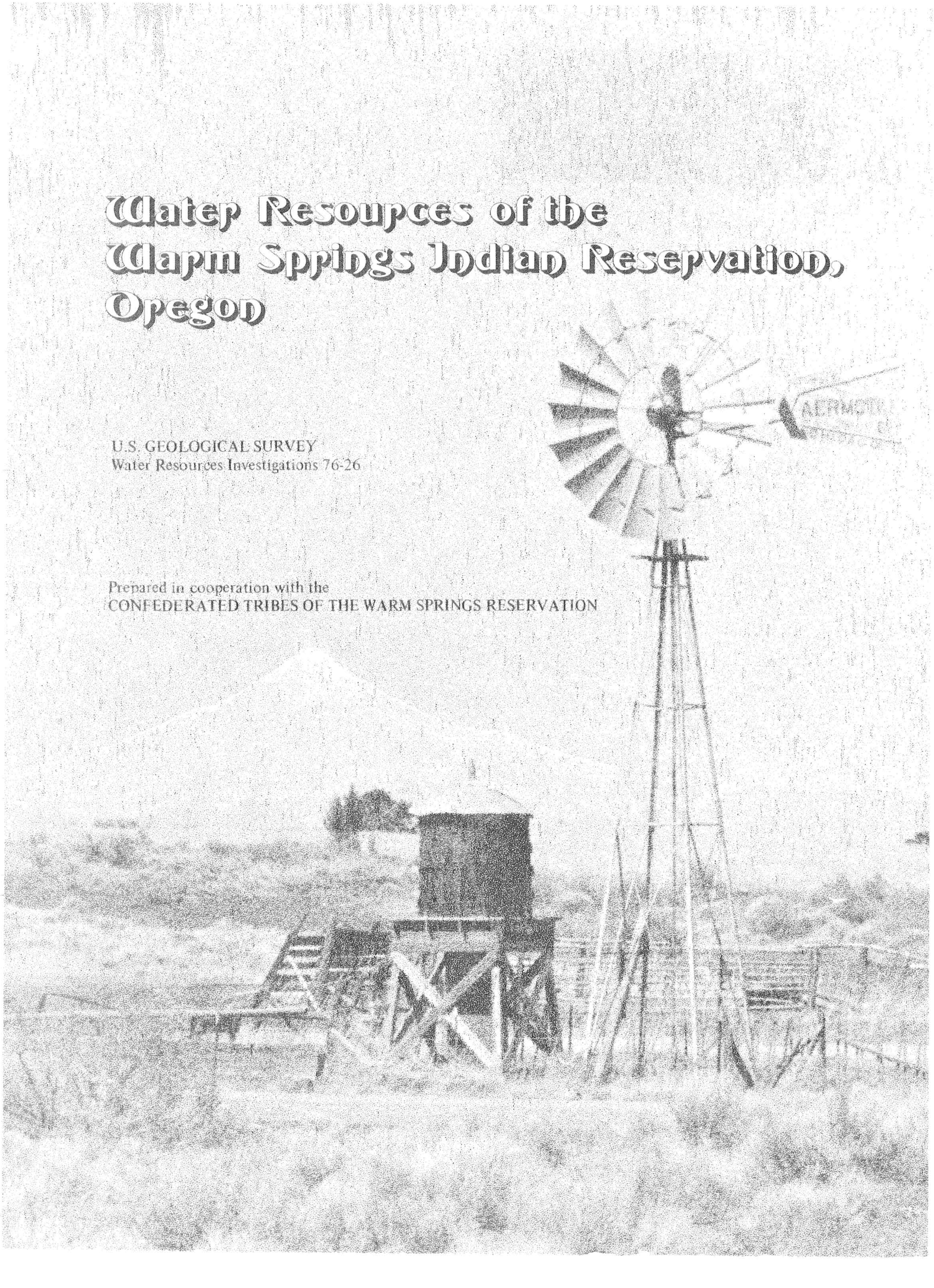
Water Resources of the Warm Springs Indian Reservation, Oregon

U.S. GEOLOGICAL SURVEY
Water Resources Investigations 76-26

Prepared in cooperation with the
CONFEDERATED TRIBES OF THE WARM SPRINGS RESERVATION



WATER RESOURCES OF THE WARM SPRINGS INDIAN RESERVATION, OREGON

By J. H. Robison and Antonius Laenen

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1976

UNITED STATES DEPARTMENT OF THE INTERIOR
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FACTORS FOR CONVERTING ENGLISH UNITS TO INTERNATIONAL SYSTEM UNITS (SI)

The following factors may be used to convert the English units in this report to the International System of Units (SI). The factors are shown to four significant figures; however, in the text the metric equivalents are shown only to the number of significant figures consistent with the values for English units.

English	Multiply by	Metric
acres	0.004047	km^2 (square kilometres)
acre-ft (acre-feet)	.001233	hm^3 (cubic hectometres)
°F (degrees Fahrenheit)	5/9, after subtracting 32	°C (degrees Celsius)
ft (feet)	.3048	m (metres)
ft^2/day (feet squared per day)	.0929	m^2/day (metres squared per day)
ft^3/s (cubic feet per second)	.02832	m^3/s (cubic metres per second)
$(ft^3/s)/mi^2$ (cubic feet per second per square mile)	.01093	$(m^3/s)/km^2$ (cubic metres per second per square kilometre)
gal (gallons)	3.785	l (litres)
gal/min (gallons per minute)	.06309	l/s (litres per second)
in (inches)	25.4	mm (millimetres)
mi (miles)	1.609	km (kilometres)
mi^2 (square miles)	2.590	km^2 (square kilometres)
tons (short)	.9072	t (tonnes, or 1,000 kilograms)

Lake Simtustus

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ABSTRACT

Water-resources data for the 1,000-square-mile (2,600-square-kilometre) Warm Springs Indian Reservation in north-central Oregon were obtained and evaluated. The area is bounded on the west by the crest of the Cascade Range and on the south and east by the Metolius and Deschutes Rivers. The mountainous western part is underlain by young volcanic rocks, and the plateaus and valleys of the eastern part are underlain by basalt, tuff, sand, and gravel of Tertiary and Quaternary ages.

There are numerous springs, some developed for stock use, and about 50 domestic and community wells; yields are small, ranging from less than 1 to as much as 25 gallons per minute (0.06 to 1.6 litres per second). Chemical quality of most ground water is suitable for stock or human consumption and for irrigation.

Average flows of the Warm Springs River, Metolius River, and Deschutes River are 440, 1,400, and 4,040 cubic feet per second (12.5, 40, and 114 cubic metres per second), respectively. Shitike Creek, which has an average flow of 108 cubic feet per second (3.06 cubic metres per second) had a peak of 4,000 cubic feet per second (110 cubic metres per second) in January 1974.

Chemical quality of the streams is good; most streams have fewer than 100 milligrams per litre of dissolved solids. Chemical and biological quality of the mountain lakes is also good; of 10 lakes studied, all had fewer than 50 milligrams per litre of dissolved solids and none had measurable fecal coliform bacteria.

INTRODUCTION

The Warm Springs Indian Reservation includes about 1,000 mi^2 (2,600 km^2), lying mostly in Jefferson and Wasco Counties of north-central Oregon (fig. 1).

The reservation was established by a treaty of 1855 with the Tribes of Middle Oregon which are now referred to as the Warm Springs and Wasco Tribes. Tabulations of the Bureau of the Census show that in 1970 the reservation population was 1,324 in Jefferson County and 251 in Wasco County, or a total of 1,575. More than half the reservation is timberland, and timber is a major source of income. Grazing of horses and cattle is a substantial activity, and cultivation of crops only a minor one. Recreation and tourism are rapidly increasing, attracted from outside the reservation by swimming, convention, and other facilities at the Kahneeta Hot Springs area.

The present study is an inventory and appraisal of the water resources of the reservation, including determination of flow in major streams, yield of water to wells and springs, and quality of water. This study was conducted in cooperation with the Confederated Tribes of the Warm Springs Reservation. The cooperation and assistance of many officials of the Confederated Tribes, of the Bureau of Indian Affairs, and of the Indian Health Service helped greatly. Well-drilling and test-pumping data and other information generously furnished by Satish Puri, Tribal Engineer, were especially helpful.

Selected technical terms used in this report are defined in a glossary on page 46.

For use of readers who may prefer to use metric units rather than English units, the conversion factors for terms used in this report are listed at the front of the report.

GEOGRAPHY

The western boundary of the reservation lies generally near the crest of the Cascade Range. The Metolius and Deschutes Rivers form the southern and eastern boundaries. The northern boundary trends slightly north of west, beginning near lat 45° N.

Altitude varies substantially, from 10,497 ft (3,199 m) on the top of Mount Jefferson, to about 1,000 ft (300 m) where the Deschutes River leaves the northeast corner of the reservation. The summit of the Cascade Range generally ranges from 4,000 to 6,000 ft (1,200 to 1,800 m) in altitude. The Cascade Range slopes eastward for 10 to 12 mi (16 to 19 km), where it abuts plateau uplands whose western edges lie at 2,600 to 3,600 ft (800 to 1,100 m), and then slopes eastward to about 2,400 ft (730 m).

In the northeastern part of the area the Mutton Mountains rise to 4,000 ft (1,340 m). Plateaus in the southeast have been deeply dissected or removed entirely by the streams that drain eastward into the Deschutes River.

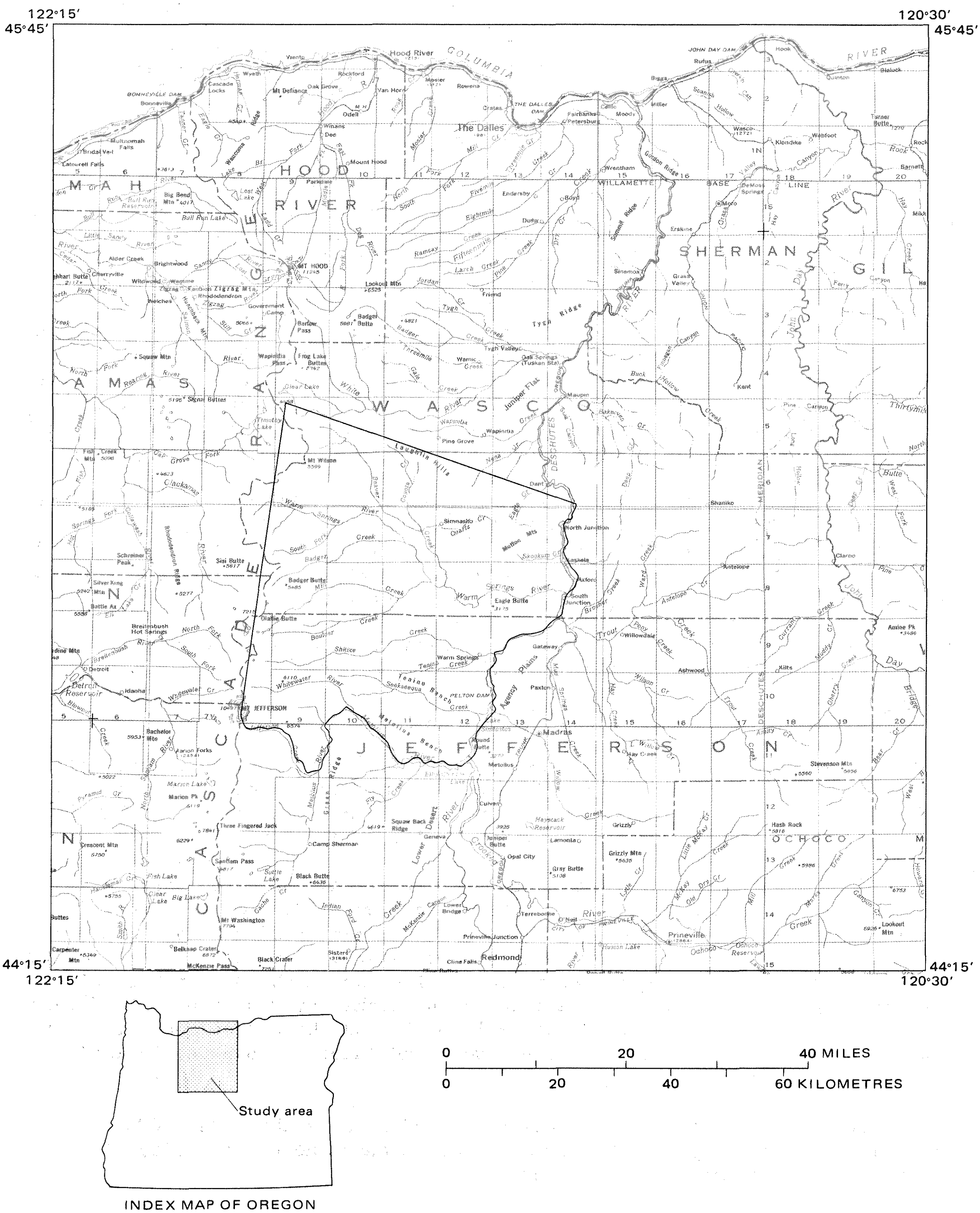


Figure 1. — Location of Warm Springs Indian Reservation.

GEOLOGY

Rocks exposed on the reservation (pl. 1) range in age from early Tertiary to Holocene and include volcanic tuff, basalt, andesite, and associated rocks, and stream- and lake-deposited ash, sand, and gravel.

Clarno Formation

The Clarno Formation, the oldest unit, is exposed only in the northeastern quarter of the reservation. It may underlie much of the reservation at unknown but varying depths, but younger formations cover and mask its true distribution. The Clarno was deposited between middle Eocene and early Oligocene time (Wolfe, 1972, p. 228).

The Clarno Formation consists primarily of very resistant andesitic and basaltic rocks whose original texture and mineralogy have been slightly altered. Other volcanic rocks include breccia, tuff (compacted, fine-grained volcanic fragments), and tuffaceous siltstone. In many places, the topmost layer of the Clarno is a rather distinctive weathering layer of soft, reddish residual clay or silt known as saprolite.

The Clarno Formation generally has a very low permeability, probably the least of all the formations. Yield of water to wells ordinarily can be expected to be inadequate for most needs; however, a community well at Simnasho, which has a sustained yield of 10 gal/min (0.6 l/s), appears to be an exception. (See tables 15 and 17 in basic-data section.)

Chemical quality of water from the Clarno is generally good. (See section on standards and table 17 of chemical analyses.)

John Day Formation

The John Day Formation overlies the Clarno Formation and is exposed in the central (including Agency) and northeastern parts of the area. The John Day formed within the late Oligocene and early Miocene Epochs (Peck, 1964) and, therefore, is about 20 to 30 million years old.

The John Day Formation consists of air-fall and water-deposited ash, tuff, ash flows, welded tuffs, and rhyolitic flows. Much of the ash and tuff is soft and easily eroded, as in the lower Warm Springs River area and lower Skookum, Dry, Shitike, and Tenino Creeks areas. On the other hand, in many places the flows are resistant to erosion, as in the Mutton Mountains and the Eagle Butte-Kahneeta area; there the rocks may resemble some of those in the Clarno Formation. Parts of Eagle Butte and the Mutton Mountains were mapped as Clarno Formation by Hodge (1940) and later as John Day Formation by Waters (1968a).

Material for the John Day Formation, which is as thick as 2,000 ft (600 m), was probably extruded from volcanoes near the present site of the Cascade Range and east of the reservation.

Permeability of the John Day is very low, especially in the ash and other fine-grained units of the formation. By necessity, rather than by choice, many wells have been completed in the John Day, but yields typically range from inadequate to barely adequate.

Chemical quality of water from the John Day Formation is variable; some exceeds recommended drinking-water limits for certain constituents. (See section on standards and table 17 of chemical analyses, in basic-data section.)

Columbia River Basalt Group

The Columbia River Basalt Group is exposed on hills of the northern part of the reservation (Laughlin Hills) and on plateaus of the eastern part (Webster Flat). It occurs in Oregon, Idaho, and Washington and was formed during the Miocene and Pliocene Epochs, which extended from 26 to 3 million years before present.

The Columbia River Basalt Group consists of basalt flows which are dense, hard, and not easily weathered or eroded, but where sufficiently fractured it will transmit water readily. On the reservation, the basalt is generally less than 300 ft (100 m) thick and lies mostly above the water table; a few springs occur locally, but the unit does not serve as an aquifer. In the Pine Grove-Wapinitia area north of the reservation, some deep irrigation wells penetrate the group and yield water from it. Most ground water from it is of good chemical quality.

Dalles Formation

The Dalles Formation is well exposed in the Seekseequa drainage area, in the middle Shitike and Tenino Creek areas, and in the canyons of the Metolius and Deschutes Rivers. At depth, the Dalles underlies the area of plateaus that include The Island; Schoolie, Mill Creek, and Miller Flats; and Tenino and Metolius Benches.

The Dalles Formation was described by Waters (1968a) as consisting of "chiefly water-laid pumice-rich pyroclastic rocks, showing much cross-bedding and channeling. Contains numerous ash falls and less abundant ash flows, a few of which are welded. Also contains some interbedded basalt and andesite flows * * *." Those deposits that may be described as sandstone, gravel, or conglomerate are of particular interest because where they lie below the water table they usually serve as good aquifers. Total thickness of the Dalles is as much as 1,000 ft (300 m) in the Metolius River basin, but is generally less than 200 ft (60 m) in the Warm Springs River basin. In most places, the sedimentary deposits predominate, but near the Metolius and Deschutes Rivers, basalt may compose at least half the total thickness.

Basalt

The unit mapped as "basalt" forms most of the plateaus in the central part of the reservation, including The Island; Schoolie, Mill Creek, and Miller Flats; and Tenino and Metolius Benches. Except where eroded, it usually caps the underlying Dalles Formation, and it is similar to basalt flows within the Dalles.

In most places, the basalt is above the water table. It is not very permeable, but does affect movement of water and tends to perch ground water above the regional water table. The mapped unit is composed mostly of a dense, unweathered lava flow or flows, but drillers report sand and brown or red clay also. Thickness ranges from less than 50 ft (15 m) to more than 300 ft (100 m).

Andesite

The unit mapped as "andesite" occupies almost all the Cascade Range lying within the reservation. It is of Pliocene or Pleistocene age, with the high peaks generally consisting of the youngest rocks.

The rocks include andesitic and basaltic lavas, mudflow, and pyroclastic (ejected volcanic) material. Overall, the formation is quite permeable, and it transmits water of excellent quality to many springs. Yields to some drilled wells, however, have been low.

Gravel

The formation mapped as "gravel" lies in the northwestern part of the reservation, generally between the base of the Cascade Range and the Warm Springs River. The gravel, of Pliocene or Pleistocene age, was derived from the andesitic rocks of the Cascade Range and was spread across the basalt-capped plateaus by eastward-flowing streams that antedated the present streams, which are deeply incised into the topography.

In places, the gravel is more than 100 ft (30 m) thick. At best, only a few feet of the gravel is saturated with water, but the permeability is good, the water quality is good, and wells that produce water from this gravel are among the most productive on the reservation.

Alluvium

Alluvium occurs in deposits underlying or adjacent to rivers and streams throughout the reservation; only the more prominent or widespread are mapped separately from the underlying formations. Sources of the sand, gravel, and clay of the alluvium are mostly in the present drainage areas of the streams.

Where it is sufficiently thick, the alluvium serves as an aquifer for the production of water by small-diameter wells. However, where the wells are shallow, they may be subject to pollution if they are improperly constructed.

HYDROLOGY

Climate

The climate is primarily continental, with some moderating effect due to the relative proximity of the Pacific Ocean. In summer, the climate in most of the reservation is generally arid, with very little rain from May through October, and maximum temperatures are near 100°F or 38°C (Celsius) for many days. Weather systems moving southward from Canada usually dominate winter months, but Pacific-spawned storms often cross the Cascade Range, dropping moisture and raising temperatures locally.

The western part of the reservation lies on the slope of the Cascade Range, where the average annual precipitation is as much as 120 in (3,000 mm). In contrast, the eastern two-thirds of the reservation is in the rain shadow of the Cascade Range and the average annual precipitation there is only 10 in (254 mm) (fig. 2). Annual snowfall is about 200 in (5,100 mm) on the crest of the Cascade Range but diminishes to about 15 in (380 mm) on the lower and eastern part of the reservation.

Table 1 shows annual precipitation at weather stations on or near the reservation and the variation that may occur from year to year. Monthly precipitation at Government Camp for 1973 and 1974 water years is shown in figure 3, which illustrates the monthly variation. Below-average snowfall in winter and early spring of 1973 resulted in a spring snowpack that was only 50 percent of normal for the Cascade Range. In 1974, snow accumulated throughout the winter and spring, resulting in a record spring snowpack.

Streams and Streamflow

At the start of this study, a continuous-stage recorder was installed on the Warm Springs River near Kahneeta Hot Springs, and a staff gage to be read daily was installed on Shitike Creek near Warm Springs. (See figure 4 for station locations.) Data from these stream-gaging stations were compared with long-term records collected at White River below Tygh Valley to define the pattern of flow (flow variability) during the 2-year study period. Figure 5, showing bar graphs of monthly runoff for the three stations, indicates seasonal variability in flow. The station on White River below Tygh Valley (14101500) was used for comparison purposes because (1) it is close geographically (see fig. 4), (2) it has a very long streamflow record (57 years), and (3) its basin lies in a topographic and climatic situation similar to the Warm Springs Reservation.

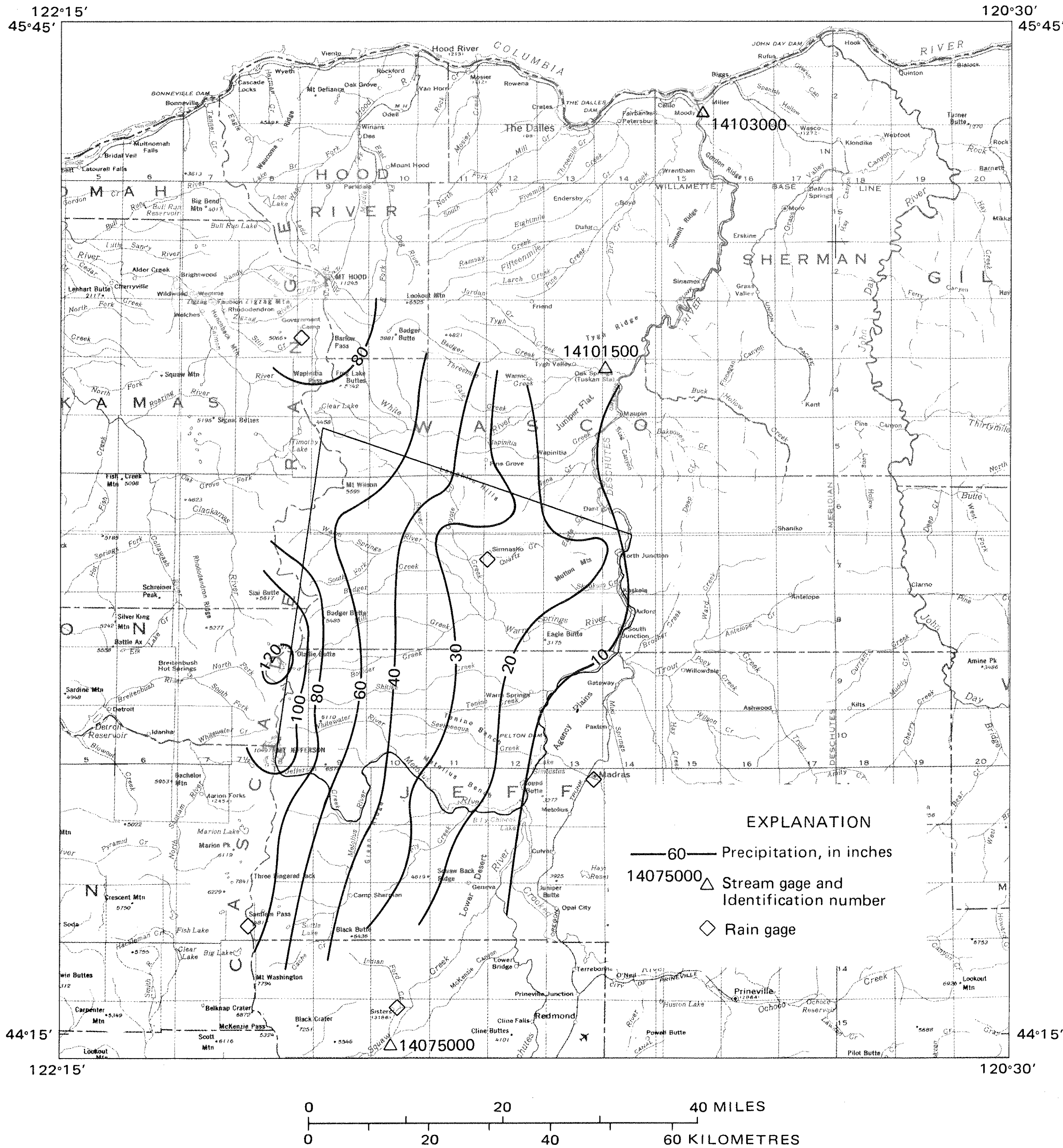


Figure 2. — Average annual precipitation, in inches.
(Adapted from Columbia-North Pacific Technical Staff, 1970)

Table 1.--Annual precipitation at selected weather stations in the vicinity of Warm Springs Indian Reservation

[Based on records of the National Weather Service]

Station	Government Camp Lat 45°18' N. Long 121°45' W. Alt 3,980 ft	Santiam Pass Lat 44°26' N. Long 121°56' W. Alt 3,780 ft	Sisters Lat 44°17' N. Long 121°32' W. Alt 3,180 ft	Simnasho Lat 44°58' N. Long 121°21' W. Alt 2,400 ft	Madras Lat 44°38' N. Long 121°08' W. Alt 2,230 ft
Calendar year			Inches		
1954	82.01	--	--	--	7.82
1955	111.65	--	--	--	9.79
1956	87.45	--	--	--	10.76
1957	79.62	--	--	15.85	12.84
1958	89.71	--	--	13.80	8.92
1959	88.77	--	8.62	--	--
1960	84.42	--	16.08	--	9.99
1961	99.35	--	18.16	--	12.87
1962	85.53	--	13.85	--	11.63
1963	72.56	--	12.94	--	11.31
1964	109.87	110.27	20.20	14.71	9.86
1965	65.70	71.27	11.80	9.56	9.57
1966	83.19	81.24	11.57	12.28	11.58
1967	79.58	80.16	12.59	--	5.89
1968	101.51	96.53	12.52	--	10.99
1969	73.58	77.39	10.74	--	13.54
1970	98.04	98.80	15.24	--	9.29
1971	113.43	--	15.12	--	9.05
1972	102.56	93.09	14.09	--	8.97
1973	87.94	95.45	12.83	--	10.82
1974	95.23	96.48	12.93	--	6.40
Average	90.08	90.07	13.71	13.24	10.10

Figure 3, which shows the precipitation at Government Camp for 1973-74, should represent the precipitation pattern in the upper basins of the three aforementioned streams. Almost all major precipitation occurs from November through May, and snow starts to accumulate in November. Occasionally, rain and warm winter winds melt large volumes of snow, causing high winter flows such as occurred in 1974 (fig. 5). Figure 5 also shows 1973 as being a low runoff year and 1974 as a high runoff year.

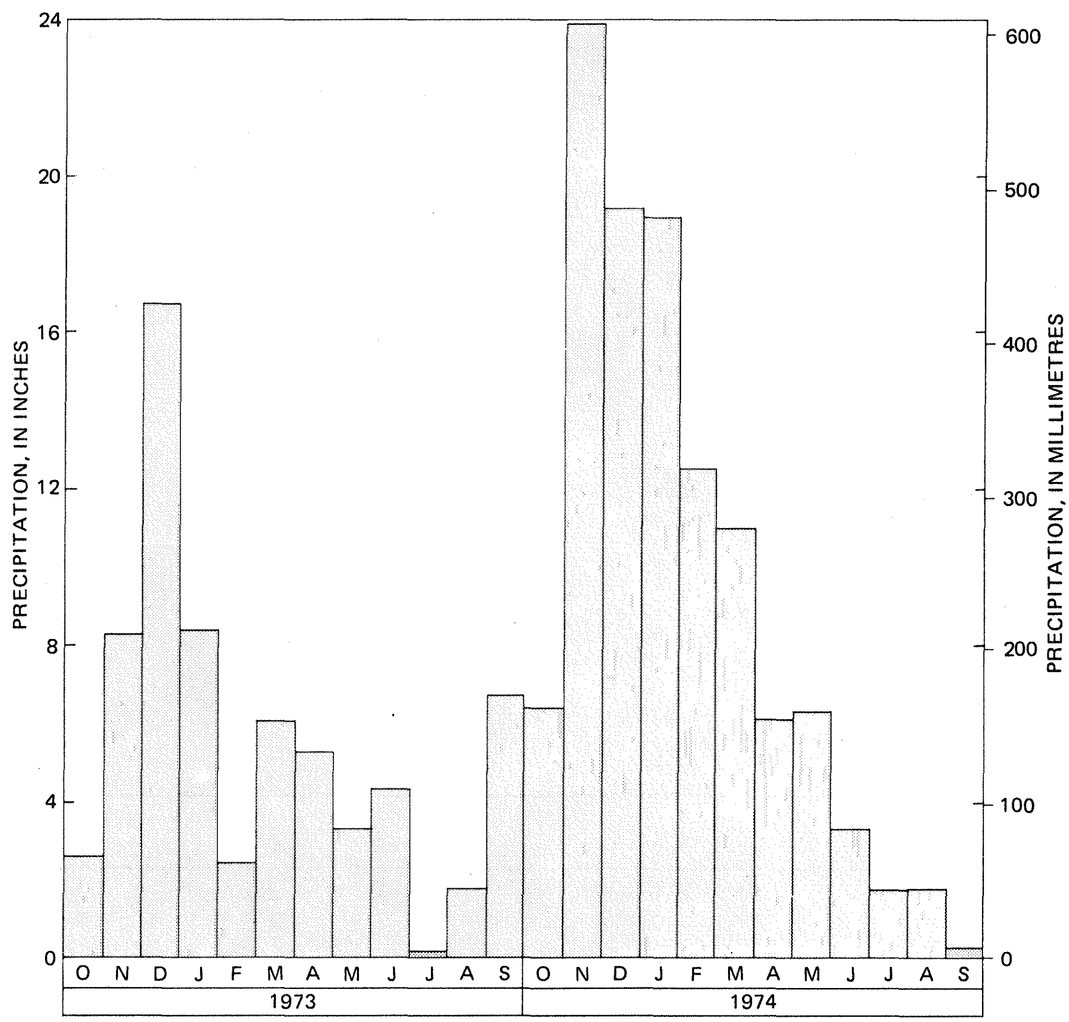


Figure 3.—Monthly precipitation at Government Camp, Oreg., 1973-74 water years. (Based on records of the National Weather Service.)

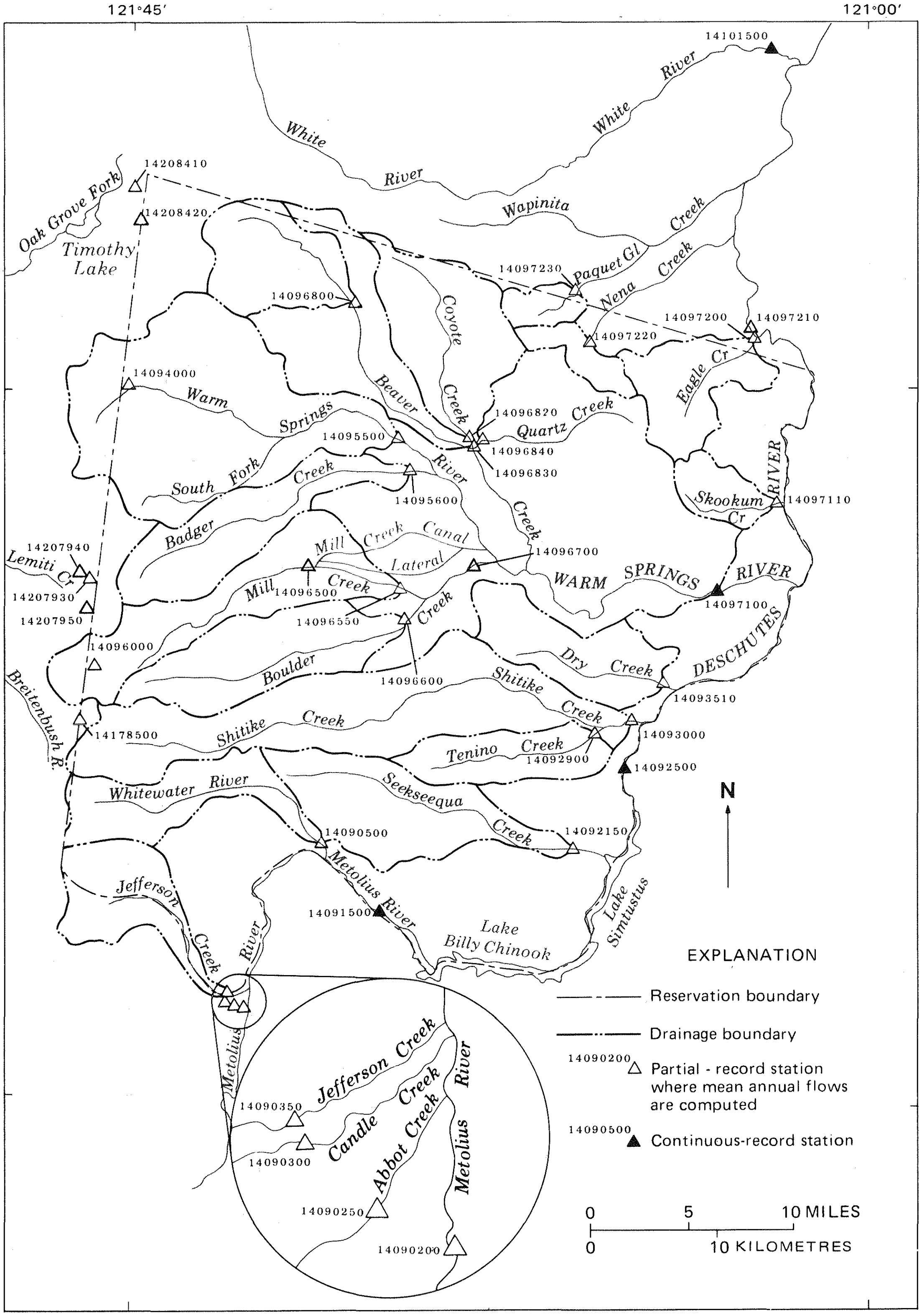


Figure 4.—Drainage basins and selected streamflow stations.

