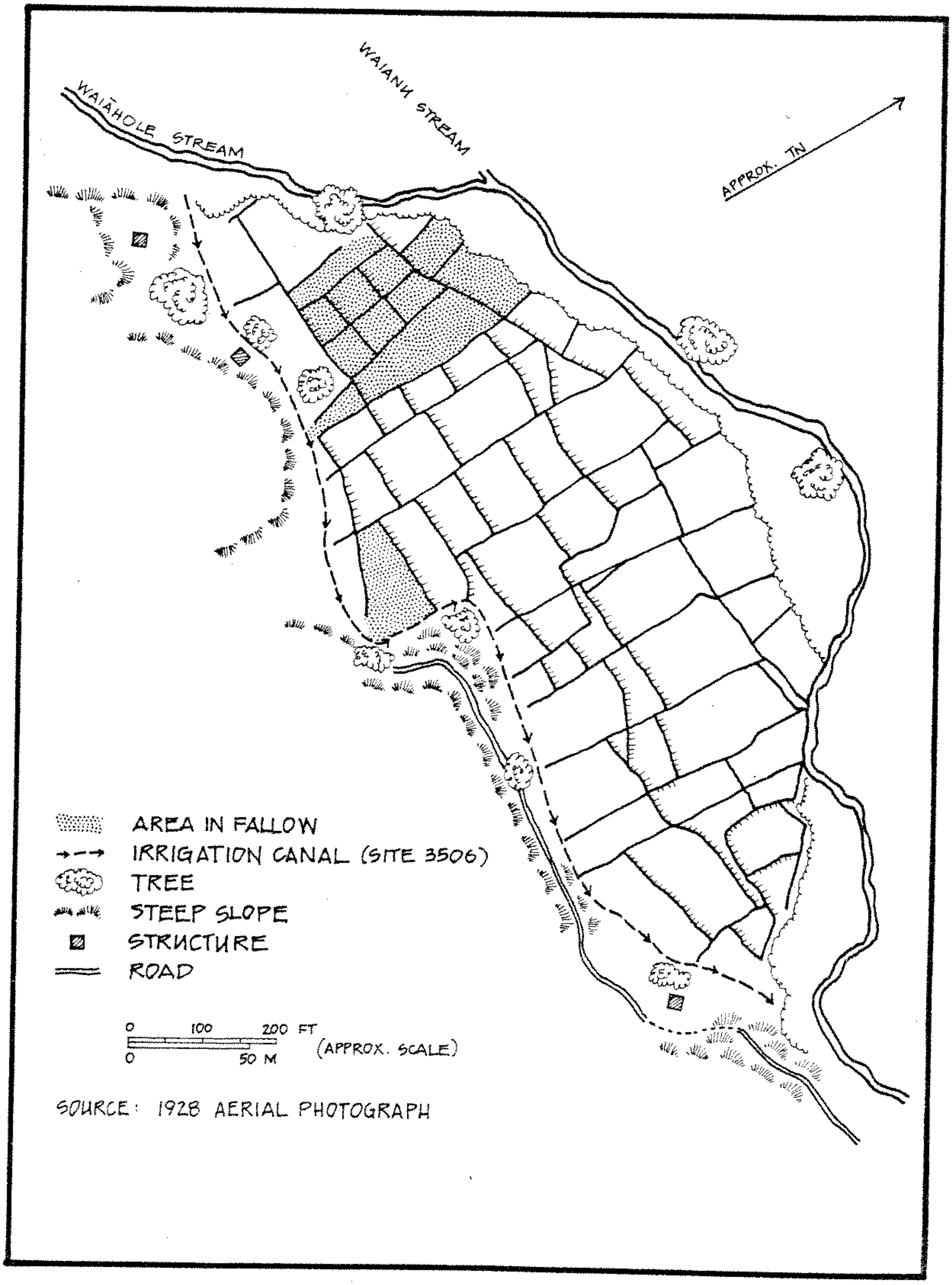


FIGURE 11a. RICE TERRACES IN WHAT IS NOW LEASE 71.
(Traced from 1928 aerial photograph)

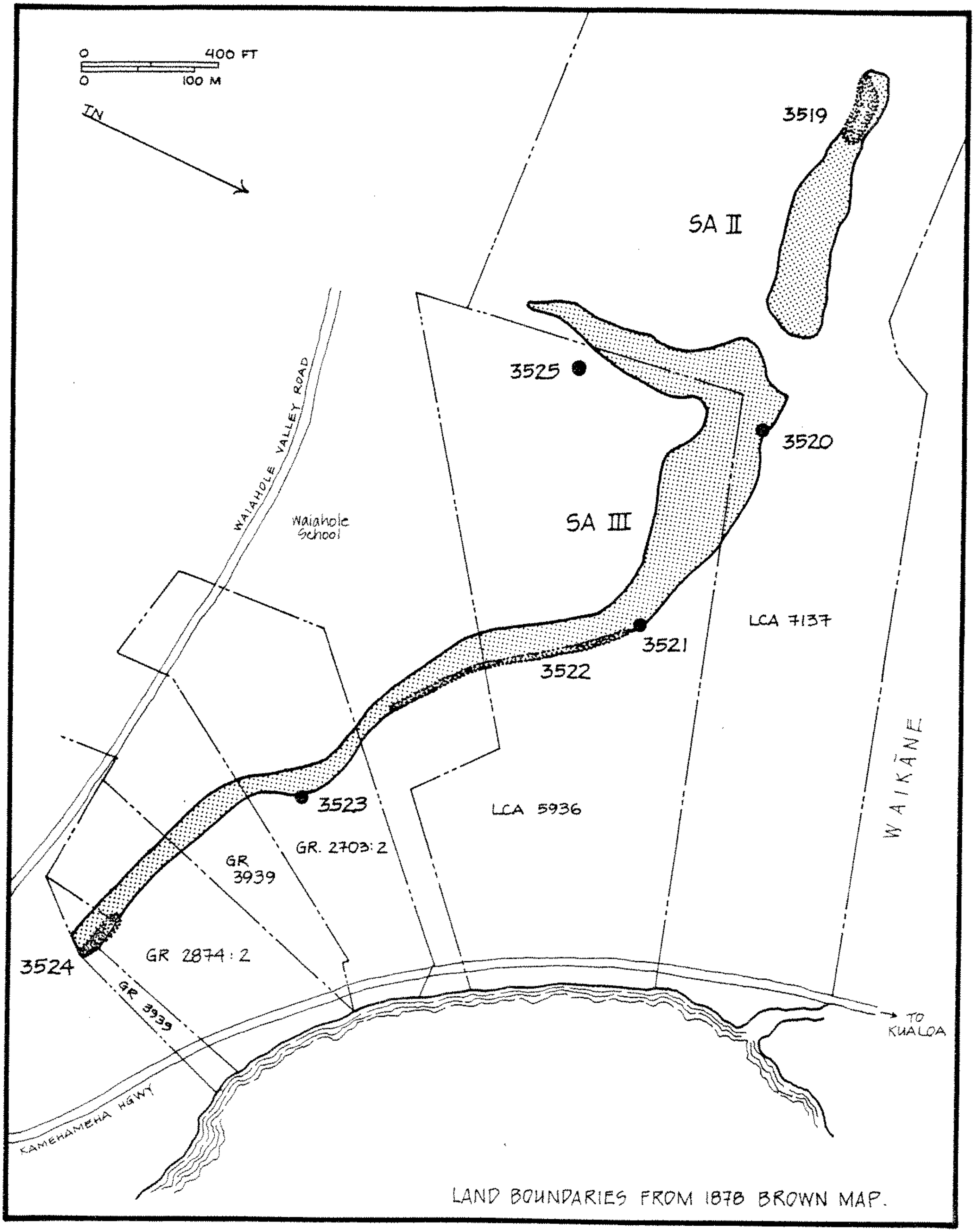


FIGURE 12. LOCATION OF SITES IN SURVEY AREAS II and III. (With 19th Century Land Boundaries)

1950s (V. Texeira, pers. comm.). There is a good probability that this system remains intact.

The area immediately mauka of the Waiāhole-Waianu stream junction was only partially surveyed. However, it appears to be heavily eroded by flood activity and site condition should be poor, should any sites remain at all.

Survey Area II

Survey Area II is a small gulch formed by the ridge which marks the northern boundary of the ahupua'a and the escarpment of Kaneloa (Figure 12). This area falls within Miyagi's dissected terrace zone. The gulch extends inland approximately 765 m (2400 ft) from the coastal flat; the actual survey followed the gulch inland only 320 m (1000 ft). Although there was water flowing through the gulch during the period of survey, it appeared to have been a factor of recent heavy rainfall. Vegetation consists primarily of miscellaneous ferns and grasses under a canopy of Java plum.

The survey area is within the boundaries of LCA 7137 to Kaho'ohanohano, a grant of the entire 'ili of Onouli. The 'ili encompasses all of the small gulch and its smaller subsidiary branches.

There are no records for the use of this gulch for rice cultivation per se, but a stream marked on the 1897 Dove map may have been used as an irrigation ditch. Extensive rice fields are noted on this map and on the 1878 Brown map on the coastal flat immediately makai of the gulch. It is not inconceiveable that a natural stream was modified for commercial irrigation purposes. This feature is clearly visible on the 1928 aerial photograph.

Only one site, 3519, is located within SA II. It is a feature labelled "Ka Loko Manu" on the Dove map, and appears to be a widening in the stream or canal channel. Its function or chronological context (other than on the map) is unknown.

Table 4.
SITES IN SURVEY AREA II

Site no.	Description	Documentary Source	Probable LCA
3519	Possible pond	1897 Dove map	7137

Survey Area III

Survey Area III encompasses the north and east escarpments of Kaneloa and a small, north-south-oriented gulch which joins the escarpment at its northwest end (see Figure 12). A narrow strip of the lowland along the base of the escarpment was also surveyed. The escarpment ranges in height from 1.6 m (5 ft) to 9.5 m (30 ft)(Miyagi 1963: 15).

Vegetation in the small gulch is primarily grassland, with a grove of mature banana trees at its mouth. Java plum dominates the escarpment canopy, with two isolated, extremely dense groves of hau along the coastal edge of Kaneloa.

The survey area crosses two 'ili grants (LCAs 5936 and 7137) and three government land grants (Grants 2703:2, 2874:2, and 3939)(see Figure 12).* The surveyor's papers for Grant 2703:2 (Makalena 1859) indicate that the coastal flat was under taro cultivation and the Kaneloa section was dry farmed (see Figure 4). There is no indication that the escarpment itself was utilized for anything other than a natural boundary.

By 1897, taro was replaced by rice and the Dove map shows several rice-related features in this area: several irrigation ditches, two rice mills and numerous rice fields (Figure 13).

With the exception of one rice mill (which was probably outside of the survey area), these features were relocated in the present survey. A total of six sites were identified in SA III (Table 5). Sites 3520, 3523, and 3524 could be directly correlated with Dove's map as rice industry features. Site 3521, an embankment projecting makai toward Waikāne Landing, may be a remnant of the early 20th century railroad used during construction of the water tunnel and during the pineapple period. Site 3522 is a possible road bed for which there is no chronological evidence. Site 3525 is an artifact scatter of basalt flakes and a porcelain sherd found in a plowed field on the Kaneloa terrace.

The steep slope of the escarpment was only partially surveyed; transects were made intermittently up the slope. There is a low probability of any sites on that steep terrain. Extremely thick stands of hau near the center of the survey area precluded examination of those areas (see Figure 9). Again, there is little chance of sites on the slope itself, although there may be features at the base of the escarpment; the 3522 road bed continues south of its mapped location into a hau thicket.

* Except for Grant 2703:2, no land use data is available in these records.

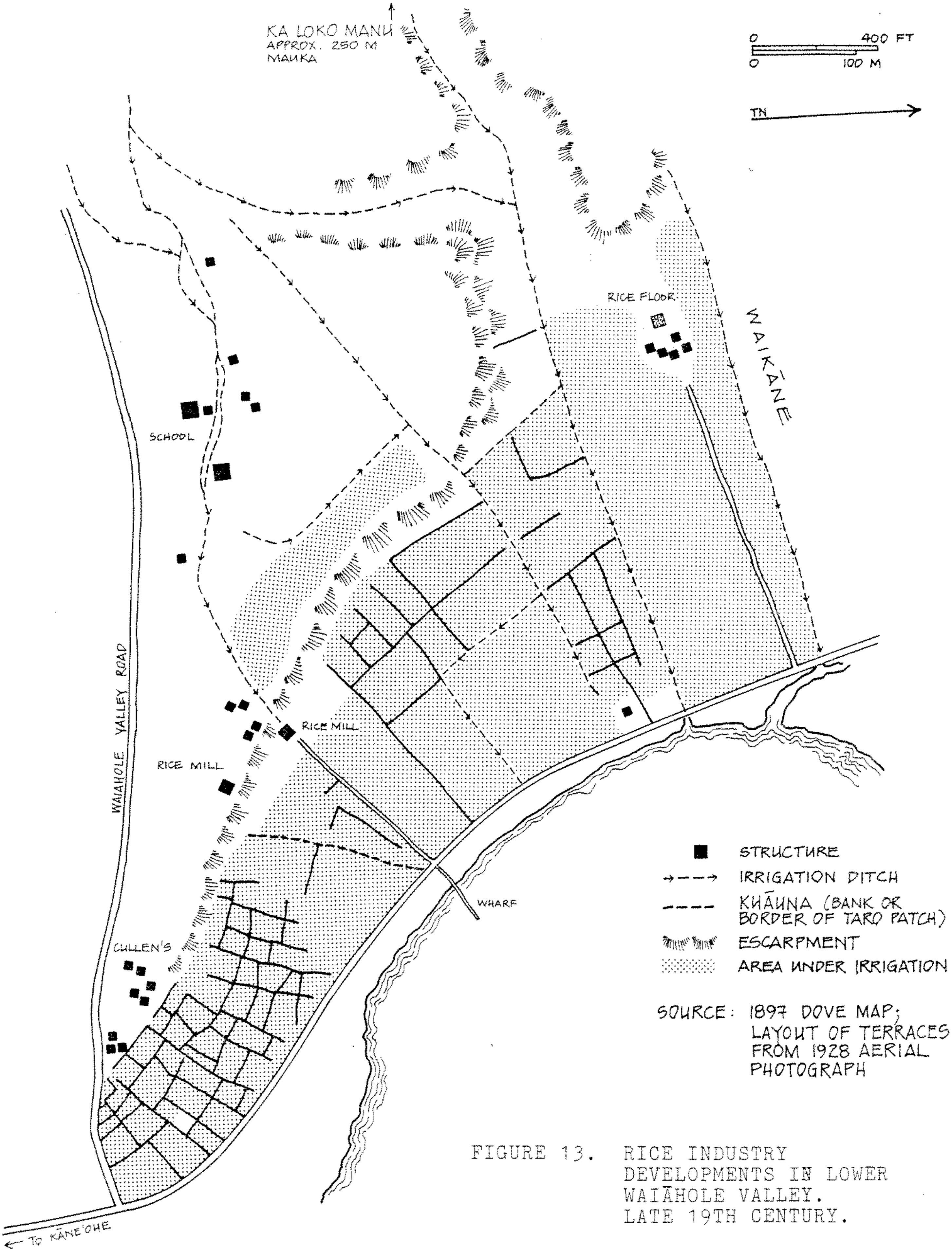


FIGURE 13. RICE INDUSTRY DEVELOPMENTS IN LOWER WAIĀHOLE VALLEY. LATE 19TH CENTURY.

Table 5.
SITES IN SURVEY AREA III

SITE NO.	SITE DESCRIPTION	DOCUMENTARY SOURCES	PROBABLE LCA OR GRANT	LEASE NO.
3520	Possible irrigation canal	1928 air photo Dove 1987	5936, 7137	---
3521	Embankment	1928 air photo	5936	22
3522	Possible road bed	---	5936	22
3523	McCandless Rice Mill	Informant 1971, 1928 air photos Dove 1897	Gr. 2703:2	23
3524	Irrigation canal and rice fields	1971 air photo Miyagi 1963: 22 1928 air photo Dove 1897	Gr. 2874:2	27
3525	Artifact scatter	---	5936	64

Survey Area IV

Survey Area IV consists of the bed of Waiāhole Stream from Kamehameha Highway bridge mauka approximately 825 m (2600 ft)(Figure 14). The depth of the stream ranges from 5 cm to more than 1.0 m; the height of the banks range from level with the stream to more than 2.0 m. Vegetation along the banks include domesticated grasses bordering cultivated fields, thick groves of hau, and small stands or individual mango and Java plum trees.

There are 11 Land Commission Awards which are adjacent to or cross the survey area (Table 7; see Figure 14). All testimonies and claims indicate that these parcels were used for taro cultivation, with up to 59 patches along the 825 m long strip. Nine of the parcels have associated kula lots, in which a variety of dryland crops were grown; these lots were on Kaneloa or on the lower slopes of the southern spur (outside of the survey area).

In the late 19th century, the entire area was converted to rice cultivation. Handy and Handy (1972: 453) describe the area as swampland in the 1930s. It is presently used for truck farming.

This area corresponds to Trembly's floodplain overlying lagoon, peat, or muck (1982: map 4). While the exposed profiles which were mapped as site 3526 do not show evidence of this base, they do indicate at least two, and possibly three, periods of irrigated cultivation, clearly separated by alluvial deposits of sands, pebbles, and cobbles (see Figure 31 in Appendix I). Site 3527 is an irrigation canal for which no clear historical associations can be made.

Table 6.
SITES IN SURVEY AREA IV

Site no.	Description	Documentary source	Probable LCA	Lease no.
3526	Buried cultural deposits (4)	Dove 1897; 1928,1971 aerial photos; Miyagi 1963: 22	---	97
3527	Irrigation canal	---	8197	93

Three small areas of the survey parcel extend beyond the immediate bed of Waiāhole Stream. These were partially surveyed and with the exception of the furthest mauka area, all appear

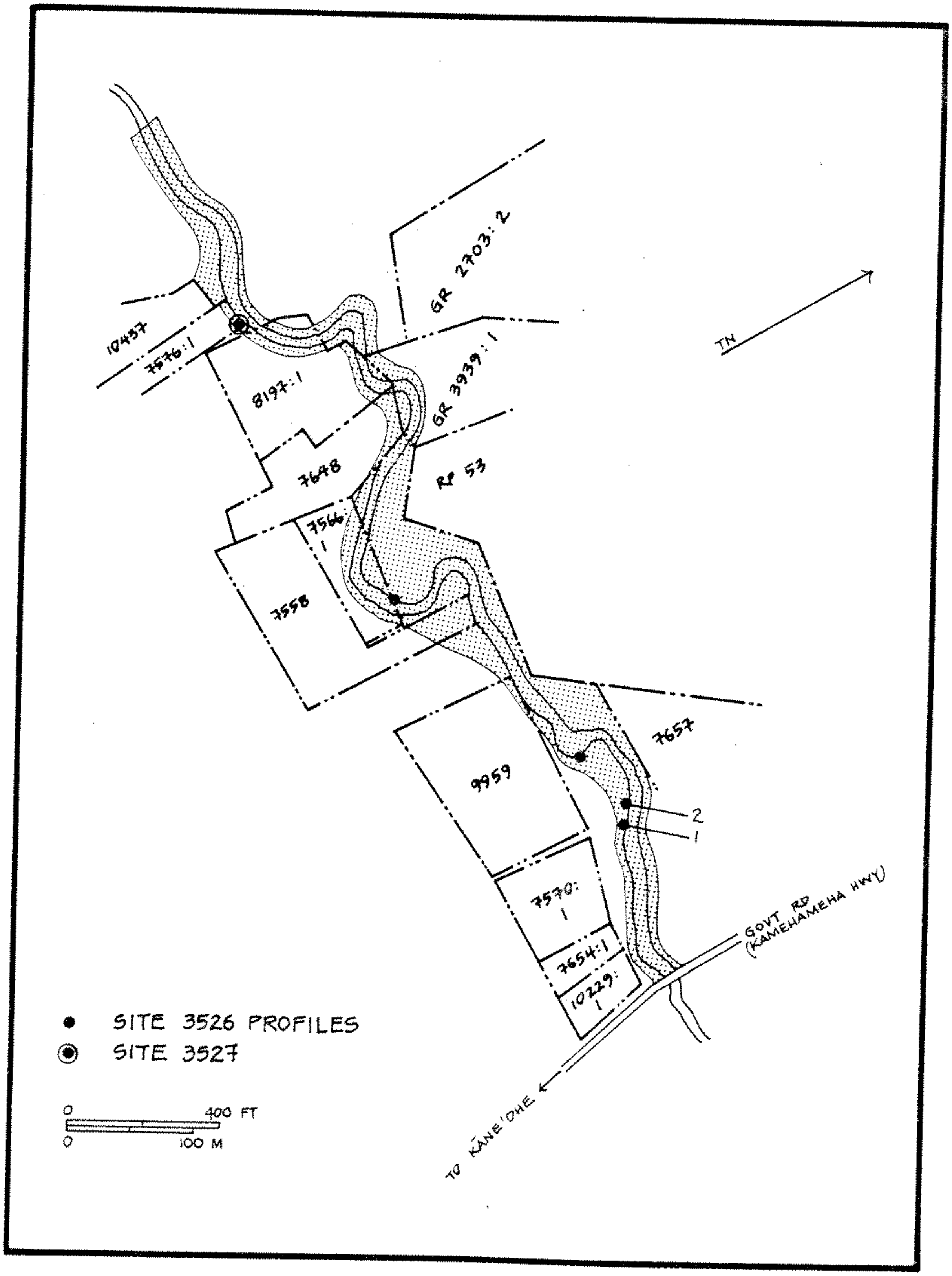


FIGURE 14. LOCATION OF SITES IN SURVEY AREA IV.
(With 19th Century Land Boundaries)

Table 7.
LAND COMMISSION AWARDS IN OR ADJACENT TO SURVEY AREA IV

LCA No.	Awardee	Taro Patch	House	Kula	Māla* of 'awa	'Ili
7566	Keawe	6	1	1		Kaneloa
					1	Uwau
7570	Kauahipaka	5	1	1		Kauakahipa
		3 (fallow)				Kauakahipa
7576	Kalaloa	6	1		1	Hopekea
		1				Uwau
7648	Kapule	4	1	1		Kuakaikoo
		7 (fallow)				Kuakaikoo
7558	Kaakau					
7654	Kimo	3	1	1		Kuaiokumu
7657	Kaukulima	2				Kapikookau
		1				Apuu
					1	Uwau
9959	Lunaai	8	2	2	2	Poea
10229	Mahule	5	1	1		Kuaiokumu
10437	Naaweawe	6	1	1		Kuakaikoo
		1				Hopekea

As there is some discrepency between the claims made by awardees and the testimonies of witnesses to corroborate those claims, I have listed only the claims. For information concerning testimonies (which in some cases provide more detailed land use information), refer to the "Foreign Testimony" volumes of the Land Commission Award records, Hawaii State Archives.

* Māla means garden, plantation, cultivated field (Pukui and Elbert 1972).

to be heavily eroded. The furthest inland parcel is densely covered in tall grasses and may be similar to lease 71 in SA I; that is, an historical irrigation system may be preserved under this grass cover.

Survey Area V

Survey Area V follows the route of Waiahole Homestead Road from Kamehameha Highway to approximately 1035 m (3395 ft) inland. The entire length of the present road is unpaved and closely hemmed by residences and cultivated fields (Figure 15).

No surface archaeological structures were observed, but based on the kinds of sites found elsewhere in the valley (e.g. buried cultural deposits like 3512 and 3526 and artifact scatters in plowed fields like 3514 and 3525), the absence of surface sites should not preclude the presence of the buried ones.

FIGURE 15. VIEW TOWARD MAUKA NEAR INLAND END OF SURVEY AREA V.

Section III.
EVALUATIONS OF SIGNIFICANCE AND RECOMMENDATIONS

Twenty-eight archaeological sites in four parcels were located in this survey in Waiāhole Valley. The purpose of this chapter is to evaluate the significance of these sites and give recommendations for their management.

A reconnaissance survey is merely a first step in identifying and evaluating archaeological resources. It essentially provides an impression of the kinds and distribution of sites that exist in a particular area. And thus, it can provide only a tentative notion of the significance of those sites.

Thus, statements of significance made in this report are, of necessity, preliminary ones, and further historical or archaeological research may result in changes in these evaluations.

Assessing Significance: the Archaeology of Waiāhole

Evaluating the significance of an archaeological site and making recommendations for its disposition in the face of potentially adverse situations can be, contrary to some thought, an objective process. Objectivity requires criteria and that is provided at the federal level by the National Register of Historic Places.

The National Register "Criteria for Evaluation: (NHRP 1977) states that the quality of significance is present in sites

> ...that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:
> A. that are associated with events that have made a significant contribution to the broad patterns of our history; or
> B. that are associated with the lives of persons significant in our past; or
> C. that embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
> D. that yielded, or may be likely to yield, information important in prehistory or history.

These criteria can be summarized in three primary frames of reference: research potential, cultural import, and public value.

Research Potential

Research value lies in the potential of a site to answer questions of substantive or methodological import, or to contribute to an understanding of cultural patterns and processes or the history or prehistory of an area. Criteria for dealing with these issues include the uniqueness of a site relative to associated features or archaeological areas, availability of supplementary historical information, the condition of the site, and the kinds of information retrieveable.

There are at least three current research problems in Hawaiian archaeology which may be addressed by sites found in this survey.

1) The human influence on the natural environment, particularly in the development of agricultural systems by pre-Contact Hawaiians.

