UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division

# WATER SUPPLIES FOR SELECTED SITES IN OLYMPIC NATIONAL PARK, WASHINGTON

By

Kenneth L. Walters

Prepared in cooperation with the
National Park Service

OPEN-FILE REPORT
70-358

Tacoma, Washington
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## ABSTRACT

Olympic National Park, on the Olympic Peninsula in northwestern Washington, comprises a rugged mountainous interior area and an elongate coastal area that includes the westernmost point of the conterminous United States.

The use of Olympic National Park and modernization of the park facilities is increasing to the extent that existing water-supply systems are becoming inadequate. In cooperation with the National Park Service, the present appraisal of the water resources was made to meet these increasing needs. Attention was given primarily to areas of the park where water-supply improvements were planned, but the overall water resources of the park were also considered. Wells, springs, and streams were evaluated as possible sources of supply.

Recorded average annual precipitation within or near the park ranges from about 17 inches to about 134 inches, but locally the annual precipitation may exceed 200 inches. The great range in precipitation is due to orographic effects of the Olympic Mountains on moisture-laden winds from the Pacific. The greatest precipitation occurs at the higher elevations in the western interior of the park, and the least occurs in the lowlands in the northeast part of the park, near Sequim.

The generally abundant precipitation produces sev large rivers and many smaller streams in the park are However, several of the large rivers are undesirable sources of water supply because they are fed by glaci melt water that contains much finely divided rock mat Also, many of the smaller streams, especially those n the Pacific Coast and in the areas of highest precipi in the interior area, often carry water that is highl colored by decomposing vegetation. For these reasons because some facilities are not near perennial stream surface water has been unsuitable for some facilities ground water must be considered as the principal sour supply.

The water in the major streams in the park is of calcium-magnesium bicarbonate type. It is soft and ha low chloride content except near the mouths of the st near the coast. Water in smaller streams is of simil quality but generally is more highly colored by organ material. Ground water is either of the calcium-magne bicarbonate or sodium bicarbonate types. It generall low in dissolved solids and in hardness. In a few pl the iron and manganese content in the ground water mal it undesirable for use without treatment.

The bedrock that underlies much of Olympic Nation Park is either fine-grained sedimentary rock of marin origin or igneous rock, and generally is capable of y only a few gallons of water per minute to wells. Aqu of potentially substantial yields are restricted larg to alluvial or glacial deposits. Yields of several h gallons per minute probably are available only from we tapping the alluvium of the lower Quinault and Quilla valleys, or deltaic deposits at Fairholm and Barnes on Lake Crescent. Only a few gallons per minute are available from wells or springs at Ozette Lake, in mu the Queets valley, and at Hurricane Ridge and Deer Pa

## PURPOSE AND SCOPE

An investigation of the water resources in the Olympic National Park was begun by the U.S. Geological Survey in September 1965 at the request of the National Park Service. The purpose of this report is to (1) present a general description of the water resources in the park and (2) describe the quantity and quality of water available at selected sites where water is now or ultimately will be needed for visitor and park use.

An evaluation was made of streams, springs, and wells presently in use or offering potential as sources of water supply. Surface-water data include streamflows and chemical quality. Ground-water data include well yields and specific capacities, spring discharges, chemical quality, and drillers' logs of wells and test holes. Estimates of the quantity of water presently used at various sites in the park also are given.

The present and anticipated needs consist of water for drinking and sanitary facilities for park visitors, for household use by park staff, and for fire protection of facilities. Therefore, an investigation was made of sources that would yield water of good quality perennially, even though at a rate of only a few tens of gallons per minute and without the use of large reservoirs or storage tanks.

In view of the generally high precipitation over the study area, the assumption was made that long-term natural recharge would be adequate for any well supply that can be obtained. Also, it was assumed that the aquifers considered to be potential sources of supply for park facilities are not likely to be affected by future pumpage on privately owned adjacent land.

Water quality was evaluated, for the most part, in relation to its natural state--no attempt was made to determine the feasibility of possible methods of treatment, which could be a significant consideration in choosing between alternative sources of supply. In general, only potential new supplies were analyzed for chemical composition. It was assumed that existing supplies were satisfactory or their undesirable qualities already were known.

## ACKNOWLEDGMENTS

The cooperation of personnel of the National Park Service during the study is greatly appreciated. For supplying data on existing water systems and offering suggestions on problem areas particular acknowledgmen is extended to Manuel Morris, formerly supervisory hydraulic engineer, National Park Service Planning an Service Center, San Francisco, Calif.; William E. Fie supervisory hydraulic engineer, National Park Service Planning and Service Center, San Francisco, Calif.; Bennett Gale, Superintendent, Olympic National Park, Port Angeles, Wash.; and Clifford B. Petersen, engine Olympic National Park, Port Angeles, Wash.

## LOCATION AND GENERAL DESCRIPTION

Olympic National Park is on the Olympic Peninsula the northwestern part of Washington. The park compri an elongate coastal area adjacent to the Pacific Ocear (fig. 1) and the central mountainous interior of the peninsula. The coastal area is about 50 miles long a extends from near the mouth of the Queets River northw beyond Cape Alava, the westernmost point of the conte United States. The interior area is roughly square, measuring about 35 miles on a side. Annual precipita in Olympic National Park ranges from about 20 inches the rain shadow near Sequim to over 200 inches in the mountainous interior. Most of the precipitation occu during the period of November through May, and the su generally are dry.

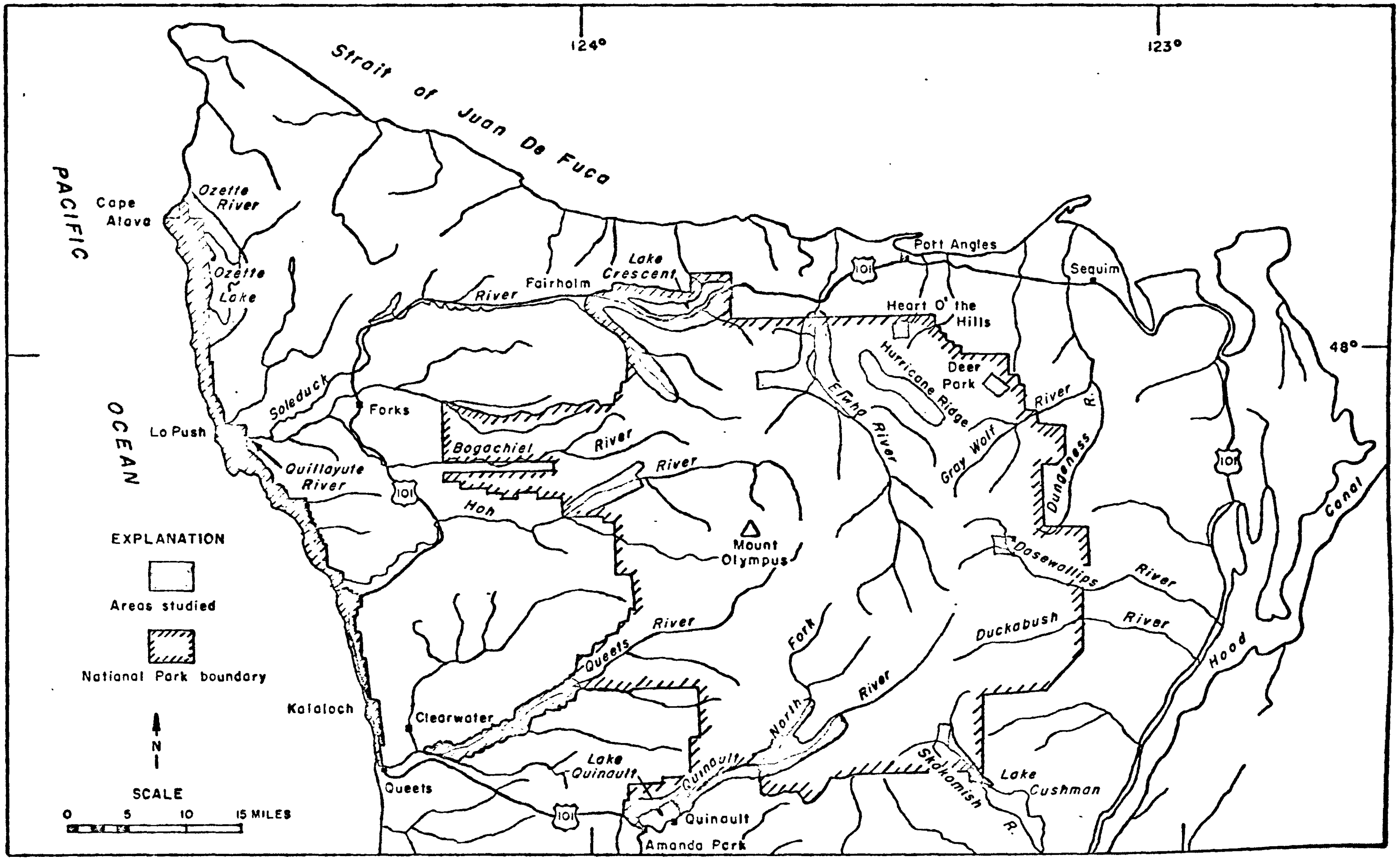



FIGURE 1.--Areas of water-supply investigations, Olympic National Park.

## Coastal Area

The southern part of the coastal area, from the Queets River to the Hoh River, is traversed by U.S. Highway 101 for about 14 miles. The central and northern parts are accessible largely by trail, except for county roads to La Push and to Ozette Lake.

The area generally is of low relief, although the altitude range from sea level to about 680 feet near Kalaloch occurs within less than a mile from the coast. Generally, the area is from 40 to 200 feet above sea level. The major streams are the Hoh and Quillayute Rivers, which originate in the mountainous interior of the park, and the Ozette River, which drains Ozette Lake. Several smaller streams originate in the low coastal hills and discharge along the beach.

The climate of this area is of the marine type, with typically cool summers and mild winters. The average annual rainfall at Forks, which is probably representative of much of the coastal area, is about 117 inches. Snow occurs rarely, and remains on the ground for only short periods.

## Interior Area

The Olympic Peninsula, and the interior area of the park, is encircled by U.S. Highway 101. From the highway, park roads extend part way up the major valleys and to Hurricane Ridge and Deer Park (fig. 4). Trails provide ready access by foot or horseback to some back-country areas, but much of the interior is difficult of access.

The interior area is mountainous and characterized by deep, V-shaped valleys and snow-covered ridges. Altitudes range from less than 100 feet in the Queets River valley to almost 8,000 feet on Mount Olympus. Most of the peaks are between 5,000 and 6,000 feet high. Several rivers--the Quinault, Queets, Hoh, Elwha, Dosewallips, and Duckabush--are fed in part by glaciers located in the upper reaches of their valleys. These rivers may contain enough finely divided rock material to appear turbid in the summer when the melting rate of the glaciers is greate Other major rivers--the Bogachiel, Soleduck, Gray Wolf, an Skokomish--have their origin in snowfields that persist most of the summer or in highland lakes. In contrast to the glacier-fed streams, these rivers generally are clear.

The climate of this area is extremely diverse, largely because of the great range in altitude and the increasing effects of the rain shadow toward the northeast. Locally on the southwestern slopes of the Olympic Mountains, which intercept moist air from over the Pacific Ocean, and locally on Mount Olympus, the annual precipitation often exceeds 200 inches. At the Quinault Ranger Station (fig. 4), altitude 200 feet, the average annual precipitation is about 134 inches, whereas at Sequim, altitude 180 feet, in the rain shadow of the mountains but outside the northeast corner of the park, the average is only about 17 inches. The average monthly precipitation at these two stations is shown in figure 2. The driest months are April through October.

## WATER RESOURCES

In this report, the water resources of the coastal area and the interior area of Olympic National Park are discussed separately. As shown in figure 1, the coastal area includes that part of the coastal strip within the park that extends northward from the Queets River to beyond Cape Alava. The interior area (fig. 1) includes several widely separated valleys and ridges of the Olympic Mountains.

### General Water Quality

The quality of water in the major rivers of Olympic National Park is generally very good, but turbidity and color are a problem at certain times of the year. The water is of the calcium-magnesium bicarbonate type--calcium and magnesium make up more than half the cations and bicarbonate makes up more than half the anions.

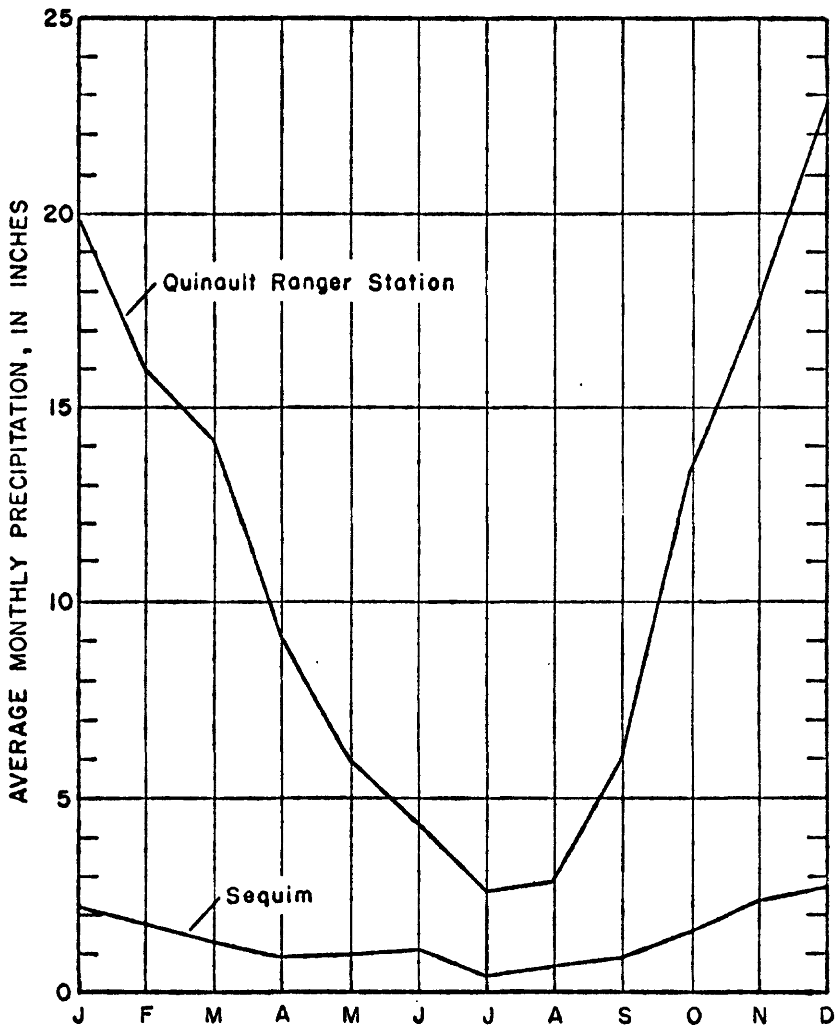



FIGURE 2.--Average monthly precipitation at Quinault Ranger Station and at Sequim, 1931-60. Data from U.S. Weather Bureau.

