UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES AND HYDROLOGIC HAZARDS OF THE EXIT GLACIER AREA NEAR SEWARD, ALASKA

By Charles E. Sloan

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DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to:

District Chief
U.S. Geological Survey
Water Resources Division
4230 University Drive, Suite 201
Anchorage, Alaska 99508-4664

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Multiply	by	to obtain
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
gallon per minute (gal/min)	0.06308	liter per second (L/s)
degree Fahrenheit (°F)	(°F-32)/1.8	degree Celsius (°C)

Other abbreviations in this report:

mg/L, milligram per liter
µS/cm at 25 °C, microsiemens per centimeter at 25 °C

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ABSTRACT

The Exit Glacier area, in the northern part of Kenai Fjords National Park near Seward, Alaska, is being developed for visitor access to the park. Information on ground-water conditions and the possibility of hydrologic hazards is needed to help plan facilities for visitor use. There is ample ground water in the Exit Glacier area for anticipated public-supply needs. There is some minor risk to roads and structures from large infrequent floods. Bank erosion along Exit Glacier Creek could be a hazard to nearby facilities. Avalanches occur in the area but hazardous areas can be recognized. The potential for large-scale glacier advance in the near future seems remote.

INTRODUCTION

Kenai Fjords National Park, established by Congress on December 2, 1980, is located on the Kenai Peninsula about 75 mi south of Anchorage, Alaska. The park was established "to maintain unimpaired the scenic and environmental integrity of the Harding Ice Field, its outflowing glaciers, and coastal fjords and islands in their natural state" (Alaska National Interest Lands Conservation Act, Public Law 96-487, Dec. 2, 1980). The Exit Glacier area, in the northern part of the park, is about 8 mi northwest of the city of Seward (fig. 1). A gravel roadway from the Seward Highway to the base of Exit Glacier was constructed in the early 1970's.

At the present time, a roadbed extends from a footbridge over the Resurrection River for 1.75 mi, to within about 1,000 ft from the terminus of the glacier. The National Park Service plans to construct a highway bridge over the Resurrection River, upgrade the road from the river to the glacier, and develop visitor facilities at the end of the road near Exit Glacier.

The U.S. Geological Survey made a hydrologic investigation of the Exit Glacier area to aid the National Park Service in planning visitor facilities and access to the area. The investigation included an evaluation of ground-water conditions and an appraisal of the probable magnitude and extent of hydrologic hazards in the area. Hydrologic hazards near Exit Glacier include the possibility of flooding, streambank erosion, avalanches, and glacier advance.

