GROUND-WATER DATA FOR SAN NICOLAS ISLAND, CALIFORNIA, 1989-90

By Lowell F.W. Duell, Jr., *and* Charles A. Kaehler

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Multiply	By	To obtain
acre	0.4047	hectare
acre	4,047	square meter
foot (ft)	0.3048	meter
gallon (gal)	3.785	liter
gallon per day (gal/d)	0.003785	cubic meter per day
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	259.0	hectare
square mile (mi^2)	2.590	square kilometer

Temperature is given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation:

$$\text{Temp. } ^\circ\text{F} = 1.8(\text{temp. } ^\circ\text{C}) + 32$$

Sea Level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviations:
min (minutes)
min/d (minutes per day)
min/cycle (minutes per cycle)
cycles/d (cycles per day)

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ABSTRACT

In an effort to gain geohydrologic knowledge and to increase the availability of ground water to the U.S. Navy on San Nicolas Island, nine test wells were drilled by the U.S. Geological Survey in 1989 and one production well was drilled by the U.S. Navy in 1990. One of the nine test wells was dry, five produced less than 10 gallons of water per day, two produced between 20 and 30 gallons per day, and one produced 400 gallons per day. The production well produced about 900 gallons per day.

Water samples were collected from eight wells during 1989-90 and analyzed for concentrations of major dissolved inorganic ions and nutrients. Five of the sampled wells were constructed in 1989, one was constructed in 1990, and two were constructed prior to 1989.

Data from the study are presented in tables and graphs. Included are geophysical, lithologic, and well-construction data and results obtained from well-pumping tests and from the chemical analysis of water from selected wells.

INTRODUCTION

Water for domestic use on San Nicolas Island (fig. 1), a U.S. Naval base, historically has been obtained from local sources--wells, springs, surface-water diversion, and a seawater distillation plant--and from the mainland (transported by barge). During 1990 some existing wells were not pumped because of declining water levels, poor water quality, and casing-corrosion problems. Prior to 1990, spring discharges had decreased and the distillation plants had been discontinued. To gain geohydrologic knowledge and to increase the availability of ground water on San Nicolas Island, the U.S. Geological Survey, in cooperation with the U.S. Department of the Navy, drilled and constructed nine test wells on the island in 1989 and the U.S. Navy drilled one production well in 1990. The wells were developed and test pumped, and six were sampled for chemical analysis. Two wells constructed prior to 1989 also were sampled for chemical analysis. The purpose of this report it to present results obtained from the well-pumping tests and from the chemical analyses, along with geophysical, lithologic, and well-construction data.

San Nicolas Island, which is occupied solely by U.S. Naval installations, is in the Pacific Ocean about 90 mi southwest of Los Angeles, California (fig. 1). The roughly oval-shaped island is about 9 mi long and 3 mi wide at its greatest extent, and its area is approximately 23 mi^2. The highest altitude on the island is 907 ft above sea level.

WELL-NUMBERING SYSTEM

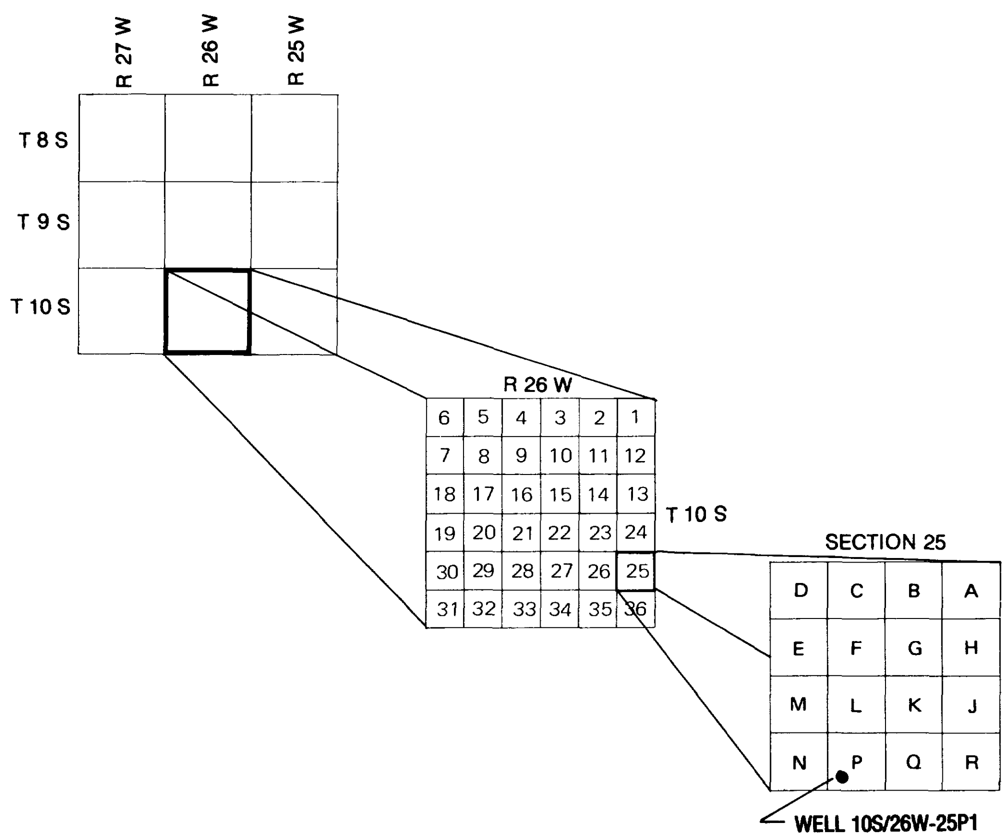
Wells are numbered according to their location in the rectangular system for subdivision of public land. For example, in well number 10S/26W-25P1, that part of the number preceding the slash indicates the township (T. 10 S.); the number and letter following the slash indicate the range (R. 26 W.); the number following the hyphen indicates the section (sec. 25); and the letter (P) indicates the 40-acre subdivision of the section according to the lettered diagram below. The final digit (1) is a serial number for wells in each 40-acre subdivision. The area covered by this report lies in the southwest quadrant of the San Bernardino base line and meridian. In figure 1, township and range designations are given along the margin of the map. The diagram below shows how well number 10S/26W-25P1 is derived.

DATA FOR SELECTED WELLS

WELL CONSTRUCTION

The 10 wells drilled during 1989-90 by the U.S. Geological Survey and the U.S. Navy were located in the areas thought most likely to produce potable ground water. The 10-inch-diameter holes were drilled by the direct mud-rotary method to depths ranging from 62 to 142 ft below land surface. Geophysical, caliper, and lithologic logs for wells drilled during 1989-90 are shown in figures 2-11.

The wells were cased with 6-inch-diameter PVC (polyvinyl chloride) casing. For the perforated intervals, either continuous-slot screen or slotted casings were used. The slot size is 0.03 in. The annular space in the wells drilled by the U.S. Geological Survey was filled with



Monterey sand (well-sorted medium sand) from the bottom of the annular space to the top of the perforated interval. The remainder of the annular space was filled with cement to land surface. The annular space in the well drilled by the U.S. Navy was filled with pea gravel from the bottom to 10 ft below land surface, and with cement to land surface. Complete well-construction data are given in table 1.

WATER LEVELS

Water levels were measured periodically with a steel tape in all the wells drilled during 1989-90 and in some older wells. The location of the wells is shown in figure 1, and the water levels are given in table 1.

TEST FOR WELL PRODUCTION

Wells drilled in 1989-90 were tested with a submersible pump to estimate well production. Test data are shown in figure 12 and include the volume of water pumped, pumping time (indicated in graphs by the width of the bars), and water-level drawdown. A pressure transducer and a data logger were used to monitor water levels during the pumping and recovery phase of the tests in wells 10S/26W-25P1, 10S/26W-36D1, 10S/26W-36E1, and 10S/26W-36K1. The transducer and data logger allow measurement and recording of water levels as frequently as once per second. Water levels were measured intermittently with an electric sounder in wells 10S/26W-34G1, 10S/26W-34L1, 10S/26W-36L1, and 10S/26W-36M1. Static water levels were not obtained for wells 10S/26W-25P1 and 10S/26W-36L1 because the pumping tests began shortly after well development. Pumping data are not given for well 10S/26W-35P1 because it was dry and for well 10S/26W-35H1 because the water level in the well did not recover within 9 days after 9 gal (the entire casing volume) of water was removed.

