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DANIEL J. EVANS, Governor

Department of Conservation
H. MAURICE AHLQUIST, Director

DIVISION OF WATER RESOURCES
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WATER SUPPLY BULLETIN No. 24

GROUND WATER IN WASHINGTON ITS CHEMICAL AND PHYSICAL QUALITY

By

A. S. VAN DENBURGH and J. F. SANTOS

Prepared in cooperation with
UNITED STATES GEOLOGICAL SURVEY, QUALITY OF WATER BRANCH,
AND THE WASHINGTON STATE POLLUTION CONTROL COMMISSION
1965

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GROUND WATER IN WASHINGTON:

ITS CHEMICAL AND PHYSICAL QUALITY

By A. S. Van Denburgh and J. F. Santos

ABSTRACT

The chemical quality of most ground water in Washington is satisfactory for municipal, industrial, and agricultural use; and much of the ground water is of excellent quality, very much better than that necessary to meet the minimum requirements for most uses. In the region west of the Cascade Divide, much ground water is obtained from sedimentary deposits of glacial or stream origin. Most of the water is dilute--the normal range of dissolved-solids content is 75 to 150 ppm (parts per million)--and soft or only moderately hard, with silica, calcium, and bicarbonate the principal dissolved constituents. Dissolved solids exceeding 250 ppm (principally sodium, chloride, and calcium) occur in certain isolated well waters that have been contaminated by sea water from the adjacent Puget Sound or Pacific Ocean, and they also occur in other ground water, most commonly in western Lewis County, where wells tap buried marine sedimentary deposits that contain saline water.

Concentrations of iron greater than 0.3 ppm occur commonly in ground water of the Puget Sound lowland and the upper Chehalis River basin; orthophosphate concentrations between 0.1 and 2.0 ppm also are common in these areas.

In the region east of the Cascade Divide, most ground water is obtained from shallow sedimentary deposits of glacial and stream origin, or from shallow to very deep aquifers contained within the layered basalt flows that underlie the Columbia Plateau. The dissolved-solids content and chemical character of much ground water east of the Cascade Divide is similar to that of water to the west. However, many wells in several areas east of the Divide yield water of poorer chemical quality and greater dissolved-solids content. Much ground water in the Columbia Basin Irrigation Project area, for example, has moderate to large hardness values (from 120 ppm to more than 1,000 ppm) and large concentrations of nitrate and sulfate (more than 50 and 100 ppm respectively). Most of the largest reported concentrations of silica and fluoride in Washington occur in water from wells 250 to more than 750 feet deep in the central and southern parts of the region east of the Cascade Range.

Ground water west of the Cascade Divide is used primarily for domestic and industrial purposes, whereas wells in the region east of the Divide provide water principally for domestic and agricultural purposes. Most ground water throughout the State is suitable for domestic, industrial, and agricultural use. Chemical quality is, or is expected to become, a problem in certain restricted areas. Excessive hardness-of-water values (more than 180 ppm) occur in some areas both east and west of the Cascade Range. Large concentrations of fluoride and nitrate (more than 1.0 and 20 ppm respectively) occur in certain areas east of the Cascade Range, whereas large amounts of dissolved solids (more than 500 ppm) and iron (more than 0.3 ppm) occur in certain areas west of the Cascade Range. Increased withdrawal of ground water from shallow aquifers along the coastline may lead to sea water contamination. In addition, saline water from the generally deeper aquifers in marine sedimentary deposits west of the Cascade Range may also become a more important source of contamination. The temperature of most ground water sampled was less than 65°F. Except for a single thermal spring, the maximum and minimum measured temperatures were 87 and 40°F.

INTRODUCTION

In July 1959 the Washington Department of Conservation's Division of Water Resources and Pollution Control Commission, in cooperation with the U. S. Geological Survey, began a program to appraise the chemical quality of ground water in the State of Washington. This progress report presents a general discussion of the chemical and physical quality of water of the major ground water aquifers in Washington and some general correlations of water quality with rock type. In addition, relationships between ground-water quality and water use are presented. Future reports will deal with a more thorough interpretation of the chemical character of ground water in specific areas.

The Appendix includes a tabulation of the chemical quality and temperature information collected during the first phases of this program, together with a large amount of additional chemical quality data from records of the U. S.

Geological Survey. The combined tabulation (table 8) includes analyses of 1,064 water samples from 567 wells and springs throughout the State. Figure 1 shows the location of these wells and springs.

Also included in the Appendix are an explanation of the well and spring location system (p. 35), an explanation of water-quality data (p. 36), and a discussion of water-quality standards (p. 36, tables 4-7).

The authors are grateful to J. E. Luzier, Ground Water Water Branch, U. S. Geological Survey, for information on the characteristics and geologic environments of ground-water occurrences in the State.

Previous Ground-Water Quality Investigations

The earliest known published chemical analysis of Washington ground water is that of a spring-water sample reported by Peale in 1886. After that, many reports were published that contain information on the chemical quality of ground water in Washington, although references to water quality are usually brief. The major part of previously published chemical quality data is contained in reports listed in the selected biblography (p. 32), and all U. S. Geological Survey chemical analyses of ground-water that appear in the above reports, except field data, are included in table 8 of this report to provide a good single reference for ground-water quality information in Washington.

GEOGRAPHY

Physiography

Washington is a state of contrasting land forms which include spectacular mountains, a lowland trough, and an extensive, arid plateau region (fig. 2). The Cascade Range--a rugged, north-trending group of mountains, is the most distinctive physiographic feature in the State. It forms a barrier that divides the State into two areas of entirely different physiographic form, climate, population density, and economy. Altitudes of the crests range from 6,000 to 8,500 feet, except for those of a few isolated higher peaks, the highest of which is Mount Rainier at 14,408 feet.

The Puget Trough is immediately west of the Cascade Range. It trends south from the Canadian border and merges with the Willamette Valley of Oregon. The lowland trough contains a large marine embayment (Puget Sound), dotted with numerous islands, which extends south to Olympia.

The Olympic Peninsula is west of the Puget Sound embayment. It is a rugged, mountainous area topped by Mount Olympus (7,965 feet), and bordered by discontinuous, terraced lowlands adjacent to the Pacific Ocean, the Strait of Juan de Fuca, and the Puget Sound embayment.

South of the Peninsula, and separated from it by the west-trending Chehalis River valley, are a group of hills with moderate relief, and altitudes as high as 3,100 feet. These hills are bordered to the west by several large embayments, which are protected from the Pacific Ocean by long, narrow sand spits.

East of the Cascade Range, two physiographically distinct areas are bounded by reaches of the Columbia and Spokane Rivers that flow from east to west. North of this boundary is the Okanogan Highlands, an area of low, rounded mountains, upland plateaus, and basins such as the Okanogan and upper Columbia River valleys.

South of this boundary and east of the Cascade Range, is a broad expanse of generally flat terrane termed the Columbia Plateau. Much of this region is underlain by a series of layered flows of volcanic rock. The flat areas underlain by these flows are interrupted by many moderately wide and deep, southwest-trending canyons (coulees), by several pronounced east-trending ridges, and by the deep gorges of the Columbia and Snake Rivers.

In the far southeastern corner of the State, the Blue Mountains form an area of moderate relief topped by Oregon Butte at 6,401 feet. These mountains occupy only a small area in Washington, and extend into Oregon to the south.

Population

According to the U. S. Bureau of Census (1961) the 1960 population of Washington was 2,853,214, a 20 percent increase over the 1950 figure and almost double the 1930 population. More than two-thirds of the people live in the Puget trough, where most of the commerce and industry are centered. Table 1 lists the area of each county, its 1960 population, its population density, and the number of ground-water analyses tabulated in this report.

GROUND-WATER USE

MacKichan (1951, 1957), and Mackichan and Kammerer (1961), have prepared estimates of ground-water use for Washington based on data from several State and Federal agencies. Table 2 summarizes their estimates of ground-water withdrawal in the State of Washington in 1950, 1955, and 1960. It shows that agricultural use not only

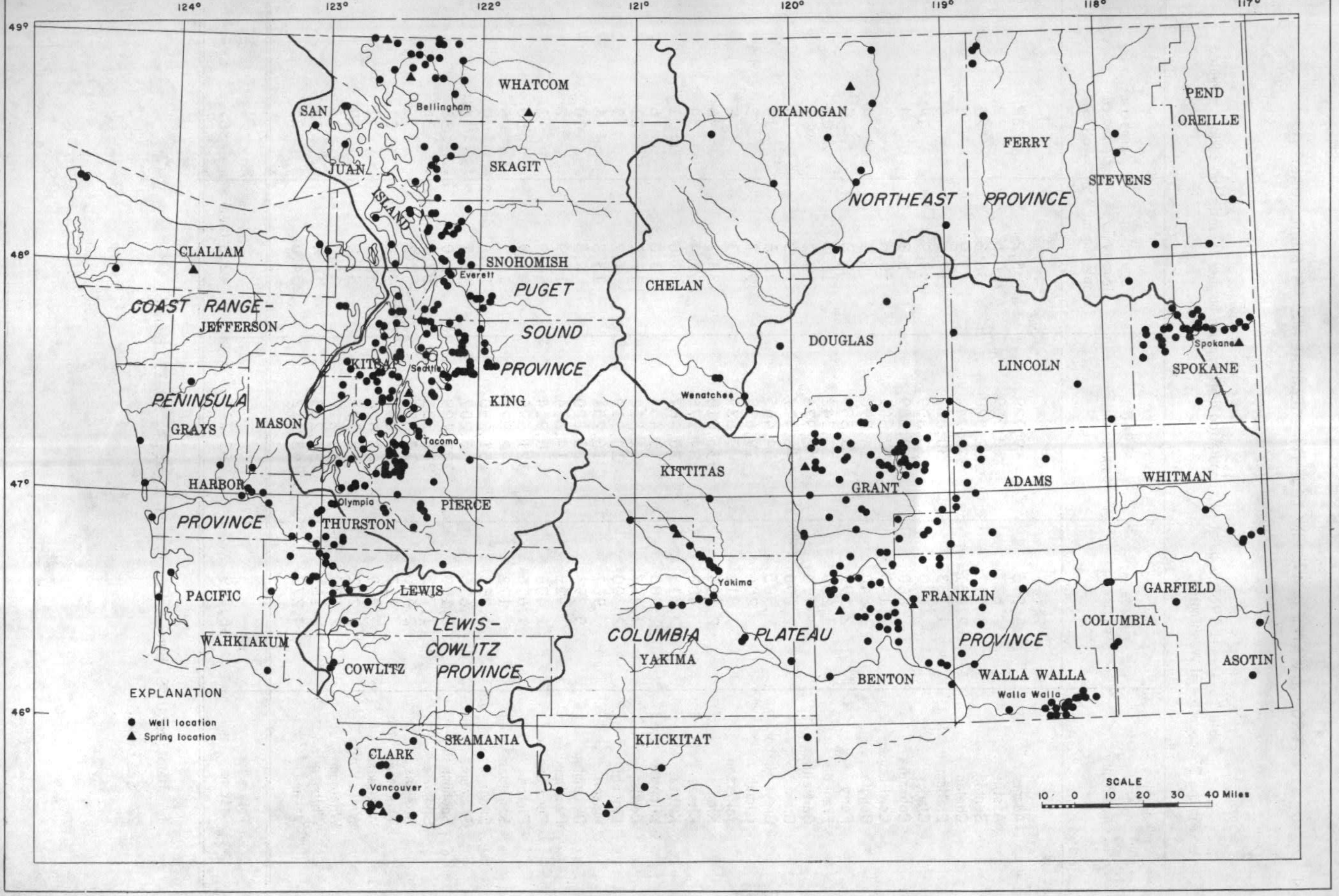


Figure 1.-- Location of wells and springs tabulated in table 8.

Table 1.--Area, 1960 population, population density, and number of wells and springs sampled in the 39 counties of Washington.

County	Area in sq. mi. 1/	1960 population 1/	Population density 1/ (people/sq.mi.)	Number of sampled wells 2/
Adams	1,895	9,929	5.2	17
Asotin	627	12,909	20.6	2
Benton	1,712	62,070	36.3	29
Chelan	2,931	40,744	13.9	3
Clallam	1,753	30,022	17.1	6
Clark	630	93,809	148.9	14
Columbia	860	4,569	5.3	4
Cowlitz	1,143	57,801	50.6	3
Douglas	1,840	14,890	8.1	4
Ferry	2,197	3,889	1.8	4
Franklin	1,260	23,342	18.5	18
Garfield	714	2,976	4.2	1
Grant	2,690	46,477	17.3	64
Grays Harbor	1,905	54,465	28.6	14
Island	206	19,638	95.3	5
Jefferson	1,812	9,639	5.3	2
King	2,134	935,014	438.2	46
Kitsap	402	84,176	209.4	34
Kittitas	2,315	20,467	8.8	1
Klickitat	1,905	13,455	7.0	6
Lewis	2,447	41,858	17.1	21
Lincoln	2,300	10,919	4.7	3
Mason	967	16,251	16.8	6
Okanogan	5,293	25,520	4.8	10
Pacific	925	14,674	15.9	2
Pend Oreille	1,406	6,914	4.9	1
Pierce	1,676	321,590	191.9	50
San Juan	172	2,872	16.7	5
Skagit	1,735	51,350	29.6	9
Skamania	1,676	5,207	3.1	3
Snohomish	2,100	172,199	82.0	35
Spokane	1,763	278,333	157.9	36
Stevens	2,486	17,884	7.2	5
Thurston	717	55,049	76.8	22
Wakiakum	269	3,426	12.7	1
Walla Walla	1,272	42,195	33.2	19
Whatcom	2,134	70,317	33.0	25
Whitman	2,167	31,263	14.4	12
Yakima	4,273	145,112	34.0	25
Totals for state	66,709	2,853,214	42.8 (av.)	567

1/ Data after U. S. Bureau of the Census, 1961, p. 49-11, table 6.

2/ See table 8.

accounts for the largest withdrawal, but also the greatest increase in withdrawal during the 10-year period. The increase in agricultural use is attributable to the development of many irrigation wells in the western part of the State. East of the Cascade Divide, where surface-water irrigation rights are near or at the limits of water availability, farmers have turned to ground water, not only to enable additional land use, but also to supplement surface-water allotments during times of surface-water shortage.

The next greatest increase in ground-water withdrawal during the period 1950-60 was in municipal use. Many cities depend entirely on wells for their water supply, with the result that more ground water must be withdrawn to provide for the greater demand as population and individual water use increases. In 1950 the average per capita use of water for municipal purposes in Washington was 217 gallons per day, with wells and springs supplying an estimated 29 percent. The 1960 estimate was only 26 percent from wells and springs, but average per capita use had increased to 270 gallons per day. This increase can undoubtedly be attributed to the intensified utilization of water-using devices, such as dishwashers, garbage-disposal units, and automatic washing machines.

Industrial utilization of ground water showed a 50 million gallon-per-day (mgd) gain during the period 1950-55, but a 10 mgd decrease between 1955 and 1960. Industrial use of surface water also decreased during the same period, possibly because obsolete or worn out equipment was replaced by new facilities or manufacturing processes that use less water.

The decrease in withdrawal of ground water for rural use reflects the population shift from rural to urban or suburban areas. Table 2 shows that the decrease in rural ground-water withdrawal is almost the same as the increase in municipal withdrawal.

Table 2.--Estimated ground-water withdrawal for agricultural, municipal, industrial, and rural use in Washington. 1/

Ground-water use	Withdrawal (millions of gallons per day) and year of estimate			Percent change between 1950 and 1960
	1950	1955	1960	
Agricultural	170	230	420	+147
Municipal	110	150	200	+ 82
Industrial	130	180	170	+ 31
Rural	65	28	7	- 89
Total	475	588	797	+ 68

1/ Data after MacKichan, 1951, 1957; and MacKichan and Kammerer, 1961.

OCCURRENCE AND CHEMICAL CHARACTER OF WASHINGTON GROUND WATER

The most important sources of ground water in Washington are basaltic volcanic rocks of the Columbia Plateau, and unconsolidated or semiconsolidated sedimentary deposits of Quaternary age that cover large areas throughout the State. A generalized geologic map that indicates the distribution of principal rock types is presented in figure 2.

The chemical quality of most ground water in Washington is satisfactory for municipal, industrial, and agricultural use; and much of the ground water is of excellent quality, very much better than that necessary to meet the minimum requirements for most uses. Although problem areas exist with regard to excessive concentrations and values of several constituents and properties--notably iron, nitrate, and hardness of water--the concentrations of most chemical constituents and properties of ground water usually are considerably less than limits recommended for drinking water by the U. S. Public Health Service (1962, p. 7, 8) as shown in tables 4 and 5. Likewise, the chemical quality of most of the ground water meets requirements of all but the strictest tolerances for industrial and agricultural use (tables 6 and 7).

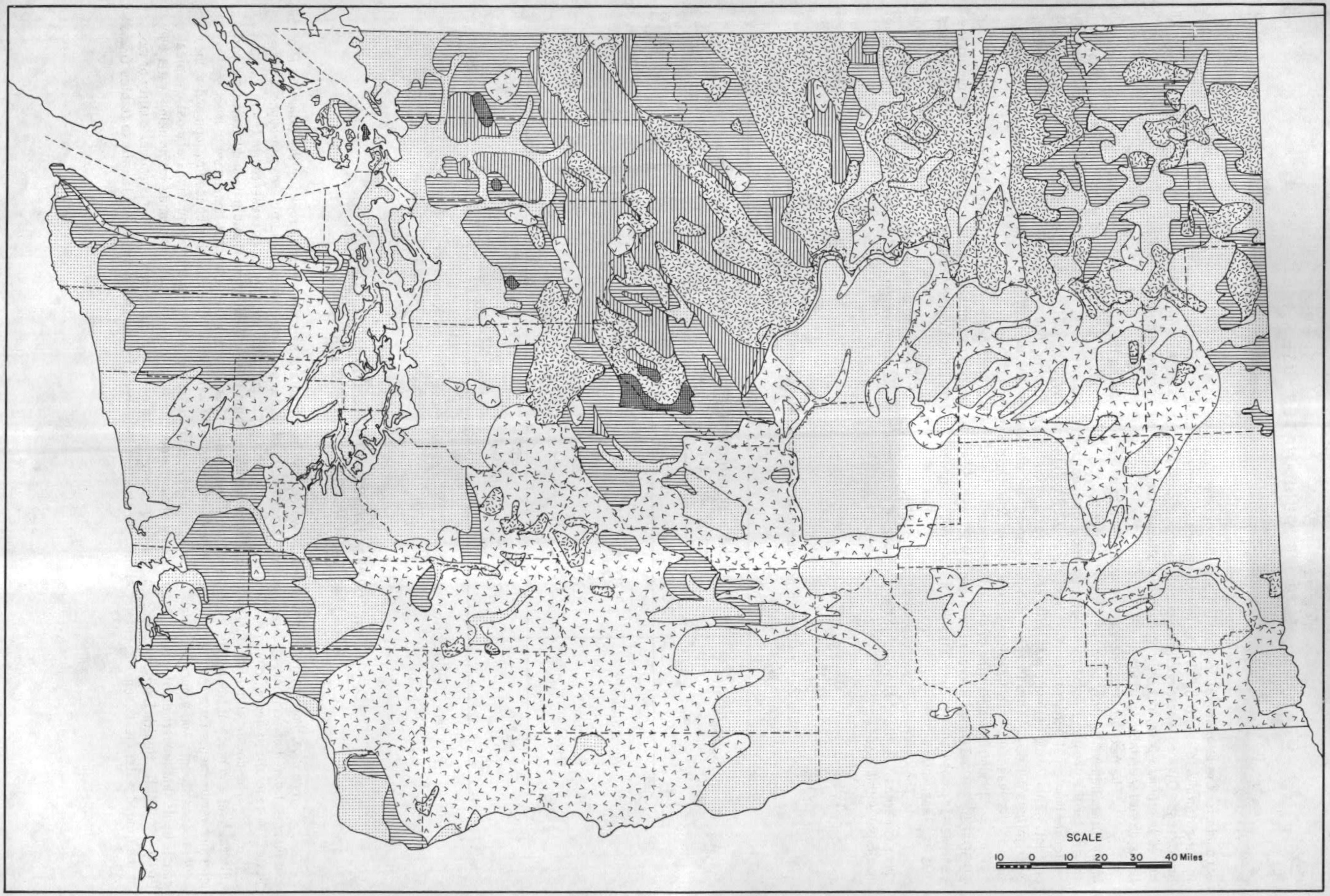
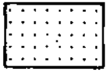
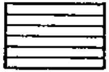
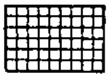


Figure 2.—Generalized geologic map.

EXPLANATION

Geologic symbol	Rock type	Geologic age	Water-bearing properties
	Alluvial, terrace, glacial, and other sedimentary deposits	Quaternary	Important source of water throughout much of state
	Sedimentary and meta-sedimentary rocks	Pre-Cambrian through Tertiary	Unimportant throughout most of state
	Volcanic rocks (primarily basaltic and andesitic)	Carboniferous through Quaternary	Important in Columbia Plateau province
	Intrusive rocks and grantic and intermediate composition	Tertiary and older	Unimportant
	Intrusive rocks of basic and ultra-basic composition	Tertiary and older	Unimportant
	Metamorphic rocks	Pre-Cambrian through Mesozoic	Unimportant

The dissolved-solids content of most Washington ground water is less than 250 ppm (fig. 3). The smallest values, commonly less than 150 ppm, occur in the ground water of mountainous regions with considerable precipitation, and in ground water from much of the Puget Sound lowland. Large dissolved-solids contents, from 500 to more than 1,000 ppm, occur in the water of generally older and deeper aquifers in the lowland area; in ground water contaminated by sea water intrusion; and in ground water of the Columbia Plateau region that has been influenced by saline surface water or by infiltration of concentrated return flow in areas of intensified irrigation.

Principal dissolved constituents of most Washington ground-water are silica, calcium, and bicarbonate, although sulfate or chloride, and sodium are important constituents in some areas. Large concentrations of sulfate (greater than 100 ppm) generally are restricted to ground water east of the Cascade Range, whereas most large sodium and chloride concentrations, exceeding 100 and 250 ppm respectively, occur west of the Cascades.

Concentrations of silica greater than 50 ppm, potassium greater than 10 ppm, fluoride greater than 1.0 ppm, and nitrate greater than 45 ppm are generally restricted to ground water of the Columbia Plateau in eastern Washington; whereas, orthophosphate concentrations of more than 0.50 ppm and iron concentrations of more than 0.30 ppm are most common adjacent to and south of Puget Sound in western Washington (figs. 4, 5, 6, and 7).

The hardness of ground water follows a pattern similar to that of dissolved-solids content (fig. 8). Most ground water contains less than 120 ppm of hardness, and thus is classified as soft or moderately hard (p. 36). However, several areas of greater concentrations occur east of the Cascade Range. Certain of the largest hardness values occur in the water of relatively shallow wells in areas of intensified irrigation such as the Columbia Basin Irrigation Project area. However, much of the generally deeper ground water in the Project area is usually soft and contains moderate to large amounts of silica, potassium, and fluoride.

Ranges in the concentration or value of measured constituents and properties of ground water in the State are summarized in table 3.

Table 3.--Ranges in the concentration or value of measured constituents and properties of ground water in Washington. a/

Constituent or property		High	Sample site	Low	Sample site
Temperature (°F)		132	53	36	428
Silica (SiO_2)	Parts per million	79	121	4.4	295
Iron (Fe) b/		35	382	.00	d/
Calcium (Ca)		5,140	295	1.2	53
Magnesium (Mg)		821	295	.0	53
Sodium (Na)		10,500	295	1.6	58
Potassium (K)		58	295	.0	d/
Bicarbonate (HCO_3)		922	116	0	295
Carbonate (CO_3)		60	140	0	d/
Sulfate (SO_4)		468	168	.0	d/
Chloride (Cl)		28,900	295	.0	d/
Fluoride (F)		2.8	6	.0	d/
Nitrate (NO_3)		99	101	.0	d/
Orthophosphate (PO_4)		4.2	294	.00	d/
Dissolved solids c/		45,500	295	33	58
Hardness		16,200	295	3	53
Specific conductance (micromhos at 25°C)		63,600	295	39	58
pH		9.4	450	4.3	295
Color		350	214	0	d/

a/ Data from table 8.
b/ Iron in solution at time of sample collection.
c/ Either calculated or residue value.
d/ More than one sample has this value or concentration.

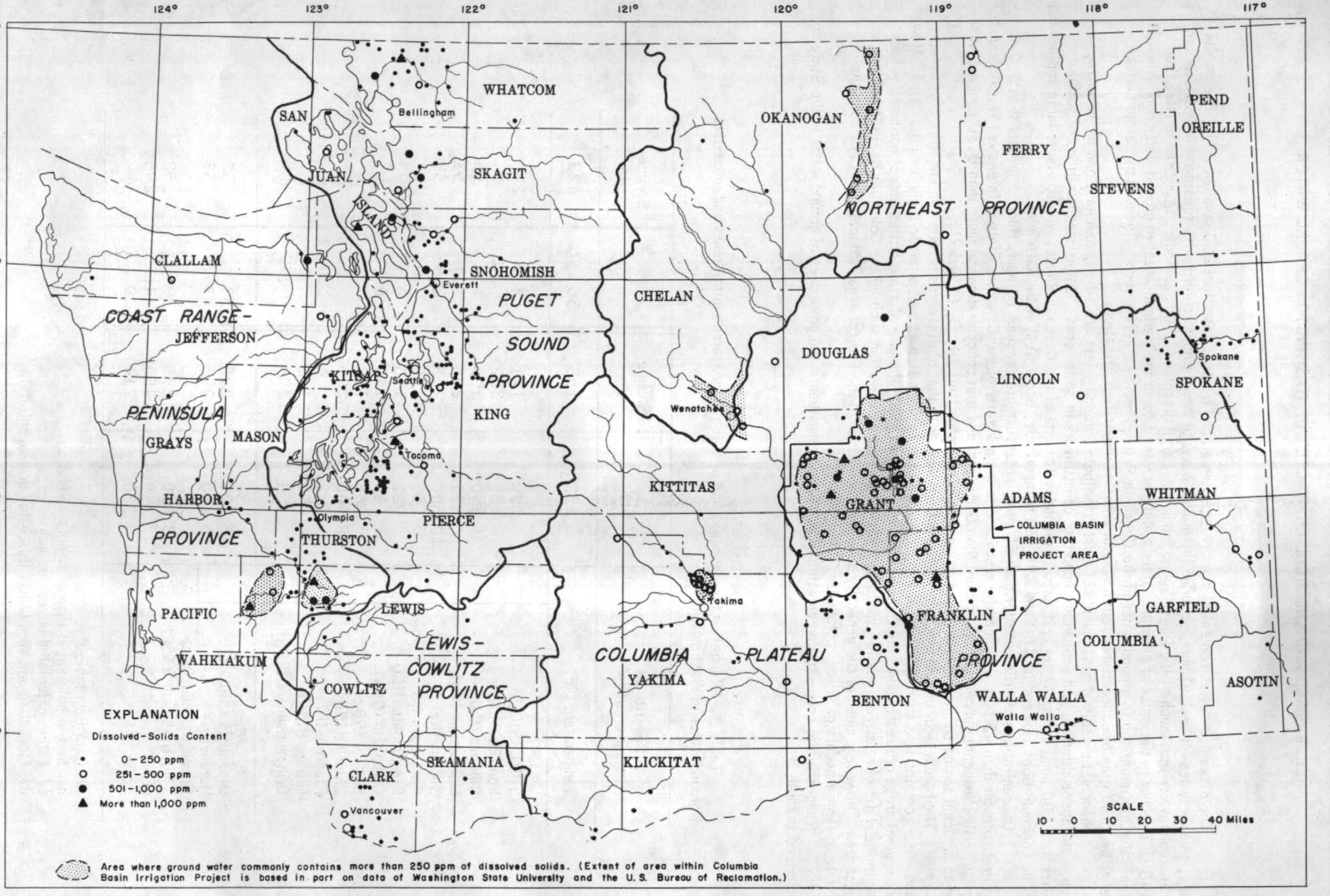


Figure 3.-- Distribution of dissolved-solids content in sampled ground water.

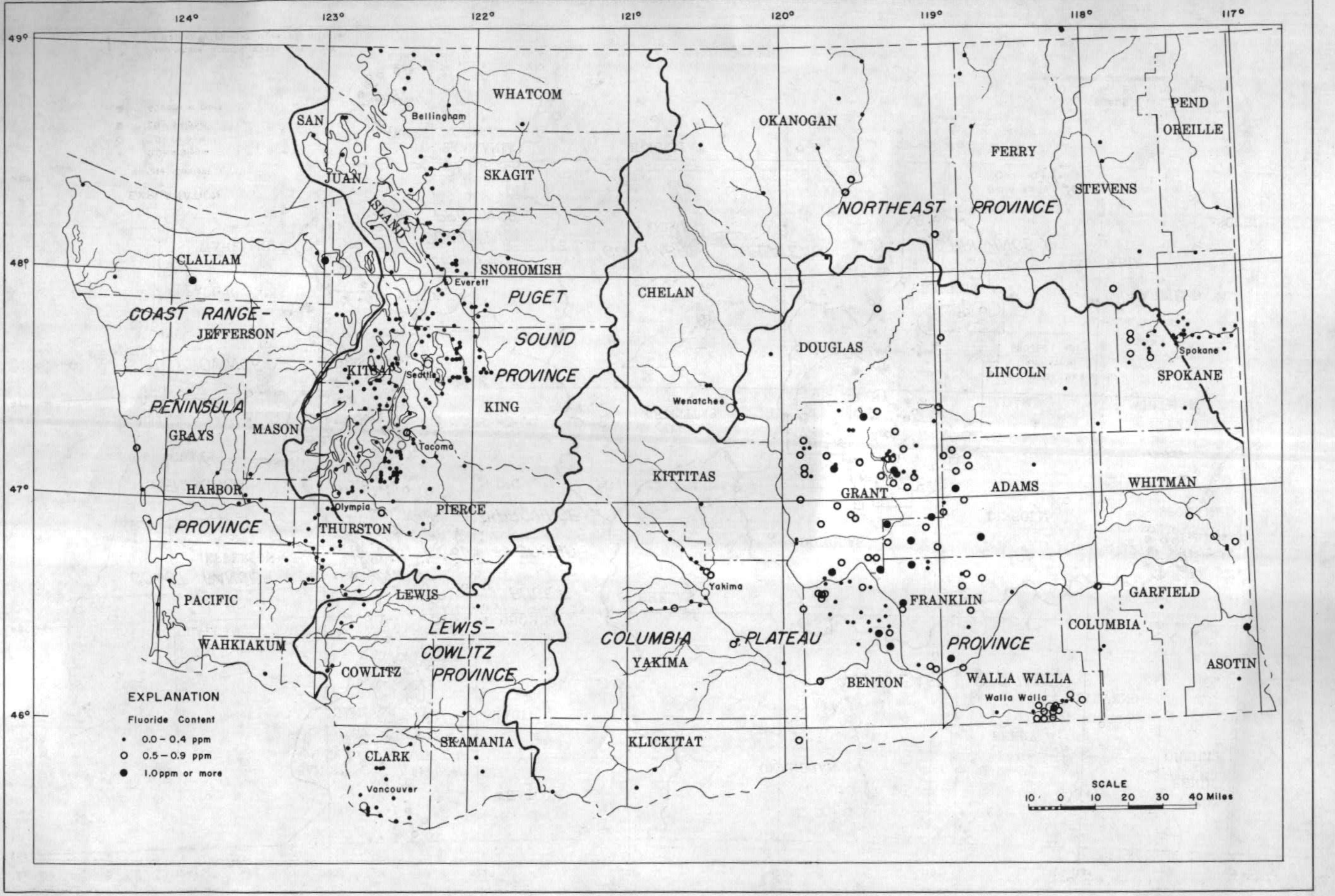


Figure 4.-- Distribution of fluoride concentrations in sampled ground water.

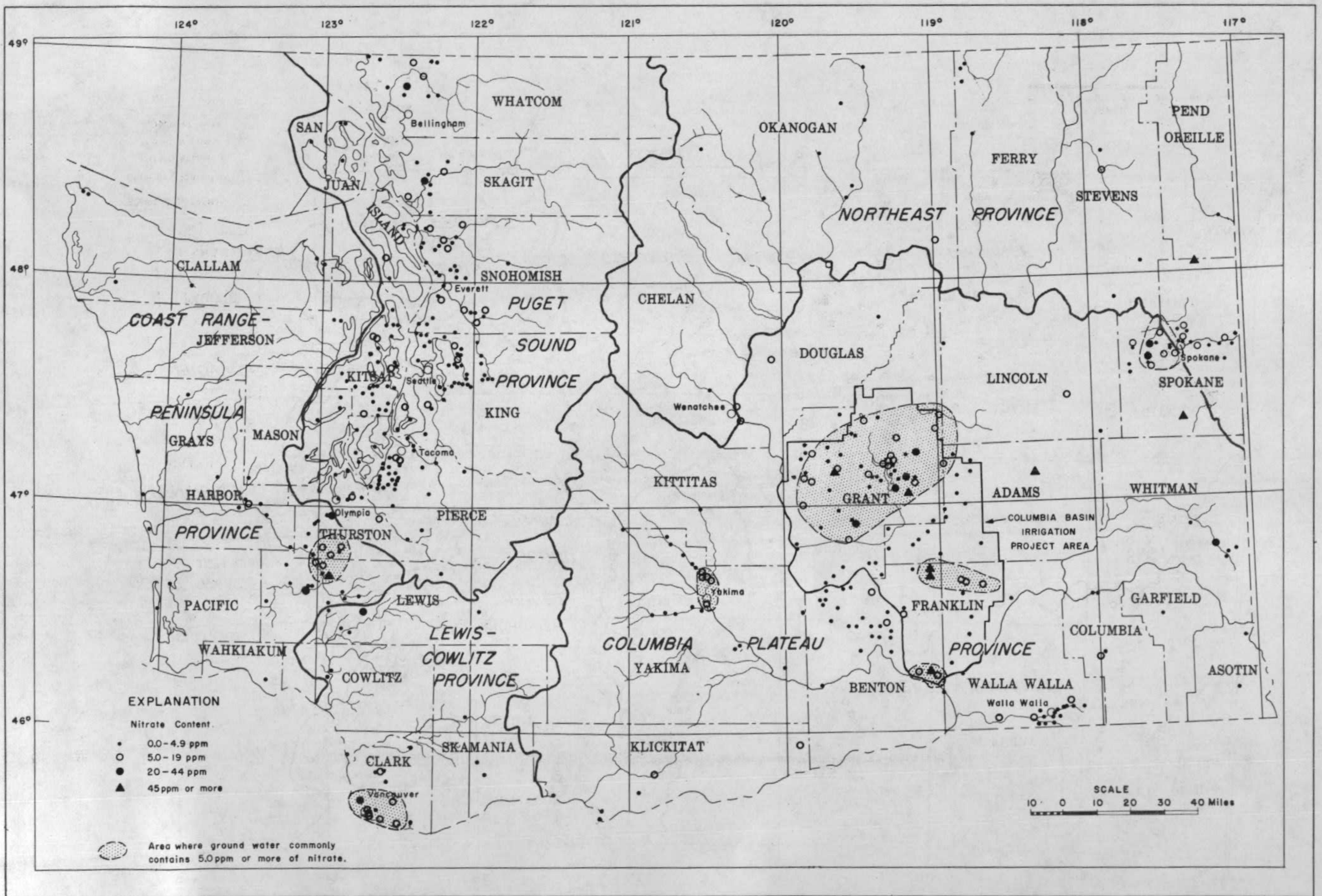


Figure 5.-- Distribution of nitrate concentrations in sampled ground water.

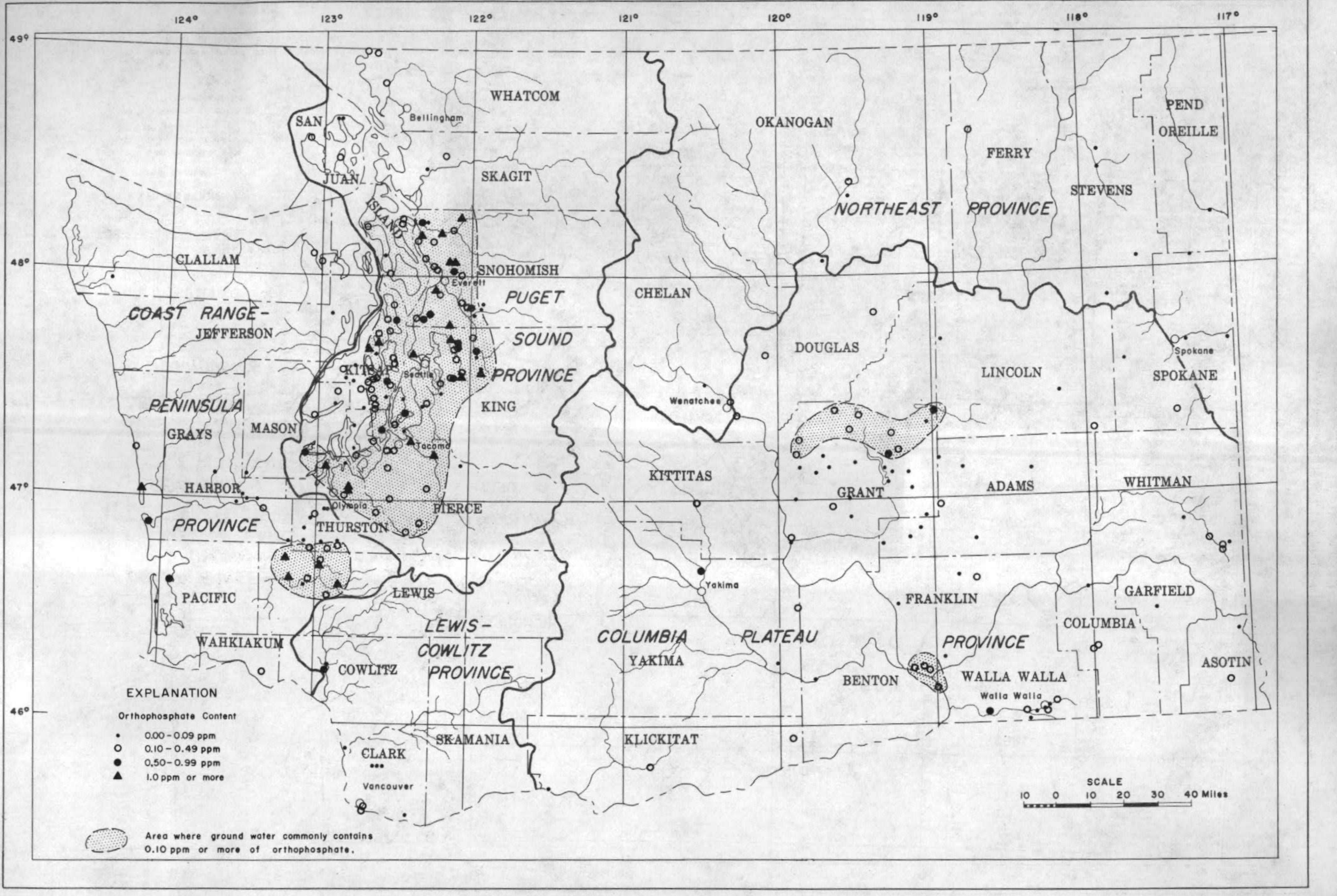


Figure 6.-- Distribution of orthophosphate concentrations in sampled ground water.

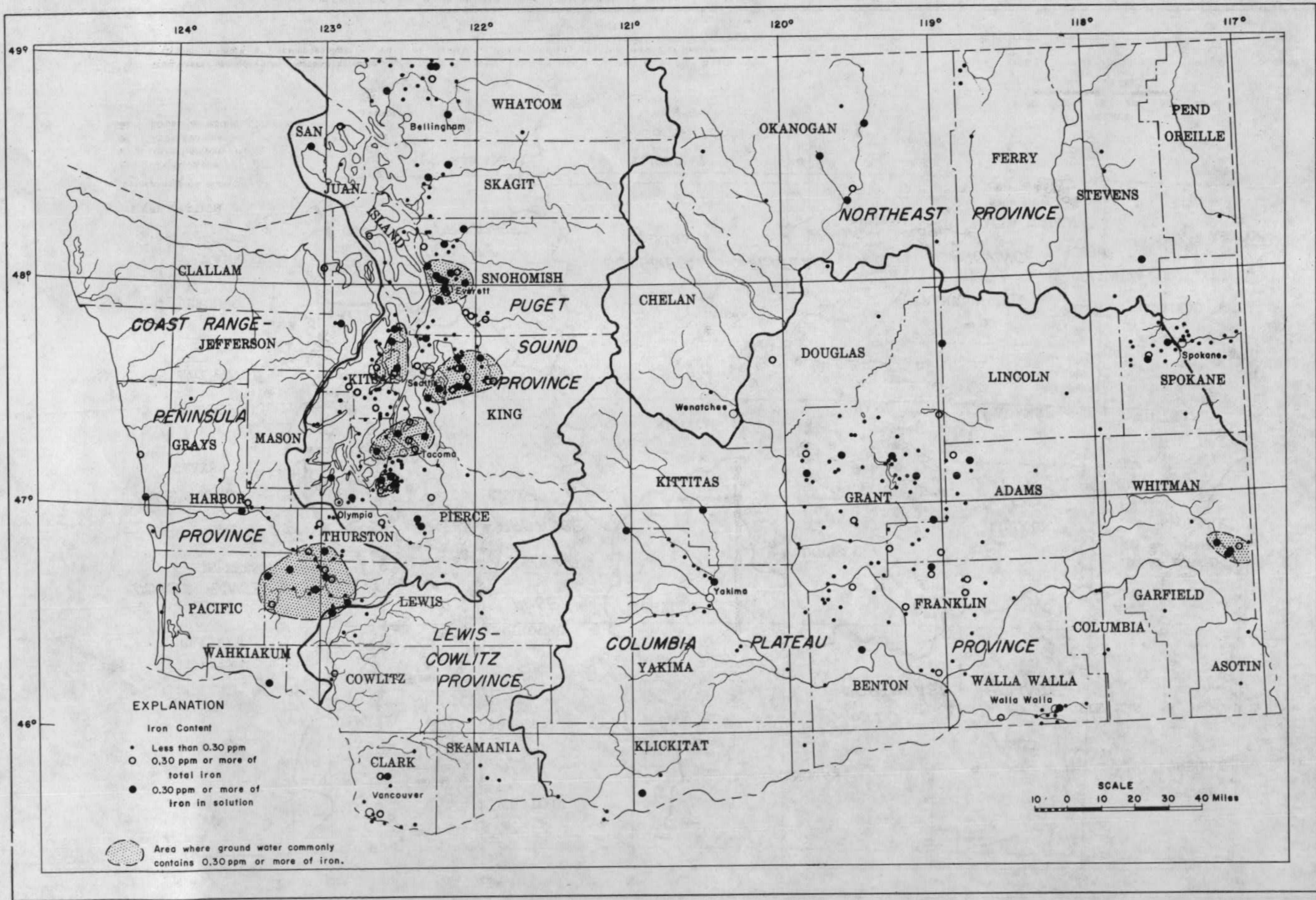


Figure 7.-- Distribution of iron concentrations in sampled ground water.