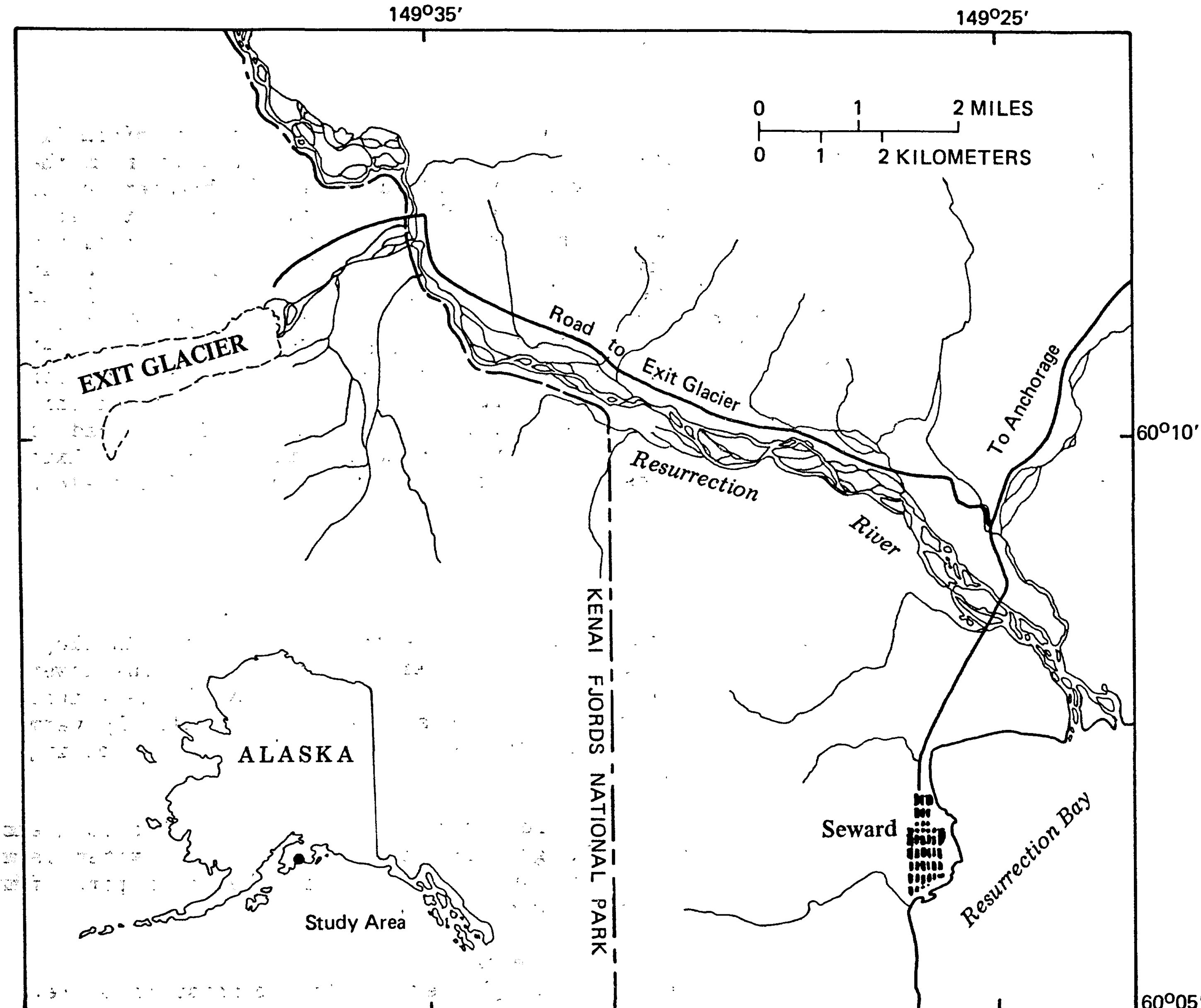


Figure 1.--Location of the Exit Glacier area near Seward, Alaska.

