Agricultural Land Assessment

For

Monsanto Company's
Proposed Important Agricultural Land

County of Maui

Prepared for:

MONSANTO
HAWAII

Prepared by:

PBR HAWAII
& ASSOCIATES, INC.

September 29, 2017

Exhibit 4

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1. Introduction/Purpose

This Agricultural Lands Assessment: 1) is prepared in support of a Petition for Declaratory Order to Designate Important Agricultural Lands (IAL) for land in the County of Maui owned by Monsanto Company and its subsidiaries (Monsanto); 2) provides an overview of various agricultural and other characteristics of the land that Monsanto proposes to designate as IAL.

Monsanto's O'ahu Land and Proposed IAL Designation

Monsanto owns approximately 1,817.35 acres of land in the County of Maui: approximately 596.117 acres on the Island of Maui (Maui) and approximately 1,221.240 acres on the Island of Moloka'i (Moloka'i). The land on Maui is in the Kihei region and the land on Moloka'i is in the Kualapu'u region.

Monsanto proposes to designate approximately 1084.079 acres (60 percent) of its total County of Maui land as IAL. The remaining approximately 733.278 acres (40 percent) is not proposed to be designated IAL at this time.

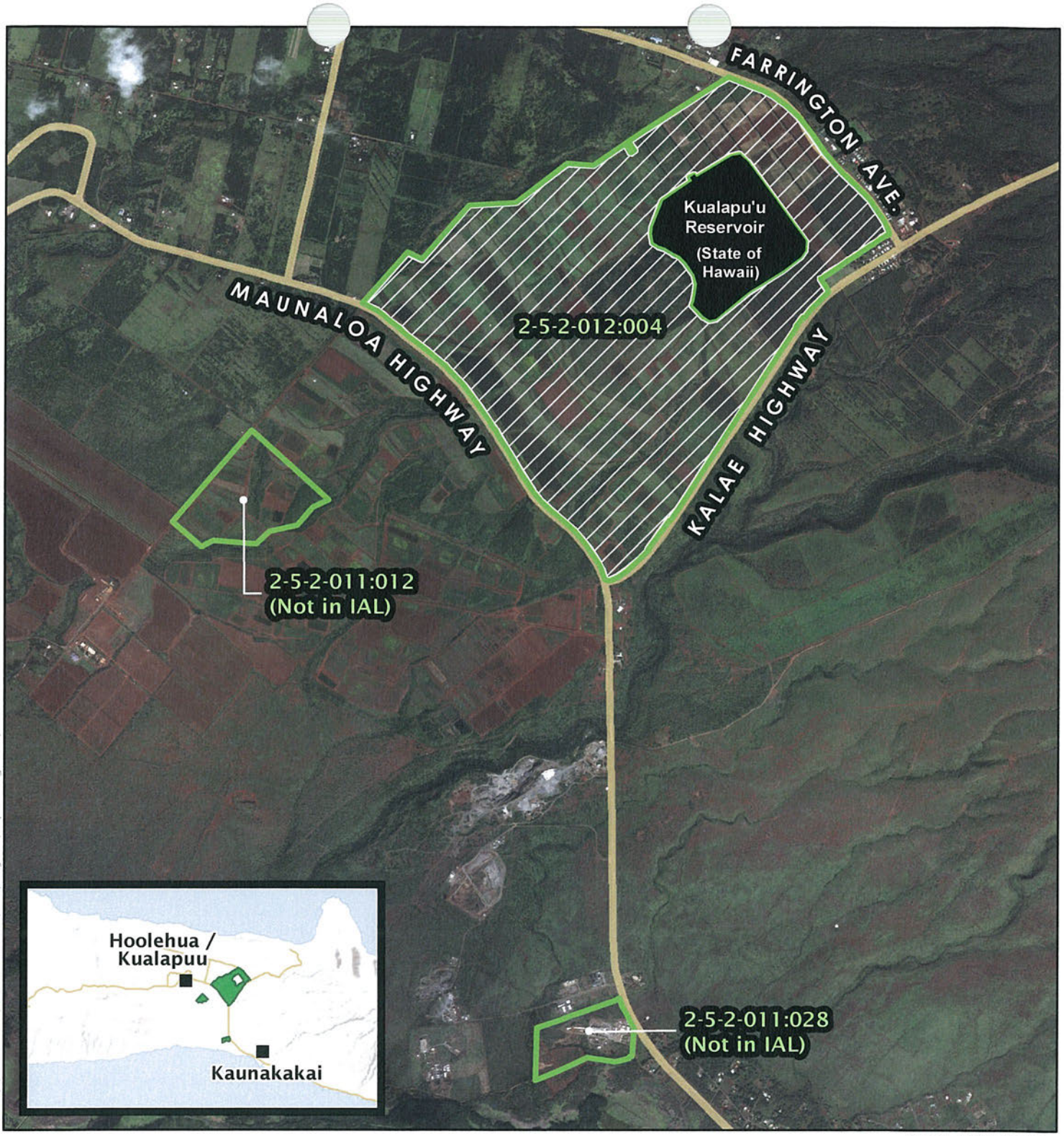
Throughout this report the term:

- "Maui County Land" refers to Monsanto's total land in the County of Maui
- "Property" refers to the land Monsanto proposes to designate as IAL

The table below shows the Tax Map Key (TMK) number of each parcel Monsanto owns in the County of Maui, the island on which the parcel is located, the area of each parcel, the area of the parcel proposed to be designated IAL, the area of each parcel that is not proposed to be designated as IAL, and parcel land use designations.

Island	TMK	Total Acres	IAL Acres (Property)	Non-IAL Acres (Remainder Land)	State Land Use District	Community Plan	Zoning
Moloka'i	2-5-2-012:004	1,084.079	1,084.079	0	Agricultural	Agriculture	Agriculture/ Interim
	2-5-2-011:012	89.075	0	89.075	Agricultural	Agriculture	Agriculture
	2-5-2-011:028	48.086	0	48.086	Agricultural	Heavy Industrial	Interim
Total		**1,221.240**	**1,084.079**	**137.161**			
Maui	2-3-8-004:020	213.337	0	213.337	Agricultural	Agriculture	Agriculture
	2-3-8-004:024	72.780	0	72.780	Agricultural	Agriculture	Agriculture
	2-2-2-002:069	310.000	0	310.000	Agricultural	Agriculture	Agriculture
Total		**596.117**	**0**	**596.117**			
MAUI COUNTY TOTAL		**1,817.36**	**1,084.079**	**733.278**			
Percentage of Total			**60%**	**40%**			

Figure 1a shows the Moloka'i TMK parcels and indicates the parcel proposed to be designated IAL by highlighting in yellow. Figure 1b shows the Maui parcels.



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DATE: 9/25/2017

LEGEND

- Monsanto Property ("Maui County Land")
- Proposed IAL ("Property")
- Owned by Others

Figure 1a

Molokai TMK Parcels and Proposed IAL

Monsanto IAL

Monsanto Company

Island of Moloka'i

North

Linear Scale (Feet)

0 700 1,400 2,800

Source: State of Hawaii. County of Maui. USDA NRCS.
Disclaimer: This graphic has been prepared for general planning purposes only.

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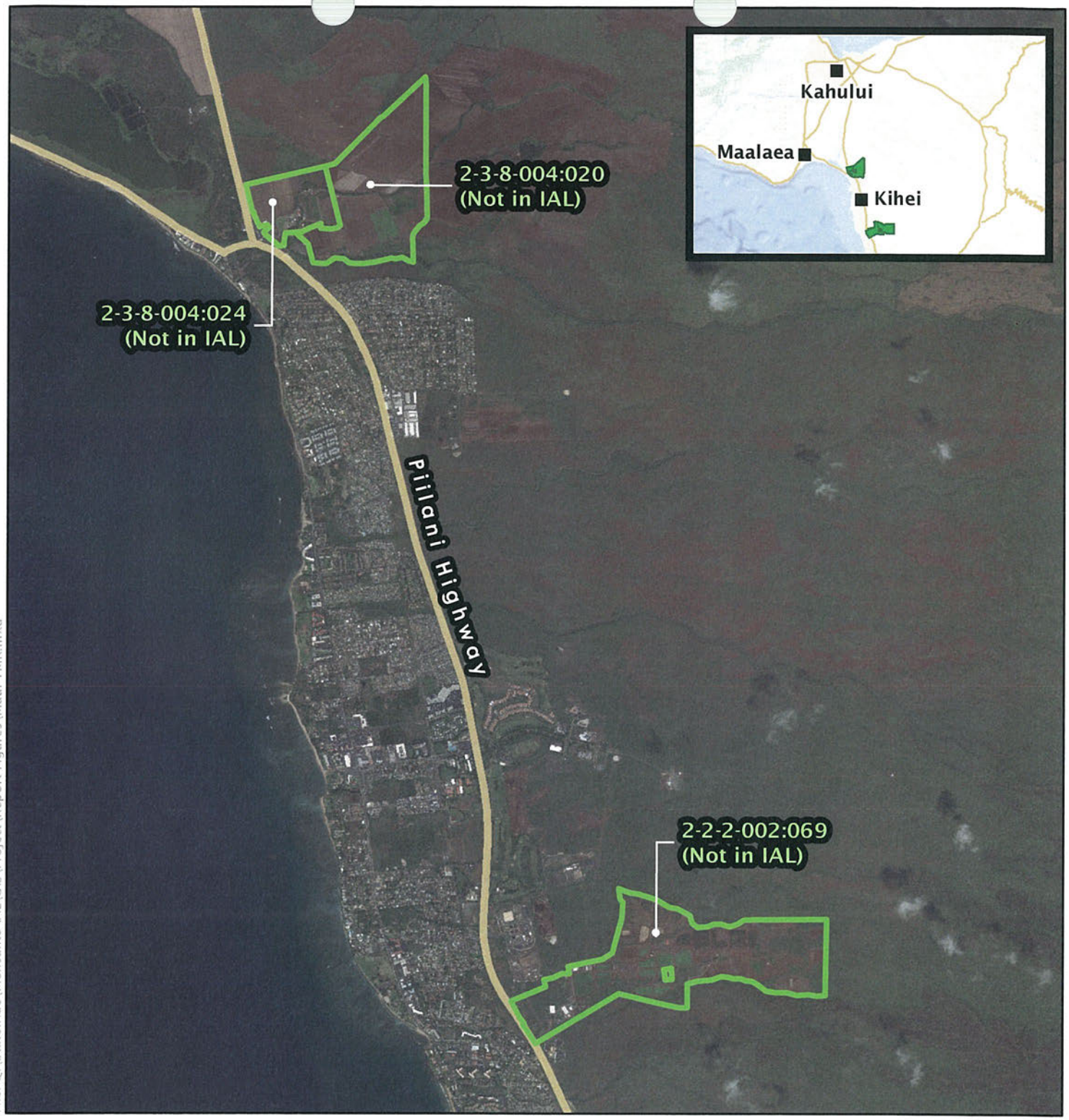

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DATE: 9/25/2017

LEGEND

Monsanto Property ("Maui County Land")

Figure 1b

Maui TMK Parcels

Monsanto IAL

Monsanto Company

Island of Maui

North

Linear Scale (Feet)

0 600 1,800 3,600

Source: State of Hawaii. County of Maui. USDA NRCS.
Disclaimer: This graphic has been prepared for general planning purposes only.

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Standards and Criteria to Identify IAL

Hawaii Revised Statues (HRS) §205-44(c) provides standards and criteria to identify IAL. HRS §205-44(a) provides that lands identified as IAL need not meet every standard and criteria, but rather, lands meeting any of the criteria shall be given initial consideration, provided that the designation of IAL shall be made by weighing the standards and criteria with each other to meet: 1) the constitutionally mandated purposes in Article XI, Section 3, of the Hawaii Constitution; and 2) the objectives and policies for IAL set forth in HRS §205-42 and HRS §205-43.

The standards and criteria to identify IAL set forth in HRS §205-44(c) are:

1) *Land currently used for agricultural production;*
2) *Land with soil qualities and growing conditions that support agricultural production of food, fiber, or fuel-and energy-producing crops;*
3) *Land identified under agricultural productivity rating systems, such as the agricultural lands of importance to the State of Hawaii (ALISH) system adopted by the board of agriculture on January 28, 1977;*
4) *Land types associated with traditional native Hawaiian agricultural uses, such as taro cultivation, or unique agricultural crops and uses, such as coffee, vineyards, aquaculture, and energy production;*
5) *Land with sufficient quantities of water to support viable agricultural production;*
6) *Land whose designation as important agricultural lands is consistent with general, development and community plans of the county;*
7) *Land that contributes to maintaining a critical land mass important to agricultural operation productivity;*
8) *Land with or near support infrastructure conducive to agricultural productivity, such as transportation to markets, water or power.*

The information in this assessment is provided to demonstrate that the Property is consistent with the standards and criteria to identify IAL as set forth in HRS §205-44(c).

2. Agricultural Use History

The Property has been in agricultural production for about 120 years, starting in approximately 1897 when what is now Molokai Properties Limited (also formerly known as Molokai Ranch, Ltd.) was formed and started ranching operations. Molokai Properties Limited used the Property for ranching until the early 1900s, when the Property became part of a pineapple plantation operated by Del Monte Corporation. Pineapple production continued until the mid-1980s when pineapple production ceased

Beginning in the mid-1980s, Molokai Properties Limited leased out a portion of the Property for coffee production, and the remainder was either used for ranching operations or left unused. After a change in ownership of the coffee farm in about 2003, coffee continued to be grown at

the Property but under three separate leases, all of which were ultimately assigned to Coffees of Hawaii, LLC.

In 2007, Monsanto leased a portion of the Property for seed corn production. In 2012, Monsanto acquired the three coffee leases from Coffees of Hawaii, LLC, and thereafter had possession of all of the Property through leases with Molokai Properties Limited. As the long-term lessee of Molokai Properties Limited, Monsanto continued to sublease a portion of the Property to a coffee farmer for coffee production and continued to use the rest of the Property for Monsanto's seed corn and soybean production. In 2015, Monsanto acquired the Property in fee simple from Molokai Properties Limited.

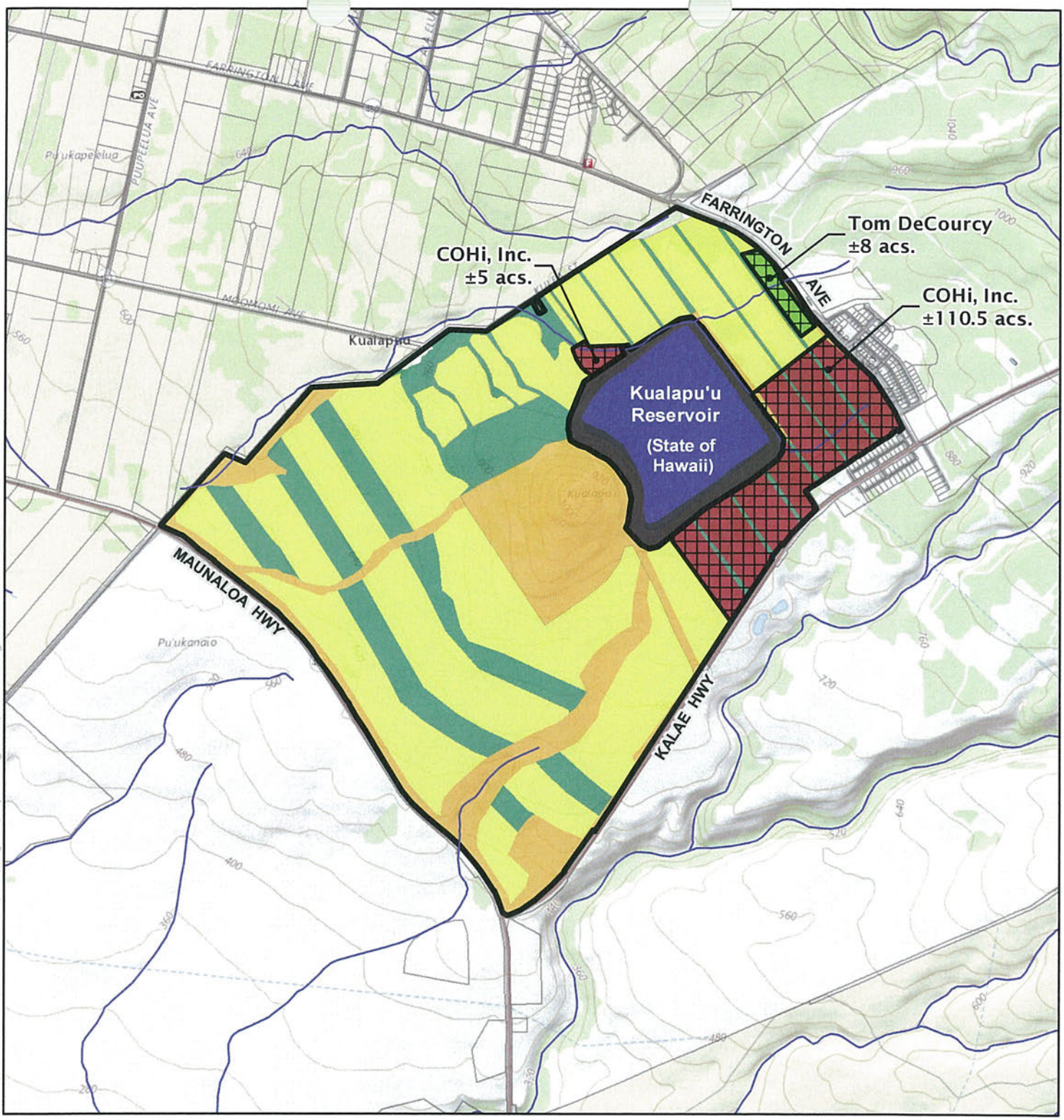
3. Current and Future Agricultural Operations

All of the Property is currently in active agricultural production. Approximately 524.4 acres or 80.9% of cultivatable acres[1] within the Property is in active seed corn and soybean production on a year-round basis. Of this, approximately 95 percent of the fields are planted with seed corn, and the remaining five percent of the fields are planted in soybeans. Each field is used to produce no more than one seed corn or soybean crop per year.

On average, approximately one-third of the fields on the Property are planted over the course of a year. This allows for year-round crop production with up to three crops per year. During the period between seed corn or soybean production, the fields are planted with cover crops for conservation and crop rotation purposes. Currently the cover crop used at the Property is a mix of cowpeas, sunn hemp, mung beans, canola, mustard, radish, buckwheat, sunflower and okra. Figure 2 shows the crop production areas on the Property, including the general location of the seed corn fields and soybean production areas.

Monsanto's agricultural operations include a comprehensive conservation plan developed in conjunction with the United States Department of Agriculture's Natural Resource Conservation Service, with a goal of soil and water conservation. This plan includes: 1) vegetation terraces established across slopes to slow and divert rain water runoff; 2) grassed waterways to channel rain water runoff and slow its flow rate; and 3) sediment basins. In addition, the plan includes use of drip irrigation, cover crops, windbreaks and field borders (including native species, such as Polynesian introduced species like Kukui *(Aleurites mollucana)*, Kou *(Cordia subcordata)*, and Kamani *(Inophyllum callophyllum)*, indigenous specie include A'ali'i *(Dodonaea viscosa)*, and endemic species such as Koa *(Acacia koa)* and the federally listed endangered species, 'Ohai *(Sesbania arborea)*, and Cook pine trees (*Araucaria columnaris*) and other tillage and dust

[1] The State Department of Agriculture (DOA) has determined the Property contains a total of 1,081.4 acres, consisting of 647.9 cultivatable acres, 210 conservation acres, and 226.179 uncultivated acres. For purposes of this analysis, Monsanto has assumed that all of the 123.5 acres leased for coffee or sun hemp seed production are cultivatable, with all conservation acres and uncultivated acres being within the portion of the Property farmed by Monsanto.



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DATE: 9/25/2017

LEGEND

- Proposed IAL
- Owned by Others
- TMK Parcels
- Reservoirs
- Streams / Gulches
- Roads

Current Agricultural Use

- Corn and Soybean
- Coffee
- Sunn Hemp Seed
- Soil Conservation
- Other (non classified, native plant restoration, pu'u, gulch)
- Leases

Source: Monsanto Company (2017). County of Maui. ESRI Online Basemap.
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 2

Agricultural Areas

Monsanto IAL

Monsanto Company — Island of Moloka'i

North

Linear Scale (Feet)

0 500 1,000 2,000

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mitigation measures. Monsanto's agricultural practices emphasize sustainability, soil and water conservation, and best management practices (Monsanto Hawaii, 2016).

Monsanto's conservation efforts on the Property include: 1) use of approximately 27 acres in an on-site gulch for restoration of native plant species, including for example, Naio or the Bastard Sandalwood *(Myoporum sandwicnese)*, A'ali'i *(Dodonaea viscosa)*; and Wiliwili *(Erythrina sandwicensis)*) to create a native forest; and 2) creation of a pollinator habitat of approximately 0.84 acres, which is fenced and includes about 100 native and non-native species and a walking path. This habitat provides a home for a monarch butterfly population to feed, lay eggs, and roost. This pollinator habitat also has an education component to allow the public to learn about the native plants. In 2015, Monsanto's habitat conservation and management activities resulted in the first in Hawaii certification by the Wildlife Habitat Council.

As described in the previous section, the Property has been used for coffee cultivation for approximately 30 years. Currently, Monsanto leases approximately 115.5 acres of the Property to COHI, Inc., a Hawaii corporation, for coffee farming, in the location shown on Figure 2. The lease to COHI, Inc. is a long-term lease, expiring in 2031.

Another tenant of Monsanto, Tom DeCourcy, sole proprietor, grows sunn hemp seeds on approximately eight acres of the Property (see Figure 2). Mr. DeCourcy has been farming on the Property since 2015, and has a year-to-year tenancy.

Collectively, the coffee farm and the sunn hemp seed farm occupy approximately 123.5 acres (12 percent) of the Property.

Coral Wireless, LLC, doing business as Mobi PCS (now owned by Verizon), leases approximately 65 square feet on Kualapu'u as a communications tower, for data and cellular communications. The State of Hawai'i has a perpetual easement of approximately 10 square feet to access and maintain Triangulation Survey Station "Middle Hill" and to access and maintain a beacon light on Kualapu'u.

The balance of the Property, consists of: 1) approximately 210 acres (20 percent) for soil conservation measures, roads, and water infrastructure (such as detention basins, berms, and filter strips); and 2) approximately 226.179 uncultivated acres, such as gulch land or land where Kualapu'u is located.

The total Property contributes to maintaining a critical land mass important to agricultural operating productivity. Land not in active cultivation includes elements essential agricultural operations; while other areas, such as gulch land or land where Kualapu'u is located, contribute toward maintaining a contiguous, intact, and functional land unit large enough to allow flexibility in agricultural production and management.

