Public-data File 86-32

HYDROLOGIC RECONNAISSANCE OF THE TULUKSAK RIVER BASIN, ALASKA, 1984-85

By

E.J. Collazzi[1] and M.A. Maurer[1]

Alaska Division of
Geological and Geophysical Surveys

May 1986

794 University Avenue, Basement
Fairbanks, Alaska 99709

[1]Alaska Division of Geological and Geophysical Surveys, P.O. Box 772116, Eagle River, Alaska 99577.

Table of Contents

List of Graphics

HYDROLOGIC RECONNAISSANCE OF THE TULUKSAK RIVER BASIN, ALASKA, 1984-85

BY

E.J. Collazzi and M.A. Maurer

PROJECT DESCRIPTION

Alaska DGGS personnel reconnoitered the Tuluksak River basin in southwestern Alaska in June 1984 and March 1985 to collect hydrologic data to describe the flow characteristics and quality of the surface water in the basin under both summer (high-flow) and winter (low-flow) conditions.

The 86-mi-long Tuluksak River drains approximately 830 mi^2 in southwestern Alaska. From its headwaters in the Kilbuck Mountains the river drops 1400 ft to enter the Kuskokwim River at the village of Tuluksak. The Tuluksak River is a slow moving, meandering stream over most of its length, cutting through several tundra areas in its lower section. The Fog River, a major tributary, drains a large area of tundra and contributes significantly to the brown color of the water in the lower section (Alt, 1977).

The upper Tuluksak basin is comprised of tightly folded Cretaceous rocks with interbedded layers of graywacke and shale, intruded by Cretaceous granitic rocks. Jurassic volcanic and sedimentary rocks in the foothills give way to Quaternary silt and sand deposits on the extensive lowlands (Beikman, 1974). The basin is generally underlain by moderately thick to thin permafrost, with isolated masses of permafrost in the mountains. Bedrock is exposed in parts of the upper basin, with alpine tundra, sedges, mosses, low shrubs and scattered stands of black spruce interspersed. Tundra vegetation dominates in the lowlands, with willow, alder, spruce, birch and cottonwood lining the major stream courses (Selkregg, 1976; Rieger and others, 1979; Alt, 1977).

The Tuluksak River basin lies within the transitional climatic zone of Alaska.

Continuous records kept for Nyac (9 to 14 years) show a summer temperature range of 37°F to 66°F and winter temperature range of -4°F to 12°F with recorded extremes of -49°F and 87°F. Precipitation averaged 23 in. including 43 in. of snow (Selkregg, 1976). Local variations in temperature and precipitation *can* be expected within the basin. Freeze-up generally occurs around the end of October and streams remain frozen until April or May.

Two significant settlements are located within the Tuluksak River basin. Tuluksak, a native village of approximately 260 people, is located at the mouth of the Tuluksak River. A largely subsistence economy relies heavily on fishing in the Tuluksak and Kuskokwim Rivers. Recurrent ice-jam flooding and some river-bank erosion occur (Alaska Department of Environmental Conservation, 1984). The mining camp of Nyac is located near mile 70 of the Tuluksak River in the upper part of the basin. Named for the "New York Alaska [Gold Dredging] Corporation", it has been the site of a placer gold mining operation since early in this century (Heiner, 1977). Extensive tailings occupy the floodplain of the Tuluksak River, Bear Creek and other smaller tributaries in this area.

DGGS personnel floated the Tuluksak River from mile 64 to its mouth in June 1984. Additional data-collection sites upriver were reached by truck from Nyac. The sites were revisited by helicopter in March 1985. Discharge, water-quality and stream-channel measurements were obtained.

Information in this report can be used to assess runoff and baseflow conditions of the river system and to estimate the year-round regimen of this southwestern Alaska river basin.

EXPLANATION OF GRAPHICS

Figure 1 is an index of U.S. Geological Survey (USGS) 1:250,000- and 1:63,360-scale topographic maps of the Tuluksak River basin.

Figure 2 shows the generalized physiography of the basin superimposed over a diagrammatic representation of the riverine system.

Figure 3 is a profile of the Tuluksak River and selected tributaries compiled from USGS 1:63,360-scale topographic maps. Comparative gradients along river segments and the position of tributaries and data-collection sites are shown.

