Appendix B

Groundwater Resources Assessments

Groundwater Resources Assessment

Assessment of the Potential Impact on Water Resources of the Honua'ula Project in Wailea, Maui

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Introduction

This report presents an assessment of the potential impact on water resources of the Honua'ula project which will be located on approximately 670 acres on TMK 2-1-08:56 and 71 in Wailea, Maui (its location is shown on Figure 1). Figure 2 illustrates the development plan and Exhibit 1 provides a detailed land use summary by its three phases of development. The land uses include 1150 residential units, a golf course, commercial and community facilities, parks, and preservation-conservation areas. The projected is bisected by a right-of-way (ROW) for the proposed extension of Piilani Highway.

Aspects of the Project That Will Impact Water Resources

Four aspects of the project have the potential to impact water resources. These are: use of groundwater for potable consumption and landscape irrigation; generation, treatment, and reuse of domestic wastewater; increase of surface water runoff; and percolation to groundwater of excess landscape irrigation. Each of these is described and quantified in the sections below.

Use of Groundwater. The project's potable and irrigation supply will be provided by brackish wells. Four of these wells have already been developed, two onsite and two others offsite on the north side of Maui Meadows (Figure 1 shows their locations). The offsite wells are referred to herein as the Kamaole wells. Table 1 provides a compilation of the expected use of brackish groundwater by development phase. This compilation incorporates the following assumptions:

- Reverse Osmosis (RO) treatment of the brackish supply will provide the project's potable water. Sixty-five (65) percent of the feedwater supply would be converted to potable water and the remaining 35 percent would be a concentrate that would be reused for golf course irrigation.
- Domestic wastewater will be treated to R-1 quality and it will be reused for golf course irrigation.
- Landscape irrigation in areas outside of the golf course will be supplied by brackish well water.
- An allowance of 10 percent for unmetered use and losses is included in the calculations of potable and brackish irrigation requirements.

Based on these assumptions, year-round average pumpage of brackish groundwater is estimated to be 1.1, 1.4, and 1.7 million gallons per day (MGD) at the completion of Phases 1, 2, and 3, respectively. To provide for summertime maximum use periods and to have standby capacity, another offsite well will be needed for Phase 1 and one more will be needed for Phase 2. The total number of the project's wells would then be six. Depending on the actual water use rates that materialize, a fifth Kamaole well may or may not be needed to complete Phase 3.

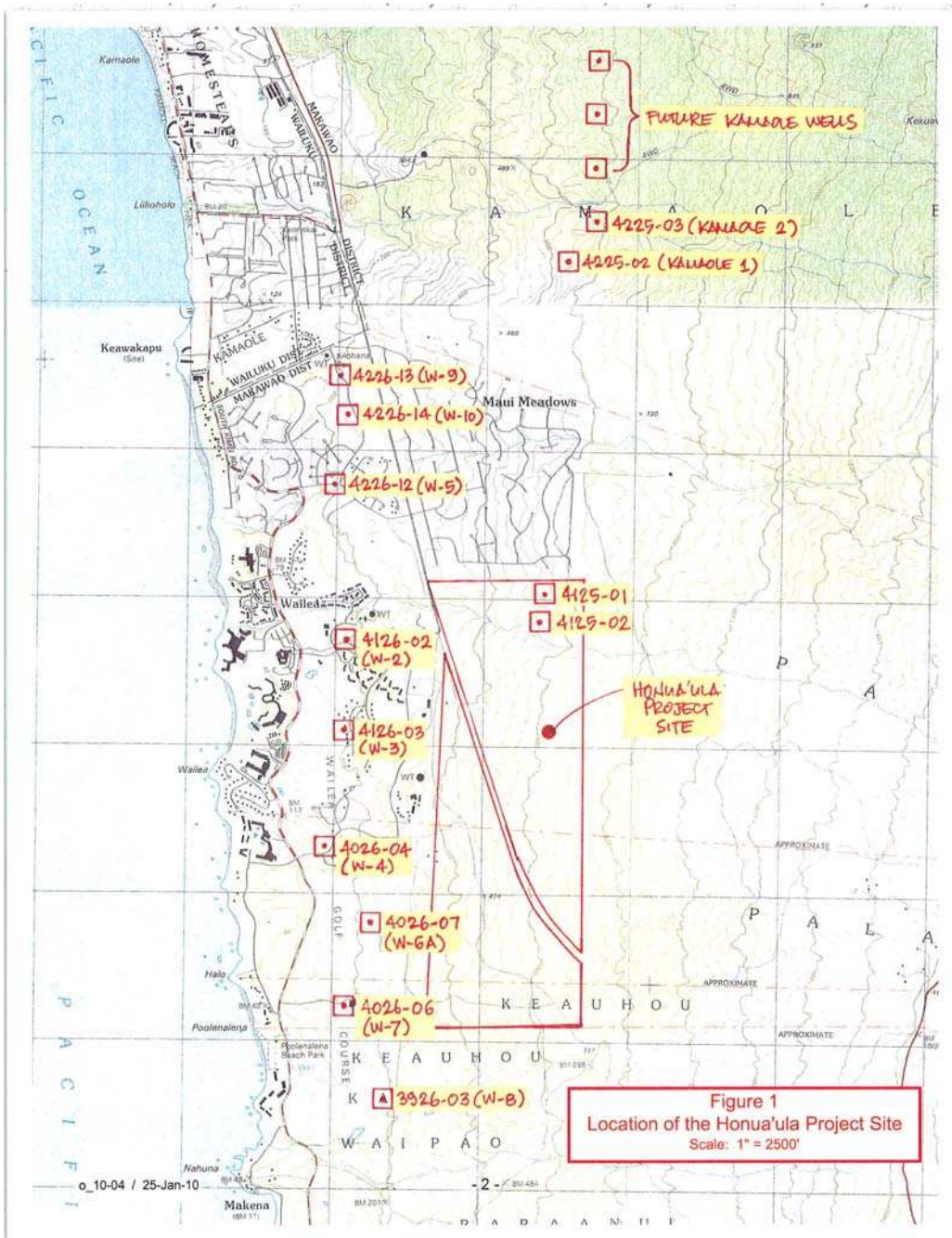

Figure 2
Project District Phase 2
Master Plan

HONUA'ULA
WAILEA, MAUI

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Exhibit 1
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Honua`ula Preliminary Land Use Summary

DRAFT November 20, 2009

(Information taken from the VITA Concept and Phasing Plans dated 12/1/2009)

Phase 1 -

Zone 640

Land Use Types	Approx. Unit Count	Approx. Roadway / Landscape Buffer Lineal Footage (L.F.)	Approx. Land Area (Acre)
SF Type A - Custom	21	--	12.2
SF Type B - Hale	53	--	29.2
SF Type C - Cottage	62	--	32.5
MF Duplex	40	--	16.9
MF Affordable Housing	75	--	10.5
Parkway (100' ROW)	--	250	0.6
Major Collector Road (60' ROW)*	--	7,150	10
Minor Collector (56' ROW)	--	--	0
Minor Street (44' ROW)	--	2,200	2.2
25' Landscape Buffer Along Piilani Highway	--	850	0.5
Mixed-use Village	--	--	7
Golf Course Envelope	--	--	105.3
Puplic parks	--	--	0
Pillani Highway Extension (150' ROW)	--	--	0
Fire Station	--	--	0
MECO Expansion	--	--	0
Golf Clubhouse	--	--	10
Golf Maintenance Yard	--	--	1.8
Native Plant Preservation Area	--	--	22
Water Tank Site	--	--	0
Waste Water Treatment Plant	--	--	2
Natural Open Area (Drainage Detention, Arch. Preserve, etc.)	--	--	3.1
	Land Area Subtotal :		**265.8**

