United States Department of the Interior

GEOLOGICAL SURVEY

EVALUATION OF THE GROUND-WATER SUPPLY AT EIGHT SITES IN GLACIER NATIONAL PARK, NORTHWESTERN MONTANA

by

Arnold J. Boettcher

two avail

Prepared by the
U. S. GEOLOGICAL SURVEY
for the
NATIONAL PARK SERVICE

OPEN-FILE REPORT

HELENA, MONTANA
1974

UNITED STATES

DEPARTMENT OF THE INTERIOR

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Abstract

Seven of eight test holes drilled in Glacier National Park derive water from the Quaternary alluvial or glacial deposits. The eighth test hole was dry. Aquifer tests indicated that production wells at the seven sites will yield enough water for domestic or campground uses. Estimated maximum pumping rates range from 4 to 50 gallons per minute (0.2 or 3.2 liters per second). The water is of excellent chemical quality and generally the major dissolved constituents are calcium and bicarbonate.

Introduction

This report describes the results of test drilling and aquifer tests at five campgrounds and three ranger stations in Glacier National Park in northwestern Montana. The activities are part of a continuing program to evaluate the water resources of Glacier National Park.

This phase of the program required evaluating the possibilities for obtaining 5 to 10 gpm (gallons per minute) or 0.3 to 0.6 l/s (liters per second) from a well at each of the eight sites. The water is needed for domestic and public uses. The work, done by the U.S. Geological Survey at the request of the National Park Service, consisted of geologic mapping, selecting test drilling locations, supervision of test drilling, aquifer testing, and analyzing the chemical quality of the water. The field work was done during the summers of 1971 and 1972.

Glacier National Park includes nearly 1,600 square miles (4,144 square kilometers) in northwestern Montana (fig. 1). The test drilling sites are near Lake McDonald, Logging Creek, and Polebridge Ranger Stations; and in the Logging Creek, Quartz Creek, Kintla Lake, River, and Two Medicine Campgrounds. Locations of these sites are shown on figure 1.

Conversion factors used in this report are as follows:

1 inch = 25.4 millimeters (mm)

1 foot = 30.5 centimeters (cm)

1 foot = 0.305 meter (m)

1 mile = 1.609 kilometers (km)

1 square mile = 2.59 square kilometers (km^2)

1 gallon per minute = 0.06309 liter per second (l/s)

1 gallon per minute per foot = 0.207 liter per second per meter (l/s per meter)

Acknowledgments

The author extends his thanks to Franklin B. Elliot, Chief of Park Maintenance, and his staff for their cooperation in providing access for the drilling equipment into and out of the sites, and for general assistance to the field crews.

Geologic setting

Rocks exposed at the sites studied range in age from Precambrian to Quaternary. The Precambrian rocks underlie the entire area. These rocks are composed primarily of dark-colored argillite, but contain quartzite, limestone, and dolomite. The Precambrian rocks contain water only in fractures and yield little or no water to wells. Overlying the Precambrian rocks are sedimentary deposits of Tertiary age and glacial and alluvial deposits of Quaternary age.

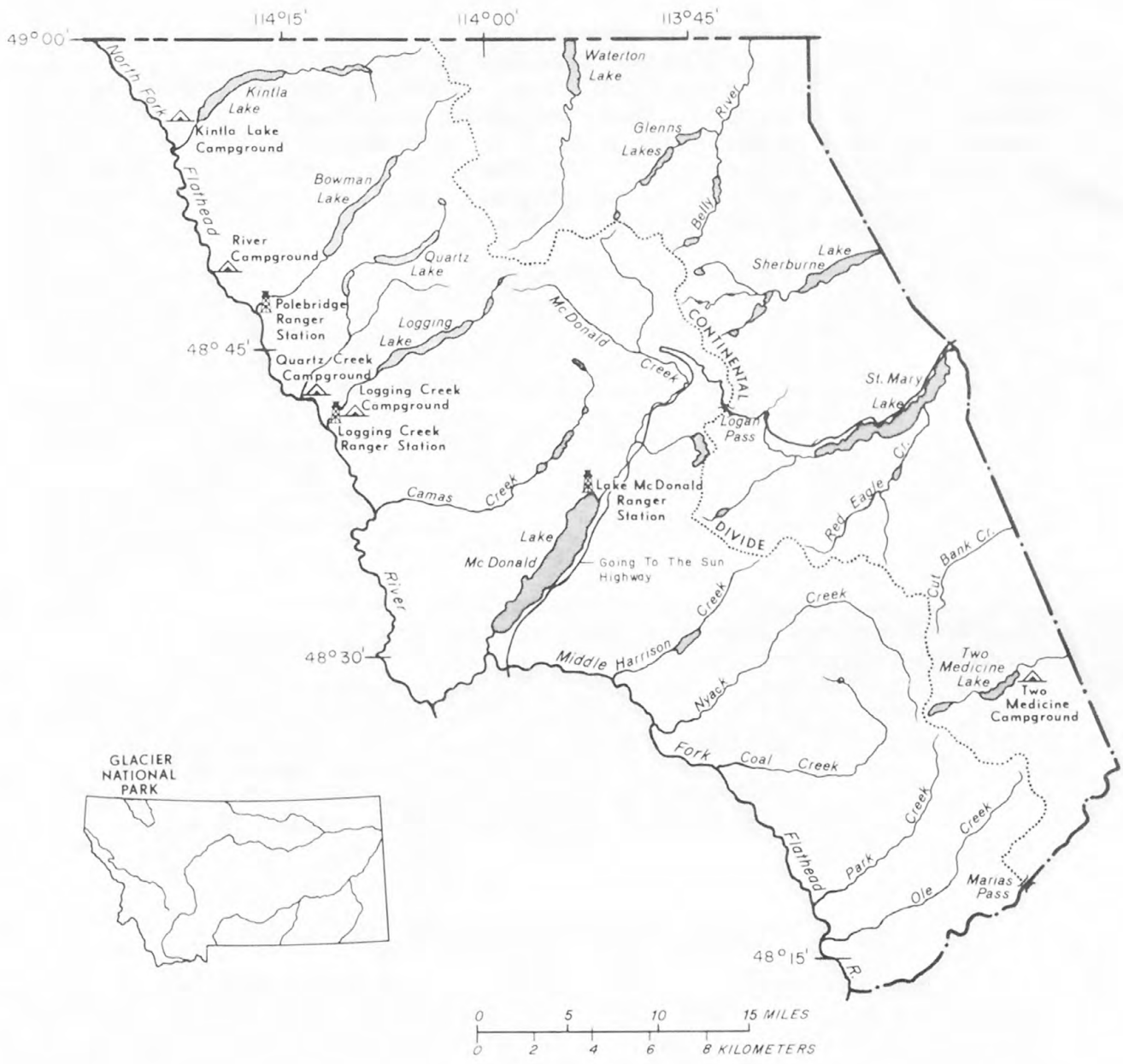


Figure 1.--Index map of Glacier National Park

The Tertiary sediments consist primarily of semi-consolidated sand, silt, and clay. Locally these sediments contain tuffaceous and other volcanic materials. Due to compaction and cementation, and the predominance of fine-grained material, more than 100 feet (30.5 meters) of these deposits would have to be penetrated by a well before a yield of more than 10 gpm (0.6 l/s) could be expected.

The glacial deposits consist of glacial till and outwash. Glacial till was deposited by ice and has not been transported or sorted by streams. Till forms moraines and in many places forms a hummocky surface. Outwash has been reworked and deposited by streams. Both types of glacial deposits are a heterogeneous mixture of boulders, gravel, sand, silt, and clay. Because of the poorly sorted, unstratified nature of these deposits, the water-bearing characteristics vary widely from place to place. Till, however, yields less water to wells than does outwash.

The Quaternary alluvial deposits are alluvium and alluvial-fan deposits. These deposits are composed of fragments eroded from the Precambrian and Tertiary rocks. Alluvium is gravel, sand, and clay deposited along the rivers and streams. The alluvial-fan deposits are unconsolidated, coarse, poorly sorted material deposited by a tributary stream where it emerges from an upland into a broad valley. Cobbles are common in both types of alluvial deposits. Wells that penetrate more than 40 feet (12.2 meters) of saturated alluvial deposits probably will yield more than 100 gpm (6.3 l/s).

Results of test drilling and aquifer testing

Eight test holes were drilled during July and August 1972 using a cable-tool drilling rig. They were cased with 6-inch (152.4 mm, millimeters) inside-diameter steel casing, which was perforated by a cutting torch or Mills knife. Each test hole is sealed from the surface to a depth of 10 feet (3.0 meters) by cement grout in the annular space between the casing and the wall of the drilled hole. A summary of the results of the test drilling at the eight sites is given in table 1. The aquifer was tested at seven of these holes; the test hole at Polebridge Ranger Station was dry and was not tested. Six test holes can be pumped at more than 10 gpm (0.6 l/s) for extended periods. The test hole at Kintla Lake Campground can be pumped at about 4 gpm (0.25 l/s).

Table 1.--Summary of test-hole data

Location	Depth (feet)	Perforated interval (feet)	Depth to water below land surface (feet)	Date measured	Specific capacity after 60 minutes (gallons per minute per foot of drawdown)	Estimated sustained yield (gpm)	Remarks
Lake McDonald Ranger Station (SW¼SW¼NE¼ sec. 11, T. 33 N., R. 18 W.)	41	26-36	16.4 19.0	7-17-72 8-30-72	220	40	
Logging Creek Ranger Station (NE¼SE¼SE¼ sec. 20, T. 34 N., R. 20 W.)	41	27-36	8.1 9.7	7-19-72 8-30-72	5.5	15	
Logging Creek Campground (NW¼SW¼NW¼ sec. 21, T. 34 N., R. 20 W.)	34	19-29	9.8 10.3	7-25-72 8-30-72	12.3	20	Located less than 100 feet from toilets.
Quartz Creek Campground (NW¼NW¼SE¼ sec. 7, T. 34 N., R. 20 W.)	45	30-40	6.0	8-30-72	17.8	30	
Kintla Lake Campground (SW¼SE¼SE¼ sec. 29, T. 37 N., R. 21 W.)	46	36-44	10.9 8.7	8- 2-72 8-31-72	.3	4	Water milky after 210 minutes of pumping.
River Campground NE¼SW¼SW¼ sec. 9, T. 35 N., R. 21 W.)	19	10-15	6.6	8-30-72	220	15	Well will probably be dry during low-flow periods of the North Fork.
Polebridge Ranger Station (NE¼SE¼NE¼ sec. 22, T. 35 N., R. 21 W.)	20	9-15	----	-------	----	--	Dry hole.
Two Medicine Campground (SW¼ sec. 36, T. 32 N., R. 12 W.)	32	18-28	18.1 17.7	8- 8-72 8-22-72	76.5	30	

Lake McDonald Ranger Station

Lake McDonald Ranger Station is at the north end of Lake McDonald, about half a mile (0.8 km, kilometer) west of the Going To The Sun Highway (fig. 1). The ranger station is on the alluvium of McDonald Creek (fig. 2).

