UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

THE STORAGE AND RELEASE OF WATER FROM A LARGE GLACIER-DAMMED LAKE: RUSSELL LAKE NEAR YAKUTAT, ALASKA, 1986

By Harold R. Seitz, Donald S. Thomas, and Bud Tomlinson

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CONVERSION FACTORS

For readers who prefer to use metric units, the conversion factors for the terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain SI unit
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
cubic foot (ft^3)	0.02832	cubic meter (m^3)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)
foot per day (ft/d)	0.3048	meter per day (m/d)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

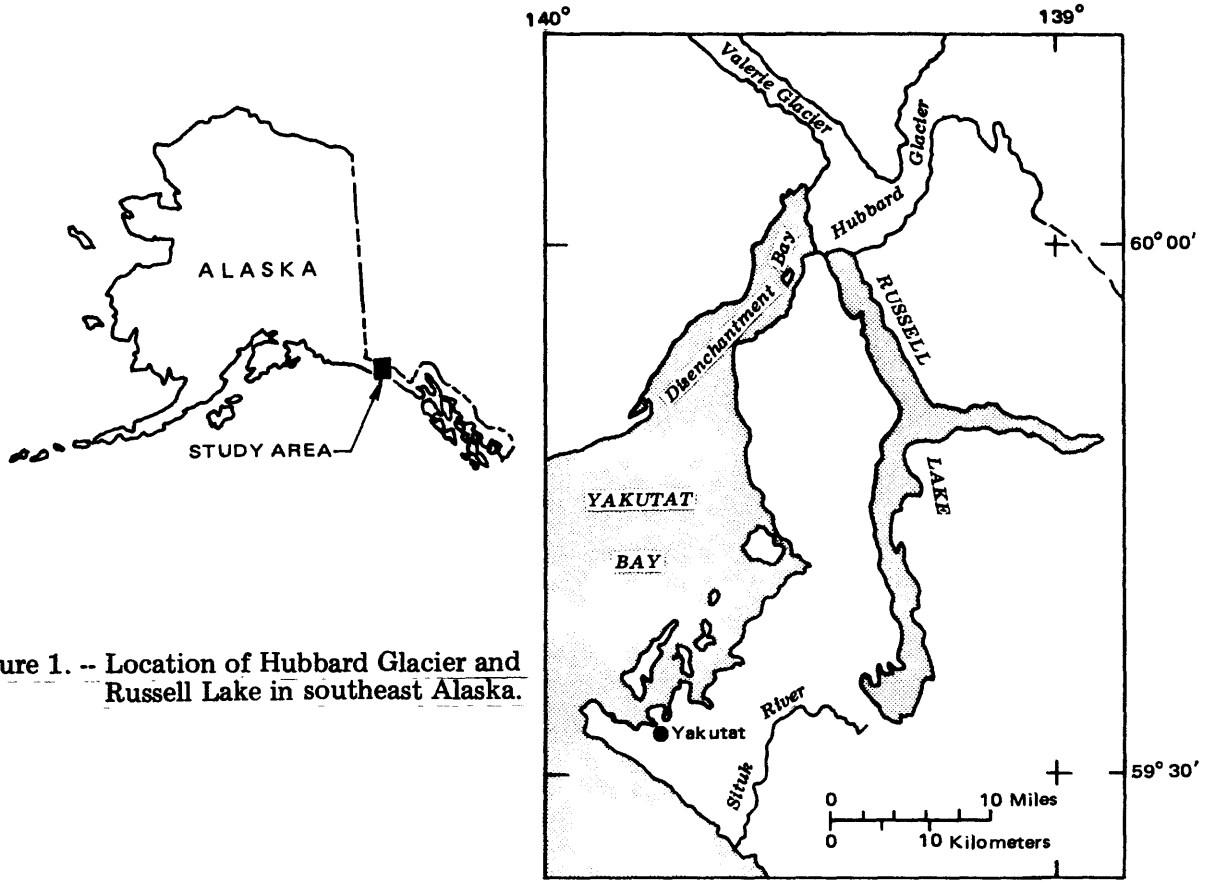

Figure 1. -- Location of Hubbard Glacier and Russell Lake in southeast Alaska.