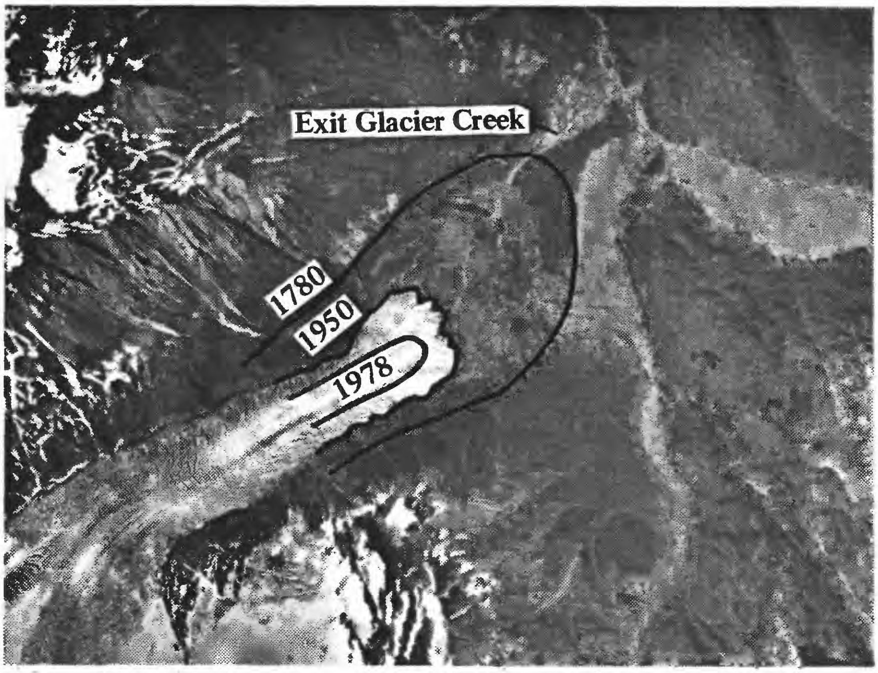
WATER RESOURCES

Surface Water - Runoff from Exit Glacier flows northeastward in a stream informally named "Exit Glacier Creek" and joins the Resurrection River about 2 mi from the glacier terminus. Exit Glacier Creek is quite turbid during the high-water season when it transports a large sediment load. Sudden channel shifts occur in the zone near the terminus of the glacier in response to changes of the terminus position and the shifting location of outflow channels that emerge from the glacier. In contrast, the channel of Exit Glacier Creek is comparatively stable in the lower three- quarters of its length, as seen using 1950 and 1978 aerial photographs (fig. 2). Average gradient of Exit Glacier Creek, determined from the Seward A-7 quadrangle, is about 80 ft/mi. The gradient of the Resurrection River at its confluence with Exit Glacier Creek is about 35 ft/mi. Largely as a result of this difference in gradient, Exit Glacier Creek deposits part of its sediment load at its mouth and in the Resurrection River. In addition to the main channel of Exit Glacier Creek, a few small tributaries carry runoff from the mountain slopes along both sides of the valley.

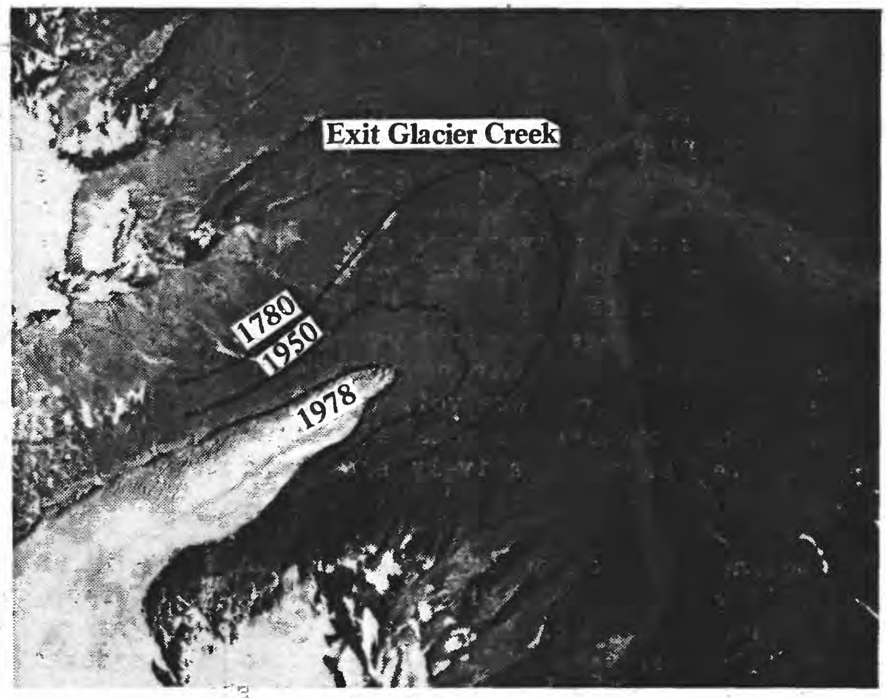
Ground Water - Springs discharge ground water from the base of the mountain slope north of the glacier terminus (fig. 3). Ground water also emerges in the lower half mile of the Exit Glacier Creek channel and in several nearby channels that empty into the Resurrection River (fig. 4). The discharge of comparatively warm ground water at about 5° C keeps these channels open and free of ice except during extended periods of extremely cold weather.

Some of the flow from Exit Glacier Creek and its tributaries is absorbed in the coarse alluvial gravels and recharges the ground-water system. Ground water is discharged from the alluvium as seepage to stream channels in the lower part of Exit Glacier valley and in the Resurrection River channel.

There are three principal geologic units in the area:
(1) Bedrock -- ice-scoured exposures near the glacier terminus consist of slate. Water-bearing characteristics of the bedrock have not been tested, but the potential for water supply does not appear as favorable as for other deposits in the area.
(2) Glacial till -- an unsorted mixture of rock fragments found in the moraines that occur as curvilinear ridges marking past positions of the Exit Glacier terminus. Till is also found in lateral moraines along the sides of the valley and may occur in a layer overlying bedrock beneath fluvial sands and gravels in the valley. Water-bearing characteristics of the glacial till are intermediate between the bedrock and outwash deposits. Large boulders litter the moraine surfaces in the valley and could occur in the subsurface till deposits as well. If encountered, the boulders could cause drilling problems.
(3) Fluvial sand and gravel -- glacial outwash deposits of sand and gravel cover most of the floor of the valley. Water-bearing characteristics of the sand and gravel include adequate porosity and permeability to provide an ample quantity of good-quality water to wells. Thickness of the outwash has not been measured but could be as much as several hundred feet in places. However, glacial till could occur as lenses or layers in the outwash alluvium, and bedrock could be present at shallow depth beneath the outwash at any given place in the valley.