A test hole was located about 50 feet (15.2 meters) northwest of the ranger station and drilled and cased 41 feet (12.5 meters) into the alluvium. The casing is perforated from 26 to 36 feet (7.9 to 11.0 meters) below land surface. The lithologic log is shown on figure 3. The test hole was bailed at about 20 gpm (1.3 l/s) for an hour to remove fine sand. At the end of bailing, clear water was being produced. Later the test hole was pumped at an average rate of 4.4 gpm (0.78 l/s) and the drawdown was 0.02 foot (6.1 mm) after 1 hour (fig. 4). The specific capacity after 1 hour is 220 gpm per foot (45.5 l/s per meter) of drawdown. The depth to water on August 30, 1972, before the aquifer test was 19.0 feet (5.8 meters) below land surface.

The test hole is located more than 100 feet (30.5 meters) from the septic tank and drain field at the ranger station and more than 150 feet (45.7 meters) from the septic tank and drain field serving the privately owned cabins to the east. All the sewage facilities are down gradient from the test hole. Ground water moves from the test hole toward Lake McDonald as indicated by the water level in the well, which was 0.83 foot (0.25 meter) higher than the level of the lake on August 31, 1973. Septic tank effluent also moves toward the lake and is not likely to contaminate the well.

Logging Creek Ranger Station

Logging Creek Ranger Station is near the confluence of Logging Creek and the North Fork Flathead River. The ranger station is on the alluvium and alluvial-fan deposits of Logging Creek (fig. 5).

The test hole is about 40 feet (12.2 meters) northeast of the ranger station. The hole was drilled and cased 41 feet (12.5 meters) into the alluvium and alluvial-fan deposits. The casing is perforated from 27 to 36 feet (8.2 to 11.0 meters) below land surface (fig. 6). The test hole was bailed at a rate of about 20 gpm (1.3 l/s) for 5 hours to remove the fine sand and to form a natural gravel pack adjacent to the perforations. At the end of bailing, clear water was being produced. The average discharge rate during

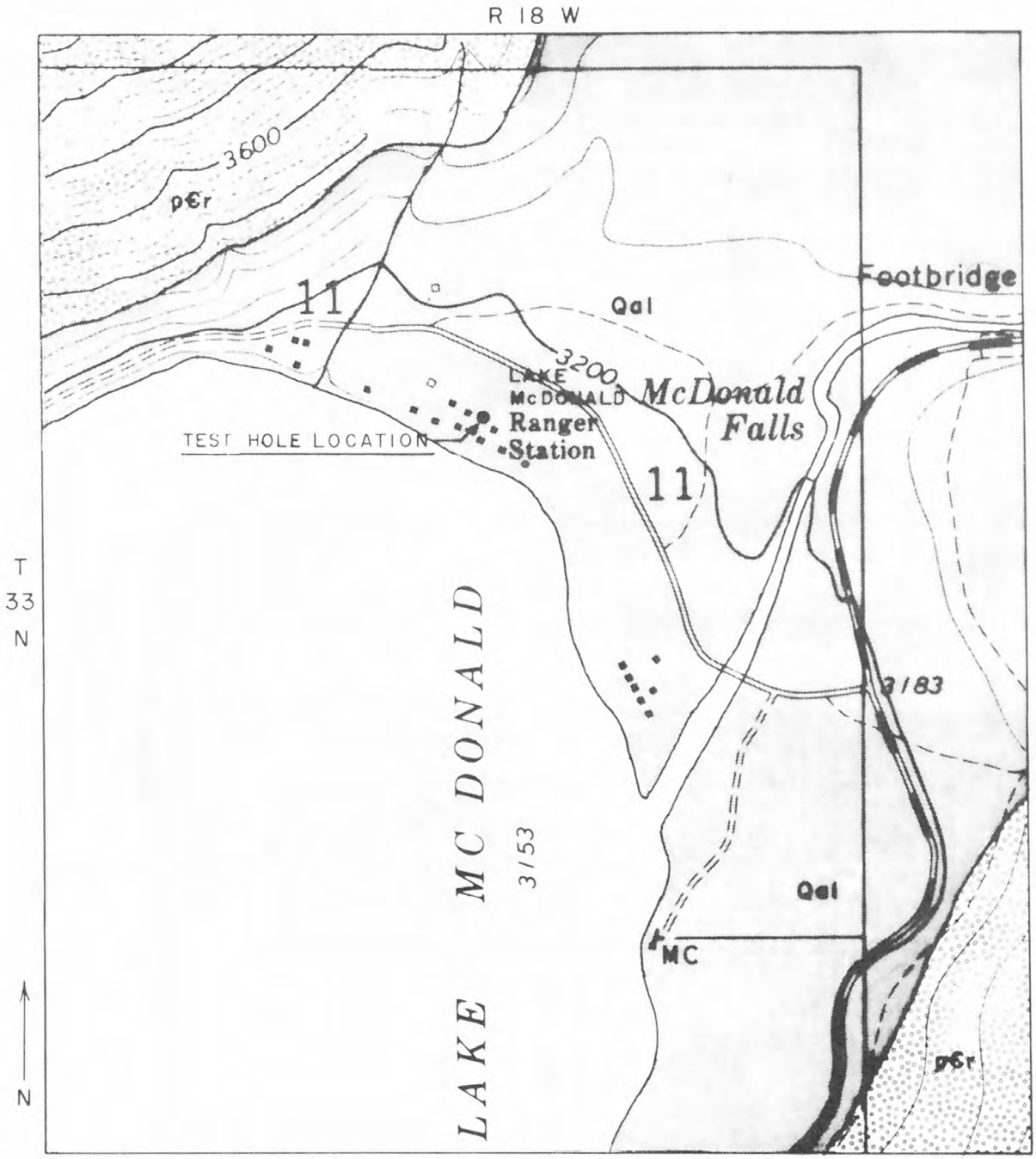


Figure 2—Geologic map of Lake McDonald Ranger Station

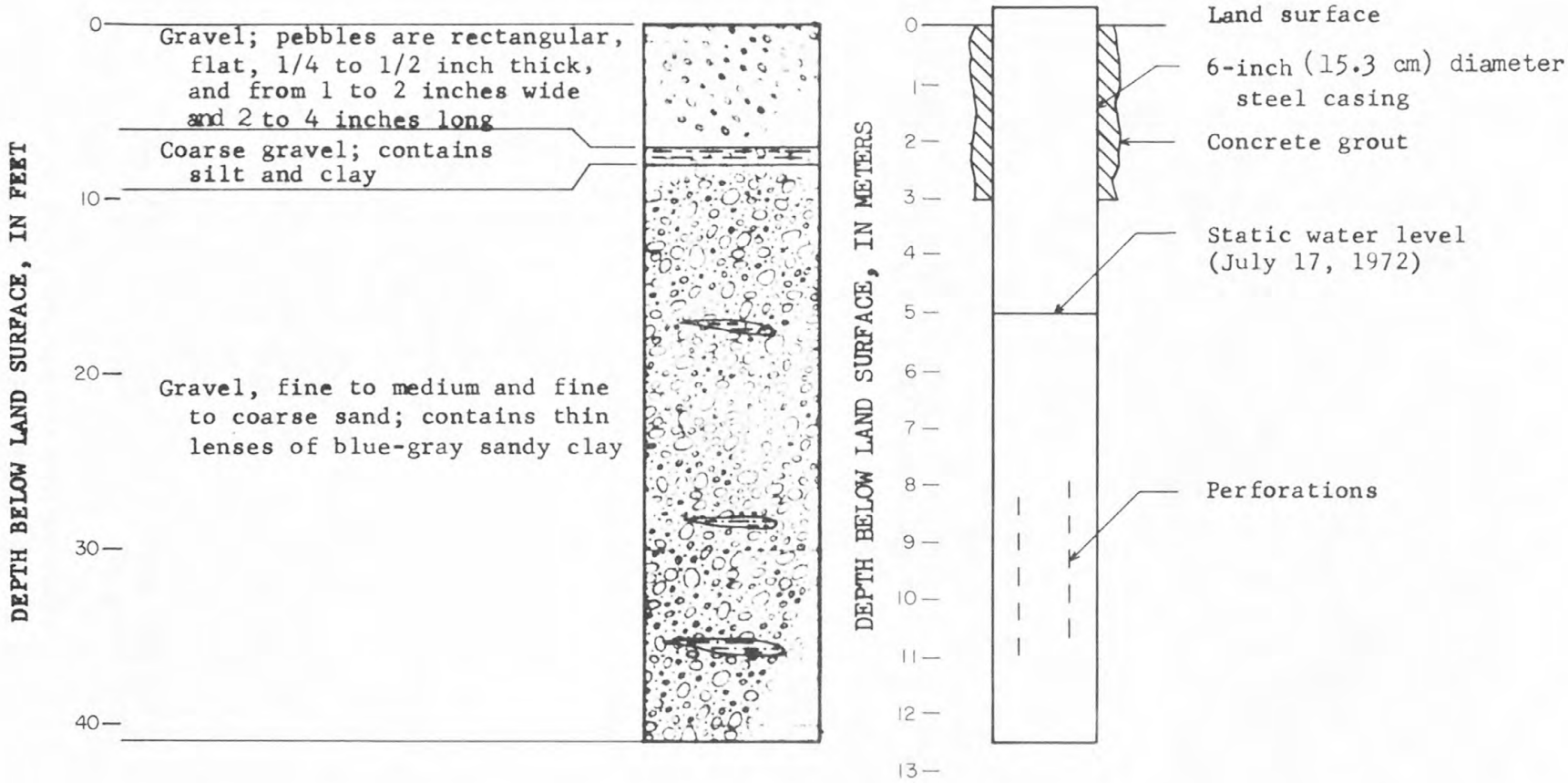


Figure 3.--Lithologic log of the test well at Lake McDonald Ranger Station.