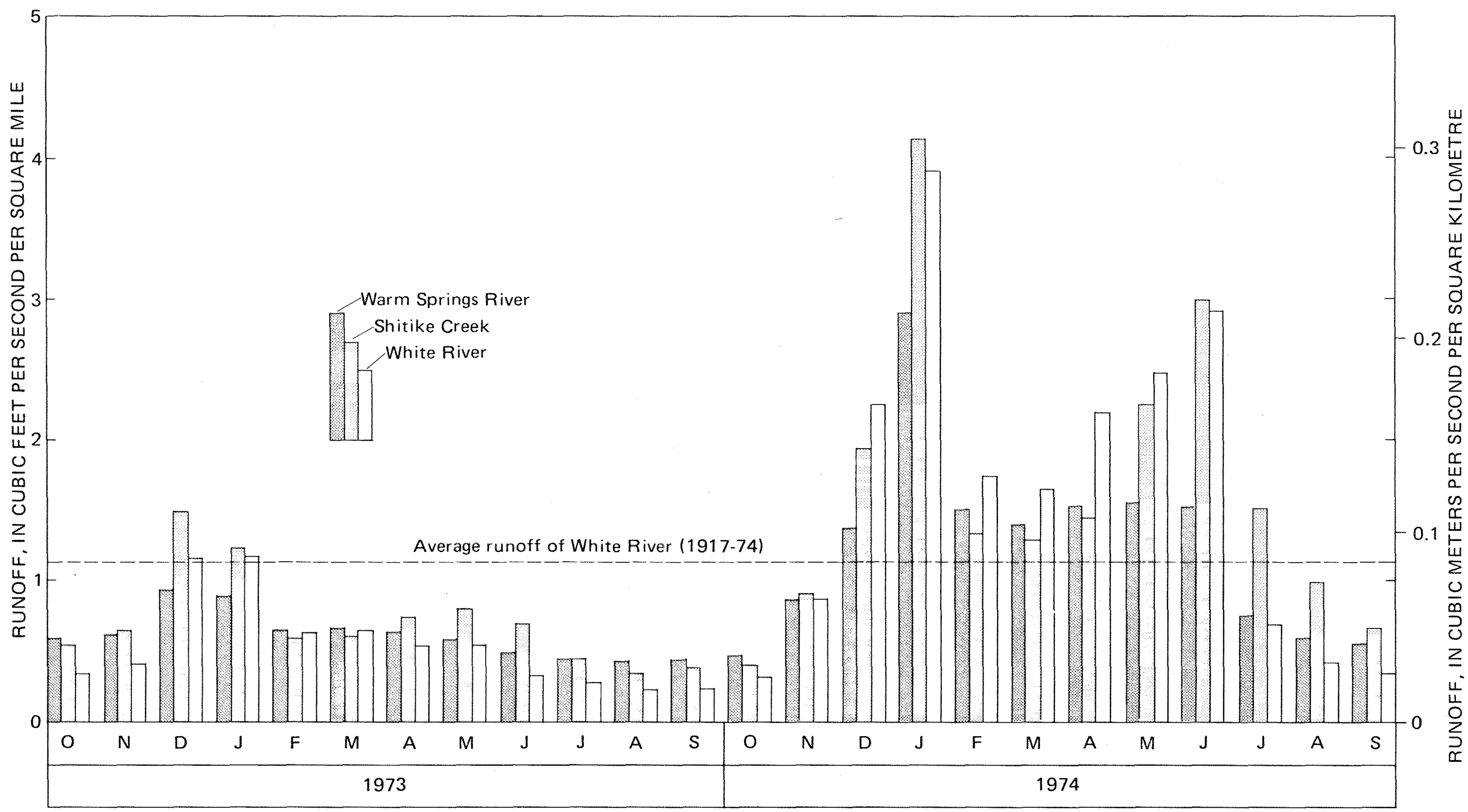


Figure 5.—Monthly mean runoff of Warm Springs River, Shitike Creek, and White River, 1973-74 water years.

Figure 6 is a graph of the mean monthly runoff of White River below Tygh Valley for 1917-74. It shows that the highest runoff normally results from snowmelt in the spring. All major streams on the reservation should have the same long-term variability as the White River and should normally experience maximum runoff periods in spring.

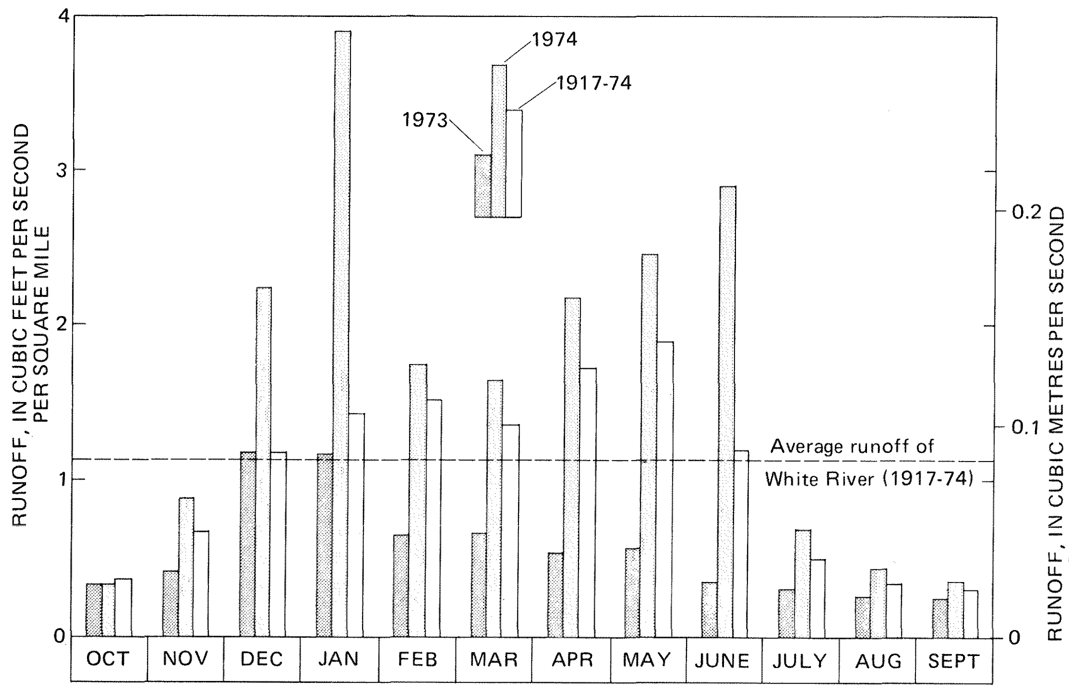


Figure 6.—Mean monthly runoff of White River below Tygh Valley (14101500), 1917-74.

Monthly measurements of selected streams, made during the 1973 water year, provided data to estimate mean annual and long-term average discharges and the variability of flow at each site. Figure 7 shows the relation of the mean flow in 1973 to the long-term average discharge for several streams. During the 1973 water year, flows in the Metolius and Deschutes Rivers were near average, but flows of the Warm Springs River, Shitike Creek, and several other streams on the reservation were only about three-fourths of average and White River below Tygh Valley was only 53 percent of average. These differences probably reflect the carryover characteristics of a large ground-water reservoir in the Metolius and Deschutes Basins and a similar characteristic in the Warm Springs River basin.

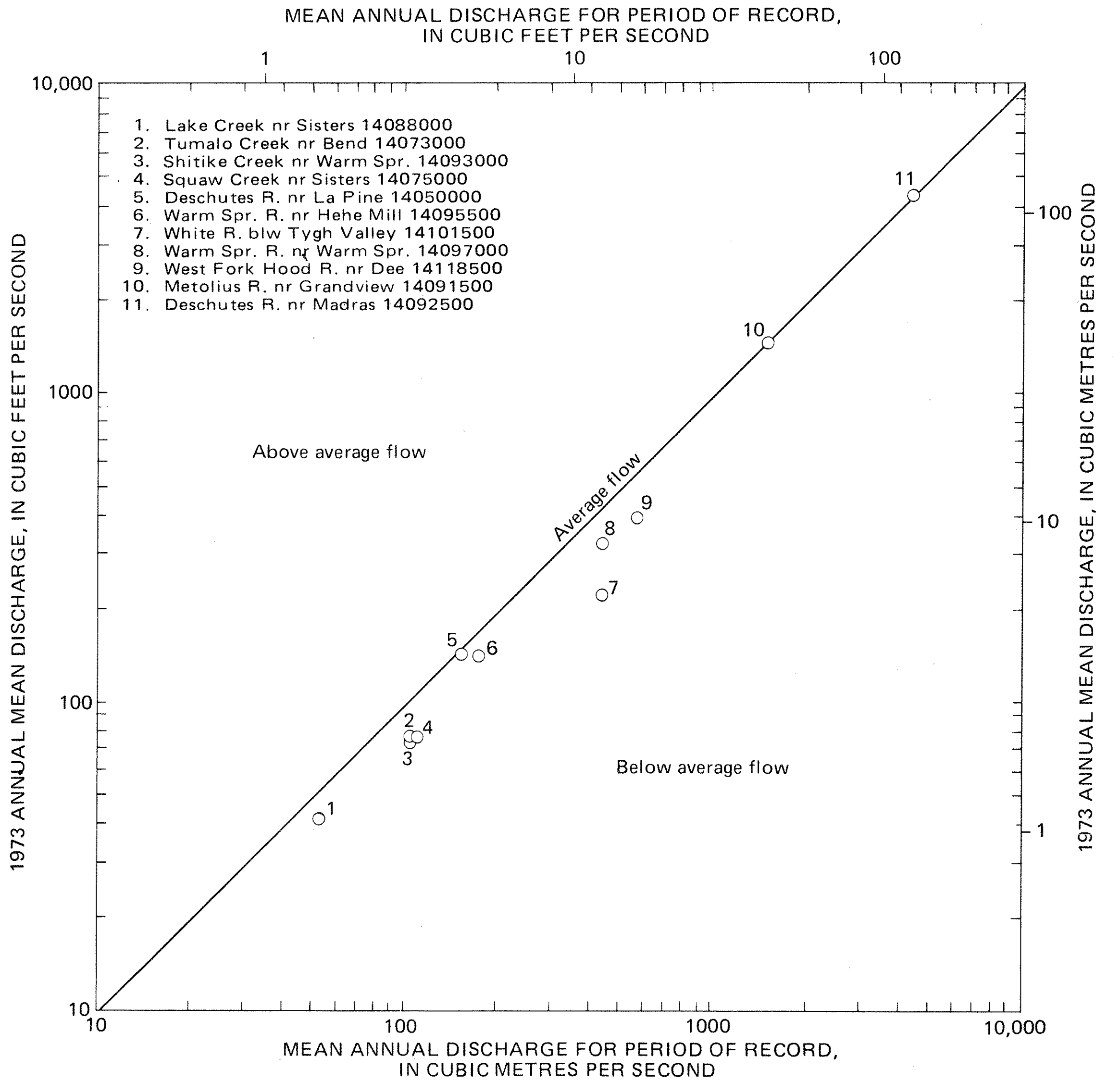


Figure 7.—Relation of annual mean discharges in 1973 to mean annual discharges for selected streams.

Dependable low flow was determined by correlating measurements at a site to concurrent daily discharge at a long-term gaging station and then projecting this relation to the dependable low flow of the long-term station (fig. 8). (See glossary for definition of dependable low flow.) The accuracy of dependable low flows for streams on the reservation is generally within 30 percent.

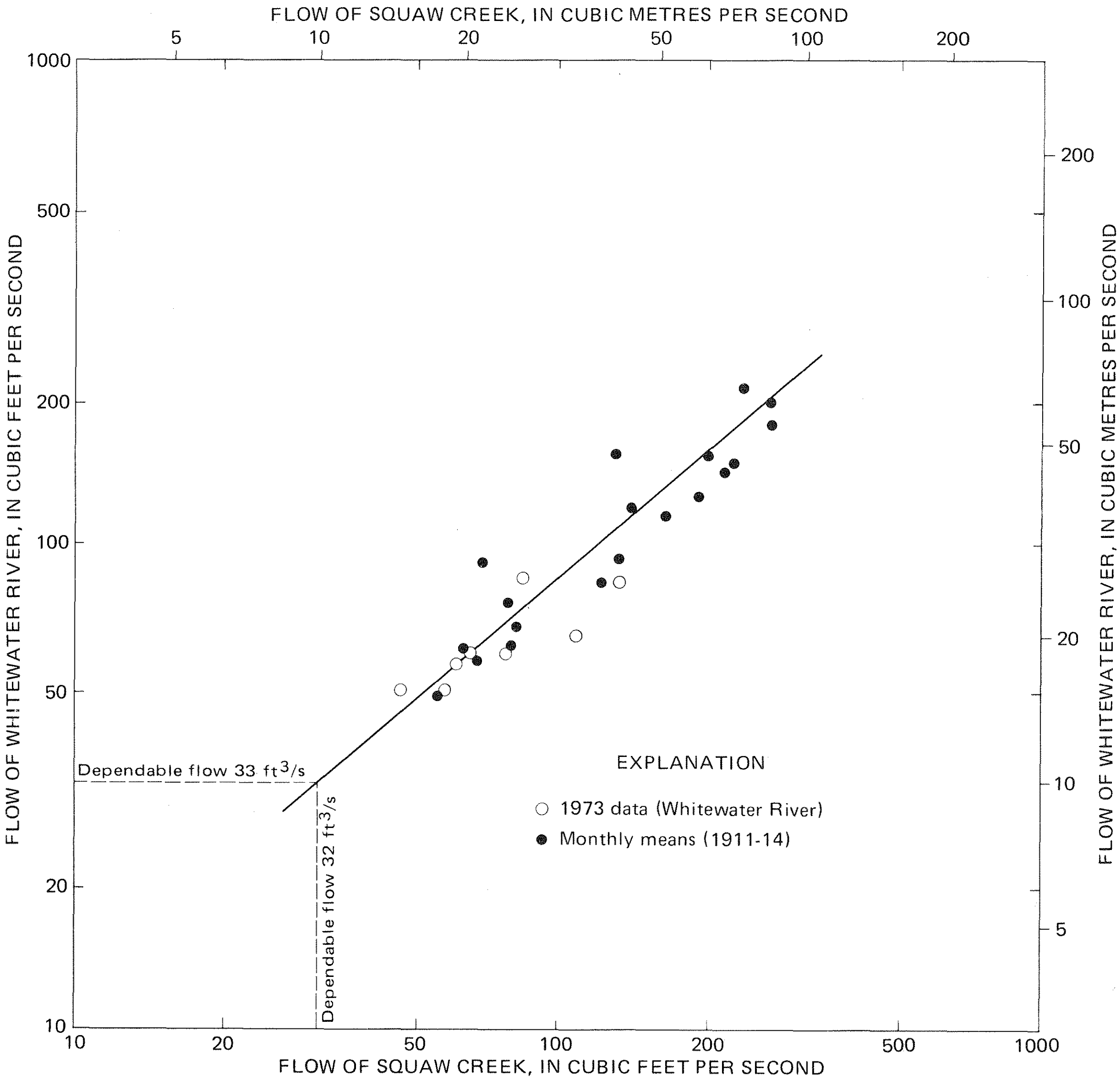


Figure 8.—Relation of low flow of the Whitewater River to concurrent flow of Squaw Creek (14075000).

As the result of a rainstorm and warm temperatures that melted ice and snow, peak flows in January 1974 were unusually high. Peak discharges of some streams were measured directly or calculated indirectly. For streams within the reservation, the recurrence intervals of the floods were estimated on the basis of recurrence intervals of floods on nearby streams. As shown in figure 9, the January 1974 peak on the White River had a recurrence interval of about 15 years, and the December 1972 peak had a recurrence interval of about 2 years.

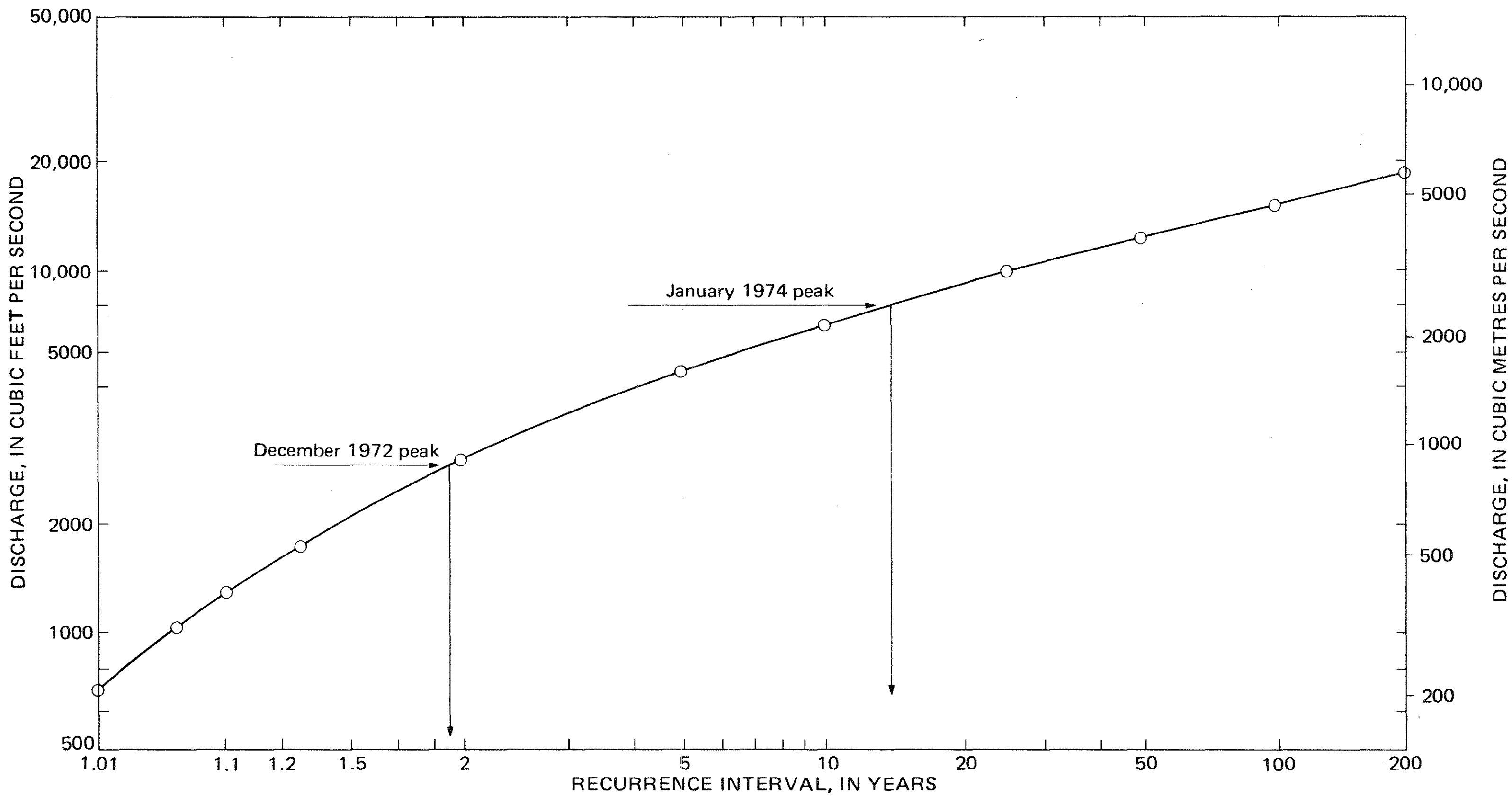


Figure 9.—Regional flood-frequency curve for White River below Tygh Valley (14101500), 1918-74.

Warm Springs River

Most of the surface flow in the northern two-thirds of the reservation is discharged by the Warm Springs River and its tributaries. The entire basin has an area of 540 mi^2 (1,400 km^2) and is the largest and most diverse on the reservation. Near its mouth, the river has a mean annual flow of 440 ft^3/s (12.5 m^3/s). In the upper part of the basin, snowmelt from fields, meadows, and lakes increases flow in spring and early summer. Substantial flows from springs issuing from beneath volcanic rocks on the slopes and foothills of the Cascade Range sustain streamflows in late summer and fall. In the lower part of the basin, which lies in a rain shadow, runoff occurs only when an intense storm passes through.

<u>Gain-loss investigation</u>.--Two investigations of the Warm Springs River were made in late spring and in early fall 1973 to determine the magnitude and origin of the various sources of inflow. (See table 7, gain-loss investigations.) The following paragraphs explain the gains and losses of the Warm Springs River. All percentages of flow refer to the total flow at the mouth. (See figure 10.)

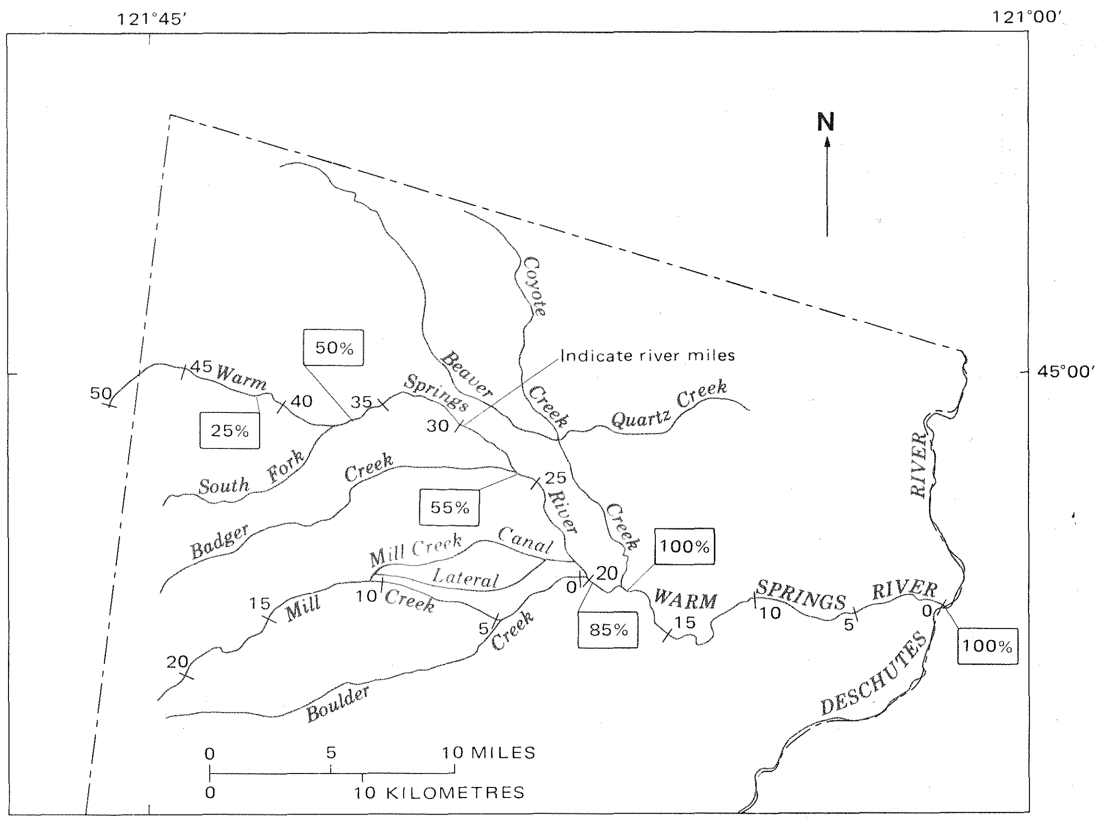


Figure 10.—Percentage of flow at several points on the Warm Springs River and its tributaries compared to flow at the mouth.

Where the Warm Springs River enters the reservation at river mile 47.0, its flow was less than 1 percent. From the reservation boundary downstream, the flow of the main stem increased greatly in stair-step fashion due to many springs. At about river mile 41, the riverflow increased, in less than 0.3 mi (0.5 km), to about 25 percent. At this location, many small springs issue at a temperature of about 43°F (6°C) from the fractured basalt. Downstream, spring inflow in Warm Springs Meadow continued to increase the flow of the river in steps. The flow reached about 50 percent at Schoolie Bridge, river mile 36.3, which is about the eastern edge of the andesite. The South Fork Warm Springs River, which joins the main stem just below Warm Springs Meadow, contributed less than 1 percent of the flow.

The first major tributary, Badger Creek, contributed only about 4 percent of the flow, with half its contribution issuing from springs just west of U.S. Highway 26. Mill Creek, the largest of the tributaries, contributed about 30 percent of the flow. The final major tributary, Beaver Creek, contributed about 15 percent of the flow. From the confluence of Beaver Creek to its mouth, the Warm Springs River showed no appreciable gain nor loss; minor spring inflow and evapotranspiration seemed to balance in the final reach of river.

Because of its size and complexity, a separate gain-loss investigation was made for Mill Creek which contributes about 30 percent of the flow of the Warm Springs River. From its headwaters at river mile 24.0, flow of Mill Creek increased to river mile 15.8, where it was 55 percent of the total flow at the mouth. In the next 20 mi (32 km) along the stream, flow was lost by seepage into the sand and gravel. Boulder Creek also lost most of its flow, before it reached Mill Creek, to the sand and gravel. Although these losses reduce the available streamflow substantially, they serve as important contributions to recharge for the sand and gravel aquifers. Mill Creek flows are finally regained in the deep canyon west of U.S. Highway 26.

Low flows.--The Warm Springs River near Kahneeta Hot Springs has a dependable flow of about 220 ft^3/s (6.2 m^3/s). In 1973, one of the drier years of record, the 7-day low flow was 232 ft^3/s (6.6 m^3/s), which has a recurrence interval of about 25 years. For the reach of the Warm Springs River below Beaver Creek, the Oregon State Department of Fish and Wildlife has suggested a June through August minimum flow, for fish propagation, of 80 ft^3/s (2 m^3/s) (written commun., K. E. Thompson, 1975). A flow of 80 ft^3/s (2 m^3/s) has a recurrence interval well in excess of 100 years.

Water year 1973 represents a low stream runoff year for the Warm Springs River, and the data collected during that year can be useful for designing irrigation projects such as the proposed dam on the Warm Springs River near Hehe Mill. For example, 12,000 acre-ft (15 hm^3) of reservoir storage would have been required in 1973 for irrigation and to maintain dependable low flows downstream. That storage, in addition to the direct diversion, would have provided water to irrigate the proposed projects on The Island and Schoolie Flat (4,233 acres, or 17.13 km^2), based on irrigation requirements specified in a report by the U.S. Bureau of Indian Affairs (1969). About three times as much storage would have been required to supply water for the combined irrigable land on The Island, Schoolie Flat, Miller Flat, Dry Creek valley, and the bench above Shitike Creek.

Peak flows.--For the most part, the river is confined within its banks during periods of high flow. The January 1974 peak at the gage site near the mouth had a magnitude of 6,350 ft^3/s (180 m^3/s)--approximately a 15-year recurrence interval.

Water quality.--Analyses of several water samples from the Warm Springs River and its tributaries show the water to be of excellent chemical quality, with low values of dissolved solids and hardness (table 10).

The river above and below sewage lagoons near Kahneeta Hot Springs was sampled twice (table 8). Both sets of samples show a substantial downstream increase in coliform bacteria, which suggests that some incompletely treated waste water may have entered the river from the lagoons. The somewhat high values (see p.60) suggest that at times the river water below the lagoons may not be suitable for human consumption; periodic checks of conditions near the lagoons may be warranted.

During winter storms, unusually large quantities of sediment enter the Warm Springs River from tributaries in the lower reach of the river (table 9). High sediment concentrations are the result of sparse vegetation, unconsolidated soils, and moderate to steep slopes. In contrast, as shown by data from Coyote Creek, sediment yields are small from the upper reach of Warm Springs River basin.

Coyote Creek, a tributary of Beaver Creek, was sampled for sediment and turbidity (table 9). On the basis of the sediment-discharge relationship derived from the few samples collected, some gross estimates of yearly sediment load can be made. The estimated yearly load for 1973 is 10 tons (9 tonnes), and the estimated yearly load for 1974 is 9,000 tons (8,000 tonnes). These values indicate relatively low sediment yields. The turbidity of the creek does not seem to be extremely high, but the stream does stay turbid even at near-zero flows. This phenomenon is attributed to montmorillonite (clay) which remains in colloidal suspension.

Shitike Creek

Shitike Creek has a mean annual flow of 108 ft^3/s (3.06 m^3/s) near its mouth. Its drainage basin, which covers an area of 105 mi^2 (272 km^2) and is the second largest on the reservation, receives an average annual precipitation of more than 50 in (1,010 mm) (fig. 2).

Topographic divides in the upper basin do not necessarily define the drainage area because very permeable rocks permit substantial ground-water movement; hence, the basin may have more contributing drainage area than indicated in figure 4. Shitike Creek has a sustained spring runoff (fig. 5), probably due to late snowmelt from the steep north-facing slopes of its upper canyon. The creek also maintains a high base flow of more than 30 ft^3/s (0.6 m^3/s) in late summer, because of ground-water inflow. The lower part of the Shitike Creek basin is in the same rain shadow as the Warm Springs River basin.

Low flows.--In late summer, when base flow occurs, the creek gains flow from its headwaters at river mile 33 downstream to river mile 22, near the eastern edge of the andesite. Between Shitike Butte and the mouth of Wolford Canyon (river mile 5.5), the change in streamflow is insignificant, which is consistent with the very low summer flow of Seekseequa Creek and the zero summer flows of Tenino and Dry Creeks. Downstream from Wolford Canyon, the creek loses some flow into the gravel that forms the valley floor.

Shitike Creek near Warm Springs has a dependable flow of about 28 ft^3/s (0.79 m^3/s). In 1973, a low summertime flow of 33 ft^3/s (0.93 m^3/s) occurred in September 1973. During a period of ice effect in December 1972, however, the low flow was 20 ft^3/s (0.57 m^3/s). In figure 11, low flows may be compared with minimum and optimum flows for fish suggested by the Oregon State Department of Fish and Wildlife (K. E. Thompson, written commun., 1975).

Peak flows.--Shitike Creek near its mouth had higher peak flows than did nearby streams with drainage basins of comparable size. In January 1974, the peak on Shitike Creek was estimated as 4,000 ft^3/s (110 m^3/s). This flood topped the banks in the lower reaches and caused considerable bank erosion and movement of gravel along the channel. During floodflows, the channel has a tendency to meander within the width of the valley floor, which should influence the design or location of structures proposed for the area. Based on records from nearby long-term stations, the recurrence interval for the January 1974 peak appears to be greater than 20 years.

Water quality.--Shitike Creek water is of excellent quality; it is low in dissolved solids, hardness, and specific conductance (table 10). One set of samples taken above and below the sewage lagoons near Warm Springs Agency showed a coliform count well below recommended levels and no significant increase below the lagoon (table 8).

Whitewater River

Most of the Whitewater River drainage area is on the slope of the Cascade Range, but the lower part lies on the edge of the rain-shadow area. The entire river course is in a deep canyon which usually retains snow until late summer. In addition, melt water from the Whitewater Glacier of Mount Jefferson also helps to sustain the summer flow of the river. The glacier acts as a self-regulating reservoir because the rate of glacial melting depends on temperature and sunshine, increasing on bright, hot days and decreasing on cool, overcast days and at night. Suspended rock flour in the melt water causes the river to become turbid when the rate of glacial melting is high.

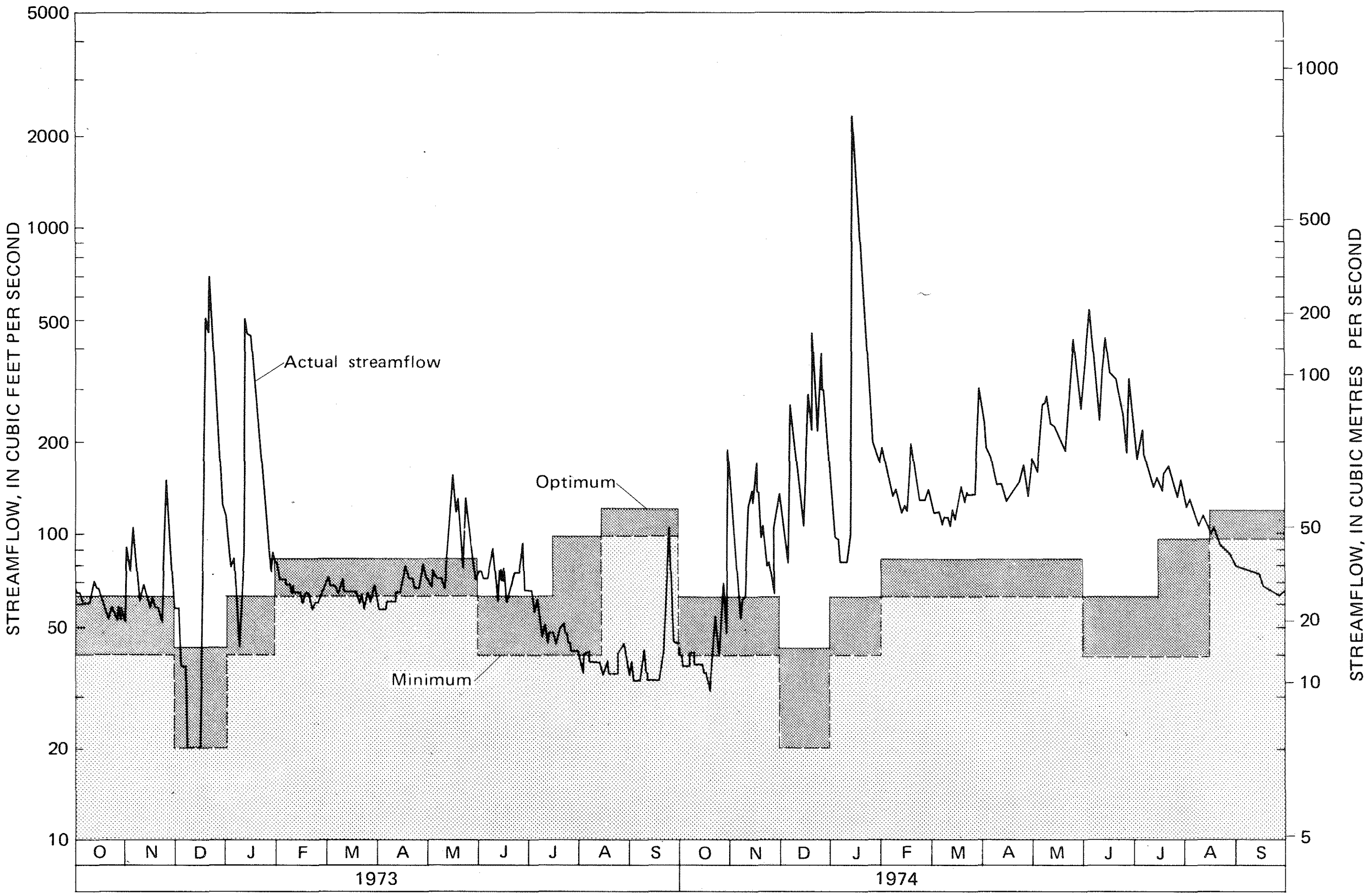


Figure 11.—Streamflow of Shitike Creek, 1973-74, compared to suggested optimum and minimum flows for fish life.

