Water Resources of the Umatilla Indian Reservation, Oregon

U.S. GEOLOGICAL SURVEY
Water Resources Investigations 77-3

Prepared in cooperation with the
CONFEDERATED TRIBES OF THE UMATILLA INDIAN RESERVATION

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By J. B. Gonthier and D. D. Harris

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1977

UNITED STATES DEPARTMENT OF THE INTERIOR
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GEOLOGICAL SURVEY
V. E. McKelvey, Director

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CONTENTS

ILLUSTRATIONS

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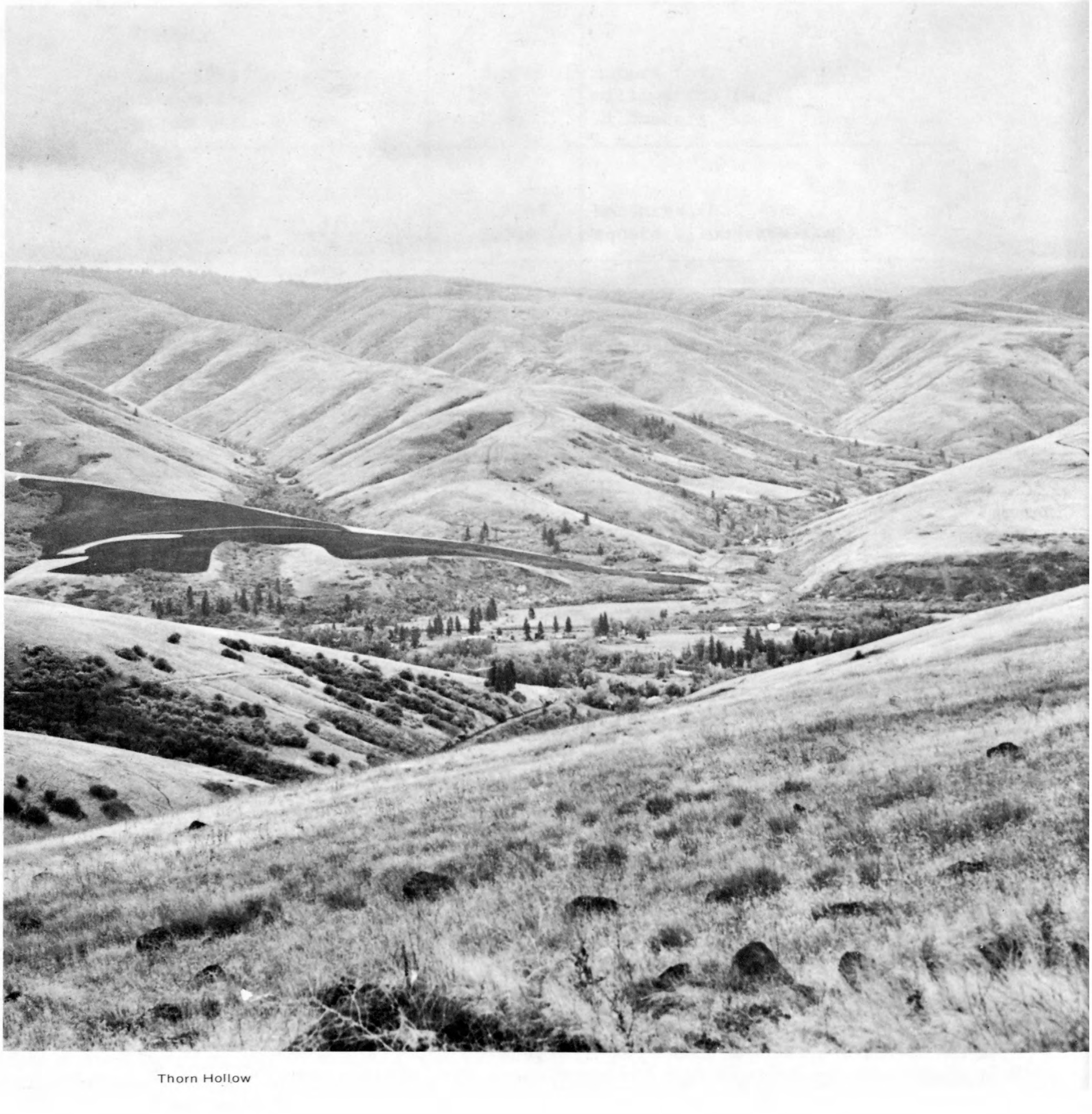
TABLES

FACTORS FOR CONVERTING ENGLISH UNITS TO INTERNATIONAL SYSTEM UNITS (SI)

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

Multiply English units	By	To obtain metric units
Length		
feet (ft)	0.3048	meters (m)
inches (in)	25.4	millimeters (mm)
miles (mi)	1.609	kilometers (km)
Area		
acres	.4047	hectares (ha)
square miles (mi^2)	2.590	square kilometers (km^2)
Volume		
acre-feet (acre-ft)	1233	cubic meters (m^3)
acre-feet (acre-ft)	.001233	cubic hectometers (hm^3)
cubic feet (ft^3)	.02832	cubic meters (m^3)
gallons (gal)	3.785	liters (L)
Mgal (million gallons)	3785	cubic meters (m^3)
Weight		
tons, short (2,000 lb)	.9072	tonnes (t)
tons per square mile ($tons/mi^2$)	.3503	tonnes per square kilometer (t/km^2)
Specific combinations		
cubic feet per second (ft^3/s)	.02832	cubic meters per second (m^3/s)
gallons per minute (gal/min)	.06309	liters per second (L/s)
gallons per minute per foot [(gal/min)/ft]	.2070	liters per second per meter [(L/s)/m]
gallons per minute per foot per foot [(gal/min)/ft/ft]	.06309	liters per second per meter per meter [(L/s)/m/m]
million gallons per day (Mgal/d)	3.785	cubic meters per day (m^3/d)
Temperature		
degrees Fahrenheit (°F)	5/9 after subtracting 32 from value of	degrees Celsius (°C)



Thorn Hollow

WATER RESOURCES OF THE UMATILLA INDIAN RESERVATION, OREGON

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ABSTRACT

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Water resources of the Umatilla Indian Reservation are poorly distributed both geographically and in time. On the reservation, only the Umatilla River and one of its principal tributaries, Meacham Creek, have significant perennial flows. Runoff of the principal streams is largely from snowmelt in the Blue Mountains and is highly variable. The principal aquifers are the Columbia River Basalt Group and the Quaternary alluvium. The basalt underlies the entire reservation to a depth of a few thousand feet, and most wells tap this source. The Quaternary alluvium is present only in the valleys of the principal streams. The alluvium averages about 12 feet (ft) in thickness in the Umatilla River valley, where it has the greatest extent; elsewhere it is generally thinner.

Surface-water outflow from the reservation averages about 600 cubic feet per second (ft^3/s), and the total stream inflow is about 540 ft^3/s. About 480 ft^3/s of the outflow is in the Umatilla River, 106 ft^3/s is in McKay Creek, and 14 ft^3/s is in other streams.

Dependable streamflow, defined here as the 7-day mean low flow that will occur once every 50 years, on the average, is 30 ft^3/s in Umatilla River above Meacham Creek near Gibbon, 5 ft^3/s in Meacham Creek below Line Creek at the east boundary, 33 ft^3/s in Umatilla River at Cayuse, and 14 ft^3/s in Umatilla River at Pendleton. Monthly mean flows in Umatilla River above Meacham Creek near Gibbon in summer and fall frequently are less than the published recommended minimum flows for spawning and rearing of trout; in the reach of the Umatilla River near Pendleton the summer and fall flows generally are below those recommended minimum flows.

Wells in the Columbia River Basalt Group range in depth from a few to 1,910 ft, and their yields range from less than 1 to more than 1,200 gallons per minute (gal/min). Small yields adequate for domestic needs can generally be obtained from the basalt. The depths required for successful wells may be

extremely variable. Evaluation of specific-capacity data from wells in the basalt in four geographic areas suggests that the basalt is more permeable beneath the south reservation and the Umatilla River valley, that the permeability decreases on the north reservation, and that it is least in the Blue Mountains.

Surface and ground waters generally are of good quality and suitable for most uses. Surface water is soft and generally contains less than 120 milligrams per liter (mg/L) of dissolved solids. Dissolved oxygen in streams is generally at or close to saturation levels at most stream temperatures and discharge rates. Ground water ranges from soft to very hard (28 to 280 mg/L), but it generally ranges between moderately hard to hard (61 to 180 mg/L). Dissolved solids in ground water range from 88 to 561 mg/L, but generally are between 200 and about 250 mg/L.

During 1975, an estimated 11 million gallons per day (Mgal/d) of surface and ground water was withdrawn from the reservation for all uses. About 4 Mgal/d was from surface-water sources and 60 percent, or 7 Mgal/d, was from ground-water sources. About 7.2 Mgal/d was used for irrigation, 3.6 Mgal/d for public supply, and the remainder was for domestic and industrial use. About 4 Mgal/d, or 40 percent of the total water withdrawn, was for public supply and for irrigation use outside the reservation boundaries.

Local seasonal declines of ground-water levels of 100 ft or more occur in shallow basalt wells in the Umatilla River valley between Mission and the west boundary. The declines are due chiefly to pumping from many small-capacity shallow wells in the basalt for irrigation of lawns and small acreages of pasture or hay.

Future potential problems on the reservation include regional decline of ground-water levels in the basalt aquifer and local contamination of surface and ground water from accidental spills of deleterious substances.

INTRODUCTION

Water is a resource that is essential for development of the economic and recreation potential of the Umatilla Indian Reservation in eastern Oregon. The climate of the reservation ranges from semiarid to humid; consequently, the geographic and seasonal distribution of the water resources is unequal and highly variable, and the period of large water demands does not coincide with the period of excess water runoff.

Purpose

The purposes of this study are (1) to assess the distribution, availability, and quality of surface and ground waters; (2) to determine the suitability of these waters for use; and (3) to define the existing or potential water-resource-related problems on the Umatilla Indian Reservation. These evaluations will serve as a basis for future planning, development, management, and conservation of these important resources by the Confederated Tribes of the Umatilla Indian Reservation.

Previous Studies

Geology and ground water are described in a general way in a U.S. Geological Survey report (Hogenson, 1964) covering the entire Umatilla River basin, including the Umatilla Indian Reservation. Data reports for stream-water quality and ground-water levels are published annually by the U.S. Geological Survey and by the Oregon Water Resources Department (formerly Oregon State Engineer). Studies of the soils of the Umatilla area were made by Harper and others (1948). The soil mapping on the Umatilla Indian Reservation is being refined by U.S. Bureau of Indian Affairs soil scientists (D. L. Lingle, U.S. Bureau of Indian Affairs, oral commun., 1975). Flood-inundation studies of the Umatilla River flood plain between Pendleton and Gibbon, Oreg., have been completed by the U.S. Army Corps of Engineers (1969, 1971, 1975). Streamflow requirements for maintenance and improvement of salmon and trout populations in the Umatilla Basin were recommended in a report (Smith, 1973) published by the Oregon Game Commission (now the Oregon Department of Fish and Wildlife). A system of storage reservoirs, canals, and dams was proposed by the U.S. Bureau of Reclamation (1959, 1970) to meet the irrigation, water-supply, and recreation needs in the Umatilla Basin.

Acknowledgments

Members of the Confederated Tribes of the Umatilla Indian Reservation, well owners, and well drillers provided the authors with cheerful cooperation and assistance in the collection of field data. Personnel of the U.S. Bureau of Indian Affairs; U.S. Public Health Service, Indian Health Division; the Water Department of the city of Pendleton; and the Umatilla County Watermaster provided data and assistance as well as invaluable discussions on the hydrology of the area.

Geography

The Umatilla Indian Reservation is in east-central Umatilla County in northeastern Oregon on the western flank of the Blue Mountains about 200 miles (mi) east of Portland, Oreg. Pendleton, Oreg., which is the county seat, largest city, and commercial center of the area, is on the Umatilla River just west of the reservation (fig. 1).

The Umatilla Indian Reservation was established by treaty in 1855; in 1885 the reservation was diminished to its present size of about 247 square miles (mi^2). In 1939, Congress restored a 22-mi^2 tract of forest lands to the Confederated Tribes of the Umatilla Indian Reservation. This tract, known as the McCoy tract, is in the Blue Mountains 7 to 10 mi south of the main reservation. About 45 percent of the land, or 71,300 acres, within the main reservation is Indian owned; the remaining 55 percent, or 87,000 acres, has been sold to non-Indians.

In 1970, the population of the reservation was about 1,800 persons, 558 of whom were Indians and 1,252 non-Indians (U.S. Bureau of the Census, 1970). Most of the people on the reservation live in the Umatilla River valley within 5 mi of the west boundary of the reservation. Small concentrations of people

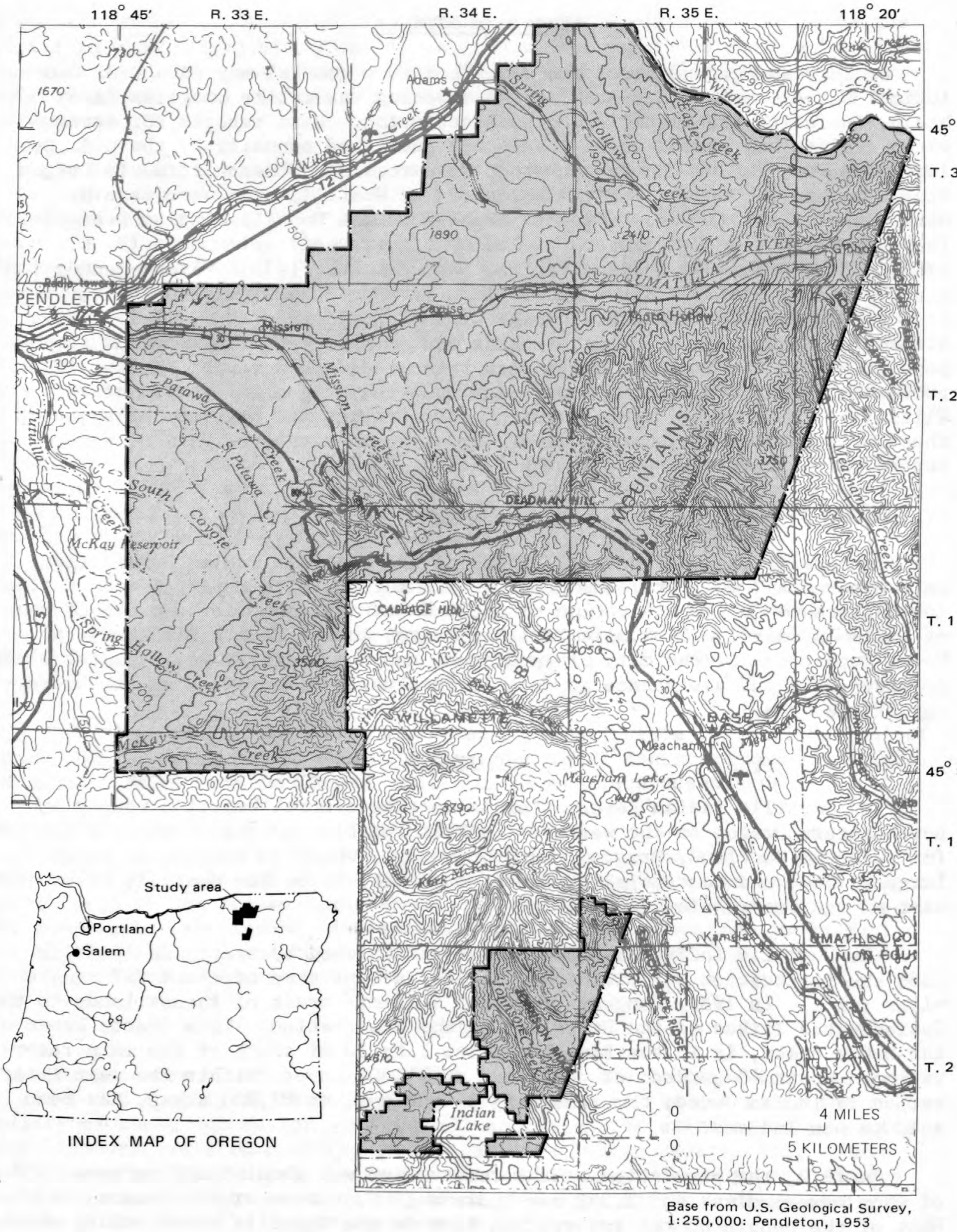

Figure 1. — Location of the Umatilla Indian Reservation, Oreg.

also live in settlements at Cayuse, Thorn Hollow, and Gibbon, and in a development in sec. 28, T. 2 N., R. 33 E., on the south reservation.

The Blue Mountains cross the reservation in a northeasterly direction and subdivide it very roughly into a western and an eastern part. The western part consists of a ramplike northwest-sloping plain, and the eastern part is the Blue Mountains. The plain is cut by the east-west trending Umatilla River valley and is more rolling and irregular to the north of the valley than it is to the south. The plains north and south of the Umatilla River valley are referred to as the north and south reservation by local residents, and that terminology is also used hereafter in this report.

The Blue Mountains in the eastern part of the reservation are part of a tilted, elevated plateau which has been deeply eroded. The topography of the Blue Mountains is characterized by steep V-shaped canyons with intervening narrow ridges. Small, partly eroded remnants of the original plateaulike summit lie in the Cabbage Hill-Deadman Hill area; larger remnants are southeast of the main reservation in the Meacham area.

The altitude of the main reservation ranges from about 1,100 to 4,030 ft. The lowest point is on the Umatilla River at the western boundary; the highest point is on Light Ridge in sec. 11, T. 1 N., R. 35 E., near the eastern boundary. The tribal lands in the McCoy tract are near the crest of the Blue Mountains and have a general altitude of about 4,200 ft and a maximum altitude of about 4,500 ft. Local relief in the Blue Mountains is as much as 1,200 ft in places.

The Umatilla River or its tributaries drain all but a few square miles of the reservation lands. Part of the McCoy tract is drained by tributaries of the Grande Ronde River. The principal streams on the reservation are the Umatilla River and Meacham and McKay Creeks.

Agriculture, livestock grazing, and forestry are the principal industries of the reservation. The plains and the bottom lands of the valleys of the Umatilla River and McKay Creek are under cultivation; winter wheat, peas, and hay are the principal crops. Steeply sloping, sparsely forested areas are rangelands. Timber is harvested from the upland forests of the Blue Mountains.

Data-Site Numbering Systems

Streamflow stations.--Streamflow stations along the main stream are numbered in downstream order, and stations on tributaries are listed between main-stream stations in the same order that the tributaries enter the main stream. Each station has been assigned a unique eight-digit number by the Geological Survey. Station numbers used in tables in this report are the same as those used in data and water-supply paper reports of the Survey.

Wells and springs.--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. In successive order, the numerals represent the township, range, and section. Thus, well 1N/33E-16ddc2 is in township 1 north, range 33 east, section 16. The letters following the section number show the location within the section, the first letter designating the quarter section (160 acres), the second number the quarter-quarter section (40 acres), and the third number the quarter-quarter-quarter section (10 acres). For springs, a suffix (s) is added to the number. Where two or more wells are in the same 10-acre subdivision, serial numbers are added after the third letter, as shown in figure 2.

Water-quality sampling sites.--Water-quality sites at stations are identified by the streamflow station number (for example, site 1, 14020000). Stream-sampling sites at locations that do not have established station numbers are identified by the latitude and longitude of the site, such as 454107118271301. The first six numerals represent the latitude, the next seven the longitude, and the last two are a serial designation. Ground-water-quality sampling sites are identified by the appropriate well or spring number.

GEOLOGY

From oldest to youngest, the geologic units underlying the Umatilla Indian Reservation are the Columbia River Basalt Group of Miocene and early Pliocene age, deposits of Tertiary (Pliocene) age, and windblown silt, volcanic ash, and alluvium of Quaternary age. Windblown silt thinly blankets much of the reservation, and thin deposits of volcanic ash also occur locally. Neither deposit has enough hydrologic importance to warrant mapping on the accompanying geologic map (pl. 1).

The geology used in this report is a refinement of the mapping by Hogenson (1964). Field investigations made during this study indicate that the axis of the "Agency Syncline" probably is in the Pendleton area outside the area covered by this study and a few miles west of the position shown on Hogenson's geologic map. The syncline is a broad, gentle northeast-trending downwarp of the Columbia River Basalt Group rocks, and the reservation lies on the east limb of the syncline.

Eocene and pre-Tertiary rocks were mapped by Hogenson (1964) in sec. 7, T. 2 S., R. 33 E., about 6 mi south of the southwest corner of the main reservation, but these rocks apparently do not extend northward into the reservation.

Columbia River Basalt Group

The entire Umatilla Indian Reservation is underlain by a thick, extensive sequence of dark-colored, well-stratified volcanic rocks that were extruded on the land surface as lava flows during middle and late Miocene and early Pliocene time. These rocks are part of the Columbia River Basalt Group, which underlies an area of about 50,000 mi^2 in neighboring Idaho, eastern Washington, and northern Oregon. The thickness of the Columbia River Basalt Group on the reservation is at least a few thousand feet; the deepest well (3N/34E-13cdb) penetrated the basalt to a depth of 1,910 ft.

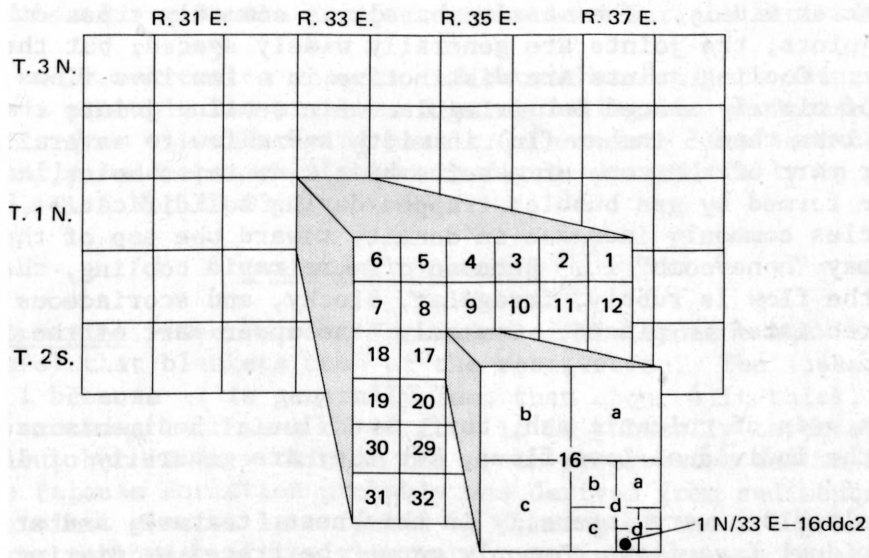

Figure 2. — Well- and spring-numbering system.

Rocks of the Columbia River Basalt Group consist of numerous individual lava flows, each ranging from a few to more than 300 ft in thickness. The internal characteristics of each lava flow reflect the cooling history of the molten lava. Because cooling and solidification of the lava was rapid, the rock is fine grained and the individual mineral grains cannot be distinguished without magnification. The color of the weathered basalt ranges through many shades of dull brown and rusty red. Freshly broken basalt is dark green to bluish black to black and, less commonly, to shades of rusty red.

A typical basalt flow on the reservation is between 30 and 50 ft thick. The flow generally consists of a bottom zone of dense, finely crystalline fractured rock which grades upward within a few inches of the bottom into more massive, even-textured basalt. The thickness of the zone of massive basalt varies widely. The massive basalt is commonly crossed by vertical cooling joints; the joints are generally widely spaced, but the spacing is irregular. Cooling joints are distinctive in a few lava flows where they consist of closely spaced but irregular intersecting joints that form columns commonly less than 5 inches (in) in width and a few to several feet in length. The upper part of the zone of massive basalt contains holes, called vesicles, that were formed by gas bubbles trapped during solidification of the lava. The vesicles commonly increase in density toward the top of the lava flow and locally may "honeycomb" it. Because of more rapid cooling, the uppermost part of the flow is rubbly, irregular, blocky, and scoriaceous (slaglike) and is brecciated in places. Commonly, the upper part of the flow is rusty red.

Thin beds of volcanic ash, tuff, and fluvial sediments occur in places between the individual lava flows, but they are generally of local extent.

Basalt flows vary laterally in thickness, texture, and structure, and the individual lava flows commonly cannot be traced or distinguished for more than a few miles.

After deposition, the rocks of the Columbia River Basalt Group were tilted, arched, downwarped, or faulted. On the reservation, the basalt strata generally dip toward the northwest. The angle of dip of the basalt varies locally and regionally; it ranges between 2° and 10° along much of the west edge of the Blue Mountains, but the basalt flows are nearly horizontal in the Pendleton area.

Tertiary Deposits

Tertiary (Pliocene) deposits overlie the Columbia River Basalt Group in two separate areas on the north and the south reservation. The Tertiary deposits consist chiefly of unconsolidated and semiconsolidated, poorly sorted basaltic sand and gravel, gravel, and clay and sandstone. These materials were deposited by streams as coalescing alluvial fans along the west edge of the Blue Mountains. The Tertiary deposits have undergone much erosion. Hogenson (1964) mapped these deposits as fanglomerate.

On the south reservation, clay and sandstone become more abundant in the upper part of the Tertiary deposits in secs. 6, 7, and 18, T. 1 N., R. 33 E., near the western boundary. The maximum thickness of the Tertiary deposits on the south reservation is estimated to be about 200 ft. Well 1N/33E-4ddd reportedly was drilled to 195 ft and did not penetrate the full thickness of the Tertiary deposits. Tertiary deposits on the north reservation are mostly semiconsolidated sand and gravel generally less than 30 ft thick.

The altitude of the surface of the Columbia River Basalt Group beneath the Tertiary deposits on the south reservation is shown in figure 3. The irregular surface indicates that the basalt was moderately dissected by erosion before the sediments were deposited. The thickness of the Tertiary deposits can be estimated from figure 3 by subtracting the altitude of the top of the Columbia River Basalt Group from the land-surface altitude.

Well logs and construction reports indicate that drillers using rotary drilling machines probably had problems distinguishing the semiconsolidated Tertiary deposits from the underlying basalt. Therefore, the surface of the basalt may actually be deeper than shown in figure 3, especially in parts of secs. 28 and 33, T. 2 N., R. 33 E.

Quaternary Deposits

Palouse Formation.--The Palouse Formation of Pleistocene age is a windblown silt (loess) that blankets much of the reservation. The loess is not shown on plate 1 because it is generally less than about 4 ft thick, although locally it may exceed a thickness of 10 ft. It is generally thickest on the north reservation, but is very thin on the south reservation and in the Blue Mountains. The Palouse Formation probably was derived from sediments deposited in an ancient glacial lake formed by damming of the Columbia River somewhere west or northwest of the reservation. The loess was transported to the area by prevailing westerly winds (Hogenson, 1964, p. 27).

Volcanic ash.--Small, thin deposits of volcanic ash occur in many places on the reservation but have not been mapped separately because they generally occupy an area of less than an acre each. The ash beds are grayish white to white, very fine grained, uniformly textured, and generally less than 5 ft thick. Prevailing westerly winds carried the ash to the reservation from centers of geologically recent volcanic activity in the Cascade Range. Stream runoff has concentrated the ash within small alluvial fans built by ephemeral streams near the edges of the principal valley.

Alluvium.--Alluvium covers the bottoms of most stream valleys of the reservation, but it is mapped only along the principal streams. In the small valleys, the alluvial deposits are thin, discontinuous, and narrow, whereas in the principal valleys they are thin but much more extensive. The alluvium in most of the principal valleys consists of unconsolidated sand and gravel, and some silt. The composition of the alluvium varies within short distances because the streams have frequently cut new channelways and reworked the alluvium during floods.

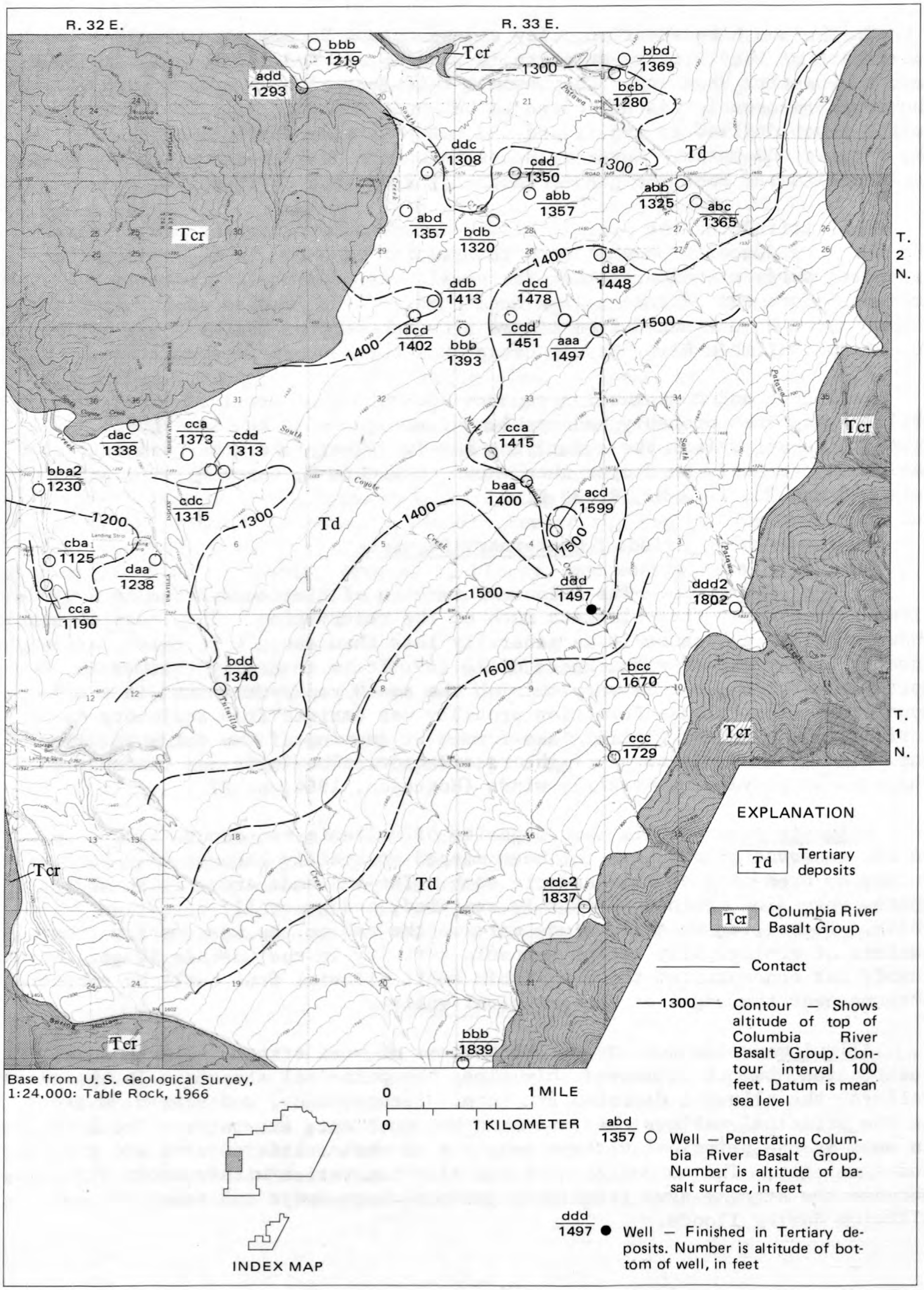

Figure 3. — Map showing approximate altitude of the surface of the Columbia River Basalt Group beneath the Tertiary deposits on the south reservation.

The principal alluvial deposits on the reservation are along the Umatilla River, McKay Creek, and Meacham Creek. The most extensive alluvial deposits are in the Umatilla River valley, where they average between 10 and 12 ft in thickness along most of the length of the valley. The alluvium is generally much thinner in the other principal valleys.

In the western part of the Umatilla River valley in the reach between the west boundary of the reservation and sec. 12, T. 2 N., R. 33 E., several wells reportedly penetrate between 30 and 132 ft of unconsolidated or semi-consolidated alluvium overlying the basalt. Most of these wells are south of the Umatilla River. The locations of the wells suggest that the thick alluvial deposits are not in an older buried valley eroded into the basalt, but occur as isolated pockets in the underlying basalt. An alternative explanation is that the thick alluvium actually may be pockets of highly fractured and broken basalt that have been misidentified by drillers.

In the arid western part of the reservation, hardpan deposits are locally present in the Tertiary sediments and in the Quaternary alluvium. The hardpan consists of white to light-gray and pink calcium carbonate and other soluble mineral salts. It is shallow and generally less than 2 ft thick, but ranges to as much as about 5 ft locally. The hardpan probably was precipitated during the evaporation of shallow ground waters.

HYDROLOGY

The source of water that occurs within the Umatilla Indian Reservation is precipitation. Some precipitation that occurs in parts of drainage basins outside the reservation boundaries enters the reservation as surface-water runoff or as ground water. On the average, an estimated 20 in of precipitation falls within the reservation boundaries each year; of this total, about 17 in is evaporated or transpired back to the atmosphere and about 3 in leaves the reservation as surface-water runoff.

Climate

The climate of the Umatilla Indian Reservation varies widely; at low altitudes it is semiarid, whereas in the Blue Mountains it is humid temperate. To illustrate this climatic range, selected climatic data for two National Weather Service weather stations near the reservation at Pendleton and Meacham, Oreg., are shown in table 1.

Weather on the reservation is controlled largely by the Pacific oceanic airmasses that move eastward through the region, bringing with them wet, cool weather in late fall and winter and dry, warm weather in summer.

Table 1.--Summary of selected climatic data for 1941-70 for weather stations at Pendleton and Meacham, Oreg.

[Data from the National Weather Service]

	Pendleton (Alt 1,482 ft)			Meacham (Alt 4,050 ft)		
Month	Normal temperature (°F)	Normal precipitation (inches)	Normal snowfall (inches)	Normal temperature (°F)	Normal precipitation (inches)	Normal snowfall (inches)
January	32.0	1.60	7.9	26.2	4.34	32.5
February	38.9	1.07	3.9	30.8	3.52	24.3
March	43.8	1.00	.9	33.4	2.90	24.6
April	50.9	1.01	.1	40.1	2.83	13.5
May	58.5	1.24	T1/	47.7	2.58	3.3
June	65.6	1.01	--	54.5	2.15	.5
July	73.5	.26	--	63.6	.56	T1/
August	71.5	.34	--	62.2	.90	--
September	64.0	.64	--	52.6	1.52	.3
October	52.6	1.11	.1	45.8	2.70	4.7
November	41.4	1.50	1.4	35.0	4.70	17.0
December	35.7	1.53	3.5	29.3	4.61	28.6
Annual	52.4	12.31	17.8	43.7	32.68	149.3

1/ Trace.

Surface Water

Stream System

Streams on the Umatilla Indian Reservation are listed in five general groups: (1) The Umatilla River and its tributaries within the reservation, (2) the south reservation streams, (3) McKay Creek, (4) north reservation streams, and (5) streams draining tribal land outside the main reservation. The principal streams, their drainage boundaries, and streamflow-data sites are shown in figure 4.

The Umatilla River, the largest stream on the reservation, has a drainage area of about 450 mi^2 at the west boundary of the reservation. The headwaters of the river are in the Umatilla National Forest in the Blue Mountains, where the drainage divide is at an altitude of about 5,000 ft. Snow that accumulates in the forested headwater area during winter melts and produces high flows in spring. The North and South Forks combine and form the Umatilla River at a point about 8 mi upstream from the east boundary of the reservation. At the east boundary, the drainage area of the river basin is 226 mi^2. In

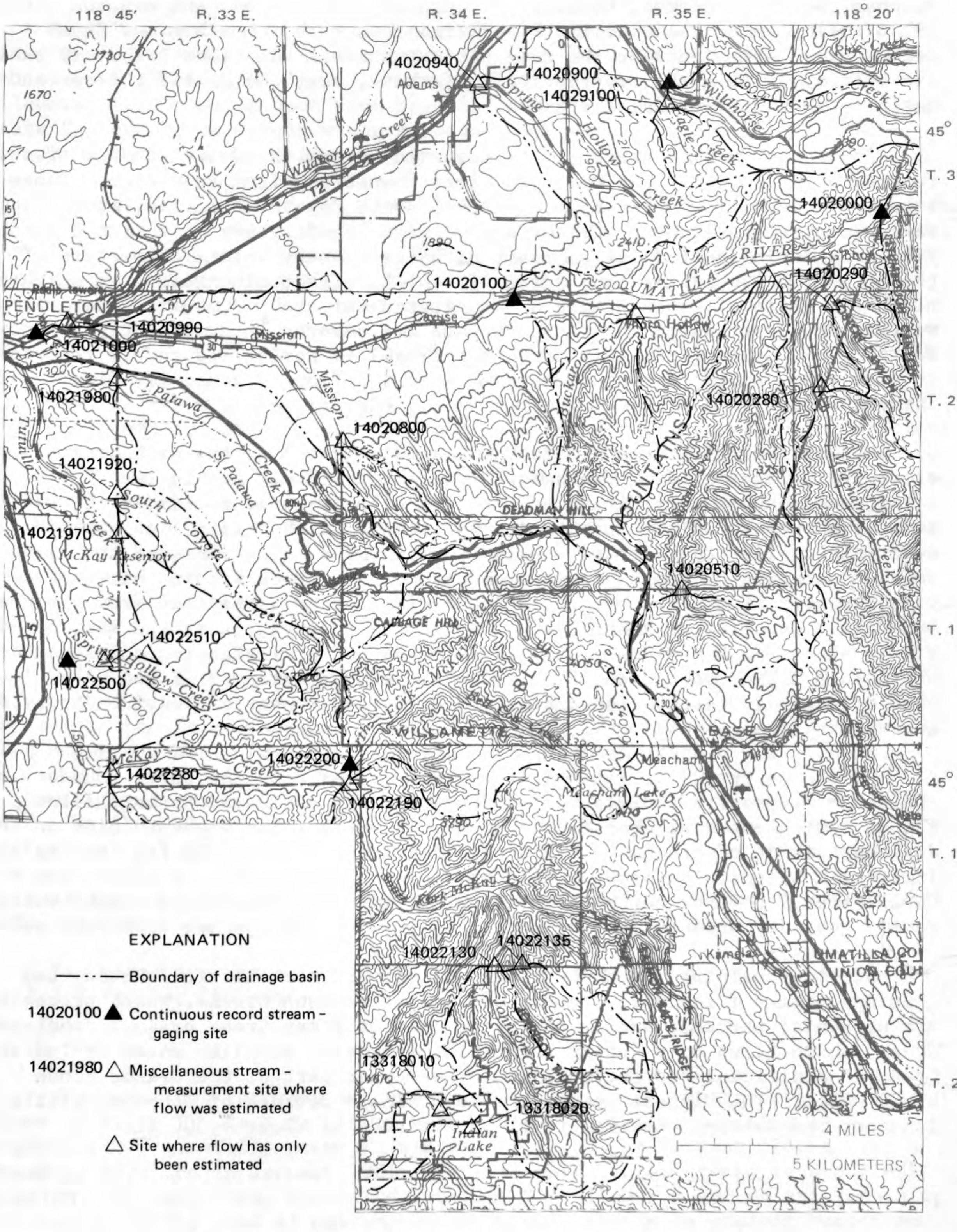

Figure 4. — Map showing drainage basins and streamflow-data sites.

downstream order, the principal tributaries within the reservation are Meacham, Squaw, Buckaroo, Coonskin, Moonshine, Cottonwood, and Mission Creeks, all of which enter the Umatilla River from the south. Meacham and Squaw Creeks drain areas outside the reservation, whereas the other tributary basins are entirely within the reservation. Of these, only the Umatilla River and Meacham Creek are perennial streams.

South reservation streams flow westward, cross the west boundary of the reservation, and enter the Umatilla River downstream from Pendleton. These streams, from north to south, are Patawa, South Coyote, Tutuilla, and Spring Hollow Creeks. All these streams at the west boundary are intermittent and flow only during periods of snowmelt or after a heavy rain. Headwaters of these streams are in the low, barren foothills of the Blue Mountains on the northwest slope of Cabbage Hill at an altitude of about 3,500 ft. During winter, the upper basins of these streams are covered intermittently by snow. North Coyote Creek (tributary of Patawa Creek) is spring fed and is reported to flow year around; during summer, most of its flow is generally diverted for irrigation use.

McKay Creek flows westward across, and just inside, the southernmost part of the main reservation. The headwaters of McKay Creek are in the Blue Mountains, and the drainage divide at its highest point near Kamela is at an altitude of about 4,500 ft. Much of the upper part of the basin lies outside the reservation, is forested, and remains snow covered during most of the winter. Small quantities of water are diverted from McKay Creek within the reservation; however, much more water is diverted at points downstream from the west boundary. The flow of McKay Creek leaving the reservation at the west boundary is stored in McKay Reservoir and is released for irrigation downstream. North Fork McKay Creek drains the south slope of Emigrant Hill and other lands outside the main reservation and enters McKay Creek near the east boundary of the reservation.

Wildhorse Creek, an intermittent stream, lies near the north boundary of the north reservation. Principal tributaries are Eagle and Spring Hollow Creeks, which enter Wildhorse Creek from the south. The highest point on the drainage divide of the basin is at an altitude of about 3,800 ft. During the irrigation season, the flow of Wildhorse Creek is augmented by water from well 3N/35E-4cbd. Another north reservation stream is Spring Hollow Creek, which rarely goes dry because it receives a small volume of seepage from springs.

Streams draining the McCoy tract include Johnson, Little Johnson, and Jennings Creeks (fig. 4). Johnson and Little Johnson Creeks, which probably are perennial streams, are in the upper part of McKay Creek basin. Jennings Creek, which flows only during periods of snowmelt, supplies water to Indian Lake, an artificial recreation lake in the upper part of the Grande Ronde River basin. The highest points on the drainage divides of Johnson, Little Johnson, and Jennings Creeks are at an altitude of about 4,500 ft.

Availability of Streamflow Data

Daily streamflow records for gaging stations on the Umatilla River and McKay Creek in and around the reservation have been collected for many years and are published in Geological Survey data reports. Since 1966, data for Wildhorse Creek near Athena have been collected and published by the Oregon State Engineer (now Oregon Water Resources Department). Availability of streamflow data is shown in table 2.

In addition to the daily flow data, many discharge measurements were made on various streams during this study. Results of the measurements, which were correlated with the long-term streamflow records, are included in the annual data report, "Water Resources Data for Oregon," U.S. Geological Survey (1976). Locations of the measuring sites are shown in figure 4.

Average Flows

Average flows of the streams on the perimeter of and within the reservation are shown in table 3. At the long-term continuous-record gaging stations on Umatilla River above Meacham Creek near Gibbon, Umatilla River at Pendleton, and McKay Creek near Pilot Rock, average flows were based on the entire period of record. Short-term records for Umatilla River at Gibbon, Umatilla River near Cayuse, North Fork McKay Creek near Pilot Rock, and Wildhorse Creek near Athena were adjusted to the long-term average. At other sites, average flows were estimated by correlating discharge measurements made at the sites with discharges at long-term gaging stations or by using unit runoff for nearby gaged sites.

Estimated average total stream inflow to the main reservation is 540 ft^3/s, or 390,000 acre-feet (acre-ft) per year (table 3). Of this total, 42 percent is from the Umatilla River, 37 percent from Meacham Creek, 19 percent from McKay and North Fork McKay Creeks, and 2 percent from other streams.

Estimated average total stream outflow from the main reservation is 600 ft^3/s, or 430,000 acre-ft per year. Of this total, 80 percent is in the Umatilla River, 18 percent in McKay Creek, and 2 percent in other streams.

Estimated average flow leaving the parcel of land drained by Johnson and Little Johnson Creeks is 2.5 ft^3/s, or 1,800 acre-ft per year.

Estimated average flow leaving the McCoy tract by way of Jennings Creek is 1.1 ft^3/s, or 800 acre-ft per year.

High Flows

Maximum flows for some streams in the vicinity of the reservation are shown in table 3. As a result of heavy rains and rapidly melting snow, highest flows generally occur in winter. Some of the largest floods, as in December 1964 and in January 1965, resulted when frozen ground reduced infiltration and, therefore, increased runoff. High flows in spring are generally the result of the gradual melting of snow, which tends to prolong runoff and reduce peak flows.

Table 2.--Streamflow data collected at sites in and near the Umatilla Indian Reservation

Station number	Station name	Period of record (calendar years)	Data collected
13318010	Jennings Creek above Indian Lake	1974-75	9 discharge measurements
13318020	Jennings Creek below Indian Lake	do	9 discharge measurements
14020000	Umatilla River above Meacham Creek, near Gibbon	1933-74	Daily, monthly, annual discharge
14020280	Meacham Creek below Line Creek at east boundary	1973-75	15 discharge measurements
14020290	Boston Canyon Creek at east boundary	do	17 discharge measurements
14020500	Umatilla River at Gibbon	1896-98, 1902-3, 1904-5, 1907-11	Daily, monthly, annual discharge
14020510	Squaw Creek at south boundary	1973-75	6 discharge measurements
14020700	Umatilla River at Cayuse	1968-74	Daily, monthly, annual discharge
14020800	Mission Creek at St. Andrews Mission	1958, 1963-64	Annual peaks
14020900	Wildhorse Creek near Athena 1/	1966-74	Daily, monthly, annual discharge
14020910	Eagle Creek near Athena	1973-75	16 discharge measurements
14020940	Spring Hollow Creek near Adams	do	17 discharge measurements
14021000	Umatilla River at Pendleton	1891-92, 1903-5, 1934-74	Daily, monthly, annual discharge
14021910	Tutuilla Creek at west boundary	1973-75	20 discharge measurements
14021920	South Coyote Creek at west boundary	do	17 discharge measurements
14021980	Patawa Creek at west boundary	do	20 discharge measurements
14022130	Johnson Creek near Kamela	1974-75	9 discharge measurements
14022135	Little Johnson Creek near Kamela	do	9 discharge measurements
14022190	McKay Creek above North Fork at east boundary	1973-75	21 discharge measurements
14022200	North Fork McKay Creek near Pilot Rock	do	20 discharge measurements
14022280	McKay Creek at west boundary	do	20 discharge measurements
14022500	McKay Creek near Pilot Rock	1926-27, 1929-74	Daily, monthly, annual discharge
14022510	Spring Hollow Creek at west boundary	1973-75	19 discharge measurements

1/ Data collected and published by Oregon Water Resources Department.

Table 3.--Summary of streamflow information

Station number	Station name	Drainage area[1/] (mi^2)	Long-term discharge[2/]: Average (ft^3/s)	Long-term discharge[2/]: Annual (acre-ft)	Maximum discharge (ft^3/s): During period of record (See table 2)	Maximum discharge (ft^3/s): [3/] 1974	Maximum discharge (ft^3/s): [3/] 1975	Minimum observed discharge (ft^3/s)
	Streams entering main reservation							
14020000	Umatilla River above Meacham Creek, nr Gibbon	131	226	164,000	4,910	2,090	5,930	16
14020280	Meacham Creek below Line Creek, at east boundary	165	200	145,000	--	--	15,000	11
14020290	Boston Canyon Creek at east boundary	5.3	6	4,000	--	330	--	.9
14020510	Squaw Creek at south boundary	8.8	3	2,000	--	--	--	0
14022190	McKay Creek above North Fork, at east boundary	100	60	43,000	--	--	--	.9
14022200	North Fork McKay Creek near Pilot Rock	48.6	40	29,000	--	806	1,980	.37
	Other inflow	--	[4/] 5	3,000	--	--	--	--
	Total stream inflow		540	390,000				
	Streams leaving main reservation							
	Umatilla River at west boundary	445	[5/] 480	348,000	--	--	--	--
14020910	Eagle Creek near Athena	3.1	[6/] 1	700	--	--	--	[6/] 0
14020940	Spring Hollow Creek near Adams	18	2	1,500	--	20	30	0
14021910	Tutuilla Creek at west boundary	8.0	1	700	--	--	--	0
14021920	South Coyote Creek at west boundary	6.8	1	700	--	--	--	0
14021980	Patawa Creek at west boundary	[7/] 30	3	2,000	--	150	200	.01
14022280	McKay Creek at west boundary	168	106	77,000	--	1,500	5,000	.9
14022510	Spring Hollow Creek at west boundary	4.8	.3	200	--	--	--	0
	Other outflow	--	[8/] 6	4,000	--	--	--	--
	Total stream outflow		600	430,000				
	Streams leaving outside parcels of reservation							
13318020	Jennings Creek below Indian Lake	5.7	1.1	800	--	--	--	0
14022130	Johnson Creek near Kamela	17.0	2.0	1,400	--	--	--	.65
14022135	Little Johnson Creek near Kamela	5.0	.5	400	--	--	--	.03
	Total outflow from parcels		3.6	2,600				
	Streams at other sites							
13318010	Jennings Creek above Indian Lake	4.1	.9	700	--	--	--	0
14020500	Umatilla River at Gibbon	310	440	319,000	9,500	--	--	44
	Squaw Creek at mouth	36	30	14,000	--	--	--	0
	Buckaroo Creek at mouth	15	10	4,000	--	--	--	0
14020700	Umatilla River at Cayuse	384	496	359,000	8,830	5,380	22,000	30
14020800	Mission Creek at St. Andrews Mission	4.45	--	--	170	67	100	0
14020900	Wildhorse Creek near Athena	15	11	8,000	937	704	521	0
	Wildhorse Creek at mouth	190	20	14,000	--	--	--	--
14021000	Umatilla River at Pendleton	637	500	362,000	15,500	4,890	14,300	10
14022500	McKay Creek near Pilot Rock	180	98.6	71,000	7,400	1,770	4,480	0

1/ Drainage areas are approximate except for stations 14020000, 14020700, 14020800, 14021000, 14022200, and 14022500.
2/ Estimated and adjusted to long-term average on basis of stations 14020000 (1933-74) and 14022500 (1933-74).
3/ Peak discharges are approximate except for stations 14020000, 14020700 (excluding 1975), 14020800, 14021000, 14022200, and 14022500.
4/ Includes estimated inflow from Little Squaw Creek and other small streams along Meacham and McKay Creeks.
5/ Estimated from Wildhorse flow at mouth subtracted from Umatilla River at Pendleton (14022500).
6/ Estimate excludes that supplied by a pumped well.
7/ Excludes about 1 mi^2 in upper basin where water has been diverted directly to the Umatilla River.
8/ Includes estimated outflow in Lost Pine Creek and other small ungaged streams around the reservation.

