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GEOLOGICAL SURVEY

CHANNEL EROSION SURVEYS ALONG THE TAPS ROUTE, ALASKA 1977

by

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and

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CONVERSION FACTORS

For use of those readers who may prefer to use the International System of Units (SI) rather than U.S. customary units, the conversion factors for the units used in this report are listed below:

Multiply U.S. customary units	By	To obtain SI units
cubic feet per second (ft^3/s)	0.02832	cubic meters per second (m^3/s)
cubic feet per second per square mile [$(ft^3/s)/mi^2$]	0.0109	cubic meters per second square kilometer [$(m^3/s)/km^2$]
feet (ft)	0.3048	meters (m)
inches (in.)	25.40	millimeters (m)
miles (mi)	1.609	kilometers (km)

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ABSTRACT

Channel surveys were made along the TAPS route during 1977 at the same 28 sites that were studied in 1976. In addition, a new site at pipeline mile 22 near Deadhorse (alignment No. 134) along the Sagavanirktok River was put under surveillance. Except for changes wrought by the completion of construction, most of the sites showed very little change. Significant events include: virtual completion of all construction activities along the pipeline, the pipeline start-up, and the breakup flood along the Sagavanirktok River which breached many river-training structures. In general, 1977 saw heavy flooding on the streams draining the north and south slopes of the Brooks Range and moderate flooding on streams further south.

Aerial photogrammetric surveys were used again in 1977 on the same seven sites as in 1976. Results document the applicability of the method for channel erosion studies, especially those on large braided rivers. However, it requires engineering judgement and personal knowledge of the particular site to avoid being occasionally led to inaccurate conclusions.

INTRODUCTION

This report is the 1977 chapter of a long-term effort to document both natural and construction-induced change at selected stream crossing sites along the trans-Alaska pipeline system (TAPS) route. It contains information obtained during the past year in a study of channel erosion along the TAPS route. This year 29 sites were investigated. With the exception of the Sagavanirktok River, all were investigated during previous years. Previous investigations for this study and background information for this report are contained in reports by Brice (1971), Childers (1972, 1974, 1975), Childers and Jones (1975), and Doyle and Childers (1975, 1976).

The year 1977 saw the startup of the pipeline. Construction activities consisted primarily of berm construction and bank protection along the northern sections of the route; with a few exceptions, this has now been completed. The 1976-1977 winter was unusually mild and the spring and summer floods were unusually moderate. Consequently, little erosion was recorded at the channel erosion sites. Those changes which did occur were generally the result of construction of river-training structures or of subchannel migration inside braided floodplains.

A number of significant events have occurred at the channel erosion sites since the 1976 surveys. Snowmelt produced a spring breakup flood on the Sagavanirktok River which measured 29,550 ft^3/s on June 5 at the

USGS gaging station near Sagwon and caused many failures on the spur dike fields on that river. It was the largest flood of the seven-year record kept by the USGS. Moderate rain on snow produced large floods on those streams draining the south slope of the Brooks Range. The National Oceanic and Atmospheric Administration weather station at Bettles recorded 0.57 in. of rain on May 31. On the same day, a record flood of 19,120 ft^3/s was recorded at the Middle Fork Koyukuk River gage near Wiseman. The following day, record floods were measured on the Jim River, 12,400 ft^3/s and on Prospect Creek, 3,800 ft^3/s. Only moderate flooding occurred on drainages further south. An exception is the Gulkana River where a record flood of 9,172 ft^3/s was measured on June 2 at the gage at Sourdough. An unusually large icing was observed at the Hammond River crossing site but caused little or no erosion. Over 6 ft of scour was measured at the centerline cross section of the Salcha River during the breakup flood in May.

This year's treatment of events on large braided rivers is somewhat different than in previous years. Experience has shown that on these rivers vertical scour or deposition is negligible except, perhaps, if measured during a flood. Visual inspections at normal or low flow are all that is needed to insure that the thalwegs are at their characteristic depths of approximately 3-5 feet. The significant changes occur through lateral erosion and changing braiding patterns. A planimetric presentation, therefore, conveys more information than the usual cross section. For the photogrammetric sites at Lowe River, Delta River at Flood Creek, and Tsina River at Ptarmigan, planimetric maps for 1976 and 1977, rather than cross sections, are used to display the changes. The photogrammetric cross sections were obtained, but these cross sections extend only to the water level at the time of the survey. During past years, the cross sections were completed by on-site surveys of the thalweg; this was not done in 1977. In many of the non-braided rivers where vertical erosion was judged not to be a problem, the thalweg was also not surveyed.

Photogrammetric surveys were completed in 1977 at the same seven sites as in 1975 and 1976. The results were scaled stereomodels, selected cross sections, and planimetric maps showing the locations of subchannels and other important features. Results from this and the previous two years of photogrammetric surveys continue to show that photogrammetry is a useful technique for channel erosion surveillance, particularly on wide, irregular floodways.

It is at times difficult to obtain comparable cross sections at the same locations on repeated stereomodels so that channel changes can be measured. The difficulty in relocating the cross section is caused by not having established cross section end points that can be precisely located on each year's air photos. This problem, and occasional unexplained minor inaccuracies of the stereomodels, necessitate the use of engineering judgement and field experience in interpretations.

All of the sites studied in this report, except for the Sagavanirktok River, Middle Fork Koyukuk River near Coldfoot, Klutina River and Castner

Creek sites, were surveyed during 1977. All field data are on file at the Alaska District Office of the Water Resources Division, U.S. Geological Survey, in Anchorage.

Except for the photogrammetrically surveyed sites, aerial photography in this report was taken by Air Photo Tech under contract to the U.S. Geological Survey or to Alyeska Pipeline Service Company. The photogrammetric surveys were conducted by North Pacific Aerial Surveys.

We would like to acknowledge the cooperation of Alyeska Pipeline Service Company which furnished some of the photographs and construction data used in this report.

Channel cross sections illustrated in the report are viewed as looking downstream. On the aerial photos, the upstream left-bank endpoint is labeled No. 1, the upstream right-bank endpoint is No. 2, the downstream left-bank endpoint is No. 3, and the downstream right-bank endpoint is No. 4.

Table 1 summarizes the findings at 28 sites for 1977 (Sagavanirktok River site not included). Locations of the 29 channel erosion survey sites are shown in figure 1.

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Brice, J. E., 1971, Measurement of lateral erosion at proposed river crossing sites of the Alaska pipeline: U.S. Geological Survey open-file report, 39 p.

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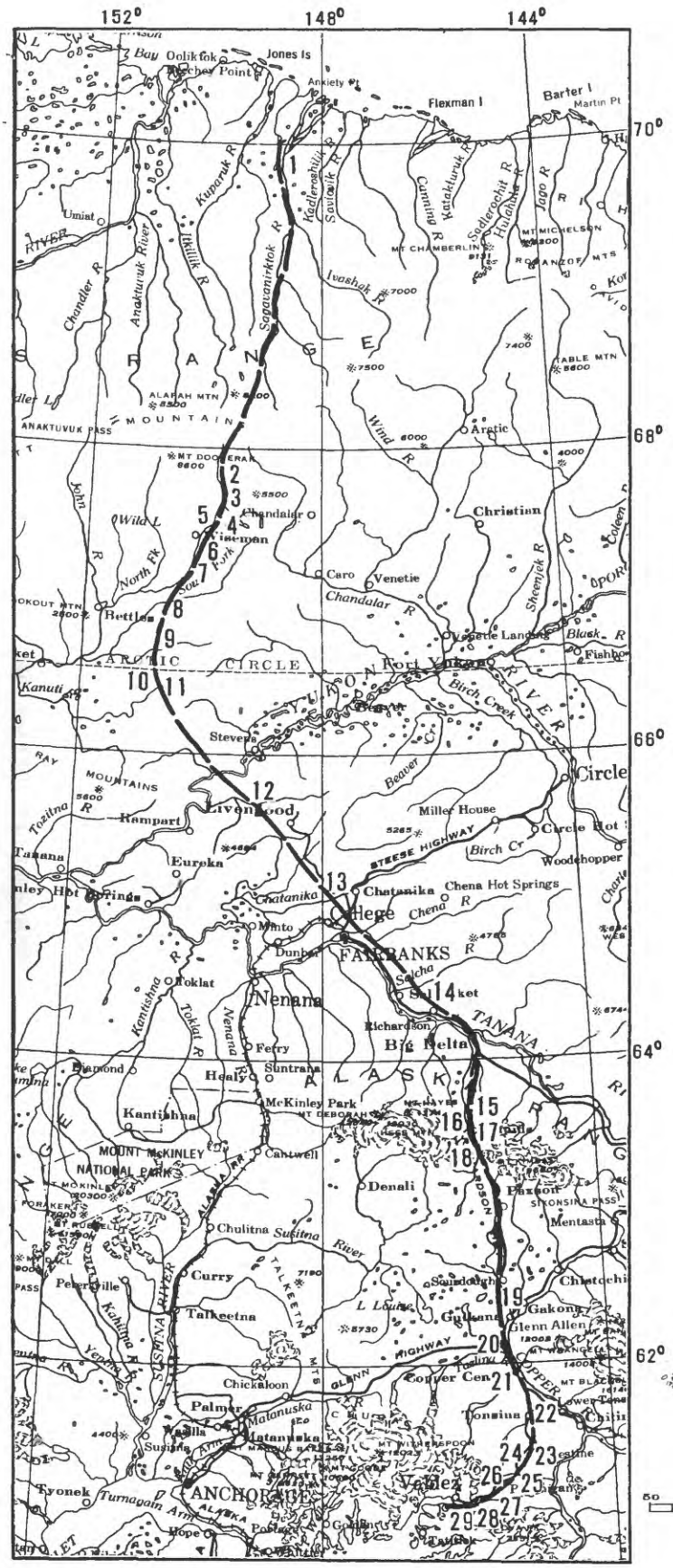
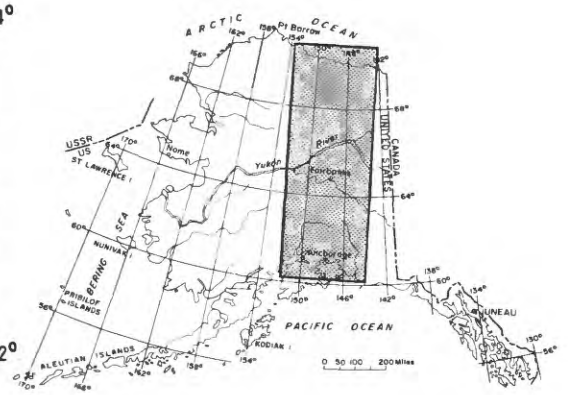


EXPLANATION

Trans-Alaska pipeline

1. Sagavanirktok River
2. Snowden Creek
3. Dietrich River
4. Middle Fork Koyukuk River
5. Hammond River
6. Middle Fork Koyukuk River
7. Middle Fork Koyukuk River
8. South Fork Koyukuk River
9. Jim River
10. Prospect Creek
11. Kanuti River
12. Hess Creek
13. Chatanika River
14. Salcha River
15. Flood Creek
16. Delta River
17. Castner Creek
18. Delta River
19. Gulkana River
20. Tazlina River
21. Klutina River
22. Tonsina River
23. Tiekel River
24. Tiekel River
25. Tsina River
26. Tsina River
27. Tsina River
28. Sheep Creek
29. Lowe River



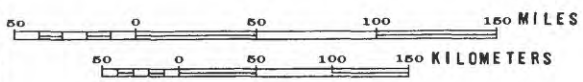


Figure 1. -- Channel erosion survey sites along the Trans-Alaska pipeline.

Table 1.--*Channel erosion survey results, 1977.*

[A negative value indicates erosion. A positive value indicates deposition or construction-related channel constriction. Note that much of the bank erosion need not have taken place below the normal flow or flood stage of the river. An example is berm construction where much of the constriction shown in the table occurred above the bankfull stage.]

		Maximum Net Change Since 1976 Survey		
	Site	Thalweg Elevation (ft)	Bank Erosion (ft)	Remarks
1.	Snowden Creek	-3	+25	Scour at the upstream section. Berm construction caused constriction at the center line.
2.	Dietrich River	+3	+70	Berm construction at the upstream section.
3.	M.F. Koyukuk R. at Hammond River	-5	+10	Construction-related centerline changes and a record breakup flood.
4.	Hammond River	+3	+50	Construction-related changes in the centerline and upstream sections.
5.	M.F. Koyukuk R. near Wiseman	0	+150	Berm construction at the centerline, and a record breakup flood.
6.	M.F. Koyukuk R. near Coldfoot	--	0	The zone of intense erosion has shifted approximately 1,400 ft downstream from site A.
7.	S.F. Koyukuk R.	--	0	Minor changes in the centerline and downstream sections.
8.	Jim River	-4	0	Completion of construction along the centerline.
9.	Prospect Creek	--	0	Access bridge removed; miscellaneous grading.
10.	Kanuti River	--	0	Dikes constructed on centerline; miscellaneous grading.
11.	Hess Creek	+2	0	Overhead crossing completed.
12.	Chatanika River	-2	+20	Changes in the downstream section. Temporary access bridge removed.
13.	Salcha River	-6	-10	Meander is naturally widening.
14.	Flood Creek	0	-8	Downstream of centerline, channel is shifting slightly.

Table 1.--*Channel erosion survey results, 1977.*--Continued

[A negative value indicates erosion. A positive value indicates deposition or construction-related channel constriction. Note that much of the bank erosion need not have taken place below the normal flow or flood stage of the river. An example is berm construction where much of the constriction shown in the table occurred above the bankfull stage.]

	Site	Maximum Net Change Since 1976 Survey: Thalweg Elevation (ft)	Bank Erosion (ft)	Remarks
15.	Delta River at Flood Creek	--	0	Two construction dikes washed out; flow no longer at left bank. Much dike construction.
16.	Castner Creek at Lower Miller Creek	--	--	Overhead crossing completed.
17.	Delta River at Phelan Creek	--	0	Subchannels continue to wander.
18.	Gulkana River	-6	0	Natural changes.
19.	Tazlina River	0	0	Centerline cross section relocated.
20.	Klutina River	--	0	No cross sections obtained.
21.	Tonsina River	--	-10	Brush cutting along the access pad.
22.	Tiekel River at Tiekel	--	0	New Richardson Highway alignment being constructed nearby.
23.	Tiekel River near Tiekel	--	0	New Richardson Highway alignment alongside centerline.
24.	Tsina River near Tiekel	--	0	Diking on the right bank of the centerline.
25.	Tsina River near Ptarmigan	--	0	Upstream cross section relocated.
27.	Tsina River at Ptarmigan	--	0	Subchannels continue to wander.
26.	Sheep Creek	--	0	Construction-related changes at the centerline section.
27.	Lowe Creek	--	0	Diking around the centerline and erosion at the upstream cross section, right bank.

Sagavanirktok River at Alignment No. 134 near Deadhorse

Location.--Lat 69°58', long 148°44', in W½ secs.: 18,19; E½ secs.: 8,17,20, T.7 N., R.14 E., 16 mi south of Deadhorse, and 16 mi North of Franklin Bluff airstrip alignment No. 134.
[Sagavanirktok (D-3), 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--The authors' interest was drawn to this site because of the problems encountered during the spring breakup flood in June 1977. Documentation of these problems can illustrate some of the dangers which may be found in construction on arctic braided rivers.

Figure 2 shows alignment No. 134 on the Sagavanirktok River near Deadhorse on August 31, 1969, prior to construction. The pipeline route and the seven spur dikes are also shown. It is evident that the character of the river changes dramatically in the reach shown in the photo. The floodplain expands from a width of 6,000 ft upstream to 15,000 ft downstream, and the slope of the river profile decreases, both of which help produce a more intricate braiding pattern (Alyeska Pipeline Service Co., written commun., 1974). Note that the major conveyance for the river flows near the right bank, but that a major subchannel flows near the left bank, along the pipeline right-of-way. The dark grey vegetated islands inside the flood plain indicate that the river maintains much of its split-channel character during higher stages.

Figure 3 is a small-scale photograph of the pipeline right-of-way on June 10, 1977, following the June 5 peak of the spring breakup flood. The spur dikes and the approximate location of the material sites are shown in the figure. Spur dikes No. 2, No. 3, and No. 4 stretch from the left bank to a vegetated island, damming the subchannels. Note that only dikes No. 1 and No. 7 remain intact; the others have been breached:

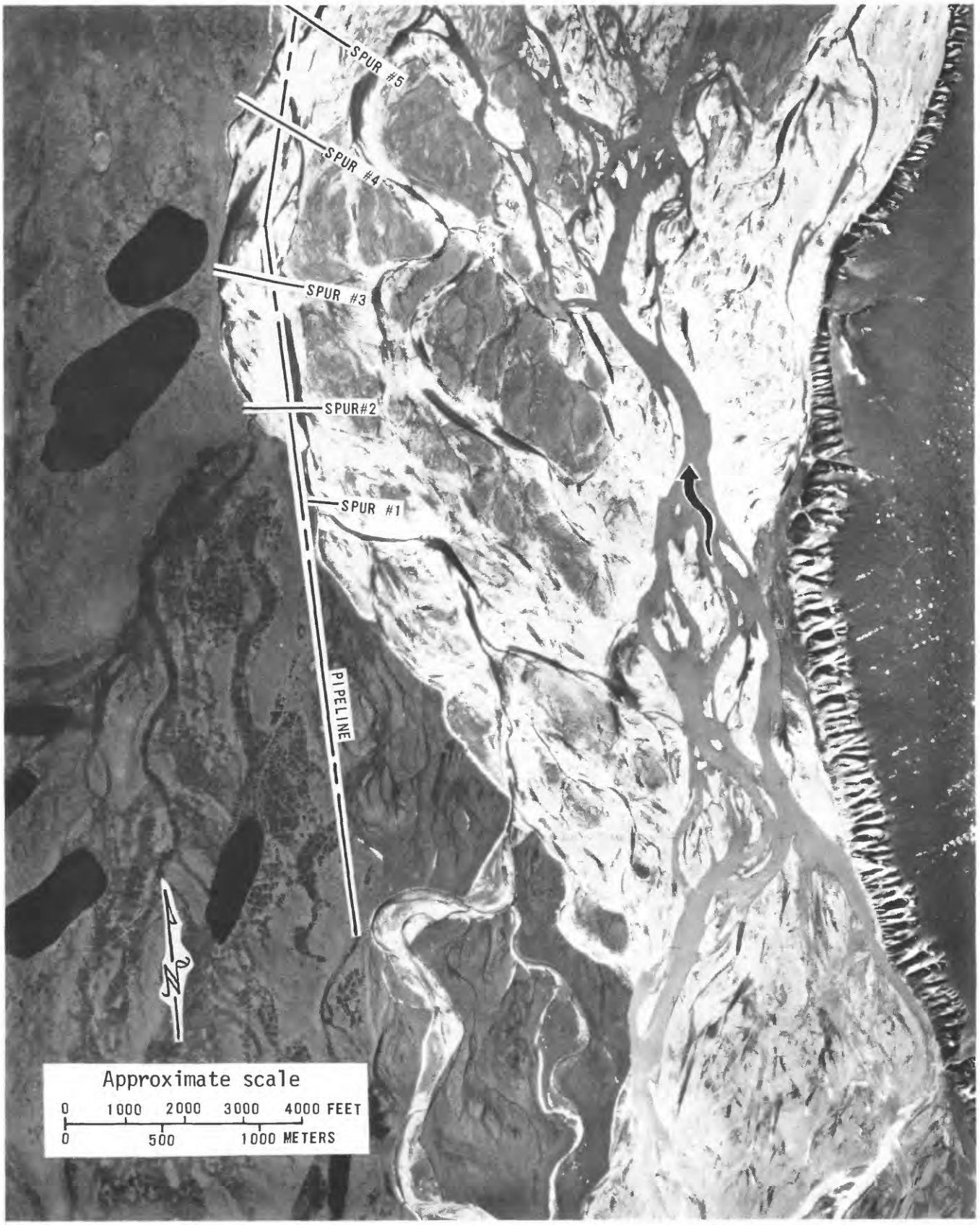


Figure 2.--Sagavanirktok River at Alignment No. 134 near Deadhorse, August 31, 1969.
AIR PHOTO TECH

Spur No. 2	breached in 1 location
Spur No. 3	breached in 2 locations
Spur No. 4	breached in 3 locations
Spur No. 5	breached in 3 locations
Spur No. 6	intentionally breached

Figure 4 shows spur No. 3 (center of the photo) on June 6, one day after peak discharge.

The breached spur dikes at least partially dammed off the subchannel and were overtopped and partially washed out. They failed to force the river to develop adequate flood conveyance elsewere in the flood plain.

Figure 5 shows a cross section of the Sagavanirktok River just downstream from spur No. 3. The figure displays a typical wide, flat profile of braided river. The pipeline design flood stage of approximately 173 ft and the June 1977 flood stage of approximately 177 ft are shown. Spur No. 3, just downstream, is projected onto the cross section. The average fall for this section of the river is 0.00174 feet per foot.

The spur dikes were designed to protect the pipeline from the pipeline design flood of 122,000 ft^3/s. The peak discharge at the spur dike field is not known. Sixty miles upstream at the USGS gaging station, Sagavanirktok River near Sagwon, which is above the confluence of the Ivashak River and several smaller tributaries, the peak discharge was 29,500 ft^3/s on June 5. This was the largest flood in the station's seven-year history. Even though the stage was higher than anticipated, it is highly unlikely that the discharge along alignment No. 134 approached that of the pipeline design flood.

Figure 4.--Spur dike no. 3 on Alignment No.134 of the Sagavanirktok River near Deadhorse, June 6, 1977.

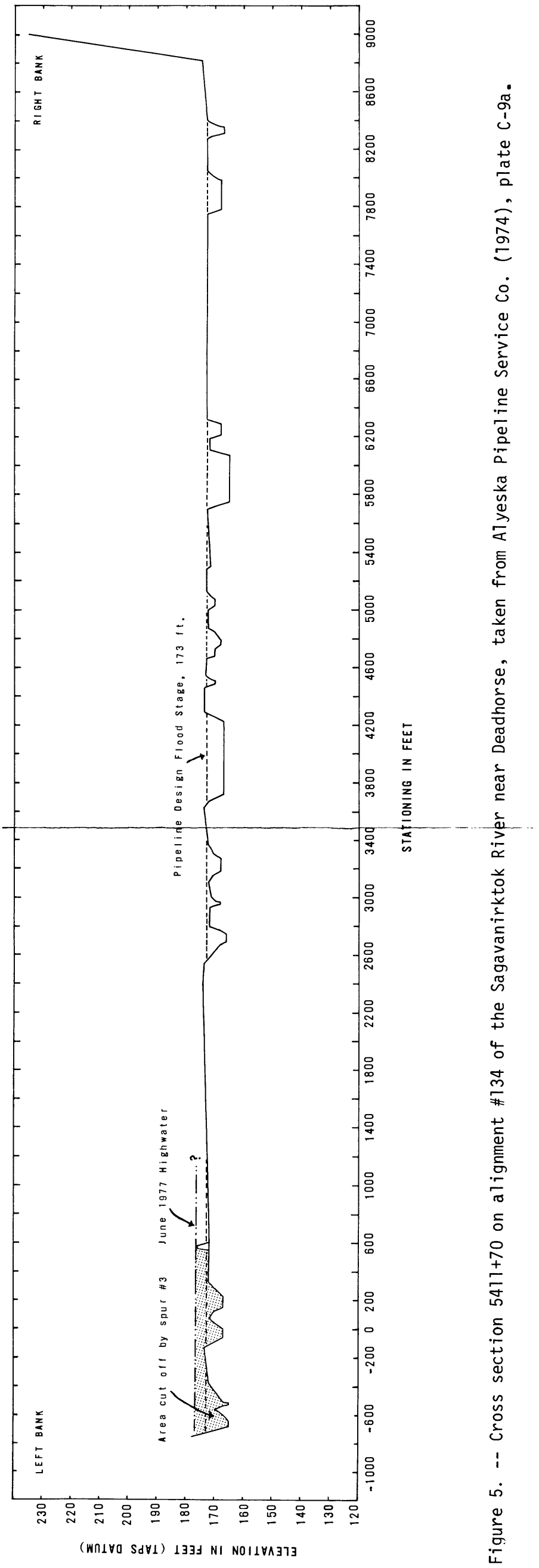


Figure 5. -- Cross section 5411+70 on alignment #134 of the Sagavanirktok River near Deadhorse, taken from Alyeska Pipeline Service Co. (1974), plate C-9a.

Snowden Creek near Dietrich Camp

Location.--67°44'20", long 149°45'10", in SW¼ sec.26, T.34 N., R.10 W., 0.5 mi upstream from mouth of Dietrich River, and about 25 mi northeast of Wiseman.

[Chandalar (C-6) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 6 shows the Snowden Creek crossing site on July 12, 1977. During the past year, protective rip-rap has been installed around the centerline.

The crossing site was resurveyed on both May 21 and September 16, 1977. In May, changes were found in the upstream cross section and changes due to the completion of construction were found in the centerline section. In addition, the September survey showed that upstream thalweg had deepened since May (fig. 7). The peak discharge of July 31, 1976, was measured by indirect methods on May 21, 1977, at a site about 0.5 mi upstream from the pipeline. The peak discharge was 460 ft^3/s or about 30 $(ft^3/s)/mi^2$.