The table below summarizes the agricultural uses on the Property:

Agricultural Use	Acres	Percent
Corn and Soybean Production	524.400	48%
Coffee & Sunn Hemp Seed Production	123.500	12%
Soil Conservation	210.00	20%
Other (uncultivated, native plant restoration, pu'u, gulch)	226.179	20%
Total	**1,084.079**	**100%**

Figure 2 shows areas of the Property used for crop production, soil conservation, and agricultural infrastructure, and other land. Figure 3 shows the Property topography; areas with relatively gentle grades are used for crop production and areas with steeper slopes used for soil conservation. The areas with steeper slopes are important to the overall Property for soil conservation and for cohesion and continuity of agricultural uses across the Property. Figure 3 also shows streams through or adjacent to the Property.

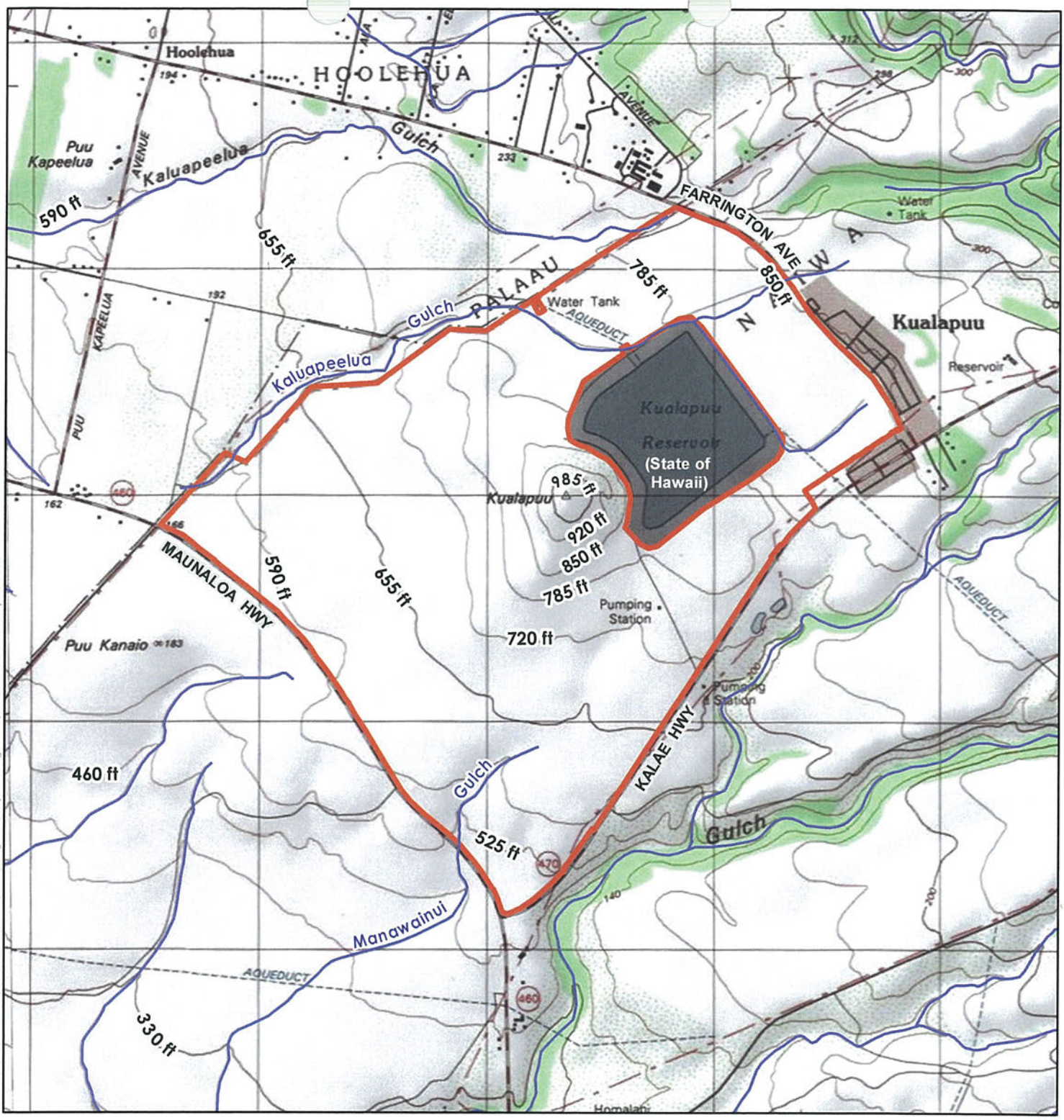
4. Agricultural Soils Productivity Ratings

The Detailed Land Classification System Agricultural Land Productivity Ratings by the Land Study Bureau (LSB), University of Hawai'i (Land Study Bureau, 1968) are based on a five-class productivity rating system using the letters A, B, C, D, and E, with A representing the class of highest productivity and E the lowest. Productivity ratings are combined with numbered Land Types under both irrigated (indicated by "i" after the Land Type number) and unirrigated conditions (indicated by the absence of an "i" after the Land Type number). For example, land designated D 38 is the same Land Type as land designated A 38i, with the difference being a much higher productivity rating with irrigation.

The LSB's *Detailed Land Classification – Island of Molokai* was published in 1968 (Land Study Bureau, 1968), before the construction and operation of the Kualapu'u Reservoir (which was built in 1969 and is surrounded by the Property) made it possible to irrigate the Property. Now, as discussed in section 7 below, the Property is irrigated.

The LSB unirrigated productivity ratings of the Property shown on the 1968 LSB map (see Figure 4a) range from C to E; however, based on the Land Type number, and with irrigation, over 93 percent of the Property has a productivity rating of A (70.4 percent) or B (22.8 percent). Less than seven percent of the Property has a productively rating of C (0.1 percent) or E (6.7 percent), and none of the Property has a productivity rating of D (see Figure 4b). Thus, the soil productivity ratings of the Property are high, and the Property has been and continues to be used for active agricultural uses.

The table on page 11 summarizes the productivity ratings of the Property, both without and with irrigation (Land Study Bureau, 1968). For detailed information on the Land Types and Overall



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DATE: 9/25/2017

LEGEND

- Proposed IAL
- Owned by Others
- Streams / Gulches

Figure 3

Topography and Streams

Monsanto IAL

Monsanto Company

Island of Moloka'i

North

Linear Scale (Feet)

0 500 1,000 2,000

Source: U.S. Geological Survey. State of Hawaii. County of Maui.
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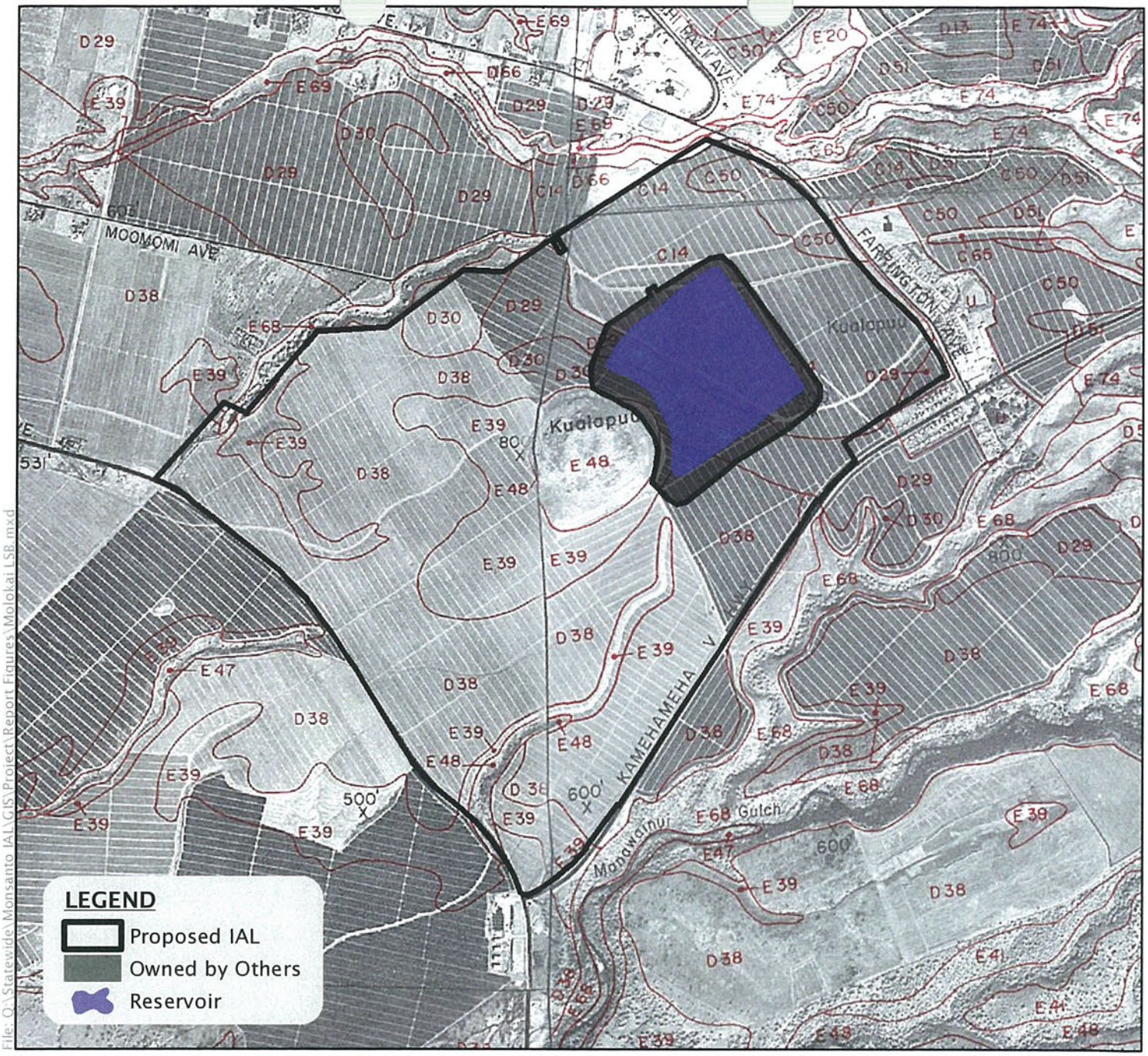

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DATE: 9/29/2017

This map, from the LSB's *Detailed Land Classification – Island of Molokai*, was published in 1968, before the construction and operation of the Kualapu'u Reservoir (built in 1969 and drawn in the upper center of the Property) made it possible to irrigate the Property.

The LSB system classifies soil productively as A, B, C, D, and E. These letter ratings are combined with a Land Type number for both irrigated (indicated by "i" after the Land Type number) and unirrigated conditions (indicated by the absence of an "i" after the Land Type number). For example, land designated D 38 (as shown throughout most of the lower portion of the Property) is the same Land Type as land designated A 38i, with the difference being a much higher productivity rating with irrigation.

As shown on this 1968 map, the unirrigated productivity ratings of the Property range from C to E without irrigation; however, based on the Land Type number, and with irrigation, over 93% of the Property has a productivity rating of A (70.4 %) or B (22.8 %) and less than 7% of the Property has a productively rating of C (0.1 %) or E (6.7 %). None of the Property has a productivity rating of D.

For more information please refer to the text in Section 4 and Appendix A.

Source: University of Hawaii Land Study Bureau (1968) *Detailed Land Classification - Island of Molokai.*
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 4a

Land Study Bureau (LSB)
Detailed Land Classification System

Monsanto IAL

Monsanto Company — Island of Moloka'i

North

Linear Scale (Feet)

0 500 1,000 2,000

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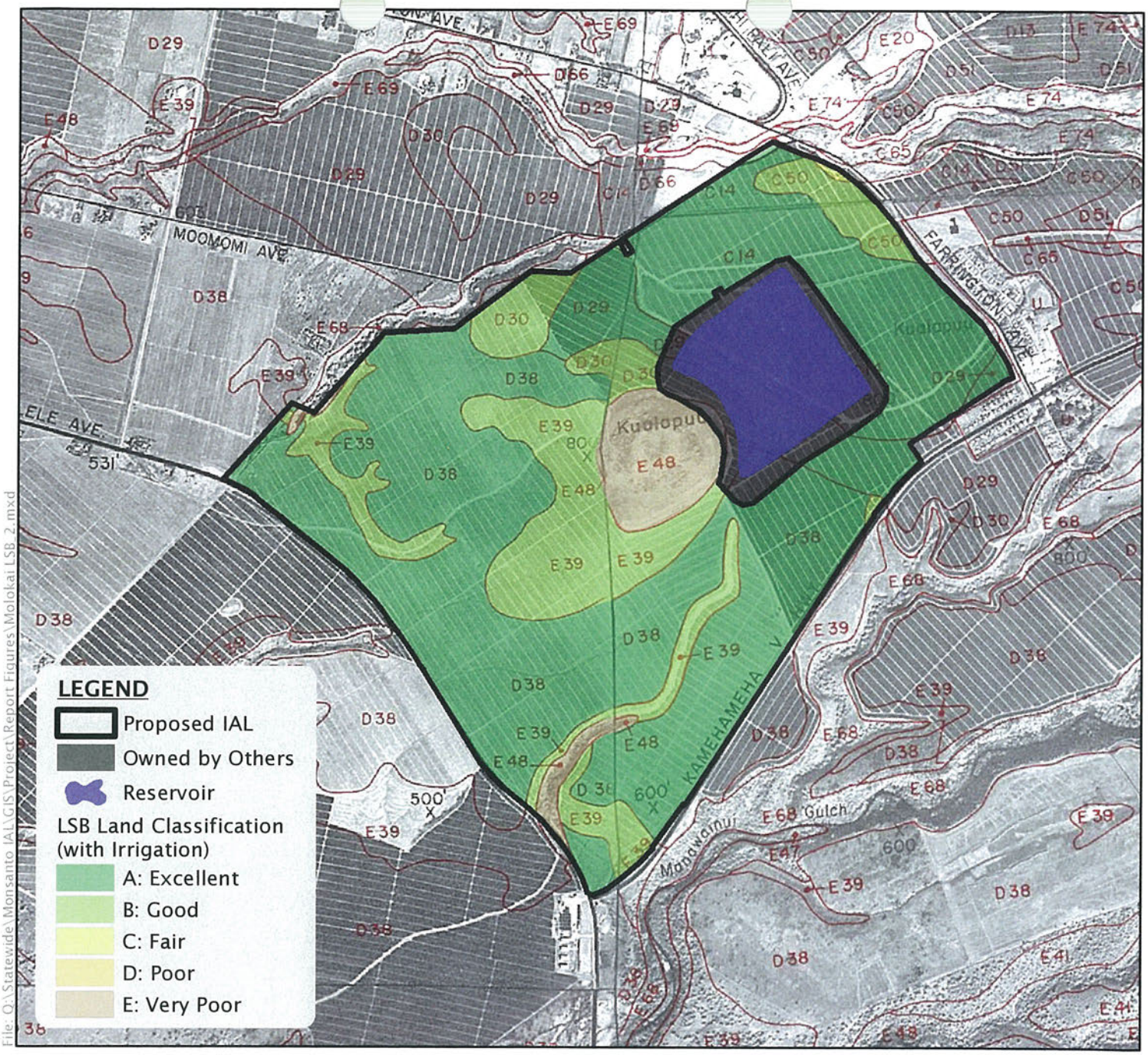

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DATE: 9/29/2017

This map, from the LSB's *Detailed Land Classification – Island of Molokai*, (colors added) was published in 1968, before the construction and operation of the Kualapu'u Reservoir (built in 1969 and drawn in the upper center of the Property) made it possible to irrigate the Property.

The LSB system classifies soil productively as A, B, C, D, and E. These letter ratings are combined with a Land Type number for both irrigated (indicated by "i" after the Land Type number) and unirrigated conditions (indicated by the absence of an "i" after the Land Type number). For example, land designated D 38 (as shown throughout most of the lower portion of the Property) is the same Land Type as land designated A 38i, with the difference being a much higher productivity rating with irrigation.

As shown on this 1968 map, the unirrigated productivity ratings of the Property range from C to E without irrigation; however, based on the Land Type number, and with irrigation, over 93% of the Property has a productivity rating of A (70.4 %) or B (22.8 %) and less than 7% of the Property has a productively rating of C (0.1 %) or E (6.7 %). None of the Property has a productivity rating of D.

For more information please refer to the text in Section 4 and Appendix A.

Source: University of Hawaii Land Study Bureau (1968) *Detailed Land Classification - Island of Molokai.*
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 4b

Land Study Bureau (LSB)
Detailed Land Classification System

Monsanto IAL

Monsanto Company — Island of Moloka'i

North — Linear Scale (Feet) 0 500 1,000 2,000

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Productivity Ratings, see Appendix A, which includes relevant pages from the LSB's *Detailed Land Classification – Island of Molokai* (Land Study Bureau, 1968).

The table below summarizes the productivity ratings of the Property both without and with irrigation (Land Study Bureau, 1968).

Land Type	Overall Productivity Rating	Total IAL	
		Acres	% of IAL
14	C		
14i	A	173.807	16.0%
29	D		
29i	A	57.960	5.3%
30	D		
30i	B	39.630	3.7%
38	D		
38i	A	532.737	49.1%
39	E		
39i	B	179.479	16.6%
48	E	70.123	6.5%
50	C		
50i	B	26.630	2.5%
51	D		
51i	C	1.298	0.1%
68	E	2.415	0.2%
	Total:	1,084.079	100%

5. Agricultural Lands of Importance to the State of Hawai'i (ALISH)

The Agricultural Lands of Importance to the State of Hawai'i (ALISH) classification system was developed in 1977 by the State Department of Agriculture (Hawaii State Department of Agriculture, 1977). The system was primarily, but not exclusively, based on the soil characteristics of lands and existing cultivation. There are three classes of land under the ALISH system: Prime, Unique, and Other.

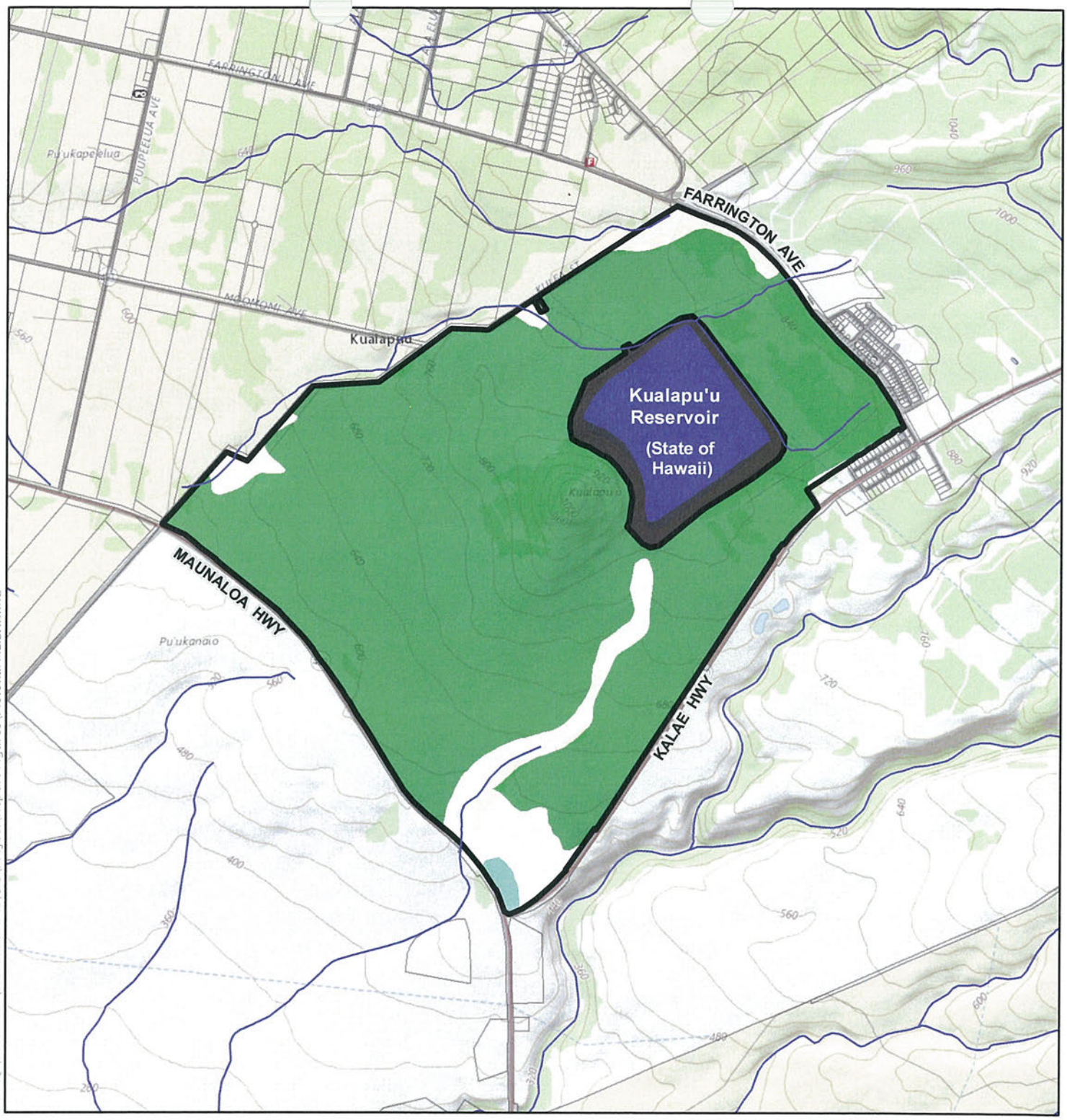
Prime ALISH is land best suited for the production of food, feed, forage and fiber crops. The land has the soil quality, growing season, and moisture supply that are needed to produce high yields of crops economically when the land, including water resources, is treated and managed according to modern farming methods.

Unique ALISH is land other than Prime ALISH that is used for the production of specific high-value food crops. The land has the special combination of soil quality, growing season, temperature, humidity, sunlight, air drainage, elevation, aspect, moisture supply, or other conditions, such as nearness to market, that favor the production of a specific crop of high quality and/or high yield when the land is treated and managed according to modern farming methods. In Hawai'i, some examples of such crops are coffee, taro, rice, watercress, and non-irrigated pineapple (Hawaii State Department of Agriculture, 1977).

Other ALISH is land other than Prime or Unique that is of state-wide or local importance for the production of food, feed, fiber, and forage crops. The land is important to agriculture in Hawai'i and yet it exhibits properties, such as seasonal wetness, erodibility, limited rooting zone, slope, flooding, or droughtiness, that exclude the land from Prime or Unique agricultural land use classifications. Two examples are: 1) lands which do not have an adequate moisture supply to be qualified as Prime; and 2) lands which have similar characteristics and properties similar to Unique, except that the land is not currently in use for the production of a "unique" crop. These Other lands can be farmed sufficiently by applying greater amounts of fertilizer and other soil amendments, drainage improvement, erosion control practices, and flood protection. Other ALISH land can produce fair to good crop yields when managed properly.

As shown on Figure 5, approximately 91% percent of the Property is classified under the ALISH system: 90 percent is classified as Prime, 0 percent is classified as Unique, and 0.7 percent is classified as Other.

The table on page 14 summarizes the ALISH classifications of the Property.



