

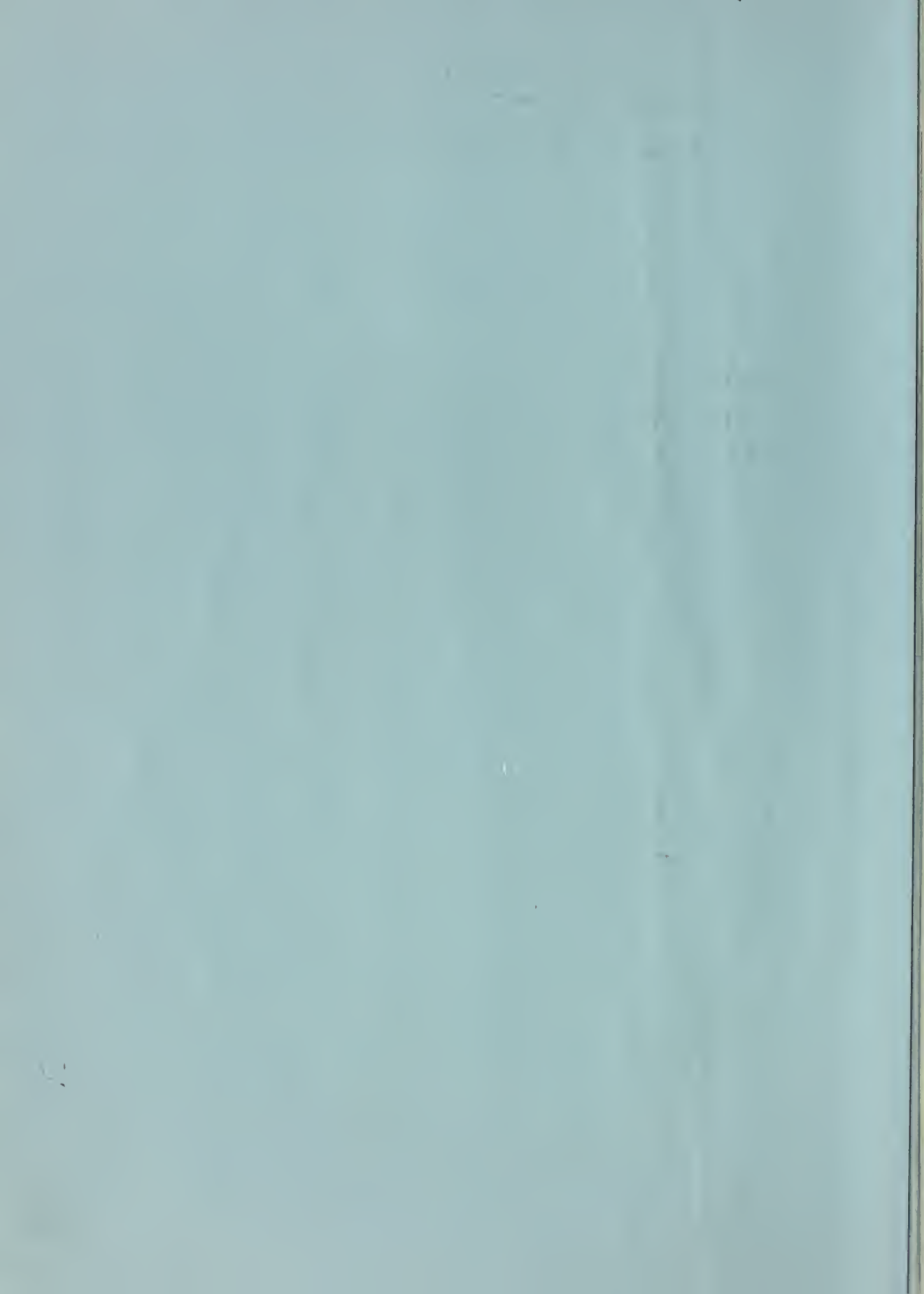
UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY  
Water Resources Division

WATER-SUPPLY STUDIES FOR ROSS LAKE AND  
LAKE CHELAN NATIONAL RECREATION AREAS  
AND NORTH CASCADES NATIONAL PARK  
DURING FISCAL YEAR 1971

ADMINISTRATIVE REPORT

For U.S. Government use only

Tacoma, Washington  
1971



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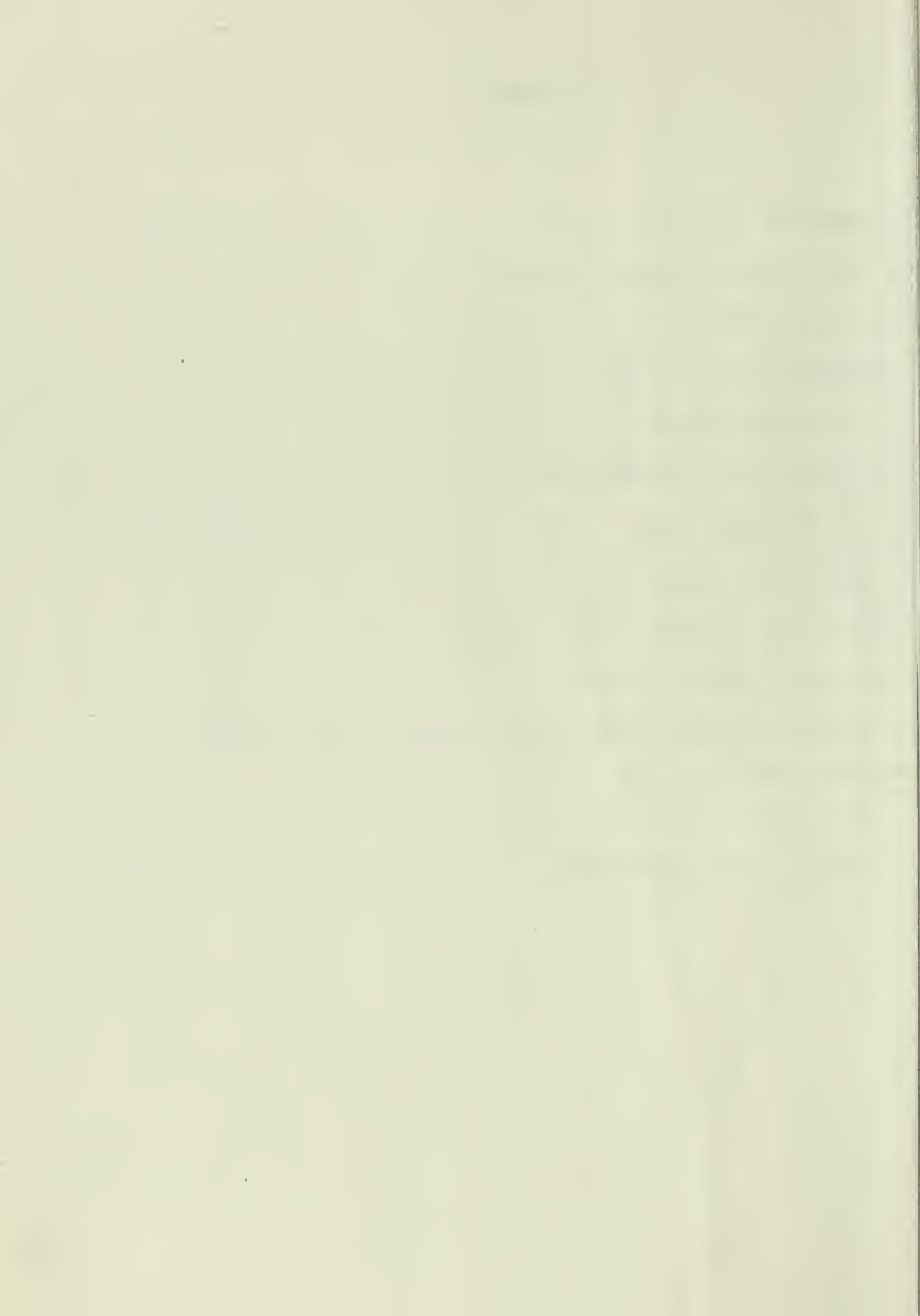
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WATER-SUPPLY STUDIES FOR ROSS LAKE AND  
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INTRODUCTION

During fiscal year 1971 investigations for water supplies were made at several locations in the Ross Lake and Lake Chelan National Recreation Areas and North Cascades National Park. The areas investigated in the Ross Lake National Recreation Area were Newhalem, Newhalem Creek, Diablo Lake Resort, Colonial Creek Campground, end of Thunder Arm, Happy Creek, Roland Point, and Hozomeen (fig. 1), while the areas studied in the Lake Chelan National Recreation Area and North Cascades National Park were, respectively, the community of Stehekin and the Bridge Creek Campground (figs. 8 and 9). The studies were made by Denzel R. Cline and Dee Molenaar.

Availability of ground water from unconsolidated deposits, and surface-water supplies for these areas are discussed in this report. Bedrock in the area probably will yield little or no water to wells tapping it, the maximum expected yield being only a few gallons per minute.



