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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

EVALUATION OF THE WATER SUPPLY AT SIX SITES IN THE CURECANTI RECREATION AREA, SOUTHWESTERN COLORADO

By

Arnold J. Boettcher

OPEN-FILE REPORT
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WATER
RESOURCES
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Colorado District
Denver, Colorado
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Prepared by the
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for the
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EVALUATION OF THE WATER SUPPLY AT SIX SITES IN THE CURECANTI RECREATION AREA, SOUTHWESTERN COLORADO

By Arnold J. Boettcher

ABSTRACT

An evaluation of the water resources was made at six sites within the National Park Service Curecanti Recreation area west of Gunnison, Colo. These six areas are to be used for picnic areas or campgrounds. The study, which was made by the U.S. Geological Survey during the summer of 1970, consisted of mapping the geology, evaluating existing supplies, selecting test-hole drilling sites, test pumping of wells, and analyzing the chemical quality of the water.

Rocks exposed at the sites range in age from Precambrian to Quaternary. The Precambrian crystalline rocks contain water only in fractures. In the areas of investigation at or near steep canyons, the fractures are drained and the crystalline rocks are not known to yield water to wells. The consolidated sedimentary deposits of Jurassic and Cretaceous ages yield either little or no water to wells. Wells drilled into the volcanic rocks of Tertiary age generally yield less than 5 gallons per minute. Wells drilled into the landslide deposits of Quaternary age yield as much as 10 gallons per minute, whereas the valley-fill deposits yield as much as 50 gallons per minute to wells. The terrace deposits generally are drained and yield no water to wells.

INTRODUCTION

This report presents an evaluation of the water resources of six recreation sites in the Curecanti Recreation area near Gunnison, Colo. Water will be needed at these sites for comfort stations, fish-cleaning stations, maintenance facilities, ranger quarters, and picnic areas or campgrounds. The work, done by the U.S. Geological Survey at the request of the National Park Service, consisted of mapping the geology, evaluating the existing water supplies, selecting locations for test drilling, supervision of test drilling, test pumping of wells, and analyzing the chemical quality of the water. The fieldwork was done from April to August 1970.

The Curecanti Recreation area, which includes the Blue Mesa and Morrow Point Reservoirs, extends from about 6 to 45 miles west of Gunnison, Colo. (fig. 1). The sites evaluated are Lake Fork, Round Corral, Ponderosa, Coal Creek, Beaver Creek, and Cebolla Creek. Round Corral is adjacent to the Morrow Point Reservoir and the others are adjacent to Blue Mesa Reservoir. Their locations are shown in figure 1.

ACKNOWLEDGMENTS

The author is indebted to J. M. Carpenter, Superintendent of the National Park Service Curecanti Recreation area, and his staff for their cooperation in providing boat transportation to the potential sites, their help in providing access for the drilling rig into the sites, and administrative details necessary for the compilation of this report. The author also thanks W. R. Hansen, D. C. Hedlund, and J. C. Olsen of the U.S. Geological Survey for the use of their preliminary geologic maps in the report area.

GENERAL GEOHYDROLOGY

Rocks exposed at the sites studied range in age from Precambrian to Quaternary (table 1). The Precambrian rocks consist of dark-colored schist, gneiss, and light-pink granite with pegmatite intrusions throughout. All Precambrian exposures were mapped as crystalline rocks because their hydraulic characteristics are similar.

The crystalline rocks contain water only in fractures. In the areas of investigation at or near steep canyons, the fractures are drained and the crystalline rocks are not known to yield water to wells.

Rocks of Precambrian age underlie the entire area and are well exposed in the canyon downstream from the Blue Mesa Dam. Unconformably overlying the Precambrian rocks are sedimentary formations of Jurassic to Quaternary ages.

The Wanakah Formation of Jurassic age overlies the Precambrian rocks and is composed of interbedded silty mudstone, cherty limestone, and gypsiferous sandstone and limestone. The Wanakah, which has a maximum thickness of about 250 feet, yields small (less than 10 gallons per minute) quantities of water to wells.

Figure 1. --Index map showing recreation sites.

Table 1.--*Rock formations in the Curecanti Recreation area*

System	Geologic unit	Thickness (feet)	Physical character	Water supply
Quaternary	Valley-fill deposits	10-50	Poorly sorted sand, gravel and clay.	Yield as much as 50 gallons per minute to wells.
	Terrace deposits	10-20	Poorly sorted sand, gravel, and volcanic ash.	Generally drained and yield no water to wells.
	Landslide deposits	As much as 130	Heterogeneous mixture of clay, silt, sand, gravel, and boulders associated with the Morrison Formation and the volcanic rocks.	Perched water table. Yield 5 to 10 gallons per minute to wells.
Tertiary	Volcanic rocks	As much as 300	Cliff forming light-gray to buff-colored welded tuff, and volcanic mudflow breccia.	Yield less than 5 gallons per minute to wells penetrating fractures.
Cretaceous	Mancos Shale	As much as 2,200	Dark-gray silty shale containing lenses of gray sandstone.	Not known to yield water to wells in study area.
Jurassic	Morrison Formation	525	Red, green, purple and light-gray silty shale and mudstone. Lower 110 to 175 feet contains lenticular beds of buff-colored massive sandstone.	Small chance of obtaining water from lenses of sandstone.

Table 1.--*Rock formations in the Curecanti Recreation area*--Continued

System	Geologic unit	Thickness (feet)	Physical character	Water supply
Jurassic	Wanakah Formation	250	Upper 25 to 60 feet contains interbedded light-gray mudstone and cherty limestone. Lower part contains fine-grained crossbedded light-gray to yellowish-gray sandstone interbedded with gypsum and gypsiferous sandstone and mudstone.	Yields less than 10 gallons per minute to wells.
Precambrian	Crystalline rocks		Fractured granite, schist, and gneiss with layers or lenses of quartz and pegmatite intrusions.	The fractured crystalline rocks are drained near the deep canyon, and probably will not yield water to wells in the study area.

Overlying the Wanakah Formation is the Morrison Formation of Jurassic age. The Morrison Formation is divided into two members. The upper member (Brushy Basin Member) is composed of varicolored bentonitic mudstone, lenticular fine-grained sandstone, and gray massive siltstone. The lower member (Salt Wash Member) is composed of lenticular fine-grained cliff-forming sandstone and red silty shale. The maximum thickness of the Morrison in the study area is about 525 feet. The Morrison yields water to wells in some localities, but in the Blue Mesa area the permeable sandstone is lenticular and is surrounded by relatively impermeable shales and siltstones.

The Mancos Shale is exposed at the Coal Creek and Ponderosa campgrounds. The Mancos, of Cretaceous age, is composed of dark-gray to black silty shale containing scattered lenses of friable gray sandstone and calcareous siltstone concretions. Locally, the Mancos is about 2,200 feet thick and almost impermeable. The Mancos is not known to yield water to wells.

Tertiary volcanic rocks cap many of the hilltops in the area. These rocks are composed of massive cliff-forming devitrified densely welded tuff, containing sanidine and biotite with scattered inclusions of pumice, overlying widespread volcanic mudflow breccia. The welded tuff ranges in color from reddish-brown to light-blue to bluish-gray. In some areas the tuff is vuggy and is as thick as 300 feet. The rocks are fractured and yield as much as 5 gpm (gallons per minute).

The Quaternary units exposed in the area are the terrace deposits, the valley-fill deposits in the streams tributary to the reservoir, and the landslide deposits. The terrace deposits consist of sand and gravel deposited by the Gunnison River. The high terrace near the mouth of Cebolla Creek is underlain by about 20 feet of poorly sorted sand and gravel and volcanic ash. No wells penetrate this unit but the deposits probably have been drained. The valley-fill deposits are composed of materials reworked from the bedrock. Generally, these deposits consist of sand, gravel, and clay, and are as much as 50 feet thick. Wells that penetrate more than 20 feet of saturated valley-fill deposits yield as much as 50 gpm. The landslide debris are composed of clay, sand, gravel, and cobbles derived mostly from the volcanic rocks and the Morrison Formation. The landslide deposits commonly yield as much as 5 to 10 gpm to wells.

