UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Ground Water Branch

REPORT ON THE PAUBA RANCH EXPLORATORY WELL, RIVERSIDE COUNTY, CALIFORNIA

By

G. F. Worts, Jr., and others

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Not reviewed for conformance with stratigraphic nomenclature of the Geological Survey

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1. For preliminary release all illustrations are at end of report.

TABLES

REPORT ON THE PAUBA RANCH EXPLORATORY WELL,

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References:

(a) Letter of 23 January 1951 from J. R. Perry, BuDocks, to U. S. Geol. Survey.
(b) Letter of 28 February 1951 from J. R. Perry, BuDocks, to Director, U. S. Geol. Survey.
(c) Confidential air mail letter of March 23, 1951, on the proposed test well on the Pauba Ranch, Riverside County, Calif., by G. F. Worts, Jr., U. S. Geol. Survey; transmitted by covering letter of April 3 from the Acting Director, U. S. Geol. Survey, to J. R. Perry, BuDocks.
(d) Confidential letter of 18 May 1951 from J. S. McHenry, BuDocks, to J. D. Sears, Acting Director, U. S. Geological Survey.
(e) Confidential letter of October 23, 1951, from T. B. Nolan, Acting Director, U. S. Geol. Survey, to J. A. McHenry, BuDocks.

INTRODUCTION

In accordance with the authority presented in references (a), (b), and (d) above, the Ground Water Branch, United States Geological Survey, assisted and advised the U. S. Navy in the construction of the Pauba Ranch exploratory well, Riverside County, California. The construction was authorized by Navy contract NOy-27088.

As requested in paragraph 2, reference (d), the Geological Survey participated in the construction and evaluation of the well to the following extent: (1) Assisted in the selection of the site on the Pauba Ranch property; (2) reviewed plans and specifications for accomplishment by contract; and (3) collected and evaluated the data obtained from the drilling and test pumping. A fourth item, furnishing a report on the potential water supply of the Temecula River basin, was not accomplished because the Navy subsequently decided it was not desired.

In reference (c) the Geological Survey advised against drilling the well as a supplemental source of water supply for Camp Joseph H. Pendleton, which is about 20 miles downstream from the well. The Geological Survey also indicated that the so-called Chappo and Upper basins of the lower Santa Margarita River valley were adequate to meet water-supply requirements at a rate at least equal to the 1951 demands, and that additional wells, if needed, should be drilled in those basins rather than on the Pauba Ranch.

Location of the Pauba Well

The location of the Pauba Ranch exploratory well is shown on plate 1 (at end of report). For the purposes of the report it is hereafter referred to as the Pauba well. Also shown on plate 1 are the nearby wells. The Pauba well is in Riverside County about 60 miles south of Riverside, 60 miles north of San Diego, 30 miles northeast of Oceanside, 3 miles southeast of Temecula, 1.5 miles east of U. S. Highway 395, 0.9 mile west of the Pauba Ranch headquarters, and 700 feet north of State Highway 71. It can be located on U. S. Geological Survey topographic map entitled "Pechanga Quadrangle," edition of 1950, scale 1:24,000. The altitude of the well as interpolated from this map is 1,050 feet above mean sea-level datum.

The final well site was selected by Lt. Cmdr. H. E. Hobson, former Public Works Officer, Camp Pendleton, and was a compromise between the site proposed by the Geological Survey and that recommended by consultants for the Pauba Ranch. The Geological Survey advised that the site should be at least one-fourth mile northeast of the Wildomar fault to avoid the possibility of encountering minor fault and gouge zones, mineral cementation, badly disturbed and possibly brecciated beds, and finer grained sediments produced as a result of possible ponding near the fault. Hydrologically, the proximity of the well to the fault was expected to have a detrimental effect on the pumping level inasmuch as the drawdown would be increased when the pumping cone of depression reached the fault, which acts as a barrier to ground-water movement. As shown on plate 1, the well is only about 1,000 feet from the Wildomar fault.

General Geologic Features

The general geology of the area in the vicinity of the well is shown on plate 1. The faults and geologic formations shown are largely from work by Mann (1949) and by Waring (1919). However, for the purposes of this report the rocks exposed at the surface have been grouped into three general categories, from oldest to youngest: (1) Basement complex, which includeds granitic intrusive rocks and metamorphic rocks of pre-Tertiary age, is essentially non-water-bearing; (2) older continental deposits which include the pre-terrace continental deposits of Pleistocene to probable Pliocene age, and terrace deposits of probable Pleistocene age, composed of gravel, sand, silt, and clay and, where saturated, are largely water bearing; and (3) alluvium, which includes the valley fill and river-channel deposits of Recent age, composed of gravel, sand, silt, and clay and, where saturated, is largely water bearing.

The basement complex is exposed only in the area southwest of the Elsinore fault zone where it has been uplifted several thousand feet above the adjacent continental deposits to the northeast. Presumably, to the north it underlies the continental deposits at considerable depth. The older continental deposits are exposed in the area northeast of the Elsinore fault zone except where they are overlain by the alluvium.

In the vicinity of the Pauba well, the older continental deposits have been displaced by the Wildomar fault, which is roughly parallel to the Elsinore fault zone. Between the two faults is a graben, or down-dropped block, in which are Pechanga and Murietta Creeks. The Temecula River flows across the Wildomar fault at a point about 2,000 feet south of the Pauba well. The three streams converge in the vicinity of the Elsinore fault zone to form the Santa Margarita River, which has carved a canyon 1,000 to 1,500 feet deep in the rocks forming the basement complex. The river finally discharges into the Pacific Ocean near Oceanside.

The Wildomar fault forms an effective barrier to ground-water movement in the older continental deposits upstream in the Temecula River basin. The difference in head of four flowing artesian wells, 500 to 550 feet in depth, on the alluvial plain of the Temecula River upstream from the fault, and water levels in nonflowing wells downstream from the fault are evidence supporting this conclusion. These wells indicate confined-water conditions for a distance of at least $2\frac{1}{2}$ miles upstream from the fault. Immediately downstream from the fault, water levels in wells are 20 or more feet below the land surface.

The alluvium and river-channel deposits extend beneath the Pechanga and Murietta Creek plains and the Temecula River plain. Preliminary examination indicates that these deposits are about 100 feet thick. The alluvium overlies and conceals segments of both the Wildomar and Elsinore faults. In the vicinity of the Pauba well, relatively recent movement along the Wildomar fault has moderately warped but not ruptured the alluvium. This warping is easily discernible across the fault trace on State Highway 71 near the Pauba well.

General Ground-Water Conditions

The alluvium and underlying older continental deposits form a relatively large ground-water basin northeast of the Wildomar fault. No attempt was made to determine the lateral extent of this basin. The principal source of ground water in the basin is probably recharge from the Temecula River upstream from the area of confined water and below Nigger canyon (east of area; not shown on pl. 1). At the lower end of Nigger canyon the water-bearing deposits are in contact with older consolidated rocks. There is minor recharge from rainfall and from small tributary streams.

Movement of ground water is generally southwestward through gently southwest-dipping water-bearing deposits beneath confining clay beds in the older continental deposits. Ground-water movement is largely impeded by the Wildomar fault.

Downstream from a point about 1 mile above the State Highway 71 bridge, the Temecula River is a perennial stream. The river gains in discharge downstream for a distance of about 4 miles. The gain is from effluent seepage of ground water in the artesian area and is caused by slow upward leakage through confining to semiconfining clay and shale beds in the older continental deposits and through the overlying alluvium and channel deposits.

The approximate area of artesian flow shown on plate 1 is somewhat greater than that shown by Waring (1919, pl. III) largely because the area is based on better and more complete hydrologic and topographic control than his map. The upstream limit of the area of artesian flow on the alluvial plain and in the river bed can be determined by projecting the pressure gradient, as controlled by the static head in the artesian wells, upstream to its intersection with the land surface. The approximate upstream limit of the area of flow is the point in the river bed where ground-water discharge begins. The gradient of the pressure surface can be roughly determined by projecting the static head in the Pauba well (20 feet above land surface, altitude 1,070 feet) upstream to the uppermost point of ground-water discharge into the river. This projection intersects the surface of the alluvial plain at an altitude of about 1,150 feet, about 0.8 mile east of the China Garden well.

Based on the above rough estimate, the area of artesian flow extends upstream on the surface of the alluvial plain a distance of at least 3 miles above the Wildomar fault, and in the river channel about 4 miles above the fault. In all it embraces an area of nearly 2 square miles. However, no detailed study has been made of the valley; hence, the area of flow may differ from that shown on plate 1.

Flows from the artesian wells may have decreased only slightly during the past 37 and possibly 50 years. Waring (1919, p. 91) states that the four wells were drilled in 1903-04, and in 1915 when he visited the area they were all reported to be flowing about 200 gpm. In 1951 they were flowing at reported rates of between 135 and 225 gpm. The owner reports a decrease in some wells due to partial casing failure or partly plugged perforations.

Shallow wells, 100 to 200 feet in depth, drilled in the artesian area upstream from the Wildomar fault tap principally water-bearing sands and gravels in the alluvium. The alluvium is recharged by seepage from the Temecula River between the mouth of Nigger canyon and the area of confined water. In the artesian area upward leakage of ground water from the older continental deposits and infiltration of rainfall and irrigation water have kept the alluvium fully recharged. Because of water-table conditions in the alluvium, the water levels in the shallow wells are below land surface, and, of course, the wells do not flow.

WELL CONSTRUCTION AND WELL LOG

The Drilling Contract

The plans and specifications for the Pauba Ranch exploratory well (NOy-27088) were prepared by the Public Works Office, 11th Naval District, San Diego, and were reviewed by the Geological Survey in April 1951. Bids were opened at the above Navy office on May 16. Subsequently, the drilling contract was awarded to the Van Noy Drilling Co., Inc., 1615 South St., Long Beach 5, Calif. The general requirements of the contract were set forth in item 2-01 as follows:

> "Furnishing all materials and equipment and performing all labor for the drilling of approximately 1,200 feet of not less than eight-inch (8") diameter test hole, the taking of an electric log, the reaming of the test hole, the casing [with 12-inch pipe, of which 200 feet perforated] and gravel packing of the well, the development of the well by washing, surging, and sand pumping, and the test pumping."

The bid submitted by the Van Noy Drilling Co., for this basic item was $34,674.20.

The selection by the Navy of a basic bid depth of 1,200 feet was taken from a report made for the Pauba Ranch by J. R. Pemberton (1950, p. 6), which states:

> "Based upon all known data the slope of the old granite surface to the north and east of the Temecula valley can be projected to a depth of from 1,000 to 1,200 feet in the vicinity of the Wildomar fault at the lower end of the Temecula valley."

Thus, it was the contention of Pemberton that 1,000 to 1,200 feet of sedimentary deposits rested upon granite in the vicinity of the Wildomar fault. Accordingly, the maximum stipulated depth of 1,200 feet was incorporated in the specifications.

Progress of Well Construction

On May 28, 1951, the Van Noy Drilling Co. moved their drilling equipment to the site. The drilling rig was a large portable rotary-type oil-well rig (Ideco) capable of drilling to a depth of about 6,000 feet. The period May 29 through June 3 was spent in "rigging up." The well was spudded in on June 4 at 9:30 a.m., and thereafter drilling was continuous around the clock--three towers per day. The drilling superintendent was Luther Cox, and the three drillers were P. E. Beck, B. S. Blaine, and E. P. Grantham. The progress of well construction and development is summarized in table 1, and photographs of the various operations are shown on plates 2 through 6 (at end of report).

Table 1.--Progress of well construction and development

Date 1951	Bit size (inches)	Footage drilled	Depth[1] (feet)	Remarks
June 4	13-3/4	225	0-225	Drilling pilot hole.
5	36	75	0-75	Fishtail reamer.
6	36	33	75-108	Do.
6-7	--	--	--	Installed 30-inch conduct pipe; landed at 108 ft. pumped 240 sacks cement down casing and up outside to land surface. Set for 12 hours.
7	28	35	108-143	Fishtail reamer; drilled through cement plug.
8	28	63	143-206	Fishtail reamer.
8	13-3/4	200	206-406	Resumed drilling pilot hole.
9		194	406-600	
10		206	600-806	
11	10-5/8	314	806-1,120	
12		215	1,120-1,335	
13		194	1,335-1,529	
14		239	1,529-1,768	New bit run in hole.
15		157	1,768-1,925	Do.
16		160	1,925-2,085	Do.
17		165	2,085-2,250	Do.
18		159	2,250-2,409	
19		69	2,409-2,478	Stopped drilling about noon.
19				Ran electric log.