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DATE: 9/25/2017

LEGEND

- Proposed IAL
- Owned by Others
- TMK Parcels
- Reservoirs
- Streams / Gulches
- Roads

ALISH

- Prime ALISH
- Unique ALISH
- Other ALISH
- Unclassified

Source: State Department of Agriculture (1977). State of Hawaii. County of Maui.
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 5

Agricultural Lands of Importance to the State of Hawaii (ALISH)

Monsanto IAL

Monsanto Company — Island of Moloka'i

North

Linear Scale (Feet)

0 500 1,000 2,000

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The table below summarizes the ALISH classifications of the Property:

ALISH Classifications	Total IAL	
	Acres	% of IAL
Prime	975.729	90%
Unique	0.000	0.0%
Other	7.453	0.7%
Unclassified	100.897	9.3%
Total:	1,084.079	100%

The area of the Property unclassified under the ALISH system includes essential elements for active agricultural operations, such as streams and drainage ways, water system infrastructure, roadways, and areas for soil conservation.

6. Solar Radiation

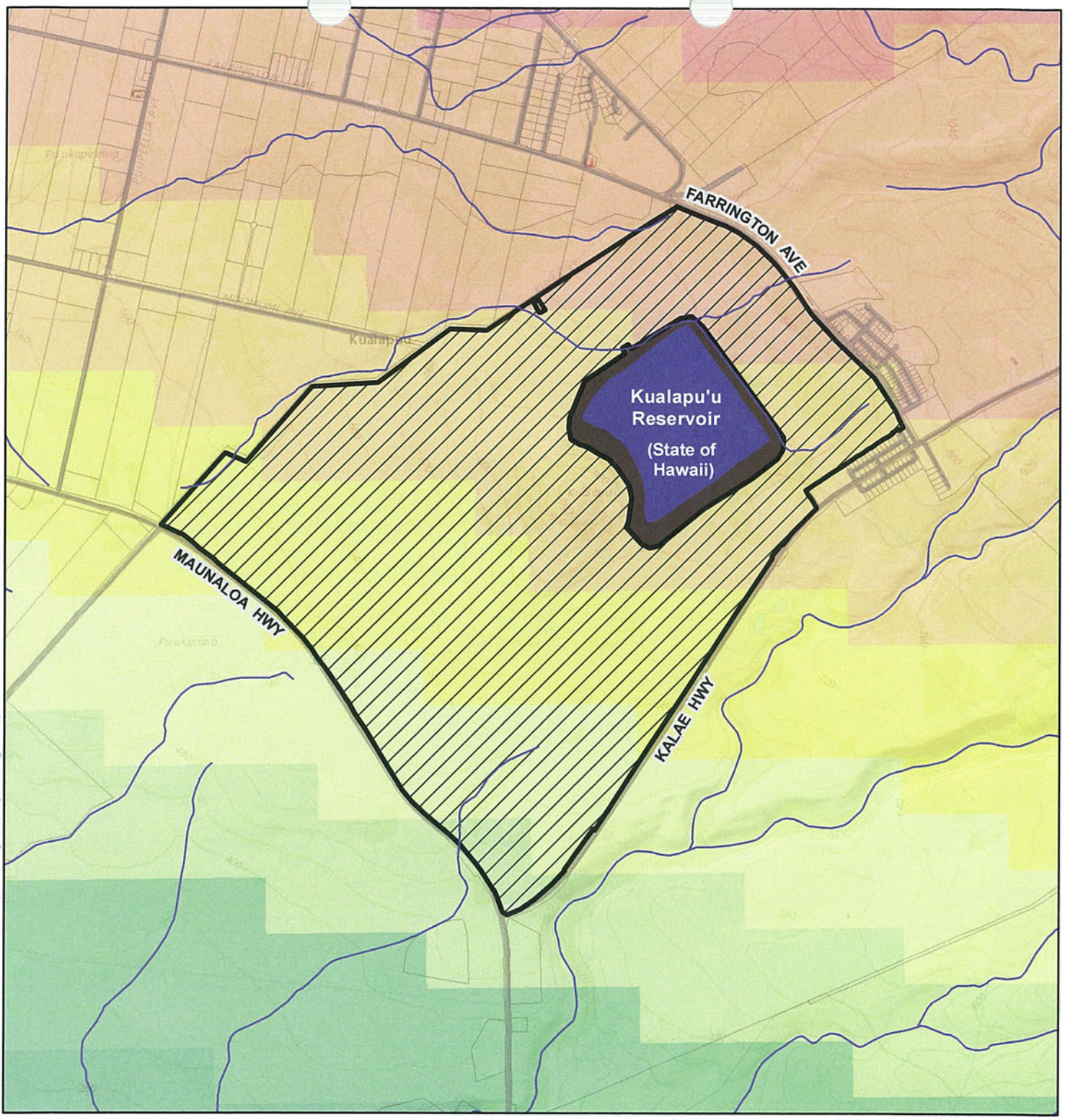
The Property receives more than sufficient solar radiation to support agricultural production. Mean annual solar radiation on the Property ranges from 215 to 240 watts per square meter per hour, based on information from the *Evapotranspiration of Hawai'i Final Report* prepared in February 2014 by the Department of Geography, University of Hawai'i at Mānoa for U.S. Army Corps of Engineers Honolulu District and State of Hawai'i Commission on Water Resource Management (Thomas W. Giambelluca, 2014). Figure 6 shows the solar radiation levels received on the Property in graphic form.

7. Water Resources and Agricultural Infrastructure

The Property has sufficient quantities of water, water-related infrastructure, and other agricultural-related infrastructure to support viable agricultural production, as summarized below. Figure 7 shows the water resources and agricultural infrastructure on the Property.

Water Resources

The Property is irrigated with water from the Moloka'i Irrigation System ("MIS"), which was constructed and is owned by the State of Hawai'i, and is operated by the State of Hawai'i Department of Agriculture (DOA). Water from the MIS can only be used for agricultural purposes. The Kualapu'u Reservoir, built in 1969 on a separate lot owned by DOA and surrounded by the Property, is part of the MIS. The MIS originally served large-scale pineapple operations, but was converted to serve diversified agriculture after pineapple operations closed in the late 1970s. The system also serves the DHHL homesteads in Ho'olehua.



DATE: 9/25/2017

LEGEND

- Proposed IAL
- Owned by Others
- TMK Parcels
- Reservoirs
- Streams / Gulches
- Roads

Mean Annual Solar Radiation (Watts/sq.meter/hour)

205 - 210	225 - 230
210 - 215	230 - 235
215 - 220	235 - 240
220 - 225	240 - 245

Source: University of Hawaii Evapotranspiration of Hawai'i (2014). State of Hawaii. County of Maui.
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 6

Solar Radiation

Monsanto IAL

Monsanto Company — Island of Moloka'i

North

Linear Scale (Feet)

0 500 1,000 2,000

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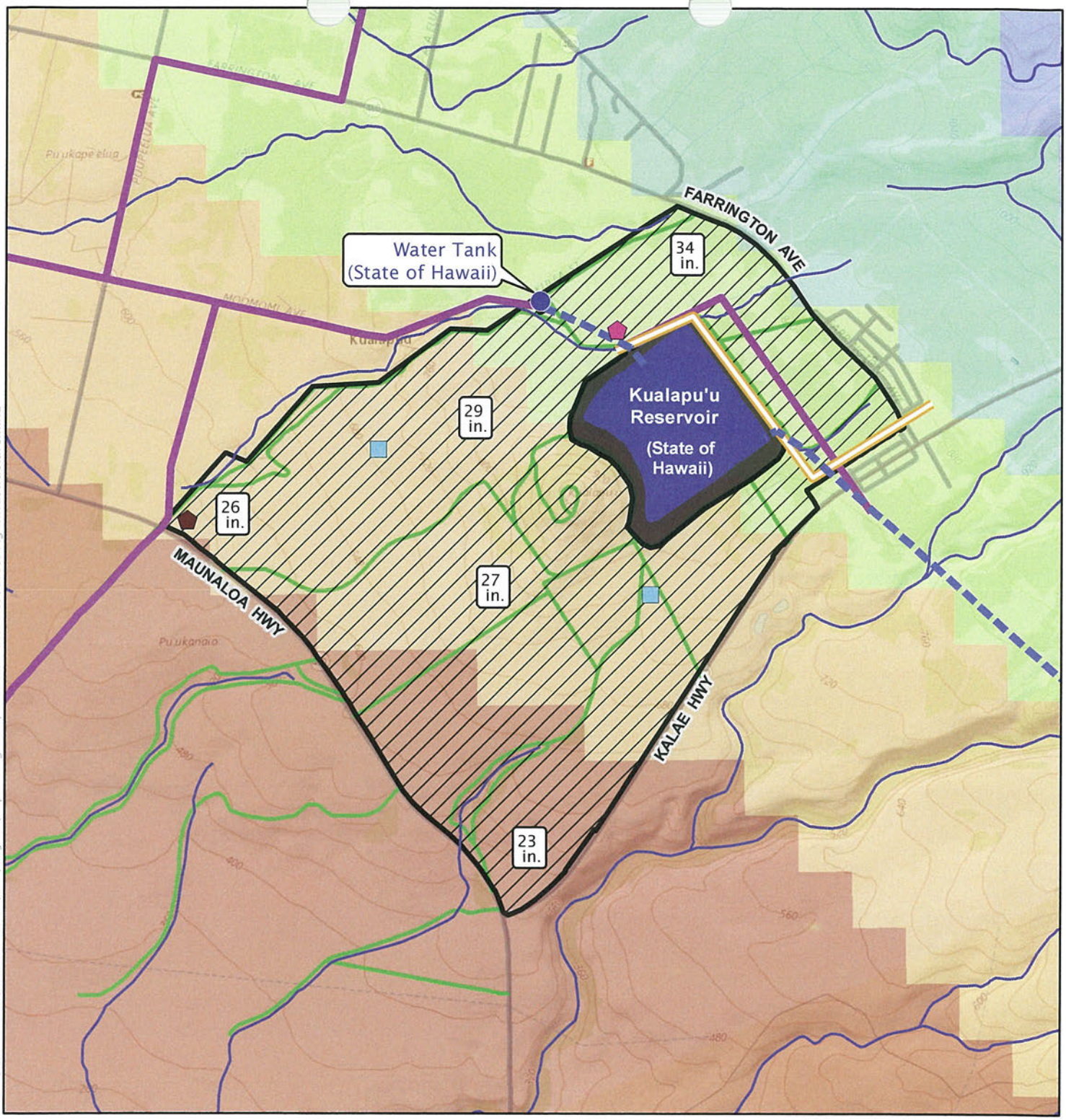

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DATE: 9/29/2017

LEGEND

- Proposed IAL
- Owned by Others
- Reservoirs
- Pipeline
- Aqueduct
- Discharge Line
- Streams / Gulches
- Field Roads / Trails
- Pumping Station
- Pump and Sand Filter Station
- Sand Filter Station
- Water Tank

Mean Annual Rainfall (Inch)

- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40
- 40 - 45

Source: Monsanto Company (2017). University of Hawaii Rainfall Atlas of Hawaii (2011). State of Hawaii. County of Maui.
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 7

Water Resources and Agricultural Infrastructure

Monsanto IAL

Monsanto Company — Island of Moloka'i

North — Linear Scale (Feet) 0 500 1,000 2,000

PBR HAWAII & ASSOCIATES, INC.

The MIS's sole water source is the Waikolu valley watershed. Three intakes divert stream flows at the 1,000-foot elevation into the Moloka'i Tunnel, and a fourth intake with a pump station at the 800 feet elevation lifts stream flows to the Moloka'i Tunnel inlet portal. Five wells provide a supplemental supply of ground water from the valley during droughts and low-flow periods. The five-mile long Moloka'i Tunnel, conveys water through the mountain by gravity to the central Moloka'i farms.

The three-year trailing monthly moving average collective water use of Monsanto and its tenants for fiscal years (July to June) 2015, 2016, and 2017 ranged from 10,789,139 to 11,737,694 gallons per month.

In addition to water from the MIS system, the Property receives a mean annual rainfall of approximately 22 to 34 inches annually (Rainfall Atlas of Hawai'i).

Agricultural Infrastructure

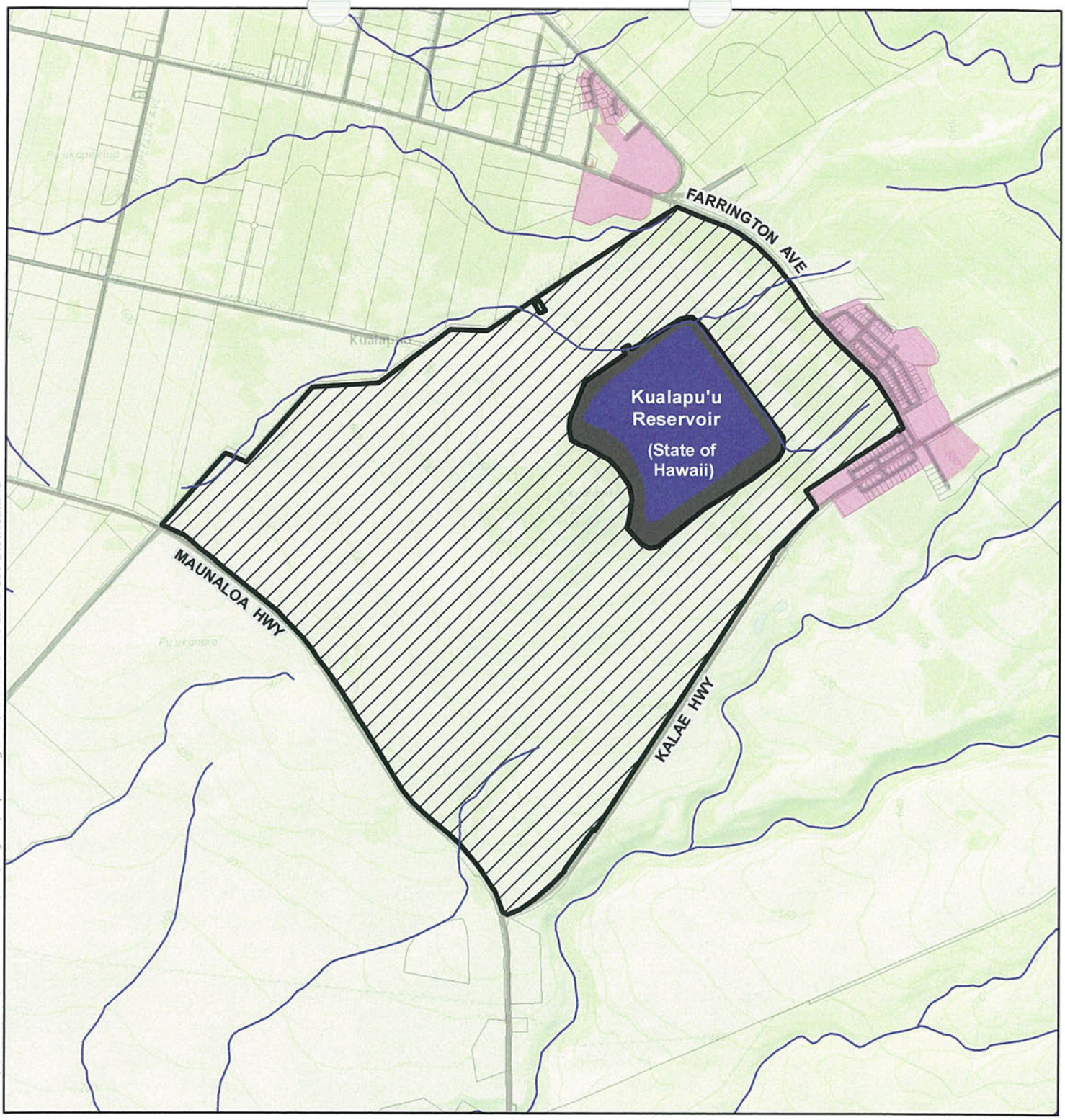
Agricultural water infrastructure on the Property includes pumping stations, filter stations, and irrigation lines. The Property also contains field roads, roads between planting areas, and has fences, gates, vegetation terraces, sediment basins, a pollinator habitat, and access to electricity and other utilities. Further, the Property is adjacent to Maunaloa Highway, Kalae Highway, and Farrington Avenue. These roads are capable of transporting farming equipment, vehicles, and workers to/from the Property and crops to/from markets. Figure 7 shows agricultural water infrastructure and field roads on the Property; Figure 1a shows Maunaloa Highway, Kalae Highway, and Farrington Avenue.

8. State Land Use District Boundaries

The State Land Use Law (HRS Chapter 205) establishes the State Land Use Commission and authorizes this body to designate all lands in the State into one of four districts: Urban, Rural, Agricultural, and Conservation. All of the Property is located within the State Agricultural District (Figure 8) (as is all of Monsanto's Maui County Land). HRS §205-2(d) specifies that lands within the State Agricultural district shall include (among other things): 1) activities or uses as characterized by the cultivation of crops, crops for bioenergy, orchards, forage, and forestry; and 2) farming activities or uses related to animal husbandry and game and fish propagation. Current uses on the Property are consistent with these uses.

9. County of Maui 2030 General Plan Countywide Policy Plan

The County of Maui 2030 General Plan Countywide Policy Plan (Countywide Policy Plan) was adopted in March 2010 and is a comprehensive policy document for the islands of Maui County to the year 2030. The plan provides the policy framework for the Maui Island Plan (which



DATE: 9/25/2017

LEGEND

- Proposed IAL
- Owned by Others
- TMK Parcels
- Reservoirs
- Streams / Gulches
- Roads

State Land Use District

- Agricultural
- Urban

Source: State Land Use Commission (2016). State of Hawaii. County of Maui.
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 8

State Land Use Districts

Monsanto IAL

Monsanto Company — Island of Moloka'i

North — Linear Scale (Feet) 0 500 1,000 2,000

PBR HAWAII & ASSOCIATES, INC.

pertains to the Island of Maui only) as well as for updating the nine detailed Community Plans. The Countywide Policy Plan provides broad goals, objectives, policies and implementing actions that portray the desired direction of the County's future.

Regarding agricultural land, the Countywide Policy Plan states:

> *"Protecting important agricultural lands is a major goal of this Plan."*
>
> *"...important agricultural lands of the County have been utilized and understood as being among Maui County's most valuable resources."*
>
> *"Maui County is blessed with vast acreage of high-quality agricultural lands. Like other unique natural resources, rich and productive agricultural land is difficult to reclaim once it is impacted by development."*

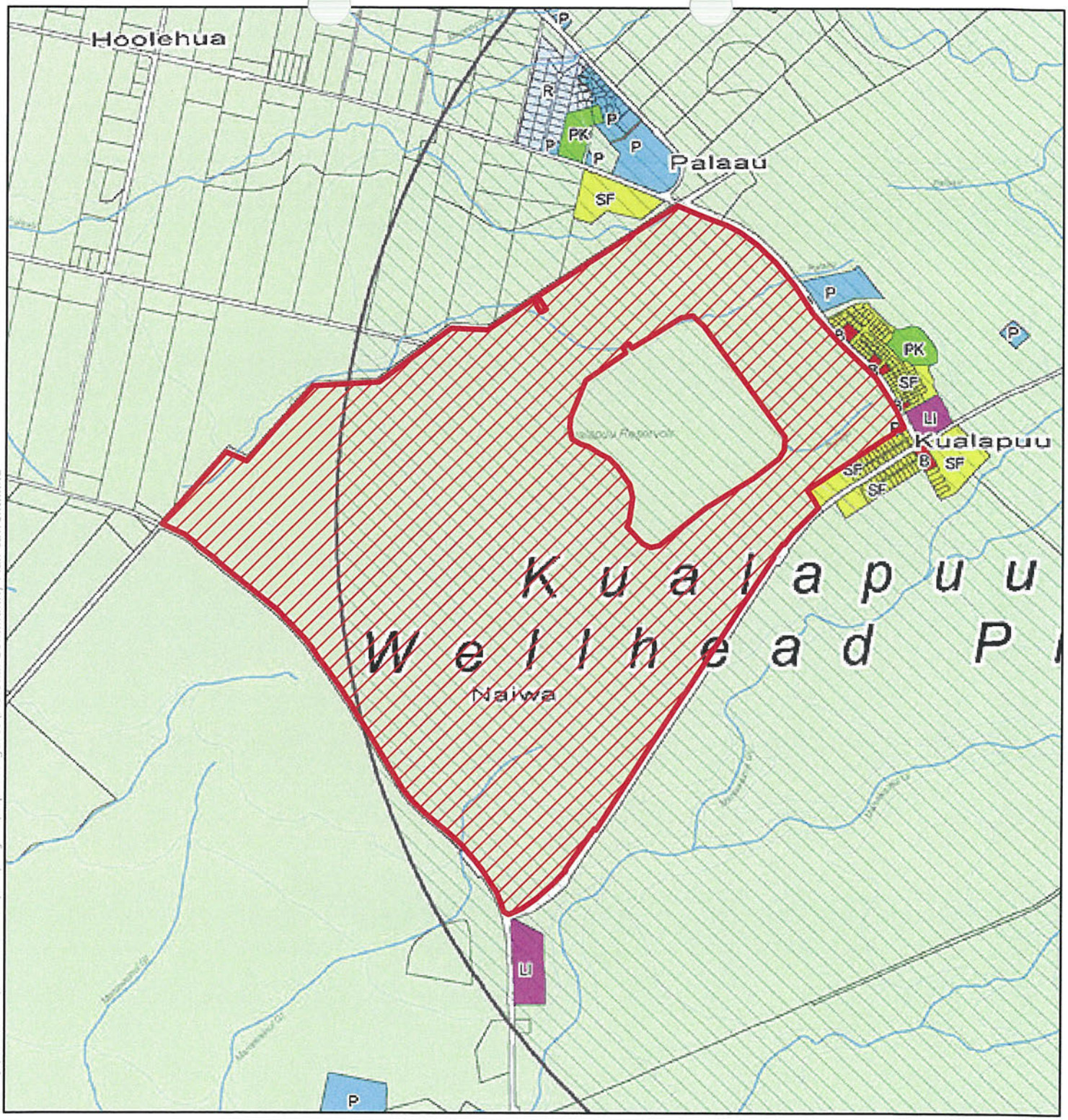
The designation of the Property as IAL is in direct support of these broad goals and statements.

Under the "Countywide goals, objectives, policies, and actions" section of the Countywide Policy Plan is an objective (Objective F.2) and several policies to "Diversify and expand sustainable forms of agriculture and aquaculture." The designation of the Property as IAL is generally consistent with this objective and these polices in that the designation of the Property as IAL will: 1) promote the use of agricultural lands for sustainable and diversified agricultural activities; 2) support ordinances, programs, and policies that keep agricultural land and water available and affordable to farmers; and 3) support education, research, and facilities that strengthen the agricultural industry (see Polices F.2 a., e., h.).

Designation of the Property as IAL also supports the Countywide Policy Plan goal of promoting sustainable land use and growth management (Goal J) and the objective to "Improve planning for and management of agricultural lands and rural areas" (Objective J.2), by implementing the policy to protect prime, productive, and potentially productive agricultural lands to maintain the islands' agricultural and rural identities and economies (Policy J.2.a.).