HYDROGEOLOGY OF THE PROPOSED RECREATION SITES

Test Drilling

Three test wells were drilled and converted into water-supply wells at the Lake Fork, Ponderosa, and Beaver Creek sites during June and July 1970 using rotary (air and hydraulic) and cable-tool

methods. The wells were cased with 6-inch steel casing that have torch-cut perforations. These wells are sealed from the surface to a depth of 10 feet with cement grout in the irregular annular space between the casing and the wall of the pilot hole. Table 2 describes the results of the test drilling. The lithologic logs of the wells are given in table 3.

Round Corral Recreation Site

The Round Corral recreation site is adjacent to the Morrow Point Reservoir on an unnamed tributary to Round Corral Creek (fig. 2). Camp sites, ranger quarters, maintenance facilities, and comfort stations are planned for construction at this site. At present, the only sources of water are springs along the unnamed tributary. The total estimated flow of the springs is about 20 gpm. The creek valley is about 250 feet wide and has heavily forested valley walls. The valley is underlain by valley-fill deposits and flanked on both sides by crystalline rocks (fig. 3).

No test drilling was done in this area because of land-acquisition problems. When water is needed, a test well should be drilled in the valley-fill deposits such as at the proposed well site in figure 3, to determine the potential ground-water supply. A well in the valley-fill deposits might yield more than 20 gpm. The crystalline rocks are not known to yield water to wells in the area.

Lake Fork Recreation Site

The Lake Fork recreation site is at the intersection of U.S. Highway 50 and the Colorado State Highway 92, about half a mile east of the Blue Mesa Dam (fig. 4). This site is planned to accommodate seven picnic shelters, two comfort stations, a ranger station and apartment, a fish-cleaning station, a boat launching ramp, a sanitary dump, and provide parking for about 200 vehicles.

The estimated peak water use is 9,800 gpd (gallons per day) during the period May through August. Water use is estimated to be 3,500 gpd in September and 1,500 gpd in October. The facility will be closed November through April.

Table 2.--*Summary of test drilling*

Site	Depth (feet)	Aquifer	Perforated interval (feet)	Depth to water below land surface (feet)	Date measured	Specific capacity (gallons per minute per foot of drawdown)	Estimated yield (gallons per minute)
Lake Fork	120	Landslide deposits	62-102 open hole from 102-120	74.3	8-3-70	0.6 (after 1630 minutes)	5
Ponderosa	38	Valley-fill deposits	18-38	8.6	8-4-70	19 (after 400 minutes)	40
Beaver Creek	27	----do----	10-27	5.6	8-4-70	.3 (after 240 minutes)	3

Table 3.--*Lithologic logs of test wells*

[Drilled by the U.S. Geological Survey, June-July 1970]

	Thickness (feet)	Depth below land surface (feet)
Lake Fork site (test-hole location shown on fig. 5; drilled by hydraulic rotary and air method):		
Landslide deposits:		
Soil	3	3
Sand, fine; contains buff-colored silt and fragments of bluish-gray and tan welded tuff	12	15
Sand, fine to medium; contains buff-colored clay and fragments of gray welded tuff	14	29
Clay, sandy; contains fragments of light-gray welded tuff	5	34
Sand, fine; contains fragments of light-gray and bluish-gray welded tuff and biotite	9	43
Sand, very fine; contains fragments of light-gray welded tuff and biotite	8	51
Sand, fine to medium; contains light-gray welded tuff fragments	5	56
Gravel, fine to medium; cobbles of light-blue welded tuff (water level 74.3 on Aug. 3, 1970)	30	86
Welded tuff, light-bluish-gray	18	104
Clay, light-gray	16	120
Ponderosa site (test-hole location shown on fig. 7; drilled by cable-tool method):		
Valley-fill deposits:		
Top soil	3	3
Gravel, fine to medium (water level 8.6 feet, Aug. 4, 1970)	14	17
Gravel, medium; contains medium sand	11	28
Clay, sandy, light-brown; contains fine gravel	3	31
Mancos Shale:		
Clay, dark-gray, dense	7	38

Table 3.--*Lithologic logs of test wells*--Continued

	Thickness (feet)	Depth below land surface (feet)
Beaver Creek site (test-hole location shown on fig. 10; drilled by cable-tool method):		
Valley-fill deposits:		
Sand, medium to coarse, and gravel (water level 5.6 feet, Aug. 4, 1970)----------	10	10
Clay, sandy, light-brown; contains fine to medium gravel----------	8	18
Clay, light-brown, contains fine to medium sand----------	7	25
Clay, light-gray, dense----------	2	27

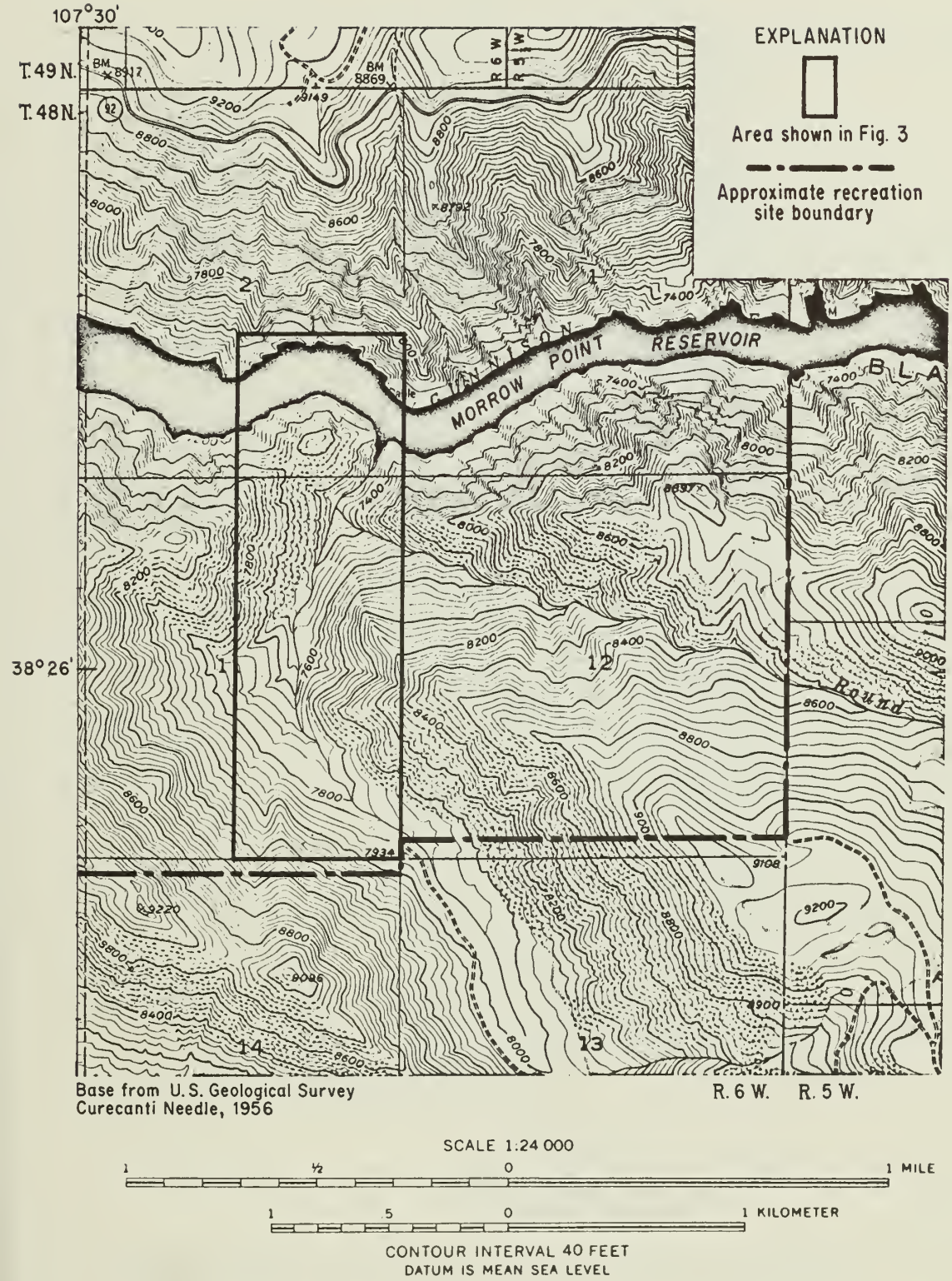

Figure 2.--Location of the Round Corral recreation site.

