LAKES

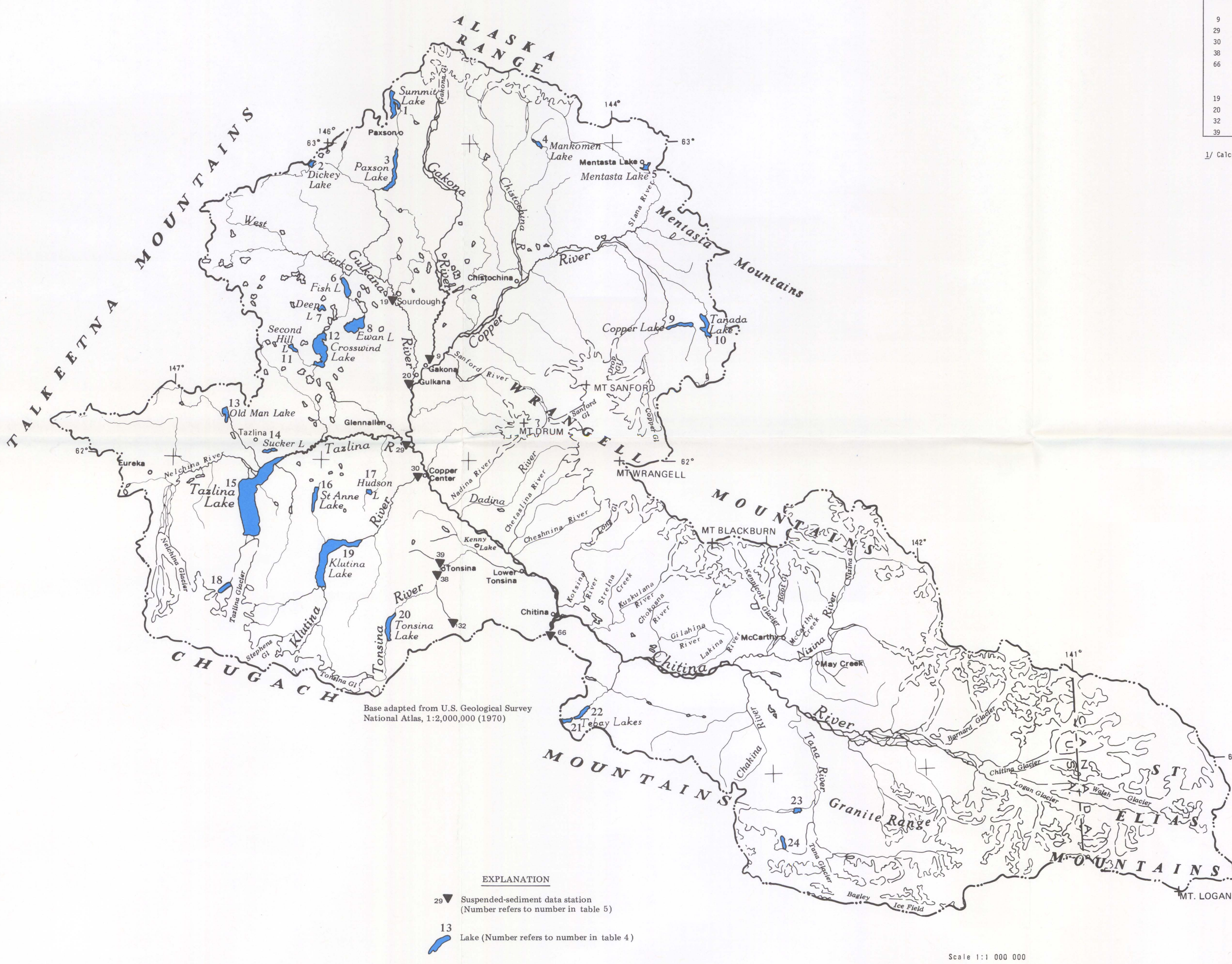

FIGURE 20. -- LOCATIONS OF SUSPENDED-SEDIMENT DATA-COLLECTION SITES AND LAKES.