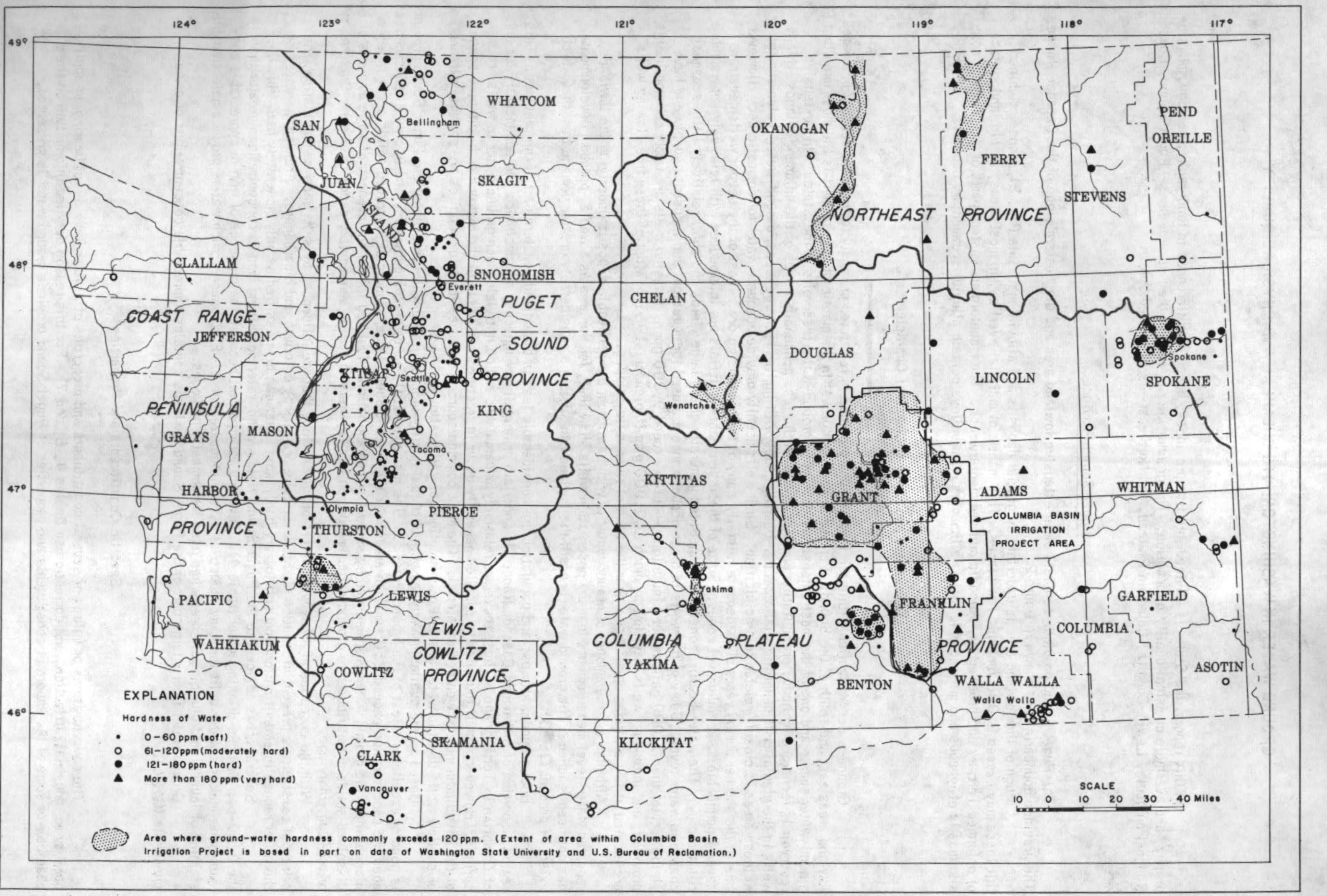


Figure 8.-- Distribution of hardness-of-water values in sampled ground water.

In this report, the State is divided into five provinces, based on differences in topography, geology, physiography, and available chemical quality information. The ground water of each of the five provinces--Puget Sound, Coast Range-Peninsula, Lewis-Cowlitz, Columbia Plateau, and Northeast--is discussed below.

Puget Sound Province

The Puget Sound province consists of an extensive lowland area and the western slope of the Cascade Range. The province boundaries are shown in figure 2.

Much of the lowland area is underlain by glacial deposits and alluvial materials (fig. 2), whose combined thickness may exceed 2,000 feet in a few places. This mantle of material overlies, in most areas, an old land surface of deformed Tertiary and pre-Tertiary volcanic and sedimentary rock. The mountainous eastern parts of the province consist mostly of igneous and metamorphic rocks, although stream valleys contain alluvial sedimentary deposits.

Occurrence and General Chemical Character of Ground Water

Ground-water utilization within the Puget Sound province is restricted primarily to the more densely populated lowland areas east and south of the Sound. Permeable sand and gravel in the mantle of glacial drift is the most important ground-water source and one of the most extensively developed ground-water reservoirs in the State. This extensive reservoir is recharged by heavy precipitation and by runoff from the less permeable slopes of the adjacent uplands. Many wells in the glacial drift penetrate shallow water-bearing zones with limited recharge areas; ground-water replenishment in these areas is closely related to precipitation. Such wells usually provide adequate water for domestic use. However, late in the summer during years of inadequate rainfall, many of these wells go dry. Most of the deeper wells penetrate several permeable sand and gravel zones. Some of these permeable materials are interbedded with relatively impermeable till and clay. The water-bearing zones thus penetrated generally afford large yields and show relatively little seasonal change in water level. Some of the wells in these deeper zones are used for municipal and industrial supply and have yields greater than 1,000 gallons per minute (gpm)--a few exceed 9,000 gpm. Artesian wells are fairly common in this province, and individual wells may flow as much as 2,000 gpm (Molenaar, 1961). Most of these free-flowing wells are located at low altitudes on plains or near the base of river valley slopes.

Although a large amount of ground water is withdrawn from the permeable deposits underlying the lowlands, repeated water-level measurements in many observation wells show that, for the area as a whole, optimum development has not been reached. The ground water beneath the lowland can sustain a considerably greater demand than that which exists at present (1963).

Both ground-water use and population are considerably less in the upland, eastern part of the province. This region, a portion of the rugged Cascade Range, is underlain principally by igneous, metamorphic, and sedimentary rocks of Cambrian to Tertiary age. These rocks are relatively impermeable and do not yield much ground water to wells or springs. However, small to moderate supplies generally occur in fractures and joints of the bedrock or in the pore spaces of the irregular mantle of weathered material. The most common sources of domestic water supplies are springs, streams, or shallow wells that tap water in small accumulations of valley alluvium.

Based on the available analyses, the chemical quality of most ground water throughout the Puget Sound province is good or excellent. Most of the ground water contains less than 150 ppm of dissolved solids, and in only a few samples does the concentration exceed 250 ppm. In areas near the Puget Sound, large amounts of dissolved solids occur in a few places where the ground water is influenced by sea-water contamination. Isolated inland occurrences of large amounts of dissolved solids are attributed to ground-water production from aquifers in marine sedimentary deposits of early Quaternary or pre-Quaternary age.

With the exception of a few well waters of the province that are influenced by salt-water contamination, the principal constituents present in solution characteristically are silica, calcium, and bicarbonate. Although hardness of the water ranges in classification from soft to very hard, most water can be classified as only moderately hard (fig. 8).

Several areas adjacent to the Puget Sound yield ground water containing iron in concentrations greater than the 0.30-ppm limit for drinking water (table 4). This fact is important because the presence of iron in appreciable concentrations makes a water unfit for many industrial uses without treatment. Furthermore, such waters produce objectionable staining of laundry and plumbing fixtures when used for domestic purposes.

Ground water from a large part of the Puget Sound lowlands contains appreciable concentrations of orthophosphate (fig. 6).

Specific Constituents and Properties

The concentrations or values of several constituents and properties of a water have direct bearing on applicability to industrial, irrigation, and domestic use (tables 4, 6, and 7). For this reason detailed information on the character of some of the important constituents and properties of Puget Sound province ground water is presented.

Silica

Several industrial applications require waters of small silica content. Ground water of the Puget Sound province contains silica in concentrations ranging from 7.0 to 63 ppm, although the majority of values fall in the 25 to 40-ppm range. The larger concentrations occur usually in water from older and generally deeper aquifers, where a greater length of "residence" time within the aquifer and a lack of influence by low-silica surface water have allowed more extensive solution of slightly soluble, silica-rich minerals. The high-silica ground water requires treatment prior to industrial use as boiler-feed water, or in the production of paper pulp and ice. For domestic purposes, large concentrations of silica contribute to crusts and deposits that are often attributed to water hardness in water-heating and water-boiling appliances.

Iron

Several problem areas of excessive iron concentration in ground water exist within the Puget Sound province (fig. 7), and it can be expected that future wells in these areas and perhaps in other areas will yield waters containing objectionable concentrations of iron.

Iron is a particularly critical problem in the Everett area of Snohomish County. Here, just as in the other iron problem areas, no obvious relation exists between aquifer depth or age and large iron concentrations. Apparently the majority of aquifers, regardless of depth or geologic age, yield water containing excessive quantities of iron.

Iron can readily be dissolved and kept in solution within an environment of very small oxygen content, termed a reducing environment. It is thus postulated that the ground water with larger concentrations of iron is derived from sedimentary material deposited in regions where organic activity or other actions depleted the oxygen content prior to and perhaps immediately after burial.

Fluoride

Ground water of the Puget Sound province contains, without exception, small amounts of fluoride (fig. 4). The maximum reported value is 0.7 ppm, but more than 90 percent of the analyses show 0.2 ppm or less. Such concentrations are far less than those suggested by the U. S. Public Health Service as being optimum for children's drinking water during the period of tooth calcification (table 5).

Nitrate

Available information indicates no regions of characteristically large nitrate concentrations in ground water of the Puget Sound province (fig. 5); none of the reported concentrations exceed the recommended maximum of 45 ppm. The isolated instances of objectionable nitrate concentrations are generally restricted to ground water obtained from shallow wells, where organic decay and chemical fertilizer of surface or near-surface origin may affect contamination.

Orthophosphate

Large amounts of orthophosphate--more than 0.50 ppm--in many well waters of the Puget Sound province are difficult to explain (fig. 6). Large orthophosphate concentrations are commonly attributed to the influence of sewage containing detergents or water-treatment and other phosphate compounds; or to the percolation of irrigation runoff in areas of extensive phosphate fertilizer use. These sources are probably of only local importance in the Puget Sound province because neither sewage contamination nor phosphate fertilizers are thought to be as wide-spread as is the region of large orthophosphate concentration. Furthermore, on the basis of studies in the Kitsap Peninsula (Van Denburgh, in press), orthophosphate concentrations appear to increase with geologic age and with depth of the aquifer. Contamination from a surface source would be expected to show an opposite trend. Finally, surface waters in the Puget Sound area invariably contain less than 0.10 ppm or orthophosphate (State of Washington, 1961) and this fact adds support for the assumption that orthophosphate may be derived from some mineralogic component of the aquifers themselves.

Dissolved-Solids Content

Very few analyses of ground-water samples from the Puget Sound province show concentrations of dissolved solids greater than 250 ppm; the isolated exceptions have been discussed briefly above. The consistently dilute character of most ground water in the province is attributable to three principal factors. First, annual volumes of precipitation are great, providing an abundant source of dilute aquifer-recharge water; in contrast, evaporation rates are small. Second, there probably are no deposits of highly soluble or even moderately soluble minerals in the area; and finally, there is, as yet, no extensive aquifer pollution of surface origin.

Hardness of Water

The hardness-of-water requirements for many industrial water uses are strict, as shown in table 6. Even for domestic utilization, water hardness greater than 120 ppm is troublesome, and that greater than 180 ppm is very objectionable. Most ground water in the Puget Sound province is soft (60 ppm or less) or only moderately hard (61 to 120 ppm). The part of the lowlands area lying in Snohomish, Skagit, Island, San Juan, Whatcom, and northern King Counties yields ground water with hardness generally between 61 and 120 ppm, whereas ground water in the southern and southwestern parts of the province (Pierce and Kitsap Counties, plus parts of Thurston, Mason, and King Counties) characteristically contains less than 60 ppm of hardness.

Just as with concentrations of silica, the objectionable hardness-of-water values commonly occur in ground water derived from older, and in many cases deeper, aquifers. This fact may become important in the future, when increased water requirements necessitate a greater utilization of water from the deeper and older water-bearing zones.

Salt-Water Contamination

Analyses of the ground-water samples from four wells (sites 187, 306, 368, and 400) located adjacent to the Puget Sound show evidence of sea-water contamination. Principal indicators of such contamination are large amounts of dissolved solids, and large concentrations of sodium and chloride relative to the concentrations of other constituents. Analyses of water samples from three of the wells indicate great variation in dissolved-solids content during the year; maximum concentrations occur during summer and early fall, the period of most intensive water use.

Sea-water contamination is not a serious problem in the Puget Sound province at present (1963). However, all areas adjacent to the Sound are subject to possible contamination, and the expected population development in these areas probably will result in increased ground-water withdrawal and accompanying increases in sea-water contamination. Furthermore, greatest ground-water use occurs during the summer and fall, the periods of lowest recharge rates, and the future expansion of water-using facilities may well be restricted by the amount of ground water that can be withdrawn during such periods without causing serious contamination. Hydrologic data on safe yields from aquifers adjacent to the Sound should be obtained and utilized to prevent the contamination problem from becoming serious.

Several wells (sites 186, 196, 197, 379, 381, and 523) yield water that might be mistaken for sea-water contamination. However, on the basis of either location or detailed chemical character, the waters from these wells are thought to reflect the influence of more concentrated ground water derived from older and somewhat deeper marine sedimentary deposits. (see p. 19 for a discussion of similar ground water in western Lewis County.)

Chemical Quality Variation with Time

Excluding wells effected by sea-water contamination, only a few ground waters show chemical quality variation with time (sites 218, 233, 409, and 416). In three of these well waters, the variation undoubtedly is seasonal, and it probably corresponds to changes in the intensity of use and recharge by dilute surface water. Only the water from well 31/5-7G1 in Snohomish County (site 416) shows a long-term chemical variation, with significant increases in the concentrations of sodium, potassium, chloride, and nitrate during the period 1944-61. This particular change probably represents the increasing influence of saline ground water from somewhat deeper aquifers during the long period of well use. Such a phenomenon probably is uncommon in the province, but may become more important in the future, owning to more intensive ground-water development.

Throughout most of the Puget Sound province, the chemical character of ground water undoubtedly has not changed appreciably within the last two decades. This assumption is based on long-term chemical quality records for the water from nine U. S. Government wells in Pierce County (sampling sites 329, 333, 336-38, 343, and 345-47), and on comparison of older chemical analyses with the large number of recent analyses of samples from wells thoughout the province.

Future potential problems, as discussed above, include sea-water contamination; increased influence of deeper saline ground water; contamination by surface water; and occurrence of excessive iron concentrations. In general, however, the chemical quality of ground water in the Puget Sound province will remain favorable if care is taken to avert or minimize the effects of future contamination.

Suitability for Use

Most ground water in the Puget Sound province is suitable for use as public supply. Only nine sampled wells yielded water with dissolved-solids contents exceeding the recommended 500-ppm limit (table 4), whereas chloride concentrations exceeded the 250-ppm recommended limit in only two samples. Iron concentrations greater than 0.30 ppm are common in ground water from much of the province, and treatment is often advisable, even before domestic use. Hardness of the water is usually acceptable for a public water supply, and water softening rarely is necessary.

Industrial requirements for water quality are generally stricter than requirements for public supply, but most ground water of the province is suitable for the majority of industrial applications without extensive treatment. Objectionable iron concentrations necessitate treatment of ground water from many parts of the province, and several industrial water-uses require prior removal of silica, calcium, and magnesium as well. Most of the ground water is ideal for use as a coolant. Measured water temperatures range from 40 to 66°F, with the majority between 47 and 57°F (table 8).

Ground-water use for irrigation is not nearly as extensive in the Puget Sound province as in other parts of the State. Nonetheless, farmers are discovering that supplemental irrigation during dry summer months increases crop yields and crop quality. In many areas, wells are the only source of sufficient water supplies during such periods. According to the Wilcox method of irrigation-water classification (see discussion on p. 39) all sampled ground waters of the province, with the exception of only eight, are excellent or good for irrigation purposes. Of these eight, only two are classified as unsuitable (wells 368 and 523), and the other six (wells 187, 303, 374, 381 and 400) are doubtful or permissible. Water from the eight wells listed above is derived from aquifers either affected by salt-water contamination, or influenced by the saline water of older formations. These two phenomena are the only ones expected to influence the suitability of Puget Sound province ground water for irrigation use in the near future.

Coast Range-Peninsula Province

The Coast Range-Peninsula province, in the extreme western part of the State, includes the Olympic Peninsula to the north, and the Coast Range to the south. The province extends from the Strait of Juan de Fuca southward to the Columbia River, and from the Pacific Ocean eastward to the Puget Sound. Its boundaries are shown in figure 2.

The mountainous central part of the Olympic Peninsula is formed by fine-grained sedimentary rocks of Mesozoic and Tertiary age. Bordering this area on the north, west, and south are discontinuous, terraced lowlands, where some Pleistocene glaciofluvial materials underlie the surface in isolated areas (fig. 2).

Occurrence and General Chemical Character of Ground Water

Ground-water occurrence in the mountains is restricted chiefly to gravel that has been deposited in the major stream valleys. Many of the deposits underlying the terraces along the coastal part of the province stand above the water table and are well drained; hence they do not store large quantities of ground water. Locally, however, as in the northeastern part of the province near Sequim, much ground water is pumped from wells that tap aquifers in sand and gravel deposits of glacial outwash. These deposits are often present in considerable thicknesses (Noble, 1960, p. 5). Most wells in the Sequim area are less than 200 feet deep, and commonly yield more than 200 gallons per minute (gpm). The ground water in these glacial outwash deposits is recharged chiefly by precipitation and infiltration from streams in the central mountainous area, where precipitation is abundant (in places it may exceed 150 inches annually). In some areas, where a less permeable layer occurs at shallow depth (Noble, 1960, p. 11), recharge to the underlying zones of permeable sand and gravel may be reduced. In some of the irrigated sections, infiltration of irrigation water has raised water levels to within a few feet of the surface during the latter part of the irrigation season.

Bedrock in the Coast Range consists of a series of volcanic and sedimentary rocks ranging in age from Eocene to Miocene (Campbell, 1953, p. 120). Ground water in the upland, south-central part of the province is of importance only in the stream valleys where the alluvial deposits are thick enough to yield economic quantities of water to wells. For example, ground water is extensively developed in the Chehalis River valley.

Both north and south of Grays Harbor, in the west-central part of the province, large areas are underlain by terrace deposits of Quaternary age. These deposits yield moderate amounts of water to wells and springs, and are the principal sources of domestic supply. A persistent capping of clay and clayey soils may restrict the infiltration of water and lessen the recharge of these terrace deposits over wide areas.

Of particular interest are the accumulations of sand deposits of Recent age that underlie the waterfront lands adjacent to Grays Harbor and Willapa Bay. These deposits are well sorted, clean, and very permeable. Yields are commonly as great as several hundred gallons per minute to shallow large-diameter wells. Water in these deposits is recharged by direct precipitation and by ground-water movement from the terraced benches to the east. Although excessive water withdrawal could cause salt-water encroachment, these ground-water bodies appear to be capable of sustaining an annual withdrawal of several hundred million gallons per year to properly spaced and operated wells (Newcomb, 1947, p. 6).

Sampled wells throughout most of the province are less than 100 feet deep, and yield water containing less than 250 ppm of dissolved solids and 120 ppm of hardness (figs. 3 and 8). Silica, calcium, and bicarbonate are generally the principal dissolved constituents of this ground water. With few exceptions, the chemical quality is considered excellent.

In the upper Chehalis River basin of western Lewis County, many deeper wells tap aquifers in marine sedimentary rocks of Tertiary age (Weigle and Foxworthy, 1962, p. 72). These wells produce generally meager supplies of ground water; most yields are less than 10 gpm. However, some wells deriving water from nonmarine sedimentary rocks of Miocene and Pliocene(?) age yield several hundred gallons per minute, and initial flows as great as 600 gpm have been reported for a few wells (Weigle and Foxworthy, 1962, p. 27). The principal constituents of this older and generally deeper ground water normally are sodium, chloride, calcium, and bicarbonate, in that order of abundance. The chemical quality of this water is characteristically marginal or poor; dissolved-solids contents greater than 500 ppm and hardness-of-water values greater than 120 ppm are commonplace. Shallow ground water in the same area contains generally less than 250 ppm dissolved solids and resembles most other well water of the province, with the exception that concentrations of orthophosphate are greater than average, just as in much ground water of the Puget Sound province.

Specific Constituents and Properties

Silica

Silica concentrations vary greatly in ground water of the province. Values range from 4.4 ppm in water from sampling site 295 to 66 ppm in that of site 182. Concentrations greater than 30 ppm occur generally in ground water of western Lewis County, while most wells in other parts of the province yield water containing less than 30 ppm of silica.

Iron

Figure 7 shows that an area of characteristically large iron concentration in ground water exists in the southeastern part of the Coast Range-Peninsula province. Many other wells throughout the province also yield water with iron concentrations more than the 0.30-ppm limit recommended for drinking water (table 8), and it is possible that additional chemical quality information would show that areas of characteristically large iron content are more widespread than indicated in figure 7. Iron values show no clear-cut relation to the depth of the water-bearing material.

Fluoride

Although a sample of water from Sol Duc Hot Springs (136°F) contained 1.6 ppm of fluoride (sampling site 53), all but one of the other ground-water samples from the province contained less than 0.5 ppm (fig. 4). Fluoride concentrations less than 0.5 ppm are well below the optimum values for drinking water (table 5).

Nitrate

Only one sample, a brine from site 295 in Lewis County, contained nitrate in excess of the 45-ppm recommended limit for drinking water. Of the remaining values reported in table 8, only one, from site 289, is great enough to be of some concern from a health standpoint. The 35 ppm of nitrate reported for water from this 36-foot well may indicate contamination from a surface source.

Orthophosphate

The area of commonly greater than average orthophosphate concentration described for ground water of the Puget Sound province extends, with a short apparent break, into the southeastern part of the Coast Range-Peninsula province (fig. 6). Largest orthophosphate concentrations reported in the State of Washington (3.1, 4.2, and 3.0 ppm) occur in the water of three shallow wells (290, 294, and 296 respectively) which derive their production from sedimentary material in the northwestern part of Lewis County. The large orthophosphate contents in samples from sites 290 and 296 are accompanied by large sodium concentrations and small hardness-of-water values. (See table 8.) It is doubtful that contamination from surface or near-surface sources is an explanation for the consistently large orthophosphate concentrations in ground water of the southeastern part of the province. (For additional information see discussion in section on Puget Sound province.)

Water samples from four wells located adjacent to the Pacific Ocean in western Grays Harbor and Pacific Counties contained orthophosphate concentrations greater than 0.10 ppm; the maximum reported value was 1.8 ppm, from a 358-foot well (sampling site 180). Again, contamination is doubted as the cause of large orthophosphate values. The fact that largest measured orthophosphate concentrations along with coast occurred in waters of the two deepest sampled wells supports the non-contamination theory.

With the exception of the coastal and western Lewis County areas, measured orthophosphate concentrations for ground water of the Coast Range-Peninsula province are generally less than 0.10 ppm.

Dissolved-Solids Content

Most ground water in the Coast Range-Peninsula province contains less than 250 ppm of dissolved solids.

Only five wells are shown by chemical analysis to yield water with dissolved-solids contents in excess of the 500-ppm recommended limit for drinking water. All five samples can be classed as sodium chloride waters. However, only the sample from site 55 is thought to exhibit direct contamination by sea water, because the other four wells are located inland, in the western part of Lewis County. Well 295 yields a brine that probably represents sea water trapped in marine sediment and altered chemically during burial. The water from wells 283, 285, and 291 represents a mixture of normal ground water of moderate dissolved-solids content, and brines similar to that of well 295.

Hardness of Water

Many shallow wells in the Coast Range-Peninsula province obtain their water from unconsolidated alluvial sands and gravels of Recent age. These aquifers are recharged primarily by surface-water percolation from adjacent streams. The hardness of the stream water in the province rarely exceeds 60 ppm, and the water from most shallow wells would therefore be expected to be soft or only moderately hard. In fact, ground-water samples from 38 of the 41 wells (and springs) less than 151 feet deep have hardness values of 120 ppm or less, whereas 5 of the 8 samples containing more than 120 ppm of hardness were derived from wells deeper than 150 feet. The larger values of hardness occur most commonly in western Lewis County, in deeper ground water derived from Tertiary sedimentary deposits of marine origin.

Salt-Water Contamination

In the Coast Range-Peninsula province fresh ground water is contaminated by salt-water intrusion from two sources--the sea and older marine sediments. In areas adjacent to the Pacific Ocean or Puget Sound, ground-water contamination by salt water is not a serious problem under the present rate of withdrawal (1963). In fact, only one analyzed sample, from site 55 in northeastern Clallam County, had a chemical composition that suggests even slight contamination by sea water. However, the problem of sea-water contamination undoubtedly will become more serious because development of ground water is very likely to increase in these areas in future years.

The second source of salt-water contamination is not significant now (1963) but will increase in importance in the future throughout much of northwestern Lewis County. In this area, the fresh-water aquifers are underlain by older marine sediments containing saline water. Increased withdrawal from the fresh-water aquifers may cause upward migration of the saline water, thus contaminating the fresh-water supply. An example of this type of contamination is illustrated by the chemical analyses of samples collected from well 416 (table 8).

Chemical Variation with Time

Long-term records of chemical quality are not available for ground water of the Coast Range-Peninsula province. However, many wells were sampled at least twice during the period 1959-61, and few of the analysis pairs show significant chemical change during that time. The analyses of water samples from only six wells (sites 171, 286, 319, 465, 467, and 472) show any appreciable seasonal change. Chemical change in these ground waters probably reflects seasonal variation in the intensity of ground-water use and recharge.

Suitability for Use

Forty-two of the 47 analyzed ground-water samples from the Coast Range-Peninsula province contained less than 500 ppm of dissolved solids. Several of the waters may require softening and iron removal prior to domestic use. All water containing dissolved solids in the 500 to 1,000-ppm range can be used for drinking, but it may have a "salty" taste. Ground water containing more than 1,000 ppm requires treatment prior to domestic use.

Some industrial water-users, particularly those that do not require small concentrations of silica, can utilize most ground water of the province without preliminary treatment. However, moderate to large hardness-of-water values and excessive concentrations of iron and dissolved solids make some ground water in the Chehalis-Centralia area unsuitable for many industrial uses without treatment. Only four sampled well waters in the province had color values greater than 10 units, and the maximum reported value was 35 units. Therefore, almost all of the ground water meets the color requirements for most industrial uses.

Temperatures of ground water in the province range from 46 to 59°F. The seasonal temperature variation is usually only a few degrees; the maximum measured seasonal difference was 7 degrees, in the waters from sites 286 and 302. The low temperature of ground water in the province makes the water an excellent coolant, although treatment for control of corrosion, scale deposition, and micro-organism growth probably would be required for water from some wells.

Waters from 41 of the 49 sampled wells in the province are classified as excellent to good for irrigation, according to the Wilcox System (p. 39). Of the remaining 8, only 1 sample, from well 295, is classified as unsuitable for irrigation. Four waters, from sites 53, 55, 291, and 296, are in the doubtful to unsuitable category, and 3 from sites 283, 285, and 290, are in the permissible-to-doubtful class. Of the 8 waters listed above, 6 are derived from relatively deep aquifers underlying the agriculturally active west-central lowlands of western Lewis County, whereas the other 2 samples are from a well and a spring in unirrigated parts of Clallam County.

Lewis-Cowlitz Province

Most of Lewis-Cowlitz province is a mountainous area--a part of the western Cascade Range. The province boundaries and generalized geology are shown in figure 2. Mountainous parts of the province are underlain chiefly by volcanic rocks, but a lowland area adjacent to the Columbia River in the southwestern part is underlain by sedimentary deposits.

Occurrence and General Chemical Character of Ground Water

The central and eastern mountainous areas, which in this province are underlain primarily by volcanic rocks of Cenozoic age, are unimportant sources of ground water. However, these areas provide large amounts of surface water that recharge some of the important aquifers.

Principal ground-water utilization occurs in the western and southwestern parts of the province--along the Cowlitz River and on the lowlands north and east of Vancouver. These areas are underlain by sand and gravel deposits of Pleistocene and Recent age, which conceal an old land surface of Tertiary and pre-Tertiary volcanic and sedimentary rocks (fig. 2). Yields from the sedimentary deposits are generally good or excellent. In the extreme southern part near Vancouver, many industrial and municipal wells yield more than 2,000 gpm, and one well was reported to yield more than 4,600 gpm (Mundorff, 1960, p. 127).

The chemical quality of most ground water in the Lewis-Cowlitz province is excellent. Dissolved-solids contents are characteristically less than 150 ppm, and hardness-of-water values are less than 100 ppm in all but one sampled ground water. As with most other water from wells west of the Cascade Divide in Washington, the principal constituents are generally silica, calcium, and bicarbonate. The single known potential problem area in the province surrounds Vancouver, where nitrate concentrations in 7 of 8 sampled well waters were more than 5.0 ppm--a sign of possible contamination.

Specific Constituents and Properties

Silica

Silica in ground water shows a large concentration variation throughout the Lewis-Cowlitz province, just as it does in other parts of Washington. The majority of well waters contain more than 30 ppm of silica, and concentrations range from 4.9 to 64 ppm; this range of values is in close agreement with extremes observed in the adjacent Peninsula-Coast Range province. On the basis of somewhat meager data, silica concentrations cannot be correlated with aquifer depth or geologic age.

Samples from wells obtaining water from gravel show a 44-ppm variation in silica concentration (from 7.9 to 52 ppm), whereas water derived from sand aquifers shows only a 25-ppm spread, and mixed aquifers (sand and gravel) yield water with only a 23-ppm variation, from 27 to 50 ppm silica.

Iron

Figure 7 shows that an area of characteristically large iron concentrations in ground water is located northwest of the province. However, the small number of available analyses are insufficient to define the extent of this area in the Lewis-Cowlitz province. Elsewhere throughout the province, available analyses indicate that iron concentrations in ground water are generally less than the 0.30-ppm limit of concern.

Fluoride

The maximum fluoride concentration observed in ground water of the province was only 0.4 ppm (fig. 4). This value is considerably less than concentrations recommended in table 5 for the drinking water of regions that have annual average maximum daily air temperatures similar to those of the province.

Nitrate

In southwestern Clark County, nitrate concentrations in ground water are characteristically greater than 5.0 ppm (fig. 5). The maximum observed nitrate value was 44 ppm, in the water of shallow well 66. The concentrations of nitrate exceeding 5.0 ppm in this area generally occur in ground water with a hardness value greater than 50 ppm; 5 water samples with hardness values less than 50 ppm also contained less than 1.0 ppm of nitrate.

Larger concentrations of nitrate in shallow ground water of the province may be attributable to contamination from at or near the land surface; but such contamination is doubtful in the water of deeper wells.

Dissolved-Solids Content

With a single exception (site 66), all analyzed ground-water samples from the Lewis-Cowlitz province contained less than 160 ppm of dissolved solids. However, field determinations reported by Weigle and Washburn (1956, p. 344) indicate that some deeper well waters in the extreme northwestern part are calcium sodium chloride brines with dissolved-solids contents greater than 10,000 ppm. These brines are similar to ground water adjacent to the province in western Lewis County.

Hardness of Water

Hardness values in samples of ground water ranged from 13 ppm (well 59) to 162 ppm (well 66). All but one of the sampled waters can be classed as soft or only moderately hard. However, field hardness-of-water determinations reported by Weigle and Foxworthy (1962, p. 240-48) indicate that a few isolated ground waters in the northwestern part of the province are hard to very hard.

Suitability for Use

Ground-water use in the Lewis-Cowlitz province is restricted primarily to domestic and industrial purposes. Low hardness-of-water values and dissolved-solids contents make the water ideal for these applications. Water temperatures are suitable for coolant purposes; observed values range from 44 to only 57°F.

For most industrial applications, water softening and corrosion control are the only treatments required prior to use. Ground water used for municipal supplies usually requires only a standard disinfectant treatment, although a few well waters in the province also require softening.

Ground water containing more than 10 ppm of nitrate should be suspected of contamination from the land surface--particularly if the well is shallow. These waters may require treatment and monitoring to insure the maintenance of acceptable sanitary quality.

All analyzed ground-water samples from the Lewis-Cowlitz province are classified as good or excellent for irrigation use according to the system of Wilcox. (See p. 39 for explanation of Wilcox system.) The amount of ground water used for irrigation within the province is unknown, but such use probably is of moderate importance in Clark and Cowlitz Counties, and it may increase in importance in the future.

Columbia Plateau Province

The Columbia Plateau province includes much of the State east of the Cascade Divide, and is dominated by the Columbia Plateau, an extensive, generally flat area that makes up almost one-fourth of the entire State. To the west and north, the plateau abuts the higher terrain of the Cascade Mountains and northern highlands. To the east, the plateau continues to the foothills of the Rocky Mountains in Idaho, and to the south it extends into Oregon. Boundaries of the province are shown in figure 2.

The plateau area is underlain by a sequence of nearly horizontal basalt flows of Miocene to Pliocene(?) age. In some places the lava is several thousand feet thick. Overlying much of the basalt is a relatively thin mantle of glacial drift, along with wind-deposited, lake-deposited, and other sedimentary material (fig. 2). The central and eastern parts of the province consist in general of a plateau, but they also include numerous anticlinal ridges and synclinal basins, as well as deeply entrenched stream gorges such as those of the Snake and Columbia Rivers.

The mountainous western part of the province is underlain almost entirely by volcanic rocks of Miocene to Recent age.

Occurrence and General Chemical Character of Ground Water

The principal aquifers in the Columbia Plateau province are the widespread Tertiary basalts, the permeable zones in the sedimentary deposits interbedded with the basalts, and the gravelly parts of overlying Quaternary deposits. These aquifers are recharged naturally by locally accumulated precipitation and by infiltrating stream water. In the vicinity of irrigation projects, recharge also occurs by the infiltration of irrigation water (Walters and Grolier, 1960, p. 12; and Molenaar, 1961, p. 16). The tops of basalt flows commonly contain fractured zones, numerous vertical joints, and other porous parts. These porous zones provide adequate conduits for the collection and migration of ground water. In these tabular aquifers, water may be confined by the dense middle parts of basalt flows. In many of the structural basins, the hydrostatic head of the confined ground water is great enough to produce flowing water at land surface. Wells tapping such aquifers have obtained yields of several hundred gallons per minute; some have exceeded 1,500 gpm (Molenaar, 1961). Throughout the Columbia Plateau province, water-bearing zones in the basalt exhibit marked differences in thickness, permeability, and areal extent. In many places sufficient yields can only be obtained by wells 500 to 1,000 feet deep. However, bodies of perched ground water are common in the upland plateau, and wells there consequently have a great range in depth and yield.

The sedimentary deposits of Pleistocene age that overlie the basalt are important sources of ground water along the stream valleys and old channels of glacial outwash. Saturated zones within these deposits are generally thin, but in places they are thick enough to yield several hundred or even a few thousand gallons of water per minute to a correctly placed and completed well. Within the Columbia Basin Irrigation Project area, the number of saturated zones overlying the basalt is increasing where natural topography and lack of sufficient man-made drainage induces infiltration of much of the irrigation return flow. Unfortunately, however, the chemical quality of much of this shallow to moderately deep ground water is poor--hardness-of-water values and dissolved-solids contents often exceed 180 and 500 ppm respectively--and deeper water of better quality must be used for domestic and industrial purposes.

The Cascade Range in the western part of the province is formed chiefly by volcanic rocks of Tertiary and Quaternary age, although non-marine sedimentary deposits of Cretaceous and Tertiary age occupy the extreme northwestern part of the province. Both population and ground-water utilization are small within the Cascade Range, and the most common sources of domestic ground-water supplies are shallow aquifers within stream valley alluvium.

Ground water of the Columbia Plateau province ranges greatly in chemical character, although dissolved-solids content is characteristically less than 250 ppm except in areas where irrigation or other sources of contamination influence ground-water quality.

In areas not subjected to intensified irrigation, the shallow aquifers in or overlying the upper parts of the basalt contain water that has calcium and bicarbonate as the principal dissolved constituents. Deeper ground water derived from aquifers within the basalt commonly contains greater concentrations of sodium and silica, with bicarbonate still the principal negative ion. This chemical variation with depth is most pronounced in the central and southern parts of the province, where deeper ground water can contain large concentrations of silica, sodium, and bicarbonate, plus appreciable amounts of potassium and fluoride, but very little calcium and magnesium.

Where irrigation has influenced the chemical character of ground water--for example, within the Columbia Basin Irrigation Project area--calcium, magnesium, bicarbonate, and sulfate are the important constituents, and concentrations of nitrate and chloride are often appreciable. A more detailed study of ground-water chemistry in the project area will appear as part of a future report.

Specific Constituents and Properties

Silica

The greatest silica concentrations reported for ground water of the State of Washington occur in the Columbia Plateau province, and in general are found in the water of deeper aquifers within the Columbia River Basalt; the maximum value, 79 ppm of silica, occurred in a sample from site 121, a 981-foot well near Warden, in south-eastern Grant County. Figure 9 shows that the majority of silica concentrations are between 41 and 60 ppm, and that concentrations tend to increase with increased well depth. The silica content of water obtained from the Columbia River Basalt is generally greater than 40 ppm, whereas concentrations in the ground water of sedimentary materials overlying the basalt are most commonly less than 50 ppm.

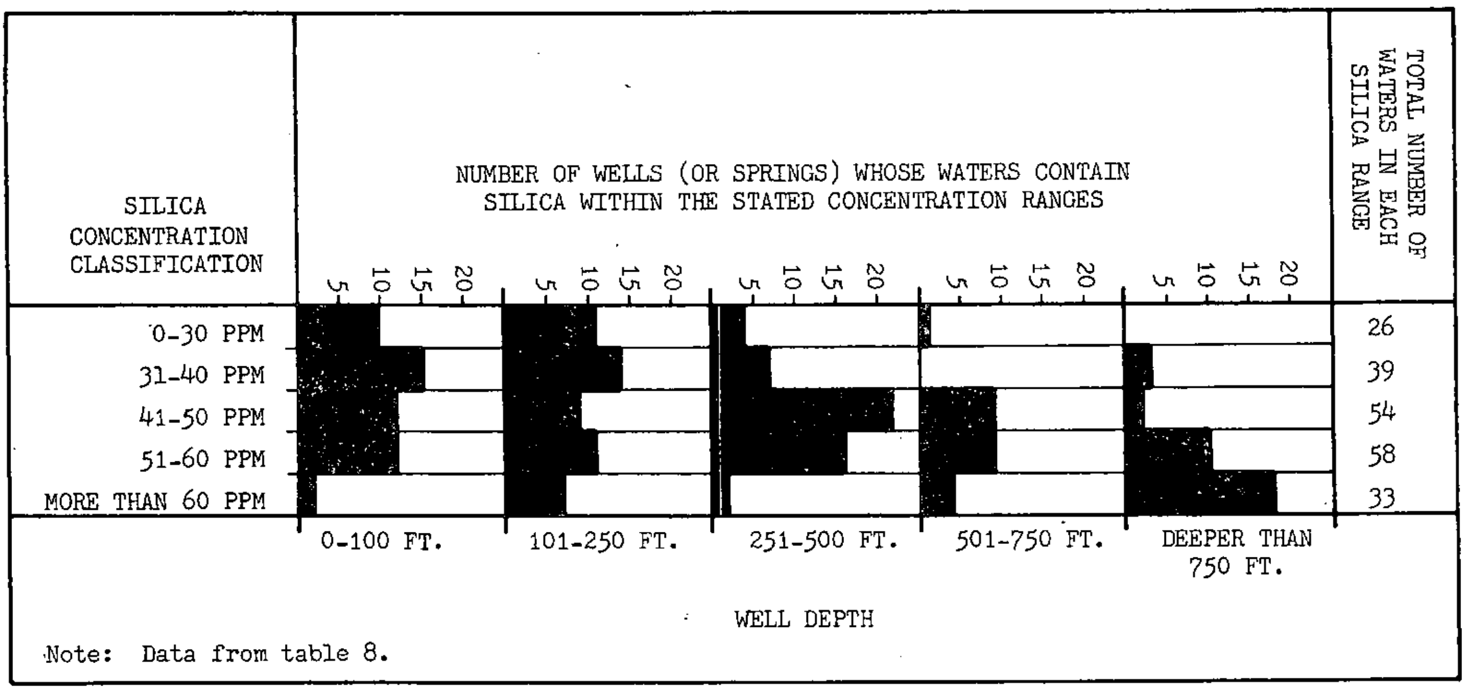


Figure 9.--Relation between silica concentrations and well depths for ground water of the Columbia Plateau province, Washington.

Iron

Concentrations of iron are less than the 0.30-ppm limit of concern (table 4) in most ground water of the Columbia Plateau province. The scattered occurrences of more than 0.30 ppm iron cannot be related to aquifer depth or rock type. Furthermore, in ground water of the central part of the province, many large iron concentrations are termed total iron values. In this water, the iron may be derived from sediment in the sample, rather than actually being in solution at the time of sample collection (p. 36).

Iron concentrations are consistently greater than 0.30 ppm in only two small, isolated parts of the province (fig. 7). The most important of these areas surrounds Pullman, in eastern Whitman County. Although the concentrations are not universally large, they exceed 0.20 ppm of iron in ground water from 9 of the 11 sampled wells, with a maximum concentration of 0.81 ppm. Foxworthy and Washburn (1957b) recorded the analyses of several samples obtained from wells in the adjacent Moscow, Idaho area; reported iron values there were characteristically greater than 1.0 ppm. Thus the Pullman-Moscow area apparently is one of characteristically excessive iron content in ground water.

Sodium

Well water derived from deeper basalt aquifers in the Columbia Plateau province contains commonly greater concentrations of sodium than does water obtained from shallow zones in the basalt and in the overlying sedimentary material. The deeper wells yield water containing commonly more than 30 ppm of sodium, whereas ground water from shallow wells not influenced by concentrated surface water contains less than 30 ppm. These differences are most pronounced in the central part of the province, where sodium concentrations exceed 70 ppm in the water of six wells (sites 2, 5, and 6 in Adams County; site 94 in Franklin County; sites 109 and 139 in Grant County) whose depths range from 304 to 1,396 feet. Greatest sodium concentrations in the province occur in the ground water of shallow wells (for example, sites 116, 132, 168, 490, and 491) whose aquifers are influenced by the more concentrated waters of surface origin. Additional analyses by the U. S. Bureau of Reclamation (Walters and Grolier, 1960) show that excessive sodium content is especially common in shallow ground water adjacent to Soap Lake, Moses Lake, and Crab Creek, in the central part of the province.

Sulfate

Most wells in the Columbia Plateau province but located outside the Columbia Basin Irrigation Project area, and many wells within the project area, yield ground water with sulfate concentrations less than 30 ppm; values smaller than 10 ppm are common.

Excessive concentrations of sulfate are in general restricted to ground water within the irrigation project area in Adams, Franklin, and Grant Counties. Here, concentrations greater than 50 ppm are common, and values greater than the 250-ppm recommended limit for drinking water (table 4) have been reported for several ground-water samples (for example, from sites 95, 101, 123, 132, and 168). Sulfate in ground water of this area probably is derived in part from irrigation returnflow containing the residual of sulfate-base fertilizers, and more importantly, from solution of somewhat soluble minerals that are constituents of the soils and sedimentary deposits underlying irrigated areas (Grolier, Bingham, and Van Denburgh, written communication). Data of the U. S. Geological Survey and the U. S. Bureau of Reclamation show that sulfate concentrations have increased appreciably in the water of many wells within irrigated parts of the project area. These increases may occur elsewhere within the project area in the future as the intensity and extent of irrigation increases.

Fluoride

Ground water in the Columbia Plateau province contains the largest fluoride concentrations reported in the State of Washington (fig. 4). The greatest concentrations of fluoride are most commonly associated with ground water from the deeper zones. Samples from fifteen wells ranging in depth from 66 to 1,815 feet (average, 740 feet) contain more than 1.0 ppm fluoride; the maximum reported concentration is 2.8 ppm in a water sample from well 6 in Adams County. The fluoride-rich ground water characteristically contains large concentrations of silica and sodium. With few exceptions, this type of water is restricted to the central and southern parts of the province.

Recommended fluoride concentrations for drinking water (table 5) are based on average maximum daily air temperatures. Such temperatures for stations at Spokane, Walla Walla, and Yakima are 56.1, 63.6, and 64.7°F respectively (Phillips, 1960, p. 14, 16). For the highest of these average maximum temperatures, the suggested upper fluoride concentration is 1.2 ppm, whereas the optimum value is 0.9 ppm, and the recommended maximum allowable concentration--a concentration twice the optimum value--is 1.8 ppm. The water samples from three wells--sites 2 and 6 in Adams County (both owned by the City of Othello) and site 141 in Grant County (owned by the City of Moses Lake)--contained more than the recommended maximum fluoride concentration. Nine sampled ground waters contained more than the suggested upper concentration of fluoride (based on the highest of the three reported average maximum daily air temperatures). The nine source wells are sites 2, 4, 6, 11, 121, 132, 139, 141, and 168, all in Adams and Grant Counties.

