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THE QUALITY OF WATER IN THE PRINCIPAL AQUIFERS OF SOUTHWESTERN WASHINGTON

By J. C. Ebbert and K. L. Payne

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(Plates are in pocket)

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METRIC CONVERSION FACTORS

Multiply	By	To obtain
feet (ft)-------------------------	0.3048	meters (m)
miles (mi)------------------------	1.609	kilometers (km)
degrees Fahrenheit (°F)-----------	0.5556, after subtracting 32	degrees Celsius (°C)
micromhos per centimeter at 25° Celsius (umhos/cm at 25°C)--	1.000	microsiemens per centimeter at 25° Celsius (uS/cm at 25°C)

OTHER CONVERSION FACTORS

nitrate, mg/L as NO_3	0.2258	nitrate, mg/L as N

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level. NGVD of 1929 is referred to as sea level in this report.

THE QUALITY OF WATER IN THE PRINCIPAL AQUIFERS OF SOUTHWESTERN WASHINGTON

By J. C. Ebbert and K. L. Payne

ABSTRACT

The quality of ground water in major aquifers in southwestern Washington was assessed in terms of inorganic-constituent, trace-metal, and fecal-coliform concentrations. Results of this assessment indicate that the ground water in this region is generally suitable for most uses.

Most ground water in southwestern Washington can be characterized as soft to moderately hard with a low concentration of dissolved solids. Nitrate was the only constituent found at concentrations above maximum contaminant levels specified by the U.S. Environmental Protection Agency primary drinking water regulations. The most prevalent detriment to the otherwise good quality of ground water in the region was concentrations of iron and manganese that exceeded limits recommended by U.S. Environmental Protection Agency secondary standards. Although these limits were exceeded in less than one-half of the samples, high concentrations of iron and manganese were common throughout the entire region.

INTRODUCTION

The Washington State Department of Ecology requested the cooperative assistance of the U.S. Geological Survey in appraising the chemical quality of water in principal aquifers in the State of Washington. This resulted in a 5-year program, initiated in 1979, to obtain and analyze water samples for chemical quality from 500 wells and springs in principal aquifers throughout the State. To apportion the wells and springs uniformly across the State, it was divided into five major regions (fig. 1), and each major region was allocated 100 wells and springs. The selection of principal aquifers in each major region was based on the delineation of principal aquifers in Washington by Molenaar and others (1980).

Purpose and Scope

The purpose of this report is to describe ground-water quality in the southwestern region, a major region which includes the aquifer regions Lewis, Cowlitz, Grays-Elochoman, Chehalis, Willapa, and part of the Olympic Peninsula as identified by Molenaar (fig. 1). To aid with the interpretation of the ground-water quality data, an effort was made to identify and describe the water-bearing formations from which water samples were taken.

Ground-water-quality samples were collected in the southwestern region during the summer of 1980, and data from those samples as well as historic ground-water-quality data are used in this report.

Criteria for Sampling-Site Selection

The number of ground-water-quality samples collected from a given aquifer was determined by a qualitative assessment of the availability, use, and economic importance of the water in that aquifer. Individual wells and springs were selected for sampling in order to provide a relatively uniform areal distribution of sites over each aquifer. Although some sites were located in areas of potential ground-water-quality degradation from landfills, industrial sites, and other localized sources of pollution, the primary objective of sampling was to provide a general assessment of the overall ground-water quality in the major aquifers.

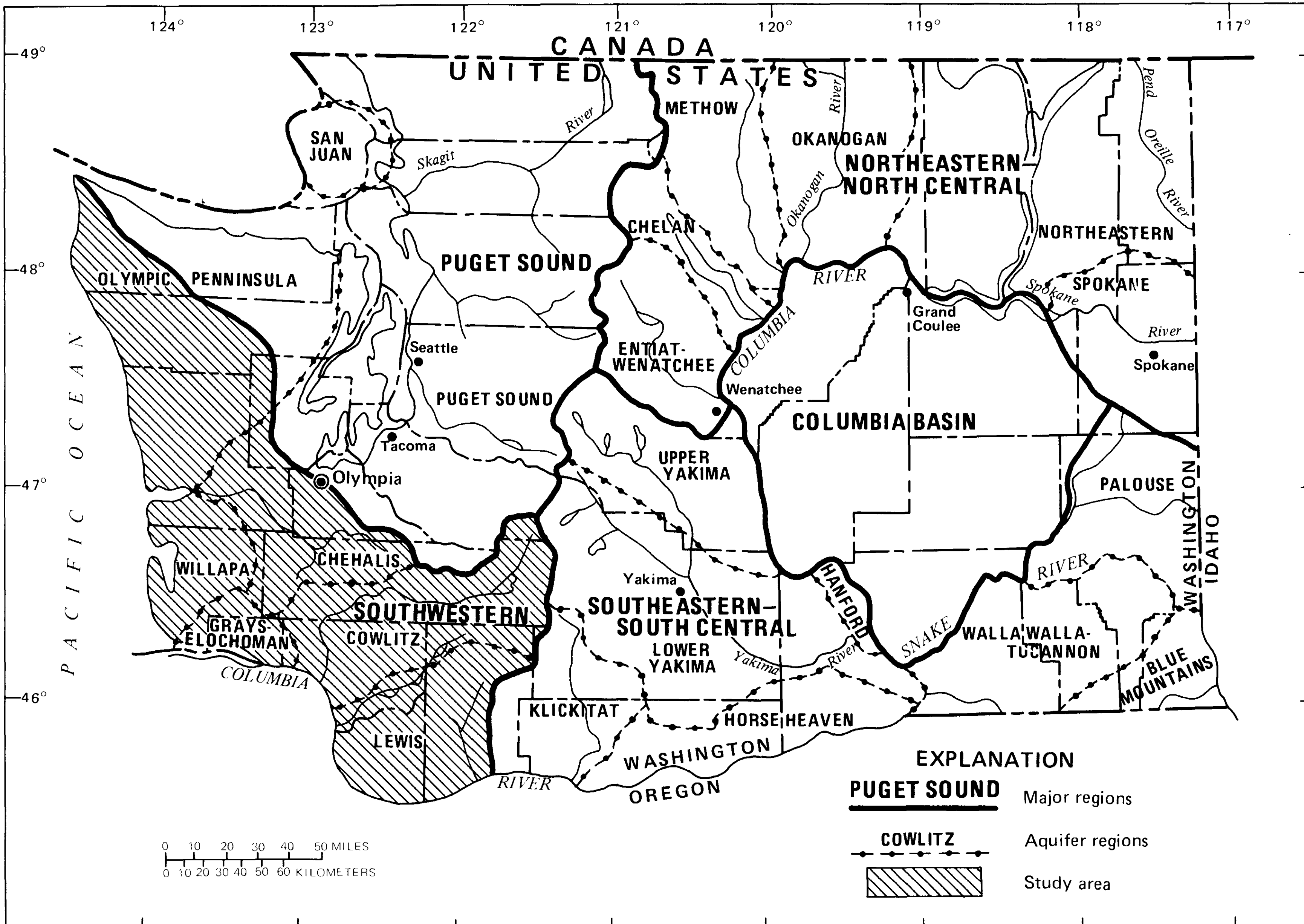


FIGURE 1.--Washington State showing principal aquifer regions as designated by Molenaar and others (1980) and five major regions.

Water-Quality Constituents and Characteristics

All samples that were collected during the summer of 1980 were analyzed for major cations and anions, total alkalinity, nitrite-plus-nitrate, iron, and manganese. Hardness, sodium-adsorption ratio, and dissolved-solids concentration were calculated from the results of the cation-anion determinations. Field determinations were made for specific conductance, pH, and fecal-coliform bacteria. In addition, approximately 20-percent of the samples were analyzed for the trace elements aluminum, arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc.

Historic ground-water-quality data generally include major cations and anions, total alkalinity, nitrate, iron, manganese, and some trace-element determinations. Dissolved-solids determinations were sometimes done gravimetrically after drying the sample at 180°C. Gravimetric determinations are used in this report if available, otherwise the calculated value is used. In comparing historic ground-water-quality data with the data collected as part of the current sampling effort, some difficulties arise due to the changing of sample types and analytical methods. Prior to 1979, iron and manganese determinations were often made on unfiltered samples, and concentrations were reported as total recoverable. Samples collected as part of the current program were filtered, and the corresponding concentrations were reported as dissolved. In a sample with a high iron concentration, a precipitate of iron hydroxide often collects on the filter during filtration. In a raw, unfiltered sample, much of this iron would be dissolved when the sample was preserved by acidification. Therefore, the concentration of iron in a filtered portion of a ground-water sample will often be less than the concentration in an unfiltered portion of the same sample.

There has also been little uniformity in the reporting of the concentration of inorganic nitrogen in water samples. Depending on the analysis, inorganic nitrogen concentrations have been reported as nitrate or as nitrite-plus-nitrate. Concentrations in filtered samples were reported as dissolved, whereas in raw, unfiltered samples they were reported as total. Furthermore, some nitrate concentrations have been reported as NO_3 rather than as elemental nitrogen (NO_3-N). In the basic data tables of this report (tables 4, 7, 10, 12, 15, and 18) these data are presented as originally reported; however, in the summary tables (tables 3, 6, 9, 11, 14, and 17) and in the tables on the plates, all nitrate and nitrite-plus-nitrate data are designated nitrate and expressed as mg/L (NO_3-N). This was done to facilitate comparison of data, and implies that for a given ground-water sample the various determinations will give similar results. For most ground-water samples this assumption is a satisfactory approximation. Determinations of nitrate and nitrite-plus-nitrate concentrations in a ground-water sample give approximately equivalent results because, in most ground water, little or no nitrite is present.

To suggest that nitrate concentrations in filtered and unfiltered portions of the same sample are equivalent, the potential for the nitrate concentration in a sample to change during the period from collection to analysis must be evaluated. Two processes which could alter the nitrate concentration in a ground-water sample are nitrification and denitrification reactions. These reactions proceed slowly, if at all, without biological mediation and sample filtration, which is done through a 0.45-um filter, removes the microorganisms responsible for such mediation, effectively stabilizing a nitrate sample for the typical period between collection and analysis. This is not the case for an unfiltered sample, and unless it is treated with a biocide (until October 1980 this was not done), there is a potential for the nitrate concentration to change from the time of collection to analysis. Should this occur, nitrate determinations on the filtered and unfiltered components of the same sample would not give similar results; however, in many unfiltered ground-water samples little or no change in nitrate concentration will occur. Denitrification is unlikely because most samples contain oxygen either initially or after collection. Furthermore, sufficient biodegradable carbon, a necessary energy source for denitrification, is usually not present in typical ground water (Viels and Hageman, 1971). Nitrification could occur, but in most ground water the concentration of reduced nitrogen compounds is low, minimizing the potential for nitrification reactions to significantly alter the initial nitrate concentration.

An additional complication in comparing recent and historic data is due to the changing of detection levels for trace-element determinations. For example, prior to 1979 many dissolved-lead determinations were done with a detection level of 100 ug/L. After 1979, they were done with a detection level of 1 ug/L.

Explanation of Geologic Unit Codes

Geologic units are given, if known, in the basic-data tables (tables 4, 7, 10, 12, 15, and 18). The geologic units refer to the water-bearing material or formation yielding water to a given well. The geologic units used are:

110ALVM - alluvium of the Quaternary Period
112GLCV - glaciofluvial deposits of the Pleistocene Epoch
112LGHL - Logan Hill Formation (Pleistocene Epoch)
120CAMS - Camas basalt (informal usage; Tertiary Period)
121TRDL - Troutdale Formation (Pliocene Epoch)

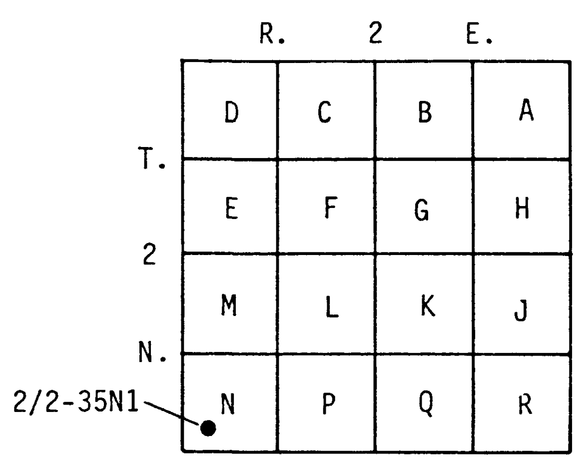
Data Presentation

Maps showing well and spring locations; ion-distribution (trilinear) diagrams; and tables listing well depths, water-bearing formations, and selected water-quality data are presented on plates 1-5. Each plate represents a part of the southwestern region. However, to maintain geographic continuity in presentation of data, the division of the region does not necessarily conform to the boundaries between aquifer regions as drawn by Molenaar and others (1980; see fig. 1).

In addition to the information presented on the plates, descriptive information, basic-data tables and summary tables are presented within the text of the report.

Well- and Spring-Numbering System

Wells in Washington are assigned numbers that identify their location within a township, range, and section. Well number 2/2-35N1 indicates successively, the township (T.2 N.), and range (R.2 E.), north and east of the Williamette base line and meridian; the letters indicating north and east are omitted. The first number following the hyphen indicates the section (35) within the township, and the letter following the section gives the 40-acre subdivision of the section, as shown below. The number following the letter is the serial number of the well within the 40-acre subdivision.



Section 35

MAXIMUM CONTAMINANT LEVELS SPECIFIED BY U.S. ENVIRONMENTAL PROTECTION AGENCY PRIMARY AND SECONDARY DRINKING WATER REGULATIONS

U.S. Environmental Protection Agency National interim primary drinking water regulations (U.S. Environmental Protection Agency, 1977b) apply to the physical and chemical characteristics of water that affect the health of consumers. They are applicable to public water supplies and are enforceable by the U.S. Environmental Protection Agency or the individual states. Primary drinking water regulations for constituents included in this report are given in table 1.

National secondary drinking water regulations were also proposed by the U.S. Environmental Protection Agency (1977a). They apply to the esthetic qualities of drinking water and, unlike the primary regulations, are intended as guidelines and are not Federally enforceable. National secondary drinking water regulations for constituents and characteristics that are included in this report appear in table 1.

TABLE 1.--Maximum contaminant levels specified by U.S. Environmental Protection Agency primary and secondary drinking water regulations

[Values in milligrams per liter unless otherwise noted]

Contaminant	Maximum contaminant level
Primary Regulations	
Arsenic	0.05
Barium	1
Cadmium	.010
Chromium	.05
Lead	.05
Mercury	.002
Nitrate (as N)	10
Selenium	.01
Silver	.05
Fluoride	[a]1.4 to 2.4
Secondary Regulations	
Chloride	250
Copper	1
Foaming agents	.5
Iron	.3
Manganese	.05
pH	6.5-8.5 units
Sulfate	250
Dissolved solids	500
Zinc	5

[a]Depends upon average daily air temperatures.

SIGNIFICANCE OF SELECTED CONSTITUENTS AND CHARACTERISTICS OF WATER

The significance of selected water-quality constituents and characteristics not included in the U.S. Environmental Protection Agency primary and secondary drinking water regulations is discussed below. Although not included in the regulations, these constituents and characteristics are important in determining the suitability of water for domestic, industrial, or agricultural uses.

Alkalinity

Alkalinity is defined as the capacity of an aqueous solution to neutralize acid. Any ion that enters into a chemical reaction with strong acid can contribute to alkalinity; however, in most natural waters carbonate and bicarbonate ions are the principal components of alkalinity. The alkalinity of water used for domestic and municipal water supplies is important because it affects the amount of chemicals required for softening and control of corrosion in distribution systems. Generally, alkalinity resulting from naturally occurring materials is not a health hazard in drinking water, and alkalinities of natural waters rarely exceed 400 to 500 mg/L as $CaCO_3$ (National Academy of Sciences, National Academy of Engineering, 1974). For industrial applications, high alkalinity can be a problem in water used for food processing, especially where acidity is necessary for flavor and stability, such as in carbonated beverages. In some cases, alkalinity is desirable because of the corrosive properties of water with low alkalinity. Maximum alkalinities in source waters used for selected industrial purposes appear in table 2.

TABLE 2.--Maximum alkalinity in waters used as a source of supply prior to treatment

[From U.S. Environmental Protection Agency, 1977b]

Industry	Alkalinity as $CaCO_3$ (mg/L)
Steam generation boiler makeup	350
Steam generation cooling	500
Textile mill products	50-200
Paper and allied products	75-150
Chemical and allied products	500
Petroleum refining	500
Primary metals industries	200
Food canning industries	300
Bottled and canned soft drinks	85

Fecal-Coliform Bacteria

Fecal-coliform bacteria are nonpathogenic bacteria that normally inhabit the gut and feces of warmblooded animals. They are a subgroup of the total coliform group, which includes bacteria of nonfecal origin. The presence of fecal-coliform bacteria in water is an indicator of the contamination of the water supply by sewage or by animal excrement. Since feces are known carriers of disease-producing bacteria, the contamination of a water supply as indicated by the presence of fecal-coliform bacteria can be a serious problem. Maximum contaminant levels for coliform bacteria in drinking water are specified by U.S. Environmental Protection Agency primary drinking water regulations in terms of total coliform bacteria, not fecal coliforms. Because the specification of these maximum contaminant levels is quite detailed, they are not included here. For the purpose of this report, it is sufficient to state that the presence of fecal-coliform bacteria in a water sample may indicate contamination of the source by sewage or animal excrement.

Hardness

The hardness of water is an important consideration for domestic, municipal, and industrial uses. It is related almost entirely to the presence of calcium and magnesium ions in water; however, other constituents, such as iron, manganese, and strontium, also contribute to hardness. The fraction of hardness, which is equivalent to the alkalinity, is called carbonate hardness, and any excess is called noncarbonate hardness. A classification of water by hardness content (Sawyer, 1960, p. 235) is as follows:

Hardness as $CaCO_3$ (mg/L)	Description
0-75	Soft
75-150	Moderately hard
150-300	Hard
More than 300	Very hard

Sodium-Adsorption Ratio

Excess sodium in irrigation water can become a problem because sodium enters into ion-exchange reactions with calcium or magnesium in the soil. This exchange process is undesirable because a buildup of sodium in the soil reduces its permeability and makes it difficult to cultivate. The adsorption of sodium from a given irrigation water is a function of the proportion of sodium to calcium and magnesium in the water. The sodium-adsorption ratio (SAR) is a measure of the degree to which sodium will be adsorbed by a soil from a given water when brought into equilibrium with it. It is defined as

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

where ion concentrations are expressed as milliequivalents per liter.

Specific Conductance

Specific conductance is a measure of the capacity of water to conduct an electrical current. It is commonly used as a measure of the mineral content of the water because it is the dissolved minerals that increase the water's current carrying capacity.

Suitability of Water for Irrigation

The suitability of water for irrigation is partly determined by the degree of mineralization and the relative concentration of the minerals dissolved in water. The U.S. Department of Agriculture (1954) developed the diagram shown in figure 2, which uses specific conductance and sodium-adsorption ratio to determine the suitability of water for irrigation. Water is classified according to the sodium hazard and salinity hazard; C1-S1 water is low in both and therefore the best classification. The higher the numbers, the poorer the water is for irrigation; C4-S4 is the poorest classification.

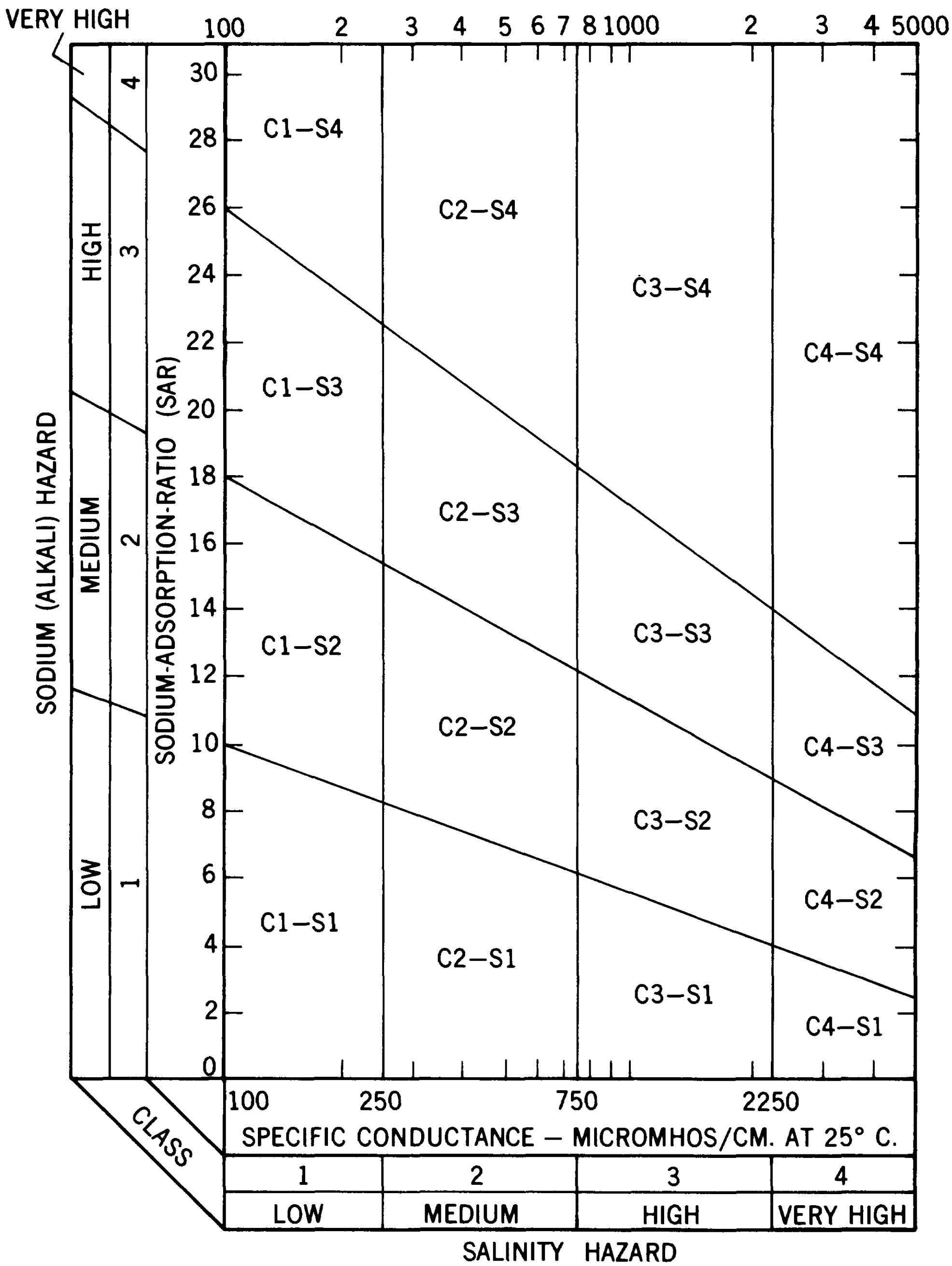


FIGURE 2.--Classification of irrigation waters (U.S. Department of Agriculture, 1954).