The amount of drawdown, volume of water pumped per cycle, and rate of water-level recovery obtained from the short-term tests can be used to estimate yield for each well. For example, at well 10S/26W-25P1 (fig. 12), an average of 95 gal of water was pumped during four consecutive 150-min pumping and recovery cycles (based on time needed for full or nearly full recovery) during a representative part of the test. A well-yield estimate of about 900 gal/d is obtained by multiplying 95 gal/cycle times 9.6 cycles/d (1,440 min/d ÷ 150 min/cycle = 9.6 cycles/d). Yield estimates for each well are given in table 1.

WATER QUALITY

Water samples were collected from eight wells using standard U.S. Geological Survey field techniques (U.S. Geological Survey, 1977). Water samples were analyzed for major dissolved inorganic ions and nutrients (nitrogen and phosphorus) by the U.S. Geological Survey laboratory in Arvada, Colorado. The methods used for laboratory analyses are those described by Fishman and Friedman (1989). The analyses are given in table 2.

Five of the sampled wells were drilled by the U.S. Geological Survey in 1989, one was drilled by the U.S. Navy in 1990, and two were older wells. The other four wells drilled by the U.S. Geological Survey were not sampled because of very low production rates and the inability to fully develop the wells to obtain samples uncontaminated by drilling fluids.

SELECTED REFERENCES

Brockmeir Consulting Engineers, Inc., 1986, Study of water system for San Nicolas Island--phase 2 (pre-final submittal): Santa Monica, California, 87 p. and 4 appendixes [available for inspection at U.S. Geological Survey, 5735 Kearny Villa Road, Suite O, San Diego, CA 92123].

Burnham, W.L., Kunkel, Fred, Hofmann, Walter, and Peterson, W.C., 1963, Hydrogeologic reconnaissance of San Nicolas Island, California: U.S. Geological Survey Water-Supply Paper 1539-O, 43 p.

Fishman, M.J., and Friedman, L.C., eds, 1989, Methods for determination of organic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter A1, 545 p.

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Table 1. *Records for selected wells*

[All wells are in T. 10 S., R. 26 W. Water level: R, well had been recently pumped (within 24 hours prior to measurement). --, no data available; <, actual value less than value shown]

State well number	Local identification	Date of well construction	Altitude of land surface, in feet above sea level	Diameter of casing, in inches	Depth of well, in feet below land surface	Perforation interval, in feet below land surface	Measure point (top of casing), in feet above land surface	Date of water-level measurement	Water level, in feet below land surface	Estimated well yield, in gallons per day
25P1	Humphrey sump #1	04-30-90	420	6	100	10-40	2.0	05-02-90	R7.55	900
34C1	Test well #5	October 1960	90	8	47	--	2.1	08-11-89 05-04-90 06-19-90	25.53 25.60 25.70	--
34G1	A-7	08-10-89	250	6	142	45-52, 80.5-132	2.6	09-15-89 04-23-90 05-02-90 06-19-90	118.55 120.34 120.00 119.22	<10
34L1	B-8	08-14-89	120	6	65	34-60	2.7	09-15-89 03-07-90 04-23-90 06-19-90	48.26 44.98 45.12 45.27	<10
35H1	D-2	08-06-89	590	6	62	23-53	2.8	09-15-89 03-05-90 04-23-90 06-19-90	53.91 50.94 50.90 55.10	<10
35P1	C-1	08-04-89	705	6	78	36-68	1.6	08-06-89 03-05-90 04-23-90 06-19-90	Dry Dry Dry Dry	--
36D1	E-5	08-08-89	543.4	6	69	29-39, 44-49	2.5	09-11-89 03-05-90 04-23-90 06-19-90	43.96 49.30 49.41 50.03	30
36E1	H-3	08-06-89	583	6	39	24-34	1.9	09-11-89 03-05-90 04-23-90 06-19-90	30.06 30.13 30.26 30.43	<10
36F1	Well #1 (Navy C)	1950 or 1951	590.7	--	67	--	0	08-07-89	R29.68	--
36F2	Well #6 (Dale's well)	August 1988	586	6	330	50-70, 90-110, 250-330	2.0	09-13-89	R37.88	--
36F3	Well #2 (Navy D)	1950 or 1951	571	12	72	--	0	06-19-90	R60.00	--
36G1	Well #3 (Navy E)	1950 or 1951	572	12	80	--	0	08-07-90	47.00	--
36K1	G-4	08-07-89	600.5	6	64	37-59	3.8	09-15-89 03-05-90 03-07-90 04-23-90 06-19-90	45.25 43.67 43.72 44.01 44.29	20
36L1	I-9	08-15-89	595	6	74	34-74	1.8	09-15-89 03-05-90	37.61 R64.24	400
36M1	F-6	08-09-89	633	6	80	27-57, 70-75	2.7	09-15-89 03-05-90 03-06-90 04-23-90 06-19-90	56.80 55.12 55.30 55.17 55.20	<10

Table 2. *Chemical analysis of water from selected wells*

[All wells are in T. 10 S., R. 26 W. For wells sampled twice, upper value is result for first date and lower value is result for second date. μS/cm, microsiemens per centimeter at 25 °C; °C, degree Celsius; mg/L, milligram per liter; μg/L, microgram per liter; --, no data available; <, actual value less than value shown]

State well number	25P1	34G1	36D1	36E1	36F1	36F2	36K1	36L1
Date	05-02-90 06-19-90	05-02-90	04-29-90	09-15-89	09-15-89	06-19-90	04-30-90	09-15-89 06-19-90
Specific conductance (μS/cm)	2,330 2,390	1,420	1,500	1,670	1,010	1,520	1,990	1,530 1,620
pH (standard units)	7.30 7.40	8.20	7.60	8.00	7.70	7.60	7.60	7.60 7.60
Temperature, water (°C)	18.0 18.0	18.0	16.0	19.0	19.0	19.0	18.0	19.0 18.5
Calcium, dissolved (mg/L as Ca)	83 78	26	51	50	40	46	46	40 40
Magnesium, dissolved (mg/L as Mg)	38 35	11	19	19	15	19	18	17 17
Sodium, dissolved (mg/L as Na)	380 400	240	230	280	150	250	360	280 270
Potassium, dissolved (mg/L as K)	9.6 9.6	5.9	8.8	9.2	8.1	8.4	8.8	9.0 8.2
Alkalinity, total field (mg/L as $CaCO_3$)	417 409	279	293	298	249	321	353	414 392
Sulfate, dissolved (mg/L as SO_4)	150 150	100	88	110	48	82	86	71 81
Chloride, dissolved (mg/L as Cl)	450 450	200	240	310	140	230	390	230 220
Fluoride, dissolved (mg/L as F)	0.60 0.60	0.40	0.70	1.1	1.0	0.80	0.50	0.50 0.50
Silica, dissolved (mg/L as SiO_2)	20 18	16	18	19	17	18	17	17 17
Solids, residue at 180 °C, dissolved (mg/L)	1,370 1,420	814	856	973	557	908	1,130	914 934
Nitrogen, ammonia, dissolved (mg/L as N)	0.13 0.06	0.04	0.02	0.01	0.01	<0.01	0.02	0.01 0.02
Nitrogen, ammonia + organic, dissolved (mg/L as N)	0.30 0.30	0.80	0.60	0.30	0.20	0.40	<0.20	<0.20 <0.20
Nitrogen, NO_2+NO_3, dissolved (mg/L as N)	<0.10 <0.10	5.30	2.50	2.10	1.60	1.10	<0.10	<0.10 <0.10
Phosphorus, ortho, dissolved (mg/L as P)	0.04 <0.01	0.12	0.04	0.09	0.03	<0.01	0.02	-- 0.01
Phosphorus, dissolved (mg/L as P)	0.54 <0.01	0.13	0.05	0.17	0.02	<0.01	0.02	-- 0.01
Boron, dissolved (μg/L as B)	800 760	510	320	310	230	430	490	490 520
Iron, dissolved (μg/L as Fe)	600 20	6	14	8	30	5	30	410 120
Manganese, dissolved (μg/L as Mn)	80 20	18	26	19	6	<1	40	60 12

