



STATE OF HAWAII  
DEPARTMENT OF LAND AND NATURAL RESOURCES  
**COMMISSION ON WATER RESOURCE MANAGEMENT**  
P.O. BOX 621  
HONOLULU, HAWAII 96809

STAFF SUBMITTAL

COMMISSION ON WATER RESOURCE MANAGEMENT

August 11, 2015  
Honolulu, Hawaii

Kealia Farms  
APPLICATION FOR A WATER USE PERMIT  
Kealia Farms (Well No. 3-3412-006), TMK (1) 6-8-002:014, WUP No. 00984  
New Irrigation Use for 0.009 mgd  
Mokuleia Ground Water Management Area, Oahu

APPLICANT:

Kealia Farms  
1338 Mokulua Drive  
Kailua, HI 96734

LANDOWNER:

Kealia Farms  
1338 Mokulua Drive  
Kailua, HI 96734

SUMMARY OF REQUEST:

The applicant requests that the Commission approve a water use permit for an allocation of **0.009** million gallons per day (mgd) of **non-potable basal** ground water from **an existing** well to supply **7 acres of noni irrigation** demand.

LOCATION MAP: See Exhibit 1

BACKGROUND:

September 19, 2013 Kealia Farms filed a well construction/ pump installation permit application as well as a water use permit application with the Commission on Water Resource Management (Commission). Additional information regarding the source, use, notification, objections, and field investigation(s) is provided in Attachment A.

January 15, 2014 Staff issued a well construction permit to Kealia Farms. A pump installation permit was not issued, as a water use permit is required prior to a pump installation permit in ground water management areas. At the time, the aquifer was overallocated, and staff indicated the need to review water use permits for potential revocations.

April 30, 2015 In the course of this review, staff discovered that a water use permit for an allocation from the Mokuleia Aquifer System Area to a different party had been extinguished by the Land Board on November 21, 1986, prior to the Water Commission’s jurisdiction. It was consequently not valid, and the Commission issued a Recognition of Record to that effect, resulting in an allocation available to accommodate this water use permit applicant.

June 15, 2015 Upon county notice of compliance with special management area requirements, staff accepted the Kealia Farms water use application as complete and routed it for review, with a comment and objection deadline of July 9, 2015. Public Notice was issued on June 17 and June 24, 2015. Comments were received, but no objection was filed.

**ANALYSIS/ISSUES:**

Section 174C-49(a) of the State Water Code establishes seven (7) criteria that must be met to obtain a water use permit. An analysis of the proposed permit in relation to these criteria follows:

(1) Water availability

Through the Hawaii Water Plan, the Commission has adopted 8 mgd as the sustainable yield for the Mokuleia Aquifer System Area (MASA). Individual existing water use permits in the MASA are shown in Exhibit 2. A summary of the current ground water conditions in the MASA is provided in Table 1:

**Table 1. Mokuleia Aquifer System Area**

<u>ITEM</u>	Mokuleia Aquifer System Area (mgd)
<b>Sustainable Yield</b>	<b>8</b>
Less: Other Existing Water Use Permits (shown in Exhibit 2)	<b>7.064</b>
Reservation to DHHL	<b>0</b>
<b>Subtotal (Current Available Allocation)</b>	<b>0.936</b>
Less: Other Completed Applications (shown in Exhibit 3)	<b>0.040</b>
Less: This Application	<b>0.009</b>
<b>Subtotal (Potential Available Allocation/Allocation Deficit)</b>	<b>0.887</b>

Therefore, there is adequate water available to accommodate this request, even with other completed applications awaiting processing and action.

(2) Reasonable-beneficial

Section 174C-3 HRS defines "reasonable-beneficial use" is

*"...the use of water in such a quantity as is necessary for economic and efficient utilization, for a purpose, and in a manner which is both reasonable and consistent with the state and county land use plans and the public interest".*

*I. Purpose of Use*

The applicant is requesting the use of brackish, non-potable ground water to irrigate 7 acres of noni. The Declaration of Policy section, §174C-2(c) HRS, states that the Water Code shall be liberally interpreted to obtain maximum beneficial use of the waters of the State for various purposes including irrigation uses.

*II. Quantity Justification*

The applicant is requesting a total of **0.009** mgd for irrigating 7 acres of noni at an average of 1,250 gallons per acre per day (gad), with an average of 250 plants per acre. The applicant's communication with a University of Hawaii Plant & Environmental Science professor recommends at least 3, up to 5 gallons per plant per day.