The locations of wells and springs sampled in Clark County are shown on plate 1, and all are within the Lewis aquifer region (fig. 1). The principal aquifers in Clark County are within the sedimentary deposits, which form the alluvial plains extending from the foothills of the Cascade Range to the Columbia River. These deposits, which overlie older, chiefly volcanic rocks of the Eocene to Miocene Epoch, consist of the Troutdale Formation and more recent alluvial deposits, which overlie the Troutdale Formation in much of the county.

The Troutdale Formation is composed of an upper and lower member. The lower member, consisting predominantly of fine sand, silt, and clay, was deposited in a lake or estuary during the Pliocene Epoch. Wells which penetrate the lower member of the Troutdale Formation yield small amounts (less than 100 gal/min) of water, except where they are finished in gravel lenses which occur within the formation. There, the yields are moderate (up to 300 gal/min). Of the wells sampled, wells 4/1E-8M2, 4/1E-16D1, and 4/1E-23H1 are thought to penetrate the lower member of the formation. The upper member of the Troutdale Formation consists of cemented gravel or semiconsolidated conglomerate. It is the most productive aquifer in the county, where the lightly cemented phases of the formation yield more than 1,000 gal/min.

Yields of water to wells which are completed in the more recent alluvial deposits vary depending on the permeability of the material. Large yields are obtained in the flood plain of the Columbia River near Camas and Vancouver.

Well 1/3E-8B2 was completed in the Boring Lava of Pliocene and Pleistocene age, the volcanic rocks that were extruded from vents in the vicinity of Portland, Oreg. The Boring Lava is not a major aquifer, but moderate yields of water are obtained from wells finished in this formation.

For several wells and springs sampled the water-bearing material is unknown. In all cases the material is probably sedimentary, but data are insufficient to determine the formation. Spring 1/2E-12B1s probably discharges from the base of the alluvial deposits at the top of the upper member of the Troutdale Formation (Mundorff, 1964).

The ground water sampled in Clark County was predominantly soft to moderately hard calcium-magnesium bicarbonate-type water. Sodium-adsorption ratios ranged from 0.2 to 1.0 (table 3), indicating general suitability of the water for irrigation purposes. None of the dissolved-solids concentrations exceeded 500 mg/L, the maximum contaminant level recommended by U.S. Environmental Protection Agency secondary drinking water regulations. No fecal-coliform bacteria were detected in the samples collected during 1980 (table 4).

Nitrate concentrations in all samples ranged from 0.00 to 9.9 mg/L (NO_3-N), with a median concentration of 0.57 mg/L (NO_3-N) (table 3). For samples collected during the summer of 1980 the range was 0.00 to 3.5 mg/L (NO_3-N), with a median concentration of 0.14 mg/L (NO_3-N). The nitrate data presented here are insufficient to allow a definitive analysis of nitrate concentrations in Clark County ground water; however, in ground water sampled during 1980, the lowest NO_3-N concentrations were generally found in water from deeper wells (greater than 150 ft) which were located north of the Fourth Plains area, indicated on the map (pl. 1), and east of the boundary between range (R. 2 E.) and range (R. 3 E.).

Trace-element concentrations that exceed maximum contaminant levels specified in U.S. Environmental Protection Agency primary and secondary drinking water regulations are listed in the table on plate 1 and in table 5. All trace element concentrations exceeding maximum contaminant levels were limited to iron and manganese, except for zinc in a sample from well 4/3E-31C1. Reported concentrations for iron and zinc are somewhat unreliable due to the potential contamination from well casings and the plumbing from the well to the sampling point. For samples collected in 1980 care was taken to avoid contamination through careful choice of the sampling point and adequate flushing of the system.

TABLE 3.--Summary of biological and major chemical-constituent data for ground-water samples from Clark County

[Values in milligrams per liter except as indicated. umho, micromhos per centimeter at 25°; col/100 mL, colonies per 100 milliliters; ug/L, micrograms per liter]

Constituent	Maximum	Minimum	Median	Number of sample sites
Specific conductance (umho)	596	41	178	46
pH (units)	8.0	6.2	7.1	45
Fecal-coliform bacteria (col/100 mL)	<1	<1	<1	16
Hardness (as $CaCO_3$)	266	14	69	46
Hardness, noncarbonate (as $CaCO_3$)	83	0	0	46
Dissolved calcium	65	3.5	16	45
Dissolved magnesium	27	1.2	6.1	45
Dissolved sodium	22	1.6	6.3	43
Sodium adsorption ratio	1	.3	.2	43
Dissolved potassium	7.6	.4	2.4	43
Alkalinity (as $CaCO_3$)	279	16	65	46
Dissolved sulfate	41	.1	2.9	46
Dissolved chloride	75	.8	3.6	46
Dissolved fluoride	.9	.0	.1	44
Dissolved silica (as SiO_2)	64	14	48	45
Dissolved solids (residue at 180°C)	317	34	144	29
Dissolved solids (sum of constituents)	364	33	137	43
Nitrate (as N)	9.9	.00	.22	43
Iron, total recoverable (ug/L)	6,600	<10	150	29
Iron, dissolved (ug/L)	40	<10	15	16
Manganese, total recoverable (ug/L)	1,300	<20	50	11
Manganese, dissolved (ug/L)	30	<1	3	16

TABLE 4.--Biological and major-chemical-constituent data for ground-water samples from Clark County

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	PH (UNITS)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	HARD-NESS (MG/L AS CACO3)
01/02E-12B01S	--	66-01-31	--	--	--	150.00	146	6.2	--	52
01/03E-08B02	120CAMS	49-05-17	390	--	--	490.00	181	7.7	--	69
01/03E-11J05	--	60-01-27	123	82	72	50.00	41	6.9	--	14
01/03E-12L04	110ALVM	80-08-21	87	79	44	20.00	75	6.9	<1	28
01/04E-09A01	121TRDL	72-04-25	307	307	301	338.00	138	7.9	--	53
02/01E-11C01	121TRDL	50-10-07	198	194	183	228.00	305	7.6	--	96
02/01E-13L01	121TRDL	80-08-21	404	401	365	245.00	167	7.2	<1	69
02/01E-23Q01	121TRDL	55-12-13	250	248	195	175.00	186	7.6	--	74
02/01E-23Q03	110ALVM	55-09-07	280	265	227	223.00	168	7.0	--	64
02/01E-27L01	110ALVM	49-03-02	108	103	60	40.00	220	--	--	86
02/01E-27L02	110ALVM	49-03-02	98	--	--	40.00	205	7.4	--	109
02/01E-35F04	110ALVM	60-01-27	85	81	34	30.00	212	7.0	--	88
02/02E-03D02	121TRDL	80-08-28	124	124	124	260.00	157	6.9	<1	63
02/02E-04E01	121TRDL	71-02-23	76	76	73	208.00	150	7.1	--	59
02/02E-04E02	121TRDL	71-02-23	80	80	77	232.00	485	7.1	--	247
02/02E-04E03	121TRDL	71-02-23	97	--	--	--	529	6.9	--	266
02/02E-04M02	110ALVM	71-02-23	28	--	--	--	596	7.1	--	265
02/02E-05K02	121TRDL	80-08-20	97	97	96	244.00	196	6.9	<1	76
02/02E-07M01	110ALVM	80-08-20	53	51	31	270.00	178	6.7	<1	63
02/02E-08A02	110ALVM	71-01-20	168	168	95	225.00	139	6.9	--	55
02/02E-20A02	121TRDL	49-05-17	221	216	65	210.00	111	8.0	--	48
02/02E-23L01	121TRDL	80-08-21	202	202	192	229.00	150	7.5	<1	58
02/02E-33L01S	--	49-05-17	--	--	--	190.00	140	7.6	--	59
02/02E-35N01	121TRDL	80-08-19	254	254	243	300.00	192	7.6	<1	74
02/03E-06K01	121TRDL	49-05-17	93	93	70	272.00	151	7.0	--	66
02/03E-19Q02	121TRDL	80-08-19	221	221	221	280.00	179	7.2	<1	70
03/01E-08L01	121TRDL	62-11-16	298	254	145	183.00	181	6.8	--	75
03/01E-14N01	121TRDL	80-08-22	190	165	129	255.00	225	7.1	<1	87
03/01E-33Q01	110ALVM	49-05-23	48	48	28	210.00	376	6.3	--	162
03/02E-02D01	121TRDL	49-05-17	140	140	136	291.00	206	7.7	--	89
03/02E-03J01	121TRDL	80-08-20	141	135	105	280.00	257	7.6	<1	110
03/02E-22G02	121TRDL	80-08-22	281	281	271	295.00	237	7.4	<1	96
03/02E-33F01	110ALVM	71-01-20	62	55	45	220.00	155	6.8	--	63
03/02E-35A01	121TRDL	80-08-21	290	288	261	279.00	177	7.4	<1	70
03/03E-19Q01	121TRDL	80-08-20	197	193	188	330.00	133	6.9	<1	45
04/01E-08M02	121TRDL	72-04-25	335	335	325	252.00	245	7.9	--	99
04/01E-16D01	121TRDL	62-11-16	277	270	256	270.00	241	6.9	--	102
04/01E-23H01	121TRDL	80-08-22	344	344	334	291.00	190	7.0	<1	75
04/02E-20A01	121TRDL	60-06-02	71	71	56	245.00	72	6.3	--	24
04/02E-21B01	121TRDL	60-06-02	73	73	67	260.00	159	6.2	--	60
04/02E-22E01	121TRDL	60-06-02	172	172	169	260.00	103	6.9	--	41
04/02E-22E06	121TRDL	80-08-22	207	205	200	240.00	65	7.4	<1	23
04/03E-31C01	121TRDL	72-04-25	138	132	116	--	159	7.6	--	57
05/01E-10D01	--	67-05-03	130	--	--	--	336	6.9	--	100
05/01E-27Q01	121TRDL	80-08-22	158	158	140	580.00	91	6.6	<1	28
05/03E-12P01	--	58-03-19	115	72	46	1190.00	83	7.2	--	31

TABLE 4.--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	HARD- NESS, NONCAR- BONATE (MG/L CACO3)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	SODIUM, DIS- SOLVED (MG/L AS NA)	SODIUM AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY FIELD (MG/L AS CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)
01/02E-12B01S	66-01-31	12	13	4.8	5.9	.4	2.8	41	9.6	4.0
01/03E-08B02	49-05-17	0	13	9.0	6.6	.3	2.8	72	4.9	6.9
01/03E-11J05	60-01-27	0	3.5	1.2	1.6	.2	.6	16	1.2	1.0
01/03E-12L04	80-08-21	3	7.5	2.2	3.4	.3	1.4	25	4.9	3.7
01/04E-09A01	72-04-25	0	12	5.7	6.3	.4	2.0	71	2.2	1.0
02/01E-11C01	50-10-07	0	--	--	--	--	--	123	18	9.2
02/01E-13L01	80-08-21	3	15	7.6	4.9	.3	2.3	66	2.6	2.3
02/01E-23Q01	55-12-13	7	20	5.8	5.1	.3	3.6	67	8.4	4.0
02/01E-23Q03	55-09-07	7	17	5.3	5.3	.3	4.1	57	8.8	3.5
02/01E-27L01	49-03-02	43	26	5.0	--	--	--	43	9.7	1.5
02/01E-27L02	49-03-02	66	31	7.6	--	--	--	43	12	6.8
02/01E-35F04	60-01-27	13	23	7.5	5.8	.3	2.5	75	11	3.8
02/02E-03D02	80-08-28	14	16	5.7	4.7	.3	2.5	49	3.1	4.2
02/02E-04E01	71-02-23	0	13	6.4	5.1	.3	2.6	61	4.2	1.9
02/02E-04E02	71-02-23	0	56	26	8.6	.2	4.2	258	3.6	5.3
02/02E-04E03	71-02-23	0	62	27	9.4	.3	4.4	279	5.2	7.5
02/02E-04M02	71-02-23	0	65	25	20	.5	7.6	267	23	18
02/02E-05K02	80-08-20	10	18	7.6	5.5	.3	2.9	66	5.1	6.2
02/02E-07M01	80-08-20	23	15	6.1	6.3	.3	1.9	40	18	8.5
02/02E-08A02	71-01-20	8	13	5.3	5.0	.3	1.8	47	6.6	3.5
02/02E-20A02	49-05-17	3	10	5.7	3.5	.2	4.4	46	7.4	4.0
02/02E-23L01	80-08-21	8	14	5.5	4.7	.3	1.8	50	2.1	3.2
02/02E-33L01S	49-05-17	6	15	5.2	4.2	.2	5.6	52	11	2.9
02/02E-35N01	80-08-19	9	21	5.2	5.3	.3	3.1	65	5.6	5.6
02/03E-06K01	49-05-17	2	14	7.5	5.7	.3	4.0	64	.8	3.0
02/03E-19Q02	80-08-19	0	15	8.0	7.7	.4	2.4	83	1.6	2.4
03/01E-08L01	62-11-16	0	20	6.1	8.2	.4	1.4	89	.4	2.8
03/01E-14N01	80-08-22	0	21	8.5	7.9	.4	2.0	110	.4	5.6
03/01E-33Q01	49-05-23	83	37	17	8.1	.3	4.0	79	41	16
03/02E-02D01	49-05-17	0	22	8.4	9.3	.4	3.6	103	2.7	4.0
03/02E-03J01	80-08-20	0	26	9.8	12	.5	2.3	110	1.7	5.0
03/02E-22G02	80-08-22	0	22	10	9.1	.4	3.0	120	2.4	2.5
03/02E-33F01	71-01-20	6	16	5.5	5.0	.3	2.8	57	4.2	3.0
03/02E-35A01	80-08-21	0	16	7.4	8.3	.4	2.6	83	2.6	2.0
03/03E-19Q01	80-08-20	0	10	4.9	6.6	.4	2.4	58	1.9	1.9
04/01E-08M02	72-04-25	0	23	10	11	.5	2.9	126	2.5	3.8
04/01E-16D01	62-11-16	0	22	11	11	.5	2.3	121	.4	3.8
04/01E-23H01	80-08-22	0	20	6.1	7.8	.4	1.9	91	2.0	3.1
04/02E-20A01	60-06-02	0	6.5	1.8	5.0	.4	.8	33	.6	.8
04/02E-21B01	60-06-02	10	18	3.5	8.1	.5	1.3	50	.8	9.5
04/02E-22E01	60-06-02	0	10	3.8	5.0	.3	.5	47	4.2	2.0
04/02E-22E06	80-08-22	0	5.9	1.9	3.3	.3	.4	25	.3	2.2
04/03E-31C01	72-04-25	0	13	6.0	10	.6	1.7	80	2.3	2.3
05/01E-10D01	67-05-03	55	26	8.5	22	1.0	2.0	45	.4	75
05/01E-27Q01	80-08-22	0	7.4	2.4	6.3	.5	1.5	34	.1	2.0
05/03E-12P01	58-03-19	0	9.4	1.8	4.4	.3	.5	39	.6	2.0

TABLE 4.--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	NITRO-GEN, NITRATE TOTAL (MG/L AS NO3)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)
01/02E-12B01S	66-01-31	.2	51	136	130	14	--	--
01/03E-08B02	49-05-17	.1	49	148	144	8.4	--	--
01/03E-11J05	60-01-27	.0	14	34	33	.60	--	--
01/03E-12L04	80-08-21	.1	25	--	64	--	--	.22
01/04E-09A01	72-04-25	.0	45	144	117	--	.04	--
02/01E-11C01	50-10-07	.6	--	192	--	--	--	--
02/01E-13L01	80-08-21	.1	48	--	128	--	--	1.2
02/01E-23Q01	55-12-13	.0	52	154	150	11	--	--
02/01E-23Q03	55-09-07	.1	47	145	137	12	--	--
02/01E-27L01	49-03-02	--	37	138	--	--	--	--
02/01E-27L02	49-03-02	--	22	128	--	--	--	--
02/01E-35F04	60-01-27	.2	45	156	154	10	--	--
02/02E-03D02	80-08-28	.1	49	--	130	--	--	3.3
02/02E-04E01	71-02-23	.1	49	137	124	4.9	--	--
02/02E-04E02	71-02-23	.1	42	290	302	.00	--	--
02/02E-04E03	71-02-23	.1	42	317	326	.00	--	--
02/02E-04M02	71-02-23	.1	41	--	364	3.6	--	--
02/02E-05K02	80-08-20	.2	44	--	145	--	--	3.5
02/02E-07M01	80-08-20	.1	49	--	143	--	--	3.2
02/02E-08A02	71-01-20	.1	35	108	108	9.7	--	--
02/02E-20A02	49-05-17	.0	36	109	104	.30	--	--
02/02E-23L01	80-08-21	.1	43	--	119	--	--	3.2
02/02E-33L01S	49-05-17	.2	50	129	133	7.2	--	--
02/02E-35N01	80-08-19	.5	28	--	125	--	--	2.4
02/03E-06K01	49-05-17	.2	58	137	137	5.4	--	--
02/03E-19Q02	80-08-19	.2	51	--	139	--	--	.00
03/01E-08L01	62-11-16	.2	64	155	159	1.4	--	--
03/01E-14N01	80-08-22	.2	61	--	173	--	--	.00
03/01E-33Q01	49-05-23	.4	64	310	279	44	--	--
03/02E-02D01	49-05-17	.2	44	151	157	1.0	--	--
03/02E-03J01	80-08-20	.9	49	--	179	--	--	1.3
03/02E-22G02	80-08-22	.2	56	--	177	--	--	.00
03/02E-33F01	71-01-20	.1	50	144	130	9.5	--	--
03/02E-35A01	80-08-21	.2	59	--	148	--	--	.00
03/03E-19Q01	80-08-20	.1	59	--	122	--	--	.00
04/01E-08M02	72-04-25	.2	60	200	190	--	.14	--
04/01E-16D01	62-11-16	.2	56	177	181	.20	--	--
04/01E-23H01	80-08-22	.1	58	--	154	--	--	.02
04/02E-20A01	60-06-02	.1	39	72	77	.50	--	--
04/02E-21B01	60-06-02	.1	39	128	126	16	--	--
04/02E-22E01	60-06-02	.1	27	83	81	.20	--	--
04/02E-22E06	80-08-22	.1	24	--	53	--	--	.05
04/03E-31C01	72-04-25	.4	43	142	127	--	.04	--
05/01E-10Q01	67-05-03	.0	51	252	216	.80	--	--
05/01E-27Q01	80-08-22	.1	58	--	98	--	--	.00
05/03E-12P01	58-03-19	.1	27	67	70	.30	--	--

TABLE 4.--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	IRON, TOTAL RECOV- ERABLE (UG/L AS FE)	IRON, DIS- SOLVED (UG/L AS FE)	MANGA- NESE, TOTAL RECOV- ERABLE (UG/L AS MN)	MANGA- NESE, DIS- SOLVED (UG/L AS MN)
01/02E-12B01S	66-01-31	10	--	--	--
01/03E-08B02	49-05-17	40	--	--	--
01/03E-11J05	60-01-27	<10	--	--	--
01/03E-12L04	80-08-21	--	20	--	2
01/04E-09A01	72-04-25	660	--	40	--
02/01E-11C01	50-10-07	60	--	--	--
02/01E-13L01	80-08-21	--	<10	--	4
02/01E-23Q01	55-12-13	<10	--	--	--
02/01E-23Q03	55-09-07	30	--	--	--
02/01E-27L01	49-03-02	100	--	--	--
02/01E-27L02	49-03-02	100	--	--	--
02/01E-35F04	60-01-27	<10	--	--	--
02/02E-03D02	80-08-28	--	20	--	3
02/02E-04E01	71-02-23	150	--	<20	--
02/02E-04E02	71-02-23	2000	--	50	--
02/02E-04E03	71-02-23	760	--	100	--
02/02E-04M02	71-02-23	170	--	<20	--
02/02E-05K02	80-08-20	--	<10	--	2
02/02E-07M01	80-08-20	--	<10	--	1
02/02E-08A02	71-01-20	60	--	<20	--
02/02E-20A02	49-05-17	4800	--	--	--
02/02E-23L01	80-08-21	--	<10	--	1
02/02E-33L01S	49-05-17	20	--	--	--
02/02E-35N01	80-08-19	--	<10	--	10
02/03E-06K01	49-05-17	--	--	--	--
02/03E-19Q02	80-08-19	--	<10	--	<1
03/01E-08L01	62-11-16	370	--	100	--
03/01E-14N01	80-08-22	--	20	--	30
03/01E-33Q01	49-05-23	100	--	--	--
03/02E-02D01	49-05-17	20	--	--	--
03/02E-03J01	80-08-20	--	<10	--	<1
03/02E-22G02	80-08-22	--	40	--	2
03/02E-33F01	71-01-20	810	--	50	--
03/02E-35A01	80-08-21	--	20	--	<1
03/03E-19Q01	80-08-20	--	10	--	8
04/01E-08M02	72-04-25	6600	--	<20	--
04/01E-16D01	62-11-16	150	--	--	--
04/01E-23H01	80-08-22	--	30	--	6
04/02E-20A01	60-06-02	2100	--	--	--
04/02E-21B01	60-06-02	20	--	-	--
04/02E-22E01	60-06-02	3200	--	--	--
04/02E-22E06	80-08-22	--	20	--	3
04/03E-31C01	72-04-25	4700	--	480	--
05/01E-10D01	67-05-03	2200	--	1300	--
05/01E-27Q01	80-08-22	--	20	--	4
05/03E-12P01	58-03-19	180	--	--	--

TABLE 5.--Trace-element concentrations in ground-water samples from Clark County

LOCAL IDENT-I-FIER	DATE OF SAMPLE	ALUM-INUM, DIS-SOLVED (UG/L AS AL)	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COPPER, DIS-SOLVED (UG/L AS CU)	LEAD, DIS-SOLVED (UG/L AS PB)	MERCURY DIS-SOLVED (UG/L AS HG)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SILVER, DIS-SOLVED (UG/L AS AG)	ZINC, DIS-SOLVED (UG/L AS ZN)
01/04E-09A01	72-04-25	--	--	--	--	<30	<50	<100	--	--	--	<80
02/02E-03D02	80-08-28	20	0	10	<1	10	6	2	.0	0	0	250
02/02E-04E01	71-02-23	--	--	--	--	<30	<50	<100	--	--	--	100
02/02E-04E02	71-02-23	--	--	--	--	<30	<50	<100	--	--	--	200
02/02E-04E03	71-02-23	--	--	--	--	<30	<50	<100	--	--	--	100
02/02E-04M02	71-02-23	--	--	--	--	<30	<50	<100	--	--	--	1500
02/02E-08A02	71-01-20	--	--	--	--	<30	<50	<100	--	--	--	<10
02/02E-35N01	80-08-19	0	0	20	2	0	9	4	.0	0	0	1200
02/03E-19Q02	80-08-19	0	1	10	<1	0	9	0	.0	0	0	530
03/02E-33F01	71-01-20	--	--	--	--	<30	150	<100	--	--	--	150
04/01E-08M02	72-04-25	--	--	--	--	<30	<50	<100	--	--	--	1100
04/03E-31C01	72-04-25	--	--	--	--	<30	<50	<100	--	--	--	5500

GROUND-WATER QUALITY IN COWLITZ COUNTY

The locations of wells sampled in Cowlitz County are shown on plate 2. These locations are within the Lewis and Cowlitz aquifer regions (fig. 1).