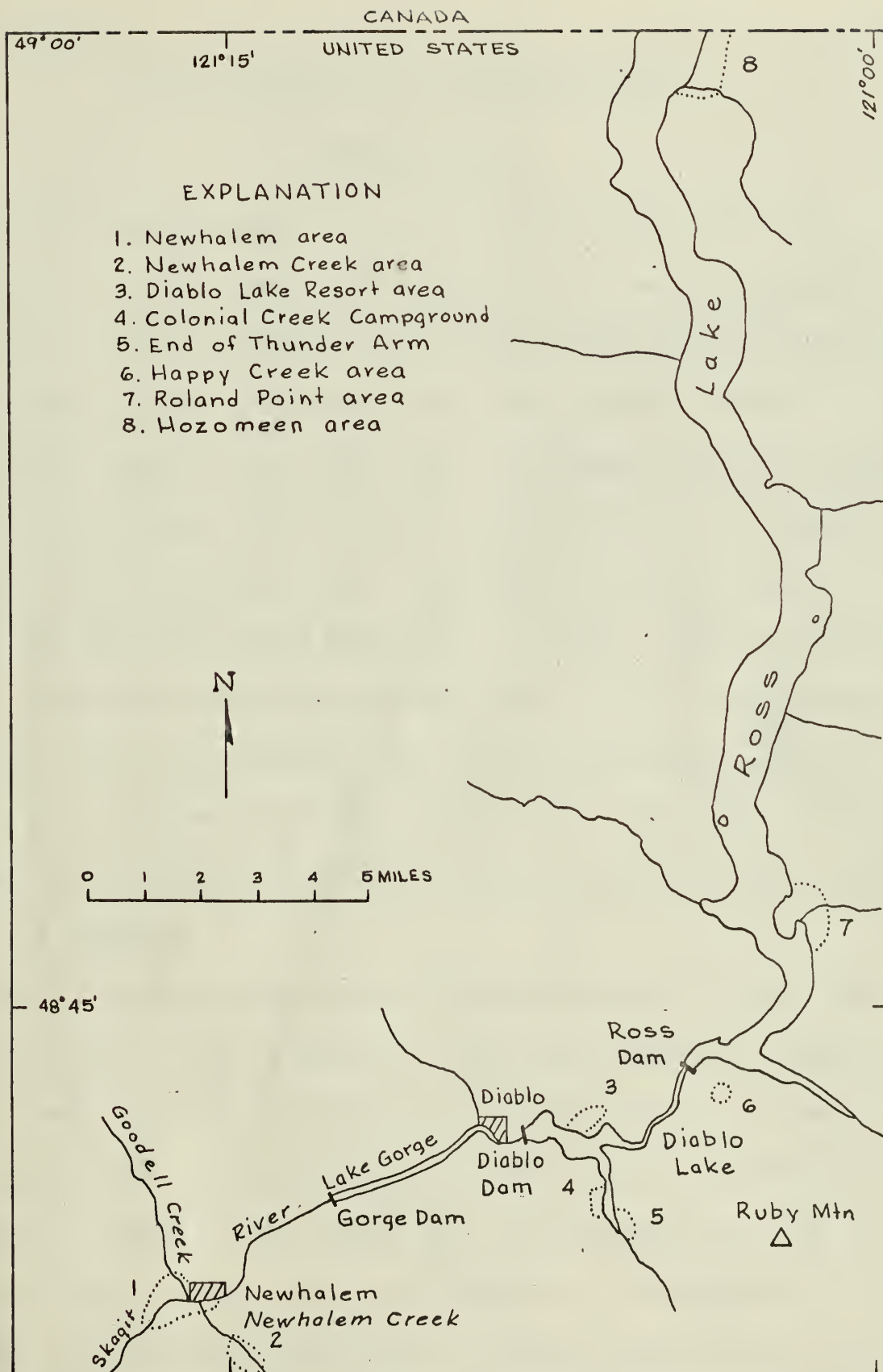
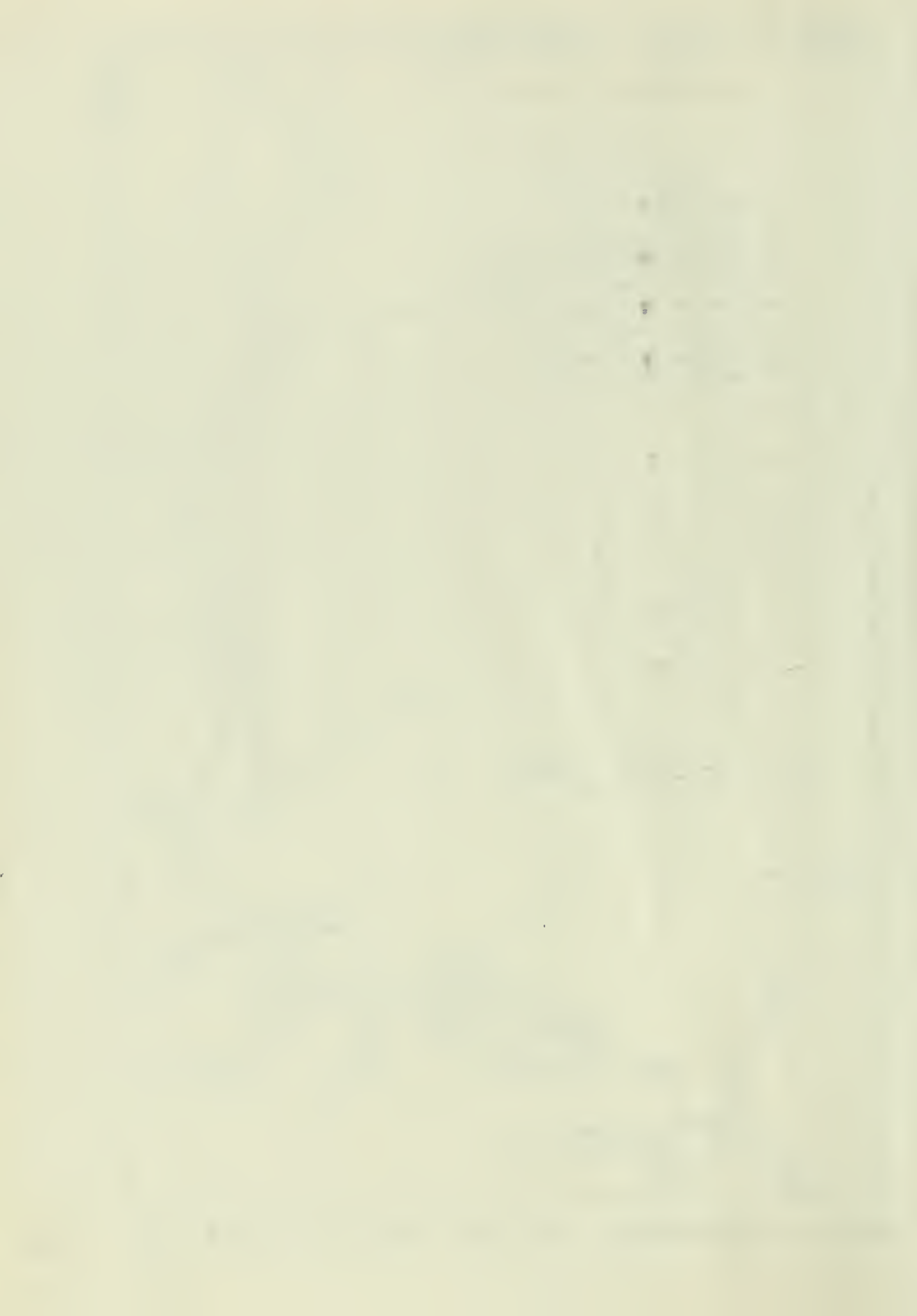


FIGURE 1.--Newhalem-Ross Lake area, showing areas of study.

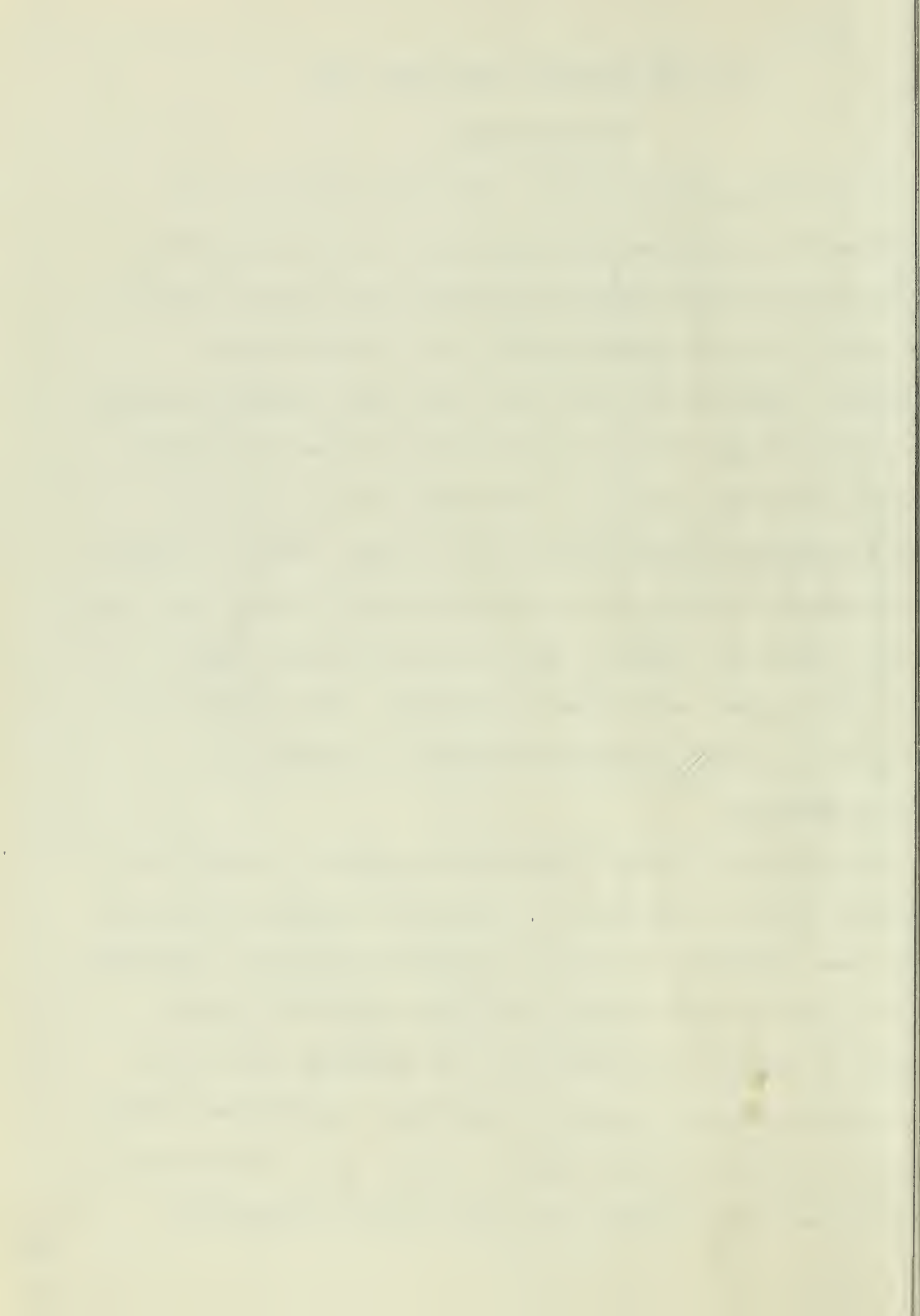


## ROSS LAKE NATIONAL RECREATION AREA

### Newhalem Area

In the Skagit River valley immediately downstream from Newhalem (fig. 2) ground water probably is readily available to wells tapping the underlying glacial and alluvial deposits. The valley floor is wide and nearly flat except for two terraces. Relative to river level, the lowest terrace (nearest the river) is about 10 to 15 feet high, and the next terrace is about 30 to 40 feet high. The Skagit River is incised into the valley alluvium about 10 to 15 feet. These unconsolidated deposits consist of sand and gravel with lesser quantities of clay, silt, and cobbles, and in places boulders, some of which are as great as 15 feet in diameter. The sediments are moderately to poorly sorted, as exposed in a gravel pit west of Newhalem.