The Commission's UH/CTAHR irrigation model, Irrigation Water Requirement Estimation Decision Support System (IWREDDS) was applied to this area, and indicates that the 1-in-5 year drought demand would be 2,383 gad, about twice the requested amount (refer to Exhibit 4). This may reflect a different assumption about the plant spacing and number of plants watered. The proposed amount appears very conservation-minded.

*III. Efficiency of Use*

The applicant states that its operations are as water efficient as possible by using drip irrigation to each plant and deficit irrigation.

*IV. Analysis of Practical Alternatives*

The applicant has identified **2** alternatives to the proposed use of brackish caprock water. An analysis of each of the alternatives is as follows:

1. Desalting – too expensive, brine disposal more of a hazard
2. Conservation – mulching, windbreaks, watering at night

The applicant notes that municipal water, wastewater, ditch water, and surface water are not available.

(3) Interference with other existing legal uses

There are 12 other wells currently in use within 1 mile of this source which use water for irrigation (refer to Exhibit 1). The closest is about 0.6 miles away. This well is about 600 feet from the ocean, so that the effects of pumping this well would stop at the ocean before reaching any nearby well.

(4) Public interest

Public interest is defined under §174C-2 - Declaration of policy, as follows:

*“(c) The state water code shall be liberally interpreted to obtain maximum beneficial use of the waters of the State for purposes such as domestic uses, aquaculture uses, irrigation and other agricultural uses, power development, and commercial and industrial uses. However, adequate provision shall be made for the protection of traditional and customary Hawaiian rights, the protection and procreation of fish and wildlife, the maintenance of proper ecological balance and scenic beauty, and the preservation and enhancement of waters of the State for municipal uses, public recreation, public water supply, agriculture, and navigation. Such objectives are declared to be in the public interest.”*

Therefore, this application meets the public interest.

(5) State & county general plans and land use designations

The proposed uses are in the State Agriculture District, and the county zoning is AG-2. Therefore, the proposed use is consistent with these land use designations.

Normal agency review includes:

- 1) the State’s Department of Land and Natural Resources (DLNR) and its State Parks, Aquatic Resources, Historic Preservation, and Land Divisions; the Department of Health (DOH) with its Clean Water, Safe Drinking Water, and Wastewater Branches; the Department of Hawaiian Home Lands (DHHL), and Land Use Commission (LUC); and the Office of Hawaiian Affairs (OHA);
- 2) the Office of the Mayor, Department of Planning and Permitting, and the Board of Water Supply.

No objections have been raised through this review. These proposed uses are consistent with the state and county general plans and land use designations. A water well is exempt from Special Management Area permits requirements, and there are no shoreline setback requirements. No historic properties are to be affected.

Therefore, this application meets the state & county general plans and land use designations.

(6) County land use plans and policies

Again normal County review includes Office of the Mayor, Department of Planning and Permitting and the Department/Board of Water Supply. Comments are noted above.

Therefore, this application meets the county land use plans and policies.

(7) Interference with Hawaiian home lands rights

All permits are subject to the prior rights of Hawaiian home lands. The Department of Hawaiian Home Lands (DHHL) and the Office of Hawaiian Affairs have reviewed this application and have no objections. However, the Department of Hawaiian Home Lands believes the application did not identify DHHL needs; staff notes that the State Water Projects Plan identifies DHHL needs, but for North Shore Aquifer System Areas the needs are listed as “0”.

Standard water use permit conditions 3g, 6, and 9f notify all water use permittees that their permits are subject to and cannot interfere with Hawaiian home land rights.

Therefore, this application will not interfere with Hawaiian home lands rights.

(8) Other issues

*I. Chapter 343 – Environmental Assessment (EA) Compliance*

**EA Triggers**

In accordance with §HRS 343-5(a), the applicant’s proposed action does not trigger the need for an EA. There are no State or county lands or funds involved, no applicable shoreline development (see (5) above), conservation district or district boundary or development boundary change, no special design district, no power station or landfill or helipad. Historic Preservation has determined that no historic properties are affected.

*II. Traditional and Customary Practices*

The OHA Kipuka database shows no sites or crown lands involved; there are no objections from OHA nor sites identified by Historic Preservation.