The mean annual flow of the Whitewater River, near its mouth, is 105 ft^3/s (3.0 m^3/s). Average flow in July and August 1973 was about 70 ft^3/s (1.4 m^3/s). In July 1973 the entire flow of the river would have irrigated only 2,700 acres (11 km^2), although irrigation projects requiring water from the Whitewater River have been proposed for 2,914 acres (11.79 km^2) (U.S. Bureau of Indian Affairs, 1969).

Jefferson Creek

Jefferson Creek has a mean annual flow of 110 ft^3/s (3.12 m^3/s) near its mouth. The creek has the poorest defined drainage basin on the reservation because the areal extent of ground-water contribution is not known. The creek drains Waldo Glacier, a small part of Whitewater Glacier, and several high lakes and snowfields. It also lies in an area of diverse geology and next to a large lava flow. High permeability of the lavas enables ground water to sustain summer flows and gives the stream the highest base flow per square mile of all the streams on the reservation. Jefferson Creek never seems to become turbid, as the Whitewater River does, even though it also carries glacial melt water.

Metolius River

The Metolius River, just below the confluence of Jefferson Creek (fig. 4), has a mean annual flow of 1,400 ft^3/s (40 m^3/s). It has one of the highest base flows per square mile of drainage area of any stream in Oregon, being sustained by the many springs and other large ground-water contributions from very permeable volcanic rocks. The head of the Metolius is a huge spring where about 100 ft^3/s (2.8 m^3/s) issues from the base of Black Butte. In the 10 mi (16 km) from the headwaters to the reservation boundary, tributaries are few but flow increases more than tenfold. Running parallel to the crest of the Cascade Range, the Metolius intercepts almost all the flow from the crest eastward to its channel.

The high permeability of the rock formations adds to flow in one segment of river but it may also decrease it in another. A comparison of concurrent records of flow indicates that losses are substantial in the reach between Jefferson Creek and the Whitewater River. The losses are regained in the lower reach between the Whitewater River and its mouth at the Deschutes River. At its confluence with the Deschutes River in Lake Billy Chinook, the Metolius River drains an area of 450 mi^2 (1,170 km^2) and has a mean annual flow of about 1,550 ft^3/s (44 m^3/s).

On the basis of the limited sampling done, water quality appears to be excellent in the Metolius River, including the Metolius arm of Lake Billy Chinook where occasional algae blooms occur (McHugh, 1972).

Deschutes River

Where the Deschutes River reaches the south boundary of the reservation, it has a mean annual flow of about 4,040 ft^3/s (114 m^3/s), including the flow of the Metolius River. At the north boundary of the reservation, the Deschutes has a mean annual flow of about 5,300 ft^3/s (150 m^3/s), including major contributions from Willow Creek, Campbell Creek, Shitike Creek, the

Warm Springs River, and Trout Creek. Flows of most creeks entering the Deschutes from the east are supplemented by return of water originally diverted from the Deschutes for irrigation. The reach of the river bounding the reservation has two major dams. Lake Billy Chinook is formed behind Round Butte Dam which backs water far up the Metolius River. Lake Simtustus is formed behind Pelton Dam.

Water quality.--Chemical quality of Deschutes River water is excellent; it is low in dissolved solids, hardness, and specific conductance (table 12).

The coliform concentration in water at the outlet of Lake Billy Chinook (table 8) indicated a level just below the State standard. However, water collected from the Deschutes River just above its confluence with Shitike Creek near Warm Springs Agency, had a significantly lower coliform concentration than the water below Lake Billy Chinook. Very high coliform concentrations were found in water from Willow and Campbell Creeks which flow into the Deschutes River between Lake Billy Chinook and Shitike Creek (table 8).

Other Streams

Most other streams on the reservation have little flow, because they lie in the rain shadow and have little or no drainage area on the slope of the Cascade Range. Most of these streams, regardless of drainage-area size, are ephemeral or nearly so. Seekseequa Creek, with a drainage area of about 50 mi^2 (130 km^2) is nearly dry in summer. Dry Creek, with a drainage area of 35 mi^2 (90 km^2), is dry in summer. The total mean annual flow of these two streams is only about 8 ft^3/s (0.23 m^3/s). Streams that flow into the Metolius River between Jefferson Creek and the Whitewater River have flows totaling about 25 ft^3/s (0.7 m^3/s), but individually do not have significant flows.

Table 10 shows that no undesirable concentrations of objectionable chemical constituents were noted in any of the smaller streams on the reservation. Even streams adjacent to the reservation that had high levels of coliform had good chemical quality at the time of sampling. Except for the high iron concentration in water from Skookum Creek, all the analyzed chemical constituents were well below recommended limits for drinking water. (See basic-data section.)

Streamflow Distribution

The Warm Springs River, Shitike Creek, the Whitewater River, and Jefferson Creek are the major streams on the reservation. Streamflow from the reservation, on a mean annual basis, is approximately 740 ft^3/s (21 m^3/s) or 17 percent of the total flow of the Deschutes River at the northeast corner of the reservation. The Metolius River receives 180 ft^3/s (5.1 m^3/s), or 12 percent, of its mean annual flow from the reservation. Table 2 summarizes drainage area, mean flow, and dependable flow (see glossary for definition of dependable flow) for 34 streamflow sites on or near the reservation. Discharge measurements made during this study are given in table 11.

Table 2.--Selected streamflow data

Station number	Stream name	Drainage area (mi²)	Estimated flows: 1973 mean (ft³/s)	Mean annual (ft³/s)	Mean annual [(ft³/s)/mi²]	Dependable low flow (ft³/s)
14090200	Metolius River	163	1,300	1,300	8.0	1,000
14090350	Jefferson Creek	27.8	82	110	4.0	32
14090500	Whitewater River	31.8	76	105	3.3	33
14091500	Metolius River 1/	316	1,501	1,490	4.7	1,090
14092150	Seekseequa Creek	47.3	2.7	6.7	.14	.7
14092500	Deschutes River 1/	7,820	4,497	4,434	.57	1,200
14092900	Tenino Creek	20.7	--	1.0	--	0
14093000	Shitike Creek 1/	105	75	108	1.0	28
14093510	Dry Creek	33.7	.2	1.5	.04	0
14094000	Warm Springs River	18	--	15	--	1.0
14095500	Warm Springs River	107	150	180	1.6	95
14095600	Badger Creek	37.2	24	28	.75	5.0
14096000	Mill Creek	5.4	--	3.5	--	>.01
14096500	Mill Creek	28.8	--	70	--	20
14096550	Mill Creek	57.6	56	72	1.2	20
14096600	Boulder Creek	28.4	11	27	.95	0
14096700	Mill Creek	140	--	110	--	55
14096800	Beaver Creek	32.1	38	44	1.4	7.0
14096820	Coyote Creek	43.2	2.4	7.5	.17	0
14096830	Beaver Creek	115	61	79	.69	26
14096840	Quartz Creek	35	--	5.0	--	0
14097100	Warm Springs R 1/	526	330	440	.84	220
14097110	Skookum Creek	10.9	--	1.0	--	0
14097200	Eagle Creek	24.4	.3	1.0	.04	0
14097210	Deschutes River	9,330	--	5,300	--	2,300
14097220	Nena Creek	15.9	.3	1.0	.06	> .01
14097230	Paquet Gulch	6.4	.2	.5	.08	0
14101500	White River 1/	417	228	427	1.0	74
14178500	Breitenbush River	1.6	--	3.5	--	.6
14207930	Slow Creek	.8	--	2.0	--	.2
14207940	Lemiti Creek	3.4	--	6.0	--	0
14207950	Olallie Creek	1.6	--	1.0	--	0
14208410	Oak Grove Fork	12.0	--	20	--	0
14208420	Clackamas Lake tributary	1.1	--	.5	--	0

1/ Daily streamflow site.

Nearly all streamflow on the reservation originates within or adjacent to its boundaries (fig. 4); Jefferson Creek and the Metolius and Deschutes Rivers, which serve as the south and east boundaries, derive streamflow both from within and outside the reservation. Less than 1 percent of the surface flow on the reservation originates outside the reservation, primarily from the uppermost reach of the Warm Springs River and from the outflow of Olallie Lake to Mill Creek. Because north and west boundary lines approximate major drainage divides, only minor streamflow crosses them. Less than 1 percent of the surface flow originating on the reservation leaves the reservation across its north and west boundaries, primarily in Paquet Gulch, Nena Creek, the Oak Grove Fork of the Clackamas River, Lemiti Creek, and the outflow of Breitenbush Lake.

Of the streams that bound the reservation, Jefferson Creek is the only one that serves as a boundary for its entire length. The boundary divides the Jefferson Creek drainage approximately in half, and about half the flow is derived from the reservation.

Except for 1941, in the past 50 years the lowest stream runoff from the reservation for many streams occurred in 1973. Thus, data for 1973 represent a near extreme, and should be valuable for planning.

Peak flows in January 1974 had recurrence intervals of greater than 20 years on Shitike Creek, 15 years on the Metolius River, and 10 years on the Deschutes River. (See table 3.) During the winter of 1964-65, one of the

Table 3.--Selected peak discharges

Station number	Stream name	Drainage area, in mi^2	Discharge, in cubic feet per second			
			Dec. 1964	Dec. 1972	Jan. 1974	May 1974
14090350	Jefferson Creek	27.8	--	350	--	--
14090500	Whitewater River	31.8	--	--	670	160
14091500	Metolius River	316	7,530	2,910	4,370	1,900
14092150	Seekseequa Creek	47.3	--	--	1/400	8.7
14092500	Deschutes River	7,820	15,800	9,660	8,400	--
14092900	Tenino Creek	20.7	--	--	1/80	--
14093000	Shitike Creek	105	--	690	1/4,000	425
14093510	Dry Creek	33.7	--	--	125	--
14095600	Badger Creek	37.2	--	--	--	109
14096550	Mill Creek	57.6	--	--	--	199
14096600	Boulder Creek	28.4	--	--	--	124
14096820	Beaver Creek	71.5	--	--	1,200	208
14096830	Coyote Creek	43.2	--	--	970	--
14096840	Quartz Creek	--	--	--	1/200	--
14097100	Warm Springs R	526	--	1,560	6,350	1,030
14097230	Paquet Gulch	6.4	--	--	140	--
14101500	White River	417	11,300	2,830	7,910	1,510

1/ Estimate.

wettest seasons of record in Oregon, peak flows of streams near the reservation had recurrence intervals ranging from 40 to more than 100 years. The May 1974 discharges in table 3 represent peaks from snowmelt.

Quality of Streamflow

Water samples were taken during the summer when it was expected that chemical quality would be poorest and biological activity would be at its highest level. Generally only one sample was taken per site, and specific changes in quality (either seasonal or long-term) were not documented.

Chemical quality of streams on the reservation generally is excellent (table 10). A complete analysis was made of a sample collected in October 1974 from the Deschutes River at the mouth near Biggs, Oreg. (table 12). (See figure 2.) The analysis indicates the very good quality of water in the basin.

Biological quality of water is highly variable and extremely dependent on temperature, nutrient, and source conditions. Taken about 1½ months apart, samples of the Warm Springs River near the sewage lagoons show a large range of total coliform in the river (table 8). Only general conclusions are warranted from analysis of biological samples taken on any one day. From the limited sampling done, biological quality seems generally good for all streams on or bordering the reservation.

Lakes and Reservoirs

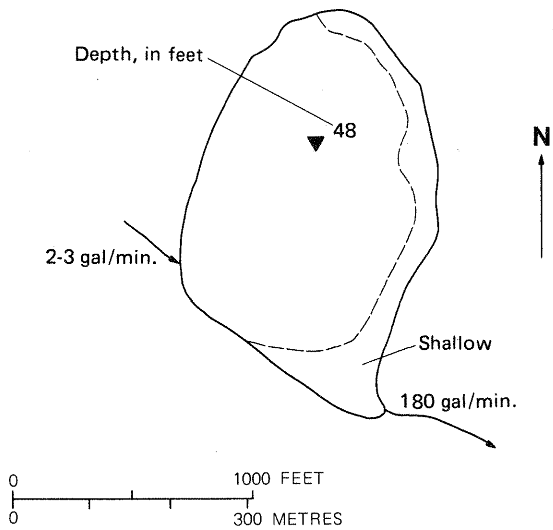
Many high-altitude lakes and several reservoirs are on or adjacent to the reservation. In October 1974, 10 high lakes and one reservoir were visited to obtain selected data. Data for the reservoirs, Lake Billy Chinook, and Lake Simtustus were obtained indirectly and from other reports.

High lakes.--Hydrography of the lakes--their inflows, outflows, and depths--are shown in figures 12 through 21. Most of the lakes are formed in depressions in the rough topography of young volcanic rocks. Those lakes that have little or no ground- or surface-water inflow receive water only from direct rainfall and snow accumulation in the depressions. All the high lakes are bog-type lakes with bottoms composed of fallen trees, talus, and mud ooze.

High lakes of the reservation have water of excellent quality. Data for temperature and dissolved-oxygen profiles were collected at the deepest point in each lake. (See figures 12-21.) Table 13 shows the parameters that were analyzed for 10 of the lakes. In many instances, dissolved solids in these lakes were of the same concentrations as would be expected in local rainwater or snow.

Because the volcanic rocks in the Cascade Range are subject to little chemical weathering, dissolved solids in the lakes are likely to remain low. There is no evidence of bacteriological pollution, even though there is recreational activity at most of the lakes. Unless the lakes are highly overused, the quality of their water should remain excellent.

Location of Sampling Site (▼)		Date of Survey	Surface Area (acres)	Lake Elevation (feet)
Latitude	Longitude			
44°45'12"	121°46'02"	1974	24	5250



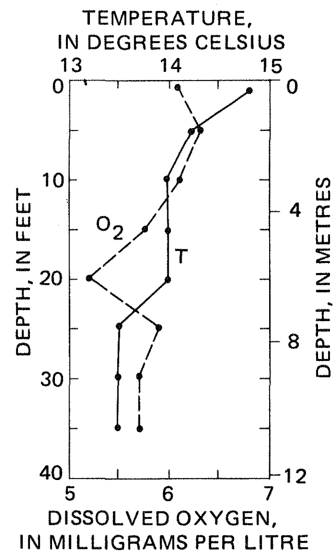
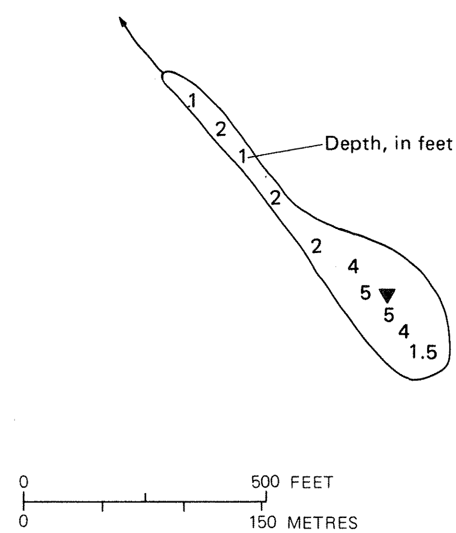


Figure 12.—Hydrography, temperature, and dissolved oxygen for Harvey Lake.

Location of Sampling site (▼)		Date of survey	Surface area (acres)	Lake elevation (feet)
Latitude	Longitude			
44°46'34"	121°46'36"	12-74	1.8	5560



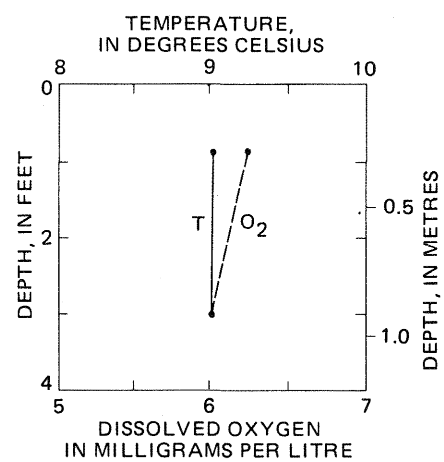


Figure 13.—Hydrography, temperature, and dissolved oxygen for Spoon Lake.

Location of Sampling Site (▼) Latitude	Location of Sampling Site (▼) Longitute	Date of Survey	Surface Area (acres)	Lake Elevation (feet)
44°47'57"	121°45'51"	9-12-74	28	4840

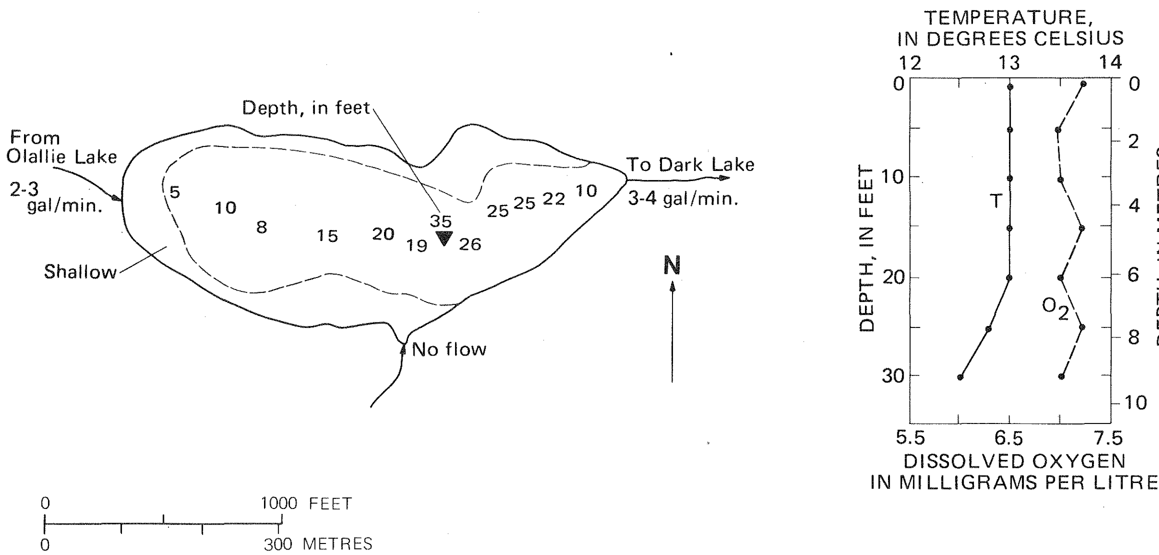


Figure 14.—Hydrography, temperature, and dissolved oxygen for Long Lake.

Location of Sampling Site (▼) Latitude	Location of Sampling Site (▼) Longitute	Date of Survey	Surface Area (acres)	Lake Elevation (feet)
44°47'49"	121°45'29"	9-12-74	23	4700

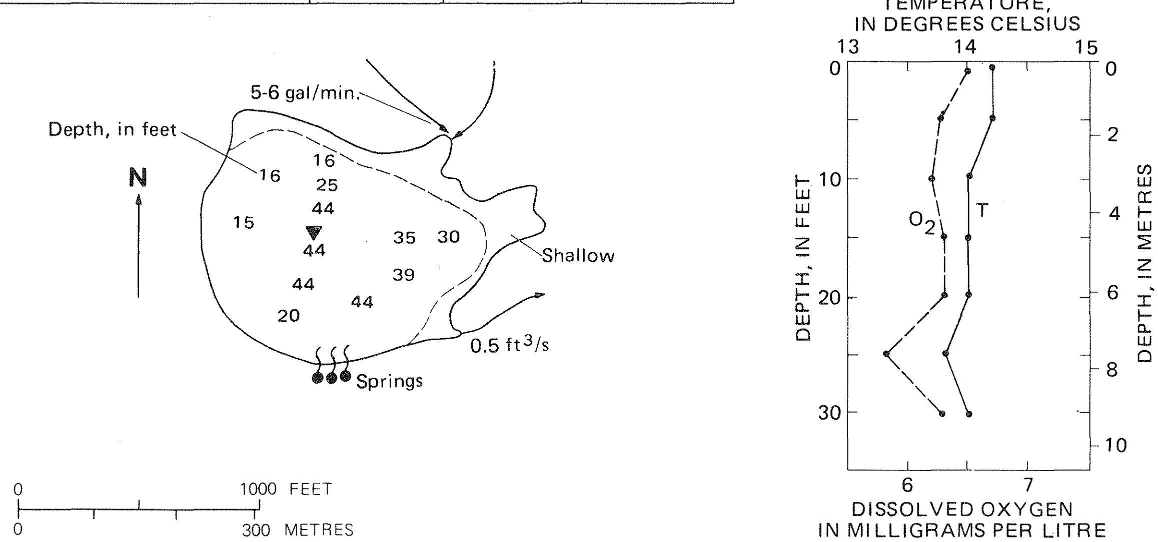


Figure 15.—Hydrography, temperature, and dissolved oxygen for Dark Lake.

Location of Sampling Site (▼)		Date of Survey	Surface Area (acres)	Lake Elevation (feet)
Latitude	Longitude			
44°47′42″	121°44′48″	9-17-74	28	4685

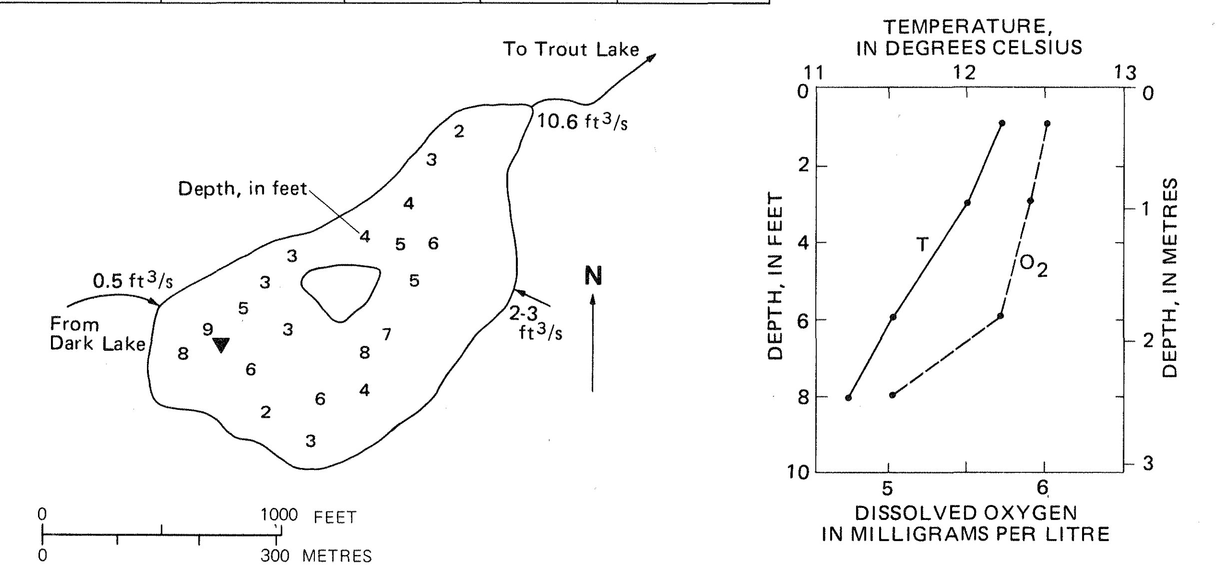


Figure 16.—Hydrography, temperature, and dissolved oxygen for Island Lake.

Location of Sampling Site (▼)		Date of Survey	Surface Area (acres)	Lake Elevation (feet)
Latitude	Longitute			
44°48′00″	121°44′05″	9-17-74	23	4419

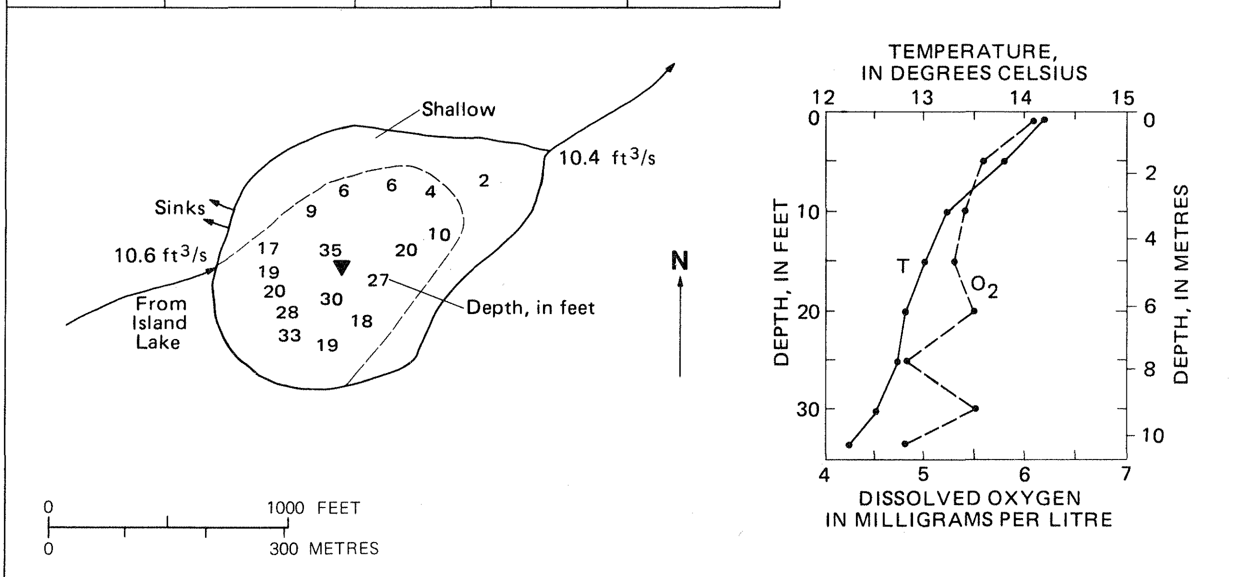


Figure 17.—Hydrography, temperature, and dissolved oxygen for Trout Lake.

Location of Sampling Site (▼)		Date of Survey	Surface Area (acres)	Lake Elevation (feet)
Latitude	Longitude			
44°47'05"	121°43'31"	9-18-74	50	4651

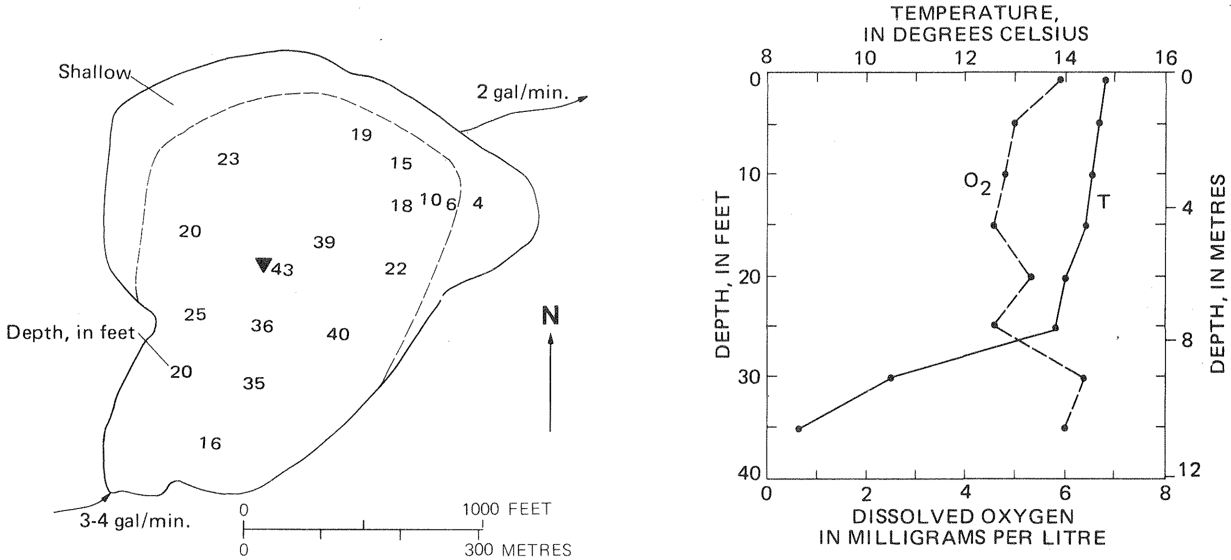


Figure 18.—Hydrography, temperature, and dissolved oxygen for Boulder Lake.

Location of Sampling Site (▼)		Date of Survey	Surface Area (acres)	Lake Elevation (feet)
Latitude	Longitude			
44°50'36"	121°44'20"	9-18-74	13	5058

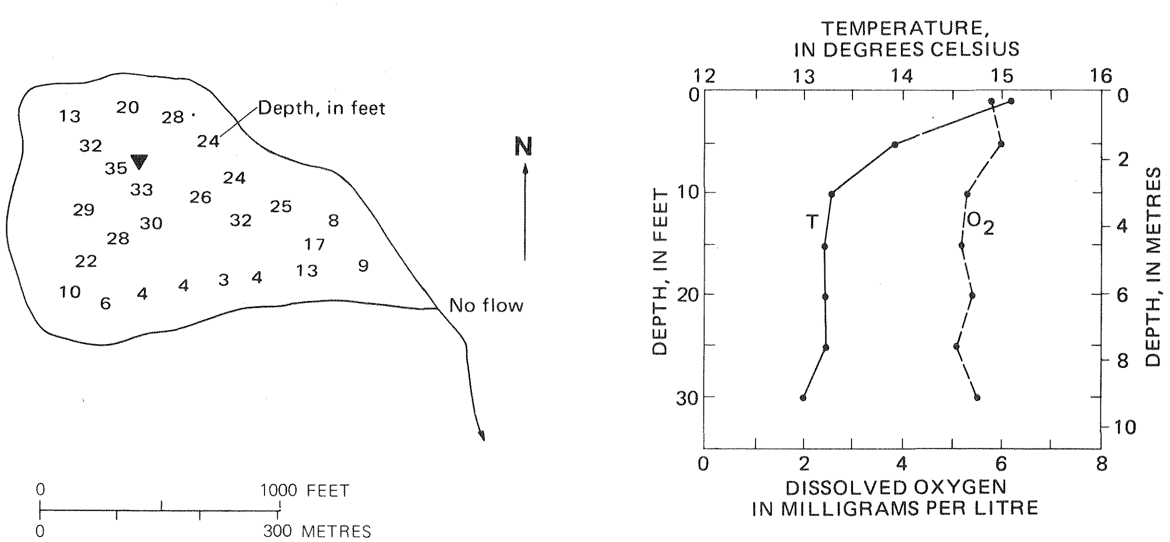
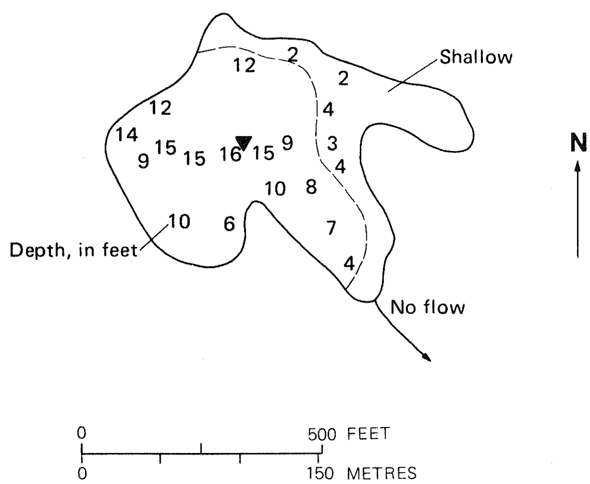


Figure 19.—Hydrography, temperature, and dissolved oxygen for Blue Lake.

