Water Availability and Flood Hazards in the John Day Fossil Beds National Monument, Oregon

By F. J. Frank and Eugene A. Oster

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations
Open-File Report 79-1487

Prepared in cooperation with the
NATIONAL PARK SERVICE

1979

UNITED STATES DEPARTMENT OF THE INTERIOR
CECIL D. ANDRUS, Secretary
GEOLOGICAL SURVEY
H. William Menard, Director

For additional information write to:
U.S. Geological Survey
P. O. Box 3202
Portland, Oregon 97208

CONTENTS

ILLUSTRATIONS

TABLES

Conversion factors for inch-pound system and International System Units (SI)

[For use of those readers who may prefer to use metric units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:]

Multiply inch-pound units	By	To obtain metric unit
	Length	
inch (in.)	25.40	millimeter (mm)
foot (ft)	0.3045	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
	Specific combinations	
gallon per minute (gal/min)	0.06309	liter per second (L/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
foot per second (ft/s)	0.3048	meter per second (m/s)
cubic foot per second per square mile [(ft^3/s)/mi^2]	0.01093	cubic meter per second per square kilometer [(m^3/s)/km^2]

Water Availability and Flood Hazards in the John Day Fossil Beds National Monument, Oregon

--

By F. J. Frank and Eugene A. Oster

--

ABSTRACT

The rock formations of the John Day Fossil Beds National Monument area are aquifers that can be expected to yield less than 10 gallons of water per minute to wells. The most permeable of the geologic units is the alluvium that occurs at low elevations along the John Day River and most of the smaller streams. Wells in the alluvial deposits can be expected to yield adequate water supplies for recreational areas; also, wells completed in the underlying bedrock at depths ranging from 50 to 200 feet could yield as much as 10 gallons per minute. Pumping tests on two unused wells indicated yields of 8 gallons per minute and 2 gallons per minute. Nine of the ten springs measured in and near the monument area in late August of 1978 were flowing 0.2 to 30 gallons per minute. Only the Cant Ranch spring and the Johnny Kirk Spring near the Sheep Rock unit had flows exceeding 6 gallons per minute.

Chemical analyses of selected constituents of the ground water indicated generally low concentrations of dissolved minerals.

Although cloudbursts in the Painted Hills unit could generate a flood wave on the valley floors, flood danger can be reduced by locating recreational sites on high ground. The campground in Indian Canyon of the Clarno unit is vulnerable to cloudburst flooding. About 80 percent of the proposed campground on the John Day River in the Sheep Rock unit is above the estimated level of 1-percent chance flood (100-year flood) of the river. The 1-percent chance flood would extend about 120 feet from the riverbank into the upstream end of the campground.

INTRODUCTION

The National Park Service is establishing visitor and camping facilities in the John Day Fossil Beds National Monument in Wheeler and Grant Counties, Oreg. These facilities require water for public supply and fire protection. Three of the proposed campsites are in flood-prone areas.

The purpose of this report is to present geologic and hydrologic information to aid in development of water supplies and to identify potential flood hazards. The objectives of this investigation were to (1) evaluate the availability of ground water at proposed or existing campgrounds and picnic areas, (2) determine the yield and quality of water from local springs, (3) examine the performance of existing wells, and (4) determine the flood hazard at proposed campgrounds.

The work was done in cooperation with the National Park Service. Personnel of the Park Service, under the supervision of B. F. Ladd, park superintendent, were helpful at all times and gave splendid cooperation, which is gratefully acknowledged. Particular thanks are given to Francis Kocis, park ranger.

LOCATION AND GEOGRAPHY

The John Day Fossil Beds National Monument lies between the Cascade Range and the Blue Mountains and consists of three widely separated units in Wheeler and Grant Counties in north-central Oregon. The Sheep Rock unit is 5 mi northwest of the town of Dayville, the Painted Hills unit is about 8 mi northwest of Mitchell, and the Clarno unit is near Clarno and about 12 mi southwest of the town of Fossil (fig. 1).

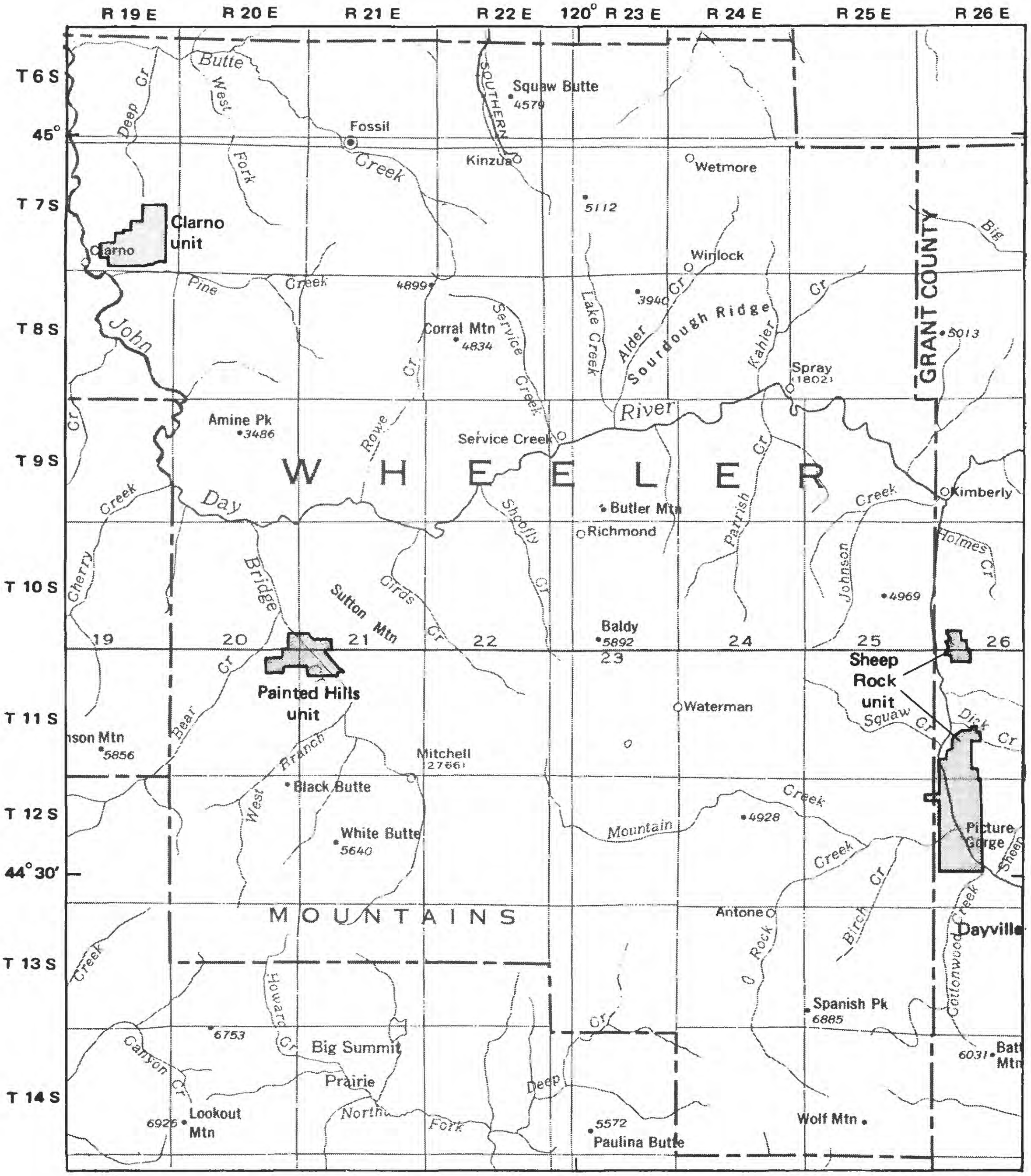
The area is drained by the John Day River and its tributaries. Flow of many of the streams in the basin is flashy; the streams rise suddenly with rain and recede quickly.

The climate is semiarid with an annual precipitation of about 13 in. Most of the hills are sparsely vegetated with bunchgrass and scattered sagebrush and juniper trees.