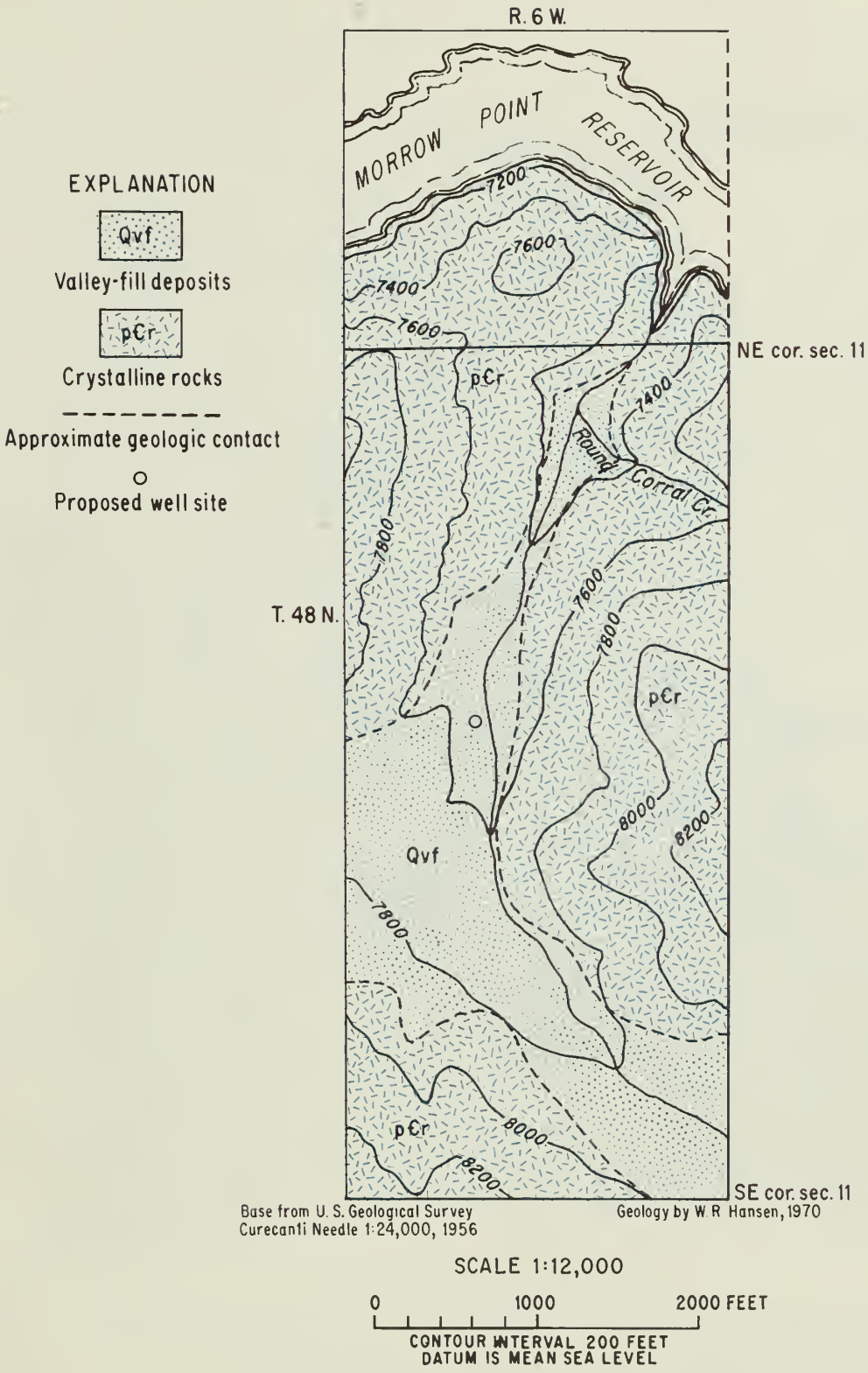

Figure 3. --Geologic map of a part of the Round Corral recreation site.

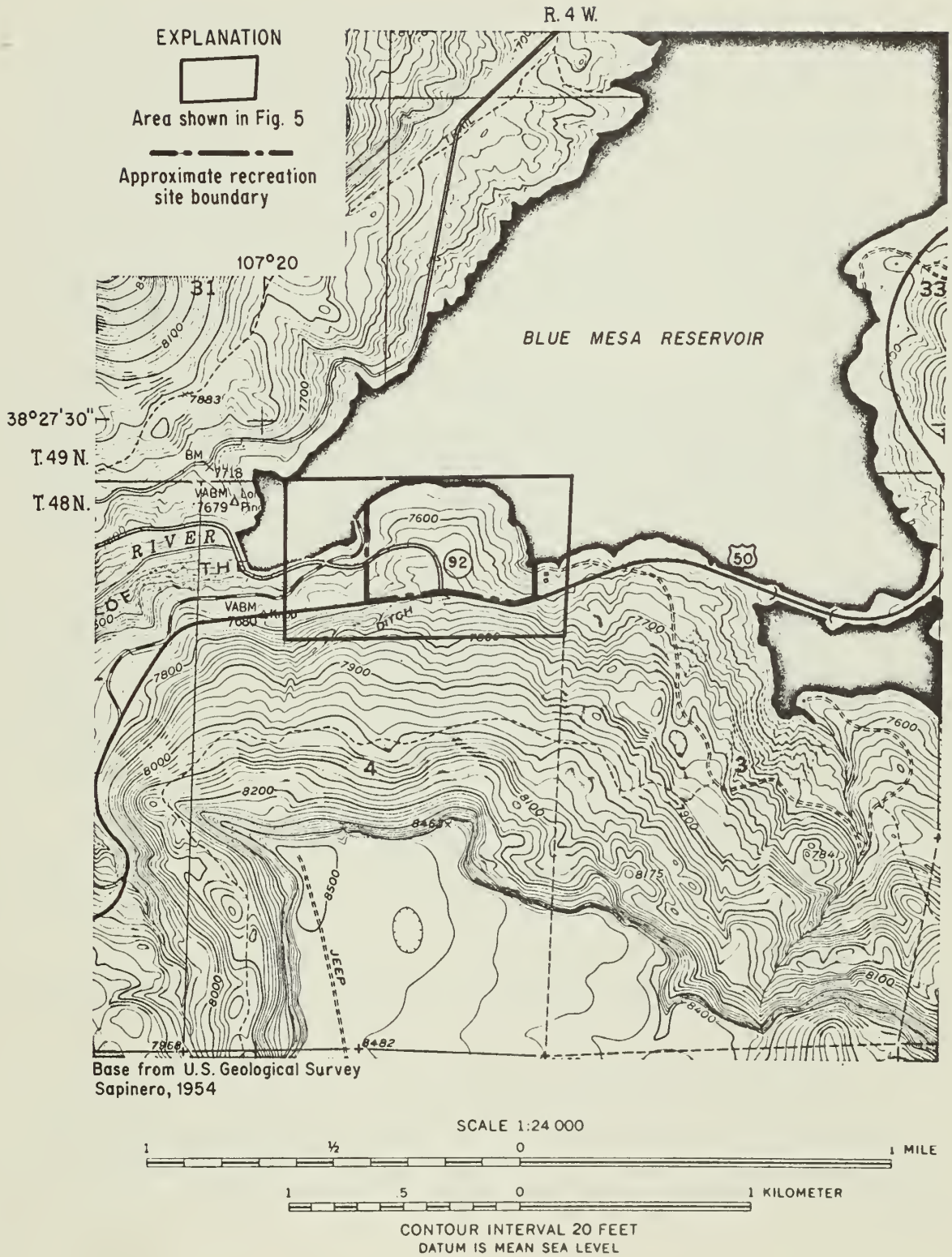

Figure 4. --Location of the Lake Fork recreation site.

The existing sources of water are a well constructed by the U.S. Bureau of Reclamation during the construction of the Blue Mesa Dam, and a spring. The spring (fig. 5) discharge varied from 6.8 to 9 gpm. The discharge is lowest during the late winter and early spring, and is highest during the period May through September as shown in table 4. The U.S. Bureau of Reclamation well (fig. 5) is 15.8 feet deep and the static water level is 10.5 feet below land surface. The well was constructed by removing a large amount of landslide material from the hillside, placing a 6-foot diameter perforated casing in the cavity, and replacing the earth around the casing. On May 12, 1970, the well was pumped at 14.4 gpm for 250 minutes and the water level declined to within 1 foot of the bottom of the well.