   On-going work at Kahana Valley (to the north of Waiāhole) is suggesting that agriculturally related burning on the valley slopes, possibly in the very early settlement period (pre-AD 1000), may have induced major erosion and infilling of the bay, resulting in a coastline change to the present configuration (P. Beggerly, pers. comm.). A similar idea for environmental degradation has been inferred for the island of Kaho'olawe, possibly as late as the AD 1500s (although chronological control is presently tenuous)(H.D. Tuggle, pers. comm.). Trembly's interpretation of lower Waiāhole Valley as an alluvial deposition over lagoon, muck, or peat (Trembly 1982) may reflect an analogous process of environment degradation and coastal infilling.

   Examination of the deposits in site 3526 along the banks of lower Waiāhole Stream and monitoring of the waterline planned for Waiahole Homestead Road (also in the lower valley) may reveal data applicable to this research problem; in particular, evidence for a lagoonal situation during the period of human occupation in Hawai'i (at least by AD 600), which could support human involvement in the subsequent landscape changes.

Landscape alteration in the development of complex irrigation systems by Hawaiians could also be examined in this context. For example, the area around the junction of Waiāhole and Waianu Streams is heavily eroded, probably from flooding. This situation has apparently developed in the last 50 years, as the 1928 aerial photograph shows well-kept fields at this locale. Modification of the natural stream regime for irrigation and the development of terraced fields at the stream juncture may have created an artificially stable situation which collapsed when the system was abandoned. Study of the archaeological remains of this historical occurrence may help in the development of specific research models and hypotheses useful in understanding similar prehistoric situations. Sites which are applicable include 3500, 3502, 3507, and 3508, which are irrigation-related features in this area.

2) The study of lithics, i.e. the process of stone tool manufacture.

Research in this field has focused primarily on the major basalt quarries near the summit of Mauna Kea on the island of Hawai'i. Little has been done on quarry sites elsewhere in the islands. However, a collection and analysis of material from the two Waiāhole quarries (reported by Kikuchi 1964) was carried out by a University of Hawaii-Manoa archaeology class in the fall 1982. This initial work can be supplemented by analysis of material from sites located in the present survey.

The range of stone artifact types and sizes from these sites suggests the quarried material was refined in workshop areas on the valley floor (e.g. sites 3505 and possibly 3512) and then distributed throughout the valley (flakes have been found in site 3514, near the Waiāhole-Waianu Stream junction, and at sites 3524, 3525, and 3526, on the coastal flat). Sourcing of raw material and analysis of stone tool characteristics and associations with other artifact types may add to an understanding of lithic manufacture within this localized area, as well as provide data for comparison with the Mauna Kea sites and material.

3) The archaeology of the 19th and 20th centuries.

This is a facet of Hawaiian archaeology which has been long neglected. In the past, Hawaiian archaeology has generally been considered the study of Hawaiian culture for several reasons (both academic as well as perceptual), including a focus on Polynesian adaptation to the Hawaiian environment and a lack of qualified historically oriented archaeologists. However, neither of these reasons is currently viable and there is a growing interest in the archaeology of ethnic groups (other than Hawaiian), of plantation systems, and of urbanization, to name a few issues.

The period of the rice industry in Waiāhole was the beginning of major changes in the traditional land use and settlement in the valley. The transition from a predominantly Hawaiian, subsistence-oriented community to one consisting primarily of Asian and haole commercial agriculturalists is little known. Documentary sources, supplemented by archaeological investigations, can lend insight to the cultural continuities, as well as discontinuities, of this period.

Sites such as 3514, which contains a range of artifacts reflecting both traditional and historical occupation, and 3517, which is known through documents to have been occupied by both Hawaiians and rice workers, are of particular interest in this respect.

The impact of commercial rice development on the subsistence taro system (both of which utilized irrigation technology) can also be studied in the coastal flat area, especially along the base of the Kaneloa escarpment where terraced fields are still intact (e.g. sites 3520 and 3524).

Cultural Value

Cultural value is a subtle factor which applies to sites with religious, mythological, social, or historical associations. Although it is generally applied to sites such as Hawaiian heiau and mythical places, historical featuresshould not be excluded from consideration. Sites such as the McCandless Rice Mill (site 3523) which associated with a character very important to the 19th and 20th century settlement in the valley, and site 3506, the irrigation canalwhichis presently being used, come to mind for this category. In the latter example, the continuity of use for over 100 years and its present excellent condition emphasize its "integrity of location, design, setting, materials, workmanship, feeling, and association" (NHRP 1977).

Public Value

Public value applies to the "exhibit and education" qualities of a site; i.e. its ability to inform the non-archaeological public about the past and about how that past is studied by archaeologists (i.e. how and why archaeologists practice their profession).

As an example of the former, site 3513, the Kuleana Ditch, and site 3521, the possible railroad berm, are both well-preserved representatives of the technological developments of their respective periods. Sites such as 3505, 3512, and 3526, which are exposed buried cultural deposits, can show something of the subject of archaeological inquiry, as well as produce artifacts which are intrinsically exhibitable.

Significance Evaluations of Specific Sites

Several sites were evaluated as exceptionally significant and are described below. Table 8 lists all sites, with abbreviated significance evaluations.

Site 3505: flake deposit. This site is an exposed cultural deposit containing considerable amounts of lithic material, including basalt flakes, adzes, a whetstone, and cores. It has been exposed by the construction of an 'auwai (irrigation canal, site 3506), which is described in 1850 land records, thus suggesting an earlier date for the deposition of the lithic deposit.

This site is significant in two respects: 1) it may be possible to trace the lithic material to two quarries located near the top of the ridge which rises from the valley floor near this site. Raw material, adze preforms and blanks, and large flakes and cores have been found in the quarries and this site may be a basalt tool-making workshop to which the quarried material was brought to be refined and fashioned into a final product; and 2) it is one of only two sites in the survey areas (site 3512 is the other) which have no historical associations in the form of written documentation or 19th or 20th century artifacts. Thus, they may be unique preservations of pre-Contact Hawaiian lifestyles in this valley which has seen considerable change since the 1800s.

Table 8.
ARCHAEOLOGICAL SITES AND MANAGEMENT CONSIDERATIONS

Site No.	Site Description	SA	Condi-tion	Signi-ficance	Poten Adverse Impacts	Recommen-dation
3500	Irrig canal	I	Fair	Low	Farm	No work
3501	Platform	I	Poor	Mod	Farm	Test
3502	Terrace facing	I	Good	Low	Farm	Map
3503	Terrace facing	I	Fair	Mod	Farm, erosion	Test
3504	Irrig canal	I	Exce	High	Farm	Map
3505	Flake deposit	I	Good	High	Farm, erosion	Pres/excav
3506	Irrig canal	I	Exce	High	Farm	Pres/map
3507	Mounded wall	I	Fair	Mod	Farm, erosion	Map
3508	Irrig system	I	Poor	Mod	Farm, erosion	Map
3509	Conc/ston found.	I	Poor	Low	Rd construct	Map
3510	Occupation area	I	Good	Unkn	Rd construct	Test
3511	Irrig canal	I	Poor	Low	Rd construct	Map
3512	Buried deposit	I	Exce	High	Rd construct	Pres/excav
3513	Kuleana Ditch	I	Exce	Mod	Rd construct	Pres/map
3514	Artifact scatter	I	Fair	High	Farm	Test
3515	Road bed	I	Fair	Low	None known	No work
3516	Irrig canal	I	Poor	Unkn	Farm	Test
3517	House/pit	I	Exce	High	Farm, rd const	Test
3518	House	I	Exce	Low	Farm	Map
3519	Ka Loko Manu	II	Poor	Unkn	Farm	Map
3520	Irrig canal	III	Fair	Mod	Farm	Map
3521	Embankment	III	Exce	Mod	Farm	Map
3522	Road bed	III	Good	Low	Farm	Map
3523	Rice Mill	III	Poor	High	Farm/residence	Test
3524	Irrig canal	III	Exce	High	Farm	Test
3525	Artif. scatter	III	Fair	High	Farm	Test
3526	Buried deposit	IV	Exce	High	Farm/erosion	Test
3527	Irrig canal	IV	Fair	Low	Farm	No work

Site 3506: irrigation canal. This site is an irrigation canal which begins at site 3505 and winds its way down the south side of the valley, across Kamehameha Highway, and into the ocean. Although its present intake can be dated to 1950, the canal itself has long appeared on historical maps and is mentioned in several Land Commission Award testimonies from the mid-1800s. Its origin may predate the earliest records since taro cultivation in the valley (for which the south side of the valley is a prime environment) is noted in several legendary traditions.

The significance of this site is precisely its continuity ---beginning in the far past, its history is continued today, as it waters the fields under lease 91. Thus, its significance is not so much in its research value, but in its cultural value (as an asset to traditional Hawaiian, 19th century Chinese, and modern farmers) and in its public value (as a tangible link among the different periods of the valley's agricultural history).

Site 3512: buried occupation deposit. This exposed cultural deposit contains lithic material, scattered charcoal, fire-cracked rock, identifiable fragments of vegetable material, and two firepits; it is clearly a habitation site. It is significant for three research reasons: 1) as noted for site 3505, this site is one of the few sites which may not have been impacted by the 19th century rice industry and thus, may contain evidence for the traditional Hawaiian use of the area; 2) its location on the knoll which separates the two primary drainages in the valley suggests an association with agricultural fields along the streams, a pattern which has recently been documented for the windward O'ahu area (in Bishop Museum work at Kawainui Marsh, Kailua); and 3) the abundance of lithic material in the deposit suggests a special activity related to this occupation, possibly tied to the two quarries mentioned above.

A wood sample collected from one firepit has been tentatively identified as koa (Acacia koa), a native forest tree, extensively used by Hawaiians for ceremonial items, canoes, and household implements. There was no example of this tree observed in the vicinity of the site, thus suggesting some antiquity for the firepit.

Cutting through the deposit to the northwest of the present road cut is site 3513, the remains of an irrigation ditch probably constructed as part of the rice industry operations. Although it is clearly separate in nature and chronology from site 3512, it should be considered part of the locale complex in any management decisions.

Site 3514: artifact scatter in plowed field. Over 230 artifacts (basalt flakes and cores, polished adze fragments, volcanic glass flakes, ceramic sherds, and bottle glass) were noted in an area of 20 by 50 m, in a field under lease 73. The chronological range of these artifacts reflects a continuity of occupation from at least the early 19th century, and possibly earlier in the prehistoric period.

This particular field was surveyed (rather than bypassed as a disturbed area) because 1) it had been freshly plowed but not yet replanted; 2) artifacts had been found earlier in a field outside of the survey boundaries (but labelled as site 3525) and I wished to test whether the presence of those artifacts was a unique instance of preservation; and 3) the field falls within the boundaries of a recorded land grant and was possibly the site of a house noted on the Dove 1897 map.

This site is particularly significant as it shows the viability of plow-zone surveys in Hawai'i, a methodology which heretofore has not been attempted, but which has the potential to yield valuable evidence on Hawaiian habitation and agricultural practices (given the large acreage presently under cultivation throughout the islands).

Site 3525, a similar artifact scatter in a plowed field, is evaluated as significant in this same light. However, as it was neither mapped nor even examined to the same extent as 3514, this evaluation is tentative.

Site 3517: abandoned wood frame house and associated trash pit. Although this site may appear to be a broken down, abandoned shack on the edge of Waiahole Homestead Road, it has a history which goes back at least to the mid-1800s and certainly to the turn-of-the-century when it was noted on the Dove 1897 map. The presence of the nearby trash or outhouse pit offers an opportunity to investigate the occupation of the flat on which the house stands and its possible association with the rice fields which once occupied the now overgrown expanse of lease 91.

Site 3523: McCandless Rice Mill. The known remains of this rice mill consist of a concrete foundation for a water-wheel and an exposed bedrock channel of an 'auwai which powered the wheel. However, the locality is definitely that of the former rice mill, constructed in the last decades of the 19th century, by a character, L.L. McCandless, who played a major role in the historical use and modification of the valley landscape.

An interview with the present resident of the site revealed that the escarpment adjacent to the channel had been long used as a trash dump and historical bottles and miscellaneous paraphernalia from the 1800s and early 1900s have been seen on the slope. In controlled excavation and with laboratory cataloging and analysis of this material, such a dump can be significant in two ways: 1) it could add considerable information on the changing character of the occupants of this area, from long-ago Hawaiians, to rice plantation employees (in 1897, plantation quarters were located near this slope), to present-day truck farmers; and thus add details to the cultural history of the valley; and 2) in a larger context, it could be used to assess the impact of growing urbanization in Honolulu and Kāne'ohe on a transitional rural area, i.e. the distribution in the kinds and quantities of historical material could suggest the kinds of economic (and by extension, social) ties which connected Waiāhole with other parts of the island.

Site 3524: irrigation canal and rice fields. This site locale is the best preserved of any "rice-related" sites in the survey areas. It shows the junction of several irrigation canals, as well as the fields which those canals fed. Further, there is some hint of traditional Hawaiian use in the presence of a basalt flake on the canal bed. Research value is high, in furthering understanding of technical aspects of the rice irrigation system, as well as investigating the possible preservation of a Hawaiian system beneath or integrated with the historical one.

Site 3526: buried cultural deposits. The cultural deposits located in the banks of Waiāhole Stream show detailed evidence of the agricultural history of the valley: at least two cultivation periods which are separated by a flood event, as well as the development of the flood plain on which the taro and later rice fields were constructed. Also, the presence of considerable amounts of charcoal in the profiles can be important in dating these events.

As mentioned above in the section on research value, this site may be useful in the investigation of early human impact on the natural environment.

Nomination forms for the National Register of Historic Places have been prepared for these sites and are included as Appendix IV.

Making Recommendations

Archaeologists deal in fragments of time and space. Sites are created, modified, buried, eroded, and buried again. And when found and excavated by archaeologists, only glimpses of these remnant sites can be seen, limited by the constraints of excavation sampling. Thus, one never knows the full extent of a site; one can only hypothesize its size, depth, chronology, function, and most of all, what that site represents in terms of the people who originally created and used it.

This problem is compounded in doing archaeology by contract because the archaeological work is often followed quickly by whatever development originally generated the work, whether highway, building, waterline, or harbor. Sites and their information are thus irretrieveably lost. For a discipline that deals with fragmentary data to begin with, this loss is indefineable.

It thus becomes critical to maximize the kinds and amounts of information which are collected. Recommendations of "no further work" or "clearance for use" must be as justified in archaeological terms as those for "additional research" must be in client/management terms.

This particular project was generated by an agricultural development which will adversely impact archaeological resources in two primary ways: through infrastructure development and farmlot expansion. Road construction and utility installation will almost certainly destroy surface features and disturb buried deposits within specific corridors of impact. Increasing farm activity will affect sites on a much broader, but less defined, scale. On-going bulldozing activity observed during the period of survey (and presumeably related to present farming) has already impacted sites which are described in this report.

Natural erosion is an additional concern, particularly around the junction of Waiāhole and Waianu Streams.

The recommendations presented in Table 8 are site-specific courses of action which should be undertaken if there is potential for adverse impact, primarily within the infrastructure corridors and in new farm lots. They are minimum levels of work and should not preclude additional research if that is warranted by subsequent analysis.

It should be emphasized that the process of archaeology is one of phases of discovery; any one phase or level of work may be the terminus of the process, but it can also be the beginning of another phase. It is difficult to predict how much work ultimately will have to be done, without proceeding on a step-by-step basis. The steps, or levels of work, are:

1) intensive survey: to detail surface characteristics of specific, defined sites through plane-table or transit mapping. For some sites, this may be all that is necessary to record pertinent data, but mapping may indicate that a site is more complex than first appeared and subsurface work may be recommended;

2) subsurface testing: vertical version of the reconnaissance survey, i.e. to look for the presence or absence of buried deposits. It may reveal that a site is shallow or contains minimal amounts of cultural material. Or, the site may be a rich one which requires full excavation to understand its process of creation and change; and

3) excavation: to recover the information which is contained within a site before the site is destroyed; field work should be preceded by the development of a research design which should intellectually and pragmatically organize the excavation, e.g. to determine the size of the sample to be dug, where to dig, and what kinds of information to look for.

In all cases where further work is carried out, a reevaluation of significance and reconsideration of recommendations should be done.

In some select cases, preservation, or the protection of site integrity by altering development plans to avoid a site, is the most desirable recommendation. Again, the emphasis is on the conservation of archaeological sites as a nonrenewable resource. Preservation should include a buffer zone of at least 50 feet beyond the immediate site features. However, if development plans are not flexible, alternative recommendations for mitigation of adverse impacts are provided.

Recommendations

The following recommendations are organized into general and specific categories. General recommendations address long-term responsibilities for managing archaeological resources in the valley. Specific recommendations are directed toward immediate plans for infrastructure and farmlot development.

General Recommendations

1) The primary recommendation of this report is the development of a plan for the management of archaeological resources within the Waiahole Valley Agricultural Park. By preparing such a plan, a piecemeal and perhaps more time-consuming approach to

site management and mitigation of adverse impacts can be avoided.

A management plan should include an inventory of known archaeological and documentary resources, a discussion of archaeological/scientific concerns and their relevance and applicability to management concerns, and a projection for kinds, amounts, and scheduling of necessary work for resource conservation and mitigation.

An outline for a cultural resource management/data recovery plan is included as Appendix V.

2) Subsidiary to this recommendation is the need for continuing survey to ascertain a more comprehensive view of the extent and nature of the archaeological resources in the valley. Selection of survey areas under the present contract was based on an evaluation that sites would exist and be preserved in presently unused areas which fall within the boundaries of mid-19th century land awards. However, based on the findings of this survey, neither of these assumptions is wholly accurate. Sites were found that were not within the boundaries of Land Commission Awards (e.g. site 3512) and that were in plowed areas (e.g. sites 3514 and 3525).

Therefore, continuing reconnaissance level survey is recommended for presently unused areas (particularly along Waiāhole Stream, mauka of lease 91) and intensive transect survey is suggested for selected cultivated fields. As per the latter, with the discovery of artifactual material in two plowed fields, there is now a possibility that the valley may contain intact archaeological sites even in cultivated areas. As this is still a hypothesis supported by only two limited tests, mapping and subsurface coring is recommended to determine the general presence of preserved subsurface cultural deposits. Fields in all micro-surface regions (as applicable, see Figure 2) should be included.

3) A recommendation made in the earlier reconnaissance survey report was to nominate the entire valley to the National Register. However, I feel that the data from this level of work is insufficient to support such a nomination, which may be appropriate following additional survey and mitigation activities (in lieu of a district nomination, forms for individual sites have been completed and are included as Appendix IV).

Specific Recommendations

1) Proposed Waiahole Valley Road. All sites located within the right-of-way or at least 100 ft from the center line of the proposed road should be further examined:

Site 3510: Although there are no surface indications of a habitation area, this site should be test excavated for buried occupation deposits. Should such deposits be found, a salvage excavation may become necessary. Sites 3509 and 3511, which are adjacent to site 3510, were evaluated as low significance features. However, because of their proximity to this site, they should be included in these investigations.

Site 3512/3513: This complex should be instrument mapped (by plane-table or transit) and salvage excavated. The present road cut has revealed enough of the site to 1) evidence the presence of buried deposits, and 2) estimate the horizontal extent of this site. Therefore, no testing is recommended before salvage work is carried out. At a minimum, excavation should be done to determine the function and chronological context of the site.

During construction of the roadway and associated utilities, monitoring by a qualified archaeologist should be undertaken, particularly when trenching for installation of utilities is being done.

2) Proposed waterline installation along Waiahole Homestead Road. Although no surface sites were found along this route, this does not preclude the presence of buried ones. Therefore, monitoring by a qualified archaeologist should be undertaken during construction work.

3) New farmlots. Under the assumption that all new leases will entail some intensification of use in presently unused areas, it is recommended that all sites falling within new lease parcels require additional work (as listed in Table 8). A reevaluation of significance and recommendations should be made following that work.

4) In areas in which the present level of use is maintained, no further work is necessary unless that level of use is intensified (e.g. by bulldozing, grading, house foundation excavation, cultivation by heavy machinery). At that time, a reassessment of this recommendation is necessary.

For example, site 3524 is in an area used for pasture, and is presently in no danger of adverse impact. However, should the lessee decide to intensify use by cultivation or construction, such action may affect the integrity of the site and further archaeological work would be necessary.

Measures for implementing this recommendation can be incorporated into the cultural resource management plan.

5) Preservation. This is an alternative which entails protecting a site (within a buffer zone) from any future adverse actions. Two sites are recommended for preservation:

Site 3505: All eroded lithic material should be collected, analyzed (especially in relation to the collected material from the two quarries) and reposited at the University of Hawaii-Manoa Archaeology Laboratory (the repository of the quarry material) as part of the preservation procedure. The material is at present in danger of being washed away by floods from Waiāhole Stream.

Site 3506: The preservation of this feature and encouragement to continue its use are not incompatible.

In Table 8, sites 3512 and 3513 are also recommended for preservation. However, they are in the direct path of a proposed road and the probability of their well-being is low. Recommendations for their disposition are thus discussed under item 1 of the specific recommendations.

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Appendix I.
SITE DESCRIPTIONS

3500: Irrigation canal: shallow, unfaced ditch, ranging in width from 1.0 to 2.0 m across; runs in an E-W orientation through pasture under lease 90, into hau thicket, and eventually into Waiāhole Stream above its junction with Waianu Stream. Where ditch enters hau thicket, there is a small pile of pebbles and cobbles on its N bank which may be from ditch maintenance; cobbles and boulders in the area suggest possible disturbance of ditch facings (which are no longer apparent). Under the hau growth, which is an area of considerable flood disturbance, the ditch appears to have widened and braided.

This site is located in SA I, in an area identified as LCA 7572: 1 to Kupoepoe, which land records indicate was cultivated in irrigated taro. Although these records do not specify the presence of a canal, such a feature would not have been unusual in an irrigated field. The canal was present by at least 1910 (Miyagi 1963: Figure 23) and is clearly visible on 1928 and 1971 aerial photographs. There is no apparent current use.

The site is in fair to poor condition, having been subjected to the vagaries of plow and bulldozer. This, and the fact that the agricultural system of which it was undoubtedly a part no longer exists, assigns it to a category of minimal significance in all respects.

3501: Platform: 4.0 m by 3.0 m, approximately 50 to 60 cm high (Figure 16). This feature is located on the S boundary of the field in lease 89 in SA I. It is constructed of rounded boulders, with cobble fill. The facing is in poor condition and collapsed on the E side. There is an aluminum beer can at the SE corner. A large embankment bordering the lease 89 field has obliterated or covered the N half of the structure.

This site is in poor condition. There is some excavation potential to determine site function and chronological context, especially as this is a possible habitation remnant of a known agricultural complex (LCA 7572:1). There is little public or cultural value.

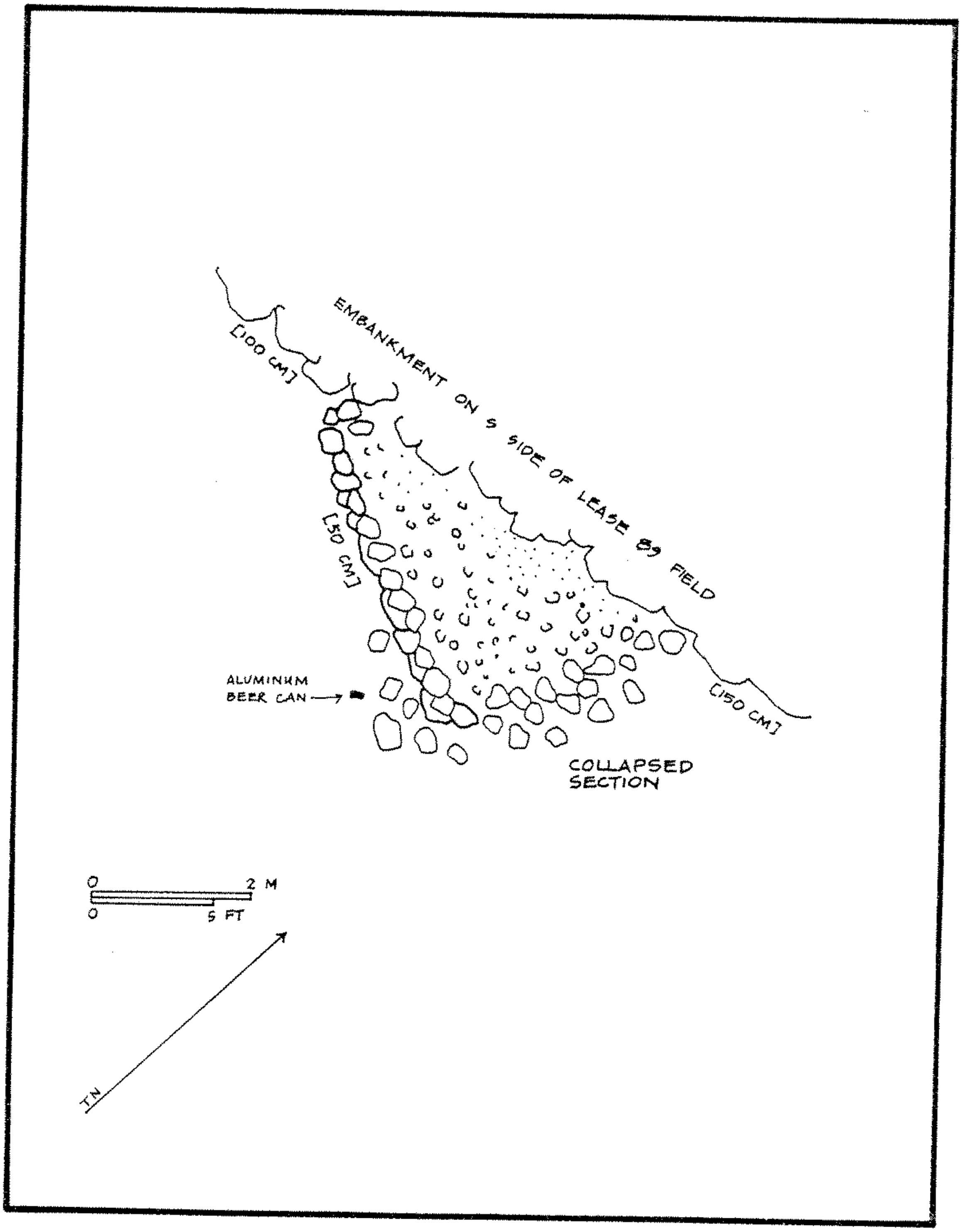

FIGURE 16. SITE 3501.

