DRILLING, CONSTRUCTION, AND CALIPER-LOG DATA FOR WELL 3-3503-01, NORTH UPPER ANAHULU EXPLORATORY WELL, OAHU, HAWAII

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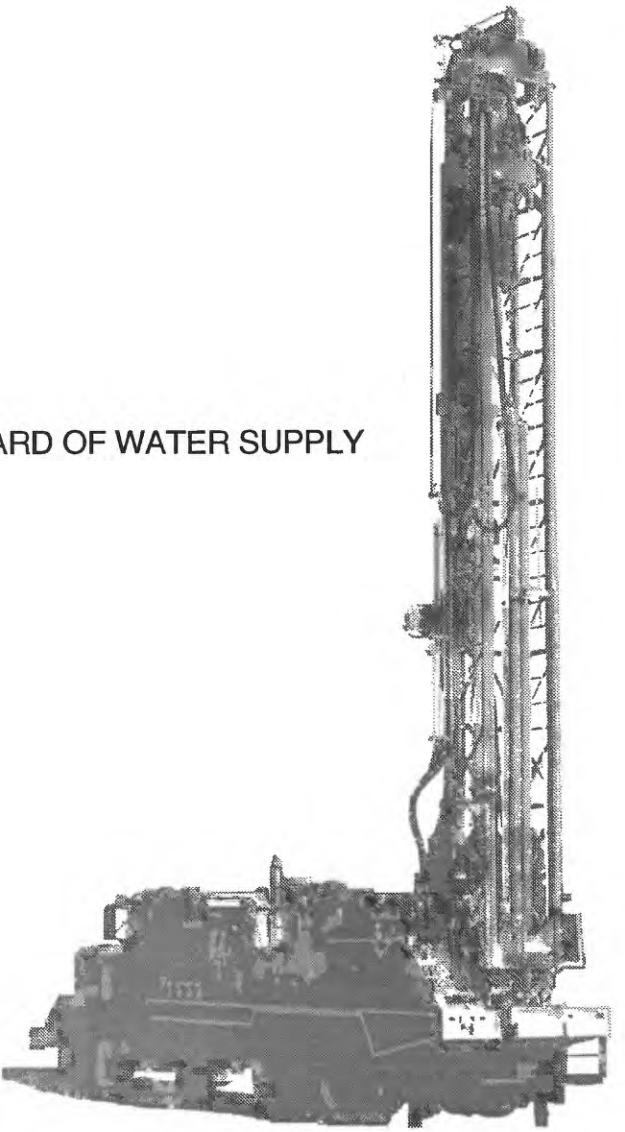

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CONTENTS

FIGURES

TABLES

Conversion Factors

Multiply	By	To obtain
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
inch (in.)	25.4	millimeter

Elevations in this report are referenced relative to mean sea level.

Drilling, Construction, and Caliper-Log Data for Well 3-3503-01, North Upper Anahulu Exploratory Well, Oahu, Hawaii

By Todd K. Presley and Delwyn S. Oki

Abstract

The North Upper Anahulu exploratory well (Hawaii State well number 3-3503-01) was drilled about 3.1 miles east of the town of Haleiwa. The well is located on agricultural land in the Kawailoa ground-water area. The well was drilled to an elevation of about -103 feet below mean sea level and penetrates about 110 feet into a basalt aquifer. Well-construction data, logs of drilling notes, geologic descriptions for the samples, and caliper-log data are presented for the well. The well is one of 12 exploratory wells drilled in the north-central Oahu area between July 1993 and May 1994 in cooperation with the Honolulu Board of Water Supply.

INTRODUCTION

Because of water-supply concerns associated with population increase on the island of Oahu, the Honolulu Board of Water Supply, in cooperation with the U.S. Geological Survey (USGS), conducted a study to assess the availability of ground water in north-central Oahu. This study included drilling 12 exploratory and monitoring wells between July 1993 and May 1994.

This report presents drilling data for North Upper Anahulu exploratory well (Hawaii State well number 3-3503-01). The well is about 3.1 mi east of the town of Haleiwa (figs. 1 and 2). The purpose of the North Upper Anahulu exploratory well is to increase spatial coverage of water levels for the Kawailoa ground-water area (Rosenau and others, 1971; Dale, 1978; Hunt, in press) and to provide a water-level observation well for monitoring.

Regional Setting

The study area is located in north-central Oahu between the crests of the Koolau Range and the Waianae Range (fig. 1). Previous studies (Rosenau and others, 1971; Dale, 1978; Hunt, in press) that describe the physical and geological aspects of the study area are summarized here. The mountain ranges are the eroded remnants of two shield volcanoes. The Mokuleia and Waialua ground-water areas are separated by low-permeability paleosols and saprolite of the Waianae Volcano that lie below the geologic contact between the Waianae and Koolau Volcanoes. The Waialua and Kawailoa ground-water areas are separated by alluvium and weathered basalt in and beneath Anahulu Gulch. Seaward flow of ground water in the Mokuleia and Waialua ground-water areas is impeded by a coastal confining unit that is composed of marine and terrestrial sediment known locally as "caprock." The caprock creates a confined artesian condition at low elevations near the shore. Further inland however, the aquifer is unconfined.