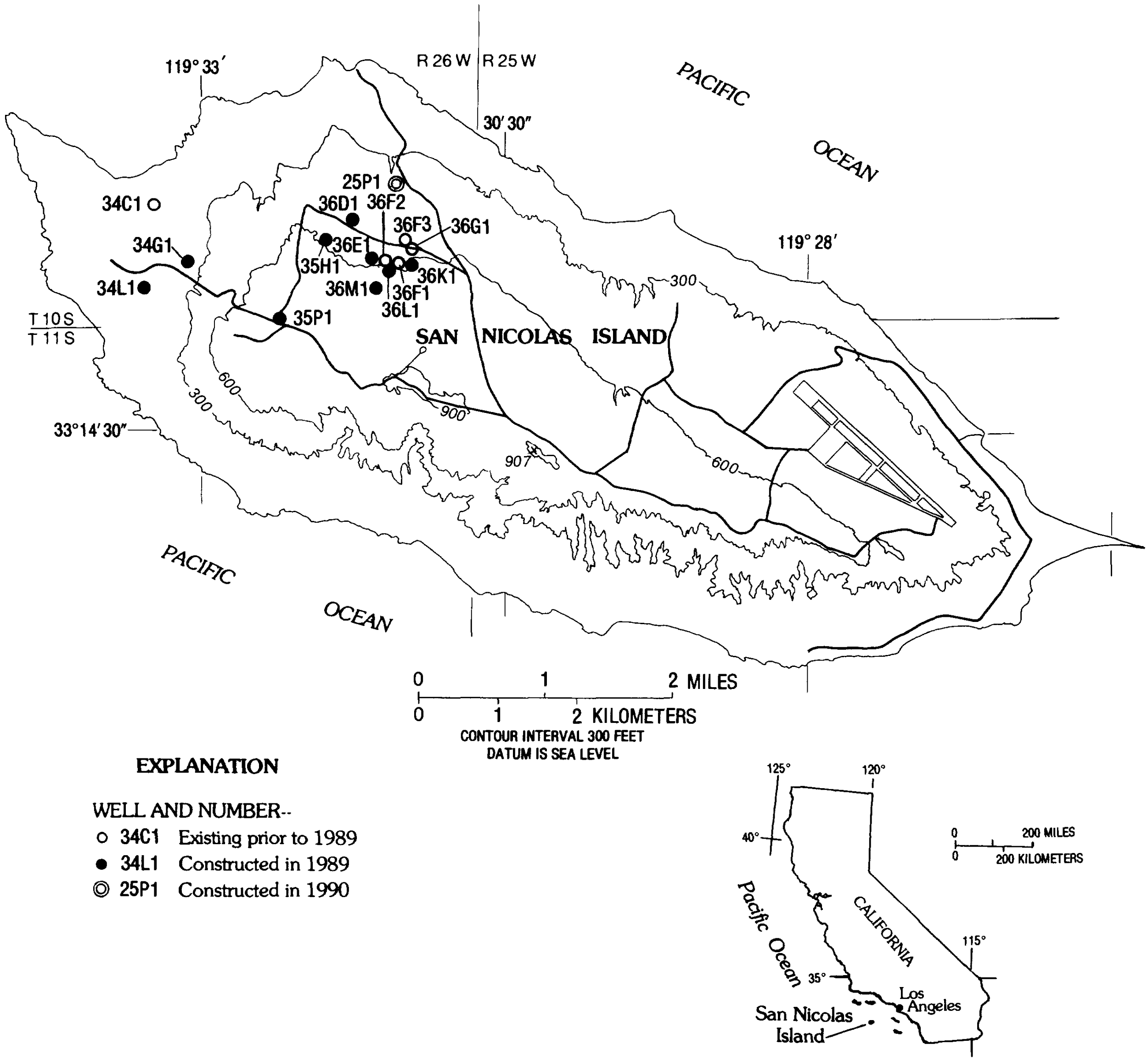

Figure 1. Location of selected wells on San Nicolas Island.

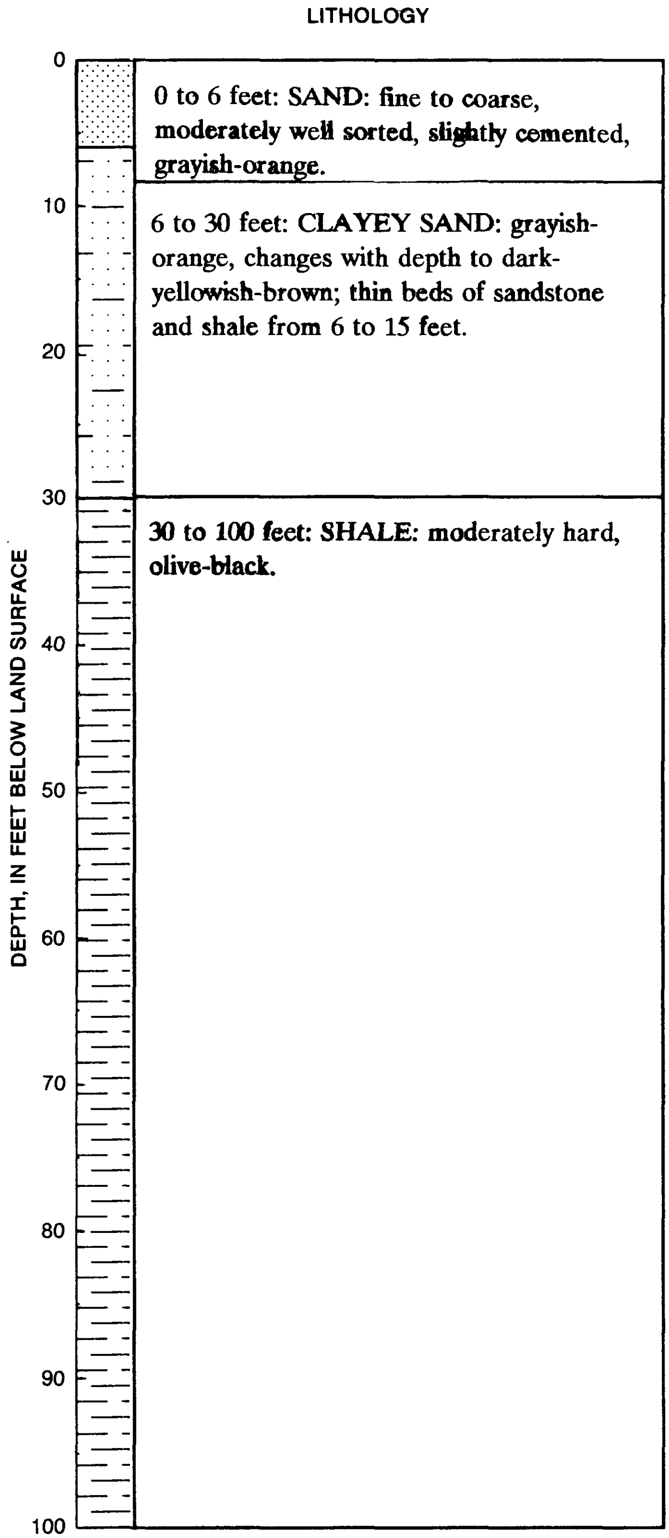

Figure 2. Lithologic log of well 10S/26W-25P1.

