CONSTRUCTION, GEOLOGIC LOG, AND AQUIFER TESTS OF THE PUAKUKUI SPRINGS MONITOR WELL (STATE WELL 2-5626-01), LIHUE, KAUAI, HAWAII

By Stephen B. Gingerich and Scot K. Izuka

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CONVERSION FACTORS, ABBREVIATIONS, AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	2.54	centimeter
foot (ft)	0.3048	meter
cubic foot per minute (ft^3/min)	0.02832	cubic meter per minute
gallon per minute (gal/min)	3.785	liter per minute
mile, statute (mi)	1.609	kilometer

Other Useful Conversions

1 ft^3/s = 448.8 gal/min

1 ft^3/s = 0.6463 Mgal/d

Vertical datum

All elevations in this report are referenced relative to mean sea level.

Abbreviation:

µS/cm, microsiemens per centimeter at 25 degrees Celsius.

Construction, Geologic Log, and Aquifer Tests of the Puakukui Springs Monitor Well (State Well 2-5626-01), Lihue, Kauai, Hawaii

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Abstract

The Puakukui Springs monitor well, located along the southern edge of the Lihue basin on the northern slope of Haupu Ridge, was drilled in 1995 and tested to study the hydrology and geology in an area where no other well information is available. The well was drilled from a ground elevation of 484 feet above sea level and penetrated 802 feet of alluvium and mafic lava flows. The water level in the well remained constant at an elevation of about 173 feet throughout the well construction.

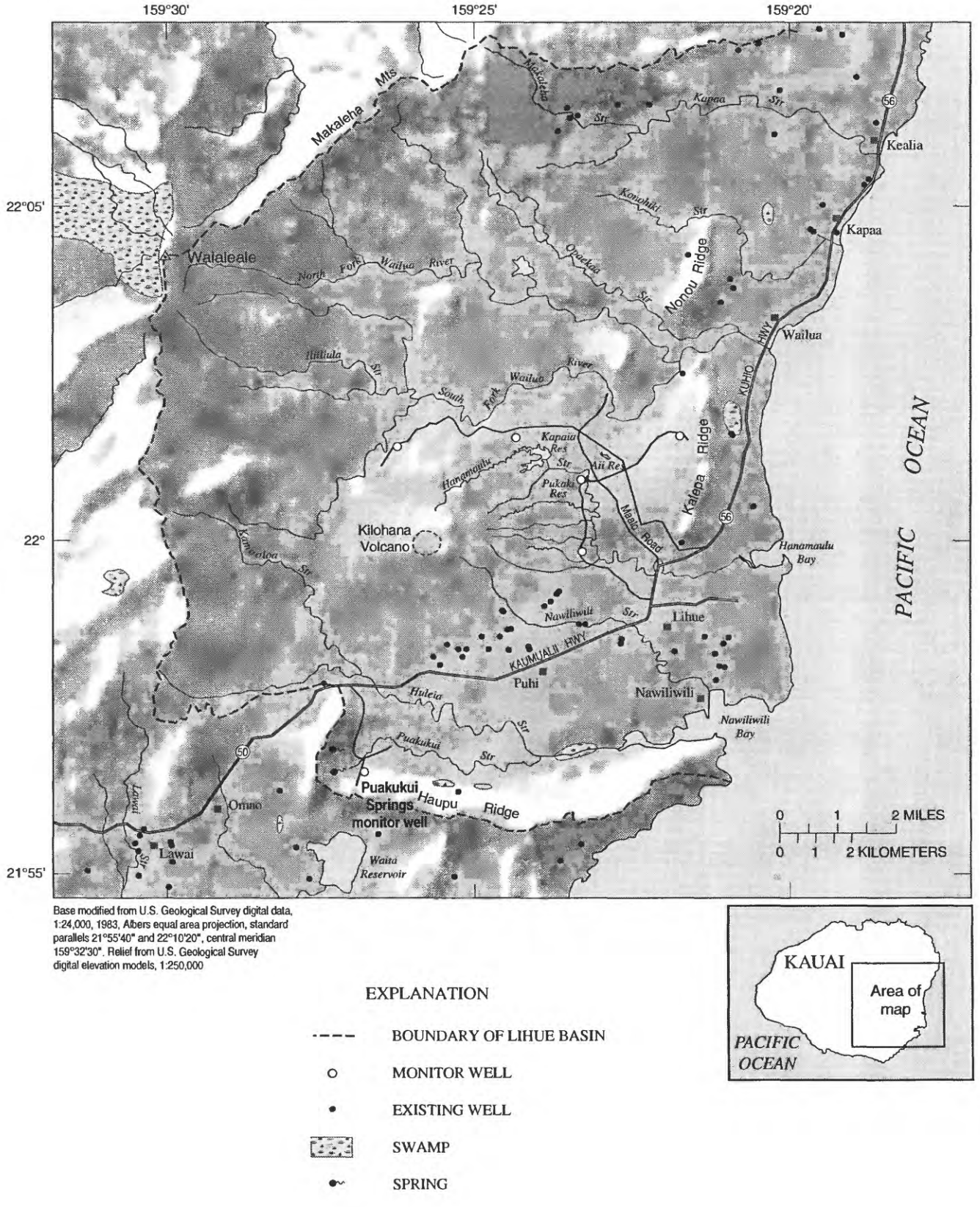
Step-drawdown and 7-day sustained-rate pumping tests were conducted to test aquifer properties. The maximum drawdown measured in the well during 7 days of sustained pumping at an average rate of 306 gallons per minute was 13.09 feet from an initial water-level elevation of 169.40 feet above sea level. Well loss, analyzed from the step-drawdown data, was estimated to be 3.56 feet. A marked increase in the drawdown at about 2,000 minutes into the sustained-rate test is apparent from the drawdown data. The temperature and specific conductance of the pumped water remained steady throughout the test.

INTRODUCTION

The Lihue basin is the center of population, government, and industry for Kauai. Recent population growth in the basin has greatly increased the demand for water in the area. The economic setback caused by Hurricane Iniki in 1993 slowed growth on Kauai and may have kept the water supply from reaching a critical stage; however, an ample water supply is needed for the island's economic recovery. Pre-Iniki studies placed Lihue's supply at the highest priority in Kauai's water plans (Commission on Water Resources Management, 1990).

The Puakukui Springs monitor well (State well 2-5626-01) is one of six monitor wells drilled in the period from April 1995 to April 1996 by the U.S. Geological Survey (USGS) in cooperation with the County of Kauai Department of Water to study the availability of ground water in the southern Lihue basin (fig. 1). The six monitor wells were sited in areas where no wells had been drilled and no subsurface information was available. Five of the six monitor wells were drilled in the central part of the Lihue basin. The sixth well, the Puakukui Springs monitor well, was drilled in the southern part of the basin. The Puakukui Springs monitor well is more than 1 mi from the nearest pumping wells in the Lihue basin and provides data for defining the regional ground-water system of the Lihue basin. The Department of Water considers the Puakukui Springs area as a potential site for future ground-water exploration and development.

The objectives of this study were met by analysis of data collected during and after the drilling operation. These data included (1) the driller's description of the well-construction details and the drilling history, (2) water levels monitored as the well was deepened, (3) a description of the geology from rock chips (cuttings) brought to the surface during drilling, and (4) the step-drawdown and 7-day aquifer tests. This report documents the location, drilling history, construction details, geologic log, and aquifer-test results of the Puakukui Springs monitor well.



Base modified from U.S. Geological Survey digital data, 1:24,000, 1983, Albers equal area projection, standard parallels 21°55'40" and 22°10'20", central meridian 159°32'30". Relief from U.S. Geological Survey digital elevation models, 1:250,000

EXPLANATION

- BOUNDARY OF LIHUE BASIN
- MONITOR WELL
- EXISTING WELL
- SWAMP
- SPRING

Figure 1. Location of the Puakukui Springs monitor well (State well 2-5626-01) and existing wells in the Lihue basin, Kauai, Hawaii.