3502: Terrace facing: partially faced embankment which parallels the SE edge of the field under lease 89. It is well-faced in sections, up to 1.0 m high, of rounded to sub-rounded boulders. A watercourse (probably the E extension of site 3500) runs along the base of the embankment and exhausts into the junction of Waiāhole and Waianu Streams. The facing, which drops to the S, is at least 25 m long; its entire configuration could not be determined due to the extremely thick grass and hau cover.

This structure is located within the boundaries of LCA 7572:1 to Kupoepoe. It is located in SA I.

The site is in moderate to good condition where it could be seen. It has little excavation potential although its spatial extent should certainly be determined if there is probability of adverse impact. It has little public or cultural value.

3503: Possible remnant terrace facing: rounded and sub-rounded cobbles, forming a facing about 30 cm high, exposed in the low, N bank of Waiāhole Stream approximately 95 m (300 ft) W of SA I. This feature may be a natural deposit; there is a large amount of similar material in the adjacent stream bed and along the stream sides.

A deeply cut canal which flows into Waiāhole Stream from the S side, directly across from this possible terrace remnant, is probably of recent construction, built to alleviate flooding in the adjacent pasture area (V. Texeira, pers. comm.). Where this canal cuts along the base of the valley side, approximately 50 to 75 m (165 to 250 ft) mauka of this site, a basalt flake was found in the side of the canal.

This site is in fair condition. Its research value is high, as it may contain intact cultural material. There is little cultural or public value.

3504: Irrigation canal: 1.0 m wide, about 50 cm deep; flows makai along the S edge of the valley floor in SA I; source unknown. Some large boulders which are visible in the bank may be a remnant facing; appears to be generally unfaced.

At one point, it is joined by a channel off of Waiāhole Stream, below which is a recently constructed dam of corrugated metal supported by hau stakes. This dam is to channel water into another ditch, site 3506.

This feature continues downstream, paralleling another canal (site 3506), and joins the main channel of Waiāhole Stream, *mauka* of its junction with Waianu Stream (Figure 17).

The dam, approximately 5 m across, forms a deep, narrow pool behind it. It is oriented E-W. The area around the pool and dam is level and covered with rounded pebbles, suggesting a flood wash area. The steep ridge forming the southern boundary of the *ahupua'a* is to the immediate S.

A 2.0 m long alignment of basalt rocks extends across the canal at its junction with Waiāhole Stream. This rudimentary dam consists of two courses of boulders, approximately 30 to 40 cm high.

This site is in excellent condition. Although its excavation potential is low, its research value is high in terms of examining the control of water in the irrigation regime and the continuity of the irrigation system from traditional to modern times. Sources for research include intensive mapping of the archaeological features, historical documents which may give some chronological control, and oral histories. Cultural and public value is limited.

3505: Flake deposit: exposed in 2.5 to 3.25 m high bank, cut into ridge probably as a result of construction of the site 3506 canal intake. A layer of *in situ* flakes occurs in the uppermost 20 to 30 cm of the exposure; below this is what appears to be flakes in an eroded slump deposit (see inset, Fig. 17). Flakes are exposed throughout the cut bank adjacent to the irrigation canal pipe, as well as to the *makai* (although not in as great a concentration). A few scattered basalt flakes were also observed on the surface of the steep slope above the cut bank. Flake material was also observed on the level surface of the pipe, but not on the embankment of the canal to the *makai* of the concrete foundation. This suggests that the main area of the deposit already has been exposed by the canal construction.

The *in situ* deposit is characterized by horizontally oriented flakes in the upper 20 cm; between 20 and 30 cm below surface, are a few scattered flakes, also oriented horizontally, and some scattered charcoal (see Figure 17, inset).

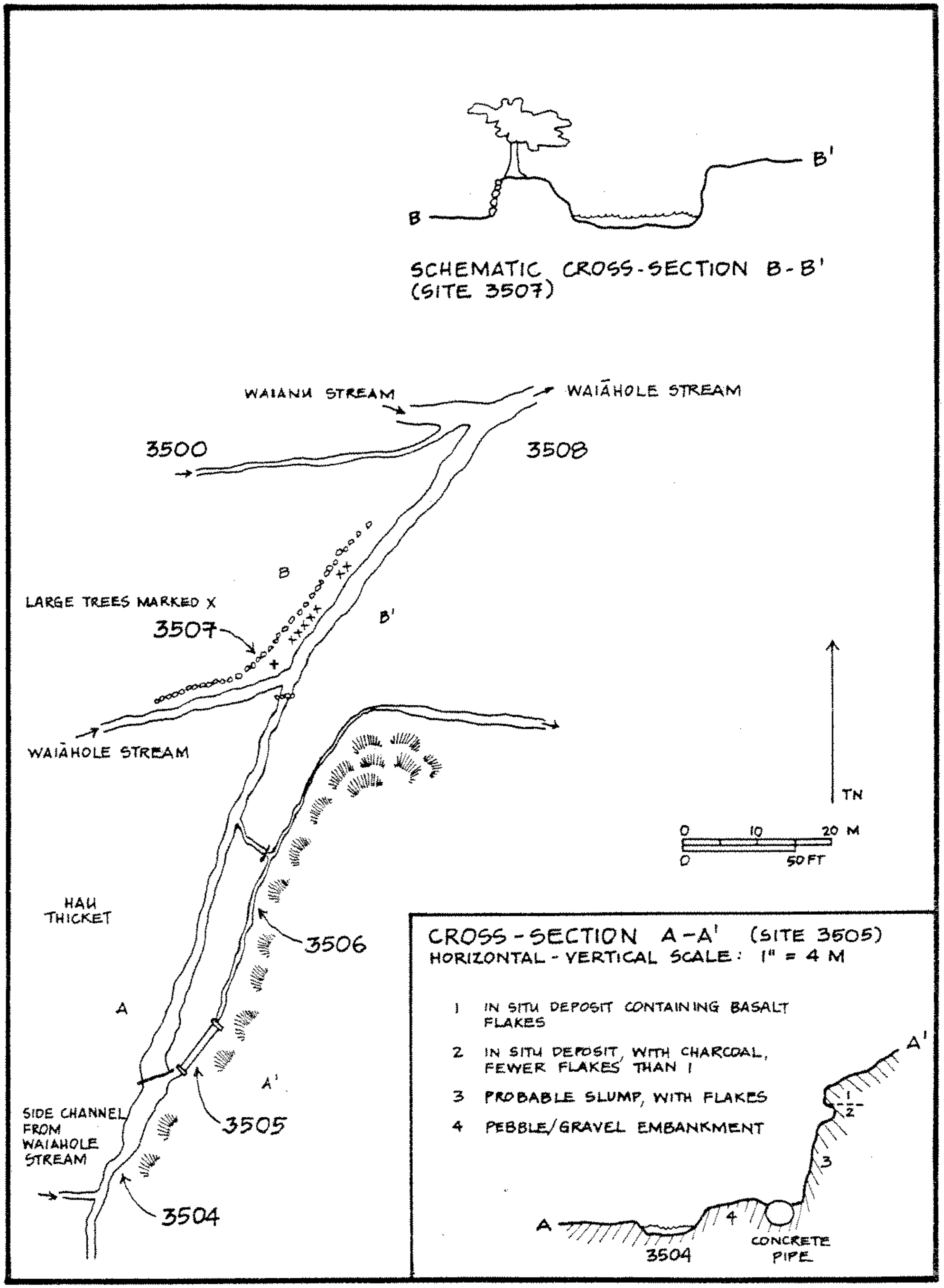

FIGURE 17. SITES 3504, 3505, 3506 and 3507.

The basalt flakes, which are visible on the vertical surface of the cut bank, number at least in the hundreds (in an area of approximately 24 sq m). They include all sizes, from large (5 by 5 cm) to small (2 by 2 cm or less). Most would appear to be in the mid-size range. Most flakes have dorsal flake scars, prominent bulbs of percussion, and step or hinge flake termination. The material is dense, fairly fine-grained, grey basalt, with no phenocrysts. There is no obvious exposure of raw material in the immediate vicinity, although two quarries have been identified near the top of the ridge above this site (approximately 575 m or 1800 ft distant). At least three adze blanks were present in the surface of the cut (Figure 18).

Although there is no mapped Land Commission Award associated with this locale, it is possible that the site area may fall within the bounds of LCA 7572:1, as described in testimonies for this claim. LCA 8830/7647 is also in the immediate vicinity. The site is located in SA I.

The site is in good condition, although it appears to be in a state of continuing slow erosion. It has high research value, as one of the few sites of probable prehistoric origin located in this survey and for its potential (in association with the nearby adze quarries) for investigating traditional lithic manufacture and use. Public value is high, as the deposit and its contents can lend themselves to display. Cultural value is minimal.

3506: Irrigation canal: well-formed channel, which appears to be presently maintained and is in excellent condition. It begins as an off-shoot of the site 3504 canal. The head of the ditch consists of a six m long iron or concrete pipe (diameter approximately 30 cm or 12"), which is partially buried in the ground. Both ends are anchored in concrete and boulders (the downstream end is marked "2.7.50" with "MT" inscribed next to it). Water gushes from the pipe into an 80 to 100 cm wide channel.

Approximately 35 m downstream of the canal intake, a possible overflow dam, of similar construction to the one described for site 3504, connects this site with 3504. At this locale (see Figure 17), a small hollow has been dug into the exposed and cut side of the ridge.

In the same area where site 3504 joins Waiāhole Stream, the 3506 canal makes a sharp turn to the E and runs

FIGURE 18. STONE TOOLS FROM SITE 3505.
(adze blanks in top row)

makai along the base of the valley side. At the base of theridge which forces this sharp turn is a small, level area which is described as a house site for LCA 7647; a structure is visible on the 1928 aerial photograph. A search for evidence of a habitation site was made but only an inconsequential pile of very recent trash was found.

The canal continues beyond the makai extent of the survey area and feeds into the taro fields in lease 91 (see Figure 7).

This canal is primarily a dirt-faced channel, but cobbles and boulders have been placed in strategic places, particularly where there is potential for flood damage. At one point where it makes a sharp-angled turn, it has been well-faced with cobbles and boulders, with facings up to 70 cm above the present water level.

This feature is also associated with sites 3516, 3517, and 3518. The first is a possible subsidiary canal feeding fields in what is now lease 71. Sites 3517 and 3518 are wood frame houses in close proximity to the canal.

This feature is described in several of the LC award testimonies (for LCAs 10230, 7660, 7650, and 7664). It is also shown on a map of 1910 irrigation ditches (Miyagi 1963: Figure 23). Miyagi (1963: 113) notes that this 'auwai appears consistently on all the historical maps he examined; and that it diverted water from upper Waiāhole Stream and irrigated the lowlands S of the main stream.

This feature runs almost the entire length of SA I and is in excellent condition. For the same reasons given for site 3504, this site is evaluated as having high research and public significance. Its cultural value is also high as it is an integral part of a continuing agricultural system. A recommendation of preservation, in this case, should not preclude continued use.

3507: Mounded wall: may be a possible levee to protect adjacent fields from flood waters backing up above the junction of Waiāhole and Waianu Streams. The wall is faced on the side away from the stream for a short section of its 20 m length. The facing is of stacked basalt boulders and is 75 to 100 cm high (see Figure 17).

Its _mauka_ end extends into a thick _hau_ grove, through which it was followed for a short way in the survey before the vegetation became impenetrable. The site is probably within the bounds of LCA 7572:1, in what is now SA I.

This site is in fair condition. Its research value is moderate as it relates to the irrigation system associated with LCA 7572:1, but excavation potential is low. Public and cultural value is minimal.

3508: Irrigation system: consists of remnant terrace facings and a possible irrigation channel, located on the S side of Waiāhole Stream, at the junction of Waiāhole and Waianu Streams, in SA I (Figure 19). The site is in extremely poor condition, primarily from stream overflow and alluviation, and from considerable recent bulldozing at its W extent. Most of the features are buried with only the uppermost rocks of terrace facings visible. N-S oriented walls appear to continue into the virtually impenetrable grass in the abandoned field under lease 71. Portions of the site appear on the 1928 aerial photograph (see Figure 11a).

The site extends approximately 200 m (650 ft) downstream.

This site is in poor condition, and as such, it has only moderate potential for research. However, it is definitely a part of the traditional agricultural system described for LCA 7647 in land records and on the 1897 Dove map. It can perhaps say something on the continuity (and contrast) of the Hawaiian system with the commercial rice period. Public and cultural value is minimal.

3509: Concrete and stone foundation: located along the edge of Waianu Stream, approximately 45 m (140 ft) _makai_ of the Waianu Stream bridge; approximately 2.0 m long, 25 cm high, and 25 cm wide, of rounded boulders set in concrete. The feature may have been a canal intake, but its associations with any other cultural features, even the canal described under site 3510, are tenuous.

This site has minimal significance in all respects. There has been considerable disturbance by a recent trash dump in the area to the north.

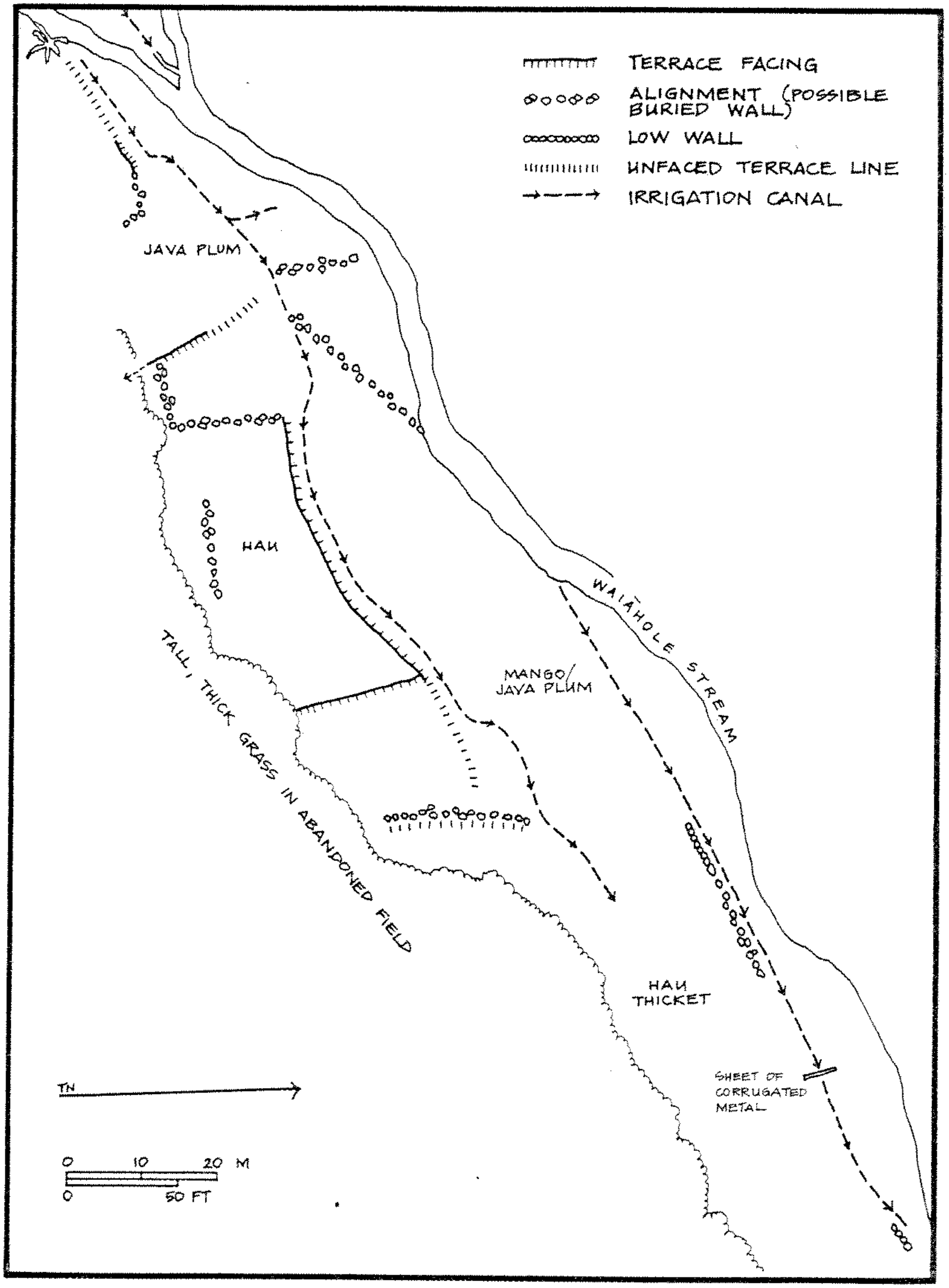

FIGURE 19. SITE 3508.
(features appear
to continue S
into tall grass)

3510: Possible occupation area: located on stream flat immediately makai of the Waianu Stream bridge and S of Waiahole Valley Road. Although there are no evident surface features, there are several plants in the vicinity (such as noni, banana, coffee, and mango) which suggest an historical occupation.

This area corresponds with a notation on the 1897 Dove map of a structure in LCA 10228:2. An erosion cut bank along the S side of this area, which may connect with the site 3509 feature, may correlate with an irrigation canal also marked on the 1897 map.

Further work is needed to test the possibility that this is indeed an occupation site. Its potential historical associations with both the LC award and with late 19th century activities in the area lends to its research value. It has minimal public or cultural value.

3511: Irrigation canal and embankment: consists of a poorly preserved canal, sections of which show a cobble facing, and an adjacent embankment; located on the stream flat N of the junction of Waianu and Waiāhole Streams in SA I (Figure 20).

The canal is 1.5 to 2.0 m across and up to 50 cm deep (where faced). The embankment is 1.5 to 2.0 m wide and up to 1.0 m high; it may have been faced on both sides, but the area toward the stream shows signs of considerable flood disturbance which would probably have destroyed any evidence of stonework.

The mauka end of the embankment has been cut off by a meander in Waianu Stream; the makai end of the canal appears to continue makai out of the survey area. Thick vegetation made delineation of these features difficult.

The site is in extremely poor condition from recent bulldozing. Given this, its significance is minimal.

3512: Buried occupation deposit: 20 to 30 cm thick cultural deposit exposed in a 1.4 to 2.0 m high road cut, located mauka of the Waianu Stream bridge (Figure 21); contains lithic material and two firepits (with charcoal, firecracked rock, and identifiable fragments of burnt vegetative material). There is scattered charcoal through the deposit(Figure 22).

The site is situated on the nose of a ridge or knoll which separates the drainages of Waiāhole and Waianu

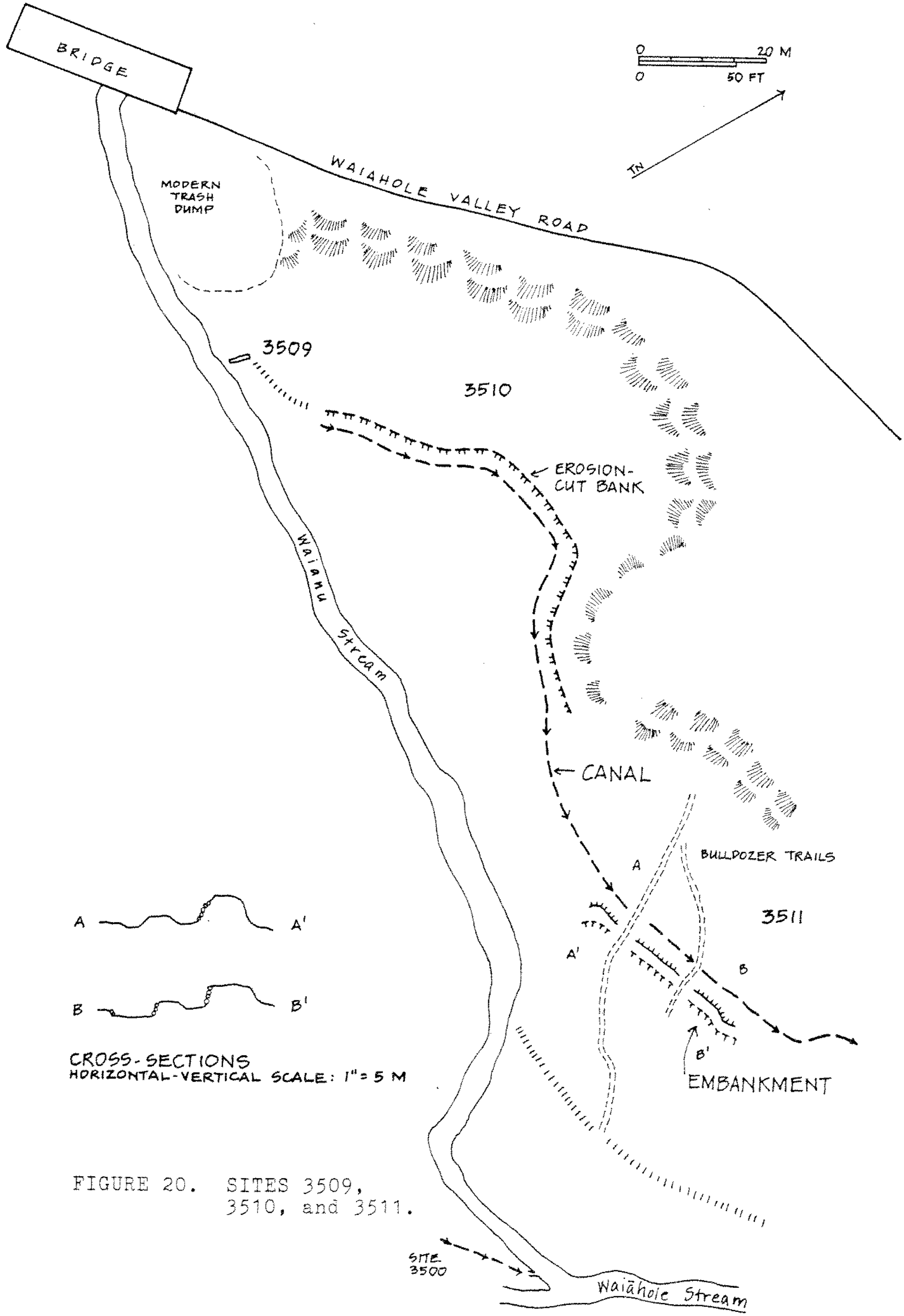

FIGURE 20. SITES 3509, 3510, and 3511.

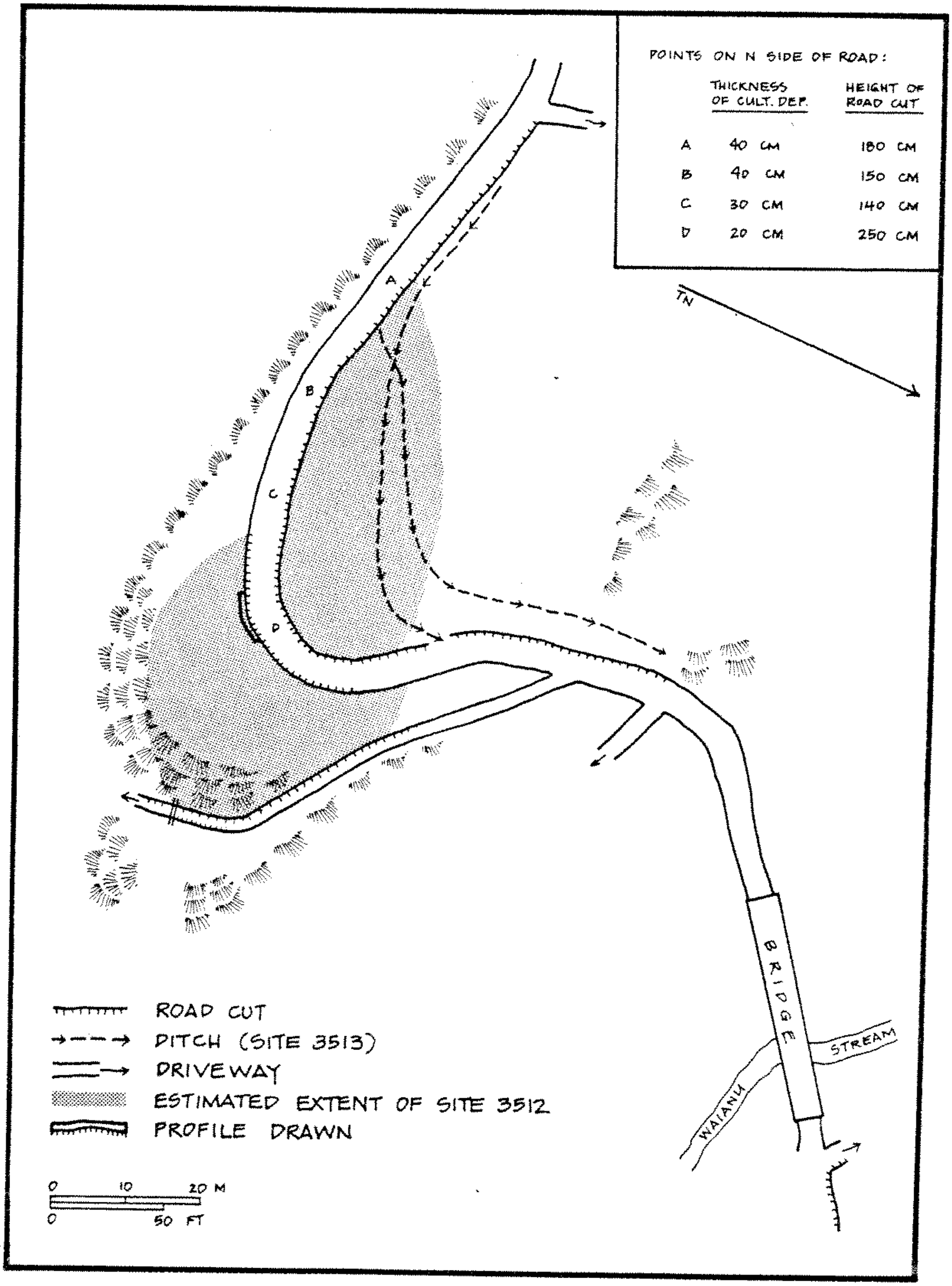

FIGURE 21. PLAN VIEW OF SITES 3512 and 3513.