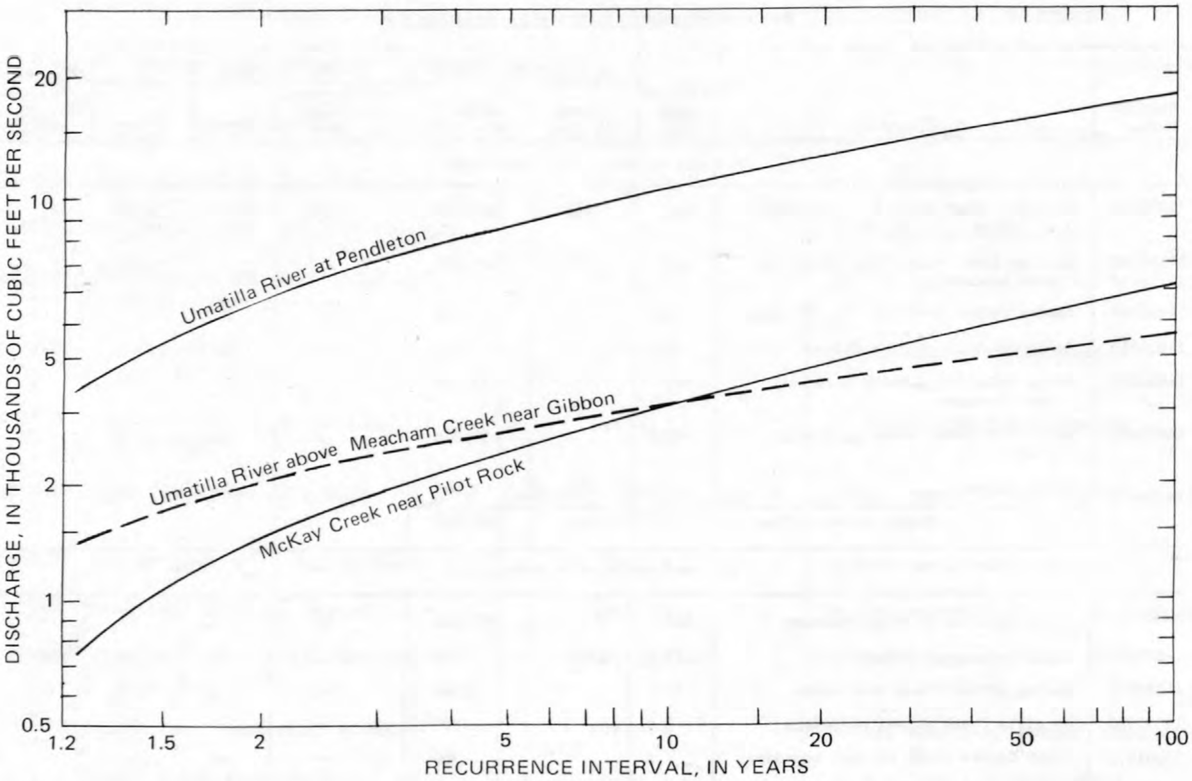

Figure 5. — Flood-frequency curves for long-term gaging stations in and near the Umatilla Indian Reservation.

Flood-frequency curves for streams at three gaging stations in and near the study area (fig. 5) represent the relation between past flood peaks and the frequency at which they occurred.

Flooding on the Umatilla River from Gibbon downstream to the mouth of Wildhorse Creek near Pendleton is described in two Flood Information reports by the U.S. Army Corps of Engineers (1969, 1975). These reports also show the areas of inundation for selected floods. According to the Corps of Engineers, the Intermediate Regional flood, or 100-year flood (that discharge equaled on the average of once every 100 years), is about 16,500 ft^3/s upstream from Wildhorse Creek. At Pendleton, the 100-year flood for the Umatilla River is about 18,000 ft^3/s; upstream from Meacham Creek it is about 4,700 ft^3/s.

On January 25, 1975, the peak discharge of 5,930 ft^3/s on Umatilla River above Meacham Creek was the highest peak since at least 1933 and was greater than the 100-year flood. Estimated peak discharge of Meacham Creek below Line Creek on January 25, 1975, probably exceeded 10,000 ft^3/s and probably was closer to 15,000 ft^3/s. At Cayuse, the peak discharge of the Umatilla River was about 22,000 ft^3/s, which is greater than the 100-year flood.

Downstream from Cayuse, the January 1975 flood on the Umatilla River attenuated to a peak discharge of 14,300 ft^3/s at Pendleton. That discharge is equivalent to about a 30-year flood.

A report by the U.S. Army Corps of Engineers (1971) describes flooding on lower McKay, Tutuilla, and Wildhorse Creeks. The report shows that the 100-year flood discharge is 7,860 ft^3/s on Tutuilla Creek about 2 mi downstream from the west reservation boundary. The 100-year flood discharge on Wildhorse Creek, at the mouth, is 9,600 ft^3/s.

As shown by the curve in figure 5, the 100-year flood discharge on McKay Creek near Pilot Rock is about 6,000 ft^3/s. The January 1975 flood on McKay Creek (4,480 ft^3/s) was equivalent to about a 40-year flood.

Frequency curves of high flow for Umatilla River above Meacham Creek, Umatilla River at Pendleton, and McKay Creek near Pilot Rock are shown in figures 6 and 7. The frequency curves show the highest mean discharges corresponding to selected durations of time and recurrence intervals. For example, a 7-day mean high discharge of about 1,000 ft^3/s on Umatilla River above Meacham Creek near Gibbon can be expected to be reached on an average of once every 2 years (fig. 6).

Low Flows

Minimum observed flows are shown in table 3. Many of the streams go dry in late summer, but the Umatilla River and Meacham Creek and segments of McKay, Johnson, Little Johnson, Spring Hollow (near Adams), and North Coyote Creeks probably have perennial flows. Eagle and Wildhorse Creeks receive some supplemental flows from wells to supply downstream irrigation water.

Frequency curves of low flow for Umatilla River above Meacham Creek, Umatilla River at Pendleton, and McKay Creek near Pilot Rock are also shown in figures 6 and 7. The curves show the lowest mean discharge for selected durations of time. For example, a 7-day mean low discharge of about 40 ft^3/s on Umatilla River above Meacham Creek near Gibbon can be expected to occur on an average of once every 2 years (fig. 6).

Some of the minimum observed flows shown in table 3 resulted from short-term reductions such as temporary damming and may not represent a dependable sustained flow. Hereafter in this report, dependable flow is considered to be the 7-day mean low flow that will be reached only on the average of once every 50 years. Flows rarely drop below the dependable flow for sustained periods. Dependable flows for some sites are listed in table 4. Most streams not included in table 4 go dry.

Table 4.--Dependable flow at selected sites

Station number	Station name	Flow (ft^3/s)
14020000	Umatilla River above Meacham Creek near Gibbon	30
14020700	Umatilla River at Cayuse	33
14020280	Meacham Creek below Line Creek at east boundary	5
14021000	Umatilla River at Pendleton	14

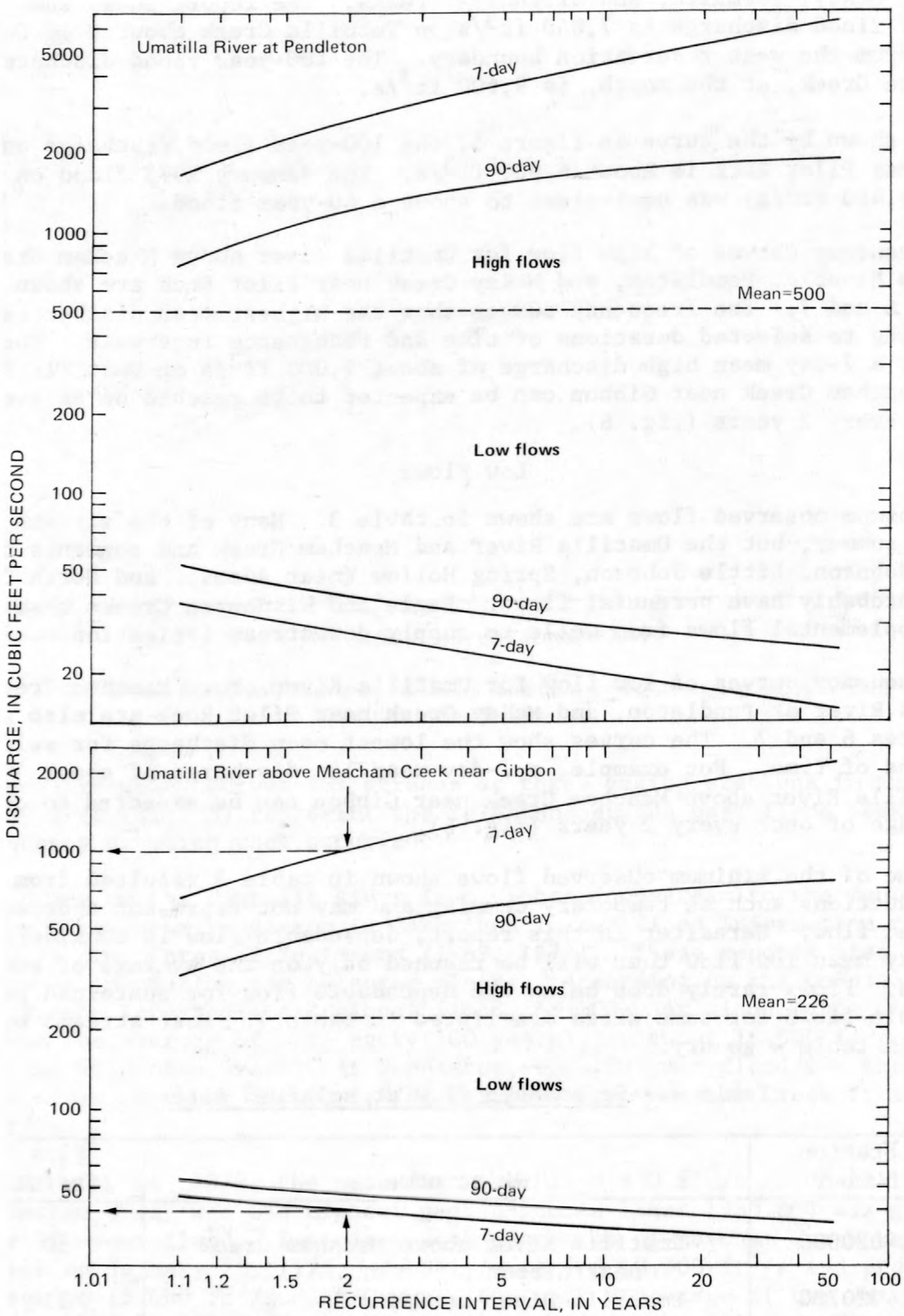

Figure 6. — Frequency curves of annual maximum and minimum flows discharged from Umatilla River at Pendleton and Umatilla River above Meacham Creek near Gibbon.

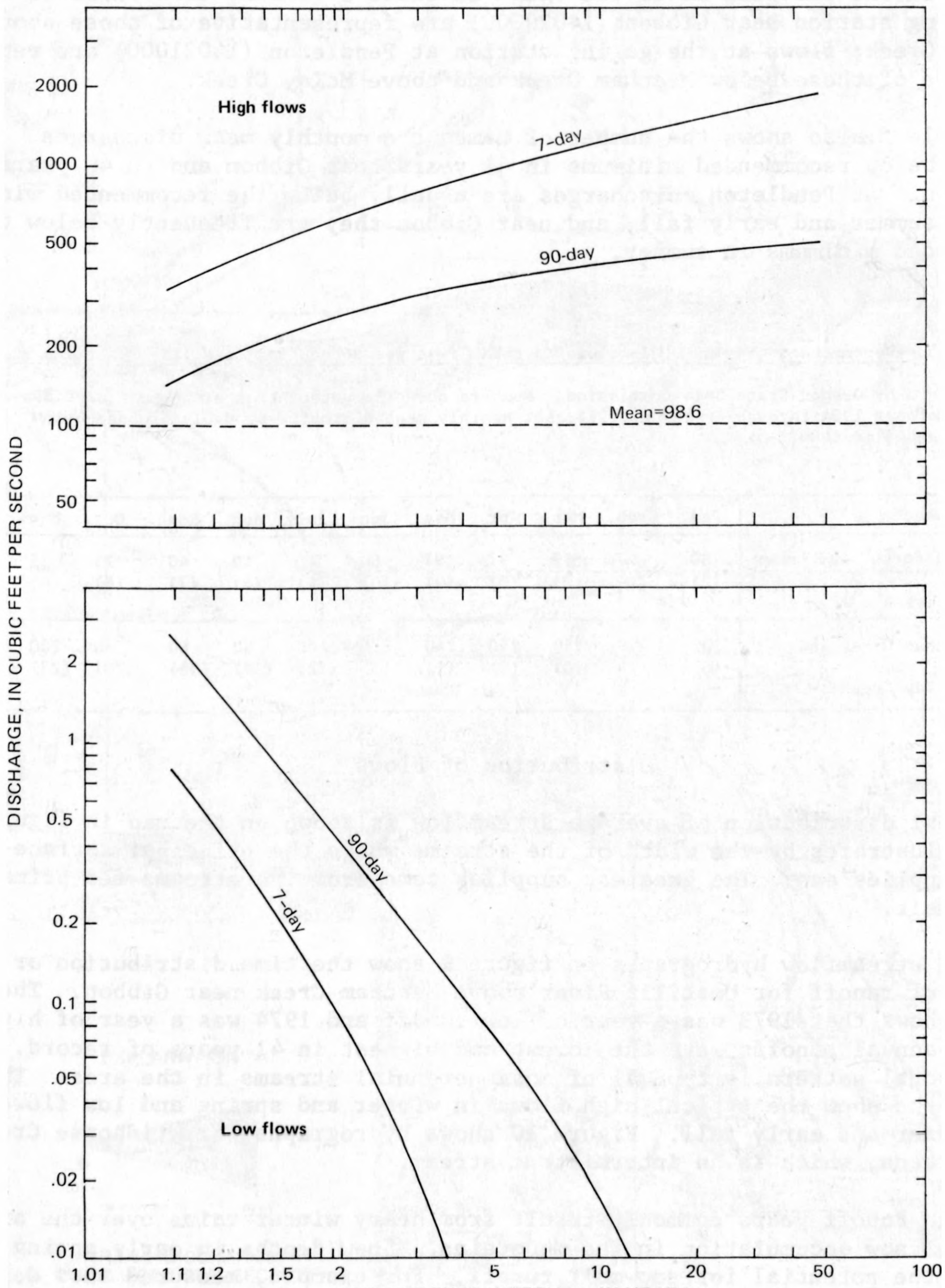

Figure 7. — Frequency curves of annual maximum and minimum flows discharged from McKay Creek near Pilot Rock.

Minimum flows recommended by the Oregon State Game Commission (now Oregon Department of Fish and Wildlife) for salmon and trout spawning and rearing on the Umatilla River are shown in table 5 (Smith, 1973). Flows at the gaging station near Gibbon (14020000) are representative of those above Meacham Creek; flows at the gaging station at Pendleton (14021000) are representative of those below Meacham Creek and above McKay Creek.

Table 5 also shows the number of times the monthly mean discharges dropped below recommended minimums in 41 years near Gibbon and in 40 years at Pendleton. At Pendleton, discharges are usually below the recommended minimums in summer and early fall, and near Gibbon they are frequently below the recommended minimums in summer.

Table 5.--Recommended minimum streamflows in cubic feet per second for fish life, Umatilla River

[Recommended by Oregon State Game Commission. Numbers shown in parentheses are number of times from October 1934 through September 1974 that monthly mean discharge probably dropped below recommended minimum]

Reach	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Below "the Forks" and above Meacham Creek	60 (2)	97 (0)	97 (0)	97 (0)	97 (0)	60 (0)	40 (1)	40 (6)	40 (7)	25 (0)	25 (0)	60 (5)
Below Meacham Creek and above McKay Creek	200 (6)	240 (1)	240 (0)	240 (0)	240 (1)	200 (3)	100 (32)	60 (39)	60 (38)	60 (20)	200 (23)	200 (8)

Distribution of Flows

Areal distribution of average streamflow is shown on the map in figure 8, which illustrates by the width of the streams where the principal surface-water supplies are. The greatest supplies come from the streams fed primarily by snowmelt.

The streamflow hydrographs in figure 9 show the time distribution or pattern of runoff for Umatilla River above Meacham Creek near Gibbon. The figure shows that 1973 was a year of low runoff and 1974 was a year of high runoff; annual runoffs were the lowest and highest in 41 years of record. The seasonal pattern is typical of most perennial streams in the area. The hydrographs show the typical high flows in winter and spring and low flows in late summer and early fall. Figure 10 shows hydrographs for Wildhorse Creek near Athena, which is an intermittent stream.

High runoff years commonly result from heavy winter rains over the area and deep snow accumulation in the mountains. Snow depths in early spring reflect the potential for snowmelt runoff. For example, measured snow depth near Meacham was zero on March 31, 1973, and 21 in on March 31, 1974. Discharge in April-May 1973 and 1974 averaged about 200 and 900 ft^3/s, respectively. Long-term average snow depth for March 31 near Meacham is about 9 in, with about 2 in of water content. (Data from records of National Weather Service.)

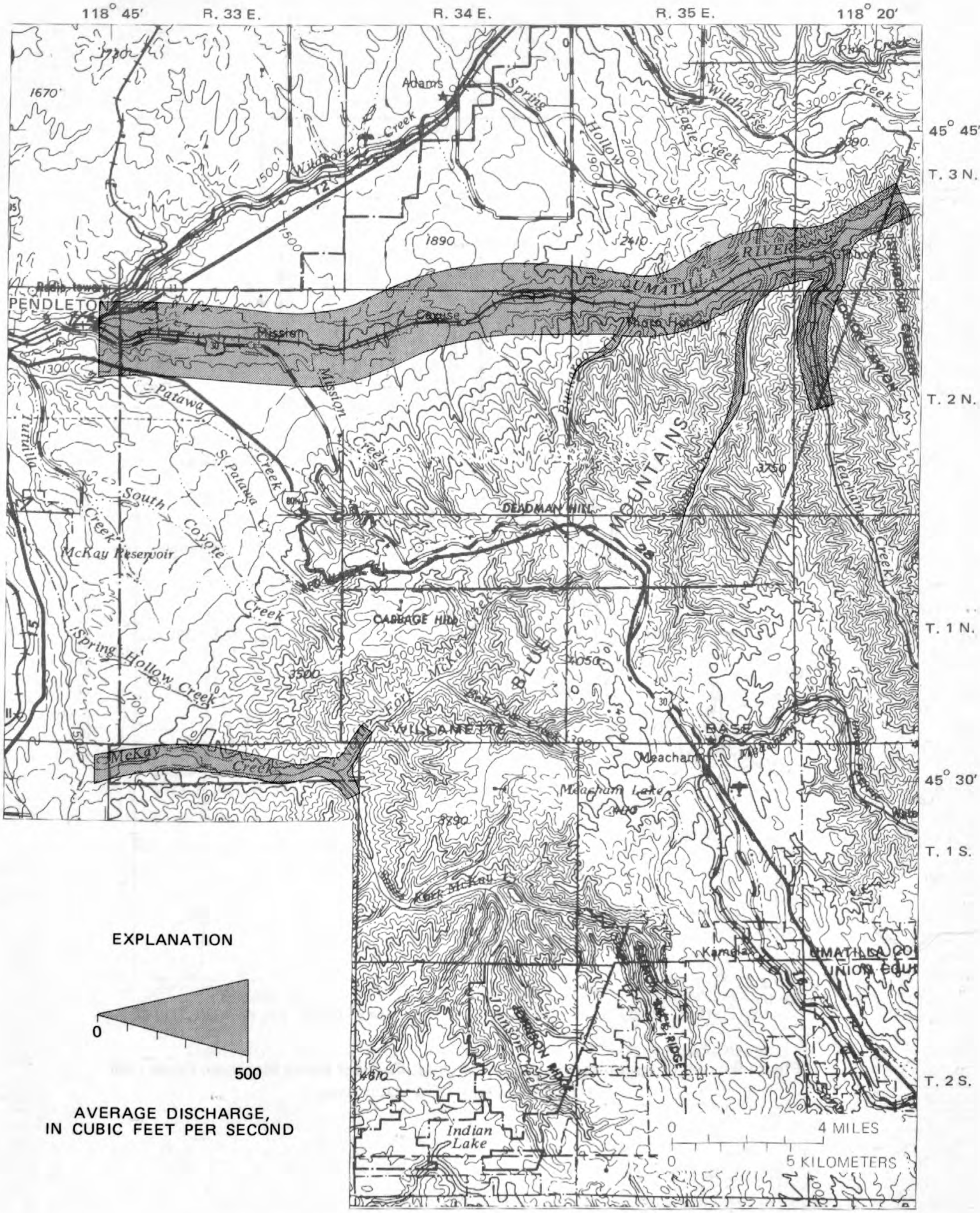

Figure 8. – Map showing average discharge of streams on the Umatilla Indian Reservation.

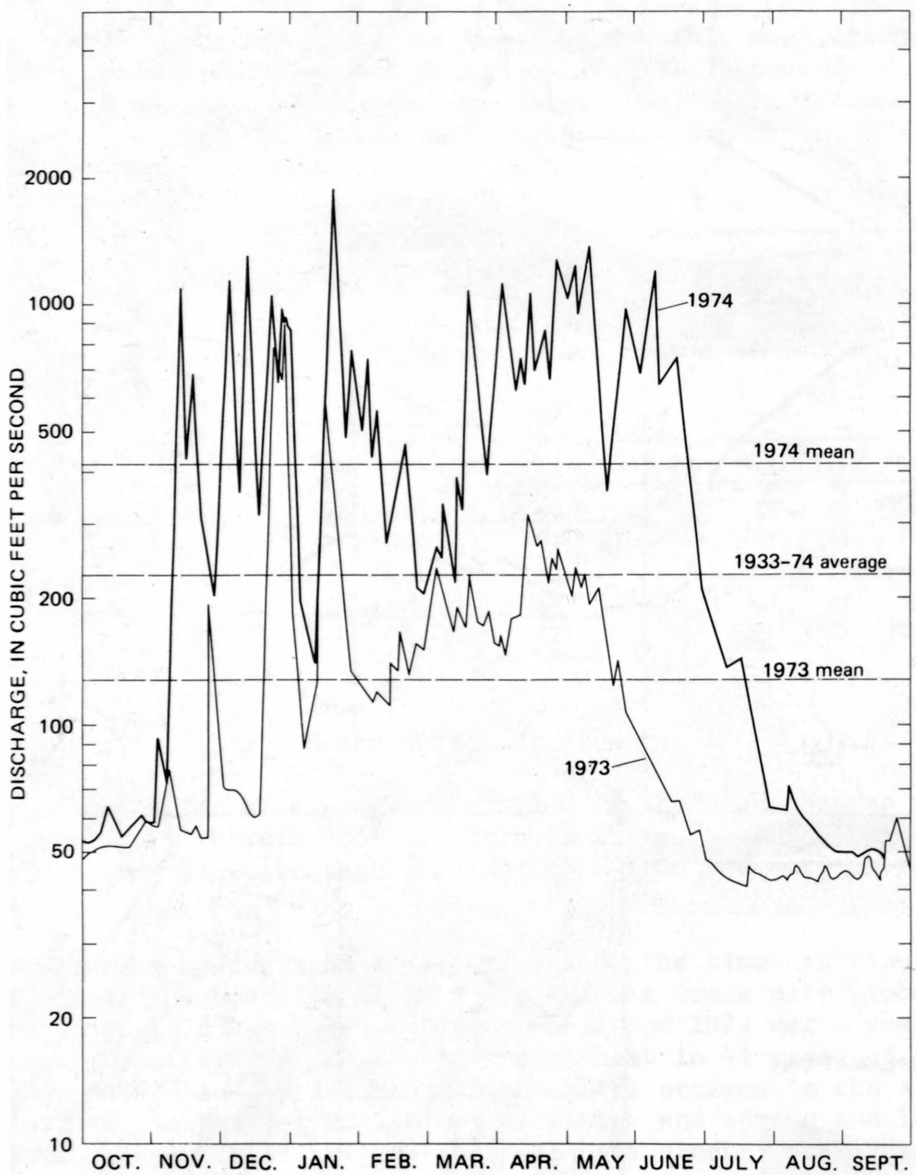

Figure 9. – Hydrographs of daily flow of Umatilla River above Meacham Creek near Gibbon, 1973 and 1974 water years.

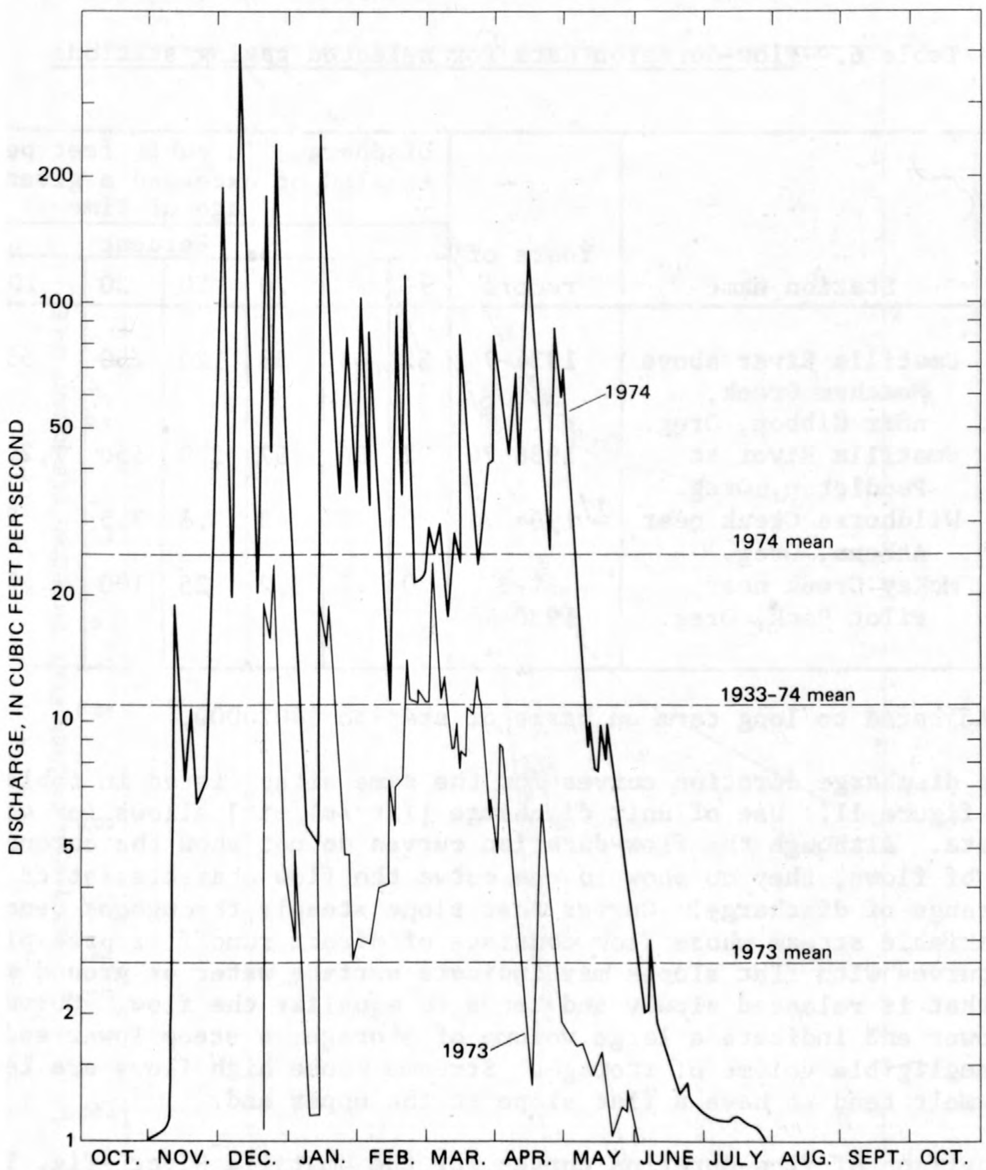

Figure 10. — Hydrographs of daily flow of Wildhorse Creek near Athena, 1973 and 1974 water years.

Variability of Flows

Variability of flows is shown by the flow-duration data in table 6. The table shows the percentage of time specified flows are equaled or exceeded. For example, in the period 1934-74, the daily mean flow of Umatilla River above Meacham Creek near Gibbon was at least 45 ft^3/s 90 percent of the time.

Table 6.--Flow-duration data for selected gaging stations

Station number	Station name	Years of record	Discharge, in cubic feet per second, equaled or exceeded a given percentage of time						
			Percent						
			99	90	70	50	30	10	1
14020000	Umatilla River above Meacham Creek, near Gibbon, Oreg.	1934-74	35	45	58	120	250	550	1,200
14021000	Umatilla River at Pendleton, Oreg.	1936-74	22	36	67	220	550	1,200	3,100
14020900	Wildhorse Creek near Athena, Oreg.	1/ 1934-74	0	0	0	.8	7.5	29	110
14022500	McKay Creek near Pilot Rock, Oreg.	1927, 1930-74	0	.2	3.2	25	100	290	800

1/ Adjusted to long term on basis of station 14020000.

Unit discharge duration curves for the same sites listed in table 6 are shown in figure 11. Use of unit discharge [$(ft^3/s)/mi^2$] allows for comparison of the data. Although the flow-duration curves do not show the chronological sequence of flows, they do show in one curve the flow characteristics throughout the range of discharge. Curves that slope steeply throughout denote a highly variable stream whose flow consists of direct runoff of precipitation, whereas curves with flat slopes may indicate surface water or ground water in storage that is released slowly and tends to equalize the flow. Curves with a flat lower end indicate a large volume of storage; a steep lower end indicates a negligible volume of storage. Streams whose high flows are largely from snowmelt tend to have a flat slope at the upper end.

Comparison of flow-duration curves for the Umatilla River (fig. 11) indicates that the slopes of the upper and lower ends are flatter for the station near Gibbon than for the station at Pendleton. This suggests that the high flows near Gibbon are sustained for a longer period by snowmelt runoff and by seepage of ground water in storage than are flows at Pendleton.

The flow-duration curves in figure 11 show that flows in Wildhorse Creek are supplied mostly by direct runoff and that the stream is dry about 35 percent of the time. Flows of McKay Creek near Pilot Rock are mostly from direct runoff, and the creek is dry about 10 percent of the time.

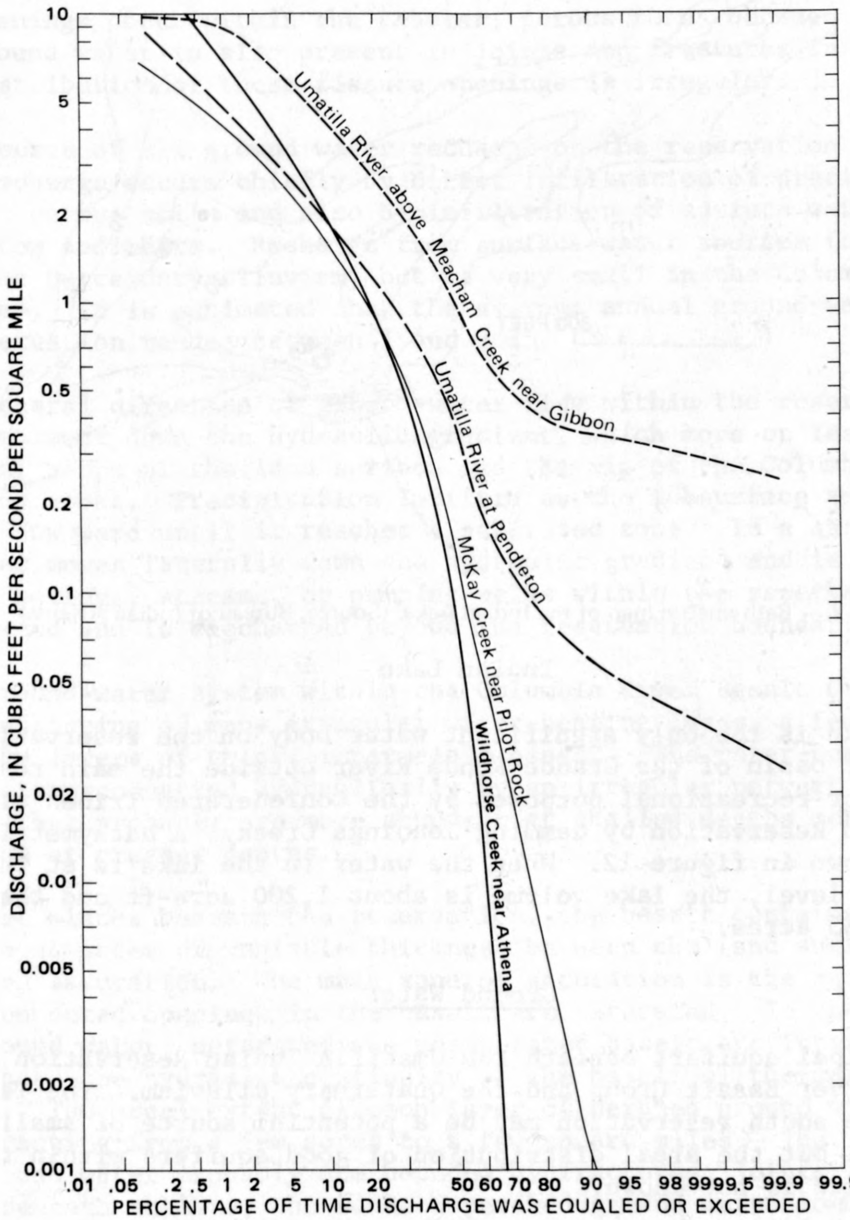

Figure 11. — Duration curves of discharge for streams in the vicinity of the Umatilla Indian Reservation.

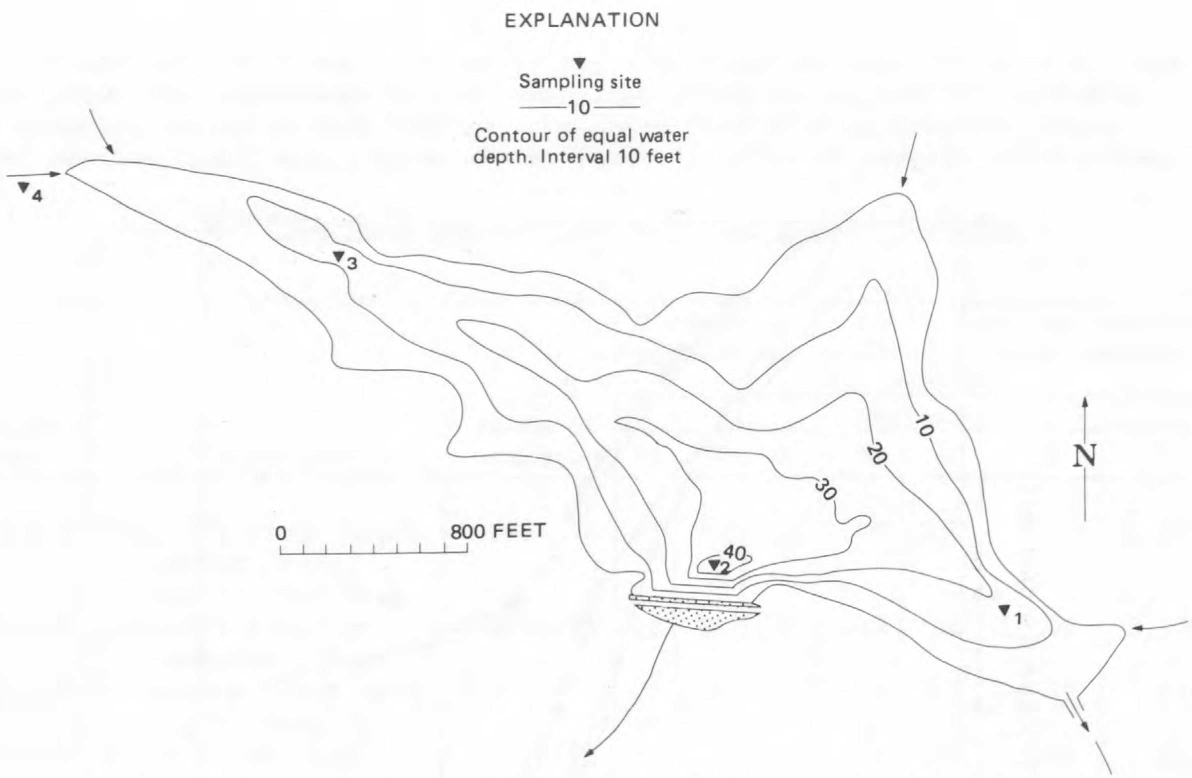

Figure 12. – Bathymetric map of the Indian Lake. (Source, Bureau of Indian Affairs.)

Indian Lake

Indian Lake is the only significant water body on the reservation and is in the drainage basin of the Grande Ronde River outside the main reservation. It was built for recreational purposes by the Confederated Tribes of the Umatilla Indian Reservation by damming Jennings Creek. A bathymetric map of the lake is shown in figure 12. When the water in the lake is at the spillway-crest level, the lake volume is about 1,200 acre-ft and the surface area is about 85 acres.

Ground Water

The principal aquifers beneath the Umatilla Indian Reservation are in the Columbia River Basalt Group and the Quaternary alluvium. The Tertiary deposits on the south reservation may be a potential source of small ground-water supplies, but the areal distribution of good aquifers within the Tertiary deposits is not known.

Only a few wells obtain water from the alluvium. Since 1914, the city of Pendleton has obtained a major part of its water requirements through infiltration galleries in the alluvium of the Thorn Hollow-Gibbon area. In 1974, the total withdrawals from the alluvium by the city were almost equal to the combined ground-water withdrawals from all wells on the reservation.

Occurrence, Recharge, Movement, and Discharge

Ground water occurs within the interconnected openings in rock units under unconfined, confined, or perched conditions. (See glossary for definitions of terms.) In granular rocks like the Tertiary deposits and the Quaternary alluvium, the openings consist of pore spaces between the individual rock particles. In the rocks of the Columbia River Basalt Group, the principal water-bearing openings occur within the tabular, porous zones between the lava flows. Ground water is also present in joints and fractures in the basalt, but the distribution of these fissure openings is irregular.

The source of all ground-water recharge on the reservation is precipitation. Recharge occurs chiefly by direct infiltration of precipitation into unsaturated porous soils and also by infiltration of surface water through stream-bottom sediments. Recharge from surface-water sources is comparatively large in the Quaternary alluvium, but is very small in the Columbia River Basalt Group. It is estimated that the average annual ground-water recharge on the reservation ranges between 1 and 3 in.

The general direction of ground-water flow within the reservation is from east to west down the hydraulic gradient, which more or less parallels the regional slope of the land surface and the dip of the Columbia River Basalt Group rocks. Precipitation infiltrates the subsurface and percolates vertically downward until it reaches a saturated zone. In a saturated zone, ground water moves laterally down the hydraulic gradient and is discharged by seepage to springs, streams, or pumping wells within the reservation or it flows westward and is discharged beyond the reservation boundaries.

The ground-water system within the Columbia River Basalt Group is complex, consisting of many irregular water-bearing layers a few feet thick separated by layers of thick, impermeable basalt. The water-bearing layers are poorly interconnected hydraulically by an irregular network of fractures and joints that probably are more abundant at shallow depths near the land surface than at greater depths.

In most places beneath the reservation, the basalt contains a zone of perched ground water of variable thickness between the land surface and the main zone of saturation. The main zone of saturation is the zone below which all interconnected openings in the basalt are saturated. In the zone of perched ground water, saturated and unsaturated basalt are interlayered and the zone lacks the hydraulic continuity of the basalt of the main zone of saturation. The areal extent of each layer of perched ground water probably is small, ranging from a few acres to a few square miles. The layers of perched ground water probably are bounded by fractures, joints, or erosional valleys. Beneath valleys, the zone of perched ground water commonly is thin or absent, whereas it may be very thick in upland areas. Beneath most of the north reservation, for example, the zone of perched ground water may be more than 200 ft thick, whereas beneath summit areas of the Blue Mountains, the perched zone probably is more than 1,000 ft thick.

Phenomena that suggest the presence of one or more zones of perched ground water are (1) water cascading downward from several different levels in a well, (2) radically different water-level altitudes in closely adjacent wells, and (3) decreasing water-level altitude with increasing depth of basalt penetration by a well. In well 1N/34E-1baa in the Blue Mountains, for example, the driller recorded small gains of water from several basalt layers and losses of water from other layers through the entire depth of the 695-ft-deep public-supply well. Irrefutable proof for the existence of a zone of perched ground water in the basalt requires extensive aquifer testing and test drilling that are beyond the scope of this study.

Many domestic wells in the basalt, especially those in the Blue Mountains and on the north reservation, obtain their yields entirely from the zone of perched ground water. The yields of wells that tap the perched zone commonly are small, but generally are adequate for domestic purposes. The depths of wells in these areas, however, tend to be extremely variable because some wells may penetrate only one layer of perched water to obtain an adequate yield, whereas others may be drilled through several.

The presence of shallow flowing wells in the basalt aquifer in most of the principal valleys indicates that ground water in the basalt tends to move upward and discharge into the alluvium beneath the valleys. The volume of upward seepage to the alluvium, however, is believed to be small.

Ground water in the perched-water zone occurs chiefly in an unconfined state or is locally confined, whereas ground water in the main zone of saturation of the basalt is chiefly confined. The total quantity of ground water in storage in the basalt probably is less than 5 percent of the total volume of basalt.

Deep-well water-level data on the reservation were too scattered to define the potentiometric surface of the main zone of saturation. However, water-level data from deep wells 2N/32E-1cdc, -2ccd, and -16bab indicate that the potentiometric surface of the main zone of saturation in the Pendleton area of the Umatilla River valley is relatively flat and is at an altitude of about 900 ft, some 100 to 200 ft below the valley floor. Water-level altitudes of 898 and 905 ft in wells 2N/33E-7ada3 and -7baa2 indicate that the same potentiometric surface probably extends beneath the valley onto the western edge of the reservation. From there, the altitude of the potentiometric surface apparently increases eastward to about 1,200 ft near Mission over a distance of 2.5 mi. East of Mission, the altitude of the potentiometric surface generally is within a few feet of the valley floor.

The hydrologic system in the basalt beneath the Umatilla River valley between Mission and the western boundary of the reservation is unique because confined ground water is also present in the shallow basalt directly underlying the Quaternary alluvium. Wells 2N/33E-8bbd, -9bca, and -9bcb, for example, tap the shallow basalt and flow each winter and spring when local pumpage is small. During the same period, wells deeper than 250 ft have water levels intermediate in altitude between those in wells tapping the shallow confined water and those tapping the main zone of saturation. Because the population of this area is large compared to other parts of the reservation, ground-water pumpage from the shallow basalt for irrigation increases substantially each summer and causes mutual interference of water levels in shallow basalt wells. Several wells tapping the shallow basalt in this area have required deepening to obtain adequate supplies in summer.

The ground water within the Quaternary alluvium in the principal valleys is virtually in a separate hydrologic system from that in the underlying basalt. The alluvium has a good hydraulic connection with adjacent streams, and it has a permeability many times greater than the basalt.

Discharge of ground water from the aquifers of the reservation occurs by seepage to springs, streams, or to adjacent geologic formations, and by evapotranspiration processes in areas where the ground water is close to the land surface. Ground water is also discharged by wells and by infiltration galleries.

Springs yielding very small flows are scattered throughout the Blue Mountains; many of the springs in moderately sloping areas have been improved for use by grazing livestock. Springs are commonly present along the base of the north-facing bluffs along the south side of the Umatilla River valley east of Mission and along similar bluffs in the McKay Creek valley. Spring seepages occurring in sec. 13, T. 3 N., R. 34 E., maintain the small perennial flow of Spring Hollow Creek on the north reservation. Similar seepages in sec. 20, T. 2 N., R. 33 E., also keep a short reach of Coyote Creek perennial. Springs also occur in the Quaternary alluvium along the Umatilla River, McKay Creek, and other principal streams on the reservation.

Shallow ground water is generally present in the Quaternary alluvium in the Umatilla River valley, McKay Creek valley, and in other principal stream valleys. In these valleys, discharge by evapotranspiration of ground water from the alluvium during the warm months probably is very large. During the cooler months, when evapotranspiration is small, discharge of ground water from the alluvium to the streams increases.

Water-Level Fluctuations

During this study, ground-water levels of several wells on the reservation were measured periodically by the Geological Survey. Measurements are also made in selected wells close to the reservation by the Oregon Water Resources Department (formerly Oregon State Engineer) and by the Water Department of the city of Pendleton. The purpose of the ground-water-level measurements was to determine the pattern and range of water-level fluctuations and to monitor the effects of ground-water pumping.

No long-term nor widespread water-level declines have been observed on the reservation, perhaps because the period of observation is too short to show them. Seasonal fluctuations and minor water-level declines have been observed. There are large withdrawals of ground water in the Pendleton area and outside the north reservation near the boundary. These withdrawals might be expected to cause small water-level declines in the basalt on the reservation.

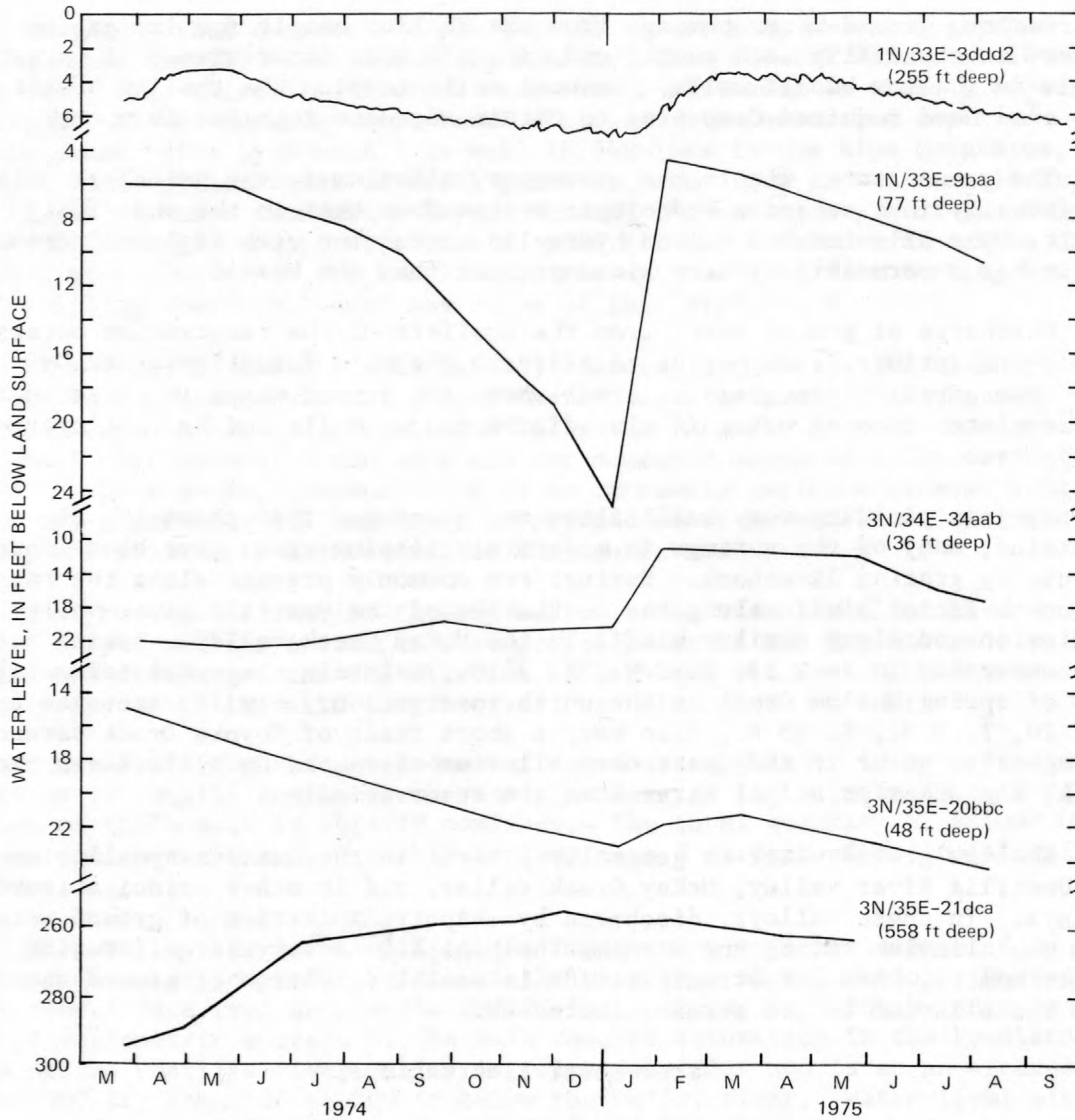

Figure 13. — Hydrographs showing typical seasonal patterns of ground-water-level fluctuations in wells on the Umatilla Indian Reservation.