Water levels in the Waialua and Kawailoa ground-water areas are about 12 ft and 4 ft, respectively, above mean sea level. Water levels in the Mokuleia ground-water area are about 20 ft. Withdrawal from the Waialua, Kawailoa and Mokuleia ground-water areas is primarily for sugarcane irrigation, although there are also several municipal wells and numerous small capacity private wells. Natural ground-water discharge occurs at springs and by subsurface flow through the caprock to the ocean (Rosenau and others, 1971).

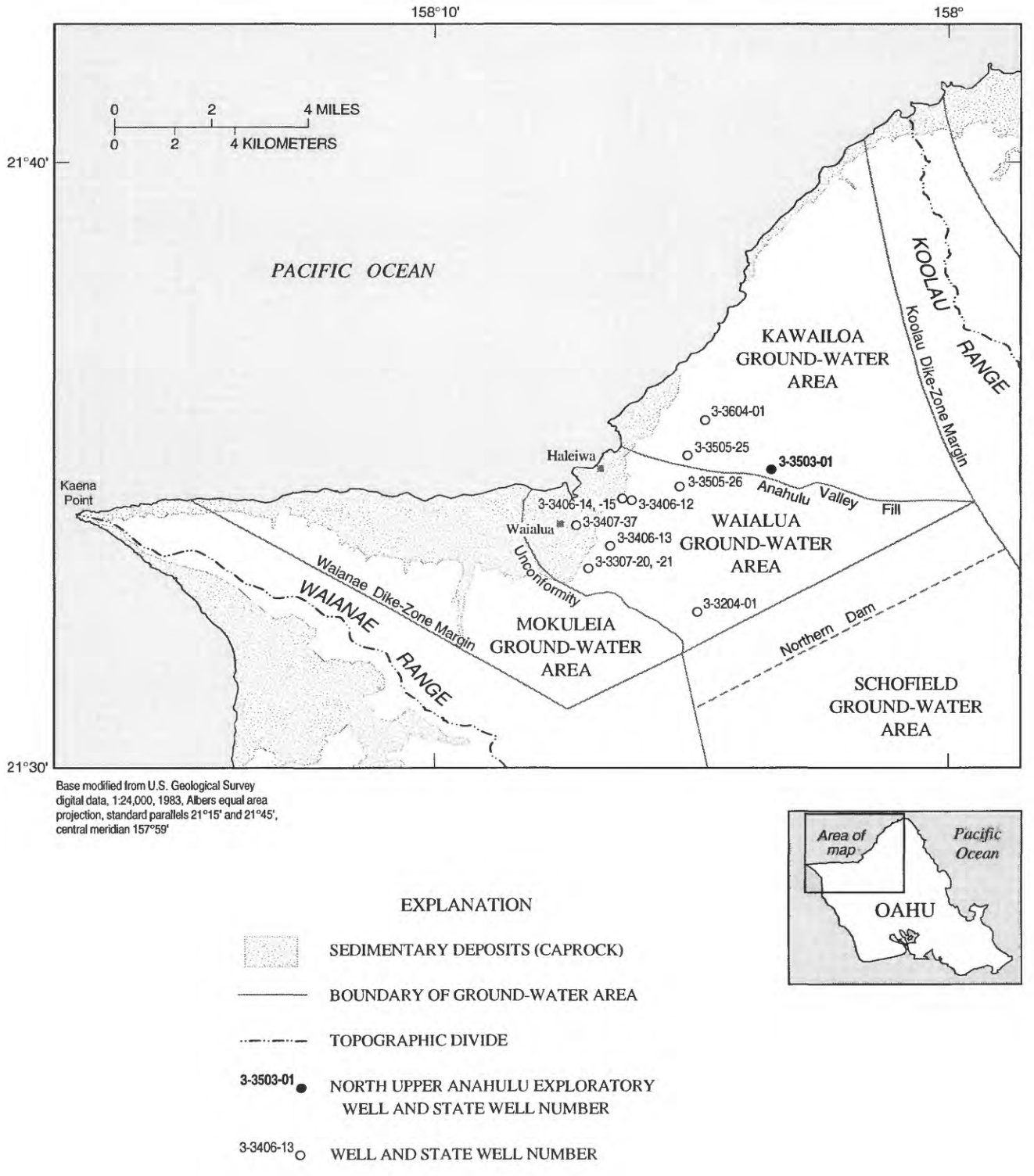

Figure 1. Ground-water areas of north-central Oahu (modified from Hunt, in press) and wells drilled during the study, Hawaii.