Nitrate

Samples from 10 ground-water sources in the State of Washington contained more than 45 ppm of nitrate (the recommended upper limit for drinking water) and 8 of these 10 samples were obtained from wells in the Columbia Plateau province (sites 14, 90, 101, 102, 126, 132, 423, and 458). Nitrate is an important constituent of water for two reasons. First, its presence in appreciable concentrations is commonly an indication of ground-water contamination from surface or near-surface sources; and second, nitrate concentrations greater than 45 ppm are believed to be harmful to infants (Walton, 1951, p. 986-96).

Five areas of generally moderate to large nitrate concentrations (greater than 5.0 ppm) in ground water occur within the province, and three of these areas are located within the Columbia Basin Irrigation Project area in Adams, Franklin, and Grant Counties (fig. 5). The intensified application of irrigation water within the project area began in the early 1950's, and although several analyses (sites 103, 142, 144, and 159) indicate the presence of moderate nitrate concentrations prior to that time, the large values are restricted to post-1950 analyses. Studies utilizing chemical-quality information from the U. S. Geological Survey and the U. S. Bureau of Reclamation show that significant increases have taken place in the nitrate concentration of water from several wells subsequent to the initiation of intensified irrigation (Grolier, Bingham, and Van Denburgh, written communication). As extreme examples, the nitrate content of water from well 101 increased from 0.4 ppm in 1952 to 99 ppm in 1958, and that of water from well 126 was 9.2 ppm in 1952 and 93 ppm in 1961. The pronounced increases observed in the nitrate content of certain ground water in the project area are attributed to the influence of downward-percolating irrigation water. This theory is supported by pronounced water-level rises in many of the contaminated wells concurrent with intensified application of irrigation water. In most of the ground water the nitrate probably is derived from soluble salts in the soil or in the underlying sedimentary material, and from nitrogen-compound fertilizers.

Another area of characteristically moderate nitrate content in ground water is located along the Yakima River adjacent to Yakima. Unfortunately, most available analyses are of water samples from wells located upstream from Yakima, whereas the most extensively irrigated areas are in the Toppenish Valley, downstream from and immediately south of Yakima.

The fifth area of established moderate to large nitrate concentrations in ground water of the Columbia Plateau province is located immediately west of Spokane. Concentrations as great as 53 ppm have been reported for the water of wells 150 feet or deeper in this extensively irrigated region. Only the water of well 432 shows an appreciable and consistent change in nitrate concentration during the period of record--a decrease from 53 to 34 ppm between 1957 and 1960, accompanied by a decrease in dissolved-solids content from 257 to 203 ppm during the same period. In this area, just as in other irrigated regions where the nitrate content of ground water is characteristically moderate or large, this constituent may well be introduced by irrigation return-flow.

Although nitrate has been related to irrigation in several areas of the province, certain isolated occurrences of large nitrate concentrations in shallow ground water of this province, and of other provinces as well, can probably be attributed to contamination by pollutants of human or animal origin.

Orthophosphate

Concentrations of orthophosphate in ground water of the Columbia Plateau province are commonly less than 0.10 ppm, although a few well waters contain as much as 0.83 ppm (fig. 6). No apparent relation exists between orthophosphate concentration and aquifer rock-type, except that the four largest recorded values for the province occur in the water of shallow wells that derive their production from sand and gravel deposits overlying the basalt.

Although the number of available orthophosphate analyses is small in most parts of this province, three areas of characteristically moderate concentration have been defined. They are located adjacent to the cities of Pasco and Pullman, and in the northern part of the Columbia Basin Irrigation Project area. In the area surrounding Pasco, large orthophosphate concentrations are found in three well waters that contain more than 10 ppm of nitrate, and both constituents may have been derived from irrigation return-flow. The source of moderate orthophosphate concentrations in two well waters (0.22 and 0.24 ppm at sites 533 and 540 respectively) near Pullman is unknown, whereas the orthophosphate in water from shallow well 537 may be attributable to surface or near-surface contaminants.

Moderate orthophosphate concentrations in ground water from the northern part of the Columbia Basin Irrigation Project area may be of mixed source. The two greatest values (0.65 and 0.55 ppm) occur in water of shallow wells 153 and 169. This orthophosphate may be derived from land-surface sources, because similar concentrations are found in the nearby waters of Crab Creek and Moses Lake (unpublished records, U. S. Geological Survey). The source of orthophosphate in water from the other wells is uncertain. However, a lack of correlation between orthophosphate and nitrate--often a contaminant of land-surface origin--in other parts of the project area (for example, well 126) makes irrigation return-flow a doubtful orthophosphate contributor.

Dissolved-Solids Content

The dissolved-solids content of most Columbia Plateau province ground water is less than 250 ppm (fig. 3). Only three areas are known to yield ground water that characteristically contains more than 250 ppm of dissolved solids, but one of these locales, within the Columbia Basin Irrigation Project area, is both extensive and important.

Most Geological Survey analyses of project area ground water are recent (post-1955), whereas intensified irrigation began in many sections during the early 1950's. Nonetheless, a comparison of these recent analyses with earlier ones of the U. S. Bureau of Reclamation--in some instances for water of the same wells--shows that intensified irrigation has altered the chemical quality of much ground water in the area, and also has caused an increase in dissolved-solids content (Grolier, Bingham, and Van Denburgh, written communication).

The dissolved-solids increase undoubtedly is due to several factors, but the principal reasons are: (1) The contribution of dissolved solids through application of fertilizers; (2) the increase in dissolved-solids content of irrigation water through evaporation and transpiration; and (3) the dissolution by irrigation water of soluble and slightly soluble material from soil and underlying sedimentary deposits. The three phenomena increase the dissolved-solids content of the irrigation runoff water that migrates downward to aquifers underlying irrigated areas. The influence of downward-migrating runoff on the native ground water is strikingly shown by pronounced and commonly spectacular rises in the water level of affected wells (Walters and Grolier, 1960; Grolier, Bingham, and Van Denburgh, written communication). For example, the water level in well 101 in Franklin County rose from 225 feet below the land surface in 1951 to only 60 feet below in 1962, and dissolved-solids content increased from 316 to 1,180 ppm between 1952 and 1958.

Increases in the dissolved-solids content of other ground water within the irrigation project area may occur in the future, as irrigation continues in presently developed areas, and as new areas are brought under intensified irrigation.

Dissolved-solids content is known to commonly exceed 250 ppm in the ground water of a second but much smaller area located immediately north of Yakima. With one exception, the greater dissolved-solids content in this area is restricted to the water of wells less than 150 feet deep; these wells derive their production from sand and gravel deposits in and adjacent to the channels of the Yakima River and Wenas Creek. The generally moderate to large amounts of dissolved solids may in part be attributed to the influence of irrigation, which is widespread in the vicinity of Yakima. This supposition is supported by the occurrence of sulfate and nitrate concentrations and hardness-of-water values greater than those found in most other ground water of the area. Also, the shallow sedimentary aquifers may contain greater amounts of slightly soluble minerals than do the deeper water-bearing zones within the basalt, thus providing a more abundant source of dissolved solids.

Other areas within the Columbia Plateau province also may yield water containing more than 250 ppm of dissolved solids. However, the presence and extent of such areas cannot be determined without additional sampling.

Hardness of Water

Ground water in the Columbia Plateau province varies greatly in reported hardness-of-water values--from 8 ppm (well 139) to 1,220 ppm (well 123). However, almost 50 percent of the sampled wells yielded water with hardness values between 61 and 120 ppm; values in this range are classified as only moderately hard.

A distinct relation exists between hardness-of-water values and well depths for the ground water of this province (fig. 10). Hardness-of-water values were greater than 120 ppm in water from 58 percent of the sampled wells that are less that are less than 501 feet deep, whereas hardness values exceeded 120 ppm in water from only 14 percent of the sampled wells that are deeper than 500 feet. This variation with well depth is attributable to two principal factors.

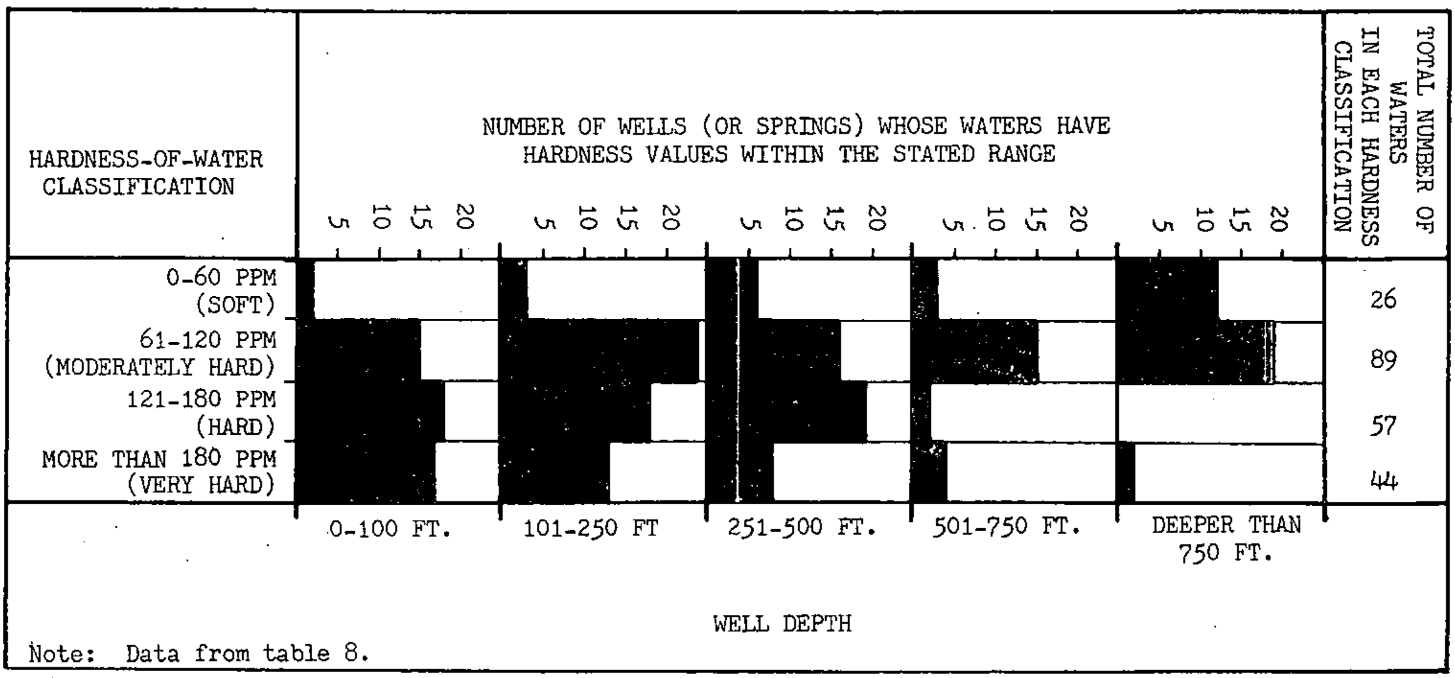


Figure 10.--Relation between hardness-of-water values and well depths for ground water of the Columbia Plateau province, Washington.

First, water derived from aquifers within the basalt normally contains only small concentrations of calcium and magnesium (the two major constituents that determine the hardness of water), whereas the water from shallow sedimentary deposits overlying the basalt contains characteristically greater concentrations. Second, shallow ground water is more subject to the influence of downward-percolating irrigation return flow or other surface water of greater dissolved-solids content.

The effect of intensified irrigation on the hardness of ground water is most readily apparent in the Columbia Basin Irrigation Project area (fig. 8). Although large hardness values were reported as early as 1916 for certain shallow ground water within this area--notably in the western part of the Quincy basin and adjacent to Crab Creek, Soap Lake, and Moses Lake--the concentrations of calcium and magnesium have increased appreciably since 1950 in the water from many deeper wells throughout the intensively irrigated parts of the project area. These changes are exemplified by analyses of the water from 342-foot well 126, southeast of Moses Lake. Between 1952 and 1961 the hardness of water from this well increased from 102 to 306 ppm, whereas the sodium content decreased from 36 to 29 ppm.

The exact source of large amounts of calcium and magnesium is uncertain. However, the two constituents, and possibly sulfate as well, probably are derived from the dissolving of slightly soluble minerals in the soil and in underlying sedimentary deposits by downward-percolating irrigation return flow.

Irrigation may also be a chemical-character influence in two small areas--west of Spokane and adjacent to Yakima--that yield ground water commonly containing more than 120 ppm of hardness.

The ground water of a small area in northeastern Benton County is derived principally from sedimentary deposits overlying the basalt, and it exhibits hardness-of-water values as great as 156 ppm. Calcium is far more abundant than magnesium in this water, and it probably has been derived in large part from solution of the slightly soluble mineral calcite ($CaCO_3$), which undoubtedly is present as a natural cementing material in the sedimentary deposits.

With the exception of the specific areas discussed above, hardness values are generally less than 120 ppm in ground water of the Columbia Plateau province, although further sampling in the future may define additional areas where ground water characteristically is hard or moderately hard.

Very soft ground water (less than 40 ppm of hardness) containing large amounts of silica and fluoride (greater than 60 and 1.0 ppm respectively) occurs in generally deeper aquifers within the basalt, in the central and south-central parts of the province.

Chemical Variation with Time

Two types of chemical quality variation--seasonal and long-term--have been observed in ground water of the Columbia Plateau province.

Appreciable variation is observed during 5- to 7-month periods between collection of sample pairs from 16 wells in the province (wells 7, 8, 16, 79, 87, 90, 122, 126, 132, 143, 164, 168, 169, 274, 490, and 493). For several of the analysis pairs, chemical change during the 5- to 7-month period actually may represent a small part of a greater long-term change, but most of the observed variations are thought to be seasonal. Hardness-of-water values and dissolved-solids contents increased in 10 of the 15 October-to-May sample pairs, and they decreased in 2 of 3 May-to-November pairs. The variations probably are due mostly to seasonal changes in the intensity of well-water use and aquifer recharge.

Long-term variation in the chemical character of ground water in the Columbia Basin Irrigation Project area has been recorded since the initiation of intensified irrigation in the early 1950's (Grolier, Bingham, and Van Denburgh, written communication). Although the characteristics and intensity of chemical quality change are not uniform throughout the project area, the most commonly observed variation is an increase in the concentrations of calcium, magnesium, sulfate, chloride, and nitrate relative to concentrations of silica, sodium, and bicarbonate. The changes produce ground water similar to that of wells 101, 102, and 126 (table 8).

Long-term chemical quality changes may become more widespread throughout much of the project area as more land blocks are brought under irrigation in the future. Elsewhere in the Columbia Plateau province, a long-term change is expected only in areas where ground water is being contaminated either by irrigation return flow or by industrial and domestic pollutants. No areas of this type are known at this time (1963), although future sampling and analysis may delineate additional areas where ground water has undergone long-term chemical quality change.

Yearly records of chemical quality dating back as far as 1947 are available for the water of 23 U. S. Government-owned wells located in Franklin (well 100), Grant (wells 107, 153-58), Spokane (wells 425-27, 429-32, 434-37, 440, 453), and Yakima Counties (wells 559, 560). Significant chemical changes are observed in only 4 of the 23 well waters (156, 426, 432, 436).

The pronounced and sudden nature of change in the water from wells 156, 426, and 436, along with that in October 1952 and September 1958 water samples from well 440, is an unusual occurrence in all but shallow ground water. These sudden changes may be anomalous variations produced by aquifer conditions not now known; however, the changes also may have resulted from an inadvertent error in identification of the sampled wells by U. S. Armed Forces personnel who collected these and most of the other ground-water samples from Armed Forces Installations throughout Washington. It also is possible that wells 156, 426, and 436 were deepened or otherwise altered without knowledge of the U. S. Geological Survey; such an alteration could easily produce the change in chemical character of the ground water shown in table 8.

Only the analyses of water from well 432 west of Spokane show a consistent change in chemical character--a decrease in dissolved-solids content--during the period of record.

Suitability for Use

Much of the ground water in the Columbia Plateau province is suitable for use without treatment in most domestic, agricultural, or industrial applications, but many wells yield water of poor chemical quality. Some of these inferior ground waters cannot be used even for domestic purposes without prior treatment. The following sections summarize the applicability of Columbia Plateau province ground water in the three use categories.

Domestic Use

The concentration of iron in a water is a critical factor in the water's applicability for domestic purposes. This constituent is a problem in the ground water of only a few small areas within the Columbia Plateau province (fig. 7). The only known critical area of excessive iron concentration surrounds Pullman in the far-eastern part of Whitman County.

The recommended limit for concentrations of both sulfate and chloride in drinking water is 250 ppm. Chloride concentrations are less than 250 ppm throughout almost the entire province, and sulfate concentrations greater than that value are reported for water samples from only five wells, all confined to Franklin and Grant Counties (wells 95, 101, 123, 132, and 168).

The samples from nine generally deep wells, all located in Adams and Grant Counties, contained more than 1.2 ppm of fluoride, which is the approximate suggested upper concentration limit for drinking water throughout much of the province (table 5). Because large concentrations of fluoride tend to mottle teeth, especially those of children (Dean, and others, 1941, p. 761-92), the amount of fluoride present in water from deeper wells throughout the central part of the province should be determined as a precaution prior to use as a drinking supply.

Water containing more than 45 ppm of nitrate is reported to be dangerous to infants and pregnant women because of the connection between large nitrate concentrations and incidence of methemoglobinemia, or "blue baby" disease (U. S. Public Health Service, 1962, p. 47-50; California Water Pollution Control Board, 1952, p. 301). The Columbia Plateau province, and particularly that part comprising the Columbia Basin Irrigation Project, is a critical area in this regard. Nitrate concentrations in excess of 45 ppm have been reported in the water of 8 sampled wells, 5 of which are located within the project area (fig. 5). The number of wells that yield water containing more than 45 ppm of nitrate may increase in the future, principally within the project area, because of the relation between this constituent and intensified irrigation.

Twelve wells and one spring within the province are reported in table 8 to yield water that contained more than 500 ppm of dissolved solids; and 4 of the 13 ground water samples are from the project area (fig. 3). Although dissolved-solids contents between 500 and 4,000 ppm are not known to be harmful physiologically, they make a water unpalatable, and should be avoided if more dilute water is available (California Water Pollution Control Board, 1952, p. 245). Within the Columbia Plateau province, large amounts of dissolved solids occur most commonly in the water of shallow wells (less than 200 feet deep), especially when that water is influenced by downward-percolating surface water of greater dissolved-solids content. The dissolved-solids content of many shallow well waters in the project area may increase in the future, as irrigation becomes more extensive.

Large hardness-of-water values are perhaps the most bothersome problem in domestic water supplies. This is true throughout much of the province, but particularly so within the project area (fig. 8). Due to chemical changes that have occurred since the initiation of intensified irrigation within this area, much shallow and relatively deep ground water contains moderate to large concentrations of calcium and magnesium; such water should be softened prior to household use.

Agricultural Use

Irrigation is the principal agricultural use of Columbia Plateau province ground water. Although the chemical quality requirements of irrigation water vary considerably depending on crop type, it is possible to make a rough classification of suitability based on concentrations of several constituents, as in table 7.

In all but a very few analyzed waters, concentrations of sulfate and chloride fall within the excellent-to-good classification (table 7). The waters from only five sampled wells (81, 95, 101, 132, 168) contained more than 200 ppm of sulfate, and only five (95, 101, 116, 132, 564) contained more than 70 ppm of chloride. Similarly, only a few sampled ground waters contained more than 350 ppm of dissolved solids, and only five, from wells 95, 101, 123, 140, and 168 in Franklin and Grant Counties, contained more than 700 ppm at the time of sample collection.

Large amounts of sodium accompanied by small concentrations of calcium and magnesium make a water undesirable for irrigation use if its dissolved-solids content also is fairly large (p. 37). Most Columbia Plateau province ground water contains more clacium plus magnesium than sodium, and thus is acceptable for irrigation in this regard. However, certain deeper ground water in the central and southern parts of the province contains characteristically small concentrations of calcium and magnesium but moderate amounts of sodium, resulting in large percent-sodium values. Nonetheless, such water, exemplified by that of wells 2, 5, and 6, is good or permissible for most irrigation purposes because its dissolved-solids content is less than 350 ppm, and its specific conductance therefore is less than about 500 micromhos (fig. 12).

Industrial Use

Table 6 presents chemical quality tolerances for several of the more common industrial water applications. Much ground water from the Columbia Plateau province fails to meet certain of the more rigid requirements, and therefore must be treated prior to use if a better supply is unavailable. Perhaps the most critical constituents and properties from this standpoint are silica, iron, dissolved-solids content, and hardness of water. With the exception of boiler or turbine feed (silica and bicarbonate tolerances), brewing (fluoride, alkalinity, and pH tolerances), and ice production (silica and alkalinity tolerances), the water from deeper aquifers within the Columbia River Basalt is of better and more uniform chemical quality than is most shallow ground water of the province.

Northeast Province

The Northeast province is an area of low rounded mountains, upland plateaus, and upland basins in northeastern Washington. The gorges of the Columbia and Spokane Rivers separate it from the Columbia Plateau to the south. East of Spokane, the province includes the Spokane Valley. The province boundaries are shown in figure 2.

Occurrence and General Chemical Character of Ground Water

The bedrock in more than one-half of the province consists of intrusive igneous rocks; sedimentary, metamorphic, and volcanic rocks make up the remainder (fig. 2). Except for some moderately productive water-bearing zones in volcanic rocks in the central part of the province, most of the bedrock has poor water-storage characteristics and does not yield much ground water.

The most substantial ground-water bodies of the province occur in long channel deposits of outwash gravel in the principal valleys. The most important deposits of this type underlie the Spokane River upstream from Spokane. In this valley, outwash deposits are locally a few hundred feet thick and overlie granitic and metamorphic bedrock. Seismic profiles and other evidence indicate that the buried bedrock surface is a deep pre-glacial and pre-basalt valley (Newcomb and others, 1953, p. 15). The permeable deposits that now partly fill it provide an underground drainage system through which ground water presumably converges westward to and beyond Spokane from an extensive recharge area in Idaho (Piper and LaRocque, 1944, p. 89). Much of the outwash is composed of highly permeable gravel. Weigle and Mundorff (1952, p. 37) have reported yields of more than 9,000 gallons per minute from wells tapping these deposits.

Almost all available ground-water analyses are of samples obtained from wells in the sedimentary deposits of river valleys. The chemical character of these water samples exhibits considerable areal variation. Ground water in valleys of the Okanogan and Wenatchee Rivers, in the western part of the province, characteristically contains more than 250 ppm of dissolved solids and has hardness-of-water values greater than 180 ppm; calcium, bicarbonate, and, in a few waters, sulfate are the principal constituents. Most wells in these valleys are less than 100 feet deep. Wells deeper than 100 feet in the Okanogan valley yield water with the greatest hardness values and dissolved-solids contents reported in the province. Ground water in the eastern part of the province, and particularly that in or adjacent to the Spokane River Valley, usually contains less than 200 ppm of dissolved solids and has hardness values less than 150 ppm. Again, calcium and bicarbonate are the principal constituents.

A distinct difference in chemical character exists between ground water from sedimentary deposits in the eastern part of the Northeast province and adjacent water from deeper aquifers within basalt of the Columbia Plateau province (for example, compare the analyses of water samples from wells 435-39 and 441 in the Northeast province with those wells 431, 432, 434, and 440 in the Columbia Plateau province). Concentrations of silica and sodium are distinctively less in ground water of the Northeast province than in that of the Columbia Plateau province.

Specific Constituents and Properties

Silica

Almost all sampled ground water from the province contained less than 30 ppm of silica. Most silica concentrations in ground water of the eastern half were less than 20 ppm, and the majority of well waters in the Spokane Valley contained only 10 to 15 ppm.

Iron

Concentrations of iron are consistently less than 0.30 ppm except in ground water of the Okanogan valley. Elsewhere throughout the province, most measured iron concentrations were less than 0.10 ppm (fig. 7).

Fluoride

The maximum fluoride concentration observed in ground water of the province was 0.7 ppm. All other values were equal to or less than 0.5 ppm (fig. 4)--well below the recommended lower limit for fluoride concentrations in drinking water (table 5).

Nitrate

Analyses of ground-water samples from the Northeast province show a wide range of nitrate concentrations. Values ranged from 0.0 ppm in water from Stevens County to 96 ppm in one isolated sample from Spokane County (well 458). This maximum nitrate concentration may have been caused by contaminated seepage from a surface source, because the well is only 14 feet deep. About 80 percent of the wells sampled throughout the province yielded water containing less than 5 ppm of nitrate--well below the limit of concern (fig. 5).

Dissolved-Solids Content

The dissolved-solids content of ground water from major sedimentary aquifers in the province ranges from a characteristic 250-350 ppm in the western part to a characteristic 125-175 ppm in the east (fig. 3). An exception to this trend is the ground water derived from isolated aquifers outside major river valleys in the western part of the province (for example, wells 309, 312, and 313 in Okanogan County). The dissolved-solids content of this water is commonly less than 200 ppm.

Hardness of Water

Hardness values for most ground-water samples from the province are greater than 120 ppm; values less than 120 ppm are restricted to samples from the northwestern and far-eastern parts (fig. 8). Hardness-of-water values exceeding 180 ppm are common in ground water obtained from sedimentary deposits in the Okanogan River valley. Similar deposits in other valleys (for example, the Wenatchee, Kettle, and Colville River valleys) may yield water with similarly large hardness values. The moderate to large calcium content (50-100 ppm) that contributes to the excessive hardness of ground water in the Okanogan valley, and the accompanying bicarbonate (200-400 ppm) and sulfate (50-100 ppm) as well, probably are derived largely from limestone and other sedimentary rocks that are common throughout much of the Okanogan River basin. Additional calcium, bicarbonate, and sulfate may be derived from percolating irrigation water in the agriculturally productive Okanogan valley.

Chemical Variation with Time

Long-term chemical quality records are available for ground water in only two isolated areas--west of Spokane, and west of Curlew in northern Ferry County. In both areas the water shows no overall long-term change in chemical character, but the shallow ground water exhibits slight to moderate year-to-year fluctuations. A sudden apparent change in the character of water from well 436 in Fort George Wright west of Spokane occurred between July 1958 and September 1959. Isolated, sudden, and pronounced changes of this type in the water of wells on Armed Forces Installations are discussed on p. 27.

Sampling of individual well waters at 5- to 7-month intervals was restricted almost entirely to Okanogan and Spokane Counties. Among the nine well waters sampled in this manner, only one--from 26-foot well 311, owned by the City of Omak in Okanogan County--exhibits significant seasonal fluctuation. Well 311 is located southeast of an extensive area of irrigated orchards, and the chemical fluctuation probably reflects changes in intensity of both water use and artificial recharge by irrigation runoff. Dissolved-solids content and hardness-of-water values were considerably greater in October 1959 and 1960 (following periods of greater water use and irrigation runoff) than in May 1960.

Suitability for Use

Most ground water in the Northeast province is suitable for domestic and agricultural use, and for all but the few industrial applications that have highly restrictive chemical quality limitations.

The only widespread water-quality problems are due to large hardness-of-water values. Most ground water in the province is obtained from sedimentary deposits that fill stream valleys such as those of the Spokane, Colville, Columbia, Okanogan, and Wenatchee Rivers. These sedimentary aquifers yield water with hardness values characteristically greater than 120 ppm; values greater than 180 ppm are common in valleys of the Okanogan and Wenatchee Rivers (fig. 8). In spite of moderate to large hardness values, the dissolved-solids content of all analyzed ground water in the province is less than 500 ppm, and generally less than 250 ppm (fig. 3).

FUTURE GROUND-WATER QUALITY TRENDS AND PROBLEMS IN WASHINGTON

In many parts of the State, the chemical quality of ground water is expected to remain excellent or satisfactory in the near future. Among such areas are: A large part of the Puget Sound lowlands; the lowlands in Clark County; much of the Yakima River valley; the eastern Washington cities of Walla Walla and Spokane, and adjacent areas; and a number of less important river valleys and other regions in both the eastern and western parts of the State.

Areas where chemical quality problems are known to exist now, or are expected to develop in the near future, are discussed below. It should be emphasized that knowledge of these problems is not conclusive and further studies are needed throughout much of the State, not only to better define the patterns of present ground water quality, but also to delineate new problem areas that are developing.

West of the Cascade Divide

Sea-water contamination occurs now, or soon will become an important future problem, in the aquifers of certain lowland areas adjacent to the saline Puget Sound and Pacific Ocean, and on islands in the Sound. In these areas, it will be necessary to: (1) Investigate the amount of ground water that may be withdrawn without chemical-quality deterioration, and then to maintain ground-water withdrawal at or below this limit; and (2) develop other sources of water supply.

Ground water not related to sea-water contamination, but nonetheless containing large amounts of dissolved solids, will continue to be encountered throughout the upper Chehalis River basin, and in isolated wells throughout the Puget Sound lowlands. This water is characteristically from older, deeper aquifers in marine sedimentary deposits. It can contain sufficient amounts of sodium, chloride, and calcium to make it unfit for domestic, industrial, or even agricultural use. The importance of this form of contamination may increase in the future owing to greater utilization of ground water. Additional wells will tap these deeper aquifers, and increased rates of ground-water withdrawal in the future may tend to pull some of the salt water upward, thus contaminating shallower aquifers.

Concentrations of iron greater than 0.30 ppm will continue to be a problem in ground water adjacent to the Puget Sound and in the upper Chehalis River basin.

East of the Cascade Divide

Many of the present and potential future ground-water quality problems east of the Cascade Divide are restricted to the Columbia Basin Irrigation Project area in Grant, Franklin, and western Adams Counties. Certain ground water throughout much of the project area contains large amounts of dissolved solids, which consist principally of calcium, magnesium, sulfate, chloride, and, in some areas, nitrate. Although concentrations of these constituents have not shown recent drastic increases in presently-irrigated areas, additional wells in these areas may come under the influence of such water in the future. Furthermore, a similar chemical character may develop in the ground water of other areas where intensified irrigation is initiated in the future. Safe ground-water supplies still are available in most parts of the project area, but they are generally restricted to deep aquifers within the basalt. To prevent contamination by the water of shallow aquifers in newly drilled deep wells, it may be necessary in the future to case the wells to a considerable depth within the basalt, and to obtain water only from the deeper zones by perforating the casing at desired intervals after first sealing off the upper zones.

When a ground-water supply is obtained for domestic use from a moderate to great depth within the basalt, the concentration of fluoride in the water should be determined, because fluoride concentrations in excess of the recommended drinking-water limits occasionally are found in such water (p. 24). Large concentrations of nitrate are common in certain parts of the project area and at other isolated spots in eastern Washington. The occurrence and distribution of this constituent should be more carefully determined and monitored in the future. Hardness of water is a problem not only within the project area but in the ground water of shallow sedimentary deposits throughout much of Washington east of the Cascade Divide (for example, in the Okanogan River valley of northern Washington). Thus, if deeper ground-water supplies of better quality are available, they should be exploited for domestic and industrial use in favor of the shallow and moderately hard to very hard ground water.

SELECTED BIBLIOGRAPHY

Adams, M. F., 1957, Water resources of the State of Washington: Washington State Coll. (now Washington State Univ.), Inst. of Technology Bull. 237, 21 p.

______1960, Water resources of the State of Washington: Washington State Coll. (now Washington State Univ.), Inst. of Technology Bull. 237, Supp. A, 10 p.

American Water Works Association, 1950, Water quality and treatment: Am. Water Works Assoc. Manual, 2d ed., 451 p.

California Water Pollution Control Board, 1952, Water quality criteria: California Water Pollution Control Board Pub. 3, 512 p.

Campbell, C. D., 1953, Introduction to Washington geology and resources: Washington Div. Mines and Geology Inf. Circ. 22, p. 114-153.

Collins, W. D., 1923, The industrial utility of public water supplies in the United States: U. S. Geol. Survey Water-Supply Paper 496, 59 p.

Collins, W. D., Lamar, W. L., and Lohr, E. W., 1934, The industrial utility of public water supplies in the United States, 1932: U. S. Geol. Survey Water-Supply Paper 658, 135 p.

Dean, H. T., and others, 1941, Domestic water and dental caries: Pub. Health Report 56, p. 761-792.

Foxworthy, B. L., 1953, Ground water in the lower Ahtanum Valley, Washington, and possible effects of increased withdrawal in that area: U. S. Geol. Survey open-file report, 26 p.

______1962, Geology and ground-water resources of the Ahtanum Valley, Yakima, County, Washington: U. S. Geol. Survey Water-Supply Paper 1598, 100 p.

Foxworthy, B. L., and Washburn, R. L., 1957a, Reconnaissance investigation of ground water in the Wellpinit area, Stevens County, Washington: U. S. Geol. Survey open-file report, 14 p.

______1957b, Ground water in the Pullman area, Whitman County, Washington: U. S. Geol. Survey open-file report, 122 p.

______1963, Ground water in the Pullman area, Whitman County, Washington: U. S. Geol. Survey Water-Supply Paper 1655, 71 p.

Griffin, W. C., Watkins, F. A., Jr., and Swenson, H. A., 1956, Water resources of the Portland, Oregon and Vancouver, Washington area: U. S. Geol. Survey Circ. 372, 45 p.

Griffin, W. C., Sceva, J. E., Swenson, H. A., and Mundorff, M. J., 1962, Water resources of the Tacoma area, Washington: U. S. Geol. Survey Water-Supply Paper 1499-B, 101 p.

Hart, D. C., 1957, Feasibility of recharging basalt aquifers in the Walla Walla area, Washington: U. S. Geol. Survey open-file report, 35 p.

Hem, J. D., 1959, Study and interpretation of chemical characteristics of natural water: U. S. Geol. Survey Water-Supply Paper 1473, 269 p.

Huntting, M. T., and others, compilers, 1961, Geologic map of Washington: Washington Dept. of Conservation.

Krieger, R. A., Hatchett, J. L., and Poole, J. L., 1957, Preliminary survey of the saline-water resources of the United States: U. S. Geol. Survey Water-Supply Paper 1374, 172 p.

Landes, Henry, 1905, Preliminary report on the underground waters of Washington: U. S. Geol. Survey Water-Supply Paper 111, 96 p.

Liesch, B. A., 1955, Records of wells, water levels, and quality of ground water in the Sammamish Lake area, King County, Washington: U. S. Geol. Survey open-file report, 193 p.

Liesch, B. A., Price, C. E., and Walters, K. L., 1963, Geology and ground-water resources of northwestern King County, Washington: Washington Dept. of Conservation Water Supply Bull. 20, 241 p.

Lohr, E. W., and Love, S. K., 1954, The industrial utility of public water supplies in the United States, 1952, pt. 2, States west of the Mississippi River: U. S. Geol. Survey Water-Supply Paper 1300, 462 p.

MacKichan, K. A., 1951, Estimated use of water in the United States, 1950: U. S. Geol. Survey Circ. 115, 13 p.

______1957, Estimated use of water in the United States, 1955: U. S. Geol. Survey Circ. 398, 18 p.

MacKichan, K. A., and Kammerer, J. C., 1961, Estimated use of water in the United States, 1960: U. S. Geol. Survey Circ. 456, 46 p.

Molenaar, Dee, 1961, Flowing artesian wells in Washington State: Washington Dept. of Conservation Water Supply Bull. 16, 115 p.

Mundorff, M. J., 1960, Geology and ground water resources of Clark County, Washington: Washington Dept. of Conservation Water Supply Bull. 9, 660 p.

Mundorff, M. J., Reis, D. J., and Strand, J. R., 1952, Progress report on ground water in the Columbia Basin Project area, Washington: U. S. Geol. Survey open-file report, 229 p.

Mundorff, M. J., Weigle, J. M., and Holmberg, G. D., 1955, Ground water in the Yelm area, Thurston and Pierce Counties, Washington: U. S. Geol. Survey Circ. 356, 58 p.

Newcomb, R. C., 1947, Ground water of the south-bar area, Grays Harbor, Washington: U. S. Geol. Survey open-file report, 12 p.

______1948, Ground water in the Kennewick area, Washington: U. S. Geol. Survey open-file report, 15 p.

______1951, Preliminary report on the ground-water resources of the Walla Walla basin, Washington-Oregon: U. S. Geol. Survey open-file report, 198 p.

______1952, Ground-water resources of Snohomish County, Washington: U. S. Geol. Survey Water-Supply Paper 1135, 133 p.

Newcomb, R. C., Sceva, J. E., and Stromme, Olaf, 1949, Ground-water resources of western Whatcom County, Washington: U. S. Geol. Survey open-file report, 134 p.

Newcomb, R. C., and others, 1953, Seismic cross sections across the Spokane River valley and the Hillyard Trough, Idaho and Washington: U. S. Geol. Survey open-file report, 16 p.

Noble, J. B., 1960, A preliminary report on the geology and ground-water resources of the Sequim-Dungeness area, Clallam County, Washington: Washington Dept. of Conservation Water Supply Bull. 11, 43 p.

Peale, A. C., 1886, Lists and analyses of the mineral springs of the United States (a preliminary study): U. S. Geol. Survey Bull. 32, 235 p.

Phillips, E. L., 1960, Climates of the states; Washington: U. S. Weather Bureau, Climatography of the United States no. 60-45, 23 p.

Piper, A. M., and LaRocque, G. A., Jr., 1944, Water-table fluctuations in the Spokane Valley and contiguous area, Washington-Idaho: U. S. Geol. Survey Water-Supply Paper 889-B, 139 p.

Price, C. E., 1960, Artificial recharge of a well tapping basalt aquifers, Walla Walla area, Washington: Washington Dept. of Conservation Water Supply Bull. 7, 50 p.

Rainwater, F. H., and Thatcher, L. L., 1960, Methods for collection and analysis of water samples: U. S. Geol. Survey Water-Supply Paper 1454, 301 p.

Roberts, E. H., 1936, The quality of Washington waters: Washington State Coll. (now Washington State Univ.), Agr. Exp. Sta., 35 p. (mimeo).

Sceva, J. E., 1950, Preliminary report on the ground-water resources of southwestern Skagit County, Washington: U. S. Geol. Survey open-file report, 40 p.

______1957, Geology and ground water resources of Kitsap County, Washington: U. S. Geol. Survey Water-Supply Paper 1413, 178 p.

Sceva, J. E., Wegner, D. E., and others, 1955, Records of wells, water levels, and quality of ground water in central Pierce County, Washington: U. S. Geol. Survey open-file report, 261 p.

Schlax, W. N., 1947, Preliminary report on ground-water resources of the central Chehalis Valley, Washington: U. S. Geol. Survey open-file report, 43 p.

State of Washington, 1961, Quality of surface waters, June 1959-July 1960: State of Washington, 97 p.

Taylor, G. C., 1944, Factual data pertaining to wells and springs in the Columbia Basin Project area, Washington: U. S. Geol. Survey open-file report, 85 p.

U. S. Bureau of the Census, 1961, Census of population: 1960: v. 1, chap. 49, p. 49-1 to 49-20.

U. S. Public Health Service, 1962, Drinking water standards, 1962: U. S. Public Health Service Pub. 956, 61 p.

U. S. Salinity Laboratory Staff, L. A. Richards, ed., 1954, Diagnosis and improvement of saline and alkali soils: U. S. Dept. of Agriculture, Agriculture Handb. 60, 160 p.

Van Denburgh, A. S., Chemical quality of ground and surface water, in Washington Dept. of Conservation, Water Resources of the Kitsap Peninsula and adjacent islands, Washington: Washington Dept. of Conservation Water Supply Bull. 18, in press.

Wallace, E. F., and Molenaar, Dee, 1961, Geology and ground-water resources of Thurston County, Washington: Washington Dept. of Conservation Water Supply Bull. 10, v. 1, 254 p.

Walters, K. L., and Grolier, M. J., 1960, Geology and ground water resources of the Columbia Basin Project area, Washington: Washington Dept. of Conservation Water Supply Bull. 8, v. 1, 542 p.

Walton, G., 1951, Survey of literature relating to infant methemoglobinemia due to nitrate-contaminated water: Am. Jour. Pub. Health, v. 41, p. 986-996.

Washburn, R. L., 1954, Preliminary investigation of ground water in the East Sound area, Orcas Island, San Juan County, Washington: U. S. Geol. Survey open-file report, 25 p.

______1957, Ground water in the Lummi Indian Reservation, Whatcom County, Washington: U. S. Geol. Survey open-file report, 31 p.

Washington Department of Conservation, 1960, Water resources of the Nooksack River basin and certain adjacent streams: Washington Dept. of Conservation Water Supply Bull. 12, 187 p.

Washington Department of Health, 1949, Chemical analyses for waters of the State of Washington: Washington Dept. of Health, 22 p., (mimeo).

______1955, Fluoride concentrations of public water supplies in Washington: Washington Dept. of Health, 7 p., (mimeo).

Wegner, D. E., 1956, Preliminary investigation of ground water in the Grayland watershed, Grays Harbor and Pacific Counties, Washington: U. S. Geol. Survey open-file report, 32 p.

Weigle, J. M., and Mundorff, M. J., 1952, Records of wells, water levels, and quality of ground water in the Spokane Valley, Spokane County, Washington: U. S. Geol. Survey open-file report, 101 p.

Weigle, J. M., and Washburn, R. L., 1956, Records of wells and springs, water levels, and quality of ground water in Lewis County, Washington: U. S. Geol. Survey open-file report, 352 p.

Weigle, J. M., and Foxworthy, B. L., 1962, Geology and ground-water resources of west-central Lewis County, Washington: Washington Dept. of Conservation Water Supply Bull. 17, 248 p.

Wilcox, L. V., 1948, The quality of water for irrigation use: U. S. Dept. of Agr. Tech. Bull. 962, 40 p.

APPENDIX

Explanation of Terminology

Well and Spring Location System

Tabulated analyses of water samples from wells and springs (table 8) are designated by location code numbers that are based on the legal rectangular subdivision of public lands, with reference to the Willamette base line and meridian. The location number 2/3-13E1 is here used as an example. The two numbers preceding the hyphen indicate the township north and range east (T. 2 N., R. 3 E.) of the Willamette base line and meridian respectively. Because the entire State of Washington is north of the Willamette base line, the letters denoting directions north and south are omitted. Most of the State is east of the Willamette meridian, and the letter "W" therefore is included for wells located west of the Willamette meridian, whereas the letter "E" is omitted for wells east of the meridian. The first number after the hyphen indicates the section (sec. 13), and the letter "E" gives the 40-acre subdivision of the section, as shown in figure 11. The

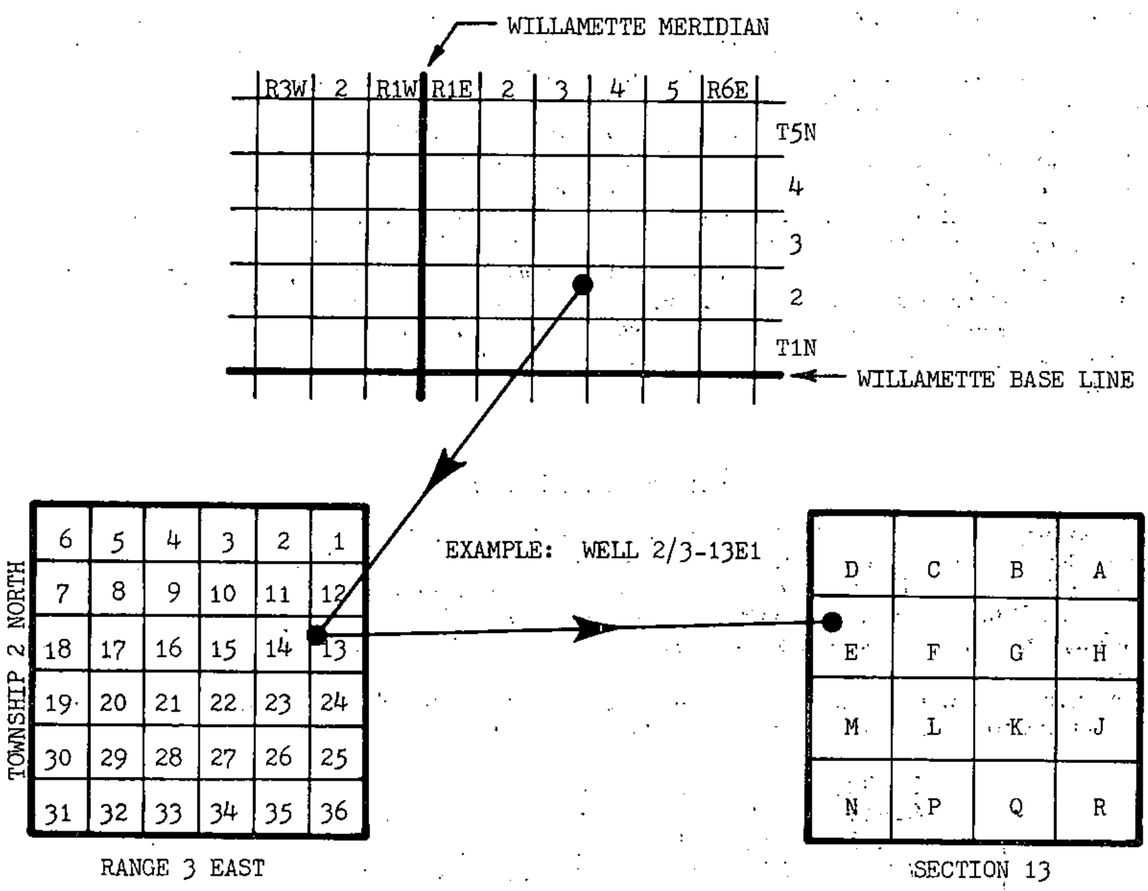


Figure 11.--Well and spring location system.

last number, 1, is the serial number of the well or spring within its particular 40-acre tract. Therefore, well 2/3-13E1 is in the southwest quarter of the northwest quarter of section 13, Township 2 north, Range 3 east, and it is the first well recorded in that tract. Springs are designated by a small "s" following the serial number.