LAKES

Lakes -- Lakes are abundant in the Copper River basin. In the drainage area above Chitina, 35 lakes have a surface area of 1 mi² or greater and 24 of these lakes have a depth of 10 ft or more (fig. 20 and table 4). The approximate volume of water in each lake was calculated by multiplying the surface area, in acres, times the estimated mean depth. The winter volume was calculated assuming that the lakes seldom, if ever, freeze below a depth of 4 ft (Fred Williams, Alaska Department of Fish and Game, oral commun., 1983). The lakes are an important component of the basin's water resources. For example, the use of only 1 ft of water from a lake that has a surface area of 1 mi² (640 acres) would provide 640 acre-ft or nearly 209 million gal. Assuming a per capita water use of 100 gal/d, the 209 million gal would meet the needs of 5,700 persons for a year.

The quality of water in the lakes of the Copper River basin is, in general, excellent. However, the water of Tazlina, St. Anne, Klutina, and Tonsina Lakes would have to be treated for removal of suspended sediment prior to most uses. Specific conductance for 17 of the largest lakes ranges from 62 to 270 µmho/cm at 25° C. Dissolved-solids concentration of water from 11 lakes sampled by the U.S. Geological Survey ranges from 53 to 181 mg/L. In June 1982 composite samples from three depth intervals were obtained from each of nine lakes in the basin (see table 4). The samples were collected near the outlet of each lake. The intervals sampled were: 3 ft below the surface, 1 ft above the bottom, and one-half the total depth. The specific conductance and temperature of the water at the sampled depth intervals showed little variability. Field measured pH of the nine lakes ranged from 7.7 to 8.2.

TABLE 4. -- SUMMARY OF DATA FOR SELECTED LAKES IN THE COPPER RIVER BASIN

[Lake area ≥ 1 mi², depth ≥ 10 ft]

Map No. (Fig. 20)	Lake	Area (mi²)	Altitude of water surface (ft)	Maximum depth (ft)	Estimated mean depth (ft)	Approximate volume (acre-ft)a	Approximate winter volume (acre-ft)	Tributary to	Water quality: Field specific conductance (µmho/cm at 25°C)	Water quality: Dissolved solids (mg/L)	Water quality: Chemical analysis available	Water quality: Date sampled	Remarks
1	Summit	6.3	3,210	214b	70b	280,000	270,000	Gulkana River	78	54	X	8/24/73	--
2	Dickey	1.3	2,870	>60b	30	25,000	22,000	Middle Fork Gulkana River	67b	--	--	--	--
3	Paxson	6.3	2,553	89b	35b	140,000	125,000	Gulkana River	100	63	X	8/23/73	--
4	Mankomen	2.0	3,001	85b	40	50,000	46,000	East Fork Chistochina River	--	--	--	--	--
5	Mentasta	1.5	2,230	>20b	10	10,000	6,000	Slana River	270b	--	--	--	--
6	Fish	4.0	2,015	18b	10b	25,000	15,000	West Fork Gulkana River	135	67	X	6/15/82	--
7	Deep	1.3	2,187	37b	25	21,000	17,000	Dog Lake	90	66	X	6/14/82	--
8	Ewan	9.7	2,090	21b	15	93,000	68,000	Middle Lake	150	74	X	6/15/82	--
9	Copper	2.8	2,905	230b	100	179,000	172,000	Copper River	--	--	--	--	--
10	Tanada	4.3	2,865	180b	80	220,000	209,000	Tanada Creek	85b	--	--	--	--
11	Second Hill	1.2	2,320	15	12	9,000	6,000	Crosswind Lake	114	55	X	6/14/82	--
12	Crosswind	14.0	2,112	100b	40	358,000	322,000	Dog Lake	110	66	X	6/15/82	--
13	Old Man	2.5	2,300	20b	12	19,000	13,000	Mendeltna Creek	195	105	X	6/15/82	--
14	Sucker	1.2	2,020	24b	10	8,000	5,000	(no surface outlet)	200	103	X	6/15/82	--
15	Tazlina	60.0	1,786	--	>10	--	--	Tazlina River	109b	--	--	--	Glacial lake, silty.
16	St. Anne	3.8	1,978	17	10	24,000	15,000	Klutina River	195	--	--	6/15/82	Silty.
17	Hudson	1.0	2,156	51b	25	16,000	13,000	Tazlina River	250	181	X	6/15/82	--
18	(unnamed)	2.3	3,120	--	>10	--	--	Tazlina Lake	--	--	--	--	Glacier dammed.
19	Klutina	26.0	1,719	>100b	>10	--	--	Klutina River	100	53	X	6/15/82	Glacial lake, silty.
20	Tonsina	5.3	1,887	--	>10	--	--	Tonsina River	62b	--	--	--	Glacial lake, silty.
21	Upper Tebay	1.2	1,842	118	90	69,000	66,000	Lower Tebay Lake	--	--	--	--	--
22	Lower Tebay	2.0	1,799	180	80	102,000	97,000	Tebay River	--	--	--	--	--
23	(unnamed)	1.0	1,500	--	>10	--	--	Tana River	--	--	--	--	--
24	(unnamed)	1.8	3,100	--	>10	--	--	Tana River	--	--	--	--	Glacier dammed.