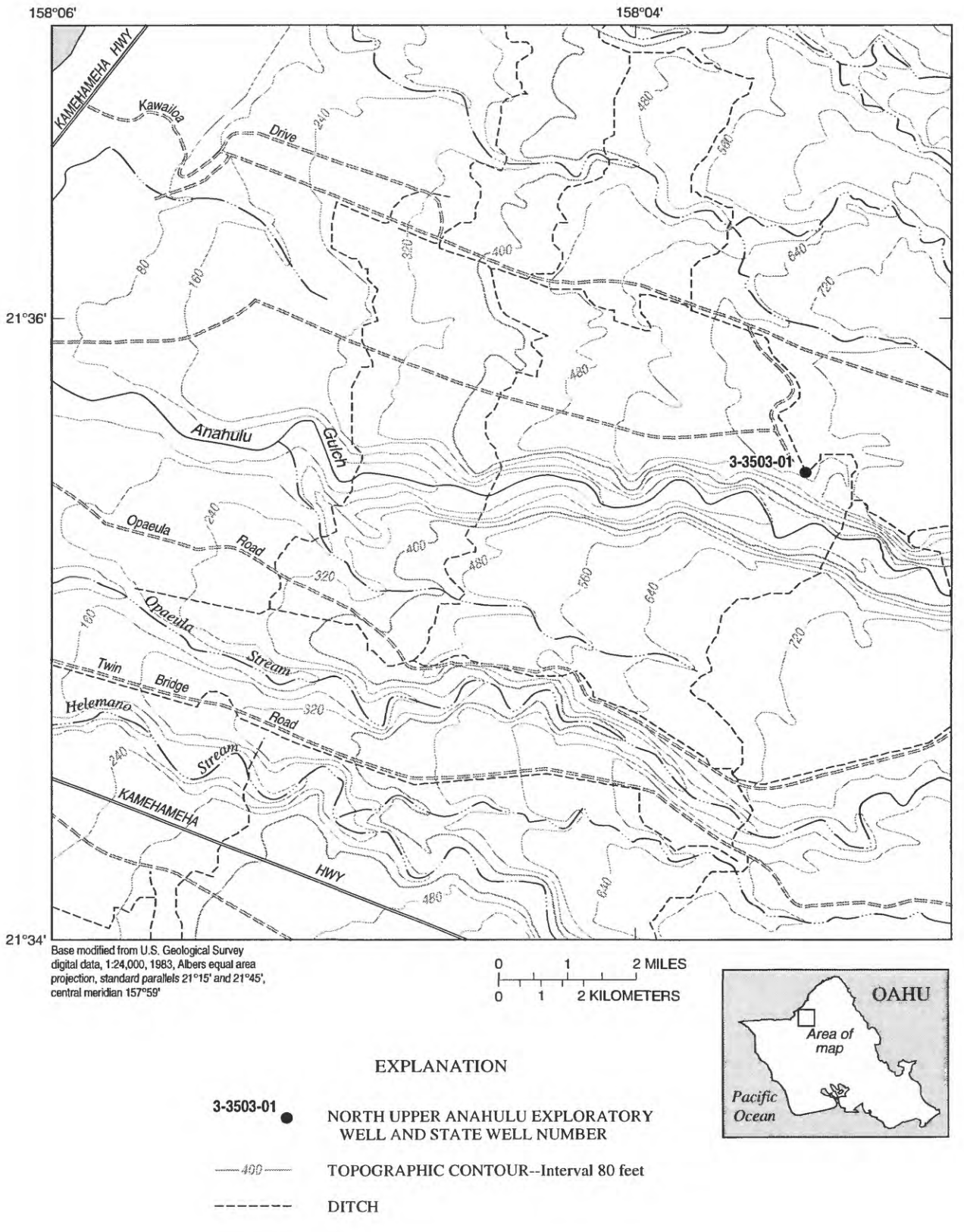

Figure 2. Location of North Upper Anahulu exploratory well, Oahu, Hawaii.

Acknowledgments

The USGS gratefully acknowledges the Waialua Sugar Company for their assistance in identifying and preparing the drill site. The USGS also thanks the Bernice Pauahi Bishop Estate for permission to drill on their land.

DRILLING, CONSTRUCTION, AND CALIPER-LOG DATA

The North Upper Anahulu exploratory well (State well number 3-3503-01) is 3.1 mi east of the town of Haleiwa on the north side of Anahulu Gulch (fig. 1). The site is located along a peripheral road of a sugarcane field (fig. 2). Well-construction data is provided in table 1 and construction details are shown in figure 3.