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INTRODUCTION

On May 29, 1986, Russell Fiord near Yakutat, Alaska was dammed by the advancing Hubbard Glacier (fig. 1). The ice dam changed Russell Fiord from a tidal estuary to a closed lake, unofficially named "Russell Lake." Water inflow to the lake, predominantly runoff of melting snow and ice from surrounding glaciated mountains, raised the level of the lake to 83 ft above sea level[3] by October 8, when the ice dam failed.

Citizens and officials of the community of Yakutat, as well as representatives of several State and Federal agencies, expressed concern about the potential effects of the ice dam, whether it would fail within a relatively short time, or might block the fiord "permanently." Failure of the ice dam could result in the release of a large volume of water into Disenchantment Bay within a short period, possibly endangering the lives of any boaters in the immediate vicinity. Should the ice dam hold, overflow at the south end of the lake would eventually occur. Flow from the lake would most likely follow the "Old Situk River Channel" (named Old Situk Creek on Geological Survey maps) (fig. 2), which is thought to have last carried glacier meltwater about 1864, when ice blocked or occupied at least part of Russell Fiord.

The level of Russell Lake throughout its filling and draining in the summer of 1986 was monitored in a cooperative effort by the U.S.D.A. Forest Service (Tongass National Forest) and the U.S. Geological Survey (Water Resources Division). The lake-level data provided the Forest Service with the information needed to implement any necessary emergency measures or to issue notification of imminent hazardous conditions to the community of Yakutat and other agencies. This report is a summary of the events at Russell Fiord/Lake during the summer of 1986 and includes tabulated data and graphs of the measured and recorded water levels in the lake.

FORMATION AND HISTORY OF RUSSELL LAKE, SUMMER 1986

Russell Lake (figs. 2 and 3) was created when Hubbard Glacier advanced rapidly during the late winter and spring of 1986, eventually closing the entrance to Russell Fiord on May 29. The main north-south arm of the lake was 34 mi long, and ranged in width from 1 to 2 mi. Nunatak Fiord, a 15-mi long arm of Russell Fiord, entered the east side of the new lake about 11 mi upstream (south) of the ice dam.

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[1]Geological Survey, Water Resources Division, Juneau, Alaska
[2]Forest Service, Tongass National Forest, Yakutat, Alaska
[3]The arbitrary datum used in this report is based on observations of mean sea level, and has not been referenced to National Geodetic Vertical Datum of 1929 (NGVD of 1929).

