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CHRIS L. WHEELER
STATE ENGINEER

GROUND WATER IN SELECTED AREAS IN THE KLAMATH BASIN, OREGON

BY
A. R. LEONARD AND A. B. HARRIS
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
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GROUND WATER IN SELECTED AREAS IN THE KLAMATH BASIN, OREGON

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By A. R. Leonard and A. B. Harris

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ABSTRACT

Ground-water features of six lowland areas in the Klamath Basin of Oregon--Klamath Marsh area, and Sprague River, Swan Lake, Yonna, Poe, and Langell Valleys--are described in this report. Rugged mountains and ridges surround and separate these lowlands where floors range in altitude from 4,100 feet in Poe Valley to 4,600 feet north of Klamath Marsh. The six areas extend over a north-south distance of 70 miles, an east-west distance of 40 miles, and include an area of approximately 600 square miles.

The area is semiarid and receives about 14 to 18 inches of precipitation a year. The growing season is short, particularly in the higher valleys, and killing frosts have been recorded every month of the year.

Extinct volcanoes and their extrusions characterize the area. Much of the area is covered by basalt, but pumice, tuff, cinders, and other ejecta occur on and beneath the surface. A thick sedimentary unit that accumulated in widespread lakes contains several hundred feet of diatomite, clay, sand, and gravel. In general, both the sedimentary rocks and the thin alluvial deposits of the valleys are poor aquifers; therefore, most wells tap permeable basalt or cindery rubble beneath the lacustrine beds. The depths of wells range from less than 50 to nearly 2,000 feet--most are between 100 and 1,000 feet deep.

The surrounding mountains are recharge areas from which ground water moves toward the lowlands. In the Klamath Marsh and stream valleys of Sprague River, Poe, and Langell Valleys, ground water moves toward the streams and downstream. In Swan Lake and Yonna Valleys, ground water in the main confined aquifer moves generally southward. The regional pattern of movement also seems generally southward, and some ground water may move beneath mountain ridges from one valley to another. Ground water is discharged in all the lowland areas, both by springs that contribute to streamflow and by evapotranspiration in marshy areas.

The principal aquifer is a confined one in broken, cavernous, or cindery lava and volcanic sediments. These permeable beds are overlain and confined by fine-grained lacustrine sediments and impervious volcanic rocks. In Sprague River, Swan Lake, and Yonna Valleys, irrigation wells that tap the confined aquifers yield a few hundred to 3,000 gpm (gallons per minute). Flowing wells occur in all areas except Swan Lake Valley. The most extensive area of flowing wells is in the Sprague River valley, where about 25 wells, some flowing more than 2,000 gpm, supply water for irrigation.

Water levels in wells fluctuate seasonally from 1 to 4 feet, being highest in late spring and lowest in late fall or winter. Perennially declining water levels were noted in two small areas. In most areas, however, water-level fluctuations are seasonal or climatically controlled, and no lasting effects from ground-water use were noted.

Ground water in the basin is of excellent quality for drinking, irrigation, and most industrial uses. It generally has a dissolved-solids content of less than 250 mg/l (milligrams per liter), hardness of less than 120 mg/l, and low concentrations of other constituents. It contains 30 to 70 mg/l of silica, which may affect its use for some industrial purposes. The mineralization of the ground water is lowest in Klamath Marsh, where the water is of the sodium bicarbonate type and has specific conductance of about 60 to 100 micromhos per centimeter. Ground water in the other areas is mostly calcium bicarbonate or calcium magnesium bicarbonate type. The specific conductance of ground water generally averages about 190 micromhos in Sprague River valley and slightly more in the four southern valleys.

In 1970, ground-water use in the six study areas totaled about 61,000 acre-feet, nearly all for irrigation. Use is greatest in Sprague River, Swan Lake, and Yonna Valleys; each of the other areas has only a few irrigation wells. About 1,000 acre-feet was flowing to waste from uncapped artesian wells in Sprague River valley and Klamath Marsh.

The present level of development of ground water has had no measurable effect on water levels in the aquifers except in three localized areas. In one area, the decline is attributed to uncontrolled flow from artesian wells; in the others, the decline may be due to local pumping from wells. It is concluded that considerably more ground water could be developed safely in most parts of the basin. Aquifers in the main part of Poe Valley and the central and west sides of Langell Valley have little potential as a source of irrigation water, but most other valley areas are potentially productive.

INTRODUCTION

Purpose and Scope

In 1969, the Oregon State Engineer requested the U.S. Geological Survey to restudy the ground-water resources in several areas in the Klamath River basin. Development of irrigation, the major use of ground water, started near the end of World War II and has continued to increase for a number of years. By 1969, the number of irrigation wells in use was about three times as many as in 1954, when an earlier reconnaissance study was made. Objectives of the present study were to (1) determine the magnitude and areal extent of present ground-water development, (2) determine the rate at which ground water is being produced in the study areas, (3) evaluate the effect of development on the perennial supply of ground water, and (4) identify areas where supplies are adequate for additional irrigation development.

Location and Extent

The project study was limited to six areas, all in Klamath County and the Klamath River drainage basin: Klamath Marsh and the adjacent area along Highway 97; Sprague River valley; and Swan Lake, Yonna, Poe, and Langell Valleys. (See fig. 1.) Sprague River, Swan Lake and Yonna Valleys have substantial irrigation development from ground water; the other areas have little ground-water development except for stock and domestic supplies. The areas studied lie generally east of the main drainage lines along the lower Williamson River, Upper Klamath Lake, and the Klamath River.

The overall area studied extends across a north-south distance of more than 70 miles and an east-west distance of more than 40 miles. Within that area, about 600 square miles was studied in detail. The six areas studied all have somewhat indefinite boundaries, but their general areas are shown in figure 1 and in the detailed geologic and ground-water maps (pls. 1, 2, 3, 4, 5).

Methods of Investigation

Many well data, including well logs, were available from earlier studies. All irrigation wells in the areas studied were field located. In addition, a large number of domestic and stock wells were field located, particularly along Highway 97, in Klamath Marsh, and in Poe and Langell Valleys, where irrigation wells are few. Altogether, about 550 wells were field located, and water levels were measured in the spring and fall of 1970 in about 400 of them. Drillers' logs filed in the State Engineer's office and logs collected for earlier studies in 1949 and 1954 provided much of the subsurface geologic data. Surface geologic mapping is available from field mapping for ground-water studies by Meyers and Newcomb (1952) and Newcomb and Hart (1958), and also from field mapping for the Oregon Department of Geology and Mineral Industries by Peterson and McIntyre (1970). The spring and fall measurements of water levels provided information on seasonal changes of water levels.

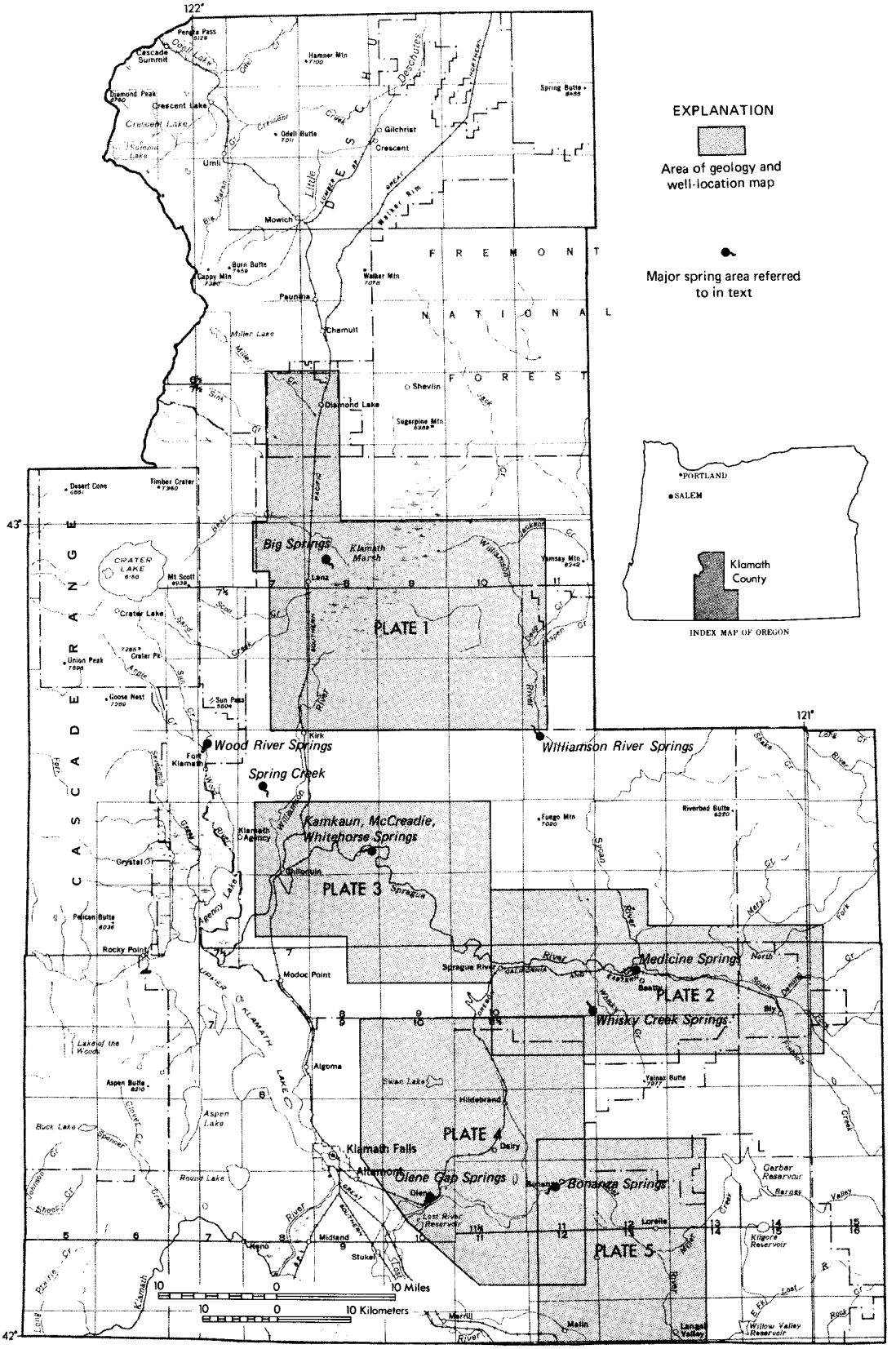

Figure 1.--Index map of Klamath County showing areas studied.

Additional data on water-level fluctuations were available from a cooperative water-level program and from recorder records of water levels in five wells. In November 1970, flowmeter tests were made in several flowing wells in Sprague River valley, and artesian head was measured in about a dozen wells. In addition to two short pumping tests made on wells in Yonna Valley, specific-capacity data were available throughout the project area from drillers' records. About 30 water samples were analyzed, and additional field measurements of specific conductance were made for water from about 100 other wells. Figures on water use were computed from records of power consumption for irrigation pumpage, from irrigated acreages, and by estimating domestic and stock use.

This report consists of two separate but related sections. The first section contains general information on geographic features, descriptions of geologic units, and general features of ground-water occurrence. The second section consists of more detailed descriptions of the six areas studied in detail. Included are information on geographic setting, geologic details that affect ground water locally, ground-water occurrence and movement, water quality, and the potential for additional development. The intention is to present all pertinent facts concerning each subarea in one place for the convenience of the reader who is concerned primarily with one or two subareas. The data in tables of well records and logs, at the end of the report, also are grouped by subarea.

Acknowledgments

The cooperation and assistance of local officials, well owners, and well drillers greatly facilitated this study. Owners furnished information concerning wells and water use and readily permitted their wells to be measured. Special thanks are due George Hazen, Gladys Shoulderblade, Frank Challis, Cecil Hunt, and George Stevenson for allowing recorders to be operated in their wells for more than a year. Jess Angel and Frank Challis kindly allowed their wells to be used for pumping tests. Robert Strathearn and Ray Smith permitted flowmeter tests to be made in wells on ranches they operated. Power data furnished through the courtesy of officials of Pacific Power & Light Co. were helpful in computing pumpage from wells. Many ranchers and landowners also furnished information on irrigation practices and on water use from flowing wells. The cooperation and assistance of all who aided in the project are gratefully acknowledged.

Well-Numbering System

The well- and spring-numbering system used in Oregon is based on the rectangular system for subdivision of public land, and each number indicates the location of the well with respect to township, range, and section. Well number 36S/12E-16bcc indicates a well in T. 36 S., R. 12 E., sec. 16. The letters show the location within the section, as shown in figure 2. The first letter (b) represents the quarter section, the second (c) the quarter-quarter section, and the third (c) the 10-acre tract. If more than one well is located within a 10-acre tract, a

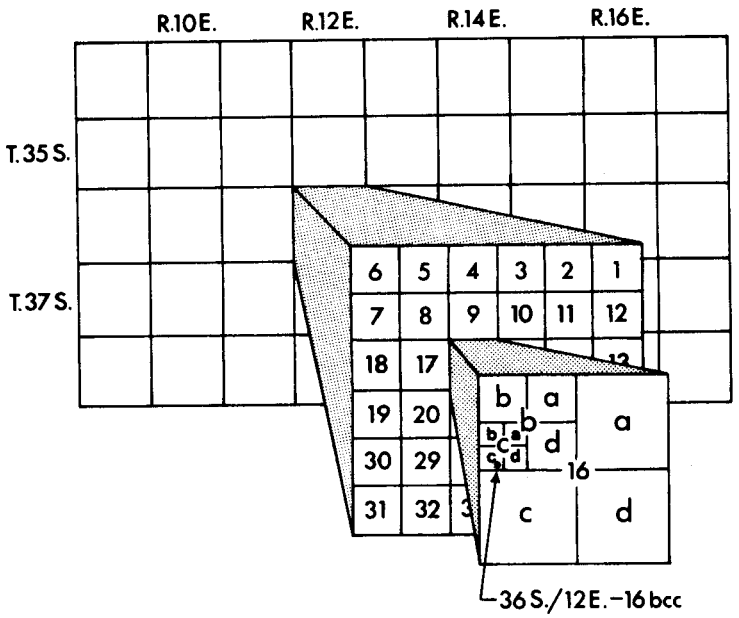

Figure 2.--Well-numbering system.

number is added following the third letter to distinguish them. In the text and tables of this report, wells are identified by location numbers based on this system.

Springs are numbered in the same way as wells except that an (s) is added following the letter designating the 10-acre tract; for instance, 30S/8E-16dcd(s).

GENERAL GEOGRAPHIC FEATURES

Landforms and Drainage

As used in Oregon, the term "Klamath Basin" includes the drainage basins of the Klamath and Lost Rivers and several small undrained areas between them. From its western boundary along the crest of the Cascade Range, the basin extends eastward about 60 to 70 miles. From the northern divide near Chemult, the Klamath Basin extends 85 miles to the California border and about 30 miles into California.

The Klamath Basin is largely a rugged, mountainous region of volcanic peaks and ridges with several intervening lowland areas--the areas studied in detail during this project. Along the western boundary, several mountains of the Cascade Range reach altitudes of 7,000 to 9,500 feet; along the eastern boundary, the highest peaks are Gearhart Mountain (alt 8,364 ft) and Yamsay Mountain (alt 8,196 ft). Much of the area between these two divides lies at 5,000 to 6,000 feet altitude; the valley lowlands are generally below 4,500 feet. In general, the area has a poorly developed drainage system, including many small streams that discharge into marshes or lose their flow in pumice or porous lava.

The principal streams are the Williamson, Sprague, and Lost Rivers. The Williamson River heads north of Fuego Mountain, flows northward about 15 miles, westward through Klamath Marsh, and thence southwestward to Upper Klamath Lake (fig. 1). The Sprague River heads east of Bly and flows generally westward to its confluence with the Williamson River near Chiloquin. Near Beatty the Sprague River is joined by its only major tributary, the Sycan River, which drains the northeastern part of Klamath Basin. The Lost River originates at the outlet of Clear Lake Reservoir in California, flows generally northwestward through Langell Valley to Bonanza, then westward through Poe Valley and southeastward to discharge into Tule Lake, just south of the California border.

Climatic Features

The Klamath Basin has a semiarid winter-rainfall type of climate with mild summers and cold winters. At Klamath Falls, temperatures as high as 105°F have been recorded in July and as low as -24°F in January. The normal annual precipitation varies with altitude, from 14.06 inches at Klamath Falls to 17.72 inches at Chiloquin and more than 60 inches in the highest parts of the mountains. Seventy percent of the precipitation falls during October to March and only 9 percent during July through September (fig. 3).

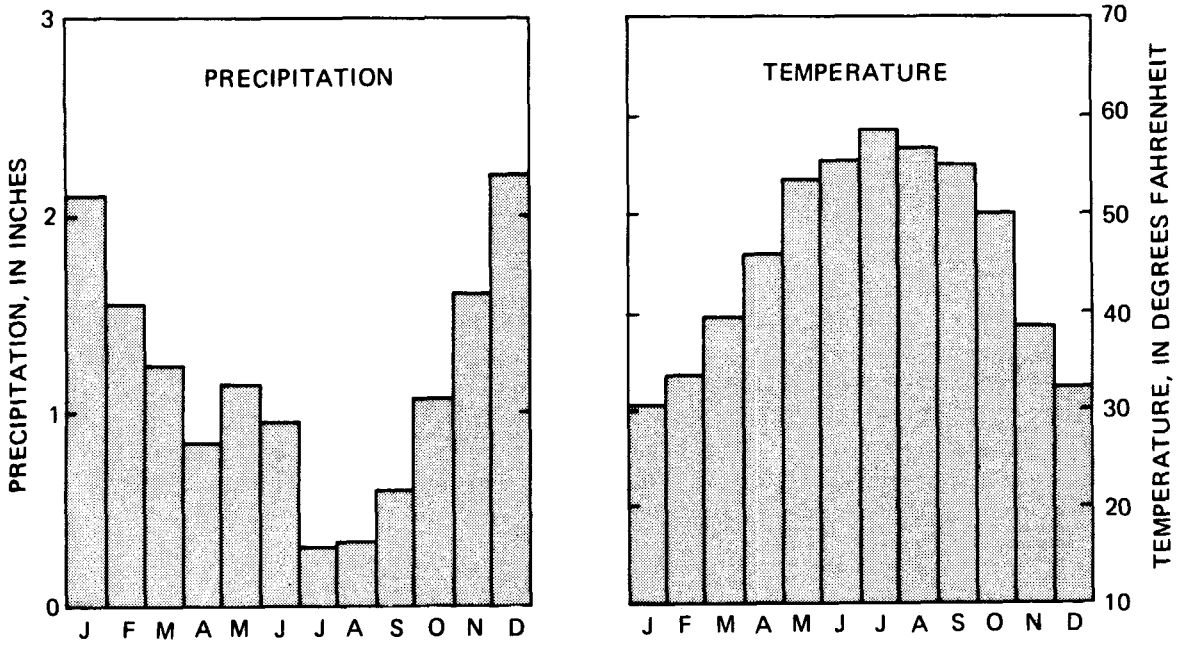

Figure 3.--Normal monthly precipitation and temperature at Klamath Falls.

Figure 4 shows the variation in annual precipitation at Klamath Falls and Chiloquin. Precipitation at Klamath Falls has ranged from only about 7 inches in 1959 to nearly 21 inches in 1957.

As in other high-altitude areas in Oregon, the Klamath Basin has a short growing season. According to National Weather Service records, the average dates for the last killing frost (28°F) in spring is May 4 and the first in autumn is October 18. However, temperatures of 28°F or below have been recorded at Klamath Falls every month of the year, and a frost such as that which damaged crops in August 1969 is not unusual. At higher altitudes the growing season is still shorter, and at Chemult the average period between killing frosts of 28°F is only 16 days.

GEOLOGIC UNITS AND THEIR WATER-BEARING PROPERTIES

Ground-water occurrence in any area is directly related to the geologic features of the area. Those features control the location and rate of recharge, the movement of water through the rocks, and the volume of water that can be pumped from wells.

The study area is predominantly a volcanic terrain that is characterized by block faulting of the Basin-and-Range type. The rocks exposed in the basin, or near enough to land surface to be reached by water wells, are consolidated volcanic rocks, unconsolidated to semi-consolidated volcanic ejecta, or unconsolidated sediments largely derived from volcanic rocks. These rocks are late Tertiary to late Quaternary in age. They were mapped and described in some detail by Meyers and Newcomb (1952) and Newcomb and Hart (1958), and also were mapped by Wells and Peck (1961) and Peterson and McIntyre (1970). The geologic maps accompanying this report are largely adapted from Peterson's and McIntyre's field maps by combining several of their mapping units. A summary of the geologic formations and their water-bearing properties is given in table 1.

Tertiary Rocks

Tertiary rocks differentiated in the study area are (1) the lower basalt unit, (2) breccia and tuff of volcanic maars, and (3) Yonna Formation. The lower basalt unit is widespread from the Sprague River area southward, but in most places is buried by the Yonna Formation, the most extensively exposed unit. The breccia and tuff associated with volcanic maars occur only in local areas that were the sites of Pliocene volcanic cones.

Lower Basalt Unit

The oldest rocks exposed in the project area or reached by water wells are volcanic rocks of Pliocene age which are termed the "lower basalt unit" in this report. These rocks were called the "lower lava rocks" by Meyers and Newcomb (1952) and by Newcomb and Hart (1958). Other geologists (Moore, 1937; Wood, 1960) have included them with the "volcanic rocks of the High Cascades."

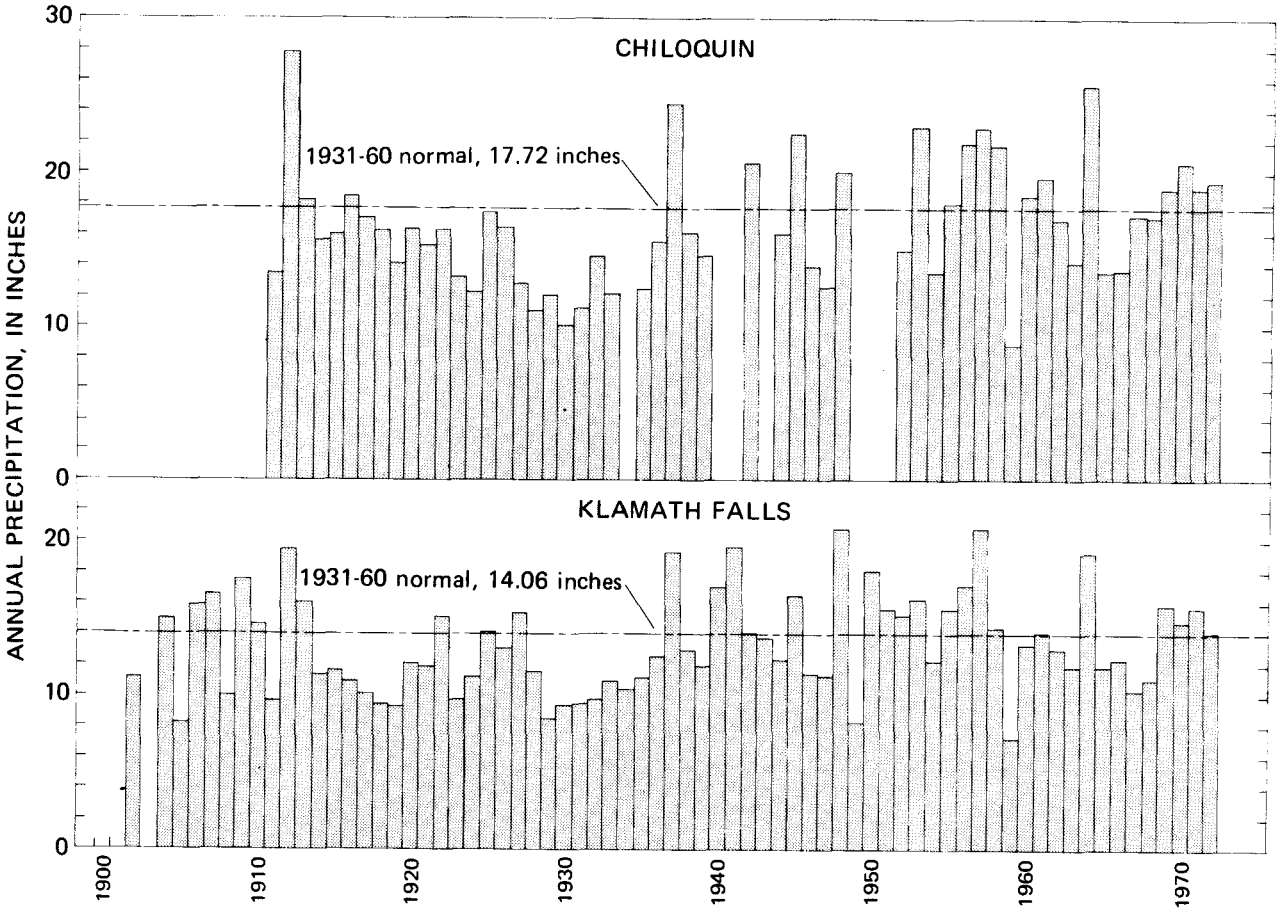

Figure 4.--Annual precipitation, 1902-1972, at Chiloquin and Klamath Falls.

Table 1.--Geologic units and their water-bearing properties

System	Series	Geologic unit	Physical character	Water-bearing properties
QUATERNARY	Holocene	Pumice	Airborne and flow pumice ejected from ancestral Mount Mazama, now Crater Lake. Consists of a widespread, generally unconsolidated to poorly consolidated mantle on the slopes and plains around and underlying Klamath Marsh.	Generally above the water table but serves as an excellent medium for the infiltration of recharge.
	Pleistocene and Holocene	Alluvium	Silt, sand, clay, peat, volcanic ash, pumice, gravel, and locally slope debris. Underlies the surface of lowland areas and lies beneath pumice locally west and northwest of Klamath Marsh.	Thin and above the water table in most areas mapped. Locally yields small quantities of water to wells in Langell, Yonna, and Swan Lake Valleys, and moderate to large supplies from gravel layers beneath younger pumice west and northwest of Klamath Marsh.
		Basalt flows	Widespread thin flows of gray, vesicular basalt in units 20-30 feet thick. Form rimrock and cap lower slopes around major valleys. Include younger basalt flows north of Sprague River which are mapped separately.	Generally fractured and permeable, but above the regional water table in most places. Generally serve as a recharge unit, but supply some domestic wells in Klamath Marsh area and other areas where base of unit extends below water table.
TERTIARY AND QUATERNARY	Pliocene and Pleistocene	Basalt, breccia, and pyroclastic rocks	A thick sequence of basaltic flows, breccia, and pyroclastic rocks forming Stukel and Bryant Mountains and other upland masses. Locally may interfinger with lacustrine beds of Yonna Formation or include flows of other basalt units.	Generally unit has low permeability. Few wells tap the unit but it yields small quantities of water to wells along the western margin of Langell Valley.
		Andesitic lava flows	Dark, platy andesitic flows forming the uplands north and east of Klamath Marsh.	Generally rocks of low permeability. Supply a few low-yielding wells on east side of Klamath Marsh.
		Rocks of volcanic eruptive centers	Eruptive and shallow intrusive rocks of main eruptive centers. Include basaltic, andesitic, and light-colored rocks such as rhyolite and dacite. Form the main mass and lower slopes of several major mountains as well as small peaks and cones.	An important recharge unit in Cascade slopes and other upland areas. Many springs on mountain slopes discharge from these rocks. Also supply water to domestic, stock, and irrigation wells in western part of Klamath Marsh area and locally near other valley areas.
TERTIARY	Pliocene	Yonna Formation	Stratified siltstone, diatomite, sandstone, pumice, gravel, and tuff, largely of lacustrine origin. Locally includes welded tuff beds or interbedded thin lava flows. Underlies lowlands and forms lower slopes around all valleys except Klamath Marsh.	Serves mainly as a confining bed for underlying aquifers. Coarser beds and lavas yield small to moderate quantities of water to wells in a few places.
		Breccia and tuff of volcanic maars	Highly dipping resistant beds of tuff and volcanic breccia that accumulated near volcanic vents. In part contemporaneous with lacustrine beds of Yonna Formation. Form a series of volcanic hills in central Sprague River valley and low mountains or hills elsewhere.	Generally broken, jointed, and permeable. Yield small to moderate quantities of water to a few wells in central Sprague River valley area.
		Lower basalt unit	Basaltic flows, tuff, and breccia. Crops out only in small areas near Harpold Gap and at east end of Sprague River valley but underlies the Yonna Formation and Quaternary basalt flows over a large area at least from Sprague River valley southward.	Principal aquifer in project area. Interflow zones, jointed lava, and breccia are highly permeable and yield large quantities of water to irrigation and other wells in Sprague River, Swan Lake, and Yonna Valleys, smaller quantities in Poe and Langell Valleys.

In the area studied, the lower basalt unit crops out only in a small area near Harpold Dam and at the east end of Sprague River valley, but it occurs extensively in the subsurface of Sprague River valley and other valleys to the south where it underlies the Yonna Formation. Similar rocks have been described in the Klamath River canyon west of Klamath Falls (Newcomb and Hart, 1958, p. 20) and mapped in the eastern part of the Klamath River drainage basin (Peterson and McIntyre, 1970, pl. 1).

Where exposed, the lower basalt unit consists of basalt flows interbedded with tuff and scoriaceous flow breccia. The basalt is columnarly jointed and vesicular and contains phenocrysts of olivine. It is characteristically dark blue-gray to grayish brown. Individual flows range from a few feet to at least 30 feet in thickness. The unit is at least 300 feet thick in the Yonna Valley area and about 800 feet thick in the Klamath River canyon west of Klamath Falls (Newcomb and Hart, 1958, p. 20). The flows are commonly reported in drillers' logs as "lava" or "rock" which is described as hard and blue, black, red, or brown. Interflow zones generally are called "cinders" or sometimes "burnt lava" or "black sand."

Water-bearing properties.--The lower basalt unit is the most prolific aquifer in the Klamath Basin areas covered by this study. Water commonly occurs in scoriaceous interflow zones and less commonly in jointed or broken lava. Many irrigation wells that penetrate 100-300 feet into these rocks yield more than 1,000 gpm, with only a few feet of drawdown. Many of the irrigation wells in Sprague River valley and in Swan Lake Valley and nearly all those in Langell, Poe, and Yonna Valleys produce water from these rocks. Specific capacities of these wells range generally from about 100 to more than 500 gpm per foot of drawdown. (See table 9.)

In most places, water in the lower basalt unit is confined by the overlying Yonna Formation, but some discharge occurs locally from seeps and springs.

Breccia and Tuff of Volcanic Maars

Several resistant knobs, cones, and low hills are formed by piles of coarse tuff and breccia that accumulated around ancient eruptive centers. The Buttes of the Gods in central Sprague River valley are of such origin, as are the low, jumbled upland north of Hildebrand, the low hills rising above Knott Tableland, and several hills on the margins of Swan Lake Valley. Peterson and McIntyre (1970, p. 14) attribute the character of these masses to their accumulation on the floor of the ancient lake in which were laid down the lacustrine sediments of the Yonna Formation. The maximum thickness of the rocks forming the unit is a few hundred feet. The only wells known to tap these broken and fractured rocks are a few stock and domestic wells near the Sprague River valley.

Yonna Formation

The name "Yonna Formation" was applied by Newcomb (1958, p. 41-48) to a section of largely lacustrine beds which is the most conspicuous and widespread unit in the areas studied. It crops out in the lower slopes and directly underlies all the lowland areas except Klamath Marsh. On the basis of fresh-water snails and diatoms (Meyers and Newcomb, 1952), a Pliocene age was assigned to the Yonna.

The Yonna consists largely of diatomite, stratified sandstone, laminated siltstone, volcanic ash and pumice, gravel, breccia, and basaltic lapilli tuff. Locally it has intercalated basalt flows or is cut by dikes. In places, the upper half of the Yonna consists largely of volcanic tuff and lapilli which form the slopes above the more prominent diatomite (Meyers and Newcomb, 1952, p. 25). Generally, the lower section of the formation consists of lacustrine sediments.

The most prominent part of the Yonna is the diatomite, which together with interbedded thin layers of ashy tuff is several hundred feet in thickness. The diatomite is a finely laminated gray to white deposit formed of siliceous shells of microscopic plants that accumulated in an extensive lake (Wood, 1960, p. 36). Although quite soft, it resists sloughing, and uncased wells drilled through the diatomite section stand open for many years.

The thickness of the Yonna varies erratically from place to place because of the irregular topography on the underlying volcanic rocks and on the Yonna. In most areas it is at least a few hundred feet thick, and Newcomb (1958) reports a maximum thickness of about 2,000 feet.

Water-bearing properties.--Locally, lacustrine beds of the Yonna yield small quantities of water to wells, although some irrigation wells, such as 35S/9E-12bdb, may obtain sizable yields from lapilli or sand beds in the formation. Generally, however, the formation is important because it is the confining bed for the underlying lower basalt unit. In all areas studied, except in the Klamath Marsh area, wells tap water confined beneath the Yonna Formation. All the flowing artesian wells in the Sprague River and Yonna Valleys tap aquifers confined by the Yonna Formation.

Tertiary and Quaternary Volcanic Rocks

The Tertiary and Quaternary volcanic rocks include: (1) A complex assemblage of intrusive and extrusive rocks formed in and around volcanic eruptive centers; (2) andesitic flows which crop out along the east side of Klamath Marsh; and (3) basalt flows, breccias, and pyroclastic rocks. Peterson and McIntyre (1970) have described these Tertiary and Quarternary rocks and discussed the uncertainties concerning their age relationships.

Rocks of Volcanic Eruptive Centers

A complex assemblage of rocks that are associated with volcanic eruptive centers have been mapped as a single unit for this report. These rocks are largely extrusive, but locally include shallow intrusive dikes and sills. Basaltic rocks predominate and include tuff and cinder cones as well as lava flows. Other rock types include andesite, rhyolite, dacite, and tuff and breccia of those compositions.

Most of the more prominent ridges and larger mountains in the areas, such as Swan Lake Rim and Yamsay and Gearhart Mountains, were formed by eruptive material that poured from centers and piled up as large shield or composite volcanoes.

Water-bearing properties.--Because of their fragmental and fractured character, the volcanic rocks of eruptive centers readily receive recharge and transmit water freely. Numerous springs issue from these rocks on the lower mountain slopes, and they feed the headwaters of streams such as the Williamson and Sprague Rivers.

These rocks are important aquifers north and west of Klamath Marsh, where they extend from the Cascade slopes beneath the pumice plain. They are tapped by domestic wells along Highway 97 and by a few high-yielding irrigation wells near the marsh. Elsewhere, only a few wells on the valley edges produce water from these rocks.

Andesitic Lava Flows

Dark-brown to black, platy andesite flows are exposed on the east side of Klamath Marsh and apparently extend eastward beneath younger volcanic rocks. Thickness of the unit is not known near the marsh, but it is at least 500 feet along the Walker Rim 30 miles to the north.

The andesite flows appear to be tight rocks likely to yield only small quantities of water to wells. The only wells known to tap these rocks in the project area are a few stock wells east of Klamath Marsh.

Basalt, Breccia, and Pyroclastic Rocks

Bryant Mountain (pl. 5), Buck Butte (pl. 4), and several other upland masses are formed of basalt, breccia, and pyroclastic rocks of undetermined origin and age (Peterson and McIntyre, 1970, p. 26). Locally, the unit includes lava flows belonging to both the lower basalt unit and the Quaternary basalt. In places, the older layers interfinger with the Yonna Formation. Thickness of the unit has not been established, but it may be a few hundred to a few thousand feet.

The broken and unconsolidated rocks of the unit transmit water readily, and springs discharge from these rocks in many places along lower mountain slopes. No irrigation wells are known to tap rocks of this unit, but yields of wells are generally adequate for domestic or stock supplies.

Quaternary Rocks

In the area studied, Quaternary rocks include basalt flows, alluvium, and pumice.

Basalt Flows

As used in this report, the Quaternary basalt flows include the younger lava flows that form the "rimrock" on the margins of many valleys, the lava underlying Knott Tableland, and lavas that form much of the upland area around Klamath Marsh (pls. 1, 2, 3, 4, 5). At most places, the flows are thin, rarely more than 50 feet in thickness. They were extruded on an irregular erosional surface on the Yonna Formation and older volcanic rocks. In places, later faulting has raised these remnants above valleys carved in the poorly resistant Yonna Formation.

Peterson and McIntyre (1970, p. 18) described the Quaternary basalt as moderately vesicular, gray, and lithologically similar to basalt of the lower basalt unit. They assigned an early Pleistocene age to it, but its age is not the same from one place to another. For instance, basalt flows northwest of Sprague River clearly represent at least two episodes of volcanic eruptions.

Because it is thin and occurs along the upland borders of major lowlands, the younger basalt generally is not an aquifer. Locally, small-yielding wells may tap perched zones in the unit, but most wells are drilled through the basalt and the underlying Yonna to tap the lower basalt unit.

Alluvium

Alluvial deposits cover the lowlands of all the main valleys and much of Klamath Marsh. These deposits include silt, clay, sand, peat, diatomite, slope debris, and locally gravel. In most areas, these deposits are only a few feet thick; exceptions are buried stream channels near the marsh, and the valley fill in Swan Lake and Langell Valleys.

Locally, shallow wells in Langell, Swan Lake, and Yonna Valleys may produce small quantities of water from the alluvium, and a few irrigation wells tap gravel-filled channels near Klamath Marsh. However, in most lowland areas, the alluvial deposits are above the water table and are nonwaterbearing.

Pumice

Airborne pumice which erupted from Mount Mazama (now Crater Lake) mantles much of the area around Klamath Marsh and northward. The pumice is grayish white when fresh and yellowish or buff when weathered. According to Newcomb and Hart (1958, p. 22), the pumice has a maximum thickness of 75 feet along Highway 97 and thins eastward to only a few feet on the east side of Klamath Marsh.

The pumice plain on the east slope of the Cascade Range and along the gentle slope southward from Chemult through Beaver Marsh is an excellent ground-water recharge area. The area is nearly devoid of surface drainageways because precipitation readily infiltrates the spongelike, pumice-covered terrain. Generally the pumice lies above the water table and no wells are known to produce water from it.

Structure

Fault lines mark the flanks of many mountains and ridges such as Swan Lake Rim, the margins of lowlands such as Langell Valley, and probably served to localize volcanic eruptive centers. As shown by geologic maps (pls. 1, 2, 3, 4, 5), the predominant fault trend is northwest-southeast, but cross faulting is not uncommon. Most faults are normal and have fault planes that dip 60° or more (Peterson and McIntyre, 1970, p. 28). Generally their displacement is less than a few hundred feet, but several, such as those forming Bryant Mountain and Swan Lake Rim, are displaced more than 1,000 feet.

The Lost River valleys (Swan Lake, Yonna, Poe, and Langell) owe their origin largely to faulting. Faulting, however, was a less important factor in the formation of Klamath Marsh and of Sprague River valley, which is largely erosional. Although the east edge of Klamath Marsh is formed by faults, the main part of the marsh is an ancient plain covered by pumice and peat which overlies alluvial sediments. A lava flow forms a barrier near Kirk that prevents downcutting and draining of the marsh. Several small anticlines trend across Yonna Valley (Meyers and Newcomb, 1952, pl. 2), and there is evidence of synclinal structure in the central part of Sprague River valley.

In general, structural features exert only local control over the movement and occurrence of ground water. The combination of rocks that dip toward the lowland and near-surface impervious lake sediments help to localize the area of flowing wells between Beatty and the town of Sprague River. In parts of Langell Valley some local aquifer compartmentation results from faulting, and Bonanza Springs is located along a fault (Meyers and Newcomb, 1952, table 2). Most fault zones, however, do not seem to impede ready circulation of ground water which moves freely across fault zones. In many places the lavas and other consolidated rocks have been reduced locally to highly permeable rubble along fault zones. Fracture permeability is increased for some distance from faults.

GENERAL GROUND-WATER FEATURES

Occurrence

As in other mountainous volcanic areas, ground water in the Klamath Basin occurs under a variety of conditions--water table, confined, and perched. Ground water is under water-table conditions in an aquifer, or water-bearing bed, that is only partly filled so that the water table, or surface of the water is at atmospheric pressure. Such conditions

occur in the shallow alluvial deposits of several valleys and in places such as the upper Williamson River valley, where permeable volcanic rocks extend from land surface to beneath the local water table. At higher altitudes around valley margins, some domestic and stock wells may tap volcanic-rock aquifers that contain water under water-table conditions.

Ground water is said to be perched when it occurs in a zone separated from the main ground-water body by an underlying unsaturated zone. In the Klamath Basin, perched zones are not common in the lowland areas studied, but occur on mountain slopes where ground water in a permeable rock layer is "perched" on an underlying layer of low permeability. Perched ground-water bodies account for many of the springs that form the headwaters of streams or occur along mountain slopes in Klamath Basin.

Most of the irrigation wells and many of the domestic and stock wells more than about 50 feet in depth tap volcanic-rock aquifers containing confined ground water. Confined water is that in an aquifer that is enclosed above and below by beds of low permeability so that the water is under pressure greater or less than the atmosphere. In Klamath Basin, confined water bodies result largely from the prevalence of good confining layers and inclined water-bearing units that extend into nearby mountain recharge areas. The diatomite, tuff, and fine-grained sediments are excellent confining layers and, when combined with the faulting and tilting of underlying permeable rocks, provide the necessary structures for a series of confined systems. Water levels in wells tapping aquifers several hundred feet deep generally rise to within 50 feet of the land surface, and flowing artesian wells occur locally in all the areas studied except Beaver Marsh and Swan Lake Valley.

Source and Movement

The source of most of the ground water in Klamath Basin is precipitation that falls within the basin and infiltrates the ground, largely in the mountains. The pumice and fractured and fragmented volcanic rocks in the mountains are porous and readily absorb precipitation and transmit it toward the lowland areas. Because precipitation is greatest at higher altitudes, infiltration and recharge are greatest along the eastern slope of the Cascades and along the northern end of the basin. The Cascade slopes also are underlain by pumice, which permits a high percentage of the precipitation to infiltrate. Consequently, much of that area has no surface streams.

In Klamath Basin, part of the ground water occurs in a relatively shallow zone under water-table or perched conditions and part in a deeper zone, largely under confined conditions. Ground water in the shallow zone generally moves only a short distance from its source. Commonly, it is discharged through springs along the mountain slopes or by evapotranspiration in lowland areas.

A large part of the water infiltrating the ground seeps downward to deep zones and moves laterally toward and beneath the lowlands. Where favorable permeable zones or fractures are intersected by streams, some of this water is discharged by large springs, such as Big, Kamkaun, Medicine, and Bonanza Springs (fig. 1). The largest springs and greatest spring discharge are along the foot of the Cascade slopes, because recharge is greatest in the adjacent uplands, and the abundant fragmental volcanic rocks provide good conduits to transmit the water. Some of the largest springs form the headwaters of the Wood River and Spring Creek outside the project area near Chiloquin; others discharge around and beneath Upper Klamath Lake (Hubbard, 1970).

Within Klamath Basin, the general circulation of ground water in the deeper zone is from north to south and from the uplands toward the valleys. All the lowlands are areas of discharge where ground water is discharged by upward seepage from confined aquifers and through springs. Discharge is widespread in the prominent marshes such as Klamath Marsh, the marshy reaches of Sprague River and Langell Valleys, and the closed basins of Yonna and Swan Lake Valleys.

In a regional report on Klamath Basin, Illian (1970, p. 18-21) has described a three-part flow system of local, intermediate, and regional circulation. Depending on the flow system in which it is moving, ground water moves varying distances from recharge sources in the mountains to areas of local, intermediate, or regional discharge. Illian postulates the movement of sizable volumes of water from the northern part of the basin to the southern part.

A detailed discussion of the regional circulation of ground water is outside the scope of the present report, which is concerned primarily with the ground water in the deeper zone. That zone supplies the water pumped for irrigation and most other uses in the areas studied. Discussions of ground-water occurrence and movement in individual areas are included in later sections of the report.

Fluctuations of Water Levels

Ground-water levels in Klamath Basin have a pattern of seasonal fluctuations similar to that in many areas in Oregon. Seasonal water levels generally are at their highest in late spring or early summer, probably as a result of recharge from melting snow in the upland recharge areas (fig. 5). Water levels are lowest in late fall following the period when discharge, both natural and by pumping from wells, is greatest.

Seasonal fluctuations in most areas are small--generally less than 4 feet, and in some places, such as Klamath Marsh, less than 1 foot. As indicated by hydrographs, fluctuations follow similar patterns from year to year, but spring highs may differ more from year to year than do the seasonal fluctuations (figs. 7,10,11,14). In the 17- to 20-year period during which periodic measurements have been made, water levels have fluctuated over a range of 4 to 20 feet. Water levels were

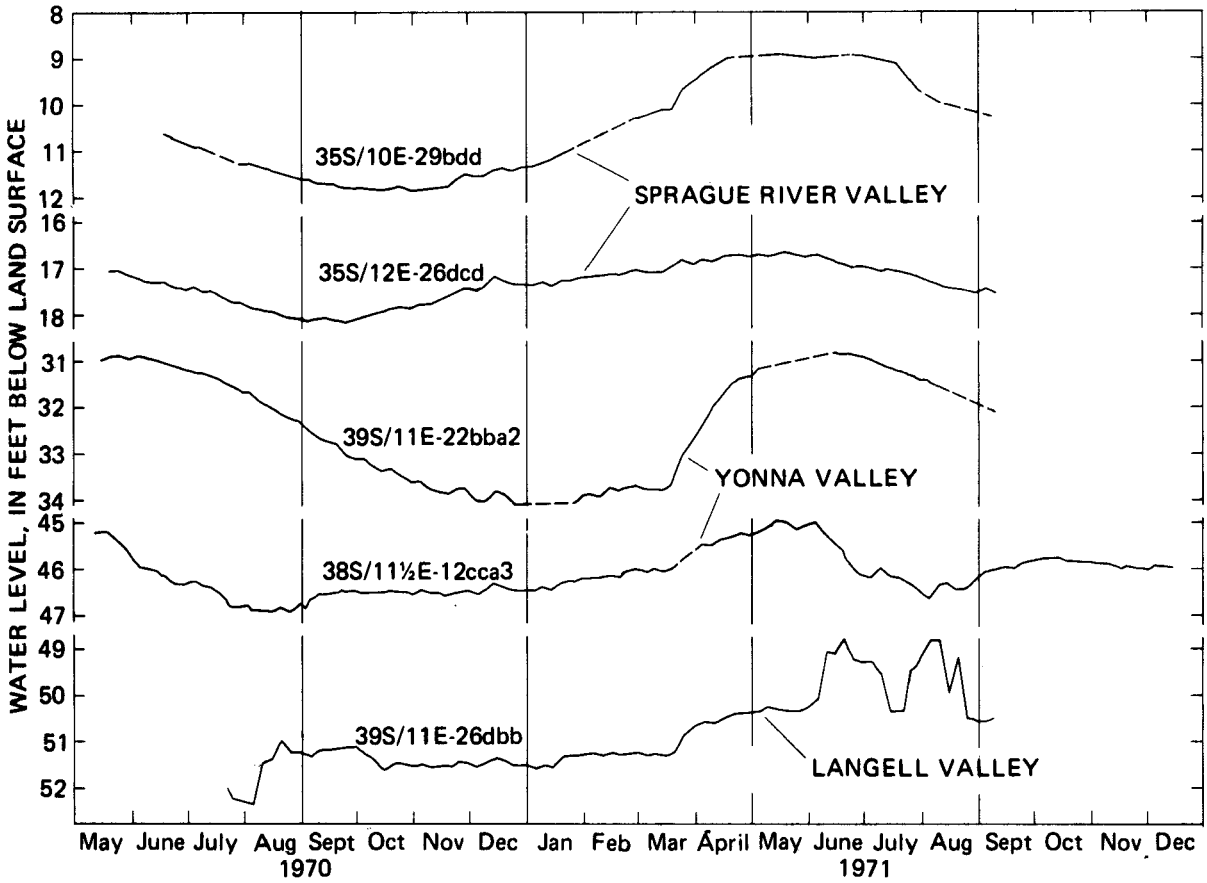

Figure 5.--Water-level fluctuations in selected wells.

highest following years of greatest precipitation and declined when precipitation was less than normal. More details on fluctuations of water levels in individual areas are given in the sections describing those areas.