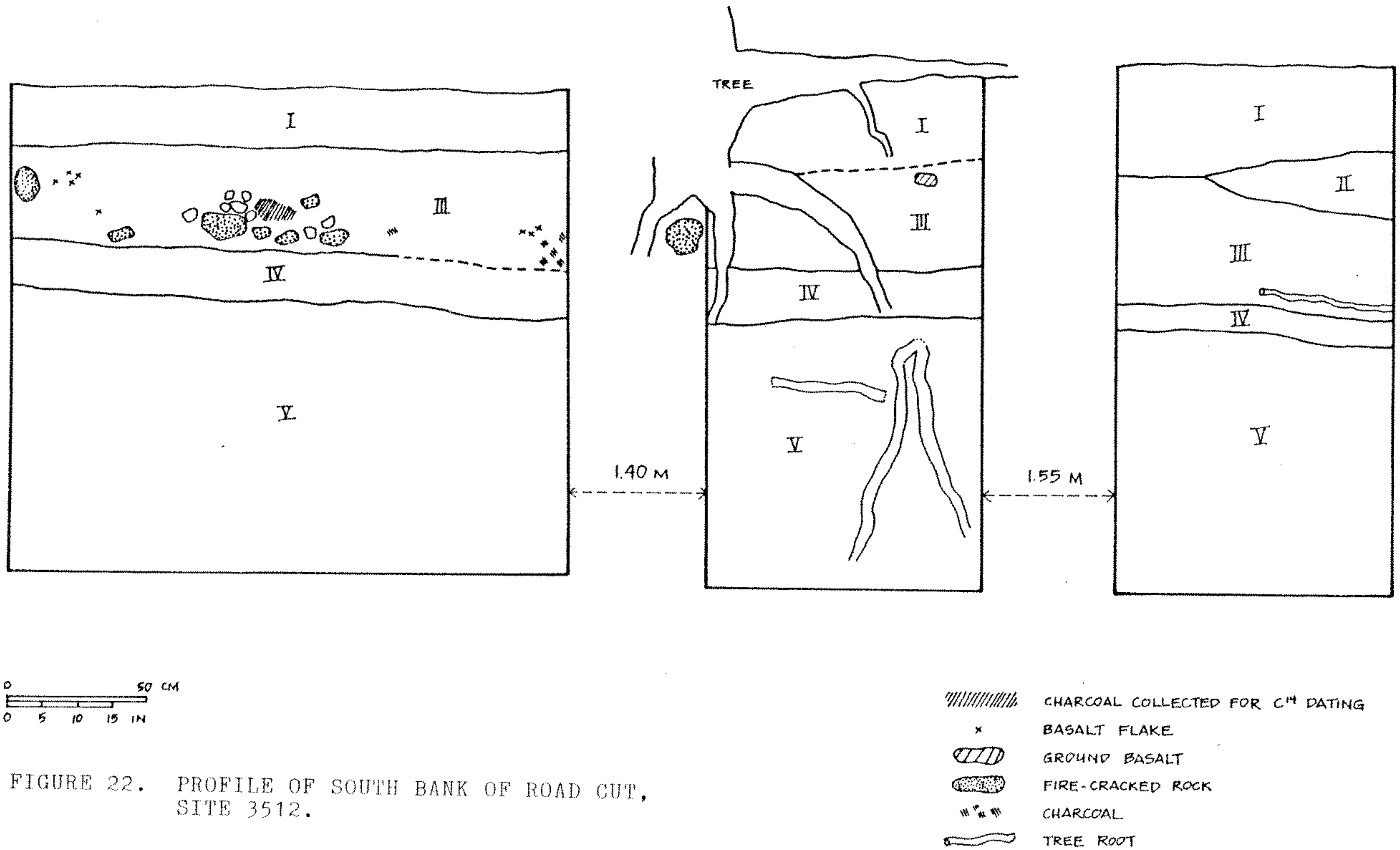

FIGURE 22. PROFILE OF SOUTH BANK OF ROAD CUT, SITE 3512.

KEY TO FIGURE 22.
SOIL DESCRIPTIONS

Stratum I: Dark brown (7.5 YR 3/2, moist) silt clay; strong medium, blocky structure; firm consistence; sticky, plastic; many fine to coarse roots; smooth, clear boundary.

II: Dark brown (7.5 YR 3/2) mixed with strong brown (7.5 YR 5/8, moist) pebbly silt clay; no structure visible; firm consistence; sticky, plastic; many fine to coarse roots; over 50% very deteriorated basalt pebbles (angular); abrupt, smooth boundary.

III: Very dark brown to black (10 YR 2/1.5, moist) silt clay; strong, medium, blocky structure; firm consistence; sticky, plastic; many fine to very coarse roots; fire-cracked basalt, basalt flakes, charcoal, one grinding stone; abrupt, smooth boundary.

IV: Dark brown (7.5 YR 3/2, moist) clay; strong, medium, columnar structure; very firm consistence; sticky,plastic; few medium to coarse roots; less than 10% basalt pebbles; abrupt, smooth boundary.

V: Dark brown (7.5 YR 3/4) mixed with strong brown (7.5 YR 5/8) saprolitic coloring; bouldery, cobbly silt clay; moderate, medium, blocky structure; firm consistence; sticky, plastic; few medium to coarse roots; greater than 30% deteriorated basalt cobbles and boulders (saprolites); lower boundary undetermined.

Streams at the W edge of SA I. The knoll has been cut by Waiahole Valley Road (which was constructed at least by the late 1920s, as it is visible on the 1928 aerial photograph). The deposit was first located in the S exposure of the road cut, then traced in the N exposure, and finally through the grooves of the "Kuleana Ditch" (site 3513), which cuts across the knoll at a higher elevation.

The site is in excellent condition. It has high research value for three reasons: 1) it is one of few sites located in this survey which may not have been impacted by the 19th century rice industry and thus, may contain evidence for the traditional Hawaiian use of the area; 2) its location on the knoll between the two drainages suggests an association with agricultural fields along the streams (Figure 23), and 3) the abundance of lithic material in the deposit suggests a special activity related to this occupation, possibly tied to the two quarries located on the S ridge of the valley.

Public value of the site, as for site 3505, lies in the exhibit quality of the deposit and its contents. Cultural value is minimal.

3513: "Kuleana Ditch": site actually consists of two dirt-faced channels cut across the knoll which separates Waianu and Waiāhole Streams. One, or both, may be associated with a flume (described on the 1897 Dove map) which crossed Waianu Stream and joined with a canal which eventually led across the Waiahole School lot and down to the McCandless Rice Mill (site 3523).

The site, located in SA I, is in excellent condition. Its research value is low but its public exhibit quality, as a reflection of rice industry technical developments, is high.

The name, "Kuleana Ditch" was passed on to me by a local resident, familiar with the area since 1949. He also informed me that the <u>mauka</u> portions of the ditch remained intact.

3514: Artifact scatter: consists of lithic material, crockery, bottle glass, volcanic glass flakes, and miscellaneous cultural debris, scattered throughout a freshly plowed field under lease 74, in the NW corner of SA I. Six transects were run across a 20 x 50 m section of the field. A total of 142 flakes, 33 pieces of crockery, 52 pieces of bottle glass, 5 volcanic

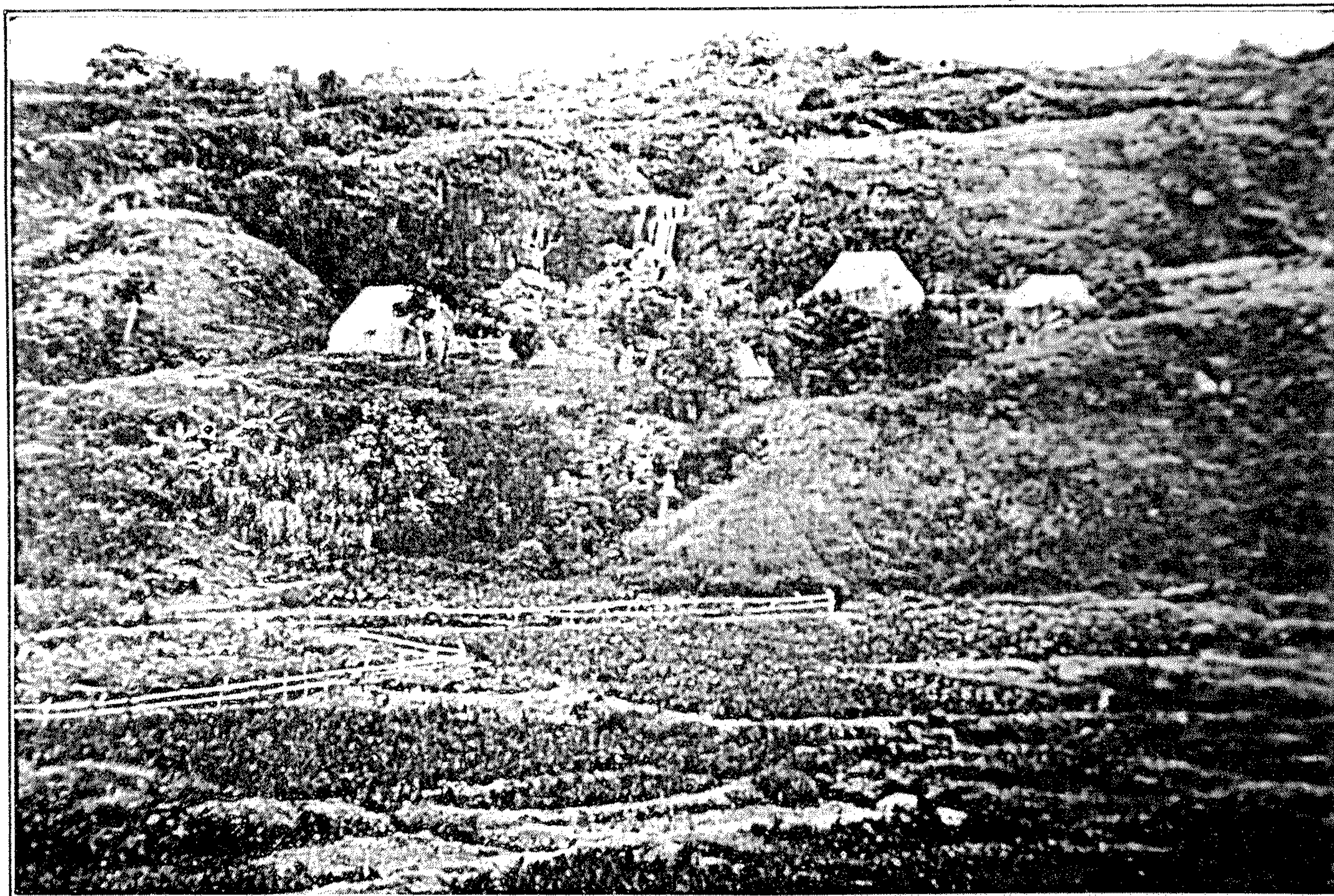

FIGURE 23. 1860 PHOTOGRAPH FROM MAUI, SHOWING SETTLEMENT PATTERN SUGGESTED FOR SITE 3512. (Photograph from J. Feher, <u>Hawaii: A Pictorial History</u>. Bishop Museum Special Publicaiton 58. 1969).

glass flakes, three polished adze fragments, a polished whetstone fragment, a polished hematite fragment, and two basalt core were found (Figure 24).

A density distribution for the different types of artifacts was calculated (Figure 25). The crockery and bottle glass (clearly of historical origin) were concentrated in the SW corner of the field while the volcanic glass and miscellaneous lithic artifacts (probably of prehistoric or traditional origin) were distributed over the northern and eastern sections. The basalt flakes were evenly distributed over the entire field, with a higher concentration along the western edge (i.e. along the edge of the field itself). This admittedly small sample suggests that 1) this area contains a multi-component site, containing a range of material representing both traditional and historical occupations; and 2) the site can probably be divided into two zones, possibly reflecting shifting loci of occupation through time (an hypothesis which can be tested through excavation).

The research value of this site is very high, as the idea of intact deposits beneath a plow zone has yet to be examined in Hawai'i. The ramifications for Hawaiian archaeology are considerable, given the large acreage of land presently under cultivation and presumeably thought to be too disturbed for research purposes.

3515: Old road bed or irrigation canal: a level, linear area located on the slope of Kaneloa, above the Waianu Stream bridge, in the NW corner of SA I. The level area ranges in width from 1.0 to 2.0 m; the high point is toward the mauka end, below the SW corner of the cultivated field under lease 74 (see Figure 11). It slopes down to the E along the middle of the Kaneloa slope.

The site falls within the boundaries of Grant 2703:3, but there are no clear historical associations.

Without further information, significance is minimal.

3516: Possible irrigation canal: distinguishable as an irrigation feature by the slight indentation in the thick grass ground cover and by its relatively boggy condition.

This feature is located within the boundaries of LCA 7664:1, which is described as under taro cultivation. The area was certainly under rice cultivation in the

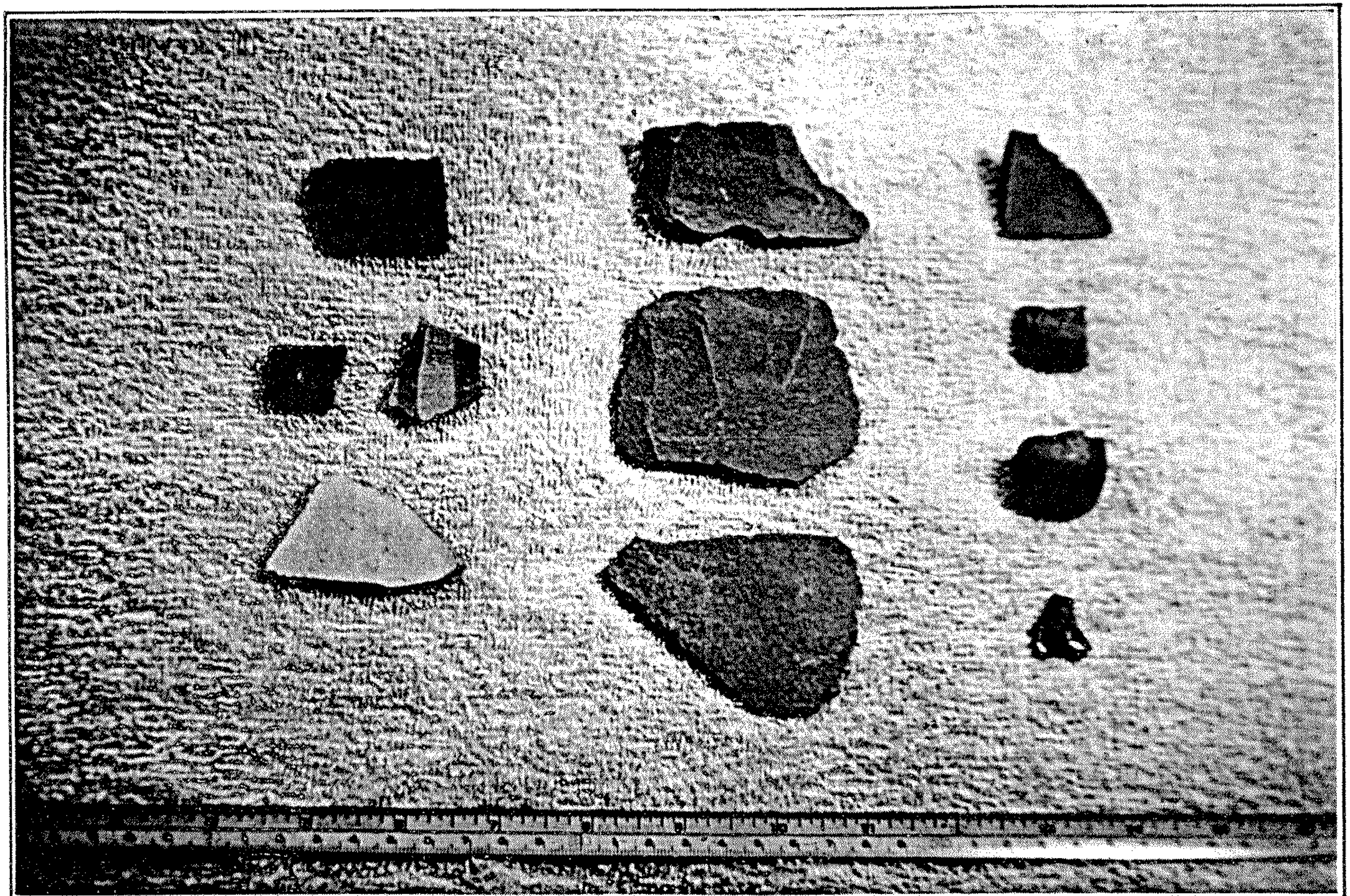

FIGURE 24. SAMPLE OF ARTIFACTS FOUND IN SITE 3514. (crockery, left; flakes, center; polished stone tools and volcanic glass, right)

BASALT FLAKES

1	1	2		2	23
2	1			3	14
	2	2	3	4	11
4	4	1	1	2	11
4	3	1	2	1	11
1	6	1	2		5
1	2	2			6

VOLCANIC GLASS

	1				
	1				
1		1			
		1			

MISC. LITHICS

AF					
FCR					
AF					CR
		FCR WTS			
PH					AF FCR
	CR				

N

AF = adze fragment
WTS = whetstone

FCR = fire-cracked rock
PH = polished hematite

CR = core

CROCKERY

			3	1	2
		2	3	4	
		3	3	4	
				2	
		1	1		2
		2			

BOTTLE GLASS

	2	2	4		3
	3	1	6	6	2
		1	6	6	1
		2	2	3	1
		2	1		
1					

MISCELLANEOUS

AL	AL				
			COR		

AL = aluminum can

COR = coral

FIGURE 25. DENSITY DISTRIBUTION OF ARTIFACTS FROM SITE 3514
(area measures approximately 20 by 50 m)

late 19th century; it is shown on the 1928 aerial photograph to be terraced and irrigated (see Figure 11a). This feature may have been part of an irrigation ditch which crossed these fields from the W end of site 3506 canal.

At the E boundary of the survey area (I), the canal widened to 2.0 m and intersected with the lower end of the site 3506 canal; it then continued downvalley into the taro fields presently under lease 91.

The area in which this site is located was not surveyed because of the dense grass cover. A statement of significance is thus premature, as the canal is obviously a part of an as yet little known system.

3517: Abandoned wood frame house and associated trash pit: small, wood frame house (with only three walls standing), and an associated trash or outhouse pit; located on a small flat at the base of the valley side near the SE corner of SA I. The Waiahole Homestead Road runs adjacent to the N side of the house and pit. White ginger and banana are growing next to the one-room structure, which contains a rusted metal bedframe.

The pit, which measures approximately 1.0 m in diameter, contains rusted metal, ceramic fragments, bottle fragments (including a bottle base inscribed "Dai Nippon"), and several short lengths of 4" x 4" lumber.

The site 3506 canal runs parallel to and across the road from the house. Near this site locale, a concrete tunnel, approximately 3.5 m long, has been built into the canal, forming a driveway of sorts across the ditch into the fields beyond (this function is suggested by its close proximity to the Homestead Road and its structural features).

A house is indicated at this site in the description of LCA 7664:1. A structure is noted on the 1897 Dove map, as well as on the 1928 aerial photograph.

The site is in excellent condition and the apparent continuity in occupation of this locale from at least the first half of the 19th century into the 20th century gives much significance to the site in research terms. The presence of the trash pit offers an opportunity to investigate the material remains of this occupation and its possible association with the cultivated fields which once occupied the now overgrown expanse of lease 71.

3518: Abandoned wood frame house: three-room, wood frame house situated between the site 3506 canal and the field presently under lease 71; along the S edge of SA I. The house appears to have been recently abandoned, as there wasstill a blanket hanging from one of the rafters at the time of the survey. An old bathtub is in the weed-overgrown yard near the canal. There are two accesses across the canal from the Waiahole Homestead Road: one is a metal mesh screen and the other consists of three hau logs laid next to each other. The latter had four hollow-tile steps leading down the slope from the road. Both appear to be recent innovations.

An informant indicated that this structure was a field house when the area was under taro cultivation in the early 1950s.

As an archaeological site, the house is in excellent condition. Without further information, however, its significance is minimal.

3519: "Ka Loko Manu": first identified on the 1897 Dove map; appears on this map as a pond in an irrigation ditch or a stream (being used as an irrigation ditch) which flowed through the gulch along the N boundary of the valley; located in SA II.

"Loko" means pond, pool, or lake; "manu" means bird, or alternatively, salty, pungent, or acrid (Pukui and Elbert 1964).

Approximately 255 to 315 m (800 to 1000 ft) upvalley from the coastal flat is a large, flooded area which covers much of the gulch floor(Figure 26). It may have been flooded at the time of the survey by recent rains rather than from a permanent state; there was no running water observed above the pond in the shallow (10 cm deep) stream channel. Below the pond, it appears that someone has cleared out and possibly deepened an exhaust channel, which is approximately 50 to 60 cm deep.

The vegetation in the vicinity of the pond is conspicuously different from the lower gulch, which is dominated by tall grasses and ferns under a Java plum canopy. The vegetation in the site area includes ti, red ginger, and banana.

A recent bulldozer cut crosses thegulch just below the pond; this is a source of red coloration in the stream in the lower gulch. At the top of the N

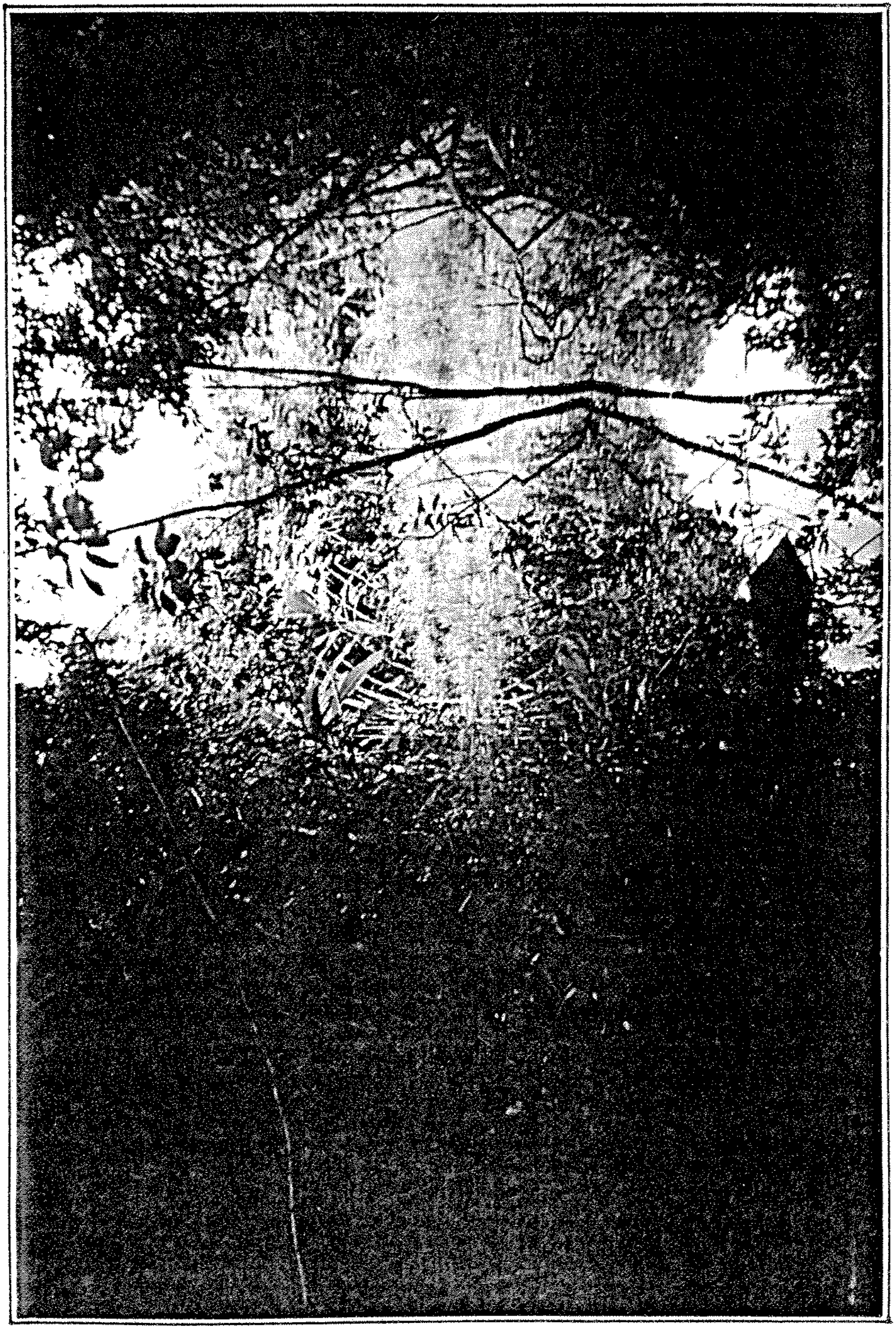

FIGURE 26. SITE 3519, KA LOKO MANU, VIEW TOWARD <u>MAUKA</u>.

ridge, a 20 cm thick deposit containing scattered charcoal flecks was observed in an eroded cut. The deposit consists of a very hard silt, with fine, sub-angular blocky structure. It overlies a basal "C" horizon. This may be evidence of some burning on the slopes, although a definite chronological date cannot be affixed.