Zone 810

Land Use Types	Approx. Unit Count	Approx. Roadway / Landscape Buffer Lineal Footage (L.F.)	Approx. Land Area (Acre)
SF Type A - Custom	22	--	12.8
SF Type B - Hale	60	--	32.9
SF Type C - Cottage	46	--	19.1
MF Duplex	16	--	5.6
MF Affordable Housing	0	--	0
Parkway (100' ROW)	--	0	0
Major Collector Road (60' ROW)*	--	4,850	6.7
Minor Collector (56' ROW)	--	--	0
Minor Street (44' ROW)	--	0	0
25' Landscape Buffer Along Piilani Highway	--	0	0
Mixed-use Village	--	--	0
Golf Course Envelope	--	--	65
Puplic parks	--	--	0
Pillani Highway Extension (150' ROW)	--	--	0
Fire Station	--	--	0
MECO Expansion	--	--	0
Golf Clubhouse	--	--	0
Golf Maintenance Yard	--	--	0
Native Plant Preservation Area	--	--	0
Water Tank Site	--	--	1.8
Waste Water Treatment Plant	--	--	0
Natural Open Area (Drainage Detention, Arch. Preserve, etc.)	--	--	8.5
		Land Area Subtotal :	**152.4**

Phase 2 -

Zone 640

Land Use Types	Approx. Unit Count	Approx. Roadway / Landscape Buffer Lineal Footage (L.F.)	Approx. Land Area (Acre)
SF Type A - Custom	11	--	6.4
SF Type B - Hale	0	--	0
SF Type C - Cottage	80	--	41.6
MF Duplex	114	--	28.6
MF Affordable Housing	200	--	18.7
Parkway (100' ROW)	--	--	0
Major Collector Road (60' ROW)*	--	5,000	6.8
Minor Collector (56' ROW)	--	--	0

Zone 810

Land Use Types	Approx. Unit Count	Approx. Roadway / Landscape Buffer Lineal Footage (L.F.)	Approx. Land Area (Acre)
SF Type A - Custom	--	--	0
SF Type B - Hale	--	--	0
SF Type C - Cottage	--	--	0
MF Duplex	6	--	1.7
MF Affordable Housing	--	--	0
Parkway (100' ROW)	--	--	0
Major Collector Road (60' ROW)*	--	--	0
Minor Collector (56' ROW)	--	--	0

Minor Street (44' ROW)	--	--	0
25' Landscape Buffer Along Piilani Highway	--	6,000	3.4
Mixed-use Village	--	--	0
Golf Course Envelope	--	--	0
Pillani Highway Extension (150' ROW)	--	4,000	15
Puplic parks	--	--	6
Fire Station	--	--	2
MECO Expansion	--	--	1
Golf Clubhouse	--	--	0
Golf Maintenance Yard	--	--	0
Native Plant Preservation Area	--	--	0
Water Tank Site	--	--	0
Waste Water Treatment Plant	--	--	0
Natural Open Area (Drainage Detention, Arch. Preserve, etc.)	--	--	5.5
		Land Area Subtotal :	135

Phase 3 -

Zone 640

Land Use Types	Approx. Unit Count	Approx. Roadway / Landscape Buffer Lineal Footage (L.F.)	Approx. Land Area (Acre)
SF Type A - Custom	2	--	1.2
SF Type B - Hale	0	--	0
SF Type C - Cottage	13	--	8.2
MF Duplex	15	--	5.2
MF Affordable Housing	175	--	12.5
Parkway (100' ROW)	--	0	0
Major Collector Road (60' ROW)*	--	0	0
Minor Collector (56' ROW)	--	0	0
Minor Street (44' ROW)	--	--	0
25' Landscape Buffer Along Piilani Highway	--	--	3
Mixed-use Village	--	--	0
Golf Course Envelope	--	--	0
Pillani Highway Extension (150' ROW)	--	--	0
Puplic parks	--	--	0
Fire Station	--	--	0
MECO Expansion	--	--	0
Golf Clubhouse	--	--	0
Golf Maintenance Yard	--	--	0
Native Plant Preservation Area	--	--	0
Water Tank Site	--	--	2
Waste Water Treatment Plant	--	--	0
Natural Open Area (Drainage Detention, Arch. Preserve, etc.)	--	--	3
		Land Area Subtotal :	35.1

Zone 810

Land Use Types	Approx. Unit Count	Approx. Roadway / Landscape Buffer Lineal Footage (L.F.)	Approx. Land Area (Acre)
SF Type A - Custom	25	--	14.6
SF Type B - Hale	68	--	39.6
SF Type C - Cottage	41	--	23.8
MF Duplex	5	--	1.7
MF Affordable Housing	0	--	0
Parkway (100' ROW)	--	--	0
Major Collector Road (60' ROW)*	--	6,100	8.3
Minor Collector (56' ROW)	--	0	0
Minor Street (44' ROW)	--	--	0
25' Landscape Buffer Along Piilani Highway	--	--	3.5
Mixed-use Village	--	--	0
Golf Course Envelope	--	--	0
Pillani Highway Extension (150' ROW)	--	--	0
Puplic parks	--	--	0
Fire Station	--	--	0
MECO Expansion	--	--	0
Golf Clubhouse	--	--	0
Golf Maintenance Yard	--	--	0
Native Plant Preservation Area	--	--	0
Water Tank Site	--	--	0
Waste Water Treatment Plant	--	--	0
Natural Open Area (Drainage Detention, Arch. Preserve, etc.)	--	--	3.5
		Land Area Subtotal :	95
		TOTAL LAND AREA :	685

* Approximately 1.5 acres major collector road ROW are in Ulupalakua Ranch property and they are irrigated by the project.
** The ROW of Highway Extension (approximately 15 acres) is within the land of State of Hawaii and Ulupalakua Ranch. They are irrigated by the project.

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Table 1

Average Brackish Water Use by Development Phase

Component of Supply	Phase 1 (MGD)	Phase 2 (MGD)	Phase 3 (MGD)
Potable System			
Average + 10%	0.1474	0.2735	0.3766
Required Raw Water Supply (65% RO Recovery)	0.2268	0.4208	0.5794
Concentrate From RO for Golf Course Irrigation Reuse	0.0794	0.1473	0.2028
WWTP R-1 Effluent (80% of Average Potable Use)	0.1072	0.1989	0.2739
Golf Course Irrigation			
Average Use	0.7167	0.7167	0.7167
Supply From RO Concentrate	0.0794	0.1473	0.2028
Supply From WWTP R-1 Effluent (80% of Potable Use)	0.1072	0.1989	0.2739
Required Supplement From Non-Potable System	0.5301	0.3705	0.2400
Supply From Brackish Wells			
Feedwater to RO System	0.2268	0.4208	0.5794
Supplement for Golf Course Irrigation	0.5301	0.3705	0.2400
Supply for Non-Potable System (Average + 10%)	0.3623	0.6390	0.8908
Total Average Withdrawal From Brackish Wells	1.1192	1.4303	1.7102

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Wastewater Generation, Treatment, and Reuse. Two alternatives are being considered for the treatment of the project's domestic wastewater: (1) use of the nearby Makena Resort's wastewater treatment plant (WWTP); or (2) constructing a new, onsite WWTP. In either case, treatment would be to R-1 quality and the treated effluent would be used for golf course irrigation. For 110 turf acres of golf course and driving range, irrigation is expected to be 0.72 MGD as a year-round average (refer to Table 2). As shown on Table 1, the portion provided by the WWTP effluent would be about 15 percent at the end of Phase 1 and increase to about 38 percent at full build-out.

Collection and Detention of the Project's Increase in Rainfall-Runoff. As identified in the February 2010 Preliminary Engineering Report by Wilson Okamoto Corporation (WOC, 2010), the tributary watershed above the project consists of almost 4000 acres. Runoff from this area, from the 670-acre project site, and from the 15-acre Piilani extension ROW drains through the Wailea Resort and its golf courses prior to discharging along the shoreline. In conformance with County drainage regulations, the project will utilize detention basins so that there will be no increase in the peak rate of stormwater runoff leaving the site as a result of the project's development.