The North Upper Anahulu exploratory well was drilled using an air-rotary system with flush-jointed 4 1/2-in. diameter drill pipe. Drilling foam and polymer were injected into the air-circulation system to assist the removal of drill cuttings and to stabilize the hole. The elevation of the ground surface in the area of the drill site is about 670 ft above mean sea level. A 12 1/2-in. diameter hole was drilled to an elevation of 592 ft and cased with 80 ft of 8 5/8-in. outside-diameter steel casing. The annular space was grouted with cement to provide a surface seal. An 6 3/4-in. diameter tri-cone tungsten-carbide button bit was then used to drill to an elevation of -103. After the total depth was reached, a Well Reconnaissance logging unit was used to record a caliper log. The well was cased with 4 1/2-in. outside-diameter flush-jointed steel casing. Slotted, 4 1/2-in. outside-diameter steel casing was installed through the water column.

Samples of the materials expelled by the circulation system while drilling were collected every 5 ft. After a depth of 230 ft was reached, the circulation was completely absorbed by the formation and no sample was recovered. The geologic log (geologic descriptions of the recovered samples from drilling) is presented in table 2, and the driller's log (driller's observations while drilling) is presented in table 3. The geologic log shows that the bore penetrated about 65 ft of clay, 40 ft of weathered basalt, and 125 ft of basalt before the circulation was lost. Within the adjacent gulch, numerous cores of aa lava flows of about 30 ft thickness are visible.

The caliper log (fig. 4) shows a few hole enlargements where the caliper arms extend up to about 11 in. between the elevations of 430 to 380 ft and -40 to -80 ft. The caliper tool has three 16-in. spring-loaded arms that

Table 1. Construction data for North Upper Anahulu exploratory well, Oahu, Hawaii
[Elevation datum of mean sea level; in., inch; ft, foot; od, outside diameter]

Well name	North Upper Anahulu exploratory well
State well number	3-3503-01
Latitude and longitude	21°35'30"N, 158°03'25"W
Hawaii tax map key number	6-2-09-1
Landowner	Bernice Pauahi Bishop Estate
Leaseholder	Waialua Sugar Company
Well completed	May 5, 1994
Working days to complete	8 days
Driller	Wayne Heick, USGS
Surface hole diameter	12 1/2 in.
Bottom of surface casing elevation	592 ft
Surface casing diameter and type	8 5/8-in. od steel, 0.188-in. thick wall
Final hole diameter	6 3/4 in.
Bottom of well elevation	-103 ft
Open interval elevations	592 ft to -103 ft
Screened interval elevations	17 ft above to -103 ft
Inner casing diameter and type	4 1/2-in. od steel, flush-jointed
Screen type	4 1/2-in. od steel, slots cut longitudinally, 0.25 x 3.0 in.
Reference mark elevation (bolt)	670.52 ft
Top of casing measuring point elevation	671.74 ft (top of 4.5-in. inner steel casing)
Water level and date of measurement	7.15 ft, February 14, 1995