Water Quality Data

Chemical analyses in table 8 show that values of as many as 18 constituents or properties of each ground-water sample. In most natural ground water the principal constituents in solution are silica (SiO_2), calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), bicarbonate (HCO_3), sulfate (SO_4), chloride (Cl), and nitrate (NO_3). Other constituents that are occasionally present in appreciable concentrations are iron (Fe), carbonate (CO_3), fluoride (F), and orthophosphate (PO_4).

Concentrations of the chemical constituents above, the hardness-of-water value, and the dissolved-solids content of water all are reported in parts per million (ppm). One ppm is equivalent to one part of a constituent per million parts of water.

The concentrations of ionized constituents also can be reported in equivalents per million (epm), a unit that expressed concentration in terms of interreacting values. The equivalents per million of a particular ion equals parts per million divided by the equivalent weight (atomic or molecular weight of the ion divided by the ionic charge) of the ion. One epm of any positive ion is equivalent to, and will combine with, exactly one epm of any negative ion. Concentrations of the four positive ions, in parts per million, multiplied by the following appropriate factors, give equivalents per million: Calcium, 0.04990; magnesium, 0.08226; sodium, 0.04350; and potassium, 0.02557.

Several properties of water are not reported in parts-per-million units. Specific conductance, for example, is a measure of the ability of a water to conduct electrical current, and it is expressed in micromhos at 25°C. The specific conductance of a water sample is related to the amount of dissolved solids present. Numerically, the dissolved-solids content of water (in parts per million) is usually 55 to 75 percent of the specific conductance value.

The pH of water is a measure of its acidity (pH less than 7.0) or alkalinity (pH greater than 7.0), and it is expressed in pH units, which are the negative logarithms of hydrogen-ion (H+) concentration.

The determination of water color is based on comparison with a standard color intensity scale; color is reported in color units.

Reported iron concentrations represent iron actually in solution at the time of sample collection, unless they are termed "total iron" values. The classification "total iron" applies to samples that were turbid or that contained sediment at the time of collection. The distinction is made because the sediment or the material forming the turbid suspension can contain iron that is determined as part of the reported iron concentration, even though the iron actually is not in solution at the time of sample collection.

Two methods can be used to determine the dissolved-solids content of a water sample. The concentrations of principal constituents can be totaled, giving a calculated dissolved-solids content; or a known volume of sample can be evaporated and the residue weighed. Results of the two procedures differ usually by less than 10 percent.

Hardness-of-water values are determined by measuring the combined concentration of calcium plus magnesium. Hardness-of-water data are reported as the calcium-carbonate equivalent of this combined concentration.

The percent-sodium value of a water is an important consideration for water use in irrigation. Percent sodium is the ratio, expressed in percentage, of the equivalents per million of sodium to the sum of the equivalents per million of all the principal positive ions in water (calcium, magnesium, sodium, and potassium).

More thorough explanations of water quality data appear in reports by Hem (1959), and by Rainwater and Thatcher (1960).

Water Quality Standards

The concentrations of certain constituents of a water are important determinents of the water's suitability for drinking. Recommended drinking-water standards for five of the several commonly determined constituents of water, as established by the U. S. Public Health Service (1962, p. 7), are presented in table 4. In addition to the above standards, the U. S. Public Health Service (1962, p. 8) also has established recommended concentration limits for fluoride in drinking water, based on an annual average of the maximum daily air temperatures for the particular location in question (table 5).

The hardness of water is an important consideration for industrial and domestic water use. The U. S. Geological Survey has classified hardness of water in the following manner:

0-60 ppm of hardness, water is soft;
61-120 ppm of hardness, water is moderately hard;
121-180 ppm of hardness, water is hard;
More than 180 ppm of hardness, water is very hard.

Table 4.--Recommended drinking-water standards for several constituents and properties of water. 1/

Constituent or property	Recommended maximum allowable concentration, in parts per million
Iron (Fe)	0.30
Sulfate (SO_4)	250
Chloride (Cl)	250
Nitrate (NO_3)	45
Dissolved solids	500

1/ Data after U. S. Public Health Service, 1962, p. 7.

Table 5.--Recommended fluoride concentrations for drinking water. 1/

Annual average of maximum daily air temperatures (°F) 2/	Recommended fluoride concentration limits, in parts per million		
	Lower	Optimum 3/	Upper
50.0-53.7	0.9	1.2	1.7
53.8-58.3	.8	1.1	1.5
58.4-63.8	.8	1.0	1.3
63.9-70.6	.7	.9	1.2
70.7-79.2	.7	.8	1.0
79.3-90.5	.6	.7	.8

1/ Data after U. S. Public Health Service, 1962, p. 8.
2/ Should be based on more than 5 years of record.
3/ Average concentrations greater than two times the optimum values constitute grounds for rejection of the drinking-water supply.

The tolerances for the concentration or value of certain constituents of water are critical in many industrial applications. A few of the more common tolerances and permissible ranges are presented in table 6.

The definition of suitable concentration limits for certain constituents of irrigation water is more uncertain, particularly because tolerances of specific plant types vary considerably. The California Water Pollution Control Board (1952, p. 151) has developed a set of approximate standards for several common constituents or properties of irrigation water, and some of these data are presented in table 7 in slightly revised form. A more complex relation exists between acceptable percent sodium and acceptable dissolved-solids content for irrigation water--a higher percent sodium is

Table 6.--Water quality tolerances for industrial applications. Allowable limits in parts per million, except pH, color. 1/

Industrial application	Silica (SiO)	Iron (Fe)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Dissolved solids	Hardness as $CaCO_3$	pH	Color
BAKING 2/	--	0.2	--	--	--	--	--	10
BREWING 2/	50	.1	--	50-70	500-1000	--	6.5-7.0	0-10
BOILER FEED:							Minimums	
0-150 psi	40	--	50	200	500-3000	80	8.0	80
151-250	20	--	30	100	500-2500	40	8.4	40
251-400	5	--	5	40	100-1500	10	9.0	5
more than 400	1	--	0	20	50	2	9.6	2
BEVERAGES 2/ 3/	--	.1-.2	--	--	850	200-250	--	5-10
COOLING	--	.5	--	--	--	--	--	50
FOOD PROCESSING 2/ 4/	--	.2	--	--	--	--	7.5 min.	--
ICE 2/	10	.1-.2	40-60	--	170-1300	70	--	5
LAUNDERING	--	--	75	--	--	50	6.0-6.8	--
PAPER PULP:								
Unbleached kraft	100	1.0	--	--	500	200	--	100
Groundwood	50	.3	--	--	500	200	--	30
Bleached kraft	50	.2	--	--	300	100	--	25
Soda and sulfate	20	.1	--	--	250	100	--	5
Fine	20	.1	--	--	200	100	--	5
RAYON PULP:								
Production	25	.05	--	--	100	8	7.8-8.3	5
Manufacture	--	.0	--	--	--	55	--	--
TEXTILES:								
Wool scouring	--	1.0	--	--	--	20	--	70
General	--	.25	--	--	--	20	--	20
Dyeing	--	.25	--	--	--	20	--	5-20
Cotton bandages	--	.2	--	--	--	20	--	5

1/ Data after American Water Works Association, 1950, and California Pollution Control Board, 1952.

2/ Must also conform to U. S. Public Health Service drinking-water standards (1962, p. 7-8).

3/ Carbonated beverages only.

4/ Canned and frozen foods only.

Table 7.--Classification of the chemical suitability of water for irrigation use. a/

Class	Specific conductance, in micromhos at 25°C	Percent sodium	Parts per million		
			Sulfate (SO_4)	Chloride (Cl)	Dissolved solids
I b/	Less than 1,000	Less than 60	Less than 200-500	Less than 70-200	Less than 700
II c/	500-3,000	60-75	200-1,000	70-600	350-2,100
III d/	More than 2,500-3,000	More than 70-75	More than 600-1,000	More than 200-600	More than 1,750-2,100

a/ Data modified after California Water Pollution Control Board, 1952, p. 151.
b/ Excellent to good: suitable for most plants under most conditions.
c/ Good to injurious: harmful to some plants under certain soil conditions, climate, farming practices.
d/ Injurious to unsatisfactory: unsuitable under most conditions.

tolerated when dissolved-solids content is low. Wilcox (1948) has developed a graph showing the relation between the suitability of water for irrigation use and the values for percent sodium and specific conductance (fig. 12). Figure 12 shows, for example, that water with a specific conductance of 500 micromhos is unsuitable or of doubtful suitability for many irrigation purposes only if the percent-sodium value exceeds about 90. (See solid dot in figure 12.) Very few analyses of ground-water samples from Washington have specific-conductance and percent-sodium values in excess of 500 micromhos and 90 percent.

A more detailed discussion of the chemical-quality problems associated with irrigation water is presented by the U. S. Salinity Laboratory Staff (1954, p. 69-82).

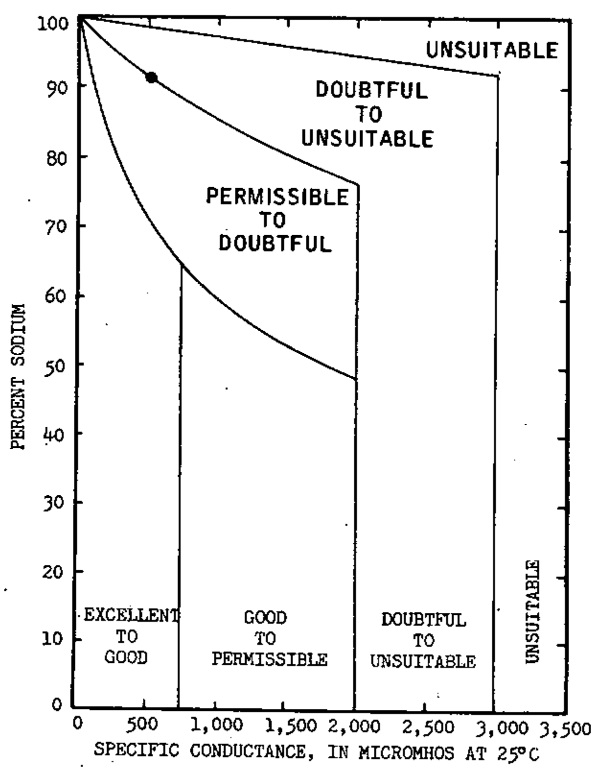


Figure 12.--Interpretation of the suitability of water for irrigation use, based on specific conductance and percent sodium. Diagram adapted after Wilcox, 1948, p. 6.

Sampling site number: All wells listed in this table are numbered consecutively. References to specific wells within the text will utilize these sample site numbers, rather than the more complicated location codes.

Well location code: See p.35 for description of location system. Location numbers followed by "s" denote springs.

Owner: U. S. Government agencies are abbreviated as follows: A.E.C., U. S. Atomic Energy Commission; B.P.A., Bonneville Power Administration; U.S.A., U. S. Army; U.S.A.F., U. S. Air Force; U.S.B.R., U. S. Bureau of Reclamation; U.S.F.W.S., U. S. Fish and Wildlife Service; U.S.F.S., U. S. Forest Service; U.S.N., U. S. Navy; U.S.N.P.S., U. S. National Park Service. In addition, A.F.B. indicates U. S. Air Force base (for example, see sampling site number 331).

Approximate altitude: Altitude of land-surface datum at well, from publications of the Washington State Department of Conservation or the U. S. Geological Survey, or from topographic maps of the U. S. Geological Survey.

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million				
									Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
						ADAMS COUNTY							
1	15/28-8E1	Chicago, Milwaukie, St. Paul & Pacific Railroad	855	415	371-414	Sand, gravel (interbedded between basalt)	10/18/60 5/4/61	64 68	65 --	0.61t --	30 --	14 --	34 --
2	15/29-4A1	City of Othello	1,050	560	--	Basalt	4/27/42	68	52	.04	3.6	3.5	78
3	15/30-23A1	G. H. Kleinbach	1,171	850	414-497, 642-670	"Porous rock" (Basalt?)	3/11/58	54	38	.40t	18	8.5	36
4	15/32-1J1	George Pence	1,366	353	334-353	Basalt	10/18/60 5/4/61	59 55	66 --	.07 --	10 --	2.1 --	51 --
5	16/28-8P1	May	925	304	--	Basalt	3/11/58	62	36	.14	5.6	3.2	86
6	16/29-34R1	City of Othello (well 3)	1,117	901	Below 407	Basalt	5/4/61	73	62	.00	3.0	.8	81
7	16/30-18A1	U. S. Government (U.S.B.R.)	1,190	392	345-392	Basalt	10/18/60 5/4/61	60 61	53 53	.04 .00	15 18	19 25	32 26
8	17/31-8R1	U. S. Government (U.S.B.R.)	1,249	155	152-155	Basalt	10/19/60 5/3/61	57 57	39 41	.01 .01	12 16	15 17	11 13
9	17/31-30C1	C. W. Haugen	1,342	337	--	Basalt	3/12/58	54	34	.11t	18	8.0	46
10	17/32-6B1	John Kulm	1,423	424	--	Basalt	3/12/58	57	33	.08	16	12	41
11	18/31-23A1	W. E. Franz	1,436	355	310-355	Basalt	3/12/58	60	30	.11	13	7.2	55
12	19/31-26D1	Ferdinand Kosanke	1,514	378	--	Basalt	3/12/58	53	48	.35	40	7.3	30
13	19/32-16M1	E. V. Doss	1,394	101	50-52, 60-98	Basalt	10/19/60 5/3/61	53 58	40 --	.01 --	22 --	11 --	33 --
14	19/35-23C1	City of Ritzville (well 3)	--	460	--	Basalt	10/22/59 5/16/60	-- 60	43 --	.01 --	63 --	36 --	23 --
15	20/31-22N1	A. C. Haas	1,700	500	--	Basalt	3/12/58	54	31	2.4t	18	12	51
16	20/31-31B1	John Bischoff	1,435	400	373-400	Basalt	10/19/60 5/3/61	60 56	42 46	.05 .00	50 38	20 14	34 37
17	20/32-32B1	U. S. Government (U.S.A.)	1,744	502	242-253, 334-355, 468-480	Basalt	12/1/59	64	55	.57	15	5.8	36
						ASOTIN COUNTY							
18	8/45-26K	Jerald Holzmiller	--	100	--	--	5/1/61	52	30	.18	18	11	10
19	10/46-5Q	Washington Water Power Co. (well 2)	--	1,815	--	Basalt	10/28/59 5/24/60	74 74	65 --	.04 --	6.5 --	.2 --	42 --
						BENTON COUNTY							
20	8/24-2J2	City of Prosser (well 2)	--	502	485-502?	Basalt	10/30/59 5/5/61	66 63	59 --	.05 --	14 --	5.1 --	43 --

Depth of water-bearing interval: Depth of interval or intervals below land surface, from publications of the Washington State Department of Conservation or the U. S. Geological Survey, or inferred from well logs on file with the above agencies.

Sample collection date: Analyses of waters reported by the sample collector to be chlorinated are indicated by "c" following collection date.

Iron: Total iron concentrations are followed by a "t". All other values represent iron in solution at the time of sample collection. See p.36 for discussion of reported iron values.

Parts per million														
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
ADAMS COUNTY														
10	196	0	41	10	0.6	0.7	0.06	302	292	132	416	7.9	5	1
--	198	0	--	--	--	--	--	--	--	132	423	7.8	--	
12	183	0	28	15	2.6	.1	--	285	287	23	397	--	--	2
9.4	172	0	22	8.2	.9	1.2	--	227	226	80	339	8.1	0	3
8.8	160	0	10	9.0	1.6	.9	.04	239	238	34	297	8.2	0	4
--	161	0	--	--	--	--	--	--	--	36	293	8.2	--	
26	212	0	50	14	1.0	.5	--	326	330	27	508	8.1	0	5
12	170	6	27	14	2.8	.0	.07	293	294	10	393	8.6	5	6
1.7	144	0	33	24	.8	2.8	.07	252	257	115	373	7.9	0	7
2.2	152	0	44	22	.7	1.7	.06	268	271	146	405	8.1	0	
1.0	121	0	13	1.0	.3	.6	.10	153	146	90	217	8.2	5	8
1.3	148	0	14	2.2	.4	1.3	.08	179	180	111	258	8.1	0	
17	142	0	62	12	.6	.1	--	268	269	78	410	8.	10	9
12	168	0	44	8.0	.5	.0	--	250	247	88	385	8.0	5	10
5.0	177	0	25	12	1.6	.3	--	236	249	62	376	8.1	0	11
5.9	152	0	46	20	.5	2.2	--	275	268	130	409	7.8	0	12
8.3	176	0	25	9.0	.7	.2	.07	236	223	100	350	8.0	0	13
--	177	0	--	--	--	--	--	--	--	101	350	8.0	--	
6.1	238	0	42	56	.2	47	.00	433	455	304	694	8.2	0	14
--	238	0	--	--	--	--	--	--	--	303	689	7.9	--	
14	208	0	37	10	.5	.3	--	276	274	94	438	7.9	10	15
9.6	146	0	80	48	.7	15	.02	371	390	207	602	7.8	0	16
10	151	0	65	32	.6	5.9	.02	323	337	152	497	8.0	0	
6.4	156	0	13	5.5	.9	.8	--	215	214	61	287	8.0	5	17
ASOTIN COUNTY														
2.7	130	0	5.2	.8	.3	.3	.13	143	136	89	210	8.1	5	18
9.9	113	5	8.9	7.8	1.1	.1	.07	202	199	17	248	8.4	5	19
--	117	3	--	--	--	--	--	--	--	19	236	8.3	--	
BENTON COUNTY														
12	187	0	4.8	6.5	.6	.2	.11	237	229	56	326	7.7	0	20
--	222	0	--	--	--	--	--	--	--	68	376	7.9	--	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
BENTON COUNTY -- Continued													
21	8/24-2H	City of Prosser (well 3)	--	599	530-599	Basalt	10/30/59 5/23/60	63 60	50 --	0.12 --	17 --	6.1 --	54 --
22	8/24-2Q	City of Prosser (well 4)	--	744	720-744	Basalt	5/11/61	60	46	.06t	16	6.6	46
23	8/30-24N	Phillips Pacific Chemical Co.	--	41	18-39	Sand, gravel	10/30/59 5/23/60	54 58	25 --	.03 --	30 --	6.9 --	7.6 --
24	10/26-11D1	U. S. Government (A.E.C.)	1,320	420	338-420	Basalt	3/24/59	--	51	.68	38	21	13
25	10/28-17B1	U. S. Government (A.E.C., well 12)	458	228	220-224	Basalt	6/15/51	--	18	--	9.2	3.8	25
26	11/26-3G1	U. S. Government (A.E.C., well 3)	514	200	116-140	Gravel, sand	8/13/51	--	24	--	23	11	12
27	11/26-5B1	U. S. Government (A.E.C., well 4)	550	168	121-168	Gravel, sand	8/14/51	--	41	--	30	10	12
28	11/27-2Q1	U. S. Government (A.E.C., well 5)	520	200	143-168	Sand, gravel	6/14/51	--	22	--	37	8.3	17
29	11/27-5Q1	U. S. Government (A.E.C., well 2)	555	204	169-185	Gravel, sand	6/14/51	--	25	--	39	9.0	17
30	11/27-20M1	U. S. Government (A.E.C., well 7)	526	321	293-321	Basalt	6/15/51	--	46	--	36	9.9	17
31	11/27-26D1	U. S. Government (A.E.C., well 6)	506	148	116-135	Gravel, sand	5/16/51	--	31	--	39	11	29
32	11/28-17D1	U. S. Government (A.E.C., well 8)	475	148	107-141	Gravel, sand	5/15/51	--	31	--	36	10	16
33	11/28-29N1	U. S. Government (A.E.C., well 11)	433	110	69-108	Gravel, sand	9/12/51	--	24	--	29	7.6	20
34	12/25-3D2	U. S. Government (A.E.C.)	646	307	244-256	Silt, sand, gravel	2/5/53	--	4.3	.01	22	6.1	14
35	12/25-29 NE 1/4s	U. S. Government (A.E.C.) (Rattlesnake Spring)	--	--	--	--	9/12/60	--	36	.03	22	10	7.2
36	12/26-25Q1	U. S. Government (A.E.C.)	549	203	169-182	Sand, gravel	8/19/53	--	20	--	34	9.6	16
37	12/28-18D1	U. S. Government (A.E.C., well 10)	498	164	117-133	Sand, silt, gravel	9/12/51	--	10	--	28	8.8	17
38	12/28-31H1	U. S. Government (A.E.C.)	433	105	65-77	Sand, gravel	2/6/53 6/10/53	-- --	30 19	.02 --	42 47	10 9.5	13 14
39	13/24-25E1	U. S. Government (A.E.C.)	924	777	625-777	Basalt	11/30/51	75	65	.02t	19	12	27
40	13/24-26G1	U. S. Government (A.E.C.)	--	705	695-705	Basalt	12/1/51	68	60	.06t	20	12	27
41	13/24-36D1	U. S. Government (A.E.C.)	909	1,092	936-1,092	Basalt	11/29/51	74	64	.03	18	11	29
42	13/25-1N2	U. S. Government (A.E.C.)	420	790	764-769	Basalt	9/21/53	--	39	--	19	11	22
43	13/25-7M1	U. S. Government (A.E.C.)	450	93	62-93	Gravel	9/2/53	60	25	.07t	26	6.7	3.5
44	13/25-30G1	U. S. Government (A.E.C.)	831	1,110	700-1,110	Basalt	12/1/51 9/2/53 10/28/54 10/24/56	82 87 84 70	62 64 67 62	.02t .08 .04 .06	17 18 17 17	9.4 10 9.4 9.3	30 30 30 30

Parts per million														
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
BENTON COUNTY -- Continued														
9.8	221	0	0.1	11	0.9	0.2	0.08	258	248	68	388	7.5	0	21
--	214	0	--	--	--	--	--	--	--	67	370	7.8	--	
10	202	0	.6	9.5	.7	.1	.09	236	236	67	336	7.8	5	22
4.1	137	0	9.1	1.2	.2	.2	.16	151	159	103	238	7.9	0	23
--	111	0	--	--	--	--	--	--	--	91	217	7.7	--	
4.8	176	0	43	7.5	.2	4.5	--	270	262	182	397	7.7	5	24
4.8	58	16	2.1	10	1.0	.3	--	119	130	39	206	9.2	5	25
4.6	126	0	20	5.9	.4	1.8	--	168	165	103	258	8.0	20	26
4.6	143	0	22	4.5	.4	1.7	--	202	195	116	270	8.2	20	27
8.0	147	0	33	8.0	.2	5.8	--	212	203	126	321	7.9	5	28
6.1	151	0	40	6.5	.3	5.5	--	223	220	134	343	7.9	5	29
10	162	0	40	6.1	.3	.1	--	245	238	130	343	7.9	5	30
9.1	199	0	15	26	1.0	1.0	--	260	252	143	418	7.4	5	31
6.9	158	0	33	7.0	.4	4.3	--	222	224	131	338	7.5	5	32
7.2	136	0	32	6.0	.5	.8	--	194	187	104	281	8.0	5	33
3.9	80	0	31	11	.3	1.4	--	133	136	80	182	8.3	4	34
1.7	114	0	11	2.8	.3	4.5	--	152	154	96	221	7.8	5	35
6.8	150	0	32	7.2	.1	.8	--	200	194	124	318	8.2	5	36
7.7	145	0	20	6.8	.3	.3	--	170	164	106	284	7.8	5	37
4.8	149	0	35	8.4	.3	16	--	233	233	146	351	7.8	3	38
5.2	158	0	34	11	.3	14	--	232	244	156	374	7.6	0	
8.5	189	0	1.8	5.8	.5	.1	--	233	215	97	291	7.8	5	39
6.7	193	0	1.5	5.5	.5	.0	--	228	218	99	292	7.8	5	40
6.7	184	0	1.8	5.4	.6	.1	--	227	213	90	277	7.7	5	41
11	143	0	23	8.0	.4	.0	--	203	216	93	296	7.6	0	42
1.8	100	0	15	1.5	.2	1.1	--	130	128	92	191	7.5	5	43
9.9	181	0	1.6	4.8	.6	.1	--	225	213	81	277	7.8	5	44
6.3	180	0	2.1	5.2	.7	.2	--	225	216	86	289	7.7	5	
7.7	178	0	2.1	5.1	.6	.0	--	227	214	81	291	7.4	5	
8.2	178	0	.4	4.8	.7	.2	--	221	207	81	286	8.0	0	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
						BENTON COUNTY -- Continued							
45	13/26-5D2	U. S. Government (A.E.C.)	465	170	126-139, 154-164	Gravel, sand	10/3/52	62	34	0.76t	31	9.7	9.3
46	13/26-13R1	U. S. Government (A.E.C.)	--	64	--	--	3/31/54	64	--	--	--	--	--
47	13/26-13R2	U. S. Government (A.E.C.)	420	68	33-63	Gravel	4/6/54	64	39	.05t	23	10	23
48	13/27-16G1	U. S. Government (A.E.C.)	405	84	53-75	Gravel	10/25/56	58	36	.05	77	20	34
						CHELAN COUNTY							
49	22/20-24R	Joe Taylor	--	52	--	--	5/3/61	59	30	.02	74	16	32
50	23/19-4D1	City of Cashmere	--	45	20-45	Sand, gravel	5/11/61	50	22	.00	48	21	16
51	23/19-5H1	City of Cashmere (well 2)	--	47	36-47	Sand, gravel, clay	1/24/39	50	19	.10t	45	21	14
						CLALLAM COUNTY							
52	28/13W-4Q1	City of Forks	--	135	97-112	Sand, gravel	5/2/61	49	15	.07	22	3.3	4.3
53	29/9W-32 NW 1/4s	U. S. Government (U.S.N.P.S., Sol Duc Hot Springs)	--	--	--	Basalt	11/30/54	132	58	--	1.2	.0	80
54	30/3W-15G1	Unknown	--	574	515-554	Gravel	11/20/59 5/24/60	-- 53	25 --	.01 --	36 --	13 --	16 --
55	30/3W-25C1	State of Washington	--	500	--	--	12/16/59	52	17	1.7t	7.5	.9	300
56	33/15W-10R1	Bay Fish Co.	--	38	33-38	Sand, gravel	5/16/52 2/27/53	-- 50	-- --	-- --	-- --	-- --	-- --
57	33/15W-14C1	Makah Indian Tribe	--	52	--	Sand	2/27/53	47	6.7	--	59	6.7	14
						CLARK COUNTY							
58	1/3-8B2	R. B. Johnston	490	390?	--	--	5/17/49	--	49	.04t	13	9.0	6.6
59	1/3-11J5	Crown Zellerbach Corp. (well 5)	50	123	72-82,	Gravel	1/27/60 6/2/60	45 52	14 --	.00t --	3.5 --	1.2 --	1.6 --
60	2/1-23Q1	City of Vancouver (well 1)	175	250	188-220	Gravel	12/13/55	50	52	.00	20	5.8	5.1
61	2/1-23Q3	City of Vancouver (well 3)	223	280	231-238, 257-273	Gravel	9/7/55	--	47	.03t	17	5.3	5.3
62	2/1-35F4	Buffalo Electro-chemical Co.	30	85	34-54, 63-81	Gravel, sand	1/27/60 7/1/60	54 55	45 --	.00 --	23 --	7.5 --	5.8 --
63	2/2-20A2	Royal Oaks Country Club	210	221	65-95, 172-216	Gravel, sand	5/17/49	50	36	4.8t	10	5.7	3.5
64	2/2-33L1s	City of Vancouver (Spring)	190	--	--	Sand, gravel	5/17/49	50	50	.02t	15	5.2	4.2
65	2/3-6K1	Carl Anderson	272	93	70-93	Basalt?	5/17/49	--	58	--	14	7.5	5.7
66	3/1-33Q1	Wil-Mar Dairy	210	48	28-48	Sand	5/23/49	--	64	.10t	37	17	8.1
67	3/2-2D1	Clark County Dairymans Coop.	295	140	136?-140	Sand, gravel	5/17/49	52	44	.02t	22	8.4	9.3
68	4/2-20A1	Lloyd Webb	245	71	56-71?	Gravel	6/2/60 10/4/60	55 54	39 --	2.1 --	6.5 --	1.8 --	5.0 --

Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Parts per million														
BENTON COUNTY -- Continued														
4.9	144	0	16	2.7	0.2	2.1	--	181	176	117	266	7.8	2	45
--	--	--	--	2.0	--	--	--	--	--	104	283	--	--	46
4.8	150	0	18	3.0	.5	4.5	--	200	202	98	292	8.2	0	47
6.6	239	0	113	22	.3	6.0	--	433	431	274	647	7.7	0	48
CHELAN COUNTY														
3.4	333	0	28	5.2	.5	11	.10	364	362	252	591	7.5	0	49
1.7	276	0	10	4.5	.2	3.1	.05	263	256	208	447	7.2	0	50
2.5	252	0	16	2.6	.0	2.4	--	247	237	199	--	--	--	51
CLALLAM COUNTY														
.2	76	0	11	3.0	.2	.4	.03	96	97	68	155	8.1	0	52
2.6	92	26	34	17	1.6	1.0	--	266	262	3	355	9.2	0	53
2.5	207	0	5.3	5.5	.1	.1	.23	206	206	142	332	7.8	0	54
--	204	0	--	--	--	--	--	--	--	144	329	8.0	--	
.8	234	0	19	320	1.1	.2	.22	783	778	22	1,420	8.0	10	55
--	268	0	15	26	.4	2.2	--	--	--	244	516	--	--	56
--	--	--	--	--	--	--	--	--	--	--	466	--	--	
1.0	208	0	20	7.0	--	3.9	--	221	--	175	377	--	--	57
CLARK COUNTY														
2.8	88	0	4.9	6.9	.1	8.4	--	144	148	69	181	7.7	--	58
.6	19	0	1.2	1.0	.0	.6	.06	33	34	14	41	6.9	0	59
--	20	0	--	--	--	--	--	--	--	13	39	6.8	--	
3.6	82	0	8.4	4.0	.0	11	.2	150	154	74	186	7.6	0	60
4.1	70	0	8.8	3.5	.1	12	--	137	145	64	168	7.0	0	61
2.5	92	0	11	3.8	.2	10	.31	154	156	88	212	7.0	0	62
--	94	0	--	--	--	--	--	--	--	86	196	6.9	--	
4.4	56	0	7.4	4.0	.0	.3	--	104	109	48	111	8.0	--	63
5.6	64	0	11	2.9	.2	7.2	--	133	129	59	140	--	--	64
4.0	78	0	.8	3.0	.2	5.4	--	137	137	66	151	7.0	--	65
4.0	96	0	41	16	.4	44	--	279	310	162	376	6.3	--	66
3.6	126	0	2.7	4.0	.2	1.0	--	157	151	89	206	7.7	--	67
.8	40	0	.6	.8	.1	.5	.01	77	72	24	72	6.3	5	68
--	42	0	--	--	--	--	--	--	--	24	73	6.3	--	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
CLARK COUNTY -- Continued													
69	4/2-21B1	Ray Langler	260	73	67-73?	Sand	6/2/60	54	39	0.02	18	3.5	8.1
							10/4/60	55	--	--	--	--	--
70	4/2-22E1	R. R. Langness	260	172	169-172	--	6/2/60	57	27	3.2t	10	3.8	5.0
							10/4/60	55	--	--	--	--	--
71	5/3-12P	U. S. Government (U.S.F.S.)	--	115	46-53, 66-72	Sand, gravel	3/19/58	53	27	.18	9.4	1.8	4.4
COLUMBIA COUNTY													
72	10/38-36C1	Wanda Harting	--	80	18-38	Gravel	10/28/59	52	48	.05	16	7.3	5.4
							5/24/60	53	--	--	--	--	--
73	10/39-30H	City of Dayton	--	1,250	180-190, 749-762, 1,223-1,250	Basalt (Principal production 1,223-1,250)	6/2/60	60	52	.02	27	10	8.8
							5/61	--	--	--	27	10	--
74	13/38-26 NW 1/4	Robert Ferrell	--	243	217-236	Basalt	1/27/61	68	67	.01	24	8.8	9.4
75	13/38-27B	R. L. Farrell	--	100	--	--	5/1/61	66	34	.00	38	9.7	17
COWLITZ COUNTY													
76	5/1W-22R	Jerry Peterson	--	34	12-34	Sand	4/26/61	55	41	.13	15	6.8	5.8
77	9/2W-14 SE 1/4	E. S. Ashe	--	35	--	--	1/27/60	44	15	.32t	4.0	.7	2.7
							6/1/60	56	--	--	--	--	--
78	9/2W-27Q	O. A. Doudonsky	--	87	--	--	4/26/61	50	47	.01	23	6.5	8.8
DOUGLAS COUNTY													
79	23/20-34R	East Wenatchee Water District (well 2)	--	60	--	--	10/20/59	58	29	.02	49	11	14
							5/18/60	58	26	.01	58	13	16
80	25/22-21H	City of Waterville (well 2)	--	600	440-448, 516-529, 577-600	Basalt	10/29/59	--	43	1.6t	46	23	23
							5/18/60	55	--	--	--	--	--
81	27/27-13A	Dale Leander	--	100	--	--	5/2/61	52	25	.00	72	38	62
82	30/25-28H	H. Hogan	--	40	--	Sand, gravel	5/2/61	52	15	.01	34	9.5	3.7
FERRY COUNTY													
83	36/33-7F1	City of Republic	--	80	50-68	Gravel	4/7/60c	--	29	.02	46	8.6	14
							10/20/60	45	--	--	--	--	--
84	39/32-(21?)	U. S. Government (U.S.A.F.)	--	14	--	Gravel	9/8/54	64	29	.21t	66	17	11
							9/22/55	46	28	.01	65	13	12
							10/25/56	44	28	.02	67	18	12
							1/6/58	47	24	.05	67	17	11
							9/16/59	40	31	.00	70	15	11
85	40/32-27R1	U. S. Government (U.S.A.F.)	--	97	--	Sand, gravel	6/18/51	--	21	.02	48	9.1	16
							3/19/52	45	20	.03	46	9.7	16
							10/20/52c	48	20	.16	47	10	15
							10/22/53c	--	21	.05	46	9.9	16
							9/8/54	64	19	.06	47	10	16
							9/22/55c	50	19	.02	46	8.6	16
							10/25/56c	50	22	.04	48	11	16
							1/6/58c	48	19	.00	48	9.8	21
							9/5/58	50	21	.04	49	10	17
							9/16/59c	45	20	.00	50	8.3	15

Parts per million											Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)				
CLARK COUNTY -- Continued														
1.3	61	0	0.8	9.5	0.1	16	0.06	126	128	60	159	6.2	5	69
--	66	0	--	--	--	--	--	--	--	65	174	6.2	--	
.5	57	0	4.2	2.0	.1	.2	.08	81	83	41	103	6.9	60	70
--	56	0	--	--	--	--	--	--	--	41	106	6.8	--	
.5	48	0	.6	2.0	.1	.3	--	70	67	31	83	7.2	0	71
COLUMBIA COUNTY														
3.5	86	0	3.5	3.5	.2	8.6	.38	138	139	70	182	7.3	0	72
--	90	0	--	--	--	--	--	--	--	81	206	7.2	--	
2.2	148	0	2.2	2.5	.3	2.1	.30	180	180	110	247	7.6	5	73
--	148	0	--	--	--	--	--	--	--	109	247	7.7	--	
5.8	140	0	2.8	2.0	.5	1.0	--	190	194	96	227	7.6	0	74
3.5	125	0	42	17	.3	2.0	.08	226	227	135	350	7.7	0	75
COWLITZ COUNTY														
2.1	75	0	10	2.2	.2	3.4	.01	124	134	66	158	6.5	5	76
.4	16	0	1.4	3.0	.1	1.4	.04	37	45	13	44	6.8	10	77
--	24	0	--	--	--	--	--	--	--	16	47	7.1	--	
1.4	120	0	2.6	2.2	.2	.6	.82	152	151	84	193	7.2	5	78
DOUGLAS COUNTY														
3.0	199	0	14	3.8	.2	16	--	238	235	168	377	7.6	0	79
3.1	222	0	25	5.5	.2	18	.44	274	270	196	444	7.5	0	
1.9	204	0	35	26	.3	18	.21	316	339	209	499	7.7	0	80
--	205	0	--	--	--	--	--	--	--	212	511	7.6	--	
12	247	0	219	32	.7	3.4	.17	586	616	336	879	8.0	0	81
1.7	134	0	16	3.2	.2	6.3	.02	156	152	124	252	8.1	5	82
FERRY COUNTY														
2.6	130	0	65	4.2	.3	3.8	.15	238	248	150	375	7.0	5	83
--	132	0	--	--	--	--	--	--	--	167	394	7.2	--	
2.5	288	0	15	1.4	.2	.4	--	284	289	234	458	7.3	5	84
2.7	279	0	18	1.2	.2	.1	--	277	286	216	462	8.1	5	
2.3	289	0	20	1.8	.3	.3	--	292	289	241	472	8.1	5	
2.2	280	0	21	2.0	.2	.6	--	283	289	237	470	7.6	5	
2.9	299	0	18	2.0	.3	.5	--	298	299	238	485	7.7	10	
4.5	196	0	27	2.1	.2	2.4	--	227	221	157	355	8.0	5	85
1.5	191	0	29	2.4	.3	2.3	--	221	223	155	354	7.8	5	
1.8	194	0	28	2.3	.3	2.0	--	222	223	158	357	7.9	2	
1.5	190	0	27	4.0	.4	2.6	--	222	226	155	360	7.8	3	
1.6	188	0	28	2.2	.3	2.7	--	219	216	158	350	7.5	0	
1.7	188	0	27	2.8	.2	2.6	--	217	214	150	365	7.8	0	
1.7	194	0	28	3.2	.3	2.9	--	229	219	165	373	7.8	0	
2.0	193	0	28	9.0	.2	2.9	--	235	234	160	394	7.7	0	
1.7	199	0	27	3.0	.3	2.7	--	230	226	164	359	7.5	0	
1.9	202	0	27	2.5	.2	2.9	--	228	224	159	374	7.9	5	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
P E R R Y C O U N T Y -- Continued													
86	40/32-(33?)	U. S. Government (U.S.A.F.)	--	14	--	--	6/18/51	--	28	0.06	48	11	9.0
							3/20/52	45	30	.17	63	19	10
							10/22/53	--	29	.05	63	15	11
							9/5/58	--	30	.03	75	14	12
F R A N K L I N C O U N T Y													
87	9/29-23J2	R. W. Gove	385	60	41-?	Gravel	10/17/60	64	33	.05	51	15	28
							5/4/61	64	32	.00	40	13	26
88	9/29-23P1	D. Harris	365	28	24-28	Gravel	4/28/42	59	26	.04t	38	11	16
89	9/29-23P2	C. C. Bayless	--	42	--	--	5/4/61	61	33	.00	61	14	14
90	9/30-20D	Desert Air Motel	--	85	48-85?	Gravel, sand	5/23/60	64	38	.02	47	14	32
							10/17/60	65	38	.09	58	18	33
							5/4/61	65	--	--	--	--	--
91	9/30-27K1	U. S. Government (B.P.A.)	420	121	--	--	10/17/60	66	39	.30	42	14	34
							5/5/61	64	--	--	--	--	--
92	9/31-4N1	Ray Sperry	658	343	320 (creviced)	Basalt	4/28/42	--	50	.04	21	12	61
							10/17/60	59	50	.02	20	7.9	58
							5/5/61	55	--	--	--	--	--
93	11/32-20A1	Loren Loeber	810	156	--	Basalt	3/13/58	59	37	.25	51	18	31
94	12/28-12H1	H. M. Cook	616	450	350,450	Basalt (creviced)	4/27/42	--	52	.04	8.8	4.6	83
							10/17/60	66	53	.88t	7.5	1.9	84
							5/4/61	58	--	--	--	--	--
95	12/28-24F1s	Unknown (Spring)	425	--	--	Gravel	3/16/58	60	32	.04	110	43	68
96	12/32-28B1	Tom Thompson	1,057	792	--	Basalt	3/13/58	67	70	.03	12	6.1	29
97	13/31-24R1	C. W. McLeon	1,174	537	150, 457, 530 (Honey-combed)	Basalt	3/13/58	52	42	1.2t	22	12	27
98	13/32-1J1	Connell Sand & Gravel Company	765	220	53-101, 211-215	Basalt	10/17/60	57	37	.06	32	10	27
							5/4/61	58	--	--	--	--	--
99	13/34-33R	U. S. Government (U.S.A.)	--	117	--	--	9/1/61	56	25	.04	17	3.8	7.8
100	14/29-9A1	U. S. Government (U.S.A.F.)	1,275	860	845-860	Basalt with sand and gravel crevices	3/20/52	60	59	.02t	15	10	48
							4/23/53	--	57	.01	20	12	44
							10/28/53	--	62	.02	19	11	45
							8/18/54	--	55	.04	21	12	43
							9/29/55	69	55	.00	20	9.9	44
							9/13/56	71	56	.00	20	10	44
							6/28/60	--	56	.15	18	11	45
							10/19/60	74	56	.02	21	11	43
							10/5/61	--	57	.04	20	10	45
101	14/30-8G1	U. S. Government (U.S.B.R.)	953	371	231-251, 271-291	Basalt	3/13/58	56	40	.81	140	106	42
102	14/30-20A1	U. S. Government	984	717	293-298	Basalt	3/13/58	53	25	.51t	74	32	24
103	14/31-36B2	City of Connell (well 1)	904	286	286 (creviced)	Basalt	4/28/42	60	45	.04	28	17	18
							3/13/58	60	38	.05	30	15	11
104	14/32-31D1	City of Connell (well 3)	876	505	--	Basalt	10/17/60	65	48	.56t	26	12	18
							5/4/61	66	--	--	--	--	--
G A R F I E L D C O U N T Y													
105	12/42-31L	City of Pomeroy	--	997	69-997	Basalt	10/28/59	71	74	.04	16	2.3	10
							5/24/60	73	--	--	--	--	--

Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Parts per million														
F E R R Y C O U N T Y -- Continued														
3.8	207	0	14	1.0	0.3	0.2	--	217	221	165	336	7.9	10	86
2.0	282	0	23	1.6	.2	.2	--	288	290	235	459	7.5	8	
3.2	268	0	22	1.5	.4	.4	--	278	284	219	446	7.8	10	
2.8	298	0	18	2.2	.3	.5	--	302	306	245	467	7.7	5	
F R A N K L I N C O U N T Y														
6.4	226	0	40	11	.5	13	.17	309	309	190	489	7.9	5	87
5.7	162	0	52	16	.4	6.3	.08	271	276	154	428	7.9	0	
5.1	190	0	18	1.6	.3	3.8	--	213	215	140	326	--	--	88
5.6	222	0	38	10	.4	11	.20	296	308	210	461	7.8	5	89
7.0	197	0	36	12	.4	41	.11	325	330	177	487	7.9	5	90
8.1	202	0	46	16	.6	74	.10	392	394	218	594	7.7	0	
--	200	0	--	--	--	--	--	--	--	196	531	7.8	--	
6.7	180	0	55	22	.6	12	.15	315	324	162	480	7.9	5	91
--	175	0	--	--	--	--	--	--	--	150	446	7.9	--	
15	158	8	86	9.5	.9	.1	--	341	336	102	480	--	--	92
18	172	0	72	8.0	1.2	.3	.05	320	324	82	464	8.1	5	
--	174	0	--	--	--	--	--	--	--	82	460	8.1	--	
2.5	241	0	53	11	.2	.4	--	323	331	200	503	7.7	5	93
14	182	7	59	9.5	1.0	.1	--	329	328	41	459	--	--	94
16	192	0	57	9.5	1.2	.2	.05	325	321	26	456	8.2	10	
--	188	4	--	--	--	--	--	--	--	28	465	8.4	--	
11	185	0	319	86	.5	5.3	--	766	796	450	1,130	7.9	0	95
5.8	125	0	15	8.2	.9	.7	--	210	215	55	256	8.0	0	96
6.4	168	0	17	5.2	.5	3.8	--	219	217	104	322	7.8	25	97
4.6	184	0	14	8.0	.6	11	.31	236	239	122	355	7.8	0	98
--	180	0	--	--	--	--	--	--	--	120	360	7.8	--	
1.9	72	0	12	4.0	.3	.6	--	107	113	58	151	7.3	0	99
7.5	182	0	26	13	1.0	.7	--	270	266	79	373	8.0	10	100
--	185	0	26	12	1.0	.2	--	--	263	99	378	8.0	5	
7.8	188	0	24	11	1.0	1.0	--	274	264	93	377	8.2	2	
6.9	188	0	27	12	1.0	.5	--	271	271	102	378	7.7	10	
7.6	186	0	24	11	.9	.9	--	265	266	91	386	8.1	0	
7.6	187	0	25	13	1.0	.8	--	269	263	91	385	8.1	0	
7.8	187	0	24	11	1.1	.6	--	267	261	92	378	7.9	0	
8.2	185	0	29	10	1.0	1.9	--	272	282	99	411	8.0	0	
8.1	186	0	25	12	1.1	.8	--	271	264	91	377	7.9	0	
7.8	294	0	368	128	.3	99	--	1,080	1,180	785	1,570	7.9	5	101
7.8	156	0	93	66	.4	55	--	451	470	315	735	7.7	0	102
4.6	158	0	23	9.5	.4	13	--	236	242	140	337	--	--	103
2.5	151	0	14	4.8	.4	14	--	204	208	136	308	8.0	5	
5.3	138	0	22	10	.5	8.8	.03	219	228	112	311	7.9	10	104
--	150	0	--	--	--	--	--	--	--	106	294	7.8	--	
G A R F I E L D C O U N T Y														
5.5	90	0	3.1	1.8	.4	.3	.04	157	154	50	162	8.0	0	105
--	91	0	--	--	--	--	--	--	--	49	156	8.2	--	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
GRANT COUNTY													
106	14/25-1D1	U. S. Government (U.S.A.)	660	938	895-900, 924-938	Sand, basalt	8/7/52	70	75	0.22	12	4.5	47
107	14/25-21B1	U. S. Government (U.S.A.)	640	522	268-290, 343-370, 512-515	Gravel, sand	9/3/53 10/28/54 1/7/58 3/24/59	65 70 72 --	70 69 -- 67	.08 .05 .07 .03	28 28 30 30	11 11 9.6 9.8	22 21 21 20
108	14/25-31M1	U. S. Government (U.S.A.)	774	699	429-440, 512-516, 672-674	Gravel, sand	9/3/53	65	43	.08	25	11	11
109	14/27-24C1	U. S. Government (U.S.A.)	862	1,396	1,371-1,393	Basalt	3/23/59 10/28/59	-- 86	64 63	.07 .00	7.0 7.0	.8 .4	80 80
110	15/23-3H1	Lester Morrison	534	84	72-83	Gravel, sand	10/18/60 5/4/61	64 60	24 --	.04 --	37 --	7.1 --	7.8 --
111	15/27-32E1	U. S. Government (U.S.A.)	725	1,140	982-1,115	Basalt	10/28/54	62	54	.29	21	8.8	26
112	15/27-34L2	U. S. Government (U.S.A.)	698	636	604-614	Basalt	1/7/58 3/24/59	71 --	-- 73	.07 .02	13 14	6.0 6.1	40 35
113	16/23-34F2	Beverly Water Co.	570	141	134-141	Sand, gravel	10/18/60	64	31	.05	24	7.9	7.6
114	16/24-1G1	U. S. Government (U.S.A.)	1,213	800	709, 727-748	Basalt	1/24/60	74	51	.26	40	24	45
115	16/24-1G2	U. S. Government (U.S.A.F.)	--	915	725-730, 884-887	Basalt	11/17/59 12/12/59	74 76	57 50	.22 .22	38 40	24 24	45 45
116	16/26-29E1	D. J. Stewart	555	19	--	Gravel	8/31/59	58	--	--	28	26	376
117	17/25-11E1	U. S. Government (U.S.B.R.)	1,154	285	233-285	Basalt	10/18/60 5/4/61	62 58	51 --	.02 --	30 --	25 --	25 --
118	17/26-28Q1	Oscar Abramson	1,127	404	--	Basalt	4/27/42	58	42	.44t	32	18	43
119	17/26-33D1	R. Christensen	1,148	340	259-264	Basalt?	5/4/61	58	56	.01	45	21	29
120	17/30-33K1	U. S. Government (U.S.A.F.)	1,745	1,002	415-480, 860-1,000	Basalt	10/28/59	72	78	.15	8.0	2.1	57
121	17/30-33K2	U. S. Government (U.S.A.F.)	--	981	635-981	Basalt	1/24/60	74	79	.45	8.5	1.9	57
122	18/23-36H1	Donald Davison	1,302	670	526-529, 665-670	Basalt	10/18/60 5/4/61	60 60	55 --	.01 --	42 --	25 --	14 --
123	18/25-8B1	Unknown	1,165	134	--	Sand	9/8/16	--	71	--	239	152	--
124	18/27-4R1	F. B. Chapman	1,050	18	--	Sand, gravel	10/8/16	--	40	--	47	26	--
125	18/28-3A1	Latter Day Saints Church	1,142	126	100-126	Gravel	10/18/60 5/3/61	60 60	54 --	.04 --	54 --	36 --	20 --
126	18/29-17P1	U. S. Government (U.S.B.R.)	1,170	342	--	Basalt	10/19/60 5/3/61	59 60	58 59	.29t .05t	53 63	34 36	28 29
127	19/23-22D1s	Unknown (Spring)	--	--	--	Basalt?	9/16/16	--	47	--	34	18	--
128	19/24-7J1	Howard Hyer	1,256	502	167-502?	Basalt	8/31/16 5/50 10/18/60 5/4/61	-- -- 60 55	42 44 48 --	-- .07 .46 --	34 27 31 --	22 18 25 --	-- 32 11 --
129	19/24-19A1	A. W. Bauer	1,234	112	--	Basalt	5/4/61	55	47	.01	50	24	20
130	19/24-28N1	G. W. Murphy	1,225	210	186	Basalt (Honeycombed)	5/1/50	--	55	.03	29	19	12
131	19/25-2N1	M. H. Dishaw	1,157	100	84-100	Sand	4/23/42	59	55	.27t	27	14	17

Parts per million														
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
GRANT COUNTY														
19	157	0	25	9.7	0.4	1.1	--	271	265	48	330	7.9	--	106
6.5	155	0	26	7.0	.4	2.2	--	250	243	115	319	7.8	5	107
6.7	156	0	25	7.4	.3	1.8	--	247	250	115	313	7.6	5	
6.4	154	0	23	7.0	.3	2.0	--	--	239	114	318	7.8	5	
6.9	157	0	24	7.2	1.0	2.1	--	245	232	115	324	7.8	5	
5.5	127	0	24	4.0	.3	3.8	--	190	184	108	262	7.8	5	108
26	216	0	28	12	1.2	.1	--	325	316	20	451	8.1	5	109
26	216	0	29	12	1.2	.5	--	325	322	19	457	8.0	5	
3.4	121	0	29	7.5	.2	1.5	0.05	178	181	122	283	7.9	5	110
--	121	0	--	--	--	--	--	--	--	123	280	7.7	--	
12	146	0	25	5.8	.6	.1	--	226	231	89	298	7.9	5	111
18	152	0	26	8.2	.4	2.5	--	--	262	57	330	7.8	5	112
19	150	0	27	7.5	.5	2.7	--	259	249	60	327	7.6	0	
3.5	108	0	15	3.2	.2	2.4	.15	148	149	92	221	8.1	5	113
10	252	0	69	19	.6	.1	--	383	384	197	566	7.9	5	114
9.6	250	0	68	19	.7	.1	--	385	380	192	575	7.7	5	115
10	254	0	70	18	.8	.2	--	383	366	199	581	7.9	5	
--	922	0	--	72	--	19	--	--	--	179	1,900	7.8	--	116
2.6	216	0	43	6.0	.8	.7	.06	290	284	177	432	7.9	5	117
--	220	0	--	--	--	--	--	--	--	180	438	7.8	--	
13	182	0	55	40	.5	.3	--	334	337	154	514	--	--	118
6.0	139	0	79	34	.5	22	.03	361	381	198	535	7.8	0	119
10	162	4	15	7.2	1.2	.1	.06	263	264	29	321	8.4	5	120
9.9	161	5	15	6.5	1.3	.1	--	264	270	29	317	8.4	10	121
2.4	170	0	35	33	.7	11	.04	302	314	206	462	7.8	5	122
--	165	0	--	--	--	12	.04	--	--	230	501	7.8	--	
--	586	0	811	14	--	6.0	--	--	1,740	1,220	--	--	--	123
--	359	0	9.1	10	--	1.0	--	--	355	224	--	--	--	124
3.3	232	0	62	32	.5	24	.05	400	422	284	612	7.8	5	125
--	244	0	--	--	--	--	--	--	--	286	618	7.8	--	
3.5	180	0	65	38	.6	71	.04	440	453	270	637	7.9	5	126
3.6	160	0	76	62	.5	93	.03	501	524	306	745	7.9	0	
--	85	50	11	6.0	--	3.0	--	--	232	159	--	--	--	127
--	235	0	20	9.0	--	.0	--	--	283	176	--	--	--	128
5.9	221	0	27	6.8	.6	.1	--	270	256	141	403	8.0	--	
2.7	176	0	29	17	.6	4.1	.06	256	262	180	394	8.1	5	
--	175	0	--	--	--	--	--	--	--	186	406	8.0	--	
2.3	193	0	54	35	.6	7.0	.06	335	347	223	531	7.9	0	129
3.5	177	0	15	6.9	.4	9.7	--	238	234	150	340	7.9	--	130
1.3	170	0	10	2.4	.4	6.7	--	218	215	125	294	--	--	131

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
GRANT COUNTY -- Continued													
132	19/25-10A1	Paul Lauzier	1,155	160	99-160	Sand	10/18/60	58	54	0.14	75	45	129
							5/3/61	58	55	.01	51	26	38
133	19/26-1R1	U. S. Government (U.S.B.R.)	1,257	459	Below 398	Basalt	10/18/60	67	59	.06	33	12	32
							5/3/61	64	--	--	--	--	--
134	19/27-17L1	D. W. Stillwell	1,121	211	--	Gravel	9/12/16	--	65	--	47	19	--
135	19/27-21C1	A. D. Gabbert	1,093	70	--	Gravel	10/19/16	--	49	--	45	8.9	--
136	19/27-23R1	S. M. Heft	1,105	78	--	Gravel	9/12/16	--	39	--	47	31	--
137	19/27-25A3	O. L. Moulton	--	34	27-34	Gravel	4/25/42	53	11	.04	28	27	56
138	19/28-10F1	H. R. Morton	1,112	76	--	Gravel	10/14/16	--	47	--	49	11	--
139	19/28-15Q1	City of Moses Lake (well 3)	1,070	909	--	Basalt	11/29/55	65	68	.00	2.8	.2	79
140	19/28-16P2	T. N. Knutzen	1,050	9	--	Sand	10/17/16	--	56	--	45	33	--
141	19/28-23D8	City of Moses Lake (well 7)	1,064	948	Below 680	Basalt	12/4/59	--	60	.02	8.0	2.1	64
							5/16/60	69	--	--	--	--	56
142	19/29-19B1	V. S. Sieler	1,190	157	152-155	Basalt	4/25/42	58	29	.04	38	12	8.6
143	19/29-22C1	U. S. Government (U.S.B.R.)	1,269	352	Below 37	Basalt	10/19/60	59	35	.98	11	4.5	24
							5/3/61	58	--	--	--	--	--
144	19/29-34D2	Fred Radach	1,256	285	--	Basalt	4/50	--	53	.03	32	20	43
145	20/23-24H1	Conrad Weber	1,298	75	70-75	Basalt	10/18/60	60	50	.00	24	20	27
							5/4/61	58	--	--	--	--	--
146	20/24-7R2	City of Quincy	1,305	376	Below 80	Basalt	1/24/39	52	51	1.0t	34	26	29
147	20/24-9D1	Cedergreen Corp.	1,316	424	253, 301-345	Basalt	9/18/16	--	44	--	32	12	--
148	20/24-9E2	Cedergreen Corp.	1,296	345	250-260, 290-300, 325-340	Basalt	4/23/42	--	42	.04	37	15	19
149	20/25-5P1	W. L. Norton	1,277	450	--	Basalt	9/27/16	--	56	--	32	12	--
150	20/25-13Q1	H. K. Vandel	1,240	278	--	Sand	9/28/16	--	51	.55	82	43	--
151	20/25-29H1	U. S. Government (U.S.B.R.)	1,225	175	155-162?	Sand	10/18/60	59	60	.07	28	13	14
							5/3/61	60	--	--	--	--	--
152	20/28-17Q1	U. S. Government (Larson A.F.B., well 7)	--	212	--	Basalt	10/21/59	55	34	.63	44	17	36
153	20/28-27E1	U. S. Government (Larson A.F.B., well 6)	1,155	134	76-83	Sand, gravel	9/14/56	55	38	.02	54	20	32
							11/5/57	55	--	.02	51	19	32
							3/28/58	56	42	.00	42	15	29
							10/31/58	55	39	.02	55	17	31
							10/21/59	55	39	.00	48	17	33
154	20/28-29E1	U. S. Government (Larson A.F.B., well 4)	--	165	160-165	Basalt	6/20/56	57	60	.04	24	10	16
							11/5/57	57	--	.04	23	11	18
							10/31/58	57	56	.07	25	9.9	16
							10/21/59	57	58	.00	24	9.7	16
155	20/28-31C1	U. S. Government (Larson A.F.B., well 5)	--	75	30-75	Sand, gravel	6/20/56	57	52	.01	48	18	24
							10/31/58	57	52	.14	40	14	18
							10/21/59	57	53	.07	37	14	20
156	20/28-32C1	U. S. Government (Larson A.F.B., well 2)	1,195	725	610-618, 652-719	Basalt	3/30/51	65	56	.01	26	16	17
							7/3/51	--	56	.01	26	16	17
							3/6/52	--	56	.06	26	16	18
							12/4/53	67	51	.06	24	14	26
							8/24/55	67	50	.01	29	15	18
							6/20/56	57	53	.01	29	18	19

Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Parts per million														
GRANT COUNTY -- Continued														
4.9	198	0	308	90	1.3	51	0.10	856	870	372	1,260	7.8	0	132
3.3	184	0	92	32	.6	31	.04	420	450	234	617	7.9	0	
5.2	208	0	24	5.5	.5	2.6	.05	276	271	131	386	7.8	5	133
--	211	0	--	--	--	--	--	--	--	132	394	7.9	--	
--	212	0	22	9.0	--	6.0	--	--	296	196	--	--	--	134
--	258	0	38	9.0	--	1.0	--	--	339	149	--	--	--	135
--	390	10	9.1	10	--	1.0	--	--	426	245	--	--	--	136
14	330	0	30	11	.7	3.8	--	344	347	181	583	--	--	137
--	198	0	81	20	--	.0	--	--	350	168	--	--	--	138
11	154	10	24	16	1.6	.4	.0	289	278	8	380	8.7	0	139
--	668	60	62	38	--	1.0	--	--	886	248	--	--	--	140
10	155	4	19	17	2.5	.9	.00	264	261	29	363	8.3	0	141
--	157	5	--	--	--	--	--	--	--	49	385	8.4	--	
2.8	119	0	25	16	.2	23	--	213	235	144	330	--	--	142
2.7	106	0	13	1.0	.4	.3	.07	145	144	46	198	8.1	10	143
--	114	0	--	--	--	--	--	--	--	61	221	8.2	--	
6.4	183	0	58	26	.5	16	--	345	333	162	508	7.8	--	144
3.0	158	.0	44	18	.7	2.2	.10	267	273	144	401	8.0	5	145
--	169	.0	--	--	--	--	--	--	--	166	437	8.1	--	
4.5	213	0	68	5.5	.0	3.2	--	327	323	192	--	--	--	146
--	161	0	18	9.0	--	.0	--	--	242	130	--	--	--	147
3.9	156	0	37	17	.4	8.4	--	257	272	154	384	--	--	148
--	151	0	18	8.0	--	1.0	--	--	227	130	--	--	--	149
--	415	0	104	7.0	--	.0	--	--	539	381	--	--	--	150
3.1	161	0	17	4.0	.9	.5	.05	220	218	124	297	8.1	5	151
--	174	0	--	--	--	--	--	--	--	134	319	8.0	--	
9.2	265	0	28	6.8	.3	13	--	319	320	181	501	7.6	5	152
7.1	243	0	51	21	.3	4.1	--	348	338	216	538	7.9	0	153
7.0	243	0	46	16	.5	4.4	--	--	332	205	523	7.9	5	
7.0	219	0	34	10	.2	5.4	.65	293	297	166	440	7.7	0	
7.4	249	0	47	16	.2	4.1	--	340	333	208	515	7.8	0	
7.3	248	0	40	13	.3	7.3	--	327	328	191	509	8.0	5	
2.7	119	0	17	7.5	.4	16	--	213	210	101	266	8.0	0	154
2.7	120	0	17	7.5	.2	14	--	--	208	103	275	8.0	5	
2.6	121	0	17	7.0	.3	11	--	205	207	103	269	8.1	0	
3.2	122	0	17	7.2	.3	13	--	208	210	100	276	7.5	5	
4.2	231	0	32	7.8	.2	15	--	315	312	194	456	8.1	0	155
3.6	190	0	26	6.5	.3	8.8	--	263	260	158	376	7.7	0	
3.8	189	0	26	6.8	.2	12	--	266	265	152	382	8.0	5	
5.0	164	0	21	6.1	.2	8.4	--	237	230	131	319	8.0	4	156
4.3	160	0	21	7.1	.3	6.0	--	233	232	131	317	7.5	15	
3.8	162	0	25	7.9	.2	9.7	--	242	235	131	328	8.1	5	
7.9	164	0	26	8.6	.6	3.6	--	243	231	117	334	7.9	5	
3.8	163	0	15	8.0	.1	13	--	232	254	134	349	8.0	0	
4.3	167	0	26	9.5	.3	15	--	256	250	146	365	8.1	0	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
GRANT COUNTY -- Continued													
156 Cont.	20/28-32C1	U. S. Government (Larson A.F.B., well 2)	1,195	725	610-618, 652-719	Basalt	11/5/57	57	--	0.02	32	16	20
							10/31/58	57	50	.02	32	18	20
							10/21/59	57	45	.12	17	6.4	39
157	20/28-32J1	U. S. Government (Larson A.F.B., well 1)	1,187	712	532-560, 600-612	Basalt	3/30/51	72	49	.02	17	8.6	35
							3/6/52	--	45	.03	18	8.3	37
							12/4/53	67	46	.05	18	9.3	37
							8/24/55	67	44	.00	17	8.4	34
							6/20/56	57	46	.04	18	7.8	35
							11/5/57	57	--	.11	17	8.4	36
							10/31/58	57	47	.04	20	6.7	36
							10/21/59	57	43	.04	17	8.0	37
158	20/28-33E1	U. S. Government (Larson A.F.B., well 3)	1,169	790	723-790	Basalt	5/26/55	50	42	.07	16	7.7	35
							6/20/56	60	40	.06	16	7.8	37
							11/5/57	60	--	.12	18	6.8	35
							10/31/58	60	40	.77	21	9.8	32
							10/21/59	60	42	.02	17	6.9	38
159	20/29-11A1	Ivan E. Cole	1,380	165	--	Basalt	4/50	--	44	.10	31	12	21
160	20/29-18J1	W. E. Lane	1,279	81	80-81	Gravel (interbed)	10/19/60	60	48	.00	8.5	5.6	35
							5/3/61	59	--	--	--	--	--
161	21/24-31L1	Ivan Overen	1,474	407	--	Basalt	10/18/60	60	50	.08	36	8.7	17
							5/3/61	59	--	--	--	--	--
162	21/26-15E1	Grant Co. P.U.D., (well 2)	1,278	347	--	Basalt	4/29/50	58	58	.04	30	15	15
163	21/26-16B3	City of Ephrata (well 2)	--	260	203-208, 241-242	Basalt	4/25/42	63	56	.04	24	12	15
							10/19/60	59	55	.03	24	10	15
							5/3/61	62	--	--	--	--	--
164	21/28-23D1	U. S. Government (U.S.B.R.)	1,295	150	--	Basalt	10/19/60	58	37	.04	54	25	39
							5/3/61	58	40	.06	71	30	48
165	21/30-3E1	Archie Zickler	1,684	451	176-203, 296-319	Basalt	10/19/60	60	46	.15	16	5.9	25
							5/3/61	60	--	--	--	--	--
166	22/25-13J2	V. J. Barbre	2,100	118	--	Basalt	10/19/60	54	49	.04	14	6.9	8.4
							5/3/61	52	--	--	--	--	--
167	22/27-23R1	E. W. Short	1,194	258	250-258	Basalt	4/50	--	49	.20	16	8.1	40
168	22/27-30P3	K. E. Savage	1,158	120	--	Basalt?	10/19/60	58	41	.05	145	68	76
							5/3/61	57	41	.00	70	26	110
169	22/30-13H1	Adolph Schell	1,290	39	--	Gravel	10/19/60	54	30	.74t	37	15	37
							5/3/61	52	33	.29	32	11	34
GRAYS HARBOR COUNTY													
170	15/4W-10G1	Emil Carlson	--	26	17-26	Gravel	6/1/60	54	27	.04	12	3.0	5.9
							10/4/60	51	--	--	--	--	--
171	16/11W-18N2	City of Westport (well 2)	--	72	Below 58	Sand, gravel	11/27/59	53	23	.01	9.0	16	29
							5/25/60	55	24	.02	9.5	12	21
							10/6/60	53	--	--	--	--	--
172	17/5W-20P	Virgil Badgett	--	80	40-80	Sand, gravel	6/1/60	52	32	.02	8.0	2.2	7.2
							10/4/60	52	--	--	--	--	--
173	17/6W-1C	Chris Wheeler	--	76	60-76	Sand, gravel	6/1/60	52	22	.04	6.5	2.1	5.1
							10/4/60	50	--	--	--	--	--
174	17/6W-4D1	City of Elma	--	40	--	Sand, gravel	11/27/59	51	20	.00	6.0	1.6	3.8
							5/25/60	51	--	--	--	--	--
175	17/7W-11B	Earl Richart	--	50?	--	--	4/26/61	53	29	2.4t	16	5.5	5.1
176	17/7W-11E	Robert Smith	--	36	--	--	4/26/61	50	32	.73	18	7.5	5.8
177	17/7W-11H	Milton Larson	--	10	--	--	4/26/61	52	25	.19	14	4.2	4.7

Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Parts per million														
G R A N T C O U N T Y -- Continued														
4.5	172	0	28	10	0.3	15	--	--	260	146	386	8.1	0	156
4.1	170	0	28	10	.3	12	--	258	259	153	371	8.0	0	Cont.
12	156	0	25	9.2	.7	.1	--	231	228	69	330	8.2	5	
12	156	5	25	8.9	.6	.2	--	233	222	78	315	8.0	3	157
8.5	155	0	24	9.0	.6	.3	--	227	224	79	315	8.1	5	
7.9	154	0	27	9.6	.6	.4	--	232	222	83	316	8.1	5	
8.7	153	0	24	9.0	.6	.8	--	222	228	77	317	8.1	0	
9.3	151	0	25	10	.6	.3	--	226	220	77	327	8.1	0	
8.8	151	0	26	9.8	.6	.1	--	--	218	77	323	8.1	0	
9.0	148	0	25	11	.8	.0	--	228	218	78	320	7.9	--	
9.3	151	0	27	11	.7	.2	--	227	228	75	317	8.1	0	
7.6	152	0	23	9.0	.5	.1	--	216	211	72	312	7.9	5	158
9.3	150	0	24	9.2	.6	.1	--	218	212	72	317	8.0	5	
8.8	151	0	24	9.0	.5	.2	--	201	211	73	313	8.2	5	
8.0	152	0	24	9.0	.5	1.2	--	220	212	93	326	8.1	5	
9.3	152	0	25	9.5	.6	.2	--	224	218	71	314	8.2	5	
4.5	145	0	21	13	.3	20	--	238	234	127	344	8.0	--	159
4.2	127	0	15	1.5	.6	.9	0.11	182	180	44	237	8.0	0	160
--	138	0	--	--	--	--	--	--	--	51	254	7.9	--	
3.5	140	0	36	8.0	.7	2.3	.18	231	240	126	323	7.5	0	161
--	146	0	--	--	--	--	--	--	--	108	303	7.0	--	
5.3	182	0	14	5.8	.3	4.1	--	237	233	137	334	7.4	--	162
3.9	150	0	11	4.3	.3	1.4	--	202	197	109	270	--	--	163
5.0	147	0	10	4.0	.4	2.1	.19	198	193	103	263	7.5	5	
--	146	0	--	--	--	--	--	--	--	103	262	7.5	--	
8.6	230	0	87	27	.6	12	.18	404	407	238	630	7.9	5	164
9.2	260	0	130	37	.4	11	.17	505	527	302	768	7.8	5	
3.8	118	0	10	5.0	.3	6.3	.08	176	177	64	231	7.5	5	165
--	118	0	--	--	--	--	--	--	--	63	233	8.0	--	
2.0	87	0	4.6	3.2	.4	1.9	.32	134	132	63	158	7.4	5	166
--	88	0	--	--	--	--	--	--	--	62	165	7.3	--	
7.2	174	0	17	6.1	.9	.0	--	230	220	73	316	8.1	--	167
9.9	304	0	468	50	1.4	3.1	.10	1,010	1,060	642	1,370	7.7	5	168
8.0	316	0	216	24	.8	5.9	.21	658	664	282	939	7.8	0	
7.5	228	0	27	9.8	.7	13	.55	290	296	156	465	7.6	5	169
6.1	202	0	23	8.5	.8	3.2	.50	252	256	123	389	7.6	5	
G R A Y S H A R B O R C O U N T Y														
.8	50	0	4.2	3.8	.0	2.7	.08	85	90	42	111	6.1	0	170
--	44	0	--	--	--	--	--	--	--	35	97	6.1	--	
6.8	121	0	5.4	38	.1	.1	.59	188	189	87	329	7.0	5	171
5.9	92	0	6.0	31	.1	.7	.29	155	158	72	257	7.4	5	
--	116	0	--	--	--	--	--	--	--	88	317	7.6	--	
1.3	45	0	3.6	3.8	.1	1.7	.11	82	82	29	94	6.6	0	172
--	43	0	--	--	--	--	--	--	--	28	94	6.8	--	
.5	32	0	4.4	3.0	.0	3.5	.04	63	67	24	78	6.2	5	173
--	35	0	--	--	--	--	--	--	--	27	84	6.2	--	
.4	28	0	2.1	4.0	.0	1.9	.02	54	58	22	73	7.4	0	174
--	30	0	--	--	--	--	--	--	--	24	72	6.2	--	
.5	82	0	.6	2.8	.1	.7	.03	100	106	62	141	6.7	10	175
.4	101	0	.6	3.2	.1	.2	.04	118	119	76	168	6.9	10	176
.4	63	0	4.2	3.5	.1	3.5	.03	91	93	52	124	6.6	5	177

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million				
									Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
GRAYS HARBOR COUNTY -- Continued													
178	17/7W-11K	G. W. Stretter	--	51	37-51	Sand, gravel	6/1/60 10/3/60	54 57	26 26	0.29 .01	14 20	5.7 3.2	4.9 5.0
179	18/6W-31H	Erling Olson	--	98	96-98?	Sand, gravel	6/1/60 10/3/60	52 51	34 --	.33t --	14 --	4.2 --	6.4 --
180	18/12W-27F1	Frank Minard	--	358	350-358	Gravel	11/27/59 5/25/60	54 58	40 --	.33 --	7.5 --	2.0 --	20 --
181	19/8W-27C1	Tagman Brothers	--	45?	--	--	5/31/60 10/3/60	51 52	18 --	.03 --	6.5 --	2.2 --	8.5 --
182	20/12W-20B1	Pacific Beach Water Company	--	190?	60-82	Gravel	1/11/51 11/27/59 5/25/60	46 -- 52	66 60 --	2.3t 3.7 --	14 12 --	7.8 6.5 --	14 14 --
183	23/9W-19	U. S. Government (U.S.F.S.)	--	46	27-30, 40-42	Gravel, sand	4/24/58	--	13	.28	5.4	1.1	2.6
ISLAND COUNTY													
184	29/2-9Q	Mutiny Sands, Inc.	--	248	230-248	Sand, gravel	5/19/60 9/29/60	50 55	47 --	.12 --	23 --	16 --	11 --
185	30/2-8J	Green Community Progressive Club	--	100	92-97	Sand, gravel	4/25/61	53	29	.04	8.0	13	15
186	32/1-33J1	City of Coupeville	--	240	190-213	Sand, gravel	5/19/60 9/29/60 4/25/61	55 53 52	36 27 --	.09 .69t --	82 90 66	61 152 178	51 73 --
187	32/3-18A1	Arrowhead Beach, Inc.	--	120	110-120	Sand, gravel	5/19/60 9/27/60 4/24/61	50 51 51	37 31 31	.07 .19 .26	39 40 33	19 18 16	120 136 79
188	32/3-19C	New Utsalady Water System	--	134	94-125	Gravel	5/19/60 9/27/60	50 --	38 --	.01 --	45 --	20 --	14 --
JEFFERSON COUNTY													
189	27/2W-22Q2	U. S. Government (U.S.F.W.S.)	--	50	31-50	Sand, gravel	5/1/61	48	16	.15	50	1.7	67
190	27/2W-24 NW 1/4	U. S. Government (U.S.F.S.)	--	167	165-166	Gravel	11/30/59	49	20	.38	32	4.5	24
KING COUNTY													
191	21/2-1L	R. K. Beymer	300	180	170-180	Sand	3/3/61	47	38	.48	5.5	5.6	5.0
192	21/4-5Q2	King County Water District No. 64	125?	325	314-325	Gravel	12/18/59 6/2/60	50 49	19 --	4.4 --	14 --	5.3 --	5.8 --
193	22/3-7J	U. S. Government (U.S.A.)	392	163	138-163	Sand	3/24/59c 11/3/59c	49 --	33 34	.01 .04	7.0 7.0	8.5 7.9	5.3 5.2
194	22/3-16F1	Queen City Broadcasting Company	--	462	445-460	Gravel	12/16/59 7/5/60	54 66	41 --	1.3t --	45 --	19 --	43 --
195	23/3-29Qs	King County Water District No. 19 (Spring)	25	--	--	Sand, gravel	3/3/61	47	28	.01t	10	8.6	6.0
196	23/4-4A1	Boeing Aircraft Company	15	686	496-595	Sand	4/19/54	56	25	.14	--	--	314
197	23/4-4B1	Tony Deptaro	15	22?	--	Sand	3/9/55	49	--	.86	--	--	--
198	23/4-28M1	Unknown	--	129	--	--	5/7/54	52	37	.03t	8.9	9.1	5.7
199	23/4-34H	R. M. Schader	--	115	85-110	Sand, gravel	6/23/60 10/4/60	64 60	32 --	.02 --	8.0 --	7.8 --	5.2 --

Parts per million											Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)				
GRAYS HARBOR COUNTY -- Continued														
0.4	96	0	4.0	4.0	0.1	0.6	0.02	107	108	58	167	7.2	5	178
.5	97	0	1.2	4.0	.1	5.0	.01	128	120	63	177	7.1	5	
.8	74	0	2.6	3.5	.1	.1	.02	102	100	52	129	6.8	10	179
--	70	0	--	--	--	--	--	--	--	50	126	6.9	--	
3.9	73	0	2.9	11	.2	.1	1.8	126	127	26	159	7.5	5	180
--	70	0	--	--	--	--	--	--	--	27	156	7.7	--	
1.6	33	0	8.0	4.8	.0	3.9	.05	70	75	25	97	6.0	0	181
--	36	0	--	--	--	--	--	--	--	29	109	5.9	--	
3.4	96	0	4.0	11	.5	.1	--	169	162	67	185	7.3	20	182
1.1		0	1.3	11	.1	.2	.11	154	161	57	183	6.2	10	
--	89	0	--	--	--	--	--	--	--	57	176	6.8	--	
1.0	23	0	2.6	2.2	.0	.4	--	40	40	18	53	6.6	0	183
ISLAND COUNTY														
3.2	155	0	8.4	11	.1	.0	.20	196	181	122	292	7.9	5	184
--	161	0	--	--	--	--	--	--	--	130	297	7.8	--	
1.4	94	0	11	10	.1	5.2	.00	139	146	72	208	7.5	5	185
11	490	0	47	82	.2	.1	.35	612	595	454	1,040	7.7	0	186
16	682	0	230	150	.2	.0	.37	1,070	1,100	849	1,720	7.7	5	
--	696	0	--	--	--	--	--	--	--	895	1,720	8.0	--	
6.6	170	0	27	185	.2	.5	.09	518	516	174	937	7.6	5	187
6.9	168	0	26	220	.2	.4	.10	562	575	174	986	7.4	5	
5.3	173	0	20	112	.2	.6	.07	382	411	149	679	7.6	5	
6.0	229	0	16	16	.2	1.0	.36	270	254	194	433	7.7	5	188
--	226	0	--	--	--	--	--	--	--	192	439	7.6	--	
JEFFERSON COUNTY														
.3	51	0	2.8	162	.0	1.2	.01	326	352	132	650	6.8	0	189
.8	83	0	5.2	58	.1	.0	--	186	196	98	329	6.7	0	190
KING COUNTY														
1.0	42	0	11	2.8	.1	.1	.18	91	90	36	104	7.4	5	191
2.6	77	0	6.7	4.0	.4	.2	.09	100	102	57	157	7.6	15	192
--	85	0	--	--	--	--	--	--	--	68	165	7.6	--	
1.6	64	0	7.3	3.0	.0	.2	--	98	95	52	128	7.2	5	193
1.3	64	0	7.4	3.2	.3	.0	--	98	93	50	124	7.3	0	
7.4	346	0	.3	8.8	.3	.5	.59	338	346	190	545	7.6	10	194
--	330	0	--	--	--	--	--	--	--	184	511	7.8	--	
1.2	44	0	20	6.0	.1	10	.07	112	116	60	158	7.3	5	195
8.4	--	--	1.9	348	.1	1.0	--	--	872	--	1,600	--	10	196
--	46	0	87	83	--	--	--	--	--	152	599	6.7	--	197
1.7	58	0	12	5.1	.1	8.0	--	117	110	60	152	6.9	3	198
1.8	59	0	7.2	4.2	.1	3.7	.19	99	95	52	133	7.4	0	199
--	58	0	--	--	--	--	--	--	--	58	149	7.2	--	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
						K I N G C O U N T Y -- Continued							
200	23/5-17F2	City of Renton	--	82	39-82	Gravel, sand	6/23/60 10/5/60	55 59	14 --	0.00 --	12 --	3.5 --	4.0 --
201	24/4-25R1	King County School District No. 400	350	154	148-154?	Gravel?	4/11/58	62	23	.41	10	10	6.0
202	24/5-23E1	Horizon View Co., Inc.	980	385	130-205	Sandstone	4/11/58	55	48	.06	32	6.3	18
203	24/5-24R2	W. E. Russell	1,150	265	118-138	Sandstone	11/24/59 6/17/60	48 54	59 54	.42 .07	23 24	4.7 4.7	15 17
204	24/5-27R	B & R Coal Co. (Mine discharge)	--	--	--	--	4/28/52	50	30	.89t	65	14	13
205	24/5-32B1	I. L. Shaw	50	72	70-72	Sand, gravel	10/6/60 5/23/61	-- 50	36 --	.16t --	17 --	7.4 --	13 --
206	24/6-4N1	King County Water District No. 82	450	300	270-291?	Sand, gravel	4/3/58	48	34	1.0t	10	4.6	4.2
207	24/6-9J1	Providence Heights College (well 2)	438	210	116-130	Sand, gravel	10/6/60 5/23/61	-- 50	25 --	.20 --	7.0 --	3.8 --	3.9 --
208	24/6-19Q1	U. S. Government (U.S.A.)	708	328	120-130, 230-250	Sandstone	3/24/59c	63	49	.03	30	7.5	7.1
209	24/6-21J1	Peters Realty	50	150	100-120	Sand, gravel	12/1/59 6/17/60	50 57	39 --	.48 --	20 --	6.4 --	30 --
210	24/6-27Q1	City of Issaquah	25	45	--	--	8/20/51	50	17	.07	22	3.5	7.4
211	24/6-28J1	Darigold Farms	80	54	32-54	Sand, gravel	8/20/51	--	22	.01	10	3.3	5.4
212	24/7-4M1	Gordon Ransom	85	24	19-24	Gravel	10/6/60 5/23/61	51 52	19 --	.23 --	14 --	2.7 --	6.2 --
213	24/7-8J1	George Brigham	100	130	98-104	Sand	10/6/60 5/23/61	51 52	30 --	.11 --	23 --	4.6 --	17 --
214	24/7-10C1	C. F. Alexander	79	52	25-50	Gravel	8/24/51	--	19	15	12	4.3	6.3
215	24/7-11L1	Fall City Water Co.	--	--	--	--	8/20/51	--	47	1.6t	20	6.8	6.6
216	25/3-14J1	Great Northern Railroad	15	545	376-378, 425-502 520-525	Gravel, boulders	10/26/60	51	42	.40t	17	6.6	43
217	25/4-30R1	Troy Laundry	90	555	297-308, 357-521	Gravel, sand	3/9/55	--	--	.11	--	--	--
218	25/5-1R1	Fred Pingrey	45	45	35-45	Sand, gravel	10/6/60 5/23/61	52 52	22 21	4.6t 1.1	11 18	4.7 8.1	10 11
219	25/5-12C1	City of Redmond	47	56	42-56?	Sand, gravel	3/24/59c	40	23	.06	10	4.7	4.9
220	25/5-21Q1	M. G. Clark	425	100	80-100	Sand	8/24/51	--	33	.02	6.3	6.2	3.8
221	25/5-23C3	Tom Forrester	370	88	78-88	Sand, gravel	4/16/58	51	24	.09	6.4	4.9	3.9
222	25/5-24R1	F. Justham	160	75	70-75?	Sand	4/9/58	54	19	5.8t	8.8	6.8	5.7
223	25/6-19A2	Weber Point Community	40	200	--	Sand	4/9/58	54	18	.78	18	3.4	22
224	25/6-19H2	W. L. Grange	50	108	103-108	Sand, gravel	10/6/60 5/23/61	52 52	29 --	.34 --	22 --	8.8 --	9.2 --
225	25/7-6R1	Carnation Farms	63	630	590-622?	Gravel, sand	10/6/60 5/23/61	54 56	27 --	1.1 --	22 --	9.2 --	22 --