10. Moloka'i Community Plan

The current Moloka'i Community Plan (2001), one of nine Community Plans for the County of Maui, advances planning goals, objectives, policies, and implementation considerations to guide decision-making on Moloka'i. The plan includes land use maps designating the Property and the surrounding area as "Agriculture" (see Figure 9a). In addition, a majority of the Property is within the Kualapu'u Wellfield Wellhead Protection Area.



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DATE: 9/26/2017

LEGEND

- Proposed IAL
- Agriculture
- Wellhead Protection Buffer

Figure 9a

Molokai Community Plan (current)

Monsanto IAL

Monsanto Company — Island of Moloka'i

North

Linear Scale (Feet)

0 500 1,000 2,000

Source: Molokai Community Plan (2001), County of Maui.
Disclaimer: This graphic has been prepared for general planning purposes only.

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As of September 2017, the Maui County Council Planning Committee is reviewing a proposed draft update to the Moloka'i Community Plan (2017 Draft)[2]. The land use maps from the proposed draft update also designate the Property and the surrounding area as "Agriculture" (see Figure 9b).

Both the current Moloka'i Community Plan (2001) and the proposed draft update (2017 Draft) contain goals, objectives, and polices supporting Molokai's agricultural character. For example, under the current plan (2001) land use polices seek to promote Molokai's agricultural base as a means of enhancing the rural/agricultural qualities associated with Molokai. Under the proposed draft update (2017 Draft) there are statements regarding Molokai's long history of agriculture and how agricultural lands significantly contribute to the island's vast open space and rural character. Non-agricultural use of agricultural lands is also discouraged.

The designation of the Property as IAL is consistent with and supports the goals and objectives of both the Moloka'i Community Plan (2001) and the proposed draft update to the Moloka'i Community Plan (2017 Draft).

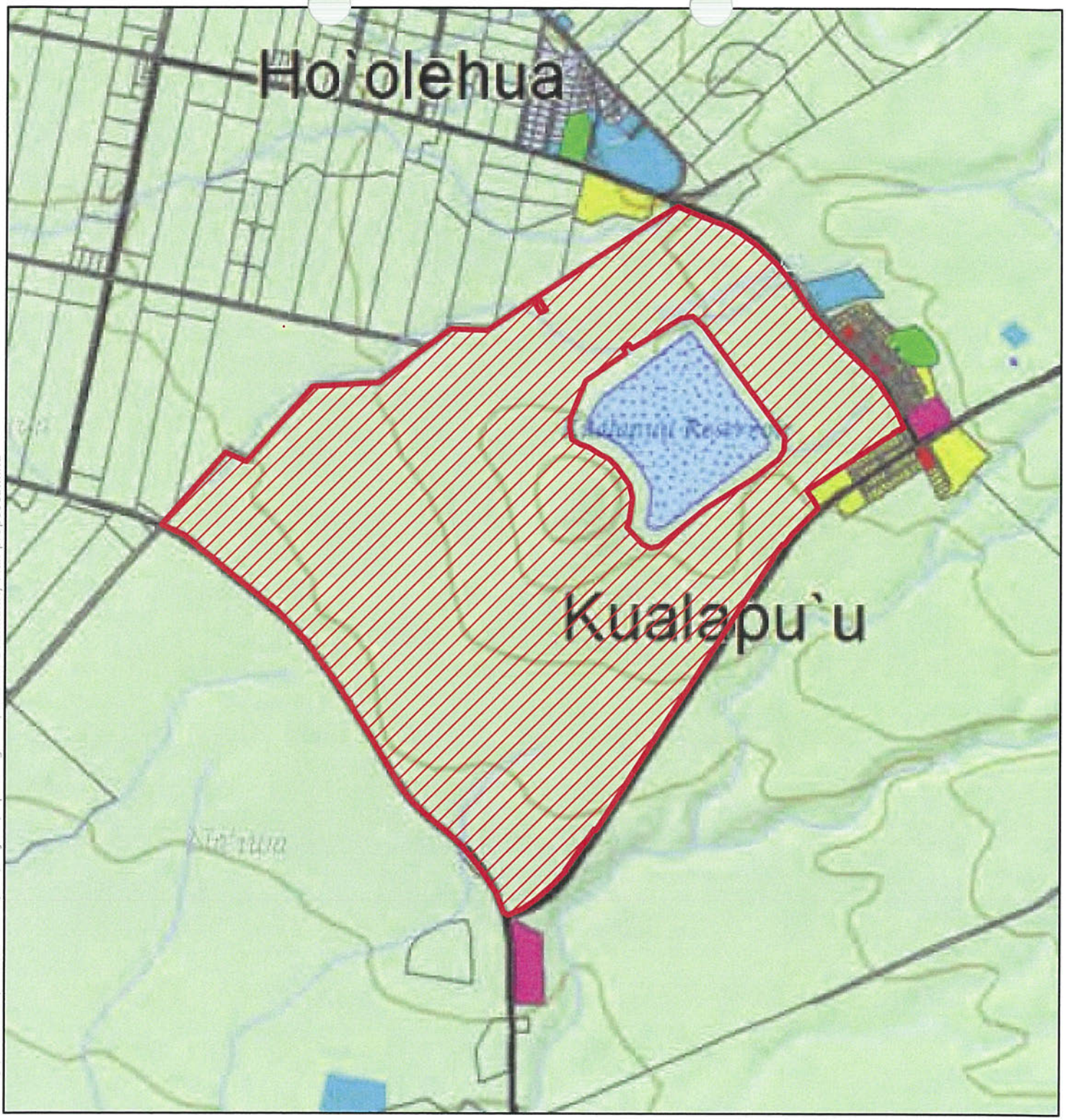
11. County of Maui Zoning

The County of Maui zoning of the Property is Agricultural District and Interim (see Appendix B). Designating the Property as IAL is consistent with both the Agricultural District (Maui County Code Chapter 19.30A, Agricultural District) and Interim Zoning Ordinance (Maui County Code, Title 19 Article I, Interim Zoning Provisions).

According to Maui County Code §19.30A.010, the purpose of the Agricultural District is to: 1) implement Chapter 205, HRS, and the goals and policies of the Maui County general plan and community plans; 2) promote agricultural development; 3) preserve and protect agricultural resources; and 4) support the agricultural character and components of the County's economy and lifestyle. Current uses on Monsanto's Maui County Land are consistent with this purpose.

According to Maui County Code §19.02A.020, the purpose of the Interim Zoning Ordinance is to provide interim regulations for various districts of Maui County pending the formal adoption of a comprehensive zoning ordinance and map. Agricultural uses are a permitted property use for lands designated under the Interim Zoning Ordinance.

[2] Moloka'i Community Plan Update, Planning Department/CPAC/MoPC DRAFT dated May 5, 2017.



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DATE: 9/26/2017

LEGEND

Proposed IAL

Agriculture

Figure 9b

Molokai Community Plan (2017 DRAFT)

Monsanto IAL

Monsanto Company — Island of Moloka'i

North — Linear Scale (Feet) 0 500 1,000 2,000

Source: Molokai Community Plan Update, Planning Department/CPAC/MoPC DRAFT dated May 5, 2017

Disclaimer: This graphic has been prepared for general planning purposes only.

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APPENDIX A:

PAGES FROM *DETAILED LAND CLASSIFICATION – ISLAND OF MOLOKAI* (LAND STUDY BUREAU 1968)

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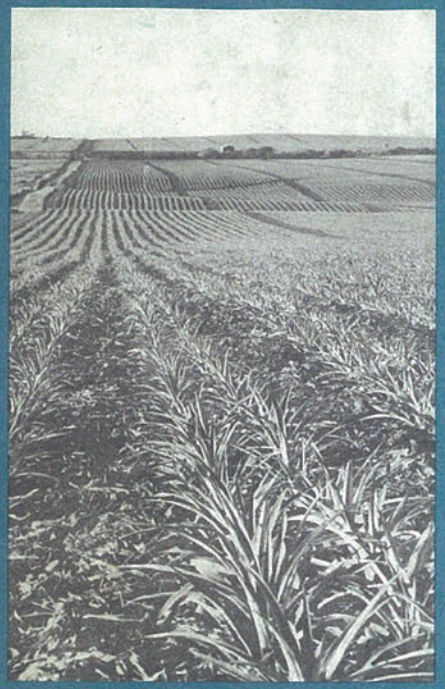

DETAILED LAND CLASSIFICATION – ISLAND OF MOLOKAI

ACKNOWLEDGMENTS

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Henry R. Meyer, Manager
Puu O Hoku Ranch
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DETAILED LAND CLASSIFICATION - ISLAND OF MOLOKAI

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CONTENTS

TABLES

FIGURES

INTRODUCTION

This land classification report is part of an inventory and evaluation of the land resources of the State of Hawaii. The report: 1. groups lands into homogeneous units (Land Types), 2. describes their condition and environment, 3. delineates the areas on aerial photo base maps, 4. rates the lands on their over-all quality (productivity) in relation to other lands, and 5. appraises their performance under selected alternative uses. The productivity of Molokai's lands and their suitability for agriculture are the chief concerns of this report.

The attributes of land, in the broadest sense, include various natural characteristics and economic and social factors occurring at a given site. The economic and social factors are not physical productivity factors and therefore are not discussed. The natural characteristics, on the other hand, include such features as soil properties, surface relief, drainage characteristics, and climate. These features are of concern in this report because they determine the land's suitability for agriculture, and consequently, relate to its productivity.

The agricultural approach is used because it accomplishes the intended goal of land inventory and productivity evaluation. This is a meaningful and applicable approach because most of the lands are now in various agricultural uses and will probably remain so in the foreseeable future. The productivity evaluations are based on state-wide standards of crop yields and levels of management. The adoption of these standards enables the direct comparison of lands on all the islands. For example, a parcel of Class C land on Molokai can be assumed comparable in over-all productivity to other Class C lands.

In addition, information on physical suitability for nonagricultural uses, such as urban sites, recreational areas, and quarry sites, can be interpreted by the technician, particularly from the Land Type description.

Land classification is but one of the functions of the Bureau as described in Act 35. This report completes the initial land classification series for the major islands of the State using aerial photos as base maps.

SUMMARY

Molokai, the fifth largest island in the Hawaiian group, covers 261 square miles and comprises four per cent of the total land area of the State. It is volcanic in origin and consists of two volcanoes, West Molokai and East Molokai, separated by the Hoolehua Plain. In geologic age, Molokai ranks near the middle of the Hawaiian Islands. The terrain, climate, vegetative zones, and soils of East Molokai are similar to the conditions found on the older islands, while West Molokai is more like Lanai. Classification of the lands of this island was based on agricultural criteria. A brief summary of the findings follows:

1. All the cultivated lands are located in the western half of Molokai. Lands are gently sloping and the soils deep; the climate is dry and sunny. The principal crop is pineapple, which is grown on 95 per cent of the 18,230 acres presently under cultivation.

2. Essentially all the lands of East Molokai are in grazing and forestry uses. Lands are steeper, wetter, and lower in productivity than elsewhere on the island. Forest reserves comprise 48,332 acres or about 30 per cent of the total land area of the island. There are 2,037 acres in forests outside the reserve area.

3. Water is scarce in West Molokai but abundant in East Molokai. Water from the Waikolu Valley in East Molokai is brought to West Molokai through the Molokai Irrigation Tunnel. Presently, only 702 acres are irrigated. These lands are producing Irish potatoes and seed corn. Productivity of existing croplands can be improved and new lands can be developed for cultivation as irrigation water is made available.

4. Erosion has been severe on Molokai resulting in the removal of large amounts of surface soil and depositing of the soil along the lee coast and in fishponds.

5. The wet and rugged mountain areas of East Molokai have physical resources suited to commercial timber production, recreation, and watershed use.

6. West Molokai has mineral resources (sand, stone, and cinders) of economic importance and beach areas with potential for resort development.

7. The remains of numerous fishponds, about 420 acres in area, occur along the lee shores of Molokai. The possible restoration of these ponds should be investigated.

FACTORS INFLUENCING LAND CHARACTERISTICS

The natural characteristics of land, and their related productivities, may differ because of variation in features such as soil properties, surface relief, drainage, elevation, and rainfall. Variations in the lands of Molokai are the result of dynamic natural and human factors. A brief discussion of these factors is presented below.

Geology. Molokai is the fifth largest (261 square miles) of the Hawaiian Islands and ranks near the middle of the group in geologic age. It is a long and narrow island, 37 miles east to west and 10 miles north to south. The highest point, 4,970 feet, is Kamakou Peak in East Molokai. Molokai lies 25 miles southeast of Oahu, 8½ miles northwest of Maui and 9 miles north of Lanai.

Molokai is volcanic in origin and consists of two volcanoes: West Molokai and East Molokai. Each is a major volcanic mountain built upward from the sea floor during the Tertiary time period. In the late Pleistocene time period, Kalaupapa Peninsula was formed through the renewal of volcanism on East Molokai.

West Molokai is a volcano comprised of thin-bedded aa and pahoehoe basalt from flows of the West Molokai volcanic series. Unlike most of the volcanoes in the Hawaiian Group, this volcano has a relatively flat dome or summit which is not indented by a caldera. The West Molokai Volcano has long been extinct, probably since the Pliocene period. Evidence of this fact exists in the lateritic soils, 10 to 50 feet deep, which cover most of West Molokai. During a series of emergences and submergences, dunes were formed on the western portion of the windward area. A high sea cliff was cut along the windward side by marine erosion, probably during the late Pliocene or early Pleistocene time period.

The caldera indented dome of the East Molokai Volcano differs markedly from that of West Molokai. Amphitheatre-headed valleys, such as Wailau and Pelekunu, occur on the windward side of the dome. On the leeward side, the valleys are smaller. This volcanic dome consists of deposits of thin-bedded aa and pahoehoe from flows of the East Molokai volcanic series. A thin layer of oligoclase andesite and trachyte covers most of the dome. This material came from large cinder cones and bulbous domes which now comprise the prominent topographic features of the area. The entire north coast of the mountain is a spectacular cliff, with a maximum height of 3,600 feet. While faulting may have had a part in the formation of this cliff, marine erosion is more likely the cause.

The Hoolehua Plain, or isthmus of Molokai, consists of lava from both the East Molokai Volcano and the older West Molokai Volcano. Most of this plain is covered with 10 to 30 feet of lateritic soil.

In the late Pleistocene period, a small volcano was formed at the base of the windward cliff and near the center of the north shore through a minor renewal of volcanism on East Molokai. The flows from this volcano built the Kalaupapa Peninsula, an area of about 2,500 acres with a high elevation of 405 feet on the southwestern rim of Kauhako Crater.

Climate. Molokai's climate provides a 12-month growing season due, among other things, to the relatively uniform warm temperature throughout the year. However, best use of this growing period can only be realized if adequate moisture is supplied through irrigation during periods of little rainfall, and if the effects of the strong winds are allayed by properly installed windbreaks.

Molokai has a mild semitropical climate. Owing to the marine influence and the prevailing northeast tradewinds, there is very little diurnal or seasonal variation in temperature. The mean annual temperature at sea level is approximately 75° F; seasonal fluctuations rarely exceed ± 10° F of this mean. Variations in temperature are due primarily to changes in elevation.

Rainfall varies markedly over very short distances on the island of Molokai (Figure 1). In the rain forests, median annual rainfall exceeds 150 inches. Along the lee and west shores, the lands are arid; median annual rainfall is less than 15 inches. On occasions southerly winds accompanied by heavy rains produce a large percentage of the year's rainfall within a period of a few days.

Surface and ground water is abundant in East Molokai but limited elsewhere. Irrigation water comes principally from Waikolu Valley and dykes feeding into the Molokai Irrigation Tunnel. Water from the tunnel is available to the croplands of Hoolehua and Maunaloa.

Crop damaging winds are most prevalent in the Hoolehua Plain and West Molokai areas.

Vegetation. Vegetation reflects the relationship between soils, elevation, and rainfall (climate); thus, it has a bearing on crop adaptability as well as land productivity. Ripperton and Hosaka recognized the correlation of vegetation to its environment and based their publication, *Vegetation Zones of Hawaii* (6), on this observation. On Molokai, the range in elevation from sea level to about 5,000 feet and the change in rainfall

have resulted in several vegetation zones. Soils have been included as another factor in the vegetative zone concept.

According to Ripperton and Hosaka, there are four distinct vegetation zones on Molokai: A, B, C, and D, with subzones in D to correlate with elevational differences. Zone A includes the sunny and arid lands so predominant in West Molokai. Zone B includes the semiarid lands of West Molokai and the southern slopes of East Molokai. Zone C includes the higher pineapple lands of Kualapuu and the higher grazing lands of East Molokai. Zone D includes the highest and wettest lands, including most of the forests. The vegetation zone descriptions are shown in Table 1.

Table 1. Vegetation Zones — Island of Molokai

Zone	Elevation (feet)	Median Annual Rainfall (inches)	Great Soil Groups	Indicator Plants	Uses
A	0-1000	>20	Low Humic Latosol, Lithosol, Alluvial, Regosol	Swollen fingergrass, pili-grass, ilima, zinnia, kiawe	Grazing, hunting
B	0-2000	20-40	Low Humic Latosol, Lithosol, Alluvial, Regosol	Kiawe, lantana, Natal redtop, indigo, Guineagrass, ekoa	Grazing, pineapple, diversified crops (irr.), hunting
C_1	0-2500	40-60	Humic Ferruginous Latosol, Lithosol	Bermudagrass, Guineagrass, lantana, guava, kikuyugrass, Christmas berry	Grazing, pineapple, hunting, forest & watershed
D_1	0-3500	>60	Humic Ferruginous Latosol, Lithosol, Hydrol Humic Latosol	Guava, ohia lehua, Hilograss, staghorn fern, kikuyugrass, puakeawe, Christmas berry	Grazing, forest & watershed, hunting
D_2	3000-5000	>100 fog	Hydrol Humic Latosol, Lithosol	Ohia lehua, tree fern, staghorn fern, pamakani, sedge	Forest & watershed, hunting

Man-made Modifications. Man has also influenced the land characteristics of Molokai through both improvement and destruction. Lands have been improved through drainage, fill, and stone removal. Increases in productivity have been achieved through irrigation and addition of soil amendments, fertilizers, and crop residue. Lands have been damaged, particularly through misuse and subsequent accelerated erosion.

PHYSICAL CHARACTERISTICS AND DESCRIPTIONS

The varied characteristics of Molokai's lands reflect the complex relationship between the geology, climate, and soils of the island. Much of the land mass formed from the East Molokai volcanic series has been cut into large canyons through stream erosion. The effect in West Molokai has been less noticeable because of the drier conditions. Characteristically, the intensity of weathering and geologic erosion increases with the amount and intensity of rainfall; thus, even on the same series of flows, the drier coastal areas have smoother topography than the wetter inland areas. Marine erosion has worn away the windward coast of the island producing high sea cliffs. Most of the arable land is in the Hoolehua Plain and near Maunaloa.

Climatically, the large increases in rainfall occur over short distances when moving from low to high elevations or when going from leeward to windward areas. These orographically induced variations are to a large extent responsible for differences in soil development as expressed in soil properties such as soil color, reaction, structure, and mineralogy.

The soils of Molokai have developed primarily from volcanic materials and have concentrated iron in the profiles. The quantities of silica and bases are low, particularly in the high rainfall areas, due to the leaching of these minerals.

The classification of the soils was basically in accord with the system used by the Soil Conservation Service and the *Soil Survey of the Territory of Hawaii* (12), with modifications to correlate with environmental conditions. Seven Great Soil Groups are mapped on Molokai: Alluvial, Low Humic Latosol, Humic Ferruginous Latosol, Humic Latosol, Hydrol Humic Latosol, Lithosol, and Regosol (see Figure 2). In West Molokai the dominant soil group is the Low Humic Latosol. The major soil group in East Molokai is the Lithosol. The Great Soil Groups are briefly described below.

The Low Humic Latosols occur primarily in the Hoolehua and Maunaloa areas and comprise the principal pineapple lands. These soils are deep, nonstony, dark reddish brown and are well adapted to a variety of crops, particularly if there is an adequate supply of irrigation water.

The Humic Ferruginous Latosols are located in the higher, cooler and wetter areas above the Low Humic Latosols. These soils are used primarily for grazing and forestry, with a small acreage in pineapple. Soil fertility is extremely low and soil reaction is extremely acid. Leaching has removed much of the soluble plant nutrients and concentrated the oxides of iron and titanium in the surface layer.

Humic Latosols occur only in a small area in East Molokai above the Low Humic Latosol plateaus. Soils in this group are less productive than those in the Low Humic Latosol Group and occur where the climate is wetter and subject to cloudiness.

Alluvial soils occur along the lee coastal flats and in the valley bottoms. These soils are usually deep but vary from nonstony to rocky. The topography is nearly level. Areas along the coast are often saline and therefore not suited for cropland use. The areas of nonstony and nonsaline soils are well adapted to a variety of crops, with irrigation.

Lithosols comprise the largest acreage of lands in East Molokai. This Soil Group includes all the shallow, rocky, and steep lands. Productivity of these lands is low. The principal uses of this area are grazing and forestry.

The Hydrol Humic Latosols are the wettest soils on Molokai and occur in the area designated as forest reserves. These soils are subject to constant rain and cloudiness and therefore are wet the year round. Forestry is the major use for the soils in this group.

Regosols consist essentially of the coarse-textured coral sands along the southern and western coast. There is an additional strip of sand in the northwestern corner of West Molokai extending inland for about four miles. The soils in this group are droughty and therefore have a relatively low productive capacity.

The varied characteristics of Molokai lands can best be described in relation to their location and use. To facilitate this discussion, the island has been subdivided into four units or regions: West Molokai-Maunaloa, Hoolehua Plain, East Molokai, and Kalaupapa.

The West Molokai-Maunaloa region embraces the we... most quarter of Molokai, bounded on the east by an imaginary north-south line starting near Moomomi in the north and passing near Puu Nana and on to the south shore. Near the center of this area is a ridge of deep lateritic soil composed of weathered volcanic material. This domelike region is flat or gently sloping, with slopes generally between 2 to 10 per cent but ranging up to 15 per cent.

Part of the upland portion of this region consists of arable lands suited to mechanical agriculture. The major soils are Lahaina silty clay, Molokai silty clay, Holomua silty clay, and Hoolehua silty clay. These soils are subject to heavy erosion, particularly where slopes are greater than 8 per cent. Rainfall

is generally less than 30 inches a year in this area. Most of this precipitation occurs in the winter months. Pineapple, a xerophytic plant, is presently the only crop suited for production in this upland area. Pineapple production is generally limited to the portions of this region where rainfall is between 20 to 30 inches and slopes are generally less than 15 per cent. The productive capacity of this area is only fair to poor for pineapple. With the availability of irrigation water from the Molokai Irrigation Project, pineapple yields will increase and the area will become suited for growing diversified crops. With water, the area will become highly productive. Actually some grazing occurs in the drier portion of this region, but it is limited by lack of forage and hence low carrying capacity.

The other portion of the upland area embraces generally the steeper and eroded lands. Soils in this region belong principally to the Molokai family and Rockland category. Annual rainfall averages about 20 inches and varies from about 30 to less than 15 inches. Grazing is the primary agricultural use. Carrying capacities are low because of limited rainfall and lack of forage. This area is easily overgrazed thus increasing the possibility of erosion. Even in grazing, the area is generally rated poor to very poor in agricultural productivity.