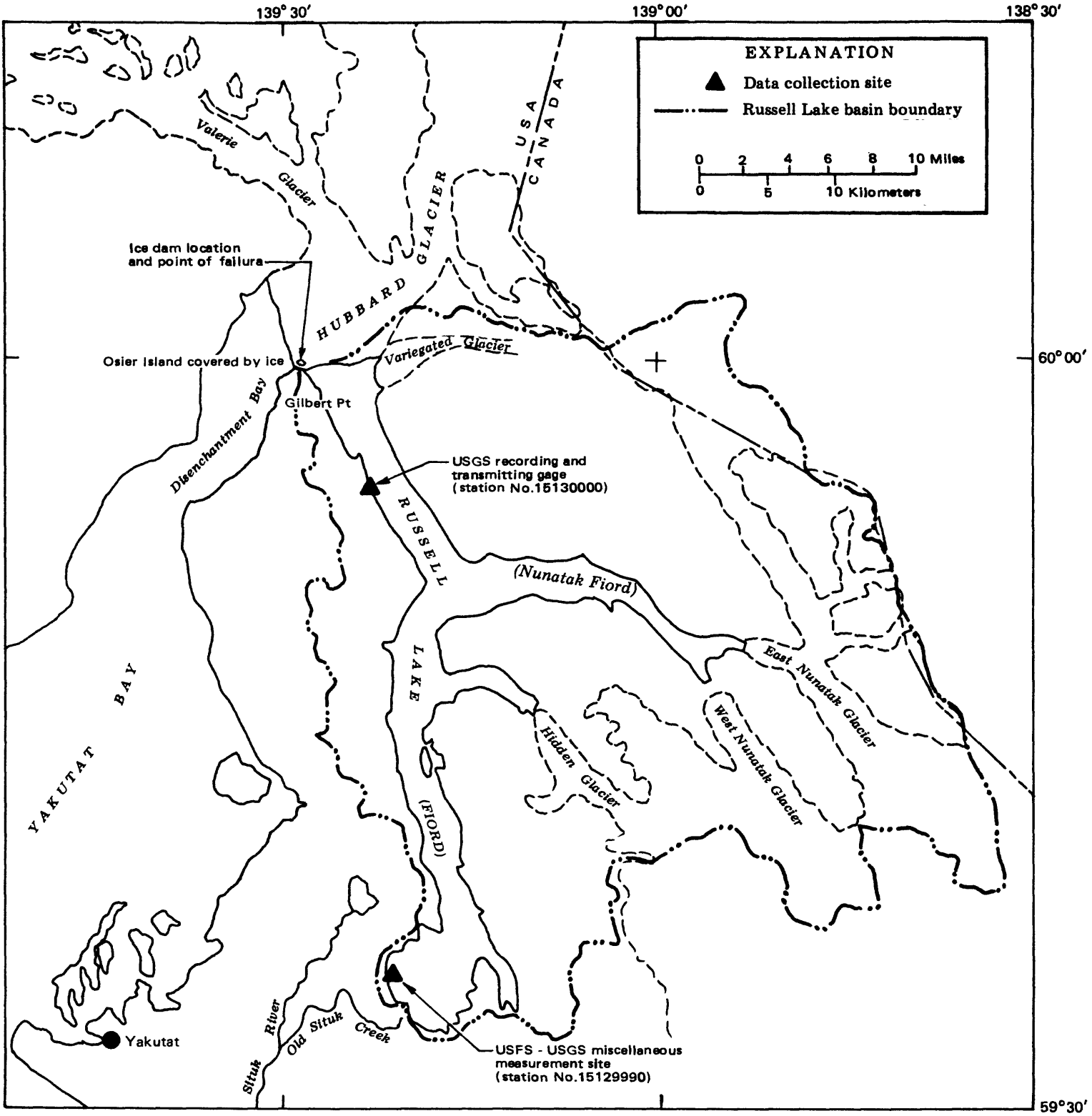

Figure 2. -- Russell Lake drainage basin and lake level monitoring sites.

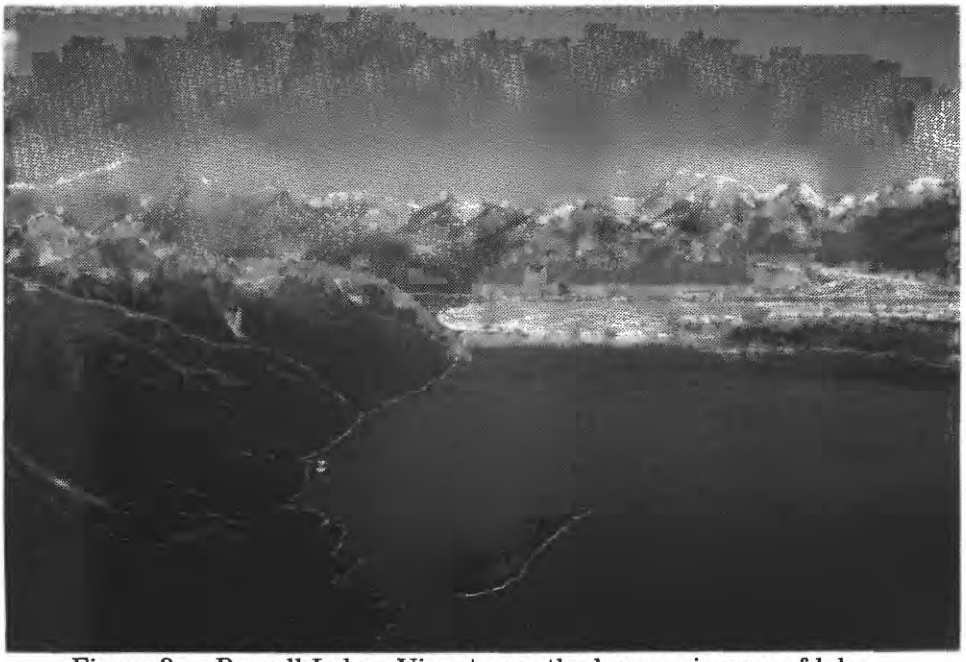

Figure 3.-- Russell Lake. View to north along main arm of lake toward Hubbard Glacier ice dam.

At the time of initial closure of the fiord, Russell Lake had a surface area of 75 mi^2. When the ice dam failed on October 8, the water level had risen to an elevation of 83 ft above sea level and the lake surface area had increased to 88 mi^2.