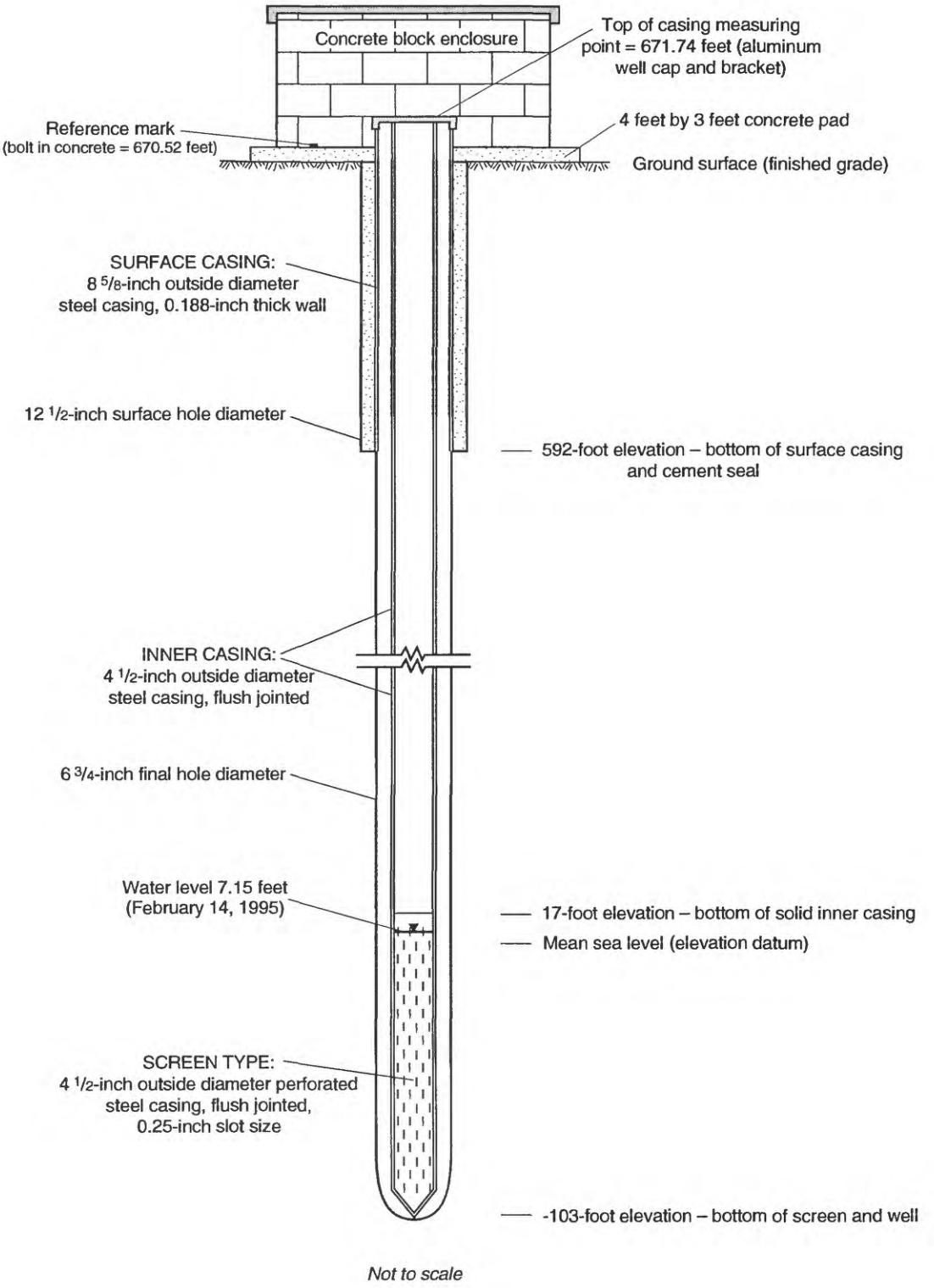

Figure 3. Construction details for North Upper Anahulu exploratory well (State well number 3-3503-01), Oahu, Hawaii.

are extended when the tool is at the bottom of the hole. As the tool is raised, the logging unit records the extension of the arms as they drag against the walls of the bore. The caliper extension is an indication of hole diameter and wall smoothness, but the instrument does not measure these attributes directly. The maximum extension for the caliper tool is 32 in.

The measuring point (elevation 671.74 ft) for water-level determination by measuring tape is located on the west-facing lock tab of the aluminum well-cap bracket affixed to the top of the 8 5/8-in. outside-diameter steel surface casing. An additional reference mark (elevation 670.52 ft) for the well site is located on the top of a stainless steel bolt emplaced into the concrete pad surrounding the well.

ADDITIONAL INFORMATION

Information for the 12 wells drilled during the north-central Oahu study is listed in table 4. Nine of the wells were drilled in the Waialua ground-water area, and three wells were drilled north of Anahulu Gulch in the Kawailoa ground-water area, including the North Upper Anahulu exploratory well (State well number 3-3503-01). Water-level time-series data were collected for all of the wells drilled and for numerous other existing wells as part of the overall monitoring effort for the project (unpublished data in files of the USGS, Honolulu). Data were collected using electronic data loggers coupled to shaft encoder-float systems or pressure transducers.

Table 2. Geologic log for North Upper Anahulu exploratory well (State well number 3-3503-01), Oahu, Hawaii.
[Elevation datum is mean sea level]

Depth below grade (feet)	Elevation (feet)	Sample description	Comments
0 to 15	670 to 655	Dark-red clay	
15 to 20	655 to 650	Dark-red clay	
25 to 30	645 to 640	Light-brown clay	
30 to 35	640 to 635	Dark-brown clay	
35 to 40	635 to 630	Dark-brown clay	
40 to 45	630 to 625	Dark-brown clay	
45 to 50	625 to 620	Dark-brown clay	
50 to 55	620 to 615	Dark-brown clay	
55 to 60	615 to 610	Light-orangish clay	
60 to 65	610 to 605	Reddish-grey, weathered saprolite	
65 to 70	605 to 600	Greyish clay or pulverized grey rock	
70 to 75	600 to 595	Greyish clay or pulverized grey rock	
75 to 80	595 to 590	Greyish clay or pulverized grey rock	
80 to 85	590 to 585	Greyish clay or pulverized grey rock	
85 to 90	585 to 580	Light-brown, weathered basalt	
90 to 95	580 to 575	Light-brown, weathered basalt	
95 to 100	575 to 570	Brownish-grey, slightly vesicular, weathered basalt	
100 to 105	570 to 565	Brownish-grey, slightly vesicular, weathered basalt	
105 to 110	565 to 560	Dark-brownish-grey, slightly vesicular basalt	
125 to 130	545 to 540	Brownish-grey, massive basalt	
130[1]	540	Brownish-grey, massive basalt	
142[1]	528	Red-brown, vesicular, oxidized basalt	
144[1]	526	Dark-grey, massive basalt	pulverized sample
153[1]	517	Grey, slightly vesicular basalt	
173[1]	497	Reddish-grey, nonvesicular basalt	
193[1]	477	Reddish, vesicular basalt	
202[1]	468	Reddish-grey, vesicular basalt	
212[1]	458	Reddish-grey, vesicular basalt	
218[1]	452	Reddish-grey, slightly vesicular basalt	
223[1]	447	Reddish-grey, vesicular, slightly weathered basalt	
232[1]	438	Reddish-grey, nonvesicular basalt	

[1] Sample bags were labeled with one depth, presumably a point sample.