Figure 4 contains a channel cross section of each data-collection site. Cross sections were developed from survey measurements taken during the June 1984 reconnaissance. Bankfull channel stage was determined from the flood-plain surface and the lower limits of permanent vegetation (Childers and Kernodle, 1983); maximum-evident-flood (MEF) stage was extrapolated from high-water marks found on the riverbanks.

Table 1 is a summary of the channel geometry and discharge measurements taken during the two reconnaissance trips and the calculated unit runoff based on these measurements. Unit runoff, obtained by dividing stream discharge by drainage area, can be used to compare seasonal water yields in a basin or subbasin (Childers and Kernodle, 1983).

Table 2 contains calculations based on the observed data. From the channel cross sections, the approximate discharge for bankfull and MEF conditions are calculated with the simplified slope-area method (Riggs, 1979). The bank full discharge indicates the maximum amount of flow that may be expected without flooding, and the MEF discharge indicates the maximum instantaneous peak discharge at the site in recent years (Childers and Kernodle, 1983). Drainage-basin characteristics are used to calculate predicted 2-yr and SO-yr floods using Lamke's (1979) method. (A 2-yr flood has a 50 percent chance of being exceeded in a particular year, whereas

a 50-yr flood has a 2 percent chance of being exceeded; these values are based on multiple regression analysis of streamflow records, which are very scanty in Alaska.) The Froude number is a mathematical relationship between mean velocity, mean depth and the gravitational constant and is used to compare states of flow at the sites. (In a rectangular channel, flow is tranquil if the Froude number is less than 1.0 and is rapid if greater than 1.0 [Dalrymple and Benson, 19681.) Observed summer conditions were used as a basis in calculating discharge using the simplified slope-area method and may be compared to the actual discharge values in Table 1. Site-specific conditions, such as changes in slope and nonuniformity of flow due to a nonideal channel reach, cause discrepancies between calculated and measured discharge values.

Table 3 is a summary of water-quality data gathered at all sites during the 1984 and 1985 reconnaissance trips.

ACKNOWLEDGEMENTS

The authors thank R.R.W. Ireland of DGGS and G.A. McCoy, formerly of DGGS, for their assistance in gathering data for this report, and

for their thoughtful review.

REFERENCES CITED

Alaska Department of Environmental Conservation, 1984, Village sanitation in Alaska, 213 p.

Alt, K.T., 1977, Inventory and cataloging of sport fish and sport fish waters of western Alaska: Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Completion Report, Project F-9-9, volume 18, 128 p.

Beikman, H.M., 1974, Preliminary geologic map of the southwest quadrant of Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-611, 2 sheets.

Childers, J.M., and Kernodle, D.R., 1983, Reconnaissance of surface-water resources in the Kobuk River basin, Alaska, 1979-80: U.S. Geological Survey Water-resources Investigations Report 83-4027, 35 p.

Dalrymple, T. and Benson, M.A., 1968, Measurement of peak discharge by the slope-area method: U.S. Geological Survey, Techniques of water-resources investigations, Book 3, Chapter A2, 12 p.

Heiner, V.D., 1977, Alaska mining history, a source document: University of Alaska Museum, History and Archaeology Series no. 17, 463 p.

Lamke, R.D., 1979, Flood characteristics of Alaskan streams: U.S. Geological Survey Water-resources Investigations Report 78-129, 61 p.

Rieger, S., Shoephorster, D.B. and Furbush, C.E., 1979, Exploratory soil survey of Alaska: U.S. Soil Conservation Service, 213 p.

Riggs, H.C., 1979, A simplified slope-area method for estimating flood discharges in natural channels: U.S. Geological Survey Journal of Research, v.4, pp. 285-291.

Selkregg, L.L., 1976, Alaska regional profiles--Southwest region: University of Alaska Arctic Environmental Information and Data Center, 313 p.