1. Depths are measured below Kelly Bushing, 7.0 feet above land surface.

Table 1.--Continued

Date 1951	Bit size (inches)	Footage drilled	Depth [1] (feet)	Remarks
June 19	24	50	206-256	Gear tooth reamer or hole-opener with 13-5/8 inch pilot bit.
20		267	256-523	
21		184	523-707	
22		136	707-843	
23		157	843-1,000	
24		62	1,000-1,062	
25		80	1,062-1,142	
26		58	1,142-1,200	
27		59	1,200-1,259	
28		6	1,259-1,265	Pulled out of hole to change bit size.
28	13-5/8	369	1,265-1,634	Reaming 10-5/8 inch hole to 13-5/8 inches.
29		398	1,634-2,032	
30		118	2,032-2,150	Pulled out of hole to change bit size.
July 1	24	70	1,265-1,335	Reaming again with gear tooth reamer with 13-5/8 inch pilot bit.
2		138	1,335-1,473	
3		129	1,473-1,602	
4		19	1,602-1,621	Rotary table being replaced.
5	--	--	--	Do.
6	24	60	1,621-1,681	
7		175	1,681-1,796	
8		97	1,796-1,893	
9		90	1,893-1,983	

1. Depths are measured below Kelly Bushing, 7.0 feet above land surface.

Date 1951	Bit size (inches)	Footage drilled	Depth[1] (feet)	Remarks
July 10	24	4	1,983-1,987	Rotary table being replaced.
11		42	1,987-2,029	Drill pipe parted; fished with overshot.
12		43	2,029-2,072	
13		5	2,072-2,087	Wore out reamer; changed bits.
14		18	2,087-2,105	
15		12	2,105-2,117	Pulled out of hole to dress bit.
16		41	2,117-2,157	Completed reaming.
17-19	Ran 1,951 feet of 12-3/4 inch ID with $\frac{1}{4}$-inch wall casing; centralizers spaced every 150 feet; "bull nose" on bottom joint; perforated pipe--3/16-inch x $2\frac{1}{4}$-inch slots, 12 slots per round, 4 rounds per foot; 1,913 feet perforated; total area of perforations about 270 square feet; perforated pipe placed from 234 to 2,147 feet below land surface. A 16-inch to 12-3/4 inch reducer 2 feet long welded to top of 12-inch pipe. Ran 197 feet of 16-inch ID $\frac{1}{4}$-inch wall casing; centralizers spaced every 150 feet; not perforated; extended 2 feet above land surface; equipped with a bolt-down steel cover plate. Gravel pack installed in well; 283 tons of mixed gravel, 50 percent $\frac{1}{2}$ inch to $\frac{1}{4}$ inch and 50 percent $\frac{1}{4}$ inch to No. 4, placed; swabbing and introduction of fresh water to wash out mud during placing of gravel.			

Date 1951	Remarks
July 19	Swabbing and pumping fresh water down drill pipe. Well began to flow at 1:15 p.m.; temperature 85°F. Flow measured with weir at 4:50 p.m. was 365 gpm, and temperature 84°F.
20	Finished swabbing out hole. Water sample No. 1 taken for analysis.
21	Flow from well not stabilized. Weir indicated 490 gpm, temperature 82°F.
22	Flow ranging from 430 to 490 gpm, temperature 82°F.
23	Capped well and installed contractor's pressure gage. After 1 hour and 40 minutes the gage indicated 15 feet of head above land surface.
24-25	Pressure gage indicated a head of 20 feet above land surface after well was shut off for a period of 24 Hours. Discharge valve on well then fully opened.
26	Flow ranging from 365 to 430 gpm, temperature 82°F. Well flowing from July 25 to start of pump test on August 3.
31	Water sample No. 2 taken for chemical analysis. Temperature 81°F.
Aug. 2	Flow 390 gpm, temperature 81°F. Installed test pump and tested equipment.
3	Flow 340 gpm, temperature 80°F.

Table 1.--Continued

Date 1951	Remarks
Aug. 3-6	Started test pumping at 7:43 p.m., Aug. 3; increased discharge by steps up to a maximum of 2,358 gpm with 96.2-foot drawdown below land surface; then decreased discharge by steps. During the test the water temperature dropped from 81°F to 77°F--the lower temperature being recorded during the greater part of the test. Ended test pumping at 11:56 p.m., August 6.
7	Water started to flow from well after test pumping at 1:05 a.m.--69 minutes after pump shut down.
8	Flow slowly increasing to 235 gpm at 5:30 p.m. Water sample No. 6 taken for chemical analysis, temperature 81°F.
10	Contractor removed test-pumping equipment. Flow had increased to only 250 gpm, temperature 81°F. Steel cover plate bolted on well.
10-11	Gate valve closed at 5:00 p.m., August 10, and contractor's pressure valve installed. At 5:00 p.m., August 11, pressure head 13 feet above land surface. Discharge valve on well then fully opened.

For any 24-hour period the rate of drilling the pilot hole (table 1) is misleading due to numerous shutdowns. Footage drilled per hour ranged from as much as 30 to as little as 4 depending upon hardness of the material being drilled and condition of the bit. During reaming, the rates ranged from 12 feet to as little as 1 foot per hour, exclusive of shutdown time. In general, drilling rates were slower in deeper parts of the well than in shallower parts owing to the increasing hardness of deposits encountered with depth. Including shutdowns, the overall average rate of drilling for the 2,478 feet of pilot hole was 9 feet per hour, and for reaming to a depth of 2,158 feet was 3 feet per hour. From the time the well was spudded in on June 4 until the well was cased and completed on July 20, a total of 47 days elapsed. Because of delays in obtaining and in removing the test pump, the contractor did not complete the requirements of the contract until August 10--a total of 68 days from the time drilling started.

On June 12 the contract depth of 1,200 feet, the maximum depth of continental deposits estimated by Pemberton (1950, p. 6), and somewhat more than the 1,050+ feet of Recent and Pleistocene deposits estimated by Mann (1949, p. 42), had been reached. However, the samples indicated that granitic basement rocks had not been encountered and the Geological Survey advised that drilling continue.

On June 17, when the pilot hole had reached a depth of 2,227 feet, the contractor made a round trip to change bits. Fragments of hard, highly micaceous, calcareous, silty, fine-grained sandstone were found wedged in the bit. The Geological Survey proposed that drilling be stopped, but it was suggested by the Navy that drilling continue until June 19. On June 19, when the pilot hole had reached a depth of 2,478 feet, it was agreed that drilling be stopped. The drill pipe was then pulled out of the hole, and an electric log was run by the Schlumberger Well Surveying Corp. (pl. 7).

The electric log indicated the principal water-bearing beds were above a depth of 2,150 feet. Accordingly, on June 20, the Geological Survey advised that the pilot hole be reamed, cased, gravel packed, and developed to that depth. Also, it was suggested that perforated casing be placed at depths of: 120-400; 490-840; 880-910; 1,040-1,670; 1,790-1,910; 1,990-2,030; and 2,070-2,150 feet--a total of 1,530 feet of perforations. Furthermore, it was suggested that alternate blank and perforated sections might be used successfully in place of continuous sections of perforated pipe to reduce cost and without decreasing the yield of the well. However, the Pauba Ranch owners intervened, and financial arrangements were agreed upon to perforate the casing continuously from 234 to 2,147 feet below land surface--a total of 1,913 feet of perforations.

The Well Log

Records of the materials penetrated by the bit during the drilling of the Pauba well were kept by the three drillers and by R. S. Brown, R. L. Wait, and L. C. Dutcher, Geologists, U. S. Geological Survey. The log kept by the drillers is given in appendix 1 at the end of this report and is shown in graphic form on plate 7.

The log by the Geological Survey was based on the materials passing over a shaker table that separated the drilling mud from the cuttings. Owing to the speed of drilling in the upper several hundred feet of hole, it was difficult to identify changes in formation. After the hole was reamed to a diameter of 36 inches to a depth of 108 feet and to a diameter of 28 inches from 108 to 206 feet, the pilot hole was then continued (table 1). The circulating drilling mud bringing up the cuttings from the bit slowed down through the enlarged reamed segment of the well, causing a differentiation in light and heavy materials before reaching the shaker table. Other complicating factors were breakdowns, changing rates of drilling and mud circulation, and time lag in transportation of the cuttings from the bit to the shaker table. Near the bottom of the hole, the time lag, as determined by use of oats and shredded paper placed in the drill pipe, was 58 minutes. Consequently, it was exceedingly difficult to obtain an accurate log of the materials penetrated. The log kept by the Geological Survey is given in appendix 2 at the end of this report and also is shown in graphic form on plate 7.

The terms used to classify materials varied among the drillers, and differed from those used by the Geological Survey. Two sets of terms were used, some loosely: "sand" vs. "sandstone" and "clay" vs. "shale." Because no sandstone pieces or bits of shale as such were seen to pass over the shaker table, the materials were classed as "sand" or "clay" by the Survey although it was suspected or known that in the deeper part of the hole the materials penetrated were fairly well consolidated.

The only pieces of material obtained were "bit samples" brought up jammed in the bit whenever a "round trip" was made. No true shale was found, but on several occasions pieces of sandstone were pried loose for inspection. Based on these samples, on comparative drilling rates, and on number of new bits worn out during drilling, it is judged that many of the materials below about 1,500 feet logged as sand were sandstone, and that below 2,150 feet the coarser elements were almost definitely sandstone rather than sand. Other inconclusive evidence was drilling speed and slight chattering of the bit and drill pipe at depths identified on the electric log as coarser material (higher resistivity).

Accordingly, the log for the Pauba well as compiled from the cuttings is somewhat generalized. An examination of the electric log (pl. 7) shows the deposits are thin bedded, and the difficulty of logging materials in which changes occur so frequently is easily visualized.

The depth of the contact between the sedimentary rocks and the granitic basement rock was not determined by drilling the Pauba well. The value of establishing the depth of this contact is highly questionable compared to the possible cost. As has been pointed out, the materials from 2,150 to 2,478 feet are well consolidated. The logs show that very little data on ground-water exploration and development in this part of the Temecula basin can be gained by drilling any deeper than 2,150 feet.

With regard to the proximity of the well to the Wildomar fault, it is believed that the cemented sands and numerous beds of fine material encountered during drilling in part may be related to the fault. So far as is known no minor fault zones or distorted beds were encountered.

The Electric Log

The electric log run on the Pauba well by the Schlumberger Well Surveying Corp. is shown on plate 7 (at end of report). The log was run on June 19 to a total depth of 2,469 feet below the Kelly bushing, or 9 feet less than the drilled depth. The electrode didn't reach bottom probably owing to drill cuttings which had settled in the bottom of the hole.

Along the left margin of plate 7 the drillers' log and the sample log are shown in abbreviated graphic form. In the center beside the spontaneous-potential curve are shown the perforated interval and the bottoms of the 30-inch, 16-inch, and 12-inch casings. Because the 30-inch conductor pipe was in place and landed at 108 feet before the electric log was run, there is, of course, no record above that depth.

The electric log was of great value in analyzing the general character and thickness of the materials penetrated, the locations for setting perforated pipe, determination of the depth to ream the well, and general quality of the water. Very briefly, the log consists of two types of curves: Resistivity and spontaneous-potential curves.

On the right side of plate 7 are three resistivity curves which measure the natural resistance in ohm-meters of the strata at lateral depth penetrations of 10 inches, 10 feet, and 19 feet. The resistivity curves are obtained by passing current through electrodes suspended in the well and measuring the change in current by use of a recording electronic wheatstone bridge principle. The resistivity of the beds opposite the electrode is measured as the electrode is lowered down the well. In general, the resistivity of coarse materials containing good quality water is high (the curves swing out to the right), and conversely, the resistivity of fine-grained materials is low (the curves swing in to the left).