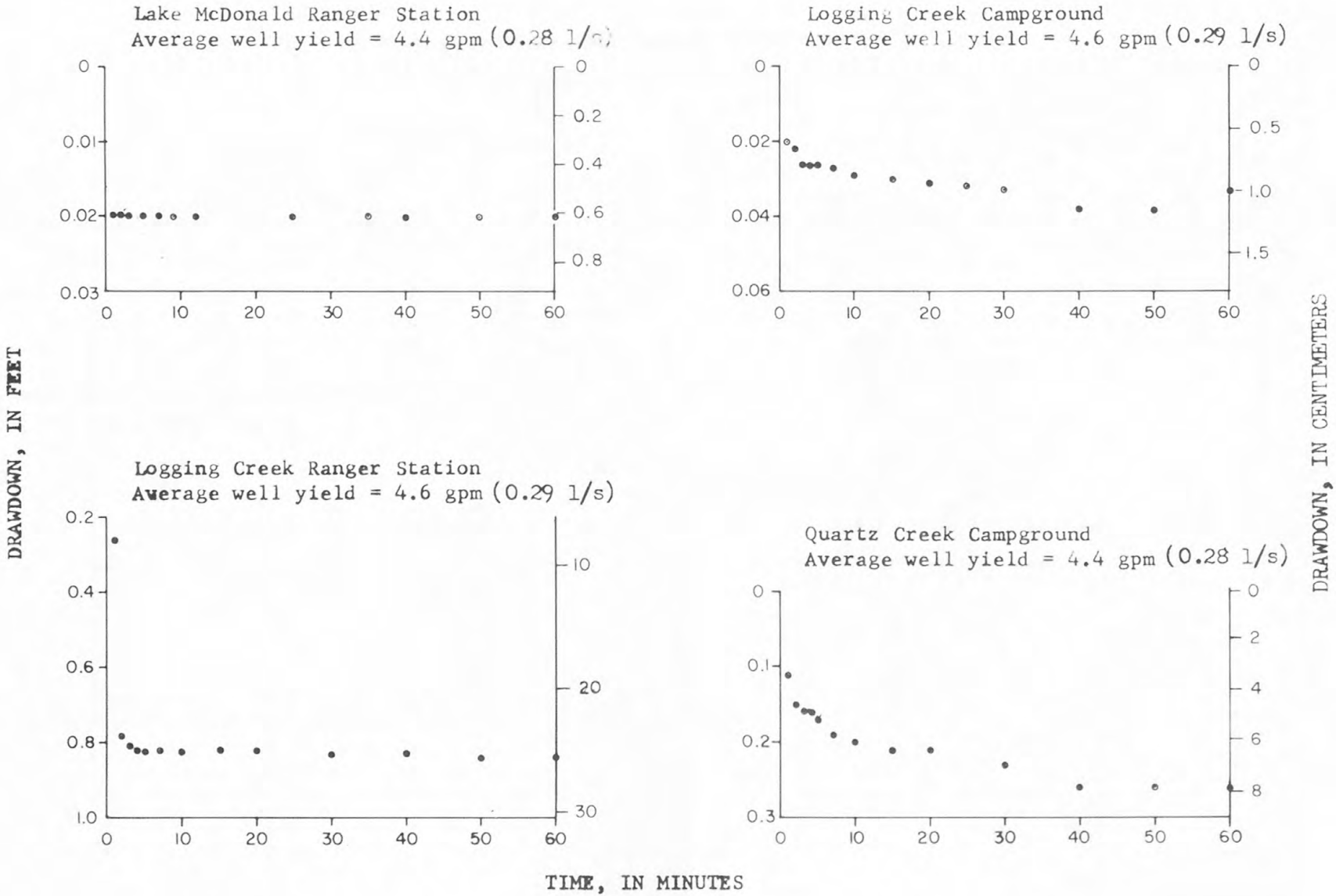


Figure 4.--Aquifer test results.

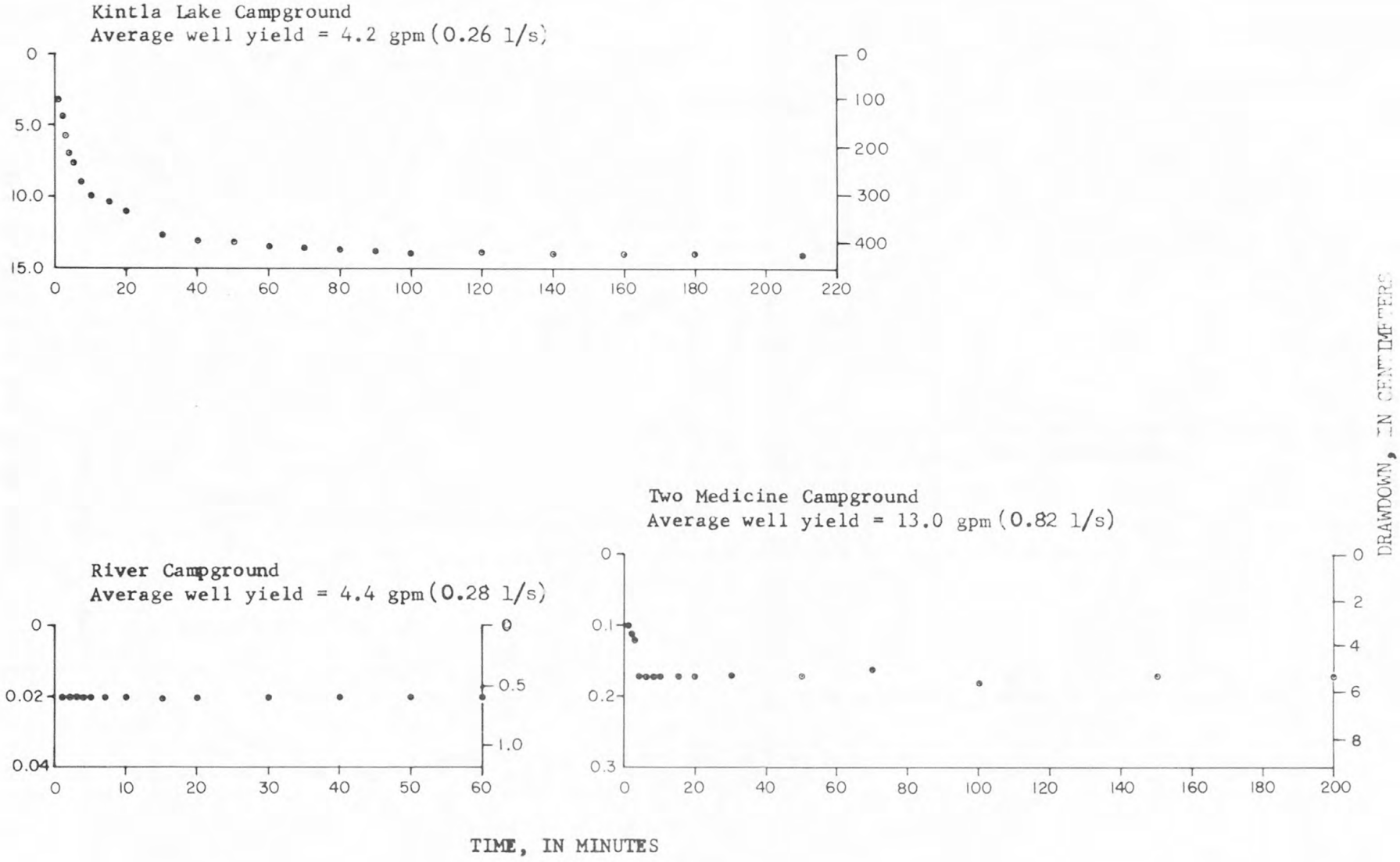


Figure 4.--Aquifer test results--continued.