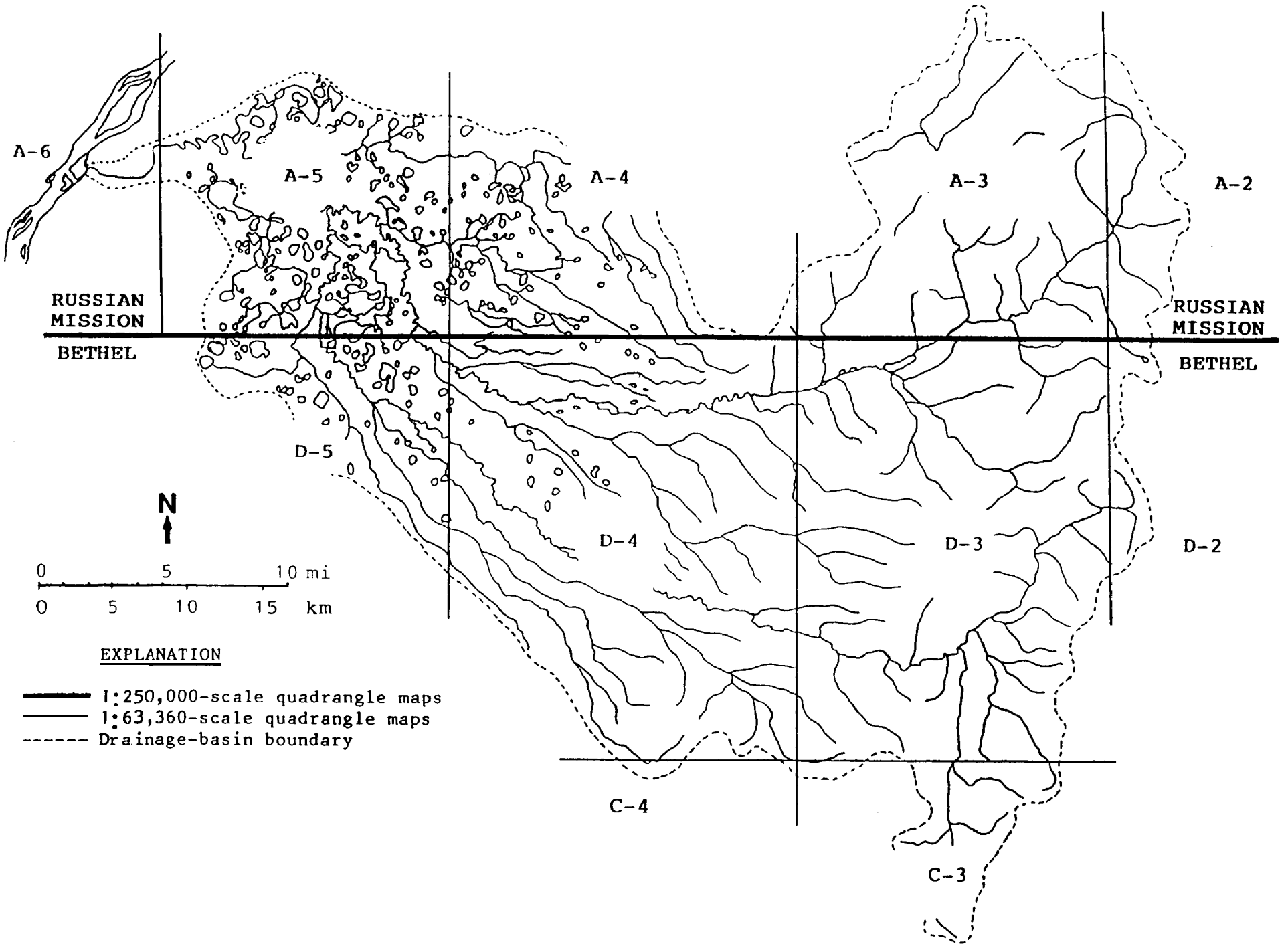

Figure 1. Index of U.S Geological Survey topographic maps by quadrangle for the Tuluksak River basin, Alaska.