The spontaneous-potential or self-potential curve, shown on the left side of plate 7, is a measure of the natural potential in millivolts as created in each stratum, mostly by electro-chemical forces. This curve is obtained by use of an electrode lowered in the well simultaneously with the resistivity electrodes. In general, this curve responds to coarse and fine materials by indicating more potential in coarser material (the curve swings out to the left) than it does in fine-grained material (the curve swings in to the right).

The only major change in character of the electrolog occurs at a depth of about 2,150 feet. Above this depth the resistivity curves express a lateral zig-zag pattern of considerable activity and amplitude; and below they express a pattern of less lateral activity and amplitude. In general, the upper segment contains alternating beds of fine and coarse materials in almost equal amounts and in beds ranging in thickness from several feet to as much as 60 feet, but averaging about 10 to 15 feet;

whereas the lower segment contains more fine than coarse materials, and further, the lower coarse materials show less resistivity than those above. The lower segment indicates individual beds range in thickness from several feet to as much as 20 feet but average between 5 and 10 feet.

The principal zones of predominantly coarse material that are probably the main water-yielding deposits are indicated at depths of about 205-280, 345-400, 490-710, 880-910, 1,035-1,325, 1,600-1,665, 1,875-1,905, and 2,055-2,150 feet below Kelly bushing--a total of 860 feet. In addition there are numerous thinner zones indicated on the log. For the interval between 108 and 2,150 feet, the log indicates roughly 1,000 feet of coarse materials, or about 50 percent of the total.

For the lower segment, 2,150 to 2,469 feet, the coarser zones are thinner and, as indicated above, have lower resistivity. Consequently, the log indicates that they would probably not yield water too readily. For this interval, there is roughly 80 to 90 feet of relatively coarse materials, or about 25 percent of the total.

A comparison of the graphic log of drill cuttings, shown along the left margin of plate 7, with the coarse and fine materials indicated by the electric log shows a good correlation to a depth of about 1,500 feet. Below that depth the correlation appears fairly good only by major zones of fine and coarse material. In the lower 200 to 300 feet the graphic log varies considerably from the electric log.

THE TEST PUMPING

Methods and Equipment

The equipment needed to run a pump and development test on a well consists of a pump capable of producing a specified discharge; a motor, usually internal combustion, of sufficient horsepower to operate the pump at the specified discharge; an instrument to measure accurately the pump discharge; and a device to measure accurately the water levels in the well during the test.

The pump used in the Pauba well test was a belt-driven, two-stage (two bowls) Johnson pump. The bowls were set at about 180 feet below the top of the casing. The motive power consisted of a 150-horsepower diesel engine.

The equipment used to measure the discharge consisted of a 10-foot length of 10-inch ID discharge pipe adapted for both 8-inch and 6-inch orifice plates on the discharge end with a piezometer tube connection about 2 feet from the orifice. In addition, the Pauba ranch owner installed a 3-foot rectangular weir below a stilling pond. Records of discharge by both methods of measurement were obtained until the weir washed out.

During the course of the test, depth-to-water measurements were made in the Pauba well and in nearby wells with a steel tape. Whenever possible the depth to water was recorded to the nearest hundredth of a foot, but owing to leakage in the casing of the Pauba well, there were times when the tape could be read only to the nearest tenth of a foot.

The contract (Item 2-09) specified that the test pumping be as follows:

> "...the well shall be pumped for twelve hours at gradually increasing rates until the practical upper limit of its capacity has been reached/not to exceed 2,000 gpm against a total head of 200 feet/ It shall then be pumped continuously for forty-eight (48) hours at this maximum rate to determine final operating water levels. After the forty-eight (48) hour nonstop test and without shutting down the pump, the rate of pumping shall be reduced in twelve (12) steps of one (1) hour duration to determine the operating water levels for each rate of flow."

Because of numerous breakdowns, this test was not run according to specifications. Accordingly, the results are not as conclusive as they would have been had there been no breakdowns in the pumping equipment.

Table 2 shows measurements of discharge as indicated by the orifice and by the weir, water-level measurements, temperature, and related comments. All data shown in the table were collected by R. S. Brown and R. L. Wait, geologists, U. S. Geological Survey.

Table 2.--Compilation of the test-pumping data

Date 1951	Hour	Water level in feet below land surface	Discharge in gpm Orifice	Discharge in gpm Weir	Temp. °F	Remarks
Aug. 3	7:43 p.m.					Start of test; used 8-inch orifice plat
	8:03	48.95	1,620	1,395	79	Weir pond not equaliz
	8:14	-	-	1,535	78½	Water contained some fine sand.
	8:25	-	1,865	-	78½	
	8:35	-	1,858	1,609		Weir pond not equaliz
	9:05	57.35	1,830	1,609		Do.
	9:10	58+	-	1,609		Tape smeared.
	9:20	58.57	1,823	1,609	78½	
	9:30	59.15	1,809	-		
	9:40	-	1,627	-		Could not measure water level.
	10:12	-	1,571	-	78	Discharge still contained some fine sa
	10:14	-	-	-		Shut down for repairs.
	10:42	-	-	-		Resumed test.
	10:43	-	1,648	-		Could not measure water level.
	10:50	-	1,627	-		Do.
	11:04	-	1,620	-		Do.
	11:30	-	1,620	1,419		Do.
	12:00	-	1,627	-		Do.
Aug. 4	12:33 a.m.	49.62	1,606	-		
	12:55	50.30	1,606	-		
	1:22	50.81	1,599	1,310	77½	
	1:34	-	-	-		Shut down for repairs.
	2:13	-	-	-		Well started to flow.
	2:18	-	-	-		Resumed test.
	2:26	35.35	1,634	-		
	2:31	37.80	1,634	-		
	2:37	40.00	1,627	-		
	2:43	41.50	1,627	-		
	2:50	42.83	1,613	-	77½	
	2:59	43.74	1,613	1,442		
	3:01	44.18	1,613	-		
	3:07	44.68	1,613	-		
	3:12	45.2+	1,599	1,419	77½	

Date 1951	Hour	Water level in feet below land surface	Discharge in gpm Orifice	Discharge in gpm Weir	Temp. °F	Remarks
Aug. 4	3:16 a.m.	45.39	1,599	-		
	3:32	46.72	1,599	1,395		
	3:50	47.72	1,599	-		
	4:12	48.10	1,578	1,419	77½	
	4:52	48.80	1,564	1,442		
	5:02	-	-	-		Shut down for repairs.
	5:43	-	-	-		Well started to flow.
	5:47	-	-	-		Resumed test.
	5:52	31.69	1,613	-		
	5:56	34.90	1,613	1,310		Weir pond not equalized
	6:00	37.11	1,613	-		
	6:05	38.60	1,627	-		
	6:09	40.92	1,627	-		
	6:12	41.26	1,606	1,395		
	6:18	41.49	1,606	-		
	6:20	41.78	1,606	-		
	6:24	42.37	1,606	-		
	6:27	42.90	1,606	-		
	6:31	43.65	1,606	-		
	6:34	44.09	1,585	1,395		
	6:52	50.20	1,767	-		Increasing discharge.
	6:55	51.00	-	-		Do.
	6:57	-	1,974	-	77	Collected water sample No. 3.
	7:02	-	1,968	-		
	7:07	56.85	1,962	1,779		
	7:10	57.40	1,968	-		
	7:15	58.02	1,968	-		
	7:20	59.10	1,968	-		
	7:30	59.23	1,968	-		
	7:33	60.63	1,968	-		
	7:35	60.86	1,962	1,704		
	7:41	61.25	1,962	-		
	7:44	-	2,010	-		
	7:47	62.53	2,010	-		
	7:53	63.05	2,010	-		
	8:03	63.61	2,010	-	77½	
	8:16	64.44	1,968	1,742		
	8:37	65.32	1,968	-		
	9:16	67.36	1,968	-		
	9:20	67.65	1,968	-		
	10:00	-	1,980	1,752	77½	
	10:15	68.30	1,980	1,742		

Table 2.--Continued

Date 1951	Hour	Water level in feet below land surface	Discharge in gpm Orifice	Discharge in gpm Weir	Temp. °F	Remarks
Aug. 4	10:30 a.m.	69.42	1,980	1,742		
	10:45	69.42	1,980	-		
	10:50	69.59	1,980	-		
	11:00	69.50	1,974	1,742	77	
	11:15	70.19	1,974	-		
	11:30	70.06	1,974	-	77	
	11:45	70.47	1,974	-		
	12:00	70.45	1,974	1,704	77	
	12:15 p.m.	70.4	1,955	-		
	12:30	70.4	1,955	1,632	77½	
	12:45	70.23	1,955	1,632	77½	
	1:00	70.73	1,955	1,679	77½	
	1:15	70.97	1,962	1,679		
	1:30	70.90	1,962	-		
	1:45	71.05	1,955	1,679		
	2:00	70.86	1,955		77½	
	2:15	70.9	1,943	-		
	2:30	71.0	1,943	-		
	2:45	71.17	1,949	1,679	77	
	3:00	71.30	1,943	1,679		
	3:15	71.45	1,943	1,679	77	
	3:30	70.95	1,918	1,679		
	3:45	70.95	1,924	1,679		
	4:00	70.95	1,918	1,679		
	4:15	70.95	1,918	1,632		
	4:30	71.45	1,918	-		
	4:32	-	1,980	-		
	4:46	73.03	1,980	-		
	5:02	73.62	1,992	-		
	5:32	73.18	1,968	1,704	77	
	6:00	73.34	1,968	-		
	7:09	73.42	1,955	1,742		
	8:00	74.14	1,968	1,742		
	9:00	74.36	1,962	1,742		
	10:01	74.70	1,962	1,742		
	10:50	-	-	-		Shut down for repairs.
Aug. 5	12:25 a.m.	-	-	-		Well started to flow.
	1:16	-	-	-		Resumed test.
	1:26	53.04	2,132	-		
	1:33	58.59	2,132	-		
	1:38	60.50	2,132	-		
	1:45	63.59	2,100	-		
	1:50	63.54	2,100	-		
	2:00	67.11	2,094	2,029	78	
	2:10	68.42	2,076	-		
	2:30	70.60	2,064	1,826		

Date 1951	Hour	Water level in feet below land surface	Discharge in gpm		Temp. °F	Remarks
			Orifice	Weir		
Aug. 5	2:45 a.m.	72.28	2,040	1,742		
	3:00	74.35	2,040	1,742		
	3:15	-	2,040	1,742		
	3:30	-	2,040	-		
	3:45	69.92	1,865	-	77½	Motor unsteady.
	4:15	76.13	2,040	1,752		
	4:30	-	-	-		Shut down for repairs.
	5:12	-	-	-		Resumed test.
	5:30	68.35	2,040	-		
	6:00	73.65	2,016	1,826		
	6:30	74.23	2,004	1,742		
	7:00	74.24	2,004	1,742		
	7:30	75.52	1,992	1,742	77½	
	8:00	77.06	1,980	1,704		
	8:30	78.4	1,986	1,704		
	9:21	78.30	1,968	1,704		
	10:00	78.92	1,968	1,609		
	11:02	79.13	1,962	-		
	12:00	79.00	1,949	1,679		
	1:10 p.m.	79.86	1,962	1,679		
	2:05	80.84	1,986	1,679		
	2:55	80.63	1,943	1,679		
	3:55	80.58	1,962	1,679		
	4:55	80.71	1,955	1,679	77	
	6:00	80.70	1,949	1,704		
	7:00	79.97	1,918	1,679	77	
	7:41	-	-	-		Shut down for repairs.
	7:58	26.8				Water-level recovery measurements.
	8:03	22.55				
	8:04	21.70				
	8:07	20.09				
	8:09	19.35				
	8:10	18.63				
	8:12	17.83				
	8:13	17.28				
	8:14	16.79				
	8:15	16.19				
	8:17	15.94				
	8:18	15.10				
	8:20	14.60				
	8:21	14.15				

Table 2.--Continued

Date 1951	Hour	Water level in feet below land surface	Discharge in gpm: Orifice	Discharge in gpm: Weir	Temp. °F	Remarks
Aug. 5	8:22 p.m.	13.83				Water-level recovery measurements.
	8:24	13.37				
	8:25	12.88				
	8:27	12.54				
	8:29	12.20				
	8:30	11.95				
	8:31	11.65				
	8:32	11.40				
	8:34	10.64				
	8:36	10.22				
	8:41	9.18				
	8:46	8.30				
	8:52	7.25				
	8:56	6.60				
	8:59	6.15				
	9:00	-	-	-		Resumed test.
	9:01	43.75	-	-		
	9:03	51.35	-	-		
	9:04	54.94	-	-		
	9:10	60.88	-	-		
	9:13	62.54	2,143	-		
	9:14	63.78	2,100	-		
	9:21	64.53	2,100	-		
	9:28	67.76	2,100	-		
	9:30	68.22	2,088	-		
	9:40	70.97	2,064	1,779		
	9:50	72.25	2,064	-		
	10:00	73.78	2,058	1,779		
	10:15	75.2	2,040	-		
	10:30	75.10	2,028	-		
	10:45	76.17	2,012	-		
	11:00	79.97	1,998	1,742		
	11:30	76.2	1,955	-		
	12:00	75.55	1,968	1,742		
Aug. 6	1:00 a.m.	81.01	1,980	1,704		
	2:00	78.76	1,955	1,742		
	3:00	79.8	1,962	-		
	4:12	78.54	1,955	-		
	5:00	82.9	-	1,742		Motor rpm unstable.