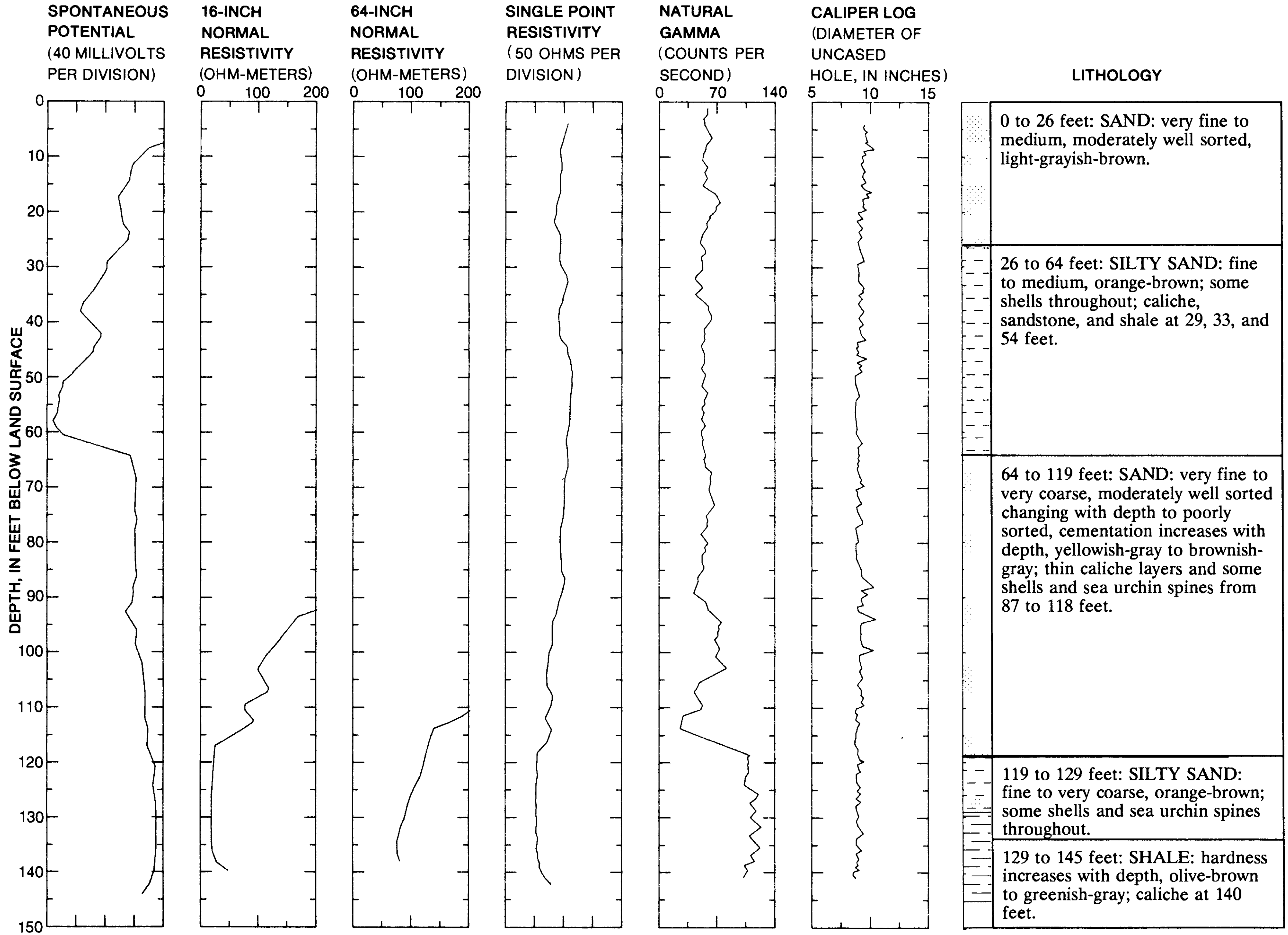

Figure 3. Geophysical, caliper, and lithologic logs of well 10S/26W-34G1.

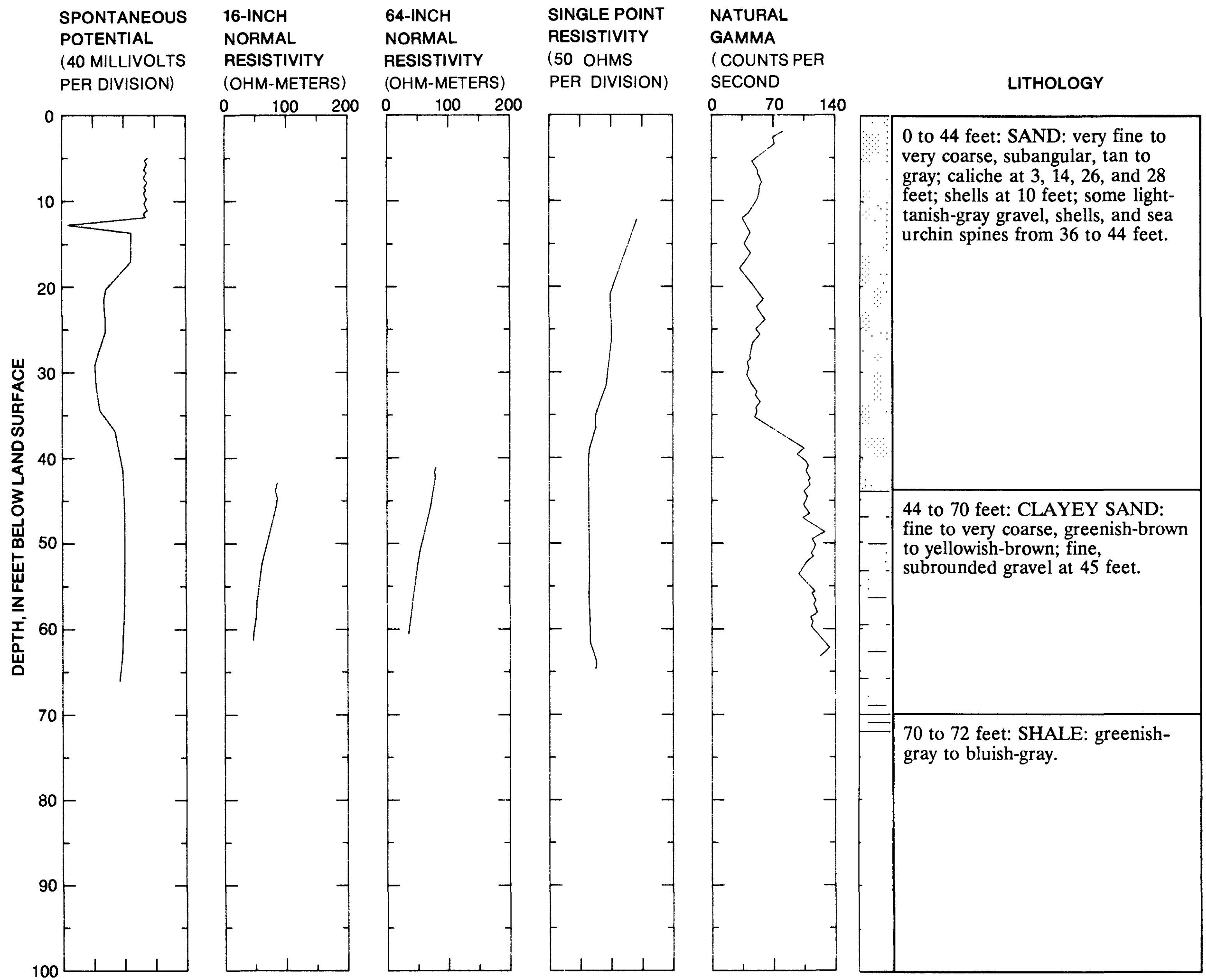

Figure 4. Geophysical and lithologic logs of well 10S/26W-34L1.