Most of the wells sampled in Cowlitz County were finished in the alluvial deposits along the Cowlitz and Columbia Rivers and in the vicinity of Toutle Lake. Alluvial deposits are the most productive sources of ground water in Cowlitz County.

Four of the wells sampled were completed in sedimentary and volcanic rocks of the Eocene Series. Owing to the poor water-bearing characteristics of this unit, it is not an important aquifer compared to the alluvial materials; however, in Rose Valley, where wells 7/1W-8R2 and 7/1W-17G2 were sampled, most of the ground water is derived from this unit.

In the northern part of Cowlitz County, the Wilkes Formation of Miocene age is a source of ground water to numerous domestic wells. This formation consists of nonmarine siltstone, sandstone, and conglomerate, which generally have poor water-bearing characteristics (Myers, 1970). Well 10/1W-31K1 was the only well sampled in this unit.

The principal ions in most Cowlitz County ground-water samples were calcium, magnesium, and bicarbonate. Because only five samples were taken from aquifers in Tertiary materials, data are insufficient to compare ion distributions to water-bearing formations. From the data presented here, no correlation is evident. The concentrations of major ions in samples were generally low, and no dissolved-solids concentrations above 300 mg/L were observed (table 6). Hardness values of the samples were predominantly in the range of soft to moderately hard (table 7). Fluoride concentrations ranged from 0.0 to 0.4 mg/L. No fecal-coliform bacteria were detected in the samples collected during 1980.

Nitrate concentrations in Cowlitz County ground-water samples were generally low compared to the maximum contaminant level of 10 mg/L NO_3-N (U.S. Environmental Protection Agency, 1976). Concentrations of NO_3-N ranged from 0.00 to 3.3 mg/L; the median concentration of NO_3-N was 0.04 mg/L (table 6).

Iron concentrations that exceeded the maximum contaminant level of 300 ug/L recommended by U.S. Environmental Protection Agency secondary drinking water regulations occurred in 13 of 23 samples (table 7). In 8 of the 13 samples, iron concentrations exceeded 1 mg/L. The highest concentration observed (15 mg/L) was in a sample from well 10/1W-25J2. This well was sampled during a pump test, and it had been flowing for 48 hours prior to sampling; therefore, it can be assumed that the sample was essentially free of iron contamination from the well casing.

Manganese concentrations that exceeded the maximum contaminant level of 50 ug/L recommended by U.S. Environmental Protection Agency secondary drinking water regulations occurred in 11 of 18 samples (table 7). Typical of many areas in western Washington, high manganese concentrations often accompanied high iron concentrations. No other trace element concentrations (table 8) exceeded levels specified by U.S. Environmental Protection Agency primary drinking water regulations.

TABLE 6.--Summary of biological and major-chemical-constituent data for ground-water samples from Cowlitz County

[Values in milligrams per liter except as indicated.
umho, micromhos per centimeter at 25°;
col/100 mL, colonies per 100 milliliters;
ug/L, micrograms per liter]

Constituent	Maximum	Minimum	Median	Number of sample sites
Specific conductance (umho)	450	44	221	25
pH (units)	9.1	6.2	7.0	25
Fecal-coliform bacteria (col/100 mL)	<1	<1	<1	12
Hardness (as $CaCO_3$)	160	78	5	25
Hardness, noncarbonate (as $CaCO_3$)	120	0	0	25
Dissolved calcium	44	2.0	19	25
Dissolved magnesium	24	.0	7.1	25
Dissolved sodium	92	2.7	10	25
Sodium adsorption ratio	18	.3	.6	25
Dissolved potassium	4.5	.2	1.5	25
Alkalinity (as $CaCO_3$)	190	13	98	25
Dissolved sulfate	98	.0	3.2	25
Dissolved chloride	83	1.5	5.4	25
Dissolved fluoride	.4	.0	.2	25
Dissolved silica (as SiO_2)	61	3.6	41	25
Dissolved solids (residue at 180°C)	254	45	168	13
Dissolved solids (sum of constituents)	288	37	164	25
Nitrate (as N)	3.3	.00	.04	25
Iron, total recoverable (ug/L)	7,400	10	250	11
Iron, dissolved (ug/L)	15,000	<10	1,320	12
Manganese, total recoverable (ug/L)	800	<20	100	7
Manganese, dissolved (ug/L)	1,300	<1	230	12

TABLE 7.--Biological and major-chemical-constituent data for ground-water samples from Cowlitz County

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	PH (UNITS)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	HARD-NESS (MG/L AS CACO3)
05/01W-14G01	110ALVM	80-08-28	30	30	30	10.00	160	6.8	<1	50
05/01W-22R01	110ALVM	61-04-26	34	34	14	--	158	6.5	--	66
05/01W-23E01	110ALVM	80-08-28	44	39	34	10.00	178	6.6	<1	54
06/01W-16P01	--	72-04-26	300	300	270	440.00	214	7.9	--	46
07/01W-08R02	--	80-08-29	600	--	--	335.00	450	7.8	<1	41
07/01W-17G02	--	80-08-29	100	100	95	240.00	360	7.2	<1	130
08/01W-19C01	--	68-04-05	520	--	--	1120.00	353	7.9	--	149
08/02W-11G01	110ALVM	67-11-01	165	165	121	100.00	347	7.8	--	160
08/02W-31M01	110ALVM	80-08-28	202	202	172	15.00	293	7.0	<1	92
08/02W-31P01	110ALVM	62-11-15	202	198	120	20.00	221	7.2	--	90
08/02W-34P01	110ALVM	62-11-15	45	45	20	20.00	103	7.1	--	31
08/02W-34P02	110ALVM	80-08-28	75	69	44	10.00	177	6.7	<1	54
09/02W-02M01	110ALVM	80-08-29	59	59	59	40.00	398	6.2	<1	140
09/02W-02P02	--	71-01-20	152	--	--	80.00	225	6.9	--	90
09/02W-11D03	110ALVM	80-08-27	120	96	85	40.00	196	7.0	<1	79
09/02W-14Q01	110ALVM	60-01-27	35	--	--	--	44	6.8	--	13
09/02W-27Q01	110ALVM	61-04-26	43	21	20	40.00	193	7.2	--	84
09/02W-29R01	110ALVM	67-09-21	100	--	--	140.00	428	9.1	--	5
09/02W-35G03	110ALVM	80-08-29	140	133	130	90.00	225	7.2	<1	95
10/01E-29H03	110ALVM	80-08-27	41	38	28	550.00	262	6.4	<1	93
10/01E-35F01	110ALVM	72-04-27	60	60	17	--	165	7.9	--	39
10/01W-25J01	110ALVM	67-11-29	400	400	90	480.00	219	6.6	--	74
10/01W-25J02	110ALVM	80-08-27	90	--	--	495.00	253	6.4	<1	69
10/01W-31K01	--	71-01-21	300	300	300	640.00	215	7.6	--	78
10/02W-27F01	110ALVM	80-08-29	112	101	96	60.00	238	6.9	<1	84

LDCAL IDENT-I-FIER	DATE OF SAMPLE	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATID	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY FIELD (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)
05/01W-14G01	80-08-28	9	11	5.5	9.9	.6	1.0	41	9.7	5.4
05/01W-22R01	61-04-26	4	15	6.8	5.8	.3	2.1	62	10	2.2
05/01W-23E01	80-08-28	0	10	7.0	8.8	.5	2.1	66	1.1	5.1
06/01W-16P01	72-04-26	0	13	3.2	30	1.9	.2	111	2.5	2.8
07/01W-08R02	80-08-29	0	15	.8	91	6.2	.5	110	13	83
07/01W-17G02	80-08-29	0	38	7.8	32	1.2	1.4	190	.6	3.5
08/01W-19C01	68-04-05	0	20	24	16	.6	2.7	184	.4	5.4
08/02W-11G01	67-11-01	1	44	12	8.8	.3	2.7	159	3.2	7.8
08/02W-31M01	80-08-28	10	24	7.8	19	.9	4.5	82	5.2	29
08/02W-31P01	62-11-15	0	24	7.4	10	.5	3.5	105	.6	6.5
08/02W-34P01	62-11-15	0	6.0	3.9	8.0	.6	1.2	36	13	1.5
08/02W-34P02	80-08-28	31	13	5.2	6.4	.4	1.5	23	23	14
09/02W-02M01	80-08-29	120	36	11	15	.6	4.1	16	98	41
09/02W-02P02	71-01-20	0	20	9.7	8.9	.4	1.2	98	2.8	10
09/02W-11D03	80-08-27	0	20	7.1	8.1	.4	1.1	83	2.6	3.2
09/02W-14Q01	60-01-27	0	4.0	.7	2.7	.3	.4	13	1.4	3.0
09/02W-27Q01	61-04-26	0	23	6.5	8.8	.4	1.4	98	2.6	2.2
09/02W-29R01	67-09-21	0	2.0	.0	92	18	.5	133	6.2	50
09/02W-35G03	80-08-29	6	24	8.6	7.1	.3	1.3	89	3.5	4.6
10/01E-29H03	80-08-27	27	23	8.7	10	.5	2.1	66	15	23
10/01E-35F01	72-04-27	0	11	2.9	17	1.2	.7	48	2.2	21
10/01W-25J01	67-11-29	0	17	7.5	17	.9	2.9	112	.2	2.8
10/01W-25J02	80-08-27	0	16	7.1	16	.8	3.0	98	9.2	6.2
10/01W-31K01	71-01-21	0	19	7.3	16	.8	2.2	112	.0	1.9
10/02W-27F01	80-08-29	0	22	7.0	12	.6	1.9	98	7.6	10

TABLE 7.--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	NITRO- GEN, NITRATE TOTAL (MG/L AS NO3)	NITRO- GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)
05/01W-14G01	80-08-28	.1	49	--	134	--	--	3.3
05/01W-22R01	61-04-26	.2	41	134	124	3.4	--	--
05/01W-23E01	80-08-28	.2	58	--	132	--	--	.00
06/01W-16P01	72-04-26	.2	46	182	164	--	.04	--
07/01W-08R02	80-08-29	.3	18	--	288	--	--	.00
07/01W-17G02	80-08-29	.0	34	--	234	--	--	.21
08/01W-19C01	68-04-05	.1	41	228	220	.00	--	--
08/02W-11G01	67-11-01	.3	36	219	211	1.2	--	--
08/02W-31M01	80-08-28	.3	54	--	195	--	--	.00
08/02W-31P01	62-11-15	.3	55	172	177	.70	--	--
08/02W-34P01	62-11-15	.3	24	83	89	.90	--	--
08/02W-34P02	80-08-28	.1	23	--	109	--	--	.00
09/02W-02M01	80-08-29	.1	25	--	243	--	--	.14
09/02W-02P02	71-01-20	.1	49	184	161	11	--	--
09/02W-11D03	80-08-27	.1	52	--	149	--	--	1.0
09/02W-14Q01	60-01-27	.1	15	45	37	1.4	--	--
09/02W-27Q01	61-04-26	.2	47	151	152	.60	--	--
09/02W-29R01	67-09-21	.3	21	254	252	.00	--	--
09/02W-35G03	80-08-29	.1	49	--	166	--	--	3.3
10/01E-29H03	80-08-27	.1	33	--	164	--	--	.00
10/01E-35F01	72-04-27	.1	23	130	107	--	.04	--
10/01W-25J01	67-11-29	.4	61	168	176	.10	--	--
10/01W-25J02	80-08-27	.2	3.6	--	136	--	--	.00
10/01W-31K01	71-01-21	.0	29	141	143	.10	--	--
10/02W-27F01	80-08-29	.3	53	--	174	--	--	.00

LOCAL IDENT- I- FIER	DATE OF SAMPLE	IRON, TOTAL RECOV- ERABLE (UG/L AS FE)	IRON, DIS- SOLVED (UG/L AS FE)	MANGA- NESE, TOTAL RECOV- ERABLE (UG/L AS MN)	MANGA- NESE, DIS- SOLVED (UG/L AS MN)
05/01W-14G01	80-08-28	--	2700	--	120
05/01W-22R01	61-04-26	130	--	--	--
05/01W-23E01	80-08-28	--	10	--	420
06/01W-16P01	72-04-26	250	--	<20	--
07/01W-08R02	80-08-29	--	<10	--	3
07/01W-17G02	80-08-29	--	1700	--	240
08/01W-19C01	68-04-05	--	--	--	--
08/02W-11G01	67-11-01	100	--	<100	--
08/02W-31M01	80-08-28	--	940	--	590
08/02W-31P01	62-11-15	3900	--	800	--
08/02W-34P01	62-11-15	7400	--	300	--
08/02W-34P02	80-08-28	--	8400	--	220
09/02W-02M01	80-08-29	--	2400	--	120
09/02W-02P02	71-01-20	40	--	<20	--
09/02W-11D03	80-08-27	--	<10	--	3
09/02W-14Q01	60-01-27	320	--	--	--
09/02W-27Q01	61-04-26	10	--	--	--
09/02W-29R01	67-09-21	160	--	--	--
09/02W-35G03	80-08-29	--	<10	--	<1
10/01E-29H03	80-08-27	--	8000	--	1300
10/01E-35F01	72-04-27	2300	--	30	--
10/01W-25J01	67-11-29	--	--	--	--
10/01W-25J02	80-08-27	--	15000	--	1100
10/01W-31K01	71-01-21	320	--	100	--
10/02W-27F01	80-08-29	--	670	--	780

TABLE 8.--Trace-element concentrations in ground-water samples from Cowlitz County

LOCAL IDENT-I-FIER	DATE OF SAMPLE	ALUMINUM, TOTAL RECOVERABLE (UG/L AS AL) (01105)	ALUMINUM, DISSOLVED (UG/L AS AL) (01106)	ARSENIC DISSOLVED (UG/L AS AS) (01000)	BARIUM, DISSOLVED (UG/L AS BA) (01005)	CADMIUM DISSOLVED (UG/L AS CD) (01025)	CHROMIUM, DISSOLVED (UG/L AS CR) (01030)	COPPER, DISSOLVED (UG/L AS CU) (01040)	LEAD, DISSOLVED (UG/L AS PB) (01049)	MERCURY DISSOLVED (UG/L AS HG) (71890)
05/01W-14G01	80-08-28	--	0	0	10	<1	10	1	4	.0
06/01W-16P01	72-04-26	40	--	--	--	--	<30	<50	<100	--
08/02W-11G01	67-11-01	--	--	<10	<1000	<5	<50	<400	<40	--
08/02W-34P02	80-08-28	--	0	1	10	<1	0	0	4	.0
09/02W-02P02	71-01-20	<10	--	--	--	--	<30	<50	<100	--
10/01E-29H03	80-08-27	--	10	2	0	0	20	0	0	.0
10/01E-35F01	72-04-27	<10	--	--	--	--	<30	<50	<100	--
10/01W-25J02	80-08-27	--	0	7	100	0	0	0	0	.0
10/01W-31K01	71-01-21	<10	--	--	--	--	<30	<50	<100	--

LOCAL IDENT-I-FIER	DATE OF SAMPLE	SELENIUM, DISSOLVED (UG/L AS SE) (01145)	SILVER, DISSOLVED (UG/L AS AG) (01075)	ZINC, DISSOLVED (UG/L AS ZN) (01090)
05/01W-14G01	80-08-28	0	0	6
06/01W-16P01	72-04-26	--	--	1500
08/02W-11G01	67-11-01	<10	<40	<500
08/02W-34P02	80-08-28	0	0	20
09/02W-02P02	71-01-20	--	--	50
10/01E-29H03	80-08-27	0	0	40
10/01E-35F01	72-04-27	--	--	<10
10/01W-25J02	80-08-27	0	0	50
10/01W-31K01	71-01-21	--	--	200

GROUND-WATER QUALITY IN LEWIS COUNTY AND IN AREAS ADJACENT TO THE CHEHALIS RIVER IN THURSTON AND GRAYS HARBOR COUNTIES

The locations of wells sampled in Lewis County and in areas adjacent to the Chehalis River in Thurston and Grays Harbor Counties are shown on plate 3. These locations are within the Cowlitz and Chehalis aquifer regions (fig. 1).

The wells sampled within Lewis County tap numerous water-bearing formations. These can be divided into three general categories—rocks of the Tertiary Period, glaciofluvial deposits of the Quaternary Period, and recent alluvial deposits (Weigle and Foxworthy, 1962).

The materials of the Tertiary Period include formations consisting of basalt, shale, and other sedimentary rocks. Compared with the glaciofluvial and alluvial deposits, the Tertiary materials are not a major aquifer in Lewis County. There are, however, a significant number of wells that tap Tertiary materials, and therefore, the chemical quality of the ground water contained in these materials is of interest. In general, yields of water to wells completed in Tertiary materials are low. An exception is the artesian aquifer formed by nonmarine sedimentary rocks underlying the North and South Forks of the Newaukum River. Some wells completed in this unit yield several hundred gallons of water per minute (Weigle and Foxworthy, 1962).

Glaciofluvial deposits of the Quaternary Period are the most important source of ground water in Lewis County. These deposits include the Logan Hill Formation, the Lacamas Creek unit, the Newaukum terrace unit, the Layton Prairie unit, undifferentiated terrace deposits, and glacial outwash (for additional information see Weigle and Foxworthy, 1962). In 1963, a number of wells, which are too numerous to plot on plate 3, were sampled in the vicinity of Marys Corner (shaded area on map). Although drillers' logs are not available for most of these wells, the locations and depths suggest that most of them tap the Logan Hill Formation.

Recent alluvial deposits in the Cowlitz, Chehalis, and Newaukum River valleys compose the third general category of water-bearing materials in Lewis County. As an aquifer, these deposits are not as productive as the glaciofluvial deposits, and most wells which tap the alluvial deposits are domestic wells.

To maintain the continuity of ground-water-quality data in the Centralia area and along the Chehalis River, ground-water-quality data from a section of southwestern Thurston County and from the Chehalis River valley in Grays Harbor County are included with data from Lewis County. The remainder of Thurston County will be included in a subsequent report. All wells in Thurston County except one, a well completed in recent alluvium along the Chehalis River, were finished in glacial-outwash materials along the Chehalis and Skookumchuck Rivers and in the vicinity of Grand Mound Prairie. In Grays Harbor County one well was completed in sandstone material of the Tertiary Period; the others were finished in alluvial or glaciofluvial materials.

Ground water sampled from the wells indicated on plate 3 and from wells in the vicinity of Marys Corner in Lewis County (shaded area, pl. 3) was predominantly calcium-magnesium bicarbonate-type water; however, numerous exceptions were found, especially in Lewis County. In Thurston and Grays Harbor Counties only one sample, from well 17/7W-2F1, was not calcium-magnesium bicarbonate-type water.

Sodium was the major cation in most of the samples from wells that were known to penetrate materials of the Tertiary Period, and it was the major cation in some of the wells completed in alluvial and glaciofluvial deposits. In all but 14 of 99 samples from the three counties (excluding Marys Corner samples) bicarbonate was the principal anion. In 6 of the 14 samples the percentage of nitrate was greater than or equal to 15 percent, a concentration great enough to change bicarbonate-type water to chloride-nitrate-type water.

Ground water sampled in the vicinity of Marys Corner had a higher percentage of sodium and chloride and a lower median dissolved-solids concentration than other ground water sampled throughout the three counties. Much of the ground water sampled in the vicinity of Marys Corner was from wells finished in the Logan Hill Formation at depths less than 40 feet. Samples from these shallow wells had a higher percentage, but not concentration, of sodium and chloride as compared with samples from other wells finished in glaciofluvial materials, indicating that the water had less contact with calcium carbonate-type materials.

On the basis of major ions, the ground water in the region is suitable for most uses. A few exceptions were found in water sampled from deep wells, such as well 14/2W-22H1 (pl. 3). This water, with a dissolved-solids concentration of 45,500 mg/L and an anionic composition of nearly 100-percent chloride, was thought by Weigle and Foxworthy (1962) to be connate. No fecal-coliform bacteria were detected in the ground water sampled during 1980 (tables 9 and 10).

Nitrate concentrations in ground-water samples, including those from Marys Corner wells, ranged from 0.00 to 18.1 mg/L (NO_3-N) (tables 9 and 11). The median NO_3-N concentration for the entire area, excluding Marys Corner samples, was 0.61 mg/L, and the median NO_3-N concentration for Marys Corner samples was 0.34 mg/L. Excluding Marys Corner samples, three samples had nitrate concentrations that exceeded 10 mg/L NO_3-N, the maximum contaminant level specified by U.S. Environmental Protection Agency primary drinking water regulations, and 90 percent of the samples contained NO_3-N concentrations of less than 2.9 mg/L. Concentrations greater than 2.9 mg/L were found in all water-bearing formations (table 12); however, they tended aggregate to shallow wells finished in unconsolidated materials.

With the exception of iron and manganese, all trace-element concentrations in ground-water samples were below maximum contaminant levels specified by U.S. Environmental Protection Agency primary and secondary drinking water regulations. Iron and manganese concentrations that exceeded secondary regulations are indicated in the table on plate 3. All data for iron and manganese are presented in tables 10 and 12, and are summarized in tables 9 and 11. Data for other trace elements are given in table 13.