A drainage area of 700 mi^2 contributed runoff to Russell Lake. In drawing the drainage basin boundaries, it was assumed that because of the head differential between Russell Lake and Disenchantment Bay (higher in the lake), no water from the main stream of Hubbard Glacier entered the lake. Obviously the glacier did contribute some water to the lake in the form of icebergs. The basin of Variegated Glacier, which shares a common terminus with the Hubbard at the entrance to Russell Fiord, was included in the drainage area of Russell Lake.

MONITORING LAKE LEVELS

Personnel of the U.S.D.A. Forest Service began measuring the rise of lake level in early June 1986 at a site near its south end. Measurements were made at this site, now designated Geological Survey station No. 15129990 (fig. 2), at irregular intervals until August 11, when once-daily readings were initiated by the Survey. In the latter part of September 1986, Geological Survey personnel, with funding and helicopter support provided by the Forest Service, constructed a continuous-recording lake level gage on the west side of Russell Lake about 6 mi upstream (south) from the ice dam. This gage, designated Geological Survey station No. 15130000, utilizes a water-level sensing device connected to a recorder, and is equipped with a satellite telemetry system through which the water-level data can be retrieved on a real-time basis. The gage was put in operation on October 5.

WATER LEVEL RISE IN RUSSELL LAKE

During the period May 29 to October 7, 1986, the water level in Russell Lake rose to an elevation of 83 ft above sea level, inundating alluvial fans, outwash plains in front of several tributary glaciers, and in places the densely forested fringes of Russell Fiord (fig. 4). The lake level rose at an average rate of 0.6 ft/d, with a maximum rise of 1 ft/d (fig. 5 and table 1). The volume of water in Russell Lake at its maximum stage, excluding the water of the "original" Russell Fiord, was calculated to have been 187 billion ft^3 (or 4.3 million acre/ft), so that the

Figure 4. -- "Drowned" trees near southern end of Russell Lake.

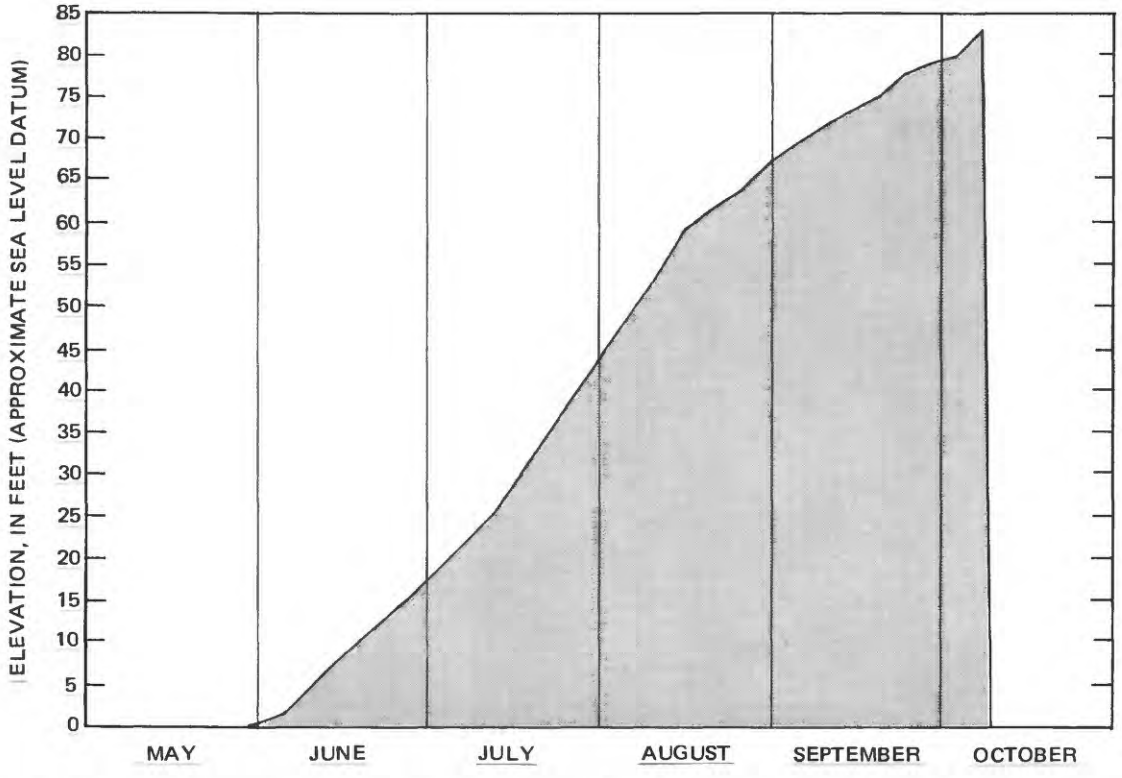

Figure 5. -- Water levels in Russell Lake, summer 1986. Graph drawn from water levels measured near south end of lake (U.S. Geological Survey station No. 15129990).