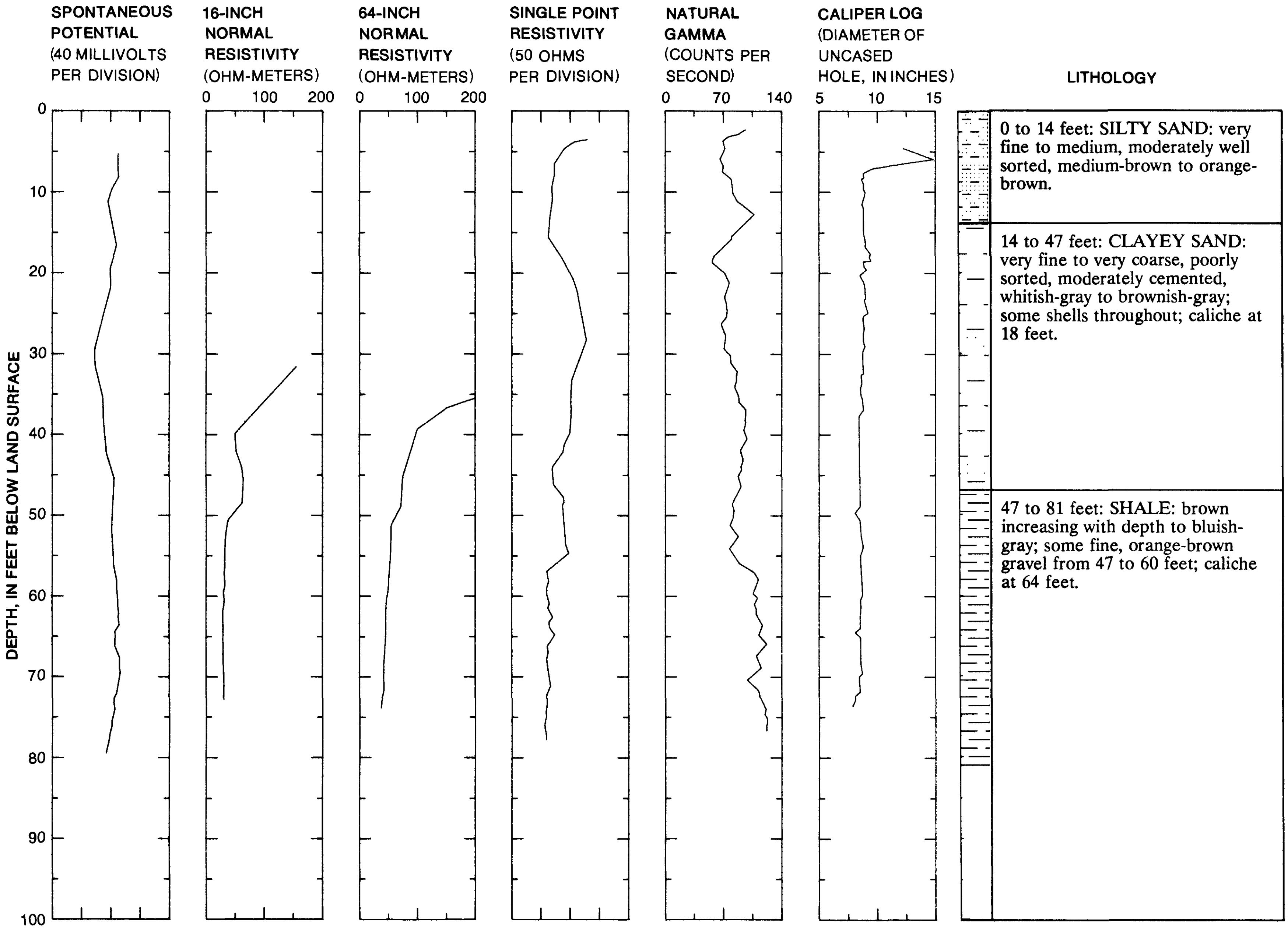

Figure 5. Geophysical, caliper, and lithologic logs of well 10S/26W-35H1.

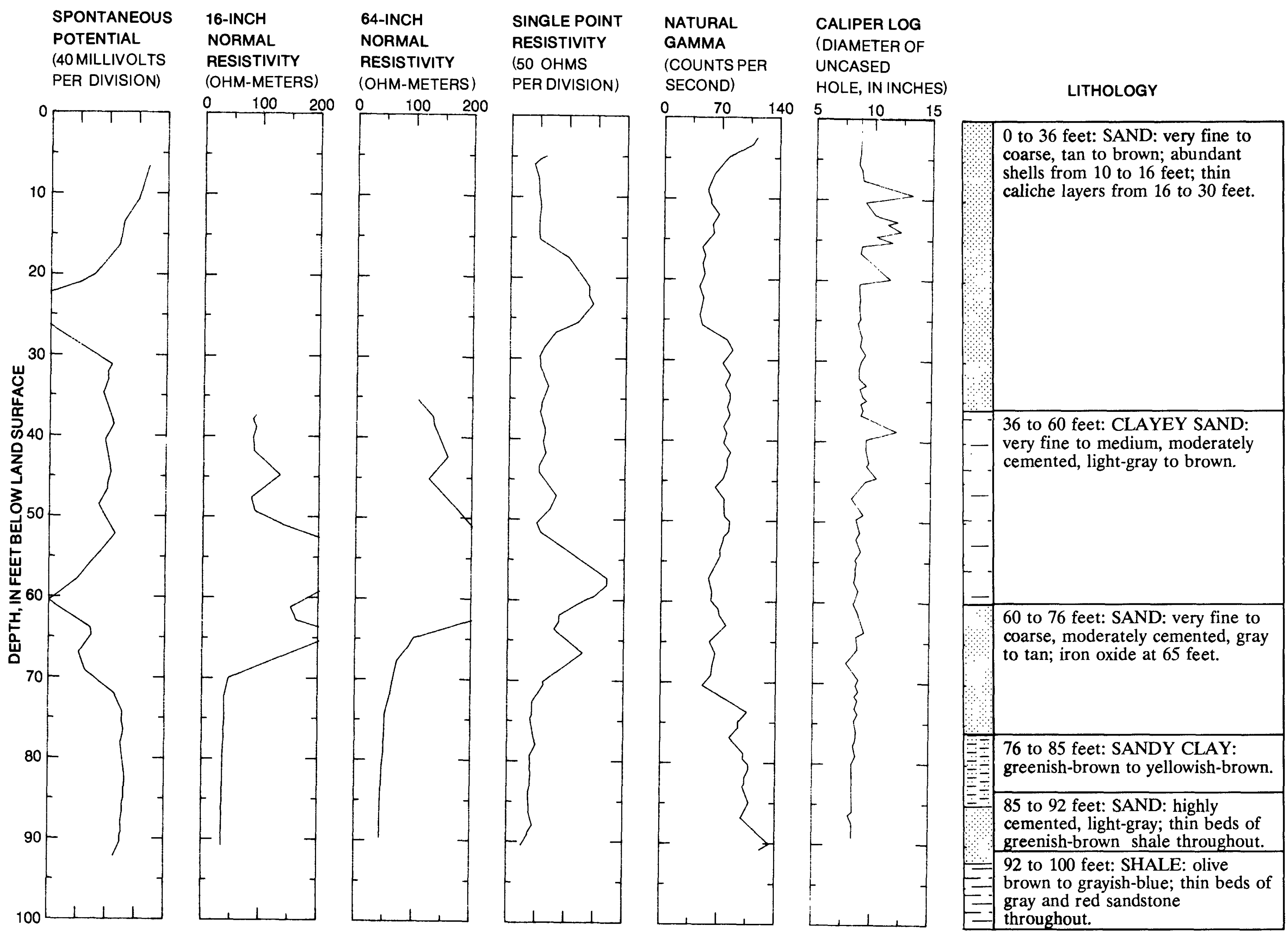

Figure 6. Geophysical, caliper, and lithologic logs of well 10S/26W-35P1.