In the coastal portion of this region, there are significant areas of Catano sand and some Mala silty clay soil. Rainfall is low, 15 inches or less. With the addition of irrigation water, some diversified agricultural crops can be grown on the Mala soil.

Western Molokai has mineral resources with economic potential and comprises an area near Papohaku Beach now under consideration for resort development. Sand, stone, and cinders comprise the mineral resources. The Catano sand is concentrated at Papohaku and Moomomi Beaches and in adjacent sand dunes. Beach rock at Halena is valuable for flagstone. Cinder material is available in the areas mauka of Hale o Lono.

The Hoolehua Plain region embraces the west-central portion of Molokai, an area east of the region just described to an imaginary north-south line starting near the westernmost point of the Kalaupapa Peninsula.

In the Hoolehua Plain region the arable soils are deep and productive. These soils are primarily of three series: Molokai silty clay, Hoolehua silty clay, and Lahaina silty clay. In productive capacity, these soils rank among the best on the island. With irrigation water from the Molokai Irrigation Project, this land may now be brought to its maximum productivity.

Median annual rainfall in this region varies from 15 to 30 inches. And, although it is near the minimum required for pineapple (the major crop), it is well distributed throughout the year. Irrigation is a key factor in the development of agriculture in this region. For crops other than pineapple, there is the additional problem of strong and persistent winds. These winds, which are predominantly from the northeast, have velocities of 13 to 24 miles per hour. They are not detrimental to pineapple but do damage other agricultural crops making windbreaks a necessity.

The Hoolehua Plain area is the portion of Molokai generally best suited to intensive agriculture for both large and small scale enterprises. Potatoes and seed corn are presently being grown in this area since irrigation water has become available from the Molokai Irrigation Project. This diversification of agriculture and the expected increase in pineapple production and improvement of grazing lands represent some changes to be expected in the Hoolehua Plain area with increased availability of irrigation water.

East Molokai, the region representing approximately the eastern half of the island, embraces conditions which range from the narrow alluvial coastal plains through the long slopes, with their many narrow gulches, to the summit plateau and the rugged canyon country. Puu Kamakou, the island's highest mountain, is located in this region. Beautiful Halawa Valley lies at the eastern end of Molokai. Along the entire north coast of East Molokai is a high pali.

Soils are highly variable throughout the east half of Molokai. Along the southern coast and in the valley bottoms, the soil is Kawaihapai, Mala, and Pulehu silty clay. As the elevation increases toward the summit, soils change to the Rockland and rough broken land groups. At the higher levels, Naiwa silty loam and Koolau silty clay soils occur. Finally, the Amalu clay-Alakai peat-rough broken land complex is found in the wet upland areas of the East Dome.

Median annual rainfall varies in this region from the low of 15 inches near Kaunakakai to a high of over 150 inches near Puu Kamakou. In the Summit-East Dome area, showers occur almost daily. This orographically induced precipitation is the prime source in replenishing the island's water supply. Furthermore, all the principal streams on Molokai emanate from this high rainy area. Most of these streams flow to the north, except for the stream in Halawa Valley which flows to the east.

Because of the marked variation in elevation and climatic conditions in East Molokai, there is a similarly great change in vegetation. On the coastal plains, the cover consists of klu,

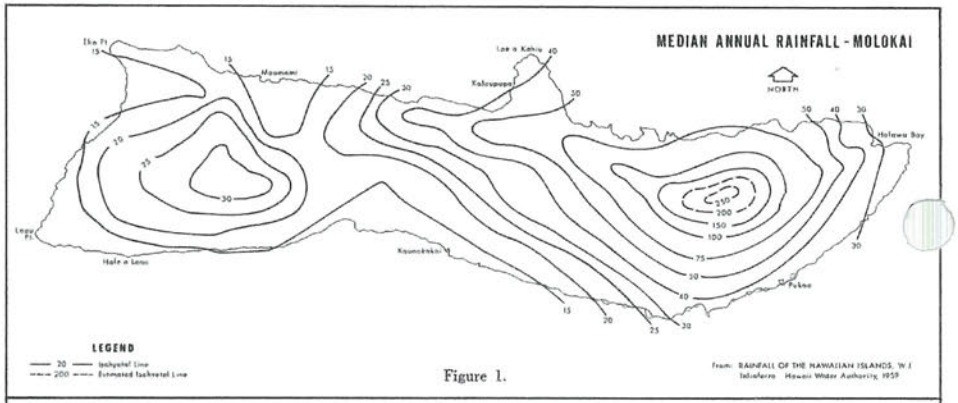

Figure 1.

From: RAINFALL OF THE HAWAIIAN ISLANDS. W. I. Taliaferro. Hawaii Water Authority. 1959

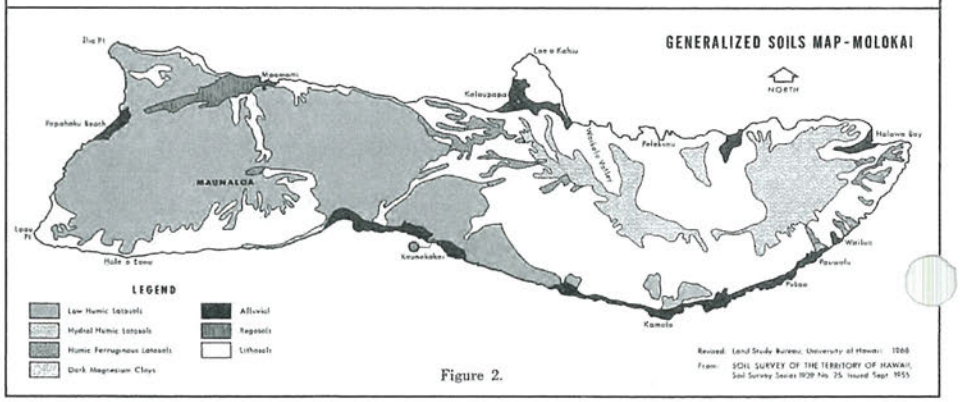

Figure 2.

Revised: Land Study Bureau, University of Hawaii. 1966
From: SOIL SURVEY OF THE TERRITORY OF HAWAII. Soil Survey Series 1939 No. 25. Issued Sept. 1955

kiawe, and annual grasses. A makai-mauka vegetation transect would pass through annual grasses, ekoa, cacti, lantana, guava, kukui nut, eucalyptus, ohia, and some sandalwood and koa. A substantial area has been planted with commercial conifers at the higher elevations. A continuous program of tree planting is underway in East Molokai at elevations above 1,500 feet. Furthermore, in this region of Molokai there is a 35 year old commercial stand of eucalyptus planted by Molokai Ranch and presently estimated to contain about a half-million board feet of saw timber.

The coastal plains of East Molokai embrace some areas considered well-suited for diversified agricultural crops and pasture-land. Halawa Valley has scenic values besides being rated moderately productive for agricultural crops. The mauka areas between the coastal plains and summit are suited for grazing and watersheds. In grazing use, they are rated as fairly productive. Near Puu o Hoku there are some improved grasslands. These areas are rated as moderately productive in grazing use. The summit and east dome sections have physical resources suited to commercial timber production, recreation, and watershed use. In fact, the high country of East Molokai, although used for hunting, is perhaps one of the least known and visited area in the State.

Kalaupapa is a low peninsula lying below the north coast pali of East Molokai and located near the center of the north coast of the island. The highest point of this peninsula is the southwestern rim of Kauhako Crater. From this rim the land slopes gently downward in all directions.

Most of the Kalaupapa Peninsula fits into the Rockland soils group. The remainder is in the Kawaihapai soil family. The latter soils are moderately productive as grazing lands.

Median annual rainfall ranges from less than 25 inches to 50 inches. This great variation in rainfall, and over such a small area, is the result of being located windward of, and in close proximity to, the high pali along the north coast of East Molokai.

The natural vegetation of Kalaupapa consists of sparse grass and shrub cover. Lantana, guava, and ekoa are the principal shrubs.

Most of the land is used for grazing. Some attempt at pasture improvement has been made particularly in the wetter areas below the pali. Small areas are devoted to growing fruits and vegetables.

CLASSIFICATION OF LAND

The procedure for inventorying and evaluating the land resources of the State involves the compilation and interpretation of a wide array of information, as well as a thorough knowledge of lands being classified. Classification requires competence in soils, geology, plant ecology, plant physiology, climatology, and farming practices.

Initially, it was necessary to find out what kinds of lands there are and where they are located. Insofar as possible, the Soil Conservation Service soil survey field sheets (11) were utilized for this purpose. Additional surveys were made in areas where the SCS field sheets were lacking or did not meet Bureau requirements. Frequent field trips were made to verify the soils, slope of land, existing land use, and other pertinent information. Finally, these facts were recorded on aerial photo maps.

Preliminary estimates were made of crop adaptations and productivities of individual soils from the aforementioned information. These estimates provided a starting basis for separating lands of significantly different levels of crop productivity. Tentative boundaries were then drawn on the aerial photo base maps.

Using these aerial photos as work sheets, field observations were then made to: 1. determine the accuracy and adequacy of existing information, 2. supplement such information when necessary, 3. refine tentative topographic and land classification boundaries, 4. inventory existing land use and record observations on the sheets, and 5. confer with land operators and other informed sources for additional information on land quality, use limitations, and cultural practices.

Major land features recognized in the field and noted on the maps were soil series, slope, and present land use. Irrigation status and modifying conditions such as stoniness, rockiness, and salinity were also recorded.

The next phase involved the groupings of lands with essentially similar conditions of fertility, topography, temperature, moisture, sunlight, wind exposure, etc., into homogeneous units called Land Types. All Land Types were then rated by productivity class on an unirrigated basis. In addition, the cultivatable Land Types were rated with irrigation. By reporting ratings for both irrigated and unirrigated situations, it is possible to anticipate the change in agricultural productivity if irrigation is applied or removed from a particular Land Type. The land classification maps indicate the irrigation status of specific tracts at the time of field inspection.

After developing a satisfactory grouping of soils and other characteristics, the final Land Types and their boundaries were established on the photo classification sheets through consolidation of some of the initial delineations.

Final on-site field reviews were made to verify the accuracy of Land Type boundaries and ratings, and to determine if further refinements were necessary. Land operators and other informed sources were consulted to obtain the benefit of their firsthand knowledge of specific tracts of lands.

The land classification maps were put in final form by n[illegible] adjustments considered necessary as a result of final field reviews. Areas delineated on the land classification maps were then measured to determine acreages of land in different uses and acreages having different levels of agricultural suitability.

LAND TYPE

All lands, other than those in urban areas, are classified into basic units known as Land Types. A Land Type is a grouping of lands having similar characteristics, such as soil properties, topography, and climate, which result in similar productive capacities. Thus, the Land Type permits 1. grouping and description of lands with similar characteristics regardless of their location, and 2. rating of their productivity.

The Land Types and their productivity ratings are listed and described in Table 2.

To better understand the classification of land, the following discussion is presented of the factors considered.

Soil provides anchorage, moisture, and mineral nutrients [illegible] crop. The degree to which a particular soil serves these [illegible]tions is a measure of its suitability for agriculture. Significant soil properties include: texture, structure, depth, drainage, parent material, mode and degree of weathering (development), stoniness, and fertility.

Texture refers to the proportion of sand, silt, and clay in a particular soil. Soils are generally classified as coarse-, medium-, or fine-textured. Coarse-textured soils have a high proportion of sand; they are easily tilled but have low moisture-holding capacities. Medium-textured soils have nearly equal portions of sand, silt, and clay. Under laboratory analyses, most Hawaiian soils of volcanic origin are classified as fine-textured (having a high clay content). In the field, however, they may not exhibit

clay-like properties, depending on the clay. The kaolinitic clays and certain amorphous oxides of iron and aluminum exhibit physical properties more like medium-textured soils and are referred to here as moderately fine-textured soils. The moderately fine- and medium-textured soils are generally the most desirable for agriculture because they have good tillability and water retention. In contrast, soils having a high montmorillonitic clay content are difficult to till because they exhibit most strongly the clay-like characteristics of stickiness and plasticity when wet, and hardness and cloddiness when dry.

Soil structure refers to the cohesion of soil material (sand, silt, and clay) into aggregates or clumps. The size, shape, and amount of these aggregations are significant because they affect the pore spaces which contain the air and moisture necessary for active root growth. Surface soils tend to be well aggregated, but subsoils are highly variable. In many instances the subsoil can be so compacted and stable that it can conduct irrigation water for years without being lined.

Soil depth refers to the distance to which roots can penetrate. Generally, the deeper the rooting depth, the more desirable the soil because more moisture can be stored and more soil volume is available from which nutrients can be obtained. Obviously, rooting depth is related to soil texture because roots can go deeper in the voids of coarse-textured soils as compared with fine-textured soils. Rooting depth is also related to soil structure because a soil with good structure enhances root penetration. In lands having compacted, structureless subsoils, rooting depth is frequently restricted to the plow layer even though the soil material may be deep. Oftentimes, this restricted depth is an inherent characteristic of that particular soil, although compaction may be caused by machinery. In addition, a high water table will restrict rooting depth to the unsaturated zone because soil air is lacking. It is evident then, that rooting depth can be effectively restricted by means other than a solid layer of material such as rock. Shallow rooted crops such as vegetables are not adversely affected. However, more deeply rooted crops such as sugar cane and orchard crops could benefit from greater soil depths.

Soil drainage refers to the frequency and duration of soil saturation with moisture. In Hawaii, unlike the continental United States, two major causes of impeded drainage are recognized: 1. excessively high rainfall throughout most of the year such that soils are saturated even on sloping land that would ordinarily be well-drained, and 2. accumulation or ponding of limited rainfall in depressions or flats. Five drainage classes are delineated: excessively-drained, well-drained, moderately well-drained, imperfectly- or somewhat poorly-drained, and poorly-drained. These classes are defined in the glossary. Well-drained soils are preferred for most agricultural purposes.

Parent material refers to the unconsolidated geologic material from which a soil has developed. In Hawaii, these materials can be broadly grouped into calcareous marine deposits, such as coral, and volcanic ejecta, which includes lava, cinders, and ash. These materials in various stages of weathering form the basic soil material in which plants take root. The significant characteristics of coral is its high concentration of calcium carbonate, which is the basic constituent of lime. Soils formed from coral have neutral to alkaline reactions and are high in calcium. As a consequence, they are unsuited to pineapple and several other crops because of the unavailability of certain minerals. Also, the sandy coral soils tend to be droughty.

Most of the soils have developed from volcanic material. The weathering process has altered, both physically and chemically, the lava, cinders, and ash to form numerous kinds of soils. Under tropical conditions of high temperature and rainfall, soils tend to become leached and relatively inert as compared with those in more temperate regions. For this reason, soil reaction tends to be acid, and fertility levels are relatively low with most soils responding to fertilizer applications.

Stoniness affects the productivity of land by limiting the use of machinery and hence the selection of crops. There are three levels of stoniness recognized in this classification: non-stony —stones are not a hinderance to machine tillage; stony—sufficient stones are present to interfere with machine tillage but not enough to make it impractical; rocky—sufficient stones are present to make machine tillage impractical. This gradation is practical but necessarily subjective because stones vary in size as well as by quantity and can equally limit land use. The degree of stoniness is sufficiently important for Land Type differentiation.

Topography deals with slope and surface configuration. To express the variation in slope, five groupings were established: 0 to 10 per cent, 11 to 20 per cent, 21 to 35 per cent, 36 to 80 per cent, and 80+ per cent. Other things being similar, lands with flatter terrain are generally suitable for a wider variety of agricultural uses than lands having steeper slopes. Cultivated lands generally have slopes of less than 20 per cent, although some steeper sloping lands are used. Thus, the 0 to 10 per cent group presents the least difficulty in using tillage machinery, in irrigation and in harvesting. The 11 to 20 per cent group is more difficult to cultivate. The upper slope limit for the use of land clearing machinery was considered to be about 35 per cent. Usually, lands with slopes between 20 to 35 per

Table 2. Land Types: Productivity Ratings and Descriptions — Island of Molokai

Land Type	Over-all Rating	Selected Crop Productivity Ratings							Machine Tillability	Stoniness	Depth (inches)	Slope (per cent)	Texture	Drainage	Median Annual Rainfall (inches)	Elevation (feet)	Color	Soil Series	Existing Uses	Vegetation Zones
		Pine-apple	Vege-table	Sugar Cane	For-age	Graz-ing	Or-chard	Tim-ber												
1	C	d	c	d	d	b	c	Co	Moderately-suited	Nonstony to slightly stony	Deep, over 30	11-20	Fine	Well-drained	35-50	0-1800	Dark reddish brown	Alaeloa	Grazing	C_1
1i	B	b	a	b	b	a	b	—												
2	D	d	e	d	e	b	d	Co	Poorly-suited	Nonstony to slightly stony	Deep, over 30	21-35	Fine	Well-drained	35-50	0-1800	Dark reddish brown	Alaeloa	Grazing	C_1
3	D	e	d	d	e	b	c	Co	Poorly-suited	Stony	Deep, over 30	11-20	Fine	Well-drained	35-50	0-1800	Dark reddish brown	Alaeloa	Grazing	C_1
3i	B	c	b	c	d	a	b	—												
4	D	e	e	d	e	b	d	Co	Poorly-suited	Stony	Deep, over 30	21-35	Fine	Well-drained	35-50	0-1800	Dark reddish brown	Alaeloa	Grazing	C_1
5	E	e	e	e	e	e	e	Co	Poorly-suited	Nonstony	Variable	0-35	Medium to moderately fine	Poorly-drained	>75	2500-5000	Dark gray to dark brown	Amalu, Koolau	Forest, water-shed	D_1 & D_2
6	E	e	e	e	e	e	e	NCo	Well-suited	Nonstony	Deep, over 30	0-10	Coarse	Excessively-drained	10-20	0-50	Light brown	Catano (Jaucus)	Grazing, recreation	A & B
6i	C	e	d	c	c	c	c	—												
7	E	e	e	e	e	e	e	NCo	Not suited	Rocky	Variable	0-10, undulating	Coarse	Well-drained to excessively-drained	10-15	0-600	Light brown	Catano (Jaucus), coral sandstone	Grazing	A
8	C	d	c	d	c	c	c	Co	Well-suited	Nonstony	Deep, over 30	0-10	Fine	Well-drained	30-50	500-2000	Dark reddish brown	Halawa	Grazing	C_1
8i	B	d	b	b	b	b	b	—												
9	D	d	d	d	d	c	c	Co	Moderately-suited	Nonstony	Deep, over 30	11-20	Fine	Well-drained	30-50	500-2000	Dark reddish brown	Halawa	Grazing	C_1
9i	C	c	c	c	c	b	b	—												
10	D	d	e	e	e	c	d	Co	Poorly-suited	Nonstony	Deep, over 30	21-35	Fine	Well-drained	30-50	500-2000	Dark reddish brown	Halawa	Grazing, forest	C_1
11	C	c	c	c	b	b	c	Co	Well-suited	Slightly stony	Deep, over 30	0-10	Moderately fine	Well-drained	40-60	0-250	Dark brown	Haleiwa	Grazing	C_1
11i	B	b	b	b	a	a	b	—												
12	D	e	e	d	c	b	b	Co	Poorly-suited	Stony	Deep, over 30	0-10	Moderately fine	Well-drained	40-60	0-250	Dark brown	Haleiwa	Grazing	C_1
12i	C	e	c	c	c	a	a	—												
13	D	d	d	e	c	c	d	NCo	Well-suited	Nonstony	Deep, over 30	0-10	Moderately fine to fine	Well- to moderately well-drained	20-35	600-1300	Dark reddish brown	Hoolehua, Waihuna	Grazing, pineapple	B
13i	A	b	b	a	a	a	a	—												
14	C	b	c	c	c	c	c	NCo	Well-suited	Nonstony	Deep, over 30	0-10	Moderately fine	Well-drained	20-35	750-900	Dark reddish brown	Hoolehua (loam)	Pineapple	B
14i	A	a	a	a	a	a	a	—												

Table 2. (Continued)

Land Type	Over-all Rating	Selected Crop Productivity Ratings							Machine Tillability	Stoniness	Depth (inches)	Slope (per cent)	Texture	Drainage	Median Annual Rainfall (inches)	Elevation (feet)	Color	Soil Series	Existing Uses	Vegetation Zones
		Pine-apple	Vege-table	Sugar Cane	For-age	Graz-ing	Or-chard	Tim-ber												
15	D	e	d	e	d	c	d	NCo	Moderately-suited	Nonstony	Deep, over 30	11-20	Moderately fine to fine	Well- to moderately well-drained	20-35	600-1400	Dark reddish brown	Hoolehua, Waihuna	Pineapple, grazing	B
15i	B	c	b	a	d	a	b	—												
16	D	e	d	e	d	c	d	NCo	Poorly-suited	Stony	Deep, over 30	11-20	Moderately fine to fine	Well- to moderately well-drained	20-35	600-1400	Dark reddish brown	Hoolehua, Waihuna	Grazing	B
16i	C	c	c	b	d	a	b	—												
17	D	d	d	e	c	c	d	NCo	Moderately-suited	Nonstony	Deep, over 30	8-12, undulating	Moderately fine to fine	Well- to moderately well-drained	20-35	600-1400	Dark reddish brown	Hoolehua, Waihuna	Pineapple, grazing	B
17i	B	b	c	b	d	a	b	—												
18	D	d	d	d	d	c	c	Co	Well-suited	Nonstony	Deep, over 30	0-10	Fine	Well- to moderately well-drained	60-80	1200-2500	Dark brown to dark gray	Kahanui	Grazing, forest	D_1
18i	D	d	d	d	d	c	c	—												
19	D	e	e	d	e	c	d	Co	Moderately-suited	Nonstony	Deep, over 30	11-20	Fine	Well- to moderately well-drained	60-80	1200-2500	Dark brown to dark gray	Kahanui	Grazing, forest	D_1
20	E	e	e	e	e	c	e	Co	Poorly-suited	Stony	Deep, over 30	21-35	Medium to moderately fine	Well-drained	30-40	750-1350	Dark reddish brown	Kalae	Pineapple, grazing	Transition: B to C_1
20i	D	c	c	d	e	b	d	—												
21	E	e	e	e	e	d	e	NCo	Not suited	Rocky	Shallow	11-20, undulating	Moderately fine	Well- to very well-drained	20-35	0-400	Dark brown	Kalaupapa	Grazing	B
22	D	d	d	d	c	c	d	NCo	Moderately-suited	Nonstony to slightly stony	Deep, over 30	11-20	Fine	Well-drained	25-40	0-1200	Dark reddish brown	Kaluaaha	Grazing, orchard	B
22i	B	c	b	b	b	a	b	—												
23	D	d	e	e	e	c	d	NCo	Poorly-suited	Stony	Deep, over 30	21-35	Fine	Well-drained	25-40	0-1200	Dark reddish brown	Kaluaaha	Grazing	B
24	E	e	e	e	e	c	e	NCo	Not suited	Rocky	Shallow	11-20, undulating	Moderately fine	Well-drained	35-50	0-250	Dark brown	Kauhako	Grazing	C_1
25	D	d	d	d	c	b	d	Co	Well-suited	Nonstony to slightly stony	Deep, over 30	0-10	Moderately fine	Well-drained	30-40	0-250	Dark brown	Kawaihapai, Mala, Pulehu	Grazing, taro	B & C_1
25i	B	b	b	b	b	a	b	—												
26	D	d	d	e	d	c	d	NCo	Well-suited	Nonstony	Deep, over 30	0-10	Moderately fine	Well-drained	30-35	1300-1400	Dark reddish brown	Kanepuu	Grazing, recreation	B
26i	B	d	b	b	b	a	b	—												
27	D	e	d	e	d	c	d	NCo	Moderately-suited	Nonstony	Deep, over 30	11-20	Moderately fine	Well-drained	30-35	1300-1400	Dark reddish brown	Kanepuu	Grazing, recreation	B
27i	C	d	c	c	c	a	b	—												
28	E	e	e	e	e	e	e	NCo	Poorly- to not suited	Nonstony	Shallow to water table	0-10	Moderately fine to fine	Imperfectly- to poorly-drained	10-35	0-10	Dark reddish brown	Kealia (salty)	Unused, grazing	A & B

