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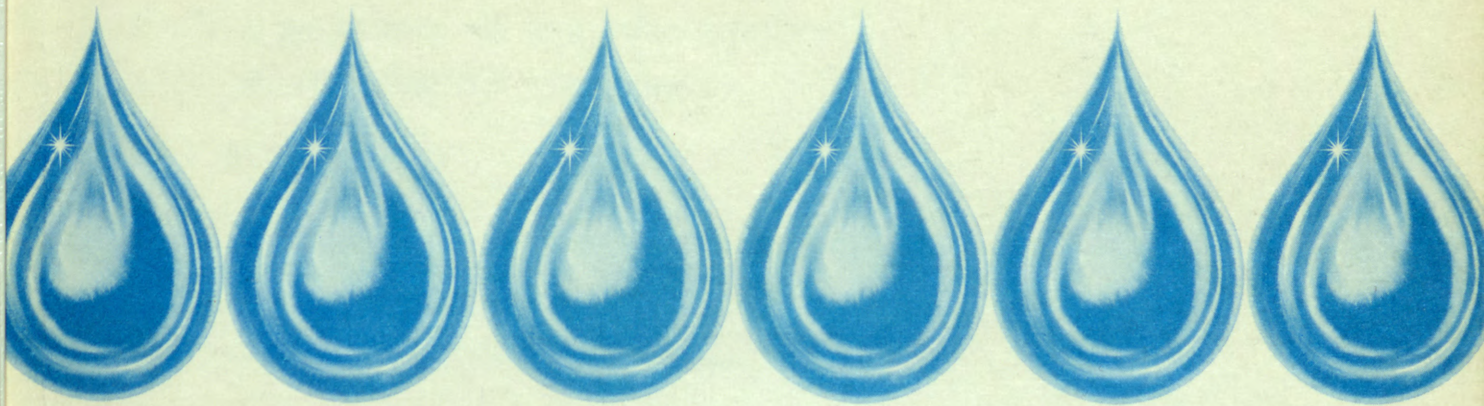
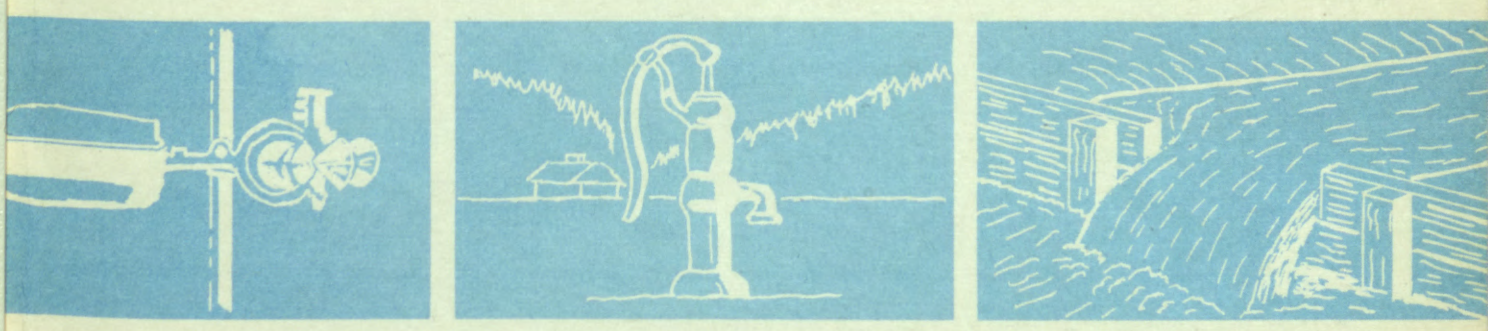


WATER RESOURCES OF THE PORT MADISON INDIAN RESERVATION, WASHINGTON



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WATER RESOURCES OF THE PORT MADISON INDIAN RESERVATION, WASHINGTON

By W. E. Lum II

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 78-112

Prepared in cooperation with the
Suquamish Tribal Council

Tacoma, Washington
1979

UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY

H. William Menard, Director

Open-File Report

For additional information write to:

U.S. Geological Survey
1201 Pacific Avenue - Suite 600
Tacoma, Washington 98402

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[Plate in pocket]

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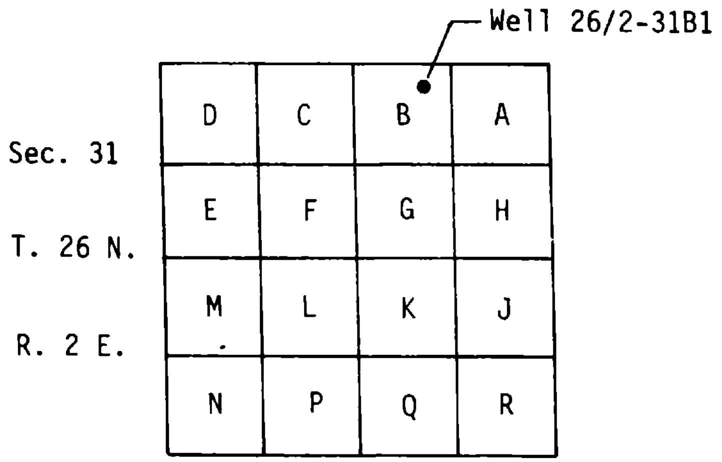
WELL-NUMBERING SYSTEM

In this report wells are designated by symbols that indicate their location according to the official rectangular public-land survey. For example, in the symbol 26/2-31B1, the part preceding the hyphen indicates successively the township and range (T.26 N., R.2 E.) north and east of the Willamette base line and meridian. The first number following the hyphen indicates the section (sec. 31), and the letter (B) indicates the 40-acre subdivision of the section, as shown in the accompanying diagram.



The last number is the serial number of the well in the particular 40-acre tract. Thus, well 26/2-31B1 is in the NW1/4NE1/4 sec. 31, T.26 N., R.2 E., and is the first well in the tract to be listed. In table 3 (computer printout) well numbers are modified somewhat, and well 26/2-31B1 becomes 26N/02E-31B01. In plate 1 (map of the study area) this same well would be marked B1.

METRIC CONVERSION FACTORS

Multiply	By	To obtain
inches	25.4	millimeters (mm)
feet (ft)	.3048	meters (m)
miles	1.609	kilometers (km)
acres	.4047	hectares (ha)
gallons per minute (gal/min)	.06309	liters per second (L/s)
gallons per day (gal/d)	3.785	liters per day (L/d)
cubic feet per second (ft^3/s)	.02832	cubic meters per second (m^3/s)
	28.32	liters per second (L/s)
feet squared per day (ft^2/d)	.0929	meters squared per day (m^2/d)
degrees Fahrenheit (°F)	Subtract 32, multiply remainder by 0.5556	degrees Celsius (°C)

WATER RESOURCES OF THE PORT MADISON INDIAN RESERVATION, WASHINGTON

By W. E. Lum II

ABSTRACT

The study summarized in this report was made to provide Suquamish Tribal leaders with information on the reservation's surface- and ground-water resources. The Tribal leaders need this information to help them manage and protect their water resources against overdevelopment. The quantity of ground water that is estimated to be available for withdrawal on a long-term basis is about 600 million gallons per year in the western part of the reservation and 400 million gallons per year in the eastern part of the reservation. It should be possible, economically and practically, to capture at least 40 percent of this ground water with properly constructed and located wells before it is discharged into the sea. This is enough water to supply at least 5,000 and 3,500 people with domestic water in these respective areas—about four times the present population.

Of nine stream sites that were studied on and near the reservation, the lowest average streamflows for a 7-day period estimated to occur an average of once in 2 years were 1.3 cubic feet per second or less. Streams at three of the sites have been observed dry at least once. The short period of data collection during this study limits the accuracy of statistical estimates of low flows.

Both surface and ground water were found to be of good quality with no unusual or harmful constituents; there was no evidence of major pollution in 1977. In the future, seawater intrusion into the ground-water system and pollution of the surface water by improperly treated sewage waste water could become problems.

INTRODUCTION

Purpose and Scope of the Study

The Port Madison Indian Reservation, which is inhabited by the Suquamish Indian Tribe, is located within a broad area that is expected to have an increase in population of as much as 50 percent in the next few years (Hansen and Molenaar, 1976). This is because of the construction and future operation of the Trident Nuclear Submarine Facility at nearby Bangor, Wash. Along with this population increase there will be a considerable increase in water use and potential for contamination of both ground and surface waters.

With this in mind, the Suquamish Tribal Council in 1975 decided that they needed: (1) An evaluation of the present ground- and surface-water resources of the Port Madison Indian Reservation and (2) development of a data base covering all water resources. These data would serve as background information, to guide the development of water supplies, to protect the resource from depletion or contamination, and to assess any future changes. Tribal officials also desired specific information on:

1) Low-flow characteristics of streams (on or near the reservation) that may be used for increasing the tribe's salmon-rearing capabilities;
2) actual or potential contamination of the ground- or surface-water resources; and
3) what impact, if any, the increased use of water in the area would have on the water resources of the reservation.

To evaluate those items and to develop the data base the Suquamish Tribal Council requested the U.S. Geological Survey to make a study of the area directed generally at the water resources of the reservation and specifically at the following areas:

1) Ground water - Determine water levels in the aquifer systems underlying the reservation and delineate possible areas for development of additional ground-water supplies; evaluate the quality of the ground water relative to actual or potential pollution problems; and tabulate the existing water use on the reservation.

2) Surface water - Collect data on surface-water quantity and quality and estimate the low flow of streams to help in future planning for use and management of the surface-water resource for any uses related to salmon rearing the tribe may undertake.

Description of the Study Area

The Port Madison Indian Reservation lies in the northern part of the Kitsap Peninsula in the Puget Sound Lowland of western Washington (fig. 1). The reservation is about 12 miles north of Bremerton, and covers 11.6 mi^2 or about 7,400 acres; 6.76 mi^2 (4,330 acres) in the western part and 4.82 mi^2 (3,080 acres) in the eastern part. About 36 percent of the reservation (2,700 acres) is in allotted status,[1] less than 1 percent (less than 1 acre) is government-owned, less than 1 percent (about 50 acres) is tribally-owned, and the remainder, about 62 percent or about 4,670 acres, is alienated land.[2]

The moderately undulating land surface in the study area rises from sea level to a maximum altitude of about 420 ft (pl. 1) and is covered mostly with second-growth fir, cedar, alder, and very dense underbrush. Land which has been cleared for housing, agriculture, or grazing accounts for less than 3 percent of the total area of the reservation. Marshland covers between 2 and 3 percent.

Economic development in the study area includes a booming (1977) building-construction industry, a small sand, gravel, and cement industry, and several stores and gas stations in the two major communities of Suquamish (pop. 1,200, 1975 est. by author) and Indianola (pop. 400, 1975 est. by author). The population of the entire reservation (1976) is estimated by the author to be about 2,400 people.

Climate of the Study Area

The normal annual precipitation over the reservation ranges from about 30 inches in the eastern part of the reservation to about 35 inches in the western part (U.S. Weather Bureau, 1965). A weather observaton station at Everett, on the mainland, about 25 miles northeast of the reservation provides long-term data on the monthly distribution of precipitation and average temperature that is representative of the study area. The average annual precipitation at the Everett station during 62 years of record (1915-76) was about 35 inches. Almost 70 percent of the precipitation occurs during the period October-March. The average annual temperature is 50.5°F, and monthly averages range from 38.2°F in January to 62.7°F in July. Average monthly precipitation and temperatures are shown in figure 2. (All climatic data are from the [U.S.] National Oceanic and Atmospheric Administration, 1977a.)

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[1]Land owned by individual members of the tribe.
[2]Land owned by non-Indians.

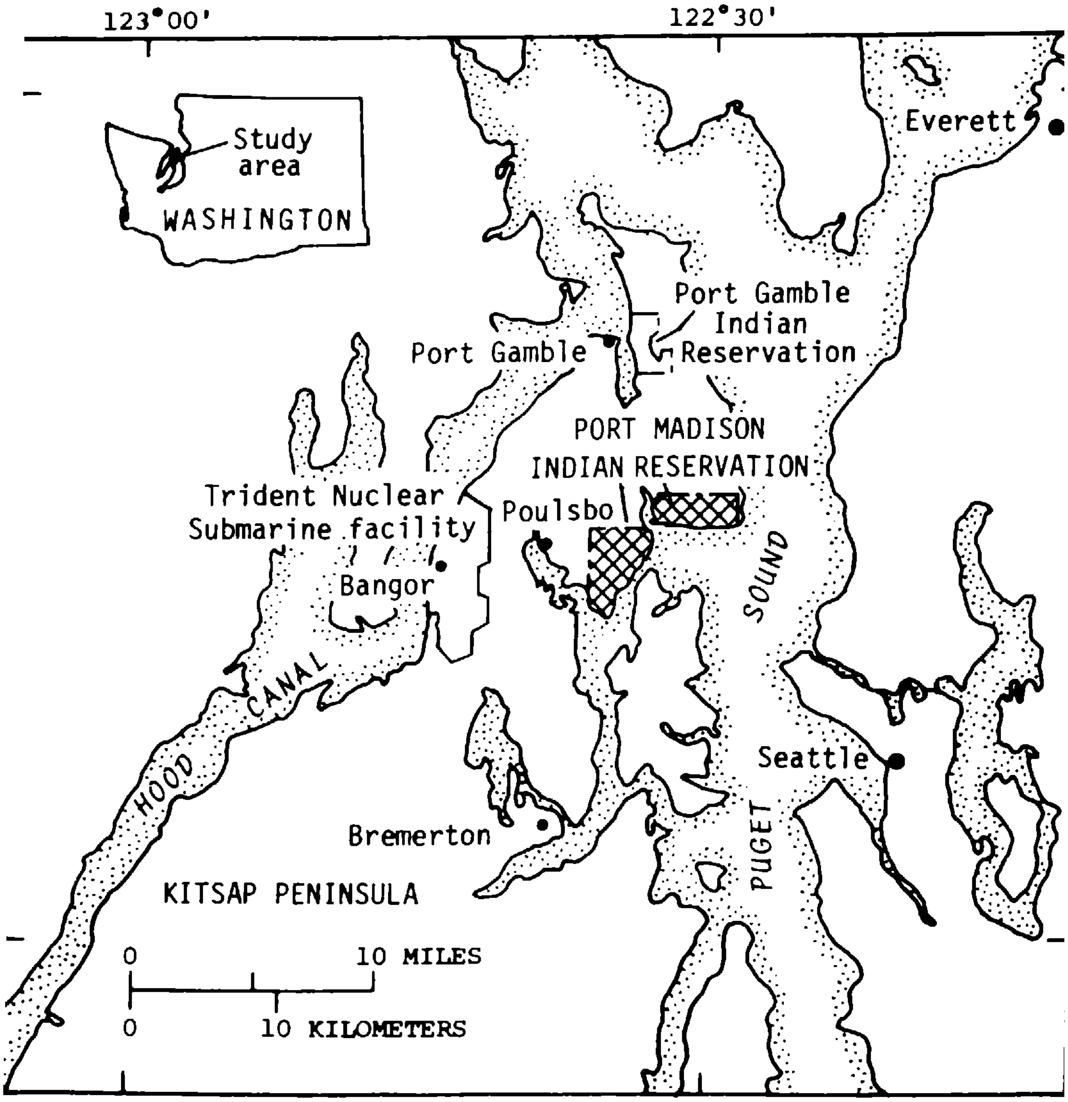


FIGURE 1.--Location of Port Madison Indian Reservation

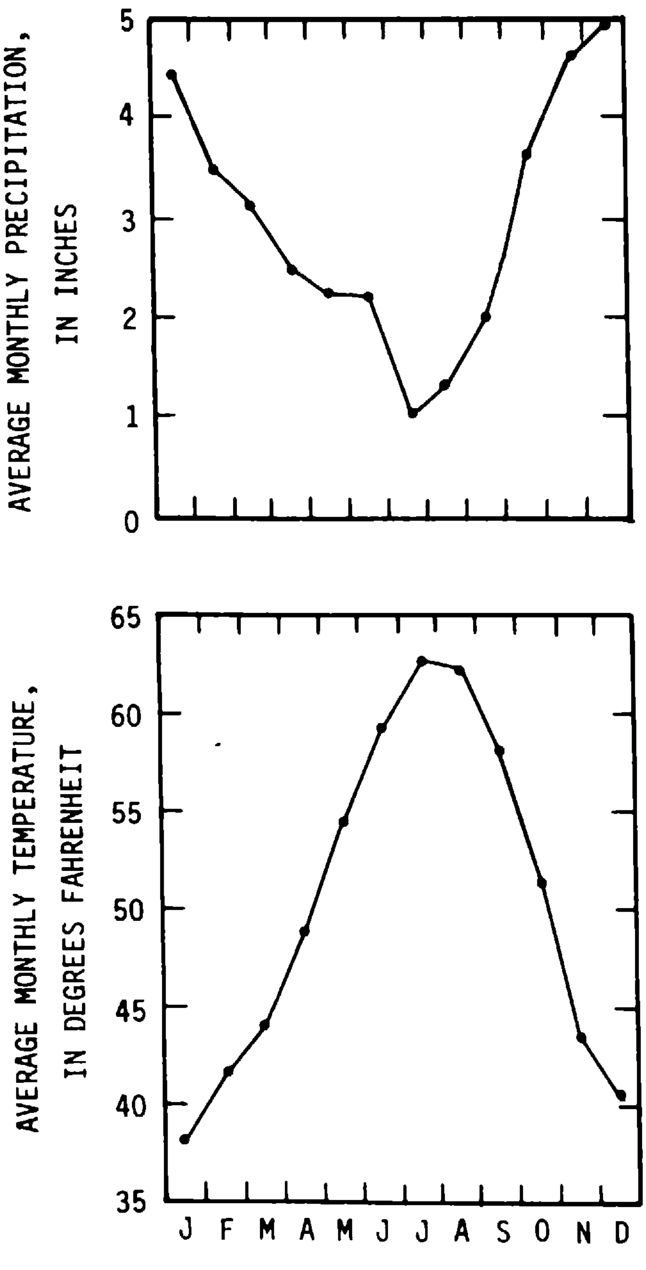


FIGURE 2.--Average monthly precipitation and temperature at Everett, Wash., for period 1915-76. Data from [U.S.] National Oceanic and Atmospheric Administration (1977a).