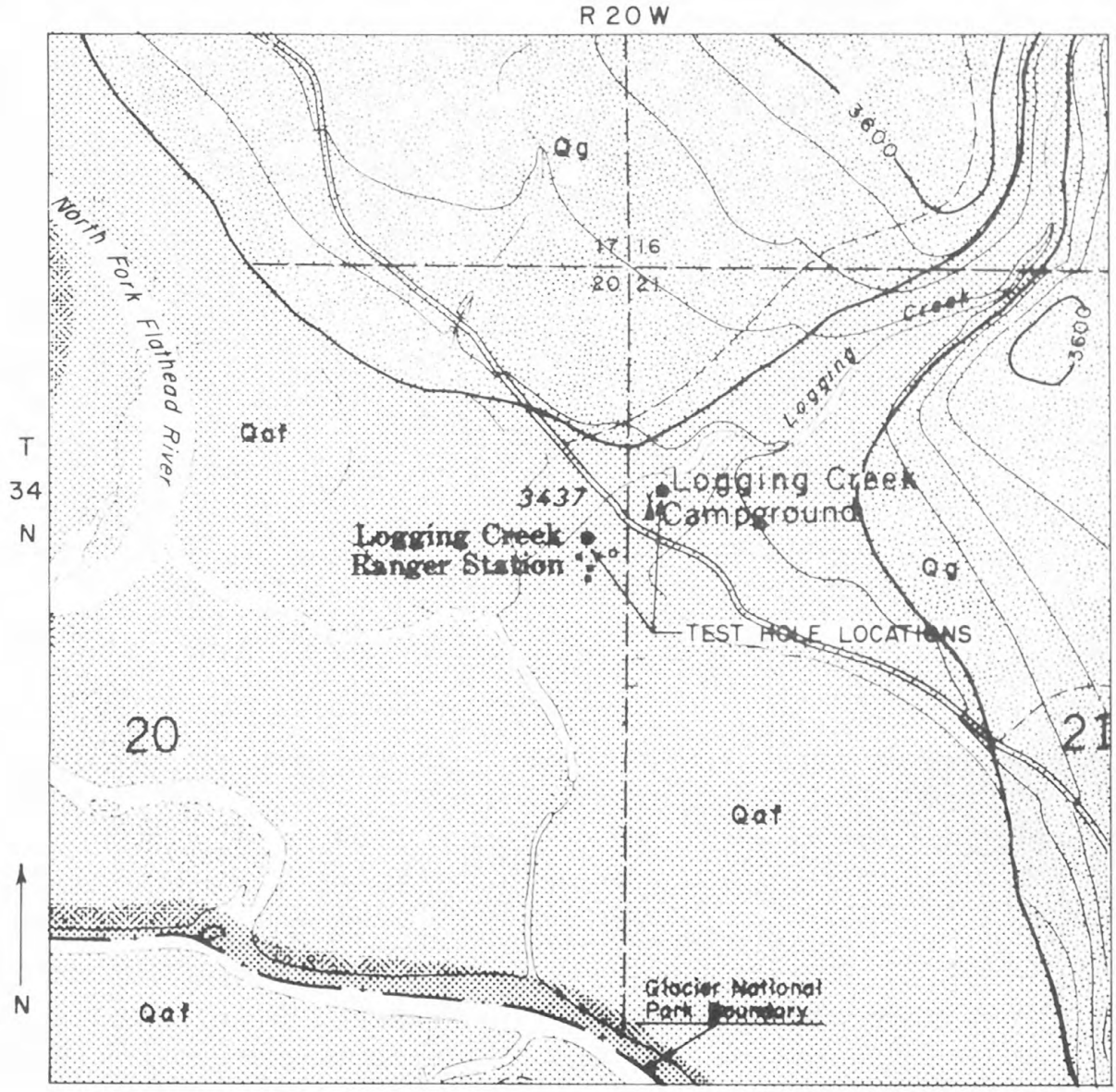


Figure 5.—Geologic map of Logging Creek Campground and Ranger Station

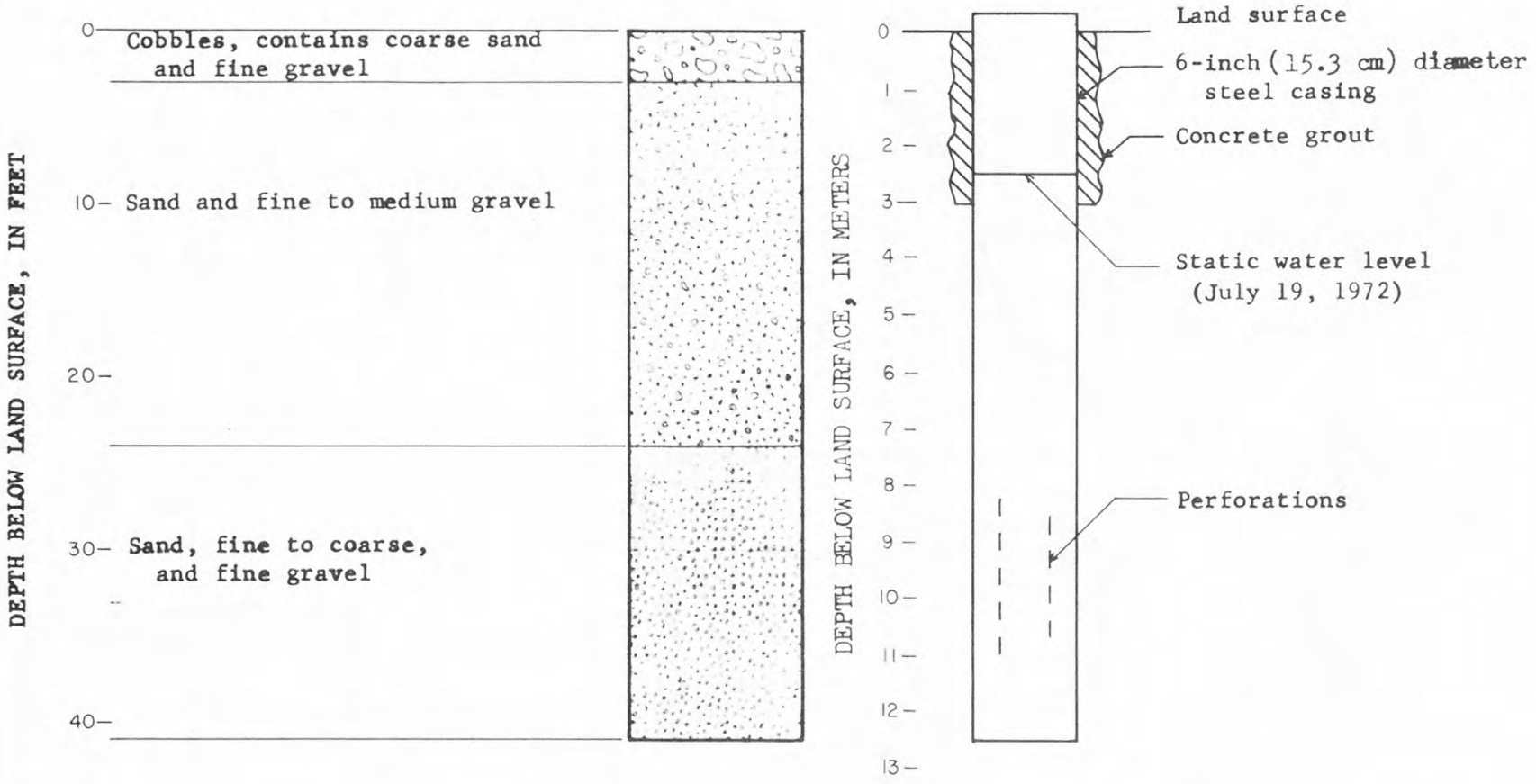


Figure 6.--Lithologic log of test well at Logging Creek Ranger Station.

a 1-hour aquifer test was 4.6 gpm (0.29 l/s), the drawdown was 0.8 foot (0.24 meter) at the end of the test (fig. 4) and the specific capacity was 5.5 gpm per foot (1.1 l/s per meter) of drawdown. The depth to water before the aquifer test was 9.7 feet (3.0 meters) below land surface on August 30, 1972.

Logging Creek Campground

Logging Creek Campground is northeast of Logging Creek Ranger Station (fig. 1). The site is located on the alluvium and alluvial-fan deposits of Logging Creek (fig. 5).

A test hole, near the center of the campground, was drilled and cased to 34 feet (10.4 meters). A boulder, which could not be penetrated, was encountered at the bottom of the hole. The casing is perforated from 19 to 29 feet (5.8 to 8.8 meters) below land surface, which is opposite coarse-grained material (fig. 7). At the completion of drilling, the test hole was bailed at about 20 gpm (1.3 l/s) for an hour to remove the fine sand. At the end of bailing, clear water was being produced. The test hole was pumped for an hour at an average rate of 4.6 gpm (0.29 l/s), the maximum drawdown was 0.04 foot (12.2 mm) (fig. 4), and the specific capacity was 12.3 gpm per foot (2.5 l/s per meter) of drawdown. The depth to water before the aquifer test was 10.3 feet (3.14 meters) below land surface on August 30, 1972.

The test hole had to be located less than 100 feet (30.5 meters) from two outdoor toilets because this is the only accessible location in the campground that is above the flood plain along Logging Creek. If a production well is contemplated at this site, removal of the toilets and disinfecting and sealing of the pits would reduce potential contamination.

Quartz Creek Campground

Quartz Creek Campground is east of Glacier Route Seven at Quartz Creek. The campground is on alluvium and alluvial-fan deposits of Quartz Creek (fig. 8).

A test hole west of the firewood-supply area in the campground was drilled and cased to 45 feet (13.7 meters) below land surface. The casing is perforated from 30 to 40 feet (9.1 to 12.2 meters) (fig. 9). The test hole was bailed at about 25 gpm (1.6 l/s) for an hour in order to clean out

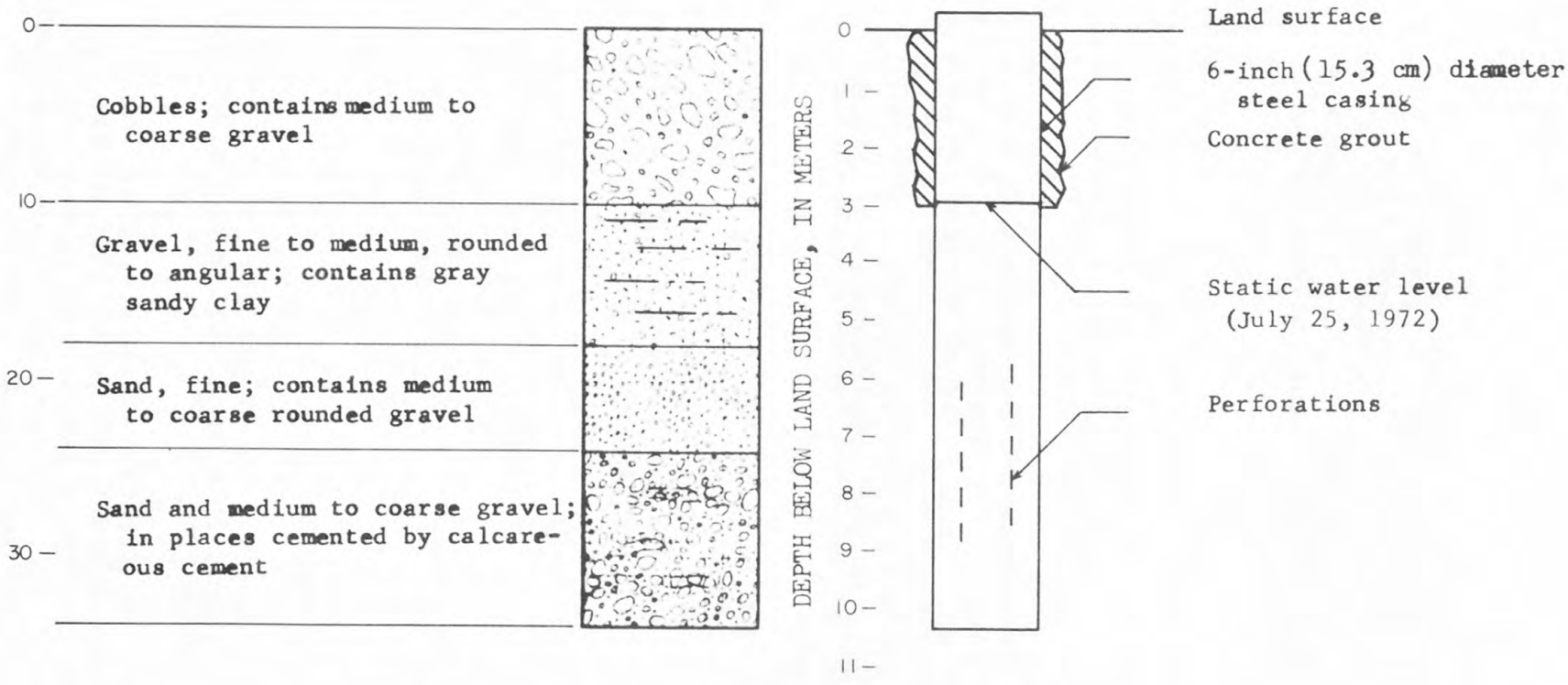
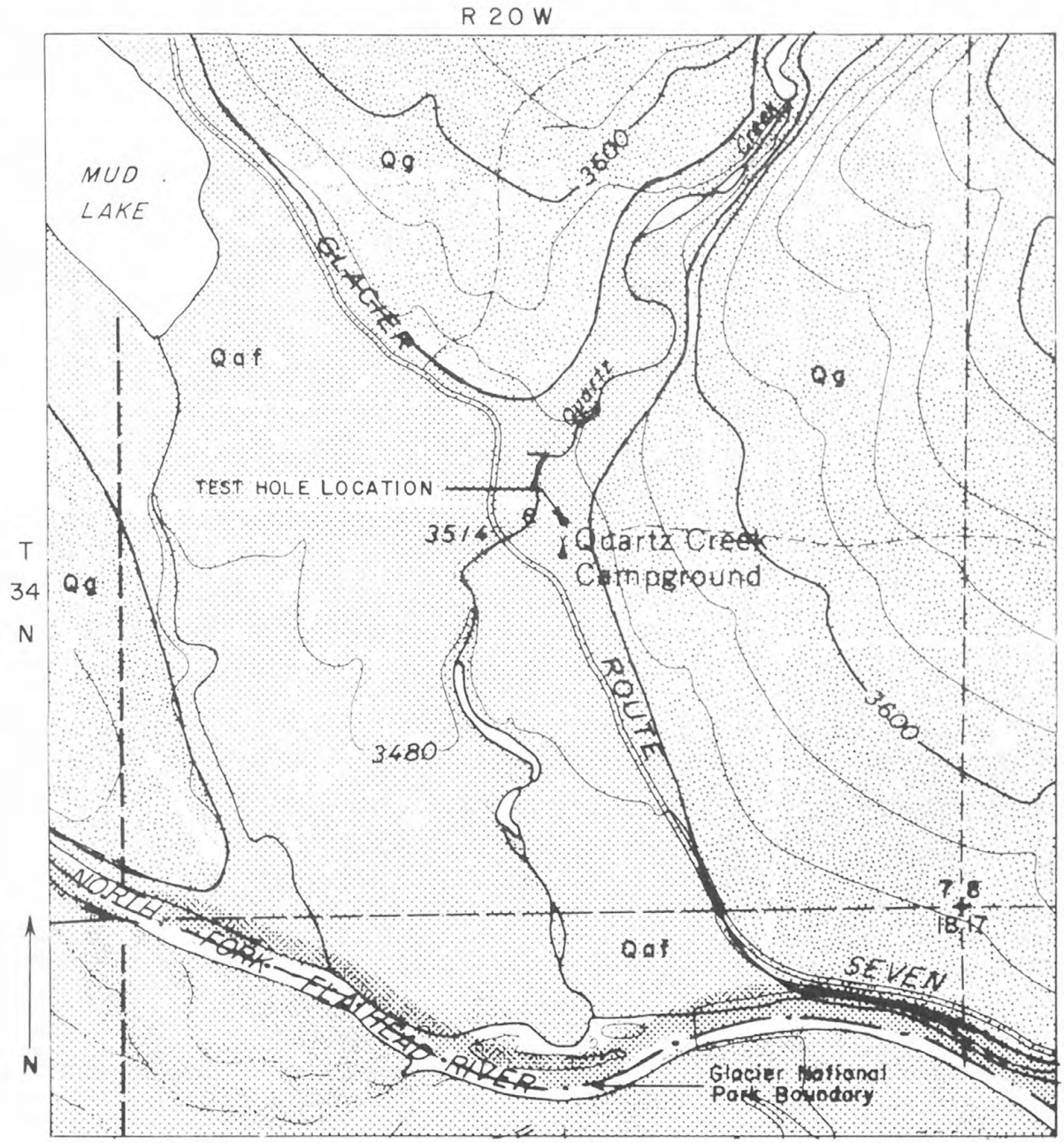