The water is soft and has a very low chloride content, except locally in estuaries where sea water is mixed with river water. Coliform values are usually very low, but increase somewhat below populated areas. The quality of water in the smaller streams of the park probably does not differ greatly from that of the major rivers at most times of the year, except that many of the smaller streams are usually more highly colored.

Ground water in Olympic National Park is either the calcium-magnesium bicarbonate or sodium bicarbonate type, with the sodium bicarbonate type being most common in areas near the coast. Most ground water sampled had only moderate dissolved-solids content and low hardness (usually less than 200 and 60 mg/l, respectively). The sanitary quality of ground water is excellent in nearly all areas except in some areas of poor drainage where the water has a definite odor of hydrogen sulfide, probably caused by decomposition of deeply buried wood and other organic matter.

None of the ground water sampled contained enough chloride to make it unsatisfactory as a source of supply, but locally at La Push some evidence exists to indicate sea-water intrusion or mixing of fresh water with older saline ground water. The iron and manganese content of ground water in some areas of the park is above the prescribed limits, and locally may be so high as to preclude its use without treatment.

The recommended limits of 0.3 mg/l (milligrams per liter) for iron and 0.05 mg/l for manganese established by the U.S. Public Health Service (1962) are based on esthetic and taste considerations rather than physiological reasons. Excessive concentrations of iron and manganese have similar effects on domestic water supplies in that they impart a metallic or astringent taste, stain food during cooking, stain and discolor laundry and plumbing fixtures, and they may foster the growth of some microorganisms in reservoirs and distribution systems. Formerly, it was recommended that the concentration of iron and manganese together not exceed 0.3 mg/l, but problems with domestic supplies usually occur when the concentration of manganese exceeds 0.15 mg/l, regardless of the iron content.

The taste threshold of iron in water is usually placed at 0.1 to 0.2 mg/l, but may be considerably higher depending on the type of chemical combination and the sensitivity of individuals. Some individuals notice a metallic taste in water containing more than 0.5 mg/l of manganese, and concentrations in excess of 0.15 mg/l have been reported to cause turbidity in water.

## Coastal Area

Because of differences in accessibility, geologic setting, availability of water, and water requirements, the coastal area has been divided for this discussion into a northern and a southern section. The southern section extends from near the mouth of the Queets River northward to the Hoh River, and the northern section extends from the Hoh River northward beyond Cape Alava.

### Southern Section

Water from most streams in the southern section of the coastal area is unsuitable without extensive treatment because of the brownish color most of the year. The color is imparted by complex organic substances leached from decomposing plants and organic soil. The water is colored least both during times of high flow when the streams are carrying a larger percentage of direct storm runoff, and during low flow when a large part of the water is from spring discharge and ground-water seepage.

In the southern section, surface water is used for park facilities only at Kalaloch. There, water from Kalaloch Creek is pumped into an elevated 30,000-gallon storage tank after it is filtered and chlorinated. From the tank, which is near the Kalaloch Ranger Station, water is distributed by pipeline to the Park Service residence area and to the campground. Water is also supplied to a concessioner's lodge and motel area.

Water demand at Kalaloch is highly seasonal, fluctuating with tourist population. The demand reaches a peak in August of about 12,000-15,000 gallons per day, and a minimum in the winter of about 2,000 gallons per day. Kalaloch Creek is one of the streams whose water most of the year is colored by large amounts of decomposing vegetation in the swamps that it drains.

Prior to 1966 ground-water development in the southern coastal section was limited to a well at the extreme south end of the coastal area, in the SE¼SW¼ sec. 22, T. 24 N., R. 13 W. The well is 115 feet deep and is reported to penetrate unsaturated gravel in a zone between 30 and 40 feet deep, and saturated gravel from a depth of 110 to 115 feet. Because it has not been used for several years, little is known of the well's yield characteristics--it is reported to have produced considerable sand and bits of decomposed wood when it was pumped.

In July 1966, a well was drilled at Kalaloch to replace the supply from Kalaloch Creek. The well (Kalaloch well 1) was drilled in the SW¼ sec. 3, T. 24 N., R. 13 W. The site is on a poorly drained terrace about one-eighth of a mile north of Kalaloch Creek and three-fourths of a mile from the ocean. The well, drilled to a depth of 78 feet (table 5), yields about 20 gpm (gallons per minute) from zones 24½ to 27 and 56 to 66½ feet below land surface. The water is turbid, somewhat colored, and contains more iron and manganese (table 3) than is recommended by the U.S. Public Health Service (1962) for drinking water.

In September 1967, a second well (Kalaloch well 2) was drilled in the valley of Kalaloch Creek about one-eighth of a mile north of Kalaloch well 1. Well 2 was intended to supplement the yield of well 1, and possibly to provide water of better quality; it yielded water similar in quantity and chemical quality to that of well 1 (table 3), except that the manganese content was somewhat lower than in the earlier samples from well 1.

The areas of potential ground-water supplies in the southern section are shown in figure 4 (in pocket). The potential as shown on this map and as discussed in the tex is based on interpretation of reconnaissance geologic data except in places where wells existed at the start of the study or where test drilling was done.

The southern section consists mainly of a marine terrace which ranges in width from a few feet to about a mile. The terrace is underlain by unconsolidated and stratified gravel, sand, silt, and clay. South of Kalaloch, and from Abbey Island to the Hoh River, these deposits extend below sea level. Between Kalaloch and Abbey Island the terrace has been eroded and bedrock is intermittently exposed along the beach. The bedrock was studied only to the extent necessary to determine its general water-bearing qualities. A fairly detailed discussion of the bedrock stratigraphy of the coast and offshore islands is given by Weissenborn and Snavely (1968).

A terrace as much as 1 mile wide along the coast in most of T. 24 N., has fair potential for ground-water supply. There, the terrace deposits contain gravel layers at altitudes low enough to be within the zone of saturation. The greatest thickness of saturated terrace deposits is likely to occur near the beach. However, production wells should be located far enough inland to prevent contamination by sea-water encroachment.

Between Kalaloch Ranger Station and the north end of the Kalaloch Campground only a thin mantle of clay and peaty material overlies fine-grained sandstone and siltstone, and an adequate ground-water supply probably cannot be developed here.

In T. 25 N., between Kalaloch Campground and Ruby Beach, bedrock is exposed in the sea cliffs up to about 35 feet above sea level. The terrace deposits that overlie the massive sandstone bedrock there are fine grained and contain numerous beds of peaty material. Significant ground-water supplies probably cannot be developed from either the bedrock or these terrace deposits except in the NE¼ sec. 5. There, a comparatively flat area about 120 feet above sea level appears to be underlain by 50 to 75 feet of sand and gravel. At the contact between the sandy gravel and the underlying sandstone, springs discharge ground water into Cedar Creek just upstream from its mouth and onto the beach just south of its mouth. The beach spring formerly supplied water for use at Ruby Beach.

Most of the coastal area south of the Hoh River in T. 26 N. has moderate potential for a ground-water supply except where bedrock is at or near the surface, in sec. 32 southeast of the mouth of the Hoh River on the Hoh Reservation. Most of the area in secs. 28, 29, and 30, T. 26 N., is underlain by as much as 100 feet of well-stratified outwash sand and gravel. Many springs discharge from the base of the gravel, which there overlies till or clay in the sea cliff. Productive wells probably could be constructed in the gravel, and additional water-bearing sand and gravel beds may underlie the till and clay below sea level.

The hills and steep slopes above the terrace along the eastern margin of this southern section of the coastal area are composed of indurated sandstone and sandy shale. On these slopes, well yields of more than a few gallons per minute are unlikely. Locally, thin deposits of glacial outwash and till-like material mantle the lower slopes, but these deposits are generally unsaturated.

## Northern Section

The major rivers that discharge into the Pacific Ocean in the northern section of the coastal area are, from south to north, the Hoh, the Quillayute, and the Ozette. These rivers generally are unsuitable as sources of water supplies because of their sediment load, contamination, and variations in flow, and because of the major expense of suitable intake and treatment facilities. Most of the smaller streams, as in the southern section, are unsuitable as sources of supply because of the brownish color of the water most of the year.

The present (1967) source of supply at La Push is a small stream about a mile south of the village. After chlorination, the water is distributed to the village, the Coast Guard Station, and a National Park concession. The entire flow of the stream (table 4) is not adequate to meet the demand during the late summer months.

The present water supply for the Rialto Beach picnic area is diverted from a small unnamed stream that originates on the point of land between Dickey River and the Pacific Ocean. The supply is barely adequate in the late summer of dry years. The flow of Ellen Creek, which discharges into the ocean about 1 mile north of Rialto Beach, would be adequate as an alternate supply, but the water is colored.

Water used at the Ozette Lake Campground is from a privately owned supply. There, water is pumped from the Ozette River near its point of discharge from Ozette Lake, than into a pressure-tank system such as that commonly used for domestic supplies.

Present use of ground water by the park facilities within the northern section of the coastal area is limited to the Mora Campground. The daily demand is highly seasonal, with the estimated maximum daily demand at Mora being about 7,000 gallons.

Ground-water production in the northern section, as in the southern section, is likely to be limited to the sand and minor gravel deposits that immediately underlie the elevated marine terraces. These unconsolidated deposits are underlain by massive non-water-bearing sandstone, conglomerate, and sandy shale, which are exposed extensively in the sea cliffs as much as 100 feet above sea level.

Well yields of more than 25 gpm are available from the alluvium north of the Hoh River near its mouth. The alluvial deposits are probably thicker, and larger yields probably could be obtained, east of where a test hole (table 5) was augered in the picnic area at the end of the road. When the test hole was pumped for 3 hours and

20 minutes at 40 gpm the water level was drawn down about 14 feet. The water contained 2.4 mg/l of dissolved iron (table 3), between 0.05 and 0.1 mg/l of manganese, and had a slight odor of hydrogen sulfide. Because the entire valley flat of the Hoh River within the coastal area is poorly drained, any ground-water supply is likely to contain much iron in solution. If a production well is needed to serve the campground near the mouth of the Hoh, consideration also should be given to locating it to the east of the picnic area to reduce the possibility of contamination from pit toilets and garbage pits.

Bedrock is extensively exposed in the sea cliffs between the mouths of the Hoh and Quillayute Rivers. As no wells have been drilled in this area, the water-bearing characteristics of the bedrock are unknown. However, examination of the bedrock at several localities revealed its dense compact nature and indicates that only meager supplies probably could be developed from it. Because the unconsolidated deposits that overlie the bedrock are thin, yields of only a few gallons per minute probably can be developed from wells tapping them (fig. 4). In this part of the northern coastal section, appreciably productive aquifers probably are restricted to valley fill that has limited occurrence along Goodman and Mosquito Creeks.

Thick water-bearing alluvial deposits occur in the valleys of the Quillayute and Dickey Rivers. Near the confluence of these rivers and seaward, the ground-water potential is defined as moderate (fig. 4), largely because of the possibility of sea-water intrusion. Also, the valley fill in this area is thinner and finer grained than that in the area to the east where, between the two rivers and north of the park boundary, larger yields may be obtained from wells drilled in an extensive terrace underlain by outwash gravel.

A well at the Quillayute auxiliary airfield in sec. 18, T. 28 N., R. 14 W., is typical of wells that can be constructed on the terrace. The well is 170 feet deep (log in table 5) and produces 197 gpm of water with 12 feet of drawdown from the static water level which is 108 feet below land surface (about 65 ft above sea level). The general movement of ground water probably is southwest toward Mora Campground.

A 38-foot dug well at Mora Campground is reported to yield 6 gpm with less than 1 foot of drawdown of the water level: its capacity probably is about 50 gpm or more. There is no indication that the well penetrated to the base of the gravel (table 5), and a deeper well at this location probably would be more productive.

Of three test holes augered near the south margin of the alluvium east of La Push, the first (La Push test hole 1), could not be developed sufficiently to permit a meaningful pumping test. When this 39-foot hole was pumped at 20 gpm the water level was drawn down to about 32 feet below land surface, the limit of lift for the centrifugal pump being used. A properly developed well of about 50 to 100 feet in depth, however, should yield several hundred gallons of water per minute. The high iron content (1.3 mg/l) of the water from this depth, as well as the low yield from the test hole indicate a restricted movement of the ground water, and suggest that the coarse gravel layer penetrated below 30 feet (table 5) may be mixed with silt or clay.

La Push test hole 2 was pumped at 42 gpm with only 1.4 feet of drawdown of the water level. Water from this 25-foot test hole contained much less iron (0.08 mg/l) than that from test hole 1.

Test hole 3, 37 feet deep, is much closer to the coast than holes 1 or 2, and was augered to monitor the chloride content of ground water in the Quillayute River valley. The test hole was pumped at 60 gpm and had only about 1.8 feet of drawdown of the water level, demonstrating that at this location the deeper gravel is at least as permeable as the shallower gravel tapped by test hole 2.

The chloride content of water from test hole 3 (table 3) was 78 mg/l as compared to 12 and 13 mg/l, respectively, for test holes 1 and 2. The 78 mg/l chloride concentration is greater than chloride concentrations in water from the other wells that were sampled (table 3) and in stream samples not affected by estuarine mixing with sea water.

With the data available, the origin of this slightly higher chloride concentration and thus the future trend in response to pumping cannot be determined. It may result from the incipient encroachment of sea water, in which case it would be expected to increase with continued pumping. However, it could result from residual chloride concentrations that have not been completely flushed out of an aquifer that is poorly connected hydraulically with the general ground-water flow system, in which case the chloride concentration might decrease with continued pumping.

The iron content (more than 2 mg/l) of water from the deeper gravel tapped by test hole 3 also was higher than that from the shallower gravel tapped by test hole 2. The manganese content of water from all three auger holes near La Push was more than the recommended maximum of 0.05 mg/l, but was less than 0.1 mg/l.

None of the three test holes in the alluvium east of La Push reached bedrock; therefore, it is not known to what depth the alluvial materials may extend, or if water of lower iron content may occur below the depth reached by test hole 1.

Near Rialto Beach, at the mouth of the Quillayute River, bedrock is exposed at the surface and the area offers little possibility for development of an adequate ground-water supply.

From Rialto Beach northward to the vicinity of Cedar Creek, a distance of about 7 miles, bedrock is well exposed in the sea cliffs. This section of the sea coast is deeply dissected by streams, and in general only a thin mantle of unconsolidated material overlies the bedrock. Except possibly in the vicinity of the mouth of Ellen Creek, appreciable ground-water supplies probably cannot be obtained in this area.

The coastal area between Cedar Creek and Ozette River--adjacent to Ozette Lake--is mantled by glacial deposits. Locally, bedrock is exposed in the sea cliffs, but generally the glacial deposits may extend below sea level and much of this area may have potential for a moderate ground-water supply (fig. 4); test drilling would be necessary to evaluate that potential.