Previous Investigations

The Kitsap Peninsula and adjacent areas have been the subject of numerous studies in the past 20 years, all of which were used in the interpretation of the geology as discussed in this report. Sceva (1957) investigated the geology and ground-water resources of Kitsap County. Garling, Molenaar, and others (1965) discussed both surface- and ground-water resources of the Kitsap Peninsula and certain adjacent islands. The latter of these two reports provided most of the geology and ground-water information used by Hansen and Molenaar (1976) to prepare a preliminary report on the availability of ground water in the area surrounding the Trident Nuclear Submarine Facility. Walters (1971) made a reconnaissance of seawater intrusion along coastal areas of Washington, including the Kitsap Peninsula. Surface-water resources of the Kitsap Peninsula, specifically low-flow characteristics of streams, were studied by Hidaka (1973) and Cummans (1977).

Acknowledgments

This study was made in cooperation with the Suquamish Tribal Council of the Port Madison Indian Reservation. The Bureau of Indian Affairs also participated in the planning of the study. Individual members of the Suquamish Tribe and other residents of the reservation and nearby areas were helpful in many ways during the field investigations. Local well drillers, Jerry Crabtree and George Burt, provided numerous drillers' logs and other pertinent data which were helpful to the study. Representatives of the Western Washington Service Unit of the Indian Health Service (U.S. Department of Health, Education, and Welfare), were also helpful, providing well logs, water-quality data, and information on pumping tests.

THE HYDROLOGIC CYCLE

: hydrologic cycle is the pattern of water movement as it circulates through tural system. Precipitation as rain and snow is the source of all fresh water. : of the precipitation runs off rapidly to streams, and a part is evaporated ly back to the atmosphere from the ground and from lakes, streams, and plant es. A part soaks into the soil where some is drawn up by plants and returns : atmosphere by transpiration from the leaves; the remainder percolates ard to a zone of saturation to become ground water. In time, most of the l water returns to the surface-water system by seepage to springs, lakes, ıs, and the sea. The hydrologic cycle is illustrated diagrammatically in figure

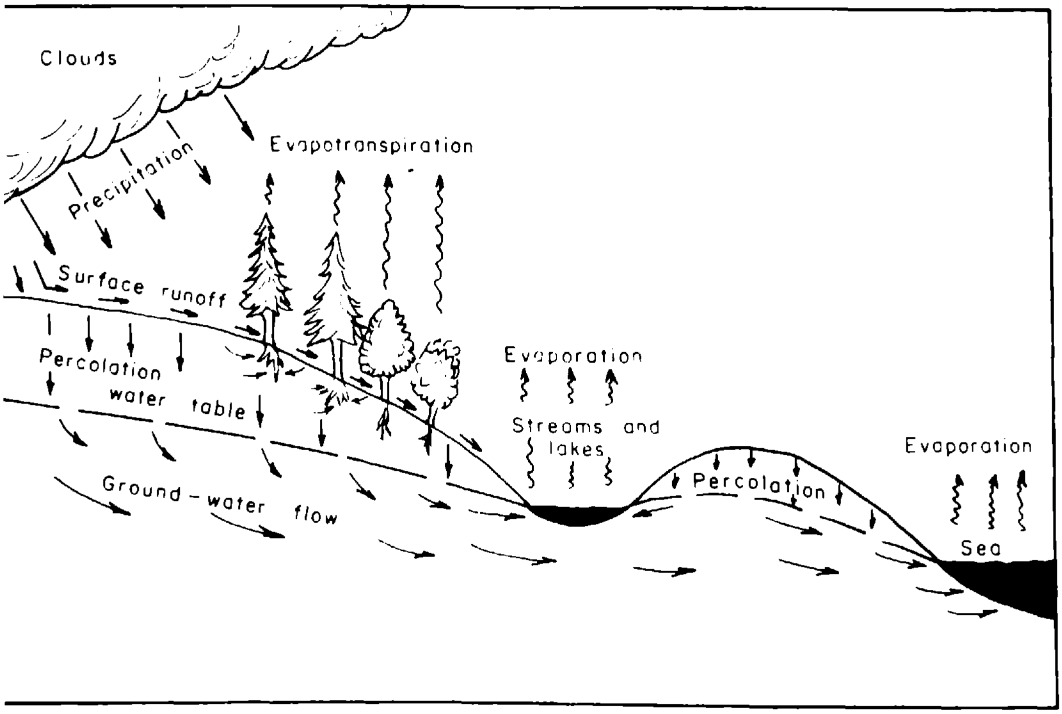


FIGURE 3.--Diagrammatic sketch of the hydrologic cycle.

Geology of the Study Area

The Port Madison Indian Reservation is underlain by thick glacial deposits; in some parts of the Puget Sound Lowland these are as much as 2,000 ft thick (Walters and Kimmel, 1968). The thickness of these deposits under the reservation is not accurately known but probably exceeds 1,000 feet. Most of the material at the surface (fig. 4) is till ("hardpan") a very compact, concretelike mixture of sediments ranging in size from clay through gravel and boulders. The till, mostly 20 to 50 ft thick, was smeared onto the land surface under moving glacial ice during the Pleistocene "ice age", which ended about 12,000 years ago. The upper 10 to 20 ft of the till is commonly weathered and brownish, whereas deeper, unweathered till is grayish-blue. Till is also found deep below land surface, deposited there by previous glacial ice advances and subsequently covered by younger glacial deposits. Drill cuttings from a deeply buried till layer are difficult to recognize, and some drillers' logs may list till as "sand, gravel, and clay" or "clay with sand and gravel" and usually list its color as "blue".

Underlying the surficial till are sand, gravel, and clay layers in varying thicknesses, as shown in the geologic sections (fig. 5). The sand and gravel were deposited both in stream channels and as deltas, and the clay and silt were generally deposited in shallow lakes, sometimes at the margins of the glacial ice sheets.

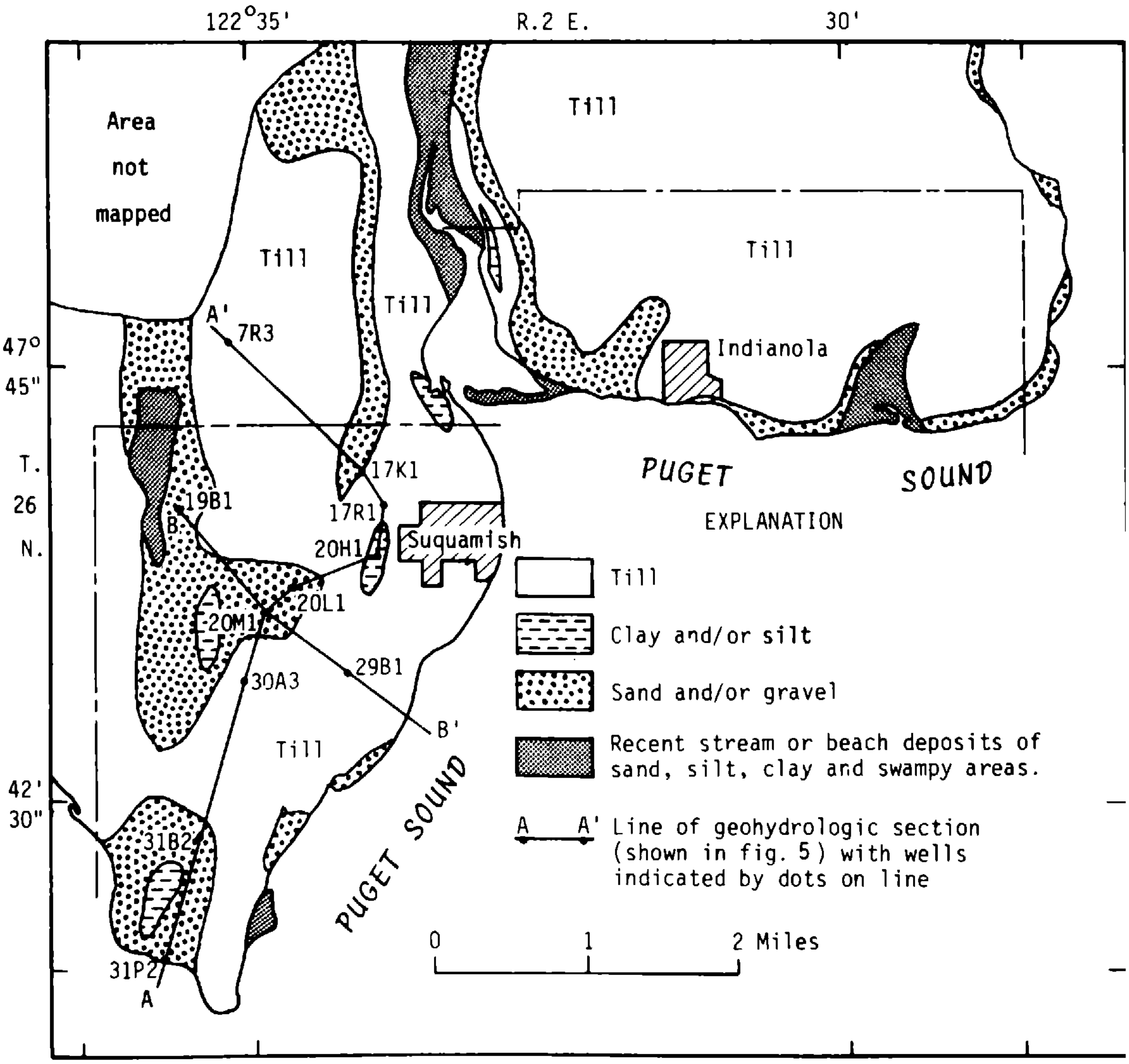


FIGURE 4.--Generalized surficial geology of the study area.

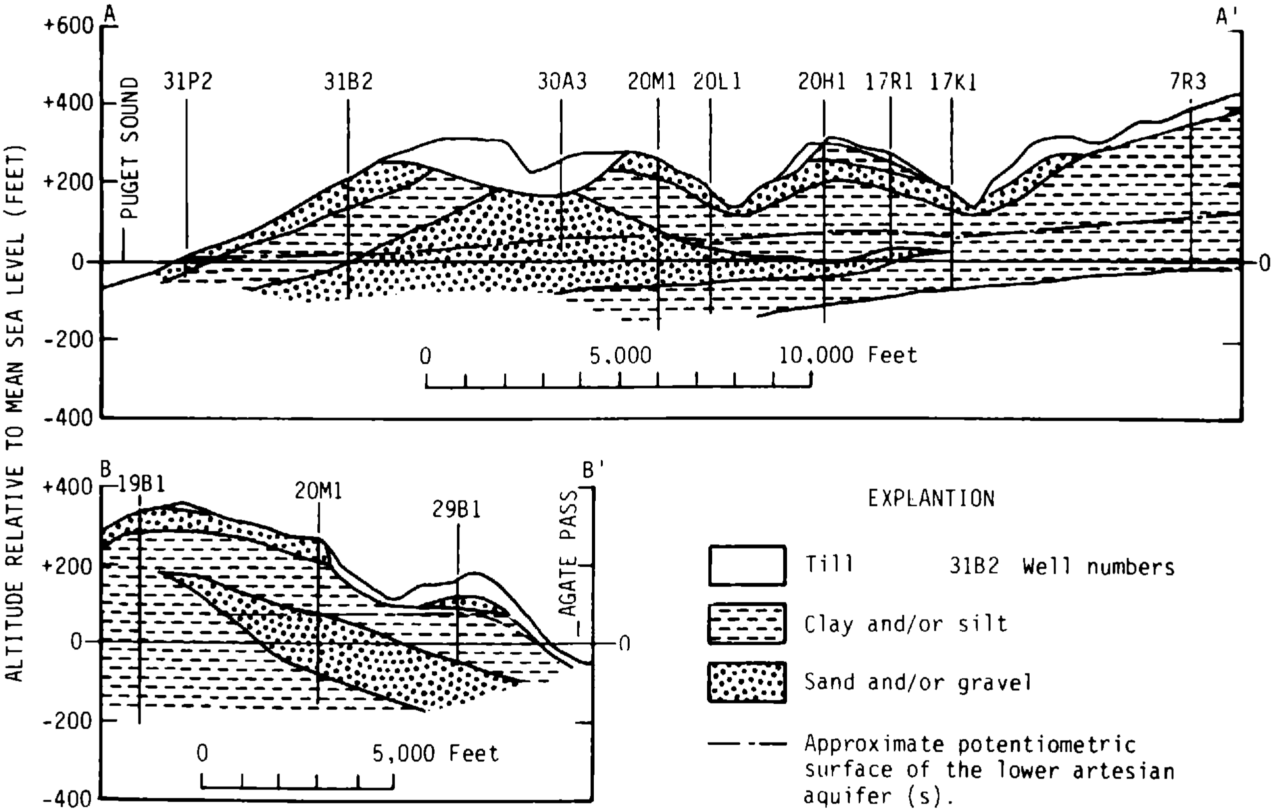


FIGURE 5.--Generalized geologic sections A-A' and B-B'. (The loctions of the sections are shown in fig. 4.)

Wells and Aquifers

Wells in the study area range in depth from 6 ft to more than 500 ft (see tables 3 and 4, p. 31 and 41) and are capable of yielding from about 1 gal/min to about 500 gal/min. Shallow wells (less than about 100 ft deep) that tap the near-surface weathered till zone and associated fine sand layers more than 100 ft above sea level yield barely enough water for one or two households and sometimes are dry, or nearly dry, late in the summer. Wells that tap the more permeable sand and gravel aquifers at greater depth (near or below sea level) are capable of producing substantial and more reliable quantities of water.

All 14 wells in the study area that have a capacity of 75 gal/min or more tap aquifers that are from about 100 ft above msl (mean sea level) to about 200 ft below msl. In the northeastern section of the reservation (north and east of Indianola) the logs of three of these wells (26/2-9H1, 10N1, and 13A1) show that the major aquifer in that area is about 50 to 200 ft below msl, and test-pumping data indicate that yields are about 75 to 150 gal/min. To the north and west of Suquamish three wells (26/1-12Q2 and 13B1, and 26/2-18D2), that tap an aquifer about 35 to 100 ft above msl, have capacities ranging from 150 to more than 300 gal/min. To the south of these wells and directly west of Suquamish wells 26/2-20H1, 20L1, and 20M1 tap an aquifer between about sea level and about 160 ft below msl, and have capacities ranging from about 200 to 500 gal/min. Southwest of Suquamish wells 26/2-30N1, 31B3, 31D2, and 31J2 tap an aquifer about 10 ft above to about 65 ft below msl, and have capacities ranging from 100 gal/min to more than 250 gal/min.

Water-level data suggest that all the lower aquifers are hydraulically interconnected to some degree, with the materials separating them allowing ground water to leak from one to another. Figure 6 shows the approximate average potentiometric surface for these lower aquifers, as determined from measured or reported water levels collected during the well inventory of October 1975-March 1976. A well drilled into the lower aquifers, as described above by area, would have a water level approximately as shown in figure 6. All water levels in the lower aquifers are artesian (that is, the water rises in the well casing above the top of the aquifer) but no flowing wells tapping these aquifers were found in the study area.