TABLE 9.--Summary of biological and major chemical-constituent data for ground-water samples from Lewis County and areas adjacent to the Chehalis River in Thurston and Grays Harbor Counties

[Values in milligrams per liter except as indicated. umho, micromhos per centimeter at 25°; col/100 mL, colonies per 100 milliliters; ug/L, micrograms per liter]

Constituent	Maximum	Minimum	Median	Number of sample sites
Specific conductance (umho)	64,600	20	132	99
pH (units)	8.3	4.3	6.9	97
Fecal-coliform bacteria (col/100 mL)	<1	<1	<1	36
Hardness (as $CaCO_3$)	16,200	4	45	102
Hardness, noncarbonate (as $CaCO_3$)	16,000	0	0	102
Dissolved calcium	5,140	1.5	11	102
Dissolved magnesium	821	.0	4.1	102
Dissolved sodium	10,500	1.1	7.1	99
Sodium adsorption ratio	36	.2	.5	99
Dissolved potassium	58	.1	1.1	99
Alkalinity (as $CaCO_3$)	305	0	51	102
Dissolved sulfate	41	.0	2.5	102
Dissolved chloride	28,900	1.0	4.3	102
Dissolved fluoride	.4	.0	.1	97
Dissolved silica (as SiO_2)	63	4.4	30	102
Dissolved solids (residue at 180°C)	1,550	21	106	60
Dissolved solids (sum of constituents)	45,500	16	107	102
Nitrate (as N)	18.1	.00	.61	99
Iron, total recoverable (ug/L)	65,000	<10	160	61
Iron, dissolved (ug/L)	7,600	<10	30	44
Manganese, total recoverable (ug/L)	500	<5	20	11
Manganese, dissolved (ug/L)	420	<1	10	41

TABLE 10.--Biological and major-chemical-constituent data for ground-water samples from Lewis County and areas adjacent to the Chehalis River in Thurston and Grays Harbor Counties

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	PH (UNITS)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./100 ML)	HARD-NESS (MG/L AS CACO3)
Grays Harbor County										
15/04W-03J01	112GLCV	80-06-25	64	64	64	112.00	148	6.7	<1	58
15/04W-03R01	112GLCV	75-04-08	62	62	55	102.00	119	--	--	43
15/04W-04G01	110ALVM	75-03-18	62	62	54	82.00	103	--	--	35
15/04W-05B01	110ALVM	75-03-18	28	--	--	84.00	118	--	--	47
15/04W-10G02	110ALVM	60-06-01	26	26	17	102.00	111	6.1	--	42
16/04W-31F01	110ALVM	75-04-08	62	62	62	80.00	104	--	--	38
16/04W-32R01	110ALVM	75-04-08	34	--	--	85.00	105	--	--	45
16/04W-33F01	110ALVM	71-04-01	48	--	--	85.00	173	6.8	--	70
16/04W-33F02	110ALVM	71-04-01	82	82	73	85.00	134	8.2	--	51
16/05W-22F01	112GLCV	80-06-25	54	54	54	80.00	71	6.3	<1	22
17/05W-20P01	112GLCV	60-06-01	80	80	40	--	94	6.6	--	29
17/05W-33F01	110ALVM	80-06-25	54	49	38	60.00	110	6.5	<1	39
17/06W-01C01	112GLCV	60-06-01	76	76	60	--	78	6.2	--	24
17/06W-04D01	110ALVM	59-11-27	40	40	24	20.00	73	7.4	--	22
17/07W-02F01	112GLCV	80-09-17	55	30	22	40.00	362	6.9	<1	29
17/07W-11B01	110ALVM	61-04-26	50	--	--	--	141	6.7	--	62
17/07W-11E01	110ALVM	61-04-26	36	--	--	--	168	6.9	--	76
17/07W-11H01	110ALVM	61-04-26	10	--	--	--	124	6.6	--	52
17/07W-11K01	110ALVM	60-06-01	51	48	37	--	167	7.2	--	58
	110ALVM	60-10-03	51	48	37	--	177	7.1	--	63
17/08W-12L02	110ALVM	80-07-23	155	153	143	30.00	230	7.8	<1	56
17/08W-15D01	110ALVM	71-03-31	100	80	75	10.00	289	8.3	--	110
17/08W-16F01	112GLCV	80-07-03	46	26	23	60.00	163	6.3	<1	57
18/06W-27P01	112GLCV	71-04-01	100	96	66	--	149	7.8	--	60
18/06W-29E01	--	80-07-23	105	85	85	65.00	184	7.5	<1	73
18/06W-31H01	110ALVM	60-06-01	98	98	96	--	129	6.8	--	52
18/06W-31K01	112GLCV	80-09-19	48	48	48	40.00	146	6.8	<1	57
18/06W-33H01	112GLCV	80-07-03	61	60	55	40.00	270	6.5	<1	32

LOCAL IDENT-I-FIER	DATE OF SAMPLE	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY FIELD (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)
15/04W-03J01	80-06-25	2	16	4.3	7.1	.4	1.0	56	1.2	5.9
15/04W-03R01	75-04-08	0	11	3.7	6.6	.4	.8	43	2.7	4.1
15/04W-04G01	75-03-18	0	9.3	2.8	5.7	.4	1.1	39	3.0	3.9
15/04W-05B01	75-03-18	0	12	4.2	5.1	.3	.9	48	2.3	2.5
15/04W-10G02	60-06-01	1	12	3.0	5.9	.4	.8	41	4.2	3.8
16/04W-31F01	75-04-08	0	9.5	3.4	4.9	.3	1.1	42	1.9	4.0
16/04W-32R01	75-04-08	1	11	4.3	6.0	.4	.9	44	2.5	3.4
16/04W-33F01	71-04-01	0	16	7.3	4.6	.2	.6	72	3.2	4.6
16/04W-33F02	71-04-01	0	12	5.1	7.4	.5	1.3	56	1.8	5.4
16/05W-22F01	80-06-25	0	6.5	1.4	5.3	.5	.6	30	.8	3.8
17/05W-20P01	60-06-01	0	8.0	2.2	7.2	.6	1.3	37	3.6	3.8
17/05W-33F01	80-06-25	0	9.9	3.4	6.4	.4	1.3	39	4.3	4.3
17/06W-01C01	60-06-01	0	6.5	2.1	5.1	.4	.5	26	4.4	3.0
17/06W-04D01	59-11-27	0	6.0	1.6	3.8	.4	.4	23	2.1	4.0
17/07W-02F01	80-09-17	0	6.8	3.0	62	5.0	1.6	62	3.1	71
17/07W-11B01	61-04-26	0	16	5.5	5.1	.3	.5	67	.6	2.8
17/07W-11E01	61-04-26	0	18	7.5	5.8	.3	.4	83	.6	3.2
17/07W-11H01	61-04-26	0	14	4.2	4.7	.3	.4	52	4.2	3.5
17/07W-11K01	60-06-01	0	14	5.7	4.9	.3	.4	79	4.0	4.0
	60-10-03	0	20	3.2	5.0	.3	.5	80	1.2	4.0
17/08W-12L02	80-07-23	0	16	3.9	24	1.4	2.3	98	1.5	9.5
17/08W-15D01	71-03-31	0	26	11	17	.7	1.5	153	1.8	15
17/08W-16F01	80-07-03	2	14	5.3	9.0	.5	.9	55	1.8	8.7
18/06W-27P01	71-04-01	0	13	6.7	7.2	.4	.3	67	1.8	4.0
18/06W-29E01	80-07-23	0	22	4.3	8.3	.4	2.7	79	9.2	3.6
18/06W-31H01	60-06-01	0	14	4.2	6.4	.4	.8	61	2.6	3.5
18/06W-31K01	80-09-19	10	14	5.3	4.1	.2	.4	47	1.4	4.1
18/06W-33H01	80-07-03	0	8.5	2.6	5.6	.4	.9	39	.4	4.4

LOCAL IDENT- I- FIER	DATE OF SAMPLE	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	NITRO- GEN, NITRATE TOTAL (MG/L AS NO3)	NITRO- GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)
				Grays Harbor County				
15/04W-03J01	80-06-25	.0	33	--	123	--	--	4.7
15/04W-03R01	75-04-08	<.1	30	94	94	--	--	2.1
15/04W-04G01	75-03-18	<.1	32	88	84	--	--	.60
15/04W-05B01	75-03-18	<.1	34	96	94	--	--	.91
15/04W-10G02	60-06-01	.0	27	90	85	2.7	--	--
16/04W-31F01	75-04-08	<.1	31	87	83	--	--	.53
16/04W-32R01	75-04-08	.1	29	85	86	--	--	.59
16/04W-33F01	71-04-01	.1	37	--	117	7.2	1.6	--
16/04W-33F02	71-04-01	.0	38	106	104	--	.80	--
16/05W-22F01	80-06-25	.0	25	--	65	--	--	.70
17/05W-20P01	60-06-01	.1	32	82	82	1.7	--	--
17/05W-33F01	80-06-25	.0	31	--	87	--	--	.60
17/06W-01C01	60-06-01	.0	22	67	63	3.5	--	--
17/06W-04D01	59-11-27	.0	20	58	54	1.9	--	--
17/07W-02F01	80-09-17	.1	32	--	217	--	--	.00
17/07W-11B01	61-04-26	.1	29	106	100	.70	--	--
17/07W-11E01	61-04-26	.1	32	119	118	.20	--	--
17/07W-11H01	61-04-26	.1	25	93	91	3.5	--	--
17/07W-11K01	60-06-01	.1	26	108	107	.60	--	--
	60-10-03	.1	26	120	128	5.0	--	--
17/08W-12L02	80-07-23	.1	33	--	149	--	--	.00
17/08W-15D01	71-03-31	.0	34	178	183	--	.30	--
17/08W-16F01	80-07-03	.1	27	--	115	--	--	3.4
18/06W-27P01	71-04-01	.0	35	110	108	--	1.1	--
18/06W-29E01	80-07-23	.2	40	--	138	--	--	.00
18/06W-31H01	60-06-01	.1	34	100	102	.10	--	--
18/06W-31K01	80-09-19	.0	23	--	100	--	--	4.3
18/06W-33H01	80-07-03	.0	27	--	79	--	--	1.4

LOCAL IDENT- I- FIER	DATE OF SAMPLE	IRON, TOTAL RECOV- ERABLE (UG/L AS FE)	IRON, DIS- SOLVED (UG/L AS FE)	MANGA- NESE, TOTAL RECOV- ERABLE (UG/L AS MN)	MANGA- NESE, DIS- SOLVED (UG/L AS MN)
15/04W-03J01	80-06-25	--	<10	--	<3
15/04W-03R01	75-04-08	--	20	--	<10
15/04W-04G01	75-03-18	--	40	--	<10
15/04W-05B01	75-03-18	--	60	--	<10
15/04W-10G02	60-06-01	40	--	--	--
16/04W-31F01	75-04-08	--	<10	--	<10
16/04W-32R01	75-04-08	--	<10	--	<10
16/04W-33F01	71-04-01	850	--	<20	--
16/04W-33F02	71-04-01	490	--	40	--
16/05W-22F01	80-06-25	--	10	--	<3
17/05W-20P01	60-06-01	20	--	--	--
17/05W-33F01	80-06-25	--	20	--	30
17/06W-01C01	60-06-01	40	--	--	--
17/06W-04D01	59-11-27	<10	--	--	--
17/07W-02F01	80-09-17	--	110	--	50
17/07W-11B01	61-04-26	2400	--	--	--
17/07W-11E01	61-04-26	730	--	--	--
17/07W-11H01	61-04-26	190	--	--	--
17/07W-11K01	60-06-01	290	--	--	--
	60-10-03	10	--	--	--
17/08W-12L02	80-07-23	--	60	--	100
17/08W-15D01	71-03-31	600	--	500	--
17/08W-16F01	80-07-03	--	20	--	10
18/06W-27P01	71-04-01	20	--	<20	--
18/06W-29E01	80-07-23	--	300	--	130
18/06W-31H01	60-06-01	330	--	--	--
18/06W-31K01	80-09-19	--	30	--	2
18/06W-33H01	80-07-03	--	10	--	<3

TABLE 10.--Continued

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	PH (UNITS)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	HARD-NESS (MG/L AS CACO3)
				Lewis County						
11/01W-07H01	112GLCV	80-09-18	62	62	61	280.00	132	7.2	<1	48
11/01W-08E02	112GLCV	53-08-25	79	78	58	240.00	156	7.3	--	59
11/01W-12F02	112GLCV	80-09-18	116	112	110	310.00	113	8.3	<1	36
11/01W-14L02	112GLCV	53-12-02	58	58	57	280.00	126	7.6	--	50
11/01W-18K01	110ALVM	80-09-18	24	24	24	120.00	118	6.7	<1	41
11/02W-04C01	112LGHL	80-09-18	143	143	141	440.00	124	6.8	<1	39
11/02W-09P02	--	71-01-21	142	142	141	--	70	7.1	--	21
11/02W-24G01	110ALVM	80-09-18	41	41	25	80.00	247	7.1	<1	61
11/02W-29P01	--	52-06-27	186	--	--	143.00	--	7.0	--	98
11/02W-32C01	--	48-04-22	220	220	60	140.00	--	8.9	--	48
	--	62-11-15	220	220	60	140.00	351	7.8	--	54
11/02W-32D01	--	48-02-17	75	--	--	134.00	--	7.5	--	63
11/02W-34R03	--	80-09-18	79	79	53	160.00	212	7.1	<1	75
12/01E-09Q01	112GLCV	53-12-02	142	73	70	572.00	126	6.6	--	24
12/01E-10P02	112GLCV	80-09-17	209	209	208	600.00	165	7.5	<1	62
12/01E-13F01	112GLCV	80-09-17	161	161	160	540.00	98	7.3	<1	34
12/01E-23B01	112GLCV	80-09-17	172	60	56	350.00	116	7.3	<1	44
12/01W-22D01	112GLCV	63-12-02	16	--	--	--	212	6.7	--	93
12/01W-26E01	112GLCV	63-12-18	21	--	--	386.00	159	6.2	--	50
12/01W-26L01	112GLCV	63-12-18	35	--	--	390.00	89	6.7	--	32
12/01W-36E02	112GLCV	63-12-18	60	--	--	330.00	156	7.1	--	57
12/02E-13H02	112GLCV	80-09-19	103	103	93	630.00	132	7.3	<1	52
12/02E-17F01	112GLCV	80-09-17	140	140	139	680.00	127	6.9	<1	45
12/02W-10N01	112LGHL	53-01-23	100	100	72	440.00	87	6.8	--	27
12/02W-24G01	112LGHL	63-12-18	36	--	--	--	54	5.6	--	12
12/02W-24N03	112LGHL	63-12-17	14	--	--	449.00	130	6.6	--	46
12/02W-27J01	112LGHL	63-12-17	52	--	--	--	254	5.9	--	27
13/01E-19K02	112LGHL	54-05-03	182	182	102	690.00	120	7.1	--	46
13/01W-17K01	--	59-11-12	1595	600	120	298.00	1090	8.1	--	140
13/01W-25B01	112LGHL	63-12-17	101	101	100	613.00	46	6.3	--	12
13/01W-28P01	112GLCV	53-02-11	135	135	132	360.00	290	7.2	--	52
13/01W-29D01	--	80-06-24	490	435	389	310.00	775	8.3	<1	100
13/01W-33C02	--	80-06-24	130	130	105	351.00	279	8.0	<1	54
13/01W-33R01	112LGHL	63-12-03	73	--	--	550.00	72	6.6	--	18
13/01W-34H01	--	63-12-17	30	--	--	--	43	6.0	--	8
13/01W-34N01	--	63-12-03	54	--	--	549.00	20	6.4	--	4
13/01W-35B01	--	63-12-17	183	--	--	406.00	298	7.4	--	43
13/02W-08A03	110ALVM	80-06-19	35	34	34	190.00	437	8.0	<1	37
13/02W-15M01	--	53-01-08	244	244	212	220.00	1070	7.6	--	148
13/02W-23N02	112GLCV	63-12-17	68	--	--	--	46	6.2	--	12

TABLE 10.--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY FIELD (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)
				Lewis County						
11/01W-07H01	80-09-18	0	11	5.0	6.8	.4	.9	59	2.3	2.7
11/01W-08E02	53-08-25	0	13	6.5	12	.7	2.0	83	1.9	3.0
11/01W-12F02	80-09-18	0	9.0	3.2	6.5	.5	1.7	41	.7	3.2
11/01W-14L02	53-12-02	0	12	4.9	6.5	.4	.8	55	2.3	1.0
11/01W-18K01	80-09-18	0	11	3.3	6.0	.4	1.1	44	1.5	4.5
11/02W-04C01	80-09-18	0	9.2	3.8	7.9	.6	2.0	57	2.5	2.9
11/02W-09P02	71-01-21	0	5.0	2.0	6.1	.6	1.6	33	.2	1.9
11/02W-24G01	80-09-18	0	16	5.1	19	1.1	.9	62	2.8	35
11/02W-29P01	52-06-27	0	25	8.7	--	--	--	113	.0	17
11/02W-32C01	48-04-22	0	8.9	6.2	--	--	--	222	.0	563
	62-11-15	0	16	3.4	57	3.4	1.5	138	4.6	28
11/02W-32D01	48-02-17	0	11	8.7	--	--	--	126	.0	8.3
11/02W-34R03	80-09-18	0	21	5.5	10	.5	1.1	94	4.2	3.1
12/01E-09Q01	53-12-02	11	4.0	3.3	4.9	.4	11	13	2.5	5.0
12/01E-10P02	80-09-17	0	16	5.3	8.2	.5	1.2	77	.9	2.4
12/01E-13F01	80-09-17	0	8.5	3.1	5.2	.4	.6	36	2.9	2.6
12/01E-23B01	80-09-17	0	10	4.5	6.0	.4	1.8	51	2.6	5.0
12/01W-22D01	63-12-02	0	28	5.7	7.5	.3	2.9	94	11	3.5
12/01W-26E01	63-12-18	22	14	3.6	9.5	.6	1.2	27	1.2	15
12/01W-26L01	63-12-18	0	7.5	3.2	5.9	.5	.7	37	2.4	4.0
12/01W-36E02	63-12-18	0	14	5.4	10	.6	.5	61	1.4	4.5
12/02E-13H02	80-09-19	0	13	4.7	7.0	.4	.7	62	2.4	3.5
12/02E-17F01	80-09-17	0	11	4.3	5.8	.4	.7	51	2.0	3.6
12/02W-10N01	53-01-23	0	6.4	2.8	7.2	.6	1.2	42	1.2	2.4
12/02W-24G01	63-12-18	6	3.5	1.0	3.3	.4	2.1	7	1.6	4.2
12/02W-24N03	63-12-17	0	12	4.0	8.4	.5	.7	51	3.8	6.5
12/02W-27J01	63-12-17	18	6.5	2.7	8.7	.7	43	9	10	27
13/01E-19K02	54-05-03	0	8.7	6.0	7.4	.5	1.7	59	1.3	2.1
13/01W-17K01	59-11-12	22	44	7.3	161	5.9	3.3	118	1.3	265
13/01W-25B01	63-12-17	0	3.5	1.0	3.9	.5	1.0	21	1.2	1.5
13/01W-28P01	53-02-11	0	11	5.9	44	2.7	1.6	116	.3	20
13/01W-29D01	80-06-24	0	33	5.0	120	5.1	2.5	140	1.0	170
13/01W-33C02	80-06-24	0	13	5.2	41	2.4	1.7	110	3.6	20
13/01W-33R01	63-12-03	0	4.5	1.8	7.2	.7	1.3	30	.0	3.2
13/01W-34H01	63-12-17	0	2.0	.8	4.0	.6	1.0	8	4.4	3.8
13/01W-34N01	63-12-03	0	1.5	.0	1.1	.2	.6	5	.0	2.0
13/01W-35B01	63-12-17	0	10	4.3	53	3.5	2.0	154	.4	6.0
13/02W-08A03	80-06-19	0	10	2.9	80	5.7	2.2	130	1.4	67
13/02W-15M01	53-01-08	22	41	11	155	5.6	3.7	126	.4	260
13/02W-23N02	63-12-17	0	4.5	.4	3.8	.5	.8	15	3.6	2.2

TABLE 10.--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	NITRO- GEN, NITRATE TOTAL (MG/L AS NO3)	NITRO- GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)
Lewis County								
11/01W-07H01	80-09-18	.1	40	--	109	--	--	1.1
11/01W-08E02	53-08-25	.2	42	126	131	.10	--	--
11/01W-12F02	80-09-18	.1	30	--	90	--	--	2.5
11/01W-14L02	53-12-02	.1	46	114	110	3.8	--	--
11/01W-18K01	80-09-18	.1	29	--	89	--	--	1.3
11/02W-04C01	80-09-18	.1	43	--	106	--	--	.00
11/02W-09P02	71-01-21	.1	34	74	71	.30	--	--
11/02W-24G01	80-09-18	.1	28	--	148	--	--	.00
11/02W-29P01	52-06-27	--	27	--	138	--	--	--
11/02W-32C01	48-04-22	--	--	--	1160	--	--	--
	62-11-15	.1	33	222	230	1.4	--	--
11/02W-32D01	48-02-17	--	17	--	139	--	--	--
11/02W-34R03	80-09-18	.2	34	--	139	--	--	.00
12/01E-09Q01	53-12-02	.3	7.9	--	75	28	--	--
12/01E-10P02	80-09-17	.1	36	--	120	--	--	.86
12/01E-13F01	80-09-17	.0	43	--	99	--	--	2.6
12/01E-23B01	80-09-17	.1	55	--	116	--	--	.07
12/01W-22D01	63-12-02	.1	32	161	148	1.0	--	--
12/01W-26E01	63-12-18	.0	29	126	116	27	--	--
12/01W-26L01	63-12-18	.1	27	135	74	1.2	--	--
12/01W-36E02	63-12-18	.1	38	121	121	11	--	--
12/02E-13H02	80-09-19	.1	37	--	112	--	--	1.5
12/02E-17F01	80-09-17	.1	35	--	102	--	--	2.0
12/02W-10N01	53-01-23	.1	38	81	85	.10	--	--
12/02W-24G01	63-12-18	.0	9.4	43	40	11	--	--
12/02W-24N03	63-12-17	.1	47	111	115	1.3	--	--
12/02W-27J01	63-12-17	.1	4.8	173	158	50	--	--
13/01E-19K02	54-05-03	.1	60	111	123	.30	--	--
13/01W-17K01	59-11-12	.0	23	594	576	.10	--	--
13/01W-25B01	63-12-17	.0	30	53	56	.40	--	--
13/01W-28P01	53-02-11	.2	28	180	184	3.9	--	--
13/01W-29D01	80-06-24	.0	20	--	438	--	--	.44
13/01W-33C02	80-06-24	.0	27	--	184	--	--	1.3
13/01W-33R01	63-12-03	.0	40	82	77	1.4	--	--
13/01W-34H01	63-12-17	.0	7.8	36	32	3.0	--	--
13/01W-34N01	63-12-03	.0	5.3	21	16	2.1	--	--
13/01W-35B01	63-12-17	.1	37	206	205	.20	--	--
13/02W-08A03	80-06-19	.1	26	--	268	--	--	.02
13/02W-15M01	53-01-08	.2	28	572	576	.40	--	--
13/02W-23N02	63-12-17	.0	16	54	42	1.6	--	--