The area is underlain by landslide deposits with outliers of the Morrison Formation (fig. 5). The source of water to the spring is probably from a sandstone within the Morrison Formation, but the water in the U.S. Bureau of Reclamation well is from the landslide deposits. The source of water in the landslide deposits probably is from seeps and springs in the Morrison Formation and local recharge from precipitation.

A test well was drilled to a depth of 120 feet in the landslide deposits (fig. 5); water was found at about 74 feet. The well casing is perforated from 62 to 102 feet below the land surface. The bottom 18 feet of the hole is uncased. The log of this well is shown in table 3. The test well was pumped at 8.3 gpm for 1,630 minutes, resulting in a drawdown of 14.2 feet. The specific capacity of the well at the end of the pumping period was 0.6 gpm per foot of drawdown.

The spring can be used as a major source of water at Lake Fork. The spring is capable of supplying 5 gpm (7,200 gpd) continuously. The remainder of the water needed (2,600 gpd) could be obtained intermittently from the test well at a rate of about 5 to 8 gpm.

The water level in the test well should not be drawn down below 86 feet below land surface. Below this point the aquifer is less permeable and the pumping level declines rapidly.

Water samples were taken from the spring, the U.S. Bureau of Reclamation well, and the test well and analyzed for dissolved constituents. The analyses (table 5) indicate that the water is a calcium-bicarbonate type water. The water in the spring contains no concentrations of constituents that would cause it to be rejected as a source of public drinking water according to standards established

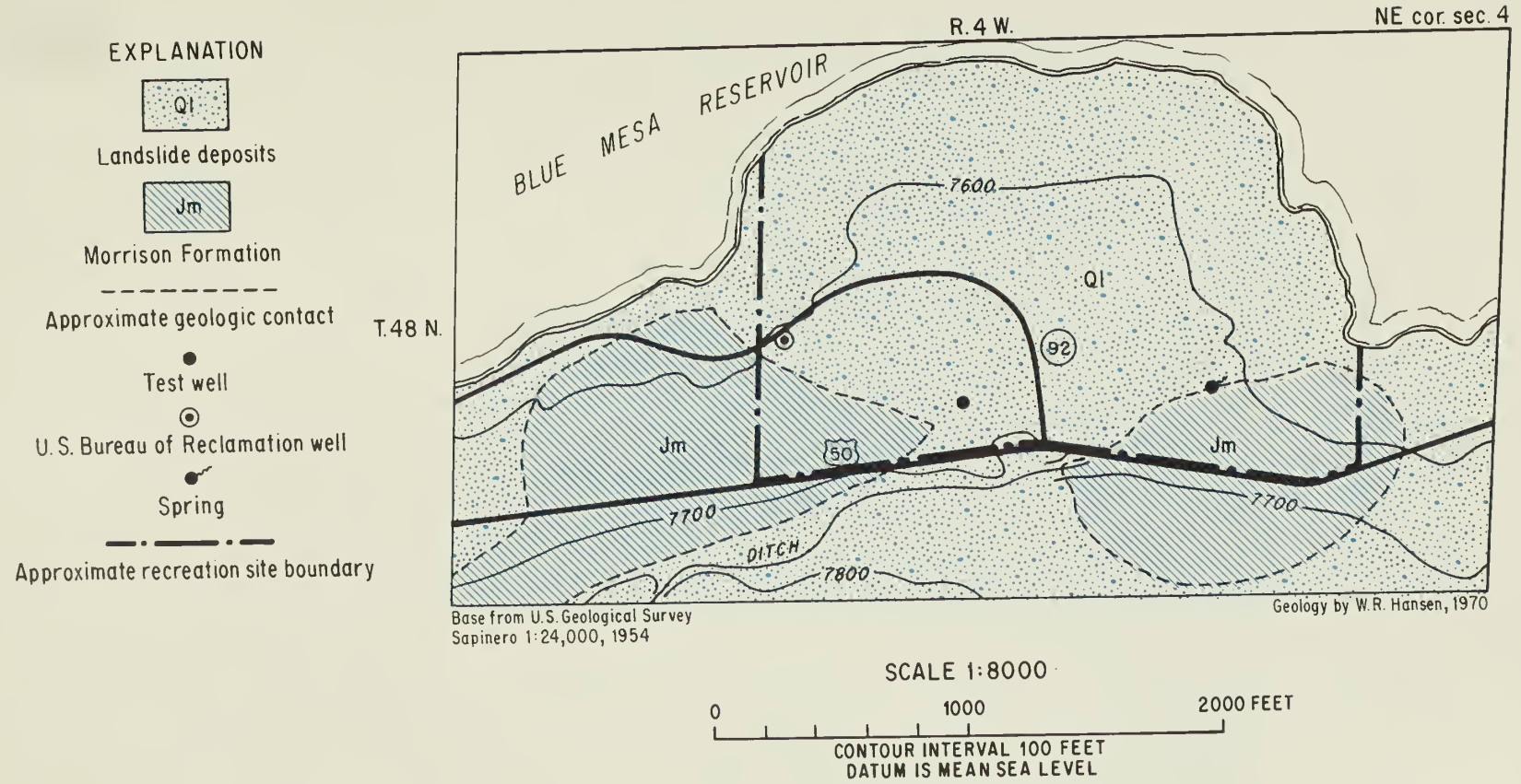

Figure 5.--Geologic map of the Lake Fork recreation site and adjacent areas.

Table 4.--*Discharge of Lake Fork spring*

Date measured	Discharge (gallons per minute)
Mar. 8, 1970	6.8
May 12, 1970	7.6
June 12, 1970	9.0
Aug. 3, 1970	8.3
Aug. 4, 1970	9.0
Sept. 22, 1970	7.2
Nov. 4, 1970	7.4

Table 5.--*Chemical analyses of water*

[Analyses by U.S. Geological Survey. Results in milligrams per liter, except as indicated. Date below source is date of collection]

Constituent or property	U.S. Bureau of Reclamation well 5/12/70	Lake Fork spring 3/19/70	Lake Fork test well 8/3/70	Ponderosa test well 8/6/70	Beaver Creek test well 8/6/70
Temperature (°C)-----	5.5	5.0	10.0	6.0	14.0
Silica (SiO_2)--------	33.0	34.0	43.0	43.0	37.0
Calcium (Ca)---------	55.0	54.0	47.0	20.0	48.0
Sodium (Na)----------	6.2	6.0	17.0	5.7	8.5
Potassium (K)--------	1.9	2.3	2.6	2.8	2.6
Bicarbonate (HCO_3)---	206.0	215.0	208.0	111.0	189.0
Sulfate (SO_4)--------	10.0	7.0	15.0	8.0	25.0
Cloride (Cl)---------	5.3	5.3	8.3	.8	5.0
Fluoride (F)---------	.3	.3	.9	.1	.3
Nitrate (NO_3)--------	12.0	1.4	2.2	.2	.1
Phosphate (PO_4)------	.28	.20	.26	.60	.09
Boron (B)------------	.00	.02	.02	.02	.03
Iron (Fe)------------	.01	.00	---------	--------	----------
Manganese (Mn)-------	.03	.01	---------	--------	----------
Arsenic (As)---------	.00	.00	.01	.01	.00
Selenium (Se)--------	.04	.00	.06	.00	.00
Dissolved solids:					
Calculated---------	235	227	248	144	231
Residue on evaporation--------	255	239	254	139	242
Hardness as $CaCO_3$----	178	176	160	80	164
Noncarbonate---------	9.0	.0	.0	.0	9.0
Specific conductance (micromhos at 25°C)	359	348	373	167	349
pH-------------------	7.0	7.4	8.1	7.6	7.5

by the U.S. Public Health Service (1962). The water in both the U.S. Bureau of Reclamation well and the test well contain a higher concentration of selenium than is presently recommended for public water supplies--0.04 and 0.06 mg/l (milligrams per liter) respectively. The maximum allowable concentration of selenium now is 0.01 mg/l. By mixing the spring water and water from the test well as suggested previously, the concentration of selenium in the total supply would be reduced.