This site is enigmatic in function and a statement of significance is premature without further information.

3520: Possible irrigation canal: occurs as a narrow ledge at the base of the Kaneloa escarpment, slightly elevated above the lowland flat; located in SA III. It can be traced along the W edge of the gully mauka of lease 64, to the mouth of the same gully, where it turns sharply makai, following the line of the Kaneloa escarpment. It leaves the base of the escarpment approximately 100 m (325 ft) from this turn and probably continues makai across the coastal flat.

A stand of mature, cultivated bananas in the gully has obscured the upper end of the canal; a thicket of hau has hidden the lower portion where it enters the lowland.

A watercourse following the same route as this feature is identified on the 1897 Dove map. It originates from the junction of Waianu and Uwau Streams in the upper Waianu drainage and branches at the head of the gulch in which "Ka Loko Manu" (site 3519) occurs. The main branch of this canal system continues across Kaneloa and then splits again at the head of the gully mauka of lease 64 to enter this subsidiary channel (see Figure 13), This canal and the one which feeds "Ka Loko Manu" carry water into the irrigated rice fields at the N end of the coastal flat. This map is the earliest showing the ditch; however, this should not be interpreted as a strictly historical feature, as it would not have been impossible for traditional Hawaiians to have dug a complex system to water taro fields.

This section of the valley was awarded to Puuiki as a konohiki, under LCA 5936; it is the 'ili of Waianu 2. There were no awards to commoners in this area.

This site is in fair condition. The lack of information concerning the transition from taro to rice cultivation in the late 1800s gives some significance to this site as a feature possibly related to both forms of irrigation. Public value and cultural import are minimal.

3521: Embankment: 1.5 to 2.0 m high, approximately 1.5 m to 2.0 m wide, resembles a railroad berm (i.e. wide, level top with steeply sloping, high sides). This features extends from the base of the Kaneloa escarpment makai onto the coastal flat in a direct line toward Waikane Landing. Although there is no corroborative evidence, this may be part of the railroad used in the construction of the Waiahole Water Tunnel and during the pineapple period. Fence posts in the vicinity appear to be reused railroad ties.

Where the embankment meets the escarpment, a 2.0 m wide cut across the feature has been made, separating the feature from the low cliff. This gap corresponds with a wide, level bench which follows the base of the escarpment for much of the coastal flat (site 3522).

The site is in excellent condition. Research value is moderate, as there is so little known about the railroad (although several people informed me that it followed the route of Waiahole Valley Road). If this is indeed the railroad, its public value is high.

3522: Possible road bed: wide, level bench at base of escarpment, slightly elevated above the coastal flat; varies in width from 4.0 to 6.0 m, covered in a high canopy of Java plum, with a false honohono ground cover. There is no visible stonework along the makai edge, which drops 50 cm to the coastal flat. A single line of tall Java plum trees forms a conspicuous boundary along that edge.

Remnant terraces, probably from rice cultivation, are visible in the pasture to the makai; dirt facings with no stonework are clearly visible near the escarpment.

Without further information, this site has little signficance.

3523: McCandless Rice Mill: presently the site of a residence in SA III. Archaeological remains consist of exposed bedrock channel in the escarpment face which served as an irrigation feature running the rice mill waterwheel, and the concrete foundation of the water wheel under the existing house.

This locality is definitely that of the former rice mill, constructed in the last decades of the 19th century, probably by the character, L.L. McCandless, who played a major role in the 20th century use and modification of the valley landscape (see Figure 13).

McCandless, a driller by profession, came to Hawai'i in 1882, and joined his brothers in developing water projects throughout the islands. He was interested in real estate and acquired much land over the years through leasing and buying(Green 1932). It was his astute acquisition of Waiāhole lands and accompanying water rights which brought together his profession and his avocation in the construction of the Waiahole Water Tunnel. He, and later his estate, controlled much of the land in the valley until its purchase by the State of Hawaii in the late 1970s.

An interview with the present resident of the site revealed that the escarpment adjacent to the bedrock channel has been long used as a trash dump, and historical bottles and miscellaneous paraphernalia from the 1800s and early 1900s have been exposed on the slope.

The research value of the rice mill site itself is minimal but the trash deposit on the slope offers an opportunity to examine the changing material culture of occupants of the area, from possibly long-ago Hawaiians, to rice plantation workers, to the present truck farmers.

While public value is minimal, cultural import is high as this site is associated with an important historical figure for the valley, as well as an important period in the valley's history.

3524: Irrigation canal and rice fields: irrigation feature consists of narrow, level bench at the base of the Kaneloa escarpment at the S end of SA III. This bench runs S from the rice mill area to the end of the survey area (and continues S out of the SA). Partially faced with small, rounded and angular cobbles, the canal bank measures about 40 cm high. A possible flake was found on the bank.

At the S end of the survey area was the junction of three canals (Figure 27). One is the level bench described above, one is a 50 to 60 cm deep earthen ditch extending S of the survey area, and one is shallow, earthen ditch extending <u>makai</u> into a <u>hau</u> grove.

The irrigation feature which extends S out the SA was followed for a short distance where it became a level bench similar to the one described above.

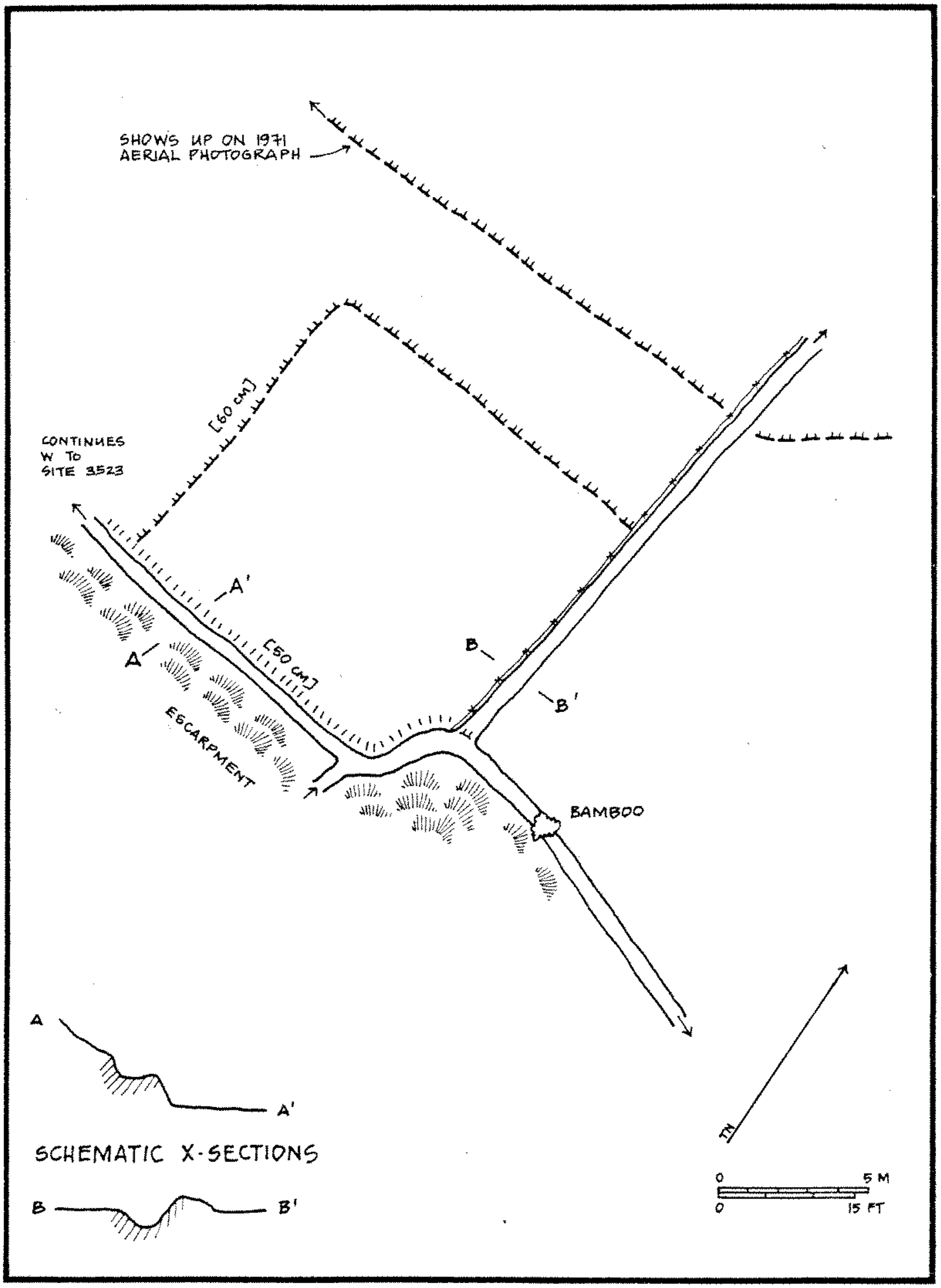

FIGURE 27. SITE 3524.

Terracing is visible in the pasture to the <u>makai</u> of the escarpment. Those immediately adjacent to the canal junction were mapped with Brunton pocket transit and tape (see Figure 27); those farther away were drawn from the 1928 aerial photograph (see Figure 13).

The site is in excellent condition. Research value is high in understanding some of the technical aspects of the rice irrigation system, as well as possibly investigating the preservation of the Hawaiian system beneath or integrated with the historical one. Public and cultural value are minimal.

3525: Artifact scatter: lithic material and a porcelain sherd were observed on the W edge of the cultivated field under lease 64 (Figure 28). No systematic transect survey of the field was carried out, as it was technically out of the survey area.

For the same reasons given for the artifact scatter in SA I (site 3514), this site has high research value. Public and cultural value are minimal.

3526: Buried cultural deposits: four profiles were noted along the lower banks of Waiāhole Stream, between 150 m (480 ft) and 415 m (1300 ft) inland of the Kamehameha Highway bridge.

Two probable agricultural horizons were noted in a 2.0 m high cut in the stream, approximately 150 m (480 ft) <u>mauka</u> of the bridge. The deposits contain considerable charcoal and a few basalt and volcanic glass flakes. The interpretation of agricultural use is based on the soil characteristics (see decription of soils in Figure 29).

The total length of the exposed stream cut is approximately 40 m (130 ft). Profile 1 is 10 m(30ft) from the E edge; profile 2 is approximately 10 m (30 ft) from the W edge. The land above the cut is presently being cultivated in bananas and other truck crops. The stream is approximately 20 to 50 cm deep at the base of the cut. A grass-covered island has formed in the center of the stream at this locale; a concrete and stone wall supporting Waiahole Valley Road is on the N side of the stream.

A 1.3 m high bank, approximately 223 m (700 ft) inland of the bridge, contains several strata of fine to coarse silts and clays; the lowest deposit shows a grey coloration which suggests a gleyed soil

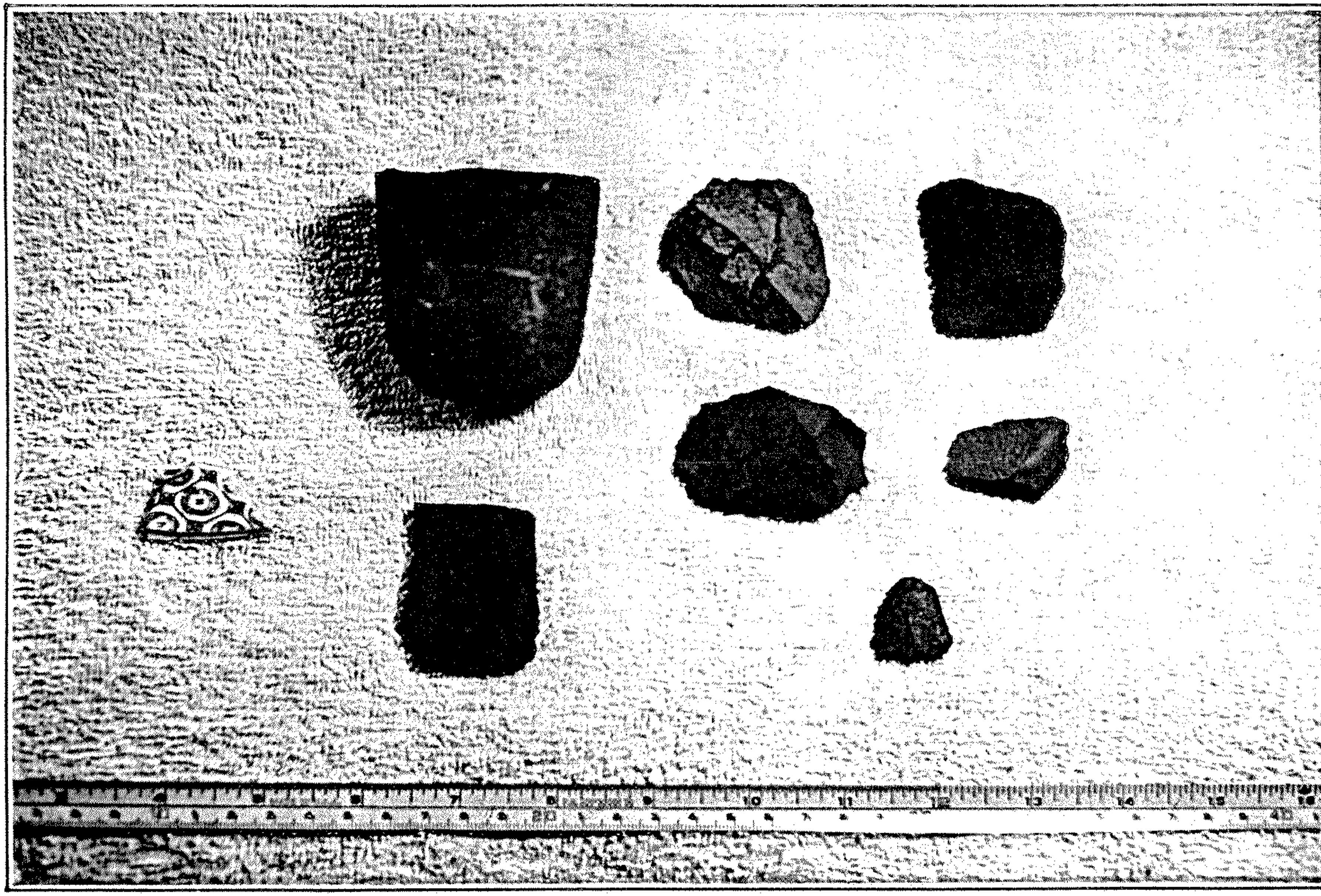

FIGURE 28. SAMPLE OF ARTIFACTS FOUND IN SITE 3525. (grinding stone, upper left; adze fragment, lower left; flakes, center and right; porcelain sherd, extreme left).

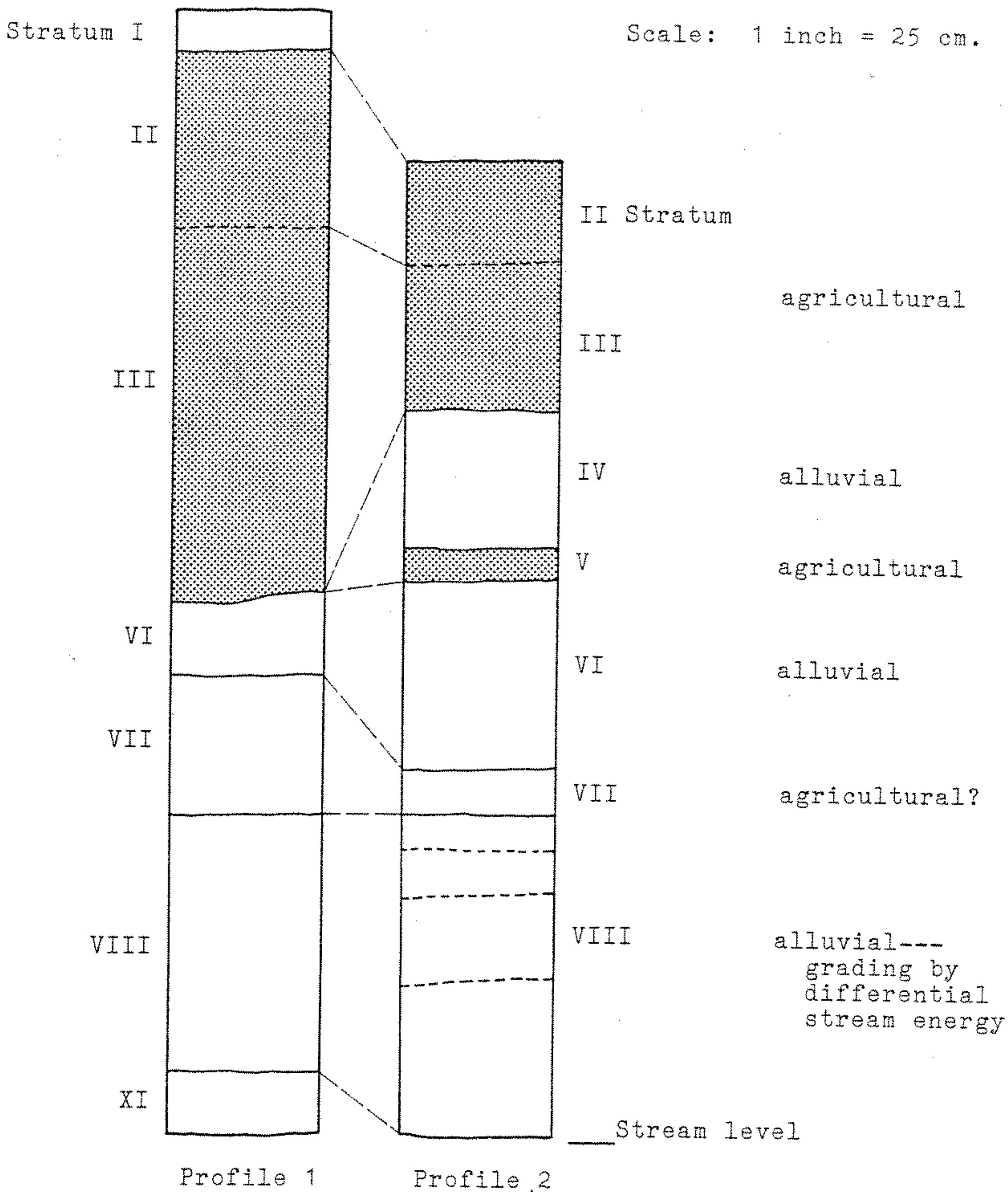

FIGURE 29. PROFILES 1 AND 2, SITE 3526.
(shading denotes inferred cultural
deposition---irrigation agriculture)

KEY TO FIGURE 29.
SOIL DESCRIPTIONS

Stratum I: Dark brown (7.5 YR 3/2, moist) silty clay; strong, medium, blocky structure; very hard consistence (dry); very firm consistence (moist); slightly sticky, slightly plastic; few fine to medium roots; less than 5% rounded pebbles; smooth, clear boundary; one flake of volcanic glass collected from boundary with Stratum II.

II: Dark brown (7.5 YR 3/2, moist) clay; strong, medium to coarse, sub-angular blocky structure; very hard consistence (dry); very firm consistence (moist); sticky, plastic; few medium roots; less than 10% rounded pebbles and cobbles; small charcoal flecks scattered throughout; clear, smooth boundary.

III: In profile 1, deposit is same as Stratum II, with reddish yellow (5 YR 6/8, moist) staining throughout (and extending into IV).

In profile 2, dark brown (7.5 YR 3/2, moist) clay loam; fine, sub-angular blocky structure; slightly sticky, slightly plastic; with reddish yellow (5 YR 5/8, moist) mottling; abrupt, smooth boundary.

IV: (occurs only in profile 2) coarse sand to small rounded cobbles in sandy loam matrix; reddish yellow; lower 5 cm is a sandy gravel with some rounded pebbles.

V: (occurs only in profile 2) Dark brown (7.5 YR 3/2, moist) silt clay; fine, sub-angular, blocky structure; very friable (moist); sticky, plastic; reddish yellow (5 YR 5/8, moist) mottling; very few, small charcoal flecks; smooth, abrupt boundary.

VI: Dark brown (7.5 YR 3/2, moist) with reddish yellow (5 YR 6/8, moist) mottling; rounded to sub-rounded pebbles to gravel in a clay loam matrix; weak, fine to medium crumb structure; firm consistence; sticky, plastic; few, very fine roots; abrupt, wavy boundary.

VII: In profile 1, dark brown (7.5 YR 3/2, moist) silty clay; with dark red (10 R 3/6, moist) mottling; friable; sticky, plastic; few, very fine roots; less than 10% rounded cobbles; abrupt, smooth boundary.

In profile 2, dark brown (7.5 YR 3/2, moist) clay; fine, columnar structure; very sticky, very plastic; friable; some charcoal flecks; abrupt, wavy boundary.

VIII: distinctly graded deposit of fine silts to small cobbles; in strong brown (7.5 YR 3/2, moist) clay loam matrix.

In profile 2, divided into four sub-strata:

VIIIa: silt to coarse sand; very fine crumb structure; slightly sticky, non-plastic; friable; some charcoal flecks (more so than in Stratum VII); abrupt, smooth boundary.

VIIIb: sands and pebbles.

VIIIc: very fine sandy silt; very fine crumb structure; slightly sticky, non-plastic; many large chunks of charcoal; few burnt kukui shell; thin bands of clay; abrupt, wavy boundary.

VIIId: coarse sands to pebbles in weakly cemented clay loam matrix; rounded to sub-rounded cobbles along lower boundary; abrupt, smooth boundary.

IX: (occurs only in profile 1) very dark brown (10 YR 2/2, moist) clay loam; sticky, plastic; approximately 25% gravels and pebbles; lower boundary undetermined.

(Evans /1978/ defines such a soil as having "formed through disturbance of the hydrological regime by man - particularly the changes wrought by forest clearance and land exploitation for farming"). Further, a facies change in this lowest deposit indicates that the stream channel has been shifting and that the present course is cutting into a former agricultural area.

A 2.5 m high bank, approximately 415 m (1300 ft) inland of the Kamehameha Highway bridge, contains a possible cultural deposit (grey/brown clay with red mottles and charcoal flecks), 60 cm above the present water level; overlying coarse, basal alluvial stratum. The upper layers of the cut bank have been heavily disturbed by recent digging and filling associated the residence on the adjacent property.

These profiles have high research value as they indicate the presence of buried, intact cultural material beneath the presently cultivated fields of the lower valley. The first set of profiles (see Figure 29), in particular, gives evidence of the natural and cultural changes in the landscape(Figure 30).

3527: Irrigation canal: 1.0 m deep canal feeding off of Waiāhole Stream to the S; intake is located mid-way between leases 91 and 93. The intake area is marked by corrugated metal and plastic sheeting, supported by _hau_ branches and boulders; approximately 20 m to the _makai_, the canal feeds into a long, 12" metal pipe which is presently overgrown in a _hau_ thicket.

Two other possible canal exhausts (into Waiāhole Stream) were noted on the N bank of the stream, slightly downstream from this site.

Without further information, the significance of this site is minimal.

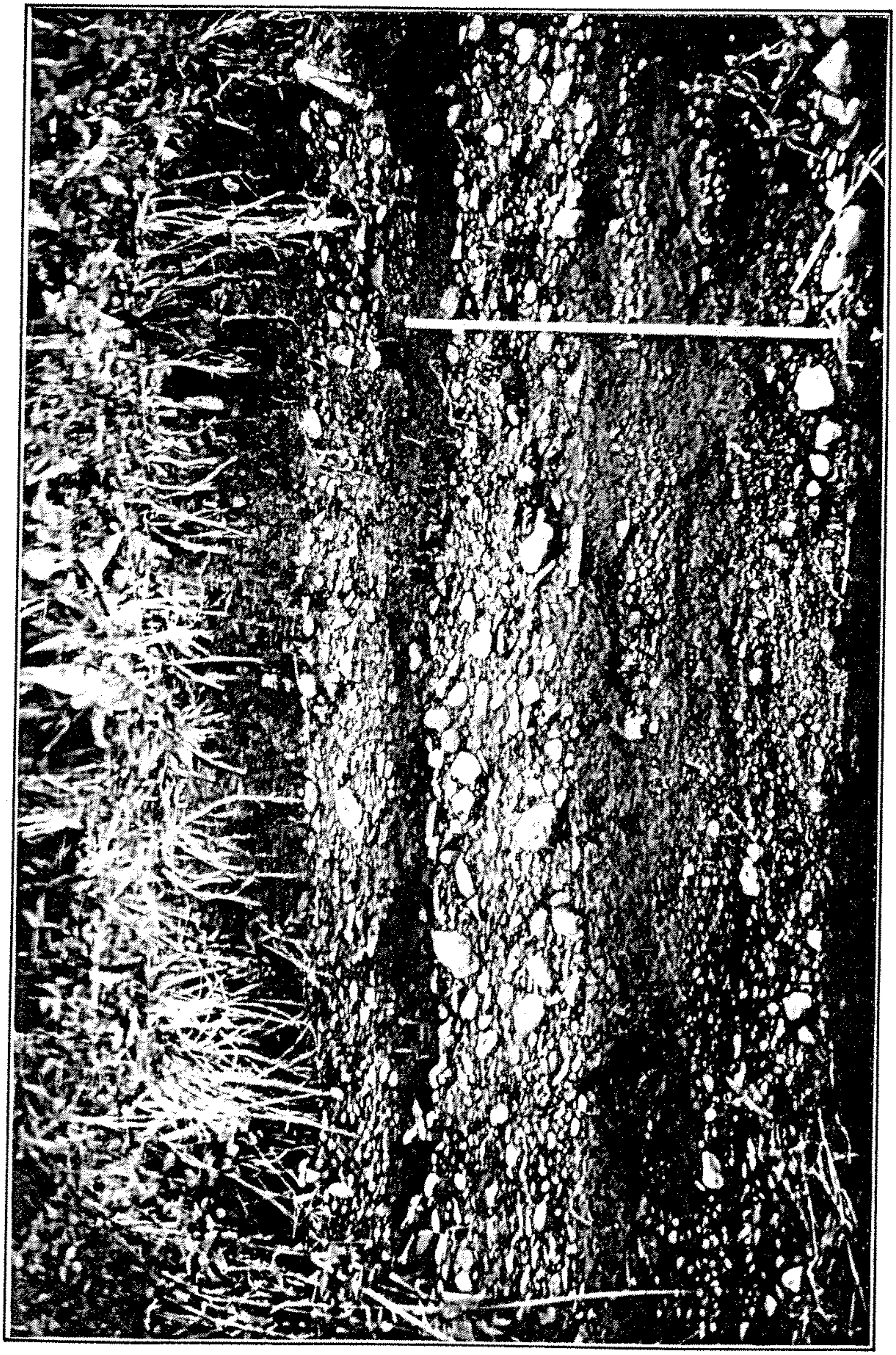

FIGURE 30. PROFILE 2, SITE 3526.