TABLE 10.--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	IRON, TOTAL RECOV- ERABLE (UG/L AS FE)	IRON, DIS- SOLVED (UG/L AS FE)	MANGA- NESE, TOTAL RECOV- ERABLE (UG/L AS MN)	MANGA- NESE, DIS- SOLVED (UG/L AS MN)
Lewis County					
11/01W-07H01	80-09-18	--	10	--	<1
11/01W-08E02	53-08-25	170	--	--	--
11/01W-12F02	80-09-18	--	290	--	40
11/01W-14L02	53-12-02	100	--	--	--
11/01W-18K01	80-09-18	--	<10	--	<1
11/02W-04C01	80-09-18	--	40	--	40
11/02W-09P02	71-01-21	2900	--	<20	--
11/02W-24G01	80-09-18	--	3100	--	240
11/02W-29P01	52-06-27	10000	--	--	--
11/02W-32C01	48-04-22	1000	--	--	--
	62-11-15	1200	--	200	--
11/02W-32D01	48-02-17	900	--	--	--
11/02W-34R03	80-09-18	--	3600	--	150
12/01E-09Q01	53-12-02	140	--	--	--
12/01E-10P02	80-09-17	--	<10	--	<1
12/01E-13F01	80-09-17	--	<10	--	<1
12/01E-23B01	80-09-17	--	20	--	<1
12/01W-22D01	63-12-02	220	--	--	--
12/01W-26E01	63-12-18	10	--	--	--
12/01W-26L01	63-12-18	440	--	--	--
12/01W-36E02	63-12-18	30	--	--	--
12/02E-13H02	80-09-19	--	<10	--	<1
12/02E-17F01	80-09-17	--	10	--	3
12/02W-10N01	53-01-23	1600	60	<5	--
12/02W-24G01	63-12-18	30	--	--	--
12/02W-24N03	63-12-17	90	--	--	--
12/02W-27J01	63-12-17	130	--	--	--
13/01E-19K02	54-05-03	90	--	--	--
13/01W-17K01	59-11-12	90	--	--	--
13/01W-25R01	63-12-17	800	--	--	--
13/01W-28P01	53-02-11	420	80	<5	--
13/01W-29D01	80-06-24	--	40	--	50
13/01W-33C02	80-06-24	--	130	--	50
13/01W-33R01	63-12-03	50	--	--	--
13/01W-34H01	63-12-17	50	--	--	--
13/01W-34N01	63-12-03	880	--	--	--
13/01W-35R01	63-12-17	390	--	--	--
13/02W-08A03	80-06-19	--	530	--	20
13/02W-15M01	53-01-08	320	60	<5	--
13/02W-23N02	63-12-17	200	--	--	--

TABLE 10.--Continued

LOCAL IDENT- I- FIER	GEO- LOGIC UNIT	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	DEPTH TO BOT- TOM OF SAMPLE INTER- VAL (FT)	DEPTH TO TOP OF SAMPLE INTER- VAL (FT)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD)	SPE- CIFIC CON- DUCT- ANCE (UMHOS)	PH (UNITS)	COLI- FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	HARD- NESS (MG/L AS CACO3)
					Lewis County					
13/02W-24P03	112GLCV	80-06-24	70	67	64	280.00	75	6.7	<1	24
13/02W-26K01	--	63-12-17	22	--	--	--	172	6.8	--	56
13/02W-27B01	112GLCV	80-06-19	330	326	316	285.00	305	8.1	<1	33
13/02W-34A03	112LGHL	57-02-27	101	100	60	444.00	169	6.8	--	65
	112LGHL	60-06-21	101	100	60	444.00	196	7.5	--	78
	112LGHL	60-10-04	101	100	60	444.00	163	7.1	--	64
13/02W-36D01	112LGHL	63-12-17	40	--	--	460.00	210	5.2	--	43
13/03W-02F01	--	53-12-03	90	90	55	260.00	110	7.1	--	30
13/03W-03B02	110ALVM	60-06-01	72	70	65	240.00	213	7.2	--	90
13/03W-09G04	110ALVM	60-06-01	37	37	36	185.00	184	6.6	--	77
13/03W-16E01	--	80-06-19	190	190	150	400.00	238	7.3	<1	60
13/04W-03L01	110ALVM	60-06-01	81	81	65	260.00	464	8.1	--	16
13/05W-33J02	--	58-10-14	270	270	250	425.00	2980	6.8	--	470
14/02W-04E01	112GLCV	52-06-27	63	53	38	190.00	--	6.3	--	55
14/02W-05G02	112GLCV	60-05-31	88	85	41	190.00	222	7.1	--	70
14/02W-05M01	112GLCV	80-06-18	78	78	48	185.00	225	6.8	<1	65
14/02W-17D02	110ALVM	60-05-31	63	62	55	175.00	264	7.3	--	76
14/02W-22H01	--	58-10-14	1200	1200	1200	--	63600	4.3	--	16200
14/04W-04G01	--	60-06-01	80	80	32	200.00	619	7.8	--	12
15/02W-29R01	112GLCV	80-06-19	70	70	70	220.00	431	6.9	<1	92
15/02W-31E10	112GLCV	80-06-18	60	60	60	175.00	114	6.6	<1	38
15/03W-36B04	112GLCV	80-06-18	51	51	51	175.00	152	6.7	<1	52
15/03W-36K02	112GLCV	54-05-24	54	54	48	164.00	128	6.5	--	43

LOCAL IDENT- I- FIER	DATE OF SAMPLE	HARD- NESS, NONCAR- BONATE (MG/L CACO3)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	SODIUM, DIS- SOLVED (MG/L AS NA)	SODIUM AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY FIELD (MG/L AS CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)
13/02W-24P03	80-06-24	0	6.0	2.2	5.5	.5	.5	26	.9	2.4
13/02W-26K01	63-12-17	0	13	5.8	16	.9	.5	81	.8	5.0
13/02W-27B01	80-06-19	0	8.0	3.1	52	4.0	2.6	120	.3	27
13/02W-34A03	57-02-27	0	14	7.3	9.7	.5	1.6	77	1.3	6.0
	60-06-21	0	24	4.5	9.4	.5	1.7	94	.2	4.8
	60-10-04	0	15	6.4	9.6	.5	1.5	75	.4	5.5
13/02W-36D01	63-12-17	40	10	4.3	18	1.2	4.2	3	3.6	15
13/03W-02F01	53-12-03	0	4.8	4.3	13	1.0	2.0	40	10	4.0
13/03W-03B02	60-06-01	0	19	10	9.0	.4	3.4	96	2.8	8.0
13/03W-09G04	60-06-01	23	20	6.5	5.8	.3	.1	54	2.8	2.0
13/03W-16E01	80-06-19	0	11	8.0	26	1.5	4.5	100	5.2	4.6
13/04W-03L01	60-06-01	0	3.5	1.7	109	12	2.3	207	1.0	32
13/05W-33J02	58-10-14	440	188	.1	341	6.8	5.5	26	12	840
14/02W-04E01	52-06-27	21	12	6.2	--	--	--	34	9.8	14
14/02W-05G02	60-05-31	1	18	6.1	19	1.0	1.4	69	7.0	19
14/02W-05M01	80-06-18	0	17	5.5	18	1.0	1.6	71	8.9	20
14/02W-17D02	60-05-31	0	19	7.0	28	1.4	2.4	134	.6	4.8
14/02W-22H01	58-10-14	16000	5140	821	10500	36	58	0	9.4	28900
14/04W-04G01	60-06-01	0	4.5	.3	151	19	1.0	305	.8	28
15/02W-29R01	80-06-19	0	23	8.4	48	2.2	2.1	110	2.0	69
15/02W-31E10	80-06-18	13	11	2.6	6.5	.5	.7	25	14	5.3
15/03W-36B04	80-06-18	0	15	3.5	7.4	.4	1.0	52	8.8	4.7
15/03W-36K02	54-05-24	15	12	3.1	6.5	.4	.9	28	6.8	8.6

TABLE 10.--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DISSOLVED (MG/L)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	NITROGEN, NITRATE TOTAL (MG/L AS NO3)	NITROGEN, NO2+NO3 TOTAL (MG/L AS N)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)
Lewis County								
13/02W-24P03	80-06-24	.0	34	--	70	--	--	.63
13/02W-26K01	63-12-17	.1	49	136	140	.40	--	--
13/02W-27B01	80-06-19	.1	31	--	197	--	--	.01
13/02W-34A03	57-02-27	.0	59	132	146	1.2	--	--
	60-06-21	.1	58	167	160	1.1	--	--
	60-10-04	.1	51	142	136	1.6	--	--
13/02W-36D01	63-12-17	.0	14	163	146	75	--	--
13/03W-02F01	53-12-03	.4	36	104	99	.00	--	--
13/03W-03B02	60-06-01	.1	51	163	164	2.0	--	--
13/03W-09G04	60-06-01	.1	36	145	141	35	--	--
13/03W-16E01	80-06-19	.1	63	--	184	--	--	.03
13/04W-03L01	60-06-01	.3	24	298	301	.30	--	--
13/05W-33J02	58-10-14	--	14	1550	1390	.10	--	--
14/02W-04E01	52-06-27	--	27	--	67	--	--	--
14/02W-05G02	60-05-31	.1	33	160	152	6.9	--	--
14/02W-05M01	80-06-18	.1	31	--	149	--	--	.98
14/02W-17D02	60-05-31	.3	50	185	198	.00	--	--
14/02W-22H01	58-10-14	--	4.4	--	45500	80	--	--
14/04W-04G01	60-06-01	.1	35	426	408	.30	--	--
15/02W-29R01	80-06-19	.2	44	--	272	--	--	.16
15/02W-31E10	80-06-18	.1	23	--	83	--	--	1.1
15/03W-36B04	80-06-18	.1	27	--	109	--	--	2.4
15/03W-36K02	54-05-24	.1	26	96	94	13	--	--

LOCAL IDENT-I-FIER	DATE OF SAMPLE	IRON, TOTAL RECOVERABLE (UG/L AS FE)	IRON, DISSOLVED (UG/L AS FE)	MANGANESE, TOTAL RECOVERABLE (UG/L AS MN)	MANGANESE, DISSOLVED (UG/L AS MN)
13/02W-24P03	80-06-24	--	50	--	10
13/02W-26K01	63-12-17	160	--	--	--
13/02W-27B01	80-06-19	--	370	--	40
13/02W-34A03	57-02-27	50	--	<5	--
	60-06-21	10	--	--	--
	60-10-04	20	--	--	--
13/02W-36D01	63-12-17	120	--	--	--
13/03W-02F01	53-12-03	460	--	--	--
13/03W-03B02	60-06-01	140	--	--	--
13/03W-09G04	60-06-01	<10	--	--	--
13/03W-16E01	80-06-19	--	1500	--	120
13/04W-03L01	60-06-01	90	--	--	--
13/05W-33J02	58-10-14	1000	--	--	--
14/02W-04E01	52-06-27	1000	--	--	--
14/02W-05G02	60-05-31	3100	--	--	--
14/02W-05M01	80-06-18	--	40	--	7
14/02W-17D02	60-05-31	1800	--	--	--
14/02W-22H01	58-10-14	65000	--	--	--
14/04W-04G01	60-06-01	740	--	--	--
15/02W-29R01	80-06-19	--	7600	--	420
15/02W-31E10	80-06-18	--	10	--	2
15/03W-36B04	80-06-18	--	30	--	<3
15/03W-36K02	54-05-24	40	--	--	--

TABLE 10.--Continued

LOCAL IDENT- I- FIER	GEO- LOGIC UNIT	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	DEPTH TO BOT- TOM OF SAMPLE INTER- VAL (FT)	DEPTH TO TOP OF SAMPLE INTER- VAL (FT)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD)	SPE- CIFIC CON- DUCT- ANCE (UMHOS)	PH (UNITS)	COLI- FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	HARD- NESS (MG/L AS CACO3)
Thurston County										
15/01W-06A01	112GLCV	60-05-31	45	32	24	275.00	75	6.8	--	25
15/01W-07E01	112GLCV	59-11-12	60	60	12	250.00	124	6.7	--	41
	112GLCV	60-05-24	60	60	12	250.00	77	6.1	--	22
15/02W-05E01	112GLCV	60-05-31	62	57	47	205.00	99	6.9	--	32
15/02W-15R01	112GLCV	60-05-31	50	50	42	220.00	112	6.8	--	36
	112GLCV	60-10-03	50	50	42	220.00	144	7.2	--	47
	112GLCV	61-04-26	50	50	42	220.00	102	6.8	--	34
15/03W-01K01	112GLCV	71-01-21	65	65	65	193.00	101	6.8	--	36
15/03W-05B01	112GLCV	60-06-21	85	85	70	155.00	136	7.1	--	37
15/03W-10L01	112GLCV	80-06-26	62	61	51	150.00	126	6.9	<1	46
15/03W-11H03	112GLCV	80-06-26	50	50	50	170.00	126	6.7	<1	45
15/03W-14C01	112GLCV	58-04-17	74	74	62	150.00	89	7.1	--	28
15/03W-14C02	112GLCV	59-11-12	80	--	--	150.00	94	6.9	--	31
15/03W-24E01	110ALVM	80-06-25	61	61	61	150.00	216	6.4	<1	74
16/03W-16L02	112GLCV	60-05-31	98	98	56	142.00	68	6.7	--	22
16/03W-31G02	112GLCV	80-06-24	65	--	--	130.00	101	6.8	<1	34
16/03W-32B01	112GLCV	80-06-25	60	60	60	145.00	100	7.0	<1	39
16/04W-36R01	112GLCV	80-06-25	33	33	33	120.00	110	6.6	<1	39

LOCAL IDENT- I- FIER	DATE OF SAMPLE	HARD- NESS, NONCAR- BONATE (MG/L CACO3)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	SODIUM, DIS- SOLVED (MG/L AS NA)	SODIUM AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY FIELD (MG/L AS CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)
15/01W-06A01	60-05-31	1	7.5	1.6	4.3	.4	.3	24	3.0	1.8
15/01W-07E01	59-11-12	0	11	3.3	6.2	.4	1.1	41	5.0	4.8
	60-05-24	2	5.5	2.1	5.1	.5	.9	20	7.8	3.2
15/02W-05E01	60-05-31	4	9.0	2.3	6.3	.5	.9	28	5.2	4.8
15/02W-15R01	60-05-31	0	10	2.8	7.4	.5	.9	38	4.4	3.2
	60-10-03	0	16	1.8	13	.8	1.2	57	3.8	4.0
	61-04-26	0	8.0	3.3	6.6	.5	1.0	34	4.4	4.0
15/03W-01K01	71-01-21	0	9.6	2.8	5.3	.4	1.0	36	3.4	3.0
15/03W-05B01	60-06-21	0	7.5	4.4	11	.8	3.1	40	12	8.2
15/03W-10L01	80-06-26	13	12	4.0	6.0	.4	1.4	33	4.3	5.3
15/03W-11H03	80-06-26	0	12	3.6	6.5	.4	1.4	50	3.3	4.2
15/03W-14C01	58-04-17	0	6.4	2.9	7.5	.6	1.0	33	8.8	2.0
15/03W-14C02	59-11-12	0	9.5	1.9	4.7	.4	1.0	33	4.2	3.8
15/03W-24E01	80-06-25	7	20	5.9	9.8	.5	1.7	67	41	5.3
16/03W-16L02	60-05-31	0	6.5	1.4	4.0	.4	.4	28	3.2	1.8
16/03W-31G02	80-06-24	0	9.2	2.7	5.1	.4	1.0	23	5.5	4.4
16/03W-32B01	80-06-25	0	11	2.7	5.2	.4	1.0	43	2.1	4.1
16/04W-36R01	80-06-25	0	10	3.3	6.1	.4	1.2	43	2.0	4.5

TABLE 10.--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	NITRO- GEN, NITRATE TOTAL (MG/L AS NO3)	NITRO- GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)
				Thurston County				
15/01W-06A01	60-05-31	.1	23	66	64	8.7	--	--
15/01W-07E01	59-11-12	.0	29	87	89	3.8	--	--
	60-05-24	.0	18	67	58	3.7	--	--
15/02W-05E01	60-05-31	.1	25	84	79	6.1	--	--
15/02W-15R01	60-05-31	.1	26	86	86	7.6	--	--
	60-10-03	.1	27	105	108	7.2	--	--
	61-04-26	.0	24	84	77	4.4	--	--
15/03W-01K01	71-01-21	.1	23	79	75	5.2	--	--
15/03W-05B01	60-06-21	.1	31	105	102	.40	--	--
15/03W-10L01	80-06-26	.1	26	--	89	--	--	2.3
15/03W-11H03	80-06-26	.0	30	--	100	--	--	2.1
15/03W-14C01	58-04-17	.1	30	66	80	1.1	--	--
15/03W-14C02	59-11-12	.0	27	76	75	2.5	--	--
15/03W-24E01	80-06-25	.0	35	--	168	--	--	2.0
16/03W-16L02	60-05-31	.1	22	56	57	.60	--	--
16/03W-31G02	80-06-24	.0	25	--	75	--	--	1.8
16/03W-32B01	80-06-25	.0	24	--	82	--	--	1.3
16/04W-36R01	80-06-25	.0	31	--	91	--	--	1.6

LOCAL IDENT- I- FIER	DATE OF SAMPLE	IRON, TOTAL RECOV- ERABLE (UG/L AS FE)	IRON, DIS- SOLVED (UG/L AS FE)	MANGA- NESE, TOTAL RECOV- ERABLE (UG/L AS MN)	MANGA- NESE, DIS- SOLVED (UG/L AS MN)
15/01W-06A01	60-05-31	80	--	--	--
15/01W-07E01	59-11-12	40	--	--	--
	60-05-24	80	--	--	--
15/02W-05E01	60-05-31	1900	--	--	--
15/02W-15R01	60-05-31	70	--	--	--
	60-10-03	20	--	--	--
	61-04-26	220	--	--	--
15/03W-01K01	71-01-21	100	--	<20	--
15/03W-05B01	60-06-21	2200	--	--	--
15/03W-10L01	80-06-26	--	30	--	1
15/03W-11H03	80-06-26	--	<10	--	6
15/03W-14C01	58-04-17	<10	--	--	--
15/03W-14C02	59-11-12	60	--	--	--
15/03W-24E01	80-06-25	--	110	--	9
16/03W-16L02	60-05-31	140	--	--	--
16/03W-31G02	80-06-24	--	20	--	5
16/03W-32B01	80-06-25	--	30	--	5
16/04W-36R01	80-06-25	--	10	--	<3

TABLE 11.--Summary of biological and major-chemical-constituent data for ground-water samples from the vicinity of Marys Corner in Lewis County

[Values in milligrams per liter except as indicated. umho, micromhos per centimeter at 25°; col/100 mL, colonies per 100 milliliters; ug/L, micrograms per liter]

Constituent	Maximum	Minimum	Median	Number of sample sites
Specific conductance (umho)	36,200	15	66	125
pH (units)	7.7	5.0	6.3	125
Fecal-coliform bacteria (col/100 mL)	--	--	--	--
Hardness (as $CaCO_3$)	6,180	1.0	18	125
Hardness, noncarbonate (as $CaCO_3$)	5,900	0	0	125
Dissolved calcium	2,210	.5	4.5	125
Dissolved magnesium	161	.0	1.5	125
Dissolved sodium	6,410	1.2	5.0	125
Sodium adsorption ratio	35	.2	.5	125
Dissolved potassium	51	.1	.9	125
Alkalinity (as $CaCO_3$)	276	.2	13	125
Dissolved sulfate	18	.0	.8	125
Dissolved chloride	14,400	.2	2.6	125
Dissolved fluoride	1.6	.0	.0	125
Dissolved silica (as SiO_2)	58	5.2	15	125
Dissolved solids (residue at 180°C)	141	17	61	124
Dissolved solids (sum of constituents)	23,700	17	61	125
Nitrate (as N)	11.7	.00	.34	125
Iron, total recoverable (ug/L)	5,100	<10	120	124
Iron, dissolved (ug/L)	--	--	--	--
Manganese, total recoverable (ug/L)	30	<20	25	2
Manganese, dissolved (ug/L)	--	--	--	--

TABLE 12.--Biological and major-chemical-constituent data for ground-water samples from the vicinity of Marys Corner in Lewis County

LOCAL IDENT- I- FIER	GEO- LOGIC UNIT	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	DEPTH TO BOT- TOM OF SAMPLE INTER- VAL (FT)	DEPTH TO TOP OF SAMPLE INTER- VAL (FT)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD)	SPE- CIFIC CON- DUCT- ANCE (UMHOS)	PH (UNITS)	HARD- NESS (MG/L AS CACO3)	HARD- NESS, NONCAR- BONATE (MG/L CACO3)
12/01W-04E01	112LGHL	63-11-18	127	127	126	543.00	64	7.1	20	0
12/01W-04J01	112LGHL	63-11-18	87	--	--	--	50	6.2	6	2
12/01W-04J02	112LGHL	63-11-19	127	--	--	--	78	6.7	23	0
12/01W-04K01	112LGHL	63-11-18	36	--	--	560.00	42	5.7	8	5
12/01W-04K02	112LGHL	63-11-19	31	--	--	552.00	27	5.4	4	0
12/01W-04K03	112LGHL	63-11-19	30	--	--	553.00	21	5.8	4	0
12/01W-04M01	112LGHL	63-11-18	23	--	--	530.00	70	5.5	18	12
12/01W-04M02	112LGHL	63-11-14	32	32	15	545.00	16	5.5	1	0
12/01W-04M03	112LGHL	63-11-19	86	86	86	537.00	68	7.0	19	0
12/01W-04M04	112LGHL	63-11-14	48	--	--	--	21	6.0	4	0
12/01W-04M05	112LGHL	63-11-18	37	--	--	--	86	5.6	12	6
12/01W-04M06	112LGHL	63-11-18	27	--	--	--	18	5.6	4	0
12/01W-04N03	112LGHL	63-11-14	92	--	--	--	58	6.9	17	0
12/01W-04N04	112LGHL	63-11-18	150	--	--	--	41	6.2	7	2
12/01W-05B01	112LGHL	63-11-20	35	--	--	--	43	5.9	12	0
12/01W-05B02	112LGHL	63-11-20	--	--	--	--	99	6.3	32	1
12/01W-05B03	112LGHL	63-11-21	24	--	--	--	39	5.4	8	1
12/01W-05B04	112LGHL	63-11-21	92	--	--	--	98	6.7	32	4
12/01W-05C01	112LGHL	63-11-20	75	75	65	522.00	30	6.2	8	0
12/01W-05C02	112LGHL	63-11-20	115	115	115	526.00	75	6.7	26	0
12/01W-05C03	112LGHL	63-11-20	72	--	--	--	38	5.7	8	1
12/01W-05C04	112LGHL	63-11-20	75	--	--	--	35	6.3	12	0
12/01W-05C05	112LGHL	63-11-20	--	--	--	--	58	6.7	19	0
12/01W-05C06	112LGHL	63-11-20	--	--	--	--	32	5.8	6	0
12/01W-05C07	112LGHL	63-11-21	65	--	--	--	74	6.2	24	8
12/01W-05E01	112LGHL	63-12-02	128	125	105	525.00	93	7.1	30	0
12/01W-05E04	112LGHL	63-11-26	85	--	--	--	152	6.5	42	12
12/01W-05G01	112LGHL	63-11-19	87	87	82	530.00	64	7.0	17	0
12/01W-05G02	112LGHL	63-11-20	77	77	68	528.00	62	6.9	17	0
12/01W-05G03	112LGHL	63-11-19	50	50	50	527.00	70	6.2	19	0
12/01W-05G04	112LGHL	63-11-19	39	39	10	528.00	43	5.5	9	5
12/01W-05G05	112LGHL	63-11-19	35	--	--	--	80	6.1	10	2
12/01W-05G06	112LGHL	63-11-19	32	--	--	--	22	6.2	5	1
12/01W-05G07	112LGHL	64-02-10	116	--	--	--	66	7.2	20	0
12/01W-05H01	112LGHL	63-11-19	33	--	--	530.00	94	5.5	24	20
12/01W-05H02	112LGHL	63-11-19	33	--	--	520.00	79	5.6	12	8
12/01W-05M01	112LGHL	63-11-26	50	50	50	510.00	97	6.2	30	4
12/01W-05M02	112LGHL	63-12-02	29	--	--	--	29	5.6	6	0
12/01W-05N01	112LGHL	63-12-02	30	--	--	500.00	36	5.6	10	4
12/01W-05P02	112LGHL	63-11-14	28	--	--	--	34	6.7	12	0