Table 2. (Continued)

Land Type	Over-all Rating	Selected Crop Productivity Ratings							Machine Tillability	Stoniness	Depth (inches)	Slope (per cent)	Texture	Drainage	Median Annual Rainfall (inches)	Elevation (feet)	Color	Soil Series	Existing Uses	Vegetation Zones
		Pine-apple	Vege-table	Sugar Cane	For-age	Graz-ing	Or-chard	Tim-ber												
29	D	c	d	e	c	c	d	NCo	Well-suited	Nonstony	Deep, over 30	0-10	Moderately fine	Well-drained	20-35	600-1400	Dark reddish brown	Lahaina	Pineapple, grazing	B
29i	A	a	a	a	a	a	a	—												
30	D	d	d	e	d	c	d	NCo	Moderately-suited	Nonstony	Deep, over 30	11-20	Moderately fine	Well-drained	20-35	600-1400	Dark reddish brown	Lahaina	Pineapple, grazing	B
30i	B	b	b	b	d	a	b	—												
31	D	d	d	e	d	c	d	NCo	Moderately-suited	Nonstony to slightly stony	Deep, over 30	8-12, undulating	Moderately fine	Well-drained	20-35	600-1400	Dark reddish brown	Lahaina	Pineapple, grazing	B
31i	B	b	c	a	d	a	b	—												
32	D	d	d	e	d	c	d	NCo	Moderately-suited	Stony	Deep, over 30	8-12, undulating	Moderately fine	Well-drained	20-35	600-1400	Dark reddish brown	Lahaina	Grazing	B
32i	C	c	d	b	d	a	b	—												
33	D	c	d	c	d	c	d	NCo	Poorly-suited	Stony	Deep, over 30	11-20	Moderately fine	Well-drained	20-35	600-1400	Dark reddish brown	Lahaina	Grazing	B
33i	C	d	d	c	d	a	c	—												
34	E	e	e	e	e	c	e	NCo	Poorly- to not suited	Stony to rocky	Moderately-deep to deep	21-35	Moderately fine to fine	Well-drained	20-35	600-1400	Dark reddish brown	Lahaina	Grazing	B
35	D	d	d	e	c	c	d	NCo	Well-suited	Nonstony	Deep, over 30	0-10, inclusions of steeper slopes	Moderately fine to fine	Well-drained	30-35	500-800	Dark reddish brown	Lahaina, Hoolehua	Pineapple, grazing	B
36	E	c	e	e	d	d	e	NCo	Well-suited	Nonstony to slightly stony	Deep, over 30	0-10	Moderately fine to fine	Well-drained	10-35	0-50	Dark reddish brown	Mala & Pulehu (Alluvial)	Grazing, orchard, vegetables	A & B
36i	A	b	a	a	a	a	a	—												
37	E	e	e	e	e	d	e	NCo	Not suited	Rocky	Deep, over 30	0-10	Moderately fine to fine	Well-drained	10-35	0-50	Dark reddish brown	Mala & Pulehu (Alluvial)	Grazing	A & B
37i	E	e	e	e	e	a	c	—												
38	D	d	e	e	d	d	e	NCo	Well-suited	Nonstony	Deep, over 30	0-10	Moderately fine	Well-drained	10-25	0-1000	Dark reddish brown	Molokai, Holomua, Waikapu, Hoolehua	Pineapple, grazing	A
38i	A	a	a	a	a	a	a	—												
39	E	e	e	e	d	d	e	NCo	Moderately-suited	Nonstony	Deep, over 30	11-20	Moderately fine	Well-drained	10-25	0-1000	Dark reddish brown	Molokai, Holomua, Waikapu, Hoolehua	Pineapple, grazing	A
39i	B	b	b	a	d	a	a	—												
40	E	e	e	e	e	d	e	NCo	Poorly-suited	Nonstony	Deep, over 30	21-35	Moderately fine	Well-drained	10-25	0-1000	Dark reddish brown	Molokai, Holomua, Waikapu, Hoolehua	Pineapple, grazing	A
40i	D	d	e	c	e	a	c	—												
41	E	e	e	e	e	d	d	NCo	Moderately-suited	Nonstony	Deep, over 30	7-14, undulating	Moderately fine	Well-drained	10-25	0-1000	Dark reddish brown	Molokai, Holomua, Waikapu, Hoolehua	Pineapple, grazing	A
41i	B	b	b	a	c	a	a	—												
42	E	d	e	e	e	d	e	NCo	Moderately-suited	Nonstony	Deep, over 30	4-15, dune complex	Moderately fine	Well-drained	10-25	0-1000	Dark reddish brown	Molokai, Holomua, Waikapu, Hoolehua	Pineapple, grazing	A
42i	B	b	b	a	c	a	a	—												

Table 2. (Continued)

Land Type	Over-all Rating	Selected Crop Productivity Ratings							Machine Tillability	Stoniness	Depth (inches)	Slope (per cent)	Texture	Drainage	Median Annual Rainfall (inches)	Elevation (feet)	Color	Soil Series	Existing Uses	Vegetation Zones
		Pine-apple	Vege-table	Sugar Cane	For-age	Graz-ing	Or-chard	Tim-ber												
43	E	e	e	e	d	d	e	NCo	Moderately-suited	Stony	Deep, over 30	0-10	Moderately fine	Well-drained	10-25	0-1000	Dark reddish brown	Molokai, Holomua, Waikapu, Hoolehua	Grazing	A
43i	B	c	b	b	b	a	a	—												
44	E	e	e	e	d	d	e	NCo	Moderately-suited	Stony	Deep, over 30	11-20	Moderately fine	Well-drained	10-25	0-1000	Dark reddish brown	Molokai, Holomua, Waikapu, Hoolehua	Grazing	A
44i	C	d	d	b	d	a	b	—												
45	E	e	e	e	e	d	e	NCo	Poorly-suited	Stony	Deep, over 30	21-35	Moderately fine	Well-drained	10-25	0-1000	Dark reddish brown	Molokai, Holomua, Waikapu, Hoolehua	Grazing	A
45i	D	e	e	d	e	a	c	—												
46	E	e	e	e	d	d	e	NCo	Moderately-suited	Stony	Deep, over 30 (eroded)	11-20	Moderately fine	Well-drained	10-25	0-1000	Dark reddish brown	Molokai, Holomua, Waikapu, Hoolehua	Grazing	A
46i	C	d	d	b	d	a	b	—												
47	E	e	e	e	e	e	e	NCo	Not suited	Rocky	Deep, over 30	0-10, inclusions of steeper slopes	Moderately fine	Well-drained	10-25	0-1000	Dark reddish brown	Molokai, Holomua, Waikapu, Hoolehua	Grazing	A
47i	E	e	e	e	e	a	e	—												
48	E	e	e	e	e	e	e	NCo	Not suited	Rocky	Deep, over 30	21-35	Moderately fine	Well-drained	10-25	0-1000	Dark reddish brown	Molokai, Holomua, Waikapu, Hoolehua	Grazing	A
49	E	e	e	e	e	e	e	NCo	Not suited	Rocky	Shallow	0-35	Moderately fine to fine	Well-drained	10-25	0-1000	Dark reddish brown	Molokai, Holomua, Waikapu, Hoolehua	Grazing	A
50	C	c	d	d	c	c	d	Co	Well-suited	Nonstony	Deep, over 30	0-10	Medium to moderately fine	Well-drained	30-40	750-1350	Dark reddish brown	Naiwa, Kalae	Pineapple, grazing	B & C_1
50i	B	c	b	b	b	b	b	—												
51	D	d	d	e	d	c	d	Co	Moderately-suited	Nonstony	Deep, over 30	11-20	Medium to moderately fine	Well-drained	30-40	750-1350	Dark reddish brown	Naiwa, Kalae	Pineapple, grazing	B & C_1
51i	C	d	c	c	d	a	b	—												
52	C	d	c	c	d	c	b	Co	Poorly-suited	Nonstony	Deep, over 30	11-20	Moderately fine	Moderately well-drained	70-90	1000-2000	Dark brown	Niulii	Grazing, forest	D_1
53	D	d	d	d	e	c	c	Co	Poorly-suited	Nonstony	Deep, over 30	21-35	Moderately fine	Moderately well-drained	70-90	1000-2000	Dark brown	Niulii	Grazing, forest	D_1
54	D	d	d	d	d	c	c	Co	Moderately-suited	Nonstony	Deep, over 30	11-20	Fine	Well-drained	40-60	2000-3500	Dark reddish brown	Olelo	Grazing, forest	D_1
55	E	d	e	e	e	c	d	Co	Poorly-suited	Nonstony	Deep, over 30	21-35	Fine	Well-drained	40-60	2000-3500	Dark reddish brown	Olelo	Forest	D_1
56	C	c	d	d	c	c	d	Co	Well-suited	Nonstony	Moderately-deep to deep	0-10	Medium	Well-drained	25-40	1000-2500	Dark reddish brown	Oli	Grazing	B
56i	B	b	b	b	a	a	b	—												

Table 2. (Continued)

Land Type	Overall Rating	Selected Crop Productivity Ratings							Machine Tillability	Stoniness	Depth (inches)	Slope (per cent)	Texture	Drainage	Median Annual Rainfall (inches)	Elevation (feet)	Color	Soil Series	Existing Uses	Vegetation Zones
		Pineapple	Vegetable	Sugar Cane	Forage	Grazing	Orchard	Timber												
57	D	c	d	d	d	c	d	Co	Moderately-suited	Nonstony	Moderately-deep to deep	11-20	Medium	Well-drained	25-40	1000-2500	Dark reddish brown	Oli	Grazing	B
57i	C	c	c	c	d	a	b	—												
58	D	d	e	e	e	c	d	Co	Poorly-suited	Nonstony	Moderately-deep to deep	21-35	Medium	Well-drained	25-40	1000-2500	Dark reddish brown	Oli	Grazing, forest	B
59	D	d	d	d	e	c	d	Co	Poorly-suited	Stony	Moderately-deep to deep	11-20	Medium	Well-drained	25-40	1000-2500	Dark reddish brown	Oli	Grazing, forest	B
60	E	e	e	e	e	c	d	Co	Poorly-suited	Stony	Variable	21-35	Medium	Well-drained	25-40	1000-2500	Dark reddish brown	Oli	Grazing, forest	B
61	D	d	e	e	d	d	e	NCo	Well-suited	Nonstony	Deep, over 30	0-10	Moderately fine to fine	Well-drained	10-25	0-800	Dark reddish brown	Pamoa, Waihuna	Grazing	A
61i	A	b	a	a	a	a	a	—												
62	E	e	e	e	d	d	e	NCo	Moderately-suited	Nonstony	Deep, over 30	11-20	Moderately fine to fine	Well-drained	10-25	0-800	Dark reddish brown	Pamoa, Waihuna	Grazing	A
62i	B	c	b	b	b	a	b	—												
63	E	d	e	e	d	d	e	NCo	Moderately-suited	Stony	Deep, over 30	0-10	Moderately fine to fine	Well-drained	10-25	0-800	Dark reddish brown	Pamoa, Waihuna	Grazing	A
63i	B	c	b	b	b	a	b	—												
64	E	e	e	e	e	d	e	NCo	Poorly-suited	Stony	Deep, over 30	11-20	Moderately fine to fine	Well-drained	10-25	0-800	Dark reddish brown	Pamoa, Waihuna	Grazing	A
64i	C	d	d	c	c	a	b	—												
65	C	e	c	c	c	c	b	Co	Moderately-suited	Nonstony to slightly stony	Deep, over 30	0-10	Moderately fine	Moderately well-drained, floods at times	30-50	600-1300	Dark reddish brown	Uaoa	Pineapple, grazing	C_1
65i	C	e*	b	b	c	c	b	—												
66	D	d	e	e	d	d	e	NCo	Well-suited	Nonstony	Deep, over 30	0-10 (in depressions)	Moderately fine	Well-drained	10-25	0-800	Dark reddish brown	Waikapu	Pineapple, grazing	A
66i	A	a	a	a	a	a	a	—												
67	E	e	e	e	e	e	e	NCo	Poorly- to not suited	Stony to rocky	Variable	0-10, dune complex	Variable	Well-drained	10-15	0-600	Dark reddish brown	Wind blown soils	Grazing	A
67i	D	e	d	d	e	d	d	—												
68	E	e	e	e	e	e	e	NCo	Not suited	Rocky	Variable	36-80	Variable	Well-drained	10-25	0-1000	Variable	Rough broken lands	Grazing	A
69	E	e	e	e	e	d	e	NCo	Not suited	Rocky	Variable	0-35	Moderately fine to fine	Well-drained	20-35	600-1400	Dark reddish brown	Rough broken lands	Grazing	B
70	E	e	e	e	e	e	e	NCo	Not suited	Rocky	Deep, over 30	0-10, inclusions of steeper slopes	Moderately fine	Well-drained	20-35	600-1400	Dark reddish brown	Rocky lands	Grazing	B
70i	D	e	e	e	e	c	c	—												

*Incidence of heartrot disease.

Table 2. (Continued)

Land Type	Over-all Rating	Selected Crop Productivity Ratings							Machine Tillability	Stoniness	Depth (inches)	Slope (per cent)	Texture	Drainage	Median Annual Rainfall (inches)	Elevation (feet)	Color	Soil Series	Existing Uses	Vegetation Zones
		Pine-apple	Vege-table	Sugar Cane	For-age	Graz-ing	Or-chard	Tim-ber												
71	E	e	e	e	e	e	e	NCo	Not suited	Rocky	Shallow	0-35	Moderately fine to fine	Well-drained	10-25	0-1000	Dark reddish brown	Rough broken lands	Grazing	B
72	E	e	e	e	e	e	e	NCo	Not suited	Rocky	Variable	36-80	Moderately fine to fine	Well-drained	25-40	0-2500	Dark reddish brown	Rough broken lands	Grazing	B
73	E	e	e	e	e	c	e	Co	Not suited	Rocky	Variable	0-35	Medium to fine	Well-drained	30-60	0-3500	Dark brown to reddish brown	Rough broken lands	Grazing, forest	C_1
74	E	e	e	e	e	c	e	Co	Not suited	Rocky	Moderately-deep to deep	36-80	Medium to fine	Well-drained	30-60	0-3500	Dark brown to reddish brown	Rough broken lands	Grazing, forest	C_1
75	E	e	e	e	e	d	e	Co	Not suited	Rocky	Shallow	36-80	Medium to fine	Well-drained	30-60	0-3500	Dark brown to reddish brown	Rough broken lands	Grazing, forest	C_1
76	E	e	e	e	e	d	e	Co	Not suited	Nonstony	Variable	36-80	Moderately fine to fine	Moderately well-drained	60-90	1000-3500	Dark gray to dark reddish brown	Rough broken lands	Grazing, forest	D_1
77	E	e	e	e	e	e	e	Co	Not suited	Nonstony	Variable	0-35	Moderately fine to fine	Poorly-drained	>75	2500-5000	Dark gray to dark brown	Rough broken lands	Forest, water-shed	D_1 & D_2
78	E	e	e	e	e	e	e	Co	Not suited	Variable	Variable	36-80	Moderately fine to fine	Well-drained	>75	2500-5000	Dark gray to dark brown	Rough broken lands	Forest, water-shed	D_1 & D_2
79	E	e	e	e	e	e	e	NCo	Not suited	Rocky	Shallow	80+	Variable	Well-drained	All ranges	0-5000	Variable	Rough broken lands	Forest, unused	All
80	E	e	e	e	e	e	e	NCo	Not suited	Nonstony	Flooded or shallow to water table	0	Fine	Poorly-drained	10-40	0	Dark gray to brown	Mangrove & swamps	Unused	A & B

cent are not machine-tilled but are still suitable for certain uses such as orchards and grazing. Lands with slopes up to 80 per cent were considered suitable for commercial forestry and low intensity grazing, but lands having slopes in excess of this were considered unsuited for timber production and agriculture. Also, lands with undulating terrain were usually differentiated from areas having uniform slopes because such lands are more difficult to farm.

Climate, with its elements of temperature, sunlight, and rainfall, constitutes the exterior environment of land, whereas soil properties comprise the interior segment. Since the seasonal fluctuations of temperature vary within a very narrow range, greater variations can be attributed to changes in elevation. Temperature at sea level averages 75° F; there is a lowering of about 1° F for every 200 to 300 foot rise in elevation. For most of the lands under 2,500 feet, nearly all types of tropical crops can be grown provided soil, terrain, and moisture are satisfactory. Above the 2,500 foot level, the temperature is sufficiently low to permit growth of selected temperate crops which normally do poorly in warm environs.

Seasonal variations in day length are not very great; however, they do have an influence on crop yields, with a marked decrease in production during the winter months. This decrease is believed correlated both with the shorter days and lower sunlight intensity because of the cloudier skies during this period. Thus, yields are generally lower in the northern and windward areas that are shaded with heavy clouds and afternoon mountain shadows.

Rainfall varies in both quantity and distribution and cannot be depended upon to fall at the required time or in the necessary amount to satisfy crop requirements. Most of the better crop producing lands are located in the drier, higher sunlight areas where most of the precipitation falls during the winter months. Hence, irrigation is necessary during the drier periods. On the other hand, where rainfall is frequent and heavy, the soils are perennially wet making the land difficult to work and causing leaching of nutrients from the soil. Arable lands with an ideal distribution of rainfall are almost nonexistent.

Erosion is severe on Molokai. Continuous overgrazing of grasslands and clean cultivation of the cropland, in combination with intense rainstorms, have left extensive areas badly eroded and no longer suited for cultivation. Silt washed from the upper lands has been deposited in fishponds, on sandy beaches, on the alluvial flats and even on the reefs in the ocean. Large stretches of the lee shores have been muddied by erosion of the lands above.

PRODUCTIVITY RATINGS

An evaluation of the quality, or productive capacity, of Molokai's lands is one of the objectives of this report. To make this evaluation, all Land Types were rated in two ways: 1. for selected crops or uses (pineapple, vegetables, sugar cane, forage, grazing, orchards, and forestry), and 2. for over-all suitability in agricultural use. The Selected Crop Productivity Rating provides flexibility to the evaluation process by permitting comparison between alternative uses both within and between Land Types. The Over-all Productivity Rating allows ready comparison between Land Types on a broader basis. For convenience in use, this rating is combined with the Land Type number and printed directly on the classification maps; for example, **D29** where **D** is the Over-all Productivity Rating and **29** is the Land Type number.

A five-class productivity rating is applied, using the letters A, B, C, D, and E, with A representing the class of highest productivity and E the lowest. To distinguish between the two types of evaluations, capital letters are used for Over-all Productivity Ratings and lower-case letters, a, b, c, d, and e, are used for Selected Crop Productivity Ratings.

The application of irrigation oftentimes results in increased productivity. Consequently, ratings were given for cultivatable Land Types under both irrigated and unirrigated conditions. Irrigated counterparts are identified with an **i** following the Land Type number, such as **A29i**; whereas **D29** is the same Land Type without irrigation. The **A** and **D** are Over-all Productivity Ratings.

The specifications for the productivity ratings were developed so that all lands throughout the State could be evaluated on a uniform basis. The rating system also leaves intact the Land Type identities for additional study or interpretation for agricultural pursuits.

Every effort was made to insure that the land's productive capacity was being evaluated, not the skill of management. Thus, the ratings interpret the interacting complex influence of climate, surface relief, drainage, wind velocities, and soil characteristics that are inherent in each Land Type under prevailing (modal) cultural practices.

These ratings stop short of placing monetary values on the lands classified, but many users of land data are not immediately concerned with dollar values. Others prefer to make their own economic evaluations, using the productivity ratings as the basis. Thus, as developed, the ratings facilitate subsequent cal-

Table 3. Land Class Rating Defined by Estimated Productivity of Selected Crops and Uses — Island of Molokai

The estimated crop yields are based upon prevailing cultural practices as described in this report. These yield estimates are considered reasonable, but crop by crop fluctuations in yields can be expected.

Pineapples

Class a: 14 tons or more fruit per acre per year (based on a 4-year crop cycle of plant and ratoon crops)
Class b: 12-14 tons per acre per year
Class c: 10-12 tons per acre per year
Class d: 8-10 tons per acre per year
Class e: Less than 8 tons per acre per year

Sugar Cane

Class a: Irrigated lands: 0.53 TSAM* or more
Unirrigated lands: 0.44 TSAM or more
Class b: Irrigated lands: 0.42-0.53 TSAM
Unirrigated lands: 0.37-0.44 TSAM
Class c: Irrigated lands: 0.33-0.42 TSAM
Unirrigated lands: 0.30-0.37 TSAM
Class d: Irrigated lands: 0.22-0.33 TSAM
Unirrigated lands: 0.19-0.30 TSAM
Class e: Irrigated lands: Less than 0.22 TSAM
Unirrigated lands: Less than 0.19 TSAM

Vegetables

Class a: Tomatoes over 25,000 pounds per acre per crop; Carrots over 11,000 pounds per acre per crop; Irish potatoes over 10,000 pounds per acre per crop; Dry onions over 17,000 pounds per acre per crop
Class b: Tomatoes 20,000-25,000 pounds per acre per crop; Carrots 9,500-11,000 pounds per acre per crop; Irish potatoes 8,000-10,000 pounds per acre per crop; Dry onions 15,000-17,000 pounds per acre per crop
Class c: Tomatoes 15,000-20,000 pounds per acre per crop; Carrots 8,000-9,500 pounds per acre per crop; Irish potatoes 6,000-8,000 pounds per acre per crop; Dry onions 13,500-15,000 pounds per acre per crop
Class d: Tomatoes 10,000-15,000 pounds per acre per crop; Carrots 6,500-8,000 pounds per acre per crop; Irish potatoes 4,000-6,000 pounds per acre per crop; Dry onions 10,000-13,500 pounds per acre per crop
Class e: Tomatoes less than 10,000 pounds per acre per crop; Carrots less than 6,500 pounds per acre per crop; Irish potatoes less than 4,000 pounds per acre per crop; Dry onions less than 10,000 pounds per acre per crop

*TSAM is Tons Sugar per Acre per Month.