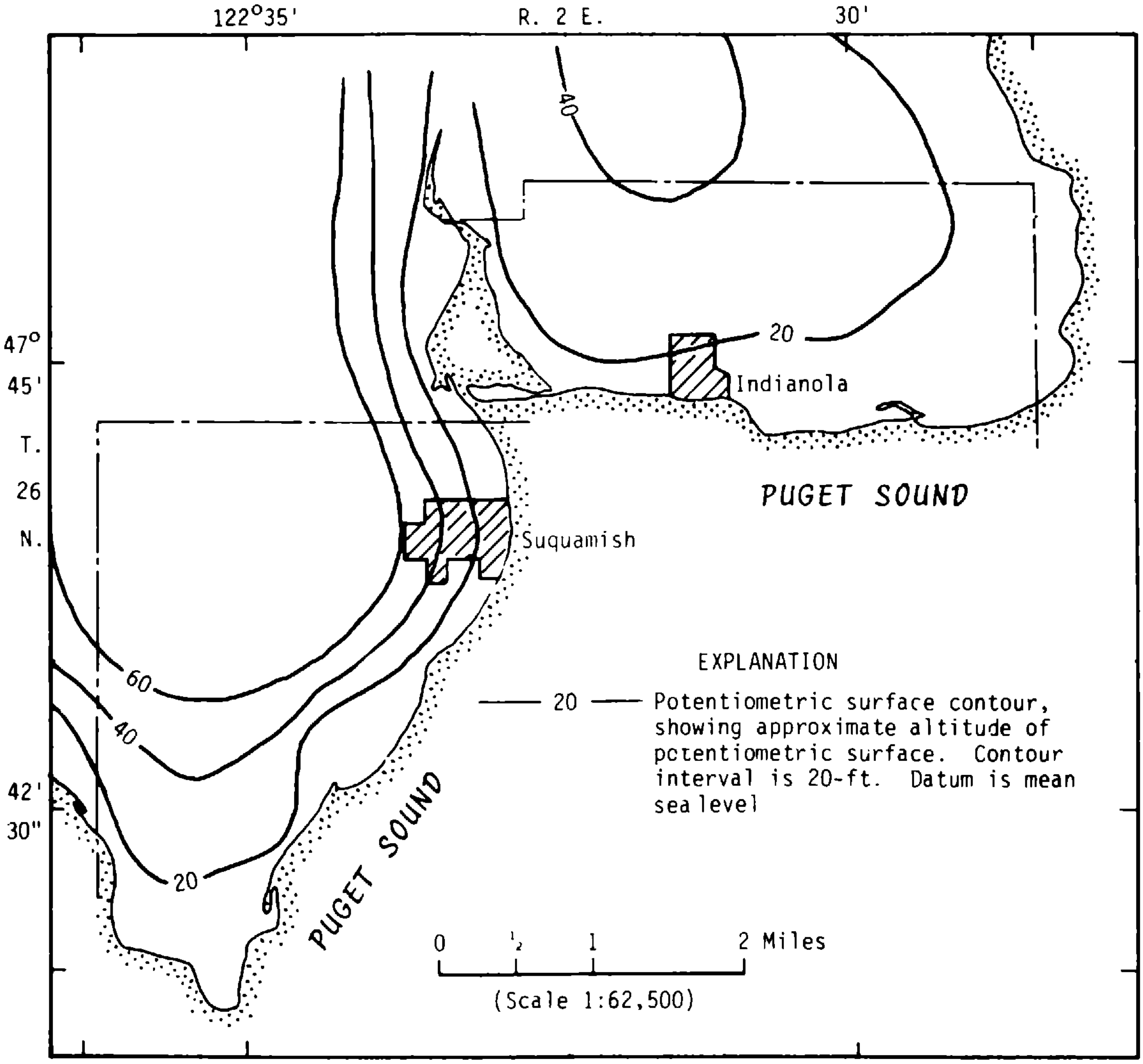
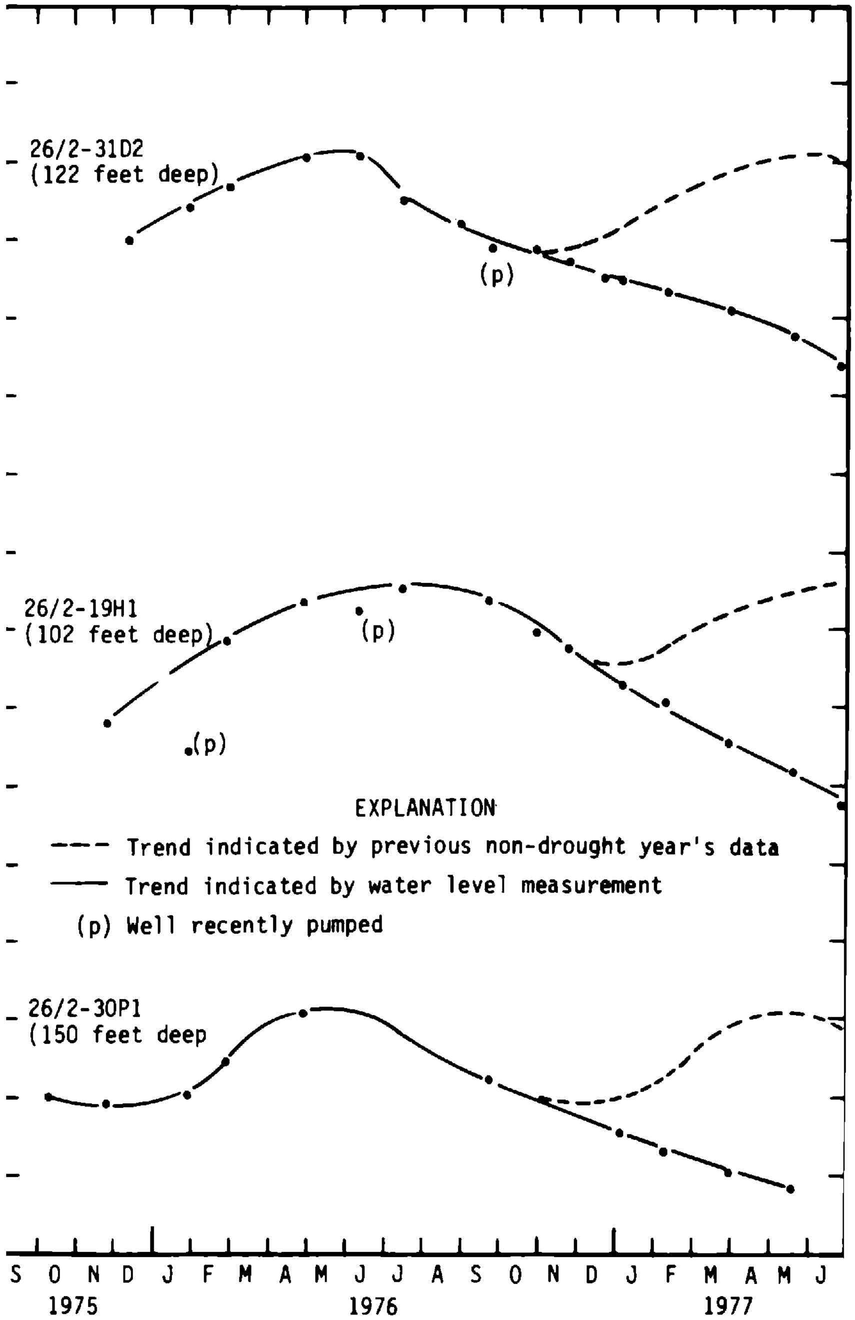


FIGURE 6.--Approximate altitude of the potentiometric surface of the lower aquifer system.

Seasonal Variations of Ground-Water Levels

Ground-water levels are subject to seasonal changes due primarily to variations in the rainfall that recharges the aquifers. Lowest water levels usually occur in late fall or early winter (October-December), which is about 3 to 4 months after the period of lowest precipitation and highest water usage. Conversely, highest water levels usually occur in late spring to early summer (May-July), after the heavy winter precipitation has had time to percolate downward and recharge the aquifers. Figure 7 shows the pattern of seasonal water-level fluctuations, and the effects of below normal precipitation during 1976-77 in three wells on the reservation. Figure 7 is based on water-level data presented in table 5 (p. 54).

Seasonal water-level fluctuations in the three wells (fig. 7), and probably others in this area, were greatly altered by the unusually dry fall and winter of 1976-77. The precipitation patterns for that period are discussed in a later section of this report. Water levels in the wells continued to decline through June 1977 (due to the less than average precipitation during the fall and winter), a time when they normally would be nearing their yearly highest levels (as projected by the dashed line in fig. 7). The long-term effects of the drought on the ground-water system of the area are not known at this time. However, the effect on deeper wells probably was less than that on shallower wells. A return to normal precipitation patterns probably would return water levels to near their long-term average levels within a year.



--Water-level fluctuations in selected wells on the dison Indian Reservation. (Note that the relative d fall-winter of 1976-77 is reflected in a decline in evels in the late winter and spring of 1977.)

Ground-Water Use in 1975

Information on water use on the reservation during the 1975 calendar year was obtained as part of this study. The use of surface water from streams or reservoirs for any purpose was practically nonexistent; therefore, only ground-water use has been tabulated. (See table 1, page 16.)

Complete and accurate pumping records were not available for any water-supply system, and calculation of the estimated ground-water use was completed for table 1 on the basis of partial records and the following assumptions and estimates:

1. Where records were not complete the average daily domestic use of water was assumed to be 125 gal/d per person (Dion and Lum, 1977) and part-time residents, usually summer only, were assumed to use an average of about 40 gal/d per person, computed on an annual basis.

2. Very little ground water is used for stock watering.

Table 1 presents the most accurate estimate available on ground-water use on the reservation.

Ground-Water-Quality Characteristics

The chemical quality of the ground water in the study area is generally good for most uses. No harmful concentrations of any constituent were found, although iron and manganese concentrations in some water were high enough to be esthetically unpleasant.

The principal constituents of the ground water include calcium, magnesium, bicarbonate, and silica. The chemical quality of the ground water is tabulated in table 6 (p. 56) and some water-quality criteria for public water supplies are listed in table 7 (p. 58). Some important constituents and properties of the ground water are discussed below.

Hardness.--There are no universal standards for classifying hardness; in general, however, values of less than 60 mg/L (milligrams per liter) indicate soft water; 61 to 120 mg/L, moderately hard water; 121 to 180 mg/L, hard water; and more than 180 mg/L, very hard water. The chemical analyses of water from all but two sampled wells in the study area indicate that the water is soft to moderately hard (hardness values of 100 mg/L or less); the two exceptions have hard water (hardness values of 124 and 132 mg/L). From the chemical analyses shown in table 6 ground water from deeper wells generally is harder than water from shallower wells. This is because the ground water found in deeper zones has had greater opportunity to dissolve calcium, magnesium, and other minerals from the materials with which it is in contact.

TABLE 1.--Estimated ground-water use on the reservation in 1975

Type of use	Water use[a] (millions of gallons per year)	Population served
Municipal:		
Suquamish	55	1200
Indianola	18	400
Other community supply systems	14	300
Commercial	1	--
Single family, domestic	23	500
Part time residents	4	[b](300)
Totals	115	[c]2,400

[a]No complete records available. Values are computed from partial records and (or) estimates and then rounded to the nearest million gallons.

[b]Part-time residents, usually summer only.

[c]Total of full-time residents only.

Chloride.--Concentrations higher than background (natural) levels may indicate the intrusion of seawater into an aquifer or possibly pollution from sewage waste water. As shown in table 6, chloride concentrations ranged from 1.5 to 26 mg/L (with all but one sample from well 26/2-17R1 being less than 8.5 mg/L) and averaged 5.2 mg/L.

Based on values obtained by Garling, Molenaar, and others (1965) and Walters (1971), natural background levels are probably less than 10 mg/L. The one higher value of 26 mg/L of dissolved chloride (well 26/2-17R1) is probably due to some localized geologic condition, and it does not necessarily indicate seawater intrusion (or other contamination); the well is a considerable distance from the shoreline and nearby wells do not have similarly high chloride concentrations. Chloride is not noticeable by taste to most people until it is present in concentrations greater than 250 mg/L.

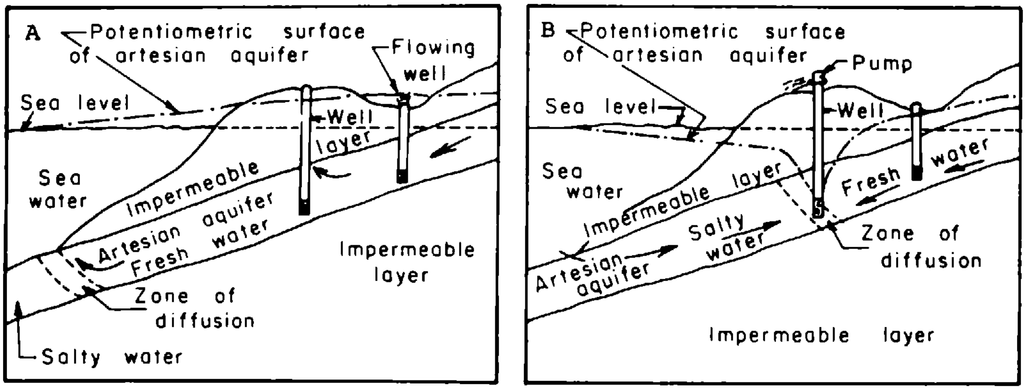
Fluoride.--A beneficial component if present in the correct concentration in public water supplies, fluoride helps to strengthen developing juvenile teeth. However, if present in excessive quantities, fluoride can cause "mottled enamel" in children's teeth. Fluoride was found in all water samples except one (and not included in analyses for six samples), although the concentrations were much less than the recommended safe maximum.

Iron and manganese.--High concentrations of iron greater than 300 μg/L (micrograms per liter) and manganese (greater than 50 μg/L), as found in 4 of the 14 ground-water samples analyzed, can cause unpleasant taste, spotting of laundry, discoloration of plumbing fixtures, and clogging of pipes. High concentrations of these two constituents, however, are common in wells throughout the Puget Sound area.

Nitrite and nitrate.--Concentrations of nitrite plus nitrate (reported as elemental N) should not exceed 10 mg/L. Above this limit serious health problems may arise. All wells tested had concentrations below this limit. High levels of nitrite and nitrate in ground water may indicate pollution from solid waste disposal sites or sewage waste water.

Seawater Intrusion

Pumping of a well situated near a marine shoreline and tapping an aquifer below sea level has the potential for causing seawater intrusion into the aquifer. Figure 8 shows schematic diagrams of the hydrologic conditions in an artesian aquifer before and after seawater intrusion. Before any large amount of water is pumped from the aquifer, the ground-water flow is in equilibrium--that is, the ground water is flowing past the well, mixing with the salty ground water in the zone of diffusion and then discharging into the seawater (part A, fig. 8). As the well is pumped intensively for an extended period of time, the flow system of the ground water changes. The potentiometric surface around the well is lowered as the fresh ground water is pumped out faster than it can be replenished. The direction of flow past the well may then reverse and salty ground water may flow to the well as shown in part B of figure 8. The potential for seawater intrusion in the study area is discussed further in the next section.



A Simplified diagram of two wells tapping a confined (artesian) aquifer under conditions of equilibrium--no intrusion has occurred.

B Diagram of the same wells under conditions of intensive pumping--intrusion has reached the well nearest to the shoreline, flow in shallow well has ceased.

FIGURE 8.--Schematic sections showing a nearshore confined aquifer before and after seawater intrusion. From Walters (1971). Arrows indicate directions of ground-water flow.

Potential Contamination

Chemical or biological contamination of ground water can be caused by many sources. The most common potential sources of contamination in areas geologically and hydrologically similar to the study area include improperly treated or managed sewage waste water, improperly located or managed solid-wastes disposal sites, and (or) seawater intrusion.

When sewage waste water is not fully treated as in individual septic tanks and drain fields or inadequate treatment plants, it can percolate into the ground-water system and cause serious contamination. Biological contamination from this source is, however, usually limited to small areas. To minimize contamination from septic tanks and drain fields, each installation should be individually designed according to local conditions. Some criteria (U.S. Public Health Service, 1967) that should be met include: (1) The septic tank and drain field should be no closer than 50 ft to, and preferably downslope from, nearby wells, streams, or lakes; (2) the area chosen should not be subject to flooding; (3) the drain field lines should be at least 4 feet above the water table; and (4) the soil should be capable of absorbing the waste water introduced into it.

Other major sources of potential contamination include overflow of untreated wastes during times of peak flow in a sewer system or discharge of incompletely treated wastes from a treatment facility that processes waste water from industries or a large number of homes.

Solid-wastes disposal sites, if poorly located or mismanaged can cause both chemical and biological contamination of the underlying ground water. Contamination may result if the bottom of a disposal pit is too close (depending on geologic factors and surface drainage) to the water table. As rainfall percolates downward some of the waste material is dissolved and carried into the soil. If this percolating water travels only a short distance before reaching the main ground-water body, the dissolved contaminants may pollute the ground water. This polluted ground water will continue to move downgradient until it is diluted or the contaminants are absorbed into the soil (and no longer objectionable), or it may be discharged from the ground-water body as pumpage from a well, seepage to a stream, or discharge to the surrounding marine waters.

Contaminants may be carried from disposal sites by surface-water runoff in stream channels or by direct sheet runoff over the land surface. Such runoff could not only contaminate streams, but could percolate down through the soil and contaminate the ground water. Contamination of the ground water from such sources might be prevented if disposal sites were kept above the water table (the vertical distance between the disposal site and the water table would depend on the ability of the soil to filter out the pollutants) and if surface-water runoff from the disposal areas were prevented.

No active or inactive solid-wastes disposal sites existed on the reservation during the present study. However, an active disposal site is in the NE 1/4 of sec. 25, T.26 N., R.1 E., just outside the western boundary of the reservation near Lemolo (pl. 1). No surface-water drainage from the site was observed during this study. The disposal site is also approximately 60 to 80 ft above the local water table. No data are available on the ground-water quality in the immediate area. However, the absence of surface-water runoff from the site and the 60 to 80 ft of natural filter material (unsaturated till and sand and gravel layers) between the bottom of the disposal pit and the water table, probably prevent any pollution of the ground water at this time (1977).

A potential for intrusion of seawater into the ground-water system exists in the near-shore areas of the reservation, and intensive residential development of shoreline areas could cause this potential to increase. However, in visits to wells during this study, no problems associated with seawater intrusion were reported by well owners. Data on the chloride concentration and specific conductance of water from five high-capacity public-supply wells (towns of Suquamish and Indianola; wells 26/2-10N1, 10R2, 10R3, 16L1 and 20H1) were collected during April 1976, and are presented in table 6. These data indicate that in 1976 seawater intrusion had not become a problem in these two communities, which use about 65 percent of the total amount of water used on the reservation.

Areas of Potential Development of Future Ground-Water Supplies

It is not possible to precisely select locations and indicate probable depths of wells to provide future ground-water supplies on the reservation. This is due to the differing thicknesses and yields of the aquifers underlying different areas of the reservation, and their absence in some locations. Some general guidelines for site selection and estimated depths and yields of wells are discussed below.

Wells should be located away from septic tanks, drain fields, or sewage-treatment sites. The distance between the shoreline and a high capacity community-supply well tapping an aquifer below mean sea level should be at least 0.5 mile to minimize the chances of seawater intrusion (the distance actually depends on many complex factors, this value, 0.5 mile, is probably a safe estimate based on present data).

The estimates of depths to the lower aquifer(s) and estimated yields (assuming proper construction and development) of the wells in those aquifers are as follows:

1. In the northeastern part of the reservation, north and east of Indianola, the lower aquifer(s) is probably about 30 to 250 ft below msl. Based on the yields of existing wells in the area, the yield per well from this aquifer(s) would be 150 gal/min or more.

2. The northwestern part of the reservation, west of Suquamish is probably the most productive area for the lower aquifer(s) in the study area. Wells drilled here to a depth of between 50 ft above and 200 ft below msl should yield as much as 500 gal/min each.

3. In the area southwest of Suquamish, wells drilled to about 10 ft above to 100 ft below msl should yield in excess of 250 gal/min.

Wells drilled to provide domestic water for only a few families may yield adequate supplies from shallower aquifers. Almost 70 percent of the wells in the study area, most of which are used for domestic purposes, are less than 165 ft deep and have yields of about 1 to 30 gal/min.

Due to variable aquifer thicknesses and permeabilities (ability to transmit ground water) and the lack of ground-water data in some parts of the reservation, it is impossible to calculate accurately the volume of water that can be safely withdrawn from the ground-water system. Overpumping the ground-water system could cause a state of imbalance, possibly depleting the ground water in storage. Depleting the amount of ground water in storage could cause shallower wells to go dry or could cause seawater intrusion into the ground-water system. Estimates of the withdrawable quantity of ground water are possible, however, by making some assumptions. Based on previous work done on the Kitsap Peninsula by Garling, Molenaar and others (1965), Sceva (1957), Hansen and Molenaar (1976), and the results of this study a conservative estimate of the rate of recharge to the ground-water system is about 5 inches of precipitation per year. This amount of recharge is equal to about 600 million gallons of water per year in the western part of the reservation and about 400 million gallons of water per year in the eastern part. Based on economic considerations and practical limitations of well spacing it is reasonable to assume that about 40 percent of this volume (240 and 160 million gallons per year, respectively) could be captured with properly located and constructed wells before being discharged to the sea. Based on an average per capita consumption of 125 gal/d per person (Dion and Lum, 1977), which includes water for personal-service-type commercial businesses, the population that could be supplied by this ground water would be about 5,000 people in the western part of the reservation and about 3,500 people in the eastern part. This is about four times the present population in both areas.