Location of Sampling Site (▼)		Date of Survey	Surface Area (acres)	Lake Elevation (feet)
Latitude	Longitude			
44°26'26"	121°46'44"	9-13-74	5	5650



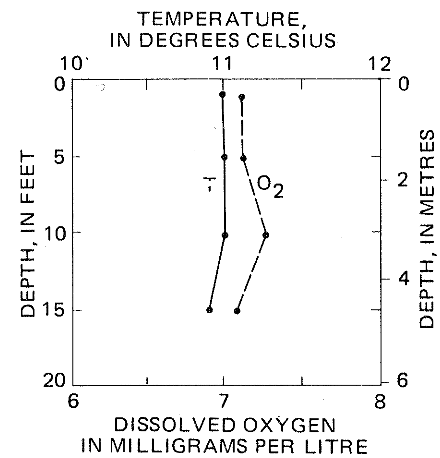
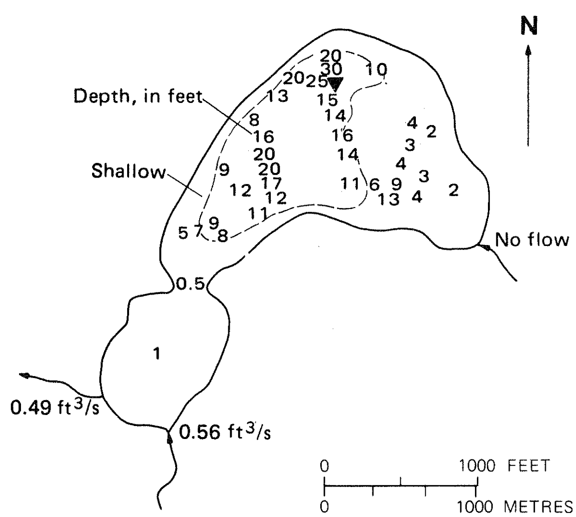


Figure 20.—Hydrography, temperature, and dissolved oxygen for Gibson Lake.

Location of Sampling Site (▼)		Date of Survey	Surface Area (acres)	Lake Elevation (feet)
Latitude	Longitude			
44°46'13"	121°46'38"	9-11-74	55	5500



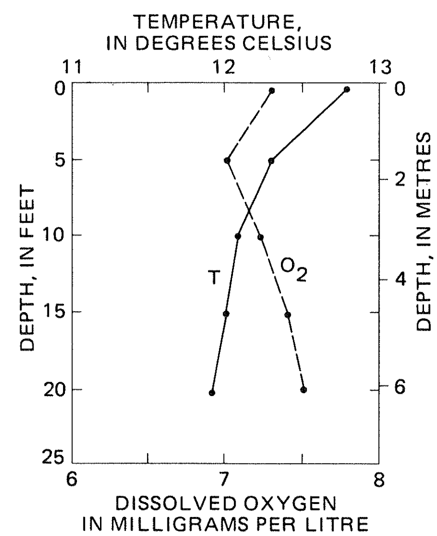


Figure 21.—Hydrography, temperature, and dissolved oxygen for Breitenbush Lake.

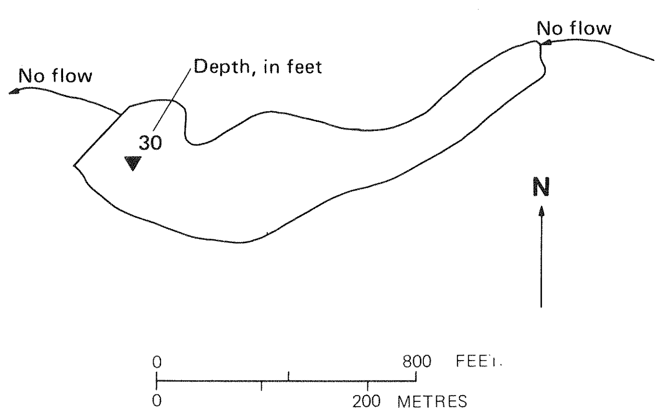
Reservoirs.--Happy Valley Reservoir is formed by an earth-fill dam across Quartz Creek just southeast of Simnasho. During most of the summer there is no inflow nor outflow to the reservoir, and only winter rains and spring runoff from snowmelt sustain its level.

A chemical analysis of Happy Valley Reservoir (see table 10) shows the good chemical quality of the water, with all analyzed constituents well below recommended limits. The fecal coliform content was 14 colonies/100 ml. Temperature and dissolved-oxygen profiles were made at the deepest point in the reservoir (fig. 22).

Lake Billy Chinook and Lake Simtustus are part of the Deschutes River system and form part of the reservation boundary. Flow through the reservoirs is large compared to their storage capacities; water constantly moves through them even in summer. Algae blooms occurring in late summer suggest that a warm, slow-moving or stagnant upper layer of water overlies a cooler, faster moving lower layer. Mullarkey (1967) observed that Lake Billy Chinook is stratified, and that in the Metolius arm, the upper layer usually moves upstream with the wind.

Chemical analyses and coliform sampling for Lakes Billy Chinook and Simtustus are discussed under the section "Deschutes River" (p. 22). Because blue-green algae blooms occur in both lakes (McHugh, 1972), they probably receive some nutrient enrichment in suspended form. Nutrients probably do not attain very high levels because blue-green algae blooms usually occur in a low-nitrogen environment and late summer should provide the most favorable environment.

Location of Sampling Site (▼)		Date of Survey	Surface Area (acres)	Lake Elevation (feet)
Latitude	Longitute			
44°58'08"	121°19'17"	9-17-74	13	2500



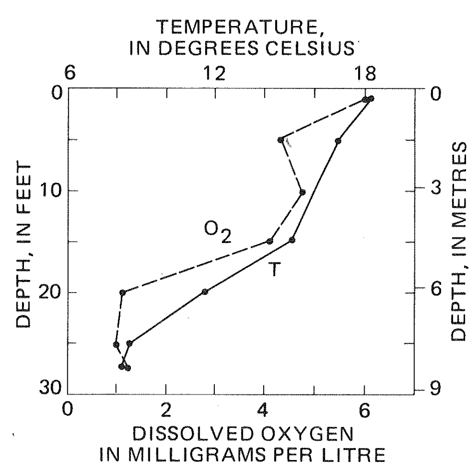


Figure 22.—Hydrography, temperature, and dissolved oxygen for Happy Valley Reservoir.

Ground Water

Occurrence and Movement

Ground water lies beneath the land surface, filling or saturating the openings of the rocks or deposits in which it occurs. An aquifer is a formation or part of one that contains sufficient saturated material to yield significant quantities of water to wells or springs.

Where the upper surface of the ground-water body is at atmospheric pressure, the surface is called the water table; most of the ground water on the reservation occurs under water-table conditions. Perched ground water is separated from an underlying body of ground water by an unsaturated zone; perched water may occur in a few places on the reservation, including part of Schoolie Flat. Confined or artesian ground water has a hydraulic head (or a water level, in a well that penetrated an aquifer) that is above the top of the aquifer; no confined water has been observed on the reservation.

The sources of ground water are precipitation, which percolates downward through unsaturated, permeable material to the water table, and water lost by leakage from lakes or streams that may lie temporarily or permanently above the water table.

Ground water may leave an aquifer in several ways. Where the water table is shallow, it may contribute directly to the flow of a stream or the level of a lake, it may emerge locally as springs, it may evaporate at the land surface, or it may supply plants which transpire water to the atmosphere. On the reservation, a small quantity of ground water is withdrawn from wells. Movement of ground water within an aquifer is mostly lateral, from areas where altitude of the water table is high to areas where it is low; the movement is generally parallel to the general slope of the topography.

Ground water in the Warm Springs Indian Reservation moves very slowly, but rather steadily, eastward from the Cascade Range, where the topography and the water table are highest and precipitation is greatest. In the process, some of the ground water is intercepted by the larger streams that cross the reservation. Not all the ground water moves eastward; some, for example, moves westward from its source in the Mutton Mountains across Schoolie Flat and is intercepted by Beaver Creek or the Warm Springs River.

The altitude (or depth below land surface) of the water table is known or may be inferred at selected points throughout the reservation, but in only a few areas is the water table regular enough or its level documented adequately enough that it can reasonably be portrayed on a map. Areas where the water table can be portrayed are the northern plateaus (see pl. 1) that lie between Shitike and Beaver Creeks, and part of Schoolie Flat. Water-table contours, based on water levels in wells and the altitudes of streams, are shown at intervals of 100 ft (30 m). The water table is relatively smooth because the area is underlain by the Dalles Formation and the gravel and basalt units, which are fairly permeable and allow ground water to move freely.

In areas underlain by less permeable rock, the water table can be expected to be quite irregular, reflecting the topography and generally occurring at depths of less than 100 ft (30 m).

Springs

Springs may occur where the water table intersects the land surface or where the land surface is intersected by formations with good permeability overlying those with low permeability. Springs are more likely to occur in areas where aquifers receive the most recharge from precipitation, as in the Cascade Range where they are abundant. However, springs may be found throughout the reservation wherever geologic conditions are favorable.

Selected springs are shown on plate 1, and data for the springs are given in table 14. (See figure 23, well- and spring-numbering system.) In the drier, eastern part of the reservation, many of the springs are the principal or sole local source of domestic or stock water. In the mountainous western part, perennial streams are abundant and there are few people and livestock; thus, there is little need to depend on springs.

Springs, in addition to those inventoried for this study, are shown on U.S. Geological Survey quadrangle maps at scales of 1:24,000 and 1:62,500.

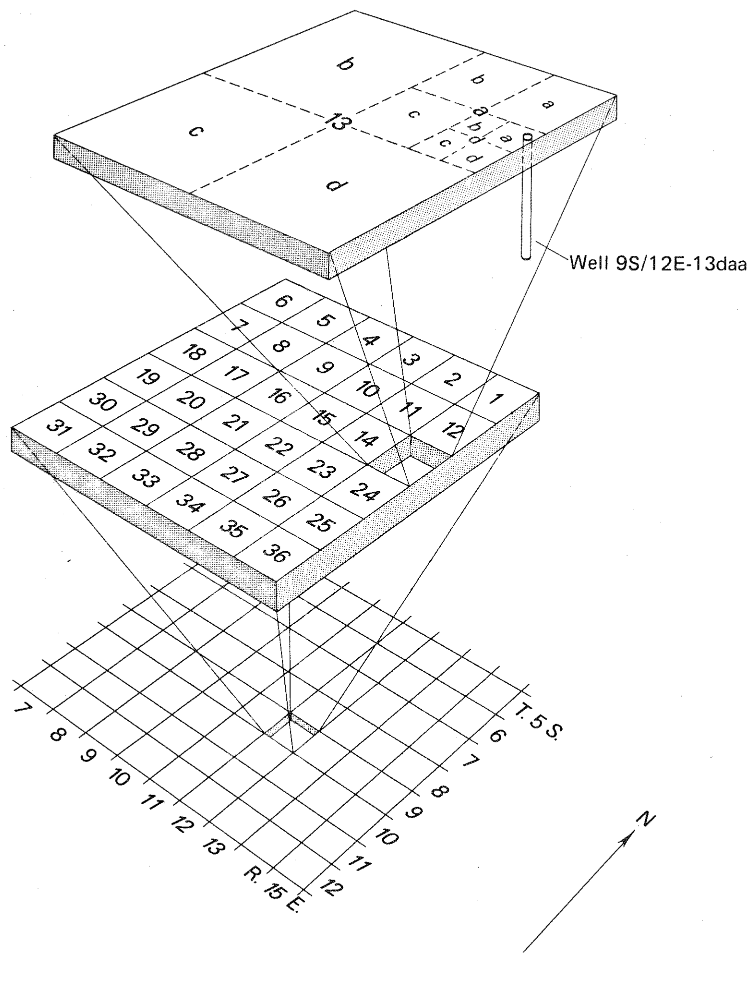


Figure 23.—Well- and spring-numbering system.

Springs occur in a variety of environments, but a few generalizations are relevant. Springs are more likely to lie near the bottom of a canyon, where the water table is nearest to the surface, than on a topographic high. A spring is more likely to emerge where a steep slope breaks into a gentle one, because the break may represent the contact between two geologic units that control movement of ground water.

Buck Springs (8S/12E-29dbb), one of the largest on the reservation, is an example of a geologically controlled spring that discharges from a perched ground-water body. The springs emerge from talus (loose rock) in the canyon (see fig. 24) several hundred feet above the river. Source area of its water is Miller Flat, including the upper Dry Creek drainage. The ground water probably moves through permeable gravels at the top of the Dalles Formation where the Dalles underlies basalt and overlies the poorly permeable John Day Formation. The ground water moves eastward beneath Miller Flat until it reaches the canyon of the Warm Springs River, but it is unaffected by local topography and does not follow the upper Dry Creek channel where it bends to the southeast. Consequently, Dry Creek does not receive ground water that would otherwise be expected to contribute to the minimum flow of the stream.

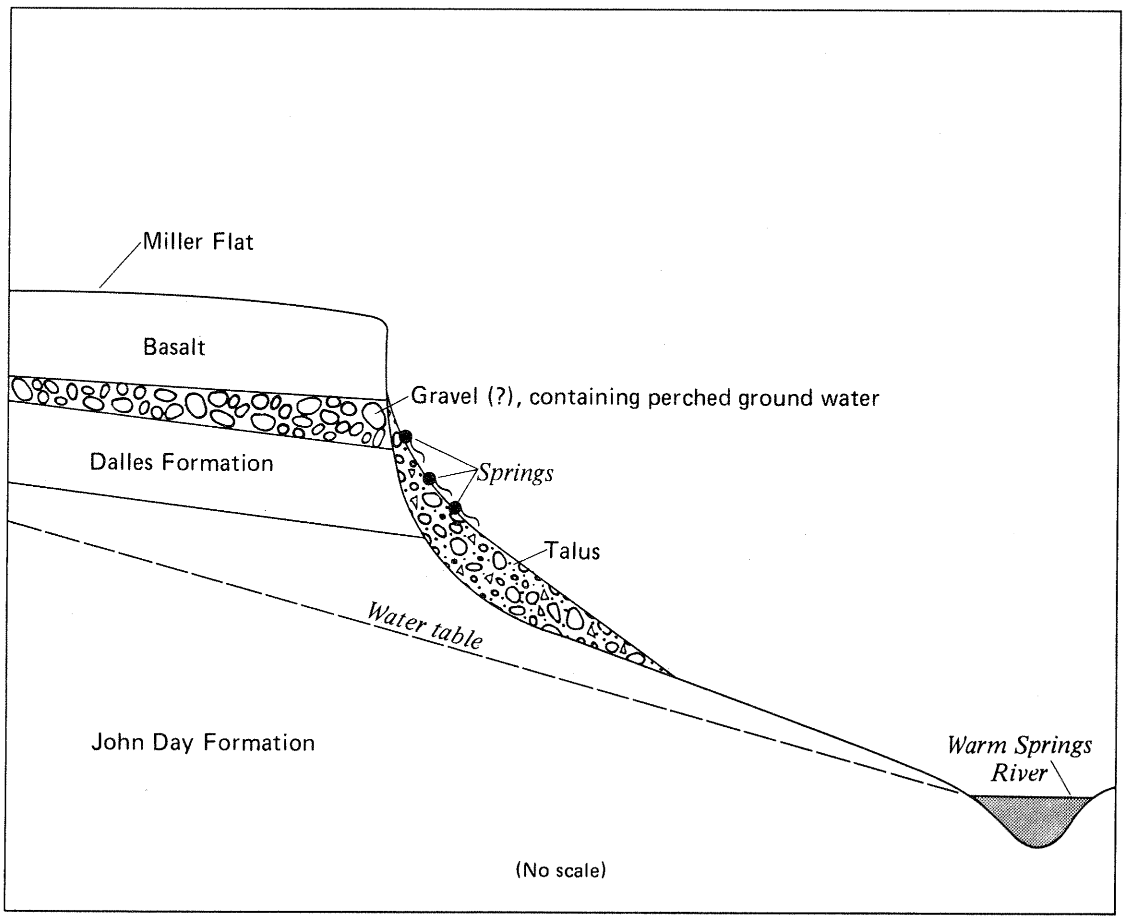


Figure 24.—Cross section showing probable conditions at Buck Springs (8S/12E-29dbb).

Many springs have been artificially developed for stock or domestic supplies, using collectors, piping, and storage facilities to obtain maximum yield or maintain sanitary protection. (See U.S. Public Health Service, 1962b, for descriptions of typical methods.) Springs need not have a large flow to be adequate; with storage tanks or cisterns, springs yielding as little as 1/8 gal/min (0.01 l/s) could supply water for more than a dozen horses or one small family.

Hot Springs

A group of warm or hot springs lies adjacent to the Warm Springs River in secs. 19 and 20, T. 8 S., R. 13 E. The springs are along a 1½-mi (2½-km) reach of the river, lie several hundred feet or less from the river, and issue only a few feet above river level. Discharges of individual springs range from small seeps to the 50 gal/min (3 l/s) estimated for the spring (8S/13E-20adc) that supplies the resort at Kahneeta Hot Springs. The springs that can be pinpointed and observed flow directly from fractures in rhyolite or welded tuff of the John Day Formation. Water from some springs may also be transmitted through rock fractures, but is dispersed through the overlying stream gravels.

Temperatures of the hot springs vary, but are as great at 182°F (83.5°C) (8S/13E-19bad). Temperature of the spring supplying the resort fluctuates seasonally from about 117° to 126°F (47° to 52°C).

Wells

More than 50 wells or test holes have been drilled on the reservation for stock water, individual domestic supplies, and community supplies. Data for wells for which records are available are contained in table 15, and logs of wells, based on drillers' reports, are in table 16. The logs, adapted to a uniform format, include descriptions and depths of materials penetrated by each well and the authors' interpretations of which formations are represented. Altitude (above sea level) of the base of each unit is based on the land-surface altitude estimated from a topographic map.

Well yields vary from one formation to another and from place to place--from less than ½ gal/min (0.03 l/s) to about 30 gal/min (2 l/s). Wells or test holes that obtain water totally or primarily from the Clarno Formation generally have low yields, and most probably will yield less than 2 gal/min (0.1 l/s) on a continuous basis. Yields of the Florence Pete test hole (7S/11E-14abd) and the Schoolie Flat 400-ft (120-m) test well (7S/12E-29cdd) were inadequate and the wells were never used.

In 1955, S. G. Brown of the Geological Survey made a pumping test of the Frank Suppah well (7S/12E-34cab), which is probably completed in the Clarno Formation (fig. 25). Varying rates of pumping made the results difficult to interpret, but Brown concluded that the well yielded about 4 gal/min (0.25 l/s) on a short-term basis and that its sustained yield would be about 2 gal/min (0.13 l/s) or 3,000 gal/day (10,000 l/day). The test shows that the well taps rocks of low permeability.

The Simnasho community well (7S/12E-7dbb) may draw water from the Clarno Formation, although no driller's log is available to verify the aquifer. The reported yield, as much as 22 gal/min (1.4 l/s) during a short-term test and as much as 10 gal/min (0.6 l/s) on a continuous basis, is unusually high for a formation as poorly permeable as the Clarno is in most places.

Because of its low permeability, the John Day Formation is not generally a good aquifer, although a number of wells and test holes have been drilled to develop water from it. Reported yields of short-term tests range from less than 1 to more than 10 gal/min (0.06 to 0.6 l/s); sustained yields probably would average less than 2 gal/min (0.12 l/s).

The 250-ft (76-m) Sarena Boyd well (8S/13E-27cdc), which produces water from the John Day Formation, was test pumped for 4½ hours on April 23, 1973 (fig. 26). During the first 2 hours of the test the drawdown was 28 ft (9 m) at a pumping rate of 5 gal/min (0.3 l/s). When the pumping rate was increased, first to 8 and then to 10 gal/min (0.5 to 0.6 l/s), the drawdown increased to 216 ft (65.8 m). Sustained yield of the well is unknown, but may be several gallons per minute or less.

The Charles Jackson well (10S/12E-1caa2), which is within 1/8 mi (200 m) of the Deschutes River, probably could yield as much as 3 or 4 gal/min (0.2 or 0.3 l/s) on a steady basis (fig. 27).

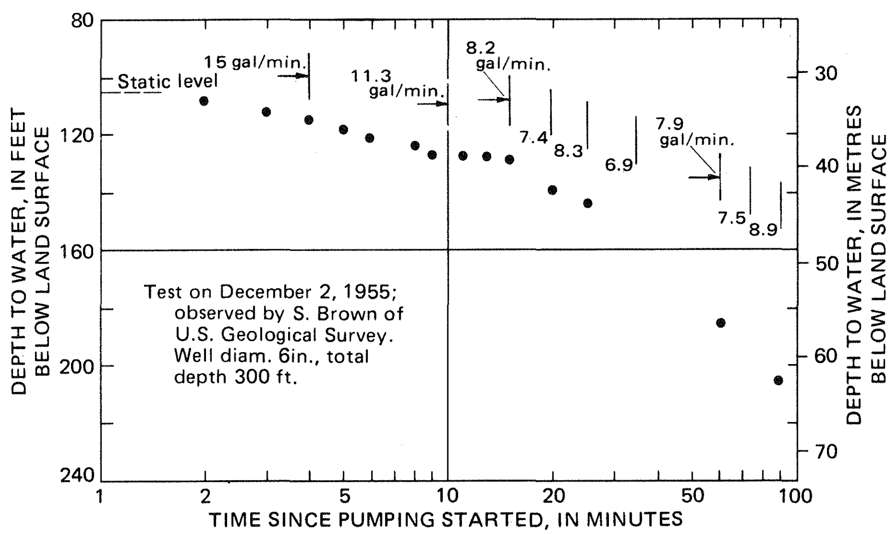


Figure 25.—Water levels during drawdown test of Frank Suppah well 7S/12E-34cab.

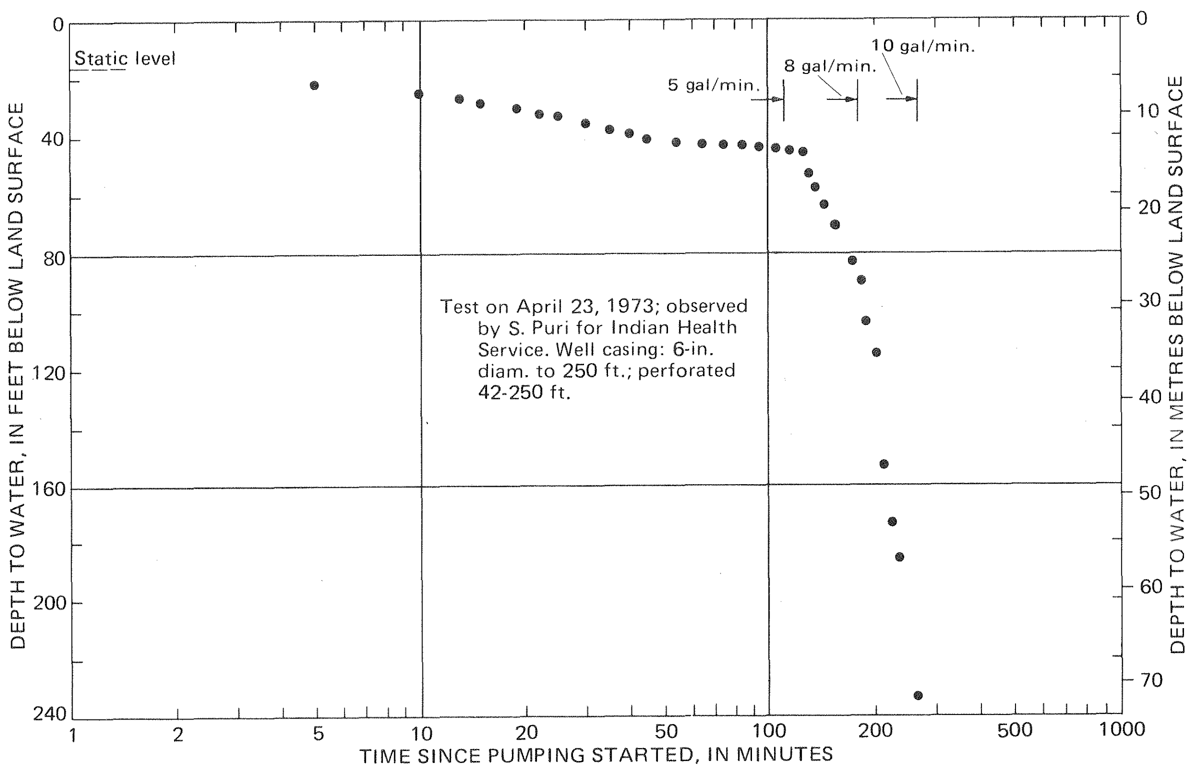


Figure 26.—Water levels during drawdown test of Sarena Boyd well 8S/13E-27cdc.

The Dalles Formation also is an aquifer that has rather low permeability. Tests made in two wells producing water from the Dalles Formation indicate that sustained yields might range from 3 to 12 gal/min (0.2 to 0.8 l/s). The Elmer Quinn well (8S/11E-25ccc) was tested at 17 to 18½ gal/min (1.1 to 1.2 l/s) (fig. 28). By the end of the 4-hour test, the water level had stabilized, indicating that the well had intercepted a source of replenishment to the aquifer. The Irene Wells well (8S/11E-33ddd) was tested at 12 gal/min (0.76 l/s) with about 33 ft (10 m) of drawdown (fig. 29). Within about 2 hours the water level stabilized in a manner similar to that of the Quinn well.

On Schoolie Flat, a test well 380 ft (116 m) deep (8S/12E-3cac), completed in basalt overlying Clarno Formation, was tested initially at 2 gal/min (0.12 l/s) (fig. 30).

Well 8S/12E-3cab is 150 ft (46 m) deep, and within several hundred feet of well 8S/12E-3cac. Well -3cab is completed in alluvium or basalt and has a shallower static water level than -3cac, suggesting that it may be perched above the water table. During one (fig. 31) of two pumping tests, the level dropped about 20 ft (6 m) in 2 hours of pumping at 3 gal/min (0.2 l/s). When the pumping rate was increased to 5 gal/min (0.3 l/s), the water level dropped rapidly, as it might if a shallow zone in the aquifer were dewatered. During a later test (not included in this report), the well was pumped for 4 hours at an average rate of 2.7 gal/min (0.17 l/s), drawing the water level down 20 ft (6 m), but without dewatering the shallow zone.

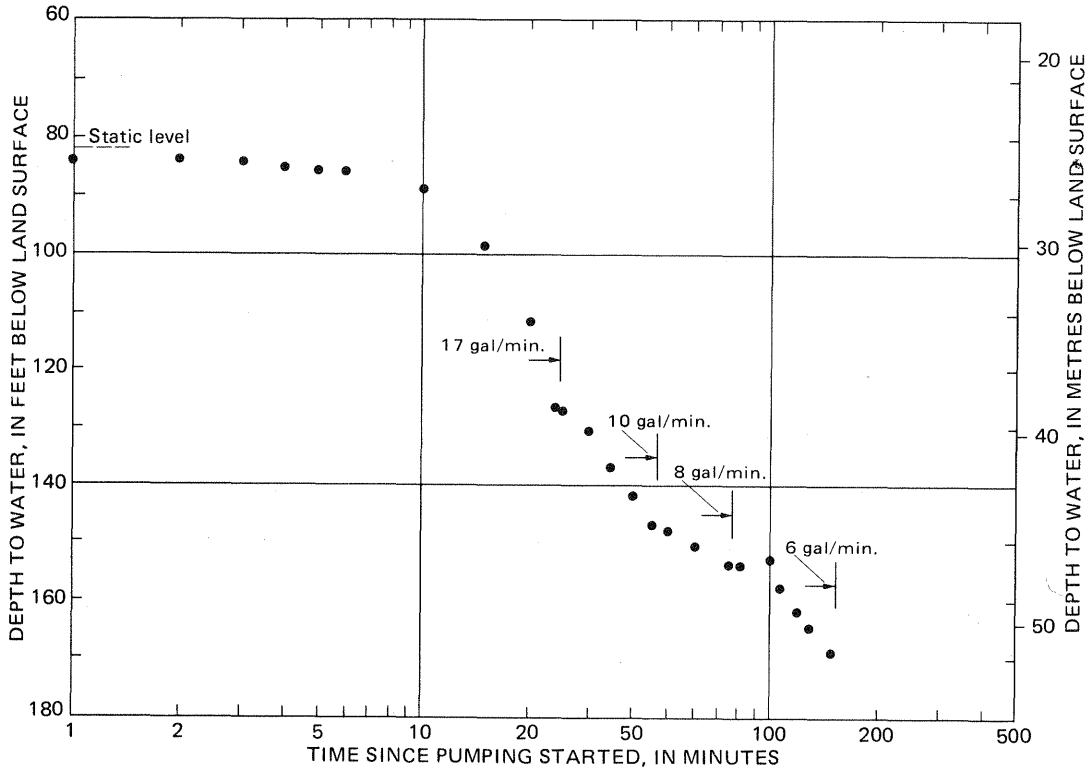


Figure 27.—Water levels during drawdown test of Charles Jackson well 10S/12E-Icaa2.

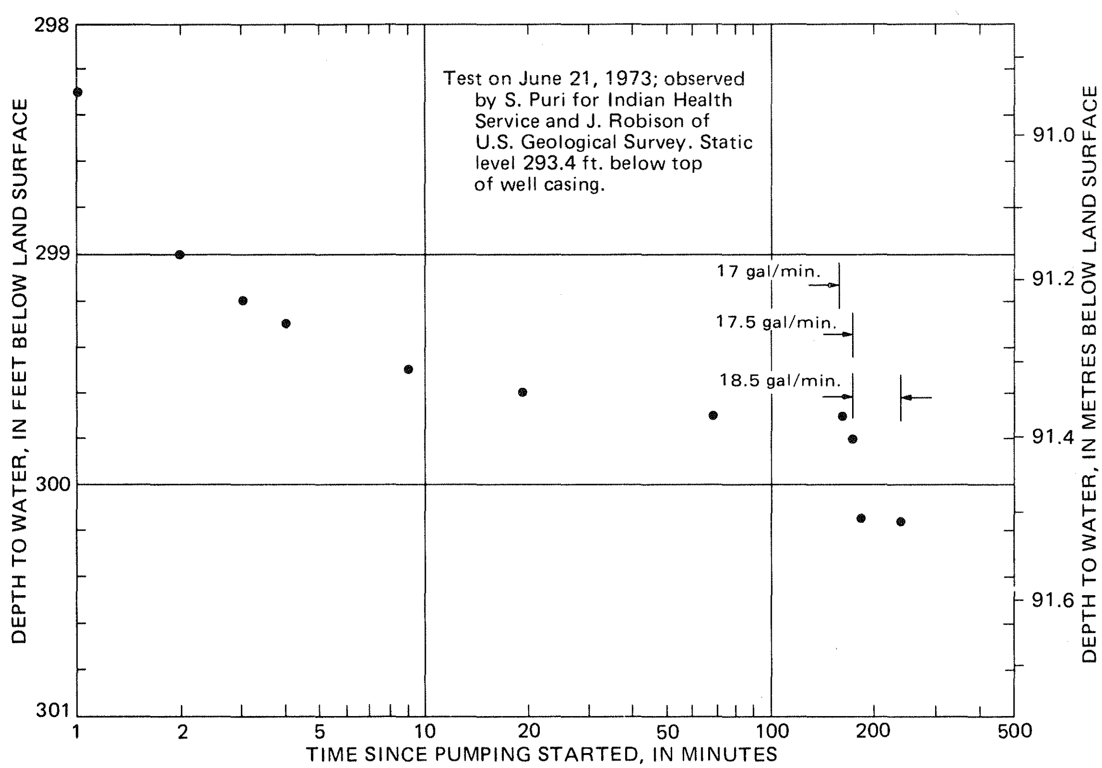


Figure 28.—Water levels during drawdown test of Elmer Quinn well 8S/11E-25ccc.

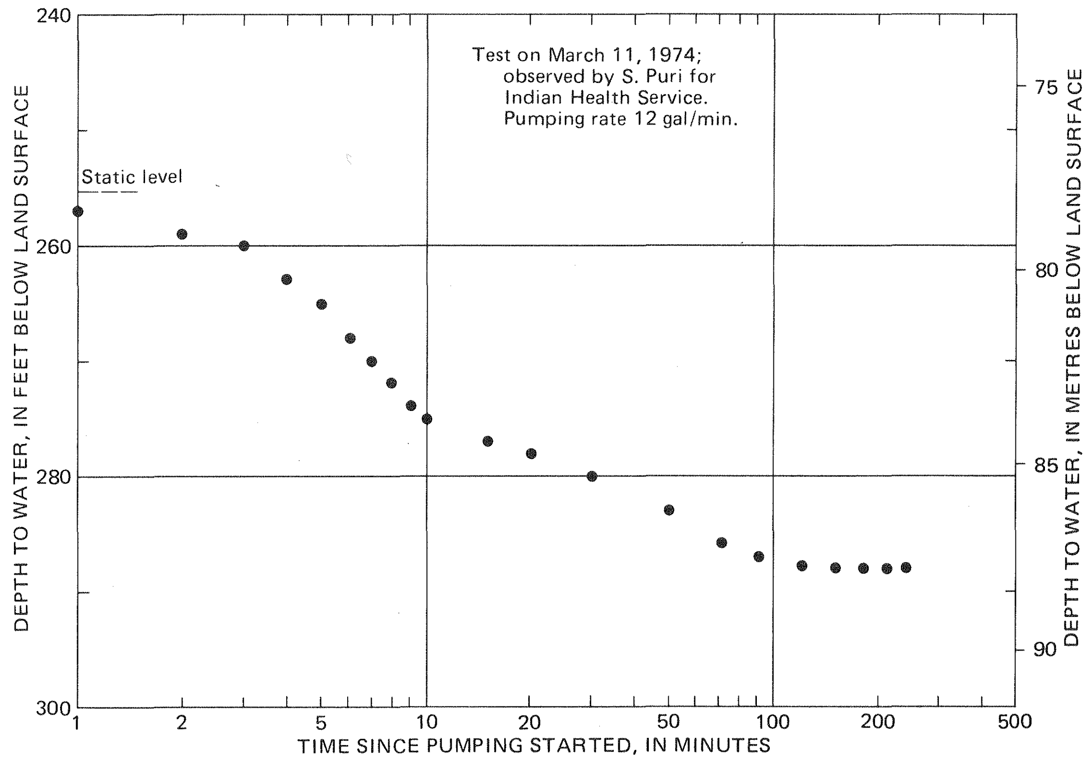


Figure 29.—Water levels during drawdown test of Irene Wells well 8S/11E-33ddd.