Quality of Ground Water

Ground water in the Klamath Basin areas studied is low in dissolved minerals, soft to moderately hard, and of excellent quality for drinking, irrigation, and most industrial uses. The water analyzed generally has a dissolved-solids content of less than 250 mg/l, hardness of less than 120 mg/l, and a specific conductance of less than 300 micromhos per centimeter. Characteristically it contains 30 to 70 mg/l of silica, which may be a problem in water used for boiler-feed or some other industrial uses. Selected chemical analyses of water from representative wells are shown graphically in figure 6.

Mineral content of the ground water is lowest in the Klamath Marsh area and highest in Swan Lake and Poe Valleys. Dissolved-solids content averages about 90 mg/l in Klamath Marsh, about 140 mg/l in Sprague River valley, and about 180 mg/l in the four southern valleys.

In the Klamath Marsh area and in Sprague River valley, the water is largely of the sodium bicarbonate type. In the four southern valleys the water is predominantly of the calcium bicarbonate or calcium magnesium bicarbonate type.

Suitability for Domestic Use

Water in the study areas is of excellent quality for most domestic uses; however, iron concentrations in water from two wells slightly exceed the U.S. Public Health Service Drinking Water Standards (tables 2, 4, 6, 7). Also water from one well had a significant concentration of nitrate, possibly resulting from seepage from a nearby corral. (Table 6).

Table 2.--U.S. Public Health Service drinking water standards

Constituent	Recommended maximum concentration (mg/l)	Range in concentration, Klamath Basin
Iron (Fe)	0.3	0-0.5
Sulfate (SO_4)	250	0.1-16
Chloride	250	0-10
Fluoride	1/ 1.2	0-0.4
Nitrate	44	0-17
Dissolved solids	500	77-268

1/ Based on average temperature at Klamath Falls.

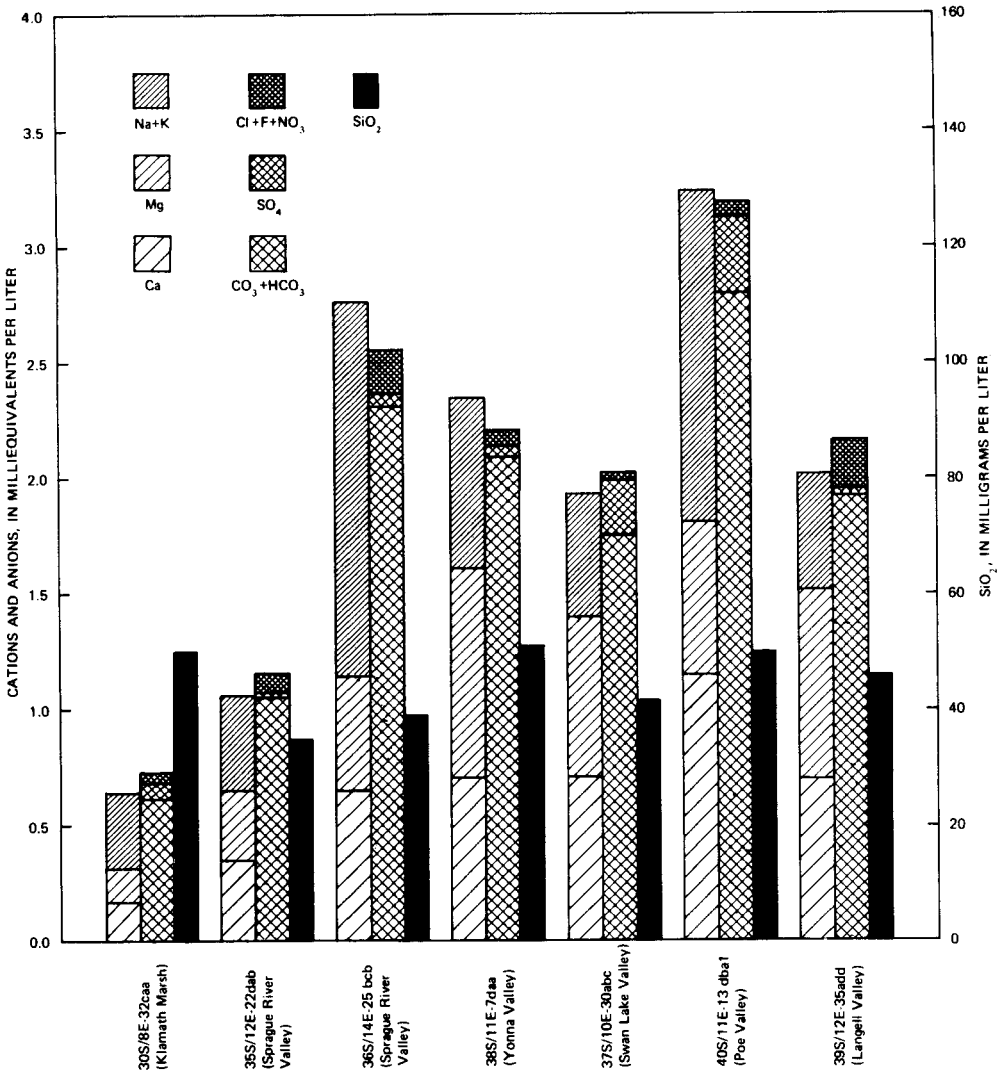

Figure 6.--Chemical analyses of water from selected wells in the Klamath Basin.

Suitability for Irrigation

According to the U.S. Department of Agriculture (U.S. Salinity Laboratory Staff, 1954), the most important characteristics in determining suitability of water for irrigation are (1) total concentration of soluble salts, (2) the relative proportion of sodium to other principal cations, and (3) the concentration of boron. Specific conductance of water gives a general indication of the concentration of soluble salts. A useful index to the sodium (alkali) hazard is the sodium-adsorption-ratio (SAR), determined by the formula

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

where the sodium (NA^{+}), calcium (Ca^{++}), and magnesium (Mg^{++}) values are in milliequivalents per liter.

Dissolved solids, boron, and SAR values for waters from areas in Klamath Basin are given in tables in later sections of the report. All the samples of water analyzed are of excellent quality for irrigation except water from well 40S/11E-3aaa in Poe Valley which is in the high sodium-hazard class.

In small concentrations, boron is essential for plant growth; however, a slightly larger concentration may be harmful to many plants. Boron-sensitive plants may be affected by water containing more than 0.33 mg/l of boron, and water containing boron concentrations exceeding 3.75 mg/l may be unsuitable for even the most tolerant plants.

In the 18 samples of water analyzed for that constituent, boron concentrations ranged from 0 to 0.05 mg/l, indicating that ground water in the study areas should be suitable for irrigating even the most boron-sensitive plants.

Use of Ground Water

In the Klamath Basin areas studied, the principal use of ground water is for irrigation. Ground water also supplies the domestic water needs of the six areas, part of the stock water, public-supply needs of the towns of Sprague River and Bly, and water for several lumber mills in Klamath Marsh and Sprague River valley. Use of water in 1970 is given in table 3.

In addition to the quantities given in table 3, an estimated 1,000 acre-feet flowed to waste from uncapped artesian wells, mostly in Sprague River valley plus a small volume in Klamath Marsh.

Table 3.--Estimated use of ground water in selected areas of Klamath Basin, 1970

Area and use	Acre-feet
Klamath and Beaver Marshes	
Irrigation	4,000
Industrial	50
Sprague River valley	
Irrigation - pumped	18,000
Irrigation - natural flow	6,000
Industrial	50
Public supply	50
Swan Lake Valley	
Irrigation	13,000
Yonna Valley	
Irrigation	13,500
Poe Valley	
Irrigation	3,800
Langell Valley	
Irrigation	2,200
All areas - domestic and stock use	500
Total (rounded)	61,000

OCCURRENCE AND AVAILABILITY OF GROUND WATER BY AREAS

In the following section, the occurrence, movement, and quality of ground water, fluctuations of water levels in wells, and availability of ground water for additional development are discussed for the six major areas covered by this report.

Klamath Marsh Area

As used in this report, the Klamath Marsh area refers to 230 square miles in the northern part of Klamath Basin (pl. 1). In addition to Klamath Marsh, the area includes the Williamson River valley to the east and the wooded fringes that rise gently away from the marsh to the north and west. The area extends along Highway 97 through Antelope Desert and Beaver Marsh nearly to Chemult at the north edge of Klamath River basin.

About 100 square miles of the area is a true marsh--a swampy, grassy plain, partly or seasonally under water and suitable only for grazing. The marsh ranges in altitude from about 4,530 feet at the northeast corner to about 4,510 feet at its outlet on the southwest. The Williamson River flows into the northeast end of the marsh from a narrow valley that extends south about 20 miles to the stream's headwaters.

On the north, east, and southeast, Klamath Marsh is bordered by escarpments which rise abruptly to altitudes 400 to 800 feet above the marsh. On the east, mountains around the marsh rise 1,000 feet above it, and Mount Yamsay, a few miles to the northeast, reaches an altitude of 8,196 feet. A gentle plain that extends from Klamath Marsh west and northwest for several miles includes the pumice plain of Beaver Marsh at an altitude of 4,640 feet, about 15 miles northwest of the marsh. Near Chemult, 6 miles north of Beaver Marsh, the divide between Klamath and Deschutes River basins is at an altitude of 4,770 feet.

The surface in and around Klamath Marsh is covered by as much as 50 feet of pumice which blew out from ancestral Mount Mazama, now occupied by the caldera of Crater Lake. In the central part of the marsh, a few feet of peat and diatomite overlie the pumice, which is underlain by layers of clay, sand, and gravel that accumulated in the ancient lake now occupied by the marsh and in the valleys of streams flowing into that lake.

Logs of wells in the marsh indicate a great local variation in thickness of sand, gravel, and clay beneath the pumice and above the underlying volcanic rocks (table 10). In well 29S/9E-32dcc, a section of clay and gravel extends to a depth of 314 feet; in well 30S/8E-29abb the sand and gravel section extends to 73 feet in depth. In other wells alluvial sediments are very thin or missing between the pumice and basalt, suggesting that the thicker sections of alluvium occur in stream channels buried by the Mazama Pumice.

Quaternary basalt formed the uplands north, east, and southeast of the marsh and created the marsh by damming the old Williamson River channel near Kirk (Peterson and McIntyre, 1970, map).

The eastern slopes of the Cascade Range, which begin a few miles west of the marsh (pl. 1), are formed by the volcanic rocks of eruptive centers. These rocks are tapped by domestic wells, which generally are 100 to 200 feet deep, at Diamond Lake junction and at Beaver Marsh. Similar rocks extend beneath the pumice and alluvial deposits on the west side of the marsh, where they furnish water to several large-yield irrigation wells. Those wells generally are 100 to 160 feet in depth; yields are 1,000 to 4,000 gpm, and specific capacities 50 to more than 600 gpm per foot of drawdown. Several flowing wells tap these rocks near the northwestern edge of the marsh. The rate of flow generally is not great, and some of the wells used for irrigation are equipped with pumps.

Wildhorse Ridge, near the northeastern part of the marsh, is formed by Tertiary and Quaternary andesite (pl. 1). The andesite probably underlies the Quaternary basalt in a wide area both north and south of the outcrop area. The andesite is a poor aquifer, but wells in that part of the area are adequate for domestic and stock supplies.

Source, occurrence, and movement of ground water.--The Klamath Marsh area is part of the 1,450-square-mile Williamson River basin, which receives ground-water recharge from precipitation principally on slopes of the Cascade Range west of the marsh, but also in the uplands around the marsh. From the upland recharge areas, ground water moves east, south, and west toward Klamath Marsh. Altitudes of water levels in wells (pl. 1) show that water-level gradients slope gently southward from Beaver Marsh and southeastward toward the marsh. In the western part of the marsh, ground water moves toward the central part of the marsh; within the main part of the marsh it moves southward, under a gradient of about 1 foot per mile, toward the lower end of the marsh.

Large springs feed the Williamson River north of Fuego Mountain (fig. 1), and the river may also gain from ground water as it flows northward toward Klamath Marsh. Ground water moving down the slope of the Cascade Range is discharged through Big Springs north of the marsh and by seepage directly into the marsh. The marsh is a gigantic discharge area where annual evapotranspiration is estimated to be about 200,000 acre-feet, predominantly from ground water.

Water-level fluctuations.--In general, water levels in the Klamath Marsh area have the same type of seasonal fluctuations as other areas in the Klamath Basin, being highest in late spring and lowest in late fall (fig. 7). However, the magnitude of seasonal fluctuations is small--autumn water levels in wells measured in 1970 averaged less than 1 foot lower than spring levels. This small seasonal decline may have been due largely to the prolonged recharge season during the summer of 1970, which resulted from the heavy snowpack in the Cascades. Another, less important factor, may have been the relatively small withdrawal of water from flowing and pumped wells for irrigation in 1970. Total pumpage was only about 4,000 acre-feet--about half as much as would be used during drier years.

Long-term records of water levels show fluctuations as much as 20 feet between highest and lowest levels (fig. 7). A comparison of water levels measured in the 1950's with those measured in 1970 shows that water levels declined an average of about 6 feet. Most of the decline was during the early 1960's, when precipitation was below normal, following several years of above-normal precipitation. The fluctuation of water level is paralleled by the fluctuation in discharge from Big Springs (fig. 7).

Old well records indicate that many of the wells started flowing about 1950, about the same time that Big Springs resumed flowing following a 20-year nonflowing period. Newcomb and Hart (1958, p. 42) analyzed the relation between the accumulation of ground water in the

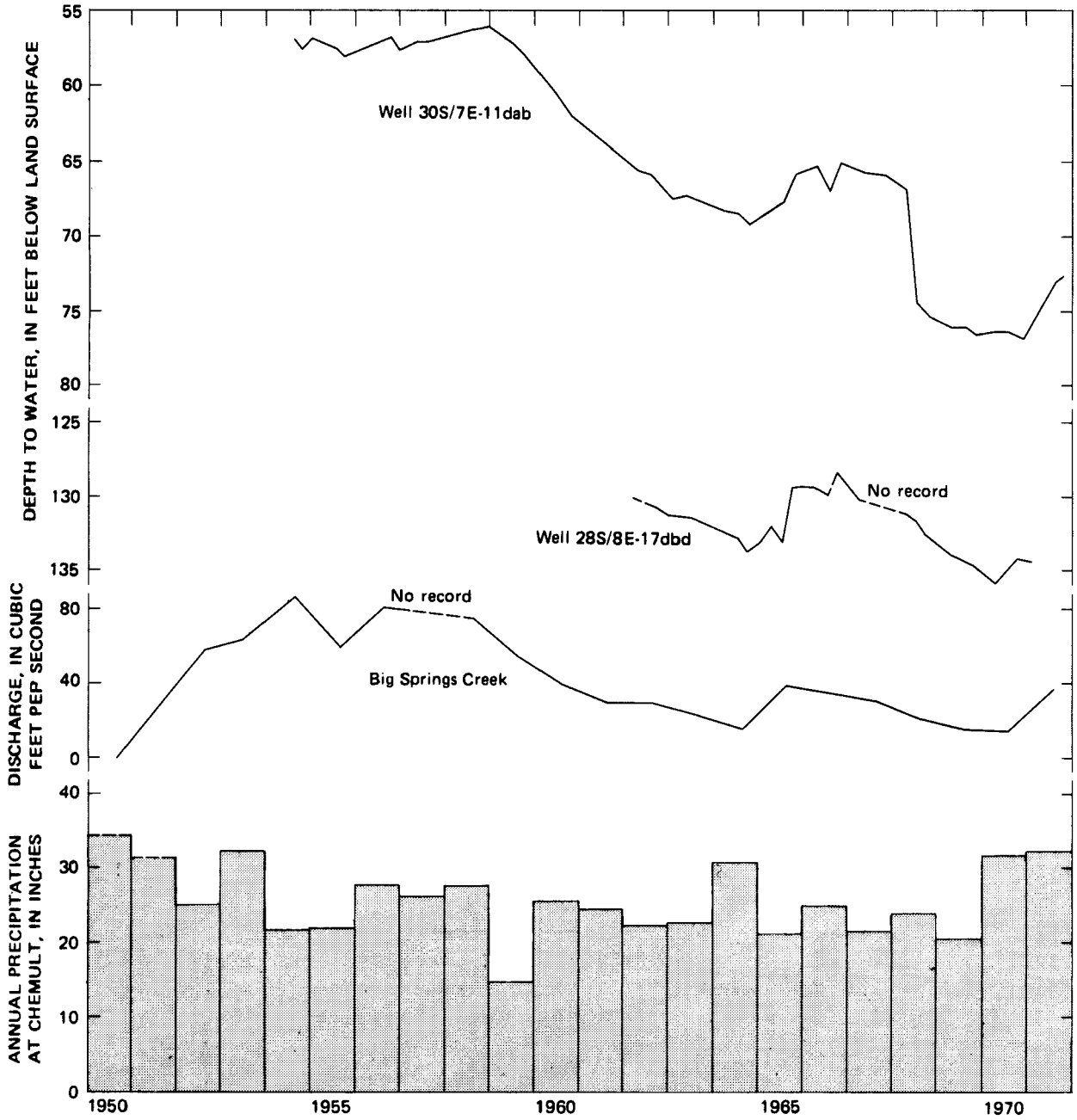

Figure 7.--Fluctuations of water levels in selected wells in Klamath Marsh area, discharge of Big Springs Creek, and precipitation at Chemult.

aquifer and the flow of Big Springs. The period they considered started during several years of below-normal precipitation when the ground-water reservoir was at a low stage. Therefore, they suggested that several years of above-normal precipitation might be required to refill the local ground-water reservoir to the stage where it would overflow through Big Springs. Beginning in 1950, ground-water levels remained at a rather high stage for several years and declined in the 1960's, so that several wells had ceased to flow by the fall of 1969. Flow from these wells started again in 1970, and in the summer of 1971 it was noted that water levels in several nonflowing wells were 4 feet above their 1970 levels. This rise in water levels followed a winter of record snowfall in the Cascade Range in 1970-71 and a snowmelt period that extended into midsummer of 1971.

Quality.--Ground water in the Klamath Marsh area is soft, low in dissolved solids, and of excellent quality for all uses. It is generally of the sodium bicarbonate type, and its mineralization and hardness are lower than for water of the other areas studied. Specific conductance averaged about 80 micromhos, dissolved solids about 90 mg/l, silica about 50 mg/l, and hardness about 20 mg/l (table 4).

Potential for additional development.--Data indicate that present development and use of ground water in the area have had no measurable effect on water levels or the volume of water in the aquifer. Use in 1970, about 4,000 acre-feet, was quite small in relation to recharge and to natural discharge. Use could safely be increased to several times the present rate at the expense of reducing natural evapotranspiration discharge less than 1 inch per year.

All the large-yielding wells in the area are along the western part of Klamath Marsh and obtain water from gravels in the alluvial channel or from the volcanic rocks of eruptive centers. It is significant that these aquifers extend laterally into the lower slopes of the Cascade Range--where recharge is high. The west-side area, therefore, has the best potential for developing additional large irrigation or industrial supplies.

On the eastern side of the marsh, Quaternary basalt overlies volcanic rocks that, according to drillers' reports, are less permeable than those on the west side. Wells in that area yield adequate quantities of water for domestic and stock supplies but are not likely to yield irrigation quantities.

Sprague River Valley

The Sprague River valley is a narrow 50-mile-long west-trending valley in the northeastern part of Klamath Basin. Unlike most of the other valleys studied, it is essentially of erosional origin. The flood plain slopes from about 4,350 feet east of Bly to about 4,250 feet near Braymill and 4,180 feet at the river's mouth near Chiloquin.

Table 4.--Chemical analyses of water from representative wells and springs in the Klamath Marsh area and Sprague River valley

Location number	Depth of well (feet)	Date of collection	Milligrams per liter																	Specific conductance (micromhos at 25°C)	pH	Temperature (°F)	Temperature (°C)	Percent sodium	Sodium-adsorption-ratio (SAR)
			Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Arsenic (As)	Dissolved solids, calculated	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Noncarbonate						
Klamath Marsh area																									
28S/8E-5dac	392	11- 7-70	60	0.03	2.0	1.7	6.1	0.8	35	0	0.0	2.0	0.2	0.1	--	0.02	90	12	0	56	8.1	--	--	55	0.78
29S/8E-7ddd	131	11- 2-70	60	0	5.1	1.9	9.2	.8	49	0	2.8	1.0	.1	.3	0.01	--	100	20	0	78	7.8	--	--	52	.88
30S/8E-16dcd(s)	Spring	8- 7-58	45	.16	3.6	1.6	6.3	1.2	31	0	2.5	2.0	.1	0	--	--	77	16	0	62	7.6	49	9	45	.69
30S/8E-32caa	150	11- 4-70	50	0	3.4	1.7	6.6	1.5	38	0	2.8	1.5	.1	.1	.03	--	87	16	0	63	7.8	--	--	52	.74
31S/7E-24bac	61	2-19-55	39	.48	3.8	3.0	16	1.8	70	--	.3	.8	.2	0	.04	--	99	22	0	112	7.5	--	--	59	1.5
31S/8E-10bbb	160	11- 4-70	36	0	3.0	2.0	7.3	1.9	40	0	6.8	1.0	.1	.1	.04	.01	78	16	0	64	7.8	--	--	55	.81
31S/11E-32bba	208	do	50	.02	9.4	4.3	5.7	2.0	72	0	2.8	0	0	.2	.01	.01	110	41	0	110	7.7	--	--	27	.39
Sprague River valley																									
34S/8E-25ddb(s)	Spring	8- 6-58	43	0	5.6	3.4	7.1	1.4	47	0	2.4	3.0	.1	0	--	--	89	28	0	88	8.1	53	12	34	.58
34S/8E-28ddc	722	9- 2-70	60	0	13	14	8.2	2.6	129	0	7.2	0	.1	.5	.02	--	170	90	0	199	8.0	--	--	19	.37
35S/9E-13bbd	119	10- 8-70	35	0	20	18	12	2.4	196	0	2.0	3.0	.1	1.6	0	--	200	144	0	306	7.9	61	16	17	.43
35S/10E-26acd	302	10-29-70	70	.05	6.2	.1	64	.5	119	23	5.0	3.0	.4	.6	0	0	230	16	0	267	8.9	--	--	90	6.95
35S/11E-24dac	612	do	43	.20	19	14	12	.8	155	0	.2	2.0	.2	.2	0	0	170	105	0	234	8.4	34	1	21	.51
35S/12E-22dab	--	10- 8-70	35	0	7.1	3.6	8.4	1.7	64	0	1.0	3.0	.1	.1	.02	--	91	32	0	104	8.0	57	14	39	.67
36S/10E-11ddc	600	8- 6-58	50	0	5.6	1.6	27	2.4	82	4	6.3	1.5	.1	0	--	--	138	21	0	161	8.5	65	18	71	2.59
36S/10E-13acc	--	11-10-52	--	--	13	3.0	22	--	105	--	5.3	--	--	--	0	--	150	45	0	170	8.4	66	19	52	1.4
36S/11E-16bcb1	380	8- 6-58	46	0	3.6	0	30	1.8	69	6	6.2	3.0	.2	0	--	--	131	9	0	151	9.1	76	24	85	3.08
Do	380	10- 8-70	50	.03	3.8	.1	30	1.9	64	11	3.2	2.5	.2	.3	0	0	140	10	0	148	8.4	73	23	87	4.11
36S/12E-2bbd	1,127	do	36	0	6.2	3.2	7.5	1.6	55	0	.8	3.0	.1	.1	.02	--	86	28	0	90	8.0	54	12	39	.62
36S/12E-4ddc	612	8- 6-58	39	0	6.4	2.4	7.6	1.6	50	0	.1	2.5	0	0	--	--	85	26	0	87	8.2	53	12	37	.65
36S/12E-22bdb	300	9- 2-70	35	0	6.6	3.6	6.9	1.4	54	0	2.5	1.0	.1	.1	.01	--	84	32	0	87	7.8	54	12	35	.53
36S/14E-25bcb	708	do	39	0	13	6.0	34	5.2	141	0	2.8	5.0	.1	1.7	.03	0	180	57	0	242	8.4	69	21	59	1.96
36S/14E-27cdc	--	do	36	.02	19	9.8	18	3.9	152	0	1.8	3.0	.1	.6	.02	--	170	88	0	237	8.3	57	14	33	.81

The valley consists of several broad, alluviated reaches, 1 to 3 miles wide, separated from each other by narrow canyonlike reaches (pls. 2, 3). The wider valley segments have a broad marshy flood plain, marked by wide meander loops and a higher bench or terrace 10 to 20 feet above the inner flood plain. Generally, the terrace surface slopes gently from the edge of the hills toward the flood plain. In places, the terrace extends several miles up the valleys of tributaries such as those along Whisky Creek and Sycan River (pls. 2, 3).

The narrows are irregular, slightly sinuous canyons several miles long where the river cuts through resistant volcanic rock such as the flank of Ferguson Mountain northeast of Beatty, or the lava flows and welded tuffs along S'Ocholis Canyon.

Generally, the valley walls are pronounced, and along much of the valley they rise steeply to mountains whose peaks are more than 1,000 feet above the valley. However, the valley walls along the reach from Beatty to the town of Sprague River are unusual. The north wall of the valley is the edge of Knott Tableland, a lava-capped plain which rises abruptly 200 feet above the valley. The tableland slopes southwestward and was formed by a thin Quaternary lava flow that flowed into and down the ancestral Sprague River valley.

From the town of Sprague River to Lone Pine the valley walls are relatively gentle slopes marked by remnants of a chain of ancient volcanoes--the Buttes of the Gods. The buttes are all small, generally a quarter of a square mile or less, but they are locally prominent topographic features. At the west end of this reach, the mile-wide alluvial flat just east of Lone Pine, and Long Prairie northwest of Lone Pine, probably represent ancient courses of the Sprague River before it cut its present course through S'Ocholis Canyon.

Ground-water geology.--The flood plain and the alluvial terrace along the Sprague River are underlain by alluvial deposits, principally silt and clay. At most places these deposits are only a few feet in thickness, but locally they may be as much as 50 feet thick and contain water-bearing gravel beds. Mapped with the alluvial deposits, in places, are pediment-gravel deposits such as those east of Bly, which lie on an elevated bench above the main level of the valley floor. Generally, these deposits are thin and above the water table, and they are not known to supply water to wells. Gravel has been produced locally from pits in these deposits near Bly and the town of Sprague River.

Valley slopes along most of the Sprague River are formed by the Yonna Formation and capped in many places by Quaternary basalt. These basalt units represent several lava flows of different ages that were extruded from different volcanic vents. The youngest is the thin flow that caps Knott Tableland. It was extruded from Fuego Mountain a few miles northwest of the tableland and flowed into and inundated the ancestral valley of the Sprague River. The flow is about 20 feet thick at the southwest end and probably less than 50 feet thick throughout. The flow dips gently southwestward, parallel to the tableland surface.

Quaternary basalt flows, older than those forming the surface of Knott Tableland, cap the High Tableland a short distance to the northwest and 300 to 500 feet higher.

Quaternary basalt flows also cap upraised fault blocks, such as Davis Hill southwest of Beatty (pl. 2), or eroded and faulted uplands. Northeast of Braymill, lava-capped uplands have been cut by numerous north-trending faults (pl. 3), showing that the capping lavas are older than the latest period of pronounced structural activity.

In most places, the Quaternary basalt is thin and non-waterbearing. In the Bly area, where the basalt dips beneath the alluvial valley, shallow wells may produce small yields from the unit. Most irrigation wells near Bly, however, also penetrate several hundred feet of the Tertiary lower basalt unit from which most of their water is produced. The large springs that are the source of flow in Whisky Creek in sec. 31, T. 36 S., R. 12 E., probably issue from permeable zones in the Quaternary basalt which extends beneath the alluvium in that area.

Several masses of volcanic eruptive rocks associated with Pliocene and Pleistocene volcanoes occur in and near the valley. These include the main mass and flanks of several large mountains, such as Calimus Butte; Saddle, Ferguson, and Medicine Mountains; and Bly Ridge. Council, Bug, and Spring Buttes are smaller volcanic features.

These rocks include a wide variety of lithologic types, including basalt, andesite, rhyolite, dacite, and pyroclastic rocks of similar compositions. In places, separately mapped Quaternary basalt was extruded from these volcanoes. In other places, lavas included with the rocks of eruptive centers locally overlie the Yonna Formation along the edge of the valley, such as east of Beatty. There the encroachment of resistant volcanic rocks from Medicine and Ferguson Mountains was largely responsible for the constriction of the valley. No wells in Sprague River valley are known to produce water from the rocks of volcanic eruptive centers.

Throughout most of the area, the lowest slopes adjacent to the Sprague River alluvial valley are formed by diatomite, tuff, sand, gravel, and basaltic breccia of the Yonna Formation. The breccia units are massive and resistant and form steep canyon walls through S'Ocholis Canyon and near Braymill. Most of the Yonna, however, is poorly consolidated and forms gentle slopes except where it is capped with more resistant volcanic rocks. The Yonna varies erratically in thickness--from less than 100 feet at the east end of the valley to about 1,000 feet north of Beatty. Near the east end of the mapped area, the Yonna consists predominantly of tuff, and east of Bly (pl. 2), it has been eroded away. There, the Tertiary basalt directly underlies the Quaternary basalt and the volcanic rocks extruded from the volcano of Gearhart Mountain (northeast of the mapped area).

In general, beds in the Yonna Formation are poorly permeable and are tapped by wells only locally. Irrigation well 35S/9E-12bdb

(table 9) produces water from black sand, sandstone, and interbedded basalt. Nearby domestic and stock wells also produce water from sedimentary strata in the Yonna. However, in most places, fine-grained strata in the Yonna serve as confining beds, and wells are drilled through the formation to tap the underlying basalt.

Several buttes adjacent to the Sprague River are the remnants of old volcanoes (maars). These include Antone Butte and the Buttes of the Gods north of the town of Sprague River, Cave Mountain northeast of Chiloquin, and an unnamed peak just south of Chiloquin. The rocks forming these features are primarily resistant blocks of breccia, agglomerate, or welded tuff that form steep rocky hills. They extend to an unknown depth in the cones of the old volcanoes.

Wells that produce water from these rocks include a stock well on the flank of Watchdog Butte and several domestic wells in the Forest Estates development on the south side of Antone Butte. These wells are 200 to 400 feet deep; yields are small but adequate for domestic or stock purposes.

The lower basalt unit underlies most of the Sprague River valley at depths ranging from less than 100 feet to about 1,000 feet. The unit also crops out in a small area at the extreme east end of the mapped area (pl. 2).

Most of the wells along Sprague River valley tap confined water in the lower basalt unit beneath fine-grained strata of the Yonna Formation. Generally, the wells are more than 100 feet in depth and several are more than 1,000 feet. Reported yields of irrigation wells range from 800 to more than 4,000 gpm and specific capacities range from 11 to 460 gpm per foot of drawdown. The average specific capacity reported for irrigation wells in the valley area is 140 gpm per foot of drawdown. Discharge from one flowing artesian well was measured at 3,000 gpm when drilled, and several flow 400 to 2,000 gpm. About half the flowing wells are equipped with pumps because their yield by natural flow is too small for an irrigation supply. (See table of well records.)

Source, occurrence, and movement of ground water.--Ground water in the Sprague River valley occurs generally in confined aquifers, principally in the lower basalt unit and the Yonna Formation. The many individual layers containing ground water in this complex system are all influenced to some degree by local variations in geology, but are treated together here because most wells are open to several water-yielding zones.

The source of ground water is precipitation that infiltrates into porous units in the uplands around the valley. Differential water-level data show that inflow to the lowland of Sprague River valley is largely from the north and east (pl. 2), although some ground water moves toward the valley from the southeast and south. Water levels also indicate a downstream component of movement in the principal confined aquifer within the lowland area. The potentiometric surface of the main

confined-water zone slopes westward from about 4,320 feet near Bly to about 4,300 feet near the town of Sprague River and to 4,260 feet at Braymill.

Water levels in the main aquifer along Sprague River valley are more than 100 feet higher than in Swan Lake Valley and nearly 200 feet higher than in Yonna Valley only 10 miles to the southwest. These water-level differentials may indicate that ground water could move from the Sprague River valley to the southern valleys. However, information available is not adequate either to substantiate or to disprove such interbasin movement.

Flowing artesian wells.--Flowing wells occur in a broad area from near Beatty to the town of Sprague River. There the potentiometric head is considerably greater than it is both upstream and downstream. In that area the head also increases with depth, so that wells 300 to 1,200 feet in depth flow at the surface. At least 35 flowing wells occur in this area, including about 25 irrigation-supply wells. The artesian conditions result from a local synclinal structure in which diatomite and other fine-grained sediments overlie and confine water-bearing sand and gravel and cindery or cavernous zones in the volcanic rock. Elevated recharge areas in the mountains north and northeast of the valley provide the other essential component for a flowing artesian system.

Shut-in pressures, measured in about 12 of these flowing wells in November 1970, were converted to head of water to obtain the altitudes on the potentiometric surface shown in figure 8. The distribution of potentiometric heads suggests local areas in which water levels will rise to about three general levels--4,310 to 4,320, 4,370 to 4,380, and to 4,420 feet (fig. 8). The areal differences in head may be caused by structural compartmentation, although faulting is not as common in the area as elsewhere in the Klamath Basin.

Areal differentiation between the zones is also indicated by water temperatures and conductivities. In the two areas near Beatty, temperatures generally are 50° to 57°F (10° to 14°C) and conductivity of water is less than 100 micromhos per centimeter. In the area east of the town of Sprague River, the water temperature is generally 65° to 72°F (18° to 22°C) and specific conductance between 100 and 200 micromhos. Surprisingly, the lower temperatures and conductivities are associated with the deeper wells.

One possible explanation for the low temperature and conductivity of water near Beatty is that the transmissivity of the aquifer is unusually high so that water is conveyed rapidly from upland recharge areas. The specific capacity of well 36S/12E-22bdb is 250 gpm per foot of drawdown, indicating a transmissivity of about 70,000 ft^2 per day. Inasmuch as specific capacities for wells near the town of Sprague River are quite comparable, unusually rapid movement of ground water does not seem to be a logical explanation for the temperature differences between the two groups of wells.

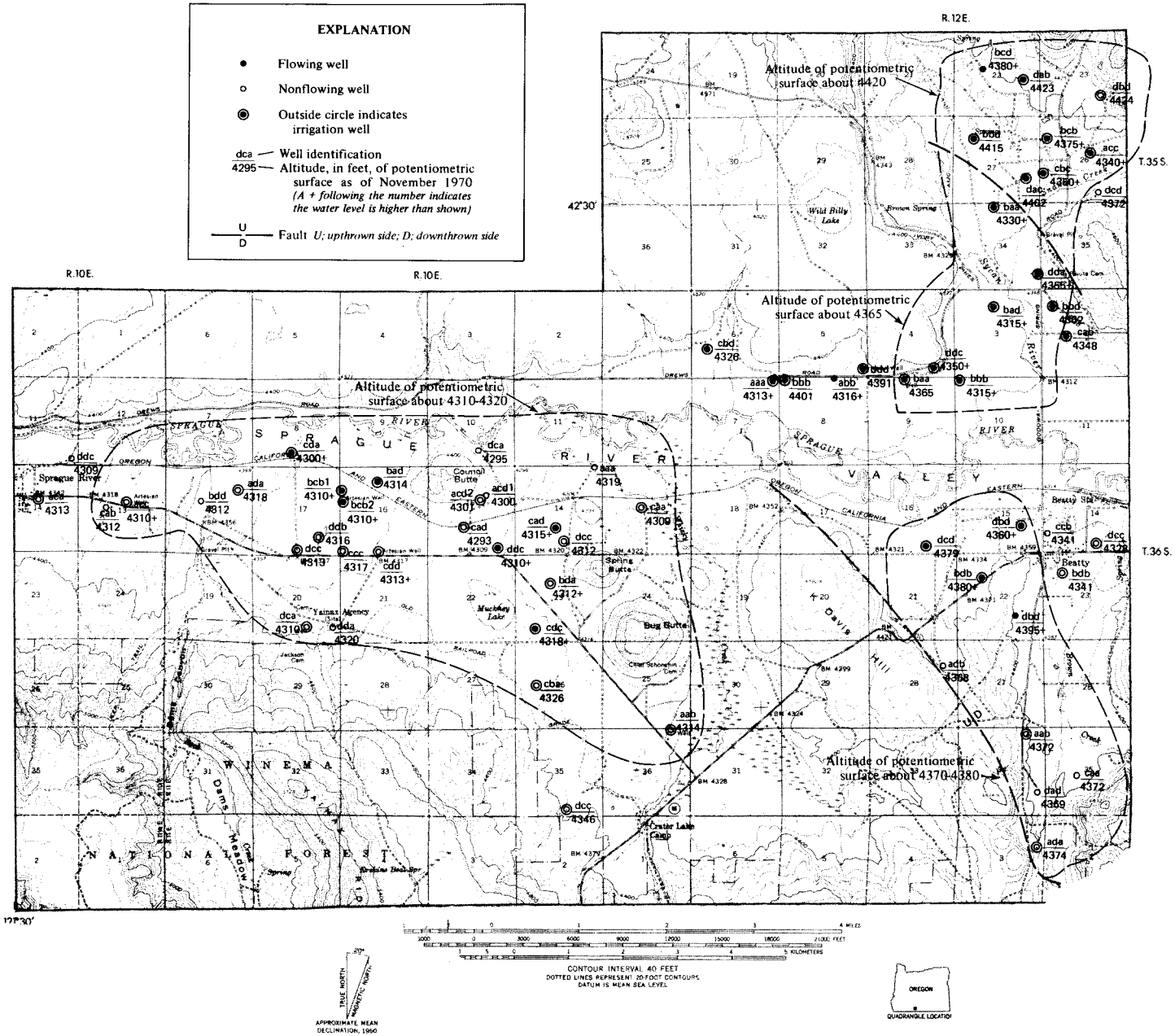

Figure 8.--Altitude of potentiometric surface in areas of artesian flow in Sprague River Valley.

Some of the differences in water level between the various areas of flowing wells may result from differences in depth of wells. North of Sprague River, wells range from 600 to 1,200 feet in depth. East of the town of Sprague River depths generally are only 300 to 600 feet, but well 36S/11E-13caa is 1,141 feet deep and well -14aaa is 1,700 feet deep. Well drillers and landowners report that artesian heads in both areas increase with depth. However, flowmeter tests made in two flowing wells failed to indicate any interchange of water between zones open to the wells. In both wells, all the flow seemed to be coming from the lowest depth that could be reached with the flowmeter.

Relation of ground water to surface water.--Sprague River valley is a major ground-water discharge area. However, seepage discharge is not uniform but is concentrated in a few local areas or short reaches of the valley. Seeps and large springs, such as Kamkaun and Medicine Springs and those feeding Whisky Creek are the principal sources of discharge.

A detailed seepage run along the river in October 1970 showed that ground-water discharge by seepage directly into the stream is localized along several reaches (fig. 9 and table 5). In the marshy area east and north of Bly, the river gains about 25 cfs (cubic feet per second) from ground-water inflow. The river also gains about 41 cfs in the constricted reach just east of Beatty, in addition to 14.6 cfs from Medicine Springs and 4 cfs inflow from Spring Creek. Between Beatty and the eastern edge of R. 9 E., the only ground-water contribution to streamflow is the 21 cfs from Whisky Creek, which originates in large springs near Crater Lake Camp (pl. 2). Near the southeast corner of T. 35 S., R. 9 E., the river gains about 29 cfs from ground water. This probably is underflow in the broad alluvial valley upstream which is forced to the surface as the stream enters the canyon reach near the mouth of Trout Creek (pl. 3). The stream neither gains nor loses flow through S'Ocholis Canyon, which is cut in sediment and tuff beds of the Yonna Formation. Several springs and spring areas contribute a total of 76 cfs in the broad alluvial flat between sec. 21, T. 34 S., R. 8 E., and sec. 31, T. 34 S., R. 9 E. In that area, the largest spring is Kamkaun Spring in the SE¼ sec. 25, T. 34 S., R. 8 E., but ground water also is discharged to the river from springs near McCready Ranch and at Whitehorse Springs in sec. 22, T. 34 S., R. 8 E.

Over the 54-mile valley reach from east of Bly to Braymill, ground-water inflow to the Sprague River is 124 cfs--about 90,000 acre-feet per year. It is of interest that this inflow is largely concentrated in a few spring areas and where the valley is constricted east of Beatty and west of the town of Sprague River. Seepage measurements indicate no direct seepage to the river between Beatty and the town of Sprague River--the valley reach where most flowing artesian wells are located. The lack of direct seepage from the main confined aquifer attests to the efficiency of the Yonna's confining beds--no measurable water moves up-water through them under natural conditions.

Fluctuations of water levels.--Water levels in wells fluctuate seasonally over a range of about 8 feet and an average of about 2 feet.

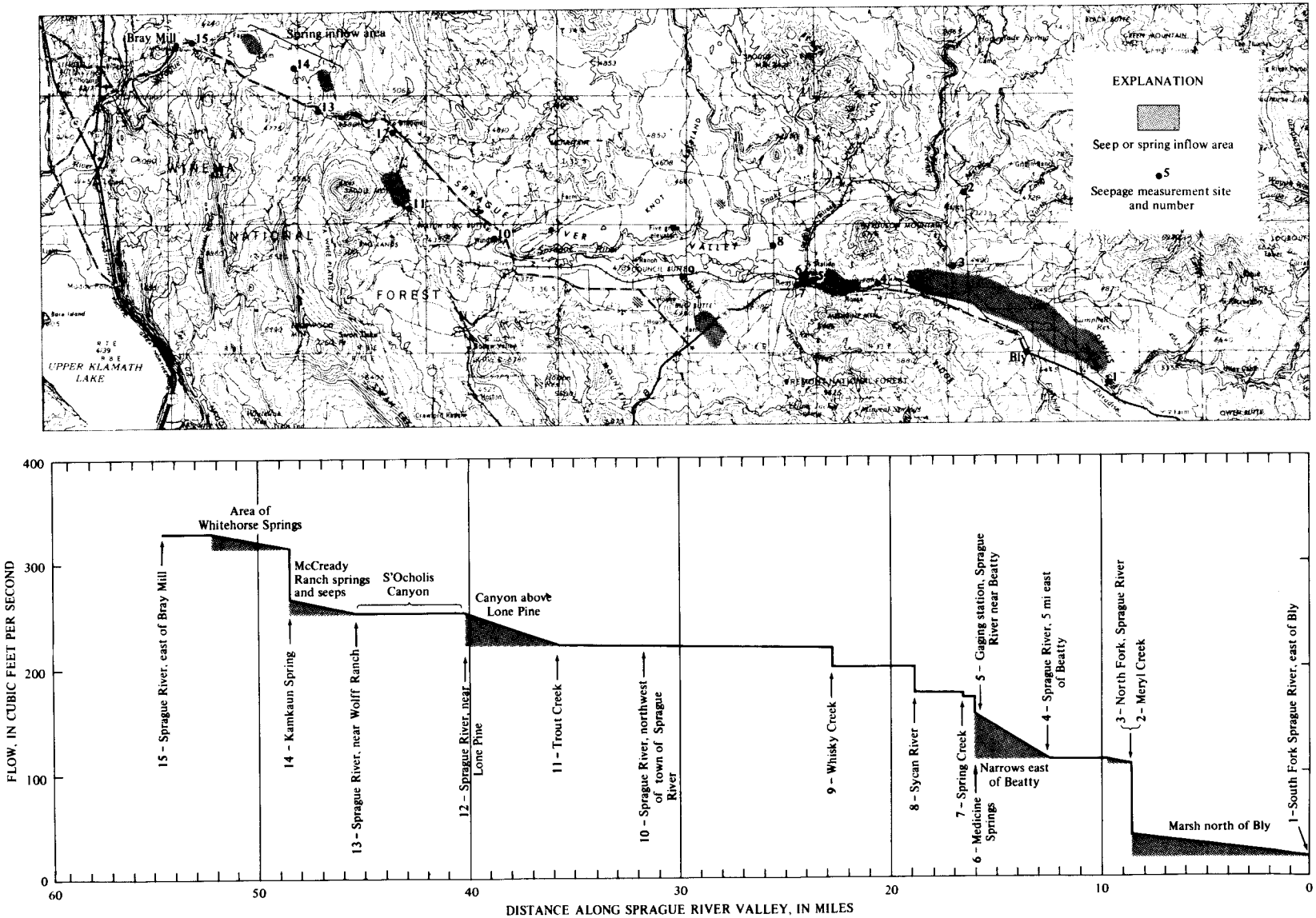

Figure 9.--Seepage measurements along the Sprague River from east of Bly to Braymill.