Date 1951	Hour	Water level in feet below land surface	Discharge in gpm Orifice	Discharge in gpm Weir	Temp. °F	Remarks
Aug. 6	6:00 a.m.	80.34	-	-		Motor rpm unstable.
	7:10	83.25	2,010	1,742		
	7:50	83.17	2,010	1,752		
	9:00	83.25	2,030	1,752	78	
	10:20	84.4	-	-		Increased discharge.
	10:25	84.11	-	-		Do.
	10:40	84.4	-	-		Do.
	11:05	-	2,358	-		Discharge water clear.
	11:20	94.6	2,358	-		
	11:25	94.7	2,358	2,179		
	11:30	96.2	2,358	-		
	11:43	97.5	2,347	2,179	77	
	12:15 p.m.	98.4	2,352	-	77	Collected water sample No. 4.
	12:30	98.9	2,326	-		Weir washed out. Point plot on plate 8.
	12:50	98.2	2,321			
	1:00	97.7	2,305			
	1:30	88.47	-			Decreased discharge.
	1:35	87.30	1,968			
	1:40	87.40	1,968			
	1:50	-	1,974			
	2:00	86.77	1,974			
	2:10	85.53	1,974			
	2:44	87.16	1,974			
	3:05	85.76	1,986			
	3:15	85.80	1,980			Point plot on pl[illegible]
	3:20	-	-			Decreased discharge.
	3:25	82.95	1,879			
	3:30	82.93	1,886			
	3:40	82.37	1,879			
	3:50	81.99	1,879			
	4:00	81.8	1,879			
	4:30	81.0	1,879			
	4:50	80.7	1,879			
	5:10	80.51	1,879			
	5:20	80.49	1,879			Point plot on plate 8.
	5:21	-	-			Decreased discharge.
	5:27	62.25	1,212			
	6:06	55.11	1,194			Flow from Studley artesian well had dropped from about 200 to 6 gpm.

Date 1951	Hour	Water level in feet below land surface	Discharge in gpm Orifice	Temp. °F	Remarks
Aug. 6	6:12 p.m.	54.2	1,212		
	6:20	54.4	1,230		
	6:40	52.17	1,248	77	
	6:55	51.25	1,230		
	7:08	50.16	1,230	77	
	7:20	50.83	1,230		Point plot on plate 8.
	7:55	-	-		Decreased discharge. Replaced 10-inch orifice plate with 6-inch orifice plate without shutdown.
	8:09	36.85	799		
	8:16	-	802		
	8:25	36.63	815		
	8:35	36.45	833		
	8:40	36.01	836		
	8:58	35.30	836		
	9:07	35.85	842		
	9:15	34.69	847		
	9:30	34.09	844	77	
	9:55	33.37	833		Point plot on plate 8.
	9:56	-	-		Decreased discharge.
	10:07	29.52	600		
	10:15	29.41	600		
	10:34	26.32	616		
	10:45	28.74	632		
	11:00	23.97	643		
	11:15	23.55	646		
	11:32	22.97	628		
	11:37	-	628	77	Collected water sample No. 5
	11:45	22.50	628		
	11:55	22.66	650	77	Point plot on plate 8.
	11:56	-	-		Shut down; end of test pumping.
Aug. 7	12:08 a.m.	6.90			Water-level recovery measurements.
	12:10	6.40			
	12:11	6.07			
	12:13	5.60			
	12:14	5.35			
	12:16	5.09			

Date 1951	Hour	Water level in feet below land surface	Discharge in gpm Orifice	Temp. °F	Remarks
Aug. 7	12:17 a.m.	4.83			Water-level recovery measurements.
	12:18	4.82			
	12:19	4.36			
	12:20	4.26			
	12:21	4.12			
	12:22	3.97			
	12;23	3.85			
	12:24	3.74			
	12:25	3.62			
	12:26	3.57			
	12:27	3.35			
	12:28	3.24			
	12:29	3.15			
	12:30	3.05			
	12:33	2.67			
	12:34	2.58			
	12:35	2.22			
	12:40	1.74			
	12:45	1.34			
	12:50	1.17			
	12:55	.25			
	1:00	.20			
	1:05	-			Water started to flow from well.

Test-Pumping Results

The difference between the discharge measured by the orifice and by the weir is considerable, and the reason therefor is not definitely known. Simultaneous measurements showed that the weir consistently indicated between 10 and 15 percent less discharge than the orifice. Because the weir was in rather poor condition (pl. 6, A) and because of seepage from the stilling pond, it is believed that the orifice measurements are the more accurate and they are therefore referred to and used throughout this report.

For the 6-inch and 8-inch orifice plates used on the 10-inch ID discharge pipe, the discharges shown in table 2 are from a table prepared by Purdue University and given in a manual prepared and published by Layne and Bowler, Inc. (1942, pp. 30-31). However, the table for the 8-inch orifice was not extended beyond a maximum discharge of 1,893 gpm with a piezometer tube reading of 37 inches. Thus, for the larger discharges the following general formula was used:

$$Q = KA\sqrt{2gh}$$

wherein $\underline{Q}$ = discharge in gpm; $\underline{A}$ = area of orifice in square inches; $\underline{K}$ = a "constant" or coefficient of discharge with a value less than 1.0; $\underline{g}$ = the gravitational constant of 32.2 ft. per second per second; and $\underline{h}$ = the head, in inches, as read in the piezometer tube.

With regard to the selection of a value for $\underline{K}$ in the above formula; it can be shown that $\underline{K}$, computed from the orifice tables, decreases as follows: 0.820 for a discharge of 992 gpm with an $\underline{h}$ of 9 inches; 0.785 for a discharge of 1,266 gpm with an $\underline{h}$ of 16 inches; 0.778 for a discharge of 1,557 gpm with an $\underline{h}$ of 25 inches; and 0.771 for a discharge of 1,865 gpm with an $\underline{h}$ of 36 inches. However, it was determined that the value of $\underline{K}$

remains constant at 0.771 for values of h greater than 30 inches. Thus, for discharges larger than 1,893 gpm, the following simplified formula was used:

$$Q = 0.771 \times 50.266 \times 8.025 \times \sqrt{h}$$

or:

$$Q = 311.01 \times \sqrt{h}$$

The greatest value of h obtained during the pump test was 57.5 inches for the period between 11:05 and 11:30 a.m., on August 6. When this value of h is substituted in the above formula, the computed discharge is 2,358 gpm (table 2).

The discharges by orifice measurement have been used to compile plate 8, which is a graph constructed from fairly well stabilized discharge and drawdown measurements obtained during the five-step pumping rate decrease from the maximum stabilized discharge and drawdown of the test as indicated in table 2. This graph could be utilized with reasonable certainty for the selection of a desired capacity pumping plant and its initial pumping level.

The pressure head or "static" level of the Pauba well was determined by sealing the well shut and attaching a pressure gage. On July 24 and 25, about a week before the test, the well was sealed for a period of 24 hours, and a maximum pressure reading of 20 feet above land surface was obtained. Four days after the test the well was again sealed for a period of 24 hours and the pressure head stabilized at 13 feet above land surface. Thus, there was a considerable difference in the static pressure head before and after the test. It is possible that the head would have increased somewhat more with time but probably not to the initial head. For the purposes of determining the specific capacity of the well, it is assumed that the pressure head would have stabilized at a point about half way between the two determined, or about 16 feet above land surface.

The specific capacity of a well is defined as the gallons per minute of yield per foot of drawdown. It provides a rough measure of the water-yielding character of the materials tapped by a well. For flowing wells the drawdown is measured in feet below the "static" pressure head or water level of zero flow, which for the Pauba well is taken to be 16 feet above land surface. Because the graph or curve shown on plate 8 is slightly concave upward, a slight increase of specific capacity with increased discharge is indicated. However, the shape of the curve is probably attributable to the manner in which the test was run. Table 3 shows the discharge, drawdown, and specific capacity obtained during the test and during periods of flow.

Table 3.--Specific capacity values for the Pauba well

Discharge (gpm)	Drawdown below zero pressure head (feet)	Specific capacity (gpm per foot of drawdown)
Flow		
Before test:		
400	19.0	21.0
After test:		
250	15.0	16.7
Pump 650	38.7	16.8
Pump 833	49.4	16.9
Pump 1,230	66.8	18.1
Pump 1,879	96.5	19.5
Pump 1,980	101.8	19.5
Pump 2,326	114.9	20.2

Considering the depth, number of perforations, and thickness of water-bearing materials, the above determined specific capacity is relatively low. This means that the water-yielding character of the materials taken as a whole for the entire perforated interval of the well cannot be classed as being any better than fair.

Temperature Variations with Discharge

The temperature of the water discharged from the well during the test pumping and periods of free flow was determined to be another variable (tables 1 and 2). According to the electric log of the Schlumberger Well Surveying Corp. (pl. 7) the bottom-hole deposits (2,469 feet) have a temperature of 93°F; whereas the nearby Studley artesian well discharges water from a zone between 280 and 548 feet, or from an average depth of about 400 feet, at a temperature of about 74°F. A comparison of the temperatures and depths of the two wells suggests a range of 19 degrees in about 2,000 feet, or about 1°F increase per 100 feet of depth. If the geothermal gradient is constant, then the temperature at the bottom of the completed well (2,150 feet) can be computed to be roughly 90°F. These data are plotted in graph form on plate 9 (at end of report).

After the initial flow from the well had stabilized, the temperature was 81° to 82°F. During the test pumping the temperature decreased immediately to 79°F and shortly thereafter to about 77°F for the remainder of the test. After the test the well again flowed, and the temperature stabilized at 81°F. Thus, based on these temperature changes, certain general conclusions can be drawn with respect to the source of water entering the well at depth.

First, when the well is free flowing the higher temperature indicates that the bulk of the water is coming from zones deeper in the well than when it is pumped. The average depth of the zone so indicated (81°F) is about 1,200 feet below land surface (pl. 9). This suggests that as much water is coming from below 1,200 feet as is coming from above that depth. On the other hand, the lower temperature (77°F) when the well is pumped indicates that the bulk of the water is coming from zones shallower in the well than when it is free flowing. The average depth of the zone indicated is about 750 feet below land surface (pl. 9). Accordingly, it is believed that the shallower deposits are more permeable and yield water more readily than the deeper deposits.

Second, the decreased temperature with increased discharge suggests that the upper and apparently more permeable deposits have a lower pressure head than the deeper zones in the well. If the pressure heads in the deep and shallow deposits were the same, then the temperature of the water while the well was flowing should have been about the same as when the well was pumping.

Finally, when the well is sealed, water of greater head from the deeper deposits moves up the casing and out into the shallower deposits. In other words, when the well is capped, the postulated differential pressure head would cause the deeper water to recharge the shallower more permeable deposits.