Ponderosa Recreation Site

The Ponderosa recreation site is at the confluence of Saddle Creek and Blue Mesa Reservoir (fig. 6) on a gentle east-facing slope. When fully developed, water will be needed for 12 comfort stations, a ranger station, a 4-unit apartment, a maintenance building, a fish-cleaning station, and a campground of about 400 campsites.

The only existing sources of water are a spring issuing from valley-fill deposits and intermittent flows in Saddle Creek. The discharge of the spring was measured at 11 gpm on August 3, 1970. This spring flows perennially according to National Park Service personnel.

The site is underlain by Mancos Shale and valley-fill deposits (fig. 7). The valley-fill deposits in Saddle Creek valley contain sand, gravel, and clay and may be as much as 50 feet thick. A test well, drilled to 38 feet, fully penetrated the valley-fill deposits of Saddle Creek (fig. 7). The well casing was perforated from 18 to 38 feet. The log of this well is shown in table 3.

The specific capacity of the well was 19 gpm per foot of drawdown, established by pumping at 16 gpm for 400 minutes with 0.84 foot drawdown. On the basis of the aquifer test, it is estimated that the well will yield as much as 40 gpm.

A water sample was obtained from the test well and analyzed for chemical constituents. The results of this analysis are shown in table 5. The water is a silica-bicarbonate type, and is of excellent chemical quality. The water contains no concentrations of constituents that would cause it to be rejected as a source of public drinking water by U.S. Public Health Service (1962) standards.

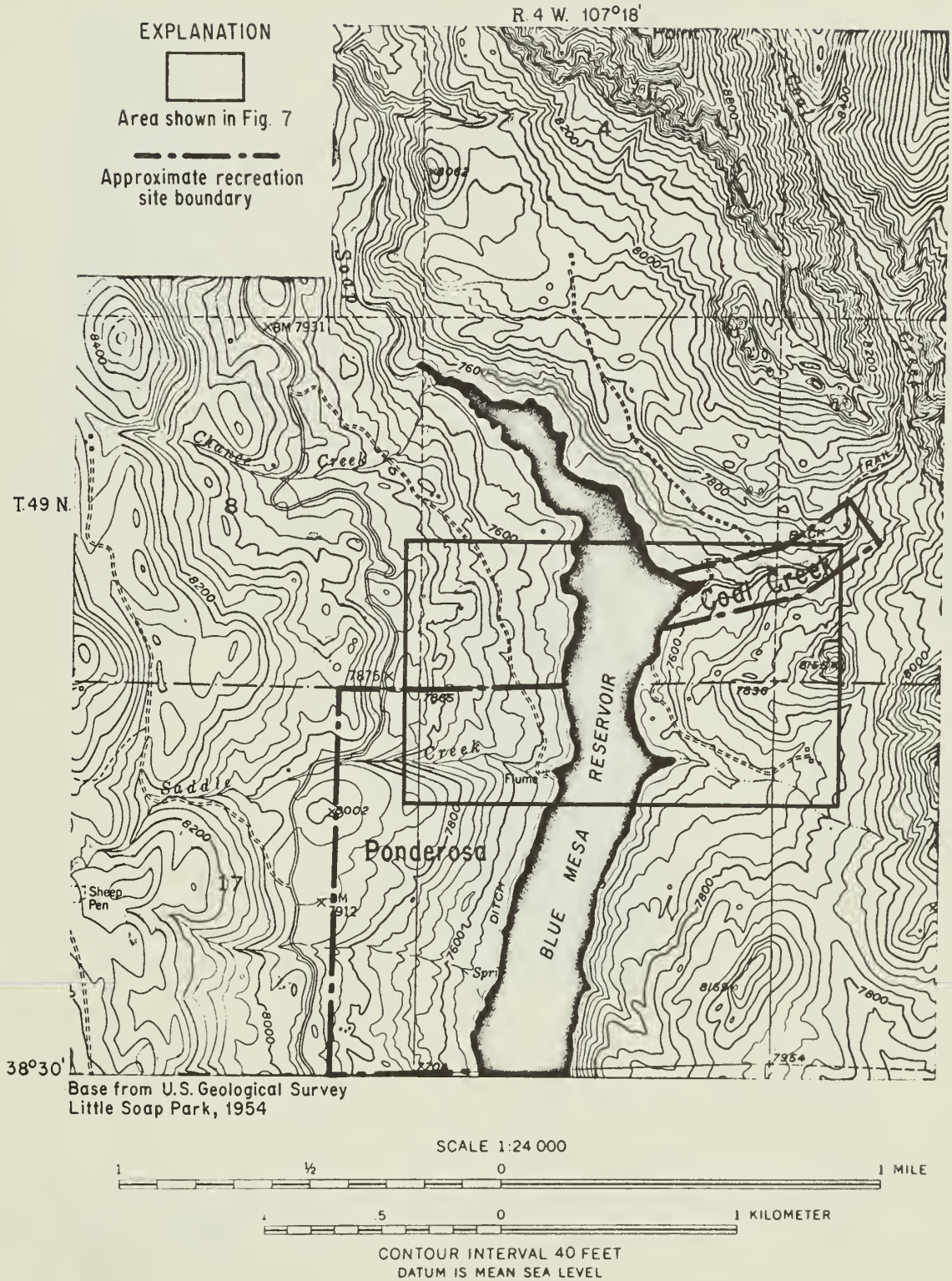

Figure 6.--Location of the Ponderosa and Coal Creek recreation sites.

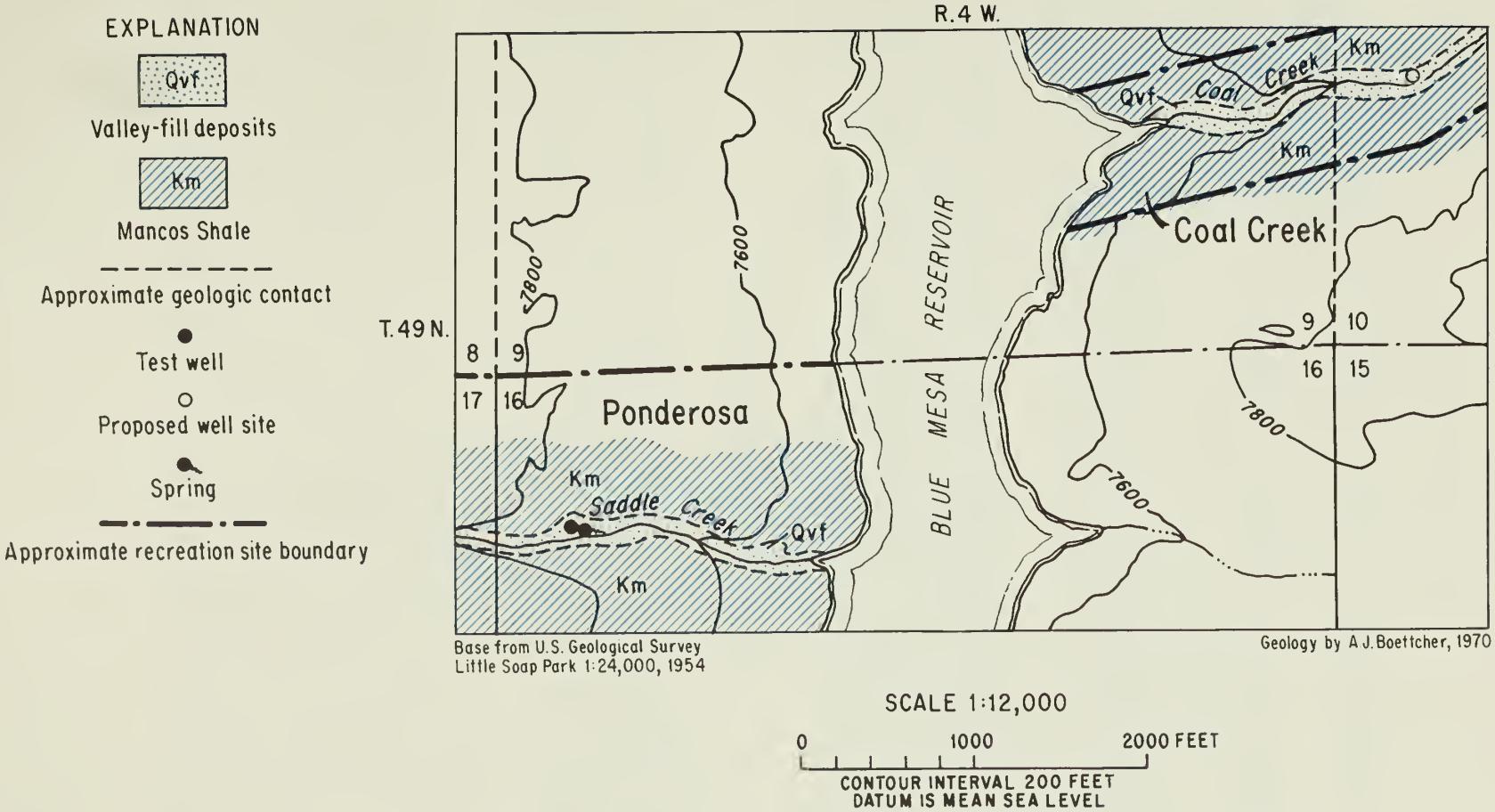

Figure 7.--Geologic map of a part of the Ponderosa and Coal Creek recreation sites and adjacent areas.