Forage (Alfalfa)

Class a: Over 9 tons hay per acre per year
Class b: 6-9 tons hay per acre per year
Class c: 4-6 tons hay per acre per year
Class d: 2-4 tons hay per acre per year
Class e: Less than 2 tons hay per acre per year

Grazing (Pasture)

Class a: Carrying capacity less than 2.5 acres per AUY (animal unit year) or estimated live beef gains 110 pounds per acre per year or more*
Class b: Carrying capacity 2.5-5 acres per AUY or estimated live beef gains 110-55 pounds per acre per year
Class c: Carrying capacity 5-10 acres per AUY or estimated live beef gains 55-27 pounds per acre per year
Class d: Carrying capacity 10-30 acres per AUY or estimated live beef gains 27-9 pounds per acre per year
Class e: Carrying capacity more than 30 acres per AUY or estimated live beef gains 9 pounds or less per acre per year

Orchard Crops

Crop yields are based upon irrigated status except for orchards in the wetter sections.

Class a: Oranges over 12,000 pounds per acre per year; papayas over 25,000 pounds per acre per year; bananas over 8,500 pounds per acre per year
Class b: Oranges 10,000-12,000 pounds per acre per year; papayas 20,000-25,000 pounds per acre per year; bananas 6,500-8,500 pounds per acre per year
Class c: Oranges 8,000-10,000 pounds per acre per year; papayas 15,000-20,000 pounds per acre per year; bananas 5,000-6,500 pounds per acre per year
Class d: Oranges 6,000-8,000 pounds per acre per year; papayas 10,000-15,000 pounds per acre per year; bananas 4,000-5,000 pounds per acre per year
Class e: Oranges less than 6,000 pounds per acre per year; papayas less than 10,000 pounds per acre per year; bananas less than 4,000 pounds per acre per year

Forestry

Co Commercial forest land: land which is producing, or is capable of producing, usable crops of woods for industrial purposes. Industrial products include sawlogs and pulpwood, but not fuelwood.
NCo Non-commercial forest land: land which is incapable of yielding usable crops of industrial wood because of adverse site conditions.

*Live beef gains are estimates unsupported by research but are considered reasonable by veteran stockmen who were consulted. Yield values shown represent long-run average expectations. Yields for individual single years may differ from these values.

culations of income possibilities in alternative uses or for land valuation purposes.

SELECTED CROP PRODUCTIVITY RATINGS

The Selected Crop Productivity Ratings express the productive capacity of a Land Type for pineapple, vegetables, sugar cane, forage, grazing, orchards, and forestry. These crops and agricultural uses were selected because they are the most probable alternatives in Hawaii. The evaluation criteria are based on crop yields, expressed in tons or pounds per acre, or by some other similar but appropriate means. The only exception is forestry where a simple differentiation is made between lands physically capable, or incapable, of commercial forestry use. The yield criteria for Selected Crop Productivity Ratings are shown in Table 3. Initial development of these yield specifications incorporated information from and judgments of specialists of the Cooperative Extension Service and the Hawaii Agricultural Experiment Station of the University of Hawaii and knowledgeable individuals from plantations, ranches, and farms.

The actual rating of each Land Type in the selected crops or land uses was at times somewhat subjective because yield data were not always available. In these instances, ratings were established by careful projection from areas of known performance and related land conditions. The Selected Crop Productivity Ratings for each Land Type are presented in Table 2.

In field operations, management skills vary widely causing fluctuations in yields. Thus, to evaluate all lands on a uniform state-wide basis, the crop yields are based on a standard set of cultural practices for each crop or use. In vegetable, orchard, and forage production, these practices are outlined by types of crops because precise needs of individual crops are beyond the scope of this report. The cultural practices described below are reasonably applicable throughout the State and reflect the prevailing or modal situations; they are not to be construed as recommendations. Specific advice should be sought from appropriate agricultural experiment station and extension service technicians.

Prevailing Cultural Practices By Land Uses

Pineapple Production. Pineapples are adapted to a drier environment than most other crops; thus, they can be grown without irrigation in areas too dry for other crops. The best locations, however, are in the zone between the very dry and the very wet environments, where annual rainfall averages between 25 to 50 inches.

LAND PREPARATION: Pineapples are grown on semiarid lands of low and medium elevations. Where annual rainfall exceeds 25 inches or where irrigation water is available, clean tillage is practiced. Trash mulching is practiced on fields which have less than 25 inches of annual rainfall, and where irrigation is not possible. Land preparation practices for these two situations are as follows:

CLEAN TILLED LAND: Old pineapple plants are removed or chopped with a disc or cut-a-way harrow. The residue is then dried and burned or plowed under. The field, now cleared of vegetation, is smoothed with a drag to prepare it for planting.

TRASH MULCHED LANDS: Old plants are chopped and allowed to dry on the surface of the land. No additional tillage is performed. At the time of planting, a trash mulch machine parts the trash, tills the soil below the area to be planted, injects fumigants, and lays mulch paper or plastic sheets.

SOIL FUMIGATION: Soil fumigation treatment is required because of the high susceptibility of pineapple plants to root nematodes. The common application is 400 to 450 pounds of DD* (soil fumigant) per acre, or its equivalent, prior to planting.

PLANTING: About 18,000 plants per acre are planted by hand. Slips are the common planting material, although some crowns and suckers are used. Most of the slips grow with reasonably favorable moisture conditions, and replanting is necessary only on a very limited scale.

FERTILIZATION: Pineapple lands have been farmed intensively for a number of years, and heavy applications of fertilizers are necessary for continued production. The following are approximate present applications:

Nitrogen (N)	600 pounds per acre per crop cycle
Phosphorous (P_2O_5)	0 to 300 pounds per acre per crop cycle**
Potassium (K_2O)	200 to 600 pounds per acre per crop cycle**
Ferrous sulfate ($FeSO_4$)	100 pounds per acre per crop cycle

Some of the more acid soils are limed at the time of planting.

*Use of trade name does not represent endorsement of the product.
**Application rates adjusted as needed. A crop cycle is plant crop plus ratoon.

IRRIGATION: Although some lands receive supplemental irrigation in drier sections, irrigation is used primarily on a limited basis during the driest period.

INSECTICIDES: Up to 24 pounds per acre of Malathion or its equivalent are applied to control ants and mealy bugs.

WEED CONTROL: Pre-emergence weedicide spray is applied immediately after planting. Application is at the rate of 4 pounds of CMU, or its equivalent, per acre. Two or three follow-up sprayings with CMU, or its equivalent, are applied at the rate of 2 pounds per acre.

Weeds appearing later are controlled with 2 to 3 applications of contact oil herbicides. Occasionally, hand weeding is also necessary. Weed control practices are less intensive for the ratoon crop.

Vegetable Production. Most vegetables, being shallow rooted, are incapable of utilizing moisture retained deep in the soil; therefore, irrigation is necessary where rainfall is insufficient to satisfy the crop's need. The crops are fast growing with a cycle of planting through harvesting usually completed in 3 to 6 months. This requires frequent plowing and cultivation. Thus, the best lands for vegetables are flat, nonstony, and well-drained to facilitate frequent irrigation and land preparation. The practices described in this section are also applicable to field production of cut flowers because the requirements are very similar.

Vegetable farmers are usually equipped with wheel tractors, power sprayers, and irrigation equipment. Sources of irrigation water include streams, wells, and municipal supplies. The practices described subsequently are for lands which have been cleared and used previously for the production of agricultural crops.

LAND PREPARATION: Crop residues and weeds are chopped with a disc harrow. The field is plowed twice and each plowing is followed by a disc harrowing. After the final harrowing, the field is smoothed with a drag. Furrows are prepared according to the appropriate method of irrigation and requirements of the crop.

SOIL TREATMENT: Most lands used for vegetable production are infested with root knot nematodes which attack crop roots. Before planting, the soil is injected with either of these chemicals and at the rates shown:

DD	400 to 450 pounds per acre
EDB	12 gallons per acre of solution having 20 per cent active ingredients

FERTILIZATION AND SOIL AMENDMENTS: Fertilizer applications vary somewhat with the crop and location. However, average ranges in total annual fertilizer additions for the major elements are as follows:

Nitrogen (N)	100 to 150 pounds per acre
Phosphorous (P_2O_5)	200 to 250 pounds per acre
Potassium (K_2O)	200 to 250 pounds per acre

Agricultural lime is added in moderate amounts to certain acid lands.

IRRIGATION: Virtually all vegetable lands are irrigated. The most common methods of irrigation are sprinklers and furrows. Fields in low lying coastal areas are irrigated 2 to 3 times a week, whereas those in higher and more humid areas are irrigated about once a week.

INSECTICIDES AND FUNGICIDES: Vegetables are susceptible to damage from a number of insect pests and fungi. Types and rates of chemicals used for their control vary greatly. Some commonly used insecticides are DDT, Toxaphene, Lindane, Malathion, and Parathion. Fungal disease can usually be controlled by a combination of seed treatments, dusts, and sprays.

WEED CONTROL: Two methods of weed control are used on vegetable croplands. Chemical herbicides are sprayed immediately after planting for pre-emergence weed control. Compounds such as vegadex or CDEC are applied at rates of 4 to 6 pounds per application per acre. Contact herbicides, including activated and aromatic oils, are sprayed at the rate of 40 gallons per acre at 6-week intervals. Mechanical weed control, the second method, is usually practiced to remove weeds in the rows.

WINDBREAKS: Vegetable crops, especially the vine types, are highly susceptible to wind damage. Planted or constructed windbreaks are provided where winds are of sufficient velocity to damage the crop. Height and spacing of the windbreaks vary with the crop, wind velocities, and the slope of the land. Trees or shrubs which are commonly used for windbreaks include ironwood, hibiscus, eucalyptus, and certain conifers, such as Norfolk Island Pine. Sugar cane is also used for windbreak purposes.

Sugar Cane Production. Although no sugar cane is grown on Molokai at present, it has been grown there in the past. Consequently, sugar cane is considered among the alternative agricultural uses.

Sugar cane is grown in the State under both irrigated and unirrigated conditions. Yields per acre on irrigated fields in the drier areas are almost always higher than those from unirrigated fields in the wetter and higher elevation locations. The irrigated fields are generally preferred to the latter. The sugar cane plant has a deep and fibrous root system which allows less frequent irrigation than for vegetables. Factors of slope and stoniness are important, but they are not as critical as in vegetable production because mechanical planting and harvesting operations are performed only once every two years.

LAND PREPARATION: Before planting, irrigated cane lands are smoothed with a land plane or bulldozer to remove humps or dips in the field. The number and sequence of tillage operations vary with the plantation and soil conditions. Normally, the land is tilled with implements such as the moldboard plow, Rome harrow, or Esco tiller. Following tillage operations, grade lines for planting and irrigation purposes are staked out by a survey crew.

Lands are not plowed and replanted after each harvest. The general practice is to allow the field to produce three or four ratoon crops.

PLANTING: Sugar cane is propagated from cuttings planted in furrows spaced 5 to 5½ feet apart. General practice is to use a planting machine that furrows the land, plants the cutting, and adds the fertilizers in one operation. The first irrigation is applied soon after planting. Approximately 3.5 to 4 tons of seed cane are planted to an acre.

In ratoon fields, old furrows are reshaped mechanically and irrigation ditches repaired. The first fertilizer applications are normally applied during the reshaping operation. After the ratoon shoots appear, blank spaces in the furrows are planted with seed cane.

FERTILIZATION: Sugar cane is grown under a wide range of soil and climatic conditions. Although the form of fertilizers and methods of fertilization differ among plantations, some generalizations can be made. Much of the nitrogen and potash fertilizer is applied in the irrigation water for irrigated fields. Manual and aerial applications of fertilizers are made for unirrigated fields.

Nitrogen is applied to all sugar cane lands. Ammonium forms of nitrogen are used predominantly. These include aqua ammonia (applied mostly in the irrigation water) and urea.

Many of the soils do not require additional phosphate. On fields receiving phosphate, 100 to 200 pounds P_2O_5 per acre (principally as ammonium or superphosphate) are applied at planting time. Rock phosphate is applied on some of the more acid soils.

Soils vary in their potassium availability. This variability is evident by the wide range in the amounts being applied (100 to 500 pounds K_2O per acre in the form of muriate of potash). The largest applications are made on the more highly leached soils (Humic Ferruginous Latosols, Hydrol[illegible] Latosols, and Humic Latosols) in the higher rainfall areas.

Lime is added to the very acid soils, particularly unirrigated fields. However, the soils used for cane production are generally high in available calcium.

IRRIGATION: Furrow irrigation is the most widely used technique for irrigating sugar cane fields. There are 24 to 50 applications of irrigation water per crop. Irrigation is usually suspended during the latter part of the second season to facilitate ripening and "drying off."

WEED CONTROL: Weeds are controlled by a combination of pre-emergence and post-emergence sprays. Among the chemicals being used are CMU, DCMU, Simazine, and Atrazine.

Forage Crop Production. In forage production frequent use of machinery for cutting and raking makes flat terrain highly desirable. Stoniness is not as great a hindrance as in vegetable production because fields are not plowed and planted at frequent intervals. Stones, however, must not protrude above the surface so as to interfere with the cutting and raking operations.

The principal forage crops produced are alfalfa and [illegible] grass. Some California grass (*Panicum purpurascens*) is also being used for forage purposes. Cultural practices are described for the first two crops only.

ALFALFA

LAND PREPARATION: Lands put into alfalfa production for the first time are cleared of brush and trees with a bulldozer. The land is then plowed, if soil depth permits, or disced and harrowed several times, if the soil is shallow. After harrowing, the field is usually smoothed with a drag. If weeds are a problem, the field may be irrigated to germinate the weed seeds. The field is then harrowed to eliminate weeds prior to seeding.

SEEDING: Alfalfa seed is innoculated only if the crop is being introduced into an area for the first time. Seeds are broadcast at a rate of 20 to 35 pounds per acre. The field is rolled to press the broadcasted seeds into the soil.

FERTILIZATION: Little or no fertilizer is added to the lands used for alfalfa production.

IRRIGATION: Fields are irrigated as needed during the dry months of the year. Approximately 4 to 5 inches of irrigation water are applied per month.

WEED CONTROL: Weeds are controlled by using selective herbicides. These are applied sparingly and only when necessary. Annual weeds are generally controlled by the successive mowings. If weed infestation becomes a critical problem, the field is plowed and replanted; in Hawaii this is every 2 to 2½ years.

HARVESTING: Alfalfa is usually cut 10 to 12 times per year. It is normally green-chopped, but some may by dried and baled as hay.

NAPIERGRASS

This grass is used extensively as soilage for dairy herds. Many of the fields used for this crop are smaller than 5 acres in area.

LAND PREPARATION: The land is plowed and then smoothed with a harrow. Irrigation furrows (approximately 3½ to 4 feet apart) are then constructed on lands where furrow irrigation is practiced.

PLANTING: Cuttings from the stalk or root serve as planting material and are usually placed in rows 3½ to 4 feet apart. Most fields are plowed and replanted every 10 years.

FERTILIZATION: Only nitrogen fertilizer is added because napiergrass is usually grown on the Gray Hydromorphic and Dark Magnesium soils which are not usually deficient in phosphorous. For fields which need nitrogen fertilizer, the average annual fertilization rate is approximately 300 pounds of nitrogen per acre (normally there are two or more applications per year).

IRRIGATION: In the more humid regions most lands producing napiergrass are not irrigated. Both furrow and overhead irrigation methods are being used on lands in drier sections.

HARVESTING: Most of the napiergrass is harvested by mechanical choppers. Some mower harvesting is still done on the smaller fields. Where mower harvesting is done, the standing crop is usually cut one swath at a time with a tractor-powered mower. After each swath is cut, the stalks are hauled to an ensilage chopper located near the feeding area. Normally, there are three to four cuttings per year.

Grazing (Pasture Production). Quality of grazing lands depends upon the growth of desirable plant species adapted to the site. Quality of feed is usually better in the drier areas, but quantities are usually limited because of the long dry season. The quantity of feed is greater in the wetter areas, but the forage is poor in quality because the feed is soggy and lacking in nutrients and dry matter. The most desirable grazing areas are in the transition zone between the dry and wet situations. Here, the quality of the feed is good and there is sufficient rainfall to support green feed during most of the year. Stoniness and slope do not become limiting factors until they begin to hamper movement of livestock.

LAND CLEARING: Trees and brush are cleared with bulldozers. Uprooted trees are windrowed or pushed into gulches where they are burned or left to rot. The area is then smoothed with a bulldozer and readied for seeding.

SEEDING: Grazing lands are often prepared for seeding by chain dragging or smoothing with a bulldozer after the land is cleared.

The following is a list of forage species commonly used for pasture purposes, together with prevailing seeding rates:

Buffelgrass	2 pounds per acre
Guineagrass	5 pounds per acre
Green panicgrass	5 pounds per acre
Pangolagrass	Sprig 6′ × 6′
Kikuyugrass	Sprig 6′ × 6′
Ekoa	15 pounds per acre
Kaimiclover	5 pounds per acre

FERTILIZATION AND SOIL AMENDMENTS: Fertilizers are usually applied at the time of planting. Usual application rates are:

Nitrogen (N)	30 to 40 pounds per acre
Phosphorus (P_2O_5)	35 to 50 pounds per acre
Potassium (K_2O)	20 to 30 pounds per acre

Agricultural lime is sometimes applied at the rate of 1,000 pounds per acre when planting lands receiving more than 60 inches of annual rainfall.

IRRIGATION: Some grazing lands are irrigated, principally by sprinkler.

STOCK WATER: Water is piped to watering troughs if stock does not have access to other sources of water.

ROTATION OF GRAZING LANDS: The animals are generally moved from one tract to another when the forage becomes closely grazed. Fences are often constructed to facilitate rotation.

WEED CONTROL: Weed control is affected either by the use of chemical herbicides or mechanical methods. Usually, ranchers practice some form of weed control as needed.

Orchard Production. Orchard crops are generally deep rooted and relatively long lasting once planted. They do not require much machine tillage. Thus, they are adapted to a wider range of land conditions with regard to slope and stoniness than other crops or uses, except grazing. However, flatter terrain and nonstony conditions facilitate operations; this is especially true if orchards are irrigated.

LAND PREPARATION: Lands being prepared for orchard crops are first harrowed to knock down the weedy and shrubby growth. Forested lands are cleared with a bulldozer. The land is then plowed and dragged. Irrigation furrows and planting layouts are tailored to the needs of the crop and the method of irrigation. Holes for planting are usually dug with tractor-mounted post hole diggers.

FERTILIZATION: Average ranges in annual fertilizer additions for the major elements are as follows:

Nitrogen (N)	100 to 150 pounds per acre
Phosphorus (P_2O_5)	200 to 250 pounds per acre
Potassium (K_2O)	200 to 250 pounds per acre

IRRIGATION: Furrow irrigation is the most widely used method, but some sprinkler irrigation is practiced. The time interval between applications varies with the location, crop, and availability of water; the normal interval is about a week. In the higher or wetter locations, the interval may be 10 to 14 days.

INSECTICIDES AND FUNGICIDES: Usually insecticides and fungicides are applied, as needed, at the rates of 2 to 5 pounds in 100 gallons of water.

WEED CONTROL: Weeds are controlled by both mechanical devices and chemical herbicides. The method used depends upon the tolerance of the trees. With mechanical devices, from 3 to 4 cultivations are made annually.

WINDBREAKS: It is common practice to provide windbreaks along the edges of fields exposed to the prevailing winds. Height and spacing of windbreaks vary with the type of orchard, wind velocities, and slope of the land.

Over-All (Master) Productivity Rating

The Over-all Productivity Rating evaluates each Land Type in its over-all or general productive capacity and not for any specific crop. Two independent methods were utilized in ascertaining and checking this over-all rating: averaging the Selected Crop Productivity Ratings and application of the Modified Storie Index (7) (8).

Under the Selected Crop Productivity Rating, each Land Type was evaluated for six uses with crop yield as the criterion. Averaging these six ratings provides an index of the land's over-all productive capacity. For example, Land Type **29** has ratings of c, d, e, c, c, and d for pineapples, vegetables, sugar cane, forage, grazing, and orchard, respectively. An average of these ratings gives an Over-all Productivity Rating of **D** for Land Type **29**. A similar rating is obtained by using the Modified Storie Index discussed below. The Over-all Productivity Rating and Selected Crop Productivity Ratings for each Land Type are shown in Table 2.

The Modified Storie Rating Index is a formula whereby the productivity index of the land is developed by multiplying the several factors in the formula. The higher the product, the better suited the Land Type is for agricultural uses.

Modified Storie Rating Index = A × B × C × X × Y

- A = percentage rating for the general character of the soil profile
- B = percentage rating for the texture of the surface horizon
- C = percentage rating for the slope of the land
- X = percentage rating for such factors as salinity, soil reaction, damaging winds, erosion, etc.
- Y = percentage rating for rainfall.

The percentage rating for each factor (A, B, C, X, and Y) increases as the favorableness of the factor increases. Therefore, it follows that as the land productivity approaches 100 per cent, the agricultural quality of the land increases. Conversely, less desirable lands have low value indexes. The

Table 4. Modified Storie Index: Percentage Ratings of Individual Factors by Land Types (Unirrigated Status Only)—Island of Molokai

Land Type No.	Factors					Land Productivity Index (Per cent)	Over-all Productivity Rating
	A	B	C	X	Y		
	Per Cent						
1	93	94	85	80	92	55	C
2	93	94	72	80	92	46	D
3	93	84	88	80	92	51	D
4	93	84	74	80	92	43	D
5	42	85	90	42	80	11	E
6	40	70	90	57	60	9	E
7	40	50	90	57	60	6	E
8	92	92	94	76	96	58	C
9	92	92	80	76	96	49	D
10	90	92	60	76	96	36	D
11	96	90	93	86	88	61	C
12	96	78	93	86	88	53	D
13	90	90	93	80	90	54	D
14	95	92	92	88	90	64	C
15	90	92	76	77	90	44	D
16	90	84	80	77	90	42	D
17	90	92	78	77	90	45	D
18	90	90	90	87	86	54	D
19	90	88	84	87	86	50	D
20	92	80	57	72	86	26	E
21	75	50	78	91	94	25	E
22	94	92	88	70	90	48	D
23	96	70	74	96	90	43	D
24	30	65	78	50	90	7	E
25	94	94	98	78	76	51	D
26	94	92	92	66	90	47	D
27	92	92	84	65	90	42	D
28	50	80	98	60	70	16	E
29	95	92	92	75	90	54	D
30	95	97	76	75	90	47	D
31	95	97	82	75	90	51	D
32	95	85	82	75	90	45	D
33	95	70	80	72	90	34	D
34	95	65	55	70	90	21	E
35	96	97	94	68	70	42	D
36	96	88	90	69	55	29	E
37	97	50	90	70	55	17	E
38	92	92	92	73	55	31	D
39	92	92	80	73	55	27	E
40	92	92	65	73	55	22	E
41	92	92	76	73	55	26	E
42	92	92	85	73	55	29	E
43	92	70	90	73	55	23	E
44	92	70	76	73	55	19	E
45	92	70	65	73	55	17	E
46	92	68	78	73	55	19	E
47	92	50	80	73	55	15	E
48	92	50	65	73	55	12	E
49	60	50	65	70	55	8	E
50	93	92	96	86	85	60	C
51	93	92	85	79	85	49	D
52	90	92	85	89	90	56	C
53	90	92	74	89	90	49	D
54	92	90	80	80	90	48	D
55	92	88	52	74	90	28	E
56	92	88	98	90	80	57	C
57	92	87	75	90	80	43	D
58	92	85	70	85	80	37	D
59	92	80	72	85	80	36	D
60	92	65	60	85	80	24	E
61	88	90	96	81	60	37	D
62	88	90	76	81	60	29	E
63	88	70	92	81	60	28	E
64	88	70	80	81	60	24	E
65	90	92	92	78	94	56	C
66	96	90	76	84	79	44	D
67	40	96	90	60	60	12	E
68	30	65	30	50	80	2	E
69	30	65	70	50	80	5	E
70	72	30	92	70	79	11	E
71	30	30	70	70	79	3	E
72	30	65	30	50	80	2	E
73	30	65	70	50	96	6	E
74	35	65	30	50	90	3	E
75	30	65	30	50	90	3	E
76	36	65	30	50	80	3	E
77	30	68	70	60	88	8	E
78	30	65	30	50	80	2	E
79	20	50	10	25	70	1	E
80	30	88	99	35	90	8	E

following tabulation shows the Modified Storie Index percentages and their equivalent Over-all Productivity Ratings.