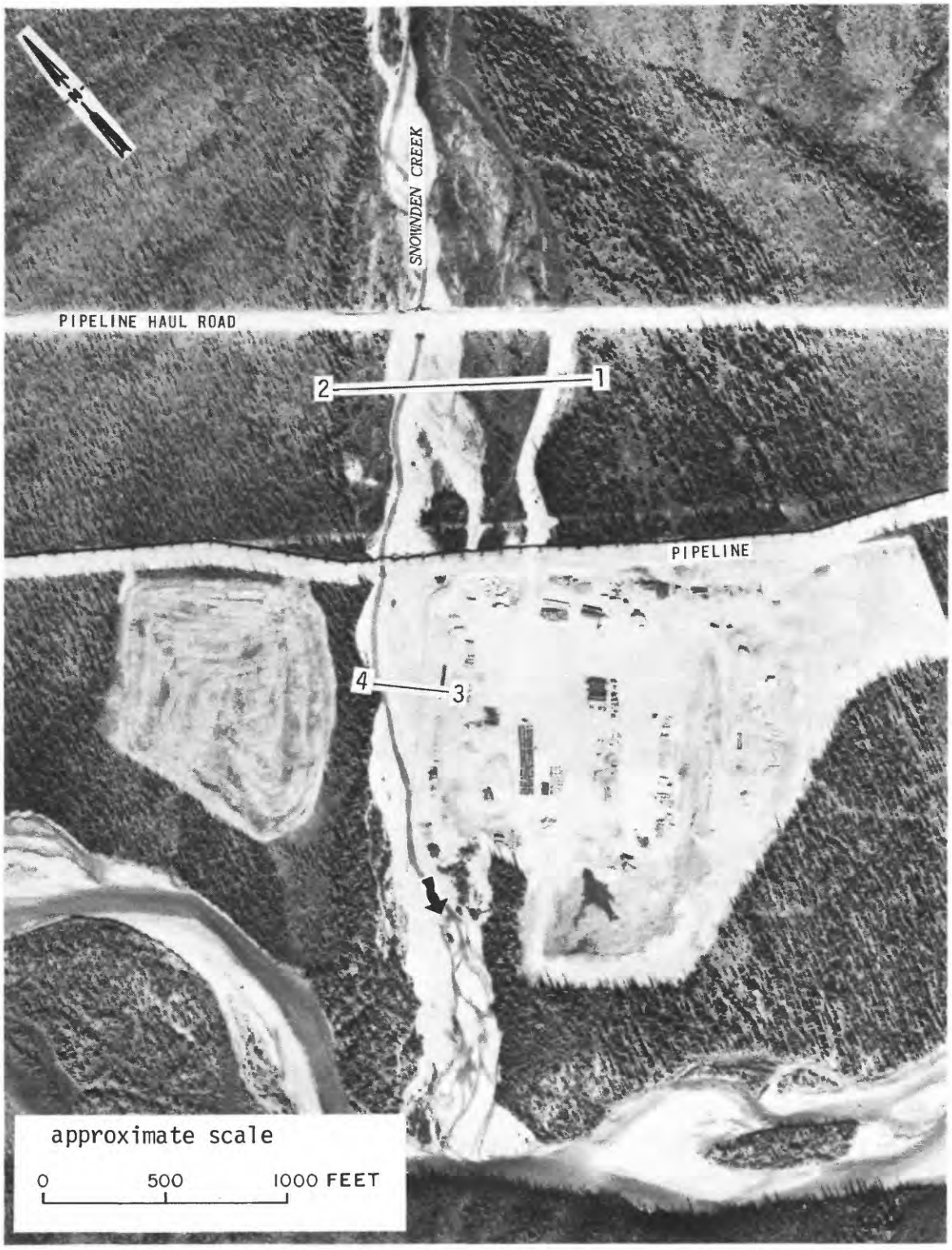
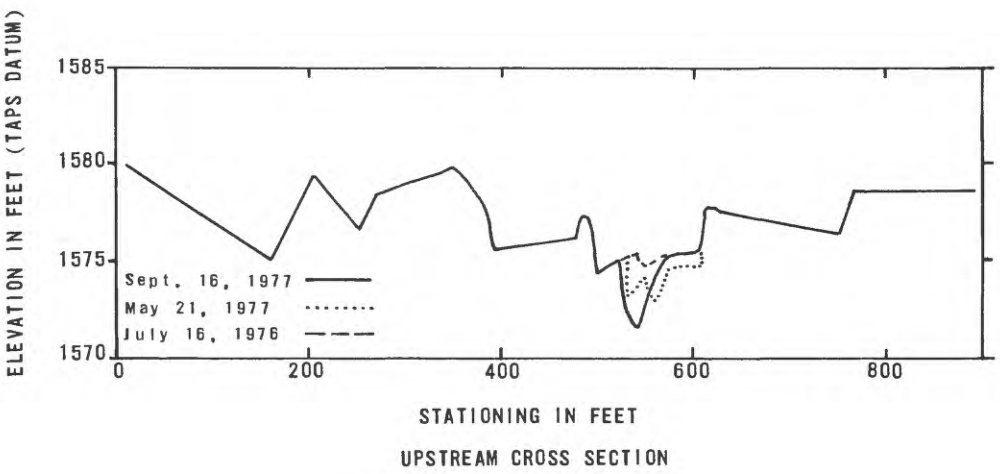


Figure 6. -- Snowden Creek near Dietrich camp, July 12, 1977

AIR PHOTO TECH



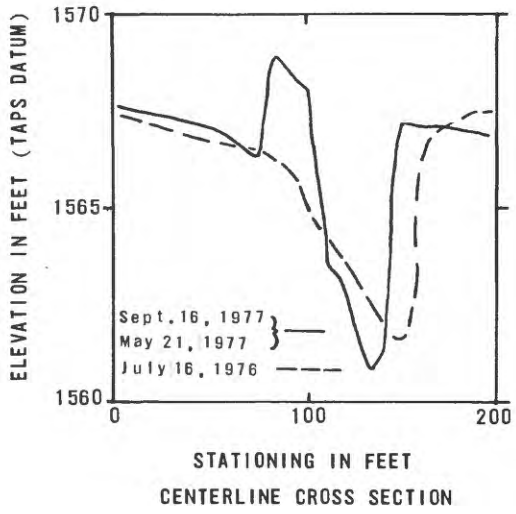


Figure 7. -- Cross sections of Snowden Creek near Dietrich Camp.

Dietrich River at Bettles River

Location.--Lat 67°38'40", long 144°44'20", in NE¼ sec.35, T.33 N., R.10 W., 0.5 mi upstream from Bettles River, and about 15 mi northeast of Wiseman.

[Chandalar (C-6) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 8 shows the Dietrich River site on July 12, 1977. During the last year, rip-rap has been installed along the right bank of the centerline.

The site was resurveyed on May 19, 1977. No reliable datum was established for this year's centerline section; thus it cannot be rigorously compared to last year's. However, it is evident that the construction activities have changed the section's shape considerably. Both the upstream and the highway bridge section have also changed (fig. 9). No survey was taken on the downstream section.

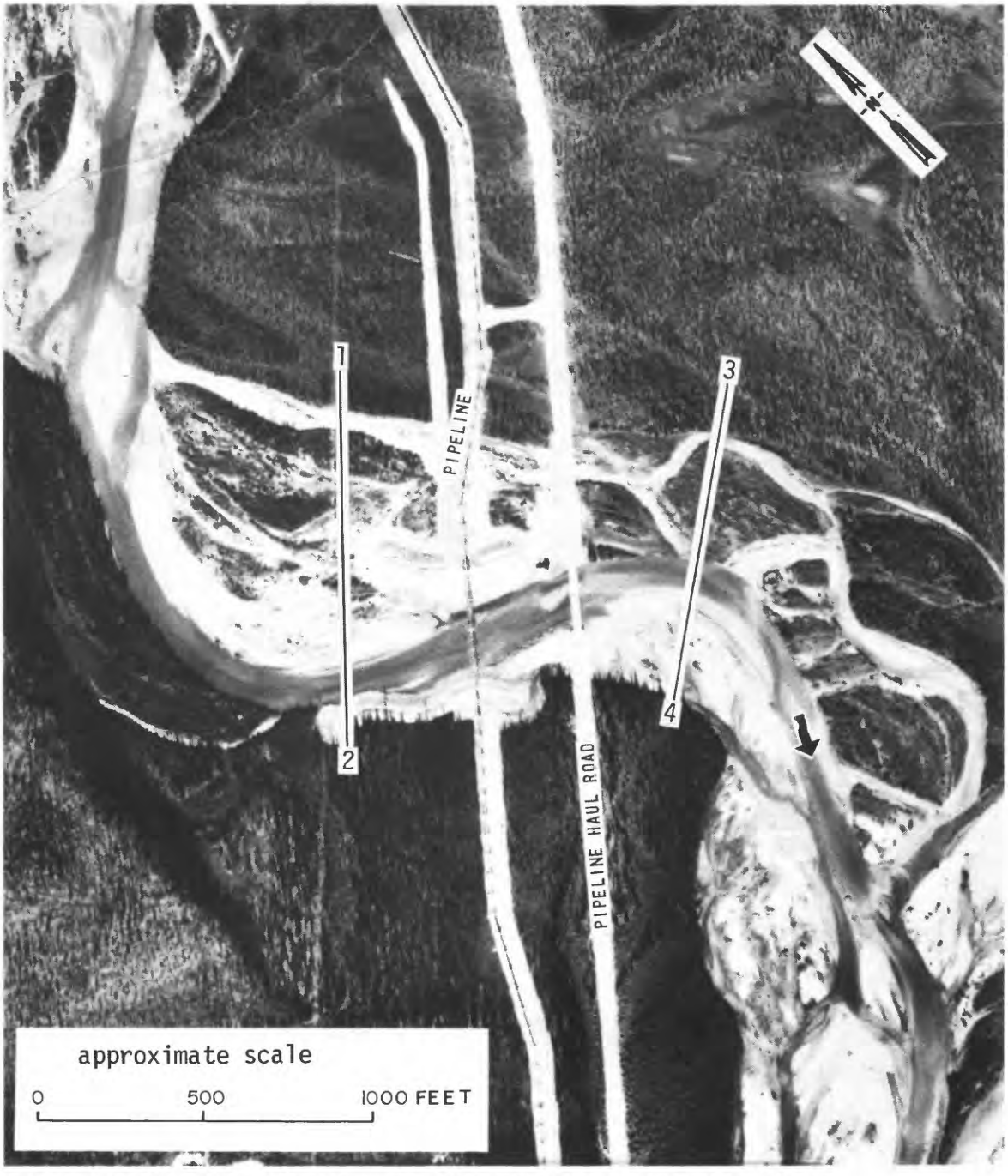


Figure 8. -- Dietrich River at Bettles River, July 12, 1977.
AIR PHOTO TECH

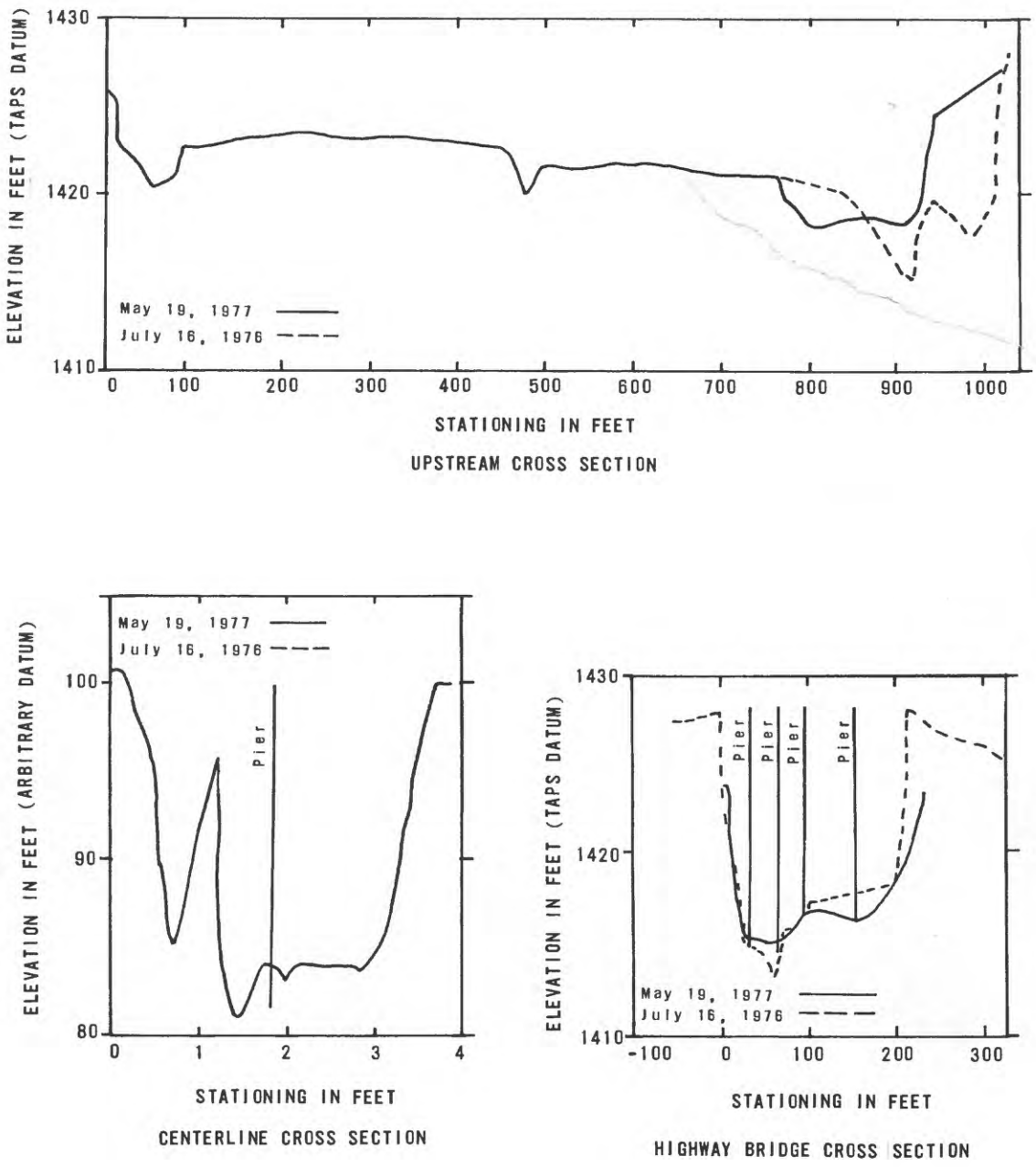


Figure 9. -- Cross section of Dietrich River at Bettles River.

Middle Fork Koyukuk River at Hammond River

Location.--Lat 67°27'45", long 150°01'20", in SE¼ sec.33, T.31 N., R.11 W., 0.3 mi upstream from Hammond River, and 4.3 mi northeast of Wiseman. [Wiseman (B-1) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 10 shows the Middle Fork Koyukuk River at the Hammond River crossing site on July 12, 1977. A protective dike extending from the right bank of the Middle Fork of the Koyukuk to the left bank of the Hammond River has been completed. A dike has been constructed on the left bank, extending from above the centerline to the haul road. In addition, fill which extended out from the left bank of the centerline has been removed by erosion.

The site was resurveyed on May 19, 1977. All cross sections are significantly changed. Construction activities have radically constricted the centerline and helped deepen the thalweg to more than 5 ft. The thalweg of the downstream section has been slightly deepened (fig.11).

The breakup flood peak occurred May 31, 12 days after the site was surveyed. The peak discharge coincided with rainfall in the area. The National Oceanic and Atmospheric Administration weather station at Bettles recorded 0.57 in. of rain on May 31. The 19,120-ft^3/s peak was the largest of the station's seven years of record.

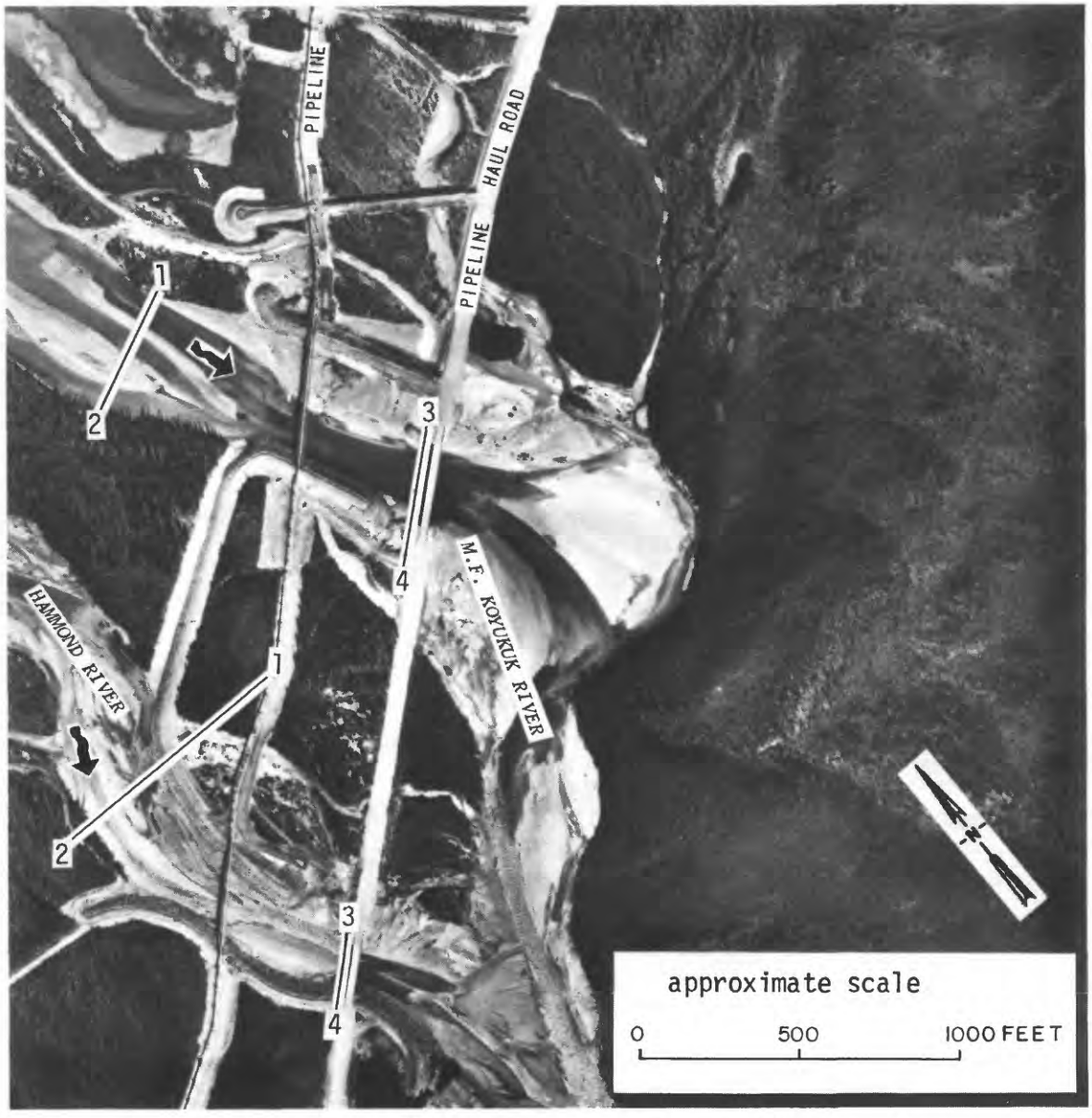
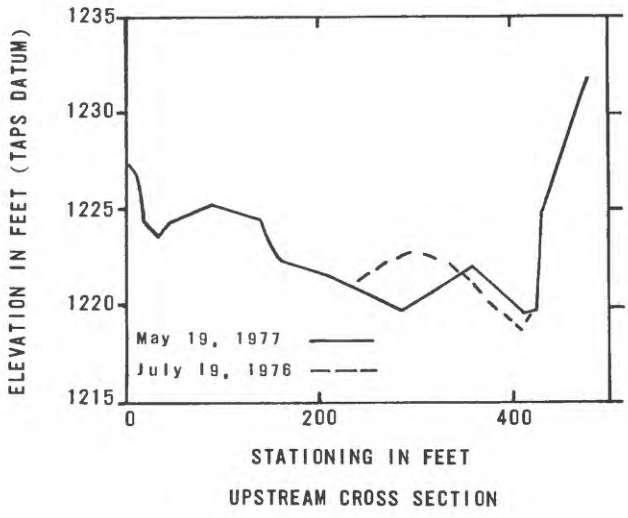
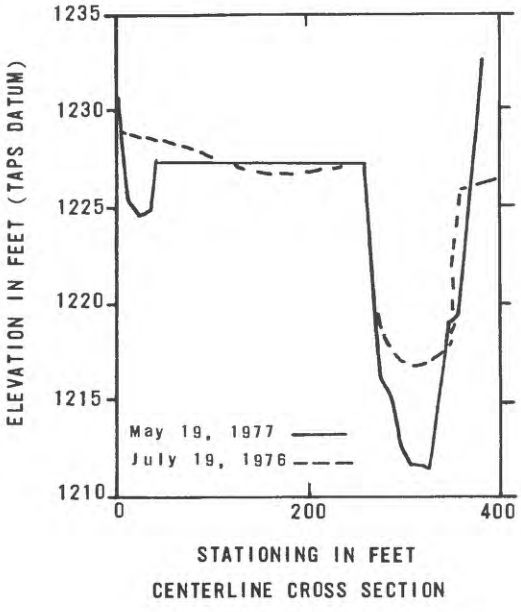


Figure 10. -- Middle Fork Koyukuk River at Hammond River and Hammond River near Wiseman, July 12, 1977. AIR PHOTO TECH





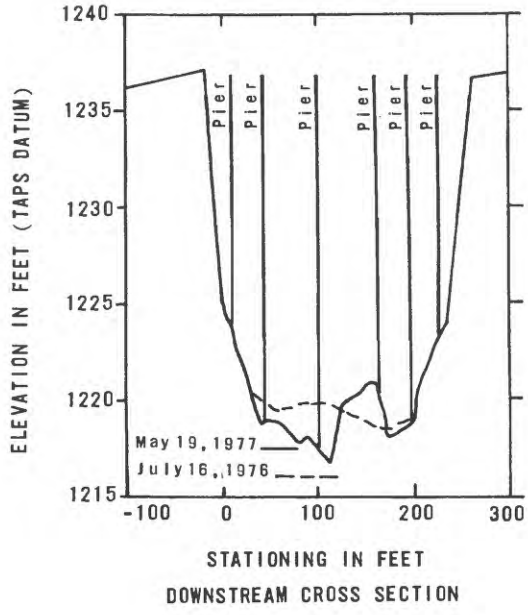


Figure 11. -- Cross sections of the Middle Fork Koyukuk River at Hammond River.

Hammond River near Wiseman

Location.--Lat 67°27'45", long 150°02'00", in SE¼ sec.32, T.31 N., R.11 W., 0.2 mi upstream from mouth at Middle Fork Koyukuk River, and 4.0 mi northeast of Wiseman.

[Wiseman (B-1) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 10 shows the Hammond River crossing site on July 12, 1977. A protective dike has been completed on the left bank of the river. Fill extending off the right bank of the centerline has eroded.

Figure 12 shows an active icing in progress on March 23, 1977. On-site observations indicated that the icing was caused by the highway bridge for the haul road. This year's survey indicated that the icing caused little or no erosion.

The crossing site was resurveyed on September 16, 1977. Figure 13 shows the changes in the three surveyed sections. The thalwegs of all three sections have become shallower by over 2.5 ft. No survey was made on the downstream section this year.

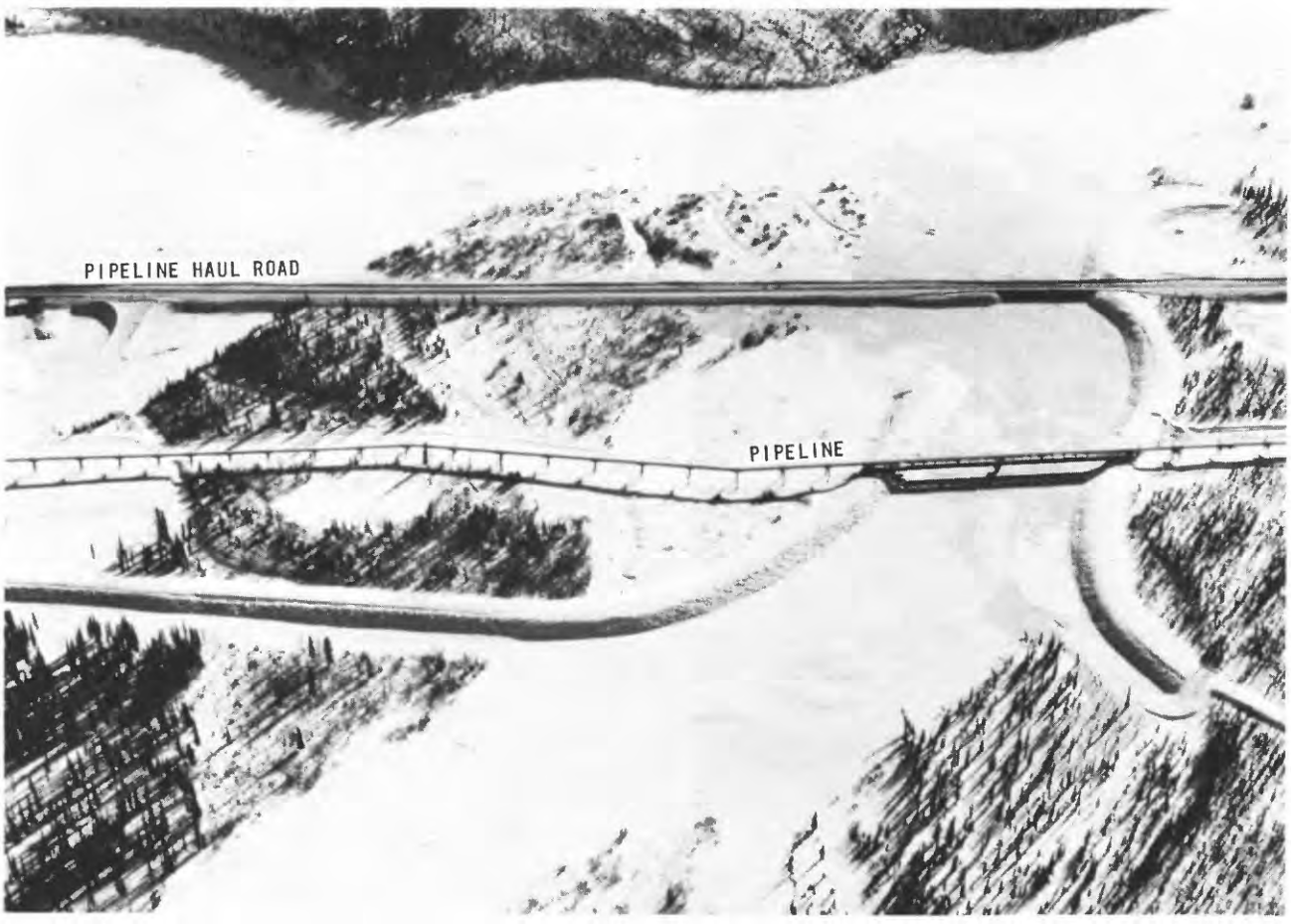


Figure 12.--Icing in progress on the Hammond River near Wiseman, March 23, 1977.