Appendix II.

LIST OF PLANTS

Common Name	Hawaiian Name	Scientific Name
kava	'awa	Piper methysticum
banana	mai'a	Musa sp.
false kamani	kamani haole	Terminalia catappa L.
guava	---	Psidium guajava
---	hau	Hibiscus tiliaceus
Java olive	---	Sterculia foetida L.
Java plum	---	Eugenia cuminii
---	koa haole	Leucaena glauca
mango	manako	Mangifera indica
pandanus	hala	Pandanus odoratissimus
panicum grass	---	Panicum maximus Jacq.
papaya	---	Carica papaya
sweet potato	'uala	Ipomoea batatas L.
rice	laiki	Oryza sativa
sugar cane	kō	Saccharum officinarum L.
taro	kalo	Colocasia esculenta L.
tobacco	paka	Nicotiana tobacum L.

Source: Marie C. Neal, In Gardens of Hawaii. B.P. Bishop Museum Special Publication 50. Bishop Museum Press. Honolulu. 1965.

Appendix III.

BIBLIOGRAPHIC REFERENCES TO THE WAIAHOLE WATER

Commissioner of Public Lands

1899 Application of L.L. McCandless and T. for 30 year license for water rights (no action taken). June 10. In, "Lis applications filed after 7/7/98 to an 10/11/99. Republic of Hawaii." Hawai Archives.

1899 Application of E.E. Paxton for 30 yr all available water on the Crown land (no action taken). June 16. In, "Li applications filed after 7/7/98 to an 10/11/99. Republic of Hawaii." Hawai Archives.

Kluegel, Charles H.

1916 "Engineering Features of the Water P Waiahole Water Company." Hawaiian A Annual for 1917. Thos. G. Thrum. H Pp. 93-107.

Larrison, G.K.

1916 "The Waiahole Tunnel Project." Hawa and Agriculturalist. Vol. 13, no. 3

McCandless, James S.

1936 History of McCandless Brothers and T in the Development of Artesian Well the Hawaiian Islands. Honolulu.

Thrum, Thos. G.

1915 "The Waiahole Water Project." Hawai and Annual for 1916. Thos. G. Thrum Pp. 174-180.

Also:

Herschler, L.H.

1966 The Waiahole Water Company, Fifty Y Service. Oahu Sugar Company. Hono

Streams at the W edge of SA I. The knoll has been cut by Waiahole Valley Road (which was constructed at least by the late 1920s, as it is visible on the 1928 aerial photograph). The deposit was first located in the S exposure of the road cut, then traced in the N exposure, and finally through the grooves of the "Kuleana Ditch" (site 3513), which cuts across the knoll at a higher elevation.

The site is in excellent condition. It has high research value for three reasons: 1) it is one of few sites located in this survey which may not have been impacted by the 19th century rice industry and thus, may contain evidence for the traditional Hawaiian use of the area; 2) its location on the knoll between the two drainages suggests an association with agricultural fields along the streams (Figure 23), and 3) the abundance of lithic material in the deposit suggests a special activity related to this occupation, possibly tied to the two quarries located on the S ridge of the valley.

Public value of the site, as for site 3505, lies in the exhibit quality of the deposit and its contents. Cultural value is minimal.

3513: "Kuleana Ditch": site actually consists of two dirt-faced channels cut across the knoll which separates Waianu and Waiāhole Streams. One, or both, may be associated with a flume (described on the 1897 Dove map) which crossed Waianu Stream and joined with a canal which eventually led across the Waiahole School lot and down to the McCandless Rice Mill (site 3523).

The site, located in SA I, is in excellent condition. Its research value is low but its public exhibit quality, as a reflection of rice industry technical developments, is high.

The name, "Kuleana Ditch" was passed on to me by a local resident, familiar with the area since 1949. He also informed me that the <u>mauka</u> portions of the ditch remained intact.

3514: Artifact scatter: consists of lithic material, crockery, bottle glass, volcanic glass flakes, and miscellaneous cultural debris, scattered throughout a freshly plowed field under lease 74, in the NW corner of SA I. Six transects were run across a 20 x 50 m section of the field. A total of 142 flakes, 33 pieces of crockery, 52 pieces of bottle glass, 5 volcanic

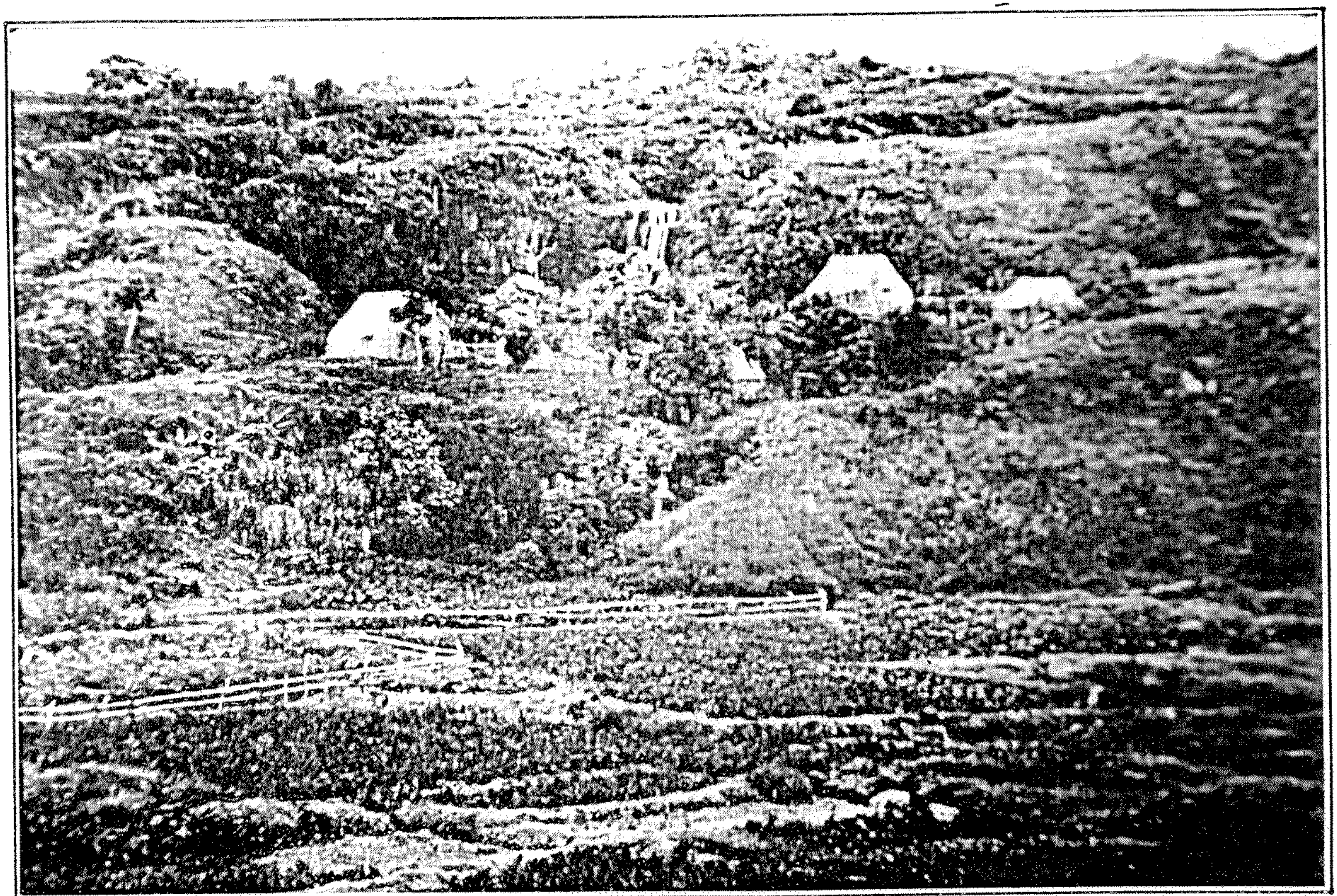

FIGURE 23. 1860 PHOTOGRAPH FROM MAUI, SHOWING SETTLEMENT PATTERN SUGGESTED FOR SITE 3512. (Photograph from J. Feher, Hawaii: A Pictorial History. Bishop Museum Special Publicaiton 58. 1969).

glass flakes, three polished adze fragments, a polished whetstone fragment, a polished hematite fragment, and two basalt core were found (Figure 24).

A density distribution for the different types of artifacts was calculated (Figure 25). The crockery and bottle glass (clearly of historical origin) were concentrated in the SW corner of the field while the volcanic glass and miscellaneous lithic artifacts (probably of prehistoric or traditional origin) were distributed over the northern and eastern sections. The basalt flakes were evenly distributed over the entire field, with a higher concentration along the western edge (i.e. along the edge of the field itself). This admittedly small sample suggests that 1) this area contains a multi-component site, containing a range of material representing both traditional and historical occupations; and 2) the site can probably be divided into two zones, possibly reflecting shifting loci of occupation through time (an hypothesis which can be tested through excavation).

The research value of this site is very high, as the idea of intact deposits beneath a plow zone has yet to be examined in Hawai'i. The ramifications for Hawaiian archaeology are considerable, given the large acreage of land presently under cultivation and presumeably thought to be too disturbed for research purposes.

3515: Old road bed or irrigation canal: a level, linear area located on the slope of Kaneloa, above the Waianu Stream bridge, in the NW corner of SA I. The level area ranges in width from 1.0 to 2.0 m; the high point is toward the <u>mauka</u> end, below the SW corner of the cultivated field under lease 74 (see Figure 11). It slopes down to the E along the middle of the Kaneloa slope.

The site falls within the boundaries of Grant 2703:3, but there are no clear historical associations.

Without further information, significance is minimal.

3516: Possible irrigation canal: distinguishable as an irrigation feature by the slight indentation in the thick grass ground cover and by its relatively boggy condition.

This feature is located within the boundaries of LCA 7664:1, which is described as under taro cultivation. The area was certainly under rice cultivation in the

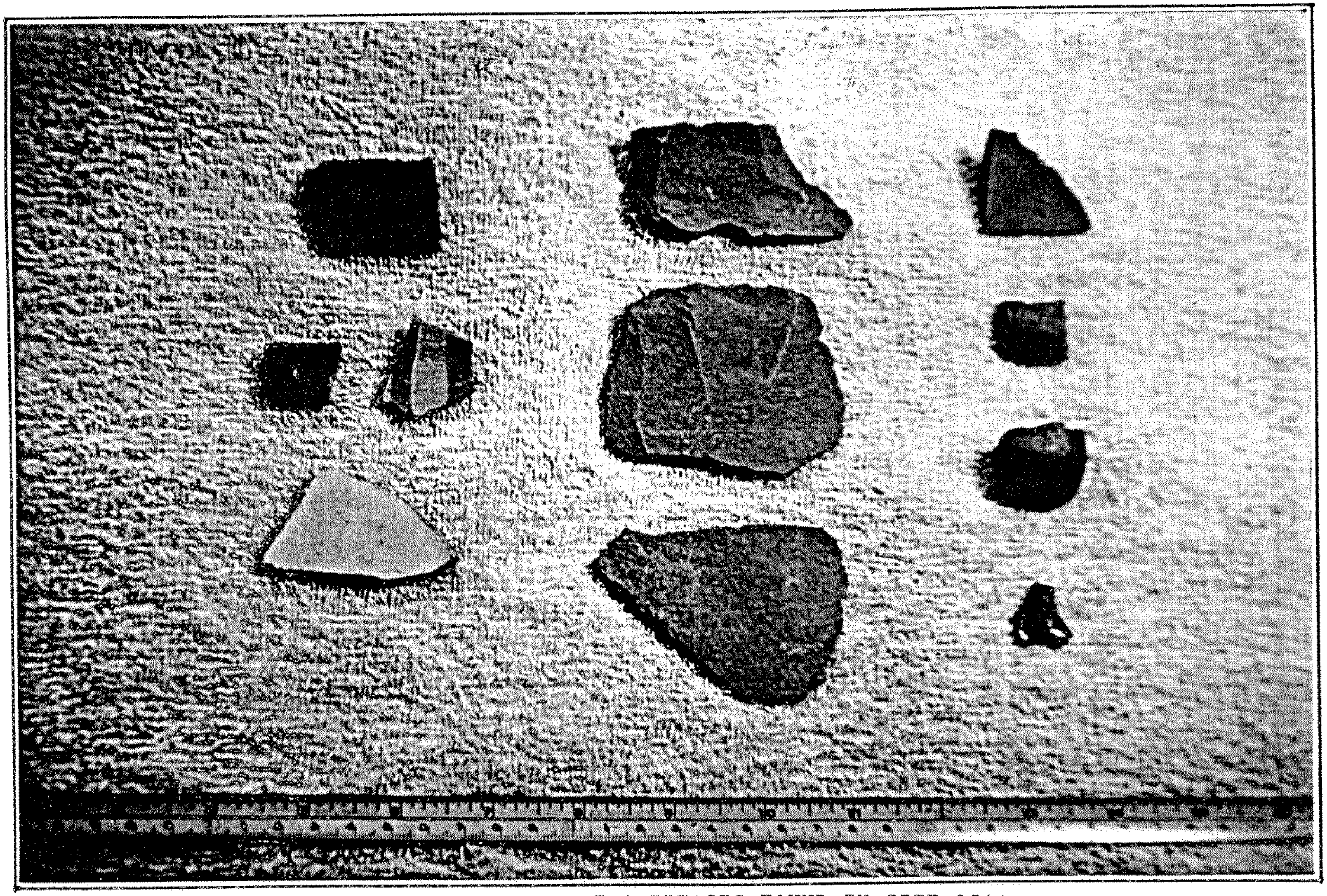

FIGURE 24. SAMPLE OF ARTIFACTS FOUND IN SITE 3514. (crockery, left; flakes, center; polished stone tools and volcanic glass, right)

BASALT FLAKES

1	1	2		2	23
2	1			3	14
	2	2	3	4	11
4	4	1	1	2	11
4	3	1	2	1	11
1	6	1	2		5
1	2	2			6

VOLCANIC GLASS

	1				
	1				
1		1			
		1			

MISC. LITHICS

AF					
FCR					
AF					CR
		FCR WTS			
PH					AF FCR
	CR				

N

AF = adze fragment
WTS = whetstone

FCR = fire-cracked rock
PH = polished hematite

CR = core

CROCKERY

			3	1	2
		2	3	4	
		3	3	4	
				2	
		1	1		2
		2			

BOTTLE GLASS

	2	2	4		3
	3	1	6	6	2
		1	6	6	1
		2	2	3	1
		2	1		
1					

MISCELLANEOUS

AL	AL				
			COR		

AL = aluminum can

COR = coral

FIGURE 25. DENSITY DISTRIBUTION OF ARTIFACTS FROM SITE 3514
(area measures approximately 20 by 50 m)

late 19th century; it is shown on the 1928 aerial photograph to be terraced and irrigated (see Figure 11a). This feature may have been part of an irrigation ditch which crossed these fields from the W end of site 3506 canal.

At the E boundary of the survey area (I), the canal widened to 2.0 m and intersected with the lower end of the site 3506 canal; it then continued downvalley into the taro fields presently under lease 91.

The area in which this site is located was not surveyed because of the dense grass cover. A statement of significance is thus premature, as the canal is obviously a part of an as yet little known system.

3517: Abandoned wood frame house and associated trash pit: small, wood frame house (with only three walls standing), and an associated trash or outhouse pit; located on a small flat at the base of the valley side near the SE corner of SA I. The Waiahole Homestead Road runs adjacent to the N side of the house and pit. White ginger and banana are growing next to the one-room structure, which contains a rusted metal bedframe.

The pit, which measures approximately 1.0 m in diameter, contains rusted metal, ceramic fragments, bottle fragments (including a bottle base inscribed "Dai Nippon"), and several short lengths of 4" x 4" lumber.

The site 3506 canal runs parallel to and across the road from the house. Near this site locale, a concrete tunnel, approximately 3.5 m long, has been built into the canal, forming a driveway of sorts across the ditch into the fields beyond (this function is suggested by its close proximity to the Homestead Road and its structural features).

A house is indicated at this site in the description of LCA 7664:1. A structure is noted on the 1897 Dove map, as well as on the 1928 aerial photograph.

The site is in excellent condition and the apparent continuity in occupation of this locale from at least the first half of the 19th century into the 20th century gives much significance to the site in research terms. The presence of the trash pit offers an opportunity to investigate the material remains of this occupation and its possible association with the cultivated fields which once occupied the now overgrown expanse of lease 71.

3518: Abandoned wood frame house: three-room, wood frame house situated between the site 3506 canal and the field presently under lease 71; along the S edge of SA I. The house appears to have been recently abandoned, as there wasstill a blanket hanging from one of the rafters at the time of the survey. An old bathtub is in the weed-overgrown yard near the canal. There are two accesses across the canal from the Waiahole Homestead Road: one is a metal mesh screen and the other consists of three hau logs laid next to each other. The latter had four hollow-tile steps leading down the slope from the road. Both appear to be recent innovations.

An informant indicated that this structure was a field house when the area was under taro cultivation in the early 1950s.

As an archaeological site, the house is in excellent condition. Without further information, however, its significance is minimal.

3519: "Ka Loko Manu": first identified on the 1897 Dove map; appears on this map as a pond in an irrigation ditch or a stream (being used as an irrigation ditch) which flowed through the gulch along the N boundary of the valley; located in SA II.

"Loko" means pond, pool, or lake; "manu" means bird, or alternatively, salty, pungent, or acrid (Pukui and Elbert 1964).

Approximately 255 to 315 m (800 to 1000 ft) upvalley from the coastal flat is a large, flooded area which covers much of the gulch floor(Figure 26). It may have been flooded at the time of the survey by recent rains rather than from a permanent state; there was no running water observed above the pond in the shallow (10 cm deep) stream channel. Below the pond, it appears that someone has cleared out and possibly deepened an exhaust channel, which is approximately 50 to 60 cm deep.

The vegetation in the vicinity of the pond is conspicuously different from the lower gulch, which is dominated by tall grasses and ferns under a Java plum canopy. The vegetation in the site area includes ti, red ginger, and banana.

A recent bulldozer cut crosses thegulch just below the pond; this is a source of red coloration in the stream in the lower gulch. At the top of the N

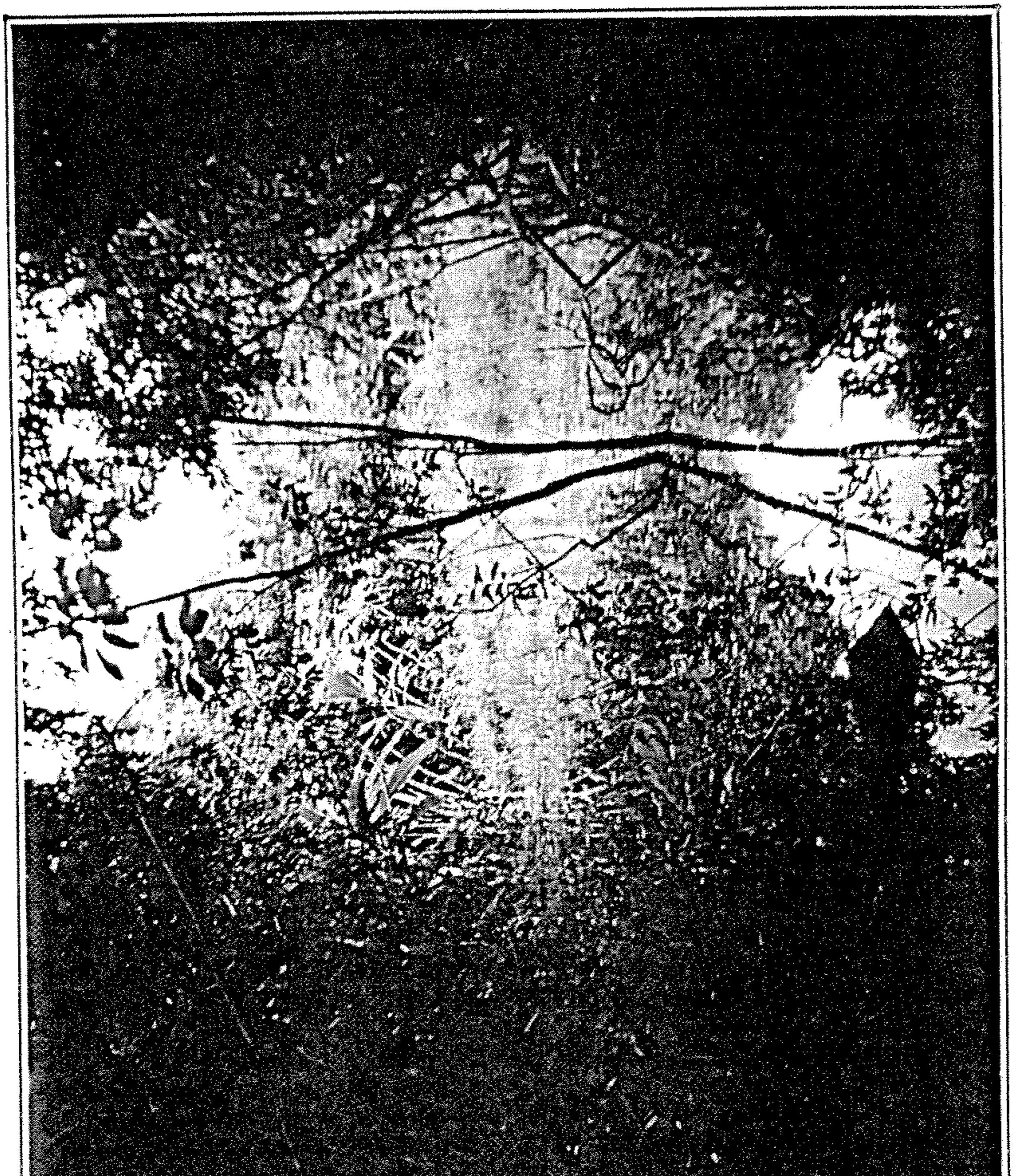

FIGURE 26. SITE 3519, KA LOKO MANU, VIEW TOWARD MAUKA.

ridge, a 20 cm thick deposit containing scattered charcoal flecks was observed in an eroded cut. The deposit consists of a very hard silt, with fine, sub-angular blocky structure. It overlies a basal "C" horizon. This may be evidence of some burning on the slopes, although a definite chronological date cannot be affixed.

This site is enigmatic in function and a statement of significance is premature without further information.

3520: Possible irrigation canal: occurs as a narrow ledge at the base of the Kaneloa escarpment, slightly elevated above the lowland flat; located in SA III. It can be traced along the W edge of the gully mauka of lease 64, to the mouth of the same gully, where it turns sharply makai, following the line of the Kaneloa escarpment. It leaves the base of the escarpment approximately 100 m (325 ft) from this turn and probably continues makai across the coastal flat.

A stand of mature, cultivated bananas in the gully has obscured the upper end of the canal; a thicket of hau has hidden the lower portion where it enters the lowland.

A watercourse following the same route as this feature is identified on the 1897 Dove map. It originates from the junction of Waianu and Uwau Streams in the upper Waianu drainage and branches at the head of the gulch in which "Ka Loko Manu" (site 3519) occurs. The main branch of this canal system continues across Kaneloa and then splits again at the head of the gully mauka of lease 64 to enter this subsidiary channel (see Figure 13). This canal and the one which feeds "Ka Loko Manu" carry water into the irrigated rice fields at the N end of the coastal flat. This map is the earliest showing the ditch; however, this should not be interpreted as a strictly historical feature, as it would not have been impossible for traditional Hawaiians to have dug a complex system to water taro fields.

This section of the valley was awarded to Puuiki as a konohiki, under LCA 5936; it is the 'ili of Waianu 2. There were no awards to commoners in this area.

This site is in fair condition. The lack of information concerning the transition from taro to rice cultivation in the late 1800s gives some significance to this site as a feature possibly related to both forms of irrigation. Public value and cultural import are minimal.

3521: Embankment: 1.5 to 2.0 m high, approximately 1.5 m to 2.0 m wide, resembles a railroad berm (i.e. wide, level top with steeply sloping, high sides). This features extends from the base of the Kaneloa escarpment makai onto the coastal flat in a direct line toward Waikane Landing. Although there is no corroborative evidence, this may be part of the railroad used in the construction of the Waiahole Water Tunnel and during the pineapple period. Fence posts in the vicinity appear to be reused railroad ties.

