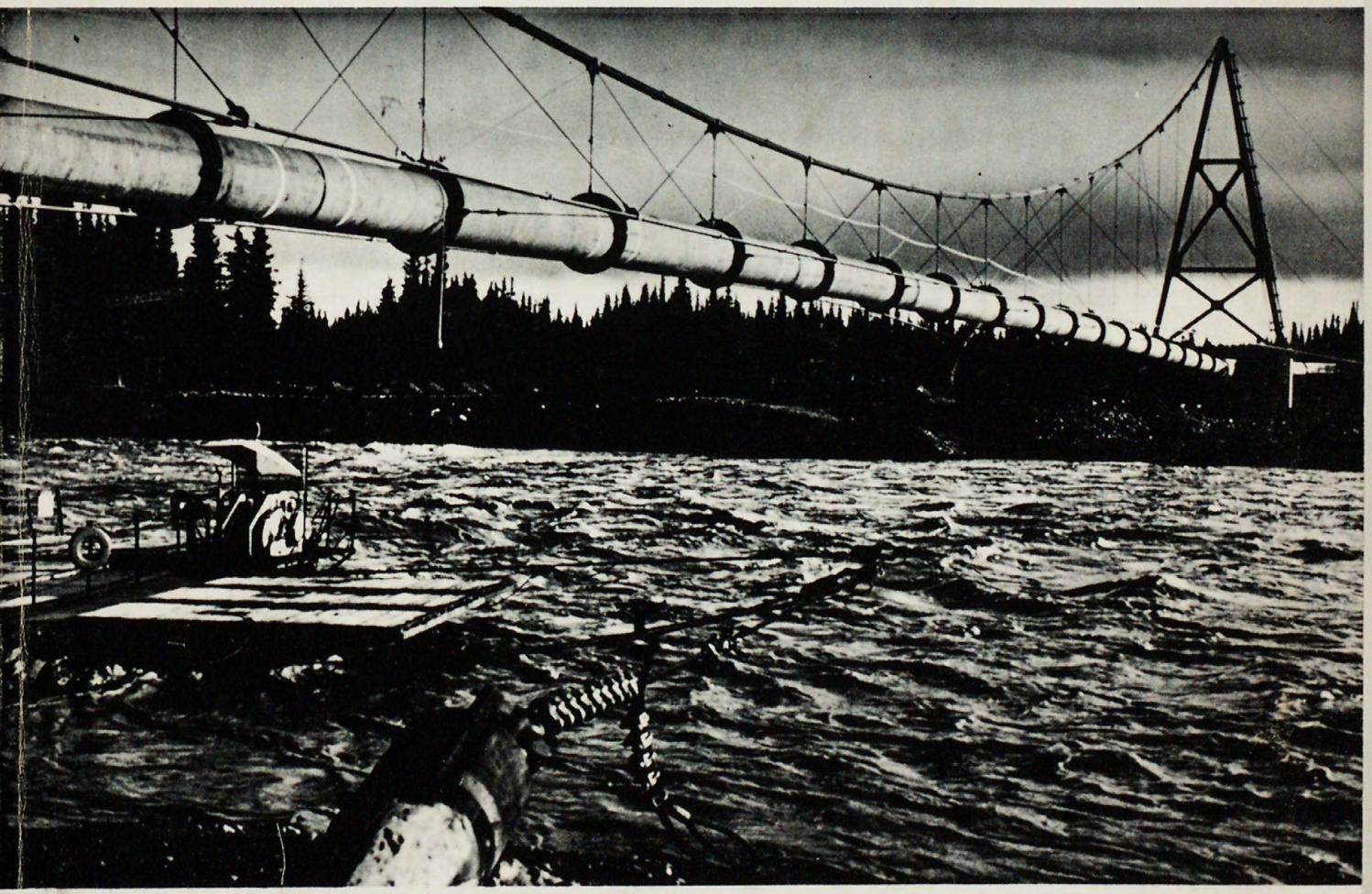
CHANNEL EROSION SURVEYS ALONG TAPS ROUTE, ALASKA, 1976



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CHANNEL EROSION SURVEYS ALONG TAPS ROUTE, ALASKA, 1976

By
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OPEN-FILE REPORT
(Basic Data)
77-170

Anchorage, Alaska
1976

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ILLUSTRATIONS

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1976

CONVERSION FACTORS

For use of those readers who may prefer to use metric units rather than English units, the conversion factors for the units used in this report are listed below:

Multiply English units	By	To obtain metric 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 per 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)

ABSTRACT

Channel surveys were made along the TAPS route during 1976 at the same 27 sites that were surveyed in 1975. One additional site was put under surveillance in 1976. Except for construction changes wrought by installation of the pipeline, most of the sites surveyed showed very little change since the 1975 surveys. Some of the significant events of 1976 at the monitored crossing sites include: glacier-dammed lake break-out floods on the Tazlina and Tsina Rivers, severe icings on the Gulkana River which resulted in a spring flood 3-4 feet (1 meter) over banktop, and virtual completion of all the buried crossings and all but one overhead crossing before the 1976 channel erosion resurveys were made.

Aerial photogrammetric surveys were used again in 1976 on the same seven sites as in 1975. Comparison of the photogrammetric surveys with each other and with on-the-ground surveys indicate that the method is generally applicable for channel erosion studies. However, it requires engineering judgement and personal knowledge of the site to avoid reaching inaccurate conclusions about channel change in some instances.

INTRODUCTION

This report contains information obtained in a study of channel erosion along the TAPS route in 1976. This year 28 sites were investigated; the stream crossing site of Castner Creek and Lower Miller Creek in the Alaska Range was included for the first time in addition to the 27 sites under surveillance in 1975. Many of these sites have been monitored for several years in this long-term effort to document and explain both natural and construction-induced change at selected stream crossing sites along the trans-Alaska oil pipeline route. Background information for this report is contained in reports by Brice (1971), Childers (1972, 1975), Childers and Jones (1975), and Doyle and Childers (1975).

The year 1976 saw the virtual completion of the pipeline construction portion of the TAPS project. All of the major stream crossings have been completed; only some bank protection remains to be done. The Department of the Interior, through the Alaska Pipeline Office, maintains a file of records documenting design and approval of stream crossings. As-built drawings required by the Department of the Interior will be included in the records submitted by Alyeska Pipeline Service Company. The records will provide data for evaluating conditions at the pipeline stream crossings during the life of the project. If hydrologic events of design proportions occur, then the as-built plans will help document success or failure of design.

The 1975-76 winter was one in which icings were relatively numerous in some locations. These icings created some problems along the haul road and the work pad in a few locations. However, the spring break-up was mild, and in general most of the surveyed streams had no unusually high flows between the times of the 1975 surveys and the 1976 surveys. The 1976 surveys appear to reflect this fact in that, for most of the streams, nearly all the reported change is the result of construction.

Some significant events which have occurred since the 1975 surveys include: a new peak of record discharge of 9,800 ft^3/s (cubic feet per second) or 277 m^3/s (cubic meters per second) at the Jim River gage on September 13, 1975; a glacier-dammed lake break-out flood of 10,000 ft^3/s (283 m^3/s) on the Tsina River on August 8, 1976; a glacier-dammed lake break-out flood of 30,000 ft^3/s (850 m^3/s) on the Tazlina River on September 22, 1976; and severe icings on the Gulkana River resulting in an ice-choked main channel in May which caused a break-up flood 3 to 4 ft (feet) or 1 m (meter) over bank top. None of these events caused any bank erosion or residual thalweg changes that could be detected at the 1976 survey sites.

An Authorized Officer Field Representative report of August 11, 1976, (Schroeder, written commun.) indicates severe siltation and erosion in Dietrich and Atigun River valleys from a storm on July 29 and 30. Geological Survey surveillance was done in mid-July, prior to the storm, and results of the storm will not be ascertained until 1977. However, a flood peak discharge rate of 33.3 $(ft^3/s)/mi^2$ (cubic feet per second per square mile) or 0.364 $(m^3/s)/km^2$ (cubic meters per second per square kilometer) on Atigun River tributary near Alyeska Pipeline Service Company Pump Station 4 was measured in September by indirect methods, using floodmarks from the flood of July 29 and 30, 1976. This compares with maximum evident flood peak discharge rates of 69.4 $(ft^3/s)/mi^2$ [0.756 $(m^3/s)/km^2$)] for Atigun River near Pump Station 4 and 76.9 $(ft^3/s)/mi^2$ [0.838$(m^3/s)/km^2$)] for Snowden Creek near Dietrich camp. These data indicate that the July 30 flooding was not unusual.

Photogrammetric surveys were done in 1976 at the same sites as in 1975. Results of the two surveys were evaluated and are discussed in the next section of this report.

All of the sites previously studied except for the Middle Fork Koyukuk River near Coldfoot, the Tazlina River and Castner Creek sites were surveyed during 1976, and all the field data are on file at the Alaska District Office of the Water Resources Division, U.S. Geological Survey, in Anchorage.

All 1976 aerial photographs in this report were taken by Air Photo Tech either under contract to the U.S. Geological Survey or to Alyeska

Pipeline Service Company. Cross section end points (EP) on photos are indicated by numbers except for three points which have the cross sections designated by stations.

Channel cross sections illustrated in the report are viewed as looking downstream. At some sites construction has obliterated TAPS centerline stakes and so the centerline cross section stationing in some cases is arbitrary in the 1976 surveys. Assuming construction is complete by the time the 1977 surveys are made, TAPS stationing will again be used for centerline cross sections. As this channel erosion study has evolved, terminology used and the orientation of illustrations has changed. The reader is advised to study the photos and illustrations in each of the references to follow the changes.

Table 1 summarizes the findings at 27 sites for 1976 (Castner Creek site not included). Locations of the 28 channel erosion surveys sites are shown in figure 1.

PHOTOGRAMMETRIC SURVEYS

In 1975, aerial photogrammetric surveys were initiated at 7 channel erosion surveillance sites. Results of the photogrammetry were scaled stereomodels and selected cross sections for each site. In 1976 aerial photogrammetry was used for channel erosion surveillance at the same sites as in 1975. Study of the 1975 and 1976 surveys continues to show that photogrammetry is a useful technique for channel erosion surveillance, particularly on wide, irregular floodways. However, two years' experience confirms the need to improve the technique.

Photographic control points carefully set and premarked for the 1975 surveys were found adequate for 1976 surveys without additional field work, and the ground control provided by these photo control points is considered by the contract photogrammetrists to be adequate for future surveys. The ability to perform subsequent channel surveys in the office is a considerable cost-saving feature of aerial photogrammetry. The main advantage of the technique is that, from the aerial photos obtained each year, a stereomodel of a site is produced which allows any cross section covered by the model to be compiled, not just the few which ground surveys produce.

Two difficulties have become apparent in using photogrammetry for channel erosion surveillance. The first is in obtaining comparative cross sections at the same locations on repeated stereomodels so that channel changes can be measured. The difficulty in relocating the cross sections is caused by not having established better cross section end points that can be precisely located on the air photos each year.

Cross sections used to define channel hydraulic features may lie along an unvegetated channel-way which is subject to much change and where permanent features do not exist. The cross sections may also extend into heavy woods where ground control points can be exposed only by cutting away many trees, which is environmentally undesirable. Establishing suitable photo-identifiable ground control points on each cross section will be done prior to the 1977 survey wherever possible. However, where precise cross section control points can not be established, there is another alternative. The alternative is the timely review of photogrammetric data by the hydrologist before the data is presented in final form. This alternative, however, involves the second shortcoming in using the photogrammetric technique: arranging for contracted service by a bidding process. An essential part of the photogrammetric technique in this channel erosion surveillance is continuing negotiation and exchange of information between the photogrammetrist and the hydrologist. The writers believe that a negotiated contract for photogrammetric services has a great advantage over a bid contract in that it would allow the hydrologist to actively participate in the compilation phase of the work and to review an unfinished draft of the cross sections. If necessary, adjustments of the cross section location for improved accuracy in the finished profile could be done most efficiently in this manner.

REFERENCES

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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Table 1.--*Channel erosion survey results, 1976.*

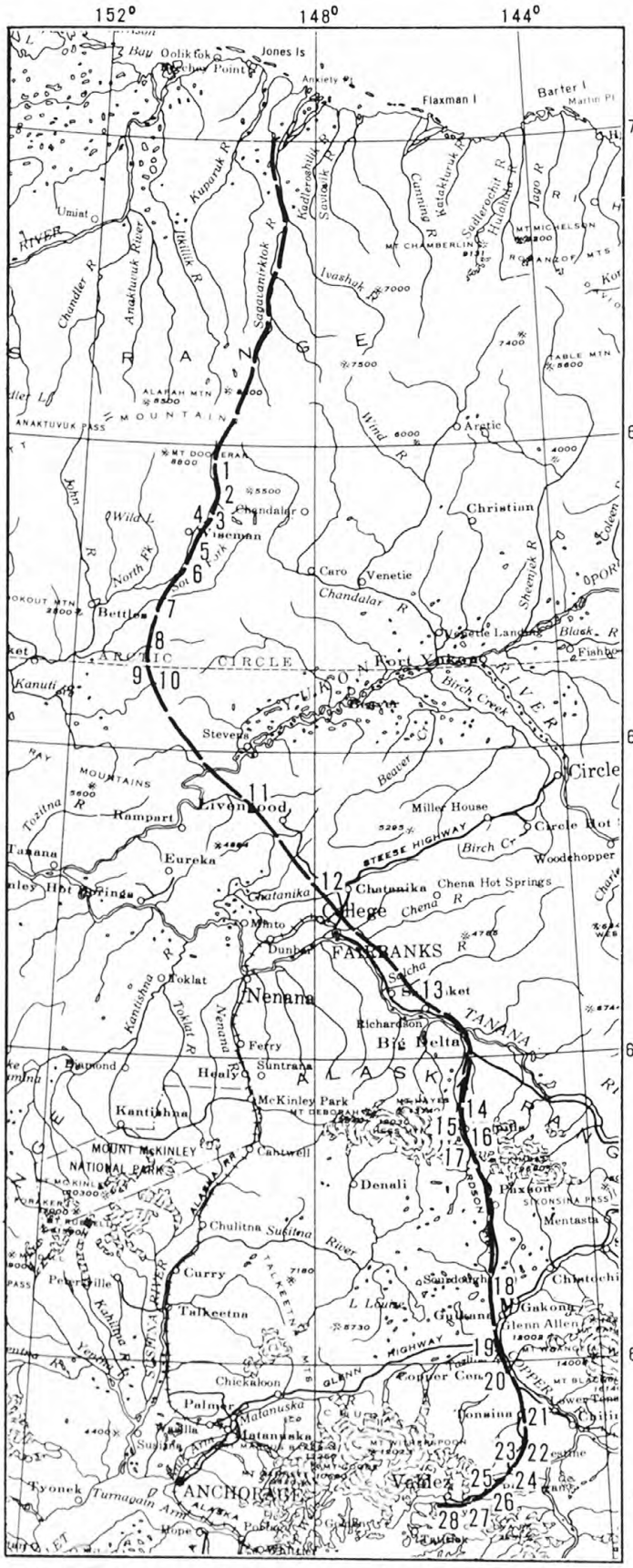
	Site	Maximum net change since 1975 survey: Thalweg elevation (ft)	Maximum net change since 1975 survey: Bank erosion (ft)	Remarks
1	Snowden Creek	+2	0	Deposition at upstream section and construction change at centerline
2	Dietrich River	+1	0	Construction change at upstream and centerline sections. Centerline section not surveyed since 1974.
3	M.F. Koyukuk River at Hammond River	+3	0	Deposition beneath highway bridge. Construction of pipe crossing has greatly constricted floodway at centerline section.
4	Hammond River	+2 and -2	10	Construction and natural changes.
5	M.F. Koyukuk River near Wiseman	+3	0	Main channel changes in downstream section. New centerline alinement.
6	M.F. Koyukuk River near Coldfoot	--	0	Comparison of photographs indicates no noticeable bank erosion.
7	S.F. Koyukuk River	-1	0	Construction changes at centerline and downstream sections.
8	Jim River	0	0	New peak of record discharge of 9,800 ft^3/s at gage in Sept. 1975.
9	Prospect Creek	-1	0	Icings filled channel by May, causing overbank flow.
10	Kanuti River	-3	0	Centerline thalweg deepened due to pipe burial.
11	Hess Creek	0	0	Changes within stream banks.

Table 1.--*Channel erosion survey results, 1976.*--Continued

Site	Maximum net change since 1975 survey: Thalweg elevation (ft)	Bank erosion (ft)	Remarks
12 Chatanika River	-2	0	Centerline thalweg deepened due to pipe burial.
13 Salcha River	-10	0	Deep hole at centerline due to pipe burial.
14 Flood Creek	-4	0	Centerline thalweg deepened due to pipe burial.
15 Delta River at Flood Creek	--	20	Lateral dikes built along right side of floodway, forcing flow more to left side.
16 Delta River at Phelan Creek	--	0	Spur dikes built along right side of floodway
17 Gulkana River	0	0	Icing-filled channel resulted in May flood 3-4 ft over bank-top. Flood caused no erosion and left little flood evidence.
18 Tazlina River	--	0	Glacier-dammed lake break-out flood of 30,000 ft^3/s observed in September caused no apparent bank erosion. Site not resurveyed.
19 Klutina River	-1	0	Centerline changed due to pipe burial.
20 Tonsina River	0	0	3- to 4-ft diameter riprap placed along right bank at centerline.
21 Tiekel River at Tiekel	-1	0	Centerline changed due to pipe burial.
22 Tiekel River near Tiekel	0	0	New centerline alinement.
23 Tsina River near Tiekel	+2	0	Centerline changed due to pipe burial.

Table 1.--*Channel erosion survey results, 1976.*--Continued

	Site	Maximum net change since 1975 survey: Thalweg elevation (ft)	Maximum net change since 1975 survey: Bank erosion (ft)	Remarks
24	Tsina River near Tiekel	+2	0	Centerline changed due to pipe burial
25	Tsina River near Ptarmigan	--	0	Centerline and downstream bank approaches altered by construction.
26	Tsina River at Ptarmigan	0	0	Much construction change at some sections. Glacier-dammed lake break-out flood of 10,000 ft^3/s in August.
27	Sheep Creek	-3	0	Centerline thalweg deepened due to pipe burial.
28	Lowe River	--	0	Channel bottom not surveyed.



EXPLANATION

Trans-Alaska pipeline

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

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

Snowden Creek near Dietrich Camp

Location.--Lat 67°44'20", long 149°45'10", in SW¼ sec.26, T.34 N., R.10 W., 0.5 mi (0.8 km) upstream from mouth of Dietrich River, and about 25 mi (40 km) northeast of Wiseman.
[Chandalar (C-6) 1:63,360, U.S. Geological Survey map.]

1976 Surveillance.--Figure 2 shows the Snowden Creek crossing site on August 2, 1976. During the past year the overhead pipe crossing has been completed and the material-removal site on the right bank at the downstream cross section has been seeded over and abandoned. Figure 2, which was taken right after the reported high water of July 29 and 30 (Schroeder, written commun., 1976), indicates that the channel had migrated laterally in places since 1975 and had partially eroded sections of the dike protecting the material storage yard on the left bank.

The crossing site was resurveyed in July 1976. No significant change was found in either the downstream or former centerline cross sections. Figure 3 shows the changes in the upstream cross section and the change due to construction in the centerline cross section since 1975.