Coal Creek Recreation Site

The Coal Creek recreation site is at the confluence of Coal Creek and the reservoir (fig. 6). The area is on a gently rolling west-facing slope and can be reached only by boat.

Forty campsites are planned to be open from May through September. The only existing perennial source of water is Coal Creek.

The proposed campground will be on the flood plain of Coal Creek. The valley-fill deposits are the only potential ground-water source. The Mancos Shale, which is adjacent to the valley-fill deposits, is not known to yield water to wells (fig. 7).

As this site cannot be reached by road, it is necessary that a well on the flood plain of Coal Creek upstream from the campground (fig. 7) be dug by hand. It should be cased with 16-inch casing, perforated in the saturated zone. The well should be deep enough to tap at least 5 feet of saturated material. Possibly a pump will not be needed if a pipe is laid in a ditch from the casing near the bottom of the well and brought to the surface as shown in figure 8.

Beaver Creek Recreation Site

The Beaver Creek recreation site, which is planned to accommodate 25 picnic tables, is on the flood plain of Beaver Creek near the confluence of the creek and Blue Mesa Reservoir (fig. 9). Precambrian rocks crop out adjacent to the flood plain (fig. 10). The peak water use is estimated to be 1,000 gpd from May to November. At present (1970) the only water supply is Beaver Creek.

A test well was drilled by cable-tool to 27 feet below land surface. The well casing was perforated from 10 to 27 feet. A log of the well is given in table 3 and indicates coarser, probably more permeable materials in the upper part of the saturated zone. The well was test pumped for 240 minutes at about 3 gpm on August 6, 1970. The drawdown after 70 minutes was 1.4 feet, but was 11.75 feet at the end of the test indicating that the formation is most permeable in the upper 2 feet of the saturated zone, and that the remainder of the saturated zone is less permeable. After 70 minutes, the specific capacity was about 2 gpm per foot of drawdown, whereas, after 240 minutes it was only about 0.3 gpm per foot of drawdown.

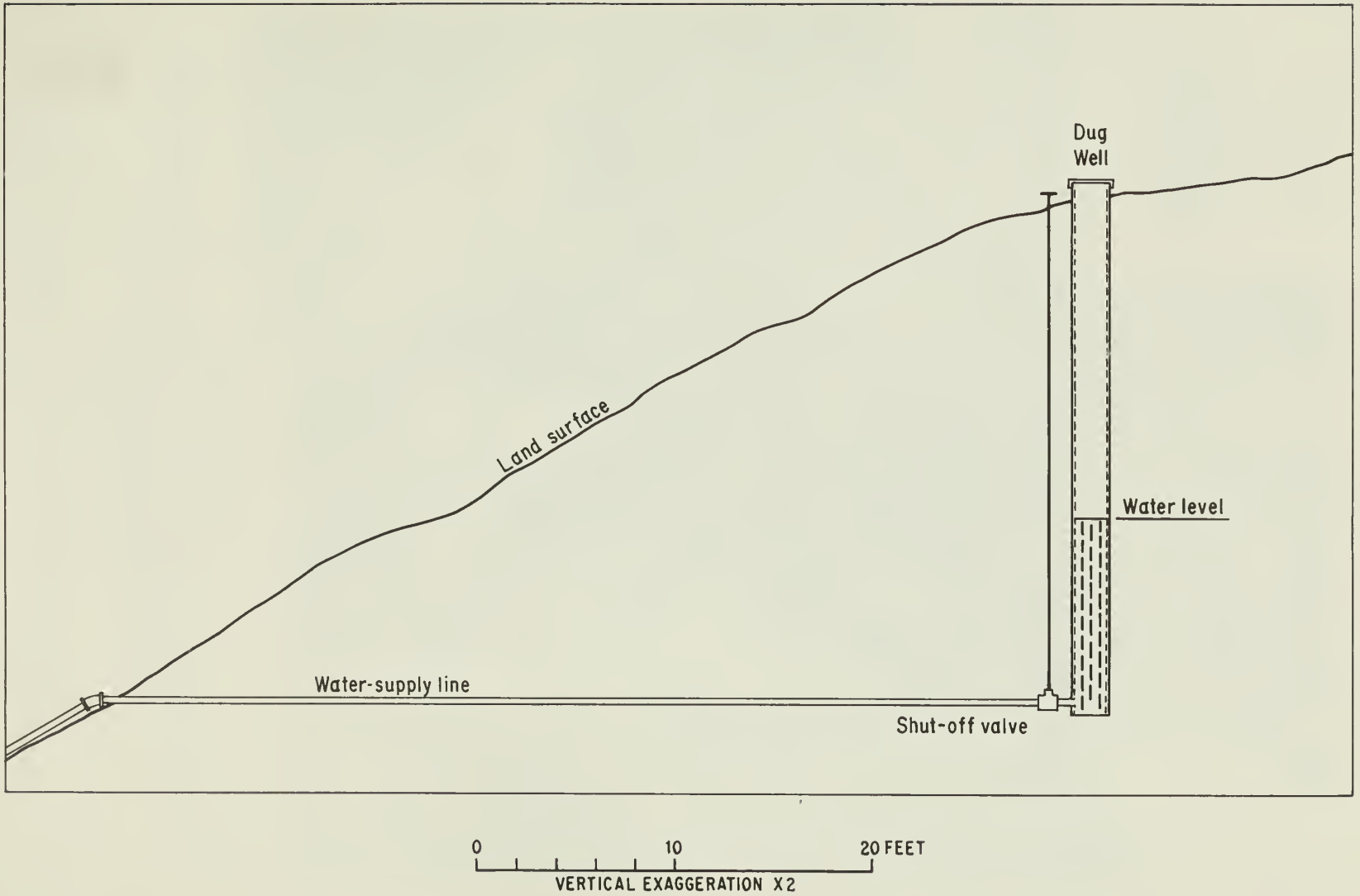

Figure 8.--Diagram showing a method to obtain water from a well at Coal Creek recreation site.