a 1 acre-ft = 326,000 gallons.
b Data from Fred Williams, Alaska Department of Fish and Game.

SELECTED REFERENCES

Andreasen, G. E., Grantz, Arthur, Zietz, Isidore, and Barnes, D. F., 1964, Geologic interpretation of magnetic and gravity data in the Copper River basin, Alaska: U.S. Geological Survey Professional Paper 316-H, p. 135-153.
Benson, C. S., and Motyka, R. J., 1979, Glacier-volcano interactions on Mt. Wrangell, Alaska: University of Alaska, Geophysical Institute, Annual Report 1977-78, p. 1-25.
Carey, K. L., 1973, Icings developed from surface water and ground water: U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory, Cold Regions Science and Engineering Monograph III-D3, 65 p.
Douglass, W. C., 1964, A history of the Kennecott mines, Kennecott, Alaska: privately published, 12 p.
Ferrians, O. J., Jr., 1963, Glaciolacustrine diamicton deposits in the Copper River basin, Alaska: U.S. Geological Survey Professional Paper 475-C, p. C121-C126.
______1965, Permafrost map of Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-445, scale 1:2,500,000.
Grantz, Arthur, White, D. E., Whitehead, H. C., and Tagg, A. R., 1962, Saline springs, Copper River lowland, Alaska: American Association Petroleum Geologists Bulletin, v. 46, no. 11, p. 1990-2002.
Johnson, P. R., and Hartman, C. W., 1969, Environmental atlas of Alaska: University of Alaska, Institute of Arctic Environmental Engineering and Institute of Water Resources, 111 p.
Lamke, R. D., 1972, Floods of the summer of 1971 in south-central Alaska: U.S. Geological Survey open-file report, 88 p.
______1979, Flood characteristics of Alaskan streams: U.S. Geological Survey Water Resources Investigations 78-129, 61 p.
MacKevett, E. M., Jr., 1978, Geological map of the McCarthy quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigations Map I-1032, scale 1:250,000.
Mendenhall, W. C., 1905, Geology of the central Copper River region, Alaska: U.S. Geological Survey Professional Paper 41, 133 p.
Moffit, F. H., 1938, Geology of the Slana-Tok District, Alaska: U.S. Geological Survey Bulletin 904, 54 p.
______1954, Geology of the eastern part of the Alaska Range and adjacent area: U.S. Geological Survey Bulletin 989-D, p. 63-218.
National Oceanic and Atmospheric Administration, 1981, Local climatological data, 1981, Gulkana, Alaska: Asheville, N.C., National Climatic Center.
National Weather Service, 1972, Mean annual precipitation -- inches: National Weather Service (Alaska), map.
Nichols, D. R., 1956, Permafrost and ground-water conditions in the Glennallen area, Alaska: U.S. Geological Survey open-file report, 14 p.
Post, Austin, and Mayo, L. R., 1971, Glacier dammed lakes and outburst floods in Alaska: U.S. Geological Survey Hydrologic Investigations Atlas HA-455, 10 p., 31 pl.
Riggs, H. C., 1970, Regional analysis of streamflow characteristics: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 4, Chapter B3, 17 p.
______1972, Low-flow investigations: U.S. Geological Survey Techniques of Water Resources Investigations, Book 4, Chapter B1, 18 p.
Scully, D. R., and Freethey, G. W., 1980, Water resources of the Cook Inlet basin, Alaska: U. S. Geological Survey Hydrologic Investigations Atlas HA-620, 4 sheets, scale 1:1,000,000.
Sloan, C. E., Zenone, Chester, and Mayo, L. R., 1976, Icings along the trans-Alaska pipeline route: U.S. Geological Survey Professional Paper 979, 31 p.
U.S. Environmental Protection Agency, 1977, Quality criteria for water, 1976: U.S. Government Printing Office, 256 p.
U.S. Water Resources Council, 1981, Guidelines for determining flood flow frequencies: U.S. Water Resources Council, Bulletin 17B of the Hydrology Committee, 183 p.
Wahrhaftig, Clyde, 1965, Physiographic divisions of Alaska: U.S. Geological Survey Professional Paper 482, 52 p.
Williams, J. R., 1970, Ground water in the permafrost regions of Alaska: U.S. Geological Survey Professional Paper 696, 83 p.
Winkler, G. R., Silberman, M. L., Grantz, Arthur, Miller, R. J., and MacKevett, E. M., Jr., 1981, Geologic map and summary geochronology of the Valdez quadrangle, southern Alaska: U.S. Geological Survey Open-File Report 80-892-A, scale 1:250,000.