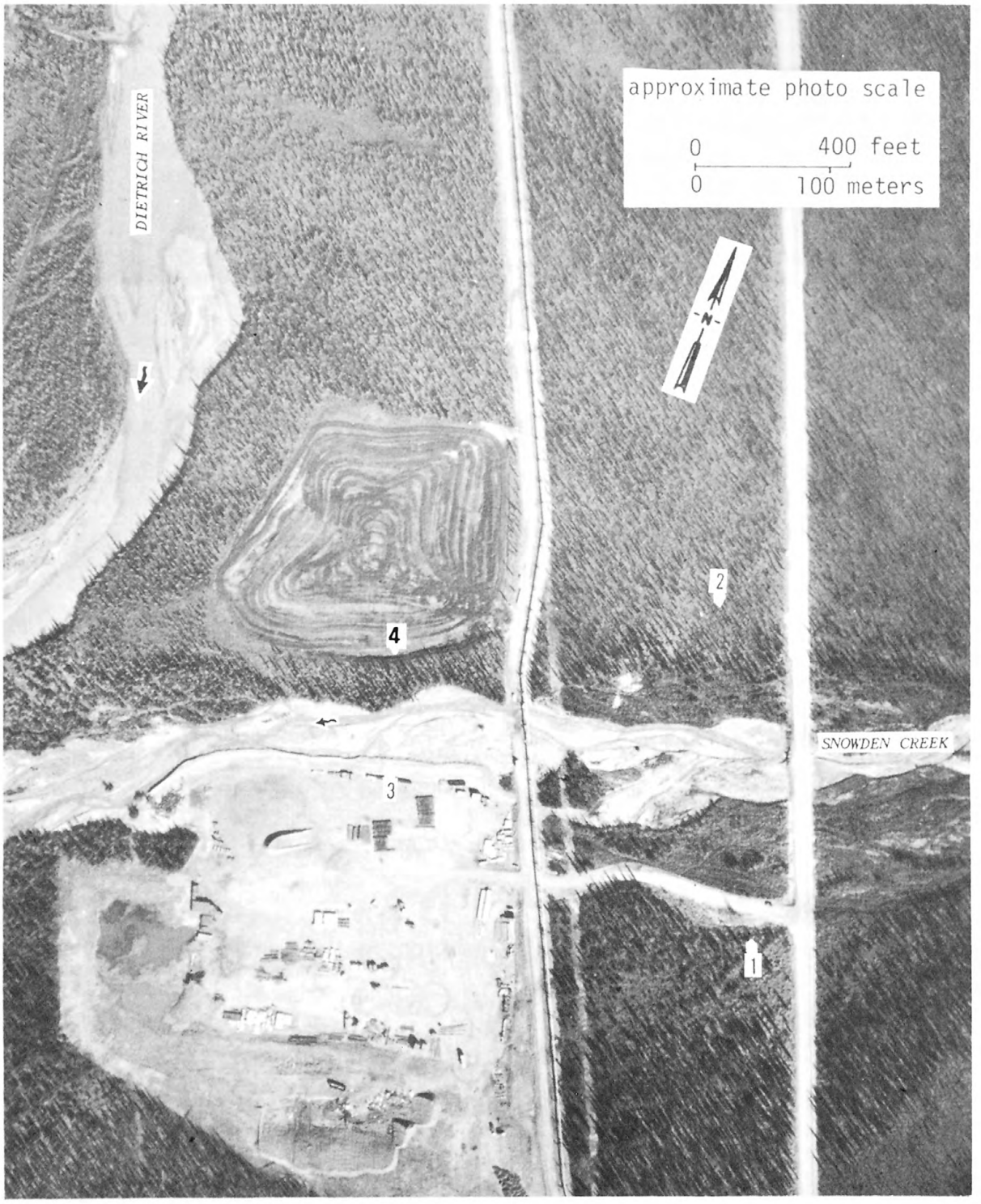


Figure 2.-- Snowden Creek near Dietrich Camp, August 2, 1976. AIR PHOTO TECH

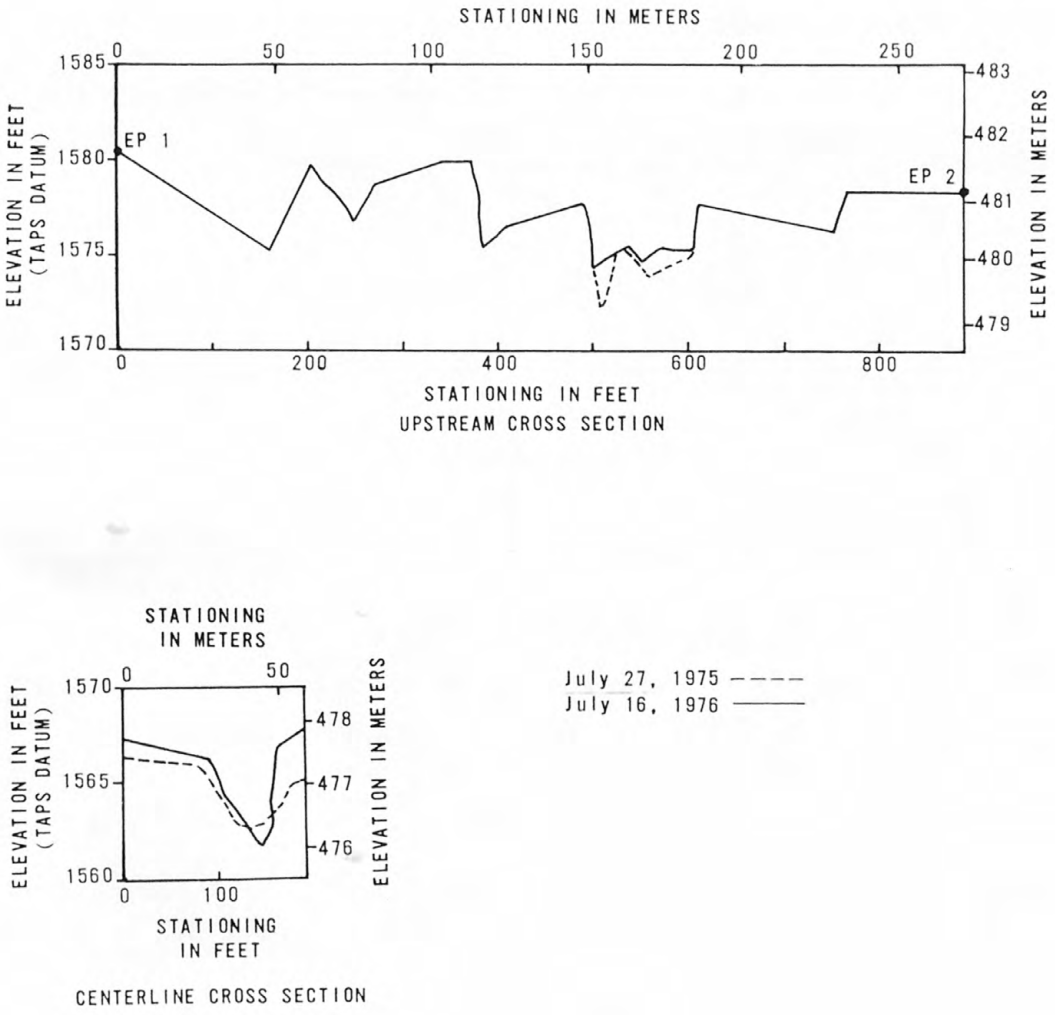


Figure 3.-- Cross sections of Snowden Creek near Dietrich Camp.

Dietrich River at Bettles River

Location.--Lat 67°38'40", long 149°44'20", in NE¼ sec.35, T.33 N., R.10 W., 0.5 mi (0.8 km) upstream from Bettles River, and about 15 mi (24 km) northeast of Wiseman.

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

1976 Surveillance.--Figure 4 shows the Dietrich River crossing site on August 2, 1976. The overhead pipe crossing is in place and bank protection along the right bank is in progress. The temporary bridge which was just upstream of the pipe crossing in 1975 has been removed.

The crossing site was resurveyed in July 1976. There was no significant change in the downstream section. Figure 5 shows construction changes in the upstream and centerline cross sections and also the thalweg shift at the highway bridge cross section.

A new survey end point was placed on the right bank of the upstream cross section to replace the one which was lost to construction.

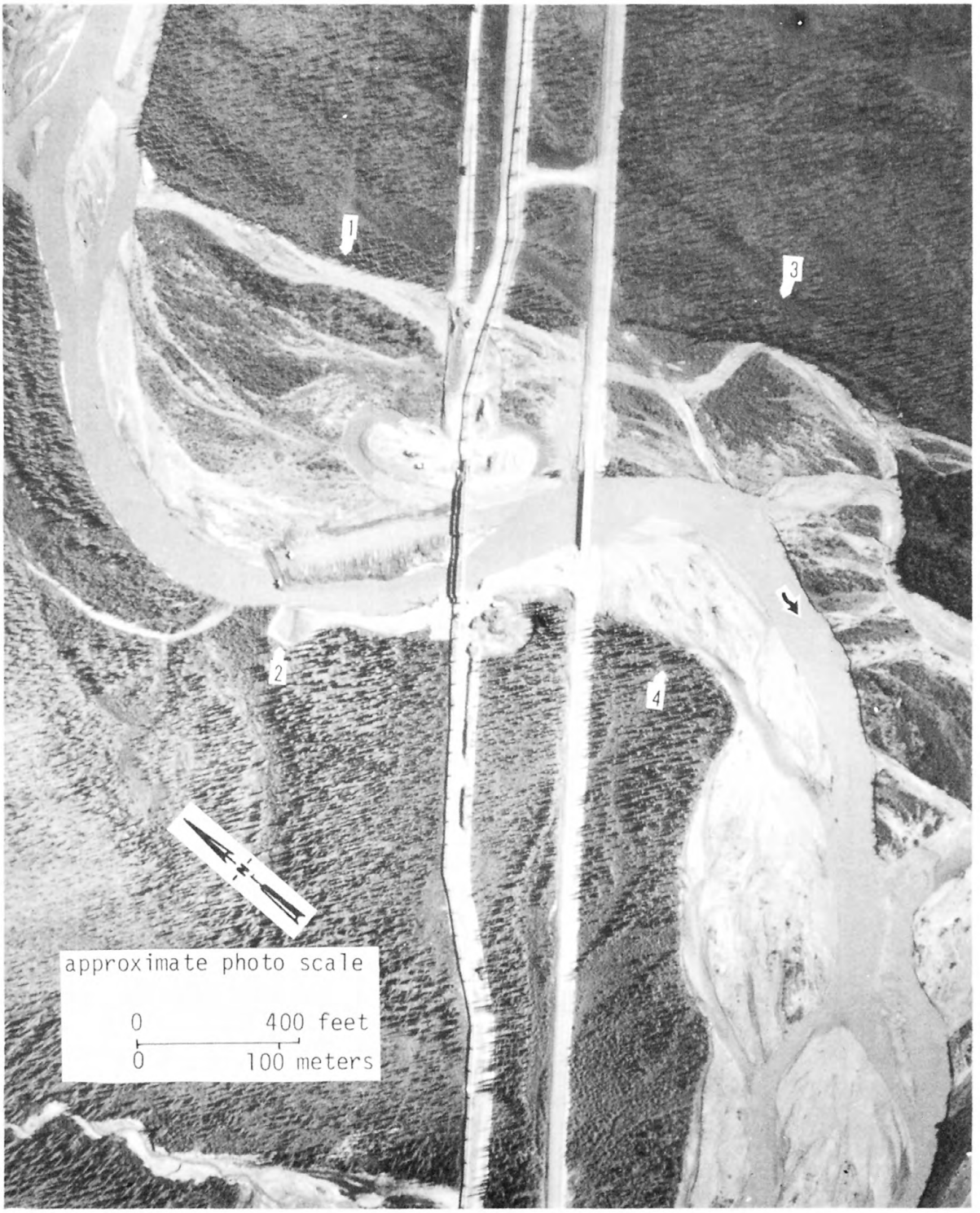
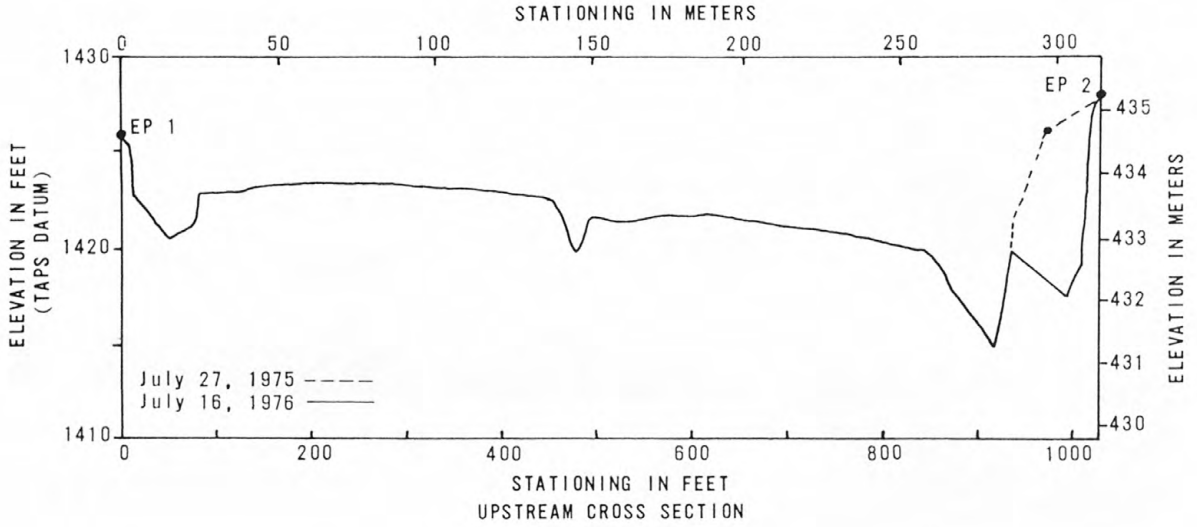
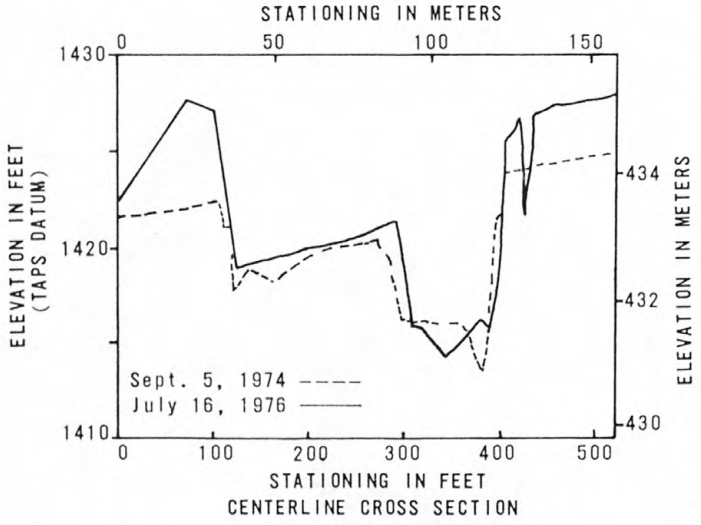


Figure 4.-- Dietrich River at Bettles River, August 2, 1976. AIR PHOTO TECH





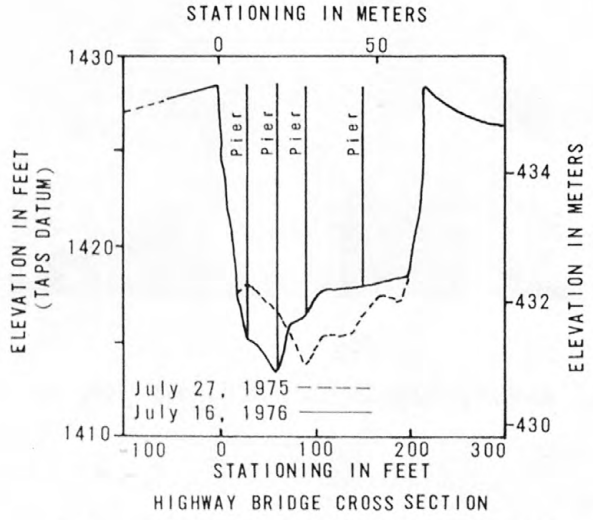


Figure 5.-- Cross sections of the Dietrich River at Bettles River.

Middle Fork Koyukuk River at Hammond River

Location.--Lat 67°27'45", long 150°01'20", in SW¼ sec.33, T.31 N., R.11 W., 0.3 mi (0.5 km) upstream from Hammond River, and 4.3 mi (6.9 km) northeast of Wiseman.

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

1976 Surveillance.--Figure 6 shows the Middle Fork Koyukuk River at Hammond River crossing site on July 19, 1976. The overhead pipe bridge has been completed and work is progressing on a protective dike which extends from the right bank of the river to the left bank of the Hammond River. On the right bank fill has been extended out from the natural bank about 65 ft (20 m).

The crossing site was resurveyed in July 1976. There was no significant change in the upstream cross section. Figure 7 shows the construction change in the centerline cross section and the change in the downstream cross section. The floodway at the pipeline crossing has been greatly constricted by the construction. At the downstream section, the bed scour which took place during the spring of 1975 has been reversed and the thalweg elevation in this section is now 1 ft (0.3 m) higher than in 1971.

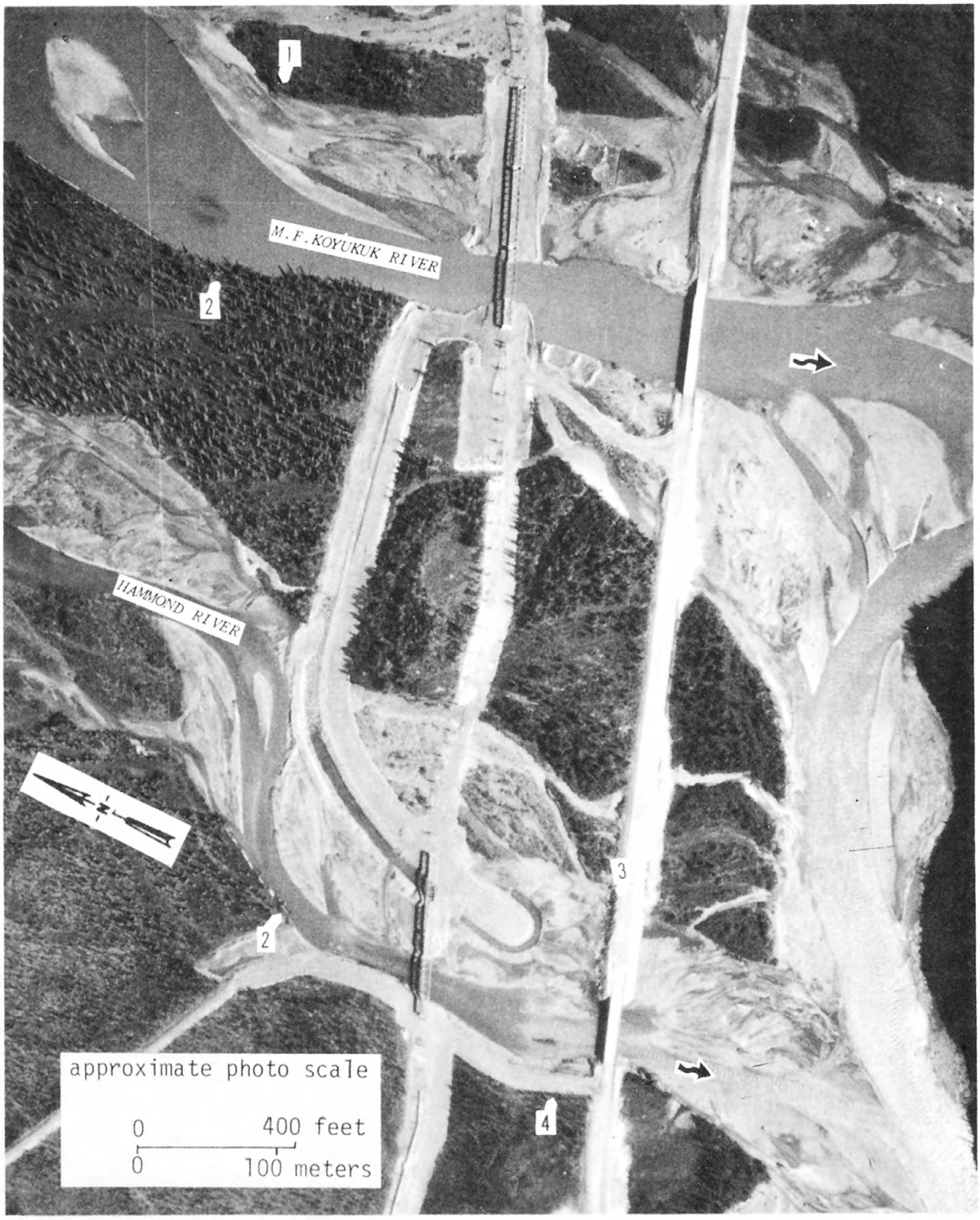


Figure 6.-- Middle Fork Koyukuk River at Hammond River and Hammond River near Wiseman, July 19, 1976. AIR PHOTO TECH

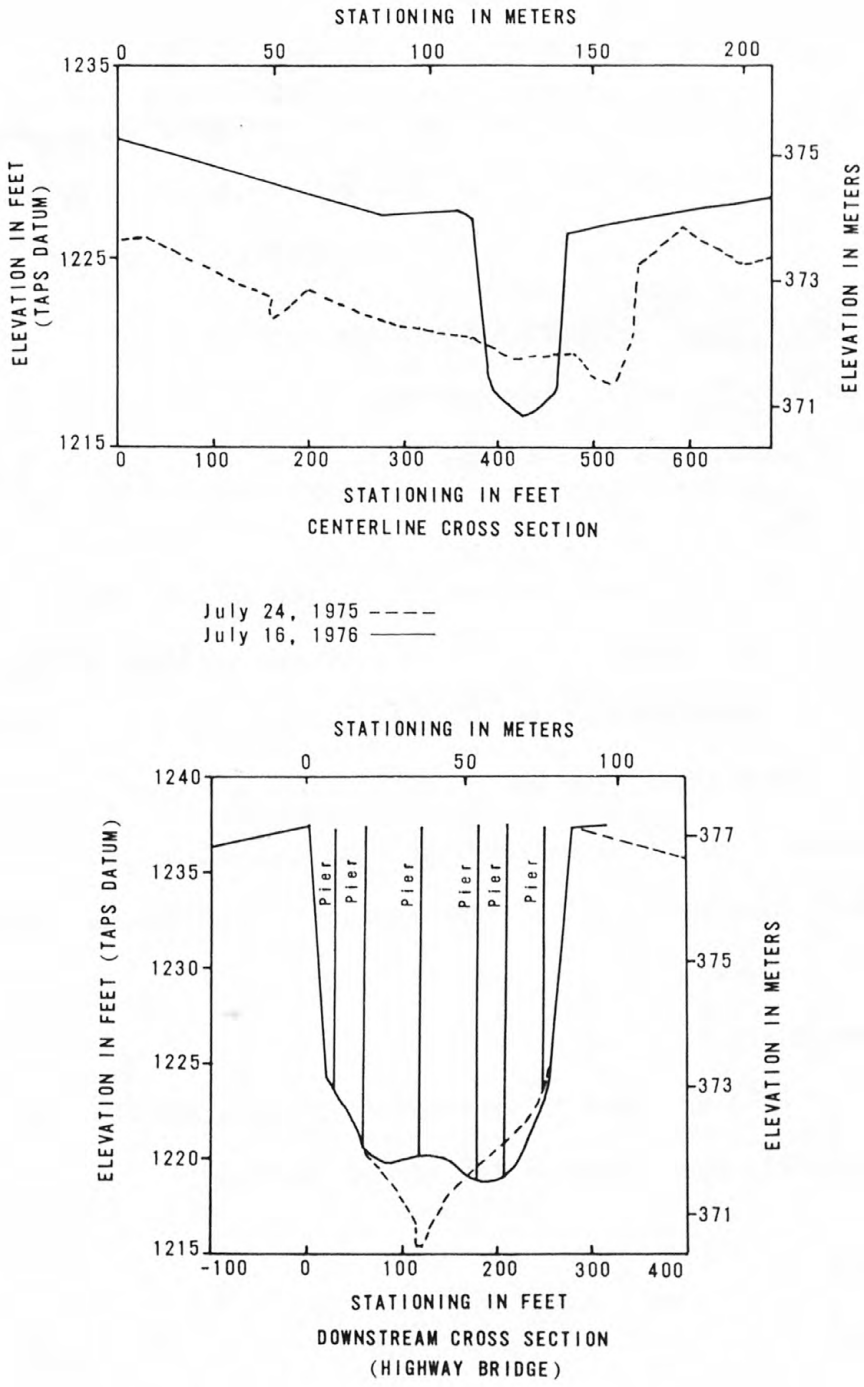


Figure 7.-- Cross sections of the Middle Fork Koyukuk River at Hammond River.