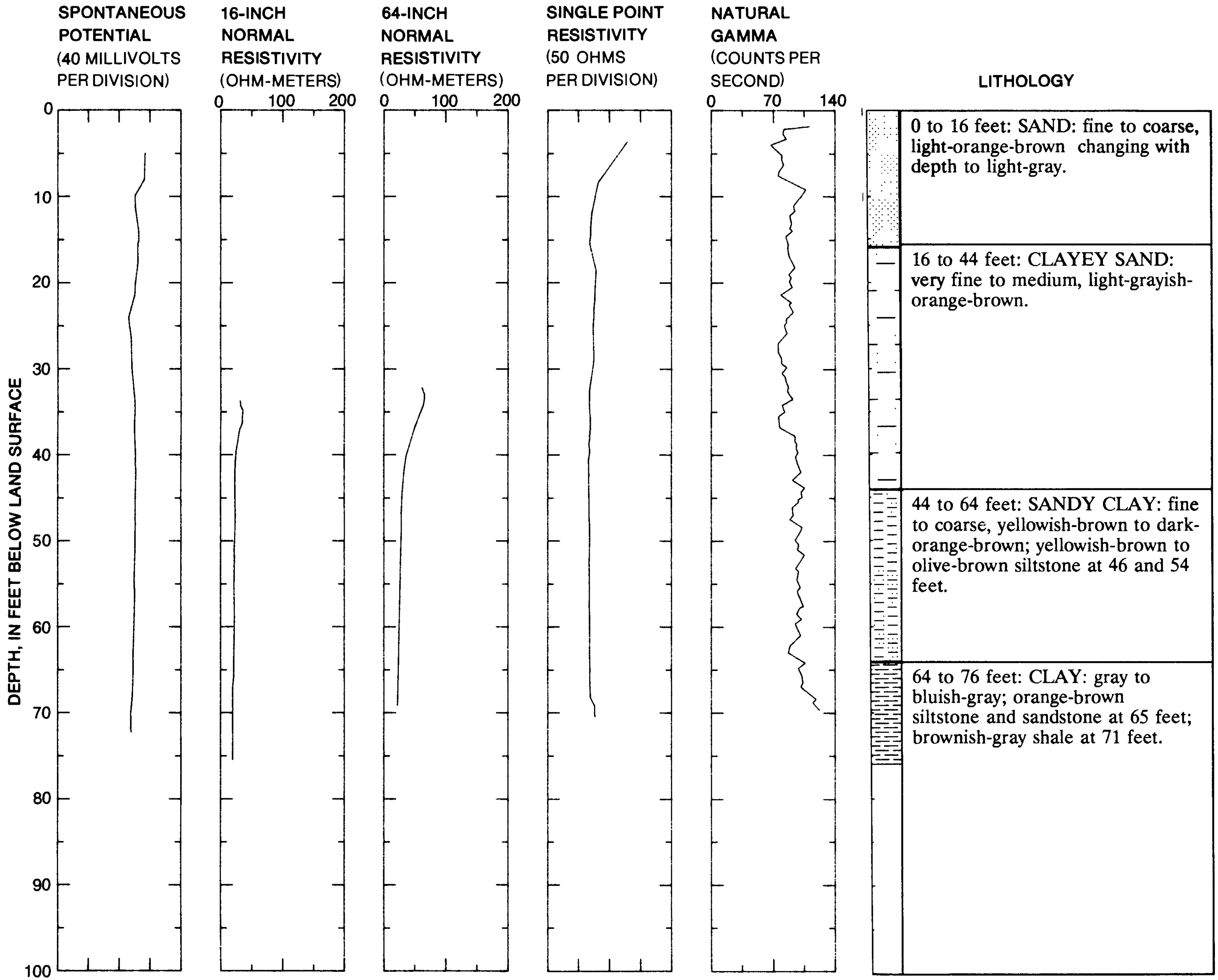

Figure 7. Geophysical and lithologic logs of well 10S/26W-36D1.

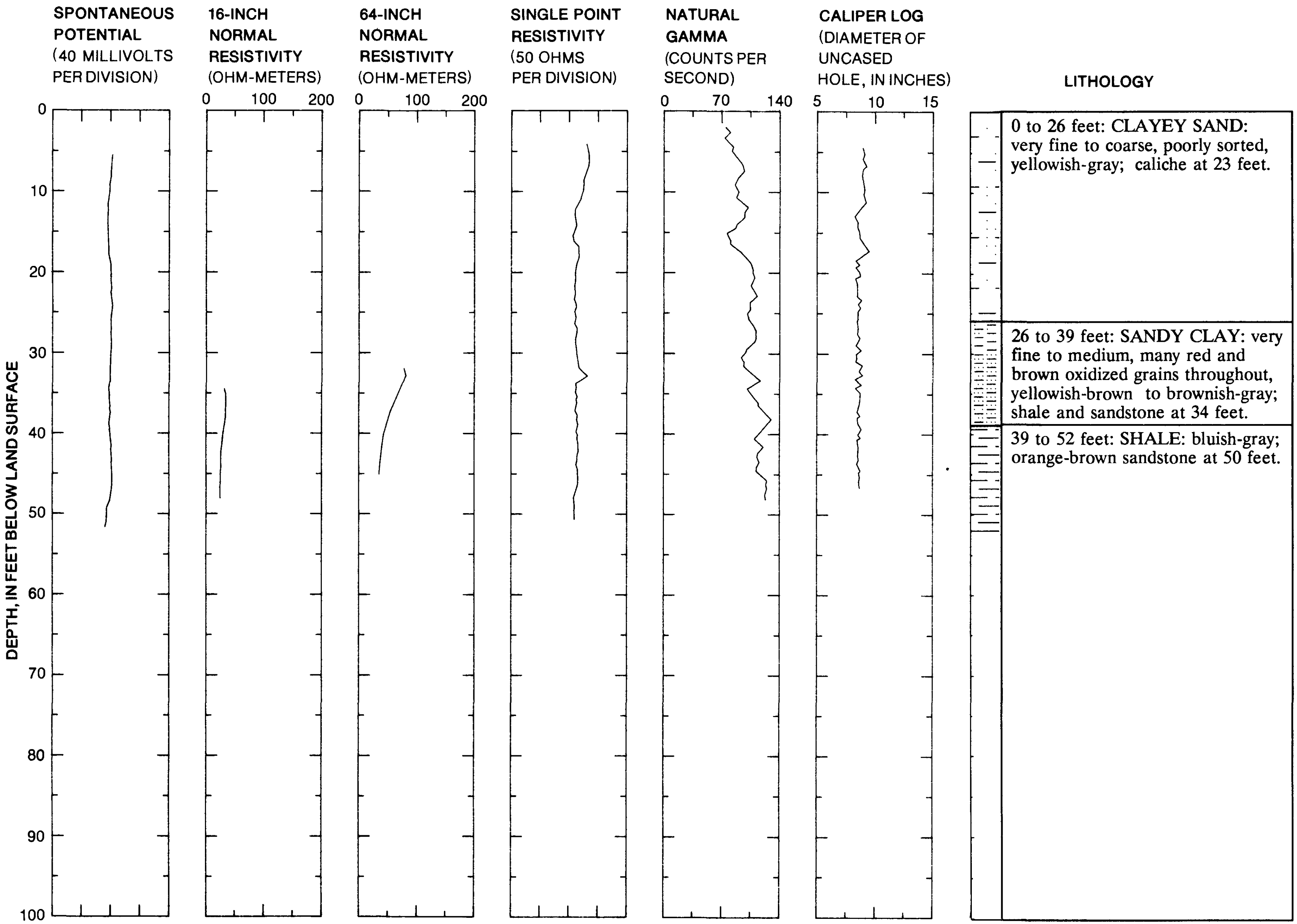

Figure 8. Geophysical, caliper, and lithologic logs of well 10S/26W-36E1.

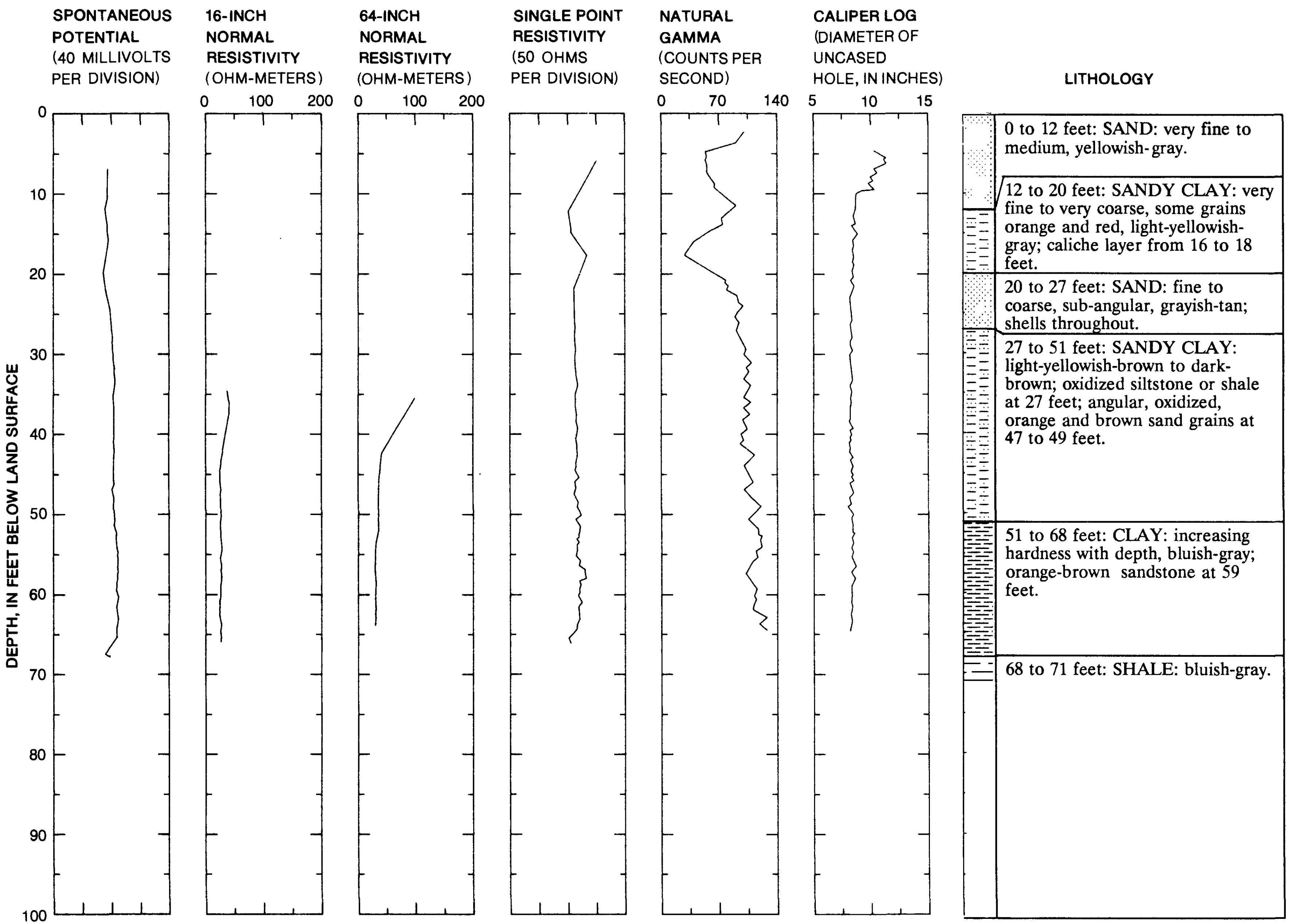

Figure 9. Geophysical, caliper, and lithologic logs of well 10S/26W-36K1.