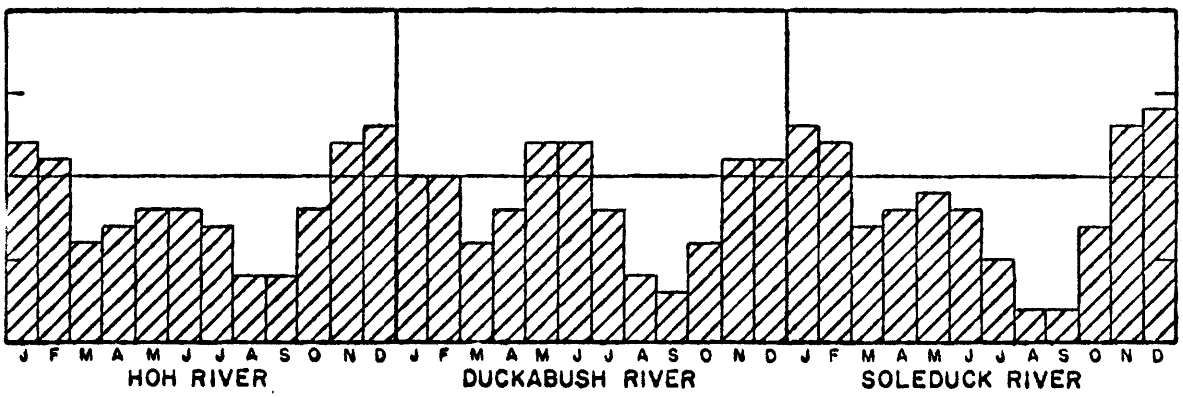
Test drilling near Ozette Lake for this study was limited to the vicinity of Ozette Lake Ranger Station, the only part of the area accessible by road. Two holes were augered, one on the west road shoulder at the south end of the Coal Creek bridge, and the other 100 feet north of Coal Creek and 30 feet east of Ozette River. A third test hole was drilled by the standard rotary method near the center of the south side of the parking lot. Gravel may underlie the till locally to the west of Ozette Lake. However, the drilled hole encountered till at a depth of 38 feet, and passed into bedrock at 96 feet without penetrating any intervening gravel (table 5). A ground-water supply probably can be obtained only from a 30-foot-thick bed of fine sand that overlies the till. Production of water from this unit would be meager, however, and a large-diameter dug well possibly would be more suitable than a drilled well.

## Interior Area

The interior of Olympic National Park is an extremely rugged mountainous area. The central part of the mountains is composed principally of partly metamorphosed, fine-grained sedimentary rocks of marine origin. These rocks are bordered on the north, east, and south by rocks of volcanic origin (Huntting and others, 1961).

The mountains are characterized by a system of radiating ridges and intermontane valleys. The valley sides generally are forested and brush-covered slopes that rise steeply to the ridge crests. Only the lower parts of the major valleys are accessible by roads; the upper reaches are difficult of access except where trails have been constructed. Owing to the lack of development of public facilities in the remote upper valleys, the occurrence of water in these parts of the park was not investigated during this study.

As shown by streamflow records (table 1, fig. 3) all major rivers of the interior area have two periods of high runoff. One, usually in December, coincides with the period of highest precipitation. The second period,




RE 3.--Average monthly distribution of discharges of
h, Duckabush, and Soleduck Rivers, for the period 1951-60.

usually in May or June, coincides with accelerated melting of snow or glaciers at the higher altitudes. The relative magnitude of the two runoff peaks depends on the median altitude of the drainage basin.

Chemical analyses of water from seven of the rivers (table 2) show that, in terms of dissolved iron and total dissolved solids, the chemical quality of the stream water appears to be superior to that of most of the ground water analyzed.

The short streams that drain areas underlain by bedrock in the lower parts of the interior area are characterized by very low flows during periods of drought. This is due both to little water being stored in the bedrock, and to rapid draining of the water stored in the thin mantle of overburden during wet periods.

The marine sedimentary rocks and volcanic rocks that occur in the interior area are dense and of low permeability, and a well drilled into them will yield only small quantities of water, if any. Except where these rocks are highly fractured, as in a fault zone, springs of substantial yield are uncommon. Locally, shallow dug wells could be constructed in the thin alluvial deposits that border the stream channels, or in weathered zones on the bedrock surface. However, such wells would yield only a few gallons a minute, and could be very vulnerable to pollution.

## Quinault Valley

The water resources of the main stem of the Quinault River valley were studied as far upstream as 2 miles above Graves Creek Ranger Station, and the valley of the North Fork of the Quinault was studied to about 1 mile upstream from the North Fork Ranger Station. In the parts of the valleys investigated, coloration of the stream water is not so pronounced as in streams of the coastal area. Canoe and Kestner Creeks are about the only ones that have sufficient flow (table 4) to be considered as substantial sources of supply but the waters are too colored for most uses.

Surface water in the Quinault River valley is used for park facilities only at the July Creek Campground where water is diverted from July Creek just above the North Shore Road. The maximum daily demand at the campground is an estimated 4,000 gallons. Surface water also is used by the Lake Quinault Resort, the Kiwanis Camp, and a small community, all of which are located on the north shore of the lake.

The National Park Service presently (1967) has developed only two ground-water supplies in the Quinault valley. The Quinault Ranger Station is supplied from a dug well about 10 feet deep; according to the park ranger the well yields water containing objectionable amounts of iron. The Graves Creek Ranger Station and campground are supplied by a spring that discharges from glacial material on the slope just east of Graves Creek. The maximum daily demand on this system averages about 3,500 gallons. The existing supply is adequate. There are no existing water supplies at North Fork Ranger Station or North Fork Campground.

The bedrock underlying the Quinault valley is principally fine-grained sedimentary rock of marine origin. Although numerous faults are believed to occur in the bedrock (Huntting and others, 1961), it is unlikely that a well in the bedrock would penetrate a zone sufficiently fractured to yield much water.

Above the mouth of Graves Creek where the Quinault valley narrows abruptly, the ground-water potential generally is poor (fig. 4). Locally, as near the footbridge crossing the Quinault River about 3 miles upstream from the Graves Creek Ranger Station, small springs discharge from a thin covering of glacial material and weathered bedrock that mantles the valley walls. These springs do not have well-defined orifices, and probably are unsuitable for development as dependable water supplies (table 4). However, wells or collection galleries dug in the thickest part of the material and located upgradient from the principal spring discharge, would provide at least meager supplies. Localities where this type of development may be possible are (1) in the draw overlooking the foot trail about 700 feet west of the footbridge, and (2) along the east side of the small flat area lying just south of the river and east of the foot trail as it approaches the bridge. Also, for a short distance above the mouth of Graves Creek, a terrace about 200 feet above river level is mantled with glacial materials that may have enough saturated thickness to yield water to a well.

Figure 4 indicates that the Quinault valley floor has good ground-water potential at most locations between Graves Creek and the mouth of North Fork Quinault River. At these locations, the alluvial and terrace deposits are thick enough and of sufficient areal extent to yield from 25 to several hundred gallons per minute. An auger hole at Graves Creek Ranger Station, which penetrated progressively coarser gravel to a depth of 16 feet, was dry at that depth, and additional penetration was not possible with the equipment being used. However, if the gravel is as much as 25 feet thick, the lower part probably is within the zone of saturation.

Yields of up to several hundred gallons per minute also may be available from the alluvial deposits that border the north side of the Quinault River for about 2 miles above the mouth of North Fork Quinault River. Elsewhere in the Quinault valley above its confluence with North Fork Quinault valley, alluvial or terrace deposits are too restricted in area and thickness to be of much importance as possible sources of ground-water supplies.

The North Fork Quinault River valley has good ground-water potential from its mouth to at least a mile upstream from the North Fork Ranger Station. An auger hole at the ranger station penetrated 15 feet of progressively coarser gravel similar to that at Graves Creek Ranger Station. The thickness of the gravel is unknown, but the existence of springs just west of the ranger station suggests that a shallow well would penetrate enough saturated gravel to yield up to several hundred gallons per minute of water.

Much of the north side of the Quinault valley between Quinault Lake and North Fork Quinault River has moderate to good ground-water potential except where bedrock is exposed, as in parts of secs. 28 and 29, T. 24 N., R. 8 W. (fig. 4).

During this study a hole was augered about 250 feet west of the U.S. Geological Survey precipitation gage in NW¼SW¼ sec. 27, T. 24 N., R. 8 W. The augering was retarded by boulders, imbedded in fine sand, that were encountered at a depth of 17 feet in this hole (table 5), but a dug well or properly screened drilled well should produce more than 25 gpm of water. A second auger hole about 0.9 mile to the west (not listed in table 5) penetrated boulders to a depth of 10 feet.

Although not tested, the ground-water potential in much of secs. 14, 15, 21, and 22, T. 24 N., R. 8 W., may be moderate to good, as suggested by evidence of coarse materials underlying the Quinault valley in this reach. Most of Irely Creek and the lower reaches of Big Creek probably mark a former course of the North Fork of the Quinault River. That the flow of a reach of Big Creek is principally underground in summer indicates that the underlying materials are highly permeable. The summer flow of Finley Creek also is mostly underground in the reach south of North Shore Road, indicating that the coarse materials extend at least that far down the Quinault valley.

An augered test hole at Quinault Ranger Station, about three-fourths of a mile west of Finley Creek, penetrated considerable thicknesses of fine-grained materials but also some water-bearing gravelly beds (table 5) and it did not reach bedrock. The hole was cased to 44 feet, with perforations from 34 to 44 feet. It was pumped at a rate of 33 gpm and had a resulting drawdown of water level of about 9 feet, which indicates a specific capacity of about 4 gpm per foot of drawdown. A chemical analysis of water from this hole (table 3) shows the water to be soft and to have unusually low concentrations of most dissolved constituents except that the concentration of manganese exceeds the recommended maximum limit.

Bedrock is exposed or is near the surface in much of the area bordering the north shore of Quinault Lake, and the unconsolidated materials that overlie bedrock are much finer grained than in the area upstream. A domestic well near McCormick Creek, in NE¼NW¼ sec. 18, T. 23 N., R. 9 W., is reported to have penetrated only clay and fine sand before reaching a thin gravel bed at a depth of about 285 feet. Springs and shallow wells less than 50 feet deep produce only a few gallons per minute of water for domestic supplies in sec. 13, T. 23 N., R. 10 W. These shallow ground waters are subject to contamination; also, some are excessively high in iron. (See example in table 3.)

Quinault Lake is impounded by a glacial moraine that is composed of a mixture of clay, sand, and boulders. Interstratified beds of clean sand and gravel produce moderate to large quantities of water. A well at the Washington State Department of Highways maintenance shop, just outside the National Park boundary, is 133 feet deep and obtains water from gravel. Another well, located at the Olympic Truck Stop across the road from the maintenance shop well, is 105 feet deep. The yield of these wells could not be determined, but probably is several tens of gallons per minute. The iron content of water from these wells is low (table 3).

## Queets Valley

The water resources of the Queets River valley were studied from the park boundary to about a mile upstream from the mouth of Sams River. Three major streams--Salmon River, Matheny Creek, and Sams River--are tributary to the Queets River within this reach. These streams generally are unsuitable or not considered as sources of supply of good-quality water for use of visitors and park personnel because of (1) variations in turbidity of the water, (2) possible contamination of the stream by spawning salmon, and (3) the expense of suitable intake and treatment facilities.

Several small tributaries of the Queets River have sufficient flow to be considered as small sources of supplies (table 4), but most are unsuitable because of the brownish color of the water most of the year. Waters of Boulder Creek, which is tributary to the Queets River at Sams Rapids, and of an unnamed stream that is tributary to the Queets in sec. 11, T. 24 N., R. 11 W., are less colored than those of most small streams in the Queets valley. However, they are north of the Queets River and access to them is limited.

Surface water is not being used as a source of supply in the Queets valley. Surface-water supplies were in use only by a few ranches before the area was taken into the National Park.

No ground-water supplies currently are being used in the Queets valley. However, several dug wells were used for domestic and stock supply before the area became part of the park. A shallow dug well formerly supplied Queets Ranger Station but it is now reportedly contaminated and is unused. The Queets Campground has no water supply.

The floor of the Queets valley is underlain by alluvial silt, sand, and boulders. These deposits, less than about 20 feet thick, are capable of yielding a few gallons per minute to dug wells. Because the alluvium that borders the lower reaches of Matheny Creek is coarser and probably thicker than that in the main part of the upper Queets valley, shallow wells in this area probably will yield as much as 25 gpm (fig. 4 ).

The ground-water potential is generally poor in the area immediately adjacent to the Queets River upstream from Lyman Rapids (sec. 19, T. 24 N., R. 11 W.). A test hole at the Queets Ranger Station (sec. 2, T. 24 N., R. 10½ W.) penetrated 8 feet of silt and fine sand, and 10 feet of boulders, then only non-water-bearing clay and fine sand from 18 to 271 feet (table 5). The character of the material penetrated from 271 to 301 feet is uncertain, but it probably is shale. The rocks into which the Queets valley is eroded are chiefly indurated marine sediments, and contain no significant aquifers.

A long terrace about 200 feet above the valley floor on the south side of the valley in the area between Lyman Rapids and Sams River is underlain by stratified glacial drift and till. As the base of the coarse terrace deposits probaly is below the valley floor, saturated gravel at about flood-plain level probably would yield as much as 25 gpm to wells.

The ground-water potential in the Queets River valley downstream from Lyman Rapids to the park boundary may be better than in the valley upstream from the rapids (fig. 4). Although the clay section penetrated by the test hole at Queets Ranger Station doubtless occurs in the lower reach too, it may be at greater depth and may be overlain by thicker deposits of the coarser water-bearing alluvial material. For example, because of the extreme coarseness of the alluvium in the lower valley, an auger hole in the SW¼ sec. 26, T. 24 N., R. 12 W. (not listed in table 5) reached a depth of only 15 feet.

In the lower reach of the valley, several springs discharge from materials that underlie a terrace ranging from about 160 to 240 feet above flood-plain level. Yields of as much as 25 gpm probably can be obtained from wells that tap these materials within the zone of saturation. Otherwise, with proper development and protection from pollution, the springs would be adequate for moderate demands.

## Hoh Valley

The investigation for potential water supplies in the Hoh River valley covered only a 6-mile reach of the valley that extends from the park boundary near the Lewis Ranch to the Hoh Ranger Station. The water resources of a short reach of the valley near the mouth of the river are described in a preceding section on the coastal area.

Of seven tributary streams visited in the summer of 1966, four were dry and the flow of the others was measured or estimated to range from 0.30 to 1.50 cfs (cubic feet per second). In only three, therefore, were the flows large enough to be considered as dependable sources of supply. None of those three carried water that was so colored to be unsuitable for domestic use.

Within the reach studied, surface water has been developed as a source of supply only at the Hoh Ranger Station. There, water is diverted from Taft Creek for use at the campground, visitor center, and ranger station. The estimated maximum daily demand is about 7,500 gallons.

Although no ground-water supplies are presently developed by the National Park Service in the Hoh valley, in most of the 6-mile reach the potential is good (fig. 4). However, because usable surface-water sources are available, the ground-water possibilities were studied in less detail than elsewhere.

The lowest part of the valley floor--a strip about 500 to 1,000 feet wide through which the river meanders--is composed of alluvium that doubtless is water bearing. Because this area is subject to flooding, however, it is unsuitable for well sites.