To quantify the required stormwater retention volume, WOC, 2010 divided the project site into 27 drainage areas and did pre- and post-development rainfall-runoff analyses. All analyses were based on the 100-year, 24-hour storm event. For this hypothetical storm event, WOC, 2010 calculated the required detention volumes so for each basin that there would be no increase in the peak runoff rate. The combined detention storage volume was computed to be 76.56 acre-feet. WOC, 2010 proposes to meet this requirement with the installation of 26 stormwater detention basins with a combined storage volume of 81.6 acre-feet.

Each of the 26 proposed detention basins would have a drain outlet consisting, in part, of a vertical perforated pipe within a gravel mound which would act as a filter. In addition to reducing the peak runoff rate by detention storage, this configuration will also capture floatables and suspended solids in the basin, thereby reducing the sediment load in water released from the detention basins. Based on this proposal, the assessment herein assumes the pre- and post-development volumes of runoff leaving the project site are the same. As a consequence, it is also assumed that the volume of rainfall which percolates to groundwater is essentially unchanged. Seepage from the detention basins will actually increase the amount of percolation, but no credit for that is included in the analyses which follow.

Percolation to Groundwater of Excess Landscape Irrigation. Percolation of excess applied irrigation water will occur from the golf course and driving range, from irrigated landscaping in roadway and buffer areas, from parks and other landscaped public areas, and from the residential parcels. The quantities of applied irrigation as year-round averages by development phase are compiled below. As a first order approximation, it is assumed that 10 percent of the applied irrigation on the golf course (with close management of application rates) percolates to groundwater and that elsewhere, the excess application rate is 15 percent. The percolation quantities are included in the summary below.

Table 2

Estimated Golf Course Irrigation Requirement

Month	Rainfall (Inches)	Pan Evaporation (Inches)	Crop Requirement (Inches)	Supply Requirement	
				(GPD / Acre)	GPD for 110 Acres
January	3.13	5.06	3.182	3,484	383,221
February	1.75	5.30	4.250	4,653	511,845
March	1.63	6.50	5.522	6,046	665,037
April	0.89	6.74	6.206	6,795	747,414
May	0.57	7.74	7.398	8,100	890,971
June	0.41	7.72	7.474	8,183	900,124
July	0.31	7.98	7.794	8,533	938,663
August	0.37	8.05	7.828	8,571	942,758
September	0.51	7.60	7.294	7,986	878,446
October	0.47	6.36	6.078	6,655	731,998
November	1.18	5.68	4.972	5,444	598,798
December	2.24	4.76	3.416	3,740	411,403
Annual	13.46	79.49	71.414	6,516	716,723

Notes:
1. Rainfall is the average of Gages 260 and 260.2.
2. Pan evaporation is the average of Gages 361, 363.1, and 372.3.
3. In computing the crop requirement, plant evapotranspiration (ET) is assumed to be equal to pan evaporation and the rainfall is assumed to be 60% effective.
4. The required supply assumes 80% application efficiency. This accounts for leakage, overspray, and periodic salt flushing.
5. The total required supply assumes 110 turf acres of golf course and driving range will be irrigated.

Summary of Estimated Percolation to Groundwater of Excess Applied Irrigation

Component of Irrigation Supply	Phase 1 (MGD)	Phase 2 (MGD)	Phase 3 (MGD)
Non-Potable System (Brackish Well Water)	0.362	0.639	0.891
- Amount Percolating to Groundwater (15%)	0.054	0.096	0.134
Golf Course System			
- RO Concentrate	0.079	0.147	0.203
- WWTP R-1 Quality Effluent	0.107	0.199	0.274
- Brackish Well Water From N-P System	0.531	0.371	0.240
- Total Irrigation Application	0.717	0.717	0.717
- Amount Percolating to Groundwater	0.072	0.072	0.072
Total Percolation to Groundwater	0.126	0.168	0.206

Description of Water Resources in the Honua'ula Project Area

Overview. Owing to the relatively dry conditions in and above the project site, there are no perennial streams in the area. Runoff occurs in the mauka-to-makai gulches which cross the site only during and for a short time following intense rainfall events. This being the case, the assessment of impacts on water resources focuses primarily on groundwater.

The project site and its offsite wells are within the Kamaole Aquifer System, an 89-square mile area delineated and regulated by the State Commission on Water Resource Management (CWRM). The Kamaole Aquifer is triangular-shaped, with its apex at the top of Haleakala and its base along the 11-mile length of shoreline from Waiakoa Gulch on the north to Cape Kinau on the south. The Waiakoa Gulch boundary of the aquifer is coincident with the Wailuku-Makawao district boundary, but it is otherwise of no known hydrologic significance. The southern boundary of the aquifer is the southeast rift zone of Haleakala which is likely to be a barrier to groundwater flow.

As far as has been demonstrated by drilled wells and by geophysical soundings, groundwater in the Kamaole Aquifer exists as a basal lens from the shoreline as far inland as the 1700-foot contour. Groundwater pumpage from the aquifer is estimated to be a little more than four MGD (a number of active wells do not have reported use). Most of this pumpage is by the nine Wailea Resort and 11 Makena Resort brackish wells which irrigate a total of five 18-hole golf courses.

In 1990, the CWRM set the sustainable yield of the Kamaole Aquifer at 11 MGD. This was based on a computed groundwater recharge of 25 MGD and the assumption that 44 percent of the recharge could be withdrawn by wells without adversely impacting the integrity of the aquifer. Several far more

detailed and sophisticated studies on the aquifer's recharge have been completed since then. These suggest that the recharge amount on which the CWRM's sustainable yield is based is substantially underestimated (refer to the tally below). As such, these studies also indicate that the actual sustainable yield for the aquifer may be as much as 50 percent greater. The most recent of these studies is considered to be the most reliable. Using the results of the latest USGS study (Engott and Vana, 2007), the groundwater flowrate may be on the order of 3.4 MGD per mile. This rate is used in the section on impacts to groundwater following later in this report.

Studies With Computations of the Kamaole Aquifer's Recharge Since 1990

Study	Year	Computed Recharge	
		M G D	% of Precipitation
USGS Water Resources Investigations Report 98-04159 by Pat Shade	1999	24	21
Water Resource Review of the Kamaole Aquifer by Waimea Water Services, Inc.	2004	29	22
USGS Scientific Investigations Report 2007-5103 by John Engott and Thomas Vana	2007	37.4	37

The project's impacts to groundwater will occur in two geographically distinct areas: (1) beneath and downgradient of the project site itself; and (2) downgradient of the project's offsite Kamaole wells on the north side of Maui Meadows. The project site spans a 1.9-mile length of the coastline. Assuming lateral dispersion on the order of 10 degrees, the project's impacts may occur across a 2.3-mile section of the shoreline. Using 3.4 MGD per coastal mile, the pre-development groundwater flowrate discharging into the marine environment is assumed to have been on the order of 7.8 MGD. Five of Wailea Resort's nine golf course irrigation wells are within this potentially impacted zone. (Of Wailea's other four wells, three are to the north and downgradient of Maui Meadows and the fourth is to the south.) Table 3 identifies these five Wailea wells and provides a compilation of their average water quality based on annual sampling by Marine Research Consultants (Dr. Steven Dollar) since 1991. According to CWRM records, the draft of these five wells is about 1.4 MGD as a year-round average. Wailea's other four wells average about 1.0 MGD.