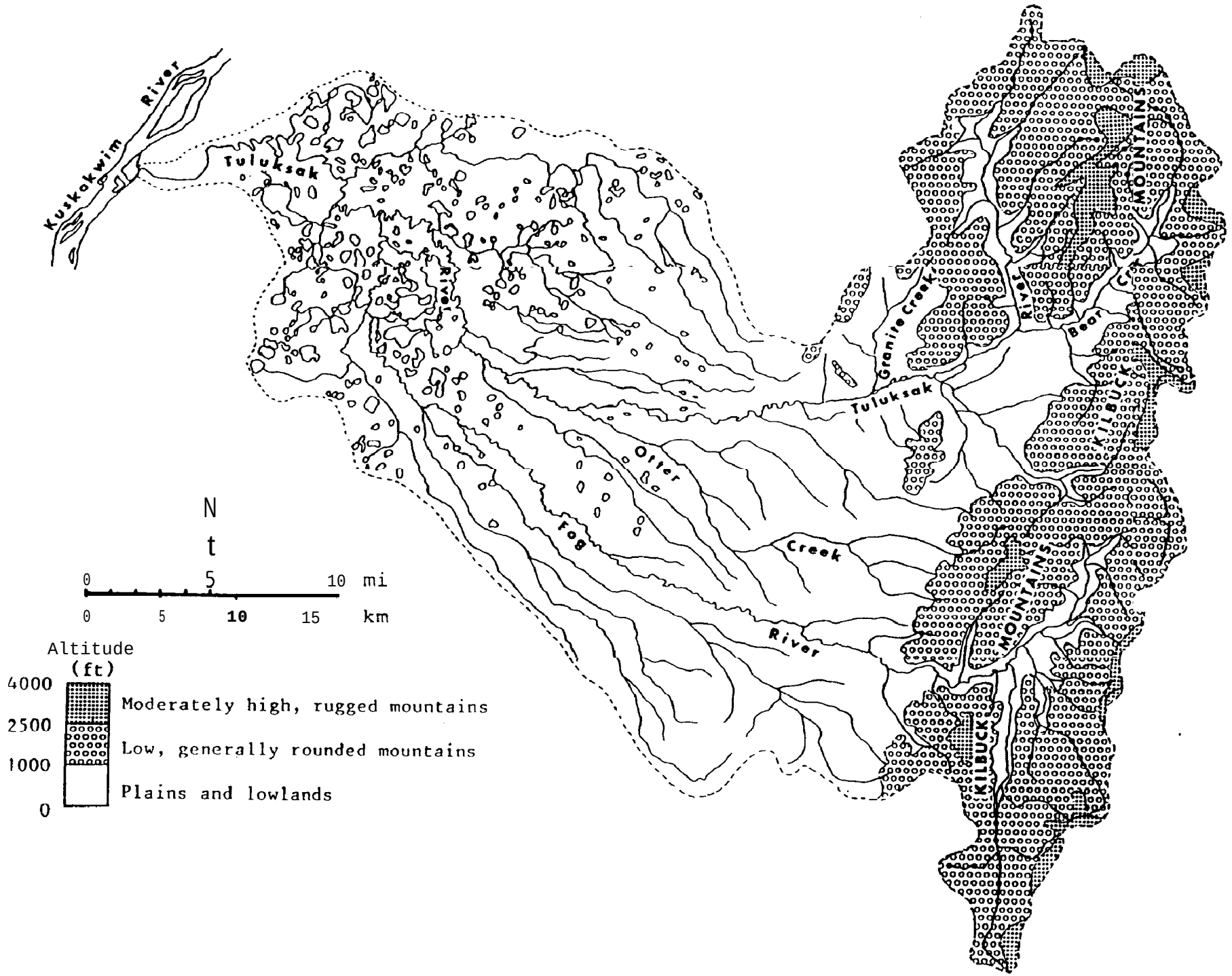

Figure 2. Generalized physiography, Tuluksak River basin, Alaska.