1950



1978

Figure 2.--Vertical photographs of Exit Glacier taken in 1950 and 1978, and position of glacier terminus on indicated dates.

Two wells were drilled on November 18, 1983: one near the visitor center and the other near the residence building (fig. 3). Both wells were drilled and cased to a depth of 60 ft. Drilling near the residence was attempted at three places before a site was found where boulders at a depth of 5 to 7 ft could be penetrated. The rock material in both wells consisted of fluvial sand and gravel with minor amounts of silt and clay.

Each well was pumped at a rate of 20 gal/min for about 1 hour. The water levels after pumping stabilized at 36 ft below land surface near the visitor center and 41 ft below land surface near the residence building. The wells should provide an adequate water supply for the expected demand. The water sampled on November 18, 1983 from the well near the residence had a temperature of 5 °C, specific conductance of 245 µS/cm at 25 °C, pH of 7.9, and alkalinity of 120 mg/L.

HYDROLOGIC HAZARDS

Glacial Advance - The probability of a major advance of Exit Glacier appears to be remote, although possible, given climate shift and sufficient time. The recent history in this century of nearly all glaciers in the Kenai Mountains, according to Austin Post (U.S. Geological Survey, written commun., 1983), has been one of slow retreat for land-ending glaciers such as Exit Glacier, and drastic retreat for extended tidewater glaciers such as Northwestern and McCarty Glaciers. Post also stated that all the larger glaciers and most of the smaller glaciers have retreated from maximum positions attained about 100 to 200 years ago. The retreat of Exit Glacier is indicated by progressive upvalley positions of the terminus in the recent past (fig. 2). Vertical aerial photographs of the glacier are available from 1978 and 1950; in addition, the position of the terminus in about 1780 can be extrapolated from tree ring analyses done by the National Park Service (G.M. Ahlstrand, written commun., 1983). These retreats are not merely changes in terminus position; the thickness of the lower parts of glaciers has decreased as well, as displayed by lateral moraines and trim lines. According to Post, if increased snow accumulation were to reverse this trend, the switch to advance would not be a sudden, dramatic event; large ice reservoirs will probably require at least several decades to refill before previous levels are attained. Therefore, any terminus advances can be expected to be relatively slow, and the onset of advance delayed for many years or even decades.

Avalanches - The mountain slopes on both sides of Exit Glacier valley are subject to avalanching. A large avalanche path stops about 600 ft from the road directly northwest of the planned development area (fig. 3). Recent avalanche paths and runout areas are easily identified and, therefore, can be avoided in the siting of structures, camping areas, and trails for hiking or skiing.

Floods - The Resurrection River, Exit Glacier Creek, and their tributaries are all subject to flooding. Annual peak flows usually result from mid-summer snow and ice melt, sometimes combined with heavy rain. Catastrophic floods apparently are rare and infrequent judging from indirect flood evidence, although flood-frequency data are not available.

Examinations of aerial photographs of the Exit Glacier drainage and the Resurrection River (Post and Mayo, 1971) show no evidence of ice-dammed lakes that could periodically or unexpectedly break out to cause large floods.