The permeable sand and gravel beds probably are more than 200 feet thick in most places. Underlying bedrock is generally quite deep, although it may be at shallow depths in a few places. The deposits at depth beneath the valley floor are probably similar to those in the gravel pit, as indicated by a log of the only well in the vicinity. This well, the Newhalem public-supply well (Seattle City Light Co. well), is at the east end of town, and was drilled to 157 feet without encountering



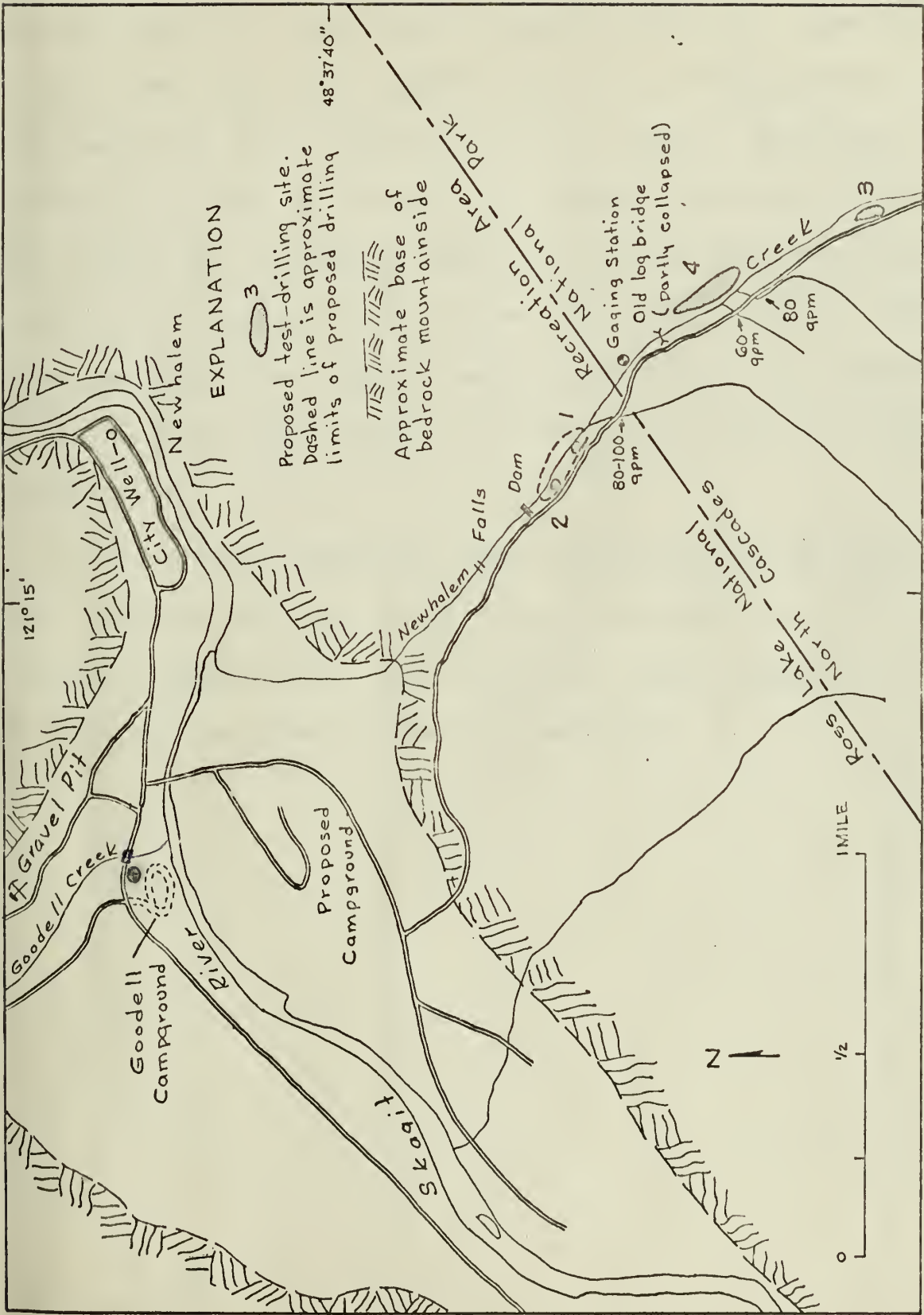


FIGURE 2.--Newhalem Creek area showing proposed test-drilling sites, and streamflow on June 14, 1971.



bedrock (table 1). The depth to water in the well ranged from 53 to 57 feet below land surface during July-October 1962; this was 22 to 27 feet lower than river level at the time. The bottom 27 feet of the well is screened. When the well was pump tested for 41 hours at rates up to 1,040 gpm (gallons per minute), the drawdown of water level was about 57 feet. The large yield obtained from the well indicates the high productivity of the unconsolidated deposits in the central part of the valley in this area.

In the Goodell Campground area, immediately across Goodell Creek from the west end of the town of Newhalem, and in the proposed campground area just across the Skagit River, test drilling can be attempted wherever convenient.



TABLE 1.--Description of materials penetrated by Newhalem  
public-supply well

| Material                                                                                                  | Thick-<br>ness<br>(feet) | Depth<br>(feet) |
|-----------------------------------------------------------------------------------------------------------|--------------------------|-----------------|
| Soil and boulders-----                                                                                    | 18                       | 18              |
| Sand, gravel, and clay-----                                                                               | 14                       | 32              |
| Sand, gravel, and clay with rocks 4 to 6 inches<br>in diameter. Clay content increases with<br>depth----- | 35                       | 67              |
| Sand, gravel, and clay. Clay content decreases<br>with depth-----                                         | 19                       | 86              |
| Sand, gravel, and rocks 3 to 5 inches in<br>diameter-----                                                 | 9                        | 95              |
| Sand, gravel, silt, and some clay. Small<br>clusters of cemented gravel-----                              | 21                       | 116             |
| Sand and gravel, loose-----                                                                               | 13                       | 129             |
| Gravel, coarse, with rocks up to 4 inches in<br>diameter-----                                             | 4                        | 133             |
| Gravel and rocks up to 5 inches in diameter,<br>very loose-----                                           | 9                        | 142             |
| Sand and gravel, some clay, compact-----                                                                  | 5                        | 147             |
| Sand and gravel, loose-----                                                                               | 3                        | 150             |
| Sand and gravel, compact. Fine sand increases<br>with depth-----                                          | 7                        | 157             |



## Newhalem Creek Valley

The Newhalem Creek valley (fig. 2), within both Ross Lake National Recreation Area and North Cascades National Park, may be the location of a camp developed in the future for youth groups. Although presumably no development will take place within the National Park, information on ground-water availability within the Park near the boundary is given in the event of future need.

Ground water probably may be obtained along the valley bottom from wells drilled into unconsolidated deposits. At sites 1 and 2 (fig. 2) permeable materials probably can be tapped unless bedrock is too near the surface. The thickness of the deposits probably ranges from a few feet to 20 feet or possibly more. Although the bottom of the V-shaped valley is narrow and the volume of unconsolidated deposits is small, infiltration from Newhalem Creek should keep the deposits saturated. The first choice for the location of a test well is at site 1 (fig. 2) where the deposits are more likely to be thicker than at site 2; both sites are easily accessible to a drilling rig. Inside the National Park boundary the sediments are more extensive than downstream, and because of this they probably are thicker and more likely to yield water to wells. Two favorable test-drilling sites are shown in



Figure 2. Site 3 is readily accessible to a drilling rig, but site 4 is not accessible at present as it is across Newhalem Creek from the road.

Streams also should be considered as a possible source of water supply. Newhalem Creek has a very large flow, 20 cfs (cubic feet per second), about 9,000 gpm, at the gaging station, even during periods of low flow. The stream has some sediment in it at times which probably can be removed by burying the intake. Creeks tributary to Newhalem Creek (fig. 2) were flowing less than 100 gpm on June 14, 1971, and are apt to be dry in late summer.



## Diablo Lake Resort

Diablo Lake Resort is on the north shore of the reservoir about 0.7 mile east of Diablo Dam (fig. 1). The resort accommodates over 100 people at times during the summer, and may be expanded in the future. The resort obtains its water from Deer Creek immediately to the east of the resort (fig. 3).

Unconsolidated materials probably are thin where present in the area, but may be thick and permeable enough along lower Deer Creek to yield water to wells. The unconsolidated deposits may be a few feet to a few tens of feet thick in the Deer Creek valley, and probably range in size from clay to large boulders. Depths to bedrock may vary considerably in short distances. The area suggested for test drilling (fig. 3) is accessible by dirt road. If a ground-water supply cannot be developed from the unconsolidated deposits, perhaps an infiltration system from the creek could be constructed.