GEOLOGIC UNITS AND THEIR WATER-BEARING CHARACTERISTICS

The rock formations underlying the John Day Fossil Beds National Monument and the adjacent area are aquifers of low permeability. Wells completed in these formations generally will yield less than 10 gal/min. Recharge is small because much of the precipitation runs off during storms, often resulting in flash floods. The most permeable of the geologic units are the coarse-grained alluvial deposits which can readily absorb and retain precipitation.

Water supplies for domestic and stock uses in the area have been obtained from small springs that flow from permeable lava rocks and landslide deposits, or from shallow wells dug in the Quaternary alluvium along the John Day River and most of the smaller streams.



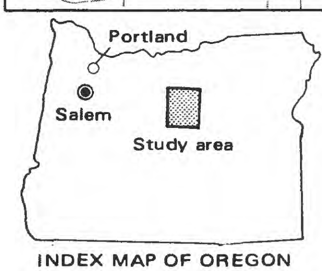


Figure 1.—Locations of Clarno, Painted Hills, and Sheep Rock units of the John Day Fossil Beds National Monument.

In the following paragraphs, geologic units in the project area are briefly described from youngest to oldest. The formally named units are of Tertiary age.

Quaternary Alluvium

The Quaternary alluvium consists of unconsolidated sand and gravel beneath flood plains and low terraces. It also includes alluvial-fan deposits and slope wash. The alluvium underlies the John Day River valley and most of its tributary valleys. Although the alluvium, where present, is probably thin, it is permeable and can accept recharge from precipitation or from infiltration of streamflow. This water percolates through alluvium into fractures and joint openings in the underlying bedrock. Wells drilled through the alluvium into the underlying rocks can be expected to yield more water than wells tapping consolidated rocks not overlain by alluvium. Shallow wells (less than 50 ft in depth) drilled in saturated alluvium or wells drilled through the alluvial deposits and completed in consolidated rocks at a maximum depth of about 200 ft may yield as much as 10 gal/min.

Landslide Deposits

The landslide deposits are made up of unstratified and unsorted mixtures of broken basalt, tuff, and sedimentary rocks. The largest slides have occurred where the Columbia River Basalt Group or welded tuff of the John Day Formation overlies clayey, tuffaceous rocks of the John Day or Clarno Formations. Some of the larger landslides are characterized by small springs that issue from the base of broken slump blocks. The landslide deposits are not likely to yield significant quantities of water to wells.

Rattlesnake Formation

The Rattlesnake Formation is composed of fanglomerate, gravel, sand, and clay. Along the John Day River valley, the formation includes an interbedded rhyolitic tuff member. The formation is not important as an aquifer in the area of the national monument. It underlies a small area in the southwestern part of the Sheep Rock unit and probably is unsaturated.

Columbia River Basalt Group, Undifferentiated

The Columbia River Basalt Group consists of a series of dense basaltic lava flows and water-laid tuff and ash beds. Locally, the formation appears to be nearly horizontal with flat erosion surfaces. It forms the rimrock capping the hills in much of the area.

Some of the lava flows are permeable enough to store precipitation, and they support the flow of many small and a few medium-sized springs. The basalt forms Picture Gorge, but elsewhere in the vicinity of the national monument, the basalt caps the summits of hills high above the valley and generally is unsaturated.

John Day Formation

The John Day Formation consists of thin- to thick-bedded white, buff, and green water-laid tuffaceous siltstone, rhyolitic eolian tuff, welded tuff, some ash-flow tuff, and pebble-tuff conglomerate. The John Day Formation is present in each of the units in the John Day Fossil Beds National Monument. Permeability of the rocks in the formation is low, and it generally can be expected to yield less than 10 gal/min to wells.

Clarno Formation

The Clarno Formation consists of andesitic flows, flow breccia, tuff, ash-flow tuff, siltstone, and conglomerate. The formation will yield only small quantities of water to wells.

Cretaceous Sedimentary Rocks

Sedimentary rocks of Cretaceous age consist of shale, siltstone, and conglomerate. In places, they are overlain by landslide deposits. The Cretaceous sedimentary rocks are present only in the Sheep Rock unit, have low permeability, and will yield only small quantities of water to wells.

WATER SUPPLY

The availability of ground water was evaluated for each of the three units in the national monument. Yields of the springs were measured (table 1), and the springs were sampled for water-quality analysis. Production tests were made on two unused wells. Records of representative wells are reported in table 2.

Designations of wells and springs discussed in this report are based on the official system for rectangular subdivision of public lands. The number indicates the location of each well or spring by township, range, and section, and its position within the section. A graphic illustration of this method of numbering is shown in figure 2. The first part of the number indicates the township; the second, the range; and the third, the section in which the well is located. The letters following the section number locate the well within the section. The first letter denotes the quarter section (160 acres); the second, the quarter-quarter section (40 acres); and the third, the quarter-quarter-quarter section (10 acres). For example, well 10S/21E-31dbc is in SW¼NW¼SE¼ sec. 31, T. 10 S., R. 21 E. Where two or more wells are located in the same 10-acre subdivision, serial numbers are added after the third letter. Springs are numbered in the same manner, except that the letter "s" is added following the final letter. The first spring recorded in SE¼SW¼SE¼ sec. 7, T. 11 S., R. 26 E. would have the number 11S/26E-7dcds. Locations of all wells and springs located in the field are shown in figures 3, 4, and 5.

Table 1.--Discharge measurements of springs

[e, estimated]

Spring No.	Name or location	Date	Discharge (gal/min)	Remarks
7S/19E-13cacs	Unnamed; north of Clarno unit.	6- 7-78	4	
		8-21-78	3	
7S/19E-24abbs	-------do--------	6- 7-78	1e	
		8-21-78	1	
7S/20E-19cccs	-------do--------	6- 7-78	.4	Cove Creek.
		8-21-78	.2	
7S/19E-25bbas	Indian Canyon	5-16-78	Not flowing.	
		8-26-78	do	
8S/19E-3acas	Across road from Clarno unit.	7-11-78	.5e	
		8-21-78	.4	
10S/26E-31ddcs	Inside Foree area	5-15-78	4	
		8-25-78	3	
11S/20E-12bccs	Near Painted Hills	5- 8-78	.5e	Flowing too slowly to measure.
		8-20-78	1.3	Flow increased possibly because of recent rain.
11S/25E-36cccs	Cal Smith	6- 7-78	5	
		8-24-78	5	
11S/26E-7dcds	Johnny Kirk	5-17-78	36	
		8-25-78	30	
12S/25E-12abas	Cant Ranch	5-17-78	20	Has 5,000-gal holding tank.
		8-25-78	17	Holding tank losing some water.

Table 2.--Records of wells

Well number: See page 5 for description of well-numbering system.

Type of well: Dr, drilled; Dg, dug.

Elevation: Elevation of land surface at well, in feet, interpolated from topographic maps.

Specific conductance of water: Field determination, in micromhos per centimeter at 25°C.

Type of pump: S, submergible; J, jet; N, none.

Use: D, domestic; N, none.

Remarks: CA, chemical analysis of water in table 3; P, pumped for the indicated number of hours, when drawdown was measured.

Well number	Owner	Type of well1/	Year com-pleted	Depth of well (feet)	Diameter of well (inches)	Character of material	Eleva-tion (feet)	Water level: Feet below datum	Water level: Date	Specific conduct-ance of water	Type of pump and hp	Well performance: Yield (gal/min)	Well performance: Draw-down (feet)	Use	Remarks
7S/19E-34adc1	Oregon Museum of Science and Industry.	Dr	--	168	6	Andesite	1,514	35.49	6- 7-78	1,000	S, 1.5	--	--	D	Water supply reported to be inadequate for camp.
7S/19E-34adc2	do	Dr	1978	2/918	8	do	1,514	98.75	8-26-78	1,010	--	7	--	D	Yield reported by camp personnel. CA.
10S/21E-31dbc	National Park Service.	Dr	--	42	6	Alluvium	1,950	7.89	5- 8-78	210	N	1.5	10.70	N	P 4 hr, CA.
10S/26E-31cdc	Mrs. O'Rourke	Dr	--	47.5	6	do	2,000	40.69	8-23-78	--	S, 2	8	3.65	N	Do.
11S/26E-6bca	Herb Asher	Dr	1973	60	6	do	2,000	22.22	6- 7-78	525	J, 0.5	--	--	D	
11S/26E-20bcb	R. Monroe	Dg	--	40.55	36	do	2,100	37.80	6- 9-78	--	N	--	--	N	Well was dry 8-26-78.