SURFACE-WATER RESOURCES

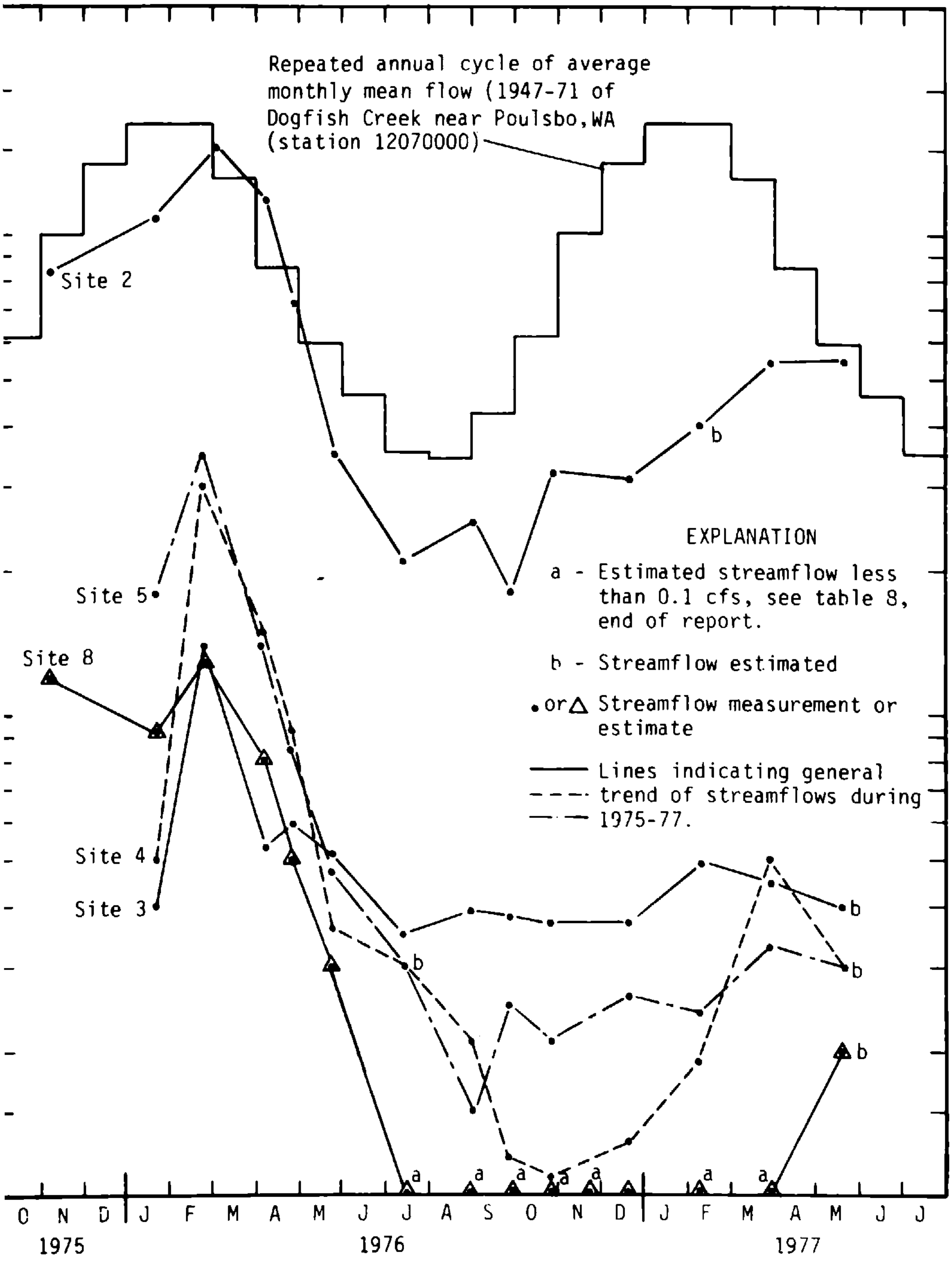
Numerous streams on the reservation and in the nearby surrounding area, although all small in size of drainage basin, appear to have potential for use in salmon-rearing programs that may be undertaken by the tribe. Five streams were visited every 4-8 weeks during this project, and data were collected on stream discharges and water quality. Four other streams were visited occasionally or are covered by data available from previous studies in the area.

Streamflow Characteristics

Streamflow patterns closely follow the seasonal trend of precipitation. The highest streamflows usually result from the higher precipitation during the period November-March. Most of the precipitation occurring as rain quickly flows over the ground surface to stream channels. Part of the precipitation that falls as snow also contributes to streamflow when it melts. Some of the rain and melting snow seeps into the soil and slowly percolates down to the water table. As precipitation diminishes in the summer, streamflow becomes more dependent on flow from springs or ground-water seepage which discharges into the stream channel. During years of normal distribution of precipitation the lowest streamflows generally occur during the period July-September and are most likely to occur in September (Cummans, 1977).

This typical seasonal streamflow pattern is illustrated in figure 9 by the 1947-71 average monthly mean flow of Dogfish Creek near Poulsbo (station 12070000) plotted for the period 1975-77. Unusually wet or dry periods, however, cause this pattern to change. For instance, during the 6-month period September 1976-February 1977, precipitation at nearby Everett, Wash., averaged almost 60 percent below the long-term average; only 9.79 inches of precipitation occurred compared to the 62-year average of 23.14 inches ([U.S.] National Oceanic and Atmospheric Administration, 1977a, 1977b). The relatively dry winter of 1976-77 caused streamflow to be significantly below that which would normally be expected. As shown in figure 9 the measurements of streamflow made at site 2, (Grovers Creek) generally follow the trend of average monthly mean flow of Dogfish Creek during the period November 1975-July 1976, a period of near normal precipitation. However, during the period September 1976-January 1977, when precipitation was deficient, the flow pattern at site 2 departed significantly from that of Dogfish Creek.

Estimates of 7-day-low flows for four recurrence intervals can be made for some streams in the study area by correlating same day streamflows in the study area with those at long-term nearby gaging stations. The value given for the 7-day-low flow represents the annual minimum 7-day average streamflow. The estimated recurrence intervals for low flows are determined for long-term stations by statistical analysis of the series of annual 7-day-low flows at the stations.



ƆURE 9.--Average monthly mean flow of Dogfish Creek and ɴeasured (or estimated) flows at selected sites on and near the Port Madison Indian Reservation.

The 7-day-low flows are presented for four recurrence intervals at five sites in table 2. Low-flow data for sites 2 and 8 are taken from a report by Cummans (1977). Data for sites 3, 4, and 5 were estimated by correlation. The coefficients of correlation (an expression of the degree of association, ranging from 0.00 for no correlation to 1.00 for perfect correlation) for the three correlated sites were greater than 0.91, a good correlation. There were insufficient data available to analyze streamflow patterns at sites 1, 6, 7, and 9. However, the streams at sites 6 and 7 have been observed dry (see table 8) and may be dry often during the low-flow period of July-September.

The short period of data collection during this study may reduce the accuracy of these values. Data collection over a longer period would certainly be helpful in more accurately and reliably estimating low flows in the streams.

TABLE 2.--7-day low-flow-frequency data at selected sites

Site number on plate 1	7-day-low flows, in cubic feet per second, for indicated recurrence intervals (years)			
	2	5	10	20
2[a]	1.3	1.2	1.1	1.0
3	.3	.3	.3	.3
4	.1	.1	0	0
5	.2	.2	.1	.1
8[a]	0	0	0	0

[a]From Cummans, 1977.

Surface-Water Quality and Potential Contamination

The quality of the surface water in the study area was assayed by 10 analyses for common chemical constituents at five sites, 15 analyses for nutrient constituents at five sites, and numerous determinations of common chemical and physical parameters at six sites. All these data are presented in tables 9 and 10 (p. 62 and 69). Also included are 1961 data collected on site 2, Grovers Creek, by Garling, Molenaar, and others (1965). Water-quality criteria for public water supplies are presented in table 7.

In general, the surface water in the study area is chemically similar to the ground water of the area. The major constituents found dissolved in the surface water, as in the ground water, include calcium, magnesium (both contributing to the hardness of the water), bicarbonate, and silica. However, the concentrations of these constituents are generally much lower in the surface water than in the ground water. During the low-flow period of late summer-early fall, when stream water comes largely from the ground-water system, the chemical character of the surface water most nearly approaches that of the ground water.

The surface water on the reservation is soft to moderately hard, and of good chemical quality for most uses. However, dissolved organic material, causing the water to appear brownish, was observed in all streams studied. The significance and seasonal variations of some constituents and properties of the surface water are discussed below.

Specific conductance.—A measurement of the capacity of water to conduct an electrical current, expressed in micromhos per centimeter (umho/cm) at 25°C. Specific conductance of the surface waters studied ranged from 20 to 140 umho/cm and averaged 90 umho/cm. Measurements of the specific conductance of a water sample can be used to estimate a rough value for the dissolved-solids concentration. Correlating the calculated dissolved-solids concentrations in surface-water samples with measured specific conductance shows, for streams in the study area, specific conductance (in umho/cm) is about 1.3 times the dissolved-solids concentration (in mg/L). Surface-water chemical-quality data reported by Garling, Molenaar, and others (1965) for the entire Kitsap Peninsula gave a similar value for the correlation.

A comparison of the specific-conductance values of ground-water samples (table 6) with those obtained in streams (table 9) during periods of summer low streamflows and higher, winter streamflows indicates that during higher streamflows the ground-water contribution to streamflow is significantly diluted with relatively pure direct surface runoff (rainwater). The resulting lower dissolved solids in the stream water are indicated by the lower specific-conductance value measured. Higher specific-conductance values (and thus higher dissolved-solids concentrations) occur when streamflow is less (little or no dilution from rainwater) and most of the streamflow is composed of ground-water outflow.

pH.—A measure of the acidity or alkalinity of water, expressed in pH units. A pH of 7.0 is "neutral," less than 7 is "acidic," and greater than 7 is "alkaline." Of the 45 pH measurements made of surface water all were between 5.8 and 7.8 units; 35 of the 45 were between 6.7 and 7.6 and the average was between 7.0 and 7.1. Data from Garling, Molenaar and others (1965) for the entire Kitsap Peninsula showed pH of surface water ranging from 6.7 to 7.6, also having an average value between 7.0 and 7.1.

Turbidity.—A measure of the dispersion of light passing through a sample of water due to particles in suspension, reported in nephelometric turbidity units (NTU). The particles in suspension are probably organic material and sometimes, at higher streamflows, clay and silt particles. Values in the study-area streams ranged from 0 (zero), virtually none, to 4 units, almost translucent (milky). Streams tend to be more turbid (higher number) at higher flows.

Total dissolved gases.—A measurement of percentage of saturation of all gases dissolved in the sample. Values ranged from 98 percent (slightly under saturation) to 102 percent (slightly over saturation). All values were less than the 110-percent limit suggested by the U.S. Environmental Protection Agency (1973) for the safe propagation of salmonoid (trout and salmon) species.

Total coliform bacteria.—A count of all coliform-bacteria colonies that occur in a specific volume (100 mL; milliliters) of sampled water after incubation for 24 hours. All streams sampled had moderate counts ranging from less than 1 to 4,000 col/100 mL and averaging about 300 col/100 mL. High coliform-bacteria concentrations may indicate pollution from manmade or natural sources, including septic tanks, solid-wastes disposal sites, and domestic and wild animal waste.

Nutrients.--Defined as those chemicals necessary for the growth and reproduction of plants (U.S. Environmental Protection Agency, 1973). Analyses were made for the major nutrients--total ammonia, nitrite, nitrate, total Kjeldahl nitrogen, total phosphorus, and dissolved orthophosphorus. Specific limits have not been established for these nutrients, but these and other constituents may contribute to nuisance aquatic growths which interfere with certain uses of the water. High concentrations of nutrients in surface waters are often considered both causes and indicators of pollution in a stream's drainage basin. Concentrations of nutrients in all samples collected during this study indicate only natural concentrations—levels not affected by man's activities.

Potential sources of contamination of the surface water on the reservation include: (1) Improperly treated sewage waste water; (2) improperly managed (future) solid-wastes disposal sites which allow overland runoff of polluted water; and (3) waste water from septic tanks. These types of potential pollution can be avoided by designing septic tanks, drain fields, and disposal sites in accordance with local hydrogeologic conditions and by designing solid-wastes disposal sites to eliminate any surface-water runoff.

As determined during this study, there was no major pollution of the water in any of the streams studied (1977). A monitoring program to protect this valuable resource from possible future pollution should include regular chemical analysis for common constituents and nutrients.

SUMMARY AND CONCLUSIONS

The unconsolidated materials underlying the Port Madison Indian Reservation are, in general, saturated with water that has fallen as precipitation on the land surface. The ground water is recoverable from several aquifers that vary greatly in thickness, lateral extent, and ability to transmit water. The more productive aquifers present under most, but not all, of the reservation are those which are from about 100 ft above msl to about 250 ft below msl; they consist mainly of coarse sand and gravel. Properly constructed wells that tap these lower aquifers may be capable of yields of as much as 500 gal/min, whereas shallower aquifers in the inland areas of the reservation (shallower than 165 ft below land surface) are, in most places, capable of yielding 1 to 30 gal/min to wells.

The data collected during this study indicate that there is enough ground water available (without greatly diminishing the amount in storage) to supply about 5,000 people in the western part of the reservation (area around Suquamish) and 3,500 people in the eastern part of the reservation (area around Indianola). This is about four times the 1977 population of the reservation.

Both ground and surface waters were found to be generally of good quality, although iron and manganese concentrations are high enough in some ground waters to be esthetically unpleasant. No evidence of pollution in 1977 of either the ground or surface waters was found during this study. However, an increase in population and corresponding increase in water use on the reservation will bring an increasing potential for pollution. Water-quality monitoring of streams and wells on a continuing basis could help to alert those using these sources of water to ongoing pollution before it becomes too serious. The water-quality problems that may need to be closely monitored in the future might include pollution of the surface water by improperly treated sewage waste and pollution of the ground water by intrusion of seawater into the coastal aquifers.

Of the nine stream sites investigated for information on low streamflows two sites had been observed dry numerous times, two were calculated to be dry for seven consecutive days in a year an average of once in 10 years during the low-flow period, and two sites did not have sufficient data for analysis. Of the three remaining sites, estimated values of 7-day low flows with a 2-year average recurrence interval were: site 2 (Grovers Creek), 1.3 ft^3/s; site 3, 0.3 ft^3/s; and site 5, 0.2 ft^3/s. These low flows probably would occur in September but may occur as early as July based on previous data for the Puget Sound area. Longer term data collection would increase the accuracy and reliability of these estimated values.

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TABLE 3.--Records of selected wells on and adjacent to the Port Madison Indian Reservation

EXPLANATION

Local number:	Numbered by township, range, section, and 40-acre subdivision, as described on page v.
Owner:	Name of owner or tenant at the time of inventory.
Altitude of land surface:	Altitude of land surface adjacent to the well, in feet, above mean sea level (msl).
Depth of well:	Depth of completed well, in feet below land surface, as measured by USGS personnel or by other agencies or as reported by well owner or driller.
Casing diameter:	As measured by USGS personnel or as reported by well owner or driller in inches.
Finish:	Method used to finish well in aquifer tapped: O, open-end casing; S, screen; C, porous concrete casing; and X, open hole in aquifer below casing.
Depth to first opening:	Depth, in feet, to top of screen or perforations, or to bottom of solid casing.
Water level and date:	As measured by USGS personnel or as reported by well owner or driller, in feet below land surface; F, well is reported to flow or was observed flowing; D, well is reported or was observed dry; R, well pumped recently.
Discharge:	Measured or reported pumped discharge of well during pumping test or actual use, in gallons per minute.
Drawdown:	Distance, in feet, that water level was lowered (below static water level) by pumping at stated discharge rate. Length of pumping period ranged from less than 1 hour to more than 24 hours.

TABLE 3.--Records of selected wells on and adjacent to the Port Madison Indian Reservation--Continued

LOCAL NUMBER	OWNER	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)
25N/02E-06A01	OLSEN, DALE	70	252
26N/01E-12Q01	WALSH, JOHN	365	169
26N/01E-12Q02	GALLANGER, H	360	290
26N/01E-13A01	STANLEY, A M	352	157
26N/01E-13B01	POULSBO, CITY OF	350	313
26N/01E-13G02	LACEY, D D	322	260
26N/01E-13H01	FREIBOTH, D E	340	150
26N/01E-13H03	BOWMAN, E D	322	148
26N/01E-13J01	BOWMAN, F	310	144
26N/01E-13J02	SCHMIDT, W A	314	26
26N/01E-13K01	ABEL, R T	318	112
26N/01E-13R01	OWENS, J	295	115
26N/01E-13R02	STENWICK, E	285	87
26N/01E-24A01	RUTH, ALLEN R	260	91
26N/01E-24A02	NELSON, L	241	14
26N/01E-24A03	FALK, J E	262	95
26N/01E-24H01	CATES, G	215	8
26N/01E-24J01	DETELS, P	260	125
26N/01E-24P01	CRIST, J	208	10
26N/01E-24Q01	OTTO, J C	160	120
26N/01E-24Q02	JENSEN, J	170	6
26N/01E-24Q03	UNKNOWN	187	215
26N/01E-24Q04	STORHOFF, E	190	6
26N/01E-24Q05	SACHO, L J	180	168
26N/01E-25B01	MONTGOMERY, R A	140	160
26N/01E-25C01	JOHANSON, A E	200	155
26N/01E-25G01	SHOTWELL, D	55	114
26N/01E-25G02	CROCKER, K R	90	150
26N/01E-25G03	SMITH	80	14
26N/01E-25K01	LOVEALL, T L	38	200
26N/01E-25K03	SMITH, A L	23	6
26N/01E-25L01	ANDERSON, J H	15	65
26N/01E-25L02	FREIBOTH, M	38	52
26N/01E-25L03	SMITH	15	11
26N/01E-25L04	HOLM, D	10	48
26N/01E-25L05	SMITH	20	9
26N/01E-25R03	FARR, DAVID	65	126
26N/01E-25R04	HUDLER, A O	40	50
26N/01E-25R05	MATERIALS, FRED HILL	60	58
26N/01E-25R06	SWARNER, C V	55	54