Modified Storie Index Percentages	Over-all Productivity Rating
85-100	A
70- 84	B
55- 69	C
30- 54	D
0- 29	E

Each Land Type with its Modified Storie Index percentage rating is shown in Table 4.

Before presenting the percentage rating scheme, each factor is discussed briefly to describe its role in determining land quality for agricultural purposes.

Factor A takes into consideration drainage and depth of soil profile. Deep and shallow soils are recognized and differentiated. Differences in drainage are recognized. The nature of the surface soil and subsoil are considered. Parent material and degree of soil development are recognized as they affect fertility, structure, depth, aeration, and moisture-holding capacity of the soil.

Factor B, which expresses the texture of the surface soil, reflects the relative workability of the soil as well as its composition of silt, sand, and clay. Stony lands, including lava lands, are placed in special categories. The soils are separated into textural groups. Soils are usually expected to react quite similarly when of homogeneous textural groups. Texture is closely associated with moisture-holding capacity and workability of the soil.

Factor C accounts for the variations in slope of the lands. The slope classes are designed to differentiate ease of irrigation, use of mechanical equipment, susceptibility to erosion, amount of surface runoff, and suitability for commercial forest production. In general, slopes exceeding 35 per cent are considered too steep for cultivated crops, and slopes greater than 80 per cent are assumed impractical for commercial forest production.

Factor X includes the miscellaneous land characteristics such as soil fertility, soil reaction, soil salinity, soil erosion, and presence of strong winds.

Factor Y accounts for rainfall and associated climatic features. As a general rule, lands in the higher rainfall zones are covered by clouds and therefore lower in productivity; irrigated lands are rated 100 because the moisture requirement is properly met. It is the general assumption that where irrigation is required, climate is usually satisfactory for crop production.

In the determination of the productivity rating, each of the Factors is assigned a relative value in accordance with the following percentage rating scheme:

Factor A. General character of the soil profile. Immature soils with little profile development; group includes alluvial, regosolic, and lithosolic soils and soils formed under the influence of excess moisture in the profile.

Deep, well-drained soils	92-100%
Deep, moderately well-drained soils	80- 91
Moderately deep, well-drained soils	90- 95
Moderately deep, moderately well-drained soils	71- 85
Moderately deep, imperfectly- to poorly-drained soils	60- 70
Shallow, moderately well-drained soils	55-
Shallow, imperfectly- to poorly-drained soils	2
Moderately well-developed to well-developed upland soils, from basalts, andesites, volcanic ash or cinders, or alluvium.	
Deep, well-drained soils	92-100%
Deep, moderately well-drained soils	85- 94
Deep, imperfectly- to poorly-drained soils	75- 84
Moderately deep, well-drained soils	90- 95
Moderately deep, moderately well-drained soils	71- 85
Moderately deep, imperfectly- to poorly-drained soils	60- 70
Shallow, well-drained soils	70- 80
Shallow, moderately well-drained soils	60- 69
Shallow, well-drained, eroded soils	40- 50
Shallow, imperfectly-to poorly-drained soils	30- 39
Waterlogged lands	25- 65
Lands in which bedrock is exposed at surface	10- 24
Lithosols and Regosols	
Shallow, well-drained soils developed from aa or volcanic cinders and ash. These soils may be cultivated but with some difficulty	70- 85%
Deep, excessively-drained coral or basaltic sands	25- 45
Lands in which stones and rocks are exposed at the surface and there is virtually no soil present	20-
Man-made lands	
Moderately deep to deep, well-drained fill materials	80- 95%
Shallow, well-drained fill materials	60- 70

Factor B. "Apparent" texture of surface soil

Silt loam and fine sandy loam	90-100%
Silty clay loam, clay loam and silty clay; clays consisting of non-expanding 1:1 type minerals and metallic oxides	85- 98
Plastic clay (high proportion of expanding 2:1 type minerals); characteristic granular structure	82- 92
Loamy sand, sandy loams	85- 95
Coarse sand, medium sand	65- 75

Miscellaneous situations	
Stony lands (including aa)	65- 85
Rocky lands	25- 70
Pahoehoe	20- 60
Factor C. Slope of land	
0 to 10 per cent	90-100%
11 to 20 per cent	75- 89
21 to 35 per cent	50- 74
36 to 80 per cent	15- 49
Over 80 per cent	0- 14
Factor X. Miscellaneous elements	
Reaction of surface soil	
Medium acid to mildly alkaline—pH 5.6 to 7.5	90-100%
Alkaline—pH greater than 7.5	85- 89
Acid—pH under 5.5	80- 89
Salinity	
None to slight—very little, if any, interference of soluble salts with normal crop growth	86-100%
Moderate—soluble salts interfere considerably with normal crop growth	75- 85
Severe—soils have excess of soluble salts (mainly sodium chloride) which prevent the growth of ordinary crop plants	55- 65
Fertility level (as measured by Modified Truog rapid chemical methods of soil testing)	
Ample	
Greater than 125 pounds available P_2O_5 per acre Greater than 240 pounds available K_2O per acre Greater than 4000 pounds CaO per acre	95-100%
Moderate	
50 to 125 pounds available P_2O_5 per acre 80 to 240 pounds available K_2O per acre 1000 to 4000 pounds CaO per acre	85- 94
Poor to very poor	
Less than 50 pounds available P_2O_5 per acre Less than 80 pounds available K_2O per acre Less than 1000 pounds CaO per acre	65- 84
Erosion	
None to slight—less than 25 per cent of the original surface soil removed from most of the area	95-100%
Moderate—25 to 50 per cent of the original surface soil removed from most of the area	90- 94
Severe—practically all the original surface soil removed from most of the area	85- 89
Winds	
Slight—winds with maximum velocities of 31 miles per hour or less	95-100%
Moderate—winds with maximum velocities of 32 to 50 miles per hour during period of strong wind activity	90- 94
Severe—winds with maximum velocities greater than 50 miles per hour during period of strong wind activity	85- 89
Factor Y. Average annual rainfall	
0-20 inches	55- 79%
21-40 inches	90- 94
41-60 inches	85- 98*
61-90 inches	80- 90
91-150 inches	70- 80
Greater than 150 inches	40- 70

Percentage ratings for unirrigated Land Types and their irrigated counterparts are identical except for Factor Y which is always 100 per cent in the latter case. For this reason, percentage ratings for the irrigated counterparts are not listed in Table 4. However, the land productivity indexes, obtained by multiplying the percentage value for the A, B, C, X, and Y Factors, are reported.

*Percentages for higher rainfall categories are reduced because of accessory factors such as cloudiness and low temperature.

LAND USE AND LAND CLASS ACREAGES

On Molokai, approximately 18,230 acres, or 11 per cent of the total island area of 167,085 acres, are in cropland. About 86,840 acres, or 52 per cent, are grazed. Forested areas outside the forest reserve comprise 2,035 acres, or one per cent, and 48,330 acres, or 29 per cent, are in the forest reserves. The remaining 11,650 acres, or 7 per cent, are in nonagricultural uses.

On the cultivated lands, pineapple is the largest single crop. This crop occupies about 17,275 acres, or 10 per cent of the total land area of Molokai. Vegetables rank second with 845 acres, about one per cent of the total island area. The principal crops in this use are Irish potatoes and seed corn. Most of the seed corn is grown in areas formerly producing alfalfa. All other crops, including orchards, account for about 110 acres.

Grazing and forestry, the less intensive forms of agricultural use, account for 137,205 acres, or about 82 per cent of the total land area.

Nonagricultural lands include pali lands, mangroves, urban sites, agricultural homesteads, recreation areas, and military installations. Steep pali lands and mangroves account for about two-thirds of the lands in this use category.

In differentiating lands by Over-all Productivity Classes, 702 acres are classified as Class A lands with irrigation. These lands include most of the acreage in vegetables and a small part of the lands in orchards. At present, no lands are classified as Class B in over-all suitability for agriculture on Molokai. Class C lands account for 4,079 acres. These lands are located primarily in the upper Hoolehua Plain section. About two-thirds of the Class C lands are used for grazing and about 23 per cent for growing pineapples. Class D lands comprise 40,842 acres or about 25 per cent of the total land area of Molokai. These are the drier lands, with gentle slopes of less than 10 per cent, located in the homestead section of the Hoolehua Plain and in the far western portion of the island. Their principal uses are pineapple and grazing. Class E lands account for 120,293 acres or almost three-fourths of the total land area. These are the rough broken lands with steep slopes located in the forest reserve area and the stony, shallow lands mauka of Kaunakakai. About half these lands are used for grazing.

A detailed breakdown of land use and land class data is presented in Tables 5, 6, and 7. These land use and land class acreages were derived from planimetric measurement of the land classification maps.

Table 5. Distribution of Lands by Use—Island of Molokai

Land Use	Acres	% of Total
Pineapple	17,274	10.34
Vegetables[1]	845	0.51
Grassland Grazing	28,707	17.18
Wooded Grazing	58,133	34.79
Orchards[2]	104	0.06
Forest	2,037	1.22
Forest Reserve	48,332	28.93
Military	316	0.19
Recreation	415	0.25
Idle Agricultural Land	2,271	1.36
Pali Land and Mangrove	7,476	4.47
Miscellaneous Use[3]	6	*
Urban	1,121	0.67
Water	48	0.03
TOTAL	167,085	100.00

*Less than 0.01 of one per cent.
[1]Primarily Irish potatoes and seed corn. 678 acres are irrigated.
[2]20 acres are irrigated.
[3]Includes dairy, 1 acre; poultry, 1 acre; sugar cane test plantings, 4 acres.

Table 6. Distribution of Lands by Class of Agricultural Productivity—Island of Molokai

Productivity Rating	Irrigated			Unirrigated			Total	
	Acres	% of Total Irrigated	% of Total Acreage	Acres	% of Total Unirrigated	% of Total Acreage	Acres	% of Total Acreage
A	702	100.00	0.42	.....	.....	.....	702	0.42
C	.....	.....	.....	4,079	2.47	2.44	4,079	2.44
D	.....	.....	.....	40,842	24.72	24.44	40,842	24.44
E	.....	.....	.....	120,293	72.81	72.00	120,293	72.00
TOTAL	702	100.00	0.42	165,214	100.00	98.88	165,916	99.30

**Excluding 48 acres in water (0.03%) and 1,121 acres in urban use (0.67%).

Table 7. Distribution of Land Types by Productivity Class—Island of Molokai

Land Type	Acreage by Class				Total Acres	% of Total
	A	C	D	E		
1	.....	52	.....	.....	52	0.03
2	.....	.....	957	.....	957	0.57
3	.....	.....	22	.....	22	0.01
4	.....	.....	247	.....	247	0.15
5	.....	.....	.....	1,018	1,018	0.61
6	.....	.....	.....	645	645	0.39
7	.....	.....	.....	1,507	1,507	0.90
8	.....	1,403	.....	.....	1,403	0.84
9	.....	.....	579	.....	579	0.35
10	.....	.....	213	.....	213	0.13
11	.....	208	.....	.....	208	0.12
12	.....	.....	109	.....	109	0.07
13	.....	.....	872	.....	872	0.52
14	.....	279	.....	.....	279	0.17
15	.....	.....	440	.....	440	0.26
16	.....	.....	453	.....	453	0.27
17	.....	.....	1,767	.....	1,767	1.06
18	.....	.....	227	.....	227	0.14
19	.....	.....	1,569	.....	1,569	0.94
20	.....	.....	.....	21	21	0.01
21	.....	.....	.....	1,337	1,337	0.80
22	.....	.....	302	.....	302	0.18
23	.....	.....	408	.....	408	0.24
24	.....	.....	.....	380	380	0.23
25	.....	.....	687	.....	687	0.41
26	.....	.....	214	.....	214	0.13
27	.....	.....	316	.....	316	0.19
28	.....	.....	.....	1,207	1,207	0.72
29	.....	.....	3,385	.....	3,385	2.03
30	.....	.....	1,022	.....	1,022	0.61
31	.....	.....	1,642	.....	1,642	0.98
32	.....	.....	61	.....	61	0.04
33	.....	.....	741	.....	741	0.44
34	.....	.....	.....	922	922	0.55
35	.....	.....	500	.....	500	0.30
36	.....	.....	.....	2,139	2,139	1.28
36i	380	.....	.....	.....	380	0.23
37	.....	.....	.....	1,080	1,080	0.65
38	.....	.....	19,039	.....	19,039	11.40
38i	322	.....	.....	.....	322	0.19
39	.....	.....	.....	2,620	2,620	1.57
40	.....	.....	.....	142	142	0.08
41	.....	.....	.....	1,599	1,599	0.96
42	.....	.....	.....	1,610	1,610	0.96
43	.....	.....	.....	2,289	2,289	1.37
44	.....	.....	.....	658	658	0.39
45	.....	.....	.....	479	479	0.29
46	.....	.....	.....	725	725	0.43
47	.....	.....	.....	12,754	12,754	7.63
48	.....	.....	.....	4,399	4,399	2.63
49	.....	.....	.....	7,577	7,577	4.54
50	.....	1,475	.....	.....	1,475	0.88
51	.....	.....	1,157	.....	1,157	0.69
52	.....	102	.....	.....	102	0.06
53	.....	.....	542	.....	542	0.32
54	.....	.....	959	.....	959	0.57
55	.....	.....	.....	163	163	0.10
56	.....	190	.....	.....	190	0.11
57	.....	.....	299	.....	299	0.18
58	.....	.....	585	.....	585	0.35
59	.....	.....	145	.....	145	0.09
60	.....	.....	.....	194	194	0.12
61	.....	.....	828	.....	828	0.50
62	.....	.....	.....	133	133	0.08
63	.....	.....	.....	193	193	0.12
64	.....	.....	.....	58	58	0.03
65	.....	370	.....	.....	370	0.22
66	.....	.....	555	.....	555	0.33
67	.....	.....	.....	443	443	0.27
68	.....	.....	.....	6,156	6,156	3.68
69	.....	.....	.....	1,484	1,484	0.89
70	.....	.....	.....	67	67	0.04
71	.....	.....	.....	133	133	0.08
72	.....	.....	.....	6,169	6,169	3.69
73	.....	.....	.....	1,387	1,387	0.83
74	.....	.....	.....	5,949	5,949	3.56
75	.....	.....	.....	2,021	2,021	1.21
76	.....	.....	.....	4,475	4,475	2.68
77	.....	.....	.....	898	898	0.54
78	.....	.....	.....	12,571	12,571	7.52
79	.....	.....	.....	32,013	32,013	19.16
80	.....	.....	.....	678	678	0.41
TOTAL	702	4,079	40,842	120,293	165,916	
%	0.42	2.44	24.44	72.00		99.30
Water					48	0.03
Urban					1,121	0.67
GRAND TOTAL					167,085	100.00

USE AND INTERPRETATION OF THE LAND CLASSIFICATION MAPS

The land classification maps and related data presented in this report can serve a wide range of demands for objective land facts. To obtain the fullest use of the land classification maps, readers should follow these steps:

1. *Use the Index Map to select the land classification sheet* which embraces the land area of interest. To simplify location on the Index Map, tax map zones and sections are overprinted in red.

2. *Locate the desired land classification map sheet and identify the desired tract* by reference to recognizable landmarks on the aerial photograph. Refer to the Legend sheet to identify map symbols.

3. *Determine the classification of the land tract* from the symbols in each delineated area. The upper-case letter tells the Over-all Productivity Rating. The numeral identifies the Land Type. The presence of the letter **i** in the symbol indicates that the Land Type is irrigated.

4. *Obtain a description of the Land Type* (soil, rainfall, elevation, topography, etc.) *and the productivity ratings in selected uses* by referring to the appropriate Land Type number in Table 2.

5. *Translate productivity class ratings into estimated crop yields* using Table 3.

6. *Obtain description of cultural practices* associated with estimated crop yields from pages 17-21.

An example of the land classification delineations as shown on the aerial photo map sheets is illustrated in Figure 3.

Figure 3.

The parcel on the left is rated as Class **D** in its Over-all Productivity without irrigation. The number **29** designates the Land Type, which is described as lands having deep, nonstony, well-drained, dark reddish brown soils of moderately fine texture. The dominant soil series is Lahaina. This Land Type occurs where the median annual rainfall is 20 to 35 inches and elevations are 600 to 1,400 feet. Topography is nearly level to gently sloping. This Land Type is well-suited to machine tillage.

In the parcel to the right, the Land Type is identical to that described above. The land is irrigated and has a higher [illegible] all Productivity Rating of **A**.

Ratings of Land Types for selected alternative crops are presented in Table 2.

Aerial photos used in this report are unrectified. Variations in scale do occur on individual map sheets. *Readers are cautioned, therefore, that boundaries and acreage measurements presented in this report should not be used for legal purposes.*

APPENDIX B:

ZONING AND FLOOD CONFIRMATION FORM (COUNTY OF MAUI)

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COUNTY OF MAUI
DEPARTMENT OF PLANNING
One Main Plaza Building
2200 Main Street, Suite 315
Wailuku, Hawaii 96793

Zoning Administration and
Enforcement Division (ZAED)
Telephone: (808) 270-7253
Facsimile: (808) 270-7634
E-mail: planning@mauicounty.gov

ZONING AND FLOOD CONFIRMATION FORM

(This section to be completed by the Applicant)

APPLICANT NAME PBR Hawaii **TELEPHONE** 808-521-5631

PROJECT NAME Monsanto **E-MAIL** tschnell@pbrhawaii.com

PROPERTY ADDRESS _____ **TAX MAP KEY** 2-5-2-012:004

☐ Yes ■ No **Will this Zoning & Flood Confirmation Form be used with a Subdivision Application?**
IF YES, answer questions A and B below and comply with instructions 2 & 3 below:

A) ☐ Yes ☐ No **Will it be processed under a consistency exemption from Section 18.04.030(B), MCC?**
IF YES, which exemption? (No. 1, 2, 3, 4 or 5) _____

B) State the purpose of subdivision and the proposed land uses (*ie 1-lot into 2-lots for all land uses allowed by law*):

INSTRUCTIONS:
1) **Please use a separate Zoning & Flood Confirmation Form for each Tax Map Key (TMK) number.**
2) **If this will be used with a subdivision application AND the subject property contains multiple districts/designations of (1) State Land Use Districts, (2) Maui Island Plan Growth Boundaries, (3) Community Plan Designations, or (4) County Zoning Districts; submit a signed and dated Land Use Designations Map, prepared by a licensed surveyor, showing the metes & bounds of the subject parcel and of each district/designation including any subdistricts.**
3) **If this will be used with a subdivision application AND the subject property contains multiple State Land Use Districts; submit an approved District Boundary Interpretation from the State Land Use Commission.**

(This section to be completed by ZAED)

LAND USE DISTRICTS/DESIGNATIONS (LUD) AND OTHER INFORMATION: [1]

☐ (SMA) Special Management Area

STATE DISTRICT: ☐ Urban ☐ Rural ☒ Agriculture ☐ Conservation

MAUI ISLAND PLAN
Growth Boundary:[2] ☐ Urban ☐ Small Town ☐ Rural ☐ Planned Growth Area ☐ Outside Growth Boundaries
Protected Area:[2] ☐ Preservation ☐ Park ☐ Greenbelt ☐ Greenway ☐ Sensitive Land ☐ Outside Protected Areas

COMMUNITY PLAN:[2] Agriculture

COUNTY ZONING: Agriculture / Interim

OTHER/COMMENTS:

☐ (PD) Planned Development
☐ (PH) Project District
☐ See Additional Comments (Pg.2)
☐ See Attached LUD Map

FEMA FLOOD INFORMATION: A Flood Development Permit is required if any portion of a parcel is designated V, VE, A, AO, AE, AH, D, or Floodway, and the project is on that portion.

FLOOD HAZARD AREA ZONES [3] & BASE FLOOD ELEVATIONS: Zone X

☐ FEMA DESIGNATED FLOODWAY | For Flood Zone AO, FLOOD DEPTH:

SUBDIVISION LAND USE CONSISTENCY: ☐ Not Consistent, (LUDs appear to have NO permitted uses in common).

_____ (Signature) ☐ Not Applicable, (Due to processing under consistency exemption No. ☐1, ☐2, ☐3, ☐4, ☐5).

☐ Interim Zoning, (The parcel or portion of the parcel that is zoned interim shall not be subdivided).

☐ [4] Consistent, (LUDs appear to have ALL permitted uses in common).

☐ [4] Consistent, upon obtaining an SMA, PD, or PH subdivision approval from Planning.

☐ [4] Consistent, upon recording a permissible uses unilateral agreement processed by Public Works (See Pg.2).

NOTES:

1 The conditions and/or representations made in the approval of a State District Boundary Amendment, Community Plan Amendment, County Change In Zoning, SMA Permit, Planned Development, Project District and/or a previous subdivision, may affect building permits, subdivisions, and uses on the land.

2 Please review the Maui Island Plan and the Community Plan document for any goals, objectives, policies or actions that may affect this parcel.

3 Flood development permits might be required in zones X and XS for any work done in streams, gulches, low-lying areas, or any type of drainageway; Flood development permits are required for work in all other zones. Subdivisions that include/adjoin streams, gulches, low-lying areas, or any type of drainageway might require the following designations to be shown on the subdivision map: 100-year flood inundation limits; base flood elevations; drainage reserves.

4 Subdivisions will be further reviewed during the subdivision application process to verify consistency, unilateral agreement requirements, and the conditions associated with a unilateral agreement [Section 18.04.030.D, Maui County Code].

REVIEWED & CONFIRMED BY:

Sheila Nakagawa 9/21/17
(Signature) (Date)

For: John S Rapacz, Planning Program Administrator, Zoning Administration and Enforcement Division