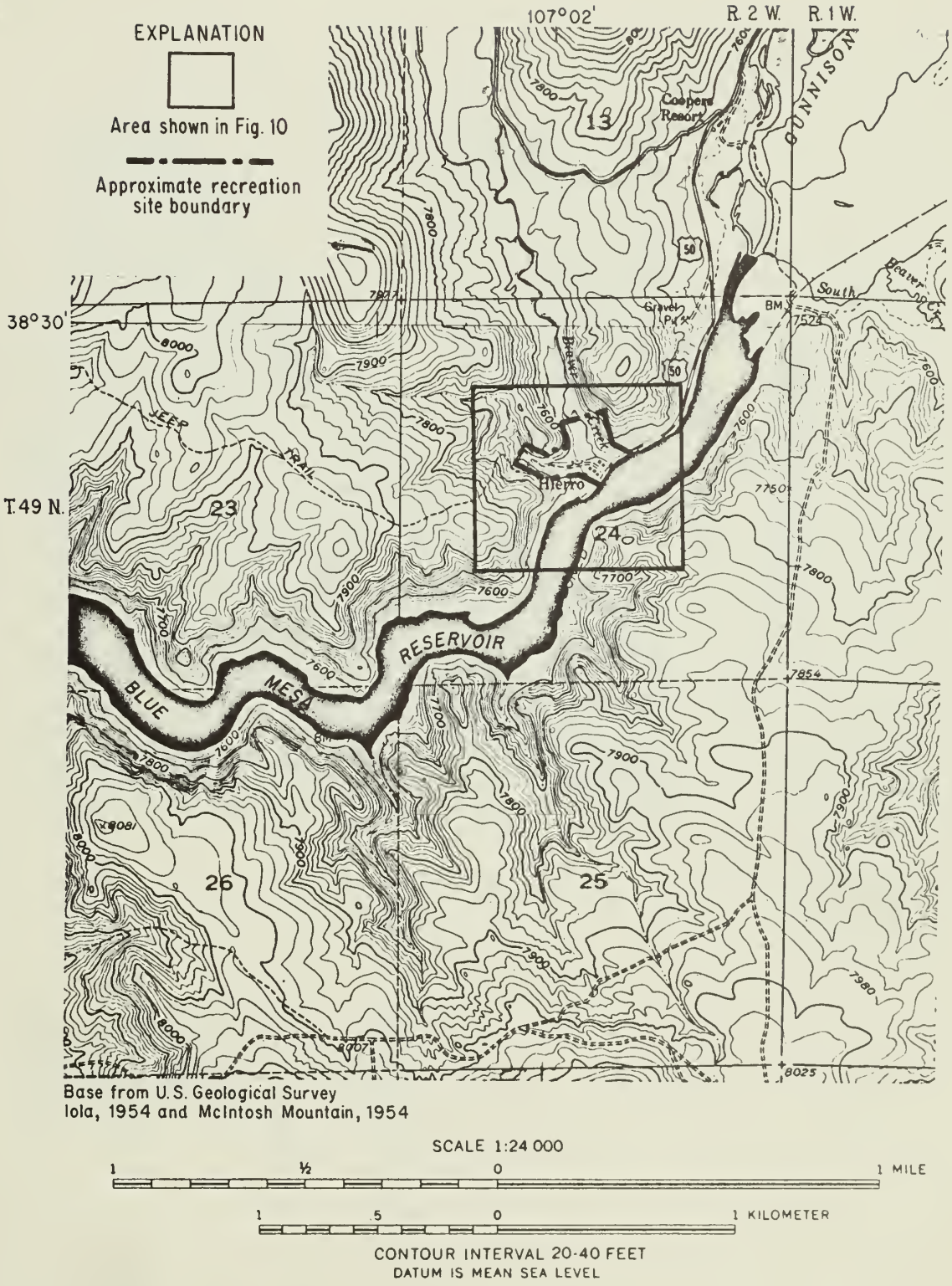

Figure 9.--Location of the Beaver Creek recreation site.

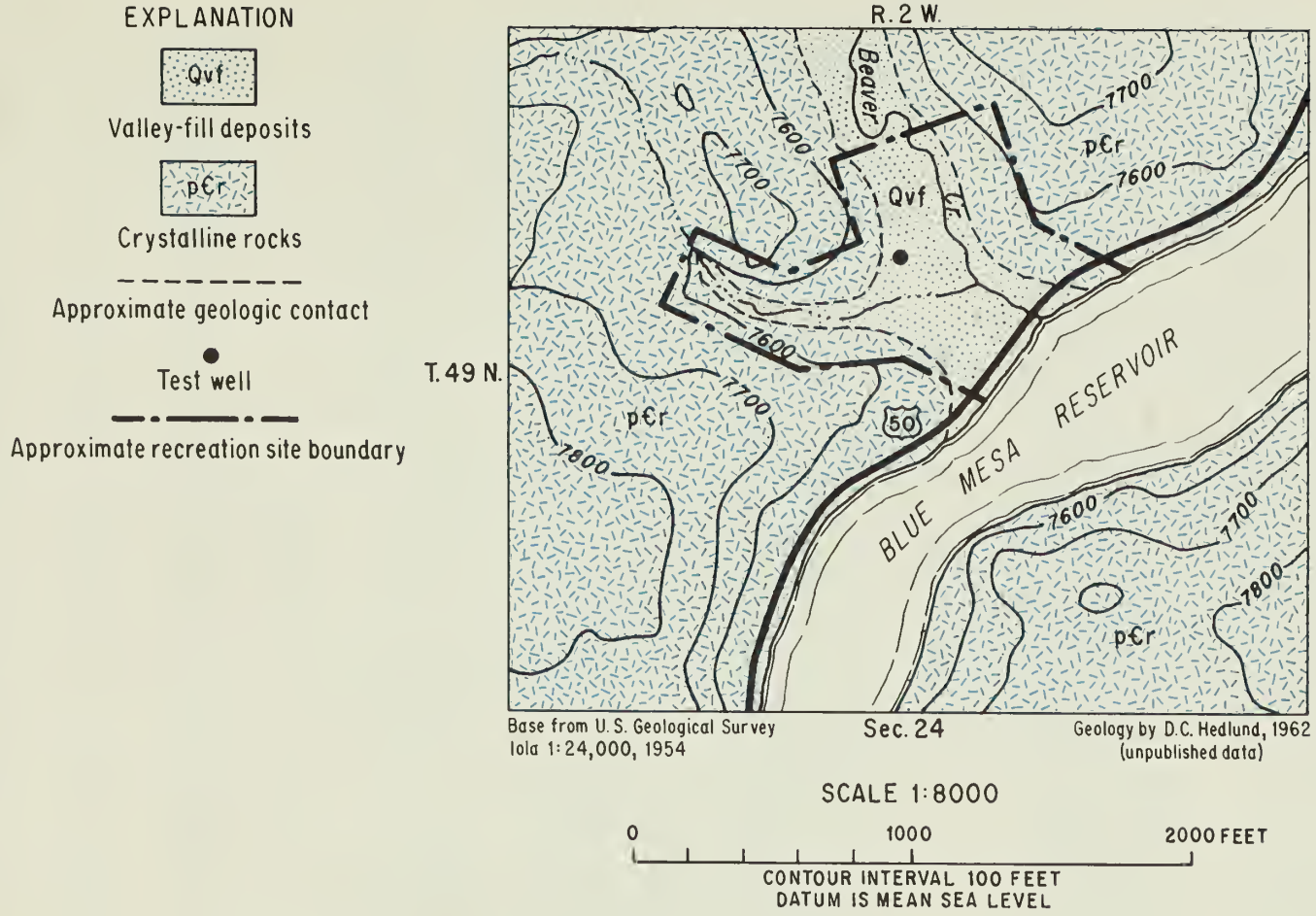

Figure 10. --Geologic map of the Beaver Creek recreation site and adjacent areas.

On the basis of the results of a pumping test, the well could be pumped at about 3 gpm intermittently. If an electric pump is to be used, an automatic shutoff could be installed in the well to prevent lowering the water level beyond 18 feet below the land surface. It is estimated that 3,500 gpd would be available from this well under the resulting pumping pattern.

A sample of the water was analyzed for its chemical content and the results are shown in table 5. The water is a calcium-bicarbonate type and contains no concentrations of constituents that would cause it to be rejected as a source of public drinking water by U.S. Public Health Service (1962) standards.

Cebolla Creek Recreation Site

The Cebolla Creek recreation site is on gently sloping east- and north-facing slopes on the west bank of Cebolla Creek where it enters the reservoir (fig. 11). A water supply will be needed for about 100 campsites, 20 picnic sites, two ranger apartments, and eight comfort stations. At present there is no water supply.

The area is underlain by Precambrian rocks, the Wanakah and the Morrison Formations, volcanic rocks, terrace gravels, and valley-fill deposits (fig. 12). The Wanakah and Morrison Formations crop out along a steep slope and probably are drained as is the terrace gravel. Small springs and seeps discharge from the valley-fill deposits.

No test drilling was performed at this site. However, a test well could be constructed in the valley-fill deposits, and a possible location is shown in figure 12.

SUMMARY

Water-resource observations based upon the investigation made at the Curecanti Recreation area are summarized below:

1. At the Round Corral recreation site a well penetrating the valley-fill deposits probably would yield as much as 20 gpm.

2. At the Lake Fork recreation site a supply of water of about 9,800 gpd can be obtained--about 7,200 gpd from the spring and the remainder can be pumped intermittently from the test well at a rate of about 5 gpm.