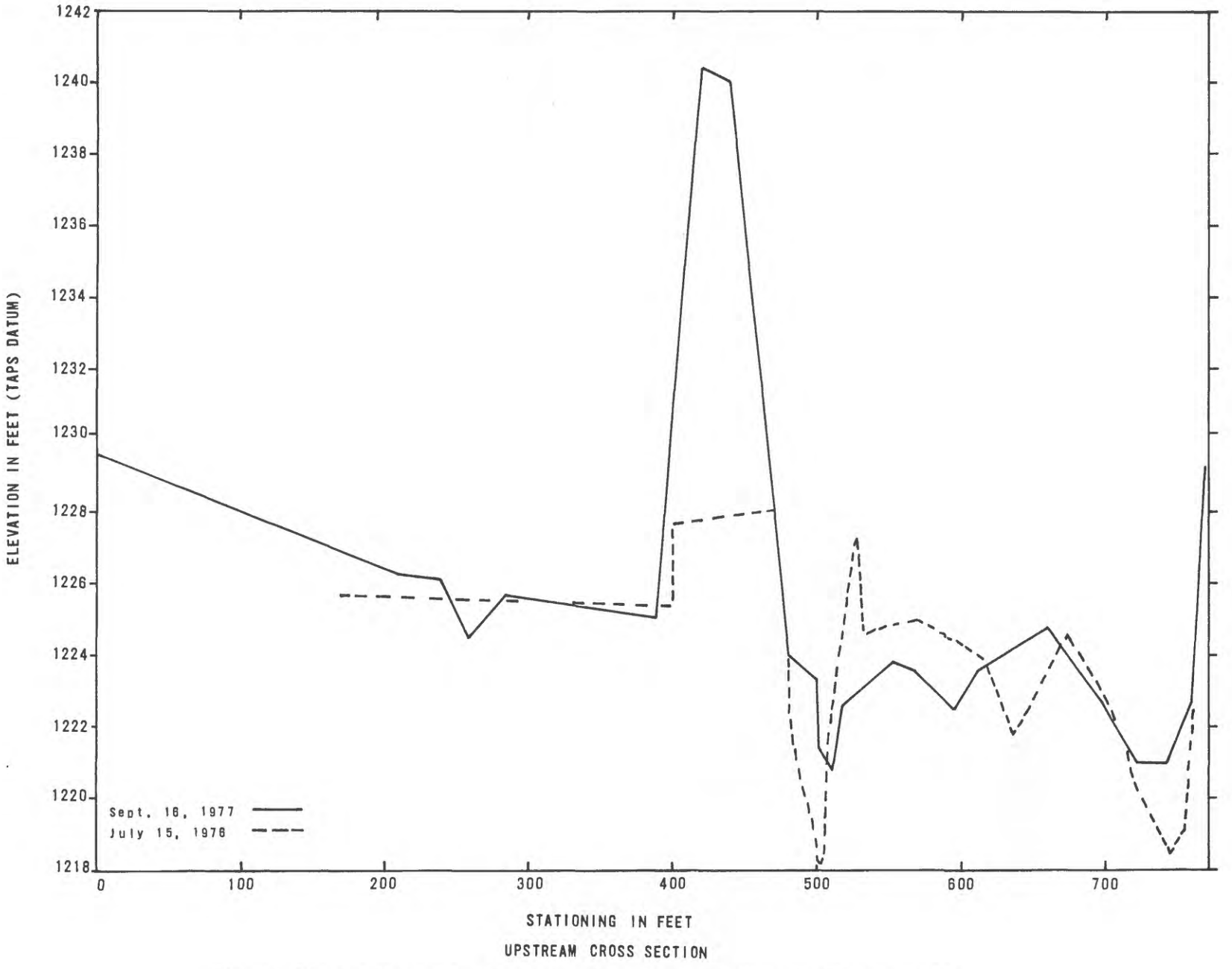


Figure 13. -- Cross sections of the Hammond River near Wiseman.

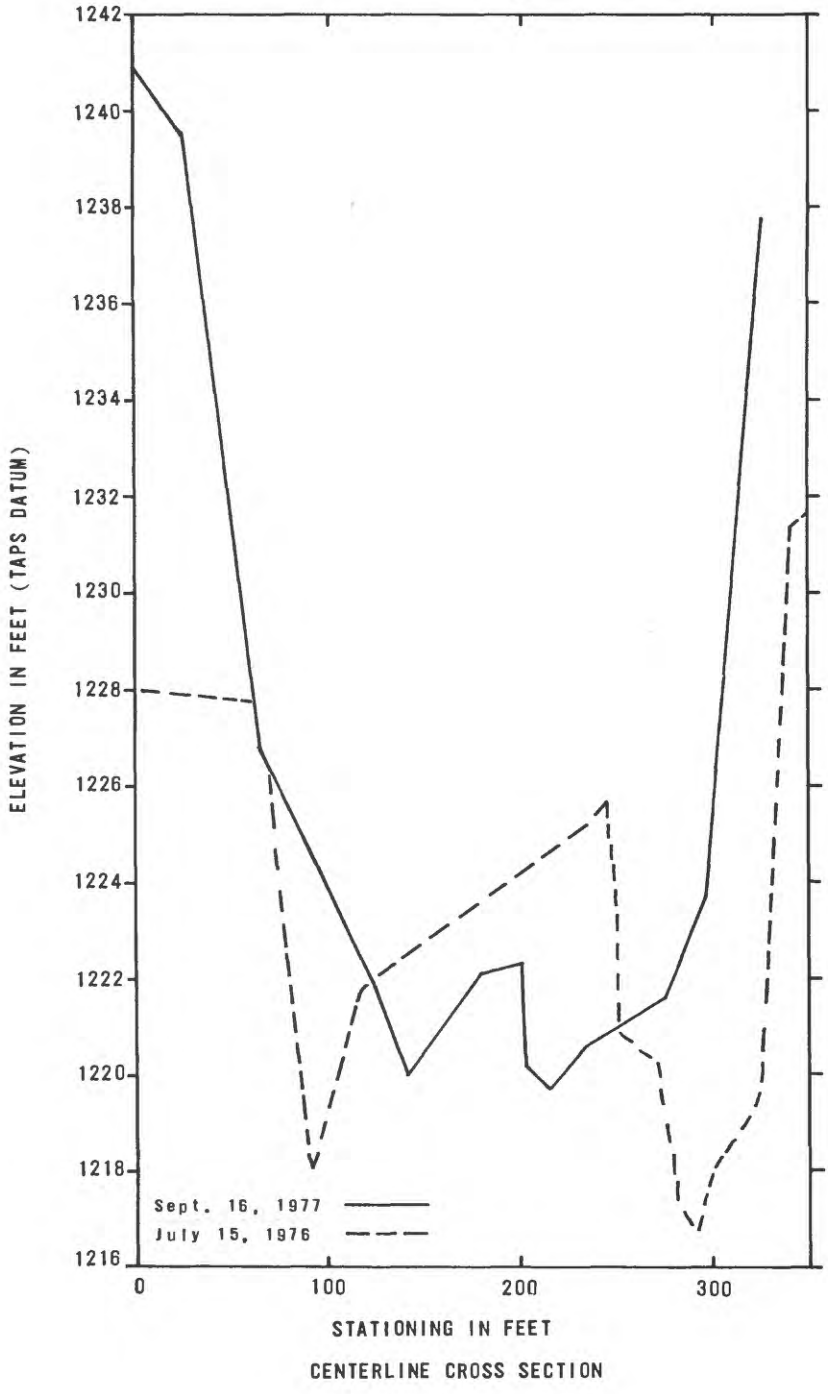


Figure 13. -- Cross sections of the Hammond River near Wiseman, continued.

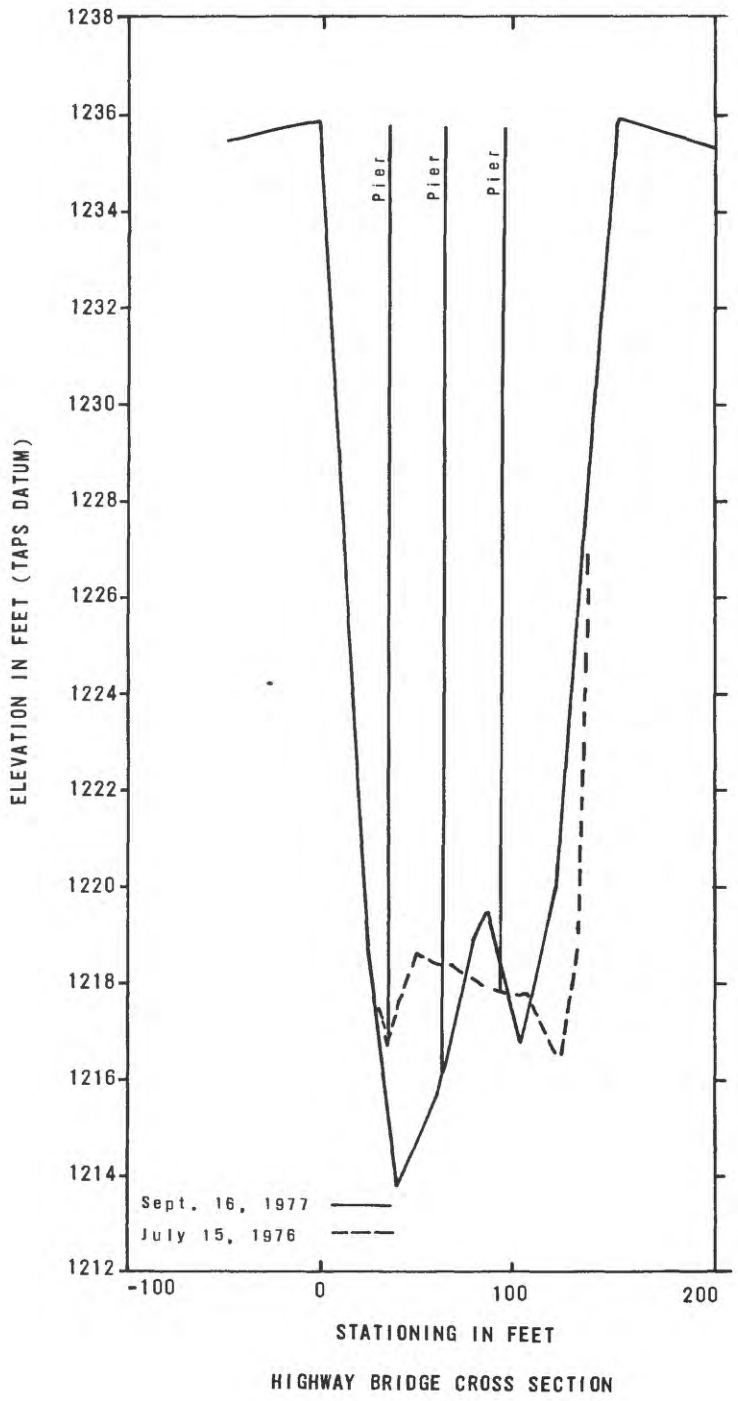


Figure 13. -- Cross sections of the Hammond River near Wiseman, continued.

Middle Fork Koyukuk River near Wiseman

Location.--Lat 67°26'05", long 150°04'45", in SE¼ sec.7, T.30 N., R.11 W., 1.5 mi upstream from Wiseman and 2.5 mi downstream from the Hammond River.

[Wiseman (B-1) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 14 shows the Middle Fork Koyukuk River near Wiseman crossing site on July 12, 1977. As noted in the discussion of the Middle Fork Koyukuk River at Hammond River site, a record flood occurred on this river during spring breakup. During the last year, construction has been largely completed. Protective dikes on both banks of the centerline have been finished, and the deep hole just off the right bank has been backfilled.

The upstream and downstream cross sections were resurveyed on May 20, 1977, and the centerline on September 16. Figure 15 shows the changes which occurred in all cross sections.

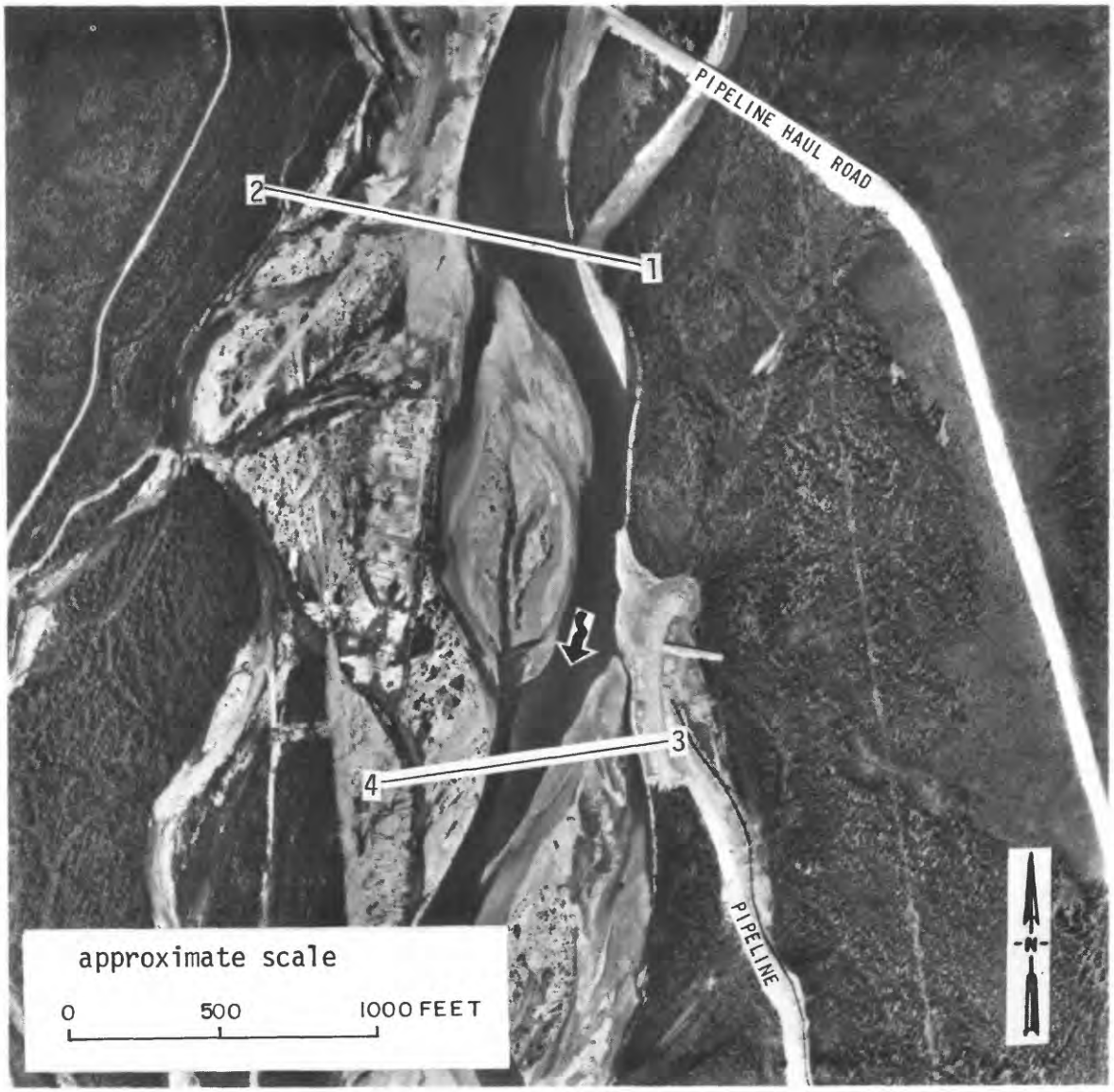
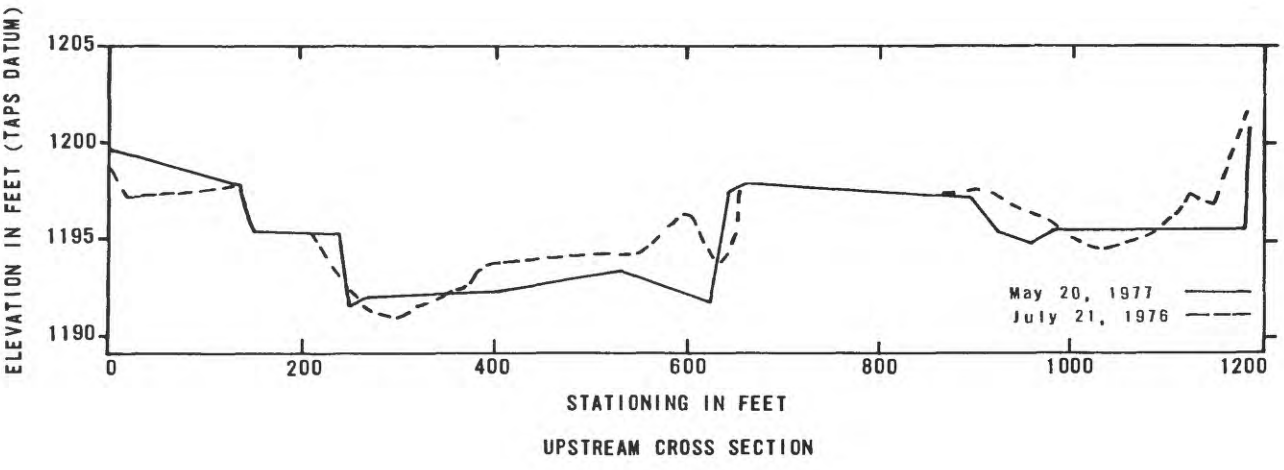


Figure 14. -- Middle Fork Koyukuk River near Wiseman, July 12, 1977.
AIR PHOTO TECH



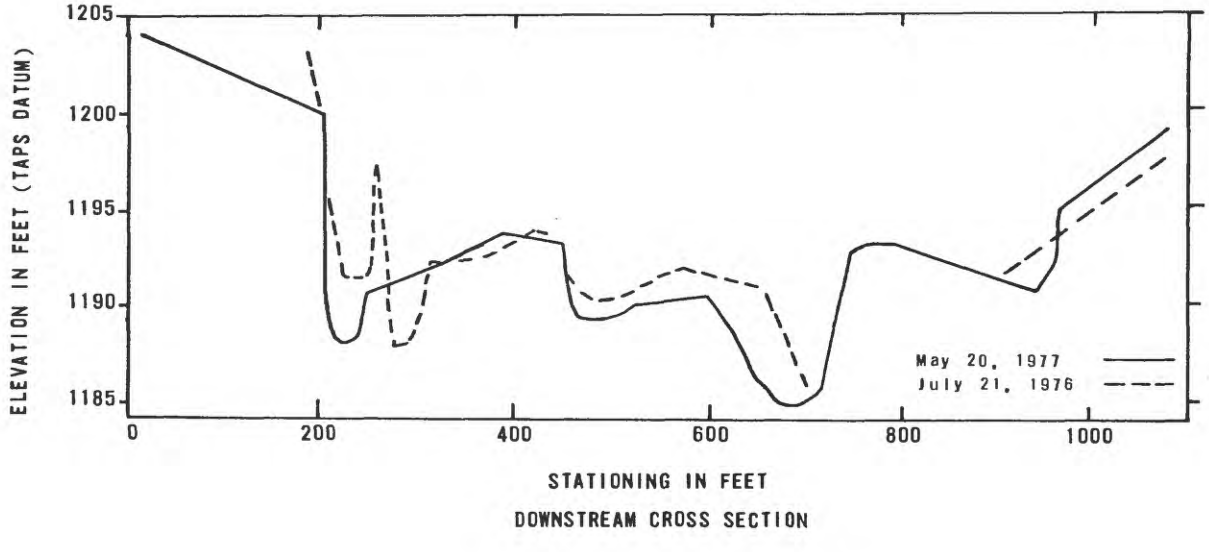


Figure 15. -- Cross sections of the Middle Fork Koyukuk River.

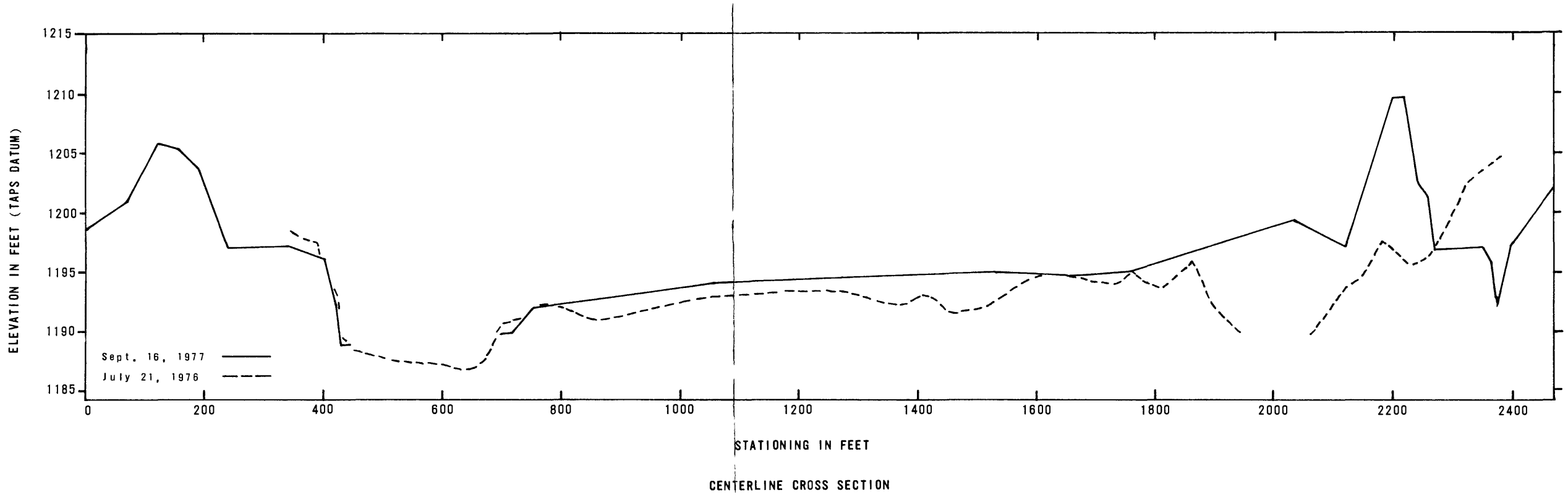


Figure 15. -- Cross sections of the Middle Fork Koyukuk River, continued.

Middle Fork Koyukuk River near Coldfoot

Location.--Lat 67°11'00", long 150°19'00", T.27 N., R.13 W., about 6 mi downstream from Coldfoot.

[Wiseman (A-1) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 16 shows the Middle Fork Koyukuk River near Coldfoot crossing site on July 12, 1977. During the last year, pipeline construction has been completed along the left bank. As noted in the discussion of the Middle Fork Koyukuk River at Hammond River site, a record flood occured on this river during spring breakup.

Comparison of the 1976 and 1977 air photos and a visual inspection of the site made in May 1977 indicate that no significant bank erosion has occured. The photos show that the river's major conveyance has shifted toward the right bank at site A, continuing a trend noted in last year's report. Consequently, the zone of intense erosion on the left bank has moved approximately 1,400 ft downstream from the 1976 location at site A.