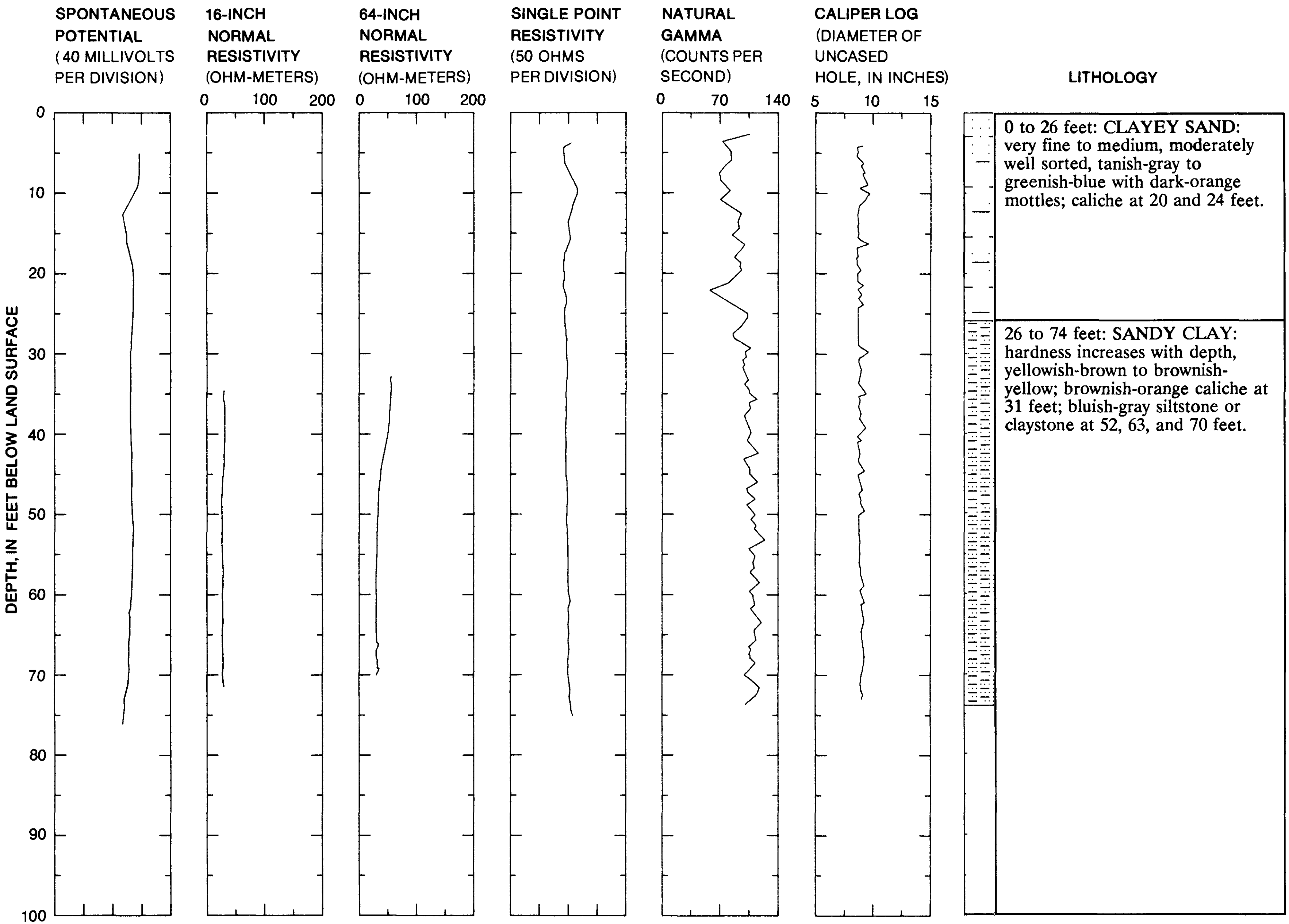

Figure 10. Geophysical, caliper, and lithologic logs of well 10S/26W-36L1.

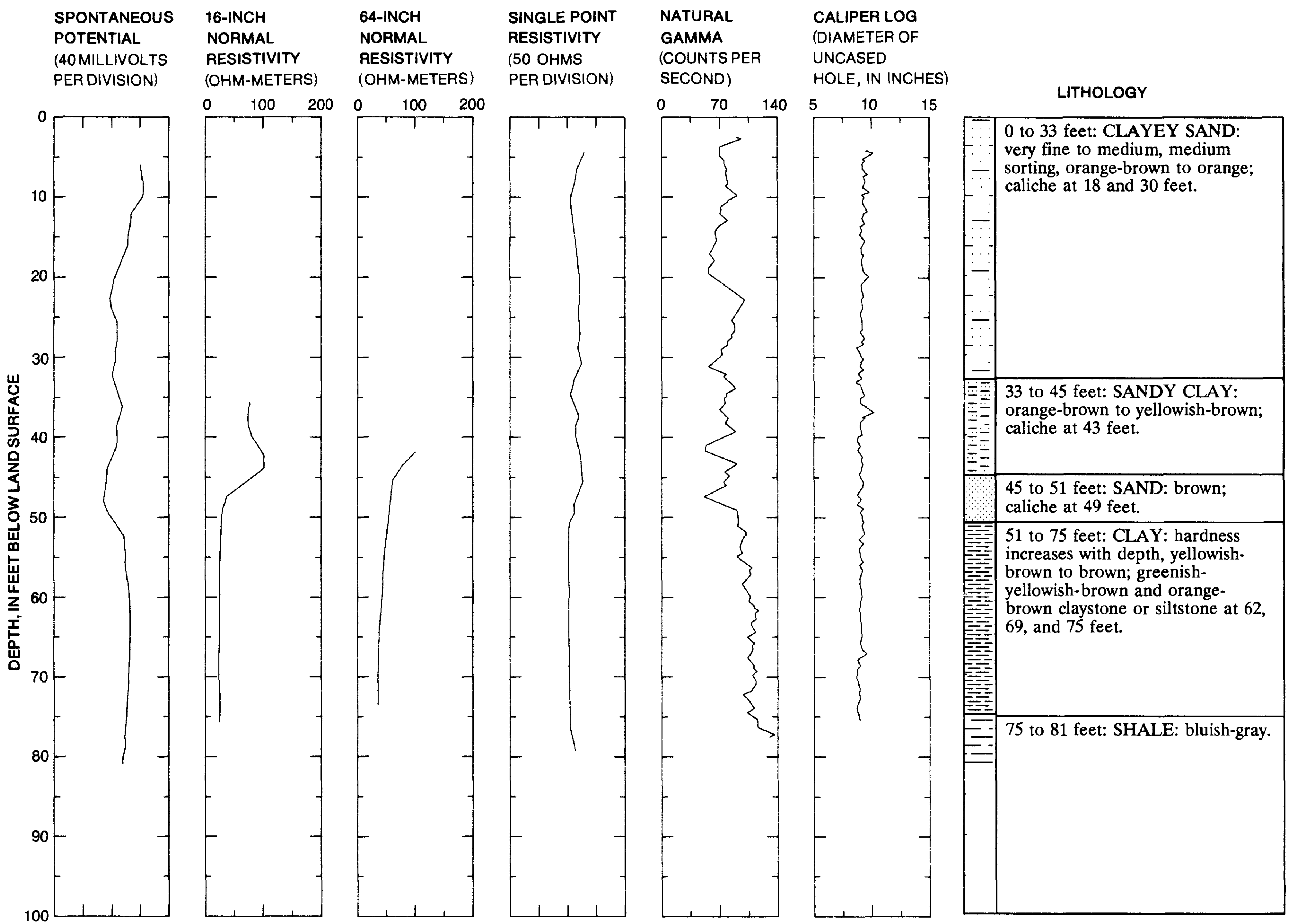

Figure 11. Geophysical, caliper, and lithologic logs of well 10S/26W-36M1.