Setting

The Puakukui Springs monitor well (State well 2-5626-01) is located along the southern edge of the Lihue basin, a large depression bounded on the west by the high mountains of central Kauai, on the south by Haupu Ridge, and on the north by the Makaleha Mountains (fig. 1). The area has undergone substantial stream erosion, weathering, and faulting followed by rejuvenated, sporadic, scattered volcanism. Two major stratigraphic units are found in the Lihue basin (fig. 2): (1) the Waimea Canyon Basalt of Pliocene and Miocene (?) age which was erupted during the main shield-volcano-building stage of Kauai and forms the bulk of the island, including the mountains surrounding the Lihue basin, and (2) the Koloa Volcanics of Pleistocene and Pliocene age which include the rejuvenated-stage volcanic lava flows and sedimentary units that partly cover and fill the floor of the basin (Hinds, 1930; Stearns, 1946; Macdonald and others, 1960). Both the Waimea Canyon Basalt and the Koloa Volcanics have been given formational rank (Langenheim and Clague, 1987).

Kilohana Volcano, in the center of the southern half of the Lihue basin, is a prominent edifice of the Koloa Volcanics. Macdonald and others (1960) described the Lihue basin as a subsidiary caldera that formed to the east of a central main caldera of the Kauai shield volcano. Stearns (1946) described the basin as the result of advanced stream erosion and the coalescing of many amphitheater-headed valleys. Numerous subsequent geologic investigations include a gravity survey (Kivroy, and others, 1965), petrologic and geochemical analyses (Macdonald, 1968; Feigenson, 1984; Clague and Dalrymple, 1988; Maaloe and others, 1992), and radiometric dating (Clague and Dalrymple, 1988). These studies have advanced the understanding of the geology of Kauai, yet the origin of the Lihue basin remains an enigma.

Ground-water exploration in the Lihue basin has been only moderately successful, owing in part to the basin's complex ground-water hydrology. Most of the ground water in the Lihue basin is developed from wells in the Koloa Volcanics, which cover almost the entire basin floor. The Koloa Volcanics are generally considered to have low to moderate permeabilities (Macdonald and others, 1960), but specific capacities of wells in this unit are highly variable. Water levels during drilling in many of these wells declined with depth in the aquifer, indicating substantial vertical head gradients. At the base of the Koloa Volcanics and resting unconformably on the underlying Waimea Canyon Basalt, are the weathered rocks and sedimentary deposits that formed during the period of erosion between the shield-volcano eruptions and the rejuvenated volcanism. These deposits probably have low permeabilities and may retard the flow of water between the Koloa Volcanics and the Waimea Canyon Basalt.

The Waimea Canyon Basalt in the Lihue basin is represented by the Napali Member, the thick accumulations of thin lava flows that formed on the flank of the Kauai shield volcano. In western Kauai, the Napali Member is extensive and forms the most permeable aquifer on Kauai, but in the Lihue basin, the Napali Member crops out only in the mountains encircling the basin. It is not certain whether any of the wells drilled thus far in the center of the basin have penetrated the Koloa Volcanics and into the underlying Napali Member. Therefore, the thickness of the Koloa Volcanics and the hydrologic properties of the underlying Napali Member are unknown.

Location

The Puakukui Springs monitor well (State well 2-5626-01) is located along the southern edge of the Lihue basin among sugarcane fields on the north slope of Haupu Ridge. The site is on the east shoulder of a sugar plantation road near the northern entrance to the McBryde tunnel, about 2 mi south of the intersection of the plantation road with State Route 50. The well was assigned the well number 2-5626-01 by the State of Hawaii Commission on Water Resources Management using the State well numbering system (table 1).

Table 1. Location, elevation, and State number of the Puakukui Springs monitor well, Kauai, Hawaii
[Datum is mean sea level]

Latitude	21°56′30″N
Longitude	159°26′51″W
Ground elevation at brass plate in concrete pad	484.58 feet
Measuring-point elevation at top of 4-inch well casing	485.40 feet
Distance and direction from Lihue	5.7 miles southwest
Distance and direction from nearest shoreline	3.8 miles northwest
State well number	2-5626-01

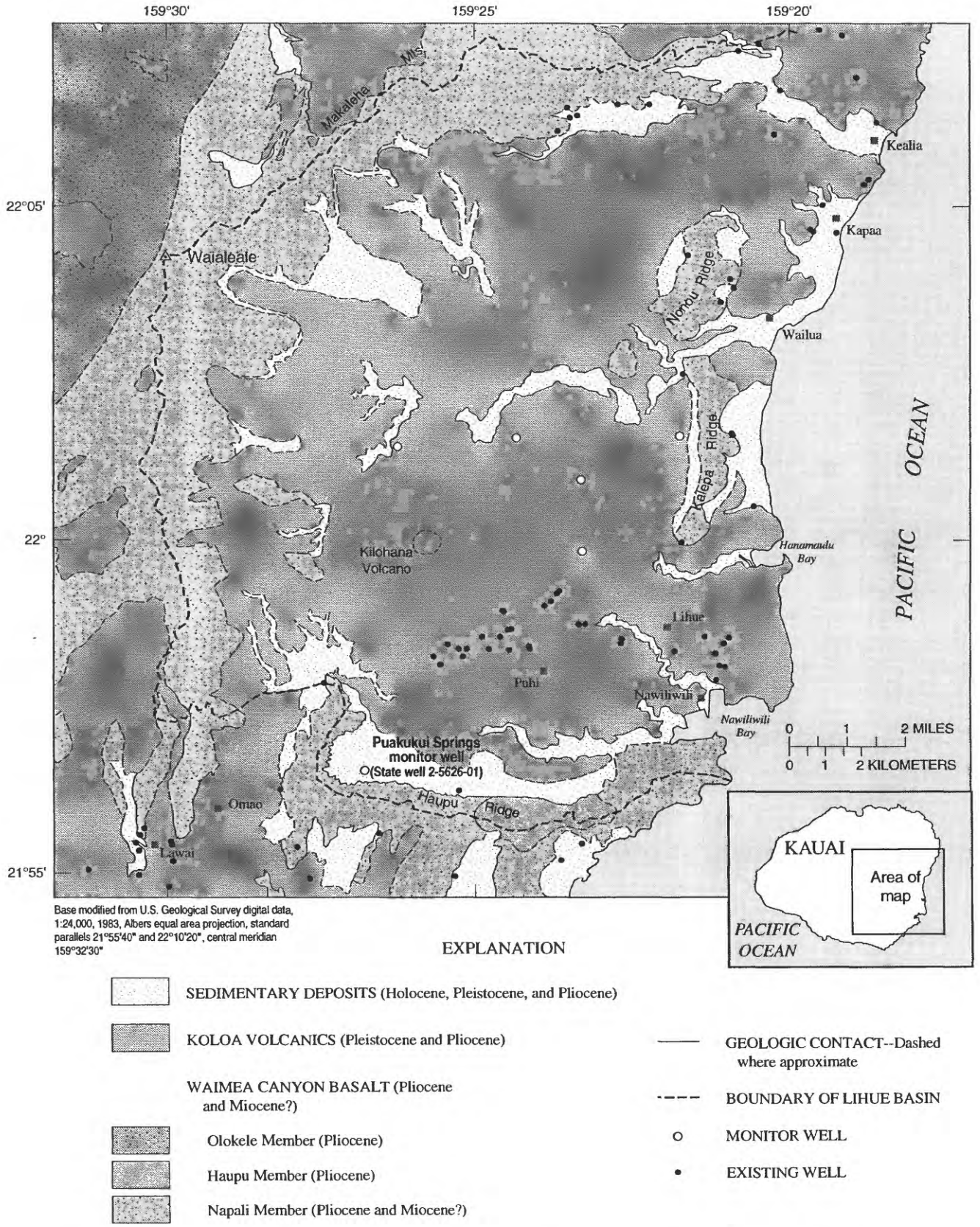


Figure 2. Geology of the Lihue basin area, Kauai, Hawaii (modified from Macdonald and others, 1960).