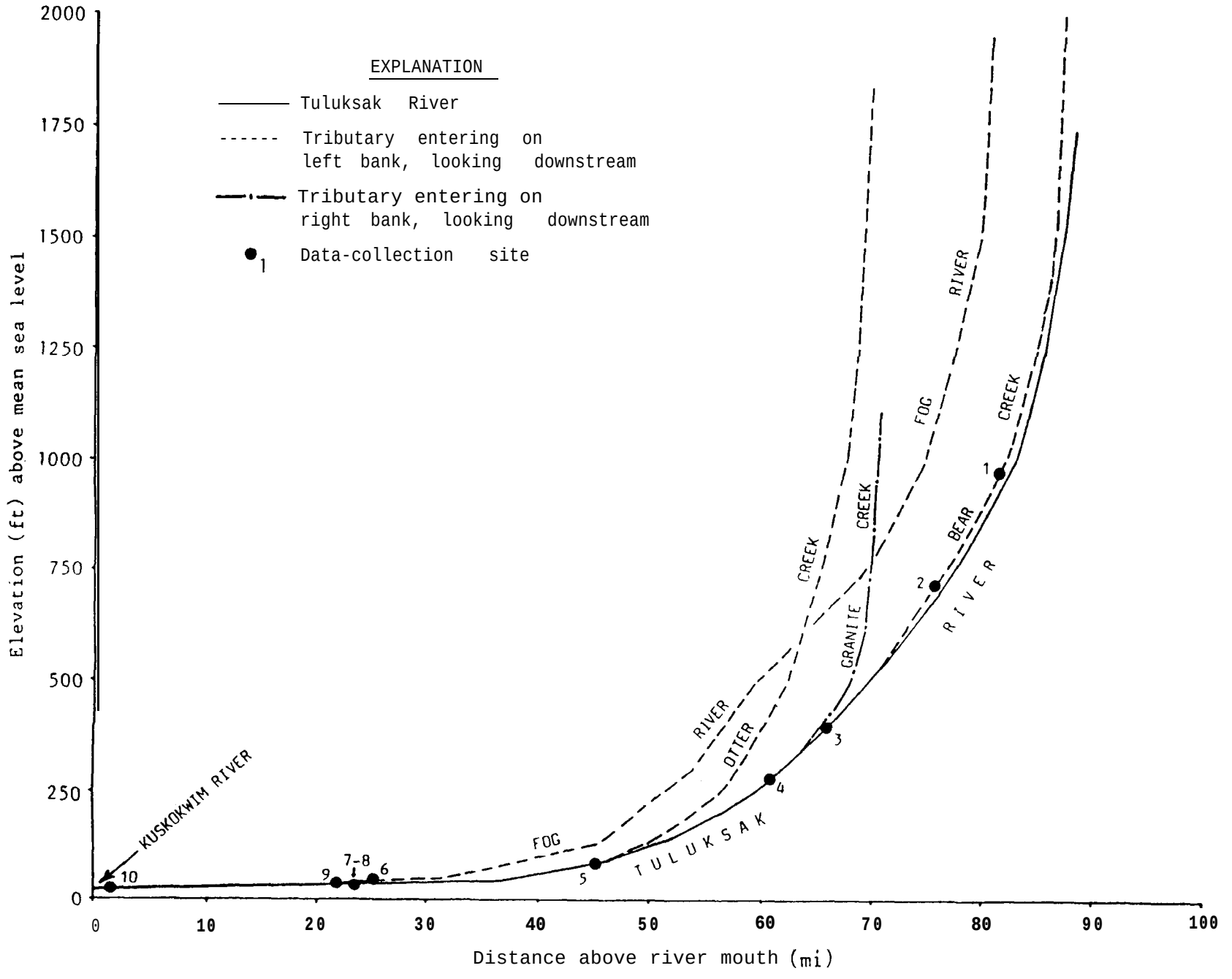

Figure 3. Profile of Tuluksak River and selected tributaries, Alaska.