Two of the project's offsite Kamaole wells have been drilled and pump tested (Nos. 4225-02 and 4225-03). At least two and possibly a third well will need to be developed. These will be located north of the two existing wells. These four or five wells will span a 0.8-mile long length at about 580-foot elevation and may impact the groundwater flow along a 1.4-mile long shoreline segment. Again using 3.4 MGD per coastal mile, the pre-development flowrate may have been on the order of 4.8 MGD. Based on CWRM records, there are 20 wells in this potentially impacted downgradient area (refer to Table 4). Most of

Table 3

Averaged Water Quality Data of the
Five Wailea Resort Golf Course Irrigation Wells
Downgradient of the Honua'ula Project Site

Well		Averaged Data, 1991 to 2009								
Wailea Number	State Number	NO_3 (µM)	NH_4 (µM)	DON (µM)	TN (µM)	PO_4 (µM)	DOP (µM)	TP (µM)	Silica (µM)	Salinity (PPT)
2	4126-02	238	1.32	7.89	248	1.66	0.66	2.32	450	1.43
3	4126-03	236	1.71	16.63	254	2.16	0.62	2.77	569	1.22
4	4026-04	196	1.31	10.42	208	2.08	0.32	2.40	580	1.64
6 A	4026-07	174	2.00	25.16	201	2.13	0.54	2.67	538	1.40
7	4026-06	332	1.42	11.60	345	2.27	0.51	2.79	550	1.81
Average of the Five Wells		235	1.55	14.34	251	2.06	0.53	2.59	538	1.50

Notes:
1. Data from Marine Research Consultants based on annual sampling from 1991 to 2009.
2. The units of µM can be converted to milligrams per liter by multiplying by the atomic weight and dividing by 1000.
3. DON and TN are dissolved organic nitrogen and total nitrogen, respectively.
4. Similarly, DOP and TP are total dissolved phosphorus and total phosphorus, respectively.

Table 4

Wells in the Downgradient Area Potentially
Impacted by the Honua'ula Project's Offsite Kamaole Wells
(Information From the Files of the State CWRM)

State Well No.	Year Drilled	Casing Diameter (Inches)	Ground Elevation (Feet MSL)	Well Depth (Feet)	Current Use
4226-06	1949	6	?	59	None
4226-10	1951	8	?	63	None
4226-11	1956	10	?	157	?
4226-15	1999	6	77	105	Landscape Irrigation
4226-17	2002	6	52	59	Landscape Irrigation
4326-02	1946	8	?	23	None
4326-03	1947	8	?	34	None
4326-04	1948	7	?	103	None
4326-05	1955	8	?	47	None
4326-06	1949	8	75	110	None (Lost)
4326-07	1990	6	64	84	?
4326-09	2001	6	64	95	Landscape Irrigation
4326-11	2004	6	80	95	Landscape Irrigation
4326-12	2004	6	83	100	Landscape Irrigation
4327-01	1947	8	?	38	None
4327-02	1947	10	?	37	None
4327-04	1949	8	?	22	None
4327-05	1949	8	?	38	?
4327-06	1967	?	?	45	None
4327-07	2000	6	56	80	Landscape Irrigation

these wells are more than 50 years old and are no longer in use. However, at least six are relatively recent (installed since the 1990s) and were developed to provide landscape irrigation for condominium parcels. The total draft of these wells is likely to be in the range of 0.12 to 0.30 MGD as a year-round average.

Potential Impacts to Groundwater Downgradient of the Honua'ula Project Site

Table 5 is a compilation of the potential year-round average changes to groundwater flowrate, salinity, and nitrogen and phosphorus loading downgradient of the project after full build-out. In addition to the data and calculations presented previously, the following assumptions are incorporated into the results compiled in Table 5:

- Of the 1.7 MGD average draft from the project's wells at full development, about 25 percent or 0.43 MGD would be supplied by the two existing onsite wells (Nos. 4125-01 and -02).
- Of the site's 18 inches of average annual rainfall, the pre- and post-development portion percolating to groundwater will be essentially the same. For this analysis, it is assumed that this amounts to one-third of the rainfall amount (the remaining two-thirds will evaporate to atmosphere or become runoff). In comparison to pre-development conditions, the post-development portion percolating to groundwater will have increases of nitrogen and phosphorus of 20 and 2.0 µM, respectively.
- For all of the sources of supply used to irrigate the golf course and other landscaped areas, the portion percolating through the root zone will have a salinity increase of 10 percent and a 50 percent reduction of their nitrogen and phosphorus concentrations as a result of plant uptake and processes in the soil.
- The R-1 WWTP effluent reused for golf course irrigation will have 775 µM (10.85 mg/l) nitrogen and 165 µM (2.00 mg/l) phosphorus.
- On a long term basis, it is assumed that the salinity of the combined brackish well water supply is 0.95 PPT. With a 65 percent product recovery rate, the salinity of the remaining 35 percent, the concentrate for irrigation reuse on the golf course, will be 2.41 PPT.
- Essentially all of the nitrogen and phosphorus in the brackish water that is run through the RO treatment process will be contained in the 35 percent of the feedwater that becomes RO concentrate and is reused for golf course irrigation.

Table 5

Compilation of Potential Changes to Groundwater in the
Area Downgradient of the Honua'ula Project Site After Full Build-Out

Component of Flow	Flowrate (MGD)	Salinity (PPT)	Nitrogen (lbs / day)	Phosphorus (lbs / day)
Pre-Development Groundwater	7.8	1.00	228.3	5.217
Withdrawal by Onsite Well Nos. 4125-01 and -02	0.43	0.95	12.59	0.288
Percolation From the Project Site to Groundwater				
- Percolating Rainfall	No Change	No Change	0.14	0.0077
- Percolation From the Golf Course				
- RO Concentrate	0.0203	2.651	0.170	0.0010
- WWTP Effluent	0.0274	0.440	0.248	0.0114
- Brackish Water	0.0240	1.045	0.070	0.0004
- Applied Fertilizer Dissolved in Percolate	--	--	0.788	0.0066
- Percolation From Other Landscaped Areas				
- Brackish Water	0.1336	1.045	0.391	0.0022
- Applied Fertilizer Dissolved in Percolate	--	--	0.981	0.0082
Post-Development Groundwater				
- Amounts	7.5753	1.0062	218.498	4.9665
- Change Compared to Pre-Development Flowrate	- 2.9%	+ 0.62%	- 4.3%	- 4.8%

- Fertilizer applications in landscaped areas will be at three pounds per 1000 square feet per year for nitrogen and at 0.5 pounds per 1000 square feet per year for phosphorus. Of these applications, 10 percent of the applied nitrogen and 2 percent of the applied phosphorus will be carried in percolate below the root zone.

- In the hundreds of feet of travel by the percolate through the vadose zone (the unsaturated lavas between the ground surface and groundwater) and the thousands of feet of travel with groundwater to discharge at the shoreline, natural processes will remove 80 percent of dissolved nitrogen and 95 percent of dissolved phosphorus. These removal rates are based on the natural removal rates of the Kealakehe WWTP effluent which is disposed of in a shallow pit upgradient of Honokohau Harbor in Kona on the Big Island. At that location, vertical travel through the vadose zone is only about 50 feet and the movement in groundwater to discharge into the upper end of the harbor is about 3500 feet.

As shown on Table 5, the computed changes to groundwater are as follows: a 2.9 percent reduction in flowrate; a 0.6 percent increase in salinity; a reduction in nitrogen loading of 4.3 percent; and a reduction in phosphorus of 4.8 percent. The largest factor contributing to these results is that most of the groundwater supply (about 75 percent) will come from the offsite Kamaole wells. These calculations indicate that, with the possible exception of a salinity increase in Wailea Resort's Well 2 (No. 4126-02) which is downgradient of Honua'ula's two onsite wells, development of the project will not impair Wailea Resort's golf course irrigation.

Potential Impacts to Groundwater Downgradient of the Offsite Kamaole Wells

About 75 percent or 1.28 MGD of the project's brackish supply will be provided by the project's four (or five) offsite Kamaole wells. As indicated previously, the downgradient area that may be impacted by this pumping is a 1.4-mile long coastal segment with a pre-development groundwater flowrate that may have been on the order of 4.8 MGD. Pumpage of the project's Kamaole wells would reduce this flowrate by about 27 percent. Some salinity increase in the downgradient wells as a result of this flowrate reduction is almost certain to occur, particularly in those wells which are closest to the shoreline.