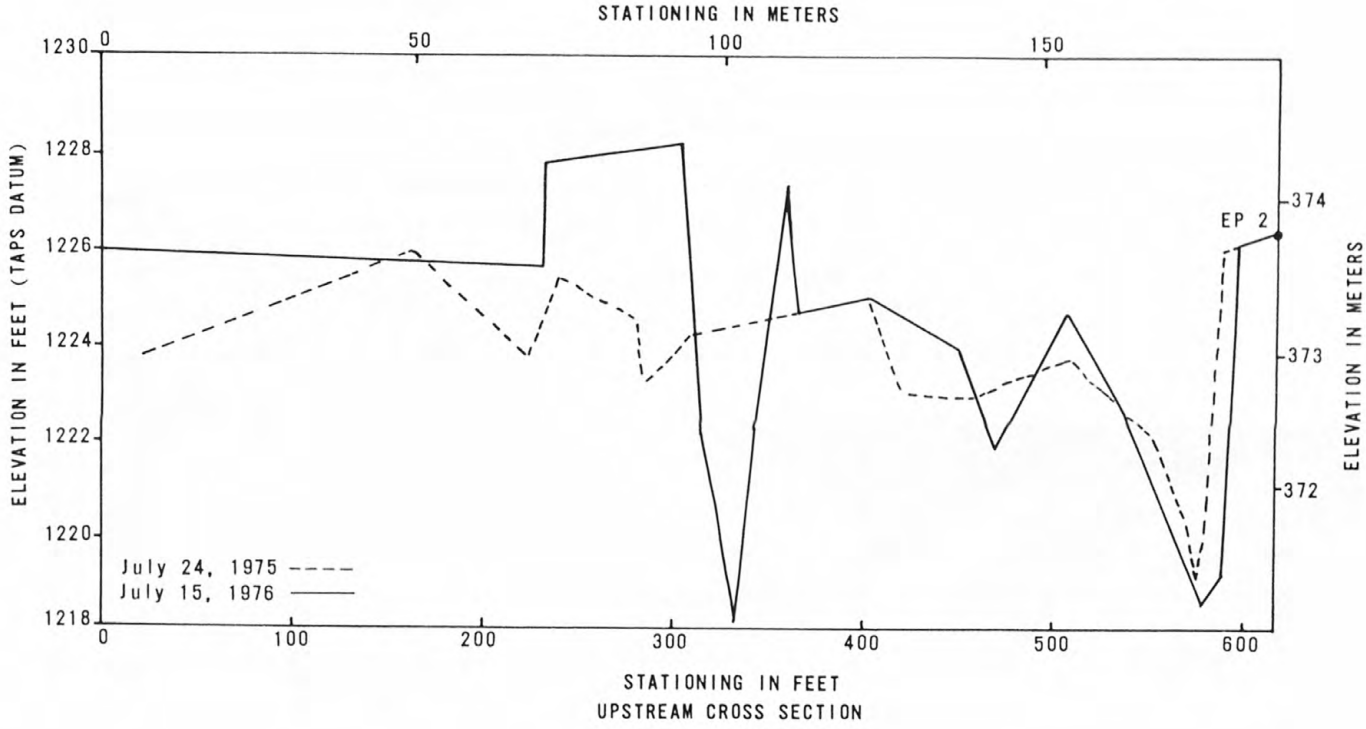
Hammond River near Wiseman

Location.--Lat 67°27'45", long 150°02'00", in SE¼ sec.32, T.31 N., R.11 W., 0.2 mi (0.3 km) upstream from mouth at Middle Fork Koyukuk River, and 4.0 mi (6.4 km) northeast of Wiseman. [Wiseman (B-1) 1:63,360, U.S. Geological Survey map.]

1976 Surveillance.--Figure 6 shows the Hammond River crossing site on July 19, 1976. The overhead pipe bridge has been completed and work is in progress on protective dikes on both banks of the river.

The crossing site was resurveyed in July 1976. Figure 8 shows the changes in all four surveyed sections since last year. The construction of the pipe bridge and dikes has caused much of the change. The upstream section right bank continues to erode. At the highway bridge, the thalweg has migrated from the left bank to the right bank and unlike the thalweg under Middle Fork Koyukuk highway bridge, the thalweg is at about the same depth as it was in 1975.

EP-4 was lost to construction, and a new EP-4 was located slightly downstream of its former position.



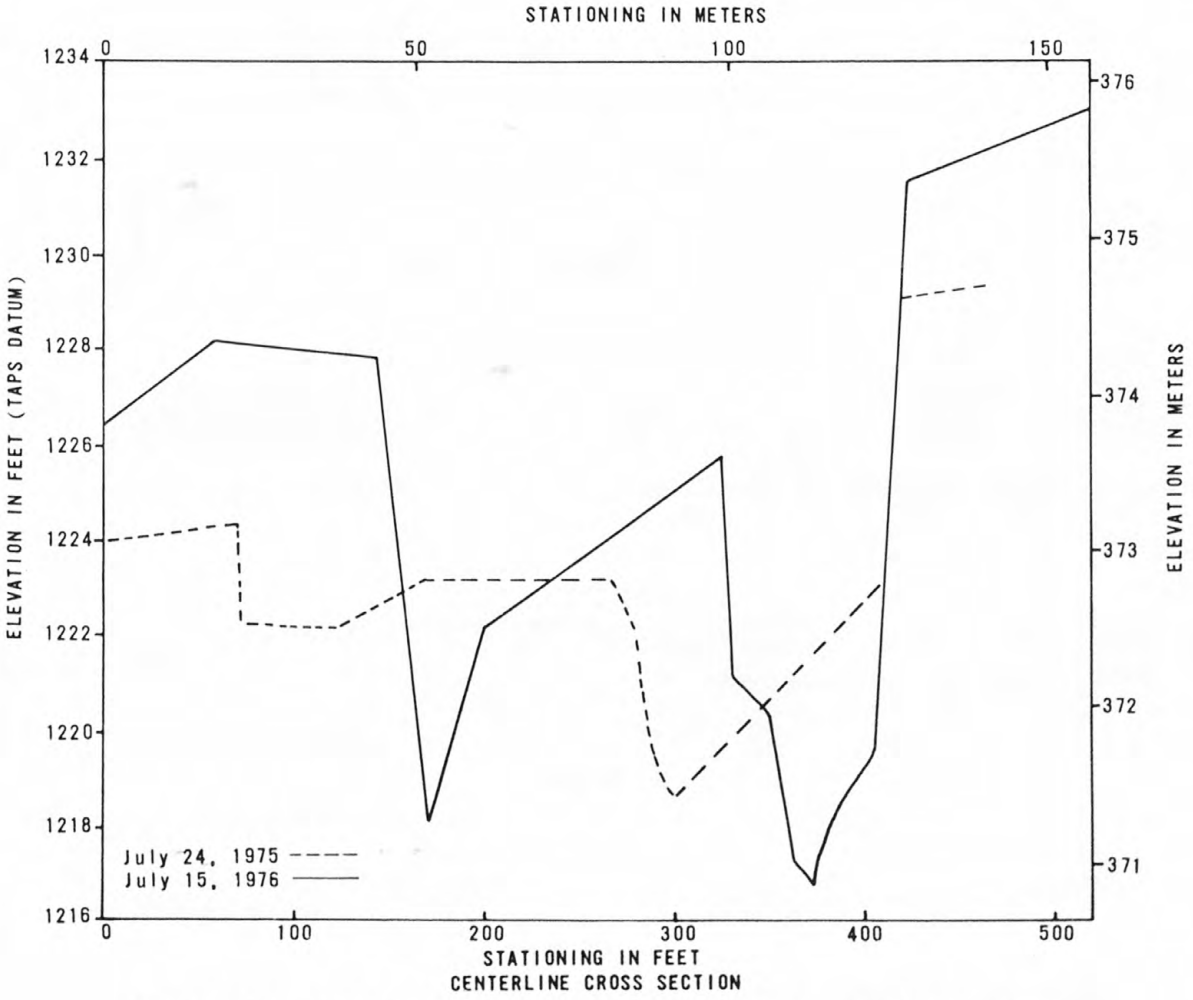


Figure 8.-- Cross sections at the Hammond River near Wiseman.

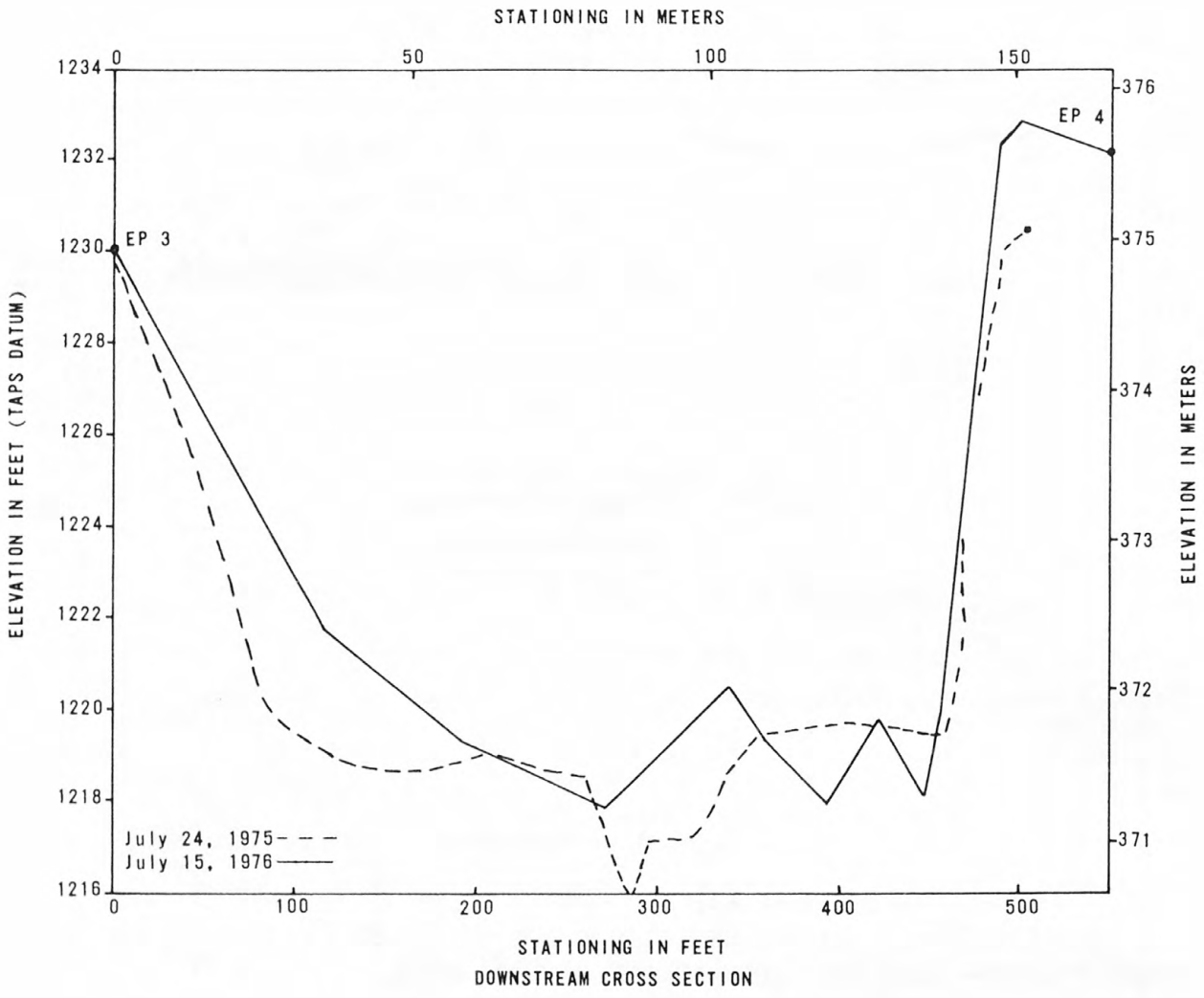


Figure 8.-- Cross sections of the Hammond River near Wiseman, continued.

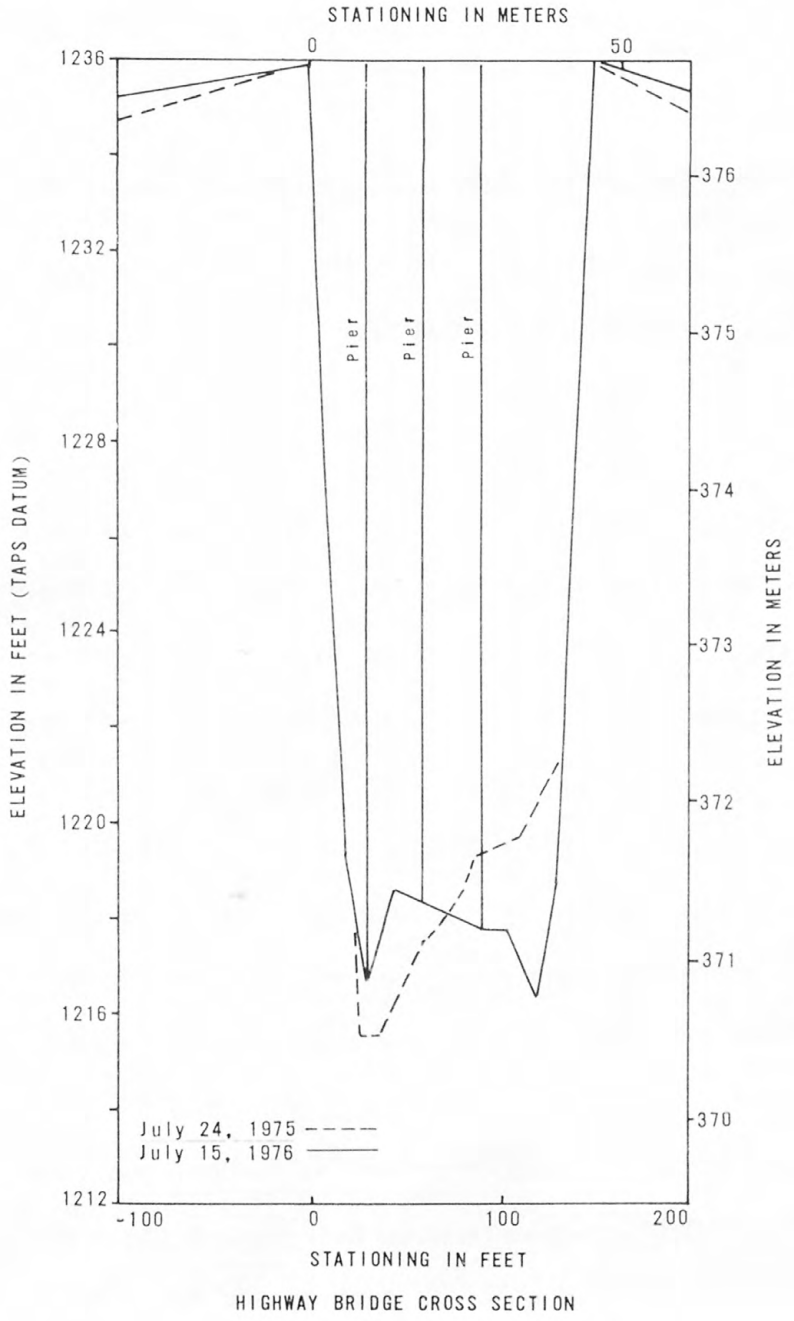


Figure 8.-- Cross sections of the Hammond River near Wiseman, continued.

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 (2.4 km) upstream from Wiseman, and 2.5 mi (4.0 km) downstream from the Hammond River.

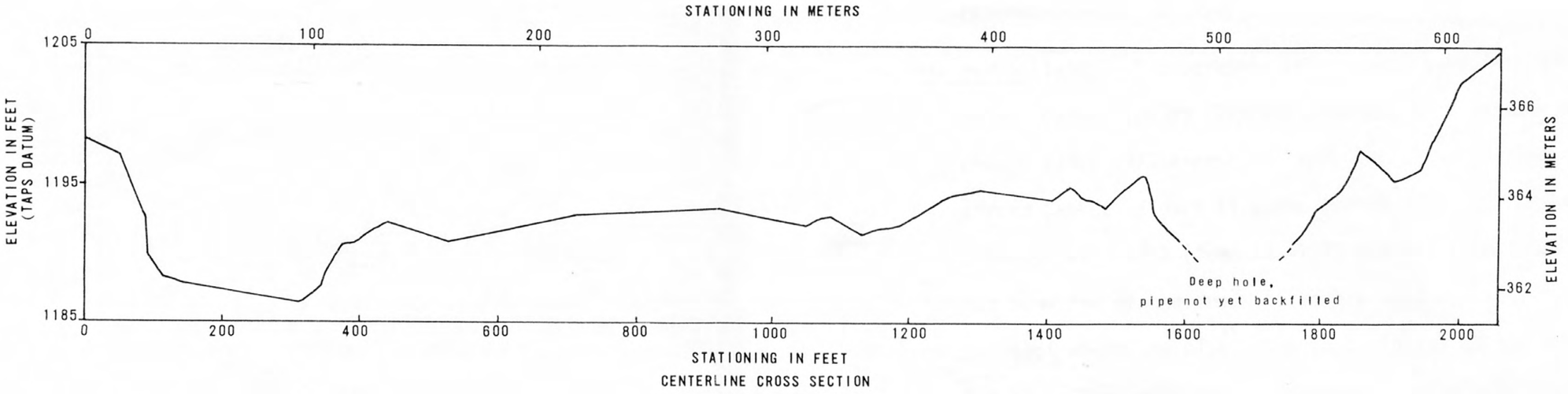
[Wiseman (B-1) 1:63,360, U.S. Geological Survey map.]

1976 Surveillance.--Figure 9 shows the Middle Fork Koyukuk River near Wiseman crossing site on August 2, 1976. The pipe has been buried on a new alinement which is just upstream from the former crossing. Work on a protective dike is in progress on the right bank where the pipe exits the ground and heavy riprap has been placed along the centerline on the left bank. The 6-ft- (1.8-m-) high dike which had paralleled the right bank on the main channel in 1975 has been removed in the course of construction for several hundred feet upstream and downstream of the centerline.

The crossing site was resurveyed in July 1976. Except for elimination of the dike on the right bank and the depression along the centerline where the pipe has been buried, the upstream cross section had not significantly changed since 1975. Figure 10 shows the new centerline cross section and the changes in the downstream cross section where the channel continues to be very active. Ongoing construction has changed the configuration of the left bank on the downstream section and resulted in destruction of EP-3.

The maximum discharge since the 1975 survey was less than 14,000 ft^3/s (396 m^3/s).

Figure 9.-- Middle Fork Koyukuk River near Wiseman, August 2, 1976.
AIR PHOTO TECH



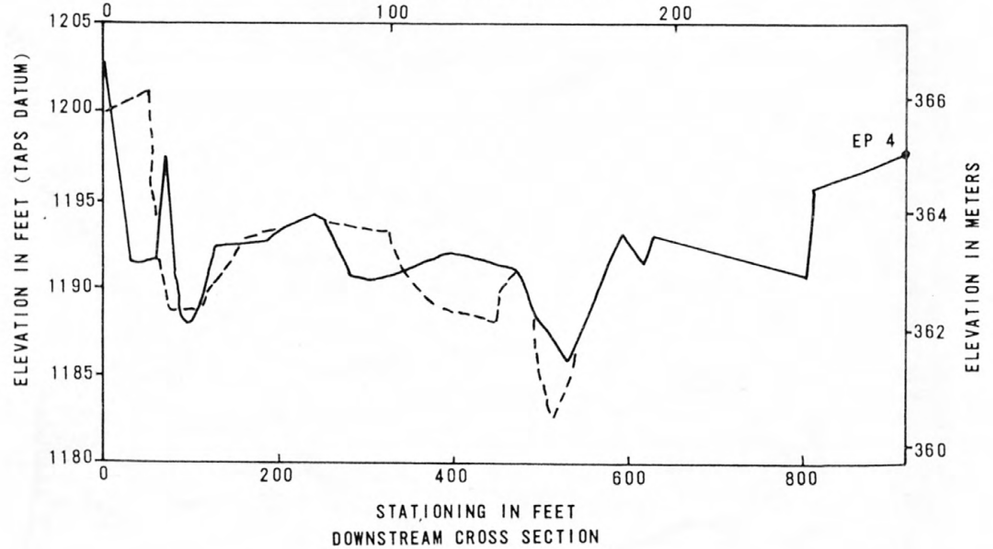


Figure 10.-- Cross sections of the Middle Fork Koyukuk River near Wiseman.

Middle Fork Koyukuk River near Coldfoot

Location.--Lat 67°11'00", long 150°19'00", T.27 N., R.13 W., about 6 mi (10 km) downstream from Coldfoot.

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

1976 Surveillance.--Photographic coverage of this site was obtained in July. Comparison of 1975 and 1976 photos indicates very little change since 1975 except for some channel migration within the stream banks. Figure 11 shows the Middle Fork Koyukuk River near Coldfoot at site A (from the 1975 report) on July 19, 1976. This has been one of the areas of severe bank erosion in the past at the spot where the pipeline passes closest to the active channel. A dike armored with heavy riprap has been placed along the bank and spur dikes have been constructed along the pipeline for protection against erosion. The photos indicate that during the past year a large part of the flow through this reach has shifted towards the right bank and thus the dynamic attack on the left bank at site A is not as severe as it has been in the past.

Figure 11.-- Middle Fork Koyukuk River near Coldfoot, July 9, 1976.
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 (18 km) upstream from the Gold Bench Mine, and 40 mi (64 km) northeast of Bettles.

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

1976 Surveillance.--Figure 12 shows the South Fork Koyukuk crossing site on July 19, 1976. The overhead pipe crossing has been completed, and both banks from above the highway bridge to below the pipeline have been diked and lined with riprap.

The crossing site was resurveyed in July 1976. There was no significant change in the upstream section. Figure 13 shows the changes in the centerline and downstream sections due mainly to construction.