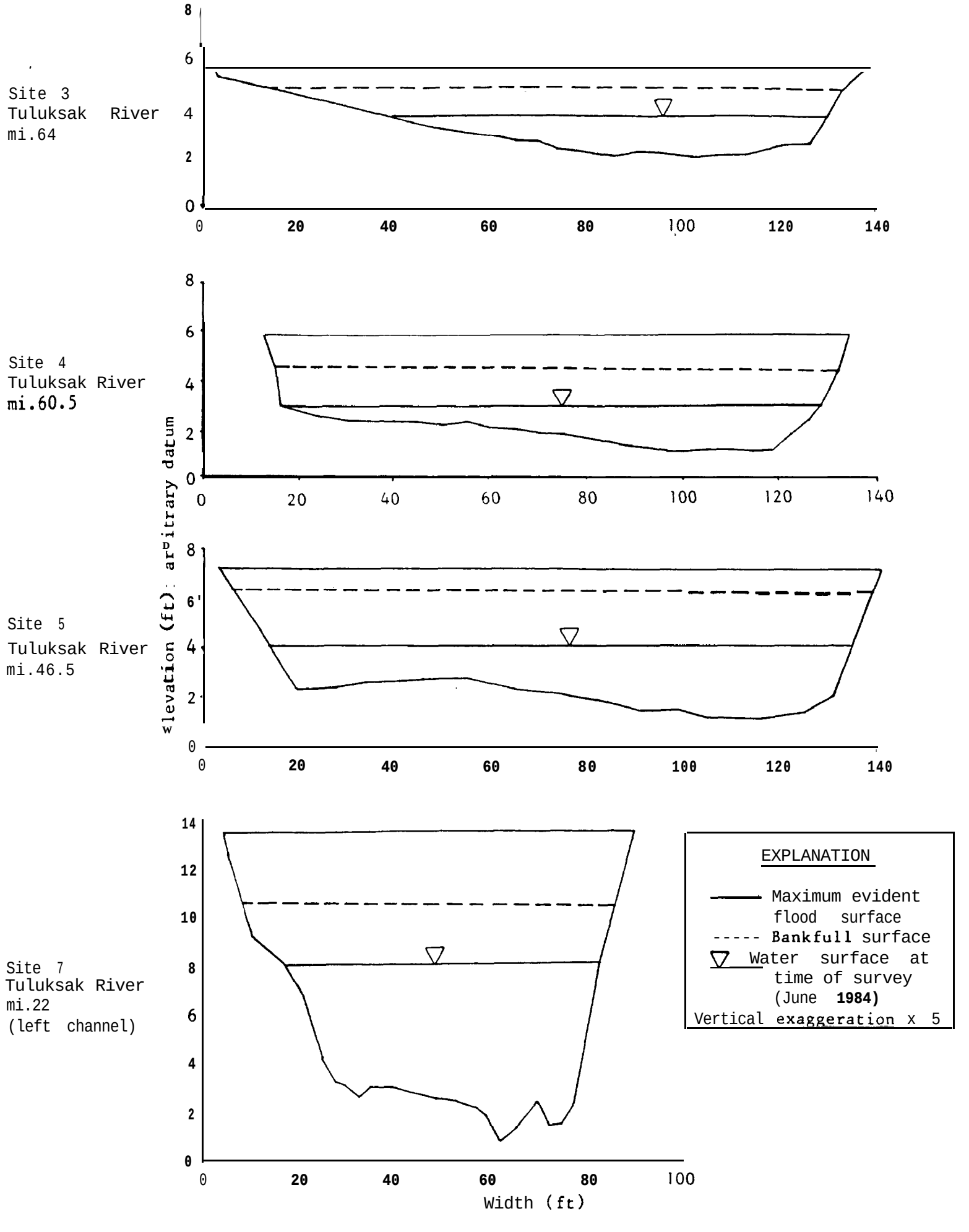

Figure 4. Channel cross-sections, Tuluksak River basin, June **1984.**

Table 1. Summary of observed discharge and cross-sectional data, Tuluksak River basin, Alaska, 1984-85.

Data collection site	Bed material	Slope (ft/ft)	Cross-sectional area-f t² winter[a]	summer	Water-surface width (ft) winter	summer	Mean depth (ft) winter	summer	Maximum depth (ft) winter	summer	Mean velocity (fps) winter	summer	Maximum velocity (fps) winter	summer	Discharge (cfs) winter	summer	Unit runoff (cfs/mi²) winter	summer
3. Tuluksak River mi 64	cobbles, gravel	0.0049	10	101	11	95	0.8	1.0	1.9	1.7	0.9	1.9	2.4	4.3	14	250	0.07	1.24
4. Tuluksak River mi 60.5	cobbles, gravel	0.0015	40	112	43	112	0.8	1.0	1.7	1.8	1.1	1.9	2.2	4.0	53	267	0.23	1.15
5. Tuluksak River mi 46.5	gravel	0.0007	52	231	61	122	0.9	1.8	3.0	2.8	0.6	1.4	2.4	2.4	71	343	0.22	1.07
7. Tuluksak River (left channel) mi 22[c]	silt, sand	0.0004	[b]	319	-	66	-	4.9	-	7.2		1.4	-	2.3	-	473	-	-
9. Tuluksak River mi 21.5	silt, sand		190	-	90	-	1.9	-	3.9	-	0.7	-	2.0	-	182	-	0.25	-

[a] 'Winter' refers to reconnaissance of March 26-27, 1985; 'summer' to June 18-22. 1984.
[b] No measurements made.
[c] Data for this site represents only the larger of two divergent channels and does not indicate total flow or runoff from this drainage area.

