Reconnaissance of Water Resources in the Haines-Port Chilkoot Area, Alaska

GEOLOGICAL SURVEY
CIRCULAR 626

Prepared in cooperation with the city of Haines and the city of Port Chilkoot

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Figure 1.—Index map showing location of the Haines-Port Chilkoot area.

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INTRODUCTION

This report summarizes an investigation made by the U.S. Geological Survey in cooperation with the cities of Haines and Port Chilkoot. Most of the fieldwork was done in 1966 and 1967. The study was made to determine the availability of surface water and ground water, the source and movement of ground water, and the potential sources of additional water. During this investigation, data were collected on present sources and use of water, on wells, on public-supply and distribution systems, on water-bearing properties of geologic units, and on water quality.

Most water in 1967 was provided by the city water systems from springs and surface sources. These sources are inadequate to meet increasing demand for water. The emphasis of this project was placed accordingly on locating a ground-water supply. There are few wells in the area and consequently ground-water data were sparse. Exploratory auger drilling was the principal method used to obtain new ground-water data. In addition, surface-water supplies were inventoried and water samples were collected for chemical analysis.

The assistance of everyone in the area is gratefully acknowledged, especially that of Mayor Novak of Haines and Mayor Heinmiller of Port Chilkoot. Special acknowledgments are also due R. W. Lemke and L. A. Yehle, Geologic Division, U.S. Geological Survey, for providing advance maps, seismic profiles, and geological and geophysical data from their concurrent geologic study of the investigation area.

In this report, data points are identified by the numbers shown in figure 5. Table 1 contains additional numbers, similar to D30–59–15daa, which are file numbers that are used by the U.S. Geological Survey and that indicate the location of the data point within the township, range, and section; their use is not required by the reader of this report unless additional data are needed.

DESCRIPTION OF THE AREA

The Haines-Port Chilkoot area is located between Chilkat and Chilkoot Inlets at the northern end of the Chilkat Peninsula in southeast Alaska (fig. 1). This 32-square mile area is 159 miles south of the Alaska Highway at Haines Junction, Yukon Territory, and is at the southern terminus of the Haines Highway. Other means of transportation serving these communities include the State of Alaska ferry system and commercial airlines from Juneau. The principal industries are lumbering, fishing, and tourism.

The climate at Haines, as in all southeast Alaska, is dominated almost entirely by maritime influences. Precipitation at Haines averages about 40 inches per year, frost-free days average about 140 per year, and the mean maximum January temperature is about 12°F (-11°C).