1/ All wells finished open hole below casing (not perforated or screened).

2/ Casing set to depth of 160 ft.

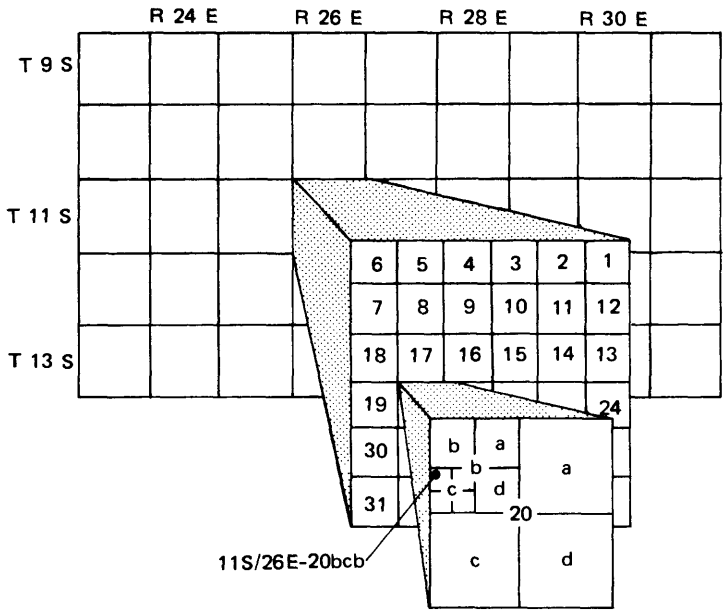


Figure 2.—Well- and spring-numbering system.

Streamflow records have been collected on the John Day River at Picture Gorge since 1926. The minimum recorded flow of the John Day River is 1.0 ft^3/s in August and September of 1930, 1936, and 1966. Statistical analysis of the streamflow record, unadjusted for upstream irrigation diversions, shows the lowest 7-day mean flow for a 2-year recurrence interval to be 14 ft^3/s and the lowest 7-day mean flow for a 10-year recurrence interval to be 2.9 ft^3/s. Water from the river could be used for irrigation and fire protection.

Water from four drilled wells and five springs in the area was analyzed by the Geological Survey and found generally to be low in dissolved constituents (table 3).

Recommended limits of constituents for drinking water have been established by the National Academy of Sciences and National Academy of Engineering (1974) and from preliminary regulations of the U.S. Environmental Protection Agency (1975). Standards are in accordance with the Safe Drinking Water Act, which became effective in June 1977. Some of the standards that apply to samples listed in table 3 include:

Constituent	Recommended limit of concentration (milligrams per liter)	
	NAS, NAE (1974)	EPA (1975)
Iron (Fe)	0.3	--
Manganese (Mn)	.05	--
Sulfate (SO_4)	250	--
Chloride (Cl)	250	--
Fluoride (F)	1/ 1.7	1/ 1.7
Boron (B)	2/ 2	--
Arsenic (As)	.1	.05
Nitrite (NO_2) + nitrate (NO_3), expressed as N	3/ 10	10

1/ Value based on average maximum daily air temperature in vicinity of Mitchell, Oreg.

2/ For tolerant plants; for sensitive plants limit is 0.75. No recommended limit for human consumption.

3/ A separate limit of 1.0 mg/L recommended for nitrite.

The preceding recommended limits are for public supplies; however, to comply with all the requirements of the Safe Drinking Water Act of 1977, additional chemical analyses for toxic chemicals must be made before water from any of the sources listed in table 3 can be presumed to be safe for human consumption.

Excessive iron causes staining of plumbing fixtures and laundry and can give a peculiar taste to the water. Iron and manganese are excessive in some ground water that otherwise is of suitable quality for domestic use.

Sulfate causes permanent (noncarbonate) hardness of water, and excessive concentrations can have a laxative effect on persons not accustomed to the water.

Chloride in excess of 500 mg/L and dissolved solids in excess of 1,000 mg/L give a salty taste to the water.

Fluoride is beneficial up to the recommended limit because it retards dental decay, but concentrations of several milligrams per liter eventually can cause darkening or mottling of children's teeth.

A boron concentration of only a few milligrams per liter has a toxic effect on plants, such as yellowing of leaves.

The constituents for which samples were analyzed were generally within recommended limits for drinking water, with the exception of water from wells 7S/19E-34adc1 and 2, which had sulfate concentrations of 260 and 280 mg/L, respectively. Well 7S/19E-34adc2 had a fluoride concentration of 3.5 mg/L. Other exceptions were the excessive concentration of iron, 0.48 mg/L, in water from well 10S/21E-31dbc, and of manganese, 0.070 mg/L, in water from well 7S/19E-34adc2.

Table 3.--Chemical analyses of water from wells and springs

Location number	Water-bearing unit1/	Depth of well (feet)	Date of col-lection	Milligrams per liter																		Sodium-adsorption-ratio (SAR)	Specific conduct-ance (micromhos/cm at 25°C)	pH	Tempera-ture	
				Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite + nitrate (as N)	Phosphate, ortho as P	Boron (B)	Arsenic (As)	Dissolved solids, calculated from determined con-stituents	Hardness (Ca, Mg)	Noncarbonate hardness				°C	°F
7S/19E-13cacs (naar Clarno unit)	Tjd	--	8-21-78	49	0.02	0.008	17	6.3	16	3.4	110	0	5.2	3.2	0.2	0.81	0.03	0.01	0.002	158	68	0	0.8	--	7.5	16	61
7S/19E-34adc1	Tc	230	8-26-78	12	.01	.01	31	1.8	220	.5	290	0	260	26	1.4	3.2	.01	1.9	.001	712	85	0	10	1,010	7.2	18	64
7S/19E-34adc2	Tc	918	do	2.1	.01	.070	14	.1	170	2.8	66	0	280	28	3.5	.004	.01	1.6	0	535	35	0	12	810	7.2	18	64
10S/21E-31dbc	Qal	42	8-22-78	29	.48	.050	47	15	53	2.2	320	0	33	4.5	.2	.36	.01	.13	.001	344	180	0	1.7	570	6.9	15	59
10S/26E-31cdc	Qal	47.5	8-23-78	35	.01	.003	30	12	140	2.1	390	0	64	27	.7	3.0	.26	.4	.014	518	120	0	5.5	750	7.5	15	59
10S/26E-31ddcs (Foree area)	Qls	--	8-25-78	23	.02	.020	25	9.8	40	1.7	200	0	11	5.5	.2	.11	0	.04	.002	215	100	0	1.7	350	7.2	--	--
11S/25E-36cccs (Cal Smith)	Qls	--	8-24-78	41	.01	.003	20	8.8	13	1.5	130	0	3.0	2.1	.2	.84	.03	.01	.002	158	86	0	.6	235	7.2	15	59
11S/26E-7dcds (Johnny Kirk)	Qls	--	8-25-78	39	.01	.001	22	11	13	1.5	150	0	2.7	2.7	.1	.34	.04	.02	.001	168	100	0	.6	245	7.0	12	54
12S/25E-12abas (Cant Ranch)	Qls	--	do	41	.01	.001	16	8.8	14	1.7	120	0	3.1	2.1	.2	.74	.02	.02	.002	149	76	0	.7	215	7.2	17	63

1/ Qal, alluvium; Qls, landslide deposits; Tc, Clarno Formation; Tjd, John Day Formation.

Excessive hardness is undesirable but is seldom cause for rejection of a water supply. The U.S. Geological Survey uses the following rating for hardness:

Hardness range (mg/L)	Rating
0-60	Soft
61-120	Moderately hard
121-180	Hard
More than 180	Very hard

Using the above rating, most of the samples analyzed were moderately hard.