SURFACE-WATER QUALITY

TABLE 5. -- SUMMARY OF SUSPENDED-SEDIMENT DATA

Map No. (fig. 20)	Station No.	Stream	Drainage area (mi²)	Sediment concentration (mg/L) maximum	Sediment concentration (mg/L) minimum	Sediment discharge (ton/d) maximum	Sediment discharge (ton/d) minimum	Average sediment yields1/ (ton/yr)	Average sediment yields1/ (ton/mi²)/yr
		Glacial Streams							
9	15200000	Gakona River at Gakona	620	9,270	1	194,000	0.2	2,100,000	3,387
29	15202000	Tazlina River near Glennallen	2,670	4,250	4	479,000	3	1,150,000	430
30	15206000	Klutina River at Copper Center	880	268	22	6,370	13	160,000	182
38	15208000	Tonsina River at Tonsina	420	164	3	2,480	0.6	30,600	73
66	15212000	Copper River near Chitina	20,600	3,840	16	1,550,000	165	65,100,000	3,160
		Nonglacial Streams							
19	15200280	Gulkana River at Sourdough	1,770	625	1	9,520	0.6	122,000	69
20	15200400	Gulkana River at Gulkana	1,970	4,000	1	176,000	8	--	--
32	15207800	Little Tonsina River nr Tonsina	22.7	73	2	19	0.03	549	24
39	15208100	Squirrel Creek at Tonsina	70.5	878	1	846	0.06	1,550	22

1/ Calculated from suspended sediment-discharge relation (figs. 22 and 23) and flow-duration curve (figs. 12 and 13).

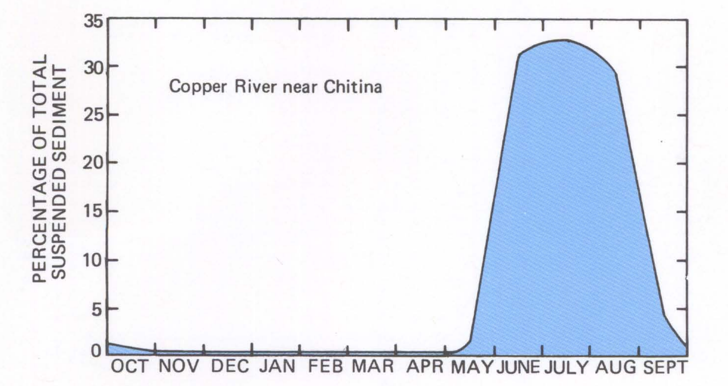

FIGURE 21. -- MEAN MONTHLY DISTRIBUTION OF SUSPENDED SEDIMENT, COPPER RIVER NEAR CHITINA.

SUSPENDED SEDIMENT

Suspended Sediment -- Although most streams of the Copper River basin are of good to excellent chemical quality, seasonally they may carry various amounts of suspended sediment. Suspended sediment has been sampled in nine basin streams -- five glacial and four nonglacial (fig. 20). The suspended-sediment data collected at various times on selected streams during the period 1952-81 are summarized on table 5.