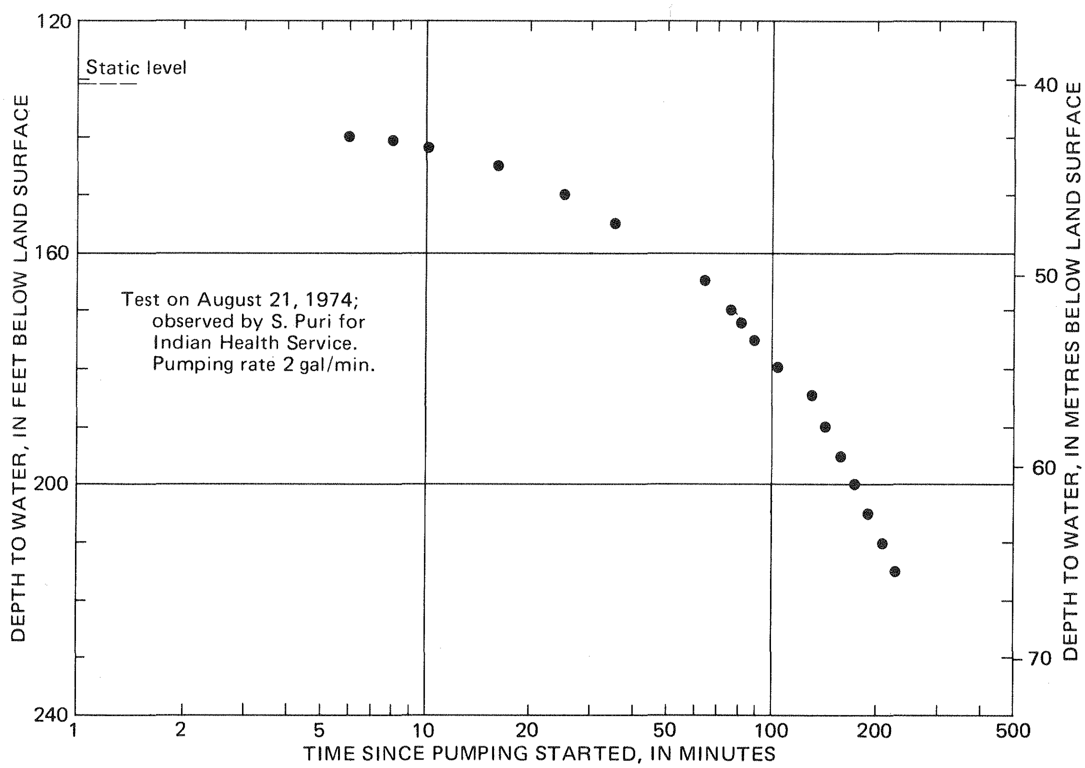


Figure 30.—Water levels during drawdown test of Schoolie Flat 380-ft test well 8S/12E-3cac.

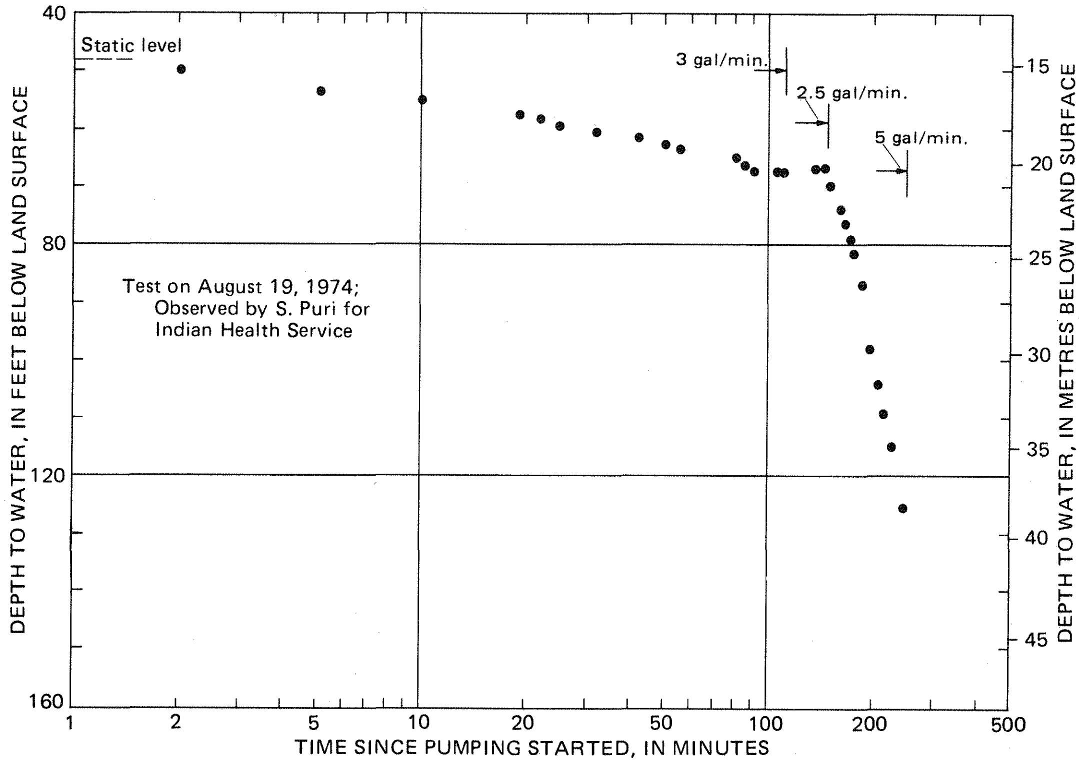


Figure 31.—Water levels during drawdown test of Schoolie Flat 150-ft test well 8S/12E-3cab.

The Albert Comedown well (7S/11E-32bdd), which produces water from the gravel unit that overlies basalt on Mill Creek Flat, was tested by the driller and observed by personnel of the Geological Survey. At a pumping rate of 22 gal/min (1.4 l/s), the water level declined 0.1 ft (0.03 m) within a few minutes, but after several hours had not dropped as much as 0.2 ft (0.06 m). Because precision of the equipment for discriminating the small changes in water level was not adequate, the permeability of the formation could not be determined; it is obviously much higher, however, than for any other formation tested.

Results similar to the Comedown well were reported by the driller of the Grant Waheneka well (7S/11E-32bab). The well, also completed in gravel, yielded 25 gal/min (1.6 l/s) with 1 in (25 mm) of drawdown reported after 5 hours of pumping.

Quality of Ground Water

Ground water from most wells and springs is of good chemical quality, low in dissolved constituents (table 17), and suitable for use by humans, stock, or for irrigation. Only 20 percent of the samples exceeded recommended limits for iron, and none exceeded recommended sulfate, chloride, or nitrate limits. (See page 83.) Except for hot springs, no samples exceeded fluoride or dissolved-solids limits. Samples from five supplies intended for human consumption exceeded 0.01 mg/l of arsenic, a limit recommended when other supplies are available, but none exceeded the recommended permissible limit of 0.05 mg/l. Most of the water sampled was soft; only two samples were more than moderately hard.

Chemical character of water, as indicated by the proportions of major constituents, can be seen from the chemical diagrams on plate 1. Water of similar sources and histories typically has similarly shaped diagrams, and dissimilar sources produce dissimilar shapes. Ground water from the western part of the reservation and from most wells adjacent to streams in the central part contains more calcium or magnesium than sodium ions. Water from poorly permeable formations, such as the John Day and Clarno Formations, is likely to have a greater proportion of sodium because of increased contact with sodium-bearing minerals, including clays.

The chemical diagrams enable visual comparison of ground water with surface water; because of less contact with rocks, surface water generally has fewer dissolved minerals than does ground water.

Water from the several hot springs (8S/13E-19bad, -20acd, and -20bdb) in the Kahneeta area contains several times as much dissolved solids as most of the ground water, and it may have a taste that is unpleasant to some persons. The chemical character is distinct, and the hot water has a higher proportion of sodium and chloride than does other water. The water is quite suitable for swimming and the associated recreational uses that have been made of it; because of excessive fluoride and arsenic, hot-springs water would not be suitable as a domestic or community supply intended for general human consumption.

Standards for the Usability of Water

Domestic Use

For drinking water, the Federal Water Pollution Control Administration (1968) recommended standards for public supplies, based on those of the U.S. Public Health Service. Some of the standards for chemical constituents reported for this study include:

Constituent	Recommended permissible limit of concentration (mg/l)	Constituent	Recommended permissible limit of concentration (mg/l)
Iron (Fe)	0.3	Nitrate (NO_3) + nitrite (NO_2), expressed as nitrate	44
Sulfate (SO_4)	250		
Chloride (Cl)	250		
Fluoride (F)	1/1.3		
Arsenic (As)	.05	Dissolved solids	500

1/ Value based on average maximum daily air temperature in the vicinity of Warm Springs. Temperature is an indication of the probable consumption of water by individuals.

The above are recommended limits for public supplies; concentrations exceeding these values may be acceptable to many users and are used in many places where more acceptable supplies are not available.

Excessive iron causes staining of plumbing fixtures and laundry and can give a peculiar taste to the water. Chloride in excess of 500 mg/l and dissolved solids in excess of 1,000 mg/l give a salty or mineral taste to the water. Sulfate causes permanent hardness of water and in excessive concentrations can have a laxative effect on persons not accustomed to the water. Fluoride is beneficial up to the recommended limit because it retards dental decay, but in concentrations of more than several milligrams per litre can eventually cause darkening or mottling of children's teeth. Large amounts of nitrate can cause methemoglobinemia (blue-baby effect) in infants.

Excessive hardness is undesirable but seldom is cause for rejection of a water supply. Commercial softeners can be used for most supplies. The U.S. Geological Survey uses the following rating for hardness:

Hardness range (as $CaCO_3$) (mg/l)	Rating
0-60	Soft
61-120	Moderately hard
121-180	Hard
More than 180	Very hard

Excessive arsenic, ingested over a prolonged period, can result in chronic poisoning. Diagnosis is difficult because many of the symptoms are often attributable to other causes.

Coliform bacteria are organisms that usually occur in sewage and in polluted waters; they may be detected after subjecting a sample of the water to a process that will allow growth of colonies of the bacteria. Common sources of coliform are soil, vegetation, and animal or human feces. A large concentration of coliform does not necessarily indicate a pollution problem, but the water may be considered to have disease-producing potential. Fecal coliform, whose source is the feces of warmblooded animals, is a variety considered to be a more positive indication of disease-producing potential. Standards considered by the Federal Water Pollution Control Administration (1968) for public water supplies include a "desirable" limit, prior to treatment, of less than 100 colonies/100 ml (millilitres) for total coliform, less than 20 colonies/100 ml for fecal coliform; and a "permissible" limit of as much as 10,000 colonies/100 ml for total coliform and as much as 2,000 colonies/100 ml for fecal coliform. After the water is treated for drinking, the coliform colonies should not exceed 4 colonies/100 ml. For contact water sports, the Oregon Department of Environmental Quality (oral commun., August 9, 1973) has established a conditional upper limit of 1,000 colonies/100 ml for total coliform.

Excessive sediment in water is objectionable primarily because of its physical appearance; most individuals would rather not drink the water. Excessive sediment clogs pipes and water tanks. There are no generally established limits for sediment concentration, but usually the higher the concentration the more objectionable it is. Removal of sediment in water can be expensive if concentration is high and continued.

Turbidity is a general measure of the optical properties of the water. High turbidity values usually reflect high sediment concentrations, but not always. It is possible to have a very low sediment concentration with high turbidity if the suspended matter is very fine or highly reflective. The desirable limit for drinking water set by the Public Health Service (1962) is 5 NTU (Nephelometric turbidity units).

Transparency is related to turbidity and is the depth to which an object (usually a black and white Secchi disk) can be seen below the surface of the water.

Use by Livestock or Fish

Ideally, the same standards would apply for water consumed by livestock as for water consumed by humans; however, animals are more tolerant of saline water than are humans--as much as about 3,000 mg/l dissolved solids for poultry and as much as 10,000 mg/l for cattle. If fish are living in a water supply, it is probably suitable for livestock consumption.

Dissolved oxygen (DO) is essential for maintaining fish and other aquatic life. The solubility of oxygen varies inversely with temperature and altitude. The availability of oxygen is controlled by the degree of mixing of the water, pollution, and other factors. For trout and salmon, the optimum concentration is 6 or more mg/l. Figure 32 shows livability zones for rainbow trout that depend on dissolved oxygen and temperature; the zones range from the most desirable (I) to lethal (IV).

Irrigation Use

General salinity, as shown by dissolved solids or by electrical conductivity, may control plant growth; dissolved solids exceeding 1,000-2,000 mg/l may have an adverse effect on crops.

The SAR (sodium-adsorption-ratio) indicates the effect that a water will have on soil-drainage characteristics. Water with a high SAR value eventually causes clogging of most soils. An SAR of about four is the limit for crops that are sensitive to the effect of soil clogging.

Boron is necessary up to about 0.5 mg/l, but in higher concentrations it has a toxic effect on plants; yellowing of leaves is one symptom. Some plants are more sensitive than others; among the more sensitive are citrus, peaches, apples, pears, and walnuts. Water that contains more than 4 mg/l of boron may be unsuitable even for tolerant crops.

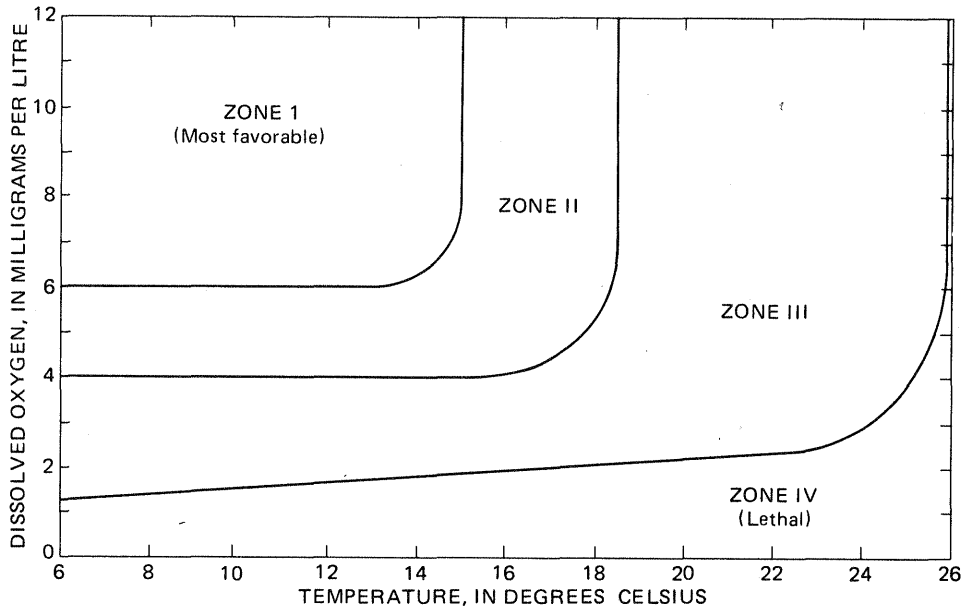


Figure 32.—Livability zones for rainbow trout based on combinations of dissolved oxygen and temperature. (Adapted from Smith and Bella, 1973, p. 129.)

CONCLUSIONS

Flows of the three major streams in or bounding the reservation--the Warm Springs, Metolius, and Deshutes Rivers--are large and have relatively constant high base flows. Flows of the smaller streams are more variable, and some streams can be expected to go dry. Chemical and biological quality of the streams is generally good, as is the quality of reservoirs and high lakes.

Availability of ground water to drilled wells is variable, ranging from less than ½ gal/min (0.03 l/s) to about 30 gal/min (2 l/s). Except in the Cascade Range, most springs yield only a few gallons per minute or less. Thus, ground water is available in quantities adequate only for stock, domestic, and very small community supplies; it is generally inadequate for irrigation or for industrial or municipal supplies.

Chemical quality of ground water is generally good, although dissolved constituents in water from some wells approach recommended limits for drinking water.

GLOSSARY OF SELECTED TERMS

Aquifer.--A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells or springs.

Base flow (base runoff).--The runoff component of a stream that is composed primarily of ground-water inflow. A stream at its seasonal minimum usually contains only base flow.

Correlation.--The relation between one variable and one or more related variables.

Discharge (outflow).--A measure of the total water that passes a given point or location, reported either as a volume (acre-feet or cubic hectometres) or as a rate (cubic feet per second, cubic metres per second, or acre-feet per year).

Drawdown.--In a well, the extent of lowering of the water level during pumping. The difference, in feet or metres, between the static water level and the pumping level.

Dependable low flow.--As used in this report, the lowest average rate of discharge during a 7-day period (excluding short periods of winter ice effect) that may be expected on the average of once in 50 years. Dependable low flows for long-term stations were determined by using a log-Pearson Type III frequency analysis.

Mean annual .....--The arithmetic average value (of streamflow or other quantity) that is obtained from all yearly values during a specific period. It differs from the Annual mean ......, which is the average value for one particular year. Similar usage also applies to other periods, such as months or days.

Permeability.--A general term that denotes the relative ease with which a porous medium, such as a geologic formation, can transmit water or other liquid.

Recurrence interval.--The average interval of time between the occurrence of events of a specified magnitude. A flood with a magnitude that has a recurrence interval of 25 years has a 4 percent chance of occurring in any given year. The actual spacing of the events is not necessarily regular; two floods of 25-year frequency can occur in consecutive years or at intervals much longer than 25 years.

Sediment yield.--The total load of fragmental material transported by or suspended in water and that passes a given location. The yield is usually reported as tons or as tons (or cubic feet) per square mile of drainage area.

Specific conductance.--The ability of water or other substance to conduct an electric current. Conductance of water increases with increasing concentration of dissolved-mineral matter; it is therefore an approximate index to the concentration of dissolved solids. Specific conductance may be measured with simple instruments either in the field or in a laboratory.

Static level.--The level at which water stands in a well that is not affected by recent pumping. The level is usually reported in feet or metres below land surface.

Streamflow.--All the discharge that occurs in a natural channel. (See Discharge.) Runoff is that part of the streamflow that is unaffected by artificial diversions, storage, or other manmade changes.

Transparency.--The depth to which an object (usually a black and white Secchi disk) can be seen below the surface of the water. It indicates the relative clarity of the water.

Transpiration.--The process by which water escapes as vapor from a living plant, principally from the leaves, and enters the atmosphere.

Water table.--The upper surface of a zone of saturation of an unconfined water body. It is defined by the levels at which water stands in wells that penetrate the water body just far enough to hold standing water. In wells that penetrate to greater depths, the water level will stand above or below the water table if an upward or downward component of ground-water flow exists.

Water year.--The 12-month period, October 1 through September 30. It is designated by the calendar year in which it ends.

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BASIC-DATA RECORDS

Table 4.--Daily discharge of the Warm Springs River, 1973-74

14097100 WARM SPRINGS RIVER NEAR KAHNEETA HOT SPRINGS, OREG.

LOCATION.--Lat 44°51'24", long 121°08'55", in SE¼SW¼ sec.23, T.8 S., R.13 E., Wasco County, Warm Springs Indian Reservation, on right bank at mile 4.6 (7.4 km).

DRAINAGE AREA.--526 mi^2 (1,362 km^2).

PERIOD OF RECORD.--October 1972 to September 1974.

EXTREMES.--Water year 1973: Maximum discharge, 1,560 ft^3/s (44.2 m^3/s) Dec. 21, gage height, 3.81 ft (1.161 m); minimum, 227 ft^3/s (6.43 m^3/s) Aug. 15, 16, Sept. 6.

Water year 1974: Maximum discharge, 6,350 ft^3/s (180 m^3/s) Jan. 16, gage height, 8.68 ft (2.646 m); minimum, 234 ft^3/s (6.63 m^3/s) Oct. 1-4.

Period of record: Maximum discharge, 6,350 ft^3/s (180 m^3/s) Jan. 16, 1974, gage height, 8.68 ft (2.646 m); minimum, 227 ft^3/s (6.43 m^3/s) Aug. 15, 16, Sept. 6, 1973.

REMARKS.--Records excellent. No regulation. Diversions above station.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1972 TO SEPTEMBER 1973
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	319	317	317	416	370	377	333	330	276	253	234	232
2	319	331	317	414	373	377	326	327	277	252	232	231
3	317	336	318	398	368	366	325	325	278	252	232	232
4	315	348	306	354	369	366	320	327	276	250	233	231
5	314	352	302	377	372	363	324	330	279	249	234	231
6	317	338	300	359	364	361	329	325	273	248	237	230
7	317	332	295	340	354	359	320	325	271	250	237	236
8	317	326	290	340	350	358	320	331	268	249	234	238
9	317	324	290	335	348	357	321	335	265	246	234	235
10	318	327	285	330	353	372	321	331	266	244	235	234
11	324	331	285	330	347	394	324	327	264	242	234	232
12	325	326	285	344	350	378	331	319	268	241	232	231
13	326	326	280	672	349	375	369	314	268	241	233	231
14	323	326	280	958	343	370	343	311	265	241	231	231
15	322	323	280	774	340	363	343	312	265	240	230	231
16	320	323	280	753	345	362	344	314	266	238	230	231
17	319	324	280	683	361	366	362	311	283	237	231	232
18	317	321	450	604	353	361	359	308	285	237	231	239
19	320	319	830	578	341	360	356	305	276	243	231	239
20	319	317	907	524	341	357	352	300	271	247	232	246
21	318	315	1220	501	337	354	343	301	267	249	231	245
22	314	314	1360	450	335	348	337	299	266	241	231	252
23	313	314	991	456	335	334	338	297	265	238	231	259
24	312	314	836	453	336	336	338	301	265	238	234	258
25	313	315	753	439	345	340	334	306	265	237	240	264
26	316	335	632	389	363	340	334	306	265	237	237	249
27	317	332	577	391	367	340	340	300	261	237	234	241
28	321	324	548	399	367	338	335	297	257	244	233	238
29	319	321	492	378	---	329	335	291	254	238	234	238
30	316	319	463	388	---	334	333	287	253	237	234	236
31	314	---	441	385	---	338	---	283	---	234	233	---
TOTAL	9858	9770	15490	14512	9876	11073	10089	9675	8058	7530	7229	7153
MEAN	318	326	500	468	353	357	336	312	269	243	233	238
MAX	326	352	1360	958	373	394	369	335	285	253	240	264
MIN	312	314	280	330	335	329	320	283	253	234	230	230
CFSM	.60	.62	.95	.89	.67	.68	.64	.59	.51	.46	.44	.45
IN.	.70	.69	1.10	1.03	.70	.78	.71	.68	.57	.53	.51	.51
AC-FT	19550	19380	30720	28780	19590	21960	20010	19190	15980	14940	14340	14190

WTR YR 1973 TOTAL 120313 MEAN 330 MAX 1360 MIN 230 CFSM .63 IN 8.51 AC-FT 238600

Table 4.--Daily discharge of the Warm Springs River, 1973-74--Continued

14097100 WARM SPRINGS RIVER NEAR KAHNEETA HOT SPRINGS, OREG.--Continued

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	236	355	605	719	1120	804	1150	798	774	513	336	309
2	237	305	459	599	962	769	1110	813	780	509	333	309
3	237	280	401	570	892	662	981	797	831	491	332	309
4	237	281	377	530	961	635	909	788	903	463	331	300
5	238	290	360	500	937	669	895	798	1120	459	327	303
6	240	281	360	470	823	716	859	834	1110	458	324	302
7	246	282	665	450	777	650	809	916	1030	447	323	302
8	243	286	732	430	746	618	777	967	951	432	324	302
9	244	351	607	440	717	625	773	1020	878	438	325	304
10	257	455	538	470	687	606	742	1020	835	433	325	306
11	255	619	495	506	671	625	713	973	823	427	324	305
12	254	682	467	570	655	669	764	984	839	416	322	304
13	251	564	497	609	631	644	733	946	866	406	324	303
14	249	432	464	1640	618	642	709	884	890	397	327	302
15	247	423	560	4730	605	809	700	870	906	387	327	302
16	241	489	665	5670	651	953	696	819	900	386	324	302
17	238	511	1130	4360	629	802	698	778	875	388	323	300
18	238	423	942	3890	615	759	708	739	855	382	322	299
19	239	373	772	3570	1380	753	717	703	832	382	324	299
20	255	352	781	2580	1010	720	714	672	806	370	326	299
21	263	355	1390	2020	923	702	716	655	772	364	324	298
22	262	343	1090	1720	834	690	738	648	725	358	322	299
23	259	329	963	1530	780	675	822	654	695	355	322	299
24	255	335	836	1330	727	667	851	669	661	351	320	299
25	254	347	1130	1240	705	672	890	698	628	348	318	298
26	249	350	980	1150	690	687	861	766	608	346	318	296
27	246	333	931	1060	684	695	803	854	584	344	315	296
28	247	386	1610	1020	775	761	772	877	556	344	315	299
29	256	492	1240	931	---	893	761	850	535	342	315	299
30	249	589	985	884	---	1310	767	821	521	347	310	299
31	258	---	900	926	---	1210	---	792	---	340	308	---
TOTAL	7680	11893	23932	47114	22205	23092	24138	25403	24089	12423	10010	9043
MEAN	248	396	772	1520	793	745	805	819	803	401	323	301
MAX	263	682	1610	5670	1380	1310	1150	1020	1120	513	336	309
MIN	236	280	360	430	605	606	696	648	521	340	308	296
CFSM	.47	.75	1.47	2.89	1.51	1.42	1.53	1.56	1.53	.76	.61	.57
IN.	.54	.84	1.69	3.33	1.57	1.63	1.71	1.80	1.70	.88	.71	.64
AC-FT	15230	23590	47470	93450	44040	45800	47880	50390	47780	24640	19850	17940

CAL YR 1973 TOTAL 128700 MEAN 353 MAX 1610 MIN 230 CFSM .67 IN 9.10 AC-FT 255300
WTR YR 1974 TOTAL 241022 MEAN 660 MAX 5670 MIN 236 CFSM 1.25 IN 17.05 AC-FT 478100

Table 5.--Daily discharge of Shitike Creek, 1973-74

14093000 SHITIKE CREEK NEAR WARM SPRINGS, OREG.

LOCATION.--Lat 44°45'41", long 121°13'57", in NW¼NW¼ sec.30, T.9 S., R.13 E., Jefferson County, Warm Springs Indian Reservation, on left bank 1.9 mi (3.1 km) east of Warm Springs and at mile 0.3 (0.5 km).

DRAINAGE AREA.--105 mi² (272 km²).

PERIOD OF RECORD.--October 1972 to September 1974.

GAGE.--Nonrecording gage. Altitude of gage is 1,380 ft (421 m), from topographic map.

EXTREMES.--Water year 1973: Maximum daily discharge, 690 ft³/s (19.5 m³/s) Dec. 21; minimum daily, 20 ft³/s (0.57 m³/s) Dec. 8-15.
Water year 1974: Maximum daily discharge, 2,300 ft³/s (65.1 m³/s) Jan. 15; minimum daily, 31 ft³/s (0.88 m³/s) Oct. 18.
Period of record: Maximum daily discharge, 2,300 ft³/s (65.1 m³/s) Jan. 15, 1974; minimum daily, 20 ft³/s (0.57 m³/s) Dec. 8-15, 1972.

REMARKS.--Records fair. No regulation. Some water is diverted for mill pond at point 0.3 mi (0.5 km) above station.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1972 TO SEPTEMBER 1973
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	66	57	57	100	75	71	60	67	75	64	38	35
2	64	90	57	91	75	71	57	67	75	64	35	38
3	64	76	59	86	71	67	57	67	75	57	38	35
4	64	102	37	78	71	67	57	75	71	60	41	33
5	61	85	37	82	71	67	57	71	71	60	41	33
6	59	76	37	71	67	67	57	71	78	57	41	33
7	59	71	30	60	67	67	60	71	88	53	38	35
8	59	66	20	44	67	64	60	71	91	50	38	41
9	59	61	20	67	64	64	60	71	86	47	38	35
10	61	68	20	75	67	67	60	71	82	50	38	35
11	68	66	20	86	64	71	60	67	60	50	38	33
12	64	64	20	158	64	67	64	71	67	47	38	33
13	66	61	20	500	64	67	64	78	75	44	38	33
14	66	61	20	450	64	64	64	86	71	47	35	33
15	66	57	20	248	60	64	71	105	75	47	35	33
16	59	61	54	216	64	64	75	152	75	44	38	33
17	61	61	126	182	60	64	78	122	78	44	38	33
18	57	59	215	158	64	64	78	116	60	44	35	33
19	57	57	495	140	64	60	71	128	64	47	35	35
20	54	57	470	128	64	60	71	105	67	50	35	38
21	57	52	690	122	60	64	71	78	71	47	35	41
22	57	57	625	110	57	57	71	78	71	47	35	53
23	52	52	376	105	60	62	67	82	75	44	35	60
24	52	52	280	100	60	64	67	128	75	44	41	78
25	52	61	224	96	60	64	67	116	75	41	41	105
26	57	150	170	78	62	64	67	100	82	41	44	57
27	52	80	164	86	64	60	75	75	91	41	44	52
28	52	71	140	82	67	60	78	71	71	41	41	44
29	57	66	128	82	---	64	78	71	64	41	38	44
30	57	61	116	82	---	67	71	71	64	41	35	41
31	52	---	110	78	---	64	---	71	---	41	35	---
TOTAL	1831	2058	4857	4041	1817	2007	1993	2673	2223	1495	1175	1265
MEAN	59.1	68.6	157	130	64.9	64.7	66.4	86.2	74.1	48.2	37.9	42.2
MAX	68	150	690	500	75	71	78	152	91	64	44	105
MIN	52	52	20	44	57	57	57	67	60	41	35	33
AC-FT	3630	4080	9630	8020	3600	3980	3950	5300	4410	2970	2330	2510

WTR YR 1973 TOTAL 27435 MEAN 75.2 MAX 690 MIN 20 AC-FT 54420

Table 5.--Daily discharge of Shitike Creek, 1973-74--Continued

14093000 SHITIKE CREEK NEAR WARM SPRINGS, OREG.--Continued

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	41	187	130	136	182	128	235	172	323	257	124	78
2	41	94	98	136	190	124	214	168	356	189	124	81
3	37	81	89	123	180	121	189	168	390	176	129	78
4	37	81	85	98	160	117	180	164	390	185	129	77
5	37	69	81	95	149	117	176	168	546	194	126	77
6	37	57	81	85	138	117	172	185	390	214	116	80
7	37	53	203	80	138	114	164	263	323	176	109	77
8	37	61	255	80	134	108	156	268	280	168	109	77
9	41	61	187	80	134	111	153	280	246	164	113	77
10	41	61	143	85	136	111	145	250	235	156	113	76
11	37	98	136	95	126	111	145	230	268	149	116	76
12	37	123	123	100	126	114	142	230	292	149	116	76
13	37	130	117	130	119	108	142	230	349	145	106	74
14	37	136	107	500	119	117	134	225	356	156	103	74
15	35	123	107	2300	122	114	128	219	427	147	100	74
16	35	165	123	2100	121	124	128	214	390	142	100	72
17	33	136	165	1200	124	128	134	209	336	142	100	70
18	31	102	284	1100	124	138	134	192	342	160	102	68
19	33	107	220	1000	194	138	134	185	323	156	94	68
20	35	98	345	760	153	134	139	185	329	168	94	67
21	53	94	460	610	145	128	142	185	310	156	91	67
22	53	85	356	450	140	131	142	185	298	147	91	67
23	53	81	314	350	133	131	145	189	310	142	94	67
24	41	81	212	300	129	131	145	199	246	134	94	67
25	41	77	378	255	129	131	156	356	251	131	91	65
26	53	69	274	230	129	134	164	427	219	131	88	65
27	57	65	293	210	133	134	160	427	185	138	88	65
28	64	94	284	190	138	164	145	349	194	142	91	65
29	67	102	255	180	---	206	145	298	313	142	85	63
30	50	117	229	175	---	286	149	280	235	147	83	64
31	71	---	187	174	---	246	---	263	---	131	81	---
TOTAL	1339	2888	6321	13407	3945	4216	4637	7363	9452	4934	3200	2152
MEAN	43.2	96.3	204	432	141	136	155	238	315	159	103	71.7
MAX	71	187	460	2300	194	286	235	427	546	257	129	81
MIN	31	53	81	80	119	108	128	164	185	131	81	63
AC-FT	2660	5730	12540	26590	7820	8360	9200	14600	18750	9790	6350	4270

CAL YR 1973 TOTAL 29237 MEAN 80.1 MAX 500 MIN 31 AC-FT 57990
WTR YR 1974 TOTAL 63854 MEAN 175 MAX 2300 MIN 31 AC-FT 126700

Table 6.--Daily discharge of the White River, 1973-74

14101500 WHITE RIVER BELOW TYGH VALLEY, OREG.

LOCATION.--Lat 45°14'30", long 121°05'38", in NE¼NE¼ sec.7, T.4 S., R.14 E., Wasco County, on left bank 200 ft (61 m) downstream from former Pacific Power & Light Co. powerplant at White River Falls, 3.9 mi (6.3 km) east of town of Tygh Valley, and at mile 2.0 (3.2 km).

DRAINAGE AREA.--417 mi^2 (1,080 km^2).

PERIOD OF RECORD.--October 1917 to September 1974.

GAGE.--Water-stage recorder. Datum of gage is 870.15 ft (265.222 m) above mean sea level (levels by Pacific Power & Light Co.). Prior to July 28, 1931, at site 750 ft (229 m) downstream at different datum. July 28, 1931, to Sept. 30, 1954, at site 700 ft (213 m) downstream at different datums.

AVERAGE DISCHARGE.--57 years (1917-74), 431 ft^3/s (12.2 m^3/s), 312,300 acre-ft/yr (385 hm^3/yr).

EXTREMES.--Water year 1973: Maximum discharge, 2,830 ft^3/s (80.1 m^3/s) Dec. 21, gage height, 5.77 ft (1.759 m); minimum, 83 ft^3/s (2.35 m^3/s) Sept. 4, 17.