Table 5.--Seepage measurements along Sprague River valley

Index no.1/	Stream and location	Flow, in cubic feet per second				Length of reach (valley miles)	Remarks
		Main stream	Tributary	Gain in main stream	Total gain		
1	South Fork, Sprague River, NW¼ sec. 8, T. 37 S., R. 15 E.	19.6	--	--	--	--	
2	(Meryl Creek, SE¼ sec. 30, T. 35 S., R. 14 E.)	--	(11.8)	--	--	--	Tributary of North Fork.
3	North Fork, Sprague River, south side sec. 3, T. 36 S., R. 14 E.	--	69.3	--	--	--	
4	Sprague River, SE¼ sec. 16, T. 36 S., R. 13 E.	114	--	25	25	12.5	Marshy valley, near Bly.
5	Sprague River, near Beatty (station 11-4975)	155	--	41	66	3.3	Constricted valley, many seep springs.
6	Medicine Springs, NW¼ sec. 13, T. 36 S., R. 12 E.	--	14.6	--	--	--	
7	Spring Creek, SE¼ sec. 14, T. 36 S., R. 12 E.	--	3.95	--	--	--	
8	Sycan River, NE¼ sec. 10, T. 36 S., R. 12 E.	--	27.3	--	--	--	
9	Whisky Creek, NE¼ sec. 13, T. 36 S., R. 11 E.	--	21.0	--	--	--	
10	Sprague River, SW¼ sec. 3, T. 36 S., R. 10 E.	224	--	2	68	15.3	
11	Trout Creek, NW¼ sec. 36, T. 35 S., R. 9 E.	--	1.27	--	--	--	
12	Sprague River, SW¼ sec. 11, T. 35 S., R. 9 E.	254	--	29	97	8.5	Lower 4 miles of reach in constricted canyon.
13	Sprague River, SE¼ sec. 6, T. 35 S., R. 9 E.	254	--	0	97	4.3	S'Ocholis Canyon reach.
14	Kamkaun Spring, SE¼ sec. 25, T. 34 S., R. 8 E.	--	49.2	--	--	--	
15	Sprague River, SE¼ sec. 9, T. 34 S., R. 8 E.	330	--	27*	124	10	*Probably all spring inflow above and below Kamkaun Spring.

1/ Index numbers identify measuring sites on figure 6.

During the time that periodic water-level measurements have been made, water levels in most wells have fluctuated 5 to 10 feet, but for most of the area water levels in 1970 were about the same as when measurements began in 1954 and 1962 (fig. 10).

However, in the area of flowing wells just east of the town of Sprague River, water levels have declined from 10 to 15 feet since about 1954. Most of the decline occurred from 1962 to 1970, when water levels in wells 36S/10E-14acc, 36S/11E-17ddb, and -20dca all declined about 9 feet. Most of this decline in the confined aquifer probably resulted from the reduction of head caused by discharge of free-flowing wells. According to landowners, several wells in the local area have stopped flowing and the flow of others is much less than when originally drilled.

Since 1970, water levels in these wells have nearly leveled off, which suggests that the aquifer may be reaching a new equilibrium condition.

Quality.--The quality of water from wells in the Sprague River valley is excellent for all uses. It is generally of the calcium bicarbonate or calcium magnesium bicarbonate type, although 4 of 15 samples were sodium bicarbonate type. Dissolved solids ranged from 84 to 230 mg/l and averaged 140 mg/l, specific conductance averaged about 190 micromhos per centimeter, and hardness about 50 mg/l (table 4). In addition to the analyses reported in table 4, the specific conductance of water from about 50 wells was measured in the field. Specific conductance ranged from 60 to 440 micromhos; water from wells in the upland north of the town of Sprague River had the highest values. Specific conductance of water from 34 flowing artesian wells averaged less than 100 micromhos, about half the average for the valley.

Potential for additional development.--Successful irrigation wells have been drilled in all parts of the Sprague River valley, although several unsuccessful wells have been reported near Beatty. Because of the large recharge potential from upland areas around the valley, the area should be capable of considerable additional development. Natural ground-water discharge to streams is at least 90,000 acre-feet per year--about four times the rate of ground-water use in 1970.

Wells at most places will need to be at least several hundred feet deep, and locally more than 1,000 feet deep. Fractured basalt and cindery interflow zones in lava are most likely to yield the largest volumes of water, although some wells (such as well 35S/9E-12bdb) also obtain part of their yields from sand and gravel interstratified with basalt flows.

There is evidence that water levels and flows from artesian wells a few miles east of the town of Sprague River are declining. That area has a number of wells that flow continuously, and such uncontrolled discharge could be depleting the aquifer. The flow of one such well, 36S/11E-16bad, increased nearly 50 percent after it has been shut in for

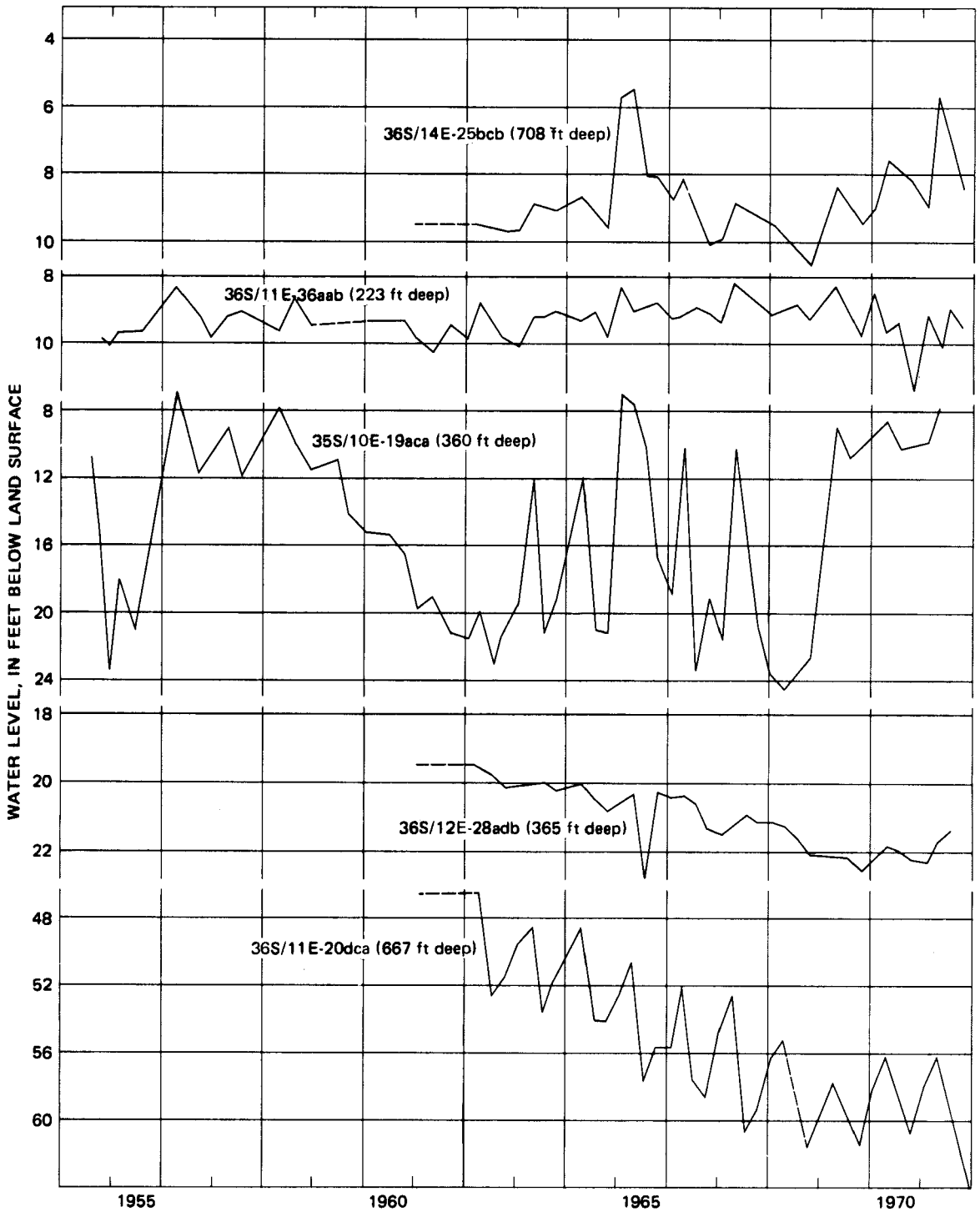

Figure 10.--Fluctuations of water levels in selected wells in Sprague River Valley.

27 hours in November 1970. The head in the aquifer would be increased by shutting these wells in when they are not in use, thus preventing further decline in water levels and allowing increased use during the irrigation season. All three areas of flowing wells probably could safely sustain additional development if the development was managed scientifically.

Swan Lake Valley

Swan Lake Valley is a 45-square-mile elliptical area, about 8 miles long and 6 miles wide. The lowland lies about 10 miles southwest of Sprague River valley across a 6,200-foot volcanic ridge. It is only about 2 miles west of Yonna Valley, across the southern part of Swan Lake Rim. Swan Lake Valley is a monotonously flat valley with a surface at 4,180 to 4,190 feet altitude. Near the northeast corner of the valley is a small playa lake, Swan Lake, which covers about a square mile and receives inflow from several natural and artificial drainage channels. A narrow neck connects Swan Lake Valley to Pine Flat, a 5- to 6-square-mile area to the southeast. A low saddle, 2 miles wide, separates Pine Flat from Poe Valley 2 miles to the southeast (pl. 4).

Except on the northwest, Swan Lake Valley is framed by steep valley walls characterized by mountains that rise more than a thousand feet above the valley. The east valley wall is a massive fault with a throw in excess of 1,000 feet. Other walls are the lower slopes of mountains, such as Hopper and Moyina Hills, which are piles of volcanic extrusive rocks. On the northwest, the valley walls are pronounced but they do not rise so abruptly as elsewhere.

The area has no natural drainage outlet, and runoff drains to Swan Lake. In addition, some areas in Pine Flat are drained by allowing drainage ditches to flow into irrigation wells in spring when the local water table is high.

Unlike most other lowlands in the Klamath Basin, Swan Lake Valley has a fill of unconsolidated lacustrine and alluvial deposits underlain by diatomite and other sediments of the Yonna Formation. In places, the thickness of the alluvial deposits is more than 100 feet, and locally it may be several hundred feet. These sediments contain a shallow water-table aquifer, of which Swan Lake is an extension. Shallow stock wells produce small quantities of water from the alluvial deposits, but they are too fine grained to yield sufficient quantities of water for irrigation supplies.

Swan Lake Rim on the northeast, the hills at the south end of the valley, and the mountains between Pine Flat and Poe Valley are all formed by volcanic rocks of Tertiary and Quaternary eruptive centers. In this area these rocks are predominantly basalt, with zones of high permeability which are tapped by several irrigation wells at the south end of the valley and in Pine Flat.

On the west, the Yonna Formation forms the valley slopes and extends beneath the valley fill at least a mile or two from the edge of the valley (pl. 4). In that area the Yonna ranges from a few hundred to nearly 2,000 feet in thickness and, as elsewhere, consists of diatomite, lacustrine sediments, and tuff. Domestic wells less than 200 feet deep tap layers of sand and gravel interbedded with the diatomite and tuff. Irrigation wells along the western and northwestern parts of the valley tap the Tertiary lower basalt unit beneath the Yonna.

Just northwest of the valley, wells 100 to 300 feet deep produce water from the lower basalt unit underlying the Yonna Formation. Several of the irrigation wells yield more than 2,000 gpm and have specific capacities greater than 1,000 gpm per foot of drawdown. Well 37S/10E-8ccc is typical; it is 281 feet deep and produces water from basalt, cinders, and volcanic sand beneath a section of diatomite and other sediments. Tested at 3,000 gpm, it had 2 feet of drawdown and a specific capacity of 1,500 gpm per foot of drawdown.

Most of the irrigation wells along the southwest edge and south end of the valley are deeper than those near the north end of the valley. These wells range in depth from about 225 to 850 feet and average about 330 feet. Generally, they tap basalt and cinders underlying 70 to 200 feet of lacustrine deposits. Yields range from 1,800 to 3,000 gpm, and specific capacities range from 24 to 1,500 gpm per foot. One of the best is well 38S/10E-16dcd, which is 225 feet deep and yields 2,650 gpm with a drawdown of 2 feet and a specific capacity of 1,325 gpm per foot. This well produces water from lava and cinders, between depths of 110 and 225 feet.

Wells along the southeast side of the valley and the adjoining part of Pine Flat are generally 100 to 300 feet deep, although well 38S/10E-25dab is 834 feet deep. Some of the domestic and stock wells, such as 38S/10E-25aab2, tap alluvial deposits, but all irrigation wells produce water from basalt or cinders of the lower basalt unit. Yields of irrigation wells range from 1,000 to 2,700 gpm, and specific capacities range from 70 to 1,600 gpm per foot of drawdown.

Occurrence and movement of ground water.--In contrast to other areas studied, Swan Lake Valley has two distinct ground-water bodies--a shallow one in the valley alluvium and a deeper one in the underlying volcanic rocks. The valley fill in Swan Lake contains a shallow unconfined ground-water body connected to Swan Lake. Ground water in that zone is replenished by seepage from irrigation canals and by runoff from slopes around the valley. Discharge is by evapotranspiration and seepage to Swan Lake. Around the east and south margins of the valley, some of the shallow ground water may move downward as a "ground-water cascade" through the fractured and fragmented rocks adjacent to the valley margin (Meyers and Newcomb, 1952, p. 55).

As in the other areas studied, the principal aquifer in Swan Lake Valley is a confined aquifer in the volcanic rocks, principally in the lower basalt unit. On the slopes adjacent to the northern part of the

valley, water levels in the main zone are at about altitude 4,170 feet--close to or a few feet lower than in the water-table aquifer in the valley fill (pl. 4, table 9).

In the southern part of Swan Lake Valley and in Pine Flat, water levels in wells in the basalt aquifer are at about altitude 4,100 to 4,115 feet. Those levels are about 60 to 80 feet lower than levels in wells in the alluvial water-table aquifer (pl. 4).

Water-level data indicate that water moves into Swan Lake Valley from the north. Illian (1970, p. 43) has estimated subsurface flow out of Sprague River subbasin to be 150,000 acre-feet per year, and some of that water may move into Swan Lake Valley. Water levels in the main confined aquifer are at about altitude 4,300 feet along Sprague River valley, 10 miles northeast of the north end of Swan Lake Valley. Differential water levels indicate a gradient of 12 or 13 feet per mile between the two valleys, so ground water could readily move from the Sprague River to Swan Lake Valley.

Water-level differentials indicate that water in the deeper zone moves from the north end of the valley to the south. However, because of the deep valley fill in the main part of the valley, the route of movement is circuitous. Water levels in wells in the south end of the valley and Pine Flat are too erratic to indicate local movement. However, those levels are slightly higher than those in Poe Valley. Hence, some ground water may move from Swan Lake Valley southward to Poe Valley.

At the north end of the valley, where water levels in the basalt are close to those in the valley-fill aquifers, some ground water from the main confined aquifer probably moves into the shallow zone and is discharged by evapotranspiration. At the south end of the valley, the shallow water table is perched 60 to 80 feet higher than water levels in the confined aquifer. Water levels in the deeper basalt aquifer are more than 100 feet below land surface, too deep to allow loss by direct evapotranspiration.

Fluctuations of water levels.--Seasonal water-level fluctuations in wells in Swan Lake Valley generally are 3 to 5 feet, and since 1949, water levels in observation wells have fluctuated over a total range of 5 to 20 feet (fig. 11). During that period, water levels in several wells, such as 37S/10E-29dbb1, rose progressively or had little change. The water level in well 37S/10E-30abc, however, has declined about 9 feet since the spring of 1968. This well is only 100 feet deep and produces water from cinders and gravel. The declining water level may represent local depletion of the aquifer. The area affected seems small, but reasons for this declining water level should be investigated in more detail.

Quality.--Ground water from the principal confined aquifer in Swan Lake Valley is of excellent quality and suitable for all uses. The water is of the calcium bicarbonate type, has a dissolved-solids concentration range from 120 to 210 mg/l and hardness from 50 to 140 mg/l

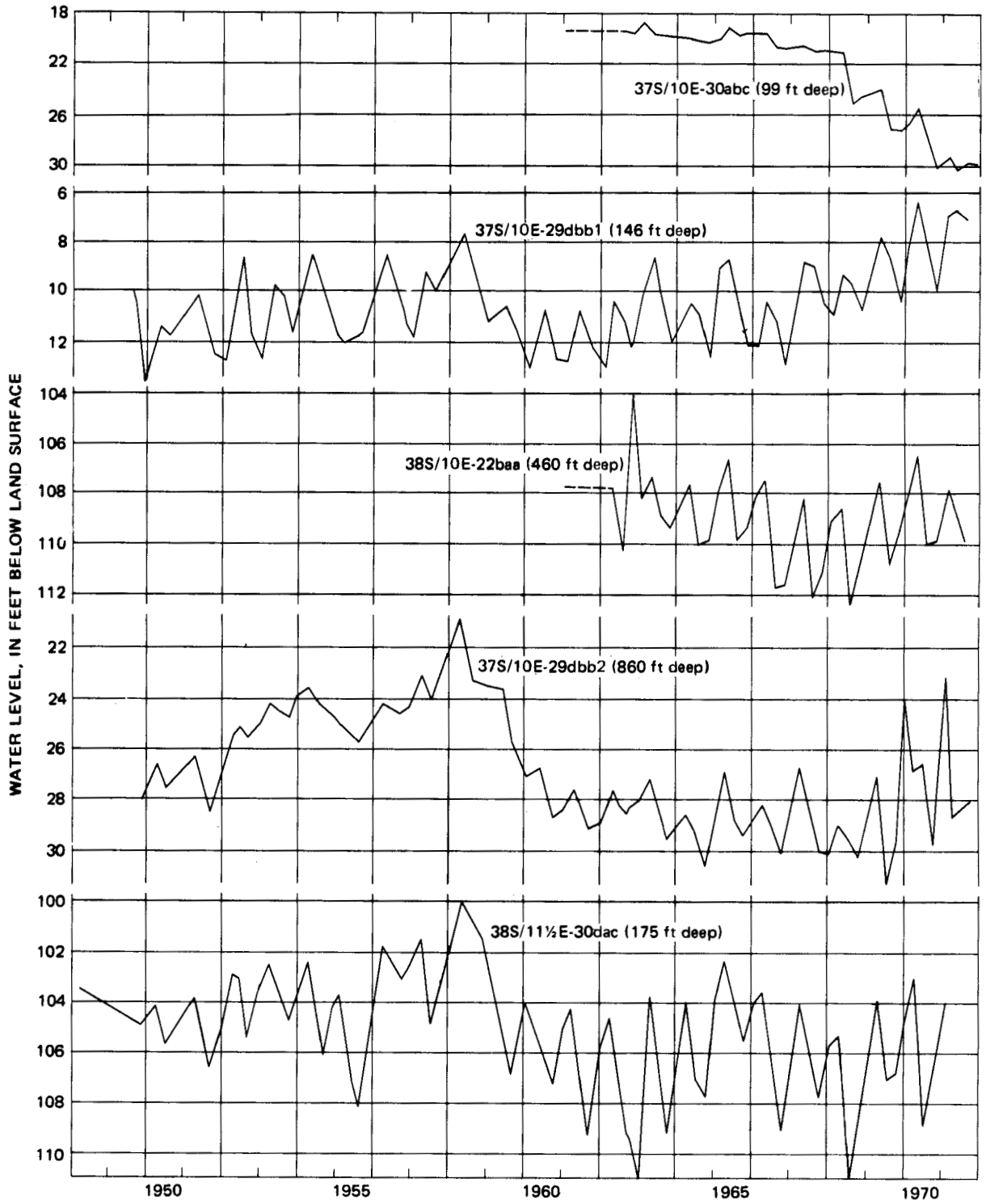

Figure 11.--Fluctuations of water levels in selected wells in Swan Lake Valley.

(table 6). However, water from the shallow water-table aquifer is of poorer quality, at least locally. Water from well 38S/10E-25aab2, which is 113 feet deep, contains 0.5 mg/l of iron and is reported to have a disagreeable taste. The water also has a high concentration of silica (70 mg/l) and a hardness of 164 mg/l, one of the highest of any water analyzed from the basin.

Potential for future development.--Except for a local area on the west edge of the valley (sec. 30, T. 37 S., R. 10 E.), the ground-water reservoir shows only seasonal effects from present pumping demands. The large yields and specific capacities of wells indicate that the confined aquifer is capable of transmitting large quantities of water toward and through the valley. Such information, together with the recorded stable water levels, indicates that the principal aquifer can probably sustain considerably larger annual withdrawals of ground water. In the central part of Swan Lake Valley, the basalt aquifer is overlain by at least 1,000 feet of alluvium and Yonna Formation and has not yet been tapped by wells. Because most of Swan Lake Valley is already irrigated, it may already have reached the maximum level of development that could be expected.

Yonna Valley

Yonna Valley is a 45-square-mile area of gently rolling lowland about 20 miles northeast of Klamath Falls. It lies about 10 miles south of Sprague River valley across a volcanic-rock ridge where altitudes reach 5,000 to 6,000 feet. Swan Lake Valley is only 2 to 3 miles west of Yonna, across Swan Lake Rim, and only a narrow saddle at the south end of the rim separates Pine Flat from Yonna Valley. Much of the valley is relatively flat and ranges in altitude from about 4,160 feet near Hildebrand to 4,100 feet near Alkali Lake (pl. 4). North of Alkali Lake several low northwest-trending ridges, 40 to 50 feet high, mark the positions of fault blocks or anticlines. Several small streams flow into the valley from the north and northeast; however, most of the valley has no external drainage and drains to the playa of Alkali Lake. An area of a few square miles near the southeast corner of the valley drains into Lost River, which traverses a short segment of the valley from Bonanza to Harpold Gap.

An alluvial veneer that forms the surface over part of the valley is predominantly silt and clay and generally is too thin to contain ground water. Faults form the east, south, and west margins of the valley where the valley walls rise abruptly several hundred feet and are capped by Quaternary or Tertiary and Quaternary basalt. Diatomite and other sedimentary deposits of the Yonna Formation form the slopes and tops of the low ridges, much of the valley lowland, and the lower slopes around the valley. Near the north end of the valley, the Yonna is less than 200 feet in thickness, but near the center it is nearly a thousand feet (pl. 4, table of well logs).

Near Hildebrand, a mass of tuff and breccia represents a volcanic maar where volcanic material was extruded on the floor of the lake in

Table 6.--Chemical analyses of water from representative wells in Swan Lake and Yonna Valleys

Location number	Depth of well (feet)	Date of collection	Milligrams per liter																	Specific conductance (micromhos at 25°C)	pH	Temperature (°F)	Temperature (°C)	Percent sodium	Sodium-adsorption-ratio (SAR)
			Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Arsenic (As)	Dissolved solids, calculated	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Noncarbonate						
Swan Lake Valley																									
37S/10E-8ccc	281	9- 1-70	44	0	8.2	7.1	9.3	2.2	89	0	4.2	1.0	0.1	0.2	0.04	0	120	50	0	140	8.0	55	13	29	0.57
37S/10E-30abc	99	11-19-49	51	.03	15	11	13*	--	128	--	1.4	1.4	.2	1.9	0	--	160	83	0	200	7.7	45	7	25	.6
38S/10E-5cbc	850	9- 1-70	40	0	28	17	16	1.3	188	0	11.0	1.5	.1	1.7	0	0	210	140	0	314	8.1	52	11	21	.59
38S/10E-25aab2	113	11- 6-70	70	.50	23	26	17	3.8	212	0	10.0	10.0	.2	.5	0	.01	260	164	0	377	7.9	--	--	21	.58
38S/11½E-30dac	175	11-20-49	47	.04	14	8.8	20*	--	124	--	2.9	6.6	.2	.4	.01	--	160	71	0	200	7.7	61	16	38	1.0
Do	175	6-11-52	45	.02	13	8.5	15	2.0	120	--	2.8	3.4	0	.7	.06	--	150	67	0	197	7.6	61	16	32	.80
Yonna Valley																									
38S/11E-7daa	325	9- 2-70	41	.02	14	8.4	11	2.2	107	0	11	1.0	.2	.3	.01	0	140	70	0	172	8.0	57	14	28	.58
38S/11½E-2dcb	583	9-22-70	40	0	11	8.0	7.4	1.4	94	0	1.8	1.5	.1	.3	.01	--	120	60	0	147	8.1	52	11	23	.41
38S/11½E-12cca1	425	4- 1-48	32	.04	38	21	21*	--	229	--	16	6.2	.2	17	.01	--	260	182	0	409	7.5	51	11	20	6.9
38S/11½E-15dda	510	9- 3-70	43	0	11	8.3	11	2.5	100	0	3.2	2.0	.1	.3	.03	--	130	62	0	159	7.9	57	14	31	.61
39S/11½E-10abc	52	11-22-49	48	.02	11	9.4	14*	--	108	--	2.1	2.4	.3	.9	0	--	140	66	0	175	7.8	55	13	31	.8

* Includes potassium.

which Yonna sediments accumulated. That area is one of wooded rocky hills unsuited for cultivation.

Nearly all the wells in Yonna Valley tap a confined aquifer in the lower basalt unit underlying the Yonna Formation. The water is under sufficient potentiometric head to rise from a few feet to a few hundred feet above the level at which it is found. Locally, flowing wells occur west of Alkali Lake, where land surface is lowest.

Yonna Valley has the greatest concentration and the largest number of irrigation wells (42) of any area in this study. In 1970, 13,500 acre-feet of water was pumped from 41 irrigation wells. Wells also supply most of the water used for domestic purposes, water for two potato-processing warehouses, and part of the stock-watering needs of the valley. Irrigation wells range in depth from less than 100 feet to nearly 1,000 feet and average 375 feet (table 9). Yields of wells are reported to range from a few to 5,000 gpm; many yield more than 2,000 gpm. Specific capacities range from 20 to 3,000 gpm per foot of drawdown and average more than 500.

Well 38S/11½E-2dcb is typical of irrigation wells in the valley. It is 583 feet in depth and taps basalt in the interval 556 and 583 feet below land surface. During a 24-hour test in September 1970, the well yielded 1,700 gpm with 5 feet of drawdown--a specific capacity of 340 gpm per foot. (See table 9, table of well records, at end of report.)

Occurrence and movement of ground water.--Ground water moves into the valley area largely from recharge sources to the north and northeast. Some of that water may move from Sprague River valley beneath the narrow intervening ridge and thence into Yonna Valley. The potentiometric surface near the town of Sprague River is at about 4,300 feet altitude and in Yonna Valley it is only about 4,100 feet, indicating a gradient of 20 feet per mile between the two lowland areas. Within Yonna Valley the water-level gradient in the confined aquifer is remarkably flat--all water levels are within a few feet of 4,110 feet altitude. This flat gradient results in part from the unusually high transmissivity of the volcanic aquifer--about 270,000 ft^2/day.[1/] Another feature of the flat gradient is the declining depth to water--from about 50 feet near Hildebrand to above land surface on the west side of Alkali Lake. Within the valley, ground water also moves generally southward toward Alkali Lake, which is a natural point of discharge. Water levels are slightly higher in Yonna than in Poe Valley, and some ground water almost certainly moves out of Yonna Valley through the ridge at the south end toward Poe Valley.

Near the center of the valley, water levels in wells 38S/11½E-15ccc and -24ccb2 are 20 to 30 feet higher than levels in nearby wells tapping

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1/ Transmissivity is the ability of an aquifer to transmit water and is reported in cubic feet per day per foot of gradient, or ft^2/day (feet squared per day).

the lower basalt unit. Both produce water from the Yonna Formation, and the higher water levels may represent a local perched zone in it.

Water-level fluctuations.--Seasonal water-level fluctuations in Yonna Valley range generally from 1 to 5 feet and average about 2 feet (fig. 12). In 1970, the water levels in about 75 wells declined an average of less than 2 feet from spring to autumn. Such fluctuations agree with long-term records of water levels from 1949 to 1972. During that period, seasonal fluctuations have been small, but water levels in some wells have fluctuated over a total range of about 10 feet (fig. 12).

Annual water-level fluctuations are demonstrated by the recorder hydrographs of wells 38S/11½E-12caa2 and 39S/11E-22bba2 (fig. 5). The hydrographs demonstrate a rise of ½ to 1½ feet in water levels in late summer as irrigation pumping slacks off. A more pronounced rise begins in late March as melting snow and increased runoff infiltrate into the aquifer system, building up the potentiometric head. Water levels start to decline again in May or June, after the winter snowpack is gone in the mountains and as irrigation pumping begins.

Minor water-level fluctuations caused by pumping irrigation wells are demonstrated by figure 13, a part of a recorder hydrograph from well 38S/11½E-12cca2, on the Frank Challis farm. The hydrograph shows about 0.08 foot of drawdown as a result of pumping well -12cdd, 1,300 feet away from the recorder well. The water level in well -12cca2 also fluctuated in response to pumping in at least one other well, possibly well 38S/11½E-12cca1, which is about 500 feet west. These slight interference effects would have a negligible effect on pumping wells, but they do confirm that the aquifer system is effectively confined.

Quality.--Ground water in Yonna Valley is of the calcium bicarbonate type and is of excellent quality for most uses (table 6). Dissolved solids in five samples analyzed ranged from 120 to 260 mg/l and were less than 150 mg/l in four of the five samples. Except for water from well 38S/11½E-12caa1, hardness was 70 mg/l or less. Water from that well also had an abnormally high nitrate content, possibly as a result of seepage from an adjacent corral.

As Yonna Valley is a topographically closed basin, the low mineral content of the ground water strongly indicates that there is enough subsurface flow of water out of the valley to remove salts that otherwise would long ago have accumulated to high concentrations.

Potential for additional development.--Gross pumpage of ground water in Yonna Valley in 1970 was more than three times the volume pumped in 1950. However, the stable water levels during the 20-year period indicate that the increased pumping has had no measurable effect on the ground-water supply. These data, together with the large transmissivities of the aquifer and the high yields and specific capacities of wells, suggest that the ground-water resource of the valley is not being used to its fullest potential. Present use probably could be safely doubled without depleting the aquifer.

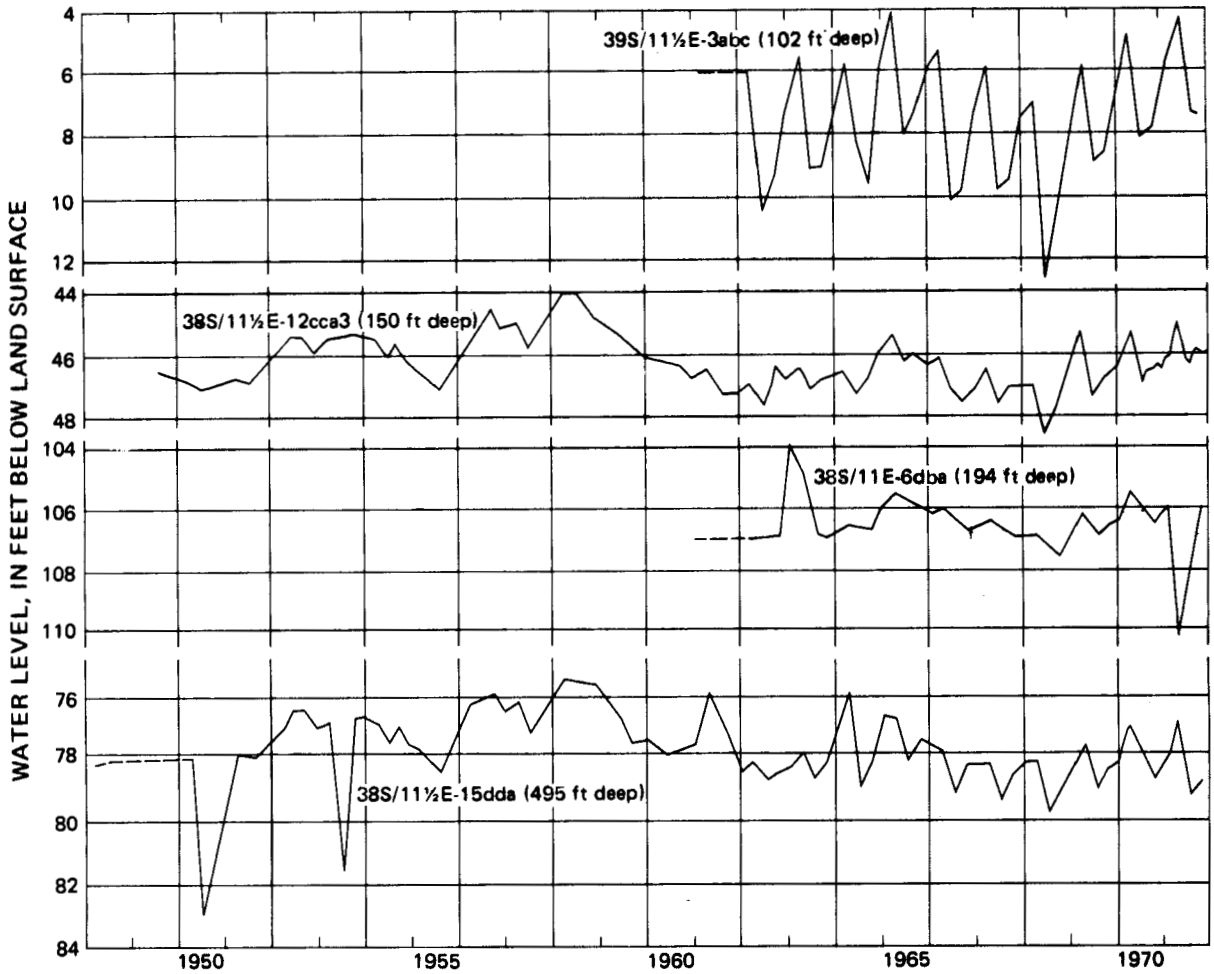

Figure 12.--Fluctuations of water levels in selected wells in Yonna Valley.

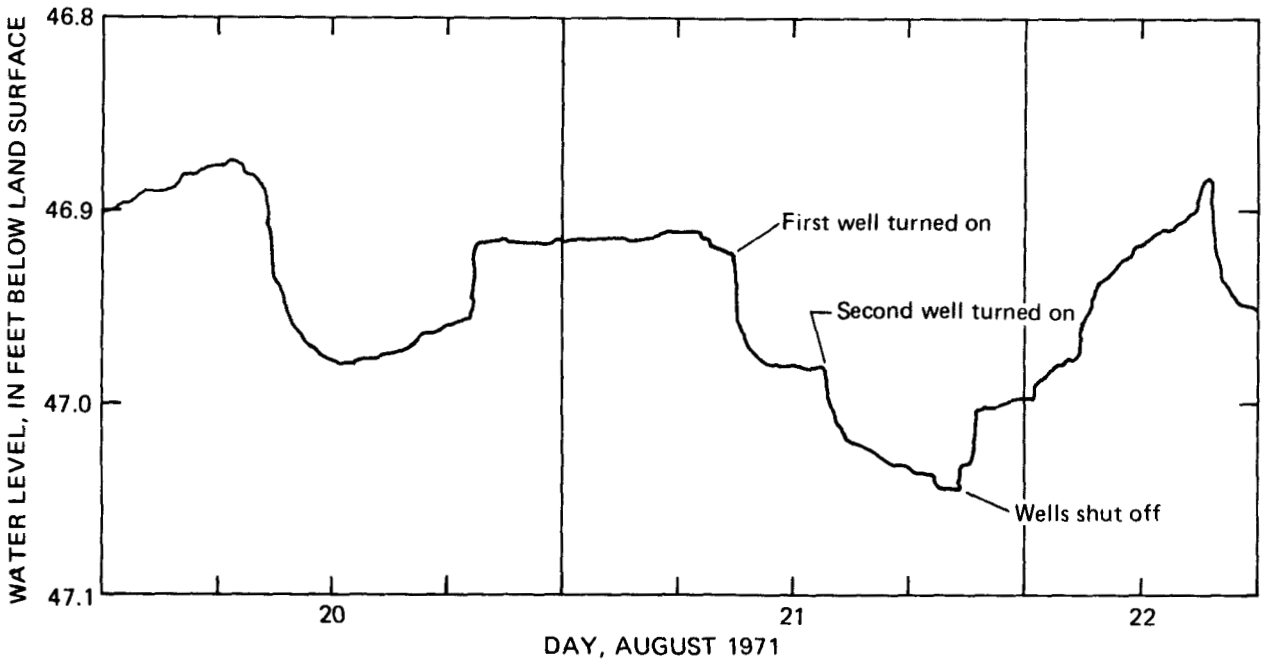

Figure 13.--Part of recorder chart showing fluctuations of water levels in well 38S/11½E-12cca3 caused by pumping nearby irrigation wells.

Well records and logs indicate that in most parts of the valley wells 200 to 600 feet deep will yield adequate quantities of ground water for irrigation. South of Alkali Lake exploratory holes may be needed to locate the best well sites, and in the central part of the valley wells may have to be drilled to depths of 1,000 feet.

Poe Valley

Poe Valley is a 25-square-mile lowland along the Lost River between the constrictions at Harpold Dam and Olene Gap. The lowland is somewhat benched, with a flood plain at an altitude of about 4,100 feet and a bench at 4,120 or 4,140 feet. Much of the valley is irrigated with water pumped from the river, and ditches skirt the edges of the upland on both sides of the valley.

Along the east and southeast sides, valley sides slope gently to altitudes of about 4,200 feet. A ridge about 2 miles wide and 4,500 to 5,500 feet in altitude separates Poe Valley from Yonna Valley and Pine Flat to the north. To the east, the north end of Bryant Mountain separates Poe Valley from Langell Valley.

Alluvial deposits are thin and are largely restricted to the narrow flood plain adjacent to the river. Most of the valley area is underlain at shallow depth by diatomite and other sediments of the Yonna Formation, and these rocks form the slopes framing much of the valley. In most places, the Yonna is a few hundred feet thick, but in the central part of the valley its thickness may be 1,000 feet. Tertiary and Quaternary basalt and other volcanic rocks form bordering uplands near the north-central and southwestern parts of the valley (pl. 4).

Occurrence and movement of ground water.--Water levels in wells in much of the valley stand at about 4,100 feet, only a few feet below land surface (pl. 4). Water levels are slightly higher in wells along both the north and south margins of the valley and at the upper end of the valley, suggesting movement of ground water toward the center of the valley and downstream. Differential water-level altitudes suggest that some ground water could move into the valley from Swan Lake and Yonna Valleys to the north.

Seepage measurements made in the Lost River in February 1966 and November 1970 indicated ground-water discharge to streams of nearly 30 cfs. Almost one-third of this ground-water inflow was from Taylor High's springs in the SW¼ sec. 19, T. 39 S., R. 11½ E. (table 8).

Most wells in Poe Valley obtain water from the lower basalt unit beneath the Yonna Formation. Along the south margin, some wells may tap the Pliocene and Pleistocene basalt. Although wells yield adequate quantities of water for domestic and stock use, the basalt aquifer seems to have much lower transmissivity than in the Yonna Valley and probably contains fewer water-yielding zones. Consequently, there are few irrigation wells--two along the north edge of the valley and seven along the east edge. Irrigation wells on the north side seem to tap the main confined zone because their water levels correspond closely with levels in other wells in the valley (pl. 4). However, several irrigation wells along the east side of the valley, including two flowing wells, have water levels at about 4,160 feet altitude and evidently tap a zone distinct from that tapped by other wells in the valley. Geologic maps do not indicate that a fault separates that area from the main part of the valley, but compartmentation caused by faulting in the volcanic rocks beneath the Yonna Formation seems a logical explanation for this water-level discrepancy. Although three of the wells flow, rates are small and all the wells are equipped with pumps to produce water for irrigation.

The irrigation wells on the east side of the valley range in depth from 344 to 736 feet and obtain water from a basalt and volcanic-sand section underlying about 100 feet of clay and sandstone of the Yonna Formation. A typical well in this group is 40S/11E-12aad, which is 689 feet deep and was tested at 800 gpm with 53 feet of drawdown, a specific capacity of 15 gpm per foot. In the fall of 1970 this well was flowing, and its head was more than 7 feet above land surface after being shut in for a few hours.

Near the southeast corner of the valley, irrigation wells 40S/11E-13bcd and -13bda1 tap the main aquifer system in basalt and cinders. From 1963 to 1967, depth-to-water levels in a nearby well (-13bda2) fluctuated between a seasonal high of about 40 to 60 feet and a low of 110 to 145 feet (fig. 14). During the same period, springtime water levels were comparable to water levels of other nearby wells (pl. 4). Since 1968, annual high-water levels in well -bda2 have been generally below a depth of 120 feet and lows have ranged from 140 to more than 150 feet. This large seasonal fluctuation in water levels is

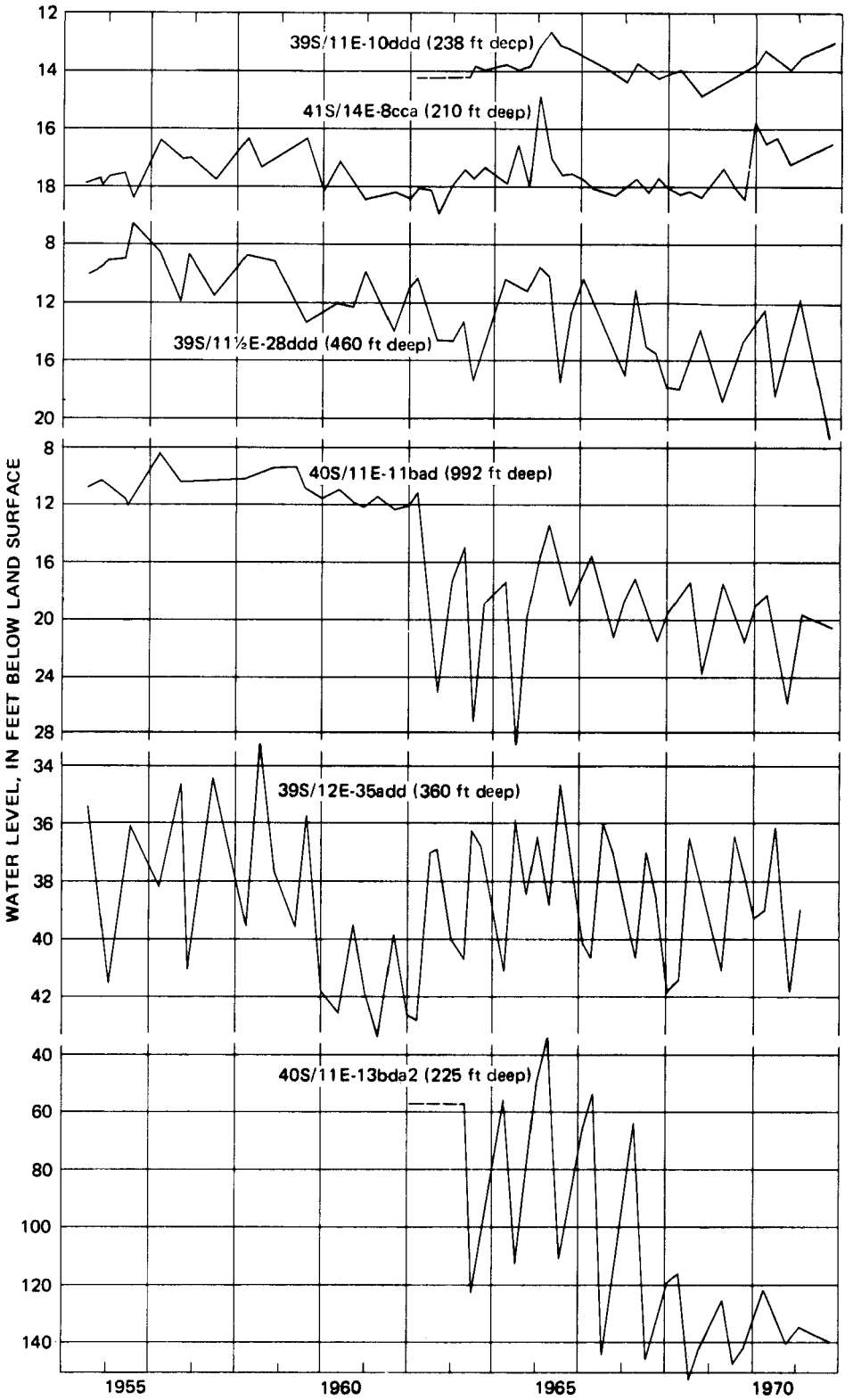

Figure 14.--Fluctuations of water levels in selected wells in Poe and Langell Valleys.

much greater than the 4- to 6-foot seasonal decline measured in other wells in the valley in 1970. The water-level decline in this area is, therefore, considered to be a localized effect that may be the result, in part, of faults forming a narrow "compartment" corresponding to boundaries for that segment of the valley (pl. 4).

Thermal water is discharged by springs in the river at Olene Gap, and wells both north and south of the gap produce warm water. According to reports, well 39S/10E-14cad, which is 720 feet deep, originally flowed, and the water level still stands near land surface. (See table of well records.) A flowing well (39S/10E-13bbb) in Stevenson Park discharges water at a temperature of about 80°F (27°C).

Another unusual flowing well is the Melvin Feigi well (40S/11E-3aaa), which is reported to be 960 feet deep and discharges a small volume of water with a temperature of 87°F (31°C). Unlike other waters sampled from the valley, the water from that well is of the sodium bicarbonate type.

Quality.--Analyses of water samples from four wells in the valley show the water to be low in dissolved solids (average 200 mg/l), soft to moderately hard, and of excellent quality for all uses (table 7). Water from well 40S/11E-3aaa had a silica concentration of 110 mg/l, about twice the average for waters sampled in Klamath Basin. A slight hydrogen-sulfide odor was noted in the water at the time of sampling.

Potential for future development.--In the Poe Valley area the few successful irrigation wells that have been drilled have considerably smaller yields and lower specific capacities than do wells in Swan Lake and Yonna Valleys. Well records indicate that large yields are likely to be obtained from wells only on the north and east edges of the valley, where the volcanic rocks have relatively high permeability. In the central and western parts of the valley, several wells drilled to depths of several hundred feet yield only moderate quantities of water--too little for an irrigation supply. Along the east side, good permeabilities, coupled with local compartmentation, produce a local aquifer system with additional potential. Wells in this area, however, would have to be several hundred feet deep and are likely to yield 1,000 gpm or less. Wells should be spaced carefully to minimize interference effects. The sizable decline in water levels near the southeast corner of the valley indicates that the local aquifer system has limited capacity and is subject to overdevelopment. Any additional wells of large yield in that area would probably aggravate still further the problem of local water-level decline.