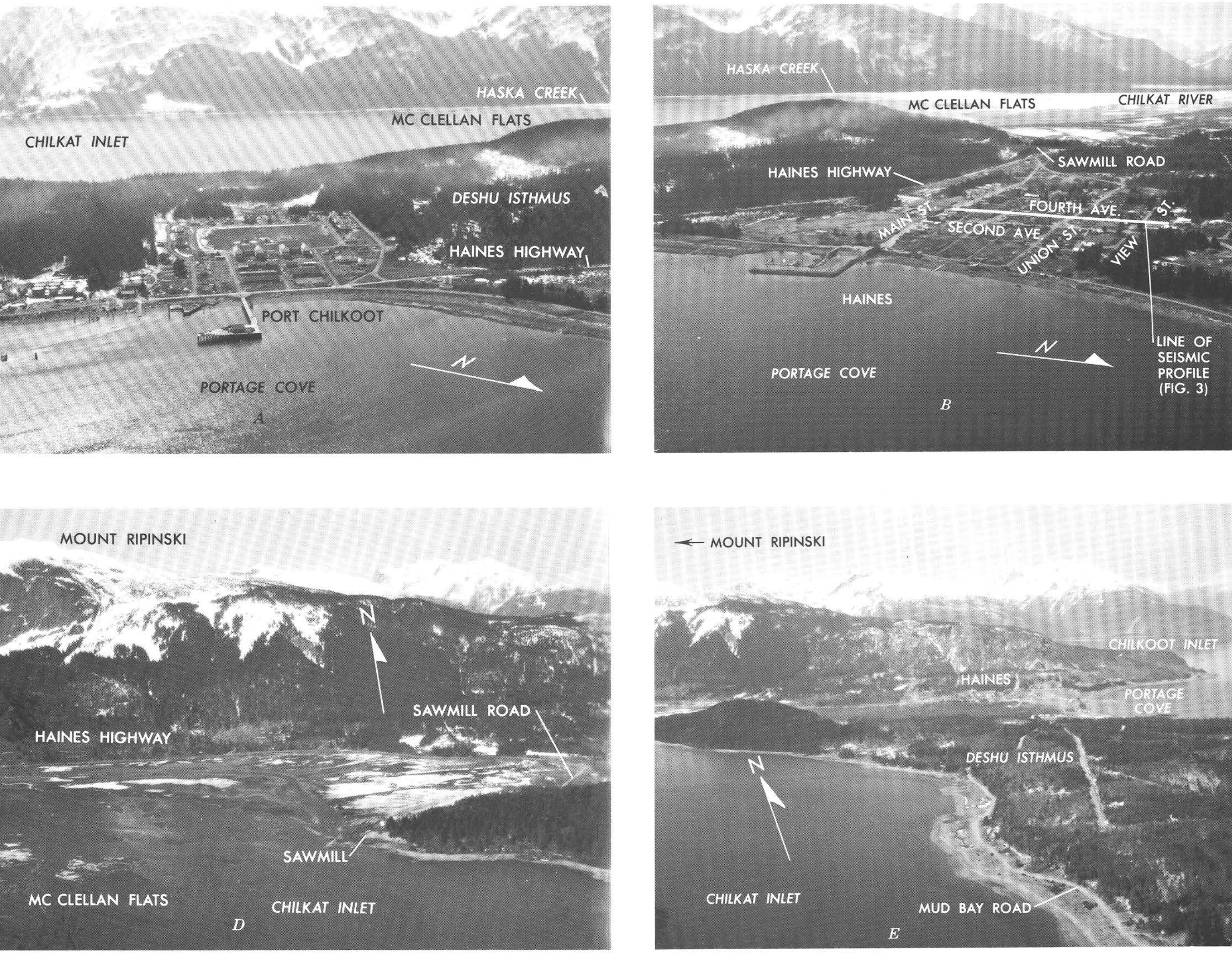


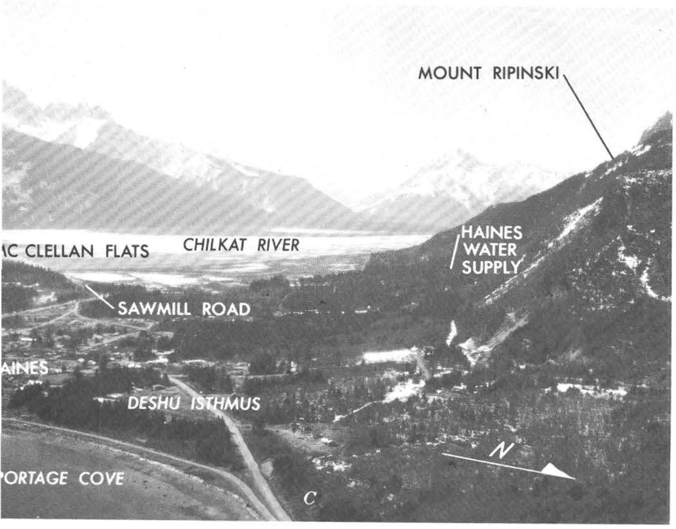
Figure 2.—Photographs of the Haines-Port Chilkoot area. Photographs *A*, *B*, and *C* form a panoramic view of the area taker
and *F* form a similar viev

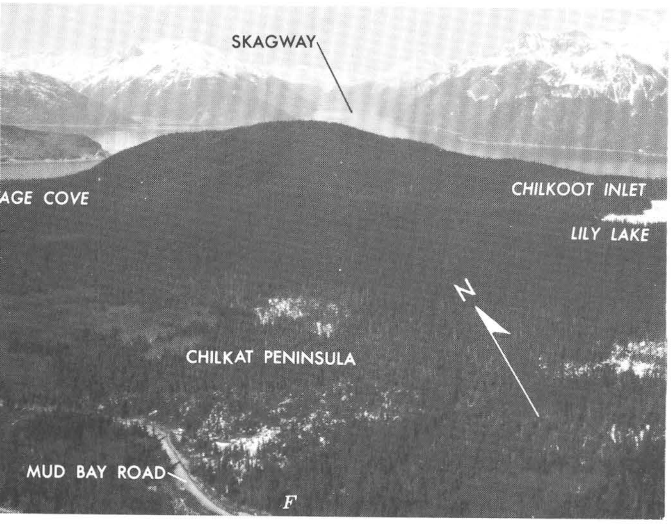
Significant geographic features and landmarks mentioned in the report are shown by the six photographs (fig. 2) taken in mid-May 1967.

GEOLOGY

Early geologic investigations near Haines were made by Knopf (1910) and by Eakin (1919); more recent investigations have been made by Barker (1952), Robertson (1956), and Munson (1962). The mapping of previous investigations and the preliminary work of R. W. Lemke and L. A. Yehle, (unpub. data, 1969) were useful in evaluating the water-bearing properties of geologic units.

Bedrock composed of metamorphic rocks of Mesozoic age underlies the entire area, although sedimentary rocks of Tertiary age may also be present at depth (R. W. Lemke and L. A. Yehle, unpub. data, 1969). Robertson (1956) mapped bedrock units consisting of metabasalt, pyroxenite, tonalite (quartz diorite), and diorite. He also mapped some slate and limestone on the





om about 1,000 feet above Chilkoot Inlet; photographs *D, E,* ken above Chilkat Inlet.

Chilkat Peninsula. A seismic profile of Haines was prepared by R. A. Farrow and E. E. McGregor in Lemke and Yehle (unpub. data, 1969). They determined that the depth to bedrock is approximately 600 feet at the deepest point near Fourth Avenue and Main Street. Two hypothetical faults were indicated in the area as shown in figure 3. Bedrock in the Haines-Port Chilkoot area is not a good source of ground water because it is very dense. Ground water occurs in the fractures that store relatively small quantities of water and consequently yield only small quantities to wells.

Surficial deposits, which constitute the best aquifers in the area, are composed of sand, gravel, and cobbles interbedded with clay, silt, and other fine-grained sediments. These unconsolidated sediments are of Quaternary age, though they may be Tertiary in part. The extent of surficial deposits near Haines was determined by several events in a complex geologic history. The area is adjacent to the Chatham Strait fault, which parallels the Chilkat Inlet. Brew, Loney, and Muffler, (1966, p. 167) concluded that horizontal movement on this fault has been as much as 50 miles. The geologic framework was established by faulting and later modified by glaciation; the result was a deep valley at the present location of Haines. That valley was subsequently filled with glacial outwash, marine clay, beach deposits, alluvium, and slope wash. Faulting during late Pleistocene or Holocene time caused displacement of the surficial deposits as shown in figure 3. However, all surface evidence of Pleistocene or Holocene faulting has been destroyed by erosion. Deglaciation has caused a regional uplift of about 1 foot each 13 years at Haines during the last half century (Hicks and Shofnos, 1965). This uplift is probably indicated by raised beach deposits along Portage Cove.

PRESENT WATER SUPPLY

HAINES

Haines obtains water from a creek, two springs, and an old mine tunnel near the base of Mount Ripinski, which is northwest of town (fig. 5). A few homes in northeast Haines receive their water supply from Johnson Creek. The main supply is generally adequate for present needs, although water shortages occur during dry periods in summer or cold periods in winter. Winter shortages are intensified as a result of allowing taps to run to prevent freezing. Although the municipal water-supply system did not freeze during the winter of 1966–67, it is reported to have frozen in some previous winters. Chemical quality of the water is generally acceptable. Results of a chemical analysis of a composite sample from the city