Figure 7.--Lithologic log of test well at Logging Creek Campground.



Base from U.S. Geological Survey
Demers Ridge, 1966

Geology by D.L.Coffin

EXPLANATION

Qaf — Alluvium and alluvial-fan deposits

Qg — Glacial deposits

Approximate geologic contact

0 50 1000 2000 3000 FEET

0 .25 .50 1 KILOMETER

Contour interval 40 ft.
Datum is mean sea level

Figure 8-Geologic Map of Quartz Creek Campground

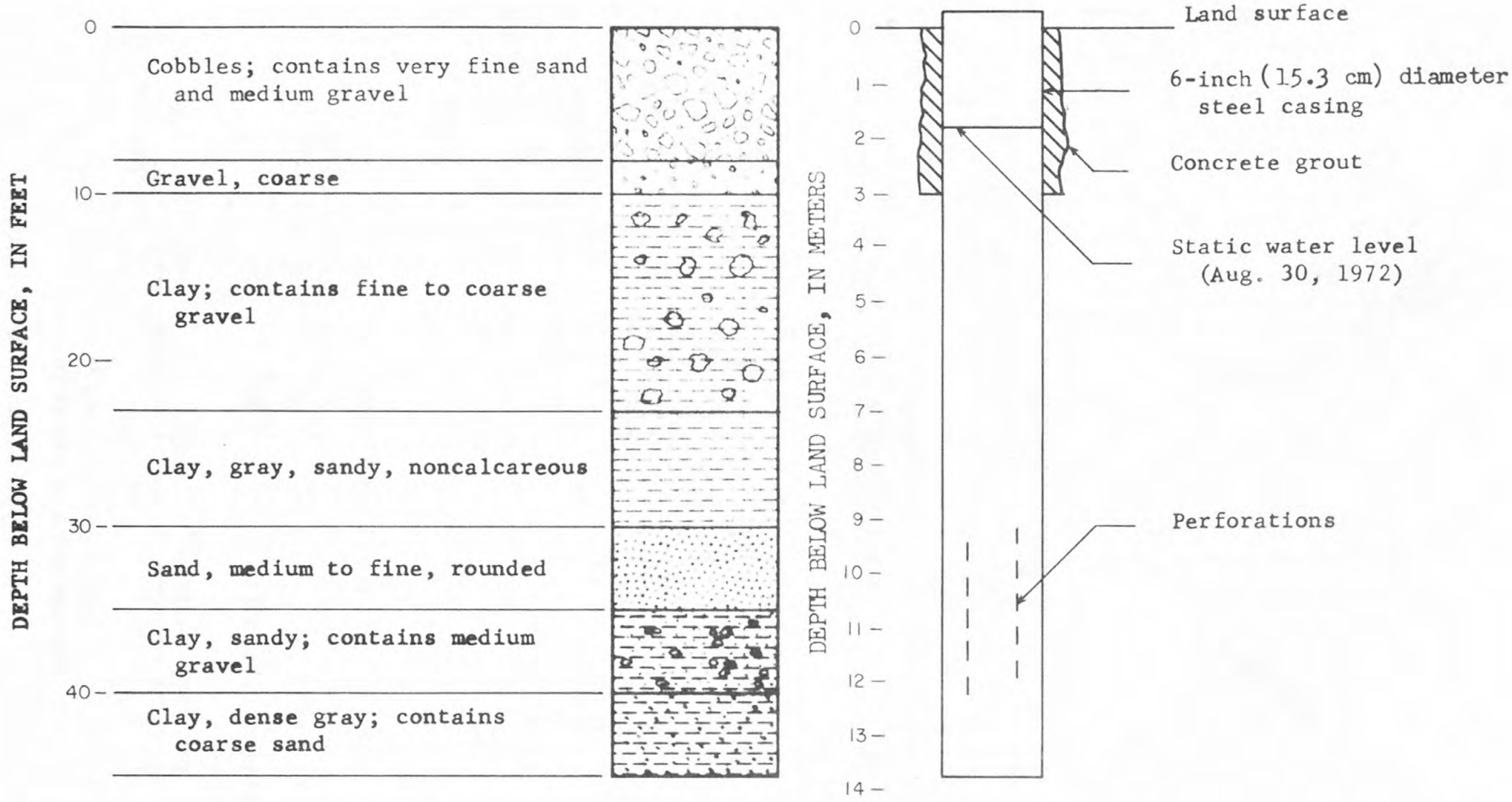


Figure 9.--Lithologic log of test well at Quartz Creek Campground.

the sand and develop a natural gravel pack. At the end of bailing, clear water was being produced. The test hole was pumped for an hour at an average rate of 4.4 gpm (0.28 l/s), the maximum drawdown was 0.26 foot (79.2 mm) (fig. 4), and the specific capacity is 17.8 gpm per foot (3.7 l/s per meter) of drawdown. The depth to water before the aquifer test was 6.0 feet (1.8 meters) below land surface on August 30, 1972.

Kintla Lake Campground

Kintla Lake Campground is at the south end of Kintla Lake (fig. 1), adjacent to the lake outlet. The campground is on glacial till and thin deposits of outwash and alluvium (fig. 10).

A test hole near the west side of the campground was drilled and cased through 46 feet (14 meters) of glacial till. Further drilling was prevented by a boulder, which could not be penetrated (fig. 11). The casing was perforated from 36 to 44 feet (11 to 13.4 meters). The test hole was bailed at about 25 gpm (1.6 l/s) and went dry after 40 minutes. The well was pumped at a rate of 4.2 gpm (0.26 l/s) for 210 minutes, the maximum drawdown was 14 feet (4.3 meters), (fig. 4), and the specific capacity is 0.3 gpm per foot (0.06 l/s per meter) of drawdown after one hour. The depth to water before the aquifer test was 8.7 feet (2.6 meters) below land surface on August 31, 1972.

The glacial till penetrated by the test hole is poorly permeable and will yield about 4 gpm (0.25 l/s) during continuous pumping. A production well at this location would adequately supply a hand pump.

Water from the test hole remained "milky" during the aquifer test. This color is caused by "glacial flour," which is silt- and clay-sized material common in glacial till. Because the entire campground area is underlain by glacial till, it is likely that a relatively shallow well at any location would produce "milky" water. Tertiary sediments underlie the till and may be capable of supplying 5 to 10 gpm (0.3 to 0.6 l/s) of clear water. A test hole into these deposits, however, would probably be more than 200 feet (61 meters) deep. The alluvium and outwash in the campground are less than 10 feet (3 meters) thick and water in these deposits could become contaminated; thus, these deposits do not appear to be alternate sources of supply.