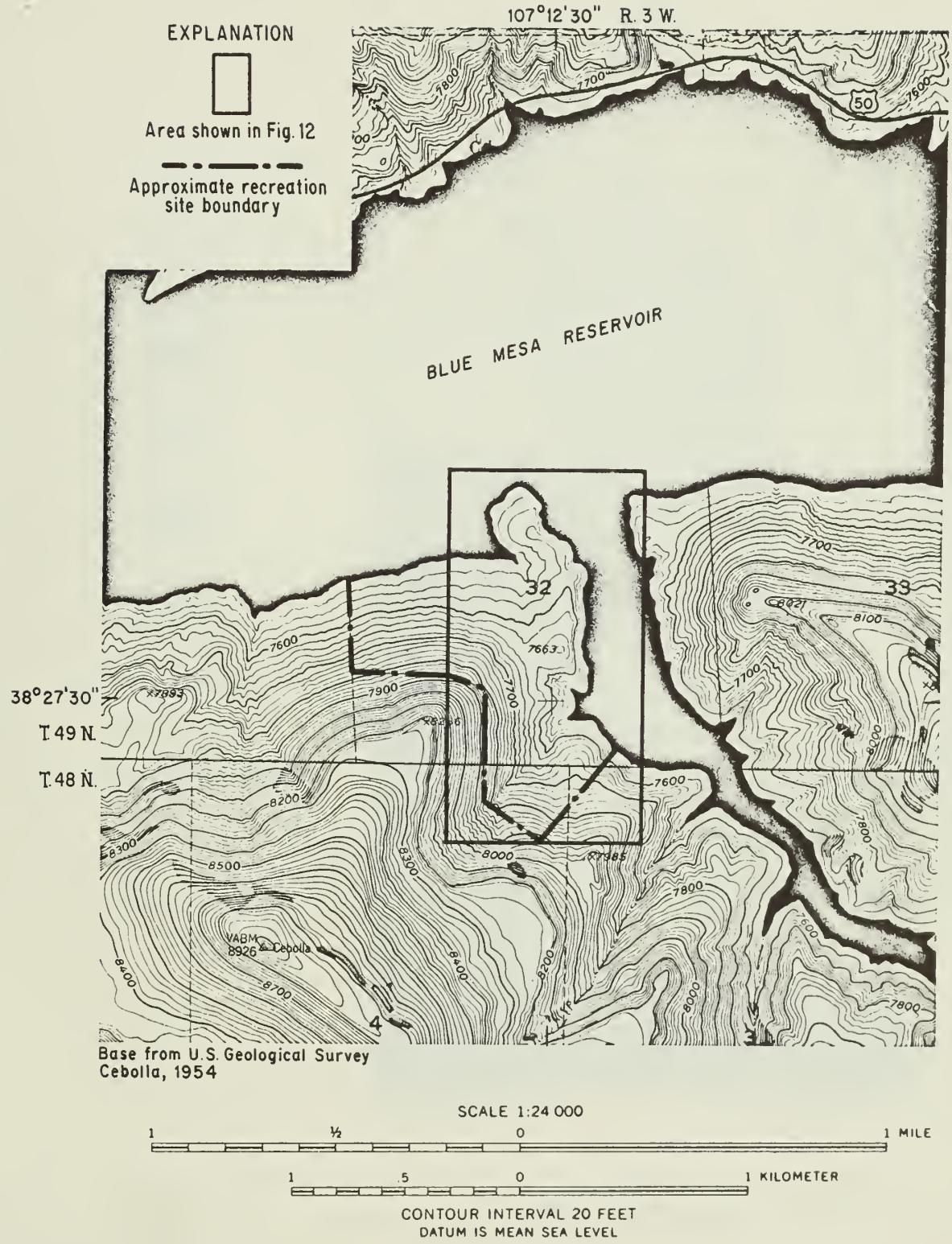

Figure 11. --Location of the Cebolla Creek recreation site.

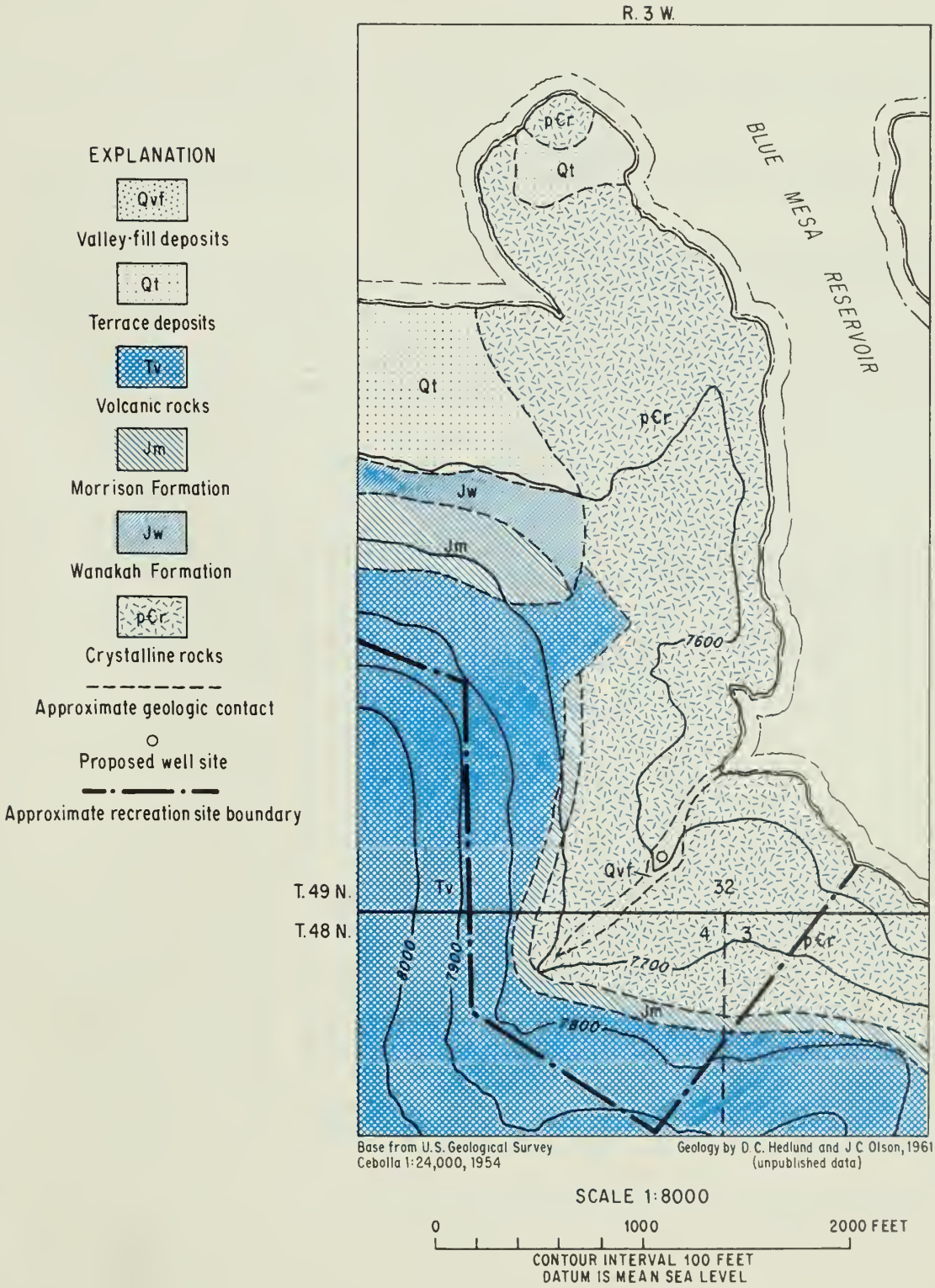

Figure 12. --Geologic map of a part of the Cebolla Creek recreation site and adjacent areas.

3. At the Ponderosa recreation site the test well tapping the valley-fill deposits will probably yield 40 gpm or about 58,000 gpd.

4. At the Coal Creek recreation site water can be obtained by a well that penetrates at least 5 feet of saturated valley-fill deposits.

5. At the Beaver Creek recreation site the test well penetrating the valley-fill deposits is capable of yielding 3,500 gpd if it is intermittently pumped at 3 gpm.

6. At the Cebolla Creek recreation site water could be obtained from a well tapping the valley-fill deposits.

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