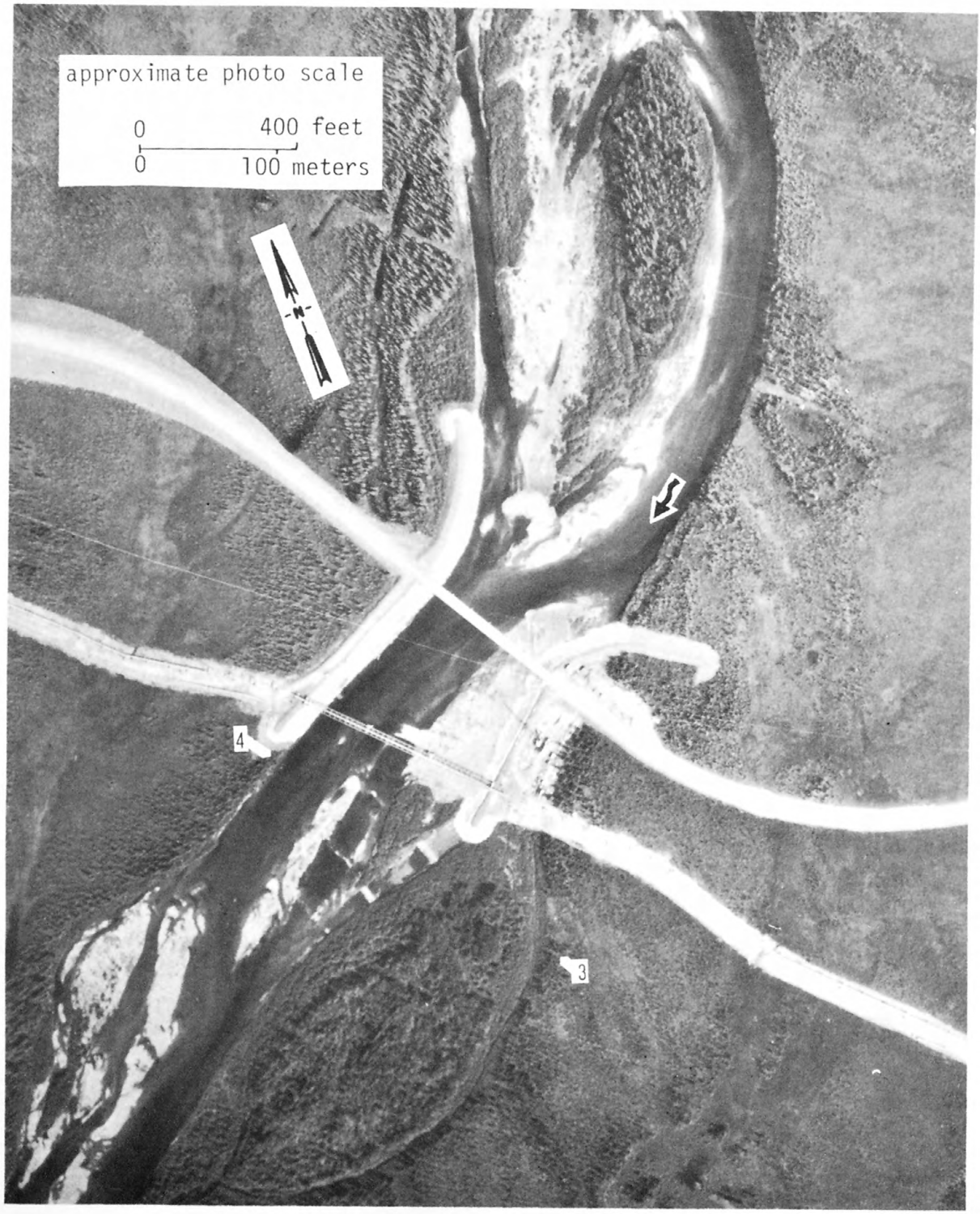


Figure 12.-- South Fork Koyukuk River near Wiseman, July 19, 1976.
AIR PHOTO TECH

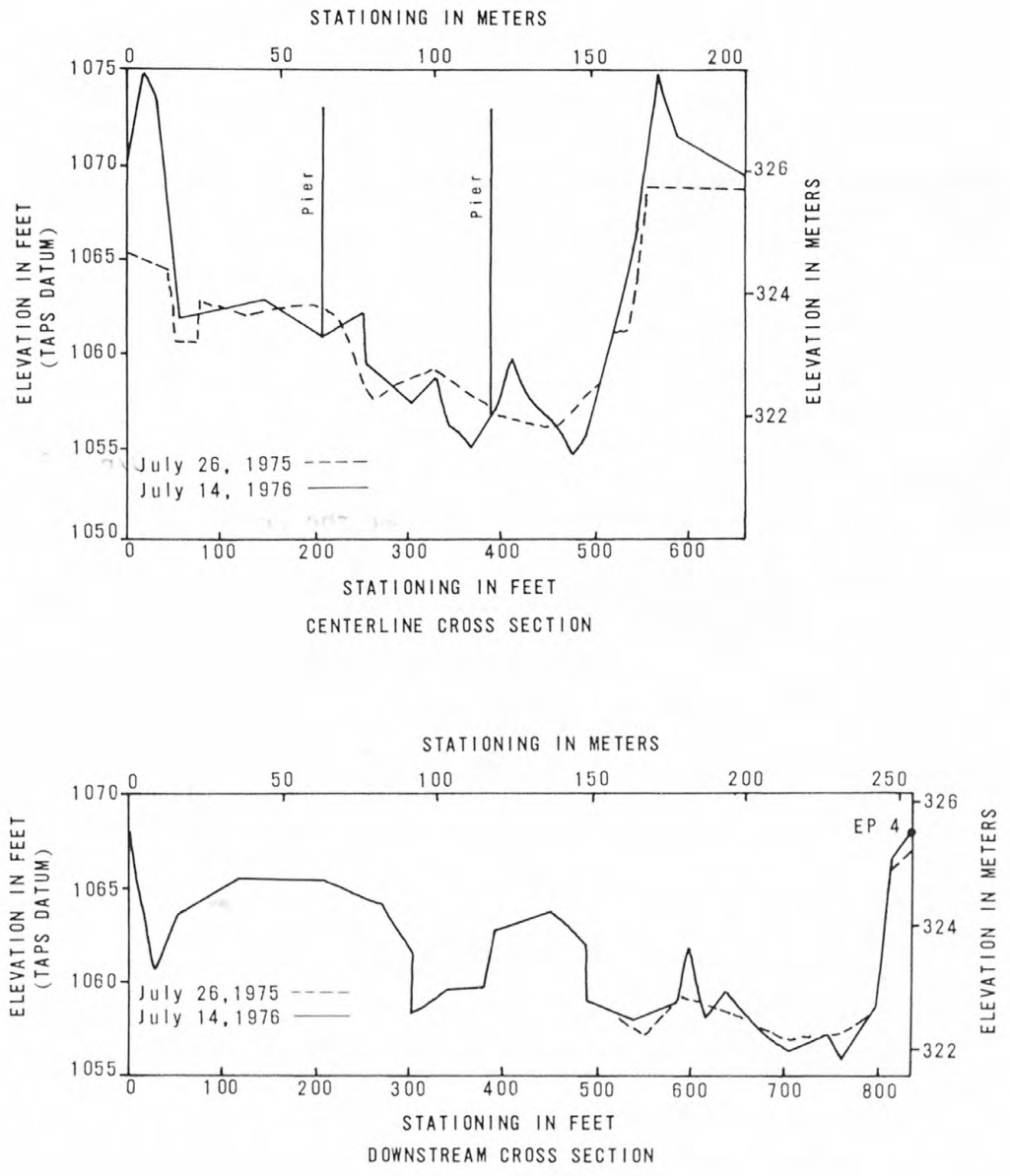


Figure 13.-- Cross sections of the South Fork Koyukuk River near Wiseman.

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 (3.9 km) upstream from Douglas Creek and 32 mi (51 km) east of Bettles Field.

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

1976 Surveillance.--Figure 14 shows the Jim River crossing site on July 19, 1976. The pipe has been buried at this crossing.

The crossing site was resurveyed in July 1976. Figure 15 shows the construction changes at the centerline cross section. Backfilling had not been completed when the survey was made.

On September 19, 1975, a new peak of record discharge of 9,800 ft^3/s (278 m^3/s) occurred at the gage about 15 mi (24 km) downstream from the pipeline crossing. The highwater marks found at the crossing site in July were 3-4 ft (1.0-1.2 m) below the Maximum Evident Flood (MEF), and the high water of September 1975 apparently caused very little change in the vicinity of the pipeline crossing.

Figure 14.-- Jim River near Prospect Creek Camp, July 19, 1976.
AIR PHOTO TECH

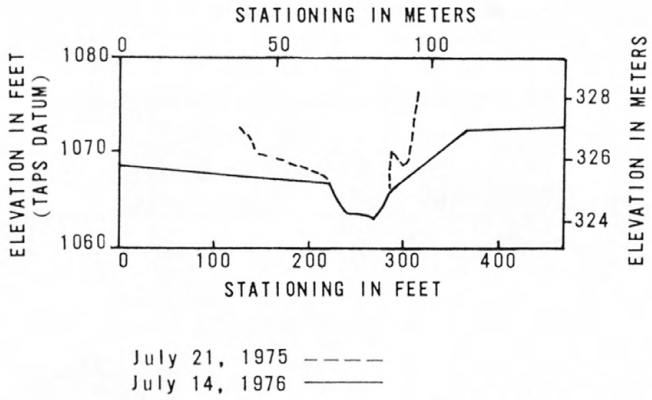


Figure 15.-- Centerline cross section of the Jim River near Prospect Creek Camp.

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 (3 km) upstream from Jim River and approximately 28 mi (45 km) east of Bettles.

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

1976 Surveillance.--Figure 16 shows the Prospect Creek crossing site on August 2, 1976. The overhead pipe crossing has been completed.

The crossing site was resurveyed in July 1976. No significant changes were found in the downstream cross section. Figure 18 shows the change at centerline section due to construction and the deepening of the upstream cross section.

The main channel was again filled with icings at the time of spring break-up, with resulting overbank flow through the borrow pit downstream of the crossing. Figure 17 shows the icing conditions and the overbank flow on April 15, 1976. Visual inspection of the pit in July and comparison of 1975 and 1976 aerial photos indicates that additional headcutting along the northeast side of the pit has taken place since last year.

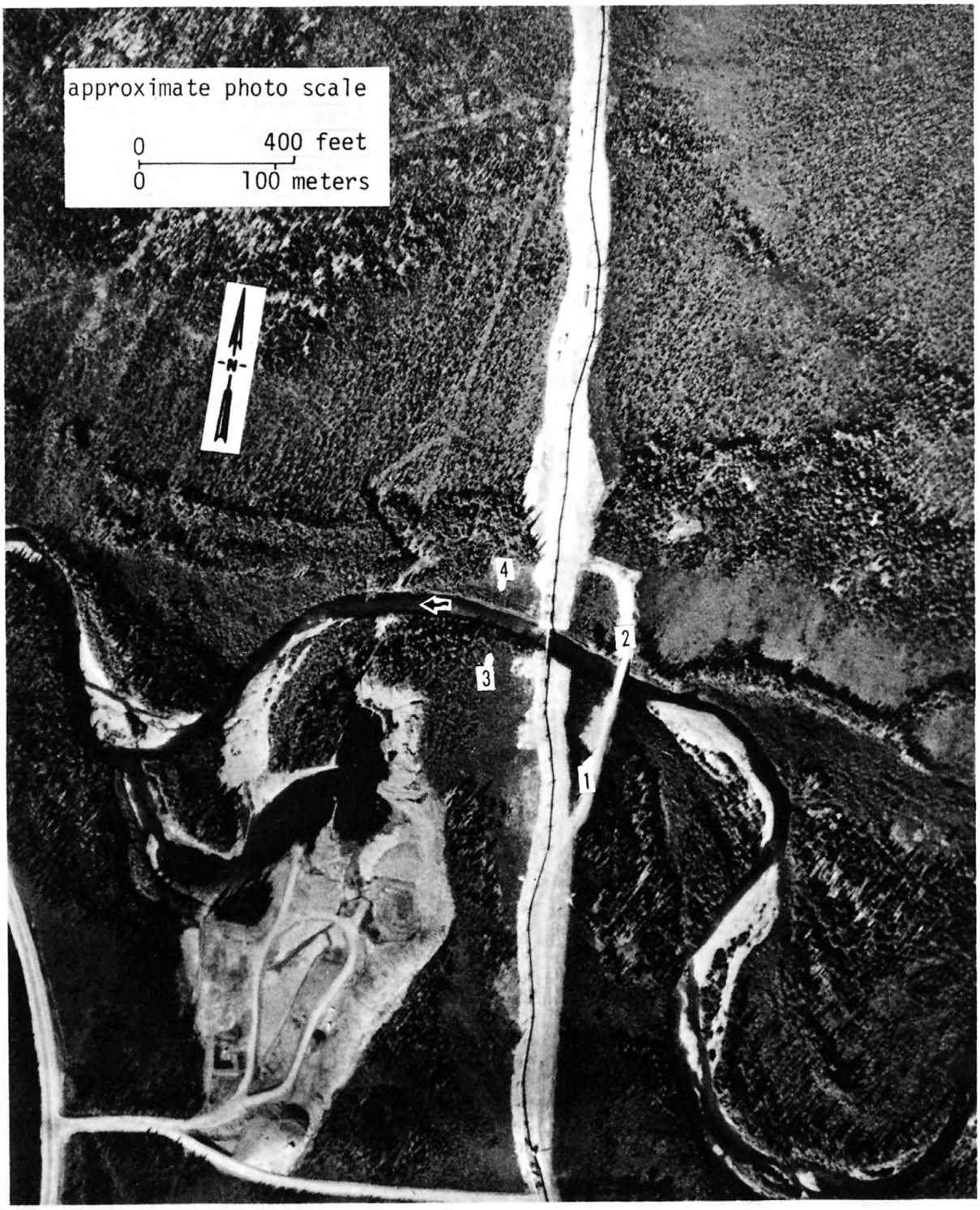


Figure 16.-- Prospect Creek near Prospect Creek Camp, August 2, 1976.
AIR PHOTO TECH

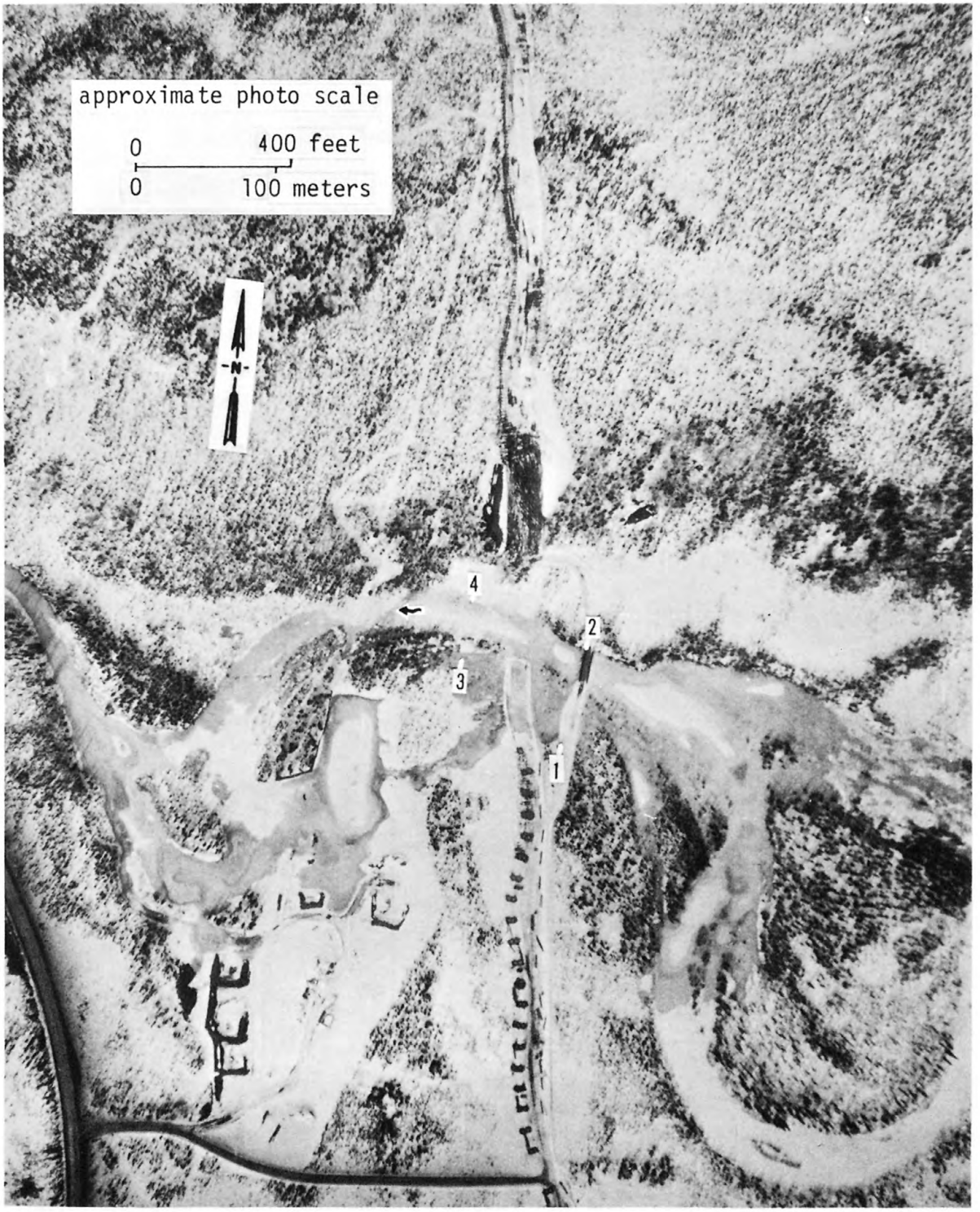


Figure 17.-- Prospect Creek near Prospect Creek Camp, April 15, 1976.
AIR PHOTO TECH

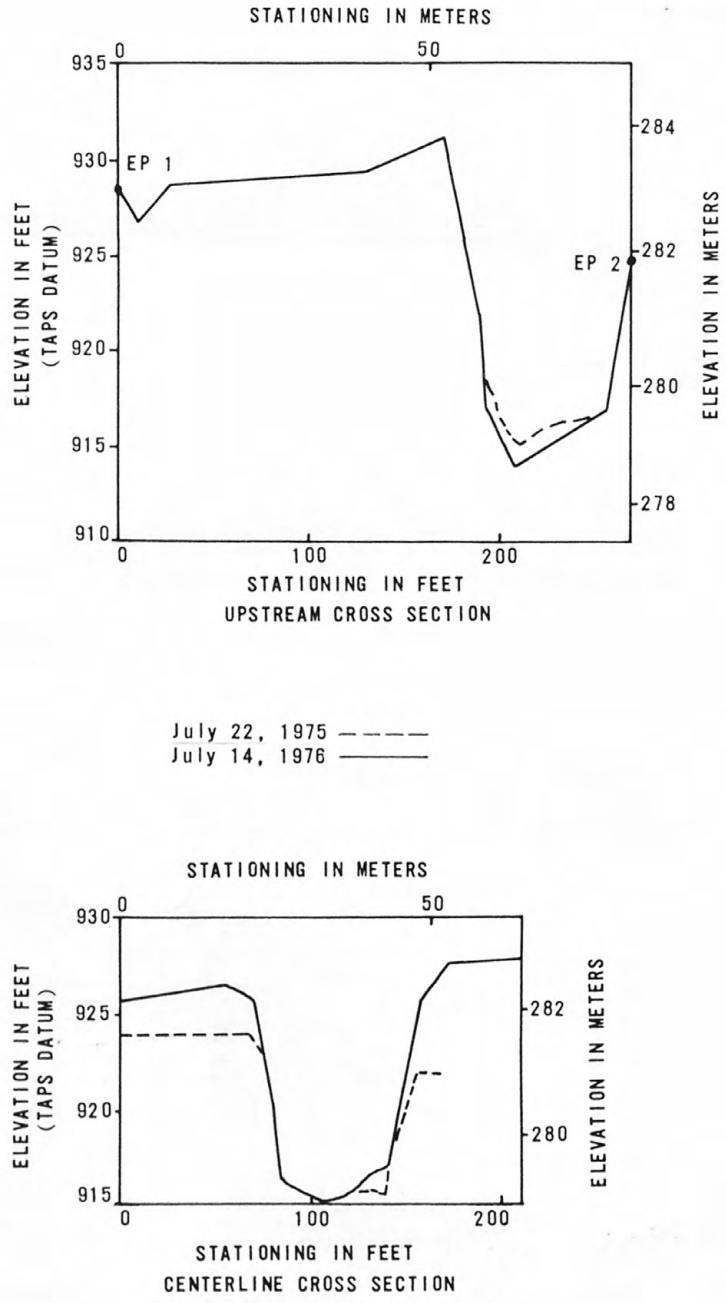


Figure 18.-- Cross sections of Prospect Creek near Prospect Creek Camp.

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 (8 km) northeast of Caribou Mountain, and approximately 44 mi (71 km) south-southeast of Bettles.

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

1976 Surveillance.--Figure 19 shows the Kanuti River crossing site on August 2, 1976. The pipe has been buried and the banks lined with riprap at centerline.

The crossing site was resurveyed in July 1976 and no significant changes were found in the upstream and downstream cross sections. Figure 20 shows the change in the centerline cross section due to construction.

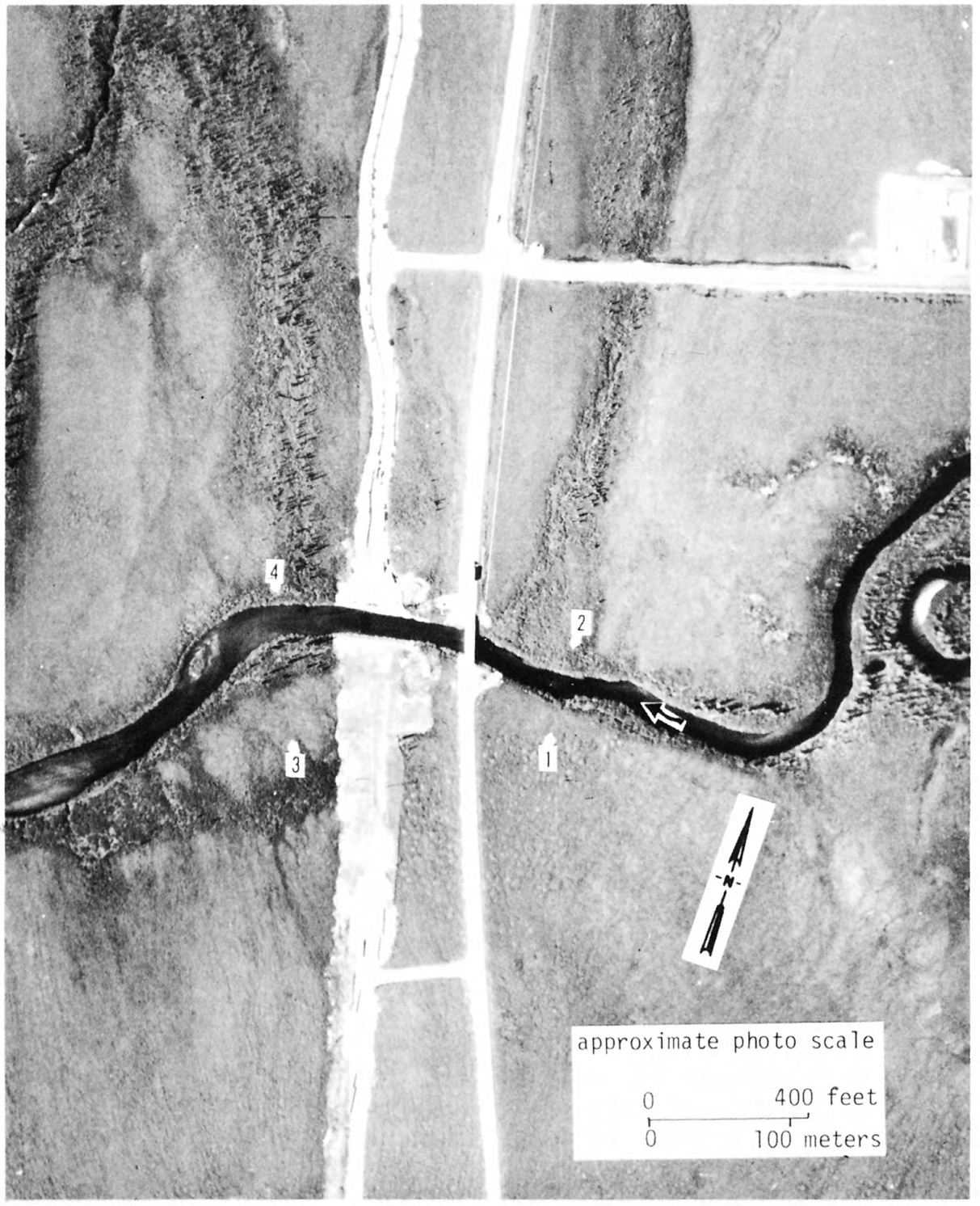


Figure 19.-- Kanuti River near Bettles, August 2, 1976. AIR PHOTO TECH

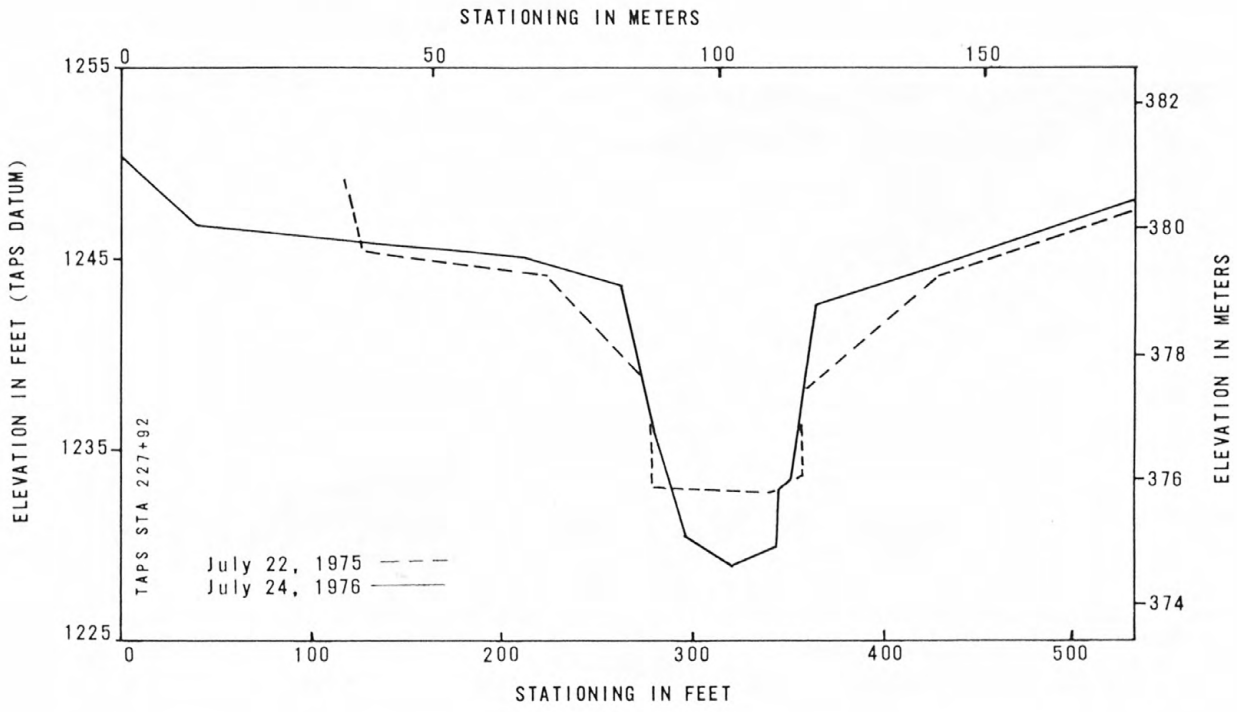


Figure 20.-- Centerline cross section of the Kanuti River near Bettles.