CASING DIAM-ETER (INCHES)	FINISH	DEPTH TO FIRST OPENING (FEET)	WATER LEVEL (FEET)	DATE WATER LEVEL MEASURED	DISCHARGE (GALLONS PER MINUTE)	DRAW-DOWN (FEET)
6	--	--	65.00	11/08/1950	--	--
6	O	--	118.37	01/31/1955	--	--
8	S	280	119.00	12/ /1968	150	71
6	--	--	137.00	1950	--	--
8	S	307	115.00	05/07/1967	311	36
6	O	--	--	--	--	--
6	S	--	--	--	--	--
6	S	144	104.00	12/11/1975	--	--
6	--	--	104.00	--	--	--
36	W	--	1.00	12/ /1975	--	--
6	P	102	61.00	08/ /1970	15	21
6	S	110	45.64	04/08/1977	30	30
6	S	82	21.00	07/21/1976	20	35
6	S	85	67.00	12/18/1974	10	8
36	C	--	2.00	12/ /1975	--	--
6	S	91	--	--	--	--
48	C	--	2.00	10/09/1975	--	--
6	--	--	--	--	--	--
96	C	--	1.00	10/09/1975	--	--
6	O	--	--	--	60	--
72	C	--	F	10/09/1975	--	--
6	S	--	--	--	--	--
60	O	--	1.00	10/09/1975	--	--
6	--	--	--	--	--	--
6	S	--	116.26	10/08/1975	--	--
6	O	--	50.00	12/ /1975	10	40
36	C	--	--	--	--	--
6	S	--	73.12	10/08/1975	--	--
96	O	--	3.00	10/08/1975	--	--
6	--	--	--	--	--	--
72	O	--	F	10/08/1975	--	--
6	O	--	5.00	--	--	--
6	S	49	--	--	10	--
36	X	3	4.00	10/08/1975	--	--
6	S	--	F	10/08/1975	--	--
60	O	--	3.00	10/08/1975	--	--
6	S	121	--	--	11	--
6	--	--	--	--	--	--
36	--	--	10.00	10/09/1975	20	--
6	S	49	20.00	12/ /1975	--	--

TABLE 3.--Records of selected wells on and adjacent to the Port Madison Indian Reservation--Continued

LOCAL NUMBER	OWNER	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)
26N/01E-25R07	WELLS, D	40	21
26N/01E-36A01	BRENNAN, J J	20	55
26N/02E-01C03	NEWELLHURS	117	529
26N/02E-01L03	ANDERSON, C E	140	57
26N/02E-01L04	ANDERSON, C E	160	20
26N/02E-01M01	CALHOUN, M	225	264
26N/02E-01P01	DAVIES, W	150	--
26N/02E-01Q01	RAUB, W	140	25
26N/02E-01R01	ELBERT, C H	5	44
26N/02E-01R02	KEMP, G E	100	124
26N/02E-02A01	LONGMATE, E G	210	22
26N/02E-02A03	LONGMATE, E G	210	543
26N/02E-02J03	EDDIE, A	260	77
26N/02E-04L01	LEFTON, D L	30	18
26N/02E-04L02	TUCKER, J C	20	50
26N/02E-04M01	SCHMUCK, M J	60	15
26N/02E-04M02	HURSLEY, R B	25	12
26N/02E-04P01	ARNESS, S A	40	14
26N/02E-07N01	STOTTLEMYER, W	372	278
26N/02E-07Q02	HOLT, JOHN	400	195
26N/02E-07R03	ANDERSON, J	390	421
26N/02E-07R04	HALSTEAD, R A	395	446
26N/02E-07R05	RICHARDS	390	296
26N/02E-08N03	BAIRD, LEON	345	94
26N/02E-08N04	MOORE, J	380	180
26N/02E-08N05	SPURLING, R L	340	211
26N/02E-09E01	MARMANN, W	20	110
26N/02E-09H01	ASSN., MILLER BA	255	452
26N/02E-09M03	JORDAN, J	25	15
26N/02E-09M04	EISENHARDT	15	46
26N/02E-09Q02	ROBINSON, W	70	55
26N/02E-09Q03	WILLIAMS, W	50	6
26N/02E-09R02	ARMSTRONG, F H	130	9
26N/02E-10K02	CURRIE	162	30
26N/02E-10N01	INDIANOLA, CITY OF	105	215
26N/02E-10R02	KITSAP PUD	115	80
26N/02E-10R01	KITSAP PUD	115	270
26N/02E-10R03	KITSAP PUD	115	1010
26N/02E-12C01	EDDIE, D	140	15
26N/02E-12H01	COMM CLUB, PT JEFFER	190	246

CASING DIAM- ETER (INCHES)	FINISH	DEPTH TO FIRST OPENING (FEET)	WATER LEVEL (FEET)		DATE WATER LEVEL MEASURED	DISCHARGE (GALLONS PER MINUTE)	DRAW- DOWN (FEET)
36	O	--	17.00		10/ /1975	--	--
6	O	--	22.00		12/10/1975	--	--
6	S	514	102.00		02/16/1977	105	85
6	--	--	--		--	--	--
36	O	--	--		--	--	--
6	S	--	--		--	--	--
6	--	--	--		--	--	--
36	O	--	5.00		01/09/1976	--	--
6	P	39	12.00		10/ /1950	--	--
6	O	--	98.00		1961	15	1
48	O	--	16.00		10/ /1950	--	--
6	O	--		D	--	--	--
36	X	50	10.00		01/ /1976	--	--
36	O	--	9.00		01/ /1976	--	--
6	S	--		F	01/ /1976	--	--
36	O	--	5.00		12/ /1975	--	--
42	O	--	5.00		12/ /1975	--	--
60	O	--	8.00		01/ /1976	--	--
6	P	--	138.00		10/ /1950	--	--
6	S	--	--		--	--	--
6	S	416	178.00		09/ /1975	6	210
6	O	--	320.00		1971	15	1
6	O	--	--		--	7	--
6	S	89	73.00		08/ /1969	10	1
6	--	--	--		--	--	--
6	S	--	--		--	--	--
6	S	--	10.00		12/16/1975	15	--
10	S	447	255.00		09/09/1969	150	85
36	O	--	3.00		12/ /1975	--	--
6	O	--		F	1955	--	--
6	S	--	--		--	--	--
36	O	--	0.00		01/ /1976	--	--
36	O	--	1.00		01/ /1976	--	--
6	O	--	10.00		01/ /1976	--	--
8	S	205	78.00		08/ /1969	85	59
8	G	--	4.00		1962	--	--
6	--	--		F	05/23/1967	--	--
--	--	--	--		--	--	--
36	O	--	5.00		01/ /1976	--	--
6	S	--	190.00		1967	--	--

TABLE 3.--Records of selected wells on and adjacent to the Port Madison Indian Reservation--Continued

LOCAL NUMBER	OWNER	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)
26N/02E-13A01	COMM CLUB, PT JEFFER	80	142
26N/02E-17B01	MCINTYRE	180	27
26N/02E-17C01	FREIHOTH, H C	320	15
26N/02E-17D02	HARTLE, T	360	20
26N/02E-17J01	FALER, OTTO	165	22
26N/02E-17K01	CHURCH, ARCHIE J	165	248
26N/02E-17K02	LINDELL, MARY	165	134
26N/02E-17R01	HAWK, GLEN	270	265
26N/02E-18A01	NELSON, C	350	20
26N/02E-18A02	REVES, T W	360	351
26N/02E-18A03	MALONEY SR, H L	335	384
26N/02E-18A04	CRAWFORD, D A	380	30
26N/02E-18A05	PEARSON, KNUTE	340	9
26N/02E-18B02	COOK, D	375	40
26N/02E-18B03	DUBOIS, A G	340	38
26N/02E-18B05	TURNENSIS, M	340	114
26N/02E-18B06	TOMPKINS, R	325	340
26N/02E-18B07	ADAIR, L D	380	60
26N/02E-18C01	MELSETH, E	315	253
26N/02E-18D02	OLSEN, CHUCK	365	284
26N/02E-18G03	KIMMEL, D L	300	65
26N/02E-18H03	EVANS, H L	320	334
26N/02E-19B01	HOMMEL, E	340	525
26N/02E-19H01	BUCZEK, JOHN	315	102
26N/02E-19J01	CHRISTENSON, E	342	102
26N/02E-19J02	NORBERG, VERN	350	73
26N/02E-20B01	CHIQUITI, JOHN	215	75
26N/02E-20E01 TW2	KITSAP CO, PUD OF	282	401
26N/02E-20H01	SUQUAMISH, TOWN-PUD	300	460
26N/02E-20L01 TW3	KITSAP CO, PUD OF	185	220
26N/02E-20M01 TW 1	KITSAP CO, PUD OF	267	345
26N/02E-20P01	SCHOLD, JOHN	120	18
26N/02E-20R01	PRESCOTT, F L	200	40
26N/02E-20R02	ISAKSON, W I	220	100
26N/02E-29B01	SCHOLD, JOHN	160	212
26N/02E-29C01	MAKRIS, C	110	120
26N/02E-29D01	CARLSON	200	170
26N/02E-29D02	CLARK, C	170	95
26N/02E-29D03	TOTTEN	190	15
26N/02E-29L01	INVESTMENT, TERRA	100	135

CASING DIAM- ETER (INCHES)	FINISH	DEPTH TO FIRST OPENING (FEET)	WATER LEVEL (FEET)	DATE WATER LEVEL MEASURED	DISCHARGE (GALLONS PER MINUTE)	DRAW- DOWN (FEET)
6	S	--	77.00	12/01/1975	75	--
36	O	--	15.00	10/11/1975	--	--
36	O	--	2.00	11/10/1975	--	--
60	O	--	10.00	12/ /1975	--	--
36	O	--	9.00	11/10/1975	--	--
6	S	243	97.00	12/01/1972	17	30
6	S	125	91.00	02/16/1971	3	32
6	S	261	187.00	01/28/1971	13	35
36	O	--	10.00	12/ /1975	--	--
6	--	--	--	--	--	--
6	S	379	85.00	1971	--	--
36	O	--	10.00	12/ /1975	--	--
90	O	--	6.00	12/ /1975	--	--
36	O	--	--	--	--	--
36	O	--	30.00	12/ /1975	--	--
6	S	109	--	--	--	--
6	--	--	--	--	--	--
36	O	--	50.00	12/ /1975	--	--
6	--	--	100.00	1951	--	--
6	S	270	115.00	06/ /1959	125	35
6	O	--	--	--	12	--
6	S	330	--	--	--	--
6	O	--	D	--	--	--
6	S	92	70.17	11/24/1975	10	20
6	S	98	83.00	12/ /1975	--	--
6	S	63	--	--	7	--
6	O	73	50.70	10/09/1972	14	11
--	--	--	220.00	07/ /1971	--	--
8	S	445	230.00	11/06/1970	196	138
8	P	185	132.50	07/14/1971	495	45
8	P	325	196.00	05/13/1971	363	36
18	O	--	10.00	10/09/1975	--	--
96	O	--	15.00	11/25/1975	--	--
5	--	--	--	--	--	--
6	S	208	83.88	06/21/1976	30	22
6	S	--	--	--	--	--
6	S	--	--	--	--	--
6	O	--	D	12/28/1975	--	--
30	O	--	6.00	11/24/1975	--	--
8	S	115	90.50	12/16/1975	50	38

TABLE 3.--Records of selected wells on and adjacent to the Port Madison Indian Reservation--Continued

LOCAL NUMBER	OWNER	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)
26N/02E-29L02	INVESTMENT, TERRA	100	131
26N/02E-29P02	ADOLPHSON, F	20	20
26N/02E-29P03	LOUNSBURY, H E	20	26
26N/02E-30A01	BLOSSOM, G	340	40
26N/02E-30A02	HALVERSON, B W	290	270
26N/02E-30A03	WILSON, JOE	258	230
26N/02E-30E01	BRENNAN, JAMES	340	305
26N/02E-30N01	BRENNAN, JAMES	205	208
26N/02E-30N02	BRENNAN, JAMES	205	215
26N/02E-30P01	HILL MAT., FRED	160	150
26N/02E-31B01	GEORGE, BEN SR.	195	186
26N/02E-31B02	CHRISTMAS, BILL	210	285
26N/02E-31B03	CHRISTMAS, BILL	220	266
26N/02E-31C01	DUNCAN, L	100	190
26N/02E-31C02	PRATT, WILLIARD	150	174
26N/02E-31D01	BAY DEV., NESIKA	100	108
26N/02E-31D02	BAY DEV., NESIKA	70	122
26N/02E-31E01	ADAMS, M	22	12
26N/02E-31E02	ADAMS, MARY	20	33
26N/02E-31J02	HOOK CC, SANDY	100	150
26N/02E-31P01	DUNCAN	25	24
26N/02E-31P02	KUPPLER, A	15	20
26N/02E-31P03	DUNCAN, U F	15	24
26N/02E-31Q01	GEORGE, BEN SR.	18	450
26N/02E-32D01	TRIBE, SUQUAMISH	25	78
26N/03E-07E06	MORRIS, W	80	128
26N/03E-07E08	WINKEL, H M	80	103
26N/03E-07M01	US NAVY	111	136
26N/03E-07M02	TEMPLE, D	70	91

CASING DIAM-ETER (INCHES)	FINISH	DEPTH TO FIRST OPENING (FEET)	WATER LEVEL (FEET)		DATE WATER LEVEL MEASURED	DISCHARGE (GALLONS PER MINUTE)	DRAW-DOWN (FEET)
8	S	111	90.00		12/24/1975	50	37
36	O	--	8.00		11/12/1975	--	--
40	O	--	8.00		11/11/1975	--	--
24	O	--	5.00		11/12/1975	--	--
6	--	--	--		--	--	--
6	S	225	194.00		05/15/1975	10	14
6	S	301	285.00		10/04/1974	7	15
8	S	198	174.00		04/02/1962	250	15
6	P	205	174.00		04/16/1962	--	--
6	S	--	124.99	R	10/09/1975	--	--
6	S	178	159.00		05/10/1971	7	13
6	S	280	200.00		01/ /1969	70	20
8	S	251	187.47		02/26/1976	165	41
6	--	--	10.00		10/10/1975	--	--
6	S	169	126.80		09/27/1972	18	41
6	S	98	83.00		01/ /1973	43	15
6	S	112	45.99		12/10/1975	100	23
36	O	--	9.00		10/10/1975	--	--
6	S	27	11.00		02/18/1971	10	18
8	P	130	--		--	100	--
6	S	21		F	10/10/1975	--	--
6	S	17		F	10/10/1975	--	--
6	S	21		F	10/10/1975	--	--
6	O	--		D	04/13/1971	--	--
6	S	73	0.00		04/30/1976	31	60
6	O	--	20.00		08/ /1974	15	1
6	O	--	85.00		06/ /1963	12	3
10	O	--	102.00		05/ /1967	--	--
6	S	86	61.00		10/31/1975	15	3

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation

Material	Thickness (ft)	Depth below land surface (ft)
26/1-12Q2. H. Gallanger Drilled by Burt Well Drilling, Dec. 1968. Altitude 360 ft. Casing: 8-inch to 280 ft. Screened 280-290 ft., slot size unknown.		
Soil----------------------------------	3	3
Till, brown, sandy-------------------	38	41
Till, blue, sandy--------------------	51	92
Sand and gravel----------------------	3	95
Till, sandy--------------------------	17	112
Clay, blue---------------------------	18	130
Silt, sandy, water-bearing-----------	32	162
Sand and gravel, fine water-bearing--	10	172
Sand, silty and clay-----------------	33	205
Sand, silty--------------------------	15	220
Sand, fine---------------------------	15	235
Clay, sandy--------------------------	41	276
Sand, silty--------------------------	1	277
Sand, water-bearing------------------	13	290
Gravel and till, water-bearing-------	11	301
26/1-13B1. City of Poulsbo. Drilled by Stoican Well Drilling, May 1967. Altitude 350 ft. Casing: 8-inch to 298 ft. Screened 298-313 ft., slot sizes 0.015 to 0.160.		
Clay, brown, sandy-------------------	3	3
Till, gray---------------------------	102	105
Sand and gravel, water-bearing (s.w.l. 95 ft.)---------------------	1	106
Till, gray, sandy--------------------	4	110
Clay, blue---------------------------	58	168
Silt, sand and clay, gray------------	6	174
Sand and gravel, muddy, water-bearing (s.w.l. 105 ft.)------------	10	184
Clay, blue---------------------------	8	192
Sand, gray, silty, water-bearing------	32	224
Sand, gray with wood chunks-----------	26	250
Sand, gray, fine with some clay-------	6	256
Sand and gravel, gray-----------------	19	275
Sand, silt, and clay, gray------------	8	283
Sand and gravel, gray, water-bearing (s.w.l. 115 ft.)------------	31	314
Clay, gray---------------------------	6	320

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation--continued

Material	Thickness (ft)	Depth below land surface (ft)
26/1-13R1. J. Owens. Drilled by Nicholson Drilling, Feb. 1977. Altitude 295 ft. Casing: 6-inch to 110 ft. Screened 110-115 ft., 0.025 slot size		
Till, brown	3	3
Till, blue	89	92
Sand, brown, with silt	17	109
Sand and gravel, brown	7	116
26/1-13R2. E. Stenwick. Drilled by Nicholson Drilling, July 1976. Altitude 285 ft. Casing: 6-inch to 82 ft. Screened 82-87 ft., 0.018 slot size.		
Till, brown	40	40
Till, blue	32	72
Sand and gravel, brown	15	87
26/1-24A1. A. Ruth. Drilled by Nicholson Drilling, Dec. 1974. Altitude 260 ft. Casing: 6-inch to 80 ft. Screened 80-85 ft., 0.018 slot size, 85-91 ft., 0.015 slot size.		
Till, brown	56	56
Clay, brown, sandy	22	78
Sand, brown, water-bearing	13	91
Clay, brown	5	96
Clay, blue sandy	19	115
26/1-25C1. A. Johanson. Drilled by C. Ruby, 1946. Altitude 200 ft. Casing: 6-inch to 154 ft. Open end casing.		
Soil and ?	8	8
Clay, blue	146	154
Gravel, water-bearing	1	155
26/1-25R3. D. Farr. Drilled by Crabtree Well Drilling, Feb 1973. Altitude 65 ft. Casing: 6-inch to 121 ft. Screened 121-126 ft., 0.014 slot size.		
Till, brown	16	16
Sand, brown	104	120
Sand and gravel, brown	8	128

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation--continued

Material	Thickness (ft)	Depth below land surface (ft)
26/2-1C3. Newellhurst Est. Drilled by Burt Well Drilling, Oct. 1976 to Feb. 1977. Altitude 117 ft. Casing: 6-inch to 514 ft. Screened 514-529 ft., 0.010 slot size.		
Soil	3	3
Sand and gravel	10	13
Till, brown	17	30
Clay, sandy, blue	11	41
Sand and gravel, blue-gray	7	48
Sand, green, compact	20	68
Sand and gravel	1	69
Clay, silty, blue, some sandy clay layers	23	92
Clay, silty, blue	40	132
Clay and sand layers	34	166
Clay, sandy, brown	9	175
Clay, blue with sand and gravel layers	10	185
Clay, blue	98	283
Till, blue	2	285
Clay, blue	34	319
Clay, silty, blue	44	363
Clay, blue	10	373
Silt	11	384
Clay, blue	63	447
Sand, fine	11	458
Clay, blue	11	469
Clay, blue, with layers of silt	20	489
Sand	9	498
Till	6	504
Sand, silty	10	514
Clay, blue	1	515
Sand, very fine, water-bearing	14	529
Clay, blue	5	534
26/2-1R2. G. Kemp. Drilled by Stoican Well Drilling, 1961. Altitude 100 ft. Casing: 6-inch to 123 ft. Open end casing.		
Soil	2	2
Till, brown	18	20
Till, gray	20	40
Sand, gray	4	44
Clay, gray	15	59
Till, brown	6	65
Clay, gray	36	101
Till, gray water-bearing	2	103
Clay, gray	19	122
Gravel, gray, water-bearing	2	124
26/2-2A3. E. Longmate. Drilled by Crabtree Well Drilling, 1964. Altitude 210 ft. Casing: 6-inch to 524 ft. Open end casing.		
Soil	2	2
Silt, very fine	223	225
Silt	280	505
Clay, blue	1	506
Silt	19	525
Limestone (?)	18	543

Note: well abandoned, no water.