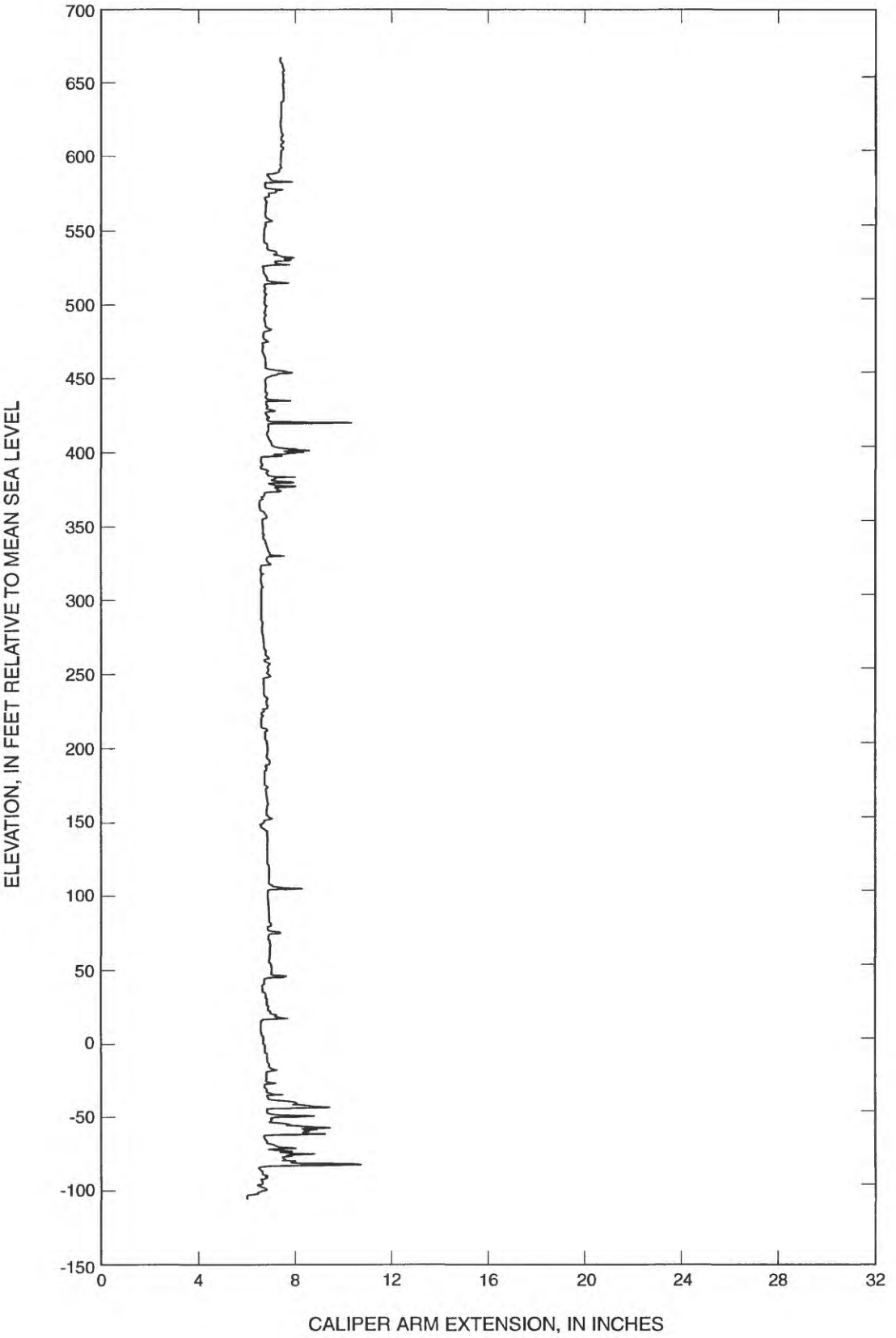

Figure 4. Caliper log for North Upper Anahulu exploratory well (State well number 3-3503-01), Oahu, Hawaii.

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Dale, R.H., 1978, A ground-water inventory of the Waialua basal-water body, island of Oahu, Hawaii: U.S. Geological Survey Open-File Report 78-24, 71 p.