Where the embankment meets the escarpment, a 2.0 m wide cut across the feature has been made, separating the feature from the low cliff. This gap corresponds with a wide, level bench which follows the base of the escarpment for much of the coastal flat (site 3522).

The site is in excellent condition. Research value is moderate, as there is so little known about the railroad (although several people informed me that it followed the route of Waiahole Valley Road). If this is indeed the railroad, its public value is high.

3522: Possible road bed: wide, level bench at base of escarpment, slightly elevated above the coastal flat; varies in width from 4.0 to 6.0 m, covered in a high canopy of Java plum, with a false honohono ground cover. There is no visible stonework along the makai edge, which drops 50 cm to the coastal flat. A single line of tall Java plum trees forms a conspicuous boundary along that edge.

Remnant terraces, probably from rice cultivation, are visible in the pasture to the makai; dirt facings with no stonework are clearly visible near the escarpment.

Without further information, this site has little signficance.

3523: McCandless Rice Mill: presently the site of a residence in SA III. Archaeological remains consist of exposed bedrock channel in the escarpment face which served as an irrigation feature running the rice mill waterwheel, and the concrete foundation of the water wheel under the existing house.

This locality is definitely that of the former rice mill, constructed in the last decades of the 19th century, probably by the character, L.L. McCandless, who played a major role in the 20th century use and modification of the valley landscape (see Figure 13).

McCandless, a driller by profession, came to Hawai'i in 1882, and joined his brothers in developing water projects throughout the islands. He was interested in real estate and acquired much land over the years through leasing and buying(Green 1932). It was his astute acquisition of Waiāhole lands and accompanying water rights which brought together his profession and his avocation in the construction of the Waiahole Water Tunnel. He, and later his estate, controlled much of the land in the valley until its purchase by the State of Hawaii in the late 1970s.

An interview with the present resident of the site revealed that the escarpment adjacent to the bedrock channel has been long used as a trash dump, and historical bottles and miscellaneous paraphernalia from the 1800s and early 1900s have been exposed on the slope.

The research value of the rice mill site itself is minimal but the trash deposit on the slope offers an opportunity to examine the changing material culture of occupants of the area, from possibly long-ago Hawaiians, to rice plantation workers, to the present truck farmers.

While public value is minimal, cultural import is high as this site is associated with an important historical figure for the valley, as well as an important period in the valley's history.

3524: Irrigation canal and rice fields: irrigation feature consists of narrow, level bench at the base of the Kaneloa escarpment at the S end of SA III. This bench runs S from the rice mill area to the end of the survey area (and continues S out of the SA). Partially faced with small, rounded and angular cobbles, the canal bank measures about 40 cm high. A possible flake was found on the bank.

At the S end of the survey area was the junction of three canals (Figure 27). One is the level bench described above, one is a 50 to 60 cm deep earthen ditch extending S of the survey area, and one is shallow, earthen ditch extending _makai_ into a _hau_ grove.

The irrigation feature which extends S out the SA was followed for a short distance where it became a level bench similar to the one described above.

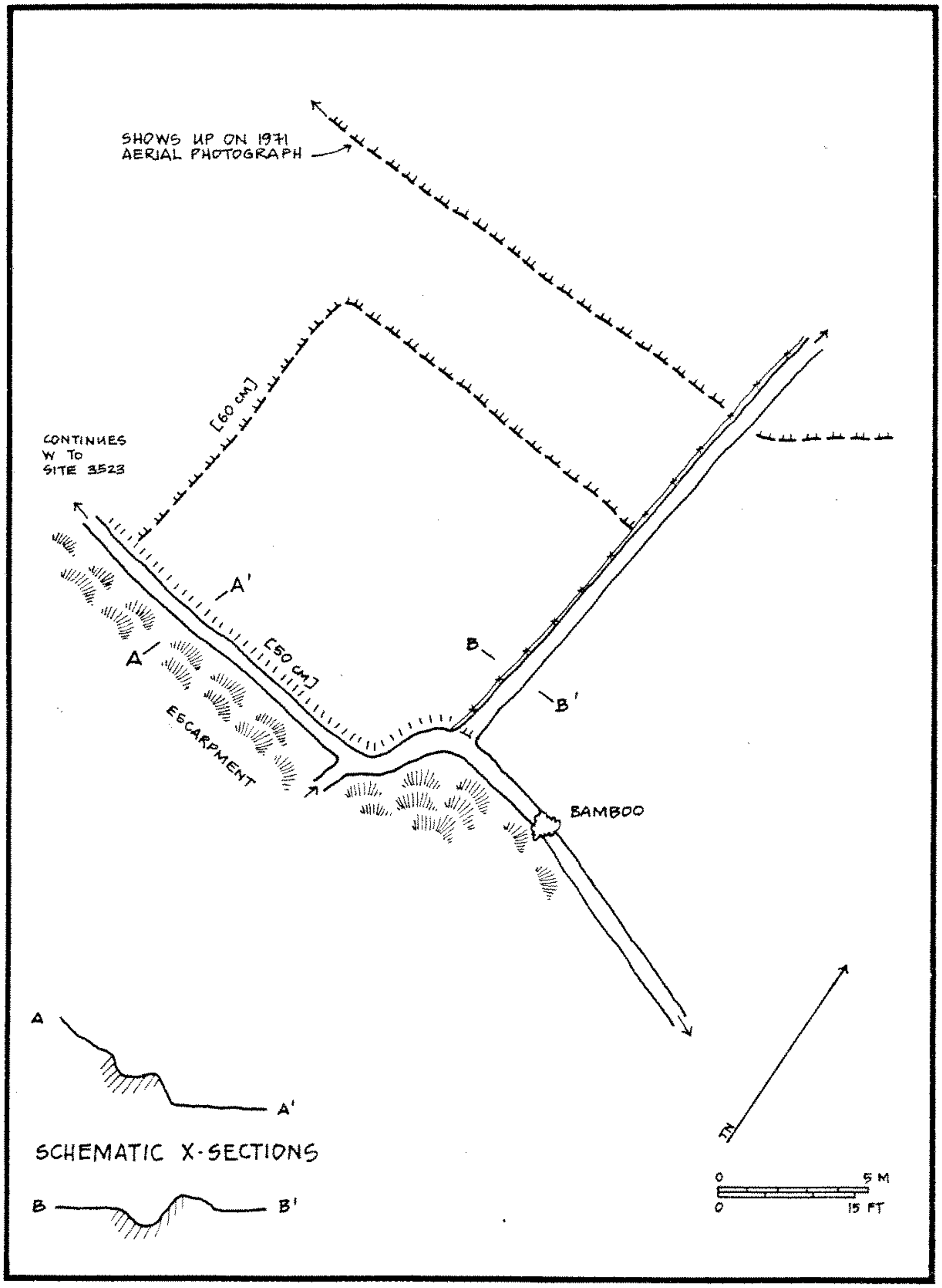

FIGURE 27. SITE 3524.

Terracing is visible in the pasture to the makai of the escarpment. Those immediately adjacent to the canal junction were mapped with Brunton pocket transit and tape (see Figure 27); those farther away were drawn from the 1928 aerial photograph (see Figure 13).

The site is in excellent condition. Research value is high in understanding some of the technical aspects of the rice irrigation system, as well as possibly investigating the preservation of the Hawaiian system beneath or integrated with the historical one. Public and cultural value are minimal.

3525: Artifact scatter: lithic material and a porcelain sherd were observed on the W edge of the cultivated field under lease 64 (Figure 28). No systematic transect survey of the field was carried out, as it was technically out of the survey area.

For the same reasons given for the artifact scatter in SA I (site 3514), this site has high research value. Public and cultural value are minimal.

3526: Buried cultural deposits: four profiles were noted along the lower banks of Waiāhole Stream, between 150 m (480 ft) and 415 m (1300 ft) inland of the Kamehameha Highway bridge.

Two probable agricultural horizons were noted in a 2.0 m high cut in the stream, approximately 150 m (480 ft) mauka of the bridge. The deposits contain considerable charcoal and a few basalt and volcanic glass flakes. The interpretation of agricultural use is based on the soil characteristics (see decription of soils in Figure 29).

The total length of the exposed stream cut is approximately 40 m (130 ft). Profile 1 is 10 m(30ft) from the E edge; profile 2 is approximately 10 m (30 ft) from the W edge. The land above the cut is presently being cultivated in bananas and other truck crops. The stream is approximately 20 to 50 cm deep at the base of the cut. A grass-covered island has formed in the center of the stream at this locale; a concrete and stone wall supporting Waiahole Valley Road is on the N side of the stream.

A 1.3 m high bank, approximately 223 m (700 ft) inland of the bridge, contains several strata of fine to coarse silts and clays; the lowest deposit shows a grey coloration which suggests a gleyed soil

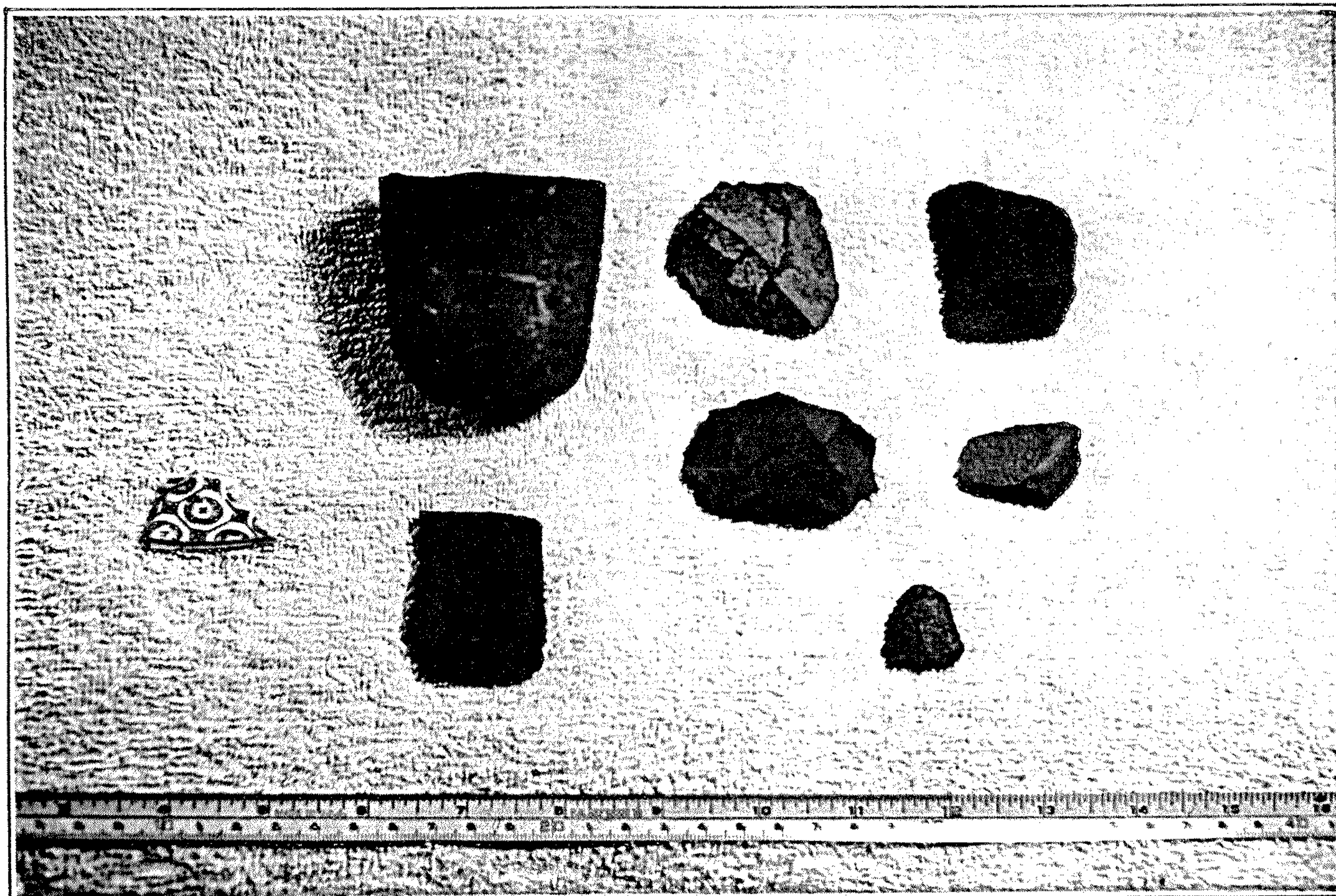

FIGURE 28. SAMPLE OF ARTIFACTS FOUND IN SITE 3525. (grinding stone, upper left; adze fragment, lower left; flakes, center and right; porcelain sherd, extreme left).

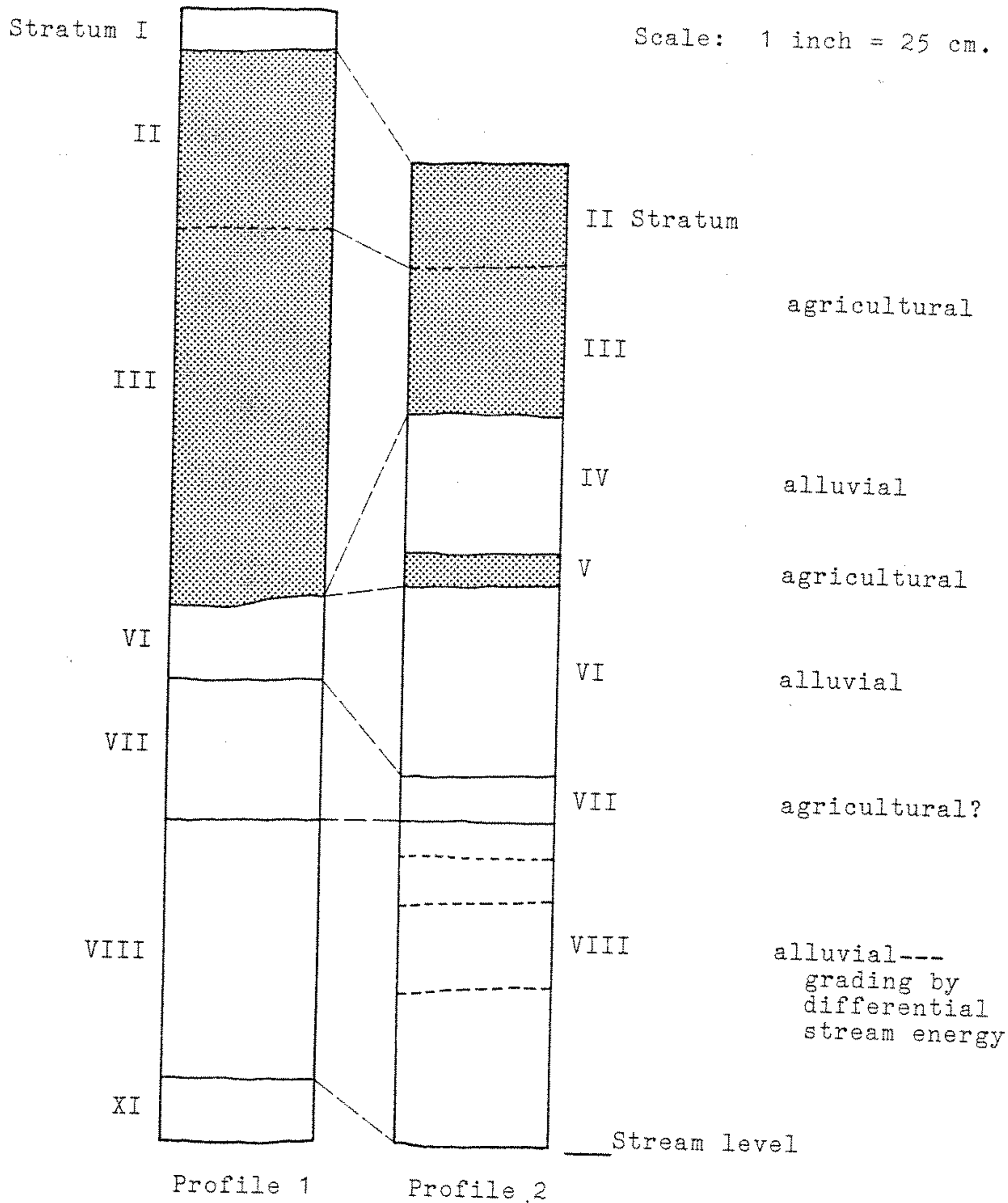

FIGURE 29. PROFILES 1 AND 2, SITE 3526.
(shading denotes inferred cultural
deposition---irrigation agriculture)

KEY TO FIGURE 29.
SOIL DESCRIPTIONS

Stratum I: Dark brown (7.5 YR 3/2, moist) silty clay; strong, medium, blocky structure; very hard consistence (dry); very firm consistence (moist); slightly sticky, slightly plastic; few fine to medium roots; less than 5% rounded pebbles; smooth, clear boundary; one flake of volcanic glass collected from boundary with Stratum II.

II: Dark brown (7.5 YR 3/2, moist) clay; strong, medium to coarse, sub-angular blocky structure; very hard consistence (dry); very firm consistence (moist); sticky, plastic; few medium roots; less than 10% rounded pebbles and cobbles; small charcoal flecks scattered throughout; clear, smooth boundary.

III: In profile 1, deposit is same as Stratum II, with reddish yellow (5 YR 6/8, moist) staining throughout (and extending into IV).

In profile 2, dark brown (7.5 YR 3/2, moist) clay loam; fine, sub-angular blocky structure; slightly sticky, slightly plastic; with reddish yellow (5 YR 5/8, moist) mottling; abrupt, smooth boundary.

IV: (occurs only in profile 2) coarse sand to small rounded cobbles in sandy loam matrix; reddish yellow; lower 5 cm is a sandy gravel with some rounded pebbles.

V: (occurs only in profile 2) Dark brown (7.5 YR 3/2, moist) silt clay; fine, sub-angular, blocky structure; very friable (moist); sticky, plastic; reddish yellow (5 YR 5/8, moist) mottling; very few, small charcoal flecks; smooth, abrupt boundary.

VI: Dark brown (7.5 YR 3/2, moist) with reddish yellow (5 YR 6/8, moist) mottling; rounded to sub-rounded pebbles to gravel in a clay loam matrix; weak, fine to medium crumb structure; firm consistence; sticky, plastic; few, very fine roots; abrupt, wavy boundary.

VII: In profile 1, dark brown (7.5 YR 3/2, moist) silty clay; with dark red (10 R 3/6, moist) mottling; friable; sticky, plastic; few, very fine roots; less than 10% rounded cobbles; abrupt, smooth boundary.

In profile 2, dark brown (7.5 YR 3/2, moist) clay; fine, columnar structure; very sticky, very plastic; friable; some charcoal flecks; abrupt, wavy boundary.

VIII: distinctly graded deposit of fine silts to small cobbles; in strong brown (7.5 YR 3/2, moist) clay loam matrix.

In profile 2, divided into four sub-strata:

VIIIa: silt to coarse sand; very fine crumb structure; slightly sticky, non-plastic; friable; some charcoal flecks (more so than in Stratum VII); abrupt, smooth boundary.

VIIIb: sands and pebbles.

VIIIc: very fine sandy silt; very fine crumb structure; slightly sticky, non-plastic; many large chunks of charcoal; few burnt kukui shell; thin bands of clay; abrupt, wavy boundary.

VIIId: coarse sands to pebbles in weakly cemented clay loam matrix; rounded to sub-rounded cobbles along lower boundary; abrupt, smooth boundary.

IX: (occurs only in profile 1) very dark brown (10 YR 2/2, moist) clay loam; sticky, plastic; approximately 25% gravels and pebbles; lower boundary undetermined.

(Evans /1978/ defines such a soil as having "formed through disturbance of the hydrological regime by man - particularly the changes wrought by forest clearance and land exploitation for farming"). Further, a facies change in this lowest deposit indicates that the stream channel has been shifting and that the present course is cutting into a former agricultural area.

A 2.5 m high bank, approximately 415 m (1300 ft) inland of the Kamehameha Highway bridge, contains a possible cultural deposit (grey/brown clay with red mottles and charcoal flecks), 60 cm above the present water level; overlying coarse, basal alluvial stratum. The upper layers of the cut bank have been heavily disturbed by recent digging and filling associated the residence on the adjacent property.

These profiles have high research value as they indicate the presence of buried, intact cultural material beneath the presently cultivated fields of the lower valley. The first set of profiles (see Figure 29), in particular, gives evidence of the natural and cultural changes in the landscape(Figure 30).

3527: Irrigation canal: 1.0 m deep canal feeding off of Waiāhole Stream to the S; intake is located mid-way between leases 91 and 93. The intake area is marked by corrugated metal and plastic sheeting, supported by _hau_ branches and boulders; approximately 20 m to _the makai_, the canal feeds into a long, 12" metal pipe which is presently overgrown in a _hau_ thicket.

Two other possible canal exhausts (into Waiāhole Stream) were noted on the N bank of the stream, slightly downstream from this site.

Without further information, the significance of this site is minimal.

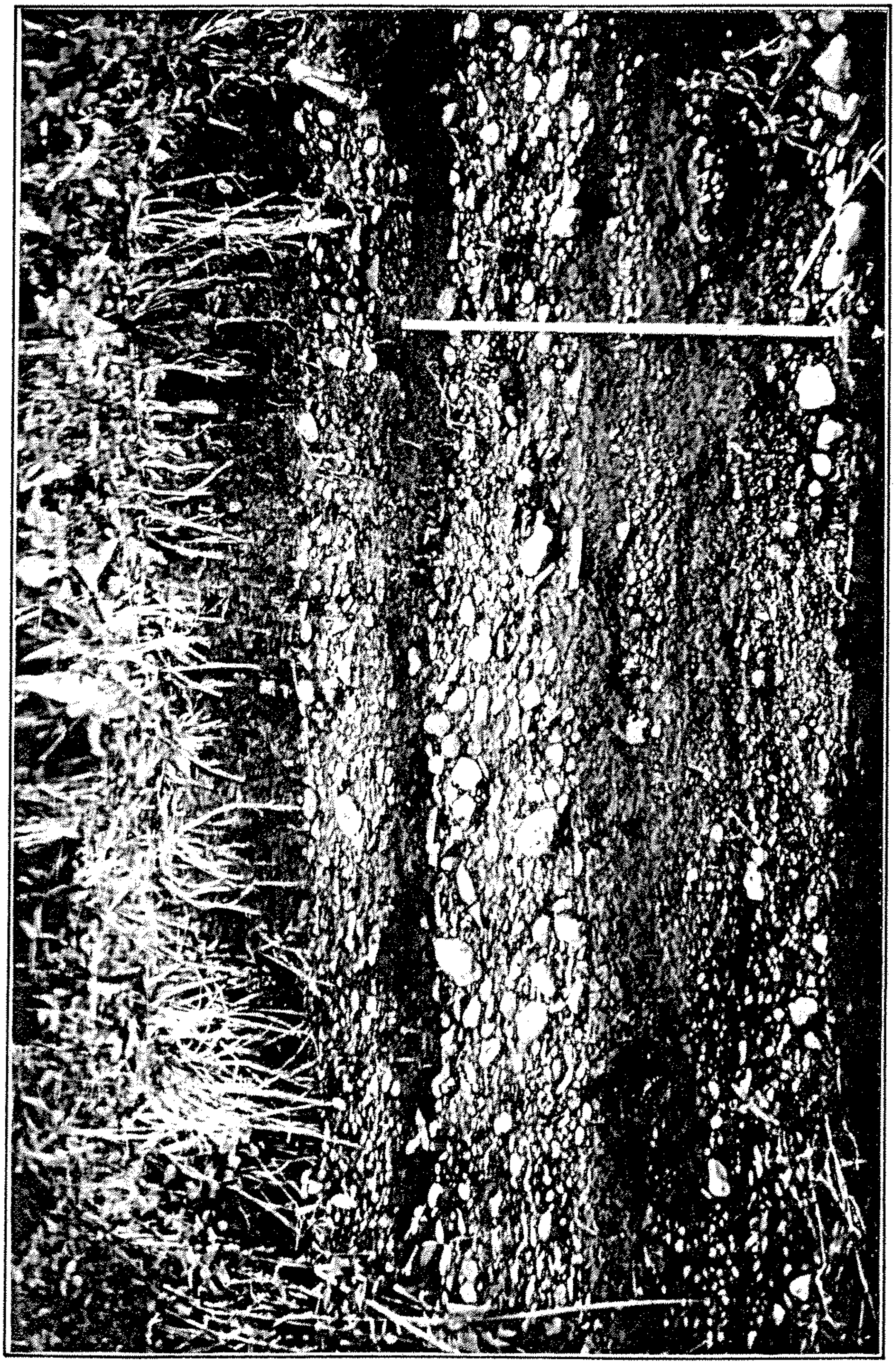

FIGURE 30. PROFILE 2, SITE 3526.

Appendix II.
LIST OF PLANTS

Common Name	Hawaiian Name	Scientific Name
kava	'awa	Piper methysticum
banana	mai'a	Musa sp.
false kamani	kamani haole	Terminalia catappa L.
guava	---	Psidium guajava
---	hau	Hibiscus tiliaceus
Java olive	---	Sterculia foetida L.
Java plum	---	Eugenia cuminii
---	koa haole	Leucaena glauca
mango	manako	Mangifera indica
pandanus	hala	Pandanus odoratissimus
panicum grass	---	Panicum maximus Jacq.
papaya	---	Carica papaya
sweet potato	'uala	Ipomoea batatas L.
rice	laiki	Oryza sativa
sugar cane	kō	Saccharum officinarum L.
taro	kalo	Colocasia esculenta L.
tobacco	paka	Nicotiana tobacum L.

Source: Marie C. Neal, In Gardens of Hawaii. B.P. Bishop Museum Special Publication 50. Bishop Museum Press. Honolulu. 1965.

Appendix III.