Low terraces border the alluvial area and are underlain by gravel of unknown thickness. About 2 miles west of the park boundary, clay is exposed locally near river level. This clay is similar to that exposed in the Queets valley and may be of comparable thickness. If so, and if the clay extends beneath the deposits of the low terraces, production from wells located on the low terraces would be from shallow depths. Several small streams that maintain substantial flows at the edge of the valley floor discharge into the low-terrace gravels, and have no surface flow across the terrace except at high flow. This indicates that the terrace gravels are, at least locally, highly permeable and should yield 25 or more gallons per minute of water to shallow wells.

Glaciofluvial deposits, chiefly gravel, are exposed in the valley walls up to an altitude of about 650 feet in some places. In the north valley wall in the lower 2 miles of the study area, clay beds locally impede the downward movement of water and small springs discharge from the coarser deposits at the top of the clay. Where not so badly dissected that they are drained, the glaciofluvial deposits would yield up to 25 gpm of water to wells.

The bedrock underlying the Hoh valley has very poor ground-water potential. Attempts to develop supplies from it should be limited to those areas where the unconsolidated deposits have been completely tested and found to be unproductive.

## Soleduck Valley

Of 26 tributary streams on the northeast side of the Soleduck River valley between the Soleduck Campground and the park entrance, 16 were either dry or had flows too small--less than 0.10 cfs--to be considered as dependable sources of supply (table 4). Most of the larger tributaries join this reach of the river from the southwest side of the valley; the North Fork Soleduck River is the only major tributary on the northeast side. The water in most tributaries is not greatly colored even at times of low flow.

A small stream near Soleduck Ranger Station is the source of supply for the station and for the resort at Sol Duc Hot Springs. The estimated maximum daily demand on this system is about 12,000 gallons. The water supply for Soleduck Campground--about 2 miles upstream from the ranger station--is from a small spring that discharges from glacial drift in the lower part of the valley wall. The estimated maximum daily demand on this system is about 3,000 gallons.

The bedrock underlying the Soleduck valley is mostly fine-grained metamorphosed sediments that appear too dense to yield much water to wells. Sol Duc Hot Springs issue from the bedrock, but apparently under highly localized geothermal conditions. Probably through a system of intersecting faults, water from local precipitation infiltrates the rock to a depth where it is heated, then discharged from several orifices at an altitude lower than the point of infiltration. The temperatures of the several springs range about from 31° to 50° Celsius or 87° to 122° Fahrenheit. The water is moderately mineralized and is unsuitable for most consumptive uses. It is used in swimming pools and for some miscellaneous purposes at the resort. The total developed spring discharge is about 140 gpm (about 20,000 gallons daily).

Glacial drift underlies the lower part of the northeast wall of the valley, between the ranger station and the campground, and locally on both sides of the valley for about 2 miles above the mouths of the North and South Forks. These deposits are not extensive and include thick beds of impermeable till. Locally, however, gravel deposits may occur at low enough altitudes to be within the zone of saturation, and they may yield water to wells. Many small springs issue from the glacial deposits; some are as high as 50 feet above the valley floor.

Glacial deposits also underlie an area traversed by the Sol Duc Hot Springs road where it roughly parallels U.S. Highway 101 for about 2 miles before entering the Soleduck valley. In the lower areas between the two roads, outside the park boundary, the glacial deposits probably will yield several hundred gallons per minute of ground water to wells. Within the park, however, these deposits are thin and are mostly above the zone of saturation; the ground-water potential of this area is poor (fig. 4).

The alluvium and low-terrace deposits in the Soleduck valley are thinner than those in any of the valleys previously discussed. Bedrock is exposed in the river channel at several places: (1) about three-fourths of a mile northwest of the mouth of the North Fork; (2) in a 2-mile reach of the river just upstream from the mouth of the North Fork; and (3) at Sol Duc Hot Springs. The alluvium and low-terrace deposits are composed principally of highly permeable gravel and boulders, and, at least where their base is exposed, they rest on bedrock. Except where bedrock is exposed in or near the river channel, yields of up to several hundred gallons per minute probably could be obtained from wells. Because these deposits are thin and only partially saturated, dug wells or infiltration galleries would probably be more successful than drilled wells, but such water supplies might be subject to contamination from surface seepage.

## Lake Crescent

The Lake Crescent area is in the fringe of the rain shadow of the Olympic Mountains and precipitation is considerably less than in any of the areas previously discussed. Many streams that discharge into the lake are short and because they drain bedrock areas of low ground-water storage, they have little or no flow during the late summer. Of 22 streams flowing into Lake Crescent, 12 were either dry or discharging less than 0.10 cfs in September of 1966 (table 4). Coloration of the water in streams is slight, and the few streams that have sufficient flow in late summer are suitable as sources of supply.

On the south shore of Lake Crescent, at the Storm King Visitor Center and at Lapoel picnic area (not shown on map, but at the mouth of Lapoel Creek) the water demands are met by surface water. The water supply for the Storm King Visitor Center area is from Falls Creek, a tributary to Barnes Creek. Water is diverted from the creek just below Marymere Falls, and is supplied to the visitor center, lodge, and other concession facilities, and to residences of park personnel. Water is diverted from Lapoel Creek to supply the Lapoel picnic area.

Present (1967) use of ground water in the Lake Crescent area is limited to the supply for the Fairholm resort and campground, and a few individual domestic supplies that utilize springs or shallow wells. The Fairholm supply is from springs that discharge at the contact between glacial deposits and bedrock about half a mile west of the lake. The estimated maximum daily demand on this system is about 10,000 gallons.

The Lake Crescent area is underlain by basaltic rocks, except along the south shore between Fairholm and Barnes Point and at the extreme north end of the lake (Brown and others, 1960). The basalt and associated interbeds are intensely folded and fractured and may be capable of yielding as much as 25 gpm of water to wells. However, no wells are known to have been drilled into these rocks in the Lake Crescent area. The other bedrock units in the area are fine-grained sandstone, siltstone, and metamorphic rocks that are virtually barren of water.

Near the northeast end of Lake Crescent, in the valley of Lyre River in sec. 14, T. 30 N., R. 9 W., glacial till and some outwash sand and gravel mantles the bedrock. Generally, the glacial deposits in the Lyre valley are too thin and limited in extent to be a major source of ground water, but at a few places they may yield some water to wells.

Near the west end of the lake, west of Fairholm, springs issue from similar glacial deposits at altitudes as high as 1,100 feet. Shallow wells having yields as much as 25 gpm probably could be developed, but test drilling would be necessary to locate sites of optimum conditions of thickness, permeability, and saturation of the glacial deposits.

Thick accumulations of gravel, which represent deltas formed by Fairholm and Barnes Creeks, contain potentially the most productive aquifers in the Lake Crescent area (fig. 4). The Fairholm Creek delta occupies a small triangular area between U.S. Highway 101 and the Fairholm Campground. A test hole on the delta penetrated mostly gravel to a depth of 56 feet (table 5), and had a static water level of 11.8 feet below land surface. It was pumped at the rate of 37½ gpm for 3½ hours and had 9.30 feet of drawdown, or a specific capacity of about 4 gpm per foot of drawdown. The water is of good chemical quality (table 3) except that the manganese content exceeds the recommended maximum. A properly constructed well near the location of the test hole should yield several hundred gallons of water per minute.

The Barnes Creek delta is much larger than that of Fairholm Creek. It includes all the flat area below an altitude of about 650 feet that extends from the visitor center to a point south of Lake Crescent Lodge.

Three test holes were augered into the deposits of the Barnes Creek delta. A log of the materials penetrated was maintained for only two (table 5). The third hole, about 300 feet south of test hole 1, penetrated materials identical to those in test hole 1. Test hole 1 was pumped for 3 hours at 60 gpm and had a 5.4-foot drawdown of the static water level which was 7.8 feet below land surface. The test indicated a specific capacity about 11 gpm per foot of drawdown. A properly constructed well of the same depth as the test hole should yield at least 500 gpm. As none of the test holes on the Barnes Creek delta encountered bedrock, it is probable that productive aquifers extend below the depths reached by the test holes.

Water from test hole 1 is of good chemical quality (table 3) except for manganese. Ground-water supplies less subject to possible future contamination from lakeshore development could be developed south of U.S. Highway 101. However, above the highway, above a land-surface altitude of about 625 feet, the delta deposits may be too thin to yield adequate quantities of ground water.

Very small deltas have formed at the mouths of Lapoel and Smith Creeks. The deposits in these deltas may be too thin to be important as sources of ground water.

## Elwha Valley

The water resources of the Elwha River valley were studied in the area between the park boundary and a point about 1 mile southeast (upstream) of Whiskey Bend. The valley of Boulder Creek, tributary to the Elwha valley, was examined between its mouth and Olympic Hot Springs. Of 11 streams in the Elwha valley that were visited in September 1966 (table 4), only three were dry or had a discharge of less than 0.10 cfs. At least during low flow, coloration of the streams in the Elwha and Boulder Creek valleys is not severe and, from this standpoint, most streams are suitable as sources of supply.

Present use of surface water is limited to a system that supplies Altair Campground and the Elwha Ranger Station. This supply is from a small spring-fed creek a few hundred feet southeast of the ranger station. The estimated maximum daily demand is 3,000 gallons.

The Elwha and Olympic Hot Springs Campgrounds are both presently supplied with ground water from springs. The estimated maximum daily demand at the Elwha Campground is about 2,000 gallons, and at the Olympic Hot Springs Campground it is about 4,000 gallons.

Several types of bedrock are exposed in the Elwha valley (Brown and others, 1960), but none are known to be good aquifers. Basaltic rocks in the valley walls and underlying the alluvium between the ranger station and park boundary may be capable of yielding as much as 25 gpm of water to wells, but no wells are known to have been drilled into them.

At Olympic Hot Springs heated water issues from bedrock under conditions similar to those at Sol Duc Hot Springs. The total discharge of Olympic Hot Springs is unknown but is reported to be considerably more than that of Sol Duc Hot Springs. The water is mineralized and discharges at a temperature of about 48°C (118°F); it is unsuitable for most domestic uses except in swimming pools.

Substantial ground-water supplies probably cannot be developed from wells in the Elwha valley above Upper Elwha Dam (north end of Lake Mills) or in the valley of Boulder Creek. However, in the valley walls many small springs issue from the contact between bedrock and overlying colluvium or glacial deposits. Such springs occur (1) at Michaels Ranch, (2) near Whiskey Bend, and (3) near the boat launching area on the west side of Lake Mills. At many places in the upper Elwha and Boulder Creek valleys, yields of as much as 25 gpm possibly can be developed from springs or from infiltration galleries constructed above small springs or seepage areas.

The floor of the Elwha valley below Lake Mills is mantled with alluvium of unknown thickness. Gravel, too coarse to penetrate with a power auger, was encountered within a few feet of the surface at both the Elwha Ranger Station and the campground. However, as indicated by the many bedrock exposures in the river channel, the gravel may not be thick anywhere in the valley. Where it extends below river level near the river, or where it is within a few feet of river level near the valley walls, the gravel is coarse enough that it may yield up to 25 gpm of water to shallow wells. Because the saturated gravel may be very thin, dug wells could be constructed to extend for a short distance into bedrock. Such large-diameter wells would thereby have the advantages of intersecting more potentially water-bearing fissures or joints in the bedrock, and providing a larger storage capacity between pumping cycles.

## Heart O'the Hills

The water resources of the Heart O'the Hills area, near the park entrance on the Port Angeles-Hurricane Ridge highway, were not studied in detail as the present water supply is adequate. The low flows of several streams in the area (table 4) show that many appear to be perennial and that surface water can be used to supply any reasonable future demand.

The water supply for the Heart O'the Hills Campground is diverted from an unnamed tributary to Ennis Creek near the park entrance. The maximum daily demand of this system is about 8,000 gallons.

Moderate ground-water potential may exist in this area (fig. 4). In contrast to many other parts of the park, the bedrock here may be capable of yielding up to 25 gpm to wells. This has not been substantiated however, as no wells are known to have been drilled into the rocks that underlie the area (Brown and others, 1960). Surficial glacial deposits are too thin in most places to be significant as sources of ground water.

## Hurricane Ridge

Partly in the rain shadow of the Olympic Mountains, Hurricane Ridge is at an altitude of about 5,000 feet, and overlooks the Elwha and Lillian River valleys. Streams on both sides of the ridge originate about 500 feet below the crest and most do not maintain perennial flow within 1,500 feet of the crest. The low flows of the streams are maintained by seepage of ground water that is in temporary storage in the thin soil cover on the bedrock.

The existing water supply for the lodge and picnic area near the west end of Hurricane Ridge is pumped from Idaho Creek, a tributary to Elwha River. The diversion is at about the point where the flow of the creek becomes perennial, and in periods of peak demand in late summer almost the entire flow (table 4) is utilized. A larger supply could be obtained from Idaho Creek by moving the diversion downstream. The existing supply could be supplemented by installing similar diversions near the heads of other streams, but more lift would be required than that from the Idaho Creek installation.

Little ground water is available on Hurricane Ridge, except that which seeps from the soil covering the bedrock. The existing system on Idaho Creek could, in fact, be regarded as a collection gallery for ground water. The bedrock of the area is mostly fine grained, somewhat metamorphosed sedimentary rock of marine origin, and is virtually barren of water except in the zone of weathering.

## Waterhole Picnic Area

The Waterhole picnic area is located at an altitude of about 5,000 feet on Hurricane Ridge, about 0.9 mile northwest of Eagle Point. The geologic and hydrologic setting in the area is almost identical to that in the lodge area. The Waterhole picnic area is in a saddle on the ridge, and ground water flows from the peaks on the southeast through the soil cover and weathered zone. The water collects in the lowest part of the saddle and discharges at rates up to a few gallons per minute into the small stream that flows west from the area. The existing spring system could be improved by construction of an efficient collection gallery that would intercept more of the migrating ground water before it is discharged. Because a water supply of this type is readily polluted by contaminants at the land surface, however, the discharge area and nearby areas upslope should be protected against contamination by public use or other means.

## Deer Park

The Deer Park area is at an altitude of about 5,250 to 5,400 feet, near the summit of Blue Mountain in the northeast corner of the park. Like Hurricane Ridge, it is partly within the rain shadow of the Olympic Mountains, and receives considerably less precipitation than most of the park.

The low flows of three small streams tributary to Maiden Creek near Deer Park are given in table 4. Two of these streams, originating at small springs within the campground, have been developed as sources of supply.

The hydrologic setting at Deer Park is similar to that of Hurricane Ridge and the Waterhole area. The unweathered bedrock is impermeable and would not yield appreciable quantities of water to wells. The minimum summer flows of the small springs in the area are maintained by ground water in transient storage in the soil cover on the bedrock. Water from rain and melting snow enters the soil in higher areas to the north of the campground and moves downslope until it discharges as springs at places where erosion has stripped off most of the soil cover.