The hydrographs in figure 13 show water-level fluctuations in representative wells on the reservation. The water levels in the four upper wells are shallow, and the hydrographs reflect the seasonal changes in ground-water storage. In each of the four wells, a rise in ground-water level occurred in January 1975 after a major storm crossed the reservation. The storm caused extensive flooding of streams and also resulted in significant ground-water recharge. Wells 1N/33E-3ddd2 and -9baa are completed in the basalt and in the

Tertiary deposits, respectively, whereas wells 3N/34E-34aab and 3N/35E-20bbc are dug wells probably completed in the basalt in the zone of perched ground water.

Water-level fluctuations in well 3N/35E-21dca (fig. 13) do not coincide with those in the other wells because it probably takes a few to several months for recharge from precipitation to percolate downward to the deep zone tapped by the well. The well is completed in the Columbia River Basalt Group in the zone of perched ground water.

The hydrographs in figure 14 show ground-water-level fluctuations in two wells in the Umatilla River valley west of Mission. The fluctuations are caused by seasonal ground-water pumping. Well 2N/33E-9bcb is 190 ft deep and is completed in the basalt in the zone of shallow confined water. The water level in the well is as much as 16 ft above the land surface during winter, when pumpage from the shallow zone in the area is small. During the irrigation season of 1974, the static water level declined by about 130 ft. The average pumping rate ranged from 2 to 10 gal/min during the decline period.

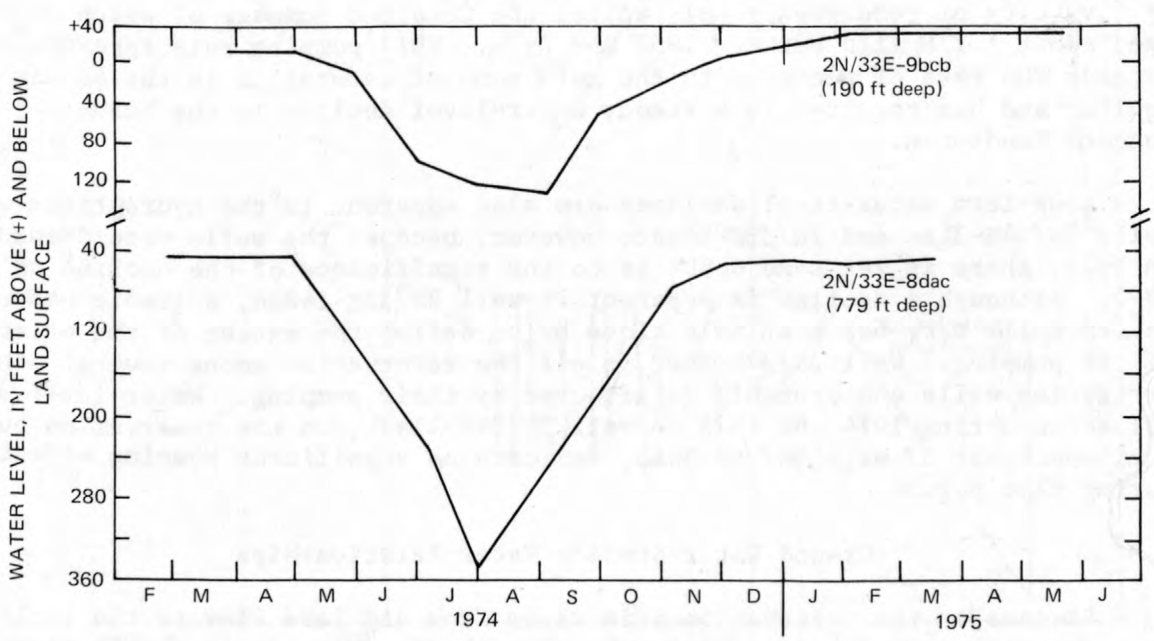

Figure 14. — Hydrographs illustrating the effects of seasonal pumping from the Columbia River Basalt Group on ground-water levels in wells on the Umatilla Indian Reservation.

Most of the water-level decline probably was caused by well interference due to pumping of several wells tapping the zone of shallow confined water within about a 1-mi radius.

Well 2N/33E-8dac is 779 ft deep and is open to the zone of shallow confined water, the zone of perched ground water, and the main zone of saturation of the basalt. In 1974, the water-level decline in the well was about 300 ft. This decline was due to its average pumping rate being 20 to 30 gal/min and to well interference. Dewatering of some layers of shallow basalt occurred in the vicinity. Water levels in both wells generally recover to preirrigation levels after the irrigation season ends.

The hydrographs in figure 15 show the seasonal fluctuations and the long-term trends in water-level fluctuations in selected deep wells in the Columbia River Basalt Group on and near the reservation. Three of the wells, 2N/32E-2ccd, -16bab, and 2N/33E-14dac, are owned by the city of Pendleton; well 2N/32E-16bab is unused. Well 3N/34E-3bac is an irrigation well. Water-level fluctuations in each well are caused chiefly by seasonal ground-water withdrawals from the basalt aquifer. The annual static water-level fluctuations in wells 2N/33E-2cdd and -16bab range from 4 to 10 ft, and the long-term trend indicates an average annual water-level decline of about 0.8 ft in each well. The seasonal and long-term declines probably are due to pumping by five city of Pendleton supply wells, the combined pumpage of which averaged about 1.1 Mgal/d between 1953 and 1974. This pumping rate apparently exceeds the rate of recharge to the main zone of saturation in the basalt aquifer and has resulted in a steady water-level decline in the basalt beneath Pendleton.

Long-term water-level declines are also apparent in the hydrographs of wells 3N/34E-3bac and 2N/33E-14dac; however, because the wells were deepened in 1972, there is yet some doubt as to the significance of the decline after 1972. Although a decline is apparent in well 2N/33E-14dac, suitable observation wells were not available close by to define the extent of the effects of its pumping. Well 3N/34E-3bac is off the reservation among several other irrigation wells and probably is affected by their pumping. Water-level data collected during 1974 and 1975 in well 3N/34E-11adb, on the reservation but 2 mi southeast of well 3N/34E-3bac, indicate no significant pumping effects during that period.

Ground Water-Surface Water Relationships

Streams on the reservation gain water from and lose flow to the rocks that underlie and are adjacent to the streambeds. Ground water will discharge to the stream at a given site when the ground-water level at the site is higher than the stream level. Streamflow moves into the subsurface when the stream level is higher than the local ground-water level. Each principal stream on the reservation gains water from and loses water to the ground-water system during a typical year. In general, during periods of low flow, most reaches lose streamflow to the ground. Streams also lose streamflow for short periods during peak discharges. Most reaches of perennial streams gain flow from the ground during periods of moderate streamflow.

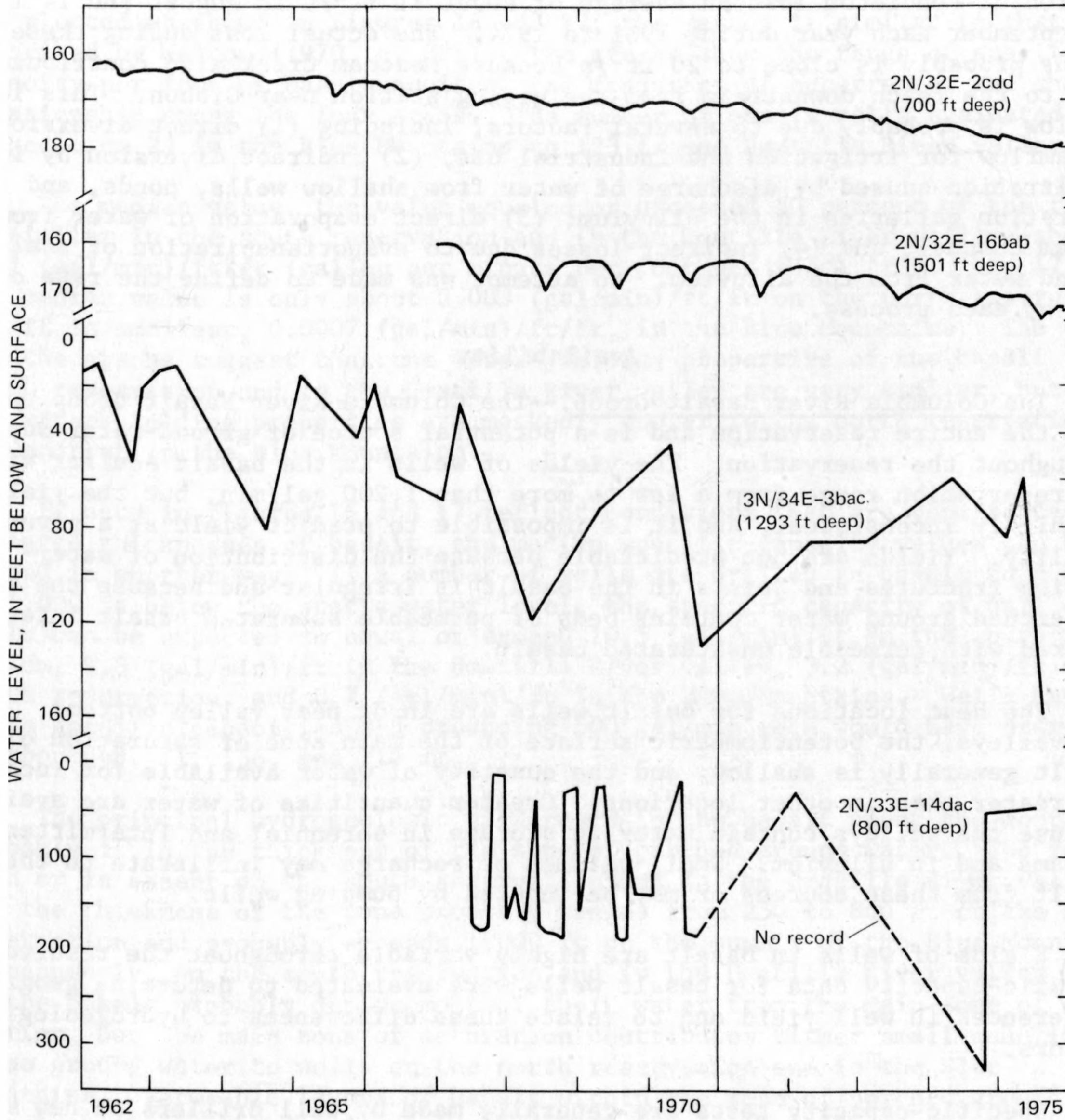

Figure 15. — Hydrographs of ground-water levels in deep wells tapping the Columbia River Basalt Group on and near the Umatilla Indian Reservation.

The hydraulic connection between streams and the aquifers is generally best in the Quaternary alluvium and is probably poorest where the streams are directly underlain by the Columbia River Basalt Group.

Stream-discharge records indicate that the reach of the Umatilla River between the gaging station above Meacham Creek near Gibbon and the gaging station at Pendleton lost an average of about 11 ft^3/s in August and 14 ft^3/s in September each year during 1931 to 1974. The actual loss during these months probably is close to 20 ft^3/s because Meacham Creek also contributes flow to the reach downstream from the gaging station near Gibbon. This loss in flow is probably due to several factors, including (1) direct diversion of streamflow for irrigation and industrial use; (2) indirect diversion by induced infiltration caused by discharge of water from shallow wells, ponds, and infiltration galleries in the alluvium; (3) direct evaporation of water from the stream channel; and (4) indirect losses due to evapotranspiration of shallow ground water from the alluvium. No attempt was made to define the rate of loss by each process.

Availability

The Columbia River Basalt Group.--The Columbia River Basalt Group underlies the entire reservation and is a potential source of ground-water supplies throughout the reservation. The yields of wells in the basalt aquifer within the reservation range from a few to more than 1,200 gal/min, but the yields are highly inconsistent, and it is impossible to predict yield at a given locality. Yields are not predictable because the distribution of water-bearing fractures and joints in the basalt is irregular and because the zone of perched ground water contains beds of permeable saturated basalt interlayered with permeable unsaturated basalt.

The best locations for basalt wells are in or near valley bottoms. In the valleys, the potentiometric surface of the main zone of saturation of the basalt generally is shallow, and the quantity of water available for recharge is greater than in other locations. Greater quantities of water are available because the valleys contain water in storage in perennial and intermittent streams and in alluvium. Small volumes of recharge may infiltrate to the basalt from these sources or may be induced by pumping wells.

Yields of wells in basalt are highly variable throughout the reservation. Specific-capacity data for basalt wells were evaluated to determine geographic differences in well yield and to relate these differences to hydrogeologic factors.

Specific-capacity tests are generally made by well drillers on new wells. The tests consist of withdrawing water from a well at a steady rate with a pump or a bailer or with compressed air for a period of 1 hour or more and measuring the change in water level, or drawdown, in the well, caused by the withdrawal. The specific capacity of a well is the pumping rate divided by the drawdown.

Because ground-water flow in basalt is chiefly parallel to the layering of the basalt and not across it, the yield and specific capacity of a well probably are determined by the number and thickness of saturated basalt zones open to the well. To enable comparisons of specific-capacity data from wells that vary in depth, the specific capacity is divided by the thickness of the basalt, below the static water level, open to the well. The value obtained is thus an average specific capacity for each foot of basalt below the static water level. The values of the specific capacity per foot of basalt below the static water level for wells in each of the four areas, were grouped, ranked, and plotted as shown in figures 16 and 17; the method is similar to that described by Walton (1970, p. 331). The graphs show the range of specific capacity per foot of basalt aquifer, the frequency of occurrence, and the relationship among the four areas. The number of basalt wells evaluated ranged from 23 in the Blue Mountains to 123 in the Umatilla River valley.

The median value, the value equaled or exceeded 50 percent of the time, is similar in the south reservation and in the Umatilla River valley--about 0.01 (gal/min)/ft/ft (gallon per minute per foot per foot) (figs. 16, 17). The median value is only about 0.003 (gal/min)/ft/ft on the north reservation, and it is smallest, 0.0007 (gal/min)/ft/ft, in the Blue Mountains. The values and the graphs suggest that the water-yielding properties of the basalt in the south reservation and in the Umatilla River valley are very similar, but that the water-yielding properties are markedly poorer in the north reservation and are poorest in the Blue Mountains.

If data in figures 16 and 17 reflect conditions that are representative of large thicknesses of basalt, the median specific-capacity values can be stated in another way. If a number of wells are drilled in basalt to a depth of 1,000 ft below the static water level, the specific capacity of half of the wells can be expected to equal or exceed 10.5 (gal/min)/ft on the south reservation, 9.8 (gal/min)/ft in the Umatilla River valley, 3.2 (gal/min)/ft on the north reservation, and 0.7 (gal/min)/ft in the Blue Mountains. Wells having these specific capacities and producing 500 gal/min each would have drawdowns of about 48, 51, 156, and 714 ft.

The principal hydrogeologic difference in the basalt among the four areas probably is in the thickness of the zone of perched ground water. The zone is thin or is absent on the south reservation and in the Umatilla River valley, but the thickness of the zone probably ranges from 250 to 800 ft on the north reservation and probably exceeds 1,000 ft on the summit of the Blue Mountains. Consequently, on the south reservation and in the Umatilla River valley, wells in the basalt probably derive most of their water from the main zone of saturation, but the main zone of saturation contributes either small quantities or no ground water to wells on the north reservation and in the Blue Mountains. Permeable layers of basalt within the zone of perched ground water contain both saturated and unsaturated beds, whereas all the permeable basalt layers are saturated within the main zone of saturation.

The south reservation.--The south reservation includes all the lands within the main reservation west of Cayuse between the valleys of the Umatilla River and McKay Creek and below an altitude of 2,000 ft.

Wells in the basalt on the south reservation range in depth from 24 to 1,002 ft; the average depth is 213 ft and median depth is 170 ft. Well yields range from a few to more than 1,200 gal/min. The largest yield is obtained

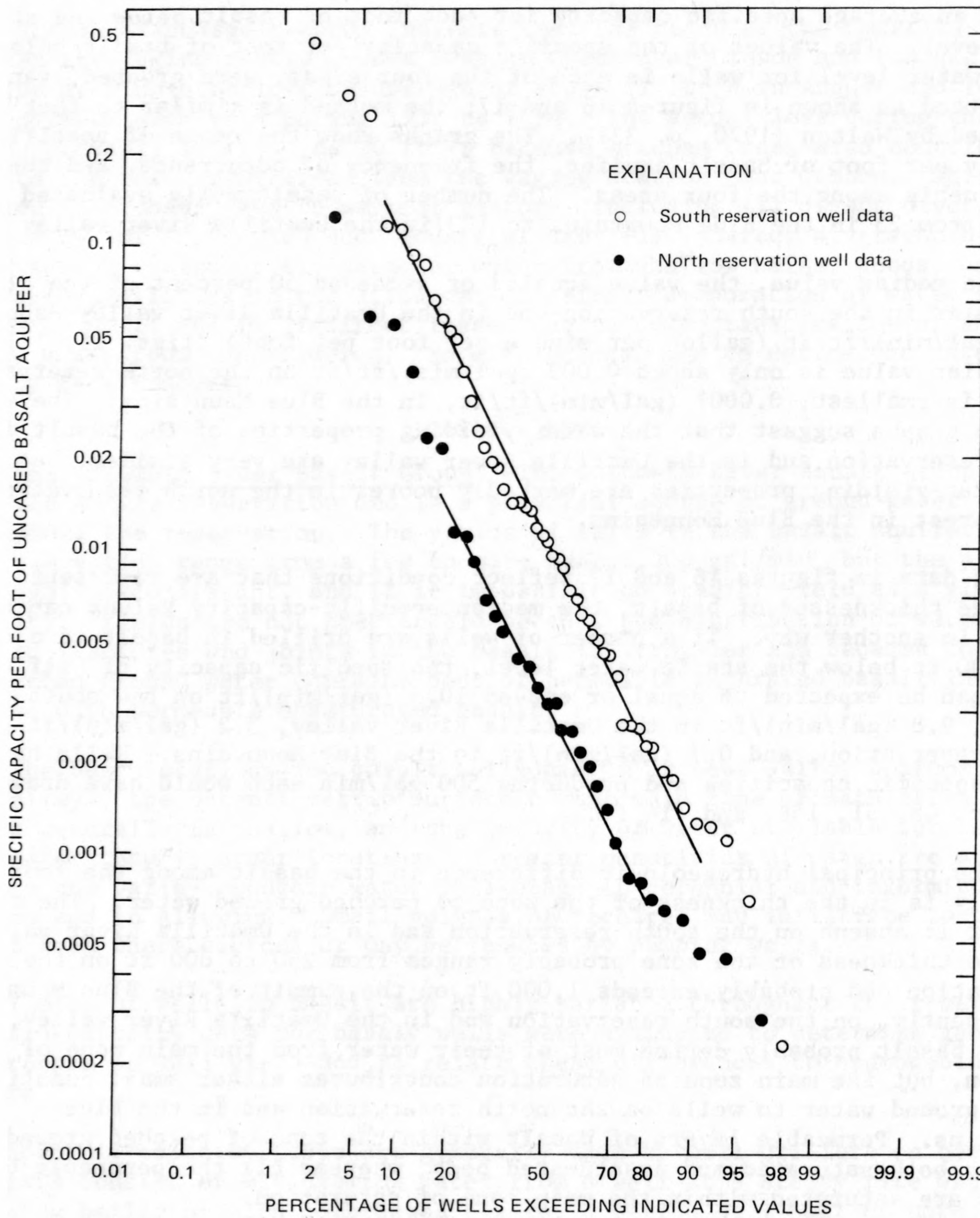

Figure 16. — Frequency graphs of specific capacity per foot of uncased basalt aquifer on the south and the north reservation.

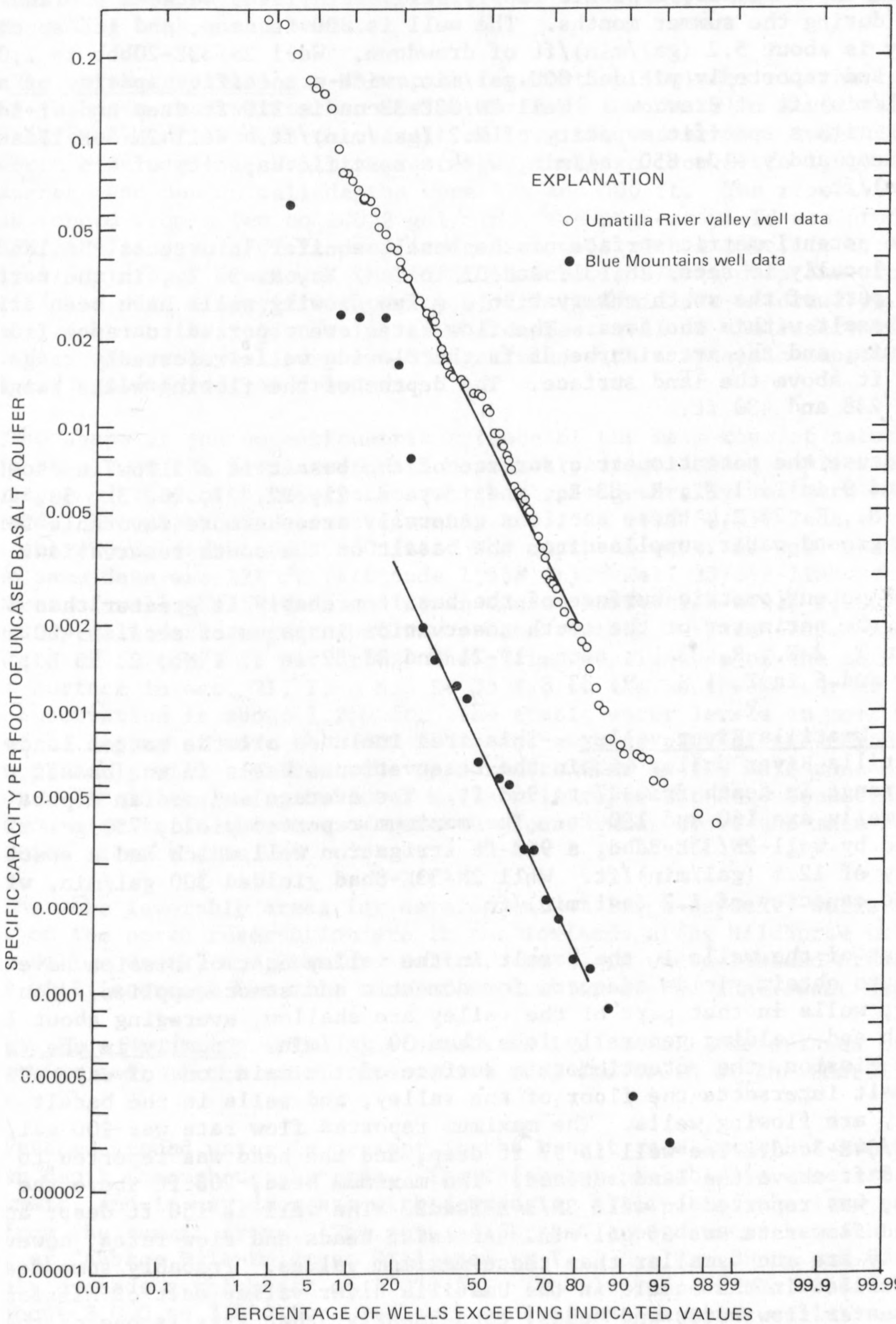

Figure 17. — Frequency graphs of specific capacity per foot of uncased basalt aquifer in the Umatilla River valley and the Blue Mountains.

from well 2N/33E-14dac, a public-supply well that yields between 900 and 1,250 gal/min during the summer months. The well is 800 ft deep, and its specific capacity is about 5.2 (gal/min)/ft of drawdown. Well 2N/33E-20bbb is 1,002 ft deep and reportedly yielded 800 gal/min, with a specific capacity of about 5.5 (gal/min)/ft of drawdown. Well 2N/33E-33cca is 310 ft deep and yields 456 gal/min, with a specific capacity of 2.2 (gal/min)/ft. Well 2N/34E-17dac is 750 ft deep and yields 850 gal/min, with a specific capacity of 4.6 (gal/min)/ft.

The potentiometric surface of the basalt aquifer intersects the land surface locally in secs. 28, 31, and 33 in T. 2 N., R. 33 E., in the north-central part of the south reservation. A few flowing wells have been drilled in the basalt within the area. The flow rates are reported to range from 2 to 25 gal/min, and the artesian heads in the flowing wells reportedly range from 9 to 12 ft above the land surface. The depths of the flowing wells range between 238 and 430 ft.

Because the potentiometric surface of the basalt is shallow in secs. 4, 5, 8, and 9 in T. 1 N., R. 33 E., and in secs. 21, 22, 27, 28, 31, 33, and 34 in T. 2 N., R. 33 E., these sections generally are the more favorable for obtaining ground-water supplies from the basalt on the south reservation.

The potentiometric surface of the basalt probably is greater than 100 ft deep in the perimeter of the south reservation in parts of secs. 15-20 and 29-31 in T. 2 N., R. 33 E.; secs. 19-21 and 28-32 in T. 1 N., R. 33 E.; and secs. 5 and 6 in T. 1 S., R. 33 E.

The Umatilla River valley.--This area includes all the bottom lands of the Umatilla River valley within the reservation. Wells in the basalt in the valley range in depth from 27 to 968 ft. The average and median depths of basalt wells are 160 and 120 ft. The maximum reported yield, 750 gal/min, was produced by well 2N/33E-8dbd, a 968-ft irrigation well which had a specific capacity of 12.5 (gal/min)/ft. Well 2N/33E-8bad yielded 300 gal/min, with a specific capacity of 1.2 (gal/min)/ft.

Most of the wells in the basalt in the valley east of Mission have been drilled to obtain yields adequate for domestic and stock supplies. Consequently, wells in that part of the valley are shallow, averaging about 120 ft in depth and yielding generally less than 30 gal/min. Locally in the valley east of Mission, the potentiometric surface of the main zone of saturation of the basalt intersects the floor of the valley, and wells in the basalt commonly are flowing wells. The maximum reported flow rate was 200 gal/min in well 2N/34E-3ccd. The well is 97 ft deep, and the head was reported to be about 46 ft above the land surface. The maximum head, 203 ft above the land surface, was reported in well 2N/34E-1add2. The well is 150 ft deep, and the reported flow rate was 55 gal/min. Artesian heads and flow rates, however, generally are much smaller than these maximum values. Probably some deep wells drilled in the basalt in the Umatilla River valley east of Mission will have greater flow rates and heads; consequently, that area is one of the more favorable areas on the reservation for wells in the basalt. Hydraulic conditions in the basalt in Meacham Creek and McKay Creek valleys and other valleys on the reservation are expected to be similar to those in the Umatilla

River valley east of Mission; therefore, all the valleys should be favorable for providing high-yield wells.

The north reservation.--The north reservation includes all the lands within the main reservation boundaries north of the Umatilla River valley. Wells have been drilled in the basalt only in the westernmost two-thirds of the north reservation. Wells there ranged in depth from 37 to 1,910 ft, but the average and median well depths were 674 and 400 ft. The reported well yields ranged from a few to 1,022 gal/min. The highest yield was produced by well 3N/35E-7aaa, a 1,787-ft-deep irrigation well with a specific capacity of 4.6 (gal/min)/ft of drawdown. Well 3N/35E-4cbd is 870 ft deep and produced 870 gal/min, with a specific capacity of 2.1 (gal/min)/ft of drawdown. Well 3N/34E-13dcb, an irrigation well, is the deepest well on the reservation at 1,910 ft. The well yielded about 330 gal/min, with a specific capacity of about 1.2 (gal/min)/ft of drawdown.

The shape of the potentiometric surface of the main zone of saturation of the basalt on the north reservation probably is a subdued replica of the topography of the north reservation which slopes generally westward and southwestward. The depth of the static water level in well 3N/35E-7aaa on May 30, 1974, was 298 ft (altitude 1,700 ft). The depth to water in well 3N/34E-11adb on the same date was 121 ft (altitude 1,538 ft). Well 3N/34E-11abd is about 2 mi west of well 3N/35E-7aaa and is an unused irrigation well, 1,030 ft deep. These deep-well data suggest that the potentiometric surface slopes westward at a rate of 50 to 75 ft per mile. The estimated altitude of the potentiometric surface in sec. 21, T. 3 N., R. 35 E., in the southwest corner of the north reservation is about 1,250 ft. The static water levels in most wells drilled to depths of more than 800 ft in the western part of the north reservation probably will represent the approximate head of the main zone of saturation. Water levels in shallower wells will represent head conditions in one or more units in the zone of perched ground water above the main zone of saturation at each site.

The more favorable areas for development of large-capacity wells in the basalt on the north reservation are in the lowlands along Wildhorse Creek, Spring Hollow Creek, and Crawford Hollow. Wells in these lowland areas generally will intercept the main zone of saturation at the shallowest depths.

The Blue Mountains.--The Blue Mountains include all the uplands of the reservation east of the south reservation area and south of the Umatilla River valley.

Perched ground water is present in the basalt to a large but generally unknown depth throughout the area. The thickness probably is greatest beneath the summit, and it may decrease with decreasing altitude of the land surface away from the summit areas. The zone of perched ground water beneath the summit of Cabbage Hill-Emigrant Hill area in T. 1 N., Rs. 34 E. and 35 E., probably exceeds a thickness of 1,000 ft. The altitude of the area ranges from about 3,000 to 3,800 ft. Probably none of the existing wells in the summit area fully penetrates the zone of perched ground water and reaches the main zone of saturation in the basalt. Most wells in the Blue Mountains on the reservation are within the Cabbage Hill-Emigrant Hill area, and these wells range in depth from 118 to 850 ft; the average and median depths are 335 and 283 ft. The average and median depth to water in these wells was 182 and 133 ft.

Well yields in the Cabbage Hill-Emigrant Hill area range from near zero to as much as 60 gal/min. The maximum reported yield was from well 1N/34E-9bca, which is reported to be 252 ft deep. The basalt in this area is poorly permeable, and it is doubtful that the reported 60 gal/min pumping rate could be maintained for more than a few hours. For example, well 1N/34E-1baa is 695 ft deep and supplies the Oregon State Highway Department Deadman Pass rest area. The well reportedly yielded 22 gal/min; the specific capacity was about 0.06 (gal/min)/ft of drawdown, and the yield reportedly was inadequate to meet the irrigation and other needs of the rest area.

Tertiary deposits.--Tertiary deposits underlie an area of about 34 mi^2 on the south reservation and about 4 mi^2 on the north reservation. On the south reservation, these deposits probably are saturated and a potential source of ground-water supplies in about 40 percent of their outcrop area. On the north reservation, the Tertiary deposits probably are unsaturated. Water in the Tertiary deposits in much of the south reservation probably is perched on the underlying basalt. The saturated thickness of the Tertiary deposits on the south reservation may exceed 100 ft in parts of secs. 3 to 6 and 9 in T. 1 N., R. 33 E., and secs. 28, 32, and 33 in T. 2 N., R. 33 E. Well yields of as much as 50 gal/min may be expected in such areas if gravel or sand-and-gravel aquifers are present.

Only a few wells on the south reservation are completed in the Tertiary deposits; consequently, very few lithologic and hydrologic data are available. Most of the wells are unused large-diameter dug wells. One drilled well (1N/33E-4ddd) is completed in the Tertiary deposits and is known to obtain its entire yield from these materials. The well is 195 ft deep and is uncased in cemented gravel and in tightly packed gravel below the water table. The well was pumped at 12 gal/min with a total drawdown of 3.1 ft, a specific capacity of about 3.8 (gal/min)/ft of drawdown.

The water-level map (fig. 18) shows approximate contour lines on the perched water table in the Tertiary deposits; the arrows indicate the general direction of ground-water flow in these deposits in part of the south reservation area. Ground water from the Tertiary deposits is discharged naturally as diffuse seepage to Patawa Creek and North Coyote Creek in secs. 9, 20, and 21 of T. 2 N., R. 33 E. Discharge also occurs by evapotranspiration of shallow ground water from the water table in the above areas and in sec. 31, T. 2 N., R. 33 E.

Estimates of the saturated thickness of the Tertiary deposits in some localities of the south reservation can be made from the water-level map (fig. 18) and the map showing the altitude of the surface of the Columbia River Basalt Group beneath the Tertiary deposits (fig. 3). The saturated thickness of the Tertiary deposits is determined by subtracting the altitude of the surface of the Columbia River Basalt Group from the water-level altitude.

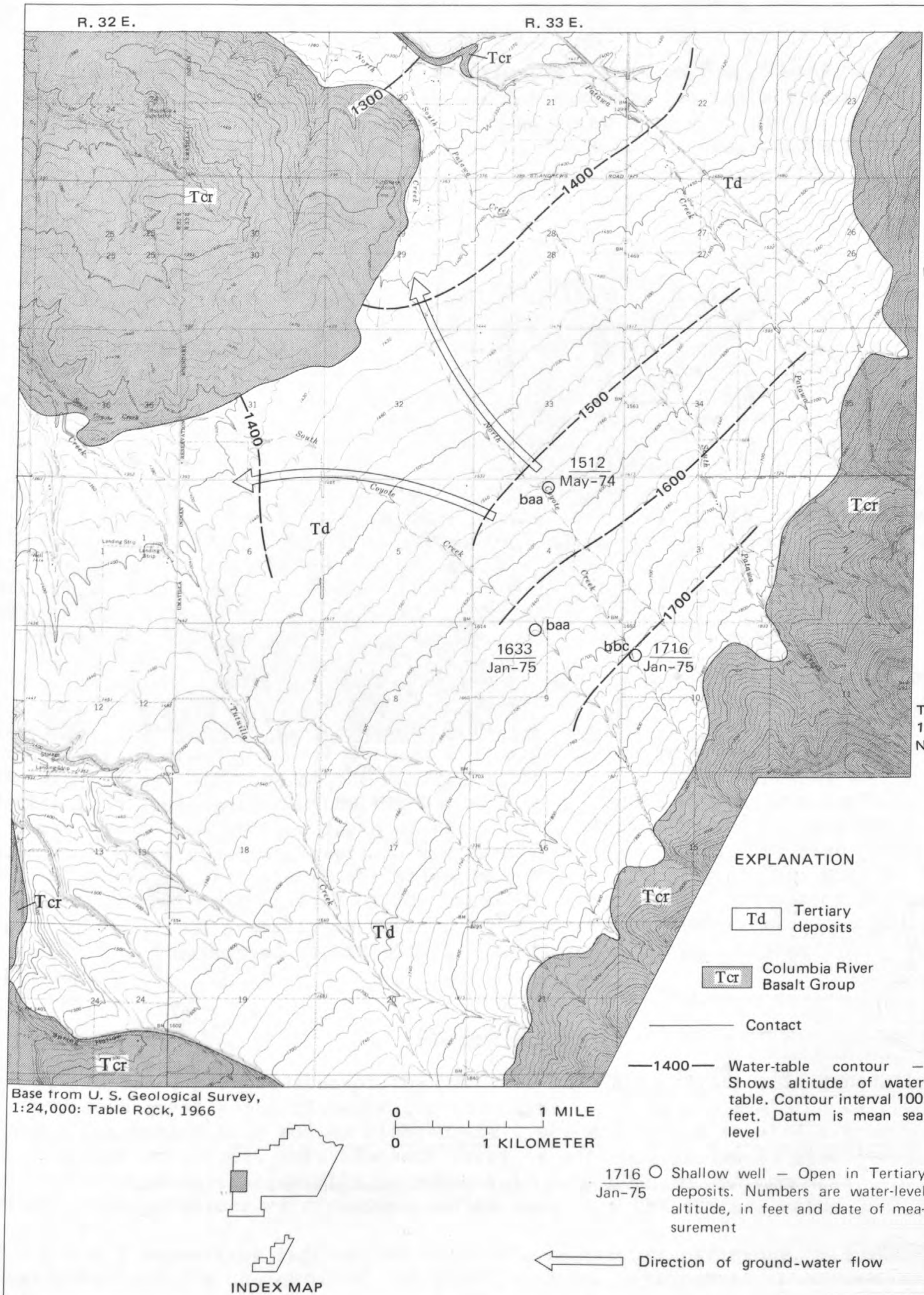

Figure 18. — Map showing approximate water-level contours in the Tertiary deposits on the south reservation.

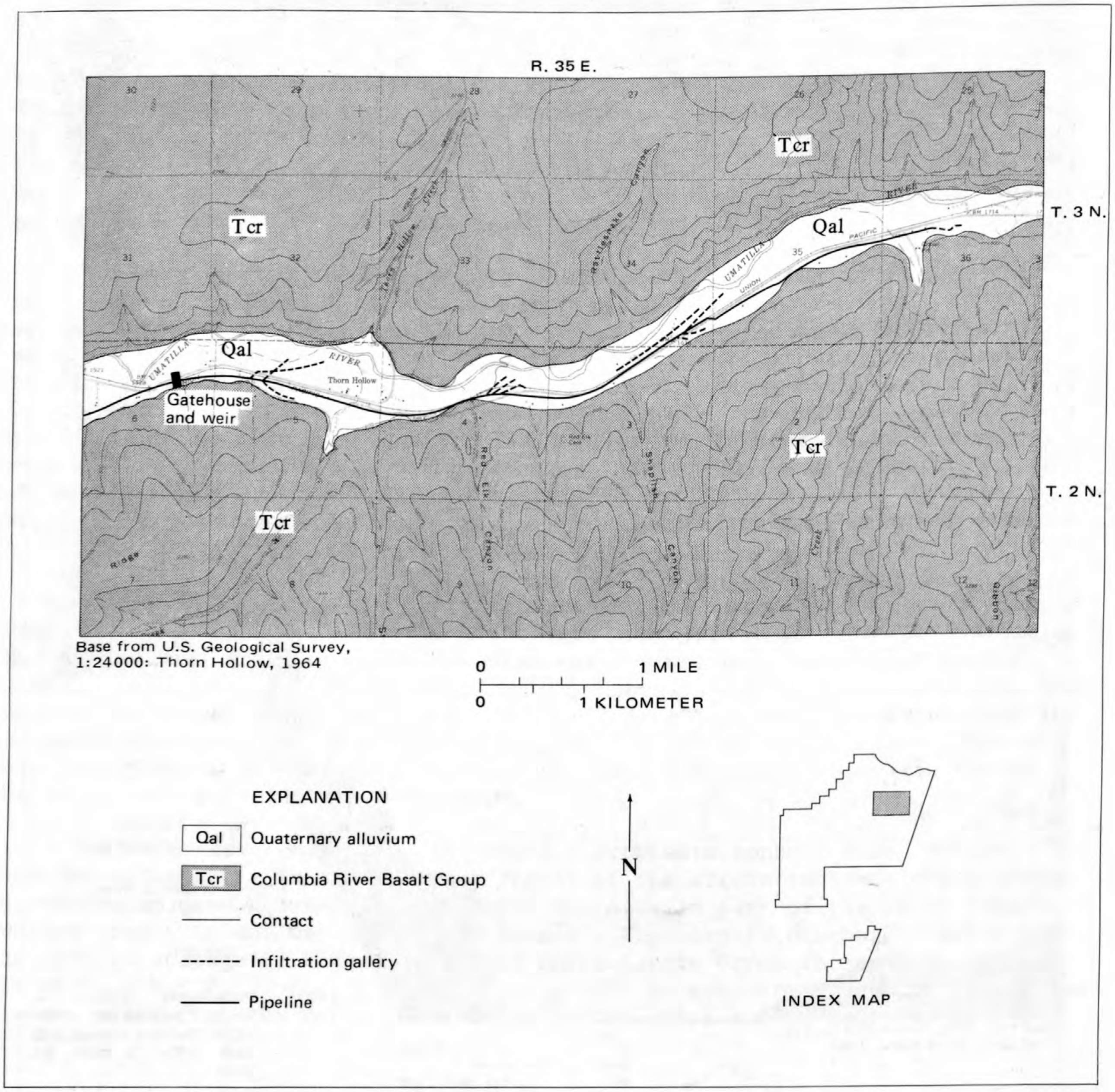

Figure 19. — Map showing locations of the infiltration galleries in the Quaternary alluvium near Thorn Hollow.

Quaternary alluvium.--Quaternary alluvium occurs in the channels and beneath the flood plains of most reservation streams, but the alluvium is generally too thin for development of ground water except in the Umatilla River valley and possibly in the valleys of McKay and Meacham Creeks. The thickness of the alluvium in the Umatilla River valley averages about 12 ft, whereas the saturated thickness probably averages between 2 and 6 ft. The saturated thickness and the extent of the alluvium is smaller in other valleys.

The most productive beds in the alluvium consist of clean, well-sorted gravel or sand and gravel, and these materials are capable of yielding as much as 75 gal/min to large-diameter wells.

In 1974, the city of Pendleton withdrew between 2.8 and 5.3 Mgal/d of ground water from infiltration galleries in the alluvium in the Umatilla River valley near Thorn Hollow. The locations of the galleries are shown in figure 19. They consist of about 14,000 ft of open-jointed pipelines buried below the water table in the Quaternary alluvium. Ground water infiltrates into the pipes through the open joints and flows by gravity in a pipeline to Pendleton. The pipeline connecting the galleries carries the water to a gatehouse and weir, where the flow rate and the turbidity of the water are monitored. The system has been in operation since about 1914. Presumably, similar infiltration galleries could be developed in the alluvium at other sites in the valley.

Dug wells and shallow ponds are also used to develop water supplies from the alluvium. Dug wells are generally more than 3 ft in diameter and are cased with concrete above the water table and lined with stone below it. Ground water enters the well through the large openings within the cobble and boulder lining. The use of the dug wells for domestic water supplies is declining because the alluvium is susceptible to contamination from surface sources due to the shallow depth of the water table and to the large permeability. For irrigation supplies, some small, shallow ponds have also been dug below the water table in the alluvium. Most of these ponds are within a few to several tens of feet of the Umatilla River and all or most of the yield of each pond probably is derived indirectly from the river. Some ponds have also been developed at sites that formerly were springs in the alluvium.

Water Quality

Surface and ground water of the Umatilla Indian Reservation is generally of very good quality and suitable for most uses. All waters are of a calcium sodium bicarbonate or a sodium bicarbonate type, and silica is also a principal dissolved constituent. Surface water is soft and is low in dissolved solids. Ground water generally is moderately hard to hard and contains greater concentrations of dissolved solids than does the surface water.

Table 7 summarizes information about the source, significance, and water-use limitations for the chemical, physical, and bacteriological characteristics of water that are listed in the data tables accompanying this report.

Table 7.--Source and significance of chemical, physical, and biological characteristics of water

Constituent	Potential source(s)	Significance or definition
Silica (SiO_2)	Silicate minerals in rocks.	Forms hard scale in high-pressure boilers.
Iron (Fe)	Iron-bearing minerals, well casings, and pipes.	In concentrations greater than 0.3 mg/L, may stain laundry and porcelain plumbing fixtures (National Academy of Sciences, 1974). Larger concentrations may impart objectionable taste to water.
Manganese (Mn)	Manganese-bearing minerals, decomposition of plant tissue.	In concentrations greater than 0.05 mg/L may cause brown to black stain in laundry and porcelain plumbing fixtures (National Academy of Sciences, 1974). Generally has same objectionable features as iron.
Calcium (Ca)	Rocks, soils, and "hardpan" deposits rich in calcium carbonate minerals and from fertilizers.	A constituent of scale deposits in water pipes, boilers, and cookware. Principal cause of water hardness.
Magnesium (Mg)	Ferromagnesium minerals in rocks.	A constituent of scale deposits in water pipes, boilers, and cookware. Second principal cause of water hardness.
Sodium (Na)	Sodium-bearing minerals in rocks; industrial wastes	Large concentrations in combination with chloride give water salty taste. Large concentrations in irrigation water may reduce soil permeability.
Potassium (K)	Potassium-bearing minerals in rocks; present in plant tissue, sewage, industrial wastes, and fertilizers.	Essential plant nutrient.
Bicarbonate (HCO_3) and carbonate (CO_3)	Carbon dioxide in air and soil atmosphere, "hardpan" deposits, or cementing material in sediments; also decomposition of organic matter in soil.	In combination with calcium and magnesium, cause carbonate hardness. Carbonates of calcium and magnesium form scale in steam boilers and hot-water facilities and release corrosive carbon dioxide gas.
Sulfate (SO_4)	Sulfide minerals in rocks, gypsum, precipitation, fertilizers, and sewage.	Sulfates of calcium and magnesium form hard scale. In concentrations greater than about 250 mg/L may have unpleasant taste and be cathartic to some individuals (National Academy of Sciences, 1974).
Chloride (Cl)	Soils and rocks, evaporite minerals, precipitation, animal wastes, and sewage.	Makes water corrosive; more than 250 mg/L may impart salty taste to water (National Academy of Sciences, 1974).
Fluoride (F)	Fluoride-bearing minerals which occur in trace amounts in most rocks.	Optimum concentrations tend to reduce decay of children's teeth; larger concentrations cause mottling of enamel of teeth. Concentration of fluoride in drinking water on reservation should not exceed 2 mg/L (U.S. Environmental Protection Agency, 1975).
Nitrate (NO_3) as N	Bacterial action in soil and plants; concentrated in plant and animal wastes, sewage, and fertilizers.	Essential plant nutrient. In surface water excessive nitrate and phosphates in combination cause algal blooms which may result in organic enrichment of water and depletion of dissolved oxygen. Consumption of water with more than about 10 mg/L of nitrate as N may cause methemoglobanemia in infants (U.S. Environmental Protection Agency, 1975). In excess of average concentrations may indicate pollution by organic wastes.
Phosphorus (P or phosphate (PO_4)	Phosphorus-bearing minerals present in most rocks in trace amounts. Component of sewage, animal wastes, fertilizers, and some detergents.	Essential plant nutrient. See nitrate.
Boron (B)	Boron-bearing minerals, volcanic gases, thermal springs, and sewage.	Essential in trace amounts to plant nutrition. In concentrations greater than about 2 mg/L, may be toxic even to tolerant crops (National Academy of Sciences, 1974).
Arsenic (As)	Dissolved from arsenic-bearing minerals. Ingredient of many herbicides and insecticides.	Prolonged consumption of water containing more than about 0.05 mg/L of arsenic may lead to chronic poisoning (U.S. Environmental Protection Agency, 1975).
Dissolved solids (residue on evaporation or calculated)		Measure of the concentration of dissolved solids in water.
Specific conductance		Indicator of the ability of a solute to conduct an electrical current. Gives indication of the concentration of dissolved solids in water.
Hardness as ($CaCO_3$)	Mainly dissolved calcium and magnesium in water.	Property of water related to the formation of an insoluble curd with soap and the formation of scale in pipes, boilers, and cooking utensils.

Table 7.--Source and significance of chemical, physical, and biological characteristics of water--Continued

Constituent	Potential source(s)	Significance or definition
Alkalinity	Negative ions (anions) in water--chiefly bicarbonate and carbonate.	Property of water that is related to its ability to neutralize acid solutions.
pH (hydrogen ion activity)	Hydrogen ions in solution.	Hydrogen ion activity expressed in negative logarithmic units. A measure of the dissociation of water molecules. A neutral solution has a pH of 7.0.
Temperature	Determined by local environment.	Important physical characteristic that affects taste, efficiency of waste-treatment processes, cooling, suitability of habitat for aquatic life, and suitability for irrigation.
Dissolved oxygen (DO)	Atmosphere, byproduct of photosynthesis in aquatic plants.	An indicator of the biochemical condition of water. Desirable fish species and other aquatic biota require high concentrations of DO. Maximum concentration of DO in water varies inversely with water temperature.
Biochemical oxygen demand (BOD)	Organic material in water.	Measurement of the amount of oxygen consumed during a given time period at a given temperature by aerobic bacteria in the process of decomposing organic material.
Coliform bacteria	Intestinal tract of warmblooded animals, soil.	Easily detected indicator of possible presence of disease-causing micro-organisms.
SAR (sodium-adsorption-ratio)	Calculated from the following equation: $$SAR = \frac{(Na^+)}{\sqrt{\frac{(Ca^{+2}) + (Mg^{+2})}{2}}}$$ where: Na^+, Ca^{+2}, Mg^{+2} are in milliequivalents per liter.	Equation predicts the degree to which irrigation water tends to enter into cation-exchange reactions in soil. High SAR values imply a hazard of sodium replacing adsorbed calcium and magnesium; this replacement is damaging to soil structure.

Surface Water

Water in the principal streams on the reservation is generally of excellent quality and contains generally less than 120 mg/L of dissolved solids. The surface water is soft, and the concentration of dissolved oxygen is generally close to saturation levels at most stream temperatures and discharge rates. Continuous measurement of water temperature at the gaging site on Umatilla River above Meacham Creek indicates that the water there is commonly too warm during periods of low flow in summer for optimum habitat conditions for spawning and rearing of salmon and trout. Records of the suspended-sediment load of the Umatilla River at the same site indicate that the sediment load of the Umatilla River on the reservation is generally lower than that of other streams in the region.

The chemical, physical, and bacteriological data for surface-water samples from sites on the Umatilla River, Meacham Creek, and McKay Creek are listed in table 8. The stations are listed in downstream order, and daily mean stream discharge is shown for each sampling date. The water samples were collected by personnel of the Bureau of Indian Affairs and analyzed by the Oregon Department of Environmental Quality or they were collected and analyzed by the U.S. Geological Survey. The locations of the sampling sites are shown in figure 20, which also shows chemical diagrams of the surface water from three representative sites at high and low stream discharge. The chemical diagrams enable visual comparisons of the chemical quality of the water from different sources and areas. The diagrams (fig. 20) indicate that the chemical quality of the streamflow of the principal streams is similar and that there are only small differences between water quality at high and low flows.