Langell Valley

Langell Valley is a narrow 40-square-mile lowland along the uppermost part of the Lost River in Oregon (pl. 5). The project area also includes about 30 square miles of rolling hills adjacent to the valley, mostly on the north and east.

Table 7.--Chemical analyses of water from representative wells and spring in Poe and Langell Valleys

Location number	Depth of well (feet)	Date of collection	Milligrams per liter																	Specific conductance (micromhos at 25°C)	pH	Temperature (°F)	Temperature (°C)	Percent sodium	Sodium-adsorption-ratio (SAR)
			Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Arsenic (As)	Dissolved solids, calculated	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Noncarbonate						
Poe Valley																									
39S/11½E-22dab	922	9- 2-70	30	0	11	4.4	25	2.0	114	0	7.0	1.5	0.1	0.2	.02	--	140	46	0	191	8.1	--	--	56	1.62
40S/11E-3aaa	960	10- 8-70	110	.02	1.2	0	66	1.0	110	21	5.8	5.0	.4	2.9	0	0	270	3	0	273	8.8	88	31	98	16.56
40S/11E-13bdal	410	10- 9-70	50	0	23	8.2	29	6.6	171	0	16	1.5	.1	1.0	0	0	220	91	0	294	8.0	61	16	44	1.32
40S/12E-6ba	240	2-18-55	27	.01	20	11	21	3.4	166	--	5.1	1.8	.1	3.4	.05	--	170	95	0	269	8.1	61	16	31	.9
Langell Valley																									
39S/11E-10cda(s)	Spring	10-23-49	38	.22	13	7.2	14*	--	106	--	2.5	1.7	.2	.6	.01	--	129	62	0	165	7.9	59	15	33	.77
39S/12E-17aab	708	9- 1-70	42	0	16	8.0	11	3.7	109	0	1.8	1.5	.1	.4	.01	0	140	73	0	171	8.1	63	17	28	.56
39S/12E-21bdb	283	9-23-70	41	.04	25	13	14	2.6	173	0	2.0	5.0	.1	.6	0	--	190	116	0	274	8.1	--	--	23	.57
39S/12E-35add	360	2-18-55	46	0	14	10	10	2.6	118	--	1.6	1.8	.1	5.8	.02	--	140	76	0	204	7.7	--	--	22	.50
40S/13E-13ddd	102	11- 5-70	60	.10	8.5	3.8	30	6.2	118	0	8.0	6.0	.2	.1	.02	--	180	36	0	212	7.9	--	--	67	2.15
40S/14E-16aba	425	9- 1-70	60	0	7.8	4.0	30	7.4	119	0	11	3.0	.2	.9	.02	0	180	36	0	203	8.0	65	18	67	2.17
40S/14E-19aab	146	11- 5-70	31	0	18	9.7	26	7.8	162	0	9.0	6.0	.2	1.3	.03	0	190	85	0	286	7.8	--	--	44	1.23

* Includes potassium.

Walls of the valley are formed largely by fault scarps that rise about 100 feet above the valley except along the southwestern side, where Bryant Mountain rises to about 6,500 feet altitude. Several narrow northwest-trending ridges, such as Gift Butte and Dead Indian Hill, are fault blocks that extend into the valley.

The upper end of the valley is at Malone Dam, about 1 mile north of the California border. From there, the lowland slopes from about 4,140 feet to about 4,110 feet near Bonanza at the lower end. In the southern part of the valley, the Lost River has been channelized and diked through a natural marsh; in the northern part the river follows a winding course. Diversion canals from Malone Dam carry irrigation water along both sides of the valley, and water is lifted to canals by several pumps along the lower course of the river.

The lowland part of the valley is covered by alluvial deposits consisting of clay, silt, and sand. Throughout most of the valley, the alluvium is thin, but it is at least 100 feet thick in the southern part and locally yields small quantities of water adequate for stock or domestic supplies. (See log of well 40S/13E-13ddd.)

Quaternary basalt forms the uplands bordering the valley on the east and north sides (pl. 5). Near Bonanza the basalt is relatively thin and overlies diatomite and other sediments of the Yonna Formation. Volcanic rocks that underlie the Yonna in the SE part of T. 39 S., R. 12 E., and southward along the west side of the valley are part of the mass of Tertiary and Quaternary basaltic rocks that form Bryant Mountain. Because these rocks have relatively low permeability, wells drilled 300 to 1,000 feet into them have specific capacities ranging from less than 1 to about 2 gpm per foot of drawdown. (See record for well 39S/11E-26dbb.)

The Yonna Formation crops out near the edge of the valley, along the north and northeast sides, and is overlain by Quaternary basalt a short distance from the valley (pl. 5). There, the Yonna is a few hundred feet thick and consists of diatomite, clay, and other sediments and locally intercalated lava flows. Irrigation and stock wells in the area generally are drilled through the Yonna to the underlying Tertiary basalt which does not crop out in the valley. In that part of the area, several irrigation wells range in depth from about 300 to 700 feet, have yields exceeding 1,500 gpm, and specific capacities of 30 to 180 gpm per foot. (See logs and records for wells 39S/11E-2dca, 39S/12E-16cac, -17aab, and -21bdb.)

Along the east side of the valley, the Quaternary basalt thickens to as much as about 100 feet from the southern part of T. 39 S. southward. There the Yonna Formation is thinner than it is near Bonanza, and it may be absent locally so that Quaternary basalt directly overlies the Tertiary basalt (Peterson and McIntyre, 1970, p. 18). It is not possible to distinguish the two basalt units in drillers' logs, but most wells in the area are believed to be drilled through Quaternary basalt and to produce water from the underlying Tertiary rocks. (See log of well 40S/14E-16aba.)

Source, occurrence, and movement.--The source of ground water in the Langell Valley area is precipitation on the surrounding uplands, particularly those to the northeast, east, and southeast. The drainage area upstream from Lost River at Bonanza is about 1,300 square miles, including about 500 square miles in California, south of the upper end of Langell Valley.

Because precipitation in Langell Valley is least among the areas studied in Klamath Basin, recharge is somewhat less than that in other areas. In addition, the rocks forming Bryant Mountain are generally of low permeability; therefore, they transmit only small quantities of ground water toward the valley.

Water levels in wells indicate a gradient toward the valley from the uplands on each side and a general downstream gradient within the valley (pl. 5). Ground water, then, follows the same pattern of movement as in other areas in Klamath Basin, from recharge areas in uplands toward discharge areas in the lowlands. Along the valley lowland, ground water is discharged by seepage into streams, as spring flow, and by evapotranspiration. This is discussed in more detail in the section on relation of ground water to surface water.

Locally, geologic controls produce anomalies that affect the general pattern of ground-water movement. This is demonstrated by water levels that are somewhat erratic and 50 to 100 feet above levels in other adjacent wells. For instance, water levels in several wells in sec. 26, T. 39 S., R. 11 E., stand at about 4,220 feet, about 100 feet above the level of water in wells 2 miles to the northeast. Also, water levels in wells in secs. 29 and 31, T. 39 S., R. 13 E., are about 65 feet higher than those in several wells along a fault a short distance to the southwest (pl. 5). These water-level anomalies probably are caused by the compartmentation of the confined aquifer in fault blocks, so that the faults serve as local barriers impeding the movement of ground water toward the valley. Bonanza and Campbell Springs also are localized by faults that form barriers to the general westward movement of ground water (Meyers and Newcomb, 1952, p. 56). However, in most places faults do not form such barriers and water moves freely across fault zones.

Most of the wells inventoried in Langell Valley are domestic and stock wells; only 10 irrigation wells were in use in the valley area in 1970. Most of the wells are from 100 to 500 feet deep and produce water from basalt, cinders, and interlayered volcanic sand in the lower basalt unit. One irrigation well, 39S/11E-26abd1, is 1,225 feet deep, and a few others are about 700 feet deep (table 9). The yields of irrigation wells in Langell Valley range widely, from about 300 to 3,000 gpm. Specific capacities of these wells range from 2 to 160 gpm per foot of drawdown. The best yielding wells are 39S/12E-16cac, -17aab, and -21bdb, which tap the lower basalt unit and yield from 2,100 to 3,000 gpm.

Most wells in Langell Valley tap confined water bodies so that

water levels in wells stand at least several feet above the top of the water-yielding zone. Along the southwest side of the valley and near Campbell Springs, east of Lorella, water levels in wells are near ground level. Two flowing wells (40S/12E-13ddd and 40S/13E-18cbc) occur about 1 mile northwest of Gift Butte. The land surface there is a few feet lower than the potentiometric head in wells a short distance to the east, suggesting that the flow conditions could result from the topographically low position of the wells.

Seasonal water-level fluctuations in wells in Langell Valley generally are only 1 to 3 feet and comparable to those elsewhere in the Klamath Basin (fig. 14). The water level in well 41S/14E-8caa, which has been measured regularly since 1954, has fluctuated between 15 to 19 feet below land surface (fig. 14).

Relation of ground water to surface water.--The general relationship of ground water to surface water, that is the movement of ground water from upland recharge areas toward discharge areas in the valleys, has been noted. Although the confining beds of low permeability impede the upward movement of ground water toward land surface, ground water in Langell Valley is discharged into streams and through springs such as Bonanza and Campbell Springs.

Seepage measurements made along the Lost River in January and February 1966 are given in table 8. These measurements show that although flow of the river increased about 22 cfs from Malone Dam to east of Bonanza, only about 6 cfs was direct ground-water seepage. The principal area of inflow in Langell Valley was at Bonanza, where springs discharged about 85 cfs. Similar measurements in November 1970 between Bonanza and Harpold Dam indicated a discharge of about 70 cfs from Bonanza Springs.

On the basis of the 1966 measurements, the annual discharge of ground water in Langell Valley is more than 60,000 acre-feet--almost 30 times the 1970 ground-water pumpage in the valley area.

Quality.--The quality of water from wells in Langell Valley is similar to that elsewhere in Klamath Basin; that is, relatively low in mineral content and suitable for all uses (table 7). Most of the water analyzed is of the calcium bicarbonate type, but samples from wells 40S/13E-13ddd and -16aba are of the sodium bicarbonate type. Dissolved solids average about 160 mg/l, hardness about 70 mg/l, boron about 0.02 mg/l, and specific conductance about 220 micromhos.

Potential for additional development.--The small seasonal fluctuation in water levels recorded in observation wells indicates that present ground-water development has no discernible effect on ground-water supplies in Langell Valley. In addition, the discharge of large quantities of ground water in the valley indicates that additional ground water might be developed at the expense of reducing natural discharge. However, the only successful irrigation wells drilled to date have been on the north and east sides of the valley, where aquifers in

Table 8.--Seepage measurements along the Lost River, Malone Dam to Olene Gap

Stream and location	Flow, in cubic feet per second				Length of reach (valley miles)	Remarks
	Main stream	Tributary	Gain (+) or loss (-) in stream	Total gain		
Lost River at Malone Dam	0.82	--	--	--	--	Upper part of reach channelized through marshy valley.
Left bank drains	--	0.05	--	--	--	
Right bank drains (3)	--	4.92	--	--	--	
Miller Creek	--	5.92	--	--	--	
Right bank drains (2)	--	2.22	--	--	--	
Left bank drains (5)	--	2.29	--	--	--	
Lost River at Keller Bridge	23.3	--	+7.1	7.1	13.2	
Left bank drains (2)	--	.71	--	--	--	
Right bank drains (2)	--	.50	--	--	--	
Rocky Canyon Creek	--	.66	--	--	--	
Lost River above Bonanza (NE¼ sec. 13, T. 39 S., R. 11 E.)	23.8	--	-1.4	5.7	2.8	
Seepage	--	.33	--	--	--	
Left bank drains	--	.68	--	--	--	
Right bank drains	--	.65	--	--	--	
Bush Creek	--	.25	--	--	--	
Lost River at Harpold Dam	111	--	+85.3	91.0	6.1	Sharply constricted valley at dam.
Left bank drains	--	7.79	--	--	--	
Right bank drains	--	1.69	--	--	--	
Taylor High spring	--	8.61	--	--	--	
Lost River at Olene Gap	139	--	+9.9	101	9.9	Sharply constricted valley at gap.

the lower basalt unit can be tapped by wells 300 to 800 feet deep. Quantities of ground water adequate for irrigation supply might be obtained at other sites on the east side of the valley from wells 500 to 1,000 feet in depth that penetrated 100 feet or more of the lower basalt rocks. Because of the nature of the volcanic rocks and the effects of faulting, depth to the permeable zones will vary from place to place and cannot be predicted from available data.

Elsewhere in the valley, and particularly on the slopes adjacent to Bryant Mountain, yields of wells probably will not be adequate for an irrigation supply, although wells in those areas provide adequate water for stock and domestic supplies.

CONCLUSIONS

Areas studied in the Klamath Basin generally have an abundance of good-quality ground water, largely in confined volcanic-rock aquifers at depths of a few hundred feet. Well records and specific-capacity data indicate that these aquifers have high transmissivities in most of the area. Hence, aquifers move water readily from upland recharge areas toward valley lowlands and yield water freely to wells. Large quantities of ground water are discharged from irrigation wells, both by pumping and by natural flow, primarily in Sprague River, Swan Lake, and Yonna Valleys. In 1970, withdrawal of ground water, largely for irrigation, totaled about 60,000 acre-feet--three times the withdrawal rate in 1954.

Water-level fluctuations generally are small. Seasonal fluctuations reflect recharge and discharge to aquifers, and in most places water levels recover from seasonal declines before the next pumping season. Long-term fluctuations are climatically controlled; therefore, some water-level decline from the relatively high levels of 1970 can be expected. As a result of such declines, some wells in Klamath Marsh will cease to flow and others will flow at a reduced rate.

Present pumping of ground water has had no detectable effect on water levels. On the basis of geologic, well, and water-level data, it is concluded that 1970 pumpage could be doubled or trebled in most areas without adverse effects on the aquifer. Exceptions are in the southeast corner of Poe Valley and the west side of Swan Lake Valley, where a few wells have perennially declining water levels.

Large additional quantities of water can be developed from wells in most of the area except the main parts of Poe and Langell Valleys. Depending on the local geology, wells will need to be several hundred to more than 1,000 feet deep. In areas susceptible to increased development, chemical quality of the ground water is excellent for irrigation and domestic use.

Controlling naturally flowing wells when they are not in use will help to prevent the reduction of artesian head in the aquifer. In Sprague River valley, artesian wells are flowing to waste, and one effect

of this uncontrolled flow has been a decline in local water level of about 10 feet since 1960. When the flow of two wells was closed off for about 24 hours in November 1970, their flow increased about 50 percent, indicating a steady recovery of artesian pressure. If flow of all wells were controlled, potentiometric heads would rise so that flow might be restored to some of the wells that have stopped flowing and the flow of others would be increased.

Continuation of the present program of water-level surveillance would provide long-term data on water-level fluctuations. Expansion of the water-level program to include measurements of artesian head in representative flowing wells in the central part of Sprague River valley would provide needed data.

In addition to maintaining surveillance of water levels, an inventory of pumpage, made periodically for the areas where use is greatest, would allow water-level fluctuations to be related to ground-water use and would help provide early warning of any overdevelopment. At the present stage of development, a simple inventory of the acreage actually being irrigated from ground water during a year should be adequate.

Special attention should be given to the small areas on the west side of Swan Lake Valley and to the southeast corner of Poe Valley where water levels are declining. Measuring water levels in additional nearby wells would help to detect any areal expansion of these problem areas.

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Table 9.--Records of selected wells in the Klamath Basin

Well number: See p. for description of well-numbering system.
Type of well: B, bored; Dg, dug; Dr, drilled; Dv, driven.
Finish: F, gravel packed and perforated; O, open end; P, perforated; X, open hole.
Altitude: Altitude of land surface at well, in feet above mean sea level.
Water level: Depth to water given in feet and decimal fractions were measured; those given in whole feet were reported by well driller or owner. F, flowing well whose static water level is not known.
Specific conductance: Field or laboratory measurements by U.S. Geological Survey personnel.
Type of pump: C, centrifugal; H, hand; J, jet; N, none; P, piston; S, submergible; T, turbine.

Well performance: Yield, in gallons per minute, and drawdown, in feet, generally reported by driller, owner, or pump company for period indicated under "Remarks."
Use: F, fire; H, domestic; I, irrigation; N, industrial; P, public supply; S, stock; U, unused.
Remarks: C, chemical analysis reported in table 4, 6, or 7; FT, yield from flow test on date given (est. indicates yield was estimated); L, driller's log in table 10; Obs, observation well whose static water level is measured periodically; P, pumped; B, bailed; or A, air lift, for indicated time to determine yield under "Well performance."

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
KLAMATH MARSH AREA																	
T. 28 S., R. 8 E.																	
5dac	State of Oregon	Dr	1962	392	6	388	X	Cinders, lava	4,710	176.91	4-21-70	--	S	27	0	H	B 3 hr, L, C.
17ccc	Chemult Gun Club	Dr	1960	100	6	100	--	Cemented gravel	4,645	84.19	do	--	S	22	0	U	B 1 hr, L.
17dbd	Boise Cascade Corp.	Dr	1958	146	12	146	P, 103-146	Decomposed rock	4,665	135.4	do	100	T, 15	110	38	U	P 8 hr, L, Obs.
19adc	Alvin Babcock	Dr	1968	126	6	126	P, 96-126	Gravel	4,640	103.20	do	--	T, ½	25	10	H	P 4 hr, L.
19daa	Holiday Village	Dr	--	120	6	--	--	Basalt	4,635	78.69	do	--	--	--	--	--	
20bbb	I. E. Erickson	Dr	1968	140	6	120	P, 90-120	Gravel	4,643	94.28	do	--	--	20	10	H	B 2 hr, L.
20bbc	E. E. Hatfield	Dr	1969	140	6	135	P, 105-135	do	4,640	105.25	do	--	S	20	0	H	Do.
20bcc	W. H. Fletcher	Dr	--	107	6	90	P	Sand and gravel	4,637	105.02	do	--	J	10	0	H	P 1 hr, L.
T. 29 S., R. 7 E.																	
1ddd1	Pacific Gas Transmission	Dr	1961	197	6	197	P, 140-180	Basalt	4,609	77.09	4-21-70	--	S	15	--	H	L.
1ddd2	do	Dr	1965	225	6	199	P, 140-180	Sand, gravel, basalt	4,609	77.13	do	--	S	60	--	H	A, L.
12aaa	C. P. Petty	Dr	1965	135	6	135	P, 70-130	Sand	4,610	63.75	do	--	S	25	0	H	P 2 hr, L.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
KLAMATH MARSH AREA--Continued																	
T. 29 S., R. 8 E.																	
7bbb	W. E. Ingalls	Dr	1962	90	6	78	X	Sand and gravel	4,612	63.06	4-21-70	--	J, 2	10	0	H	B 2 hr, L.
7dda	Southern Pacific Transp. Co.	Dr	1926	128	8	64	X	Basalt	4,648	115.04	do	--	J, 2	--	--	U	L.
7ddd	Boise Cascade Corp.	Dr	1967	131	12	127	P 67-127	Basalt boulders	4,645	111.79	do	--	25	--	--	N, I	L, C.
32cbb	Crown Zellerbach	Dr	--	--	6	--	--	--	4,603	72.50	do	--	--	--	--	I, F	
34bbc	J. O'Conner	Dr	--	52	6	--	--	Pumice(?)	4,615	28.44	do	--	--	--	--	U	
T. 29 S., R. 9 E.																	
32dcc	Klamath Indian Trust	Dr	1961	355	8	268	P 148-168, X	Cinders, sand	4,517	2.79	4-21-70	--	P	250	100	S	P 8 hr, L.
T. 30 S., R. 7 E.																	
11dab	Crown Zellerbach	Dr	--	123	6	--	--	--	4,610	76.35	4-21-70	--	T, 15	--	--	N	Obs.
20adc	Winema Natl. Forest	Dr	--	--	8	--	--	--	4,700	143.94	5-22-70	--	--	--	--	H	
T. 30 S., R. 8 E.																	
13abc	Crown Zellerbach	Dr	1964	71	6	42	P 30-42	Lava, gravel	4,550	16.74	4-21-70	78	S, 3/4	20	0	N, S	B 2 hr, L.
13ccb	C. C. Pinneo	Dr	1957	329	6	302	X	Sand and gravel	4,535	6.09	do	--	N	--	--	U	L.
14caa1	J. P. McAuliffe	Dr	--	59	6	--	--	--	4,540	4.92	do	--	--	--	--	S	
14caa2	do	Dr	--	--	6	--	--	--	4,540	4.51	do	--	--	--	--	U	
14ccc	do	Dr	--	--	6	--	--	--	4,530	2.85	do	--	--	--	--	U	
15dbb1	do	Dr	--	190	6	--	--	--	4,533	1.43	do	--	--	300	--	U	
15dbb2	do	Dr	1967	176	16	105	X	--	4,539	7.98	do	--	T, 60	3,000	--	I	
16dcd(s)	Big Springs	Spring	--	--	--	--	--	Gravel	4,540	--	--	62	--	6,000	--	I, S	Flow 9-29-70, C.
21aab	J. P. McAuliffe	Dr	--	90	6	50	X	do	4,540	F	11- 1-69	58	N	1,300	--	U	FT (est.) 1954.
21abc	do	Dv	--	35	2	--	--	--	4,550	12.85	4-21-70	--	N	--	--	U	
22acb	do	Dr	--	--	6	--	--	--	4,530	F	10-25-69	65	C, ½	400	--	H, S	FT (est.) 1954 (60 gpm 1969).
22bdd	do	Dr	--	65	4	--	--	--	4,535	6.87	4-21-70	--	--	--	--	U	

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
KLAMATH MARSH AREA--Continued																	
T. 30 S., R. 8 E.--Continued																	
23ddd	Kittridge Ranch	Dr	--	160	6	--	--	--	4,521	F	10-24-69	62	N	30	--	S	FT (est.) 1969.
24aac	J. P. McAuliffe	Dr	--	--	8	--	--	--	4,530	3.83	4-21-70	--	S	--	--	S	
25acb	C. C. Pinneo	Dr	--	640	6	640	O	Sand, "loose lava"	4,518	F	11- 1-69	62	--	225	--	I, S	FT (est.) 1961.
25bcb	do	B	--	312	6	312	X	Rock	4,519	F	do	--	N	450	--	I, S	Do.
25dbc	do	B	--	80	2	80	--	"Loose lava"	4,517	F	do	--	N	110	--	I	Do.
26dcb	William Kittridge	Dr	--	--	6	--	--	--	4,321	F	10-24-69	62	N	75	--	H, S	FT (est.) 1969.
28acb	H. W. Tompkins	Dr	1956	87	6	86	P 46-80	Sand, gravel	4,542	8.10	4-22-70	--	J, ½	--	--	S	L.
29aad	do	Dr	--	--	6	--	--	--	4,546	12.12	do	--	C, ½	--	--	S	
29abb	do	Dr	--	110	18	75	P 61-73, X	Gravel, lava, cinders	4,550	16.18	do	--	C, 15	2,400	49	I, S	P 4 hr, L.
30bdb	Southern Pacific Transp. Co.	Dr	1924	75	8	--	--	Sand, gravel	4,562	25.92	do	--	N	--	--	U	L.
31bca	D. L. Higgins	Dr	1964	46	6	46	P 26-46	do	4,551	16.84	do	70	J, ½	20	0	H	B 2 hr, L.
32caa	Ben Adair	Dr	1963	150	16	121	P 20-116	do	4,535	6.65	do	63	T, 25	4,000	6	I	P 4 hr, L, C.
32cdc	do	Dr	1966	125	6	98	P 28-98	Cinders and lava	4,530	+.90	do	--	--	360	--	U	P 2 hr, flow 60 gpm, L.
T. 30 S., R. 9 E.																	
20acd	M. G. Emery	Dr	1963	105	6	42	P 31-42, X	Sand, gravel	4,535	7.95	4-22-70	--	N	40	0	U	B 2 hr, L.
30bbb	C. C. Pinneo	Dr	--	--	6	--	--	--	4,519	.38	do	--	N	--	--	U	
36bbb	Ora Summers	Dr	--	104	6	--	--	--	4,530	19.89	do	--	P	--	--	S	
T. 30 S., R. 10 E.																	
24aab	E. R. Dennis	Dr	1962	231	8	80	X	Gravel	4,570	82.07	4-22-70	--	P	20	15	S	B 4 hr, L.
36dab	Dr. J. H. Lawrence	Dr	1962	141	8	82	X	Gravel, sand	4,580	45	7-30-62	--	P	25	8	H, S	B 2½ hr, L.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
KLAMATH MARSH AREA--Continued																	
T. 31 S., R. 7 E.																	
1adc	Swanson Cattle Co.	Dr	1962	452	18	322	P 48-322, X	Lava, black sand	4,545	12.04	4-22-70	60	T, 75	3,200	12	I	P 7 hr, L, Obs.
12dab	do	Dr	--	--	4	--	--	--	4,541	11.89	do	--	S, ½	--	--	H	
24bac	Joe Ball	Dr	1949	61	10	54	X	Pumice and sand	4,553	24	6-15-53	112	S	60	30	H	B, L, C.
T. 31 S., R. 8 E.																	
6bba	Ben Adair	Dr	1966	274	16	112	P 42-112, X	Cinders, basalt	4,542	9.35	4-22-70	--	T, 50	3,500	55	I	P 3 hr, L.
7bbb	Unknown	Dr	--	--	6	--	--	--	4,541	11.74	do	--	--	--	--	U	
7cbb	Dayton Hyde	Dr	--	535(?)	10	--	--	--	4,540	.26	11- 2-70	70	T, 15	700	--	H, I	
8aaa	Arnold Christenson	Dr	--	--	8	--	--	--	4,527	F	10-24-69	--	--	--	--	S	
10bbb	Warner Valley Stock Co.	Dr	1962	160	18	156	P 26-150	Pumice, sand, and gravel	4,523	F	do	64	T, 60	1,500	7	I	P 3 hr, L, C.
10cbb	Arnold Christenson	Dr	--	--	4	--	--	--	4,521	F	do	70	N	--	--	S	
21cca	Swanson Cattle Co.	Dr	--	--	6	--	--	--	4,519	F	10-27-69	65	N	--	--	S	
29cbd1	do	Dr	--	--	2	--	--	--	4,517	+2.32	4-20-70	--	N	--	--	U	
29cbd2	do	Dr	--	--	2	--	--	--	4,517	F	do	--	N	--	--	S	
30dab	do	Dr	--	--	10	--	--	--	4,523	3.21	do	--	N	--	--	U	
30dcb	do	Dr	--	--	6	--	--	--	4,525	--	--	72	--	--	--	H	
33dcc	do	Dr	1961	430	18	258	F, P 40-258, X	Lava	4,521	5.18	4-20-70	75	T, 75	--	--	I	L.
34bcb	do	Dr	--	--	3	--	--	--	4,517	F	10-27-69	80	--	--	--	S	
36aac	Unknown	Dr	--	--	6	--	--	--	4,517	F	11- 1-69	85	--	--	--	S	
T. 31 S., R. 9 E.																	
17dca	Ora Summers	Dr	--	--	6	--	--	--	4,520	3.23	4-22-70	--	--	--	--	U	

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
KLAMATH MARSH AREA--Continued																	
T. 31 S., R. 11 E.																	
32bad	Deep Creek Ranch	Dr	1962	107	6	49	X	Cinders, gravel	4,620	43.74	4-22-70	--	N	15	25	U	B 1½ hr, L.
32bba	do	Dr	1950	240	6	--	--	White sand	4,600	87.20	do	110	S	--	--	H	C.
T. 32 S., R. 7 E.																	
36bdd	Southern Pacific Transp. Co.	Dr	1928?	130	6	--	--	--	4,520	4.64	4-20-70	--	N	--	--	U	
T. 32 S., R. 8 E.																	
5cdb	Swanson Cattle Co.	Dr	--	--	3	--	--	--	4,513	F	10-27-69	--	--	--	--	S	
30cdd	Kirk Ranch	Dr	--	54	6	--	--	--	4,517	7.00	4-20-70	--	J	--	--	H, S	
SPRAGUE RIVER VALLEY																	
T. 34 S., R. 8 E.																	
19caa	R. L. Carlson	Dr	1916	250	6	40	X	--	4,320	52.42	4-17-70	--	S, 1½	--	--	H	
19cad	do	Dr	--	165	6	140	X	--	4,253	3.31	do	--	N	--	--	U	
19cdd	do	Dr	--	196	6	40	X	--	4,265	.28	do	--	N	--	--	U	
24daa	Floyd Hescock	Dr	1916	290	6	--	--	--	4,275	15.93	4-23-70	--	S, 1	--	--	H, S	
25ddb(s)	Kamkaun Spring	Spring	--	--	--	--	--	Basalt	4,260	--	7-29-69	75	N	22,000	--	S	Flow 9-29-70, C.
28bba	Henrietta Emich	Dr	1947	82	6	--	--	--	4,265	1.64	4-17-70	--	J, ½	--	--	H	
28ddb	M. W. Poole and Robert Moisio	Dg	--	44	48+	--	--	--	4,301	22.53	do	255	J, 3/4	--	--	H	
28ddc	do	Dr	1967	722	16	40	X	Lava, basalt	4,318	55	do	199	T, 50	3,200	7	I	P 4 hr, L, C, Obs.
T. 34 S., R. 9 E.																	
15bad	Ted Hyde	Dr	--	600+	6	--	--	--	4,480	207.1	4-23-70	--	--	--	--	U	
30dda	Dr. Earl Harris	Dr	1942	208	8	50+	X	--	4,282	22.90	4-17-70	--	J, 1	--	--	H	
31dbb	Henry Wolff	Dr	--	92	6	--	X	Chalk	4,270	9.32	do	--	J, 2½	--	--	H	
32bba	W. K. Plummer	Dr	1968	176	5	20	X	Cinders, lava	4,300	37.10	do	--	S	30	10	H	B 2 hr, L.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
SPRAGUE RIVER VALLEY--Continued																	
T. 35 S., R. 8 E.																	
1bcb	Henry Wolff	Dr	1952	102	6	--	--	--	4,305	4.11	4-17-70	--	N	--	--	U	Obs.
T. 35 S., R. 9 E.																	
11bcd	William and Cal Hogg	Dr	1968	75	6	20	X	Gravel and shale	4,278	8.63	4-16-70	--	S, 3/4	5	40	H	B 2 hr, L.
11bdb	Robert Knott	Dr	1967	120	8	49	X	Lava, basalt	4,282	12	1967	--	N	30	15	U	B 1 hr, L.
12bcc	John Kronenberger	Dr	1959	110	8	19	X	Sand, shale	4,280	8.40	4-16-70	--	1/2	40	19	H, S	P 3 hr, L.
12bdb	do	Dr	1969	1,200	16	20	X	Lava, sand	4,285	25.70	do	--	T, 100	1,900	94	I	Do.
13aaa	F. H. Taylor	Dr	--	116	--	--	--	--	4,275	11.55	do	--	--	--	--	S	
13bbd	do	Dr	1964	119	6	31	X	Lava	4,285	42.38	do	306	J, 3/4	1	70	H	B 1 hr, L, C.
13bdd	John Dobranski	Dr	1961	205	8	20	X	Sand and gravel	4,300	35.18	do	--	P, 3	20	75	H, S	B, L.
35ada	Stern Skeen	Dg	--	19	18	--	--	--	4,300	5.63	11-19-69	--	J, 1½	--	--	H	
T. 35 S., R. 10 E.																	
19aca	Theodore Crume	Dr	1951	360	6	80±	X	--	4,300	8.63	4-16-70	280	J, 1½	--	--	H	Obs.
21bad	do	Dr	1960	925	18	39	X	Basalt	4,340	66.5	do	235	T, 125	2,900	51	I	P 12 hr, L.
23dda	E. O. Koepke	Dr	1963	365	8	30±	--	--	4,420	24.89	11-20-69	440	S, 1	--	--	H	
24cbd	Ross and Reeves	Dr	--	390	6	--	--	--	4,390	F	4-17-70	--	S, 3/4	--	--	H, S	
26acd	H. E. Cash	Dr	1967	300	6	160	X	Gray rock	4,480	81.18	do	267	S, 1½	25	20	H	B 1 hr, L, C.
29bdd	G. D. Hazen	Dr	1969	350	8	19	X	Black sandstone	4,295	10.53	6-16-70	--	N	25	60	S	B 2 hr, L, Obs.
29cab	do	Dr	--	--	6	--	--	--	4,293	3.65	4-17-70	--	N	--	--	U	Obs.
30ccc	Dick Perry	Dr	--	62	6	--	--	--	4,286	4.46	do	--	--	--	--	U	
31add	Joe Hambrick	Dr	1967	233	6	233	P 214-233	Sand, pumice	4,310	40.7	do	--	--	30	30	H, S	B 1 hr, L.
33bca	H. J. Zehe	Dr	--	225	8	60	X	--	4,315	25.24	4-16-70	320	S, 3/4	--	--	H, S	
34acb	Klamath Falls Forest Estates	Dr	1963	130	8	38	X	Lava	4,380	31.20	4-17-70	375	S, 1	39	4	H	P 2 hr, L.
34dbb	Thomas Lisecki	Dr	1968	104	6	19	X	Sandstone	4,365	13.67	do	--	J	15	20	H	B 2 hr, L.
35bcd	John Kerkes	Dr	1968	80	6	20	X	Black sandstone	4,380	31.61	11-20-69	325	--	18	3	H	Do.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
SPRAGUE RIVER VALLEY--Continued																	
T. 35 S., R. 10 E.--Continued																	
35cbb	Sylvan Crume	Dr	--	--	8	--	--	--	4,365	13.85	4-17-70	--	J	--	--	--	
T. 35 S., R. 11 E.																	
22bcb	Leroy Griffith	Dr	--	--	8	--	--	--	4,595	58.02	4-16-70	--	--	--	--	U	
24dac	R. E. Bonney	Dr	1952	612	8	45	X	Chalk	4,565	80.34	do	234	P, 9	--	--	H, S	C.
30dbc	Reeves and Ross	Dr	1953	987	6	--	--	--	4,365	17.76	4-20-70	--	--	--	--	U	
T. 35 S., R. 12 E.																	
22bcd	Rimrock Ranch, Inc.	Dr	--	--	10	--	--	--	4,380	F	10-16-69	125	C	800	--	H	
22dab	do	Dr	--	--	12	--	--	--	4,406	F	4-20-70	104	N	3,000	--	I	FT 1970, C.
23dbd	T. L. Turner	Dr	1965	965	16	45	X	Lava	4,445	17.8	4-15-70	--	T, 30	2,760	55	I	P 1½ hr, L.
26acc	W. A. Joe, Jr.	Dr	1963	1,168	8	116	X	Lava, sand	4,340	F	5-15-70	95	N	900	--	H, I	FT 1963, L.
26bdb	Rimrock Ranch, Inc.	Dr	1963	570	12	180	X	Sandstone and rock	4,375	F	10-16-67	85	N	3,000	--	I	Do.
26cbc	Josh Foster estate	Dr	1939?	300	6	--	--	--	4,350	F	11-10-52	100	N	75	--	I	
26dcd	Gladys Shoulderblade	Dr	1962	500	10	20	X	Lava	4,390	16.9	4-15-70	--	--	472	67	U	P 3 hr, L, Obs.
27bbd	Rimrock Ranch, Inc.	Dr	1961	794	12	80	X	Rock	4,345	F	5-15-70	75	N	2,200	--	I	FT 1961, L.
27dac	D. G. Givins	Dr	1962	720	12	80	X	Cinders and sandstone	4,348	F	do	95	--	840	80	I	P 1½ hr, L.
32acd	Unknown	Dr	--	900	6	--	--	--	4,498	3.10	4-16-70	--	--	--	--	U	
34baa	do	Dr	--	--	6	--	--	--	4,330	F	5-15-70	95	C, 1/3	--	--	H	
34dda	John and Lillian Mills	Dr	1959	845	12	80	X	Gravel, sand, and "lava rock"	4,355	F	4-16-70	80	T, 25	1,250	60	I	P 2 hr, L.
T. 35 S., R. 14 E.																	
31ada	Harry Obenchain	Dr	1970	320	8	19	X	Lava and pumice	4,380	55.43	10-19-70	--	T, 15	556	268	H, I	A 2 hr, L.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
SPRAGUE RIVER VALLEY--Continued																	
T. 36 S., T. 10 E.																	
2ccd	Irwin Crume	Dr	--	625	6	--	--	--	4,350	13.90	4-20-70	--	J, 1½	--	--	S	
4aad	H. J. Zehe	Dr	1965	225	8	60	X	--	4,360	41.72	do	225	S, 3/4	--	--	S	
6ddd	Joe LaHoda	Dr	1949	420	10	64	--	Sand, gravel, pumice	4,289	23.44	4-16-70	--	N	--	--	U	L.
9dca	H. T. Robbins	Dr	1949	70	6	11	X	Black sand	4,305	9.17	do	--	N	--	--	U	L.
9ddc	Hiram Robbins estate	Dr	1930?	400	4+	--	--	--	4,300	8.72	do	--	--	--	--	S	
11ddc	Great Northern Railway Co.	Dr	--	600	--	--	--	Lava	4,310	.72	4-20-70	161	T, 7½	--	--	U	C.
13acc	Hiram Robbins estate	Dr	--	274	12	--	--	--	4,310	F	do	180	N	--	--	I	C.
13cab	Ralph Smith	Dr	1941	400	12	42	X	Black sand	4,318	2.22	do	--	N	400	--	H	
14acc	C. J. Emmich	Dr	1955	527	14	40	X	Basalt, cinders	4,342	26.10	4-16-70	225	T, 10	1,350	98	I	P ½ hr, L, Obs.
14cab1	Sprague River Water Assoc.	Dr	1938	500	12	84	X	Black sand	4,350	36.77	do	--	T, 20	--	--	P	L.
14cab2	do	Dr	1941	500	12	84	X	--	4,350	37.47	do	--	N	--	--	U	
T. 36 S., R. 11 E.																	
8cda	Ray Smith	Dr	1947	523	12	470	X	Rock	4,300	F	4-18-70	140	--	1,200	--	I	FT 1955, L.
10dca	Unknown	--	--	--	8	--	--	--	4,320	23.15	4-16-70	--	S	--	--	U	
13caa	G. H. Smith	Dr	1962	1,141	8	398	X	Lava rock	4,320	10.62	do	--	C	500	--	I	FT 1962, L.
14aaa	Edwin and Rae Walker	Dr	1963	1,700	12	296	X	Lava rock and cinders	4,320	+1.04	do	200	--	100	94	U	B 3 hr, L.
14cad	E. K. Viera	Dr	1968	361	16	100	X	Basalt and sandstone	4,315	F	4-17-70	135	60	560	--	I	FT 1968, L.
14dcc	do	Dr	1958	580	8	155	X	Lava and sandstone	4,315	.41	4-18-70	--	T, 40	1,000	--	I	FT 1958, L.
15acd1	C. K. Neathery	Dr	1958	182	8	20	X	Lava rock	4,315	13.28	4-16-70	--	--	50	0	U	B 2 hr, L.
15acd2	Dennis Hickey	Dr	1963	100	12	40	X	Rock	4,330	27.97	do	--	T, 25	4,000	3	H, I	P 4 hr, L.
15cad	Accurate Electronics, Inc.	Dr	1947	260	16	180	X	Broken basalt	4,310	15.83	do	--	T, 30	3,000	57	I	P, L.
15ddc	Edwin Walker	Dr	1963	558	12	162	X	Sandstone, rock	4,310	F	do	135	T, 20	1,600	--	H, I	FT 1963, L.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
SPRAGUE RIVER VALLEY--Continued																	
T. 36 S., R. 11 E.--Continued																	
16bad	Ray Smith	Dr	--	586	10	106	X	--	4,305	F	4-16-70	185	--	--	--	I, S	
16bcb1	do	Dr	1952	386	20	105	X	Basalt	4,310	F	4-18-70	151	T, 100	4,000	--	I	FT 1952, L, C.
16bcb2	do	Dr	--	--	8	--	--	--	4,310	F	do	148	--	--	--	I, S	
16ccc	Accurate Electronics, Inc.	Dr	1948	313	14	--	--	Rock	4,321	F	do	--	T, 30	--	--	I	
16cdd	Ray Smith	Dr	1944	225	14	--	--	--	4,316	F	do	158	N	--	--	I	
17dcc	E. D. Firsick	Dr	1952	463	12	64	X	Rock	4,335	17.20	do	--	T, 30	1,500	8	I	L, Obs.
17ddb	do	Dr	1946	330	12	97	X	Broken basalt	4,327	6.65	do	--	T, 20	--	--	H, I	L.
18ada	M. L. Conley	Dr	1951	625	12	100	X	Basalt	4,330	6.49	do	--	T, 30	400	--	I	L.
18bdd	do	Dr	--	--	12	--	--	--	4,320	3.46	do	--	--	--	--	U	
20dca	George Bernard	Dr	1959	667	18	260	X	Basalt and cinders	4,370	55.45	do	--	T, 100	4,000	7½	I	P 4 hr, L, Obs.
20dda	do	Dr	1959	424	6	--	--	Basalt	4,350	24.12	do	--	J, 1	30	0	H	B 1 hr, L.
23bda	H. E. Mitchell	Dr	1957	402	8	139	X	Lava rock and sand	4,312	F	do	115	C, 10	860+	--	I	FT 1957, L.
23cdc	do	Dr	--	--	--	--	--	--	4,318	F	do	180	T, 50	--	--	I	
26cba	do	Dr	--	--	--	--	--	--	4,330	2.36	do	--	T, 50	--	--	I	
35dcc	Mark Time, Inc.	Dr	1962	384	16	120	X	Rock, sand, and gravel	4,380	32.70	do	155	T, 100	3,200	90	I	P 4 hr, L.
36aab	William Gallagher	Dr	1948	223	16	96	--	Cinders, rock, and gravel	4,325	10.01	do	--	T, 50	2,400	--	I	L, Obs.
T. 36 S., R. 12 E.																	
2bbd	L. L. Crawford	Dr	1963	1,127	16	150	X	"White rock"	4,349	+6.7	11-19-70	90	T, 60	2,200	70	I	P 4 hr, L, C.
2cab	Lloyd Crawford	Dr	1969	--	8	--	--	--	4,329	+5	do	90	--	100	--	S, I	
3bad	Gene Plemons	Dr	1954	909	16	100	X	Sand and lava rock	4,315	F	4-16-70	85	--	200	--	I	FT 1954, L.
4ddc	do	Dr	1954	612	8	280	X	Black sand and pumice	4,350	F	do	87	--	650	--	H, I	FT 1960, L, C.
5ddd	P. H. Fairclo	Dr	1954	970	8	120?	X	--	4,339	F	do	95	N	--	--	H,I,S	

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
SPRAGUE RIVER VALLEY--Continued																	
T. 36 S., R. 12 E.--Continued																	
6cbd	Ernest Firsick	Dr	1967	950	16	534	P 460-520, X	Lava and cinders	4,322	F	4-16-70	110	T, 100	700	--	I	FT 1967, L.
7aaa	D. Crume	Dr	--	--	6	--	--	--	4,313	F	do	90	N	25	--	H,I,S	
8abb	P. H. Fairclo	Dr	1940	600	12	--	--	--	4,316	F	do	170	T, 40	10	--	S	FT (est.) 1954.
8bbb	Byron Ross	Dr	1957	960	8	106	X	Lava, sand	4,312	F	5-15-70	100	N	900	--	I	FT 1957, L.
9baa	L. L. Crawford	Dr	1956	730	8	80	X	Black sand	4,305	F	do	90	N	1,350	--	I, S	FT 1956, L.
10bbb	Lewis Mateny	Dr	1962	715	8	40	X	Black sand and pumice	4,315	F	4-16-70	90	--	300	--	I, S	FT 1962, L.
12dccl	Weyerhaeuser	Dr	1958	180	8	115	X	Lava rock	4,330	6.98	4-20-70	--	C, 7½	110	4 in.	U	P 4 hr, L, Obs.
13bd(s)	Medicine Springs	Spring	--	--	--	--	--	Volcanic rock	4,340	--	--	--	--	6,550	--	--	Flow 9-30-70.
14ccb	Beatty Recreation Hall	Dr	1948	--	6	--	--	Sand and gravel	4,345	1.09	4-20-70	--	N	--	--	U	Obs.
14dcc	Mike Deely	Dr	--	450	12	280	--	--	4,330	3.0	4-16-70	75	T, 15	1,700	--	H, I	
15dbd	W. L. McNair	Dr	1960	512	6	160	X	Broken lava rock	4,360	F	do	--	--	700	--	H,I,S	FT 1960, L.
16dcd	Bernard Heffer	Dr	1965	524	12	142	X	Black sand and rock	4,340	F	5-19-70	88	--	1,800	--	H,I,S	FT 1965, L.
22bdb	Homer Delmeter	Dr	1966	300	12	193	X	Hard, broken basalt	4,380	F	5-23-66	82	C, 40	3,500	14	I	P 2 hr, L, C.
22dbd	Dallas Givan	Dr	1968	770	18	80	X	Lava rock	4,395	F	10-17-69	100	N	300	190	S	P ½ hr, L.
23bdb	Edwin Rezendes	Dr	1962	520	12	80	X	Red and black cinders	4,350	8.0	4-16-70	--	T, 30	1,275	72	I	P ½ hr, L.
28adb	Mike Deely	Dr	1961	365	8	11	X	Cinders, sand, and gravel	4,390	21.72	4-20-70	--	J	60	0	S	B, L, Obs.
34aab	do	Dr	1967	520	16	35	X	Broken basalt	4,410	46.0	4-16-70	--	T, 50	1,200	68	I	P 4 hr, L.
34dad	do	Dr	--	--	6?	--	--	--	4,390	18.1	do	200	--	--	--	H	
35caa	do	Dr	1962	660	16	100	X	--	4,380	5.40	do	--	--	--	--	U	
T. 36 S., R. 13 E.																	
22ada	Floyd Martin	Dr	1948	165	6	--	--	Pumice	4,370	44.90	4-16-70	--	C	--	--	H	