The Copper River near Chitina, downstream from its confluence with the Chitina River, carries an estimated 65 million tons of sediment out of the basin each year. Nearly all of this sediment load is transported during the open-water period. A pronounced increase in suspended sediment carried by the river starts in mid-May and ends in September (fig. 21).

Two of the three streams that drain glacier-fed lakes (Klutina and Tonsina Rivers) have relatively low maximum sediment concentrations (table 5). This is probably due to the sediment-retention effects of the lakes. However, the Tazlina River appears to be an exception. One probable cause of this higher sediment load is the periodic breakout of glacier-dammed lakes that empty into Lake Tazlina. The high sediment load could also be due to the long distance that the Tazlina River flows through fine-grained unconsolidated sediments between Lake Tazlina and the measurement site.

Suspended-sediment concentrations for lowland (nonglacial) streams such as the Gulkana River are highest during spring breakup when snowmelt runoff is high. The maximum suspended-sediment concentration of 4,000 mg/L was sampled in the Gulkana River at Gulkana during the peak runoff of 16,300 ft³/s. The relation of suspended-sediment discharge to water discharge for selected glacial and nonglacial streams in the Copper River basin is shown in figures 22 and 23.

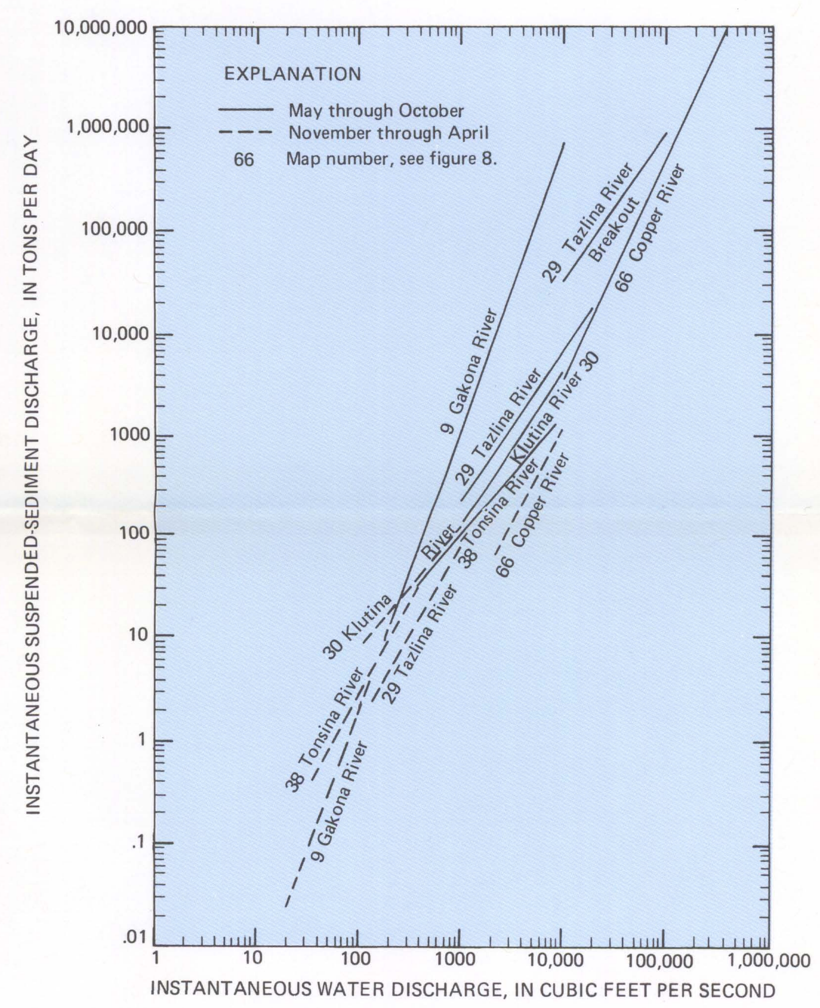

FIGURE 22. -- RELATION OF SUSPENDED-SEDIMENT DISCHARGE TO WATER DISCHARGE FOR FIVE GLACIAL STREAMS.