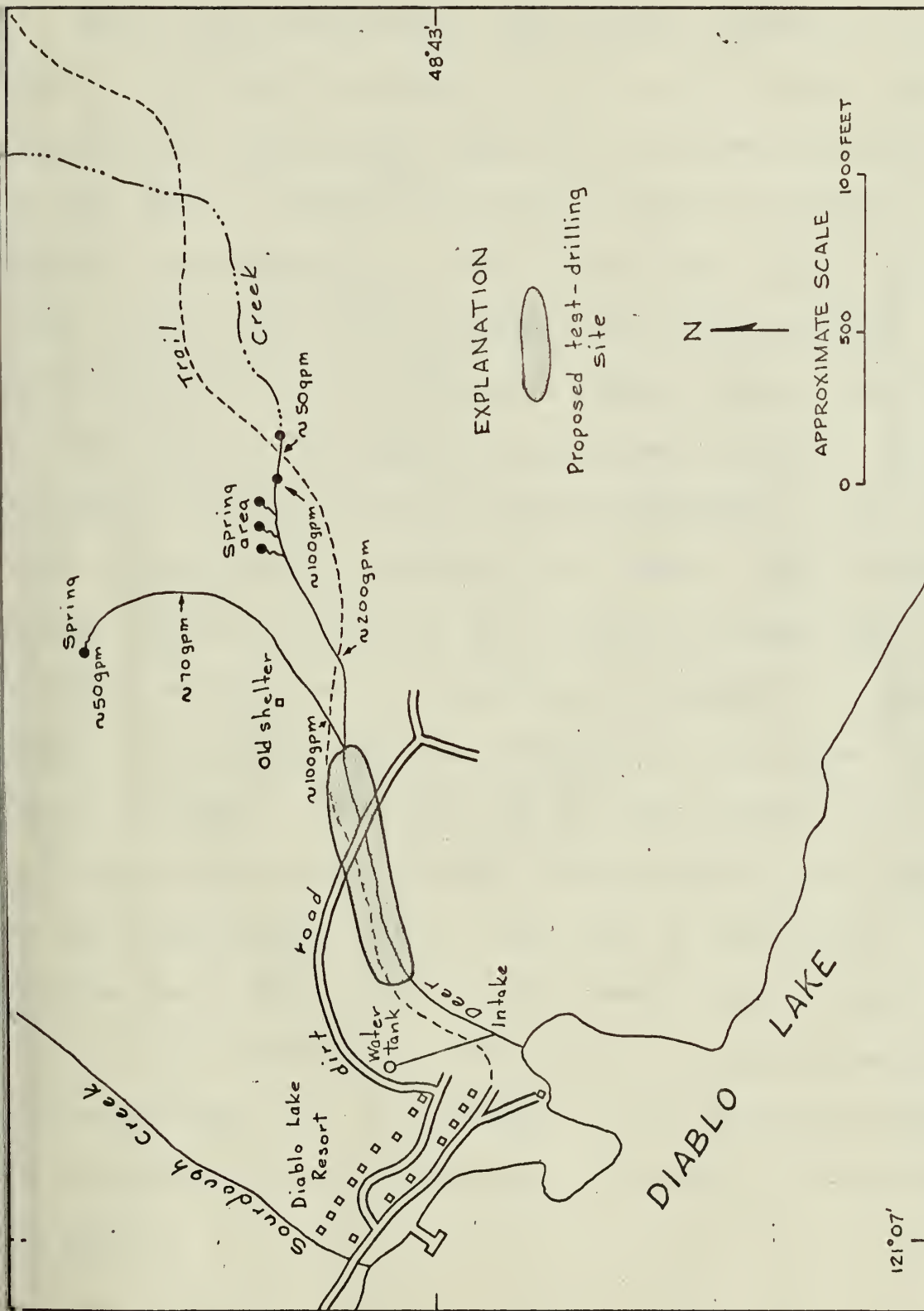


FIGURE 1.--Diablo Lake Resort area, showing estimated streamflows on June 2, 1971 and proposed test-drilling site.



Several springs feed Deer Creek which, according to the owners, has flowed continuously for the last 15 years (1957-71), but Sourdough Creek on the west side of the resort goes dry in most years. Although the flows of the Deer Creek and the springs were estimated at several points (fig. 3) on June 2, 1971, the low flows of late summer will be the critical determining factors for developing a water supply. The flow of Deer Creek at the intake in late summer of 1970, a very dry year, was reported to be more than adequate for the water needs of the resort, according to the owners. The northernmost spring, which is the head of the tributary to Deer Creek (fig. 3), probably would be the most favorable to develop for a water supply if sufficient water is available in late summer. This spring is higher in altitude than the other springs, and probably is not effected by much sediment-laden runoff which is more characteristic of the upper part of Deer Creek. Also, because the northern spring is more remote from the trail, there would be less likelihood of pollution. The spring area along the main stream (fig. 3) is rather low and swampy, but could be developed by gravity collection of the water in an enclosed spring box.



The owners of the resort report very little sediment in Deer Creek in its lower reach at the intake. At the third (uppermost) trail crossing (fig. 3), however, the stream brings down a large amount of debris, including large boulders. Most of this material appears to be deposited before the stream reaches the second trail crossing. On June 2, 1971 the creek flow started roughly 100 feet above the second trail crossing; probably water is in the streambed as far as the third trail crossing during only short periods in winter and spring.

A water sample collected March 22, 1971 from Deer Creek by personnel of the National Park Service and analyzed by the Washington Division of Health indicated good-quality water. The constituents were as follows:

|                                | <u>Milligrams<br/>per liter</u> |
|--------------------------------|---------------------------------|
| Silica ( $\text{SiO}_2$ )      | 5                               |
| Iron (Fe)                      | .0                              |
| Manganese (Mn)                 | .0                              |
| Calcium (Ca)                   | 7.2                             |
| Magnesium (Mg)                 | 2.4                             |
| Sodium (Na)                    | 1.1                             |
| Potassium (K)                  | .9                              |
| Bicarbonate ( $\text{HCO}_3$ ) | 29                              |
| Sulfate ( $\text{SO}_4$ )      | 5.4                             |
| Chloride (Cl)                  | 1.5                             |
| Nitrite ( $\text{NO}_2$ )      | .6                              |



|                                                            | Milligrams<br>per liter |
|------------------------------------------------------------|-------------------------|
| Nitrate ( $\text{NO}_3$ )                                  | 1.2                     |
| Orthophosphate ( $\text{PO}_4$ )                           | .0                      |
| Total solids                                               | 41                      |
| Hardness as $\text{CaCO}_3$                                | 28                      |
| Noncarbonate hardness<br>as $\text{CaCO}_3$                | 4                       |
| Specific conductance<br>(micromhos at $25^\circ\text{C}$ ) | 62                      |
| pH                                                         | 6.5                     |
| Color                                                      | 5                       |
| Turbidity                                                  | .1                      |
| Odor                                                       | nil                     |

Another possibility for obtaining a ground-water supply would be to develop a well in hydraulic continuity with Diablo Lake, along the west shore of the small bay into which Deer Creek discharges. The end of the small peninsula to the west is bedrock, but along the bay in particular there is some possibility of the bedrock surface being deeper than 12 feet below high-water level in the reservoir, the distance it reportedly is normally lowered. Access for equipment may be somewhat difficult, however.

Should consideration be given to obtaining a water supply directly from Diablo Lake, the intake should be positioned deep enough and far enough from shore to preclude possible pollution.



## Colonial Creek Campground

Colonial Creek Campground is on Thunder Arm of Diablo Lake (fig. 1) and obtains its water supply via gravity pipeline from a small dam on Rhode Creek (locally known as Proudly Creek; fig. 4). The campground used nearly a million gallons of water in 1970; probably during periods of maximum campground use the diversion amounts to about 15,000 gallons per day, or an average of 10 gpm.

Test drilling for water at Colonial Creek Campground very likely will locate ground-water supplies that will yield more than 10 gpm to wells. The campground is situated on thick alluvial fans formed by Colonial and Rhode Creeks. The unconsolidated deposits consist of clay to boulder-size material. Wells drilled near the lake probably can tap a sufficient thickness of saturated sediments to obtain an adequate water supply. The variable nature of both the deposits and the possibility of encountering buried bedrock may mean that more than one test well must be drilled to be successful. A suggested site for a test well is in the parking area of the south campground area, opposite the boat dock, or in the gravel pit (fig. 4). The site is accessible and yet far enough removed from restroom drainfields, and away from the line of this drainage toward the lake.