Water year 1974: Maximum discharge, 7,910 ft^3/s (224 m^3/s) Jan. 16, gage height, 9.74 ft (2.969 m); minimum, 94 ft^3/s (2.66 m^3/s) Oct. 4.

Period of record: Maximum discharge, 13,300 ft^3/s (377 m^3/s) Jan. 6, 1923, gage height, about 13.3 ft (4.05 m), site and datum then in use, from rating curve extended above 5,000 ft^3/s (142 m^3/s); minimum, 7.5 ft^3/s (0.21 m^3/s) Aug. 31, 1961, minimum daily, 71 ft^3/s (2.01 m^3/s) Aug. 31, 1941.

REMARKS.--Records good. No regulation. Diversions above station for irrigation.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1972 TO SEPTEMBER 1973
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	150	145	187	420	312	293	201	234	167	128	107	94
2	146	175	188	416	300	292	195	238	170	123	107	90
3	141	181	186	388	297	288	187	238	165	121	113	87
4	136	200	169	332	293	285	190	245	160	121	109	85
5	133	203	142	352	286	281	205	241	154	123	109	90
6	130	177	131	308	279	276	214	231	149	121	115	88
7	130	167	130	286	265	272	205	231	147	123	105	92
8	130	162	130	251	258	269	197	231	147	121	99	94
9	130	157	129	258	255	271	198	231	144	119	97	90
10	131	163	129	308	258	312	199	225	139	119	97	92
11	141	163	130	324	251	325	211	228	137	119	97	94
12	140	157	132	425	248	304	219	218	133	115	97	88
13	142	154	134	1140	248	303	226	221	133	115	101	87
14	145	152	138	1240	248	291	228	234	130	115	101	87
15	142	149	143	936	245	282	222	241	137	117	99	87
16	140	149	154	901	251	283	241	245	135	121	97	85
17	140	149	253	810	262	283	265	231	149	123	99	83
18	138	148	583	708	255	273	248	225	152	115	96	85
19	137	149	763	642	245	269	245	215	135	117	94	87
20	137	145	762	560	238	262	248	205	126	121	94	96
21	136	142	2180	520	234	255	238	199	121	121	90	96
22	137	141	1460	470	231	247	248	196	123	117	92	107
23	135	139	1130	450	231	241	269	196	128	117	90	115
24	132	151	1060	430	234	240	258	209	128	111	103	130
25	132	157	936	416	248	238	238	218	130	111	107	167
26	141	428	756	368	269	239	238	209	147	113	94	123
27	146	273	714	368	276	235	255	199	144	117	90	109
28	146	226	642	356	279	229	245	199	135	117	88	111
29	145	209	550	340	---	209	241	190	130	113	92	111
30	143	194	505	340	---	203	241	185	128	109	97	115
31	142	---	465	332	---	205	---	176	---	105	97	---
TOTAL	4294	5305	15111	15395	7296	8255	6815	6784	4223	3648	3073	2965
MEAN	139	177	487	497	261	266	227	219	141	118	99.1	98.8
MAX	150	428	2180	1240	312	325	269	245	170	128	115	167
MIN	130	139	129	251	231	203	187	176	121	105	88	83
AC-FT	8520	10520	29970	30540	14470	16370	13520	13460	8380	7240	6100	5880

CAL YR 1972 TOTAL 215252 MEAN 588 MAX 4810 MIN 129 AC-FT 427000
WTR YR 1973 TOTAL 83164 MEAN 228 MAX 2180 MIN 83 AC-FT 165000

Table 6.--Daily discharge of the White River, 1973-74--Continued

14101500 WHITE RIVER BELOW TYGH VALLEY, OREG.--Continued

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	109	339	473	841	1190	635	1190	1110	977	708	238	152
2	101	193	407	738	1060	606	1140	1050	1110	635	231	152
3	99	157	375	650	977	545	1030	1020	1280	578	218	150
4	99	152	351	540	1040	529	956	1030	1480	561	215	152
5	97	157	328	500	956	589	915	1050	1820	556	205	150
6	99	160	343	480	861	641	695	1230	1580	529	190	147
7	109	157	782	470	802	589	841	1390	1390	488	182	145
8	103	162	950	460	751	556	815	1510	1220	463	179	142
9	103	305	732	450	714	534	821	1510	1130	463	176	142
10	103	498	623	470	677	519	789	1400	1130	425	176	147
11	101	671	556	500	647	545	815	1310	1210	412	173	145
12	103	802	503	540	623	578	929	1320	1390	391	176	142
13	101	647	508	623	595	545	847	1170	1530	363	176	140
14	99	488	458	1540	572	578	815	1070	1600	359	171	137
15	99	425	572	5930	561	770	815	984	1620	359	168	137
16	103	653	815	6460	589	802	795	881	1500	347	162	135
17	103	545	1380	4340	567	808	815	795	1500	347	162	137
18	103	444	1220	4090	600	782	854	732	1530	343	162	135
19	101	375	1030	3470	936	757	867	683	1480	339	168	135
20	115	347	1050	2590	795	720	854	653	1390	332	173	133
21	117	332	1930	2040	745	689	874	612	1230	328	165	133
22	123	309	1610	1740	689	671	956	629	1160	324	162	130
23	121	290	1400	1570	635	641	1040	683	1080	316	160	130
24	133	290	1250	1410	595	629	1030	738	950	301	165	126
25	130	287	1760	1350	578	647	1060	901	874	290	162	123
26	126	276	1410	1280	572	677	1010	1150	795	283	160	126
27	113	269	1390	1180	550	714	956	1260	714	276	157	128
28	109	371	1480	1160	623	802	943	1200	671	272	155	126
29	133	420	1370	1080	---	943	943	1110	647	265	152	140
30	115	444	1160	1030	---	1190	1020	1050	683	258	152	147
31	182	---	1030	1100	---	1220	---	998	---	248	155	---
TOTAL	3452	10965	29246	50622	20500	21451	27630	32229	36671	12159	5446	4164
MEAN	111	366	943	1633	732	692	921	1040	1222	392	176	139
MAX	182	802	1930	6460	1190	1220	1190	1510	1820	708	238	152
MIN	97	152	328	450	550	519	789	612	647	248	152	123
AC-FT	6850	21750	58010	100400	40660	42550	54800	63930	72740	24120	10800	8260

CAL YR 1973 TOTAL 102117 MEAN 280 MAX 1930 MIN 83 AC-FT 202500
WTR YR 1974 TOTAL 254535 MEAN 697 MAX 6460 MIN 97 AC-FT 504900

Table 7.--Gain-loss investigations of the Warm Springs River and Mill Creek in 1973

To study channel gains and losses, discharge measurements of the Warm Springs River and its tributaries and diversions were made from May 31 to June 6 and again from October 2 to 5. Measurements were made along the entire length of Mill Creek, which contributes 30 percent of the total flow at its confluence with the Warm Springs River and has therefore been treated as a subreach of the river. Measurements were made during periods when flows of the streams were reasonably constant. During the first measuring period (May 31-June 6), flows at the gaging station at Kahneeta Hot Springs varied less than 2 percent for any 2 days and only about 3.5 percent for the entire period. During the second measuring period, flows at the gaging station varied by less than 1 percent. No measurable precipitation had fallen within the drainage basin for 5 days prior to the first set of measurements nor for 7 days preceding the second set.

In compiling this table, tributary flow was considered to be a contribution, not a gain; diversion was considered to be a deduction, not a loss. Indicated gains or losses may be substantially in error because of inaccuracies in open-channel measurements. Water temperatures have been included in this tabulation because they were helpful in locating major springs.

Date	Stream or diversion	Location	River mile	Discharge, in cubic feet per second: Main stem	Tributary(+) diversion(-)	Gain or loss in section	Total gain	Water temp. °C
		WARM SPRINGS RIVER						
	Warm Springs River	Headwater	51.4	--	--	--	--	--
	do	McQuinn line (reservation boundary)	47.0	--	--	--	--	--
5-31-73	Dry Creek	Near McQuinn line in sec.36, T.6 S., R.8 E.	45.2	--	+0.25	--	--	--
Do	Warm Springs River	do	44.8	2.03	--	--	2.03	8.5
Do	do	At old reservation boundary in sec.6, T.7 S., R.9 E.	43.4	2.24	--	+0.21	2.24	7.0
6- 4-73	do	do	43.4	2.29	--	--	2.29	8.5
Do	R.B. tributary	In sec.4, T.7 S., R.9 E.	41.5	--	+1.40	--	--	10.0
Do	Warm Springs River	10 ft below confluence with tributary in sec.4, T.7 S., R.9 E.	41.5	5.34	--	+1.70	5.34	13.0
Do	R.B. tributary	0.1 mi upstream from upper bridge in sect.3, T.7 S., R.9 E.	40.5	--	+1.50	--	--	--
Do	Warm Springs River	At upper bridge on road W240 in sec.3, T.7 S., R.9 E.	40.4	66.7	--	+59.9	66.7	7.5
Do	Bunchgrass Creek	Near Warm Springs Meadows in sec.2, T.7 S., R.9 E.	39.7	--	+2.02	--	--	11.0
Do	Warm Springs River	30 ft below confluence with Bunchgrass Creek in sec.2, T.7 S., R.9 E.	39.7	76.8	--	+8.10	76.8	10.5
Do	Big Springs	Near Schoolie Bridge in sec.7, T.7 S., R.10 E.	36.3	--	+1.12	--	--	9.5
Do	Warm Springs River	At Schoolie Bridge in sec.7, T.7 S., R.10 E.	36.3	128	--	+50.1	128	13.5
Do	S.F. Warm Springs River	Near Schoolie Pasture at road B200 crossing in sec.18, T.7 S., R.10 E.	36.1	--	+1.84	--	--	14.5
6- 5-73	Warm Springs River	At old gage site (14095500) at HeHe Mill, in sec.18, T.7 S., R.11 E.	29.3	129	--	-1.0	129	14.0
Do	Badger Creek	At Highway 26 crossing approximately 1.5 mi from mouth, in sec.20, T.7 S., R. 11 E.	26.4	--	+14.8	--	--	11.1
Do	Mill Creek Canal	At Highway 26 crossing approximately 2.5 mi from mouth in sec.25, T.8 S., R.11 E.	21.0	--	+2.29	--	--	13.5
6- 6-73	Mill Creek	At Highway 26 crossing approximately 2.9 mi from mouth in sec.21, T.8 S., R.11 E.	20.3	--	+86.2	--	--	12.0
6- 5-73	Warm Springs River	300 ft above confluence with Beaver Creek in sec.18, T.8 S., R.12 E.	18.3	244	--	+12.0	244	14.5
Do	Beaver Creek	At mouth in sec.18, T.8 S., R.12 E.	18.3	--	+45.4	--	--	17.0
6- 6-73	Warm Springs River	Near Tohet Springs in sec.35, T.8 S., R.12 E.	14.4	272	--	-17.0	272	18.0
6- 4-73	Warm Springs River	At fish hatchery in sec.24, T.8 S., R.12 E.	10.3	261	--	-11.0	261	--
Do	do	At gage site (14097100) nr Kahneeta Hot Springs in sec.23, T.8 S., R.13 E.	4.5	278	--	+17.0	278	--
		MILL CREEK						
	Mill Creek	Headwater	24.0	--	--	--	--	--
6- 6-73	do	Outflow of Island Lake near Trout Lake	22.0	15.2	--	+15.2	15.2	15.5
Do	do	Outflow of Trout Lake, in sec.12, T.9 S., R.8 E.	21.4	12.1	--	-3.10	12.1	16.5
Do	N.F. Mill Creek	Outflow of Blue Lake, 3.0 mi from mouth, in sec.25, T.8 S., R.8 E.	17.9	--	+.026	--	--	14.0
Do	Mill Creek	At road B244 crossing in sec.27, T.8 S., R.9 E.	15.8	48.9	--	+36.8	48.9	10.0
Do	do	30 ft above diversion structure, in sec.17, T.8 S., R.10 E.	10.0	46.6	--	-2.30	46.6	12.5
Do	Mill Creek lateral	30 ft below diversion structure, in sec.17, T.8 S., R.10 E.	10.9	--	-7.68	--	--	12.5
6- 5-73	Mill Creek	At road crossing below Potters Pond, in sec.19, T.8 S., R.11 E.	6.2	48.7	--	+9.80	48.7	11.0
Do	Boulder Creek	At B100 road crossing, 1.6 mi upstream from mouth, in sec.31, T.8 S., R.11 E.	4.6	--	Dry	--	--	--
Do	Mill Creek	At Highway 26 crossing, in sec.21, T.8 S., R.11 E.	2.9	86.2	--	+37.5	86.2	12.0

Table 7.--Gain-loss investigations of the Warm Springs River and Mill Creek in 1973--Continued

Date	Stream or diversion	Location	River mile	Discharge, in cubic feet per second: Main stem	Discharge: Tributary(+) diversion(-)	Discharge: Gain or loss in section	Discharge: Total gain	Water temp. °C
		WARM SPRINGS RIVER						
	Warm Springs River	Headwater.	51.4	--	--	--	--	--
	... do ...	McQuinn line (Reservation boundary).	47.0	--	--	--	--	--
10- 5-73	... do ...	At old reservation boundary in sec.6, T.7 S., R.9 E.	43.4	0.26	--	--	0.26	3.0
Do...	R.B. Tributary	In sec.4, T.7 S., R.9 E.	41.5	--	+0.10	--	--	9.5
Do...	Warm Springs River	10 ft below confluence with tributary in sec.4, T.7 S., R.9 E.	41.5	.99	--	+0.63	0.99	5.0
Do...	R.B. tributary	0.1 mi upstream from upper bridge in sec.3, T.7 S., R.9 E.	40.5	--	+.10	--	--	--
Do...	Warm Springs River	At upper bridge on road W240 in sec.3, T.7 S., R.9 E.	40.4	66.6	--	+65.5	66.6	5.0
Do...	Bunchgrass Creek	Near Warm Springs Meadows in sec.2, T.7 S., R.9 E.	39.7	--	+1.30	--	--	6.5
Do...	Warm Springs River	30 ft, below confluence with Bunchgrass Creek in sec.2, T.7 S., R.9 E.	39.7	73.8	--	+5.90	73.8	6.0
Do...	Big Springs	Near Schoolie Bridge in sec.7, T.7 S., R.10 E.	36.3	--	+1.00	--	--	--
Do...	Warm Springs River	At Schoolie Bridge in sec.7, T.7 S., R.10 E.	36.3	116	--	+41.2	116	7.5
Do...	S.F. Warm Springs River	Near Schoolie Pasture at road B200 crossing in sec.18, T.7 S., R.10 E.	36.1	--	+.30	--	--	--
10- 3-73	Warm Springs River	At old gage site (14095500) at Hehe Mill, in sec.18, T.7 S., R.11 E.	29.3	118	--	+2.0	118	7.5
Do...	Badger Creek	At Highway 26 crossing approx. 1.5 mi from mouth, in sec.20, T.7 S., R.11 E.	26.4	--	+8.16	--	--	--
Do...	Mill Creek Canal	At Highway 26 crossing approx. 2.5 mi from mouth in sec.25, T.8 S., R.11 E.	21.0	--	+.3	--	--	--
10- 2-73	Mill Creek	At Highway 26 crossing approx. 2.9 mi from mouth in sec.21, T.8 S., R.11 E.	20.3	--	+70.4	--	--	9.0
10- 3-73	Warm Springs River	300 ft above confluence with Beaver Creek in sec.18, T.8 S., R.12 E.	18.3	195	--	-2.0	195	18.5
Do...	Beaver Creek	At mouth in sec.18, T.8 S., R.12 E.	18.3	--	+35.7	--	--	10.0
Do...	Warm Springs River	Near Tohet Springs in sec.35, T.8 S., R.12 E.	14.4	227	--	-4.0	227	7.0
Do...	Warm Springs River	At fish hatchery in sec.24, T.8 S., R.12 E.	10.3	240	--	+13.0	240	7.0
Do...	... do ...	At gage site (14097100) nr Kahneeta Hot Springs in sec.23, T.8 S., R.13 E.	4.5	237	--	-3.0	237	7.0
		MILL CREEK						
	Mill Creek	Headwater.	24.0	--	--	--		
10- 5-73	... do ...	Outflow of Trout Lake, in sec.12, T.9 S., R.8 E.	21.4	4.37			4.37	12.0
Do...	N.F. Mill Creek	Outflow of Blue Lake, 3.0 mi from mouth, in sec.25, T.8 S., R.8 E.	17.9	--	0	--	--	--
10- 2-73	Mill Creek	At road B244 crossing in sec.27, T.8 S., R.9 E.	15.8	32.8	--	+28.4	32.8	4.5
Do...	... do ...	30 ft above diversion structure, in sec.17, T.8 S., R.10.	10.0	37.2	--	+4.4	37.2	4.5
Do...	Mill Creek lateral	30 ft below diversion structure, in sec.17, T.8 S., R.10 E.	10.9		-4.37	--	--	4.5
Do...	Mill Creek	At road crossing below Potters Ponds, in sec.19, T.8 S., R.11 E.	6.2	28.2	--	-4.6	28.2	8.5
Do...	Boulder Creek	At B100 road crossing, 1.6 mi upstream from mouth, in sec.31, T.8 S., R.11 E.	4.6	--	dry	--	--	--
Do...	Mill Creek	At Highway 26 crossing, in sec.21, T.8 S., R.11 E.	2.9	70.4	--	+42.2	70.4	9.0

Table 8.--Coliform sampling at selected sites

Station number	Stream name	Discharge (ft^3/s)	Date of collection	Coliform, in colonies per 100 ml	
				Total	Fecal
14092100	Deschutes River below Round Butte Dam	4,570	7-30-74	800	--
14092350	Willow Creek near Madras	100	do	4,600	--
14092460	Campbell Creek near Warm Springs	15	do	12,800	--
14092700	Deschutes River near Warm Springs	4,600	do	520	--
	Shitike Creek above sewage lagoons	130	do	262	--
14093000	Shitike Creek at Warm Springs	152	do	343	--
	Warm Springs River above sewage lagoons at Kahneeta village	347	do	440	--
	do	299	9-19-74	10	2
14097100	Warm Springs River below sewage lagoons near Kahneeta	347	7-30-74	2,100	--
	do	299	9-19-74	320	16

Table 9.--Turbidity and sediment sampling at selected sites

Station number	Stream name	Date	Discharge (ft^3/s)	Turbidity (NTU)	Sediment concentration (mg/l)	Sediment discharge (tons/day)
14090500	Whitewater River	8- 2-73	83.8	81	--	--
	do	8-31-73	49.7	14	--	--
14092460	Campbell Creek	6- 7-73	21	--	185	10
	do	7-30-74	15	--	32	1.3
14096820	Coyote Creek	2- 6-73	.9	28	12	.03
	do	3- 5-73	2.9	43	14	.11
	do	4- 3-73	.4	24	16	.02
	do	5- 2-73	.03	19	4	.0003
	do	1-14-74	150	76	264	107
	do	1-28-74	55	40	--	--
14096830	Beaver Creek	3- 5-73	52.3	24	4	.56
14096840	Quartz Creek	1-14-74	200	--	2,170	1,170
14097050	Warm Springs River tributary	do	29	--	224	17
14097100	Warm Springs River	do	1,910	--	412	2,120
	do	1/15/74	4,610	--	917	11,400

Table 10.--Chemical analyses of selected surface water

[Analyses by the U.S. Geological Survey]

Station number	Name	Discharge (ft^3/s)	Date of collection	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)	Nitrate + nitrite (N)	Phosphate (PO_4)	Arsenic (As)	Boron (B)	Dissolved solids[1/]	Hardness, as $CaCO_3$	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)	Temperature (°F)	Sodium-adsorption-ratio (SAR)
				Milligrams per litre																						
14090200	Metolius River near Camp Sherman	1,230	5/30/73	30	0.02	0.00	5.4	3.1	6.9	1.3	53	0	2.1	1.5	0.1	0.05	0.25	--	--	77	26	82	8.1	6.0	43	0.6
14090350	Jefferson Creek near Camp Sherman	86	do	22	.04	.01	3.0	.8	2.5	.7	26	0	2.1	.7	.1	.02	.09	--	--	45	11	34	8.0	5.0	41	.3
14090500	Whitewater River near Grandview	85	do	27	.20	.00	4.3	1.5	3.3	.9	29	0	3.3	.5	.1	.04	.09	--	--	56	17	46	8.2	6.0	43	.4
14092110	Deschutes River below Round Butte Dam	4,570	7/30/74	31	.14	--	7.8	4.9	10	2.0	69	0	3.6	1.9	.1	.13	.11	0.002	--	96	40	140	7.0	13.0	55	.7
14092150	Seekseequa Creek near Warm Springs	1.4	5/30/73	67	.11	.03	19	8.7	22	5.8	148	0	3.3	2.6	.3	.13	.18	--	--	203	83	232	8.2	19.0	66	1.1
14092350	Willow Creek near Madras	26	6/ 7/73	37	.12	.01	19	13	30	4.7	159	0	17	10	.5	1.7	.25	--	--	218	100	323	8.1	18.0	64	1.3
14092460	Campbell Creek near Warm Springs	21	do	28	.23	.01	8.7	4.0	8.9	5.8	66	0	5.5	2.1	.7	.98	1.4	--	--	102	38	124	8.3	15.5	60	.6
14092700	Deschutes River near Warm Springs	4,600	7/30/74	30	.04	--	8.3	5.4	9.0	2.0	70	0	3.1	1.9	.1	.11	.10	.002	--	95	43	140	7.4	13.0	55	.6
14092870	Shitike Creek at water-supply diversion	130	do	21	.04	--	3.2	1.0	2.9	.9	22	0	1.1	1.7	.1	.19	.01	.001	--	44	12	55	6.5	16.0	61	.4
14093700	Trout Creek near South Jordan	8.1	6/ 7/73	38	.06	.00	26	9.9	50	4.9	180	26	22	9.4	1.1	.72	.71	--	--	280	110	410	9.0	20.0	68	2.1
14096500	Mill Creek at Old Mill Camp	46	6/ 6/73	24	.05	.01	6.5	1.6	3.3	.8	37	0	2.0	.5	.0	.35	.12	--	--	59	23	54	8.2	12.5	54	.3
14096550	Mill Creek at Potters Pond	48	6/ 5/73	23	.04	.01	4.9	1.6	3.2	.8	36	0	2.0	.8	.2	.05	.09	--	--	55	19	54	8.2	11.0	52	.3
14096830	Beaver Creek near Simnasho	39	5/31/73	31	.09	.01	7.9	3.3	5.1	1.4	56	0	2.0	.9	.0	.01	.09	--	--	79	33	84	8.1	15.5	60	.4
14096900	Warm Springs River above Kahneeta	234	9/10/73	29	.10	.03	7.1	3.0	5.0	1.4	51	0	.7	1.3	.0	.05	.21	.004	--	73	30	81	8.0	16.0	61	.4
14097100	Warm Springs River near Kahneeta	234	do	28	.13	.00	7.1	3.5	7.9	1.6	61	0	.5	2.7	.2	.03	.18	.003	--	82	32	95	8.1	17.2	63	.6
14097110	Skookum Creek near Kahneeta	.71	5/ 9/74	47	1.1	.00	5.7	1.8	18	1.3	62	0	3.6	3.1	.3	.03	.40	.029	0.02	113	22	116	7.6	11.0	52	1.7
14097210	Deschutes R. at Dant	4,300	6/ 7/73	30	.05	.02	7.4	4.5	9.6	1.8	72	0	2.8	1.9	.1	.09	.25	--	--	94	37	112	8.3	13.8	57	.7
14097230	Paquet Gulch near Wapinitia	.01	5/30/73	50	.05	.00	20	6.5	8.0	3.8	105	0	2.4	1.7	.2	.10	.43	--	--	145	77	162	7.7	13.0	55	.4
	Happy Valley Reservoir	--	9/17/74	31	--	--	15	5.3	9.2	1.3	99	0	1.6	1.6	.2	.24	.12	--	--	115	59	150	7.9	18.5	65	.5

1/ Calculated values with bicarbonate recomputed as carbonate.

Table 11.--Streamflow measurements

Station number	Stream	Location	Drainage area (mi^2)	Measurements: Date	Measurements: Discharge (ft^3/s)
14090200	Metolius River	NW¼SE¼ sec.2, T.12 S., R.9 E.	163	10-12-72	1,300
				11- 9-72	1,340
				12-14-72	1,370
				1- 9-73	1,360
				2- 7-73	1,350
				3- 7-73	1,280
				4- 2-73	1,290
				5- 3-73	1,250
				5-30-73	1,230
				7- 3-73	1,190
				8- 2-73	1,170
				8-31-73	1,180
14090250	Abbot Creek	SW¼NW¼ sec.2, T.12 S., R.9 E.	9.22	10-12-72	12.0
				12-14-72	10.0
				2- 7-73	13.8
				4- 2-73	12.5
				5-30-73	11.2
				8- 2-73	10.8
14090300	Candle Creek	NE¼NE¼ sec.3, T.12 S., R.9 E.	17.3	10-12-72	103
				12-14-72	74.2
				2- 7-73	98.9
				4- 2-73	91.4
				5-30-73	82.5
				8- 2-73	75.6
14090350	Jefferson Creek	SW¼SE¼ sec.34, T.11 S., R.9 E.	27.8	10-12-72	97.9
				11- 9-72	87.6
				12-14-72	65.0
				1- 9-73	83.5
				2- 7-73	85.7
				3- 7-73	75.5
				4- 2-73	61.2
				5- 3-73	76.9
				5-30-73	86.0
				7- 3-73	75.0
				8- 2-73	73.4
				8-31-73	64.9

Table 11.--Streamflow measurements--Continued

Station number	Stream	Location	Drainage area (mi^2)	Measurements: Date	Measurements: Discharge (ft^3/s)
14090500	Whitewater River	SE¼SW¼ sec.21, T.10 S., R.10 E. (near old gage site; previous record 1911-14)	30.6	10- 3-72	60.4
				11- 9-72	59.3
				1- 8-73	73.2
				2- 5-73	67.6
				3- 6-73	54.6
				4- 2-73	49.8
				5- 2-73	56.8
				5-30-73	85.1
				7- 2-73	63.8
				8- 2-73	83.8
				8-31-73	49.7
				10- 6-73	42.4
				1-15-74	1/ 670
				5- 7-74	160
14092150	Seekseequa Creek	SE¼NW¼ sec.27, T.10 S., R.12 E.	47.3	10- 3-72	1.70
				11- 8-72	2.11
				12-14-72	2.12
				1- 8-73	2.28
				2- 6-73	3.54
				3- 6-73	4.96
				4- 3-73	3.21
				5- 2-73	2.26
				5-30-73	1.36
				7- 5-73	.98
				8- 2-73	.83
				8-31-73	1.00
				10- 6-73	2.22
				5- 8-74	8.70
				7-31-74	1.34
14092350	Willow Creek	Lat 44°40'19" N., long 121°13'36" W.	--	6- 7-73	25.5
14092460	Campbell Creek	Lat 44°42'53" N., long 121°13'32" W.	--	6- 7-73	20.6
				7-30-74	2/ 15

See footnotes at end of table.

Table 11.--Streamflow measurements--Continued

Station number	Stream	Location	Drainage area (mi^2)	Measurements: Date	Measurements: Discharge (ft^3/s)
14092900	Tenino Creek	NE¼SW¼ sec.26, T.9 S., R.12 E.	20.7	2- 5-73	2/ 0.15
				5- 2-73	.02
				5-19-74	1.12
14093510	Dry Creek	NW¼SE¼ sec.17, T.9 S., R.13 E.	33.7	10- 3-72	Dry
				11- 8-72	Dry
				12-14-72	Frozen
				1- 8-73	Frozen
				2- 5-73	.015
				3- 6-73	Dry
				4- 3-73	Dry
				5- 2-73	Dry
				8- 3-73	Dry
				1-15-74	1/ 125
				1-30-74	2/ 3
				5-10-74	.25
14093700	Trout Creek	Lat 44°49'02" N., long 121°04'31" W.	--	6- 7-73	8.06
14093980	Dry Creek	NW¼NW¼ sec.36, T.6 S., R.8½ E.	--	4- 6-73	.25
				5-29-73	2/ .25
14094000	Warm Springs River	NW¼SE¼ sec.36, T.6 S., R.8½ E.	--	10-10-72	1.40
				5-29-73	2.03
14094010	Warm Springs River	NW¼NE¼ sec.6, T.7 S., R.9 E.	--	10-11-72	1.58
				5-31-73	2.24
				10- 5-73	.26

See footnotes at end of table.

Table 11.--Streamflow measurements--Continued

Station number	Stream	Location	Drainage area (mi^2)	Measurements	
				Date	Discharge (ft^3/s)
14095500	Warm Springs River	NE¼NE¼ sec.18, T.7 S., R.11 E. (at old gage site; previous record 1915-16, 1948-54)	107	11- 8-72 2- 6-73 3- 6-73 4- 4-73 5- 2-73 6- 5-73 7- 2-73 8- 3-73 10- 3-73 5- 7-74	138 2/150 150 2/130 140 129 2/128 128 118 357
14095550	Badger Creek	SE¼SW¼ sec.19, T.7 S., R.11 E.	--	7-31-74	7.66
14095600	Badger Creek	NE¼SW¼ sec.20, T.7 S., R.11 E.	37.2	2- 6-73 4- 4-73 6- 5-73 8-30-73 10- 3-73 5- 9-74 7-31-74	25.9 21.9 14.8 6.45 8.16 109 14.1
14096000	Mill Creek (Olallie Lake outlet)	Sec.12, T.9 S., R.8 E. (near old gage site; previous record 1915-16)	5.6	10-10-72 5-29-73	.18 7.07
14096550	Mill Creek	SE¼NW¼ sec.19, T.8 S., R.11 E.	57.6	2- 6-73 4- 4-73 6- 5-73 8- 3-73 10- 2-73 5- 9-74	63.7 48.9 48.7 29.6 28.2 199

See footnotes at end of table.

Table 11.--Streamflow measurements--Continued

Station number	Stream	Location	Drainage area (mi^2)	Measurements: Date	Measurements: Discharge (ft^3/s)
14096600	Boulder Creek	SE¼NE¼ sec.31, T.8 S., R.11 E.	28.4	2- 6-73	6.96
				4- 4-73	4.29
				6- 5-73	Dry
				8- 3-73	Dry
				10- 2-73	Dry
				5- 9-74	124
14096800	Beaver Creek	SE¼SW¼ sec.11, T.6 S., R.10 E.	32.1	10- 4-72	11.6
				11- 8-72	13.1
				12-13-72	7.73
				1- 8-73	18.4
				2- 6-73	23.0
				3- 5-73	21.9
				4- 3-73	19.6
				5- 2-73	19.6
				5-31-73	13.2
				7- 2-73	10.4
				8- 3-73	9.03
				8-30-73	9.30
				10- 6-73	9.50
				5- 7-74	102
14096810	Indian Creek	SE¼SE¼ sec.11, T.6 S., R.10 E.	6.16	4- 3-73	.86
				5- 7-74	28.0
14096820	Coyote Creek	NE¼SW¼ sec.14, T.7 S., R.11 E.	43.2	1-20-73	2/1.5
				2- 6-73	.92
				3- 5-73	2.93
				4- 3-73	.42
				5- 2-73	.03
				5-31-73	2/.01
				7- 2-73	0
				1-14-74	2/150
				1-15-74	1/970
				1-28-74	55
				5- 8-74	1.13

See footnotes at end of table.

Table 11.--Streamflow measurements--Continued

Station number	Stream	Location	Drain-age area (mi^2)	Measurements	
				Date	Dis-charge (ft^3/s)
14096830	Beaver Creek	NE¼SW¼ sec.14, T.7 S., R.11 E.	115	10-11-72	40.8
				11- 8-72	42.1
				12-13-72	47.5
				1- 8-73	46.6
				2- 6-73	60.0
				3- 5-73	55.2
				4- 3-73	52.9
				5- 2-73	51.4
				5-31-73	39.2
				7- 2-73	35.9
				8- 3-73	36.0
				8-30-73	35.2
				10- 6-73	35.3
				5- 8-74	209
14096950	Buck Springs	Lat 44°50'43" N., long 121°19'32" W.	--	7-20-73	.58
				5-10-74	1.48
14097110	Skookum Creek	SW¼NW¼ sec.32, T.7 S., R.14 E.	10.9	10- 4-72	2/ .10
				5- 9-74	.71
14097200	Eagle Creek	Lat 45°01'45" N., long 121°07'02" W.	24.4	2- 5-73	1.0
				3- 5-73	.43
				4- 3-73	.15
				5- 2-73	.05
				5-30-73	2/ .03
				7- 2-73	Dry
				5- 8-74	1.36
14097210	Deschutes River	NW¼NW¼ sec.19, T.6 S., R.14 E.	--	7- 6-73	4,300

See footnotes at end of table.

Table 11.--Streamflow measurements--Continued

Station number	Stream	Location	Drainage area (mi^2)	Measurements: Date	Measurements: Discharge (ft^3/s)
14097220	Nena Creek	NW¼SE¼ sec.22, T.6 S., R.12 E.	15.9	10-11-72	0.015
				11- 8-72	.016
				5-30-73	[2].01
				8- 3-73	.005
				1-30-74	[2]3
14097230	Paquet Gulch	SE¼SW¼ sec.3, T.6 S., R.12 E.	6.43	10-11-72	.08
				11- 8-72	.083
				12-13-72	.068
				1- 8-73	.081
				2- 6-73	.38
				3- 5-73	.72
				4- 3-73	.25
				5- 2-73	.12
				5-30-73	.006
				7- 2-73	Dry
				1-15-74	[1]140
				1-30-74	6
				5- 8-74	.63
14097600	Clear Creek tributary	SE¼SE¼ sec.8, T.5 S., R.9 E.	--	5-29-73	.18
14178500	North Fork Breitenbush River (at lake outlet)	NW¼ sec.25, T.9 S., R.8 E.	1.6	10-10-72	.81
				5-29-73	7.31
				9-11-74	.49
14207930	Slow Creek	N½ sec.12, T.8 S., R.8 E.	.8	10-10-72	[2].25
				5-29-73	2.58

See footnotes at end of table.