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation--continued

Material	Thickness (ft)	Depth below land surface (ft)
26/2-7R3. J. Anderson. Drilled by Crabtree Well Drilling, Sept. 1975. Altitude 390 ft. Casing: 6-inch to 416 ft. Screened 416-421 ft., 0.015 slot size.		
Soil	1	1
Clay, brown	9	10
Till, brown	13	23
Sand, brown, dry	14	37
Clay, brown	10	47
Clay, blue	8	55
Clay, brown	6	61
Clay, blue	9	70
Clay, brown, sandy	25	95
Sand, dirty	35	130
Silt, blue-black	4	134
Clay, blue	96	230
Clay, with silt layers	18	248
Clay, blue	166	414
Sand and gravel	7	421
26/2-8N3. L. Baird. Drilled by Burt Well Drilling, Aug. 1975. Altitude 345 ft. Casing: 6-inch to 89 ft. Screened 89-94 ft., 0.014 slot size.		
Soil	1	1
Sand, brown, dry	27	28
Till, gray	22	50
Sand, brown, dry	35	85
Sand, brown, water-bearing	9	94
26/2-9H1. Miller Bay Assoc. Drilled by Stoican Well Drilling, Sept. 1969. Altitude 255 ft. Casing: 10-inch to 358 ft., 8-inch to 432 ft. Screened 432-452 ft., various slot sizes from 0.025 to 0.090.		
Clay, brown, sandy	133	133
Clay, blue with some sand	12	145
Clay, blue	95	240
Peat	20	260
Clay, blue with some gravel	35	295
Clay, blue with some sand	51	346
Sand, fine, water-bearing	9	355
Clay and till, blue	12	367
Gravel, water-bearing	9	376
Clay, blue	2	378
Sand and gravel, water-bearing	1	379
Clay, blue	29	408
Sand, fine	4	412
Till, blue	3	415
Sand and gravel, gray, water-bearing	41	456
26/2-9M4. Eisenhardt. Drilled by Philpott Drilling, 1955. Altitude 15 ft. Casing: 6-inch to 46 ft. Open end casing.		
Sand	20	20
Sand and gravel	6	26
Clay, blue	20	46
Sand and gravel	1	47
Note: well was flowing in 1955, does not flow 1976.		

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation--continued

Material	Thickness (ft)	Depth below land surface (ft)
26/2-10N1. Kitsap P.U.D., Indianola Water Supply. Drilled by Harbor Pump and Drilling, Aug. 1969. Altitude 105 ft. Casing: 8-inch to 205 ft. Screened 205-215 ft., unknown slot size.		
Till, brown	14	14
Till, gray	4	18
Till, brown	4	22
Till, gray, sandy	29	51
Clay, blue	108	159
Sand, gray with some peat and clay	12	171
Clay and peat	18	189
Sand and gravel with some clay layers	7	196
Till, gray	9	205
Sand and gravel, water-bearing	9	214
Sand	8	222
Clay, gray with peat	1	223
26/2-10R3. Kitsap P.U.D., Indianola Town Supply. Drilled Mar. 1972. Altitude 110 ft. Casing: 8-inch (?). Final finish and depth unknown.		
Sand, gravel, clay and silt, layered	146	146
Clay, blue with some gravel	29	175
Clay, blue	35	210
Clay, blue, and silt, with gravel	28	238
Sand, fine, water-bearing	10	248
Sand, gravel, and some clay	89	337
Silt and clay, gray	29	366
Sand, gravel, silt and clay layered	50	416
Clay, gray, some thin layers of gravel, silt, and peat	212	628
Sand, fine and silt, some thin gravel layers	383	1011
26/2-17K1. A. Church. Drilled by Burt Well Drilling, Dec. 1972. Altitude 165 ft. Casing: 6-inch to 243 ft. Screened 243-248 ft., 0.012 slot size.		
Clay, brown, sandy	17	17
Sand, brown	19	36
Clay, gray, sandy	7	43
Clay, blue, sandy	14	57
Clay, blue	74	131
Sand, blue, fine	9	140
Clay, blue, sandy	8	148
Silt, blue	89	237
Sand, blue, fine water-bearing	13	250
26/2-17K2. M. Lindell. Drilled by Burt Well Drilling, Feb. 1971. Altitude 165 ft. Casing: 6-inch to 125 ft. Screened 125-134 ft., 0.006 slot size.		
Soil	3	3
Clay, brown, sandy	22	25
Clay, blue	53	78
Clay, silty	22	100
Clay, blue	25	125
Sand, fine, water-bearing	9	134

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation--continued

Material	Thickness (ft)	Depth below land surface (ft)
26/2-17R1. G. Hawk. Drilled by Burt Well Drilling, Jan. 1971. Altitude 270 ft. Casing: 6-inch to 261 ft. Screened 261-265 ft., 0.010 slot size.		
Soil	2	2
Till, brown	5	7
Clay, brown, sandy	43	50
Sand, dry	40	90
Clay, blue, silty	135	225
Sand, silty	35	260
Clay, blue	2	262
Sand, water-bearing	3	265
26/2-18D2. C. Olsen. Drilled by Sjolseth, June 1959. Altitude 365 ft. Casing: 6-inch to 270 ft. Screened 270-284 ft.		
Clay and till	100	100
Gravel	40	140
Clay and sand	30	170
Sand, medium grained	30	200
Sand, dirty	22	222
Sand, fine	30	252
Sand, medium grained, clean	8	260
Sand, fine to coarse grained and gravel	10	270
(no record)	14	284
26/2-19B1. E. Hommel. Drilled by Burt Well Drilling, 1974. Altitude 340 ft. Casing: 6-inch to 525 ft.		
Sand, brown	28	28
Sand and gravel	31	59
Clay, blue	247	306
Silt	157	463
Clay, blue	62	525
Sand	1	526
Clay, blue	1	527
Note: Well abandoned, no water.		
26/2-19H1. J. Buczek. Drilled by Nicholson Well Drilling, June 1975. Altitude 315 ft. Casing: 6-inch to 92 ft. Screened 92-102 ft., 0.012 slot size.		
Clay, brown with gravel	16	16
Sand, brown	58	74
Clay, blue	10	84
Sand, gray, water-bearing	18	102
Clay, blue	6	108
Note: water level observation well.		

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation--continued

Material	Thickness (ft)	Depth below land surface (ft)
26/2-19B1. E. Hommel. Drilled by Burt Well Drilling, 1974. Altitude 340 ft. Casing: 6-inch to 525 ft. Open end casing.		
Sand, brown	28	28
Sand and gravel	31	59
Clay, blue	247	306
Silt	157	463
Clay, blue	62	525
Sand	1	526
Clay, blue	1	527
Note: well abandoned, no water.		
26/2-19H1. J. Buczek. Drilled by Nicholson Well Drilling, June 1975. Altitude 315 ft. Casing: 6-inch to 92 ft. Screened 92-102 ft., 0.012 slot size.		
Clay, brown with gravel	16	16
Sand, brown	58	74
Clay, blue	10	84
Sand, gray, water-bearing	18	102
Clay, blue	6	108
Note: water level observation well.		
26/2-19J2. V. Norberg. Drilled by Nicholson Drilling, Dec. 1975. Altitude 350 ft. Casing: 6-inch to 63 ft. Screened 63-73 ft., 0.012 slot size.		
Till, brown	70	70
Sand and gravel	3	73
Clay	1	74
Till, brown	23	97
Sand and gravel	10	107
Clay and sand, brown	10	117
Sand, brown	3	120
Clay, brown	13	133
26/2-20B1. J. Chiquiti. Drilled by Burt Well Drilling, Oct. 1975. Altitude 215 ft. Casing: 6-inch to 73 ft. Open end casing.		
Soil	5	5
Sand, brown	29	34
Clay, blue, sandy	2	36
Till, brown	27	63
Sand, brown, dry	12	75
Sand and gravel, water-bearing	1	76

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation--continued

Material	Thickness (ft)	Depth below land surface (ft)
26/2-20E1. Kitsap P.U.D., Test Well. Drilled by Story-Armstrong Drilling, June 1971. Altitude 282 ft. Casing: 8-inch to 390 ft. Well destroyed after drilling.		
Sand, gravel, and silt, brown--------	18	18
Sand, brown, fine with some silt and gravel------------------------	37	55
Silt and clay, gray, some peat layers----------------------------	113	168
Silt, sand, and gravel, gray, cemented--------------------------	16	184
Sand, brown, fine, with silt and gravel----------------------------	34	218
Sand and gravel, cemented-----------	7	225
Sand and silt, gray, fine------------	33	258
Gravel with sand, gray--------------	3	261
Sand and silt, gray, fine to very fine-------------------------	20	281
Silt and clay, gray------------------	67	348
Silt, gray, sandy, some wood pieces--	7	355
Sand and gravel, gray----------------	1	356
Silt, sand, and gravel, gray, cemented--------------------------	9	365
Sand, gray, fine, with some silt and wood--------------------------	10	375
Silt, sand, and gravel, gray, cemented--------------------------	10	385
Silt, dark gray, with some fine sand------------------------------	16	401
26/2-20H1. Kitsap P.U.D., Suquamish Town Supply. Drilled by Burt Well Drilling, Nov. 1970. Altitude 300 ft. Casing: 8-inch to 445 ft. Screened 445-460 ft., 0.014 slot size.		
Clay, brown, sandy-----------------	49	49
Sand, brown------------------------	46	95
Clay, brown------------------------	5	100
Sand, brown------------------------	1	101
Clay, blue-------------------------	26	127
Sand, brown------------------------	3	130
Till, blue-------------------------	5	135
Clay, blue-------------------------	60	195
Clay, brown------------------------	5	200
Clay, blue-------------------------	71	271
Silt, blue-------------------------	5	276
Sand, fine some water--------------	6	282
Clay with sand layers--------------	27	309
Sand, fine some water--------------	2	311
Sand, cemented---------------------	38	349
Clay, blue-------------------------	28	377
Silt, blue-------------------------	3	380
Clay, blue-------------------------	5	385
Silt, blue-------------------------	23	408
Clay, blue-------------------------	7	415
Sand, water-bearing----------------	45	460

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation--continued

Material	Thickness (ft)	Depth below land surface (ft)
26/2-20L1. Kitsap P.U.D., Test Well. Drilled by Story-Armstrong Drilling, July 1971. Altitude 185 ft. Casing: 8-inch to 266 ft. Perforations 325-345 ft.		
Sand, brown, fine with silt--------	37	37
Sand and gravel, brown-------------	4	41
Silt, brown and fine sand----------	17	58
Clay, gray, silty------------------	42	100
Silt, gray, with sand, wood, and peat------------------------	44	144
Sand, brown-gray, and silty sand and gravel----------------------	20	164
Sand and gravel, brown-gray--------	26	190
Sand, gray-brown, coarse with some gravel----------------------	5	195
Sand and gravel, brown-gray--------	28	223
Sand and gravel, gray-brown, with silt------------------------	13	236
Sand, brown, silty-----------------	5	241
Till, gray-------------------------	9	250
Clay, gray, silty------------------	66	316
26/2-20M1. Kitsap P.U.D., Test Well. Drilled by Story-Armstrong Drilling, May 1971. Altitude 267 ft. Casing: 8-inch to 437 ft. Perforations 325-345 ft.		
Silt, brown, sandy-----------------	12	12
Sand, brown, silty-----------------	49	61
Silt, gray, with fine sand---------	13	74
Silt, brown, with fine sand--------	4	78
Silt, gray, with fine sand---------	6	84
Silt, brown, with fine sand--------	6	90
Clay, gray, silty------------------	89	179
Silt and clay, gray, with very fine sand-----------------------	10	189
Sand and gravel with silt----------	39	228
Sand, silt, and some gravel--------	19	247
Sand and gravel with some silt-----	12	259
Sand, gray, fine to very fine------	45	304
Sand and gravel--------------------	3	307
Sand and gravel, cemented----------	16	323
Sand and gravel, very coarse-------	22	345
Silt and clay, some sand-----------	71	416
Clay and gravel--------------------	2	418
Silt, sand, and pebbles------------	14	432
Clay and gravel--------------------	5	437
Silt, black, with shell fragments------------------------	13	450

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation--continued

Material	Thickness (ft)	Depth below land surface (ft)
26/2-29B1. J. Schold. Drilled by Crabtree Well Drilling, Mar. 1976. Altitude 160 ft. Casing: 6-inch to 208 ft. Screened 208-212 ft., 0.012 slot size.		
Till, brown	16	16
Till, gray	24	40
Sand and gravel	1	41
Sand	22	63
Clay, blue	82	145
Till, blue	7	152
Silt	35	187
Clay, blue	22	209
Sand	3	212
26/2-29D2. C. Clark. Drilled by Stanfill Drilling, Dec. 1975 Altitude 170 ft. Casing: 6-inch to 95 ft. Open end casing.		
Soil	4	4
Clay, brown	16	20
Clay, silty	30	50
Silt	18	68
Clay, blue	27	95
Note: no water found		
26/2-29L1. Terra Investments. Drilled by Reliable Well Drilling, Dec. 1975. Altitude 100 ft. Casing: 8-inch to 115 ft. Screened 115-135 ft., 0.012 slot size.		
Till, brown	30	30
Sand and gravel, brown	65	95
Sand and clay, brown	20	115
Sand, water-bearing	20	135
26/2-29L2. Terra Investments. Drilled by Reliable Well Drilling, Dec. 1975. Altitude 100 ft. Casing: 8-inch to 111 ft. Screened 111-131 ft., 0.012 slot size.		
Till, brown	35	35
Sand and gravel, brown	55	90
Sand and clay, brown	23	113
Sand, water-bearing	18	131
26/2-30A3. J. Wilson. Drilled by Stoican Well Drilling, May 1975. Altitude 258 ft. Casing: 6-inch to 225 ft. Screened 225-230 ft., 0.060 slot size.		
Soil	2	2
Till, brown	26	28
Sand, brown	6	34
Till, gray	6	40
Till, brown	42	82
Sand, brown	144	226
Sand and gravel, brown, water-bearing	3	229
Sand, fine, water-bearing	1	230

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation--continued

Material	Thickness (ft)	Depth below land surface (ft)
26/2-30E1. J. Brennan. Drilled by Bach Well Drilling, Oct. 1974. Altitude 340 ft. Casing: 6-inch to 301 ft. Screened 301-305 ft., 0.015 slot size.		
Till	150	150
Clay, blue	5	155
Till, sandy	110	265
Sand with clay	8	273
Till	24	297
Clay, blue	6	303
Sand, water-bearing	2	305
Clay, blue	5	310
26/2-30N1. J. Brennan. Drilled by Axelson. Altitude 205 ft. Casing: 8-inch to 198 ft. Screened 198-208 ft., 0.060 slot size.		
Soil	3	3
Till	33	36
Sand, fine, water-bearing	138	174
Sand and gravel, water-bearing	34	208
26/2-31B1. B. George. Drilled by Burt Well Drilling, May 1971. Altitude 195 ft. Casing: 6-inch to 178 ft. Screened 178-186 ft., 0.012 slot size.		
Sand, brown	14	14
Till, brown	33	47
Till, gray	60	107
Till, brown	20	127
Sand, dry	31	158
Sand, brown, dry	21	179
Sand, water-bearing	7	186
26/2-31B2. W. Christmas. Drilled by Philpot Drilling, 1969. Altitude 210 ft. Casing: 6-inch to 265 ft. Screened 265-285 ft., various slot sizes 0.020 to 0.035.		
Sand and clay, brown	71	71
Clay, blue	30	101
Clay and sand, brown	118	219
Sand, gray	47	266
Till, water-bearing	4	270
Gravel	15	285
26/2-31B3. W. Christmas. Drilled by Burt Well Drilling, Feb. 1976. Altitude 220 ft. Casing: 8-inch to 236 ft. Screened 236-251 ft., 0.010 slot size; 251-266 ft., 0.014 slot size.		
Clay, sandy	23	23
Sand, dry	26	49
Till	38	87
Clay, brown, sandy	115	202
Gravel and sand, water-bearing	7	209
Sand, blue, fine, water-bearing	18	227
Gravel, large, water-bearing	8	235
Gravel and sand	22	257
Sand, medium fine	10	267

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation--continued

Material	Thickness (ft)	Depth below land surface (ft)
26/2-31C2. W. Pratt. Drilled by Burt Well Drilling, Sept. 1972. Altitude 150 ft. Casing: 6-inch to 169 ft. Screened 169-174 ft., 0.014 slot size.		
Sand and gravel	18	18
Sand, brown	9	27
Clay with gravel	4	31
Till	29	60
Clay with gravel, brown	5	65
Till	15	80
Sand, brown, dry	81	161
Sand, fine, gray, water-bearing	15	176
26/2-31D1. Nesika Bay Development. Drilled by Burt Well Drilling, Jan. 1973. Altitude 100 ft. Casing: 6-inch to 98 ft. Screened 98-108 ft., 0.014 slot size.		
Clay, sandy	2	2
Till, brown	86	88
Sand, fine to medium	20	108
26/2-31D2. Nesika Bay Development. Drilled by Burt Well Drilling, Dec. 1975. Altitude 70 ft. Casing: 6-inch to 112 ft. Screened 112-122 ft., 0.012 slot size.		
Soil	3	3
Till, brown	65	68
Sand and gravel	21	89
Gravel	2	91
Sand and gravel, coarse	31	122
Note: water level observation well.		
26/2-31E2. M. Adams. Drilled by Burt Well Drilling, Feb. 1971. Altitude 20 ft. Casing: 6-inch to 27 ft. Screened 27-33 ft., 0.014 slot size.		
Soil, "sandy loam"	3	3
Clay, brown, sandy	21	24
Sand and gravel, water-bearing	9	33
26/2-31P2. A. Kuppler. Drilled by Stoican Well Drilling, 1969. Altitude 15 ft. Casing: 6-inch to 17 ft. Screened 17-20 ft., unknown slot size. Well flowing at land surface.		
Sand with silty layers	20	20
26/2-31Q1. B. George. Drilled by Burt Well Drilling, Apr. 1971. Altitude 18 ft. Casing: 6-inch to 350 ft., 5-inch to 450 ft. Well abandoned, no water found.		
Soil	3	3
Clay, brown, sandy	46	49
Sand, dry	13	62
Clay, blue	96	158
Sand	2	160
Clay, blue	131	291
Clay, silty	159	450