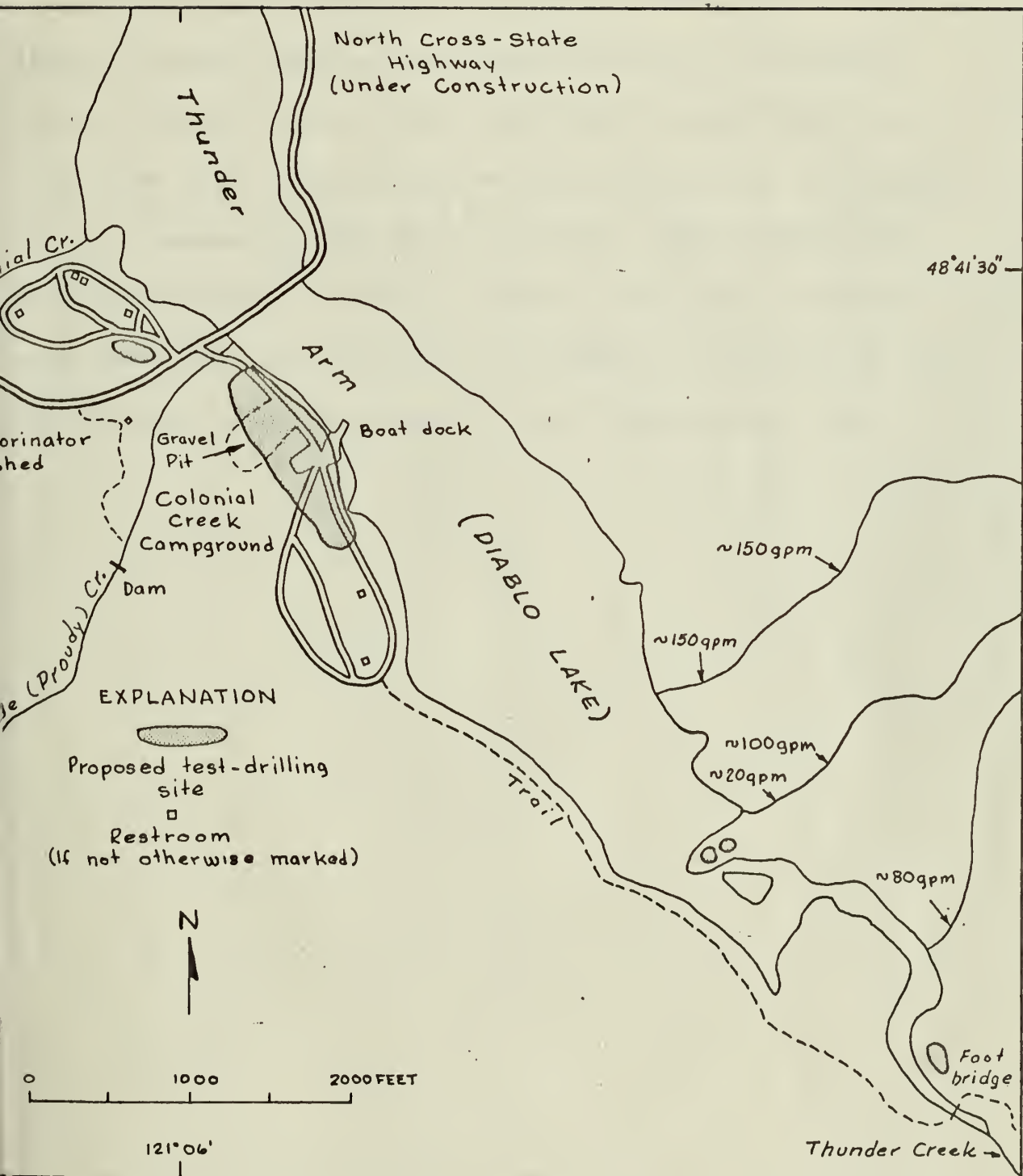


FIGURE 4.--Colonial Creek Campground and proposed boat-in campground areas, showing estimated streamflows on June 3, 1971 and proposed test-drilling sites.



On June 3, 1971, Colonial and Rhode Creeks, were the only flowing streams crossing the roads and trails on the west side of Thunder Arm (fig. 4). Although Colonial Creek has a very large flow, it probably has much sediment in it most of the time because of its glacial origin. Rhode Creek had a flow estimated to be between 500 and 1,000 gpm; the creek reportedly flows year-around at the dam but in late fall or winter sinks into the alluvium before reaching the road.



## End of Thunder Arm

A campground accessible by boats only has been proposed for the end of Thunder Arm on Diablo Lake, in the vicinity of either of the two areas shown as possible test-drilling sites (fig. 4). Both the peninsula location and the one near the footbridge are only a little above high reservoir level; much of the land in the area was swampy on June 3, 1971. The maximum water level can rise about 1.7 feet higher than at the time of observation on June 3. Diablo Lake normally has rapid water-level changes of 4 feet during the summer, and a total fluctuation of about 10 feet during the year. The test-drilling sites suggested for ground-water supplies at these areas (fig. 4) are on the highest land, only a few feet above lake level. The depth to bedrock is unknown, but probably is at least a few tens of feet below the land surface. Sediments may contain much sand and finer grained material; however, coarse permeable material most likely underlies the areas in places. Access for test drilling would need to be provided, probably by barge for drilling on the peninsula, but might be difficult to provide for the site near the footbridge.



Streams might be considered for a water supply if they flow perennially. On June 3, 1971, three streams in the area (fig. 4) had flows that were estimated to be more than adequate--ranging from 80 to 150 gpm--but the streams could be dry by September. The middle stream, which descends the mountainside and empties into the swamp immediately north of the peninsula, loses most of its water into the ground here. The late-summer flow of this stream should be checked at some distance up the mountainside.



## Happy Creek Area

The Happy Creek area, which is on the ridge above Ross Dam and on the new north cross-state highway under construction (fig. 1), is at the lower terminal of a proposed tramway to the top of Ruby Mountain (fig. 1). Quantities of water needed for the proposed facility are expected to be small.

Water possibly can be obtained from a shallow well or infiltration gallery dug in unconsolidated materials adjacent to the creek, near the upstream end of the upper relatively flat area (site 1, fig. 5). Bedrock is at very shallow depth at this site, probably less than 15 feet, and may be less than 5 feet. Permeable materials may occur here because the streambed consists mostly of cobbles. If not, the material could be excavated and backfilled with gravel. Access to this site for a drilling rig or backhoe needs to be provided.

Another possible site for a test well is in the lower flat area, on the south side of Happy Creek, beside a tributary stream (site 2, fig. 5). The thickness of unconsolidated materials here is probably less than 15 feet, but could be as much as 20 to 30 feet. This site is less desirable than the one upstream because of possible contamination from any development up-valley, unless the sediments are thick enough to provide a filtration effect..



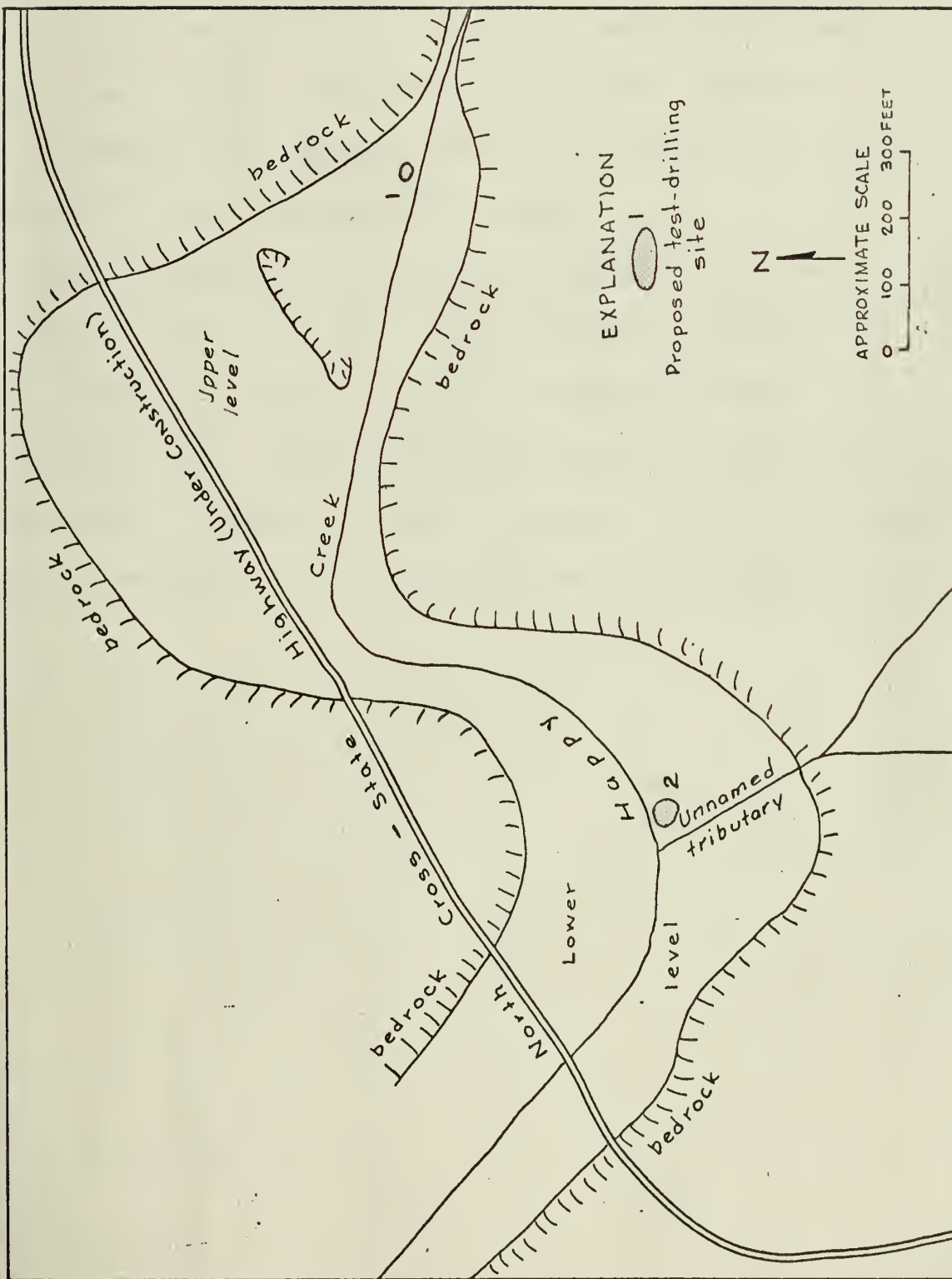


FIGURE 5.--Happy Creek area showing proposed test-drilling site.



Happy Creek could be utilized for a water supply as it reportedly flows continuously, and has more than adequate quantities of water. The flow of the creek on May 26, 1971 was estimated to be roughly 1,000 to 1,500 gpm, and the flow probably is still large in late summer.

Another possibility for a water supply is the small unnamed tributary stream (fig. 5). This stream had an estimated flow of 100 gpm on May 26, 1971, each branch having a flow of about 50 gpm. Because the stream may be dry by fall, the flow should be checked in the late summer and fall for several years to determine its availability as a water supply.



## Roland Point Area

Roland Point, on the east shore of Ross Lake about 3 miles above Ross Dam (fig. 1), is undeveloped and accessible only by boat or trail at the present time (1971). The Park Service plans to build a road into the area and develop a major visitor facility, including campgrounds.

Roland Point is a bedrock knob connected by isthmus to the steeper mountain slope on the east. The isthmus and the shoreline to the south, to a small cove, contain unconsolidated glacial deposits except in the vicinity of Roland Creek where an alluvial fan descends from a bedrock outcrop (fig. 6).