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
SPRAGUE RIVER VALLEY--Continued																	
T. 36 S., R. 13 E.--Continued																	
22add	Floyd Martin	Dr	1963	180	16	20	X	Lava and cinders	4,390	63.74	4-16-70	215	T, 75	3,100	105	I	P 8 hr, L.
T. 36 S., R. 14 E.																	
5aaa	Yamsay Land & Cattle Co.	Dr	1965	305	16	240	X	Rock	4,415	86.29	10-14-69	--	--	2,600	8	U	P 2 hr, L.
7aad	Harry O'benchain	Dr	1961	143	18	120	P 40-120, X	Lava and cinders	4,350	28.82	do	--	T, 30	3,500	0	I	P 4 hr, L, Obs.
24cca	Walter Campbell and Henry Gerber	Dr	1944	140	6	--	--	--	4,460	117.58	4-16-70	--	2	--	--	S	
25bcb	D. J. Campbell and H. C. Gerber	Dr	1961	708	18	64	X	"Burnt" lava	4,352	6.00	do	290	T, 60	2,360	97	I	P 4 hr, L, C, Obs.
27ccd	Henry Gerber	--	--	--	6	--	--	--	4,345	9.68	10-14-69	--	C, 1	--	--	H	
27cdc	do	Dr	1956	438	18	80	X	Lava rock	4,345	8.00	4-16-70	255	T, 60	2,724	61	I	P 3½ hr, L, C, Obs.
29ddb	C. P. Merkley	Dr	1968	485	18	24	X	Lava and cinders	4,380	38.50	do	--	T, 100	2,300	108	I	P 3 hr, L.
30bac	do	Dr	1962	376	12	40	X	Lava rock	4,400	77.29	do	--	T, 40	2,350	7	I	P 4 hr, L.
34bdd	Spangler Lumber Co.	Dr	1950	300	12	88	X	Basalt	4,350	3.73	do	--	T, 50	500	91	N	P, L.
34dcc	Bly Water Co.	Dr	1928	204	10	50	X	do	4,360	--	--	--	T, 7½	125	4	P	P 5 hr.
35ddd	Ruth Hall	Dr	1960	400	18	60	X	Lava	4,353	13.9	4-16-70	230	C, 75	--	--	I	L, Obs.
T. 37 S., R. 12 E.																	
3ada	Mike Deely	Dr	1969	470	16	20	X	Lava, sand, and gravel	4,420	45.6	4-16-70	--	T, 50	1,500	88	I	P 4 hr, L.
T. 37 S., R. 14 E.																	
1baa	E. M. Bell	Dr	1967	260	10	34	X	Lava and pumice	4,355	21.5	9-10-67	--	T, 20	1,000	58½	I	P 4 hr, L.
3acc	R. C. Clark	Dr	1968	290	8	96	P 60-80, X	Lava and cinders	4,365	24	6-21-68	230	T	60	0	I	B 1 hr, L.
T. 37 S., R. 15 E.																	
6ddd	Don Nonella	Dr	1968	880	18	105	X	Broken lava	4,375	39.45	4-16-70	--	T, 100	2,500	100	I	P 4 hr, L.
7aba	do	--	--	--	18	--	--	--	4,380	46.76	do	--	S	--	--	H	

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
SWAN LAKE VALLEY																	
T. 37 S., R. 10 E.																	
8bcb	Don Roberts	Dr	--	--	10	--	--	--	4,360	189.8	4-15-70	140	--	--	--	H	
8ccc	do	Dr	1951	281	18	170	X	Cinders, sand, and gravel	4,240	77.2	do	140	T, 100	3,000	2	I	P 3 hr, L, C, Obs.
9dcd	do	Dr	1951	142	16	19	X	Cinders	4,215	45.9	do	100	T, 75	4,750	4	I	P 2 hr, L.
18aca	Paul Golden	Dr	1954	325	16±	--	--	--	4,230	80.1	4-14-70	--	T, 75	--	--	I	L.
18adc	Gardner	Dr	--	120	10	--	--	Gravel	4,218	62.0	do	--	S, 1½	180	--	H, S	
19ada	H. D. Whiteline	Dr	1946	155	6	30	X	Black sandstone and gravel	4,205	22.74	4-23-70	--	P	11½	2	H	P 4 hr, L, Obs.
21aaa	Unknown	--	--	--	6	--	--	--	4,195	70.2	4-15-70	--	P	--	--	U	
21aca	do	--	--	--	13	--	--	Alluvium	4,190	1.75	do	--	N	--	--	U	
21bba	do	Dr	--	49	6	--	--	do	4,195	25.9	do	--	P	--	--	U	
23bab	do	--	--	--	10	--	--	--	4,195	76.1	do	--	P	--	--	U	
28bad	Charles Collman	--	--	--	6	--	--	Alluvium	4,180	2.58	4-14-70	--	P	--	--	U	
29aba	Don Roberts	Dr	--	300	6	--	--	--	4,185	28.4	do	180	P	--	--	U	
29dbb1	do	Dr	1949	146	10	--	--	--	4,188	7.5	do	--	P	--	--	U	Obs.
29dbb2	do	Dr	1949	860	18	20	X	Gravel	4,188	27.1	do	--	P	--	--	U	L, Obs.
30abc	Fred Coleman	Dr	1949	99	16	55	X	Cinders, gravel	4,220	25.4	do	200	T, 40	2,500	--	I	L, C, Obs.
30bda	do	Dr	--	120	12	--	--	--	4,220	46.4	4-15-70	--	T, 7½	--	--	I	
31bcc	Marshall Bros.	Dr	1953	1,800	16	580	X	Chalk and rock	4,210	46.0	do	200	T, 50	900+	--	I	L.
36adc	V. Nevin Cattle Co.	Dr	1951	125	6	--	--	Gravel	4,190	17.3	do	--	P	--	--	U	
T. 38 S., R. 10 E.																	
5bdd	Maude Liskey	--	--	--	--	--	--	Fill?	4,189	36.99	4-18-70	--	S	--	--	S	
5cbc	do	Dr	1957	850	18	39	X	Lava	4,195	87.2	4-14-70	314	T, 100	2,150	90	I	P 4 hr, L, C.
6dbb	Marshall Bros.	Dr	--	400±	8	--	--	--	4,240	67.4	do	--	P	--	--	S	
9bbc1	George Fawver	Dr	1963	280	8	42	X	Basalt, shale	4,187	1.46	4-18-70	--	N	15	10	H	B 1 hr, L.
9bbc2	Delbert Dehlinger	Dr	--	--	16	--	--	--	4,187	.99	do	--	N	--	--	U	

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
SWAN LAKE VALLEY--Continued																	
T. 38 S., R. 10 E.--Continued																	
9cbc1	R & S Ranch	Dr	1949	131	6	25	X	Basalt	4,214	109.9	4-15-70	--	N	85	7	U	P 3 hr, L, Obs.
9cbc2	Delbert Dehlinger	Dr	1958	325	16	193	P 153-185	Lava, cinders, sand	4,195	95.18	4-23-70	235	T, 100	2,400	35	I	P 4 hr, L.
13bbb1	V. Nevin Cattle Co.	Dr	1949	276	16	40	X	Lava, cinders	4,192	76.7	4-15-70	132	T, 75	1,600	19	I	P 3 hr, L, Obs.
13bbb2	do	Dr	--	--	12	--	--	--	4,192	9.4	do	--	--	--	--	U	
15ccb	Klamath County	Dr	--	74	5	50	X	--	4,198	13.39	4-13-70	--	N	--	--	U	
16bbb	Maude Liskey	Dr	1965	295	18	20	X	Red and black lava	4,224	123.43	do	--	T, 100	2,850	8.3	I	P 4 hr, L.
16dcd	do	Dr	1957	225	18	39	X	Lava and cinders	4,225	124.00	do	--	T, 100	2,650	2	I	P 4 hr, L, Obs.
16dda	D. L. House	Dr	1962	460	18	9	X	Broken lava, sand, pumice	4,203	104.73	4-23-70	--	T, 30	1,800	25	I	P 5 hr, L.
22ada	Michael Short	Dr	1955	348	18	100	X	Volcanic rock	4,195	97.62	4-13-70	195	T, 100	3,000	3	I	P 4 hr, L.
22baa	do	Dr	1958?	460	18	100	--	Basalt	4,205	106.53	do	--	S, ½	--	--	H	L, Obs.
23aca	V. Nevin Cattle Co.	Dr	--	250	18	--	--	--	4,220	113.55	do	--	T, 100	--	--	I	
23bdd	Lloyd Goldbek	Dr	1958?	260	18	94	--	Lava, cinders	4,200	102.10	do	185	T, 100	--	--	I	L, Obs.
25aab1	G. C. Mitchell	Dr	1949	524	14	329	X	do	4,190	79.72	4-18-70	--	T, 60	2,050	7	I	P 5 hr, L, Obs.
25aab2	do	Dr	1949	113	6	--	X	Sand, gravel	4,190	11.20	do	377	T, 1½	--	--	H	C.
25dab	V. A. Deyarmie	Dr	1965	834	8	138	X	Lava	4,187	68.45	do	290	T, 25	1,000	9.3	I	P 2 hr, L.
26bac	Maude Liskey	Dr	1949	582	16	16	X	Basalt, cinders	4,240	126.09	4-13-70	--	T, 75	2,165	2.5	I	P, L.
36abb	Richard Dilling	Dr	--	--	6	--	--	--	4,190	35.32	4-24-70	--	--	--	--	H	
36bbb	Maude Liskey	Dr	1958	266	8	32	X	Broken lava	4,235	141.79	4-23-70	--	T, 5	575	2	S	P 4 hr, L.
T. 38 S., R. 11½ E.																	
6cad	V. Nevin Cattle Co.	Dr	1951	224	18	--	X	Basaltic breccia	4,200	89.2	4-15-70	--	T, 100	2,970	2	I	P 4 hr, L, Obs.
7ddd	do	Dr	1950	280	16	--	X	Lava	4,230	94.5	do	--	T, 100	--	--	I	Obs.
20ccb	D. S. Moore	Dr	1967	341	16	150	X	Broken lava	4,300	175.7	do	--	T, 125	2,000	10	I	P 4 hr, L.
29ada	V. Nevin Cattle Co.	Dr	1952	135	16	--	X	Lava, cinders	4,200	97.80	do	--	T, 75	2,660	.7	I	Do.
29dad	Guy Barton	Dr	1948	136	16	60	X	Vesicular lava	4,195	98.2	do	--	T, 50	1,450	4	I	P.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
SWAN LAKE VALLEY--Continued																	
T. 38 S., R. 11½ E.--Continued																	
30cba	V. Nevin Cattle Co.	Dr	1951	281	18	--	X	Cinders, lava	4,210	94.5	4-15-70	--	T, 100	--	--	I	L, Obs.
30dac	D. S. Moore	Dr	1947	175	14	120	P 100-120, X	Cinders, broken lava	4,217	103.0	do	200	T, 30	--	--	I	L, C, Obs.
30ddd	do	Dr	1933?	145	12	--	X	Cinders, lava	4,190	75.70	do	--	T, 50	2,700	7	I	L, Obs.
31bcd	Richard Dilling	Dr	1966	862	12	138	X	Lava and shale	4,187	76.96	10-30-70	--	T, 50	2,700	39	I	P 4 hr, L.
32bdd	Stanley Petersen	Dr	1948	197	16	64	X	Cinders	4,185	72.0	4-14-70	--	T, 50	2,000	13	I	P 10 hr, L; recharge well.
32dcd	do	Dr	1952	298	20	58	X	Lava	4,183	58.68	4-18-70	--	T, 75	3,800	28	I	P 2 hr, L; recharge well.
33dca	do	Dr	1949	212	16	20	X	do	4,230	116.05	do	--	T, 60	1,600	1	I	P, L.
T. 39 S., R. 11½ E.																	
5bca	Stanley Petersen	Dr	1946	260	16	21	X	Basalt	4,210	93.67	11-19-49	--	T, 50	1,800	25	I	P 4 hr, L.
6aca	J. R. Murphy	Dr	1959	505	16	170	X	Lava, broken lava	4,190	81.56	4-18-70	--	T, 75	2,600	28	I	P 4 hr, L; originally drilled in 1949; deepened 42 ft and reconditioned in 1959.
YONNA VALLEY																	
T. 37 S., R. 11½ E.																	
15ccb	L. L. Chapman	Dr	1952	458	17	32	X	Broken lava	4,237	135.48	4-14-70	--	T, 125	--	--	I	L.
22bdb	do	Dr	--	--	6?	--	--	--	4,224	106.7	do	--	S	--	--	H, S	
22dca	do	Dr	--	--	8±	--	--	--	4,256	138.75	do	--	T, 30	--	--	H, I	
34acc	Andrew Bodnar estate	Dr	1960	220±	8	60±	X	--	4,202	98.78	do	--	T	--	--	S	
34dbb	do	Dr	1963	256	18	162	X	Rock and sandstone	4,205	105.67	do	--	T, 75	2,800	3	I	P 4 hr, L.
36add	Don Schreiner	Dr	1953	390	--	--	--	Broken lava, cinders	4,266	154	4-23-70	--	T, 100	2,000	16	I	P 4 hr, L, Obs.
T. 38 S., R. 11 E.																	
5cdd	Leonard Ritter	Dr	1948	200	16	12	X	Lava rocks	4,241	129.9	4-14-70	--	T, 100	1,600	2	I	P 5 min, L.
6cbd	J. P. Colahan	Dr	1962	370	18	6	X	Broken lava	4,198	85.5	do	--	T, 60	2,300	34	I	P 5½ hr, L.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
								YONNA VALLEY--Continued									
								T. 38 S., R. 11 E.--Continued									
6dda	Bernie Jendrzejewski	Dr	1953	194	16	--	X	Basalt	4,217	105.46	4-14-70	--	T, 60	3,200	5	I	P 4 hr.
7bad	Harold Mallory	Dr	1948	586	16	42	X	Broken lava and sandstone	4,198	84.23	4-15-70	--	T, 75	1,400	19	I	L.
7cba	Louis Tofell	Dr	1948	260	12	--	X	Lava and cinders	4,200	86.02	do	--	T, 30	1,000	--	I	Do.
7daa	Weyerhaeuser Co.	Dr	1968	325	16	40	X	Black lava	4,250	138.90	do	172	T, 100	2,800	4	I	P 4 hr, L, C.
7dab	do	Dr	1969	335	6	277	X	Lava	4,254	143.56	4-21-70	165	S, 7½	60	1	H	P 2 hr, L.
8acc	Leonard Ritter	Dr	1968	267	16	114	X	--	4,287	174.81	10-26-70	--	T, 100	2,900	5	I	P.
18bba	Unknown	Dr	--	--	12	100	X	--	4,175	64.10	4-15-70	--	T, 30	2,000	--	I	
19bba	Horsefly Irrigation Dist.	Dr	1967?	206	16	90	X	--	4,178	65.47	4-10-70	--	T, 100	3,700	--	I	
19cbd	Haskins & Co.	Dr	1931?	500±	16	--	--	--	4,143	30.57	4-15-70	--	T, 75	--	--	I	Oil-test well.
31abal	do	Dr	1948	177	16	81	X	Cinders, lava	4,182	66.96	4-21-70	--	T, 30	2,800	3	I	P 4 hr, L.
31ddd	Fred Rueck	Dr	--	227	10	--	--	--	4,143	31.60	4-15-70	450	P	--	--	U	
								T. 38 S., R. 11½ E.									
1baa	Karl Dehlinger	Dr	1965	460	16	460	P 260-460	Cinders and sandstone	4,205	96.35	4-14-70	255	T, 100	--	--	I	L.
1cdb	Grant Brown	Dr	--	90	12±	--	--	--	4,184	69.2	4-18-70	--	J, ½	--	--	S	
2dcb	Jess Angel	Dr	1954	583	18	31	X	Basalt	4,181	69.63	4-10-70	147	T, 40	1,700	5	I	P 24 hr, L, C.
3dbd	J. N. Drew	Dr	--	194	16	20	X	--	4,192	82	4-14-70	--	T, 60	1,800	--	I	
10adb	do	--	--	--	--	--	--	--	4,160	16.95	do	--	S, ½	--	--	H	
10bad	W. N. Drew	Dr	1949	285	6	40	X	--	4,180	32.38	do	--	S	--	--	S	
10cac	G. P. Wu	Dr	1966	821	16	160	X	Chalk and sandstone	4,200	92	7- 6-66	--	T, 150	3,000	29	I	P 4 hr, L.
11ada	Frank Challis	Dr	1948	224	16	20	X	Sandstone and lava	4,157	42.17	4-14-70	200	T, 30	1,700	9	I	L, Obs.
11baa	Jess Angel	Dr	--	404	6	40	X	Lava	4,165	59.98	4-10-70	--	--	--	--	H	
12aba	Grant Brown	Dr	1948	280	16	8	X	Sandstone, gravel, broken lava	4,174	62.70	4-18-70	--	T, 25	1,500	.5	I	P 3 hr, L.
12ccal	Frank Challis	Dr	1942	425	12	18	X	Lava rock	4,153	39.58	4-21-70	180	T, 20	1,300	6	I	P ½ hr, L, C.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
								YONNA VALLEY--Continued									
								T. 38 S., R. 11½ E.--Continued									
12cca2	Frank Challis	Dr	1948	389	6	22	X	Basalt	4,152	39.48	9-23-70	--	J, 4	--	--	H	
12cca3	do	Dr	1942	150	12	5	X	Cinders and lava	4,161	45.57	4-14-70	--	N	500	73	U	L, Obs.
12cdd	do	Dr	1950	170	20	--	X	Lava	4,162	46.50	4-15-70	175	T, 40	2,200	3	I	P 2 hr.
13aca	R. M. Robertson	Dr	1948	183	16	40±	X	Lava and sandstone	4,158	43.45	4-23-70	--	T, 30	1,600	6½	I	L, Obs.
13ccc	Herman Pendegraft	Dr	1938	600	20	16	X	Chalk	4,152	19.17	4-14-70	--	N	--	--	U	Obs.
13dca	do	Dr	1947	475	16	16	X	Lava and cinders	4,151	34.48	do	--	T, 30	--	--	I	L.
15bdd	George McCollum	Dr	1951	520	18	100	X	do	4,210	100.59	do	--	T, 75	3,000	1½	I	P 24 hr, L.
15dda	do	Dr	1948	495	12	--	X	do	4,185	77.81	do	159	T, 75	1,200	5	I	P, L, C, Obs.
22acd	Cliff Sewald	Dr	1938	275	6	20	X	Black sand	4,220	106.69	10-27-70	--	S	--	--	S	L.
22dba	do	Dr	1970	670	12	21	X	Cinders	4,270	159.86	4-21-70	--	T	500	143	I	P 24 hr, L.
23bdc	do	Dr	1946	286	12	12	X	Lava and black sand	4,160	53.54	4-14-70	--	T	1,600	17	U	P, L.
24cbb1	Virgil Schmoe	Dr	1949	996	20	--	X	Lava and cinders	4,162	52.02	do	--	T, 50	2,000	26	I	P 4 hr, L.
24cbb2	do	Dr	--	--	6	--	--	--	4,162	20.15	do	--	P	--	--	U	
24cdc	Haskins & Co.	Dr	1949	984	18	40	X	Broken lava	4,151	39.04	do	--	T, 60	2,100	42	I	L, P.
25cbb	Richard Hoeffler	Dr	--	276	18	40±	X	Rock	4,146	32.70	4-21-70	--	T, 30	--	--	I	Obs.
26ada	Hoeffler Bros.	Dr	1948	191	20	20	X	Broken lava and cinders	4,155	46.09	4-14-70	--	T, 75	3,600	--	I	L.
34bcb	Ernest Wiseman	Dr	--	57?	10	--	--	--	4,135	18.10	4-15-70	285	J, ¼	--	--	S, H	
34bda	Elizabeth Bell	Dr	1963	296	6	63	X	Chalk and gravel	4,130	6.11	5-18-70	--	J, ½	50	0	H	B 3 hr, L.
34cbd	Ernest Wiseman	Dr	1969	135	18	21	X	Broken lava	4,133	16.86	4-23-70	225	T, 25	5,000	13	I	P 4 hr, L.
34cdd	L. J. Horton	Dr	1949	57	16	--	X	Broken lava and cinders	4,120	5.50	4-15-70	--	T, 25	3,000	--	I	L.
35dbc	Robert Walker	Dr	--	--	12	--	--	--	4,140	25.85	do	--	T, 25	--	--	I	
36bbc	Horsefly Irrigation Dist.	Dr	1935±	550	24	30	X	--	4,157	46.02	4-10-70	180	N	4,500	--	I	Oil-test well.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
								YONNA VALLEY--Continued									
								T. 39 S., R. 11 E.									
5cac	Stan Masten	Dr	1943	316	6	68	X	Lava and cinders	4,140	28.64	5-15-70	--	J, 1/3	--	--	H	L.
5dcb	Garry Freitag	Dr	1946	157	6	153	X	do	4,148	34.71	do	--	J, ½	--	--	S, H	L.
7aac	Lloyd Hankins	Dr	1967	203	18	80	X	--	4,158	46.57	10-30-70	--	T, 75	3,000	97	I	
7cdc	Mrs. M. L. Hankins	Dr	1949?	150	6	20	X	--	4,121	7.62	4-24-70	320	T	--	--	H	
7ddd	La Vern Hankins	Dr	1949	125	6	--	--	--	4,115	3.70	do	--	N	--	--	U	
9dcb	Walt Casebeer	Dr	1920	--	6	--	--	--	4,116	5.77	do	--	--	--	--	U	
9dcd	R. T. Davison	Dr	--	283	6	40	X	Lava	4,113	1.71	5-15-70	185	J, 1/3	--	--	H	
16dad	Mary Schmitt	Dr	--	48	6	--	--	Basalt	4,143	32.27	do	--	J, 3/4	--	--	S, H	
17aca	Lloyd Hankins	Dr	--	130	6	--	--	--	4,120	3.35	4-24-70	--	S	--	--	H	
18dca	Hankins Farms	Dr	--	515	6	--	--	--	4,119	2.93	do	--	N	--	--	U	
18ddb	Roy Whitlach	--	--	--	--	--	--	--	4,118	1.13	do	--	--	--	--	S, H	
20aad	Robert Woods	Dr	1949	585	16	20	--	Broken basalt	4,182	62.54	4-10-70	--	T, 50	1,050	67	I	P 3 hr, Obs.
20bdd	Pacific Gas Transmission Co.	Dr	1967	215	6	19	X	Basalt, lava	4,132	16.10	5-15-70	--	S, 1	75	189	H	A, L.
20cda	R. T. Williams	--	--	--	--	--	--	--	4,139	21.34	10- 6-69	--	S, 1	--	--	S	
21add	Cliff Sewald	Dr	1946?	400	16	100	X	--	4,160	43.66	4-10-70	--	T, 60	1,000	90	I	P 336 hr.
22bba1	Cecil Hunt	Dr	--	--	8	--	--	--	4,164	50.61	4-15-70	--	T, 2	--	--	S	
22bba2	do	Dr	1966	110	16	18	X	Rock	4,164	50.47	do	--	N	1,150	43	U	P 4 hr, L, Obs.
								T. 39 S., R. 11½ E.									
1dda	R. C. Brown	Dr	1968	209	6	125	X	Lava	4,128	16.97	4-20-70	600	J, ½	--	--	U	
2dcc	L. J. Horton	Dr	1955	763	20	27	X	Lava rock and gravel	4,105	F	4-15-70	145	T, 15	5,500	55	H	P, L.
3abc	Robert Horton	Dr	--	102	7	--	--	--	4,115	4.14	do	--	--	--	--	U	Obs.
10abc	L. J. Horton	Dr	1948	52	16	30	X	Lava and cinders	4,110	F	do	175	T, 15	2,500	5	H,S,I	P, L, C.
10acc	do	Dr	--	--	--	--	--	--	--	--	--	--	T, 30	--	--	I	
12ada	E. A. Bergdorf	Dr	1930	217	6	42	X	Broken lava	4,128	19.34	4-23-70	--	J, 3/4	--	--	S, H	L.
13dab	Virgil Schmoe	Dr	1968	395	16	38	X	Lava	4,131	20	5- 6-68	--	T, 200	1,900	103	I	P 6 hr, L.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
								POE VALLEY									
								T. 39 S., R. 10 E.									
12ccb	G. E. Stevenson	Dr	1936	420	5	--	--	Diatomite	4,104	5.30	4-22-70	--	J, 1/3	--	--	H	
13bbb	Klamath County Park Comm.	Dr	1964	758	6	40	X	Lava	4,095	F	9- 2-70	1,100	N	20	--	H	FT (est.) 1964, L.
13dcc	R. E. High	Dr	--	120	8	--	--	Basalt	4,129	28.92	4-15-70	--	J, 1½	--	--	H, S	
14cad	do	Dr	--	720	--	--	--	do	4,110	1.95	do	--	J, 1	--	--	H, S	Originally flowed.
								T. 39 S., R. 11 E.									
30acd	Mrs. Sarah Donart	Dr	--	275	5	--	--	--	4,115	F	4-21-70	--	T, 7½	--	--	H,S,I	
31bdb	RSI Ranch	Dr	--	96?	6	---	--	--	4,140	14.44	4-10-70	--	S, 1	--	--	H, S	
								T. 39 S., R. 11½ E.									
18dbd	John Marshall	--	--	68	--	--	--	--	4,149	46.84	4-22-70	--	S	--	--	H, S	
20bbb	J. R. Chapman	Dg	--	--	36±	--	--	--	4,120	13.13	do	--	N	--	--	U	
20dab	Mrs. Z. E. Sullivan	Dr	--	250	6	--	--	--	4,110	12.14	do	--	J, 1/3	--	--	H, S	
22bcb	Masten Dairy	Dr	1970	164	10	144	X	Lava	4,165	85	4-23-70	--	T, 15	1,000	8	I, S	P 4 hr, L.
22cbb	do	Dr	1958	185	6	79	X	do	4,135	32	10-14-58	--	T, 3	100	68	H	P 2 hr, L.
22dab	P. T. Hatchett	Dr	1952	922	12	--	X	Basalt, lava	4,225	103.32	4- 9-70	191	T, 40	--	--	I	L, C.
22dad	do	Dr	1959	212	8	23	X	do	4,170	67	9-28-59	--	S	10	60	H, S	B 1 hr, L.
22dbd	Gerald Longhofer	Dr	1964	129	6	76	X	Lava	4,180	93.14	4-18-70	--	S	40	0	H	Do.
22ddb	B. E. Smith	Dr	--	--	8	--	--	--	4,155	55.43	4-10-70	--	S, 1	--	--	H, S	
25cba	do	--	--	--	--	--	--	--	4,145	44.73	do	--	--	--	--	H	
26acd	do	Dr	--	142?	12	--	X	--	4,158	58.06	4- 9-70	--	T, 3	--	--	H, S	
28bba	Richard Spielman	Dr	--	240	6	--	X	Basalt	4,103	4.58	4-15-70	--	J, 1½	--	--	H, S	
28dcc	Unknown	Dg	--	35	60	--	--	--	4,114	4.38	do	--	N	--	--	U	
28ddd	B. E. Smith	Dr	--	460	6	60	X	Chalk	4,105	12.50	do	--	J, 1	--	--	H, S	Obs.
29abc	Richard Spielman	Dr	--	344	6	--	X	Basalt	4,121	25.03	do	--	S, 3	--	--	H, S	
29cbc	do	Dg	--	100	13	--	--	Chalk	4,173	79.0	do	--	S, 1	--	--	S	

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
POE VALLEY--Continued																	
T. 39 S., R. 11½ E.--Continued																	
29cdd	Thye DeHoop	Dr	--	--	--	--	--	--	4,170	39.28	4-15-70	--	S, ½	--	--	S	
30aab	Taylor High	Dr	1943	62	7	52	X	Basalt	4,114	14.94	do	--	J, 1	--	--	H	L.
33ddd	R. R. Rodgers	Dr	--	300+	6	--	--	--	4,106	10.50	4-22-70	--	C, ½	--	--	S	
34cdc	Mrs. Pauline Roberts	Dr	1960	510	8	33	X	Sand and gravel	4,105	14	1960	--	--	6	46	H	P 1 hr, L.
35dac	B. E. Smith	Dr	--	--	10	--	--	--	4,110	9.48	4-22-70	--	J, 1/3	--	--	H	
T. 40 S., R. 11 E.																	
1aaa	W. E. Freuer	Dr	1965	344	14	20	X	Basalt	4,158	F	4-15-70	--	T, 30	1,750	100	S, I	P 3 hr, L, C. Drilled to 240 ft in 1953.
1aad	Bedfield Cemetery	Dr	1953	83	8	--	--	Sandstone, conglomerate	4,170	20.27	10-29-70	--	J, 1	--	--	I	L.
1abd	George Rajnus	Dr	1965	177	6	18	X	Blue shale	4,160	15.70	4-10-70	--	N	10	62	H	B 1 hr, L.
1caa	William Rajnus	Dr	1966	170	6	19	X	Shale	4,142	6.76	do	--	S	11	19	H	Do.
2bad	G. B. Bowman, Jr.	Dr	--	85	6	--	--	--	4,116	9.27	4-22-70	--	J, 1/3	--	--	H	
3aaa	Melvin Feigi	Dr	1942	960	8	62	X	Shale	4,110	F	do	273	C, 1	--	--	H, S	L, C.
4bba1	Dale Bebber	Dr	--	--	6	--	--	--	4,162	30.35	4-15-70	--	S	--	--	S	
4bba2	do	Dr	1960	682	8	26	X	Basalt, black sand	4,175	59	1-25-60	--	S	23	55	H	B 1 hr, L.
5aaa	Robert Konaston	Dr	--	--	7	--	--	--	4,170	5.99	4-22-70	--	S	--	--	S	
11bad	A. W. Schaupp	Dr	1952	992	8	40	X	Basalt	4,147	19.20	4-23-70	--	T, 5	70	80	I, S	L, Obs.
12aad	W. J. Rajnus, Jr.	Dr	1964	689	18	21	X	Broken lava	4,152	F	4-18-70	215	T, 100	600	--	S, I	FT 1964, L.
13bcd	Carl Rajnus	Dr	1956?	736	16	--	--	Lava, cinders	4,230	137.40	4- 9-70	--	T, 40	300	54	I	P 4 hr, L.
13bda1	do	Dr	1956	500	12	272	X	Lava, cinders, gravel	4,195	112.44	do	294	T, 60	1,200	40	I	P 3 hr, L, C.
13bda2	do	Dr	--	245	--	--	--	Lava	4,204	121.32	do	--	S	--	--	H	L, Obs.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
								POE VALLEY--Continued									
								T. 40 S., R. 12 E.									
7bad	L. D. Cogley	Dr	1963	141	6	41	X	Basalt	4,200	44.26	4-10-70	--	S, 1½	30	0	H	B 1 hr, L.
7bdb	do	Dr	1965	702	16	20	X	Lava, shale	4,190	75	do	--	T, 100	950	120	I	P 4 hr, L.
18aad	W. J. Rajnus, Jr.	Dr	1950	550	16	--	X	Basalt, cinders	4,175	12.78	do	250	T, 60	1,300	70	I	P, L.
18bbc	do	Dr	1947	193	6	6	X	Black sand	4,174	15.26	do	--	J, ½	--	--	H	L.
								LANGELL VALLEY									
								T. 39 S., R. 11 E.									
2dca	D. J. Horsley	Dr	1967	296	16	145	X	Rock	4,180	70.29	4-14-70	--	T, 100	1,350	27	I	P 4 hr, L.
4dac	James Heseltine	Dr	1949	400	6	100	X	do	4,170	58.78	5-18-70	--	T, 2	20	15	H, S	
10caa	George Franklin	Dr	1948	211	6	40	X	Broken lava	4,113	.99	5-19-70	--	J, 1/3	--	--	H	
10ccb	Bob Hartley	Dr	1946	166	6	40	X	Lava	4,110	2.02	4-24-70	--	J, ½	300	1½	H	P, L.
10cda(s)	Bonanza Springs	Spring	--	--	--	--	--	Basalt	4,107	--	--	--	--	--	--	--	C.
10dcb	Cecil Hunt	Dr	--	--	6	--	--	--	4,110	1.32	4-14-70	--	C, 7½	--	--	I	
10ddd	Lost River Cemetery	Dr	--	238	12	--	X	--	4,125	12.67	5-19-70	--	15	--	--	I	Obs.
12acc	D. F. Driscoll	Dr	--	180	6	--	X	Basalt	4,200	88.29	5-15-70	--	S	--	--	H	
12bdc	do	Dr	--	230	6	--	--	do	4,160	10.14	do	--	--	--	--	U	
12caa	George Mullanex	--	--	120	--	--	--	--	4,165	8.72	5-19-70	--	--	--	--	H, S	
12dba	Art Davina	Dr	1965	329	12	160	X	Lava rock	4,240	135.12	4-14-70	--	S	100	0	H	B 2 hr, L.
13daa	Harold Gravett	Dr	--	243	6	--	--	Basalt	4,160	40.02	5-19-70	--	N	--	--	U	
14abb	Donald Ralph	Dr	1948	170	6	--	--	--	4,120	8.24	5-15-70	--	J, ½	--	--	H	
14bdb	Pete Janelie	Dr	--	400	6	--	--	--	4,160	49.83	do	--	S, 3/4	--	--	H, S	
24abc1	Dennis Babson	Dr	--	576	12	--	--	--	4,190	13.97	4-15-70	--	S, 1½	--	--	H	
24abc2	do	Dr	--	120	6	--	--	--	4,190	11.92	do	--	--	--	--	U	
26abd1	H. D. Knox	Dr	1964	1,225	16	50	P 50-62, X	Broken basalt	4,225	5.76	4-24-70	--	15	320	168	I	P 2 hr, L, Obs.
26abd2	do	--	--	--	6	--	--	--	4,227	5.50	4-15-70	--	H	--	--	U	
26aca	do	Dr	1966	470	12	20	X	Sand	4,225	4.03	do	--	T, 20	175	207	I	P 6 hr, L.

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
LANGELL VALLEY--Continued																	
T. 39 S., R. 11 E.--Continued																	
26dbb	J. C. Stevenson, Jr.	Dr	1962	488	8	20	X	Lava and sandstone	4,255	31.27	4-15-70	--	N	200	120	U	P 6 hr, L, Obs.
36abb	do	Dr	1964	361	20	20	X	Lava	4,240	70.07	do	--	J	50	90	U	P 1 hr, L.
T. 39 S., R. 12 E.																	
7ada	Harold Williams	Dr	1968	--	6	--	--	--	4,170	65.00	5-19-70	340	S	--	--	H, S	Water contains excessive iron.
7add	do	Dr	--	125	--	--	--	Basalt	4,150	24.77	do	220	S, 2	--	--	H, S	
7cba	Rock Creek Ranch	Dr	1951	257	16	20	X	Lava rock	4,200	86.22	4-14-70	210	T, 30	1,050	16	I	P 4 hr, L.
7dad	Gary Williams	Dr	1966	160?	8	--	--	--	4,150	33.47	5-19-70	350	--	--	--	H	
7dba	do	Dr	--	80	6	--	--	--	4,140	25.42	do	290	J, 3/4	--	--	H, S	
7dcb	Haley	Dr	--	100	6	--	--	--	4,140	5.56	4-14-70	--	S, 3/4	--	--	S	
16cac	Harold Williams	Dr	1961	730	12	272	X	Cinders and lava	4,190	92.40	do	--	T, 75	2,100	63	I	P 4 hr, L.
17aab	do	Dr	1964	708	16	130	X	Broken lava	4,190	88.93	do	171	T, 100	3,000	19	I	P 4 hr, L, C.
19abc1	Dennis Babson	Dr	1941	4,365	18	--	--	--	4,130	--	--	--	N	--	--	U	Oil-test well.
19abc2	do	Dr	--	--	6	--	--	--	4,130	10.68	4-15-70	--	N	--	--	U	
20cdd	John Yparrea	Dr	--	135	--	--	--	Basalt	4,125	2.47	5-19-70	--	J, ½	--	--	H, S	
21bdb	R. E. Evatt	Dr	1969	440	16	--	X	Cinders	4,235	123.56	4-14-70	274	T, 100	2,600	7	I	P 4 hr, L, C.
21dcd	R. G. Schafle	Dr	1924	170	--	--	--	Sandstone, basalt	4,190	63.27	5-19-70	--	S, 3/4	--	--	H, S	
26cba	Bob Parson	Dr	--	118	6	--	--	Basalt	4,215	52.65	5-20-70	235	S, 1½	--	--	H, S	
28ccd	Eva Adams	Dr	--	71	6	--	--	--	4,170	30.08	do	--	J, 1	--	--	H, S	
29aca	Jack Lomkin	Dr	--	45	6	--	--	Basalt, cinders	4,140	19.81	do	--	J, 1	--	--	H, S	
29dbc	Eva Adams	Dr	--	88	6	--	X	Basalt	4,140	22.21	4-15-70	--	J, ½	--	--	H	Obs.
31aaa	Douglas Walls	Dr	--	160	6	--	--	--	4,160	6.31	5-21-70	--	J, ½	--	--	H, S	
31cac	Grace Deerborn	--	--	200?	--	--	--	--	4,160	7.55	do	--	J, 3/4	--	--	H, S	
33aab	Harris	Dr	--	68	8	--	--	Rock	4,140	9.23	5-19-70	--	J, ½	--	--	H	
33acb	Eli Rosandich	Dr	--	62	6	--	--	--	4,140	7.70	5-20-70	--	J, ½	--	--	H, S	

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
LANGELL VALLEY--Continued																	
T. 39 S., R. 12 E.--Continued																	
34bac	Lawrence Horton	Dr	--	480	6	--	--	--	4,145	17.81	5-20-70	--	S, 1	--	--	H, S	Water tastes bad.
35add	Cummings	Dr	--	360	6	--	--	Basalt	4,180	38.09	4-15-70	204	J, ½	--	--	H, S	C, Obs.
35ccc	L. F. Nichols	--	--	--	--	--	--	--	4,179	2.96	5-20-70	--	J, 1/3	--	--	H	
35cdc	Louis Randle	Dr	--	200	6	--	--	--	4,185	29.32	5-22-70	--	S, 3/4	--	--	H, S	
35ddc	Mrs. Hitson	Dr	--	140	6	--	--	--	4,148	7.47	5-20-70	--	J, 1	--	--	H, S	
T. 39 S., T. 13 E.																	
29bad1	Luther Noble	--	--	350±	18	--	--	--	4,400	57.72	4-15-70	--	--	--	--	U	
29bad2	do	Dr	--	--	8	--	--	--	4,398	58.67	do	--	T, 50	--	--	I	
29cdb	E. H. Kent	Dr	1970	719	8	19	X	Shale and lava	4,350	8.04	11- 5-70	--	T, 25	525	144	I	P 4 hr, L.
30dcd	M. D. Settle	Dr	1948	280	16	--	--	Broken rock	4,310	F	4-15-70	200	S	230	45	H, S	P, L.
31ccc	Louis Randle	Dr	--	124	6	--	--	Basalt	4,175	1.30	5-20-70	--	J, ½	--	--	H	
31dba	E. H. Kent	Dr	--	110	6	20	X	do	4,258	17.80	do	--	J, 1	--	--	H, S	
T. 40 S., R. 13 E.																	
2abb	Tommy Seater	Dr	--	120	8	--	--	Basalt?	4,150	.90	5-20-70	--	S, 2	--	--	H	
2bda	James Lane	Dr	--	160	12	--	--	do	4,170	.90	do	--	J, 2	--	--	H	
3aad	John Harris	Dg	--	62	48	--	--	do	4,178	11.06	do	--	J, 3/4	--	--	H, S	
3ada	do	Dr	--	62	4	--	--	do	4,173	6.20	do	--	P	--	--	H	
4bcb	Art Monroe	Dr	--	68	8	--	--	do	4,150	F	5-21-70	315	J, ½	--	--	H	
5aad	Art Strue	Dr	--	30	6	--	--	do	4,171	21.51	5-20-70	--	J, ½	--	--	H, S	
6abc	Robert Young	Dr	1922	45	--	--	--	do	4,175	10.46	5-21-70	--	J, ½	--	--	H	
6bac	M. W. Deerborn	Dr	--	--	8	--	--	--	4,230	65.03	4-15-70	--	N	--	--	U	
9aab	Art Monroe	Dr	--	--	6	--	--	--	4,158	9.87	5-21-70	--	J, 3/4	--	--	H	
9acb	M. W. Deerborn	Dr	--	150	8	--	--	--	4,200	10.39	do	--	T, ½	--	--	H, S	
10cab	Jacobsen	Dr	--	190	6	--	--	--	4,150	4.12	do	--	C, 3/4	--	--	H, S	

Table 9.--Records of selected wells in the Klamath Basin--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Type of pump and hp	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
LANGELL VALLEY--Continued																	
T. 40 S., R. 13 E.--Continued																	
13ddd	R. W. Welch	Dr	1965	102	6	50	X	Sand	4,137	F	11- 5-70	212	--	27	27	H	B 1 hr, L, C; flows 3-5 gpm.
23dad	Kayhill	Dr	--	107	6	--	--	Alluvium	4,130	3.56	5-21-70	--	T, 1	--	--	H	
24cbc	do	Dr	--	75	7	--	--	do	4,130	3.70	do	--	P	--	--	H	
T. 40 S., R. 14 E.																	
6cba	G. Keady	Dr	--	80	6	--	--	--	4,160	6.75	5-22-70	--	J, ½	--	--	H, S	
6dac	A. A. Mitchell	Dr	--	200	6	--	--	Basalt	4,235	60.15	do	--	P	--	--	U	
6dba	Hayden Drewett	Dr	--	400	12	--	--	do	4,220	46.60	do	--	T, ½	--	--	H, S	
7dab	Wilham Gardner	Dr	1966	81	6	19	X	Basalt and sandstone	4,165	21.58	5-20-70	--	--	6	28½	H	B 1 hr, L.
16aba	Charles and Silas Kilgore	Dr	1962	425	12	365	X	Lava and sand	4,320	176.5	4-17-70	203	T, 100	1,750	37	I	P 5 hr, L, C.
18cbc	Lloyd Gift	Dr	--	100	5	--	--	Alluvium	4,135	F	5-21-70	--	J, ½	10	--	U	Estimate flow to be 5-7 gpm.
19aab	Norman Jacob	Dr	1965	146	6	23	X	Lava and sandstone	4,168	25.07	do	286	S	29	0	H	B 1 hr, L, C.
19abb	Louis Randall	Dr	--	100	6	--	--	--	4,144	5.47	5-22-70	--	J, ½	--	--	H	
19bba	Beebe Ranch	Dr	--	--	6	--	--	--	4,142	3.48	5-21-70	--	J, ½	--	--	H, S	
29bbc	Norman Jacobs	Dr	--	100	6	--	--	Basalt	4,165	18.47	5-22-70	--	J, 3/4	--	--	H, S	
29dcb	George Ferhlund	Dr	--	50	6	--	--	--	4,162	19.82	do	--	J, 3/4	--	--	H, S	
32ddc	Fred Ferhlund	Dr	--	255	12	--	--	Basalt	4,142	5.82	do	--	--	--	--	H, S	
T. 41 S., R. 13 E.																	
1cbc	Frank Grohs	Dr	1959	43	6	10	X	Sand and gravel	4,140	2.85	5-22-70	--	--	20	6	H, S	B 1 hr, L.
12caa	Loveness Lumber Co.	Dr	--	--	6	--	--	--	4,140	2.26	5-21-70	--	J, ½	--	--	S	
13dac	Eric McRenolds	Dr	--	20	6	--	--	--	4,160	10.36	do	--	P	--	--	H	
13dbb	John Hellekson	Dr	1959	75	6	50	P 50-73	Sand and gravel	4,160	8.31	do	--	S, ½	40	12	H	B 1 hr, L.
T. 41 S., R. 14 E.																	
5acc	Charles Kilgore	Dr	1947	150	6	--	--	Basalt	4,144	8.50	11- 4-70	--	C	--	--	H, S	
8cca	do	Dr	--	210	16	8	X	do	4,165	16.51	4-15-70	--	T, 75	1,350	--	I	L, Obs.