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

1976 Surveillance.--Figure 21 shows the Hess Creek crossing site on June 26, 1976. A temporary access bridge has been constructed just upstream of centerline. The workpad extends to both banks and work is in progress on the overhead pipe crossing. At the time of the resurvey, this was the only channel erosion site under surveillance where the pipe crossing had not yet been done.

The crossing site was resurveyed in July 1976. All three cross sections have changed within the stream banks, as shown in figure 22. This channel remains active. A meander cutoff occurred in 1975, most probably during the new MEF flood, about 1,500 ft (457 m) downstream from the TAPS crossing. The peak discharge since the 1975 survey is 8,300 ft^3/s (235 m^3/s) on May 5, 1976.

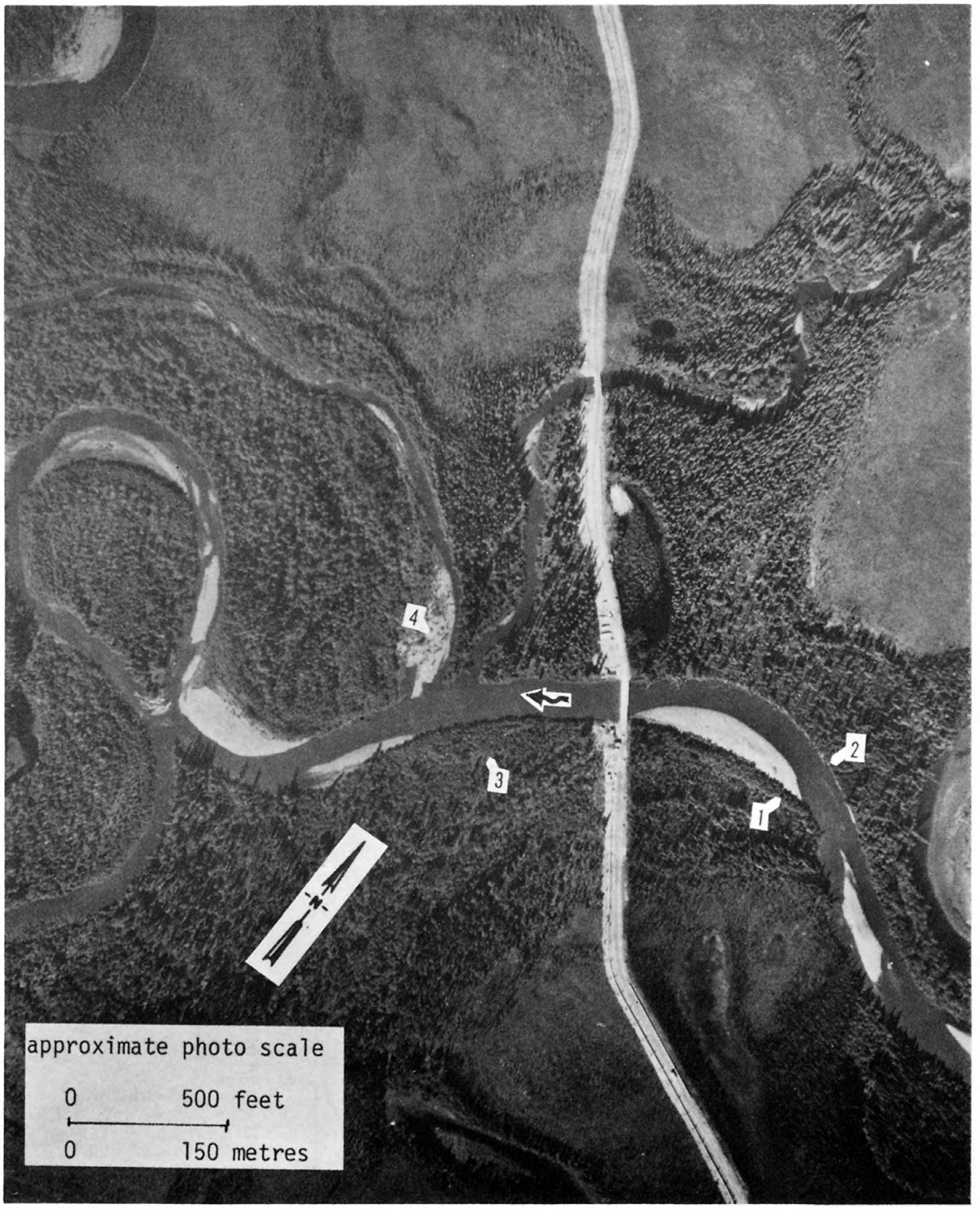
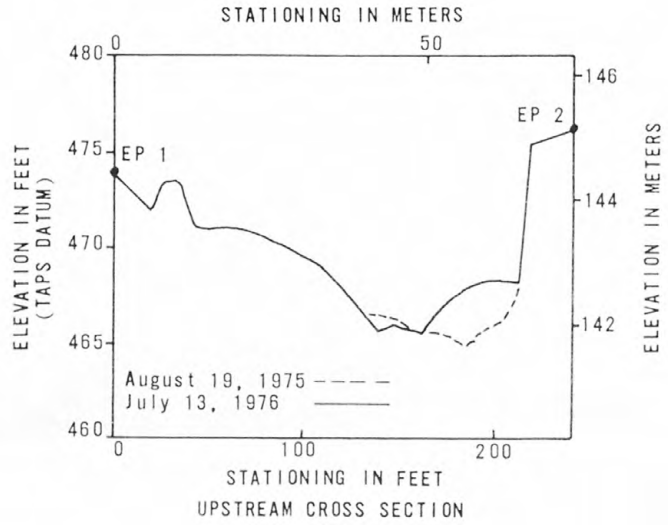
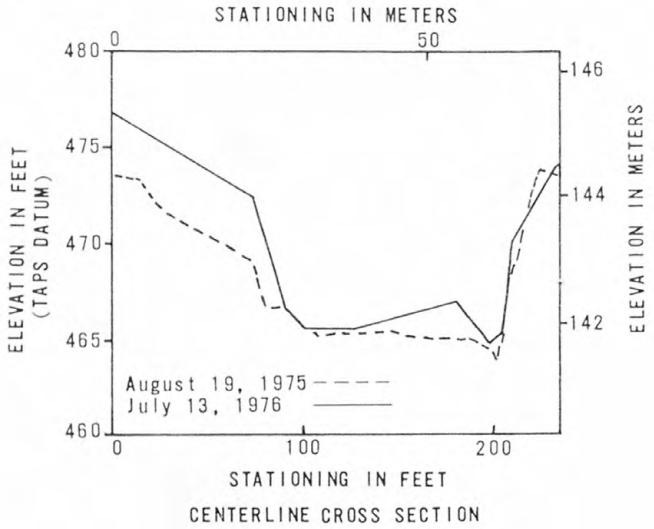


Figure 21.-- Hess Creek near Livengood, June 26, 1976. AIR PHOTO TECH





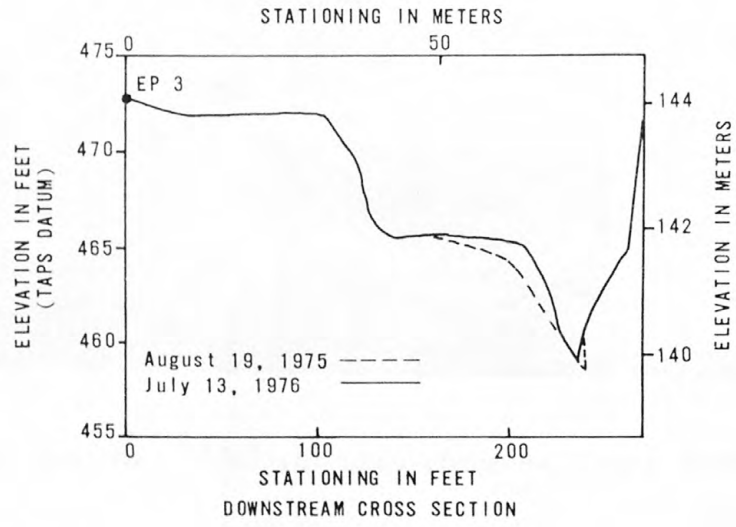


Figure 22.-- Cross sections of Hess Creek near Livengood.

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 (7.2 km) west of Olnes and 15 mi (24 km) north of Fairbanks.

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

1976 Surveillance.--Figure 23 shows the Chatanika River crossing site on June 26, 1976. A bridge has been installed just upstream of the pipe centerline, and the pipe has been buried across the channel. A log crib has been built at the left bank on the centerline to help stabilize the bank sloughing.

The crossing site was resurveyed in July 1976. No significant changes were found in the upstream or downstream sections. Figure 24 shows the changes at centerline due to construction. At the upstream section, the submerged log which was forcing flow against the left bank and causing undercutting in 1975 has been washed downstream, and the thalweg has shifted back toward the center of the channel.

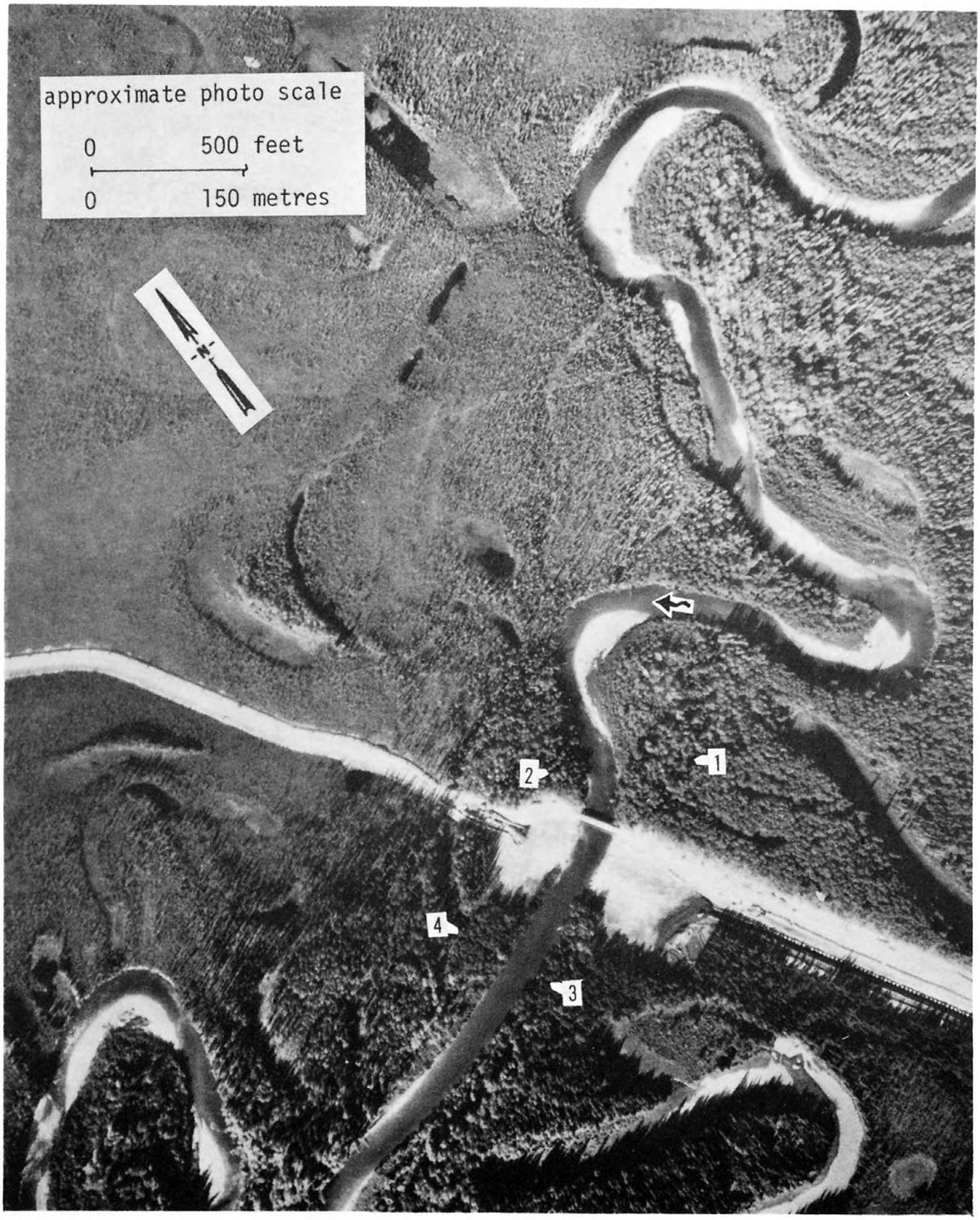


Figure 23.-- Chatanika River near Olnes, June 26, 1976. AIR PHOTO TECH

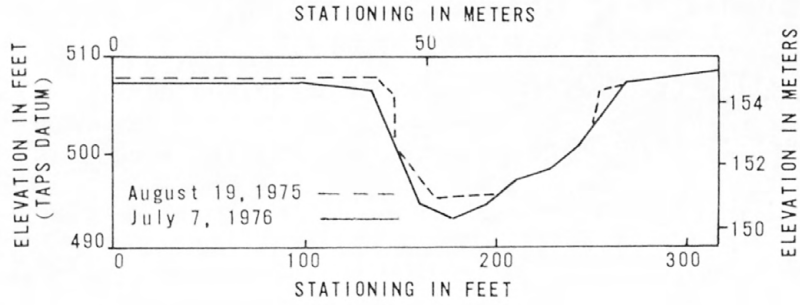


Figure 24.-- Centerline cross section of the Chatanika River near Olnes.

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 (13 km) upstream from the Richardson Highway. [Big Delta (B-6) 1:63,360, U.S. Geological Survey map.]

1976 Surveillance.--Figure 25 shows the Salcha River crossing site on August 1, 1976. The pipe has been buried across the flood plain and main channel.

The crossing site was resurveyed in September 1976. No significant changes were found in the upstream or downstream cross sections. Figure 26 shows the construction changes at the centerline. The deep hole is a result of pipe burial.

Maximum discharge since the 1975 survey was less than 10,000 ft^3/s (283 m^3/s).

Figure 25.-- Salcha River near Salchaket, August 1, 1976. AIR PHOTO TECH

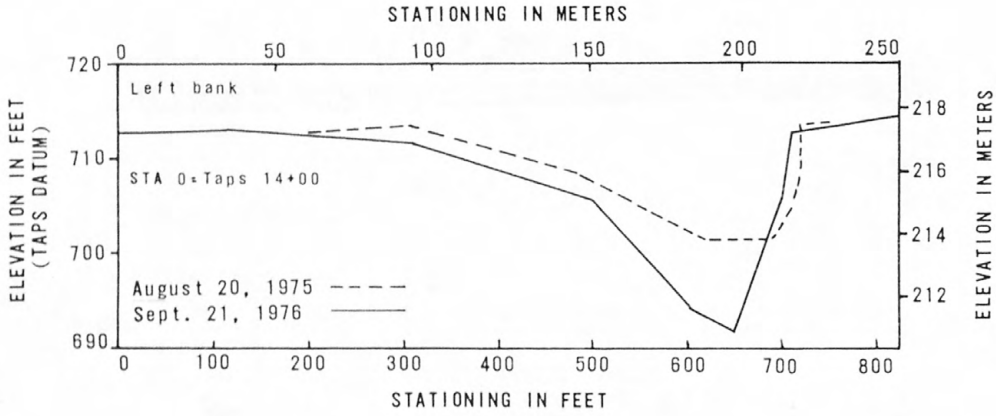


Figure 26.-- Centerline cross section of the Salcha River near Salchaket.

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 (0.2 km) upstream from Delta River, and about 6 mi (10 km) south of Rapids. [Mt. Hayes (B-4) 1:63,360, U.S. Geological Survey map.]

1976 Surveillance.--Figure 27 shows the Flood Creek crossing on July 6, 1976. The pipe has been buried across the Flood Creek fan.

The crossing site was resurveyed photogrammetrically in July 1976, and the downstream section was resurveyed on the ground in September. There were no significant changes in the upstream or downstream cross sections at Flood Creek itself although the channel at the downstream section is straightening. All three cross sections have been changed by construction at the fan edges. Figure 28 shows the construction change at centerline at Flood Creek itself.

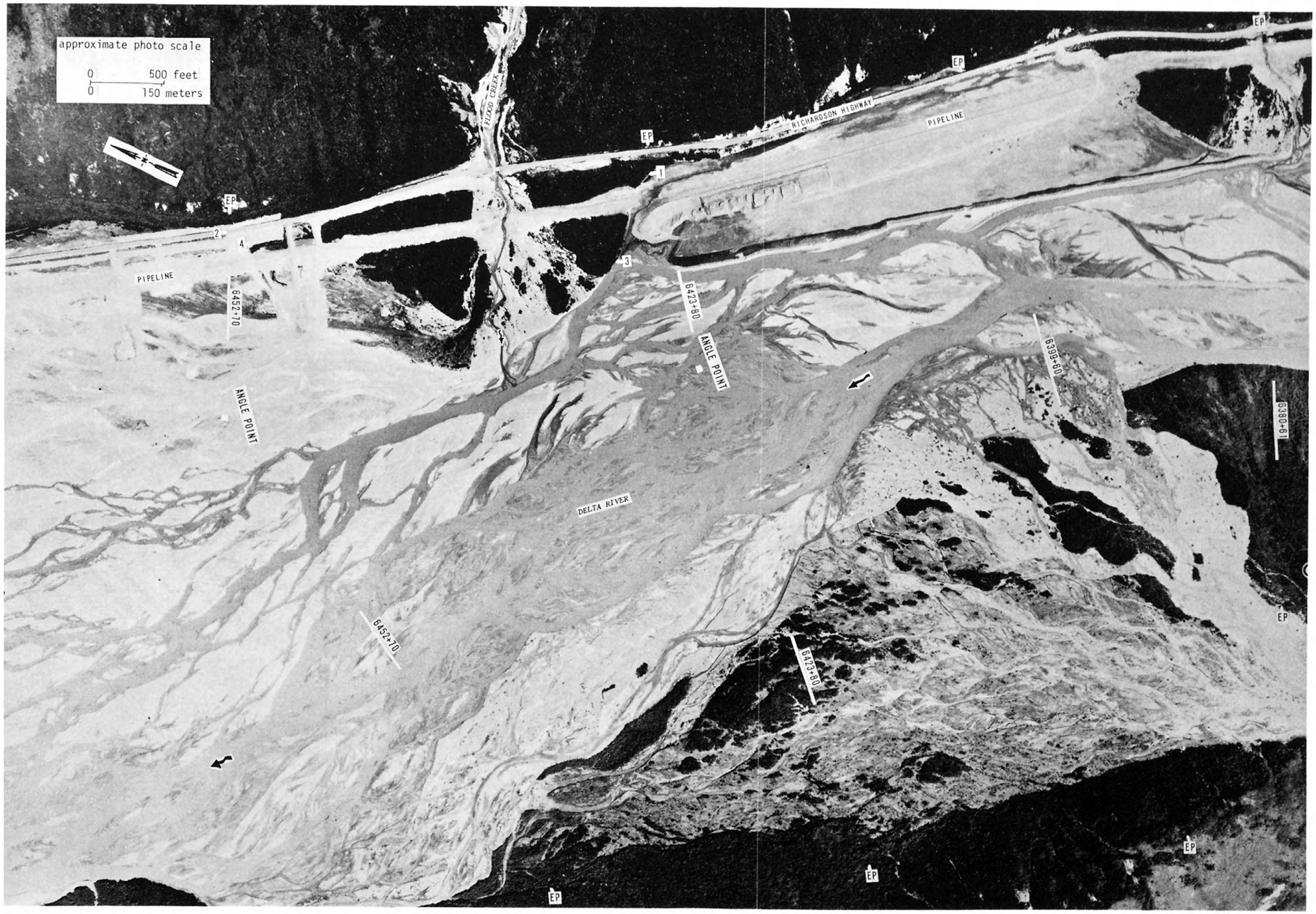


Figure 27.-- Delta River at Flood Creek and Flood Creek near Rapids, July 6, 1976. AIR PHOTO TECH

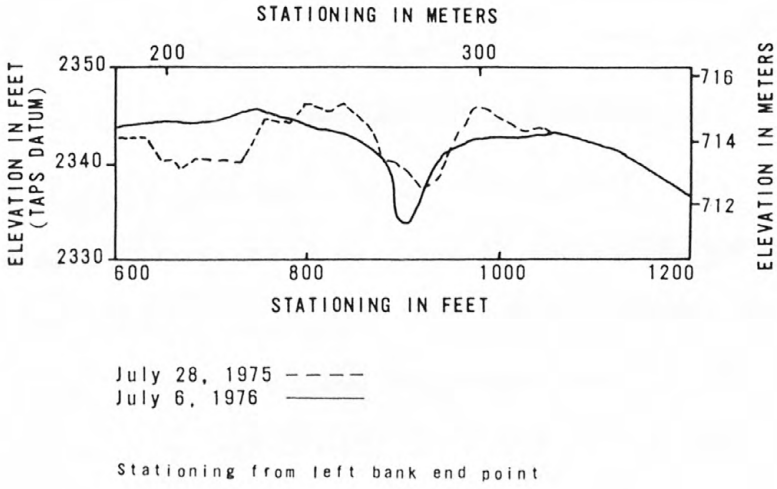


Figure 28.-- Centerline cross section of Flood Creek near Rapids.