Some ground water that is not presently being used is discharged at the surface in a marshy area about 300 feet southeast of the southernmost of the two springs that have been developed (not shown on map). A collection gallery, if constructed in the lower part of the marshy area at about the altitude of the developed spring and parallel to the stream, would probably yield enough water to supplement the existing supply. However, both the existing supply and the proposed collection gallery would be subject to pollution if a source for such pollution were allowed to develop at or near the land surface. Therefore, the nearby areas upgradient should be protected from contamination.

## Dosewallips Valley

The water resources of the Dosewallips River valley were investigated only between the park boundary and the Dosewallips Ranger Station, a distance of about 2 miles.

The low flows of Constance and Station Creeks (table 4) suggest that these creeks are adequate to meet foreseeable needs even during drought years. The present water supply for the ranger station and campground is from Station Creek. The supply is ample and is of satisfactory quality except for sediment that occasionally becomes a problem. The estimated maximum daily demand is about 2,750 gallons.

The potential for ground-water supplies in the Dosewallips valley is poor to moderate. Although no wells are known to have been drilled into the bedrock underlying the valley, the dense rock probably will not yield more than a few gallons per minute to wells. Furthermore, water from springs that issue from fracture zones in the bedrock to the west of the area investigated is reported to be mineralized, although the extent of mineralization is not known.

The Dosewallips valley is narrow and steep sided, and contains an appreciable amount of alluvium only in the vicinity of the campground. Bedrock is exposed on the south side of the river at the west end of the campground, and on the north side of the river at the east end of the campground. Although these bedrock exposures suggest that the alluvium is thin, abandoned former channels of the stream, now filled with alluvium, might yield some water to shallow wells. The widest part of the valley in the vicinity of the campground is interpreted as having moderate ground-water potential (fig. 4) because of the possibility that alluviated former channels may exist there. Yields from wells in the channel gravels--if the gravels do exist--would probably be in the range of 5 to 25 gpm.

## Valley of North Fork Skokomish River

The water resources of the valley of the North Fork Skokomish River were investigated for a distance of about 4 miles upstream from the park boundary. Of 11 streams whose low flows are recorded (table 4), nine appear to be perennial, even during a drought year. Coloration of the water in these streams during periods of low flow is not marked, and most streams that have sufficient discharge are suitable as sources of supply. Surface water is not presently being used as a source of supply within the park in the valley of the North Fork Skokomish River.

Ground water that supplies Staircase Ranger Station and the campground is from springs that discharge from glacial deposits in the lower part of the valley wall immediately northeast of the ranger station. The estimated maximum daily demand on this system is about 4,000 gallons.

Several types of bedrock are exposed within the area studied, but, in general, none appear to be capable of more than small yields to wells. The bedrock in the area of Staircase Ranger Station and campground--mostly marine sedimentary rocks--is jointed and fractured, and several small springs issue from it. None of the springs is adequate individually for more than a very small supply, but the presence of springs suggests that here the joints and fractures are sufficiently open and interconnected that wells would produce significant quantities of water from the bedrock. The depth to which open joints and fractures extend can be determined only by test drilling, but generally the fractures become tightly closed or do not exist due to the increased pressure at depth. Exploratory drilling into the bedrock to depths much more than about 100 feet probably would not be economically feasible.

Glacial deposits partly mantle the bedrock in the valley walls up to several hundred feet above river level. In most places these deposits are discontinuous and are too thin for the development of water supplies from wells. Locally, however, glacial deposits of sand and gravel are extensive enough and of sufficient thickness to collect and transmit water to springs that discharge at the top of the underlying bedrock. These glacial deposits are potentially the most productive aquifers in the valley, and water supplies could be developed at points of natural discharge or by construction of infiltration galleries.

In the area studied, the alluvium of the valley floor is very thin, and consists mostly of large boulders embedded in silt and fine sand. Nowhere is the bedrock surface known to be far below the riverbed, and wells in the alluvium throughout most of the valley floor would penetrate almost no saturated permeable zones. Locally, silt-free gravel may overlie the bedrock at about river level and near the channel, where yields of up to 5 gpm might be developed from the gravel and the upper few feet of bedrock. However, such wells would be very shallow and very vulnerable to contamination, not only from the land surface near the well but also from stream water that may become momentarily polluted by nearby campground use.

The ground-water potential of the lower valley walls and valley floor is interpreted to be moderate (fig. 4). However, yields of more than 5 gpm on the valley floor are not likely unless wells encounter water-bearing zones at depth in the bedrock.

TABLE 1.--Streamflow data for major rivers[1]

| River and location | Drainage area (sq mi) | Period of record | Average discharge | | Maximum discharge | | Minimum discharge | |
|---|---|---|---|---|---|---|---|---|
| | | | cfs | acre-ft/yr | cfs | Date | cfs | Date |
| Quinault[2] | 264 | 1911-22, 1926-64 | 2,793 | 2,022,000 | 50,200 | 11- 4-55 | 276 | 9-12-44 |
| Queets[3] | 445 | 1930-49 | 4,115 | 2,979,000 | 130,400 | 1-22-35 | 368 | 9- 9-44 |
| Hoh[4] | 208 | 1926-64 | 2,028 | 1,468,000 | 38,700 | 11-26-49 | 247 | 11-14-29 |
| Soleduck[5] | 83.8 | 1917-21, 1933-64 | 626 | 453,200 | 23,500 | 11-26-49 | 51 | 9-11-44 |
| Elwha[6] | 269 | 1897-1901, 1918-64 | 1,493 | 1,081,000 | 41,600 | 11-18-1897 | 10 | 10- 3-38 |
| Dosewallips[7] | 93.7 | 1930-60 | 445 | 322,200 | 13,200 | 11-26-49 | 65 | 12- 4-36 |
| Duckabush[8] | 66.5 | 1910-11, 1938-64 | 413 | 299,000 | 8,960 | 11-26-49 | 45 | 10-26-42 |
| Skokomish[9] | 57.2 | 1924-64 | 493 | 356,900 | 27,000 | 11- 5-34 | 16 | 9-23-30 |

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[1]Data from U.S. Geological Survey (1964), except for data on Queets and Dosewallips Rivers which are from Washington State Department of Conservation and Development, Division of Water Resources (1955).

[2]On left bank at outlet of Quinault Lake, 50 feet downstream from bridge on U.S. Highway 101.

[3]On right bank 2 miles downstream from Clearwater River.

[4]On left bank 1 mile downstream from Maple Creek, 5 miles downstream from South Fork.

[5]On right bank 300 feet downstream from South Fork.

[6]On right bank half a mile upstream from Little River.

[7]On left bank half a mile upstream from Corrigenda Ranger Station, 7½ miles upstream from mouth.

[8]On left bank 4½ miles upstream from mouth

[9]On left bank 1¼ miles upstream from Lake Cushman, 2 miles upstream from Dry Creek.

TABLE 2.--Chemical analyses of water in major rivers

| River (with sampling point and period and average frequency of sampling) | | Milligram: | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) |
| Quinault at | Max | 5.2 | 0.27 | 10 | 0.8 | 1.9 | 0.4 | 29 | 6 |
| Quinault Lake | Min | 3.0 | .04 | 8.0 | .1 | 1.3 | .0 | 22 | 4 |
| (1959-67, | Mean | 4.5 | .14 | 8.8 | .5 | 1.5 | .2 | 26 | 5 |
| semiannual) | | | | | | | | | |
| Queets near | Max | 5.9 | 3.00 | 10 | 1.3 | 3.0 | .8 | 32 | 10 |
| Queets | Min | 3.9 | .06 | 3.5 | .2 | 1.9 | .0 | 10 | 3. |
| (1960-67, | Mean | 5.1 | .35 | 7.9 | .8 | 2.4 | .3 | 24 | 6. |
| quarterly) | | | | | | | | | |
| Hoh near Forks | Max | 6.9 | 7.60 | 12 | 1.6 | 2.9 | .6 | 34 | 11 |
| (1960-67, | Min | 3.2 | .07 | 3.5 | .2 | 1.2 | .0 | 13 | 1. |
| quarterly) | Mean | 4.8 | .51 | 10 | .8 | 1.8 | .3 | 29 | 8. |
| Soleduck near | Max | 8.0 | .63 | 15 | 1.7 | 2.7 | .7 | 47 | 9. |
| Forks | Min | 3.5 | .00 | 5.0 | .1 | 1.4 | .0 | 18 | 2. |
| (1960-67, | Mean | 5.3 | .07 | 10 | 1.2 | 2.0 | .3 | 35 | 6. |
| quarterly) | | | | | | | | | |
| Elwha near | Max | 7.8 | .62 | 16 | 1.7 | 2.3 | .6 | 51 | 9. |
| Port Angeles | Min | 3.0 | .00 | 10 | .1 | 1.2 | .0 | 32 | 4. |
| (1959-67, | Mean | 6.1 | .15 | 13 | 1.0 | 1.8 | .2 | 42 | 7. |
| quarterly) | | | | | | | | | |
| Dosewallips at | Max | 9.4 | 1.30 | 18 | 2.0 | 3.3 | .6 | 56 | 8. |
| Brinnon | Min | 4.3 | .00 | 8.5 | .2 | .9 | .0 | 27 | 4 |
| (1959-67, | Mean | 6.6 | .14 | 13 | 1.1 | 1.7 | .2 | 43 | 6 |
| quarterly) | | | | | | | | | |
| Duckabush near | Max | 7.2 | .28 | 11 | 1.3 | 1.8 | .5 | 37 | 4 |
| Brinnon | Min | 3.7 | .01 | 6.5 | .5 | .9 | .0 | 24 | 2 |
| (1960-67, | Mean | 5.6 | .07 | 9.1 | .9 | 1.4 | .2 | 31 | 3. |
| quarterly) | | | | | | | | | |

| per liter | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Hardness as $CaCO_3$ | | | | | | | |
| Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Phosphate ($PO_4$) | Dissolved solids (residue at 180°C) | Calcium, magnesium | Non-carbonate | Dissolved oxygen | Specific conductance (μmhos/cm) at 25°C | pH | Color | MPN (most probable number coliform groups per 100 ml) |
| 2.0 | 0.2 | 0.5 | 0.06 | 42 | 27 | 4 | 13.0 | 65 | 7.3 | 10 | 230 |
| .5 | .0 | .0 | .00 | 32 | 22 | 2 | 9.2 | 54 | 6.8 | 0 | 0 |
| 1.2 | .1 | .2 | .01 | 37 | 24 | 3 | 10.6 | 60 | 7.1 | 5 | 20 |
| 3.0 | .1 | 1.4 | .04 | 49 | 30 | 6 | 12.9 | 81 | 7.5 | 80 | 430 |
| 1.2 | .0 | .0 | .00 | 26 | 10 | 1 | 9.2 | 30 | 6.4 | 0 | 0 |
| 2.1 | .1 | .3 | .01 | 40 | 23 | 3 | 11.1 | 61 | 7.1 | 10 | 86 |
| 3.5 | .2 | .6 | .05 | 53 | 35 | 8 | 13.2 | 88 | 7.6 | 25 | 930 |
| .5 | .0 | .0 | .00 | 28 | 10 | 0 | 10.2 | 38 | 6.6 | 0 | 0 |
| 1.4 | .1 | .2 | .01 | 46 | 29 | 5 | 11.3 | 71 | 7.3 | 5 | 87 |
| 1.8 | .2 | .3 | .04 | 58 | 43 | 6 | 13.7 | 102 | 7.9 | 15 | 360 |
| .8 | .0 | .0 | .00 | 27 | 16 | 0 | 9.2 | 38 | 7.0 | 0 | 0 |
| 1.2 | .1 | .1 | .01 | 46 | 31 | 3 | 11.3 | 74 | 7.5 | 5 | 28 |
| 1.0 | .3 | .3 | .11 | 67 | 46 | 6 | 14.1 | 106 | 8.1 | 10 | 430 |
| .0 | .0 | .0 | .00 | 42 | 29 | 2 | 10.0 | 63 | 6.4 | 0 | 0 |
| .6 | .1 | .1 | .02 | 54 | 38 | 4 | 11.6 | 86 | 7.6 | 5 | 24 |
| 1.5 | .2 | .4 | .10 | 72 | 52 | 6 | 13.6 | 114 | 7.9 | 10 | 230 |
| .2 | .0 | .0 | .00 | 38 | 24 | 2 | 10.0 | 57 | 6.9 | 0 | 0 |
| .8 | .1 | .2 | .02 | 53 | 38 | 3 | 11.6 | 86 | 7.5 | 5 | 29 |
| 1.5 | .1 | .3 | .07 | 47 | 32 | 3 | 13.9 | 73 | 7.9 | 10 | 430 |
| .2 | .0 | .0 | .00 | 32 | 20 | 0 | 10.7 | 46 | 7.1 | 0 | 0 |
| .7 | .1 | .1 | .01 | 39 | 26 | 1 | 12.1 | 60 | 7.4 | 5 | 78 |