Table 10.--Drillers' logs of representative wells

KLAMATH MARSH AREA

28S/8E-5dac. State of Oregon. Altitude 4,710 ft. Drilled by A. M. Jannsen Drilling Co., 1962. Casing: 6-in. diam to 388 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Pumice, pink	16	16
Pumice, pea-sized	22	38
Gravel, cemented	52	90
Gravel, cemented, water-bearing (3 gpm)	68	158
Gravel, loose	7	165
Sand and gravel, loose, water-bearing (5 gpm)	68	233
Sand, loose, and heaving, water-bearing (5 gpm)	32	265
Sand and gravel, cemented	20	285
Pumice, pea-sized, water-bearing (6 gpm)	2	287
Sand, hard	16	303
Sand, heaving	42	345
Cinders, lava, and broken rock	42	387
Pumice, pea-sized, white, water-bearing	5	392

28S/8E-17ccc. Chemult Gun Club. Altitude 4,645 ft. Drilled by A. M. Jannsen Drilling Co., 1960. Casing: 6-in. diam to 100 ft

Materials	Thickness (feet)	Depth (feet)
Pumice	92	92
Gravel, cemented	8	100

28S/8E-17dbd. Boise Cascade Corp. Altitude 4,665 ft. Drilled by A. M. Jannsen Drilling Co., 1958. Casing: 12-in. diam to 146 ft; perforated 103-146 ft

Materials	Thickness (feet)	Depth (feet)
Pumice	78	78
Rock, decomposed, with clay layers; water-bearing 101-146 ft	68	146

28S/8E-19adc. Alvin Babcock. Altitude 4,640 ft. Drilled by Powell Well Drilling, 1968. Casing: 6-in. diam to 126 ft; perforated 96-126 ft

Materials	Thickness (feet)	Depth (feet)
Soil and pumice	3	3
Pumice, brown	7	10
Pumice, gray	20	30
Pumice, white, pea-sized	13	43
Pumice, brown, and gravel	25	68
Gravel, cemented	17	85
Gravel, water-bearing	41	126

28S/8E-20bbb. I.E. Erickson. Altitude 4,643 ft. Drilled by Powell Well Drilling, 1968. Casing: 6-in. diam to 120 ft; perforated 90-120 ft

Materials	Thickness (feet)	Depth (feet)
Pumice and soil	3	3
Pumice, pink	9	12
Pumice, gray	28	40
Pumice, white, pea-sized	23	63
Pumice, gray, and gravel	15	78
Gravel, cemented	9	87
Gravel, water-bearing	31	118
Clay, red	10	128
Clay, yellowish-brown	12	140

28S/8E-20bbc. E. E. Hatfield. Altitude 4,640 ft. Drilled by Powell Well Drilling, 1969. Casing: 6-in. diam to 135 ft; perforated 105-135 ft

Materials	Thickness (feet)	Depth (feet)
Pumice and soil	1	1
Pumice, pink, with pumice boulders	27	28
Pumice, sand-sized	11	39
Pumice, white	11	50
Pumice, white, pea-sized	36	86
Gravel, cemented	12	98
Gravel, water-bearing	42	140

28S/8E-20bcc. W. H. Fletcher. Altitude 4,637 ft. Drilled by Richard Akin Well Drilling; date unknown. Casing: 6-in. diam to 90 ft; perforated at unknown depth

Materials	Thickness (feet)	Depth (feet)
Pumice	16	16
Sandstone	74	90
Sand and gravel	17	107

29S/7E-1ddd1. Pacific Gas Transmission. Altitude 4,610 ft. Drilled by unknown driller, 1961. Casing: 6-in. diam to 197 ft; perforated 140-180 ft

Materials	Thickness (feet)	Depth (feet)
Pumice	50	50
Basalt, hard	10	60
Basalt, broken	45	105
Pumice	10	115
Basalt, broken	60	175
Sand, black, water-bearing	13	188
Basalt, water-bearing	9	197

29S/7E-1ddd2. Pacific Gas Transmission. Altitude 4,609 ft. Drilled by Dick Akins Well Drilling, 1965. Casing: 10-in. diam to 22 ft, 8-in. diam 20-199 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Pumice	56	56
Basalt, shattered	7	63
Pumice	25	88
Pumice, sand, and gravel	38	126
Clay, yellow, and sand and gravel	67	193
Basalt, gray, shattered	5	198
Basalt, gray, hard	27	225

29S/7E-12aaa. C. P. Petty. Altitude 4,610 ft. Drilled by Roy W. Powell, 1965. Casing: 6-in. diam to 135 ft; perforated 70-130 ft

Materials	Thickness (feet)	Depth (feet)
Pumice	56	56
Shale, gray, hard	17	73
Sand, water-bearing	62	135

29S/8E-7bbb. W. E. Ingalls. Altitude 4,612 ft. Drilled by Mathers & Son, 1962. Casing: 6-in. diam to 78 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Pumice, yellow	4	4
Pumice, brown, coarse, crumbly	66	70
Clay, gray, hard, fine	8	78
Sand, medium, and fine gravel	12	90

29S/8E-7dda. Southern Pacific Transportation Co. Altitude 4,648 ft. Drilled by E. V. Enloe, 1926. Casing: 8-in. diam to 64 ft

Materials	Thickness (feet)	Depth (feet)
Pumice	35	35
Sand, black, dry	8	43
Pumice, white	10	53
Clay, brown	9	62
Basalt, blue	24	86
Sandstone, white	20	106
Basalt, honeycombed, water-bearing	22	128

29S/8E-7ddd. Boise Cascade Corp. Altitude 4,645 ft. Drilled by Ken Hartley Well Drilling, 1967. Casing: 12-in. diam to 127 ft; perforated 67-127 ft

Materials	Thickness (feet)	Depth (feet)
Pumice	20	20
Volcanic-rock conglomerate	23	43
Pumice	16	59
Boulders, brown (conglomerate)	11	70
Basalt boulders, blue	41	111
Basalt boulders and red lava rock	14	125
Basalt boulders, dense	6	131

Table 10.--Drillers' logs of representative wells--Continued

KLAMATH MARSH AREA--Continued

29S/9E-32dcc. U.S. National Bank Indian Trust. Altitude 4,517 ft. Drilled by E. E. Storey Well Drilling, 1961. Casing: 8-in. diam to 268 ft; perforated 148-168 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Pumice and clay	23	25
Sand, fine	18	43
Sand and clay	27	70
Pumice and sand	5	75
Sand	5	80
Sand, heaving	10	90
Clay	15	105
Sand	35	140
Clay, black	40	180
Sand and pumice	30	210
Cinders and sand	20	230
Clay, black	20	250
Clay, green	64	314
Lava, black	41	355

30S/8E-13abc. Crown Zellerbach. Altitude 4,550 ft. Drilled by Powell Well Drilling, 1964. Casing: 6-in. diam to 42 ft; perforated 30-42 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Pumice, yellow, hard	22	24
Sandstone	13	37
Lava, red	29	66
Gravel, clean	5	71

30S/8E-13ccb. C. C. Pinneo. Altitude 302 ft. Drilled by S. M. Munnerlyn, 1957. Casing: 6-in. diam to 302 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	7	7
Clay, yellow, and gravel	23	30
Gravel, water-bearing	3	33
Clay, yellow	5	38
Rock, gray	79	117
Gravel, water-bearing	3	120
Clay, blue	60	180
Rock, gray	5	185
Clay, blue	70	255
Sand and gravel	45	300
Clay, blue	29	329
Quicksand, black	--	--

30S/8E-28acb. H. W. Tompkins. Altitude 4,542 ft. Drilled by Charles E. Hartley, 1956. Casing: 6-in. diam to 86 ft; perforated 46-80 ft

Materials	Thickness (feet)	Depth (feet)
Loam, black	1	1
Pumice	47	48
Sand, brown	31	79
Gravel, coarse, water-bearing	½	79½
Sand, water-bearing	4½	84
Lava, black, water-bearing	3	87

30S/8E-29abb. H. W. Tompkins. Altitude 4,550 ft. Drilled by John A. Van Meter, 1961. Casing: 18-in. diam to 75 ft; perforated 61-73 ft

Materials	Thickness (feet)	Depth (feet)
Soil and pumice	2½	2½
Pumice, brown	16½	19
Sand, brown, and pumice	21	40
Quicksand	1	41
Sand and gravel	30	71
Gravel, coarse, and lava	3	74
Lava, gray, hard	10	84
Lava, broken, and cinders	7	91
Lava, creviced, water-bearing	16	107
Sand, gravel, and red clay	3	110

30S/8E-30bdb. Southern Pacific Transportation Co. Altitude 4,562 ft. Driller unknown; drilled 1924. Casing: 8-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Pumice	14	14
Sand	4	18
Pumice	1	19
Sand, black, caving	27	46
Pumice, hard	2	48
Sand	19	67
Gravel, cemented	8	75

30S/8E-31bca. D. L. Higgins. Altitude 4,551 ft. Drilled by Powell Well Drilling, 1964. Casing: 6-in. diam to 46 ft; perforated 26-46 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Pumice	21	23
Sand	15	38
Gravel, small-sized, clean	8	46

30S/8E-32caa. Ben Adair. Altitude 4,535 ft. Drilled by Ken Hartley Well Drilling, 1963. Casing: 20-in. diam to 20 ft, 16-in. diam to 121 ft; perforated 20-116 ft

Materials	Thickness (feet)	Depth (feet)
Soil	1	1
Pumice	16	17
Pumice, sand, and gravel	51	68
Sand, black, volcanic, and gravel	22	90
Ash, volcanic	4	94
Sand and gravel and volcanic ash, layered	27	121
Boulders, basaltic, and sand and gravel	16	137
Gravel, volcanic, and reddish-brown sand	11	148
Ash, volcanic	2	150

30S/8E-32cdc. Ben Adair. Altitude 4,530 ft. Drilled by E. E. Storey Well Drilling, 1966. Casing: 6-in. diam to 98 ft; perforated 28-98 ft

Materials	Thickness (feet)	Depth (feet)
Soil	1	1
Clay, brown, and pumice	40	41
Pumice	14	55
Cinders, brown	23	78
Cinders, black	20	98
Lava, brown	21	119
Cinders, brown	6	125

30S/9E-20acd. M. G. Emery. Altitude 4,535 ft. Drilled by Wilson Drilling Contractor, 1963. Casing: 6-in. diam to 42 ft; perforated 31-42 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	5	5
Pumice and clay	15	20
Chalk, whitish-yellow	40	60
Sand, gray, very little water	1	61
Clay, blue-gray	34	95
Sand and gravel	10	105

Table 10.--Drillers' logs of representative wells--Continued

KLAMATH MARSH AREA--Continued

30S/10E-24aab. E. R. Dennis. Altitude 4,570 ft. Drilled by Powell Well Drilling, 1962. Casing: 8-in. diam to 80 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Sand and pumice, brown	22	22
Sandstone, brown	6	28
Sand, black, and gravel	3	31
Sandstone, brown	8	39
Sand, black, and gravel	5	44
Sandstone, brown	3	47
Gravel, cemented	13	60
Sandstone, gray	7	67
Sand, black, water-bearing	3	70
Conglomerate, brown and red	80	150
Sandstone, water-bearing	20	170
Conglomerate, brown	15	185
Sand, black, and pumice	20	205
Cinders, red, and pumice	10	215
Sandstone, brown	3	218
Basalt, gray	10	228
Gravel, loose, coarse, water-bearing	3	231

30S/10E-36dab. Dr. J. H. Lawrence. Altitude 4,580 ft. Drilled by Powell Well Drilling, 1962. Casing: 8-in. diam to 82 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Pumice, yellow	3	3
Pumice, yellow, and boulders	36	39
Sand, black, fine, and boulders, water-bearing	22	61
Sand, black, fine, water-bearing	8	69
Conglomerate, brown	7	76
Sandstone, gray	7	83
Pumice, whitish-gray, and sandstone; water-bearing	9	92
Conglomerate, brown	47	139
Sand, water-bearing	2	141

31S/7E-1adc. Swanson Cattle Co. Altitude 4,545 ft. Drilled by Enloe Drilling Co., 1962. Casing: 18-in. diam to 372 ft; perforated 48-372 ft

Materials	Thickness (feet)	Depth (feet)
Pumice and black sand	321	321
Lava, gray	44	365
Sand, black	81	446
Lava, gray	6	452

31S/7E-24bac. Joe Ball. Altitude 4,553 ft. Drilled by Lloyd V. Wilson, 1953. Casing: 10-in. diam to 54 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, gravel, and gray pumice	12	12
Pumice, light-pink, solid	6	18
Pumice, dark-pink, solid	16	34
Pumice, broken	14	48
Pumice and coarse sand, some water	6	54
Pumice and sand, more water	7	61

31S/8E-6bba. Ben Adair. Altitude 4,542 ft. Drilled by E. E. Storey Well Drilling, 1966. Casing: 16-in. diam to 112 ft; perforated 42-112 ft

Materials	Thickness (feet)	Depth (feet)
Soil	1	1
Clay, yellow, and pumice	9	10
Clay, yellow	10	20
Pumice	45	65
Cinders, black	46	111
Chalk, yellow	1	112
Lava, brown	10	122
Boulders, gray, basaltic	10	132
Lava, brown	14	146
Basalt, gray	35	181
Shale, green	8	189
Basalt, gray	17	206
Lava, brown	14	220
Lava, black, broken	54	274

31S/8E-10bbb. Warner Valley Stock Co. Altitude 4,523 ft. Drilled by John A. Van Meter, 1962. Casing: 18-in. diam to 156 ft, 20-in. diam to 28 ft; perforated 26-150 ft

Materials	Thickness (feet)	Depth (feet)
Peat and soil	4½	4½
Pumice, white	2½	7
Pumice, pink, and sand	22	29
Pumice, white, and sand	13	42
Sand, black, and pumice	10	52
Quicksand, coarse, and some gravel	6	58
Sand, packed, and pumice	15	73
Sand, coarse, loose, and pumice	9	82
Sandstone	3	85
Quicksand and gravel	2	87
Sand, packed, and pumice	2	89
Clay and pumice	2	91
Gravel, large-sized, and sand	6	97
Clay, yellow	3	100
Sandstone	3	103
Sand, gravel, and pumice	36	139
Gravel, cemented	3	142
Gravel and sand	14	156
Lava, gray	4	160

31S/8E-33dcc. Lucas Cattle Co. Altitude 4,521 ft. Drilled by Enloe Drilling Co., 1961. Casing: 18-in. diam to 258 ft; perforated 40-258 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Pumice	38	40
Sand, black, and pumice	25	65
Lava, black	27	92
Lava, decomposed	28	120
Clay, white, soft	15	135
Lava, black, honeycombed	16	151
Lava, gray, decomposed	17	168
Lava, black, decomposed	14	182
Lava, yellow, honeycombed, with clay filler	24	206
Conglomerate, pumice, and pink-beige clay	12	218
Lava, red	40	258
Basalt, gray (crevice 263-265 ft)	20	278
Lava, black, solid	15	293
Lava, fissured	18	311
Lava, decomposed	29	340
Claystone, green, soft	6	346
Conglomerate and 1-in.-diam cobbles	12	358
Clay, blue	9	367
Silt, brown	11	378
Conglomerate, with ½-in.-diam pebbles	27	405
Clay, yellow	12	417
Sand, red	3	420
Lava	10	430

31S/11E-32bad. D. H. Dean. Altitude 4,620 ft. Drilled by Powell Well Drilling, 1962. Casing: 6-in. diam to 49 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Sand and pumice	4	4
Gravel, medium-sized, water-bearing	2	6
Conglomerate, brown	38	44
Sandstone, brown	5	49
Cinders, gray, water-bearing	24	73
Cinder rock, red, water-bearing	31	104
Gravel, fine, water-bearing	3	107

Table 10.--Drillers' logs of representative wells--Continued

SPRAGUE RIVER VALLEY

34S/8E-28ddc. M. W. Poole and Robert Moisio. Altitude 4,318 ft. Drilled by E. E. Storey Well Drilling, 1966. Casing: 16-in. diam to 40 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Pumice and clay	4	4
Clay, yellow	28	32
Gravel	2	34
Clay, blue	116	150
Shale, gray	208	358
Shale, green	196	554
Shale, brown	31	585
Lava, brown, broken	50	635
Basalt, gray	2	637
Lava, brown	16	653
Basalt, gray	32	685
Lava, red	15	700
Lava, brown	6	706
Basalt, gray, broken	16	722

34S/9E-32bba. W. K. Plummer. Altitude 4,300 ft. Drilled by Powell Well Drilling, 1968. Casing: 5-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Sandstone, brown	3	3
Lava, black	26	29
Basalt, gray	69	98
Lava, black, creviced	14	112
Basalt, gray	46	158
Lava, black	5	163
Lava, red	13	176

35S/9E-11bcd. William and Cal Hogg. Altitude 4,278 ft. Drilled by Powell Well Drilling, 1968. Casing: 6-in. diam to 20 ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Sandstone, brown	12	15
Clay, gray	17	32
Gravel, pea-sized, water-bearing	3	35
Shale, blue	27	62
Shale, green	13	75

35S/9E-11bdb. Knott. Altitude 4,282 ft. Drilled by Charles E. Hartley Well Drilling, 1967. Casing: 8-in. diam to 49 ft

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	4	4
Shale, yellow	4	8
Clay, yellow	25	33
Clay, blue	26	59
Lava, black	10	69
Sand, black	2	71
Lava, black	10	81
Lava, black, and sand	2	83
Lava, black	6	89
Shale, brown, broken	31	120

35S/9E-12bcc. John Kronenberger. Altitude 4,280 ft. Drilled by Charles E. Hartley Well Drilling, 1959. Casing: 8-in. diam to 19 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, black, loose	3	3
Shale, yellow	7	10
Sand, yellow	½	10½
Shale, yellow	23½	34
Sand and pumice	2	36
Shale, blue	55	91
Sand, blue	1	92
Shale, blue	10	102
Sand, blue, medium-coarse	1	103
Shale, blue	6	109
Sand, blue	1	110

35S/9E-12bdb. John Kronenberger. Altitude 4,285 ft. Drilled by E. E. Storey Well Drilling, 1969. Casing: 16-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Shale, green	118	120
Shale, green, with streaks of sandstone	327	447
Lava, black, broken	44	491
Basalt, gray	61	552
Shale, gray	24	576
Sandstone, black	70	646
Shale, green, with streaks of black lava	41	687
Shale, green, sticky	52	739
Chalk, yellow	23	762
Shale, gray	59	821
Shale, gray, sandy	52	873
Shale, gray	46	919
Shale, green, with streaks of black sand	281	1,200

35S/9E-13bbd. F. H. Taylor. Altitude 4,285 ft. Drilled by Powell Well Drilling, 1964. Casing: 6-in. diam to 31 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Lava, brown	117	119

35S/9E-13bdd. John Dobranski. Altitude 4,300 ft. Drilled by Mike Dawson, 1961. Casing: 8-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Silt, black	1	1
Gravel, cemented	6	7
Clay, yellow	6	13
Clay, yellow, sandy, water-bearing	1	14
Chalk, black	18	32
Chalk, green	22	54
Chalk, green-gray	19	73
Chalk, gray	32	105
Chalk, green	32	137
Chalk, gray	31	168
Chalk, green, and sand, layered	19	187
Sand and small-sized gravel, water-bearing	18	205

35S/10E-21bad. Theodore Crume. Altitude 4,340 ft. Drilled by E. E. Storey Well Drilling, 1960. Casing: 18-in. diam to 39 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Gravel and sand	2	6
Clay, yellow	12	18
Clay, green	17	35
Clay, blue-green	50	85
Shale, blue	40	125
Shale, blue-green	22	147
Basalt, gray	6	153
Shale, gray	147	300
Basalt, gray	35	335
Shale, gray	64	399
Basalt, gray	16	415
Shale, green	40	455
Basalt, gray	260	715
Basalt, black	40	755
Shale, blue	5	760
Basalt, black	5	765
Volcanic ash	2	767
Basalt, black	6	773
Shale, blue	12	785
Basalt, gray	11	796
Shale, gray	4	800
Volcanic ash	5	805
Basalt, black	15	820
Shale, blue	10	830
Cinders, brown	5	835
Basalt, black	80	915
Shale, blue	5	920
Basalt, black	5	925

Table 10.--Drillers' logs of representative wells--Continued

SPRAGUE RIVER VALLEY--Continued

35S/10E-26acd. H. E. Cash. Altitude 4,480 ft. Drilled by Charles Hartley Well Drilling, 1967. Casing: 6-in. diam to 160 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Rock, yellow	28	30
Rock, blue	99	129
Clay, gray	6	135
Rock, gray	45	180
Shale, gray	67	247
Clay, gray	39	286
Rock, gray	14	300

35S/10E-29bdd. G. D. Hazen. Altitude 4,295 ft. Drilled by Powell Well Drilling, 1969. Casing: 8-in. diam to 19 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Diatomite, white, water-bearing	6	8
Clay, reddish-brown	38	46
Shale, blue	26	72
Sandstone, black, soft	15	87
Shale, dark-green	49	136
Shale, light-green	62	198
Shale, blue	58	256
Shale, dark-green	26	282
Sandstone, black, soft	5	287
Shale, gray, sandy	23	310
Shale, dark-green	28	338
Shale, gray, sandy	6	344
Sandstone, black, water-bearing	6	350

35S/10E-31add. Joe Hambrick. Altitude 4,310 ft. Drilled by Charles Hartley Well Drilling, 1965. Casing: 6-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Loam, sandy	5	5
Shale, yellow	9	14
Clay, yellow	4	18
Clay, blue	102	120
Sand, black, fine	3	123
Clay, blue	68	191
Sand, black, and pumice	14	205
Clay, blue	5	210

35S/10E-34acb. Klamath Forest Estates. Altitude 4,380 ft. Drilled by Charles Hartley Well Drilling, 1963. Casing: 8-in. diam to 38 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Loam, sandy	1	1
Lava, weathered	57	58
Shale, blue	54	112
Lava, black	16	128
Rock, broken, loose; good aquifer	2	130

35S/10E-34dbb. Thomas Lisecki. Altitude 4,365 ft. Drilled by Powell Well Drilling, 1968. Casing: 6-in. diam to 19 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Sandstone, brown	47	49
Diatomite, white	44	93
Sandstone, water-bearing	9	102
Claystone, blue	2	104

35S/10E-35bcd. John Kerkes. Altitude 4,380 ft. Drilled by Powell Well Drilling, 1968. Casing: 6-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Sandstone, brown	44	46
Diatomite, white	23	69
Sandstone, brown	9	78
Sandstone, black, hard	2	80

35S/12E-23dbd. T. L. Turner. Altitude 4,445 ft. Drilled by Wilson Drilling Contractor, 1965. Casing: 16-in. diam to 45 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Clay, brown	3	8
Boulders	1	9
Clay, brown and blue, and gravel; water bearing in upper part	39	48
Sand, black	12	60
Clay, blue	38	98
Sand, black	22	120
Clay, blue	19	139
Sand, black	6	145
Rock, white	5	150
Clay, blue	16	166
Rock, white	8	174
Clay, green	34	208
Sand, black	8	216
Clay, green	14	230
Sand, black	6	236
Chalk, green	27	263
Sand, black	16	279
Clay, brown and green	28	307
Lava, black	6	313
Shale, green, with layers of sand	138	451
Shale, blue-green	39	490
Lava, black, brown, and gray	290	780
Shale, green-gray, with sand	21	801
Lava, red, and sand	36	837
Lava, red and gray	49	886
Lava, red and black, broken	49	935

35S/12E-26acc. W. A. Joe, Jr. Altitude 4,340 ft. Drilled by W. L. Hartley & Son, 1963. Casing: 8-in. diam to 116 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Old well	635	635
Lava, white	202	837
Sandstone, black	232	1,069
Lava	99	1,168

35S/12E-26bcb. Rimrock Ranch. Altitude 4,375 ft. Drilled by W. L. Hartley & Son, 1963. Casing: 12-in. diam to 180 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Sandstone	57	60
Chalk	40	100
Sand and boulders	60	160
Chalk	20	180
Sandstone	220	400
Rock	50	450
Sandstone	104	554
Rock	16	570

35S/12E-26dcd. Gladys Shoulderblade. Altitude 4,390 ft. Drilled by Francis Drilling, 1962. Casing: 10-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Sandstone, light-brown	20	25
Clay, blue	3	28
Gravel, small-sized, water-bearing	7	35
Clay, blue, and small-sized gravel	15	50
Sandstone and small-sized gravel	20	70
Clay, brown, with layers of coarse gravel	80	150
Sandstone, brown	23	173
Clay, brown	25	198
Lava, blue	46	244
Lava, white, and conglomerate; contains water in small seams	256	500

Table 10.--Drillers' logs of representative wells--Continued

SPRAGUE RIVER VALLEY--Continued

35S/12E-27bbd. Rimrock Ranch, Inc. Altitude 4,345 ft. Drilled by W. L. Hartley & Son, 1961. Casing: 12-in. diam to 80 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Sandstone	34	38
Rock, broken	37	75
Rock, solid	15	90
Chalk	537	627
Rock	167	794

35S/12E-27dac. D. G. Givins. Altitude 4,348 ft. Drilled by Dallas G. Givan, 1962. Casing: 12-in. diam to 80 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Chalk, white	25	30
Sand, gray	5	35
Chalk, white	65	100
Clay, blue, with seams of sand	100	200
Sand and gravel	50	250
Clay, light-brown	50	300
Cinders, black, water-bearing	40	340
Clay, bluish-gray, with streaks of pumice and red cinders; water-bearing	80	420
Clay, bluish-gray, with sand lenses	160	580
Gravel, small, dark-colored	10	590
Clay, blue	10	600
Sandstone, gray	50	650
Sand, water-bearing	25	675
Clay, blue	25	700
Sand, gravel, and clay	20	720

35S/12E-34dda. John and Lillian Mills. Altitude 4,355 ft. Drilled by W. L. Hartley & Son, 1959. Casing: 12-in. diam to 80 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Gravel, cemented	4	7
Sandstone, yellow	8	15
Shale, yellow	12	27
Gravel	6	33
Shale, blue	35	68
Shale, blue, and sand	14	82
Shale, blue	45	127
Gravel	4	131
Shale, blue	16	147
Gravel	4	151
Shale	38	189
Sand	7	196
Shale	29	225
Shale and sand	147	372
Gravel	22	394
Shale	54	448
Rock and pumice	152	600
Shale and sand	150	750
Lava, white	95	845

35S/14E-31ada. Harry Obenchain. Altitude 4,380 ft. Drilled by E. E. Storey Well Drilling, 1970. Casing: 8-in. diam to 19 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	1	1
Basalt, blue	4	5
Lava, brown	75	80
Basalt, gray	10	90
Lava, brown	13	103
Shale, brown	59	162
Lava, brown	108	270
Lava, brown, with streaks of pumice	42	312
Lava, brown, broken	8	320

36S/10E-6ddd. Joe LaHoda. Altitude 4,289 ft. Drilled by John A. Van Meter, 1949. Casing: 10-in. diam to 64 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Sand and clay	3	5
Hardpan	3	8
Chalk, yellow, water-bearing at 15 ft	7	15
Chalk, green	125	140
Sand, black, water-bearing	3	143
Sand and chalk	15	158
Pumice, water-bearing	3	161
Chalk, green	84	245
Sand, black, and gravel	36	281
Sand, cinders, pumice, and gravel	50	331
Chalk	4	335
Sand and gravel, packed	13	348
Chalk	72	420

36S/10E-9dca. H. T. Robbins. Altitude 4,305 ft. Drilled by John A. Van Meter, 1949. Casing: 6-in. diam to 11 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Hardpan	2	4
Chalk	8	12
Sand	11	23
Chalk	14	37
Sand, black, water-bearing	18	55
Chalk	15	70

36S/10E-14acc. C. J. Emmich. Altitude 4,350 ft. Drilled in 1955; driller unknown. Casing: 14-in. diam to 40 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Old well	411	411
Basalt, gray, broken	26	437
Cinders, black	9	446
Basalt, broken	71	517
Chalk, gray	10	527

36S/10E-14cab1. Sprague River Water Assoc. Altitude 4,355 ft. Drilled by George Hartley, 1938. Casing: 12-in. diam to 84 ft

Materials	Thickness (feet)	Depth (feet)
Conglomerate	14	14
Chalk	386	400
Sand, black	100	500

36S/11E-8cda. Ray Smith. Altitude 4,300 ft. Drilled by W. L. Hartley, 1947. Casing: 12-in. diam to 470 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Chalk	504	504
Rock	19	523

36S/11E-13caa. G. H. Smith. Altitude 4,320 ft. Drilled by W. L. Hartley & Son, 1962. Casing: 8-in. diam to 398 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Lava, broken	426	428
Clay	372	800
Lava	341	1,141

36S/11E-14aaa. Edwin and Rae Walker. Altitude 4,320 ft. Drilled by W. L. Hartley & Son, 1963. Casing: 12-in. diam to 296 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Sandstone	47	50
Sand, black	215	265
Rock	15	280
Clay, blue	180	460
Cinders and boulders	700	1,160
Lava	200	1,360
Clay	8	1,368
Lava	332	1,700

Table 10.--Drillers' logs of representative wells--Continued

SPRAGUE RIVER VALLEY--Continued

36S/11E-14cad. E. K. Viera. Altitude 4,315 ft. Drilled by E. E. Storey Well Drilling, 1968. Casing: 16-in. diam to 100 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Clay, brown	5	8
Hardpan	7	15
Clay, green	15	30
Sand, black	1	31
Clay, green and black	41	72
Clay, green, with streaks of sand	38	110
Shale, green	5	115
Sandstone, black	1	116
Shale, green	15	131
Pumice	1	132
Sandstone, black	27	159
Shale, green	52	211
Sandstone, black	50	261
Shale, green	21	282
Sandstone, black	22	304
Lava, black	36	340
Basalt, black, crevices	21	361

36S/11E-14dcc. E. K. Viera. Altitude 4,315 ft. Drilled by W. L. Hartley & Son, 1958. Casing: 8-in. diam to 155 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	1	1
Chalk	79	80
Sand, black	60	140
Chalk	150	290
Lava, red	90	380
Sandstone	80	460
Lava, blue, hard	120	580

36S/11E-15acd1. C. K. Neathery. Altitude 4,315 ft. Drilled by W. L. Hartley & Son, 1958. Casing: 8-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Sandstone	16	16
Lava	166	182

36S/11E-15acd2. Dennis Hickey. Altitude 4,330 ft. Drilled by W. L. Hartley & Son, 1963. Casing: 16-in. diam to 40 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
"Soft formation"	6	6
Rock	94	100

36S/11E-15cad. Accurate Electronics, Inc. Drilled by W. L. Hartley, 1947. Casing: 16-in. diam to 180 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Chalk, clay, and sand	160	160
Lava, broken, water-bearing	100	260

36S/11E-15ddc. Edwin Walker. Altitude 4,310 ft. Drilled by W. L. Hartley & Son, 1963. Casing: 12-in. diam to 162 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Clay and sand	146	150
Chalk	182	332
Rock	20	352
Chalk	25	377
Rock	103	480
Sandstone	40	520
Rock	38	558

36S/11E-16bcb1. Ray Smith. Altitude 4,310 ft. Drilled by W. L. Hartley, 1952. Casing: 20-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil and chalk	52	52
Sand, black	40	92
Sandstone, black	30	122
Clay, blue	129	251
Boulders	60	311
Basalt, water-bearing	75	386

36S/11E-17dcc. E. D. Firsick. Altitude 4,335 ft. Drilled by W. L. Hartley, 1952. Casing: 12-in. diam to 64 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Chalk	400	400
Rock	63	463

36S/11E-17ddb. E. D. Firsick. Altitude 4,327 ft. Drilled by W. L. Hartley, 1946. Casing: 12-in. diam to 97 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Chalk	280	280
Lava, broken	50	330

36S/11E-18ada. M. L. Conley. Altitude 4,330 ft. Drilled by W. L. Hartley, 1951. Casing: 12-in. diam to 100 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Chalk and clay	568	568
Basalt	57	625

36S/11E-20dca. George Bernard. Altitude 4,370 ft. Drilled by E. E. Storey Well Drilling, 1959. Casing: 18-in. diam to 260 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Topsoil	2	2
Clay	168	170
Sand	74	244
Shale, green	41	285
Basalt, gray	43	328
Shale, gray	57	385
Clay, reddish-brown, and sand	10	395
Basalt, gray	55	450
Lava, red, hard	37	487
Shale, brown	8	495
Cinders, black	65	560
Basalt, gray	4	564
Cinders, hard	11	575
Basalt, gray	20	595
Shale, brown	10	605
Basalt, gray	15	620
Lava, brown	3	623
Basalt, gray	7	630
Lava, red	10	640
Basalt, black	27	667

36S/11E-20dda. George Bernard. Altitude 4,350 ft. Drilled by E. E. Storey Well Drilling, 1959. Casing: 6-in. diam to unknown depth; unperforated

Materials	Thickness (feet)	Depth (feet)
Old well	302	302
Basalt, gray	13	315
Shale, gray	15	330
Basalt, gray	16	346
Conglomerate	44	390
Lava, red, hard	30	420
Shale, gray	1	421
Lava, red, hard	3	424

Table 10.--Drillers' logs of representative wells--Continued

SPRAGUE RIVER VALLEY--Continued

36S/11E-23bda. Mitchell. Altitude 4,312 ft. Drilled by W. L. Hartley & Son, 1957. Casing: 8-in. diam to 139 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	8	8
Chalk	74	82
Sandstone	138	220
Chalk and sand	159	379
Lava, broken	23	402

36S/11E-35dcc. Mark Time, Inc. Altitude 4,380 ft. Drilled by Oren L. Storey Well Drilling, 1962. Casing: 16-in. diam to 120 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, black	4	4
Hardpan	6	10
Chalk, white	20	30
Sandstone	15	45
Clay, blue	25	70
Clay, blue, gritty	42	112
Clay, blue, hard	13	125
Pumice	6	131
Sandstone, black, soft	65	196
Sandstone	3	199
Sandstone, soft	45	244
Sandstone, black and brown, hard	46	290
Clay, yellow, with pumice	15	305
Clay, yellow, with gravel	13	318
Sandstone, gray, hard	8	326
Gravel, cemented, hard	2	328
Rock, gray, hard	19	347
Gravel, cemented	2	349
Gravel, loose	3	352
Rock, black, very hard	31	383
Gravel, loose, with lots of water	1	384

36S/11E-36aab. William Gallagher. Altitude 4,325 ft. Drilled by J. S. Wilson, 1948. Casing: 16-in. diam to 96 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Hardpan	5	9
Chalk	11	20
Sand, black, water-bearing	15	35
Sand, black	35	70
Sandstone, black	10	80
Clay, yellow, sandy, water-bearing	4	84
Sand, fine	21	105
Gravel, coarse, and brown pumice	25	130
Rock, gray, hard, and gravel, water-bearing	45	175
Cinders, gray, hard	37	212
Rock, gray, hard	8	220
Cinders, hard, broken, water-bearing	3	223

36S/12E-2bbd. L. L. Crawford. Altitude 4,349 ft. Drilled by W. L. Hartley & Son, 1963. Casing: 16-in. diam to 150 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Sandstone	5	8
Chalk	132	140
Sandstone	20	160
Chalk	274	434
Rock, white	693	1,127

36S/12E-3bad. Gene Plemons. Altitude 4,315 ft. Drilled by W. L. Hartley & Son, 1954. Casing: 16-in. diam to 100 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Pumice	17	17
"River" gravel	32	49
Chalk	481	530
Sandstone and rock, streaks; first artesian flow at 532 ft	213	743
Lava, black; flow of water increased at 887 ft	166	909

36S/12E-4ddc. Gene Plemons. Altitude 4,350 ft. Drilled by W. L. Hartley & Son, 1960. Casing: 8-in. diam to 280 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Gravel, cemented	17	17
Chalk	203	220
Sand, black	60	280
Chalk	332	612

36S/12E-6cbd. Ernest Firsick. Altitude 4,322 ft. Drilled by Charles E. Hartley Well Drilling, 1967. Casing: 16-in. diam to 187 ft, 12-in. diam 180-534 ft; perforated 460-520 ft

Materials	Thickness (feet)	Depth (feet)
Loam, sandy	3	3
Pumice	4	7
Boulders	25	32
Sand, black, and pumice	13	45
Clay, yellow	42	87
Sand, black, fine	2	89
Clay, blue	50	139
Sand, black, coarse, and pumice	15	154
Clay, blue	4	158
Sand, black, coarse, and pumice	11	169
Clay, gray	101	270
Clay, blue, and thin shale layers	130	400
Lava	3	403
Clay, blue, and thin shale layers	37	440
Lava	10	450
Shale	6	456
Clay, blue	39	495
Lava, broken; artesian flow approximately 200 gpm	15	510
Sand, black, coarse	10	520
Pumice	5	525
Lava, blue	8	533
Clay, blue	107	640
Lava, blue	6	646
Pumice	8	654
Clay, green, sticky	36	690
Lava, hard	10	700
Clay, brown	20	720
Lava, hard	6	726
Clay, brown	14	740
Lava	4	744
Lava, black, and medium-sized sand	12	756
Pumice	22	778
Shale, brown	27	805
Clay, green	44	849
Lava, blue and black, hard	90	939
Lava, broken	11	950
Cinders and fine sand	--	--

36S/12E-8bbb. Byron Ross. Altitude 4,312 ft. Drilled by W. L. Hartley & Son, 1957. Casing: 8-in. diam to 106 ft/ unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Chalk	464	470
Lava, loose, water-bearing at 490 ft	20	490
Chalk with pumice	410	900
Sand, black, water-bearing at 940 ft	40	940
Lava, blue, solid	20	960

36S/12E-9baa. L. L. Crawford. Altitude 4,305 ft. Drilled by W. L. Hartley & Son, 1956. Casing: 8-in. diam to 80 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Gravel, cemented	3	3
Chalk	57	60
Sandstone	30	90
Chalk	190	280
Sand, black, and sandstone, water-bearing	20	300
Chalk	428	728
Sand, black, water-bearing	2	730

Table 10.--Drillers' logs of representative wells--Continued

SPRAGUE RIVER VALLEY--Continued

36S/12E-10bbb. Lewis Mateny. Altitude 4,315 ft. Drilled by Mike Dawson, 1962. Casing: 8-in. diam to 40 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Pumice, brown	18	18
Clay, blue, soft	22	40
Diatomite, green	185	225
Sand, black, and pumice, water-bearing	35	260
Diatomite, green	25	285
Pumice, brown, water-bearing	45	330
Gravel, fine, water-bearing	3	333
Sand, black, and pumice	17	350
Diatomite, green	35	385
Pumice, brown, water-bearing	20	405
Diatomite, green	80	485
Sand, black, and pumice, water-bearing	225	710

36S/12E-12dcc1. Weyerhaeuser Timber Co. Altitude 4,330 ft. Drilled by W. L. Hartley & Son, 1958. Casing: 8-in. diam to 115 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Sandstone and sand	115	115
Lava	65	180

36S/12W-15dbd. W. L. McNair. Altitude 4,360 ft. Drilled by W. L. Hartley & Son, 1960. Casing: 6-in. diam to 160 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Gravel, cemented	22	27
Chalk	123	150
Chalk and streaks of sand	350	500
Lava, broken, water-bearing	12	512

36S/12E-16dcd. Bernard Heffer. Altitude 4,340 ft. Drilled by W. L. Hartley & Son, 1965. Casing: 12-in. diam to 142 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Chalk	101	104
Sand, black	29	133
Chalk	287	420
Rock	104	524

36S/12E-22bdb. Homer Delmeter. Altitude 4,380 ft. Drilled by Charles E. Hartley Well Drilling, 1966. Casing: 12-in. diam to 193 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil and sandy loam	3	3
Shale	38	41
Clay, blue	31	72
Clay, yellow	43	115
Pumice, coarse, water-bearing	20	135
Sand, brown, medium-sized	1	136
Shale, brown	31	167
Clay, black, sticky	38	205
Cinders, black	1	206
Lava, black	44	250
Lava, red, broken; artesian from 260-275 ft	20	270
Lava, red and blue	15	285
Lava, black, broken	10	295
Basalt, blue, hard, broken	5	300

36S/12E-22dbd. Dalley Givan. Altitude 4,395 ft. Drilled by Charles E. Hartley Well Drilling, 1968. Casing: 18-in. diam to 80 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Loam, sandy	2	2
Loam, heaving	2	4
Clay, yellow	37	41
Clay, blue	22	63
Lava, black	14	77
Clay, blue and black	11	88
Lava, black	14	102
Lava, black water-bearing	12	114
Lava, black	12	126
Shale, green	12	138

36S/12E-22dbd.--Continued

Materials	Thickness (feet)	Depth (feet)
Lava, black and blue	31	169
Lava, red and brown	45	214
Lava, black	11	225
Lava, red	30	255
Lava, blue, very hard	5	260
Lava, red, creviced	21	281
Lava, black	77	358
Lava, red	145	503
Ash, red, creviced	2	505
Lava, red	176	681
Basalt, blue, very hard	89	770

36S/12E-23bdb. Edwin Rezendes. Altitude 4,350 ft. Drilled by Jerry L. Stephens, 1962. Casing: 12-in. diam to 80 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Hardpan, yellow	2	5
Clay, blue	25	30
Sand, black, fine	5	35
Clay, blue	55	90
Sand, black	2	92
Clay (chalk), with thin layers of sand	388	480
Pumice	5	485
Clay, brown	4	489
Cinders, red and black	31	520

36S/12E-28adb. Mike Deely. Altitude 4,390 ft. Drilled by Pat McGinley, 1961. Casing: 8-in. diam to 11 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Clay, brown, and gravel; some water at 45 ft	53	57
Pumice	3	60
Clay, brown	85	145
Sand, brown, fine	20	165
Clay, brown, and cinders	17	182
Pumice	5	187
Clay, brown, and gravel	103	290
Chalk, dark-green	37	327
Lava	38	365

36S/12E-34aab. Mike Deely. Altitude 4,410 ft. Drilled by Charles E. Hartley Well Drilling, 1967. Casing: 16-in. diam to 35 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Sand	1	1
Hardpan	14	15
Pumice	20	35
Sandstone and cinders	25	60
Pumice	10	70
Sandstone	4	74
Lava, brown and black	18	92
Shale, brown	24	116
Lava, black and brown	29	145
Basalt, black	105	250
Lava, red and brown	10	260
Basalt, black	20	280
Lava, red	14	294
Lava, black	104	398
Lava, brown	35	433
Shale, brown	7	440
Lava, brown	14	454
Basalt, blue, broken, water-bearing from 480-520 ft	66	520

Table 10.--Drillers' logs of representative wells--Continued

SPRAGUE RIVER VALLEY--Continued

36S/13E-22add. Floyd Martin. Altitude 4,390 ft. Drilled by Pat McGinley Well Drilling, 1963. Casing: 16-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Clay, brown, some water	55	55
Clay, brown, and gravel	5	60
Lava, soft	15	75
Lava	37	112
Lava and cinders	12	124
Cinders, red and black, loose, water-bearing	4	128
Lava, black	4	132
Lava, black, and cinders	8	140
Lava, black and brown	36	176
Lava and cinders	4	180

36S/14E-5aaa. Yamsay Land & Cattle Co., 1965. Altitude 4,415 ft. Drilled by W. L. Hartley & Son, 1965. Casing: 16-in. diam to 240 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Rock	35	35
Sandstone	110	145
Rock	160	305

36S/14E-7add. Harry Obenchain. Altitude 4,350 ft. Drilled by W. L. Hartley & Son, 1961. Casing: 18-in. diam to 120 ft; perforated 40-120 ft

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Sandstone and clay	36	41
Lava, broken, and cinders, water-bearing	79	120
Lava, solid	20	140
Lava, water-bearing	3	143

36S/14E-25bcb. D. J. Campbell and H. C. Gerber. Altitude 4,352 ft. Drilled by W. L. Hartley & Son, 1961. Casing: 18-in. diam to 64 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Lava and boulders	56	61
Clay	31	92
Lava	128	220
Cinders	60	280
Lava	90	370
Lava, broken	50	420
Lava	150	570
Lava, water-bearing	110	680
Clay	12	692
Lava, hard	16	708

36S/14E-27cdc. Henry Gerber. Altitude 4,345 ft. Drilled by W. L. Hartley & Son, 1956. Casing: 18-in. diam to 80 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	8	8
Gravel, cemented	32	40
Clay	39	79
Lava	84	163
Clay	30	193
Lava	11	204
Clay	81	285
Basalt	63	348
Lava	20	368
Pumice	2	370
Lava, blue, hard	30	400
Rock, red	38	438

36S/14E-29ddb. C. P. Merkley. Altitude 4,380 ft. Drilled by E. E. Storey Well Drilling, 1968. Casing: 18-in. diam to 24 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Lava, brown	12	14
Rock, yellow	6	20
Basalt, black	7	27
Lava, brown	91	118
Basalt, black	3	121
Lava, brown	20	141

36S/14E-29ddb.--Continued

Materials	Thickness (feet)	Depth (feet)
Basalt, black	5	146
Rock, yellow	5	151
Lava, brown	1	152
Shale, brown	210	362
Gravel and clay	33	395
Shale, brown	48	443
Lava, brown	26	469
Basalt, gray	3	472
Cinders, brown, caving	13	485

36S/14E-30bac. C. P. Merkley. Altitude 4,400 ft. Drilled by W. L. Hartley & Son, 1962. Casing: 12-in. diam to 40 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Boulders	20	23
Sandstone	71	94
Lava	86	180
Clay, yellow	100	280
Lava	96	376

36S/14E-34bdd. Spangler Lumber Co. Altitude 4,350 ft. Drilled by Bill Hartley, 1950. Casing: 12-in. diam to 88 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
"Soft formation"	104	104
Rock	196	300

36S/14E-35ddd. Ruth Hall. Altitude 4,353 ft. Drilled by Hatch Drilling Co., 1960. Casing: 18-in. diam to 60 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Pumice, black	22	24
Clay, yellow, and lava	11	35
Lava, black, and clay	25	60
Lava, black, and boulders, hard	107	167
Lava, black, and streaks of clay	60	227
Lava, water-bearing	76	303
Lava, black, hard, and streaks of clay	97	400

37S/12E-3ada. Mike Deely. Altitude 4,420 ft. Drilled by Pat McGinley, 1961. Casing: 8-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Hardpan	6	10
Clay, brown, and gravel	47	57
Lava	39	96
Lava, black, broken	12	108
Lava, black, hard	3	111
Lava, black, soft	19	130
Lava, hard	31	161
Lava, brown, decomposed	9	170
Lava, hard	25	195
Cinders, red, soft	9	204
Lava, hard	57	261
Cinders, red, soft	12	273
Lava, black, broken, water-bearing	17	290
Clay, brown	22	312
Clay, blue	33	345
Chalk, blue	50	395
Sand, brown	5	400
Clay, brown	60	460
Rock	10	470

37S/14E-1baa. E. M. Bell. Altitude 4,355 ft. Drilled by E. E. Storey Well Drilling, 1967. Casing: 8-in. diam to 34 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, black	3	3
Clay, brown	12	15
Shale, yellow	19	34
Basalt, black	6	40
Lava, brown	20	60
Cinders, red	5	65
Lava, brown, with streaks of sand	45	110
Basalt, black	31	141
Lava, red	4	145
Lava, brown	55	200
Lava, brown, with streaks of pumice	40	240
Lava, brown, broken	20	260

Table 10.--Drillers' logs of representative wells--Continued

SPRAGUE RIVER VALLEY--Continued

37S/14E-3acc. R. C. Clark. Altitude 4,365 ft. Drilled by Denny M. McClane Well Drilling, 1968. Casing: 8-in. diam to 96 ft; perforated 60-80 ft

Materials	Thickness (feet)	Depth (feet)
Clay, brown	4	4
Clay, brown, and gravel	17	21
Boulders and yellow clay	17	38
Basalt, gray, broken, water-bearing	17	55
Lava, brown	40	95
Basalt, black	36	131
Lava, red	6	137
Lava, black	81	218
Sand, brown	17	235
Cinders, brown, water-bearing	5	240
Cinders, red, and sand	41	281
Cinders, black	9	290

37S/15E-6ddd. Don Nonella. Altitude 4,375 ft. Drilled by W. L. Hartley & Son, 1968. Casing: 18-in. diam to 105 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Sand and gravel, water-bearing	4	6
Sandstone, brown	74	80
Lava	40	120
Cinders and clay	10	130
Sandstone, yellow	20	150
Lava	230	380
Clay, red	20	400
Lava	50	450
Clay, red	30	480
Lava	35	515
Clay and cinders, red	5	520
Lava	70	590
Boulders and clay	40	630
Lava	110	740
Basalt	85	825
Lava, broken, water-bearing	55	880

SWAN LAKE VALLEY

37S/10E-8ccc. Don Roberts. Altitude 4,240 ft. Drilled by W. L. Hartley & Son, 1952. Casing: 18-in. diam to 170 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Chalk	4	6
Boulders	6	12
Chalk	78	90
Sand, black, water-bearing	64	154
Sandstone, brown	36	190
Lava rock	81	271
Cinders, water-bearing	4	275
Boulders and red sand	6	281

37S/10E-9dcd. Don Roberts. Altitude 4,215 ft. Drilled by W. L. Hartley & Son, 1951. Casing: 18-in. diam to 17 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Sandstone, brown	15	17
Lava rock	111	128
Cinders and broken rock, water-bearing	14	142