Sheep Rock Unit

Cant Ranch

Spring 12S/25E-12abas supplies water for the Cant Ranch (table 1); the spring flows about 20 gal/min steadily. It could be utilized more fully by installing additional water-storage facilities. The flow of Cal Smith Spring (11S/25E-36cccs) is about 5 gal/min. The rehabilitation of the spring site by cleaning and improving the spring orifices and by installing necessary diversion pipes to a central concrete structure for the collection of water would probably increase the flow from this spring. The chemical analyses of the water from these springs indicate that the water contains relatively low concentrations of dissolved minerals.

Proposed Campground

A campground has been proposed on the west side of the river in SW¼ sec. 31, T. 11 S., R. 26 E. (pl. 1). This campground could be supplied from the Cant Ranch spring or Cal Smith Spring. If these springs cannot be used, wells could be drilled into the alluvium underlying a terrace about 15 ft above river level along the John Day River at the proposed campground. At its lowest level each year, the water table would probably be in bedrock underlying the alluvium and within 20 ft of the land surface. A well drilled to a depth of 50 to 150 ft at this location may be expected to yield about 10 gal/min.

Turtle Cove Area

Johnny Kirk spring (11S/26E-7dcds, table 1), about 2 mi north of Turtle Cove, flows in excess of 30 gal/min. On the basis of constituents determined (table 3), the water from this spring is of suitable quality for public supplies.

A dug well (11S/26E-20bcb, table 2) near Turtle Cove taps alluvial deposits to a depth of only 40 ft and does not fully penetrate the deposits nor the underlying rocks. On June 9, 1978, the static water level of the well was 37.80 ft; it was dry on August 26, 1978. A well penetrating the alluvium may be expected to yield 3 to 5 gal/min to supply water for a picnic area.

In the Turtle Cove area, the most favorable sites for supply wells would be near the John Day River (pl. 1). A well located there, and having a depth between 100 and 150 ft, may yield 5 to 10 gal/min. The alluvium is probably saturated at depths of 20 to 45 ft, depending on nearness to the river. The thickness of the alluvium at the site is unknown, but it is estimated to be 40 to 50 ft, so that a 100-ft well would extend through the alluvium into the upper, saturated, part of the underlying John Day Formation. The John Day Formation has low permeability, and no significant increase in yield would be expected at depths greater than 150 ft.

Foree Area

Spring 10S/26E-31ddcs (table 1) in the Foree area (pl. 1) flows 3 to 4 gal/min. Rehabilitation of this spring, as of the Cal Smith Spring, would probably increase the flow, so it should provide ample water for the area if storage facilities were added. The concentrations of chemical constituents determined for water from this spring (table 3) are within recommended limits for public supply.

Two wells near the Foree area are 47 and 60 ft deep and reportedly yield ample supplies for domestic uses (see wells 11S/26E-6bca and 10S/26E-31cdc, table 2). Well 10S/26E-31cdc, which is 6 in. in diameter and 47 ft deep, was pump tested for yield. At the start of the test, static water level was 40.69 ft below the surface, and the pump was set at a depth of 45 ft. Following are the recorded measurements:

Step	Time since pumping began (min)	Rate (gal/min)	Drawdown (feet)	Remarks
1	15	3	0.94	
	60	3	.94	
	120	3	1.00	
2	120	5		Increased pumping rate.
	130	5	1.80	
	175	5	1.85	
	225	5	1.90	
3	226	7.5		Increased pumping rate.
	229	7.5		Pump breaking suction; shut off pump. Lowered pump to 47-foot depth.
	0			Started pump.
4	2	8	1.97	
	60	8	3.67	
	75	8	3.65	
5	80	10		Increased pumping rate.
	82	10	6.50	Pump breaking suction.
	85			Shut off pump.

The test indicates that the well could produce between 6 and 7 gal/min with a pump setting at 45 ft, or about 8 gal/min with a pump setting at 47 ft. The test also indicates that the yield of a well in this part of the area should increase with greater penetration of the saturated zone. The dissolved-mineral content (table 3) of the water from this well is higher than that of water from most springs, but it is not excessive.

Ground-water conditions and the thickness of the alluvium in the Foree area can be expected to be about the same as those described in the Turtle Cove area. If wells are needed for a water supply in the Foree area, they should be drilled in the low ground near the river (see pl. 1). Wells drilled to depths of 100 to 150 ft (based on the pumping test at Foree) should yield about 10 gal/min.

Painted Hills Unit

In the Painted Hills unit, one spring (11S/20E-12bccs, table 1) was measured. The volume of water produced by this spring will at times be less than 0.5 gal/min. Water from the spring contained a large amount of white sediment, which was not analyzed.

A pump test was made on well 10S/21E-31dbc, which was drilled in the alluvium near Bridge Creek. The well is 6 in. in diameter and 42 ft in depth. The static water level before the test was 9.65 ft, and the pump was set at a depth of 38 ft. A summary of the measurements recorded during the test is presented below:

Step	Time since pumping began (min)	Rate (gal/min)	Drawdown (feet)	Remarks
1	40	2	13.65	Water muddy.
2	42	4	13.65	Increased pumping rate.
	45	4	20.83	Water clearing up.
	60	4	28.35	Pump broke suction.
3	65	1.5	28.35	Decreased pumping rate.
	111	1.5	24.69	
	240	1.5	20.35	
	240	2	20.35	Increased pumping rate.
4	315	2	23.80	
	320	2	24.30	
5	320	4	24.30	Increased pumping rate.
6	325	4	28.35	Pump broke suction. Decreased pumping rate.

Test results indicate that the well can be safely pumped at 1.5 gal/min. The well would be adequate for a picnic facility, provided it was equipped with a hand pump or adequate storage facilities.

Sites 1 and 2 in the Painted Hills unit (pl. 1) are suggested for test drilling for water supplies.

At both site 1 and site 2 at the Painted Hills unit, ground water is recharged periodically by precipitation and also by infiltration from the nearby intermittent stream. The geologic structure at sites 1 and 2 is favorable, because both sites are near the axis of a major northwest-trending, gently plunging syncline, a structural downwarp in which formation bedding slopes toward the axis of the fold from both sides.

Site 1 at the proposed Park Service campsite is in the SE¼ of sec. 36, T. 10 S., R. 21 E., near an intermittent stream. A 200- to 300-foot well at this site should penetrate rocks of the John Day Formation, which is estimated to exceed a thickness of 300 ft in the area. Openings in the formation are expected to be saturated below a depth of 25 to 50 ft, depending on the well-site elevation. The formation has low permeability, and ground water is expected to come from relatively permeable beds and from small fracture and joint openings that may be present in the formation. The number and size of the fractures and joints and of water-bearing beds was not determined because the formation here is poorly exposed. No significant increase in ground water should be expected at depths greater than 300 ft. The formation would be expected to yield less than 10 gal/min to a well of 300-foot depth.

Site 2 is 1.5 mi south of site 1 in the NE¼ of sec. 11, T. 11 S., R. 20 E. The geologic conditions at site 2 are similar to those described above for site 1, except that the top of the zone of saturation may be at greater depth. At site 2, 8 to 10 ft of unsaturated coarse-grained alluvial deposits overlie the John Day Formation.

Clarno Unit

Three springs (table 1), several miles northeast of the Clarno unit, yield from a fraction of a gallon to several gallons per minute. Another spring near the unit (8S/19E-3acas) has a yield of only about half a gallon per minute. On the basis of the constituents determined, the water from these springs is low in mineral content. Springs in Indian Canyon (7S/19E-25bbas) cease to flow during much of the year.

At Camp Hancock, an existing well (7S/19E-34adc1) was reported to be 230 ft deep, but it has caved below a depth of 168 ft. This well is reported to be inadequate for camp needs, and a new well, tapping andesite of the Clarno Formation, was drilled during June 1978. That well (7S/19E-34adc2) was drilled to a depth of 918 ft and has a reported yield of about 7 gal/min. The water from this well is slightly above the recommended limit for sulfate and contains about twice the maximum fluoride recommended (table 3).

Future wells in the area probably would be the most successful if drilled in the alluvial material at low elevation near the John Day River or Pine Creek, where the probability for recharge from streamflow infiltration is good. Desirable depths would range between 200 and 250 ft and may extend through the alluvium into the underlying bedrock.