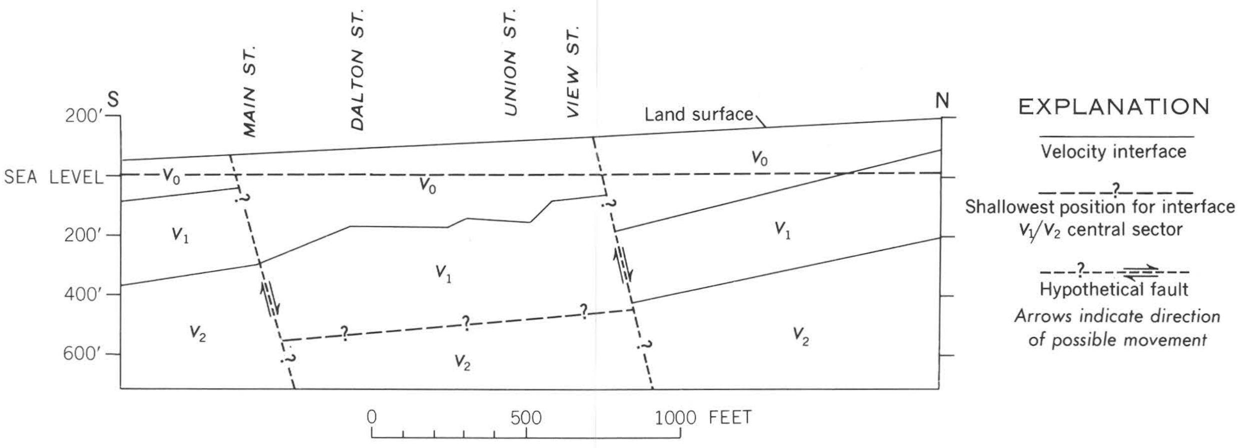


Figure 3.—Seismic profile along Fourth Avenue, Haines. From R. A. Farrow and E. E. McGregor in R. W. Lemke and L. A. Yehle (unpub. data). Location of profile shown in figure 5.

V_0 = 5,1000–6,250 fps (feet per second) velocity. Possibly bedded clay, gravel, and gravelly sand, silt and clay.

$V_1 \approx$ 10,500 fps velocity. Possibly indurated glacial drift (?) or soft rock (?) with some hard rock and clay seams.

V_2 = 24,350 fps velocity. Bedrock.

supply are shown in table 2 (sample 41). Water resources of the area were briefly discussed by Cederstrom (1952).

Mr. J. C. Fox, consulting engineer, Haines, (written commun., 1957) determined the flow available to the system between June 11 and 15, 1957, by using a V-notch weir. His results are as follows:

	Gallons per hour
Creek (unnamed)	780
West Spring	2,000
Center Spring	720
Meyers Tunnel	3,720
Total	[1]7,220

[1]120 gallons per minute.

At the time of Mr. Fox's measurements, only 87 gpm (gallons per minute) of the 120 gpm available were taken into the system; 60 of the 87 gpm were unused and overflowed at the tank. Weather records and other streamflow records indicate that the period June 11–15 were days of high runoff. Therefore the reported quantities are more than could be expected at times of low flow. Mr. Fox stated that about 500 gpm could ultimately be developed by collecting all streamflow within about 3,600 feet of the present sources.

Haines obtained supplemental water from Port Chilkoot until the Haines system was completed in 1952. The Haines system presently provides water to about 600 people. Although there are no meters on the system, present demand may average 60,000 gpd (gallons per day).

PORT CHILKOOT

The present source for water at Port Chilkoot is Lily Lake about 2½ miles southeast of town. The system was constructed by the U.S. Army and very few records are available. This source of water is adequate, but the intake facilities and the pipeline between the lake and town are reportedly in poor condition (J. J. Millegan and Associates, written commun., Aug. 19, 1965). Lily Lake is in a muskeg area which causes the water to be discolored and to have a poor taste.

Haska Creek, across the Chilkat Inlet, from Chilkoot, was used for water supply by the U.S. Army, Corps of Engineers for a short period during the 1930's. Water was transported across the Chilkat Inlet in a pipeline held above ground level and water level by wooden supports, but this system became obsolete. Haska Creek is not considered as a source of additional water because of problems involved in constructing and maintaining a pipeline across the Chilkat Inlet. Analysis of water from Haska Creek (sample 43, table 2) indicated that the water quality is very satisfactory. The creek reportedly flows all year.

Port Chilkoot, in one of several attempts to solve its water problems, drilled a test well to a depth of 110 feet in 1960 (Waller and Tolen, 1962). This test well (well 32, fig. 5) was reportedly drilled into "egg-sized water-bearing gravel," but was never developed and tested. Measurements reveal that the lower 6 feet of the test well are filled with sand or mud. If this well were completed, developed, and tested, it might be used to determine the water-bearing properties of rocks underlying the area; it might prove to be an adequate source of water to meet the present needs of Port Chilkoot. Water obtained from the test well is of good chemical quality (table 2, sample 32). Geophysical logs were made by the U.S. Geological Survey, but further testing of this well was beyond the scope of this investigation.

HYDROLOGY

SURFACE WATER

Surface water is water moving in streams or stored in lakes and glaciers. It is closely related to ground water; thus, intensive development of one often adversely affects the other. In the Haines-Port Chilkoot area, surface water consists of the Chilkat River, its tributaries, a few small streams that flow directly into the Chilkat and Chilkoot Inlets, and Lily Lake. Surface water constitutes a major part of the present water supply for both communities.

A partial inventory of surface-water resources was made on April 21, 1967. The discharges of the creek crossing Sawmill Road and of Haska Creek were measured; all other stream discharges were estimated. Results of the measurements and estimates of the surface flow were:

	Cubic feet per second	*Gallons per minute*
Unnamed creek crossing Sawmill Road.	10.2	4,570
Haska Creek	3.1	1,390
Unnamed creeks crossing State Highway 7 between Haines and mile 4 (total flow).	1.3	580
Unnamed creeks crossing Lutak Road between Haines and mile 3 (total flow).	1.3	580

The streams vary greatly in discharge and respond quickly to precipitation and snowmelt. Most of them are not significantly affected by ground-water discharge, although an exception might be the creek crossing Sawmill Road. The above discharges are probably representative of late winter low flow of these streams. However, no previous records are available for comparison and there are no nearby stream-gaging stations for use in interpreting the long term significance of the measurements. If an expanded surface-water supply is proposed, a stream gaging station should be installed on the creek crossing Sawmill Road. Such a station could determine the long-term low-flow characteristics of streams in the area.

GROUND WATER

Ground water is water that fills openings in the rocks of the earth's crust and that thus forms a saturated zone. Where ground water is unconfined, the water table is free to move upward or downward as water is added to or removed from the zone of saturation. Where ground water is confined by overlying less permeable materials, water rises in wells that penetrate the confining stratum and may even flow from the well. When water is withdrawn from an unconfined or water-table aquifer, a cone of depression is formed adjacent to the well. When water is withdrawn from a confined or artesian aquifer, a cone of depression is formed in the pressure surface; the aquifer is not dewatered immediately but may be dewatered with time. The cone of depression resulting from water withdrawal from an unconfined aquifer is local in extent and enlarges slowly; withdrawal of water from a confined aquifer affects a much larger area—the cone of depression enlarges rapidly. With continued withdrawal, an artesian system gradually becomes a water-table system. Both types of aquifer systems are found in the Haines-Port Chilkoot area. Sand and gravel constitute the aquifers; clay or silty sand constitutes the confining beds. It is conceivable that a well may receive water from several artesian aquifers, because the sediments are interbedded.