TABLE 4.--Drillers' logs of selected wells on and adjacent to the Port Madison Indian Reservation--continued

Material	Thickness (ft)	Depth below land surface (ft)
26/2-32D1. Suquamish Tribe ("Remington" Property). Drilled by Bartholomew Drilling, Apr. 1976. Altitude 25 ft. Casing: 6-inch to 73 ft. Screened 73-78 ft., 0.010 slot size.		
Soil	4	4
Sand, fine	76	80
26/3-7E6. W. Morris. Drilled by Burt Well Drilling, Aug. 1974. Altitude 80 ft. Casing: 6-inch to 128 ft. Open end casing.		
Soil	2	2
Till, brown	42	44
Till, gray	11	55
Till, gray, sandy	9	64
Clay, blue, sandy	27	91
Till, blue	25	116
Clay, blue, silty	9	125
Till, blue	1	126
Till, brown, water-bearing layers	2	128
26/3-7E8. H. Winkel. Drilled by Reliable Drilling, June 1963. Altitude 80 ft. Casing: 6-inch to 103 ft. Open end casing.		
Soil	1	1
Clay, brown, with sand	4	5
Till, brown	17	22
Till, blue	20	42
Clay, blue with some gravel	26	68
Till, blue	27	95
Clay and gravel	5	100
Sand and gravel, water-bearing	3	103
26/3-7M1. U.S. Navy. Drilled May 1967. Altitude 111 ft. Casing: 10-inch to 136 ft. Open end casing.		
Soil	3	3
Till	38	41
Clay, blue	34	75
Sand and gravel	53	128
Gravel	8	136
26/3-7M2. D. Temple. Drilled by Burt Well Drilling, Oct. 1975. Altitude 70 ft. Casing: 6-inch to 86 ft. Screened 86-91 ft., 0.012 slot size.		
Soil	2	2
Till, brown	53	55
Till, gray	25	80
Sand, brown, dry	1	81
Till, brown	5	86
Sand and gravel	5	91

TABLE 5.--Water-level measurements in selected wells

Well number	Date	Time	Depth to water below land surface (ft)
26/1-25B1	10/08/75	10:40 a.m.	116.26
	01/27/76	12:40 p.m.	116.57
	02/26/76	11:10 a.m.	116.21
	04/28/76	10:15 a.m.	115.84
26/1-25G2	10/08/75	10:50 a.m.	73.12
	01/27/76	12:50 p.m.	72.82
	02/26/76	11:00 a.m.	72.65
26/2-19H1	11/24/75	1:00 p.m.	[a]70.17
	01/27/76	11:20 a.m.	[a]70.52
	02/26/76	10:40 a.m.	69.11
	04/28/76	10:00 a.m.	[a]68.63
	06/09/76	3:00 p.m.	[a]68.72
	07/14/76	12:35 p.m.	68.45
	09/22/76	11:15 a.m.	68.60
	10/27/76	1:00 p.m.	69.00
	11/23/76	10:40 a.m.	69.22
	01/04/77	1:20 p.m.	69.69
	02/09/77	10:05 a.m.	69.91
	03/29/77	9:55 a.m.	70.44
	05/18/77	10:00 a.m.	70.81
	06/28/77	10:58 a.m.	71.24
26/2-20L1	07/13/71	--	[b]132.5
	11/21/75	1:25 p.m.	131.83
	04/05/76	1:40 p.m.	131.13
26/2-30P1	10/09/75	10:00 a.m.	124.99
	11/25/75	1:00 p.m.	125.05
	01/27/76	11:10 a.m.	124.94
	02/26/76	10:25 a.m.	124.55
	04/28/76	9:50 a.m.	123.90
	09/22/76	10:55 a.m.	124.76
	01/04/77	1:05 p.m.	125.44
	02/09/77	9:50 a.m.	125.70
	03/29/77	9:40 a.m.	125.95
	05/18/77	9:40 a.m.	126.11

TABLE 5.--Water-level measurements in selected wells--continued

Well number	Date	Time	Depth to water below land surface (ft)
26/2-31B3	01/29/76	9:55 a.m.	187.69
	02/26/76	10:10 a.m.	187.47
26/2-31D2	12/10/75	12:14 p.m.	45.99
	12/11/75	12:16 p.m.	[c]69.03
	12/11/75	1:15 p.m.	[d]56.24
	01/27/76	11:00 a.m.	45.56
	02/26/76	10:00 a.m.	45.30
	04/28/76	9:35 a.m.	44.92
	06/09/76	3:15 p.m.	44.89
	07/14/76	10:35 a.m.	45.47
	08/31/76	10:50 a.m.	45.79
	09/22/76	10:50 a.m.	46.10
	10/27/76	1:20 p.m.	46.10
	11/23/76	10:10 a.m.	46.26
	12/20/76	10:45 a.m.	46.47
	01/04/77	12:55 p.m.	46.49
	02/09/77	9:40 a.m.	46.67
	03/29/77	9:30 a.m.	46.89
	05/18/77	9:35 a.m.	47.21
	06/28/77	10:26 a.m.	47.58

[a]Well pumped recently.

[b]Robinson and Noble, Inc. written commun., 1976.

[c]Pumping level after 24 hours at 100 gal/min, not shown in figure 7.

[d]1 hour after pump shut off, not shown in figure 7.

TABLE 6.--Chemical analyses of water from selected wells

Well number	Date of sample	Time	Altitude of land surface datum (ft above msl)	Pump or flow period prior to sampling (min)	Instantaneous flow rate (gal/min)	Specific conductance (µmhos/cm)	pH (units)	Temperature (°C)	Color (platinum-cobalt units)	Hardness (Ca,Mg) (mg/L)	Noncarbonate hardness (mg/L)	Dissolved calcium (Ca) (mg/L)	Dissolved magnesium (Mg) (mg/L)	Dissolved sodium (Na) (mg/L)	Dissolved potassium (K) (mg/L)	Bicarbonate (HCO_3) (mg/L)
26/1-13J1	02-28-61	--	310	--	--	101	7.5	9.0	0	36	8	8.0	4.0	4.0	0.4	34
26/2-10N1	04-08-76	3:00 p.m.	105	--	--	164	--	--	--	--	--	--	--	--	--	--
10R2	02-27-61	--	125	--	--	146	7.4	9.0	5	58	0	9.0	8.7	6.0	2.0	72
10R2	04-08-76	2:00 p.m.	115	--	--	128	--	--	--	--	--	--	--	--	--	--
10R3	04-08-76	1:45 p.m.	115	--	--	236	--	--	--	--	--	--	--	--	--	--
17K1	12-18-72	11:30 a.m.	165	105	17	150	8.0	10.0	6	124	54	15	21	6.2	2.4	85
17K2	03-03-71	10:45 a.m.	165	--	2	163	7.4	10.0	10	76	6	15	9.5	6.4	1.8	85
17R1	02-16-71	9:45 a.m.	270	--	15	248	7.7	10.0	12	96	--	16	14	22	2.1	122
20B1	12-08-72	11:30 a.m.	215	--	14	116	7.1	--	5	68	6	--	17	6.6	1.3	76
20L1	07-14-71	6:00 p.m.	185	--	495	148	7.9	9.4	4	66	--	11	9.5	6.1	2.2	95
20M1	05-22-71	4:00 p.m.	267	--	360	240	7.5	--	9	132	--	26	17	8.7	3.2	185
31B3	02-25-76	10:40 a.m.	200	1,240	160	155	7.1	9.3	20	80	11	14	11	5.4	1.7	84
31C2	10-02-72	1:45 p.m.	150	--	20	--	7.6	--	5	60	--	--	--	--	--	--
31D2	12-10-75	2:50 p.m.	70	155	100	145	7.2	9.5	4	64	0	10	9.5	4.8	1.0	84
31E2	04-14-71	12:30 p.m.	20	--	10	120	7.1	10.0	14	42	--	9.2	4.6	5.8	.7	63
32D1	05-20-76	--	35	--	31	--	7.3	--	--	100	--	--	--	--	--	--
26/3- 7M1	06-13-44	--	111	--	--	--	8.5	--	--	95	--	--	--	--	--	177
16L1	04-14-76	10:45 a.m.	80	--	--	172	--	--	--	--	--	--	--	--	--	--
20H1	04-14-76	11:00 a.m.	300	--	--	145	--	--	--	--	--	--	--	--	--	--

TABLE 6.--Chemical analyses of water from selected wells--Continued

Well number	Date of sample	Time	Carbonate (CO_3) (mg/L)	Alkalinity as $CaCO_3$ (mg/L)	Dissolved sulfate (SO_4) (mg/L)	Dissolved chloride (Cl) (mg/L)	Dissolved fluoride (F) (mg/L)	Dissolved silica (SiO_2) (mg/L)	Dissolved solids (residue at 180° C) (mg/L)	Dissolved solids (sum of constituents) (mg/L)	Total nitrite plus nitrate (N) (mg/L)	Dissolved iron (Fe) (µg/L)	Dissolved manganese (Mn) (µg/L)
26/1-13J1	02-28-61	--	0	--	0.2	6.2	0.0	24	70	74	[a]10.0	150	--
26/2-10N1	04-08-76	3:00 p.m.	--	--	--	3.2	--	--	--	--	--	--	--
10R2	02-27-61	--	0	--	7.0	4.8	.1	35	103	109	[a].2	590	--
10R2	04-08-76	2:00 p.m.	--	--	--	4.3	--	--	--	--	--	--	--
10R3	04-08-76	1:45 p.m.	--	--	--	6.6	--	--	--	--	--	--	--
17K1	12-18-72	11:30 a.m.	--	70	13	2.5	.1	19	--	122	.01	760	220
17K2	03-03-71	10:45 a.m.	--	70	9.3	4.5	.1	5	--	95	.7	140	--
17R1	02-16-71	9:45 a.m.	--	100	6.7	26	.1	10	--	158	.7	100	72
20B1	12-08-72	11:30 a.m.	--	62	5.4	4.3	.2	15	--	87	.1	80	--
20L1	07-14-71	6:00 p.m.	--	78	14	2.0	.1	1	--	95	.2	540	43
20M1	05-22-71	4:00 p.m.	--	152	2.6	1.5	.1	2.5	--	154	.5	200	770
31B3	02-25-76	10:40 a.m.	--	69	14	3.0	.1	28	103	119	.02	830	40
31C2	10-02-72	1:45 p.m.	--	--	5.0	5.0	.1	--	--	--	.01	50	50
31D2	12-10-75	2:50 p.m.	0	69	5.2	2.7	.1	28	85	103	.01	180	30
31E2	04-14-71	12:30 p.m.	--	52	11	6.0	.1	3.8	--	73	.7	160	29
32D1	05-20-76	--	--	--	10	3.0	.1	--	--	134	.4	100	50
26/3- 7M1	06-13-44	--	--	125	.4	8.5	--	32	--	152	--	170	200
16L1	04-14-76	10:45 a.m.	--	--	--	2.2	--	--	--	--	--	--	--
20H1	04-14-76	11:00 a.m.	--	--	--	2.1	--	--	--	--	--	--	--

[a]Nitrate (NO_3) only.

TABLE 7.--Water-quality criteria for public water supplies (from Drost, 1977)

Constituent or characteristic	Recommended maximum[a]	Desirable criteria[b]	Detrimental effects of exceeding recommended limits, and other remarks
Physical:			
Color	75 platinum-cobalt units	[c]< 10 platinum-cobalt units	Esthetically undesirable to consumer; economically undesirable to some industries.
Temperature	no recommendation	--	High temperatures may stimulate growth of taste- and odor-producing organisms.
Turbidity	--do--	--	Can reduce the effectiveness of chlorination by physically protecting microorganisms from direct contact with the disinfectant.
Microbiological:			
Coliform (total)[d]	1 col/100 mL	< 1 col/100 mL	Coliform content is an indication of the sanitary quality of the water (high content = unsanitary).
Coliform (total)[e]	20,000 col/100 mL	< 100 col/100 mL	Do.
Inorganic chemicals:			
Alkalinity	no recommendation	--	High concentrations cause unpleasant taste; low concentrations may indicate highly acidic water.
Ammonia	0.5 mg/L	< 0.01 mg/L	May indicate pollution; may interfere with chlorination; is sometimes corrosive to copper and copper alloys.
Chloride	250 mg/L	< 25 mg/L	Salty taste; may indicate seawater intrusion. The recommended maximum is based on taste preferences, not on toxic considerations.
Fluoride	2.0 mg/L	--	May cause dental fluorosis. The recommended maximum is dependent upon air temperature. The value of 2.0 mg/L is for an annual average maximum daily air temperature of 59°F to 64°F.
Hardness	no recommendation	--	High levels (usually in excess of 200 mg/L) may cause undesirable taste and may result in increased soap and detergent use; low levels indicate corrosiveness.
Iron (dissolved)	300 ug/L	virtually absent	Bad taste; stains fixtures and laundry; accumulates in pipes.
Manganese	50 µg/L	--	Do.
Nitrate (as N)	10 mg/L	virtually absent	Highly toxic to some infants.
Nitrite (as N)	1 mg/L	--	Highly toxic (more so than nitrate).
pH (range)	5.0-9.0	--	Water may be corrosive where pH is less than 5.0.
Sodium	no recommendation	--	High concentrations may indicate presence of sewage or industrial effluents; concentrations exceeding 20 mg/L may adversely affect individuals on restricted sodium intakes.
Sulfate	250 mg/L	< 50 mg/L	Possible bad taste; possible laxative effect.
Dissolved solids	[b]500 mg/L	< 200 mg/L	Possible bad taste; possible laxative effect; possibly corrosive.

[a]U.S. Environmental Protection Agency (1973).

[b]U.S. Environmental Protection Agency (1968).

[c]Symbol "<" means less than.

[d]These values are for water after treatment or for water which will not be treated before use.

[e]These values are for raw water (before treatment).

TABLE 8.--Streamflow measurements and estimates at selected sites (from U.S. Geological Survey 1947, 1958, 1959 and author's data 1975-77)

Site no. on plate 1	Drainage area (mi^2)	Date	Streamflow (ft^3/s)
1	1.05	08/15/61	0.20
		12/21/76[a]	.29
2	6.45	07/09/47	.44
		07/24/47	.43
		08/05/47	.33
		08/26/47	.37
		09/17/47	.69
		09/29/47	.60
		08/27/58	.36
		02/27/61[a]	[b]10-15
		08/15/61[a]	[b]1-2
		11/06/75[a]	8.36
		01/20/76[a]	10.9
		03/03/76[a]	15.2
		04/06/76[a]	11.8
		04/27/76[a]	7.19
		05/25/76[a]	3.49
		07/12/76[a]	2.08
		09/01/76[a]	2.52
		09/28/76[a]	1.79
		10/26/76[a]	3.19
		12/20/76[a]	3.07
		02/09/77[a]	[b]4.0
		03/29/77[a]	5.42
		05/18/77[a]	5.45
3	.22	01/21/76[a]	.40
		02/24/76[a]	1.40
		04/05/76[a]	[b].6
		04/06/76[a]	.53
		04/26/76[a]	.59
		05/24/76[a]	.51
		07/13/76[a]	.35
		08/31/76[a]	[b].3
		09/01/76[a]	.39
		09/27/76[a]	.38
		09/30/76[a]	[b].4
		10/26/76[a]	.37
		12/20/76[a]	.37
		02/09/77[a]	.49
		03/29/77[a]	.45
		05/18/77[a]	[b].4

TABLE 8.--Streamflow measurements and estimates at selected sites (from U.S. Geological Survey 1947, 1958, 1959 and author's data 1975-77)--continued

Site no. on plate 1	Drainage area (mi^2)	Date	Streamflow (ft^3/s)
4	0.62	08/26/47	0.06
		08/27/58	.18
		01/21/76[a]	.50
		02/24/76[a]	3.00
		04/05/76[a]	[b]1.5
		04/06/76[a]	1.48
		04/26/76[a]	.93
		05/24/76[a]	.36
		07/13/76[a]	[b].3
		08/31/76[a]	[b].3
		09/01/76[a]	.21
		09/27/76[a]	.12
		09/30/76[a]	[b].1
		10/26/76[a]	.11
		12/20/76[a]	.13
		02/09/77[a]	.19
		03/29/77[a]	.50
		05/18/77[a]	[b].3
5	2.35	08/26/47	[b].05
		08/27/58	.14
		08/28/59	.06
		01/20/76[a]	1.80
		02/24/76[a]	3.50
		04/05/76[a]	[b]1.5
		04/06/76[a]	1.42
		04/26/76[a]	.85
		05/24/76[a]	.47
		07/14/76[a]	[b].3
		08/31/76[a]	[b].2
		09/01/76[a]	.15
		09/27/76[a]	.25
		09/30/76[a]	[b].3
		10/26/76[a]	.21
		12/20/76[a]	.26
		02/09/77[a]	.24
		03/29/77[a]	.33
		05/18/77	[b].3
6	.47	08/15/61	Dry
		01/20/76	[b].1
		02/24/76	[b].2
		07/14/76	Dry

TABLE 8.--Streamflow measurements and estimates at selected sites (from U.S. Geological Survey 1947, 1958, 1959 and author's data 1975-77)--continued

Site no. on plate 1	Drainage area (mi^2)	Date	Streamflow (ft^3/s)
7	0.28	08/15/61	Dry
8	1.79	08/26/47	Dry
		08/27/58	Dry
		08/28/59	Dry
		11/06/75[a]	1.20
		01/20/76[a]	.92
		02/24/76[a]	1.29
		04/05/76[a]	[b]1.0
		04/06/76[a]	.81
		04/26/76[a]	.50
		05/24/76[a]	.30
		07/14/76[a]	[b].01
		08/31/76[a]	[b].01
		09/27/76[a]	[b].01
		09/30/76[a]	[b].01
		10/26/76[a]	[b].01
		11/23/76[a]	[b].01
		12/20/76[a]	[b].01
		02/09/77[a]	[b].05
		03/29/77[a]	[b].1
		05/18/77[a]	[b].2
9	1.44	08/26/47	[b].04
		08/27/58	[b].01
		08/25/59	.02
		11/06/75[a]	[b].02

[a]Water-quality data also collected at this time see tables 9 and 10.