Proposed sites for drilling are shown on plate 1. Site 1 is at the foot of Indian Canyon, where the surface is alluvium and coarse rock rubble. Site 2 is in a narrow valley between bedrock ridges near the southwest corner of sec. 34, T. 7 S., R. 19 E. The valley is filled with alluvium to an undetermined depth, and the surface slopes toward Pine Creek and the John Day River.

At both sites, ground water probably is recharged by precipitation and by infiltration of streamflow from Pine Creek and the John Day River. In both locations, fracture and joint openings in the consolidated rocks may be recharged by the downward movement of ground water from the overlying alluvium.

FLOOD HAZARDS

Sheep Rock Unit

Streamflow records have been collected since 1926 on the John Day River at Picture Gorge (sec. 17, T. 12 S., R. 26 E.), 3 mi upstream from the proposed campground (pl. 1). Flood-frequency analysis of the streamflow records by the log-Pearson type III method indicates the 1-percent chance flood (100-year flood) discharge to be 9,700 ft^3/s. The 1-percent chance flood is a flood magnitude that has one chance in 100 of being exceeded in any one year. The occurrence of floods is assumed to be random in time; no schedule or regularity of occurrence is implied. The exceedance of a 1-percent chance flood is no guarantee, therefore, that a similar or greater size flood will not occur next week or next year. Floods on the river are most likely from December to early June as a result of snowmelt. The most severe floods are the result of snowmelt accompanied by heavy rain.

Three cross sections of the river were surveyed in the proposed campground--one near the downstream end, one near the middle, and one near the upstream end of the campground (fig. 3). Flood elevations at these cross sections were determined from slope-conveyance computations. Figure 4 shows a view of the proposed campground area from the south end.

At the upstream cross section (no. 3, fig. 5), the 1-percent chance flood extends about 120 ft into the campground area from the riverbank. At the middle and downstream cross sections, the 1-percent chance flood is confined to the channel. Figure 5 shows the flood level at the cross sections.

During the summer months, local cloudburst storms can occur in the surrounding hills. The draw west of the campground drains an area of about 1 mi^2. An intense storm concentrated in this draw could generate a flood wave several feet high. The highway cuts through an alluvial fan from this draw. The cut is 5 to 6 ft deep at the south end and several hundred feet long, extending from near the south end of the campground to near the driveway to McGraw's trailer. Water coming down the draw would be deflected to the south and north by the highway cut. The water deflected to the south would flow into the river at the gate at the south end of the campground area. The water deflected to the north could flow to the river through the campground area north of the highway cut, across from McGraw's experimental garden.

Painted Hills Unit

During summer, the Painted Hills unit is also subject to cloudburst storms characterized by intense rainfall of short duration. The most severe storm known to the Bridge Creek area occurred July 13, 1956, and was concentrated north of Mitchell (U.S. Geological Survey, 1964, p. 54-56). The

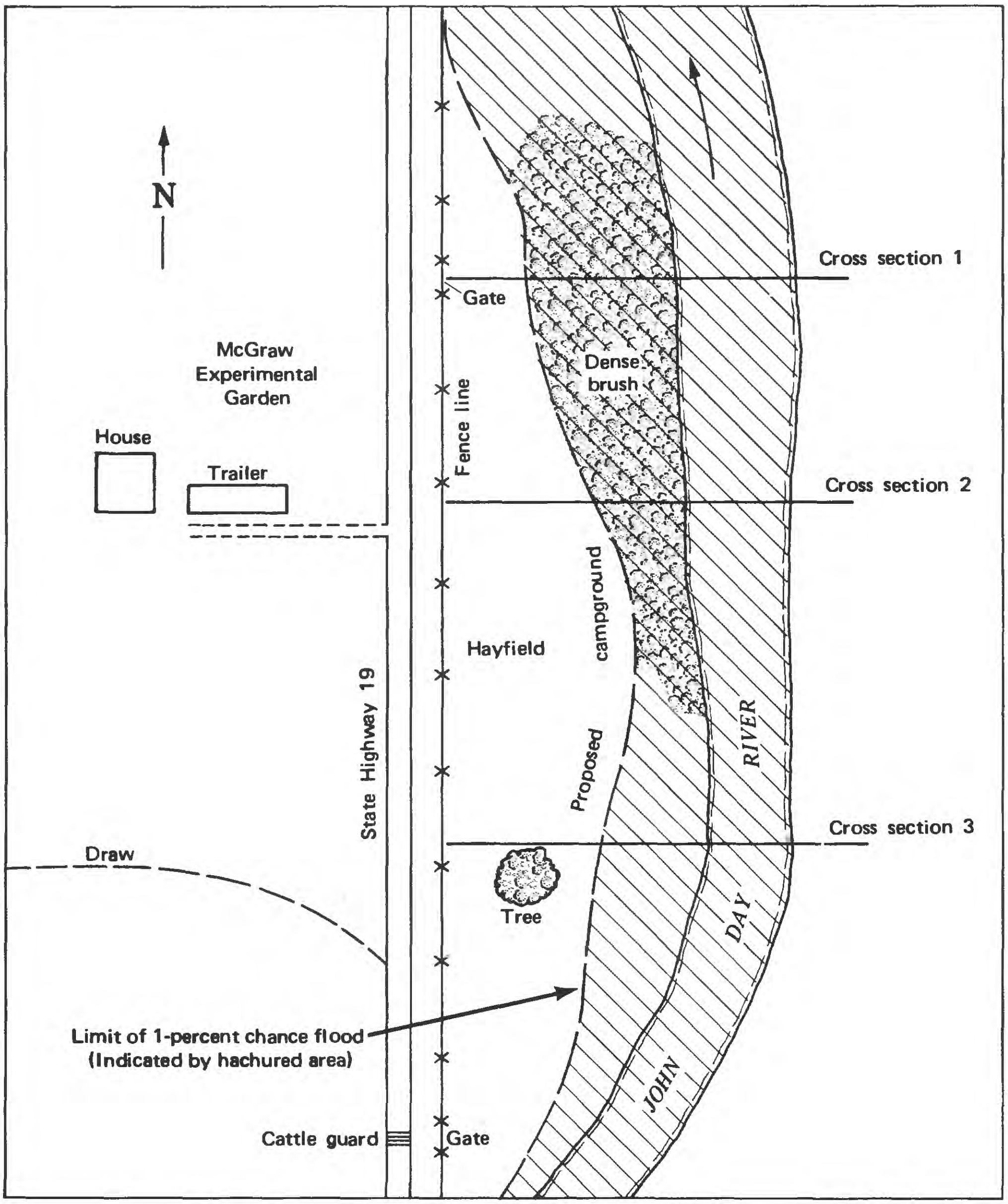


Figure 3.—Sketch map of proposed Sheep Rock unit campground. (Not to scale.)

Figure 4.--Proposed Sheep Rock unit campground area, looking northward.