Effect of Pumping on Nearby Wells

During the test pumping, measurements of flow were made on the Studley artesian well 3,000 feet to the northeast (pl. 1). The flow in this distant well decreased from 200 gpm before the test (reported by owner) to no flow on August 6, the day of maximum pump discharge from the Pauba well; and after the test the flow slowly increased. This shows conclusively that pumping the Pauba well strongly affected the artesian aquifers tapped by existing wells. On the other hand, measurements made in wells southwest of the Wildomar fault showed no drawdown at all during the test suggesting that the fault may be an effective ground-water barrier. However, these wells are less than 100 feet deep, and the interpretation of the measurements is not conclusive with regard to changes in head in deeper zones at those points.

It is believed that the drawdown in the Pauba well was adversely affected by the proximity of the well to the Wildomar fault. Pumping the Pauba well had a marked effect on the discharge of the Studley artesian well 3,000 feet away. Accordingly, the Wildomar fault, which has been shown to be a ground-water barrier and which is only 1,000 feet away, must have intercepted the cone of depression created during the pumping. Thus, the drawdown was greater than it would have been had the well been farther away from the fault.

CHEMICAL QUALITY OF GROUND WATER

General Quality

Six samples of water were collected from the Pauba well for analysis by the Sanitation Laboratory, Eleventh Naval District, San Diego. In addition, one sample of water was taken from the Studley artesian well 3,000 feet to the northeast (pl. 1). The date and hour that the six samples were taken in relation to the period of well development are shown in tables 1 and 2.

In general, the six samples were collected for three principal reasons: To determine the overall character of the water; to ascertain whether or not any variations occurred before, during, and after the test pumping; and to detect changes or variations in quality with increases and decreases in discharge. Table 4 shows the analyses of the six samples from the Pauba well and one from the nearby Studley artesian well.

Table 4.--Analyses of waters from the Pauba and Studley artesian wells

(The following tabulation is as shown on the U. S. Navy Sanitation Laboratory water-analysis sheets.)

[Results expressed in parts per million]

Constituent	Pauba well, sample number						Studley well
	a1	a2	b3	b4	b5	c6	
Total hardness ($CaCO_3$)	8	8	32	29	26	9	16
Calcium hardness ($CaCO_3$)	4	4	22	22	18	5	14
Magnesium hardness ($CaCO_3$)	4	4	10	7	8	4	2
Alkalinity P ($CaCO_3$)	20	14	20	8	9	10	6
Alkalinity M ($CaCO_3$)	130	130	130	120	130	128	104
Caustic alkalinity (OH)($CaCO_3$)	0	0	0	0	0	0	0
Free carbon dioxide (CO_2)	-	-	0	0	0	0	0
Chloride (Cl)	52	52	76	74	68	52	96
Sulfate (SO_4)	12	12	21	19	18	15	31
Total dissolved solids	205	205	230	230	230	205	270
Iron (Fe)	0	.2	.1	.1	.1	.3	.2
Silica (SiO_2)	12	20	14	16	20	20	14
pH	9.2	9.35	9.1	9.1	9.12	9.3	8.9
Hydrogen sulfide (H_2S)	-	-	-	0	0	0	0
DPWO 11 ND Lab. No.	1295	1301	1304	1305	1306	1307	1303
Date collected	7-20-51	7-31-51	8-4-51	8-6-51	8-6-51	8-8-51	8-8-51
Temperature (°F)	82	81	77	77	77	81	74

a. Sample taken prior to test pumping; well flowing.
b. Sample taken during test pumping.
c. Sample taken after test pumping; well flowing.

Quality Variations with Discharge

Samples 1 and 2 were collected before the test pumping, and sample 6 after the test (table 4). In general, the analyses of these three are quite similar. Samples 3, 4, and 5 were collected during the test and also are quite similar. However, a comparison of the pumping and non-pumping analyses reveals that during the test pumping there were marked increases in the total hardness from 8 to 30 ppm; calcium hardness, from 4 to 20 ppm; chloride, from 52 to 74 ppm; sulfate, from 12 to 20 ppm; and total dissolved solids, from 205 to 230 ppm. On the other hand, there was a decrease in iron from 0.2 to 0.1 ppm and a slight decrease in pH from 9.3 to 9.1. Other constituents show inconclusive trends.

It was indicated in the preceding section of the report that during the test pumping the average source of water was believed to be at a shallower depth in the well than the average source during flowing or nonpumping conditions. This interpretation is strengthened by comparison of the two suites of analyses obtained from the Pauba well with the analysis from the Studley well. The test pumping suite is more similar to the Studley well analysis than is the nonpumping suite of analyses. Thus, it is believed that when the Pauba well is pumped the bulk of the water is supplied from deposits in the upper 1,000 feet.

SUMMARY

1. The Temecula River ground-water basin is in the southwestern part of Riverside County, Calif., about 30 miles inland from the Pacific Ocean. The deposits of the basin are composed of sand, sandstone, clay, shale, and some gravel, the coarser elements of which yield water to wells. The basin is bounded on the southwest by the Wildomar fault which acts as a barrier to ground-water movement. The Pauba well is in this basin and is about 1,000 feet upstream from the fault. Clay beds in the basin cause the water to be confined for several miles upstream from the fault. Wells, such as the Pauba well, which penetrate the clay beds and tap the interbedded sand, gravel, and clay, are flowing artesian wells. Four wells drilled to depths of between 540 and 550 feet in 1903-04 are still flowing at reported rates of between 135 and 225 gpm. The area of artesian flow is localized in the lower part of the Temecula River flood plain and reconnaissance indicates that it covers about 2 square miles.

2. On June 4, 1951, construction of the Pauba well began, on June 19 the pilot hole was stopped at a depth of 2,478 feet, and on June 19 an electric log was run. An examination of the driller's log, the log compiled by the Geological Survey, and the electric log showed that the base of the deepest major water-bearing sand was at a depth of about 2,150 feet. The well was then reamed, cased, and gravel packed to that depth. Preperforated pipe was placed from 234 to 2,147 feet below land surface--a total of 1,913 feet.

Because only minor sandstone beds were penetrated below 2,150 feet, for all practical purposes this depth is considered to be the bottom of the Temecula River ground-water basin. Within this depth, an aggregate of about 1,000 feet of the deposits is water yielding. It was anticipated that the well would bottom in granitic rocks; however, none were encountered. The value of drilling deeper to determine the depth to granitic rocks is questionable.

3. The well was developed as a flowing artesian well that had a "static" head of 20 feet above land surface and a flow of about 400 gpm before the test pumping and a "static" head of 13 feet and a flow of 250 gpm after the test. It is believed that neither the flow nor the head will return to the initial amount, but will return to intermediate levels.

4. The test pumping of the Pauba well was run from August 3 to 6 to determine yield and drawdown of the well, and the effect on nearby wells. The maximum stabilized discharge obtained was 2,326 gpm with a drawdown of about 115 feet below the average static head, which is estimated to be about 16 feet above land surface. The results of the test show that the specific capacity was 17 to 20 gpm per foot of drawdown, which is a relatively small value for a well tapping over 1,000 feet of water-yielding deposits. Nevertheless, the well is capable of being pumped at rates up to 2,000 gpm with initial pumping levels somewhat less than 100 feet below land surface.

5. The development of pumping wells in the artesian area of the Temecula River basin would have an adverse effect on the existing flowing wells. During the period of maximum discharge from the Pauba well, the flow from the Studley artesian well 3,000 feet away stopped. Large withdrawals would cause a drop in artesian head with a resulting decrease and possible eventual cessation of flow from these wells. This possibility should be considered and thoroughly understood before the installation of pumping plants in the basin is undertaken. It is probable that by perforating

only zones deeper than those tapped by existing artesian wells, even though it is believed that the deeper zones yield water less readily, this adverse effect could be delayed somewhat.

6. The overall chemical quality of the water in the basin and from the Pauba well is considered to be very good for human consumption. Seven samples of water were collected for chemical analysis by the Sanitation Office, Eleventh Naval District, San Diego. Six were from the Pauba well--two before, three during, and one after test pumping; the seventh was taken from the nearby Studley artesian well. A comparison of these analyses indicates that the water collected from the Pauba well during the test is higher in most constituents than water samples collected before and after the test. Further, the samples taken during pumping more closely resemble the analysis from the shallower Studley artesian well. This suggests that the bulk of the pumped water is from the upper segment of the Pauba well.

7. The temperature of water in the Pauba well was 93°F at 2,469 feet as shown on the electric log, was about 81°F when the well was flowing, and was about 77°F during pumping. The temperature of water from the nearby Studley artesian well was 74°F. These data indicate a geothermal gradient of about 1°F increase in temperature per 100 feet of depth. More critical, perhaps, are the variations in temperature with yield, suggesting that the flowing water rises from a zone whose average depth is on the order of 1,200 feet, whereas the pumped water rises from a zone whose average depth is about 750 feet. Furthermore, these variations suggest that the shallower zone is more permeable and has less pressure head than the deeper zone. This latter condition further suggests that when the well is capped, water from the deeper zone moves up the casing and recharges the shallower zone.

8. The conclusions presented in paragraphs 6 and 7 cast some doubt on the productivity of the deeper deposits in the Pauba well, and thus on the advisability of constructing wells in the Temecula River basin to depths as great as 2,150 feet. Should the Navy decide to develop a water supply in the basin, it is suggested that flow, conductivity, and temperature traverses be run on the Pauba well to determine quantitatively the relative productivity of the water-bearing zones tapped throughout the full perforated depth of the well. The data so collected would largely determine the lower limit of economic deep-well construction in the basin.

REFERENCES

Letters pertinent to the construction of the Pauba well are listed at the beginning of this report and are identified by alphabetical reference. Reports by others, which cover the area in which the well was drilled and which are referred to throughout the text, are listed herewith:

LAYNE AND BOWLER, INC., 1942, Layne vertical turbine pumps: Pump Bull. 4-42, 32 p.

MANN, J. F., JR., 1949, Late Cenozoic geology of a portion of the Elsinore fault zone, southern California: Typed rept. for Doctorate thesis, Univ. of So. Calif., Los Angeles, 132 p.

PEMBERTON, J. R., petroleum geologist, Los Angeles, 1950, Artesian water resources of the Pauba ranch: Typewritten rept., 7 p., 1 pl.

WARING, G. A., 1919, Ground water in the San Jacinto and Temecula basins, California: U. S. Geol. Survey Water-Supply Paper 429, 113 p.

STIPULATED JUDGEMENT, SUPERIOR COURT, SAN DIEGO COUNTY, CALIF., 1940, A water rights agreement between users of water from the Santa Margarita River system, number 42850.

APPENDIX 1

Driller's Log

The following table is a verbatim copy of the driller's log of the Pauba well. One term, "shell," has been placed in quotation marks to indicate that it does not apply to fossils; rather, in this case it is a term applied to indicate a brittle bed which drills hard accompanied by a characteristic clatter of the drill pipe. The driller's log is also shown in graphic and abbreviated form on the electric log (pl. 7).

16-A-54

9-063
(December 1949)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

No. [illegible]/2-1701

OTHER Nos. Pauba Well

WELL LOG

CONFIDENTIAL

Driller's log

State Calif. County Riverside Subarea Pechanga quadrangle

Owner Vail Company Ranch

Location 1,900 feet north and 1,300 feet west of SE corner sec. 17, T. 8 S., R. 2 W., SBM & M (projected). Temecula River Basin.

Drilled by Van Noy Drilling Co. Address Long Beach, Calif.

Date June [illegible]-July [illegible], 1951 Casing diam. 16- to 12-inch Land-surf. alt. 1050 interp.

Source of data Driller's daily log.