**RECOMMENDATION:**

Due to the applicant’s proper land use in providing agricultural products with medicinal value and their thoughtful use of water and conservation measures, staff recommends that the Commission approve the issuance of water use permit no. 00984 to Kealia Farms for the reasonable and beneficial use of 0.009 million gallons per day of Non-Potable water for from the Kealia Farms Well (Well No. 3-3412-006), subject to the standard water use permit conditions listed in Attachment B and the following special conditions:

1. Should an alternate permanent source of water be found for this use, then the Commission reserves the right to revoke this permit, after a hearing.

2. Approve a pump installation permit for the Kealia Farms Well (Well No. 3-3412-006), subject to the standard pump installation permit conditions listed in Attachment C and the following special conditions:
  - a. None


Respectfully submitted,

  
W. ROY HARDY  
Acting Deputy Director

Attachment(s): A (Water Use Permit Detailed Information)  
B (Water Use Permit Standard Conditions)  
C (Pump Installation Permit Standard Conditions)

Exhibit(s): 1 (Location Map)  
2 (Existing Water Use Permits and 12-Month Moving Average Withdrawal)  
3 (Pending Water Use Permit Applications)  
4 (IWREDDS printout - Summary)

APPROVED FOR SUBMITTAL:

  
SUZANNE D. CASE  
Chairperson

**WATER USE PERMIT DETAILED INFORMATION**

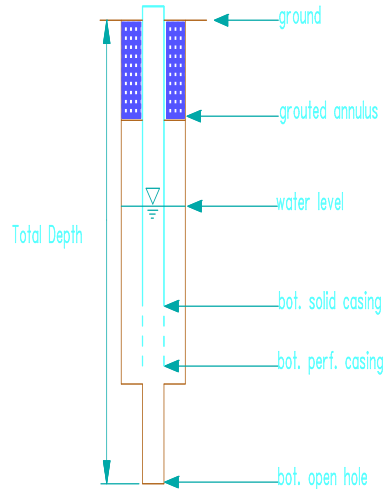
**Source Information**

**AQUIFER:** Mokuleia System, North Sector, Oahu  
 Sustainable Yield: 8 mgd  
 Existing Water Use Permits: 7.064 mgd  
 Available Allocation: 0.936 mgd  
 Total other pending applications: 0.027 mgd  
 This application: 0.009 mgd

**WELL:** Kealia Farms (Well No. 3-3412-006)  
 Location: Mokuleia, Oahu, TMK: (1) 6-8-002:014  
 Year Drilled: 2014  
 Casing Diameter: 4 in.  
Elevations (msl= 0 ft.)  
 Water Level: 5 ft.  
 Ground: 16 ft.  
 Bottom of Solid Casing: 4 ft.  
 Bottom of Perforated: -4 ft.  
 Bottom of Open Hole: na ft.

Total Depth: 20 ft.  
 Grouted Annulus Depth: **11 ft.**

Pump Capacity (proposed) 30 gpm



Use Information

Quantity Requested:	0.009 gallons per day.
New Water Use:	
Place of Water Use:	TMK:(1)6-8-002:014
Reported Water Usage:	gpd
Nearby Similar Water Usage:	gpd
Mokuleia Aquifer System	
Current 12-Month Moving Average Withdrawal (See Exhibit 2):	< 1.000 mgd

Nearby Surrounding Wells and Other Registered Ground Water Use

There are 12 other wells within a mile of the well (see Exhibit 1). All are much farther from the well than the shoreline where pumping effects would end.

Public Notice

In accordance with HAR §13-171-17, a public notice was published in the Honolulu Advertiser on 07/15/2015 and 07/15/2015 and a copy of the notice was sent to the Office of the Mayor. Copies of the completed application were sent to the Department/Board of Water Supply, Department of Planning and Permitting, Department of Health, Department of Hawaiian Home Lands, Office of Hawaiian Affairs, the various divisions within the Department of Land and Natural Resources, and other interested parties for comments. Written comments and objections to the proposed permit were to be submitted to the Commission by **July 9, 2015**.

Objections

The public notice specifies that an objector meet the following requirements: (1) state property or other interest in the matter; (2) set forth questions of procedure, fact, law, or policy, to which objections are taken; (3) state all grounds for objections to the proposed permits, (4) provide a copy of the objection letter(s) to the applicant, and (5) submit objections meeting the previous requirements to the Commission by **July 9, 2015**.

To the best of staff's knowledge there are no objectors who have property interest within the Mokuleia Aquifer System or who will be directly and immediately affected by the proposed water use.