Table 12.--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY FIELD (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)
12/01W-04E01	63-11-18	4.5	2.3	5.3	.5	1.0	30	.4	1.5	.1
12/01W-04J01	63-11-18	1.0	.8	6.3	1.1	.9	3	2.8	9.5	.0
12/01W-04J02	63-11-19	6.0	1.9	6.6	.6	1.0	31	.8	3.5	.1
12/01W-04K01	63-11-18	2.0	.9	3.9	.6	.3	3	1.0	5.5	.0
12/01W-04K02	63-11-19	1.5	.3	1.8	.4	.4	5	1.4	3.2	.0
12/01W-04K03	63-11-19	1.0	.4	1.4	.3	.3	7	1.6	1.2	.0
12/01W-04M01	63-11-18	4.0	1.9	4.3	.4	.7	7	.8	5.0	.0
12/01W-04M02	63-11-14	.5	.0	1.6	.6	.8	5	.2	.8	.0
12/01W-04M03	63-11-19	5.5	1.4	5.6	.6	.9	30	.0	1.5	.0
12/01W-04M04	63-11-14	1.0	.4	1.6	.3	.9	8	1.2	1.0	.0
12/01W-04M05	63-11-18	3.5	.8	10	1.3	.9	7	13	6.2	.1
12/01W-04M06	63-11-18	1.0	.2	1.2	.3	.8	5	.8	1.0	.0
12/01W-04N03	63-11-14	4.0	1.7	5.6	.6	.6	24	.6	1.5	.1
12/01W-04N04	63-11-18	1.0	1.1	4.4	.7	.5	6	6.4	4.5	.0
12/01W-05B01	63-11-20	3.5	.7	2.9	.4	1.6	11	5.0	3.0	.0
12/01W-05B02	63-11-20	8.5	2.6	6.4	.5	1.4	31	4.2	4.5	.1
12/01W-05B03	63-11-21	2.5	.3	3.6	.6	.5	7	4.0	3.0	.0
12/01W-05B04	63-11-21	8.5	2.8	5.8	.4	1.0	29	.6	4.5	.1
12/01W-05C01	63-11-20	1.5	1.1	2.7	.4	.3	13	.0	1.5	.0
12/01W-05C02	63-11-20	6.5	2.4	5.0	.4	.9	35	.0	2.2	.0
12/01W-05C03	63-11-20	2.0	.6	2.9	.5	2.4	7	5.2	2.2	.1
12/01W-05C04	63-11-20	2.5	1.4	3.2	.4	.5	16	.8	1.2	.1
12/01W-05C05	63-11-20	4.5	1.9	4.4	.4	1.0	26	.8	2.8	.1
12/01W-05C06	63-11-20	1.5	.5	3.6	.7	.5	9	2.0	3.0	.0
12/01W-05C07	63-11-21	5.0	2.9	3.9	.3	.8	16	.4	3.2	.1
12/01W-05E01	63-12-02	7.0	2.9	8.4	.7	1.1	46	1.6	1.8	.1
12/01W-05E04	63-11-26	10	4.0	12	.8	2.4	30	5.2	6.8	.1
12/01W-05G01	63-11-19	4.5	1.4	6.8	.7	1.0	31	.4	2.2	.1
12/01W-05G02	63-11-20	4.5	1.4	5.9	.6	.9	25	.6	.8	.1
12/01W-05G03	63-11-19	4.5	1.9	4.7	.5	1.5	23	.8	4.5	.1
12/01W-05G04	63-11-19	2.0	.9	2.7	.4	1.9	4	7.6	1.0	.0
12/01W-05G05	63-11-19	2.5	1.0	8.6	1.2	3.5	7	12	5.8	.1
12/01W-05G06	63-11-19	1.0	.6	1.7	.3	.2	4	3.6	1.2	.0
12/01W-05G07	64-02-10	4.0	2.3	5.8	.6	1.0	31	.4	.8	.1
12/01W-05H01	63-11-19	6.0	2.2	5.1	.5	2.4	3	5.0	7.5	.0
12/01W-05H02	63-11-19	3.0	1.1	8.7	1.1	.7	4	3.8	6.0	.0
12/01W-05M01	63-11-26	8.0	2.6	6.2	.5	.8	26	.2	7.5	.1
12/01W-05M02	63-12-02	2.0	.4	2.3	.4	.9	8	1.2	3.0	.0
12/01W-05N01	63-12-02	2.0	1.2	2.0	.3	.5	6	.8	3.0	.0
12/01W-05P02	63-11-14	4.0	.3	1.6	.2	.2	14	.8	1.5	.0

TABLE 12.--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	NITRO- GEN, NITRATE TOTAL (MG/L AS NO3)	NITRO- GEN, NO2+NO3 TOTAL (MG/L AS N)	IRON, TOTAL RECOV- ERABLE (UG/L AS FE)	MANGA- NESE, TOTAL RECOV- ERABLE (UG/L AS MN)
12/01W-04E01	63-11-18	38	76	72	.80	--	<10	--
12/01W-04J01	63-11-18	6.8	43	33	3.3	--	80	--
12/01W-04J02	63-11-19	34	79	74	1.5	--	50	--
12/01W-04K01	63-11-18	6.2	32	29	7.3	--	70	--
12/01W-04K02	63-11-19	7.1	31	19	.20	--	120	--
12/01W-04K03	63-11-19	7.4	28	18	.40	--	2500	--
12/01W-04M01	63-11-18	7.5	48	28	18	--	40	--
12/01W-04M02	63-11-14	15	23	22	.10	--	30	--
12/01W-04M03	63-11-19	39	81	75	2.7	--	40	--
12/01W-04M04	63-11-14	15	32	26	.20	--	200	--
12/01W-04M05	63-11-18	9.5	69	63	7.6	--	100	--
12/01W-04M06	63-11-18	13	23	22	.60	--	40	--
12/01W-04N03	63-11-14	41	78	71	2.0	--	30	--
12/01W-04N04	63-11-18	11	38	33	.40	--	280	--
12/01W-05B01	63-11-20	6.2	49	31	.80	--	1600	--
12/01W-05B02	63-11-20	22	81	76	6.9	--	130	--
12/01W-05B03	63-11-21	5.9	30	26	2.6	--	130	--
12/01W-05B04	63-11-21	36	98	88	12	--	1300	--
12/01W-05C01	63-11-20	15	33	30	.20	--	890	--
12/01W-05C02	63-11-20	34	74	73	.60	--	680	--
12/01W-05C03	63-11-20	7.3	34	30	2.7	--	450	--
12/01W-05C04	63-11-20	22	44	42	.20	--	150	--
12/01W-05C05	63-11-20	29	60	61	.20	--	3100	--
12/01W-05C06	63-11-20	6.8	59	24	1.0	--	80	--
12/01W-05C07	63-11-21	19	61	59	14	--	60	--
12/01W-05E01	63-12-02	42	95	93	.40	--	640	--
12/01W-05E04	63-11-26	21	114	113	33	--	110	--
12/01W-05G01	63-11-19	37	74	73	.20	--	90	--
12/01W-05G02	63-11-20	40	76	71	1.8	--	40	--
12/01W-05G03	63-11-19	28	68	63	3.4	--	30	--
12/01W-05G04	63-11-19	8.3	34	33	6.0	--	10	--
12/01W-05G05	63-11-19	7.0	63	53	8.3	--	60	--
12/01W-05G06	63-11-19	6.8	23	19	1.0	--	180	--
12/01W-05G07	64-02-10	31	62	65	.20	--	960	--
12/01W-05H01	63-11-19	7.1	68	63	26	--	750	--
12/01W-05H02	63-11-19	5.2	58	50	19	--	20	--
12/01W-05M01	63-11-26	25	79	74	7.2	--	300	--
12/01W-05M02	63-12-02	6.7	44	23	1.6	--	160	--
12/01W-05N01	63-12-02	9.4	34	28	6.0	--	70	--
12/01W-05P02	63-11-14	8.8	28	26	.20	--	90	--

TABLE 12.--Continued

LOCAL IDENT- I- FIER	GEO- LOGIC UNIT	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	DEPTH TO BOT- TOM OF SAMPLE INTER- VAL (FT)	DEPTH TO TOP OF SAMPLE INTER- VAL (FT)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD)	SPE- CIFIC CON- DUCT- ANCE (UMHOS)	PH (UNITS)	HARD- NESS (MG/L AS CACO3)	HARD- NESS, NONCAR- BONATE (MG/L CACO3)
12/01W-05P03	112LGHL	63-11-14	116	--	--	--	76	7.1	23	0
12/01W-05Q01	112LGHL	63-11-14	41	--	--	--	39	5.8	10	4
12/01W-05R01	112LGHL	63-11-14	48	--	--	540.00	69	5.2	18	16
12/01W-06B01	112LGHL	63-11-20	30	--	--	512.00	47	6.4	15	6
12/01W-06B02	112LGHL	63-12-02	32	--	--	--	22	5.8	5	2
12/01W-06B03	112LGHL	63-12-02	41	--	--	--	53	5.7	12	9
12/01W-06C01	112LGHL	63-11-21	36	--	--	510.00	43	5.5	9	4
12/01W-06D01	112LGHL	63-11-21	40	--	--	--	155	5.9	42	38
12/01W-06D02	112LGHL	63-11-21	38	--	--	--	35	5.5	6	0
12/01W-06G01	112LGHL	63-11-21	106	106	106	505.00	116	7.3	38	0
12/01W-06H01	112LGHL	63-11-26	39	--	--	518.00	88	5.5	7	2
12/01W-06J01	112LGHL	63-12-02	30	--	--	--	80	5.7	19	14
12/01W-06K01	112LGHL	63-11-26	31	--	--	500.00	29	6.1	6	0
12/01W-06K02	112LGHL	63-11-21	--	--	--	--	33	6.4	6	0
12/01W-06L01	112LGHL	63-11-21	106	106	90	505.00	118	7.1	38	0
	112LGHL	71-01-21	106	106	90	505.00	122	7.1	38	0
12/01W-06N01	112LGHL	63-11-13	120	--	--	--	110	7.3	40	0
12/01W-06P01	112LGHL	63-11-13	33	--	--	495.00	30	6.3	7	0
12/01W-06Q01	112LGHL	63-11-26	27	--	--	--	215	5.4	45	40
12/01W-07A01	112LGHL	63-11-13	19	--	--	503.00	68	5.7	22	10
12/01W-07B01	112LGHL	63-11-13	26	--	--	501.00	40	6.1	12	0
12/01W-07C01	112LGHL	63-11-13	82	82	82	501.00	91	6.7	31	0
12/01W-07J01	112LGHL	63-11-12	--	--	--	--	65	5.8	22	3
12/01W-08A01	112LGHL	63-11-14	40	--	--	540.00	90	5.0	28	25
12/01W-08A02	112LGHL	63-11-14	100	--	--	--	74	6.7	24	0
12/01W-08A03	112LGHL	63-11-14	44	--	--	--	28	6.4	6	0
12/01W-08C01	112LGHL	63-11-13	37	--	--	530.00	39	6.1	6	2
12/01W-08D01	112LGHL	63-11-13	39	--	--	523.00	37	5.7	7	4
12/01W-08K01	112LGHL	63-11-06	26	--	--	528.00	26	5.7	6	0
12/01W-08K02	--	64-04-24	1710	--	--	525.00	36200	6.7	6180	5900
12/01W-08L01	112LGHL	63-11-07	28	--	--	520.00	79	6.4	26	0
12/01W-08M01	112LGHL	63-11-07	92	--	--	--	117	7.0	44	0
12/01W-08N02	--	72-02-07	215	--	--	--	112	6.3	39	0
12/01W-08P01	112LGHL	63-11-07	27	27	22	522.00	85	6.2	24	2
12/01W-08Q01	112LGHL	63-11-06	22	--	--	515.00	51	6.0	14	6
12/01W-08Q02	--	63-11-26	220	141	74	--	88	6.6	28	0
12/01W-08R01	112LGHL	63-11-06	60	60	60	515.00	109	7.0	38	0
12/01W-09A02	112LGHL	63-11-07	92	92	90	561.00	68	7.0	22	0
12/01W-09A03	112LGHL	63-11-12	--	--	--	--	20	5.8	2	0
12/01W-09B01	112LGHL	63-11-13	100	100	100	560.00	29	6.1	5	0

TABLE 12.--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	SODIUM, DIS- SOLVED (MG/L AS NA)	SODIUM AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY FIELD (MG/L AS CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)
12/01W-05P03	63-11-14	5.5	2.3	6.8	.6	1.0	36	.4	1.5	.1
12/01W-05Q01	63-11-14	2.0	1.2	2.3	.3	.9	7	1.0	3.0	.0
12/01W-05R01	63-11-14	4.0	2.0	3.1	.3	.8	2	.8	3.8	.0
12/01W-06B01	63-11-20	4.0	1.3	2.5	.3	.5	9	6.4	1.5	.0
12/01W-06B02	63-12-02	1.0	.6	2.0	.4	.3	3	3.2	2.0	.0
12/01W-06B03	63-12-02	2.5	1.3	4.4	.6	.9	3	6.8	5.8	.0
12/01W-06C01	63-11-21	2.0	.9	4.0	.6	.4	5	1.8	4.0	1.0
12/01W-06D01	63-11-21	10	4.2	8.7	.6	3.4	4	1.4	12	.1
12/01W-06D02	63-11-21	1.5	.5	3.6	.7	.9	7	.6	3.0	.1
12/01W-06G01	63-11-21	9.5	3.5	9.7	.7	1.1	57	1.8	2.0	.1
12/01W-06H01	63-11-26	1.5	.8	13	2.1	.3	5	.6	13	.1
12/01W-06J01	63-12-02	5.0	1.5	5.0	.5	2.5	5	6.4	7.0	.0
12/01W-06K01	63-11-26	2.0	.3	2.8	.5	.3	7	.4	3.5	.0
12/01W-06K02	63-11-21	1.5	.8	3.1	.5	1.5	13	.0	2.8	.1
12/01W-06L01	63-11-21	9.5	3.6	11	.8	1.2	58	1.0	2.0	.1
	71-01-21	9.0	3.7	10	.7	1.4	58	.0	2.1	.1
12/01W-06N01	63-11-13	9.5	3.9	7.8	.5	1.0	56	.4	2.0	.1
12/01W-06P01	63-11-13	2.0	.4	2.8	.5	.6	7	3.2	1.8	.0
12/01W-06Q01	63-11-26	10	4.8	7.3	.5	20	5	4.8	28	.0
12/01W-07A01	63-11-13	6.0	1.6	3.4	.3	.9	11	3.2	4.0	.0
12/01W-07B01	63-11-13	3.5	.8	2.7	.3	1.2	13	2.8	1.8	.0
12/01W-07C01	63-11-13	8.0	2.6	6.9	.5	1.2	44	.8	2.2	.0
12/01W-07J01	63-11-12	7.0	1.1	3.0	.3	.4	19	.4	4.0	.0
12/01W-08A01	63-11-14	6.5	3.0	2.3	.2	1.2	3	1.0	4.5	.0
12/01W-08A02	63-11-14	6.0	2.2	5.7	.5	1.0	34	.8	2.5	.0
12/01W-08A03	63-11-14	1.5	.4	2.1	.4	.6	6	2.6	3.8	.0
12/01W-08C01	63-11-13	1.5	.6	4.8	.8	.2	5	.4	5.8	.0
12/01W-08D01	63-11-13	1.0	1.1	3.4	.6	.2	3	.4	5.8	.0
12/01W-08K01	63-11-06	2.0	.1	2.5	.5	.4	7	.0	2.0	.1
12/01W-08K02	64-04-24	2210	161	6410	35	51	276	18	14400	1.6
12/01W-08L01	63-11-07	7.0	2.0	6.3	.5	1.2	38	.0	2.5	.1
12/01W-08M01	63-11-07	10	4.6	7.6	.5	1.2	58	.0	1.8	.1
12/01W-08N02	72-02-07	8.5	4.3	7.2	.5	1.3	56	1.4	2.6	.0
12/01W-08P01	63-11-07	7.0	1.4	6.6	.6	1.6	21	2.4	6.2	.0
12/01W-08Q01	63-11-06	3.5	1.4	3.1	.4	1.2	8	.4	3.2	.0
12/01W-08Q02	63-11-26	6.0	3.2	6.1	.5	1.1	42	.2	2.5	.1
12/01W-08R01	63-11-06	9.0	3.9	7.9	.6	.8	49	.0	3.2	.1
12/01W-09A02	63-11-07	5.5	2.1	4.7	.4	1.0	28	.0	1.2	.1
12/01W-09A03	63-11-12	.5	.3	2.4	.7	.6	7	.4	1.2	.0
12/01W-09B01	63-11-13	1.0	.6	3.3	.6	.5	7	4.4	2.0	.0

TABLE 12.--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	NITRO- GEN, NITRATE TOTAL (MG/L AS NO3)	NITRO- GEN, NO2+NO3 TOTAL (MG/L AS N)	IRON, TOTAL RECOV- ERABLE (UG/L AS FE)	MANGA- NESE, TOTAL RECOV- ERABLE (UG/L AS MN)
12/01W-05P03	63-11-14	45	90	85	.80	--	40	--
12/01W-05Q01	63-11-14	8.8	28	29	5.9	--	90	--
12/01W-05R01	63-11-14	7.8	54	49	25	--	30	--
12/01W-06B01	63-11-20	6.1	42	33	5.3	--	160	--
12/01W-06B02	63-12-02	5.3	43	18	2.1	--	160	--
12/01W-06B03	63-12-02	7.0	73	36	5.8	--	120	--
12/01W-06C01	63-11-21	7.0	53	31	7.4	--	140	--
12/01W-06D01	63-11-21	7.9	107	99	49	--	50	--
12/01W-06D02	63-11-21	9.7	36	27	3.0	--	130	--
12/01W-06G01	63-11-21	44	104	106	.10	--	10	--
12/01W-06H01	63-11-26	6.4	60	53	14	--	80	--
12/01W-06J01	63-12-02	6.8	51	54	17	--	30	--
12/01W-06K01	63-11-26	6.6	20	22	1.7	--	20	--
12/01W-06K02	63-11-21	19	35	37	.10	--	20	--
12/01W-06L01	63-11-21	43	113	107	.10	--	30	--
	71-01-21	40	108	102	.10	--	100	<20
12/01W-06N01	63-11-13	44	107	102	.10	--	90	--
12/01W-06P01	63-11-13	7.6	37	25	2.4	--	270	--
12/01W-06Q01	63-11-26	5.6	135	132	48	--	310	--
12/01W-07A01	63-11-13	8.0	54	34	15	--	130	--
12/01W-07B01	63-11-13	11	40	34	1.9	--	100	--
12/01W-07C01	63-11-13	40	90	89	.10	--	320	--
12/01W-07J01	63-11-12	10	48	43	5.9	--	20	--
12/01W-08A01	63-11-14	9.5	60	61	31	--	190	--
12/01W-08A02	63-11-14	38	83	78	.40	--	20	--
12/01W-08A03	63-11-14	7.0	24	22	.40	--	120	--
12/01W-08C01	63-11-13	8.2	34	30	5.8	--	50	--
12/01W-08D01	63-11-13	6.6	29	27	6.1	--	320	--
12/01W-08K01	63-11-06	9.2	23	22	1.3	--	<10	--
12/01W-08K02	64-04-24	51	--	23700	11	--	--	--
12/01W-08L01	63-11-07	45	88	87	.20	--	<10	--
12/01W-08M01	63-11-07	49	109	109	.10	--	1700	--
12/01W-08N02	72-02-07	49	90	108	--	.02	220	30
12/01W-08P01	63-11-07	23	77	68	7.3	--	40	--
12/01W-08Q01	63-11-06	6.3	38	33	9.0	--	630	--
12/01W-08Q02	63-11-26	39	83	84	.30	--	200	--
12/01W-08R01	63-11-06	48	105	105	1.7	--	70	--
12/01W-09A02	63-11-07	42	78	77	3.7	--	140	--
12/01W-09A03	63-11-12	15	28	25	.10	--	150	--
12/01W-09B01	63-11-13	8.2	32	24	.30	--	5100	--

TABLE 12.--Continued

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	PH (UNITS)	HARD-NESS (MG/L AS CACO3)	HARD-NESS, NONCAR-BONATE (MG/L CACO3)
12/01W-09B03	112LGHL	63-11-12	97	--	--	--	69	7.0	20	0
12/01W-09B04	112LGHL	63-11-12	40	--	--	--	60	5.7	16	13
12/01W-09D04	112LGHL	63-11-14	68	--	--	533.00	56	7.0	16	0
12/01W-09D05	112LGHL	63-11-12	--	--	--	--	82	7.3	25	0
12/01W-09D06	112LGHL	63-11-12	30	--	--	--	35	5.8	9	5
12/01W-09D07	112LGHL	63-11-12	88	--	--	--	77	7.2	24	0
12/01W-09D08	112LGHL	63-11-12	73	--	--	--	81	7.2	24	0
12/01W-09D09	112LGHL	63-11-13	--	--	--	--	59	7.1	15	0
12/01W-09D10	112LGHL	63-11-18	26	--	--	--	58	6.4	17	0
12/01W-09E01	112LGHL	63-11-12	106	106	106	535.00	71	7.2	20	0
12/01W-09E02	112LGHL	63-11-12	110	110	110	545.00	69	7.0	22	0
12/01W-09H01	112LGHL	63-11-07	10	--	--	--	15	6.2	4	0
12/01W-09J02	112LGHL	63-11-07	29	--	--	550.00	63	5.8	16	12
12/01W-09L01	112LGHL	63-11-07	19	--	--	530.00	28	5.8	6	0
12/01W-09N01	--	63-11-18	200	--	--	540.00	201	7.7	62	0
12/01W-09N02	112LGHL	63-11-07	45	--	--	540.00	29	6.0	5	0
12/01W-09R01	112LGHL	63-11-07	26	--	--	--	21	5.6	4	0
12/01W-09R02	112LGHL	63-11-07	30	--	--	--	61	6.3	26	0
12/01W-15E01	--	63-12-03	16	16	16	440.00	140	6.9	48	0
12/01W-16Q01	--	63-11-06	18	--	--	--	183	6.8	70	0
12/01W-16Q02	--	63-11-06	22	22	22	--	139	6.8	52	0
12/01W-16Q03	--	63-11-06	40	--	--	392.00	107	6.6	39	0
12/01W-16Q04	--	63-11-26	58	--	--	--	171	7.0	66	0
12/01W-16Q05	--	63-11-26	58	58	53	--	148	6.8	56	0
12/01W-18D02	112LGHL	63-11-06	21	--	--	--	115	6.7	40	0
12/01W-18D03	112LGHL	63-11-06	18	18	18	478.00	120	5.4	32	28
12/01W-18M01	112LGHL	63-11-06	87	--	--	480.00	158	7.2	59	0
12/01W-19C01	112LGHL	63-12-02	34	--	--	500.00	37	6.0	10	2
12/01W-20F02	112LGHL	63-12-03	22	--	--	470.00	31	5.9	7	0
12/02W-13A01	112LGHL	63-12-03	14	--	--	473.00	130	6.7	40	7
12/02W-13A02	112LGHL	63-12-02	18	--	--	--	149	6.6	54	0
12/02W-13H01	112LGHL	63-12-02	35	--	--	--	33	5.9	6	0
13/01W-31N01	112LGHL	63-12-04	98	--	--	500.00	113	7.7	34	0
13/01W-31N03	112LGHL	63-12-04	--	--	--	--	157	5.6	43	39
13/01W-31N04	112LGHL	63-12-17	--	--	--	--	27	5.8	6	2
13/01W-31P01	--	63-12-04	185	185	165	507.00	135	7.2	51	0
13/01W-31Q01	112LGHL	63-12-04	98	98	98	510.00	88	7.0	30	0
13/01W-31R02	112LGHL	63-12-03	27	--	--	--	24	6.2	5	0
13/01W-31R03	--	63-12-18	165	--	--	--	85	6.9	31	0
13/01W-32N01	112LGHL	63-12-03	122	122	122	520.00	102	6.9	36	0
13/01W-32N02	112LGHL	63-12-03	96	--	--	--	86	6.8	28	0
13/01W-32N03	112LGHL	63-12-02	109	--	--	--	96	7.0	35	0
13/01W-32N04	112LGHL	63-12-04	26	--	--	--	48	6.5	7	3
13/01W-32N05	112LGHL	63-12-04	31	--	--	--	40	6.4	10	0
13/01W-32P01	112LGHL	63-12-04	47	--	--	--	43	6.8	10	8
13/01W-32P03	112LGHL	63-12-04	29	--	--	--	27	6.0	6	0