37S/10E-18aca. Paul Golden. Altitude 4,230 ft. Drilled by W. L. Hartley & Son, 1954. Casing: Diameter unknown

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Chalk	40	44
Sand, black	156	200
Lava	125	325

37S/10E-19ada. H. D. Whiteline. Altitude 4,205 ft. Drilled by Chet Coleman, 1946. Casing: 6-in. diam to 30 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Chalk	24	24
Sand, black, and gravel (tuff)	91	115
Clay, white	30	145
Sandstone, black, and gravel (tuff)	10	155

37S/10E-29dbb2. Don Roberts. Altitude 4,188 ft. Drilled to 158 ft in 1949; deepened to 860 ft in 1951. Driller unknown. Casing: 18-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Chalk, white, green, and red	135	135
Gravel	20	155
Sand, black	3	158
Chalk	102	260
Sandstone, soft	10	270
Chalk	590	860
Rock	--	--

37S/10E-30abc. Fred Coleman. Altitude 4,220 ft. Drilled by Ken Hartley, 1949. Casing: 16-in. diam to 55 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, brown, sandy	5	5
Sandstone and gravel (tuff)	27	32
Cinders, black, and gravel	66	98
Basalt, hard	2	100

37S/10E-31bcc. Marshall Bros. Altitude 4,210 ft. Drilled by W. L. Hartley & Son, 1953. Casing: 16-in. diam to 580 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Chalk	500	500
Sand, dry	70	570
Chalk	490	1,060
Rock (welded tuff?)	15	1,075
Chalk	85	1,160
Rock (sedimentary)	302	1,462
Chalk	41	1,503
Rock (sedimentary)	61	1,564
Chalk and tuff agglomerate, alternating layers	236	1,800

38S/10E-5cbc. Maude Liskey. Altitude 4,195 ft. Drilled by Wilson Drilling Contractor, 1957. Casing: 18-in. diam to 39 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil and brown clay	6	6
Boulders	3	9
Clay	3	12
Clay, brown, and gravel	22	34
Clay, gray	4	38
Mud, dark-gray	20	58
Rock, brown, conglomerate	12	70
Lava, green, water-bearing at 70 ft	95	165
Lava, dark-gray	35	200
Lava, black, with white seams	48	248
Lava, dark-gray, with white seams	67	315
Lava, dark-brown, with seams of sand	7	322
Lava, gray, with white seams	83	405
Lava, gray, and sand	10	415
Lava, black	90	505
Lava, black, with white seams	31	536
Shale, dark-brown	14	550
Lava, black, with white seams	115	665
Lava, black, hard	60	725
Lava, black, with white seams	40	765
Lava, dark-gray, with brown shells	35	800
Lava, black	25	825
Lava, brown, with gray shells	15	840
Lava, gray and black	10	850

Table 10.--Drillers' logs of representative wells--Continued

SWAN LAKE VALLEY--Continued

38S/10E-9bbc1. George Fawver. Altitude 4,187 ft. Drilled by E. E. Storey Well Drilling, 1963. Casing: 8-in. diam to 42 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Boulders, large	21	23
Clay, yellow	7	30
Clay, yellow, and small-sized gravel	85	115
Shale, gray	80	195
Clay, yellow	14	209
Basalt, gray	12	221
Shale, gray and brown	39	260
Basalt, gray	20	280

38S/10E-9cbc1. R & S Ranch. Altitude 4,214 ft. Drilled by Vouchatzer, 1949. Casing: 6-in. diam to 25 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Clay	10	12
Lava rock	11	23
Shale	6	29
Lava boulders	30	59
Boulders	6	65
Lava rock	6	71
Boulders	9	80
Lava rock	5	85
Basalt	15	100
Lava rock	8	108
Basalt	8	116
Lava rock; water at 123 ft	15	131

38S/10E-9cbc2. Delbert Dehlinger. Altitude 4,195 ft. Deepened from 284 ft to 325 ft by Wilson Drilling Contractor, 1958. Casing: 16-in. diam to 193 ft; perforated 153-185 ft; open hole below 193 ft

Materials	Thickness (feet)	Depth (feet)
Old well	284	284
Lava, black, very hard	18	302
Lava, porous, with black sand	13	315
Lava, porous, with red cinders	10	325

38S/10E-13bbb1. V. Nevin Cattle Co. Altitude 4,192 ft. Drilled by Ken Hartley, 1949. Casing: 16-in. diam to 40 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Clay, yellow	28	31
Lava rock, black, porous	45	76
Ashes, lava (tuff?)	11	87
Lava rock, porous	53	140
Basalt, blue, dense, hard	40	180
Lava rock, porous	36	216
Cinders, red	5	221

38S/10E-16bbb. Maude Liskey. Altitude 4,224 ft. Drilled by Wilson Drilling Contractor, 1965. Casing: 18-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Lava rock (boulders)	50	50
Lava rock, brown	35	85
Lava, red and brown; water at 140 ft	75	160
Lava, black	5	165
Lava, red	20	185
Lava, red (boulders with sand)	15	200
Lava boulder, black	15	215
Lava, red, with sand	5	220
Lava, black, broken	10	230
Lava, red, porous	10	240
Lava, black, porous, with crevices	45	285
Lava, black, blue, and gray	10	295

38S/10E-16dcd. Maude Liskey. Altitude 4,225 ft. Drilled by Wilson Drilling Contractor, 1957. Casing: 18-in. diam to 39 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Boulders	3	8

38S/10E-16dcd.--Continued

Materials	Thickness (feet)	Depth (feet)
Clay, yellow, and gravel	12	20
Chalk, white and yellow	25	45
Chalk, red and brown	15	60
Chalk, black	10	70
Chalk, brown and white	40	110
Lava rock, black and gray, porous	20	130
Lava, black, very hard	10	140
Lava rock, black, porous	8	148
Cinders, red, water-bearing	2	150
Lava, black, porous	12	162
Lava, red, very porous, water-bearing	3	165
Lava, gray, black, and red	10	175
Sand, gray and red, coarse	2	177
Lava, gray, with fine gray sand	14	191
Lava, gray, hard	20	211
Lava, red, porous, water-bearing	8	219
Lava, gray, hard	2	221
Lava, gray, porous	4	225

38S/10E-16dda. D. L. House. Altitude 4,203 ft. Drilled by Charles E. Hartley Well Drilling, 1962. Casing: 18-in. diam to 9 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil and sandy loam	1	1
Overburden boulder lava	11	12
Shale, yellow; streak of find sand	84	96
Shale, blue	122	218
Peat, black	6	224
Lava rock, black, burnt	6	230
Shale, blue	155	385
Shale, gray, hard	23	408
Lava, black, hard, burnt	9	417
Lava rock, blue, hard, broken	35	452
Sand and pumice, coarse	2	454
Lava rock, broken, very good aquifer	6	460

38S/10E-22ada. Michael Short. Altitude 4,195 ft. Drilled by W. L. Hartley & Son, 1955. Casing: 18-in. diam to 100 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Chalk	266	268
Rock	80	348

38S/10E-22baa. Michael Short. Altitude 4,205 ft. Drilled by W. L. Hartley & Son, 1958. Casing: 18-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Rock, lava	8	11
Chalk	327	338
Rock, lava	122	460

38S/10E-23bdd. Lloyd Goldbek. Altitude 4,200 ft. Drilled by W. L. Hartley & Son, 1958(?). Casing: 18-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Soil	9	9
Chalk	191	200
Lava rock	60	260

Table 10.--Drillers' logs of representative wells--Continued

SWAN LAKE VALLEY--Continued

38S/10E-25aabl. G. C. Mitchell. Altitude 4,190 ft. Drilled by Blair Wilson, 1949. Casing: 14-in. diam to 329 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, brown, sandy	5	5
Sand and clay mixture, brown	19	24
Sand, brown, coarse, water-bearing	4	28
Clay, blue	27	55
Clay, brown, with sand	15	70
Sandstone, brown, and shale	12	82
Gravel and cinders	3	85
Sandstone, blue	2	87
Clay, blue, with sand	1	88
Clay, yellow	5	93
Gravel with black obsidian pebbles	3	96
Clay, yellow and brown	2	98
Gravel, multicolored	3	101
Sand, multicolored, coarse	2	103
Clay, yellow	5	108
Chalk, gray	22	130
Chalk, blue, with brown clay layers	78	208
Shale, black, sandy	4	212
Clay, rusty, semihard	38	250
Clay, gray and brown	66	316
Gravel, mixed colors	1	317
Sandstone, mixed colors, hard	6	323
Clay, brown	4	327
Sandstone, mixed colors, hard	2	329
Lava, broken, and boulders	5	334
Chalk, white	4	338
Lava, black, hard	8	346
Chalk, gray	8	354
Lava rock	6	360
Chalk, green	29	389
Lava rock	14	403
Chalk, gray	10	413
Shale, black	5	418
Chalk, green, and rock shells	11	429
Lava rock, black, hard	56	485
Basalt	3	488
Rock and red cinders	10	498
Cinders, red, and gravel, crevice	2	500
Lava rock	20	520
Lava boulders and cinders	4	524

38S/10E-25dab. V. A. Deyarmie. Altitude 4,187 ft. Drilled by E. E. Storey Well Drilling, 1965. Casing: 8-in. diam to 138 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	1	1
Clay, brown	2	3
Hardpan	1	4
Clay, brown, and sand	11	15
Clay, blue, and sand	15	30
Clay, gray, and sand	15	45
Clay, brown, and sand	27	72
Clay, green	78	150
Shale, green	204	354
Shale, brown	73	427
Shale, green	338	765
Lava, black	69	834

38S/10E-26bac. Maude Liskey. Altitude 4,240 ft. Drilled by Ken Hartley, 1949. Casing: 16-in. diam to 15 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Clay, yellow	3	5
Sandstone, brown	5	10
Clay, yellow	9	19
Shale, blue	11	30
Clay, yellow	35	65
Sandstone, yellow	35	100
Sandstone, yellow, and red clay	50	150
Basalt, black, porous	25	175
Clay, red, and sandstone	23	198
Basalt, black, porous	199	397
Cinders, red	4	401
Basalt, black, porous	27	428
Basalt rock, blue, massive	14	442
Lava rock, porous, water-bearing	45	487

38S/10E-26bac.--Continued

Materials	Thickness (feet)	Depth (feet)
Basalt rock, massive	16	503
Lava rock, red, and cinders	8	511
Basalt, black, porous	13	524
Basalt rock, massive	13	537
Basalt, black, porous, water-bearing	22	559
Sand, black, basaltic, coarse	1	560
Basalt, black, porous	21	581
Basalt rock, blue, massive, dense, hard	1	582

38S/10E-36bbb. Maude Liskey. Altitude 4,235 ft. Drilled by Wilson Drilling Contractor, 1958. Casing: 8-in. diam to 32 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Sand, brown	6	6
Clay, brown and red	24	30
Lava rock, brown	85	115
Rock, dark-gray	37	152
Rock, blue-gray, hard	5	157
Rock, gray-blue to black	80	237
Crevice; lost all cuttings	2	239
Rock, black	15	254
Crevice; lost all cuttings	5	259
Rock, black	7	266

38S/11½E-6cad. V. Nevin Cattle Co. Altitude 4,200 ft. Drilled by W. L. Hartley & Son, 1951. Casing: 18-in. diam to unknown depth; unperforated

Materials	Thickness (feet)	Depth (feet)
Silt and clay, with talus blocks	25	25
Silt and clay	149	174
Rock, hard layers, alternating with flow breccia; water-bearing	50	224

38S/11½E-20ccb. D. S. Moore. Altitude 4,300 ft. Drilled by W. L. Hartley & Son, 1967. Casing: 16-in. diam to 150 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Sandstone	26	32
Lava rock	248	280
Lava, broken, water-bearing	61	341

38S/11½E-29ada. V. Nevin Cattle Co. Altitude 4,200 ft. Drilled by W. L. Hartley & Son, 1950. Casing: 16-in. diam to unknown depth; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil and sand	10	10
Clay, yellow	60	70
Sandstone, reddish-brown	7	77
Boulders	2	79
Sandstone	7	86
Rock imbedded in red, sandy clay	14	100
Basalt rock	12	112
Gravel, volcanic	14	126
Lava	2	128
Basalt boulders, caving cinders at bottom	7	135

38S/11½E-30cba. V. Nevin Cattle Co. Altitude 4,210 ft. Drilled by W. L. Hartley & Son, 1951. Casing: 6-in. diam to unknown depth; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	45	45
Clay, yellow	40	85
Lava, broken, and boulders	15	100
Rock, solid	123	223
Cinders, water-bearing	22	245
Rock, solid	36	281

Table 10.--Drillers' logs of representative wells--Continued

SWAN LAKE VALLEY--Continued

38S/11½E-30dac. D. S. Moore. Altitude 4,217 ft. Drilled by Fred Hilton, 1947. Casing: 14-in. diam to 120 ft; perforated 100-120 ft

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	15	15
Boulders, hard, with loose cinders	125	140
Lava rock, black	17	157
Boulders, loose, and cinders	8	165
Cinders	10	175

38S/11½E-30ddd. D. S. Moore. Altitude 4,190 ft. Drilled by George Hartley, 1933(?). Casing: 12-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	33	33
Lava rock, black	23	56
Clay	9	65
Lava rock, black	45	110
Clay	8	118
Lava rock, black	5	123
Cinders, broken	22	145

38S/11½E-31bcd. Richard Dilling. Altitude 4,187 ft. Drilled by E. E. Storey Well Drilling, 1966. Casing: 12-in. diam to 138 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Clay, yellow	3	5
Shale, gray	17	22
Sand, brown	8	30
Shale, gray	8	38
Clay, yellow	100	138
Shale, gray	62	200
Sand, black	1	201
Shale, green	299	500
Clay, green	148	648
Lava, black	214	862

38S/11½E-32bdd. Stanley Petersen. Altitude 4,185 ft. Drilled by Pat McGinley, 1948. Casing: 16-in. diam to 64 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Loam, sandy	10	10
Shale, blue	120	130
Rock, gray, and cinders, water-bearing	65	195
Cinders, red, water-bearing	2	197

38S/11½E-32dcd. Stanley Petersen. Altitude 4,183 ft. Drilled by E. E. Storey Well Drilling, 1952. Casing: 20-in. diam to 58 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
"Hardpan"	5	8
Sand and white chalk	23	31

38S/11½E-32dcd.--Continued

Materials	Thickness (feet)	Depth (feet)
Boulders, loose	18	49
Lava, black	38	87
Basalt, gray, hard	123	210
Gravel	1	211
Basalt, no cuttings	14	225
Basalt	3	228
Lava, red	13	241
Basalt, black	29	270
Lava, black	28	298
Sand, black	--	--

38S/11½E-33dca. Stanley Petersen. Altitude 4,230 ft. Drilled by Frank Tofell, 1949. Casing: 16-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	11	11
Sandstone	97	108
Rock	104	212

39S/11½E-5bca. Stanley Petersen. Altitude 4,210 ft. Drilled by Pat McGinley, 1946. Casing: 16-in. diam to 21 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, black	19	19
Boulders	2	21
Dirt; some water at 50 ft	31	52
Basalt rock	89	141
Sand, water-bearing	9	150
Basalt rock, water-bearing	110	260

39S/11½E-6aca. J. R. Murphy. Altitude 4,190 ft. Drilled by J. S. Wilson, 1949; deepened 42 ft in 1959. Casing: 16-in. diam to 170 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	8	8
Hardpan	5	13
Sand	11	24
Shale	86	110
Chalk, green, sandy	15	125
Shale, brown	25	150
Rock, black	5	155
Shale, green	135	290
Chalk, green	60	350
Shale, dark-brown, sandy	30	380
Shale, brown	17	397
Lava rock, black, hard	56	453
Lava, bouldery, water-bearing	10	463
Lava, porous	5	468
Crevice	2	470
Lava, porous	20	490
Crevice	10	500
Lava, black	5	505

YONNA VALLEY

37S/11½E-15ccb. L. L. Chapman. Altitude 4,237 ft. Drilled by W. L. Hartley & Son, 1952. Casing: 17-in. diam to 32 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Sandstone	43	45
Rock	200	245
Sandstone	50	295
Rock	163	458

37S/11½E-34dbb. Andrew Bodnar. Altitude 4,205 ft. Drilled by W. L. Hartley & Son, 1963. Casing: 18-in. diam to 162 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Chalk	32	35
Sandstone	98	133

37S/11½E-34dbb.--Continued

Materials	Thickness (feet)	Depth (feet)
Chalk	7	140
Sandstone	10	150
Chalk and sandstone	10	160
Sandstone	15	175
Rock	10	185
Sandstone	15	200
Rock	56	256

Table 10.--Drillers' logs of representative wells--Continued

YONNA VALLEY--Continued

Materials	Thickness (feet)	Depth (feet)
37S/11½E-36add. D. E. Schreiner. Altitude 4,266 ft. Drilled in 1953 (driller unknown). Casing: Unknown		
Clay	5	5
Sandstone	2	7
Rock, yellow, and chalk	43	50
Clay, blue	60	110
Sandstone	35	145
Rock	8	153
Clay, gray	117	270
Sandstone, black	20	290
Rock, gray, hard	35	325
Soapstone	10	335
Sandstone, black and red	15	350
Lava cinders	10	360
Rock, red	14	374
Sandstone, brown	12	386
Lava, broken	4	390
38S/11E-5cdd. Leonard Ritter. Altitude 4,241 ft. Drilled by Fred Hilton, 1948. Casing: 16-in. diam to 12 ft; unperforated		
Soil, sandy	4	4
Clay, brown	26	30
Shale, blue	35	65
Sandstone	2	67
Shale, blue	111	178
Sandstone, black	4	182
Lava, red-coated, with gravel coming out of cracks; water-bearing	18	200
38S/11E-6cbd. J. P. Colahan. Altitude 4,198 ft. Drilled by Charles E. Hartley Well Drilling, 1962. Casing: 18-in. diam to 6 ft; unperforated		
Loam, sandy	4	4
Clay, yellow, sandy	28	32
Clay, blue	219	251
Lava, blue, burnt	5	256
Clay, blue	38	294
Lava, blue	9	303
Clay, gray, and black sand	25	328
Lava, black, burnt	6	334
Lava, black, weathered	19	353
Lava boulders, blue, broken; very good aquifer	17	370
38S/11E-7bad. Harold Mallory. Altitude 4,198 ft. Drilled by Ken Hartley, 1948. Casing: 16-in. diam to 42 ft; unperforated		
Sand	31	31
Shale, blue	3	34
Sand	5	39
Shale, blue, with trace of black sand between 145-150 ft	143	182
Slate, gray, and blue shale, interbedded	28	210
Shale, blue	82	292
Lava, black and red	83	375
Cinders, red	5	380
Rock, hard	38	418
Lava, red, hard	37	455
Rock, red, porous, and cinders	20	475
Rock, red and black, hard	13	488
Cinders, red	14	502
Lava, red and brown, hard	15	517
Basalt, green	7	524
Sand and sandstone, red and brown, with some volcanic ash	43	567
Lava, black, broken, water-bearing	19	586
38S/11E-7cba. Louis Tofell. Altitude 4,200 ft. Drilled by owner, 1948. Casing: 12-in. diam to unknown depth; unperforated		
Sand	1	1
Sandstone	28	29
Chalk, yellow	66	95
Gravel	2	97
Rock	40	137
Rock, red, volcanic, broken, water-bearing	92	229
Rock	8	237
Clay, gray	5	242
Cinders, red-gray, water-bearing	18	260
38S/11E-7daa. Weyerhaeuser Co. Altitude 4,250 ft. Drilled by E. E. Storey Well Drilling, 1968. Casing: 16-in. diam to 40 ft; unperforated		
Sand	6	6
Chalk, yellow	4	10
Shale, green	193	203
Sandstone, black	23	226
Shale, red and brown	9	235
Lava, brown and red	35	270
"Ironite," hard	34	304
Basalt, black	6	310
Lava, black, badly caving	15	325
38S/11E-7dab. Weyerhaeuser Co. Altitude 4,254 ft. Drilled by E. E. Storey Well Drilling, 1968; deepened in 1969. Casing: 6-in. diam to 277 ft; unperforated		
Sand	4	4
Shale, green, and yellow chalk	216	220
Sandstone, black	25	245
Shale, brown	16	261
Cinders	14	275
"Ironite"	20	295
Lava, brown and red	15	310
"Ironite"	9	319
Lava, brown	12	331
"Ironite"	4	335
38S/11E-31abal. Haskins & Co. Altitude 4,182 ft. Drilled by W. L. Hartley & Son, 1948. Casing: 16-in. diam to 81 ft; unperforated		
Soil	3	3
Sandstone, brown	52	55
Lava, blue	100	155
Cinders, red, and broken lava	22	177
38S/11½E-1baa. Karl Dehlinger. Altitude 4,205 ft. Drilled by Enloe Drilling Co., 1965. Casing: 20-in. diam to 18 ft, 16-in. diam to 460 ft; perforated 260-460 ft		
Loam, sandy	3	3
Clay, light-brown	18	21
Clay, green and light-gray	99	120
Clay, green	94	214
Clay, blue and green	14	228
Clay, gray	70	298
Clay, green, sticky	19	317
Clay, blue	10	327
Clay, blue, and black cinders	25	352
Cinders, black	71	423
Sandstone	3	426
Cinders, black	34	460
38S/11½E-2dcb. Jess Angel. Altitude 4,181 ft. Drilled by W. L. Hartley & Son, 1953. Casing: 18-in. diam to 31 ft; unperforated		
Sand	30	30
Chalk, blue	256	286
Sandstone, red, tuffaceous	270	556
Basalt, water-bearing	27	583

Table 10.--Drillers' logs of representative wells--Continued

YONNA VALLEY--Continued

38S/11½E-10cac. G. P. Wu. Altitude 4,200 ft. Drilled by W. L. Hartley & Son, 1966. Casing: 16-in. diam to 160 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Sandstone	20	20
Chalk	132	152
Sandstone	13	165
Chalk	207	372
Sandstone	449	821

38S/11½E-11ada. Frank Challis. Altitude 4,157 ft. Drilled by Fred Hilton, 1948. Casing: 16-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	7	7
Clay, brown	½	7½
Shale, blue, some water at 50 ft	42½	50
Sandstone, medium-grained, brown	2	52
Shale, blue	142	194
Sandstone, medium-grained, black	20	214
Lava, black, broken, water-bearing	10	224

38S/11½E-12aba. Grant Brown. Altitude 4,174 ft. Drilled by Fred Hilton, 1948. Casing: 16-in. diam to 8 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	4	4
Clay, brown	8	12
Shale, blue	80	92
Sandstone	17	109
Shale, blue	126	235
Sandstone, black, some water	27	262
Gravel, sandstone, some water	10	272
Lava, black, broken, water-bearing	8	280

38S/11½E-12ccal. Frank Challis. Altitude 4,153 ft. Drilled by George Hartley, 1942. Casing: 12-in. diam to 18 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Loam, sandy	10	10
Chalk, blue	60	70
Gravel and fine sand, water-bearing	3	73
Chalk, blue	227	300
Gravel, coarse, water-bearing	8	308
Chalk, blue	72	380
Sandstone, yellow	1	381
Chalk	19	400
Lava rock, hard, dense	1	401
Lava rock, porous and blocky	24	425

38S/11½E-12cca3. Frank Challis. Altitude 4,161 ft. Drilled by Stuart, 1942. Casing: 12-in. diam to 5 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Chalk	140	140
Cinders, water-bearing	8	148
Lava, red, porous	2	150

38S/11½E-13aca. R. M. Robertson. Altitude 4,158 ft. Drilled by W. L. Hartley & Son, 1948. Casing: 16-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Chalk	128	128
Sandstone, black	33	161
Lava, burnt, broken, and red cinders; water-bearing	22	183

38S/11½E-13dca. Herman Pendegraft. Altitude 4,151 ft. Drilled by Fred Hilton, 1947. Casing: 16-in. diam to 16 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	6	6
Chalk, diatomaceous	54	60
Sand; trickle of water	½	60½
Chalk, diatomaceous	189½	250
Sand, black, fine; some water	2	252
Chalk, diatomaceous	216	468
Lava, cindery, broken	2	470
Cinders, round, bouldery; abundant water	5	475

38S/11½E-15bdd. George McCollum. Altitude 4,210 ft. Drilled by W. L. Hartley & Son, 1951. Casing: 18-in. diam to 100 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	12	12
Chalk	421	433
Lava	70	503
Cinders	17	520

38S/11½E-15dda. George McCollum. Altitude 4,185 ft. Drilled by Southern Oregon Well Drilling Co., Inc., 1948. Casing: 12-in. diam to unknown depth; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Sand	4	6
Clay	32	38
Rock	12	50
Shale, water-bearing	2	52
Sand	2	54
Shale	191	245
Rock, black	6	251
Shale	21	272
Rock	16	288
Shale	10	298
Rock	20	318
Shale and rock	25	343
Shale	19	362
Lava, water-bearing (200 gpm)	70	432
Cinders, red, water-bearing	15	447
Cinders and brown clay	27	474
Lava and cinders	21	495

38S/11½E-22acd. Cliff Sewald. Altitude 4,220 ft. Drilled by Fred Hilton, 1938. Casing: 6-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	7	7
Sandstone, brown, with some clay streaks	8	15
Chalk, diatomaceous	180	195
Sandstone, brown, broken	5	200
Chalk, diatomaceous	45	245
Sand, black, fine; some water	10	255
Chalk, diatomaceous	20	275

38S/11½E-22dba. Cliff Sewald. Altitude 4,270 ft. Drilled by Charles E. Hartley Well Drilling, 1970. Casing: 12-in. diam to 21 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Lava	35	35
Clay, yellow	100	135
Clay, blue, and boulders	52	187
Clay, blue	313	500
Lava	44	544
Basalt	96	640
Lava	30	670
Cinders, red	--	--

38S/11½E-23bdc. Cliff Sewald. Altitude 4,160 ft. Drilled by Fred Hilton, 1946. Casing: 12-in. diam to 12 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	1	1
Sandstone with clay seams	13	14
Chalk, diatomaceous	186	200
Sand and chalk, water-bearing	25	225
Lava, black, porous	30	255
Sand, black, fine, water-bearing	1	256
Rock, black, porous	14	270
Sand, black, fine, water-bearing	2	272
Lava, black, porous	13	285
Sand, black, fine	1	286

Table 10.--Drillers' logs of representative wells--Continued

YONNA VALLEY--Continued

38S/11½E-24cbb1. Virgil Schmoe. Altitude 4,162 ft. Drilled by Fred Hilton, 1949. Casing: 20-in. diam to unknown depth; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Gravel, cemented	2	4
Clay, brown	31	35
Shale, green	20	55
Sand	1	56
Shale, blue	157	213
Sand, black	3	216
Shale, green	478	694
Sandstone, green	2	696
Shale, green	3	699
Sandstone, green	2	701
Shale, green	64	765
Sandstone, black	18	783
Shale, green	14	797
Sand	3	800
Shale, sandy	57	857
Lava, black	20	877
Cinders, red	3	880
Lava, black	104	984
Lava, broken, and yellow cinders	12	996

38S/11½E-24cdc. Haskins & Co. Altitude 4,151 ft. Drilled by W. L. Hartley & Son, 1949. Casing: 18-in. diam to 40 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Chalk	487	487
Sandstone and shale	275	762
Lava	67	829
Sandstone and shale	19	848
Lava	125	973
Lava, burnt, broken, water-bearing	11	984

38S/11½E-26ada. Hoeffler Bros. Altitude 4,155 ft. Drilled by Fred Hilton and Ken Hartley, 1948. Casing: 20-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	1	1
Sandstone, buff-colored	5	6
Shale, blue	34	40
Sand	1	41
Shale, blue	30	71
Sand	1	72
Shale, blue	32	104
Sand	2	106
Shale, blue	65	171
Lava, black, dense	12	183
Lava, broken, and yellow cinders, water-bearing	8	191

38S/11½E-34bda. Elizabeth Bell. Altitude 4,130 ft. Drilled by W. L. Hartley & Son, 1963. Casing: 6-in. diam to 63 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Chalk	290	294
Gravel	2	296

38S/11½E-34cbd. Ernest Wiseman. Altitude 4,133 ft. Drilled by Charles E. Hartley Well Drilling, 1969. Casing: 18-in. diam to 21 ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Chalk	29	32
Lava, water-bearing at 135 ft	103	135

38S/11½E-34cdd. L. J. Horton. Altitude 4,120 ft. Drilled by Fred Hilton, 1949. Casing: 16-in. diam to unknown depth; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Hardpan, brown	2	5
Clay, yellow	4	9
Shale, blue	9	18
Lava, broken, and gravel	4	22
Basalt boulder	3	25
Lava, broken, and cinders	28	53
Basalt boulders	4	57

39S/11E-5cac. Stan Masten. Altitude 4,140 ft. Drilled by W. L. Hartley & Son, 1943. Casing: 6-in. diam to 68 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	8	8
Quicksand	6	14
Chalk, blue	274	288
Lava, broken, and red cinders, water-bearing	28	316

39S/11E-5dcb. Garry Freitag. Altitude 4,148 ft. Drilled by W. L. Hartley & Son, 1946. Casing: 6-in. diam to 153 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Quicksand	8	14
Clay, yellow	103	117
Lava	38	155
Cinders, red, water-bearing	2	157

39S/11E-20bdd. Pacific Gas Transmission Co. Altitude 4,132 ft. Drilled by E. E. Storey Well Drilling, 1967. Casing: 6-in. diam to 19 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Clay and sand	10	10
Lava, black	29	39
Shale, green	7	46
Lava, black	73	119
Shale, green	7	126
Lava, black and red	61	187
Basalt, black	17	204
Lava, black, red, and brown	11	215

39S/11E-22bba2. Cecil Hunt. Altitude 4,164 ft. Drilled by Enloe Drilling, 1966. Casing: 16-in. diam to 18 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Sandstone	14	18
Clay, brown	69	87
Rock, black	23	110

39S/11½E-2dcc. L. J. Horton. Altitude 4,105 ft. Drilled by Ken Hartley Well Drilling, 1955. Casing: 20-in. diam to 27 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	7	7
Hardpan and yellow shale	11	18
Shale, blue, with traces of sand at 140 ft and 440 ft	447	465
Sandstone	15	480
Shale, blue	152	632
Gravel, volcanic	10	642
Shale, blue	5	647
Lava, very dense	23	670
Basalt	65	735
Lava, burnt	28	763

Table 10.--Drillers' logs of representative wells--Continued

YONNA VALLEY--Continued

39S/11½E-10abc. L. J. Horton. Altitude 4,110 ft. Drilled by Fred Hilton, 1949. Casing: 16-in. diam to 30 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, black	3	3
Hardpan, yellow	11	14
Lava, broken, and yellow cinders	47	61

39S/11½E-12ada. E. A. Bergdorf. Altitude 4,128 ft. Drilled by W. L. Hartley, 1930. Casing: 6-in. diam to 42 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Chalk, yellow	31	31
Chalk, blue	146	177
Lava, blue, broken	40	217

39S/11½E-13dab. Virgil Schmoe. Altitude 4,131 ft. Drilled by E. E. Storey Well Drilling, 1968. Casing: 16-in. diam to 38 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Sand and clay	9	12
Clay, yellow	6	18
Shale, green, with streaks of sandstone	347	365
Lava, brown and red, soft, broken	25	390
Lava, black	5	395

POE VALLEY

39S/10E-13bbb. Klamath County Park Commission. Altitude 4,095 ft. Drilled by W. L. Hartley & Son, 1964. Casing: 6-in. diam to 40 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Fill	4	4
Mud	12	16
Chalk	734	750
Lava	8	758

39S/11½E-22bcb. Masten Dairy. Altitude 4,165 ft. Drilled by E. E. Storey Well Drilling, 1970. Casing: 10-in. diam to 144 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Clay and soil	1	1
Shale, brown	4	5
Chalk	37	42
Lava, brown	23	65
Shale, brown	20	85
Lava, black	30	115
Lava, black, with streaks of brown shale	20	135
Lava, brown	5	140
Lava, black	10	150
Lava, brown	8	158
Lava, black	6	164

39S/11½E-22cbb. Masten Dairy. Altitude 4,135 ft. Drilled by E. E. Storey Well Drilling, 1958. Casing: 6-in. diam to 79 ft

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Chalk, yellow	15	20
Chalk, blue, sandy	25	45
Shale, green	120	165
Lava, black	20	185

39S/11½E-22dab. P. T. Hatchett. Altitude 4,225 ft. Drilled by W. L. Hartley & Son, 1949-52. Casing: 12-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	12	12
Shale, blue-green	382	394
Basalt, dense, hard	18	412
Shale, blue-green	90	502
Lava, broken, water-bearing	36	538
Lava, dense, hard	122	660
No record	262	922

39S/11½E-22dad. P. T. Hatchett. Altitude 4,170 ft. Drilled by James A. Roberts, 1959. Casing: 8-in. diam to 23 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil and small boulders	3	3
Hardpan	2	5
Clay	17	22
Basalt boulders	54	76
Lava rock, red, water-bearing (2 gpm)	19	95
Lava rock, gray	45	140

39S/11½E-22dad.--Continued

Materials	Thickness (feet)	Depth (feet)
Lava rock, red, water-bearing (approx. 3 gpm)	8	148
Lava rock, gray	22	170
Lava rock, red	6	176
Lava rock, gray	6	182
Lava rock, red, water-bearing (approx. 6 gpm)	30	212

39S/11½E-22dbd. Gerald Longhofer. Altitude 4,180 ft. Drilled by Charles E. Hartley Well Drilling, 1964. Casing: 6-in. diam to 76 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Clay, yellow	14	16
Lava boulders	2	18
Clay, yellow	19	37
Lava boulders, hard	4	41
Clay, yellow	19	60
Clay, blue	59	119
Lava, brown, hard	10	129

39S/11½E-30aab. Taylor High. Altitude 4,114 ft. Drilled by Clyde Van Meter, 1943. Casing: 7-in. diam to 52 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Chalk, sticky	24	27
Sandstone, water-bearing	6	33
Basalt	3	36
Hardpan	3	39
Boulders and clay	6	45
Basalt, solid	13	58
Basalt, creviced, water-bearing	7	65

39S/11½E-34cdc. Mrs. Pauline Roberts. Altitude 4,105 ft. Drilled by John A. Van Meter, 1960. Casing: 8-in. diam to 33 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Hardpan	1	3
Chalk, yellow	7	10
Sand and chalk	14	24
Chalk, green	32	56
Sand	5	61
Chalk, green	231	292
Sand and gravel	101	393
Chalk, green and gray	108	501
Chalk and sand, layered	3	504
Chalk, yellow	6	510

Table 10.--Drillers' logs of representative wells--Continued

POE VALLEY--Continued

40S/11E-1aaa. W. E. Freuer. Altitude 4,158 ft. Drilled by E. E. Storey Well Drilling, to 240 ft in 1953; deepened to 344 ft in 1965. Casing: 14-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Gravel and clay	11	15
Rock, crevices	135	150
Basalt, water bearing	10	160
Basalt, blue	55	215
Basalt, black, water-bearing	23	238
Basalt, black	2	240
Lava, black	45	285
Lava, black, with streaks of shale	49	334
Shale, green	7	341
Basalt, blue	3	344

40S/11E-1aad. Bedfield Cemetery. Altitude 4,170 ft. Drilled 1953; driller unknown. Casing: 8-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Conglomerate, hard, mostly lava	5	9
Sandstone, green, water-bearing at 15 ft (7½ gpm)	16	25
Sand, brown, hard, water-bearing at 26 ft (10 gpm)	1	26
Rock, gray	37	63
Sand, coarse, and broken rock, water-bearing	2	65
Sandstone, green	16	81
Conglomerate, yellow, hard	2	83

40S/11E-1abd. George Rajnus. Altitude 4,160 ft. Drilled by John A. Van Meter, 1965. Casing: 6-in. diam to 18 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Sandstone, brown	15	15
Shale, blue, hard	100	115
Shale, blue, medium-hard	62	177

40S/11E-1caa. William Rajnus. Altitude 4,142 ft. Drilled by John A. Van Meter, 1967. Casing: 6-in. diam to 19 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Hardpan	2	5
Shale, brown, hard	22	27
Shale, blue	8	135
Shale, gray	25	160
Shale, gray, hard	10	170

40S/11E-3aaa. Melvin Feigi. Altitude 4,110 ft. Drilled to 722 ft by Clyde Van Meter, 1942; deepened later to 960 ft. Casing: 8-in. diam to 62 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Chalk; seep at 75 ft	93	95
Sandstone, water-bearing	2	97
Chalk	55	152
Sandstone, water-bearing	1	153
Chalk	200	353
"Limestone," blue, hard, water-bearing	16	369
Chalk, sticky	171	540
Shale and chalk, layered	62	602
Slate, hard	5	607
Chalk and slate, layered	53	660
"Limerock," hard	22	682
Slate, hard	20	702
Shale, hard, water-bearing	20	722
No record	238	960

40S/11E-4bba2. Dale Bebber. Altitude 4,175 ft. Drilled by James A. Roberts, 1960. Casing: 8-in. diam to 26 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Boulders, small, and soil	3	3
Shale, yellow	20	23
Shale, green	62	85
Shale, sandy, water-bearing (2 gpm)	2	87

40S/11E-4bba2.--Continued

Materials	Thickness (feet)	Depth (feet)
Shale, green	33	120
Shale, gray	10	130
Shale, green	242	372
Shale, gray, hard	4	376
Shale, green, sandy, water-bearing (3 gpm)	3	379
Shale, green	191	570
Shale, green, sandy, water-bearing (2 gpm)	3	573
Shale, green	70	643
Basalt rock, black	24	667
Lava rock, brown	4	671
Basalt rock, black	8	679
Sand, black, water-bearing (16 gpm)	3	682

40S/11E-11bad. A. W. Schaupp. Altitude 4,147 ft. Drilled by J. A. Roberts, 1952

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Sandstone	15	20
Chalk	465	485
Rock	17	502
Chalk	126	628
Rock	98	726
Chalk, sandy	9	735
Rock	6	741
Chalk, sandy	5	746
Rock	8	754
Chalk	53	807
Rock	29	836
Chalk	19	855
Rock, alternating with thin chalk layers	107	962
Rock	19	981
Chalk	4	985
Rock	3	988
Chalk	4	992

40S/11E-12aad. W. J. Rajnus, Jr. Altitude 4,152 ft. Drilled by John A. Van Meter to 662 ft in 1961; deepened to 689 ft in 1964. Casing: 18-in. diam to 21 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Sandstone	6	11
Clay, gray	69	80
Shale, gray	5	85
Sandstone	7	92
Lava, black	18	110
Lava, crevice	9	119
Lava, black, broken	32	151
Lava, black	153	304
Basalt, blue	155	459
Lava, gray, and green clay	39	498
Clay, green, and sandstone	42	540
Shale, sandy	35	575
Mud, bronw	64	639
Sand, black, loose	4	643
Rock, creviced	19	662
Lava, gray, broken	27	689

Table 10.--Drillers' logs of representative wells--Continued

POE VALLEY--Continued

40S/11E-13bcd. Carl Rajnus. Altitude 4,230 ft. Drilled by John A. Van Meter, 1956(?). Casing: 16-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Old well	481	481
Lava, burnt, and gravel	4	485
Lava boulders, cindery, and mud	12	497
Mud, gray, and small boulders	18	515
Clay, brown, and gravel	4	519
Lava, gray	7	526
Mud, gravel, and boulders	6	532
Lava, gray	5	537
Mud and boulders	38	575
Lava, gray	5	580
Lava, cindery, and mud	8	588
Lava, gray	1	589
Lava, cindery, and mud	5	594
Lava, gray	8	602
Mud and boulders	5	607
Lava, gray	4	611
Conglomerate	20	631
Lava boulders, gray and red	7½	638½
Mud and boulders	26½	665
Lava, broken, and gravel and sand	12	677
Basalt, gray	8	685
Sand and cinders	6	691
Lava, gray	23	714
Boulders and mud	10	724
Basalt, gray, very hard	12	736

40S/11E-13bda1. Carl Rajnus. Altitude 4,195 ft. Drilled to 302 ft by Charles Hartley in 1952; deepened to 500 ft by John A. Van Meter in 1956. Casing: 12-in. diam to 272 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil and brown sandstone	20	20
Shale, yellow, hard	40	60
Shale, blue, hard	30	90
Shale, green, hard	30	120
Clay	60	180
Gravel	1	181
Clay	24	205
Basalt boulders and clay	14	219
Basalt and red mud or clay	26	245
Boulders and clay	16	261
Basalt	41	302
Lava, broken	13	315
Lava, gray, solid	12	327
Boulders and mud	3	330
Lava, gray	24	354
Gravel and mud	11	365
Lava, gray	2	367
Lava, cindery	21	388
Lava, gray, creviced, water-bearing	8	396
Lava, rotten	3	399
Sand and gravel	6	405
Sand and cinders	5	410
Lava, gray	11	421
Cinders and broken lava	22½	443½
Lava, porous, water-bearing	15½	459
Sand, coarse	2	461
Lava, black, creviced, water-bearing	14	475
Lava, gray, creviced	9	484
Sandstone, brown	6	490
Sand, brown, and cinders, mud, and small boulders	7	497
Lava, gray	3	500

40S/11E-13bda2. Carl Rajnus. Altitude 4,204 ft. Drilled before 1954; driller unknown. Casing: Unknown

Materials	Thickness (feet)	Depth (feet)
Sandstone, hard	16	16
Shale, hard	19	35
Lava, black, hard	37	72
Sand, black	1	73
Lava, black, hard	22	95
Lava, dark-colored, soft	37	132
Clay, black	3	135
Lava, hard	25	160
Shale, brown	14	174

40S/11E 13bda2.--Continued

Materials	Thickness (feet)	Depth (feet)
Shale, black and brown	41	215
Lava, hard, clean	12	227
Shale, soft	5	232
Lava, blue	13	245

40S/12E-7bad. L. D. Cogley. Altitude 4,200 ft. Drilled by E. E. Storey Well Drilling, 1963. Casing: 6-in. diam to 41 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Clay, yellow, and boulders	23	25
Basalt, brown	35	60
Basalt, gray	80	140
Basalt, gray, broken	1	141

40S/12E-7bdb. L. D. Cogley. Altitude 4,190 ft. Drilled by John A. Van Meter, 1965. Casing: 16-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	½	½
Lava, black, decomposed, and clay	51½	52
Shale, brown, and green clay	3	55
Shale, black	13	68
Shale, brown, and green clay	17	85
Shale, black	55	140
Shale, brown	33	173
Shale, dark-brown, and clay	8	181
Clay, green, and black shale	33	214
Lava, black, and blue clay	23	237
Shale, brown, and blue clay	7	244
Lava, black, and blue clay	52	296
Shale, brown, and yellow clay	114	410
Sandstone, green	76	486
Shale, brown	24	510
Sandstone, green	5	515
Shale, gray-green, hard	88	603
Clay, yellow, and black shale	7	610
Shale, gray, and green mud	20	630
Shale, brown and gray	72	702

40S/12E-18aad. W. J. Rajnus, Jr. Altitude 4,175 ft. Drilled by J. S. Wilson, 1950. Casing: 16-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Soil and sandy clay	6	6
Rock, gray and dark-blue	24	30
Rock, black and green	30	60
Shale, brown	5	65
Sand and gravel, black	10	75
Sandstone, brown	8	83
Rock and gravel	41	124
Cinders, red	9	133
Basalt	49	182
Cinders	17	199
Rock, with seams	11	210
Gravel, brown, and shells of rock	46	256
Rock, gray, hard	9	265
Sandstone, black	5	270
Rock, gray; seams	3	273
Sand, fine	7	280
Rock, black	15	295
Shale, brown	27	322
Crevices	15	337
Shale	158	495
Crevices	10	505
Conglomerate, broken, and shale	45	550
Basalt	--	--

40S/12E-18bbc. W. J. Rajnus, Jr. Altitude 4,174 ft. Drilled by J. S. Wilson, 1947. Casing: 6-in. diam to 6 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Gravel	5	5
Chalk, yellow, blue, and green	65	70
Chalk, blue-black	80	150
Sand, black and white, water-bearing (1 gpm)	15	165
Chalk, gray	22	187
Sand, black, water-bearing	6	193

Table 10.--Drillers' logs of representative wells--Continued

LANGELL VALLEY

39S/11E-2dca. D. J. Horsley. Altitude 4,180 ft. Drilled by W. L. Hartley & Son, 1967. Casing: 16-in. diam to 145 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Chalk	124	130
Rock	166	296

39S/11E-10ccb. Bob Hartley. Altitude 4,110 ft. Drilled by owner, 1946. Casing: 6-in. diam to 40 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	8	8
Quicksand	7	15
Chalk, yellow	23	38
Chalk, green	122	160
Sandstone, brown	3	163
Lava, brown, water-bearing	3	166

39S/11E-12dba. Art Davina. Altitude 4,240 ft. Drilled by W. L. Hartley & Son, 1965. Casing: 12-in. diam to 160 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Lava rock	3	3
Clay	38	41
Lava rock	113	154
Clay	8	162
Lava rock	68	230
Clay	21	251
Lava rock	22	273
Clay	4	277
Lava rock, water-bearing	52	329

39S/11E-26abd1. H. D. Knox. Altitude 4,225 ft. Drilled by E. E. Storey Well Drilling, 1964. Casing: 16-in. diam to 63 ft; perforated 50-62 ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Clay, yellow, and gravel	5	8
Sandstone, brown	24	32
Clay, black, and cinders	19	51
Boulders, small, and brown clay	8	59
Clay, brown	5	64
Basalt, gray	74	138
Clay, yellow and black, and gravel	20	158
Basalt, gray	23	181
Shale, brown	4	185
Basalt, gray	11	196
Gravel, fine	2	198
Lava, brown	3	201
Basalt, gray	9	210
Shale, brown	2	212
Lava, red and brown	7	219
Cinders, black	2	221
Clay, brown	5	226
Basalt, gray	9	235
Lava, black and red	65	300
Shale, gray	10	310
Lava, black and red	70	380
Basalt, gray	2	382
Basalt, black and red	83	465
Shale, gray	5	470
Lava, black	14	484
Lava, black, broken	8	492
Basalt, gray	18	510
Lava, red and brown	75	585
Lava, red, with streaks of green shale	20	605
Lava, black and red	28	633
Basalt, gray	17	650
Lava, red	4	654
Basalt, gray	36	690
Lava, red	5	695
Basalt, gray	45	740
Lava, black and red	30	770
Basalt, gray	18	788
Lava, red	7	795
Basalt, gray	54	849
Lava, red	6	855
Basalt, gray	115	970
Basalt, gray, with streaks of red lava	22	992