Table 2. Summary of construction of the Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii
[Datum for water-level and bottom-of-hole elevations is mean sea level. Land surface elevation is about 484 ft above mean sea level; ft, feet]

Date		Significant events
November 1995	1	Drilling began
	5	Surface casing installed
	21	Continued drilling from 228 ft elevation; increase in water lifted out of well at 128 ft, 108 ft, and 38 ft elevation; continued drilling to 26 ft elevation
	22	Water level before drilling about 173 ft elevation and bottom-of-hole 26 ft elevation; large increase in water lifted out of well at 10 to -17 ft elevation; continued drilling to -76 ft elevation
	27	Water level before drilling about 173 ft elevation and bottom-of-hole -76 ft elevation; possible increase in water lifted out of hole at -96 ft elevation; continued drilling to -136 ft elevation
	28	Water level before drilling about 173 ft elevation and bottom-of-hole -136 ft elevation; drilling terminated at -317 ft elevation (total depth of 802 ft)
December 1995	1	Water level 169.8 ft elevation; performed step-drawdown test
	4	Water level 169.4 ft elevation; began sustained pumping test at 306 gallons per minute
	11	Terminated sustained pumping test, drawdown of 13 ft, began recovery monitoring
January 1996	28	Installed PVC casing, well completed

The area within a 1 mi radius of the well is covered by a network of artificial and natural surface-water bodies. Waita Reservoir lies 0.8 mi to the south and Puakukui Stream, a tributary of Huleia Stream, is within 0.2 mi northwest of the well. The Puakukui Springs, which feed Puakukui Stream, are located within 0.7 mi of the well. A small irrigation ditch lies a few feet to the west of the site. The well is located about 3.8 mi inland of the eastern coast of Kauai.

Acknowledgments

The construction, data collection, and testing of the Puakukui Springs monitor well was made possible with the cooperation and assistance of Mr. Murl Nielsen, Manager and Chief Engineer, and the staff of the County of Kauai Department of Water. We are grateful to Mr. David Pratt and Mr. Gregg Kamm for permitting the construction of the well on Grove Farm Company, Inc. land. Drilling, aquifer-test, and elevation information were drawn extensively from the notes of G. Wayne Heick of the U.S. Geological Survey.

DRILLING METHODS AND HISTORY

The well was bored by rotary drilling with a 12-1/4-in. diameter tungsten-carbide bit. Air and foam were injected down through the hollow drill stem and circulated back up the space between the stem and the well boring to remove cuttings and water from the hole. Greater lifting power was needed as the drilling penetrated deeper below the water table. Table 2 summarizes the construction history of the well and shows that water levels remained steady at an elevation of 173 ft as the well was deepened. The drillers reported a noticeable increase in water being circulated from the hole at 128 ft elevation, 108 ft elevation, 38 ft elevation, in the interval between 10 and -17 ft elevation, and possibly at -96 ft elevation. Drilling was terminated at -317 ft elevation, a total depth of 802 ft. The elevation of the brass plate in the cement pad at the well is 484.58 ft and the elevation of the measuring point is 485.40 ft. Solid, flush-jointed 4-in. (outer diameter) PVC casing was installed in the well from 484 to 464 ft elevation. Construction details of the finished well are shown in figure 3.

GEOLOGIC LOG

The geologic log of the Puakukui Springs monitor well was compiled by examination of cuttings brought to the surface by the air and foam circulated through the well bore. Samples were collected at 5-ft depth intervals and air dried before being examined macroscopically. The complete lithologic descriptions appear in appendix 1; the geologic log is shown in figure 4.

The Puakukui Springs monitor well penetrated a 802-ft section of alluvium and mafic lava flows. The uppermost part of the section consists of a 20-ft layer of surface soil, and 250 ft of clay and deeply weathered

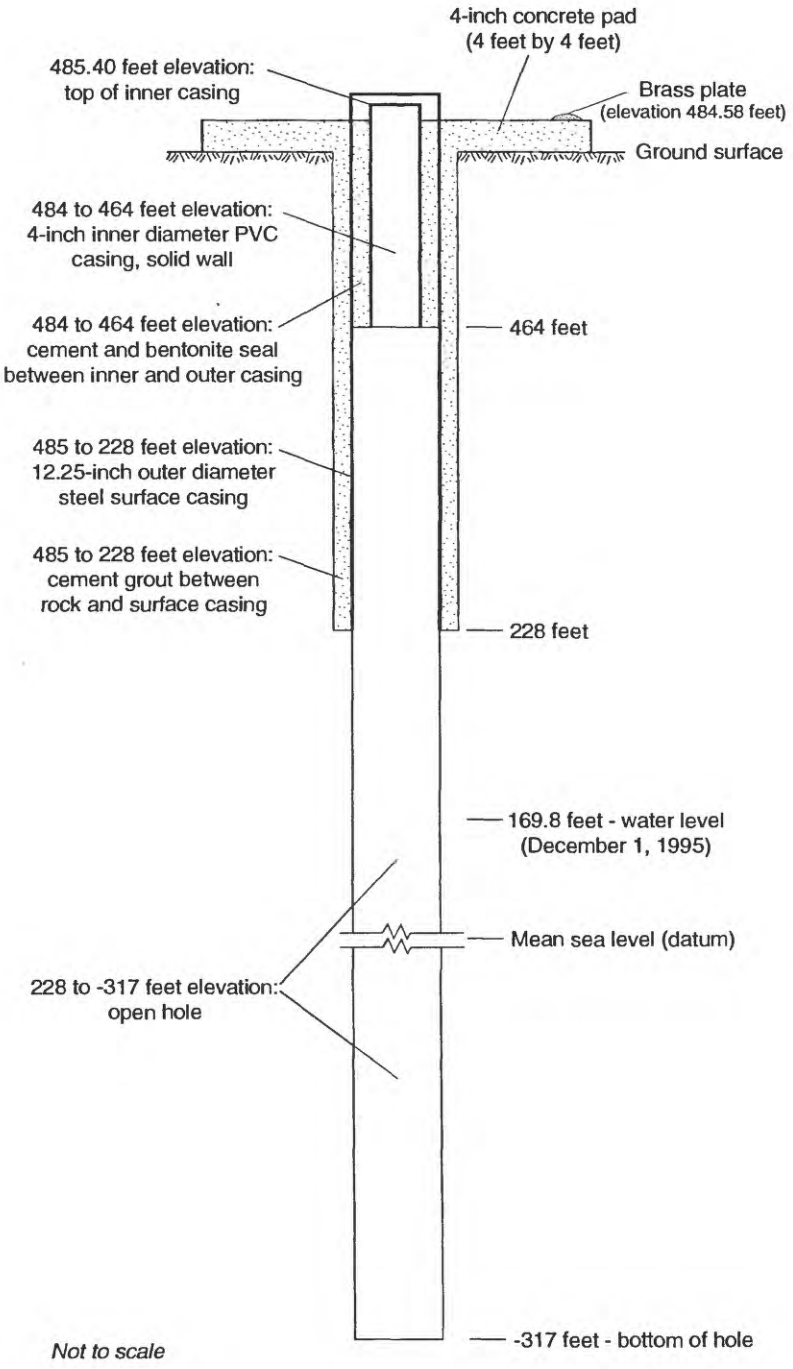


Figure 3. Construction details of the Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii.