Ground water and surface water are closely related; surface water can be made to flow from a stream or lake through the ground to a nearby

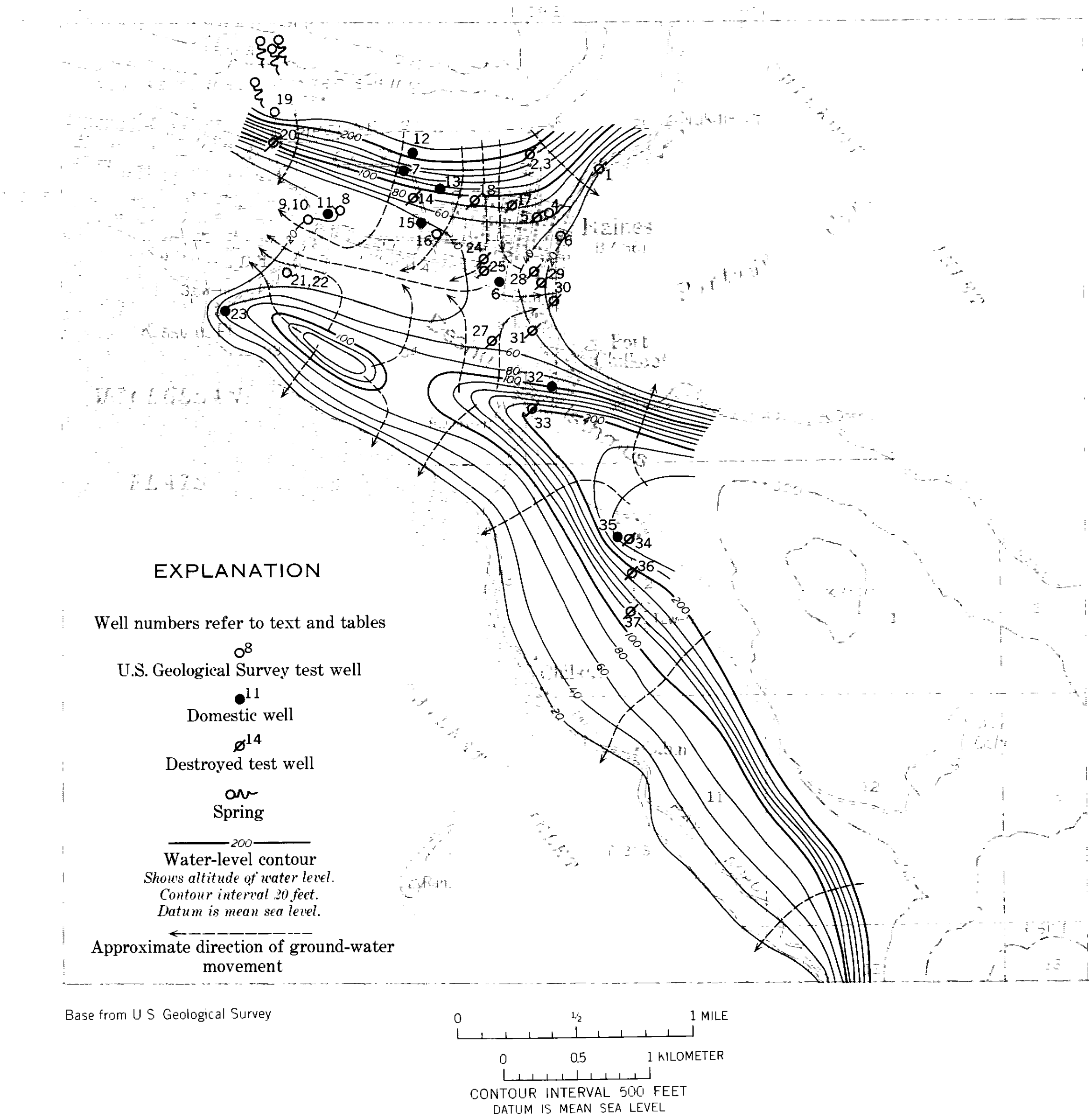


Figure 4.—Generalized water-table contours and direction of ground-water movement.

well. This process is known as induced infiltration. This relationship is often utilized to make use of the natural filtering properties of sand and gravel that are near a stream. Large withdrawals from this type of system could cause the surface-water source to dry up.

Ground water moves down the hydraulic gradient, which approximately parallels the slope of the land surface. Figure 4 shows generalized water-level contours and the direction of ground-water movement in the area. Movement is generally perpendicular to water-level contours. Ground water moves relatively rapidly through clean well-sorted sand and gravel; it moves slowly through silty sand or clay, which may constitute confining layers. All ground water near Haines is derived locally and is thus directly related to precipitation. The slopes northwest and southwest of town are the principal recharge areas. Most ground water in the area moves down the valley west of Haines, although some also moves into Portage Cove. The areal extent and storage capacity of all aquifers near Haines are small. The generally low concentrations of dissolved mineral constituents suggest that water is in the ground for a relatively short time and that the rocks are not readily soluble.

Test drilling was required during the study because few wells had been drilled in the area and well records were not available. Eleven test wells were augered in 1966 and 15 in 1967. Locations of all test wells and selected domestic wells are shown in figure 5; descriptions are given in table 1. Pipe casings were installed to permit geophysical logging and observation of water levels. The test wells were cleaned out by pumping air or water into the well. Water was then pumped from the well and a sample collected for quality-of-water analysis. The geophysical logs and other records are on file, as noted in table 1, in the Juneau office of the Water Resources Division. It was not possible to determine hydraulic characteristics of the aquifers because the test wells were small in diameter, and because no large-capacity wells were available for test pumping.

QUALITY OF WATER

Chemical quality of water in the Haines-Port Chilkoot area is summarized in table 2. In general, the water is of the calcium bicarbonate type and is suitable for most uses. Some water in the area is moderately hard. The main problem caused by hard water is the scum formed as the water reacts with soap. Most hardness can be removed from water by simple treatment. Treatment commonly consists of passing the water through a chemical chamber that exchanges harmless sodium ions for calcium and magnesium ions that cause water to be hard.