(Enter type of well, perforations, yield, and drawdown at end of log)

CORRELATION	MATERIAL (Depth measured below kelly bushing, 7.0 feet above land surface)	THICKNESS (feet)	DEPTH (feet)
	Sand and gravel	145	145
	Sand	46	191
	Clay and sand	5	196
	Sand	69	265
	Sand and gravel	68	333
	Sand, hard	12	345
	Sand	61	406
	Sand, coarse	19	425
	Sand, hard	11	436
	Clay streaks and hard sand	11	447
	Sand, coarse	5	452
	Clay	13	465
	Clay and sand	5	470
	Clay and coarse sand	24	494
	Clay and sand	7	501
	Sand	44	545
	Clay	9	554
	Sand	16	570
	Clay, sandy	30	600
	Sand, coarse, hard	42	642
	"Shell" (note: not fossils but a hard bed)	2	644
	Sand, hard	16	660
	Clay, sandy	42	702
	Sand, coarse	76	778
	Sand and clay	17	795
	Shale	11	806
	Clay, sandy	23	829
	Sand and streaks of clay	14	843
	Sand, coarse	16	859
	Shale, sandy	11	870
	Sand, hard	10	880
	Shale, sandy	12	892

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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

No. 8/2-17M1

WELL LOG

OTHER Nos. Pauba Well

Driller's log

State ______ County ______ Subarea ______

Owner ______

Location ______

Drilled by ______ Address ______

Date ______ Casing diam. ______ Land-surf. alt. ______

Source of data ______

(Enter type of well, perforations, yield, and drawdown at end of log)

CORRELATION	MATERIAL	THICKNESS (feet)	DEPTH (feet)
	Sand, hard	9	901
	Sand	26	927
	Shale, sandy	65	992
	Sand and streaks of shale	128	1,120
	Sand and shale streaks	26	1,146
	Sand	19	1,165
	Hard "shell" (note: a hard bed)	1	1,166
	Shale, sandy	62	1,228
	Shale	45	1,273
	"Shell"	2	1,275
	Shale	18	1,293
	Shale and small "shells" (thin hard beds)	42	1,335
	Shaley "shells"	15	1,350
	Sand, hard	10	1,360
	Shale, sandy, hard	35	1,395
	Shale	51	1,446
	Sand-shale	29	1,475
	Shale	54	1,529
	Sand and shale, extra hard	10	1,539
	Sand and shale	59	1,598
	Shale	7	1,605
	Sand and shale	98	1,703
	Shale	37	1,740
	Shale and streaks of sand	28	1,768
	Shale, sandy, hard	48	1,816
	Shale, tough	8	1,824
	Sand and shale	101	1,925
	Sand and shale, hard	57	1,982
	Shale	13	1,995
	Sand and shale	127	2,122
	Cavity (bit dropped 2 feet)	2	2,124
	Sand and shale	29	2,153

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UNITED STATES
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WATER RESOURCES DIVISION

No. 8/2-17M1

OTHER Nos. Pauba Well

Driller's log

WELL LOG

State ______ County ______ Subarea ______

Owner ______

Location ______

Drilled by ______ Address ______

Date ______ Casing diam. ______ Land-surf. alt. ______

Source of data ______

(Enter type of well, perforations, yield, and drawdown at end of log)

CORRELATION	MATERIAL	THICKNESS (feet)	DEPTH (feet)
	Shale, sandy	20	2,173
	Shale, hard	23	2,196
	Shale	20	2,216
	Sand and shale	13	2,229
	Shale	30	2,259
	Sand and shale	33	2,292
	Shale, hard	19	2,311
	Shale	94	2,405
	Shale, hard	4	2,409
	Shale, tough	18	2,427
	Sand and shale	3	2,430
	Shale, tough	5	2,435
	Shale	43	2,478
	Note: For perforations and other data see table 1 and USGS log.		

APPENDIX 2

U. S. Geological Survey Log

The following tabulation is the composite log prepared from both field sampling data and brief laboratory analysis of the drill cuttings. Other data collected during the course of drilling are also shown. These include a brief description of the bit samples, temperature of drilling mud, and pertinent data at the end of the log. This log is also shown in graphic and abbreviated form on the electric log (pl. 7).

16-A-53

9-063
(December 1949)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

No. 8/2-17[illegible]

WELL LOG

OTHER NOS. Pauba Well

CONFIDENTIAL

USGS log

State Calif. County Riverside Subarea Pechanga quadrangle

Owner Vail Company Ranch

Location 1,900 feet north and 4,300 feet west of SE corner sec. 17, T. 8 S., R. 2 W., SBM & B (projected). Temecula River Basin.

Drilled by Van Noy Drilling Co. Address Long Beach, Calif.

Date June-July 20, 1951 Casing diam. 16- to 12-inch Land-surf. alt. 1050 interp.

Source of data Field sampling during drilling by RE, LD, and [illegible]

(Enter type of well, perforations, yield, and drawdown at end of log)

CORRELATION	MATERIAL Depth measured below Kelly bushing, 7.0 feet above land surface	THICKNESS (feet)	DEPTH (feet)
	Soil, sandy, gray (excludes the 7.0 feet from land surface to Kelly bushing)	4	4
	Sand, very coarse, and some gravel up to ½-inch; gray to brown, soft	26	30
	Sand, very coarse, brown, and some gray clay; soft	10	40
	Sand, medium, brown	10	50
	Sand, medium to coarse, and gravel up to ½-inch, micaceous, dark yellow-brown, soft. Some clay streaks 50 to 80 feet	78	128
	Sand, very coarse, and clay; micaceous, few pebbles, light brown, slightly harder; mostly clay near base	32	160
	Sand, very coarse, and gravel up to ½-inch; light yellow-brown	31	191
	Clay, micaceous, blue-gray to light yellow-brown	5	196
	Clay; sand, coarse; and some fine gravel; light brown. Clay, sandy, blue-gray, 220 to 225 feet	29	225
	Sand, very coarse, some clay streaks, gravelly near base, light brown	45	270
	Gravel, fine to medium, some coarse sand, yellow-brown	20	290
	Sand, very coarse, yellow-brown, and some gray clay. Clay increasing with depth	30	320
	Sand, very coarse, yellow-brown	20	340
	Sand, very coarse, yellow-brown, and some gray clay, fairly hard	16	356
	Sand, coarse, yellow-brown; gray clay probably in streaks 370 to 380 feet; soft	44	400
	Sand, fine to coarse; gravel, fine; and a little yellow clay	7	407
	Clay, light olive-gray, soft	25	432
	Sand, medium, [illegible] gravel, and clay, olive-gray; pebbly near base. Mud temperature 78° F.	17	449
		Sheet 1 of 7	

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No. 8/2-17M1

OTHER Nos. Pauba Well

USGS log

WELL LOG

State ______ County ______ Subarea ______

Owner ______

Location ______

Drilled by ______ Address ______

Date ______ Casing diam. ______ Land-surf. alt. ______

Source of data ______

(Enter type of well, perforations, yield, and drawdown at end of log)

CORRELATION	MATERIAL	THICKNESS (feet)	DEPTH (feet)
	Clay, sandy, dark olive-gray, fairly soft	47	496
	Sand, coarse, and little gravel, clean (?), brown	10	506
	Sand, coarse, brown; and yellow-brown clay	14	520
	Gravel, medium, and little yellow-brown clay	10	530
	Sand, coarse, micaceous, brown; and gray-brown clay. More clay near base	17	547
	Gravel, medium, micaceous, and a little gray-brown clay. Mud temperature 79° F.	11	558
	Clay, yellow-brown, and little sand	12	570
	Sand, fine to coarse, some medium gravel, and some gray clay	10	580
	Clay, gray, and some coarse sand	10	590
	Sand, fine to coarse, some gravel up to ¼-inch, and little clay. May be some cobbles at 598 feet	11	601
	Sand, fine to coarse, buff; and some clay beds	23	624
	Cobbles or possibly boulders	2	626
	Sand, very coarse, yellow; decrease in grain size near base	14	640
	Gravel or cobbles	2	642
	Sand, fine to coarse, buff; and fine gravel	16	658
	Clay; sand, medium to coarse; and some gravel near base; yellow	12	670
	Sand, coarse, and green-gray to brown clay; probably interbedded, hard near base	34	704
	Sand, fine to coarse, with streaks of brown clay; fairly soft, but hard near base	74	778
	Clay, dark olive-green, sandy, soft	32	810
	Sand, very coarse, and some gravel near base; little clay. A little low grade coal 820 to 830 feet	30	840
	Sand, very coarse, yellow-brown, and gray-green clay, fairly soft. Mostly clay near base	40	880

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No. 8/2-17M1

WELL LOG

OTHER NOS. Pauba Well

USGS log

State ________ County ________ Subarea ________

Owner ________

Location ________

Drilled by ________ Address ________

Date ________ Casing diam. ________ Land-surf. alt. ________

Source of data ________

(Enter type of well, perforations, yield, and drawdown at end of log)

CORRELATION	MATERIAL	THICKNESS (feet)	DEPTH (feet)
	Sand, very coarse, and gravel or cobbles; coarser with depth; some olive-gray clay near top; fairly hard	30	910
	Clay, olive-gray and blue, and some fine sand. Carbonaceous and micaceous zones 920 to 930 feet. More sand near base	30	940
	Sand, very coarse, micaceous, brown; and little olive-gray clay	10	950
	Clay, dark green-gray, and sand, coarse, micaceous; fairly hard. More sand near base, and a sand streak 963 to 965 feet	50	1,000
	Sand, coarse to very coarse, with little olive-gray clay	20	1,020
	Clay, gray-green, and some sand, coarse, micaceous	20	1,040
	Sand, coarse, yellow-brown, and little gray-green clay, fairly soft	20	1,060
	Clay, sandy, light olive-gray; more clay near base	20	1,080
	Sand, very coarse, brown, micaceous, and little clay, fairly hard	40	1,120
	Sand, very coarse, brown, and clay, blue, plastic; less clay near base, fairly hard	30	1,150
	Gravel, fine; sand, coarse; and olive-green clay; quite hard. Coarse gravel 1,167 to 1,169 feet	20	1,170
	Sand, very coarse, micaceous, buff; and clay, olive-gray, soft	40	1,210
	Sand, coarse, yellow-brown; and little olive-gray clay. Mud temperature 81° F.	10	1,220
	Clay, olive-gray to blue, and very fine sand, hard. Sand or fine gravel 1,250 to 1,253, 1,265 to 1,268, 1,273 to 1,276, and 1,282 to 1,28[illegible] feet	75	1,295
	Sand, medium, buff, and little gray clay; in part carbonaceous, hard	34	1,329
	Clay, blue, plastic, with brown clay nodules; and little sand, hard	31	1,360

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WATER RESOURCES DIVISION

No. [illegible]/2-17[illegible]

OTHER NOS. Pauba Well

USGS log

WELL LOG

State ____ County ____ Subarea ____

Owner ____

Location ____

Drilled by ____ Address ____

Date ____ Casing diam. ____ Land-surf. alt. ____

Source of data ____

(Enter type of well, perforations, yield, and drawdown at end of log)

CORRELATION	MATERIAL	THICKNESS (feet)	DEPTH (feet)
	Sand, coarse, yellow-brown, and some olive-gray clay. More clay near base, quite hard	32	1,392
	Clay, olive-gray, partly carbonaceous; and sand, medium, buff, below 1,410 feet; fairly hard	44	1,436
	Sand, coarse, micaceous, buff; some silt and little olive-gray clay	14	1,450
	Clay, olive-gray, micaceous; and considerable sand, coarse, buff; hard. Sand and fine gravel 1,532 to 1,535 feet, very hard	124	1,574
	Sand, medium, buff; and clay, olive-gray; in part micaceous. Less clay below 1,600 feet, fairly hard	56	1,630
	Sand, very coarse; gravel, medium; and very little clay, olive-gray; quite hard	30	1,660
	Clay, olive-gray, micaceous; and very little coarse sand; hard. Mud temperature 78° F.	80	1,740
	Clay, blue to olive-gray, and sand, coarse, micaceous, buff, very hard	20	1,760
	Clay, blue-gray, plastic; and very little sand, fine to medium, hard. Considerable sand 1,790 to 1,800 feet	69	1,829
	Gravel, fine to medium; sand, coarse; and little blue clay	7	1,836
	Sand, coarse, buff, micaceous; grading downward to sandy clay	27	1,863
	Gravel and coarse sand, gray; some gray clay; very hard	12	1,875
	Clay, olive-gray, some sand, fairly hard	11	1,886
	Sand, coarse, buff, gray, very hard	4	1,890
	Clay, olive-gray, some sand, fairly hard. Hard sand and gravel (?) 1,916 to 1,918 feet	50	1,940
	Sand, coarse, micaceous, buff; and considerable clay, olive-gray. Mud temperature 85° F.	57	1,997
	Sand, coarse, and some gravel, buff, very hard	13	2,010