39S/11E-26abd1.--Continued

Materials	Thickness (feet)	Depth (feet)
Basalt, gray, with streaks of red lava	10	1,002
Basalt, gray	127	1,129
Basalt, gray, broken, water-bearing	3	1,132
Basalt, gray	20	1,152
Basalt, gray, with streaks of red lava	16	1,168
Basalt, gray	15	1,183
Basalt, gray, crevice filled with black sand	6	1,189
Basalt, gray	7	1,196
Shale, gray	6	1,202
Basalt, gray	23	1,225

39S/11E-26aca. H. D. Knox. Altitude 4,225 ft. Drilled by K. S. K. Drilling, 1966. Casing: 12-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Sandy, brown	8	8
Boulders	112	120
Claystone, blue, medium-soft	80	200
Claystone, gray, hard	200	400
Sand, medium, water-bearing	70	470

39S/11E-26dbb. J. C. Stevenson, Jr. Altitude 4,255 ft. Drilled by Enloe Drilling Co., 1962. Casing: 8-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Clay, yellow	25	28
Clay, green, and sand	7	35
Shale	10	45
Clay and sand	5	50
Rock, gray	48	98
Sandstone	15	113
Clay, gray, with sand	32	145
Clay, brown and yellow	52	197
Clay, green and yellow	28	225
Clay, gray and brown	22	247
Lava rock, black	12	259
Basalt, gray, hard	37	296
Lava, broken	4	300
Clay, gray and brown	69	369
Sandstone	119	488

39S/11E-36abb. J. C. Stevenson, Inc. Altitude 4,240 ft. Drilled by Enloe Drilling Co., 1964. Casing: 20-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	8	8
Lava, reddish-brown	3	11
Lava, black	10	21
Lava rock, brown	3	24
Lava, black and red	27	51
Lava rock, black	41	92
Lava, brown	14	106
Lava, black	138	244
Lava, black and red	105	349
Lava, black, very hard	12	361

39S/12E-7cba. Rock Creek Ranch. Altitude 4,200 ft. Drilled by W. L. Hartley & Son, 1951. Casing: 16-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Chalk	142	142
Lava rock	115	257

Table 10.--Drillers' logs of representative wells--Continued

LANGELL VALLEY--Continued

39S/12E-16cac. Harold Williams. Altitude 4,190 ft. Drilled by W. L. Hartley & Son, 1961. Casing: 12-in. diam to 272 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Chalk	96	100
Sandstone, black	80	180
Chalk	50	230
Sand, dry	10	240
Chalk	35	275
Lava rock	60	335
Sandstone	6	341
Lava rock	221	562
Lava rock, red	113	675
Lava, broken	33	708
Cinders, red, and lava rock	22	730

39S/12E-17aab. Harold Williams. Altitude 4,190 ft. Drilled by W. L. Hartley & Son, 1964. Casing: 16-in. diam to 130 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Sandstone, yellow	15	20
Clay, yellow	15	35
Sandstone, brown	73	108
Clay, pink	7	115
Lava rock	115	230
Basalt rock	40	270
Lava rock	195	465
Basalt rock	50	515
Lava rock	105	620
Basalt rock	50	670
Clay and cinders	4	674
Sandstone, yellow	12	686
Lava rock, water-bearing	22	708

39S/12E-21bdb. R. E. Evatt. Altitude 4,235 ft. Drilled by Charles Hartley Well Drilling, 1969. Casing: Cased to unknown depth; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Clay, yellow, and gravel	7	10
Rock	3	13
Clay, yellow, and boulders	13	26
Rock, blue	25	51
Clay, blue	12	63
Pumice, white	6	69
Rock, blue-gray	5	74
Clay, blue and yellow	41	115
Rock	45	160
Clay, blue	4	164
Rock	11	175
Clay, blue	4	179
Rock	9	188
Clay, blue	6	194
Rock	8	202
Clay, brown, sandy	6	208
Clay, blue	24	232
Rock	69	301
Clay, red	7	308
Rock	2	310
Clay, blue, hard	32	342
Rock, blue	9	351
Clay, yellow, hard	19	370
Rock, red	70	440
Cinders, red, water-bearing	--	--

39S/13E-29cdb. E. H. Kent. Altitude 4,350 ft. Drilled by E. E. Storey Well Drilling, 1969 and 1970. Casing: 8-in. diam to 19 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil and boulders	3	3
Basalt, gray	22	25
Shale, yellow	3	28
Lava, red	27	55
Basalt, black	52	107
Lava, red	6	113
Basalt, black	43	156
Lava, red	5	161

39S/13E-29cdb.--Continued

Materials	Thickness (feet)	Depth (feet)
Basalt, black	20	181
Lava, brown and red	93	274
Basalt, black	16	290
Lava, black and red	36	326
Basalt, black and gray	35	361
Lava, brown	7	368
Basalt, gray	22	390
Lava, brown	101	491
Chalk, yellow	24	515
Lava, brown, hard	32	547
Shale, green	28	575
Shale, green, with streaks of decomposed brown lava; water-bearing	134	709
Shale, green	10	719

39S/13E-30dcd1. M. D. Settle. Altitude 4,310 ft. Drilled by W. L. Hartley, 1948. Casing: 16-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Soil and sand	50	50
Rock, broken	230	280

40S/13E-13ddd. R. W. Welch. Altitude 4,137 ft. Drilled by John A. Van Meter, 1965. Casing: 6-in. diam to 50 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	1½	1½
Hardpan	1½	3
Sand and some layers of clay	43	46
Clay, green	14	61
Sand, coarse	24	85
Clay, gray, and sand, layered	17	102

40S/14E-7dab. William Gardner. Altitude 4,165 ft. Drilled by John A. Van Meter, 1966. Casing: 6-in. diam to 19 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil and cobblestone	1½	1½
Hardpan	5	6½
Lava boulders, gray, hard	6	12½
Hardpan	2½	15
Boulders and clay	1	16
Lava, gray, hard	3	19
Clay and sand	4	23
Lava, gray	18½	41½
Sand, black, coarse	1	42½
Sandstone, medium-hard	27½	70
Basalt, blue, hard	1	71
Sand and clay	1	72
Sandstone	3	75
Basalt, gray	4	79
Basalt and sand; crevice	1	80
Sandstone	1	81

Table 10.--Drillers' logs of representative wells--Continued

LANGELL VALLEY--Continued

40S/14E-16aba. Charles and Silas Kilgore. Altitude 4,320 ft. Drilled by Ken Hartley Well Drilling, 1962. Casing: 12-in. diam to 365 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	½	½
Hardpan, yellow	3½	4
Shale, yellow, sandy	16	20
Basalt boulders, extremely hard, imbedded in soft clay	75	95
Lava, red, and volcanic ash	19	114
Lava, black, cemented with brown sandy ash	24	138
Lava, gray	9	147
Lava, brown, porous, dry	21	168
Ash, brown, volcanic	10	178
Basalt boulders, greenish	14	192
Tuff, brown, volcanic	17	209
Basalt boulders, blue, porous	5	214
Ash, brown, sandy	2	216
Basalt boulders, caving	21	237
Tuff, red, volcanic	4	241
Basalt boulders	16	257
Ash, red, volcanic	35	292
Clay or ash, buckskin color	24	316
Clay or ash, brown, with greenish-white specks	6	322
Clay, brown	18	340
Clay, light-colored, sticky	6	346
Lava rock, black, dense	9	355
Lava, brown	20	375
Lava, black, porous, water-bearing; water level dropped from 84 ft to 178 ft	7	382
Lava, black, dense	8	390
Lava, brown	13	403
Lava, blue, dense, with bubble holes; trace of sand	16	419
Lava, red	6	425

40S/14E-19aab. Norman Jacob. Altitude 4,168 ft. Drilled by John A. Van Meter, 1965. Casing: 6-in. diam to 23 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Lava, bubbly	9	9
Lava, gray	43	52
Lava, gray, broken	62	114
Lava, brown	4	118
Sandstone, brown, hard	28	146

41S/13E-1cbc. Frank Grohs. Altitude 4,140 ft. Drilled by Powell Well Drilling, 1959. Casing: 6-in. diam to 40 ft; perforated 10-40 ft

Materials	Thickness (feet)	Depth (feet)
Sandstone	5	5
Sand and gravel	17	22
Clay, tan	16	38
Rock	5	43

41S/13E-13dbb. John Hellekson. Altitude 4,160 ft. Drilled by Powell Well Drilling, 1959. Casing: 6-in. diam to 75 ft; perforated 50-73 ft

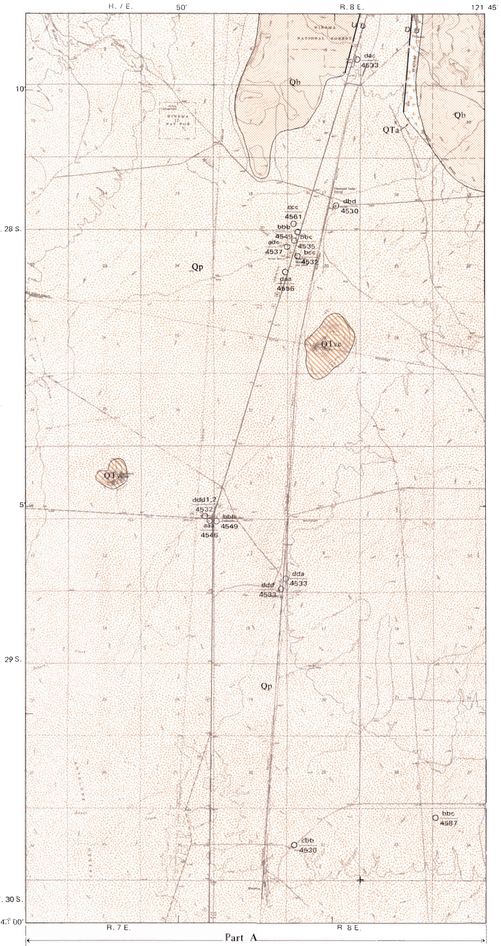
Materials	Thickness (feet)	Depth (feet)
Soil	8	8
Sandstone	27	35
Sand and gravel, water-bearing	40	75

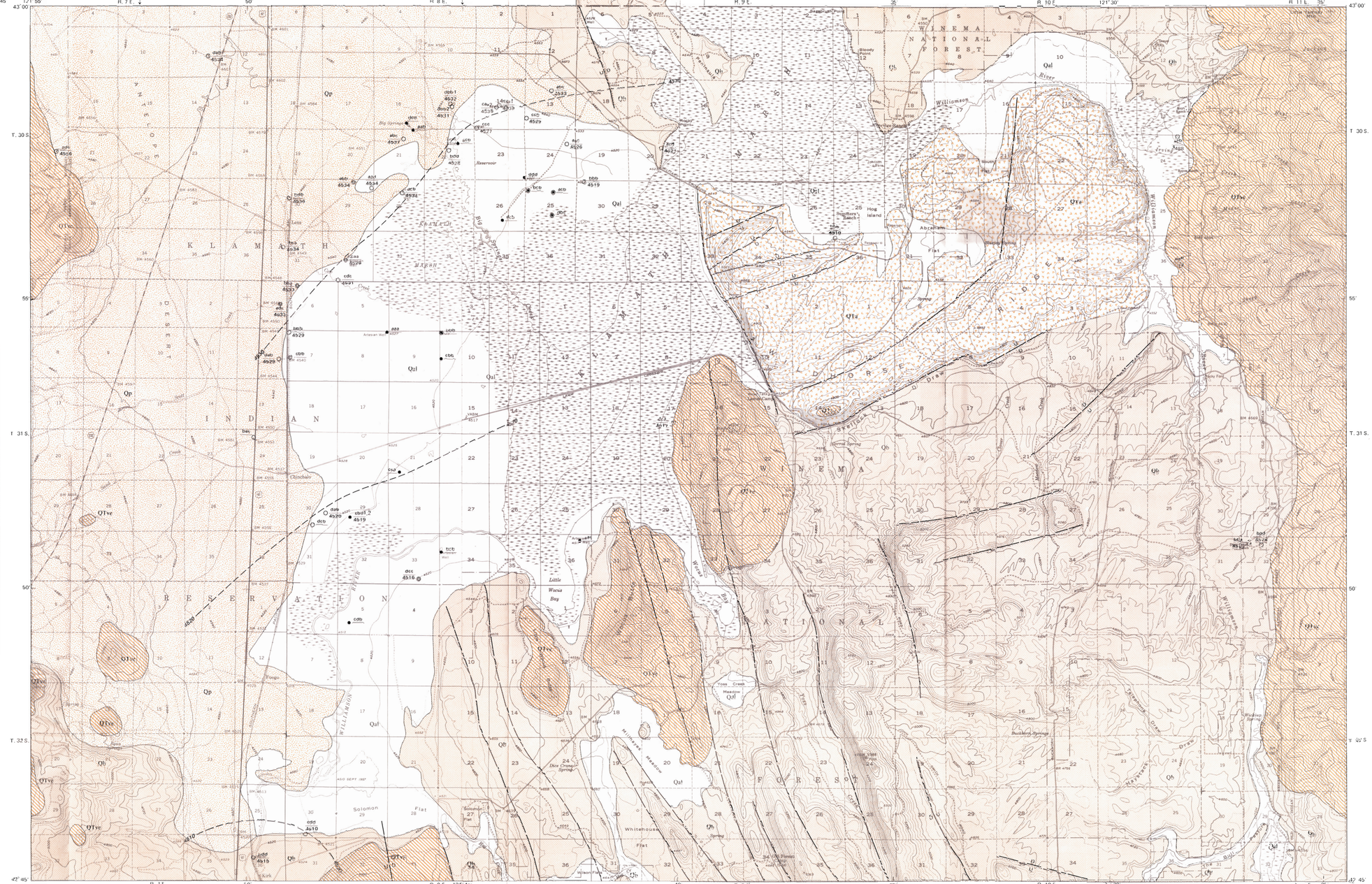
41S/14E-8cca. Charles Kilgore. Altitude 4,165 ft. Drilled by Fred Hilton; date unknown. Casing: 16-in. diam to 210 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Rock	70	70
Basalt breccia, water-bearing	2	72
Basalt, hard	98	170
Basalt breccia, water-bearing	8	178
Basalt, hard	32	210

OREGON STATE ENGINEER
GROUND WATER REPORT NO. 21

Prepared in cooperation with the
UNITED STATES GEOLOGICAL SURVEY





Base from U.S. Geological Survey
Scale 1:24,000 Chemult, Mazama, 1967; Round Butte, 1968.
Scale 1:62,500 Klamath Marsh, Lenz, 1955; Yamsay Mtn. 1960

SCALE 1:62500

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 1967

Geology after unpublished mapping by N. V. Peterson and J. R. McIntyre, Oregon Dept. Geol. and Min. Ind.

EXPLANATION

Holocene

Qp — Pumice

Airborne and flow pumice ejected from ancestral Mount Mazama. In part is younger than most of the alluvium (Qal). Consists of a widespread generally unconsolidated to poorly consolidated mantle on the slopes and plains west and north of Klamath Marsh. Generally above water table but serves as an excellent medium for the infiltration of water from the surface

Pleistocene and Holocene

Qal — Alluvium

Silt, sand, clay, peat, volcanic ash, pumice, and gravel. Thin and above the water table in most areas mapped. Locally yields moderate to large supplies from gravel layers beneath younger pumice west and northwest of Klamath Marsh

Qb — Basalt flows

Widespread thin flows of gray, vesicular basalt in units 20-50 feet thick. Form terraces and cap lower slopes around the marsh and adjacent lowland. Generally fractured and permeable, but above the regional water table in most places. Generally serve as a recharge unit, but may supply small yields locally to wells where base of unit extends below water table

Pliocene and Pleistocene

QTa — Andesitic lava flows

Dark, platy andesitic flows forming the splendid cone of the main part of Klamath Marsh. May have been contemporaneous with the basaltic flows farther south. Tight rocks apparently lacking much water-bearing capacity

QTve — Rocks of volcanic eruptive centers

Eruptive and shallow intrusive rocks of many eruptive centers. Include basaltic andesite, and light-colored rocks such as rhyolite and dacite. Form the main mass and lower slopes of several major mountains as well as small cinder cones and domes. Some mainly as recharge areas, but yield small to moderate supplies to domestic wells along Highway 97 and large supplies to irrigation wells on west side of Klamath Marsh

QUATERNARY

TERTIARY AND QUATERNARY

Contact

Fault
U, upthrown side; D, downthrown side

— — 4140 — —
Water-level contour
Shows altitude of water level. Contour interval 10 feet. Datum is mean sea level

Flowing well

Nonflowing well

Outside circle indicates irrigation well

abcd — *Well identification*
4167 — *Altitude of water level, in feet as of April-May, 1970*

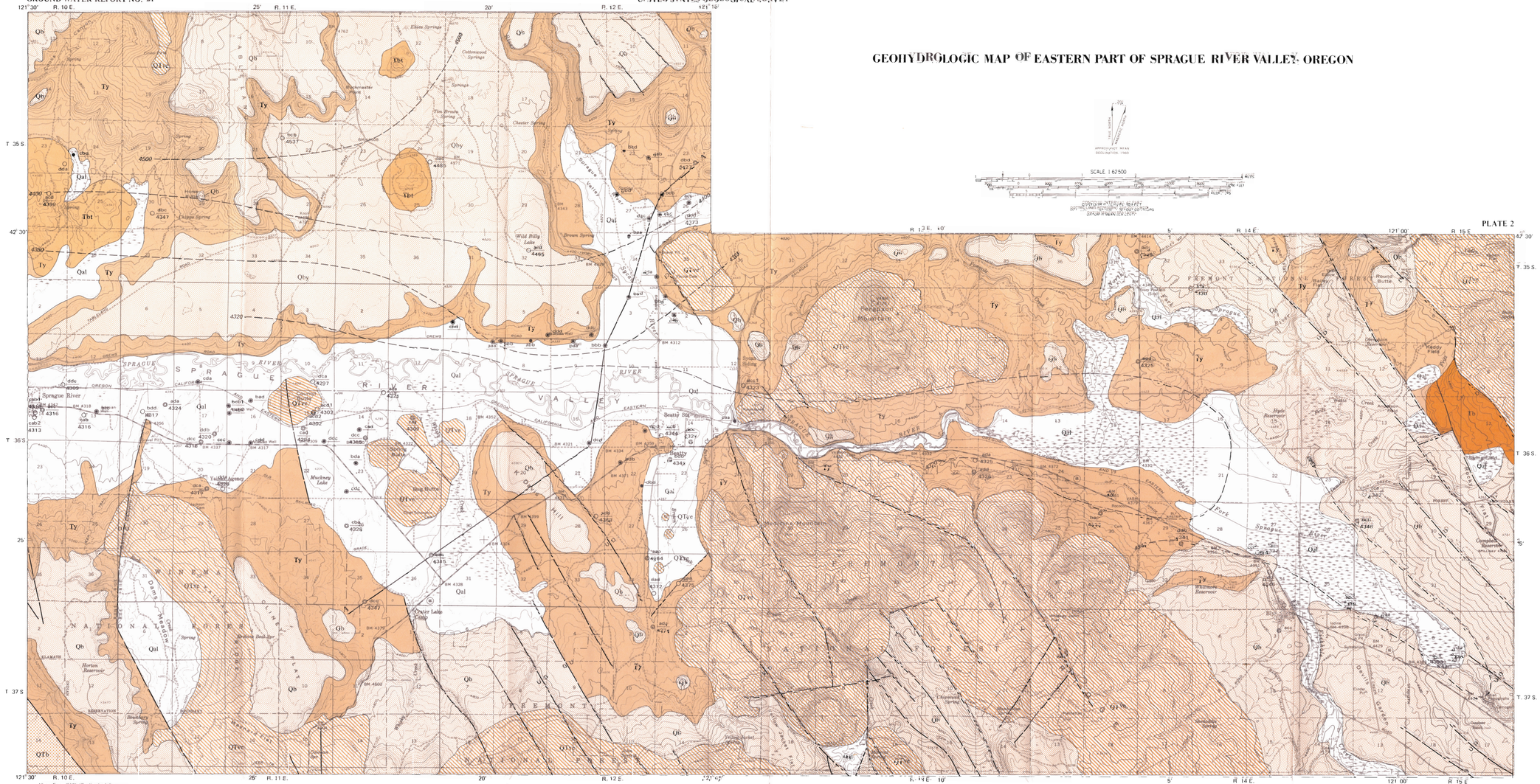
GEOHYDROLOGIC MAP OF KLAMATH MARSH AREA, OREGON

OREGON STATE ENGINEER
GROUND WATER REPORT NO. 21

Prepared in cooperation with the
UNITED STATES GEOLOGICAL SURVEY

GEOHYDROLOGIC MAP OF EASTERN PART OF SPRAGUE RIVER VALLEY, OREGON

PLATE 2



Base from U.S. Geological Survey
Scale 1:62,500: Chiloquin Mtn, Bly, Beatty, Fishhole Mtn, 1966

Geology after unpublished mapping
by N. V. Peterson and J. R. McIntyre,
Oregon Dept. Geol. and Min. Ind.

EXPLANATION

QUATERNARY

Holocene and Pleistocene

Qal — Alluvium

Silt, sand, clay, peat, volcanic ash, pumice, gravel, and some slope debris near escarpments. Thin and above the water table along most of Sprague River Valley.

Qby / Qb — Basalt flows

Qb, widespread thin flows of gray, vesicular basalt in units 20-30 feet thick. Form mesas and cap slopes around valley. Generally fractured and permeable. Dual above the regional water table in most places. Generally serve as a recharge unit. Qby, younger basalt flows underlying Knott Tableland north of the Sprague River in mapped area.

QTvc — Basalt, breccia, and pyroclastic rocks

A thick sequence of basaltic flows, breccia, and pyroclastic rocks which locally may contain flows of the lower basalt (Tb) or Quaternary basalt (Qb), or may be interfingered with lacustrine beds of Yonna Formation. No wells penetrate units in mapped area.

QTvr — Rocks of volcanic eruptive centers

Eruptive and shallow intrusive rocks of major eruptive centers, including basaltic andesite, and highly vesicular, dense, sub-vitreous dacite. Form the main mass and lower slopes of several major mountains as well as small pebble and cinder cones. Serve mainly as a recharge unit in mapped area.

TERTIARY AND QUATERNARY

Pliocene and Miocene

Ty — Yonna Formation

Stratified siltstone, diatomite, sandstone, pumice, gravel, and tuff, largely of lacustrine origin and referred to the Yonna Formation. Locally includes welded tuff beds or interbedded thin lava flows. Fine-grained beds confine water in underlying aquifers. Coarser beds and lenses locally yield moderate to large quantities of water to wells.

Tbt — Breccia and tuff of volcanic centers

Resistant beds of tuff and volcanic breccia that accumulated near volcanic vents. In part contemporaneous with lacustrine beds of Yonna Formation. Generally broken, jointed, and permeable; yield small to moderate quantities of water to a few wells near town of Sprague River.

Tb — Lower basalt

Basaltic flows, tuff, and breccia. Crops out in only a small area, but underlies the Yonna Formation and Quaternary basalt flows over large area. May be productive aquifer in project area. Interflow zones, dipped vesicular zones, and highly permeable and cavernous zones yield large quantities of water to wells in Sprague River Valley.

Contact

Fault
U, upthrown side; D, downthrown side

A — A
Line of section.

— — 4140 — —
Water-level contour
Shows altitude of water level. Contour interval 10 feet. Datum is mean sea level.

Flowing well

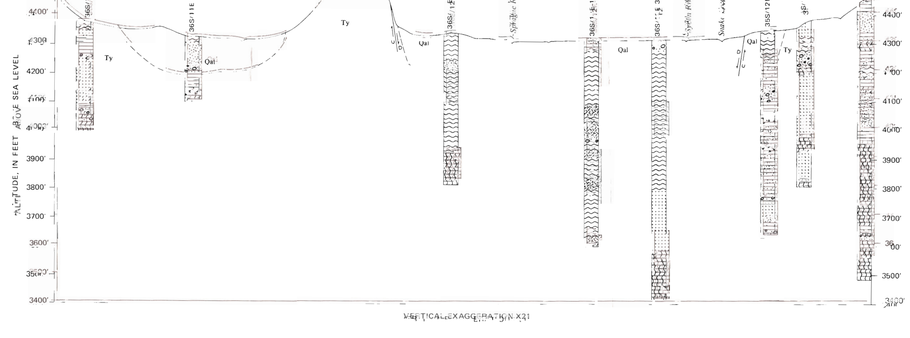
Nonflowing well

Outside circle indicates irrigation well

ada — *Well identification*
4167 — *Altitude of water level, in feet as of April-May, 1970*

Soil
Clay
Sandstone
Sand
Sand and gravel
Diatomite, "chalk," "blue shale"
Pumice
Cinders
Basalt, lava

Log of well (selected)



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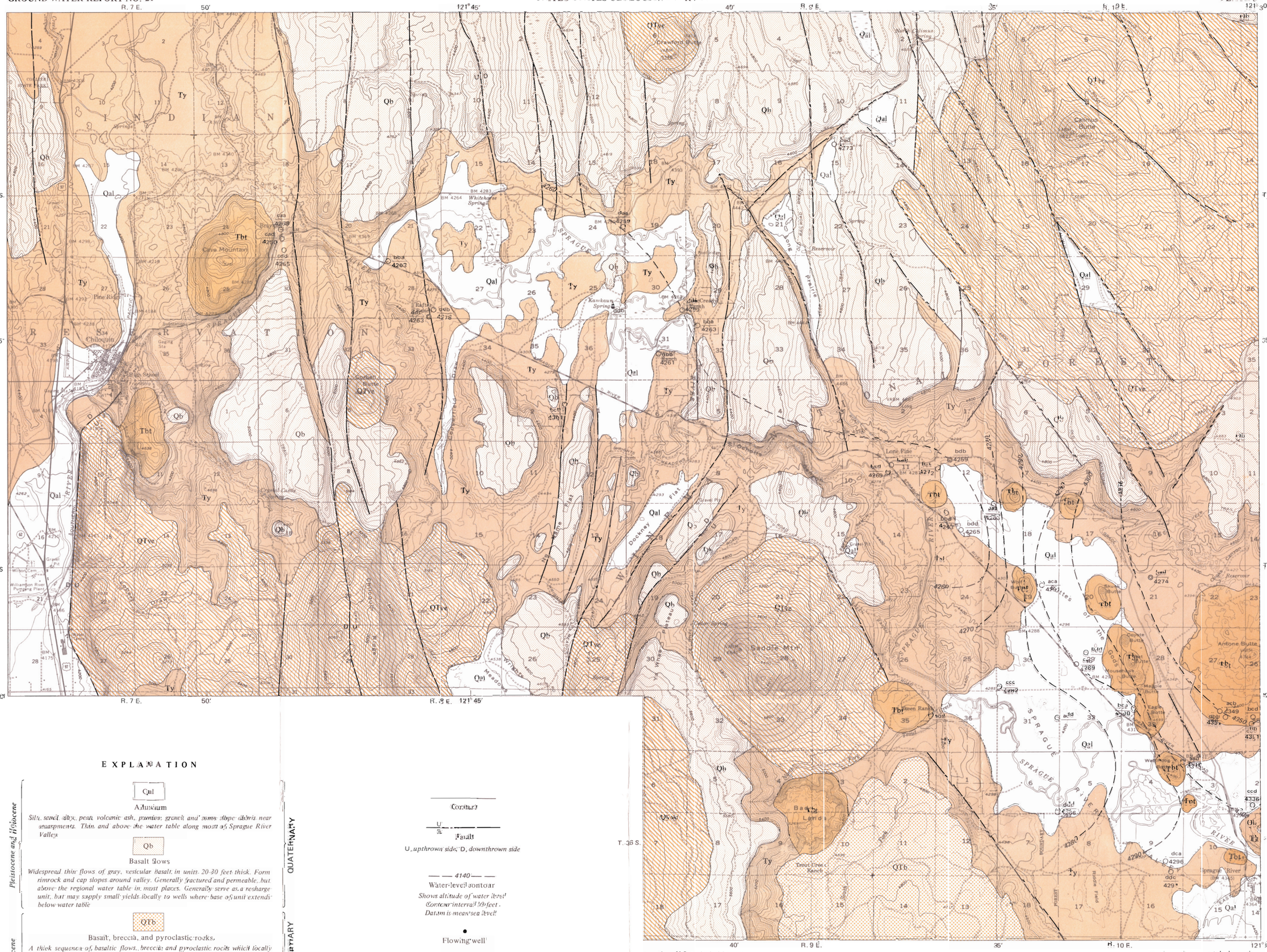


Base from U.S. Geological Survey
Scale 1:62,500: Calimus Butte, 1956; Chiloquin, Swan Lake, 1957

Geology after unpublished mapping by N. V. Peterson and J. R. McIntyre, Oregon Dept. G.S.I. and Min. Ind.

SCALE 1:62,500

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20 FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1957

EXPLANATION

QUATERNARY — *Pleistocene and Holocene*

Qal — Alluvium

Silt, sand, clay, peat, volcanic ash, pumice, gravel, and some slope debris near escarpments. Thin and above the water table along most of Sprague River Valley.

Qb — Basalt flows

Widespread thin flows of gray, vesicular basalt in units 20-30 feet thick. Form rimrock and cap slopes around valley. Generally fractured and permeable, but above the regional water table in most places. Generally serve as a recharge unit, but may supply small yields locally to wells where base of unit extends below water table.

QUATERNARY AND TERTIARY — *Pliocene and Pleistocene*

QTb — Basalt, breccia, and pyroclastic rocks.

A thick sequence of basaltic flows, breccia and pyroclastic rocks which locally may contain flows of the lower basalt (Tb) or Quaternary basalt (Qb), or may interfinger with lacustrine beds of Yonna Formation. No wells penetrate unit in mapped area.

QTve — Rocks of volcanic eruptive centers

Eruptive and shallow intrusive rocks of main eruptive centers. Include basaltic, andesitic, and light-colored rocks such as rhyolite and dacite. Form the main mass and lower slopes of several major mountains as well as small peaks and cones. Serve mainly as a recharge unit in mapped area.

TERTIARY — *Pliocene*

Ty — Yonna Formation

Stratified siltstone, diatomite, sandstone, pumice, gravel, and tuff, largely of lacustrine origin and referred to the Yonna Formation. Locally includes welded tuff beds or interbedded thin lava flows. Fine-grained strata confine water in underlying aquifers. Coarser beds and lavas locally yield moderate to large quantities of water to wells.

Tbt — Breccia and tuff of volcanic vents

Resistant beds of tuff, subvolcanic breccia that accumulated near volcanic vents. Impart contemporaneous with lacustrine beds of Yonna Formation. Generally broken, jointed, and permeable, yield small to moderate quantities of water to a few wells near town of Sprague River.

Contour

Fault

U, upthrown side; D, downthrown side

4140

Water-level contour

Shows altitude of water level. Contour interval 40 feet. Datum is mean sea level.

Flowing well

Nonflowing well

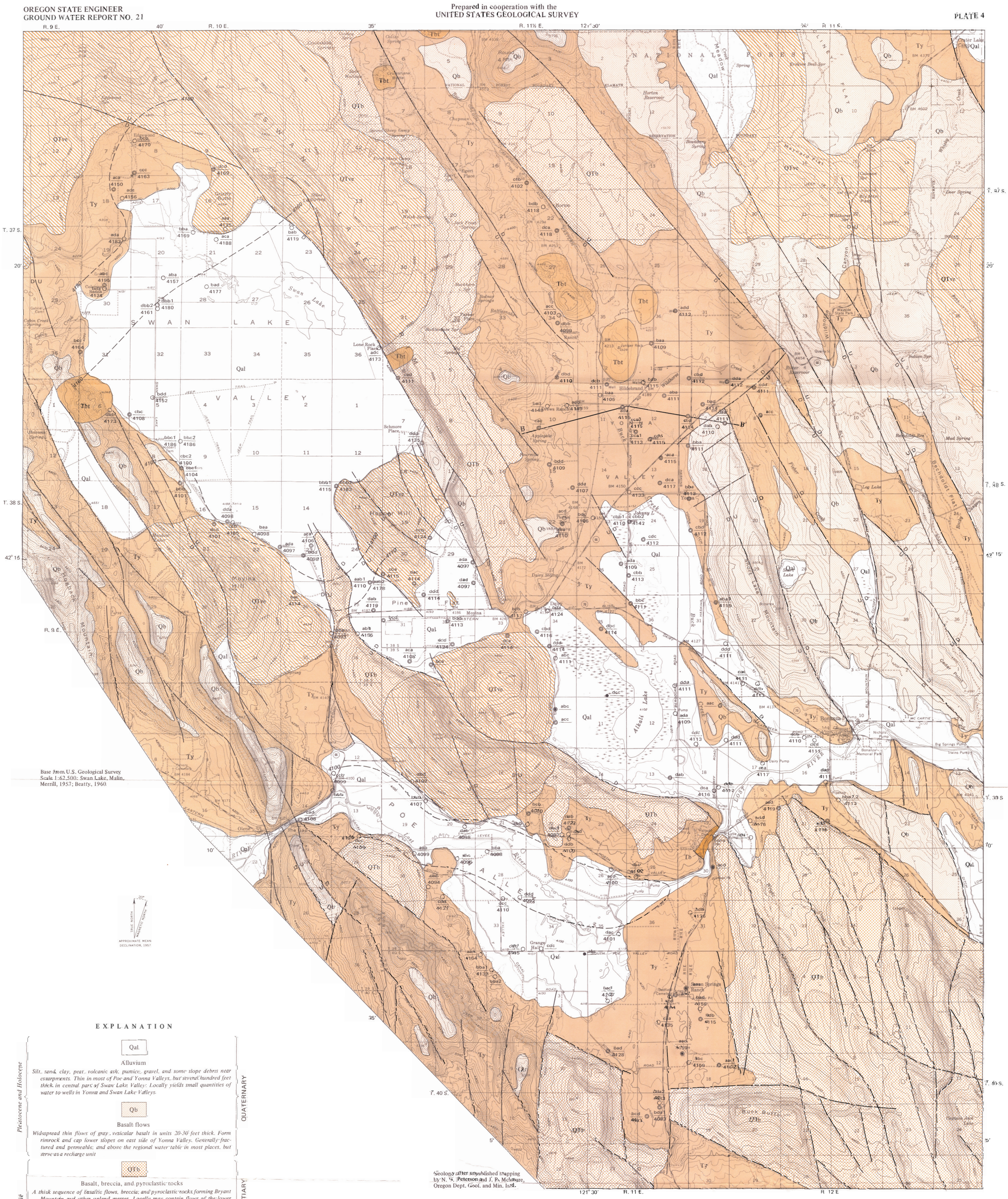
Outside circle indicates irrigation well

ada — *Well identification*

4287 — *Altitude of water level in feet as of April-May, 1959*

GEOHYDROLOGIC MAP OF WESTERN PART OF SPRAGUE RIVER VALLEY, OREGON

Prepared in cooperation with the
UNITED STATES GEOLOGICAL SURVEY



EXPLANATION

QUATERNARY — *Pleistocene and Holocene*

Qal — Alluvium

Silt, sand, clay, peat, volcanic ash, pumice, gravel, and some slope debris near escarpments. Thin in most of Poe and Yonna Valleys, but several hundred feet thick in central part of Swan Lake Valley. Locally yields small quantities of water to wells in Yonna and Swan Lake Valleys.

Qb — Basalt flows

Widespread thin flows of gray, vesicular basalt in units 20-30 feet thick. Form rimrock and cap lower slopes on east side of Yonna Valley. Generally fractured and permeable, and above the regional water table in most places, but serve as a recharge unit.

QUATERNARY AND TERTIARY — *Pliocene and Pleistocene*

QTb — Basalt, breccia, and pyroclastic rocks

A thick sequence of basaltic flows, breccia, and pyroclastic rocks forming Bryant Mountain and other upland masses. Locally may contain flows of the lower basalt (Tb), or Quaternary basalt (Qb), or may interfinger with lacustrine beds of Yonna Formation. Few wells penetrate unit but it may yield water to a few irrigation wells along the east margin of Swan Lake Valley.

QTve — Rocks of volcanic eruptive centers

Eruptive and shallow intrusive rocks of main eruptive centers. Include basaltic, andesitic, and light-colored rocks such as rhyolite and dacite. Form the main mass and lower slopes of several major mountains as well as small peaks and cinder cones. Serve mainly as a recharge unit, but yield small to moderate supplies to a few wells along margins of Swan Lake and Poe Valleys.

TERTIARY — *Pliocene*

Ty — Yonna Formation

Stratified siltstone, diatomite, sandstone, pumice, gravel, and tuff, largely of lacustrine origin and referred to the Yonna Formation. Locally includes welded tuff beds or interbedded thin lava flows. Fine-grained strata confine water in underlying aquifers. Coarse beds and lavas locally yield moderate to large quantities of water to wells.

Tbt — Breccia and tuff of volcanic craters

Highly cliffing resistant beds of tuff and volcanic breccia that accumulated near volcanic vents. In part contemporaneous with lacustrine beds of Yonna Formation. Generally fractured, jointed, and permeable, but not penetrated by wells in mapped area.

Tb — Lower basalt

Basaltic flows, tuff, and breccia. Crops out in only a small area, but underlies the Yonna Formation and Quaternary basalt flows around and beneath valley areas. Most productive aquifer in project area. Interflow zones, jointed lava, and breccia are highly permeable and yield large quantities of water to irrigation wells in Swan Lake, Yonna, and Poe Valleys.

Contact

Fault — U, upthrown side; D, downthrown side

B — B′ Line of section.

4140 Water level contour — Shows altitude of water level. Contour interval varies. Datum is mean sea level.

Flowing well

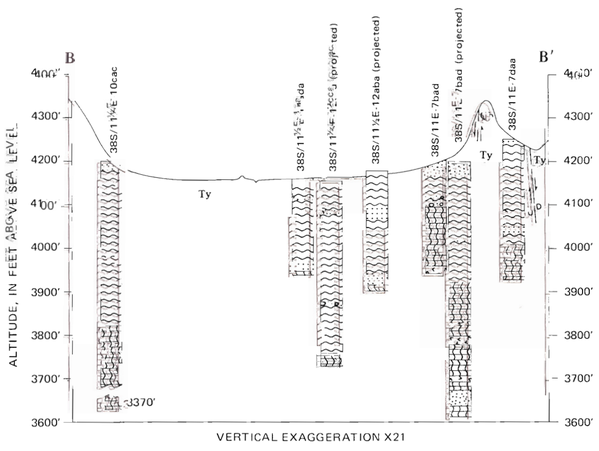
Nonflowing well

Outside circle indicates irrigation well.

ada — Well identification
4167 — Altitude of water level, in feet as of April-May, 1970

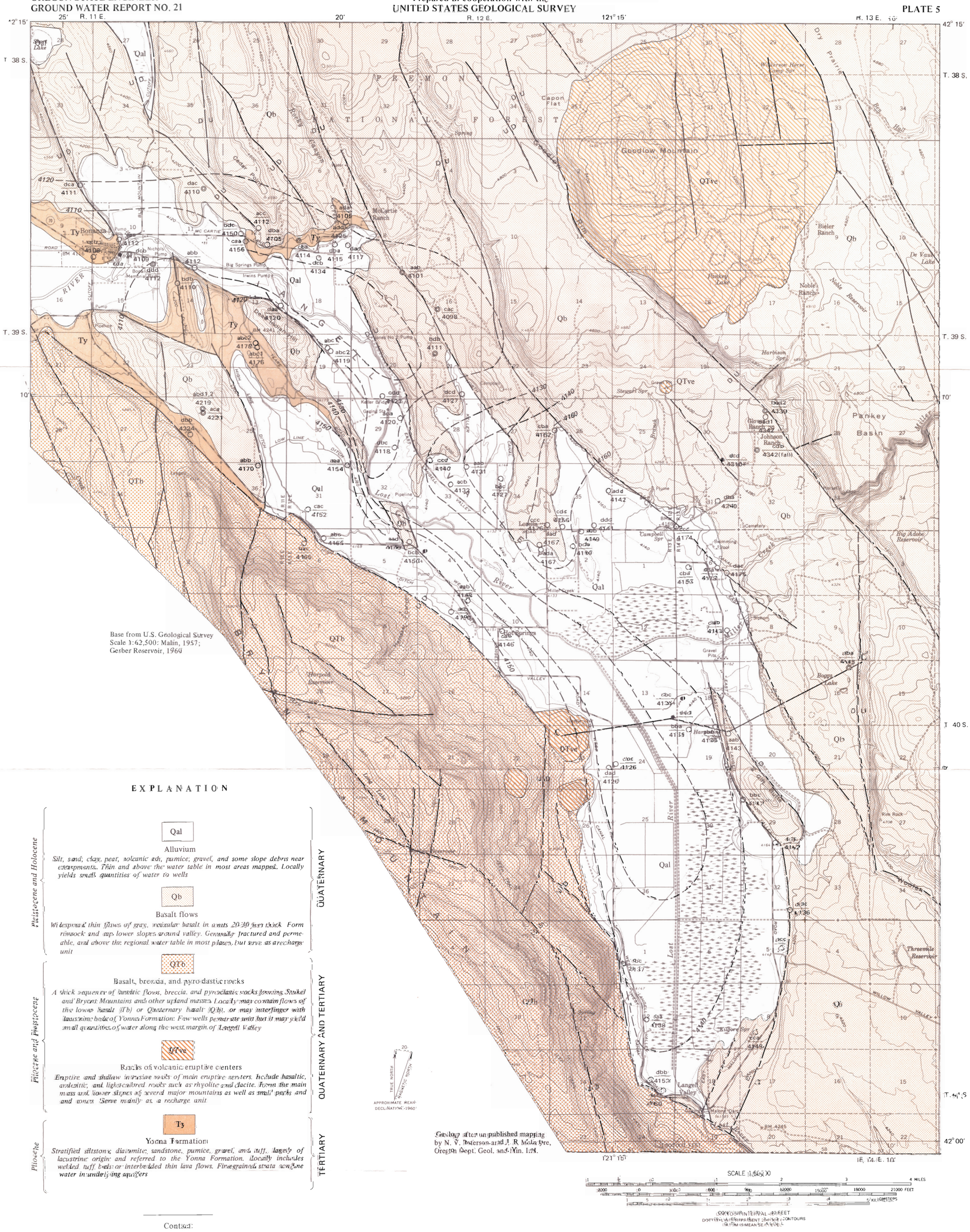
Soil
Sandstone
Sand
Sand and gravel
Diatomite, "chalk," "blue shale"
Cinders
Basalt, lava

Log of well or test hole



GEOHYDROLOGIC MAP OF SWAN LAKE, YONNA, AND POE VALLEYS, OREGON

Prepared in cooperation with the
UNITED STATES GEOLOGICAL SURVEY



Geology after unpublished mapping by N. V. Peterson and J. R. McIntyre, Oregon Dept. Geol. and Min. Ind.

EXPLANATION

QUATERNARY — Pleistocene and Holocene

Qal — Alluvium

Silt, sand, clay, peat, volcanic ash, pumice, gravel, and some slope debris near escarpments. Thin and above the water table in most areas mapped. Locally yields small quantities of water to wells

Qb — Basalt flows

Widespread thin flows of gray, vesicular basalt in units 20-30 feet thick. Form rimrock and cap lower slopes around valley. Generally fractured and permeable, and above the regional water table in most places, but serve as a recharge unit

QUATERNARY AND TERTIARY — Pliocene and Pleistocene

QTb — Basalt, breccia, and pyroclastic rocks

A thick sequence of basaltic flows, breccia, and pyroclastic rocks forming Stukel and Bryant Mountains and other upland masses. Locally may contain flows of the lower basalt (Tb) or Quaternary basalt (Qb), or may interfinger with lacustrine beds of Yonna Formation. Few wells penetrate unit but it may yield small quantities of water along the west margin of Langell Valley

QTve — Rocks of volcanic eruptive centers

Eruptive and shallow intrusive rocks of main eruptive centers. Include basaltic, andesitic, and light-colored rocks such as rhyolite and dacite. Form the main mass and lower slopes of several major mountains as well as small peaks and and cones. Serve mainly as a recharge unit

TERTIARY — Pliocene

Ty — Yonna Formation

Stratified siltstone, diatomite, sandstone, pumice, gravel, and tuff, largely of lacustrine origin and referred to the Yonna Formation. Locally includes welded tuff beds or interbedded thin lava flows. Fine-grained strata confine water in underlying aquifers

Contact

Fault
U, upthrown side; D, downthrown side

C — C′
Line of section

4140
Water-level contour
Shows altitude of water level. Contour interval 40 feet. Datum is mean sea level.

Flowing well

Nonflowing well

Outside circle indicates irrigation well

Well identification

Altitude of water level, in feet as of April-May, 1970

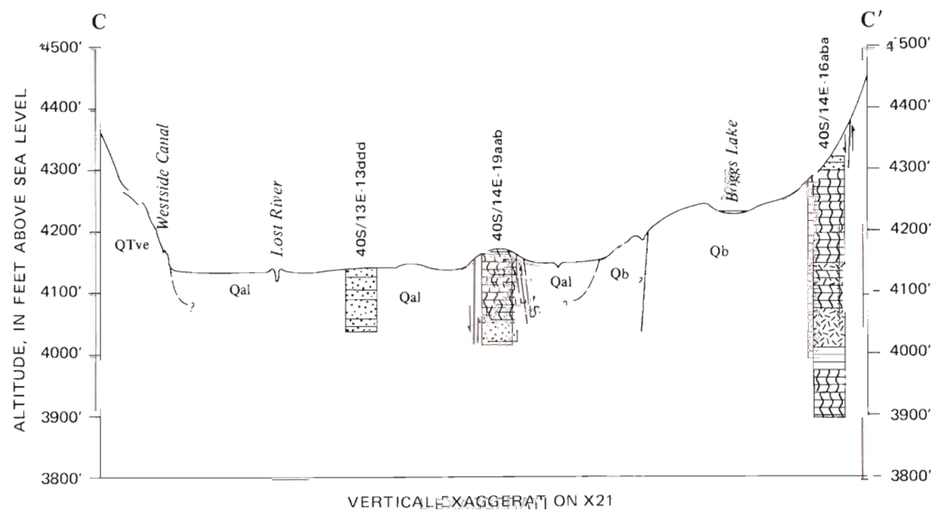
Clay

Sand

Pumice

Basalt, lava

Log of well or test hole



GEOHYDROLOGIC MAP OF LANGELL VALLEY, OREGON