The chemical quality of ground water at Haines and Port Chilkoot for the most part meets the standards for potable water recommended by the U.S. Public Health Service (1962). Standards for some of the chemical constituents are listed in the following table, which shows recommended limits for public water supply.

Constituent	*Concentration in milligrams per liter*
Iron	0.3
Chloride	250
Nitrate	45
Sulfate	250
Dissolved solids[1]	500

[1]1,000 mg/l (milligrams per liter) permitted if no other supply is available. The quality of water in the study area was evaluated in accordance with these standards.

Excessive iron (more than 0.3 mg/l) was noted in only four samples. It is surprising that three of these are from surface-water sources. High iron content is often found in ground water from surficial deposits, but surface water generally does not contain excessive iron.

Excessive chloride (more than 250 mg/l) was noted only in water from test well 22 (22 feet deep), which had 1,050 mg/l, but water from test well 21 (72 feet deep and about 10 feet away) contained 198 mg/l chloride. High

Table 1.—*Records of wells*

Map distance: Scaled from the southeast corner of section (fig. 5).
Depth of well: Reported depth or log depth (cased depth in parentheses) below land-surface datum.
Diameter of casing: N, not cased.
Use of water: Com, commercial; D, domestic; E, emergency or standby; Ind, industrial; N, none; O, observation; TW, test well.

Well	File	Map distance North (feet)	Map distance West (feet)	Owner or user	Year completed	Depth of well (feet)
1	D30–59–26cac	1,575	3,625	Alaska Highway Commission	1966	14
2	26cbc	1,830	5,000	Tom Ward	1966	9
3	26cbc2	1,850	5,150	do	1966	18
4	26ccc	600	4,775	City of Haines	1967	82 (50)
5	26ccc2	475	5,125	do	1966	19
6	26ccd	25	4,425	John Schnabel	1966	64 (35)
7	27cad	1,525	2,700	Ed Alex	1957	60
8	27cca	700	4,200	Alaska Highway Commission	1967	97 (92)
9	27ccc	400	4,900	City of Haines	1967	97 (95)
10	27ccc2	400	4,890	do	1967	45 (43)
11	27ccd	525	4,450	Cliff Reeves	1960	60
12	27dbc	1,900	2,125	Dr. Stan Jones	1964	64
13	27dca	1,050	1,950	Tom Helms	1943	284
14	27dcb	1,000	2,600	R. E. Henderson	1967	95
15	27dcc	400	2,300	Alaska Highway Commission	1943	123
16	27dcc2	50	2,100	do	1966	87 (35)
17	27dda	750	350	City of Haines	1966	67 (17)
18	27ddb	925	1,200	do	1967	99
19	28add	2,875	500	do	1967	25
20	28daa	2,100	575	do	1967	10
21	33aad	4,325	260	do	1967	92 (72)
22	33aad2	4,325	250	do	1967	32 (22)
23	33aca	3,450	1,600	Alaska Forest Products, Inc.	1966	120
24	34aac	4,525	975	Haines-Port Chilkoot School District	1966	21
25	34aac2	4,425	1,000	do	1966	67 (63)
26	34aad	4,025	625	Alex Chevron	1959	64
27	34adc	2,750	775	City of Port Chilkoot	1967	40
28	35bbc	4,250	5,100	Presbyterian Mission	1966	34
29	35bbc2	4,000	4,950	City of Haines	1966	87
30	35bcb	3,650	4,625	do	1966	50
31	35bcc	2,925	5,050	Presbyterian Mission	1966	31
32	35cbd	1,775	4,600	City of Port Chilkoot	1960	105
33	35ccb	1,125	5,150	do	1967	30
34	D31–59–2bda	3,550	3,100	Federal Aviation Agency	1967	22
35	2bdb	3,600	3,300	do	1953 (?)	17.6

Depth to water: Given in feet and tenths below or above (+) land surface.
Altitude of land surface: All altitudes are barometric and are given in feet above mean sea level.
Remarks: GS, U.S. Geological Survey test well; L, log or well available; D, destroyed; Sh, shothole; Sp, sand point; QW, determination of water quality given in table 2; Gp, geophysical log on file at Federal Building, Juneau, Alaska.

Diameter of casing (inches)	Use of water	Depth to water	Altitude of land surface	Date of measurement	Remarks
N	TW	-------------------	20.0	--------------	GS, L, D
N	TW	Dry	180.0	2–28–66	GS, L, D, Sh
N	TW	Dry	180.0	2–28–66	GS, L, D
2	TW, O	12.35	82.0	4–15–67	GS, L, Sp, QW, Gp
N	TW	Dry	117.0	3– 2–66	GS, L, D
2	TW, O	Flow	30.0	4–24–67	GS, L, Sp, QW, flow ½ gpm.
6	D	Flow	170.0	1967	QW
2	TW, O	+3.2	32.0	4–15–67	GS, L, Sp, QW, Gp
2	TW, O	Flow	27.0	4–15–67	GS, L, Sp, QW, flow ½ gpm.
2	TW, O	2.55	27.0	4–15–67	GS, Sp, QW, Gp
8	N	Flow	22.0	4–27–67	QW, flow ¼ gpm.
6	D	Flow	215.0	1964	QW
8	N	0.00	92.8	5– 2–67	L, QW, Gp, pumped 16 gpm.
N	TW	-------------------	100.0	--------------	GS, L, D
8	N	13 (reported)	40.0	1943	L, D, pumped 35 gpm, reported salty.
2	TW, O	4.52	37.0	4–22–67	GS, L
1.6	TW	-------------------	85.0	--------------	GS, L, D
N	TW	-------------------	87.0	--------------	GS, L, D
2	TW, O	7.25	244.0	4–15–67	GS, L
N	TW	Dry	140.0	4–11–67	GS, L, D
2	TW, O	4.50	22.0	4–15–67	GS, L, QW, Gp
2	TW, O	5.80	22.0	4–15–67	GS, L, QW
6	Ind	Flow	25.0	1966	QW, electric submersible pump.
2	TW	-------------------	42.0	--------------	GS, L, D, Sh
2	TW, O	-------------------	41.0	--------------	GS, L, D (1967), chloride = 300 mg/l. Iron = 0.8 mg/l, hardness = 242 mg/l.
6	Com	Flow	52.0	1967	QW
N	TW	-------------------	102.0	--------------	GS, L, D
N	TW	-------------------	57.0	--------------	GS, L, D
N	TW	-------------------	52.0	--------------	GS, L, D
N	TW	-------------------	33.0	--------------	GS, L, D
N	TW	-------------------	52.0	--------------	GS, L, D
8	N	14.95	99.0	4–24–67	L, QW
N	TW	Dry	202.0	4– 3–67	GS, L, D
N	TW	-------------------	251.0	--------------	GS, L, D
48x48	D, E	1.0	245.0	4–22–67	QW, electric centrifugal pump.