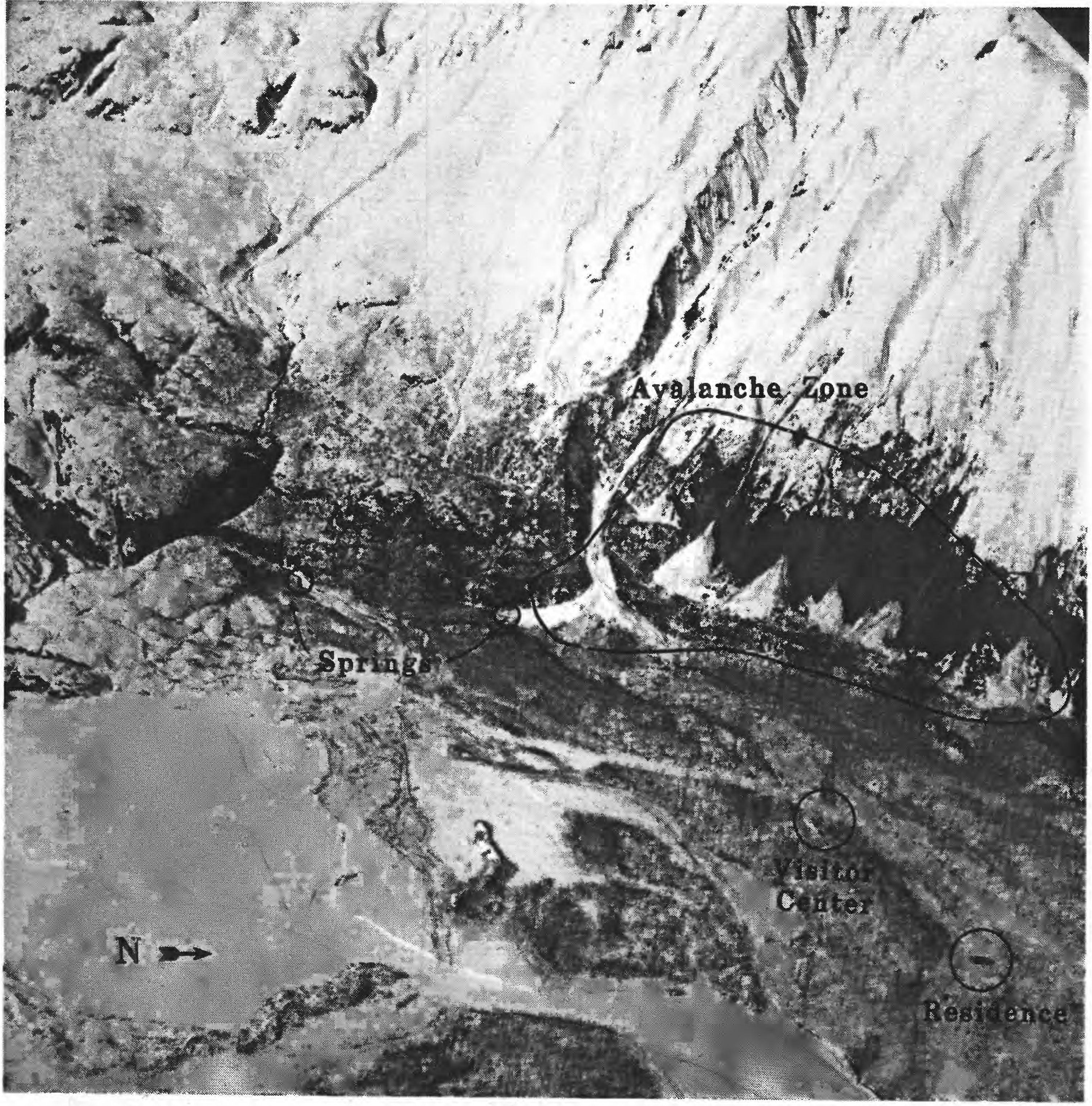


Figure 3.--Oblique photograph north of Exit Glacier terminus taken March 30, 1983, showing location of ground-water discharge at the base of the mountain slope, and avalanche zone.