The principal dissolved constituents in surface water are bicarbonate, silica, and calcium, in order of decreasing concentration. The concentration of bicarbonate ranged from 25 to 61 mg/L, whereas silica ranged from 25 to 37 mg/L and calcium from 3.5 to 11 mg/L.

Small densities of fecal coliform colonies were generally present in stream waters sampled on the reservation, and the density of these organisms generally was greatest when the stream-discharge rate was high. The highest density of fecal coliform detected in surface water was 620 MPN/100 mL (most probable number per 100 mL), which occurred in a sample taken on July 19, 1971, from site 8 on McKay Creek below the North Fork of McKay Creek. The high value probably is due to wastes from livestock grazing near the sampling site. The density of fecal coliform determined on the same date at site 9 a few miles downstream was 130 MPN/100 mL.

These coliform data indicate that the raw surface waters on the reservation are not safe for drinking without being treated. Because of the lack of valid epidemiological data, no standards have been adopted for fecal coliform densities of water used for recreational purposes such as swimming. It has been suggested that an arbitrary value of 1,000 fecal coliform colonies per 100 mL will be considered as a maximum value for water used for swimming (National Academy of Sciences, 1974, p. 32).

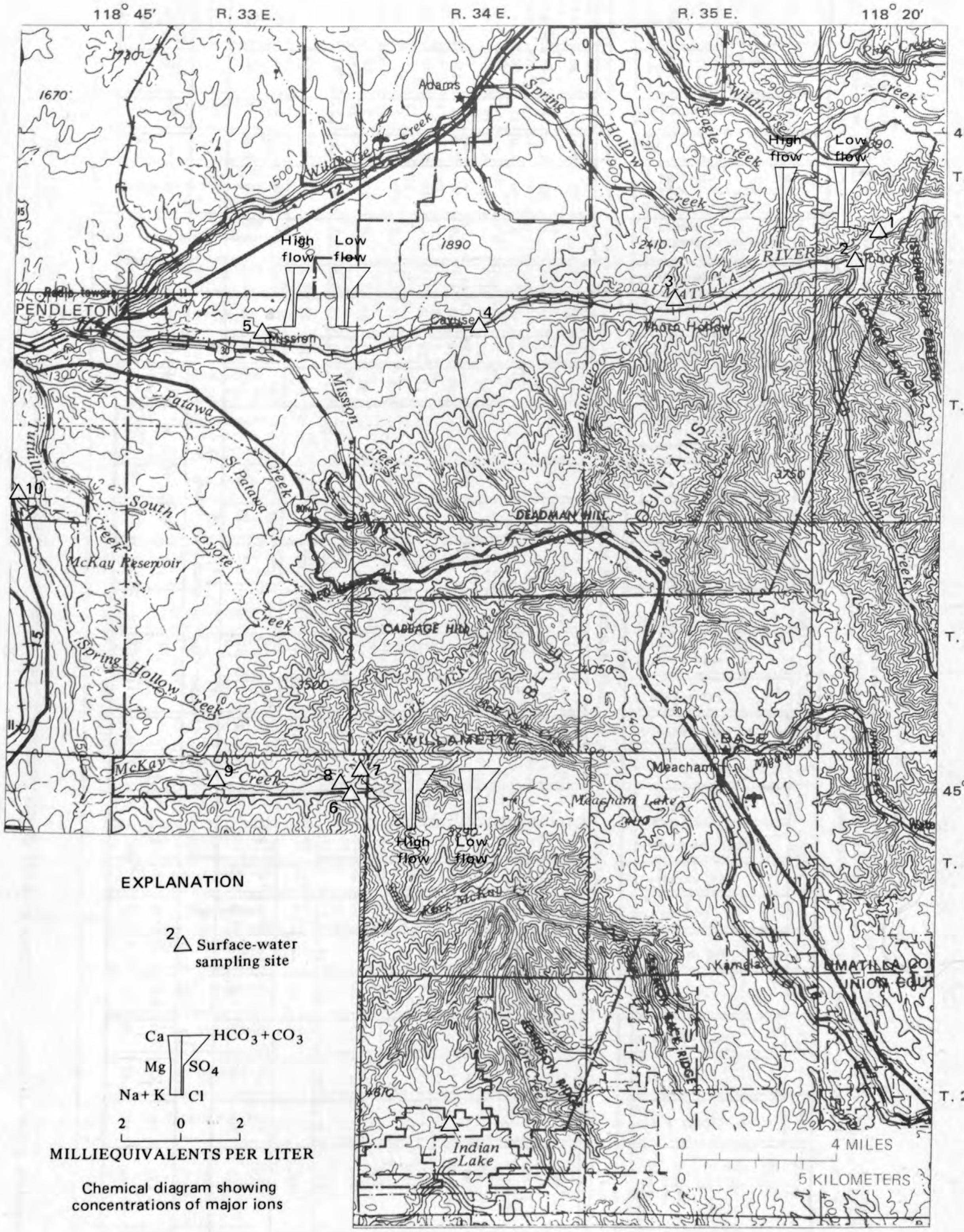

Figure 20. — Map showing locations of sampling sites and selected chemical diagrams for surface waters.

Table 8.--Water quality of streams in the Umatilla Indian Reservation area

[Note: Prior to 1975, samples were collected by the Bureau of Indian Affairs and analyzed by the Oregon State Department of Environmental Quality. In 1975, samples were collected and analyzed by U.S. Geological Survey. Station numbers shown are standard network numbers (8-digit) or numbers comprised of latitude-longitude (15-digit), as used in Geological Survey annual data reports. Under coliform, values for total are MPN/100 mL (most probable number); under fecal, values are MPN/100 mL, EC media]

Date of collection	Daily mean discharge (ft^3/s)	Milligrams per liter: Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite plus nitrate, as N	Ammonium total, as N	Phosphate, ortho, as P	Boron (B)	Arsenic (As)	Dissolved solids: Calculated from determined constituents	Dissolved solids: Residue on evaporation	Hardness, as $CaCO_3$	Total alkalinity, as $CaCO_3$	Dissolved oxygen	Biochemical oxygen demand	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)	Coliform (MPN/100 mL): Total	Coliform (MPN/100 mL): Fecal
(Site 1) 14020000 - Umatilla River above Meacham Creek at bridge east of Gibbon																													
6-21-71	192	--	--	--	--	--	--	--	--	--	0.5	2	--	0.04	0.80	0.05	--	--	--	77	17	23	10.2	0.7	51	7.6	14	60	< 45
7-19-71	67	--	--	--	--	--	--	--	--	--	<.5	3	--	.05	.01	<.01	--	--	--	102	25	33	9.4	.6	87	7.6	18	< 45	< 45
8-16-71	53	--	--	--	--	--	--	--	--	--	5	3	--	<.02	.03	.04	--	--	--	87	25	35	9.9	.2	90	8.0	17	60	--
9-13-71	46	--	--	--	--	--	--	--	--	--	1	4	--	<.05	.01	.10	--	--	--	72	27	35	11.0	--	88	8.0	14	230	< 45
10-12-71	45	--	--	--	--	--	--	--	--	--	3	4	--	<.05	<.01	.07	--	--	--	89	28	38	11.4	.9	84	7.8	10	130	< 45
11- 8-71	86	--	--	--	--	--	--	--	--	--	1	3	--	<.05	<.01	.03	--	--	--	57	26	34	13.6	1.4	70	8.0	4	60	< 45
12- 6-71	880	--	--	--	--	--	--	--	--	--	7	1	--	.22	.08	.11	--	--	--	128	16	16	12.3	1.5	56	--	5	230	60
2-14-72	445	--	--	--	--	--	--	--	--	--	4	2	--	.11	.07	.12	--	--	--	83	17	19	13.1	.8	57	--	3	60	--
3-13-72	2,460	--	--	--	--	--	--	--	--	--	5	.4	--	.25	.10	.17	--	--	--	78	15	15	15.9	9.5	42	--	5	7,000	230
5- 8-72	884	--	--	--	--	--	--	--	--	--	1	1	--	.24	.02	.02	--	--	--	54	10	13	16.2	6.0	38	7.4	5	620	60
5-30-75	595	25	0.04	0.01	5.2	1.5	2.5	1.2	25	--	1.6	1.5	0.1	.01	--	.01	0.02	0.00	51	--	19	21	--	--	36	--	6	--	--
10-22-75	101	30	.00	.00	7.6	2.6	6.0	2.0	43	0	1.8	3.2	.1	.05	--	.03	.19	.00	75	--	30	35	--	--	103	6.8	7	--	--
(Site 2) 14020300 - Meacham Creek at mouth near Gibbon																													
5-30-75	1/420	28	.06	.01	4.5	1.8	2.4	1.4	27	--	1.3	1.1	.1	.01	--	.01	.00	.00	54	--	19	22	--	--	40	--	8	--	--
10-22-75	22	27	.02	.00	6.8	2.9	3.2	2.0	42	0	1.9	1.1	.1	.05	--	.01	.02	.00	66	--	29	34	--	--	68	7.2	8	--	--

See footnotes at end of table.

Table 8.--Water quality of streams in the Umatilla Indian Reservation area--Continued

Date of col-lection	Daily mean discharge (ft^3/s)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite plus nitrate, as N	Ammonium total, as N	Phosphate, ortho, as P	Boron (B)	Arsenic (As)	Dissolved solids: Calculated from determined constituents	Dissolved solids: Residue on evaporation	Hardness, as $CaCO_3$	Total alkalinity, as $CaCO_3$	Dissolved oxygen	Biochemical oxygen demand	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)	Coliform (MPN/100 mL): Total	Coliform (MPN/100 mL): Fecal
		Milligrams per liter																											
(Site 3) 454107118271301 - Umatilla River at Thorn Hollow bridge																													
6-21-71	2/310	--	--	--	--	--	--	--	--	--	0.5	2.0	--	0.02	0.07	0.05	--	--	--	68	20	25	9.7	0.7	55	7.6	18	< 45	< 45
7-19-71	2/73	--	--	--	--	--	--	--	--	--	2	2	--	.03	<.01	.01	--	--	--	95	26	33	8.3	--	78	8.0	22	60	< 45
8-16-71	2/46	--	--	--	--	--	--	--	--	--	3	3	--	.03	.02	.04	--	--	--	83	25	35	10.1	.3	83	8.4	22	120	--
9-13-71	2/49	--	--	--	--	--	--	--	--	--	4	4	--	<.05	.06	.09	--	--	--	72	29	35	--	--	84	8.4	18	< 45	--
10-21-71	2/52	--	--	--	--	--	--	--	--	--	4	4	--	<.05	<.01	.04	--	--	--	80	26	32	12.0	.8	75	8.0	13	60	< 45
11- 8-71	2/169	--	--	--	--	--	--	--	--	--	1	2	--	.05	.02	<.01	--	--	--	64	23	32	13.6	2.0	67	8.2	6	130	< 45
12- 6-71	2/3,730	--	--	--	--	--	--	--	--	--	3	1	--	.39	.11	.13	--	--	--	183	18	18	12.3	1.6	60	--	5	1,300	230
5-30-75	2/1,020	27	0.04	0.00	5.1	0.8	2.7	1.3	26	--	1	1.1	0.1	.01	--	.04	0.00	0.00	52	--	16	21	--	--	--	--	8	--	--
10-22-75	3/113	29	.10	.01	7.8	2.9	5.4	2.0	44	0	2.3	2.6	.1	.06	--	.02	.16	.00	74	--	31	36	--	--	73	7.2	9	--	--
(Site 4) 454033118331801 - Umatilla River at Cayuse bridge																													
6-21-71	2/310	--	--	--	--	--	--	--	--	--	< .5	2	--	<.02	.07	.08	--	--	--	77	20	26	10.0	.1	56	7.6	19	60	< 45
7-19-71	2/73	--	--	--	--	--	--	--	--	--	< .5	2	--	.05	.03	.10	--	--	--	87	26	33	8.3	--	79	8.0	23	230	< 45
8-16-71	2/46	--	--	--	--	--	--	--	--	--	3	2	--	.04	.03	.09	--	--	--	84	27	36	8.8	--	84	8.4	23	230	--
9-13-71	2/49	--	--	--	--	--	--	--	--	--	1	3	--	<.05	.10	.07	--	--	--	97	29	37	--	--	84	8.4	--	< 45	--
10-12-71	2/52	--	--	--	--	--	--	--	--	--	3	3	--	<.05	<.01	.06	--	--	--	81	28	37	11.6	1.1	80	8.2	13	< 45	< 45
11- 8-71	2/169	--	--	--	--	--	--	--	--	--	2	3	--	<.05	<.01	<.01	--	--	--	68	27	32	13.9	2.4	70	8.2	6	500	60

See footnotes at end of table.

Table 8.--Water quality of streams in the Umatilla Indian Reservation area--Continued

Date of collection	Daily mean discharge (ft^3/s)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite plus nitrate, as N	Ammonium total, as N	Phosphate, ortho, as P	Boron (B)	Arsenic (As)	Dissolved solids: Calculated from determined constituents	Dissolved solids: Residue on evaporation	Hardness, as $CaCO_3$	Total alkalinity, as $CaCO_3$	Dissolved oxygen	Biochemical oxygen demand	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)	Coliform (MPN/100 mL): Total	Coliform (MPN/100 mL): Fecal
		Milligrams per liter																											
(Site 4) 454033118331801 - Umatilla River at Cayuse bridge - Continued																													
12- 6-71	[2]3,730	--	--	--	--	--	--	--	--	--	2	1	--	0.37	0.10	0.13	--	--	--	292	21	19	12.5	2.6	61	--	5	230	60
5-30-75	[2]1,020	27	0.07	0.01	3.5	1.2	3.5	1.3	27	--	1.6	.9	0.1	.02	--	.03	--	--	53	--	14	22	--	--	40	--	9	--	--
10-22-75	[2]113	28	.03	.00	10	2.9	5.1	2.0	48	0	1.8	3.1	.1	.07	--	.02	0.16	0.00	77	--	37	39	--	--	65	7.2	10	--	--
(Site 5) 454029118405801 - Umatilla River at Mission bridge																													
6-21-71	[2]310	--	--	--	--	--	--	--	--	--	.5	1	--	<.02	.03	.07	--	--	--	75	21	27	9.3	.6	60	7.6	21	< 45	< 45
7-19-71	[2]73	--	--	--	--	--	--	--	--	--	<.5	2	--	.03	<.01	.03	--	--	--	100	29	35	8.7	--	83	8.0	22	60	< 45
8-16-71	[2]46	--	--	--	--	--	--	--	--	--	3	3	--	.03	.02	.08	--	--	--	85	29	39	9.0	.1	85	8.4	25	7,000	--
9-13-71	[2]49	--	--	--	--	--	--	--	--	--	3	4	--	.05	.02	.07	--	--	--	113	31	38	--	--	92	8.3	21	230	--
10-12-71	[2]52	--	--	--	--	--	--	--	--	--	3	4	--	<.05	<.01	.06	--	--	--	75	31	39	11.3	--	85	8.0	15	< 45	< 45
11- 8-71	[2]169	--	--	--	--	--	--	--	--	--	1	3	--	<.05	<.01	<.01	--	--	--	78	25	33	15.1	3.8	71	8.0	6	620	< 45
12- 6-71	[2]3,736	--	--	--	--	--	--	--	--	--	4	1	--	.44	.08	.16	--	--	--	418	21	20	12.5	3.1	65	--	5	2,400	60
1-17-72	[2]338	--	--	--	--	--	--	--	--	--	3	2	--	.25	.02	.07	--	--	--	73	22	26	13.7	3.2	77	--	6	60	--
2-14-72	[2]1,190	--	--	--	--	--	--	--	--	--	3	1	--	.29	.09	.13	--	--	--	61	19	20	13.4	2.4	61	--	--	620	--
3-13-72	[2]6,800	--	--	--	--	--	--	--	--	--	6	1	--	.44	.12	.19	--	--	--	80	18	18	16.3	9.1	45	--	7	7,000	130
4-11-72	[2]1,210	--	--	--	--	--	--	--	--	--	1	2	--	.12	.03	<.01	--	--	--	82	19	20	15.7	4.4	56	7.4	7	230	< 45
5- 8-72	[2]1,870	--	--	--	--	--	--	--	--	--	1	1	--	.08	.02	.06	--	--	--	73	13	15	13.2	3.3	49	7.4	7	< 45	< 45

See footnotes at end of table.

Table 8.--Water quality of streams in the Umatilla Indian Reservation area--Continued

Date of collection	Daily mean discharge (ft^3/s)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite plus nitrate, as N	Ammonium total, as N	Phosphate, ortho, as P	Boron (B)	Arsenic (As)	Dissolved solids: Calculated from determined constituents	Dissolved solids: Residue on evaporation	Hardness, as $CaCO_3$	Total alkalinity, as $CaCO_3$	Dissolved oxygen	Biochemical oxygen demand	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)	Coliform (MPN/100 mL): Total	Coliform (MPN/100 mL): Fecal
		Milligrams per liter																											
(Site 5) 454029118405801 - Umatilla River at Mission bridge--Continued																													
6-12-72	2/385	--	--	--	--	--	--	--	--	--	0.3	9	--	0.04	0.06	0.08	--	--	--	62	19	23	11.3	--	59	7.6	15	< 45	< 45
5-30-75	2/1,020	28	0.03	0.00	5.1	1.2	2.7	1.4	29	0	1.2	1.6	0.1	.02	--	.01	--	--	56	--	18	24	--	--	42	--	11	--	--
10-22-75	3/113	26	.02	.00	8.6	3.2	5.3	2.1	47	0	2.0	3.1	.1	.04	--	.01	0.16	0.00	74	--	35	39	--	--	63	7.6	10	--	--
(Site 6) 14022190 - McKay Creek above North Fork near Pilot Rock																													
5-29-75	1/30	37	.15	.00	7.8	1.8	3.8	1.9	34	--	1.7	1.6	.1	.01	--	.04	.00	.00	73	--	27	28	--	--	61	--	15	--	--
10-21-75	1/1	29	.05	.02	11	4.3	5.2	2.7	61	--	2.8	1.6	.1	.04	--	.04	.02	.00	87	--	45	50	--	--	105	8.1	11	--	--
(Site 7) 14022200 - North Fork McKay Creek near Pilot Rock																													
5-29-75	14	36	.07	.00	6.4	2.9	3.9	1.8	41	--	1.7	1.5	.1	.02	--	.04	.00	.00	75	--	28	34	--	--	71	--	20	--	--
10-21-75	2.9	29	.01	.02	9.3	3.9	5.6	2.3	59	0	2.3	1.5	.1	.01	--	.04	.01	.00	83	--	39	48	--	--	125	7.4	10	--	--
(Site 8) 453012118372500 - McKay Creek below North Fork McKay Creek near Pilot Rock																													
6-21-71	4/43	--	--	--	--	--	--	--	--	--	1	1	--	.05	.03	.10	--	--	--	104	29	35	8.7	.8	71	7.4	22	60	60
7-19-71	4/3.4	--	--	--	--	--	--	--	--	--	<.5	1	--	.05	<.01	.06	--	--	--	107	87	45	9.1	.2	93	7.6	20	2,400	620
8-16-71	4/.5	--	--	--	--	--	--	--	--	--	1	1	--	.07	.05	.11	--	--	--	103	39	52	10.0	--	108	7.8	19	2,400	--
9-13-71	4/1.3	--	--	--	--	--	--	--	--	--	1	1	--	.10	.01	.13	--	--	--	123	43	48	10.8	--	104	7.8	17	130	60
10-12-71	4/4.6	--	--	--	--	--	--	--	--	--	1	1	--	.05	<.01	.09	--	--	--	96	39	50	12.0	1.5	94	7.6	12	60	60
11- 8-71	4/28	--	--	--	--	--	--	--	--	--	2	2	--	.21	<.01	.05	--	--	--	73	35	42	2	1.5	82	7.8	4	620	120

See footnotes at end of table.

Table 8.--Water quality of streams in the Umatilla Indian Reservation area--Continued

Date of collection	Daily mean discharge (ft^3/s)	Silica (SiO_3)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite plus nitrate, as N	Ammonium total, as N	Phosphate, ortho, as P	Boron (B)	Arsenic (As)	Dissolved solids: Calculated from determined constituents	Dissolved solids: Residue on evaporation	Hardness, as $CaCO_3$	Total alkalinity, as $CaCO_3$	Dissolved oxygen	Biochemical oxygen demand	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)	Coliform (MPN/100 mL) Total	Coliform (MPN/100 mL) Fecal
		Milligrams per liter																											
(Site 8) 453012118372500 - McKay Creek below North Fork McKay Creek near Pilot Rock--Continued																													
12- 6-71	4/1,480	--	--	--	--	--	--	--	--	--	6	1	--	0.60	0.22	0.27	--	--	--	--	27	23	12.0	1.7	74	--	4	1,300	230
4-11-72	4/240	--	--	--	--	--	--	--	--	--	1	2	--	.09	.05	.10	--	--	--	81	20	20	15.8	4.3	64	7.5	5	60	< 45
6-12-72	4/32	--	--	--	--	--	--	--	--	--	.5	1	--	.04	.11	.14	--	--	--	86	29	36	11.6	--	89	7.2	14	1,300	--
(Site 9) 453024118414200 - McKay Creek at bridge below Sumac Road near Pilot Rock																													
6-21-71	4/43	--	--	--	--	--	--	--	--	--	1	1	--	.04	.08	.12	--	--	--	90	32	38	8.9	.5	79	7.8	22	60	< 45
7-19-71	4/3.4	--	--	--	--	--	--	--	--	--	< .5	1	--	.04	.01	.07	--	--	--	114	39	48	9.4	.3	102	8.0	20	620	130
8-16-71	4/.5	--	--	--	--	--	--	--	--	--	4	1	--	.05	.06	.14	--	--	--	105	42	54	10.8	1.4	114	8.4	19	620	--
9-13-71	4/1.3	--	--	--	--	--	--	--	--	--	2	1	--	< .05	.04	.12	--	--	--	117	44	52	11.0	--	110	8.4	17	230	--
10-12-71	4/4.6	--	--	--	--	--	--	--	--	--	2	1	--	< .05	.01	.07	--	--	--	100	43	54	11.3	1.0	103	8.0	12	60	60
11- 8-71	4/29	--	--	--	--	--	--	--	--	--	2	2	--	.26	.09	.02	--	--	--	79	30	40	13.4	2.0	82	8.2	4	620	< 45
(Site 10) 14023500 - McKay Creek at bridge below dam (gage site)																													
6-21-71	9.5	--	--	--	--	--	--	--	--	--	6	2	--	.29	.08	.12	--	--	--	108	43	44	12.3	1.7	100	8.0	16	230	60
7-19-71	314	--	--	--	--	--	--	--	--	--	5	1	--	.42	.03	.17	--	--	--	109	36	38	11.9	1.9	93	7.4	11	< 45	< 45
8-16-71	430	--	--	--	--	--	--	--	--	--	8	2	--	.40	.06	.19	--	--	--	114	35	41	11.3	1.5	110	7.2	13	< 45	--
9-13-71	128	--	--	--	--	--	--	--	--	--	4	2	--	.22	.11	.19	--	--	--	154	44	50	10.3	--	107	7.4	17	60	--
10-12-71	1.4	--	--	--	--	--	--	--	--	--	7	4	--	.27	.04	.10	--	--	--	--	61	71	9.0	1.2	142	7.2	11	230	60

1/ Estimated.
2/ Discharge from station at Cayuse (14020100).
3/ Discharge from station at Pendleton (14021000).
4/ Discharge from station near Pilot Rock (14022500).

Water temperature has been recorded at Umatilla River above Meacham Creek near Gibbon since 1960. Maximum recorded temperature at that site is 25°C (77°F); the minimum is 0°C (32°F). Maximum and minimum monthly water temperatures are shown in figure 21. These temperatures are compared with the temperature range suitable for spawning and rearing of trout; the annual spawning periods of the trout are also known. It is evident from figure 21 that the water temperatures at times exceed the preferred temperatures for spawning and rearing.

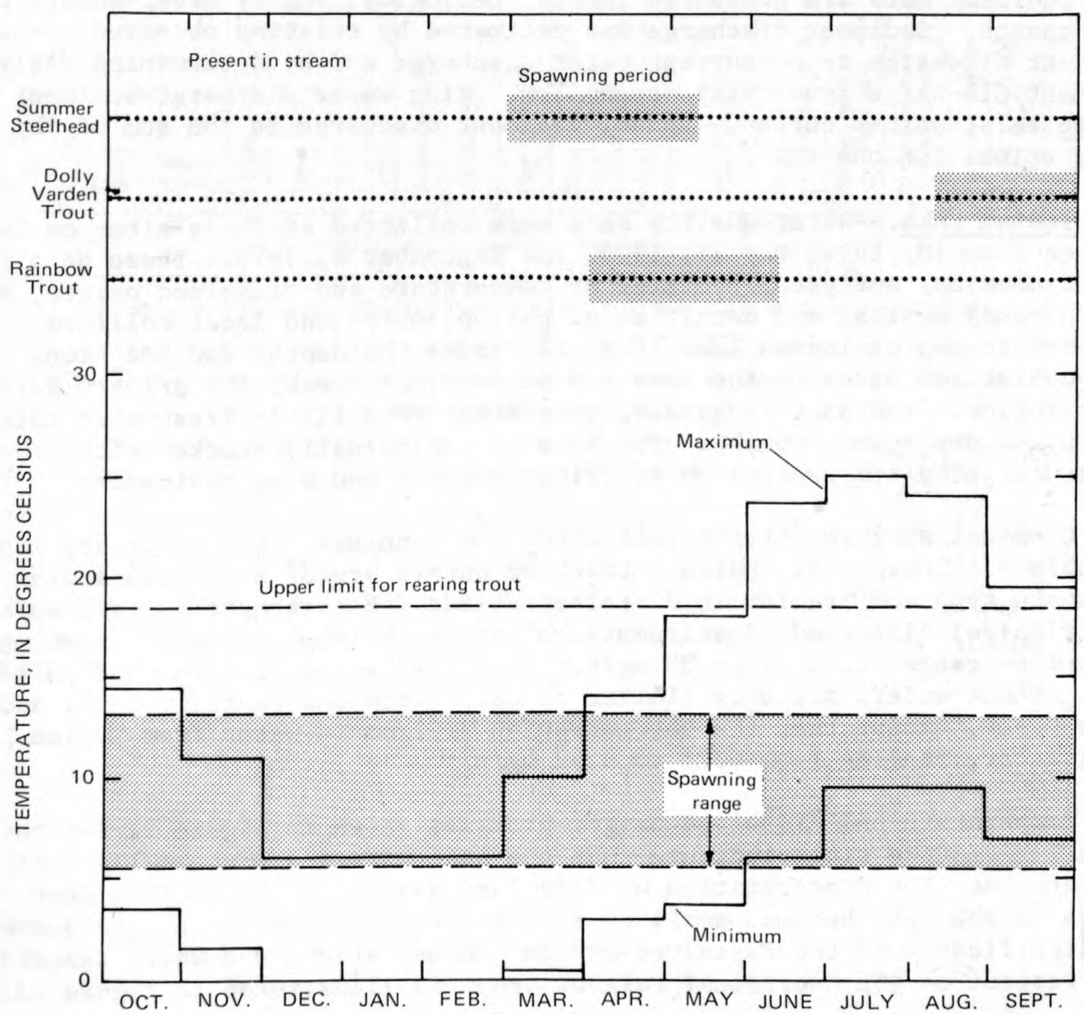

Figure 21. — Monthly maximum and minimum water temperatures for Umatilla River above Meacham Creek near Gibbon (1960-74) and temperature ranges suitable for spawning and rearing of trout. (Smith, 1973.)

Sediment data were obtained at Umatilla River above Meacham Creek near Gibbon from 1962 through 1968. During that period, the maximum instantaneous suspended-sediment concentration observed was 4,200 mg/L during a flood on January 28, 1965. A size analysis of that sample showed that 16 percent of the sediment was sand, 62 percent was silt, and 22 percent was clay. The estimated average annual suspended-sediment discharge at the site was 4,300 tons/year, or 33 tons/mi^2 (tons per square mile). The average rate is small compared to the average of 210 tons/mi^2 determined for the period 1963-70 on Umatilla River near Umatilla, 50 mi downstream, and 280 tons/mi^2 determined on John Day River near McDonald Ferry, 100 mi west of the reservation.

Sediment data are presented in U.S. Geological Survey water-supply papers and reports. Sediment discharge was estimated by relating observed suspended-sediment discharge to concurrent water discharge and by determining daily sediment discharge from daily streamflow, using water discharge-sediment discharge relationship curves. Annual sediment discharge is the sum of the daily values for the year.

Indian Lake.--Water-quality data were collected at three sites on Indian Lake on June 10, 1974, May 29, 1975, and September 4, 1975. These data included chemical analyses, profiles of temperature and dissolved oxygen, water-transparency depths, and densities of phytoplankton and fecal coliform. The bathymetric map of Indian Lake (fig. 12) shows the depths and locations of the data-collection sites on the lake and on Jennings Creek, the primary surface-water inflow. Indian Lake generally receives very little freshwater inflow during the dry summer months. The lake is periodically stocked with trout and is used chiefly for recreation by Tribal members and area residents.

Chemical analyses of the lake water and Jennings Creek water are listed in table 9. These data indicate that the waters are of a calcium sodium bicarbonate type and are low in dissolved solids. Bicarbonate and silica are the principal dissolved constituents; bicarbonate ranged from 27 to 34 mg/L and silica ranged from 26 to 35 mg/L. Dissolved solids ranged from 53 to 67 mg/L. These waters are very similar to water from the Umatilla River and McKay Creek, except that the concentration of iron in water from Indian Lake was greater, ranging from 0.21 to 0.92 mg/L.

Temperature and dissolved-oxygen profiles shown in figure 22 for the three Indian Lake sites indicate that the lake waters are thermally stratified and that the concentration of dissolved oxygen in the cooler, deep waters of the lake becomes small or is depleted, especially in late summer. The significance of the dissolved-oxygen concentrations and water temperature with respect to the habitat of rainbow trout is illustrated in figure 23. The

Table 9.--Chemical analyses of water from Indian Lake (site 2) and Indian Lake inflow

[Analyses by the U.S. Geological Survey]

Date of collection	Time	Depth (feet)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite plus nitrate, as N	Phosphate, ortho, as P	Dissolved solids, calculated	Hardness (as $CaCO_3$)	Total alkalinity (as $CaCO_3$)	Specific conductance (micromhos/cm at 25°C)	pH
			Data in milligrams per liter except as noted																
4522151183400 - Jennings Creek (Indian Lake inflow)																			
6-10-74	3:15 pm	--	35	0.92	5.4	1.7	3.6	1.7	31	2.3	0.8	0.1	0.03	0.08	67	20	25	56	7.3
5-29-75	4:00 pm	--	33	.21	4.3	1.9	2.8	1.5	31	1.1	1.0	.1	.00	.05	61	19	25	48	7.5
4522051183305 - Indian Lake (site 2)																			
6-10-74	1:00 pm	1	28	.28	5.6	1.8	2.8	1.2	28	2.4	.8	.0	.03	.04	57	21	23	46	8.0
5-29-75	12:30 pm	1	27	.37	4.7	1.8	2.6	1.2	27	1.4	1.1	.1	.01	.04	54	19	22	46	7.6
Do	12:35 pm	36	27	.44	4.3	2.0	2.5	1.2	27	1.2	.0	.1	.00	.04	53	19	22	46	6.5
9- 4-75	10:00 am	1	26	.57	5.3	1.2	3.0	1.4	28	1.8	.0	.2	.01	.01	54	18	23	49	7.6
Do	10:05 am	36	27	.92	5.5	1.3	2.7	1.5	34	1.9	.9	.1	.01	.01	59	19	28	59	6.6

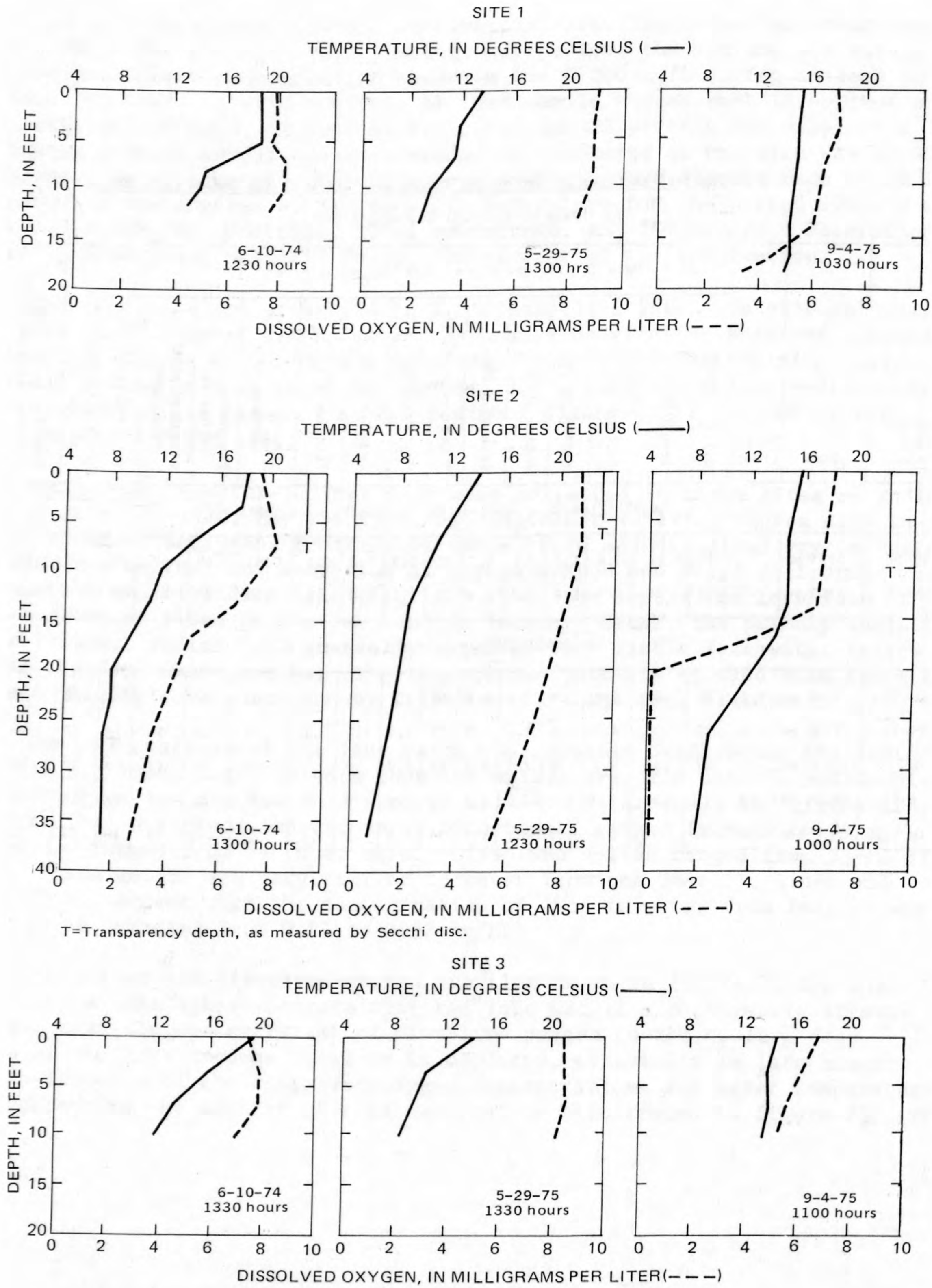

Figure 22. – Seasonal profiles of water temperatures and dissolved-oxygen concentration for three sites at Indian Lake.

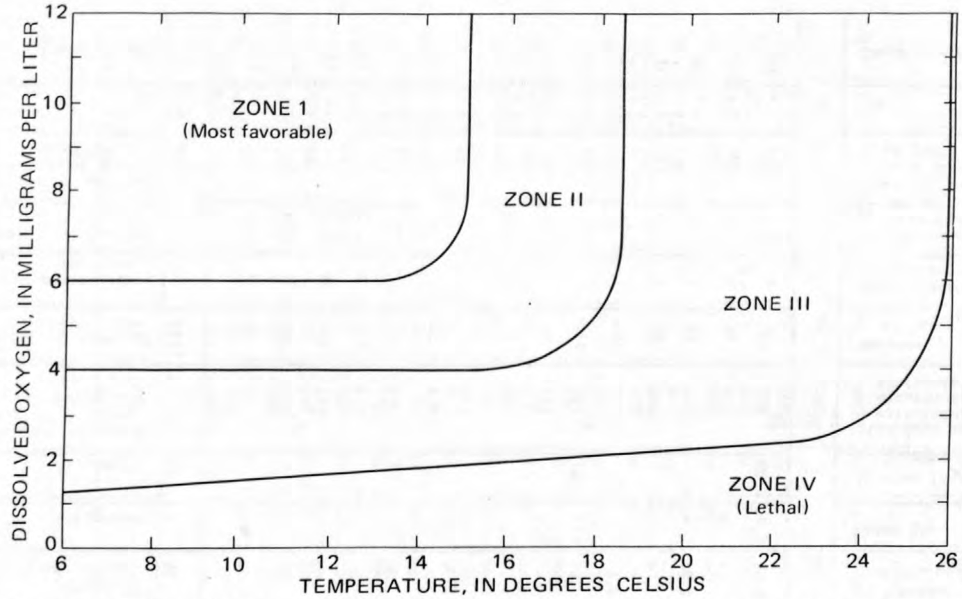

Figure 23. — Livability zones for rainbow trout based on combinations of dissolved oxygen and temperature. (Adapted from Smith and Bella, 1973, p. 129.)

dissolved oxygen becomes depleted in cooler, deeper waters because decaying organic matter accumulates and settles to the bottom where it consumes more oxygen than is produced through photosynthesis by aquatic vegetation.

Analysis of phytoplankton (microscopic organisms that drift passively with the currents) populations on the lake indicated a total count of 4,800 cells/mL on May 29, 1975, and about 2,100 cells/mL on September 4, 1975. On May 29, 1975, about 56 percent of the total algae population was of the yellow-brown algae type, whereas 44 percent was of the green algae type. On September 4, 1975, nearly 100 percent of the algae was of the blue-green algae type, a group that can cause nuisance algae blooms. An algal bloom is an excessive growth of the algae that may occur when sufficient nutrients are available. Algal blooms result in depletion of dissolved oxygen in a lake which in turn may cause a reduction in the population of desirable species of fish.

No fecal coliform bacteria were detected in the lake-water samples, but a count of five colonies/100 mL was determined on Jennings Creek on June 10, 1974.

Ground Water

The Columbia River Basalt Group.--Ground water from the Columbia River Basalt Group is of the calcium sodium bicarbonate or sodium bicarbonate type. Water from wells in the basalt in the eastern two-thirds of the reservation is almost entirely of the calcium sodium bicarbonate type, whereas water from deep wells in the basalt near the west-central boundary of the reservation is of the sodium bicarbonate type.

Chemical analyses of ground water from the area in and around the reservation are listed by source in table 10. Chemical diagrams of selected water samples from each aquifer source are shown on plate 1 for comparison.

Table 10.--Chemical analyses of water from selected wells and springs in the Umatilla Indian Reservation area

Location number	Date of collection	Milligrams per liter: Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite plus nitrate, as N	Phosphate, ortho, as P	Boron (B)	Arsenic (As)	Dissolved solids, calculated from determined constituents	Hardness, as $CaCO_3$	Noncarbonate hardness	Sodium-adsorption-ratio (SAR)	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)
Columbia River Basalt Group																								
1N/33E-10bcc	6-19-74	55	0.02	0	28	11	55	2.4	148	0	9.2	7.3	0.3	4.1	0.09	0.00	0.00	221	120	0	0.6	292	7.8	13
-10ccc	6-20-74	49	.06	0	17	7.7	12	3.0	104	0	7.9	3.0	.1	1.7	.14	.01	0	159	74	0	.6	204	7.6	12
1N/34E-1baa	6- 6-74	56	.09	0	18	8.1	8.8	2.3	114	0	2.9	1.5	.2	.61	1.0	.01	0	160	78	0	.4	189	8.0	10
1N/35E-8abb	5- 5-74	56	.24	0	18	8.4	6.2	1.9	113	0	1.4	1.3	.1	.08	.08	.02	0	150	80	0	.3	177	8.0	11
1/ 2N/32E-2ccd	1959	59	.08	.00	26	8	30	7.0	--	--	13	11	.6	.5	2.8	--	--	235	101	--	1.3	--	7.4	16
2/ Do	1973	53	.08	.02	26	11	27	5.8	--	--	8.4	6.9	.6	.47	.05	--	.01	3/ 200	110	--	--	330	8.3	--
4/ 2N/32E-2ddd	1- 7-49	40	.01	--	27	7.6	5/ 31		--	0	21	26	.3	--	--	--	--	271	98	--	--	--	7.7	--
Do	6-24-54	42	.37	.05	26	18	60	--	--	--	20	33	.4	--	--	--	--	300	--	--	2.2	--	8.2	--
1/ Do	7-15-54	53	.01	.15	8.7	1.2	72	--	--	--	22	18	.7	.2	--	--	--	275	95	--	--	--	8.5	--
1/ Do	1959	56	.04	.00	9.3	2.2	64	9	--	--	24	24	.6	.0	--	--	--	270	32	--	--	--	8.6	--
2/ Do	1973	58	.04	--	22	3	71	14	--	--	31	36	1.1	.05	.04	--	.01	340	67	--	--	405	8.4	--
Do	6/ 11:48 a.m.	46	.32	.34	45	13	65	18	200	--	63	63	.3	1.5	.02	.03	0	419	170	2	2.2	--	--	15
Do	6/ 12:35 p.m.	49	.01	0	37	11	73	17	196	--	61	61	.4	1.1	.02	.03	0	411	140	0	2.7	--	--	15
Do	6/ 1:00 p.m.	50	.01	0	37	8.9	75	17	195	--	61	60	.4	.98	.02	.02	0	410	130	0	2.9	--	--	16
Do	6/ 8:15 p.m.	55	0	0	25	6.2	81	15	184	--	53	52	.5	.45	.02	.02	0	380	88	0	3.8	--	--	17
1/ 2N/32E-9abd	1959	41	.04	0	32	11	24	5	--	--	8	12	.3	.0	--	--	--	3/ 243	125	--	.9	--	7.8	--
2/ Do	1973	60	.03	--	30	11	21	5	--	--	11	7.7	.3	.74	.10	--	.01	3/ 256	123	--	--	310	8.0	--
4/ 2N/32E-10bda	1-17-49	50	.20	--	31	10	5/ 24		149	--	10	10	.2	--	--	--	--	235	121	--	--	--	7.5	--
Do	6-13-52	49	.03	.00	32	12	30	5.2	220	--	11	7.9	.2	2.9	--	.08	--	259	--	0	1.1	385	7.8	--
1/ Do	7-15-54	40	.1	.0	37	13	5/ 41		--	--	16	18	.5	2.0	--	--	--	3/ 295	144	--	--	--	7.6	--
1/ Do	1959	39	.04	.00	38	13	33	5.3	162	--	22	20	.3	.0	--	--	--	274	148	--	1.2	--	7.5	--
1/ Do	1973	47	.01	--	48	17	27	6.3	226	--	28	22	.4	1.7	.03	--	.01	352	189	--	--	510	7.9	--

See footnotes at end of table.

Table 10.--Chemical analyses of water from selected wells and springs in the Umatilla Indian Reservation area--Continued

Location number	Date of collection	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite plus nitrate, as N	Phosphate, ortho, as P	Boron (B)	Arsenic (As)	Dissolved solids, calculated from determined constituents	Hardness, as $CaCO_3$	Noncarbonate hardness	Sodium-adsorption-ratio (SAR)	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)
		Milligrams per liter																						
Columbia River Basalt Group--Continued																								
4/2N/32E-10ccd	1954	49	0.01	0	35	10	5/46		--	--	30	39	0.3	0.7	--	--	--	311	128	--	--	--	7.9	13
1/ Do	1959	47	.08	.00	30	8	39	6.3	147	--	21	18	.4	.0	--	--	--	284	109	--	1.5	--	7.8	--
2/ Do	1973	62	.01	.01	32	9.3	31	6.8	--	--	21	14	.5	1.2	.05	--	0.01	3/293	117	--	--	390	7.9	--
2N/33E-2daa	6-20-74	52	.03	.01	11	2.8	40	7.9	118	1	21	11	.9	.07	.05	.04	.00	206	39	0	2.8	277	8.4	14
-2ddc	do	53	.03	.01	14	3.4	31	7.1	130	0	11	5.7	.7	.12	.04	.03	.00	191	49	0	1.9	251	8.3	13
-4dda	do	43	.02	0	22	7.5	35	9.0	181	0	13	9.9	.3	.34	.04	.08	.00	231	86	0	1.6	339	8.0	12
-7aac	do	70	.01	0	20	7.9	31	5.5	174	0	11	6.1	.6	.25	.03	.02	.00	239	82	0	1.5	315	8.2	17
-7bcc1	do	56	.03	0	67	26	33	7.6	248	0	47	62	.3	7.3	.04	.06	.00	454	270	71	.9	719	7.9	13
-8aca	do	51	.03	0	27	12	22	4.3	171	0	11	6.5	.2	1.4	.05	.12	.00	225	120	0	.9	321	7.3	12
-8cba	6-21-74	50	.03	.02	17	6.7	44	9.2	172	1	16	11	.8	.64	.06	.02	.00	244	70	0	2.3	348	8.4	14
-8dac	6-20-74	49	.04	.03	12	2.4	59	11	183	0	19	9.5	.5	.28	.01	.02	.00	254	40	0	4.1	352	8.5	16
-9aca	do	38	.02	.05	19	7.0	66	8.1	207	7	19	13	.5	.00	.03	.06	.00	280	76	0	3.3	422	8.4	12
-10bcc2	do	49	.11	0	18	9.0	12	4.8	125	2	8.4	4.4	.2	1.5	.05	.10	.00	176	82	0	.6	247	8.5	14
-12cbb	5- 1-74	76	.10	.03	17	5.0	27	4.7	138	0	7.3	2.8	.7	.18	.08	.01	.00	210	63	0	1.5	238	8.3	12
-12ccc	6-21-74	56	.02	.00	20	7.9	14	2.5	118	0	8.0	4.7	.3	.61	.07	.01	.00	175	82	0	.7	223	7.9	--
2/ -14dac	1973	65	.50	--	20	7.8	14	3.8	--	--	6.5	3.5	.3	.05	.03	--	.01	3/201	82	--	--	225	8.2	--
7/ Do	12-19-66	44	.17	8/.05	22	6.8	16	.5	9/138	--	6.6	1.9	.5	.0	.13	--	--	3/202	84	--	.8	230	8.1	--
Do	2- 5-75	55	.03	.04	21	7.8	17	4.8	139	--	8.9	4.4	.4	.00	.06	.01	.00	188	85	0	.8	243	8.1	16
-19add	6-19-74	50	.03	.00	16	9.1	39	10	170	0	18	10	.8	.25	.02	.02	.00	238	77	0	1.9	343	8.3	14
-20bbb	do	68	.03	.00	17	3.8	47	7.7	158	0	16	13	.9	.12	.03	.03	.00	252	58	0	2.7	334	8.3	19
-24ddd	6-21-74	58	.12	0	33	12	22	4.1	114	0	17	2.4	.3	19	.08	.02	.00	290	130	38	.8	380	7.7	18
-25bbb	4-26-74	55	.03	0	52	13	41	3.9	233	0	11	3.3	.6	16	.11	.03	.00	366	180	0	1.3	518	8.0	13

See footnotes at end of table.