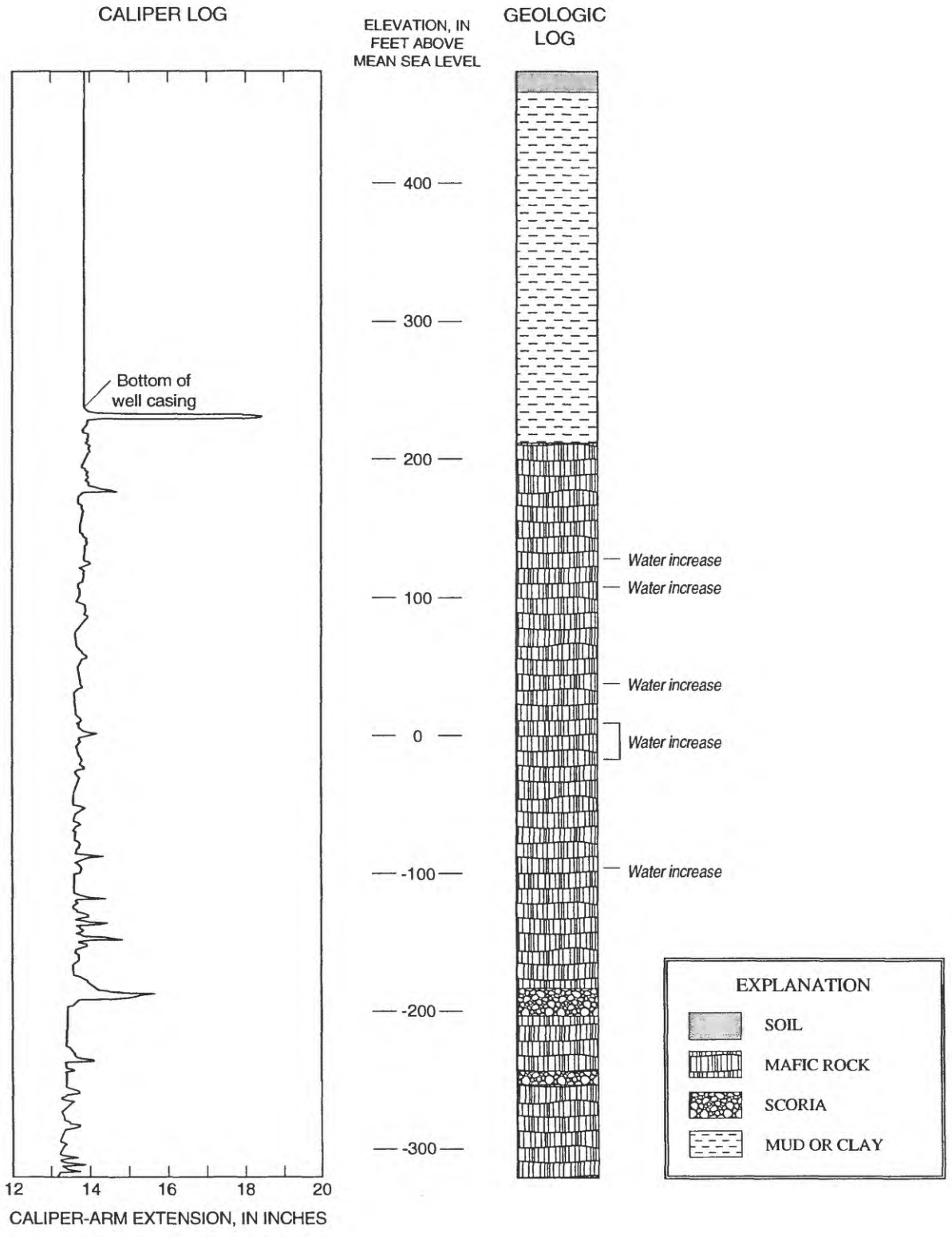


Figure 4. Geologic log and caliper-arm extension with depth in the Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii.

Table 3. Step-drawdown aquifer-test results, Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii
[min/ft^2, minutes per square foot; min^2/ft^5, minutes squared per feet raised to the fifth power]

Analysis method[1]	Aquifer loss, *B* (min/ft^2)	Well loss, *C* (min^2/ft^5)	Well loss at pumping rate of 306 gallons per minute (feet)
Hantush and Bierschenk	8.791×10^{-2}	2.193×10^{-3}	3.69
Eden and Hazel	2.530×10^{-2}	2.029×10^{-3}	3.42
Average	5.661×10^{-2}	2.111×10^{-3}	3.56

[1]Methods of analysis are documented in Kruseman and de Ridder (1994)

alluvium. The rest of the hole penetrated a thick section of vesicular mafic lava flows intermixed with layers of cinders. Cinder layers were noted in the intervals from 153 ft to 143 ft elevation, 83 ft to 73 ft elevation, -12 ft to -32 ft elevation, and -162 ft to -182 ft elevation.

AQUIFER TESTS

Two aquifer tests were performed at the Puakukui Springs monitor well; a step-drawdown test to measure the well efficiency, and a sustained-rate test which can be used to estimate aquifer properties in the vicinity of the well. The aquifer tests were conducted using a 50-horsepower, 6-in. diameter submersible pump with the intake elevation set at 19 ft. Measurements of the depth to water in the pumping well were made using an electric tape. The flow rate was determined using a totalizing flow meter.

The step-drawdown test, conducted on December 1, 1995 consisted of four 60-min steps at average withdrawal rates of 65, 141, 223, and 304 gal/min followed by 885 min of recovery monitoring (fig. 5 and appendix 2). The elevation of static water level at the start of the test was 169.78 ft. The data were analyzed to estimate the two components of drawdown in the pumped well: (1) the hydraulic head loss in the aquifer, and (2) the hydraulic head losses from water entering the well. Estimates of the aquifer loss and well loss shown in table 3 were obtained using the methods of Hantush and Bierschenk and Eden and Hazel in Kruseman and de Ridder (1994).

Values of drawdown measured in the pumped well during the sustained test were corrected by subtracting the estimated well loss at the measured pumping rate from the observed drawdown. Well loss at a specific pumping rate is calculated using:

$$s_w = CQ^2, \qquad (1)$$

where:

s_w = well loss, in feet;

C = coefficient of well loss, in minutes squared per feet raised to the fifth power; and

Q = pumping rate, in feet cubed per minute.

For an average pumping rate of 306 gal/min (41.04 ft^3/min), the estimated well loss from equation 1 is 3.56 ft.

The sustained-rate aquifer test was conducted from December 4–11, 1995 for 10,080 min (about 7 days) at an average rate of 306 gal/min; recovery was monitored for 8,940 min at the end of the test (appendix 3). The elevation of static water level at the start of the test was 169.40 ft. Flow rates during the test fluctuated between 308 and 305 gal/min. The maximum drawdown measured in the pumped well was 13.09 ft after 10,080 min into the test. After a correction for well loss, the drawdown in the aquifer was calculated to be 9.59 ft. The pumped water was discharged to an unlined ditch which flows into Puakukui Stream about 1,300 ft away from the pumping well.

A marked increase in drawdown at about 2,000 min into the sustained-rate test (fig. 6) is apparent in the plot. The record of pumping rate shows that the measured rate remained steady during this time period.

During the sustained-rate test, the pumped water was analyzed periodically for temperature and specific conductance, both of which remained steady throughout the test; temperatures ranged from 23.3 to 24.4°C and specific conductance ranged from 254 to 258 µS/cm.