Table 2. Summary of calculated discharge and cross-sectional data, Tuluksak River basin, Alaska, 1984-85.

Data collection site	Calculated bankfull characteristics						Calculated MEF characteristics			Drainage basin characteristics[a]					Predicted flood		Froude number (6/84 flow)	Calculated slope-area discharge at observed 6/84 stage (cfs)
	Cross-sectional area (ft^2)	Water-surface width (ft)	Mean depth (ft)	Maximum depth (ft)	Mean velocity (fs)	Discharge (cfs)	Cross-sectional area (ft^2)	Discharge (cfs)	Unit runoff (cfs/mi^2)	Area (mi^2)	Mean annual precipitation (in.)	Mean minimum temperature, January(°F)	% of basin forested	% of basin under lakes	Q_2 (cfs) 2-year flood	Q_{50} 50-year flood		
3. Tuluksak River mi. 64	215	118	1.8	2.0	5.3	I.130	334	2,030	10.1	202	20	-4	21	0	1,820	4,860	0.34	414
4. Tuluksak River mi. 60.5	297	118	2.5	3.4	3.9	1.170	441	1.970	8.5	233	20	-4	24	0	2.040	5,350	0.34	319
5. Tuluksak River mi. 46.5	510	132	3.9	5.1	3.5	1.790	645	2,440	7.6	322	20	-4	19	0	2.850	7,180	0.18	623
6. Fog River	[b]									327	20	-4	6	2	2.740	6,860		
7. Tuluksak River (left channel) mi. 22[c]	495	79	6.3	9.6	2.7	1.360	737	2.310			-	-				-	0.11	758
9. Tuluksak River mi. 21.5										715	20	-4	12	2	5.190	11,700		
10. Tuluksak River mi. 1.5										825	20	-4	12	3	5.620	12,400		

[a] Mean annual precipitation and mean minimum January temperature from Lamke (1979); other characteristics planimetrically determined from USGS topographic maps.

[b] No measurements made.

[c] Data for this site represents only the larger of two divergent channels and does not indicate total flow or runoff from this drainage area.

Table 3. Water quality at selected sites. Tuluksak River basin, Alaska, 1984-85.

Data collection site	Water temperature (°C) winter[a]	summer	Specific conductance (umhos/cm @ 25°C) winter	summer	Oxygen dissolved (mg/l) winter	summer	Oxygen dissolved (percent saturation) winter	summer	Bicarbonate Alkalinity field (mg/l) winter	summer	pH (units) winter	summer	Calcium dissolved (mg/l) winter	Magnesium dissolved (mg/l) winter	Sodium dissolved (mg/l) winter	Potassium dissolved (mg/l) winter
1. Bear Creek above Nyac Dredge	0	13.0	81	72	14.3	10.4	100	97	34	-	6.3	6.7	2.52	1.04	2.90	0.34
2. Bear Creek below Nyac Dredge	0	11.5	91	74	14.0	11.2	97	100	37	-	6.7	6.5	2.54	1.08	2.81	0.42
3. Tuluksak River mi. 64	0	8.5	73	68	14.0	11.2	96	95	37	36	6.8	7.0	2.49	1.01	2.66	0.34
4. Tuluksak River mi. 60.5	0	9.9	83	67	13.2	11.5	91	100	37	34	6.5	6.2	2.22	0.99	1.50	0.33
5. Tuluksak River mi. 46.5	0	9.5	80	65	11.2	11.5	77	100	38	35	6.6	7.1	2.12	1.01	1.71	0.22
6. Fog River	0		86		0.0		0		39	-	7.1		1.59	1.15	3.96	0.60
7. Tuluksak River (left channel) mi. 22		12.9		72		10.5		99								
9. Tuluksak River mi. 21.5	0		84		7.0		47		39	-	6.2		2.25	1.03	3.18	0.48

[a] 'Winter' refers to reconnaissance of March 26-27, 1985; 'summer' to June 18-22.1984.