Figure 3 was created to provide an approximation of salinity increases in the six active wells. Static water levels and salinity data for these wells, as on file with the CWRM, are plotted on the graph and a curve fitted to these data was created. The groundwater level reduction can be expected to vary with the square root of the flowrate, meaning that a 27 percent reduction in flow is likely to create a 15 percent drop in static water levels. If the static level-to-salinity relationship remains as defined by the fitted curve on Figure 3, projected salinity increases may be on the order of five percent. If the actual impact impairs the utility of the downgradient landscape irrigation wells, additional Kamaole wells to distribute the draft over a greater area would alleviate this.

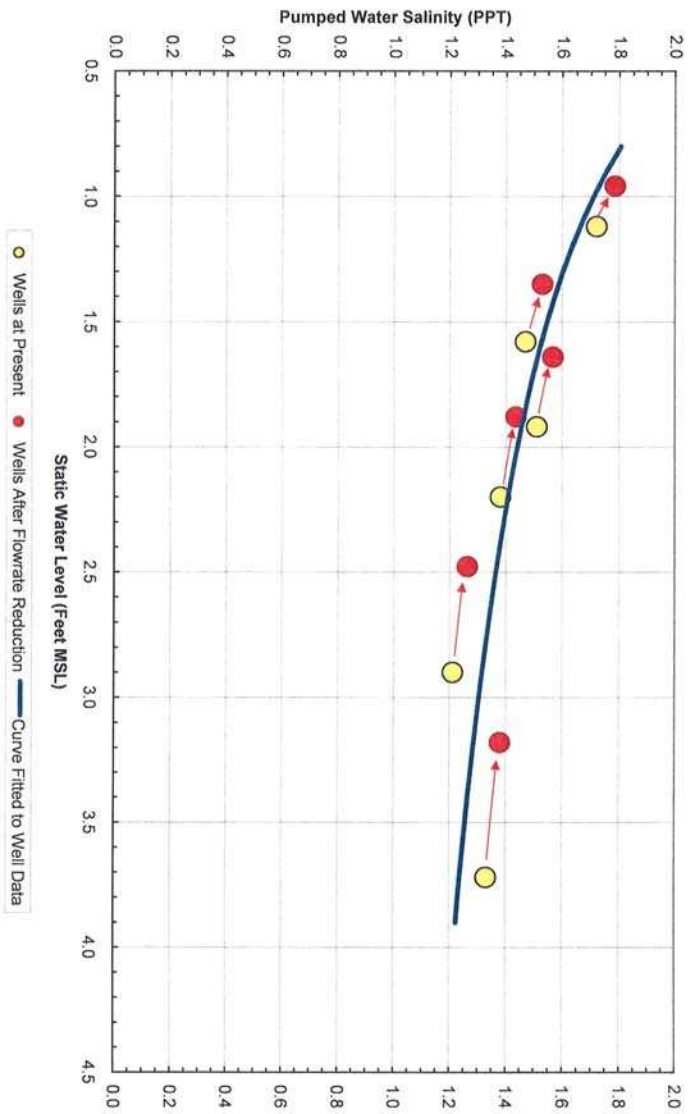

Figure 3. Relationship of Static Water Level to Pumped Water Salinity in Active Wells Downgradient of the Honua'ula Project's Kamaole Wells

Groundwater – Supplement Report July 16, 2010

TNWRE
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Original ☑ will ☐ will not be mailed to you.

July 16, 2010
10-152 | 10-04

MEMORANDUM

To: Tom Schnell - PBR
Charlie Jencks - Honua'ula Partners

From: Tom Nance

Subject: Responses to the Planning Commission's Informational Request on Existing Wells in and Other Aspects of the Kamaole Aquifer (Comments 9, 10, and 11)

This memo and its attachments address requests made by the Planning Commission regarding existing wells and other aspects of the Kamaole Aquifer System.

Data For All Wells in the Kamaole Aquifer (Comment 10)

Figures 1 to 5 are maps which show the locations of all wells known to the State Commission on Water Resource Management (CWRM) in the 89-square mile Kamaole Aquifer System. Table 1 is the CWRM's listing of these wells with dates of construction, as-built dimensions, and reported water levels and chlorides as measured during initial sampling of these wells. There are a total of 134 wells in this table, many of which are more than 60 years old and no longer in use.

Inland to at least the 1700-foot elevation contour, groundwater in the aquifer occurs as a basal lens. The direction of groundwater flow in the basal lens is mauka-to-makai. For this reason, it is instructive to group the aquifer's wells in three categories: (1) Wells in the mauka-makai corridor that may be affected by the Honua'ula project's wells; (2) wells to the north that will not be affected by the project's wells; and (3) wells to the south that also will not be affected by the project's wells. Table 1 groups the aquifer's wells in these three corridors and Table 2 is a summary of the status of wells in the three mauka-to-makai corridors.

Figures 6, 7, and 8 depict pumpage information for wells in the Kamaole Aquifer that has been reported to the CWRM since January 2000. Figure 6 shows the pumpage of the nine active wells that provide irrigation supply for Wailea Resort's three golf courses. Pumpage reporting for these wells stopped in June 2007. Figure 7 is a similar depiction for the nine active Makena Resort wells that irrigate two golf courses. Its reporting of pumpage stopped in September 2009. Figure 8 depicts all other well

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pumpage as reported to the CWRM. It amounts to just six wells, only three of which continue to report pumpage. In other words, only three of the 43 wells in the aquifer that are known or presumed to still be active (Table 2) are presently reporting their pumpage.

Figure 9 combines the pumpage totals on Figures 6, 7, and 8. During the period when reporting of the Wailea and Makena Resort wells was consistent, their combined total averaged 3.4 MGD. If other reported pumpage plus plausible estimates for other known or presumed active wells are added to the total for the golf courses, it appears that current total pumpage could be about 4.7 MGD but is probably closer to 4.0 MGD. Of this amount, about 1.9 MGD is occurring in the 3.8-mile wide mauka-makai corridor that may be affected by the Honua'ula project's existing and future wells.

Reporting to the CWRM of water levels and chlorides has been essentially non-existent. Only the three wells still reporting to the CWRM provide that information. For Well 4226-16 (Maui Kamaole AOAO), the chloride data is obviously incorrect (an order of magnitude less than actual) and depths to water are listed in the column where water level should be provided. For Wells 4326-11 and -12 (Ke Alii's two wells), the chlorides appear reasonable (1200 to 1350 mg/l), but depths to water rather than water level are reported.

Figure 10 illustrates data for the chlorides of the six most consistently used Makena golf course wells (chloride analyses were done in my office). These depict stable chlorides for a decade of monthly sampling.

"Level of the Transition Zone" for the Kamaole Aquifer (Comment 11)

The short answer to this comment is that no actual data exists on the aquifer's "level of the transition zone". No well has been drilled to sufficient depth through the basal lens to define the depth and character of transition zone anywhere in the aquifer. However, what is known or can be reasonably surmised regarding the transition zone is as follows:

- From the shoreline inland to the 1700-foot elevation contour across the Kamaole Aquifer, groundwater exists as a basal lens.
- Groundwater levels along the 1700-foot contour are about 6 feet above sea level (Well Nos. 4422-01, 4621-01, and 4622-02). That translates to the midpoint of the transition zone being about 240 feet below sea level.

- Wells along or just below the 600-foot elevation contour (Nos. 4125-01, 4125-02, 4225-02, 4225-03, 4424-01, 4425-01, and 4524-01) have water levels from 2.6 to 3.1 feet above sea level, indicating a mid-point of the transition zone between 100 and 125 feet below sea level.
- The stability of the transition zone, although obviously not directly measured, can be inferred from the stability of chlorides pumped by wells. Figure 10 provides the most accurate and complete record of this.