Ground-water supplies may be available from the unconsolidated deposits near the shore of Ross Lake, particularly at sites 1 and 2 (fig. 6), on the alluvial fan of Roland Creek. The creek's high flows occasionally bring considerably debris down the mountain, thus the drilling sites should be a little distance from the stream's high flow line. The deposits here range in size from clay to large boulders and probably some permeable zones occur. The deposits may be several tens of feet thick near the lakeshore. An investigation of the area when the lake level is low might yield additional information on the thickness and character of the deposits. Because bedrock possibly is near the surface, and the unconsolidated



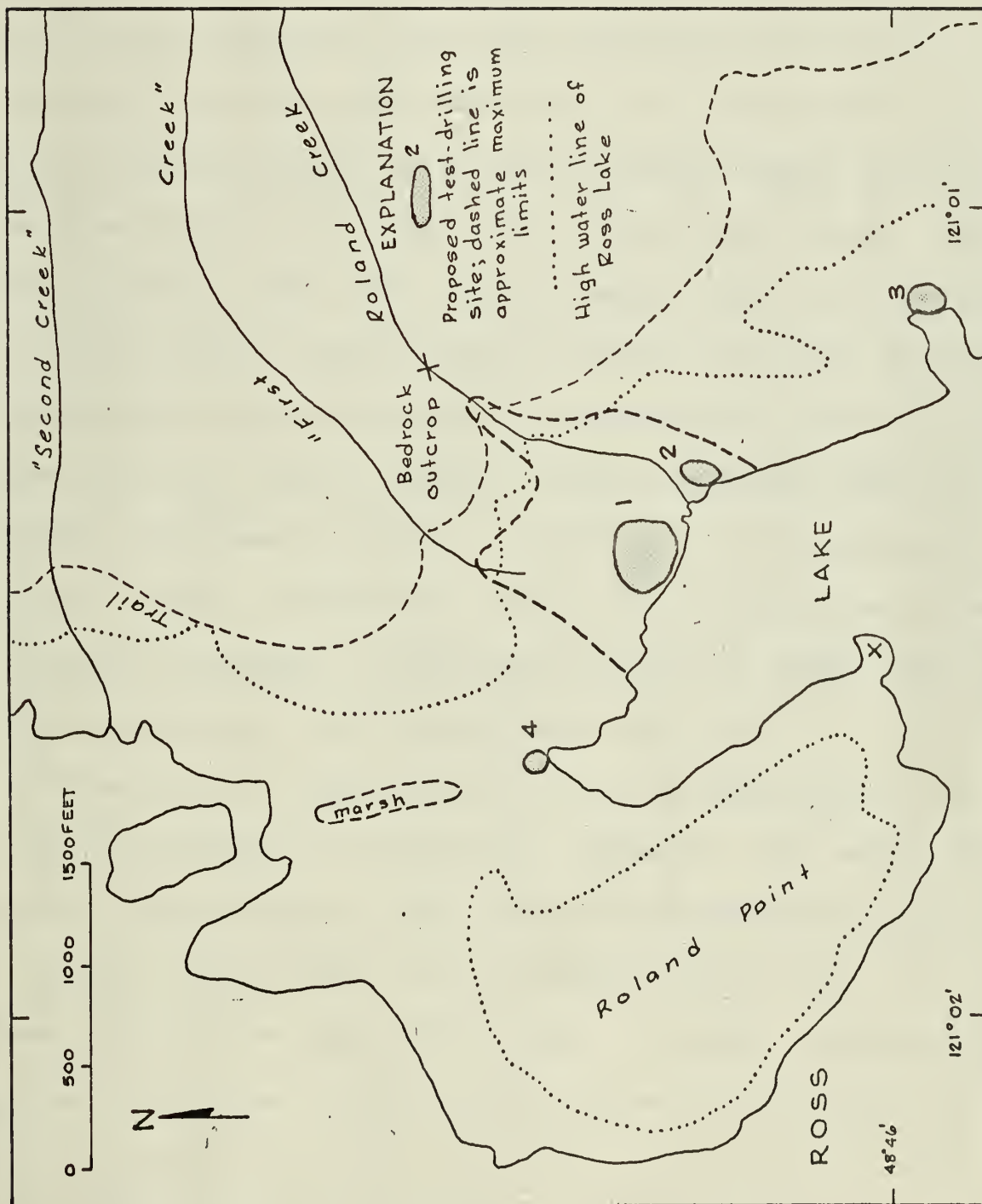


FIGURE 6. --Roland Point area, showing proposed test-drilling sites.



deposits may become dewatered at low lake levels--which often can be as much as 125 feet lower, and have been as much as 254 feet below maximum lake level--sufficient water may be available only during the summer when the lake is full. One factor that may offset any shortage of water during periods of low lake level is the infiltration of water from Roland Creek, which flows all year. The dashed boundary (fig. 6) is estimated to be the limit of the area that is feasible for test drilling. Bedrock crops out in Roland Creek approximately 350 feet upstream from the trail, but how rapidly the unconsolidated deposits thicken downstream is unknown. The location of the boundary in the vicinity of the middle creek is more indefinite. Based on present knowledge, if Ross Dam is raised in height, test drilling should be done along Roland Creek first.

Site 3 is in a small gully that may be underlain by saturated permeable unconsolidated sediments. The sediments probably are relatively thin, and may be finer grained than at sites 1 and 2. Also, site 3 is more likely to be dewatered when the lake level is down. A stream flows down the gully at times but was not flowing on June 16, 1971.



Site 4 is in a very small and short gully, and has conditions similar to those at site 3. A surface-water divide is situated just south of the marsh so little water runs down the gully. If the few rounded boulders in the gully bottom are glacial deposits rather than stream deposits, bedrock may be deeper than it appears.

Glacial deposits mantle the bedrock along the shore between site 3 and site 4 and apparently extend north across the relatively flat isthmus (fig. 6). Test drilling could be attempted along the shoreline from site 2 to the point near site 3. However, although no bedrock crops out along the shore, it probably is not very deep, in which case the sediments probably would dewater rather rapidly when the lake level is lowered. In the area west and north of the marsh (fig. 6) test drilling can be attempted, but bedrock probably is at rather shallow depths. A glacially cut valley in the bedrock, filled with unconsolidated sediment, may exist under the isthmus, but its existence would have to be determined, most feasibly by geophysical surveys.



In the event of failure to obtain an adequate ground-water supply, Roland Creek can be considered as a source of water for the Roland Point area. The creek had a flow of roughly 1,000 gpm on June 15, 1971 near the mouth, and the flow upstream was not noticeably different. Two years earlier, on August 12, 1969, the flow at the mouth was measured to be 494 gpm, and near the trail crossing the flow was 987 gpm, indicating a loss into the alluvial fan of almost 500 gpm. The flows of Roland Creek and the other creeks should be checked in the fall to see if the flows are adequate; the other two creeks may be dry in the fall because their flows were rather small in June 1971. On June 15, 1971 the first creek north of Roland Creek had a flow estimated to be 100 to 150 gpm, and the second creek had a flow estimated to be 150 gpm. The first creek sinks into the alluvial fan and disappears downstream from the trail. A small creek (not shown on fig. 6) about 200 feet north of the second creek had a flow at the trail crossing estimated to be 30 to 35 gpm on June 15, 1971, but is unlikely to yield an adequate amount of water in late summer. South of Roland Creek no other streams were observed crossing the trail for approximately 3,800 feet, at which point a small creek had a flow of about 20 gpm.



### Hozomeen Area

The community of Hozomeen is located on the east shore of Ross Lake 1 mile south of the Canadian border (fig. 7). The community is along the base of a bedrock scarp and has two camping areas--an upper campground located on a high terrace of unconsolidated material, and a lower campground on an alluvial fan next to the lake. In addition, this summer (1971) 10 more campsites are to be added southwest of the gravel pit. The Seattle City Light Co. work camp is situated on an intermediate terrace of unconsolidated deposits.

Ground-water supplies may be available from unconsolidated deposits in places along the shore of Ross Lake. However, (1) bedrock may be at shallow depths, (2) the deposits possibly are dewatered at low lake levels--the lake can be as much as 254 feet lower, which exposes the valley floor--and (3) the deposits may contain too much fine material to yield sufficient water.

East of the edge of the bedrock scarp the land surface is much flatter. The proposed raising of Ross Dam will raise the lake level about 125 feet above present maximum level and will submerge all present facilities, all likely test-drilling sites along the road, and roughly half of the present scarp.