SUMMARY

The Puakukui Springs monitor well (State well 2-5626-01) is located along the southern edge of the Lihue basin among sugarcane fields on the north slope of

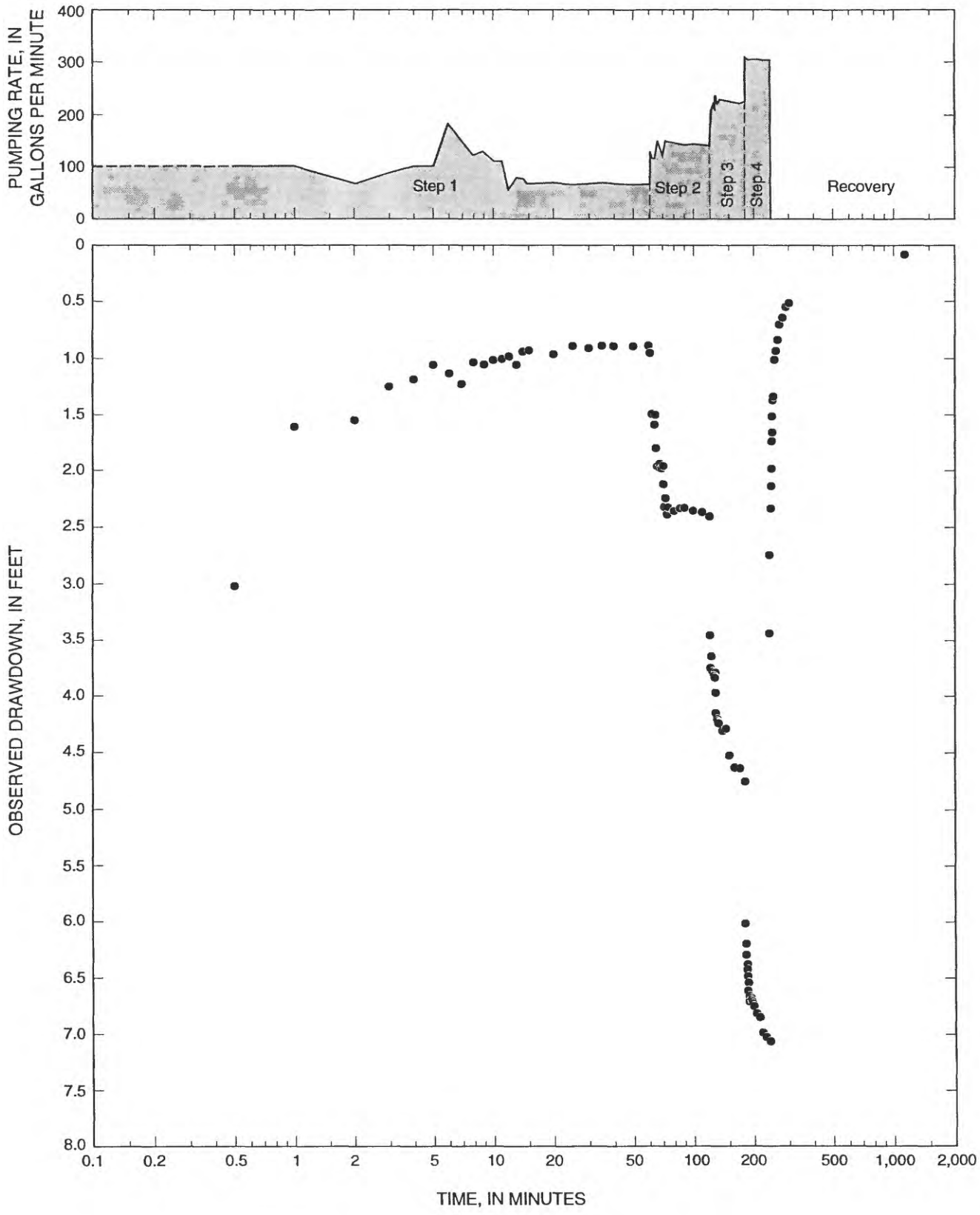


Figure 5. Drawdown with time during step-drawdown aquifer test (December 1, 1995), Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii.

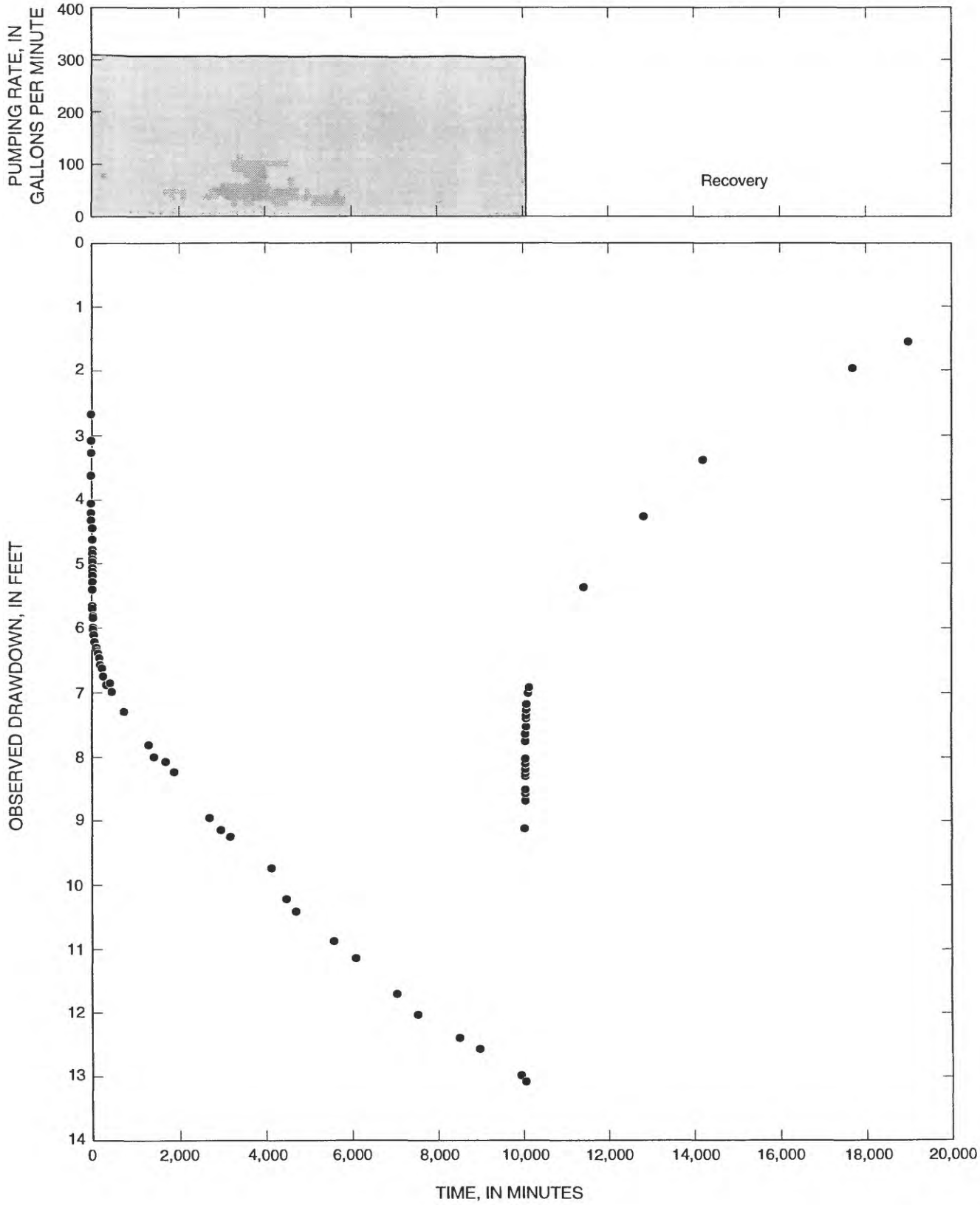


Figure 6. Drawdown with time during 7-day sustained-rate aquifer test (December 4–11, 1995), Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii.