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UNITED STATES
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GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

No. 8/2-17[illegible]

WELL LOG

OTHER Nos. Pauba Well

USGS log

State ______ County ______ Subarea ______

Owner ______

Location ______

Drilled by ______ Address ______

Date ______ Casing diam. ______ Land-surf. alt. ______

Source of data ______

(Enter type of well, perforations, yield, and drawdown at end of log)

Correlation	Material	Thickness (feet)	Depth (feet)
	Sand, very coarse, micaceous, buff; and considerable clay, olive-gray, hard	40	2,050
	Clay, olive-gray; and sand, very coarse, micaceous, buff; fairly hard. Bit sample from 2,079 feet: Clay, olive, micaceous, and black carbonaceous inclusions, tough. Mud temperature 86° F.	30	2,080
	Gravel, medium; sand, very coarse; and considerable olive-green clay; somewhat hard. Possible cavity 2,122 to 2,124 feet; lost considerable drilling mud.	70	2,150
	Sand, medium, very clayey, hard. Sand 2,172 to 2,177 feet	27	2,177
	Clay, light olive-gray, micaceous, hard	42	2,219
	Gravel, medium; sand, medium; sand, medium; and clay, olive-green, very hard. Bit sample from 2,227 feet: Sandstone, fine, clayey to silty, micaceous, and a little fine gravel; very hard.	11	2,230
	Clay, dark olive-green, and little sand, coarse; micaceous, very hard	20	2,250
	Gravel, medium; sand, medium; and clay, olive-green; micaceous, very hard. Mud temperature 86° F.	18	2,268
	Clay, light green-brown, micaceous; and very little sand, fine to medium, very hard	32	2,300
	Clay, olive-gray; and some sand, fine to medium; coarse sand and gravel 2,310 to 2,312 and 2,335 to 2,337 feet; very hard	50	2,350
	Clay, olive-gray to blue; and some bags of dark brown-black, carbonaceous material; micaceous, very hard	10	2,360
	Clay, blue and buff streaks; and some sand, fine to coarse; very hard	20	2,380
	Clay, blue, plastic, and small amount of fine sand; very hard	22	2,402

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(December 1949)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

No. 8/2-17M1

WELL LOG

OTHER Nos. Pauba Well

USGS log

State ______ County ______ Subarea ______

Owner ______

Location ______

Drilled by ______ Address ______

Date ______ Casing diam. ______ Land-surf. alt. ______

Source of data ______

(Enter type of well, perforations, yield, and drawdown at end of log)

CORRELATION	MATERIAL	THICKNESS (feet)	DEPTH (feet)
	Sand, fine, and some clay, olive-gray to blue; extremely hard (note: This may be sand shown on electric log at about 2,395 feet)	5	2,407
	Clay, olive-gray and blue; some fine sand; micaceous, very hard. Bit sample from 2,409 feet: Clay, blue to olive, tough; some lenses of white clay and fine sand.	23	2,430
	Sand, fine, and clay, blue and olive-gray; very hard	10	2,440
	Clay, blue and olive-gray; and some sand, fine, micaceous; very hard	38	2,478

Note: If the depth is measured below land surface, 7.0 feet should be subtracted from the figures in the depth column. This was not done owing to difficulty in correlation between this log and the driller's and electric log.

Well reamed.- 36 inches in diameter to 10[illegible] feet; 2[illegible] inches in diameter to 206 feet; and 24 inches in diameter to 2,157 feet below Kelly bushing.

Casing record.- 30-inch conductor pipe landed at 10[illegible] feet below Kelly bushing and cemented on outside to land surface. 16-inch ID casing from 1.35 feet above land surface to 197 feet; 16-inch to 12-inch reducer 197 to 199 feet; and 12-inch ID casing 199 to 2,150 feet below land surface. Bull nose on bottom of casing. Centralizers on casing spaced every 150 feet.

Perforations.- 234 to 2,147 feet below land surface-- a total of 1,913 feet. Perforations machine cut vertical

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UNITED STATES
DEPARTMENT OF THE INTERIOR
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WATER RESOURCES DIVISION

No. 8/2-17H1

WELL LOG

OTHER Nos. Pauba Well

USGS log

State ______ County ______ Subarea ______

Owner ______

Location ______

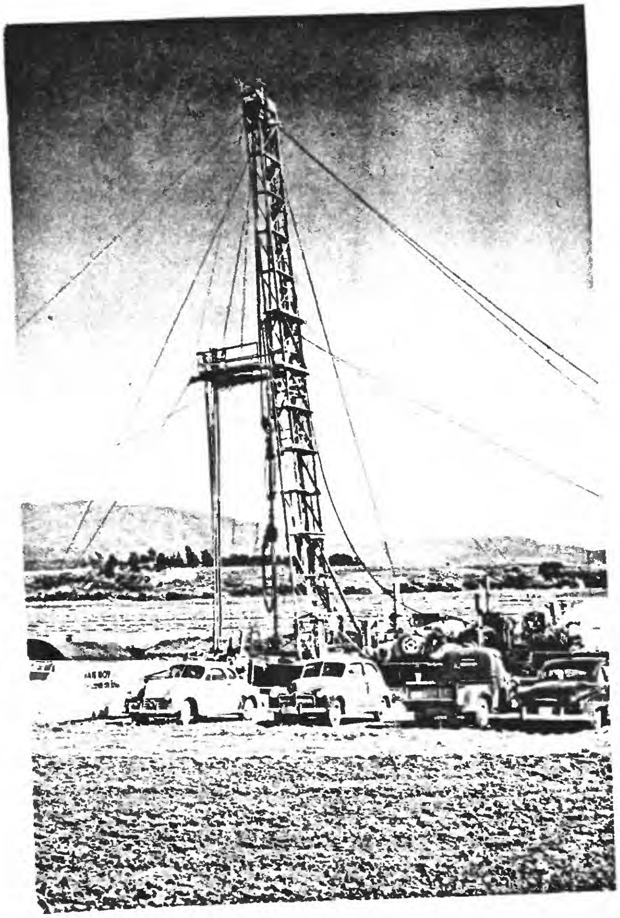
Drilled by ______ Address ______

Date ______ Casing diam. ______ Land-surf. alt. ______

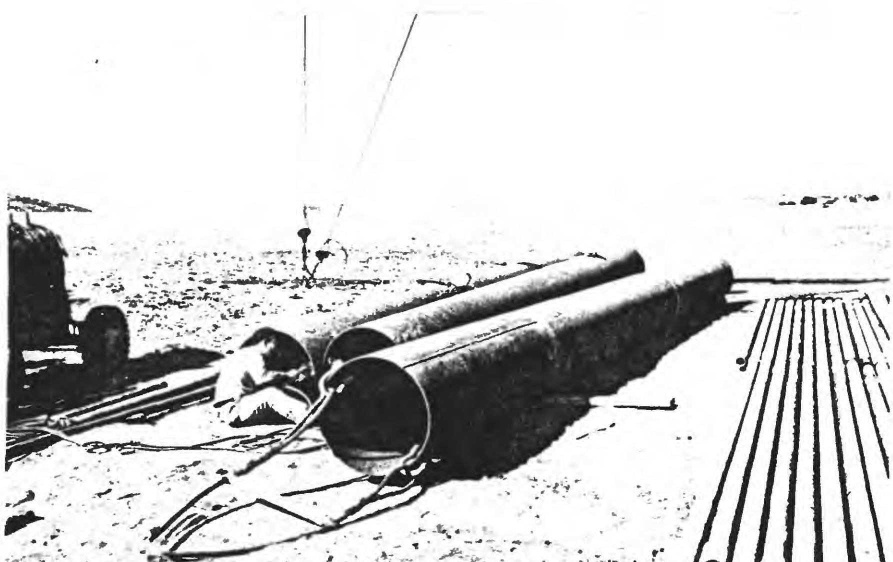
Source of data ______

(Enter type of well, perforations, yield, and drawdown at end of log)

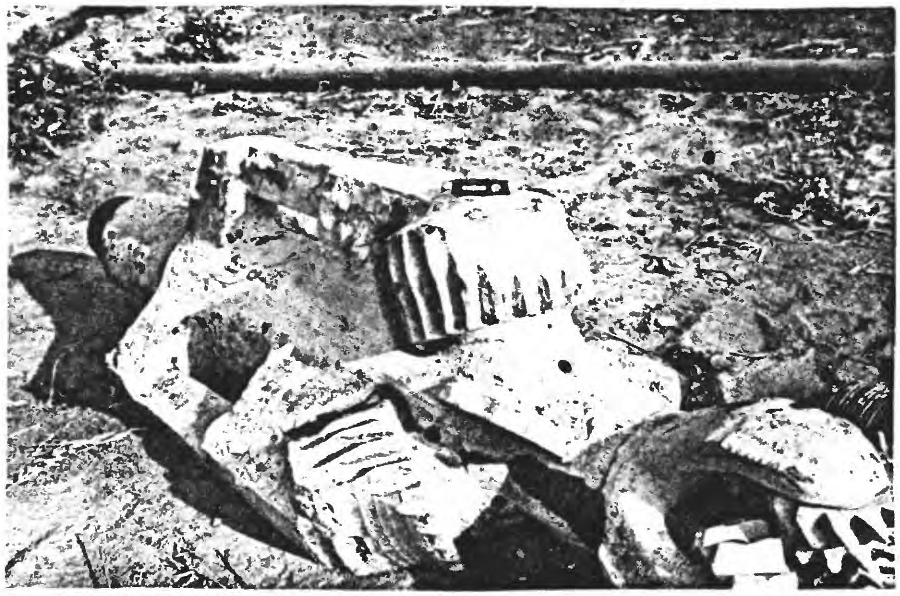
Correlation	Material	Thickness (feet)	Depth (feet)
	slots 3/16-inch x 2¼-inch, 12 slots per round, 4 rounds per foot.		
	Gravel pack.- About 283 tons of mixed gravel installed--50% of ½-inch to ¼-inch and 50% of ¼-inch to No. 4.		
	Artesian flow and head.- Before the pump test the well flow stabilized at about 400 gpm at a temperature of 81° F; the maximum "static" pressure head was about 20 feet above land surface. Four days after the pump test the well flow stabilized at about 250 gpm at a temperature of 81° F; the maximum "static" pressure head was about 13 feet above land surface.		
	Pump test.- Run Aug. 3 to 6. Maximum stabilized discharge was 2,326 gpm with a drawdown of 98.9 feet below land surface and about 114.9 feet below an average "static" pressure head (16 feet above land surface). Temperature of water during the test was 77° F.		