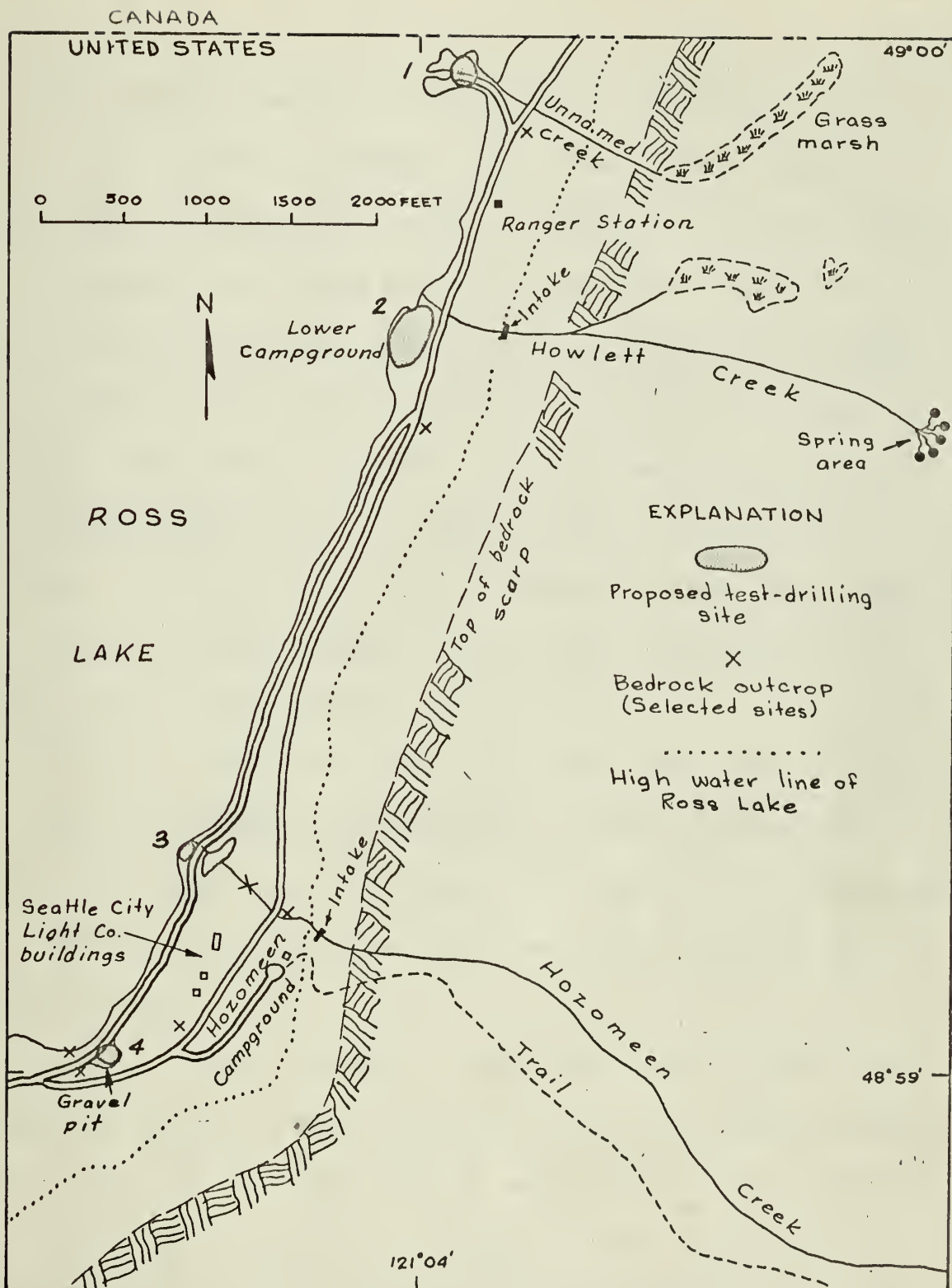


FIGURE 7.--Hozomeen area, showing proposed test-drilling sites.



Under present Ross Dam and lake-level conditions, site 1 may have the greatest thickness of unconsolidated deposits of the four sites shown on figure 7, because it is the farthest from the base of the scarp and also nearest the end of the lake. The site is easily accessible except when it is under about a foot of water during periods of highest lake level, generally from June to October. Also, because Hozomeen can have a considerable depth of snow in winter, access may be difficult. If test drilling is successful at this site, the land surface can be aggraded to above the lake level to protect the well and provide access to it.

Site 2, on the alluvial fan of Howlett Creek where a test well might be reasonably successful, is easily accessible. The most favorable places to drill here are in the northeastern part and in the western part near the short road into the campground area.

Site 3 is on the shoulder of the road next to a boat-launching access, and next to a dip in the road where it crosses Hozomeen Creek. Although the site is above water, the ranger stated that much of this lower road between Hozomeen Creek and the south end of the lower campground is under water at high lake level. Bedrock crops out only a short distance up the stream and may be at rather shallow depths beneath the site.



Site 4 is on the floor of a gravel pit and at road level, so is easily accessible. This is the most likely of the four sites at which bedrock might be encountered--bedrock crops out nearby and the site is higher than the others, being roughly 10 to 15 feet above lake level. Material in the pit consists of much sand and gravel, with some clay and boulders. Deposits beneath the surface, however, may be considerably different than those exposed in the pit.

An investigation of the lakebed when the lake level is down may yield additional information that can be used in evaluating test-drilling possibilities in the Hozomeen area.

If the lake level is raised by the proposed higher Ross dam, ground water might be obtained from shallow wells drilled in the lower areas of the upland, such as east of the marshes (fig. 7). The character and thickness of the deposits in these areas are unknown, but the deposits probably are relatively thin. Induced infiltration from streams may help provide an adequate supply all year.



Another possible source of a water supply, is one or more of several springs that head the south branch of Howlett Creek, and are located roughly 3,000 feet east of the lower campground (fig. 7). The combined flow of the springs on June 18, 1971 was estimated to be at least 100 gpm. One spring was estimated to be flowing 40 to 50 gpm. The flow of Howlett Creek reportedly is not much less in the fall than in early summer.

Two streams supply the Hozomeen area at present (1971). The lower campground and ranger station is supplied by Howlett Creek, while the upper campground and the Seattle City Light Co. work camp are supplied by Hozomeen Creek. The intake for each water system is part way up the face of the bedrock scarp. Howlett Creek had a flow estimated to be 300 to 400 gpm on June 17, 1971, and Hozomeen Creek had a flow on the order of 2,000 gpm. The flow of Howlett Creek in September 1970, a very dry year, reportedly was about the same as on June 17, 1971 and the flow of Hozomeen was only a little less, so each creek alone will yield more than an adequate water supply for the entire community. Although sediment occasionally gets into the present systems, this problem probably could be improved by burying the intakes in gravel behind a small dam.



The unnamed creek near the Canadian border (fig. 7) was flowing roughly 120 to 150 gpm on June 17, 1971, but in late fall the flow reportedly is very small. Although perennial, the creek probably should not be considered adequate for a water supply.

A stream near the Canadian border (not shown on fig. 7) flows westward toward the northernmost of the two grass marshes but the stream gradually sinks into the ground before reaching the marsh. The flow of the stream was estimated to be 200 to 300 gpm on June 17, 1971. During flooding the stream extends much farther westward, and probably floods the low area around and east of the grass marshes. Whether this stream would be adequate in the fall for consideration as a water supply is unknown.



LAKE CHELAN NATIONAL RECREATION AREA AND  
NORTH CASCADES NATIONAL PARK

The study during fiscal year 1971 was preceded by a brief reconnaissance during fiscal year 1969 of both surface- and ground-water resources at Stehekin and at other existing and prospective campgrounds in the Stehekin River valley.

Stehekin

The 1969 study showed that during late summer the water from Purple Creek--the principal source of supply for Stehekin--is nearly all utilized by the community via several gravity pipelines, and that virtually no flow occurs below the points of diversion on the creek. According to local residents, the water of Purple Creek reaches the lake only during the high-flow period of late spring and early summer; during most of the summer tourist season the water infiltrates into the coarse material of the talus cone upon which the community is situated. On August 25, 1969, the measured flow of Purple Creek was 0.14 cfs (63 gpm) above the uppermost of two diversion structures (fig. 8). At that time water sampled from the creek showed a coliform content of 1 per 100 milliliters of water, well within the generally accepted limits for public



consumption. On June 14, 1971, Purple Creek had a flow estimated to be about 10 cfs (4,500 gpm) between the two diversion points. A smaller, unnamed creek to the north is tapped above the talus cone--at a point undetermined at the time of this study--by a gravity pipeline which transports water to a campground and one or two homes located north of Purple Creek. This unnamed stream was dry in August 1969 but, in the upper part of the talus cone and below the point of diversion, it had an estimated flow of 0.15 cfs (68 gpm) on June 16, 1971. Because of the generally depleted flows of Purple Creek and the unnamed stream by late summer and the potential for future pollution of this surface-water source as a result of increased tourism in the area, the feasibility of development of a ground-water supply was investigated in more detail in 1971.

The community of Stehekin is situated generally along the toe of two major talus cones that descend from the canyons of Purple Creek and the unnamed creek to the north (fig. 8). The upper parts of the cones are composed of coarse cobbles and large angular boulders, some greater than 5 feet across, and the lower parts generally have similarly coarse materials but in a matrix with a greater proportion of gravel, coarse sand, and mud. There is very little evidence of sorting of



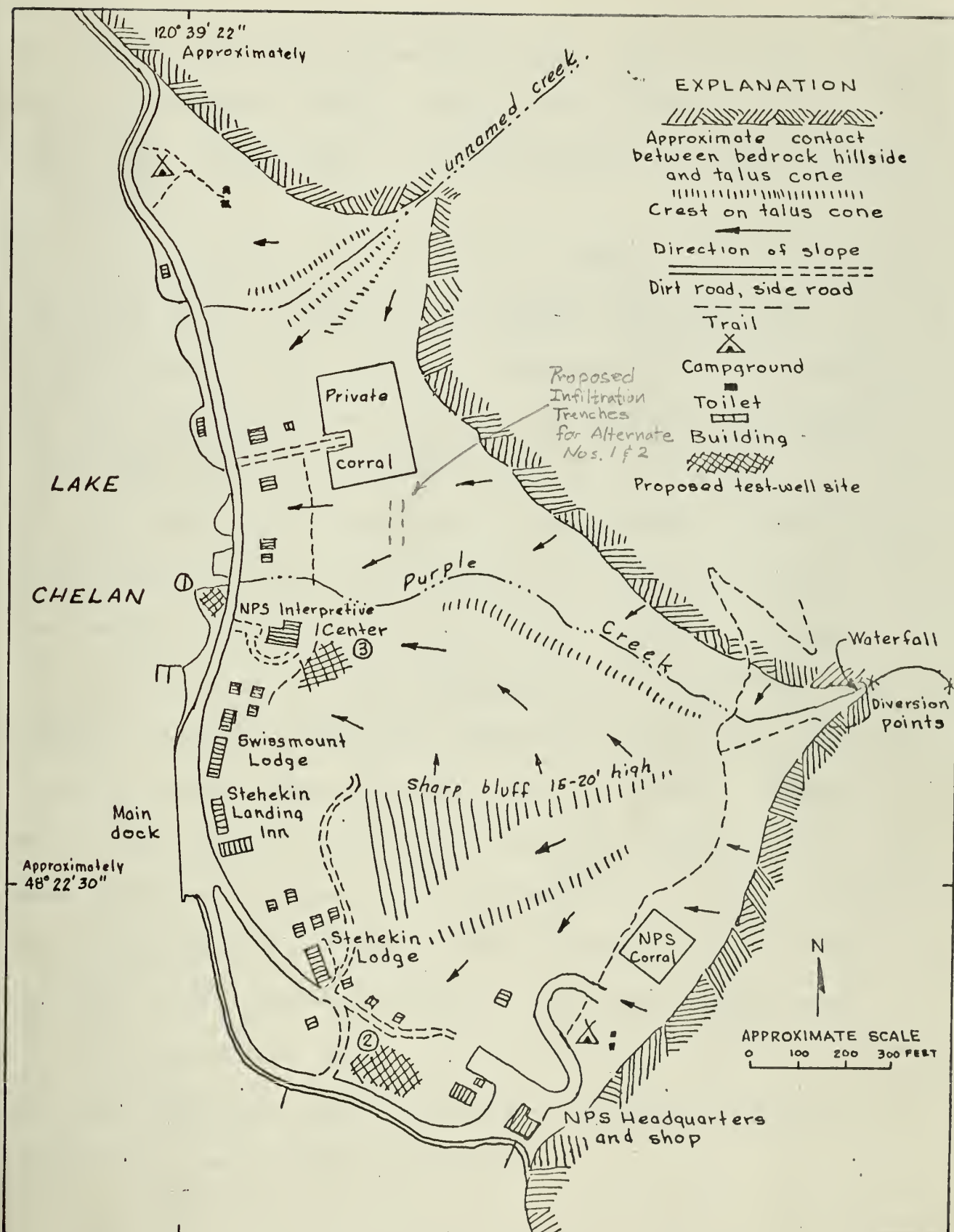


FIGURE 8.--Community of Stehekin and proposed test-well sites.



the material by normal stream deposition. Apparently the talus and associated smaller detritus were deposited during flash floods and by snowslides originating in the high mountains above the lake.