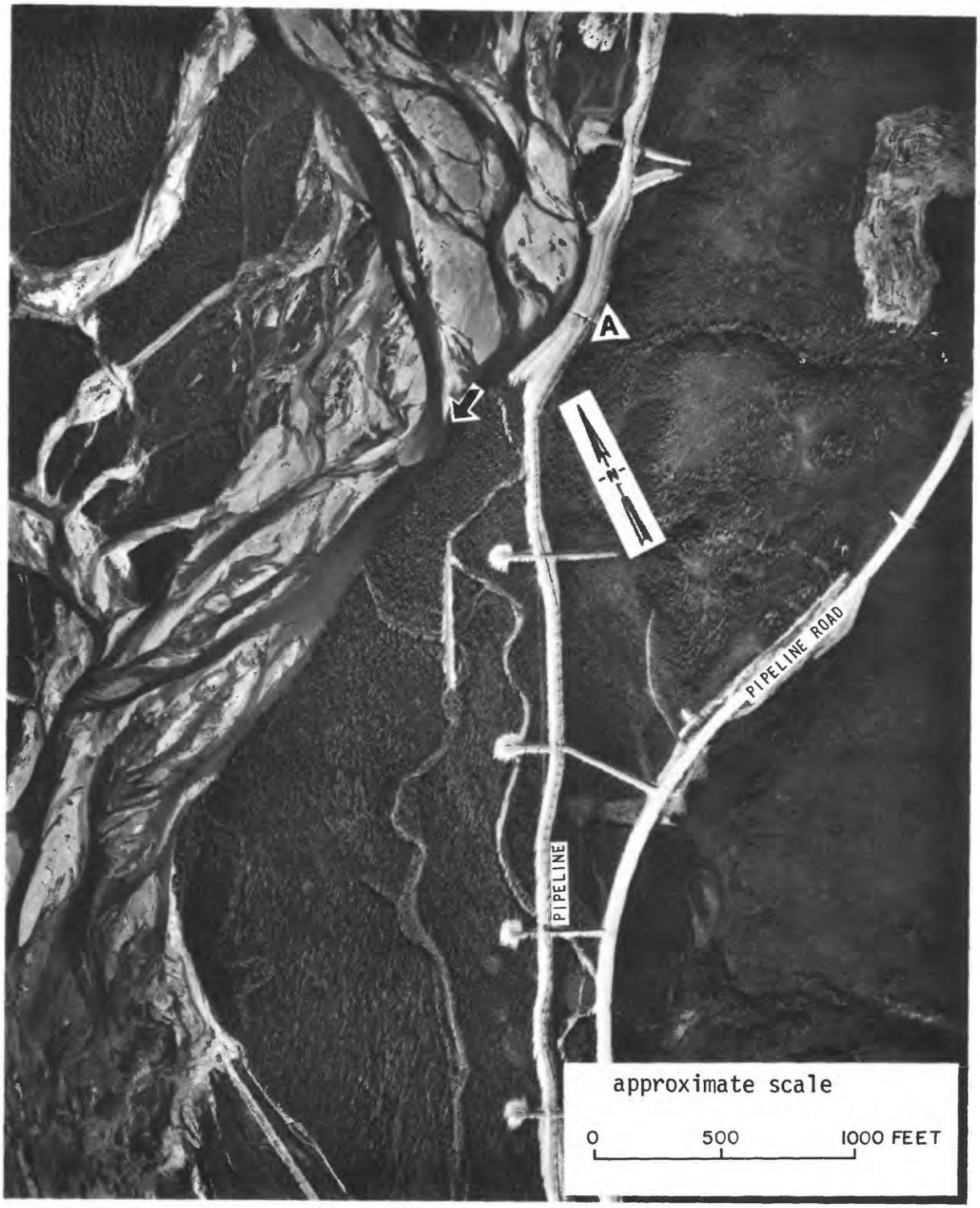


Figure 16. -- Middle Fork Koyukuk River near Coldfoot, July 12, 1977.
AIR PHOTO TECH

South Fork Koyukuk River near Wiseman

Location.--Lat 67°01'10", long 150°16'40", in SW¼ sec.6, T.25 N., R.12 W., 11 mi upstream from the Gold Bench Mine, and 40 mi northeast of Bettles.

[Wiseman (A-1) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 17 shows the South Fork Koyukuk site on July 12, 1977. The site was resurveyed on September 17, 1977. There has been no significant change in the upstream cross section since 1975, but minor changes were found in both the centerline and downstream cross sections (fig. 18).

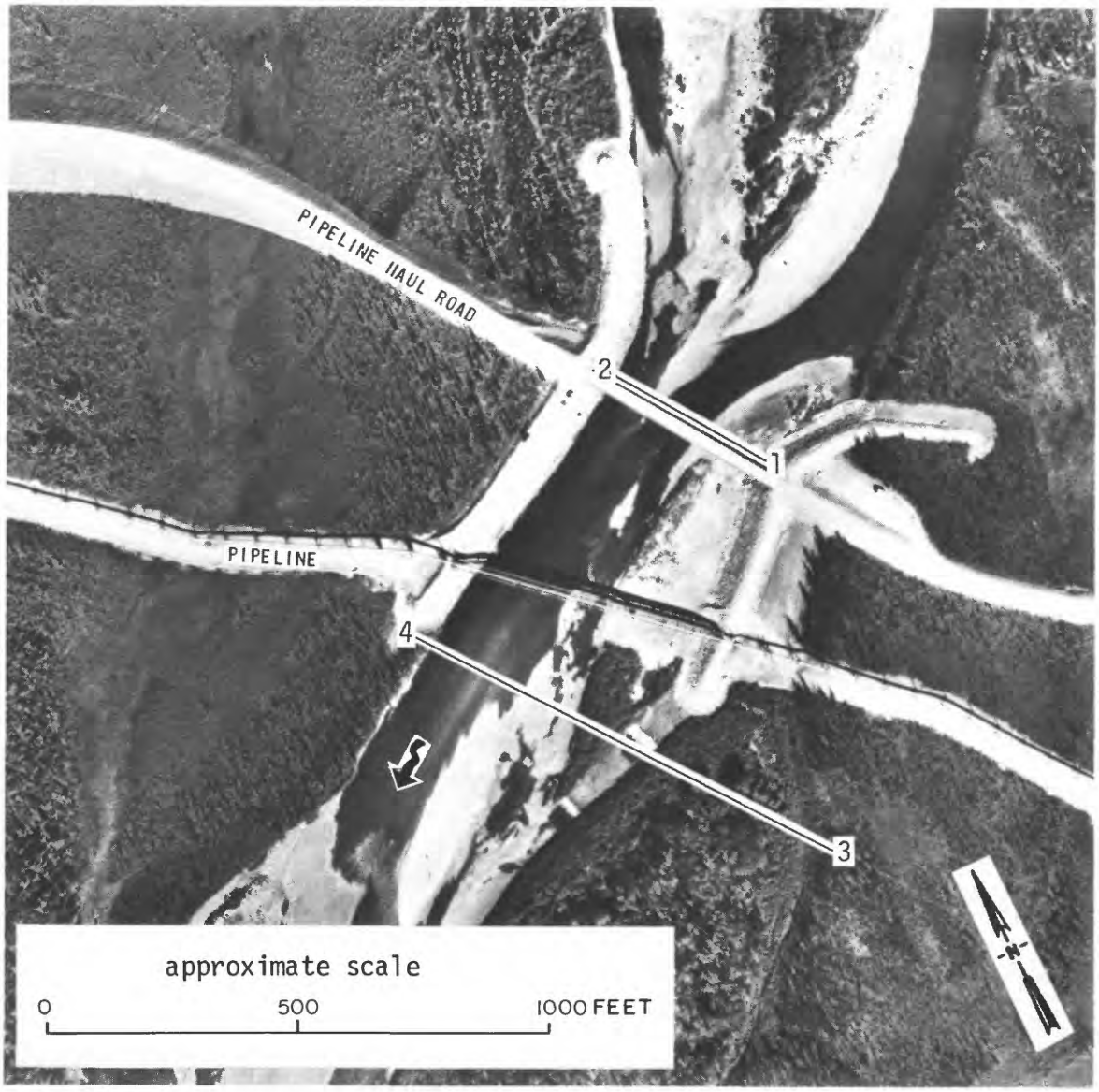
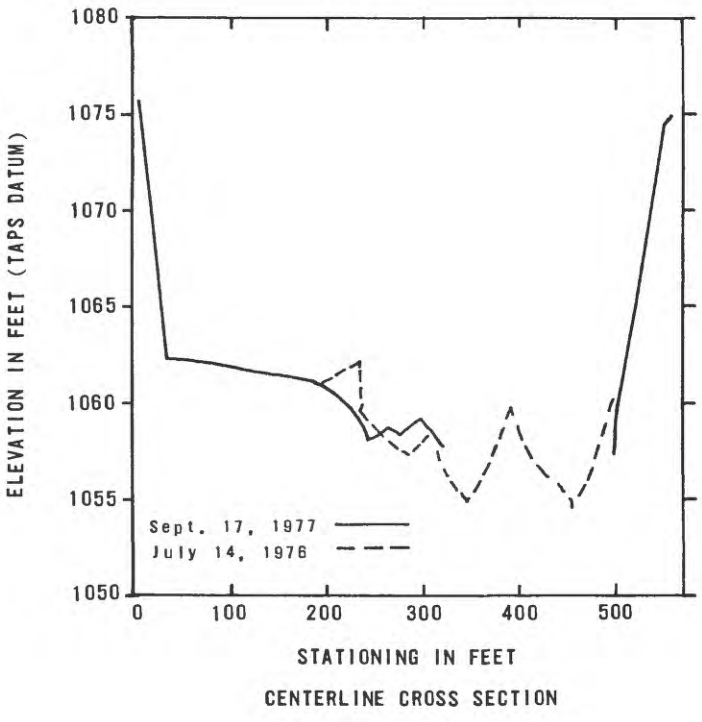


Figure 17. -- South Fork Koyukuk River near Wiseman, July 12, 1977.
AIR PHOTO TECH



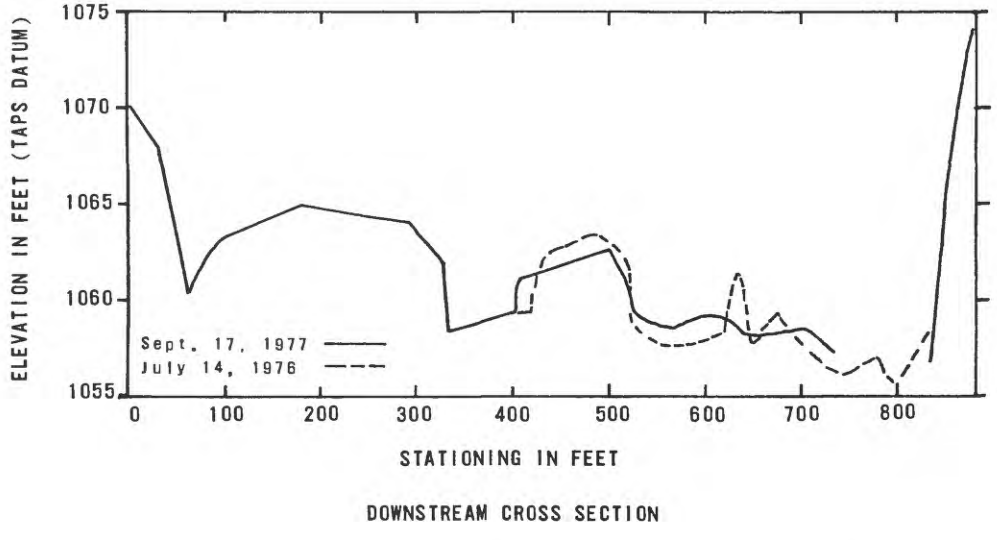


Figure 18. -- Cross sections of the South Fork Koyukuk River near Wiseman.

Jim River near Prospect Creek Camp

Location.--Lat 66°53'00", long 150°31'20", in SE¼ sec.23, T.24 N., R.14 W., 2.4 mi upstream from Douglas Creek and 32 mi east of Bettles Field. [Bettles (D-2) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 19 shows the Jim River crossing on September 1, 1977. The site was resurveyed on May 18, 1977. During the last year, backfilling and other construction activities have deepened the centerline cross section, the only significant change in the three measured sections (fig. 20). In addition, a berm has been constructed on the left bank at the centerline.

On June 1, during the spring breakup flood, a discharge of 12,400 ft^3/s was recorded at the Jim River gage near Bettles; this was the largest flood of the station's 7-year record.

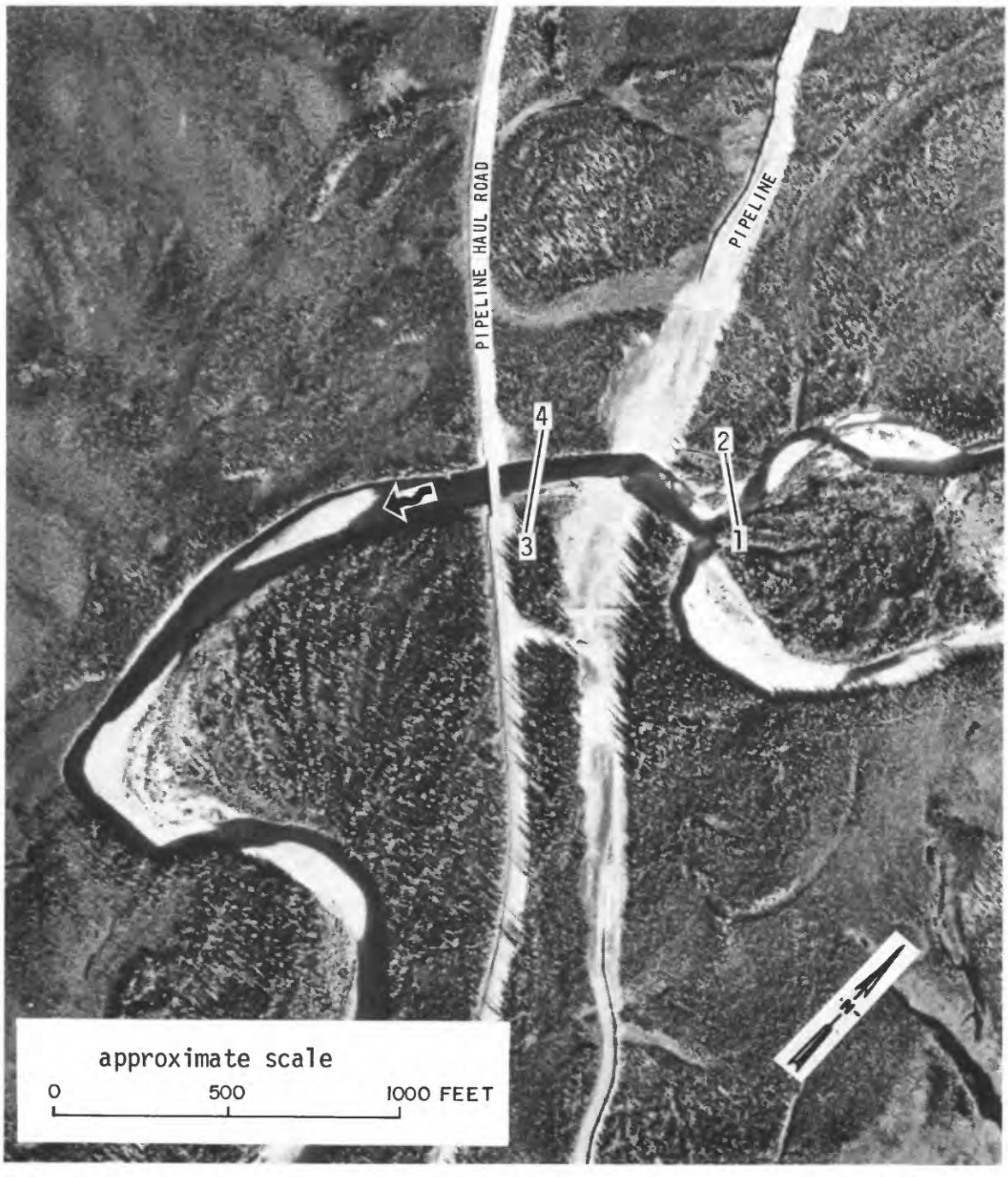


Figure 19. -- Jim River near Prospect Creek camp, September 1, 1977.

AIR PHOTO TECH

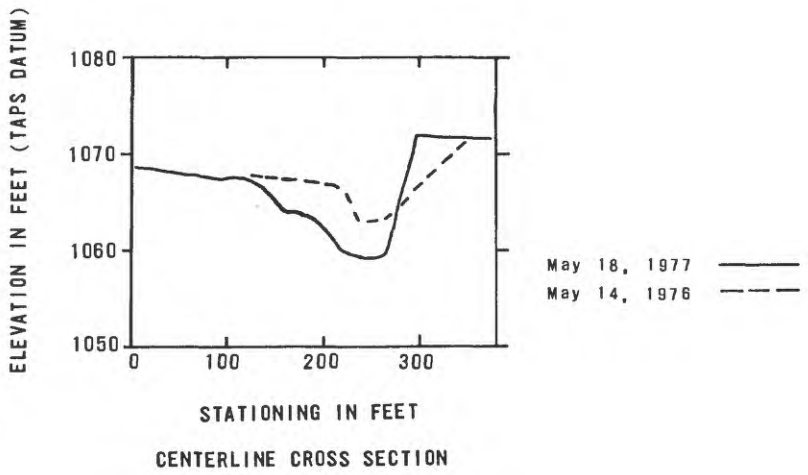


Figure 20. -- Cross section of Jim River near Prospect Creek Camp.

Prospect Creek near Prospect Creek Camp

Location.--Lat 66°46'50", long 150°40'30", in NW¼ sec.31, T.23 N., R.14 W., 2 mi upstream from Jim River and approximately 28 mi east of Bettles. [Bettles (D-2) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 21 shows the Prospect Creek site as of September 1, 1977. During the last year, there has been some grading on the upstream and centerline cross sections, and the access bridge over the upstream crossing has been removed. The site was resurveyed on September 17, 1977, and no significant changes were found in any cross section.

On June 1, the breakup flood peak was measured at 3,800 ft^3/s at the gage near Prospect Creek camp. It was the largest flood of the station's three years of record.

Figure 21. -- Prospect Creek near Prospect Creek camp, September 1, 1977.
AIR PHOTO TECH

Kanuti River near Bettles

Location.--Lat 66°26'30", long 150°37'30", in SE¼ sec.30, T.19 N., R.14 W., 5 mi northeast of Caribou Mountain, and approximately 44 mi south-southeast of Bettles.

[Bettles (B-2) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 22 shows the Kanuti River crossing site on July 13, 1977. The site was resurveyed on September 19, 1977. During the last year, protective dikes have been constructed on both banks of the centerline cross section. In addition, grading has changed the bank's profile, but that of the stream remains unchanged. There were no significant changes in either the upstream or downstream cross section.

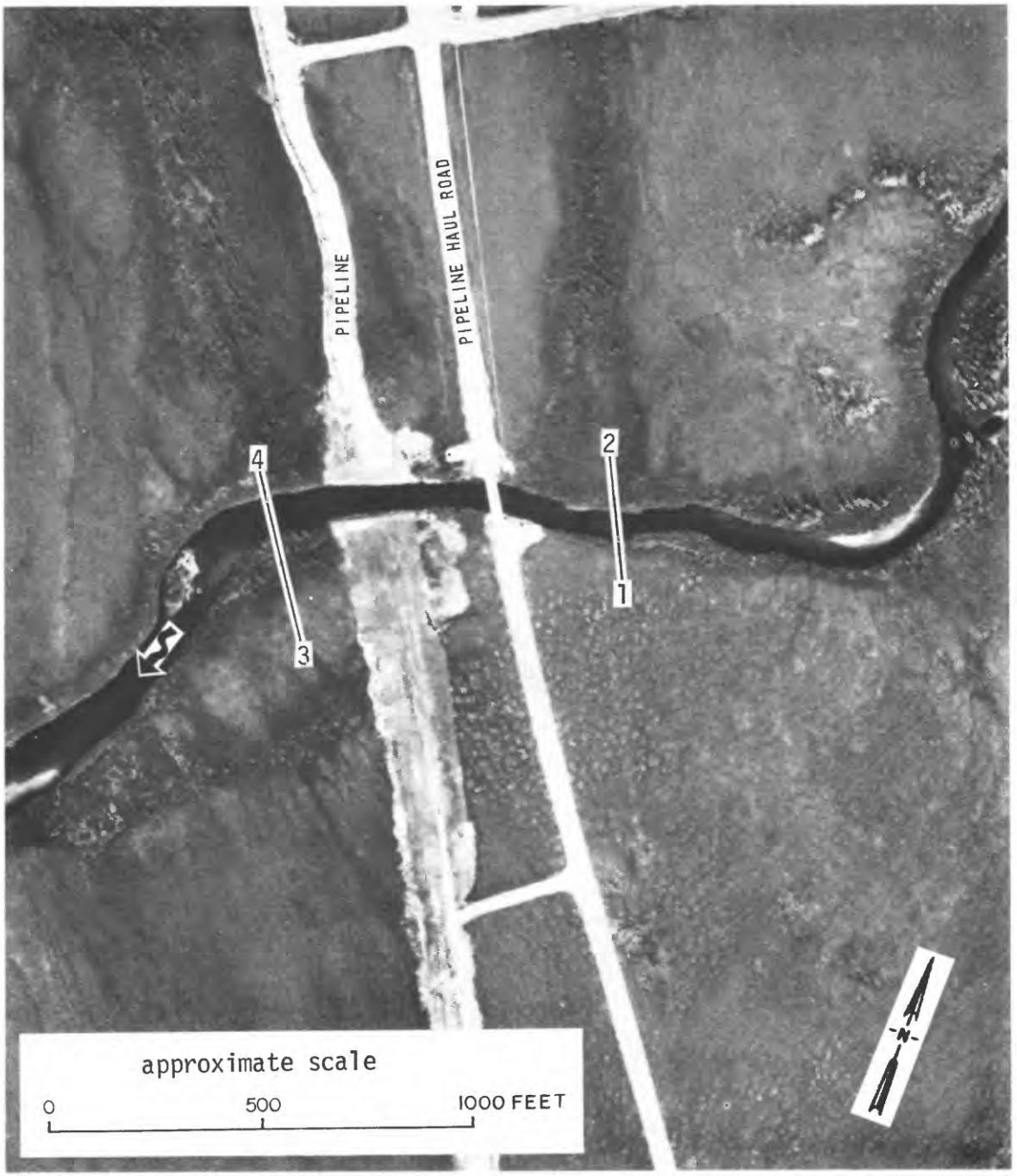


Figure 22. -- Kanuti River near Bettles, July 13, 1977.
AIR PHOTO TECH

Hess Creek near Livengood

Location.--Lat 65°40'30", long 149°04'20", in SW¼ sec.20, T.10 N., R.7 W., at Fish Creek and 19 mi northwest of Livengood.

[Livengood (C-5) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 23 shows the Hess Creek crossing site on July 13, 1977. The overhead pipeline crossing has been completed, and the temporary access bridge constructed last year has been removed. The Hess Creek and Castner Creek sites are the only channel erosion crossing sites to have the pipeline crossing completed between the 1976 and 1977 surveys. All others were finished before the 1976 survey. The crossing site was resurveyed on May 14, 1977. Figure 24 shows the construction-related changes in the centerline cross section.

The 1977 breakup flood was only moderate. The peak was measured as 6,480 ft^3/s at the gage near Livengood on May 19, five days after the site was surveyed.

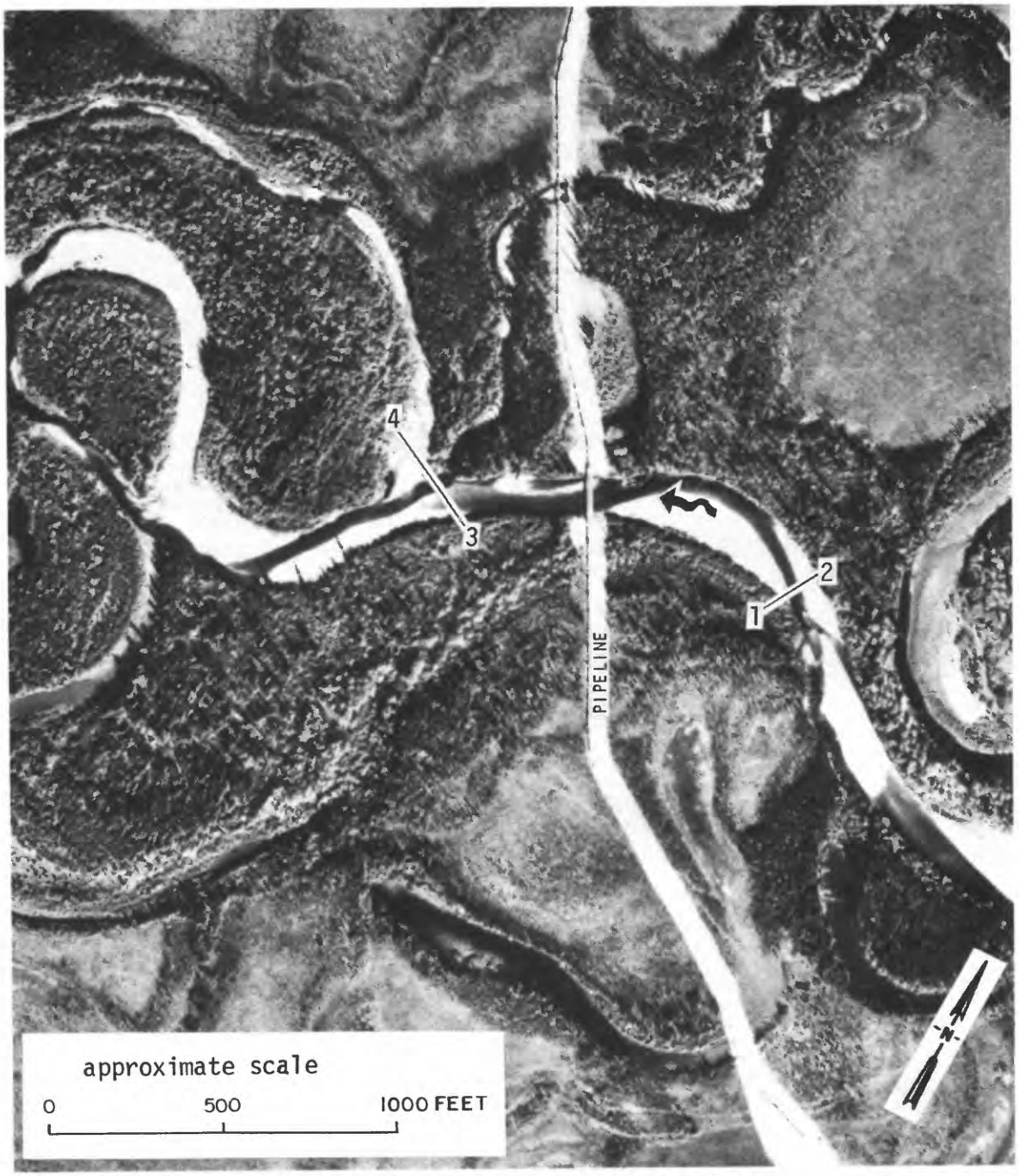


Figure 23. -- Hess Creek near Livengood, July 13, 1977.