[b]Streamflow estimated.

Site number, date and time of sample collection	Streamflow (ft^3/s)	Specific conductance (micromhos/cm)	pH (units)	Water temperature (°C)	Turbidity (NTU)	Dissolved oxygen (mg/L)	Total dissolved gases (percent)	Total coliform bacteria (col/100 mL)
Site 1								
12/21/76 10:30 a.m.	0.29	126	7.4	7.4	1	11.0	100	[a]370
Site 2								
Grovers Creek								
02/27/61 (b)	[c]10-15	76	6.7	5.6	--	--	--	--
08/15/61	[c]1-2	140	--	15.6	--	--	--	--
11/06/75 11:20 a.m.	8.36	--	--	8.5	--	--	--	--
01/20/76 2:40 p.m.[b]	10.9	85	6.7	4.8	1	10.6	101	27
03/03/76 10:20 a.m.	15.2	84	6.3	1.0	1	12.2	101	220
04/06/76 12:30 p.m.	11.8	79	6.7	9.2	1	9.3	100	240
04/27/76 10:10 a.m.[b]	7.19	73	6.9	8.4	1	9.9	102	150
05/25/76 10:10 a.m.	3.49	117	7.2	9.8	2	9.1	99	4,000
07/12/76 11:00 a.m.	2.08	126	7.6	13.0	2	8.2	99	1,600
09/01/76 10:00 a.m.[b]	2.52	111	6.7	11.8	1	8.9	98	--
09/28/76 10:10 a.m.	1.79	136	6.8	12.4	1	8.3	98	600
10/26/76 12:10 p.m.	3.19	107	7.2	9.2	1	8.9	98	160

TABLE 9.--Selected physical and chemical characteristics of water at selected stream sites--continued

Site number, date and time of sample collection	Streamflow (ft^3/s)	Specific conductance (micromhos/cm)	pH (units)	Water temperature (°C)	Turbidity (NTU)	Dissolved oxygen (mg/L)	Total dissolved gases (percent)	Total coliform bacteria (col/100 mL)
Site 2 (continued)								
12/20/76 1:30 p.m.	3.07	122	7.1	4.6	1	10.5	98	360
03/29/77 11:40 a.m.	5.42	--	--	6.0	--	--	--	--
05/18/77 1:10 p.m.	5.45	--	--	10.4	--	--	--	--
Site 3								
01/21/76 12:45 p.m.[b]	.40	97	7.4	5.2	0	12.4	101	52
02/24/76 1:45 p.m.	1.40	88	7.5	5.6	1	11.5	100	200
04/05/76 11:45 a.m.	[c].6	80	6.6	7.4	0	11.4	100	8
04/06/76 11:40 a.m.	.53	87	7.1	8.2	--	--	--	--
04/26/76 1:40 p.m.[b]	.59	105	7.1	8.6	1	11.3	100	11
05/24/76 2:15 p.m.	.51	107	7.4	10.2	1	11.1	100	110
07/13/76 1:15 p.m.[b]	.35	116	7.8	11.6	1	10.5	100	200
08/31/76 12:50 p.m.	[c].3	90	7.4	12.6	1	10.2	100	48
09/01/76 1:40 p.m.	.39	--	--	12.4	--	--	--	--
09/27/76 1:05 p.m.	.38	114	6.9	11.8	1	10.6	100	--

TABLE 9.--Selected physical and chemical characteristics of water at selected stream sites--continued

Site number, date and time of sample collection	Streamflow (ft^3/s)	Specific conductance (micromhos/cm)	pH (units)	Water temperature (°C)	Turbidity (NTU)	Dissolved oxygen (mg/L)	Total dissolved gases (percent)	Total coliform bacteria (col/100 mL)
Site 3 (continued)								
09/30/76 2:05 p.m.	[c]0.4	--	--	11.8	--	--	--	97
10/26/76 11:10 a.m.	.37	100	7.8	9.2	1	11.2	100	82
12/20/76 12:30 p.m.	.37	107	7.6	5.8	1	12.2	100	270
02/09/77 11:45 a.m.	.49	--	--	7.0	--	--	--	--
03/29/77 11:10 a.m.	.45	--	--	6.2	--	--	--	--
05/18/77 1:15 p.m.	[c].4	--	--	9.8	--	--	--	--
Site 4								
01/21/76 10:50 a.m.[b]	.50	70	7.1	3.8	0	13.0	101	100
02/24/76 12:45 p.m.	3.00	57	7.2	5.0	1	12.0	100	210
04/05/76 11:15 a.m.	[c]1.5	70	[d]5.8	6.8	0	11.4	100	14
04/06/76 11:10 a.m.	1.48	66	6.1	7.8	--	--	--	--
04/26/76 12:40 p.m.[b]	.93	81	7.1	7.8	1	11.7	100	43
05/24/76 1:20 p.m.	.36	113	7.2	9.6	0	11.2	100	160
07/13/76 2:10 p.m.[b]	[c].3	124	7.7	11.0	0	10.7	100	190

TABLE 9.--Selected physical and chemical characteristics of water at selected stream sites--continued

Site number, date and time of sample collection	Streamflow (ft^3/s)	Specific conductance (micromhos/cm)	pH (units)	Water temperature (°C)	Turbidity (NTU)	Dissolved oxygen (mg/L)	Total dissolved gases (percent)	Total coliform bacteria (col/100 mL)
Site 4 (continued)								
08/31/76 12:25 p.m.	[c]0.3	106	7.2	11.4	0	10.4	99	320
09/01/76 2:00 p.m.	.21	--	--	11.6	--	--	--	--
09/27/76 1:40 p.m.	.12	126	6.9	11.2	0	10.4	100	--
09/30/76 1:55 p.m.	$.1^{3}$	--	--	11.0	--	--	--	(e)
10/26/76 10:45 a.m.	.11	123	7.6	9.0	0	11.0	99	100
12/20/76 12:15 p.m.	.13	121	7.2	5.4	1	12.1	99	90
02/09/77 11:30 a.m.	.19	--	--	6.5	--	--	--	--
03/29/77 10:55 a.m.	.50	--	--	5.2	--	--	--	--
05/18/77 1:20 p.m.	[c].3	--	--	9.4	--	--	--	--
Site 5								
01/20/76 1:00 p.m.[b]	1.80	72	6.8	5.4	1	12.0	100	34
02/24/76 11:15 a.m.	3.50	64	7.1	5.2	1	12.0	100	160
04/05/76 10:35 a.m.	[c]1.5	57	5.9	5.8	1	11.9	100	9
04/06/76 10:30 a.m.	1.42	56	6.7	7.2	--	--	--	--
04/26/76 11:20 a.m.[b]	.85	73	6.6	6.4	1	12.0	100	13

Site number, date and time of sample collection	Stream-flow (ft^3/s)	Specific conductance (micromhos/cm)	pH (units)	Water tempera-ture (°C)	Turbidity (NTU)	Dissolved oxygen (mg/L)	Total dissolved gases (percent)	Total coliform bacteria (col/100 mL)
Site 5 (continued)								
05/24/76 12:25 p.m.	0.47	91	7.1	9.8	1	10.6	100	110
07/14/76 11:10 a.m.[b]	[c].3	90	6.8	10.0	1	10.7	100	1,700
08/31/76 11:10 a.m.	[c].2	105	7.1	12.2	1	10.1	99	290
09/01/76 2:15 p.m.	.15	--	--	11.4	--	--	--	--
09/27/76 11:35 a.m.	.25	108	6.8	11.4	1	9.6	99	--
09/30/76 1:40 p.m.	[c].3	--	--	11.2	--	--	--	56
10/26/76 10:00 a.m.	.21	116	7.5	9.2	1	10.4	99	190
12/20/76 11:05 a.m.	.26	103	7.2	3.6	1	12.3	100	470
02/09/77 10:55 a.m.	.24	--	--	6.0	--	--	--	--
03/29/77 10:20 a.m.	.33	--	--	4.8	--	--	--	--
Site 8								
11/06/75 1:30 p.m.	1.20	--	--	8.5	--	--	--	--
01/20/76 11:15 a.m.[b]	.92	37	6.8	4.8	0	12.5	101	26
02/24/76 10:15 a.m.	1.29	32	6.9	5.0	1	7.9	100	100

TABLE 9.--Selected physical and chemical characteristics of water at selected stream sites--continued

Site number, date and time of sample collection	Streamflow (ft³/s)	Specific conductance (micromhos/cm)	pH (units)	Water temperature (°C)	Turbidity (NTU)	Dissolved oxygen (mg/L)	Total dissolved gases (percent)	Total coliform bacteria (col/100 mL)
Site 8 (continued)								
04/05/76 9:55 a.m.	[c]1.0	20	6.7	7.0	1	10.9	101	31
04/06/76 9:50 a.m.	.81	38	6.3	8.2	--	--	--	--
04/26/76 10:25 a.m.[b]	.50	25	7.1	6.8	2	11.4	101	12
05/24/76 11:15 a.m.	.30	41	6.5	10.0	1	9.7	100	600
07/14/76 10:20 a.m.[b]	(f)	71	6.7	10.4	2	6.6	98	450
08/31/76 9:50 a.m.	(f)	126	5.8	10.8	3	2.3,[g]2.9	99	120
09/27/76 10:50 a.m.	(f)	107	5.9	11.2	4	7.0	99	--
09/30/76 1:30 p.m.	(f)	--	--	11.2	--	--	--	(e)
10/26/76 9:40 a.m.	(f)	--	--	9.6	--	--	--	--
11/23/76 10:00 a.m.	(f)	--	--	7.0	--	--	--	--
12/20/76 10:30 a.m.	(f)	--	--	5.6	--	--	--	--
02/09/77 9:30 a.m.	[c].05	--	--	5.5	--	--	--	--
03/29/77 9:15 a.m.	[c].1	--	--	4.8	--	--	--	--
05/18/77 9:30 a.m.	[c].2	--	--	8.6	--	--	--	--

Site number, date and time of sample collection	Stream-flow (ft^3/s)	Specific conductance (micromhos/cm)	pH (units)	Water tempera-ture (°C)	Turbidity (NTU)	Dissolved oxygen (mg/L)	Total dissolved gases (percent)	Total coliform bacteria (col/100 mL)
Site 9								
11/06/75 1:25 p.m.	5.02	--	--	9.0	--	--	--	--

[a]Fecal-coliform sample taken at same time, less than 1 col/100 mL.

[b]Additional water-quality data collected at this time available in table 10.

[c]Streamflow estimated.

[d]Lab pH value, later same day, was 6.8.

[e]Less than 1 col/100 mL.

[f]Streamflow estimated to be equal to or less than 0.01 ft^3/s

[g]Second dissolved-oxygen sample taken at 10:30 a.m., same day.

TABLE 10.--Chemical analyses of water at selected stream sites

Date	Time	Color (platinum-cobalt units)	Hardness (Ca,Mg) (mg/L)	Noncarbonate hardness (mg/L)	Dissolved calcium (Ca) (mg/L)	Dissolved magnesium (Mg) (mg/L)	Dissolved sodium (Na) (mg/L)	Dissolved potassium (K) (mg/L)	Bicarbonate (HCO_3) (mg/L)
Site 2 (12069710) - Grovers Creek near Indianola, Wash.									
1961									
Feb 27	--	150	30	--	6.5	3.4	--	--	25
Aug 15	--	60	--	--	--	--	--	--	--
1976									
Jan 20	1440	150	41	12	8.0	5.0	3.7	1.2	35
Apr 27	1010	--	--	--	--	--	--	--	--
Sep 01	1000	--	61	0	12	7.6	5.8	1.5	87
Site 3 (12069721) - Miller Bay Trib. No. 3 near Suquamish, Wash.									
1976									
Jan 21	1245	55	44	7	7.2	6.3	4.2	1.0	45
Apr 26	1340	--	--	--	--	--	--	--	--
Jul 13	1315	--	51	6	7.9	7.7	4.7	.9	56
Site 4 (12069720) - Miller Bay Trib. No. 2 near Suquamish, Wash.									
1976									
Jan 21	1050	70	30	13	5.7	3.9	3.0	.7	21
Apr 26	1240	--	--	--	--	--	--	--	--
Jul 13	1410	--	50	5	10	6.0	5.6	1.0	55

TABLE 10.--Chemical analyses of water at selected stream sites--continued

Date	Carbonate (CO_3) (mg/L)	Alkalinity as $CaCO_3$ (mg/L)	Dissolved sulfate (SO_4) (mg/L)	Dissolved chloride (Cl) (mg/L)	Dissolved fluoride (F) (mg/L)	Dissolved silica (SiO_2) (mg/L)	Dissolved solids (residue at 180° C) (mg/L)	Dissolved solids (sum of constituents) (mg/L)	Dissolved solids (tons per acre-ft)
Site 2 (12069710) - Grovers Creek near Indianola, Wash.									
1961									
Feb 27	0	--	--	3.2	--	--	86	--	--
Aug 15	--	--	--	--	--	--	--	--	--
1976									
Jan 20	--	29	9.6	4.2	0.1	18	72	70	0.10
Apr 27	--	--	--	--	--	--	--	--	--
Sep 01	0	71	7.7	3.2	--	--	--	--	--
Site 3 (12069721) - Miller Bay Trib. No. 3 near Suquamish, Wash.									
1976									
Jan 21	--	37	8.5	4.0	.1	24	70	79	.10
Apr 26	--	--	--	--	--	--	--	--	--
Jul 13	0	46	8.8	3.6	--	--	--	--	--
Site 4 (12069720) - Miller Bay Trib. No. 2 near Suquamish, Wash.									
1976									
Jan 21	--	17	7.2	3.4	.1	16	47	57	.06
Apr 26	--	--	--	--	--	--	--	--	--
Jul 13	0	45	9.6	4.6	--	--	--	--	--

TABLE 10.--Chemical analyses of water at selected stream sites--continued

Date	Dis-solved solids (tons per day)	Total nitrate (N) (mg/L)	Total nitrite (N) (mg/L)	Total ammonia nitro-gen (N) (mg/L)	Total Kjel-dahl nitro-gen (N) (mg/L)	Total phos-phorus (P) (mg/L)	Dis-solved ortho. phos-phorus (P) (mg/L)	Dis-solved iron (Fe) (µg/L)	Dis-solved man-ganese (Mn) (µg/L)
Site 2 (12069710) - Grovers Creek near Indianola, Wash.									
1961									
Feb 27	--	--	--	--	--	--	--	--	--
Aug 15	--	--	--	--	--	--	--	--	--
1976									
Jan 20	2.14	0.48	0.01	0.15	0.74	0.06	0.04	340	30
Apr 27	--	.08	.01	.18	.65	.06	.04	--	--
Sep 01	--	.08	.01	.18	.63	.11	.09	--	--
Site 3 (13069721) - Miller Bay Trib. No. 3 near Suquamish, Wash,									
1976									
Jan 21	.08	.34	.00	.05	.19	.02	.02	150	0
Apr 26	--	.22	.00	.06	.38	.02	.02	--	--
Jul 13	--	.18	.01	.02	.26	.03	.02	--	--
Site 4 (12069720) - Miller Bay Trib. No. 2 near Suquamish, Wash.									
1976									
Jan 21	.06	1.3	.01	.07	.54	.02	.01	120	10
Apr 26	--	.76	.00	.07	.48	.05	.01	--	--
Jul 13	--	1.1	.00	.03	.19	.03	.02	--	--

Date	Time	Color (platinum-cobalt units)	Hardness (Ca,Mg) (mg/L)	Noncarbonate hardness (mg/L)	Dissolved calcium (Ca) (mg/L)	Dissolved magnesium (Mg) (mg/L)	Dissolved sodium (Na) (mg/L)	Dissolved potassium (K) (mg/L)	Bicarbonate (HCO_3) (mg/L)
Site 5 (12069731) - Port Orchard Trib. No. 2 near Suquamish, Wash.									
1976									
Jan 20	1300	70	27	8	5.4	3.2	3.0	0.5	23
Apr 26	1120	--	--	--	--	--	--	--	--
Jul 14	1110	--	46	0	9.1	5.7	5.1	.6	56
Site 8 (12069760) - Port Orchard Trib. No. 4 at Keyport, Wash.									
1976									
Jan 20	1115	200	19	8	3.7	2.3	2.1	.8	13
Apr 26	1025	--	--	--	--	--	--	--	--
Jul 14	1020	--	35	4	7.6	3.8	3.8	.6	37

Date	Carbonate (CO_3) (mg/L)	Alkalinity as $CaCO_3$ (mg/L)	Dissolved sulfate (SO_4) (mg/L)	Dissolved chloride (Cl) (mg/L)	Dissolved fluoride (F) (mg/L)	Dissolved silica (SiO_2) (mg/L)	Dissolved solids (residue at 180° C) (mg/L)	Dissolved solids (sum of constituents) (mg/L)	Dissolved solids (tons per acre-ft)

TABLE 10.--Chemical analyses of water at selected stream sites--continued

Date	Dis-solved solids (tons per day)	Total nitrate (N) (mg/L)	Total nitrite (N) (mg/L)	Total ammonia nitro-gen (N) (mg/L)	Total Kjel-dahl nitro-gen (N) (mg/L)	Total phos-phorus (P) (mg/L)	Dis-solved ortho. phos-phorus (P) (mg/L)	Dis-solved iron (Fe) (µg/L)	Dis-solved man-ganese (Mn) (µg/L)
Site 5 (12069731) - Port Orchard Trib. No. 2 near Suquamish, Wash.									
1976									
Jan 20	0.35	1.0	0.01	0.07	0.41	0.02	0.01	180	20
Apr 26	--	.40	.00	.10	.46	.02	.02	--	--
Jul 14	--	.45	.00	.12	.30	.03	.02	--	--
Site 8 (12069760) - Port Orchard Trib. No. 4 at Keyport, Wash.									
1976									
Jan 20	.19	.25	.01	.17	.61	.02	.02	350	10
Apr 26	--	.11	.01	.21	.76	.04	.02	--	--
Jul 14	--	.04	.00	.13	.30	.02	.02	--	--

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