Table 1.—*Records of wells*

Well	File	Map distance North (feet)	Map distance West (feet)	Owner of user	Year completed	Depth of well (feet)
36	2bdd	2,750	3,000	Federal Aviation Agency	1967	3
37	2cad	1,950	3,050	do	1967	58

Table 2.—*Quality-of-water analyses from*

Sample (well or gaging site)[1]	Date of collection	Source	Depth of well (feet)	Temperature (°F)	Temperature (°C)	Iron (Fe)[2]	Calcium (Ca)[2]	Magnesium (Mg)[2]	Bicarbonate (HCC_3)[2]	Sulfate (SO_4)[2]
4	4–10–67	Aluvium	51	40	4.5	0.07	32	4.9	103	28
6	3–12–66	do	64	------	-----	.04	28	10	102	33
7	4–30–67	do	60	------	-----	.10	40	6.1	40	76
8	4–10–67	do	92	40	4.5	.05	120	26	71	320
9	4– 6–67	do	95	41	5.0	.03	44	13	116	37
10	4– 6–67	do	43	------	-----	.20	30	7.3	190	30
11	12– 5–60	do	60	42	5.5	.18	51	9.3	111	98
12	3–14–66	do	64	------	-----	.00	118	4.5	93	232
13	5– 2–67	do	284	------	-----	.20	88	3.6	91	175
21	4–14–67	do	72	42	5.5	.02	32	24	169	60
22	4–27–67	do	22	40	4.5	.00	20	2.9	70	5.0
22	4–13–67	do	32	40	4.5	.05	44	80	421	36
22	4–13–67	do	32	40	4.5	.05	52	66	386	28
22	4–13–67	do	22	39	4.0	.02	20	2.4	71	4.0
23	7–25–67	do	120	------	-----	.05	260	8.5	94	520
26	3– –67	do	64	------	-----	.02	15	17	116	30
32	3–14–67	do	105	------	-----	.38	8.8	4.9	39	11
35	4–22–67	do	18	41	5.0	.05	4.0	2.4	22	2.0
[4]38	7– 5–61	Chilkat River	-------	------	-----	.03	8.0	1.2	26	6.0
40	4–21–67	Johnson Creek	-------	34.5	1.5	.02	24	2.4	65	14
41	4–15–67	Haines Public supply.	-------	------	-----	.02	42	6.1	58	62
42	4–27–67	Creek crossing Sawmill Road.	-------	34	1.5	.60	11	1.8	27	16
[4]43	4–21–67	Haska Creek	-------	33.5	1.0	.03	22	3.6	63	28
44	12– 6–60	Port Chilkoot public supply.	-------	------	-----	.74	15	2.6	38	19
45	--------------	Tank Farm supply.	-------	------	-----	3.21	28	.0	64	25

[1]Sample numbers (4–35) are identical to well numbers on table 1; numbers 40–45 refer to surface-water or public-supply samples.

[2]Constituents given in milligrams per liter.