TABLE 12.--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY FIELD (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)
12/01W-09B03	63-11-12	5.0	1.8	5.4	.5	1.1	30	.0	1.5	.1
12/01W-09B04	63-11-12	4.5	1.3	3.1	.3	.4	3	.0	5.5	.0
12/01W-09D04	63-11-14	3.5	1.8	5.2	.6	.6	24	.4	1.2	.1
12/01W-09D05	63-11-12	5.0	3.0	7.5	.7	1.1	39	.0	1.0	.1
12/01W-09D06	63-11-12	2.0	.9	2.3	.3	.3	4	.6	1.5	.0
12/01W-09D07	63-11-12	5.0	2.7	6.9	.6	1.1	37	.4	1.5	.2
12/01W-09D08	63-11-12	6.0	2.3	6.5	.6	.8	33	.0	1.8	.1
12/01W-09D09	63-11-13	4.0	1.3	6.1	.7	.6	27	.4	1.0	.1
12/01W-09D10	63-11-18	4.5	1.5	4.4	.5	.5	16	.8	2.0	.0
12/01W-09E01	63-11-12	5.0	1.7	7.1	.7	1.1	33	.6	1.8	.1
12/01W-09E02	63-11-12	5.5	1.9	5.8	.5	.8	31	.4	1.5	.1
12/01W-09H01	63-11-07	1.0	.3	1.6	.4	.1	5	2.0	.2	.0
12/01W-09J02	63-11-07	3.0	2.0	4.2	.5	.7	4	.0	3.5	.0
12/01W-09L01	63-11-07	2.0	.2	2.7	.5	.4	7	.0	2.5	.0
12/01W-09N01	63-11-18	13	7.1	22	1.2	1.6	106	1.6	1.5	.1
12/01W-09N02	63-11-07	1.5	.4	2.5	.5	.6	7	.0	2.8	.1
12/01W-09R01	63-11-07	1.5	.1	2.0	.4	.4	6	.0	2.2	.0
12/01W-09R02	63-11-07	9.0	.8	2.7	.2	.4	26	2.0	2.8	.1
12/01W-15E01	63-12-03	12	4.3	11	.7	1.2	71	.0	2.5	.1
12/01W-16Q01	63-11-06	16	7.3	12	.6	.7	89	.4	4.0	.1
12/01W-16Q02	63-11-06	12	5.4	9.0	.5	.8	68	.0	3.2	.1
12/01W-16Q03	63-11-06	8.5	4.4	7.4	.5	.6	51	.0	2.8	.1
12/01W-16Q04	63-11-26	15	6.9	12	.6	.9	87	.6	2.8	.1
12/01W-16Q05	63-11-26	13	5.7	9.2	.5	.8	72	2.8	2.8	.1
12/01W-18D02	63-11-06	9.0	4.3	9.6	.7	1.0	57	.0	2.2	.1
12/01W-18D03	63-11-06	9.0	2.3	5.0	.4	4.4	3	11	8.5	.1
12/01W-18M01	63-11-06	11	7.7	11	.6	1.9	82	.0	2.5	.1
12/01W-19C01	63-12-02	2.5	.9	2.6	.4	.3	7	3.6	3.0	.0
12/01W-20F02	63-12-03	2.0	.5	2.2	.4	.6	10	.0	2.5	.0
12/02W-13A01	63-12-03	10	3.7	7.6	.5	4.4	33	9.4	4.5	.1
12/02W-13A02	63-12-02	12	5.8	9.4	.6	.9	56	2.8	7.5	.1
12/02W-13H01	63-12-02	2.0	.2	3.4	.6	1.2	8	1.8	4.2	.0
13/01W-31N01	63-12-04	8.5	3.1	11	.8	2.0	56	1.2	2.2	.1
13/01W-31N03	63-12-04	9.0	5.0	9.6	.6	1.6	4	.2	13	.0
13/01W-31N04	63-12-17	2.0	.3	2.0	.3	.3	5	1.8	1.5	.0
13/01W-31P01	63-12-04	12	5.1	8.5	.5	1.5	66	.8	3.0	.1
13/01W-31Q01	63-12-04	7.5	2.9	5.5	.4	1.1	42	.8	2.8	.1
13/01W-31R02	63-12-03	1.0	.7	2.0	.4	.5	5	3.6	1.8	.0
13/01W-31R03	63-12-18	8.0	2.7	5.8	.5	.9	41	1.2	2.0	.0
13/01W-32N01	63-12-03	10	2.8	6.7	.5	1.5	50	.4	2.5	.0
13/01W-32N02	63-12-03	7.5	2.2	7.1	.6	1.4	41	.0	2.5	.0
13/01W-32N03	63-12-02	9.5	2.8	6.2	.5	1.3	48	.0	2.5	.0
13/01W-32N04	63-12-04	1.5	.8	5.1	.8	1.2	4	2.6	5.5	.0
13/01W-32N05	63-12-04	2.5	1.0	3.5	.5	1.1	16	.6	2.5	.0
13/01W-32P01	63-12-04	3.0	.5	3.5	.5	1.3	8	4.6	3.0	.1
13/01W-32P03	63-12-04	1.5	.6	1.8	.3	.6	10	.0	2.0	.0

TABLE 12.--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	NITRO-GEN, NITRATE TOTAL (MG/L AS NO3)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	IRON, TOTAL RECOV-ERABLE (UG/L AS FE)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN)
12/01W-09B03	63-11-12	47	87	82	1.9	--	10	--
12/01W-09B04	63-11-12	8.8	44	41	15	--	40	--
12/01W-09D04	63-11-14	45	82	74	2.1	--	10	--
12/01W-09D05	63-11-12	50	92	93	.40	--	670	--
12/01W-09D06	63-11-12	11	32	33	11	--	470	--
12/01W-09D07	63-11-12	50	90	90	.40	--	60	--
12/01W-09D08	63-11-12	48	94	90	4.0	--	<10	--
12/01W-09D09	63-11-13	46	82	77	1.5	--	230	--
12/01W-09D10	63-11-18	28	64	61	9.0	--	20	--
12/01W-09E01	63-11-12	49	89	88	1.3	--	30	--
12/01W-09E02	63-11-12	48	88	84	1.2	--	160	--
12/01W-09H01	63-11-07	8.2	17	17	.30	--	40	--
12/01W-09J02	63-11-07	6.6	50	42	20	--	200	--
12/01W-09L01	63-11-07	14	30	28	2.3	--	140	--
12/01W-09N01	63-11-18	20	129	132	1.2	--	670	--
12/01W-09N02	63-11-07	6.8	23	20	1.8	--	150	--
12/01W-09R01	63-11-07	7.8	26	18	.20	--	90	--
12/01W-09R02	63-11-07	11	58	45	.20	--	910	--
12/01W-15E01	63-12-03	49	125	122	.00	--	50	--
12/01W-16Q01	63-11-06	46	141	141	1.3	--	<10	--
12/01W-16Q02	63-11-06	40	116	113	1.0	--	20	--
12/01W-16Q03	63-11-06	30	87	84	.20	--	2900	--
12/01W-16Q04	63-11-26	44	129	136	.90	--	570	--
12/01W-16Q05	63-11-26	36	114	114	.60	--	1700	--
12/01W-18D02	63-11-06	58	118	118	.10	--	1300	--
12/01W-18D03	63-11-06	9.3	84	78	26	--	120	--
12/01W-18M01	63-11-06	45	125	128	.10	--	130	--
12/01W-19C01	63-12-02	8.1	53	30	5.0	--	120	--
12/01W-20F02	63-12-03	12	31	27	1.0	--	550	--
12/02W-13A01	63-12-03	33	113	109	16	--	10	--
12/02W-13A02	63-12-02	44	126	121	5.4	--	30	--
12/02W-13H01	63-12-02	15	41	33	.20	--	440	--
13/01W-31N01	63-12-04	43	102	105	.40	--	310	--
13/01W-31N03	63-12-04	7.8	105	101	52	--	20	--
13/01W-31N04	63-12-17	5.7	23	20	3.4	--	80	--
13/01W-31P01	63-12-04	45	111	116	.50	--	<10	--
13/01W-31Q01	63-12-04	34	78	80	.20	--	240	--
13/01W-31R02	63-12-03	6.0	20	19	.10	--	160	--
13/01W-31R03	63-12-18	42	83	88	.30	--	10	--
13/01W-32N01	63-12-03	39	92	93	.20	--	190	--
13/01W-32N02	63-12-03	33	81	79	.00	--	100	--
13/01W-32N03	63-12-02	38	90	89	.00	--	150	--
13/01W-32N04	63-12-04	5.8	38	34	8.5	--	20	--
13/01W-32N05	63-12-04	13	31	34	.20	--	160	--
13/01W-32P01	63-12-04	5.6	35	31	4.2	--	120	--
13/01W-32P03	63-12-04	14	30	27	.20	--	170	--

TABLE 13.--Trace-element concentrations in ground-water samples from Lewis County and areas adjacent to the Chehalis River in Thurston and Grays Harbor Counties

LOCAL IDENT- I- FIER	DATE OF SAMPLE	ALUM- INUM, DIS- SOLVED (UG/L AS AL)	ARSENIC DIS- SOLVED (UG/L AS AS)	BARIUM, DIS- SOLVED (UG/L AS BA)	CADMIUM DIS- SOLVED (UG/L AS CD)	CHRO- MIUM, DIS- SOLVED (UG/L AS CR)	COPPER, DIS- SOLVED (UG/L AS CU)	LEAD, DIS- SOLVED (UG/L AS PB)	MERCURY DIS- SOLVED (UG/L AS HG)	SELE- NIUM, DIS- SOLVED (UG/L AS SE)
					Grays Harbor County					
16/04W-33F01	71-04-01	--	--	--	--	<30	<50	<100	--	--
16/04W-33F02	71-04-01	--	--	--	--	<30	<50	<100	--	--
17/07W-11K01	62-11-14	--	--	--	--	--	--	--	--	--
17/08W-12L02	80-07-23	0	3	20	<1	10	8	0	.0	0
17/08W-15D01	71-03-31	--	--	--	--	<30	<50	<100	--	--
18/06W-27P01	71-04-01	--	--	--	--	<30	<50	<100	--	--
18/06W-29E01	80-07-23	0	2	20	<1	10	0	0	.0	0
					Lewis County					
11/01W-07H01	80-09-18	10	1	10	<1	0	9	1	.0	0
11/02W-09P02	71-01-21	--	--	--	--	<30	100	<100	--	--
12/02E-13H02	80-09-19	20	1	5	<1	0	5	1	.0	0
13/01W-29D01	80-06-24	0	3	20	2	10	6	0	.0	0
13/01W-33C02	80-06-24	10	6	20	<1	0	5	0	.0	0
13/02W-24P03	80-06-24	20	1	10	<1	0	31	0	.0	0
13/03W-16E01	80-06-19	20	1	10	<1	0	1	2	.0	0
15/02W-31E10	80-06-18	20	0	20	<1	0	1	2	.0	0
					Thurston County					
15/03W-01K01	71-01-21	--	--	--	--	<30	<50	<100	--	--
15/03W-10L01	80-06-26	20	1	20	<1	10	10	0	.0	0

LOCAL IDENT- I- FIER	DATE OF SAMPLE	SILVER, DIS- SOLVED (UG/L AS AG)	ZINC, DIS- SOLVED (UG/L AS ZN)
	Grays Harbor County		
16/04W-33F01	71-04-01	--	50
16/04W-33F02	71-04-01	--	50
17/07W-11K01	62-11-14	--	1900
17/08W-12L02	80-07-23	0	10
17/08W-15D01	71-03-31	--	<10
18/06W-27P01	71-04-01	--	<10
18/06W-29E01	80-07-23	0	30
	Lewis County		
11/01W-07H01	80-09-18	0	20
11/02W-09P02	71-01-21	--	150
12/02E-13H02	80-09-19	0	20
13/01W-29D01	80-06-24	0	3
13/01W-33C02	80-06-24	0	5
13/02W-24P03	80-06-24	0	20
13/03W-16E01	80-06-19	0	50
15/02W-31E10	80-06-18	0	80
	Thurston County		
15/03W-01K01	71-01-21	--	100
15/03W-10L01	80-06-26	0	80

GROUND-WATER QUALITY ALONG THE COAST OF PACIFIC AND GRAYS HARBOR COUNTIES

The locations of wells sampled along the coast of Pacific and Grays Harbor Counties are shown on plate 4. These locations are within the Willapa and Olympic Peninsula aquifer regions (fig. 1).

Most wells along the coast of Pacific and Grays Harbor Counties are completed in unconsolidated sand or sand and gravel deposits. Deeper wells (more than 100 ft) often penetrate alternating layers of clay and gravel, and it is not uncommon for deeper wells to be constructed so that they tap more than one water-bearing layer of gravel.

On the North Beach Peninsula in Pacific County, Tracy (1978) divided the unconsolidated materials that overlie the basalt bedrock into an upper and lower aquifer, which are divided by a relatively thick (40 to 60 ft) layer of clay. The upper unit is a water-table aquifer composed of dune and marine sand. Most wells on the peninsula tap this aquifer, and many of these wells are only 20 to 30 feet deep. The lower aquifer is composed of sand, gravel, and clay deposits that underlie the layer of clay separating it from the upper aquifer.

In addition to the ground-water-quality data presented in this report, the ground-water-quality data base for the coastal areas of Pacific and Grays Harbor Counties contains the results of numerous chloride determinations that resulted from an investigation in 1968, and again in 1978, of seawater intrusion along coastal Washington. Reference to these investigations is made herein, but for more complete information see Walters (1971) and Dion and Sumioka (1984).

There was a slight predominance of calcium-magnesium bicarbonate-type water from wells sampled along the coastal areas of Grays Harbor and Pacific Counties (pl. 4). Samples in which sodium plus potassium were principal cations were almost evenly distributed between samples in which bicarbonate was the major anion and samples in which sulfate, chloride, and nitrate were major anions. In samples where sodium plus potassium were predominant, sodium was usually the major cation. The presence of sodium bicarbonate-type water indicates that there is a source of sodium in coastal ground water that is not directly related to seawater intrusion, where a high percentage of chloride would also be present. Although chloride concentrations ranged from 6.2 to 6,700 mg/L, the median concentration was 14 mg/L (table 14). These data do not point to widespread seawater intrusion, a conclusion that agrees with the data of Dion and Sumioka (1984). Most of the ground water sampled was soft or moderately hard, and the medium concentration of dissolved solids was 129 mg/L (table 14).

Nitrate concentrations ranged from 0.00 to 2.6 mg/L (NO_3-N), and the median concentration was 0.09 mg/L (NO_3-N; table 14). Of the coastal wells sampled, those most subject to nitrate contamination from surficial sources are the shallow wells finished in the water-table aquifer of the North Beach Peninsula. The median NO_3-N concentration in samples from these wells was 0.52 mg/L. Although this concentration is higher than the median concentration for all coastal samples, it is far below the maximum contaminant level of 10 mg/L NO_3-N. No fecal-coliform bacteria were detected in samples of coastal area ground water (table 15).

Ground-water samples that contained iron and manganese concentrations in excess of maximum contaminant levels recommended by U.S. Environmental Protection Agency secondary drinking water regulations were common. No other trace-element concentrations in coastal area ground-water samples exceeded maximum contaminant levels (table 16).

TABLE 14.--Summary of biological and major chemical-constituent data for ground-water samples from the coastal areas of Pacific and Grays Harbor Counties

[Values in milligrams per liter except as indicated. umho, micromhos per centimeter at 25°; col/100 mL, colonies per 100 milliliters; ug/L, micrograms per liter]

Constituent	Maximum	Minimum	Median	Number of sample sites
Specific conductance (umho)	18,000	45	181	47
pH (units)	8.4	5.7	7.5	47
Fecal-coliform bacteria (col/100 mL)	<1	<1	<1	30
Hardness (as $CaCO_3$)	2,600	15	56	47
Hardness, noncarbonate (as $CaCO_3$)	2,500	0	0	47
Dissolved calcium	180	1.7	11	47
Dissolved magnesium	510	1.1	6	47
Dissolved sodium	3,400	4.3	14	47
Sodium adsorption ratio	29	.4	.8	47
Dissolved potassium	160	.4	2.1	47
Alkalinity (as $CaCO_3$)	290	7	60	47
Dissolved sulfate	820	.0	4.4	47
Dissolved chloride	6,700	6.2	14	47
Dissolved fluoride	.5	.0	.2	40
Dissolved silica (as SiO_2)	62	6.8	31	40
Dissolved solids (residue at 180°C)	174	54	129	10
Dissolved solids (sum of constituents)	415	50	128	40
Nitrate (as N)	2.6	.00	.09	46
Iron, total recoverable (ug/L)	3,000	15	402	12
Iron, dissolved (ug/L)	3,900	<10	110	31
Manganese, total recoverable (ug/L)	400	<10	50	8
Manganese, dissolved (ug/L)	350	<1	30	31

TABLE 15.--Biological and major-chemical-constituent data for ground-water samples from the coastal areas of Pacific and Grays Harbor Counties

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	ELEV. OF LAND SURFACE DATUM (FT. NGVD)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH FIELD (UNITS)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	HARD-NESS (MG/L AS CACO3)
Grays Harbor County										
15/11W-05M01	--	80-07-10	273	142	142	170.00	250	6.1	<1	16
16/11W-01M01	--	80-07-10	168	--	--	50.00	173	6.9	<1	56
16/11W-09J01	--	80-07-10	150	150	150	20.00	253	7.4	<1	92
16/11W-18N02	--	59-11-27	69	69	58	20.00	329	7.0	--	87
	--	60-05-25	69	69	58	20.00	257	7.4	--	72
16/11W-31D02	--	80-07-10	48	48	46	15.00	305	8.3	<1	100
16/12W-12B01	--	80-07-10	116	110	55	20.00	325	8.4	<1	65
16/12W-24J03	--	70-08-28	700	676	187	16.00	201	7.8	--	72
16/12W-25J04	--	80-07-10	255	255	250	15.00	400	7.5	<1	140
17/12W-03R01	--	71-03-31	513	512	492	10.00	350	8.0	--	130
17/12W-03R02	--	80-07-01	515	515	495	10.00	348	7.3	<1	120
17/12W-15A01	--	80-07-02	20	--	--	12.00	265	7.8	<1	83
18/12W-03L01	--	80-07-03	155	155	155	15.00	242	7.8	<1	99
18/12W-03P01	--	80-07-03	455	455	447	20.00	146	7.9	<1	33
18/12W-10C01	--	80-07-03	55	--	--	18.00	162	7.5	<1	54
18/12W-15R03	--	80-07-02	110	88	54	60.00	608	7.0	<1	67
18/12W-27F01	--	59-11-27	358	358	350	10.00	159	7.5	--	26
19/11W-33B01	--	62-11-14	56	52	44	--	188	7.5	--	81
19/12W-09C01	--	80-07-03	161	159	134	15.00	290	7.1	<1	80
19/12W-27D03	--	80-07-01	100	--	--	6.00	173	8.0	<1	58
20/12W-08P01	--	80-07-01	234	--	--	60.00	172	7.3	<1	53
20/12W-20B01	--	51-01-11	250	--	--	110.00	185	7.3	--	67
	--	59-11-27	250	--	--	110.00	183	6.2	--	57
	--	80-09-16	250	--	--	110.00	175	7.0	<1	51

LOCAL IDENT-I-FIER	DATE OF SAMPLE	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)
15/11W-05M01	80-07-10	0	3.8	1.5	41	4.5	1.4	45	15	27
16/11W-01M01	80-07-10	0	9.2	8.0	10	.6	3.2	70	.7	8.7
16/11W-09J01	80-07-10	0	17	12	9.8	.4	2.6	110	3.0	9.0
16/11W-18N02	59-11-27	0	9.0	16	29	1.3	6.8	99	5.4	38
	60-05-25	0	9.5	12	21	1.1	5.9	75	6.0	31
16/11W-31D02	80-07-10	11	11	18	14	.6	10	91	2.2	33
16/12W-12B01	80-07-10	0	4.7	13	33	1.8	15	110	4.7	28
16/12W-24J03	70-08-28	3	16	7.6	10	.5	2.1	69	2.2	18
16/12W-25J04	80-07-10	0	28	17	17	.6	8.8	140	.2	34
17/12W-03R01	71-03-31	0	28	14	26	1.0	4.7	174	.0	8.1
17/12W-03R02	80-07-01	0	25	13	25	1.0	4.8	170	1.2	8.6
17/12W-15A01	80-07-02	0	5.3	17	14	.7	18	110	7.4	10
18/12W-03L01	80-07-03	0	27	7.7	11	.5	.9	110	.9	10
18/12W-03P01	80-07-03	0	8.2	3.0	16	1.2	2.6	60	1.1	8.7
18/12W-10C01	80-07-03	0	12	5.8	11	.7	1.5	59	.3	9.7
18/12W-15R03	80-07-02	0	17	6.0	120	6.4	1.7	290	11	11
18/12W-27F01	59-11-27	0	7.5	2.0	20	1.7	3.9	60	2.9	11
19/11W-33B01	62-11-14	0	20	7.5	7.8	.4	.4	89	2.4	6.2
19/12W-09C01	80-07-03	15	18	8.4	22	1.1	.9	65	6.1	38
19/12W-27D03	80-07-01	4	13	6.3	8.3	.5	.8	54	1.3	14
20/12W-08P01	80-07-01	0	10	6.9	12	.7	2.0	53	6.4	13
20/12W-20B01	51-01-11	0	14	7.8	14	.7	3.4	79	4.0	11
	59-11-27	--	12	6.5	14	.8	1.1	--	1.3	11
	80-09-16	0	11	5.6	14	.9	1.4	67	2.6	12