AIR PHOTO TECH

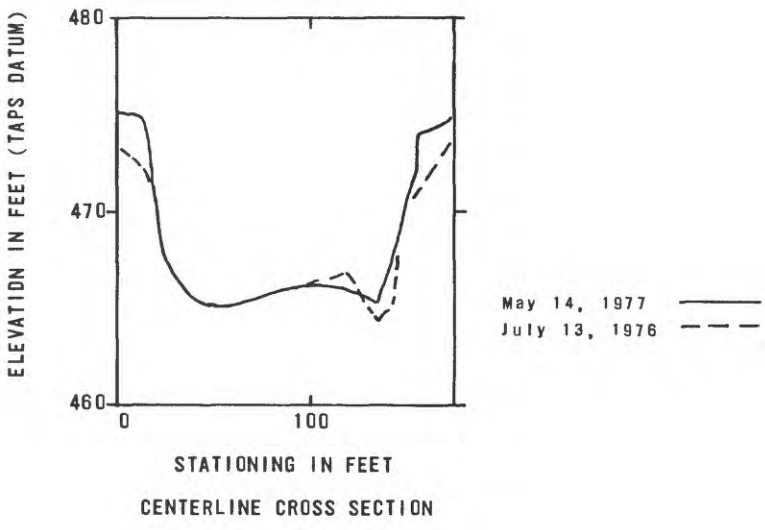


Figure 24. -- Cross section of Hess Creek near Livengood.

Chatanika River near Olnes

Location.--Lat 65°03'41", long 147°48'39", in NW¼ sec.29, T.3 N., R.1 W., approximately 4.5 mi west of Olnes and 15 mi north of Fairbanks. [Livengood (A-2) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 25 shows the Chatanika River crossing site on July 13, 1977. The temporary access bridge installed before last year's survey had been removed.

The site was resurveyed on May 13, 1977. No significant change was found at the upstream cross section, but the downstream and centerline sections both displayed marginal deepening of their thalwegs (fig. 26).

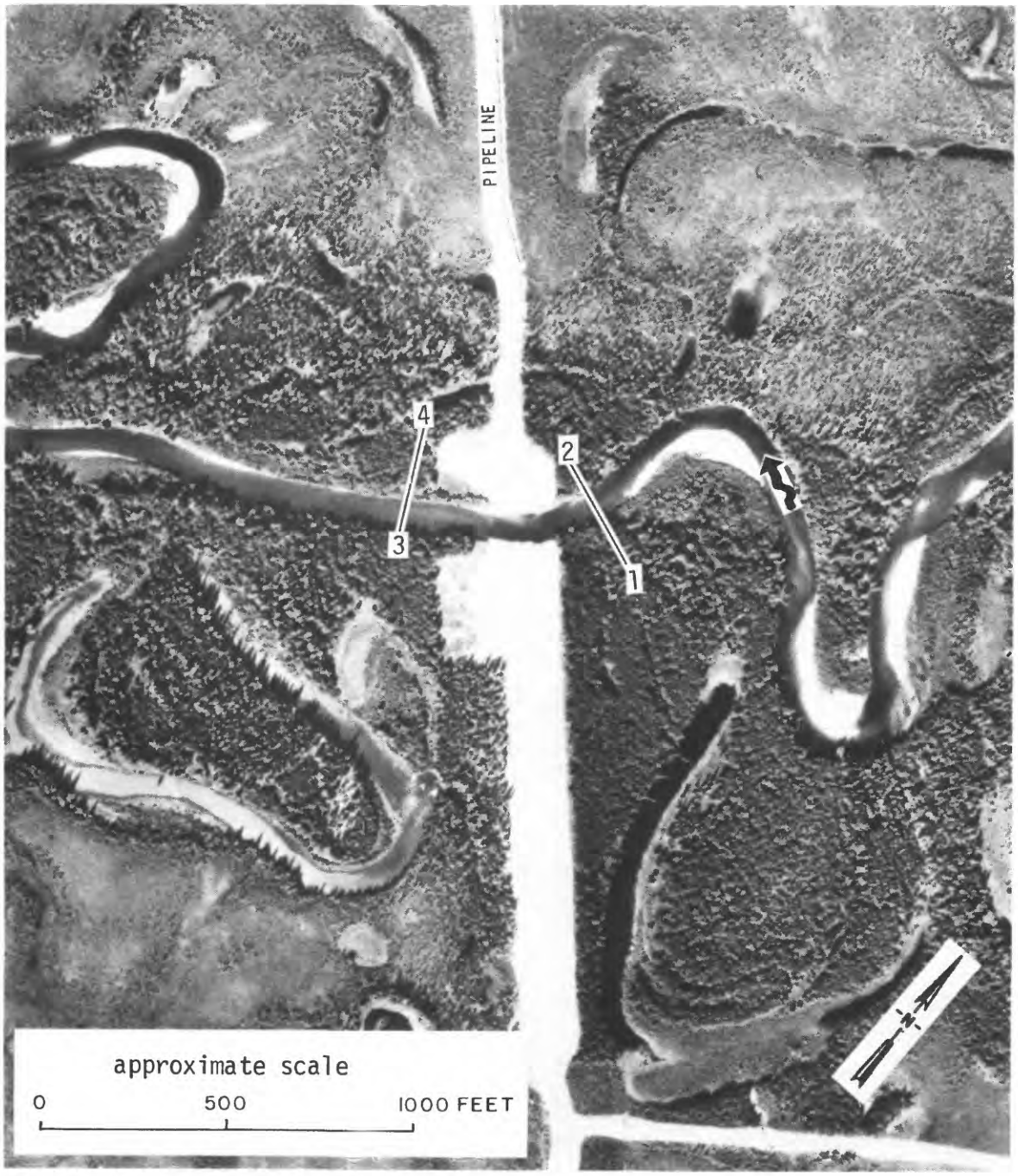
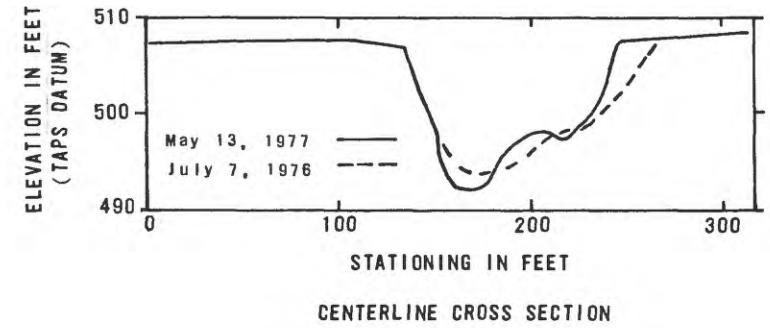


Figure 25. -- Chatanika River near Olnes, July 13, 1977.

AIR PHOTO TECH



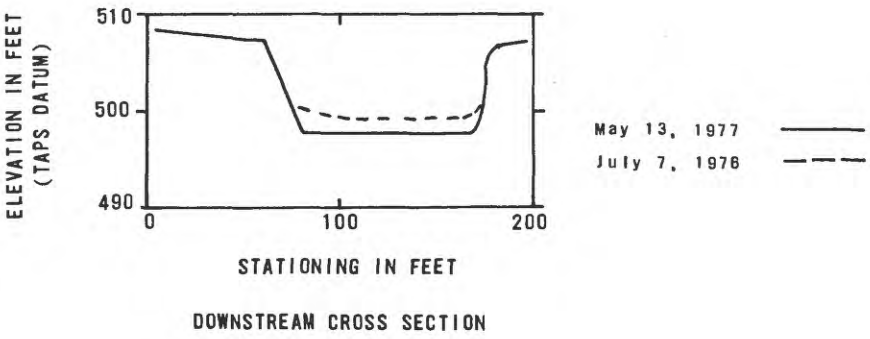


Figure 26. -- Cross sections of the Chatanika River near Olnes.

Salcha River near Salchaket

Location.--Lat 64°29'00", long 146°39'30", in NE¼ sec.13, T.5 S., R.5 E., about 8 mi upstream from the Richardson Highway.

[Big Delta (B-6) 1:63,360, U.S. Geological Survey Map.]

1977 Surveillance.--Figure 27 shows the Salcha River crossing on July 13, 1977. The site was resurveyed on May 12, 1977. The river at this site continues to be active; changes were found in all three cross sections. In each case the right bank has been eroded. The most dramatic effects occurred at the centerline where over 10 ft of lateral erosion and over 6.2 ft of vertical scour (fig. 28) were measured during the breakup flood. The peak of the flood occurred on May 19. It was measured as 11,500 ft^3/s at the Salcha River gage near Salchaket, and is considered a moderate flood.

Taken together, the three cross sections indicate that the meander has widened during the last year, continuing a trend noted in 1974.

Figure 27. -- Salcha River near Salchaket, July 13, 1977.

AIR PHOTO TECH

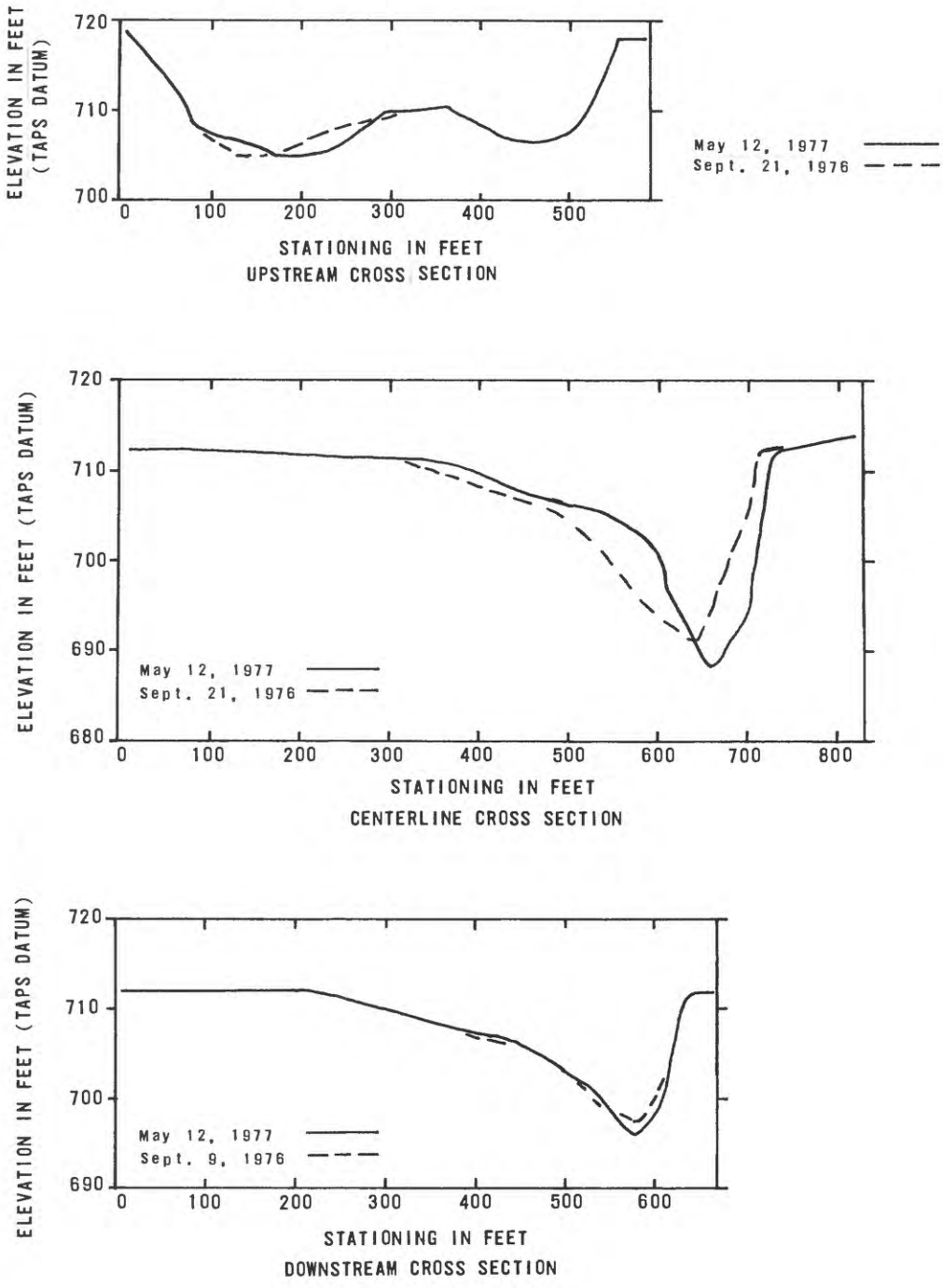


Figure 28. -- Cross sections of the Salcha River near Salchaket.

Flood Creek near Rapids

Location.--Lat 63°26'42", long 145°48'06", in NE¼ sec.15, T.17 S., R.10 E., at pipeline crossing, 0.1 mi upstream from Delta River, and about 6 mi south of Rapids.

[Mt. Hayes (B-4) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 29 shows the Flood Creek crossing on July 10, 1977. The crossing was resurveyed photogrammetrically on that date and a field inspection was made in September. It appears that the only significant change is below the downstream cross section where the channel is straightening.

There were no significant changes in either the upstream or centerline cross sections except for a berm construction on the centerline 250 ft southeast of Flood Creek. The only noticeable difference in the downstream cross section is that the channel has moved approximately 8 ft northwest (fig. 30).

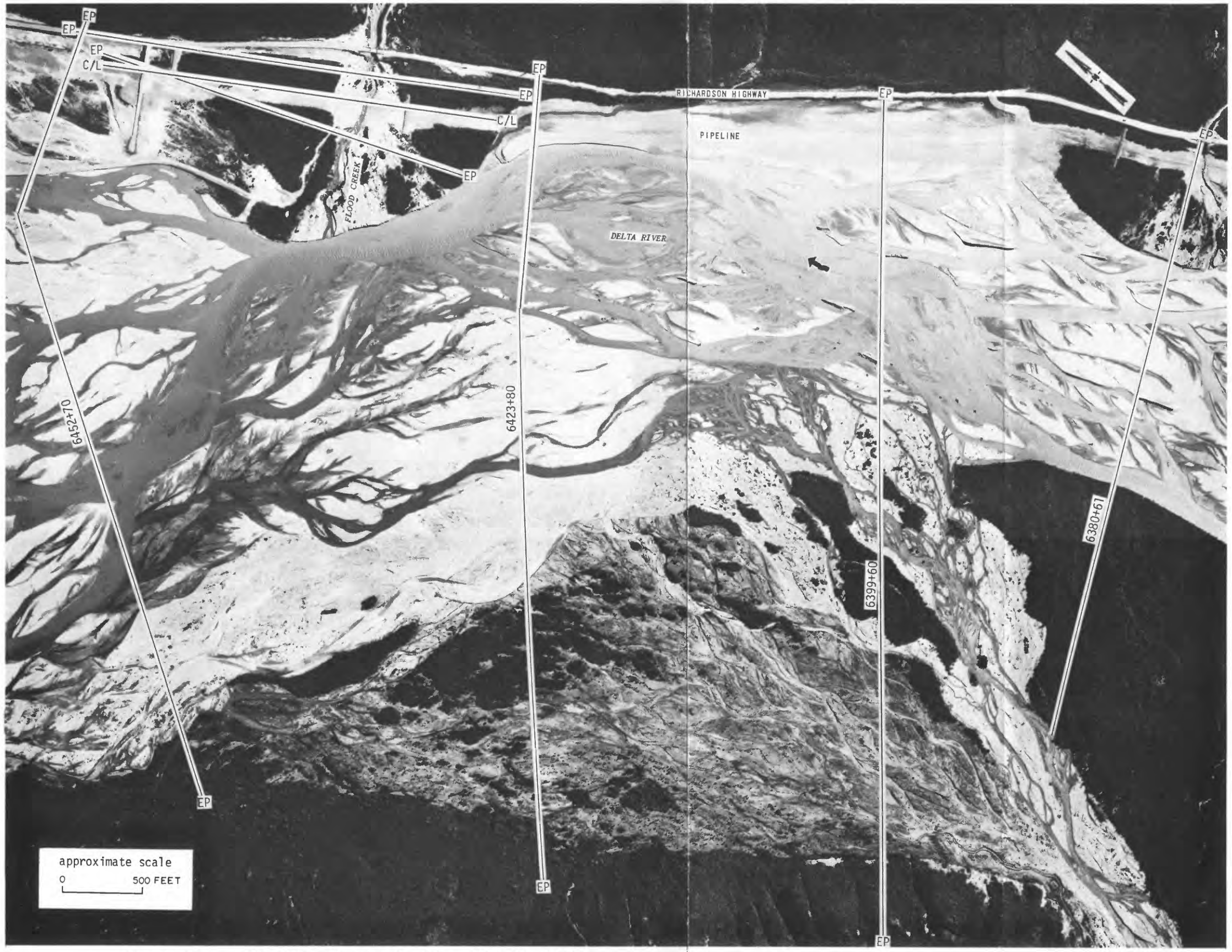


Figure 29. -- Flood Creek near Rapids, July 10, 1977.
NORTH PACIFIC AERIAL SURVEYS

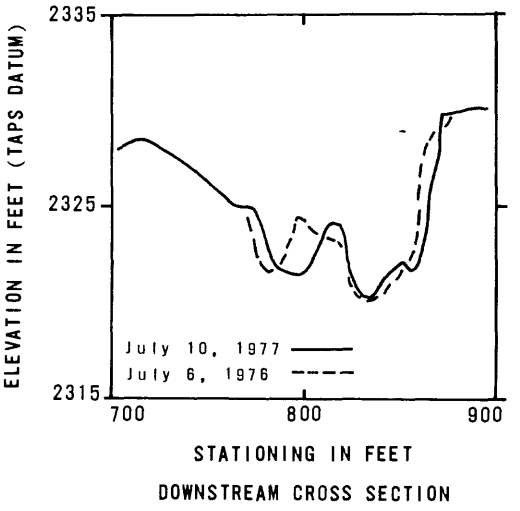


Figure 30. -- Cross section of Flood Creek near Rapids.

Delta River at Flood Creek

Location.--Lat 63°26'30", long 145°48'00", sec.15, T.17 S., R.10 E., about 6 mi south of Rapids.

[Mt. Hayes (B-4) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 31a shows the Delta River at the Flood Creek site on July 10, 1977, the date of the photogrammetric survey. In 1976, (fig. 31b) two lateral construction dikes running past the two upstream cross sections artificially constricted the river near its left bank. These washed out during the past year. As a result, the major conveyance near cross sections 6399+60 and 6423+80 has shifted closer to the right bank and the braiding pattern is more intricate (fig. 31a).

There were no significant changes near the 6380+61 and 6452+70 cross sections. However, the dike arrangement for 6452+70 was changed between the July photo and the field inspection of September. Currently, a temporary dike from the toe of the Flood Creek fan diverts the left-most channel toward midstream to allow dry construction on the spur-dike field.

The July photograph shows the main channel on cross section 6423+80 attacking the longshore dike which protects the pipeline. In September, it was noted that the main channel had shifted back toward the center of the channel and a bar had formed along the longshore dike.

PREPARED BY NORTH PACIFIC AERIAL SURVEYS, INC., ANCHORAGE, ALASKA

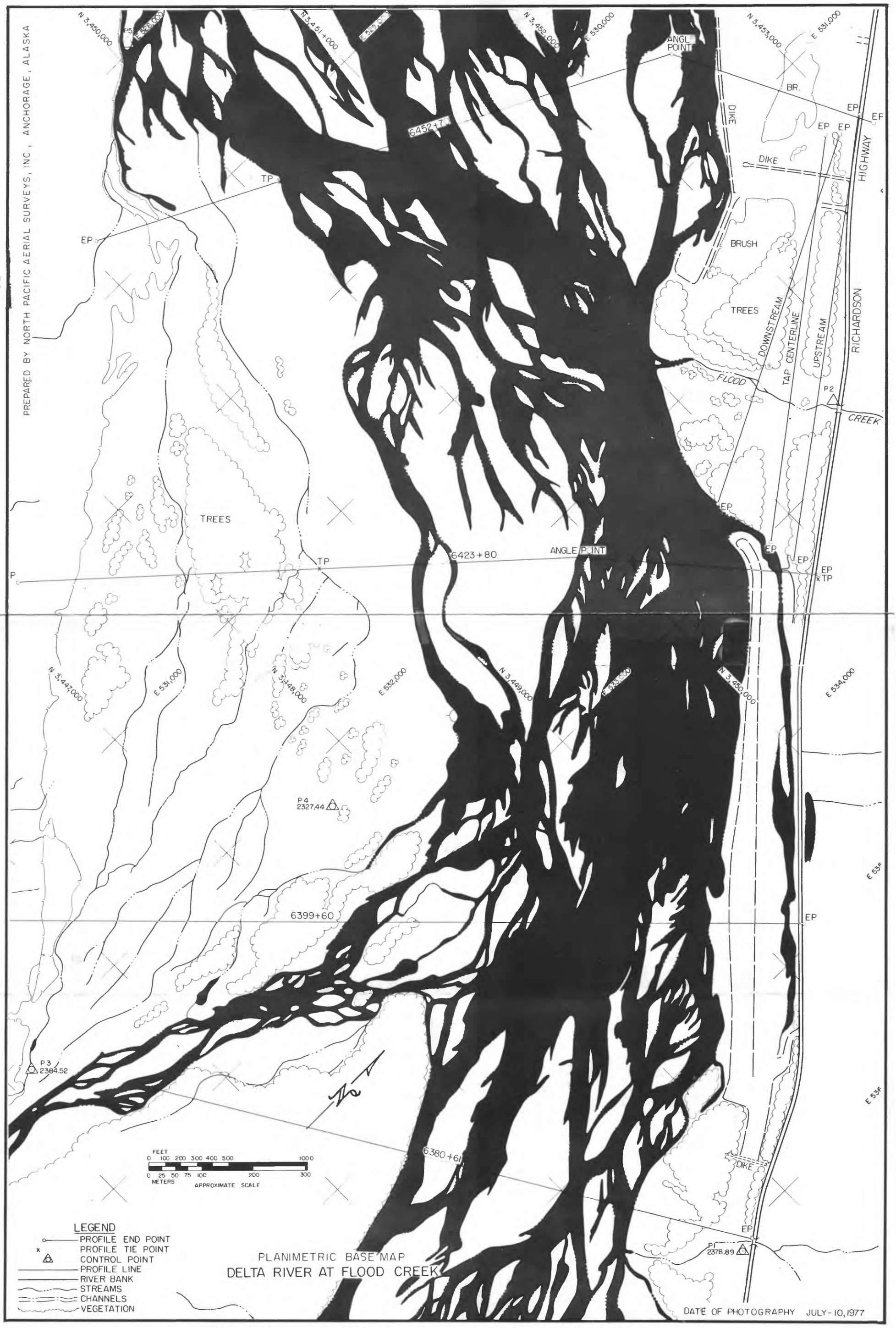


Figure 3la. -- Planimetric map of the Delta River at Flood Creek.

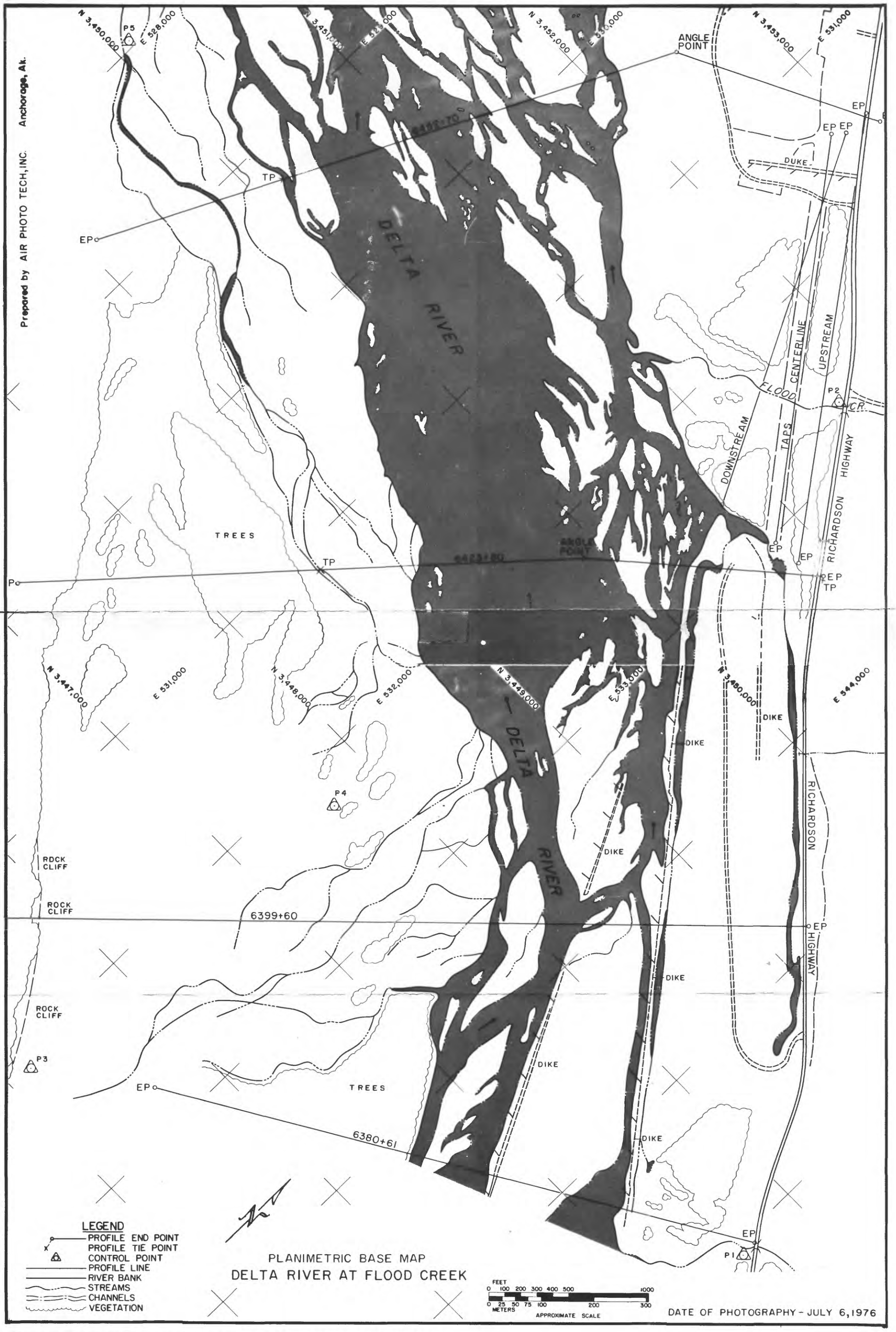


Figure 31b. -- Planimetric map of the Delta River at Flood Creek.