The selection of drilling sites at Stehekin included an evaluation of (1) the geology and probable occurrence and source of ground water--either by subsurface flow toward the lake from the intermittent creeks, or by hydraulic continuity between the lake water and ground water within the talus material--and (2) the possibility of contamination of the ground water by effluent from several pit toilets and from other waste discharges from the community's various buildings and facilities--the Park Service headquarters (office and shop), Interpretive Center, dwellings, and horse corral; three lodges (Swissmont Lodge, Stehekin Landing Inn, and Stehekin Lodge); several small cabins and trailers; and half a dozen private homes and a corral. Most of the residences and other buildings have individual septic tanks and drain systems, a few of which are only a short distance (20-200 ft) from the lakeshore and a few feet above lake level. In consideration of the foregoing conditions, test-drilling sites were selected at the general areas outlined in figure 8.



Site 1 was selected for its location near the lakeshore and near lake level, where access is favorable for a drilling rig and where the geologic conditions appear most favorable for avoiding the larger talus blocks higher on the cone. Also, the ground water here probably is in hydraulic continuity with the lake water, so that a dependable well-water supply is assured--that is, if the level in a well at this site is drawn down by pumping to substantially below lake level, water from the lake probably would be induced to move to the well. The sand and gravel through which the lake water would pass probably would filter out any bacteriological contamination that might be present in the lake water. Site 1 is downslope (lakeward) from the Park Service Interpretive Center (which serves also as a home for a park family) and therefore possibly is subject to contamination from that building's septic-tank effluent. However, if the well were drilled and cased to a depth of at least 30 feet below lake level, the possibility of bacteriological contamination from such landward sources would be diminished by infiltration through the overlying rock material.



Site 2 meets the same criteria as site 1 for ease of access and proximity to the lakeshore. However, it is about 45 feet above lake level and would require deeper drilling to reach water. As at site 1, the possibility of contamination from upslope septic-tank systems would be diminished by drawing the water from rock materials 30-40 feet below lake level. The principal advantage of this site over site 1 would be its proximity to higher ground, which would facilitate installation of a storage tank for a gravity-supply system.

Site 3, at an elevation of about 30 feet above lake level, is upslope from any nearby septic-tank system and therefore, of the three sites, would offer the least possibility of contamination by man's present (1971) activities and developments in the area.



## Bridge Creek Campground

The existing Bridge Creek Campground is situated on a relatively flat morainal bench about 80 feet higher than the Stehekin River, about one-quarter mile downstream from the junction of the river with Bridge Creek (fig. 9). A small stream, Clear Creek, crosses the campground, is bridged by the road, and descends sharply below the bench to the Stehekin River. Water for campground use is presently taken directly from Clear Creek at the campground. Water sampled from the creek on August 26, 1969, had a coliform count of 1 per 100 milliliters of water. On that date Clear Creek had a measured flow of 0.96 cfs (431 gpm) 300 feet above the road, and 1.16 cfs (521 gpm) 200 feet downstream from the road, indicating a gain of water in its flow across the bench. On June 15, 1971, the creek had a flow estimated to be about 6 cfs (2,700 gpm) at the road crossing.

The morainal material underlying the bench consists mostly of coarse cobbles and boulders, with some gravel and coarse sand. The flow measurements of Clear Creek (noted above) indicate that the morainal material contains ground water (at or above stream level) that contributes to the streamflow. On this assumption, a potable ground-water supply probably can be obtained from a relatively shallow dug or drilled well.



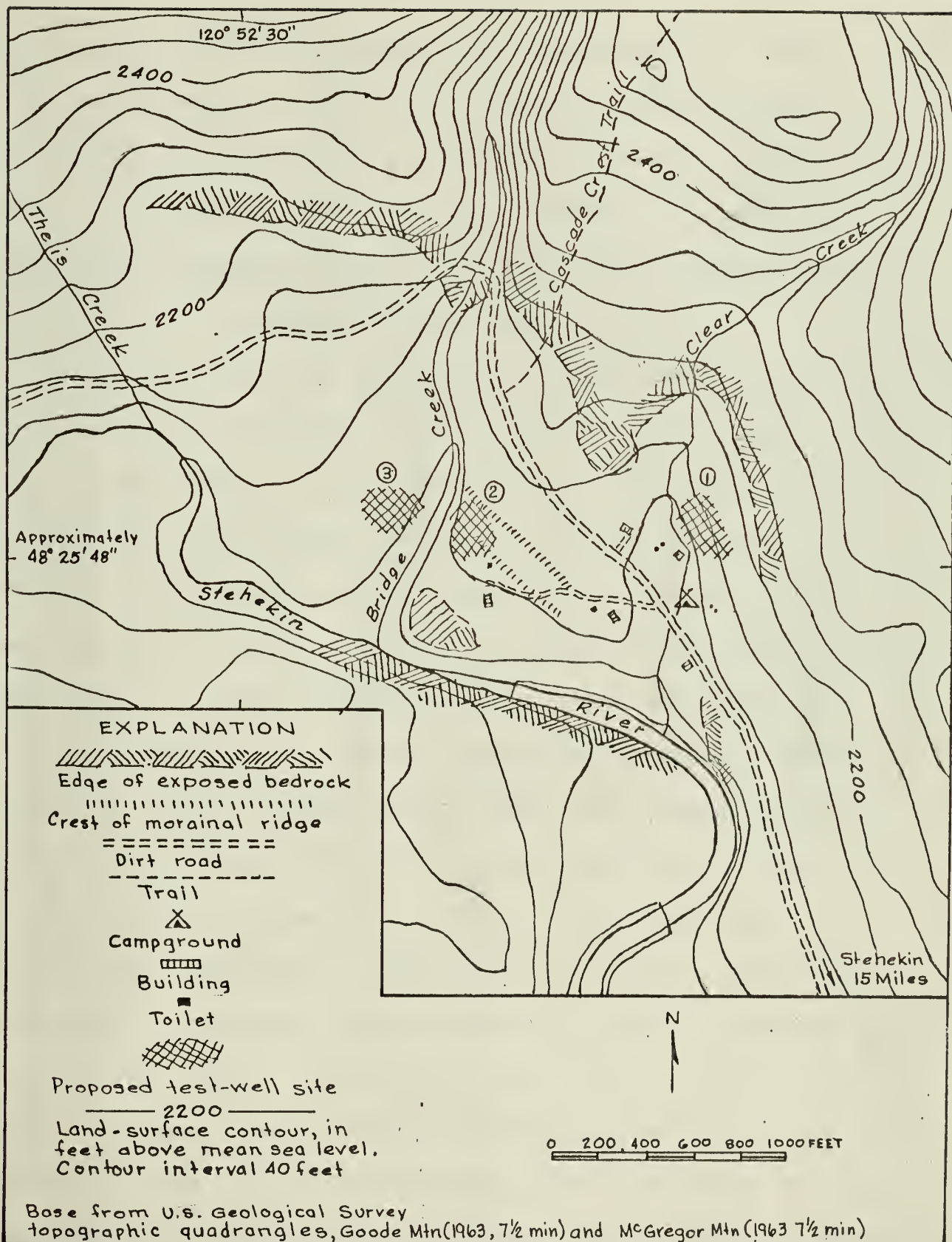


FIGURE 9. --Bridge Creek Campground and proposed test-well sites.



adjacent to the stream channel, and upslope and far enough from the existing pit toilets and proposed facilities to preclude the possibilities of contamination (site 1 on fig. 9). Water for campground use from such a shallow well could be obtained by handpump, should installation of electrical-power facilities be impractical in the immediate future.

Other well sites can be considered should an electrical-power source be available for operation of larger pumping facilities--through a local generator plant or an extension of powerlines from outside the area. As shown in figure 9, bedrock occurs at the surface along the hillside above the morainal bench, and also along the Stehekin River across from the bench. It forms isolated outcrops below the bench near the river and forms the channel containing several waterfalls below the bridge crossing Bridge Creek. The configuration of the bedrock surface beneath the morainal material is unknown except where it is observed at such outcrops, but test wells at the sites indicated in figure 9 probably would penetrate only the unconsolidated morainal cobbles, gravel, and coarse sand before reaching ground water at or slightly above the level of Bridge Creek. The morainal bench immediately east of Bridge Creek is 30-40 feet above creek level, hence drilling from the top of the bench in this area (site 2) probably would require penetrating that thickness of material to reach water.



Across Bridge Creek--within the triangle formed between the creek, Stehekin River, and the road--the morainal bench has a lower level extension which is nearer creek level. A small stream, Theis Creek (fig. 9), flows from the hillside above this area and crosses the western edge of the bench before joining the Stehekin River. At the road culvert this creek had a flow of 0.14 cfs (63 gpm) on August 26, 1969, and a flow estimated to be about 0.50 cfs (225 gpm) on June 15, 1971. For a ground-water supply on this bench, where the campground might be extended in the future, water probably can be obtained by a relatively shallow well at site 3 (fig. 9), although in most places the bench is composed of large cobbles and angular boulders which would make digging or drilling difficult. Selection of a site for a permanent supply well should include an evaluation, based on the best available projections of use and plans for specific facilities, of the possibility of contamination from toilets or garbage pits in the area, and also of the possibility of being endangered by high flows of the Stehekin River.