BIBLIOGRAPHIC REFERENCES TO THE WAIAHOLE WATER TUNNEL

Commissioner of Public Lands

1899 Application of L.L. McCandless and T. Lansing for 30 year license for water rights of Waiahole (no action taken). June 10. In, "List of applications filed after 7/7/98 to and including 10/11/99. Republic of Hawaii." Hawaii State Archives.

1899 Application of E.E. Paxton for 30 yr lease of all available water on the Crown land of Waiahole (no action taken). June 16. In, "List of applications filed after 7/7/98 to and including 10/11/99. Republic of Hawaii." Hawaii State Archives.

Kluegel, Charles H.

1916 "Engineering Features of the Water Project of the Waiahole Water Company." _Hawaiian Almanac and Annual for 1917_. Thos. G. Thrum. Honolulu. Pp. 93-107.

Larrison, G.K.

1916 "The Waiahole Tunnel Project." _Hawaiian Forester and Agriculturalist_. Vol. 13, no. 3, pp. 81-81.

McCandless, James S.

1936 _History of McCandless Brothers and Their Part in the Development of Artesian Well Water in the Hawaiian Islands_. Honolulu.

Thrum, Thos. G.

1915 "The Waiahole Water Project." _Hawaiian Almanac and Annual for 1916_. Thos. G. Thrum. Honolulu. Pp. 174-180.

Also:

Herschler, L.H.

1966 _The Waiahole Water Company, Fifty Years of Water Service_. Oahu Sugar Company. Honolulu.

Appendix IV.

NATIONAL REGISTER OF HISTORIC PLACES
NOMINATION FORMS

FOR

WAIĀHOLE VALLEY, DISTRICT OF KO'OLAUPOKO
ISLAND OF O'AHU

NPS Form 10-900 (7-81)

OMB NO. 1024-0018
12/31/84

United States Department of the Interior
National Park Service

For NPS use only
received
date entered

National Register of Historic Places Inventory—Nomination Form

See instructions in *How to Complete National Register Forms*
Type all entries—complete applicable sections

1. Name

historic

and/or common 50-80-10-3512

2. Location

street & number Waiahole Valley Road ___ not for publication

city, town Waiahole Valley ___ vicinity of ~~congressional district~~

state Hawaii code 50 county Honolulu code 80

3. Classification

Category	Ownership	Status	Present Use	
___ district	X public	___ occupied	___ agriculture	___ museum
___ building(s)	___ private	X unoccupied	___ commercial	___ park
___ structure	___ both	___ work in progress	___ educational	___ private residence
X site	**Public Acquisition**	**Accessible**	___ entertainment	___ religious
___ object	___ in process	___ yes: restricted	___ government	___ scientific
	___ being considered	X yes: unrestricted	___ industrial	X transportation
		___ no	___ military	___ other:

4. Owner of Property

name State of Hawaii

street & number Hawaii Housing Authority

city, town Honolulu ___ vicinity of state Hawaii

5. Location of Legal Description

courthouse, registry of deeds, etc. Bureau of Conveyances

street & number Dept. of Land and Natural Resources

city, town Honolulu state Hawaii

6. Representation in Existing Surveys

title has this property been determined eligible? ___ yes ___ no

date ___ federal ___ state ___ county ___ local

depository for survey records

city, town state

9. Major Bibliographical References

NONE

10. Geographical Data

Acreage of nominated property 0.5
Quadrangle name Kaneohe Quadrangle scale 1:24000
UMT References

A 0 5 (Zone) 6 1 7 7 6 4 (Easting) 2 3 7 6 0 3 0 (Northing)
B ___ Zone ___ Easting ___ Northing
C ___ D ___
E ___ F ___
G ___ H ___

Verbal boundary description and justification Site is bounded on the south by steep slope of ridge; on the east by abandoned dirt rd. which extends south from Waiahole Valley road; north side is estimated, based on cultural material exposed in 2 historically constructed ditches. Main part of site is exposed in cut banks of Waiahole Valley Road, 70 m inland of Waianu Stream bridge (SW end).

List all states and counties for properties overlapping state or county boundaries

state code county code

state code county code

11. Form Prepared By

name/title M.J. Tomonari-Tuggle

organization Hawaii Housing Authority date 29 January 1983

street & number 2752 Kahoaloha Ln telephone 947-1726

city or town Honolulu state Hawaii

12. State Historic Preservation Officer Certification

The evaluated significance of this property within the state is:

___ national ___ state ___ local

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service.

State Historic Preservation Officer signature

title date

For NPS use only
I hereby certify that this property is included in the National Register

date

Keeper of the National Register

Attest: date
Chief of Registration

7. Description

Condition		Check one	Check one
X excellent	___ deteriorated	X unaltered	X original site
___ good	___ ruins	___ altered	___ moved date ______
___ fair	___ unexposed		

Describe the present and original (if known) physical appearance

This site is located near the middle of Waiahole Valley in a cut bank of Waiahole Valley Road, immediately inland of where the road crosses Waianu Stream. The site is an exposed cultural deposit, measuring 20 to 30 cm thick, which contains lithic material, scattered charcoal, fire-cracked rock, identifiable fragments of vegetable material, and two firepits. It is clearly a habitation site, and possibly associated with lithic manufacture.

A wood sample has been tentatively identified as koa (Acacia koa), a native Hawaiian forest tree, which was used extensively by Hawaiians for ceremonial items, canoes, and household implements. There were no examples of this tree in the vicinity of the site at the time the site was located.

The site is exposed in a 1.4 to 2.0 m high road cut. It is situated on thenose of a ridge or knoll which separates the two primary drainages of the valley, Waianu and Waiahole Streams. The knoll has been cut by Waiahole Valley Road (which was constructed at least by the late 1920s, based on an 1928 U.S. military aerial photograph). The deposit is estimated to extend over an area of approximately 30 by 70 m.

8. Significance

Period	Areas of Significance—Check and justify below			
X prehistoric	X archeology-prehistoric	___ community planning	___ landscape architecture	___ religion
___ 1400–1499	___ archeology-historic	___ conservation	___ law	___ science
___ 1500–1599	___ agriculture	___ economics	___ literature	___ sculpture
___ 1600–1699	___ architecture	___ education	___ military	___ social/humanitarian
___ 1700–1799	___ art	___ engineering	___ music	___ theater
___ 1800–1899	___ commerce	___ exploration/settlement	___ philosophy	___ transportation
___ 1900–	___ communications	___ industry	___ politics/government	___ other (specify)
		___ invention		

Specific dates **Builder/Architect**

Statement of Significance (in one paragraph)

This site is significant for three research reasons: 1) it is an occupation site for which there are no known historical references and in which there are no apparent historical artifacts; that is, there is a high probability that it is of pre-Contact Hawaiian origin. If so, this may be one of the few such sites which survived the landscape changes in the lower valley wrought by the rice industry in the 19th century;

2) its location on the knoll which separates the two primary drainages in the valley suggests an association with agricultural fields along the streams and thus may be the habitation component of a cohesive residential/agricultural unit; this kind of habitation-agricultural association has been suggested by recent work in an area approximately five miles to the south and may reflect a settlement pattern typical of this windward area which has yet to be closely examined;

3) the abundance of lithic material in the exposed deposit suggests a special activity related to this occupation. There are two known quarry sites in the valley and at least three other sites which contained considerable quantities of basalt flakes, cores, and worked tools. This site can therefore contribute to an understanding of the production, distribution, and use of basalt tools in this Hawaiian cultural setting.

NPS Form 10-900
(7-81)

OMB No. 1024-0018

United States Department of the Interior
National Park Service

For NPS use only
received
date entered

National Register of Historic Places Inventory—Nomination Form

See instructions in *How to Complete National Register Forms*
Type all entries—complete applicable sections

1. Name

historic

and/or common 50-80-10-3514

2. Location

street & number Waiahole Valley Road (north branch) ___ not for publication

city, town Waiahole Valley ___ vicinity of ~~congressional district~~

state Hawaii code 50 county HOnolulu code 80

3. Classification

Category	Ownership	Status	Present Use	
___ district	X public	X occupied	X agriculture	___ museum
___ building(s)	___ private	___ unoccupied	___ commercial	___ park
___ structure	___ both	___ work in progress	___ educational	___ private residence
X site	**Public Acquisition**	**Accessible**	___ entertainment	___ religious
___ object	___ in process	___ yes: restricted	___ government	___ scientific
	___ being considered	___ yes: unrestricted	___ industrial	___ transportation
		___ no	___ military	___ other:

4. Owner of Property

name State of Hawaii

street & number Hawaii Housing Authority

city, town Honolulu ___ vicinity of state Hawaii

5. Location of Legal Description

courthouse, registry of deeds, etc. Bureau of Conveyances

street & number Dept. of Land and Natural Resources

city, town Honolulu state Hawaii

6. Representation in Existing Surveys

title has this property been determined eligible? ___ yes ___ no

date ___ federal ___ state ___ county ___ local

depository for survey records

city, town state

9. Major Bibliographical References

NONE

10. Geographical Data

Acreage of nominated property 0.25
Quadrangle name Kaneohe Quadrangle scale 1:24000
UMT References

	Zone	Easting	Northing		Zone	Easting	Northing
A	05	617780	2376282	B			
C				D			
E				F			
G				H			

Verbal boundary description and justification The N, S, and W boundaries are defined by the edges of the westernmost section of the field under Hawaii Housing Authority lease #73. The E boundary of the site is 20 m from the W boundary. The site may continue to the E but that area was not surveyed.

List all states and counties for properties overlapping state or county boundaries

state code county code

state code county code

11. Form Prepared By

name/title M.J. Tomonari-Tuggle, consultant archaeologist

organization Hawaii Housing Authority date 29 January 1983

street & number 2752 Kahoaloha Ln. telephone 947-1726

city or town Honolulu state Honolulu

12. State Historic Preservation Officer Certification

The evaluated significance of this property within the state is:

___ national ___ state ___ local

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service.

State Historic Preservation Officer signature

title date

For NPS use only
I hereby certify that this property is included in the National Register

date

Keeper of the National Register

Attest: date

Chief of Registration

7. Description

Condition
___ excellent
___ good
X fair
___ deteriorated
___ ruins
___ unexposed

Check one
___ unaltered
X altered

Check one
X original site
___ moved date ___

Describe the present and original (if known) physical appearance

This site is an artifact scatter in a plowed field. Over 230 artifacts, including basalt flakes and cores, polished adze fragments, volcanic glass flakes, ceramic sherds, and bottle glass, were noted in an area of 20 by 50 m. The chronological range of these artifacts reflects a continuity of occupation from at least the early 19th century, and possibly earlier in the prehistoric period. The field in which this site is located falls within the boundaries of a recorded land grant from the 19th century and was possibly the site of a house noted on an 1897 map by C.V.E. Dove (Public Lands Map #21, State Survey Office).

A density distribution for the different types of artifacts was calculated. The crockery (33) and bottle glass (52), which are clearly of historical origin, were concentrated in the SW corner of the field, while the volcanic glass (5) and miscellaneous lithic artifacts (7), which are probably of prehistoric or traditional origin, were distributed over the northern and eastern sections. The basalt flakes (142) were evenly distributed over the entire field, with some concentration along the western edge (i.e. along the edge of the field itself). This small sample suggests that 1) this area contains a multi-component site, containing a range of material representing both traditional and historical occupations and 2) the site can probably be divided into two zones, possibly reflecting shifting loci of occupation through time (an hypothesis which could be tested through excavation).

8. Significance

Period	Areas of Significance—Check and justify below			
X prehistoric	X archeology-prehistoric	___ community planning	___ landscape architecture	___ religion
___ 1400–1499	X archeology-historic	___ conservation	___ law	___ science
___ 1500–1599	___ agriculture	___ economics	___ literature	___ sculpture
___ 1600–1699	___ architecture	___ education	___ military	___ social/humanitarian
___ 1700–1799	___ art	___ engineering	___ music	___ theater
X 1800–1899	___ commerce	___ exploration/settlement	___ philosophy	___ transportation
X 1900–	___ communications	___ industry	___ politics/government	___ other (specify)
		___ invention		

Specific dates **Builder/Architect**

Statement of Significance (in one paragraph)

This site is particularly significant as it shows the viability of plow-zone surveys in Hawai'i, a methodology which heretofore has not been attempted, but which has the potential to yield valuable evidence on Hawaiian residential and agricultural practices (given the large acreage presently under cultivation throughout the islands).

Within this specific area, the artifactual material from this field shows a range in functional categories as well as in chronological occupation. Questions which could be addressed by this material include ones concerning a more detailed accounting of activity and occupation areas, shifting areas of occupation through time, the continuity of use of traditional tools into the historical period (suggested by the the broad distribution of flaked material as compared with the more localized concentrations of historical debris).

This last question is of particular interest in that it is generally thought that traditional tools were abandoned with the introduction of metal tools after Western contact in 1778. If basalt tools could be found to be contemporary with ceramics and bottle glass, this could change current thought on the continuity of aspects of Hawaiian culture into the historical period.

NPS Form 10-900 (7-81)

OMB NO. 1024-0018
EXP. 1 /31/84

United States Department of the Interior
National Park Service

For NPS use only
received
date entered

National Register of Historic Places Inventory—Nomination Form

See instructions in *How to Complete National Register Forms*
Type all entries—complete applicable sections

1. Name

historic

and/or common 50-80-10-3517

2. Location

street & number Waiahole Homestead Road ___ not for publication

city, town Waiahole Valley ___ vicinity of ~~congressional district~~

state Hawaii code 50 county Honolulu code 80

3. Classification

Category	Ownership	Status	Present Use	
___ district	X public	___ occupied	___ agriculture	___ museum
___ building(s)	___ private	X unoccupied	___ commercial	___ park
___ structure	___ both	___ work in progress	___ educational	___ private residence
X site	**Public Acquisition**	**Accessible**	___ entertainment	___ religious
___ object	___ in process	___ yes: restricted	___ government	___ scientific
	___ being considered	___ yes: unrestricted	___ industrial	___ transportation
		___ no	___ military	X other: None

4. Owner of Property

name State of Hawaii

street & number Hawaii Housing Authority

city, town Honolulu ___ vicinity of state Hawaii

5. Location of Legal Description

courthouse, registry of deeds, etc. Bureau of Conveyances

street & number Dept. of Land and Natural Resources

city, town Honolulu state Hawaii

6. Representation in Existing Surveys

title has this property been determined eligible? ___ yes ___ no

date ___ federal ___ state ___ county ___ local

depository for survey records

city, town state

9. Major Bibliographical References

NONE

10. Geographical Data

Acreage of nominated property 0.06
Quadrangle name Kaneohe Quadrangle scale 1:24000
UMT References

	Zone	Easting	Northing		Zone	Easting	Northing
A	0 5	6 1 8 3 5 8	2 3 7 6 0 4 2	B			
C				D			
E				F			
G				H			

Verbal boundary description and justification Site is a 22 by 10 m level area between Waiahole Homestead Rd. and south ridge of valley; bounded to N by road and to S,E, and W by rising valley sides.

List all states and counties for properties overlapping state or county boundaries

state code county code

state code county code

11. Form Prepared By

name/title M.J. TomonariTuggle, Consultant archaeologist

organization Hawaii Housing Authority date 29 January 1983

street & number 2752 Kahoaloha Ln/. telephone 947-1726

city or town Honolulu, state Hawaii

12. State Historic Preservation Officer Certification

The evaluated significance of this property within the state is:

___ national ___ state ___ local

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service.

State Historic Preservation Officer signature

title date

For NPS use only
I hereby certify that this property is included in the National Register

date

Keeper of the National Register

Attest: date

Chief of Registration

7. Description

Condition		Check one	Check one
X excellent	___ deteriorated	X unaltered	X original site
___ good	___ ruins	___ altered	___ moved date ______
___ fair	___ unexposed		

Describe the present and original (if known) physical appearance

This site consists of a small, wood frame house (with only three walls standing) and an associated trash or outhouse pit. It is located on a small flat at the base of the south valley ridge. The Waiahole Homestead Road runs adjacent to the north side of the house and pit. White ginger and banana are growing next to the one-room structure, which contains a rusted metal bedframe and other debris.

The pit, whih measures approximately 1.0 m in diameter, contains rusted metal, ceramic fragments, bottle fragments (including a bottle base inscribed "Dai Nippon"), and several short lengths of 4" by $' lumber.

An irrigation canal (site 50-80-10-3506) runs parallel to and across the road from the house. Near this site locale, a concrete tunnel, approximately 3.5 m long, has been built into the canal, forming a driveway of sorts across the ditch into the fields beyond (this driveway function is suggested by the close proximity to the Homestead Road and its structural features).

A house is indicated at this site in the description of Land Commission Award 7664:1. A structure is noted on an 1897 map by C.V.E. Dove (Public Lands Map #21, State Survey Office), as well as on a 1928 U.S. military aerial photograph of the valley.

8. Significance

Period	Areas of Significance—Check and justify below			
___ prehistoric	___ archeology-prehistoric	___ community planning	___ landscape architecture	___ religion
___ 1400–1499	X archeology-historic	___ conservation	___ law	___ science
___ 1500–1599	___ agriculture	___ economics	___ literature	___ sculpture
___ 1600–1699	___ architecture	___ education	___ military	___ social/ humanitarian
___ 1700–1799	___ art	___ engineering	___ music	___ theater
X 1800–1899	___ commerce	___ exploration/settlement	___ philosophy	___ transportation
X 1900–	___ communications	___ industry	___ politics/government	___ other (specify)
		___ invention		

Specific dates **Builder/Architect**

Statement of Significance (in one paragraph)

This site is in excellent condition and the apparent continuity in occupation of this locale from at least the first half of the 19th century into the 20th century gives much significance to the site in research terms.

The period of the rice industry in Waiahole (late 1800s) was the beginning of major changes in the traditional land use and settlement in the valley. The transition from a predominantly Hawaiian, subsistence-oriented community to one consisting primarily of Asian and Caucasian commercial agriculturalists is little known. Documentary sources, supplemented by archaeological investigations, can lend insight to the cultural continuities, as well as discontinuities, of this period. Sites such as this one, which is known through documents to have been occupied by both Hawaiians and rice workers, are of especial interest in this respect. The trash or outhouse pit, in particular, offers an opportunity to investigate the material remains of this occupation.

NPS Form 10-900 (7-81)

...1024-0018
Exp. 10/31/84

United States Department of the Interior
National Park Service

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received
date entered

National Register of Historic Places Inventory—Nomination Form

See instructions in *How to Complete National Register Forms*
Type all entries—complete applicable sections

1. Name

historic

and/or common 50-80-10-3524

2. Location

street & number Kamehameha Highway ___ not for publication

city, town Waiahole Valley X vicinity of ~~congressional district~~

state Hawaii code 50 county Honolulu code 80

3. Classification

Category	Ownership	Status	Present Use	
___ district	X public	___ occupied	X agriculture	___ museum
___ building(s)	___ private	X unoccupied	___ commercial	___ park
___ structure	___ both	___ work in progress	___ educational	___ private residence
X site	**Public Acquisition**	**Accessible**	___ entertainment	___ religious
___ object	___ in process	___ yes: restricted	___ government	___ scientific
	___ being considered	___ yes: unrestricted	___ industrial	___ transportation
		___ no	___ military	___ other:

4. Owner of Property

name State of Hawaii

street & number Hawaii Housing Authority

city, town Honolulu ___ vicinity of state Hawaii

5. Location of Legal Description

courthouse, registry of deeds, etc. Bureau of Conveyances

street & number Dept. of Land and Natural Resources

city, town Honolulu state Hawaii

6. Representation in Existing Surveys

title has this property been determined eligible? ___ yes ___ no

date ___ federal ___ state ___ county ___ local

depository for survey records

city, town state

9. Major Bibliographical References

None

10. Geographical Data

Acreage of nominated property 0.10

Quadrangle name Kaneohe Quadrangle scale 1:24000

UMT References

	Zone	Easting	Northing		Zone	Easting	Northing
A	05	619062	2376440	B			
C				D			
E				F			
G				H			

Verbal boundary description and justification Site is bounded on south side by low escarpment; to E by defined bank of seaward irrigation ditch; to N and W by open pasture area. N and W boundaries are estimated and not well-defined.

List all states and counties for properties overlapping state or county boundaries

state code county code

state code county code

11. Form Prepared By

name/title M.J. Tomonari-Tuggle, consulting archaeologist

organization Hawaii Housing Authority date 29 January 1983

street & number 2752 Kahoaloha Ln. telephone 947-1726

city or town Honolulu state Hawaii

12. State Historic Preservation Officer Certification

The evaluated significance of this property within the state is:

___ national ___ state ___ local

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service.

State Historic Preservation Officer signature

title date

For NPS use only
I hereby certify that this property is included in the National Register

date

Keeper of the National Register

Attest: date

Chief of Registration

7. Description

Condition		Check one	Check one
X excellent	___ deteriorated	X unaltered	X original site
___ good	___ ruins	___ altered	___ moved date ______
___ fair	___ unexposed		

Describe the present and original (if known) physical appearance

This site is the well-preserved junction of several irrigation canals, as well as the fields which those canals once fed. The main canal is presently a narrow, level bench at the base of a low escarpment; it runs south from the site of the old McCandless Rice Mill (no longer standing) along the base of the escarpment to this site locale, where it joins with two other ditches, one a 50 to 60 cm deep earthen ditch continues southward, and a shallower, earthen ditch which extends seaward.

Terraced fields are visible in the pasture area to the seaward side of the escarpment. These are known from historical maps (from 1878 and 1897) to have been used for rice cultivation (which was a major industry in the valley between 1870 and 1920).

The site area is approximately 20 by 20 m, although it at one time certainly extended beyond the present boundaries. After abandonment of the rice fields, the terraced areas were put to a variety of uses, including truck farming and pasture. The area seaward of the site is in residential and intensive nursery use as well as pasture at present.

8. Significance

Period	Areas of Significance—Check and justify below			
___ prehistoric	___ archeology-prehistoric	___ community planning	___ landscape architecture	___ religion
___ 1400–1499	X archeology-historic	___ conservation	___ law	___ science
___ 1500–1599	X agriculture	___ economics	___ literature	___ sculpture
___ 1600–1699	___ architecture	___ education	___ military	___ social/humanitarian
___ 1700–1799	___ art	___ engineering	___ music	___ theater
X 1800–1899	___ commerce	___ exploration/settlement	___ philosophy	___ transportation
X 1900–	___ communications	___ industry	___ politics/government	___ other (specify)
		___ invention		

Specific dates **Builder/Architect**

Statement of Significance (in one paragraph)

This site is in excellent condition and offers an opportunity to investigate technical aspects of the historical rice irrigation system, as well as looking at the possible preservation of a Hawaiian subsistence system beneath or integratedwith the historical one.

This site is one of the best preserved locales related to the rice industry developments which occurred in the late 1800s. Besides its research potential in addressing questions related to this use of the area, it is a representative site of a critical period in the history of Waiahole Valley, when the traditional Hawaiian subsistence community was beginning to be impacted by the introduction of a commercial plantation operation, i.e. the rice industry.

Irrigation agriculture was the basic form, but the purpose and crops were very different, one was subsistence taro and one was commercial rice. This site has the potential for looking at a changing technology within a common mold.

Appendix V.

AN OUTLINE FOR A CULTURAL RESOURCE MANAGEMENT/ DATA RECOVERY PLAN

WAIĀHOLE VALLEY AGRICULTURAL PARK
Waiāhole Valley, District of Ko'olaupoko, O'ahu

I. PURPOSE: to organize future archaeological work into a management-oriented, but scientifically based framework; to allow planning and scheduling of archaeological work within the context of development projects, thereby avoiding work done in reaction to, rather than in anticipation of, future development.

II. SCOPE OF WORK: should identify archaeological resources, define areas and kinds of potential development impacts on those resources, and specify the kinds of archaeological work which will be needed to mitigate any adverse impacts; recommended archaeological work should be framed in a scientific research design which integrates the archaeology of Waiāhole Valley into a regional context and which poses questions which substantively and/or methodologically contribute to the state-of-the-art of the discipline.

III. INVENTORY OF RESOURCES: the present survey identified archaeological sites in a variety of environmental situations, including presently occupied or used areas, which suggests that Waiāhole (beyond the survey boundaries) may contain significantly more archaeological resources than originally thought for this relatively heavily utilized valley on O'ahu. Information on the wide range of archaeological resources is necessary for developing a sampling strategy for a data recovery plan; additional survey in Waiāhole can provide this information (see general recommendation 2, p. 50).

IV. RESEARCH DESIGN: a scientifically based framework for organizing archaeological work; should present goals, objectives, priorities, and a strategy for achieving those ends.

A. Formulating a cultural history of Waiāhole should be one goal of the archaeological research: to establish a preliminary chronology of valley occupation and a sense of how settlement began and developed in the prehistoric past (Miyagi's 1963 masters' thesis is a good base for the post-Contact history).

B. Developing research-oriented problems to guide archaeological work: three current research problems which could be applied to this area are 1) the human influence on the natural landscape; 2) the study of stone tools; and 3) the archaeology of the 19th and 20th centuries. Work in specific sites can address research questions in the context of these general problems. Examples are presented in Section III, pp. 40-42.

C. Composing a strategy for implementing the research design, including stipulating the amounts and kinds of data to be collected from which sites (i.e. sampling).

V. INTEGRATION OF ARCHAEOLOGICAL RECOMMENDATIONS WITH DEVELOPMENT PLANS: scheduling necessary archaeological work as part of planning for specific development projects (e.g. waterline installation, new lease award); will maximize archaeological data recovery within the areal limits and time constraints of development.

Archaeological work which is planned prior to and in conjunction with development can be framed in a scientific context, thereby meeting mitigation needs as well as contributing to the discipline of archaeology. For the developer, this management approach anticipates necessary archaeological investigations and avoids a piece-meal and often time-consuming method of contracting for such services.