Briefs in Support

Responses to objections, or briefs in support, regarding the application are required to be filed with the Commission ten (10) days after an objection is filed and, presumably, copies are served to the applicant. No briefs in support were filed with the Commission.



**STANDARD WATER USE PERMIT CONDITIONS**

1. The water described in this water use permit may only be taken from the location described and used for the reasonable beneficial use described at the location described above. Reasonable beneficial uses means "the use of water in such a quantity as is necessary for economic and efficient utilization which is both reasonable and consistent with State and County land use plans and the public interest." (HRS § 174C-3)
2. The right to use ground water is a shared use right.
3. The water use must at all times meet the requirements set forth in HRS § 174C-49(a), which means that it:
  - a. Can be accommodated with the available water source;
  - b. Is a reasonable-beneficial use as defined in HRS § 174C-3;
  - c. Will not interfere with any existing legal use of water;
  - d. Is consistent with the public interest;
  - e. Is consistent with State and County general plans and land use designations;
  - f. Is consistent with County land use plans and policies; and
  - g. Will not interfere with the rights of the Department of Hawaiian Home Lands as provided in section 221 of the Hawaiian Homes Commission Act and HRS § 174C-101(a).
4. The ground water use here must not interfere with surface or other ground water rights or reservations.
5. The ground water use here must not interfere with interim or permanent instream flow standards. If it does, then:
  - a. A separate water use permit for surface water must be obtained in the case an area is also designated as a surface water management area;
  - b. The interim or permanent instream flow standard, as applicable, must be amended.
6. The water use authorized here is subject to the requirements of the Hawaiian Homes Commission Act, as amended, if applicable.
7. The water use permit application and submittal, as amended, approved by the Commission at its meeting are incorporated into this permit by reference.
8. Any modification of the permit terms, conditions, or uses may only be made with the express written consent of the Commission.
9. This permit may be modified by the Commission and the amount of water initially granted to the permittee may be reduced if the Commission determines it is necessary to:
  - a. protect the water sources (quantity or quality);
  - b. meet other legal obligations including other correlative rights;
  - c. insure adequate conservation measures;
  - d. require efficiency of water uses;
  - e. reserve water for future uses, provided that all legal existing uses of water as of June, 1987 shall be protected;
  - f. meet legal obligations to the Department of Hawaiian Home Lands, if applicable; or
  - g. carry out such other necessary and proper exercise of the State's and the Commission's police powers under law as may be required.

Prior to any reduction, the Commission shall give notice of its proposed action to the permittee and provide the permittee an opportunity to be heard.