Table 1.--Water levels in Russell Lake near Yakutat, Alaska, June to October 1986.

[Measurements made at monitoring site near south end of lake, Geological Survey station No. 15129990. Water levels in feet; approximate sea level datum.]

Day	June	July	August	September	October	October 8, 1986 Hour*	October 8, 1986 Water level
1	--	--	--	68.0	79.1	0745	42.1
2	--	--	--	68.5	79.5	0800	41.0
3	1.0	--	44.6	68.9	80.0	0815	39.5
4	1.3	--	--	69.4	80.5	0830	38.4
5	1.6	20.7	--	69.8	81.3	0845	37.1
6	--	--	47.9	70.1	82.0	0945	33.8
7	--	--	--	70.5	82.7	1030	29.3
8	--	--	--	70.9	--	1200	25.4
9	--	--	--	71.3	--	1215	24.1
10	--	--	--	71.6	--	1330	21.6
11	--	--	54.5	72.0	--		
12	6.6	25.3	55.6	72.3	--		
13	--	--	57.2	72.7	--		
14	--	--	58.3	72.9	--		
15	--	--	58.9	73.3	--		
16	--	--	59.4	73.7	--		
17	--	29.9	60.0	74.0	--		
18	--	--	60.4	74.4	--		
19	--	--	60.9	74.7	--		
20	--	--	61.2	75.1	--		
21	--	--	61.8	75.9	--		
22	--	--	62.1	76.4	--		
23	--	36.6	62.4	77.3	--		
24	13.3	--	63.1	77.7	--		
25	--	--	63.5	78.1	--		
26	14.8	--	64.0	78.3	--		
27	--	--	64.7	78.5	--		
28	--	--	65.6	78.6	--		
29	--	--	66.0	78.8	--		
30	--	--	66.9	79.0	--		
31	--	--	67.4	--	--		

*Alaska Standard Time

average daily runoff to the lake during its 131-day lifetime would have been 16,500 ft^3/s. The maximum daily inflow, during a rainy period in late July and early August, is estimated to have been 26,000 ft^3/s.

FAILURE OF THE ICE DAM AND DRAINING OF THE LAKE

During the final days of September and the first week of October, the ice dam (fig. 6) appeared to be narrowing due to calving at the Hubbard Glacier terminus. Observers, noting the decreasing width of the ice dam and an increase in discharge of sediment-laden water at the base of the terminus on its downstream (Disenchantment Bay) side, concluded that the dam would probably fail within a short time.

Data from the continuous-recording lake-stage gage and observations (actually sounds of crashing icebergs and rushing water) by a Geological Survey glaciologist at Gilbert Point above the ice dam indicate that the ice dam began to "break out" between 2300 and 2400 hours on October 7. The gage was kept in operation by Geological Survey personnel on site until 2200 hours on October 8, at which time the lake level had reached the former high tide level of what was once again Russell Fiord.

Forest Service personnel flagged the declining water levels at the south end of the lake (station No. 15129990) on October 8; the levels were later surveyed and referenced to the datum used by the Geological Survey (table 1).

The maximum rate of decline of the lake level, between 0200 and 0600 hours (fig. 7 and table 2) was 5.4 ft/hr, which translates to an average discharge from the lake of about 3,800,000 ft^3/s during the 4-hour period. The flow from the lake produced swift currents through the breach between Osier Island and the steep rock face below Gilbert Point, and a plume of sediment-laden water could be seen extending out into Disenchantment Bay (fig. 8) and down Yakutat Bay to its mouth.

FUTURE MONITORING OF WATER LEVELS AT RUSSELL FIORD/LAKE

Scientists believe the cycle of filling and draining of Russell Lake will be repeated (written commun., L.R. Mayo, U.S. Geological Survey, October 1986), but the timing for such a recurrence can not be predicted with certainty. The protective terminal moraine of Hubbard Glacier was not eroded by the breakout flood, and part of the glacier's terminus still rests on Osier Island (fig. 9).