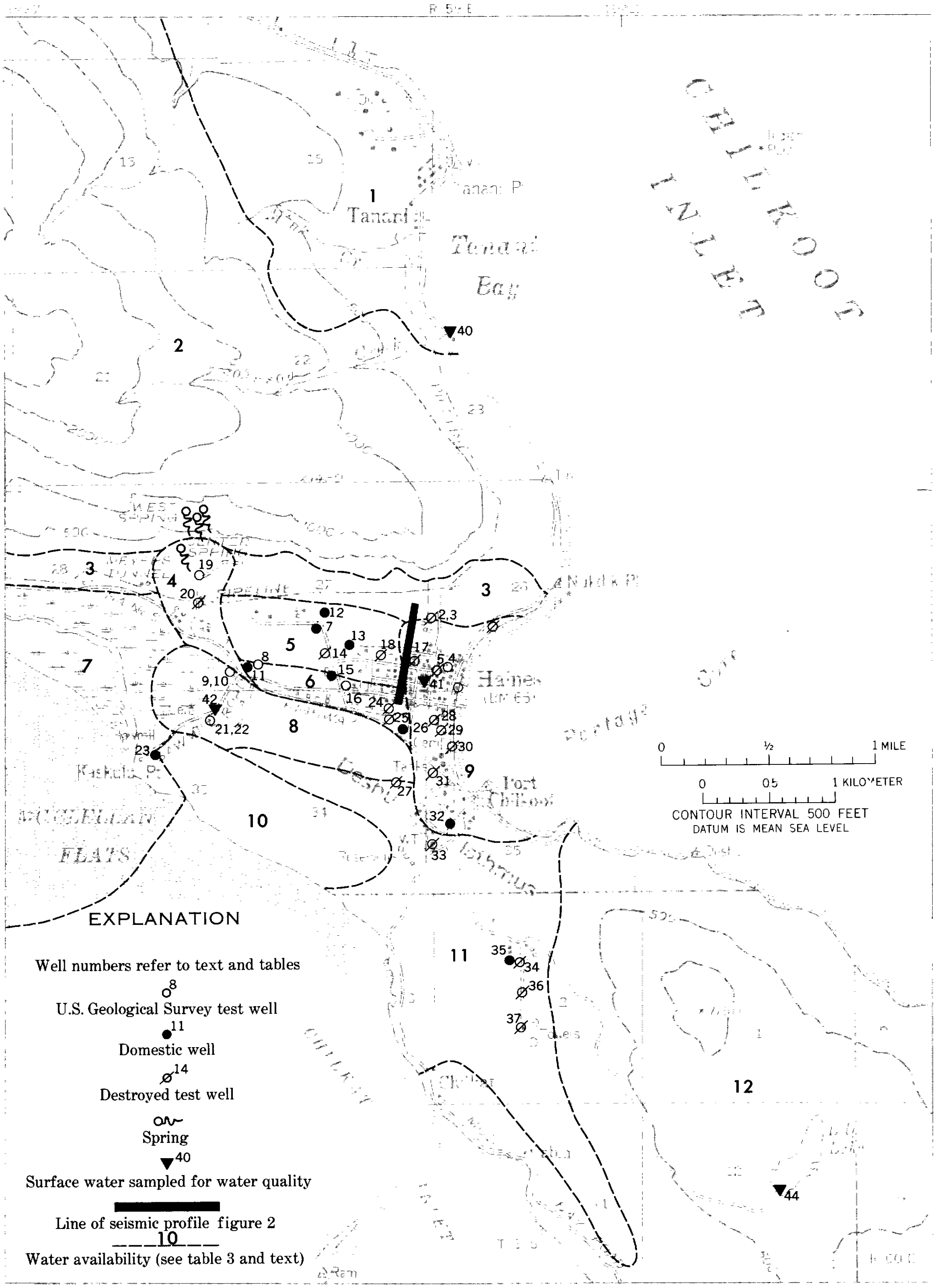
near Haines, Alaska—Continued

Diameter of casing (inches)	Use of water	Depth to water	Altitude of land surface	Date of measurement	Remarks
N	TW	-------------------	183.0	--------------	GS, L, D
N	TW	-------------------	127.0	--------------	GS, L, D

wells and streams near Haines, Alaska

Chloride (Cl)[2]	Fluoride (F)[2]	Nitrate (NO_3)[2]	Hardness[2] as $CaCO_3$		Specific conductance (micromhos at 25°C)	Total dissolved solids[2]	pH	Remarks[3]
			Calcium magnesium	Non-carbonate				
6.0	0.2	0.1	100	16	300	140	7.9	
5.0	.1	.2	112	28	255	145	7.9	ADF (8837).
7.0	.1	.1	125	92	275	179	6.8	
9.0	.4	.2	407	349	950	524	7.1	
5.0	.2	.1	164	19	350	170	7.6	
14	.2	2.1	105	.0	450	251	7.2	
6.0	.0	.0	165	74	383	253	7.9	ADF (6359).
3.9	.1	.1	313	237	600	421	7.7	ADF (8838).
4.0	.1	.0	235	160	600	340	7.9	
198	.5	.1	179	40	1,020	543	7.3	
6.7	.0	.6	62	5	138	82	7.0	ADF (10130); aresnic 0.00.
1,050	.45	.2	439	94	3,550	2,030	7.9	After 1 hr., pump at 32 ft.
950	.5	.4	400	84	3,300	1,900	7.8	After 2 hrs., pump at 32 ft.
10	.2	.2	60	2.0	160	80	7.3	After 1 hr., pump at 22 ft.
3.0	.2	.2	684	607	1,200	877	7.6	
60	.1	.1	107	12	442	246	7.7	ADF (8836).
7.4	.1	.2	42	8	126	63	8.4	ADF (8839).
2.0	.1	.1	20	2	50	27	6.0	
1.0	.1	.1	25	4	57	35	7.0	ADF (6731); sec. 29, T. 28 S., R. 56 E.
5.0	.1	1.1	70	17	160	86	7.6	
5.0	.2	.2	165	83	300	157	7.4	
3.9	.1	.4	35	13	89	56	6.8	ADF (10129); arsenic 0.00.
2.0	.1	.2	70	19	170	101	7.3	Sec. 6, T. 31 S., R. 59 E.
6.0	.0	.0	48	17	113	72	7.2	ADF (6360).
2.8	.5	1.2	71	46	201	89	8.1	ADF (8725); sec. 9, T. 30 S., R. 59 E.

[3]ADF ( ) = Additional data in files for laboratory analysis indicated.
[4]Sample locations that occur off map are not shown.



Base from U S Geological Survey

Figure 5.—Location of wells and sample sites and delineation of areas of ground water availability.

chloride is possibly caused by salt water from McClellan Flats and represents water from the underlying salt-water wedge near the interface. It might also be caused by trapped sea water that has not been completely flushed since uplift. Regardless of which is true, only moderate pumping from the 72-foot depth in test well 21 would cause rapid deterioration of water quality.

Nitrate may be an index of decaying organic material; thus, nitrate provides a check on water pollution. The recommended limit of nitrate concentration (NO_3) is 45 mg/l. All samples had less than 2.1 mg/l, which indicated that contamination was not a problem in 1967.

Excessive sulfate (more than 250 mg/l) was noted only in wells 8 and 23. The effect of sulfate (SO_4) in water has not been studied in detail; its presence may have a laxative effect on humans (Hem, 1959, p. 239).

Large concentrations of total dissolved solids (more than 500 mg/l) were noted in four wells, but only well 22 had excessive total dissolved solids (more than 1,000 mg/l). Total dissolved-solids content is directly related to electrical conductivity. Study of the 18 ground-water samples from Haines-Port Chilkoot indicates that total dissolved-solids content is about 65 percent of the conductivity expressed as micromhos per centimeter at 25°C. Thus the approximate concentration of total dissolved solids can be computed after the conductivity has been measured. Because the ratios between ions are rather consistent, a rough chemical analysis can alsobe computed.

Temperature of ground water in the area ranged from 4° to 6°C. Surface water at the same time (late April 1967) was about 1°C. Even though the temperature differential is only 4° to 5°C, advantages of the warmer water are obvious.

Near Sawmill Road, ground-water quality changed considerably with depth in the same well. For example, water containing about 2,300 mg/l total dissolved solids was obtained from well 22 at 31 feet. When the well point was raised to 21 feet, the yield was increased and dissolved solids were reduced to about 100 mg/l. The poor-quality water is associated with fine sediments of low permeability that were probably deposited in a bog or lagoon. Hydrogen sulfide and an associated oily substance found in water in well 27 also indicate that poor-quality water can generally be expected from fine-grained sediments. In similar circumstances wells should be constructed and pumped with caution. Wells should not be perforated opposite such fine-grained materials or pumped at rates that would induce flow of water from these zones.