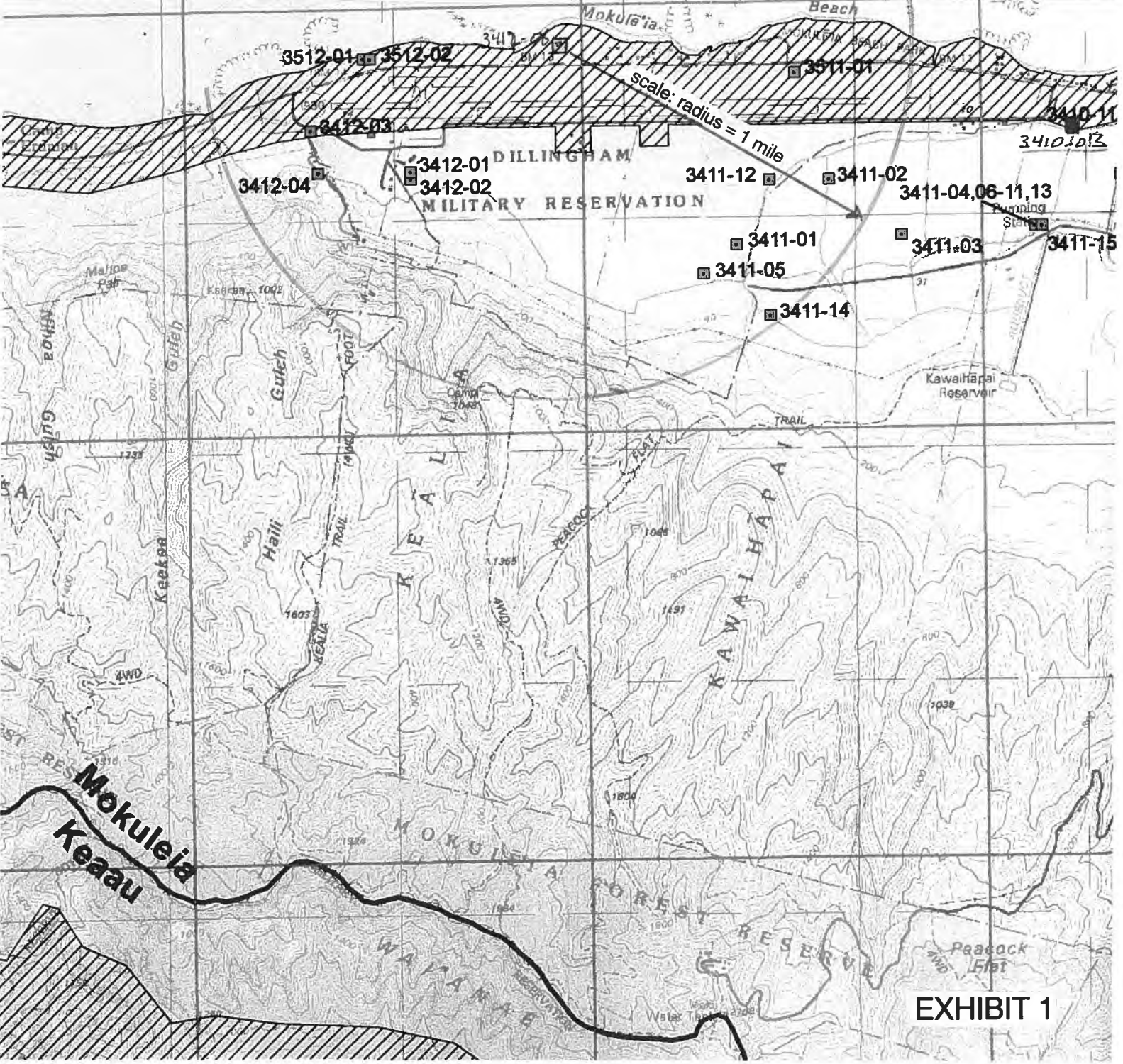
10. An approved flowmeter(s) **must** be installed to measure monthly withdrawals and a monthly record of withdrawals, salinity, temperature, and pumping times must be kept and reported to the Commission on Water Resource Management on forms provided by the Commission on a **monthly** basis (attached).
11. This permit shall be subject to the Commission's periodic review of the Mokuleia Aquifer System Area's sustainable yield. The amount of water authorized by this permit may be reduced by the Commission if the sustainable yield of the Mokuleia Aquifer System Area, or relevant modified aquifer(s), is reduced.
12. A permit may be transferred, in whole or in part, from the permittee to another, if:
  - a. The conditions of use of the permit, including, but not limited to, place, quantity, and purpose of the use, remain the same; and
  - b. The Commission is informed of the transfer within ninety days.

Failure to inform the department of the transfer invalidates the transfer and constitutes a ground for revocation of the permit. A transfer which involves a change in any condition of the permit, including a change in use covered in HRS § 174C-57, is also invalid and constitutes a ground for revocation.
13. The use(s) authorized by law and by this permit do not constitute ownership rights.
14. The permittee shall request modification of the permit as necessary to comply with all applicable laws, rules, and ordinances which will affect the permittee's water use.
15. The permittee understands that under HRS § 174C-58(4), that partial or total nonuse, for reasons other than conservation, of the water allowed by this permit for a period of four (4) continuous years or more may result in a permanent revocation as to the amount of water not in use. The Commission and the permittee may enter into a written agreement that, for reasons satisfactory to the Commission, any period of nonuse may not apply towards the four-year period. Any period of nonuse which is caused by a declaration of water shortage pursuant to section HRS § 174C-62 shall not apply towards the four-year period of forfeiture.
16. The permittee shall prepare and submit a water shortage plan within 30 days of the issuance of this permit as required by HAR § 13-171-42(c). The permittee's water shortage plan shall identify what the permittee is willing to do should the Commission declare a water shortage in the Mokuleia Ground Water Management Area.
17. The water use permit shall be subject to the Commission's establishment of instream standards and policies relating to the Stream Protection and Management (SPAM) program, as well as legislative mandates to protect stream resources.
18. Special conditions in the attached cover transmittal letter are incorporated herein by reference.
19. The permittee understands that any willful violation of any of the above conditions or any provisions of HRS § 174C or HAR § 13-171 may result in the suspension or revocation of this permit.