The recording lake-level gage, installed at considerable effort and expense by both the Geological Survey and the Forest Service, will continue to be operated by the Survey, with the financial support of the Forest Service. The water-level data are being transmitted via satellite telemetry on a real-time basis, and are available to concerned persons and agencies that may be affected by the filling and release of water from Russell Lake.

Figure 6. -- Hubbard Glacier ice dam below Gilbert Point, a few days prior to its failure (October 1986).

SELECTED REFERENCES

Begley, Sharon, and White, Bill, 1986, Alaska's runaway glacier: Newsweek, August 25, 1986, p. 52-53.

Lemonick, M. D., 1986, Alaska's speeding glacier: Time, September 1, 1986, p. 68-69.

Post, Austin, and Mayo, L. R., 1971, Glacier-dammed lakes and outburst floods in Alaska: U.S. Geological Survey Hydrological Investigations Atlas HA-455, 10 p., 3 sheets.

Schornak, Tom, 1986, Scientists marvel at Hubbard Glacier, a kaleidoscope of new information: Southeastern (Alaska) Log, September 1986, p. B-8 and B-9.

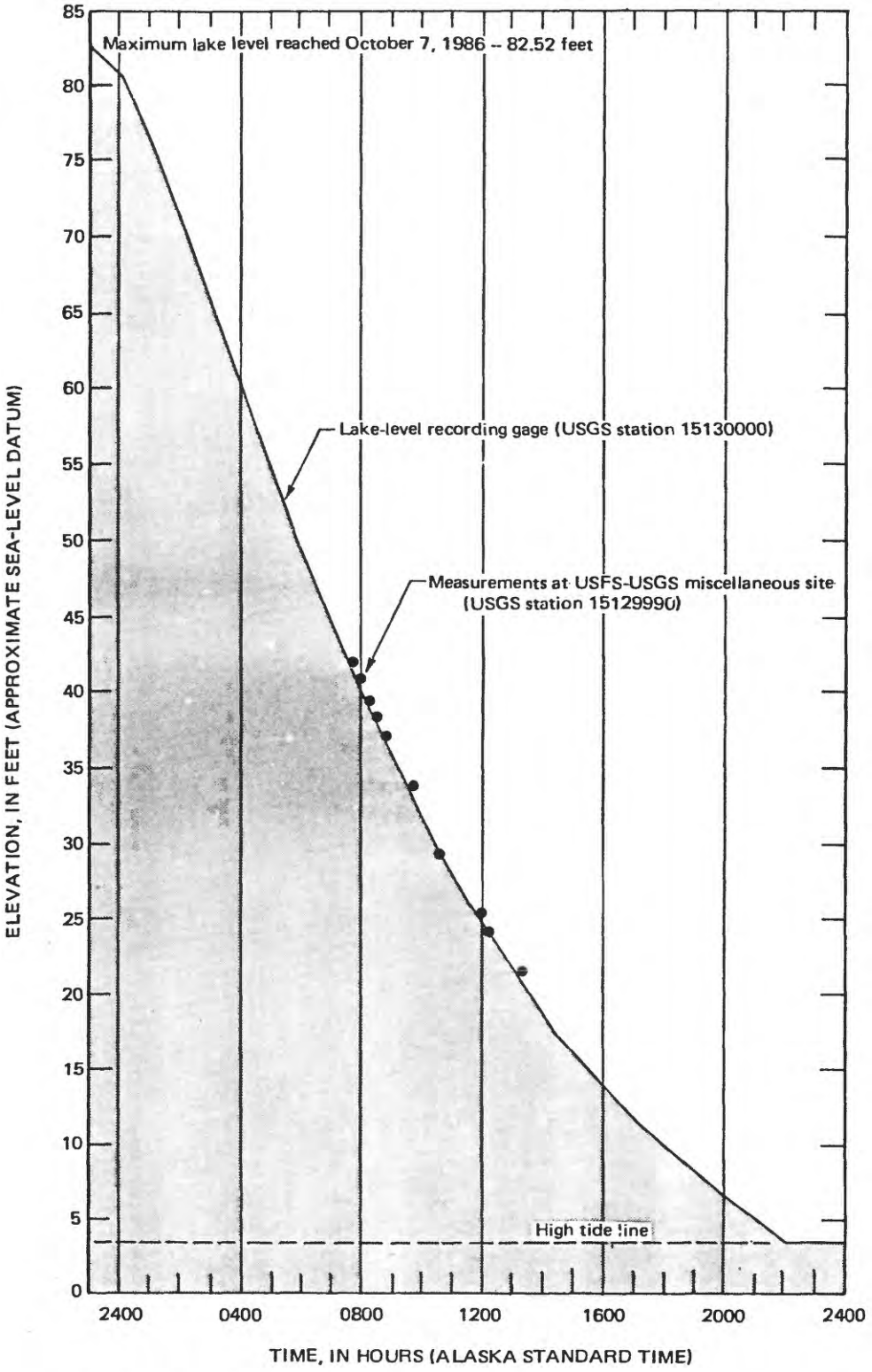

Figure 7. -- Water level in Russell Lake near Yakutat, Alaska following failure of Hubbard Glacier ice dam, October 8, 1986.

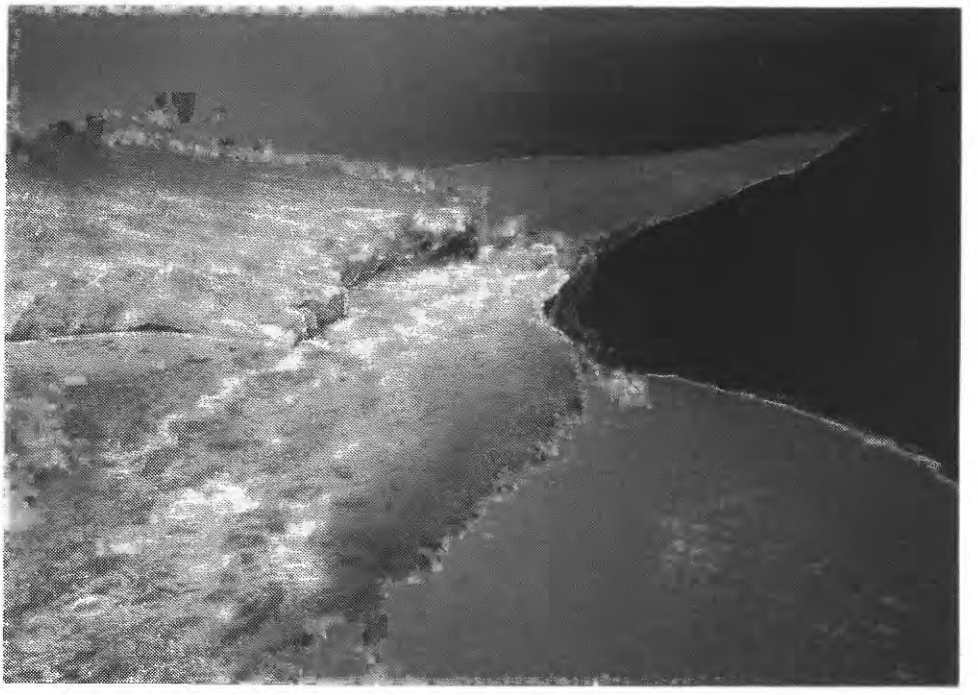

Figure 8. -- Water flowing from Russell Lake (background) into Disenchantment Bay (foreground) through breach in Hubbard Glacier ice dam (October 8, 1986).

Figure 9. -- Terminus of Hubbard Glacier resting on Osier Island (left foreground) following draining of Russell Lake.

Table 2.--Water levels in Russell Lake near Yakutat, Alaska, October 7-8, 1986.

[Recorded at Geological Survey station No. 15130000. Water levels in feet; approximate sea level datum.]

Hour*	Water level October 7	October 8
0100	82.2	76.4
0200	82.2	70.9
0300	82.2	65.7
0400	82.2	60.2
0500	82.3	54.1
0600	82.3	49.4
0700	82.3	44.6
0800	82.3	39.9
0900	82.4	36.0
1000	82.4	31.7
1100	82.4	28.0
1200	82.4	24.6
1300	82.4	21.5
1400	82.4	18.4
1500	82.4	16.1
1600	82.4	13.9
1700	82.4	11.8
1800	82.4	10.3
1900	82.4	8.3
2000	82.6	6.6
2100	82.5	5.0
2200	82.5	3.4
2300	82.5	--
2400	80.7	--

*Alaska Standard Time