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 (10 km) south of Rapids.

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

1976 Surveillance.--Figure 27 shows the Delta River at Flood Creek site on July 6, 1976. Lateral dikes have been built to protect the buried pipe between Michael and Flood Creeks. These dikes have forced the flow to the left side of the channel to some extent.

The site was resurveyed photogrammetrically in July. Figure 29 shows the lateral dikes and the changes in three of the four resurveyed cross sections since 1975. Section 6452+70 was not found to be changed significantly. At section 6380+61 the left bank has eroded approximately 20 ft (6.1 m) since the 1975 survey. No underwater configurations were surveyed during a visual inspection of the site in September 1976, but it is estimated that the thalweg has not changed significantly in any of the sections.

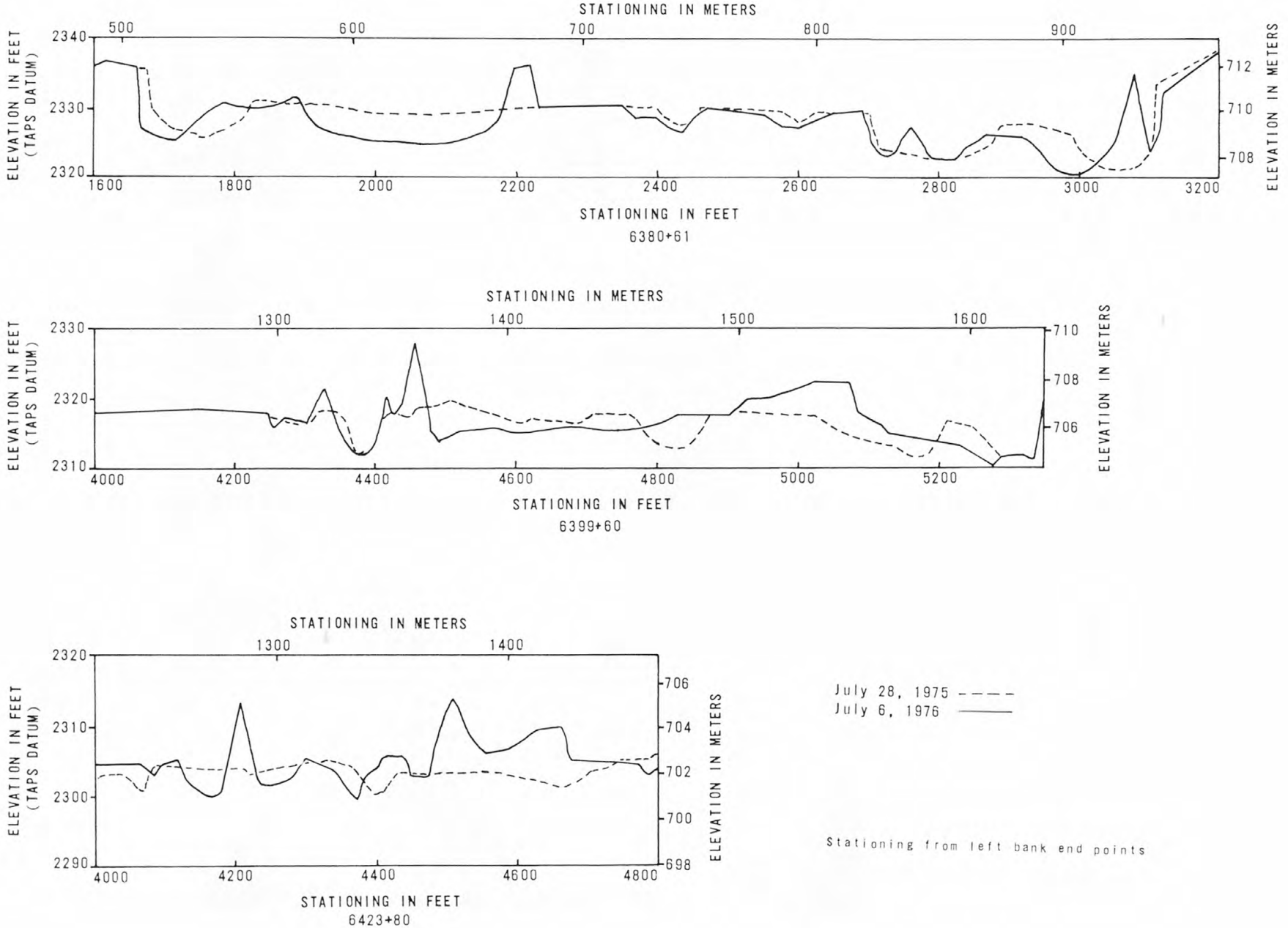


Figure 29.-- Cross sections of Delta River at Flood Creek.

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 (16 km) south of Rapids.

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

1976 Surveillance.--The writers' interest was drawn to these crossings sites because of large icings along these streams in the past and the construction of the pipeline across the floodways on Vertical Support Members (VSMs). No survey was made because aerial photos and site inspection are considered to be sufficient to observe any significant changes at this site.

Figure 30 shows the Castner Creek and Lower Miller Creek near Rapids site on August 1, 1976. The VSMs can be seen in place across the entire floodway. Figure 31 shows the completed pipe on a similar crossing on Miller Creek which is just south of these two crossings. The light truck under the pipe in the photo gives an idea of the scale.

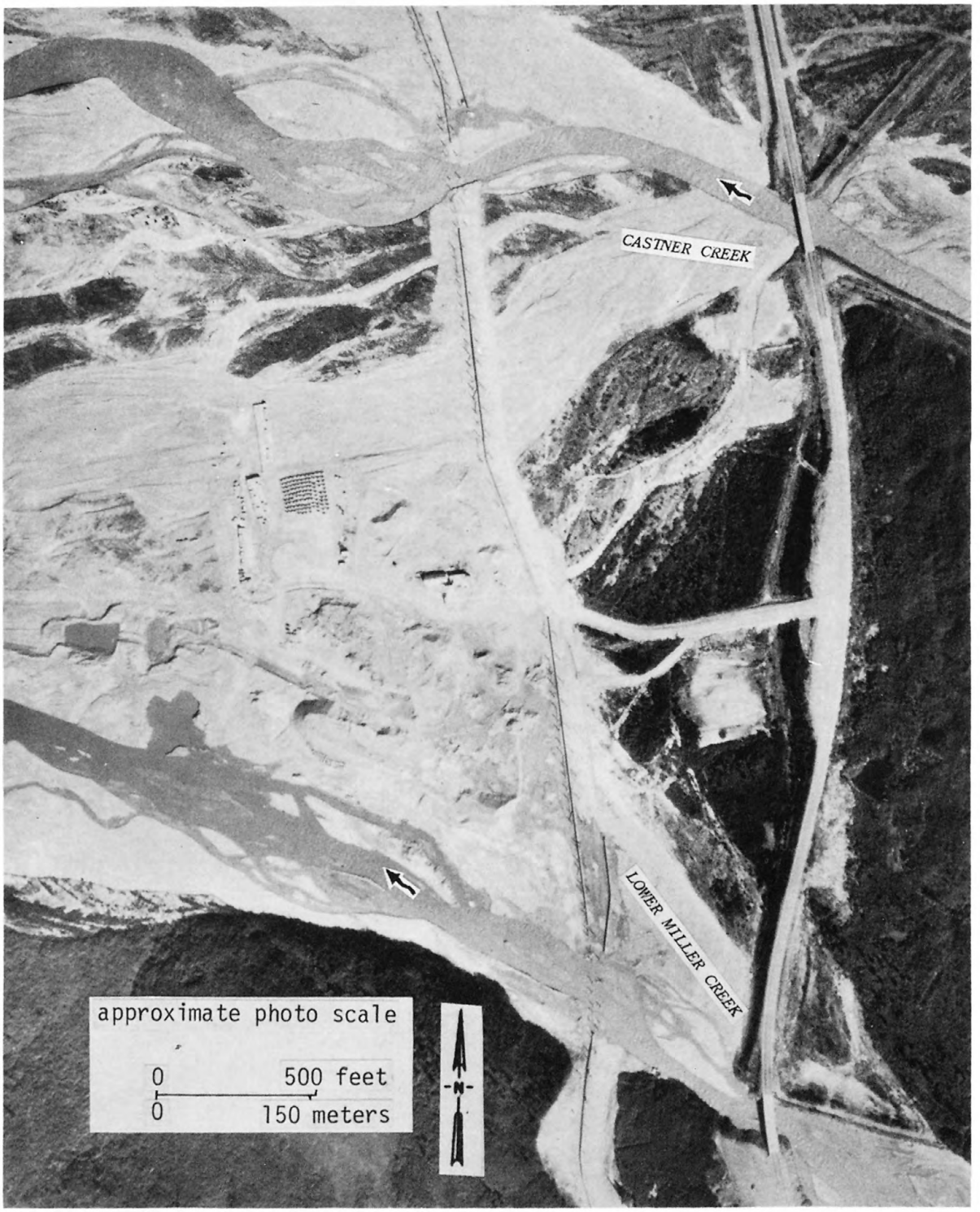


Figure 30.-- Castner Creek and Lower Miller Creek near Rapids, August 1, 1976. AIR PHOTO TECH

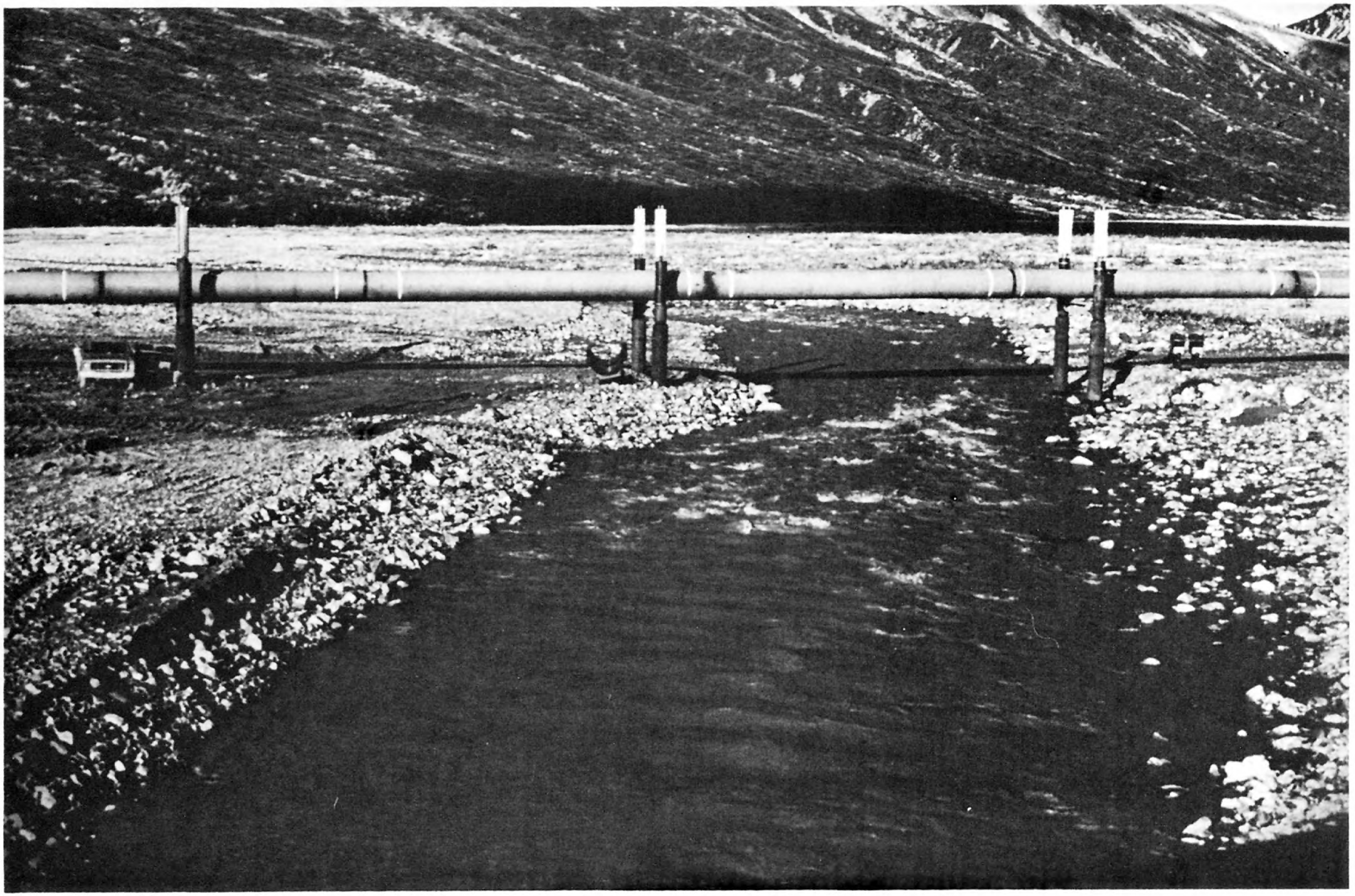


Figure 31.-- Pipe crossing Miller Creek on VSM's, September 22, 1976. AIR PHOTO TECH

Delta River at Phelan Creek

Location.--Lat 63°20'30", long 145°44'00", sec.13 and 24, T.18 S., R.10 E., about 14 mi (23 km) south of Rapids.

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

1976 Surveillance.--Figure 32 shows the Delta River at Phelan Creek site on July 6, 1976. The pipe has been buried along the right side of the flood plain and construction of protective spur dikes is in progress.

The site was resurveyed photogrammetrically in July and no significant changes were found in any of the surveyed cross sections. The subchannels have continued to shift back and forth within the flood plain. A field inspection of the site was made in September and a check of the thalweg at section 6007+35 indicated no change since 1975.

During the 1975 survey of this site, a flood survey was run at section 6072+50. The flood survey results for Delta River at Phelan Creek are shown in Table 2 on the following page. Flood surveys for most of the other channel erosion sites along the TAPS route have already been published (Childers, 1974). This reference describes the method used to determine flood magnitude and frequency.

Figure 32.-- Delta River at Phelan Creek, July 6, 1976. AIR PHOTO TECH

Table 2.--*Flood Survey Results for Delta River at Phelan Creek*

Location

latitude - 63°21'15"

longitude - 145°44'00"

Drainage basin characteristics

Drainage area, A - 584 mi^2

Basin Storage, S_t - 2 percent

Glaciers, G - 4 percent

Mean annual precipitation, P - 18 in

Precipitation intensity, $I_{24,2}$ - 2.0 in

Flood characteristics

2-year flood, Q_2 - 7,500 ft^3/s

50-year flood, Q_{50} - 14,900 ft^3/s

Bankfull channel characteristics

Width, W - 410 ft

Mean depth, d - 4.0 ft

Slope, S - .0028

Median bed material - Small cobbles

Bankfull discharge, Q_B - 9,500 ft^3/s

Maximum Evident Flood

Top width - 910 ft

Discharge - 14,500 ft^3/s

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 (2.4 km) upstream from Sourdough Creek, and about 1 mi (2 km) northwest of Sourdough. [Gulkana (C-4) 1:63,360, U.S. Geological Survey map.]

1976 Surveillance.--Figure 33 shows the Gulkana River site on August 1, 1976. The pipe alinement has been changed since the 1975 survey and the new crossing site is shown in the lower right hand corner of Figure 33. It was decided to continue monitoring the cross section at the former pipeline crossing because of the several years of cross section data already obtained and the relative position of the sections on the meander loops which should provide an excellent long-term record of river behavior on a meandering reach.

The site was resurveyed in September 1976. No significant change was found in any section; however, at section 5 the left bank continues to slump. Bank slumping has moved EP-9 15 ft (4.6 m) closer to the stream since the 1975 survey, but the surveyed profile is the same as in 1975. This indicates that as the bank slumps into the stream, the flow carries the material downstream.

During the 1975-76 winter, the Gulkana had repeated icings which completely filled the main channel by spring. During break-up in May, water depths 3-4 ft (1.0-1.2 m) over banktop were observed in the survey site area. The water flowed gently through

the trees during the spring thaw while the main channel was clogged with ice. This ice later rotted away without causing any major ice jams. The ice slightly bent the upstream member of one pier on the Alyeska access bridge downstream from the pipeline crossing.

The high water in May left very little flood evidence; during the September site inspection, there was virtually no indication of a flood in May, despite the May flood's being a new MEF. The discharge was small and the velocities low, resulting in little or no erosion.

The peak discharge since the 1975 survey was 3,800 ft^3/s (108 m^3/s) on May 27, 1976.

Figure 33.-- Gulkana River near Sourdough, August 1, 1976. AIR PHOTO TECH

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 (0.2 km) downstream from Moose Creek, and 2.5 mi (6.4 km) southeast of Glennallen. [Gulkana (A-3) 1:63,360, U.S. Geological Survey map.]

1976 Surveillance.--Figure 34 shows the Tazlina River crossing site on July 31, 1976. The overhead pipe crossing has been completed.

The crossing site was visually inspected in September 1976 during the peak of a glacier-dammed lake break-out flood which occurred on September 22, 1976. The peak discharge computed by indirect methods was 30,000 ft^3/s (850 m^3/s). Observation of the stream banks during this sudden high flow showed no bank erosion taking place; however, measured cross sections were not obtained.

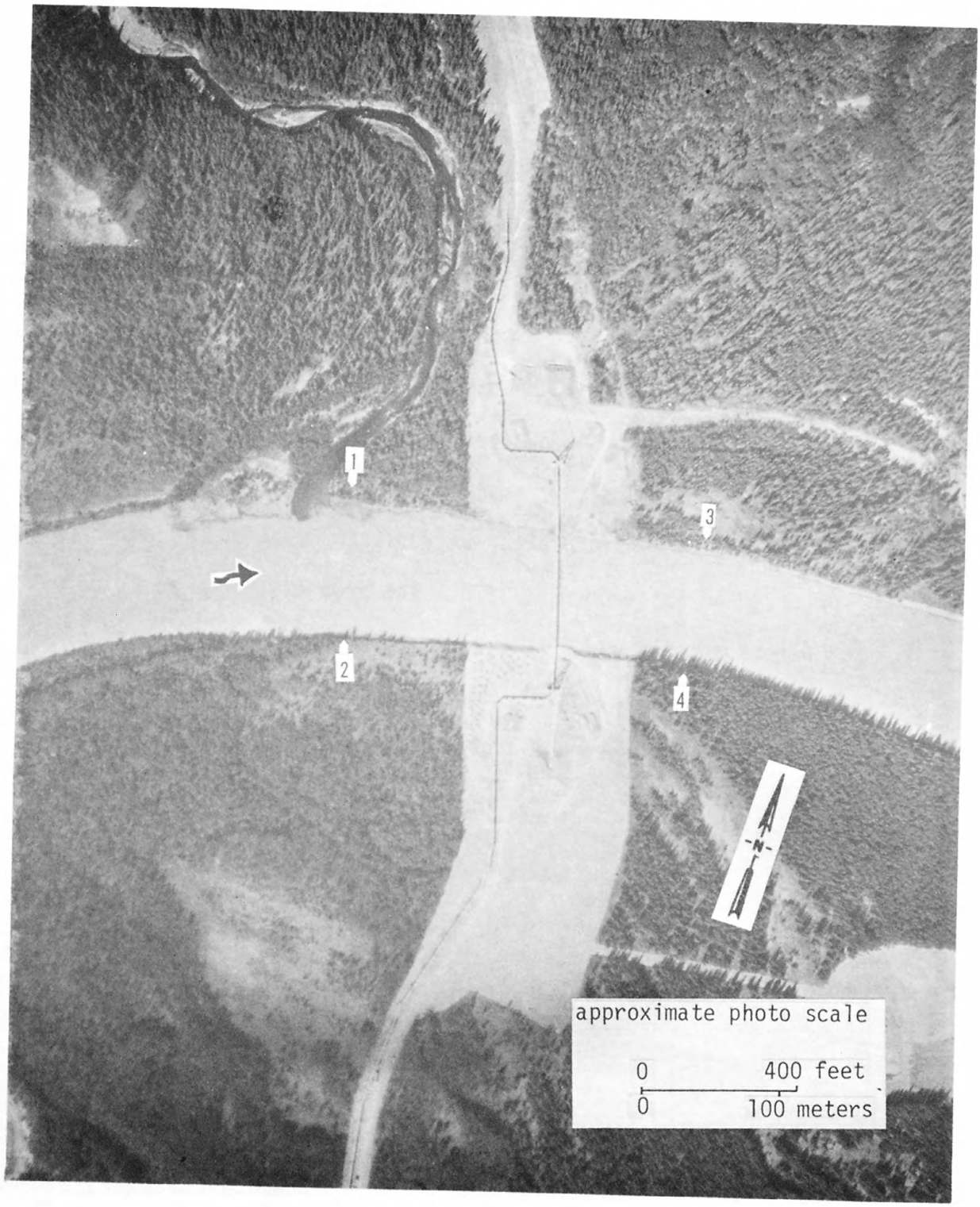


Figure 34.-- Tazlina River near Glennallen, July 31, 1976. AIR PHOTO TECH

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 (2.4 km) upstream from Copper River, and 1 mi (2 km) west of Copper Center.

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

1976 Surveillance.--Figure 35 shows the Klutina River crossing site on July 31, 1976. The pipe has been buried across the channel.

The crossing site was resurveyed in September 1976. No significant changes were found in the upstream or downstream cross sections. Figure 36 shows the construction-related changes in the centerline cross section.