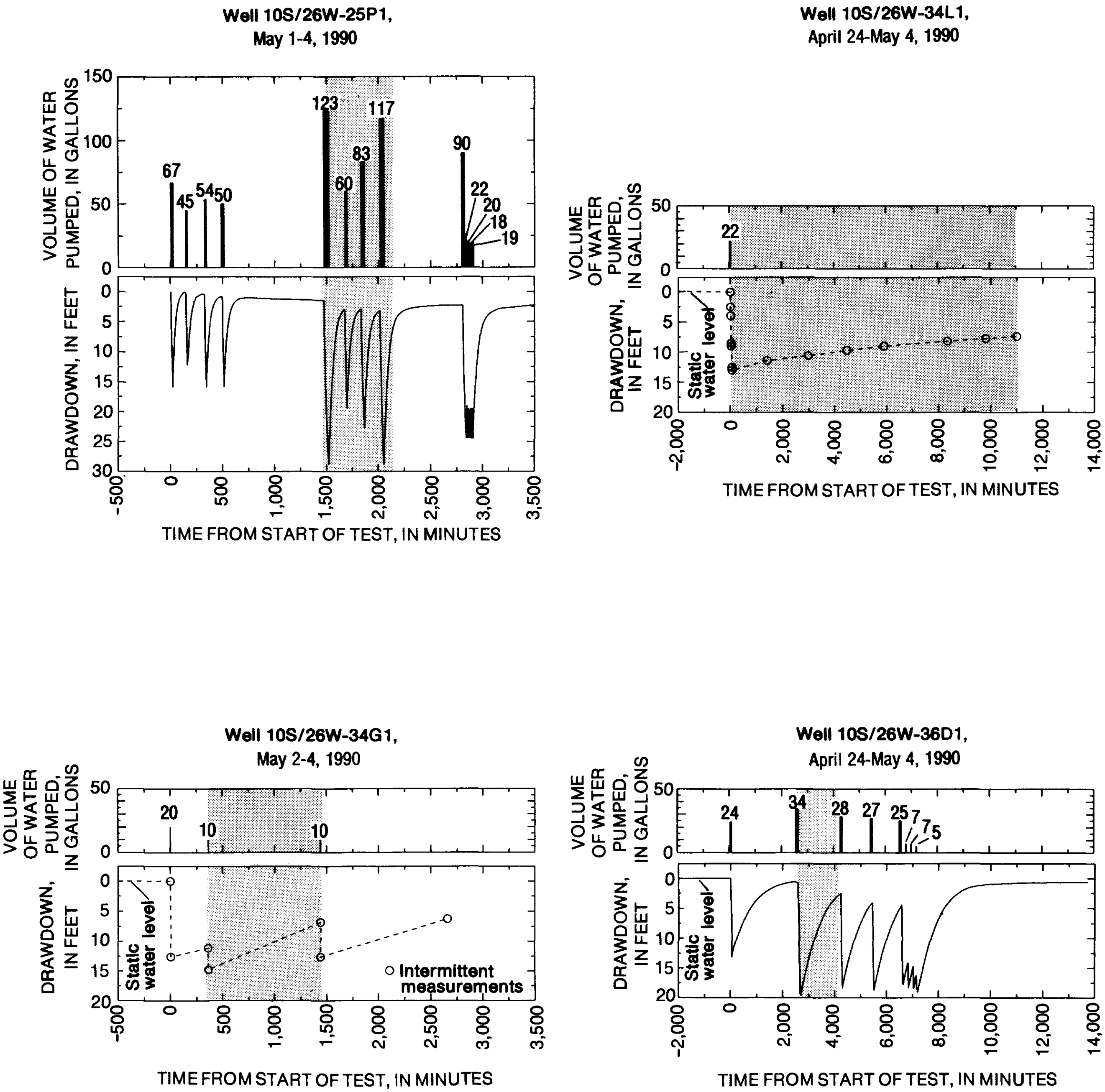

Figure 12. Volume of water pumped and water-level drawdown during testing at selected wells, April and May 1990. Pumping time is indicated by width of bar, and the number at top of bar is gallons pumped. The period of time used to calculate estimated well yield is indicated by shading.

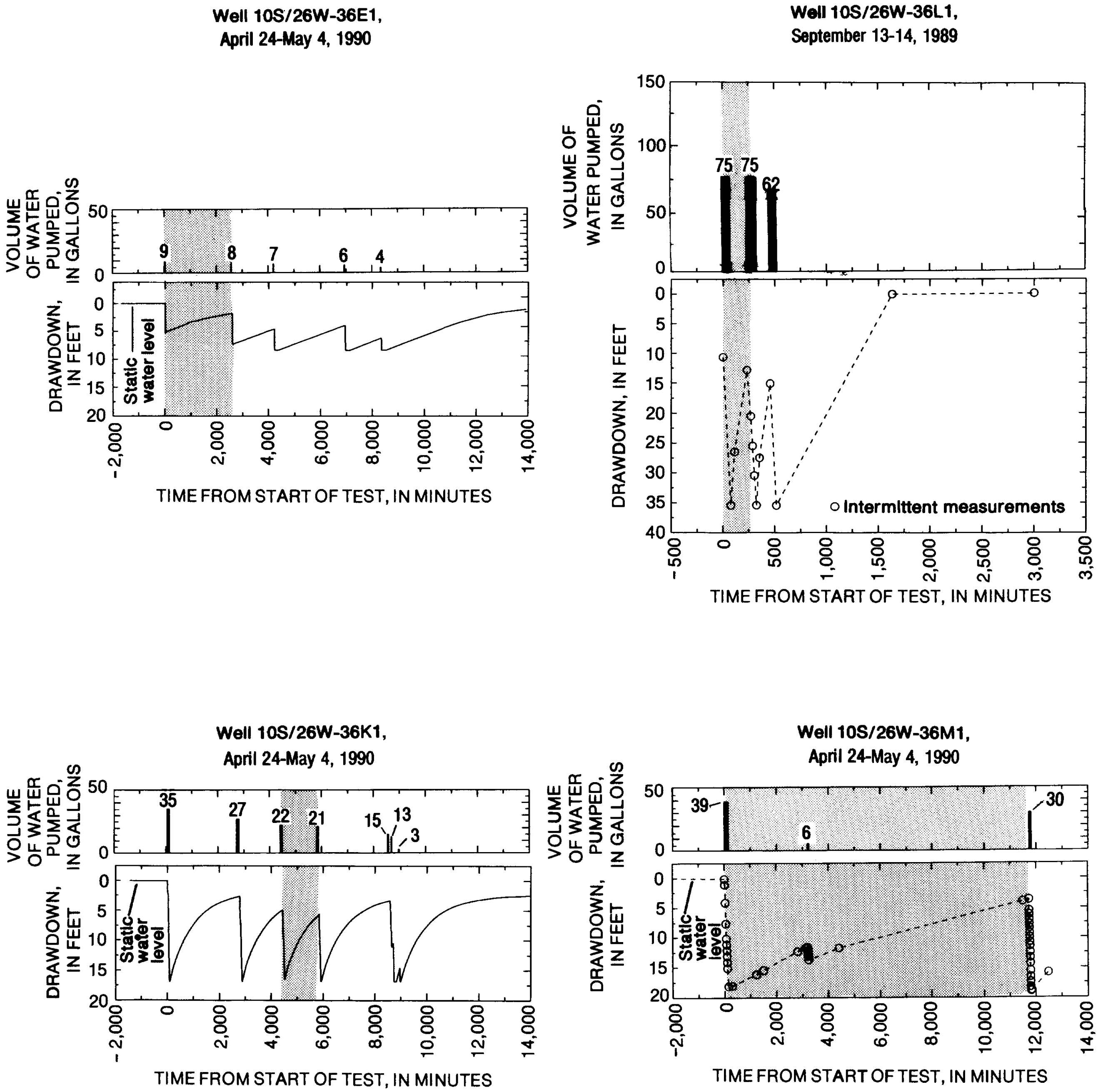

Figure 12.--Continued.