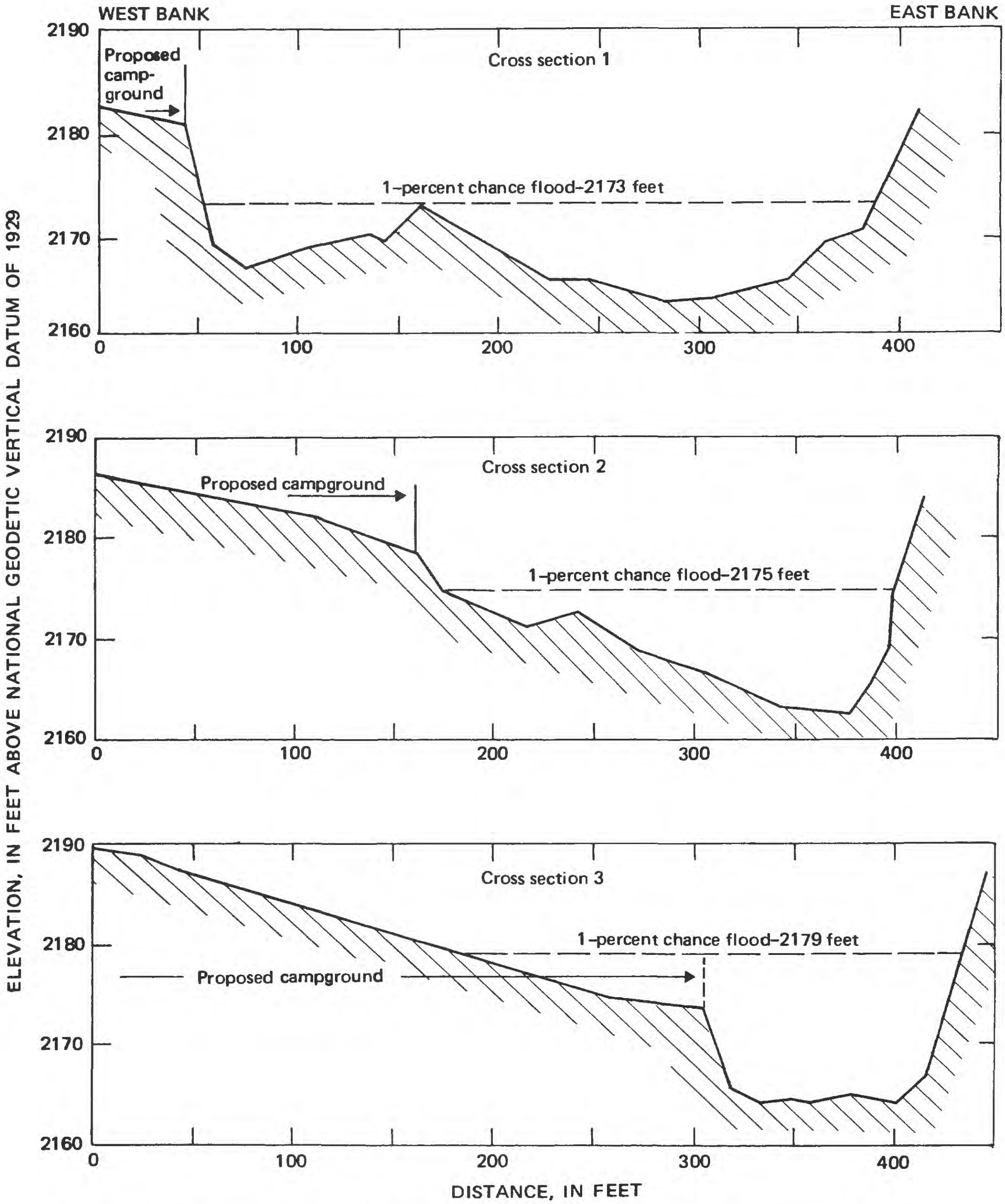


Figure 5.—Cross sections at proposed Sheep Rock unit campground area.

peak discharge of this flood was determined to be 14,400 ft^3/s at a site 2 mi northwest of Mitchell and 16,300 ft^3/s at a site 1.5 mi above the mouth of Bridge Creek (see fig. 6). No data are available on which to estimate the percent chance occurrence for these floods, although severe storms are known to have hit Mitchell in 1904 and 1884. The 1956 storm also produced a peak height of about 32 ft above the streambed in Meyers Canyon, which is tributary to Bridge Creek.

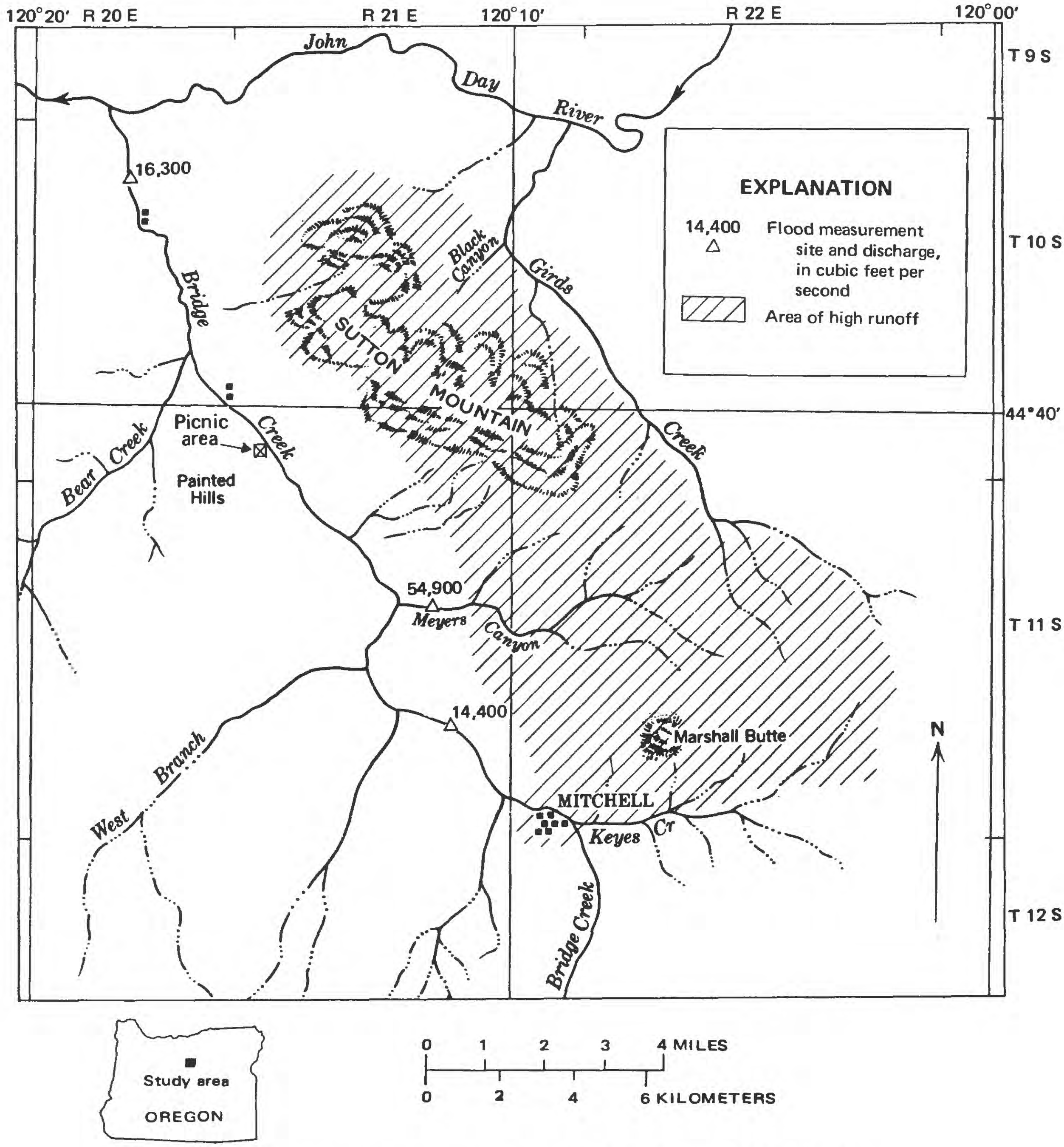


Figure 6.—Flood-measurement sites and discharges, July 13, 1956, in Bridge Creek area, near Mitchell.

Intense, short-duration flood peaks attenuate or flatten out rapidly as they move downstream. For example, the State Police estimated that the cloudburst flood of 1956 reached a height of 25 to 30 ft in Mitchell, where the water is confined in a narrow canyon. Two miles west of Mitchell, where the valley is 300 ft wide and the channel is shallow, the flood reached a height about 7 ft above the streambed. The combined 1956 flood peak of Bridge Creek and Meyers Canyon probably attenuated further by the time it reached the proposed picnic area 3½ mi downstream from Meyers Canyon.

A cross section was surveyed through the proposed picnic area in sec. 31, T. 10 S., R. 21 E. (figs. 7, 9). Slope-conveyance computations show that a discharge of 16,000 ft^3/s (which was possibly equaled or exceeded in 1956) would reach an elevation of 1,946.5 ft, about 2 ft above ground level in the picnic area. At this elevation, the water would spread westward from the channel about 300 ft and eastward from the channel about 500 ft. The bankfull capacity of the channel was computed to be 4,100 ft^3/s. The storm of July 3, 1978, which washed gravel across the county road in many places, brought the stream level to about bankfull at the picnic area. Figure 8 shows a view of the area looking west, and figure 9 is a sketch map of the picnic area.