Castner Creek and Lower Miller Creek near Rapids

Location.--Lat 63°24'00", long 145°44'00", sec.36, T.17 S., R.10 E., about 10 mi south of Rapids.

[Mt. Hayes (B-4) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 32 shows the Castner Creek and Lower Miller Creek near Rapids site on July 29, 1977. During the last year, overhead crossings have been completed across both streams.

Comparison of the 1976 and 1977 air photos, as well as a visual inspection of the site made on September 19, 1977, indicate that no significant change has occurred during the past year.

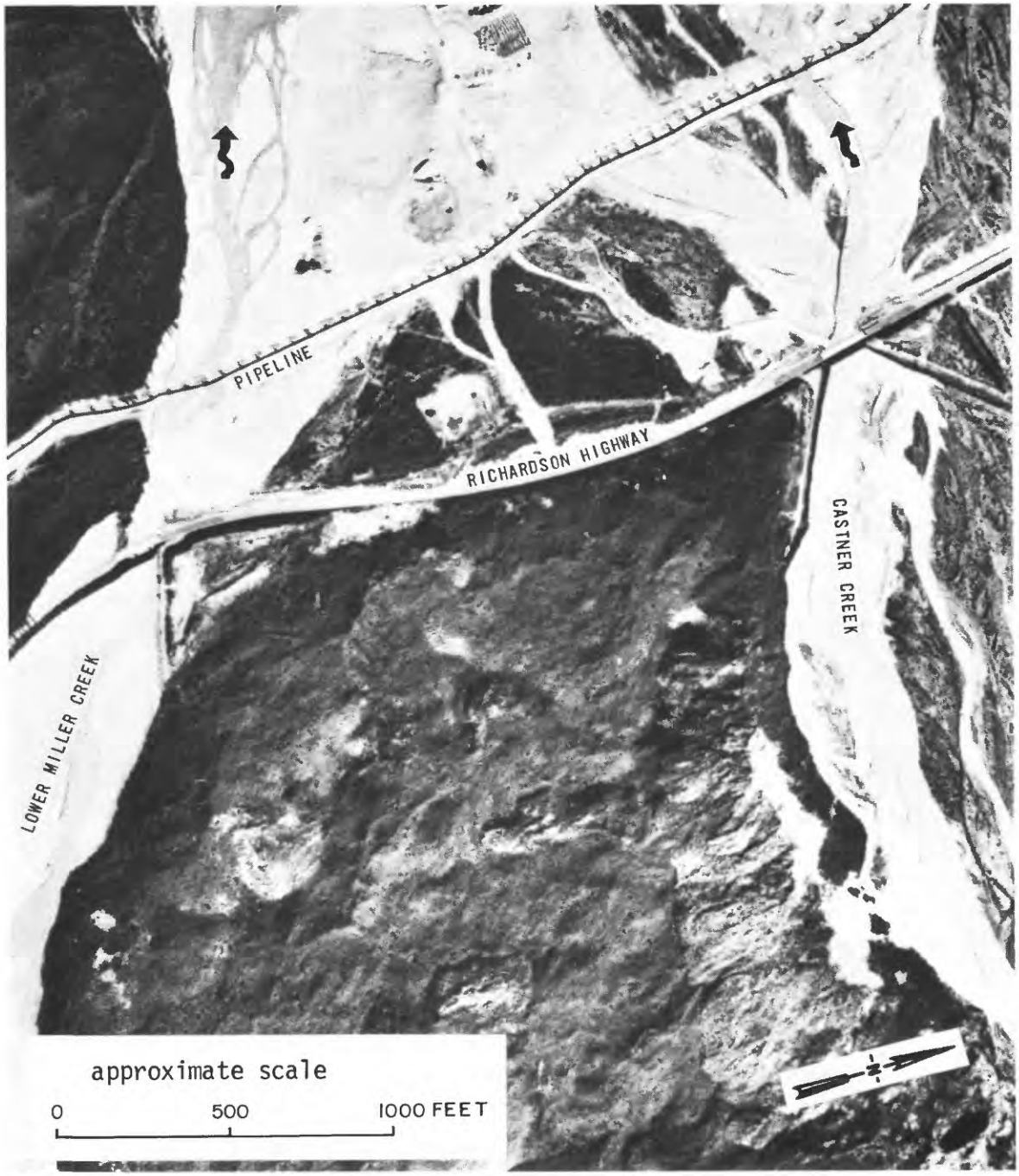


Figure 32. -- Castner and Lower Miller Creeks, July 29, 1977.

AIR PHOTO TECH

Delta River at Phelan Creek

Location.--Lat 63°20'30", long 145°44'00", sec.13 and sec.24, T.18 S., R.10 E., about 14 mi south of Rapids.

[Mt. Hayes (B-4) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 33 shows the Delta River at Phelan Creek site as of July 10, 1977. The three upstream spur dikes and the longshore dike near the center of the picture have been constructed during the last year. The picture shows part of the flow to be surrounding the downstream spur dike, but a field inspection of the site made in September indicated that this is no longer the case.

The site was resurveyed photogrammetrically in July. The different subchannels have continued to change position inside the flood plain, but no significant changes have been found in the surveyed cross sections since the site was established in 1975.

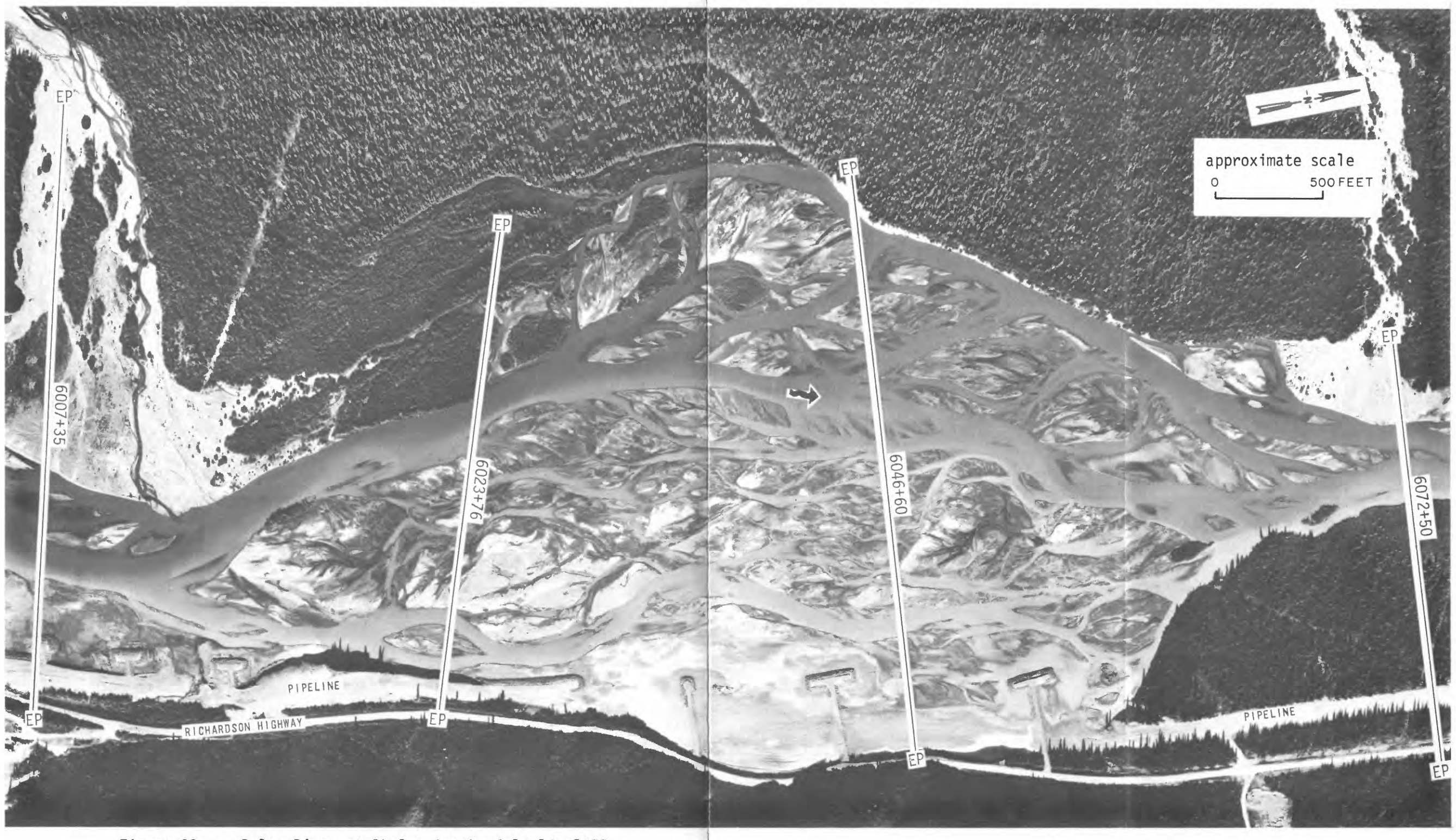


Figure 33. -- Delta River at Phelan Creek, July 10, 1977.
NORTH PACIFIC AERIAL SURVEYS

Gulkana River near Sourdough

Location.--Lat 62°32'28", long 145°32'00", in SE¼ sec.23, T.9 N., R.2 W., at pipeline crossing, 1.5 mi upstream from Sourdough Creek, and about 1 mi northwest of Sourdough.

[Gulkana (C-4) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 34 shows the Gulkana River site on July 29, 1977. The pipeline crossing was moved after the 1975 survey and appears in the lower right-hand corner of the figure. As explained in Doyle and Childers (1976), it was decided to continue monitoring this site because of the excellent past records accumulated.

The site was resurveyed on May 10, 1977. Only cross section No. 5 showed significant change (fig. 35). The left bank of cross section No. 5 has slumped every year since 1974. However, comparison of air photos of July 1977 and August 1976 shows the bank has not changed position laterally.

The breakup flood peaked on June 2, after the site was surveyed. It was the largest of the station's five years of record; 9,172 ft^3/s was measured at the gage near Sourdough.

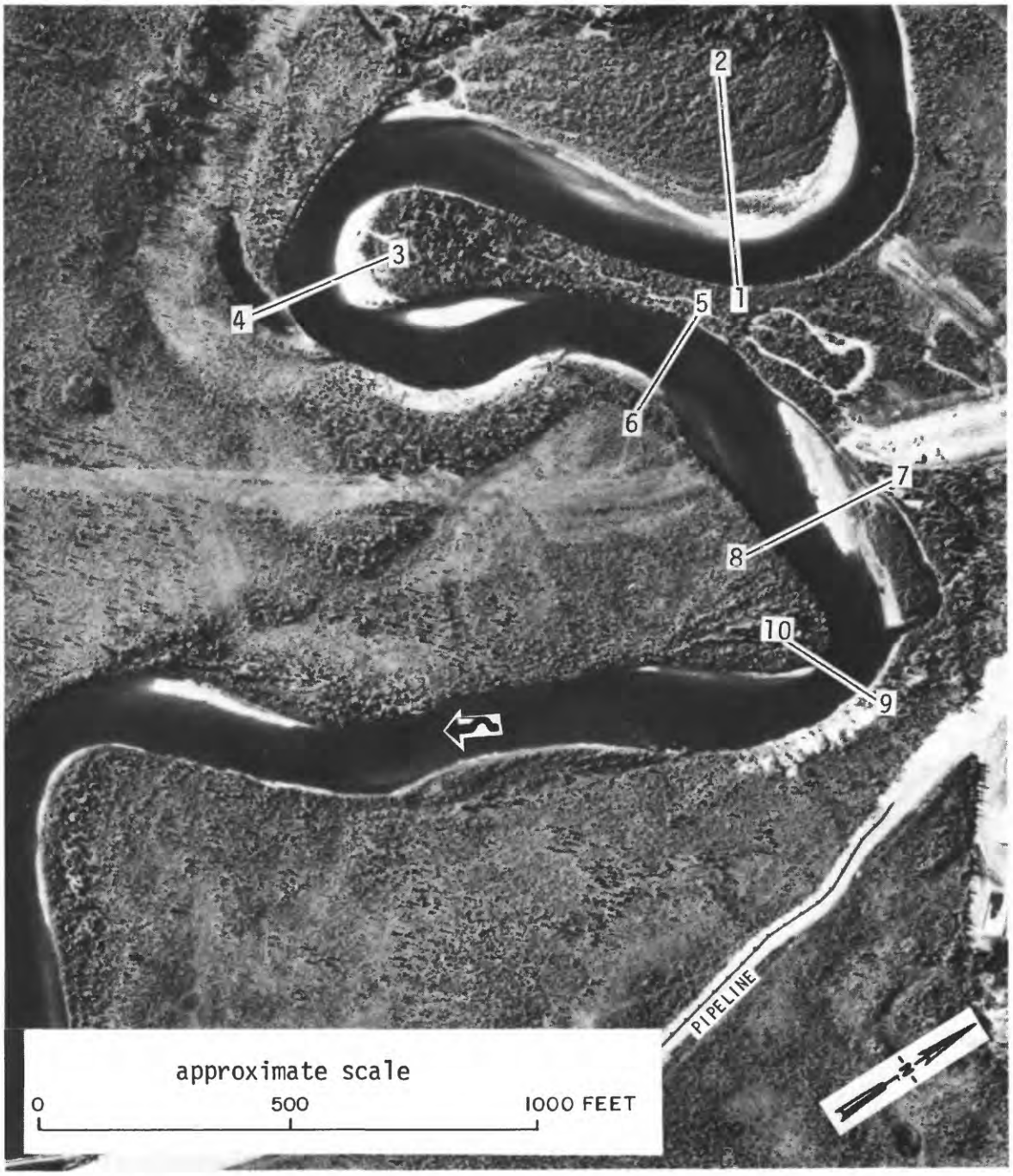


Figure 34. -- Gulkana River near Sourdough, July 29, 1977. AIR PHOTO TECH

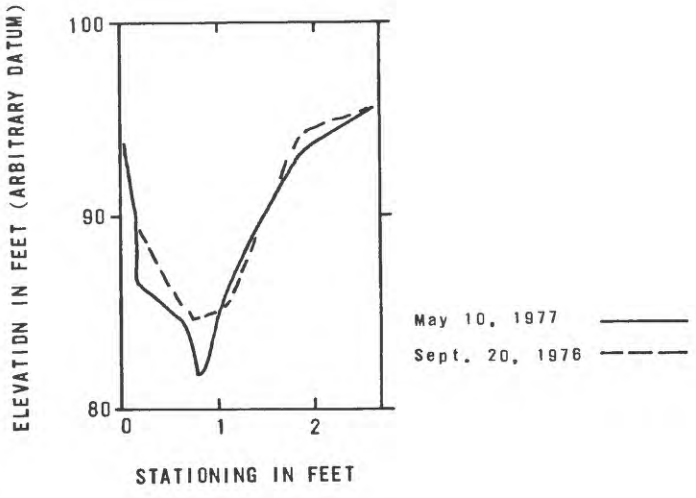


Figure 35.--Cross section No. 5 of the Galkana River near Sourdough.

Tazlina River near Glennallen

Location.--Lat 62°04'39", long 145°28'30", in NE¼ sec.6, T.3 N., R.1 W., at pipeline crossing, 0.1 mi downstream from Moose Creek, and 2.5 mi southeast of Glennallen.

[Gulkana (A-3) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 36 shows the Tazlina River crossing on July 29, 1977. Cross sections were resurveyed September 21, 1977. Cross sections were not obtained after construction was completed in 1976 and the centerline section had not been resurveyed since 1974. The centerline as actually constructed, and the 1977 centerline cross section are both approximately 200 ft east of the 1974 section. The shape of this year's section and on-site observations indicate that little change has occurred. No significant change has been found in either the downstream or upstream sections since 1974.

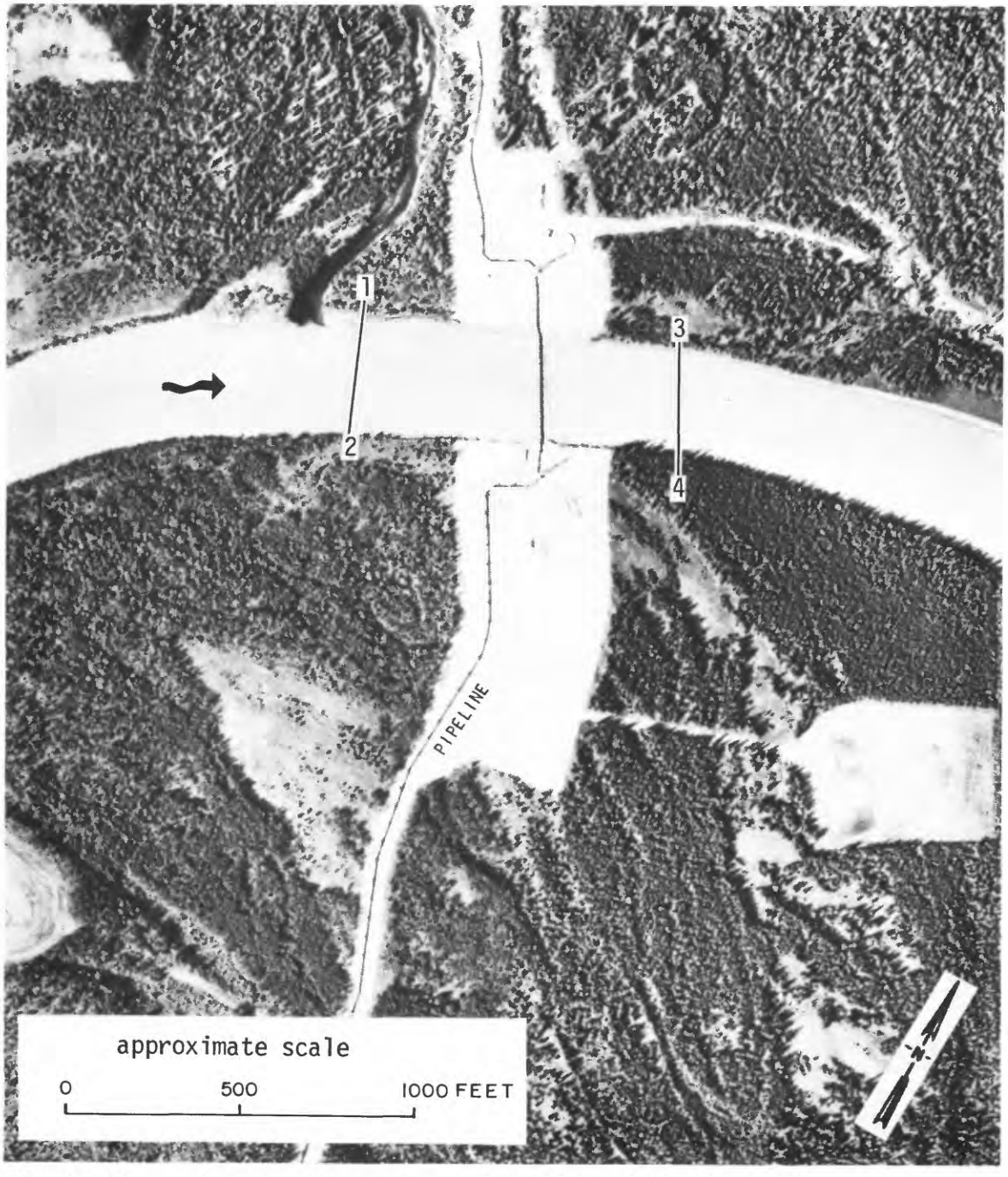


Figure 36. -- Tazlina River near Glennallen, July 29, 1977. AIR PHOTO TECH

Klutina River near Copper Center

Location.--Lat 61°57'15", long 145°19'30", in SE¼ sec.13, T.2 N., R.1 W., at pipeline crossing 1.5 mi upstream from Copper River, and 1 mi west of Copper Center.

[Valdez (D-4) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 37 shows the Klutina River site on July 29, 1977. Comparison of the 1976 and 1977 photography, and a visual inspection made on September 23, 1977, indicate that no signficant change has occurred. No cross sections were measured.

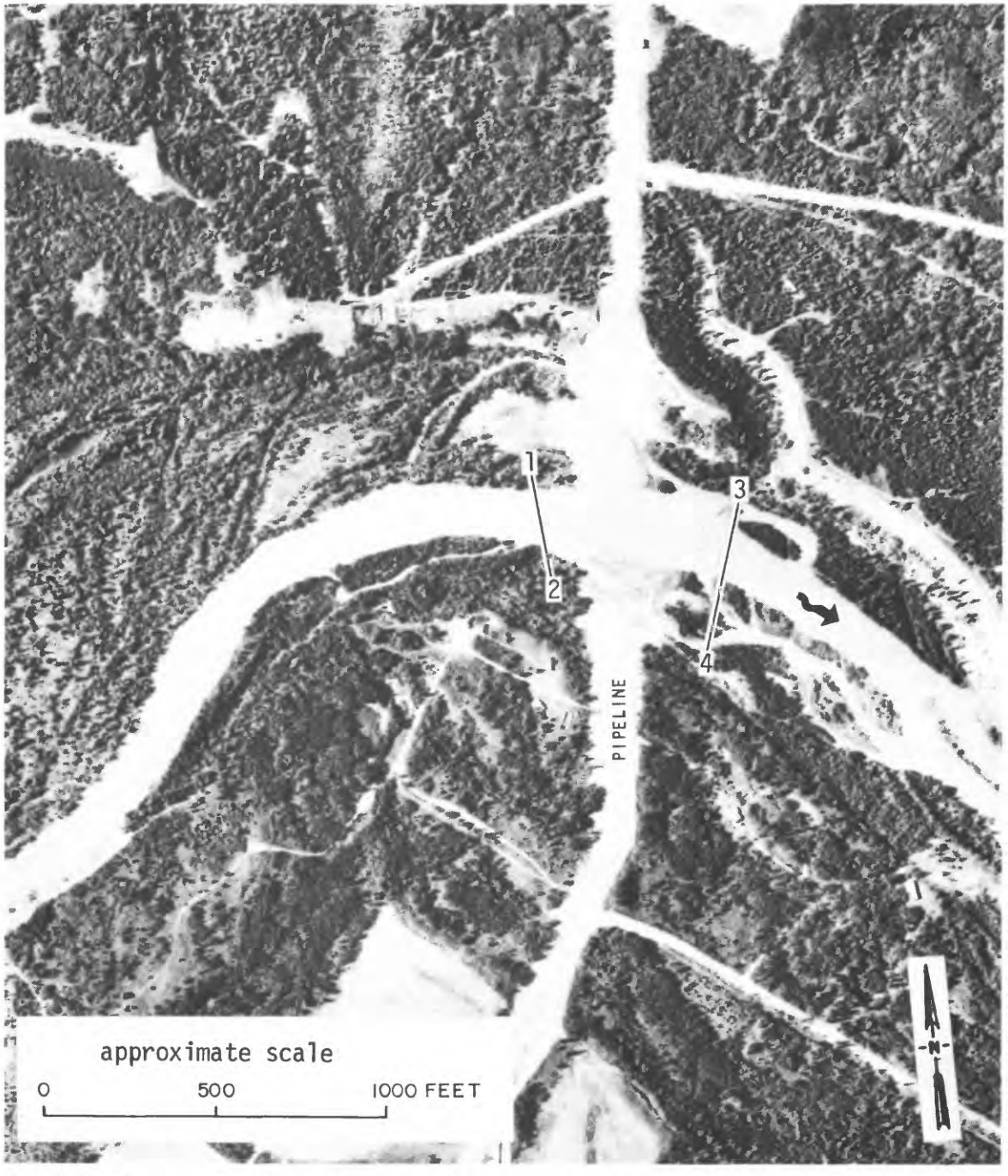


Figure 37. -- Klutina River near Copper Center, July 29, 1977.