Parts per million														
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
KING COUNTY -- Continued														
0.5	49	0	10	2.2	0.1	0.8	0.02	71	74	44	110	6.9	0	200
--	54	0	--	--	--	--	--	--	--	46	119	6.7	--	
4.2	82	0	12	2.5	.0	.1	--	108	104	66	156	7.7	5	201
9.6	171	0	16	3.0	.1	.0	.24	217	196	106	307	8.0	2	202
3.1	120	0	13	2.5	.1	.1	.68	181	183	77	222	7.7	5	203
3.3	122	0	14	3.5	.2	.1	.57	181	181	79	225	7.6	5	
1.1	235	0	44	2.9	.1	1.0	--	287	289	220	438	7.7	2	204
3.8	113	5	1.6	1.8	.1	.0	.35	142	143	73	192	8.5	25	205
--	116	2	--	--	--	--	--	--	--	72	201	8.3	--	
3.3	59	0	.5	1.8	.0	3.3	--	91	96	44	106	7.2	5	206
.8	44	0	2.2	2.8	.1	.7	.14	69	68	33	85	7.3	0	207
--	46	0	--	--	--	--	--	--	--	32	85	7.1	--	
3.2	102	0	30	3.0	.1	.1	--	180	182	106	236	7.5	0	208
6.6	150	0	2.6	18	.2	.2	1.4	199	196	76	297	7.7	10	209
--	154	0	--	--	--	--	--	--	--	79	298	7.9	--	
1.8	94	0	8.6	2.4	.1	.1	--	109	109	69	162	8.0	5	210
1.6	47	0	6.3	3.4	.2	3.5	--	79	84	38	105	7.0	5	211
2.0	58	0	7.0	3.0	.1	2.6	.04	86	88	46	119	6.0	0	212
--	78	0	--	--	--	--	--	--	--	75	202	6.1	--	
4.5	129	0	3.6	5.5	.2	.3	1.2	154	152	76	221	7.8	0	213
--	128	0	--	--	--	--	--	--	--	75	223	8.0	--	
2.4	69	0	1.0	4.8	.2	2.5	--	102	104	48	120	7.2	350	214
3.4	104	0	5.4	2.5	.2	.2	--	145	143	78	175	7.7	10	215
4.4	176	0	.2	20	.1	.3	2.4	223	219	70	323	7.7	35	216
--	105	32	16	9.0	--	--	--	--	--	102	303	9.2	--	217
1.6	78	0	2.8	4.0	.1	.5	.29	95	100	47	136	7.1	15	218
2.0	102	0	7.6	9.0	.1	.4	.07	128	136	78	202	6.8	60	
1.1	50	0	5.4	3.8	.1	5.6	--	84	82	44	116	7.3	0	219
1.4	49	0	6.3	4.1	.2	.9	--	86	88	41	102	7.2	5	220
1.9	45	0	4.7	2.0	.0	.5	--	70	72	36	90	7.4	0	221
2.1	61	0	7.7	4.0	.0	.4	--	84	82	50	126	7.3	5	222
3.1	124	0	1.4	3.0	.0	1.8	--	132	131	59	202	8.0	5	223
1.6	128	0	2.4	4.0	.1	1.0	.40	142	141	91	211	7.6	0	224
--	126	0	--	--	--	--	--	--	--	90	214	7.7	--	
4.2	164	0	7.6	3.0	.2	.0	.58	178	176	93	269	8.0	0	225
--	164	0	--	--	--	--	--	--	--	92	274	8.0	--	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
						KING COUNTY -- Continued							
226	25/7-18C1	Lux	190	101	95-101?	Sand, gravel	4/24/61	54	21	0.10t	7.5	7.6	4.2
227	26/3-1D3	James Phillips	315	94	--	--	2/25/54	49	31	.00	13	13	7.8
228	26/3-2C1	R. P. Kelly	110	101	--	--	2/25/54	54	48	.18	18	5.9	7.3
229	26/4-5E1	Holyrood Cemetary	430	565	470-495; 495-537	Boulders; gravel	5/14/54	50	40	.93	21	13	19
230	26/4-16Q1	Acacia Memorial Park	250	287	125-184, 199-275	Sand, gravel	2/23/54	50	34	.00	18	1.5	6.1
231	26/4-30K1	Washelli Cemetary Company	330	260	--	Sand, gravel	2/25/54	50	36	.02	19	2.0	6.2
232	26/5-5E1	Bothell Water District	245	224	189-220	Sand, gravel	8/24/51	--	47	.03	21	8.4	8.6
233	26/5-23Q	Aries Gardens (well 1)	--	20	6-13	Sand, gravel	6/22/60 10/5/60 4/24/61	60 53 52	9.3 20 30	1.8t .06 .13	11 9.0 13	5.2 5.2 3.6	4.1 4.2 16
234	26/6-13D1	City of Duvall	45	215	202-215?	Sand, gravel	10/6/60 5/23/61	50 52	16 --	.11 --	24 --	5.8 --	32 --
235	26/6-30Q1	W. E. McElfatrick	95	53	52-53	Gravel	4/24/61	50	29	.11	16	6.8	16
236	26/6-31L1	Stanley Robstad	100	353	348-353	Gravel?	10/6/60 5/23/61	49 50	31 --	.26 --	17 --	5.8 --	14 --
						KITSAP COUNTY							
237	22/1-1M2	E. P. Eberle	40	62	55-62	Sand, gravel	10/4/60 5/25/61	54 56	29 --	.11 --	14 --	3.8 --	4.6 --
238	22/1-8H1	R. I. Mirador	305	100	80-100	Sand, gravel	3/1/61	48	20	.05	6.0	2.9	3.0
239	22/1-12D2	Kenneth Lake	25	353	343-353	Sand	10/4/60 5/25/61	50 51	38 --	.09 --	12 --	1.5 --	19 --
240	22/1-12R2	A. Steiner	120	18	8-18	Sand, gravel	10/4/60 5/25/61	58 58	18 --	.03 --	15 --	1.8 --	11 --
241	22/2-4P	U. S. Government (U.S.A.)	226	269	236-269	Sand, gravel	3/24/59c	47	23	.02	15	6.2	8.4
242	23/1-7D1	Sunnyslope Water Development Co.	470	219	102-119	Sand, gravel	3/2/61	40	25	.01	9.0	4.5	3.7
243	23/1-10A1	Christina Silvernail	215	184	174-184	Gravel	2/28/61	50	24	.01	10	7.1	4.3
244	23/1-26H2	W. J. Moffitt	190	90	55-70	Gravel ?	2/28/61	49	36	.81t	8.0	7.1	3.7
245	23/2-2C3	J. P. Noble	25	--	--	--	10/4/60 5/25/61	54 54	33 --	.05 --	15 --	8.8 --	7.8 --
246	23/2-28K3	F. Eaton	340	98	--	Gravel	3/2/61	45	24	.01	6.5	3.9	3.6
247	24/1W-2G	J. J. Snapp	390	65	60-65?	--	2/28/61	--	20	.16t	12	3.2	7.1
248	24/1W-7C1	W. Lewis	500	140	137-140	Gravel	2/28/61	47	21	.07	8.0	5.1	3.3
249	24/1W-29Q1	H. W. Blanchard	525	85	15-28	Gravel	10/4/60 5/25/61	51 51	17 --	.85t --	22 --	1.5 --	7.9 --
250	24/1W-35P1	Eugene Logan	330	88	74-79	Sand	10/4/60 5/25/61	49 50	21 --	1.3t --	7.0 --	2.7 --	2.8 --
251	24/1-25M1	City of Port Orchard (well 6)	20	832	805-832	Gravel	3/3/61	49	35	.04	18	3.6	5.5
252	24/1-26N1	Wilkins Distributing Company	20	197	88-190	Sand, gravel	10/4/60 4/26/61	47 49	36 --	.05 --	18 17	3.2 4.1	5.1 --

Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Parts per million														
KING COUNTY -- Continued														
1.1	64	0	5.4	1.8	0.1	0.1	0.00	81	88	50	116	7.5	5	226
2.7	74	0	20	10	.2	13	--	147	157	86	222	7.4	2	227
2.5	92	0	4.1	4.5	.2	1.9	--	138	124	69	172	7.5	2	228
5.4	170	0	3.7	3.8	.2	4.7	--	195	187	106	285	7.8	9	229
2.2	60	0	9.9	3.5	.2	1.2	--	107	104	51	137	7.5	0	230
2.2	71	0	6.2	4.0	.2	1.8	--	113	114	56	145	7.2	1	231
4.0	128	0	1.7	2.9	.3	.7	--	158	158	87	201	7.2	25	232
1.2	46	0	13	3.5	.1	4.9	.01	75	75	49	124	7.3	5	233
1.5	32	0	15	4.8	.0	8.1	.06	84	86	44	121	6.4	5	
3.7	97	0	2.8	1.5	.2	.4	2.1	121	120	47	159	7.8	5	
2.2	174	0	2.2	8.8	.0	.8	.47	178	179	84	290	8.1	0	234
--	174	0	--	--	--	--	--	--	--	82	296	8.0	--	
3.4	125	0	2.2	2.0	.2	.2	.98	139	140	68	199	8.1	5	235
2.8	117	0	1.2	2.5	.1	.2	.53	133	133	66	187	8.1	5	236
--	116	0	--	--	--	--	--	--	--	65	188	8.2	--	
KITSAP COUNTY														
1.8	70	0	4.8	1.8	.1	.1	.28	94	92	50	122	8.1	5	237
--	70	0	--	--	--	--	--	--	--	50	124	8.0	--	
.0	29	0	.2	3.0	.0	6.0	.07	55	59	27	73	7.4	0	238
2.6	92	1	.8	1.5	.1	.1	.27	122	120	36	151	8.3	5	239
--	92	1	--	--	--	--	--	--	--	35	152	8.3	--	
.9	46	0	15	9.0	.0	4.9	.04	99	100	45	151	6.3	5	240
--	54	0	--	--	--	--	--	--	--	48	146	6.5	--	
1.5	90	0	.5	3.0	.1	.1	--	102	95	63	154	7.5	5	241
.5	60	0	.4	1.2	.0	.1	.11	75	68	41	99	8.0	0	242
.8	72	0	1.8	2.0	.1	.1	.28	85	85	54	124	7.6	0	243
1.0	62	0	4.4	2.0	.1	.2	.11	94	96	49	115	7.2	20	244
2.1	105	0	3.6	1.5	.1	.1	.43	124	120	74	176	8.1	5	245
--	106	0	--	--	--	--	--	--	--	74	178	7.9	--	
.2	35	0	2.4	3.8	.1	4.4	.09	66	70	32	85	7.3	0	246
.3	50	0	6.8	5.2	.1	2.0	.00	82	88	43	123	6.1	0	247
.0	56	0	.2	1.2	.0	.3	.26	67	65	41	93	7.7	0	248
.3	90	0	4.4	1.2	.0	.1	.06	98	98	61	152	7.9	5	249
--	92	0	--	--	--	--	--	--	--	62	155	8.1	--	
.4	34	0	.8	2.5	.0	4.0	.02	58	60	29	74	7.0	5	250
--	46	0	--	--	--	--	--	--	--	35	87	7.2	--	
1.4	81	2	1.2	1.2	.0	.1	.34	108	105	60	142	8.4	0	251
1.3	79	0	3.6	1.8	.1	.3	.35	109	108	58	137	8.0	5	252
--	79	1	--	--	--	--	--	--	--	59	138	8.4	--	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
KITSAP COUNTY -- Continued													
253	24/1-33K3	City of Bremerton (well 3)	55	538	--	Sand, gravel	11/15/44	--	23	0.01	12	4.4	9.6
254	24/1-33K5	City of Bremerton (well 5)	35	587	--	Sand, gravel	12/16/59 6/3/60	54 54	31 --	.01 --	15 --	2.6 --	6.9 --
255	24/1-33K6	City of Bremerton (well 6)	45	562	492-552	Sand, gravel	11/15/44	--	30	--	15	3.0	8.3
256	24/2-33H1	W. L. Cheney	20	134	133-134	Sand, gravel	2/28/61	51	38	.06	15	2.2	17
257	25/1-9G1	L. R. Fairfield	80	164	135-140	Gravel	6/3/60 10/5/60	58 54	37 --	.08 --	13 --	6.6 --	6.3 --
258	25/1-23K	B. P. Bitle	190	69	--	--	2/28/61	47	20	3.3t	10	6.1	4.7
259	25/2-26K3	D. W. Buchanan	120	175	171-175	Sand	2/1/61	50	35	.45	18	5.8	5.6
260	25/2-34R	U. S. Government (U.S.A.)	--	250	164-174, 195-205	Sandy clay, sand	3/24/59c 11/2/59c	49 --	27 28	.03 .04	11 10	7.3 7.3	6.2 5.8
261	25/2-35H3	Baxter-Wycoff Co. (well 3)	10	813	90-105, 697-780	Gravel, sand	10/5/60 5/25/61	53 56	26 --	.04t --	20 --	12 --	18 --
262	25/2-35M2	H. I. Foss	260	148	143-148	Sand, gravel	2/27/61	50	28	2.3t	11	12	7.5
263	26/1-10L	U. S. Government (U.S.A.)	--	128	103-128	Sand, gravel	3/24/59c 11/2/59c	40 --	27 28	.01 .02	9.0 8.0	6.6 6.9	3.5 4.8
264	26/1-13J1	E. Bowman	310	144	130-144	Gravel	2/28/61	48	24	.15	8.0	4.0	4.0
265	26/1-36P1	U. S. Government (U.S.N., well 1)	14	380	--	--	10/5/60 5/25/61	53 55	33 --	.24 --	28 --	5.3 --	20 --
266	26/2-10Q1	Merwin Calhoun	125	260	254-260	Sand, gravel	2/27/61	48	35	.59	9.0	8.7	6.0
267	27/2-25N1	State of Washington	5	298	266-272?	Sand	2/27/61	52	39	.15	14	9.2	16
268	27/2-26N	U. S. Government (U.S.A.)	--	175	120-130	Sand, gravel	3/24/59c 11/2/59c	48 --	42 42	.30t .43	17 16	10 9.7	12 15
269	27/2-28G1	E. C. Fall	165	134	128-134	Gravel	2/27/61	47	28	.27	7.5	6.4	4.5
270	28/2-35M2	E. D. Byer	150	107	103-107	Gravel	2/27/61	49	31	.04	7.6	11	7.6
KITTITAS COUNTY													
271	17/18-1B1	City of Ellensburg	--	1,208	232-250	Sand, gravel	3/14/57 10/19/59	54 55	58 --	.74 --	18 --	9.2 --	8.6 --
KLICKITAT COUNTY													
272	2/13-21 NW 1/4s	M. A. Leonardo (Spring)	--	--	--	--	7/29/30	57	48	.03	22	11	7.8
273	2/13-33R1	Spokane, Portland and Seattle Railway Company	--	149	138-149	Basalt	7/28/30	60	51	.04	20	8.3	22
274	3/11-30F1	Underwood Fruit and Warehouse Co.	--	265	--	Basalt	10/29/59 7/1/60	63 65	57 --	.10 --	16 --	6.1 --	11 --
275	3/15-21B1	Lyle Woods	--	70	60-70?	Gravel	6/28/60	54	61	.73	15	8.0	12
276	4/16-20H1	Klickitat County	--	200	48-58, 117-127	Gravel (interbeds within basalt)	5/19/60 10/21/60	55 55	47 --	.16 --	21 --	14 --	13 --
277	5/23-3A	R. J. Peterson	--	81	80-81	Sand (interbed within basalt)	5/5/61	61	55	.00	46	12	29

Parts per million														
Potas-sium (K)	Bicar-bonate (HCO_3)	Carbon-ate (CO_3)	Sulfate (SO_4)	Chlo-ride (Cl)	Fluo-ride (F)	Nitrate (NO_3)	Ortho-phos-phate (PO_4)	Dissolved solids: Calcu-lated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
KITSAP COUNTY -- Continued														
1.2	69	0	6.3	2.0	0.1	0.0	--	93	94	48	126	--	--	253
1.7	69	2	3.4	1.5	.3	.0	0.38	99	101	48	129	8.3	0	254
--	70	2	--	--	--	--	--	--	--	48	133	8.4	--	
1.6	72	0	4.6	1.8	.0	.0	--	100	99	50	137	--	--	255
2.0	95	2	.0	4.8	.1	.1	.91	129	119	46	168	8.5	5	256
3.0	88	0	.4	2.5	.1	.5	1.1	114	108	60	145	7.7	5	257
--	89	0	--	--	--	--	--	--	--	59	148	7.9	--	
.4	65	0	3.2	2.2	.0	1.4	.08	80	81	50	121	6.8	5	258
2.0	91	0	4.0	2.8	.2	.3	.39	120	113	69	159	7.3	10	259
1.9	67	0	6.0	6.0	.3	.9	--	100	94	58	142	7.8	5	260
1.6	67	0	6.4	5.8	.1	.7	--	99	94	55	122	7.7	5	
2.0	154	0	6.6	5.2	.1	.1	.19	166	164	100	264	8.2	0	261
--	154	0	--	--	--	--	--	--	--	100	263	8.2	--	
.6	89	0	5.8	6.0	.1	5.3	.11	120	114	77	184	7.4	10	262
1.1	50	0	4.9	4.2	.1	5.1	--	86	85	50	118	7.4	0	263
.7	52	0	5.7	5.5	.1	4.2	--	91	87	48	139	7.5	0	
.4	34	0	.2	6.2	.0	10	.11	74	70	36	101	7.5	0	264
1.9	129	0	.4	22	.1	3.4	2.1	180	182	92	274	7.6	5	265
--	130	0	--	--	--	--	--	--	--	92	266	7.8	--	
2.0	72	0	7.0	4.8	.1	.2	.24	109	103	58	146	7.4	5	266
3.2	126	0	.0	5.5	.1	.1	.82	150	149	73	213	8.1	5	267
2.8	128	0	.9	3.5	.2	.3	--	152	147	85	210	7.2	10	268
2.7	132	0	.5	5.5	.3	.0	--	157	150	80	217	7.3	0	
.8	56	0	5.6	2.0	.1	.5	.16	84	85	44	110	7.8	5	269
2.5	86	0	15	8.2	.1	.9	.26	134	128	82	200	7.9	0	270
KITTITAS COUNTY														
2.0	120	0	1.3	2.0	.2	.8	.25	159	151	83	197	7.4	0	271
--	122	0	--	--	--	--	--	--	--	84	202	7.7	--	
KLICKITAT COUNTY														
2.1	116	0	8.6	5.0	--	7.0	--	169	171	100	--	--	--	272
4.5	137	0	18	4.0	--	.0	--	195	187	84	--	--	--	273
3.0	107	0	.7	4.8	.2	.0	.09	152	158	65	145	7.9	0	274
--	112	0	--	--	--	--	--	--	--	68	188	7.8	--	
1.1	111	0	.0	2.5	.4	.8	--	156	155	70	183	7.9	0	275
2.0	145	0	3.8	6.2	.3	8.0	.10	186	181	110	271	7.5	5	276
--	149	0	--	--	--	--	--	--	--	115	280	7.6	--	
4.3	163	0	46	27	.5	10	.13	310	333	165	464	7.9	0	277

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million				
									Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
						LEWIS COUNTY							
278	11/1W-8E2	City of Toledo	240	79	58-78	Sand	8/25/53	52	42	0.17t	13	6.5	12
279	11/1W-14L2	Harvey Daniels	280	58	--	Gravel	12/2/53	51	46	.10	12	4.9	6.5
280	12/2W-10N1	L. P. Schwarzkopf	440	100	72-100	Gravel, sand	1/23/53	50	38	1.6	6.4	2.8	7.2
281	12/1-9Q1	C. E. Farr	572	143	70-73	Sand	12/2/53	51	7.9	.14	4.0	3.3	4.9
282	12/7-9Q	U. S. Government (U.S.F.S.)	--	66	58-62	Gravel, sand	6/20/58	47	29	.02	12	2.4	4.6
283	13/1W-17K1	T. R. Teitzel	298	1,595	120, 500-600?	--	11/12/59 5/24/60	56 57	23 --	.09 --	44 --	7.3 --	161 --
284	13/1W-28P1	R. L. Wade	360	135	132-135+	Sand	2/11/53	51	28	.42	11	5.9	44
285	13/2W-15M1	Dennis Hamilton	220	244	229-244	Sand	1/8/53	51	28	.32	41	11	155
286	13/2W-34A3	City of Napavine	444	101	60-100	Gravel	2/27/57 6/21/60 10/4/60 4/26/61	52 59 55 52	59 58 51 --	.05 .01 .02 --	14 24 15 --	7.3 4.5 6.4 --	9.7 9.4 9.6 --
287	13/3W-2P1	H. D. Peters	260	90	Below 55	Basalt?	12/3/53	52	36	.46	4.8	4.3	13
288	13/3W-3B2	A. P. Erp	240	72	65-70	Sand?	6/1/60 10/4/60	57 55	51 --	.14 --	19 --	10 --	9.0 --
289	13/3W-9G4	Art Scherer	185	37	36-37+	Gravel	6/1/60 10/4/60	54 54	36 --	.00 --	20 --	6.5 --	5.8 --
290	13/4W-3L1	Charles Christin	260	81	65-81	Sand	6/1/60 10/4/60	59 53	24 --	.09 --	3.5 --	1.7 --	109 --
291	13/5W-33J2	John Kaszycki	425	270	--	--	10/14/58	51	14	1.0t	188	.1	341
292	13/1-19K2	R. R. Szelap	690	18	102-120, 128-182	Sand, gravel	5/3/54	50	60	.09	8.7	6.0	7.4
293	14/2W-5G2	City of Centralia (well 5)	185	88	41-88	Gravel	5/31/60 10/3/60	53 53	33 --	3.1t --	18 --	6.1 --	19 --
294	14/2W-17D2	W. L. Ritter	175	62	55-62	Gravel	5/31/60 10/3/60	48 54	50 --	1.8 --	19 --	7.0 --	28 --
295	14/2W-22H1	Oscar Keto	240	1,200	--	--	10/14/58	57	4.4	65t	5,140	821	10,500
296	14/4W-4G1	C. B. Ingalls	200	80	--	Shale?	6/1/60 10/4/60	54 52	35 --	.74 --	4.5 --	.3 --	151 --
297	14/5-17B1	U. S. Government (U.S.F.S.)	--	120	43-45, 68-70, 110-115	Sand, gravel, clay (porous)	7/16/58	--	26	1.5	12	4.6	6.4
298	15/3W-36K2	Clifford Reisinger	164	54	48-54	Gravel, boulders	5/24/54	52	26	.04	12	3.1	6.5
						LINCOLN COUNTY							
299	21/38-24G	M. L. Jones	--	16	14-16	Gravel	5/2/61	51	34	.00	27	7.9	13
300	23/37-29F	H. Armstrong	--	213	185-213	Sand? (interbed within basalt)	5/2/61	48	38	.05	40	18	26
301	26/31-32A	City of Almira (well 1)	--	208	Below 60	Basalt	12/3/59 5/18/60	-- 56	43 --	1.1 --	28 --	16 --	30 --

Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Parts per million														
LEWIS COUNTY														
2.0	101	0	1.9	3.0	0.2	0.1	--	131	126	59	156	7.3	1	278
.8	67	0	2.3	1.0	.1	3.8	--	110	114	50	126	7.6	1	279
1.2	51	0	1.2	2.4	.1	.1	--	85	81	27	87	6.8	3	280
11	16	0	2.5	5.0	.3	28	--	75	--	24	126	6.6	2	281
.7	58	0	1.5	2.5	.1	.1	--	82	78	40	98	7.4	5	282
3.3	144	0	1.3	265	.0	.1	1.2	576	594	140	1,090	8.1	5	283
--	146	0	--	--	--	--	--	--	--	141	1,050	7.7	--	
1.6	141	0	.3	20	.2	3.9	--	184	180	52	290	7.2	5	284
3.7	154	0	.4	260	.2	.4	--	576	572	148	1,070	7.6	7	285
1.6	94	0	1.3	6.0	.0	1.2	.35	146	132	65	169	6.8	0	286
1.7	114	0	.2	4.8	.1	1.1	.34	160	167	78	196	7.5	0	
1.5	92	0	.4	5.5	.1	1.6	.34	136	142	64	163	7.1	0	
--	92	0	--	--	--	--	--	--	--	63	161	7.0	--	
2.0	49	0	10	4.0	.4	.0	--	99	104	30	110	7.1	3	287
3.4	117	0	2.8	8.0	.1	2.0	.21	164	163	90	213	7.2	0	288
--	120	0	--	--	--	--	--	--	--	90	216	7.0	--	
.1	66	0	2.8	2.0	.1	35	.09	141	145	77	184	6.6	0	289
--	68	0	--	--	--	--	--	--	--	77	179	6.6	--	
2.3	252	0	1.0	32	.3	.3	3.1	301	298	16	464	8.1	35	290
--	246	0	--	--	--	--	--	--	--	16	459	8.1	--	
5.5	32	0	12	840	--	.1	--	1,390	1,550	470	2,980	6.8	0	291
1.7	72	0	1.3	2.1	.1	.3	--	123	111	46	120	7.1	7	292
1.4	84	0	7.0	19	.1	6.9	.26	152	160	70	222	7.1	10	293
--	86	0	--	--	--	--	--	--	--	69	219	7.0	--	
2.4	163	0	.6	4.8	.3	.0	4.2	198	185	76	264	7.3	10	294
--	162	0	--	--	--	--	--	--	--	76	252	7.4	--	
58	0	0	9.4	28,900	--	80	--	45,500	--	16,200	63,600	4.3	0	295
1.0	372	0	.8	28	.1	.3	3.0	408	426	12	619	7.8	20	296
--	348	0	--	--	--	--	--	--	--	14	584	7.6	--	
.7	72	0	2.2	2.0	.2	1.0	--	90	88	49	124	6.8	10	297
.9	34	0	6.8	8.6	.1	13	--	94	96	43	128	6.5	8	298
LINCOLN COUNTY														
3.7	133	0	16	3.8	.3	5.1	.25	177	175	100	252	8.0	5	299
2.0	228	0	12	10	.3	17	.09	275	279	174	429	7.9	5	300
3.8	200	0	24	11	.8	1.7	.00	258	247	134	391	7.8	0	301
--	198	0	--	--	--	--	--	--	--	138	406	8.0	--	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million				
									Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
MASON COUNTY													
302	19/6W-29N1	State of Washington	--	16	--	--	6/1/60 10/3/60	51 58	15 --	0.06 --	5.0 --	2.0 --	2.5 --
303	20/3W-20E	Simpson Plywood Company	--	926	877-926	Sand, gravel	5/24/60 10/5/60	58 56	16 --	.00 --	3.5 --	.0 --	30 --
304	20/3W-20H	Port of Shelton	--	--	--	--	5/24/60 10/5/60	49 49	17 --	.03 --	6.0 --	1.6 --	2.1 --
305	22/2W-1C	Terra Linda Auto Court	15	42	--	--	3/2/61	50	21	.02	9.0	3.6	3.0
306	22/3W-26Q	R. J. Folmer	10	55	51-55	--	3/2/61 8/16/61	48 52	19 19	.20 .21t	11 31	4.4 13	22 60
307	23/2W-13R1	State of Washington	--	210	174-180, 194-195, 207-208	Gravel, sand	5/23/61	48	24	.04	10	4.4	3.1
OKANOGAN COUNTY													
308	31/30-24R1	City of Nespelem (well 1)	--	30	--	--	10/21/59 5/18/60	52 52	23 --	.01 --	46 --	18 --	16 --
309	33/22-8N1	City of Twisp	--	50	48-50	Gravel	10/20/59 5/18/60	52 46	13 --	.02 --	33 --	4.1 --	4.3 --
310	33/26-16C1	City of Okanogan	--	113	74-95	Sand, gravel	3/27/58	58	19	.44	54	23	34
311	34/26-26Q1	City of Omak	--	26	4-26	Sand, gravel	10/21/59 5/17/60 10/20/60	60 53 56	28 23 --	.19t .41t --	55 40 --	29 23 --	13 10 --
312	35/25-6	U. S. Government (U.S.F.S.)	--	50	30-50	Gravel	1/10/61	--	15	.35	34	7.1	4.9
313	36/19-32	U. S. Government (U.S.F.S.)	--	50	31-50	Gravel	9/16/59	--	9.0	.02	18	1.0	1.9
314	37/27-16F	City of Tonasket (well 1)	--	155	145-155	Sand, gravel	10/20/59 5/17/60	51 53	23 --	.04 --	70 --	19 --	23 --
315	37/27-16H	City of Tonasket (well 2)	--	130	--	--	10/20/59 5/17/60	54 53	32 --	1.6 --	100 --	21 --	26 --
316	38/26-20F1s	S. R. Burbery (Spring)	--	--	--	Schist, slate	10/25/54	53	18	.00	82	9.0	9.1
317	40/27-28L1	City of Oroville (well 1)	--	33	--	Sand, gravel	10/20/59 5/17/60	56 --	22 --	.02 --	65 --	16 --	27 --
PACIFIC COUNTY													
318	12/11W-15P	Ralph McGough	--	10	--	--	12/9/59 5/26/60	-- --	20 --	.12 --	4.0 --	1.8 --	8.2 --
319	13/10W-8R1	Harbor Sea Foods	--	455	447-455	Gravel	12/9/59 5/26/60 10/14/60	-- -- --	24 32 --	.05 .04 --	26 19 --	3.1 4.1 --	24 14 --
PEND OREILLE COUNTY													
320	32/45-32E	Reuben Waldroup	--	37	--	Sand, gravel	5/2/61	49	24	.00	14	3.6	4.2
PIERCE COUNTY													
321	16/3-22A2	Charles McPhail	580	426	421-426	Sand, gravel	2/8/61	48	48	.26	26	3.7	25
322	16/4-5D1	S. R. White	640	116	50-60?	Sand?	12/15/60	49	50	.23	21	12	10
323	17/3-13G2	F. Kronquist	--	30	--	--	2/23/61	--	--	.34	--	--	--

Parts per million											Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)				
MASON COUNTY														
0.3	30	0	0.4	1.5	0.0	0.3	0.01	42	47	20	55	6.8	5	302
--	32	0	--	--	--	--	--	--	--	24	63	6.7	--	
.1	46	12	5.4	10	.0	.0	.81	101	102	8	147	9.1	5	303
--	48	11	--	--	--	--	--	--	--	9	147	9.2	--	
.0	30	0	.4	1.8	.0	.0	.04	44	48	22	54	6.7	0	304
--	29	0	--	--	--	--	--	--	--	22	53	7.0	--	
.0	47	0	.2	2.2	.0	2.0	.03	64	64	38	91	6.6	0	305
.4	90	0	3.6	13	.1	.0	.35	118	113	46	189	7.9	0	306
1.4	76	0	19	132	--	--	--	312	--	132	595	7.5	--	
.4	60	0	.0	1.5	.1	.2	.15	74	76	43	97	7.8	0	307
OKANOGAN COUNTY														
2.8	200	0	48	1.8	.7	6.7	--	262	255	188	416	7.7	0	308
--	195	0	--	--	--	--	--	--	--	184	406	7.7	--	
1.2	111	0	14	.8	.0	2.1	--	128	127	100	215	7.2	0	309
--	109	0	--	--	--	--	--	--	--	98	190	7.2	--	
4.4	227	0	109	3.0	.5	.7	.00	360	--	229	567	7.8	0	310
5.2	244	0	75	1.8	.5	1.6	--	329	320	256	519	8.0	0	311
4.0	194	0	55	2.0	.4	.5	.19	254	257	196	412	7.8	0	
--	249	0	--	--	--	--	--	--	--	257	532	7.9	--	
2.7	126	0	24	.8	.1	.3	--	151	156	114	253	7.3	5	312
.5	62	0	3.7	.0	.0	.5	--	66	65	49	111	7.1	5	313
4.0	279	0	52	8.8	.4	4.9	--	342	337	250	555	7.8	0	314
--	280	0	--	--	--	--	--	--	--	258	571	7.6	--	
4.0	403	0	58	3.5	.4	.3	--	444	434	338	709	7.2	5	315
--	380	0	--	--	--	--	--	--	--	325	672	7.3	--	
2.8	234	0	63	1.5	.1	1.2	--	302	306	242	481	7.7	0	316
4.6	254	0	67	3.5	.3	4.8	--	335	328	228	543	7.7	0	317
--	246	0	--	--	--	--	--	--	--	221	515	7.7	--	
PACIFIC COUNTY														
.5	25	0	3.0	9.0	.1	.6	.00	59	59	17	82	6.3	5	318
--	21	0	--	--	--	--	--	--	--	16	76	6.6	--	
1.6	139	0	.6	13	.1	.0	.03	160	155	78	255	7.5	5	319
2.9	101	0	1.4	9.0	.0	.7	.94	134	137	64	188	8.0	5	
--	141	0	--	--	--	--	--	--	--	79	260	7.7	--	
PEND OREILLE COUNTY														
.9	60	0	8.6	.8	.2	1.8	.03	88	89	50	120	6.7	5	320
PIERCE COUNTY														
2.0	160	0	1.4	3.2	.1	.2	.39	189	186	80	249	7.7	20	321
2.5	142	0	1.2	2.5	.1	.1	.26	170	163	100	223	7.4	5	322
--	--	--	--	--	--	--	--	--	--	--	--	--	--	323

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
						PIERCE COUNTY -- Continued							
324	17/3-13J2	H. D. Alloway	--	24	--	--	2/23/61	--	--	0.44	--	--	--
325	17/3-24J1	Harvey Lay	--	89	--	--	2/23/61	--	--	.17	--	--	--
326	17/4-30M3	Dillard Stevens	--	96	--	--	2/23/61	49	--	.35	--	--	--
327	18/2-35Q1	George Lenz	390	149	136-149	Gravel	11/28/60	49	31	.15	10	4.6	5.1
328	18/4-10Q1	A. S. Andrews	639	98	94-98	Sand, gravel	11/28/60	49	33	.50t	16	6.3	6.4
329	19/1-34G1	U. S. Government (U.S.A.)	215	36	18-36	Sand, gravel	11/10/47	51	23	.00	12	3.9	--
							1/26/49	--	21	--	11	3.8	--
							5/26/50	58	21	.03	10	3.6	4.7
							7/23/52	56	21	.05	11	4.5	5.6
							9/10/53	52	22	.07	11	3.6	5.4
							9/13/54	51	21	.06	11	3.6	4.5
							10/10/55	51	19	.02	12	3.3	5.4
							11/6/56	51	17	.05	12	3.0	5.0
							1/13/58	53	16	.04	12	3.7	5.4
330	19/2-10F5	Lakewood Water District	270	497	474-497	Gravel, sand (with hardpan layers)	3/22/60	56	41	.46	9.0	5.2	6.1
331	19/2-12A1	U. S. Government (McChord A.F.B., well 832)	285	141	117-141?	Sand	11/12/59	52	24	.47	17	4.3	8.7
							9/22/60	52	28	.03	16	5.5	7.0
							9/20/61	52	29	.02	18	3.9	6.7
332	19/2-13G1	U. S. Government (McChord A.F.B., well 711)	294	200	145-181	Gravel	5/27/48	52	37	.01	9.6	4.6	--
							7/21/49	52	36	.05	11	4.6	--
							6/22/50	50	35	.05	10	4.6	4.9
							1/5/51	52	35	.01	9.8	4.5	5.3
							3/13/52	--	34	.04	10	4.9	5.4
							12/10/52	52	33	.04	11	5.1	5.4
							11/19/53	--	36	.04	11	5.2	5.8
							11/5/54	54	33	.06	11	5.5	6.5
							10/18/55	52	29	.00	10	4.9	5.5
							12/10/56	54	30	.02	11	4.8	5.4
							10/14/57	52	--	.00	12	5.2	5.4
							11/5/58	54	35	.01	12	4.7	5.3
							11/12/59	52	33	.00	12	4.1	5.4
							9/21/60	52	33	.00	12	5.3	5.8
							9/20/61	54	33	.00	12	4.9	5.8
333	19/2-13G2	U. S. Government (McChord A.F.B., well 781)	300	298	140-153, 165-182, 264-278	Gravel, sand	7/21/49	52	29	.03	14	5.3	--
							6/22/50	50	28	.06	13	5.4	5.2
							1/5/51	52	29	.04	16	6.6	6.0
							3/13/52	--	27	.06	13	5.6	5.5
							12/10/52	54	26	.06	12	5.4	5.1
							11/19/53	--	28	.07	13	5.3	5.6
							11/5/54	55	26	.05	13	5.9	5.1
							10/18/55	53	26	.03	13	5.1	5.5
							12/10/56	54	25	.01	15	5.8	5.7
							10/14/57	54	--	.01	14	6.4	5.9
							11/5/58	54	28	.08	16	4.9	5.6
							11/12/59	54	32	.01	15	5.5	5.6
							9/21/60	54	26	.01	14	5.2	5.7
							9/20/61	55	27	.00	14	5.5	5.8
334	19/2-14L1	U. S. Government (McChord A.F.B., well 5003)	310	220	210-220	Gravel, sand	11/13/59	50	24	.03	7.0	3.3	4.9
							9/22/60	52	29	.04	7.0	3.6	5.1
							9/20/61	52	28	.01	7.0	3.9	5.5
335	19/2-14L2	U. S. Government (McChord A.F.B., well 5001)	310	435	94-96, 138-140, 150-152, 220-254	Sand, gravel	11/5/58	48	33	.35	10	4.4	7.0
							11/13/59	50	35	.27	9.0	5.0	6.9
							9/22/60	52	33	.23	9.0	5.1	7.1
							9/20/61	54	32	.21	9.0	4.9	6.8
336	19/2-18Q1	U. S. Government (Fort Lewis, well 2)	234	239	215-228	Sand, gravel	4/3/42	--	31	--	10	5.8	5.4
							11/10/47	52	36	--	14	6.0	--
							5/26/50	54	9.2	60t	9.1	3.2	4.5
							5/2/51	53	30	1.1	9.8	5.2	5.0
							7/23/52	--	30	.09	9.4	6.2	5.2
							9/10/53	53	31	1.2	9.4	5.2	5.0
							9/13/54	54	31	.86	9.6	5.6	4.3
							10/10/55	53	26	.43t	11	4.7	5.5

Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Parts per million														
PIERCE COUNTY -- Continued														
--	--	--	--	--	--	--	--	--	--	--	--	--	--	324
--	--	--	--	--	--	--	--	--	--	--	--	--	--	325
--	--	--	--	--	--	--	--	--	--	--	--	--	--	326
1.3	63	0	0.4	2.8	0.1	0.6	0.26	87	88	44	110	7.5	5	327
2.9	96	0	3.0	2.5	.1	.1	.49	118	117	66	160	7.8	5	328
--	36	0	15	8.2	.1	3.1	--	--	88	46	121	6.5	--	329
--	39	0	14	6.1	.1	2.0	--	--	83	43	118	7.5	--	
2.2	38	0	13	4.8	.2	1.2	--	79	80	40	105	6.9	--	
.8	40	0	14	5.0	.1	3.2	--	85	86	46	121	7.0	5	
.7	42	0	13	4.7	.1	3.4	--	85	84	42	119	6.6	3	
.7	36	0	15	4.9	.1	1.9	--	80	78	42	114	7.5	5	
1.0	40	0	13	4.5	.0	3.6	--	82	84	44	121	6.5	0	
.6	38	0	15	4.5	.0	1.5	--	78	81	42	117	6.3	0	
.7	41	0	14	4.5	.0	3.8	--	80	84	45	122	6.5	5	
1.5	67	0	2.1	2.2	.1	.5	.28	101	95	44	119	7.5	5	330
2.7	83	0	5.2	6.2	.0	.2	--	110	114	60	165	7.8	0	331
2.9	82	0	5.8	3.8	.1	.1	--	109	111	62	155	7.8	5	
2.8	83	0	7.6	3.0	.1	.2	--	112	115	61	151	7.7	0	
--	62	0	3.0	2.8	.1	.2	--	--	92	43	111	7.0	--	332
--	62	0	4.8	3.0	.1	1.0	--	--	97	46	123	7.5	--	
2.2	60	0	4.2	3.1	.2	1.1	--	95	97	44	115	7.0	--	
3.4	61	0	5.0	2.9	.3	.8	--	97	94	43	112	7.7	5	
2.2	65	0	5.8	2.8	.0	.9	--	98	97	45	117	7.6	2	
2.2	62	0	6.4	3.2	.1	1.2	--	98	102	48	126	7.3	5	
1.9	62	0	5.1	2.6	.1	1.0	--	99	96	49	121	7.6	3	
1.7	62	0	6.6	3.5	.1	1.5	--	100	106	50	127	7.2	5	
2.1	61	0	5.9	3.0	.0	1.6	--	92	96	45	123	7.4	0	
2.1	62	0	5.9	3.0	.0	1.2	--	94	96	47	123	7.4	0	
2.2	60	0	6.3	3.2	.1	1.8	--	--	97	51	127	7.6	0	
2.3	64	0	5.7	3.2	.1	1.4	--	102	102	50	124	7.8	5	
1.0	63	0	5.7	2.5	.0	1.5	--	96	99	47	129	7.8	0	
2.4	64	0	7.2	3.2	.1	2.6	--	104	108	52	136	7.8	5	
2.3	64	0	7.2	3.5	.1	1.1	--	102	101	50	127	7.3	5	
--	66	0	6.3	4.1	.2	4.3	--	--	102	57	143	7.2	--	333
2.4	64	0	6.9	4.0	.2	4.9	--	102	103	55	140	7.0	--	
3.8	74	0	9.1	4.5	.3	11	--	123	119	67	164	7.4	5	
1.6	68	0	8.7	3.9	.0	4.4	--	103	105	56	141	7.4	2	
1.7	62	0	7.7	3.9	.1	3.0	--	95	98	52	134	7.4	7	
1.7	60	0	7.3	3.7	.1	3.3	--	98	96	54	133	7.4	3	
1.6	60	0	8.1	4.0	.1	4.3	--	98	106	57	137	7.0	5	
1.9	60	0	8.3	4.0	.0	5.7	--	100	100	53	139	7.2	0	
1.9	65	0	10	4.8	.0	6.5	--	107	108	61	155	7.1	0	
1.9	64	0	9.1	4.5	.1	7.6	--	--	109	61	157	7.4	0	
1.9	63	0	9.2	4.5	.1	5.4	--	107	110	60	147	7.2	0	
1.9	66	0	9.2	5.0	.1	5.2	--	113	110	60	155	7.2	0	
1.9	63	0	8.8	4.0	.0	4.4	--	101	106	56	146	7.3	5	
2.0	64	0	8.8	3.8	.1	3.9	--	103	109	58	141	7.1	0	
1.9	48	0	2.7	2.2	.0	.1	--	70	76	31	92	7.6	0	334
2.2	49	0	3.2	1.5	.1	.0	--	76	78	32	95	7.6	5	
2.2	52	0	3.2	3.0	.1	.0	--	79	75	34	93	7.4	0	
2.0	65	0	1.6	2.0	.1	.2	--	92	95	43	115	7.4	5	335
2.3	69	0	2.6	1.8	.2	.0	--	98	91	43	120	7.6	5	
2.4	70	0	2.6	1.5	.1	.2	--	95	97	44	121	7.7	5	
2.3	66	0	3.4	3.0	.1	.1	--	95	92	43	115	7.4	5	
1.4	70	0	1.7	2.0	.1	.0	--	92	85	49	119	--	--	336
--	72	0	7.4	3.0	.1	.3	--	--	106	60	137	7.9	--	
3.2	38	0	8.4	4.4	.4	.3	--	61	64	36	93	7.0	--	
4.5	70	0	1.6	2.3	.2	.1	--	93	85	46	138	7.6	3	
1.6	68	0	1.9	2.5	.1	.1	--	91	88	49	114	7.3	5	
2.0	69	0	.8	2.0	.1	.2	--	90	85	45	110	7.6	3	
1.5	68	0	1.6	2.5	.1	.1	--	90	81	47	111	7.4	5	
1.7	67	0	3.5	2.8	.1	.7	--	89	88	47	120	7.3	15	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
						PIERCE COUNTY -- Continued							
337	19/2-19B1	U. S. Government	234	224	192-214	Sand, gravel	4/3/42	--	33	--	10	5.5	5.4
		(Fort Lewis,					11/10/47	51	34	5.1t	14	7.5	--
		well 1)					1/26/49	--	33	--	10	5.2	--
							4/18/51	53	31	.67t	14	7.8	5.5
							7/23/52	55	31	.13	13	7.3	5.9
							9/10/53	53	33	.54t	11	5.6	5.5
							9/13/54	53	32	8.1t	12	6.3	4.9
338	19/2-19F1	U. S. Government	235	229	189-220	Sand, gravel	11/10/47	51	31	.62t	11	5.5	--
		(Fort Lewis,					1/26/49	--	21	--	11	4.1	--
		well 3)					5/26/50	54	31	7.1t	11	5.7	4.5
							4/19/51	--	30	.94t	11	5.2	5.0
							7/24/52	55	30	7.6t	11	6.3	5.3
							9/10/53	52	33	.05	11	5.1	5.1
							9/13/54	52	27	1.5t	12	6.2	4.7
							3/24/59	56	30	.66	12	5.3	5.1
							10/26/59	52	31	.45	12	5.7	5.4
339	19/2-19Q1s	U. S. Government	--	--	--	--	11/10/47	53	11	.02	8.1	3.1	--
		(Sequalitchew					1/26/49	--	11	--	8.3	3.2	--
		Spring)					5/31/50	54	11	.01	8.2	3.2	4.3
							4/18/51	54	8.4	.11	8.2	3.1	4.0
							7/24/52	55	8.1	.05	9.0	4.1	5.0
							9/10/53	57	11	.04	8.5	3.2	5.0
							9/13/54	57	11	.07	9.2	3.5	4.5
							10/10/55	--	10	.01	9.1	2.9	5.0
							11/6/56	--	7.0	.05	8.5	3.3	4.8
							1/13/58	55	9.6	.05	9.7	2.9	4.9
							3/24/59	--	8.2	.03	9.0	3.4	4.8
							9/13/60	54	11	.03	11	4.0	5.7
340	19/2-23H1	U. S. Government	--	158	120-138?	Gravel, sand	11/6/58	52	43	.46	10	4.9	9.1
		(McChord A.F.B.,					11/16/59	54	37	.57	8.5	4.9	9.1
		well 846)					9/23/60	52	42	.49	8.0	5.0	8.7
							9/21/61	52	42	.13	9.0	4.1	8.9
341	19/2-24A1	U. S. Government	--	91	50-70?	Sand, gravel	11/12/59	50	25	.02	11	4.9	4.5
		(McChord A.F.B.,					9/22/60	52	23	.05	11	5.1	4.6
		well 562)											
342	19/2-25 SW 1/4	U. S. Government	336	52	--	--	9/13/54	52	22	.10	9.6	3.0	3.9
		(Fort Lewis,					10/10/55	51	21	.09	9.9	2.9	4.7
		well 10)											
343	19/2-27G1	U. S. Government	287	1,008	235-368,	Sand, gravel	11/10/47	53	53	.06	7.8	5.2	--
		(Fort Lewis,			378-390,		1/26/49	--	48	--	8.0	5.0	--
		well 8)			400-440		5/26/50	53	42	--	9.4	5.9	7.1
							4/18/51	53	48	.44	7.8	5.0	7.2
							7/24/52	55	48	.06	8.4	6.2	7.1
							9/8/53	53	50	.13	8.2	5.4	7.2
							9/13/54	54	48	1.0t	9.0	5.3	6.3
344	19/2-30B2	U. S. Government (U.S.A.)	210	10	--	--	10/26/59	54	15	.08	14	4.2	5.8
345	19/2-31J1	U. S. Government	282	1,000	210-260,	Sand, gravel, clay	5/27/50	53	46	8.4t	5.8	3.8	4.6
		(Fort Lewis,			300-355,		4/18/51	54	42	.92t	5.6	3.8	4.7
		well 5)			610-626,		7/24/52	55	42	2.5t	6.4	4.4	4.9
					660-692,		9/10/53	--	48	2.2t	5.8	3.3	4.7
					732-740,		9/13/54	53	43	1.4t	6.4	4.4	4.2
					895-905,		10/10/55	54	39	.99t	5.6	2.9	4.9
					955-962		10/26/59	54	42	5.2t	6.0	3.0	4.4
346	19/2-32H2	U. S. Government	291	1,340	105-130,	Sand, gravel	11/10/47	51	31	.02	12	6.5	--
		(Fort Lewis,			204-216,		1/26/49	--	27	--	14	7.3	--
		well 6)			340-348,		5/27/50	52	30	.03	13	7.2	5.2
					800-825,		4/18/51	52	26	.05	15	8.7	5.8
					950-990,		7/23/52	55	28	.18t	13	7.7	5.7
					1,240-		9/10/53	53	27	.36t	15	8.0	5.7
					1,270		9/13/54	52	26	1.5t	16	8.6	5.3
							10/10/55	51	24	.84t	15	7.7	5.9
							11/6/56	51	23	.02	16	8.5	5.7
							1/13/58	53	22	.06	17	8.4	5.9

Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Parts per million														
P I E R C E C O U N T Y -- Continued														
1.4	68	0	1.6	2.1	0.1	0.0	--	93	86	48	116	--	--	337
--	64	0	24	2.6	.1	.1	--	--	118	66	158	7.3	--	
--	66	0	1.5	2.4	.1	.2	--	--	87	46	111	7.5	--	
5.1	66	0	24	2.7	.2	.3	--	123	118	67	158	7.3	5	
2.1	68	0	18	3.2	.1	.4	--	114	110	62	145	7.4	5	
2.0	67	0	8.3	2.5	.1	.3	--	101	97	50	127	7.6	5	
2.3	64	0	13	2.8	.1	.2	--	105	98	56	137	7.2	5	
--	68	0	3.5	2.8	.0	.2	--	--	89	50	117	7.5	--	338
--	59	0	3.6	3.3	.2	.0	--	--	79	44	108	6.9	--	
4.5	65	0	3.4	3.2	.2	.2	--	96	95	51	119	7.3	--	
4.2	69	0	2.6	2.9	.1	.3	--	96	92	49	115	7.4	10	
1.7	71	0	4.2	2.9	.1	.1	--	97	92	53	120	7.4	5	
1.6	68	0	1.7	2.5	.1	.2	--	94	90	48	115	7.4	3	
1.1	66	0	3.5	3.2	.1	.2	--	91	88	55	118	7.1	10	
1.7	70	0	3.0	3.0	.0	.4	--	94	87	52	126	7.2	5	
1.7	72	0	3.3	2.8	.0	.1	--	97	92	54	131	7.4	5	
--	46	0	4.0	3.3	.0	.3	--	--	55	33	87	6.9	--	339
--	44	0	4.5	3.3	.1	.4	--	--	56	34	89	7.4	--	
1.8	41	0	5.8	3.8	.1	.3	--	59	54	34	87	7.0	--	
2.6	40	0	5.8	3.7	.1	.3	--	56	52	33	84	6.8	5	
.8	48	0	5.8	3.8	.1	.4	--	61	60	39	93	7.0	5	
.6	48	0	5.3	3.1	.1	.7	--	61	57	34	93	7.1	3	
.7	44	0	6.6	3.8	.1	.1	--	61	56	37	95	6.6	5	
1.0	44	0	5.4	3.0	.0	.4	--	59	57	35	95	6.8	0	
.6	44	0	6.1	3.5	.0	.1	--	56	55	35	94	6.8	5	
.9	45	0	6.5	3.5	.0	.8	--	61	58	36	98	6.8	0	
1.0	46	0	6.2	3.5	.0	.8	--	60	53	36	99	6.7	0	
.9	57	0	6.4	3.0	.2	.7	--	71	71	44	117	6.7	0	
3.2	79	0	.8	1.5	.2	.5	--	112	109	45	127	7.3	5	340
2.6	74	0	.4	1.5	.0	.4	--	101	111	41	129	7.3	5	
2.6	70	0	1.0	1.2	.2	.3	--	104	108	40	123	7.3	5	
2.8	68	0	2.4	1.5	.2	.1	--	104	104	39	115	7.3	10	
.9	63	0	5.1	3.0	.1	.5	--	86	86	48	125	6.8	0	341
1.2	62	0	5.2	3.0	.0	.8	--	85	83	48	121	7.2	5	
.7	48	0	5.2	3.4	.1	.3	--	72	69	36	96	6.6	5	342
.8	54	0	3.9	3.0	.0	.3	--	74	73	37	103	6.7	0	
--	66	0	2.6	2.3	.2	.0	--	--	108	41	112	7.7	--	343
--	65	0	2.3	2.5	.1	.3	--	--	107	40	112	7.2	--	
3.7	70	0	4.1	2.7	.1	.2	--	110	107	48	121	7.7	--	
5.3	68	0	3.1	2.4	.1	.2	--	113	104	40	113	7.7	5	
2.6	66	0	3.5	3.0	.1	.1	--	112	106	46	115	7.4	5	
2.5	73	0	2.9	2.2	.2	.1	--	115	106	43	116	7.5	3	
2.7	66	0	4.0	2.4	.2	.0	--	110	101	44	117	7.3	5	
1.3	59	0	11	3.5	.0	2.5	--	86	82	52	134	6.8	5	344
4.5	43	0	4.2	3.0	.2	.1	--	94	90	30	80	7.1	--	345
3.7	45	0	3.3	3.0	.1	.2	--	89	84	30	78	7.3	15	
2.1	46	0	3.9	2.1	.1	.2	--	89	86	34	80	7.5	5	
2.1	47	0	3.0	2.0	.2	.2	--	93	88	28	79	7.5	7	
.7	42	0	3.7	2.2	.1	.1	--	86	82	34	81	7.3	5	
2.1	40	0	3.6	1.8	.1	.4	--	80	82	26	80	7.3	20	
2.4	42	0	3.3	2.0	.0	.2	--	84	86	28	80	7.8	20	
--	70	0	5.5	3.8	.1	1.2	--	--	96	57	130	7.3	--	346
--	81	0	6.0	3.7	.1	3.2	--	--	115	65	156	6.8	--	
2.2	78	0	5.9	3.6	.1	1.1	--	107	98	62	140	7.3	--	
3.5	94	0	5.5	4.9	.1	1.9	--	118	109	73	164	7.3	3	
2.0	84	0	6.0	3.5	.1	2.0	--	109	103	64	153	7.3	5	
1.4	96	0	5.2	3.4	.1	1.2	--	114	103	70	163	7.2	3	
1.4	96	0	5.8	3.0	.1	.5	--	114	108	75	172	7.3	5	
1.5	91	0	5.1	3.0	.0	1.4	--	109	106	69	166	7.3	0	
1.3	92	0	5.8	3.5	.0	1.4	--	110	108	75	169	7.1	5	
1.5	96	0	6.0	3.8	.0	1.2	--	113	111	77	173	7.2	0	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million				
									Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
PIERCE COUNTY -- Continued													
347	19/3-18M1	U. S. Government (McChord A.F.B., well 190)	315	550	200-210, 215-220, 245-252, 412-470, 480-500	Sand, gravel	5/27/48	50	49	0.03	7.8	4.8	--
							7/21/49	52	48	.04	8.0	4.4	--
							6/22/50	50	46	.05	7.8	4.6	7.4
							1/5/51	50	47	.02	7.3	4.7	7.6
							3/18/52	50	44	.06	7.8	5.0	7.6
							12/10/52	51	43	.04	7.6	4.9	7.2
							11/19/53	--	46	.08	7.6	5.0	7.8
							11/5/54	54	41	.09	9.0	5.8	6.8
							10/18/55	50	37	.03	7.7	4.4	7.9
							12/10/56	52	41	.01	7.7	4.8	8.0
							10/14/57	52	--	.00	8.7	5.7	7.3
							11/5/58	52	44	.05	8.5	4.2	7.2
							11/12/59	50	37	.01	8.0	4.4	7.4
							9/21/60	52	43	.05	8.0	4.4	7.8
							9/20/61	55	42	.01	10	3.9	7.2
348	19/6-4M1	Marion Water District	690	305	63-115	Sand, gravel	12/18/59	51	39	.08	22	9.1	7.0
							7/13/60	53	--	--	22	--	--
349	20/1W-11C	Peninsula School District No. 401	220	224	214-224	Sand, gravel	3/1/61	49	32	.26	7.5	6.5	4.5
350	20/1W-24F	John Conboy	75	285	70-100?, 160-180	Sand	3/1/61	49	41	.13	30	7.6	10
351	20/2-9NW	Day Island Water District	10	481	450-453	Gravel	11/4/38	52	51	.28t	10	6.4	16
352	20/2-13J2	City of Tacoma (well 11-A)	269	113	92-114	Gravel, sand	3/22/60	56	28	.00	16	10	8.0
							10/25/60	54	28	.04	16	11	7.1
353	20/2-15C1	University Place Water Company	400	288	249-288	Sand, gravel	6/21/60	56	32	.10	8.0	7.1	5.0
354	20/2-29Q1	West Tacoma Newsprint Co. (well 1)	19	548	540-548?	Gravel?	10/1/38	51	45	.07	18	5.8	10
355	20/2-29Q2	West Tacoma Newsprint Co. (well 2)	14	854	495-681, 702-775, 840-854	Sand, gravel, boulders	10/1/38	53	46	.07	12	6.2	7.6
356	20/2-32B1	West Tacoma Newsprint Co. (well 3)	22	1,172	550-594, 643-849, 1,021-1,112	Sand, gravel, boulders	10/1/38	54	50	.04	11	5.9	9.2
357	20/2-33Cs	State of Washington (Spring)	--	--	--	--	10/4/38	54	19	.01	8.4	3.4	5.0
358	20/3-18D3	City of Tacoma (well 9-A)	280	127	90-121	Sand, gravel	4/21/52	50	31	.11	8.8	8.0	5.5
359	20/3-19F1	City of Tacoma (well 5-A)	266	378	--	Gravel, sand	1/4/39	--	28	.04t	11	6.7	4.9
360	20/3-19P1	City of Tacoma (well 1)	261	310	--	Gravel, sand	10/27/31	--	25	.29t	7.9	4.4	4.1
							1/4/39	48	24	.04t	7.2	4.0	3.4
361	20/3-30N1	City of Tacoma (well 3-A)	271	358	72-144, 233-314	Sand, gravel, boulders	1/4/39	--	26	.06t	8.9	4.8	4.2
362	20/4-24B2	Fiberboard Products, Inc.	60	456	366-436	Sand, gravel	12/2/59	55	45	.10	18	5.3	42
							6/2/60	57	--	--	--	--	--
363	20/4-24F3	Standard Brands of California (well 3)	61	572	462-508	Gravel	1/11/38	53	44	.14t	18	6.3	59
364	20/4-32J1s	City of Puyallup (Maplewood Spring)	--	--	--	--	1/11/38	46	30	.13t	9.2	5.7	4.5
365	21/1W-2C	Peninsula School District No. 401	50	158	82-88, 110-115	Sand, gravel	3/1/61	49	28	.02t	11	5.9	5.5

Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Parts per million														
PIERCE COUNTY -- Continued														
--	65	0	2.5	1.8	0.1	0.0	--	--	103	39	110	7.1	--	347
--	58	0	1.6	1.9	.2	.0	--	--	104	38	113	7.5	--	
1.8	66	0	1.7	1.9	.2	.1	--	104	103	38	110	7.3	--	
4.2	66	0	2.6	1.9	.4	.2	--	108	101	38	106	7.7	8	
1.6	68	0	2.5	1.7	.2	.1	--	104	104	40	110	7.8	3	
1.7	64	0	2.2	1.9	.1	.0	--	100	107	39	110	7.3	5	
1.7	66	0	2.0	1.6	.2	.2	--	105	99	40	110	7.8	3	
1.6	66	0	2.6	2.8	.1	.3	--	103	107	49	114	7.5	5	
1.8	64	0	2.3	1.8	.1	.4	--	95	99	37	111	7.4	0	
1.5	65	0	2.2	1.8	.1	.1	--	99	97	39	111	7.2	5	
1.5	65	0	2.0	1.8	.1	.2	--	--	99	45	116	7.5	5	
1.5	64	0	2.1	2.0	.1	.2	--	102	101	38	107	7.4	5	
1.6	64	0	1.8	2.0	.0	.0	--	94	98	38	113	7.8	0	
1.8	63	0	2.2	2.2	.2	.2	--	101	101	38	111	7.8	5	
1.6	66	0	2.8	2.0	.2	.3	--	103	105	41	111	7.6	0	
1.4	112	0	10	3.5	.3	.1	.03	147	140	92	209	6.8	5	348
--	120	0	--	--	--	--	--	--	--	98	215	7.0	--	
.8	64	0	.2	2.5	.1	.6	.08	87	83	46	111	7.2	0	349
4.9	156	0	.4	2.8	.1	.7	.49	175	171	106	250	7.8	5	350
2.2	101	0	.4	1.9	.2	.8	--	139	141	51	--	--	--	351
1.7	80	0	18	7.2	.1	10	.08	138	147	82	212	7.2	0	352
1.7	78	0	17	9.5	.1	9.2	.10	138	138	86	212	7.1	0	
1.2	55	0	7.8	3.5	.1	2.1	.13	94	90	49	122	7.0	0	353
3.9	108	0	1.2	2.8	.0	.4	--	140	142	69	--	--	8	354
1.6	84	0	2.1	2.2	.0	.0	--	119	121	55	--	--	4	355
1.8	84	0	1.8	2.0	.0	.0	--	123	126	52	--	--	5	356
1.4	46	0	4.1	3.0	.0	.5	--	68	66	35	--	--	0	357
1.2	54	0	11	5.3	.1	4.3	--	102	100	55	131	7.3	3	358
1.4	58	0	7.0	4.2	.3	4.9	--	97	94	55	--	--	--	359
1.4	38	0	4.9	4.0	--	5.3	--	76	76	38	--	--	--	360
1.2	35	0	4.2	3.3	.0	6.0	--	71	70	34	--	--	--	
.9	54	0	2.8	2.6	.0	.9	--	78	78	42	--	--	--	361
5.2	185	0	.9	7.5	.3	.2	2.2	218	214	67	303	7.4	5	362
--	185	0	--	--	--	--	--	--	--	68	303	8.0	--	
4.3	222	0	1.8	13	.0	.0	--	256	255	71	--	--	--	363
1.6	59	0	4.2	2.1	.0	.3	--	87	83	46	--	--	--	364
.2	73	0	.0	3.5	.1	.1	.08	90	83	52	125	7.6	0	365

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
						PIERCE COUNTY -- Continued							
366	21/1-35D	Shorewood Beach Water Company	25	432	350-379	Gravel	3/1/61	51	41	0.62	21	15	10
367	21/2-8C1	City of Gig Harbor (well 1)	60	375	73-75, 260-265	Sand, gravel	3/2/61	50	34	.22	12	6.9	5.5
368	21/3-16N1	Hyada Mutual Water Co. (well 3)	90	207	170-207?	Sand, gravel	12/3/59 6/2/60 10/31/60	50 53 52	39 41 39	.10 .78t 3.7t	40 54 50	43 81 74	306 572 484
369	21/3-26N	City of Tacoma	11	785	660-736?	Gravel, sand	1/13/38 12/29/44	-- --	32 39	.05t 1.5t	16 21	6.1 6.6	51 53
370	21/3-35B1	Buffelen Lumber and Mfg. Co.	7	856	820-856	Gravel	12/18/59 6/2/60	63 63	46 --	.18 --	16 --	2.5 --	58 --
						SAN JUAN COUNTY							
371	35/2W-14H	William Hughes	--	132	130-132	Sand, gravel	5/17/60 9/28/60	50 54	31 --	.27 --	60 --	29 --	29 --
372	36/3W-17E	Roche Harbor Lime and Cement Co.	--	46	26-32, 34-40	Sand, gravel	3/9/61	--	30	1.2	21	15	16
373	37/2W-13B	East Sound Water District	--	50	30-50	Sand, gravel	5/17/60 9/28/60	51 52	23 --	.05 --	46 --	6.8 --	9.3 --
374	37/2W-14A2	R. C. Purdue	--	168	160-168	Metasediments	10/28/54	50	11	.03	3.2	.0	91
375	37/2W-14G4	Vernon Curtis	--	11	--	--	5/17/60 9/28/60	50 --	35 --	2.2t --	66 --	27 --	39 --
						SKAGIT COUNTY							
376	33/3-5H1	Oscar Denton	90	112	90-112	Sand	11/21/49	--	--	.05	--	--	--
377	33/4-33D1	H. A. Galbraith	--	--	--	--	11/21/49	--	--	.03	--	--	--
378	34/4-7P1	N. Fortin	25	27	18-26?	Sand, gravel	11/21/49	--	--	.03	--	--	--
379	34/4-16F1	M. C. Turley	70	135	135+	Gravel	11/21/49	--	--	.02	--	--	--
380	34/4-33P1	M. C. Holmgrem	65	103	100-103	Gravel	11/21/49	--	--	.03	--	--	--
381	35/3-11R1	L. H. Routan	20	197	192-197	Sand, gravel	11/21/49	--	--	.03	--	--	--
382	35/4-32P	Water Refineries, Inc.	--	45	--	--	12/17/59 5/18/60	50 52	59 --	35 --	9.0 --	9.6 --	37 --
383	35/5-8D1	State of Washington (well 6)	--	231	133-226	Sand	12/17/59 5/18/60	52 51	32 --	.44 --	23 --	11 --	23 --
384	35/5-30M1	Skagit County Public Util. Dist. No. 1	--	50	46-50	Sand, gravel	4/18/52	--	43	.02	14	8.3	8.0
						SKAMANIA COUNTY							
385	4/7-4	U. S. Government (U.S.F.S.)	--	176	100-112, 161-176	Basalt?	8/8/60	--	4.9	4.6t	8.0	1.7	13
386	4/7-27L1	U. S. Government (U.S.F.S.)	--	220	93-127	Basalt	2/24/58	44	20	.23t	4.8	1.4	2.5
387	7/6-26	U. S. Government (U.S.F.S.)	--	312	210-250?	Andesite?	8/25/59	47	43	.24	8.0	2.3	8.6
						SNOHOMISH COUNTY							
388	27/3-24Q3	City of Edmonds	290	106	--	Sand	12/18/59 5/16/60	-- 58	36 --	.00 --	9.5 --	9.4 --	5.9 --

Parts per million														
								Dissolved solids						
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Calculated	Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
PIERCE COUNTY -- Continued														
3.4	163	0	0.4	4.5	0.1	0.2	0.39	177	168	112	258	7.7	10	366
1.8	83	0	.4	2.2	.1	.3	.87	105	99	58	141	7.8	0	367
3.5	92	0	103	535	.3	.1	.15	1,120	1,190	276	2,040	6.9	0	368
5.1	83	0	174	1,050	.1	.1	.04	2,020	2,100	470	3,550	6.6	5	
4.1	89	0	146	880	.5	1.7	.05	1,730	1,750	429	3,050	7.1	5	
2.4	188	5	1.5	12	.0	.0	--	219	215	65	--	--	--	369
2.2	199	0	1.6	17	.2	3.4	--	242	246	80	368	--	--	
3.4	193	0	.4	14	.3	.4	1.7	238	248	50	350	7.8	30	370
--	188	0	--	--	--	--	--	--	--	52	335	7.4	--	
SAN JUAN COUNTY														
6.0	317	0	20	32	.2	.8	.22	364	346	268	616	7.5	0	371
--	315	0	--	--	--	--	--	--	--	265	612	7.4	--	
2.4	117	0	16	24	.1	.3	.14	183	189	113	300	7.1	0	372
.7	127	0	37	13	.1	2.4	.03	201	204	143	331	7.1	0	373
--	124	0	--	--	--	--	--	--	--	137	323	6.9	--	
.6	202	6	11	16	.2	.0	--	238	238	8	393	8.6	0	374
2.7	259	0	68	48	.2	.1	.03	414	413	274	676	7.8	10	375
--	257	0	--	--	--	--	--	--	--	268	675	7.5	--	
SKAGIT COUNTY														
--	358	0	20	34	.2	18	--	--	--	320	708	--	--	376
--	136	0	2.0	6.0	.2	.0	--	--	--	94	233	--	--	377
--	60	0	9.0	13	.2	20	--	--	--	84	237	--	--	378
--	602	45	52	78	.6	.2	--	--	--	32	1,320	--	--	379
--	194	0	14	22	.2	.0	--	--	--	154	385	--	--	380
--	322	0	16	216	.3	1.1	--	--	--	142	1,180	--	--	381
3.1	144	0	.5	29	.2	.2	.09	254	230	62	318	6.3	35	382
--	131	0	--	--	--	--	--	--	--	65	295	6.2	--	
3.2	142	0	.7	27	.2	.0	.36	191	181	101	315	7.7	5	383
--	145	0	--	--	--	--	--	--	--	104	309	7.9	--	
3.1	75	0	10	7.3	.1	8.2	--	139	138	69	176	7.0	2	384
SKAMANIA COUNTY														
.6	39	6	3.8	9.0	.1	.0	--	66	70	27	114	9.3	10	385
.7	29	0	1.0	1.5	.1	.0	--	46	53	18	53	7.6	5	386
2.1	56	0	1.8	2.8	.1	.3	--	97	93	30	102	7.1	5	387
SNOHOMISH COUNTY														
2.1	70	0	10	5.0	.1	3.3	.21	116	113	62	160	7.6	5	388
--	67	0	--	--	--	--	--	--	--	63	159	7.3	--	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
						SNOHOMISH COUNTY -- Continued							
389	27/4-10N1	Alderwood Manor Water District	--	176	148-176	Sand, gravel	12/1/59 6/17/60	50 50	45 --	0.00 --	13 --	6.1 --	7.8 --
390	27/4-21N1	Layne Pacific Co.	--	342	300-342	Gravel	12/1/54	49	42	.00	13	7.8	9.6
391	27/5-35E1	R. A. Worl	150	85	80-85	Sand, gravel	10/13/60 4/24/61	51 50	33 --	.71 --	15 15	5.7 5.8	12 --
392	27/6-13M	Albert Weishaupt	--	50	28-50	Gravel, sand	6/22/60 10/5/60	58 52	16 --	.07 --	10 --	3.6 --	4.1 --
393	27/7-5L	D. R. Smith	--	30	18-30	Gravel	6/23/60 10/5/60	65 54	13 --	31t --	14 --	6.2 --	5.0 --
394	28/4-1G	Associated Sand and Gravel Co.	--	312	284-312	Sand, gravel	6/22/60 11/5/60 4/25/61	53 50 50	32 36 --	9.6t 4.0 --	9.0 9.5 --	8.6 7.4 --	8.6 8.3 --
395	28/5-7G2	Snohomish County Public Utility District No. 1	500	217	144-217?	Sand, gravel	10/13/60 4/25/61	51 52	33 --	.05 --	10 --	10 --	5.3 --
396	28/6-29H1	C. R. Cedergreen	50	138	130-138	Gravel	10/12/60 4/24/61	53 51	27 --	.95t --	20 --	9.2 --	14 --
397	28/6-34A	Floyd McKennon	--	160	68-80	Sand, gravel	6/22/60 10/5/60	62 53	28 --	1.5t --	16 --	7.9 --	8.6 --
398	28/6-35E2	Stokley VanCamp Company	25	300	125-198	Gravel	10/12/60 4/24/61	52 51	23 --	.07 --	10 --	3.8 --	36 --
399	28/7-28N1	Lester Thayer	330	108	96-108	Gravel	10/6/60	51	21	.03	11	7.1	4.3
400	29/4-1A1	Priest Point Beach Water Co.	125	174	157-172	Sand, gravel	10/12/60 4/24/61	51 50	31 30	.31 15t	19 22	20 19	151 137
401	29/5-2C1	City of Marysville	--	267	218-267	Gravel	12/18/59 5/16/60	48 49	25 --	.81 --	18 --	7.5 --	6.1 --
402	29/5-19K1	Soundview Pulp Co.	15	110	90-105	Sand, gravel	11/18/44	--	31	.37	16	16	14
403	29/5-29G1	Eclipse Mill Co.	20	217	77-86, 170-190	Sand, gravel	11/18/44	--	40	2.1t	16	13	38
404	29/6-8M1	William Owens	310	66	60-66	Sand	10/5/60	52	21	4.2	16	5.7	6.4
405	30/4-17C1	T. L. Whyte	45	377	367-377	Gravel, sand	10/12/60 4/24/61	52 50	39 --	.98 --	12 --	11 --	7.9 --
406	30/4-35R1	Potlatch Beach Water District	135	171	160-171	Sand	10/5/60 5/24/61	49 50	40 --	.89 --	36 --	19 --	11 --
407	30/5-23J1	A. B. Franzen	340	26	--	--	9/2/44	--	23	.10t	22	13	8.5
408	30/5-26M1	H. Morney	--	82	82-?	--	10/5/60 5/24/61	52 51	36 --	2.0t --	20 --	9.2 --	29 --
409	30/5-27P1	Larry Johnston	35	133	99-125?	Gravel?	10/12/60 4/24/61	52 51	36 30	.14 .60	21 18	7.4 7.3	31 22
410	30/8-16	U. S. Government (U.S.F.S.)	--	160	141-156?	Sand, gravel	3/16/60	--	19	--	20	5.3	5.8
411	31/3-24Q1	E. D. Hervin	150	183	169-180	Sand	10/12/60 4/24/61	53 51	32 --	.03 --	18 --	13 --	7.9 --
412	31/4-18E1	Jack Strattan	160	225	218-224	Gravel, sand	10/5/60 5/24/61	50 54	48 --	4.3t --	28 --	18 --	13 --
413	31/4-24Ns	City of Marysville (Edwards Springs)	--	--	--	--	9/2/44	50	31	--	9.0	6.2	5.6
414	31/4-26B	Vernon Linth	--	216	205-216	Sand, gravel	6/23/60 10/5/60	50 50	32 --	.08t --	12 --	4.5 --	5.5 --

Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Parts per million														
SNOHOMISH COUNTY -- Continued														
2.7	85	0	4.2	3.5	0.2	0.2	0.60	125	123	58	156	7.7	0	389
--	83	0	--	--	--	--	--	--	--	58	161	7.9	--	
4.6	103	0	2.0	3.0	.3	.0	.7	134	127	64	171	8.1	0	390
4.0	106	0	.0	1.5	.2	.6	2.6	128	128	61	176	7.5	5	391
--	112	0	--	--	--	--	--	--	--	61	179	8.2	--	
.9	37	0	7.0	3.5	.0	9.8	.01	73	72	40	105	6.4	0	392
--	37	0	--	--	--	--	--	--	--	39	107	6.3	--	
1.7	84	0	.0	3.8	.1	.1	.01	85	80	60	146	6.6	5	393
--	85	0	--	--	--	--	--	--	--	62	151	6.5	--	
2.4	95	0	.2	2.2	.2	.8	2.9	114	116	58	126	7.2	10	394
2.2	88	0	.2	2.8	.1	.6	2.5	117	115	54	139	7.0	75	
--	81	0	--	--	--	--	--	--	--	53	142	7.3	--	
1.7	70	0	7.6	5.8	.0	6.9	.17	115	113	67	162	7.5	0	395
--	69	0	--	--	--	--	--	--	--	60	145	7.8	--	
1.6	102	0	13	10	.0	9.4	.11	154	159	88	239	6.8	5	396
--	103	0	--	--	--	--	--	--	--	84	244	6.7	--	
3.1	88	0	9.4	9.0	.1	.6	.43	126	120	72	190	7.6	5	397
--	87	0	--	--	--	--	--	--	--	72	190	7.5	--	
2.0	96	0	9.0	25	.1	.3	.98	157	156	41	257	7.8	5	398
--	104	0	--	--	--	--	--	--	--	46	272	8.0	--	
.6	62	0	3.5	4.2	.0	10	.05	93	96	57	137	7.0	0	399
7.6	101	0	53	230	.2	1.2	.26	564	572	132	1,050	7.7	0	400
7.4	104	0	53	210	.3	.8	.17	531	552	132	954	7.9	5	
1.3	104	0	2.8	2.5	.2	.2	.69	116	118	76	179	7.8	5	401
--	106	0	--	--	--	--	--	--	--	79	176	7.9	--	
4.7	115	0	15	24	.2	.05	--	178	171	106	280	--	--	402
3.0	144	0	3.2	43	.2	--	--	227	221	93	370	--	--	403
1.6	82	0	7.4	4.2	.1	.3	.36	107	107	64	158	7.2	5	404
2.2	100	0	4.2	6.0	.1	.1	.15	133	130	75	182	7.7	15	405
--	97	0	--	--	--	--	--	--	--	75	178	7.7	--	
3.4	224	0	1.2	6.0	.2	2.0	.43	230	229	170	364	7.4	5	406
--	228	0	--	--	--	--	--	--	--	171	369	7.7	--	
4.1	138	0	7.4	7.4	.1	2.7	--	156	151	108	250	--	--	407
9.3	182	0	5.0	3.5	.2	1.2	1.6	205	201	88	296	8.0	5	408
--	185	0	--	--	--	--	--	--	--	90	297	--	--	
4.6	178	0	1.2	3.8	.2	1.7	1.2	196	199	83	288	7.7	5	409
3.7	140	0	2.8	3.5	.2	3.6	.68	161	159	75	235	7.2	5	
1.3	90	0	6.5	3.0	.2	.1	--	105	105	72	167	8.1	5	410
2.5	116	0	13	9.5	.1	.3	.30	154	147	99	235	7.8	0	411
--	111	0	--	--	--	--	--	--	--	98	221	7.9	--	
4.5	187	0	3.8	9.8	.4	1.1	.97	220	224	144	329	6.9	15	412
--	218	0	--	--	--	--	1.3	--	--	148	363	7.0	--	
1.4	66	0	3.4	3.6	.2	.6	--	94	90	48	119	7.5	--	413
1.7	65	0	3.8	3.2	.1	.7	.24	96	91	48	123	8.1	0	414
--	64	0	--	--	--	--	--	--	--	49	125	8.0	--	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
SNOHOMISH COUNTY -- Continued													
415	31/5-2L1	City of Arlington	--	21?	17-21?	Gravel?	4/27/61	48	8.5	0.08	9.0	3.5	2.2
416	31/5-7G1	Peter Henning	45	150	145-150	Sand, gravel	9/2/44	51	39	1.1	37	22	27
							10/5/60	49	39	1.8	39	19	47
							5/24/61	52	--	--	--	--	--
417	31/5-7H1	A. J. Strotz	40	18	6-17?	Sand	9/2/44	--	28	9.4t	17	14	5.5
418	31/5-15A1	City of Arlington	125	120	--	Gravel, sand	9/2/44	48	28	.10	9.4	9.0	4.7
419	31/5-28C1	Washington Cooperative Association	120	13	8-13?	Sand, gravel	9/2/44	--	12	.01	5.4	3.1	4.7
420	32/4-28B1	A. C. Ladd	285	32	24-26	Gravel	10/12/60	53	30	.04	18	11	8.7
							4/24/61	50	26	.02	16	11	8.4
421	32/4-29B2	Stanwood Water Co. (well 4)	--	250	50-250	Sand	10/5/60	48	33	.13	22	13	16
422	32/6-18H1	G. M. Eliott	440	110	100-110	Silt, sand	10/5/60	49	24	.83	40	17	66
							5/24/61	53	--	--	--	--	--
SPOKANE COUNTY													
423	22/43-32L	William Hendrixson	--	115	80-115	Basalt	5/2/61	49	52	.03	33	8.7	26
424	24/40-3N1	State of Washington	--	440	215-218, 400-440	Basalt, "loose rock"	12/1/59	--	45	.20	23	9.7	18
							5/16/60	58	--	--	--	--	--
425	24/40-22L1	U. S. Government (U.S.A., well 45-C)		345	60-65, 335-345	Basalt	11/6/57c	56	--	.12	29	11	15
							7/22/58c	69	45	--	30	10	14
							9/23/59c	60	45	.10	30	10	16
							9/12/60c	--	43	.03	29	11	15
							11/8/60c	54	43	.07	29	11	16
426	24/41-3N	U. S. Government (Fairchild A.F.B., well 2)	--	410	--	Basalt	2/26/47	59	51	.02	21	9.2	--
							8/5/47	61	50	.02	19	9.4	--
							1/1/48	--	51	.04	20	9.5	--
							8/11/48	59	55	.06	20	9.0	--
							7/19/49	57	48	.13	20	7.4	--
							12/6/50	56	50	.05	19	10	13
							-/-/51	59	49	.01	19	9.2	12
							1/14/53	61	49	.04	20	9.5	12
							12/15/53	59	43	.03	17	6.3	11
							10/6/54	61	48	.08	19	9.4	13
							6/16/55	--	50	.10	19	9.5	13
							6/5/56	52	47	.46	19	9.3	13
							10/30/56	54	42	.12	19	9.1	13
							7/30/57	54	--	.03	19	5.7	10
							11/6/57	58	--	.17	20	8.5	13
							7/22/58c	69	47	--	21	8.6	13
							9/22/59	60	45	.29	20	7.7	12
							11/8/60c	54	20	.28	36	11	5.4
							10/10/61	60	18	.63	33	10	5.0
427	24/41-11N1	U. S. Government (U.S.A., well 37-C and L)		274	204-209, 225-274	Basalt	11/5/57c	55	--	.08	14	4.0	5.3
							7/22/58c	59	42	.03	13	4.5	4.9
							9/23/59	60	39	.01	14	4.2	6.3
							11/8/60c	50	35	.06	13	4.3	5.9
428	24/45-4s	U. S. Government (U.S.A.F.,spring)	--	--	--	--	11/5/57	36	10	.07	2.2	.2	1.8
							10/10/58c	--	13	.10	4.0	.4	1.9
429	25/40-34 NE 1/4	U. S. Government (U.S.A., well 87-C, no. 2)	--	196	110-120, 150-160, 180-195	Basalt	11/5/57	51	--	.04	30	8.2	16
							7/22/58c	70	49	--	32	7.8	16
							9/23/59	60	50	.00	31	8.2	18
							11/8/60c	54	48	.03	29	9.4	18
430	25/40-14R1	U. S. Government (U.S.A., well 87-L)		356	335-356	Basalt	11/6/57c	58	--	.04	21	9.8	12
							7/22/58c	68	42	--	20	12	14
							9/23/59	61	43	.02	22	10	14
							11/8/60c	52	44	.04	20	11	15

Parts per million											Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)				
SNOHOMISH COUNTY -- Continued														
0.7	41	0	8.0	1.5	0.0	0.7	0.00	54	58	37	86	7.2	5	415
4.9	213	10	1.0	41	.1	.1	--	287	271	183	473	--	--	416
8.6	230	0	.4	64	.2	8.5	1.3	351	343	174	571	7.2	15	
--	250	0	--	--	--	--	--	--	--	178	583	7.2	--	
2.3	128	0	3.0	4.6	.0	4.5	--	142	131	100	217	6.7	--	417
1.5	76	0	7.0	2.8	.1	1.2	--	101	101	60	138	7.7	--	418
.7	22	0	3.2	6.4	.1	12	--	58	65	26	84	7.4	--	419
1.1	86	0	21	8.2	.1	6.0	.09	146	152	92	230	7.0	0	420
.8	74	0	21	7.2	.1	9.1	.00	136	147	83	204	6.9	5	
6.4	158	0	11	6.0	.2	.6	.96	187	180	106	276	8.2	5	421
6.4	359	0	5.4	5.8	.4	6.6	1.6	351	357	169	561	7.7	10	422
--	364	0	--	--	--	--	1.5	--	--	171	570	7.5	--	
SPOKANE COUNTY														
.4	106	0	24	13	.3	56	.36	266	285	118	359	7.3	5	423
1.7	149	0	11	3.0	.5	.0	.00	185	178	97	255	7.8	0	424
--	148	0	--	--	--	--	--	--	--	100	265	7.9	--	
2.8	148	0	20	5.5	.2	.4	--	191	197	118	284	7.9	5	425
2.8	150	0	21	3.8	.3	.0	--	201	195	118	277	7.6	0	
3.0	148	2	21	5.5	.4	.0	--	206	204	117	294	8.3	5	
2.8	154	0	19	5.0	.3	.2	--	201	205	118	296	8.2	5	
2.9	153	0	19	6.2	.3	.2	--	203	197	116	291	8.0	5	
--	130	0	11	2.8	.2	.1	--	--	163	90	220	--	--	426
--	130	0	11	2.4	.4	.0	--	--	167	86	220	7.9	--	
--	130	0	11	3.8	.3	.0	--	--	164	89	225	7.6	--	
--	122	0	11	2.6	.2	.9	--	--	168	87	218	7.7	--	
--	96	0	12	2.1	.2	3.5	--	--	155	80	203	7.6	--	
2.4	127	0	11	2.2	.2	.3	--	171	164	88	215	7.7	2	
5.1	127	0	10	2.1	.4	.2	--	170	164	85	212	7.7	5	
2.1	124	0	11	2.1	.3	.1	--	167	166	89	220	7.5	5	
1.7	87	0	9.7	2.8	.3	8.0	--	143	143	68	183	7.5	2	
2.1	125	0	11	2.6	.3	.4	--	168	164	86	219	7.9	4	
1.4	129	0	10	2.8	.3	.2	--	170	166	86	224	7.2	5	
1.8	121	0	11	2.5	.4	.3	--	164	160	86	219	7.7	0	
2.0	113	0	14	1.8	.3	1.0	--	158	155	85	215	7.6	0	
1.6	86	0	11	2.0	.2	9.3	--	--	139	71	184	7.4	0	
2.1	118	0	11	2.2	.3	.4	--	--	154	85	214	7.6	5	
2.1	126	0	10	1.8	.4	.6	--	166	164	88	218	7.8	5	
1.7	109	0	12	2.2	.4	2.3	--	157	156	82	208	7.8	0	
2.5	150	0	14	5.2	.3	4.5	--	173	168	133	275	8.0	0	
2.2	142	0	14	3.5	.2	3.2	--	160	162	125	262	7.8	5	
1.3	62	0	5.8	1.0	.2	6.0	--	--	110	52	129	7.5	5	427
1.3	59	0	6.3	1.2	.2	6.2	--	109	110	51	121	7.1	0	
1.3	61	0	7.0	2.8	.5	7.1	--	112	112	52	136	7.8	0	
1.1	60	0	6.6	2.2	.2	6.2	--	105	107	50	135	7.9	5	
.4	9	0	.7	.5	.0	2.2	--	22	22	6	27	5.6	5	428
.4	25	0	.7	2.0	.0	1.9	--	36	40	12	46	6.4	0	
1.3	152	0	4.5	5.0	.3	12	--	--	203	108	283	7.8	5	429
1.5	153	0	5.2	4.5	.4	12	--	203	206	112	281	7.2	0	
1.6	154	0	5.4	5.2	.8	13	--	209	205	111	282	7.7	0	
1.3	152	0	5.0	6.8	.4	13	--	206	198	111	288	7.7	5	
1.5	129	0	9.6	3.0	.3	.7	--	--	155	93	229	7.8	5	430
1.5	138	0	8.1	5.2	.7	1.0	--	172	167	100	240	7.5	0	
1.6	134	2	8.2	3.8	.6	.5	--	172	164	98	235	8.3	0	
1.2	141	0	7.8	5.5	.4	.4	--	174	165	97	247	8.0	5	

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
SPOKANE COUNTY -- Continued													
431	25/41-1R1	U. S. Government (U.S.A., well 07-C, no. 2)	2,265	415	392-398, 402-408	Basalt	7/23/58c	68	47	--	28	13	11
							9/23/59	62	48	0.56	27	14	12
							11/8/60c	57	46	.15	26	14	14
432	25/41-10G1	U. S. Government (U.S.A., well 07-L)	2,344	150	95-110, 115-150	Basalt	11/6/57c	61	--	.03	41	14	12
							7/22/58c	66	43	--	38	13	12
							9/23/59	61	43	.00	32	13	11
							11/8/60c	54	42	.05t	30	11	12
433	25/41-28	U. S. Government (Fairchild A.F.B. well 3)	--	--	--	--	12/16/53	57	21	.02	28	9.5	5.3
434	25/41-34 (C?)	U. S. Government (U.S.A.F.)	--	433	--	--	10/30/56	56	45	.18	33	11	14
							7/23/58c	60	45	--	38	8.0	14
							9/22/59	56	48	.13	34	9.3	14
							11/8/60	54	40	.62t	36	9.8	15
435	25/42-11	U. S. Government (Fort George Wright, well 5)	--	62	--	--	2/26/47	50	14	.02	26	7.3	--
							8/5/47	53	14	.01	28	8.8	--
							8/11/48	55	15	.02	30	9.3	--
							7/19/49	50	14	.05	32	9.5	--
							12/6/50	56	15	.01	31	11	3.6
							-/-/51	56	14	.00	32	10	3.4
							1/14/53	58	14	.04	29	10	3.1
							12/15/53	52	15	.01	29	9.5	3.3
							10/6/54	51	13	.04	33	11	2.4
							10/27/55	54	13	.00	31	10	3.3
							10/30/56	54	16	.02	37	12	3.4
							11/6/57	51	--	.02	37	10	3.0
							7/22/58	60	13	--	34	11	2.8
436	25/42-11M1	U. S. Government (Fort George Wright, well 6)	--	52	--	--	1/2/48	--	13	.01	27	7.9	--
							8/11/48	54	14	--	--	--	--
							7/19/49	50	13	.06	27	7.5	--
							12/6/50	54	14	.01	25	7.8	2.5
							12/51	55	12	.00	24	7.3	2.1
							1/14/53	54	12	.10	25	7.4	1.9
							12/15/53	53	13	.02	24	7.4	2.4
							10/6/54	54	11	.03	25	7.5	2.3
							10/29/55	53	11	.00	27	7.1	2.9
							10/30/56	56	14	.05	26	8.4	2.4
							11/6/57	50	--	.01	28	7.5	2.4
							7/22/58c	68	13	--	28	7.8	2.3
							9/22/59	58	16	.15	34	11	5.6
							11/8/60c	52	21	.04	36	11	5.4
437	25/42-11M2	U. S. Government (Fort George Wright, well 7)	--	230	--	--	10/6/54	54	22	.03	35	11	5.3
							10/27/55	54	21	.00	35	9.7	5.8
							10/30/56	56	23	.06	35	12	5.6
							11/6/57	51	--	.01	37	9.7	5.4
							7/22/58	60	22	--	36	11	5.4
							9/22/59	54	22	.05	37	11	5.7
							11/15/60c	52	21	.02	36	11	5.4
438	25/42-13B1	Empire Ice & Shingle Company	1,883	200	--	Gravel	5/6/42	52	15	.08	34	13	6.4
439	25/42-25 SW 1/4	U. S. Government (U.S.A.)	--	261	--	--	9/22/59	58	21	.00	38	11	5.4
							11/8/60c	50	14	.09	41	14	3.1
440	25/42-29R1	City of Spokane (Geiger Field well 1)	--	400	374-384?	--	2/14/52	--	49	.04	20	10	9.7
							10/15/52	55	44	.08	28	10	7.6
							10/27/53	--	51	.05	19	10	9.4
							1/7/55	--	49	.06	19	10	9.0
							12/22/55c	52	41	.00	19	9.3	9.2
							12/18/56c	53	39	.02	19	10	9.2
							11/6/57c	41	--	.07	21	9.3	9.5
							9/26/58	40	49	.03	30	10	7.8
							9/29/59	--	46	.02	22	9.2	9.3
							9/21/60	58	45	.01	20	9.2	9.2
							10/3/61	50	46	.00	20	9.8	9.2
441	25/43-4B2	City of Spokane	2,047	227	208-227	Sand, gravel	4/18/52	52	12	.07	39	19	4.1

Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Parts per million														
SPOKANE COUNTY -- Continued														
2.2	165	0	6.4	2.5	0.3	0.0	--	191	188	124	270	7.2	0	431
2.1	169	0	9.3	3.0	.5	.0	--	199	190	126	283	8.0	0	
2.0	168	0	11	6.2	.4	.3	--	203	193	124	291	7.8	5	
2.3	144	0	22	3.0	.1	53	--	--	257	160	373	7.9	5	432
2.2	137	0	20	3.0	.2	46	--	244	239	150	334	7.4	0	
2.0	127	0	18	2.2	.4	38	--	223	219	132	306	8.0	0	
2.0	121	0	17	4.2	.3	34	--	212	203	120	291	7.8	5	
1.7	130	0	10	2.8	.3	1.5	--	144	145	109	230	7.7	2	433
1.3	122	0	13	7.8	.3	39	--	224	219	128	311	7.5	0	434
1.4	118	0	14	9.5	.3	49	--	237	256	128	330	7.4	0	
1.6	120	0	13	7.0	.2	40	--	226	231	123	302	7.6	5	
1.4	121	0	15	9.5	.3	43	--	230	229	130	327	8.0	5	
--	111	0	9.7	2.0	.1	1.6	--	--	118	95	194	--	--	435
--	124	0	10	1.6	.1	2.5	--	--	126	106	208	7.5	--	
--	124	0	12	2.0	.2	2.4	--	--	135	113	223	7.7	--	
--	132	0	13	2.5	.1	3.5	--	--	141	119	244	7.9	--	
1.1	138	0	12	2.1	.1	2.4	--	146	141	123	239	7.8	2	
2.4	140	0	10	2.1	.2	2.0	--	145	141	121	234	7.7	5	
2.1	132	0	12	1.8	.1	1.3	--	138	140	113	237	8.1	5	
1.5	129	0	9.6	2.2	.1	1.7	--	135	134	111	228	7.8	2	
1.3	138	0	13	4.0	.0	4.2	--	150	150	128	252	7.8	3	
1.9	133	0	12	3.2	.1	2.2	--	143	140	118	240	7.7	0	
1.8	153	0	16	2.2	.0	4.0	--	167	158	142	278	8.0	0	
1.5	146	0	12	3.8	.0	2.3	--	--	149	134	265	7.7	5	
1.7	136	0	15	2.8	.1	4.4	--	152	148	130	249	7.4	0	
--	114	0	10	2.2	.1	1.5	--	--	116	100	206	7.7	--	436
--	112	0	14	3.0	--	--	--	--	--	--	206	--	--	
--	110	0	10	2.3	.1	1.1	--	--	119	98	203	7.9	--	
1.6	103	0	11	2.3	.1	1.4	--	116	111	94	184	7.9	2	
3.0	101	0	10	2.5	.2	1.0	--	112	108	90	184	7.8	5	
1.2	104	0	10	1.4	.1	1.0	--	111	116	93	186	8.0	5	
1.0	100	0	9.5	2.7	.2	2.0	--	112	109	90	185	7.9	3	
1.2	106	0	11	2.2	.0	2.3	--	115	116	93	193	7.9	3	
1.7	112	0	10	2.1	.0	2.1	--	119	111	97	205	8.2	0	
1.4	103	0	10	4.5	.2	1.8	--	120	112	99	202	7.5	5	
1.3	110	0	9.6	2.0	.0	2.2	--	--	116	101	202	7.9	5	
1.3	108	0	11	3.8	.3	2.8	--	123	118	102	197	7.5	0	
2.5	148	0	14	3.0	.0	3.6	--	163	159	131	270	8.2	5	
2.4	154	0	13	3.0	.2	4.8	--	173	168	134	275	8.2	5	
2.1	154	0	13	2.9	.1	4.6	--	172	174	133	279	7.9	3	437
2.7	150	0	13	2.4	.0	4.8	--	168	169	127	273	7.9	0	
2.5	151	0	14	3.0	.1	4.1	--	173	158	137	273	7.8	0	
2.3	149	0	13	2.5	.1	4.8	--	--	165	132	273	8.0	5	
2.5	154	0	13	2.5	.1	4.9	--	173	170	136	274	7.4	0	
2.4	154	0	14	3.2	.1	4.5	--	176	168	136	279	8.2	0	
2.6	154	0	13	2.8	.1	4.8	--	173	169	134	275	8.1	0	
1.8	153	0	13	5.2	.0	6.8	--	171	166	138	288	--	--	438
2.2	156	0	14	3.5	.1	5.1	--	177	173	140	284	8.2	0	439
1.7	174	0	16	3.5	.0	5.6	--	185	177	159	305	7.7	5	
2.5	122	0	6.7	1.8	.2	2.0	--	162	166	91	211	7.9	3	440
2.1	119	0	15	4.5	.1	12	--	182	188	111	253	8.0	3	
2.8	121	0	6.0	1.6	.3	3.2	--	163	155	88	213	8.1	2	
2.3	114	0	7.2	2.5	.2	2.6	--	158	160	88	211	7.8	5	
2.8	117	0	6.8	1.8	.3	4.2	--	152	153	86	213	8.1	0	
2.7	121	0	6.5	1.8	.1	4.2	--	152	157	88	211	8.0	0	
2.6	118	0	6.7	2.0	.2	6.3	--	--	153	91	214	7.8	5	
2.2	130	0	14	3.0	.3	9.7	--	190	195	118	258	7.8	0	
2.8	119	0	7.8	2.2	.4	5.8	--	164	161	93	220	7.8	0	
2.7	118	0	6.2	2.0	.3	5.3	--	158	161	88	216	8.0	5	
2.8	119	0	7.4	2.5	.3	4.7	--	162	158	90	209	8.0	0	
2.1	178	0	19	3.7	.1	16	--	203	200	175	333	7.9	3	441

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
SPOKANE COUNTY -- Continued													
442	25/43-8D1	Union Sand & Gravel Company	--	--	--	--	5/7/42	51	11	0.04	30	12	3.1
443	25/43-9G1	Charles Perry	1,892	32	--	Sand, gravel	6/6/51	45	11	.13	7.8	2.7	1.7
444	25/43-11G1	City of Spokane (Electric Station, well 1)	1,902	38	--	Gravel	12/1/38	48	11	.04	35	17	2.5
445	25/43-11G4	City of Spokane (Electric Station, well 4)	1,902	45	--	Gravel	7/26/61	48	12	.00	34	16	3.0
446	25/43-11J	City of Spokane (Parkwater Station, well 5)	1,947	126	--	Sand, gravel, boulders	10/22/59	--	12	.00	34	16	3.1
							5/17/60	49	--	--	--	--	--
							7/26/61	48	12	.00	33	16	2.8
447	25/44-15E1	Modern Electric Water Company (well 5)	2,052	147	--	--	5/7/42	48	11	.08	32	15	2.6
448	25/44-18M1	F. C. Lawhead	1,964	79	--	Gravel, sand	6/6/51	53	12	.12	28	11	2.8
449	25/45-4A1	Hagen	2,060	135	--	Gravel	6/6/51	54	12	.08	35	16	3.0
450	25/45-14N	Spokane County Golf Course	--	186	160-186	Sand, gravel, boulders	10/22/59	--	20	.09	17	.9	3.8
							5/17/60	59	--	--	--	--	--
451	25/45-18A1	O. B. Nilson	2,036	98	--	--	5/7/42	52	11	--	23	8.8	2.2
452	26/42-7G1	E. M. Covington	1,625	45	29-45?	Sand, gravel	6/6/51	50	25	.22	87	14	12
453	26/42-20 SW 1/4	U. S. Government (U.S.A.F.)	--	159	--	--	12/18/53	56	15	.03	29	9.2	3.6
							10/6/54	53	16	.03	34	13	4.0
							10/27/55	55	16	.18	35	11	4.4
							10/30/56	54	17	.11	35	13	4.0
							11/6/57	51	--	.07	37	12	4.2
							7/22/58c	68	17	--	36	12	4.2
							9/22/59	52	17	.03	36	12	4.3
							11/8/60c	46	16	.05	35	12	4.6
454	26/43-16F2	Kaiser Aluminum & Chemical Corp. (well 5)	1,940	268	238-268?	Sand, gravel	10/22/59	--	11	.01	34	14	3.5
							5/17/60	53	--	--	--	--	--
455	26/43-19A1	Country Homes Estate	1,936	163	--	Gravel?	5/7/42	50	9.4	.04	27	14	2.6
456	26/43-27E1	North Spokane Irrigation District No. 8	--	255	--	--	6/6/51	51	12	.08	28	10	2.6
457	26/45-36E1	E. C. Rossman	--	149	--	Gravel?	5/7/42	48	12	.08	35	16	3.1
458	29/44-6H	L. Ambacher	--	14	--	--	5/2/61	45	30	.00	30	7.8	11
STEVENS COUNTY													
459	28/39-25H	Porter Carter	--	350	--	--	12/1/59	--	24	.01	36	9.5	7.3
							5/17/60	54	--	--	--	--	--
460	30/41-33P	Loon Lake Park Co.	--	70	--	--	12/1/59	--	14	3.1	18	6.2	8.2
							5/17/60	48	--	--	--	--	--
461	34/39-10L	Arden Lumber Co.	--	38	25-38	Gravel	5/2/61	53	23	.00	46	7.8	6.2
462	35/39-10A	City of Colville (well 5)	--	236	182-236	Gravel	1/25/60	--	14	.09	60	14	3.9
							5/17/60	50	--	--	--	--	--
463	35/39-10B1	City of Colville	--	210	30-160	Gravel	3/27/58	50	16	.13	57	14	3.6

Parts per million											Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
								Dissolved solids						
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Calculated	Residue on evap. at 180°C	Hardness (as $CaCO_3$)				
SPOKANE COUNTY -- Continued														
1.6	137	0	12	1.7	0.0	4.4	--	143	138	124	245	--	--	442
1.6	37	0	6.5	.4	.1	.4	--	51	50	31	73	7.2	8	443
1.6	176	0	13	2.6	.0	3.2	--	173	163	157	--	--	--	444
1.9	168	0	14	2.0	.1	4.6	--	171	162	150	294	7.9	0	445
2.0	169	0	15	1.2	.0	4.0	0.00	170	170	149	301	8.0	0	446
--	164	0	--	--	--	--	--	--	--	149	287	8.1	--	
1.8	166	0	15	1.5	.1	4.3	--	168	162	150	292	8.0	0	
1.8	157	0	13	.9	.0	2.4	--	156	148	142	269	--	--	447
1.6	137	0	10	1.4	.1	5.2	--	140	137	115	237	8.2	6	448
1.5	170	0	16	1.0	.1	5.4	--	174	166	153	297	7.8	7	449
1.3	29	16	4.8	1.2	.0	1.0	.00	80	84	46	112	9.4	5	450
--	75	0	--	--	--	--	--	--	--	58	137	7.9	--	
1.5	101	0	10	1.0	.0	2.3	--	110	104	94	183	--	--	451
3.2	268	0	33	14	.2	32	--	352	364	274	569	7.3	6	452
1.3	124	0	9.5	2.8	.1	1.7	--	133	132	110	222	7.8	3	453
1.8	154	0	14	3.5	.1	.2	--	163	166	138	280	7.8	3	
2.3	152	0	13	2.6	.0	6.0	--	165	163	133	278	8.0	0	
2.1	151	0	14	2.8	.0	6.5	--	168	158	141	280	8.0	0	
2.2	152	0	14	3.0	.0	8.3	--	--	162	142	282	7.9	5	
2.3	149	0	14	3.2	.1	8.5	--	170	163	140	274	7.8	0	
2.2	152	0	14	2.8	.0	7.0	--	170	166	138	272	8.1	5	
2.0	153	0	15	3.2	.1	8.9	--	172	164	139	283	8.2	5	
2.2	137	0	13	14	.0	5.0	.05	164	170	142	291	8.1	5	454
--	139	0	--	--	--	--	--	--	--	140	290	8.1	--	
1.7	134	0	12	2.0	.0	4.5	--	139	136	125	243	--	--	455
2.1	123	0	11	2.3	.1	3.9	--	133	142	111	248	8.0	5	456
1.9	173	0	15	1.0	.0	1.7	--	171	164	153	295	--	--	457
5.1	37	0	21	5.5	.2	96	.09	225	238	107	303	6.3	5	458
STEVENS COUNTY														
2.2	173	0	5.9	1.2	.5	.0	.00	172	165	129	271	7.8	0	459
--	176	0	--	--	--	--	--	--	--	132	279	8.0	--	
2.3	104	0	2.6	3.0	.4	.0	.00	109	103	70	178	6.7	0	460
--	104	0	--	--	--	--	--	--	--	71	177	6.6	--	
1.7	172	0	8.2	1.5	.2	13	.03	193	202	147	303	7.6	5	461
1.4	234	0	20	.8	.2	.0	.04	229	225	206	392	7.8	0	462
--	232	0	--	--	--	--	--	--	--	210	393	7.8	--	
2.0	231	0	20	.0	.2	.0	.00	227	240	200	382	7.7	0	463

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million				
									Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
THURSTON COUNTY													
464	15/1W-6A1	P. D. Northcraft	275	45	24-32, 42-45	Gravel	5/31/60 10/3/60	51 52	23 --	0.08 --	7.5 --	1.6 --	4.3 --
465	15/1W-7E1	City of Bucoda	250	60	--	Gravel	11/12/59 5/24/60 10/3/60	50 49 52	29 18 --	.04 .08 --	11 5.5 --	3.3 2.1 --	6.2 5.1 --
466	15/2W-5E1	H. J. Smith	205	62	47-62	Sand, gravel	5/31/60 10/3/60	51 53	25 --	1.9 --	9.0 --	2.3 --	6.3 --
467	15/2W-15R1	R. L. Dickey	220	50	42-44, 49-50	Gravel	5/31/60 10/3/60 4/26/61	51 51 52	26 27 24	.07 .02 .22	10 16 8.0	2.8 1.8 3.3	7.4 13 6.6
468	15/3W-5B1	Melvin Paulson	155	85	70-85	Gravel	6/21/60 10/4/60	55 51	31 --	2.2t --	7.5 --	4.4 --	11 --
469	15/3W-14C1	State of Washington	150	74	57-74	Sand, gravel	4/17/58	51	30	.00	6.4	2.9	7.5
470	15/3W-14C2	State of Washington	150	80	--	Sand, gravel	11/12/59 5/24/60	50 51	27 --	.06 --	9.5 --	1.9 --	4.7 --
471	16/3W-16L1	Centralia Fruit Farms	142	98	56-98	Gravel	5/31/60 10/3/60	52 52	22 --	.14 --	6.5 --	1.4 --	4.0 --
472	17/2W-15P1	Henri Schlottman	198	82	46-69	Gravel	6/21/60 10/3/60 4/26/61	52 54 53	17 20 15	.02 .02 .11	7.0 11 6.5	2.2 3.0 2.0	3.9 5.2 3.8
473	17/2W-16R1	A. P. Thomas	195	34	21?-34	Sand, gravel	5/31/60 10/3/60	52 52	19 --	.09 --	5.0 --	.6 --	3.2 --
474	17/3W-25P1	J. W. Sutmiller	145	66	64-66+	Gravel	5/31/60 10/3/60	50 52	23 --	1.4t --	7.0 --	1.6 --	4.6 --
475	17/3W-35E1	W. A. White	145	43	40-43+	Sand, gravel	5/31/60 10/3/60	53 51	25 --	.06 --	6.0 --	2.2 --	3.5 --
476	17/2-19J5	J. M. Hales	350	87	31-62?	Gravel, sand, clay	2/12/52	51	21	2.0t	7.8	3.4	4.7
477	17/2-19N1	City of Yelm	350	63	35-62?	Gravel	11/12/59 5/24/60	50 50	23 --	.25 --	9.0 --	2.9 --	4.6 --
478	17/2-29L4	Gilbert Roehr	350	53	30-42	Gravel, sand	2/12/52	51	33	1.2t	11	5.7	6.1
479	18/1W-10R3	Thurston County Public Utilities District No. 1	200	178	163-178	Sand, clay	4/17/58	50	--	.78	6.4	4.9	8.2
480	18/1W-15H1	Thurston County Public Utilities District No. 1	170	186	166-177	Sand, gravel	11/13/59 5/26/60	52 54	45 --	.02 --	12 --	4.6 --	5.5 --
481	18/1W-21D3	L. C. Huntamer	190	153	139-153	Gravel, sand	4/20/58	51	35	.06	6.4	5.4	5.2
482	18/2W-24P1	City of Olympia	--	208	193-208	Gravel	12/30/44	--	34	.25t	8.0	9.1	6.3
483	18/1-18A1	E. Deck, Jr.	20	120	111-120	Sand, gravel	11/16/55	--	36	.24t	12	5.7	6.4
484	19/1W-4D	Johnson Point Community Corp.	--	131	121-131	Sand, gravel	12/10/60 4/26/61	47 54	32 31	.11 .05	17 16	17 20	9.7 9.4
485	19/2W-9R1	Coopers Point Water Company	10	360	340-360	Gravel, sand, clay	11/12/59 5/26/60	52 52	46 --	.62 --	14 --	2.9 --	20 --
WAHKIAKUM COUNTY													
486	9/5W-32Q2	State of Washington	--	244	183-192, 211-244	Basalt (Peat, 230-231)	4/26/61	52	46	1.1	14	7.2	20

Parts per million											Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
								Dissolved solids						
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Calculated	Residue on evap. at 180°C	Hardness (as $CaCO_3$)				
THURSTON COUNTY														
0.3	29	0	3.0	1.8	0.1	8.7	0.08	64	66	25	75	6.8	0	464
--	31	0	--	--	--	--	--	--	--	26	75	6.9	--	
1.1	50	0	5.0	4.8	.0	3.8	.20	89	87	41	124	6.7	0	465
.9	24	0	7.8	3.2	.0	3.7	.08	58	67	22	77	6.1	10	
--	52	0	--	--	--	--	--	--	--	41	113	7.0	--	
.9	34	0	5.2	4.8	.1	6.1	.05	79	84	32	99	6.9	5	466
--	34	0	--	--	--	--	--	--	--	30	99	6.3	--	
.9	46	0	4.4	3.2	.1	7.6	.11	86	86	36	112	6.8	5	467
1.2	69	0	3.8	4.0	.1	7.2	.18	108	105	47	144	7.2	5	
1.0	42	0	4.4	4.0	.0	4.4	.07	77	84	34	102	6.8	5	
3.1	49	0	12	8.2	.1	.4	.02	102	105	37	136	7.1	25	468
--	46	0	--	--	--	--	--	--	--	37	138	6.8	--	
1.0	40	0	8.8	2.0	.1	1.1	.12	80	66	28	89	7.1	0	469
1.0	40	0	4.2	3.8	.0	2.5	.11	75	76	31	94	6.9	0	470
--	40	0	--	--	--	--	--	--	--	30	95	6.9	--	
.4	34	0	3.2	1.8	.1	.6	.02	57	56	22	68	6.7	0	471
--	34	0	--	--	--	--	--	--	--	25	74	6.5	--	
1.4	25	0	6.0	4.0	.0	7.1	.03	61	57	26	81	7.1	0	472
1.4	27	0	8.2	7.0	.0	20	.02	89	91	40	120	6.3	0	
1.3	24	0	5.4	3.2	.0	6.4	.00	56	62	24	80	6.3	0	
.4	19	0	1.0	2.2	.0	3.4	.02	44	43	15	51	6.5	0	473
--	18	0	--	--	--	--	--	--	--	16	51	6.5	--	
.8	37	0	1.2	3.0	.1	.5	.12	60	60	24	73	6.7	10	474
--	37	0	--	--	--	--	--	--	--	25	75	6.6	--	
.4	34	0	.6	2.0	.1	1.0	.04	58	57	24	67	6.9	0	475
--	34	0	--	--	--	--	--	--	--	23	64	7.0	--	
1.6	34	0	4.4	5.2	.5	9.4	--	75	75	33	97	7.0	5	476
1.0	38	0	4.4	3.8	.0	5.0	.11	73	75	34	101	6.7	0	477
--	40	0	--	--	--	--	--	--	--	34	96	6.6	--	
2.0	64	0	3.5	3.5	.2	4.7	--	102	103	51	129	7.3	5	478
2.0	60	0	5.6	1.0	.1	.8	1.2	--	106	36	110	6.9	2	479
1.7	72	0	1.3	2.8	.1	.3	1.0	108	104	49	126	7.3	0	480
--	74	0	--	--	--	--	--	--	--	49	126	7.6	--	
2.0	40	0	10	3.0	.1	6.6	.14	94	88	38	111	7.3	0	481
1.7	73	0	6.0	3.2	.1	.2	--	105	104	57	136	--	--	482
2.1	75	0	2.9	4.5	.1	.4	--	107	107	53	139	6.9	5	483
2.0	132	0	3.1	18	.1	.3	.05	164	155	114	262	7.2	5	484
2.0	137	0	3.0	20	.1	.3	.01	169	185	123	274	7.6	0	
1.9	92	0	.3	10	.1	.8	2.2	143	143	47	192	7.2	5	485
--	101	0	--	--	--	--	--	--	--	48	191	7.5	--	
WAHKIAKUM COUNTY														
3.3	125	0	4.0	4.2	.3	.1	.35	163	160	64	209	7.6	20	486

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million				
									Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
WALLA WALLA COUNTY													
487	6/35-10P1	Frank Barard	735	1,145	1,135-1,145	Basalt	8/1/58	75	72	0.03	12	1.7	32
488	6/35-12N1	A. A. Durand	775	590	565-590	Basalt	11/19/46	--	66	--	24	6.8	--
489	6/36-9P1	Baker and Baker Corp.	1,000	2,061	Below 1,900?	Basalt	11/29/46	64	60	.09	16	9.8	--
490	7/33-34P2	H. H. Taylor	440	30	22-30?	Gravel	10/27/59	58	43	.11	43	17	130
							5/24/60	--	44	4.2t	52	19	153
							11/30/60	56	34	.15t	38	13	123
491	7/33-34P3	H. H. Taylor	--	26	22-26?	Gravel?	5/1/61	57	35	.05	48	15	130
492	7/35-23M1	U. S. Government (B.P.A.)	772	515	463-515	Basalt	11/21/46	68	55	.03	11	2.1	--
493	7/35-33J1	Walla Walla College	--	85	--	Gravel	10/29/59	56	58	.02	50	23	13
							5/29/60	56	56	.02	65	27	17
							11/30/60	54	53	.03	51	20	12
							5/1/61	58	--	--	--	--	--
494	7/35-36F3	College Place Water Dept. (well 3)	--	708	554-705	Basalt	10/22/59	68	65	.04	20	5.5	21
							5/24/60	68	--	--	--	--	--
495	7/36-13F1	City of Walla Walla (well 1)	1,250	810	750-810	Basalt	11/26/46	--	54	--	17	8.2	--
							10/27/59	52	50	.01	16	6.5	6.2
							5/24/60	54	--	--	--	--	--
496	7/36-22N1	City of Walla Walla (well 4)	1,045	789	400-789	Basalt	10/27/59	58	61	.77	19	5.2	25
							5/24/60	56	--	--	--	--	--
497	7/36-28R1	City of Walla Walla (well 5)	1,020	1,090	903-1,090	Basalt	7/29/60	74	62	.06	16	5.3	29
498	7/36-33A1	H. E. Studebaker	1,020	762	630-635, 664-690	Basalt	7/29/60	62	46	.17	19	5.8	23
499	7/36-35R	J. E. Levin	1,150	222	--	Basalt	11/21/46	--	54	--	28	9.4	--
500	7/37-5D1	Gale Kibler	1,290	118	90-118	Gravel, sand, clay	11/15/46	--	34	--	54	20	--
501	7/37-13J1	R. E. Meiners	2,315	525	--	Basalt	11/18/46	--	56	--	22	11	--
502	7/37-16Q	Leo Gilkerson	1,490	14	--	--	11/26/46	--	52	--	35	13	--
503	7/37-18F1	City of Walla Walla (well 3)	1,320	1,169	Below 176	Basalt	1/28/57	56	56	.03	17	6.5	9.3
504	7/37-18G1	David Kibler	1,400	100	--	Gravel, sand	11/18/46	--	39	--	20	8.7	--
505	9/31-24M2	U. S. Government (U.S.A.)	--	155	111-145	Gravel	4/28/61	53	44	.02	34	14	19
WHATCOM COUNTY													
506	37/8-25E1s	U. S. Government (U.S.F.S., spring)	--	--	--	Basalt	10/27/54	54	23	.02	8.4	3.9	6.4
507	38/1-4D	Neptune Beach Water Association	--	144	133-144	Sand	3/1/60	46	23	.07	31	22	20
508	38/5-2Q2	Emma Bodtke	--	18	--	--	3/2/60	--	--	.01	10	3.6	--
509	38/5-29D	Tony Fresia	--	16	12-16	Gravel	3/2/60	--	--	3.4	16	21	3.6
510	39/2-19M	City of Ferndale	--	161	--	--	12/17/59	45	21	.06	45	23	132
							5/18/60	55	--	--	--	--	--
511	39/2-19Q3	City of Ferndale	--	157	125-157	Sand, gravel	3/1/60	50	--	.56	42	19	116
512	39/2-36D1s	C. V. Wilder (Larabee Spring)	--	--	--	Gravel	4/7/49	--	19	.01	23	10	18

Parts per million														
								Dissolved solids						
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Calculated	Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
WALLA WALLA COUNTY														
8.6	126	0	3.2	6.5	0.7	0.0	0.00	199	186	37	226	8.2	0	487
--	142	0	31	6.5	.6	.2	--	--	--	88	239	--	--	488
3.4	108	0	5.7	3.8	.6	.4	--	--	154	80	186	--	--	489
8.1	508	0	20	17	.2	5.8	.80	534	554	176	848	7.7	0	490
8.4	578	0	33	22	.3	6.5	.62	624	621	210	959	7.7	0	
8.2	456	0	22	18	.4	.1	.52	482	488	150	753	7.8	5	
9.4	494	0	30	25	.4	5.6	.37	542	555	181	847	8.0	5	491
7.8	125	0	3.8	3.6	.6	.1	--	--	171	36	214	--	--	492
6.0	238	0	16	23	.2	7.0	.43	313	312	219	501	7.3	0	493
6.8	292	0	19	31	.2	8.6	.29	375	389	272	586	7.0	0	
6.2	232	0	14	22	.2	6.6	.32	299	313	210	463	7.4	5	
--	272	0	--	--	--	--	--	--	--	250	544	7.2	--	
5.2	136	0	5.4	4.2	.5	.0	.00	194	200	72	229	8.2	0	494
--	136	0	--	--	--	--	--	--	--	70	235	8.1	--	
--	96	0	9.7	1.8	.2	.2	--	--	--	76	150	--	--	495
2.6	97	0	1.7	1.0	.2	.5	.18	133	140	67	163	7.7	0	
--	95	0	--	--	--	--	--	--	--	66	157	7.7	--	
5.2	149	0	5.3	2.5	.9	.2	.08	197	196	69	257	8.1	0	496
--	151	0	--	--	--	--	--	--	--	71	248	8.1	--	
5.5	148	0	5.0	3.0	1.0	.1	.01	200	193	62	245	8.2	0	497
3.2	142	0	2.8	2.5	.7	.1	.11	173	168	71	230	8.2	0	498
--	142	0	30	3.2	.6	3.4	--	--	--	108	231	--	--	499
--	291	0	10	3.8	.6	7.0	--	--	--	216	459	--	--	500
--	106	0	19	3.2	.6	3.9	--	--	--	100	227	--	--	501
--	168	0	28	3.5	.4	3.8	--	--	--	141	291	--	--	502
2.6	106	0	2.5	1.0	.2	.2	--	147	132	69	169	8.0	0	503
--	132	0	16	4.5	.2	.2	--	--	--	86	213	--	--	504
4.6	156	0	38	12	.5	2.3	--	245	246	143	364	7.9	5	505
WHATCOM COUNTY														
2.4	27	0	25	4.0	.2	.3	--	87	88	37	113	7.3	0	506
--	218	0	--	14	.3	--	--	--	226	167	415	8.1	--	507
--	37	0	--	--	--	--	--	--	82	40	135	6.4	--	508
--	160	0	--	3.5	.1	--	--	--	162	128	255	7.4	--	509
7.6	289	6	24	162	.2	.0	.31	563	556	206	1,030	8.4	5	510
--	303	0	--	--	--	--	--	--	--	215	1,000	8.1	--	
--	291	0	--	121	--	--	--	--	480	184	811	8.2	--	511
3.0	124	0	8.5	22	.2	2.0	--	167	171	98	296	7.3	--	512

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
WHATCOM COUNTY -- Continued													
513	39/3-10J2	Emma MacMillan	115	92	48-50	Sand	3/1/60	--	--	0.07	13	2.1	--
514	39/3-18D2	Meridian Water Association	--	24	16-24	Sand	3/1/60	--	22	.28	16	7.8	12
515	39/4-32P	Otto Sehrt	--	179	--	--	3/2/60	--	--	.28	17	11	--
516	39/4-34C	Don Haaland	--	100	--	--	3/2/60	--	32	.12	27	9.9	41
517	39/5-3P1	Joe Zender	--	44	30-44	Gravel	3/2/60	--	--	.06	26	4.6	--
518	40/1-3F	City of Blaine (well 5)	--	53	--	--	12/17/59 5/18/60	48 46	25 --	.00 --	12 --	5.2 --	5.1 --
519	40/1-3M1s	City of Blaine (spring)	--	--	--	Gravel?	4/7/49	--	24	.01	12	6.5	5.8
520	40/2-8D	B. R. McPhail	175	30?	--	Sand?	3/1/60	--	--	.06	37	13	--
521	40/2-25A1	Jule Crabtree	60	20	--	Sand	3/1/60	--	--	.23t	13	3.2	3.7
522	40/3-9R1	Delta Water Association	--	37	24-37	Sand, gravel	3/1/60	--	--	.01	14	3.1	--
523	40/3-28M	K. VanderGriend	--	375	--	--	3/1/60	--	--	--	180	250	--
524	40/3-36H1	City of Everson	90	30	30-?	Gravel	4/8/49	48	19	.01	28	12	21
525	40/4-9A	Andrew Hento	--	15	--	--	3/2/60	--	--	4.2	7.0	18	--
526	40/4-10D1	John Brayard	45	84	--	Gravel	4/8/49	--	48	12	14	17	13
527	40/4-33D	James Rorabaugh	--	25?	--	Sand, gravel?	3/1/60	--	--	.54t	14	19	--
528	40/5-9Q	H. Kelly	--	102	--	--	3/2/60	--	--	.06	18	5.5	--
529	41/1-31Q1	City of Blaine	55	247	170-200	Sand, gravel	3/26/58	50	26	.13t	14	6.8	9.9
530	41/4-33H	City of Sumas	--	58	50-58	Gravel	3/1/60	--	--	.00	23	4.6	--
WHITMAN COUNTY													
531	14/45-5B2	Washington State University (well 2)	2,364	237	--	Basalt	12/2/38	56	65	.24t	22	16	22
532	14/45-5B3	Washington State University	2,365	223	195-220	Basalt	3/28/55	--	--	.03	25	15	--
533	14/45-5D3	City of Pullman (well 3)	2,341	167	159-162	Basalt	3/30/55 11/17/59c	-- --	-- 69	.19t .39	24 22	13 15	-- 22
534	14/45-5D4	Northern Pacific Railway Company	2,342	166	89-99	Basalt	3/30/55	--	--	.02	22	14	--
535	14/45-5E1	City Ice Co.	2,341	95	Below 19	Basalt, sand?	3/30/55	--	--	.22	22	13	--
536	14/45-5G1	Washington State University (well 3)	2,364	213	116-130	Basalt	3/28/55	--	--	.21	21	15	--
537	15/44-15A2	City of Albion	2,244	78	47-78	Decomposed granite	3/28/58 11/17/59c 5/16/60	50 -- 50	50 46 --	.09 .81 --	42 42 --	13 15 --	17 18 --
538	15/45-26K1	Orval Boyd	2,608	302	198-204?, 292-302?	Basalt	3/30/55 5/1/61	-- 50	-- 26	.67t .08t	24 32	9.4 17	-- 32
539	15/45-32N1	City of Pullman (well 2)	2,340	231	170-176?	Basalt	3/30/55	--	--	.32	21	14	--
540	15/45-32N2	City of Pullman (well 4)	2,340	954	Below 399	Basalt	3/28/58 11/59c	58 --	67 60	.50 .36	22 24	15 13	25 22

Parts per million											Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)				
WHATCOM COUNTY -- Continued														
--	39	0	--	--	--	--	--	--	85	41	122	6.5	--	513
--	47	0	12	14	0.2	32	--	--	132	72	218	6.9	--	514
--	470	0	--	8.0	--	.0	--	--	450	86	706	8.1	--	515
--	235	0	--	6.5	--	.0	--	--	238	108	372	8.0	--	516
--	105	0	--	--	--	--	--	--	118	84	188	8.2	--	517
1.3	70	0	4.4	2.5	.1	.1	.25	90	93	51	129	7.5	5	518
--	70	0	--	--	--	--	--	--	--	61	128	7.4	--	
2.0	78	0	6.7	3.3	.2	.1	--	99	90	57	133	7.3	--	519
--	188	0	--	4.0	--	--	--	--	190	146	346	7.5	--	520
--	44	0	--	4.0	--	--	--	--	82	46	120	6.6	--	521
--	30	0	10	6.0	.1	9.8	--	--	83	48	131	6.8	--	522
--	120	0	--	4,500	--	--	--	--	--	1,500	14,500	7.5	--	523
2.2	44	0	12	84	.2	5.6	--	206	215	119	388	6.6	--	524
--	20	0	1.4	3.0	--	.8	--	--	--	90	195	7.1	--	525
2.8	138	0	1.6	14	.2	.2	--	180	175	105	245	6.8	--	526
--	130	0	--	--	--	--	--	--	152	114	290	6.7	20	527
--	74	0	--	--	--	--	--	--	92	68	152	7.2	--	528
4.0	96	0	8.8	2.0	.1	.0	.45	119	121	63	171	8.0	0	529
--	82	0	--	--	--	--	--	--	111	76	173	8.1	--	530
WHITMAN COUNTY														
4.2	203	0	1.8	3.3	.2	.2	--	235	224	121	--	--	--	531
--	216	0	2.9	4.0	--	--	--	--	--	124	323	7.8	--	532
--	190	4	3.7	4.0	--	--	--	--	--	113	304	8.4	--	533
4.2	196	0	3.1	4.2	.5	.2	.22	238	225	118	346	7.7	5	
--	185	0	12	5.0	--	--	--	--	--	112	305	8.2	--	534
--	198	0	2.1	3.0	--	--	--	--	--	108	299	8.2	--	535
--	203	0	2.9	3.0	--	--	--	--	--	114	305	8.3	--	536
2.4	171	0	22	13	.2	22	.30	268	243	158	404	6.8	0	537
1.7	192	0	18	12	.5	23	.00	272	278	166	406	7.0	0	
--	174	0	--	--		--	--	--	--	164	411	6.9	--	
--	154	0	23	3.0	--	--	--	--	--	99	287	8.3	--	538
5.6	170	4	72	2.2	.6	.7	.03	276	276	150	421	8.4	5	
--	184	6	.8	4.0	--	--	--	--	--	110	291	8.5	--	539
4.4	207	0	4.9	2.0	.4	.1	.05	243	236	117	319	7.7	1	540
4.1	194	0	.7	3.2	1.4 a/	.1	.24	224	224	114	307	7.8	5	

a/ Fluoridated

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
W H I T M A N C O U N T Y -- Continued													
541	15/46-20P1	N. T. Carson	2,590	250	--	Sand	3/29/55	--	--	0.25	58	24	--
542	16/43-14L	City of Colfax	--	765	Below 280	Basalt	11/59	--	63	.09	21	11	24
							5/16/60	64	--	--	--	--	--
Y A K I M A C O U N T Y													
543	9/22-12H	A. C. Pride	--	100	96-100?	Gravel?	5/5/61	61	57	.01	48	14	17
544	10/20-3N2	City of Toppenish (well 2)	--	160	--	Gravel	1/26/39	57	32	.05	22	7.9	6.8
545	10/20-9A	City of Toppenish (well 6)	--	863	792-863	Sand, gravel	10/19/59	69	68	.08	13	2.2	19
							5/19/60	60	--	--	--	--	--
546	12/16-13D1	Herke Brothers	1,800	146	130-140	Basalt	8/30/51	--	54	.06	16	9.7	10
547	12/16-17J1	S. A. Mondor	2,050	11	--	Gravel	8/30/51	--	47	.11	10	5.8	5.6
548	12/17-16D3	Oral Brown	1,510	384	325-384	Basalt	10/21/59	60	53	.05	13	5.3	17
							5/19/60	--	--	--	--	--	--
549	12/17-16R1	B. S. Borton & Sons	1,550	1,078	1,035-1,078	Basalt	4/18/52	63	38	.27	12	6.6	7.2
550	12/18-5G2	H. E. Anderson	1,190	10	3-10	Sand, gravel	8/29/51	--	52	.03	23	12	19
551	12/18-5J1	Joel Richwine	1,170	18	17-18	Sand	8/29/51	--	51	.02	24	14	16
552	12/18-11E1	S. H. Schreiner	1,170	213	205-213	Sand, gravel	8/30/51	--	61	.03	30	16	9.6
553	12/23-13B	Woodrow Wright	--	153	--	--	5/5/61	61	54	.20t	28	11	11
554	13/19-31J1	Yakima Farmers Supply Company	1,015	84	75-84?	Sand, gravel	8/29/51	--	39	.02	34	11	12
555	14/18-3N1s	H. E. Mulford (spring)	--	--	--	--	11/19/48	59	66	.05	32	19	13
556	14/18-12D	John Knopp	--	124	100-124?	Gravel	11/22/48	--	58	.26	42	19	23
557	14/18-13R2	B. Barnheart	--	60	--	--	11/19/48	--	53	.03	60	26	62
558	14/19-19G	H. B. Larson	--	134	117-134?	Sand?	5/5/61	54	57	.00	84	31	58
559	14/19-28B?	U. S. Government (U.S.A.)	--	600?	--	Basalt	4/20/51	70	56	.04	15	11	19
							9/29/53	70	59	.15	16	11	19
							11/29/54	64	53	.06	16	11	19
							10/5/55	68	50	.08	16	9.4	19
							10/25/56	67	49	.06	15	11	19
							1/6/58	68	--	.03	16	10	18
							3/30/59	68	51	.05	17	11	18
							9/14/60	68	52	.04	15	11	19
560	14/19-28F?	U. S. Government (U.S.A.)	--	548	--	Basalt?	4/20/51	65	50	.05	35	19	32
							9/18/52	63	50	.12	25	15	27
							9/29/53	61	53	.20	36	18	32
							11/29/54	60	48	.12	33	17	31
							10/5/55	59	45	.08	34	17	30
561	14/19-28 NE 1/4	U. S. Government (U.S.A.)	--	590	--	Basalt	9/17/52	66	52	.11	17	10	22
							11/29/54	62	49	.86	17	10	21
							10/5/55	63	49	.27	17	9.3	20
562	15/17-13C1	G. E. Cameron	--	385	360-385?	Sand, basalt?	11/22/48	55	42	.13	12	7.3	23
563	15/18-33P1	R. H. Kershaw	--	400	--	Sand	11/22/48	--	59	.04	23	12	13
564	16/14-1J1	U. S. Government (U.S.F.S.)	--	200	--	Basalt	5/4/59	--	24	.79	84	10	45
565	16/14-1R1	U. S. Government (U.S.F.S.)	--	41	36-41	Sand, gravel	11/4/59	--	25	.03	26	5.2	7.9

Parts per million														
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
WHITMAN COUNTY -- Continued														
--	168	0	21	29	--	--	--	--	--	243	597	7.4	--	541
3.5	173	0	7.7	2.2	0.5	0.2	0.05	218	217	98	285	7.9	0	542
--	172	0	--	--	--	--	--	--	--	100	290	8.0	--	
YAKIMA COUNTY														
7.4	190	0	44	11	.4	2.3	.07	295	315	179	425	7.9	5	543
1.9	113	0	5.1	2.7	.0	2.0	--	136	136	87	--	--	--	544
4.1	105	0	.3	1.0	.6	.2	--	160	158	42	171	7.8	0	545
--	105	0	--	--	--	--	--	--	--	42	173	7.7	--	
1.8	116	0	4.4	3.0	.2	1.6	--	158	155	80	194	7.7	5	546
3.7	74	0	2.4	.7	.2	1.0	--	113	111	49	--	7.3	10	547
3.2	113	0	.4	1.8	.5	.1	--	150	149	54	185	7.9	0	548
--	111	0	--	--	--	--	--	--	--	54	179	8.2	--	
3.1	85	0	4.4	1.2	.3	.2	--	115	114	57	136	7.9	8	549
5.3	160	0	8.0	11	.2	1.5	--	211	209	107	285	7.2	25	550
5.6	180	0	5.1	2.5	.3	1.8	--	209	205	117	284	7.2	25	551
3.2	133	0	29	18	.3	2.7	--	235	251	141	315	7.3	5	552
2.9	131	0	17	6.5	.6	4.1	.15	200	217	114	274	7.8	5	553
4.8	116	0	21	26	.3	6.0	--	211	221	130	320	7.3	15	554
5.8	193	0	18	9.1	.2	3.1	--	261	262	158	370	7.6	--	555
2.9	210	0	21	20	.4	16	--	306	309	183	437	8.3	--	556
4.8	442	0	20	5.2	.4	6.2	--	455	445	256	676	7.7	--	557
6.3	459	0	60	13	.6	7.0	.83	544	559	338	823	7.9	5	558
6.2	151	0	.7	4.1	.5	.0	--	187	179	83	235	8.0	4	559
3.6	149	0	.7	3.8	.5	.1	--	187	176	85	244	7.8	4	
3.6	148	0	1.8	4.4	.5	.7	--	183	172	85	235	7.6	7	
4.0	147	0	.2	3.5	.5	.0	--	175	173	79	238	8.1	0	
3.5	149	0	.7	4.0	.4	.2	--	176	174	83	234	7.8	0	
3.6	147	0	.3	4.0	.5	.0	--	--	171	81	236	7.8	0	
4.0	146	0	.5	3.5	.6	.3	--	178	174	87	239	7.8	5	
3.7	147	0	.8	4.0	.6	.2	--	178	174	82	220	7.9	0	
7.2	246	0	23	9.2	.6	2.0	--	299	284	165	429	7.7	3	560
4.1	198	0	12	6.4	.5	.5	--	238	231	124	344	7.6	2	
4.5	239	0	23	8.8	.6	3.8	--	297	293	164	441	7.5	8	
4.4	218	0	21	9.2	.5	8.5	--	280	272	152	425	7.3	6	
4.4	222	0	21	8.2	.6	8.1	--	277	280	155	432	7.7	0	
4.5	154	0	1.2	4.3	.5	.2	--	188	178	84	246	7.9	3	561
4.3	154	0	1.4	4.9	.5	.7	--	185	183	84	249	7.7	8	
4.6	151	0	.2	4.5	.5	.2	--	179	175	81	247	7.7	0	
5.0	124	0	9.8	2.0	.4	.1	--	163	167	60	213	7.2	--	562
4.0	146	0	10	5.2	.2	2.1	--	200	205	107	266	7.5	--	563
.7	200	0	17	106	.1	.0	--	386	416	250	701	7.1	10	564
1.3	98	0	18	3.5	.1	1.2	--	136	140	86	208	7.0	0	565

Sampling site number	Well location code	Owner	Approx. altitude above sea level (in feet)	Well depth (in feet)	Depth of water-bearing interval (in feet)	Water-bearing material	Sample collection date	Temperature (°F)	Parts per million				
									Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
YAKIMA COUNTY -- Continued													
566	16/17-19E1	G. S. Green	--	115	--	Sand	11/19/48	--	61	0.08	16	9.2	8.8
567	16/17-32J1s	Malotte (spring)	--	--	--	--	11/19/48	62	53	.06	12	6.6	17

Parts per million														
Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Orthophosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evap. at 180°C	Hardness (as $CaCO_3$)	Specific conductance (Micromhos at 25°C)	pH	Color	Sampling site number
YAKIMA COUNTY--Continued														
4.8	116	0	3.3	2.4	0.2	0.7	--	164	162	78	202	7.4	--	566
4.3	104	0	9.2	1.8	.4	.3	--	156	158	57	185	7.7	--	567