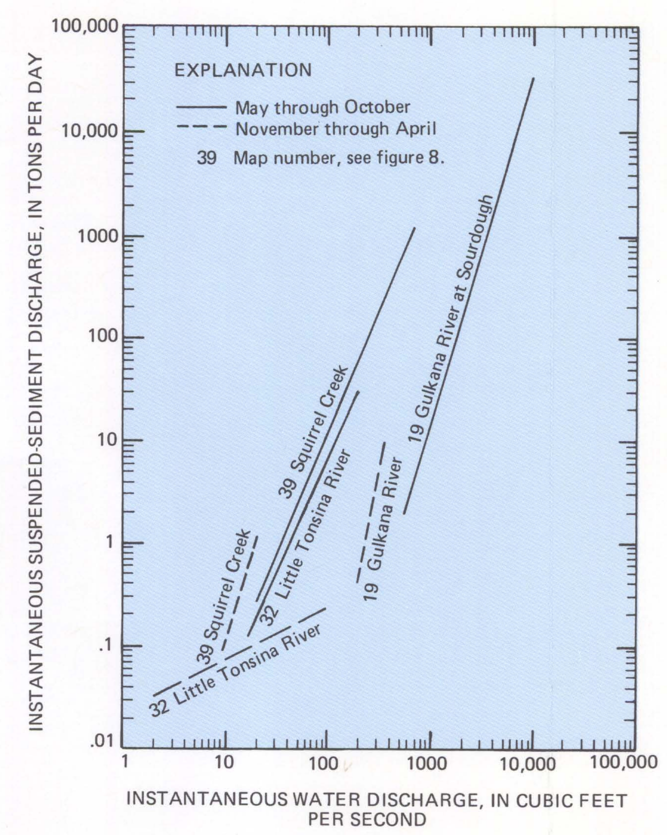

FIGURE 23. -- RELATION OF SUSPENDED-SEDIMENT DISCHARGE TO WATER DISCHARGE FOR THREE NONGLACIAL STREAMS.

TABLE 6. -- RANGE IN PHYSICAL AND CHEMICAL CHARACTERISTICS OF SURFACE WATER

[In milligrams per liter (mg/L) unless otherwise noted; Pt-Co, platinum-cobalt units]

Characteristic		Number of determinations	Range	Recommended limit for public water supply
Specific conductance	(µmho/cm)	1,017	50 -664	--
pH		892	6.0- 8.6	5.0-9.0
Color	(Pt-Co)	690	0 -165	75
Dissolved oxygen (DO)		155	8 - 14	--
Dissolved solids		688	29 -447	500 1/
Silica (SiO_2)		702	0.1- 31	--
Hardness (Ca, Mg, as $CaCO_3$)		719	23 -376	--
Calcium (Ca)		706	6 - 98	--
Magnesium (Mg)		705	0.1- 32	--
Potassium (K)		628	0 - 9.4	--
Bicarbonate (HCO_3)		766	14 -340	--
Sulfate (SO_4)		754	0.2-190	250
Chloride (Cl)		705	0 - 40	250
Fluoride (F)		625	0 - 0.8	2.4
Nitrate (as N)		671	0 - 1.1	10
Phosphate (PO_4)		55	0 - 0.5	--
Total organic carbon (C)		19	1.5- 23	--
Arsenic (As)	(µg/L)	2	6 - 16	50 µg/L
Barium (Ba)	(µg/L)	1	500	1,000 µg/L
Cadmium (Cd)	(µg/L)	1	1	10 µg/L
Chromium (Cr)	(µg/L)	1	90	50 µg/L
Cobalt (Co)	(µg/L)	1	22	--
Copper (Cu)	(µg/L)	2	2 -260	1,000 µg/L
Iron (Fe)	(µg/L)	58	20 -980	300 µg/L
Lead (Pb)	(µg/L)	1	19	50 µg/L
Manganese (Mn)	(µg/L)	58	0 -510	50 µg/L
Mercury (Hg)	(µg/L)	1	0.3	2 µg/L
Nickel (Ni)	(µg/L)	1	66	--
Selenium (Se)	(µg/L)	1	1	10 µg/L
Silver (Ag)	(µg/L)	1	5	--
Zinc (Zn)	(µg/L)	2	0 -190	5,000 µg/L

1/ Generally recognized limit for good quality water.