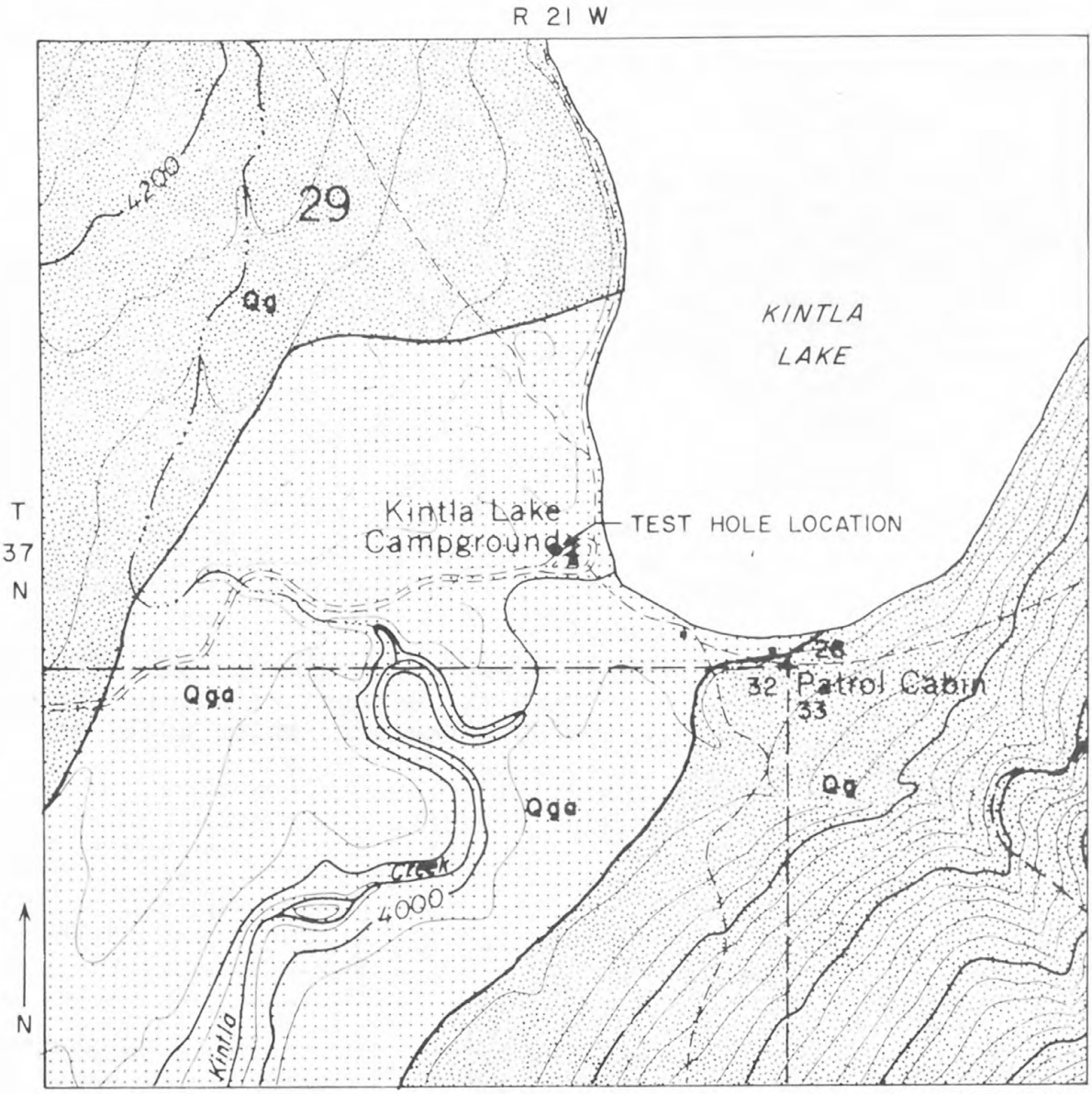


Figure 10.—Geologic map of Kintla Lake Campground

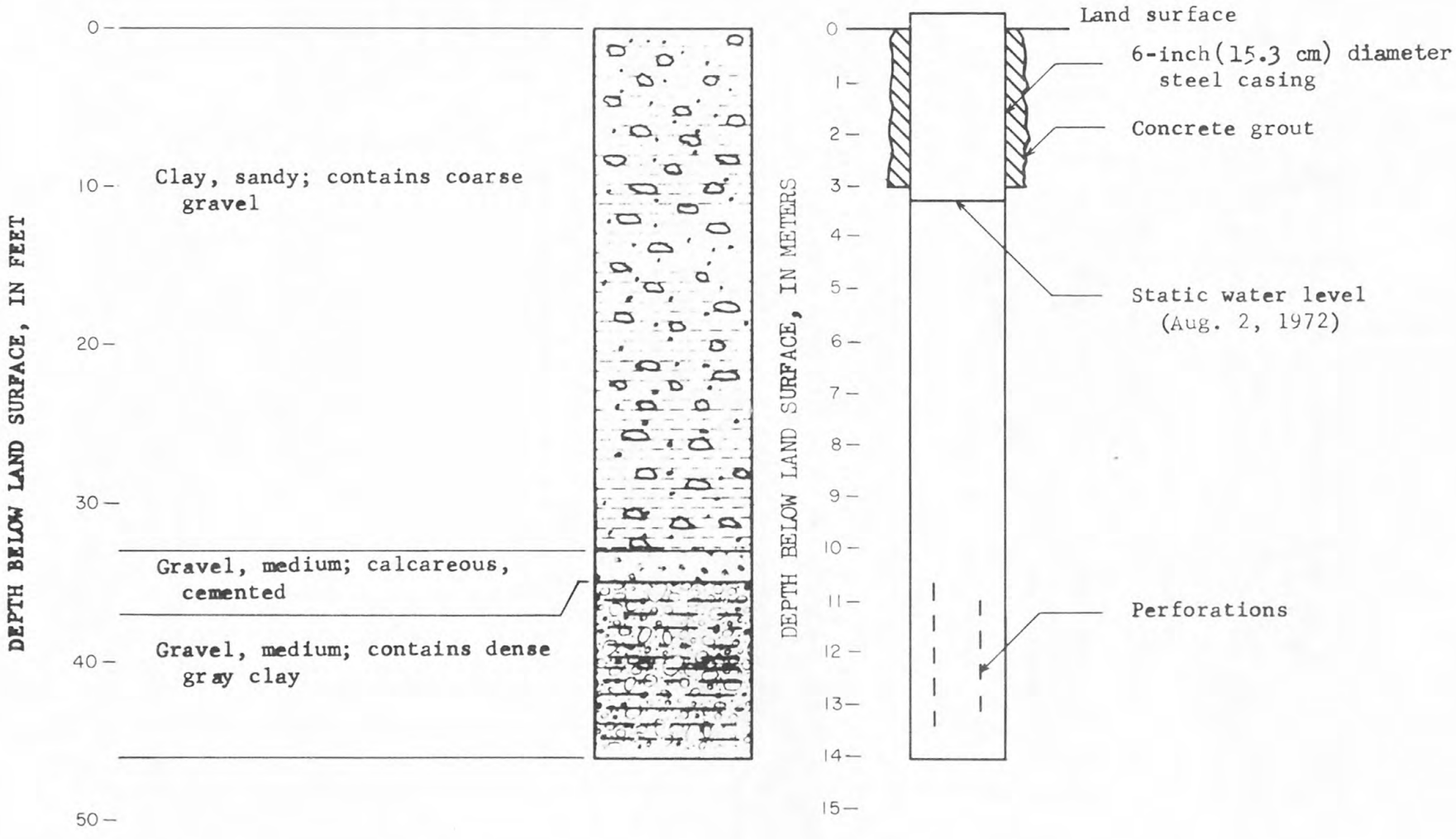


Figure 11.--Lithologic log of test well at Kintla Lake Campground.

The objections to using water containing "glacial flour" are based mainly on the appearance of the water. Water from the test hole contains no chemical constituents in amounts that would cause rejection for public drinking water according to U.S. Public Health Service standards (1962) (see section on Water quality).

River Campground

River Campground is located about 2.5 miles (4 km) north of Polebridge Ranger Station. This campground is on the alluvium along the North Fork Flathead River. Semiconsolidated sediments of Tertiary age are exposed in the river bottom (fig. 12).

A test hole near the entrance to the campground was drilled and cased to 19 feet (5.8 meters). Relatively impermeable Tertiary sediments are penetrated at 14 feet (4.3 meters) (fig. 13). The test hole is perforated between 10 and 15 feet (3.0 and 4.6 meters) below land surface. The test hole was bailed for 2 hours at a rate of about 20 gpm (1.3 l/s). At the end of bailing, clear water was being produced. The test hole was pumped for an hour at an average rate of 4.4 gpm (0.28 l/s), the maximum drawdown was 0.02 foot (6.1 mm) (fig. 4), and the specific capacity is 220 gpm per foot (45.5 l/s per meter) of drawdown. The water level before the aquifer test was 6.6 feet (2.0 meters) below land surface, August 30, 1972.

Because this test hole taps the alluvium, which is hydraulically connected to the river, the water level in the well will fluctuate as the river stage fluctuates. Chances are good that the well will be dry during periods of low river stage (October to May). However, the campground is used only during the summer and early fall. A well drilled at any location in the campground would probably penetrate about the same thickness of alluvium, and all the alluvium is hydraulically connected to the river. A more dependable water supply will require test drilling east of the campground or will require a deep test hole penetrating the Tertiary sediments.