Table 10.--Chemical analyses of water from selected wells and springs in the Umatilla Indian Reservation area--Continued

Location number	Date of col-lection	Milligrams per liter																			Sodium-adsorption-ratio (SAR)	Specific conduct-ance (micromhos/cm at 25°C)	pH	Temperature (°C)
		Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite plus nitrate, as N	Phosphate, ortho, as P	Boron (B)	Arsenic (As)	Dissolved solids, calculated from determined con-stituents	Hardness, as $CaCO_3$	Noncarbonate hardness				
										Columbia River Basalt Group--Continued														
2N/33E-27abb	6-20-74	58	.04	0	19	7.5	17	2.9	136	0	4.8	1.9	0.5	0.21	0.05	0.01	0	180	78	0	0.8	228	8.0	15
-31aaa	do	57	.12	0	8.3	2.0	54	7.6	153	2	13	9.4	.4	.33	.06	.02	.00	231	29	0	4.4	314	8.6	16
-31cca	6-19-74	66	.10	0	20	7.7	18	3.3	136	0	5.7	3.5	.6	.23	.03	.00	.00	193	82	0	.9	237	8.1	13
10/ -33cca	6-18-58	68	.00	.0	20	8.8	23	4.8	154	0	7.0	4.0	.6	.0	.00	--	--	212	86	0	1.1	260	7.9	16
Do	6-20-74	59	.08	0	21	8.4	22	4.8	152	0	6.0	3.8	.5	.05	.12	.01	0	201	87	0	1.0	262	8.2	14
2N/34E-2adb	6-21-74	59	.02	0	30	12	19	3.0	177	0	9.7	5.7	.4	1.7	.06	.02	0	234	120	0	.7	328	7.9	15
-2cbb1	do	82	.02	0	20	6.0	19	3.6	136	0	1.5	2.7	.6	.00	.05	.02	0	203	75	0	1.0	219	7.9	15
-4ccb	6- 6-74	68	.03	.01	14	2.9	32	5.4	138	1	2.4	3.0	.5	.00	.05	.02	.00	197	47	0	2.0	232	8.4	16
-17aaa2	6-21-74	58	.05	0	30	11	24	.9	167	0	11	2.6	.5	5.4	.09	.02	.00	245	120	0	1.0	339	7.6	12
-17dcc	6- 7-74	73	.03	.01	17	5.3	16	2.9	115	0	3.6	3.2	.4	.00	.05	.03	0	178	64	0	.9	194	8.3	20
2N/35E-4add	6-21-74	54	.04	0	20	8.1	12	1.9	132	0	2.8	1.9	.3	.01	.05	.02	0	166	83	0	.6	210	8.3	12
-4bbc1	6-18-74	58	.32	.06	25	10	16	2.0	154	0	11	1.9	.6	.09	.04	.01	0	201	100	0	.7	268	8.1	14
-6bdc	4-25-74	78	.05	1.4	20	6.4	19	2.3	135	0	1.5	1.6	.5	.03	.02	.01	0	198	76	0	.9	214	8.3	12
3N/34E-12cdd	6-18-74	53	.03	0	47	16	48	1.5	285	0	14	9.4	.9	7.0	.10	.02	.00	362	180	0	1.5	555	7.5	13
-16dac	do	52	.02	0	41	16	41	3.7	276	0	9.1	12	1.0	2.0	.06	.01	.00	321	170	0	1.4	490	7.8	14
-22dbc	do	50	.03	0	43	19	40	5.0	275	0	30	12	.8	1.4	.04	.02	.00	342	190	0	1.3	524	7.9	14
-32bbb	6-20-74	54	.02	0	68	25	29	1.8	285	0	23	31	.6	4.9	.09	.02	0	395	270	39	.8	674	7.6	14
-33abc	6- 6-74	53	.12	--	47	17	37	3.6	256	0	16	11	.7	8.3	.10	.02	.00	385	190	0	1.2	523	7.9	14
3N/35E-3cdd	do	55	.13	.01	30	13	14	3.4	121	0	17	4.8	.3	11	.10	.01	0	246	130	29	.5	311	7.6	11
-4cbd	6-18-74	85	.04	.01	23	7.5	23	4.4	165	0	7.0	2.8	.5	.00	.05	.01	0	235	88	0	1.1	277	8.1	22
-7aaa	do	82	.04	0	24	5.0	30	5.6	164	0	8.6	3.5	.6	.03	.06	.01	.00	241	81	0	1.5	284	8.2	26
-18add	do	35	.04	.01	17	4.0	48	5.4	174	0	10	3.3	.6	2.9	.04	.01	0	222	59	0	2.7	326	8.2	13

See footnotes at end of table.

Table 10.--Chemical analyses of water from selected wells and springs in the Umatilla Indian Reservation area--Continued

Location number	Date of collection	Milligrams per liter Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite plus nitrate, as N	Phosphate, ortho, as P	Boron (B)	Arsenic (As)	Dissolved solids, calculated from determined constituents	Hardness, as $CaCO_3$	Noncarbonate hardness	Sodium-adsorption-ratio (SAR)	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)
Columbia River Basalt Group--Continued																								
3N/35E-19dbb	6-18-74	79	.02	0	25	7.0	31	4.6	175	0	9.6	3.4	0.6	0.69	0.07	0.01	0.00	250	91	0	1.4	306	8.1	21
-29adc	6-20-74	34	.02	0	17	6.5	20	3.9	126	0	11	2.4	.6	.00	.02	.01	.00	158	69	0	1.0	228	8.3	12
-35acc1	do	43	.16	0	7.5	3.0	4.0	2.0	50	0	2.9	.9	.1	.03	.08	.01	.00	89	31	0	.3	86	7.0	11
3N/36E-29cac1	6- -74	51	.24	0	10	3.0	9.3	2.3	64	0	3.3	3.3	.1	.48	.07	.04	.00	116	37	0	.7	120	7.3	8
1S/33E-1cda	6-19-74	58	.05	.06	18	6.1	15	3.2	112	0	3.6	2.6	.5	2.4	.07	.05	0	173	70	0	.8	191	7.9	12
Quaternary alluvium or soil																								
1N/33E-28cdc(s)	6-19-74	54	.12	0	15	6.5	13	2.9	99	0	5.9	2.5	.2	1.3	.08	.02	.00	155	64	0	.7	185	7.5	10
-30aac	do	56	.03	0	28	12	23	3.9	168	0	12	9.5	.8	.59	.05	.02	.00	231	120	0	.9	343	7.4	13
2N/33E-8adc1	6-20-74	53	.02	0	73	24	71	6.9	291	0	95	41	.5	12	.07	.03	.00	561	280	42	1.8	857	7.7	11
2N/34E-8bab	6-21-74	43	.12	0	25	10	16	5.4	147	0	8.9	3.6	.2	2.5	.06	.14	0	196	100	0	.7	282	7.1	13
2N/35E-3bcd	do	46	.27	0	11	4.4	5.5	2.2	61	0	3.8	1.5	.1	1.2	.07	.03	.00	110	46	0	.4	117	6.8	8
2/ -6aca2	1973	44	.03	.09	7.5	3.4	6.0	2.5	--	--	4.4	1.9	.1	1.2	.11	--	.01	132	32	--	--	86	6.3	--
Do	6- 7-74	42	.21	0	8.7	3.4	4.9	1.9	53	0	2.9	1.0	.1	.52	.07	.03	.00	94	36	0	.4	95	7.5	8
-14aba1	6-20-74	45	.02	0	7.6	3.2	4.1	1.7	53	0	2.6	1.1	.1	.00	.05	.01	0	92	32	0	.3	92	6.9	--
3N/35E-12cdd	6-18-74	44	2.00	.01	7.1	2.6	4.1	2.1	42	0	3.3	1.0	.1	.18	.08	.02	0	88	28	0	.3	78	6.9	15
3N/36E-31cbb(s)	6-20-74	54	.11	0	9.5	3.3	4.7	1.6	51	0	4.1	1.8	.1	.19	.07	.01	0	105	37	0	.3	92	7.3	13
1S/33E-5aac(s)	6-19-74	56	.02	0	28	9.6	21	3.4	166	0	9.0	3.1	.3	1.2	.12	.02	.00	218	110	0	.9	295	7.5	13

1/ Analysis by consulting engineers.

2/ Analyst unknown.

3/ Determined from residue on evaporation at 180°C.

4/ Analysis by Charlton Laboratories, Inc., Portland, Oreg.

5/ Sodium and potassium.

6/ Sampled on July 7, 1975, at indicated time.

7/ Analysis by Oregon State Board of Health.

8/ Less than indicated value.

9/ Indicates value calculated from the bicarbonate alkalinity.

10/ Casing also perforated in Tertiary sediment.

Dissolved solids in water samples from the basalt range from 89 to 454 mg/L, but generally are greater than 200 mg/L. Silica, a principal dissolved constituent, ranged from 34 to 85 mg/L, a concentration range that would cause formation of hard scale deposits if the water were used as feed water for high-pressure boiler systems. Silica does not affect the use of water for other purposes.

The U.S. Geological Survey's (Hem, 1970, p. 225) classification of water with respect to hardness is listed in table 11 below. Hardness is a property of water caused primarily by the presence of calcium and magnesium ions. Water in the basalt ranges from soft to very hard; most water falls within the moderately hard to hard ranges in the above classification. Water from the basalt on the north reservation generally is harder than in other localities and contains between 170 and 270 mg/L of hardness.

Table 11.--Hardness classification of waters

Hardness range (mg/L of $CaCO_3$)	Description
0-60	Soft
61-120	Moderately hard
121-180	Hard
More than 180	Very hard

The principal cations (positive ions) in water from the basalt are calcium and sodium; concentrations ranged from 7.5 to 68 mg/L for calcium and from 4 to 81 mg/L for sodium. The concentration of bicarbonate, the principal anion (negative ion) ranged from 50 to 285 mg/L; the higher concentrations, 256 to 285 mg/L, were in water samples from wells in T. 3 N., R. 34 E., in the north reservation.

Iron and manganese in water from the basalt generally are less than the 0.3 and 0.05 mg/L limit, respectively, recommended for these constituents in drinking water by the National Academy of Sciences (1974). Iron and manganese. 0.32 and 0.06 mg/L, respectively, were excessive in water from well 2N/35E-4bbc1. Manganese was high, 1.4 mg/L in well 2N/35E-6bdc and 0.06 mg/L in well 1S/33E-1cda. Three chemical analyses out of nine made on water from well 2N/32E-2ddd also contained excessive iron and (or) manganese. Similarly, one sample out of a total of three from well 2N/33E-14dac contained excessive iron.

The concentration of fluoride in water from the basalt ranged from 0.1 to 1.1 mg/L; these concentrations are well below the maximum recommended concentrations for drinking water by the U.S. Environmental Protection Agency (1975). The recommended maximum concentration is dependent on the annual average of maximum daily air temperatures in the vicinity. Because of the large difference in altitude within the reservation, the annual average maximum daily air temperature ranges from about 12° to 17.5°C (53.3° to 63.8°F). The recommended maximum fluoride concentration is 2.0 mg/L for the above temperature range.

The temperature of water from the basalt ranges from 8° to 26°C (46° to 79°F), the higher temperatures occurring in water from deeper wells. The temperature of ground water from wells less than about 100 ft deep is generally about the same as the mean annual air temperature. The mean annual temperature on the reservation ranges from about 7°C (44°F) in the Blue Mountains to about 11°C (52°F) in low areas near the west edge of the reservation. Below a depth of about 100 ft, ground-water temperatures increase gradually due to a natural increase of temperature within the Earth. Hogenson (1964, p. 55) found that in the Umatilla Basin area, the increase in ground-water temperature in the basalt generally ranged from 1° to 2.2°C (2° to 4°F) for each 100 ft of well depth.

Quaternary alluvium and soil.--Chemical analyses of water from Quaternary alluvium and from springs issuing from shallow soil overlying basalt bedrock are listed together at the end of table 10. The source of water from the springs is unknown, but it is believed to be from a very shallow depth; therefore, the analyses are included with those from the Quaternary alluvium.

In the eastern part of the reservation, ground water from the Quaternary alluvium and from springs generally is low in dissolved solids and is soft, whereas in the more arid western part of the reservation these waters generally contain greater concentrations of dissolved solids and are harder.

The chemical quality of shallow ground water in the eastern part of the reservation is similar to that of the surface water. Compare the chemical diagrams of wells 2N/35E-3bcd, -6aca1, -14aba1, and 3N/35E-12cdd on plate 1 with the chemical diagrams in figure 20.

The highest concentrations of dissolved solids (561 mg/L), calcium (73 mg/L), sodium (71 mg/L), sulfate (95 mg/L), chloride (41 mg/L), and nitrate (12 mg/L) in ground water on the reservation were in water from well 2N/33E-8adc1 in the Quaternary alluvium in the western part of the reservation. The well is more than 1,500 ft south of the Umatilla River. The high concentration of dissolved substances probably is due to leaching of shallow hardpan deposits in the alluvium by local recharge from precipitation and from irrigation water.

Similar hardpan deposits are also present in the Tertiary deposits; therefore, similar-type ground water can be anticipated from some of the Tertiary deposits locally on the south reservation. No water samples were collected from wells in the Tertiary deposits during this study.

In the period 1972-74, the U.S. Public Health Service, Indian Health Division, made tests of water samples from domestic wells within the reservation; tests were limited chiefly to water samples from Indian-owned wells. The results of the tests indicated that the water in a significant proportion of the samples had indications of contamination by organic wastes (Victor Byerly, U.S. Public Health Service, oral commun., 1974). A survey of the well-construction data by the U.S. Public Health Service personnel indicated that the probable contamination was of local origin and probably results from seepage and migration of wastes from shallow subsurface waste-treatment systems through crevices in shallow basalt or through poorly sealed annular spaces around well casings. Because similar methods of construction of well and waste-treatment systems were used in non-Indian residences, the problem could be more widespread than has been detected.

The U.S. Public Health Service has replaced the suspected contaminated wells with generally deeper wells in which the casings have been pressure grouted with cement to a significant depth or into solid, unbroken basalt to ensure a good seal. Waste-treatment systems have also been improved, and most Indian residences in the more densely populated Mission area have been connected to a sewer. Tests made on water from the new wells indicated that the problem seems to be alleviated (Victor Byerly, U.S. Public Health Service, oral commun., 1975).

Water Withdrawals and Water Use

During 1974, the average daily surface- and ground-water withdrawals on the Umatilla Indian Reservation for all uses was estimated to be about 11 Mgal/d, or 12,000 acre-ft per year. The principal sources of these withdrawals, in order of decreasing importance, were the Umatilla River, the Quaternary alluvium, and the Columbia River Basalt Group. Data are summarized in table 12 for each principal category of water use and for each water source.

Table 12.--Summary of estimated water withdrawals and water use on the Umatilla Indian Reservation during 1974

Use	Source					Total		
	Columbia River Basalt Group (Mgal/d)	Tertiary sediments (Mgal/d)	Quaternary alluvium (Mgal/d)	Surface water (Mgal/d)	Surface water (ft^3/s)	(Mgal/d)	(ft^3/s)	(acre-ft/yr)
Irrigation	2.80	--	0.34	4.08	6.31	7.22	11.17	8,090
Public supply	.26	--	3.30	--	--	3.56	5.51	3,990
Domestic	.14	0.003	.02	--	--	.16	.25	180
Industrial	--	--	--	.05	.08	.05	.08	56
Total (rounded)	3.20	.003	3.7	4.1	6.4	11	17	12,000

Estimates of the quantities of water withdrawn from each source and for each type of use are based on field observations made during 1974, on discussions with irrigators and well owners, and on data supplied by the city of Pendleton Water Department and the Umatilla County watermaster. Withdrawals by the Thorn Hollow infiltration galleries in 1974 for public supply are based on weekly gage-height observations and a rating table for the weir. These data were supplied by the Pendleton Water Department. Estimates of irrigation use are based on irrigation periods of 180 or 210 days. Irrigation use varies each year with climatic and soil-moisture conditions and with crops grown. Estimates of domestic use are based on estimated per capita consumption rates of 75 or 100 gal/day, depending on whether or not lawns were watered.

About 4 Mgal/d, or 4,500 acre-ft per year, or 37 percent, was withdrawn from ground-water sources within the reservation and used for public supply and irrigation outside the reservation boundaries. Most of the water withdrawn from the Quaternary alluvium by the infiltration gallery near Thorn Hollow and from the basalt by well 2N/33E-14dac is used for public supply in Pendleton. In 1974, about 0.7 Mgal/d, or 800 acre-ft per year was withdrawn from the basalt at well 3N/35E-4cbd to augment flow in Wildhorse Creek. This water was then diverted from Wildhorse Creek several miles downstream to irrigate farmlands outside the reservation. The remaining 7 Mgal/d, or 8,000 acre-ft per year was used entirely within the reservation and was returned to the land either by irrigation or by subsurface waste-treatment systems.

About 7.2 Mgal/d, or 8,000 acre-ft per year of water was used for irrigation; of this amount, about 4.1 Mgal/d, or 4,500 acre-ft per year was surface water and about 3.1 Mgal/d, or 3,500 acre-ft per year, was ground water. About 2.6 Mgal/d, or 2,900 acre-ft per year or 64 percent of the total surface-water withdrawals for irrigation, was diverted from the Umatilla River at one diversion site in sec. 6, T. 2 N., R. 33 E., for flood irrigation of adjacent lands. Most of the remaining surface water used for irrigation was diverted from the Umatilla River upstream at several scattered small diversion sites. Most of the ground water used for irrigation was withdrawn from the Columbia River Basalt Group. More than half the water pumped for irrigation from the basalt was pumped from wells 3N/34E-13cdb, -23baa2, 3N/35E-4cbd, and -7baa on the north reservation, whereas the remainder was pumped from more widely scattered wells on the south reservation or along the Umatilla River valley. Some of the principal irrigation wells in these areas are 2N/33E-20bbb1, -33cca, and 2N/34E-17dcc. The average daily withdrawal for irrigation during the irrigation season is estimated to be about 14 Mgal/d, or about two times the average daily irrigation-use rate.

All the water withdrawn from the reservation for public-supply use is from ground-water sources. In 1974, the Quaternary alluvium and the Columbia River Basalt Group supplied about 3.6 Mgal/d, or 4,000 acre-ft per year, to the city of Pendleton. About 3.3 Mgal/d, or 3,700 acre-ft per year was withdrawn from the alluvium by the infiltration gallery and about 0.3 Mgal/d, or 300 acre-ft per year was withdrawn from the basalt at well 2N/33E-14dac. The average daily withdrawal rate of the infiltration gallery in 1974 ranged from about 2.8 to 5.3 Mgal/d. Well 2N/33E-14dac was used only in the summertime to augment the flow of the infiltration gallery which gradually declines each summer. A small volume of the water from these sources is used to supply the water needs of the Bureau of Indian Affairs complex, the Tribal headquarters, adjacent Indian housing projects, and a few homes in the Mission area.

Surface- and ground-water withdrawals within the reservation for all categories of water use are expected to increase at a gradual rate if the present withdrawal trend continues. Discharge of the Umatilla River during summer and fall generally is smaller than the estimated minimum recommended discharge that will provide an adequate spawning and rearing habitat for salmon and trout. Increased diversions of surface water during periods of low flow will further aggravate this problem. Small diversions of surface water for irrigation of small acreages of pasture along the Umatilla River probably are increasing. The combined withdrawal rates of the small diversions could become significant and, consequently, should be monitored.

Pumping for irrigation of small acreages from domestic wells in the shallow basalt in the Umatilla River valley west of Mission is already sufficient to cause local seasonal declines of ground-water levels of more than 100 ft (fig. 14). Increased withdrawals of ground water from the shallow basalt in this area could magnify the drawdown and well-interference problems and would require deepening of some wells to obtain a dependable yield.

Several tens of square miles of lands, chiefly in the north and south reservation, are suitable for irrigation. Irrigation of these lands would require very large volumes of water each year, exactly how much depending on the types of crops grown. Irrigation of all these lands on the reservation could be accomplished by using surface water or a combination of surface and ground water; in either case, the construction of large surface-water impoundments would be required to retain the runoff.

Ground-water withdrawals from the basalt aquifer on the reservation could supply an estimated 12 to 15 Mgal/d, or 13,000 to 17,000 acre-ft per year. Such large withdrawal rates, however, would require sophisticated planning and design to minimize the adverse effects of pumping. Water-level declines, well interference, and depletion of ground-water storage in the basalt could be expected if additional wells are drilled. Wells generally would have to be much deeper than those presently in use, and pumping lifts in wells on the north or south reservation would generally be in excess of 400 ft.

SUMMARY OF PROBLEMS RELATED TO WATER RESOURCES

The principal water-resource-related problems on the reservation are (1) unequal seasonal and areal distribution of streamflow, (2) depletion of the Umatilla River during low-flow periods, (3) local seasonal declines of ground-water levels, and (4) local ground-water contamination. Additional problems that can be anticipated are (1) regional declines of ground-water levels and (2) surface- and ground-water contamination by accidental spills of various substances.

High flows and flooding in winter and spring cause soil erosion and property damage, whereas summer and fall flows commonly are inadequate to meet the requirements for irrigation, spawning and rearing of salmon and trout, or other beneficial uses. To reduce the high flows and increase the low flows, impoundments to store and release excess streamflows would be needed.

Depletion of streamflow in the Umatilla River is caused by natural processes such as evapotranspiration and is probably increased by artificial means such as direct and indirect diversions. Indirect diversion includes induced infiltration of streamflow to pumping wells and infiltration galleries near the stream. Data are not available to determine whether a reduction of the indirect diversions would result in measurable increases in low streamflow in the Umatilla River.

Local seasonal declines of ground-water levels on the reservation occur chiefly in the Umatilla River valley west of Mission. The declines probably are caused by increased summertime withdrawals of ground water from many wells tapping shallow basalt. Excessive declines result in inadequate yields in some wells in summer and would require deepening of the wells to obtain dependable supplies.

Local contamination of ground water probably is caused by seepage of wastes from subsurface waste-treatment systems into inadequately sealed wells. The problem may be alleviated by better siting of subsurface waste systems, by improving septic tanks and drain fields, by constructing sewers, and by cementing well casings at greater depths in solid, unbroken rock.

Small regional declines of ground-water levels may eventually occur in the basalt aquifer even if development of the aquifer for irrigation and other large uses increases at its present gradual rate. Declines of ground-water levels occur because recharge and storage of the aquifer are too small for replenishment of the pumped water. Water-level declines will be small and manageable if withdrawals from the aquifer continue to be from widely spaced wells, but declines could become serious if wells are closely spaced and withdrawals are large.

Because good hydraulic data for the basalt aquifer are sparse, large-scale development of the aquifer for irrigation or other uses should be planned to proceed in a gradual, systematic manner. Gradual development will allow accumulation of good hydraulic data that will aid in (1) determination of proper well spacing, (2) computation of ground-water recharge, and (3) minimization of the effects of pumping stresses on the aquifer system.

Accidental spills of contaminating substances are possible on the reservation because major railroads, highways, and oil and gas pipelines cross the reservation and because use of agricultural chemicals is intense. An accidental spill of contaminants at the city of Pendleton infiltration galleries, near Thorn Hollow, could have serious consequences, because the galleries are a source of water supply for more than 15,000 persons. The infiltration galleries and associated pipelines parallel the mainline railroad tracks for about 5 mi and are generally within a few tens to a few hundred feet of them. To ensure public safety in the event of an accident near the galleries, a foolproof plan should be developed to immediately notify Pendleton Water Department officials. The Water Department could then take appropriate action to determine the nature of the accident and, if necessary, shut down the galleries.

A water-resources monitoring program would help the Tribes to identify problems such as streamflow depletion or declines of ground-water levels within the reservation boundaries. The program would also provide background data to aid in the management and development of the water resources so as to minimize the adverse effects of development and to help identify potential problems and problem areas. Monitoring sites should include stream-gaging stations, observation wells, water-quality stations, and precipitation stations. The locations and rates of surface- and ground-water withdrawals also should be determined. The intensity and frequency of observations at each monitoring site would have to be determined by the particular needs, goals, and priorities of the Tribes and by the adequacy of the existing data.

To ensure public safety and health and to minimize the potential for contamination of the surface and ground waters, the Tribes should consider establishing rules, regulations, and general standards for drilling, construction, operation, and location of wells; subsurface waste-treatment systems; and solid-waste disposal sites. In the absence of a tribal agency to establish and oversee such regulations, the Tribes could review the adequacy of existing State regulations and adopt them as necessary.

GLOSSARY OF SELECTED TERMS

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

Confined ground water.--Ground water that is under pressure significantly greater than atmospheric. In a well that taps a confined ground-water body, the static water level is above the top of the aquifer.

Drawdown.--The lowering of ground-water level caused by pumping. It is the difference, generally, in feet or meters, between the static water level and the pumping water level in a well.

Evapotranspiration.--Water withdrawn from a land area by evaporation from water surfaces and moist soil and by plant transpiration.

Hydraulic gradient.--The change in static head per unit of distance in a given direction. The direction generally is understood to be that of the maximum rate of decrease in head.

Intermittent (or seasonal) stream.--A stream that flows only at certain times of the year when it receives water from springs or from some surface source such as melting snow in mountainous areas.

Perched ground water.--Unconfined ground water separated from an underlying body of ground water by an unsaturated zone.

Perennial stream.--A stream that flows continuously.

Potentiometric surface.--A surface that represents the static head. In an aquifer it is defined by the levels at which water stands in tightly cased wells.

Runoff.--That part of the precipitation that appears in surface streams.

Specific capacity.--The rate of discharge of water in a well divided by the drawdown of water level within the well. It is an approximate index of the capability of an aquifer to transmit water.

Static head.--The height above a datum (mean sea level) of the surface of a column of water in a well. The terms "head" and "static water level" are used interchangeably in this report. The static water level in a well represents the average head of the water-bearing materials open to the well bore.

Unconfined ground water.--Ground water in an aquifer that has a water table.

Water table.--The water surface in an unconfined water body at which the pressure is atmospheric.

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Table 13.--Records of selected wells and springs in the Umatilla Indian Reservation area

Well or spring number: See page for description of well- and spring-numbering system.
Type of well: Refers to method of drilling. C, cable tool; D, dug; R, rotary.
Altitude: Altitude of land surface at well, in feet above mean sea level, estimated from topographic maps.
Diameter of well: Nominal inside diameter of the innermost casing at the surface.
Depth of casing: Depth of casing indicates length of blank casing.
Finish: O, open end; P, perforated; S, screened; X, open hole.
Aquifer: Qa, Quaternary alluvium; Ts, Tertiary sediments; Tcr, Columbia River Basalt Group.

Water level: Depths to water below land surface given in feet and decimal fraction were measured by the Geological Survey or the Oregon State Water Resources Department; those given in whole feet were reported by well driller or owner. F, flowing well whose static water level is not known, + indicates feet of head above land surface.
Type of test: A, air lift; B, bailed; F, flowing; P, pumped.
Remarks: C, chemical analysis reported in table 10; L, driller's log in table 14; O, observation well whose water level is measured periodically. OSE-GWR, data reported in Oregon State Engineer ground-water report series; WSP, data reported in U.S. Geological Survey Water-Supply Paper 1620.

Well or spring number	Owner	Type of well	Year com-pleted	Alti-tude (feet)	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Aquifer	Water level		Well performance				Remarks
										Feet below datum	Date	Yield (gal/min)	Draw-down (feet)	Period (hr)	Type of test	
								T. 1 N., R. 32 E.								
1bba2	J. R. Hanna	R	1968	1,340	150	6	110	X	Tcr	26.4	1-30-74	40	75	--	A	L, O.
1cba	M. J. Kilby and R. F. Peterson	R	1967	1,380	375	10	211	X	Tcr	90	1- 3-67	285	35	4	P	L.
1cbb	R. Knoebel	C	1954	1,414	504	8	185	X	Tcr	110	1954	95	--	--	--	L. Well 1M2 in WSP.
1cca	M. J. Kilby and R. F. Peterson	R	1974	1.380	285	10	242	X	Tcr	90	4- 4-74	350	175	1	A	L.
1daa	David Horne	R	1968	1,408	233	6	--	X	Tcr	89	9- 4-68	50	21	--	A	L.
14ada	Ford Robertson	C	1963	1,370	250	8	188	X	Tcr	70	10- 8-63	40	30	1	B	L.
								T. 1 N., R. 33 E.								
3ddd1	John Straughn	C	1930?	1,833	121	10	20	X	Tcr	33.2	1-31-74	90	--	--	--	L. Well 3R1 in WSP.
3ddd2	do	R	1971	1,819	255	10	26	X	Tcr	4.1	1-31-74	10	0	2	B	L, O.
4acd	Art Motanic	R	1974	1,610	215	6	120	X	Tcr	75	9-19-74	19	14	3	P	L.
4baa	Lawrence Patrick	C	1964	1,562	170	6	162	X	Tcr	45	3-19-64	10	80	--	B	L.
4ddd	Nellie Charlie	C	1964	1,682	195	6	144	X	Ts	139.0	5-10-74	12	55	--	P	L.
7bdd	Marvin Cargill	C	1959	1,470	207	6	47	X	Tcr	--	--	25	20	--	B	L. Well 7F1 in WSP.
9baa	Unknown	D	--	1,658	77	48	8	X	Ts	6.2	5-30-74	--	--	--	--	O.
10bbc	do	D	--	1,720	41	48	8	X	Ts	5.8	3-27-74	--	--	--	--	O. Well 10D1 in WSP.
10bcc	Harvey Grove	R	1969	1,765	357	8	47	X	Tcr	139	1-31-74	25	--	2½	A	C, L.
10ccc	Herbert Ghangraw	C	1958	1,819	96	6	27	X	Tcr	26	2-24-58	8	90	1	B	C, L.
11bbc2	Mary Tias	R	1974	1,860	222	6	40	X	Tcr	11.1	7-11-74	30	88	3	P	L.
11dbb	John Storie	R	1968	1,990	100	6	30	X	Tcr	18	7-30-68	60	62	--	A	L.
16ddc2	Wilbur Minthorn	C	1964	1,921	243	6	25	X	Tcr	11.0	7-21-74	20	45	--	A	L.

Table 13.--Records of selected wells and springs in the Umatilla Indian Reservation area--Continued

Well or spring number	Owner	Type of well	Year com- pleted	Alti- tude (feet)	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Aquifer	Water level		Well performance				Remarks
										Feet below datum	Date	Yield (gal/min)	Draw- down (feet)	Period (hr)	Type of test	
T. 1 N., R. 33 E.--Continued																
28bbb	Dean Windham	R	1974	1,850	300	6	22	X	Tcr	120.0	6-17-74	20	80	1	A	L.
28cdc(s)	Unknown	--	--	1,958	--	--	--	--	Soil	--	--	2-3/4	--	--	--	C.
28ddd	Raymond Burke	R	1974	2,055	191	6	41	X	Tcr	10	9-20-74	17	52	3	P	L.
29bdd	C. J. Gilbert	R	1967	1,800	434	6	80	X	Tcr	80	12-19-74	60	140	1	A	L.
29dba	Raymond Eagle	R	1974	1,855	313	6	29	X	Tcr	44	9-21-74	22	51	3	P	L.
30aac	Sam Gilbert	D	--	1,670	15	36	--	--	Qa	--	--	--	--	--	--	C. Two dug wells 15 ft deep and 25 ft apart.
33abb	Jeanette Jones	R	1974	2,000	232	6	40	X	Tcr	131	9-20-74	16	10	3	P	L.
T. 1 N., R. 34 E.																
1ada	C. C. Curl	C	1930	3,600	495	6	--	X	Tcr	261	7- 1-74	6	--	--	--	
1baa	Oregon State Highway Dept.	R, C	1969	3,580	695	6	664	S	Tcr	216	9-30-69	22	365	11	P	C, L.
1dad	A. R. Winn	R	1971	3,600	261	6	26	X	Tcr	72	9- 7-71	7	--	6	A	L.
1dbd	Beryl Grilley	R	1972	3,520	283	6	22	X	Tcr	98	9-10-72	20	200	1	A	L.
3cbc	Barney Olsen	R	1972	3,575	143	6	21	X	Tcr	110	9- 5-72	20	13	1	A	L.
3cca	Lawrence Boltz	R	1969	3,575	360	6	22	X	Tcr	320	7-31-69	13	--	2	A	L.
5cbd	Mel Wilson	R	1974	3,210	400	6	20	X	Tcr	171	2-25-74	10	40	1	A	L.
7bad	Orval McCormach	R	1967	3,220	850	6	110	X	Tcr	565	9-19-67	25	--	--	A	L.
8acc	Oregon State Highway Dept.	C	1965	3,355	425	6	187	X	Tcr	345	10- 8-65	10	5	2	B	L.
9bca	Ralph Barr	R	1974	3,285	252	6	179	P, X	Tcr	150	11-28-74	60	85	1	A	L.
10bdd	W. A. Stewart	R	1974	3,340	427	6	20	X	Tcr	276	7-21-74	1-1/2	48	1	A	L.
16bcd	A. P. Brunette	R	1974	3,293	280	6	20	X	Tcr	90	3- 4-74	45	160	2	A	L.
17acb2	Ernest Roberts	R	1971	3,358	290	6	21	X	Tcr	100	8-30-71	50	--	--	A	L.
17bdb	John Knight	R	1971	3,405	320	6	21	X	Tcr	185	8-24-71	37	--	--	A	L.
17bdd	Hale	R	1970	3,420	300	6	21	X	Tcr	160	8-24-70	8	100	2	A	L.

Table 13.--Records of selected wells and springs in the Umatilla Indian Reservation area--Continued

Well or spring number	Owner	Type of well	Year com-pleted	Alti-tude (feet)	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Aquifer	Water level: Feet below datum	Water level: Date	Well performance: Yield (gal/min)	Well performance: Draw-down (feet)	Well performance: Period (hr)	Well performance: Type of test	Remarks
									T. 1 N., R. 35 E.							
4ccb	Mike Hillis	R	1974	3,765	450	6	18	X	Tcr	285	10-16-74	3	100	3	A	L.
5dad	Holt	C	1957	3,800	320	8	33	X	Tcr	50	9-14-57	2-1/2	80	2	B	L. Well 4M1 in WSP.
6abc	Cynthia Nordyke	R	1974	3,590	300	6	30	X	Tcr	--	--	--	--	--	--	L.
6add2	Albert Lavadour	R	1974	3,635	283	6	19	X	Tcr	240	11-25-74	10	40	2	A	L.
8abb	Camp Fire Girls, Inc.	R	1970	3,755	421	6	68	X	Tcr	125	6- 5-70	20	200	1	A	C, L.
9bbb	H. H. Pederson	R	1974	3,700	425	6	18	X	Tcr	167	6- 6-74	5	220	1	A	L.
9bbc	do	R	1972	3,730	705	6	20	X	Tcr	600	9-11-72	3	100	1	A	L.
16bbb	Joe Angotti	R	1970	3,740	215	6	20	X	Tcr	36	8-26-70	1	179	1/4	A	L.
									T. 2 N., R. 32 E.							
1cdc	Hugh Whitbread	C	1954	1,105	575	8	22	X	Tcr	206.7	11- 6-74	20	30	--	B	L, O.
2ccd	City of Pendleton	C	1958	1,065	700	24	186	X	Tcr	177.3	11-18-74	2,400	86	45	P	C, L, O. OSE-GWR 15, 18; well 2N1 in WSP.
2ddd	do	C	1948	1,095	774	20	148	X	Tcr	185	1948	1,700	27	88	P	C, L. Well 2R in WSP. Drilled to 935 ft, hole crooked at 124 ft; re-drilled to 774 ft in same hole.
9abd	Oregon State Hospital	C	1954	1,050	851	20	57	X	Tcr	135	1954	700	58	50 min.	P	C, L. Well 9B1 in WSP.
10bda	City of Pendleton	C	1949	1,054	761	16	81	X	Tcr	139	11-23-48	1,100	10	30	P	C, L. Well 10F1 in WSP.
10ccd	do	C	1952	1,070	1,008	16	81	X, P	Tcr	153	10- -52	585	--	--	--	C, L.
16bab	do	C	1965	1,070	1,501	20	390	X	Tcr	171.0	11- 5-74	525	361	8	P	L.
36dac	D. W. McCoy	R	1968	1,350	260	6	37	X	Tcr	47	9-13-68	60	113	--	A	L.
									T. 2 N., R. 33 E.							
2cbd1	J. D. Mills	R	1970	1,258	346	6	23	X	Tcr	73	7- 1-70	100	0	4	A	L.
2daa	C. I. Thompson	R	1969	1,305	195	6	88	X	Tcr	57	9-11-69	10	123	2	A	C, L.
2dbd2	Ellen Cowapoo	R	1974	1,287	170	6	50	X	Tcr	39	8-27-74	10	64	3	P	L.
2ddc	Kenneth Bill	C	1963	1,270	124	6	36	X	Tcr	10.2	11- 7-74	30	13	3	P	C, L.
3cac2	Dan Broncheau	R	1974	1,221	165	6	60	X	Tcr	23	7- 3-74	30	23	1-1/2	P	L.
3cad	Esther Johnson	R	1974	1,226	83	6	71	X	Tcr	15	7- 9-74	30	3	1/2	P	L.

Table 13.--Records of selected wells and springs in the Umatilla Indian Reservation area--Continued

Well or spring number	Owner	Type of well	Year com-pleted	Alti-tude (feet)	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Aquifer	Water level: Feet below datum	Water level: Date	Well performance: Yield (gal/min)	Well performance: Draw-down (feet)	Well performance: Period (hr)	Type of test	Remarks
							T. 2 N., R. 33 E.--Continued									
3cbb	J. L. Haguewood	R	1971	1,422	481	6	66	X	Tcr	200	9-27-71	40	163	1	A	L.
3cbd	W. J. Wilkinson	R	1968	1,222	125	6	22	X	Tcr	60	4-12-68	40	--	--	A	L.
3cca	Jean Walker	R	1974	1,221	205	8	26	X	Tcr	16	7-11-74	30	--	--	A	L.
3cda	Harvey Jim	R	1974	1,225	80	6	55	X	Tcr	12	7- 9-74	20	28	2	P	L.
3dad	Nadine Van Mechlen	R	1974	1,249	191	6	20	X	Tcr	16	11-13-74	25	10	2	P	L.
4cad	Joseph Johnson	C	1958	1,203	92	6	13	X	Tcr	18	4-15-58	30	1½	1	B	L.
4cbd	H. M. Hart	C	1970	1,190	252	8	65	X	Tcr	21	6-29-70	20	40	25	P	L.
4dda	W. A. Wilson	R	1967	1,215	410	6	20	X	Tcr	9.4	11- 6-74	28	385	--	A	C, L.
5bcb	E. M. Clark	C	1965	1,372	122	8	33	X	Tcr	80	10- 4-65	15	25	16	B	L.
6bac	Steve Caldwell	R	1973	1,148	348	6	21	X	Tcr	265	8-16-73	32	85	1	B	L.
6bad	A. B. Caldwell	C	1964	1,150	232	8	25	X	Tcr	90	6-17-64	30	60	2	B	L.
6bbd	C. P. Hyke	R	1967	1,145	400	6	26	X	Tcr	320	8-30-67	20	--	--	A	L.
7aac	Pendleton Redi-Mix	R	--	1,142	500	8	18	X	Tcr	--	--	--	--	--	--	C.
7abd	David McKay	C	1963	1,143	54	6	18	X	Tcr	18	8-10-74	25	12	2	P	L.
7ada3	Eva Watchman	R	1974	1,163	334	6	70	X	Tcr	265.2	11- 6-74	15	18	3	P	L.
7add1	Leon Abell	R	1973	1,195	457	6	30	X	Tcr	133	7-31-73	30	90	1	A	L.
7baa2	Lowell Spiess	C	1956	1,138	500	10	60	X	Tcr	233.0	10-22-74	--	--	--	--	L.
7baa3	do	R	1970	1,139	120	6	19	X	Tcr	15	4-30-70	60	100	1	A	L.
7bcc1	W. P. Hall	R	1968	1,128	400	6	40	X	Tcr	20	8- 9-68	40	160	--	A	C, L.
7bcd	Delamarter Nursing Home	C	1957	1,152	310	8	21	X	Tcr	250	7-13-57	30	8	½	B	L.
8aac	Marvin Berland	R	1973	1,168	143	6	21	X	Tcr	37.7	10-24-74	60	70	1	A	L.
8abd	Bob Williams	R	1974	1,165	210	6	44	X	Tcr	73	7-21-74	25	69	2½	P	L.
8aca	Muriel Johnson	C	1964	1,169	28	6	20	X	Tcr	6.0	10-24-74	60	--	--	P	C, L.
8acb	Mr. Hatton	C	1961	1,167	125	6	39	X	Tcr	39.5	10-24-74	60	0	--	F	L.
8acc	Robert Oylear	R	1967	1,182	156	6	29	X	Tcr	36.5	10-24-74	60	80	1	A	L.
8ada	Mamie Minthorn	R	1974	1,179	370	6	66	X	Tcr	43.2	10- 3-74	30	9	1	P	L.
8adc1	Maude Antoine	D	--	1,176	25	--	--	--	Qa	--	--	--	--	--	--	C. Well depth approximate
8bad	Bill Duff	R	1974	1,158	410	8	72	X	Tcr	150	12-20-74	300	250	1	A	L.

Table 13.--Records of selected wells and springs in the Umatilla Indian Reservation area--Continued

Well or spring number	Owner	Type of well	Year com-pleted	Alti-tude (feet)	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Aquifer	Water level: Feet below datum	Water level: Date	Well performance: Yield (gal/min)	Well performance: Draw-down (feet)	Well performance: Period (hr)	Well performance: Type of test	Remarks
									T. 2 N., R. 33 E.--Continued							
8bbd	H. H. Hart	R	1975	1,155	225	6	28	X	Tcr	166	5- 1-75	18	23	1	P	L. Flowing well before deepened from 175 to 225 ft.
8bcd	K. E. Bowman	R	1969	1,195	115	6	28	X	Tcr	13	3-28-69	70	20	2	A	L.
8bdc	Mike Kilby	C	1963	1,194	101	8	26	X	Tcr	57.4	11- 6-74	45	0	1	B	L.
8cad1	Richard Bowman	C, R	1968	1,205	262	8	41	X	Qa, Tcr	90	8-26-68	120	--	1½	A	L.
8cba	H. W. Schuening	C, R	1971	1,208	448	6	37	X	Tcr	310	8-28-71	50	--	4	A	L.
8cbc	Bob Lovett	R	1975	1,270	575	6	42	X	Tcr	175	4-10-75	20	125	1	A	L.
8dac	Richard Purchase	C	1949	1,208	779	8	96	X	Tcr	26	1949	60	35	¼	B	C, L. Well 8J1 in WSP.
8dbd	do	C	1959	1,205	968	12	64	X	Qa, Tcr	24	2-27-59	750	60	4	P	L. Well 8K1 in WSP.
9aad	Louise Showaway	R	1974	1,212	120	6	60	X	Tcr	28	7-22-74	8	9	1	P	L.
9abc1	Wilbur Hisey	C	1959	1,202	114	8	19	X	Tcr	20	8-31-59	35	74	1	B	L.
9aca	Sherman Alexander	C	1958	1,205	125	6	43	X	Tcr	12	8-29-74	15	104	1	P	C, L.
9acc2	Uriah Alexander	R	1974	1,202	150	6	58	X	Tcr	20	11- 4-74	14	0	2	P	L.
9acd	Floyd Alexander	R	1974	1,205	204	6	63	X	Tcr	134	7-10-74	20	12	1½	P	L.
9adb	Phillip Minthorn	R	1974	1,209	232	6	57	X	Tcr	49	8-26-74	15	23	3	P	L.
9bac	Richard Spurlich	R	1973	1,190	343	6	21	X	Tcr	69.1	10-23-74	15	170	1	A	L.
9bbc	D. Newson	C	1961	1,180	60	8	41	X	Tcr	8.5	10-24-74	8	44	1	B	L.
9bca	Rogers Construction, Inc.	R	1968	1,185	152	6	98	P, X	Qa, Tcr	F	4- 4-74	40	25	1	A	L.
9bcb	do	R	1969	1,182	190	6	178	X	Tcr	+15	2- 4-75	20	106	1	A	L.
9daa1	Anna Wannassay	C, R	1974	1,214	252	6	36	X	Tcr	18	11-26-74	14	3	2	P	L.
9daa2	Wilbur Jones	R	1974	1,213	260	6	25	X	Tcr	88.9	10-23-74	45	48	--	--	L.
9dba	John Bergen	C	1974	1,210	215	8	39	X	Tcr	42.6	10-23-74	100	45	1	A	L.
10aac	Viola Wocatsie	R	1974	1,236	100	6	53	X	Tcr	9	8-14-74	30	13	2	P	L.
10abc	Melissa Parr	R	1974	1,230	191	6	27	X	Tcr	18	8-27-74	15	130	5	P	L.
10abd2	Thelma Rieck	R	1974	1,234	100	6	63	X	Tcr	10	7-10-74	20	64	3	P	L.
10bbb	W. A. Jenner	R	1967	1,213	120	6	18	X	Tcr	8	10-20-67	1	92	1	A	L.
10bcb	N. H. Loughlin	C	--	1,215	252	6	--	--	Tcr	36.9	11-30-74	30	1½	--	B	L.
10bcc1	Halfmoon Market	C	1957	1,215	235	8	16	X	Tcr	135	6-16-57	95	--	5	P	L.

Table 13.--Records of selected wells and springs in the Umatilla Indian Reservation area--Continued

Well or spring number	Owner	Type of well	Year com- pleted	Alti- tude (feet)	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Aquifer	Water level		Well performance				Remarks
										Feet below datum	Date	Yield (gal/min)	Draw- down (feet)	Period (hr)	Type of test	
							T. 2 N., R. 33 E.--Continued									
10bcc2	C. E. Wood	R	1972	1,219	158	6	33	X	Tcr	40	4-26-72	100	103	1	A	C, L.
10bcd	Dennis Van Dorn	C	1961	1,220	85	8	35	X	Tcr	7.2	10-23-74	12	70	1	B	L.
10cab	Kay Elk	R	1974	1,220	175	6	64	X	Tcr	82	7- 9-74	7	79	4½	P	L.
10cba1	James Logan	C	1961	1,221	210	8	42	X	Tcr	26.0	10-23-74	30	180	1	B	L.
10cba3	Jack Carpenter	R	1968	1,220	90	6	40	X	Tcr	15	4-11-68	90	--	--	A	L.
11aaa	McKinley Williams	C	1963	1,277	56	6	54	X	Tcr	11	11-21-63	25	13	--	B	L.
11adc1	Mart James	C	1964	1,278	50	8	44	X	Tcr	8.1	10-23-74	60	20	--	B	L.
11adc2	Jack Baker	R	1973	1,279	160	6	55	X	Tcr	13.2	10-23-74	35	--	1	A	L.
11bcc	Margaret Elk	C, R	1963	1,253	115	6	31	X	Tcr	17	9- 9-64	20	11	--	B	L.
11cab	V. R. Case	D	--	1,269	15	36	15	O	Qa	13.2	10-23-74	45	--	--	--	
11daa	William So Happy	C	1963	1,280	72	6	20	X	Tcr	16	12-26-63	15	12	--	B	L.
12aca1	Rex Huesties	R	1973	1,305	65	6	21	X	Tcr	2	12- 4-73	25	50	2	A	L.
12aca2	Marvin Patrick	R	1974	1,301	85	6	30	X	Tcr	1	8-30-74	20	2	2	P	L.
12acb	Lita Lavadour	R	1974	1,302	130	6	32	X	Tcr	9	8-30-74	25	4	2	P	L.
12bca	Julia Cowapoo	C	1964	1,290	32	6	30	X	Tcr	8	9-15-64	10	12	--	B	L.
12cbb	U.S. Public Health Service, Indian Health Division	R	1972	1,285	150	6	59	X	Tcr	5	2-25-72	60	59	3½	P	C, L. Reported flow 2 gal/min.
12ccc	James Bronson	R	1969	1,386	80	4	72	X	Tcr	+5	1-14-70	2	--	--	F	C, L.
13bbb	Joe Sheoship	R	1974	1,399	80	6	46	X	Tcr	0	7-22-74	30	45	1	P	L.
14dac	City of Pendleton	C, R	1972	1,467	800	12	157	X	Tcr	29	2-15-72	1,000	191	59	P	C, L, O.
18daa	Andrew Dumont	R	1974	1,347	273	6	106	X	Tcr	82	11-13-74	23	15	2½	P	L.
19add	Ferman Ghangraw	C	1964	1,310	127	6	22	X	Tcr	42	4- 8-64	15	74	--	B	C, L.
20bbb	Louis Umbarger	C	1970	1,281	1,002	12	62	X	Tcr	16	11- 4-70	800	146	4	P	C, L, O.
20ddc	Boyd Jones	C	1964	1,363	55	6	28	X	Tcr	18	7-23-64	12	18	1½	B	L.
21cdd	C. C. Curl	C	1962	1,391	51	8	47	X	Tcr	12	10-27-62	12	26	1½	B	L.
22bbd	George Bonbright	R	1969	1,414	142	8	84	X	Tcr	40	12-31-69	--	--	--	--	L.
22bcb	W. C. Rohde	R	1969	1,390	155	8	40	X	Tcr	25	9-15-69	75	125	1	A	L.
24bab	Edward James	R	1974	1,575	112	6	41	X	Tcr	42	9-12-74	22	42	3	P	L.

Table 13.--Records of selected wells and springs in the Umatilla Indian Reservation area--Continued

Well or spring number	Owner	Type of well	Year com- pleted	Alti- tude (feet)	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Aquifer	Water level: Feet below datum	Water level: Date	Well performance: Yield (gal/min)	Well performance: Draw- down (feet)	Well performance: Period (hr)	Well performance: Type of test	Remarks
							T. 2 N., R. 33 E.--Continued									
24ddd	St. Andrews Mission	R	1967	1,760	58	6	20	X	Tcr	30	10- 3-67	100	--	--	A	C, L.
25bbb	Sam Kash Kash	C	1965	1,695	182	6	43	X	Tcr	50	7-11-74	30	7	1	P	C, L.
25ddc	Oscar Grubbs	R	1974	2,000	135	6	18	X	Tcr	67	5-25-74	30	40	1	A	L.
27abb	Mary Lawyer	R	1969	1,458	193	6	95	X	Tcr	98	12- 9-69	15	62	1	A	C, L.
27abc	Sidney Whitesell	R	1973	1,480	145	6	115	X	Tcr	40	5-11-73	10	85	--	A	L.
28abb	Eliza Bill	R	1974	1,413	211	6	93	X	Tcr	22	11-14-74	15	49	2½	P	L.
28bdb	Dale Tucker	C	1965	1,410	430	12	110	X	Tcr	+12	7- 1-65	80	125	10	P	L. Reported flow 8 gal/min.
28cdd	Elizabeth Badroads	R	1974	1,463	170	6	59	X	Tcr	18	9-16-74	25	33	3	P	L.
28daa	Carl Sampson	R	1974	1,469	109	6	89	P	Tcr	18	11-11-74	12	38	3	P	L.
28dcd	L. A. Wells	R	1970	1,493	238	8	151	X	Tcr	+9	4-27-70	125	100	1	A	L. Reported flow 25 gal/min.
29abd	I. M. Jordan	R	1972	1,375	190	6	29	X	Tcr	30	11- 3-72	30	150	1	A	L.
29dcd	Leonard Cree	R	1974	1,428	110	6	77	X	Tcr	11	7-15-74	30	79	3	P	L.
29ddb	Bob Thorne	R	1975	1,425	258	8	23	X	Tcr	10	4- 1-75	120	40	1	A	L.
31aaa	R. J. Pond	R	1969	1,462	543	6	24	X	Tcr	350	12-15-69	8	180	1	A	C, L.
31cca	Roy Allister	R	1974	1,385	110	6	21	X	Tcr	F	5-10-74	20	50	1	A	C, L. Reported flow 2 gal/min.
31cdc	Jeff Kubin	R	1974	1,403	245	8	22	X	Tcr	10	4-18-74	70	180	1	A	L.
31cdd	Gene Simmons	R	1974	1,400	292	6	23	X	Tcr	16	8-21-74	35	120	2	A	L.
33aaa	Elsie Minthorn	R	1974	1,517	107	6	107	X	Tcr	9	9-18-74	25	24	3	P	L.
33bbb	R. D. Becker	R	1971	1,445	140	6	53	X	Tcr	42	5-29-71	70	--	6	A	C, L.
33cca	L. H. Kinzer	C	1952	1,520	310	12	75	X	Ts, Tcr	F	6-22-53	456	205	2½	P	C, L. Well 33N1 in WSP.
							T. 2 N., R. 34 E.									
1acd2	Moses Lloyd	R	1974	1,495	135	6	60	X	Tcr	.6	10-16-74	20	76	1	P	L.
1add2	Eileen Clark	R	1974	1,505	150	6	37	X	Tcr	+203	11-16-74	55	203	2	P	L. Reported flow 55 gal/min.
1bdc	Lucy Johnson	C	1964	1,482	27	6	25	X	Tcr	3	5-21-64	60	12	--	B	L.
2adb	J. E. Morrow	R	1973	1,515	223	6	30	X	Tcr	18	7-19-73	30	202	1	A	C, L.