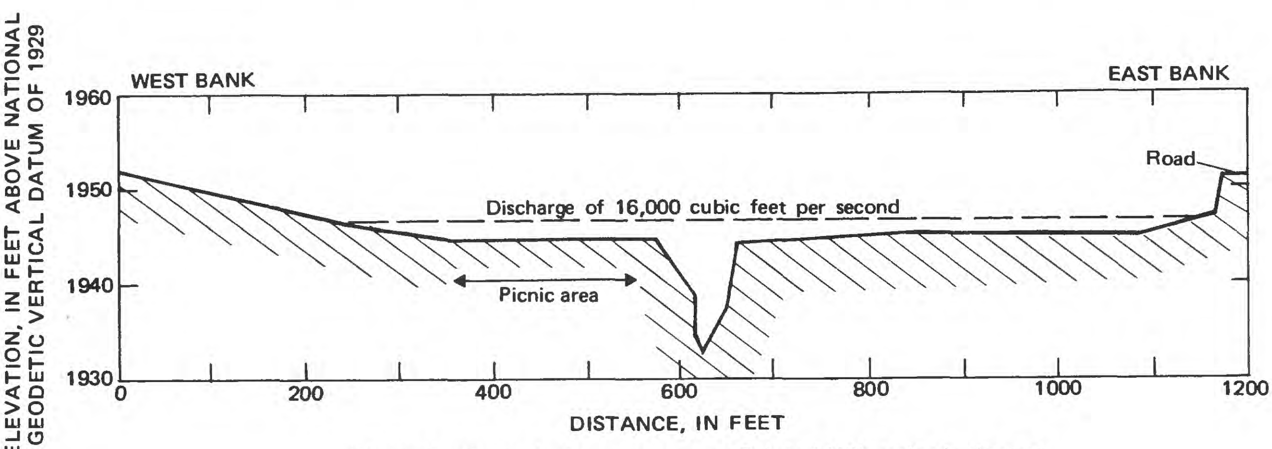


Figure 7.—Cross section at proposed Painted Hills unit picnic area.

In the vicinity of the road intersection near the center of sec. 36, T. 10 S., R. 20 E., the valley is 700 to 800 ft wide, and the stream channels are quite shallow, only 2 to 3 ft deep. This draw drains an area of about 7 mi^2. An intense storm centered on this drainage could generate a flood wave several feet above the valley floor, with velocities sufficient to wash away automobiles and trailers (U.S. Geological Survey, 1964, p. 56). However, flood danger would be eliminated if any permanent recreation sites were located on higher ground at least 5 ft above the valley floor.

Figure 8.--Painted Hills unit picnic area on Bridge Creek, looking west.

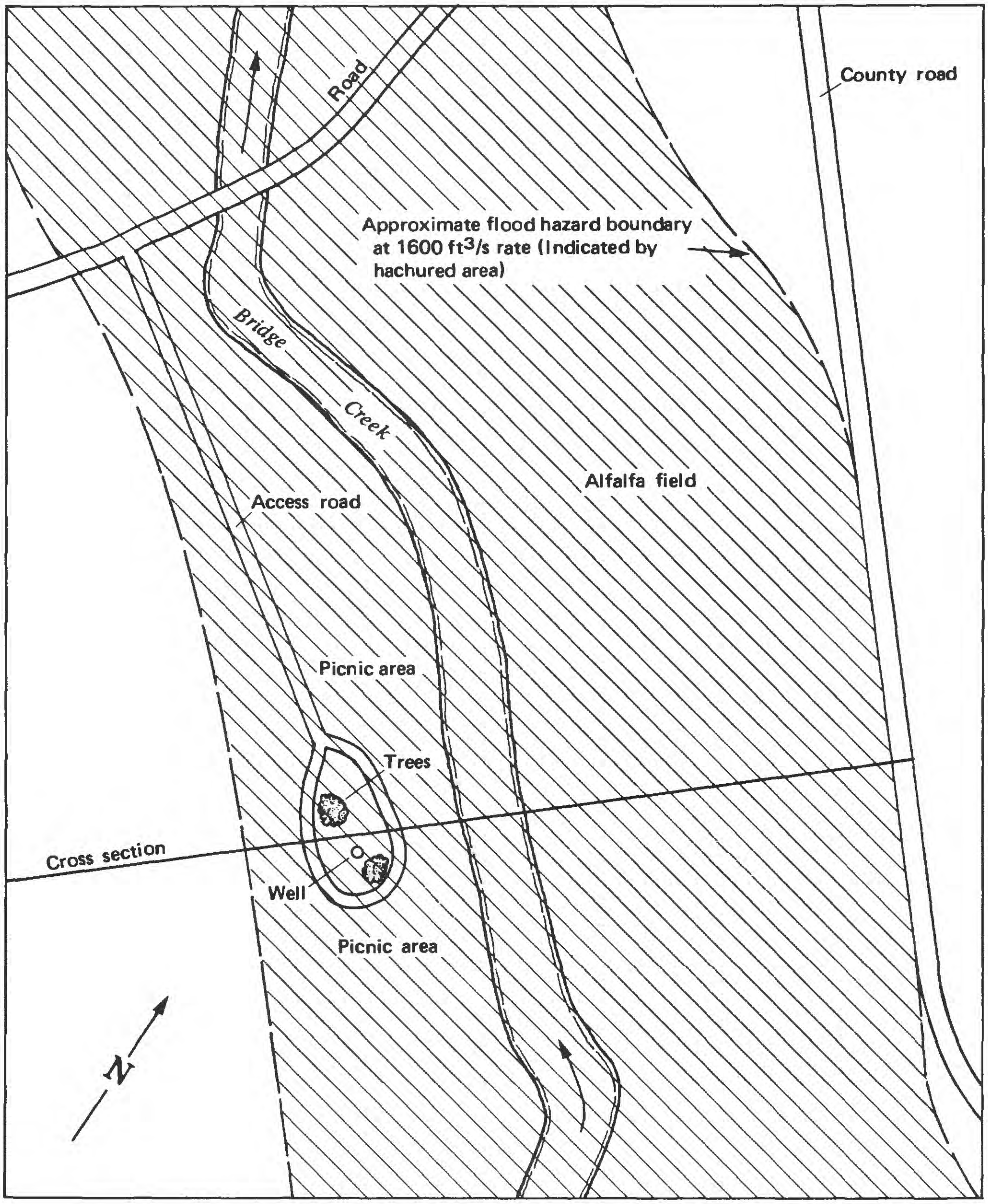


Figure 9.–Sketch map of Painted Hills unit picnic area. (Not to scale.)

Clarno Unit

The campground in Indian Canyon is located in the mouth of a draw that drains an area of approximately 3 mi^2. Experience at other sites in central and eastern Oregon shows that cloudburst storms can yield peak discharges ranging from a few hundred to several thousand cubic feet per second per square mile from small drainage areas. The most severe storm recorded in eastern Oregon had a peak yield of 5,650 $(ft^3/s)/mi^2$ from 5 mi^2 in Umatilla County. The Meyers Canyon flood of July 13, 1956, near Mitchell, Oreg., yielded 4,290 $(ft^3/s)/mi^2$ from 12.7 mi^2 (fig. 6). Although such storms occur infrequently, they are most likely in spring and summer. It was not possible to determine the percent chance of occurrence for such a storm.