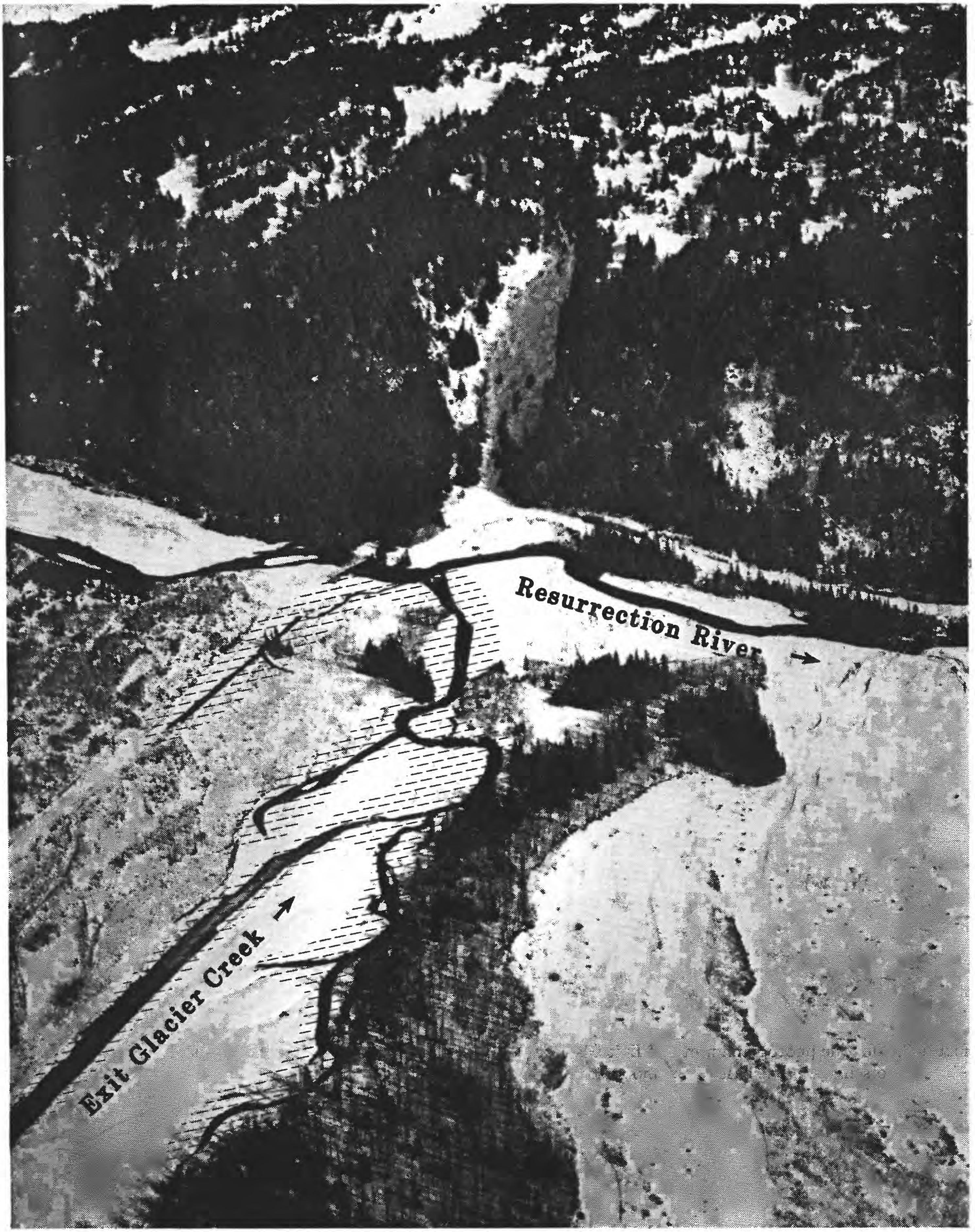


Figure 4.--Oblique photograph of the confluence of the Resurrection River and Exit Glacier Creek, March 30, 1983. Open-water leads (hachure marks) indicate ground-water discharge.

Normal summer flow inundates the present road at its approach to the west end of the footbridge over the Resurrection River. The upper end of the road past the visitor center also acts as a runoff channel for tributary flow to Exit Glacier Creek.

The surface of outwash deposits near the proposed development center does not appear to have been flooded during the last several decades. If channel changes in the upper part of Exit Glacier Creek were to cause flooding of this area, the water could spread out and would be comparatively shallow. Slight elevations in the terrain, such as moraines or constructed embankments, could be used to protect buildings or other structures from the effects of flooding.

Bank Erosion - Exit Glacier Creek appears to be actively eroding its banks along most of its length. The rate of bank erosion could accelerate during a large flood. It would seem prudent, therefore, not to construct any facilities closer than a few hundred feet from the banks of Exit Glacier Creek.

CONCLUSIONS

1. Ground water appears to be adequate in the Exit Glacier area for anticipated public supply needs.

2. The potential for Exit Glacier to have a major advance in the near future seems remote.

3. Avalanches occur in the area but hazardous areas can be readily delineated.

4. In the glacier's drainage basin, no ice-dammed lakes are evident that pose flood hazards from sudden release of water.

5. Some minor risk to roads and structures exists from large, infrequent floods.

6. Bank erosion along Exit Glacier Creek could pose a risk to facilities.

REFERENCE CITED

Post, Austin, and Mayo, L.R., 1971, Glacier dammed lakes and outburst floods in Alaska: U.S. Geological Survey Hydrologic Investigations Atlas HA-455, 3 sheets, 10 p., scale 1:1,000,000.