STANDARD PUMP INSTALLATION PERMIT CONDITIONS

1. The Chairperson to the Commission on Water Resource Management (Commission), P.O. Box 621, Honolulu, HI 96809, shall be notified, in writing, at least two (2) weeks before any work covered by this permit commences and staff shall be allowed to inspect installation activities in accordance with §13-168-15, Hawaii Administrative Rules (HAR).
2. No withdrawal of water shall be made other than for testing until a Certificate of Pump Installation Completion has been issued by the Commission.
3. This permit shall be prominently displayed, or made available, at the site of construction work until work is completed.
4. The pump installation permit shall be for installation of a gpm rated capacity, or less, pump in the well. This permanent capacity may be reduced in the event that the pump test data does not support the capacity.
5. A water-level measurement access shall be permanently installed, in a manner acceptable to the Chairperson, to accurately record water levels.
6. The permittee shall install an approved meter or other appropriate means for measuring and reporting withdrawals and appropriate devices or means for measuring chlorides and temperature at the well head.
7. Well Completion Report Part II shall be submitted to the Chairperson within sixty (60) days after completion of work (please contact staff or visit <http://files.hawaii.gov/dlnr/cwrm/forms/WCR2.pdf> for current form).
8. The permittee, well operator, and/or well owner shall comply with all applicable laws, rules, and ordinances, and non-compliance may be grounds for revocation of this permit.
9. The pump installation permit application and, if relevant, any related staff submittal approved by the Commission are incorporated into this permit by reference.
10. If the HWCPIS are not followed and as a consequence water is wasted or contaminated, a lien on the property may result.
11. Any variances from the HWCPIS shall be approved by the Chairperson **prior** to invoking the variance.
12. The work proposed in the pump installation permit application shall be completed within two (2) years from the date of permit approval, unless otherwise specified. The permit may be extended by the Chairperson upon a showing of good cause and good-faith performance. A request to extend the permit shall be submitted to the Chairperson no later than the date the permit expires.
13. The permittee, its successors, and assigns shall indemnify, defend, and hold the State of Hawaii harmless from and against any loss, liability, claim, or demand for property damage, personal injury, or death arising out of any act or omission of the applicant, assigns, officers, employees, contractors, and agents under this permit or relating to or connected with the granting of this permit.
14. Special conditions in the attached cover transmittal letter are incorporated herein by reference.

**Kealia Farms Well  
(3412-06)**





**Report Parameters**

Island: Oahu  
 Applicant: All  
 Well # Prefix: All  
 Date: All  
 Aquifer: 30401 Mokuleia  
 TMK: All  
 Aquifer Type: All  
 Water Quality: All  
 Not: None  
 Proposed Use: All

WUP = Water Use Permit, 12-MAV = 12 month moving average, Diff = WUP-12-MAV, mgd = million gallons per day

**Island of Oahu**

**Aquifer System Ground Water Management Area: 30401 Mokuleia**

**Sustainable Yield (mgd): 8**

WUP No	Approved	Permittee	Well No	Well Name	WUP (mgd)	12-MAV (mgd)	Diff (mgd)	Date Last Reported
38	09/11/1981	United States Air Force	3-3314-003	USAF Kaena Point	0.018	0.000	0.018	04/30/2008
49	06/02/1993	Waialua Sugar Company, Inc.	3-3409-013	Pump 11	0.530	0.000	0.530	01/31/2006
52	06/02/1993	Waialua Sugar Company, Inc.	3-3411-004	Pump 5	2.550	0.581*		05/28/2015
			3-3411-006	Pump 5				04/30/2015
			3-3411-007	Pump 5				04/30/2015
			3-3411-008	Pump 5				04/30/2015
			3-3411-009	Pump 5				04/30/2015
			3-3411-010	Pump 5				04/30/2015
			3-3411-011	Pump 5				04/30/2015
			3-3411-013	Pump 5				04/30/2015
53	09/11/1981	Directorate of Public Works, Environmental Div., DPW, U.S. Army Garrison	3-3412-002	Dillingham Airfield	0.055	0.126	-0.071	07/06/2015
446	10/23/1996	Mokuleia Aquafarm	3-3409-024	MAF 1	0.250	none*		
606	01/30/2002	C&C DOE	3-3407-025	Waialua HS	0.039	0.004	0.035	06/30/2015
669	02/18/2004	Hawaii Fish Company Inc	3-3412-004	Hawaii Fish Co. 1	0.576	0.003	0.573	06/30/2015
679	01/13/2004	KAALA RANCH	3-3309-002	Mokuleia	0.127	0.002	0.125	04/04/2012
766	07/12/2006	Mark Hamamoto (Mohala Farms)	3-3306-016	Hamamoto 2006	0.013	0.002	0.011	04/30/2015
777	12/14/1988	Dillingham Ranch Aina LLC	3-3310-002	Mokuleia 2	0.850	0.000	0.850	05/31/2015
779	09/11/1981	Dillingham Ranch Aina LLC	3-3410-003	Shop Well	1.500	0.048	1.452	05/31/2015
813	09/11/1981	North Shore Water Company, LLC	3-3410-001	Crowbar Ranch	0.500	0.095	0.405	06/30/2015
941	09/17/2003	Stanhope Farms	3-3308-002	Stanhope Farms	0.056	0.007	0.049	05/15/2015