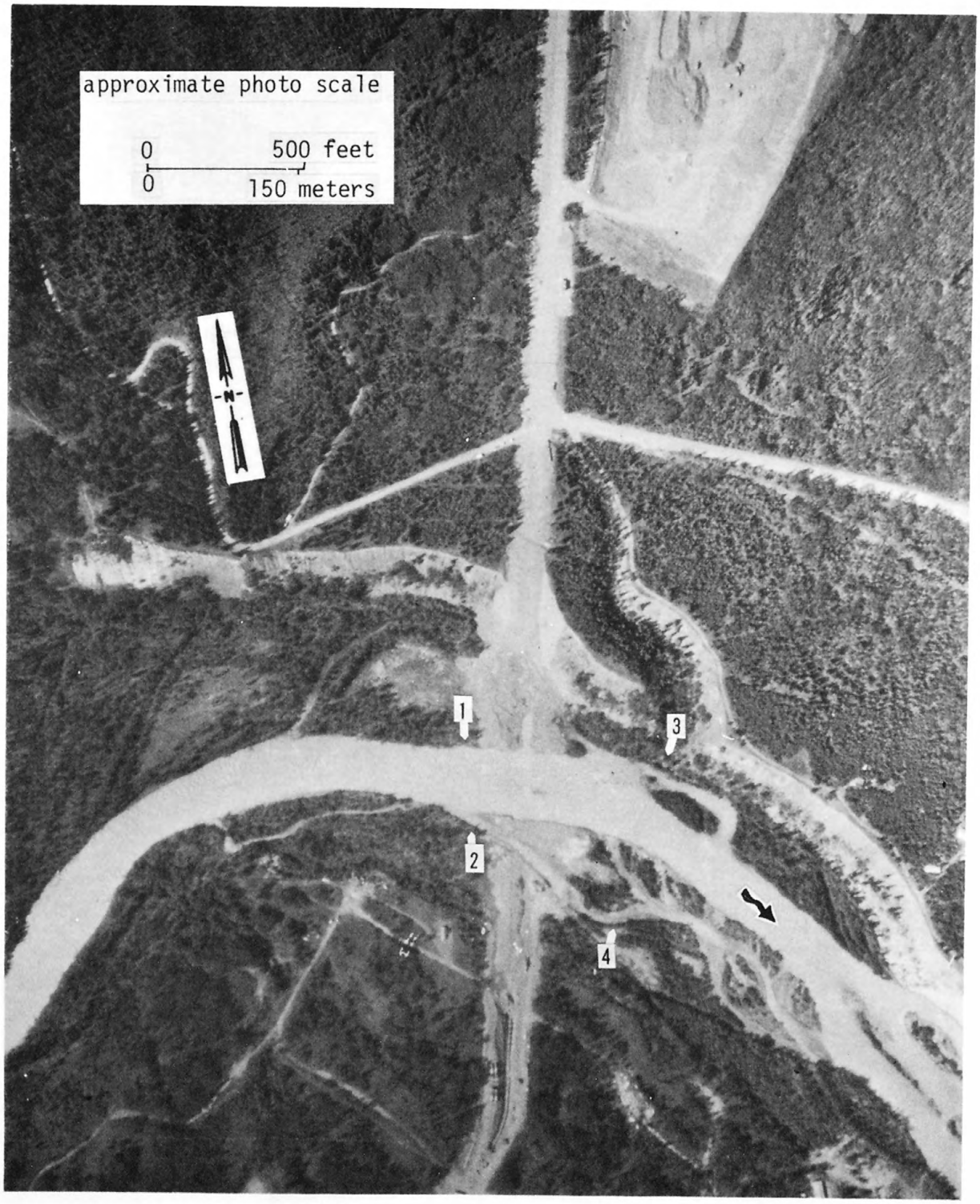


Figure 35.-- Klutina River near Copper Center, July 31, 1976. AIR PHOTO TECH

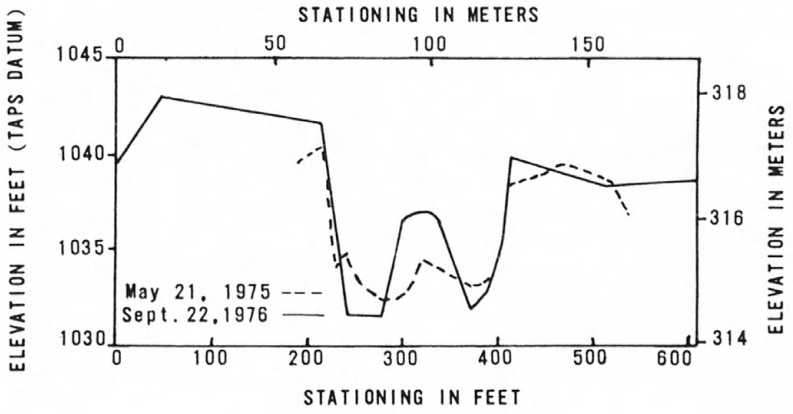


Figure 36.-- Centerline cross section of Klutina River near Copper Center.

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 (1.3 km) upstream from Little Tonsina River, and 6.5 mi (10.5 km) south of Tonsina. [Valdez (C-4) 1:63,360, U.S. Geological Survey map.]

1976 Surveillance.--Figure 37 shows the Tonsina River crossing site on June 24, 1976. There has been additional construction work along the centerline and 3- to 4- ft-(1.0- to 1.2- m-) diameter riprap has been placed along the right bank at centerline since the May 1975 survey.

The crossing site was resurveyed in September 1976. Figure 38 shows construction changes at the centerline cross section. There was no significant change in either the upstream or downstream cross section.

The peak discharge for the Tonsina River since the 1975 survey was 4,600 ft^3/s (130 m^3/s) on July 14, 1975. The peak discharge during the 1976 water-year was 3,200 ft^3/s (90 m^3/s), both June 30 and July 1.

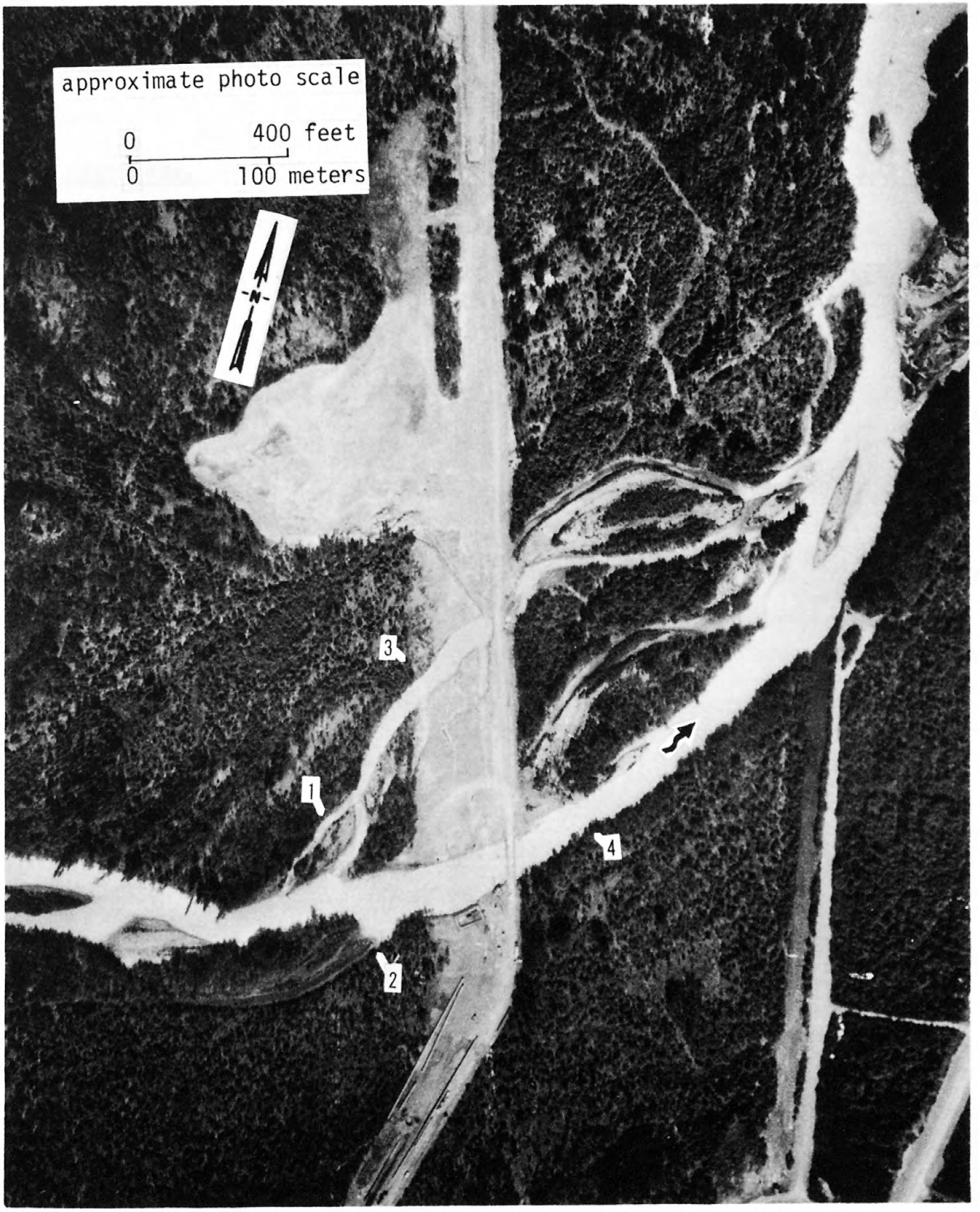


Figure 37.-- Tonsina River near Tonsina, June 24, 1976. AIR PHOTO TECH

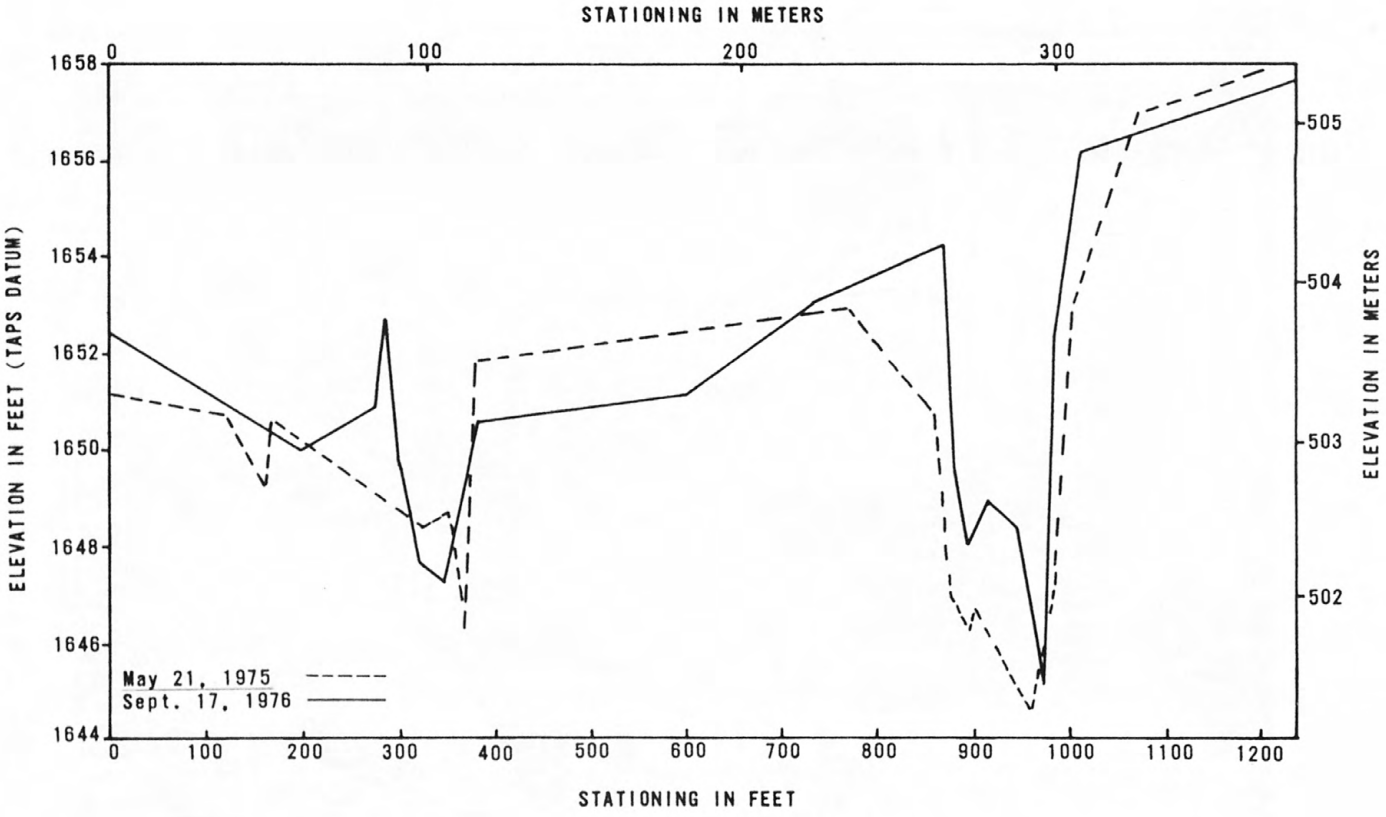


Figure 38.-- Centerline cross section of Tonsina River near Tonsina.

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 (6.0 km) upstream from the Tsina River, and 0.5 mi (0.8 km) south of Tiekel. [Valdez (B-4) 1:63,360, U.S. Geological Survey map.]

1976 Surveillance.--Figure 39 shows the Tiekel River at Tiekel crossing site on July 31, 1976. The pipe has been buried across the channel, and a dike has been constructed on the left bank at centerline to prevent high water from flowing down the pipeline.

The crossing site was resurveyed in May 1976. There was no significant change in either the upstream or downstream sections. Figure 40 shows the construction-related changes at the centerline section. Apart from the dike on the left bank, the centerline cross section is much the same as it was in 1973.

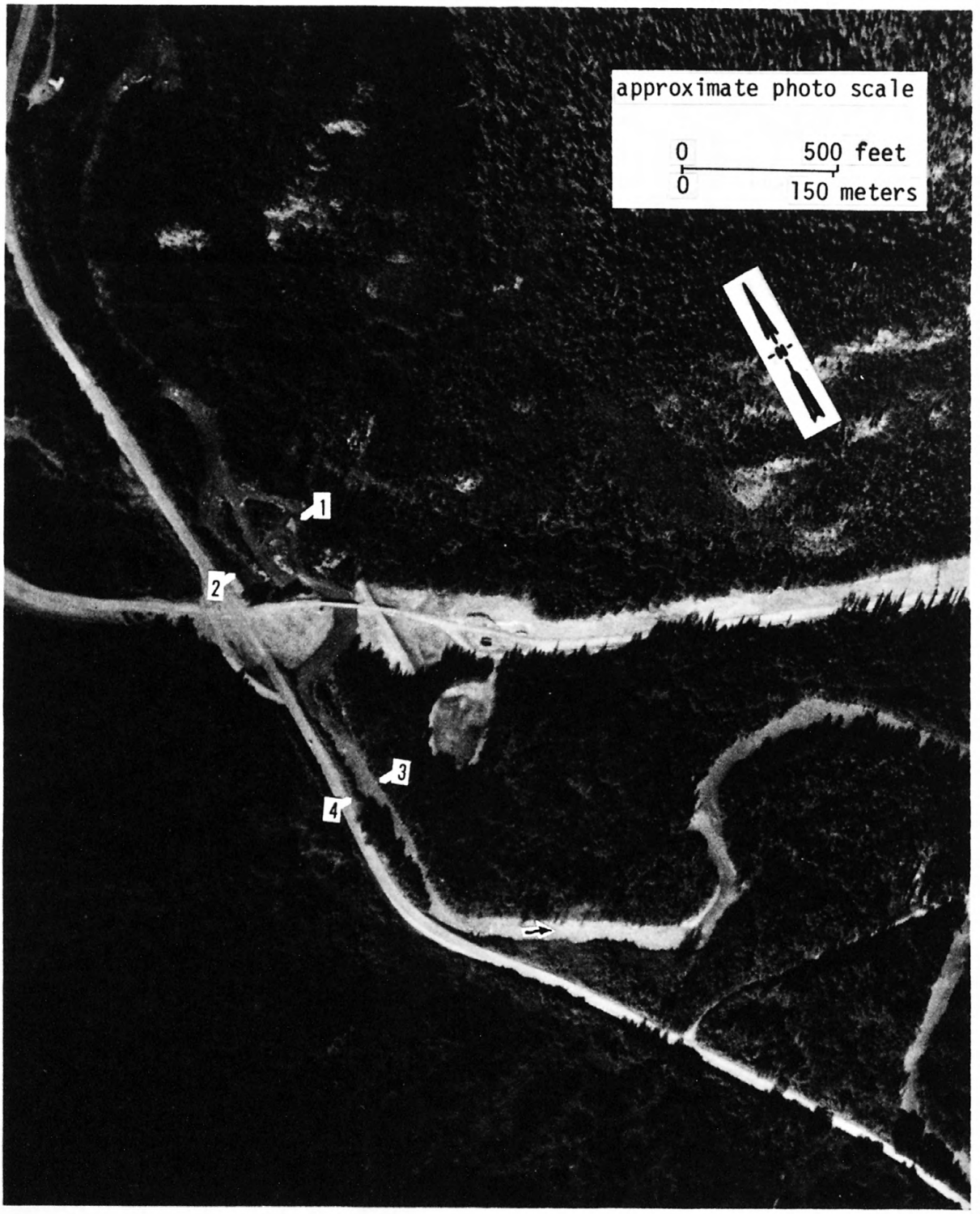


Figure 39.-- Tiekel River at Tiekel, July 31, 1976. AIR PHOTO TECH

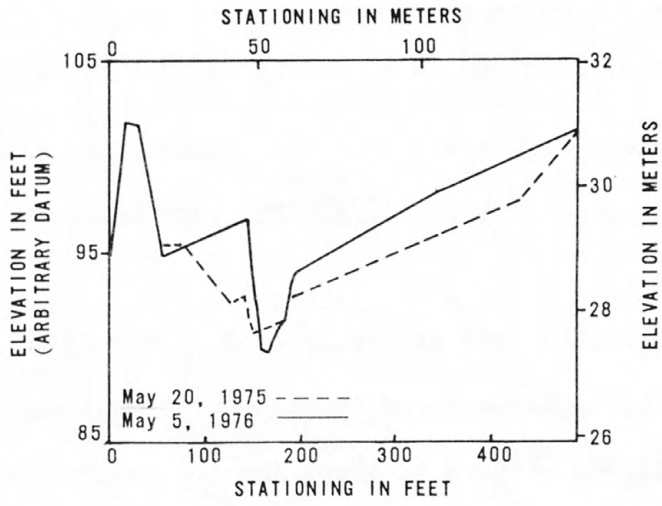


Figure 40.-- Centerline cross section of Tiekel River at Tiekel.

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 (2 km) upstream from Tsina River, and 3.6 mi (5.8 km) southeast of Tiekel.
[Valdez (B-4) 1:63,360, U.S. Geological Survey map.]

1976 Surveillance.--Figure 41 shows the Tiekel River near Tiekel crossing site on July 31, 1976. The pipe has been placed beneath the channel.

The crossing site was resurveyed in May 1976. There was no significant change found in either the upstream or downstream cross sections. Figure 42 shows the new centerline cross section.

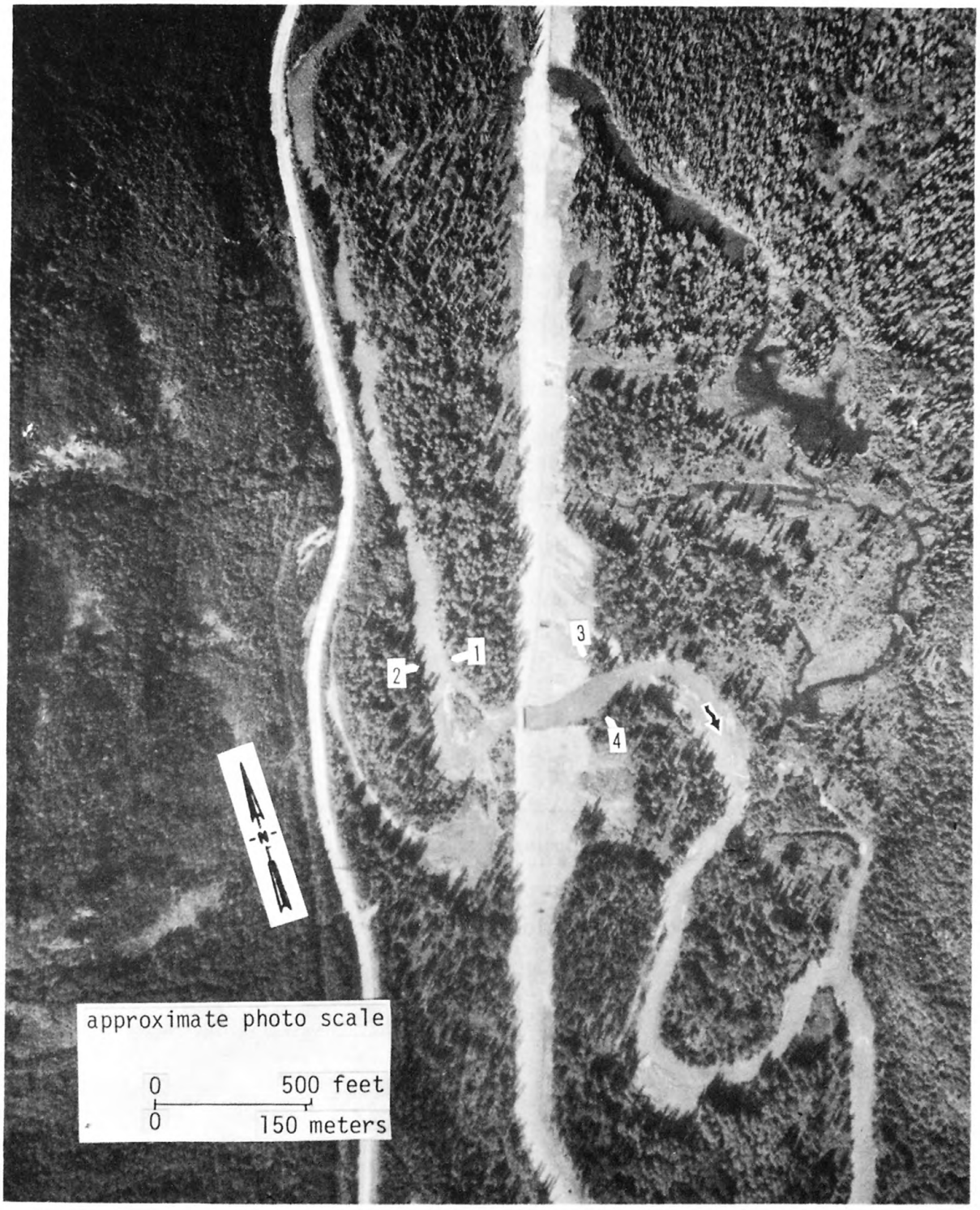


Figure 41.-- Tiekel River near Tiekel, July 31, 1976. AIR PHOTO TECH

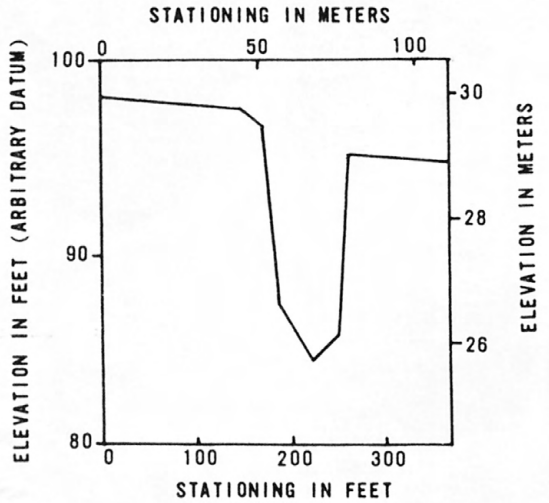


Figure 42.-- Centerline cross section of Tiekel River near Tiekel, May 8, 1976.