Need For a Monitor Well Before Production Wells are Utilized in the Kamaole Aquifer (Comment 9)

Nothing in the available data from wells across the entire aquifer and more specifically in the mauka-makai corridor that may be affected by the Honua'ula project's wells suggests that a monitor well is needed. Nevertheless, Honua'ula will construct its upgradient golf course monitor well to a depth that will allow it to also be used to monitor the transition zone below the basal lens. The well will be installed prior to the start of use of the project's production wells. Periodic profiling of salinity and temperature through the monitor well's water column will be done. These data will be used to track salinity in the basal lens and the movement, if any, of the transition zone.

Attachments

Table 1. CWRM Listing of All Wells in the Kamaole Aquifer System (No. 60304)

Well No.	Well Name	Owner/User	Year Drilled	Latitude	Longitude	Type	Case Dia. in.	Total Depth ft.	Ground Elev ft.	Bottom Solid Casing ft	Bottom Perf Casing ft	Bottom of Hole ft MSL	Static Head ft MSL	Chloride mg/l	Temp °F	Installed Capacity (MGD)	Use
WELLS TO THE SOUTH THAT WILL NOT BE IMPACTED BY THE HONUA'ULA PROJECT WELLS																	
3725-01	Moomuku 1 Cluc Inc.	Hawaii VIP Country	2004	203748	1562552	ROT	6	280	264	4	-16	-16	2.1			0.432	AGRCP
3726-01	Kanahena	Romachak E	1975	203719	1562626		4	31					0				IRR
3726-03	Millar	Millar C F	1985	203745	1562625		4	125	110			-15	1				IRR
3726-04	Kanahena-Erniss	Ernisse D & E	1990	203728	1562630	DUG	48	19						4		0.014	IRR
3824-01	Berkowicz		2005	203840	1562442	ROT	6	1322	1294	-8	-28	-28	5.16		77	0.065	MUNPR
3826-01	Seibu 2	Honua LLC	1978	203840	1562612	PER	12	222	200	6	-22	-22	2.21			0.576	IRRGC
3826-02	Seibu 3	Makena Resort Corp	1978	203841	1562612	PER	12	220	197	7	-23	-23	2.08			0.576	IRRGC
3826-03	Seibu 4	Makena Resort Corp	1978	203852	1562615	PER	12	228	205	7	-23	-23	1.58	1100		0.576	IRRGC
3826-04	Seibu 7	Makena Resort Corp	1985	203828	1562622	PER	12	195	173	128	45	-22	0			0.216	IRRGC
3826-05	Seibu 12	Makena Resort Corp	1989	203852	1562618	PER	12	231	203	10	-20	-28	2.57	1900			UNU
3925-01	Makena 68	State DLNR-Eng	1964	203912	1562559	ROT	8	382	352	9	-11	-30	0.8	465	21.4		OBS
3926-01	Makena	Garcia S	1972	203904	1562639	ROT	4	32						1080			
3926-02	Seibu 1	Seibu Haw Inc	1977	203932	1562613	PER	12	211	189	9	-21	-22	1.75			0.576	IRRGC
3926-03	Wailea 8	Wailea Golf LLC	1976	203947	1562613	PER	12	208	179	-1	-21	-29	1.57	666		0.504	IRRGC
3926-04	Seibu 5	Makena Resort Corp	1984	203922	1562611	PER	12	230	211	11	-19	-19	0			0.576	IRRGC
3926-05	Seibu 6	Makena Resort Corp	1984	203928	1562612	PER	12	224	200	6		-24		668		0.576	IRRGC
3926-06	Seibu 8	Makena Resort Corp	1988	203915	1562610	PER	12	263	244	11	-19	-19	1			0.576	IRRGC
3926-07	Seibu 9	Makena Resort Corp	1988	203945	1562607	PER	12	242	220	8	-22	-22	1			0.576	IRRGC
3926-08	Seibu 10	Makena Resort Corp	1988	203903	1562614	PER	12	290	266			-24	0.93				IRRGC
3926-09	Seibu 11	Makena Resort Corp	1988	203909	1562613	PER	12	278	258	10	-20	-20	2			0.288	IRRGC
3926-11	Makena Surf	Makena Surf Assoc	2002	203936	1562640	ROT	6	55	41	-4	-14	-14	0.93			0.331	IRRLA
4019-01	Polipoli Tunnel	Ulupalakua Rch		204049	1561958	TUN			6200								
4020-01	Waikaukane Tun	Ulupalakua Rch		204022	1562031				5750								
4020-02	Cornwall Tunnel	Ulupalakua Rch		204044	1562055				4850								
4020-03	Morton Tunnel	Haleakala Rch		204056	1562051				4850								
4021-01	Waikaahi Tunnel	Ulupalakua Rch		204054	1562104				4600								
4026-01	TMK 2-1-11-3	Churchill F	1950	204037	1562644		8	24					10.8				UNU
4026-02	Tmk 2-1-11-1	Polo Beach Club	1950	204042	1562644		8	32									IRR
4026-03	Makena	Harkins W	1951	204033	1562645		8	32	OTH								
4026-04	Wailea 4	Wailea Golf LLC	1972	204043	1562625	ROT	12	210	179	0	-21	-31	1.04	363		1.008	IRRGC
4026-05	Wailea 6	Wailea Res Co	1975	204022	1562626	PER	12	189	158	8	-12	-31	2	600		0.259	OBS
4026-06	Wailea 7	Wailea Golf LLC	1975	204007	1562622	PER	12	204	184	5	-15	-20	2	620		1.008	IRRGC
4026-07	Wailea 6A	Wailea Golf LLC	1994	204025	1562615	ROT	12	272	252	0	-20	-20	0.5	460	20.6		IRRGC
4026-13	Kea Lani Irr	KEA LANI MAUI	2002	204041	1562633	ROT	6	94	83	-2	-11	-11	0.9			0.331	IRRLA
WELLS WITHIN THE MAUKA-TO-MAKAI CORRIDOR THAT MAY BE IMPACTED BY HONUA'ULA PROJECT WELLS																	
4122-01	Keawakapu	Tavares H		204115	1562202											0.144	IRR
4125-01	Wailea 670 1	Palauea Part	1991	204137	1562534	ROT	10	559	522	-27	-37	-37	2.8			0.72	IRRGC
4125-02	Wailea 670 2	Palauea Part	1991	204131	1562535	ROT	10	550	523	-6	-26	-27	3.7			0.72	IRRGC
4126-01	Wailea 1	Wailea Res Co	1950	204137	1562637	PER	10	90	85		-5	-5	7	590	20	0.036	OBS
4126-02	Wailea 2	Wailea Golf LLC	1969	204128	1562621	PER	12	198	181	3	-17	-17	2	490		1.008	IRRGC
4126-03	Wailea 3	Wailea Golf LLC	1969	204108	1562622	PER	12	174	153	0	-20	-21	1	555		1.08	IRRGC
4126-04	Grand Wailea Salt		1991	204101	1562632		4	80								0.36	AGRAQ
4126-05	Wailea Ike Irr	Grand Champion Villas	2004	204138	1562616	ROT	6	206	189	-2	-17	-17	1.77		73	0.216	IRRLA
4225-01	Maui Meadows		2006	204227	1562516	ROT	14	802	763	-17	-39	-39	0.29		68.9		UNU
4225-02	Wailea 670 No. 1		2007	204251	1562529	ROT	12	581	545	7	-33	-36	2.22		69.9		UNU
4225-03	Wailea 670 No. 2		2007	204302	1562522	ROT	12	604	573	9	-31	-31	3.15		67.4		UNU
4226-01	Tmk 2-1-10-07	Correl A	1946	204212	1562650			41									IRR