Table 3 (part II)

Data collection site	Sulfate dissolved (mg/l) winter [a]	Chloride dissolved (mg/l) winter	Silica dissolved (mg/l) winter	Turbidity (NTU) winter	Turbidity (NTU) summer	Suspended sediment concentration (mg/l) summer	Strontium total (ug/l) summer	Vanadium total (ug/l) summer	Barium total (ug/l) summer	Aluminum total (ug/l) summer	Beryllium total (ug/l) summer	Silver total (ug/l) summer	Nickel total (ug/l) summer	Chromium total (ug/l) summer
1. Bear Creek above Nyac Dredge	8.51	1.82	2.62	0.3	4		60	< 10	20	710	< 2	< 2	< 5	< 5
2. Bear Creek below Nyac Dredge	9.81	1.59	2.19	0.4	4		60	< 10	20	90	< 2	< 2	< 5	< 5
3. Tuluksak River mi. 64	6.29	1.71	2.26	0.3	10	4	60	< 10	< 10	78	< 2	< 2	< 5	< 5
4. Tuluksak River mi. 60.5	5.63	1.68	2.43	0.3	20	2	60	< 10	< 10	55	< 2	< 2	< 5	< 5
5. Tuluksak River mi. 46.5	5.03	1.80	2.34	1	70	6	60	< 10	< 10	170	< 2	< 2	< 5	< 5
6. Fog River	3.94	2.05	3.84	20										
7. Tuluksak River (left channel) mi. 22					80	18	60	< 10	30	260	< 2	< 2	< 5	< 5
8. Tuluksak River (right channel) mi. 22					110		60	< 10	20	60	< 2	< 2	< 5	< 5
9. Tuluksak River mi. 21.5	4.45	1.90	2.81	6		-	-							
10. Tuluksak River mi. 1.5				11		-	-							

[a] 'Winter' refers to reconnaissance of March 26-27, 1985; 'summer' to June 18-22,1984.

Table 3 (part III)

Data collection site	Antimony total (ug/l) summer [a]	Titanium total (ug/l) summer	Cadmium total (ug/l) summer	Zinc total (ug/l) summer	Lead total (ug/l) summer	Selenium total (ug/l) summer	Mercury total (ug/l) summer	Iron total (ug/l) summer	Boron total (ug/l) summer	Manganese total (ug/l) summer	Hagnesium total (ug/l) summer	Copper total (ug/l) summer	Arsenic total (ug/l) summer
1. Bear Creek above Nyac Dredge	< 10	< 50	< 0.5	6	< 5	< 2	< 0.05	610	< 50	21	1700	< 5	< 2
2. Bear Creek below Nyac Dredge	< 10	< 50	< 0.5	2	< 5	< 2	< 0.05	65	< 50	< 20	1800	< 5	< 2
3. Tuluksak Rivet mi. 64	< 10	< 50	< 0.5	3	< 5	< 2	< 0.05	52	< 50	< 20	1800	< 5	< 2
4. Tuluksak River mi. 60.5	< 10	< 50	< 0.5	3	< 5	< 2	< 0.05	57	< 50	< 20	1700	< 5	< 2
5. Tuluksak Rivet mi. 46.5	< 10	< 50	< 0.5	2	< 5	< 2	< 0.05	470	< 50	38	1700	< 5	< 2
7. Tuluksak River (left channel) mi. 22	< 10	< 50	< 0.5	4	< 5	< 2	< 0.05	2000	< 50	97	2400	< 5	2
a. Tuluksak Rivet (tight channel) mi. 22	< 10	< 50	< 0.5	2	< 5	< 2	< 0.05	1200	< 50	81	1800	< 5	< 2

[a] 'Winter' refers to reconnaissance of Match 26-27. 1985; 'summer' to June 18-22.1984.

Notes

Specific conductance. dissolved oxygen concentration. and bicarbonate alkalinity concentration showed little seasonal variation at most sites despite seasonal variation in streamflow and water temperature. The concentration of dissolved solids (as indicated by specific conductance and major ion concentrations) was similar among sites. There was a progressive increase in turbidity from headwater to lower Tuluksak sites.

Water samples had undetectable concentrations of most trace metals and minor elements. Strontium, barium, aluminum, zinc, iron, and manganese were detected in relatively low concentrations, except for elevated Iron values at lower Tuluksak sites in the summer.