TABLE 15.--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	NITRO-GEN, NITRATE TOTAL (MG/L AS NO3)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)
				Grays Harbor County				
15/11W-05M01	80-07-10	.1	22	--	152	--	--	2.6
16/11W-01M01	80-07-10	.3	37	--	120	--	--	.08
16/11W-09J01	80-07-10	.2	54	--	177	--	--	.00
16/11W-18N02	59-11-27	.1	23	189	188	.10	--	--
	60-05-25	.1	24	158	155	.70	--	--
16/11W-31D02	80-07-10	.2	31	--	174	--	--	.00
16/12W-12B01	80-07-10	.2	21	--	186	--	--	.00
16/12W-24J03	70-08-28	.1	31	132	128	.00	--	--
16/12W-25J04	80-07-10	.2	55	--	245	--	--	.00
17/12W-03R01	71-03-31	.2	57	--	242	--	--	--
17/12W-03R02	80-07-01	.1	54	--	241	--	--	1.4
17/12W-15A01	80-07-02	.3	30	--	171	--	--	.59
18/12W-03L01	80-07-03	.1	20	--	144	--	--	.00
18/12W-03P01	80-07-03	.2	43	--	119	--	--	.00
18/12W-10C01	80-07-03	.2	37	--	114	--	--	.00
18/12W-15R03	80-07-02	.0	30	--	372	--	--	.20
18/12W-27F01	59-11-27	.2	40	127	126	.10	--	--
19/11W-33B01	62-11-14	.1	32	--	132	.10	--	--
19/12W-09C01	80-07-03	.1	26	--	159	--	--	.14
19/12W-27D03	80-07-01	.2	36	--	114	--	--	.23
20/12W-08P01	80-07-01	.1	40	--	123	--	--	.05
20/12W-20B01	51-01-11	.5	66	162	169	.10	--	--
	59-11-27	.1	60	161	154	.20	--	--
	80-09-16	.2	59	--	150	--	--	.00

LOCAL IDENT-I-FIER	DATE OF SAMPLE	IRON, TOTAL (UG/L AS FE)	IRON, DIS-SOLVED (UG/L AS FE)	MANGA-NESE, TOTAL (UG/L AS MN)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)
15/11W-05M01	80-07-10	--	110	--	10
16/11W-01M01	80-07-10	--	130	--	180
16/11W-09J01	80-07-10	--	2300	--	260
16/11W-18N02	59-11-27	10	--	--	--
	60-05-25	20	--	--	--
16/11W-31D02	80-07-10	--	50	--	20
16/12W-12B01	80-07-10	--	40	--	7
16/12W-24J03	70-08-28	420	--	200	--
16/12W-25J04	80-07-10	--	640	--	140
17/12W-03R01	71-03-31	1600	--	300	--
17/12W-03R02	80-07-01	--	720	--	300
17/12W-15A01	80-07-02	--	60	--	20
18/12W-03L01	80-07-03	--	30	--	80
18/12W-03P01	80-07-03	--	150	--	30
18/12W-10C01	80-07-03	--	410	--	270
18/12W-15R03	80-07-02	--	170	--	4
18/12W-27F01	59-11-27	330	--	--	--
19/11W-33B01	62-11-14	1000	--	400	--
19/12W-09C01	80-07-03	--	20	--	4
19/12W-27D03	80-07-01	--	70	--	80
20/12W-08P01	80-07-01	--	410	--	50
20/12W-20B01	51-01-11	2300	--	--	--
	59-11-27	3700	--	--	--
	80-09-16	--	3900	--	350

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	ELEV. OF LAND SURFACE DATUM (FT. NGVD)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH FIELD (UNITS)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	HARD-NESS (MG/L AS CACO3)
Pacific County										
10/11W-09D02	--	80-07-09	21	21	18	20.00	170	6.5	<1	40
10/11W-21D03	--	80-07-09	23	--	--	10.00	160	6.5	<1	39
11/11W-04K05	--	75-10-09	20	13	4.4	15.00	224	5.8	--	68
11/11W-04L01	--	75-10-09	20	18	7.0	17.30	45	5.7	--	20
11/11W-04L02	--	75-10-09	20	18	8.5	18.00	83	6.1	--	18
11/11W-16N02	--	80-07-09	24	--	--	20.00	98	6.3	<1	27
12/11W-15P01	--	59-12-09	10	--	--	--	82	6.3	--	17
12/11W-21M03	--	80-07-08	30	--	--	60.00	165	6.2	<1	35
12/11W-22E02	--	80-07-09	--	--	--	20.00	138	5.9	<1	34
12/11W-27N03	--	75-10-08	90	80	6.6	9.40	147	7.7	--	38
12/11W-28G01	--	71-04-19	82	77	57	15.00	158	7.7	--	34
12/11W-28G02	--	80-07-09	274	274	261	15.00	158	7.2	<1	33
12/11W-28N05	--	75-10-08	10	9.0	4.0	8.70	18000	7.6	--	2600
12/11W-28P01	--	75-10-08	20	17	8.4	17.40	318	6.3	--	110
12/11W-28P02	--	80-07-09	25	--	--	25.00	258	6.3	<1	73
12/11W-28Q01	--	75-10-08	20	18	10	19.00	76	6.2	--	18
13/10W-08R01	--	59-12-09	455	455	447	10.00	255	7.5	--	78
	--	60-05-26	455	455	447	10.00	188	8.0	--	64
	--	71-03-31	455	455	447	10.00	303	8.3	--	100
	--	80-07-11	455	455	447	10.00	295	8.2	<1	95
13/10W-21F01	--	80-07-11	180	180	150	40.00	400	7.8	<1	170
14/11W-03G01	--	78-05-24	208	--	--	--	170	7.8	--	53
	--	78-11-29	208	--	--	--	159	7.5	--	48
14/11W-11C01	--	80-07-10	198	192	189	10.00	165	7.7	<1	59
14/11W-13A04	--	80-07-10	490	--	--	10.00	160	8.2	<1	55
15/11W-18G01	--	80-07-10	72	72	66	14.00	240	7.8	<1	25
15/11W-20M01	--	80-07-10	304	--	--	15.00	180	8.2	<1	63
15/11W-32E01	--	80-07-11	146	--	--	20.00	700	7.8	<1	42
15/11W-32G01	--	71-03-31	81	81	81	20.00	236	7.9	--	15

LOCAL IDENT-I-FIER	DATE OF SAMPLE	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)
10/11W-09D02	80-07-09	15	7.2	5.4	16	1.1	1.5	25	16	19
10/11W-21D03	80-07-09	5	6.9	5.2	13	.9	2.1	34	6.4	17
11/11W-04K05	75-10-09	9	15	7.4	16	.8	.8	59	12	23
11/11W-04L01	75-10-09	13	4.0	2.5	4.3	.4	1.0	7	2.6	11
11/11W-04L02	75-10-09	5	2.9	2.6	7.2	.7	.9	13	2.3	13
11/11W-16N02	80-07-09	10	5.6	3.1	6.7	.6	.9	17	1.1	10
12/11W-15P01	59-12-09	0	4.0	1.8	8.2	.9	.5	21	3.0	9.0
12/11W-21M03	80-07-08	7	5.7	5.0	17	1.3	2.1	28	5.7	22
12/11W-22E02	80-07-09	9	11	1.5	7.4	.6	2.1	25	12	7.2
12/11W-27N03	75-10-08	0	4.0	6.7	12	.9	6.8	48	5.6	14
12/11W-28G01	71-04-19	2	4.9	5.4	17	1.3	3.3	32	9.0	25
12/11W-28G02	80-07-09	4	4.4	5.3	14	1.1	2.9	29	5.7	21
12/11W-28N05	75-10-08	2500	180	510	3400	29	160	64	820	6700
12/11W-28P01	75-10-08	8	33	6.3	23	1.0	4.9	100	6.2	37
12/11W-28P02	80-07-09	31	19	6.2	16	.8	4.1	42	17	18
12/11W-28Q01	75-10-08	7	4.6	1.7	8.7	.9	.5	11	1.6	15
13/10W-08R01	59-12-09	0	26	3.1	24	1.2	1.6	114	.6	13
	60-05-26	0	19	4.1	14	.8	2.9	83	1.4	9.0
	71-03-31	0	31	5.7	25	1.1	1.7	134	1.5	20
	80-07-11	0	29	5.5	23	1.0	2.0	120	.9	18
13/10W-21F01	80-07-11	0	33	20	13	.4	12	200	.3	8.4
14/11W-03G01	78-05-24	0	12	5.5	13	.8	1.0	53	2.6	14
	78-11-29	0	11	4.9	12	.8	1.0	53	4.0	21
14/11W-11C01	80-07-10	2	14	5.8	9.6	.5	1.3	57	4.4	12
14/11W-13A04	80-07-10	1	17	3.1	7.7	.5	1.6	54	8.2	8.6
15/11W-18G01	80-07-10	0	2.2	4.7	40	3.5	8.3	88	3.2	15
15/11W-20M01	80-07-10	11	18	4.5	10	.5	1.7	52	7.1	15
15/11W-32E01	80-07-11	0	6.5	6.3	130	8.7	5.0	100	24	150
15/11W-32G01	71-03-31	0	1.7	2.5	41	4.7	2.5	75	5.3	18

LOCAL IDENT-I-FIER	DATE OF SAMPLE	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	NITRO-GEN, NITRATE TOTAL (MG/L AS NO3)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)
Pacific County								
10/11W-09D02	80-07-09	.2	26	--	109	--	--	.52
10/11W-21D03	80-07-09	.2	35	--	110	--	--	.46
11/11W-04K05	75-10-09	--	--	--	--	--	.02	--
11/11W-04L01	75-10-09	--	--	--	--	--	.57	--
11/11W-04L02	75-10-09	--	--	--	--	--	.35	--
11/11W-16N02	80-07-09	.1	20	--	68	--	--	2.2
12/11W-15P01	59-12-09	.1	20	59	59	.60	--	--
12/11W-21M03	80-07-08	.2	25	--	103	--	--	.83
12/11W-22E02	80-07-09	.2	7.0	--	73	--	--	1.8
12/11W-27N03	75-10-08	--	--	--	--	--	.07	--
12/11W-28G01	71-04-19	.1	35	120	120	--	.30	--
12/11W-28G02	80-07-09	.2	31	--	103	--	--	.25
12/11W-28N05	75-10-08	--	--	--	--	--	2.0	--
12/11W-28P01	75-10-08	--	--	--	--	--	1.3	--
12/11W-28P02	80-07-09	.2	13	--	128	--	--	2.0
12/11W-28Q01	75-10-08	--	--	--	--	--	.17	--
13/10W-08R01	59-12-09	.1	24	155	160	.00	--	--
	60-05-26	.0	32	137	134	.70	--	--
	71-03-31	.0	28	182	193	--	.00	--
	80-07-11	.2	25	--	176	--	--	.00
13/10W-21F01	80-07-11	.2	51	--	258	--	--	.00
14/11W-03G01	78-05-24	.1	31	111	111	--	.08	--
	78-11-29	.1	31	114	107	--	.11	--
14/11W-11C01	80-07-10	.2	25	--	107	--	--	.00
14/11W-13A04	80-07-10	.2	25	--	104	--	--	.00
15/11W-18G01	80-07-10	.5	30	--	157	--	--	.00
15/11W-20M01	80-07-10	.2	18	--	106	--	--	.00
15/11W-32E01	80-07-11	.3	33	--	415	--	--	.00
15/11W-32G01	71-03-31	.1	29	[illegible]	145	--	.00	--

LOCAL IDENT-I-FIER	DATE OF SAMPLE	IRON, TOTAL (UG/L AS FE)	IRON, DIS-SOLVED (UG/L AS FE)	MANGA-NESE, TOTAL (UG/L AS MN)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)
10/11W-09D02	80-07-09	--	430	--	70
10/11W-21D03	80-07-09	--	1700	--	80
11/11W-04K05	75-10-09	--	--	--	--
11/11W-04L01	75-10-09	--	--	--	--
11/11W-04L02	75-10-09	--	--	--	--
11/11W-16N02	80-07-09	--	20	--	1
12/11W-15P01	59-12-09	120	--	--	--
12/11W-21M03	80-07-08	--	70	--	4
12/11W-22E02	80-07-09	--	1600	--	20
12/11W-27N03	75-10-08	--	--	--	--
12/11W-28G01	71-04-19	420	--	50	--
12/11W-28G02	80-07-09	--	280	--	20
12/11W-28N05	75-10-08	--	--	--	--
12/11W-28P01	75-10-08	--	--	--	--
12/11W-28P02	80-07-09	--	20	--	<3
12/11W-28Q01	75-10-08	--	--	--	--
13/10W-08R01	59-12-09	50	--	--	--
	60-05-26	40	--	--	--
	71-03-31	60	--	30	--
	80-07-11	--	40	--	30
13/10W-21F01	80-07-11	--	180	--	280
14/11W-03G01	78-05-24	760	--	<10	--
	78-11-29	--	<10	--	2
14/11W-11C01	80-07-10	--	20	--	5
14/11W-13A04	80-07-10	--	<10	--	10
15/11W-18G01	80-07-10	--	580	--	50
15/11W-20M01	80-07-10	--	10	--	6
15/11W-32E01	80-07-11	--	40	--	40
15/11W-32G01	71-03-31	50	--	50	--

TABLE 16.--Trace-element concentrations in ground-water samples from the coastal areas of Pacific and Grays Harbor Counties

LOCAL IDENT-I-FIER	DATE OF SAMPLE	ALUM-INUM, DIS-SOLVED (UG/L AS AL)	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COPPER, DIS-SOLVED (UG/L AS CU)	LEAD, DIS-SOLVED (UG/L AS PB)	MERCURY DIS-SOLVED (UG/L AS HG)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)
Pacific County										
11/11W-16N02	80-07-09	10	1	8	<1	0	70	0	.0	0
12/11W-28G01	71-04-19	--	--	--	--	<30	<50	<100	--	--
12/11W-28G02	80-07-09	10	3	10	<1	0	6	0	.0	0
13/10W-08R01	71-03-31	--	--	--	--	<30	<50	<100	--	--
	80-07-11	0	1	8	<1	0	4	0	.0	0
14/11W-13A04	80-07-10	0	5	8	<1	0	4	0	.0	0
15/11W-32G01	71-03-31	--	--	--	--	<30	<50	<100	--	--
Grays Harbor County										
15/11W-05M01	80-07-10	0	1	30	<1	0	5	3	.0	0
16/11W-09J01	80-07-10	10	1	10	<1	10	5	3	.0	0
16/12W-25J04	80-07-10	0	1	20	<1	0	4	2	.0	0
17/12W-03R01	71-03-31	--	--	--	--	<30	<50	<100	--	--
17/12W-03R02	80-07-01	0	1	20	<1	0	8	0	.0	0
18/12W-03L01	80-07-03	20	1	10	<1	10	3	0	.0	0
18/12W-03P01	80-07-03	0	0	9	<1	0	8	0	.0	0

LOCAL IDENT-I-FIER	DATE OF SAMPLE	SILVER, DIS-SOLVED (UG/L AS AG)	ZINC, DIS-SOLVED (UG/L AS ZN)
Pacific County			
11/11W-16N02	80-07-09	0	100
12/11W-28G01	71-04-19	--	50
12/11W-28G02	80-07-09	0	10
13/10W-08R01	71-03-31	--	<10
	80-07-11	0	6
14/11W-13A04	80-07-10	0	5
15/11W-32G01	71-03-31	--	<10
Grays Harbor County			
15/11W-05M01	80-07-10	0	1700
16/11W-09J01	80-07-10	0	420
16/12W-25J04	80-07-10	0	40
17/12W-03R01	71-03-31	--	20
17/12W-03R02	80-07-01	0	30
18/12W-03L01	80-07-03	0	40
18/12W-03P01	80-07-03	0	70

GROUND-WATER QUALITY FOR THE QUINAULT LAKE AREA IN GRAYS HARBOR COUNTY

The locations of wells sampled in the vicinity of Quinault Lake in Grays Harbor County are shown on plate 5. These locations are within the Olympic Peninsula aquifer region (fig. 1). All wells sampled in the vicinity of Lake Quinault were finished in glaciofluvial or alluvial deposits.

The ground water sampled in the vicinity of Lake Quinault can be characterized as soft water with a low concentration of dissolved solids. Hardness values ranged from 14 to 38 mg/L as $CaCO_3$, and dissolved-solids concentrations ranged from 26 to 127 mg/L (table 17). Except for the sample from well 22/10W-33A1, all water was calcium-magnesium bicarbonate-type (pl. 5). Nitrate concentrations in the ground-water samples were low, ranging from 0.00 to 0.19 mg/L (NO_3-N). Concentrations of iron and manganese that exceed recommended concentration levels were found in two samples, and somewhat low pH values (less than 6.5) were found in three samples (table 18). No other trace-metal determinations were made on samples collected in 1980, and historic data are sparse (table 19).

TABLE 17.--Summary of biological and major chemical-constituent data for ground-water samples from the vicinity of Quinault Lake in Grays Harbor County

[Values in milligrams per liter except as indicated. umho, micromhos per centimeter at 25°; col/100 mL, colonies per 100 milliliters; ug/L, micrograms per liter]

Constituent	Maximum	Minimum	Median	Number of sample sites
Specific conductance (umho)	195	36	63	8
pH (units)	7.9	6.2	6.6	8
Fecal-coliform bacteria (col/100 mL)	<1	<1	<1	3
Hardness (as $CaCO_3$)	38	14	20	8
Hardness, noncarbonate (as $CaCO_3$)	5	0	0	8
Dissolved calcium	11	3.6	5.2	8
Dissolved magnesium	3.3	.7	1.3	8
Dissolved sodium	32	2.0	3.2	8
Sodium adsorption ratio	2.4	.2	.3	8
Dissolved potassium	1.0	.2	.4	8
Alkalinity (as $CaCO_3$)	103	9	24	8
Dissolved sulfate	3.3	.9	2.5	8
Dissolved chloride	4.2	2.2	2.9	8
Dissolved fluoride	.1	0	.05	8
Dissolved silica (as SiO_2)	15	6.1	12	8
Dissolved solids (residue at 180°C)	124	38	54	4
Dissolved solids (sum of constituents)	127	26	40	8
Nitrate (as N)	.19	.00	.05	8
Iron, total recoverable (ug/L)	1,700	80	235	4
Iron, dissolved (ug/L)	690	20	35	4
Manganese, total recoverable (ug/L)	170	<20	<50	3
Manganese, dissolved (ug/L)	10	3	7	4

TABLE 18.--Biological and major-chemical-constituent data for ground-water samples from the vicinity of Quinault Lake in Grays Harbor County

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	PH (UNITS)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	HARD-NESS (MG/L AS CACO3)
21/09W-02L01	112GLCV	65-09-30	28	--	--	560.00	96	7.9	--	38
22/10W-31A01	112GLCV	72-03-01	291	285	245	150.00	195	7.3	--	34
22/10W-31A01S	112GLCV	80-07-01	--	--	--	170.00	64	6.9	<1	21
23/09W-04P01	110ALVM	80-09-16	100	95	90	230.00	71	6.4	<1	26
23/09W-10L01	110ALVM	80-07-01	130	68	68	200.00	36	6.3	<1	14
23/09W-19N01	112GLCV	58-04-24	46	42	27	200.00	53	6.6	--	18
23/10W-19E01	112GLCV	72-03-01	98	98	83	470.00	61	6.6	--	17
23/10W-23E03	112GLCV	80-07-01	101	100	92	412.00	45	6.2	<1	17

LOCAL IDENT-I-FIER	DATE OF SAMPLE	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY FIELD (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)
21/09W-02L01	65-09-30	0	9.6	3.3	5.9	.4	.3	43	2.4	3.0
22/10W-31A01	72-03-01	0	11	1.5	32	2.4	.4	103	2.6	4.2
22/10W-31A01S	80-07-01	0	4.9	2.1	3.2	.3	.2	25	.9	3.8
23/09W-04P01	80-09-16	4	8.4	1.1	2.3	.2	.4	22	3.3	2.2
23/09W-10L01	80-07-01	5	4.4	.7	2.0	.2	.3	9	3.3	2.6
23/09W-19N01	58-04-24	0	5.4	1.1	2.6	.3	1.0	19	2.6	2.2
23/10W-19E01	72-03-01	0	3.6	1.9	5.1	.5	.5	28	1.0	3.6
23/10W-23E03	80-07-01	0	5.0	1.1	3.1	.3	.4	23	1.8	2.8

LOCAL IDENT-I-FIER	DATE OF SAMPLE	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	NITRO-GEN, NITRATE TOTAL (MG/L AS NO3)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)
21/09W-02L01	65-09-30	.1	15	68	66	.20	--	--
22/10W-31A01	72-03-01	.1	14	124	127	--	.04	--
22/10W-31A01S	80-07-01	.1	14	--	45	--	--	.14
23/09W-04P01	80-09-16	.0	6.1	--	38	--	--	.00
23/09W-10L01	80-07-01	.0	6.7	--	26	--	--	.05
23/09W-19N01	58-04-24	.0	13	40	40	.40	--	--
23/10W-19E01	72-03-01	.1	6.6	38	39	--	.01	--
23/10W-23E03	80-07-01	.0	10	--	39	--	--	.19

LOCAL IDENT-I-FIER	DATE OF SAMPLE	IRON, TOTAL RECOV-ERABLE (UG/L AS FE)	IRON, DIS-SOLVED (UG/L AS FE)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)
21/09W-02L01	65-09-30	190	--	<50	--
22/10W-31A01	72-03-01	80	--	<20	--
22/10W-31A01S	80-07-01	--	20	--	10
23/09W-04P01	80-09-16	--	690	--	4
23/09W-10L01	80-07-01	--	40	--	3
23/09W-19N01	58-04-24	280	--	--	--
23/10W-19E01	72-03-01	1700	--	170	--
23/10W-23E03	80-07-01	--	30	--	10

TABLE 19.--Trace-element concentrations in ground-water samples from the vicinity of Quinault Lake in Grays Harbor County

LOCAL IDENT-I-FIER	DATE OF SAMPLE	ARSENIC DIS-SOLVED (UG/L AS AS)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COPPER, DIS-SOLVED (UG/L AS CU)	LEAD, DIS-SOLVED (UG/L AS PB)	ZINC, DIS-SOLVED (UG/L AS ZN)
21/09W-02L01	65-09-30	<5	<30	10	--	70
22/10W-31A01	72-03-01	--	<30	<50	<100	<10
23/10W-19E01	72-03-01	--	<30	<50	<100	110

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