Well No.	Well Name	Owner/User	Year Drilled	Latitude	Longitude	Type	Case Dia. in.	Total Depth ft.	Ground Elev ft.	Bottom Solid Casing ft	Bottom Perf Casing ft	Bottom of Hole ft MSL	Static Head ft MSL	Chloride mg/l	Temp °F	Installed Capacity (MGD)	Use
4226-02	2-1-10-05	Texeira J	1946	204213	1562650			45									IRR
4226-03	Tmk 2-1-10-04	Pabst W	1946	204215	1562651			31									IRR
4226-04	2-1-10-20	Crouse J	1946	204216	1562651			30									ABNSLD
4226-05	Tmk 2-1-10-01	Carter C	1949	204217	1562653		8	22									UNU
4226-06	Tmk 3-9-04-98	Tom Tf	1949	204255	1562649		6	59									UNU
4226-07	Tmk 3-9-04-75	Kurihara H	1951	204229	1562641		8	65									UNU
4226-08	Tmk 3-9-04-78	Kiyan S	1951	204231	1562643		8	75									ABNSLD
4226-09	Tmk 3-9-04-81	Teruya F	1951	204241	1562642		8	114									UNU
4226-10	Tmk 3-9-04-86	Kurihara H	1951	204249	1562647		8	63									UNU
4226-11	Tmk 3-9-04-125	Harada L	1956	204257	1562630		10	157									IRR
4226-12	Wailea 5	Wailea Golf LLC	1972	204201	1562624	ROT	12	202	179	0	-21	-23	1.04	1050		0.36	IRRGC
4226-13	Wailea 9	Wailea Golf LLC	1989	204227	1562622	PER	12	222	202	0	-20	-20	1.4			0.576	IRRGC
4226-14	Wailea 10	Wailea Golf LLC	1990	204218	1562620	PER	12	248	234	6	-14	-14		600		1.008	IRRGC
4226-15	Hale Kamaole Assc.	Hale Kamaole	1999	204247	1562646	ROT	6	105	77	-8	-28	-28	3.72		21.6	0.18	IRRLA
4226-16	Maui Kamaole AOAO	Maui Kamaole AOAO	2001	204225	1562637	ROT	6	155	129	4	-16	-26	0.23		70.5	0.331	IRRLA
4226-17	Kamaole Sands	Maui Vista AOAO	2002	204258	1562649	ROT	6	59	52	-1	-7	-7	2.2		72	0.216	IRRLA
4226-18	Maui Hill AOAO	AOAO Association	2003	204242	1562634	ROT	6	147	134	-3	-13	-13	1.18		70	0.216	IRRLA
4226-19	Kilohana Waena		2006	204232	1562633	ROT	6	135									UNU
4326-01	Tmk 3-9-20-26	Akina A	1945	204332	1562659		6	28									UNU
4326-02	Tmk 3-9-20-17	Akina J	1946	204324	1562658		8	23									UNU
4326-03	Tmk 3-9-20-14	Kuaana W	1947	204320	1562657		8	34									UNU
4326-04	Tmk 3-9-19-02	Shigeta D	1948	204312	1562640		7	103									IRR
4326-05	Tmk 3-9-20-20	Akina A	1951	204327	1562655		8	47									UNU
4326-06	Tmk 3-9-18-09	Lindley C	1959	204342	1562645		8	110	-19			-35					ABNLOS
4326-07	Kamaole-Bosa	Bosa Corp	1990	204306	1562642	ROT	6	84	64	0	-20	-20	2.9	60	22.2		IRR
4326-09	Kihei-Maui Vista	Maui Vista AOAO	2001	204346	1562654	ROT	6	95	64	-7	-27	-31	1.58			0.288	IRRLA
4326-11		Ke Alii , LLC	2004	204325	1562647	ROT	6	100	83	3	-17	-17	1.91		72.7	0.432	IRRLA
4326-12		Ke Alii , LLC	2004	204317	1562640	ROT	6	95	80	5	-15	-15	1.92		73.1	0.216	IRRLA
4326-13	Aloha Village		2005	204318	1562646	ROT	6	80	66	4	-14	-14	1.56		72.3	0.18	IRRLA
4327-01	TMK 3-9-16-25	Dang Y O	1947	204352	1562702		8	38									UNU
4327-02	TMK 3-9-17-37	Toba J	1947	204356	1562707		10	31									IRR
4327-03	TMK 3-9-05-51	Flood E	1949	204334	1562703		8	26									IRR
4327-04	TMK 3-9-05-25	Brown J	1949	204337	1562703		8	22									IRR
4327-05	TMK 3-9-05-22	Murphy F	1949	204341	1562704		8	38									OTH
4327-06	TMK 3-9-16-03	Machida S	1967	204352	1562705			45									IRR
4327-07	Kihei-Akahi	Kihei Akahi Condo Assc.	2000	204344	1562705	ROT	6	80	56	5		-24	1.12		73.4	0.216	IRRPA
4327-08	Kalama Beach A1		2009	204400	1562717	ROT	2	16									OBS
4327-09	Kalama Beach A2		2009	204400	1562717	ROT	2	45									OBS
4327-10	Kalama Beach A3		2009	204400	1562717	ROT	2	70									OBS
4426-02	Kihei Injection	Maui DPW	1974	204406	1562626	PER	18	230	109	-51		-121	4				OTH
4427-01	TMK 3-9-05-52	Maui County		204414	1562722												IRR
4427-04	TMK 3-9-11-38	Nishiji R	1949	204423	1562725		8	24									IRR
4427-05	TMK 3-9-02-02	Akina F	1950	204417	1562701		8	82									UNU
WELLS TO THE NORTH THAT WILL NOT BE IMPACTED BY HONUA'ULA PROJECT WELLS																	
4422-01	Waiohuli	U S G S	2001	204419	1562205	ROT	4	1940	1864	30	-60	-76	5.58				OBS
4424-01	Keokea Highlands 2	Maui Highlands Prop, LLC	2005	204459	1562502	ROT	8	577	553	-4	-24	-24	2.6			0.432	MUNPR
4425-01	Keokea Highlands	Maui Highlands LLC	2004	204459	1562502	ROT	6	570	551	1	-19	-19	2.76			0.432	MUNPR
4426-01	Kihei Inject TH	Maui Dpw	1972	204420	1562641	ROT	2	203									OBS
4426-03	Kihei-Maui R&T	Maui R&T Part	1990	204456	1562641	ROT	8	157	124	-3	-33	-33	1.87	369	20		IRRLA
4427-02	TMK 3-9-02-8	Akina F	1945	204429	1562707		8	30									UNU
4427-03	Medo	Miranda H	1948	204438	1562718		10	22									UNU
4427-06	Kihei Fire B1	2009	204416	1562722	ROT		2	16									OBS
4427-07	Kihei Fire B2	2009	204416	1562722	ROT		2	40									OBS
4427-08	Kihei Fire B3	2009	204416	1562722	ROT		2	70									OBS