Table 13.--Records of selected wells and springs in the Umatilla Indian Reservation area--Continued

Well or spring number	Owner	Type of well	Year com-pleted	Alti-tude (feet)	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Aquifer	Water level: Feet below datum	Water level: Date	Well performance: Yield (gal/min)	Well performance: Draw-down (feet)	Well performance: Period (hr)	Well performance: Type of test	Remarks
							T. 2 N., R. 34 E.--Continued									
2cbb1	Louie Dick, Jr.	R	1966	1,448	61	6	24	X	Tcr	+34	3-10-66	40	--	--	B	C, L. Reported flow 30 gal/min.
2cbb2	do	R	1974	1,460	171	6	26	X	Tcr	12	9-11-74	25	0	3	P	L.
3bbb	Layton Mann	D	--	1,675	19	36	--	--	Tcr	15	10-17-74	--	--	--	--	Well 3D1 in WSP.
3ccc	Martha Kirk	C	1964	1,413	51	6	23	X	Tcr	5	7-20-74	30	6	1	P	L.
3ccd	Mary Hines	R	1974	1,413	97	6	35	X	Tcr	+46	8-27-74	200	--	--	F	L.
3cdb1	Lillian Hoptowit	C	1964	1,415	60	5	51	X	Tcr	+39	5-22-64	60	--	--	F	L.
3cdb2	Orville Sheoship	R	1974	1,455	123	6	67	X	Tcr	.4	10-17-74	30	12	1½	P	L.
4ccb	L. L. Dickerson	R	1973	1,375	462	6	36	X	Tcr	+71.6	10-22-74	20	0	1	P	C, L. Reported flow 10 gal/min.
4ccc	Keith Farrow	R	1974	1,380	280	6	55	X	Tcr	10	8- 3-74	5	230	2	P	L.
4cdc	Marion Silman	R	1973	1,388	363	6	105	X	Tcr	F	8-13-73	40	20	1	A	L. Reported flow 15 gal/min.
4cdd	Lawrence Picard	R	1973	1,422	242	6	30	X	Tcr	0	7-24-73	30	242	1	A	L.
4dda	Alphonse Shippentower	R	1974	1,407	200	6	40	X	Tcr	0	8- 3-74	12	135	2½	P	L.
5dcd	James Sloan	C	1965	1,370	56	6	30	X	Tcr	11	6- 8-65	25	35	2	B	L.
5ddd	Steve So Happy	R	1974	1,375	150	6	20	X	Tcr	12	9-11-74	15	59	3	P	L.
8bab1	Clinton Case	D	--	1,357	10	36	--	--	Qa	7.2	8-31-53	--	--	--	--	C. Well 8C1 in WSP.
8bad	L. W. Keller	C	1965	1,358	124	8	20	X	Tcr	9	9-24-65	80	20	2	B	L.
8cdc	Keith Day	R	1970	1,500	120	6	22	X	Ts, Tcr	19	5-28-70	60	--	7	A	L.
9bab	Virgil Bronson	R	1968	1,388	295	6	34	X	Tcr	F	5-27-68	150	--	--	F	L.
12ccc	Anna Johnson	R	1967	2,040	555	6	20	X	Tcr	470	1-24-67	8	--	--	A	L.
15bad	Fred Price	R	1970	1,722	400	6	26	X	Tcr	60	6- 7-70	100	0	4	P	L.
16adc	Ernestine Waters	R	1974	1,740	146	6	54	X	Tcr	122	7-17-74	20	7	1	P	L.
17aaa	Phillip Guyer	C	1964	1,550	47	6	41	X	Tcr	14	7-12-74	10	26	2	P	C, L.
17dcc	R. A. Fowler	C	1971	1,710	750	10	24	X	Tcr	+5	9-29-58	850	185	6	P	C, L. Well 17Q1 in WSP.
18bad	Bryson Liberty	C	1964	1,442	74	6	61	X	Tcr	7.5	10-22-74	30	15	--	B	L.
18dab	Peter Lloyd	R	1974	1,538	120	6	46	X	Tcr	56	7-12-74	30	1	1	P	L.
18dbb	Francis Wilson	C	1964	1,498	56	6	33	X	Tcr	16	7-17-74	30	35	1	P	L.

Table 13.--Records of selected wells and springs in the Umatilla Indian Reservation area--Continued

Well or spring number	Owner	Type of well	Year com- pleted	Alti- tude (feet)	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Aquifer	Water level		Well performance				Remarks
										Feet below datum	Date	Yield (gal/min)	Draw- down (feet)	Period (hr)	Type of test	
T. 2 N., R. 34 E.--Continued																
19dad	Edwin Tucker, Jr.	R	1970	1,875	247	8	23	X	Tcr	86.0	10-22-74	60	80	--	A	L.
T. 2 N., R. 35 E.																
3bcc	J. H. Cahill	R	1973	1,618	115	6	40	X	Tcr	2	8- 6-73	45	92	1	A	L.
3bcd	Charles Cahill	D	--	1,618	12	36	--	--	Qa	8.8	10-10-74	--	--	--	--	C.
3bda	Sharon Weathers	R	1974	1,630	244	6	34	X	Tcr	13	11-14-74	27	4	2	P	L.
4adb	David Remington	C	1957	1,630	106	8	42	X	Tcr	30	6-24-57	10	--	--	B	L. Well 4H1 in WSP.
4add	Virgil Weathers	R	1973	1,618	82	6	38	X	Tcr	+2	8- 6-73	75	--	--	F	C, L.
4bbc1	H. Wishart	C	1964	1,578	60	6	30	X	Tcr	F	9-24-64	15	29	--	B	C, L. Reported flow 1 gal/min.
4bca	Dale Philips	R	1969	1,575	100	6	26	X	Tcr	+4	6-18-69	4	--	--	F	L.
4cab	Aurelia Shippentower	R	1974	1,588	120	6	45	X	Tcr	4.9	10-15-74	20	38	1	P	L.
5aca	Amy Webb	C	1964	1,565	40	6	34	X	Tcr	12.8	10-16-74	12	18	--	B	L.
5add	D. A. Davis	R	1970	1,575	90	4	82	X	Tcr	+9	6-11-69	75	--	--	F	
5bdc	Arnold Lavadour, Sr.	C	1964	1,640	60	6	18	X	Tcr	18	6-17-64	4	35	--	B	L.
5dac	Irma Sam	R	1974	1,605	110	6	55	X	Tcr	38	8- 4-74	20	13	1	P	L.
6aca1	W. L. Dunlavy	C, R	1969	1,524	102	8	18	X	Tcr	+17	6-10-69	85	--	1	A	L. Reported flow 15 gal/min.
6aca2	City of Pendleton	C	1914	1,525	--	--	--	--	Qa	--	--	--	--	--	--	C. Gate house and weir for ground-water infiltration.
6bdc	Joe Thompson	C	1964	1,518	51	6	24	X	Tcr	8	7-20-74	30	8	1	P	C, L.
6eab	Bill Minthorn	R	1974	1,518	56	6	40	X	Tcr	14	8-15-74	10	3	1½	P	L.
11dca	Frank Tubbs	R	1969	1,900	70	6	31	X	Tcr	10	6- 9-69	50	--	--	A	L.
14aba1	John Kittson	D	--	1,930	10	36	--	--	Qa	--	--	--	--	--	--	C.
14aba2	do	R	1974	1,930	109	6	20	X	Tcr	+12	11-16-74	13	--	2	P	L.
T. 3 N., R. 33 E.																
24ddc	U.S. Department of Agriculture Research Station	C	1969	1,499	400	12	50	X	Tcr	111	6- 1-73	55	240	24	P	L.
33aca	Roy Duff	R	1970	1,417	243	8	31	X	Tcr	53	1-27-70	40	107	1	A	L.

Table 13.--Records of selected wells and springs in the Umatilla Indian Reservation area--Continued

Well or spring number	Owner	Type of well	Year com-pleted	Alti-tude (feet)	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Aquifer	Water level: Feet below datum	Water level: Date	Well performance: Yield (gal/min)	Well performance: Draw-down (feet)	Well performance: Period (hr)	Well performance: Type of test	Remarks
T. 3 N., R. 34 E.																
2bcc	F. C. Lieuallen	R	1973	1,605	275	6	178	X	Tcr	190	12-13-73	35	60	1	A	L.
3bac	B. L. Davis Ranch, Inc.	C	1972	1,545	1,263	12	60	X	Tcr	59.4	5- 7-75	984	46	48	P	L, O. Well 3D1 in WSP.
3dbb	S. J. Lieuallen	C	1964	1,570	173	8	167	X	Tcr	121.6	1-24-74	500	6	8	P	L.
4daa	City of Adams	C	1960	1,515	650	10	32	X	Tcr	0	2- 1-60	100	102	2	P	L.
11adb	B. L. Davis Ranch, Inc.	C	1940	1,659	1,030	8	--	X	Tcr	127.4	12- 3-74	200	233	3	P	L, O. Well 11H1 in WSP.
12bcb	Wilma Tucker	R	1974	1,675	300	6	60	X	Tcr	132	8-15-74	5	105	2	P	L.
12cdd	Charles Betts	C	1941	1,715	140	6	--	--	Tcr	--	--	--	--	--	--	C.
13cdb	Barnett-Rugg, Inc.	C	1967	1,810	1,910	10	460	X, P	Tcr	195	11- 6-67	330	285	8	P	L.
16dac	C. T. Burke	C	1960	1,538	285	8	147	X	Tcr	40	6-18-60	5	80	1	B	C, L.
17cbb	Standard Oil Co.	C	1950	1,493	386	8	--	--	Tcr	61	1950	26	69	½	B	L. Well 17M1 in WSP.
20bcb	B. G. Haynes	C	--	1,490	155	8	7	X	Tcr	14	8-28-53	30	1	¼	B	L. Well 20E1 in WSP.
20ddc	Janie LaFave	R	1966	1,538	136	6	19	X	Tcr	42	12-14-66	20	--	--	A	L.
22dbc	Irvin Mann	C	1944	1,630	315	8	63	X	Tcr	18	5- 8-44	40	30	--	B	C, L. Well 22Q1 in WSP.
23baa2	Barnett-Rugg, Inc.	R	1968	1,780	880	10	28	X	Tcr	60	4-12-68	650	313	12	P	L.
26bbb	M. F. Tubbs	R	1974	1,685	590	6	21	X	Tcr	80	9- 4-74	75	120	2	A	L.
32bbb	R. G. Bafus	C	--	1,540	159	8	54	X	Tcr	48.8	11- 7-74	30	70	--	B	C, L. Well 32D1 in WSP.
33abc	Richard Burke	C	1964	1,660	200	6	18	X	Tcr	50	4- 2-64	4	148	--	B	C, L.
33acb	Winnie Burke	R	1974	1,640	252	6	30	X	Tcr	51	9-11-74	21	17	3	P	L.
34aab	Unknown	D	--	1,715	37	60	--	--	Tcr	21.8	11- 6-74	--	--	--	--	O.
35baa	Billy La Vinia	C	1964	1,798	110	6	44	X	Tcr	70	4-10-64	1	39	--	B	L.
T. 3 N., R. 35 E.																
3cdd	E. C. Gentry	C	1967	2,027	115	6	45	P, X	Qa, Tcr	19.8	6- 6-74	10	80	1	B	C, L.
4cbd	Johns, Smith & Beamer, Inc.	C	1966	2,068	1,103	16	27	X	Tcr	318	12-14-66	870	100	8	P	C, L.
7aaa	B. L. Davis Ranch, Inc.	C	1970	1,984	1,787	16	115	X	Tcr	298.3	5- 5-74	1,022	240	15	P	C, L.
12cdd	W. Meekins	C	1966	2,320	50	6	21	X	Tcr	7.5	6-18-74	18	5	1	P	C, L.

Table 13.--Records of selected wells and springs in the Umatilla Indian Reservation area--Continued

Well or spring number	Owner	Type of well	Year com- pleted	Alti- tude (feet)	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Aquifer	Water level: Feet below datum	Water level: Date	Well performance: Yield (gal/min)	Well performance: Draw- down (feet)	Well performance: Period (hr)	Well performance: Type of test	Remarks
							T. 3 N., R. 35 E.--Continued									
15bca	Mr. Adams	C	--	2,340	100	8	39	X	Tcr	20	1953	70	--	--	B	L. Well 15B1 in WSP.
18add	Frank Williams	C	1947	1,905	176	6	--	--	Tcr	F	1947	5	--	--	B	C, L. Well 18H1 in WSP.
19dbb	Barnett-Rugg, Inc.	C	1946	1,878	968	8	22	X	Tcr	275	9- -53	--	--	--	--	C, L. Well 19L1 in WSP.
20bbc	R. G. Bafus	D	--	1,971	47	36	--	X	Tcr	21.9	11- 6-74	--	--	--	--	O.
21dca	Barnett-Rugg, Inc.	R	1968	2,198	558	6	60	X	Tcr	254.8	12- 3-74	--	--	--	--	L, O.
28dbc	John Sheoship	R	1974	2,245	375	6	24	X	Tcr	49	12-11-74	8	99	5	P	L.
29adc	D. S. Hall	R	1966	2,290	65	6	21	X	Tcr	35	3-31-66	60	--	--	A	C, L.
32ddd	Pershing Sams	C	1964	1,600	74	6	60	X	Tcr	28	7-17-64	7	35	--	B	L.
35acc1	J. D. Simpson	C	1964	1,658	60	6	--	X	Tcr	--	--	--	--	--	--	C.
35acc2	Scott MacGregor	R	1971	1,680	92	8	27	X	Tcr	0	5-23-71	100	50	5	P	L.
35acc3	J. D. Simpson	R	1974	1,798	89	6	36	X	Tcr	11	11-15-74	25	3	2	P	L.
35adb	Jeff Heise	R	1970	1,685	80	4	72	X	Tcr	+5	1-12-70	20	--	--	F	L.
36aac	R. E. Smith	R	1970	1,735	100	4	90	X	Tcr	+6.5	10-10-74	20	--	--	F	L.
36bad	C. P. Black	D	--	1,710	12	48	--	0	Qa	9.7	10-10-74	--	--	--	--	
							T. 3 N., R. 36 E.									
29aac1	Mervin Duffy	R	1974	1,835	123	6	37	X	Tcr	12.3	10-10-74	30	24	1	P	L.
29aac2	Robert McBean	R	1974	1,835	100	6	42	X	Tcr	0	7-18-74	60	0	½	P	L.
29acb	Fred Gray	R	1974	1,823	92	6	40	X	Tcr	8.7	10-10-74	30	21	2½	P	L.
29cab	Ina Brouillard	R	1974	1,820	83	6	34	X	Tcr	12.8	10-10-74	20	12	1	P	L.
29cac	Clifford Picard	C	1964	1,820	88	6	43	X	Tcr	25	8- 4-64	10	--	--	B	C, L.
31abd	Walter Reed	R	1974	1,755	115	6	40	X	Tcr	0	8- 4-74	30	30	1	P	L.
31cbb(s)	D. Franklin	--	--	2,200	--	--	--	--	--	--	--	20	--	--	F	C.
32bcb	Louis Quaempts	R	1974	1,780	109	6	33	X	Tcr	F	11-25-74	80	0	2	P	L.

Table 13.--Records of selected wells and springs in the Umatilla Indian Reservation area--Continued

Well or spring number	Owner	Type of well	Year com- pleted	Alti- tude (feet)	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Aquifer	Water level: Feet below datum	Water level: Date	Well performance: Yield (gal/min)	Well performance: Draw- down (feet)	Well performance: Period (hr)	Well performance: Type of test	Remarks
T. 4 N., R. 34 E.																
35cdb	B. L. Davis Ranch, Inc.	C	1967	1,622	1,640	12	775	X	Tcr	19	10-12-67	1,259	468	36	P	L.
T. 4 N., R. 35 E.																
29cda	Henry Koepke	C	1940	1,790	486	8	--	--	Tcr	--	--	--	--	--	--	L. Well 29P1 in WSP.
30bdd	City of Athena	C, R	1970	1,884	746	8	520	X	Tcr	185	5-12-70	554	215	17	P	L.
T. 1 S., R. 32 E.																
1bbd	Verna Gilliland	R	1968	1,475	497	8	18	X	Tcr	6.8	7-30-74	100	102	--	A	L.
1cba	Frank Rice	C	1966	1,498	78	8	28	X	Tcr	16	8- 9-66	5	62	2	B	L.
1dca	A. M. Insko	R	1974	1,518	262	6	225	X	Tcr	+62	3- 4-75	125	72	72	P	L. Reported flow 80 gal/min.
1dcb	J. E. Sutherland	R	1974	1,520	548	8	20	X	Tcr	+12	11-25-74	250	560	4	P	L. Reported flow 5 gal/min.
T. 1 S., R. 33 E.																
1cda	Leslie Minthorn	R	1973	1,860	80	8	19	X	Tcr	17.6	11- 5-74	20	40	1½	A	C, L, O.
2dcb	Jesse Jones	R	1974	1,800	75	6	44	X	Tcr	6	8-16-74	30	1	1	P	L.
4cbb	Charles McKay	R	1974	1,665	103	6	50	X	Tcr	7	7-15-74	30	6	2½	P	L.
5aac(s)	Unknown	--	--	1,750	--	--	--	--	--	--	--	13	--	--	F	C.
5bdd1	Beatrice Duffy	R	1974	1,635	88	6	32	X	Tcr	2	9-21-74	16	0	3	P	L.
5bdd2	R. V. Stanhope	R	1974	1,640	140	8	22	X	Tcr	+28	11-21-74	350	168	2	A	L. Reported flow 75 gal/min.
6cac	Inez Reeves	R	1974	1,570	248	6	20	X	Tcr	+25	9-22-74	30	0	3	P	L.
6cbd	R. V. Stanhope	R	1971	1,558	330	8	20	X	Tcr	+86	8- 4-71	350	--	--	A	L. Reported flow 40 gal/min.
6ccb	Bernedette Nez	R	1974	1,535	211	6	20	X	Tcr	0	10-24-74	15	21	2	P	L.

Table 14.--Drillers' logs of selected wells in the Umatilla Indian Reservation area

1N/32E-1bba2. J. R. Hanna. Altitude 1,340 ft. Drilled by Troy Griffin, 1968. Casing: 6-in. diam to 110 ft

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Clay, dark-red	20	24
Clay, brown	36	60
Clay, brown, with gravel	30	90
Gravel	20	110
Rock, medium-brown, with seams of hard yellow clay	40	150

1N/32E-1cba. M. J. Kilby and R. F. Peterson. Altitude 1,380 ft. Drilled by Roy T. French, 1967. Casing: 8-in. diam to 211 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Clay, white	4	6
Gravel, medium-sized	10	16
Clay, red	41	57
Clay, brown	53	110
Sandstone, brown, water-bearing	22	132
Gravel, large-sized, water-bearing	123	255
Rock, red	5	260
Rock, brown, broken	72	332
Basalt, gray	10	342
Rock, black, with blue clay	18	360
Rock, brown, with yellow clay	10	370
Rock, brown, porous, water-bearing from 360-375 ft	5	375

1N/32E-1cbb. R. Knoebel. Altitude 1,414 ft. Drilled by Mr. Turner, 1954-55. Casing: 8-in. diam to 185 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Gravel	4	6
Clay, red	119	125
Gravel, water-bearing (8 gal/min)	10	135
Clay, blue, and gravel	50	185
Basalt, black, broken	110	295
Rock, red	10	305
Basalt, gray	75	380
Clay, blue, and gravel	10	390
Basalt, black	20	410
Basalt, gray	25	435
Rock, red	35	470
Basalt, black	15	485
Basalt, black, water-bearing at 501 ft	19	504

1N/32E-1cca. M. J. Kilby and R. F. Peterson. Altitude 1,380 ft. Drilled by Troy Griffin, 1974. Casing: 10-in. diam to 242 ft

Materials	Thickness (feet)	Depth (feet)
Soil	1	1
Gravel	2	3
Gravel and claystone	187	190
Rock, broken	46	236
Rock, light-brown	39	275
Rock, light-brown, broken	10	285

1N/32E-1daa. David Horne. Altitude 1,408 ft. Deepened by Troy Griffin, 1968. Casing: Unknown

Materials	Thickness (feet)	Depth (feet)
Original well	125	125
Clay	5	130
Gravel, coarse, with clay	40	170
Rock, brown, with clay	57	227
Rock, red	3	230
Rock, brown, broken, water-bearing	3	233

1N/32E-14ada. Ford Robertson. Altitude 1,370 ft. Drilled by Ben Dreyer Drilling Contractor, 1963. Casing: 8-in. diam to 188 ft; perforated

Materials	Thickness (feet)	Depth (feet)
Soil	20	20
Gravel	9	29
Gravel, cemented	159	188
Rock, black, hard	29	217
Rock, red, soft	11	228
Rock, black, soft, water-bearing	17	245
Rock, gray, hard	5	250

1N/33E-3ddd1. John Straughn. Altitude 1,833 ft. Drilled in 1930's; driller unknown. Casing: 10-in. diam to 20 ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Gravel and boulders	13	16
Basalt	105	121

1N/33E-3ddd2. John Straughn. Altitude 1,819 ft. Drilled by Project Corp., 1971. Casing: 10-in. diam to 26 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	4	4
Claystone, light-brown	3	7
Gravel, coarse	10	17
Basalt, brown	25	42
Basalt, black, medium-hard	73	115
Basalt, black, porous	5	120
Basalt, gray, hard	55	175
Basalt, black, softer	30	205
Basalt, gray	50	255

1N/33E-4acd. Art Motanic. Altitude 1,610 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 120 ft

Materials	Thickness (feet)	Depth (feet)
Silt, with cobbles	11	11
Rock, broken, soft	98	109
Basalt, hard	11	120
Basalt, medium-hard	63	183
Basalt, broken, soft	13	196
Basalt, medium-hard	14	210
Basalt, soft, with "soapstone"	5	215

1N/33E-4baa. Lawrence Patrick. Altitude 1,562 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 162 ft

Materials	Thickness (feet)	Depth (feet)
Silt	8	8
Gravel, cemented	56	64
Silt	34	98
Sand and gravel, cemented	64	162
Rock, cemented	8	170

1N/33E-4ddd. Nellie Charlie. Altitude 1,682 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 144 ft

Materials	Thickness (feet)	Depth (feet)
Silt	8	8
Sand, cemented, and gravel	66	74
Silt	5	79
Gravel, brown, cemented	41	120
Gravel, red	5	125
Sand and gravel, cemented	17	142
Gravel, tightly packed	53	195

1N/33E-7bdd. Marvin Cargill. Altitude 1,470 ft. Drilled by W. R. Ille & Co., 1959. Casing: 6-in. diam to 47 ft

Materials	Thickness (feet)	Depth (feet)
Silt	5	5
Sand and gravel, cemented	25	30
Clay	100	130
Basalt	70	200
Basalt, vesicular	7	207

1N/33E-10bcc. Harvey Grove. Altitude 1,765 ft. Drilled by Davis Drilling, 1969. Casing: 8-in. diam to 47 ft, 7-in. diam 40-97 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	5	5
Clay, brown, and gravel	2	7
"Hardpan," brown, and some large cobbles	28	35
Gravel, pea-sized, and sand and clay	60	95
Basalt, gray	75	170
Basalt, red and black, honeycombed	20	190
Basalt, black	32	222
Rock, red, honeycombed	23	245
Basalt, brown, fractured, and clay	20	265

Table 14.--Drillers' logs of selected wells in the Umatilla Indian Reservation area--Continued

Materials	Thickness (feet)	Depth (feet)
1N/33E-10ccc. Herbert Ghangraw. Altitude 1,819 ft. Drilled by D. K. Smith, 1958. Casing: 6-in. diam to 27-1/2 ft		
Soil	3	3
Gravel, cemented	14	17
Boulders	2	19
Gravel, cemented	13	32
Gravel, water-bearing	1	33
"Hardpan"	12	45
Gravel, cemented	45	90
Basalt, brown, water-bearing	6	96
1N/33E-11bbc. Mary Tias. Altitude 1,860 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 39-1/2 ft		
Soil	9	9
Basalt, broken	3	12
Basalt, solid	27	39
Basalt, black	114	153
Basalt	10	163
Crevice	1	164
Basalt, black	6	170
Basalt	22	192
Basalt, red and black	30	222
1N/33E-11dbb. John Storie. Altitude 1,990 ft. Drilled by Troy Griffin, 1968. Casing: 6-in. diam to 30 ft		
Soil	2	2
Gravel, with clay	18	20
Clay, yellow	3	23
Basalt	42	65
Rock, brown	5	70
Rock, red	10	80
Rock, gray	20	100
1N/33E-16ddc2. Wilbur Minthorn. Altitude 1,921 ft. Deepened by Haden Drilling Co., 1964. Casing: 6-in. diam to 24-1/2 ft		
Soil	12	12
Rock, brown	12	24
Rock, red	8	32
Rock, brown	2	34
Basalt, broken to dense, fairly hard	16	50
Basalt, black, hard, dense	175	225
Basalt, vesicular, water-bearing	18	243
1N/33E-28bbb. D. E. Windham. Altitude 1,850 ft. Drilled by Troy Griffin, 1974. Casing: 6-in. diam to 22 ft; unperforated		
Soil	4	4
Claystone	9	13
Rock, brown	151	164
Rock, dark-brown	9	173
Rock, brown, water-bearing	68	241
Basalt	39	280
Basalt, gray, hard	6	286
Rock, black, and blue claystone	14	300
1N/33E-28ddd. Raymond Burke. Altitude 2,055 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 41 ft		
Silt	10	10
Basalt, broken	19	29
Basalt, medium-hard	67	96
Basalt, hard	27	123
Basalt, medium-hard	33	156
Basalt, medium-hard, broken	30	186
"Soapstone," broken	5	191
1N/33E-29bdd. C. J. Gilbert. Altitude 1,800 ft. Drilled by Roy T. French, 1967. Casing: 6-in. diam to 80 ft		
Soil	3	3
Boulders, large-sized	7	10
Clay, red	5	15
Clay and boulders	60	75
1N/33E-29bdd.--Continued		
Basalt, gray	14	89
Rock, red, soft	21	110
Basalt, gray	37	147
Rock, brown	13	160
Basalt, black	55	215
Rock, red	20	235
Basalt, gray	30	265
Rock, brown, porous	14	279
Basalt, black	56	335
Rock, red and brown	20	355
Basalt, black	11	366
Basalt, black, porous	22	388
Basalt, gray	21	409
Basalt, black, and shale seams	25	434
1N/33E-29dba. Raymond Eagle. Altitude 1,855 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 29 ft		
Silt	5	5
Basalt, broken	10	15
Basalt, medium-hard	15	30
Basalt, hard	157	187
Basalt, medium-hard, with "soapstone"	56	243
Basalt, medium-hard	64	307
Basalt, broken, with "soapstone"	6	313
1N/33E-33abb. Jeanette Jones. Altitude 2,000 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 40 ft		
Silt and cobbles	25	25
Basalt, broken	6	31
Rock, medium-hard	10	41
Rock, medium-hard, with broken seams	159	200
Rock, with "soapstone" seams, soft	8	208
Basalt, broken	24	232
1N/34E-1baa. Oregon State Highway Department. Altitude 3,580 ft. Casing: 8-in. diam to 69 ft, 6-in. diam to 695 ft; perforated 288-303 ft		
Soil, brown	1	1
Basalt, gray, broken	15	16
Cinders, brown	10	26
Basalt, gray, medium-hard, broken	128	154
Basalt, gray, medium-hard	50	204
Basalt, gray, broken, with sandy clay seams	30	234
Basalt, with some water	18	252
Basalt, gray, medium-hard, broken	36	288
Basalt, water-bearing (10 gal/min)	16	304
Basalt, gray, broken	14	318
Basalt, gray, medium-hard	50	368
Cinders, broken	8	376
Basalt, gray, medium-hard, broken	42	418
Cinders, brown	6	424
Basalt, gray, hard	54	478
Basalt, gray, medium-hard, broken	30	508
Basalt, gray, broken, with "soapstone"	52	560
Basalt, gray, broken	24	584
Clay, sandy	8	592
Basalt, with sand and gravel interbeds	103	695

Table 14.--Drillers' logs of selected wells in the Umatilla Indian Reservation area--Continued

1N/34E-1dad. A. R. Winn. Altitude 3,600 ft. Drilled by Davis Drilling, 1971. Casing: 6-in. diam to 26 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	4	4
Soil and rocks, brown	3	7
Basalt, fractured	5	12
Basalt, gray, hard	25	37
Rock, decomposed, red and brown	2	39
Basalt, brown, medium-hard	7	46
Rock, brown, and light-tan clay	7	53
Basalt, brown, hard	4	57
Rock, red and brown, and clay	9	66
Basalt, gray, medium-hard	25	91
Rock, brown, fractured, and clay	37	128
Rock, gray and brown	11	139
Rock, black and brown, honeycombed	14	153
Rock, red and black, honeycombed	8	161
Rock, black, and clay	6	167
Basalt, gray, medium-hard	20	187
Basalt, red and black, honeycombed	32	219
Basalt, gray, medium-hard	42	261

1N/34E-1dbd. Mrs. Beryl Grilley. Altitude 3,520 ft. Drilled by Troy Griffin. Casing: 6-in. diam to 22 ft

Materials	Thickness (feet)	Depth (feet)
Soil	1	1
Rock, brown, and claystone	14	15
Basalt, gray, medium-hard	55	70
Rock, red	22	92
Basalt	39	131
Rock, light-brown	43	174
Basalt, medium-hard	56	230
Rock, light brown	22	252
Basalt, hard	11	263
Rock, black, medium-hard	20	283

1N/34E-3cbc. Barney Olsen. Altitude 3,575 ft. Drilled by Troy Griffin, 1972. Casing: 6-in. diam to 21 ft

Materials	Thickness (feet)	Depth (feet)
Soil	1	1
Rock, brown, broken	14	15
Basalt	68	83
Rock, dark-brown, and green claystone	8	91
Rock, medium-hard, black	32	123
Rock, medium-hard, and black and blue claystone	20	143

1N/34E-3cca. L. Boltz. Altitude 3,575 ft. Drilled by Rudd W. Davis, 1969. Casing: 6-in. diam to 22 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Basalt, gray, broken	12	14
Basalt, gray	20	34
Basalt, honeycombed	2	36
Basalt, gray, broken	14	50
Basalt, black, honeycombed	7	57
Basalt, gray	9	66
Basalt, brown and gray, broken	16	82
Basalt, brown, honeycombed, water-bearing	18	100
Basalt, gray, broken	28	128
Basalt, red and black, honeycombed, water-bearing	14	142
Basalt, brown and gray	28	170
Basalt, red and black, honeycombed, and green clay, water-bearing	10	180
Basalt, gray, broken	14	194
Basalt, gray	81	275
Basalt, gray, broken	18	293
Basalt, black, honeycombed	15	308
Basalt, gray	27	335
Basalt, black and red, honeycombed, and green clay	9	344
Basalt, gray	16	360

1N/34E-5cbd. M. Wilson. Altitude 3,210 ft. Drilled by Larry Burd Well Drilling, 1974. Casing: 6-in. diam to 20 ft

Materials	Thickness (feet)	Depth (feet)
Soil	1	1
Basalt, black and brown	74	75
Basalt, purple, black, and gray	160	235

1N/34E-5cbc.--Continued

Materials	Thickness (feet)	Depth (feet)
Basalt, brown	23	258
Basalt, red, water-bearing	5	263
Basalt, gray, red, and black	137	400

1N/34E-7bad. Orval McCormack. Altitude 3,220 ft. Drilled to 110 ft by D. K. Smith, 1965; deepened by Roy T. French, 1967. Casing: 6-in. diam to 110 ft

Materials	Thickness (feet)	Depth (feet)
Soil, clay, and broken rock	3	3
Rock, broken, and hard clay	19	22
Rock, broken	10	32
Basalt, brown and black	68	100
Basalt, gray	10	110
Rock, gray	10	120
Rock, gray, decomposed	4	124
Rock, gray	52	176
Rock, brown, porous	18	194
Rock, gray	12	206
Clay, brown	6	212
Rock, gray, porous, water-bearing	15	227
Rock, gray, with clay seams	37	264
Rock, gray	8	272
Rock, red, porous	10	282
Rock, gray	143	425
Rock, gray, with clay seams	102	527
Rock, gray, broken	118	645
Rock, gray	55	700
Rock, gray and red, porous	90	790
Rock, brown	12	802
Rock, gray, porous	48	850

1N/34E-8acc. Oregon State Highway. Altitude 3,355 ft. Drilled by D. K. Smith, 1965. Casing: 6-in. diam to 187 ft

Materials	Thickness (feet)	Depth (feet)
Clay, brown	14	14
Soil, clay, and some rock	21	35
Rock, broken, and clay, brown	14	49
Clay, brown	3	52
Rock, broken, and clay	10	62
Clay, brown	8	70
Basalt, black, broken	6	76
Basalt, gray and black	59	135
Basalt, black, broken, water-bearing	5	140
Basalt, black	10	150
Basalt, black, broken, and sticky brown clay	20	170
Clay, hard, dry, caving	17	187
Basalt, gray	95	282
Rock, reddish-brown	18	300
Basalt, brown, gray, and black	115	415
Basalt, black, broken, water-bearing	7	422
Basalt, gray	3	425

1N/34E-9bca. Ralph Barr. Altitude 3,285 ft. Drilled by Larry Burd Well Drilling, 1974. Casing: 6-in. diam to 179 ft; perforated 159-177 ft

Materials	Thickness (feet)	Depth (feet)
Clay	28	28
Basalt, red	17	45
Basalt, brown	24	69
Basalt, black	44	113
Basalt, gray and brown	127	240
Basalt, red, with sandstone	12	252

1N/34E-10bdd. W. A. Stewart. Altitude 3,340 ft. Drilled by Larry Burd Well Drilling, 1974. Casing: 6-in. diam to 20 ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Basalt, black, gray, brown, and red	424	427

Table 14.--Drillers' logs of selected wells in the Umatilla Indian Reservation area--Continued

Materials	Thickness (feet)	Depth (feet)
1N/34E-16bcd. A. P. Brunette. Altitude 3,293 ft. Drilled by Larry Burd Well Drilling, 1974. Casing: 6-in. diam to 20 ft		
Soil and clay	4	4
Rock, broken	7	11
Basalt, gray, brown, and black	216	227
Basalt, black, with sandstone	2	229
Basalt, gray, with vesicles	9	238
Basalt, gray	7	245
Basalt, gray, hard	35	280
1N/34E-17acb2. E. Roberts. Altitude 3,358 ft. Drilled by Project Corp., 1971. Casing: 6-in. diam to 21 ft		
Soil, brown	8	8
Basalt, brown	8	16
Basalt, gray	49	65
Basalt, brown, with white and green clay, water-bearing	45	110
Basalt, green, with streaks of brown and yellow clay	30	140
Basalt, gray	15	155
Basalt, brown, with blue and white clay	15	170
Basalt, gray and grayish-brown	35	205
Basalt, with brown and green clay	22	227
Basalt, gray-brown and gray, broken	10	237
Basalt, gray, hard	13	250
Basalt, gray, broken	10	260
Basalt, grayish-brown	20	280
1N/34E-17bdb. John Knight. Altitude 3,405 ft. Drilled by Project Corp., 1971. Casing: 6-in. diam to 21 ft		
Soil, brown	5	5
Basalt, gray, hard	35	40
Basalt, black, soft	30	70
Basalt, black and gray, hard	55	125
Basalt, porous, with clay	23	148
Basalt, gray, porous	27	175
Basalt, gray, hard	10	185
Basalt, porous, brown	5	190
Basalt, gray, hard	10	200
Basalt, brown, broken	35	235
Basalt, black, hard	13	248
Basalt, gray, hard	55	303
Basalt, brown and black, porous	17	320
1N/34E-17bdd. Mr. Hale. Altitude 3,420 ft. Drilled by Project Corp., 1970. Casing: 6-in. diam to 21 ft		
Soil, brown, sandy	6	6
Basalt, brown and black	69	75
Basalt, brown, soft	5	80
Basalt, gray	10	90
Basalt, brown, soft	3	93
Basalt, gray, brown, red, and black	182	275
Basalt, brown, soft, porous	15	290
Basalt, gray	10	300
1N/35E-4ccb. Mike Hillis. Altitude 3,765 ft. Drilled by Larry Burd Well Drilling, 1974. Casing: 6-in. diam to 18 ft		
Soil	2	2
Basalt, gray, black, red, and green	403	405
Basalt, red, with white sandstone	5	410
Basalt, brown and gray	40	450
1N/35E-5dad. Mr. Holt, Altitude 3,800 ft. Drilled by D. K. Smith, 1957. Casing: 8-in. diam to 33 ft		
Soil and small broken rock	4	4
Clay, brown and red, and broken rock	28	32
Basalt, gray, brown, and black	150	182
Basalt, brown; very little water	40	222
Basalt, black and gray	98	320
1N/35E-6abc. Cynthia Nordyke. Altitude 3,590 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 27 ft		
Basalt, brown, fractured	3	3
Basalt, gray, hard	9	12
Basalt, gray-brown	28	40
Basalt, gray, hard	10	50
Basalt, red	25	75
Basalt, gray, medium-hard	65	140
Claystone, yellow	50	190
Basalt, gray, medium-hard	51	241
Claystone, red	59	300
1N/35E-6add2. Albert Lavadour. Altitude 3,635 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 19 ft		
Soil	5	5
Soil and rock	4	9
Basalt	10	19
Basalt, brown and red	56	75
Clay, brown	4	79
Basalt	11	90
Basalt, red, and tan clay, water-bearing	3	93
Basalt	30	123
Basalt, with clay	160	283
1N/35E-8abb. Camp Fire Girls Inc. Altitude 3,755 ft. Drilled by Troy Griffin, 1970. Casing: 6-in. diam to 68 ft		
Soil	1	1
Claystone, red and brown	39	40
Rock, brown, medium-hard	8	48
Claystone, red, and rock	3	51
Rock, brown	80	131
Rock, brown, soft	29	160
Basalt, medium-hard	178	338
Rock, red and black	77	415
Basalt	6	421
1N/35E-9bbb. Henry Pederson. Altitude 3,700 ft. Drilled by Larry Burd Well Drilling, 1974. Casing: 6-in. diam to 18 ft		
Basalt, broken	4	4
Basalt, gray, hard	52	56
Basalt, red, soft	14	70
Basalt, gray, hard	15	85
Basalt, red, soft	5	90
Basalt, black, soft, water-bearing (2 gal/min)	76	166
Basalt, black, hard	11	177
Basalt, black, soft	52	229
Basalt, black, with "soapstone"	3	232
Basalt, black, red, and brown, soft	147	379
Basalt, gray, hard	6	385
Basalt, brown, with "soapstone"	33	418
Basalt, black, hard	7	425
1N/35E-9bbc. H. H. Pederson. Altitude 3,730 ft. Drilled to 302 ft by Roy T. French, 1967; deepened to 705 ft by Troy Griffin, 1972. Casing: 6-in. diam to 20 ft		
Rock, broken	14	14
Rock, brown and gray	14	28
Rock, brown, porous	5	33
Rock, gray	38	71
Rock, red, with green shale	13	84
Rock, brown, with clay seams	14	98
Rock, red, porous	12	110
Rock, brown and black	29	139
Rock, brown, porous	13	152
Rock, gray	127	279
Rock, black, porous, with green shale	15	294
Rock, gray	8	302
No information	148	450
Rock, dark-brown	45	495
Basalt, black	183	678
Rock, brown, soft	12	690
Basalt	15	705

Materials	Thickness (feet)	Depth (feet)
1N/35E-16bbb. Joseph Angotti. Altitude 3,740 ft. Originally drilled by Roy T. French, 1966; deepened by Project Corp., 1970. Casing: 6-in. diam to 20 ft		
Soil	4	4
Basalt, broken	10	14
Basalt, black, hard	42	56
Rock, soft, porous	11	67
Basalt, gray, hard	43	110
Basalt, red, with blue clay	5	115
Basalt, gray, medium-hard	10	125
Basalt, brown, soft	5	130
Basalt, gray, medium-hard	85	215
2N/32E-1cdc. Hugh Whitbread. Altitude 1,105 ft. Drilled by D. K. Smith, 1954. Casing: 8-in diam to 22 ft		
Soil	3	3
Gravel	11	14
Rock, brown, broken	7	21
Basalt, gray and black, hard	124	145
Clay, blue	7	152
Shale, black, cemented, caving	12	164
Basalt, gray and black	118	282
Basalt, red	5	287
Basalt, brown and gray	113	400
Basalt, brown, soft	10	410
Basalt, black, broken	60	470
Basalt, gray	32	502
Basalt, black, broken, water-bearing	73	575
2N/32E-2ccd. City of Pendleton. Altitude 1,065 ft. Drilled by Midland Drilling Co., 1958. Casing: 30-in. diam to 10 ft; 24-in. diam to 186 ft		
Soil, black, soft	1	1
Boulders, black, hard	3	4
Boulders, gray, medium-hard	6	10
Basalt, dark-colored, hard	43	53
Clay, brown, soft	13	66
Clay and broken basalt	2	68
Basalt, dark-colored, broken, medium-hard	48	116
Basalt, dark-colored, hard	15	131
Clay, red and green, soft	3	134
Basalt, black, medium-hard	20	154
Clay, black, soft, and broken rock	4	158
Rock, dark-colored, broken medium-hard	19	177
Basalt, dark-colored, hard	18	195
Basalt, dark-colored, broken medium-hard	15	210
Basalt, dark-colored, medium-hard to hard	90	300
Cinders, brown, soft	10	310
Basalt, brown, medium-hard to hard	135	445
Basalt, brown, broken, soft	8	453
Basalt, brown to dark-colored, medium-hard to hard	104	557
Basalt, dark-colored, medium-hard	143	700
2N/32E-2ddd. City of Pendleton. Altitude 1,095 ft. Drilled by A. A. Durand & Son, 1945-48. Casing: 30-in. diam to 21½ ft; 20-in. diam to 148 ft, 12-in diam liner from 295-620 ft		
Gravel	14	14
Basalt, black, soft	11	25
Basalt, black, hard	48	73
Basalt and "soapstone," soft	12	85
Basalt, black, hard	24	109
Basalt, soft to medium-hard	32	141
Basalt, hard	18	159
Basalt, black, soft, water-bearing at 180 ft	32	191
Basalt, hard	5	196
Basalt, black, soft	14	210
Rock, red, soft	7	217
Rock, soft	10	227
Rock, black, medium-hard	48	275
Basalt, gray, hard	62	337
Basalt, black, medium-hard	6	343
Basalt, gray	12	355
Rock, red, soft, broken	30	385
Basalt, gray, hard	51	436
Basalt, black, soft, water-bearing	24	460
Basalt, black, hard	3	463
Basalt, black, soft	11	474
Basalt, gray, hard	8	482
2N/32E-2ddd.--Continued		
Basalt, black, medium-hard to hard	208	690
Basalt, black, medium-hard, water-bearing	43	733
Basalt, gray, hard	4	737
Basalt, black	24	761
Basalt, gray, hard	22	783
Basalt, brown, red, and gray, soft, water-bearing	11	794
Basalt, gray, hard	17	811
Basalt, brown and black	20	831
Rock, gray, hard	20	851
Basalt, black and gray	55	906
Rock, black, porous, water-bearing	16	922
Basalt, black	23	945
2N/32E-9abd. Oregon State Hospital. Altitude 1,050 ft. Drilled by R. J. Strasser Drilling Co., 1954. Casing: 16-in. diam to 56 ft		
Soil	4	4
Clay and boulders	5	9
Clay and sand	9	18
Clay and gravel	6	24
Basalt, brown and gray	32	56
Basalt, gray and red	23	79
Basalt, gray, broken	2	81
Basalt, gray	7	88
Basalt, broken, with green clay	3	91
Basalt, gray and red	143	234
Clay, brown, sticky	4	238
Basalt, gray	9	247
Basalt, gray, broken	10	257
Basalt, brown, honeycombed	17	274
Basalt, gray	36	310
Basalt, gray, creviced	3	313
Basalt, gray	24	337
Basalt, gray and brown, porous, water-bearing at 350 ft	24	361
Basalt, gray	18	379
Basalt, gray and red, porous	28	407
Basalt, gray, creviced 413-415 ft	56	463
Basalt, gray, broken	8	471
Basalt, gray, creviced	45	516
Basalt 516-519 ft and 553-554 ft	164	680
Basalt, brown, porous	11	691
Basalt, gray	160	851
2N/32E-10bda. City of Pendleton. Altitude 1,054 ft. Drilled in 1949; driller unknown. Casing: 16-in. diam to 80½ ft; perforated 12-in. diam liner 681-761 ft		
Gravel and rock	17	17
Basalt, black, creviced 70-77 ft, 259-316 ft, 363-370 ft, 428 ft, 615 ft, 650 ft, and 668 ft	697	714
Basalt, red	14	728
Basalt, black	33	761

2N/32E-10ccd. City of Pendleton. Altitude 1,070 ft. Drilled by Durand, 1952. Casing: 16-in. diam to 81 ft.