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 (8.8 km) upstream from Tiekel River, and 8 mi (13 km) southwest of Tiekel. [Valdez (A-4) 1:63,360, U.S. Geological Survey map.]

1976 Surveillance.--Figure 43 shows the Tsina River near Tiekel crossing site on July 6, 1976. The pipe has been buried across the channel.

The crossing site was resurveyed photogrammetrically in July 1976, and elevations of the streambed below the water surface were obtained in September. No significant changes were found in either the upstream or downstream sections. Figure 44 shows the construction-related change at the centerline section. A September inspection of the site which followed a glacier-dammed lake break-out flood of 10,000 ft^3/s (283 m^3/s) on August 8, 1976, indicated that the high water had caused little or no change in any of the sections.

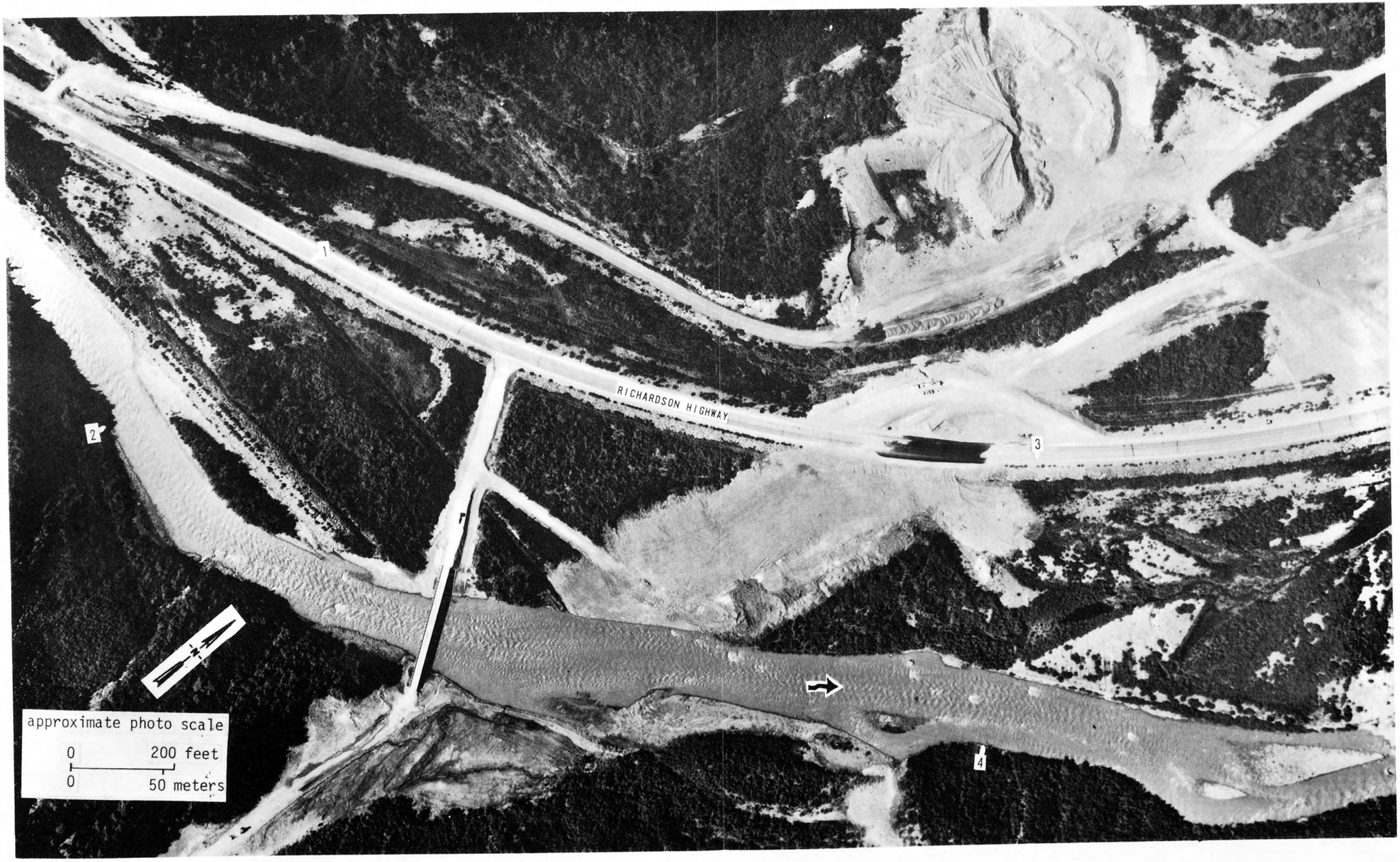


Figure 43.-- Tsina River near Tiekel, July 6, 1976. AIR PHOTO TECH

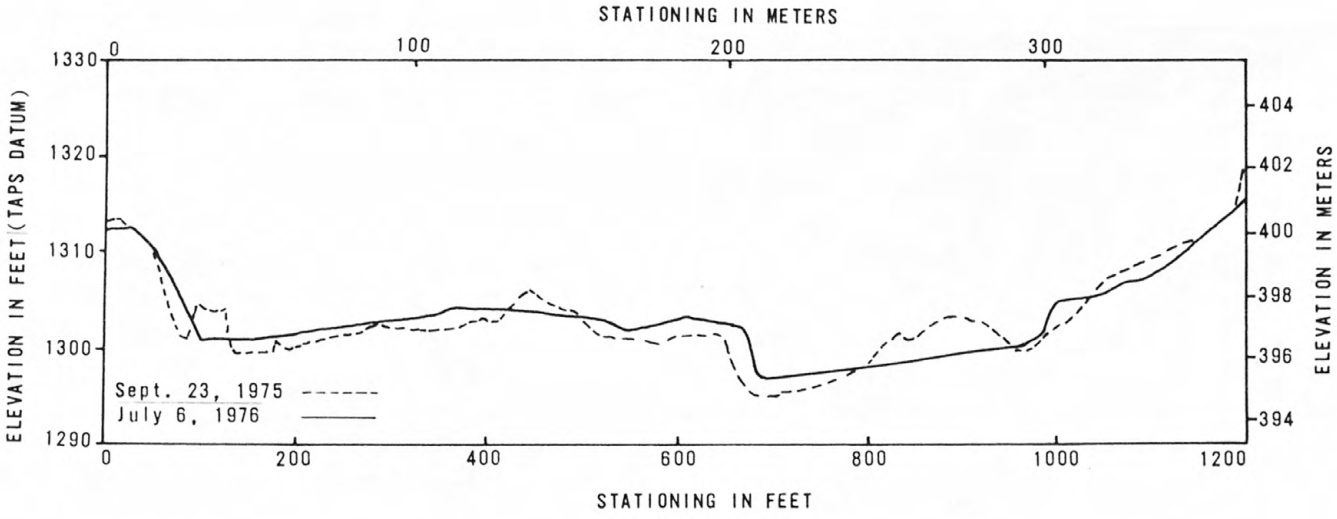


Figure 44.-- Centerline cross section of Tsina River near Tiekel.

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 (91 m) downstream from Cascade Creek, and 2.5 mi (4 km) east of Ptarmigan. [Valdez (A-5) 1:63,360, U.S. Geological Survey map.]

1976 Surveillance.--Figure 45 shows the Tsina River near Ptarmigan crossing site on July 31, 1976. The pipe has been buried under the channel.

The crossing site was resurveyed in August 1976 following a glacier-dammed lake break-out flood on August 8, 1976. A flood survey was made at the flood survey site about 1 mi (1.6 km) downstream of this crossing, and a discharge of 10,000 ft^3/s (283 m^3/s) was computed for the break-out flood. The flood apparently caused little change in the sections at the crossing site. Except for construction-related changes at the centerline and downstream section approaches, there was no significant change in any of the three cross sections. Thalweg elevations were not determined because of high water at the time of the survey.

Figure 45.-- Tsina River near Ptarmigan, July 31, 1976. 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 (2 km) northwest of Ptarmigan.

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

1976 Surveillance.--Figure 46 shows the Tsina River at Ptarmigan crossing site on July 6, 1976. The pipe has been buried and there has been much stockpiling and movement of river-run gravel along the right side of the flood plain in the vicinity of the centerline. Dikes have been built upstream of the pipeline to protect the pipe. The dike on the left bank has been extended downstream of the centerline since the photo was taken, and heavy riprap has been dumped along the streamward face of the dike.

The site was resurveyed photogrammetrically in July 1976. No significant changes were found in the channel way of section 305+50 or in the supplemental section. There has been no significant channel change in section 328+00, but a big stockpile of gravel has been pushed up on the right side of the channel way. Section 352+64 has changed considerably since the photogrammetric survey due to subsequent construction; therefore this section is not shown. Figure 47 shows the changes wrought by construction and subchannel migration in sections 335+00 and 346+00.

In August a glacier-dammed lake broke out, with a resulting flood peak of 10,000 ft^3/s (283 m^3/s) on August 8, 1976. This

break-out flood was the highest flow during TAPS construction on the Tsina.

In September, a field survey was made of the site to determine high water elevations and thalweg depths in some channels. The break-out flood in August caused no apparent bank erosion and no evident deepening of the thalweg through this reach. Figure 47 also shows the high water marks from the August break-out flood along the left-bank dike. At section 352+64 where the dike was not yet built at the time of the photogrammetric survey, the high water mark was 1.5 ft (0.5 m) below the top of the dike.

Figure 46.-- Tsina River at Ptarmigan, July 6, 1976. AIR PHOTO TECH

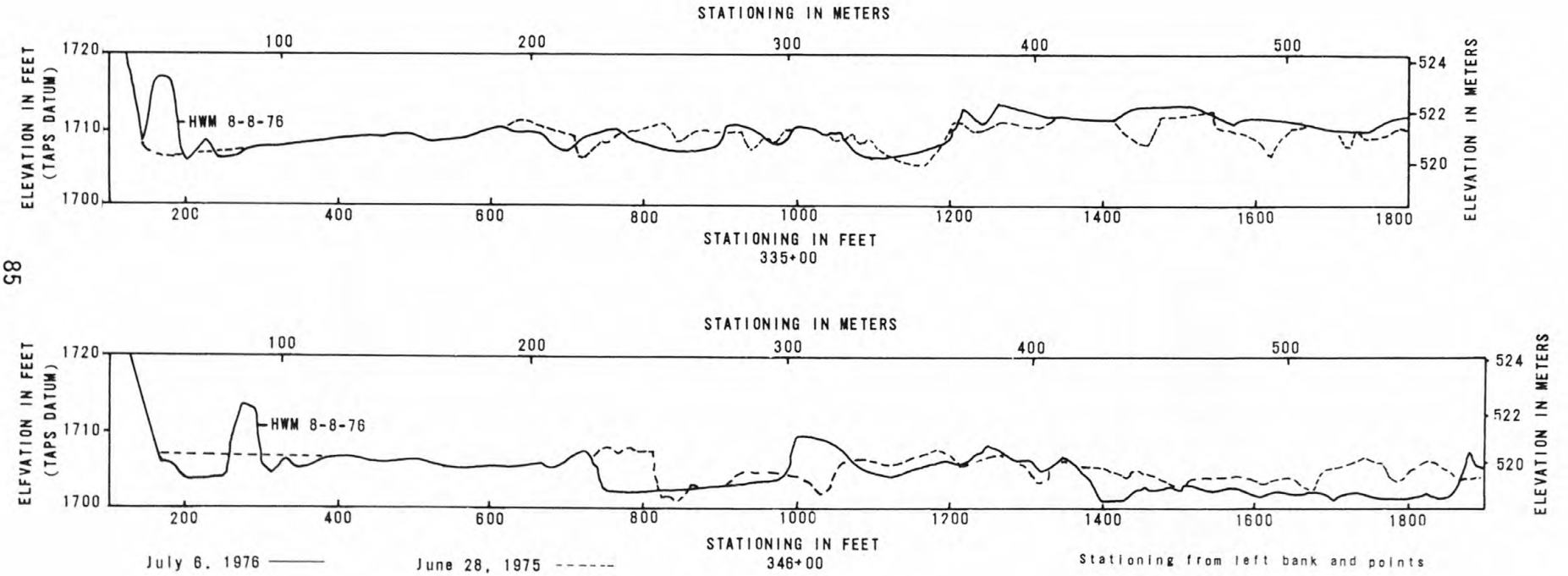


Figure 47.-- Cross sections of Tsina River at Ptarmigan.

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 (0.3 km) upstream from Lowe River, and 18 mi (29 km) east of Valdez.

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

1976 Surveillance.--Figure 48 shows the Sheep Creek crossing site on July 6, 1976, during the construction of the buried crossing.

The crossing site was resurveyed photogrammetrically in July 1976 and by an on-the-ground survey in September. There were no significant changes found in either the upstream or the downstream cross sections. Figure 49 shows the construction-related changes at centerline during construction and after construction had been completed.

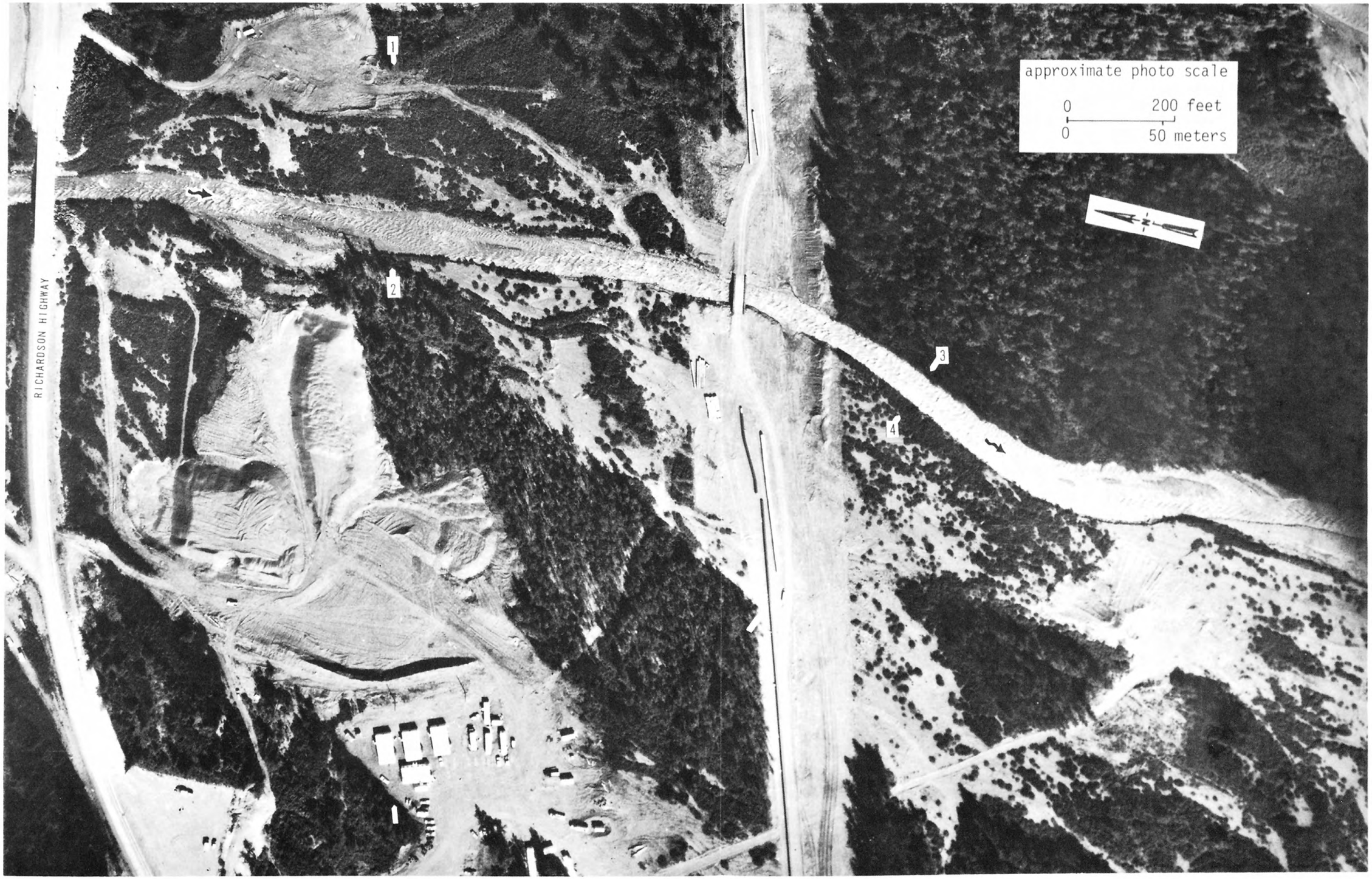


Figure 48.-- Sheep Creek near Valdez, July 6, 1976. AIR PHOTO TECH

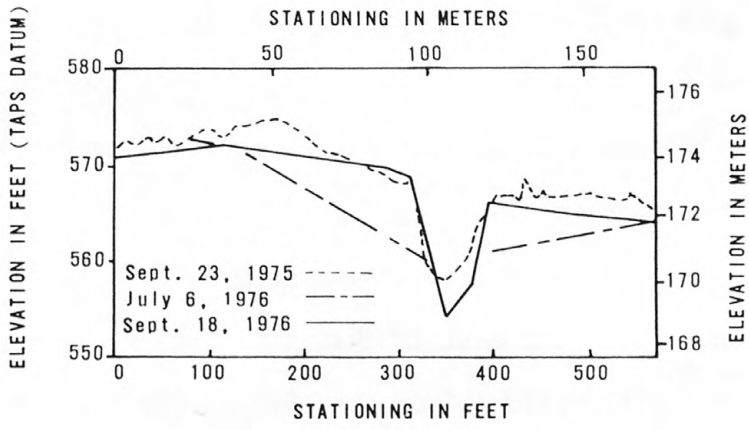


Figure 49.-- Centerline cross section of Sheep Creek near Valdez.

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 (0.3 km) upstream from Bear Creek, and 16 mi (26 km) east of Valdez.

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

1976 Surveillance.--Figure 50 shows the Lowe River crossing site on July 6, 1976. The pipe has been buried across the flood plain.

The crossing site was resurveyed photogrammetrically in July 1976. There were no significant changes found in any of the cross sections. The centerline left bank excavation remained to be backfilled. As in the past at this site, there has been considerable anabranch migration since the 1975 survey. In September a visual inspection was made of the site and no bank erosion was apparent along the left bank in the vicinity of the centerline. Thalweg depths were not surveyed in 1976.

The peak discharge since the 1975 survey was 8,000 ft^3/s (227 m^3/s) on August 1, 1976.

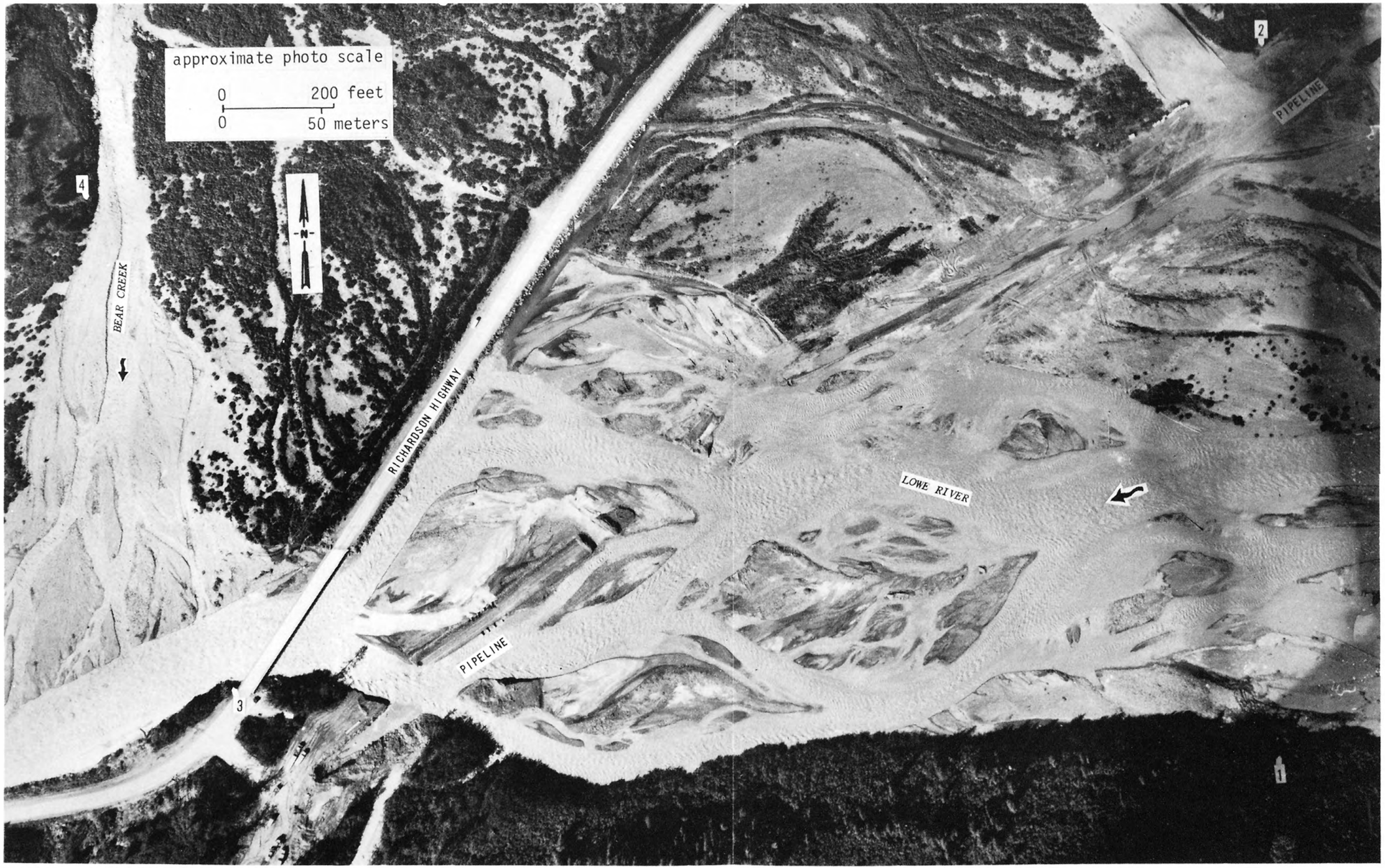


Figure 50.-- Lowe River near Valdez, July 6, 1976. AIR PHOTO TECH