Table 11.--Streamflow measurements--Continued

Station number	Station	Location	Drainage area (mi^2)	Measurements	
				Date	Discharge (ft^3/s)
14207940	Lemiti Creek	SE¼ sec.2, T.8 S., R.8 E.	3.4	10-10-72 5-29-73	2/0.10 5.00
14207950	Olallie Creek	SE¼ sec.24, T.8 S., R.8 E.	1.6	10-10-72 5-29-73	1.35 2/.10
14208410	Clackamas Lake tributary	SW¼SE¼ sec.36, T.5 S., R.8½ E.	1.06	10-10-72 5-29-73	Dry .07
14208420	Oak Grove Fork	NE¼SW¼ sec.25, T.5 S., R.8½ E.	12.0	10-10-72 4- 6-73 5-29-73 8- 1-74	Dry 3.45 .16 .30

1/ Estimate by slope conveyance.

2/ Field estimate.

Table 12.--Chemical analysis of water from Deschutes River near Biggs, Oreg.

[MG/L = milligrams per litre, UG/L = micrograms per litre]

Station number	Date of collection	Discharge, in cubic feet per second
14103000	10-20-74	5,310

ALK.TOT (AS CACO3)	MG/L		65	MANGANESE DISSOLVED	UG/L	0
ARSENIC DISSOLVED	UG/L		1	MANGANESE SUSPENDED	UG/L	30
ARSENIC SUSPENDED	UG/L		0	MANGANESE TOTAL	UG/L	30
ARSENIC TOTAL	UG/L		1	MERCURY DISSOLVED	UG/L	0.0
BICARBONATE	MG/L		79	MERCURY SUSPENDED	UG/L	0.0
CADMIUM DISSOLVED	UG/L	<	1	MERCURY TOTAL	UG/L	0.0
CADMIUM SUSPENDED	UG/L	<	9	NITROGEN TOT AS N	MG/L	0.36
CADMIUM TOTAL	UG/L	<	10	NITROGEN TOT AS NO3	MG/L	1.6
CALCIUM DISS	MG/L		8.3	NITROGEN TOTKJD AS N	MG/L	0.31
CARBON TOT ORGANIC	MG/L		1.9	NO2 + NO3 AS N TOT	MG/L	0.05
CHLORIDE DISS	MG/L		2.3	PH		8.1
CHROMIUM DISSOLVED	UG/L		0	PHOSPHORUS TOT AS P	MG/L	0.07
CHROMIUM SUSPENDED	UG/L		0	POTASSIUM DISS	MG/L	1.8
CHROMIUM TOTAL	UG/L		0	RESIDUE DIS CALC SUM	MG/L	103
COBALT DISSOLVED	UG/L		0	RESIDUE DIS TON/AFT		0.12
COBALT SUSPENDED	UG/L	<	50	RESIDUE DIS TON/DAY		1300
COBALT TOTAL	UG/L	<	50	RESIDUE DIS 180C	MG/L	91
CONDUCTIVITY			135	SAR		0.7
COPPER DISSOLVED	UG/L		2	SELENIUM DISSOLVED	UG/L	0
COPPER SUSPENDED	UG/L	<	8	SELENIUM SUSPENDED	UG/L	0
COPPER TOTAL	UG/L	<	10	SELENIUM TOTAL	UG/L	0
FLUORIDE DISS	MG/L		0.1	SILICA DISSOLVED	MG/L	32
HARDNESS NONCARB	MG/L		0	SODIUM DISS	MG/L	11
HARDNESS TOTAL	MG/L		45	SODIUM PERCENT		33
IRON DISSOLVED	UG/L		20	STREAMFLOW(CFS)-INST		5310
IRON TOTAL	UG/L		120	SULFATE DISS	MG/L	2.5
LEAD DISSOLVED	UG/L		2	TURBIDITY (JTU)		2
LEAD SUSPENDED	UG/L	<	98	WATER TEMP (DEG C)		12.5
LEAD TOTAL	UG/L	<	100	ZINC DISSOLVED	UG/L	20
MAGNESIUM DISS	MG/L		6.0	ZINC SUSPENDED	UG/L	20
				ZINC TOTAL	UG/L	40

Table 13.--Quality of water in selected high lakes

Name (drainage)	Date (1974)	Dissolved solids residue at 180°C (mg/l)	Specific conductance (micromhos)	Silica (SiO_2) (mg/l)	Bicarbonate (HCO_3) (mg/l)	pH	Temperature °C	Temperature °F	Transparency (metres)	Fecal coliform (colonies/100 ml)1/
Harvey (Shitike Creek)	9-18	21	16	7.7	3	7.3	14.8	59	11	0
Spoon (Boulder Creek)	9-12	8	3	.5	2	5.8	9.0	48	> 2	0
Long (Boulder Creek)	do	10	6	1.9	4	6.5	13.0	55	> 8	0
Dark (Boulder Creek)	do	15	10	3.5	6	6.9	14.2	57	6.1	0
Island (Boulder Creek)	9-17	47	39	21	27	7.8	12.2	54	> 3	0
Trout (Boulder Creek)	do	38	36	18	23	7.8	14.2	57	5.8	0
Boulder (Boulder Creek)	9-18	25	16	7.5	11	7.4	14.8	59	6.1	0
Blue (Mill Creek)	do	10	5	.6	3	7.7	15.1	59	> 11	0
Gibson (Breitenbush River)	9-13	7	3	.5	2	6.9	11.0	52	> 5	0
Breitenbush (Breitenbush River)	9-11	14	7	3.8	2	6.6	12.8	55	> 8	0

1/ 300 ml sample filtered.

Table 14.--Records of selected springs

Number: See figure 23 for description of spring-numbering system.
Altitude: Altitude of land surface at spring, in feet above mean sea level, interpolated from topographic maps.
Rate: Estimated yield of spring, in gallons per minute.

Specific conductance: Electrical conductivity of water, in micromhos per centimetre, adjusted to 25°C.
Remarks: U, undeveloped, S, developed for stock use; D, developed for domestic use; P, developed for community use; R, developed for recreational use; C, chemical analysis in table 17.

Number	Latitude/longitude		Name or (location)	Altitude (ft)	Flow			Specific conductance	Date	Remarks
					Rate (gal/min)	Temperature °C	Temperature °F			
5S/11E-35ddd	45 05 08	121 22 50	Kelly Spring	2,740	2	14.5	58	220	7/23/74	U, C.
6S/9E-21bbd	45 02 16	121 40 51	Willow Springs	3,900	15	11.5	53	70	do	U, C.
6S/9E-26bac	45 01 28	121 38 11	Deadman Spring	3,540	Dry	--	--	--	7/24/74	U.
6S/10E-19cba	45 01 27	121 35 53	(South of Beaver Butte)	3,840	60	8.0	46	80	do	U.
6S/11E-3bac	45 04 57	121 24 51	Daniel Spring	2,800	.3	15.5	60	290	7/23/74	S, C.
6S/11E-3bbd	45 04 57	121 24 59	Government Spring	2,800	<.1	11.0	52	310	do	S.
6S/11E-8dbc	45 03 38	121 26 57	Coyote Spring	2,730	1	15.5	60	350	do	S, C.
6S/11E-14bca	45 03 03	121 23 44	(West of Bald Peter Butte)	2,700	2	13.0	55	280	do	U.
6S/11E-14cbc	45 02 46	121 23 54	do	2,660	.2	16.5	62	250	do	S.
6S/11E-24caa	45 01 58	121 22 14	(South of Bald Peter Butte)	2,800	<.1	15.0	59	210	do	D. Unused.
6S/11E-27aab	45 01 36	121 24 15	Log Spring	2,615	8	17.5	63	210	do	S, D, C.
6S/12E-22cab	45 01 59	121 17 29	(Nena Creek)	2,640	.4	9.0	48	180	5/17/74	S.
6S/12E-27bca	45 01 22	121 17 38	Nena Spring	2,670	.2	10.5	51	260	do	S, C.
7S/10E-7daa	44 58 18	121 34 58	Big Spring	2,720	--	9.5	49	--	5/17/73	U, C.
7S/10E-35cab	44 55 00	121 31 06	Nellie Spring	2,760	--	--	--	--	7/24/74	U.
7S/11E-1dcc	44 59 03	121 22 02	(Simnasho Butte)	2,760	--	--	--	--	--	P.
7S/11E-11abc	44 58 50	121 23 22	(Southwest of Simnasho Butte)	2,660	--	18.0	64	210	9/13/73	U.
7S/11E-11ddc	44 58 12	121 22 59	(North of Quartz Creek)	2,360	<.1	13.0	55	300	7/31/74	S.
7S/11E-33abd	44 55 19	121 25 41	(Mill Creek Flat)	2,600	1	10.0	50	--	5/16/74	D, C. Unused.
7S/12E-16cdb	44 57 28	121 18 45	(South of Happy Valley Reservoir)	2,700	0	--	--	--	5/ 8/74	U.
7S/12E-18cab	44 57 37	121 21 16	(South of Simnasho)	2,500	0	--	--	--	do	S.
7S/12E-26dda	44 55 41	121 15 26	(North of Kishwalks)	3,150	<.1	14.0	57	170	9/12/73	U.
7S/13E-5dbb	44 59 32	121 12 10	(North of Shaniko Butte)	3,430	.003	21.0	70	150	do	S.
7S/13E-6bdc	44 59 38	121 13 40	(Northwest of Shaniko Butte)	3,430	<.1	11.5	53	150	do	U.
7S/13E-11bad	44 59 04	121 08 34	Mutton Mountain Spring	3,400	<.1	11.0	52	80	do	S.
7S/13E-16dba	44 57 45	121 10 47	Little Fawn Spring	3,300	Dry	--	--	--	do	U.
7S/13E-17ddb	44 57 34	121 11 51	Eagle Springs	3,710	.1	12.0	54	96	do	S, C.
7S/14E-4cbc	44 59 26	121 04 05	(Near Hardy)	1,340	1	21.0	70	160	9/11/73	U.
7S/14E-8bca	44 58 55	121 05 11	(Antoken Creek)	1,420	1	17.0	63	240	do	S, C.
7S/14E-17bcb	44 58 00	121 05 22	(Southwest of North Junction)	1,320	1.5	17.0	63	93	do	U, C.
8S/12E-3acd	44 54 18	121 16 54	(East of Schoolie Flat)	2,800	2	17.0	63	130	7/31/73	U, C.
8S/12E-11cdd	44 53 02	121 16 00	La Clair Spring	2,790	Dry	--	--	--	9/12/73	S.
8S/12E-14dcd	44 52 20	121 15 46	Kuckup Spring	2,500	<.1	--	--	216	9/11/73	D, C.

Table 14.--Records of selected springs--Continued

Number	Latitude/longitude		Name or (location)	Altitude (ft)	Flow Rate (gal/min)	Temperature °C	Temperature °F	Specific conductance	Date	Remarks
8S/12E-17bab	44 52 54	121 19 51	(Mouth of Beaver Creek)	2,080	15	--	--	--	5/15/73	U.
8S/12E-29dbb	44 50 43	121 19 32	Buck Spring	2,350	450	15.0	59	108	7/20/73	U, C.
8S/13E-1aaa	44 54 42	121 07 06	(South of Skookum Creek)	1,680	< .1	17.0	63	634	5/ 9/74	U.
8S/13E-7cca	44 53 07	121 13 58	Wire Corral Spring	1,830	3	16.0	61	122	6/ 8/74	D, C.
8S/13E-10cdb	44 53 11	121 10 01	(Southwest of Charley Corral)	1,820	1	14.0	57	240	9/11/73	S.
8S/13E-11bdb	44 53 34	121 08 50	Charley Corral Spring	1,940	1	13.5	56	228	do	S, C.
8S/13E-12bda	44 53 34	121 06 55	(East of Charley Corral)	1,960	.5	14.5	58	250	do	S.
8S/13E-16bba	44 52 57	121 11 29	(North of Kahneeta)	1,700	Dry	--	--	--	do	U.
8S/13E-19bad	44 51 01	121 12 19	(Hot spring east of hatchery)	1,570	1	83.5	182	1,790	5/14/73	U, C.
8S/13E-20acb	44 51 53	121 12 13	(Hot spring west of Kahneeta)	1,460	10	42.0	108	1,500	1/24/74	U.
8S/13E-20acd	44 51 43	121 12 03	Kahneeta Hot Spring	1,450	50	47.0	117	1,400	do	R, C.
8S/13E-20bdb	44 51 13	121 12 30	Middle Kahneeta Hot Spring	1,480	3	55.5	132	1,740	5/17/73	U, C.
8S/13E-30aaa	44 51 16	121 13 02	(Northeast of Eagle Butte)	2,140	<.01	13.5	56	311	do	S, C.
8S/13E-35bbc	44 50 14	121 09 06	Harold Culpus	1,560	<.1	16.5	62	299	9/10/73	D, C.
8S/14E-7baa	44 53 35	121 06 13	(East of Charley Corral)	1,800	.5	16.0	61	500	9/11/73	S.
8S/14E-8abb	44 53 46	121 04 51	do	1,640	.3	14.0	57	320	do	U.
8S/14E-20bbb	44 52 06	121 05 32	Rattlesnake Spring	1,340	3	6.5	44	137	4/12/73	D, C.
8S/14E-31cbb	44 49 52	121 06 45	(South of Webster Flat)	1,840	10	13.0	55	336	do	U, C.
9S/9E-7bdd	44 48 17	121 42 54	(Below Trout Lake)	4,560	15	4.0	39	70	4/ 9/73	D.
9S/9E-34dad	44 44 41	121 38 40	Peters Pasture Spring	3,750	25	6.0	43	160	7/25/74	D.
9S/11E-32adb	44 44 58	121 26 26	Tommy Corral	3,060	.5	7.0	45	110	3/ 9/73	U.
9S/11E-34bbd	44 45 02	121 24 53	Seymore Springs	2,890	< 1	11.0	52	180	4/ 8/73	S.
9S/12E-1daa	44 48 58	121 14 13	(South of Eagle Butte)	1,760	.25	13.0	55	284	4/11/73	S, C.
9S/12E-3cbb	44 49 03	121 17 47	Tohet Spring	1,700	.25	13.0	55	256	do	S, C.
9S/12E-10cac	44 48 03	121 17 24	(Upper Dry Creek)	1,640	< .1	23.5	74	320	do	U.
9S/12E-10ccc	44 47 52	121 17 41	do	1,820	< 1	16.5	62	188	do	U, C.
9S/12E-10dba	44 48 08	121 17 01	do	1,570	< 1	28.0	82	300	do	U.
9S/12E-13daa	44 47 16	121 14 17	(Dry Creek)	1,550	.25	10.5	51	508	do	S, C.
9S/12E-17abd	44 47 34	121 19 29	Symentire Spring	2,440	< 1	13.5	56	300	4/ 9/73	U.
9S/12E-31caa	44 44 39	121 20 59	(Tenino Creek)	2,000	1	9.5	49	260	3/ 9/73	U, C.
9S/13E-1cba	44 49 03	121 07 46	(Webster Flat)	1,910	Dry	--	--	--	4/12/73	D.
9S/13E-6cab	44 49 04	121 13 47	(South of Eagle Butte)	1,760	< 1	14.0	57	280	4/11/73	D.
10S/9E-33baa	44 39 55	121 40 25	(East of Bald Peter)	5,500	175	3.0	37	50	7/25/74	D, C.

Table 14.--Records of selected springs--Continued

Number	Latitude/longitude		Name or (location)	Altitude (ft)	Flow					Remarks
					Rate (gal/min)	Temperature °C	Temperature °F	Specific conductance	Date	
10S/10E-4dad	44 43 41	121 32 30	(Upper Seekseequa Creek)	3,520	1.5	3.5	38	96	3/ 9/73	S, C.
10S/11E-30cba	44 40 21	121 28 32	Peters Spring	3,070	40	10.5	51	128	3/ 7/73	D, C.
10S/11E-33dca	44 39 13	121 25 27	Beachkomb Spring	2,760	.75	7.0	45	200	do	S.
11S/11E-2add	44 38 45	121 22 22	Daisy Spring	2,440	20	11.5	53	200	do	U.
11S/11E-7add	44 38 03	121 27 09	Mud Spring	2,950	< .1	6.5	44	200	do	S.
11S/12E-8abc	44 38 16	121 19 04	Pipp Spring	2,260	3	13.5	56	280	do	S.
11S/12E-21cab	44 36 19	121 18 14	Dave Ike Spring	2,310	< 1	7.5	45	290	do	S.
11S/12E-21ccc	44 35 52	121 18 33	(South of Dave Ike Spring)	2,280	2	8.5	47	290	3/ 8/73	U.

Table 15.--Records of wells and test holes

Number: See figure 23 for description of well-numbering system.
Finish: S, screen; P, perforated. Interval in feet below land surface.
Altitude: Altitude of land surface at well, in feet above mean sea level, interpolated from topographic maps.
Pump: N, none; P, piston; S, submersible; J, jet.

Well performance: Yield, in gallons per minute, and drawdown, in feet below nondischarging water level, reported by driller.
Use: U, unused; D, domestic; S, stock; P, public or community supply.
Remarks: L, driller's log of well in table 16; C, chemical analysis in table 17.

Number	Latitude/longitude		Name	Year completed	Depth of well (ft)	Diameter of well (in.)	Depth of casing (ft)	Finish	Water level			Well performance			Use	Remarks
									Altitude (ft)	Feet below datum	Date	Pump	Yield (gal/min)	Drawdown (ft)		
5S/10E-22dcb	45 06 56	121 31 48	Bear Springs Camp	1970	100	6	26	--	3,050	8	5/29/70	N	6	75	U	L.
7S/10E-25daa	44 55 55	121 29 00	Dorothy Wally	1973	140	6	133	S 133-138	2,650	118	4/ 7/73	S	25	4	D	L, C.
7S/11E-14abd	44 58 00	121 23 10	Florence Pete	1965	122	6	15	--	2,310	--	--	N	--	--	U	L. Test hole, capped.
7S/11E-32bab	44 55 30	121 27 17	Grant Waheneka	1972	81	6	76	S 76-81	2,625	63	1/22/74	N	25	.1	D	L.
7S/11E-32bdd	44 55 05	121 27 10	Albert Comedown	1974	72	6	--	--	2,615	50	7/25/74	S	22	.1	D	C.
7S/11E-36cba	44 55 04	121 22 37	Island Windmill	1935	500	6	350	--	2,630	--	--	P	--	--	S	Unused. No log. No access for water level.
7S/12E-7dbb	44 58 28	121 20 53	Simnasho well	1935	565	6	46	--	2,440	272	9/14/72	S	22	25	P	
7S/12E-29cdd	44 55 36	121 19 45	Schoolie Flat 400-ft test	1974	400	6	30	--	2,700	342	8/ 2/74	N	--	--	U	L. Unsuccessful test hole, less than ½ gal/min.
7S/12E-34cab	44 55 02	121 17 27	Frank Suppah	1935	300	6	12	--	2,811	100	12/ 1/55	P	2	--	--	U.S. Geological Survey pump test.
8S/11E-6cad	44 54 06	121 28 17	Sidwalter well	1935	407	6	--	--	2,605	20	--	S	--	--	P	C.
8S/11E-16dca	44 52 16	121 25 31	Phillip Guerin	1965	208	6	33	--	2,615	30	11/28/65	J	3	146	D	L, C.
8S/11E-25ccc	44 50 23	121 22 40	Elmer Quinn	1973	352	6	300	S 300-350	2,642	290	6/21/73	--	18	6	D	L, C. U.S. Geological Survey pump test.
8S/11E-33ddd	44 49 36	121 25 14	Irene Wells	1974	327	6	322	S 322-327	2,735	255	3/11/74	S	12	30	D	L, C. Pump test.
8S/11E-34ddd	44 49 31	121 24 00	Miller well	1934	320	6	20	--	2,680	208	12/26/34	P	--	--	S	Unused. No access for water level.
8S/12E-3acd	44 54 19	121 16 56	Velma Peters	1965	308	6	20	--	2,810	14	5/ 7/74	N	--	--	--	L. Unsuccessful test hole.
8S/12E-3cab	44 54 13	121 17 27	Schoolie Flat 380-ft test	1973	380	6	70	P 70-300	2,770	132	5/15/74	N	2	33	D	L. Unused. Pump test.
8S/12E-3cac	44 54 09	121 17 28	Schoolie Flat 150-ft test	1974	150	6	20	--	2,760	40	9/ 4/74	N	--	--	P	C. Pump test.
8S/12E-4ddd	44 53 53	121 17 57	Schoolie Flat well	1958	150	6	15	--	2,720	82	5/14/74	S	--	--	P	L, C. Owned by Yahtin.
8S/13E-17dbd	44 52 26	121 12 08	Margaret Charley	1965	122	6	30	--	1,580	7	11/26/65	J	2	31	D	L, C.
8S/13E-23cbc	44 51 33	121 09 09	Ella Wolfe	1965	35	6	31	--	1,410	15	11/ 9/65	J	5	15	D	L. Unused.
8S/13E-23cdc	44 51 20	121 08 53	Kip Culpus	1965	220	6	0	--	1,410	--	--	--	--	--	U	L. Abandoned test hole.

Table 15.--Records of wells and test holes--Continued

Number	Latitude/longitude	Name	Year completed	Depth of well (ft)	Diameter of well (in.)	Depth of casing (ft)	Finish	Water level			Well performance				Remarks
								Altitude (ft)	Feet below datum	Date	Pump	Yield (gal/min)	Drawdown (ft)	Use	
8S/13E-27bb	--	Frank Suppah	1965	162	6	0	--	1,420	--	--	--	--	--	U	L. Abandoned test hole.
8S/13E-27cdc	44 50 26 121 10 01	Sarena Boyd	1973	250	6	42	P 42-250	1,590	15	5/ 6/74	N	8	220	D	L. Unused. Pump test.
8S/13E-32bdd	44 50 00 121 12 23	Ida McKinley	--	--	--	--	--	1,920	--	--	--	--	--	D	C.
8S/13E-33cab	44 49 52 121 11 21	Delbert Frank	1972	385	6	25	P 25-385	1,805	19	2/11/72	S	11	182	D	L, C.
8S/14E-17dcd	44 52 09 121 04 39	Clarence Meanus	1965	162	6	100	--	1,300	30	11/ 6/65	J	3	110	D	L.
8S/14E-20bda	44 51 52 121 05 01	Sanders Heath	1971	125	6	55	P 55-125	1,290	26	1/ 3/72	S	4	40	D	L, C.
8S/14E-20dac	44 51 34 121 04 35	Nathan Heath	1958	34	6	33	--	1,280	27	9/10/58	--	12	3	D	
8S/14E-21acb	44 51 52 121 03 35	Clara Moody	1965	22	6	20	--	1,270	5	11/ 8/65	J	12	9	D	L.
9S/8E-4ddb	44 48 10 121 46 54	Olallie Lake Guard Station	1962	254	6	240	P 240-253	4,950	226?	10/10/62	P	7	28	D	L, C. Outside reservation.
9S/8E-10cba	44 48 09 121 46 53	Olallie Peninsula Camp	1962	242	6	225	P 225-240	4,948	0	7/22/74	P	15	25	D	L. Unused. Outside reservation.
9S/11E-2baa	44 49 27 121 23 23	Prossana Williams	1972	375	6	370	S 370-375	2,680	352	6/ 7/73	N	18	6	D	L. Unused.
9S/12E-14bba	44 47 44 121 16 16	Lulu Scott	1945	101	6	--	--	1,550	10	1945	P	--	--	S	Unused.
9S/12E-14bbb	44 47 44 121 16 30	do	1945	580	--	--	--	--	--	--	--	--	--	U	"Dry" test hole; abandoned.
9S/12E-14dac	44 47 11 121 15 33	Dan Macy	1971	102	6	24	P 24-40	1,665	18	4/11/73	N	--	--	--	L. Unused.
9S/12E-23aaa	44 46 53 121 15 22	"Johnson No. 3"	1935	804?	6	--	--	1,720	--	--	--	--	--	S	Reported windmill; now destroyed.
9S/12E-32cda	44 44 26 121 19 43	Delton Switzler	1968	132	6	21	--	1,840	56	9/28/66	S	12	26	D	L, C.
9S/12E-33ccc	44 44 24 121 18 54	Dan Macy	1971	150	8	20	--	1,730	38	10/ 7/71	J	4	"0"	D	L.
9S/12E-34aba	44 45 07 121 16 57	Clifford Courtney	1963	500	6	20	--	1,590	12	10/10/63	S	4½	450	D	L. Unused.
9S/12E-34bcd1	44 44 45 121 17 32	Bart Clements	1965	82	6	64	--	1,620	4	1/23/74	N	2	57	U	Do.
9S/12E-34bcd2	44 44 48 121 17 35	Ed Manion	1967	84	6	63	--	1,620	5	2/17/67	S	10	48	D	L.
9S/12E-36dda	44 44 27 121 14 08	Stanley Smith, Jr.	1971	35	6	25	--	1,380	9	12/10/71	S	15	4½	D	L, C.
9S/13E-17dad	44 47 20 121 11 41	Dry Creek Camp	1964	19	6	19	--	1,350	6	4/11/73	N	5	4	--	L. Unused.

Table 15.--Records of wells and test holes--Continued

Number	Latitude/longitude	Name	Year completed	Depth of well (ft)	Diameter of well (in.)	Depth of casing (ft)	Finish	Water level: Altitude (ft)	Water level: Feet below datum	Water level: Date	Well performance: Pump	Well performance: Yield (gal/min)	Well performance: Drawdown (ft)	Use	Remarks
9S/13E-17dcd	44 46 53 121 12 00	Andrew David	1965	20	6	19	--	1,360	15	10/29/65	P	8	3	D	L.
10S/12E-1caa1	44 43 46 121 14 45	Zane Jackson	1960	80	6	16	P 16-27	1,410	14	12/20/60	S	5	50	D	Do.
10S/12E-1caa2	44 43 52 121 14 48	Charlie Jackson	1973	175	6	75	P 75-175	1,470	79	5/16/74	N	7	90	D	L. Unused.
10S/12E-15bdb	44 42 20 121 17 28	Annie Smith	1935	288	6	--	--	2,150	203	3/26/73	S	7	--	D	C.
10S/12E-28bdb	44 40 33 121 18 33	Gilbert Kalama	1965	62	6	24	--	1,920	20	11/15/65	J	6	28	D	L.
10S/12E-29add	44 40 26 121 19 09	Orin Johnson	1965	52	6	24	--	1,940	6	do	J	10	10	D	L, C.
10S/12E-29bdd	44 40 28 121 19 38	Ray Johnson	1971	47	4	42	--	1,950	21	1/ 8/71	J	9	11	D	L.
10S/12E-30abc	44 40 39 121 20 48	Karen Wallulatum	1965	42	6	24	--	2,020	16	11/16/65	S	7	8	D	L.
10S/12E-30bbd	44 40 42 121 21 10	Avex Miller, Jr.	1965	62	6	23	--	2,030	20	do	J	4½	36	D	L, C.
10S/12E-31bca	44 39 44 121 21 11	"Johnson No. 2"	1935	402?	6	--	--	2,330	355?	--	P	15	10	S	Unused. No access to casing.
10S/12E-34ccc	44 39 05 121 17 47	Wewa well	1935	616	6	390	--	2,090	345	1948	P	2½	55	S	Filled in to 193 ft, 3/7/73.
11S/12E-2ccc	44 38 29 121 16 02	Simtustus Park	1962	68	6	68	--	1,640	52	3/ 7/73	P	15	"0"	D	L, C.
11S/12E-18dcc	44 36 42 121 20 22	Joe Estabrook	1958	370	6	12	--	2,580	260	1958	P	20	--	D	L, C. Present yield reported low.

Table 16.--Drillers' logs of wells

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
5S/10E-22dcb. Bear Springs Campground. Alt 3,050 ±50 ft. Drilled by Keller Well Drilling Co., 1970. Casing: 6-in diam to 26 ft; unperforated. Water level 8 ft, 1970. Reported yield 6 gal/min with 75 ft drawdown in 3½ hr			
Soil and gravel	3	3	3,047
Clay, brown	9	12	3,038
Andesite:			
Clay and rock	11	23	3,027
Rock, gray, soft	8	31	3,019
Rock, medium-hard	8	39	3,011
Rock, hard	5	44	3,006
Rock, soft	1	45	3,005
Rock, gray, soft	25	70	2,980
Rock, soft	2	72	2,978
Rock, hard	9	81	2,969
Rock, broken	3	84	2,966
Rock, hard	6	90	2,960
Rock, red, soft	5	95	2,955
Clay, brown	5	100	2,950
7S/10E-25daa. Dorothy Wally. Alt 2,650 ±10 ft. Drilled by Archie Fox Well Drilling, 1973. Casing: 6-in. diam to 133 ft; screen 133-138 ft. Water level 118 ft, 1973. Reported yield 25 gal/min with 4 ft drawdown in 4 hr			
Soil	2	2	2,648
Gravel:			
Gravel and clay	55	57	2,593
Gravel	8	65	2,585
Clay	66	131	2,519
Gravel, water-bearing	9	140	2,510
7S/11E-14abd. Florence Pete. Alt 2,310 ±10 ft. Drilled by George McClanahan Well Drilling, 1965. Casing: 6-in. diam to 15 ft; hole abandoned			
Alluvium:			
Clay, brown, and sand	12	12	2,298
Gravel, coarse	3	15	2,295
Clarno Formation:			
Clay, red	107	122	2,188
7S/11E-32bab. Grant Waheneka. Alt 2,625 ±5 ft. Drilled by Archie Fox Well Drilling, 1972. Casing: 6-in diam to 76 ft; screen 76-81 ft. Water level 63 ft, 1974. Reported yield 25 gal/min with 1 in drawdown in 5 hr			
Soil	1	1	2,624
Gravel:			
Clay, yellow, and broken rock	29	30	2,595
Clay, brown, sandy	41	71	2,554
Gravel, water-bearing	2	73	2,552
Basalt:			
Rock, broken, water-bearing	8	81	2,544
7S/12E-29cdd. Schoolie Flat 400-ft test well. Alt 2,700 ±5 ft. Drilled by H & H Well Drilling, 1974. Casing: 6-in diam to 30 ft; unperforated. Water level 342 ft, 1974. Reported yield less than 1/2 gal/min			
Soil	4	4	2,696
Basalt:			
Lava, medium-hard	10	14	2,686
Clay, yellow	12	26	2,674
Sandstone, brown	64	90	2,610
Clay, red	10	100	2,600
Clay, brown, and gravel	40	140	2,560
Clay, light-gray, and gravel	15	155	2,545
Clay, light-tan	95	250	2,450
John Day Formation:			
Claystone	20	270	2,430
Clarno Formation:			
Rock, fractured	130	400	2,300
7S/12E-34cab. Frank Suppah. Alt 2,811 ±1 ft. Drilled by R. J. Strasser Drilling Co., about 1935. Casing: 6-in diam to 12 ft. Water level 100 ft, 1955. Sustained yield about 2 gal/min based on U.S. Geological Survey tests			
Soil and gravel	12	12	2,799
John Day Formation:			
Basalt, soft	108	120	2,691
Clarno Formation:			
Basalt, hard	58	178	2,633
Rock, fractured	122	300	2,511
8S/11E-16dca. Phillip Guerin. Alt 2,615 ±5 ft. Drilled by George McClanahan Well Drilling, 1965. Casing: 6-in diam to 30 ft; unperforated. Water level 30 ft, 1965. Reported yield 30 gal/min with 146 ft drawdown in 1 hr			
Clay, brown, and sand	3	3	2,612
Gravel:			
Gravel, coarse, and clay	27	30	2,585
Basalt:			
Basalt, gray	6	36	2,579
Claystone, yellow	10	46	2,569
Basalt	129	175	2,440
Dalles Formation:			
Sandstone, brown	21	196	2,419
Claystone, red	4	200	2,415
Basalt	8	208	2,407
8S/11E-25ccc. Elmer Quinn. Alt 2,642 ±5 ft. Drilled by Archie Fox Well Drilling, 1973. Casing: 6-in diam to 300 ft, 5-in diam to 350 ft; screened 300-305 ft and 345-350 ft. Water level 290 ft, 1973. U.S. Geological Survey-observed test yielded 18 gal/min with 6 ft drawdown in 4 hr			
Soil	1	1	2,641
Clay, yellow	3	4	2,638
Basalt:			
Basalt, broken	56	60	2,582
Clay, red, soft	10	70	2,572
Basalt, broken, and clay	40	110	2,532
Clay, red, soft	15	125	2,517
Basalt, broken	25	150	2,492
Basalt, hard	15	165	2,477
Basalt, soft, broken, and clay	20	185	2,457
Basalt, hard	15	200	2,442
Basalt, soft, and brown clay	50	250	2,392
Basalt	10	260	2,382
Dalles Formation:			
Clay, brown, soft, and broken basalt	30	290	2,352
Clay, brown, soft	10	300	2,342
Sand, water-bearing	5	305	2,337
Sandstone, black	40	345	2,297
Sand, water-bearing	7	352	2,290
8S/11E-33ddd. Irene Wells. Alt 2,735 ±10 ft. Drilled by Archie Fox Well Drilling, 1974. Casing: 6-in diam to 322 ft; screen 322-327 ft. Water level 255 ft, 1974. Reported yield 12 gal/min with 30 ft drawdown in 2 hr			
Soil	1	1	2,734
Clay	2	3	2,732
Basalt:			
Rock, broken, and clay	4	7	2,728
Lava rock	76	83	2,652
Sand and clay	14	97	2,638
Lava rock	5	102	2,633
Sand and clay	16	118	2,617
Lava rock	129	247	2,488
Dalles Formation:			
Sand and clay	73	320	2,415
Sand and gravel, water-bearing	7	327	2,408