Materials	Thickness (feet)	Depth (feet)
Rock, brown, and clay	4	4
Basalt, broken	2	6
Basalt, brown, medium-hard, broken	24	30
Basalt, black, hard	2	32
Rock, broken	12	44
Rock, yellow, broken	6	50
Rock, broken	3	53
Basalt, hard	3	56
Basalt, gray, hard	8	64
Basalt, brown and red, broken, medium-hard, and mud	11	75
Shells, medium-hard, and brown mud	6	81
Rock, brown, broken, medium-hard to hard	7	88
Rock, gray and brown, hard	9	97
Rock, brown, broken, with some mud	3	100
Rock, gray, hard	2	102
Rock, black, broken, with gray mud	7	109
Rock, gray, hard	14	123
Basalt, gray and black, medium-hard to hard	12	135
Rock, red, broken, with soft mud	3	138
Rock, brown, medium-hard, and mud	6	144
Basalt, brown and gray, hard	20	164
Rock, brown and red, broken, with some soft mud	4	168
Rock, brown, hard	5	173
Basalt, gray, medium-hard to hard	57	230
Rock, brown, broken, and mud	10	240
Rock, brown, broken	14	254
Basalt, black and gray, medium-hard to hard	51	305
Rock, broken, and some mud	15	320
Basalt, gray and black, medium-hard to hard	15	335
Rock, red, medium-hard	4	339
Basalt, black, medium-hard	13	352
Rock, red	2	354
Basalt, black and gray, hard	30	384
Basalt, brown, black, and gray, broken 384-400 ft	92	476
Rock, brown, broken, and some clay	7	483
Basalt, black, medium-hard to hard, broken 585-590 ft	107	590
Rock, red, broken, soft	2	592
Basalt, brown and green, medium-hard to hard	11	603
Basalt, green and black, medium-hard to hard, broken 603-615 ft	60	663
Rock, red, broken, with brown clay	2	665
Rock, broken, with brown mud	6	671
Basalt, black, brown, and green, medium-hard to very hard; broken 743-759 ft	337	1,008

2N/32E-16bab. City of Pendleton. Altitude 1,070 ft. Drilled by R. J. Strasser Drilling Co., 1965. Casing: 24-in. diam to 91 ft, 20-in. diam to 390 ft

Materials	Thickness (feet)	Depth (feet)
Boulders and soil	13	13
Basalt, black and gray	30	43
Basalt, broken, and clay	4	47
Basalt, red, little water	35	82
Basalt, gray, hard	61	143
Basalt, red and yellow, with "soapstone"	22	165
Basalt, black and brown, hard	61	226
Basalt, red, with "soapstone"	26	252
Basalt, brown, black, and gray, hard	38	290
Basalt, porous, broken, with clay	33	323
Basalt, brown, porous, with "soapstone"	44	367
Basalt, black, broken	4	371
Basalt, red, hard	7	378
Clay, yellow	3	381
Basalt, black and gray, hard	254	635
Basalt, red, broken	7	642
Basalt, black and gray, hard	209	851
Basalt, brown and black, porous	12	863
Basalt, gray, hard	9	872
Basalt, reddish-gray	11	883
Basalt, black, gray, and brown	259	1,142
Basalt, brown and red, porous, and clay	51	1,193
Basalt, gray, brown, and black, hard	211	1,404
Basalt, red and black	9	1,413
Basalt, gray and brown, hard	88	1,501

2N/32E-36dac. D. W. McCoy. Altitude 1,350 ft. Drilled by Troy Griffin, 1968. Casing: 6-in. diam to 37 ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Clay	9	12
Rock, black	45	57
Basalt	73	130
Rock, brown	35	165
Basalt	5	170
Rock, red	5	175
Rock, black	37	212
Rock, gray	18	230
Rock, red	10	240
Rock, black	6	246
Rock, red	14	260

2N/33E-2cbdl. Jerry Mills. Altitude 1,258 ft. Drilled by Rudd W. Davis, 1970. Casing: 6-in. diam to 23 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	5	5
Soil, light-brown, sandy	6	11
Rock, red and black, medium-hard	12	23
Basalt, gray, hard	35	58
Rock, black, honeycombed	50	108
Basalt, gray, hard	12	120
Rock, black, honeycombed	10	130
Rock, reddish-gray, hard	14	144
Rock, red, medium-hard	2	146
Rock, brown, medium-hard, and blue clay	21	167
Rock, red, medium-hard	6	173
Rock, black, porous	11	184
Basalt, brown, medium-hard	26	210
Basalt, gray, hard	28	238
Basalt, brown, medium-hard	3	241
Basalt, gray, hard	59	300
Basalt, black and red, honeycombed	21	321
Rock, blue, porous, water-bearing	25	346

2N/33E-2daal. C. I. Thompson. Altitude 1,305 ft. Drilled by Troy Griffin, 1969. Casing: 6-in. diam to 88 ft

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Claystone, yellow	24	28
Rock, black, soft, with claystone	7	35
Claystone, yellow	11	46
Claystone, dark-red	37	83
Rock, dark-red	9	92
Rock, black, red, and brown	73	165
Basalt	30	195

2N/33E-2dbd2. Ellen Cowapoo. Altitude 1,287 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 50 ft

Materials	Thickness (feet)	Depth (feet)
Silt	18	18
Cobbles and broken rock	7	25
Basalt, broken	2	27
Basalt, hard	23	50
Basalt, broken, water-bearing	27	77
Basalt, medium-hard	71	148
Basalt, gray, hard	22	170

2N/33E-2ddc. Kenneth Bill. Altitude 1,270 ft. Drilled by Haden Drilling Co., 1963. Casing: 6-in. diam to 36 ft

Materials	Thickness (feet)	Depth (feet)
Silt	11	11
Basalt, broken	24	35
Basalt, reddish-color, hard	20	55
Basalt, broken, with hard layers 3-7 ft thick	69	124

Materials	Thickness (feet)	Depth (feet)
2N/33E-3cac2. Dan Broncheau. Altitude 1,221 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 60 ft		
Sand and gravel, gray	9	9
Sand, gravel, and boulders	8	17
Basalt, black, fractured	31	48
Basalt, black, hard	12	60
Basalt, black, hard, water-bearing	18	78
Basalt, black with claystone beds	12	90
Basalt, black	75	165
2N/33E-3cad. Esther Johnson. Altitude 1,226 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 71 ft		
Soil and cobbles, brown, sandy	6	6
Gravel, sand, and cobbles, brown	4	10
Boulders and cobbles	3	13
Basalt, gray, fractured, and gray clay	12	25
Basalt, black, vesicular	36	61
Basalt, black, hard	15	76
Basalt, black, fractured, water-bearing (60 gal/min)	7	83
2N/33E-3cbb. J. L. Haguewood. Altitude 1,422 ft. Drilled by Troy Griffin, 1971. Casing: 6-in. diam to 66 ft		
Soil	1	1
Boulders, cemented	9	10
Rock, brown, and claystone	18	28
Rock, brown	25	53
Rock, brown, and claystone	4	57
Rock, red	26	83
Rock, dark-brown	19	102
Basalt	5	107
Rock, brown	16	123
Rock, black, medium-hard	87	210
Rock, black, and blue claystone	15	225
Basalt	95	320
Rock, black, medium-hard	13	333
Basalt	118	451
2N/33E-3cbd. W. J. Wilkinson. Altitude 1,222 ft. Drilled by Roy T. French, 1968. Casing: 6-in. diam to 22 ft		
Soil	3	3
Gravel	12	15
Basalt, gray	35	50
Basalt, black, fractured, and shale	15	65
Basalt, black	25	90
Rock, brown	35	125
2N/33E-3cca. Jean Walker. Altitude 1,221 ft. Drilled by Larry Burd Well Drilling, 1974. Casing: 8-in diam to 26 ft		
Gravel	12	12
Clay	8	20
Basalt, black, medium-hard	54	74
Basalt, black, soft, water-bearing	28	102
Basalt, black, hard	6	108
Basalt, gray, hard	97	205
2N 33E-3cda. Harvey and Thelma Jim. Altitude 1,225 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 55 ft		
Soil, brown	1	1
Gravel, cobbles, and sand	4	5
Basalt, black, weathered	8	13
Basalt, black, hard	3	16
Basalt, black, soft	9	25
Basalt, black, fractured	13	38
Basalt, black, water-bearing	4	42
Basalt, black, hard	23	65
Basalt, black, medium-hard	15	80
2N/33E-3dad. Nadine Van Mechlen. Altitude 1,249 ft. Drilled by Wallace Well Drilling, 1974. Casing: 6-in diam to 20 ft		
Silt, with cobbles	9	9
Basalt, gray, hard	39	48
Basalt, gray, soft	16	64
Basalt, gray, hard	78	142
Basalt, red and gray, soft, water-bearing	18	160
Basalt, medium-hard, layers	31	191
2N/33E-4cad. Joseph Johnson. Altitude 1,203 ft. Drilled by D. K. Smith, 1958. Casing: 6-in. diam to 13 ft		
Soil	4	4
Mud, black	2	6
"Hardpan," brown	6	12
Basalt, brown, water-bearing below 87 ft	80	92
2N/33E-4cbd. H. M. Hart. Altitude 1,190 ft. Drilled by B & B Drilling Co., 1970. Casing: 8-in diam to 64½ ft		
Soil, and hard silt, partially cemented	13	13
Sand, silty, and 6-in. diam gravel	20	33
Clay, brown, hard, with some pea-sized gravel	14	47
Clay, blue, hard, with some pea-sized gravel	8	55
Clay, blue, hard	8	63
Basalt, brownish-black	15	78
Basalt, grayish-black, slightly fractured	66	144
Rock, brown, medium-hard, with blue clay beds	53	197
Rock, gray, hard, with thin layers of blue soft rock	34	231
Rock, reddish-purple medium-hard	12	243
Basalt, black, vesicular	5	248
Rock, reddish-purple	3	251
Basalt, black, hard, dense	1	252
2N/33E-4dda2. Mrs. W. A. Wilson. Altitude 1,215 ft. Drilled by Troy Griffin, 1967. Casing: 6-in. diam to 20 ft		
Soil	3	3
Clay, with gravel	10	13
Basalt	187	200
Rock, brown	10	210
Shale, blue	1	211
Rock, black, medium-hard	14	225
Rock, black, hard	50	275
Rock, brown, with shale	35	310
Rock, black	35	345
Rock, brown, hard	8	353
Shale, green	1	354
Basalt	56	410
2N/33E-5bcb. E. M. Clark. Altitude 1,372 ft. Drilled by Allison Drilling Co., 1965. Casing: 8-in. diam to 33 ft		
Soil, sandy	5	5
Rock, black, soft	75	80
Rock, black, hard	17	97
Rock, brown	25	122
2N/33E-6bac. Steve Caldwell. Altitude 1,148 ft. Drilled by Troy Griffin, 1973. Casing: 6-in. diam to 21 ft		
Soil	10	10
Rock, brown, broken	4	14
Rock, brown, hard	32	46
Rock, black	94	140
Rock, dark-brown	27	167
Rock, black, medium-hard	28	195
Basalt	67	262
Rock, black, medium-hard	23	285
Basalt	13	298
Basalt, gray, hard	28	326
Rock, brown, water-bearing	22	348

Materials	Thickness (feet)	Depth (feet)
2N/33E-6bad. A. B. Caldwell. Altitude 1,150 ft. Drilled by Allison Drilling Co., 1964. Casing: 8-in. diam to 25 ft		
Soil, sandy	4	4
Silt	14	18
Rock, red	10	28
Rock, black	22	50
Rock, gray	50	100
Rock, black	12	112
Rock, red	18	130
Rock, black, water-bearing 125-232 ft	102	232
2N/33E-6bbd. C. P. Hyke. Altitude 1,145 ft. Drilled by Roy T. French, 1967. Casing: 6-in. diam to 26 ft		
Soil	2	2
Rock, broken	12	14
Rock, gray	16	30
Rock, brown	26	56
Rock, gray	36	92
Rock, brown, with clay seams	65	157
Rock, gray	90	247
Rock, red	8	255
Rock, brown	60	315
Rock, gray	52	367
Rock, gray, porous	11	378
Rock, red, porous	8	386
Rock, gray, porous	12	398
Rock, gray	2	400
2N/33E-7abd. David McKay. Altitude 1,143 ft. Drilled by Haden Drilling Co., 1963. Casing: 6-in diam to 18 ft		
Soil and gravel	14	14
Basalt, red, decomposed	4	18
Basalt, black	36	54
2N/33E-7ada3. Eva Watchman. Altitude 1,163 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 70 ft		
Silt	11	11
Basalt, hard	22	33
Basalt, broken	6	39
Basalt, hard	15	54
Basalt, broken, with "soapstone"	2	56
Basalt, hard	14	70
Basalt, dark-gray, hard	65	135
Basalt, red, broken	25	160
Basalt, hard	72	232
Rock, soft, with "soapstone" seams	8	240
Basalt, hard	78	318
Basalt, broken, with "soapstone"	16	334
2N/33E-7add1. Leon Abell. Altitude 1,195 ft. Originally drilled to 96 ft by Gary Grieb, 1970; deepened by Larry Burd Well Drilling, 1973. Casing: 6-in. diam to 30 ft		
Soil	3	3
Clay, brown and yellow	20	23
Basalt, black	47	70
Rock, red	7	77
Basalt, black	9	86
Basalt, black, broken	10	96
Basalt, hard	27	123
Basalt, soft	5	128
Basalt, water-bearing	41	169
"Soapstone," red and blue, water-bearing	16	185
Basalt, black, water-bearing	175	360
Basalt, black and red, water-bearing	11	371
Basalt, red	10	381
Basalt, brown and black	19	400
Basalt, black	30	430
Basalt, red, with blue "soapstone"	15	445
Basalt, red and black, with blue "soapstone"; water-bearing	12	457
2N/33E-7baa2. L. Spiess. Altitude 1,138 ft. Drilled by Roy T. French, 1956. Casing: 10-in. diam to 60 ft		
Soil	4	4
Gravel	14	18
Basalt, black	22	40
Sand, black	3	43
Basalt, gray	42	85
Basalt	12	97
Ash, black and red	31	128
Basalt, gray	19	147
Rock, red	13	160
Rock, black	20	180
Basalt, gray	60	240
Ash, black and red	40	280
Basalt, gray	22	302
Basalt, black	28	330
Basalt, gray	35	365
Basalt, red and black	15	380
Basalt, gray	85	465
Basalt, red	35	500
2N/33E-7baa3. Lowell Spiess. Altitude 1,139 ft. Drilled by Troy Griffin, 1970. Casing: 6-in. diam to 19 ft		
Gravel and boulders	13	13
Basalt	55	68
Rock, brown	12	80
Rock, black	6	86
Rock, black, with blue claystone; water-bearing 112 to 118 ft	34	120
2N/33E-7bcc1. W. P. Hall. Altitude 1,128 ft. Drilled by Troy Griffin, 1968. Casing: 6-in. diam to 40 ft		
Soil	2	2
Gravel	8	10
Rock, black	25	35
Rock, brown	5	40
Basalt	47	87
Rock, black	68	155
Basalt	26	181
Rock, brown	10	191
Rock, dark-brown	20	211
Rock, black, with blue shale	44	255
Clay, brown	13	268
Rock, brown	2	270
Rock, red, medium-hard	7	277
Rock, brown, soft	11	288
Rock, black, with blue shale	7	295
Basalt	17	312
Rock, red, medium-hard	18	330
Basalt	70	400
2N/33E-7bcd. Delamarter Nursing Home. Altitude 1,152 ft. Drilled by Ben Dreyer, 1957. Casing: 8-in. diam to 21 ft		
Clay, red	16	16
Rock, red, soft	16	32
Rock, gray and black, hard	26	58
Rock, red, soft	18	76
Rock, gray and black, hard	45	121
Rock, black, soft	38	159
Rock, gray, moderately hard	12	171
Rock, green, hard	22	193
Boulders, green	16	209
Shale, red, soft	15	224
Rock, gray	39	263
Shale, red, soft	9	272
Rock, gray and brown, soft, water-bearing	32	304
Rock, black, hard	6	310

Materials	Thickness (feet)	Depth (feet)
2N/33E-8aac. Marvin Berland. Altitude 1,168 ft. Drilled by Troy Griffin, 1973. Casing: 6-in. diam to 21 ft		
Soil	1	1
Gravel and rock	8	9
Rock, broken	6	15
Rock and mud, black	10	25
Basalt, black	30	55
Basalt, gray, hard	70	125
Rock, light-brown, water-bearing	6	131
Rock, red, and green claystone, water-bearing	12	143
2N/33E-8abd. Bob Williams. Altitude 1,165 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 44 ft		
Soil	6	6
Gravel, small-sized, and large boulder	8	14
Basalt, black, hard	2	16
Basalt, black, hard, fractured	10	26
Basalt, black, hard, water-bearing (2 gal/min)	4	30
Basalt, black, fractured	2	32
Basalt, black, hard	12	44
Basalt, black, weathered	56	100
Cinders, red	2	102
Basalt, black, with claystone stringers	28	130
Basalt, black, badly fractured	35	165
Basalt, black	15	180
Basalt, black, medium-fractured	17	197
Basalt, black, soft	13	210
2N/33E-8aca. Muriel Johnson. Altitude 1,169 ft. Drilled by J. V. Stratton, 1964. Casing: 6-in. diam to 20 ft		
Soil	11	11
Silt	2	13
Basalt, broken	2	15
Basalt, soft	5	20
Basalt, hard	8	28
2N/33E-8acb. Mr. Hatton. Altitude 1,167 ft. Drilled by Ben Dreyer Drilling Contractor, 1961. Casing: 8-in. diam to 12 ft, 6-in. diam to 39 ft		
Soil and gravel	12	12
Rock, gray, hard	3	15
Boulders	5	20
Rock, gray, hard	9	29
Boulders	9	38
Rock, gray, hard	47	85
Boulders	6	91
Rock, gray, hard	13	104
Boulders	11	115
Rock, red, and sand, water-bearing	8	123
Rock, blue, hard	2	125
2N/33E-8acc. Robert Oylear. Altitude 1,182 ft. Drilled by Troy Griffin, 1967. Casing: 6-in. diam to 29 ft		
Soil	5	5
Boulders and clay	5	10
Clay and gravel	8	18
Rock, medium-hard	7	25
Basalt, black, hard	65	90
Rock and shale, black, soft, water-bearing	13	103
Rock, black, hard	20	123
Rock, brown	19	142
Rock, gray, medium-hard	10	152
Basalt	4	156
2N/33E-8ada. Mamie Minthorn. Altitude 1,179 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 66 ft		
Gravel and boulders	5	5
Gravel and coarse sand	5	10
Gravel, large-sized, and cobbles	11	21
Basalt, black, soft	25	46
Basalt, black, hard, fractured	13	59
Basalt, black, hard, water-bearing (2 gal/min)	7	66
Basalt, black, hard	254	320
Claystone, blue	50	370
2N/33E-8bad. Bill Duff. Altitude 1,158 ft. Drilled by Troy Griffin, 1974. Casing: 8-in. diam to 72 ft		
Soil	2	2
Gravel and boulders	9	11
Basalt, black	5	16
Basalt, gray, hard	51	67
Rock, dark-brown, and blue claystone, water-bearing	4	71
Rock, black, medium	56	127
Rock, light-brown	5	132
Rock, black	6	138
Basalt, gray	15	153
Rock, black, and green claystone, water-bearing	22	175
Rock, light-brown	25	200
Rock, black, medium	84	284
Basalt, gray, hard	12	296
Rock, dark-brown	6	302
Basalt, gray, hard	46	348
Rock, red, gray, and brown, water-bearing	17	365
Basalt, gray	7	372
Rock, light-brown, water-bearing	28	400
2N/33E-8bbd. H. H. Hart. Altitude 1,155 ft. Drilled to 175 ft by Roy T. French, 1968; deepened by Larry Burd Well Drilling, 1975. Casing: 6-in. diam to 28 ft		
Soil	6	6
Gravel, medium	4	10
Basalt, black, hard	50	60
Basalt, black and red	10	70
Clay, green	3	73
Basalt, black	17	90
Basalt, black and brown	85	175
Basalt, with "soapstone"	11	186
Basalt, black	27	213
2N/33E-8bcd. K. E. Bowman. Altitude 1,195 ft. Drilled by Rudd W. Davis, 1969. Casing: 6-in. diam to 28 ft		
Soil, brown, and small rocks	8	8
Clay, light-tan	12	20
Basalt, brown	14	34
Basalt, gray, hard	51	85
Rock, red and black, honeycombed, with clay, water-bearing	25	110
Basalt, gray, hard	5	115
2N/33E-8bdc. Mike Kilby. Altitude 1,194 ft. Drilled by Ben Dreyer Drilling Contractor, 1963. Casing: 8-in. diam to 26 ft		
Soil	2	2
Clay, brown	9	11
Gravel	15	26
Rock, green	12	38
Rock, brown, water-bearing(10 gal/min)	4	42
Rock, gray, hard	49	91
Rock, red	4	95
Rock, brown	6	101

2N/33E-8cad1. Richard Bowman. Altitude 1,205 ft. Drilled by Ben Dreyer Drilling Contractor to 50 ft, 1965; deepened by Rudd W. Davis, 1968. Casing: 8-in. diam to 41 ft

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	9	9
Clay and gravel	9	18
Gravel, sandy	15	33
Clay and gravel	8	41
Sand	2	43
Rock, black, medium	7	50
Basalt, gray, hard	32	82
Rock, black, medium	5	87
Basalt, gray, hard	15	102
Rock, black, medium	22	124
Rock, gray, medium	18	142
Rock, gray, very hard, water-bearing	35	177
Basalt, brown, cracked	25	202
Basalt, dark-brown, soft, water-bearing	5	207
Basalt, red, honeycombed, water-bearing	17	224
Basalt, gray, hard	18	242
Basalt, black and red, honeycombed, water-bearing	20	262

2N/33E-8cba. H. W. Schuening. Altitude 1,208 ft. Drilled to 105 ft by Rudd W. Davis, 1965; deepened by Roy T. French, 1971. Casing: 6-in. diam to 37 ft

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Gravel, cemented	4	8
Clay, yellow, fine, soft	28	36
Basalt, black, medium-hard	45	81
Basalt, gray, fine, hard	15	96
Rock, red, water-bearing	9	105
Rock, red and black, honeycombed	6	111
Basalt, brown	5	116
Basalt, gray, hard	9	125
Basalt, blue, hard	12	137
Basalt, gray, hard	11	148
Rock, brown, with green bentonite, water-bearing	36	184
Rock, red and black, honeycombed	26	210
Basalt, gray	4	214
Basalt, brown	21	235
Rock, black, coarse	40	275
Basalt, gray, hard	42	317
Rock, black, with green clay	47	364
Basalt, blue, hard	5	369
Basalt, gray, hard	46	415
Rock, red, black, and brown, coarse, with clay; water-bearing	33	448

2N/33E-8cbc1. Bob Lovett. Altitude 1,270 ft. Drilled to 222 ft by Rudd W. Davis, 1967; deepened to 460 ft by Rudd W. Davis, 1969; deepened to 575 ft by Larry Burd Well Drilling, 1975. Casing: 6-in. diam to 42 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	14	14
Gravel, silty, packed	7	21
"Hardpan," brown	18	39
Basalt, brown, fractured	3	42
Basalt, brown, medium	32	74
Basalt, gray, medium, water-bearing	34	108
Clay, blue, soft	1	109
Rock, blue, coarse, water-bearing	29	138
Clay, blue, and gravel, water-bearing	5	143
Basalt, gray, hard	13	156
Basalt, decomposed	11	167
Rock, light-red, medium, water-bearing	7	174
Basalt, brown, fractured	19	193
Basalt, brown, caves, water-bearing	15	208
Basalt, brown, cubed or fractured, caving	14	222
Basalt, black, honeycombed, with green clay	30	252
Basalt, gray	6	258
Basalt, black, honeycombed, with green bentonite	4	262
Basalt, gray, broken	25	287
Basalt, brown, honeycombed, with green clay	2	289
Basalt, black, honeycombed	22	311
Basalt, gray	5	316
Basalt, black, honeycombed	6	322
Basalt, gray	4	326
Basalt, black, honeycombed	6	332

2N/33E-8cbc1.--Continued

Materials	Thickness (feet)	Depth (feet)
Basalt, gray	6	338
Basalt, red and black, honeycombed	26	364
Basalt, gray	6	370
Basalt, red and black, honeycombed, with gray clay	9	379
Basalt, gray, broken	19	398
Basalt, gray	20	418
Basalt, gray, broken	6	424
Basalt, gray, broken, and red honeycombed basalt and green clay	6	430
Basalt, gray, broken	12	442
Basalt, gray	9	451
Basalt, gray, broken	9	460
Basalt, gray, water-bearing	23	483
Basalt, red, water-bearing	21	504
Basalt, gray	63	567
Basalt, brown, with sandstone, water-bearing	5	572
Basalt, brown	3	575

2N/33E-8dac1. Richard Purchase. Altitude 1,208 ft. drilled by Don Smith, 1949. Casing: 8-in. diam to 95½ ft

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Gravel, cemented	34	40
Clay, sandy	5	45
Gravel, cemented	45	90
Rock, black, broken	25	115
Basalt, black, solid	90	205
Basalt, brown, black, and red	165	370
Basalt, gray, with clay seams	33	403
Basalt, brown, porous	5	408
Basalt, gray	57	465
Rock, red	7	472
Basalt, gray, black, and brown	90	562
Rock, red, green, black, and brown	23	585
Basalt, gray, hard	12	597
Basalt, black	15	612
Basalt, gray, hard	10	622
Basalt, black, water-bearing	31	653
Basalt, gray	23	676
Basalt, black, porous	10	686
Basalt, gray	14	700
Basalt, black, water-bearing	27	727
Basalt, black	52	779

2N/33E-8dbd. Richard Purchase. Altitude 1,205 ft. Drilled to 604 ft by Don Smith, 1953; deepened to 968 ft by D. K. Smith, 1959. Casing: 12-in. diam to 66 ft

Materials	Thickness (feet)	Depth (feet)
Soil	15	15
Gravel, cemented	2	17
Gravel, loose	2	19
Gravel, loosely cemented	6	25
Clay, brown	2	27
Clay, cemented	3	30
Clay and gravel	11	41
"Hardpan," gravel, and sand	91	132
Rock, red and brown	33	165
Basalt, black and gray	37	202
Basalt, brown, broken	5	207
Basalt, black, brown, and dark-gray	143	350
Clay, hard, sticky	6	356
Basalt, gray, hard, with shale seams	38	394
Basalt, brown, porous; some water	16	410
Basalt, dark-gray	48	458
Rock, red	7	465
Basalt, gray and brown	38	503
Crevice, muddy	4	507
Basalt, gray, hard	38	545
Basalt, brown; some water	15	560
Basalt, gray and brown	25	585
Basalt, red, brown, and black, broken, water-bearing	5	590
Basalt, black and gray	14	604
Basalt, gray	10	614
Basalt, brown; some water	5	619
Basalt, gray and black	38	657
Basalt, black, porous, water-bearing	7	664
Basalt, black, broken at 665 ft; water-bearing	56	720
Basalt, black and gray	215	935
Basalt, black, porous, water-bearing	30	965
Basalt, gray	3	968

Table 14.--Drillers' logs of selected wells in the Umatilla Indian Reservation area--Continued

2N/33E-9aad. Louise Showaway. Altitude 1,212 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 60 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	2	2
Boulder and small-sized gravel	10	12
Gravel, sand, and brown clay	10	22
Basalt, black, fractured	26	48
Basalt, black, slightly fractured	4	52
Basalt, black	8	60
Basalt, black, medium to hard	38	98
Claystone, black, hard	22	120

2N/33E-9abc1. Wilbur Hisey. Altitude 1,202 ft. Drilled by Ben Dreyer Drilling Contractor, 1959. Casing: 8-in. diam to 19 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Gravel	16	18
Rock, gray, hard	12	30
Rock, black, soft, water-bearing	3	33
Rock, gray, hard	79	112
Sand	2	114

2N/33E-9aca Sherman Alexander. Altitude 1,205 ft. Drilled by Yager Drilling Co., 1958. Casing: 6-in. diam to 43 ft

Materials	Thickness (feet)	Depth (feet)
Gravel	31	31
Basalt, blue, soft	11	42
Basalt, blue, hard	8	50
Basalt, blue, medium, water-bearing 112-118 ft	75	125

2N/33E-9acc. Uriah Alexander. Altitude 1,202 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 58 ft

Materials	Thickness (feet)	Depth (feet)
Cobbles, with silt	37	37
Basalt, broken	4	41
Basalt, hard	17	58
Basalt, gray, hard	32	90
Basalt, gray, broken, water-bearing	3	93
Basalt, gray, hard	53	146
Basalt, gray, broken, water-bearing	4	150

2N/33E-9acd. Floyd Alexander. Altitude 1,205 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 63 ft

Materials	Thickness (feet)	Depth (feet)
Soil and cobbles	9	9
Basalt, soft	4	13
Clay, gray	6	19
Basalt, soft, broken	31	50
Basalt, hard	13	63
Basalt, black	121	184
Basalt, brown and black, with blue claystone	20	204

2N/33E-9adb. Phillip Minthorn. Altitude 1,209 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 57 ft

Materials	Thickness (feet)	Depth (feet)
Silt, with cobbles	8	8
Cobbles and gravel	14	22
Basalt, broken	14	36
Basalt, medium-hard	21	57
Basalt, gray, hard	53	110
Basalt, broken, water-bearing	2	112
Basalt, gray, hard	112	224
Basalt, broken	8	232

2N/33E-9bac. Richard Spurlich. Altitude 1,190 ft. Drilled by Troy Griffin, 1973. Casing: 6-in. diam to 21 ft

Materials	Thickness (feet)	Depth (feet)
Boulders and soil	4	4
Gravel, cemented	11	15
Basalt	148	163
Rock, black	12	175
Rock, black, and green claystone	32	207
Rock, black, medium	39	246
Rock, hard	5	251

2N/33E-9bac.--Continued

Materials	Thickness (feet)	Depth (feet)
Rock, light-brown	43	294
Rock, black, and green claystone, water-bearing	49	343

2N/33E-9bbc. Delwin Newson. Altitude 1,180 ft. Drilled by John Hershey Well Drilling, 1961. Casing: 8-in. diam to 41 ft

Materials	Thickness (feet)	Depth (feet)
Soil and gravel	28	28
Gravel, coarse	13	41
Rock, gray, hard	4	45
Rock, black, medium, water-bearing	15	60

2N/33E-9bca. Rogers Construction, Inc. Altitude 1,185 ft. Drilled by Rudd W. Davis, 1968. Casing: 6-in. diam to 98 ft; perforated 79-98 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	4	4
Soil, brown, silty	6	10
"Hardpan," brown, and some cobbles	11	21
Gravel, gray, cemented	25	46
Clay, gray, and gravel, water-bearing	44	90
Basalt, gray, hard, water-bearing	10	100
Basalt, gray, hard	20	120
Rock, soft, porous, water-bearing	32	152

2N/33E-9bcb. Rogers Construction, Inc. Altitude 1,182 ft. Drilled by Rudd W. Davis, 1969. Casing: 6-in. diam to 178 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown, sandy	2	2
Gravel, medium-sized, water-bearing	5	7
"Hardpan"	5	12
Cobbles	4	16
"Hardpan"	18	34
Gravel, medium-sized, water-bearing	4	38
"Hardpan"	40	78
Basalt, gray and brown, broken	2	80
Clay, gray	10	90
Basalt, gray	14	104
Basalt, gray, broken	14	118
Basalt, gray	8	126
Basalt, gray, broken	5	131
Basalt, black, honeycombed, with green clay	11	142
Basalt, black, gray, and brown, broken	39	181
Basalt, brown, broken, water-bearing 181-186 ft	9	190

2N/33E-9daa1. Anna Wannassay. Altitude 1,214 ft. Drilled by Haden Drilling Co. to 197 ft, 1963; deepened to 252 ft by Swiftwater Drilling Co., 1974. Casing: 6-in. diam to 24 ft

Materials	Thickness (feet)	Depth (feet)
Soil, cobbles, and gravel	8	8
Basalt, black, broken	77	85
Basalt, gray, with broken beds	167	252

2N/33E-9daa2. Wilbur Jones. Altitude 1,213 ft. Drilled by Larry Burd Well Drilling, 1974. Casing: 6-in. diam to 25 ft

Materials	Thickness (feet)	Depth (feet)
Gravel and boulders	18	18
Basalt, gray, hard	27	45
Basalt, black, with green sandstone	16	61
Basalt, red, with sandstone	½	61½
Basalt, brown, with sandstone	1½	63
Basalt, gray	160	223
Basalt, black, with green sandstone	37	260

2N/33E-9dba. John Bergen. Altitude 1,210 ft. Drilled to to 139 ft by R. C. Allison Drilling Co., 1964; deepened to 215 ft by Larry Burd Well Drilling, 1974. Casing: 8-in. diam to 39 ft

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	10	10
Gravel, medium	25	35
Rock, black	41	76
Rock, gray	58	134
Rock, red	5	139
Basalt, gray	57	196
Basalt, red	19	215

2N/33E-10aac. Viola Wocatsie. Altitude 1,236 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 52 ft

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Gravel and cobbles, large-sized	24	30
Boulder and clay	11	41
Basalt, black, hard	49	90
Basalt and claystone, water-bearing	10	100

2N/33E-10abc. Melissa Parr. Altitude 1,230 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 27 ft

Materials	Thickness (feet)	Depth (feet)
Silt	8	8
Cobbles	2	10
Cobbles, with broken rock	2	12
Basalt, hard	16	28
Basalt, hard, with "soapstone" seams	163	191

2N/33E-10abd2. Thelma Rieck. Altitude 1,234 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 63 ft

Materials	Thickness (feet)	Depth (feet)
Soil and cobbles	2	2
Boulders and cobbles	5	7
Sand and cobbles	6	13
Basalt, broken, and clay	8	21
Basalt, solid	42	63
Basalt, black	28	91
Basalt, fractured	2	93
Basalt, black, with fractures at 95 ft and 97 ft	7	100

2N/33E-10bbb. W. A. Jenner. Altitude 1,213 ft. Drilled by Troy Griffin, 1967. Casing: 6-in. diam to 18 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Gravel and yellow clay	6	8
Basalt	70	78
Rock, black, medium-hard	18	96
Basalt	24	120

2N/33E-10bcb. N. H. Loughlin. Altitude 1,215 ft. Driller and date drilled unknown

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Gravel and soil	7	12
Gravel, loose, water-bearing	4	16
Sand	4	20
Sand and gravel, cemented	7	27
Basalt, broken	8	35
Basalt, black and gray	194	229
Basalt, black, porous, water-bearing	23	252

2N/33E-10bcc1. Halfmoon Market. Altitude 1,215 ft. Drilled by Ben Dreyer Drilling Contractor, 1957. Casing: 10-in. diam to 14 ft, 8-in. diam to 16 ft

Materials	Thickness (feet)	Depth (feet)
Gravel	14	14
Rock, soft	2	16
Rock, blue, hard	48	64
Rock, red, medium	11	75
Rock, black, hard	9	84
Rock, blue, hard	43	127
Boulders	8	135
Rock, gray, hard	75	210
Shale, green	5	215

2N/33E-10bcc1.--Continued

Materials	Thickness (feet)	Depth (feet)
Crevices	15	230
Rock, black, soft	5	235

2N/33E-10bcc2. C. E. Wood. Altitude 1,219 ft. Drilled by Troy Griffin, 1972. Casing: 6-in. diam to 33 ft

Materials	Thickness (feet)	Depth (feet)
Boulders and gravel	12	12
Rock, brown, medium-hard	9	21
Rock, black	2	23
Claystone, blue, hard	1	24
Basalt	16	40
Rock, black, medium-hard, and claystone, water-bearing	3	43
Basalt	27	70
Rock, brown, and yellow claystone	11	81
Rock, black, medium-hard	5	86
Basalt	44	130
Rock, light-brown	25	155
Rock, gray, honeycombed, water-bearing	3	158

2N/33E-10bcd. Dennis Van Dorn. Altitude 1,220 ft. Drilled by John Hershey Well Drilling, 1961. Casing: 8-in. diam to 35 ft

Materials	Thickness (feet)	Depth (feet)
Gravel and soil	19	19
Clay, brown	4	23
Rock, black, medium-hard	8	31
Rock, gray, hard	19	50
Boulders and sand	3	53
Rock, gray, very hard	20	73
Rock, black, soft, and sand, water-bearing	12	85

2N/33E-10cab. Kay Elk. Altitude 1,220 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 64 ft

Materials	Thickness (feet)	Depth (feet)
Rock, cemented	12	12
Sand, "dirty"	3	15
Clay, brown	12	27
Basalt, broken	7	34
Basalt, solid	29	63
Basalt, black	112	175

2N/33E-10cba1. James Logan. Altitude 1,221 ft. Drilled by John Hershey Well Drilling, 1961. Casing: 8-in. diam to 42 ft

Materials	Thickness (feet)	Depth (feet)
Gravel, coarse	42	42
Rock, black	8	50
Rock, red, soft	3	53
Rock, black, medium-hard	50	103
Rock, gray, hard	17	120
Boulders and sand	9	129
Rock, black, hard	11	140
Rock, gray	55	195
Rock, black, water-bearing	15	210

2N/33E-10cba3. Jack Carpenter. Altitude 1,220 ft. Drilled by Roy T. French, 1968. Casing: 8-in. diam to 17 ft, 6-in. diam to 40 ft

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Gravel, medium-sized	14	18
Clay, brown	5	23
Rock, brown, broken	5	28
Clay, green	7	35
Basalt, gray	35	70
Clay, brown	3	73
Rock, red, porous	17	90

2N/33E-11aaa. McKinley Williams. Altitude 1,277 ft. Drilled by Haden Drilling Co., 1963. Casing: 6-in. diam to 54 ft

Materials	Thickness (feet)	Depth (feet)
Cobbles and broken basalt	16	16
Silt	12	28
Gravel	11	39
Gravel, with some sand	14	53
Basalt	3	56

2N/33E-11adc1. Mart James. Altitude 1,278 ft. Drilled by Allison Drilling Co., 1964. Casing: 8-in. diam to 44 ft

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	2	2
Sand	8	10
Sand and gravel	32	42
Rock, black	8	50

2N/33E-11adc2. Jack Baker. Altitude 1,279 ft. Deepened by Larry Burd Well Drilling from 15 ft, 1973. Casing: 8-in. diam to 21 ft, 6-in. diam to 55 ft

Materials	Thickness (feet)	Depth (feet)
Old well	15	15
Gravel	5	20
Basalt, very soft	28	48
Basalt, black, hard	34	82
Basalt, black, water-bearing 82-87 ft	44	126
Basalt, black and brown, water-bearing	2	128
Basalt, gray	18	146
Basalt, black, with blue "soapstone," water-bearing	14	160

2N/33E-11bcc. Margaret Elk. Altitude 1,253 ft. Drilled by Haden Drilling Co., 1963. Casing: 6-in. diam to 30 ft

Materials	Thickness (feet)	Depth (feet)
Silt and gravel	15	15
Basalt, broken	5	20
Basalt, hard	24	44

2N/33E-11daa. William So Happy. Altitude 1,280 ft. Drilled by Haden Drilling Co., 1963. Casing: 6-in. diam to 20 ft

Materials	Thickness (feet)	Depth (feet)
Silt	7	7
Gravel and cobbles	2	9
Rock, red	63	72

2N/33E-12aca1. Rex Huesties. Altitude 1,305 ft. Drilled by Allison Drilling Co., 1973. Casing: 6-in. diam to 21 ft

Materials	Thickness (feet)	Depth (feet)
Soil, ashy	2	2
Gravel	16	18
Rock, broken	13	31
Rock, red	24	55
Rock, black, broken	10	65

2N/33E-12aca2. Marvin Patrick. Altitude 1,301 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 30 ft

Materials	Thickness (feet)	Depth (feet)
Cobbles, broken	18	18
Basalt, hard	22	40
Basalt, gray, broken	45	85

2N/33E-12acb. Lita Lavadour. Altitude 1,302 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 32 ft

Materials	Thickness (feet)	Depth (feet)
Cobbles, with silt	18	18
Basalt, hard	50	68
Basalt, brown, with sandstone	5	73
Basalt, hard	57	130

2N/33E-12bca. Julia Cowapoo. Altitude 1,290 ft. Drilled to 23 ft by Haden Drilling Co., 1963; deepened to 32 ft by Jack V. Stratton, 1964. Casing: 6-in. diam to 20 ft

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Gravel	12	18
Basalt, broken	5	23
Basalt, soft, with hard layers, water-bearing	9	32

2N/33E-12cbb. U.S. Public Health Service, Indian Health Division. Altitude 1,285 ft. Drilled by Dick Akins Well Drilling, 1972. Casing: 6-in. diam to 59 ft

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Boulders, broken	6	12
Basalt, gray	15	27
Basalt, broken	15	42
Basalt, gray, hard	2	44
Basalt, broken	10	54
Basalt, gray, hard	29	83
Basalt, gray, medium-hard	6	89
Basalt, gray, hard	51	140
Claystone, blue	4	144
Basalt, brown, medium-hard	6	150

2N/33E-12ccc. James Bronson. Altitude 1,386 ft. Drilled by Project Corp., 1969. Casing: 4-in. diam to 72 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	5	5
Clay, brown	11	16
Basalt, black	26	42
Shale, green	16	58
Basalt, gray	7	65
Basalt, black	7	72
Rock, red, porous, water-bearing	8	80

2N/33E-13bbb. Joe Sheoship. Altitude 1,399 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 46 ft

Materials	Thickness (feet)	Depth (feet)
Gravel and sand	17	17
Basalt, black, medium-hard	13	30
Basalt, black, hard	16	46
Basalt, black, medium-hard	15	61
Basalt, black, weathered	19	80

2N/33E-14dac. City of Pendleton. Altitude 1,461 ft. Drilled to 450 ft by R. J. Strasser Drilling Co., 1966; deepened to 800 ft by R. J. Strasser Co., 1972. Casing: 12-in. diam to 157 ft

Materials	Thickness (feet)	Depth (feet)
Soil	8	8
Gravel and boulders	55	63
Clay, yellow and brown	22	85
Clay, brown; contains sand and gravel	55	140
Rock, broken	9	149
Basalt, black, brown, and gray	182	331
Basalt, black, medium-hard	16	347
Rock, black, porous	4	351
Basalt, black and gray, medium-hard to hard	83	434
Basalt, gray, crevices	2	436
Basalt, gray, and clay	44	480
Basalt, black and gray, medium-hard	40	520
Basalt, black, with clay seams	41	561
Basalt, brown and gray, hard to broken	87	648
Basalt, brown, porous	9	657
Basalt, gray, medium-hard	17	674
Basalt, broken	7	681
Basalt, black, medium-hard	15	696
Rock, brown, decomposed	4	700
Basalt, brown, medium-hard, with crevices	31	731
Basalt, gray	40	771
Rock, broken, and clay	11	782
Basalt, gray	18	800

2N/33E-18daa. Andrew Dumont. Altitude 1,347 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 105 ft

Materials	Thickness (feet)	Depth (feet)
Silt	18	18
Basalt, red, soft, broken	38	56
Basalt, gray, broken	31	87
Basalt, gray, medium-soft	18	105
Basalt, gray, medium-hard	106	211
Basalt, red, broken, water-bearing	10	221
Basalt, gray, hard	27	248
Basalt, gray, medium-hard	11	259
Basalt, red and gray, broken, water-bearing	14	273

Table 14.--Drillers' logs of selected wells in the Umatilla Indian Reservation area--Continued

2N/33E-19add. Ferman Ghangraw. Altitude 1,310 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 22 ft

Materials	Thickness (feet)	Depth (feet)
Silt	8	8
Gravel, cemented	9	17
Rock, hard	110	127

2N/33E-20bbb. L. A. Umbarger. Altitude 1,281 ft. Drilled to 784 ft by John Hershey Well Drilling, 1970; deepened to 1,002 ft by Charles Jungmann Drilling Co., 1970. Casing: 12-in. diam to 62 ft

Materials	Thickness (feet)	Depth (feet)
Soil	12	12
Soil, gravel, and clay	50	62
Rock, gray, medium-hard	129	191
Rock, red, soft, little water	13	204
Rock, gray, hard	115	319
Rock, blue, medium-hard	17	336
Boulders and sand	5	341
Clay, brown, and fine gravel	11	352
Rock, gray, hard	9	361
Clay, black, and fine gravel	5	366
Rock, red and gray, soft to hard	195	561
Sand, gray, and boulders	7	568
Shale, black, and clay and fine gravel	13	581
Rock, gray	43	624
Rock, red, medium-hard, water-bearing	6	630
Rock, black, medium-hard	21	651
Rock, gray, hard	133	784
Basalt, gray, black, and red	218	1,002

2N/33E-20ddc. Boyd Jones. Altitude 1,363 ft. Drilled by Roy T. French, 1964. Casing: 6-in. diam to 28 ft

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Gravel, cemented	16	20
Basalt, black, hard	20	40
Basalt, red and brown, soft	15	55

2N/33E-21cdd. C. C. Curl. Altitude 1,391 ft. Drilled by John Hershey Well Drilling, 1962. Casing: 8-in. diam to 47 ft

Materials	Thickness (feet)	Depth (feet)
Soil	16	16
Gravel, fine	25	41
Rock, brown	7	48
Rock, black, soft, water-bearing	3	51

2N/33E-22bbd. George Bonbright. Altitude 1,414 ft. Drilled by Project Corp., 1969. Casing: 10-in. diam to 18 ft, 8-in. diam to 84 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	4	4
Gravel, coarse	6	10
Claystone, gray, hard	4	14
Basalt, black	11	25
Clay, brown	20	45
Basalt, red, soft	35	80
Basalt, black	47	127
Rock, porous, water-bearing	13	140
Basalt, black	2	142

2N/33E-22bcb. W. C. Rohde. Altitude 1,390 ft. Drilled by Troy Griffin, 1969. Casing: 8-in. diam to 40 ft

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Clay, brown, with gravel	106	110
Rock, brown, medium-hard, water-bearing	45	155

2N/33E-24bab. Edward James. Altitude 1,575 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 41 ft

Materials	Thickness (feet)	Depth (feet)
Silt, with cobbles	10	10
Basalt, broken	17	27
Basalt, hard	15	42
Basalt, medium-hard	16	58
Basalt, gray	12	70
Basalt, brown, medium-hard, with "soapstone" seams	42	112

2N/33E-24ddd. St. Andrews Mission. Altitude 1,760 ft. Drilled by Roy T. French, 1967. Casing: 6-in. diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Rock, broken, loose	8	8
Rock, brown, broken	8	16
Rock, gray	12	28
Rock, brown, broken, water-bearing	30	58

2N/33E-25bbb. Sam Kash Kash. Altitude 1,695 ft. Drilled to 95 ft by J. V. Stratton, 1964, deepened to 182 ft by Haden Drilling Co., 1965. Casing: 6-in. diam to 43 ft

Materials	Thickness (feet)	Depth (feet)
Silt and gravel	15	15
Basalt, broken	23	38
Rock, soft	5	43
Rock, hard, water-bearing	52	95
Basalt, black, hard, dense; sand at bottom	87	182

2N/33E-25ddc. Oscar Grubbs. Altitude 2,000 ft. Drilled by Larry Burd Well Drilling, 1974. Casing: 6-in. diam to 18 ft

Materials	Thickness (feet)	Depth (feet)
Clay	12	12
Basalt, gray	68	80
Basalt, black, with "soapstone," water-bearing	4	84
Basalt, black	3	87
Basalt, brown, water-bearing	1	88
Basalt, gray	4	92
Basalt, black, with "soapstone," water-bearing	1	93
Basalt, gray	15	108
Basalt, gray, water-bearing	19	127
Basalt, brown, water-bearing	8	135

2N/33E-27abb. Mary Lawyer. Altitude 1,458 ft. Drilled by Troy Griffin, 1969. Casing: 6-in. diam to 95 ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Claystone, brown, with gravel	70	73
Claystone, red, hard	60	133
Rock, brown, medium	38	171
Rock, black	2	173
Rock, dark-brown, water-bearing	7	180
Rock, black, with blue claystone	9	189
Basalt	4	193

2N/33E-27abc. Sidney Whitesell. Altitude 1,480 ft. Drilled by Larry Burd Well Drilling, 1973. Casing: 6-in. diam to 115 ft

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Gravel	74	80
Clay	35	115
Basalt	23	138
"Soapstone" and basalt	4	142
Basalt, brown, broken	3	145

2N/33E-28abb. Eliza Bill. Altitude 1,413 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 92 ft

Materials	Thickness (feet)	Depth (feet)
Silt, cobbles, and broken rock	56	56
Basalt, gray, broken	43	99
Basalt, gray, hard	36	135
Basalt, red, soft, water-bearing	10	145
Basalt, gray, water-bearing	66	211

2N/33E-28bdb. Dale Tucker. Altitude 1,410 ft. Drilled by Roy T. French, 1965. Casing: 12-in. diam to 110 ft

Materials	Thickness (feet)	Depth (feet)
Soil	8	8
Gravel and clay	82	90
Basalt, black, coarse	20	110
Basalt, gray, red, and brown	174	284
Basalt, gray, hard	26	310
Basalt, black, broken, water-bearing at 210 ft, 310-430 ft	120	430

Materials	Thick-ness (feet)	Depth (feet)
2N/33E-28cdd. Elizabeth Badroads. Altitude 1,463 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 59 ft		
Silt and cobbles	12	12
Rock, soft, broken	37	49
Basalt, medium-hard	32	81
Basalt, hard	51	132
Basalt, hard, with "soapstone" seams	38	170
2N/33E-28daa. Carl Sampson. Altitude 1,469 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 91 ft, 5-in. diam to 109 ft; perforated 89-109 ft		
Silt, with cobbles	21	21
Basalt, soft, broken	59	80
Basalt, broken, water-bearing	11	91
Basalt, gray, soft, water-bearing	18	109
2N/33E-28dcd. L. A. Wells. Altitude 1,493 ft. Drilled by Troy Griffin, 1970. Casing: 10-in. diam to 84 ft, 8-in. diam to 151 ft		
Soil	3	3
Boulders and gravel, with claystone	12	15
Rock, brown, medium, with claystone	126	141
Rock, brown	9	150
Rock, black, water-bearing	34	184
Rock, gray, hard	54	238
2N/33E-29abd. I. M. Jordan. Altitude 1,375 ft. Drilled by Troy Griffin, 1972. Casing: 6-in. diam to 29 ft		
Soil	5	5
Claystone	5	10
Gravel and claystone	8	18
Rock, brown	25	43
Rock, brown, medium	22	65
Basalt, black	5	70
Basalt, gray, hard	11	81
Rock, light-brown	5	86
Rock, black, medium, water-bearing	27	113
Rock, brown, medium	5	118
Basalt, gray, medium	17	135
Rock, dark-brown, and green claystone	8	143
Rock, black, and blue claystone	42	185
Rock, light-brown, and blue claystone, water-bearing	5	190
2N/33E-29dcd. Leonard Cree. Altitude 1,428 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 77 ft		
Soil	8	8
Basalt, "dirty," broken	2	10
Clay, brown	6	16
Basalt, broken	34	50
Basalt, solid	27	77
Basalt, black, soft	33	110
2N/33E-29ddb. Bob Thorne. Altitude 1,425 ft. Drilled by Larry Burd Well Drilling, 1975. Casing: 8-in. diam to 22½ ft		
Soil	3	3
Gravel	9	12
Basalt, brown	38	50
Basalt, black, water-bearing	6	56
Basalt, gray and brown	69	125
Basalt, brown, hard	25	150
Basalt, gray	20	170
Basalt, black, water-bearing	35	205
Basalt, black and gray	27	232
Basalt, brown, hard	3	235
Basalt, gray	8	243
2N/33E-29ddb.--Continued		
Basalt, brown, broken	3	246
Basalt, gray	12	258
2N/33E-31aaa. R. J. Pond. Altitude 1,462 ft. Drilled by Troy Griffin, 1969. Casing: 6-in. diam to 24 ft		
Soil	2	2
Rock, brown, with claystone	37	39
Rock, black	9	48
Basalt	75	123
Rock, black	54	177
Rock, brown	85	262
Rock, dark-red, with claystone	21	283
Rock, black, red, and brown	137	420
Rock, gray, hard	73	493
Rock, red, with blue claystone	10	503
Rock, black	32	535
Rock, gray, hard	8	543
2N/33E-31cca. Roy Allister. Altitude 1,385 ft. Drilled by Larry Burd Well Drilling, 1974. Casing: 6-in. diam to 21 ft		
Soil	1	1
Basalt, black	11	12
Basalt, gray	31	43
Basalt, brown, black, red, and gray, water-bearing	60	103
Basalt, gray	7	110
2N/33E-31cdc. Jeff Kubin. Altitude 1,403 ft. Drilled by Larry Burd Well Drilling, 1974. Casing: 8-in. diam to 22 ft		
Soil	4	4
Clay	20	24
Sandstone	41	65
Sandstone and broken rock	5	70
Sandstone	15	85
Basalt, brown, water-bearing	28	113
Basalt, gray and brown	7	120
Basalt, black, water-bearing	8	128
Basalt, gray	52	180
Rock, red	10	190
Basalt, brown, water-bearing	5	195
Basalt, gray, black, and brown	27	222
Basalt, red, water-bearing	5	227
Basalt, brown	18	245
2N/33E-31cdd. Gene Simmons. Altitude 1,400 ft. Drilled by Larry Burd Well Drilling, 1974. Casing: 6-in. diam to 23 ft		
Soil	7	7
Sandstone	80	87
Basalt, brown, water-bearing	13	100
Basalt, gray, black, brown, and red	192	292
2N/33E-33aaa. Elsie Minthorn. Altitude 1,517 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 95 ft, 5½-in. diam 95-107 ft		
Silt and cobbles	20	20
Basalt, soft, broken	60	80
Basalt, red, medium-hard	16	96
Basalt, medium-hard, broken	11	107