A. PORTABLE OIL WELL RIG USED TO DRILL PAUBA WELL. View looking south. Photo, June 1951

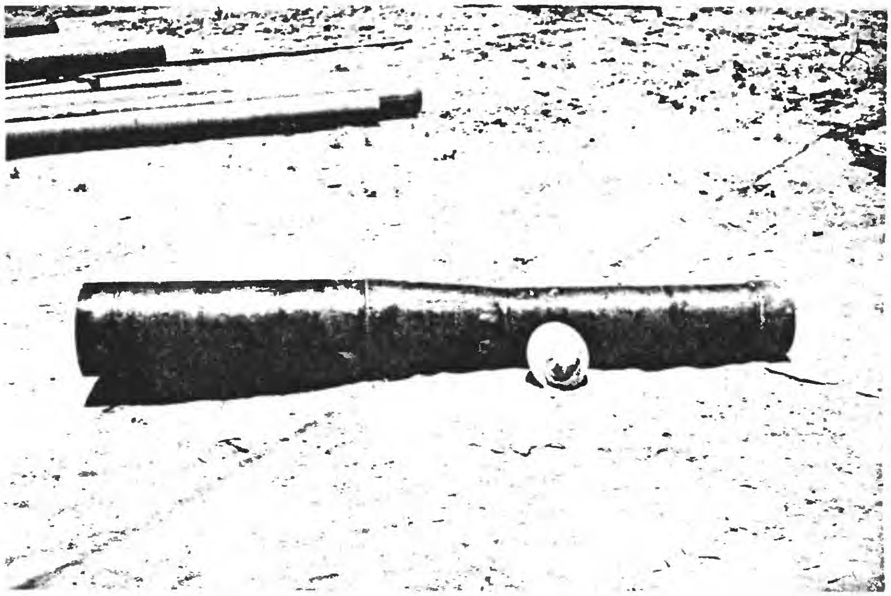


B. THREE LENGTHS OF 30-INCH CONDUCTOR PIPE. View looking northeast up Temecula River valley. Photo, June 1951

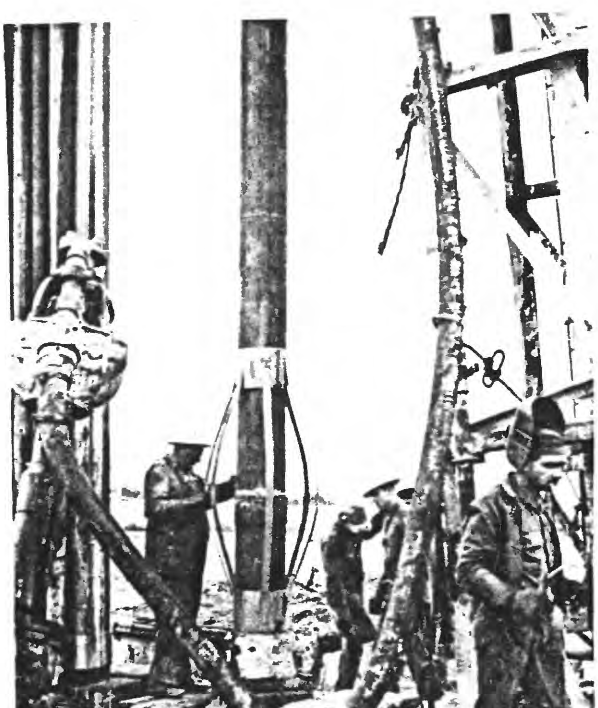


A. WORN WALL-CUTTER GEARS ON 24-INCH REAMER; AND 13-5/8 INCH PILOT BIT. Photo, July 1951

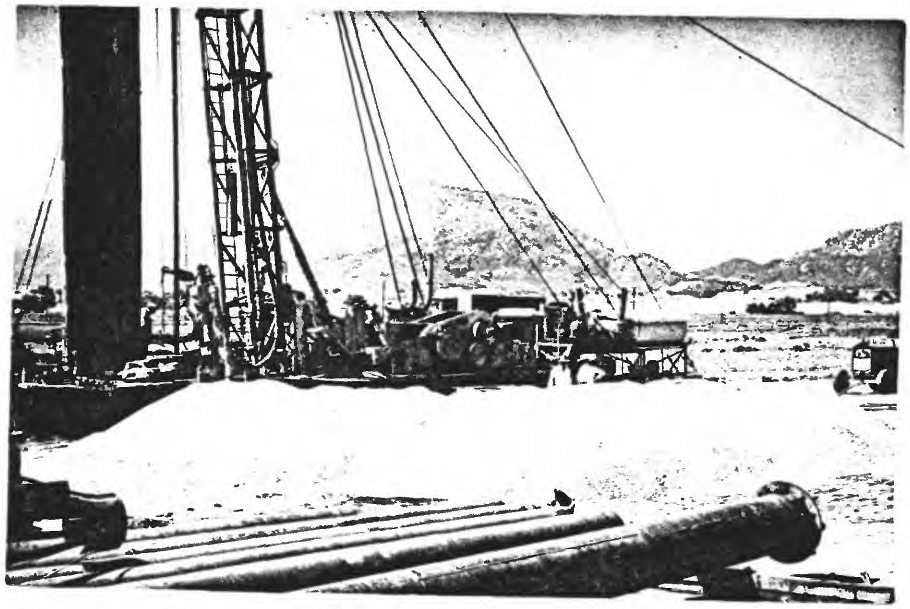
B. BULL NOSE NOW AT 2,150 FEET; AND MACHINE-CUT PERFORATIONS. Photo, July 1951



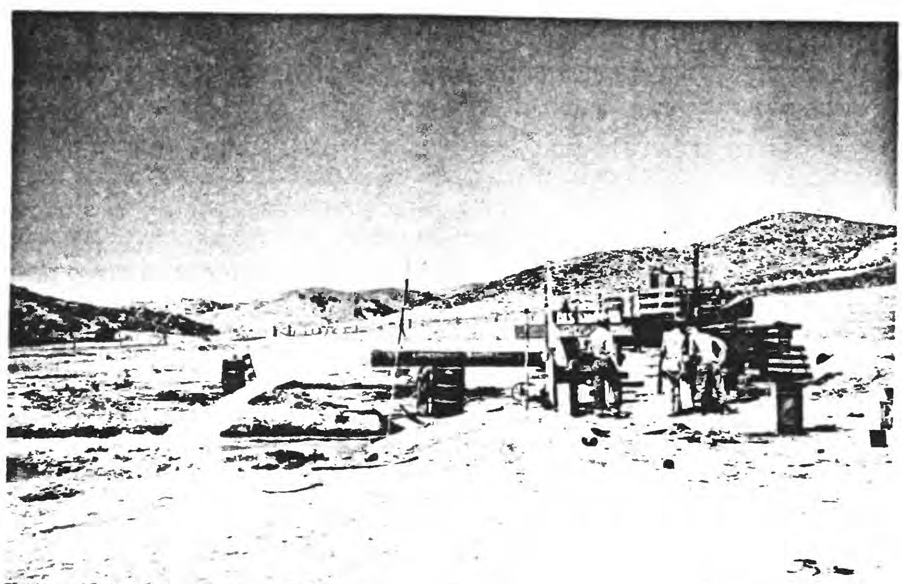
A. REDUCER; 16-INCH TO 12-INCH. Photo, July 1951



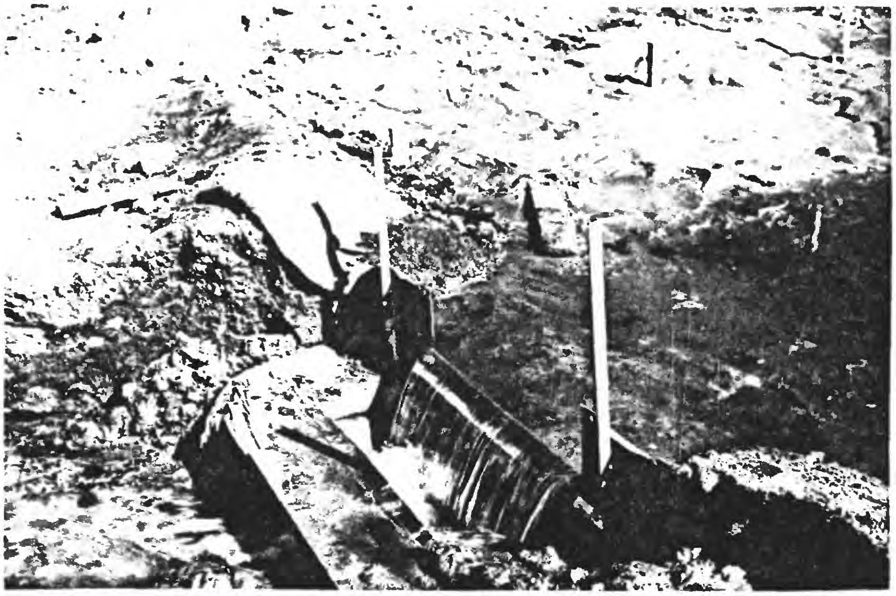
B. RUNNING PERFORATED CASING WITH CASING CENTRALIZER IN PLACE. Photo, July 1951



A. GRAVEL PACK (283 TONS) PLACED IN WELL. GRANITIC ROCKS ON SKYLINE SOUTHWEST OF ELSINORE FAULT. View looking south. Photo, July 1951



B. TEST PUMPING; DISCHARGING ABOUT 2,300 GPM. OLDER CONTINENTAL DEPOSITS IN RIGHT BACKGROUND. View looking southwest. Photo, August 1951



A. FLOW OVER WEIR ABOUT 250 GPM. Photo, August 1951

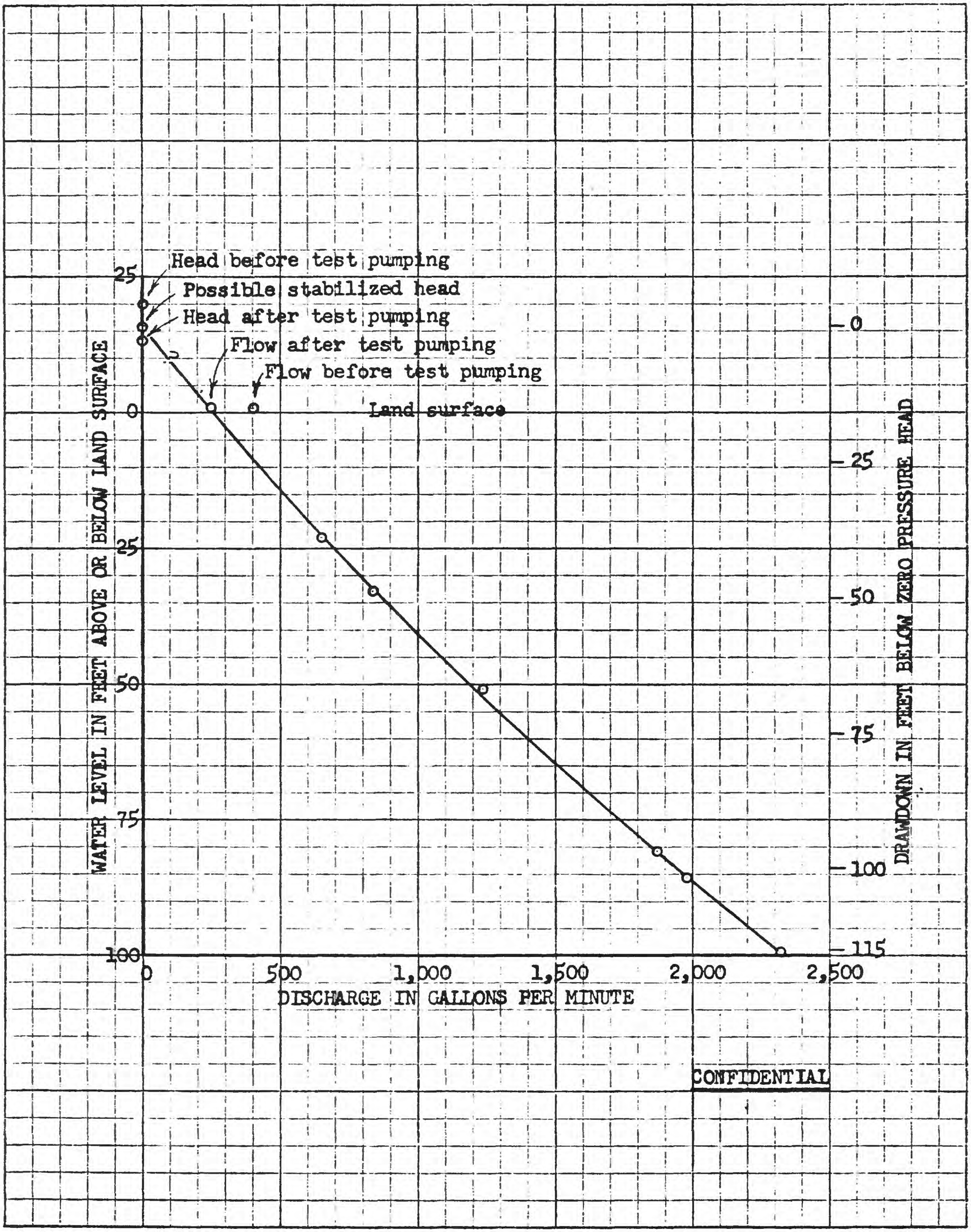
B. WELL FLOWING ABOUT 250 GPM AFTER TEST PUMPING. Photo, August 1951

9-213-B
(March 1939)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

File PLATE 8

DISCHARGE-DRAWDOWN CURVE FOR THE PAUBA WELL



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