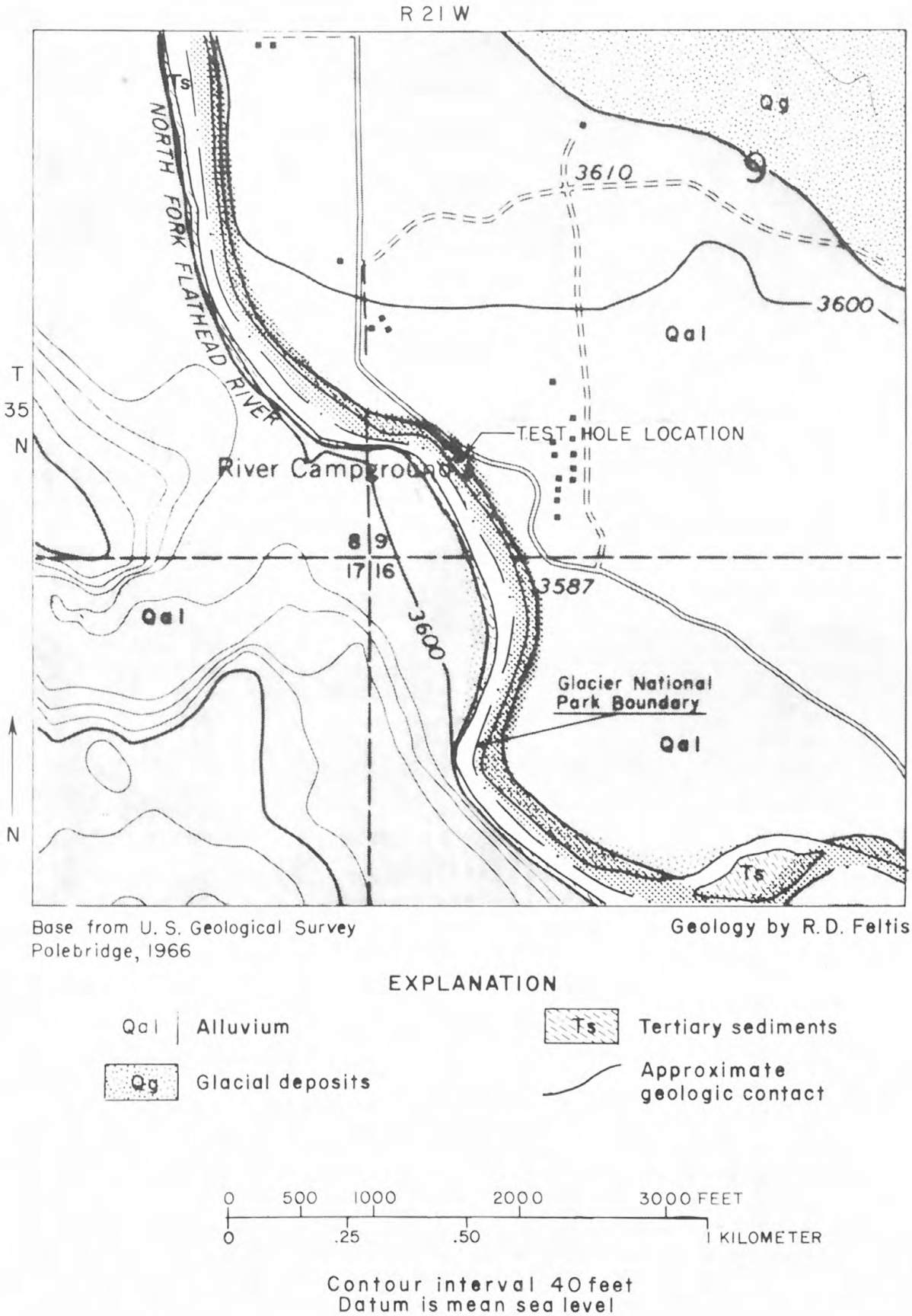


Figure 12– Geologic map of River Campground

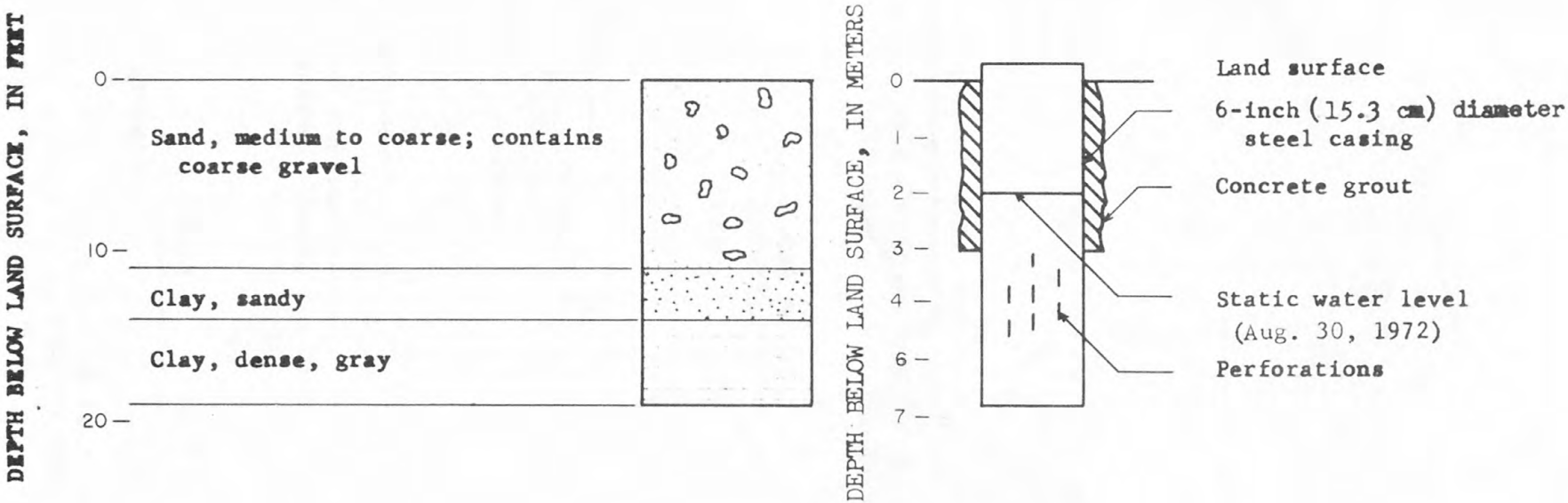


Figure 13.--Lithologic log of the test well at River Campground.

Polebridge Ranger Station

Polebridge Ranger Station is at the east end of the bridge across the North Fork Flathead River. The area is underlain by a thin mantle of alluvium and alluvial-fan deposits that overlie Tertiary sediments (fig. 14).

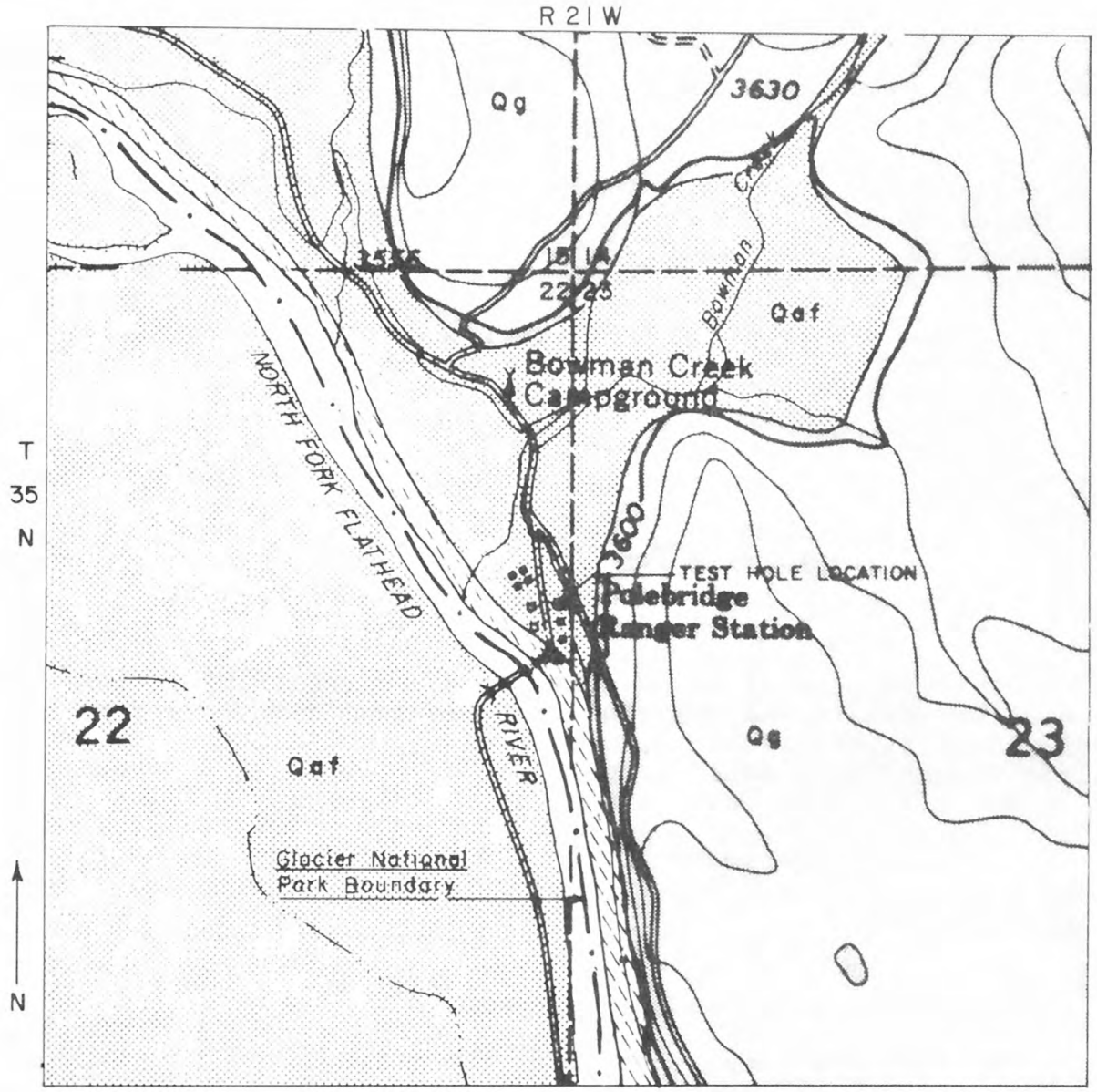
A test hole was drilled about 100 yards (91.4 meters) north of the entrance station. The test hole is 20 feet (6.1 meters) deep and penetrated 14 feet (4.3 meters) of alluvium (fig. 5). The top of the Tertiary sediments is several feet above the river (fig. 15) and, except during the snowmelt period, the alluvium is drained. Because the base of the alluvium is above river level and because the alluvium underlies only a small area east of the river, it appears unlikely that water can be supplied to the ranger station from the alluvium along the North Fork Flathead River.

Other sources of water that are worth exploring include a shallow well in the alluvium along Bowman Creek or a deep well in the Tertiary sediments. A test hole in the alluvium along Bowman Creek would probably have to be 30 to 40 feet (9.1 to 12.2 meters) deep and be drilled near the bridge across Bowman Creek. A test hole in the Tertiary sediments would probably have to be 100 to 200 feet (30.5 to 61 meters) deep but could be drilled at any convenient location near the ranger station.

Two Medicine Campground

Two Medicine Campground is at the northeast end of Two Medicine Lake. The campground is on alluvium and glacial deposits and is surrounded by mountains composed of Precambrian argillite (fig. 16).

A test hole was drilled about 200 feet (61 meters) southwest of the entrance to the campground and west of the road to the boat dock. The test hole was drilled and cased to 32 feet (9.8 meters). The casing is perforated from 18 to 28 feet (5.5 to 8.5 meters), which is opposite highly permeable alluvium (fig. 17). The test hole was bailed at about 25 gpm (1.6 l/s) for more than 2 hours to remove the fine sand and form a natural gravel pack. At the end of bailing, clear water was being produced. The test hole was pumped at 13 gpm (0.82 l/s) for 200 minutes, the maximum drawdown was 0.18 foot (0.5 meter) (fig. 4), and the specific capacity is 76.5 gpm per foot (15.8 l/s per meter) of drawdown after 60 minutes. The depth to water before the aquifer test was 17.7 feet (5.4 meters) below land surface on August 22, 1972.



Base from U.S. Geological Survey
Polebridge, 1966

Geology by R.D. Feltis

EXPLANATION

- Qaf — Alluvium and alluvial–fan deposits
- Qg — Glacial deposits
- Ts — Tertiary sediments
- Approximate geologic contact

0 500 1000 2000 3000 FEET
0 .25 .50 1 KILOMETER

Contour interval 40 feet
Datum is mean sea level

Figure 14-Geologic map of Polebridge Ranger Station

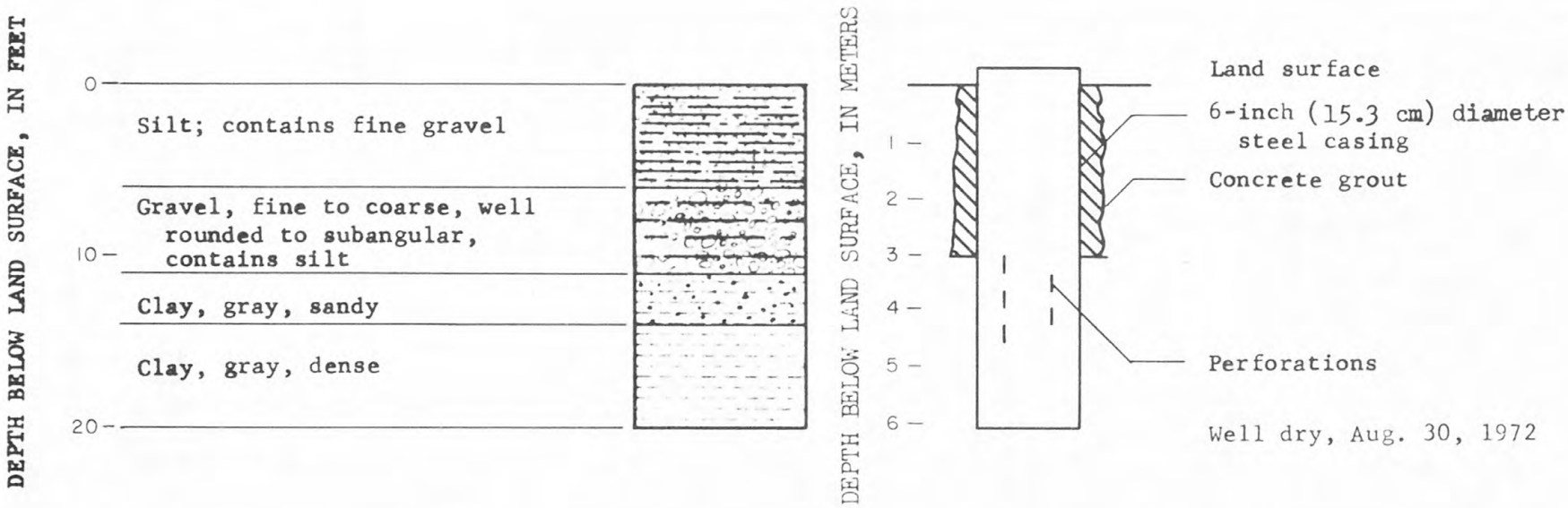


Figure 15.--Lithologic log of the test well at Polebridge Ranger Station.