TABLE 3.--Chemical analyses of ground water from wells and test holes

| Well or test hole and location | Depth (feet) | Date of sample collection | Temperature (°C) | Milligrams per liter: Silica ($SiO_2$) | Iron (Fe) | Manganese (Mn) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Bicarbonate ($HCO_3$) | Carbonate ($CO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Dissolved solids: Calculated | Dissolved solids: Residue on evaporation at 180°C | Hardness (as $CaCO_3$) | Specific conductance (μmhos/cm) at 25°C | pH | Color | Turbidity (Jackson candle units) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kalaloch well 1, near Kalaloch | 56½ | 7-25-66 | -- | -- | 0.44 | 0.77 | -- | -- | -- | -- | -- | -- | 2.3 | 6.9 | -- | -- | -- | 328 | 39 | 278 | 6.6 | 30 | 170 | Collected upon completion of well after pumping 4 hr at 15 gpm. |
| Do. | 66½ | 7-26-66 | -- | -- | .58 | .58 | -- | -- | -- | -- | -- | -- | 2.8 | 14 | -- | -- | -- | 223 | 32 | 218 | 6.5 | 10 | 100 | Collected after pumping 4 hr at 15 gpm, 3 hr at 20 gpm, and 8 hr at 30 gpm. |
| Do. | 66½ | 7-28-66 | -- | -- | .40 | .62 | -- | -- | -- | -- | -- | -- | -- | 12 | -- | -- | -- | 194 | 30 | 198 | 6.5 | 90 | 110 | Collected after pumping 4 hr at 15 gpm, 8 hr at 30 gpm, and 27 hr at 20 gpm. |
| Do. | 66½ | 8-18-66 | 9 | 34 | 1.90 | .21 | 9.2 | 4.0 | 64 | 3.3 | 200 | 0 | .4 | 14 | 0.4 | 1.0 | 228 | 232 | 40 | 338 | 7.9 | -- | -- | |
| Do. | 66½ | 1-19-67 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | (e). |
| Kalaloch well 2, near Kalaloch | -- | 9-12-67 | -- | 25 | [b].16 | .12 | 8.1 | 6.0 | 42 | 2.5 | 134 | 0 | 1.0 | 12 | .3 | .1 | 161 | 171 | 36 | 290 | 6.7 | -- | -- | Pumped at 40 gpm. |
| Do. | -- | 9-13-67 | -- | 25 | [b].42 | .12 | 8.2 | 3.9 | 42 | 2.6 | 144 | 0 | 1.0 | 12 | .2 | .1 | 166 | 171 | 36 | 290 | 6.7 | -- | -- | Pumped at 33.4 gpm, with drawdown of 16.17 feet. |
| Do. | -- | 9-13-67 | -- | 25 | [b].35 | .08 | 8.6 | 3.9 | 46 | 2.7 | 155 | 0 | 1.0 | 12 | .3 | .2 | 178 | 182 | 38 | 282 | 6.7 | -- | -- | Pumped at 33.4 gpm, with drawdown of 21.22 feet. |
| Well at private home in NW¼SW¼ sec. 13, T. 23 N., R. 10 W. | 44 | 6-17-66 | -- | -- | 2.9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 21 | 377 | -- | 5 | -- | |
| Well at State highway shop in SW¼NW¼ sec. 23, T. 23 N., R. 10 W. | 133 | 6-17-66 | -- | -- | .01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 31 | 355 | -- | 0 | -- | |
| Well at Olympic Truck Stop in SW¼NW¼ sec. 23, T. 23 N., R. 10 W. | 105 | 6-17-66 | -- | -- | .02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 25 | 379 | -- | 0 | -- | |
| Test hole augered at Quinault Ranger Station | 44 | 9-13-67 | 8 | 7.1 | [b].03 | -- | 6.0 | 1.0 | 4.6 | .6 | 30 | 0 | .2 | 2.2 | .1 | .5 | 37 | 36 | 9 | 59 | 6.2 | 10 | -- | Collected after pumping 4 hr at 33 gpm; water has strong hydrogen sulfide odor.[a] |
| Test hole augered near mouth of Hoh River | 21 | 9-14-67 | 9 | 9.5 | [b]2.6 | -- | 6.3 | 2.6 | 16 | 1.0 | 47 | 0 | .6 | 8.5 | .1 | 1.5 | 74 | 110 | 31 | 149 | 7.2 | 160 | -- | Collected after pumping 3 hr at 40 gpm; water has slight hydrogen sulfide odor.[a] |
| Test hole 1 augered 1 mile east of La Push | 39 | 9-19-67 | 9 | 28 | 1.3 | -- | 15 | 6.6 | 8.3 | .8 | 79 | 0 | .4 | 12 | .1 | .0 | 110 | 118 | 65 | 167 | 6.5 | 5 | -- | Collected after pumping 3 hr at 20 gpm.[a] |
| Test hole 2 augered 1 mile east of La Push | 25 | 9-19-67 | 8 | 20 | .08 | -- | 8.2 | 3.5 | 7.5 | .8 | 38 | 0 | .4 | 13 | .1 | .9 | 73 | 83 | 35 | 113 | 6.2 | 5 | -- | Collected after pumping 3 hr at 42 gpm.[a] |
| Test hole 3 augered 0.2 mile east of La Push | 37 | 9-15-67 | 9 | 46 | [b]2.2 | -- | 14 | 10 | 48 | 2.5 | 94 | 0 | 2.4 | 78 | .1 | .1 | 249 | 260 | 76 | 420 | 6.3 | 10 | -- | Collected after pumping 5 hr at 60 gpm; water has slight hydrogen sulfide odor.[a] |
| Test hole augered at Fairholm | 44 | 9-20-67 | 7 | 14 | .01 | -- | 22 | 4.0 | 5.2 | .5 | 92 | 0 | 5.6 | 3.0 | .1 | .2 | 86 | 86 | 72 | 163 | 7.5 | 5 | -- | Collected after pumping 3½ hr at 37½ gpm.[a] |
| Test hole augered at Barnes Point | 45 | 9-20-67 | 7 | 11 | .00 | -- | 19 | 4.0 | 2.7 | .4 | 78 | 0 | 5.8 | 1.0 | .0 | .3 | 82 | 84 | 64 | 136 | 7.2 | 5 | -- | Collected after pumping 3 hr at 60 gpm.[a] |

[a]Sample meets the requirements or recommendations of the U.S. Public Health Service (1962) in concentrations of copper, zinc, lead, silver, cadmium, barium, chromium, cyanide, selenium, phenol, alkyl benzene sulfonate, and arsenic. Manganese concentration greater than 0.05 mg/l (the recommended maximum), but less than 0.1 mg/l.

[b]Iron in solution at time of analysis.

TABLE 4.--Low flows recorded for selected streams, [illegible] and 1966

| Stream | Location of discharge measurement | Date | Discharge (cfs) |
|---|---|---|---|
| Tributaries to Quinault River: | | | |
| Unnamed stream | Easternmost of two spring discharges along foot trail, about 700 feet west of Pony Bridge | 9-17-65 | 0.05 |
| Do. | do. | 9-13-66 | .05 |
| Do. | Westernmost of two spring discharges along foot trail, about 800 feet west of Pony Bridge | 9-17-65 | <.05 |
| Do. | do. | 9-13-66 | *.03 |
| Graves Creek | -- | 9-13-66 | *20 |
| Unnamed stream | About 4.00 miles northeast of Howe Creek bridge | 10-10-66 | Dry |
| Do. | About 3.80 miles northeast of Howe Creek bridge | 10-10-66 | Dry |
| Do. | About 3.25 miles northeast of Howe Creek bridge | 10-10-66 | Dry |
| Do. | About 2.75 miles northeast of Howe Creek bridge | 10-10-66 | Dry |
| Do. | SW¼SE¼ sec. 24, T. 24 N., R. 8 W., about 2.45 miles northeast of Howe Creek bridge | 9-13-66 | Dry |

*Estimated flow.

TABLE 4.--Low flows recorded for selected streams, 1965 and 1966--Continued

| Stream | Location of discharge measurement | Date | Discharge (cfs) |
|---|---|---|---|
| Tributaries to Quinault River (continued): | | | |
| Unnamed stream | SW¼SE¼ sec. 24, T. 24 N., R. 8 W., about 1.30 miles northeast of Howe Creek bridge | 9-13-66 | *0.10 |
| Howe Creek | NE¼SW¼ sec. 26, T. 24 N., R. 8 W., at road crossing | 9-13-66 | *10 |
| Canning Creek | SE¼SE¼ sec. 27, T. 24 N., R. 8 W., at road crossing | 9-13-66 | *6 |
| Bunch Creek | NW¼NW¼ sec. 34, T. 24 N., R. 8 W., at road crossing | 9-13-66 | *1 |
| Unnamed stream | NW¼SE¼ sec. 28, T. 24 N., R. 8 W., about 2.80 miles east of Big Creek bridge | 9-13-66 | *.50 |
| Big Creek | SE¼SE¼ sec. 25, T. 24 N., R. 8 W., at bridge | 9-13-66 | *20 |
| Finley Creek | SW¼NE¼ sec. 3, T. 23 N., R. 8 W., at bridge | 9-13-66 | Dry |
| Canoe Creek | SE¼SW¼ sec. 4, T. 23 N., R. 9 W., at bridge | 9-13-66 | 1.95 |
| Unnamed stream | NE¼NE¼ sec. 8, T. 23 N., R. 9 W., at road crossing about 1.10 miles northeast of Dawdy Creek | 9-13-66 | *.10 |

| | | | |
|---|---|---|---|
| Unnamed stream, tributary to Big Creek | SE¼SW¼ sec. 25, T. 24 N., R. 8 W., at road crossing about 0.30 mile west of Big Creek bridge | 9-13-66 | 0.46 |
| Kestner Creek, tributary to Canoe Creek | SW¼SE¼ sec. 4, T. 23 N., R. 8 W., at bridge, just above confluence with Canoe Creek | 9-13-66 | .77 |
| Tributaries to Quinault Lake: | | | |
| Dawdy Creek | NW¼SW¼ sec. 8, T. 23 N., R. 9 W., at bridge | 9-13-66 | .71 |
| Unnamed stream | NE¼SE¼ sec. 7, T. 23 N., R. 9 W., at culvert, about 0.10 mile southwest of Dawdy Creek bridge | 9-13-66 | *<.10 |
| July Creek | SE¼SE¼ sec. 7, T. 23 N., R. 9 W., at culvert | 9-17-65 | .76 |
| Do. | do. | 9-13-66 | .88 |
| Slide Creek | NE¼NW¼ sec. 18, T. 23 N., R. 9 W., at culvert | 9-17-65 | .58 |
| Do. | do. | 9-13-66 | .22 |
| McCormick Creek | SE¼NW¼ sec. 18, T. 23 N., R. 9 W., at culvert | 9-13-66 | .06 |

*Estimated flow.

TABLE 4.--Low flows recorded for selected streams, 1965 and 1966--Continued

| Stream | Location of discharge measurement | Date | Discharge (cfs) |
|---|---|---|---|
| Tributaries to Quinault Lake (continued): | | | |
| Unnamed stream | NW¼SE¼ sec. 13, T. 23 N., R. 10 W., at culvert about 0.50 mile east of Higley Creek | 9-17-65 | 1.35 |
| Do. | do. | 9-13-66 | *.50 |
| Higley Creek | NE¼SW¼ sec. 13, T. 23 N., R. 10 W., at bridge | 9-17-65 | .95 |
| Do. | do. | 9-13-66 | .47 |
| Unnamed stream | NW¼SW¼ sec. 13, T. 23 N., R. 10 W., at culvert, about 0.30 mile southwest of Higley Creek bridge | 9-13-66 | *.10 |
| Tributaries to Queets River: | | | |
| North Creek | Sec. 2, T. 24 N., R. 10½ W., at road crossing | 9-17-65 | .55 |
| Do. | do. | 9-14-66 | *<.10 |
| Unnamed stream | Sec. 2, T. 24 N., R. 10½ W., at road crossing, about 1.20 miles southwest of Queets Ranger Station | 9-14-66 | *<.10 |
| Killea Creek | NE¼NE¼ sec. 12, T. 24 N., R. 11 W., at culvert, about 1.40 miles southwest of Queets Ranger Station | 9-14-66 | .15 |

| | | | |
|---|---|---|---|
| Tributaries to Queets River (continued): | | | |
| Phelan Creek | NW¼SW¼ sec. 11, T. 24 N., R. 11 W., at culvert, about 3.10 miles southwest of Queets Ranger Station | 9-14-66 | 0.88 |
| Drinkwater Creek | SW¼SW¼ sec. 11, T. 24 N., R. 11 W., at culvert, about 3.40 miles southwest of Queets Ranger Station | 9-14-66 | .30 |
| Unnamed stream | SE¼SE¼ sec. 10, T. 24 N., R. 11 W., at culvert, about 2.10 miles northeast of Matheny Creek bridge | 9-14-66 | 1.21 |
| Newman Creek | NE¼NW¼ sec. 15, T. 24 N., R. 11 W., at culvert, about 1.30 miles northeast of Matheny Creek bridge | 9-14-66 | *.10 |
| Matheny Creek | NW¼NW¼ sec. 22, T. 24 N., R. 11 W., at bridge | 9-14-66 | *18 |
| Unnamed stream | SW¼NW¼ sec. 20, T. 24 N., R. 11 W., at culvert, about 2.10 miles southwest of Matheny Creek bridge | 9-14-66 | *<.10 |
| Mud Creek | NE¼SE¼ sec. 19, T. 24 N., R. 11 W., about 3.40 miles northeast of Salmon River bridge | 9-14-66 | 1.64 |
| Unnamed stream | SW¼SE¼ sec. 26, T. 24 N., R. 12 W., at culvert, about 0.60 mile east of Salmon River bridge | 9-14-66 | 1.88 |

*Estimated flow.

TABLE 4.--Low flows recorded for selected streams, 1965 and 1966--Continued

| Stream | Location of discharge measurement | Date | Discharge (cfs) |
|---|---|---|---|
| Tributaries to Queets River (continued): | | | |
| Salmon River | NW¼SW¼ sec. 26, T. 24 N., R. 12 W. | 9-14-66 | *20 |
| Tributaries to Pacific Ocean: | | | |
| Unnamed stream | NW¼SW¼ sec. 22, T. 24 N., R. 13 W., at temporary camp and gravel pit, 0.2 mile north of south end of Pacific Coast area | 9-17-65 | .51 |
| Do. | do. | 9-14-66 | Dry |
| Do. | NW¼SW¼ sec. 22, T. 24 N., R. 13 W., 0.30 mile north of south end of Pacific Coast area | 9-14-66 | .15 |
| Do. | NW¼NW¼ sec. 22, T. 24 N., R. 13 W., 0.80 mile north of south end of Pacific Coast area | 9-14-66 | Dry |
| Do. | SW¼SW¼ sec. 15, T. 24 N., R. 13 W., about 100 feet south of Beach Trail 1 | 9-17-65 | .39 |
| Do. | do. | 9-14-66 | .10 |
| Do. | SW¼SW¼ sec. 15, T. 24 N., R. 13 W., about 350 feet north of Beach Trail 1 | 9-17-65 | .35 |
| Do. | do. | 9-14-66 | .12 |

| | | | |
|---|---|---|---|
| Tributaries to Pacific Ocean (continued): | | | |
| Unnamed stream | NE¼NE¼ sec. 16, T. 24 N., R. 13 W., at Beach Trail 2 | 9-14-66 | *<0.10 |
| Do. | SW¼SW¼ sec. 9, T. 24 N., R. 13 W., about 175 feet north of Beach Trail 2 | 9-14-66 | Dry |
| Do. | SE¼SW¼ sec. 21, T. 25 N., R. 13 W., at Beach Trail 4 | 9-14-66 | *.20 |
| Do. | NE¼SW¼ sec. 21, T. 25 N., R. 13 W., about 0.45 mile north of Beach Trail 4 | 9-14-66 | *.05 |
| Do. | NE¼SW¼ sec. 21, T. 25 N., R. 13 W., about 0.50 mile north of Beach Trail 4 | 9-14-66 | *.05 |
| Do. | SE¼NW¼ sec. 21, T. 25 N., R. 13 W., about 0.70 mile north of Beach Trail 4 | 9-14-66 | *<.05 |
| Do. | NW¼NW¼ sec. 21, T. 25 N., R. 13 W., about 1.25 miles south of Beach Trail 6 | 9-14-66 | *.10 |
| Do. | SE¼NE¼ sec. 17, T. 25 N., R. 13 W., about 0.50 mile south of Beach Trail 6 | 9-16-65 | 3.46 |
| Do. | do. | 9-14-66 | *.50 |