Materials	Thickness (feet)	Depth (feet)
2N/33E-33bbb. R. D. Becker. Altitude 1,445 ft. Drilled by Rudd W. Davis, 1971. Casing: 6-in. diam to 53 ft		
Soil, brown	8	8
"Hardpan," brown, and cobbles	22	30
Gravel, pea-sized	2	32
Gravel, cemented	9	41
Gravel, coarse	4	45
Clay and gravel	7	52
Basalt, black	24	76
Basalt, gray, medium	9	85
Basalt, brown	10	95
Basalt, gray, fractured	10	105
Basalt, black, porous	35	140
2N/33E-33cca. L. H. Kinzer. Altitude 1,520 ft. Drilled by B & G Drilling Co., 1952. Casing: 12-in. diam to 75 ft; perforated 75 ft		
Soil	6	6
Soil and gravel	12	18
Gravel and clay	78	96
Basalt	41	137
Basalt, gray, water-bearing at 210 ft	92	229
Gravel	2	231
Basalt, gray	4	235
Basalt, black	75	310
2N/34E-1acd2. Moses Lloyd. Altitude 1,495 ft. Drilled by Bartholomew Drilling Co., 1974. Casing: 6-in. diam to 60 ft		
Soil	3	3
Rocks and sand, dirty	9	12
Rock, broken	5	17
Basalt, soft	4	21
Basalt, hard	39	60
Basalt, black	55	115
Basalt, fractured, and blue claystone, water-bearing	9	124
Basalt, black	11	135
2N/34E-1add2. Eileen Clark. Altitude 1,505 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 37 ft		
Silt, with cobbles	21	21
Basalt, gray, hard	88	109
Basalt, gray, broken, water-bearing	31	140
Basalt, medium-hard	10	150
2N/34E-1bdc. Lucy Johnson. Altitude 1,482 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 25 ft		
Cobbles and sand	14	14
Gravel, fine	8	22
Gravel, coarse	5	27
2N/34E-2adb. J. E. Morrow. Altitude 1,515 ft. Drilled by Troy Griffin, 1973. Casing: 6-in. diam to 30 ft		
Soil	5	5
Rock, brown, broken	8	13
Rock, brown, hard	17	30
Rock, red and black	33	63
Basalt	26	89
Rock, dark-brown	8	97
Rock, brown, and green claystone	7	104
Rock, red, water-bearing	53	157
Basalt, black	24	181
Rock, dark-brown, water-bearing	11	192
Rock, black, and green claystone	31	223
2N/34E-2cbb1. Louie Dick, Jr. Altitude 1,448 ft. Drilled by Roy T. French, 1966. Casing: 6-in. diam to 24 ft		
Soil	4	4
Gravel	8	12
Basalt, gray, hard	33	45
Basalt, black, broken	16	61
2N/34E-2cbb2. Louie Dick, Jr. Altitude 1,465 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 26 ft		
Silt, with cobbles	11	11
Basalt, broken	2	13
Basalt, hard	13	26
Basalt, gray, hard	82	108
Basalt, broken, water-bearing	21	129
Basalt, gray, hard	28	157
Basalt, broken	14	171
2N/34E-3ccc. Martha Kirk. Altitude 1,413 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 23 ft		
Silt and gravel	7	7
Basalt, hard	44	51
2N/34E-3ccd. Mary Hines. Altitude 1,413 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 35 ft		
Soil	1	1
Boulders	6	7
Basalt, soft, broken	11	18
Basalt, firm	8	26
Basalt, hard	9	35
Basalt, black, hard	28	63
Basalt, fractured	1	64
Basalt, solid	19	83
Basalt, fractured, with blue claystone	5	88
Basalt, black	1	89
Basalt, fractured, brown	5	94
Basalt, black	3	97
2N/34E-3cdb1. Lillian Hoptowit. Altitude 1,415 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 19 ft, 5-in. diam to 51 ft		
Silt	2	2
Cobbles and gravel, with silt	13	15
Rock, black, very hard	35	50
Rock, soft	8	58
Rock, broken, and blue shale	2	60
2N/34E-3cdb2. Orville Sheoship. Altitude 1,455 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 66½ ft		
Soil	4	4
Basalt, brown, broken	34	38
Basalt, blue, broken	5	43
Basalt, blue	24	67
Basalt, black	33	100
Basalt, brown, fractured	11	111
Basalt, black	12	123
2N/34E-4ccb. L. L. Dickerson. Altitude 1,375 ft. Drilled by Larry Burd Well Drilling, 1973. Casing: 8-in. diam to 21 ft, 6-in. diam to 36 ft		
Soil	1	1
Gravel	20	21
Basalt, gray	134	155
Clay, green	3	158
Basalt, gray	72	230
Clay, green	5	235
Basalt, gray, water-bearing	227	462

Table 14.--Drillers' logs of selected wells in the Umatilla Indian Reservation area--Continued

2N/34E-4ccc. Keith Farrow. Altitude 1,380 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 55 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	1	1
Gravel, large-sized, and cobbles	9	10
Gravel, large-sized, and sand	3	13
Basalt, black, medium, with fractures	32	45
Basalt, black, hard	10	55
Claystone, blue	5	60
Basalt, black, hard	120	180
Basalt and red and blue clay	38	218
Basalt, black, hard	62	280

2N/34E-4cdc. Marion Silman. Altitude 1,388 ft. Drilled by Troy Griffin, 1973. Casing: 6-in. diam to 105 ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Gravel	11	14
Basalt	50	64
Rock, black, brown, and red, water-bearing	299	363

2N/34E-4cdd. Lawrence Picard. Altitude 1,422 ft. Drilled by Larry Burd Well Drilling, 1973. Casing: 6-in. diam to 30 ft

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Gravel	10	15
Basalt, black, hard	35	50
Basalt, black, medium	17	67
Basalt, with blue "soapstone"	48	115
Basalt, brown	8	123
Basalt, black	47	170
Basalt, black and blue	68	238
Basalt, brown and blue, broken, vesicular	4	242

2N/34E-4dda. Alphonse Shippentower. Altitude 1,407 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 40 ft

Materials	Thickness (feet)	Depth (feet)
Cobbles and large-sized gravel	14	14
Basalt, gray, hard	126	140
Basalt, rusty	5	145
Basalt and claystone	15	160
Claystone, black	20	180
Claystone, black, porous	20	200

2N/34E-5dcd. James Sloan. Altitude 1,370 ft. Drilled by Skinner & Sons, 1965. Casing: 6-in. diam to 30 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	1	1
Clay, brown, and coarse gravel	5	6
Basalt, black, broken, water-bearing	50	56

2N/34E-5ddd. Steve So Happy. Altitude 1,375 ft. Drilled by Wallace Well Drilling, 1974. Casing: 6-in. diam to 20 ft

Materials	Thickness (feet)	Depth (feet)
Silt and cobbles	8	8
Basalt, hard	13	21
Basalt, gray, hard	93	114
Basalt, red, broken, water-bearing	26	140
Basalt, hard	10	150

2N/34E-8bad. L. W. Keller. Altitude 1,358 ft. Drilled by Skinner & Sons, 1965. Casing: 8-in. diam to 20 ft

Materials	Thickness (feet)	Depth (feet)
Clay, brown, and boulders	8	8
Basalt, black, broken	8	16
Basalt, gray, hard	30	46
Basalt, black, and brown clay, water-bearing	10	56
Basalt, black, and trace of green "soapstone"; water-bearing	2	58
Basalt, black, hard	42	100
Basalt, gray, with cracks; water-bearing	4	104

2N/34E-8cdc. Keith Day. Altitude 1,500 ft. Drilled by Rudd W. Davis, 1970. Casing: 6-in. diam to 22 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	4	4
Cobbles and gravel, packed	16	20
"Hardpan," brown, and cobbles	16	36
Sandstone, brown	6	42
Clay, brown, and gravel	3	45
Sandstone, water-bearing	22	67
Sandstone, brown, water-bearing	13	80
Sandstone, water-bearing	11	91
Basalt, black, porous	17	108
Rock, blue, medium, and clay, water-bearing	12	120

2N/34E-9bab. Virgil Bronson. Altitude 1,388 ft. Drilled by Virgil Bronson, 1968. Casing: 6-in. diam to 34 ft

Materials	Thickness (feet)	Depth (feet)
Soil	9	9
Rock, brown, decomposed	5	14
Rock, gray, with green seam	16	30
Rock, gray, hard	27	57
Rock, red, porous	16	73
Rock, gray, porous, with green shale	32	105
Rock, black, porous	35	140
Rock, black, porous, and yellow shale	8	148
Rock, red, porous	24	172
Rock, gray, with green seams	23	195
Rock, gray	40	235
Rock, brown	28	263
Rock, brown, porous, with orange shale	22	285
Rock, brown, broken	10	295

2N/34E-12ccc. Anna Johnson. Altitude 2,040 ft. Drilled by Roy T. French, 1967. Casing: 6-in. diam to 20 ft

Materials	Thickness (feet)	Depth (feet)
Clay, brown	12	12
Basalt, black	126	138
Rock, red	6	144
Basalt, black	108	252
Rock, red	8	260
Basalt, black, broken	77	337
Rock, brown, porous	63	400
Basalt, gray	111	511
Basalt, black, porous, broken	32	543
Basalt, gray	12	555

2N/34E-15bad. Fred Price. Altitude 1,722 ft. Drilled to 258 ft by Roy T. French, 1966; deepened to 400 ft by Rudd W. Davis, 1970. Casing: 6-in. diam to 26 ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Clay	14	17
Basalt, black	21	38
Basalt, brown, porous, water-bearing	5	43
Basalt, black and gray	60	103
Rock, brown, porous, water-bearing	8	111
Rock, red, porous	20	131
Clay, blue	8	139
Rock, black, porous	4	143
Rock, red, porous, with black streaks	47	190
Rock, black and red, porous	40	230
Rock, red, porous, with black spots, water-bearing	6	236
Rock, black, with clay seams	16	252
Rock, black, porous, water-bearing	6	258
Basalt, gray, hard	30	288
Basalt, brown, fractured	18	306
Clay, blue, and red and brown rock	16	322
Rock, red and black, medium	11	333
Basalt, brown and gray, medium to hard	39	372
Basalt, black and red, honeycombed, water-bearing	22	394
Basalt, black, honeycombed	6	400

Table 14.--Drillers' logs of selected wells in the Umatilla Indian Reservation area--Continued

2N/34E-16adc. Ernestine Waters. Altitude 1,740 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 54 ft

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Clay, brown, gummy	8	12
Clay, white, dry	8	20
Clay, white, with basalt	4	24
Basalt, hard	3	27
Basalt, broken	14	41
Basalt, solid	12	53
Basalt, black and brown	85	138
Basalt, fractured	8	146

2N/34E-17aaa. Phillip Guyer. Altitude 1,550 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 41 ft

Materials	Thickness (feet)	Depth (feet)
Silt	3	3
Boulders, large-sized	11	14
Cobbles and gravel	15	29
Cobbles and large-sized gravel, with silt binder	9	38
Rock, solid	7	45
Rock, black, soft	2	47

2N/34E-18bad. Bryson Liberty. Altitude 1,442 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 61 ft

Materials	Thickness (feet)	Depth (feet)
Silt	9	9
Clay, blue and gray	7	16
Silt, with cobbles and coarse to fine gravel	34	50
Rock, red	10	60
Basalt, black, vesicular	13	73
Rock, hard	½	73½

2N/34E-18dab. Peter Lloyd. Altitude 1,538 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 46 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	6	6
Clay, yellow, and gravel and sand	4	10
Gravel, large-sized, and brown sandy clay	5	15
Basalt, black, weathered	7	22
Basalt, black and red, weathered	11	33
Basalt, black, hard	12	45
Basalt, gray, medium	75	120

2N/34E-18dbb. Francis Wilson. Altitude 1,498 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 33 ft

Materials	Thickness (feet)	Depth (feet)
Silt and gravel	16	16
Gravel, coarse and fine	4	20
Basalt, red	8	28
Basalt, brown	6	34
Basalt, soft	22	56

2N/34E-19dad. Edwin Tucker, Jr. Altitude 1,875 ft. Drilled by Troy Griffin, 1970. Casing: 8-in. diam to 23 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Basalt, medium	154	156
Rock, reddish-brown	9	165
Rock, dark-red, water-bearing	8	173
Basalt	44	217
Rock, red	10	227
Rock, black	20	247

2N/35E-3bcc. J. H. Cahill. Altitude 1,618 ft. Drilled by Troy Griffin, 1973. Casing: 6-in. diam to 40 ft

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Claystone and gravel	29	33
Basalt, black	8	41
Rock, black, and blue claystone, water-bearing	44	85
Rock, brown	11	96
Rock, black	19	115

2N/35E-3bda. Sharon Weathers. Altitude 1,630 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 34 ft

Materials	Thickness (feet)	Depth (feet)
Silt, with cobbles	12	12
Cobbles	4	16
Basalt, broken	4	20
Basalt, gray, hard	120	140
Basalt, red, soft, water-bearing	3	143
Basalt, gray	97	240
Basalt, gray, broken, water-bearing	4	244

2N/35E-4adb. David Remington. Altitude 1,630 ft. Drilled by Ben Dreyer Drilling Contractor, 1957. Casing: 8-in. diam to 42 ft

Materials	Thickness (feet)	Depth (feet)
Soil	9	9
Gravel	5	14
Gravel, cemented	18	32
Rock, black, soft	22	54
Rock, black, medium	24	78
Rock, red, medium	12	90
Rock, black, soft	16	106

2N/35E-4add. Virgil Weathers. Altitude 1,618 ft. Drilled by Troy Griffin, 1973. Casing: 6-in. diam to 38 ft

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Claystone and gravel	19	23
Rock, brown, water-bearing	16	39
Rock, black, medium, water-bearing	43	82

2N/35E-4bbc1. Harold Wishart. Altitude 1,578 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 30 ft

Materials	Thickness (feet)	Depth (feet)
Cobbles and sand	18	18
Gravel, pea-sized, and sand	3	21
Rock, medium-hard	6	27
Boulders, water-bearing	2	29
Rock, hard	31	60

2N/35E-4bca. Dale Philips. Altitude 1,575 ft. Drilled by Project Corp., 1969. Casing: 6-in. diam to 26 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	3	3
Boulders and coarse gravel	23	26
Basalt, black	9	35
Basalt, gray	55	90
Rock, brown, broken, water-bearing	10	100

2N/35E-4cab. Aurelia Shippentower. Altitude 1,588 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 45 ft

Materials	Thickness (feet)	Depth (feet)
Gravel and sand	8	8
Gravel and cobbles	12	20
Basalt, black, hard	100	120

2N/35E-5aca. Amy Webb. Altitude 1,565 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 34 ft

Materials	Thickness (feet)	Depth (feet)
Sand and gravel	20	20
Rock, broken	12	32
Rock	8	40

2N/35E-5add. D. A. Davis. Altitude 1,575 ft. Drilled by Project Corp., 1970. Casing: 6-in. diam to 82 ft

Materials	Thickness (feet)	Depth (feet)
Boulders and coarse gravel	22	22
Basalt, black	60	82
Rock, red, porous, water-bearing	8	90

Table 14.--Drillers' logs of selected wells in the Umatilla Indian Reservation area--Continued

Materials	Thickness (feet)	Depth (feet)
2N/35E-5bdc. Arnold Lavadour, Sr. Altitude 1,640 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 18 ft		
Silt	13	13
Rock, brown	28	41
Rock, red	9	50
Rock, black	3	53
Rock, red	7	60
2N/35E-5dac. Irma Sam. Altitude 1,605 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 55 ft		
Gravel and cobbles	8	8
Gravel, cobbles, and sand	14	22
Basalt, black, hard	88	110
2N/35E-6aca1. W. L. Dunlavy. Altitude 1,524 ft. Drilled to 27 ft by D. K. Smith, 1962; deepened to 102 ft by Rudd W. Davis, 1969. Casing: 8-in. diam to 18 ft		
Soil and small-sized gravel	4	4
Soil and large-sized gravel	14	18
Basalt, black	4	22
Basalt, black, broken, water-bearing	3	25
Basalt, black	5	30
Basalt, black, broken	4	34
Basalt, gray	6	40
Basalt, red and black, honeycombed, and green clay, water-bearing	6	46
Basalt, gray, broken, and green clay, water-bearing	12	58
Basalt, red and black, honeycombed, and green clay, water-bearing	5	63
Basalt, red and black, honeycombed, and green clay	18	81
Basalt, gray and black, broken	17	98
Basalt, gray	4	102
2N/35E-6bdc. Joe Thompson. Altitude 1,518 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 24 ft		
Cobbles and gravel	18	18
Rock, black, hard	6	24
Rock, medium-hard	25½	49½
Rock, black, medium-hard	2	51½
2N/35E-6cab. Bill Minthorn. Altitude 1,518 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 40 ft		
Soil	6	6
Boulders, gravel, and large-sized sand	6	12
Basalt, black, hard	44	56
2N/35E-11dca. Frank Tubbs. Altitude 1,900 ft. Drilled by Project Corp., 1969. Casing: 6-in. diam to 31 ft		
Soil, brown	2	2
Boulders and coarse gravel	24	26
Basalt, black	19	45
Rock, gray, porous, water-bearing	15	60
Basalt, gray	8	68
Rock, red, porous	2	70
2N/35E-14aba2. John Kitson. Altitude 1,930 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 20 ft		
Silt	8	8
Basalt, gray, hard	96	104
Basalt, red, soft, water-bearing	5	109
3N/33E-24ddc. U.S. Department of Agriculture Research Station. Altitude 1,499. Drilled by Rudd W. Davis, 1969. Casing: 12-in. diam to 50 ft		
Soil	5	5
Conglomerate	4	9
Boulders, medium-sized	4	13
Basalt, gray, broken	8	21
3N/33E-24ddc.--Continued		
Rock, decomposed	19	40
Basalt, gray, with layers of red honeycombed basalt and white and green clay	111	151
Basalt, red, honeycombed, water-bearing	6	157
Basalt, brown and gray, upper part broken	33	190
Basalt, red and black, honeycombed, and green clay	13	203
Basalt, gray, upper part broken	21	224
Basalt, black, honeycombed, and green clay	12	236
Basalt, gray	9	245
Basalt, black, honeycombed, and green clay	11	256
Basalt, gray	11	267
Basalt, brown, honeycombed, water-bearing	5	272
Basalt, black, honeycombed, and green clay	9	281
Basalt, gray, with broken layers	37	318
Basalt, red and black, honeycombed, water-bearing	9	327
Basalt, gray	12	339
Basalt, black, honeycombed, and green clay, water-bearing	6	345
Basalt, gray, with broken layers	55	400
3N/33E-33aca. Roy Duff. Altitude 1,417 ft. Drilled by Troy Griffin, 1970. Casing: 8-in. diam to 31 ft		
Soil	3	3
Claystone	25	28
Rock, medium	9	37
Rock, black	29	66
Basalt	16	82
Rock, dark-brown, with yellow claystone	11	93
Claystone, yellow	8	101
Rock, black, medium	19	120
Rock, black, with blue claystone	43	163
Basalt	20	183
Basalt, gray, hard	11	194
Rock, brown, hard	4	198
Basalt, gray, hard	21	219
Rock, black, with blue shale	16	235
Rock, black, water-bearing	8	243
3N/34E-2bcc. F. C. Lieuallen. Altitude 1,605 ft. Drilled by Troy Griffin, 1973. Casing: 6-in. diam to 178 ft		
Soil	10	10
Rock, black, broken	43	53
Rock, black, medium	12	65
Basalt, gray	12	77
Rock, brown, medium	31	108
Rock, black, broken	39	147
Rock, brown	28	175
Rock, red, water-bearing	81	256
Basalt	19	275

3N/34E-3bac. B. L. Davis Ranch, Inc. Altitude 1,545 ft. Drilled to 298 ft by D. K. Smith, 1952; deepened to 1,263 ft by D. K. Smith, 1972. Casing: 12-in. diam to 60 ft

Materials	Thickness (feet)	Depth (feet)
Silt	3	3
"Hardpan"	6	9
Rock, broken, cemented	9	18
Basalt, broken	4	22
Basalt, black and gray	103	125
Basalt, black, porous and broken	40	165
Basalt, gray and black	83	248
Basalt, black, with porous and broken layers	50	298
Basalt, black	112	410
Basalt, black, with gray clay seams	25	435
Basalt, black, broken and porous	118	553
Basalt, gray, hard	27	580
Basalt, black, porous	35	615
Basalt, gray, with seams	61	676
Basalt, black	36	712
Basalt, black, porous	20	732
Basalt, black	13	745
Clay, gray, sticky	26	771
Basalt, black and gray	99	870
Basalt, porous, and red rock	30	900
Basalt, black, porous, and red rock and gray clay	72	972
Basalt, gray	28	1,000
Rock, brown and black, with broken layers	80	1,080
Basalt, gray	65	1,145
Basalt, black, broken	15	1,160
Basalt, gray	28	1,188
Clay, gray, sticky	1	1,189
Rock, reddish-brown, broken	21	1,210
Basalt, black	53	1,263

3N/34E-3dbb. S. J. Lieuallen. Altitude 1,570 ft. Drilled by Charles Jungmann Drilling Co., 1964. Casing: 10-in. diam to 60 ft, 8-in. diam to 167 ft

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Basalt, broken	54	60
Basalt, black, hard	5	65
Basalt, gray, hard	42	107
Basalt, black	53	160
Clay, brown	8	168
Basalt	5	173

3N/34E-4daa. City of Adams. Altitude 1,515 ft. Drilled by D. K. Smith, 1960. Casing: 10-in. diam to 32 ft

Materials	Thickness (feet)	Depth (feet)
Soil	13	13
Rock, broken, and soil	3	16
Basalt, black, broken	4	20
Basalt, black and gray	75	95
Basalt, black, water-bearing	10	105
Basalt, gray, mud streaks	22	127
Basalt, gray and black, water-bearing	16	143
Basalt, gray and black	38	181
Basalt, black, broken, with gray clay	23	204
Basalt, black and gray	21	225
Basalt, black, muddy	25	250
Basalt, gray and black	115	365
Basalt, black, broken, muddy	26	391
Basalt, gray and black	153	544
Basalt, black, broken, and gray clay seams	38	582
Basalt, gray	36	618
Basalt, black, broken, muddy	32	650

3N/34E-11adb. B. L. Davis Ranch, Inc. Altitude 1,659 ft. Drilled to 340 ft by A. A. Durand, 1940; deepened to 1,030 ft by D. K. Smith, 1968. Casing: 8-in. diam to 341 ft

Materials	Thickness (feet)	Depth (feet)
Soil	29	29
Rock, black, hard	6	35
Rock, brown	10	45
Basalt, black and gray, hard	130	175
Basalt, black, soft	3	178
Basalt, black, hard	109	287
Rock and clay, soft	14	301
Rock, hard	6	307
Clay and rock, soft	2	309
Basalt, black, broken	6	315
Basalt, gray and black	125	440
Basalt, black, broken, some clay	40	480

3N/34E-11adb.--Continued

Materials	Thickness (feet)	Depth (feet)
Basalt, gray	28	508
Basalt, black, porous	47	555
Basalt, gray, reddish brown, and black	475	1,030

3N/34E-12bcb. Wilma Tucker. Altitude 1,675 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 60 ft

Materials	Thickness (feet)	Depth (feet)
Basalt and claystone	23	23
Basalt, soft	17	40
Basalt, black, with some blue clay	195	235
Basalt, black	65	300

3N/34E-13cdb. Barnett-Rugg, Inc. Altitude 1,810 ft. Drilled by Charles Jungmann Drilling Co., 1967. Casing: 20-in. diam to 81 ft, 10-in. diam to 460 ft, 8-in. diam 857-1,117 ft; perforated 1,008-1,022 ft, 1,062-1,077 ft, 1,088-1,094 ft

Materials	Thickness (feet)	Depth (feet)
Soil	10	10
Rock, broken	69	79
Basalt, brown, gray, and black	1,831	1,910

3N/34E-16dac. C. T. Burke. Altitude 1,538 ft. Drilled by D. K. Smith, 1960. Casing: 8-in. diam to 147 ft

Materials	Thickness (feet)	Depth (feet)
Soil	20	20
"Hardpan" and some broken rock	5	25
Clay, brown	65	90
Clay, gray	28	118
Clay, brown, broken, and clay	29	147
Basalt, brown	13	160
Basalt, black	5	165
Basalt, black, broken, and clay	47	212
Basalt, black, hard and soft streaks, with "soapstone"	73	285

3N/34E-17cbb. Standard Oil Co. Altitude 1,493 ft. Drilled by A. A. Durand, 1950. Casing: 8-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Soil	20	20
Gravel, cemented	35	55
Clay and rock	3	58
Basalt, porous, and some clay	12	70
Basalt, brown	35	105
Basalt, porous	20	125
Basalt, broken	12	137
Basalt, porous	48	185
Basalt, hard	4	189
Basalt, porous	16	205
Basalt	15	220
Basalt, porous, with clay	30	250
Basalt, broken	5	255
Basalt, porous	15	270
Basalt, broken	15	285
Basalt, hard, water-bearing	4	289
Basalt	21	310
Basalt, broken	7	317
Basalt, gray	4	321
Basalt, hard, water-bearing 338-343 ft	24	345
Basalt	15	360
Basalt, hard	26	386

3N/34E-20bcb. B. G. Haynes. Altitude 1,490 ft. Drilled by A. A. Durand; year unknown. Casing: 8-in. diam to 7 ft

Materials	Thickness (feet)	Depth (feet)
Silt	4	4
Basalt, brown, soft	3	7
Basalt, blue, hard	4	11
Basalt, brown	14	25
Basalt, blue, medium	20	45
Basalt, brown, and clay	21	66
Basalt, blue, hard	65	131
Basalt, brown, medium, water-bearing	13	144
Basalt, blue, hard	11	155

3N/34E-20ddc. Janie LaFave. Altitude 1,538 ft. Drilled by Roy T. French, 1966. Casing: 6-in. diam to 19 ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Clay, broken	9	12
Rock, brown	8	20
Basalt, gray, hard	45	65
Basalt, black, broken, water-bearing	20	85
Basalt, gray, hard	20	105
Basalt, soft, broken, water-bearing	31	136

3N/34E-22dbc. Irvin Mann. Altitude 1,630 ft. Drilled by A. A. Durand, 1944. Casing: 8-in. diam to 63 ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
"Hardpan"	7	10
Gravel	3	13
Shale, red, hard	3	16
Basalt, broken	24	40
Basalt, red, soft	20	60
Basalt, blue, hard	78	138
Basalt, broken	22	160
Basalt	20	180
Basalt, soft	15	195
Basalt, hard	33	228
Shale	17	245
Basalt	60	305
Basalt, crevice; dry at 315 ft	10	315

3N/34E-23baa2. Barnett-Rugg, Inc. Altitude 1,780 ft. Drilled by Roy T. French, 1968. Casing: 10-in. diam to 28 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Clay, brown	16	18
Basalt, gray, broken	4	22
Basalt, gray	8	30
Basalt, decomposed	4	34
Clay, gray and yellow	8	42
Rock, red, broken	3	45
Basalt, gray, broken	15	60
Rock, red, porous, water-bearing	8	68
Basalt, gray	6	74
Rock, brown, with clay seams	11	85
Basalt, broken	8	93
Rock, brown	3	96
Rock, brown, and yellow clay	18	114
Rock, red, and shale	19	133
Rock, brown, with clay seams	25	158
Basalt, black	29	187
Rock, red, porous	20	207
Rock, brown	10	217
Basalt, black	33	250
Basalt, black, porous	35	285
Basalt, gray	17	302
Basalt, gray, porous	18	320
Basalt, gray	13	333
Rock, brown	7	340
Basalt, gray and black	197	537
Basalt, black, with clay	11	548
Rock, red, porous, and shale	8	556
Basalt, black and gray	66	622
Basalt, gray, porous	31	653
Rock, brown, broken	7	660
Basalt, gray	30	690
Basalt, brown, broken, water-bearing	13	703
Basalt, gray, broken	89	792
Rock, red and brown	28	820
Basalt, porous	33	853
Basalt, gray, hard	12	865
Basalt, gray, porous	15	880

3N/34E-26bbb. M. F. Tubbs. Altitude 1,685 ft. Drilled by Great Western Well Drilling, 1974. Casing: 6-in. diam to 21 ft

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Basalt, broken	2	6
Basalt, brown and black	209	215
Shale, blue-green, water-bearing	3	218
Basalt, black, hard	222	440
Basalt, water-bearing	20	460

3N/34E-26bbb.--Continued

Materials	Thickness (feet)	Depth (feet)
Basalt, black	80	540
Basalt, black with blue streaks	50	590

3N/34E-32bbb. R. G. Bafus. Altitude 1,540 ft. Drilled by D. K. Smith; date unknown. Casing: 8-in. diam to 54 ft

Materials	Thickness (feet)	Depth (feet)
Soil	14	14
Rock, cemented, broken	51	65
Basalt, gray, hard	45	110
Basalt, brown, broken, water-bearing	30	140
Basalt, red, water-bearing	14	154
Basalt, gray	5	159

3N/34E-33abc. Richard Burke. Altitude 1,660 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 18 ft

Materials	Thickness (feet)	Depth (feet)
Silt	2	2
Gravel	5	7
Rock	193	200

3N/34E-33acb. Winnie Burke. Altitude 1,640 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 30 ft

Materials	Thickness (feet)	Depth (feet)
Silt and cobbles	9	9
Basalt, broken	2	11
Basalt, gray, hard	51	62
Basalt, red and brown, broken	9	71
Basalt, gray, hard	75	146
Basalt, medium-hard, with "soapstone" seams	106	252

3N/34E-35baa. Billy La Vinia. Altitude 1,798 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 44 ft

Materials	Thickness (feet)	Depth (feet)
Silt	6	6
Rock, red, decomposed	38	44
Basalt, black	65½	109½

3N/35E-3cdd. E. C. Gentry. Altitude 2,027 ft. Drilled by Rudd W. Davis, 1967. Casing: 6-in. diam to 45 ft; perforated 20-41 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	12	12
Soil, gray, silty, with some clay	10	22
Basalt, brown, fractured	5	27
Rock, black and red; some water	10	37
Basalt, gray, fractured, caving; water-bearing	7	44
Rock, honeycombed	12	56
Basalt, gray, very hard	13	69
Basalt, brown, medium	10	79
Rock, black, honeycombed	36	115

3N/35E-4cbd. Johns, Smith & Beamer, Inc. Altitude 2,068 ft. Drilled by D. K. Smith, 1966. Casing: 16-in. diam to 26½ ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Clay, brown	7	10
Basalt, black, broken, and hard clay	15	25
Basalt, dark-gray	38	63
Basalt, black, broken, and clay	27	90
Basalt, black and brown, broken	290	380
Basalt, black, broken and porous	93	473
Basalt, brown and black, porous	22	495
Basalt, black and dark-gray	142	637
Basalt, black, broken	98	735
Basalt, dark-gray	15	750
Basalt, black, broken, with streaks of clay	180	930
Basalt, black and brown, porous, water-bearing	93	1,023
Basalt, black, broken, water-bearing	67	1,090
Basalt, dark-gray	13	1,103

Table 14.--Drillers' logs of selected wells in the Umatilla Indian Reservation area--Continued

3N/35E-7aaa. B. L. Davis Ranch, Inc. Altitude 1,984 ft. Drilled by D. K. Smith, 1970. Casing: 16-in. diam to 115 ft; 12-in. diam 504-584 ft

Materials	Thickness (feet)	Depth (feet)
Record destroyed in fire	1,180	1,180
Basalt, black, water-bearing	20	1,200
Basalt, gray	175	1,375
Shale, black, caving	30	1,405
Basalt, black and gray, water-bearing	65	1,470
Basalt, black, with gray clay	110	1,580
Shale, black	50	1,630
Basalt, black and gray	150	1,780
Basalt, black, porous, water-bearing	7	1,787

3N/35E-12cdd. Wes Meekins. Altitude 2,320 ft. Drilled by E. M. J. Behrens, 1966. Casing: 6-in. diam to 21 ft

Materials	Thickness (feet)	Depth (feet)
Clay, gray, and small boulders	11	11
Boulders, medium-sized	39	50

3N/35E-15bca. Mr. Adams. Altitude 2,340 ft. Drilled by Moore & Anderson; date unknown. Casing: 8-in. diam to 38½ ft

Materials	Thickness (feet)	Depth (feet)
Gravel and soil	7	7
Boulders	31	38
Rock, brown, water-bearing	62	100

3N/35E-18add. Frank Williams. Altitude 1,905 ft. Drilled by A. A. Durand, 1947. Casing: 6-in. diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Soil	10	10
Gravel, cemented	4	14
Basalt, hard	1	15
Basalt, black and gray	85	100
Basalt, black, water-bearing	34	134
Basalt, black, hard	42	176

3N/35E-19dbb. Barnett-Rugg, Inc. Altitude 1,878 ft. Drilled by A. A. Durand, 1946. Casing: 8-in. diam to 22 ft

Materials	Thickness (feet)	Depth (feet)
Soil	7	7
Boulders	21	28
Basalt and boulders, gray	12	40
Basalt, gray, hard	2	42
Basalt, porous	26	68
Basalt, gray	8	76
Basalt, black, upper part porous	38	114
Basalt, gray, water-bearing	88	202
Basalt, gray, hard	16	218
Basalt, black, creviced, porous, with "soapstone"	94	312
Basalt, black	113	425
Rock, red, soft	20	445
Basalt, black	48	493
Basalt and clay	14	507
Rock, hard, decomposed, caving	11	518
Basalt and clay	20	538
Basalt, gray, hard, and clay	87	625
Basalt, decomposed	15	640
Not reported	13	653
Basalt	9	662
Basalt, decomposed	10	672
Basalt, hard	6	678
Basalt, gray	24	702
Basalt and red clay	28	730
Basalt, black	14	744
Basalt, broken	39	783
Basalt, black, hard	58	841
Basalt, brown, soft	5	846
Basalt, porous	33	879
Basalt, black, with "soapstone"	21	900
Basalt, black, hard	68	968

3N/35E-21dca. Barnett-Rugg, Inc. Altitude 2,198 ft. Drilled by Roy T. French, 1968. Casing: 6-in. diam to 60 ft

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Clay, brown	2	5
Gravel	15	20
Clay, brown	5	25

3N/35E-21dca.--Continued

Materials	Thickness (feet)	Depth (feet)
Gravel, cemented	30	55
Basalt, gray	43	98
Rock, red, porous, with yellow shale	40	138
Rock, brown, with clay seams	22	160
Basalt, gray	55	215
Rock, brown	5	220
Rock, red and black, porous	25	245
Basalt, gray, lower part porous	25	270
Rock, brown	8	278
Basalt, gray	7	285
Rock, brown	10	295
Rock, red, porous, with yellow shale	20	315
Basalt, gray	65	380
Rock, brown, broken	5	385
Basalt, gray	7	392
Basalt, gray and red, porous	18	410
Basalt, gray, and green shale	25	435
Rock, brown	8	443
Rock, red, porous, with yellow shale	17	460
Rock, brown	15	475
Rock, brown, porous, with shale	35	510
Basalt, gray, with green shale	20	530
Basalt, black, porous	28	558

3N/35E-28dbc. John Sheoship. Altitude 2,245 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 24 ft

Materials	Thickness (feet)	Depth (feet)
Silt	2	2
Basalt, broken	8	10
Basalt, gray, hard	14	24
Basalt, medium-hard	152	176
Basalt, with seams of "soapstone"	7	183
Basalt, broken	9	192
Basalt, hard, water-bearing	94	286
Basalt, medium-hard, with seams	89	375

3N/35E-29adc. D. S. Hall. Altitude 2,290 ft. Drilled by Roy T. French, 1966. Casing: 6-in. diam to 21 ft

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Basalt, gray, very hard	51	55
Basalt, black, broken	10	65

3N/35E-32ddd. Pershing Sams. Altitude 1,600 ft. Drilled by Haden Drilling Co., 1964. Casing: 6-in. diam to 59½ ft

Materials	Thickness (feet)	Depth (feet)
Silt	20	20
Silt and rock	14	34
Rock, broken	27	61
Rock, solid	13	74

3N/35E-35acc2. Scott MacGregor. Altitude 1,680 ft. Drilled by Rudd W. Davis, 1971. Casing: 8-in. diam to 27 ft

Materials	Thickness (feet)	Depth (feet)
Soil and some gravel	3	3
Cobbles and gravel	9	12
Gravel, cemented, and cobbles	6	18
Gravel, pea-sized, and coarse sand	6	24
Basalt, black, medium, water-bearing	36	60
Basalt, gray, medium, water-bearing	15	75
Rock, gray, porous	7	82
Basalt, gray, hard	10	92

3N/35E-35acc3. J. D. Simpson. Altitude 1,798 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 36 ft

Materials	Thickness (feet)	Depth (feet)
Silt, with cobbles	18	18
Basalt, broken	5	23
Basalt, gray, hard	14	37
Basalt, broken	6	43
Basalt, broken, with seams	8	51
Basalt, broken, medium-hard	38	89

Materials	Thickness (feet)	Depth (feet)
3N/35E-35adb. Jeff Heise. Altitude 1,685 ft. Drilled by Project Corp., 1970. Casing: 4-in. diam to 72 ft		
Boulders and coarse gravel	21	21
Basalt, black	51	72
Rock, red, porous, water-bearing	8	80
3N/35E-36aac. R. E. Smith. Altitude 1,735 ft. Drilled by Project Corp., 1970. Casing: 6-in. diam to 90 ft		
Boulders and coarse gravel	42	42
Basalt, black	48	90
Rock, red, porous, water-bearing	10	100
3N/36E-29aac1. Mervin Duffy. Altitude 1,835 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 37 ft		
Soil	12	12
Rock, broken	5	17
Basalt, solid	20	37
Basalt, black, soft	6	43
Basalt	18	61
Basalt, fractured	10	71
Basalt, solid	34	105
Basalt, red, water-bearing	18	123
3N/36E-29aac2. Robert McBean. Altitude 1,835 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 42 ft		
Gravel	9	9
Basalt, broken	19	28
Basalt, hard	18	46
Basalt, soft, fractured	4	50
Basalt, hard	16	66
Basalt, fractured	2	68
Basalt	8	76
Basalt, red, soft, water-bearing	21	97
Basalt, black, hard	3	100
3N/36E-29acb. Fred Gray. Altitude 1,823 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 40 ft		
Soil	3	3
Sand, clay, and gravel	17	20
Basalt, broken	7	27
Basalt, hard	13	40
Basalt, black	11	51
Basalt, soft, fractured	6	57
Basalt, fractured at 63 ft	6	63
Basalt, black	10	73
Basalt, soft	9	82
Basalt, hard	3	85
Basalt, soft, fractured	3	88
Basalt, hard	4	92
3N/36E-29cab. Ina Brouillard. Altitude 1,820 ft. Drilled by Bartholomew Drilling, 1974. Casing: 6-in. diam to 34 ft		
Soil	4	4
Clay and rocks	10	14
Basalt, broken	8	22
Basalt, hard	18	40
Basalt, broken	8	48
Basalt, solid	2	50
Basalt, broken	28	78
Basalt, broken, and blue claystone	5	83
3N/36E-29cac. Clifford Picard. Altitude 1,820 ft. Drilled by Haden Well Drilling Co., 1964. Casing: 6-in. diam to 43 ft		
Gravel, silty	28	28
Basalt, broken	13	41
Basalt, hard	22	63
Basalt, broken, with gravel near base	6	69
Basalt, hard	19	88
3N/36E-31abd. Walter Reed. Altitude 1,755 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 40 ft		
Soil	4	4
Gravel, cobbles, and sand	6	10
Cobbles, large-sized, and boulders	7	17
Basalt, black, medium-hard	6	23
Basalt, black, hard	92	115
3N/36E-32bcb. Louis Quaempts. Altitude 1,780 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 33 ft		
Silt, with cobbles	7	7
Cobbles	8	15
Basalt, gray, hard	86	101
Basalt, red, soft, water-bearing	8	109
4N/34E-35cdb. B. L. Davis Ranch, Inc. Altitude 1,622 ft. Drilled by D. K. Smith, 1967. Casing: 16-in. diam to 45 ft, 12-in. diam to 775 ft		
Soil	6	6
Clay and gravel	35	41
Basalt, gray and black	108	149
Basalt, brown, broken	24	173
Basalt, black	62	235
Basalt, brown, broken	16	251
Basalt, black and gray	171	422
Basalt, black, broken	15	437
Basalt, gray and black	83	520
Basalt, gray, and sticky clay	90	610
Basalt, brown and black, broken	140	750
Rock, black, and sand and some clay	13	763
Rock, broken, and sticky gray clay	12	775
Basalt, black	60	835
Basalt, gray, brown, and black, water-bearing	130	965
Basalt, gray, with brown clay seams	75	1,040
Basalt, black, porous	19	1,059
Clay, sticky	2	1,061
Basalt, gray	122	1,183
Basalt, black and red, with clay seams	7	1,190
Basalt, brown, porous	5	1,195
Basalt, black and gray	80	1,275
Basalt, black, broken	39	1,314
Basalt, black and gray	153	1,467
Basalt, black, porous, and clay	13	1,480
Basalt, gray	10	1,490
Rock, brown and red, broken, and blue clay	8	1,498
Basalt, gray	62	1,560
Rock, brown, black, and red, broken	20	1,580
Basalt, gray and black, caving	60	1,640
4N/35E-29cda. Henry Koepke. Altitude 1,790 ft. Drilled by A. A. Durand, 1940. Casing: 8-in. diam to unknown depth		
Soil	16	16
Boulders	4	20
Rock, hard	2	22
Basalt, hard	27	49
Basalt, medium	7	56
Rock, soft	74	130
Rock, medium	15	145
Rock, soft	51	196
Rock, hard	59	255
Basalt, gray	30	285
Basalt, hard	7	292
Basalt, gray	31	323
Basalt, hard	9	332
Basalt, black and gray	89	421
Basalt, gray, hard	37	458
Basalt, black	28	486

Table 14.--Drillers' logs of selected wells in the Umatillà Indian Reservation area--Continued

Materials	Thickness (feet)	Depth (feet)
4N/35E-30bdd. City of Athena. Altitude 1,884 ft. Drilled by R.J. Strasser Drilling Co., 1970. Casing: 8-in. diam to 520 ft, 12-in. diam to 24 ft		
Soil	5	5
Basalt, brown, broken	14	19
Basalt, gray, medium-hard	86	105
Basalt, gray, broken	10	115
Basalt, hard	10	125
"Soapstone," gray, broken	21	146
Basalt, gray, medium-hard	30	176
Basalt, gray, hard	68	244
Basalt, gray, broken	20	264
Basalt, gray, hard	27	291
Sandstone	5	296
Basalt, gray, hard	9	305
Basalt, broken	1	306
Basalt, gray, hard	18	324
Rock, black, and blue clay	37	361
Basalt, gray, hard	23	384
Basalt, gray, porous	8	392
Basalt, gray, hard	22	414
Basalt, gray, broken	4	418
Basalt, gray, hard	28	446
Shale, black	8	454
Basalt, gray, medium-hard	3	457
Basalt, brown, broken	19	476
Basalt, gray, hard	23	499
Basalt, broken	11	510
Basalt, gray, hard	26	536
Basalt, porous	5	541
Basalt, gray, medium-hard	35	576
Basalt, gray, broken	32	608
Basalt, gray, hard	6	614
Clay, blue	20	634
Basalt, gray, broken	6	640
Basalt, gray, hard	68	708
Basalt, red	5	713
Basalt, brown, broken	7	720
Basalt, red	6	726
Basalt, gray, broken	9	735
Basalt, gray, medium-hard	11	746
1S/32E-1bbd. Verna Gilliland. Altitude 1,475 ft. Drilled by Troy Griffin, 1968. Casing: 6-in. diam to 18 ft		
Soil	3	3
Gravel, with clay	14	17
Rock, black	9	26
Rock, red	4	30
Rock, black, with blue shale	35	65
Rock, dark-red	12	77
Rock, black	18	95
Rock, gray, hard	10	105
Shale, black and blue	5	110
Basalt, gray, hard	40	150
Rock, brown, black and gray	43	193
Shale, dark-brown and blue	7	200
Clay, dark-brown and yellow	24	224
Basalt	36	260
Rock, black, medium	40	300
Basalt	85	385
Rock, red, with blue shale	3	388
Rock, dark-red	3	391
Rock, black	29	420
Rock, gray, hard	48	468
Rock, red	29	497
1S/32E-1cba. Frank Rice. Altitude 1,498 ft. Drilled by R. C. Allison Well Drilling, 1966. Casing: 8-in. diam to 27½ ft		
Soil	3	3
Clay, brown	4	7
Gravel, large-sized	12	19
Boulders	8	27
Rock, gray	33	60
Rock, black	18	78
1S/32E-1dca. A. M. Insko. Altitude 1,518 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 225 ft		
Silt, with cobbles	8	8
Basalt, gray, hard	117	125
Basalt, red, porous	7	132
Basalt, gray, hard	44	176
Basalt, gray, broken	2	178
Basalt, gray, hard	82	260
Basalt, broken	2	262
1S/32E-1dcb. J. E. Sutherland. Altitude 1,520 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 8-in. diam to 20 ft		
Silt	9	9
Basalt, gray	33	42
Basalt, brown	2	44
Basalt, brown and gray	18	62
Basalt, gray	194	256
Basalt, red, soft	11	267
Basalt, gray, hard	223	490
Basalt, gray, with "soapstone" seams	58	548
1S/33E-1cda. Leslie Minthorn. Altitude 1,860 ft. Drilled by Larry Burd Well Drilling, 1973. Casing: 8-in. diam to 19 ft		
Soil	6	6
Clay and gravel	4	10
Basalt, gray	37	47
Clay, brown	3	50
Basalt, gray	30	80
1S/33E-2dcb. Jesse Jones. Altitude 1,800 ft. Drilled by Swiftwater Well Drilling, 1974. Casing: 6-in. diam to 44 ft		
Soil	3	3
Clay, light-brown	11	14
Clay, dark-brown	7	21
Gravel, medium-sized	2	23
Basalt, black, fractured	46	69
Basalt, black, water-bearing	6	75
1S/33E-4cbb. Charles McKay. Altitude 1,665 ft. Drilled by Bartholomew Drilling Co., 1974. Casing: 6-in. diam to 50 ft		
Soil	9	9
Basalt, broken	3	12
Basalt, solid	18	30
Basalt, red, soft	15	45
Basalt, solid	58	103

Materials	Thickness (feet)	Depth (feet)
1S/33E-5bdd1. Beatrice Duffy. Altitude 1,635 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 32 ft		
Silt, with cobbles	5	5
Rock, broken	20	25
Basalt, medium-hard	8	33
Basalt, hard	12	45
Basalt, medium-hard	43	88
1S/33E-5bdd2. R. V. Stanhope. Altitude 1,640 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 8-in. diam to 22 ft		
Silt, with cobbles	9	9
Basalt, gray, hard	28	37
Basalt, brown	6	43
Basalt, gray, hard	75	118
Basalt, broken	2	120
Basalt, gray, hard, with "soapstone" seams	20	140
1S/33E-6cac. Inez Reeves. Altitude 1,570 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 20 ft		
Cobbles	8	8
Basalt, hard	13	21
Basalt, medium-hard	115	136
Basalt, hard, with "soapstone" seams	77	213
Basalt, hard, broken	35	248
1S/33E-6cbd. R. V. Stanhope. Altitude 1,558 ft. Drilled by Rudd W. Davis, 1971. Casing: 8-in. diam to 20 ft		
Soil, brown	5	5
Clay, red, and gravel, packed	7	12
Rock, red and black, medium	4	16
Basalt, blue, hard	7	23
Basalt, gray, hard	68	91
Basalt, blue, medium	28	119
Basalt, blue, hard	127	246
Basalt, green, hard	15	261
Basalt, gray, very hard	63	324
Basalt, black, porous, honeycombed	6	330
1S/33E-6ccb. Bernedette Nez. Altitude 1,535 ft. Drilled by Wallace Well Drilling Co., 1974. Casing: 6-in. diam to 20 ft		
Silt, with cobbles	6	6
Basalt, hard	15	21
Basalt, medium-hard	66	87
Basalt, medium-hard, with seams; water-bearing	106	193
Basalt, medium-hard, with "soapstone"	18	211

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