Haupu Ridge. The well was constructed during the period from November 1, 1995 to January 28, 1996 to study the hydrology and geology in an area where no other well information is available. The brass plate in the cement pad at the well has an elevation of 484.58 feet and the well is 802 feet deep (bottom is at -317 feet elevation) and has a boring diameter of 12 inches. Flush-jointed 4-inch (outer diameter) PVC casing, perforated below the water table, was installed in the top 20 feet of the hole.

During drilling, water levels remained steady at about 173 feet elevation as the hole was deepened. The drillers reported a noticeable increase in water being circulated from the hole at 128 feet elevation, 108 feet elevation, 38 feet elevation, in the interval between 10 and -17 feet elevation, and possibly at -96 feet elevation. The Puakukui Springs monitor well penetrated a 802-foot section of alluvium and mafic lava flows.

Step-drawdown and 7-day sustained-pumping-rate tests were conducted to test aquifer properties. The maximum drawdown measured in the pumped well was 13.09 feet (initial water-level elevation was 169.40 feet) during 7 days of sustained pumping at an average rate of 306 gallons per minute. Well loss, analyzed from the step-drawdown data was estimated to be 3.56 feet for an average pumping rate of 306 gallons per minute. The temperature and specific conductance of the pumped water remained steady throughout the test.

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Appendix 1. Lithologic descriptions of drill cuttings from Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii
[Datum is mean sea level; depth measured from 483 feet above sea level]

Elevation (feet)			Depth (feet)			Sample description[1]
483	to	478	0	to	5	loose soil
478	to	473	5	to	10	loose soil
473	to	468	10	to	15	no sample
468	to	463	15	to	20	loose soil
463	to	458	20	to	25	red-brown, sticky clay
458	to	453	25	to	30	red-brown, sticky clay
453	to	448	30	to	35	red-brown, sticky clay
448	to	443	35	to	40	red-brown, sticky clay
443	to	438	40	to	45	red-brown, sticky clay
438	to	433	45	to	50	red-brown, sticky clay
433	to	428	50	to	55	red-brown, sticky clay
428	to	423	55	to	60	red-brown, sticky clay
423	to	418	60	to	65	red-brown, sticky clay
418	to	413	65	to	70	red-brown, sticky clay
413	to	408	70	to	75	red-brown, sticky clay
408	to	403	75	to	80	red-brown, sticky clay
403	to	398	80	to	85	red-brown, sticky clay
398	to	393	85	to	90	red-brown, sticky clay
393	to	388	90	to	95	red-brown, sticky clay
388	to	383	95	to	100	red-brown, sticky clay
383	to	378	100	to	105	red-brown, sticky clay
378	to	373	105	to	110	red-brown, sticky clay
373	to	368	110	to	115	red-brown, sticky clay
368	to	363	115	to	120	red-brown, sticky clay
363	to	358	120	to	125	red-brown, sticky clay
358	to	353	125	to	130	red-brown, sticky clay
353	to	348	130	to	135	red-brown, sticky clay
348	to	343	135	to	140	red-brown, sticky clay
343	to	338	140	to	145	red-brown, sticky clay
338	to	333	145	to	150	red-brown, sticky clay
333	to	328	150	to	155	red-brown, sticky clay
328	to	323	155	to	160	red-brown, sticky clay
323	to	318	160	to	165	red-brown, sticky clay
318	to	313	165	to	170	red-brown, sticky clay
313	to	308	170	to	175	red-brown, sticky clay
308	to	303	175	to	180	red-brown, sticky clay
303	to	298	180	to	185	red-brown, sticky clay
298	to	293	185	to	190	red-brown, sticky clay
293	to	288	190	to	195	red-brown, sticky clay
288	to	283	195	to	200	red-brown, sticky clay
283	to	278	200	to	205	no sample
278	to	273	205	to	210	red-brown, sticky clay
273	to	268	210	to	215	red-brown, sticky clay
268	to	263	215	to	220	red-brown, sticky clay
263	to	258	220	to	225	red-brown, sticky clay
258	to	253	225	to	230	red-brown, sticky clay
253	to	248	230	to	235	red-brown, sticky clay
248	to	243	235	to	240	red-brown, sticky clay
243	to	238	240	to	245	red-brown, sticky clay
238	to	233	245	to	250	dark-brown clay and weathered gravel
233	to	228	250	to	255	no sample
228	to	223	255	to	260	no sample
223	to	218	260	to	265	dark-brown clay and weathered gravel
218	to	213	265	to	270	dark-brown clay and weathered gravel
213	to	208	270	to	275	light-brownish-grey, weathered mafic rock
208	to	203	275	to	280	light-brownish-grey, weathered mafic rock
203	to	198	280	to	285	light-brownish-grey, weathered mafic rock
198	to	193	285	to	290	light-grey, weathered mafic rock
193	to	188	290	to	295	light-grey, weathered mafic rock

Appendix 1. Lithologic descriptions of drill cuttings from Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii --Continued

[Datum is mean sea level; depth measured from 483 feet above sea level]

Elevation (feet)			Depth (feet)			Sample description[1]
188	to	183	295	to	300	light-grey, weathered mafic rock
183	to	178	300	to	305	light-grey, weathered mafic rock
178	to	173	305	to	310	light-grey, weathered mafic rock
173	to	168	310	to	315	light-grey, weathered mafic rock
168	to	163	315	to	320	light-grey, weathered mafic rock
163	to	158	320	to	325	light-grey, moderately weathered, vesicular mafic rock
158	to	153	325	to	330	light-grey, moderately weathered, vesicular mafic rock
153	to	148	330	to	335	grey to reddish-grey, vesicular, aphyric mafic rock
148	to	143	335	to	340	grey to reddish-grey, vesicular, aphyric mafic rock
143	to	138	340	to	345	light-grey, moderately weathered, vesicular mafic rock
138	to	133	345	to	350	medium-grey, vesicular, aphyric mafic rock
133	to	128	350	to	355	medium-grey, vesicular, aphyric mafic rock
128	to	123	355	to	360	medium-grey, vesicular, aphyric mafic rock
123	to	118	360	to	365	brownish-dark-grey, vesicular, aphyric mafic rock
118	to	113	365	to	370	brownish-dark-grey, vesicular, aphyric mafic rock
113	to	108	370	to	375	brownish-dark-grey, vesicular, aphyric mafic rock
108	to	103	375	to	380	brownish-dark-grey, vesicular, aphyric mafic rock
103	to	98	380	to	385	dark-grey, vesicular, aphyric mafic rock
98	to	93	385	to	390	brownish-dark-grey, vesicular, aphyric mafic rock
93	to	88	390	to	395	brownish-dark-grey, vesicular, aphyric mafic rock
88	to	83	395	to	400	brownish-dark-grey, vesicular, aphyric mafic rock
83	to	78	400	to	405	dark-grey to red-brown, highly vesicular mafic rock
78	to	73	405	to	410	dark-grey to red-brown, highly vesicular mafic rock
73	to	68	410	to	415	yellowish-grey, weathered, vesicular mafic rock
68	to	63	415	to	420	yellowish-grey, weathered, vesicular mafic rock
63	to	58	420	to	425	dark-grey to reddish-grey, vesicular mafic rock
58	to	53	425	to	430	light-grey, weathered, vesicular mafic rock
53	to	48	430	to	435	light-grey, weathered, vesicular mafic rock
48	to	43	435	to	440	dark-grey to reddish-grey, vesicular mafic rock
43	to	38	440	to	445	dark-grey to reddish-grey, vesicular mafic rock
38	to	33	445	to	450	dark-grey to reddish-grey, vesicular mafic rock
33	to	28	450	to	455	dark-grey to reddish-grey, vesicular mafic rock
28	to	23	455	to	460	dark-grey to reddish-grey, vesicular mafic rock
23	to	18	460	to	465	dark-grey to reddish-grey, vesicular mafic rock
18	to	13	465	to	470	medium-grey, partly weathered, vesicular mafic rock
13	to	8	470	to	475	medium-grey, partly weathered, vesicular mafic rock
8	to	3	475	to	480	dark-grey, unweathered, vesicular mafic rock
3	to	-2	480	to	485	dark-grey, unweathered, vesicular mafic rock
-2	to	-7	485	to	490	dark-grey, unweathered, vesicular mafic rock
-7	to	-12	490	to	495	dark-grey, unweathered, vesicular mafic rock
-12	to	-17	495	to	500	red-grey, vesicular mafic rock
-17	to	-22	500	to	505	red-grey, vesicular mafic rock
-22	to	-27	505	to	510	red-grey, vesicular mafic rock
-27	to	-32	510	to	515	red-grey to brown-grey, vesicular mafic rock
-32	to	-37	515	to	520	medium-brownish-grey, slightly weathered, vesicular mafic rock
-37	to	-42	520	to	525	medium-brownish-grey, slightly weathered, vesicular mafic rock
-42	to	-47	525	to	530	medium-brownish-grey, slightly weathered, vesicular mafic rock
-47	to	-52	530	to	535	medium-brownish-grey, slightly weathered, vesicular mafic rock
-52	to	-57	535	to	540	medium-brownish-grey, slightly weathered, vesicular mafic rock
-57	to	-62	540	to	545	grey, unweathered mafic rock with rounded vesicles and some olivine
-62	to	-67	545	to	550	grey, unweathered mafic rock with rounded vesicles and some olivine
-67	to	-72	550	to	555	grey, unweathered mafic rock with rounded vesicles and some olivine
-72	to	-77	555	to	560	light-grey, dense, slightly vesicular olivine mafic rock
-77	to	-82	560	to	565	light-grey, dense, slightly vesicular olivine mafic rock
-82	to	-87	565	to	570	light-grey, dense, slightly vesicular olivine mafic rock
-87	to	-92	570	to	575	dark-grey to reddish-dark-grey, vesicular mafic rock
-92	to	-97	575	to	580	dark-grey to reddish-dark-grey, vesicular mafic rock
-97	to	-102	580	to	585	dark-grey to reddish-dark-grey, vesicular mafic rock
-102	to	-107	585	to	590	dark-grey to reddish-dark-grey, vesicular mafic rock