POTENTIAL SOURCES OF ADDITIONAL WATER

The most obvious source of fresh water in the Haines-Port Chilkoot area is the Chilkat River. It is nearby, has a dependable flow, and generally has satisfactory chemical quality; however, the river contains glacial flour or suspended silt that causes a milky appearance and which is difficult to remove. The creek that crosses Sawmill Road near the north edge of Haines has adequate flow for projected needs during most of the year, but it is discolored with organic material. Other creeks in the area do not have adequate water for dependable public supply. Surface water might be imported by pipeline from outside the area, but the cost would probably be prohibitive. Investigation of such sources was beyond the scope of this study. The author concludes that ground water will be the best source of additional water in the area.

Table 3 summarizes the availability of ground water near Haines and Port Chilkoot. Yields shown in table 3 are the maximum expected from a properly constructed well. Water is probably not available in significant quantities from the bedrock. Large quantities are probably available from the surficial deposits in only a few areas.

Table 3.—*Summary of ground-water availability in the Haines-Port Chilkoot area, Alaska*

Area (fig. 5)	Geologic summary	Present development	Ground-water potential in surficial deposits[1]
1	Thin surficial deposits over bedrock.	No wells, no test wells.	As much as 25 gpm (possibly more near Mink Creek).
2	Isolated surficial deposits over bedrock.	do	Less than 5 gpm; generally drained or thinly saturated.
3	Slide and slopewash or glacial deposits over bedrock.	No wells, two test wells.	As much as 25 gpm; composed of poorly sorted material containing many boulders.
4	Alluvial fan and slopewash deposits over bedrock.	do	As much as 50 gpm; poorly sorted material with perched water.
5	At least 100 feet of clay overlying a few hundred feet of unknown sedimentary rocks which overlie bedrock.	Three wells, two test wells.	No yield upper 100 feet. Less than 100 gpm from lower sediments.
6	Similar to area 5 except that clay might be thinner because of possible faulting and subsequent erosion.	Three wells, four test wells.	No yield upper 50 feet. Less than 100 gpm from lower sediments.
7	Thick surficial deposits over bedrock; tidal flats in part.	One well, no test wells.	As much as 100 gpm; quality of water may be poor.
8	Glacial outwash, beach deposits, or younger alluvium in eroded channel; thick upper clay of areas 5 and 6 has been eroded.	No wells, four test wells.	As much as 500 gpm; quality of water variable. Considerable drainage from muskeg areas.
9	Glacial and beach deposits terrace over bedrock.	One well, nine test wells.	As much as 100 gpm; water-bearing beds are not extensive and may be partly drained.
10	Thin surficial deposits over bedrock.	No wells, no test wells.	Less than 10 gpm.
11	Surficial deposits over bedrock.	One well, five test wells.	As much as 25 gpm. Excellent to poor quality of water.
12	Isolated surficial deposits over bedrock.	No wells, no test wells.	Less than 5 gpm.

[1]Less than 5 gpm from bedrock.

On the basis of exploratory test augering by the U.S. Geological Survey in 1967, area 8 (fig. 5) is the one most likely to provide adequate water for the needs of the community. At the present time (1967), no supply wells obtain water from this area. Two pairs of test wells were installed in area 8. Two water-bearing zones were tested at each site because relatively impermeable material was found between them; the zones are presumed to be correlative at both sites. At Haines Highway and Sawmill Road, well 9 was 97 feet deep and well 10 was 45 feet deep. Near the creek crossing of Sawmill Road, well 21 was 92 feet deep and well 22 was 32 feet deep. Gravel in the upper zone had good water-bearing characteristics; it was cleaner, more rounded, and better sorted than any other water-bearing gravel found near Haines. The upper zone at the highway was between 11 and 47 feet below land surface; at the creek crossing, it was between 12 and 35 feet. Results of analyses of water from the upper zone (table 2) indicate that quality of water can deteriorate rapidly with depth. Total dissolved solids ranged from 80 to 2,030 mg/l in well 22. This points out the need to use care in constructing wells in these materials and in planning pumping rates and schedules; wells should not be completed in zones with poor quality of water. Analyses of water from the upper part of test well 22 and from the creek (sample 42, table 2) indicate that the water is very similar. Thus, there is probably a good hydraulic connection between the creek and the upper aquifer, and drawdown in the upper zone would probably be less than expected.

The lower water-bearing zone will not yield as much water as the upper zone because the material is not as well sorted. However, if a well system is constructed to tap the upper zone, adjacent wells completed in the lower zone might provide a separate economical source of water. Water quality in the lower zone in the southeastern part of area 8 might be better than that from the upper zone because of its proximity to the recharge area and smaller possibility of the occurrence of salt water.

There are a few factors that discourage development of area 8. The gravel zones are not continuous with area and depth in the underlying materials and the water is of poor quality. Also more than one well may be required to obtain adequate water for the total supply without causing excessive drawdown. Excessive drawdown in the upper zone could cause poor-quality water from the underlying zone or discolored water from the creek to enter the well. A surveillance program will be required to determine changes in water quality. Specific conductance measurements would adequately identify chemical changes; bacteriologic tests would detect contamination. Although there have been reports of arsenic in the water in area 8, it was not present in the two samples for which it was analyzed.

Areas 7 and 9 are less favorable for ground-water development than area 8, but they are the most desirable areas for additional investigation if area 8 proves to be unsatisfactory. It should be noted that most test holes have not reached bedrock. If none of the suggested areas prove satisfactory, deeper drilling might reveal large quantities of good-quality water. Area 7 is an extension of area 8, and the water-bearing properties of the surficial deposits presumably are similar. The area is periodically flooded by tide water; therefore, the salt-water intrusion near the Chilkat Inlet may affect water quality. No test wells were drilled in area 7. Only the Sawmill well (well 23, table 1) presently obtains water from the area.

Area 9 has even less potential for development of ground water than area 7. Geologic relationships near the ridge at Second Avenue and Union Street in Haines are not well understood. Coarse material on this ridge prohibited augering deeper than about 17 feet. Consequently, it was impossible to determine the stratigraphic relationship of the thick clay a city block to the west and the beach deposits a city block to the east. The clay was not observed on the slope to the east of the ridge and was not found in a nearby test well (test well 4, fig. 5). Test well 4 (at the Health Center) was drilled through materials with fair water-bearing properties and the water quality was satisfactory.

Well 6 (near the beach at Main Street) has flowed for more than a year with no noticeable decrease of pressure or quantity. Yet, the raised beach deposits are of local extent and the recharge area is small; the underlying till deposits further restrict recharge; and local contamination of water in the surficial deposits is possible. Therefore, area 9 may not provide a suitable supply of water.

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