Table 16.--Drillers' logs of wells--Continued

8S/11E-34ddd. Miller Well. Alt 2,680 ±5 ft. Drilled by R. J. Strasser Drilling Co., 1934. Casing: 6-in. diam to 20 ft. Water level 208 ft, 1934

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
Basalt:			
Basalt	248	248	2,432
Dalles Formation:			
Gravel, cemented	72	320	2,360

8S/12E-3acd. Velma Peters. Alt 2,810 ±10 ft. Drilled by George McClanahan Well Drilling, 1965. Abandoned test hole

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
Alluvium:			
Clay, red	12	12	2,808
Claystone, yellow	30	42	2,778
Basalt:			
Basalt, fractured	168	210	2,610
Basalt	44	254	2,566
Basalt, fractured	54	308	2,512

8S/12E-3cab. Schoolie Flat 380-ft test well (Ella Wolfe). Alt 2,770 ±10 ft. Drilled by Archie Fox Well Drilling, 1973. Casing: 6-in diam to 302 ft; perforated 70-75, 245-250, 290-300 ft. Water level 132 ft, 1974. Reported yield 2 gal/min with 33 ft drawdown in 1 hr

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
Basalt(?):			
Rock, broken, and yellow clay	18	18	2,752
Gravel and reddish-brown clay	7	25	2,745
Clay, brown, soft, and gravel	15	40	2,730
Gravel and red clay	10	50	2,720
Clay, red, sticky	10	60	2,710
Clay, light-brown, and sand	10	70	2,700
Clay, white, and sand	10	80	2,690
Clay, red, soft	5	85	2,685
Clay, red, and gravel	5	90	2,680
Rock, yellow, soft, and clay	140	250	2,520
Clarno Formation:			
Rock, brown, hard	130	380	2,390

8S/12E-4ddd. Schoolie Flat Well (Yahtin). Alt 2,710 ±10 ft. Drilled by Lawrence Kowaleski, 1958. Casing: 6-in diam to 15 ft. Water level 82 ft, 1974

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
Soil	2	2	2,708
Gravel	4	6	2,704
Basalt(?):			
Clay, red	113	119	2,591
Clay, gray	16	135	2,575
Clay, red	4	139	2,571
"Bed rock"	11	150	2,560

8S/13E-17dbd. Margaret Charley. Alt 1,580 ±10 ft. Drilled by Lawrence Kowaleski, 1959; reconditioned by George McClanahan Well Drilling, 1965. Casing: 6-in diam to 30 ft; unperforated. Water level 7 ft, 1965. Reported yield 2 gal/min with 31 ft drawdown in 2 hr

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
John Day Formation:			
Clay, yellow, and gravel	16	16	1,564
Clay, red	109	125	1,455

8S/13E-23cbc. Ella Wolfe. Alt 1,410 ±10 ft. Drilled by George McClanahan Well Drilling, 1965. Casing: 6-in diam to 31 ft; unperforated. Water level 15 ft, 1965. Reported yield 5 gal/min with 15 ft drawdown in 1 hr

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
Soil	3	3	1,407
Alluvium:			
Clay, red, and sand	8	11	1,399
Gravel, coarse	5	16	1,394
John Day Formation:			
Clay, brown	15	31	1,379
Claystone, white	1	32	1,378
Claystone, brown	3	35	1,375

8S/13E-23cdc. Kip Culpus. Alt 1,410 ±10 ft. Drilled by George McClanahan Well Drilling, 1965. Hole abandoned

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
Alluvium:			
Gravel, coarse	25	25	1,385
John Day Formation:			
Clay, red	195	220	1,190

8S/13E-27bb. Franklin Suppah. Alt 1,420 ±20 ft. Drilled by George McClanahan Well Drilling, 1965. Hole abandoned; exact location not confirmed

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
Alluvium:			
Clay, brown, and sand	7	7	1,413
Gravel, coarse	5	12	1,408
John Day Formation:			
Clay, red	150	162	1,258

8S/13E-27cdc. Sarena Boyd. Alt 1,590 ±20 ft. Drilled by Archie Fox Well Drilling, 1973. Casing: 6-in diam to 250 ft; perforated 42-250 ft. Water level 15 ft, 1974. Reported yield 8 gal/min with 220 ft drawdown in 4 hr

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
John Day Formation:			
Clay, sandy, loose	75	75	1,515
Clay, yellow, sandy	75	150	1,440
Clay, white	20	170	1,420
Clay, light-red	10	180	1,410
Clay, white, sandy	10	190	1,400
Clay, dark-red, sticky	60	250	1,340

8S/13E-33cab. Delbert Frank. Alt 1,805 ±5 ft. Drilled by Archie Fox Well Drilling, 1972. Casing: 6-in diam to 247 ft, 5-in diam to 385 ft; perforated 25-385 ft. Water level 19 ft, 1972. Reported yield 7 gal/min with 230 ft drawdown in 6 hr

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
Clay, yellow	7	7	1,798
Gravel	2	9	1,796
John Day Formation:			
Clay, tan	16	25	1,780
Clay, reddish-brown	10	35	1,770
Clay, tan	15	50	1,755
Clay, red-brown, with white specks	35	85	1,720
Clay, gray-tan	25	110	1,695
Clay, red	20	130	1,675
Clay, gray	55	185	1,620
Clay, gray, hard	40	225	1,580
Sandstone, brown	10	235	1,570
Clay, red, hard	48	283	1,522
Sandstone, water-bearing	5	288	1,517
Clay, red, hard	87	375	1,430
Sand, gravel, and clay	5	380	1,425
Clay, red	5	385	1,420

8S/14E-17dcd. Clarence Meanus. Alt 1,300 ±5 ft. Drilled by George McClanahan Well Drilling, 1965. Casing: 6-in diam to 100 ft; unperforated. Water level 30 ft, 1965. Reported yield 3 gal/min with 110 ft drawdown in 1 hr

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
Alluvium:			
Gravel and sand	23	23	1,277
John Day Formation:			
Clay, white, and fine sand	70	93	1,207
Sandstone, brown	69	162	1,138

8S/14E-20bda. Sanders Heath. Alt 1,290 ±10 ft. Drilled by Archie Fox Well Drilling, 1971. Casing: 8-in diam to 125 ft; perforated 55-60, 120-125 ft. Water level 26 ft, 1971. Reported yield 4 gal/min with 40 ft drawdown in 4 hr

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
John Day Formation:			
Clay, yellow, and gravel	13	13	1,277
Clay, yellow	17	30	1,260
Clay, blue-green	27	57	1,233
Clay, green	18	75	1,215
Clay, gray	50	125	1,165

Materials	Thickness (feet)	Depth (feet)	Altitude (feet±)
8S/14E-20dac. Nathan Heath. Alt 1,280 ±10 ft. Drilled by Lawrence Kowaleski, 1958. Casing: 6-in diam to 33 ft. Water level 27 ft, 1958. Reported yield 12 gal/min with 3 ft drawdown in 3 hr			
Soil, sand	6	6	1,274
Alluvium:			
Gravel, coarse, and clay	28	34	1,246
8S/14E-21acb. Clara Moody. Alt 1,270 ±10 ft. Drilled by George McClanahan Well Drilling, 1965. Casing: 6-in diam to 20 ft; unperforated. Water level 5 ft, 1965. Reported yield 12 gal/min with 9 ft drawdown in 1 hr			
Alluvium:			
Clay, brown, and sand	7	7	1,263
Gravel, coarse	12	19	1,251
Gravel, medium	3	22	1,248
9S/8E-4ddb. Olallie Lake Guard Station. Alt 4,950 ±25 ft. Drilled by Steinman Bros., 1962. Casing: 6-in diam to 26 ft, 5-in diam 234-254 ft; perforated 240-253 ft. Water level 226 ft, 1962. Reported yield 7 gal/min with total drawdown (28 ft) in 1 hr			
Clay, brown, sandy	1	1	4,949
Andesite:			
Rock, gray, soft	20	21	4,929
Rock, gray, medium-soft	29	50	4,900
Rock, brown, soft	6	56	4,894
Rock, brown, broken	4	60	4,890
Rock, brown, medium-hard	12	72	4,878
Rock, brown, soft	13	85	4,865
Rock, brown, medium-hard	20	105	4,845
Rock, gray, hard	43	148	4,802
Rock, brown, hard	11	159	4,643
Rock, gray, hard	82	241	4,709
Cinders, red, loose	13	254	4,696
9S/8E-10cba. Olallie Lake Peninsula Campground. Alt 4,948 ±25 ft. Drilled by Steinman Bros., 1962. Casing: 6-in diam to 22 ft, 5-in diam 190-242 ft; perforated 225-240 ft. Water level 0 ft, 1974. Reported yield 15 gal/min with total drawdown in 1 hr			
Clay, brown, sandy, and broken rock	3	3	4,945
Andesite:			
Rock, gray, medium-hard	7	10	4,938
Rock, gray, broken	3	13	4,935
Rock, gray, medium-soft	22	35	4,913
Rock, gray, hard	13	48	4,900
Rock, brown, hard	20	68	4,880
Rock, gray, hard	49	117	4,831
Rock, brown, hard	3	120	4,828
Rock, gray, hard	37	157	4,791
Rock, brown, hard	5	162	4,786
Rock, gray, hard	32	194	4,754
Cinders, red, loose	8	202	4,746
Rock and clay, red, decomposed	34	236	4,712
Rock, red, decomposed (water-bearing)	6	242	4,706
9S/11E-2baa. Prosanna Williams. Alt 2,680 ±5 ft. Drilled by Archie Fox Well Drilling, 1973. Casing: 6-in diam to 370 ft; screened 370-375 ft. Water level 352 ft, 1973. Reported yield 18 gal/min with 6 ft drawdown in 4 hr			
Soil	3	3	2,677
Basalt:			
Basalt, broken, and clay	47	50	2,630
Clay, red, soft	10	60	2,620
Basalt, broken, and clay	18	78	2,602
Clay, red, soft	19	97	2,583
Basalt, broken, and clay	56	153	2,527
Clay, red, soft	202	355	2,325
Dalles Formation:			
Sand and gravel, water-bearing	20	375	2,305
9S/12E-14dac. Dan Macy. Alt 1,665 ±5 ft. Drilled by Cunningham Well Drilling, 1971. Casing: 6-in diam to 40 ft; perforated 24-40 ft. Water level 18 ft, 1973			
Soil	4	4	1,661
John Day Formation:			
Basalt, soft	27	31	1,634
Clay, brown	65	96	1,569
Sand, water-bearing	6	102	1,563
9S/12E-32cda. Delton Switzler. Alt 1,840 ±20 ft. Drilled by Lawrence Kowaleski, 1966. Casing: 6-in diam to 21 ft. Water level 56 ft, 1966. Reported yield 12 gal/min with 26 ft drawdown in 1 hr			
Soil, black	2	2	1,838
Gravel	8	10	1,830
John Day Formation:			
Clay, yellow	32	42	1,798
Clay, gray	38	80	1,760
Clay, yellow, with basaltic fragments	11	91	1,749
Clay, yellow, hard, with basaltic fragments	38	129	1,711
Clay, blue	3	132	1,708
9S/12E-33ccc. Dan Macy. Alt 1,730 ±10 ft. Drilled by Cunningham Well Drilling, 1971. Casing: 8-in. diam to 20 ft. Water level 38 ft, 1971. Reported yield 4 gal/min with "no" drawdown in 1 hr			
Soil	2	2	1,728
John Day Formation:			
Clay	58	60	1,670
Clay, sandy	60	120	1,610
Sand, water-bearing	30	150	1,580
9S/12E-34aba. Clifford ("Pete") Courtney. Alt 1,590 ±10 ft. Drilled by Lawrence Kowaleski, 1963. Casing: 6-in diam to 20 ft; unperforated. Water level 15 ft, 1963. Reported yield 4½ gal/min with 450 ft drawdown in 2 hr			
John Day Formation:			
Clay, red	20	20	1,570
Clay, yellow	65	85	1,505
Claystone, blue	95	180	1,410
Claystone, red	102	282	1,308
Sand, black, water-bearing	3	285	1,305
Clay, red, and fine sand	160	445	1,145
Sand, black, fine	1	446	1,144
Clay, red	54	500	1,090
9S/12E-34bcd1. Bart Clements. Alt 1,620 ±10 ft. Drilled by George McClanahan, 1965. Casing: 6-in diam to 64 ft; unperforated. Water level 8 ft, 1965. Reported yield 2 gal/min with 57 ft drawdown in 1 hr			
Alluvium:			
Clay, brown, and sand	10	10	1,610
John Day Formation:			
Claystone, brown	60	70	1,550
Sandstone, gray	12	82	1,538
9S/12E-34bcd2. Ed Manion. Alt 1,620 ±10 ft. Drilled by Lawrence Kowaleski, 1967. Casing: 6-in diam to 63 ft; unperforated. Water level 5 ft, 1967. Reported yield 10 gal/min with 48 ft drawdown in 1 hr			
Alluvium:			
Clay, black	18	18	1,602
Sandstone, light-green	3	21	1,599
Sand, loose	6	27	1,593
Pumice and black clay	2	29	1,591
John Day Formation:			
Clay, blue, with sand	6	35	1,585
Clay, black, with sand and decayed wood	13	48	1,572
Clay, blue, with gravel	9	57	1,563
Clay, yellow, with sand and gravel	27	84	1,536

Materials	Thick-ness (feet)	Depth (feet)	Alti-tude (feet±)
9S/12E-36dda. Stanley Smith, Jr. Alt 1,380 ±10 ft. Drilled by Archie Fox Well Drilling, 1971. Casing: 6-in diam to 25 ft; screen 25-30 ft. Water level 9 ft, 1971. Reported yield 15 gal/min with 4½ ft drawdown in 3½ hr			
Soil	1	1	1,379
Alluvium:			
Sand, gravel, and clay, consolidated	11	12	1,368
Sand and gravel, unconsolidated	1	13	1,367
Sand, gravel, and clay, consolidated	7	20	1,360
Sand and gravel, unconsolidated	10	30	1,350
John Day Formation:			
Clay, yellow	5	35	1,345
9S/13E-17dad. Dry Creek Campground. Alt 1,350 ±10 ft. Drilled by Lawrence Kowaleski, 1964. Casing: 6-in diam to 19 ft; unperforated. Water level 7 ft, 1973. Reported yield 5 gal/min with 4 ft drawdown in 1 hr			
Soil, sandy	7	7	1,343
Alluvium:			
Gravel	5	12	1,338
Clay, soft	4	16	1,334
Gravel	3½	19½	1,330
9S/13E-17dcd. Andrew David. Alt 1,360 ±10 ft. Drilled by George McClanahan Well Drilling, 1965. Casing: 6-in diam to 19 ft; unperforated. Water level 15 ft, 1965. Reported yield 8 gal/min with 3 ft drawdown in 1 hr			
Loam sandy	8	8	1,352
Alluvium:			
Gravel, coarse	12	20	1,340
10S/12E-1caa1. Zane Jackson. Alt 1,410 ±10 ft. Drilled by Bert Abrams, 1960. Casing: 6-in diam to 27 ft; perforated 16-27 ft. Water level 14 ft, 1960. Reported yield 5 gal/min with 50 ft drawdown in 3 hr			
Alluvium:			
Sand, consolidated	6	6	1,404
Sand, loose	13	19	1,391
Gravel, coarse, and hardpan	2	21	1,389
John Day Formation:			
Clay, silty	4	25	1,385
Clay, tuffaceous	55	80	1,330
10S/12E-1caa2. Charlie Jackson. Alt 1,470 ±10 ft. Drilled by Archie Fox Well Drilling, 1973. Casing: 6-in. diam to 175 ft; perforated 75-175 ft. Water level 79 ft, 1974. Reported yield 7 gal/min with 90 ft drawdown in 4 hr			
Clay, soil, and gravel	3	3	1,467
Alluvium:			
Gravel	37	40	1,430
Rock, broken, and clay	20	60	1,410
Gravel, water-bearing	15	75	1,395
John Day Formation:			
Clay, brown, and sand	70	145	1,325
Clay, green, and sand	5	150	1,320
Clay, red-brown, sticky	25	175	1,295
10S/12E-28bdb. Gilbert Kalama. Alt 1,920 ±10 ft. Drilled by George McClanahan Well Drilling, 1965. Casing: 6-in diam to 24 ft; unperforated. Water level 20 ft, 1965. Reported yield 6 gal/min with 28 ft drawdown in 1 hr			
Alluvium:			
Clay, brown, and sand	10	10	1,910
Gravel, coarse	8	18	1,902
Dalles Formation:			
Sandstone, brown	44	62	1,858

Materials	Thick-ness (feet)	Depth (feet)	Alti-tude (feet±)
10S/12E-29add. Orin Johnson. Alt 1,940 ±10 ft. Drilled by George McClanahan Well Drilling, 1965. Casing: 6-in diam to 24 ft; unperforated. Water level 6 ft, 1965. Reported yield 10 gal/min with 10 ft drawdown in 1 hr			
Alluvium:			
Clay, brown, and sand	7	7	1,933
Gravel, coarse, and sand	10	17	1,923
Dalles Formation:			
Sandstone, gray	35	52	1,888
10S/12E-29bdd. Ray Johnson. Alt 1,950 ±10 ft. Drilled by Bert Abrams, 1971. Casing: 4-in diam to 42 ft; unperforated. Water level 21 ft, 1971. Reported yield 9 gal/min with 11 ft drawdown in 2 hr			
Alluvium:			
Silt, sandy	17	17	1,933
Silt, sandy, with gravel	7	24	1,926
Dalles Formation:			
Sandstone, dark	4	28	1,922
Sandstone, light-colored, with gravel	19	47	1,903
10S/12E-30abc. Karen Wallulatum. Alt 2,020 ±10 ft. Drilled by George McClanahan Well Drilling, 1965. Casing: 6-in diam to 24 ft; unperforated. Water level 16 ft, 1965. Reported yield 7 gal/min with 8 ft drawdown in 1 hr			
Alluvium:			
Clay, brown, and sand	4	4	2,016
Gravel, medium, and clay	14	18	2,002
Gravel, medium, and claystone	11	29	1,991
Dalles Formation:			
Claystone, brown	13	42	1,978
10S/12E-30bbd. Avex Miller, Jr. Alt 2,030 ±10 ft. Drilled by George McClanahan Well Drilling, 1965. Casing: 6-in diam to 23 ft; unperforated. Water level 20 ft, 1965. Reported yield 4½ gal/min with 36 ft drawdown in 1 hr			
Alluvium:			
Clay, brown, and sand	2	2	2,028
Dalles Formation:			
Sandstone, brown	60	62	1,968
11S/12E-2ccc. Simtustus Park Campground. Alt 1,640 ±10 ft. Drilled by Bert Abrams, 1962. Casing: 6-in diam to 68 ft; unperforated. Water level 52 ft, 1973. Reported yield 15 gal/min with "no apparent" drawdown in 1½ hr			
Alluvium:			
Conglomerate (pumice)	28	28	1,612
Dalles Formation:			
Ash, red, cemented	23	51	1,589
Basalt, vesicular	17	68	1,572
11S/12E-18dcc. Joe Estabrook. Alt 2,580 ±10 ft. Drilled by Bert Abrams (?), 1958. Casing: 6-in diam to 12 ft. Water level 152 ft when drilled; later dropped to 260 ft. Reported yield 20 gal/min when drilled, but in 1973 piston pump produced several gallons per minute or less			
Soil	3	3	2,577
Basalt:			
Pumice	7	10	2,570
Basalt	8	18	2,562
Basalt, vesicular	24	42	2,538
Dalles Formation:			
Tuff	76	118	2,462
Basalt, gravel, sandstone, and conglomerate	198	316	2,264
Lava rock	26	342	2,238
Sandstone	28	370	2,210

Table 17.--Chemical analyses of water from selected wells and springs

[Analyses by the U.S. Geological Survey]

Location number	Name or (location)	Well (W) or spring (S)	Principal geologic source	Date of collection	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)	Nitrate + nitrite (N)	Phosphate (PO_4)	Arsenic (As)	Boron (B)	Dissolved solids 1/	Hardness, as $CaCO_3$	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)	Temperature (°F)	Sodium adsorption-ratio (SAR)
					Milligrams per litre																						
5S/11E-35ddd	Kelly Spring	S	Tjd	7/23/74	76	0.59	--	16	3.2	18	4.3	103	0	2.5	2.0	0.2	--	--	--	--	174	53	174	7.5	14.5	58	1.1
6S/9E-21bbd	Willow Springs	S	Ta	7/24/74	19	.02	--	3.1	3.4	1.8	.1	26	0	1.1	.8	.0	--	--	--	--	42	22	42	7.5	11.5	53	.2
6S/11E-3bac	Daniel Spring	S	Tjd	7/23/74	73	.05	0.00	37	3.4	15	3.7	158	0	1.6	2.2	.1	0.20	0.43	0.000	--	215	110	252	7.2	15.5	60	.6
6S/11E-8dbc	Coyote Spring	S	Tc	do	44	.20	--	41	8.4	17	.8	210	0	1.9	2.8	.2	--	--	.002	--	221	140	322	7.6	15.5	60	.6
6S/11E-27aab	Log Spring	S	Tc	do	69	.07	.01	12	7.8	12	3.7	100	0	1.0	2.4	.1	.18	.31	.001	--	158	62	166	7.3	17.5	63	.7
6S/12E-27bca	Nena Spring	S	Tjd	5/17/74	72	.05	.30	23	1.9	27	3.5	109	0	6.6	16	.1	1.0	.40	.005	0.01	209	65	253	7.6	10.5	51	1.5
7S/10E-7dda	Big Spring	S	Ta	5/17/73	38	.03	.00	8.5	4.4	5.4	1.5	66	0	2.0	1.3	.1	.01	.15	--	--	94	39	98	7.9	9.5	49	.4
7S/10E-25daa	Dorothy Wally	W	Qg	7/23/74	30	2.2	.05	6.8	6.5	6.7	7.5	67	0	2.6	2.5	.2	.18	.12	.000	.25	99	44	106	8.3	--	--	.4
7S/11E-32bdd	Albert Comedown	W	Qg	7/25/74	39	.19	.00	9.4	5.6	1.9	1.3	58	0	2.1	1.6	.1	.79	.09	.000	.02	93	47	104	7.1	10.5	51	.1
7S/11E-33abd	(Mill Creek Flat)	S	Qg	5/16/74	35	.18	.00	11	4.7	5.1	.7	70	0	2.1	1.4	.7	.19	.09	--	.004	96	47	118	7.3	10.0	50	.3
7S/12E-7dbb	Simnasho well	W	Tc	9/13/73	33	.05	.00	19	1.8	19	.7	105	0	6.2	1.5	.3	.08	.28	.019	.01	134	55	178	7.9	--	--	1.1
7S/12E-34cab	Frank Suppah	W	Tjd	12/2/55	40	--	--	10	3.8	13	1.4	72	0	2.6	2.8	1.0	2.3	--	--	--	112	41	136	8.1	--	--	.9
7S/13E-17ddb	Eagle Springs	S	Tjd	9/12/73	43	.17	.00	7.0	2.6	9.5	1.7	54	0	1.1	3.6	.1	.09	.21	.006	--	96	28	96	7.5	11.8	53	.8
7S/14E-8bca	(Antoken Creek)	S	Tjd	9/11/73	35	.05	.00	15	.8	31	.6	124	0	4.1	2.4	.9	1.2	.18	.006	--	156	41	204	7.7	16.8	62	2.1
7S/14E-17bcb	(Southwest of North Junction)	S	Tjd	do	46	.09	.00	5.2	1.1	13	1.3	44	0	4.1	1.3	.2	1.2	.37	--	--	100	18	93	7.7	17.0	63	1.4
8S/11E-6cad	Sidwalter well	W	Tb/Td	9/13/73	48	.02	.00	9.9	6.8	8.8	1.8	83	0	1.8	6.0	.1	.87	.49	.002	.01	129	53	148	8.0	--	--	.5
8S/11E-16dca	Phillip Guerin	W	Tb/Td	1/24/74	49	.09	.03	9.4	6.0	11	1.5	85	0	1.8	1.4	.3	1.0	.18	0	.003	127	48	142	7.6	--	--	--
8S/11E-25ccc	Elmer Quinn	W	Td	6/21/73	48	.68	.02	12	5.7	16	3.0	95	0	3.4	3.3	.3	1.7	.25	.004	.01	147	53	178	7.6	14.3	58	1.0
8S/11E-33ddd	Irene Wells	W	Td	5/ 9/74	34	.08	.00	12	5.4	8.8	2.7	82	0	1.6	1.5	1.0	.53	.18	.001	.00	110	52	142	8.0	14.0	57	.5
8S/12E-3acd	(East of Schoolie Flat)	S	Tjd	7/31/74	40	.68	.02	9.1	4.9	7.8	1.2	60	0	2.6	2.5	.1	.09	.40	.003	.02	99	43	--	7.0	17.0	63	.5
8S/12E-3cac	Schoolie Flat 90-ft test	W	Tb	8/19/74	54	2.1	2.5	23	9.6	19	2.2	166	0	4.4	4.5	.3	.00	.92	.022	.01	204	97	273	6.9	--	--	.8
8S/12E-4ddd	Schoolie Flat well	W	Tb	9/12/73	59	.02	.00	18	7.6	13	2.2	115	0	2.9	4.7	.3	1.1	.71	.006	.01	170	76	198	7.4	--	--	.6
8S/12E-14dcd	Kuckup Spring	S	Tjd(?)	9/11/73	65	.05	.00	15	6.0	22	2.0	117	0	3.3	7.9	.6	1.5	.43	.02	.01	187	62	216	7.4	--	--	1.2

1/ Calculated values with bicarbonate recomputed as carbonate.

Table 17.--Chemical analyses of water from selected wells and springs--Continued

[Analyses by the U.S. Geological Survey]

Location number	Name or (location)	Well (W) or spring (S)	Principal geologic source	Date of collection	Milligrams per litre: 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)	Nitrate + nitrite (N)	Phosphate (PO_4)	Arsenic (As)	Boron (B)	Dissolved solids 1/	Hardness, as $CaCO_3$	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)	Temperature (°F)	Sodium-adsorption-ratio (SAR)
8S/12E-29dbb	Buck Spring	S	Td	7/20/73	38	0.33	0.00	9.8	5.5	4.8	1.1	73	0	1.3	1.3	0.1	0.16	0.12	0	0.03	99	47	108	8.2	15.0	59	0.3
8S/13E-1aaa	(South of Skookum Creek)	S	Tjd	5/ 9/74	73	0	.03	12	3.3	130	6.5	368	2	17	16	1.1	.12	1.0	.002	.02	444	44	634	8.4	17.0	63	8.6
8S/13E-7cca	Wire Corral Spring	S	Tjd	6/ 8/73	45	.07	.00	8.6	2.1	14	1.3	60	0	6.0	2.9	.5	.68	.21	.029	.02	113	30	122	7.6	16.0	61	1.1
8S/13E-11bdb	Charley Corral Spring	S	Tjd	9/11/73	80	.48	.00	7.2	1.2	43	5.5	129	0	7.0	5.2	.7	.81	.71	.013	--	218	23	228	7.6	13.5	56	3.9
8S/13E-17dbd	Margaret Charley	W	Tjd	5/17/73	43	1.6	.15	11	.4	100	.9	263	0	11	11	1.0	.65	.95	.018	0	314	29	443	7.5	17.5	63	8.1
8S/13E-19bad	(Hot spring east of hatchery)	S	Tjd	5/14/73	78	.60	.05	13	.3	400	11	603	0	31	240	21	.00	.25	.34	5.6	1,100	34	1,790	8.1	83.5	182	30
8S/13E-20acd	Kahneeta Hot Spring	S	Tjd	1/24/74	51	.06	.00	3.8	.0	320	3.8	504	0	34	150	23	.87	.25	.30	2.6	841	10	1,400	8.2	47.0	117	45
8S/13E-20bdb	(Hot spring west of Kahneeta)	S	Tjd	5/17/73	58	.05	.02	5.2	.2	380	1.3	386	103	39	220	27	.04	.25	--	--	1,020	14	1,740	8.8	55.5	132	45
8S/13E-30aaa	(Northeast of Eagle Butte)	S	Tjd	do	67	.06	.01	32	4.2	27	4.8	168	0	18	4.7	.4	.83	.71	--	--	245	97	311	7.8	13.5	56	1.2
8S/13E-32bdd	Ida McKinley	W	Tjd	do	76	.05	.00	14	3.9	35	5.1	138	0	6.9	6.7	.5	1.5	.18	.005	.00	223	51	257	7.5	15.5	60	2.1
8S/13E-33cab	Delbert Frank	W	Tjd	9/10/73	51	.20	.03	12	1.4	60	4.0	179	0	11	9.1	.7	.87	.31	.017	.07	242	36	319	8.2	--	--	4.4
8S/13E-35bbc	Harold Culpus	S	Tjd	do	88	.09	.01	17	2.0	46	7.6	162	0	10	7.8	.7	.92	.67	.009	.05	264	51	299	7.8	16.6	62	2.8
8S/14E-20bbb	Rattlesnake Spring	S	Tjd(?)	4/12/73	42	.07	.00	7.9	2.3	14	5.3	54	0	8.4	2.1	.2	2.4	.61	.012	--	120	29	137	8.1	6.5	44	1.1
8S/14E-20bda	Sanders Heath	W	Tjd	do	57	.25	.06	8.2	.3	96	14	164	0	91	6.5	.3	2.7	.64	.018	.04	367	22	491	7.5	--	--	9.0
8S/14E-31cbb	(South of Webster Flat)	S	Tcr	do	54	.07	.01	31	13	23	4.2	188	0	8.9	6.9	.6	.82	.18	--	--	238	130	336	8.1	13.0	55	.9
9S/8E-4ddb	Olallie Lake Guard Station	W	Ta	7/22/74	13	.66	--	3.1	1.9	2.7	.9	25	0	1.5	1.7	.0	--	--	--	--	38	16	60	7.4	7.5	45	.3
9S/12E-1daa	(South of Eagle Butte)	S	Tjd	4/11/73	77	.11	.01	21	3.3	34	6.6	157	0	6.5	6.9	.6	.57	.28	.000	--	236	66	284	7.6	13.0	55	1.8
9S12E-3cbb	Tohet Spring	S	Tjd	do	77	.06	.01	21	5.6	25	6.6	135	0	6.8	4.8	.4	1.6	.21	.005	--	221	76	256	7.9	13.0	55	1.3
9S/12E-10ccc	(Upper Dry Creek)	S	Td/Tjd	do	69	.06	.01	13	5.4	16	4.4	100	0	4.1	7.9	.3	.99	.31	--	--	174	55	188	7.7	16.5	62	.9

1/ Calculated values with bicarbonate recomputed as carbonate.

Table 17.--Chemical analyses of water from selected wells and springs--Continued

[Analyses by the U.S. Geological Survey]

Location number	Name or (location)	Well (W) or spring (S)	Principal geologic source	Date of collection	Milligrams per litre: Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO4)	Chloride (Cl)	Fluoride (F)	Nitrate + nitrite (N)	Phosphate (PO_4)	Arsenic (As)	Boron (B)	Dissolved solids 1/	Hardness, as $CaCO_3$	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)	Temperature (°F)	Sodium adsorption ratio (SAR)
9S/12E-13daa	(Dry Creek)	S	Tjd	4/11/73	70	0.02	0.00	28	6.3	78	4.4	263	0	23	15	0.8	0.95	0.31	0.008	--	360	96	508	7.5	10.5	51	3.5
9S/12E-31caa	(Tenino Creek)	S	Td/Tjd	3/ 9/73	73	.18	.01	20	10	20	4.1	164	0	3.5	3.6	.4	.08	.25	.000	0.00	216	91	260	7.6	9.3	49	.9
9S/12E-32cda	Delton Switzler	W	Tjd	1/23/74	51	.07	.00	20	.4	65	7.4	229	0	7.6	5.5	.4	.10	.67	.001	.04	271	52	382	7.7	--	--	3.9
10S/9E-33baa	(East of Bald Peter)	S	Ta	7/25/74	21	.02	.00	4.3	1.0	1.7	.3	21	0	.5	.6	.0	.00	.09	.001	--	40	15	32	7.5	3.0	37	.2
10S/10E-4dad	(Upper Seekseequa Creek)	S	Ta	3/ 9/73	34	.78	--	9.4	4.9	3.2	.9	62	0	3.6	1.4	.1	.04	.31	--	--	89	44	96	7.5	3.5	38	.2
10S/11E-30cba	Peters Spring	S	Tb	3/ 7/73	44	.30	--	12	6.9	4.1	1.3	83	0	2.3	1.1	.1	.07	.15	--	--	113	58	128	7.1	10.3	51	.2
10S/12E-15bdb	Annie Smith	W	Td	5/ 7/74	63	.05	.00	16	6.3	20	3.4	122	0	5.3	4.2	.1	1.5	.28	.002	.006	185	66	226	7.8	--	--	1.1
10S/12E-29add	Orin Johnson	W	Td	3/ 8/73	55	.60	1.4	17	12	14	4.3	159	0	2.4	1.8	.2	.00	.46	--	--	188	92	243	7.1	--	--	.6
10S/12E-30bbd	Alex Miller, Jr.	W	Td	3/ 7/73	69	.11	.00	15	8.9	21	6.2	152	0	2.8	2.8	.2	2.0	.25	.000	.00	210	74	248	7.4	--	--	1.1
11S/12E-2ccc	Simtustus Park	W	Td	4/ 9/73	20	3.9	.02	8.7	6.4	20	3.0	107	0	5.4	2.9	.2	.05	.09	.000	--	124	48	174	8.3	13.0	55	1.3
11S/12E-18dcc	Joe Estabrook	W	Td	3/ 6/73	45	.08	.00	17	9.2	20	3.9	144	0	4.4	4.1	.5	1.0	.18	.000	.00	180	80	245	7.6	--	--	1.0

1/ Calculated values with bicarbonate recomputed as carbonate.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
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