*Estimated flow

TABLE 4.--Low flows recorded for selected streams, 1965 and 1966--Continued

| Stream | Location of discharge measurement | Date | Discharge (cfs) |
|---|---|---|---|
| Tributaries to Pacific Ocean (continued): | | | |
| Steamboat Creek | SW¼SE¼ sec. 8, T. 25 N., R. 13 W., at Beach Trail 6 | 9-16-65 | *2.00 |
| Do. | SW¼SE¼ sec. 8, T. 25 N., R. 13 W. | 9-14-66 | 1.74 |
| Unnamed stream | NE¼SW¼ sec. 5, T. 25 N., R. 13 W., about 0.85 mile north of Beach Trail 7 | 9-14-66 | Dry |
| Do. | NE¼NW¼ sec. 5, T. 25 N., R. 13 W., about 1.45 miles north of Beach Trail 7 | 9-14-66 | *<.05 |
| Cedar Creek | SE¼SW¼ sec. 32, T. 26 N., R. 13 W. | 9-16-65 | 13.8 |
| Do. | do. | 9-14-66 | 4.59 |
| Unnamed stream | NE¼SW¼ sec. 32, T. 26 N., R. 13 W., about 0.15 mile north of Cedar Creek | 9-14-66 | *<.05 |
| Do. | SE¼NW¼ sec. 32, T. 26 N., R. 13 W., about 0.45 mile north of Cedar Creek | 9-14-66 | Dry |
| Tributaries to Hoh River: | | | |
| Taft Creek | NW¼SW¼ sec. 12, T. 27 N., R. 10 W., at road crossing | 8-17-66 | *10 |
| Do. | do. | 9-14-66 | *.30 |

| | | | |
|---|---|---|---|
| Tributaries to Hoh River (continued): | | | |
| Snider Creek | NW¼SW¼ sec. 14, T. 27 N., R. 10 W., at road crossing | 8-17-66 | Dry |
| Do. | do. | 9-14-66 | Dry |
| Unnamed stream | SW¼NW¼ sec. 22, T. 27 N., R. 10 W., at road crossing | 8-17-66 | *.45 |
| Do. | do. | 9-14-66 | *.50 |
| Twin Creek | do. | 8-17-66 | *8.25 |
| Do. | do. | 9-14-66 | *1.50 |
| Unnamed stream | NE¼NW¼ sec. 28, T. 27 N., R. 10 W., about 1.6 miles east of park entrance | 9-14-66 | Dry |
| Do. | NE¼NE¼ sec. 29, T. 27 N., R. 10 W., about 1.1 miles east of park entrance | 9-14-66 | Dry |
| Do. | SW¼NW¼ sec. 29, T. 27 N., R. 10 W., about 0.2 mile east of park entrance, 400 feet north of road crossing | 8-17-66 | *.10 |
| Do. | SW¼NW¼ sec. 29, T. 27 N., R. 10 W., about 0.2 mile east of park entrance, at road crossing | 8-17-66 | Dry |
| Do. | do. | 9-14-66 | Dry |

*Estimated flow.

TABLE 4.--Low flows recorded for selected streams, 1965 and 1966--Continued

| Stream | Location of discharge measurement | Date | Discharge (cfs) |
|---|---|---|---|
| Tributaries to Pacific Ocean: | | | |
| Unnamed stream | SE¼SE¼ sec. 13, T. 26 N., R. 14 W., about 50 feet north of mouth of Hoh River | 9-14-67 | *0.20 |
| Do. | NE¼SE¼ sec. 13, T. 26 N., R. 14 W., about 0.3 mile north of mouth of Hoh River | 9-14-67 | *.10 |
| Do. | SE¼SW¼ sec. 27, T. 28 N., R. 15 W., at La Push water supply intake | 9-16-65 | .13 |
| Tributaries to Soleduck River: | | | |
| Unnamed stream | NW¼NE¼ sec. 4, T. 28 N., R. 9 W., at road crossing, about 1.75 miles southeast of Soleduck Ranger Station | 9-13-66 | Dry |
| Do. | SE¼SW¼ sec. 33, T. 29 N., R. 9 W., at road crossing, about 1.35 miles southeast of Soleduck Ranger Station | 9-13-66 | *.10 |
| Do. | SW¼SW¼ sec. 33, T. 29 N., R. 9 W., at road crossing, about 1.20 miles southeast of Soleduck Ranger Station | 9-13-66 | Dry |
| Do. | NW¼SW¼ sec. 33, T. 29 N., R. 9 W., at road crossing, about 1.15 miles southeast of Soleduck Ranger Station | 9-13-66 | Dry |

| | | | |
|---|---|---|---|
| Tributaries to Soleduck River (continued): | | | |
| Unnamed stream | NE¼SE¼ sec. 32, T. 29 N., R. 9 W., at road crossing, about 0.85 mile southeast of Soleduck Ranger Station | 9-13-66 | *0.05 |
| Do. | SE¼SW¼ sec. 29, T. 29 N., R. 9 W., at road crossing, about 150 feet northwest of Soleduck Ranger Station | 9-13-66 | *.50 |
| Do. | SE¼SW¼ sec. 29, T. 29 N., R. 9 W., at road crossing, about 0.1 mile northwest of Soleduck Ranger Station | 9-13-66 | *.40 |
| Do. | SW¼SW¼ sec. 29, T. 29 N., R. 9 W., at road crossing, about 0.2 mile northwest of Soleduck Ranger Station | 9-13-66 | Dry |
| Do. | SW¼SW¼ sec. 29, T. 29 N., R. 9 W., at road crossing, about 0.35 mile northwest of Soleduck Ranger Station | 9-13-66 | *.15 |
| Do. | SW¼SW¼ sec. 29, T. 29 N., R. 9 W., at road crossing, about 0.40 mile northwest of Soleduck Ranger Station | 9-13-66 | *.20 |
| Do. | Sec. 30, T. 29 N., R. 9 W., at road crossing, about 0.60 mile northwest of Soleduck Ranger Station | 9-13-66 | *.40 |
| Do. | Sec. 30, T. 29 N., R. 9 W., at road crossing, about 1.0 mile northwest of Soleduck Ranger Station | 9-13-66 | *.10 |

*Estimated flow.

TABLE 4.--Low flows recorded for selected streams, 1965 and 1966--Continued

| Stream | Location of discharge measurement | Date | Discharge (cfs) |
|---|---|---|---|
| Tributaries to Soleduck River (Continued): | | | |
| Unnamed stream | Sec. 30, T. 29 N., R. 9 W., at road crossing, about 1.2 miles northwest of Soleduck Ranger Station | 9-13-66 | Dry |
| Do. | Sec. 30, T. 29 N., R. 9 W., at road crossing, about 1.3 miles northwest of Soleduck Ranger Station | 9-13-66 | Dry |
| Do. | Sec. 30, T. 29 N., R. 9 W., at road crossing, about 1.45 miles northwest of Soleduck Ranger Station | 9-13-66 | *.15 |
| Do. | Sec. 19, T. 29 N., R. 9 W., at road crossing, about 1.6 miles northwest of Soleduck Ranger Station | 9-13-66 | Dry |
| Do. | Sec. 19, T. 29 N., R. 9 W., at road crossing, about 2.05 miles nothwest of Soleduck Ranger Station | 9-13-66 | Dry |
| Do. | Sec. 18, T. 29 N., R. 9 W., at road crossing, about 3.45 miles northwest of Soleduck Ranger Station | 9-13-66 | Dry |
| Do. | Sec. 18, T. 29 N., R. 9 W., at road crossing, about 3.75 miles northwest of Soleduck Ranger Station | 9-13-66 | Dry |
| Do. | Sec. 18, T. 29 N., R. 9 W., at road crossing, about 3.90 miles northwest of Soleduck Ranger Station | 9-13-66 | Dry |

| | | | |
|---|---|---|---|
| Tributaries to Soleduck River (continued): | | | |
| Unnamed stream | Sec. 18, T. 29 N., R. 9 W., at road crossing, about 4.05 miles northwest of Soleduck Ranger Station | 9-13-66 | *<0.05 |
| Do. | NE¼SW¼ sec. 1, T. 29 N., R. 10 W., at road crossing, about 0.70 mile southeast of North Fork Soleduck River bridge | 9-13-66 | Dry |
| Do. | SW¼NW¼ sec. 1, T. 29 N., R. 10 W., at road crossing, about 0.70 mile southeast of North Fork Soleduck River bridge | 9-13-66 | Dry |
| Do. | SE¼SW¼ sec. 35, T. 30 N., R. 10 W., at road crossing, about 0.70 mile northwest of North Fork Soleduck River bridge | 9-13-66 | *.20 |
| Do. | SW¼SW¼ sec. 35, T. 30 N., R. 10 W., at road crossing, about 0.75 mile northwest of North Fork Soleduck River bridge | 9-13-66 | *.25 |
| Do. | SE¼NE¼ sec. 28, T. 30 N., R. 10 W., at road crossing, about 1.95 miles from park entrance | 9-13-66 | *.05 |
| Unnamed stream, tributary to Pacific Ocean | NW¼NW¼ sec. 26, T. 31 N., R. 16 W., at Cape Alava | 10-13-65 | *1.70 |

*Estimated flow.

TABLE 4.--Low flows recorded for selected streams, 1965 and 1966--Continued

| Stream | Location of discharge measurement | Date | Discharge (cfs) |
|---|---|---|---|
| Tributaries to Lake Crescent: | | | |
| Unnamed stream | SW¼NW¼ sec. 27, T. 30 N., R. 9 W., at road crossing, about 1.45 miles east of Ovington Creek | 9-13-66 | Dry |
| Ovington Creek | SW¼NE¼ sec. 29, T. 30 N., R. 9 W. | 9-13-66 | Dry |
| Unnamed stream | SW¼NW¼ sec. 29, T. 30 N., R. 9 W., about 0.3 mile west of Ovington Creek | 9-13-66 | Dry |
| Do. | Sec. 30, T. 30 N., R. 9 W., about 0.7 mile west of Ovington Creek | 9-13-66 | Dry |
| Do. | Sec. 30, T. 30 N., R. 9 W., about 1.3 miles west of Ovington Creek | 9-13-66 | Dry |
| Do. | Sec. 30, T. 30 N., R. 9 W., flume about 1.05 miles east of junction North Shore Road and U.S. Highway 101 | 9-13-66 | *0.30 |
| Do. | Sec. 30, T. 30 N., R. 9 W., about 0.25 mile northeast of junction North Shore Road and U.S. Highway 101 | 9-13-66 | Dry |
| Eagle Creek | Sec. 30, T. 30 N., R. 9 W., at U.S. Highway 101 | 9-13-66 | *.30 |
| Cross Creek | Sec. 31, T. 30 N., R. 9 W., at U.S. Highway 101 | 9-13-66 | *.30 |

| | | | |
|---|---|---|---|
| Tributaries to Lake Crescent (continued): | | | |
| Lapoel Creek | SW¼NW¼ sec. 32, T. 30 N., R. 9 W., at U.S. Highway 101 | 9-13-66 | 0.96 |
| Unnamed stream | NW¼SW¼ sec. 33, T. 30 N., R. 9 W., about 1.05 miles east of Lapoel Creek | 9-13-66 | Dry |
| Aurora Creek | SW¼NE¼ sec. 33, T. 30 N., R. 9 W., at U.S. Highway 101 | 9-13-66 | Dry |
| Unnamed stream | SW¼NW¼ sec. 34, T. 30 N., R. 9 W., about 0.6 mile east of Aurora Creek | 9-13-66 | *.05 |
| Smith Creek | SW¼NE¼ sec. 34, T. 30 N., R. 9 W., at U.S. Highway 101 | 9-13-66 | Dry |
| Unnamed stream | NW¼SE¼ sec. 34, T. 30 N., R. 9 W., about 0.2 mile east of Smith Creek | 9-13-66 | *.25 |
| Do. | NW¼SW¼ sec. 35, T. 30 N., R. 9 W., about 0.55 mile east of Smith Creek | 9-13-66 | *.20 |
| Do. | SE¼NW¼ sec. 35, T. 30 N., R. 9 W., about 0.65 mile southwest of Barnes Creek bridge on U.S. Highway 101 | 9-13-66 | *.15 |
| Do. | SE¼NW¼ sec. 35, T. 30 N., R. 9 W., about 0.60 mile southwest of Barnes Creek bridge on U.S. Highway 101 | 9-13-66 | Dry |

*Estimated flow.

TABLE 4.--Low flows recorded for selected streams, 1965 and 1966--Continued

| Stream | Location of discharge measurement | Date | Discharge (cfs) |
|---|---|---|---|
| Tributaries to Lake Crescent (continued): | | | |
| Unnamed stream | SE¼NW¼ sec. 25, T. 30 N., R. 9 W., about 0.85 mile northeast of Storm King Visitors Center | 9-13-66 | Dry |
| Do. | NW¼NE¼ sec. 25, T. 30 N., R. 9 W., about 0.10 mile south of Sledge Hammer Point | 9-13-66 | *0.10 |
| Do. | NW¼SW¼ sec. 19, T. 30 N., R. 8 W., about 0.80 mile northeast of Sledge Hammer Point | 9-13-66 | *.15 |
| Do. | SE¼NE¼ sec. 19, T. 30 N., R. 8 W., waterfall about 0.15 mile west of park entrance | 9-13-66 | *.30 |
| Log Cabin Creek | SE¼NE¼ sec. 14, T. 30 N., R. 9 W., at road crossing | 10-14-66 | *.40 |
| Idaho Creek, tributary to Elwha River | About 50 feet downstream from Hurricane Ridge Lodge water intake | 9-16-66 | .01 |
| Tributaries to Boulder Creek: | | | |
| Crystal Creek | About 0.10 mile northeast of Olympic Hot Springs Campground | 9- 9-66 | .61 |
| Unnamed stream | About 0.35 mile northeast of Crystal Creek | 9- 9-66 | Dry |
| Hell Creek | About 0.70 mile northeast of Crystal Creek | 9- 9-66 | *.30 |

| | | | |
|---|---|---|---|
| Tributaries to Boulder Creek (continued): | | | |
| Cougar Creek | About 1.70 miles northeast of Crystal Creek | 9- 9-66 | 1.47 |
| Deer Creek | About 2.10 miles northeast of Crystal Creek | 9- 9-66 | *<.01 |
| Deep Creek | About 2.50 miles northeast of Crystal Creek | 9- 9-66 | .75 |
| Deadmans Gulch | About 2.70 miles northeast of Crystal Creek | 9- 9-66 | Dry |
| Unnamed stream | About 2.90 miles northeast of Crystal Creek | 9- 9-66 | *.15 |
| Tributaries to Elwha River: | | | |
| Stubey Creek | SW¼SW¼ sec. 17, T. 29 N., R. 7 W., flows into Lake Mills | 9- 9-66 | 1.06 |
| Unnamed stream | About 0.15 mile south of Elwha Ranger Station | 9- 9-66 | 1.26 |
| Griff Creek | At Elwha Ranger Station | 9- 9-66 | 2.63 |
| Tributaries to Morse Creek: | | | |
| Unnamed stream | SW¼SW¼ sec. 7, T. 29 N., R. 5 W., about 0.75 mile southeast of Rocky Creek | 9- 8-66 | *<.05 |
| Do. | SW¼SW¼ sec. 7, T. 29 N., R. 5 W., about 0.55 mile southeast of Rocky Creek | 9- 8-66 | *.10 |