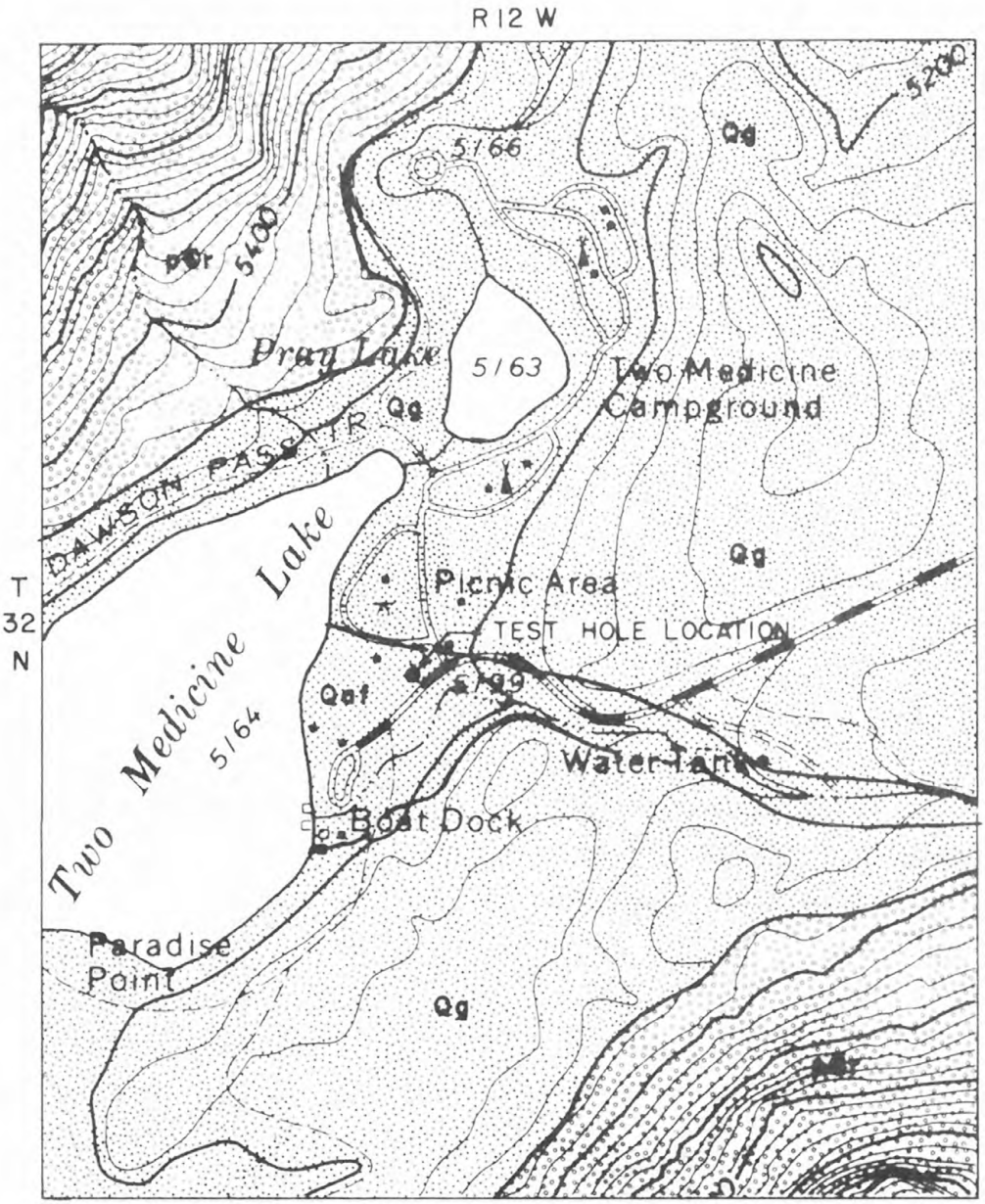


Figure 16.— Geologic map of Two Medicine Campground

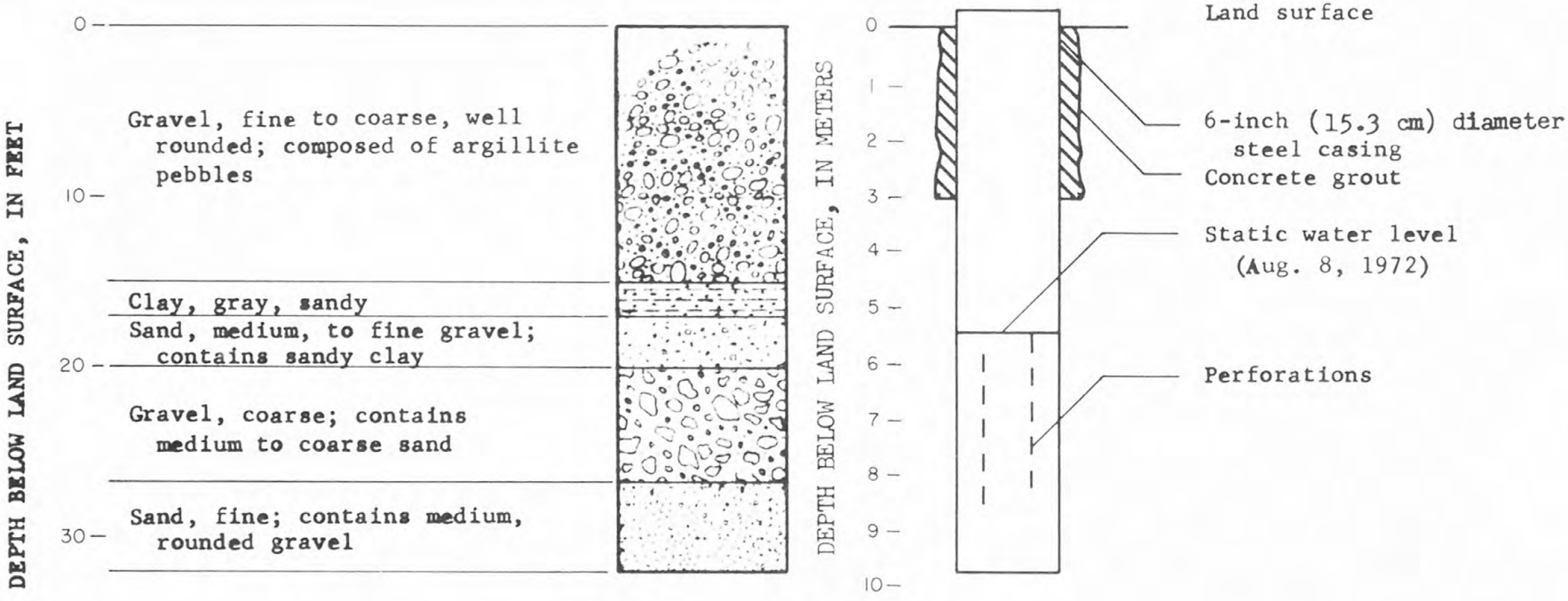


Figure 17.--Lithologic log of the test well at Two Medicine Campground.

Water quality

Water samples were obtained from seven of the test holes during the aquifer tests and were analyzed for dissolved chemical constituents by the U.S. Geological Survey laboratory in Salt Lake City, Utah. The analyses of dissolved constituents are given in table 2. Calcium and bicarbonate are the principal constituents. The major dissolved constituents in the water from the test hole at Lake McDonald Ranger Station are silica, calcium, and bicarbonate. Water from these test holes contains no chemical constituents in amounts that would cause rejection for drinking water used on interstate carriers according to standards established by the U.S. Public Health Service in 1962.

Contamination of ground water by septic tank or cesspool effluent is usually indicated by relatively high concentrations of nitrate. The test wells sampled in Glacier National Park produced water low in nitrate. Thus, the water shows no indication of contamination. If water samples were collected at least annually and analyzed for chemical and bacteriological content, contamination could be detected before becoming a major problem.

Summary

Results of test drilling at the eight sites in Glacier National Park are summarized below:

1. Six of the test wells will produce more than 10 gpm (0.6 l/s). The well at Kintla Lake Campground will yield 4 gpm (0.25 l/s) during continuous pumping. The test well at Polebridge Ranger Station is dry.

2. If a production well is contemplated at the Logging Creek Campground site, removal of the toilets and disinfecting and sealing of the pits would be necessary to reduce possible contamination.

3. The septic tanks and drain fields at the Lake McDonald Ranger Station and adjacent private property will not contaminate a production well at the site of the test hole.

4. The water from the test wells contains no constituent in amounts that would cause rejection for public drinking water according to standards established by the U.S. Public Health Service.

Table 2.--Chemical analyses of water

[Analyses by U.S. Geological Survey.
Results in milligrams per liter, except as indicated.]

Constituents or property	Lake McDonald Ranger Station	Logging Creek Ranger Station	Logging Creek Campground	Quartz Creek Campground	Kintla Lake Campground	River Campground	Two Medicine Campground	U.S. Public Health Service Drinking Water Standards (1962)
Date collected	8-30-72	8-30-72	8-30-72	8-30-72	8-31-72	8-30-72	8-22-72	
Silica (SiO_2)	14	4.7	5.4	6.2	13	6.0	4.1	
Iron (Fe)[1]	10	20	10	30	20	10	20	300
Manganese (Mn)[1]	30	0	0	0	32	0	0	50
Calcium (Ca)	10	13	7.4	13	43	38	7.4	
Magnesium (Ma)	3.8	2.3	2.1	3.3	17	7.8	4.1	
Sodium (Na)	6.3	1.0	1.1	1.2	3.3	.9	1.0	
Potassium (K)	.7	.2	.3	.3	.7	.4	.4	
Bicarbonate (HCO_3)	54	53	33	61	233	144	45	
Carbonate (CO_3)	0	0	0	0	0	0	0	
Sulfate (SO_4)	8.4	2.8	5.0	2.3	5.1	10	5.7	250
Chloride (Cl)	3.0	.9	.8	.9	.9	1.0	1.3	250
Fluoride (F)	0	0	.1	0	.1	.1	.1	1.5
Nitrate (NO_3)	.3	.02	.1	.04	.04	.03	.01	45
Phosphate (PO_4)	.05	.06	.11	.06	.06	.06	.03	
Dissolved solids (calculated)	72	51	39	57	198	135	46	500
Hardness (total)	41	42	27	46	180	130	35	
Specific conductance (micromhos at 25°C)	104	88	59	100	349	241	77	
pH		7.3	7.3	7.0	7.9	7.4	6.9	
Temperature (°C)	5.0	13.0	14.0		6.5	13.5	8.0	

[1] Reported in micrograms per liter

References

Ross, C. P., 1959, Geology of Glacier National Park and the Flathead region, northwestern Montana: U.S. Geol. Survey Prof. Paper 296, 125 p.

U.S. Public Health Service, 1962, Drinking Water Standards, 1962: U.S. Public Health Service Pub. 926, 61 p.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