CHEMICAL QUALITY

Chemical Quality -- During the period 1948-82 more than 1,000 water samples were collected at 81 stream sites in the basin. A summary of the physical and chemical characteristics of those samples is shown in table 6.

Dissolved-solids concentration in samples of surface water from the Copper River basin ranged from 29 to 447 mg/L, but most streams contain less than 200 mg/L dissolved solids. The only properties or elements that exceed recommended limits (U.S. Environmental Protection Agency, 1977) for drinking water are color, iron, and manganese (table 6). Color can be aesthetically undesirable but presents no health hazard. Iron can affect the taste of water and either iron or manganese can stain fabrics and plumbing fixtures.

Surface-water samples collected within a small area in the center of the basin contain anomalously high (10-40 mg/L) concentrations of chloride. This area coincides roughly with the area of "chloride-rich" ground water in the basin and encompasses most of the saline springs discussed in an earlier section of the report. Thus, ground-water seepage and spring discharge probably affect the chemical quality of the streams in this area, most markedly during low-flow periods. The locations of the sampling sites and the areal distribution of chloride concentration in streams during low flow are shown in figure 24.

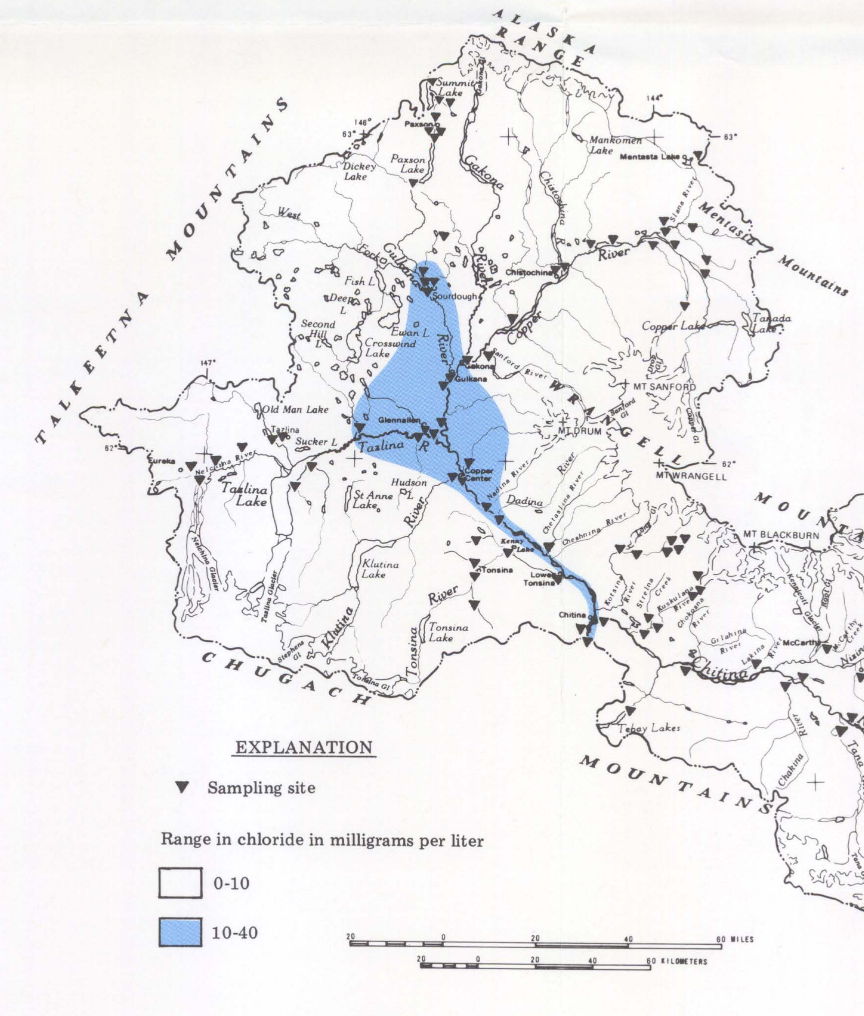

FIGURE 24. -- GENERAL AREAL CONCENTRATION OF CHLORIDE IN STREAMS AT LOW FLOW.

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WATER RESOURCES OF THE COPPER RIVER BASIN, ALASKA

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1985