Summary for Mokuleia (20 detail records)

**Total:** 7.064 0.287 6.777

**SY Available:** 0.936

Sustainable Yield 422

\* latest report



WUPA No	Well No.	Applicant	Well Name	mgd	Received	Accept
<b>Aquifer System: 30401 Mokulelela</b>						
1,003	3-3410-001	North Shore Water Company, LLC	Crowbar Ranch	1.709	07/02/2015	
1,003	3-3410-003	North Shore Water Company, LLC	Shop Well		07/02/2015	
1,004		North Shore Water Company, LLC	Well 1	1.300	07/02/2015	
1,004		North Shore Water Company, LLC	Well 2		07/02/2015	
984	3-3412-006	Kealia Farms	Kealia Farms	0.009	09/19/2013	05/26/2015
999	3-3208-001	Candace Chase	Chase	0.013	05/08/2015	06/12/2015
1,002	3-3308-003	Kalea Properties LLC	Kalea 2012	0.027	06/15/2015	06/15/2015
				<b>5 WUPAs totalling 3.058</b>		

Number of Wells: 7



WUPA No	Well No.	Applicant	Well Name	mgd	Received	Void
<b>Aquifer System: Mokulelela 30401</b>						
1,003	3-3410-001	North Shore Water Company, LLC	Crowbar Ranch	1.709	07/02/2015	No
1,003	3-3410-003	North Shore Water Company, LLC	Shop Well		07/02/2015	No
1,004		North Shore Water Company, LLC	Well 1	1.300	07/02/2015	No
1,004		North Shore Water Company, LLC	Well 2		07/02/2015	No
				<b>4 WUPAs totalling 3.009</b>		

Number of Wells: 4

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 \* SUMMARY \*  
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 TMK : 68002014  
 SOILS: Beaches(0.063), Jaucas(0.937)

ANNUAL IRRIGATION REQUIREMENT (INCHES)

WATER BUDGET COMPONENTS												
NIR	GIR	GAL_A	G_RAIN	N_RAIN	ER	ER21	RO	INT	ET0	ET	DR	
29.4	34.6	939.8	37.4	28.5	13.7	17.7	3.9	4.9	53.3	43.1	14.8	

ACRES		GIR STATISTICS									
UNIT	MEAN	MED.	XMAX	XMIN	50%	80%	90%	95%			
inch/acre	34.610	34.657	42.335	23.837	35.017	37.680	38.873	39.773			
Thou. gpd/acre	2.575	2.578	3.150	1.773	2.605	2.803	2.892	2.959			
Total thou. gpd	9.636	9.649	11.787	6.637	9.749	10.491	10.823	11.073			

ACRES		NIR STATISTICS									
UNIT	MEAN	MED.	XMAX	XMIN	50%	80%	90%	95%			
inch/acre	29.419	29.459	35.985	20.261	29.765	32.028	33.042	33.807			
Thou. gpd/acre	2.189	2.192	2.677	1.507	2.214	2.383	2.458	2.515			
Total thou. gpd	8.191	8.202	10.019	5.641	8.287	8.917	9.199	9.412			

Note:- Irrigated area for the selected TRICKLE, DRIP irrigation system is 0.5 of the total area

MONTHLY IRRIGATION REQUIREMENT (INCHES)