AIR PHOTO TECH

Tonsina River near Tonsina

Location.--Lat 61°35'50", long 145°13'40", in NE¼ sec.21, T.3 S., R.1 E., at pipeline crossing, 0.8 mi upstream from Little Tonsina River, and 6.5 mi south of Tonsina.
[Valdez (C-4) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 38 shows the Tonsina River crossing site on July 29, 1977. During the last year considerable brush cutting has occurred on the upstream side of the access pad, and minor construction work along the centerline is still being completed.

This site was resurveyed on September 23, 1977. No significant changes were found in either the upstream or downstream cross sections, but the centerline section was found to have widened slightly (fig. 39).

Only moderate flooding occurred on the Tonsina River in 1977. The year's peak discharge occurred on July 15. It was measured as 5,060 ft^3/s at the gage near Tonsina.

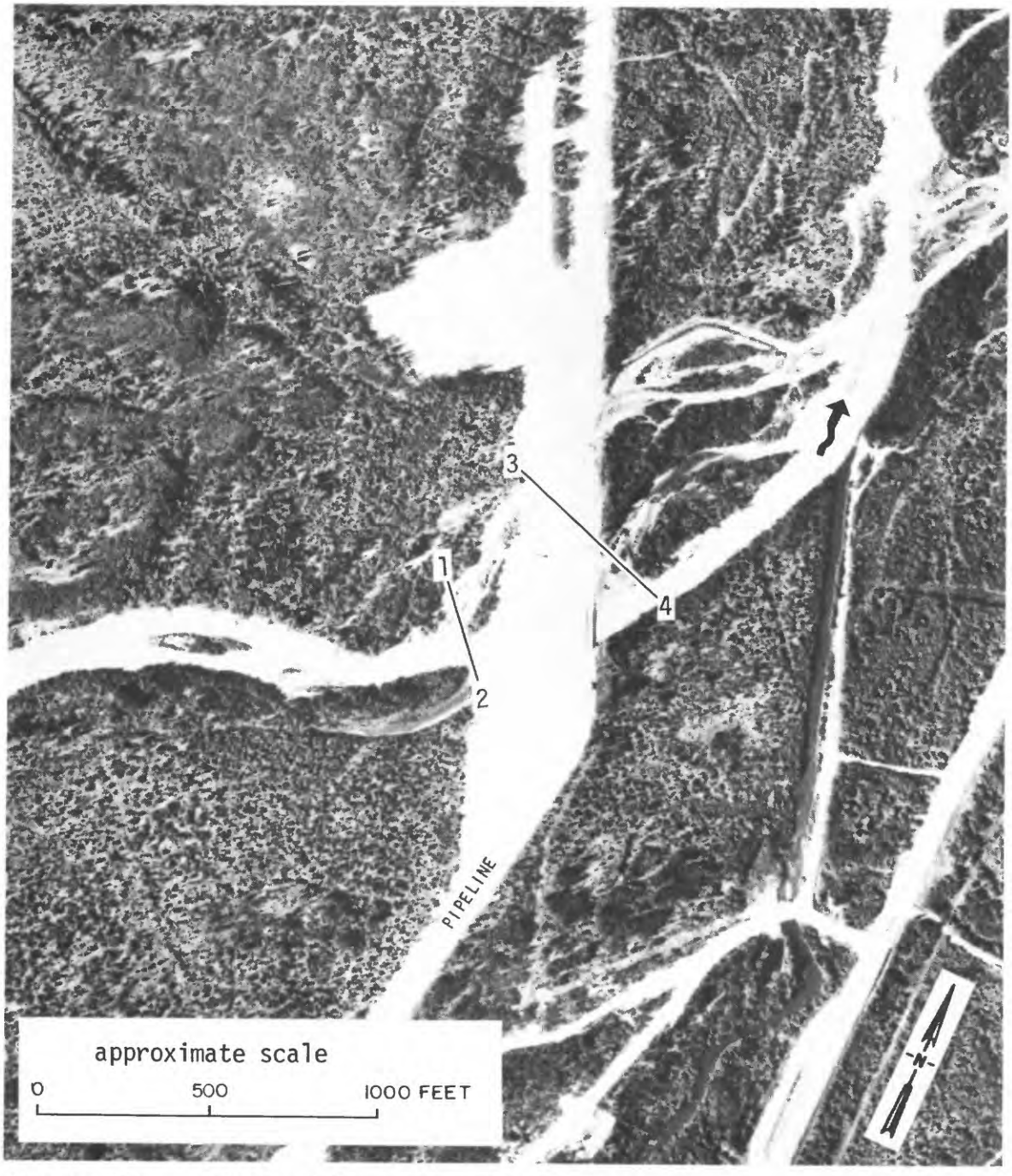


Figure 38. -- Tonsina River near Tonsina, July 29, 1977. AIR PHOTO TECH

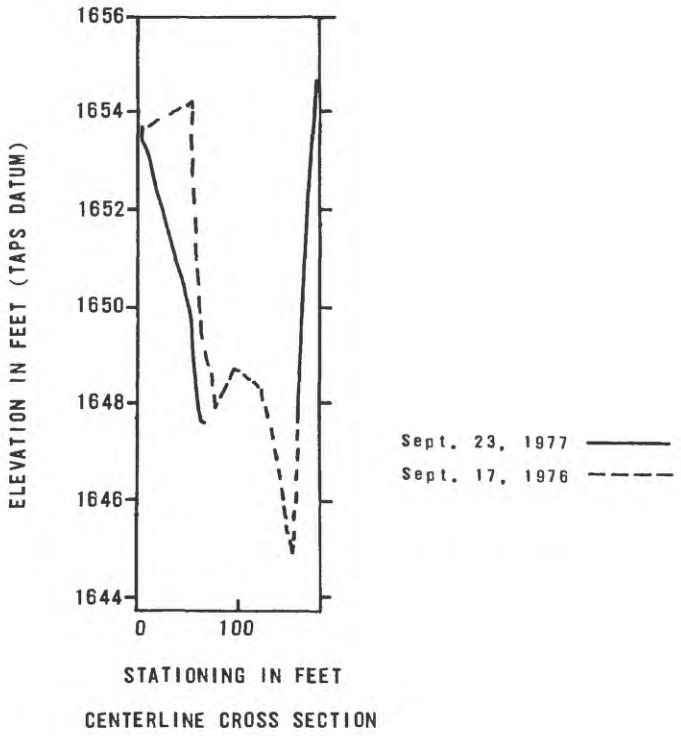


Figure 39. -- Cross section of the Tonsina River near Tonsina.

Tiekel River at Tiekel

Location.--Lat 61°19'12", long 145°18'33", in NW¼ sec.30, T.6 S., R.1 W., at pipeline crossing, 3.7 mi upstream from the Tsina River, and 0.5 mi south of Tiekel.

[Valdez (B-4) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 40 displays the Tiekel River at Tiekel crossing site on July 11, 1977. The site was resurveyed on September 23, 1977; at that time the centerline appeared to be still under construction. Note that a new alignment for the Richardson Highway has been constructed near the crossing.

Apart from minor grading operations, no major change was found in the centerline cross section. Visual inspection indicated no significant change in either the upstream or downstream sections; in fact, none has been found since the site was established in 1973.

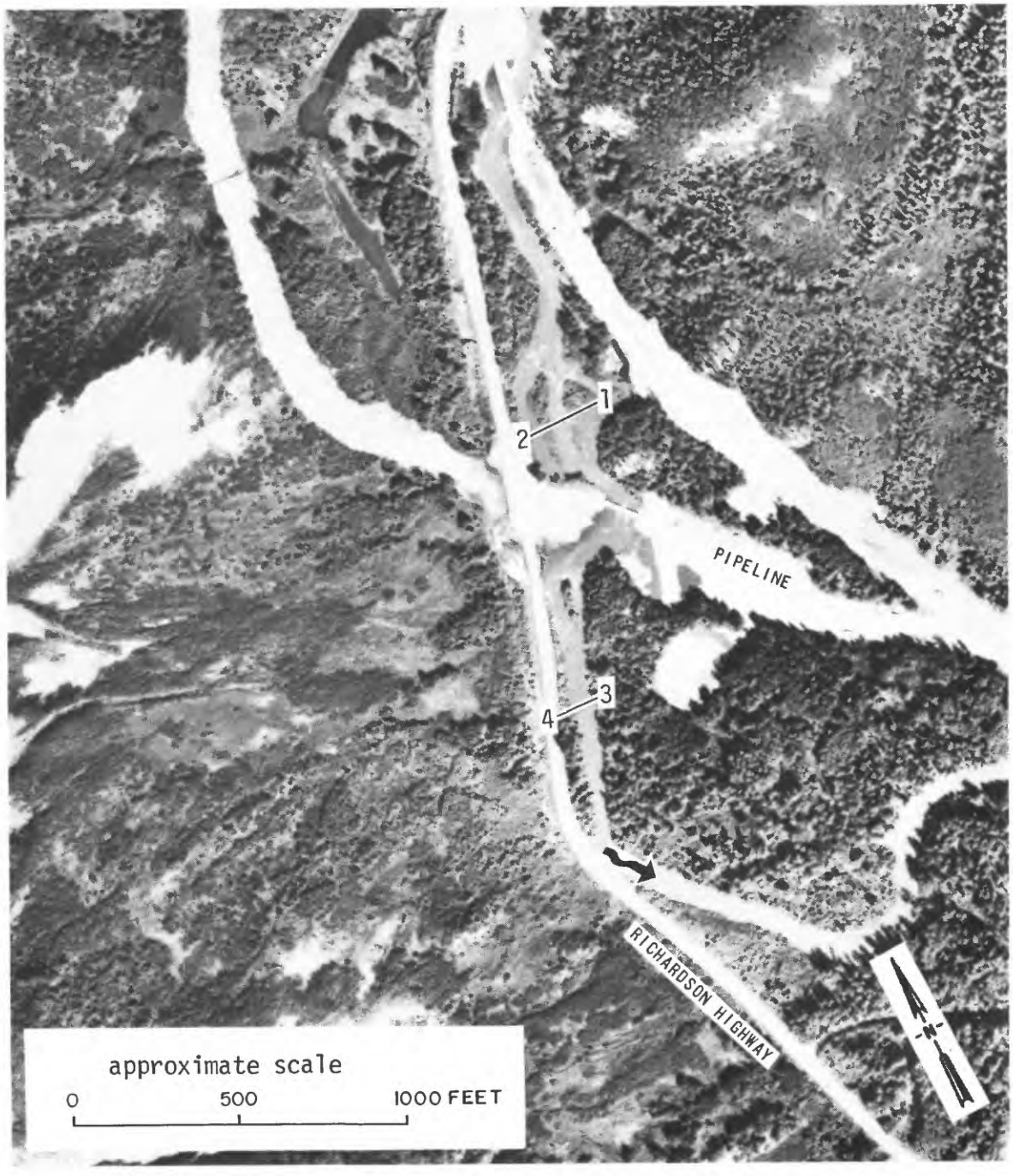


Figure 40. -- Tiekel River at Tiekel, July 11, 1977. AIR PHOTO TECH

Tiekel River near Tiekel

Location.--Lat 61°16'36", long 145°16'21", in NW¼ sec.8, T.7 S., R.1 E., at pipeline crossing, 1 mi upstream from Tsina River, and 3.6 mi southeast of Tiekel.

[Valdez (B-4) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 41 shows the Tiekel River crossing site near Tiekel on July 11, 1977. A new alignment for the Richardson Highway was being constructed alongside the centerline. The highway bridge has been installed just upstream from the temporary access bridge for the pipeline.

The crossing site was resurveyed on September 22, 1977. No significant changes were found in any cross section. No changes have been found in the upstream or the downstream section since the site was established in 1973.

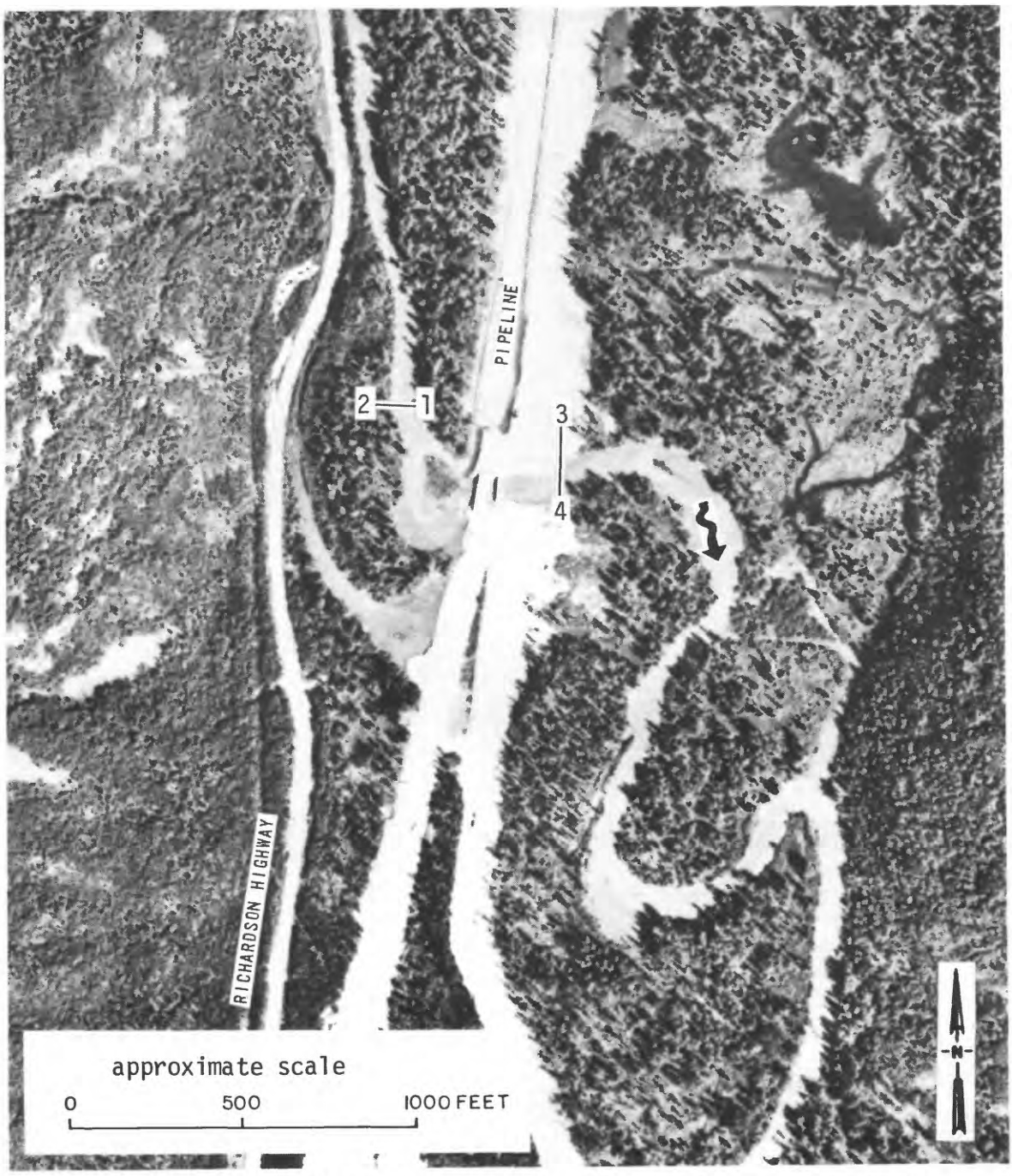


Figure 41. -- Tiekel River near Tiekel, July 11, 1977. AIR PHOTO TECH

Tsina River near Tiekel

Location.--Lat 61°12'48", long 145°22'30", in SE¼ sec.34, T.7 S., R.1 W., at pipeline crossing, 5.5 mi upstream from Tiekel River, and 8 mi southwest of Tiekel.

[Valdez (A-4) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 42 displays the Tsina River near Tiekel crossing site on July 11, 1977. The crossing was resurveyed photogrammetrically on that date and was visited in September. Except for a dike constructed across the right bank of the centerline, no signficant changes were found in any of the three cross sections.

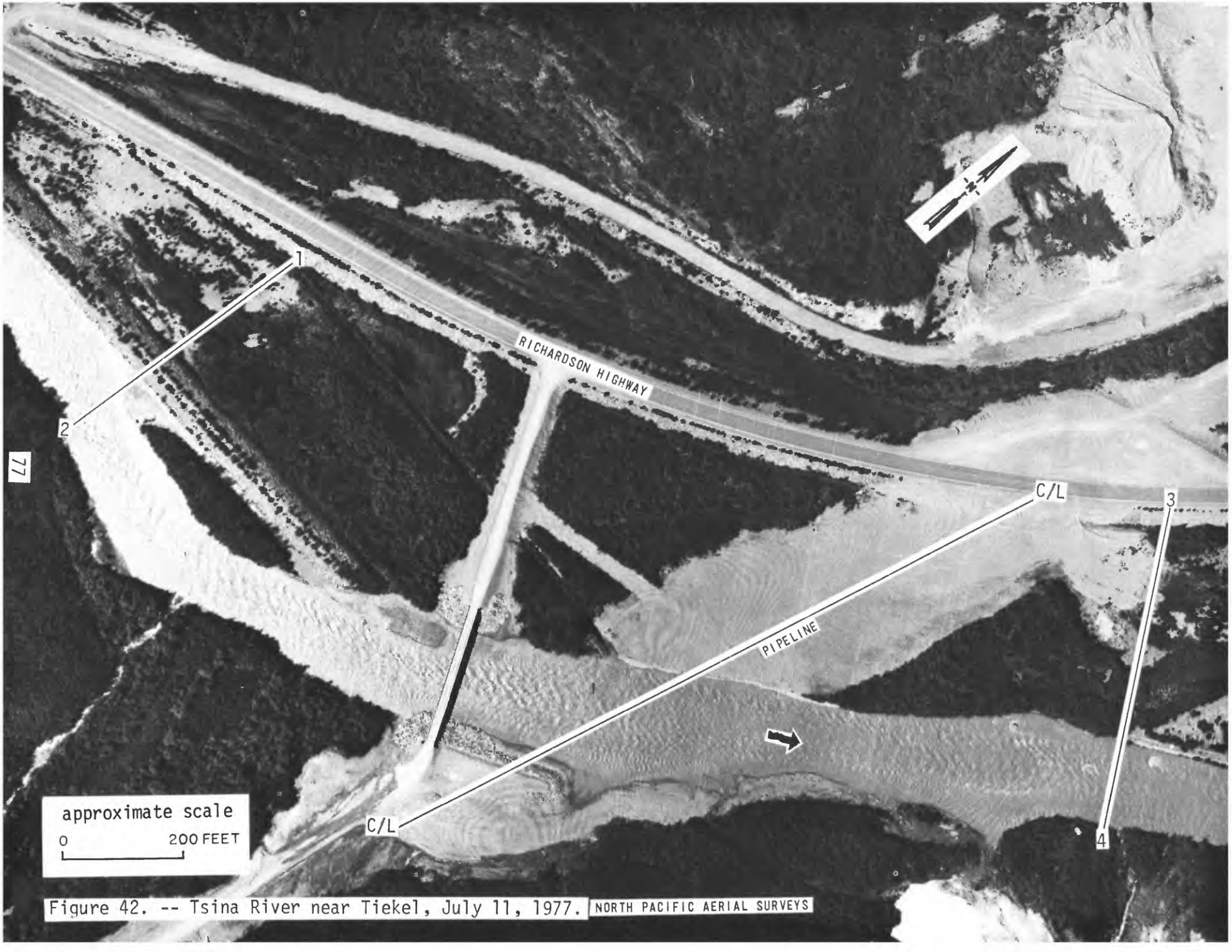


Figure 42. -- Tsina River near Tiekel, July 11, 1977. NORTH PACIFIC AERIAL SURVEYS

Tsina River near Ptarmigan

Location.--Lat 61°12'00", long 145°33'06", in SE¼ sec.3, T.8 S., R.2 W., at pipeline crossing, 300 ft downstream from Cascade Creek, and 2.5 mi east of Ptarmigan.

[Valdez (A-5) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 43 shows the Tsina River near Ptarmigan crossing site on July 11, 1977. This crossing was resurveyed on September 22, 1977. During the past year, the reference points for the upstream crossing have been destroyed, and the cross section could not be exactly resurveyed. A new upstream cross section was therefore established. Its shape and on-site visual observations indicate that there has been no significant change in this cross section. No changes have been noted in either the centerline or downstream sections since the site was established in 1973.

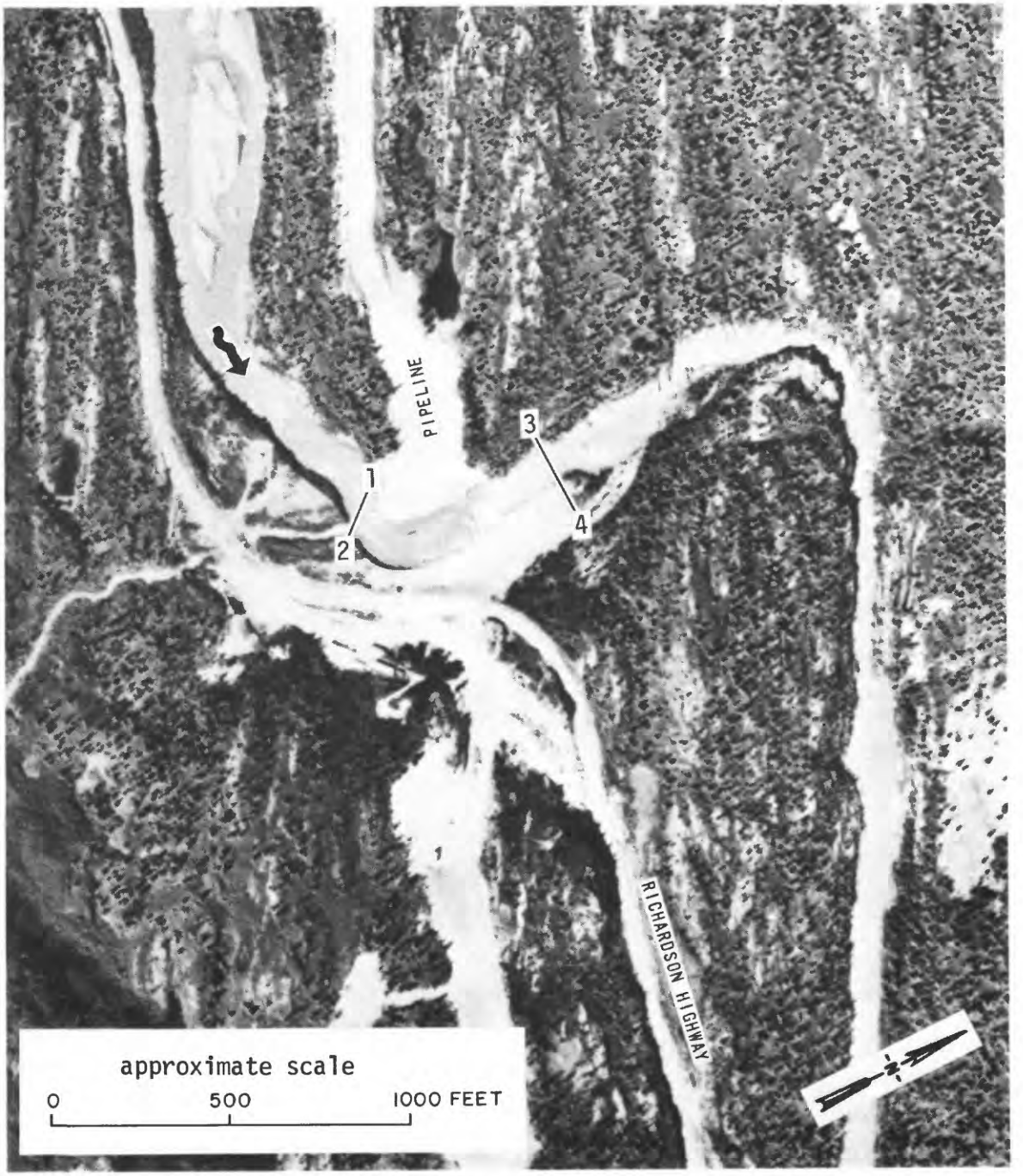


Figure 43. -- Tsina River near Ptarmigan, July 11, 1977. AIR PHOTO TECH

Tsina River at Ptarmigan

Location.--Lat 61°11'40", long 145°39'10", in NE¼ sec.7, T.8 S., R.2 W., at pipeline crossing, at Ptarmigan Creek 1 mi northwest of Ptarmigan.

[Valdez (A-5) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 44 shows the Tsina River at Ptarmigan site on July 11, 1977. The site was resurveyed photogrammetrically on that date and visited in September. Dikes have been constructed along the channel upstream from the centerline. These have constricted the braiding pattern and moved it toward the right bank.

There has been no significant change in the channelway of the 305+50, 328+00 and 335+00 cross sections, but the big stockpile of gravel on the right side of the channel just north of the centerline has been removed since 1976. Cross sections 346+00, 352+64 and the supplementary section have changed considerably. However, the channels are within the major banks of the stream, and no significant erosion of vegetated area or the flood plain has occurred (fig. 45 a and b).