Well No.	Well Name	Owner/User	Year Drilled	Latitude	Longitude	Type	Case Dia. in.	Total Depth ft.	Ground Elev ft.	Bottom Solid Casing ft	Bottom Perf Casing ft	Bottom of Hole ft MSL	Static Head ft MSL	Chloride mg/l	Temp °F	Installed Capacity (MGD)	Use
4427-09	Kihei Baptist Chapel	Kihei Baptist Chapel	1978	204433	1562721	DUG	20	15								0.021	IRRLA
4527-01	TMK 3-9-02-36	Akina R	1945	204529	1562716		6	30								0.17	AGRCP
4527-02	Tmk 3-9-02-32	Yee W	1946	204519	1562714		8	35									IRR
4527-03	Tmk 3-9-01-02	Perreira L	1947	204533	1562740		8	20									UNU
4527-04	Tmk 3-9-08	Maui County	1948	204504	1562737		7	47									UNU
4527-05	Tmk 3-9-08	Maui County	1948	204503	1562738			70									UNU
4527-06	Tmk 3-9-01-9	Teruya E	1948	204550	1562721		6	28									IRR
4527-07	Tmk 3-9-23-30	Uyeno H	1949	204540	1562717		8	42									UNU
4527-08	Kihei-Piilani	Blackfield Haw	1990	204544	1562711	ROT	10	71	41	3	-17	-30	0.75	27	23.3	0.057	IRR
4527-10	Kihei-Koa	Koa Res Assoc	1992	204555	1562737	DUG	24	14	7	0	-5	-7		335	24.4	0.043	IRRLA
4527-12	Waiohuli 1	Baldwin Malama	1989	204526	1562708	DUG	60	20									ABNSLD
4527-14	Kauhale Makai	Kauhale Makai	2001	204547	1562740	ROT	6	86	9	-48		-77	1.69		74	0.216	IRRPA
4527-16	St. Theresa Church		2007	204459	1562729	ROT	6	45	71							0.086	IRRLA
4527-17	Kihei			204513	1562716	DUG	66	11									UNU
4527-18	Kaonoulu 5		2007	204559	1562726	ROT	6	50	18	-2	-32	-32	3.14			0.086	IRRLA
4621-01	Kula 1800 No. 1		2007	204630	1562116	ROT	16	1832	1760	8	-72	-72	5.19		70.3		UNU
4621-02	Kula 1800 No. 2		2008	204638	1562114	ROT	16	1815	1737	4	-56	-78	6.31		70		UNU
4627-01	Tmk 3-9-01-24	Uehara T		204646	1562737												OTH
4627-02	Tmk 3-9-06-08	Ventura J	1946	204654	1562748		8	20								0.119	IRR
4627-03	Tmk 3-9-01-54	Ting L	1947	204628	1562734		10	29									OTH
4627-04	Tmk 3-9-06-07	Agirogi R	1947	204650	1562747		10	18									IRR
4627-05	Tmk 3-9-06-09	Watson H	1947	204655	1562748		10										IRR
4627-06	Tmk 3-9-06-13	Clark C	1947	204657	1562747		6	23									IRR
4627-07	Tmk 3-9-01-29	Pimental A	1947	204658	1562744		10	24									UNU
4627-08	Tmk 3-9-01-33	Hashimoto T	1948	204634	1562711		6	116									IRR
4627-09	Tmk 3-9-01-50	Gusukuma T	1948	204653	1562741		4	35									IRR
4627-10	Tmk 3-9-06-06	Fujimoto I	1948	204648	1562747		7	19									IRR
4627-11	Tmk 3-9-01-99	Alo S	1949	204626	1562733		8	19									IRR
4627-12	Tmk 3-9-15-12	Fedalizo C	1950	204642	1562738		8	31									IRR
4627-13	Tmk 3-9-15-14	Bosque J	1950	204643	1562738		8	29	20	9		-9	3.1				IRR
4627-14	Tmk 3-9-01-34	Hashimoto T	1969	204635	1562701	ROT		200	130			-70					IRR
4627-15	Tmk 3-9-26-43	Neubauer A	1969	204643	1562703	ROT	4	110									IRR
4627-16	Tmk 3-9-26-67	Batoon A	1969	204648	1562701	ROT	4	161									IRR
4627-17	Tmk 3-9-26-66	Tavares H	1969	204651	1562701	ROT	4	120									IRR
4627-19	Maui Lu	Maui Lu Resort	1956	204623	1562739	DUG											IRRLA

Table 2

Summary of the Status of Wells Pumping From the Kamaole Aquifer's Basal Lens

Categories of Well Status	Tabulation of Wells in Mauka-to-Makai Corridors			All Wells in the Kamaole Aquifer
	Wells to the South That Will Not Be Impacted by the Honua'ula Project's Wells	Wells That May Be Impacted by the Honua'ula Project's Wells	Wells to the North That Will Not Be Impacted by the Honua'ula Project's Wells	
Total Number of Wells	34	55	45	134
Wells Known or Presumed to be in Use	17	16	10	43
Wells Known to No Longer be in Use or Do Not Draw From the Basal Lens	11	20	16	47
Wells of Unknown Status Relative to Their Use	6	19	19	44
Estimated Average Pumpage in MGD	2.4	1.9	0.4	4.7

Notes:
1. Locations of all the wells are shown on Exhibit A and Exhibit B is a complete listing of all wells.
2. Wells known to no longer be in use or do not draw from the basal lens include: those listed as unused, abandoned, sealed, or lost in Exhibit B; high elevation tunnels which tap perched groundwater; wells used for observation only; and production wells not yet in service. This latter group includes the Honua'ula project's four completed wells.
3. Pumpage amounts were estimated from reported pumpage (Figures 1, 2, and 3) and assigning an average of 0.075 MGD for condominium and hotel irrigation wells and lesser amounts to wells serving smaller parcels.

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Original ☑ will ☐ will not be mailed to you.

July 20, 2010
10-157 | 10-04

MEMORANDUM

To: Tom Schnell - PBR
Charlie Jencks - Honua'ula Partners

From: Tom Nance

Subject: Cost of the Potable and Non-Potable Systems

This memo provides estimates of the cost to construct and operate the Honua'ula project's potable and non-potable systems in order to address Comment 17 of the Planning Commission. You can use Figure 4 in my December 2009 Water Systems master plan report in creating the map requested in Comment 12.

A number of assumptions had to be made to create cost estimates for the project's consumers at this stage of the project's planning. The most significant of these are:

- The analysis is based on full build-out of the project.
- The estimated potable and non-potable infrastructure cost is $21 million (refer to Table 1). Not included in this estimate are: construction and installed pumps in the two onsite wells (these were done in the early 1990s); and all onsite potable and non-potable pipelines throughout the project.
- The $21 million infrastructure cost is recovered in water sales at 6 percent over 20 years.
- Groundwater pumpage and RO treatment are 10 percent greater than actual water sales to account for leakage and unmetered use.
- Power for well pumps, booster pumps, and the RO plant is purchased from MECO at an average of $0.30/KWH.
- Pump efficiencies are 78 percent and the motors driving them are 87 percent efficient.

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- Sixty-seven (67) percent of the feedwater through the RO plant is recovered as drinking water and 33 percent is concentrate which is reused for golf course irrigation.
- Costs for operating personnel, administration, and miscellaneous supply and maintenance will be 40 percent of the power to operate the pumps and RO plant.
- Purchase of non-potable (brackish) and RO-treated potable water by customers throughout the project will be distributed as follows:

Projected Water Sales in Average MGD

Water System	Service Pressure Zone		Both Zones
	640' Zone	810' Zone	
Potable	0.260	0.082	0.342
Non-Potable	0.556	0.254	0.810
Total for Both	0.816	0.336	1.152

Based on the foregoing set of assumptions, the daily operating cost for both systems in both service zones would be $3,000. The daily cost of capital recovery would be $4,950. Generally where dual water service is available, the sale price for potable water is about double the price for non-potable water. Using that as a guideline, the cost to consumers, with and without capital recovery and ignoring a profit to the utility, would be as follows:

Estimated Cost in Dollars Per Thousand Gallons

Cost Items Included	Potable Water	Non-Potable Water
Based on Operation and Maintenance Exclusively (No Capital Recover)	$ 4.00	$ 2.00
Based on Operation, Maintenance, and Full Capital Recovery	$ 10.64	$ 5.32

Attachment

Table 1

Estimated Cost of the Honua'ula Water System Infrastructure

Infrastructure Item	Amount
Construction and Testing of Kamaole Wells 1 to 4	$ 1,570,000
Outfit Kamaole Wells 1 to 4	3,000,000
Offsite Pipeline and Access Road, Wells to 640' Tank	6,500,000
RO Plant and Potable and Non-Potable Tanks at 640'	4,200,000
Potable and Non-Potable Booster Pumps at 640' Tank	500,000
Pipelines and Access Road, 640' to 810' Tanks	750,000
Potable and Non-Potable Tanks at 810'	1,850,000
Total for Construction	$ 18,370,000
Engineering and Construction Management	2,630,000
Total	$ 21,000,000