Appendix 1. Lithologic descriptions of drill cuttings from Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii --Continued

[Datum is mean sea level; depth measured from 483 feet above sea level]

Elevation (feet)			Depth (feet)			Sample description[1]
-107	to	-112	590	to	595	dark-grey to reddish-dark-grey, vesicular mafic rock
-112	to	-117	595	to	600	dark-grey to reddish-dark-grey, vesicular mafic rock
-117	to	-122	600	to	605	dark-grey to reddish-dark-grey, vesicular mafic rock
-122	to	-127	605	to	610	dark-grey to reddish-dark-grey, vesicular mafic rock
-127	to	-132	610	to	615	dark-grey to reddish-dark-grey, vesicular mafic rock
-132	to	-137	615	to	620	dark-grey to reddish-dark-grey, vesicular mafic rock
-137	to	-142	620	to	625	dark-grey to reddish-dark-grey, vesicular mafic rock
-142	to	-147	625	to	630	light-grey, weathered, vesicular mafic rock
-147	to	-152	630	to	635	light-grey, weathered, vesicular mafic rock
-152	to	-157	635	to	640	dark-grey to reddish-grey, vesicular, aphyric mafic rock
-157	to	-162	640	to	645	dark-grey to reddish-grey, vesicular, aphyric mafic rock
-162	to	-167	645	to	650	dark-grey to reddish-grey, vesicular, aphyric mafic rock
-167	to	-172	650	to	655	dark-grey to reddish-grey, vesicular, aphyric mafic rock
-172	to	-177	655	to	660	brownish-grey, slightly weathered, vesicular mafic rock
-177	to	-182	660	to	665	grey, unweathered, vesicular mafic rock
-182	to	-187	665	to	670	dark-reddish-brown scoria
-187	to	-192	670	to	675	dark-reddish-brown scoria
-192	to	-197	675	to	680	red-grey scoria
-197	to	-202	680	to	685	red-grey scoria
-202	to	-207	685	to	690	medium-grey, moderately vesicular, olivine mafic rock
-207	to	-212	690	to	695	medium-grey, moderately vesicular olivine mafic rock
-212	to	-217	695	to	700	dark-reddish-brown scoria
-217	to	-222	700	to	705	dark-grey to red grey, vesicular mafic rock
-222	to	-227	705	to	710	dark-grey to red grey, vesicular mafic rock
-227	to	-232	710	to	715	dark-grey to red grey, vesicular mafic rock
-232	to	-237	715	to	720	dark-grey to red grey, vesicular mafic rock
-237	to	-242	720	to	725	light-grey, weathered, vesicular mafic rock
-242	to	-247	725	to	730	red-grey scoria
-247	to	-252	730	to	735	red-grey scoria
-252	to	-257	735	to	740	dark-grey, vesicular, olivine mafic rock
-257	to	-262	740	to	745	dark-grey, vesicular, olivine mafic rock
-262	to	-267	745	to	750	brownish-dark-grey, slightly weathered mafic rock
-267	to	-272	750	to	755	brownish-dark-grey, slightly weathered mafic rock
-272	to	-277	755	to	760	medium-dark-grey, vesicular mafic rock
-277	to	-282	760	to	765	medium-dark-grey, vesicular mafic rock
-282	to	-287	765	to	770	brownish-grey, slightly weathered, vesicular mafic rock
-287	to	-292	770	to	775	grey, vesicular mafic rock
-292	to	-297	775	to	780	brownish-grey, slightly weathered, vesicular mafic rock
-297	to	-302	780	to	785	brownish-grey, vesicular mafic rock
-302	to	-307	785	to	790	brownish-grey, slightly weathered, vesicular mafic rock
-307	to	-312	790	to	795	brownish-grey, slightly weathered, vesicular mafic rock
-312	to	-317	795	to	800	light- to medium-grey, slightly weathered, vesicular mafic rock
-317	to	-322	800	to	805	brownish-grey, slightly weathered, vesicular mafic rock

[1] Cuttings from rotary drilling lifted by air, foam, and polymer; sample repository: U.S. Geological Survey, Hawaii District office; Date of logging: February, 1996

Appendix 2. Data from step-drawdown aquifer test, December 1, 1995, Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii

[min, minutes; ft, feet; gal/min, gallons per minute; depth to water measured from 486.07 ft above mean sea level; -, no measurement made]

Time (min)	Depth to water (ft)	Drawdown (ft)	Pumping rate (gal/min)
0	316.29	0	0
0.5	319.32	3.03	100
1	317.91	1.62	100
2	317.85	1.56	68
3	317.55	1.26	88
4	317.48	1.19	100
5	317.36	1.07	100
6	317.43	1.14	180
7	317.53	1.24	150
8	317.33	1.04	120
9	317.35	1.06	128
10	317.31	1.02	110
11	317.30	1.01	110
12	317.28	0.99	55
13	317.35	1.06	76
14	317.24	0.95	76
15	317.23	0.94	66
20	317.26	0.97	68
25	317.19	0.90	64
30	317.21	0.92	66
35	317.19	0.90	68
40	317.19	0.90	66
50	317.19	0.90	65
60	317.19	0.90	65
61	317.25	0.96	128
62	317.79	1.50	116
63	317.88	1.59	116
64	317.80	1.51	116
65	318.09	1.80	132
66	318.26	1.97	148
67	318.27	1.98	148
68	318.23	1.94	132
69	318.28	1.99	132
70	318.25	1.96	120
71	318.42	2.13	140
72	318.62	2.33	148
73	318.54	2.25	148
74	318.68	2.39	148
75	318.62	2.33	148
80	318.66	2.37	146
85	318.63	2.34	143
90	318.63	2.34	142
100	318.65	2.36	143
110	318.67	2.38	141
120	318.71	2.42	141
121	319.75	3.46	-
122	319.94	3.65	208
123	320.05	3.76	-
124	320.09	3.80	-
125	320.09	3.80	-
126	320.12	3.83	-
127	320.13	3.84	220
128	320.11	3.82	208
129	320.27	3.98	236
130	320.45	4.16	-
131	320.50	4.21	220
132	320.53	4.24	-
133	320.52	4.23	-