Hunt, C.D., Jr., in press, Geohydrology of the island of Oahu, Hawaii: U.S. Geological Survey Professional Paper 1412-B.

Rosenau, J.C., Lubke, E.R., and Nakahara, R.H., 1971, Water resources of north-central Oahu, Hawaii: U.S. Geological Survey Water-Supply Paper 1899-D, 40 p.

Table 3. Driller's log for the North Upper Anahulu exploratory well (State well number 3-3503-01), Oahu, Hawaii.
[Elevation datum is mean sea level]

Depth below grade (feet)	Elevation (feet)	Description
0 to 31	670 to 639	Red-oxidized-brown clay, dry
31 to 53	639 to 617	Blue rock, decomposed, broken, medium-dry
53 to 63	617 to 607	Red oxidized rock, medium-soft, damp
63 to 79	607 to 591	Hard, blue rock
79 to 90	591 to 580	Red-brown, oxidized, medium-hard rock
90 to 106	580 to 564	Blue-gray, medium-hard rock
106 to 113	564 to 557	Red-brown rock, medium-hard, circulation lost
113 to 131	557 to 539	Very hard rock, no circulation
131 to 144	539 to 526	Red-brown, medium-soft rock, circulation returned
144 to 153	526 to 517	Blue-gray, very hard rock
153 to 173	517 to 497	Medium-hard, fractured rock, lost circulation
173 to 193	497 to 477	Red-Brown, medium-soft rock, circulation returned
193 to 213	477 to 457	Hard rock, good circulation
213 to 217	457 to 453	Medium-hard rock, fractured, lost circulation
217 to 221	453 to 449	Reddish, hard rock, circulation returned
221 to 233	449 to 437	Very hard rock, circulation lost
233 to 245	437 to 425	Reddish, medium-hard rock, circulation returned
245 to 248	425 to 422	Fractures and voids, circulation lost
248 to 265	422 to 405	Hard, broken rock, no circulation
265 to 269	405 to 401	Fractured, very soft, no circulation
269 to 273	401 to 397	Medium-soft rock, no circulation
273 to 290	397 to 380	Hard rock, some fractures, no circulation
290 to 295	380 to 375	Big void, clinkers, no circulation
295 to 312	375 to 358	Broken, fractured clinkers, no circulation
312 to 317	358 to 353	Large void, some clinkers, no circulation
317 to 329	353 to 341	Very broken, medium to soft rock, no circulation
329 to 340	341 to 330	Very hard rock, slow drilling, no circulation
340 to 369	330 to 301	Medium-soft rock, no circulation
369 to 393	301 to 277	Hard rock, no circulation
393 to 406	277 to 264	Very hard rock, slow drilling, no circulation
406 to 437	264 to 233	Medium-soft rock, no circulation
437 to 453	233 to 217	Very hard rock, slow drilling, no circulation
453 to 459	217 to 211	Void and soft clinkers, no circulation
459 to 467	211 to 203	Hard rock, slow drilling, no circulation
467 to 493	203 to 177	Medium-soft rock, no circulation
493 to 513	177 to 157	Hard rock, no circulation
513 to 527	157 to 143	Medium-soft rock, no circulation
527 to 535	143 to 135	Medium-hard rock, no circulation
535 to 565	135 to 105	Medium-soft rock, voids and clinkers, no circulation
565 to 572	105 to 98	Medium -hard rock with voids and clinkers, no circulation
572 to 601	98 to 69	Medium soft rock, voids and clinkers,
601 to 603	69 to 67	Soft, voids and clinkers,
603 to 612	67 to 58	Medium-hard rock, no circulation
612 to 617	58 to 53	Medium rock, no circulation
617 to 621	53 to 49	Hard rock, no circulation
621 to 636	49 to 34	Medium-soft rock, no circulation
636 to 641	34 to 29	Medium-hard rock, no circulation
641 to 668	29 to 2	Medium-soft rock, voids and fractures, no circulation
668 to 690	2 to -20	Hard rock, no circulation
690 to 695	-20 to -25	Voids and fractures, no circulation
695 to 708	-25 to -38	Medium-hard rock, no circulation
708 to 730	-38 to -60	Medium-soft rock, no circulation
730 to 736	-60 to -66	Medium-hard rock, no circulation
736 to 753	-66 to -83	Medium-soft rock, no circulation
753 to 756	-83 to -86	Medium-hard rock, no circulation
756 to 775	-86 to -105	Medium-soft rock, no circulation