*Estimated flow

TABLE 4.--Low flows recorded for selected streams, 1965 and 1966--Continued

| Stream | Location of discharge measurement | Date | Discharge (cfs) |
|---|---|---|---|
| Tributaries to Morse Creek (continued): | | | |
| Unnamed stream | SE¼SE¼ sec. 12, T. 29 N., R. 6 W., about 0.45 mile southeast of Rocky Creek | 9- 8-66 | *<0.05 |
| Rocky Creek | NE¼SW¼ sec. 12, T. 29 N., R. 6 W. | 9- 8-66 | *.25 |
| Unnamed stream | SE¼NW¼ sec. 12, T. 29 N., R. 6 W., about 0.35 mile northwest of Rocky Creek | 9- 8-66 | *.25 |
| Do. | SW¼NW¼ sec. 12, T. 29 N., R. 6 W., about 0.30 mile southeast of Lake Creek | 9- 8-66 | *.01 |
| Lake Creek | NE¼NE¼ sec. 11, T. 29 N., R. 6 W. | 9- 8-66 | 2.69 |
| Ennis Creek, tributary to Strait of Juan de Fuca | NE¼SE¼ sec. 3, T. 29 N., R. 6 W., about 0.25 mile southeast of Heart O'the Hills Ranger Station | 9- 8-66 | 2.43 |
| Tributaries to Ennis Creek: | | | |
| Unnamed stream | SE¼NE¼ sec. 3, T. 29 N., R. 6 W., about 0.15 mile southeast of Heart O'the Hills Ranger Station | 9- 8-66 | *.10 |
| Do. | NE¼NE¼ sec. 3, T. 29 N., R. 6 W., about 200 feet south of entrance to Heart O'the Hills Campground | 9-15-65 | 2.44 |
| Do. | do. | 9-15-65 | *.15 |

| | | | |
|---|---|---|---|
| Tributaries to Maiden Creek: | | | |
| Unnamed stream | Culvert about 1.35 miles northwest of Obstruction Point trail head, Deer Park area | 9-12-66 | *.05 |
| Do. | Culvert about 0.55 mile northwest of Obstruction Point trail head, Deer Park area | 9-12-66 | *.05 |
| Do. | Culvert on loop road at Obstruction Point trail head, Deer Park area | 9-12-66 | *.10 |
| Tributaries to Dosewallips River: | | | |
| Station Creek | At Dosewallips Ranger Station | 9-15-65 | 1.23 |
| Do. | do. | 9- 7-66 | 2.53 |
| Constance Creek | At road crossing | 9- 7-66 | 3.21 |
| Tributaries to North Fork Skokomish River: | | | |
| Unnamed stream | At bridge near end of road about 3.5 miles northwest of Ranger Station | 9- 7-66 | *.30 |
| Do. | Culvert about 0.10 mile southeast of bridge near end of road | 9- 7-66 | *0.20 |

*Estimated flow.

TABLE 4.--Low flows recorded for selected streams, 1965 and 1966--Continued

| Stream | Location of discharge measurement | Date | Discharge (cfs) |
|---|---|---|---|
| Tributaries of North Fork Skokomish River (continued): | | | |
| Unnamed stream | Spring discharge about 0.60 mile southeast of bridge near end of road | 9- 7-66 | *0.10 |
| Do. | Culvert about 1.70 miles northwest of Slate Creek | 9- 7-66 | *.20 |
| Do. | Culvert about 0.15 mile northwest of Slate Creek | 9- 7-66 | .92 |
| Slate Creek | At road crossing, about 0.60 mile northwest of ranger station | 9- 7-66 | 1.27 |
| Unnamed stream | Culvert about 0.50 mile northwest of ranger station | 9- 7-66 | *.05 |
| Lincoln Creek | At bridge about 0.30 mile southeast of ranger station | 9- 7-66 | Dry |
| Unnamed stream | Spring discharge about 0.30 mile northwest of park entrance | 9- 7-66 | *.10 |
| Do. | Spring discharge about 0.15 mile northwest of park entrance | 9- 7-66 | *.10 |
| Do. | Spring discharge about 0.05 mile northwest of park entrance | 9- 7-66 | *.10 |

TABLE 5.--Logs of wells and test holes

| | Thick-ness (feet) | Depth (feet) |
|---|---|---|
| Kalaloch well 1, Kalaloch Campground. SW¼ sec. 3, T. 24 N., R. 13 W. Drilled by Stoican Drilling Co., 1966. Altitude about 50 ft. Casing: 10-inch to 59 ft, perforated 24.5-27 ft. Screen: 8-inch stainless steel, 0.060-inch slot 56-61 ft, 0.030-inch slot 61.5-66.5 ft. | | |
| Gravel, pebble to cobble size (road fill)----- | 3 | 3 |
| Clay, sticky, tan, very little sand----------- | 8 | 11 |
| Clay, sticky, layered, red-brown, tan, and blue-gray, some fine sand------------------ | 3 | 14 |
| Clay and sand, blue-gray, water-bearing at 14 ft-------------------------------------- | 7 | 21 |
| Gravel, weathered, fine to medium, and medium to coarse sand, water-bearing-------------- | 5 | 26 |
| Clay, very sandy, blue-gray, with some small rounded pebbles----------------------------- | 10 | 36 |
| Gravel, weathered, fine to medium, and fine to coarse sand and some clay, slightly water-bearing-------------------------------- | 4 | 40 |
| Clay, sandy, soft, blue-gray----------------- | 5 | 45 |
| Clay, soft, blue-gray------------------------ | 9½ | 54½ |
| Gravel, weathered, fine to coarse, rounded, and some sand and clay, water-bearing------- | 2 | 56½ |
| Gravel, weathered, fine to medium, and medium sand, water-bearing------------------------ | 2 | 58½ |
| Sand, weathered, fine to medium, water-bearing-------------------------------------- | 6½ | 65 |
| Sand, weathered, medium, water-bearing-------- | ½ | 65½ |
| Clay, sandy, hard (decomposed rock)----------- | 2½ | 68 |
| Rock (very fine-grained sandstone or mudstone), greenish-gray, contains veinlets of calcite, not water-bearing------------------------- | 10 | 78 |

TABLE 5.--Logs of wells and test holes--Continued

| | Thick-ness (feet) | Depth (feet) |
|---|---|---|
| Test hole, lower Hoh River. NW¼ sec. 19, T. 26 N., R. 13 W. Augered January 1967. Altitude about 10 ft. Casing: 4-inch to 21 ft, perforated 14-21 ft. | | |
| Silt | 3 | 3 |
| Gravel | 8 | 11 |
| Clay, soft | 2 | 13 |
| Gravel, fine | 5 | 18 |
| Gravel and some clay | 7 | 25 |
| Gravel, fine | 3 | 28 |
| Gravel, coarse, or decomposed bedrock | 2 | 30 |
| Well, Quillayute auxiliary airfield. SW¼ sec. 18, T. 28 N., R. 14 W. Drilled 1943. Altitude 173.3 ft. Casing: 10-inch, perforated 123-163 ft. | | |
| Soil, black | 4 | 4 |
| Clay, yellow | 10 | 14 |
| Sand, packed, with gravel and boulders | 91 | 105 |
| Sand, with gravel and some boulders | 59 | 164 |
| Clay, blue | 6 | 170 |
| Well, Mora Campground. SW¼ sec. 23, T. 28 N., R. 15 W. Dug December 1961. Altitude about 25 ft. Casing: 36-inch to 38 ft, perforated 26-38 ft. | | |
| Sand and clay, reddish-brown, with rotted vegetation | 4 | 4 |
| Sand, gravel, and silt | 2 | 6 |
| Sand, fine, clean, gray | 6 | 12 |
| Sand, and gravel to 3-inches diameter | 6 | 18 |
| Sand, and gravel to 12-inches diameter | 10 | 28 |
| Gravel, to 18-inches diameter | 10 | 38 |

| | Thick-ness (feet) | Depth (feet) |
|---|---|---|
| st hole 1, La Push. SW¼ sec. 23, T. 28 N., R. 15 W. Augered January 12, 1967. About 1 mile east of La Push, 50 ft inside pasture gate at end of road along south side of sec. 22, T. 28 N., R. 15 W. Altitude about 10 ft. Casing: 4-inch to 39 ft, perforated 32-39 ft. | | |
| ay, sandy, brown | 10 | 10 |
| avel | 3 | 13 |
| ay | 5 | 18 |
| avel, fine | 12 | 30 |
| ivel, coarse | 18 | 48 |
| t hole 2, La Push. SW¼ sec. 23, T. 28 N., . 15 W. Augered January 13, 1967. bout 1 mile east of La Push, about 100 ft ast and 80 ft south of pasture gate at end f road along south side of sec. 22, T. 28 N., . 15 W. Altitude about 10 ft. Casing: -inch to 25 ft, perforated 18-25 ft. | | |
| y, sandy, soft, brown | 8 | 8 |
| i, fine, clayey, brown | 6 | 14 |
| vel, sandy | 6 | 20 |
| vel and fine to medium sand | 8 | 28 |
| t hole 3, La Push. SW¼ sec. 22, T. 28 N., . 15 W. Augered January 17, 1967. About .2 mile east of east boundary of village, n north shoulder of road along south side f sec. 22, T. 28 N., R. 15 W., about 150 ft est of abandoned boat hull. Altitude about 0 ft. Casing: 4-inch to 37 ft, rforated 30-37 ft. | | |
| y, sandy, soft | 9 | 9 |
| / and scattered gravel | 4 | 13 |
| 1 and gravel | 27 | 40 |
| el, coarse | 15 | 55 |

TABLE 5.--Logs of wells and test holes--Continued

| | Thick-ness (feet) | Depth (feet) |
|---|---|---|
| Test hole 1, Ozette. SW¼ sec. 29, T. 31 N., R. 15 W. Augered January 11, 1967. On west shoulder of road, at south end of the Coal Creek bridge. Altitude about 40 ft. | | |
| Clay, sandy, brown, with wood at 9 ft--------- | 13 | 13 |
| Sand, fine------------------------------------ | 9 | 22 |
| Clay, soft------------------------------------ | 6 | 28 |
| Sand, fine, and soft clay-------------------- | 26 | 54 |
| Till, clayey, blue, with fine angular pebbles- | 24 | 78 |

| | | |
|---|---|---|
| Test hole 2, Ozette. SW¼ sec. 29, T. 31 N., R. 15 W. Augered January 11, 1967. 100 ft north of Coal Creek and 30 ft east of Ozette River. Altitude about 35 ft. | | |
| Clay, brown----------------------------------- | 8 | 8 |
| Sand, fine------------------------------------ | 6 | 14 |
| Gravel(?)------------------------------------- | 2 | 16 |
| Clay------------------------------------------ | 2 | 18 |
| Till, clayey, blue---------------------------- | 55 | 73 |

| | | |
|---|---|---|
| Test hole 3, Ozette. SW¼ sec. 29, T. 31 N., R. 15 W. Drilled March 7, 1967 by Stoican Drilling Co. Near center of south side of parking lot. Altitude about 40 ft. | | |
| Clay and sand, blue, with some wood---------- | 8 | 8 |
| Sand, fine to very fine, blue---------------- | 30 | 38 |
| Till, clayey, blue---------------------------- | 58 | 96 |
| Rock, medium-hard, gray and white------------ | 8 | 104 |

TABLE 5.--Logs of wells and test holes--Continued

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Test hole, Quinault. NW¼SW¼ sec. 27, T. 24 N., R. 8 W. Augered January 26, 1967. About 250 ft west of USGS precipitation gage. Altitude about 370 ft. | | |
| Sand | 8 | 8 |
| Clay | 2 | 10 |
| Sand | 4 | 14 |
| Clay | 2 | 16 |
| Sand | 1 | 17 |
| Boulders, imbedded in fine sand | 6 | 23 |
| Test hole, Quinault Ranger Station. NE¼ sec. 9, T. 23 N., R. 9 W. Augered January 24, 1967. In southwest corner of ranger station work area. Altitude about 235 ft. Casing: 4-inch to 44 ft, perforated 34-44 ft. | | |
| Clay, sandy, brown | 15 | 15 |
| Gravel, fine | 3 | 18 |
| Gravel, coarse | 10 | 28 |
| Gravel and clay | 3 | 31 |
| Clay | 2 | 33 |
| Clay and gravel, in layers | 10 | 43 |
| Sand and gravel | 15 | 58 |
| Gravel, fine | 10 | 68 |
| Sand, fine, and clay | 15 | 83 |
| Clay and fine sand | 22 | 105 |

TABLE 5.--Logs of wells and test holes--Continued

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Test hole, Queets Ranger Station. NE¼ sec. 2, T. 24 N., R. 10½ W. Drilled March 9, 1967 by Stoican Drilling Co. About 150 ft southwest of ranger's residence. Altitude about 280 ft. | | |
| Silt and fine sand | 8 | 8 |
| Boulders | 10 | 18 |
| Sand, fine, and blue clay with pebbles | 66 | 84 |
| Clay, sticky, blue, and some very fine sand | 14 | 98 |
| Clay, blue, with pebbles, and some medium sand | 70 | 168 |
| Clay, blue, with pebbles, and some fine soft sand | 26 | 194 |
| Clay, blue, with some pebbles and sand | 29 | 223 |
| Sand, fine | 8 | 231 |
| Clay, sandy, blue | 40 | 271 |
| Shale(?), sandy, blue | 30 | 301 |
| Test hole, Fairholm. NW¼ sec. 30, T. 30 N., R. 9 W. Augered January 10, 1967. 180 ft west of boat ramp and 25 ft south of center line of boat ramp road. Altitude about 590 ft. Casing: 4-inch to 44 ft, perforated 37-44 ft. | | |
| Silt | 3 | 3 |
| Gravel, medium | 5 | 8 |
| Gravel, medium to coarse | 5 | 13 |
| Clay, sandy | 9 | 22 |
| Gravel, medium | 16 | 38 |
| Gravel, coarse | 10 | 48 |
| Gravel and boulders | 8 | 56 |
| Bedrock, decomposed (or till) | 7 | 63 |

TABLE 5.--Logs of wells and test holes--Continued

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Test hole 1, Barnes Point. SE¼ sec. 26, T. 30 N., R. 9 W. Augered January 4, 1967. About 200 ft south of boathouse near district ranger's residence. Altitude about 585 ft. Casing: 4-inch to 45 ft, perforated 38-45 ft. | | |
| Gravel, medium to coarse | 5 | 5 |
| Gravel, fine to medium | 3 | 8 |
| Gravel, medium | 20 | 28 |
| Gravel and sand | 10 | 38 |
| Gravel, clayey | 5 | 43 |
| Gravel, medium | 20 | 63 |
| Test hole 2, Barnes Point. SE¼ sec. 26, T. 30 N., R. 9 W. Augered January 8, 1967. About 40 ft east of junction of roads to boat ramp and to ranger's residence. Altitude about 595 ft. | | |
| Gravel, coarse, and silt | 8 | 8 |
| Gravel, coarse to very coarse | 16 | 24 |
| Clay, sandy | 4 | 28 |
| Gravel, fine | 12 | 40 |
| Gravel, fine to medium | 10 | 50 |
| Sand and clay | 3 | 53 |
| Gravel, medium | 12 | 65 |