Appendix 2. Data from step-drawdown aquifer test, December 1, 1995, Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii--Continued

[min, minutes; ft, feet; gal/min, gallons per minute; depth to water measured from 486.07 ft above mean sea level; -, no measurement made]

Time (min)	Depth to water (ft)	Drawdown (ft)	Pumping rate (gal/min)
134	320.53	4.24	224
135	320.54	4.25	228
140	320.61	4.32	-
145	320.59	4.30	-
150	320.82	4.53	-
160	320.93	4.64	-
170	320.94	4.65	222
180	321.05	4.76	226
181	322.31	6.02	-
182	322.49	6.20	307
183	322.59	6.30	305
184	322.68	6.39	-
185	322.72	6.43	303
186	322.78	6.49	-
187	322.84	6.55	-
188	322.91	6.62	-
189	322.96	6.67	-
190	323.00	6.71	-
191	322.98	6.69	305
192	322.97	6.68	-
193	322.98	6.69	-
194	322.99	6.70	-
195	323.02	6.73	305
200	323.05	6.76	-
205	323.11	6.82	-
210	323.15	6.86	305
220	323.29	7.00	304
230	323.33	7.04	304
240	323.36	7.07	304
241	319.74	3.45	0
242	319.05	2.76	0
243	318.63	2.34	0
244	318.43	2.14	0
245	318.28	1.99	0
246	318.04	1.75	0
247	317.96	1.67	0
248	317.81	1.52	0
249	317.67	1.38	0
250	317.64	1.35	0
255	317.31	1.02	0
260	317.23	0.94	0
265	317.13	0.84	0
270	317.00	0.71	0
280	316.94	0.65	0
290	316.84	0.55	0
300	316.81	0.52	0
1,125	316.38	0.09	0

Appendix 3. Data from 7-day sustained-rate aquifer test, December 4–11, 1995, Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii

[min, minutes; ft, feet; gal/min, gallons per minute; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C; static water level at start of test was 169.40 feet above mean sea level; depth to water measured from 486.07 feet above mean sea level; -, no measurement made]

Time (min)	Depth to water (ft)	Drawdown (ft)	Pumping rate (gal/min)	Drawdown, corrected for well loss (ft)	Temperature (° C)	Specific conductance (µS/cm)
0	316.67	0	0	0	-	-
0.25	319.35	2.68	-	-0.82	-	-
0.5	319.77	3.10	-	-0.40	-	-
1	319.95	3.28	307	-0.22	-	-
2	320.31	3.64	-	0.14	-	-
3	320.75	4.08	-	0.58	-	-
4	320.91	4.24	-	0.74	-	-
5	321.01	4.34	-	0.84	-	-
6	321.13	4.46	305	0.96	-	-
7	321.31	4.64	-	1.14	-	-
8	321.47	4.80	-	1.30	-	-
9	321.63	4.96	-	1.46	-	-
10	321.54	4.87	305	1.37	-	-
11	321.67	5.00	-	1.50	-	-
12	321.76	5.09	-	1.59	-	-
13	321.82	5.15	-	1.65	-	-
14	321.90	5.23	-	1.73	-	-
15	321.98	5.31	305	1.81	-	-
20	322.12	5.45	-	1.95	-	-
25	322.37	5.70	-	2.20	-	-
30	322.39	5.72	-	2.22	-	-
35	322.43	5.76	-	2.26	-	-
40	322.53	5.86	-	2.36	-	-
50	322.69	6.02	306	2.52	-	-
60	322.72	6.05	307	2.55	-	-
70	322.73	6.06	-	2.56	-	-
80	322.81	6.14	307	2.64	-	-
90	322.89	6.22	307	2.72	-	-
100	322.91	6.24	-	2.74	-	-
120	323.00	6.33	307	2.83	-	-
140	323.07	6.40	307	2.90	23.9	258
160	323.09	6.42	307	2.92	-	-
180	323.16	6.49	308	2.99	-	-
210	323.26	6.59	306	3.09	-	-
240	323.32	6.65	306	3.15	-	-
300	323.46	6.79	307	3.29	23.8	258
360	323.57	6.90	307	3.40	-	-
420	323.55	6.88	308	3.38	23.6	257
480	323.69	7.02	308	3.52	-	-
780	323.99	7.32	308	3.82	-	-
1,320	324.51	7.84	307	4.34	23.6	256
1,440	324.69	8.02	307	4.52	-	-
1,680	324.77	8.10	307	4.60	24.0	256
1,920	324.94	8.27	307	4.77	23.6	256
2,760	325.66	8.99	307	5.49	23.6	256
3,000	325.84	9.17	306	5.67	-	-
3,240	325.95	9.28	307	5.78	24.0	254
4,200	326.44	9.77	307	6.27	23.7	255
4,500	326.91	10.24	306	6.74	-	-

Appendix 3. Data from 7-day sustained-rate aquifer test, December 4–11, 1995, Puakukui Springs monitor well (State well 2-5626-01), Kauai, Hawaii--Continued

[min, minutes; ft, feet; gal/min, gallons per minute; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C; static water level at start of test was 169.40 feet above mean sea level; depth to water measured from 486.07 feet above mean sea level; -, no measurement made]

Time (min)	Depth to water (ft)	Drawdown (ft)	Pumping rate (gal/min)	Drawdown, corrected for well loss (ft)	Temperature (° C)	Specific conductance (µS/cm)
4,740	327.11	10.44	306	6.94	23.8	255
5,640	327.57	10.90	307	7.40	24.0	255
6,120	327.83	11.16	307	7.66	24.1	256
7,080	328.41	11.74	306	8.24	23.9	255
7,560	328.72	12.05	306	8.55	24.4	254
8,520	329.09	12.42	306	8.92	23.3	257
9,000	329.26	12.59	306	9.09	24.1	255
9,960	329.67	13.00	306	9.50	23.3	257
10,080	329.76	13.09	306	9.59	-	-
10,082	325.82	9.15	0	9.15	-	-
10,083	325.38	8.71	0	8.71	-	-
10,084	325.26	8.59	0	8.59	-	-
10,085	325.21	8.54	0	8.54	-	-
10,086	324.99	8.32	0	8.32	-	-
10,087	324.94	8.27	0	8.27	-	-
10,088	324.87	8.20	0	8.20	-	-
10,089	324.78	8.11	0	8.11	-	-
10,090	324.73	8.06	0	8.06	-	-
10,095	324.43	7.76	0	7.76	-	-
10,100	324.32	7.65	0	7.65	-	-
10,105	324.21	7.54	0	7.54	-	-
10,110	324.08	7.41	0	7.41	-	-
10,120	324.02	7.35	0	7.35	-	-
10,130	323.95	7.28	0	7.28	-	-
10,140	323.88	7.21	0	7.21	-	-
10,170	323.70	7.03	0	7.03	-	-
10,200	323.61	6.94	0	6.94	-	-
11,490	322.06	5.39	0	5.39	-	-
12,860	320.96	4.29	0	4.29	-	-
14,250	320.06	3.39	0	3.39	-	-
17,700	318.65	1.98	0	1.98	-	-
19,020	318.24	1.57	0	1.57	-	-