Table 4. Construction data for wells drilled during the study, Oahu, Hawaii

State well number	Well name	Latitude	Longitude	Hawaii state tax map key number	Landowner	Well completed	Working days to complete
3-3204-01	Kaheaka exploratory well	21°32'52"	158°04'52"	6-5-01-2	Castle and Cooke Land Company	March 2, 1994	16 days
3-3307-20	Thompson Corner exploratory well I	21°33'41"	158°07'02"	6-5-01-1	Castle and Cooke Land Company	July 9, 1993	14 days
3-3307-21	Thompson Corner exploratory well II	21°33'41"	158°07'02"	6-5-01-1	Castle and Cooke Land Company	August 9, 1993	15 days
3-3406-12	Twin Bridge Road deep monitor well	21°34'56"	158°06'10"	6-4-01-1	Castle and Cooke Land Company	March 9, 1994	27 days
3-3406-13	Kaamooloa exploratory well	21°34'06"	158°06'36"	6-5-01-2	Castle and Cooke Land Company	January 12, 1994	4 days
3-3406-14	Helemano exploratory well I	21°34'58"	158°06'21"	6-2-07-11	Castle and Cooke Land Company	October 15, 1993	11 days
3-3406-15	Helemano exploratory well II	21°34'58"	158°06'21"	6-2-07-11	Castle and Cooke Land Company	November 15, 1993	15 days
3-3407-37	Kiikii exploratory well	21°34'28"	158°07'16"	6-6-23-3	Castle and Cooke Land Company	April 21, 1994	27 days
3-3503-01	North Upper Anahulu exploratory well	21°35'30"	158°03'25"	6-2-09-1	Bishop Estate	May 5, 1994	8 days
3-3505-25	North Lower Anahulu exploratory well	21°35'45"	158°05'04"	6-2-09-1	Bishop Estate	December 23, 1993	7 days
3-3505-26	Opaeula exploratory well	21°35'11"	158°05'14"	6-2-10-1	Bishop Estate	October 4, 1993	10 days
3-3604-01	Kawailoa deep monitor well	21°36'24"	158°04'44"	6-1-05-1	Bishop Estate	January 9, 1994	28 days

Table 4. Construction data for wells drilled during the study, Oahu, Hawaii--Continued

State well number	Well name	Bottom of surface casing elevation (feet)	Surface casing outside diameter (inch)	Hole diameter (inch)	Bottom of well elevation (feet)	Open interval elevations (feet)	Inner casing outside diameter (inch) and type	Screened interval elevations (feet)	Measuring point elevation (feet)	Water level	
										Height above sea level (feet)	Date and time
3-3204-01	Kaheaka exploratory well	643	8 5/8	6 3/4	-55	643 to -55	4 1/2, steel	25 to -55	741.59 (top of casing)	12.44	Jan. 27,1995 17:20
3-3307-20	Thompson Corner exploratory well I	-65	12 5/8	12 1/4	-82	-65 to -82	12 5/8, steel	-65 to -82	99.10 (bolt)	11.32	Aug 5, 1993 15:51
3-3307-21	Thompson Corner exploratory well II	17	8 5/8	7 7/8	-80	17 to -80	4 1/2, PVC	20 to -80	101.40 (top of casing)	11.29	Aug. 5, 1993 15:51
3-3406-12	Twin Bridge Road deep monitor well	9	6 5/8	6 1/4	-596	9 to -596	4 1/2, steel	24 to -596	53.10 (top of casing)	11.10	Feb. 15, 1995 12:09
3-3406-13	Kaamooloa exploratory well	10	6 5/8	6 1/4	-10	10 to -10	4 1/2, PVC	10 to -10	42.35 (top of casing)	11.87	Feb. 13, 1995 14:45
3-3406-14	Helemano exploratory well I	-51	8 5/8	7 7/8	-78.5	-72 to -78.5	4 1/2, PVC	-68.5 to -78.5	13.79 (top of casing)	10.92	Feb. 15, 1995 12:26
3-3406-15	Helemano exploratory well II	-52	8 5/8	7 7/8	-291	-271 to -291	4 1/2, steel	-271 to -291	14.41 (top of casing)	11.15	Feb. 15, 1995 12:28
3-3407-37	Kiikii exploratory well	-115	8 5/8	6 3/4	-135	-125 to -135	4 1/2, steel	-115 to -135	14.68 (top of casing)	11.70	Feb. 13, 1995 13:44
3-3503-01	North Upper Anahulu exploratory well	592	8 5/8	6 3/4	-103	592 to -103	4 1/2, steel	17 to -103	671.74 (top of casing)	7.15	Feb 14, 1995 13:54
3-3505-25	North Lower Anahulu exploratory well	182	8 5/8	7 7/8	-18	182 to -18	4 1/2, PVC	22 to -18	234.24 (top of casing)	4.75	Feb.14, 1995 15:08
3-3505-26	Opaeula exploratory well	229	6 5/8	6 1/4	-65	229 to -65	4 1/2, PVC	15 to -65	288.08 (top of casing)	10.52	Feb. 15, 1995 11:14
3-3604-01	Kawailoa deep monitor well	190	6 5/8	6 1/4	-392	190 to -392	4 1/2, steel	9 to -391	309.01 (top of casing)	4.40	Feb. 14, 1995 14:18