WATER BUDGET COMPONENTS												
MO	NIR	GIR	GAL_A	G_RAIN	N_RAIN	ER	ER21	RO	INT	ET0	ET	DR
1	0.5	0.6	17.1	6.7	5.3	1.7	2.8	0.9	0.4	3.3	2.2	3.5
2	0.8	0.9	24.7	4.6	3.6	1.6	2.0	0.5	0.4	3.4	2.4	2.0
3	1.6	1.9	52.6	4.1	3.3	1.6	2.0	0.4	0.5	4.4	3.3	1.7
4	2.3	2.7	73.2	2.9	2.2	1.4	1.5	0.2	0.5	4.7	3.8	0.7
5	3.5	4.2	112.8	1.7	1.2	0.8	0.9	0.1	0.4	5.3	4.4	0.4
6	4.2	4.9	133.1	0.9	0.6	0.5	0.5	0.0	0.3	5.4	4.6	0.1
7	4.1	4.8	131.1	1.3	0.8	0.7	0.8	0.1	0.4	5.5	4.8	0.2
8	4.1	4.8	131.1	1.3	0.8	0.7	0.7	0.1	0.3	5.5	4.8	0.2
9	3.6	4.2	113.6	1.3	0.9	0.7	0.7	0.1	0.3	5.0	4.3	0.2
10	2.6	3.0	82.2	3.0	2.1	1.1	1.4	0.4	0.4	4.3	3.6	1.0
11	1.3	1.6	43.0	4.3	3.3	1.4	2.0	0.5	0.5	3.3	2.6	1.9
12	0.8	0.9	25.2	5.5	4.3	1.5	2.4	0.6	0.5	3.1	2.2	2.9

GIR STATISTICS									
MO	MEAN	MED.	XMAX	XMIN	50%	80%	90%	95%	
1	0.6	0.5	2.1	0.0	0.6	1.2	1.6	2.1	
2	0.9	1.0	3.3	0.0	0.8	1.5	1.9	2.3	
3	1.9	1.7	3.8	0.0	1.8	3.0	3.6	3.9	
4	2.7	2.8	4.4	1.0	2.7	3.6	4.0	4.4	
5	4.2	4.3	5.4	2.1	4.2	4.9	5.2	5.2	
6	4.9	5.0	6.0	3.3	5.0	5.4	5.4	5.4	
7	4.8	5.0	6.0	2.9	4.9	5.5	5.7	5.7	
8	4.8	5.0	6.7	1.6	4.9	5.6	5.6	5.6	
9	4.2	4.3	5.5	1.8	4.2	4.9	5.0	5.0	
10	3.0	3.2	4.6	1.0	3.0	3.8	4.2	4.2	
11	1.6	1.5	3.3	0.5	1.5	2.3	2.7	3.1	
12	0.9	1.0	2.5	0.0	0.8	1.5	2.0	2.4	

\*\*\*\*\*  
 \* Commission on Water Resources Management IWREDSS Summary \*  
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IWREDSS estimates that irrigation needs for the application is:

UNIT	DROUGHT FREQUENCY				OTHER STATISTICS			
	1 in 2	1 in 5	1 in 10	1 in 20	Mean	Median	Max	Min
inch/acre	35.017	37.680	38.873	39.773	34.610	34.657	42.335	23.837
Thou. gpd/acre	2.605	2.803	2.892	2.959	2.575	2.578	3.150	1.773
Total thou. gpd	9.749	10.491	10.823	11.073	9.636	9.649	11.787	6.637

\*Drought frequency of 2, 5, 10 and 20 year return periods are GIR values of 50%, 80%, 90% and 95% probabilities, respectively.

\*GIR of 1 in 5 year return period is recommended by CTAHR for design or water use allocation purposes.

where:  
 Irrigation season = 1-1 TO 12-31  
 Irrigation total days = 365 days

Irrigation system:  
 TYPE = TRICKLE, DRIP  
 Design Application Efficiency = 85 %  
 Fraction of Soil Surface Irrigated = 50 %  
 Fraction extracted from irrigated zone = 40 %

Climate Data Base:  
 Location = WAIALUA 847 UNITED Latitude 21.5667  
 Length of Record = 51 YEARS (1950-2000)  
 No. of missing rainfall days = 0  
 No. of missing ET days = 0

TMK = 68002014  
 TMK Area (Acre) = 7.485  
 Soil Series = Beaches(0.063), Jaucas(0.937)  
 SCS Curve Number = 68  
 Net Irrigated Area (Acre) = 3.742  
 Depth to water table (feet) = 5.00

Crop type = CITRUS  
 Max Leaf Area Index = 7.000