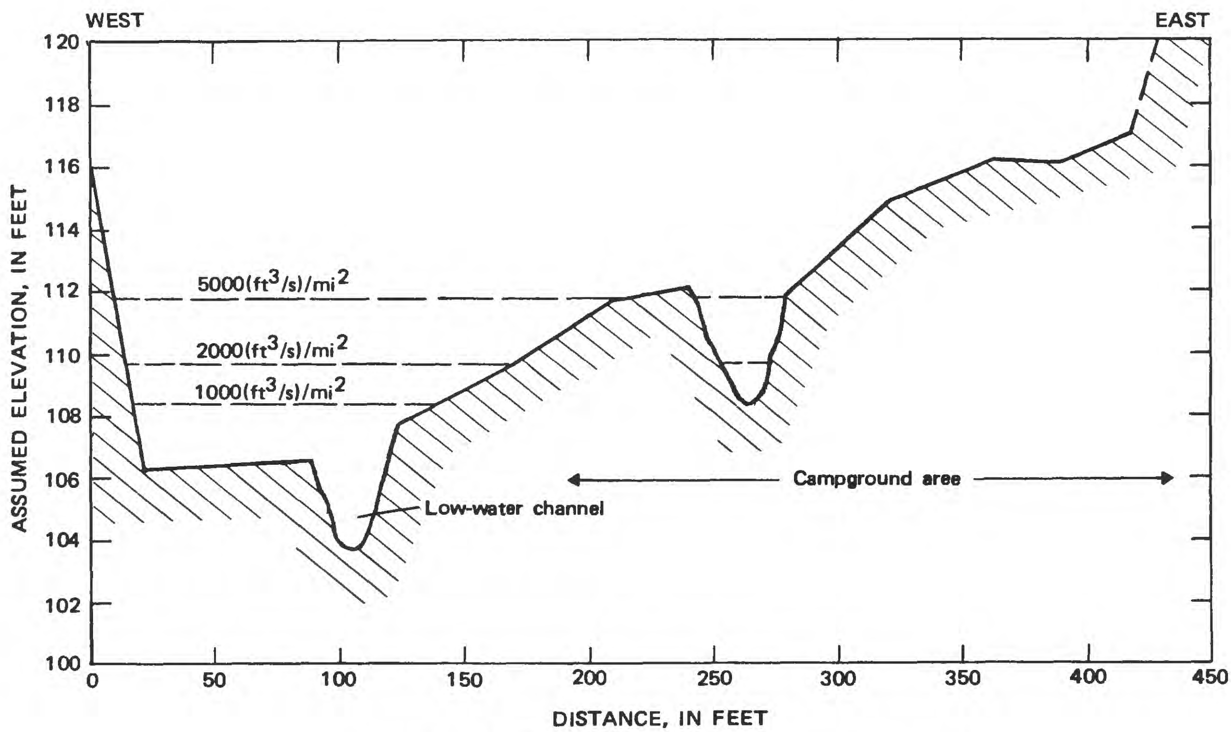


Figure 10.—Cross section at Indian Canyon campground.

A cross section was surveyed near the north fence line of Indian Canyon campground (figs. 10, 11), and the north-south (downstream) slope of the draw was determined. Slope-conveyance computations were made to determine the area subject to flooding at three rates of runoff--1,000, 2,000, and 5,000 $(ft^3/s)/mi^2$ (fig. 10). The east bank of the draw has the broadest area subject to flooding. Because of the steep slope of the draw, flood velocities would be high. A mean velocity of 17 ft/s was computed for the 5,000 $(ft^3/s)/mi^2$ discharge. Construction of camp facilities and an access road on the higher ground near the east side of the draw would alleviate the flood hazard. Figure 12 is a photograph showing the Indian Canyon campground.

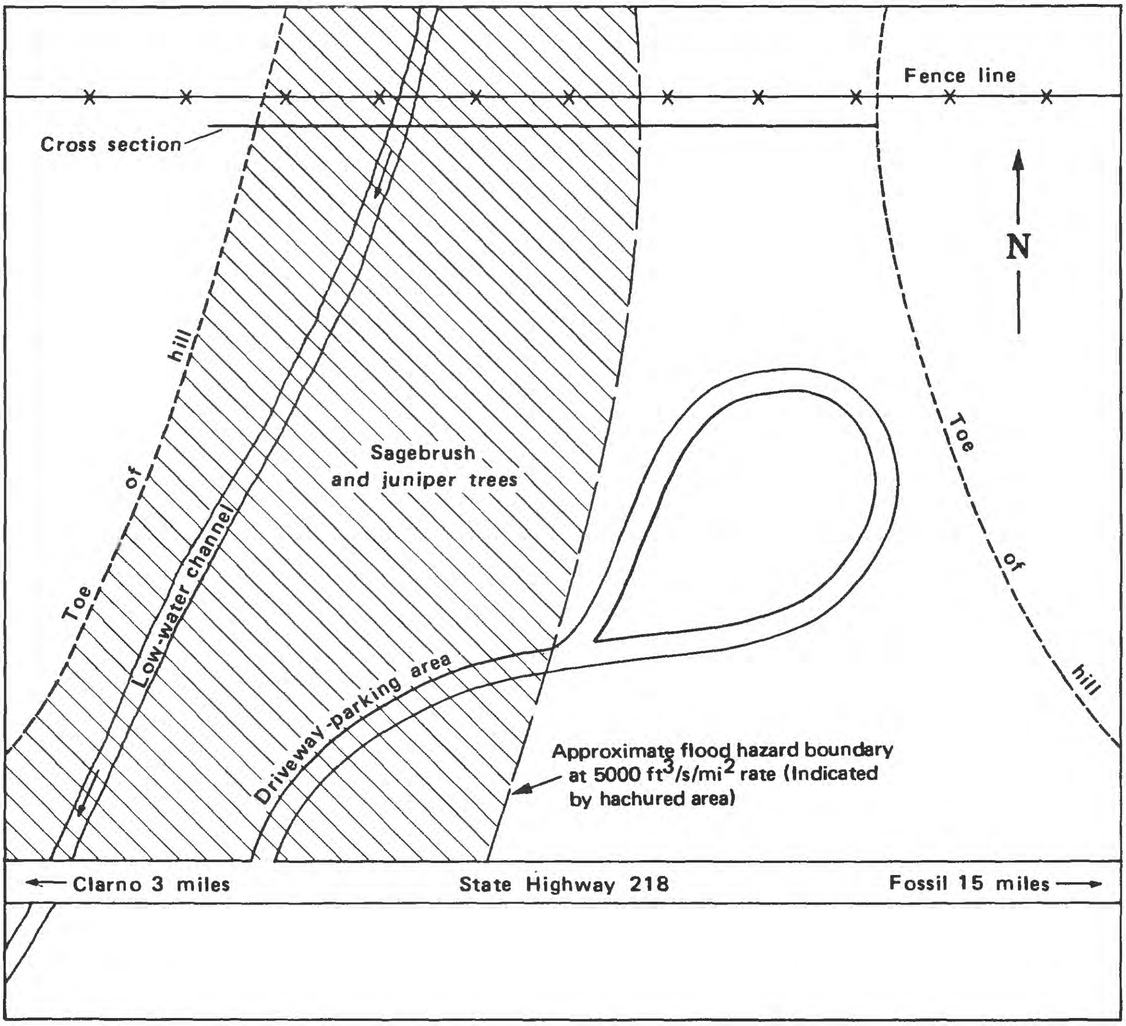


Figure 11.--Sketch map of Indian Canyon campground. (Not to scale.)

Figure 12.--Indian Canyon campground area.

REFERENCES

Brown, C. E., and Thayer, T. P., 1966, Geologic map of the Canyon City quadrangle, northeastern Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-447.

National Academy of Sciences, National Academy of Engineering, 1974, Water quality criteria, 1972: Washington, D.C., U.S. Government Printing Office, 594 p.

Robinson, P. T., 1975 [1976], Reconnaissance geologic map of the John Day Formation in the southwestern part of the Blue Mountains and adjacent areas, north-central Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-872.

Swanson, D. A., 1966, Reconnaissance geologic map of the east half of the Bend quadrangle, Crook, Wheeler, Jefferson, Wasco, and Deschutes Counties, Oregon: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-568.

U.S. Environmental Protection Agency, 1975, National interim primary drinking water regulations: Federal Register, v. 40, no. 248, Wednesday, December 24, 1975, part IV, Washington, D.C., p. 59566-59587.

U.S. Geological Survey, 1964, Summary of floods in the United States during 1956: U.S. Geological Survey Water-Supply Paper 1530, 85 p.

White, W. H., 1964, Geology of the Picture Gorge quadrangle, Oregon: Corvallis, Oregon State University published Master's thesis, 167 p.