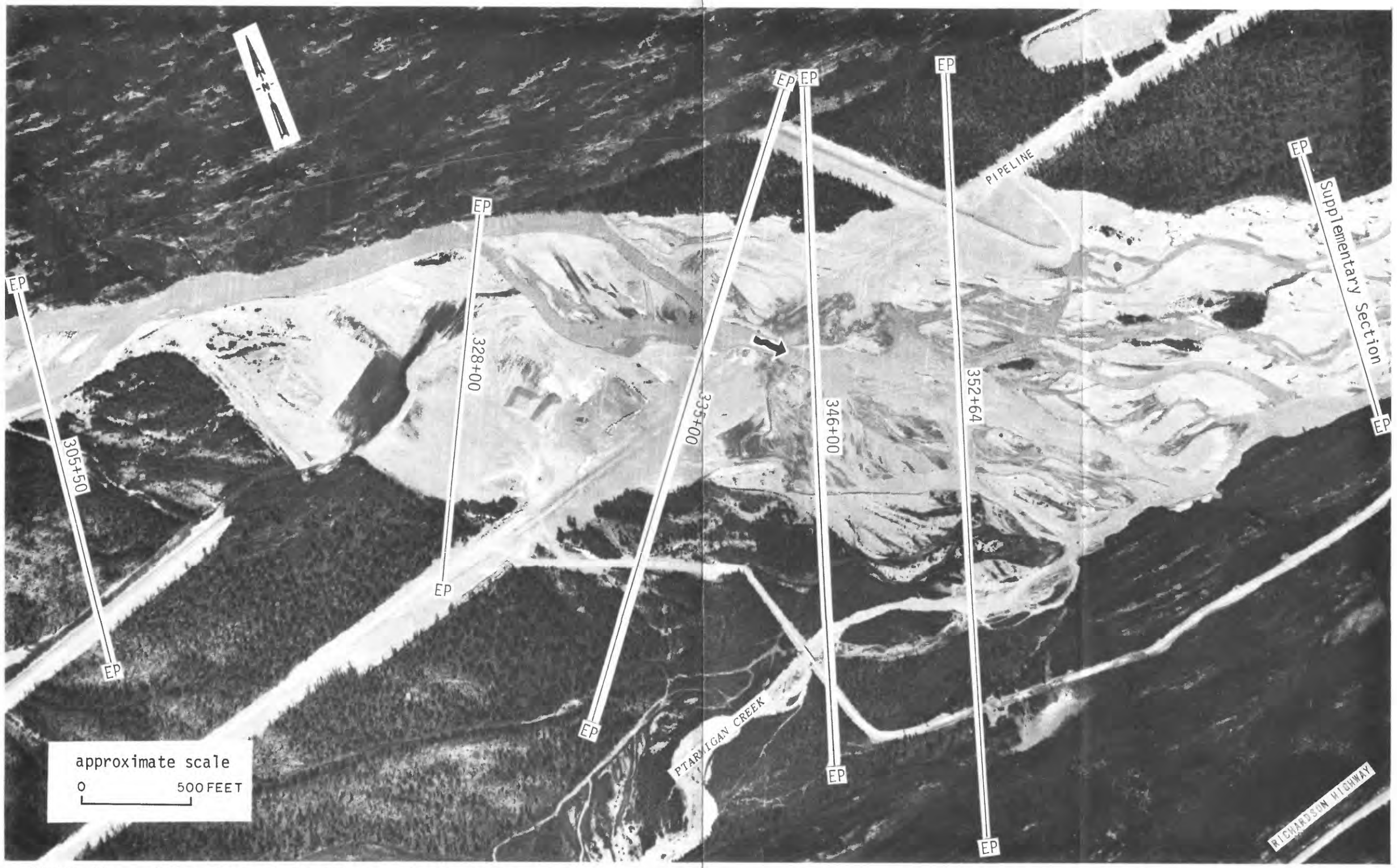


Figure 44. -- Tsina River at Ptarmigan, July 11, 1977.
NORTH PACIFIC AERIAL SURVEYS

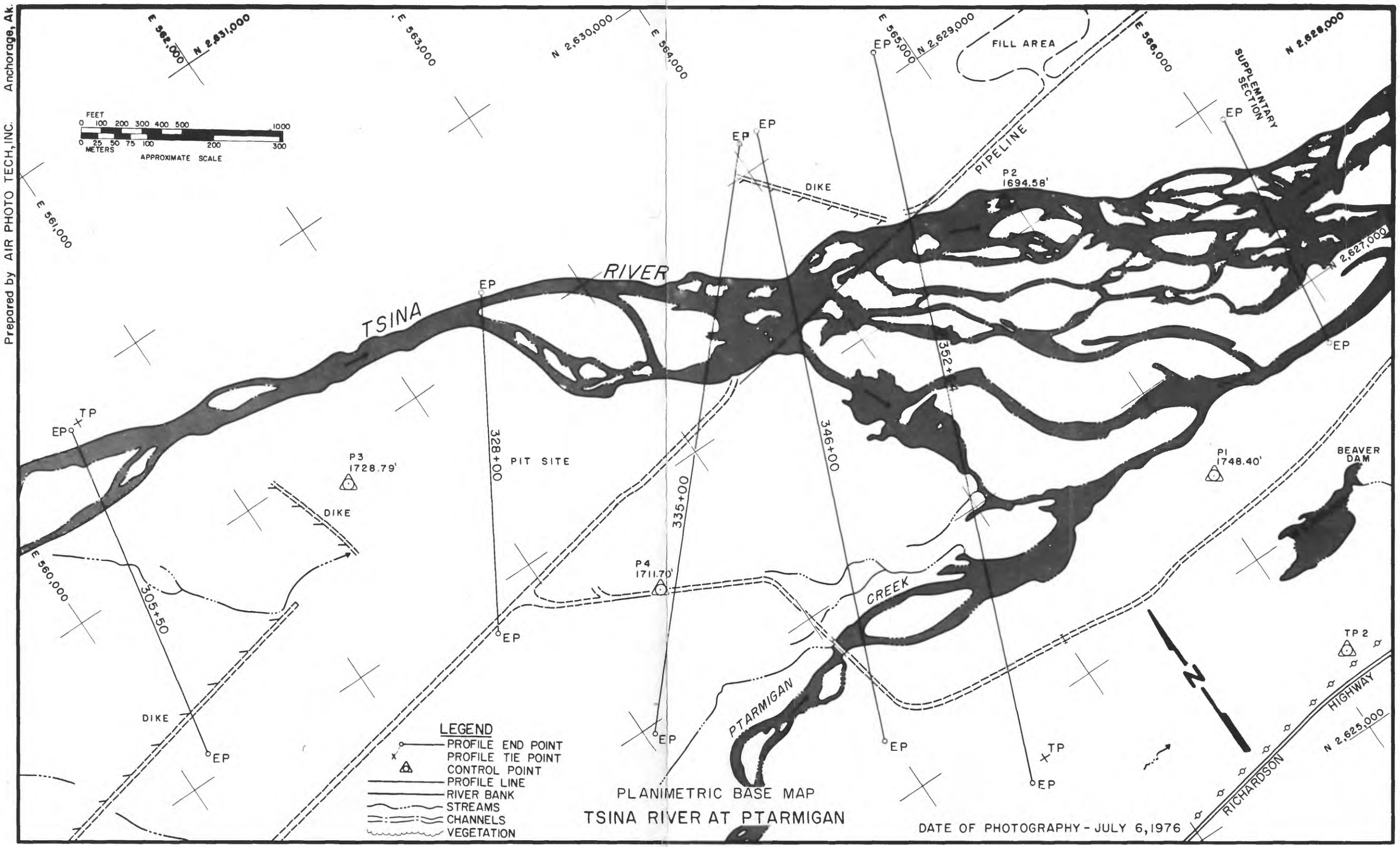


Figure 45a. -- Planimetric map of the Tsina River at Ptarmigan, July 6, 1976.

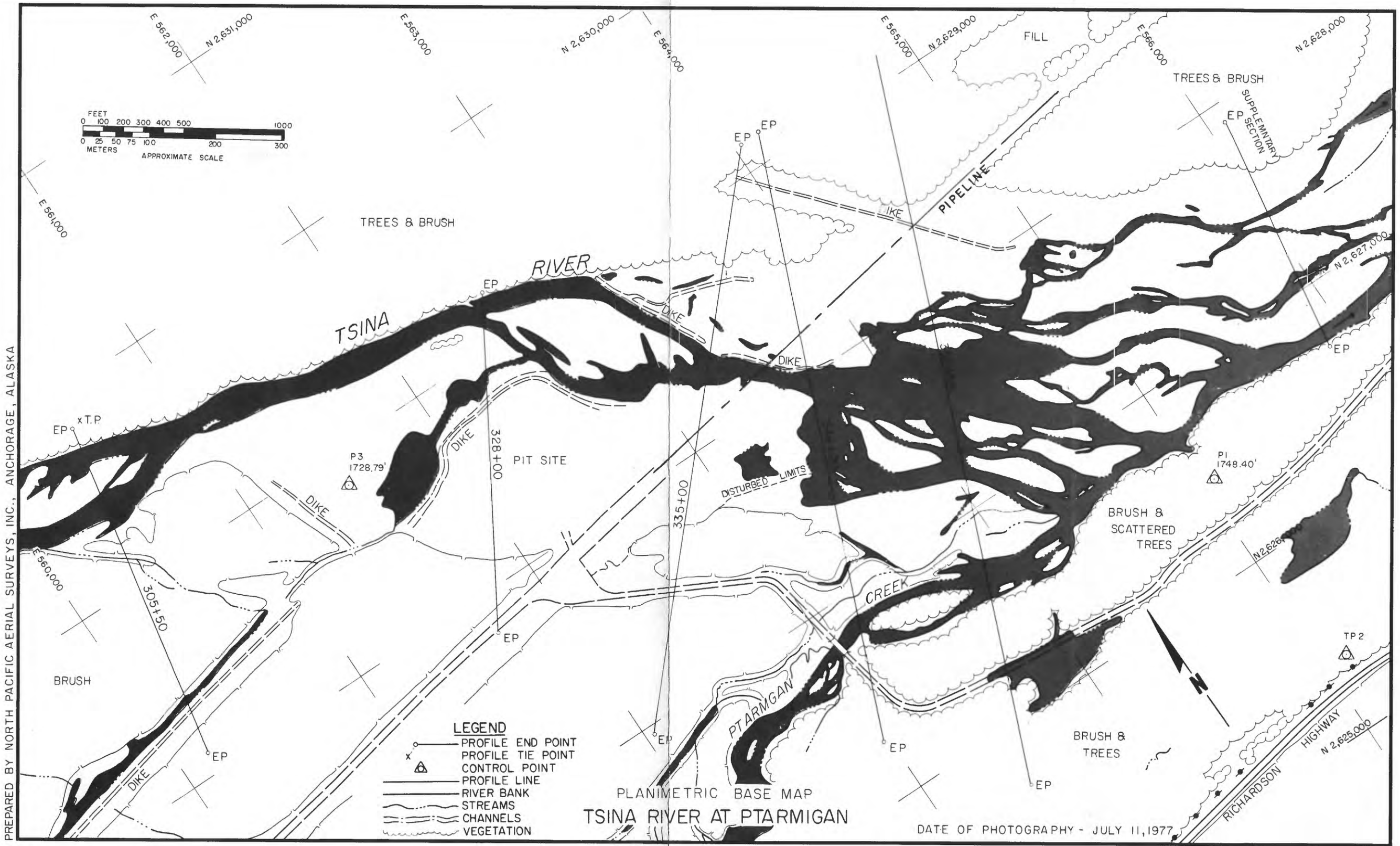


Figure 45b. -- Planimetric map of the Tsina River at Ptarmigan, July 11, 1977.

Sheep Creek near Valdez

Location.--Lat 61°06'30", long 145°48'30", in SW¼ sec.5, T.9 S., R.3 W., at pipeline crossing, 0.2 mi upstream from Lowe River, and 18 mi east of Valdez.

[Valdez (A-5) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 46 shows the Sheep Creek crossing site on July 11, 1977. The site was resurveyed photogrammetrically on that date and a field inspection was made in September.

No significant changes were found in either the upstream or downstream cross sections. Figure 47 displays changes made by construction equipment on the centerline in the last year.

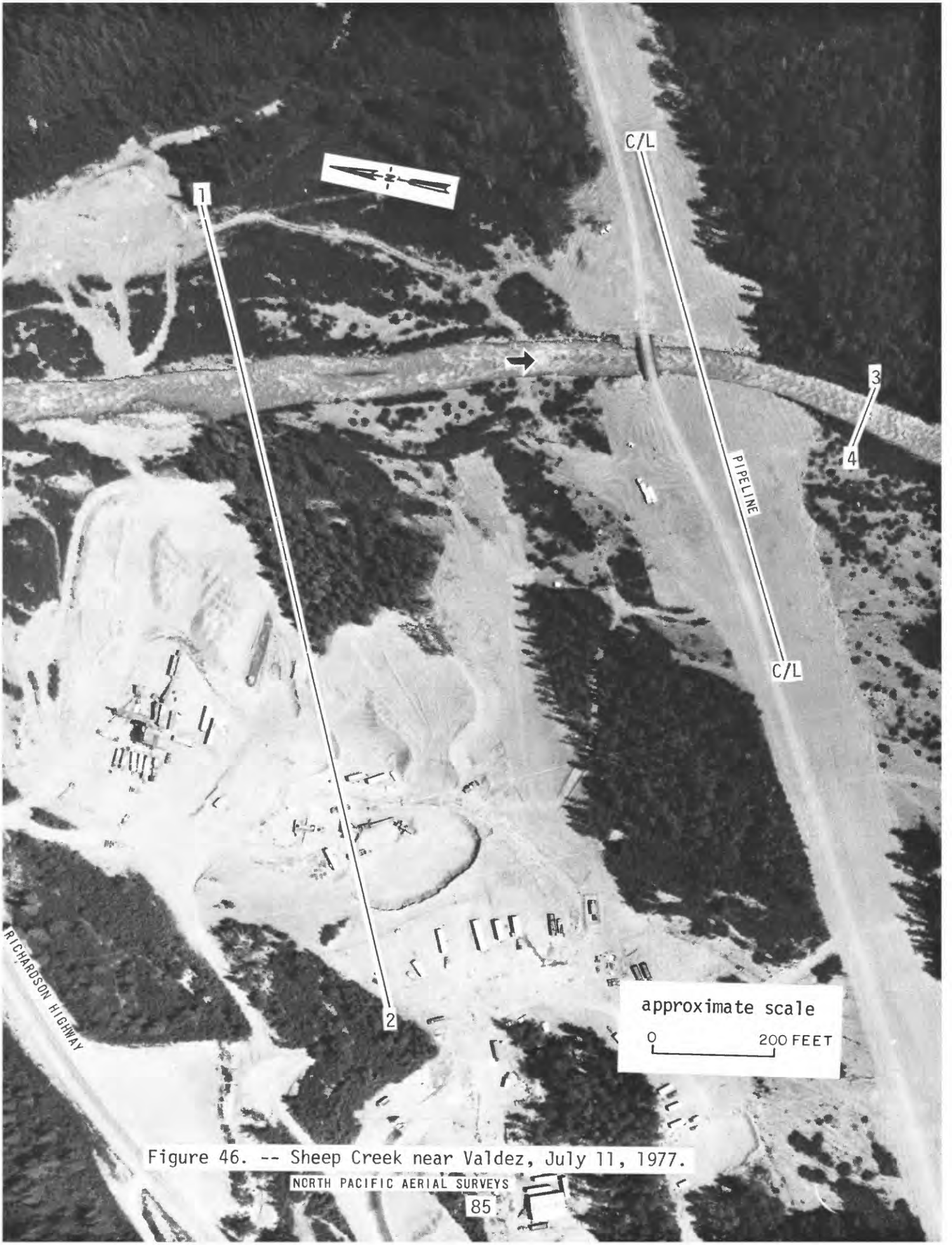


Figure 46. -- Sheep Creek near Valdez, July 11, 1977.

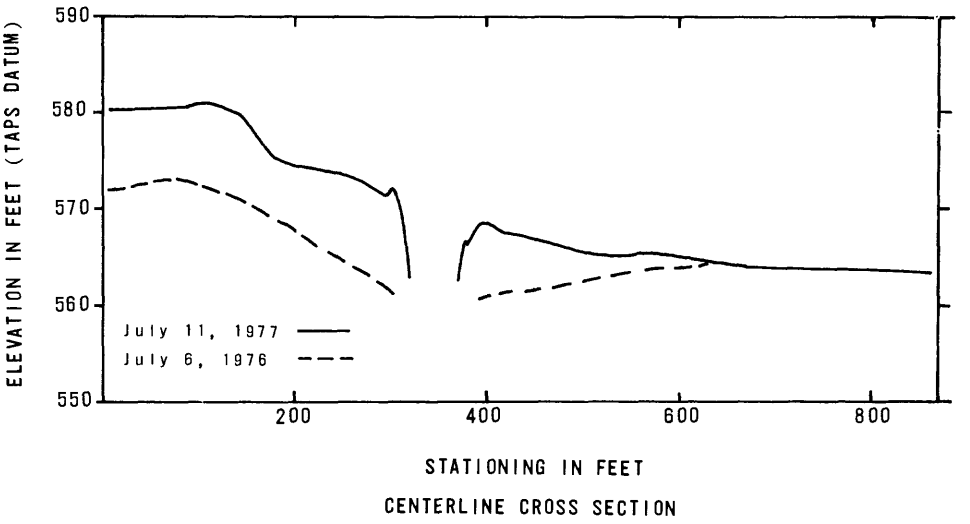


Figure 47. -- Cross section of Sheep Creek near Valdez.

Lowe River near Valdez

Location.--Lat 61°05'50", long 145°51'00", in SW¼ sec.12, T.9 S., R.4 W., at pipeline crossing, 0.2 mi upstream from Bear Creek, and 16 mi east of Valdez.

[Valdez (A-5) 1:63,360, U.S. Geological Survey map.]

1977 Surveillance.--Figure 48 shows the Lowe River crossing site on July 11, 1977. The site was resurveyed photogrammetrically on that date, and a field inspection was made in September.

No significant change was found in the downstream cross section, but high water has covered the flood plain along the right bank at the upstream section. During the last year, the left bank of the centerline has been backfilled and a rip-rap dike has been constructed at the shore. This changed the profile of the left bank at the centerline, but the remainder of the cross section is identical to the last year's (fig. 49).

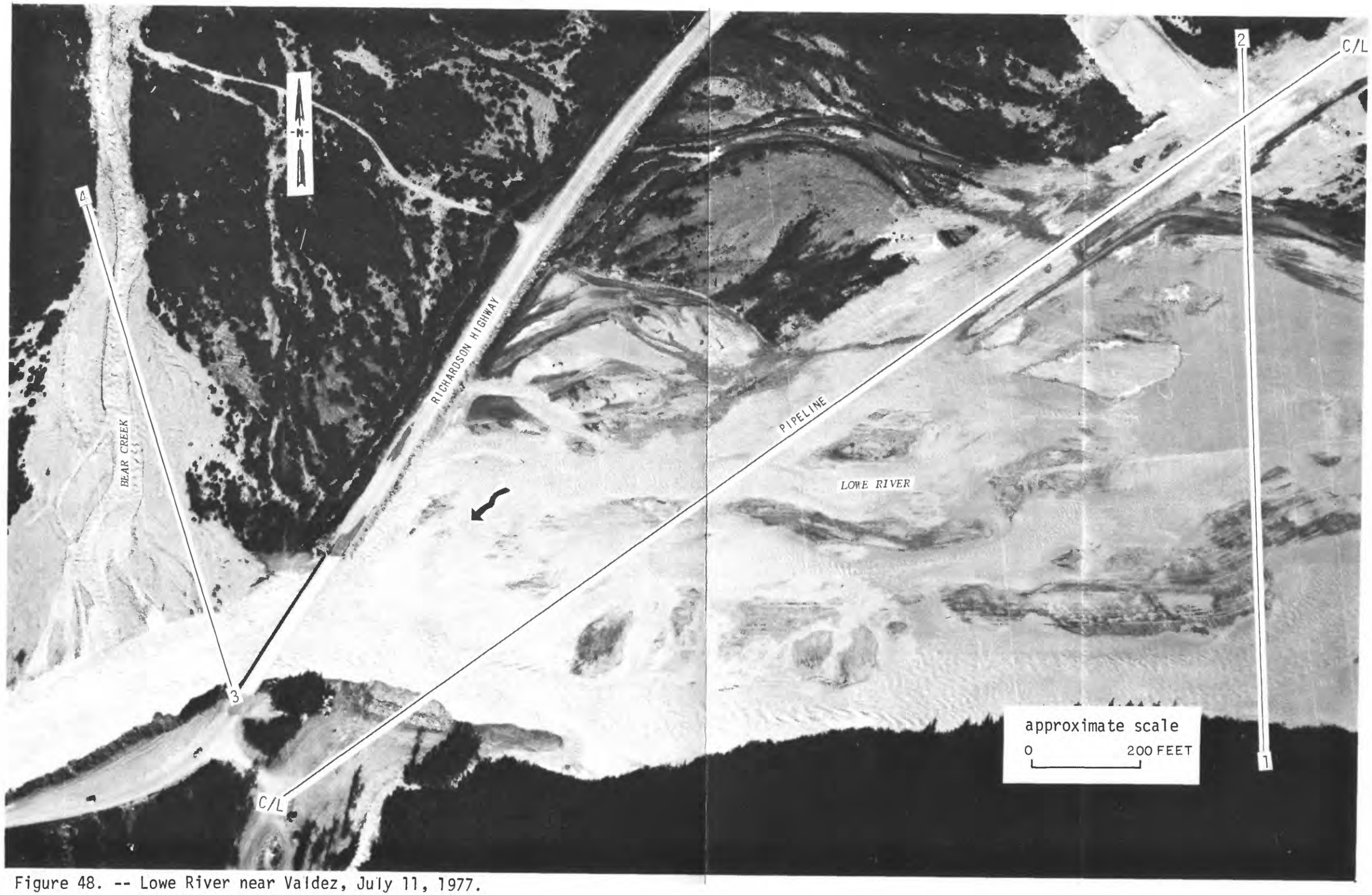


Figure 48. -- Lowe River near Valdez, July 11, 1977.
NORTH PACIFIC AERIAL SURVEYS

Figure 49a. -- Planimetric map of the Lowe River near Valdez.

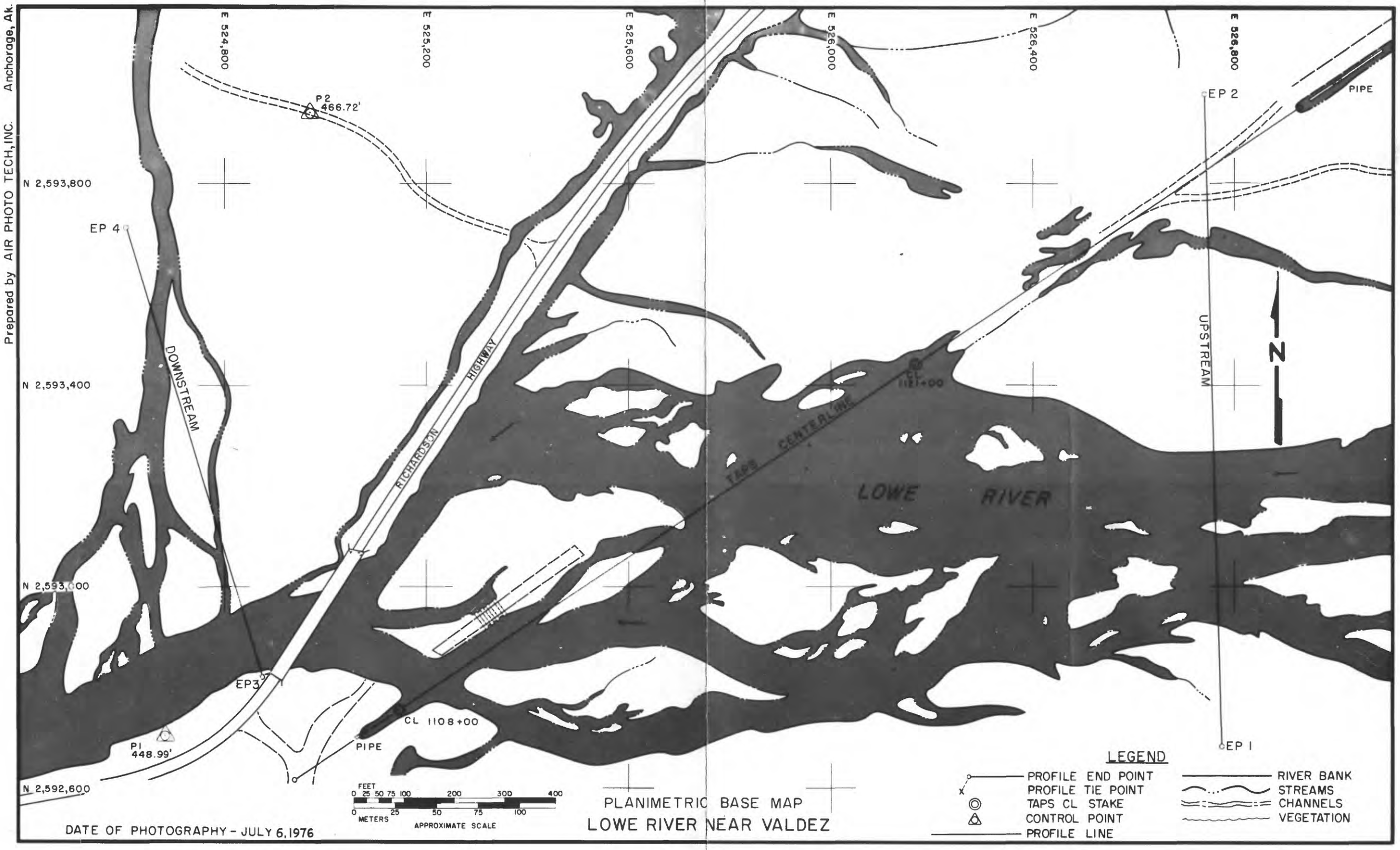


Figure 49b. -- Planimetric map of the Lowe River near Valdez.